Henderson Interchange
NEPA Alternatives Analysis Report

Prepared for:

Nevada Department of Transportation

May 2021

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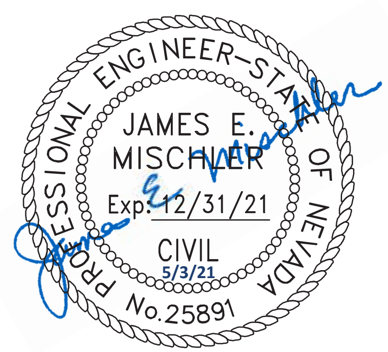

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Executive Summary

The Henderson Interchange is located within the southeast Las Vegas Valley area in Henderson, Nevada. The interchange serves as the junction between I-215 to the west, I-515 to the north, I-11 to the south, and Lake Mead Parkway (SR-564) to the east.

The purpose of this Alternatives Analysis Report is to document the refinement of two alternatives developed in the February 2020 Henderson Interchange Feasibility Study (Feasibility Study) that was completed for the City of Henderson, based on recommendations from the August 2020 Value Analysis Study Report (VA Study), and to identify a single Build Alternative.

In the initial Feasibility Study, Option 1 was a traditional interchange configuration similar to the existing configuration, with the number of lanes increased as warranted by traffic operations analysis. Estimated 70th percentile year 2027 year of expenditure project cost was determined through the Cost Risk Assessment workshop was $327.7 million. While the Feasibility Study anticipated that construction might begin in year 2027, current projections are that it may become possible to construct the project sooner, perhaps as early as 2023, depending on available funding. Making other refinements to be consistent with the current NEPA cost estimating efforts, the year 2023 year of expenditure project cost for an apples-to-apples comparison with current cost estimates for new alternatives is $307.7 million.

Figure E-1. Feasibility Study Option 1 Looking South

In the initial Feasibility Study, Option 2 was a crossover style interchange with both directions of both the north-south and east-west highways crossing each other at special grade separation structures. For example, northbound (NB) lanes of I-11 would elevate and cross over southbound (SB) lanes so that the NB traffic would then be on the west side of the SB lanes. NB lanes would then cross back over into the normal position on the right at a point north of the interchange. The advantage of a crossover style interchange is that fewer bridges would be needed, and the bridges would be single level instead of multi-level stacked flyover structures. Estimated 70th percentile project year 2027 cost determined through the Cost Risk Assessment workshop was $297.9 million. Making other refinements to be consistent with the current NEPA cost estimating efforts, the year 2023 year of expenditure construction costs for comparison with current cost estimates for new alternatives is $262.7 million.

NDOT developed and maintains a spreadsheet based conceptual cost estimating tool known as the "Wizard." The spreadsheet allows the user to input quantities for generalized items such as widening, new roadways, bridges, walls, and demolition, and returns costs that are based on unit prices for previous construction projects. Construction and project cost estimates for alternatives in the Feasibility Study and this report were developed using NDOT's Wizard cost estimating spreadsheet tool. Differences between the Feasibility Study estimates and the current estimates for the same alternatives could be attributed to updated unit prices in the Wizard spreadsheet, lesser cost appreciation to year 2023 instead of 2027, and deviations associated with the probabilistic Cost Risk Assessment methodology.

Figure E-2. Feasibility Study Option 2 Looking South

A week-long Value Analysis (VA) workshop was held in June 2020 with independent subject matter experts drawn from NDOT, FHWA, and the consultant team. The VA team made 14 recommendations as detailed in the August 4, 2020 Value Analysis Study Report. Five VA Study ideas were accepted by NDOT and used as a starting point for refinement of Option 1 into a new Option 3, and to develop an improved Option 2, designated as Option 2A.

Key modifications for improvement of Option 2 included not crossing over the north-south I-11/I-515 highway and reconfiguring ramps beneath the central system interchange bridge.

Key modifications for development of the new Option 3 included retaining as much of the existing system interchange as possible while constructing a median-to-median flyover connector between I-215 and I-515.

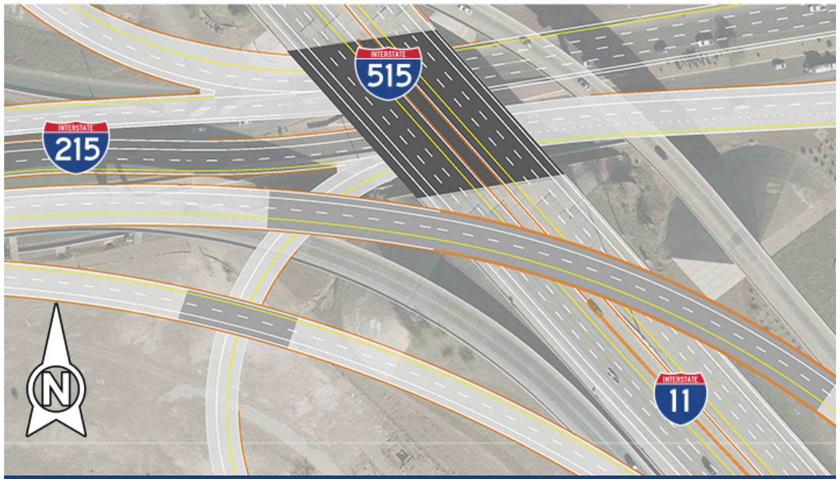


Figure E-3. Improved Option 2A Crossover System Interchange

Figure E-4. New Option 3 System Interchange with Median Connector

Preliminary (15%) plans were prepared under this study for improved Option 2A and new Option 3 to serve as a base for development of horizontal and vertical geometrics, structure layout, traffic operations analysis, safety, and cost estimates. Preliminary 15% plans were prepared for Option 1 under the previous Feasibility Study.

Option 2A project costs for Year of Expenditure 2023 are estimated to be $261.4 million, approximately $1.3 million less than the Feasibility Study Option 2 from which it was derived and approximately $46.3 million less than Feasibility Study Option 1.

Option 3 project costs for Year of Expenditure 2023 are estimated to be $276.3 million, approximately $31.1 million less than the Feasibility Study Option 1 from which it was derived and approximately $14.9 million more than Option 2A.

Each of the build alternatives (Option 1 from the Feasibility Study, Option 2A, and new Option 3) were found to meet the needs of the project with varying effectiveness:

» Resolve existing roadway deficiencies
» Provide transportation improvements to serve existing/future growth areas
» Restore local traffic connectivity
» Accommodate regional and local plans

Based on results of the weighted scoring conducted on January 27, 2021 and as summarized in **Table E.1**, the consensus of the Technical Advisory Committee is to recommend that the Department identify Option 2A as the single build alternative to be evaluated further in the NEPA environmental study. Option 2A is the least-cost alternative and meets each of the needs of the project.

Even though Option 3 retains much of the existing system interchange and most of the existing flyover bridges, Option 2A has the least structure cost because crossover style interchanges require fewer and smaller bridges with most ramps on only two levels. Option 3 would leave the Department with large new flyover bridges on the Median Connector that would require maintenance and replacement at a future date. Additionally, Option 3 yields unsatisfactory traffic operations performance in the PM peak sensitivity analysis. It was determined by the study team that traffic operations performance for Option 3 could be improved by addition of braided ramps for EB traffic entering from Gibson

Road, but the addition of the braided ramps would result in an increase to capital and life-cycle costs that would result in this modified "Option 3A" such that the alternative, if fully developed, would score no better than a distant second-position tie with Option 1.

Table E-1 on the following page summarizes rankings of fully developed build alternatives against the evaluation criteria for the project.

NDOT Management concurred with the TAC recommendation to continue in NEPA with Option 2A as the single Build Alternative at a virtual teleconference meeting held on March 2, 2021. City of Henderson Management subsequently concurred with NDOT's recommendation to continue in NEPA with Option 2A as the single Build Alternative at a separate virtual teleconference meeting held on March 4, 2021.

Table E-1. Comparison of Build Alternatives

Criterion	Option 1	Option 2A	Option 3
Safety*, including consideration of whether the alternative could meet design criteria and improve safety for users without need for design exceptions. Weight = 7	No FHWA design exceptions required, no weaving areas of concern. Score 10/10	Few FHWA design exceptions required for shoulder width, no weaving areas of concern. Score 9/10	Few FHWA design exceptions required for design speed and shoulder width, moderate concern with weaving between Gibson Road and the system interchange. Score 5/10
Traffic Operations Performance* Weight = 9	Traffic operation measures of effectiveness show satisfactory performance for design year traffic. Score 10/10	Traffic operation measures of effectiveness show satisfactory performance for design year traffic. Score 9/10	Unsatisfactory performance for design year traffic for the EB weaving segment between Gibson Road and the system interchange. Score 1/10
Accessibility*, including consideration of whether the alternative could maintain existing connections or add access points between the local road network and the interstate highway system. Weight = 8	Restores connectivity between Lake Mead Parkway and Gibson Road, but does not provide connectivity between Auto Show and I-215. Score 7/10	Restores connectivity between Lake Mead Parkway and Gibson Road and provides connectivity between Auto Show and I-215. Score 10/10	Restores connectivity between Lake Mead Parkway and Gibson Road and provides connectivity between Auto Show and I-215. Score 10/10
Capital Cost Weight = 8	Highest project cost $307.7 M Score 8/10	Lowest project cost $261.4 M Score 10/10	Median project cost $276.6 M Score 9/10
Time to Construct – Weight = 3	Typical for system interchange. Score 5/10	Typical for system interchange. Score 5/10	Typical for system interchange. Score 5/10
Environmental Aspects – Weight = 8	Minimal impacts – Score 10/10	Minimal impacts – Score 10/10	Potential Noise – Score 9/10
Maintenance of Traffic (Phased Construction) Weight = 6	Typical impacts associated with major interchange reconstruction projects. Score 6/10	Typical impacts associated with major interchange reconstruction projects. Score 6/10	Fewer impacts than comparable interchange reconstruction projects. Score 9/10
Additional GP Lane Weight = 6	Future GP lane if needed would need to be constructed at a cost of $25 M. Score 4/10	Extra lane for future use is included in the base design for I-215 and I-515. Score 10/10	Extra lane for future use is included in the base design for I-215 and I-515. Score 10/10
O&M Costs Weight = 6	O&M costs would be $1.6 M greater than the least costly alternative. Score 9/10	Lowest O&M cost among build alternatives. Score 10/10	O&M costs would be $3.5 M greater than the least cost alternative. Score 8/10
Number of Bridges Retained As-Is	11	15	20
Number of Bridges Retained and Modified	9	7	7
Number of Bridges Demolished	7	5	0
New Bridges Constructed	5	11	2
Percent of Bridge Deck 15-20 Years Old	40%	61%	61%
Area of New Bridge Deck	592,250 Sq. Ft.	275,060 Sq. Ft.	477,790 Sq. Ft.
Total Bridge Deck Area to Maintain	987,270 Sq. Ft.	707,160 Sq. Ft.	1,232,360 Sq. Ft.
KEY: Good / Better / Best	**Median Weighted Score 8.0/10**	**Highest Weighted Score 9.1/10** **Recommended as the Single Build Alt.**	**Lowest Weighted Score 7.3/10**

* Directly tied to Purpose and Need

Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
EB	eastbound
FHWA	Federal Highway Administration
I-11	Interstate 11
I-215	Interstate 215
I-515	Interstate 515
ITS	intelligent transportation system
mph	miles per hour
MSE	mechanically stabilized embankment
M-VMT	million vehicle miles traveled
N/A	not applicable
NB	northbound
NDOT	Nevada Department of Transportation
NEPA	National Environmental Policy Act
Project	Henderson Interchange I-215/I-515/I-11/Lake Mead Parkway reconstruction project
RTC	Regional Transportation Commission of Southern Nevada
RTP	Regional Transportation Plan
RTIP	Regional Transportation Improvement Plan
SB	southbound
SNTS	Southern Nevada Traffic Study, NDOT
VA	value analysis
VPH	vehicles per hour
WB	westbound
YOE	year of expenditure

Table of Contents

1.0 Introduction

This Alternatives Analysis Report is prepared for the Henderson Interchange NEPA Study and builds upon the February 2020 Henderson Interchange Feasibility Study (Feasibility Study) by the City of Henderson. The purpose of this report is to document improvements and refinements to the alternatives developed by the February 2020 Henderson Interchange Feasibility Study (Feasibility Study) as recommended by the August 2020 Value Analysis Study Report (VA Study).

The Henderson Interchange Feasibility Study developed the study area, logical termini, Purpose and Need for the project and established scoring criteria for evaluation of alternatives.

Four routes begin or end at the Henderson Interchange. The study area shown in **Figure 1.4** was developed by the Feasibility Study and includes the north-south highway along I-515 and I-11 between Galleria Drive (northern terminus) and Horizon Drive (southern terminus) and includes the east-west highway along Lake Mead Parkway and I-215 between Van Wagenen Street (eastern terminus) and Valle Verde Drive (western terminus).

These logical termini allow for development of a project that could be constructed alone, serving a significant purpose, addressing environmental impacts on a sufficient scale, without requiring implementation of other future projects.

The Feasibility Study identified 39 ideas that were evaluated and combined into three build alternatives for evaluation, one of which was subsequently eliminated. The eliminated alternative introduced signalized intersections in place of free-flowing ramps on the east-west highway and was found to have less traffic operations capacity and higher construction cost than Option 1. Two build alternatives designated as Option 1 and Option 2 were recommended by the Feasibility Study for further evaluation. Feasibility study alternatives provided sufficient general-purpose lanes to accommodate Design Year 2040 traffic volumes and provided space in the median areas for construction of future HOV lanes on I-215 and I-515. The alternatives also included space for a median HOV direct connection between I-215 and I-515.

Option 1 was a traditional interchange configuration similar to the existing configuration, with the number of lanes increased as warranted by traffic operations analysis. Estimated 70th percentile year of expenditure 2027 project cost determined through the Cost Risk Assessment workshop was $327.7 million. While the Feasibility Study anticipated that construction might begin in year 2027, current projections are that it may become possible to construct the project sooner, perhaps as early as 2023, depending on available funding. Making other refinements to be consistent with current NEPA cost estimating efforts, the year 2023 year of expenditure project cost for apples-to-apples comparison with current cost estimates is $307.7 million.

Figure 1.1 Feasibility Study Option 1 Looking South

Option 2 was a cross-over style interchange with both the north-south and east-west highways crossing over at special grade separation structures. Estimated 70th percentile year 2027 project cost determined through the Cost Risk Assessment workshop was $297.9 million. Making other refinements to be consistent with current NEPA cost estimating efforts, the year of expenditure 2023 project cost for comparison with current cost estimates is $262.7 million.

NDOT developed and maintains a spreadsheet based conceptual cost estimating tool known as the "Wizard." The spreadsheet allows the user to input quantities for generalized items such as widening, new roadways, bridges, walls, demolition, etc. and returns costs that are based on unit prices for previous construction projects. Construction and project cost estimates for alternatives in the Feasibility Study and this report were developed using NDOT's Wizard cost estimating spreadsheet tool. Differences between the Feasibility Study estimates and the current estimates for the same project could be attributed to updated unit prices in the Wizard spreadsheet, lesser cost appreciation to 2023 instead of 2027, and deviations associated with the probabilistic Cost Risk Assessment methodology.

Both alternatives studied in the Feasibility Study proposed to improve Lake Mead Parkway east to Van Wagenen Street as shown in **Figure 1.3**. Lake Mead Parkway would be widened to four through lanes in each direction from Eastgate Road/Fiesta Henderson Boulevard to Van Wagenen Street in order to improve capacity of the local arterial street. Accesses to existing businesses and cross streets would remain as they currently exist.

Figure 1.2 Feasibility Study Option 2 Looking South

Figure 1.3 Widening of Lake Mead Parkway for All Options

1.1 Project Purpose and Need

The purpose of the proposed project that was developed by the Feasibility Study is to:

- Resolve existing roadway deficiencies
- Provide transportation improvements to serve existing and future growth areas
- Restore local traffic connectivity
- Accommodate regional and local plans

Purpose: Resolve Existing Roadway Deficiencies

Need: The existing system interchange between I-215 and I-515 was constructed between 2004 and 2006 when the population of the Las Vegas Valley was approximately 1.5 million people. The population has since increased by about 50% and is projected to continue to increase. Traffic volumes at the interchange exceed the original design year forecasts. Additionally, a service interchange was constructed at I-215/Gibson Road close to the system interchange creating eastbound (EB) weaving conflicts between vehicles entering at Gibson Road bound for Lake Mead Parkway and vehicles transitioning to the System interchange ramps. The westbound (WB) Gibson Road off-ramp is also closer than desirable to the I-515 ramps entering WB I-215. AASHTO[1] recommends at least 2,000 feet from one freeway entrance to the following exit between system and service interchanges, and the distance for the WB approach to Gibson Road is approximately 1,500 feet. The resulting increased travel time within the I-515/I-11 and I-215 corridors create delays for users and is a contributing factor to crashes. Specific areas where deficient traffic operations are observed are identified on **Figure 1.5** and include:

1. The I-215 EB to I-11 southbound (SB) interchange ramp merges from two lanes to one lane, and then joins the I-11 SB mainline. The ramp merge results in upstream queues (vehicles waiting in line) on the ramp itself and I-215 EB during peak traffic times. This increased travel time could contribute to crashes.
2. The approximately 1,500' long weaving movement along I-215 WB, between the system interchange ramps and Gibson Road off-ramp resulted in increased travel time and queues prior to recent restriping and placement of barriers to prevent motorists on Lake Mead Parkway/I-215 WB from exiting to Gibson Road, which eliminated access for WB motorists to the exit at Gibson Road.
3. The approximately 1,300' long weaving movement along EB I-215 between the Gibson Road on-ramp and the system interchange ramps results in increased

[1] A Policy on Geometric Design of Highways and Streets, 7th Edition (2018), Figure 10-70

Figure 1.4 Study Area

travel time and queues that could contribute to crashes. This weaving movement impacts the traffic that could reach and be served by the system interchange ramps. Under existing conditions, traffic on EB I-215 between Gibson Road and the system interchange ramps experiences speeds as low as 40 miles per hour (mph) during the PM peak period.

4. The I-215 EB system ramp merges on to I-515 northbound (NB), followed by the NB Auto Show Drive on-ramp merging on to the freeway. These ramp merges occur within about one-quarter mile and neither of these ramps include an auxiliary lane or a parallel acceleration lane. These successive merges result in traffic slowdowns (to approximately 50 mph) along the freeway.

5. Occasionally, SB I-11 traffic exiting to Horizon Drive experiences queuing, resulting from deficiencies along Horizon Drive (at the Horizon Drive Interchange); these queues extend onto the mainline. When this queue spillback occurs, freeway speeds as low as approximately 30 mph in the PM peak period were observed along I-11 SB just upstream of the Horizon Drive off-ramp. The Horizon Drive Interchange has poor operations resulting in queue spillback to I-11 SB and could contribute to crashes. Meeting needs of the local street Horizon Drive would be outside the scope of this project, but mitigating the impacts of Horizon Drive deficiencies on I-11 traffic operations is part of this project.

6. The SB I-515 to WB I-215 system-to-system ramp experiences significant increased travel time and queuing. Long queues occur on SB I-515 and block the SB on-ramp from Auto Show. There is insufficient capacity on the system ramp.

7. WB Lake Mead Parkway drops from two lanes to one lane at the system interchange. This reduction in the number of lanes results in upstream queues that may extend to the Lake Mead Parkway/Eastgate Road intersection and could contribute to crashes.

Purpose: Provide Transportation Improvements to Serve Existing and Future Growth Areas

Need: Existing roadway deficiencies result in increased travel time that could contribute to crashes and travel delays for motorists. In addition to the existing roadway deficiencies listed in the previous section, by the year 2040, the demand for the I-215 EB system ramp to I-515 NB is expected to exceed the available capacity. In the year 2040 PM peak hour, a demand of more than 3,400 vehicles is expected along this existing one-lane ramp. This bottleneck is expected to result in extensive upstream queuing and increased travel time along I-215 EB. With the year 2040 No-Build Alternative, the I-215 EB section between Gibson Road and the I-515 system ramps is expected to experience speeds as low as 20 mph in the PM peak period. Similarly, year 2040 traffic demands exceed existing capacity for some of the other ramp movements between the I-215 and I-515 freeways. Capacity improvements to the system interchange are needed to meet the projected year 2040 demand.

Purpose: Restore Local Traffic Connectivity

Need: Interim safety and capacity improvement projects incorporated in 2019, including restriping of I-215 and I-515 resulted in loss of connectivity for some users at adjacent interchanges. Motorists heading west on Lake Mead Parkway towards I-215 are no longer permitted to exit at Gibson Road. Motorists heading south on I-515 from Auto Show Drive are no longer permitted to exit to I-215 or Lake Mead Parkway. Members of the public that attended the March 2019 public meeting commented that the connectivity should be restored.

Purpose: Accommodate Regional and Local Plans

Need: To accommodate NDOT's ongoing development of a valley-wide High Occupancy Vehicle (HOV) network through the study area and to not preclude NDOT's siting of an I-11 corridor within the Las Vegas Valley. The I-11 corridor may be selected upon completion of NDOT's current Planning and Environmental Linkages (PEL) study anticipated in 2022.

The study team considered whether designation of the existing highway as I-11 would materially increase peak traffic volumes for the Henderson Interchange. The existing US Route 93 highway between Phoenix and Las Vegas has already been widened to four lanes for much of the corridor, therefore future interstate traffic is not anticipated to increase by an amount that would impact the interchange operation. In addition, the study team observed that traffic on I-15 during AM and PM peak travel times tapers off dramatically south of Las Vegas, even though the I-15 corridor connects to the much larger Los Angeles metro area. As reported in the January 2021 Nevada Department of Transportation I-11 Tier 1 EIS Traffic Section Report, *"…On the southeast, volumes today on US 93 are about 22,000 vehicles, growing to almost 40,000 vehicles per day in 2040 due to normal growth plus*

Figure 1.5 Areas of Deficient Traffic Operations

the effect of an I-11 interstate in Arizona. The magnitude of these interstate volumes is overwhelmed by the trips generated within the metropolitan area on the prospective corridors. In addition, many of these trips from the two I-11 entry points into the Las Vegas region disperse to/from trip attractions in the metropolitan area; very few are "through" trips on I-11."

Traffic projections from the I-11 Tier 1 EIS Traffic Section Report are compared with traffic projections prepared as part of this study in **Table 1.1**, and the data supports the study team conclusion that the preponderance of traffic at the Henderson Interchange during peak times is and would remain from local sources, and designation of the full route between the Henderson Interchange and Phoenix as I-11 would not result in meaningful increases to peak traffic volumes at the Henderson Interchange. Conversely, the study team concluded that routing I-11 away from the Henderson Interchange would not result in meaningful decreases in peak traffic volumes at the Henderson Interchange.

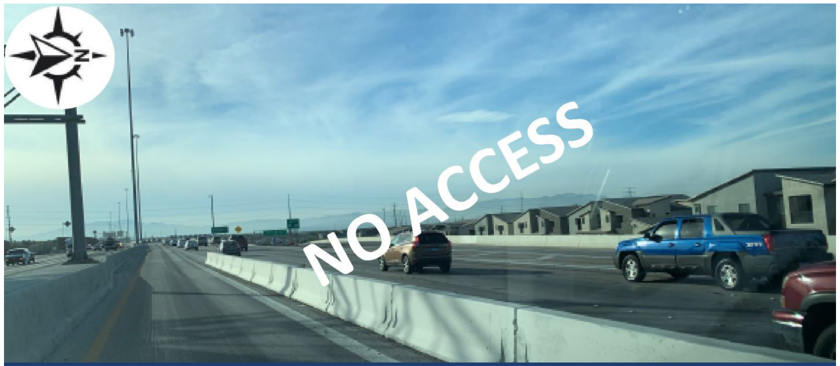


Figure 1.6 No Access from Lake Mead Parkway to Gibson Road

Table 1.1 Comparison of Traffic Projections

Source: I-11 Tier 1 EIS Traffic Section Report Table 1							Source: This Study		
Facility	From	To	2040 NA Base	2040 NA with I-11	Daily Volume +/-	Daily Volume Change	2040 NA with I-11*	2040 Option 2A Volume	Excess Volume in this Study
I-11	Horizon Drive	System Interchange	128,400	139,700	11,300	9%	5,930	5,990	60
I-515	Auto Show Drive	Sunset Road	151,500	157,400	5,900	4%	6,690	7,560	870
I-215	Gibson Road	Stephanie Street	197,500	201,900	4,400	2%	8,580	8,570	-10

*Critical Peak Direction Volume

2.0 Value Analysis Study

A week-long Value Analysis (VA) workshop was held in June 2020 with independent subject matter experts drawn from NDOT, FHWA, and the consultant team. The VA team developed 14 recommendations (ideas) as detailed in the August 4, 2020 Value Analysis Study Report attached as **Appendix 3**.

Five VA Study ideas that were accepted by NDOT are shown in **Table 2.1**. Potential savings estimated by the VA Workshop participants based on conceptual level sketches have been further refined by the study team and actual savings estimated through the alternatives refinement process were found to be less than anticipated by the VA Study team.

The study team identified six VA Study ideas for further study in the event that some or all of the five recommended ideas were found to not be feasible. These six ideas are shown in **Table 2.2** and were either incorporated into the five larger accepted ideas or were mutually exclusive to one or more of those accepted ideas.

Table 2.1 Accepted VA Study Recommendations

VA Study Recommendation Description	Potential Savings	
	Option 1	Option 2
IG-01 – Option 2. This alternative proposes to only cross over the east-west highway, not the north-south highway	N/A	$15,671,000
IG-20 – Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure	$2,049,000	$2,049,000
IG-26 – Options 1 & 2. Build a 3-lane median-to-median flyover connection in each direction with one lane striped out on opening day. In the future, the unopened lane could be opened an HOV	$49,251,000	$6,377,000
IG-27 – Option 2. Reconfigure the WB to SB ramp under the existing I-11/I-515 structure as a loop ramp that merges with the EB to SB ramp, then merges with SB I-11 on the right side.	N/A	$20,670,000
IM-01 – Option 2. Retain the existing SB I-515 braided off-ramp to Ramp SE, connecting Ramp SE to the crossed over EB I-215/Lake Mead Parkway lanes	N/A	$5,521,000

Table 2.2 VA Study Ideas Set Aside for Further Study in the Event that Accepted Ideas Were Found to Not Be Feasible

VA Study Idea Description	Potential Savings	
	Option 1	Option 2
IG-09 – Options 1 & 2. Relocate the WB off-ramp to Gibson to be west of Gibson Road to eliminate the potential need for braided ramps. This would result in a need to acquire right-of-way in the northwest quadrant of the I-215/Gibson Road interchange.	Not Costed	Not Costed
IG-11 – Option 1. Reconfigure the EB I-215 to NB I-515 ramp to be a left-hand exit and relocate the EB I-215 to SB I-11 ramp in its current location. This idea is incorporated into Idea IG-26 and should be considered only if IG-26 is found to not be feasible.	Not Costed	N/A
IG-22 – Option 1. Continue the three lane EB I-215 to NB I-515 ramp from the flyover and drop the third lane so that it exits at Auto Show Drive. Accepted Idea IG-26 provides this same benefit at a lower cost and this idea should be considered only if IG-26 is found to not be feasible.	Not Costed	N/A
IG-23 – Option 1. Shift the EB I-215 diverge point for north/south movements further east to allow more weaving length between Gibson Road and the system interchange. This idea would be considered only if IG-26 is found to not be feasible.	Not Costed	N/A
IA-04 – Option 1. Shift the EB-215 to NB I-515 ramp to the median. This idea is incorporated into Idea IG-26 and should be considered only if IG-26 is found to not be feasible.	Not Costed	N/A
IA-06 – Options 1 & 2. Relocate the EB on-ramp from Gibson to be west of Gibson Road to eliminate the potential need for braided ramps. This would result in a need to acquire right-of-way in the southwest quadrant of the I-215/Gibson Road interchange.	Not Costed	Not Costed

3.0 Development of Supporting Alternative Information

The study team modified the geometric layouts of Option 1 and Option 2 alternatives from the Feasibility Study to implement the accepted VA Study recommendations shown in **Table 2.1**. Improvements contained in both Feasibility Study options to widen Lake Mead Parkway to four through lanes in each direction east to Van Wagenen were retained in the alternatives studied in this Alternatives Analysis report.

The study team concluded by inspection that the improvement ideas for Option 2 would result in reduction of project costs without adversely impacting traffic operations because the operation of the interchange would be very similar to the Feasibility Study Option 2. Major costs savings would include elimination of the northern and southern crossover structures, elimination of a bridge for a braided WB ramp to Gibson Road, and avoiding the demolition and replacement of an existing bridge carrying a braided ramp to Auto Show Drive. Therefore, the study team elected to set the Feasibility Study Option 2 aside in favor of Option 2A because there appeared to be no disadvantages to counteract the advantages of cost savings.

The study team concluded by inspection that improvement ideas for Option 1 would result in the reduction of cost because the alternative would retain the existing flyover bridges in the system interchange. However, there were concerns that performance could be degraded both now and in the future by implementation of the accepted VA Study recommendations because the geometry between Gibson Road and the system interchange would be restored to the configuration that existed prior to 2017, and that configuration experienced safety issues related to weaving within a short distance for WB traffic from Lake Mead Parkway heading to Gibson Road. Therefore, the study team retained the original Option 1 alternative for consideration and renamed the modified Option 1 alternative as Option 3, which is analyzed in detail in this report. The study team recognized that the cost advantages of Option 3 might not outweigh the potential for degraded traffic operations or safety.

Geometric layouts are included on four separate PDF roll plots included with this report as Attachment 1. Roll plots are prepared for Options 2A and 3, in both the E-W and N-S directions.

Design criteria for geometric layouts of the alternatives was based on AASHTO and NDOT Design Criteria and was summarized in the September 28, 2020 Design Standards Memo (**Appendix 4**).

3.1 Improvements to Local Roads

As described in the Feasibility Study, and depicted in **Figure 3.1**, traffic projections for Lake Mead Parkway indicated a need for four lanes in each direction between Eastgate Road/Fiesta Henderson Boulevard and Van Wagenen Street. Proposed improvements are identical for both Options 1 and 2, with the existing northern curb line retained in place and widening taking place to the south where there is sufficient existing right-of-way. Medians and the south side sidewalk would be reconstructed, and bus stop pockets and bus stops would be reconstructed. WB Lake Mead Parkway would widen to five lanes approaching the Eastgate Road/Fiesta Henderson Boulevard intersection with the outside lane striped as a through/right lane.

Figure 3.1 Proposed Lake Mead Parkway Intersection at Eastgate

Eastgate Road would be retained in its current configuration. Fiesta Henderson Boulevard would be widened at the approach to Lake Mead Parkway to accommodate a triple left turn storage bay.

This project would not make improvements to Valle Verde Drive, Stephanie Street, Gibson Road, Galleria Drive, Sunset Road, Auto Show Drive or Horizon Drive except for reconstruction made necessary by ramp terminal improvements or signal timing adjustments.

3.2 Option 1

Option 1 was developed and described in the Feasibility Study, including conceptual (15%) plans, profiles, and project cost estimates. The premise of Option 1 was to retain the existing system interchange configuration while widening mainline and ramps as warranted by traffic analysis combined with:

» Braided ramps east of Gibson Road for both EB and WB motorists

» Eastgate Road/Fiesta Henderson Boulevard retained as an at-grade intersection in the current configuration with lanes added as indicated by traffic modeling

» NB I-11 auxiliary lane between Horizon Drive and Lake Mead Parkway

» I-515 widening north of the system interchange

» SB I-515 three-lane fork to I-215/Lake Mead Parkway

» Accommodate (leave space for) future single-lane HOV connections in each direction from the median of I-515 north of the system interchange to the median of I-515 west of the system interchange

Option 1 was determined in the Feasibility Study to satisfy most of the needs for the project without need for FHWA design exceptions. One drawback was that access between Auto Show Drive and I-215 would not be provided by Option 1.

3.3 Option 2A Refinement

Accepted recommendations for Option 2A included:

» Only cross over the east-west highway and not the north-south highway (see **Figure 1.2** for the Feasibility Study configuration and **Figure 3.2** for the new configuration)

» Reduce the NB off-ramp to Auto Show to one lane to reduce the width of the braided structure

» Build a three-lane (in each direction) median-to-median connection between I-215 and I-515

» Reconfigure Ramp WS to pass beneath the I-515/I-11 bridge as a loop ramp that merges with Ramp ES and then merges with SB I-11 on the right side

» Retain the existing SB I-515 braided off-ramp to Ramp SE, connecting Ramp SE to the crossed over EB I-215/Lake Mead Parkway lanes

The study team found that not crossing over the north-south highways as recommended by VA Study Idea IG-01 could be accomplished by reconfiguring Ramps WS and SE as recommended by VA Study Ideas IG-27 and IM-01, and by constructing a new flyover bridge for Ramp NW as shown in **Figure 3.2**. It would not be possible to retain the existing Ramp NW bridge, but the total value of structures saved by these three VA Study ideas exceeds the value of the flyover bridge and these ideas were successfully incorporated into Option 2A by the study team.

Constructing a median connector between I-215 and I-515 necessitates reconstructing the existing highways to spread the lanes to receive the new elevated median connector lanes as shown in **Figure 3.3**.

Year 2040 traffic operations analysis showed that narrowing the NB off-ramp to Auto Show Drive would result in degraded traffic performance, however, it was determined by the study team that the existing single lane ramp tangent bridge could be restriped for two lanes within the 28' wide bridge deck as shown in **Figure 3.4**, leaving two-feet wide left and right shoulders. This would necessitate a Design Exception. The consensus of the study team was that a Design Exception for bridge shoulder width would likely be approved with mitigating factors including ample sight distance for motorists using the ramp and highway lighting. Accepted Idea IG-01 was successfully incorporated into Option 2A by the study team.

Figure 3.2 Improved Option 2A Crossover System Interchange

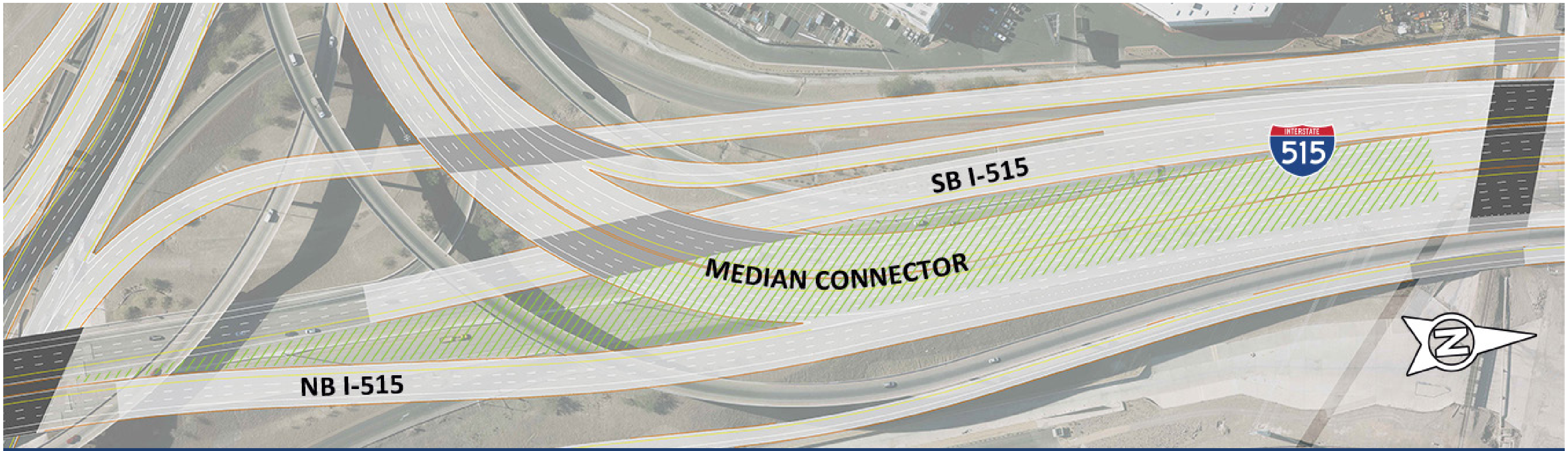


Figure 3.3 Spreading I-515 for the Median Connector

Figure 3.4 Option 2A: Two-Lane NB Auto Show Drive Off-Ramp

Each Option 2A roadway was given a unique designation as shown in **Table 3.1**.

Table 3.1 Option 2A Roadway Designations			
Designation	**Roadway Name**	**Designation**	**Roadway Name**
ASD2	NB I-515 off-ramp to Auto Show Drive	NE	NB off-ramp from I-11 to Lake Mead Parkway
ASSW	Ramp from Auto Show Drive to WB I-215	NW	Ramp from NB I-11 to WB
E	EB I-215/Lake Mead Parkway	P	Existing I-215
EG	EB I-215 off ramp to Gibson Road	SE	Ramp from SB I-515 to EB
ES	Ramp from EB I-215 to SB I-11	SS1	SB on-ramp from Sunset Drive to I-515
GE	EB on-ramp from Gibson Road	SS2	NB off-ramp from I-515 to Sunset Drive
GS	On-ramp from Gibson to SB I-11	ST1	EB on-ramp from Stephanie to I-215
GW	WB on-ramp from Gibson Road to I-215	ST2	WB off-ramp from I-215 to Stephanie
L	Existing I-11/I-515	SWG	Ramp from SB I-515 to Gibson Road
L-NB	NB I-11/I-515 shifted east to land MC	W	WB Lake Mead Parkway/I-215
L-SB	SB I-11/I-515 shifted west to land MC	WS	WB Lake Mead Parkway to SB I-11
MC	Median connector between I-215 and I-515	WN	WB Lake Mead Parkway to NB I-515

3.3.1 Option 2A Geometry

The vertical profiles shown in **Table 3.2** and **Appendix 5** were developed for each alignment in Option 2A based on the Design Standards Memo. Because of the constrained interchange area and the need for a crossover style interchange to have roadways get up and over another roadway and then back down, it was not possible to meet the desired NDOT criteria of minimum vertical curve length of 1,000 feet. Vertical curves shorter than 1,000 feet would not require an FHWA approved Design Exception as long as they still meet AASHTO criteria.

The minimum AASHTO desired criteria of three times design speed was met for all cases, and the minimum curvature rate (K) values for Stopping Sight Distance (SSD) on crest vertical curves were achieved for all vertical curves.

Minimum AASHTO K values for comfort on sag vertical curves were met for all curves. SSD criteria based on headlights was not met for twelve sag curves; however, FHWA-approved Design Exceptions for SSD on sag vertical curves are not required. Highway lighting designed to meet appropriate luminosity would be needed to mitigate this issue.

Horizontal curves shown in **Table 3.3** were developed for each alignment in Option 2A based on the Design Standards Memo. Superelevation transition diagrams are shown in **Appendix 7**. Design Exceptions for horizontal curvature are not needed for Option 2A.

Table 3.2 Option 2A Vertical Curve Summary

Segment	PVI Sta	Length	K	V_d	Design Speed Met
ASD2	19+87.90	600.0	144	45	60 Headlight
ASSW	7+75.00	150	109	50	50 Crest
	10+65.85	400	63.4	50	50 Comfort, 35 Headllight
	34+30.58	300	70.7	50	55 Comfort, 40 Headlight
	41+27.50	200	85.7	35	50 Crest
E	20+24.00	200	213	45	70 Headlight
	29+00.00	600	143	45	60 Headlight
	39+26.50	153	61.5	45	45 Crest
EG	20+06.30	600.0	168	50	60 Crest
ES	14+68.06	200	204	50	70 Headlight
	18+50.00	550	115	50	55 Crest
	23+25.00	300	66	50	55 Comfort, 40 Headlight
	25+50.00	150	87.7	50	50 Crest
	30+00.00	300	221	50	70 Headlight
	51+80.00	600	153	50	60 Crest
	59+07.00	425	114	45	50 Headlight
GE	12+57.75	190	26.1	25	25 Headlight
	16+82.90	600	87.7	45	50 Crest
GS	16+94.95	389.9	87.7	45	50 Crest
GW	15+69.00	500.0	155	45	60 Crest
L	347+94.00	1,000	292	70	70 Crest
	359+25.00	1,000	229	70	70 Headlight
	373+00.00	1,000	585	70	70 Crest
	398+50.00	1,000	872	70	70 Crest
	418+32.00	1,000	557	70	70 Headlight
L-NB	76+40.00	260	108	70	70 Comfort, 50 Headlight
	85+15.00	1,490	254	70	70 Crest
	94+15.00	310	116	70	70 Comfort, 50 Headlight
L-SB	71+62.50	725	598	70	70 Crest
	79+25.00	800	274	70	70 Crest
	86+25.00	600	122	70	70 Comfort, 55 Headlight
	92+64.21	675	247	70	70 Crest
	99+76.71	750	912	70	70 Crest
MC	56+13.32	449	539	65	70 Crest
	67+11.09	800	335	65	70 Headlight
	84+00.00	620	168	60	60 Crest
	88+35.00	250	106	45	50 Headlight
MC	93+25.00	730	221	45	65 Crest
	97+98.76	200	156	45	60 Headlight
	101+98.76	600	253	65	70 Crest
	106+53.76	310	116	65	70 Comfort, 55 Headlight
NE	26+13.67	300	176	45	60 Crest
	33+61.52	500	103	25	50 Headlight
NW	17+29.76	470	96.6	45	50 Headlight
	24+31.03	650	68.7	45	45 Crest
	31+59.31	450	45	45	45 Comfort, 30 Headlight
P	22+14.00	950	168	70	70 Crest
	35+20.41	800	539	70	70 Crest
	57+65.00	750	549	70	70 Crest
	68+92.00	1,000	297	70	70 Crest
SE	31+00.00	1,300	248	50	70 Crest
	43+50.00	1,000	226	45	70 Headlight
	52+28.17	500	61.7	25	45 Crest
SS1	15+88.27	300	324	45	60 Crest
	23+00.00	200	62.7	35	45 Crest
SS2	13+00.00	100.0	119	35	55 Crest
ST1	11+81.19	150	42.4	25	35 Crest
	16+62.00	620	95.6	45	50 Headlight
ST2	18+93.32	350.0	160	45	65 Headlight
SWG	17+06.09	300	50.8	45	45 Comfort, 35 Headlight
	24+83.67	550	62.2	45	45 Crest
	37+98.56	300	366	25	25 Headlight
W	12+00.00	400	59.1	45	50 Comfort, 35 Headlight
	18+50.00	675	61.6	45	45 Crest
	27+25.00	650	66.6	45	55 Comfort, 40 Headlight
	52+93.54	1,900	205	70	65 Crest
	66+48.86	700	128	70	70 Comfort, 55 Headlight
	76+47.85	750	463	70	70 Headlight
WS	12+09.86	200	61	25	45 Crest
	15+50.00	400	149	25	60 Headlight
	22+95.49	300	104	45	50 Crest
WN	14+90.50	325	61.5	45	45 Crest
	20+50.00	400	143	45	60 Headlight
	36+00.00	500	81	45	45 Headlight
	42+42.00	600	79.7	45	45 Crest

Table 3.3 Option 2A Horizontal Curve Summary

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
ASD 2	1	10+00.00	14+89.47	2,002	0.043	45	45
	2	18+58.82	21+21.64	3,000	0.031	45	45
	3	22+74.36	24+66.23	2,500	0.031	45	45
ASSW	1	6+12.58	10+00.04	11,064	0.020	50	50
	2	13+88.32	15+49.34	2,000	0.051	50	50
	3	16+80.31	21+23.09	2,848	0.039	50	50
	4	21+23.09	24+69.85	2,890	0.038	50	50
	5	24+69.85	30+06.07	5,115	0.023	50	50
	6	30+06.07	35+08.45	5,860	0.020	50	50
	7	39+90.33	45+43.41	444	0.075	35	35
E	1	16+82.91	18+39.77	735	0.077	45	45
	2	20+19.41	21+91.92	735	0.077	45	45
	3	29+11.23	30+39.28	1,208	0.061	45	45
	4	32+82.70	34+61.51	1,524	0.053	45	45
	5	41+37.88	44+12.15	9,551	0.020	65	65
	6	44+12.15	45+58.14	2,362	0.067	65	65
	7	49+58.03	52+18.43	2,424	0.065	65	65
	8	53+42.07	54+67.30	15,034	0.020	65	65
	9	56+70.95	59+86.31	6,282	0.029	65	65
	10	69+70.18	72+55.74	2,966	0.053	65	65
EG	1	17+14.24	18+64.12	6,000	0.020	50	50
ES	1	10+00.00	14+02.15	2,000	0.051	50	50
	2	19+06.28	21+43.25	2,000	0.051	50	50
	3	50+40.63	51+88.50	5,970	0.020	50	50
	4	54+06.47	56+54.69	1,272	0.068	45	45
	5	56+54.69	68+41.91	1,556	0.060	45	45
GE	1	14+83.77	17+51.17	8,012	0.020	45	45
	2	20+44.08	22+45.17	2,000	0.043	45	45
GS	1	15+39.03	16+59.41	4,000	0.024	45	45
	2	22+63.86	24+82.31	8,000	0.020	45	45
GW	1	10+00.00	12+14.51	1,235	0.060	45	45
	2	12+14.51	16+90.53	3,330	0.028	45	45
	3	16+90.53	23+21.58	4,279	0.027	45	50

Table 3.3 Option 2A Horizontal Curve Summary (cont.)

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
L	1	102+20.42	130+07.77	6,000	0.034	70	70
	2	187+89.09	216+11.67	6,254	0.033	70	70
	3	216+11.67	256+19.00	6,000	0.034	70	70
	4	269+14.11	278+63.87	3,000	0.062	70	70
	5	344+54.80	349+75.43	10,000	0.020	70	70
	6	394+23.48	408+21.62	3,000	0.062	70	70
	7	429+35.67	443+35.38	10,000	0.020	70	70
	8	465+35.63	471+78.45	10,000	0.020	70	70
	9	543+71.04	570+86.85	5,000	0.040	70	70
	10	606+92.87	624+28.39	4,000	0.049	70	70
	11	636+11.23	651+51.16	3,000	0.062	70	70
	12	679+07.60	714+96.16	4,000	0.049	70	70
	13	745+17.57	749+05.04	10,000	0.020	70	70
	14	761+46.49	764+73.71	5,000	0.040	70	70
	15	772+08.63	797+71.12	4,000	0.049	70	70
	16	803+21.47	828+96.78	5,000	0.040	70	70
	17	855+80.83	866+25.85	10,000	0.020	70	70
	18	925+90.33	938+96.40	2,881	0.064	70	70
	19	938+96.41	962+36.41	3,000	0.062	70	70
	20	962+36.42	978+03.82	5,501	0.037	70	70
	21	1009+16.92	1015+28.30	15,000	0.020	70	70
	22	1032+74.51	1048+80.65	3,000	0.062	70	70
	23	1077+62.15	1087+34.67	3,035	0.062	70	70
	24	1089+58.43	1093+32.49	1,494	0.080	70	70
	25	1098+50.34	1113+81.73	2,006	0.079	70	70
	26	1126+13.50	1133+59.85	1,500	0.080	70	70
L-NB	1	74+44.68	77+88.71	3,000	0.062	70	70
	2	81+39.40	86+53.25	3,000	0.062	70	70
	3	92+64.01	102+44.08	2,917	0.064	70	70
L-SB	1	63+69.26	65+71.98	5,966	0.034	70	70
	2	68+76.45	70+81.48	6,034	0.034	70	70
	3	76+66.94	80+39.32	6,012	0.034	70	70
	4	84+59.51	95+98.65	9,584	0.022	70	70
	5	95+98.65	108+33.85	2,824	0.066	70	70
	6	111+71.24	113+98.55	7,976	0.026	70	70

Table 3.3 Option 2A Horizontal Curve Summary (cont.)

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
MC	1	53+88.88	56+77.81	3,001	0.056	65	65
	2	66+61.69	70+27.32	6,247	0.030	65	65
	3	74+27.51	76+83.93	2,387	0.066	65	65
	4	80+83.82	82+30.38	2,399	0.066	65	65
	5	85+85.35	89+18.39	571	0.080	45	45
	6	89+18.39	97+85.29	686	0.079	45	45
	7	97+85.29	100+73.62	964	0.069	45	45
	8	105+19.36	112+47.93	3,000	0.056	65	65
NE	1	15+14.32	16+61.74	6,000	0.020	45	50
	2	24+12.36	26+80.94	3,030	0.031	45	45
	3	27+95.53	29+50.50	3,000	0.031	45	45
	4	30+95.53	34+45.93	200	0.074	25	25
	5	34+45.93	36+99.29	839	0.036	25	25
NW	1	18+28.43	26+03.79	1,100	0.064	45	45
	2	26+03.79	33+18.02	2,024	0.043	45	45
	3	33+96.17	34+94.92	2,200	0.040	45	45
	4	36+36.11	37+41.87	4,000	0.034	45	55
P	1	10+79.75	16+47.64	4,003	0.049	70	70
	2	16+47.64	21+39.43	4,000	0.049	70	70
	3	45+48.91	63+15.89	16,401	0.020	70	70
	4	63+15.89	67+00.21	16,401	0.020	70	70
	5	67+00.21	77+69.75	16,401	0.020	70	70
	6	210+33.57	220+84.44	22,201	0.020	70	70
	7	233+92.53	246+77.82	6,000	0.034	70	70
	8	326+64.80	373+06.82	3,535	0.055	70	70
	9	388+61.91	408+69.61	8,595	0.025	70	70
	10	416+45.99	452+72.45	7,640	0.027	70	70
	11	469+19.41	501+12.25	4,584	0.044	70	70
	12	501+12.25	531+87.26	7,639	0.027	70	70
	13	591+28.63	605+41.27	3,820	0.051	70	70
	14	644+05.66	667+75.25	4,800	0.042	70	70
SE	1	10+00.00	13+67.65	2,280	0.046	45	50
	2	22+88.13	33+80.88	2,909	0.032	45	45
	3	50+95.37	55+87.25	509	0.050	25	25

Table 3.3 Option 2A Horizontal Curve Summary (cont.)

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
SS1	1	10+00.00	13+45.73	2,000	0.043	45	45
	2	14+95.43	17+59.26	2,000	0.043	45	45
	3	19+94.50	24+98.45	1,225	0.043	35	35
SS2	1	12+36.15	19+28.41	1,435	0.055	35	35
ST1	1	10+00.00	10+75.39	440	0.053	25	25
	2	11+39.25	13+62.01	658	0.079	45	45
	3	15+03.49	21+82.43	1,856	0.046	45	45
ST2	1	13+00.00	20+85.32	2,590	0.035	45	45
SWG	1	13+78.28	17+12.12	2,000	0.043	45	45
	2	19+76.83	24+60.65	3,000	0.031	45	45
	3	27+71.73	30+28.01	2,000	0.043	45	45
	4	30+28.01	33+72.14	6,988	0.020	45	45
W	1	17+79.91	19+63.67	712	0.076	45	45
	2	21+44.59	24+23.68	759	0.076	45	45
	3	26+32.48	28+27.22	1,776	0.047	45	45
	4	29+47.64	31+65.36	1,224	0.061	45	45
	5	32+74.64	34+48.47	800	0.075	45	45
	6	38+26.00	39+76.98	4,000	0.034	45	45
	7	44+07.77	47+63.17	1,840	0.080	70	70
	8	52+46.50	55+33.92	1,840	0.080	70	70
	9	68+91.65	72+06.89	5,024	0.040	70	70
WS	1	10+00.00	18+88.99	304	0.063	25	25
	2	20+85.63	24+84.24	588	0.080	45	45
	3	24+84.24	27+03.92	1,988	0.051	50	50
WN	1	11+21.53	22+32.42	1,753	0.048	45	45
	2	22+32.42	27+86.95	1,798	0.047	45	45
	3	39+56.57	46+52.20	2,665	0.034	45	45
	4	46+52.20	54+05.75	2,300	0.039	45	45

PVI Point of Vertical Inflection
PC Point of Curvature
K Rate of Vertical Curvature
PT Point of Tangency
Sta Station along Alignment
e Rate of Superelevation
Vd Design Speed
DSM Design Speed Met

3.3.2 Option 2A Structures

There are 27 existing structures within the project area. Existing structures were constructed around 2005 and are in good condition with remaining service life well beyond design year 2040. An assessment of existing structures is included in **Appendix 2**.

Option 2A retains 15 structures with no modifications needed:

- B-613 Culvert beneath I-215 1,200' west of Stephanie
- B-2121 Culvert beneath I-215 1,100' east of Stephanie
- G-1465 I-11 over UPRR
- H-1961 Arroyo Grande Boulevard over I-215
- H-2799S SB on-ramp from Auto Show over Ramp SE
- H-2799N NB off-ramp to Auto Show over Ramp WN
- H-2879S SB on-ramp from Galleria over SB ramp to Sunset
- H-2879N NB off-ramp to Galleria over NB ramp from Sunset
- I-1459L SB on-ramp from Galleria Drive over Sunset Road
- I-1459R NB off-ramp to Galleria over Sunset Road
- I-1464 I-11/I-515 over Lake Mead Parkway/I-215
- I-1466 Horizon Drive over I-11
- I-1960 Stephanie over I-215
- I-1962 Valle Verde Drive over I-215
- I-2881 Galleria Drive over I-515

Option 2A retains and widens 5 structures:

- G-1463 I-515 over UPRR
- H-1460 I-515 over Gibson Road
- H-1836 I-515 over Warm Springs Road
- I-1459 I-515 over Sunset Road
- I-1959 I-215 over Gibson Road

Bridge G-1463 is a single-span post-tensioned cast-in-place concrete box girder over UPRR with separate superstructures for NB and SB traffic. The original deck widths were 145 feet and a 2004 widening project increased the SB width by 55 feet for a total SB width of 200 feet. Option 2A would widen both the NB and SB decks as shown in **Figure 3.5**. New widening would be similar to the 2004 project with a closure pour at deck level. Although NDOT no longer designs new bridges to be founded on spread foundations behind MSE walls, the widened bridge decks would be supported by spread foundations comparable to the original and 2004 construction. The existing bridge appears to be in good condition despite two different MSE systems and previous widening.

Figure 3.5 Option 2A New and Widened I-515 Bridges Over UPRR

Bridge H-1460 is a two-span post-tensioned cast-in-place concrete box girder over Gibson Road with separate superstructures for NB and SB traffic that would be widened on both sides for Option 2A as shown in **Figure 3.6**. This bridge has an acute skew angle, and the SB and NB decks are separated by a 1" wide longitudinal joint. The existing median barrier is wholly located on the SB structure and both structures are variable width due to on and off ramps from the north. The existing bridge exhibits cracking and spalling at the corners due to the high skew. One additional column would be needed at each structure for the widening. With the acute skew the widening could exacerbate the horizontal rotation of the superstructure noted in the inspection report and this would need to be addressed in detailed design.

Figure 3.6 Option 2A Widening of I-515 Bridge over Gibson Road

Bridge H-1836 is a single-span post-tensioned cast-in-place concrete box girder over Warm Springs Road with separate superstructures for NB and SB traffic that would be widened on both sides for Option 2A as shown in **Figure 3.7**. The existing bridge appears to be in good condition and there should be no unusual issues with widening in-kind.

Bridge I-1459 is a single-span post-tensioned cast-in-place concrete box girder over Sunset Road with separate superstructures for NB and SB traffic that would be widened on both sides for Option 2A as shown in **Figure 3.8**. The existing bridge appears to be in good condition with no unusual issues with widening in-kind.

Bridge I-1959 is a single-span post-tensioned cast-in-place concrete box girder over Gibson Road with separate superstructures for EB and WB traffic that would be widened for Option 2A on both sides as shown in **Figure 3.9**. The existing bridge is in good condition. Widening could either be accomplished in-kind or by using a precast box.

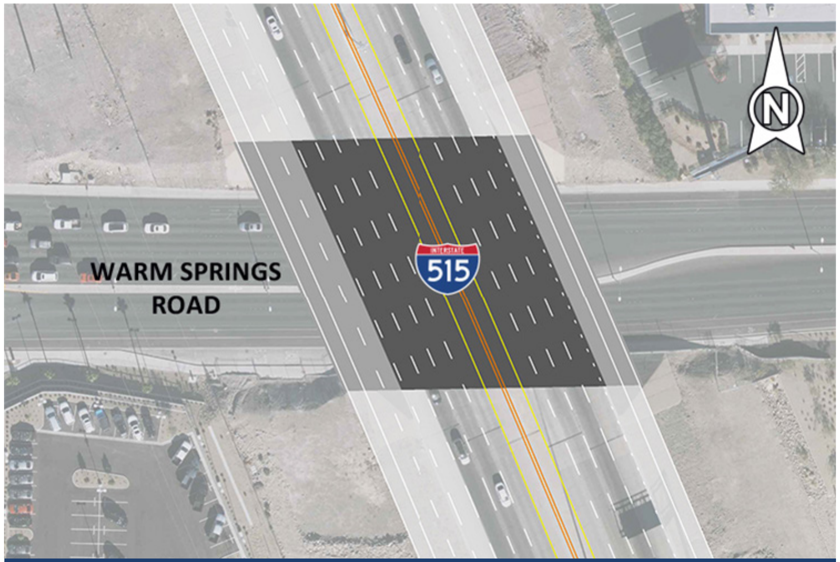


Figure 3.7 Option 2A Widening of I-515 Bridge over Warm Springs

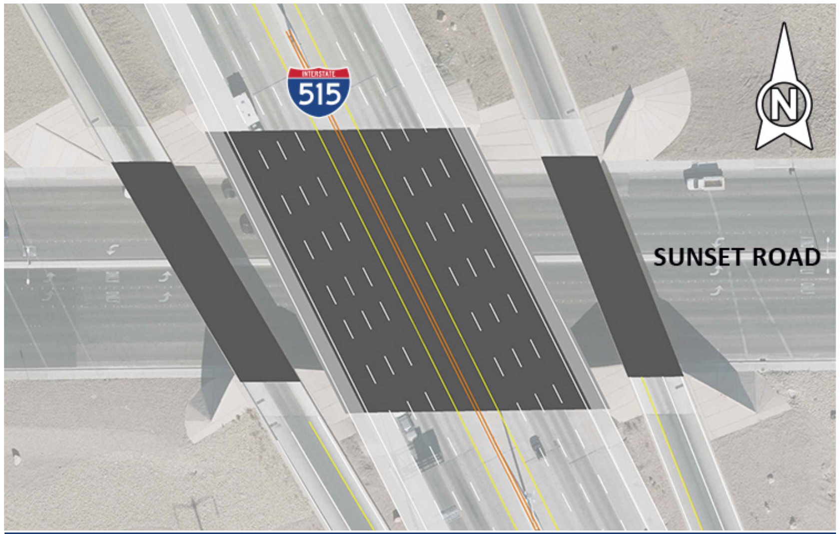


Figure 3.8 Option 2A Widening of I-515 Bridge over Sunset Road

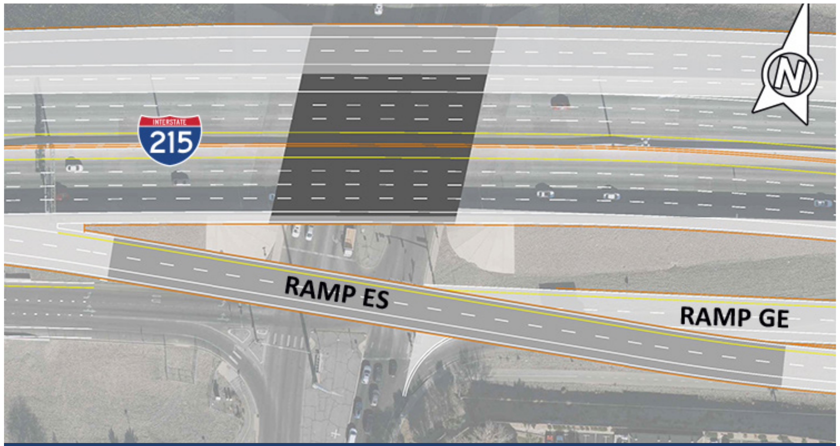


Figure 3.9 Option 2A I-215 Bridges at Gibson Road

Various modifications would be made to 2 structures for Option 2A:

- G-1958 I-215 over UPRR – Connect decks, re-deck portions of the bridge, and relocate fascia barriers
- I-2747 Auto Show Drive over I-515 – No modification to the bridge, but Option 2A would open up the area beneath the bridge to widen the roadway

Bridge G-1958 is a three-span steel plate girder bridge with separate cast-in-place decks for EB and WB traffic. The Option 2A configuration reverses a portion of the WB deck to carry EB traffic, resulting in the need to relocate the median barrier as shown in **Figure 3.10**. Plans to connect the decks of the WB & EB structures may present long-term issues due to the skew and aspect ratio of the connected decks that would need to be addressed in detailed design. The decks have opposite cross slopes, and a connected deck would relocate the crown, thus necessitating that a portion of the existing WB bridge would be redocked with thicker haunches over the girders. A connected deck would change the aspect ratio from principally longitudinal to more equal longitudinal/transverse with the obtuse corners closer to each other than the bridge length.

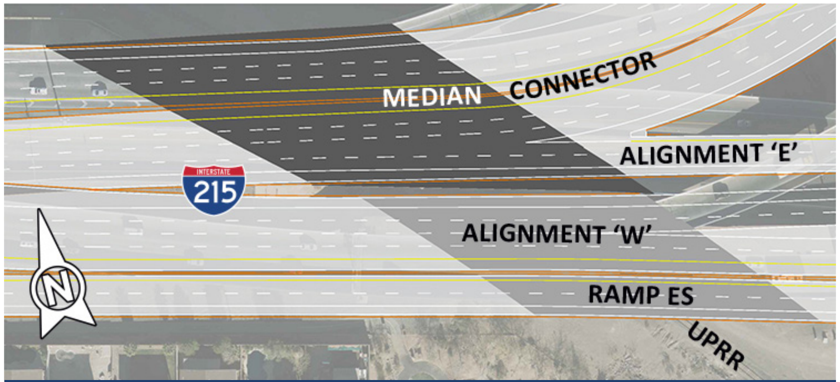


Figure 3.10 Option 2A I-215 Bridges over UPRR

Five existing bridges are not retained by Option 2A and would be demolished:

- I-2108 Existing Ramp ES/EN flyover
- I-2109 Existing Ramp EN flyover
- I-2110 Existing Ramp NW flyover
- I-2111 Existing Ramp SW over existing Ramp SE
- I-2112 Existing I-215 over existing Ramp SE

Eleven new bridges would be constructed with Option 2A:

- WB I-215 over EB I-215 (Eastern crossover)
- WB I-215 over Median Connector (Western crossover)
- Ramp SE over Ramp WS
- WB I-215 over UPRR
- Ramp SE over UPRR
- Ramp SE over Gibson Road and Ramp GE
- Ramp NW over I-11 and Ramp WS
- Median Connector over Ramp SE
- Median Connector over SB I-515
- Ramp WN over UPRR
- Ramp SE over UPRR

The crossover bridge carrying WB I-215 over EB I-215 is anticipated to be a single-span, highly skewed post-tensioned cast-in-place concrete box girder constructed on stub abutments on extended foundations behind MSE walls as shown in **Figure 3.11**.

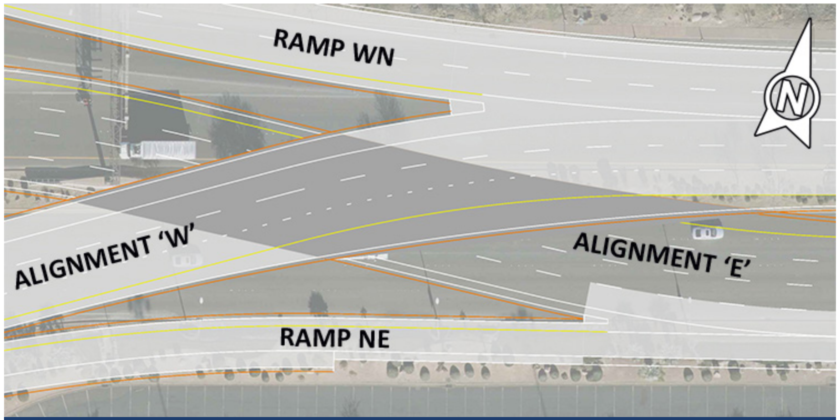


Figure 3.11 Eastern Crossover Bridge

The crossover bridge carrying WB I-215 over the median connector would be highly skewed (approximately 80 degrees) if constructed as a traditional bridge type because opposing directions of travel are adjacent to each other. If a traditional bridge type were used, the clear span length would be approximately 400 feet. This high skew and span length are not feasible for traditional bridge types. While tied arch bridges could accommodate the required length, the high skew would be a disqualifying factor.

The study team evaluated several structure types in an effort to yield a structure that is functionally skewed, but not structurally skewed. Structure types considered included post-tensioned concrete boxes supported by straddle bents and a concrete deck supported by transverse precast concrete bulb-tee girders. The study team prepared conceptual plans based on a straddle bent bridge configuration as depicted in **Figure 3.12**, similar to the existing I-515 SB on-ramp bridge pictured in **Figure 3.13**.

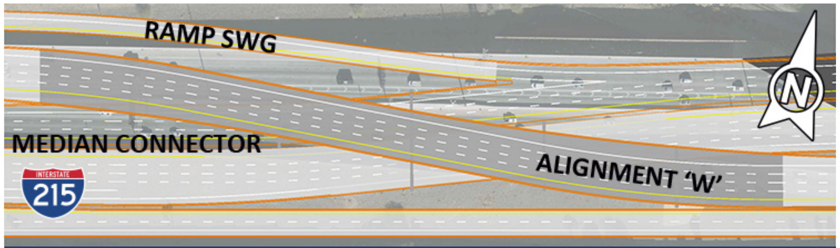


Figure 3.12 Western Crossover Bridge


Figure 3.13 Existing I-515 SB On-ramp Bridge

The Ramp SE bridge over Ramp WS would be a single-span post-tensioned cast-in-place concrete box girder constructed on stub abutments as shown in **Figure 3.2**.

The WB I-215 and EB Ramp ES bridges over UPRR would be three-span post-tensioned cast-in-place concrete box girders constructed on stub abutments as shown in **Figure 3.10**.

The Ramp ES bridge over Gibson Road and Ramp GE would be a four-span post-tensioned cast-in-place concrete box girders constructed on stub abutments on extended foundations behind MSE walls as shown in **Figure 3.9**.

The new Ramp NE bridge over I-11 and Ramp WS would be a four-span post-tensioned cast-in-place concrete box girders constructed on stub abutments behind MSE walls at the west end and with an abutment slope at the east end as shown in **Figure 3.2**. The bridge would be founded on extended foundations.

» Median Connector bridges over SB I-515 and Ramp SE would be single-span, highly skewed post-tensioned cast-in-place concrete box girders constructed on stub abutments behind MSE walls as shown in **Figure 3.3**. The abutments would be founded on extended foundations.

The Ramp WN NB and Ramp SE SB bridges over UPRR would be single-span post-tensioned cast-in-place concrete box girders constructed on stub abutments behind MSE walls as shown in **Figure 3.5**. The abutments would be founded on extended foundations.

Option 2A would extend three culvert structures:

- Entrance to a three-cell culvert in the southwest interchange quadrant beneath new Ramp ES as shown in **Figure 3.14**
- Entrance to a two-cell culvert in the southeast interchange quadrant adjacent to the outlet of a culvert from the Fiesta Henderson Casino property as shown in **Figure 3.15**
- Outlet of a culvert in the southwest corner of Lake Mead Parkway and Fiesta Henderson Boulevard with a "fillet" to accommodate a pedestrian path as shown in **Figure 3.16**

It is anticipated by the study team that culvert extensions would be cast-in-place concrete structures similar to the existing culverts.

Retaining wall locations and heights would be determined during detailed design. In addition to cast-in-place or MSE walls constructed for new or widened bridges, MSE retaining walls are anticipated by the study team to be needed at the following locations for Option 2A to accommodate grade differentials where there is insufficient space to allow for sloping embankments:

- I-11 from Station “L” 276+00 to 344+00 to accommodate SB widening adjacent to a drainage channel
- Between the Median Connector and SB I-515
- Between Ramp ASSW and SB I-515
- Between Ramps ASSW and SE
- Two separate walls between Ramp WN and the retention basin in the northeast quadrant of the system interchange
- Between Alignments E and W adjacent to the eastern crossover
- Between Alignment E and Ramp WN
- Between Alignment W and Ramp NE
- Between Alignment W and Ramp NW
- Between Alignments E and W, east of the UPRR bridge
- Between Alignments W and MC adjacent to the western crossover
- Between Ramps ES and W west of UPRR
- Between Ramp ES and the combined path between Gibson Road and the park

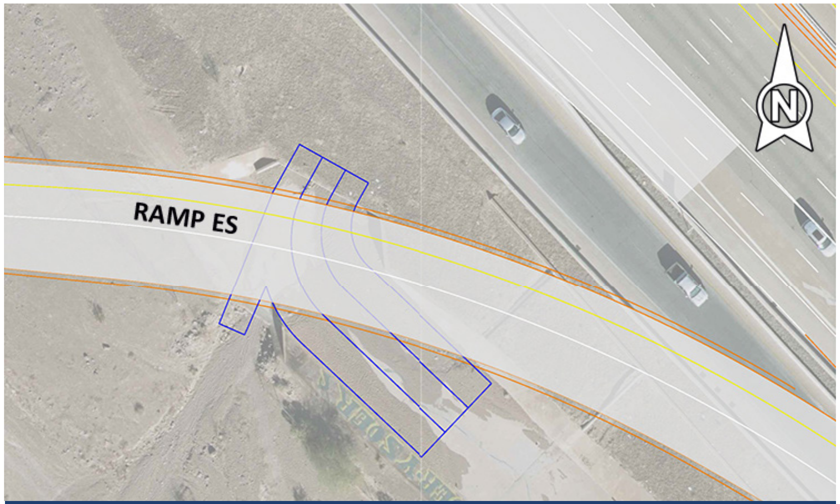


Figure 3.14 Option 2A Culvert Extension for Ramp ES

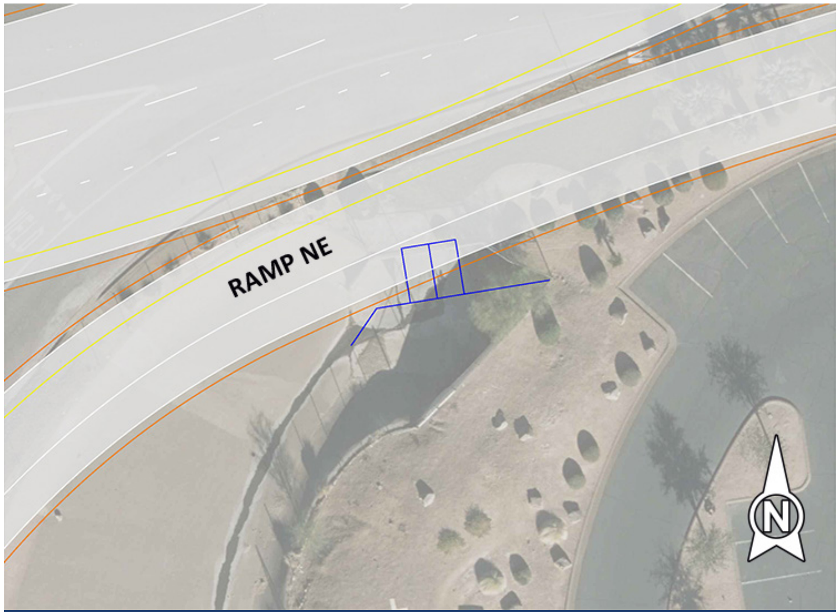


Figure 3.15 Option 2A Culvert Extension for Ramp NE

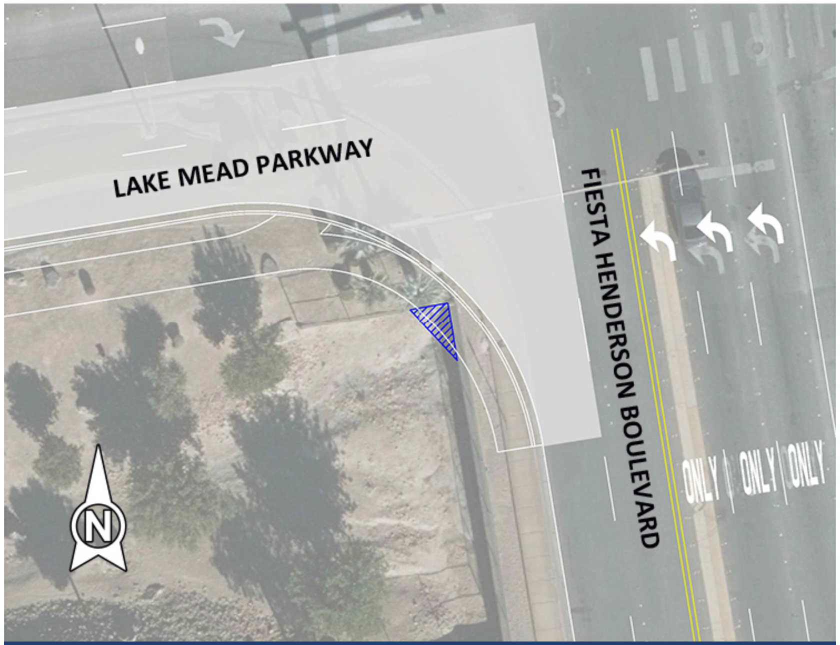


Figure 3.16 Culvert Extension for Pedestrian Path at Southwest Corner of Lake Mead Parkway and Fiesta Henderson Boulevard

- Between Ramp SWG and the northern right-of-way
- Between Ramp ES and EB I-215 west of Gibson
- Between the WB on-ramp from Gibson and the north right-of-way
- Between the EB off-ramp to Gibson and a culvert headwall

Noise wall locations would be determined by subsequent noise analysis to be conducted in a later phase of this project. Noise wall locations are anticipated by the study team to be needed at locations currently served by noise walls that would be disturbed by this project, and a currently unserved area between WB I-215 and apartment buildings constructed between Arroyo Grande Boulevard and the UPRR crossing after the original interchange was built. Noise walls may be supported on separate foundations, retaining walls, or bridge railings as appropriate.

3.3.3 Option 2A Combined Path

There is an existing 12' wide combined pedestrian and bicycle path along the south right-of-way of I-215 between Gibson Road and Acacia Park that would be reconstructed within the 16' wide space between the Ramp ES retaining wall and the right-of-way line.

3.3.4 Option 2A Guide Concept Plans

Guide sign concept plans for Option 2A are included with this report as separate PDF roll plots (Attachment 2) and include the area along I-515 and I-11 between Galleria Drive (northern terminus) and Horizon Drive (southern terminus), and along Lake Mead Parkway (NV 564) and I-215 between Eastgate Road (eastern terminus) and Valle Verde Drive (western terminus). The guide sign concept plans include the guide signs for the system interchange and the following service interchange exit ramps:

- I-515: Auto Show Drive, Sunset Road, Galleria Drive (NB)
- I-215: Gibson Rodd, Stephanie Street, Valle Verde Drive (WB)

Challenges involved in developing the guide sign layout for Option 2A included:

- Each of the four legs of the system interchange have different route designations, specifically I-11 to the south, I-515 to the north, I-215 to the west, and Lake Mead Parkway (NV 564) to the east. This complicates the guide signing by requiring multiple route designations on the guide signs
- I-11 and I-515 carry the underlying route designations US 93 and US 95, adding to the number of route designations that need to be incorporated in the guide signs
- Closely spaced interchanges on I-215 and I-515 reduce the available distance between guide signs between these interchanges and the I-515/I-215 system interchange, as well as additional interchanges to the west on I-215 and to the north on I-515
- Option 2A provides two ramps from SB I-515 to WB I-215. The first ramp is the median crossover (EXIT 23B), a left exit three-lane ramp. The second ramp departs from SB I-515 after the SB Auto Show Drive entrance ramp, providing a connection from Auto Show Drive to WB I-215 and Gibson Road and is signed as EXIT 23C. Due to the prior exit signing for Lake Mead Parkway EAST (EXIT 23A) and I-215 WEST (EXIT 23B), there is only one advance signing on SB I-515 for this exit. The guide signs for the two ramps from SB I-515 to I-215 WEST are shown in **Figure 3.17**.

Conventional interchange signing was used for most of the interchange exit signs. Overhead Arrow Per Lane Guide signs were used for the SB I-515 to WB I-215 and EB I-215 to NB I-515 median crossover ramps, as well as the SB I-215 exit to Horizon Drive. The Guide Sign Concept Plan for Option 2A includes Overhead Arrow Per Lane signs for the NB I-515 exit to Auto Show Drive (EXIT 62).

3.3.5 Option 2A Earthwork

Earthwork calculations were prepared for Option 2A based on surfaces in the MicroStation project files and preliminary retaining wall layouts.

Estimated earthwork for Option 2A includes 94,000 cubic yards of excavation, 47,000 cubic yards of MSE (coarse sand) embankment, and 885,000 cubic yards of common embankment. The MSE embankment and approximately 791,000 cubic yards of the common embankment would need to be imported to the project area from approved borrow sites.

3.4 Option 3

Accepted recommendations for Option 1 to create a new Option 3 included:

- Reduce the NB off-ramp to Auto Show to one lane to reduce the width of the braided structure
- Build a three-lane median-to-median (in each direction) flyover connection between I-215 and I-515

Year 2040 traffic operations analysis showed that narrowing the NB off-ramp to Auto Show Drive would result in degraded traffic operations performance; however, it was determined by the study team that the existing single lane ramp tangent bridge could be restriped for two lanes within the 28’ wide bridge deck, similar to Option 2A as shown in **Figure 3.4**, leaving 2' wide left and right shoulders. This would necessitate a Design Exception. The consensus of the study team was that a Design Exception for bridge shoulder width would likely be approved with mitigating factors including ample sight distance for motorists using the ramp and highway lighting. Accepted Idea IG-01 was successfully incorporated into new Option 3 by the study team.

Constructing a three-lane median connector in each direction between I-215 and I-515 allows for most of the existing core system interchange to remain unchanged as shown in **Figure 3.18**, including most of the existing flyover bridges. The existing 32’ wide Ramp NW bridge is currently striped for a single lane so that the left shoulder has sufficient width for Stopping Sight Distance (SSD) for 45 mph. Traffic operations analysis showed that two lanes are required for this movement, and the study team determined

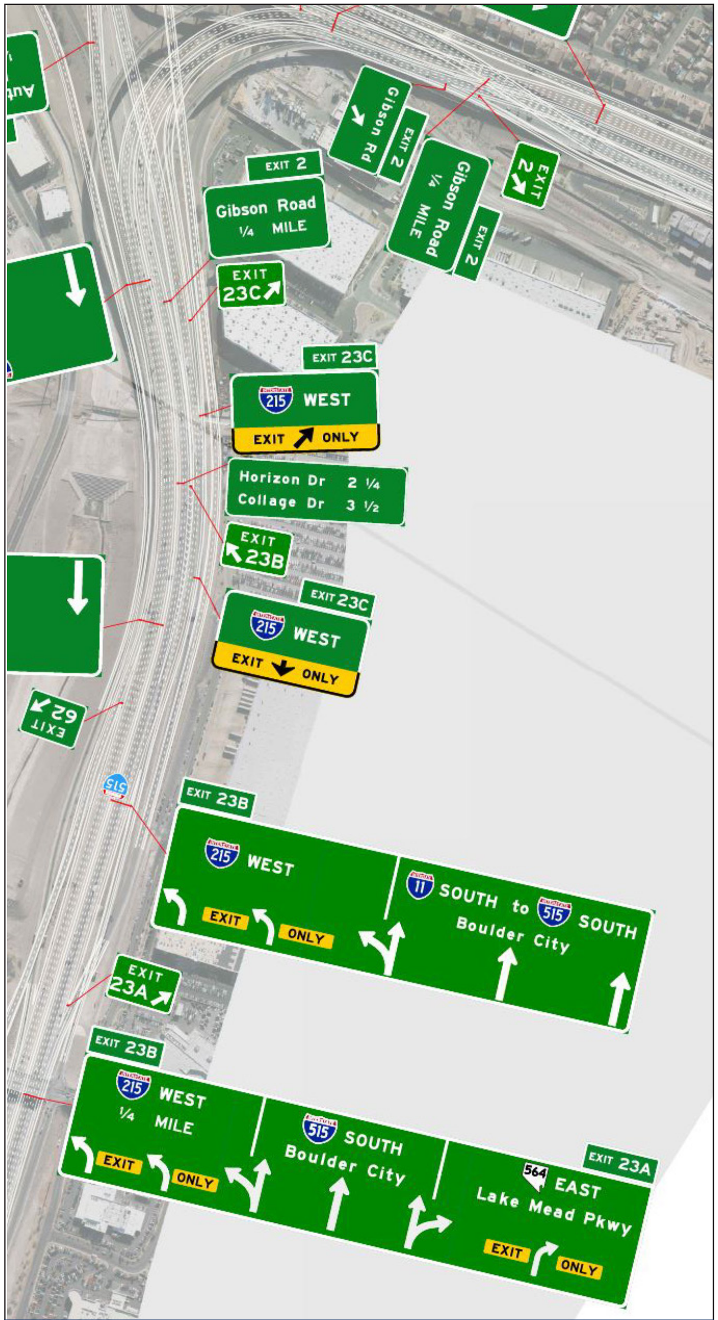


Figure 3.17 SB I-515 Two Exits to I-215 West

that the existing bridge could be restriped for two lanes with a 2’ right shoulder and 6’ left shoulder. A left shoulder width of 6’ would accommodate SSD that meets only 35 mph design speed. The intended design speed for this ramp is 45 mph. Therefore, a Design Exception would be needed to retain and restripe the existing Ramp NW bridge.

The median connector shown in **Figure 3.19** would need to be elevated to cross over the existing interchange and would need to "land" back down to match existing I-215 just east of Gibson Road and to match I-515 just south of the UPRR crossing. The existing highways would need to be shifted outward to accommodate landing the median connector as shown in **Figure 3.20**. Shifting the existing lanes of I-515 north of the Lake Mead Parkway bridge would result in the need to reconstruct a portion of the Ramp EN bridge north of Pier 9 on a new alignment shifted east to clear the shifted I-515 lanes beneath. The length of the median connector flyover bridge is established by the need to clear the shifted lanes of I-215 and I-515. Existing Ramp EN would be used to provide access from Gibson Road to NB I-515, and to provide access from EB I-215 and Gibson Road to Auto Show Drive that does not currently exist.

Existing Ramp SW would be used to provide access from Auto Show Drive to WB I-215 that does not currently exist, and to provide access from SB I-515 to Gibson Road. Existing Ramp EN would be used to provide access from Gibson Road to NB I-515, and to provide access from EB I-215 to Auto Show Drive that does not currently exist.

Option 3 would restore the WB weaving area between the system interchange and the Gibson Road off-ramp that was removed by the restriping project in 2017-2018. Mitigating factors include the removal of traffic heading from SB I-515 to WB I-215 into the Median Connector and moving the painted gore for the WB exit to Gibson Road further west.

3.4.1 Option 3 Geometry

Each Option 3 roadway was given a unique designation as shown in **Table 3.4**.

Vertical profiles shown in **Table 3.5** and **Appendix 6** were developed for each alignment in Option 3 based on the Design Standards Memo. Because of the constrained interchange area and the cost-saving goal of landing the Median Connector south of the I-515 bridge over UPRR and east of the I-215 bridges over Gibson Road, it was not possible to meet the desired NDOT criteria of minimum vertical curve length of 1,000 feet for the beginning and ending sag vertical curves. Vertical curves shorter than 1,000 feet would not require an FHWA approved Design Exception as long as they still meet AASHTO criteria.

Minimum AASHTO desired criteria of three times design speed was met for all cases, and the minimum K values for SSD on crest vertical curves were achieved for all vertical curves.

Minimum AASHTO K values for comfort on sag vertical curves were met for all curves. SSD criteria based on headlights was not met for three sag curves. However, FHWA-approved Design Exceptions for SSD on sag vertical curves are not required. Highway lighting could mitigate this issue.

Horizontal curves shown in **Table 3.6** were developed for each alignment based on the Design Standards Memo. Superelevation transition diagrams are shown in **Appendix 8**. Design Exceptions for horizontal curvature are not needed for Option 3.

Table 3.4 Option 3 Roadway Designations

Designation	Roadway Name
ASD2	NB I-515 off-ramp to Auto Show Drive
ASSW	Ramp from Auto Show Drive to WB I-215
E	EB I-215/Lake Mead Parkway
EN	Existing & reconst. ramp from EB I-215 to NN I-515
EG	EB I-215 off ramp to Gibson Road
ES	Ramp from EB I-215 to SB I-11
L	Existing I-11/I-515
L-NB	NB I-11/I-515 shifted east to land MC
L-SB	SB I-11/I-515 shifted west to land MC
MC	Median connector between I-215 and I-515
NW	Ramp from NB I-11 to WB
P	Existing I-215
SE	Ramp from SB I-515 to EB
SW	SB I-515 to WB I-215
SWG	Ramp from SB I-515 to Gibson Road
W	WB Lake Mead Parkway/I-215
WN	WB Lake Mead Parkway to NB I-515

Figure 3.18 Option 3 Unchanged Central Interchange (Median Connector Not Shown)

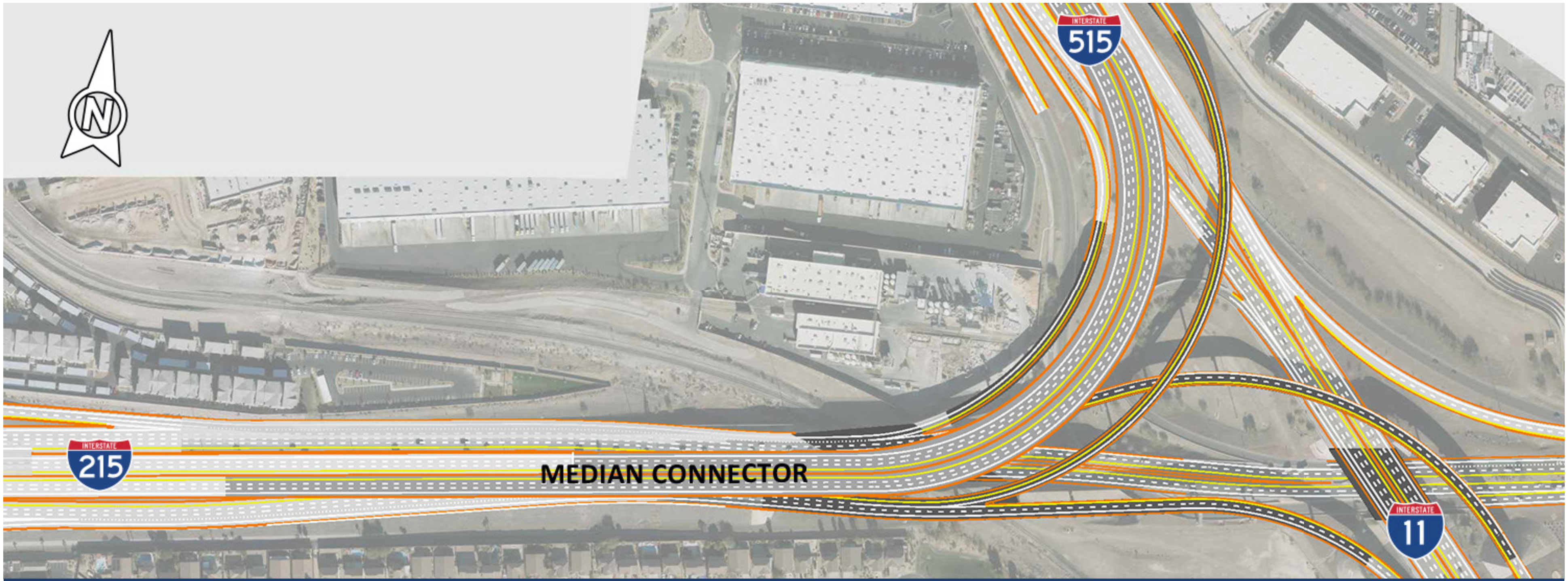


Figure 3.19 Option 3 Elevated Median Connector

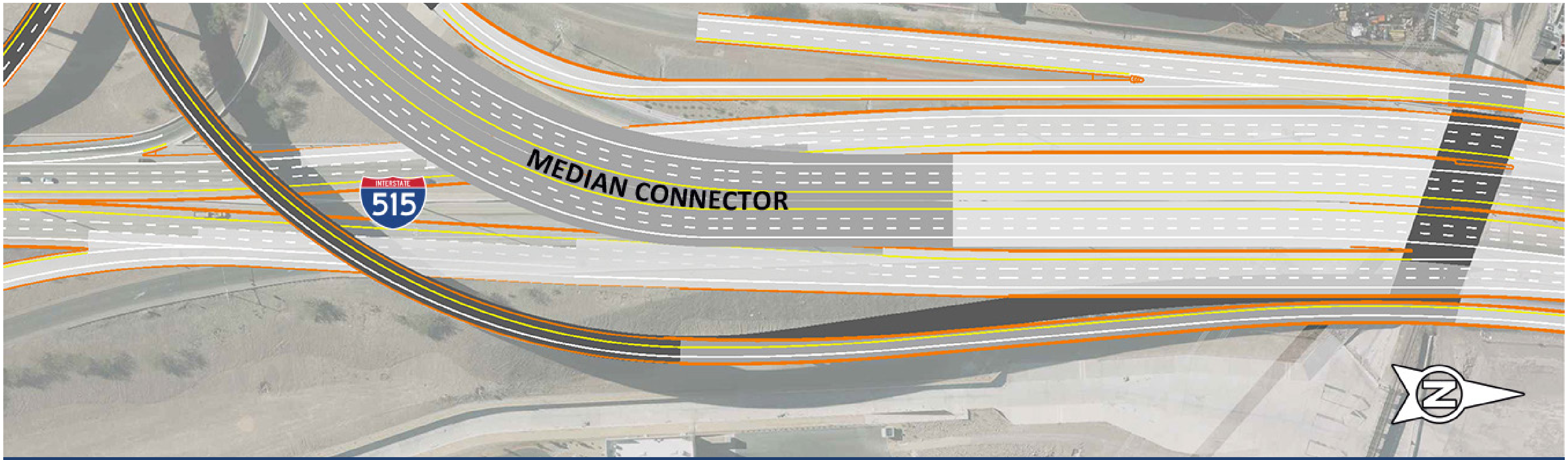


Figure 3.20 Option 3: Spreading I-515 for the Median Connector

Table 3.5 Option 3 Vertical Curve Summary

	PVI Sta	Length	K	V_d	Design Speed Met
ASD2	18+75.82	700	148	45	60 Headlight
ASSW	13+78.03	200	200	50	50 Crest
	16+51.25	300	48	50	50 Comfort, 35 Headllight
E	29+85.15	1,000	675	45	70 Headlight
	43+52.77	900	168	45	60 Headlight
	57+83.66	1,000	206	45	45 Crest
EG	19+42.52	600	240	60	65 Crest
	25+55.98	253	79	50	60 Comfort, 45 Headlight
ES	11+44.37	250	37	50	70 Headlight
	15+83.71	349	61	50	55 Crest
	29+17.24	1,000	676	50	55 Comfort, 40 Headlight
GW	15+69.00	500	155	45	60 Crest
L	347+94.00	1,000	292	70	70 Crest
	359+25.00	1,000	229	70	70 Headlight
	373+00.00	1,000	585	70	70 Crest
	398+50.00	1,000	872	70	70 Crest
L-NB	297+04.51	1,000	869	70	70 Crest
L-SB	190+04.01	300	1,152	70	70 Crest
	198+52.34	1,000	709	70	70 Crest
MC	168+58.80	600	261	65	70 Crest
	185+28.47	601	131	65	70 Headlight
	199+59.50	500	167	65	60 Crest
	206+89.54	400	113	45	50 Headlight
P	22+14.00	950	168	70	70 Crest
	35+20.41	800	539	70	70 Crest
	57+65.00	750	549	70	70 Crest
	68+92.00	1,000	297	70	70 Crest
SE	39+57.36	200	192	50	60 Crest
SS1	15+88.27	300	324	45	60 Crest
	23+00.00	200	63	35	45 Crest
SS2	13+00.00	100	119	35	55 Crest
ST1	11+81.19	150	42	25	35 Crest
	16+62.00	620	96	45	50 Headlight
ST2	18+93.32	350	160	45	65 Headlight

Table 3.5 Option 3 Vertical Curve Summary (cont.)

SWG	24+00.37	800	541	45	45 Comfort, 35 Headlight
	34+47.35	400	93	45	50 Crest
W	27+42.36	1,000	189.7	45	> 70 Headlight
	40+55.05	700	122.8	45	55 Crest
	58+26.55	700	417.5	50	> 70 Headlight
	76+47.85	750	463	70	70 Crest
WN	17+90.55	450	80	45	30 Headlight
	22+99.18	400	50	45	40 Crest

Table 3.6 Option 3 Horizontal Curve Summary

Table 3.6 - Option 3 Horizontal Curve Summary

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
ASD2	1	10+00.00	11+73.83	1,275	0.059	45	45
	2	23+39.03	24+80.62	3,000	0.031	45	45
ASSW	1	10+00.00	12+18.02	8,000	0.020	50	50
	2	13+23.90	14+79.62	2,000	0.051	50	50
	3	16+25.58	19+48.78	4,441	0.026	50	50
	4	19+48.78	22+47.97	4,441	0.026	50	50
E	1	22+41.74	26+29.70	4,982	0.041	70	70
	2	37+58.18	39+26.81	4,988	0.041	70	70
	3	39+26.81	44+80.68	15,488	0.020	70	70
	4	44+80.68	48+93.98	4,475	0.026	50	50
	5	50+75.23	54+89.88	3,555	0.032	50	50
	6	62+66.70	64+44.59	8,012	0.020	50	50
EG	1	10+00.00	13+13.29	8,000	0.026	70	70
	2	18+53.67	20+50.98	5,000	0.024	50	50
	3	26+65.26	26+94.02	65	0.071	15	15
ES	1	10+00.00	11+08.45	110	0.058	15	15
	2	14+96.82	16+04.55	6,000	0.024	55	55
	3	18+09.05	20+49.74	2,988	0.043	55	55
	4	21+63.94	25+54.70	5,018	0.028	55	55
	5	33+23.39	37+75.88	3,000	0.043	55	55
	6	41+10.81	44+44.22	2,825	0.045	55	55
	7	50+04.94	57+76.64	762	0.076	45	45
	8	59+45.26	63+55.30	7,050	0.020	55	55
	9	66+49.50	71+55.74	8,000	0.020	65	65

Table 3.6 Option 3 Horizontal Curve Summary (cont.)

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
GW	1	10+00.00	12+14.51	1,235	0.060	45	45
	2	12+14.51	16+90.53	3,330	0.028	45	45
	3	16+90.53	23+21.58	4,279	0.027	50	50
L	1	102+20.42	130+07.77	6,000	0.034	70	70
	2	187+89.09	216+11.67	6,254	0.033	70	70
	3	216+11.67	256+19.00	6,000	0.034	70	70
	4	269+14.11	278+63.87	3,000	0.062	70	70
	5	344+54.80	349+75.43	10,000	0.020	70	70
	6	394+23.48	408+21.62	3,000	0.062	70	70
	7	429+35.67	443+35.38	10,000	0.020	70	70
	8	465+35.63	471+78.45	10,000	0.020	70	70
	9	543+71.04	570+86.85	5,000	0.040	70	70
	10	606+92.87	624+28.39	4,000	0.049	70	70
	11	636+11.23	651+51.16	3,000	0.062	70	70
	12	679+07.60	714+96.16	4,000	0.049	70	70
	13	745+17.57	749+05.04	10,000	0.020	70	70
	14	761+46.49	764+73.71	5,000	0.040	70	70
	15	772+08.63	797+71.12	4,000	0.049	70	70
	16	803+21.47	828+96.78	5,000	0.040	70	70
	17	855+80.83	866+25.85	10,000	0.020	70	70
	18	925+90.33	938+96.40	2,881	0.064	70	70
	19	938+96.41	962+36.41	3,000	0.062	70	70
	20	962+36.42	978+03.82	5,501	0.037	70	70
	21	1009+16.92	1015+28.30	15,000	0.020	70	70
	22	1032+74.51	1048+80.65	3,000	0.062	70	70
	23	1077+62.15	1087+34.67	3,035	0.062	70	70
	24	1089+58.43	1093+32.49	1,494	0.080	70	70
	25	1098+50.34	1113+81.73	2,006	0.079	70	70
	26	1126+13.50	1133+59.85	1,500	0.080	70	70
L-NB	1	277+61.40	279+26.20	3,012	0.062	70	70
	2	289+32.65	290+95.48	2,976	0.063	70	70
	3	296+54.46	301+34.64	1,976	0.079	70	70
	4	301+34.64	307+87.93	2,929	0.064	70	70

Table 3.6 Option 3 Horizontal Curve Summary (cont.)

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
L-SB	1	179+24.91	181+85.99	3,976	0.049	70	70
	2	188+36.46	191+63.99	4,988	0.041	70	70
	3	194+74.41	200+91.50	1,988	0.079	70	70
MC	1	153+89.68	156+34.61	2,999	0.062	70	70
	2	158+08.64	161+75.19	12,049	0.020	65	65
	3	183+84.98	199+75.50	738	0.077	45	45
	4	206+28.85	209+97.02	3,000	0.062	70	70
NE	1	10+00.00	13+28.73	3,500	0.055	70	70
	2	18+43.05	19+90.48	6,000	0.020	50	50
	3	27+65.79	33+27.57	2,765	0.033	45	45
	4	35+23.22	38+28.26	163	0.078	25	25
NW	1	10+00.00	11+71.22	5,000	0.070	70	70
	2	24+83.62	36+54.00	912	0.071	45	35
	3	39+34.58	43+14.37	1,766	0.077	65	65
P	1	10+79.75	16+47.64	4,003	0.049	70	70
	2	16+47.64	21+39.43	4,000	0.049	70	70
	3	45+48.91	63+15.89	16,401	0.020	70	70
	4	63+15.89	67+00.21	16,401	0.020	70	70
	5	67+00.21	77+69.75	16,401	0.020	70	70
	6	210+33.57	220+84.44	22,201	0.020	70	70
	7	233+92.53	246+77.82	6,000	0.034	70	70
	8	326+64.80	373+06.82	3,535	0.055	70	70
	9	388+61.91	408+69.61	8,595	0.025	70	70
	10	416+45.99	452+72.45	7,640	0.027	70	70
	11	469+19.41	501+12.25	4,584	0.044	70	70
	12	501+12.25	531+87.26	7,639	0.027	70	70
	13	591+28.63	605+41.27	3,820	0.051	70	70
	14	644+05.66	667+75.25	4,800	0.042	70	70
SE	1	10+00.00	14+60.85	2,280	0.046	50	50
	2	21+56.34	31+13.41	4,465	0.026	50	50
	3	31+13.41	33+65.59	2,058	0.042	45	45
SS1	1	10+00.00	13+45.73	2,000	0.043	45	45
	2	14+95.43	17+59.26	2,000	0.043	45	45
	3	19+94.50	24+98.45	1,225	0.043	35	35

Table 3.6 Option 3 Horizontal Curve Summary (cont.)

Curve		PC Sta	PT Sta	Radius	e	V_d	DSM
SS2	1	12+36.15	19+28.41	1,435	0.055	35	35
ST1	1	10+00.00	10+75.39	440	0.053	25	25
	2	11+39.25	13+62.01	658	0.079	45	45
	3	15+03.49	21+82.43	1,856	0.046	45	45
ST2	1	13+00.00	20+85.32	2,590	0.035	45	45
SWG	1	10+00.00	10+61.46	589	0.080	45	45
	2	10+61.46	12+14.91	560	0.080	45	45
	3	12+14.91	15+97.50	2,755	0.033	45	45
	4	17+31.60	21+45.06	5,000	0.036	45	65
	5	28+15.52	29+77.96	2,000	0.051	45	50
	6	38+31.91	39+81.05	5,000	0.020	45	45
	7	39+81.05	41+79.40	15,000	0.020	45	45
W	1	13+89.07	15+66.28	7,976	0.020	45	45
	2	20+34.13	22+11.61	7,988	0.020	45	45
	3	30+11.69	32+33.69	1,976	0.044	45	45
	4	37+16.65	39+49.11	2,024	0.043	45	45
	5	43+32.63	46+23.40	2,791	0.039	50	50
	6	47+57.51	51+67.99	4,964	0.024	50	50
	7	66+62.46	69+03.21	7,988	0.021	60	60
	8	69+03.21	81+81.17	16,472	0.020	70	70
WN	1	1000	1759.5	5,000	0.020	45	45
	2	1759.5	2734.11	1,100	0.073	45	50

PVI Point of Vertical Inflection
PC Point of Curvature
K Rate of Vertical Curvature
PT Point of Tangency

Sta Station along Alignment
e Rate of Superelevation
Vd Design Speed
DSM Design Speed Met

3.4.2 Option 3 Structures

There are 27 existing structures within the project area. Existing structures were constructed around 2005 and are in good condition with remaining service life well beyond design year 2040. An assessment of existing structures is included in **Appendix 2**.

Option 3 retains 20 structures with no modifications needed:

- B-613 Culvert beneath I-215 1,200’ west of Stephanie
- B-2121 Culvert beneath I-215 1,100’ east of Stephanie
- G-1465 I-11 over UPRR
- G-1958 I-215 over UPRR
- H-1961 Arroyo Grande Boulevard over I-215
- H-2799S SB on-ramp from Auto Show over Ramp SE
- H-2799N NB off-ramp to Auto Show over Ramp WN
- H-2879S SB on-ramp from Galleria over SB ramp to Sunset
- H-2879N NB off-ramp to Galleria over NB ramp from Sunset
- I-1459L SB on-ramp from Galleria Drive over Sunset Road
- I-1459R NB off-ramp to Galleria over Sunset Road
- I-1464 I-11/I-515 over Lake Mead Parkway/I-215
- I-1466 Horizon Drive over I-11
- I-1960 Stephanie over I-215
- I-1962 Valle Verde Drive over I-215
- I-2108 Existing Ramp ES/EN flyover
- I-2110 Existing Ramp NW flyover
- I-2111Existing Ramp SW over existing Ramp SE
- I-2112 Existing I-215 over existing Ramp SE
- I-2881 Galleria Drive over I-515

Option 3 retains and widens 5 structures:

- G-1463 I-515 over UPRR
- H-1460 I-515 over Gibson Road
- H-1836 I-515 over Warm Springs Road
- I-1459 I-515 over Sunset Road
- I-1959 I-215 over Gibson Road

Bridge G-1463 is a single-span post-tensioned cast-in-place concrete box girder over UPRR with separate superstructures for NB and SB traffic. The original deck widths were 145 feet and a 2004 widening project increased the SB width by 55 feet for a total SB width of 200 feet. Option 3 would widen both the NB and SB decks as shown in **Figure 3.21**. New widening would be similar to the 2004 project with a closure pour at deck level. Although NDOT no longer designs new bridges to be founded on spread foundations behind MSE walls, the widened bridge decks would be supported by spread foundations comparable to the original and 2004 construction. The existing bridge appears to be in good condition despite two different MSE systems and previous widening.

Figure 3.21 Option 3 New and Widened I-515 Bridges over UPRR

Bridge H-1460 is a two-span post-tensioned cast-in-place concrete box girder over Gibson Road with separate superstructures for NB and SB traffic that would be widened on both sides for Option 3 as shown in **Figure 3.6** for Option 2A. This bridge has an acute skew angle, and the SB and NB decks are separated by a 1" wide longitudinal joint. The existing median barrier is wholly located on the SB structure and both structures are variable width due to on and off ramps from the north. The existing bridge exhibits cracking and spalling at the corners due to the high skew.

One additional column would be needed at each structure for the widening. With the acute skew the widening could exacerbate the horizontal rotation of the superstructure noted in the inspection report and this would need to be addressed in detailed design.

Bridge H-1836 is a single-span post-tensioned cast-in-place concrete box girder over Warm Springs Road with separate superstructures for NB and SB traffic that would be widened on both sides for Option 3 as shown in **Figure 3.7** for Option 2A. The existing bridge appears to be in good condition and there should be no unusual issues with widening in-kind.

Bridge I-1459 is a single-span post-tensioned cast-in-place concrete box girder over Sunset Road with separate superstructures for NB and SB traffic that would be widened on both sides for Option 3 as shown in **Figure 3.8** for Option 2A. The existing bridge appears to be in good condition with no unusual issues with widening in-kind.

Bridge I-1959 is a single-span post-tensioned cast-in-place concrete box girder over Gibson Road with separate superstructures for EB and WB traffic that would be widened for Option 3 on both sides as shown in **Figure 3.22**. South side widening would vary in width across the bridge.

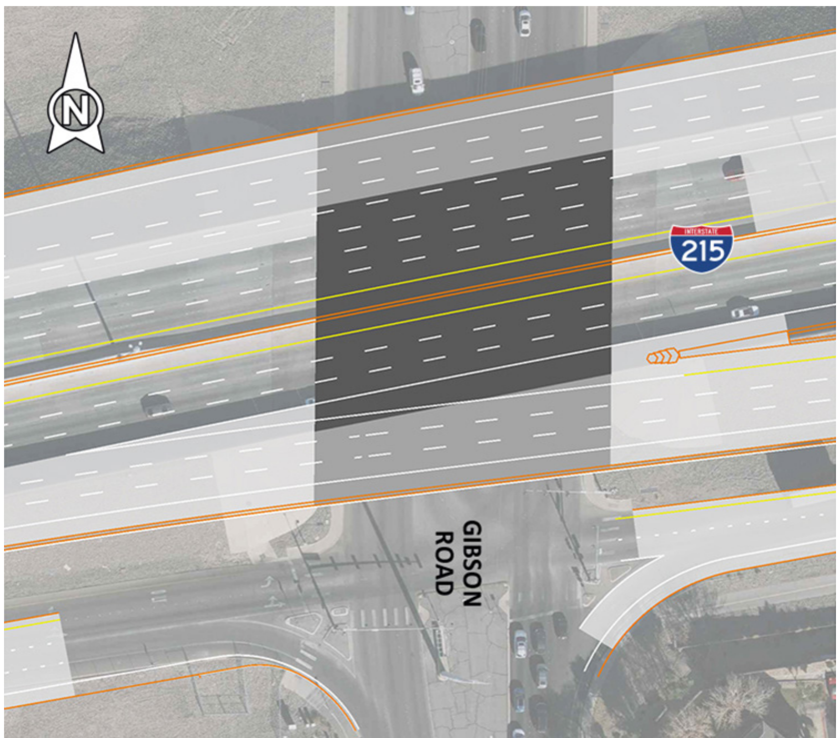


Figure 3.22 Option 3 I-215 Bridge Widening Over Gibson Road

Various modifications would be made to two structures for Option 3:

- I-2109 Existing Ramp EN flyover – The northern portion beyond Pier 9 would be demolished and reconstructed on an alignment shifted east to clear the widened I-515 lanes below as shown on **Figure 3.20**. The reconstructed bridge would be a steel plate girder structure matching the existing bridge.
- I-2747 Auto Show Drive over I-515 – No modification to the bridge, but Option 3 would open up the area beneath the bridge to widen the roadway.

Two new bridges would be constructed with Option 3:

- Median Connector
- New Ramp SE/SW over UPRR

The Median Connector structure would be carried by two separate three-lane bridges constructed above the existing interchange as shown in **Figure 3.19**. In order to maximize reuse of existing bridges, the existing I-215 lanes connecting to the existing, unchanged central system interchange would be spread beginning just west of the UPRR structures, with the Median Connector matching existing grade just east of the existing Gibson Road bridge. Similarly, the existing I-515 lanes would be spread just north of the Lake Mead Parkway/I-215 bridge, and the Median Connector would match existing grade just south of the UPRR structure. Abutment positions would be established to clear the existing roadways beneath the Median Connector bridges, and multiple straddle bents would be used to support the bridge above active roadways. Multiple bridge segments would be established to provide for expansion joints spaced between 1,000-1,200 feet apart, with maximum span length for a post-tensioned cast-in-place concrete box girder assumed by the study team to be 250 feet.

The Ramp SE/SW SB bridge over UPRR would be a single-span post-tensioned cast-in-place concrete box girder constructed on stub abutments behind MSE walls as shown in **Figure 3.21**. The abutments would be founded on extended foundations.

Option 3 would extend one culvert structure. The outlet of a culvert in the southwest corner of Lake Mead Parkway and Eastgate Road would be extended with a "fillet" to accommodate a pedestrian path as shown for Option 2A in **Figure 3.16**. It is anticipated by the study team that the culvert extension would be cast-in-place concrete structure similar to the existing culvert.

Retaining wall locations and heights would be determined during detailed design. In addition to cast-in-place or MSE walls constructed for new or widened bridges, MSE retaining walls are anticipated by the study team to be needed at the following locations for Option 3 to accommodate grade differentials where there is insufficient space to allow for sloping embankments:

» I-11 from Station “L” 276+00 to 344+00 to accommodate SB widening adjacent to a drainage channel
» Between the Median Connector and I-515 lanes
» Between the Median Connector and I-215 lanes
» Between new Ramp EN and the existing retention basin
» Between widened EB I-215 and the combined path between Gibson Road and Acacia Park
» Between widened WB I-215 and the north right-of-way east of Gibson Road
» Between the WB on-ramp from Gibson and the north right-of-way
» Between the EB off-ramp to Gibson and a culvert headwall

Similar to Option 2A, noise wall locations would be determined by a subsequent noise analysis to be conducted in a later phase of this project. Noise wall locations are anticipated by the study team to be needed at locations currently served by noise walls that would be disturbed by this project, and a currently unserved area between WB I-215 and apartment buildings constructed after the original interchange was built.

3.4.3 Option 3 Combined Path

There is an existing 12’ wide combined pedestrian and bicycle path along the south right-of-way of I-215 between Gibson Road and Acacia Park. Option 3 would reconstruct the EB on-ramp from Gibson Road to be closer to the combined path and the path would be reconstructed as needed to match the existing width.

3.4.4 Option 3 Guide Sign Concept Plan

A guide sign layout for Option 3 was prepared and included separately on roll Guide sign concept plans for Option 3 are included with this report as separate PDF roll plots (Attachment 2) and include the area along I-515 and I-11 between Galleria Drive (northern terminus) and Horizon Drive (southern terminus), and along Lake Mead Parkway (NV 564) and I-215 between Eastgate Road (eastern terminus) and Valle Verde Drive (western terminus). The guide sign concept plans include the guide signs for the system interchange and the following service interchange exit ramps:

» I-515: Auto Show Drive, Sunset Road, Galleria Drive (NB)
» I-215: Gibson Rodd, Stephanie Street, Valle Verde Drive (WB)

Challenges involved in developing the guide sign layout for Option 3 included:

» Each of the four legs of the system interchange have different route designations, specifically I-11 to the south, I-515 to the north, I-215 to the west, and Lake Mead Parkway (NV 564) to the east. This complicates the guide signing by requiring multiple route designations on the guide signs
» I-11 and I-515 carry the underlying route designations US 93 and US 95, adding to the number of route designations that need to be incorporated in the guide signs
» Closely spaced interchanges on I-215 and I-515 reduce the available distance between guide signs between these interchanges and the I-515/I-215 system interchange, as well as additional interchanges to the west on I-215 and to the north on I-515
» Option 3 includes two ramps from EB I-215 to NB I-515. The first ramp is the median crossover (EXIT 1A), a left exit three-lane ramp. The second ramp uses a shared exit to I-11 SOUTH (EXIT 1B) and utilizes the existing EB I-215 to NB I-515 flyover ramp. This creates two consecutive ramps signed to I-515 NORTH, one a left-side exit and the second a right-side exit. The second exit provides a connection to AUTO Show Drive, but due to the limitations on the number of destinations provided on a guide sign the Auto Show Drive destination is not shown on the guide signs prior to the exit. The guide signs for the two ramps from EB I-215 to I-515 NORTH are shown in **Figure 3.23**.

Conventional interchange signing was used for most of the interchange exit signs. Overhead Arrow Per Lane Guide signs were used for the SB I-515 to WB I-215 and EB I-215 to NB I-515 median crossover ramps, as well as the SB I-215 exit to Horizon Drive.

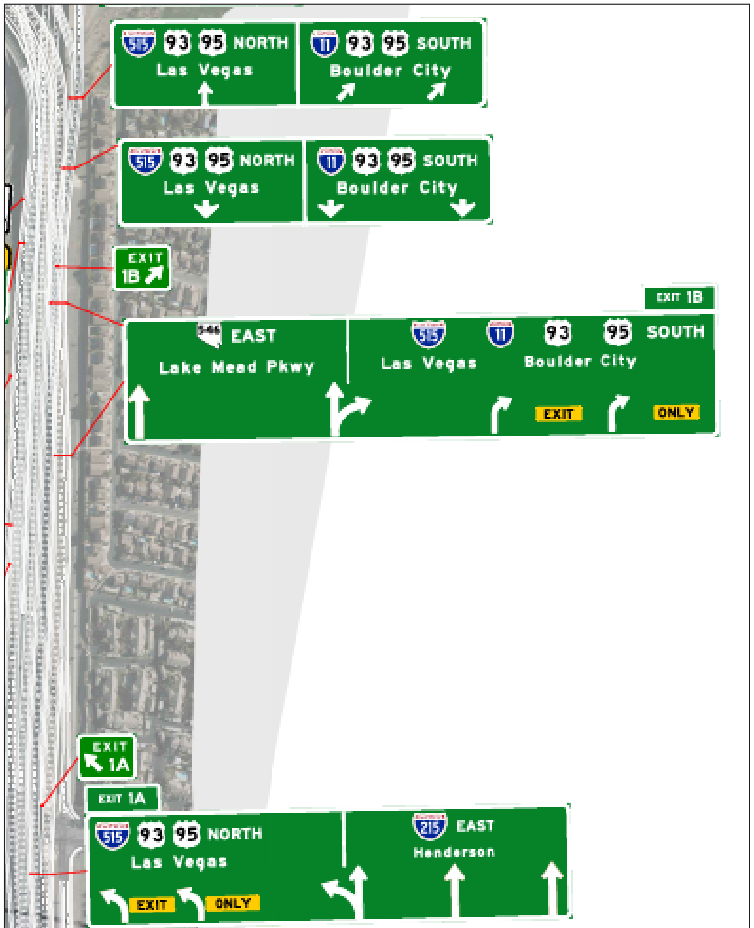


Figure 3.23 EB I-215 Two Exits to I-515 North

The Guide Sign Concept Plan for Option 3 includes Overhead Arrow Per Lane signs for the single lane NB exit to Auto Show Drive (EXIT 62).

3.4.5 Option 3 Earthwork

Earthwork calculations were prepared for Option 3 based on surfaces in the MicroStation project files and preliminary retaining wall layouts.

Estimated earthwork for Option 2A includes 23,000 cubic yards of excavation, 64,000 cubic yards of MSE (coarse sand) embankment, and 193,000 cubic yards of common embankment. The MSE embankment and approximately 170,000 cubic yards of the common embankment would need to be imported to the project area from approved borrow sites.

3.5 Potential Refinement of Option 3

Traffic operation performance for Option 3 as documented in Section 4 was found to be unsatisfactory because of EB congestion on I-215 due to weaving associated with the EB on-ramp from Gibson Road. The study team investigated whether Option 3 traffic operations could be improved by braiding the EB on-ramp traffic from Gibson Road. As shown in **Figure 3.24**, revising the layout of Option 3 to include braided ramps would be feasible, and the alternative was partially developed as "Option 3A".

Costs for Option 3A were derived by estimating the changes that would be needed from Option 3, including adding a braided ramp bridge carrying Ramp ES traffic over the EB Gibson Road on-ramp and lengthening the EB to NB Median Connector bridge to accommodate ramp braiding beneath. Based on the preliminary scoring of Option 3A presented in Section 6, showing that this alternative would not be scored better than the highest ranked alternative, the study team stopped further development of Option 3A.

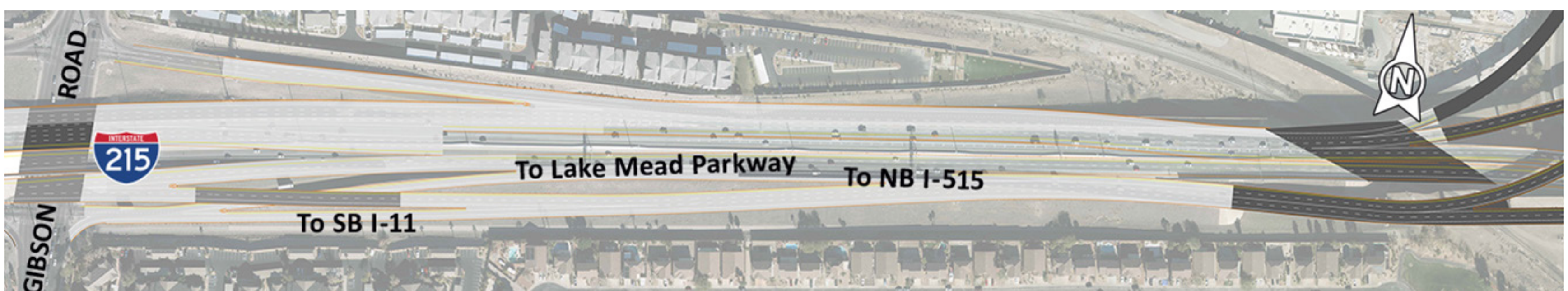


Figure 3.24 – Potential Ramp Braiding to Refine Option 3 into Option 3A

4.0 Traffic Operations Analysis

Traffic analysis of existing conditions, the No-Build alternative, and Build Alternative Option 1 were completed using the Aimsun Next traffic model developed and calibrated as part of the Feasibility Study. Traffic analysis and modeling of improved Option 2A and new Option 3 for this Henderson Interchange NEPA Project were completed using the same Aimsun Next model developed and calibrated for the Feasibility Study, with coding and associated improvements to include Options 2A and 3.

Results previously published in the Feasibility Study for Year 2017 existing condition, the Year 2040 No-Build alternative and Option 1 are presented alongside results for Year 2040 improved Option 2A and new Option 3 in this study. It should be noted, however, that Aimsun Next uses probabilistic modeling methodologies and comparisons of results from Feasibility Study models from more than a year earlier with improved Option 2A and new Option 3 modeled with this current study is not an apples-to-apples comparison. The consensus of the study team was that the results from the two separate modeling exercises would be sufficient to allow for evaluation of the improved Option 2A and new Option 3 alternatives with traffic operations results computed by the Feasibility Study for existing conditions, the No-Build alternative and Option 1.

The traffic modeling was completed within the "I-515/I-215 FS" subarea created in the Southern Nevada Aimsun Next model as part of the Feasibility Study. For the current project, two Build Alternatives (Option 2A and Option 3) were evaluated for the forecast year 2040 operations as part of this Project. Existing conditions, the No-Build alternative, and Build Alternative Option 1 were modeled with the previous Feasibility Study.

Two peak periods – AM peak (7:00 AM–9:00 AM) and PM peak (4:00 PM–6:00 PM) – were the periods for analysis. The year 2040 Origin Destination matrices and demands developed during the Feasibility Study for the "I-515/I-215 FS" subarea were used as is, without any modifications. The calibration parameters established during the Feasibility Study were applied for the evaluation of the two Build Alternatives. The traffic analysis and modeling intend to compare Option 2A's anticipated performance against Option 3 from a traffic operations perspective, and the new alternatives performance with the previously published results for Option 1 in the Feasibility Study.

4.1 Year 2017 Existing Conditions

The existing conditions Aimsun Next model was previously developed in the Feasibility Study to calibrate the traffic model to the year 2017 field traffic conditions and results are republished in this study. A calibrated model is necessary to evaluate future improvement alternatives. At the start of the Feasibility Study traffic modeling in early 2019, NDOT was constructing changes to the system interchange (I-515/I-215 Restriping Project). The most recent dataset available to calibrate the model that would not be influenced by 2017 restriping as available from the precursor Southern Nevada Traffic Study (SNTS). Therefore, the existing year traffic operations observations, as available from the calibrated Aimsun model, were from the year 2017. The following are the specific areas of the Year 2017 existing conditions (for the year 2017) transportation network where deficient traffic operations were observed:

- The I-215 EB to I-11 SB interchange ramp merges from two lanes to one lane and then joins the I-11 SB mainline. This lane reduction and ramp-merge, insufficient capacity, results in upstream queues (on the ramp itself and upstream, along I-215 EB) during peak periods of traffic.
- The weaving movement along I-215 EB, between the Gibson Road on-ramp and the system interchange ramps results in increased travel time and queues. This weaving movement impacts the traffic that can reach and be served by the system interchange ramps. Under existing conditions, the I-215 EB section between Gibson Road and the system interchange ramps experiences speeds as low as 50 mph and 40 mph during critical 15-minute peak periods of travel within the AM and the PM periods, respectively. The weaving distance and associated weaving capacity and system ramp capacity are insufficient.
- The I-215 EB system ramp merges on to I-515 NB, followed by the NB Auto Show Drive on-ramp merging on to the freeway. These ramp merges occur within about one-quarter mile, and neither of these ramps includes an auxiliary lane or a parallel acceleration lane. These successive (closely spaced) merges result in a slowdown (to approximately 50 mph) along the freeway. This slowdown also results in upstream queues on the system ramp.
- Occasionally, SB I-11 traffic exiting to Horizon Drive experiences queuing, resulting from deficiencies along Horizon Drive (at the Horizon Drive Interchange); these queues extend onto the mainline. When this queue

spillback occurs, freeway speeds as low as approximately 30 mph in the PM peak period were observed along I-11 SB just upstream of the Horizon Drive off-ramp. The Horizon Drive Interchange has poor operations resulting in queue spillback to I-11 SB.

» The SB I-515 to WB I-215 system-to-system ramp experiences significant increased travel time and queuing. Long queues occur on SB I-515 and block the SB on-ramp from Auto Show. There is insufficient capacity on the system ramp.

Freeway and ramp traffic operational results (density, speed, flow, demand volume) from the Aimsun Next model for the existing conditions (the year 2017) for the two-hour AM (7:00–9:00 AM) and PM (4:00–6:00 PM) modeling periods are included in **Appendix 1**.

As noted earlier, NDOT constructed interim improvements at the system interchange in the year 2019. NDOT's I-515/I-215 Restriping Project provided two-lanes for the SB I-515 to WB I-215 movement increasing its capacity. Additionally, a second lane was provided for most of the length of the EB I-215 to NB I-515 system ramp (moving the location of the merge to a single lane away from the existing weave section). Three compromises had to be made to accommodate these improvements:

1. Traffic on SB Auto Show Drive to I-515 lost access to WB I-215 and must use alternate routes (Gibson Road and Eastgate/Lake Mead Parkway) to access WB I-215.
2. Traffic on Lake Mead Parkway can no longer access Gibson Road directly and must use Stephanie Street or Eastgate Road. Delineation and a physical barrier prevent this access to Gibson Road.
3. One lane instead of two lanes serve WB Lake Mead Parkway traffic as it enters I-215 (one lane was repurposed to serve the SB to WB system ramp).

Since 2017, traffic volumes and increased travel time has worsened, with slower speeds and more queues experienced at all of the locations identified earlier. Additionally, queuing, and slow traffic is also observed on:

» The NB I-11 to WB I-215 ramp behind the reduction from two to one lane (along the system ramp)

» At the Eastgate intersection on Lake Mead Parkway

» On I-215 (within the Study Area)

4.2 Year 2040 No-Build Alternative

The No-Build alternative was modeled for Design Year 2040 by the previous Feasibility Study. and results are repeated in this document. In addition to the deficiencies observed with the existing conditions, by the year 2040, the demand for the I-215 EB system ramp to I-515 NB significantly exceeds the available capacity.

» In the year 2040 PM peak hour, a demand of more than 3,400 vehicles is projected along this existing one-lane ramp. This bottleneck is expected to result in extensive upstream queuing and increased travel time along I-215 EB

» This bottleneck results in queues that spillback onto the weaving section along I-215 EB, between the Gibson Road on-ramp and the system interchange ramps

» The interaction between these two bottlenecks results in severe queuing and increased travel time

» With the year 2040 No-Build Alternative, the I-215 EB section between Gibson Road and the system interchange ramps is expected to experience speeds as low as 20 mph in the PM peak period

» The impacts of this bottleneck and other adjacent upstream bottlenecks are expected to result in queues that extend for several miles upstream along I-215 EB

Similarly, the year 2040 traffic demands exceed the existing capacity for some of the other system-to-system ramp movements between the I-11, I-215 and I-515 freeways.

» The I-215 EB system ramp to I-11 SB is expected to have a year 2040 demand of approximately 3,000 vehicles per hour (vph) in the PM peak period. This demand significantly exceeds the available capacity of the existing one-lane ramp.

» The I-11 NB system ramp to I-215 WB and the I-515 SB system ramp to I-215 WB are expected to have a year 2040 demand of more than 2,000 vph. These demands exceed the available capacity of these existing one-lane ramps.

» Significant increased travel time and queuing are expected near the system interchange due to these ramps being overcapacity.

» Capacity improvements to the system interchange are needed to meet the projected year 2040 demand.

In the No-Build Alternative, WB Lake Mead Parkway drops from two lanes to one lane at the system interchange. This reduction in the number of lanes results in upstream queues that may extend to the Lake Mead Parkway/ Eastgate Road intersection. This bottleneck severely limits the number of vehicles that can travel west of here and along I-215 WB.

Along I-515 SB, with the No-Build Alternative, the Galleria Drive on-ramp and the Sunset Road on-ramp merge successively within about one-quarter mile, and neither of these ramps includes an auxiliary lane or a parallel acceleration lane. Further south, there are two closely spaced off-ramps to Auto Show Drive and I-215/Lake Mead Parkway. The interaction of these ramps, together with an increase in volumes by the year 2040, result in severe increased travel time along the freeway. The speeds along the freeway slow down to approximately 10 mph during certain critical 15-minute peak periods of travel within the PM period.

The year 2040 traffic demands at the Lake Mead Parkway/Eastgate Road intersection are expected to be significantly higher than the available capacity. This is expected to result in severe increased travel time and queuing at this intersection that prevents/delays vehicles in traveling through this intersection to the other parts of the network.

The I-11 NB on-ramp from Horizon Drive on-ramp is forecast to have a demand of more than 2,000 vph in the AM peak hour. Under the No-Build Alternative, this is a one-lane ramp, and it has a short acceleration lane on the freeway. This results in excessive queuing upstream past the ramp terminal intersection and along Horizon Drive.

Freeway and ramp traffic operational results (density, speed, flow, demand volume) from the Aimsun Next model for the year 2040 No-Build Alternative for the two-hour AM (7:00–9:00 AM) and PM (4:00–6:00 PM) modeling periods are included in **Appendix 1**.

4.3 Year 2040 Build Alternative Option 1

Build Alternative Option 1 was modeled for the Feasibility Study. Traffic operations analysis and modeling were completed iteratively and in coordination with the study team for the Feasibility Study to ensure that the proposed Build Alternative Option 1 would provide a satisfactory level of operations (better than the No-Build Alternative) for the design year of 2040.

- With Option 1, the ramps at the system interchange have sufficient capacity to handle the projected year 2040 demand. However, it is noted that the I-215 EB system ramp to I-515 NB will likely be near or at capacity by the year 2040. With Option 1, this ramp has three lanes that drop down to two lanes that merge onto I-515 NB.
- Option 1 includes braiding of the Gibson Road ramps along I-215 and the system interchange ramps. This significantly improves the operations along I-215 EB and WB near the system interchange. Freeway speeds of approximately 60 mph or greater are expected along I-215 near the system interchange in both the AM and the PM peak periods. However, a segment leading into the interchange, on EB I-215, is near capacity by the year 2040.
- Option 1 would also include two lanes for WB Lake Mead Parkway at the systemI-515/I-215 interchange. This alleviates the queuing upstream of here, that would be expected with the No-Build Alternative.
- Along I-515 SB, Option 1 includes auxiliary lanes for the Galleria Drive on-ramp and the Sunset Road on-ramp. The additional capacity on the freeway results in better operations and the freeway speeds are expected to be approximately 60 mph or greater in both the AM and the PM peak periods.
- Option 1 includes several improvements to the Lake Mead Parkway/ Eastgate Road intersection. These improvements greatly alleviate the increased travel time issues at this intersection and adequately process the traffic to the rest of the network. However, it is noted that this intersection will likely be near or at capacity by the year 2040. Furthermore, accommodation of a pedestrian crosswalk, at-grade, across the widened Lake Mead Parkway could be of concern due to the length of the crossing and the extent of exposure to vehicles. Traffic operations at the intersection traffic operation would fail if green time is apportioned to accommodate an at-grade pedestrian crossing of Lake Mead Parkway. Potential mitigation could include a grade-separated pedestrian crossing of Lake Mead Parkway.
- Option 1 proposes to improve the I-11 NB Horizon Drive on-ramp to be a two-lane ramp, with the I-515 NB section between Horizon Drive and the system interchange I-515/I-215 Interchange proposed to be improved to a five-lane section. This results in better operations for the Horizon Drive on-ramp, with all the demand processed through the ramp, onto the freeway.

Freeway and ramp traffic operational results (density, speed, flow, demand volume) from the Aimsun Next model for the year 2040 Build Alternative (Option 1) for the two-hour AM (7:00–9:00 AM) and PM (4:00–6:00 PM) modeling periods are included in **Appendix 1**.

4.4 Year 2040 Build Alternative Option 2A

Traffic operations analysis and modeling for the current study were completed iteratively and in coordination with the study team to ensure that the proposed Build Alternative Option 2A reflects the design intent and is evaluated for operational traffic results for the design year of 2040.

The following is a summary of observations on the year 2040 operations of Option 2A compared to that of the existing conditions:

- With Option 2A, the system ramps at the system interchange have sufficient capacity to handle the projected year 2040 demand.
- In the PM peak period, along I-215 EB, near the modeling area's western limits (Valle Verde Drive), the freeway is expected to have insufficient capacity to process the forecast demand. This would limit (meter) the traffic that could enter the system.
- With Option 2A, along I-215 EB, the ramp to I-515 NB is from the freeway's median (left-side exit). This configuration reduces the concentration of vehicles on the outside lanes of the freeway. The ramp to I-515 SB is located earlier, between the Gibson Road off- and on-ramps. This location for the I-515 SB off-ramp alleviates the weaving issue (that currently exists) between the Gibson Road on-ramp and the system interchange.
- Along I-215 WB, west of the Stephanie Street off-ramp, Option 2A includes lane drops to match the freeway's existing configuration. The lane drops, together with the weaving between the Stephanie Street on-ramp and the Valle Verde Drive off-ramp, is expected to result in increased travel time in both the AM and the PM peak periods. This increased travel time on the freeway results in queues on Stephanie Street because vehicles cannot quickly enter the freeway at the WB Stephanie Street on-ramp.
- Option 2A includes two lanes for WB Lake Mead Parkway at the system interchange. This additional lane alleviates the queuing upstream of here (compared to existing conditions).
- Option 2A includes several improvements to the Lake Mead Parkway/ Eastgate Road intersection. These improvements greatly alleviate the increased travel time issues at this intersection and adequately process the traffic to the rest of the network. However, it is noted that this intersection would likely be near or at capacity by the year 2040. Furthermore, accommodation of a pedestrian crosswalk, at-grade, across the widened Lake Mead Parkway could be of concern due to the length of the crossing and the extent of exposure to vehicles. Traffic operations at the intersection traffic operation would fail if green time is apportioned to accommodate an at-grade pedestrian crossing of Lake Mead Parkway. Potential mitigation could include a grade-separated pedestrian crossing of Lake Mead Parkway.
- Along I-515 SB, Option 2A includes auxiliary lanes for the Galleria Drive on-ramp and the Sunset Road on-ramp. This additional capacity results in better operations (compared to existing conditions) for the section between Sunset Road on-ramp and Auto Show Drive off-ramp.
- Option 2A improves the I-515 NB Horizon Drive on-ramp to be a two-lane ramp, with the I-515 NB section between Horizon Drive and the I-515/I-215 Interchange improved to a five-lane section. This five-lane section results in better operations for the Horizon Drive on-ramp, with all the demand processed through the ramp onto the freeway.
- Along I-515 NB, Option 2A includes an auxiliary lane between the Auto Show Drive on-ramp and the Sunset Road off-ramp. The freeway's additional capacity, provided by the auxiliary lane, results in better operations.

Freeway and ramp traffic operational results (density, speed, flow, demand volume) from the Aimsun Next model for the year 2040 Option 2A Build Alternative for the two-hour AM (7:00–9:00 AM) and PM (4:00–6:00 PM) modeling periods are included in **Appendix 1**.

4.5 Year 2040 Build Alternative Option 3

Traffic operations analysis and modeling for the current study were completed iteratively and in coordination with the study team.

The following is a summary of observations on the year 2040 operations of Option 3 compared to that of the existing conditions:

- With Option 3, the system ramps at the I-515/I-215 Interchange have sufficient capacity to handle the projected year 2040 demand.

- In the PM peak period, along I-215 EB, near the modeling area's western limits (Valle Verde Drive), the freeway is expected to have insufficient capacity to process the forecast demand. This would limit (meter) the traffic that could enter the system.
- With Option 3, along I-215 EB, the ramp to I-515 NB is from the freeway's median (left-side exit) and occurs earlier (compared to existing conditions) between the Gibson Road off-ramp and on-ramp. This left-side exit reduces the concentration of vehicles on the outside lanes of the freeway. However, the ramp to I-515 SB is expected to significantly increase in volume by the year 2040 (especially in the PM peak period). The majority of vehicles from Gibson Road on-ramp are destined to I-515 NB and are forced to weave across the vehicles destined to I-515 SB. This high-volume weaving section is expected to be a significant bottleneck, resulting in increased travel time upstream and freeway speeds as low as approximately 25 mph (as far upstream as in the area between Valle Verde Drive on-ramp and Stephanie Street off-ramp). The metering effect along I-215 EB described in the previous bullet masks this issue to a certain extent. However, when capacity improvements are made to the portion of the freeway west of this Project's limits, this weaving issue is expected to become critical and limit the traffic that could reach the I-515/I-215 Interchange.
- Along I-215 WB, west of the Stephanie Street off-ramp, Option 3 includes lane drops to match the freeway's existing configuration. The lane drops, together with the weaving between the Stephanie Street on-ramp and the Valle Verde Drive off-ramp, is expected to result in increased travel time in both the AM and the PM peak periods. This increased travel time results in queues along Stephanie Street because vehicles cannot quickly enter the freeway at the WB Stephanie Street on-ramp.
- Option 3 includes two lanes for WB Lake Mead Parkway at the I-515/I-215 Interchange. This additional lane alleviates the queuing upstream of here (compared to existing conditions).
- Option 3 includes several improvements to the Lake Mead Parkway/Eastgate Road intersection. These improvements greatly alleviate the increased travel time issues at this intersection and adequately process the traffic to the rest of the network. However, it is noted that this intersection would likely be near/at capacity by the year 2040. Furthermore, accommodation of a pedestrian crosswalk, at-grade, across the widened Lake Mead Parkway could be of concern due to the length of the crossing and the extent of exposure to vehicles. The intersection would fail if green time is apportioned to accommodate an at-grade pedestrian crossing of Lake Mead Parkway. Potential mitigation could include a grade-separated pedestrian crossing of Lake Mead Parkway.
- Along I-515 SB, Option 3 includes auxiliary lanes for the Galleria Drive on-ramp and the Sunset Road on-ramp. The additional capacity provided by the auxiliary lanes results in better operations (compared to existing conditions) for the section between Sunset Road on-ramp and Auto Show Drive off-ramp.
- Option 3 improves the I-515 NB Horizon Drive on-ramp to be a two-lane ramp, with the I-515 NB section between Horizon Drive and the I-515/I-215 Interchange proposed to be a five-lane section. This capacity improvement results in better operations for the Horizon Drive on-ramp, with all the demand processed through the ramp onto the freeway.
- With Option 3, along I-515 NB, the ramp from WB Lake Mead Parkway merges near the I-515/I-215 Interchange and has an acceleration lane. By the year 2040, during the AM peak period, this ramp is expected to have approximately 1,500 vph. There are four lane-drops and merges along a roughly one-mile stretch of the freeway downstream of this ramp. These successive lane-drops cause increased travel time in the freeway's outside lanes, with freeway speeds as low as 40 mph (in the section upstream of the Auto Show Drive on-ramp). This 40 mph reported speed is the average across all the freeway lanes; the inside lanes' speed is expected to be higher, and the outside lanes' speed is much lower than 40 mph.

Because of the increased travel time issues noted along I-215 EB (between Gibson Road on-ramp and the I-515/I-215 Interchange) and I-515 NB (north of the WB Lake Mead Parkway on-ramp), Build Alternative Option 3 is expected to have unsatisfactory traffic operations by the year 2040. Both Options 1 and 2A are expected to provide satisfactory traffic operations performance through year 2040.

Freeway and ramp traffic operational results (density, speed, flow, demand volume) from the Aimsun Next model for the year 2040 Build Alternative (Option 3) for the two-hour AM (7:00–9:00 AM) and PM (4:00–6:00 PM) modeling periods are included in **Appendix 1**.

4.6 Comparison of the Alternatives Based on Aimsun Next Model Results

Network/sub-area wide Measures of Effectiveness (MOEs) were determined and evaluated from the Aimsun Next model for the modeled alternatives. The following is a brief description of some of the key MOEs:

- Latent Vehicles: The number of vehicles expected to be processed in the traffic simulation but are not simulated because of the roadway network's limited physical capacity to process vehicles. The vehicles are outside of the model, not always because the entire system is saturated. Bottleneck locations near the boundaries of the model do not allow vehicles to proceed. In the absence of alternative routes, vehicles are backed up outside the model perimeter and unable to enter the network. If the bottleneck conditions are removed, the volume of the latent vehicles may see a significant reduction. Example: Consider a water distribution system where all the pipes are full, but there's still water in the reservoir trying to get into the pipe network for a given time. The water unable to enter due to inadequate capacity (and no alternate pipe available to satisfy the demand) is the latent demand (or latent vehicles for the roadway network).
- Latent Delay Time: The amount of time latent vehicles must wait to enter the network. In our water distribution system example, this would be how long the water in the reservoir would wait before entering the pipe system.
- Total Network Delay: This measures the amount of time each vehicle is delayed in the simulation and sums them all into a single delay time. The better the network operates, the lower the total network delay.
- Average Network Delay: This measures the average delay experienced by vehicles in the simulation. The better the network operates, the lower the average network delay.

Table 4.1 and Figure 4.1 includes a comparison of the network/sub-area MOEs for the two-hour AM (7:00–9:00 AM) and PM (4:00–6:00 PM) modeling periods for the modeled alternatives from the Feasibility Study (current year, No-Build and Option 1) and from the current study (Options 2A and 3).

Table 4.1 and **Appendix 1** show that all three build alternatives have only a few latent vehicles (ranging from 3-404 vehicles) during the AM peak period. These latent vehicles are due to lane drops along WB I-215, west of the Stephanie Street off-ramp. During the PM peak period, the higher number of latent vehicles observed (ranging from 4,200-6,146) are primarily due to bottlenecks along EB I-215 west of Stephanie Street. Improving the capacity of this stretch of I-215 is outside the scope of this Project.

Figure 4.1 illustrates the operation of the Build Alternative Options for one representative MOE (Total Network Delay) and shows the average and the standard deviation in Total Network Delay for both the AM and the PM modeling periods.

Figure 4.1 shows the Option 2A Crossover Interchange to have more latent vehicles than Options 1 and 3 in the PM period. Additionally, the Total Network Delay for Option 2A is higher than for Option 1 and slightly higher than Option 3 in the PM period. However, Option 3 is expected to have unsatisfactory traffic operations, and Build Alternatives Option 1 and 2A were noted to have no noticeable traffic operations issues. This lower performance by Option 2A on a network-wide basis is because of the model's entry conditions along I-215 EB and not due to any increased travel time issues along the study facilities. In Option 2A, more vehicles are concentrated in the outside lanes near the model entrance because of the Henderson Interchange system ramp configurations along I-215 EB. Because of capacity issues along I-215 EB at this location, some additional vehicles (compared to Options 1 and 3) cannot enter the model network. When capacity improvements are made to the portion of the freeway west of this Project's limits, it is expected that Option 2A would have better network/sub-area wide MOEs compared to Option 3.

The lack of capacity on I-215 west of the system interchange influences the network-wide performance to the extent that a clear differentiation between the Build Alternatives is not apparent (**Figure 4.1**). However, in examining the results on a segment-by-segment basis (**Appendix 1**), it becomes evident that Options 1 and 2 offer better traffic operations performance at critical locations than Option 3.

4.7 Sensitivity Analysis

As required for NEPA traffic modeling, future conditions for the roadways outside of the study area were established in accordance with the Regional

Transportation Plan that does not show widening of I-215 west of the study area nor widening of I-515 north of the study area beyond the three lanes in each direction that exists today. As noted in Section 4.6 above, the Aimsun Next model results for the build alternatives were skewed because traffic

Table 4.1 Network Performance

	Parameter	2017 Existing Condition*	Design Year 2040 No Action* Total	No Action* Absolute Difference*	No Action* Percent Difference		Option 1* Total	Option 1* Absolute Difference	Option 1* Percent Difference		Option 2A Total	Option 2A Absolute Difference	Option 2A Percent Difference		Option 3 Total	Option 3 Absolute Difference	Option 3 Percent Difference	
Network Performance AM Peak 7:00-9:00	**Total Traveled Distance (mi)**	**181,811**	**202,409**	**20,598**	**11%**		**256,327**	**53,918**	**27%**		**253,066**	**50,657**	**25%**		**254,428**	**52,019**	**26%**	
	Total Travel Time (hr)	**3,656**	**8,372**	**4,716**	**129%**		**5,899**	**2,473**	**30%**		**6,064**	**2,308**	**28%**		**6,284**	**2,088**	**25%**	
	Latent Vehicles (veh)	1	11,786	11,785		▲	3	11,783		▼	402	11,384		▼	404	11,382		▼
	Number of Arrived Vehicles	54,950	63,849	8,899	16%	▲	76,984	13,135	21%	▲	76,397	12,548	20%	▲	76,328	12,479	20%	▲
	Number of Active Vehicles	1,724	4,536	2,812	163%	▲	2,454	2,082	46%	▼	2,709	1,827	40%	▼	2,823	1,713	38%	▼
	Total Network Vehicles (veh)	**56,674**	**80,171**	**23,497**	**41%**		**79,441**	**730**	**1%**		**79,508**	**663**	**1%**		**79,555**	**616**	**1%**	
	Total Delay Time (hr, inside network)	1,522	5,304	3,782	248%		3,299	2,005	38%		3,823	1,481	28%		4,019	1,285	24%	
	Delay Time (sec/mi/veh, inside network	30	94	64	213%		46	48	51%		54	40	43%		57	37	39%	
	Latent Delay Time (hr)	-	2,408	2,408		▲	-	2,408		▼	66	2,342		▼	65	2,343		▼
	Total Network Delay (hr)	**1,522**	**7,712**	**6,190**	**407%**	▲	**3,299**	**4,413**	**57%**	▼	**3,889**	**3,823**	**50%**	▼	**4,084**	**3,628**	**47%**	▼
	Average Network Delay (sec/veh)	**97**	**346**	**249**	**257%**	▲	**150**	**196**	**57%**	▼	**176**	**170**	**49%**	▼	**185**	**161**	**47%**	▼
Network Performance PM Peak 4:00-6:00	**Total Traveled Distance (mi)**	**206,663**	**195,651**	**11,012**	**5%**		**257,959**	**62,308**	**32%**		**250,895**	**55,244**	**28%**		**255,173**	**59,522**	**30%**	
	Total Travel Time (hr)	**4,926**	**8,636**	**3,710**	**75%**		**7,206**	**1,430**	**17%**		**6,534**	**2,102**	**24%**		**6,974**	**1,662**	**19%**	
	Latent Vehicles (veh)	2	18,220	18,218		▲	4,200	14,020		▼	6,146	12,074		▼	5,145	13,075		▼
	Number of Arrived Vehicles	65,537	67,954	2,417	4%	▲	81,940	13,986	21%	▲	80,620	12,666	19%	▲	81,432	13,478	20%	▲
	Number of Active Vehicles	1,961	4,348	2,387	122%	▲	3,382	966	22%	▼	2,881	1,467	34%	▼	3,037	1,311	30%	▼
	Total Network Vehicles (veh)	**67,499**	**90,522**	**23,023**	**34%**		**89,521**	**1,001**	**1%**		**89,647**	**875**	**1%**		**89,614**	**908**	**1%**	
	Total Delay Time (hr, inside network)	2,445	6,021	3,576	146%		5,568	453	8%		4,896	1,125	19%		5,131	890	15%	
	Delay Time (sec/mi/veh, inside network	43	111	68	158%		78	33	30%		70	41	37%		72	39	35%	
	Latent Delay Time (hr)	-	3,981	3,981		▲	752	3,229		▼	1,268	2,713		▼	1,023	2,958		▼
	Total Network Delay (hr)	**2,445**	**10,002**	**7,557**	**309%**	▲	**6,320**	**3,682**	**37%**	▼	**6,164**	**3,838**	**38%**	▼	**6,154**	**3,848**	**38%**	▼
	Average Network Delay (sec/veh)	**130**	**398**	**268**	**206%**	▲	**254**	**144**	**36%**	▼	**248**	**150**	**38%**	▼	**247**	**151**	**38%**	▼

*2017 Existing Condition, No-Action, and Option 1 were modeled for the Feasibility Study

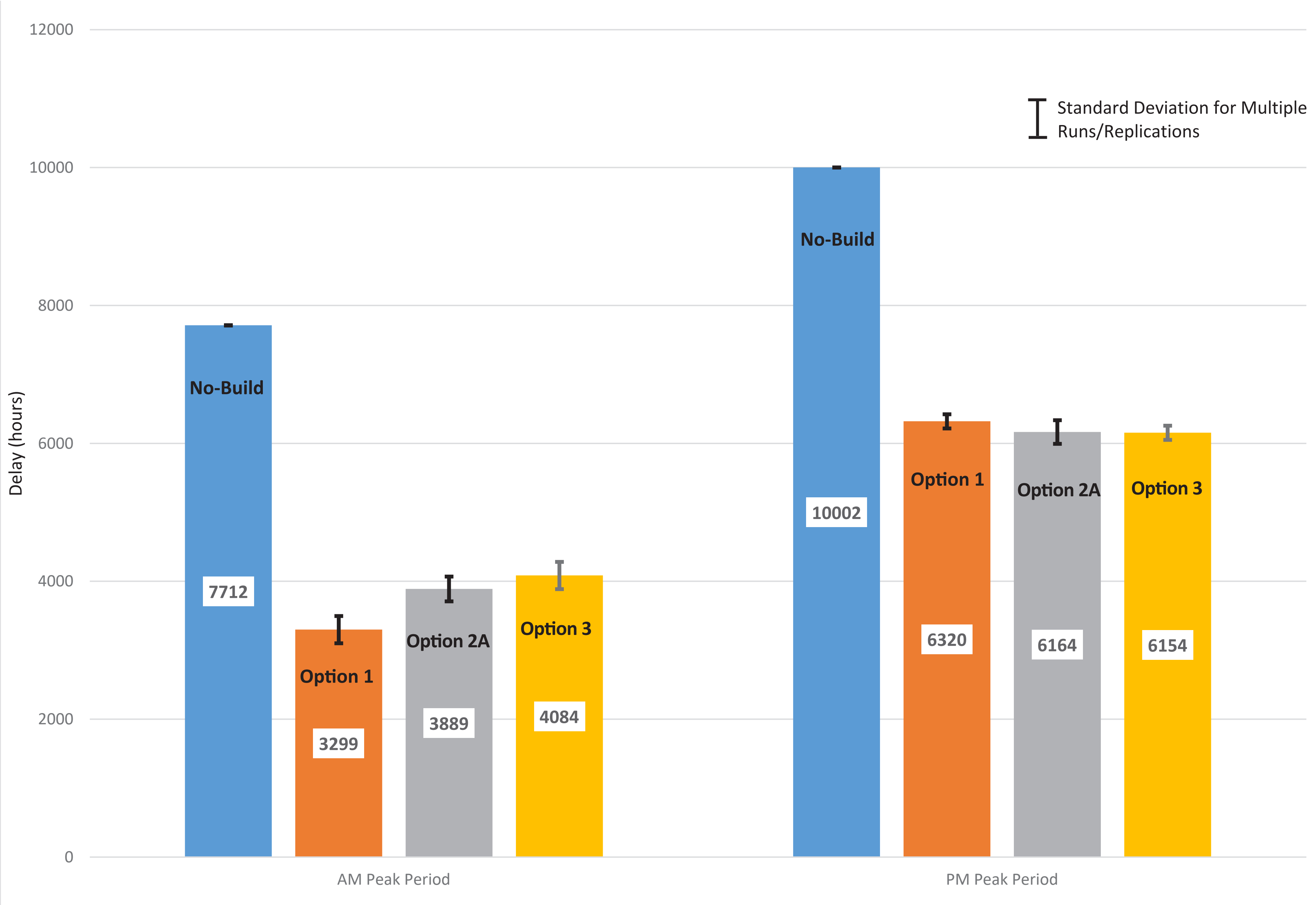


Figure 4.1 Total Network Delay (hours)

demand was constrained from entering the study area on I-215 by insufficient roadway capacity outside of the study area. The configuration of I-515 did not yield this issue.

EB I-215 is expected to have insufficient capacity to process the forecast demand in the PM peak period near the modeling area's western limits at Valle Verde Drive. This would limit (meter) the traffic that can enter the system. The study team was concerned that this could result in the Aimsun Next models erroneously indicating that the interchange configurations were adequate for year 2040 traffic volumes when in fact, the results were impacted by the traffic not being able to get to the interchange area because of external constraints.

Therefore, a sensitivity analysis was completed for the PM peak period, where the capacity of the I-215 EB freeway was increased (by the addition of a freeway lane) near the modeling area's western limits (Valle Verde Drive) in order to process the entire forecast demand to the Henderson Interchange. As part of the sensitivity analysis, the driver behavior parameters, at selected locations, were also made aggressive to process the traffic through the model network. The objective of the sensitivity analysis was to understand the operations of the build alternatives when the entire forecast demand is able to reach the system interchange. It should be noted that preliminary/conceptual studies have already been completed (or are underway) to widen I-215 for the provision of additional lanes and thereby increase the capacity of I-215.

Therefore, this sensitivity analysis accounts for planning activities that would reasonably result in more capacity along I-215.

The sensitivity analysis reinforces the observations made in Section 4.5 for Option 3. With the Option 3 sensitivity analysis, the weaving issue along I-215 EB between the Gibson Road on-ramp and the Henderson Interchange is confirmed as a significant bottleneck. This high-volume weaving section is expected to result in congestion as far upstream as in the area between the EB Valle Verde Drive on-ramp and EB Stephanie Street off-ramp and continuing eastward to the system interchange. This is shown in the Aimsun Next screenshots in **Figure 4.2** showing the backup and in **Figure 4.3** showing travel speeds. Only the eastbound conditions are appurtenant to this project, as westbound conditions are controlled by roadway configurations outside of the project area. With the Option 3 sensitivity analysis, by the end of the two-hour PM modeling period, more than 1,000 eastbound vehicles are expected to be backed up, unable to enter the model network because of this weaving issue. Eastbound mainline freeway speeds of 12 mph are predicted for Option 3 while Options 1 and 2A are predicted to have eastbound freeway speeds in excess of 55 mph. No critical issues related to the proposed improvements were observed in the sensitivity analysis for either Option 1 or Option 2A.

Table 4.2 and **Figure 4.4** show a summary comparison of the key MOEs for the No-Action Alternative and Build Alternative Options 1, 2A and 3. The No-Build and Option 1 MOEs were included with the Feasibility Study.

From **Table 4.2**, comparing the Total Network Delay for the sensitivity analysis scenarios, when the entire forecast demand is able to enter the model network, it can be seen that Options 1 and 2A are clearly better than Option 3.

It should be noted that the latent vehicles shown in **Table 4.2** for Options 1 and 2A sensitivity analysis, and a portion of the latent vehicles shown in **Table 4.2** for the Option 3 sensitivity analysis are vehicles that are backed up when trying to exit the model network in the westbound direction. These vehicles would not have an impact on the operations of the system interchange.

Table 4.2 Sensitivity Analysis PM Network Performance

	Parameter	2017 Existing Condition*	Design Year 2040															
			No Action*				Option 1				Option 2A				Option 3			
			Total	Absolute Difference*	Percent Difference		Total	Absolute Difference	Percent Difference		Total	Absolute Difference	Percent Difference		Total	Absolute Difference	Percent Difference	
Network Performance PM Peak 4:00-6:00	**Total Traveled Distance (mi)**	**206,663**	**195,651**	**11,012**	**5%**		**272,540**	**76,889**	**39%**		**267,879**	**72,228**	**37%**		**260,396**	**64,745**	**33%**	
	Total Travel Time (hr)	**4,926**	**8,636**	**3,710**	**75%**		**6,715**	**1,921**	**22%**		**6,645**	**1,991**	**23%**		**7,672**	**964**	**11%**	
	Latent Vehicles (veh)	2	18,220	18,218		▲	326	17,894		▼	1,910	16,310		▼	2,923	15,297		▼
	Number of Arrived Vehicles	65,537	67,954	2,417	4%	▲	86,030	18,076	27%	▲	84,526	16,572	24%	▲	82,700	14,746	22%	▲
	Number of Active Vehicles	1,961	4,348	2,387	122%	▲	2,794	1,554	36%	▼	2,809	1,539	35%	▼	3,690	658	15%	▼
	Total Network Vehicles (veh)	**67,499**	**90,522**	**23,023**	**34%**		**89,150**	**1,372**	**2%**		**89,245**	**1,277**	**1%**		**89,313**	**1,209**	**1%**	
	Total Delay Time (hr, inside network)	2,445	6,021	3,576	146%		4,404	1,617	27%		4,728	1,293	21%		5,424	597	10%	
	Delay Time (sec/mi/veh, inside network	43	111	68	158%		58	53	48%		64	47	43%		75	36	32%	
	Latent Delay Time (hr)	-	3,981	3,981		▲	37	3,944		▼	426	3,555		▼	574	3,407		▼
	Total Network Delay (hr)	**2,445**	**10,002**	**7,557**	**309%**	▲	**4,441**	**5,561**	**56%**	▼	**5,154**	**4,848**	**48%**	▼	**5,998**	**4,004**	**40%**	▼
	Average Network Delay (sec/veh)	**130**	**398**	**268**	**206%**	▲	**179**	**219**	**55%**	▼	**208**	**190**	**48%**	▼	**242**	**156**	**39%**	▼

*2017 Existing Condition and No-Action were modeled for the Feasibility Study

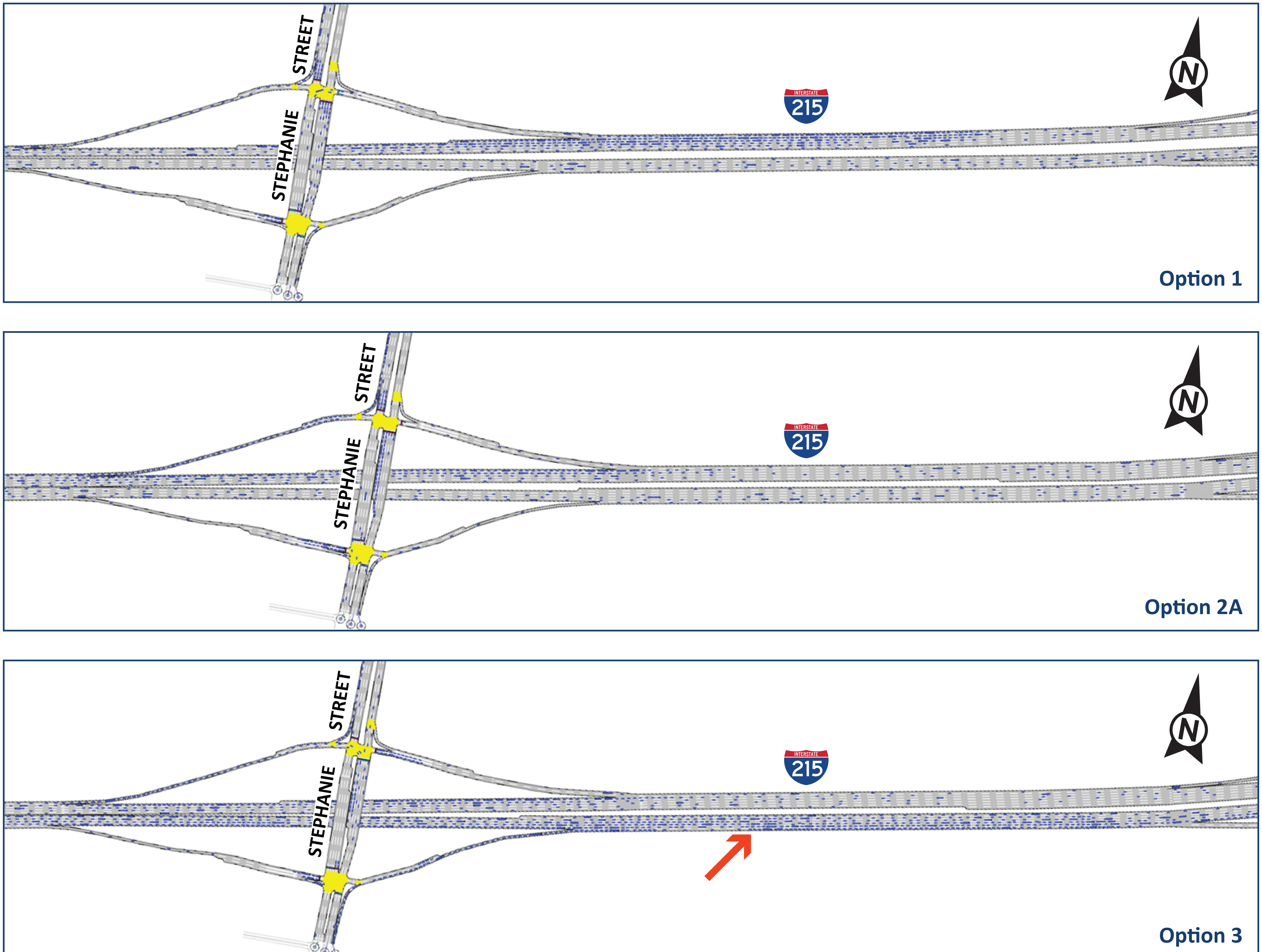


Figure 4.2 Aimsum Next Screenshots

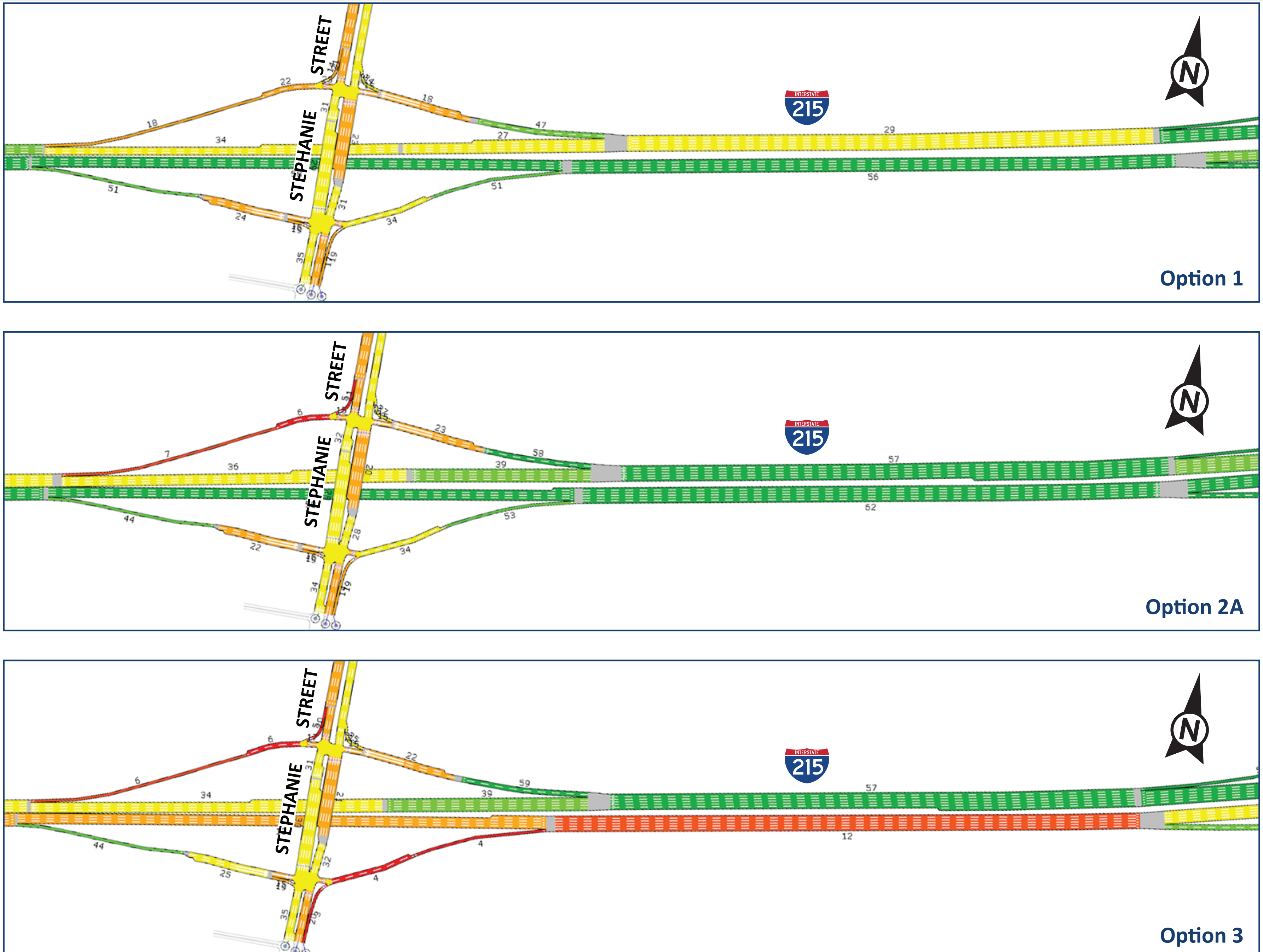


Figure 4.3 Predicted Travel Speed

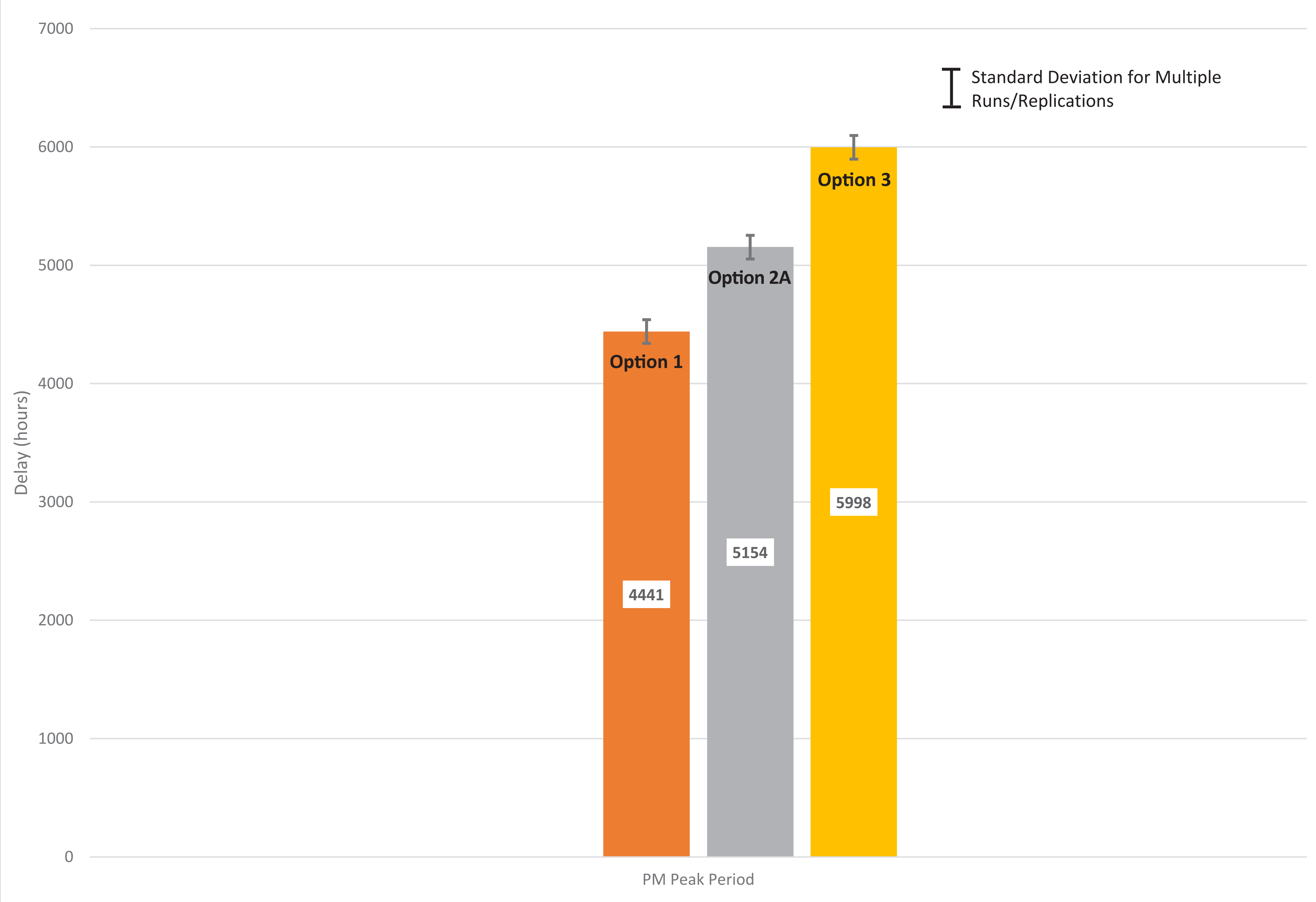


Figure 4.4 Sensitivity Analysis - PM Network Delays (hours)

5.0 Weaving Safety Analysis

5.1 Introduction

The study team identified two areas each in Options 2A and 3 for further study to ascertain whether proposed weaving segments would be predicted to be problematic for safety.

For Option 2A, the two areas included:

- NB I-515 where traffic from NB I-11 merges with traffic from EB I-215, and traffic from I-215 that wishes to exit at Auto Show Drive would need to weave across two lanes from I-11 within a length of approximately 1,610’ to reach the exit (**Figure 5.1**)
- WB I-215 where traffic from WB Lake Mead Parkway merges with traffic from NB I-11, and traffic from I-11 that wishes to exit at Gibson Road would need to weave across two lanes from Lake Mead Parkway within a length of approximately 2,350’ to reach the exit (**Figure 5.2**)

For Option 3, both areas are located between Gibson Road and the system interchange (**Figure 5.3**) and include:

- WB I-215 where traffic from I-11 merges with traffic from Lake Mead Parkway, and traffic from Lake Mead Parkway that wishes to exit at Gibson Road would need to weave across two lanes from I-11 within a length of approximately 1,720’ to reach the exit
- EB I-215 where the Gibson Road on-ramp is added on the right, and traffic from Gibson Road that wishes to reach Lake Mead Parkway would need to weave across two lanes of traffic from I-215 within a length of approximately 1,540’ to reach the lanes destined to Lake Mead Parkway

These weaves are not applicable for Option 1 because that alternative provides braided ramps to and from Gibson Road (no weaving) and because Option 1 would not accommodate access between Auto Show Drive and I-215. Therefore, Option 1 was not included in the weaving analysis.

5.2 Methodology

The study team recommended use of FHWA’s ISATe methodology to analyze the weaving segments. This methodology requires that both directions of travel be modeled for each segment, even when the area of interest is in only one direction. Therefore, three models were established to predict the safety performance of the four areas. Both areas of concern for Option 3 are addressed by a single model.

Each model was run with the weave allowed, and with the weave prohibited to ascertain the impact to traffic safety that would be predicted if each of the weaves of concern were allowed. In the field, weaves could be prohibited either by signage and enforcement, or by installation of physical barriers. The method of prohibiting the weave is immaterial to the ISATe weave analysis.

The study team conducted a sensitivity analysis to ascertain whether traffic volumes that are higher or lower than 2040 projections would materially impact predicted crash rates. The model results were extracted for the 2040 traffic projections and for traffic volumes higher than 2040 projections by 10%, 25%, 50%, and 100%. Based on traffic growth of approximately 0.5% per year, these increases would represent additional years of traffic growth beyond 2040 of approximately 19, 45, and 139 years, respectively. Similarly, predicted safety results for lower traffic volumes than 2040 projections were determined for reductions of 10%, 25%, 50% and 75%.

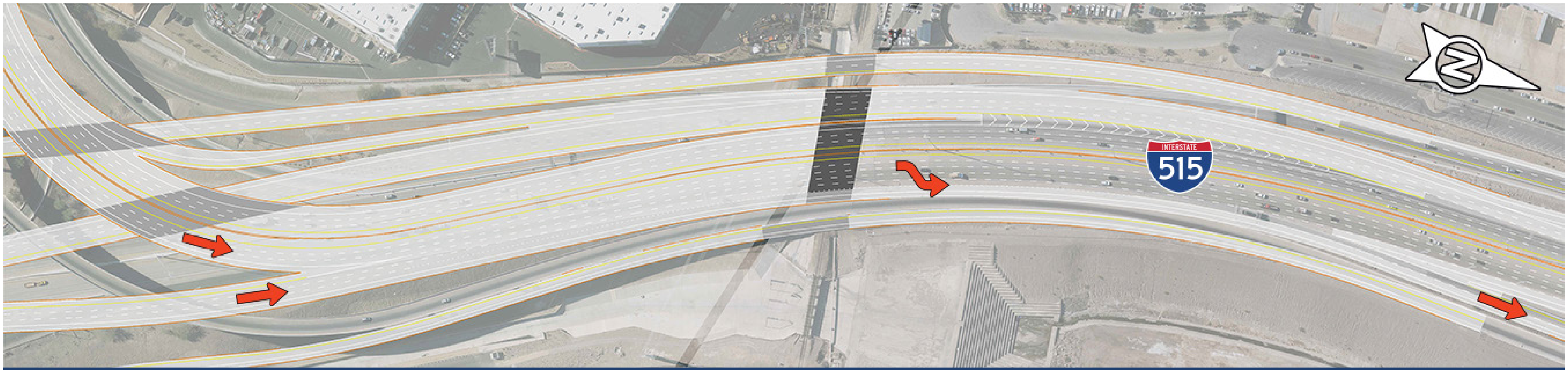


Figure 5.1 Option 2A NB Weave of Traffic from I-215 Across I-11 Traffic to Reach the Auto Show Exit

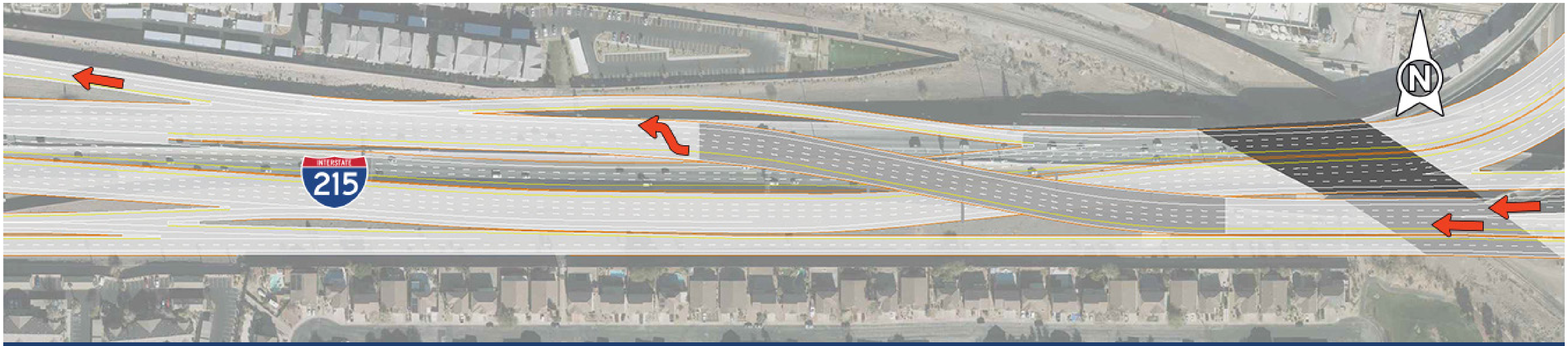


Figure 5.2 Option 2A WB Weave of Traffic from NB I-11 Across Lake Mead Parkway Traffic to Reach the Gibson Road Exit

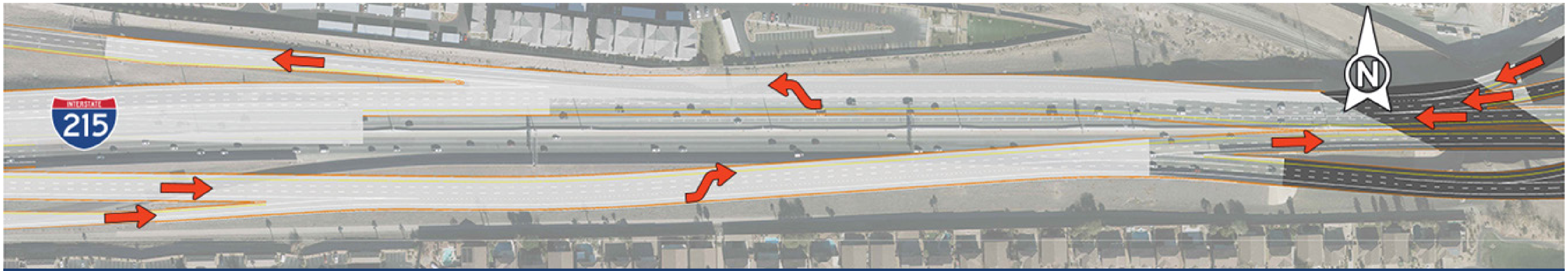


Figure 5.3 Option 3 EB and WB Weaves to and from Gibson Road

Table 5.1 ISATe Predicted Annual Crashes

Design Year 2040 Location	AADT	Predicted Crashes With Weave	Severity[1] K	A	B	C	PDO	Seg. Length	Location	AADT	Predicted Crashes No Weave	Severity[1] K	A	B	C	PDO
Option 2A I-515 NB/SB Segment[A]	100% Increase	59.9	0.2	0.5	3.1	12.5	43.6	0.38	Option 2A I-515 NB/SB Segment[B]	100% Increase	50.2	0.1	0.4	2.5	10.1	37.2
	50% Increase	36.2	0.1	0.3	2.2	8.0	25.5			50% Increase	30.6	0.1	0.3	1.8	6.5	22.0
	25% Increase	26.4	0.1	0.3	1.9	5.9	18.3			25% Increase	22.6	0.1	0.2	1.5	4.8	15.9
	10% Increase	21.4	0.1	0.3	1.7	4.7	14.6			10% Increase	18.4	0.1	0.2	1.4	3.9	12.8
	2040 AADT	18.3	0.1	0.2	1.6	3.9	12.5			2040 AADT	15.9	0.1	0.2	1.3	3.3	11.0
	10% Decrease	15.6	0.1	0.2	1.4	3.2	10.6			10% Decrease	13.6	0.1	0.2	1.2	2.7	9.4
	25% Decrease	12.0	0.1	0.2	1.3	2.3	8.2			25% Decrease	10.7	0.1	0.2	1.1	2.0	7.4
	50% Decrease	7.1	0.0	0.1	0.8	1.5	4.6			50% Decrease	6.4	0.0	0.1	0.7	1.3	4.3
	75% Decrease	3.1	0.0	0.1	0.4	0.7	1.9			75% Decrease	2.9	0.0	0.1	0.4	0.7	1.8
Option 2A I-215 EB-WB Segment[C]	100% Increase	61.0	0.2	0.5	3.1	13.8	43.5	0.48	Option 2A I-215 EB-WB Segment[D]	100% Increase	55.4	0.1	0.4	2.8	12.3	39.8
	50% Increase	38.4	0.1	0.3	2.3	8.9	26.8			50% Increase	35.2	0.1	0.3	2.0	8.0	24.7
	25% Increase	28.7	0.1	0.3	1.9	6.6	19.8			25% Increase	26.4	0.1	0.3	1.7	6.0	18.4
	10% Increase	23.5	0.1	0.2	1.7	5.3	16.1			10% Increase	21.7	0.1	0.2	1.6	4.8	15.1
	2040 AADT	20.2	0.1	0.2	1.6	4.5	13.9			2040 AADT	18.8	0.1	0.2	1.4	4.1	13.0
	10% Decrease	17.3	0.1	0.2	1.5	3.7	11.8			10% Decrease	16.1	0.1	0.2	1.3	3.4	11.2
	25% Decrease	13.3	0.1	0.2	1.3	2.6	9.2			25% Decrease	12.5	0.1	0.2	1.2	2.4	8.7
	50% Decrease	8.1	0.0	0.1	0.8	1.6	5.4			50% Decrease	7.7	0.0	0.1	0.8	1.5	5.2
	75% Decrease	3.7	0.0	0.1	0.4	0.8	2.4			75% Decrease	3.6	0.0	0.1	0.4	0.8	2.3
Option 3 I-215 EB-WB Segment[E]	100% Increase	67.7	0.2	0.5	3.5	15.2	48.3	0.43	Option 3 I-215 EB-WB Segment[F]	100% Increase	51.9	0.1	0.4	2.5	10.9	37.9
	50% Increase	41.6	0.1	0.4	2.6	9.7	28.8			50% Increase	32.4	0.1	0.3	1.9	7.1	23.1
	25% Increase	30.6	0.1	0.3	2.2	7.1	20.9			25% Increase	24.2	0.1	0.2	1.6	5.3	17.0
	10% Increase	24.8	0.1	0.3	1.9	5.7	16.8			10% Increase	19.9	0.1	0.2	1.5	4.3	13.9
	2040 AADT	21.3	0.1	0.3	1.8	4.8	14.4			2040 AADT	17.3	0.1	0.2	1.4	3.6	12.0
	10% Decrease	18.1	0.1	0.2	1.7	3.9	12.2			10% Decrease	14.9	0.1	0.2	1.3	3.0	10.4
	25% Decrease	14.0	0.1	0.2	1.4	2.8	9.4			25% Decrease	11.8	0.1	0.2	1.1	2.2	8.2
	50% Decrease	8.3	0.0	0.1	0.9	1.8	5.5			50% Decrease	7.2	0.0	0.1	0.7	1.5	4.9
	75% Decrease	3.7	0.0	0.1	0.4	0.9	2.3			75% Decrease	3.4	0.0	0.1	0.4	0.7	2.2

[1]Crash Severity Key
K=Fatality
A=Disabling (serious) injury
B=Evident injury
C=Possible (claimed) injury
PDO=Property damage only

Color Key
Equal to No-Weave Crash Rate (green)
Higher than No-Weave Crash Rate (yellow)

[A]Weave permitted in the NB direction
[B]No weave allowed in the NB direction
[C]Weave permitted in the WB direction
[D]No weave allowed in the WB direction
[E]Weave permitted in both the EB & WB directions
[F]No weave allowed in either the EB or WB direction

5.3 Results

ISATe analysis reports predicted crash numbers per year for varying severity types, including property damage only, possible (claimed) injury, evident injury, disabling injury and fatalities. For purposes of comparison of predicted crash rates between the weaves being prohibited or allowed, disabling injuries and fatalities are considered to be the most critical values. Predicted annual crashes are shown in **Table 5.1**.

Option 2A I-515 NB Segment – This freeway segment, with an approximate length of .38 miles, was analyzed with NB weaving movements between the intersecting segments of EB I-215 to NB I-515, NB I-11 to NB I-515 and the Auto Show NB off ramp. The total predicted average annual crash frequency for 2040 traffic projections was found to be approximately 18.3 crashes with the weave permitted, versus 15.9 crashes with the weave prohibited, an increase of approximately 15%. The number of fatal and disabling injury crashes combined for 2040 projections was predicted to be the same (0.3 crashes per year) both with and without the weave. Fatal crashes are predicted to be identical both with and without the weave for traffic volumes ranging from 75% less than 2040 projections to 50% more. Disabling injury crashes are predicted to be slightly (0.1) greater with the weave than without the weave for traffic volumes higher than 2040 traffic projections.

Option 2A I-215 WB Segment – This freeway segment, with an approximate length of .48 miles, was analyzed with WB weaving movements between the intersecting segments of NB-11 to WB I-215, WB LMP to WB I-215 and the Gibson Road WB off ramp. The total predicted average annual crash frequency for 2040 traffic projections was found to be approximately 20.2 crashes with the weave permitted, versus 18.8 crashes with the weave prohibited, an increase of approximately 7%. The number of fatal and disabling injury crashes combined for 2040 traffic projections was predicted to be the same (0.3 crashes per year) both with and without the weave. Fatal and disabling injury crashes are predicted to be identical both with and without the weave for traffic volumes ranging from 75% less than 2040 projections to 50% more.

Option 3 I-215 EB & WB Segment – This freeway segment, with an approximate length of .48 miles, was analyzed with WB weaving movements between the intersecting segments of NB-11 to WB I-215, WB LMP to WB I-215, from Auto Show on ramp and the Gibson Road WB off ramp. The freeway segment was analyzed with weaving movements between the intersecting segments of EB I-215 to SB I-11 and Gibson Road EB on-ramp to Lake Mead Parkway. The total predicted average crash frequency was found to be approximately 21.3 crashes with the weaves permitted versus 17.3 crashes with the weaves prohibited, an increase of approximately 23%. The number of combined fatal and serious injury crashes for projected 2040 traffic volumes is predicted to be approximately one-third higher (0.4 versus 0.3 crashes per year). Fatal and disabling injury crashes for traffic volumes greater than 2040 projections are predicted to similarly be higher with the weaves than without the weaves.

5.4 Conclusions and Recommendations

Allowing weaving movements versus prohibiting weaving movements would, in general, always result in greater numbers of crashes for any facility. In order for a highway interchange to be useful to motorists, some amount of weaving must be permitted so that motorists could reach their respective destinations.

Based on the predicted total numbers of crashes and the predicted fatal and disabling injury crashes for Option 2A, the study team recommends that the benefits to motorists that ensue from allowing the weaves likely outweighs the increase of property damage, possible injuries, and evident injury crashes. Further, the configuration of Option 2A could be modified to allow the NB exit to Auto Show without a weave by constructing a loop ramp in the northeast quadrant of the system interchange, with an approximate cost of $4–5 million (**Figure 5.4**). This loop ramp could be constructed with the current project or added at some later date without major modifications to the Option 2A configuration.

Figure 5.4 Option 2A: Optional Ramp from EB I-215 to Auto Show

The study team recommends that Option 2A continue to be considered as a feasible alternative, and that the benefit-cost analysis that would be performed in subsequent project development phases should consider whether:

» The benefit of permitting the weaves is greater than the predicted cost of increased crashes that could result from allowing the weaves, and

» The benefit of crash reductions from constructing a loop ramp to eliminate the NB weaving segment for Option 2A is greater than the estimated cost of constructing a loop ramp.

Based on the predicted total numbers of crashes and the predicted fatal and disabling crashes for Option 3, the study team recommends that the benefits to motorists that ensue from allowing the weaves may outweigh the increases to property damage, possible injury, evident injury, and disabling injury crashes and that the increase in predicted numbers of crashes should not be considered to be a fatal flaw for Option 3. The study team notes, however, that predicted increases to crash numbers would be greater for Option 3 than for Option 2A within the same section of highway between Gibson Road and the system interchange, as shown in **Table 5.2**. The study team recommends that this result be considered in the comparison between Options 2 and 3 that would be performed to identify a single Build Alternative.

Table 5.2 Comparison of Options 2A & 3

Predicted Crashes with Weave for I-215 between Gibson Road and the System Interchange		Severity				
		K	A	B	C	PDO
Option 2A	20.2	0.1	0.2	1.6	4.5	13.9
Option 3	21.3	0.1	0.3	1.8	4.8	14.4

The study team recommends that Option 3 continue to be considered as a feasible alternative but scored lower for safety than Option 2A.

6.0 Evaluation of Alternatives

Build alternatives evaluated include:

- Option 1 from the previous Feasibility Study
- Option 2A from the current project
- New Option 3 from the current project

6.1 Design Exceptions

The ten controlling criteria requiring FHWA concurrence on Design Exceptions are shown in **Table 6.1** along with a description of whether the criteria are met for each of the three build alternatives. Option 1 would require no design exceptions, Option 2A would require two design exceptions, and Option 3 would require four design exceptions. Design exceptions from FHWA for Stopping Sight Distance on sag vertical curves are not required.

6.2 Right-of-Way

Acquisition of additional right-of-way would not be needed for any of the Build Alternatives. Temporary Construction Easements may be needed for construction near right-of-way boundaries.

Right-of-way would not be a differentiating factor between alternatives.

6.3 Utility Impacts

As identified by the previous Feasibility Study, there are numerous underground and overhead utilities within the project area and some impact to utilities would result from any of the build alternatives. The anticipated utility impacts would be typical for construction projects of this magnitude, and no unusual impacts have been identified by the study team that would result in differentiation between the build alternatives.

Table 6.1 Design Exceptions

Criteria	Option 1	Option 2A	Option 3
Design Speed	No Deficiency	No Deficiency	See Stopping Sight Distance
Lane Width	No Deficiency	No Deficiency	No Deficiency
Shoulder Width	No Deficiency	Left and right Left and right shoulder width on existing Bridge H-2799N would be 2’ Multiple median locations where high-mast lighting foundations result in narrower shoulders	Left and right shoulder width on existing Bridge H-2799N (Ramp ASD2) would be 2’ Right shoulder of existing Bridge I-2110 (Ramp NW) would be 2’ Multiple median locations where high-mast lighting foundations result in narrower shoulders
Horizontal Curve Radius	No Deficiency	No Deficiency	No Deficiency
Superelevation Rate	No Deficiency	No Deficiency	No Deficiency
Stopping Sight Distance	No Deficiency	No Deficiency	SSD on existing Bridge I-2110 (Ramp NW) meets 35 mph instead of 45 mph
Maximum Grade	No Deficiency	No Deficiency	No Deficiency
Cross Slope	No Deficiency	No Deficiency	No Deficiency
Vertical Clearance	No Deficiency	No Deficiency	No Deficiency
Design Loading Structural Capacity	No Deficiency	No Deficiency	No Deficiency

6.4 Maintenance of Traffic During Construction

Reconstruction of a major interchange while maintaining traffic operations is feasible but challenging. Based on construction year traffic, the study team recommends that the existing numbers of lanes be maintained for each movement insofar as practical, that a minimum of two lanes in each direction should be maintained for I-11, I-515 and I-215 mainlines, and that at least one lane in each direction should be maintained for Lake Mead Parkway within the western interchange area between the I-515/I-11 on- and off-ramps. Maintaining the existing number of lanes, albeit with narrowed shoulders and narrowed lanes as applicable, is preferred. Construction phasing plans showing how the project could be constructed under traffic would be developed during a subsequent development phase for the single Build Alternative.

Certain elements are common to all three build alternatives. Widening of bridges over local roadways including Gibson Road, Warm Springs Road, and Sunset Road would require some lane restrictions and periodic closures. Reconstruction of on- and off-ramps such as for the Stephanie and Gibson service interchanges would necessitate temporary closures of the ramps with detours either to adjacent service interchanges or to temporary pavement as traffic volumes warrant. Widening of bridges and construction of new bridges over railroad spurs will need to be performed while rail traffic is maintained using railroad flaggers.

The construction phasing plan would need to be planned out to minimize impacts to motorists as practical. For example, the Ramp NW flyover bridge would need to be completed to maintain the north-to-west NW traffic prior to building Ramp EN and Ramp SW movements. Ramp ES movements would need to be constructed prior to Ramp NW.

6.4.1 Option 1

Phasing for construction of Option 1 could have the following broad components:

» Construct the new Ramp EN (EB to NB) flyover bridge to the point of conflict with the existing Ramp EN bridge so that the time when that movement would be detoured could be minimized

» Construct the MSE embankment for Ramp SW (SB to WB) up to the underside of the existing Ramp SW bridge so that the time when that movement would be detoured could be minimized

» Construct Ramp WN (WB to NB), WS (WB to SB), SE (SB to EB) and Ramp NE (NB to EB) improvements under traffic

» Identify acceptable detours for Ramp ES and Ramp NW to maintain traffic while those bridges are demolished and replaced

6.4.2 Option 2A

Maintenance of traffic for Option 2A was examined in greater detail than for Options 1 or 3 after the scoring of alternatives showed Option 2A to be the highest ranked build alternative. Conceptual plans showing five phases of construction were developed to show that construction of the system interchange for Option 2A under traffic is feasible. Conceptual MOT plans are included with this report as PDF roll plots (Attachment 3).

There could be many different ways to phase the construction and the concepts presented with this report show only one. The concepts may be refined and amended in a subsequent development phase, and even by a construction contractor. The conceptual plans show only the phases involved with the system interchange reconstruction and do not include details for reconstruction of service interchange ramps not directly associated with system interchange reconstruction.

Twelve traffic movements would need to be maintained or detoured during construction as shown in **Table 6.2**. Phasing for construction of Option 2A could have the following broad components:

» **Phase I**

- Restripe existing roadways to have narrower lanes to a minimum of 10’ and narrow shoulders to a minimum of 2’ in the current location of each roadway
- Construct proposed elements that are outside the footprint of the traffic being maintained, such as Ramps ES (EB to SB), NE (NB to EB), WN (WB to NB) and portions of Ramp SE (SB to EB) and WS (WB to SB)
- Construct temporary pavement for Ramp NW (NB to WB) that will be used in the next phase
- Construct the "spread" lanes of I-215 and I-515 outside of the mainline travel lanes where the median connector would be landed
- Widen WB Lake Mead Parkway from Eastgate to the freeway underpass

- Phase II
  - Relocate all E-W traffic to the at-grade lower level of the eastern crossover on Lake Mead Parkway so that traffic in both directions can be maintained on what will ultimately become the lower-level roadway
  - Construct the eastern crossover structure and elevated pavement for the new WB Lake Mead Parkway
  - Construct a portion of Ramps NW (NB to WB) and WS (WB to SB),
  - Construct portions of what will become the lower of the western crossover adjacent to the UPRR crossing
- Phase III
  - Detour the EB on-ramp from Gibson Road to adjacent interchange(s)
  - Detour Ramp SE (SB to EB) to adjacent interchange(s)
  - Construct a portion of the median connector
  - Complete the remainder of new Ramp NW (NB to WB)
- Phase IV
  - Construct a portion of the western crossover structure
  - Construct a portion of the median connector
- Phase V
  - Demolish portions of the existing Ramp EN bridge and implement crossover operation
  - Construct remaining elements of the median connector and the western crossover bridge
  - Open full interchange to traffic

Table 6.2 Option 2A Maintenance of Traffic Movements

Movement	Construction Year Peak Hour Volume	Recommended # Lanes
Eastbound	2,220 vph	2
Eastbound to Northbound	2,180 vph	2
Eastbound to Southbound	2,290 vph	2
Westbound	2,830 vph	2
Westbound to Northbound	950 vph	1
Westbound to Southbound	170 vph	1
Northbound	3,090 vph	3
Northbound to Eastbound	620 vph	1
Northbound to Westbound	1,660 vph	1
Southbound	2,840 vph	2
Southbound to Eastbound	1,190 vph	1
Southbound to Westbound	2,230 vph	2

There may be brief times when a system interchange ramp would need to be taken out of service for short term construction efforts or to restripe for a new construction phase. It would be possible to detour traffic to adjacent service interchanges to provide access to motorists. As an example, the westbound lanes on the Horizon Drive bridge over I-11 could be restriped for three narrower lanes, with the left-most lane used to implement a free movement "Texas Turnaround" separated from the signal-controlled traffic by reboundable delineator posts. The Texas Turnaround could be employed in the event that it becomes necessary to close Ramp SE (SB to EB) or Ramp EN (EB to NB).

6.4.3 Option 3

Phasing for construction of Option 3 could be less costly than for Options 1 or 2 because the majority of the central system interchange would be retained. Ramp EN movements would need to be temporarily detoured to allow for reconstruction of the northern portion of the bridge on a new alignment, and the majority of construction of "spread" lanes on I-215 and I-515 to accommodate the Median Connector could be accomplished while traffic is maintained on existing roadways.

Construction of the elevated Median Connector flyover bridge on straddle bents could require intermittent full nighttime closures of roadways underneath during certain overhead operations.

6.4.4 Maintenance of Traffic Costs

Costs for maintenance of traffic during construction are estimated as a percentage of total construction costs. The percentage used for Options 1 and 2 was 10% and a lower value of 8% was used for Option 3 because maintenance of traffic costs for Option 3 that retains much of the existing system interchange would be less than for the other alternatives.

6.5 Environmental Considerations

The Feasibility Study considered potential environmental impacts for each of the ideas that were considered for inclusion with build alternatives. Each of the build alternatives are anticipated to have similar environmental impacts resulting from noise, appearance, and constructing improvements closer to the combined path adjacent to the south right-of-way line of I-215 east of Gibson Road.

For purposes of this report, environmental considerations would not be a differentiating factor between the build alternatives.

6.6 Project Costs

NDOT developed and maintains a spreadsheet based conceptual cost estimating tool known as the Wizard. The spreadsheet allows the user to input quantities for generalized items such as widening, new roadways, bridges, walls, demolition, etc. and returns costs that are based on unit prices for previous construction projects. Project costs were estimated based on use of NDOT's Wizard spreadsheet for construction year 2021 and are presented in **Table 6.3**. Raw costs calculated by the Wizard spreadsheet were further refined using Cost Risk Assessment factors developed during the Feasibility Study to estimate the 70th percentile cost estimates for the anticipated Year of Expenditure (YOE) of 2027, shown in **Table 6.4**. Quantities were estimated based on preliminary 15% plans for each option.

Conceptual estimates by Value Analysis workshop participants anticipated that new Option 3 would result in project cost savings of approximately $51.3 million over Feasibility Study Option 1. The actual YOE project cost reduction was approximately $31.1 million.

Table 6.3 Wizard Year 2021 Capital Cost

Item	Option 1	Option 2A	Option 3
Roadway	$37,543,929	$50,518,602	$42,905,382
Bridge	$126,947,569	$72,621,315	$103,821,751
Walls	$8,716,060	$15,947,467	$16,766,510
Traffic Signals	$667,667	$667,667	$667,667
Demolition	$9,768,180	$11,722,995	$4,011,058
Additional Items	$18,364,341	$15,147,805	$16,817,237
Erosion Control	$1,010,039	$833,129	$924,948
Traffic Control	$20,200,775	$16,662,585	$14,799,169
Roadside Safety	$6,060,232	$4,998,776	$5,549,688
Landscape & Aesthetics	$6,060,232	$4,998,776	$5,549,688
Mobilization	$16,473,732	$13,588,338	$14,826,917
Construction Engineering	$17,626,893	$14,539,522	$15,864,801
Engineers Estimate of Probable Construction Cost	**$269,439,649**	**$222,246,977**	**$242,504,816**
Preliminary Engineering	$5,388,793	$4,444,940	$4,850,096
R/W Engineering	$5,233	$5,233	$5,233
Final Engineering	$5,388,793	$4,444,940	$4,850,096
NEPA	$538,879	$444,494	$485,010
Administration	$2,694,396	$2,222,470	$2,425,048
Legal	$2,694,396	$2,222,470	$2,425,048
Environmental	$0	$0	$0
Engineers Estimate of Probable Project Cost	**$286,150,139**	**$236,031,524**	**$257,545,347**

Table 6.4 70th Percentile Year of Expenditure 2023 Capital Cost

Item	Option 1	Option 2A	Option 3
Engineers Estimate of Probable Construction Cost	$291,400,000	$253,700,000	$262,600,000
Engineers Estimate of Probable Project Cost	$307,700,000	$261,400,000	$276,600,000

Conceptual estimates by Value Analysis workshop participants anticipated that improved Option 2A would result in project cost savings of approximately $50.3 million over Feasibility Study Option 2. The actual YOE project cost reduction was approximately $1.3 million.

Cost savings calculated during VA workshops are estimated using incomplete information at a conceptual level, and it is not unusual for workshop estimates to differ greatly from estimates that benefit from subsequent design efforts. A further advantage of Option 3 over Option 1, and of Option 2A over Feasibility Study Option 2 is that future physical HOV improvements such as roadway lanes and wider bridge decks are incorporated into the original construction for Option 2A and for new Option 3, whereas Feasibility Study Options 1 and 2 would require additional construction with associated construction costs. The extra lanes would be marked as closed on opening day, and future use of these lanes as either general purpose or HOV lanes could be accomplished with a restriping project.

6.7 Future Operations and Maintenance Costs

Future operations and maintenance (O&M) costs include regular maintenance of constructed elements, including but not limited to roadway pavement, signs, pavement marking, lighting, traffic control devices, bridges, retaining walls, and noise walls. The number of lanes is very similar for each of the three build alternatives, as is the area of retaining walls and sound walls. Signs, lighting, and traffic control devices would also be similar for each of the alternatives. The area of bridge deck, both existing and new, differs between the alternatives and the cost to maintain bridges would therefore be the primary differentiator between the alternatives. The area of existing bridge deck within the project area is approximately 789,330 square feet.

6.7.1 Option 1

Option 1 would retain approximately 395,020 square feet of existing bridge deck that was constructed around 2005. The bridges are in generally good condition and have remaining service life, but the existing bridge decks would be expected to require maintenance sooner than new bridge decks constructed with this project.

Option 1 would construct approximately 592,250 square feet of new bridge deck, for a total bridge deck area requiring future maintenance of approximately 987,270 square feet. New deck area would represent approximately 60% of the total bridge area. Based on unit prices for bridge maintenance published in the Feasibility Study, the bridge maintenance cost for Option 1 is estimated to be approximately $274,000 per year, or $5.5 million over 20 years.

6.7.2 Option 2A

Option 2A would retain approximately 432,100 square feet of existing bridge deck that was constructed around 2005. The bridges are in generally good condition and have remaining service life, but the existing bridge decks would be expected to require maintenance sooner than new bridge decks constructed with this project.

Option 2A would construct approximately 275,060 square feet of new bridge deck, for a total bridge deck area requiring future maintenance of approximately 707,160 square feet. New deck area would represent approximately 39% of the total bridge area. Based on unit prices for bridge maintenance published in the Feasibility Study, the bridge maintenance cost for Option 2A is estimated to be approximately $197,000 per year, or $3.9 million over 20 years.

6.7.2 Option 3

Option 3 would retain approximately 754,570 square feet of existing bridge deck that was constructed around 2005. The bridges are in generally good condition and have remaining service life, but the existing bridge decks would be expected to require maintenance sooner than new bridge decks constructed with this project.

Option 3 would construct approximately 477,790 square feet of new bridge deck, for a total bridge deck area requiring future maintenance of approximately 1,232,360 square feet. New deck area would represent approximately 39% of the total bridge area.

Although it may appear to be counterintuitive, Option 3 that retains the greatest area of existing bridge deck actually results in construction of more new bridge deck area than Option 2A and results in a total bridge deck area that would require future maintenance exceeding the areas of both Options 1 and 2A. The total area of Option 3 bridge deck exceeds the Option 1 area by 25% and exceeds the Option 2A area by 74%.

Based on unit prices for bridge maintenance published in the Feasibility Study, the bridge maintenance cost for Option 3 is estimated to be approximately $369,000 per year, or $7.4 million over 20 years.

6.8 Cost to Add Future Capacity

Future costs may also include implementation of HOV lanes to connect future HOV lanes on I-215 with future HOV lanes on I-515. As reported in the Feasibility Study, the estimated cost in current year dollars to construct HOV connectivity for the Option 1 configuration would be approximately $25 million. Based on recommendations from the VA Study, both Options 2A and 3 construct the physical improvements that would be needed for future HOV connectivity with the initial project, and the future cost to add HOV connectivity would be negligible, with only signing and pavement marking revisions needed.

6.9 Scoring and Comparison of Alternatives

Evaluation criteria are described in **Table 6.5**. Criteria were developed and assigned weights (importance) ranging from 1-10 by the Technical Advisory Committee (TAC) that included representatives of NDOT, FHWA, City of Henderson, and the consultant team. Weights were determined by consensus of the TAC with 1 representing the lowest importance and 10 representing the highest importance.

Table 6.5 Evaluation Criteria

Criteria	Description
Safety*	Consideration of whether the alternative resolves existing roadway deficiencies, the number and type of design exceptions needed for the alternative, potential conflict movements and weaving analysis results
Traffic Operations*	Performance of each alternative for 2040 peak traffic for both the NEPA analysis and the sensitivity analysis
Accessibility*	Consideration of whether the alternative reconnects Lake Mead Parkway to Gibson Road and whether a connection between I-215 and Auto Show Drive is accommodated
Capital Costs	Year of Expenditure (2023) project costs, ranked low to high
O&M Costs	Difference in operations and maintenance costs, ranked low to high
Cost for Future Additional GP Lane	Difference in costs to add a future lane (either GP or HOV), ranked low to high
Environmental Aspects	Qualitative consideration of anticipated differences in impacts such as noise, air quality, environmental justice, and hazardous waste
Time to Construct	Qualitative consideration of anticipated differences in time to construct each alternative
*Directly tied to Purpose and Need	

6.9.1 Fully Developed Alternatives

Scoring of the three fully developed build alternatives is shown in **Table 6.6**. Each build alternative was scored by the TAC at a build alternatives evaluation meeting held January 27, 2021. Scores were assigned by consensus of the TAC ranging from 1 (lowest) to 10 (highest).

Table 6.6 Scoring of Build Alternatives

		Scores		
Criterion	Weight	Option 1	Option 2A	Option 3
Safety	7	10	9	5
Traffic Operations	9	10	9	1
Accessibility	8	7	10	10
Capital Cost	8	8	10	9
O&M Costs	6	9	10	8
Time to Construct	3	5	5	5
Environmental Aspects	8	10	10	9
Maintenance of Traffic Impacts	6	6	6	9
Additional GP Lane	6	4	10	10
Weighted Total (Weight x Score)		**489**	**555**	**445**
Percent of Maximum Score		**80%**	**91%**	**73%**
Weighted Score (out of 10)		**8.0**	**9.1**	**7.3**

Scores for each of the criteria and for each of the alternatives were multiplied by the weights assigned to each criterion to yield a weighted score as shown in the summation of **Table 6.6**.

Safety. Each of the build alternatives resolves existing roadway deficiencies with varying effectiveness. Options 1 and 2A have few design exceptions, and the shoulder width design exception for existing Bridge H-2799N in Option 2A could be eliminated by NDOT if the bridge would be replaced with a longer and wider structure. Option 2A performed better in the weaving analysis than Option 3, and the configuration of Option 1 did not have the weaves of concern in Option 3 between Gibson Road and the system interchange. Option 3 restores the westbound weave between the system interchange and Gibson Road that was previously mitigated by the 2017 restriping project. Option 3 necessitates a design exception for the NB to WB Ramp NW flyover bridge that would be restriped to carry two lanes because of substandard design speed (35 mph vs. 45 mph desired) and stopping sight distance (35 mph met instead of 45 mph desired). The consensus of the TAC was that the safety of Option 1 would be best with a score of 10/10, safety of Option 2A would be nearly as good with a score of 9/10, and Option 3 is ranked lowest with a score of 5/10.

Traffic Operations. Aimsun Next analysis performed in accordance with NEPA methodology as part of the Feasibility Study showed that Options 1 and 2 provide comparable performance in meeting the transportation needs to serve existing and future growth areas. Work performed under the current study showed that traffic operations performance and safety performance for Option 2A would be slightly better than for Option 3.

Each of the build alternatives improved traffic operations when compared to the No-Build alternative. Total year 2040 AM and PM peak network delay from the NEPA traffic operations model would be 17,714 hours for the No-Build alternative. Total year 2040 network delay would be 9,619 hours for Option 1, 10,053 hours for Option 2A, and 10,238 hours for Option 3.

A sensitivity analysis performed as part of this study for each of the three build alternatives showed that both Options 1 and 2A provide satisfactory performance, but Option 3 would yield unacceptable backups and low mainline freeway speeds (12 mph) in the eastbound direction on I-215 as a result of conflicts in the weaving area between Gibson Road and the system interchange. The consensus of the TAC was that the traffic operations performance of Option 1 would be best with a score of 10/10, safety of Option 2A would be nearly as good with a score of 9/10, and Option 3 is ranked lowest with a score of 1/10.

Accessibility. Each of the build alternatives restore local traffic connectivity to Gibson Road. Option 1 does not provide connectivity from I-215 to and from Auto Show Drive while Options 2 and 3 provide full connectivity. The consensus of the TAC was to score Options 2A and 3 as 10/10 and to score Option 1 lower with a score of 7/10 based on access to Gibson Road being more important than access to Auto Show Drive to member of the public who shared their opinions during the Feasibility Study.

Capital Cost. Year of Expenditure 2023 project costs are lowest for Option 2A. Option 3 would cost $15.2 M more than Option 2A and Option 1 would cost $46.3 M more than Option 2A. The consensus of the TAC was that they did not want capital cost to be the controlling factor, so they scored the alternatives in a narrow range with Option 1 (highest cost) scored 8/10, Option 2A (lowest cost) scored 10/10, and Option 3 (median cost) scored 9/10.

Time to Construct. Each of the build alternatives could be constructed within a time frame commensurate with typical reconstruction of system interchanges. The consensus of the TAC was to score each alternative 5/10.

Environmental Aspects. Detailed environmental studies had not yet been completed at the time this report was prepared, so the TAC made a qualitative assessment of the anticipated environmental aspects for each of the alternatives.

All three alternatives would be constructed within the existing right-of-way footprint. Therefore, the TAC ascertained that environmental justice would not be a factor for this project.

Each of the alternatives carry comparable traffic volumes at comparable heights above adjacent neighborhoods and at comparable distances from residences. Consensus of the TAC was that any needed noise mitigation would be comparable for each of the build alternatives. However, the TAC was concerned that structural limitations for noise walls on bridges might result in lesser mitigation of noise impacts from the elevated median connector flyover structure.

Neither of the alternatives are anticipated to require excavation below the clay cap placed over the previously mitigated hazardous waste site in the southwestern interchange quadrant, therefore the consensus of the TAC was that hazardous waste impacts would be negligible for all three alternatives. Each of the alternatives pass through an area of a known perchlorate contamination flume beneath I-515 from a point just north of Auto Show to a point near Warm Springs Road. Likely mitigation would involve monitoring excavations for bridge foundations during construction along with a need for a site-specific NPDES permit for groundwater discharge. There would be no difference in impacts between the three build alternatives.

Options 1 and 2A have comparable traffic operations performance while Option 3 has unsatisfactory performance for the PM peak on EB I-215. The consensus of the TAC was that air quality for Options 1 and 2A could be better than for Option 3, but the difference would not likely be meaningful.

The TAC scored Options 1 and 2A 10/10 for Environmental Aspects, but scored Option 3 one point lower because of concern whether noise from the elevated flyover structure could be satisfactorily mitigated by sound walls constructed on bridge railings.

Maintenance of Traffic Impacts. Detailed maintenance of traffic plans had not been developed at the time this report was prepared, so the TAC made a qualitative assessment of the anticipated maintenance of traffic impacts on motorists. The consensus of the TAC was that Options 1 and 2A would have typical impacts associated with major system interchange reconstruction projects and scored them 6/10. The TAC anticipated that Option 3 could be constructed with fewer impacts to existing traffic than typical interchange reconstruction projects and therefore scored Option 3 as 9/10.

Additional Lane. Each of the build alternatives accommodates regional and local plans, including future HOV lanes and selection of a corridor for I-11 between Las Vegas and Phoenix. Future physical HOV improvements such as roadway pavement and wider bridge decks are incorporated into the original construction for Option 2A and for new Option 3, whereas Option 1 would require additional construction with associated construction cost of approximately $25 million in current-year dollars to add HOV lanes within the space set aside for the future expansion. The extra lanes in Options 2A and 3 would be marked as closed on opening day, and future use of these lanes as either general purpose or HOV lanes could be accomplished with a restriping project. The consensus of the TAC was to score Options 2A and 3 as 10/10, with Option 1 scored lower at 4/10.

O&M Costs. Each of the alternatives would have similar operation and maintenance costs for roadway, pavement, signing, marking and drainage facilities. The primary difference between O&M costs would derive from the amount of bridge deck to maintain. Option 2A would have the least amount of bridge deck to maintain (668,540 sq. ft.), Option 1 would have the median amount of bridge deck to maintain (987,270 sq. ft.) and Option 3 would have the greatest amount of bridge deck to maintain (1,232,360 sq. ft.). The consensus of the TAC was that they did not want O&M cost to be the controlling factor, so they scored the alternatives in a narrow range with Option 1 (median cost) scored 9/10, Option 2A (lowest cost) scored 10/10, and Option 3 (highest cost) scored 8/10.

6.9.2 Partially Developed Alternative

The study team recognized the advantage that Option 3 could have for reduced impacts to traffic during construction by retaining the core system interchange and investigated whether braiding the EB on-ramp from Gibson Road could be feasible. A new alternative designated "Option 3A" was partially developed to ascertain the feasibility and cost impacts associated with refinement of Option 3.

Partially developed Option 3A was scored by the TAC at a regular progress meeting held March 3, 2021 with the results shown in **Table 6.7**. The summary score would result in a virtual tie for distant second place with Option 1, and the consensus of the TAC was to abandon further development of Option 3A.

Safety was judged to be comparable to Option 3 with a score of 5/10, with the need for an additional design exception for Stopping Sight Distance on the EB to NB ramp bridge balanced by braiding of the Gibson on-ramp.

Traffic Operations for Option 3A was not modeled using Aimsun Next; however, the TAC anticipated that Option 3A would likely perform as well as Option 2A with a score of 9/10.

Accessibility for Option 3A would be comparable to Options 2A and 3 and was therefore scored 10/10.

Capital Cost for Option 3A would be the highest of all alternatives, with Year of Expenditure 2023 project cost of $318.0 M. The TAC, therefore, scored Option 3A one point lower than the highest cost fully developed alternative (Option 1) with a score of 7/10.

Time to Construct for Option 3A was judged by the TAC to be comparable to the three fully developed alternatives and typical for reconstruction of a system interchange and was therefore scored 5/10.

Environmental Aspects for Option 3A were judged by the TAC to be comparable to Option 3 with a score of 9/10, with concerns whether the elevated flyover structures could be adequately mitigated for noise impacts.

Maintenance of Traffic Impacts for Option 3A were judged by the TAC to be comparable to Option 3 with a score of 9/10.

Additional GP Lane – Option 3A would construct an additional lane for future use similar to Options 2A and 3 and was therefore scored 10/10.

O&M Costs for Option 3A would be the highest of all alternatives because it would have the largest bridge deck area of any of the alternatives. Option 3A was therefore scored one point lower than the highest cost fully developed alternative (Option 3) with a score of 7/10.

Table 6.7 Scoring of Partially Developed Option 3A

Criterion	Weight	Score
Safety	7	5
Traffic Operations	9	9
Accessibility	8	10
Capital Cost	8	7
O&M Costs	6	7
Time to Construct	3	5
Environmental Aspects	8	9
Maintenance of Traffic Impacts	6	9
Additional GP Lane	6	10
Weighted Total (Weight x Score)		495
Percent of Maximum Score		81%
Weighted Score (out of 10)		8.1

6.10 TAC Recommendation

Based on results of the weighted scoring conducted January 27, 2021 and as summarized in **Table 6.8**, the consensus of the TAC is to recommend that the Department identify Option 2A as the single build alternative to be evaluated further in the NEPA environmental study. Option 2A is the least-cost alternative and meets each of the needs of the project.

Even though Option 3 retains much of the existing system interchange and most of the existing flyover bridges, Option 2A has the least structure cost because crossover style interchanges require fewer and smaller bridges with most ramps on only two levels. Option 3 would leave the Department with large new flyover bridges on the Median Connector that would require maintenance and replacement at a future date. Additionally, Option 3 yields unsatisfactory traffic operations performance in the PM peak sensitivity analysis.

NDOT Management concurred with the TAC recommendation to continue in NEPA with Option 2A as the single Build Alternative at a virtual teleconference meeting held on March 2, 2021. City of Henderson Management subsequently concurred with NDOT's recommendation to continue in NEPA with Option 2A as the single Build Alternative at a separate virtual teleconference meeting held on March 4, 2021.

Table 6.8 Comparison of Build Alternatives

Criterion	Option 1	Option 2A	Option 3
Safety*, including consideration of whether the alternative could meet design criteria and improve safety for users without need for design exceptions. Weight = 7	No FHWA design exceptions required, no weaving areas of concern. Score 10/10	Few FHWA design exceptions required for shoulder width, no weaving areas of concern. Score 9/10	Few FHWA design exceptions required for design speed and shoulder width, moderate concern with weaving between Gibson Road and the system interchange. Score 5/10
Traffic Operations Performance* Weight = 9	Traffic operation measures of effectiveness show satisfactory performance for design year traffic. Score 10/10	Traffic operation measures of effectiveness show satisfactory performance for design year traffic. Score 9/10	Unsatisfactory performance for design year traffic for the EB weaving segment between Gibson Road and the system interchange. Score 1/10
Accessibility*, including consideration of whether the alternative could maintain existing connections or add access points between the local road network and the interstate highway system. Weight = 8	Restores connectivity between Lake Mead Parkway and Gibson Road, but does not provide connectivity between Auto Show and I-215. Score 7/10	Restores connectivity between Lake Mead Parkway and Gibson Road and provides connectivity between Auto Show and I-215. Score 10/10	Restores connectivity between Lake Mead Parkway and Gibson Road and provides connectivity between Auto Show and I-215. Score 10/10
Capital Cost Weight = 8	Highest project cost $307.7 M Score 8/10	Lowest construction cost $261.4 M Score 10/10	Median construction cost $276.6 M Score 9/10
Time to Construct – Weight = 3	Typical for system interchange. Score 5/10	Typical for system interchange. Score 5/10	Typical for system interchange. Score 5/10
Environmental Aspects – Weight = 8	Minimal impacts – Score 10/10	Minimal impacts – Score 10/10	Potential noise – Score 9/10
Maintenance of Traffic (Phased Construction) Weight = 6	Typical impacts associated with major interchange reconstruction projects. Score 6/10	Typical impacts associated with major interchange reconstruction projects. Score 6/10	Fewer impacts than comparable interchange reconstruction projects. Score 9/10
Additional GP Lane Weight = 6	Future GP lane if needed would need to be constructed at a cost of $25 M. Score 4/10	Extra lane for future use is included in the base design for I-215 and I-515. Score 10/10	Extra lane for future use is included in the base design for I-215 and I-515. Score 10/10
O&M Costs Weight = 6	O&M costs would be $1.6 M greater than the least costly alternative. Score 9/10	Lowest O&M cost among build alternatives. Score 10/10	O&M costs would be $3.5 M greater than the least cost alternative. Score 8/10
Number of Bridges Retained As-Is	11	15	20
Number of Bridges Retained and Modified	9	7	7
Number of Bridges Demolished	7	5	0
New Bridges Constructed	5	11	2
Percent of Bridge Deck 15-20 Years Old	40%	61%	61%
Area of New Bridge Deck	592,250 Sq. Ft.	275,060 Sq. Ft.	477,790 Sq. Ft.
Total Bridge Deck Area to Maintain	987,270 Sq. Ft.	707,160 Sq. Ft.	1,232,360 Sq. Ft.
KEY: Good (yellow); Better (blue); Best (green)	**Median Weighted Score 8.0/10**	**Highest Weighted Score 9.1/10** **Recommended as the Single Build Alt.**	**Lowest Weighted Score 7.3/10**

* Directly tied to Purpose and Need

Appendix 1

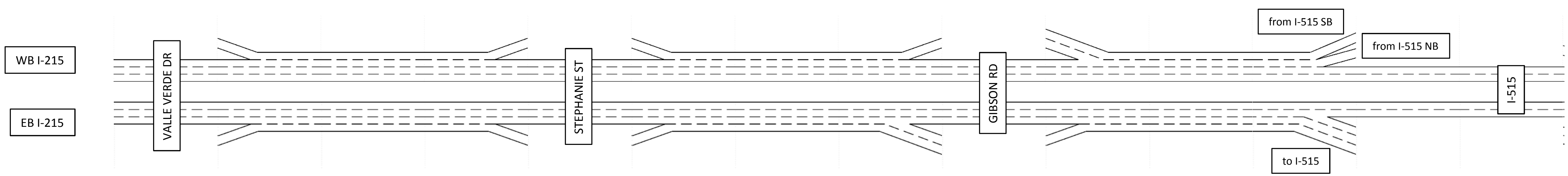
Traffic Operations Line Diagrams

Year 2017

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	3178	1147	1676	1011	2286	341	3255	665	2681	1151	1244	2147	2656	1553
Density (veh/mi/ln)	29.0	6.9	26.3	23.7	24.8	24.7	29.1	14.6	24.4	3.9	23.7	42.1	24.9	18.6
Speed (mph)	66.4	62.4	61.6	54.0	66.1	33.7	52.9	54.3	66.2	60.1	58.1	42.3	43.8	65.6
Peak 15 Flow(veh/hr)	6946	467	7375	1388	6004	1004	6615	885	5876	795	6246	2002	1656	2832
Peak 60 Flow (veh/hr)	6059	439	6475	1358	5092	885	5874	808	5035	580	5574	1843	1153	2623
Flow (veh/hr)	5736	426	6151	1263	4878	745	5618	780	4820	468	5277	1758	1085	2425
Volume (veh)	11473	853	12302	2526	9756	1491	11237	1560	9640	936	10554	3516	2169	4850
Demand Volume (veh)	11243	858	12101	2493	9608	1451	11059	1542	9516	935	10452	3486	2140	4825
Percent Served	102%	99%	102%	101%	102%	103%	102%	101%	101%	100%	101%	101%	101%	101%

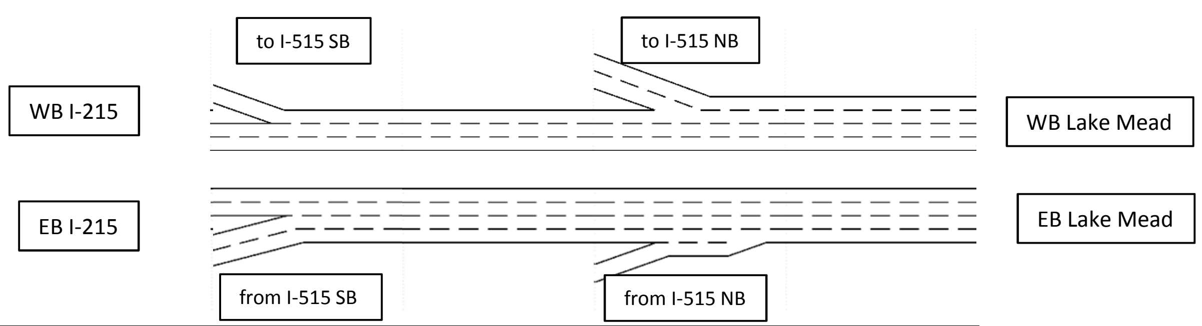


Segment Length (ft)	3167	944	1643	773	2332	530	2062	1739	3396	1032	781	1074	1080	1984
Density (veh/mi/ln)	28.6	7.4	30.1	66.0	20.9	11.7	18.4	6.1	22.3	7.7	22.4	19.6	8.9	9.3
Speed (mph)	62.9	59.0	59.6	36.5	67.3	56.3	66.2	61.9	62.0	54.3	55.7	57.7	70.5	67.1
Peak 15 Flow(veh/hr)	5328	526	5806	1396	4819	724	5522	946	4694	570	5242	3782	1678	1670
Peak 60 Flow (veh/hr)	5076	460	5520	1345	4499	699	5167	790	4368	528	4896	3429	1469	1470
Flow (veh/hr)	4920	431	5337	1158	4173	653	4824	760	4064	478	4543	3302	1243	1245
Volume (veh)	9841	862	10674	2316	8345	1307	9648	1521	8129	956	9086	6603	2486	2490
Demand Volume (veh)	9836	871	10707	2401	8307	1292	9599	1486	8113	966	9080	6627	2453	2453
Percent Served	100%	99%	100%	96%	100%	101%	101%	102%	100%	99%	100%	100%	101%	102%

Year 2017

AM	
Notes On/Off Ramp	

Segment Length (ft)	1273	1016	833	836
Density (veh/mi/ln)	1.4	15.3	6.8	23.8
Speed (mph)	44.8	60.9	53.5	39.5
Peak 15 Flow(veh/hr)	76	2883	950	3578
Peak 60 Flow (veh/hr)	68	2690	800	3431
Flow (veh/hr)	61	2486	718	3204
Volume (veh)	122	4971	1437	6408
Demand Volume (veh)	126	4951	1421	6372
Percent Served	97%	100%	101%	101%



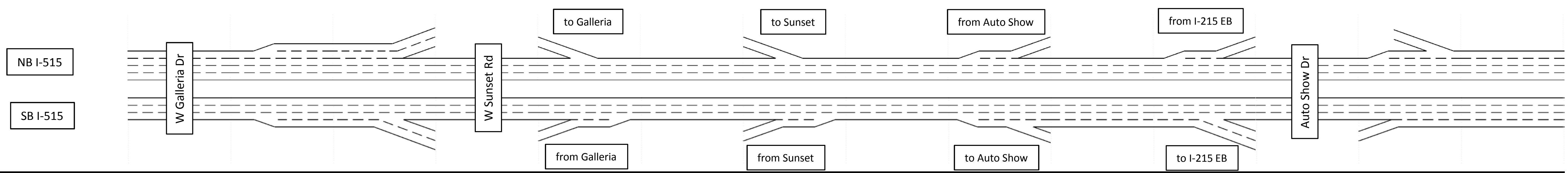
Segment Length (ft)	7454	91	1656	1125
Density (veh/mi/ln)	5.9	10.3	4.4	27.9
Speed (mph)	53.7	46.1	47.5	23.3
Peak 15 Flow(veh/hr)	851	2298	624	2856
Peak 60 Flow (veh/hr)	678	2148	310	2464
Flow (veh/hr)	633	1878	207	2094
Volume (veh)	1267	3756	415	4187
Demand Volume (veh)	1252	3704	415	4119
Percent Served	101%	101%	100%	102%

Year 2017

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	1026	1044	2706	3450	1281	1380	2902	881	804	7027	2996	1829	1142
Density (veh/mi/ln)	14.2	4.6	21.0	4.3	22.5	10.3	26.6	5.6	29.5	45.1	15.4	4.3	12.3
Speed (mph)	69.4	61.5	69.2	66.3	68.7	62.3	63.9	54.0	53.8	42.0	67.8	63.9	68.6
Peak 15 Flow(veh/hr)	5418	660	4842	341	5160	781	5876	391	5524	2182	3633	378	3896
Peak 60 Flow (veh/hr)	5255	576	4679	310	4983	705	5680	342	5333	1960	3368	295	3644
Flow (veh/hr)	4889	558	4330	280	4605	643	5244	304	4932	1842	3088	275	3355
Volume (veh)	9779	1116	8660	561	9209	1285	10488	608	9863	3684	6175	549	6710
Demand Volume (veh)	9665	1150	8515	556	9070	1289	10359	607	9752	3646	6106	553	6659
Percent Served	101%	97%	102%	101%	102%	100%	101%	100%	101%	101%	101%	99%	101%

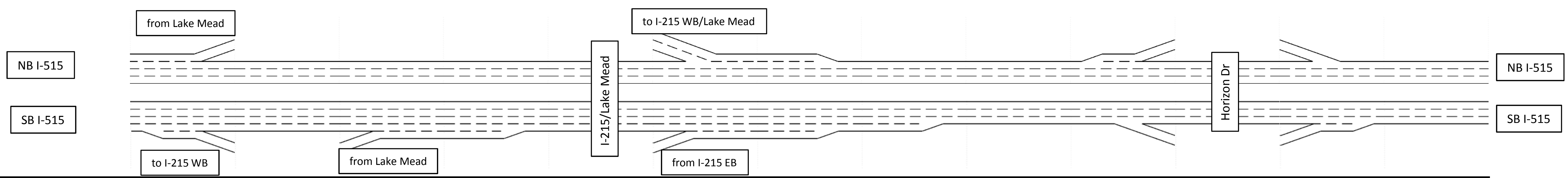


Segment Length (ft)	3398	1023	2567	2234	749	880	3319	980	453	7454	2819	1738	1616
Density (veh/mi/ln)	18.2	5.2	17.6	5.1	16.0	6.9	20.2	9.8	14.4	5.9	16.4	4.4	13.4
Speed (mph)	69.2	62.0	69.5	65.2	65.8	56.0	66.3	60.8	66.2	53.7	64.9	57.8	61.8
Peak 15 Flow(veh/hr)	4940	757	4149	451	4586	432	4914	806	4103	851	3548	300	3784
Peak 60 Flow (veh/hr)	4482	700	3805	368	4171	390	4551	695	3855	678	3191	267	3448
Flow (veh/hr)	4277	639	3640	328	3968	382	4355	596	3759	633	3132	248	3380
Volume (veh)	8554	1278	7280	656	7937	764	8710	1192	7518	1267	6263	495	6759
Demand Volume (veh)	8566	1284	7282	654	7937	761	8697	1196	7502	1252	6250	481	6730
Percent Served	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	100%	103%	100%

Year 2017

AM
Notes On/Off Ramp

Segment Length (ft)	679	4739	928	3980	902	499	4945	1759	4818
Density (veh/mi/ln)	13.8	12.5	12.0	16.8	18.2	63.7	10.2	2.9	11.1
Speed (mph)	52.3	70.8	53.6	67.9	65.3	26.3	70.8	64.7	70.7
Peak 15 Flow(veh/hr)	955	3088	1842	4525	4538	2035	2608	212	2793
Peak 60 Flow (veh/hr)	801	2845	1445	4293	4285	1923	2357	194	2538
Flow (veh/hr)	719	2635	1285	3915	3906	1739	2163	187	2345
Volume (veh)	1439	5269	2570	7830	7813	3478	4325	374	4691
Demand Volume (veh)	1421	5238	2555	7793	7793	3471	4323	388	4711
Percent Served	101%	101%	101%	100%	100%	100%	100%	96%	100%

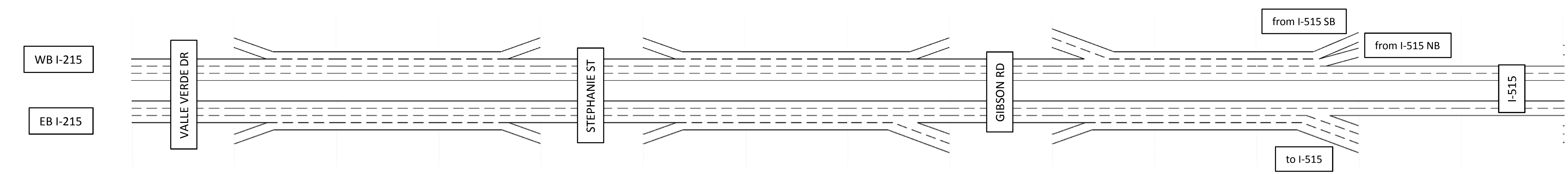


Segment Length (ft)	2147	1271	1273	2030	393	995	913	830	5100	1080	3291	1223	5599
Density (veh/mi/ln)	42.1	5.7	1.4	4.8	6.0	30.5	10.1	13.5	15.8	14.2	11.0	2.3	11.6
Speed (mph)	42.3	71.6	44.8	71.4	71.3	48.5	64.3	62.9	67.2	59.4	70.1	56.6	69.7
Peak 15 Flow(veh/hr)	2002	1888	76	1960	1964	2081	3838	3829	3811	963	2861	157	3008
Peak 60 Flow (veh/hr)	1843	1673	68	1733	1733	1621	3324	3323	3328	884	2476	150	2618
Flow (veh/hr)	1758	1625	61	1685	1685	1469	3150	3148	3135	841	2288	143	2418
Volume (veh)	3516	3250	122	3369	3369	2938	6300	6295	6271	1683	4576	286	4836
Demand Volume (veh)	3486	3244	126	3370	3370	2981	6352	6352	6352	1666	4685	292	4977
Percent Served	101%	100%	97%	100%	100%	99%	99%	99%	99%	101%	98%	98%	97%

Year 2017

PM
Notes On/Off Ramp

	4-6 PM													
Segment Length (ft)	3178	1147	1676	1011	2286	341	3255	665	2681	1151	1244	2147	2656	1553
Density (veh/mi/ln)	29.7	11.0	28.1	26.5	27.2	27.3	25.5	16.8	26.2	4.5	26.8	55.0	24.5	18.7
Speed (mph)	65.1	61.0	59.9	50.5	63.6	33.5	59.7	53.2	63.9	59.9	54.7	39.3	43.9	63.9
Peak 15 Flow(veh/hr)	6364	737	7106	1474	5790	926	6615	1009	5643	641	6242	2232	1340	2802
Peak 60 Flow (veh/hr)	6007	694	6679	1348	5375	851	6215	912	5294	569	5828	2195	1122	2487
Flow (veh/hr)	5747	663	6405	1298	5107	785	5886	881	4986	560	5536	2108	1067	2354
Volume (veh)	11494	1327	12810	2595	10215	1571	11773	1762	9972	1119	11071	4217	2135	4708
Demand Volume (veh)	11309	1323	12632	2598	10034	1527	11561	1769	9791	1091	10882	4134	2119	4630
Percent Served	102%	100%	101%	100%	102%	103%	102%	100%	102%	103%	102%	102%	101%	102%

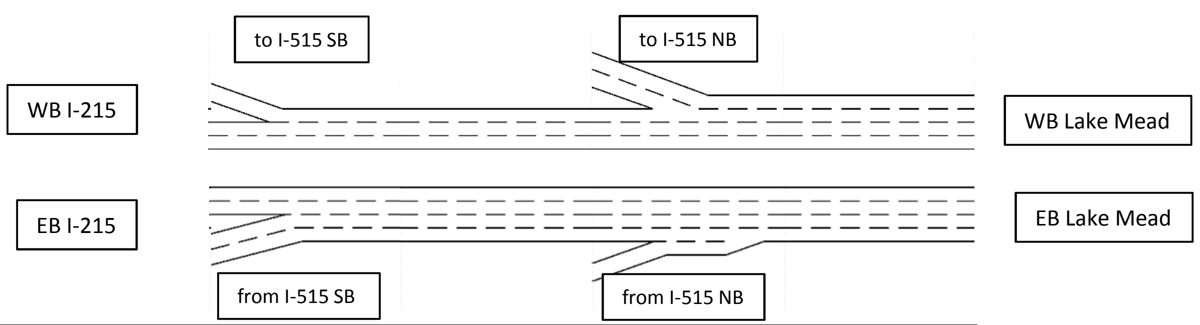


Segment Length (ft)	3167	944	1643	773	2332	530	2062	1739	3396	1032	781	1074	1080	1984
Density (veh/mi/ln)	46.3	6.9	48.2	26.4	57.4	14.7	38.9	6.5	41.1	7.1	33.9	31.0	12.7	13.2
Speed (mph)	51.2	59.0	44.9	50.9	39.6	52.0	46.4	63.0	48.6	50.6	48.2	49.4	68.0	65.2
Peak 15 Flow(veh/hr)	6492	497	7062	1373	5949	918	6773	994	5729	491	6115	4176	2223	2204
Peak 60 Flow (veh/hr)	6434	425	6847	1315	5588	774	6340	872	5504	419	5908	4079	2036	2027
Flow (veh/hr)	6246	404	6648	1280	5363	743	6104	846	5267	403	5674	3959	1712	1712
Volume (veh)	12493	809	13296	2560	10727	1486	12208	1692	10533	806	11349	7918	3424	3425
Demand Volume (veh)	12440	805	13245	2544	10701	1468	12169	1685	10484	820	11304	7893	3411	3411
Percent Served	100%	100%	100%	101%	100%	101%	100%	100%	100%	98%	100%	100%	100%	100%

Year 2017

PM
Notes On/Off Ramp

Segment Length (ft)	1273	1016	833	836
Density (veh/mi/ln)	3.0	15.9	6.5	25.0
Speed (mph)	44.6	59.1	53.4	38.0
Peak 15 Flow(veh/hr)	166	2993	866	3693
Peak 60 Flow (veh/hr)	141	2628	693	3322
Flow (veh/hr)	132	2491	685	3182
Volume (veh)	264	4983	1369	6364
Demand Volume (veh)	265	4895	1345	6240
Percent Served	100%	102%	102%	102%



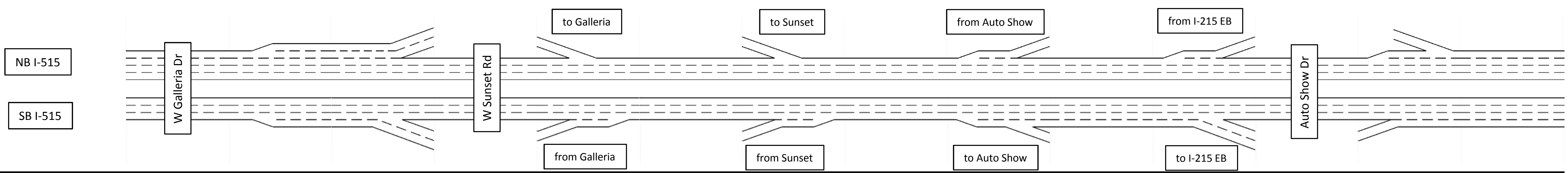
Segment Length (ft)	7454	91	1656	1125
Density (veh/mi/ln)	9.6	15.4	3.5	42.0
Speed (mph)	53.0	44.5	45.9	21.0
Peak 15 Flow(veh/hr)	1190	3068	383	3286
Peak 60 Flow (veh/hr)	1088	2945	183	3085
Flow (veh/hr)	1008	2720	158	2898
Volume (veh)	2016	5441	315	5797
Demand Volume (veh)	2005	5416	301	5717
Percent Served	101%	100%	105%	101%

Year 2017

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	1026	1044	2706	3450	1281	1380	2902	881	804	7027	2996	1829	1142
Density (veh/mi/ln)	13.7	7.1	18.4	7.3	21.0	12.7	27.4	10.3	29.7	54.2	12.9	4.3	10.5
Speed (mph)	68.3	60.1	68.9	65.5	67.9	61.4	60.1	52.9	49.6	36.6	67.4	63.9	68.2
Peak 15 Flow(veh/hr)	4940	1016	3990	694	4466	942	5354	685	4771	2174	2841	312	3115
Peak 60 Flow (veh/hr)	4770	921	3900	500	4353	796	5142	578	4599	1939	2687	277	2959
Flow (veh/hr)	4613	848	3765	476	4239	777	5016	543	4467	1888	2577	272	2846
Volume (veh)	9226	1696	7530	951	8479	1554	10031	1086	8934	3776	5153	543	5692
Demand Volume (veh)	9151	1681	7471	908	8379	1538	9917	1085	8831	3701	5130	527	5657
Percent Served	101%	101%	101%	105%	101%	101%	101%	100%	101%	102%	100%	103%	101%

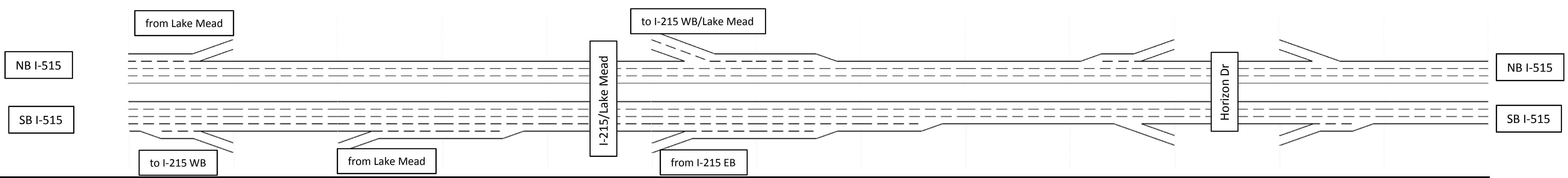


Segment Length (ft)	3398	1023	2567	2234	749	880	3319	980	453	7454	2819	1738	1616
Density (veh/mi/ln)	21.7	6.2	20.9	7.2	25.7	25.9	28.6	8.6	22.8	9.6	34.0	11.6	20.3
Speed (mph)	67.7	61.3	67.8	64.6	55.1	40.6	60.3	60.5	61.2	53.0	51.0	42.5	55.6
Peak 15 Flow(veh/hr)	5403	851	4694	516	5092	882	5891	609	5414	1190	4242	526	4716
Peak 60 Flow (veh/hr)	5102	807	4347	489	4801	846	5624	554	5131	1088	4054	458	4513
Flow (veh/hr)	4977	762	4219	463	4687	835	5532	518	5014	1008	4025	420	4446
Volume (veh)	9954	1523	8437	927	9373	1670	11064	1036	10029	2016	8050	840	8893
Demand Volume (veh)	9933	1538	8394	923	9317	1652	10969	1004	9965	2005	7960	848	8808
Percent Served	100%	99%	101%	100%	101%	101%	101%	103%	101%	101%	101%	99%	101%

Year 2017

PM
Notes On/Off Ramp

Segment Length (ft)	679	4739	928	3980	902	499	4945	1759	4818
Density (veh/mi/ln)	13.2	10.3	11.5	14.7	15.9	26.1	10.9	3.0	11.8
Speed (mph)	52.5	70.4	53.5	67.0	65.0	41.4	69.9	64.1	69.6
Peak 15 Flow(veh/hr)	886	2480	1749	3634	3660	1247	2426	258	2672
Peak 60 Flow (veh/hr)	695	2294	1297	3490	3492	1162	2332	201	2534
Flow (veh/hr)	687	2159	1221	3381	3377	1109	2267	189	2453
Volume (veh)	1373	4318	2442	6762	6753	2217	4534	377	4907
Demand Volume (veh)	1345	4312	2420	6732	6732	2239	4493	368	4861
Percent Served	102%	100%	101%	100%	100%	99%	101%	103%	101%



Segment Length (ft)	2147	1271	1273	2030	393	995	913	830	5100	1080	3291	1223	5599
Density (veh/mi/ln)	55.0	8.4	3.0	7.1	9.0	48.9	17.6	29.7	34.7	45.7	13.2	4.5	14.4
Speed (mph)	39.3	70.7	44.6	70.7	70.4	43.6	60.4	53.6	53.2	46.1	67.9	54.8	67.7
Peak 15 Flow(veh/hr)	2232	2720	166	2836	2836	2290	5111	5123	5162	2226	3332	344	3668
Peak 60 Flow (veh/hr)	2195	2494	141	2618	2620	2183	4804	4802	4797	1970	2950	310	3261
Flow (veh/hr)	2108	2344	132	2476	2477	2075	4551	4550	4569	1909	2658	269	2914
Volume (veh)	4217	4687	264	4952	4953	4149	9101	9100	9139	3817	5315	537	5829
Demand Volume (veh)	4134	4674	265	4939	4939	4192	9131	9131	9131	3671	5460	538	5998
Percent Served	102%	100%	100%	100%	100%	99%	100%	100%	100%	104%	97%	100%	97%

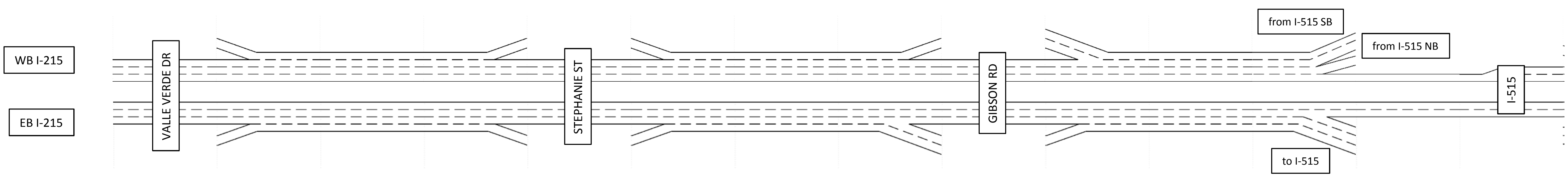
Year 2040 No-Action Alternative

AM

Notes On/Off Ramp

7-9 AM

Segment Length (ft)	3178	1147	1676	1011	2286	341	3255	665	2680	1098	1244	1124	2657	1553
Density (veh/mi/ln)	33.5	5.4	31.3	24.3	28.7	22.7	34.8	22.3	21.0	4.2	23.7	24.5	35.6	78.8
Speed (mph)	64.9	62.2	58.5	52.5	65.0	34.9	49.7	54.1	64.9	61.4	58.4	32.1	43.6	24.6
Peak 15 Flow(veh/hr)	6801	348	7146	1381	5771	820	6562	1312	5296	388	5654	1584	1678	2436
Peak 60 Flow (veh/hr)	6595	342	6933	1325	5622	798	6416	1240	5204	371	5566	1576	1616	2418
Flow (veh/hr)	6465	333	6796	1251	5544	787	6329	1183	5143	368	5511	1568	1544	2400
Volume (veh)	12930	665	13592	2503	11087	1574	12659	2366	10285	736	11022	3136	3087	4801
Demand Volume (veh)	14801	875	15675	2515	13160	2009	15169	2332	12837	1567	14405	5227	3129	6049
Percent Served	87%	76%	87%	99%	84%	78%	83%	101%	80%	47%	77%	60%	99%	79%

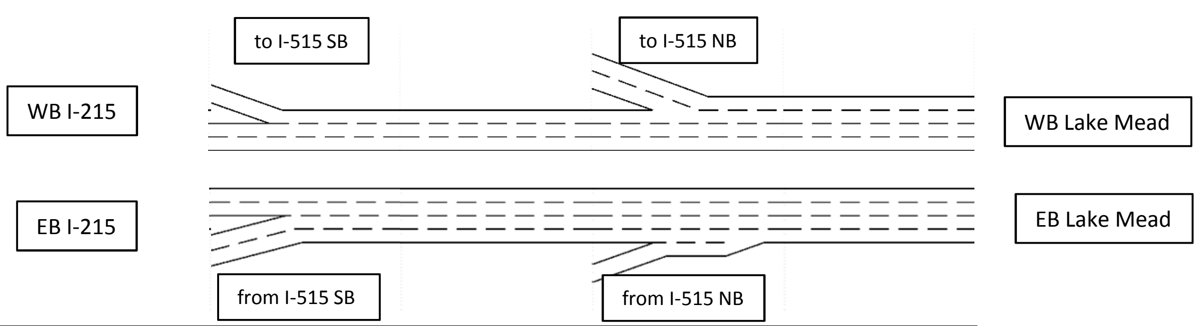


Segment Length (ft)	3167	944	1643	773	2332	531	2029	1790	3396	1032	779	1074	1080	1984
Density (veh/mi/ln)	120.7	22.7	115.0	20.8	131.5	138.9	127.2	18.3	109.8	25.0	89.5	133.3	10.9	10.3
Speed (mph)	29.2	42.0	28.3	50.3	25.4	18.4	17.9	41.0	17.2	36.4	23.3	18.1	62.1	65.8
Peak 15 Flow(veh/hr)	6748	679	7395	1504	5878	1080	6737	971	5451	886	6135	4047	1834	1826
Peak 60 Flow (veh/hr)	5359	652	5849	1132	4534	1004	5360	862	4340	822	5117	3552	1490	1492
Flow (veh/hr)	4517	614	5067	1031	3956	988	4856	794	4012	783	4775	3398	1344	1345
Volume (veh)	9034	1228	10134	2062	7912	1977	9712	1587	8025	1566	9549	6795	2687	2690
Demand Volume (veh)	12938	1222	14160	2856	11303	1768	13071	1921	11150	1551	12701	8890	3811	3811
Percent Served	70%	101%	72%	72%	70%	112%	74%	83%	72%	101%	75%	76%	71%	71%

Year 2040 No-Action Alternative

AM
Notes On/Off Ramp

Segment Length (ft)	1274	1016	833	835
Density (veh/mi/ln)	2.2	84.3	11.7	38.1
Speed (mph)	44.1	17.0	52.3	32.6
Peak 15 Flow(veh/hr)	107	2532	1272	3878
Peak 60 Flow (veh/hr)	100	2517	1241	3762
Flow (veh/hr)	98	2500	1221	3733
Volume (veh)	196	4999	2443	7467
Demand Volume (veh)	225	6274	2902	9176
Percent Served	87%	80%	84%	81%



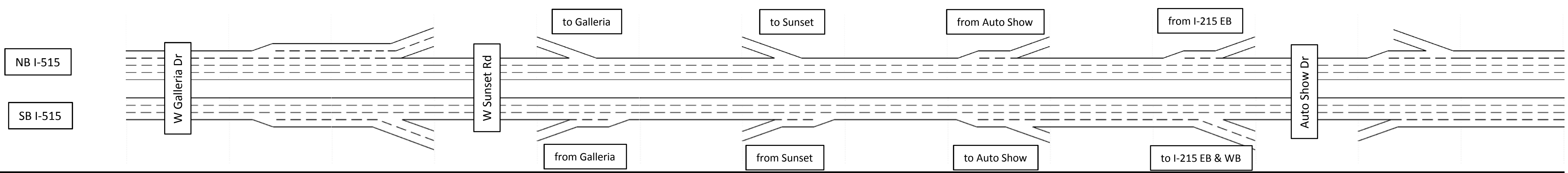
Segment Length (ft)	3893	91	1656	1125
Density (veh/mi/ln)	16.2	12.0	5.2	27.8
Speed (mph)	44.0	44.8	47.6	25.4
Peak 15 Flow(veh/hr)	813	2637	268	2793
Peak 60 Flow (veh/hr)	801	2294	257	2554
Flow (veh/hr)	793	2138	243	2370
Volume (veh)	1585	4276	486	4741
Demand Volume (veh)	2589	6400	484	6884
Percent Served	61%	67%	100%	69%

Year 2040 No-Action Alternative

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	1026	1044	2706	3450	1281	1380	2902	881	804	7027	2996	1829	1142
Density (veh/mi/ln)	19.7	8.3	26.9	4.0	28.5	14.3	38.0	10.6	47.3	136.5	22.5	6.1	17.2
Speed (mph)	66.2	61.3	67.5	66.6	66.7	61.5	57.2	50.0	43.4	9.1	63.1	62.7	66.6
Peak 15 Flow(veh/hr)	6655	1142	5539	299	5797	934	6731	560	6158	1968	4328	401	4728
Peak 60 Flow (veh/hr)	6522	1071	5474	280	5736	910	6620	538	6094	1919	4247	392	4619
Flow (veh/hr)	6431	1015	5417	262	5678	876	6553	521	6032	1898	4134	379	4514
Volume (veh)	12861	2030	10833	525	11356	1751	13106	1043	12065	3795	8269	757	9027
Demand Volume (veh)	14048	2039	12009	709	12718	1941	14659	1043	13616	5125	8491	757	9248
Percent Served	92%	100%	90%	74%	89%	90%	89%	100%	89%	74%	97%	100%	98%

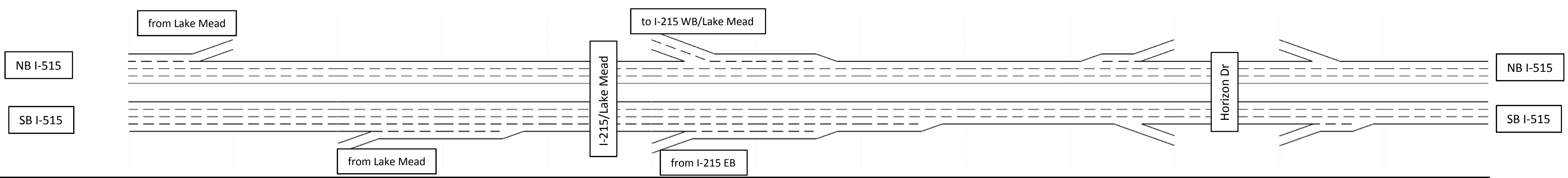


Segment Length (ft)	3398	1023	2567	2234	749	880	3319	980	453	3560	2819	1738	1616
Density (veh/mi/ln)	163.8	6.4	177.2	34.2	152.5	210.6	46.4	7.7	14.6	23.3	5.5	7.2	5.7
Speed (mph)	7.3	51.2	6.7	42.2	11.5	3.3	31.5	61.0	61.5	50.9	72.0	57.5	70.8
Peak 15 Flow(veh/hr)	3840	702	3180	406	3547	548	4107	492	3620	2389	1263	454	1683
Peak 60 Flow (veh/hr)	3797	691	3118	388	3482	526	4003	470	3543	2363	1187	432	1603
Flow (veh/hr)	3721	608	3114	373	3480	521	3999	465	3534	2359	1177	408	1586
Volume (veh)	7441	1217	6227	745	6960	1043	7998	929	7068	4717	2354	815	3171
Demand Volume (veh)	13210	1883	11327	767	12093	1243	13336	1611	11725	7816	3909	803	4712
Percent Served	56%	65%	55%	97%	58%	84%	60%	58%	60%	60%	60%	101%	67%

Year 2040 No-Action Alternative

AM	
Notes On/Off Ramp	

Segment Length (ft)	679	4739	928	3980	902	499	4945	1759	4818
Density (veh/mi/ln)	24.4	15.8	16.8	22.4	25.2	106.2	14.2	5.6	15.9
Speed (mph)	50.4	70.1	53.4	65.9	61.6	16.7	70.0	63.6	69.5
Peak 15 Flow(veh/hr)	1270	3478	1939	5397	5404	2192	3226	396	3650
Peak 60 Flow (veh/hr)	1236	3389	1870	5226	5235	2160	3095	373	3469
Flow (veh/hr)	1220	3292	1784	5074	5075	2124	2949	357	3304
Volume (veh)	2440	6584	3568	10149	10150	4248	5899	713	6608
Demand Volume (veh)	2902	6346	3613	9959	9959	4048	5911	700	6611
Percent Served	84%	104%	99%	102%	102%	105%	100%	102%	100%



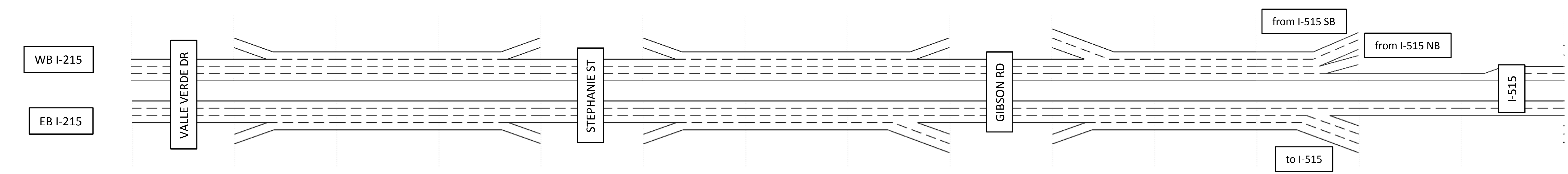
Segment Length (ft)	1271	1274	2030	393	995	913	830	5100	1080	3291	1223	5599
Density (veh/mi/ln)	5.6	2.2	4.8	6.0	30.2	10.0	13.7	16.0	23.6	8.6	3.8	9.7
Speed (mph)	71.5	44.1	71.3	71.3	48.1	64.1	62.3	66.0	56.7	70.6	56.3	69.9
Peak 15 Flow(veh/hr)	1677	107	1759	1760	1814	3579	3591	3630	1393	2239	268	2472
Peak 60 Flow (veh/hr)	1603	100	1700	1699	1554	3254	3257	3273	1350	1929	246	2188
Flow (veh/hr)	1586	98	1681	1681	1445	3126	3127	3132	1329	1805	233	2040
Volume (veh)	3171	196	3363	3362	2891	6251	6254	6265	2658	3610	466	4080
Demand Volume (veh)	4712	225	4937	4937	3765	8702	8702	8702	3372	5330	468	5798
Percent Served	67%	87%	68%	68%	77%	72%	72%	72%	79%	68%	99%	70%

Year 2040 No-Action Alternative

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	3178	1147	1676	1011	2286	341	3255	665	2680	1098	1244	1124	2657	1553
Density (veh/mi/ln)	37.0	8.8	48.4	107.2	33.3	20.6	26.5	20.5	21.5	4.7	24.6	19.9	48.1	78.8
Speed (mph)	61.6	60.3	45.4	18.1	58.2	34.6	60.1	53.1	63.3	59.4	56.6	32.0	41.6	23.1
Peak 15 Flow(veh/hr)	6908	544	7430	1840	5689	747	6454	1180	5278	413	5677	1312	2149	2303
Peak 60 Flow (veh/hr)	6815	530	7337	1807	5564	716	6280	1098	5182	405	5585	1273	2041	2283
Flow (veh/hr)	6777	527	7299	1791	5502	709	6206	1071	5134	401	5535	1270	1999	2266
Volume (veh)	13555	1054	14598	3583	11003	1417	12412	2143	10268	803	11070	2540	3998	4531
Demand Volume (veh)	15294	1462	16756	4014	12743	1623	14366	2105	12261	1695	13956	4123	3976	5857
Percent Served	89%	72%	87%	89%	86%	87%	86%	102%	84%	47%	79%	62%	101%	77%

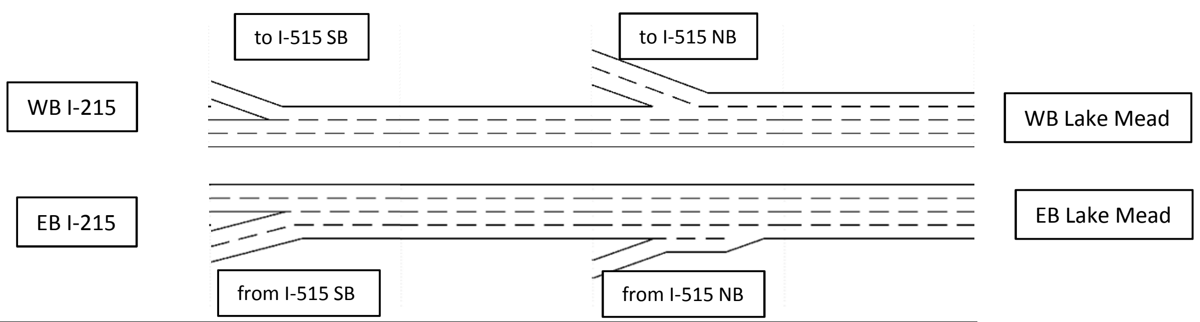


Segment Length (ft)	3167	944	1643	773	2332	531	2029	1790	3396	1032	779	1074	1080	1984
Density (veh/mi/ln)	152.9	75.7	140.1	15.2	123.3	145.0	74.3	6.2	81.1	11.2	87.2	126.6	5.6	5.3
Speed (mph)	9.7	21.2	9.2	43.9	14.1	13.0	20.8	61.0	20.5	42.7	18.9	16.5	63.3	67.0
Peak 15 Flow(veh/hr)	4742	784	5344	833	4352	1490	5662	871	4438	535	4800	3877	847	864
Peak 60 Flow (veh/hr)	3587	717	4256	672	3539	1336	4802	793	3959	515	4401	3715	725	728
Flow (veh/hr)	3435	712	4122	663	3432	1331	4737	780	3921	489	4399	3684	707	708
Volume (veh)	6870	1423	8243	1325	6865	2661	9473	1560	7841	977	8798	7369	1414	1417
Demand Volume (veh)	15522	1453	16975	2805	14170	2697	16867	2316	14551	905	15456	12830	2627	2627
Percent Served	44%	98%	49%	47%	48%	99%	56%	67%	54%	108%	57%	57%	54%	54%

Year 2040 No-Action Alternative

PM
Notes On/Off Ramp

Segment Length (ft)	1274	1016	833	835
Density (veh/mi/ln)	5.2	98.8	11.5	43.5
Speed (mph)	43.4	12.9	51.6	29.3
Peak 15 Flow(veh/hr)	230	2520	1249	3734
Peak 60 Flow (veh/hr)	227	2507	1196	3713
Flow (veh/hr)	223	2489	1182	3681
Volume (veh)	445	4977	2363	7363
Demand Volume (veh)	525	6381	2803	9184
Percent Served	85%	78%	84%	80%



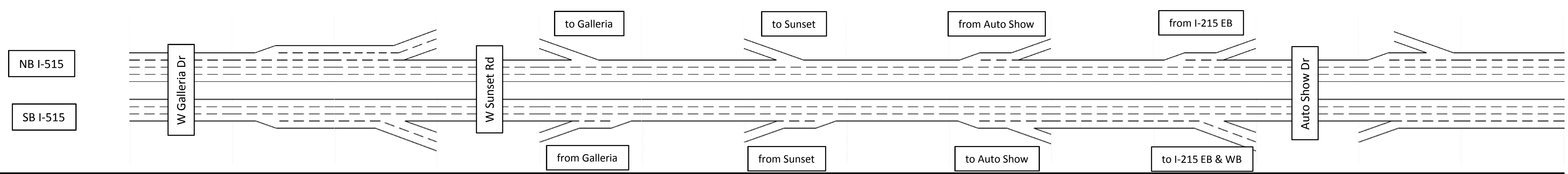
Segment Length (ft)	3893	91	1656	1125
Density (veh/mi/ln)	22.8	10.2	6.2	25.8
Speed (mph)	43.2	44.7	45.3	24.5
Peak 15 Flow(veh/hr)	1144	2005	310	2425
Peak 60 Flow (veh/hr)	1104	1831	279	2137
Flow (veh/hr)	1097	1805	274	2093
Volume (veh)	2194	3611	549	4186
Demand Volume (veh)	4034	6660	547	7207
Percent Served	54%	54%	100%	58%

Year 2040 No-Action Alternative

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	1026	1044	2706	3450	1281	1380	2902	881	804	7027	2996	1829	1142
Density (veh/mi/ln)	15.0	7.6	19.8	7.5	22.6	16.1	33.9	17.5	36.2	110.0	13.6	10.4	12.3
Speed (mph)	67.3	60.4	68.7	65.9	67.6	60.8	55.2	46.8	44.5	12.0	66.3	58.7	65.9
Peak 15 Flow(veh/hr)	5080	1006	4158	539	4659	1051	5644	821	4845	2112	2806	580	3378
Peak 60 Flow (veh/hr)	5027	929	4111	495	4602	1005	5564	803	4768	2080	2692	555	3247
Flow (veh/hr)	4975	916	4059	491	4550	979	5528	791	4734	2078	2655	546	3202
Volume (veh)	9950	1831	8119	982	9099	1958	11056	1582	9469	4156	5309	1092	6405
Demand Volume (veh)	11723	1798	9925	1539	11464	2313	13777	1601	12176	6832	5344	1114	6459
Percent Served	85%	102%	82%	64%	79%	85%	80%	99%	78%	61%	99%	98%	99%



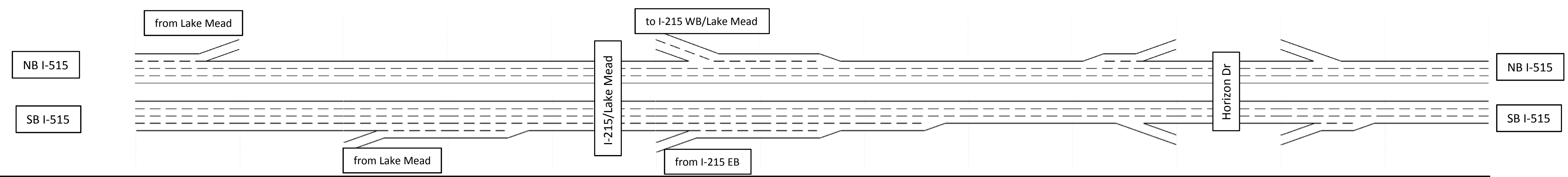
Segment Length (ft)	3398	1023	2567	2234	749	880	3319	980	453	3560	2819	1738	1616
Density (veh/mi/ln)	160.3	5.1	171.8	122.6	159.9	222.0	46.5	5.8	15.0	23.2	5.9	8.9	6.3
Speed (mph)	7.1	50.3	6.7	20.4	11.0	2.3	31.4	60.9	61.4	51.2	71.4	58.6	70.5
Peak 15 Flow(veh/hr)	3611	548	3083	496	3537	527	4054	364	3718	2417	1324	554	1848
Peak 60 Flow (veh/hr)	3552	518	3038	450	3475	509	3980	353	3627	2370	1262	532	1791
Flow (veh/hr)	3545	507	3034	435	3459	503	3964	349	3615	2368	1249	517	1766
Volume (veh)	7091	1015	6068	870	6918	1007	7929	698	7229	4735	2498	1034	3532
Demand Volume (veh)	12058	1766	10292	971	11263	2294	13557	1153	12404	8157	4248	1090	5337
Percent Served	59%	57%	59%	90%	61%	44%	58%	61%	58%	58%	59%	95%	66%

Year 2040 No-Action Alternative

PM

Notes On/Off Ramp

Segment Length (ft)	679	4739	928	3980	902	499	4945	1759	4818
Density (veh/mi/ln)	23.9	9.6	21.7	23.1	22.5	39.8	14.1	7.4	16.3
Speed (mph)	50.1	70.4	52.6	56.9	59.3	34.8	69.0	61.0	68.2
Peak 15 Flow(veh/hr)	1271	2177	2466	4525	4525	1496	3178	462	3634
Peak 60 Flow (veh/hr)	1195	2061	2311	4343	4350	1432	2926	421	3346
Flow (veh/hr)	1184	2017	2268	4284	4270	1378	2887	418	3301
Volume (veh)	2369	4034	4536	8568	8541	2755	5773	837	6603
Demand Volume (veh)	2803	3655	4523	8178	8178	2391	5787	838	6625
Percent Served	85%	110%	100%	105%	104%	115%	100%	100%	100%



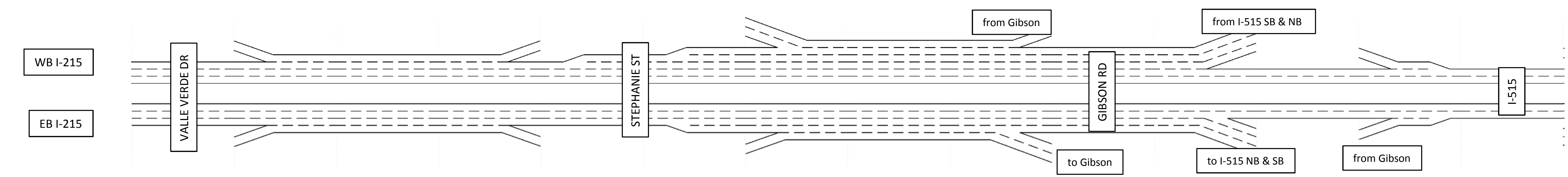
Segment Length (ft)	1271	1274	2030	393	995	913	830	5100	1080	3291	1223	5599
Density (veh/mi/ln)	6.2	5.2	5.7	7.2	33.3	11.5	15.4	19.3	33.7	8.7	7.3	10.9
Speed (mph)	71.2	43.4	70.6	70.8	47.5	64.1	62.4	62.9	52.9	69.9	54.9	68.9
Peak 15 Flow(veh/hr)	1859	230	2083	2088	1704	3734	3748	3805	1826	2000	480	2484
Peak 60 Flow (veh/hr)	1788	227	2014	2014	1635	3607	3607	3596	1804	1830	441	2277
Flow (veh/hr)	1767	223	1993	1994	1576	3571	3573	3573	1765	1809	432	2246
Volume (veh)	3534	445	3986	3987	3152	7141	7145	7147	3530	3618	864	4493
Demand Volume (veh)	5337	525	5862	5862	5998	11859	11859	11859	5409	6450	860	7310
Percent Served	66%	85%	68%	68%	53%	60%	60%	60%	65%	56%	101%	61%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	3178	1147	1676	1011	1609	918	582	2396	1135	1283	1772	3329	2230	1246
Density (veh/mi/ln)	40.8	7.3	54.7	37.7	75.4	99.0	9.6	69.5	57.0	27.0	16.9	23.0	2.3	21.1
Speed (mph)	61.2	60.9	43.6	38.9	37.1	31.2	54.9	30.9	44.2	60.4	69.2	64.9	68.2	62.0
Peak 15 Flow(veh/hr)	7484	469	7936	1384	6748	6785	1070	7871	1272	6951	3825	3255	178	3449
Peak 60 Flow (veh/hr)	7465	451	7917	1322	6674	6661	1034	7681	1189	6674	3635	3103	162	3245
Flow (veh/hr)	7434	444	7877	1264	6612	6611	1015	7626	1187	6448	3481	2965	153	3111
Volume (veh)	14867	887	15754	2529	13225	13221	2030	15253	2375	12895	6962	5929	306	6223
Demand Volume (veh)	14801	875	15675	2515	13160	13160	2009	15169	2332	12837	6932	5905	311	6216
Percent Served	100%	101%	101%	101%	100%	100%	101%	101%	102%	100%	100%	100%	98%	100%

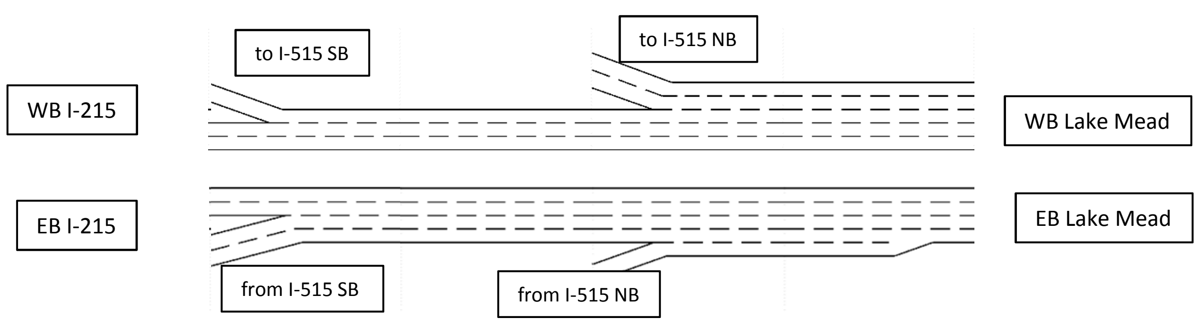


Segment Length (ft)	3167	944	1636	773	2419	605	2752	909	1537	1130	2112	1441	2618
Density (veh/mi/ln)	44.8	10.6	31.3	33.8	27.6	16.2	20.2	8.0	24.1	19.1	12.9	1.6	13.0
Speed (mph)	53.0	58.5	59.9	51.8	63.9	56.4	65.6	55.2	60.4	67.0	70.3	68.3	68.9
Peak 15 Flow(veh/hr)	6903	697	7557	1501	6085	1012	7075	1028	6069	4114	1960	118	2063
Peak 60 Flow (veh/hr)	6706	658	7357	1457	5894	950	6835	1003	5825	3961	1872	111	1976
Flow (veh/hr)	6488	615	7106	1431	5676	905	6583	976	5608	3812	1798	105	1903
Volume (veh)	12975	1229	14212	2861	11353	1810	13167	1952	11217	7625	3595	211	3807
Demand Volume (veh)	12938	1222	14160	2856	11303	1768	13071	1921	11150	7552	3598	213	3811
Percent Served	100%	101%	100%	100%	100%	102%	101%	102%	101%	101%	100%	99%	100%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

AM
Notes On/Off Ramp

Segment Length (ft)	1218	1200	1812	708
Density (veh/mi/ln)	2.3	24.2	13.7	22.2
Speed (mph)	51.6	48.9	51.8	43.3
Peak 15 Flow(veh/hr)	138	3593	1555	5171
Peak 60 Flow (veh/hr)	122	3359	1479	4839
Flow (veh/hr)	117	3226	1417	4641
Volume (veh)	233	6452	2834	9283
Demand Volume (veh)	225	6441	2902	9342
Percent Served	104%	100%	98%	99%



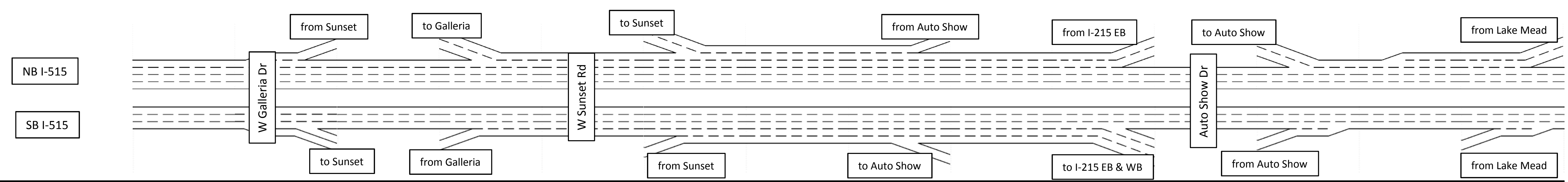
Segment Length (ft)	2790	81	1488	627
Density (veh/mi/ln)	14.5	17.3	4.8	25.3
Speed (mph)	52.6	50.2	50.9	34.7
Peak 15 Flow(veh/hr)	1613	3680	270	3946
Peak 60 Flow (veh/hr)	1572	3547	257	3803
Flow (veh/hr)	1513	3417	243	3661
Volume (veh)	3027	6834	486	7322
Demand Volume (veh)	3005	6816	481	7297
Percent Served	101%	100%	101%	100%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	3312	538	2077	3255	952	850	3586	585	1792	6784	1488	1313	2534	1812
Density (veh/mi/ln)	28.3	23.5	23.3	5.7	21.9	8.0	18.7	10.2	21.0	21.4	20.8	2.8	18.3	13.7
Speed (mph)	62.3	46.8	66.3	66.2	63.0	62.7	66.9	52.8	66.0	50.9	68.7	65.6	63.6	51.8
Peak 15 Flow(veh/hr)	7594	1141	6454	401	6839	1098	7940	570	7384	2789	4602	402	5004	1555
Peak 60 Flow (veh/hr)	7290	1071	6226	388	6611	1040	7650	540	7138	2718	4424	380	4805	1479
Flow (veh/hr)	7049	1015	6028	375	6400	998	7396	524	6868	2623	4244	362	4604	1417
Volume (veh)	14099	2030	12056	751	12801	1995	14791	1048	13736	5246	8488	724	9209	2834
Demand Volume (veh)	14048	2039	12009	709	12718	2002	14720	1046	13674	5183	8491	699	9190	2902
Percent Served	100%	100%	100%	106%	101%	100%	100%	100%	100%	101%	100%	104%	100%	98%

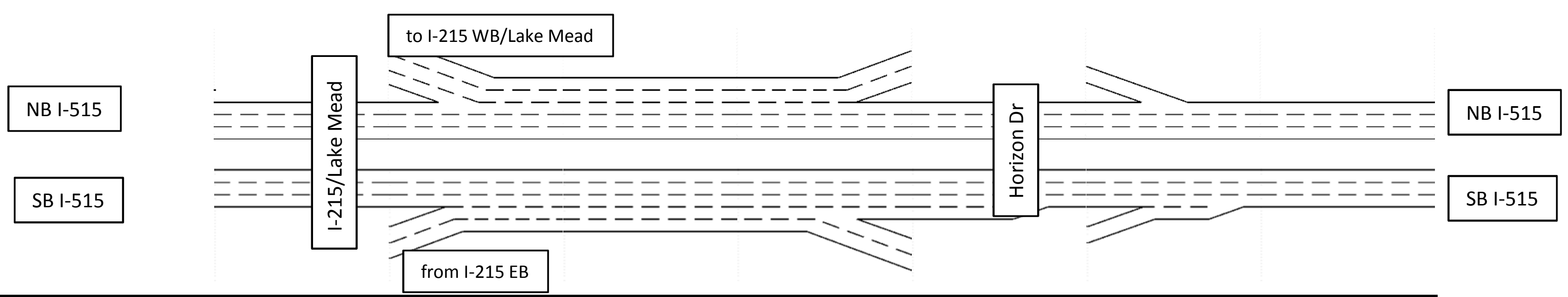


Segment Length (ft)	3512	881	2315	2124	789	555	3446	1258	1980	3409	905	494	3590	1218
Density (veh/mi/ln)	29.5	7.5	28.6	6.0	22.8	12.0	20.5	13.2	20.0	26.9	8.5	7.5	9.8	2.3
Speed (mph)	65.6	62.9	66.2	64.9	66.8	55.5	66.0	63.2	60.3	51.4	70.4	53.3	70.2	51.6
Peak 15 Flow(veh/hr)	7417	1044	6352	424	6761	728	7404	918	6415	4460	1940	422	2326	138
Peak 60 Flow (veh/hr)	6915	991	5927	400	6327	684	7008	866	6135	4296	1843	409	2251	122
Flow (veh/hr)	6596	943	5655	386	6042	661	6709	829	5883	4120	1769	395	2166	117
Volume (veh)	13192	1886	11309	771	12084	1323	13418	1657	11766	8239	3537	789	4332	233
Demand Volume (veh)	13210	1883	11327	767	12093	1304	13397	1669	11728	8232	3496	800	4296	225
Percent Served	100%	100%	100%	101%	100%	101%	100%	99%	100%	100%	101%	99%	101%	104%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

AM
Notes On/Off Ramp

Segment Length (ft)	3644	971	6264	232	3707	1759	4818
Density (veh/mi/ln)	15.2	8.9	14.5	18.5	14.1	5.7	15.9
Speed (mph)	70.4	66.8	68.4	54.1	70.3	63.4	69.5
Peak 15 Flow(veh/hr)	3486	1951	5425	2190	3226	396	3649
Peak 60 Flow (veh/hr)	3333	1839	5172	2082	3095	374	3469
Flow (veh/hr)	3184	1764	4946	1992	2949	357	3304
Volume (veh)	6369	3528	9893	3983	5898	713	6608
Demand Volume (veh)	6288	3443	9731	3821	5911	700	6611
Percent Served	101%	102%	102%	104%	100%	102%	100%



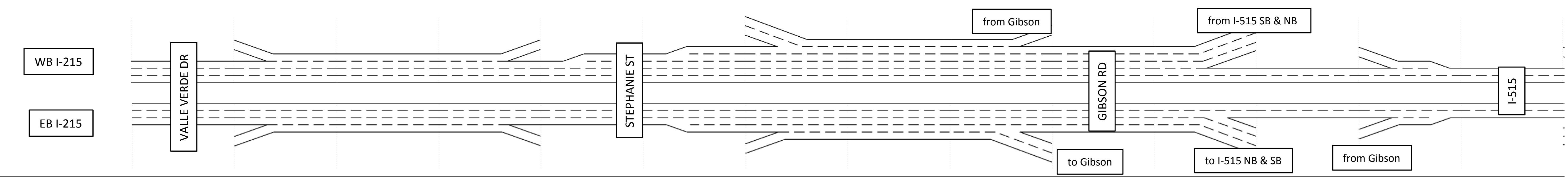
Segment Length (ft)	1341	2809	8162	832	3033	1223	5599
Density (veh/mi/ln)	10.2	18.7	12.5	12.4	13.3	3.8	14.1
Speed (mph)	70.2	51.0	67.6	60.9	66.2	56.0	69.1
Peak 15 Flow(veh/hr)	2455	2041	4508	1581	2943	266	3216
Peak 60 Flow (veh/hr)	2373	1945	4319	1540	2782	246	3020
Flow (veh/hr)	2283	1897	4185	1502	2686	232	2918
Volume (veh)	4566	3793	8371	3003	5371	463	5835
Demand Volume (veh)	4521	3707	8228	2898	5330	468	5798
Percent Served	101%	102%	102%	104%	101%	99%	101%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	3178	1147	1676	1011	1609	918	582	2396	1135	1283	1772	3329	2230	1246
Density (veh/mi/ln)	41.0	11.8	50.7	117.7	80.7	119.5	16.4	107.0	139.1	39.5	16.6	22.7	2.9	21.2
Speed (mph)	59.4	60.0	44.4	15.0	31.8	24.4	41.3	21.9	19.3	50.9	67.3	64.1	68.6	61.3
Peak 15 Flow(veh/hr)	7307	732	8004	1748	6265	6278	969	7199	1221	6786	3632	3178	223	3328
Peak 60 Flow (veh/hr)	7268	712	7978	1736	6247	6249	895	7140	1003	6266	3359	2926	195	3121
Flow (veh/hr)	7264	706	7970	1727	6246	6248	857	7111	985	6190	3304	2891	195	3083
Volume (veh)	14528	1411	15941	3454	12492	12496	1714	14222	1971	12380	6607	5782	390	6166
Demand Volume (veh)	15294	1462	16756	4014	12743	12743	1623	14366	2105	12261	6537	5724	395	6119
Percent Served	95%	97%	95%	86%	98%	98%	106%	99%	94%	101%	101%	101%	99%	101%

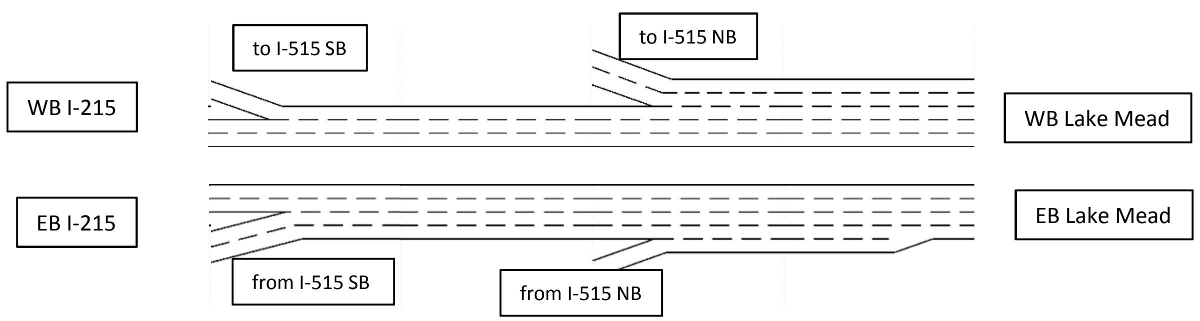


Segment Length (ft)	3167	944	1636	773	2419	605	2752	909	1537	1130	2112	1441	2618
Density (veh/mi/ln)	71.5	12.8	64.8	24.8	45.2	28.0	23.8	7.8	25.8	28.1	7.6	0.9	7.6
Speed (mph)	30.9	56.8	29.4	50.4	42.4	51.9	63.4	60.9	63.0	63.7	71.4	68.4	70.1
Peak 15 Flow(veh/hr)	6599	799	7271	1207	6095	1529	7610	1118	6533	5430	1114	66	1166
Peak 60 Flow (veh/hr)	6531	727	7248	1190	6072	1480	7531	1093	6440	5353	1099	61	1155
Flow (veh/hr)	6519	718	7238	1181	6057	1429	7489	1082	6409	5324	1083	59	1141
Volume (veh)	13038	1436	14476	2363	12114	2858	14979	2165	12817	10649	2166	117	2283
Demand Volume (veh)	15522	1453	16975	2805	14170	2697	16867	2316	14551	12045	2506	120	2627
Percent Served	84%	99%	85%	84%	85%	106%	89%	93%	88%	88%	86%	97%	87%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

PM
Notes On/Off Ramp

Segment Length (ft)	1218	1200	1812	708
Density (veh/mi/ln)	5.1	24.8	10.8	21.6
Speed (mph)	51.5	49.1	52.4	42.9
Peak 15 Flow(veh/hr)	279	3570	1232	4808
Peak 60 Flow (veh/hr)	265	3389	1158	4554
Flow (veh/hr)	262	3340	1127	4457
Volume (veh)	524	6681	2253	8914
Demand Volume (veh)	525	6643	2252	8895
Percent Served	100%	101%	100%	100%



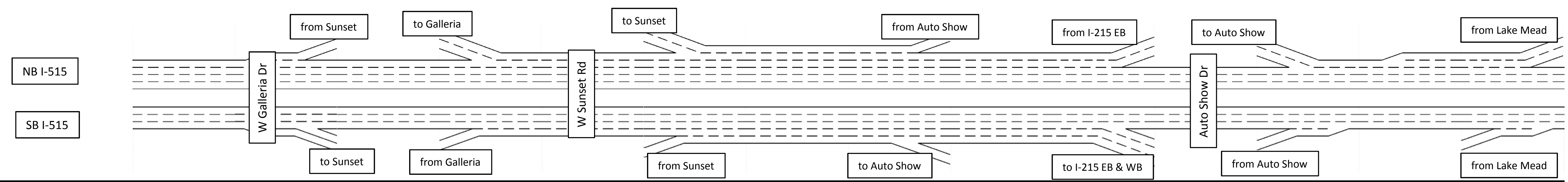
Segment Length (ft)	2790	81	1488	627
Density (veh/mi/ln)	20.0	17.0	5.4	20.6
Speed (mph)	51.6	48.1	50.8	36.5
Peak 15 Flow(veh/hr)	2235	3390	315	3696
Peak 60 Flow (veh/hr)	2073	3223	278	3504
Flow (veh/hr)	2048	3190	273	3464
Volume (veh)	4097	6380	546	6928
Demand Volume (veh)	4034	6660	547	7207
Percent Served	102%	96%	100%	96%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	3312	538	2077	3255	952	850	3586	585	1792	6784	1488	1313	2534	1812
Density (veh/mi/ln)	21.0	24.0	17.6	10.8	17.7	9.1	17.1	12.8	18.5	26.4	12.9	4.5	12.2	10.8
Speed (mph)	65.6	42.4	68.2	65.2	64.5	62.2	64.9	54.9	64.2	49.9	70.0	64.0	65.7	52.4
Peak 15 Flow(veh/hr)	6012	1009	5031	725	5771	1215	6986	720	6253	3284	2943	602	3532	1232
Peak 60 Flow (veh/hr)	5714	929	4780	709	5468	1150	6613	699	5918	3187	2724	568	3284	1158
Flow (veh/hr)	5649	917	4726	702	5425	1128	6551	692	5856	3165	2688	563	3247	1127
Volume (veh)	11297	1834	9452	1404	10850	2257	13102	1383	11712	6329	5376	1126	6495	2253
Demand Volume (veh)	11723	1798	9925	1539	11464	2313	13777	1601	12176	6832	5344	1114	6459	2252
Percent Served	96%	102%	95%	91%	95%	98%	95%	86%	96%	93%	101%	101%	101%	100%

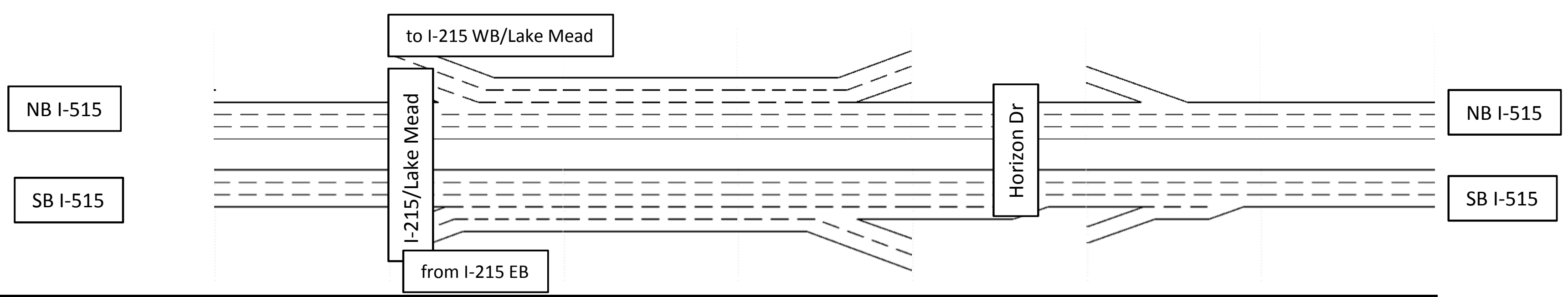


Segment Length (ft)	3512	881	2315	2124	789	555	3446	1258	1980	3409	905	494	3590	1218
Density (veh/mi/ln)	26.8	7.0	26.0	7.5	21.2	23.4	21.3	9.2	24.1	26.7	10.4	9.2	12.1	5.1
Speed (mph)	65.9	62.6	66.7	64.4	67.0	50.3	64.4	63.4	54.3	51.6	69.3	54.1	69.5	51.5
Peak 15 Flow(veh/hr)	6740	954	5766	554	6324	1247	7597	655	6924	4536	2367	530	2846	279
Peak 60 Flow (veh/hr)	6126	882	5251	500	5756	1161	6934	594	6362	4181	2193	507	2693	265
Flow (veh/hr)	6029	874	5158	484	5643	1153	6809	578	6244	4112	2140	493	2636	262
Volume (veh)	12057	1748	10316	968	11286	2305	13619	1155	12488	8224	4279	985	5271	524
Demand Volume (veh)	12058	1766	10292	971	11263	2294	13557	1153	12404	8157	4248	1090	5337	525
Percent Served	100%	99%	100%	100%	100%	100%	100%	100%	101%	101%	101%	90%	99%	100%

Year 2040 Build Alternative Option 1 - Expanded Existing Configuration

PM
Notes On/Off Ramp

Segment Length (ft)	3644	971	6264	232	3707	1759	4818
Density (veh/mi/ln)	10.2	11.6	13.6	12.7	14.0	7.4	16.3
Speed (mph)	69.9	63.1	63.7	54.4	69.1	61.6	68.2
Peak 15 Flow(veh/hr)	2295	2347	4660	1490	3181	462	3636
Peak 60 Flow (veh/hr)	2136	2180	4310	1396	2926	421	3348
Flow (veh/hr)	2117	2162	4275	1374	2887	418	3301
Volume (veh)	4233	4324	8550	2747	5774	836	6603
Demand Volume (veh)	4206	4261	8467	2680	5787	838	6625
Percent Served	101%	101%	101%	102%	100%	100%	100%



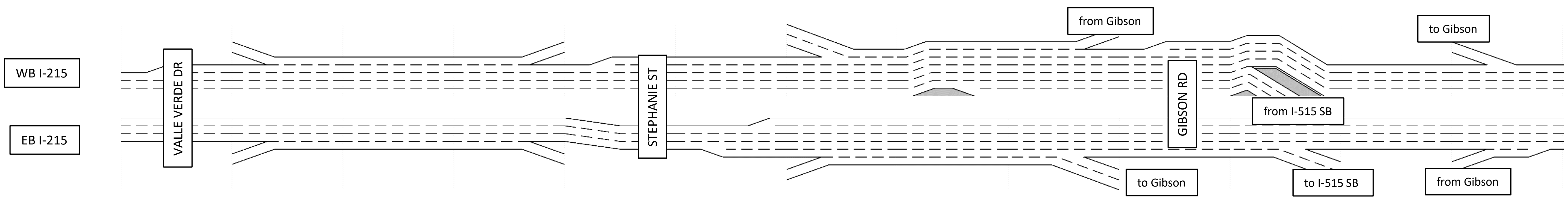
Segment Length (ft)	1341	2809	8162	832	3033	1223	5599
Density (veh/mi/ln)	13.2	26.1	17.0	29.8	14.2	7.3	16.6
Speed (mph)	68.8	49.2	64.7	50.5	66.6	54.3	67.4
Peak 15 Flow(veh/hr)	3100	2591	5636	2642	2994	476	3432
Peak 60 Flow (veh/hr)	2954	2563	5521	2588	2933	434	3364
Flow (veh/hr)	2897	2555	5458	2553	2907	429	3338
Volume (veh)	5795	5109	10916	5107	5815	858	6675
Demand Volume (veh)	5862	5998	11859	5409	6450	860	7310
Percent Served	99%	85%	92%	94%	90%	100%	91%

Year 2040 Build Alternative Option 2**A** Crossover Interchange

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	3176	1147	1631	1008	1583	818	492	2514	1100	1625	2587	1061	140
Density (veh/mi/ln)	47.2	8.2	94.6	182.3	85.6	73.5	9.6	24.6	22.2	20.6	10.6	19.3	4.3
Speed (mph)	50.9	52.3	32.7	6.4	36.2	41.0	58.0	55.1	55.2	57.2	64.2	60.4	48.9
Peak 15 Flow(veh/hr)	7502	507	7892	1132	6997	7023	1097	8119	1321	7030	2231	4804	234
Peak 60 Flow (veh/hr)	7307	451	7754	1004	6820	6817	1048	7884	1237	6724	2125	4608	221
Flow (veh/hr)	7173	427	7601	985	6621	6627	1020	7647	1210	6437	2031	4407	210
Volume (veh)	14345	854	15203	1970	13243	13255	2040	15295	2421	12873	4062	8814	421
Demand Volume (veh)	14801	875	15675	2515	13160	13160	2009	15169	2332	12837	4067	8771	420
Percent Served	97%	98%	97%	78%	101%	101%	102%	101%	104%	100%	100%	100%	100%



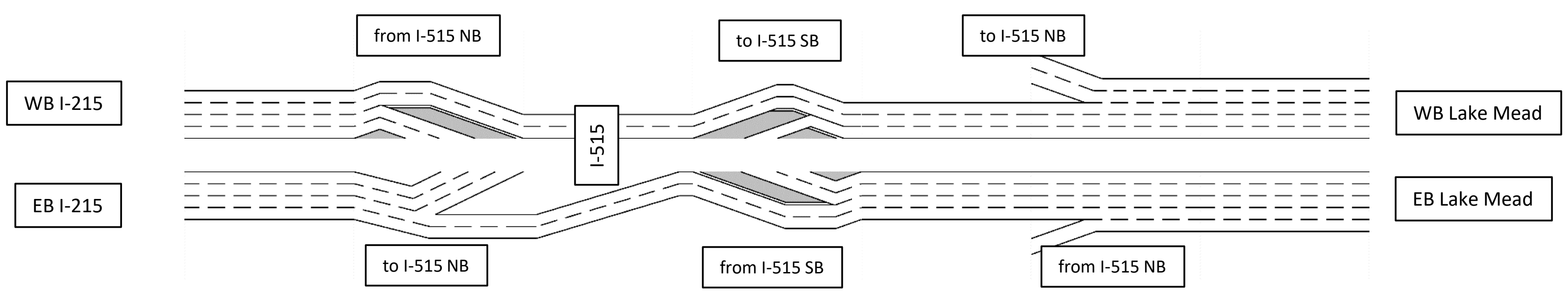
Segment Length (ft)	3167	944	1636	773	2418	602	2649	1025	1015	1622	1569	655
Density (veh/mi/ln)	42.3	10.5	30.0	27.4	29.0	16.8	17.2	8.3	19.1	14.1	14.0	16.5
Speed (mph)	54.6	58.9	60.4	54.1	60.5	56.2	65.1	54.6	62.0	64.6	68.6	45.3
Peak 15 Flow(veh/hr)	6929	696	7604	1526	6118	1055	7134	1046	6085	1952	4132	834
Peak 60 Flow (veh/hr)	6719	658	7374	1472	5903	975	6864	1027	5833	1872	3958	770
Flow (veh/hr)	6486	615	7104	1431	5676	937	6618	1009	5608	1812	3799	740
Volume (veh)	12972	1229	14209	2862	11352	1875	13235	2018	11217	3624	7599	1480
Demand Volume (veh)	12938	1222	14160	2856	11303	1768	13071	1921	11150	3607	7543	1467
Percent Served	100%	101%	100%	100%	100%	106%	101%	105%	101%	100%	101%	101%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

AM
Notes On/Off Ramp

Segment Length (ft)	2143	3017	1004	1709	1229	6190	513
Density (veh/mi/ln)	21.1	14.0	36.4	3.1	32.2	22.5	25.1
Speed (mph)	55.0	53.5	43.1	37.8	36.2	43.0	38.7
Peak 15 Flow(veh/hr)	5036	1649	3428	136	3588	1476	5138
Peak 60 Flow (veh/hr)	4827	1560	3259	121	3382	1416	4800
Flow (veh/hr)	4618	1490	3125	116	3240	1364	4595
Volume (veh)	9236	2980	6249	233	6480	2727	9190
Demand Volume (veh)	9190	2962	6228	225	6453	2804	9258
Percent Served	100%	101%	100%	103%	100%	97%	99%



Segment Length (ft)	1941	1483	1038	5077	659	1899	734
Density (veh/mi/ln)	19.9	18.3	19.9	16.2	18.4	5.1	25.1
Speed (mph)	52.8	48.5	48.1	46.9	46.9	48.2	40.5
Peak 15 Flow(veh/hr)	4919	2830	2068	1608	3670	270	3928
Peak 60 Flow (veh/hr)	4722	2744	1987	1571	3549	258	3803
Flow (veh/hr)	4539	2634	1905	1511	3418	243	3660
Volume (veh)	9077	5269	3810	3022	6835	486	7321
Demand Volume (veh)	9010	5196	3814	3002	6816	481	7297
Percent Served	101%	101%	100%	101%	100%	101%	100%

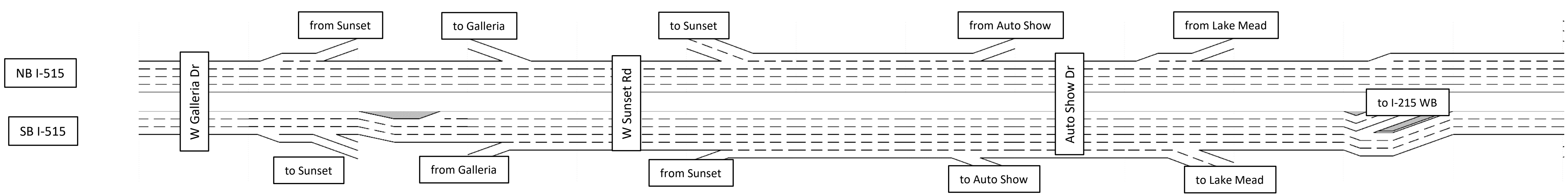
Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	1498	544	1981	3224	1113	1010	3406	612	1688	6190	1998
Density (veh/mi/ln)	29.5	23.2	22.3	5.6	24.0	7.8	23.3	10.0	25.9	22.5	23.8
Speed (mph)	60.5	47.1	68.3	66.7	67.5	62.6	64.4	50.5	60.3	43.0	59.5
Peak 15 Flow(veh/hr)	7614	1142	6474	401	6864	1066	7916	542	7411	1476	5930
Peak 60 Flow (veh/hr)	7279	1071	6208	387	6599	1009	7609	533	7115	1416	5703
Flow (veh/hr)	7031	1015	6013	374	6389	973	7361	516	6843	1364	5478
Volume (veh)	14062	2030	12026	748	12778	1945	14722	1031	13685	2727	10957
Demand Volume (veh)	14048	2039	12009	709	12718	1941	14658	1043	13616	2804	10811
Percent Served	100%	100%	100%	106%	100%	100%	100%	99%	101%	97%	101%



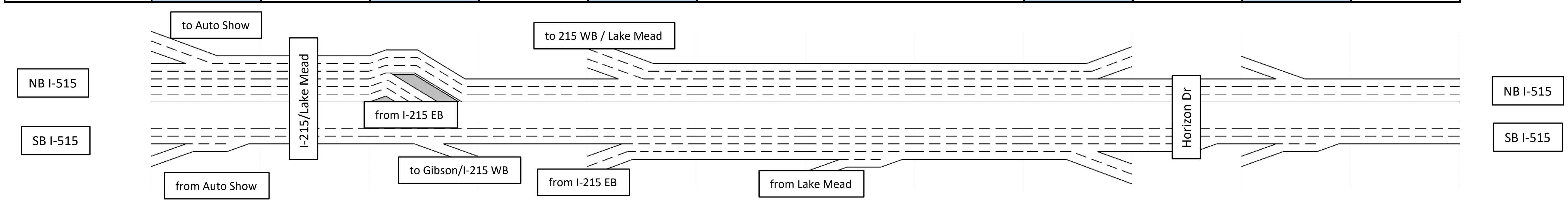
Segment Length (ft)	3379	1023	2458	2124	784	556	3672	1131	1831	5077	1463	2829	467
Density (veh/mi/ln)	29.6	7.7	24.5	6.0	17.8	11.7	16.5	12.7	14.4	16.2	12.9	15.1	9.5
Speed (mph)	65.6	61.4	67.2	65.0	68.4	54.9	67.8	63.1	68.9	46.9	68.7	53.4	69.3
Peak 15 Flow(veh/hr)	7428	1047	6354	424	6766	705	7382	887	6465	1608	4795	2630	2152
Peak 60 Flow (veh/hr)	6916	991	5925	399	6325	656	6977	837	6137	1571	4563	2518	2052
Flow (veh/hr)	6596	943	5655	386	6042	635	6683	800	5884	1511	4374	2410	1968
Volume (veh)	13192	1886	11309	771	12083	1270	13365	1600	11768	3022	8749	4821	3937
Demand Volume (veh)	13210	1883	11327	767	12093	1242	13336	1611	11725	3002	8723	4787	3936
Percent Served	100%	100%	100%	101%	100%	102%	100%	99%	100%	101%	100%	101%	100%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

AM
Notes On/Off Ramp

Segment Length (ft)	1642	1703	1483	4282	753	6077	233	3707	1759	4818
Density (veh/mi/ln)	2.9	15.1	18.3	15.3	10.6	14.6	18.6	14.1	5.7	15.9
Speed (mph)	66.7	65.7	48.5	70.6	54.6	68.3	54.1	70.2	63.4	69.5
Peak 15 Flow(veh/hr)	427	6350	2830	3530	1919	5434	2210	3223	395	3648
Peak 60 Flow (veh/hr)	410	6120	2744	3378	1818	5197	2108	3096	375	3469
Flow (veh/hr)	390	5865	2634	3227	1732	4958	2003	2949	356	3304
Volume (veh)	780	11729	5269	6455	3464	9917	4007	5899	713	6608
Demand Volume (veh)	757	11569	5196	6372	3443	9816	3905	5911	700	6611
Percent Served	103%	101%	101%	101%	101%	101%	103%	100%	102%	100%



Segment Length (ft)	1652	600	1582	3302	3966	184	1709	7711	833	3038	1223	5599
Density (veh/mi/ln)	6.6	12.1	4.4	10.2	20.1	13.2	3.1	12.2	12.1	13.2	3.8	14.1
Speed (mph)	58.9	63.6	44.4	70.7	45.4	62.7	37.8	67.6	61.1	65.5	56.0	69.1
Peak 15 Flow(veh/hr)	407	2535	226	2310	2001	4313	136	4457	1533	2940	267	3188
Peak 60 Flow (veh/hr)	391	2442	207	2238	1920	4159	121	4279	1506	2772	245	3014
Flow (veh/hr)	382	2351	196	2156	1864	4021	116	4141	1462	2681	232	2913
Volume (veh)	764	4702	392	4313	3728	8041	233	8282	2924	5363	464	5827
Demand Volume (veh)	803	4739	443	4296	3707	8002	225	8228	2898	5330	468	5798
Percent Served	95%	99%	88%	100%	101%	100%	103%	101%	101%	101%	99%	100%

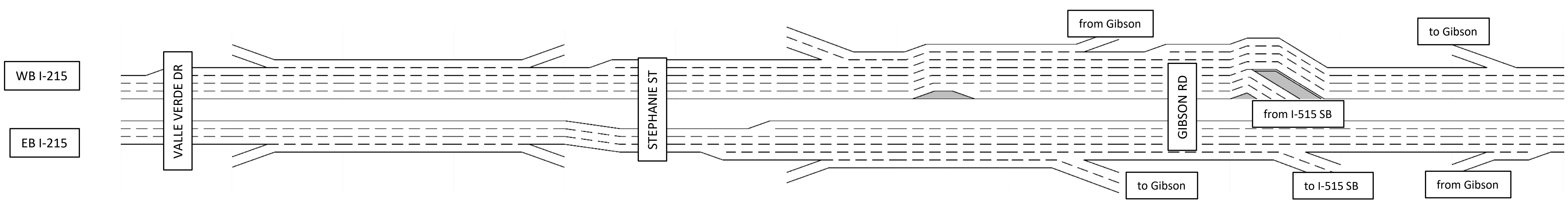
Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	3176	1147	1631	1008	1583	818	492	2514	1100	1625	2587	1061	140
Density (veh/mi/ln)	47.2	13.6	89.7	174.2	80.8	78.9	7.9	22.4	20.0	20.9	7.5	22.2	6.5
Speed (mph)	49.5	50.4	31.9	6.7	33.7	37.1	55.6	55.9	55.5	55.1	64.4	57.6	48.3
Peak 15 Flow(veh/hr)	7023	714	7703	1143	6614	6724	936	7820	1147	6813	1628	5220	345
Peak 60 Flow (veh/hr)	6950	685	7622	1111	6545	6550	856	7412	1118	6288	1481	4795	316
Flow (veh/hr)	6887	677	7566	1096	6463	6454	838	7281	1095	6175	1444	4725	312
Volume (veh)	13775	1353	15132	2192	12926	12907	1677	14561	2190	12350	2889	9450	623
Demand Volume (veh)	15294	1462	16756	4014	12743	12743	1623	14366	2105	12261	2891	9370	622
Percent Served	90%	93%	90%	55%	101%	101%	103%	101%	104%	101%	100%	101%	100%



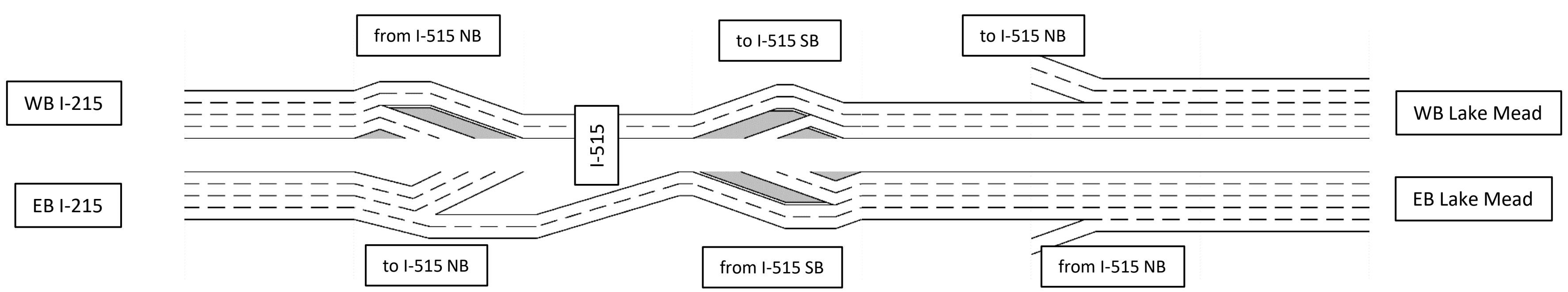
Segment Length (ft)	3167	944	1636	773	2418	602	2649	1025	1015	1622	1569	655
Density (veh/mi/ln)	66.9	12.5	34.9	20.8	31.4	27.0	17.7	6.9	17.7	17.5	13.8	9.5
Speed (mph)	31.8	58.0	51.8	54.9	56.7	52.9	66.9	62.7	68.9	64.1	69.4	45.8
Peak 15 Flow(veh/hr)	6077	798	6806	1125	5696	1509	7187	1026	6178	2263	3963	454
Peak 60 Flow (veh/hr)	6024	726	6751	1101	5662	1452	7083	1005	6081	2243	3848	432
Flow (veh/hr)	6011	718	6729	1094	5635	1407	7044	1000	6046	2236	3813	429
Volume (veh)	12022	1436	13459	2188	11271	2813	14088	2000	12093	4471	7627	858
Demand Volume (veh)	15522	1453	16975	2805	14170	2697	16867	2316	14551	5729	8822	874
Percent Served	77%	99%	79%	78%	80%	104%	84%	86%	83%	78%	86%	98%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

PM
Notes On/Off Ramp

Segment Length (ft)	2143	3017	1004	1709	1229	6190	513
Density (veh/mi/ln)	23.2	17.8	36.9	7.1	33.6	19.0	25.7
Speed (mph)	54.6	52.7	43.0	37.3	36.5	44.2	38.0
Peak 15 Flow(veh/hr)	5512	2021	3394	272	3661	1316	4999
Peak 60 Flow (veh/hr)	5100	1899	3207	267	3478	1208	4686
Flow (veh/hr)	5032	1870	3158	263	3420	1187	4596
Volume (veh)	10064	3739	6317	526	6840	2374	9193
Demand Volume (veh)	9991	3714	6278	525	6802	2420	9222
Percent Served	101%	101%	101%	100%	101%	98%	100%



Segment Length (ft)	1941	1483	1038	5077	659	1899	734
Density (veh/mi/ln)	17.5	22.0	11.4	22.3	16.9	5.7	16.9
Speed (mph)	55.6	48.0	48.7	46.1	46.8	48.2	44.2
Peak 15 Flow(veh/hr)	4411	3316	1145	2233	3370	320	3690
Peak 60 Flow (veh/hr)	4283	3179	1114	2065	3179	279	3462
Flow (veh/hr)	4246	3140	1106	2045	3152	275	3428
Volume (veh)	8491	6279	2211	4090	6304	550	6856
Demand Volume (veh)	9696	6991	2705	4033	6739	547	7286
Percent Served	88%	90%	82%	101%	94%	101%	94%

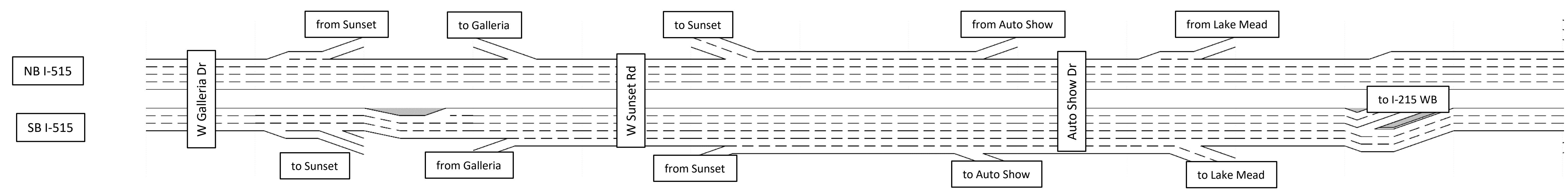
Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	1498	544	1981	3224	1113	1010	3406	612	1688	6190	1998
Density (veh/mi/ln)	20.5	23.8	16.9	10.2	20.0	8.6	20.2	12.7	20.5	19.0	16.0
Speed (mph)	65.0	42.4	69.6	65.6	67.6	62.1	64.5	51.3	63.0	44.2	67.2
Peak 15 Flow(veh/hr)	5953	1012	4944	703	5648	1154	6804	717	6146	1316	4812
Peak 60 Flow (veh/hr)	5661	930	4724	674	5382	1091	6470	673	5795	1208	4591
Flow (veh/hr)	5583	917	4664	667	5329	1066	6393	669	5719	1187	4529
Volume (veh)	11165	1835	9327	1334	10658	2131	12787	1337	11438	2374	9058
Demand Volume (veh)	11723	1798	9925	1539	11464	2216	13680	1583	12097	2420	9678
Percent Served	95%	102%	94%	87%	93%	96%	93%	84%	95%	98%	94%



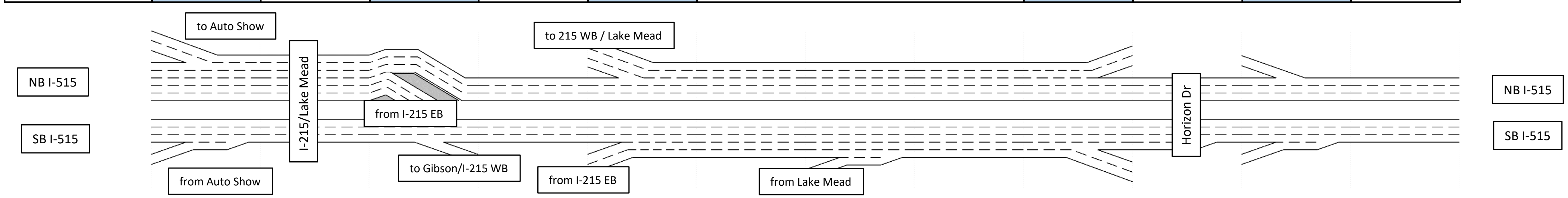
Segment Length (ft)	3379	1023	2458	2124	784	556	3672	1131	1831	5077	1463	2829	467
Density (veh/mi/ln)	26.9	7.2	22.3	7.5	16.6	23.1	17.2	8.5	15.7	22.3	12.4	12.9	10.4
Speed (mph)	65.9	61.1	67.4	64.5	68.4	49.1	66.3	64.0	67.1	46.1	68.4	53.3	69.0
Peak 15 Flow(veh/hr)	6746	957	5774	554	6331	1188	7548	612	6917	2233	4690	2305	2371
Peak 60 Flow (veh/hr)	6126	882	5251	500	5757	1114	6885	559	6333	2065	4284	2099	2190
Flow (veh/hr)	6029	874	5158	484	5644	1104	6761	543	6221	2045	4187	2052	2139
Volume (veh)	12057	1749	10317	968	11288	2208	13521	1086	12442	4090	8374	4104	4277
Demand Volume (veh)	12058	1766	10292	971	11263	2197	13460	1073	12386	4033	8353	4105	4248
Percent Served	100%	99%	100%	100%	100%	101%	100%	101%	100%	101%	100%	100%	101%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 2**A** Crossover Interchange

PM
Notes On/Off Ramp

Segment Length (ft)	1642	1703	1483	4282	753	6077	233	3707	1759	4818
Density (veh/mi/ln)	4.7	13.0	22.0	9.4	13.5	13.0	11.2	14.0	6.7	16.3
Speed (mph)	64.9	66.2	48.0	70.6	53.1	64.5	54.4	69.1	62.5	68.2
Peak 15 Flow(veh/hr)	658	5466	3316	2149	2344	4510	1330	3179	462	3633
Peak 60 Flow (veh/hr)	603	5183	3179	2001	2172	4170	1238	2925	420	3347
Flow (veh/hr)	597	5121	3140	1979	2141	4118	1217	2887	418	3301
Volume (veh)	1194	10242	6279	3958	4281	8236	2435	5774	836	6603
Demand Volume (veh)	1194	10871	6991	3880	4261	8141	2354	5787	838	6625
Percent Served	100%	94%	90%	102%	100%	101%	103%	100%	100%	100%



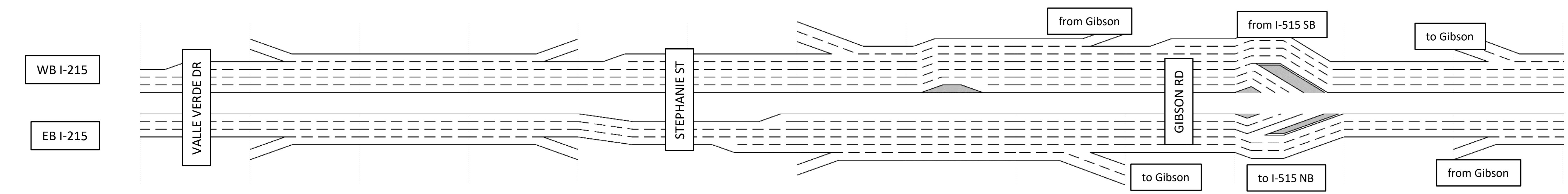
Segment Length (ft)	1652	600	1582	3302	3966	184	1709	7711	833	3038	1223	5599
Density (veh/mi/ln)	8.4	13.3	0.9	12.4	25.9	16.7	7.1	16.0	25.2	13.3	7.3	16.0
Speed (mph)	59.4	63.9	44.1	70.2	44.7	61.4	37.3	65.0	53.5	66.5	54.4	67.6
Peak 15 Flow(veh/hr)	543	2853	47	2818	2400	5169	272	5443	2584	2906	482	3320
Peak 60 Flow (veh/hr)	506	2689	44	2653	2383	5027	267	5303	2487	2821	438	3255
Flow (veh/hr)	492	2631	41	2592	2366	4958	263	5228	2439	2793	428	3222
Volume (veh)	984	5262	81	5184	4732	9916	526	10457	4879	5586	856	6444
Demand Volume (veh)	1108	5355	96	5259	5998	11257	525	11781	5331	6450	860	7310
Percent Served	89%	98%	84%	99%	79%	88%	100%	89%	92%	87%	100%	88%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

AM
Notes On/Off Ramp

	7-9 AM												
Segment Length (ft)	3176	1147	1655	1008	1608	918	582	2396	1135	1434	6071	1416	433
Density (veh/mi/ln)	46.8	8.2	94.3	181.3	85.4	69.6	8.8	24.0	22.1	20.1	11.0	22.9	6.4
Speed (mph)	51.3	52.2	32.8	6.6	35.8	41.7	59.9	55.6	55.3	58.1	61.5	55.1	61.4
Peak 15 Flow(veh/hr)	7475	486	7905	1138	6980	7016	1090	8174	1328	7043	2235	4801	852
Peak 60 Flow (veh/hr)	7307	455	7749	1007	6806	6818	1045	7888	1233	6728	2128	4612	807
Flow (veh/hr)	7181	427	7609	992	6621	6624	1015	7644	1206	6444	2031	4417	777
Volume (veh)	14362	854	15219	1984	13242	13249	2031	15288	2412	12887	4061	8834	1554
Demand Volume (veh)	14801	875	15675	2515	13160	13160	2009	15169	2332	12837	4067	8771	1567
Percent Served	97%	98%	97%	79%	101%	101%	101%	101%	103%	100%	100%	101%	99%



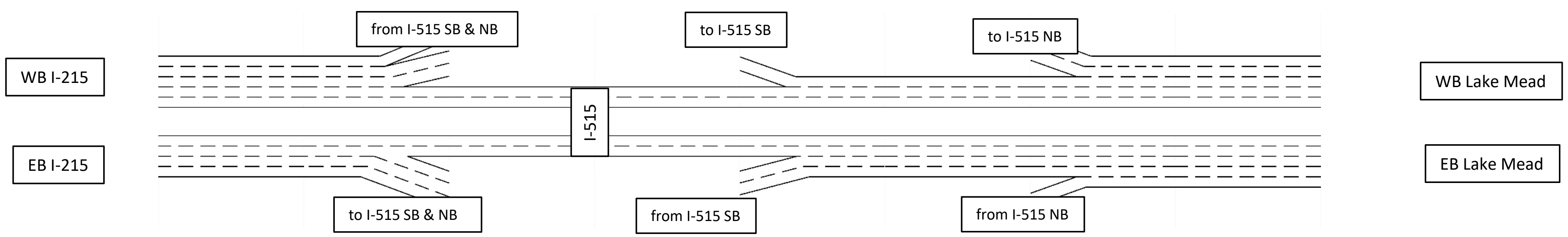
Segment Length (ft)	3167	944	1636	773	2419		605	2675	1010	1122	6388	1243	875
Density (veh/mi/ln)	42.8	10.5	30.0	26.7	27.0		16.7	16.8	8.2	17.5	10.9	21.1	17.8
Speed (mph)	54.1	58.8	60.5	54.5	64.3		56.3	66.3	55.3	64.9	61.6	60.4	43.1
Peak 15 Flow(veh/hr)	6913	696	7596	1526	6093		1042	7112	1036	6063	2164	3904	888
Peak 60 Flow (veh/hr)	6715	658	7373	1475	5898		970	6851	1021	5829	2092	3738	819
Flow (veh/hr)	6486	614	7105	1431	5674		931	6608	1001	5606	2003	3608	777
Volume (veh)	12973	1229	14210	2861	11349		1863	13216	2003	11212	4006	7217	1553
Demand Volume (veh)	12938	1222	14160	2856	11303		1768	13071	1921	11150	3945	7206	1551
Percent Served	100%	101%	100%	100%	100%		105%	101%	104%	101%	102%	100%	100%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

AM
Notes On/Off Ramp

Segment Length (ft)	1656	1975	3255	1256	1218	1200	1650	708
Density (veh/mi/ln)	18.6	13.7	15.9	29.9	2.4	27.9	21.3	24.9
Speed (mph)	55.8	42.3	47.1	52.5	48.1	42.5	39.6	39.9
Peak 15 Flow(veh/hr)	5684	624	1651	3551	139	3675	1560	5108
Peak 60 Flow (veh/hr)	5419	594	1562	3265	122	3380	1475	4842
Flow (veh/hr)	5192	575	1491	3117	117	3224	1415	4628
Volume (veh)	10384	1150	2982	6234	233	6449	2830	9256
Demand Volume (veh)	10338	1160	2962	6216	225	6441	2902	9342
Percent Served	100%	99%	101%	100%	103%	100%	98%	99%



Segment Length (ft)	1476	696	2539	3134	81	1541	593
Density (veh/mi/ln)	20.7	17.0	16.4	15.9	17.8	5.1	16.5
Speed (mph)	56.1	49.0	58.3	48.0	48.3	47.6	46.0
Peak 15 Flow(veh/hr)	4696	2647	2063	1618	3672	268	3942
Peak 60 Flow (veh/hr)	4547	2574	1988	1575	3549	257	3807
Flow (veh/hr)	4386	2485	1903	1516	3419	243	3663
Volume (veh)	8773	4969	3806	3031	6838	485	7325
Demand Volume (veh)	8757	4946	3811	3011	6822	481	7304
Percent Served	100%	100%	100%	101%	100%	101%	100%

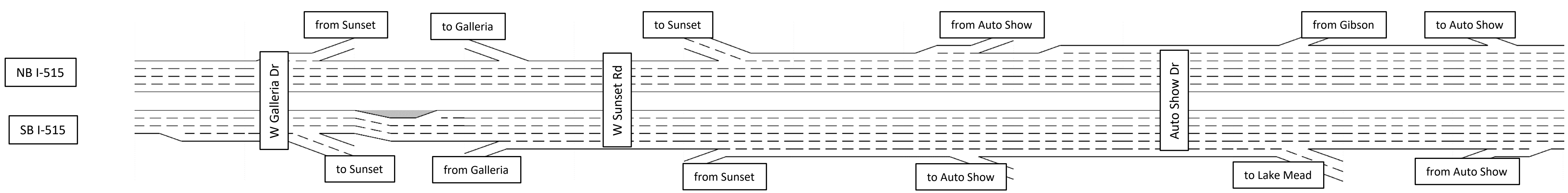
Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

AM
Notes On/Off Ramp

7-9 AM

Segment Length (ft)	3310	554	1952	3113	1396	1224	3277	536	1011	923	1687	1806	283
Density (veh/mi/ln)	28.0	22.5	22.3	5.6	24.4	7.7	38.2	11.3	35.1	58.1	40.5	20.7	5.6
Speed (mph)	63.0	46.8	68.2	66.7	66.4	64.1	45.5	47.8	49.9	40.6	29.4	60.0	65.3
Peak 15 Flow(veh/hr)	7480	1141	6353	399	6751	1077	7824	552	7359	7359	637	6793	400
Peak 60 Flow (veh/hr)	7206	1072	6157	385	6545	1015	7555	542	7064	7077	604	6503	380
Flow (veh/hr)	7025	1016	6006	374	6380	981	7360	517	6841	6839	583	6250	361
Volume (veh)	14050	2031	12013	748	12761	1963	14721	1034	13681	13678	1166	12499	723
Demand Volume (veh)	14048	2039	12009	709	12718	1941	14658	1043	13616	13616	1206	12410	724
Percent Served	100%	100%	100%	106%	100%	101%	100%	99%	100%	100%	97%	101%	100%



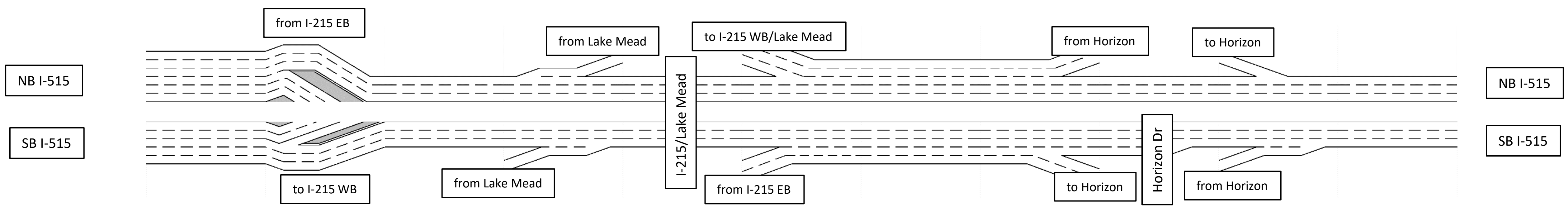
Segment Length (ft)	3512	881	2315	2124	785	555	3432	1352	2172	1531	1758	717
Density (veh/mi/ln)	29.5	7.5	24.3	6.0	17.8	11.7	16.7	12.8	14.5	21.5	10.9	6.2
Speed (mph)	65.6	62.8	67.1	64.9	68.4	55.4	67.1	63.6	68.3	48.7	70.0	61.1
Peak 15 Flow(veh/hr)	7424	1044	6355	424	6766	708	7386	899	6465	2256	4166	408
Peak 60 Flow (veh/hr)	6915	990	5925	399	6328	662	6985	846	6133	2163	3974	386
Flow (veh/hr)	6596	943	5654	386	6041	642	6689	810	5881	2086	3798	376
Volume (veh)	13192	1886	11308	771	12083	1285	13378	1620	11762	4171	7595	752
Demand Volume (veh)	13210	1883	11327	767	12093	1242	13336	1611	11725	4162	7563	794
Percent Served	100%	100%	100%	101%	100%	103%	100%	101%	100%	100%	100%	95%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

AM
Notes On/Off Ramp

Segment Length (ft)	260	6388	1967	1650	3471	959	6252	232	3707	1759	4818
Density (veh/mi/ln)	16.0	10.9	22.2	21.3	15.3	9.8	14.5	18.2	14.1	5.7	15.9
Speed (mph)	68.1	61.6	63.8	39.6	70.0	59.2	68.4	54.1	70.2	63.4	69.5
Peak 15 Flow(veh/hr)	7179	2164	5019	1560	3486	1916	5388	2156	3223	395	3648
Peak 60 Flow (veh/hr)	6900	2092	4809	1475	3331	1816	5148	2058	3096	375	3469
Flow (veh/hr)	6604	2003	4601	1415	3183	1732	4913	1958	2949	356	3304
Volume (veh)	13208	4006	9202	2830	6366	3464	9826	3916	5899	713	6608
Demand Volume (veh)	13134	3945	9190	2902	6288	3443	9731	3820	5911	700	6611
Percent Served	101%	102%	100%	98%	101%	101%	101%	103%	100%	102%	100%



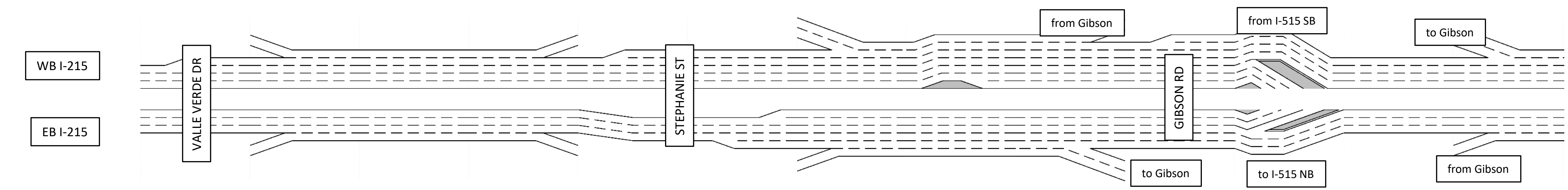
Segment Length (ft)	439	6071	2173	1218	2306	2808	7182	832	3033	1223	5599
Density (veh/mi/ln)	11.9	11.0	10.3	2.4	10.3	18.2	12.3	12.0	13.7	3.8	14.1
Speed (mph)	66.2	61.5	70.1	48.1	70.5	51.5	67.9	61.2	65.2	56.0	69.1
Peak 15 Flow(veh/hr)	4532	2235	2310	139	2437	1980	4450	1527	2937	267	3191
Peak 60 Flow (veh/hr)	4356	2128	2229	122	2351	1920	4269	1500	2768	245	3013
Flow (veh/hr)	4174	2031	2148	117	2267	1864	4134	1456	2680	232	2914
Volume (veh)	8348	4061	4297	233	4534	3728	8267	2912	5359	464	5829
Demand Volume (veh)	8356	4067	4290	225	4515	3707	8221	2891	5330	468	5798
Percent Served	100%	100%	100%	103%	100%	101%	101%	101%	101%	99%	101%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

PM
Notes On/Off Ramp

	4-6 PM												
Segment Length (ft)	3176	1147	1655	1008	1608	918	582	2396	1135	1434	6071	1416	433
Density (veh/mi/ln)	47.0	13.6	89.6	172.5	80.1	76.2	7.4	21.9	19.4	20.1	7.8	28.6	7.1
Speed (mph)	49.7	50.2	31.9	6.9	33.3	37.1	57.5	56.5	55.9	56.2	61.7	50.6	60.8
Peak 15 Flow(veh/hr)	7051	711	7716	1182	6641	6692	936	7837	1127	6810	1627	5188	940
Peak 60 Flow (veh/hr)	6953	685	7627	1127	6532	6536	847	7393	1085	6292	1481	4802	869
Flow (veh/hr)	6884	676	7560	1112	6447	6440	830	7260	1072	6179	1443	4728	859
Volume (veh)	13767	1351	15121	2223	12894	12879	1660	14520	2145	12358	2886	9456	1717
Demand Volume (veh)	15294	1462	16756	4014	12743	12743	1623	14366	2105	12261	2891	9370	1695
Percent Served	90%	92%	90%	55%	101%	101%	102%	101%	102%	101%	100%	101%	101%



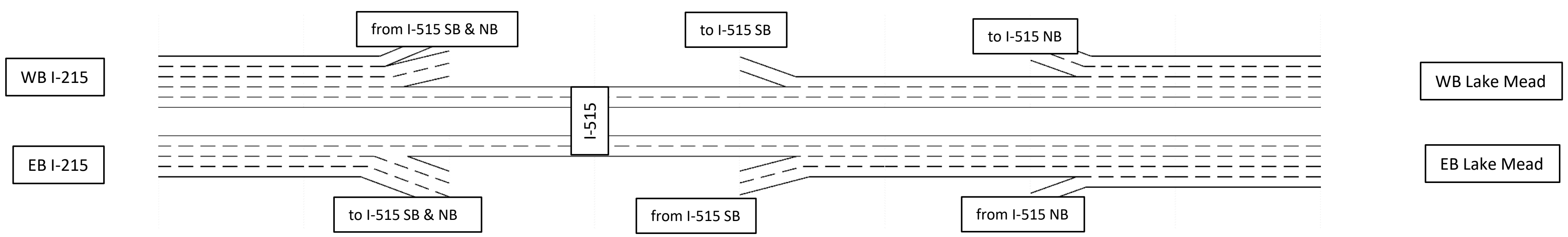
Segment Length (ft)	3167	944	1636	773	2419	605	2675	1010	1122	6388	1243	875
Density (veh/mi/ln)	75.9	13.1	70.7	25.0	73.0	113.4	29.1	7.4	21.9	15.8	22.0	10.6
Speed (mph)	29.0	55.5	26.6	49.9	31.1	17.0	49.7	60.0	60.3	60.9	54.9	43.7
Peak 15 Flow(veh/hr)	6524	800	7260	1172	6060	1452	7487	1040	6445	2987	3462	488
Peak 60 Flow (veh/hr)	6437	726	7153	1168	5986	1375	7339	1008	6339	2891	3455	475
Flow (veh/hr)	6416	718	7127	1163	5960	1364	7316	1007	6309	2874	3439	466
Volume (veh)	12831	1436	14255	2325	11920	2728	14631	2014	12618	5749	6878	932
Demand Volume (veh)	15522	1453	16975	2805	14170	2697	16867	2316	14551	6316	8236	905
Percent Served	83%	99%	84%	83%	84%	101%	87%	87%	87%	91%	84%	103%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

PM
Notes On/Off Ramp

Segment Length (ft)	1656	1975	3255	1256	1218	1200	1650	708
Density (veh/mi/ln)	20.4	14.9	20.3	29.6	5.5	28.9	20.2	26.3
Speed (mph)	54.7	42.2	46.4	52.3	47.5	42.4	40.2	38.7
Peak 15 Flow(veh/hr)	6042	690	2029	3268	278	3572	1469	5049
Peak 60 Flow (veh/hr)	5648	637	1903	3125	265	3392	1381	4779
Flow (veh/hr)	5572	627	1873	3069	262	3330	1367	4696
Volume (veh)	11144	1254	3746	6138	523	6661	2734	9392
Demand Volume (veh)	11064	1232	3714	6119	525	6643	2803	9446
Percent Served	101%	102%	101%	100%	100%	100%	98%	99%



Segment Length (ft)	1476	696	2539	3134	81	1541	593
Density (veh/mi/ln)	17.2	19.2	9.6	22.1	17.2	5.8	15.3
Speed (mph)	58.4	48.6	59.2	47.2	47.3	47.5	46.4
Peak 15 Flow(veh/hr)	3930	2787	1173	2254	3430	320	3754
Peak 60 Flow (veh/hr)	3926	2785	1142	2102	3239	280	3521
Flow (veh/hr)	3906	2777	1130	2081	3211	276	3487
Volume (veh)	7812	5554	2260	4162	6422	551	6974
Demand Volume (veh)	9141	6514	2627	4112	6739	547	7286
Percent Served	85%	85%	86%	101%	95%	101%	96%

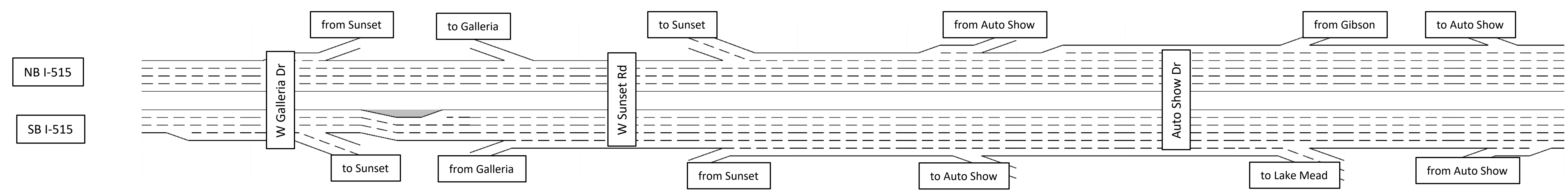
Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

PM
Notes On/Off Ramp

4-6 PM

Segment Length (ft)	3310	554	1952	3113	1396	1224	3277	536	1011	923	1687	1806	283
Density (veh/mi/ln)	20.8	22.8	17.1	10.6	20.6	8.7	29.3	13.0	24.7	25.5	5.0	13.4	8.8
Speed (mph)	66.3	42.6	69.5	65.6	66.5	63.3	48.8	52.6	54.6	52.8	49.7	69.7	65.0
Peak 15 Flow(veh/hr)	5921	1012	4949	722	5677	1160	6829	710	6171	6165	260	5881	598
Peak 60 Flow (veh/hr)	5681	930	4748	698	5433	1115	6545	674	5866	5863	247	5609	572
Flow (veh/hr)	5627	918	4708	693	5401	1089	6489	666	5811	5809	245	5557	568
Volume (veh)	11254	1835	9415	1387	10802	2179	12978	1331	11622	11618	490	11115	1136
Demand Volume (veh)	11723	1798	9925	1539	11464	2216	13680	1583	12097	12097	480	11617	1157
Percent Served	96%	102%	95%	90%	94%	98%	95%	84%	96%	96%	102%	96%	98%



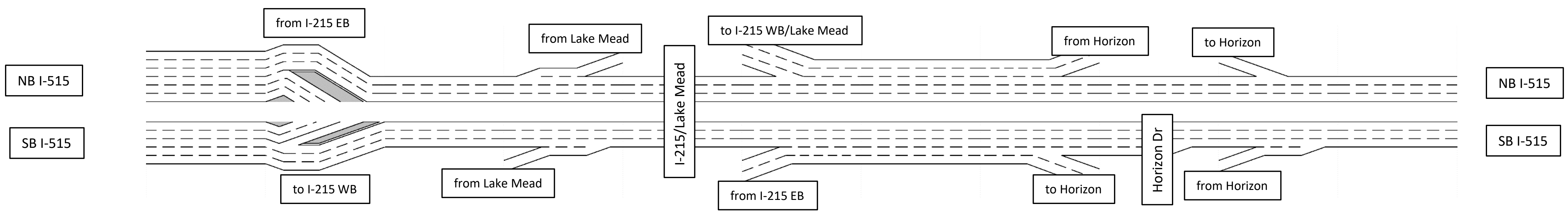
Segment Length (ft)	3512	881	2315	2124	785	555	3432	1352	2172	1531	1758	717
Density (veh/mi/ln)	26.8	7.0	22.1	7.5	16.6	22.6	17.6	8.7	16.2	28.1	10.3	7.5
Speed (mph)	65.9	62.5	67.3	64.4	68.4	50.3	65.0	64.2	65.2	47.6	69.7	61.7
Peak 15 Flow(veh/hr)	6746	956	5771	554	6330	1206	7564	626	6901	2930	3988	500
Peak 60 Flow (veh/hr)	6126	882	5252	500	5755	1126	6896	570	6333	2692	3653	473
Flow (veh/hr)	6029	874	5158	484	5643	1115	6771	554	6221	2660	3569	458
Volume (veh)	12058	1748	10316	968	11287	2229	13541	1108	12442	5320	7137	916
Demand Volume (veh)	12058	1766	10292	971	11263	2197	13460	1073	12386	5265	7121	1029
Percent Served	100%	99%	100%	100%	100%	101%	101%	103%	100%	101%	100%	89%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Year 2040 Build Alternative Option 3 - Retain Core Interchange

PM
Notes On/Off Ramp

Segment Length (ft)	260	6388	1967	1650	3471	959	6252	232	3707	1759	4818
Density (veh/mi/ln)	15.0	15.8	15.5	20.2	9.0	12.5	12.5	10.3	14.0	6.8	16.3
Speed (mph)	67.9	60.9	64.2	40.2	69.9	57.4	65.3	54.5	69.1	62.2	68.2
Peak 15 Flow(veh/hr)	6478	2987	3492	1469	2039	2357	4401	1213	3179	461	3633
Peak 60 Flow (veh/hr)	6172	2891	3280	1381	1899	2176	4070	1141	2925	420	3347
Flow (veh/hr)	6121	2874	3246	1367	1878	2144	4020	1122	2887	418	3301
Volume (veh)	12242	5749	6492	2734	3756	4288	8041	2244	5774	836	6603
Demand Volume (veh)	12774	6316	6459	2803	3655	4261	7916	2129	5787	838	6625
Percent Served	96%	91%	101%	98%	103%	101%	102%	105%	100%	100%	100%



Segment Length (ft)	439	6071	2173	1218	2306	2808	7182	832	3033	1223	5599
Density (veh/mi/ln)	11.9	7.8	12.5	5.5	13.3	24.8	16.6	24.2	14.4	7.4	16.5
Speed (mph)	65.0	61.7	69.5	47.5	69.3	50.7	65.2	53.9	65.7	54.2	67.4
Peak 15 Flow(veh/hr)	4428	1627	2807	278	3073	2522	5582	2608	2961	477	3417
Peak 60 Flow (veh/hr)	4118	1481	2651	265	2912	2515	5437	2532	2905	435	3338
Flow (veh/hr)	4028	1443	2590	262	2853	2506	5368	2486	2884	430	3314
Volume (veh)	8055	2886	5180	523	5706	5013	10737	4971	5767	860	6629
Demand Volume (veh)	8150	2891	5259	525	5784	5998	11781	5331	6450	860	7310
Percent Served	99%	100%	98%	100%	99%	84%	91%	93%	89%	100%	91%

Density, Speed, Volume, Demand Volume, and Percent Served statistics are for the two-hour peak period.
This line diagram is to be reviewed in conjunction with the Peak Hour Volumes exhibits included as an Attachment.

Appendix 2

Existing Bridge Assessment

Henderson Interchange (I-215/I-515) NEPA Project

Clark County, Nevada

Existing Bridge Assessment

Report

Prepared For:

C-A Group
2785 S. Rainbow Blvd.
Las Vegas, NV 89146-4008

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1432 South Jones Blvd.
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ITI Project No.: 120-254

Rev.	Date.	By	Chk:	Comments
0	*12/22/2020*	*CEJ*		*Draft - Issued for Review*

PROFESSIONAL ENGINEER-STATE OF NEVADA
CHARLES E. JOSEPH
EXP. 6/30/2021
CIVIL
No. 12258

12/23/2020

TABLE OF CONTENTS

INTRODUCTION

This report presents an assessment of existing bridges within the Henderson Interchange (Interchange) study area that could be affected by the three (3) different options being studied for this interchange. Under each option, existing bridges are proposed to be retained, replaced, or modified/widened. This report addresses the existing bridges to be retained, widened and/or modified.

ASSESSMENT METHODOLOGY

The existing bridges were assessed through several steps:

- **Document Review** – A review of the following documents was performed:
    - As-Built Bridge Plans – The bridges within this project were constructed and/or widened at different time periods so it was important to check the structural details for suitability of widening and potential seismic issues. Also, the General Notes indicate which design codes/criteria, the construction specifications and material properties were used.
    - Bi-annual Bridge Inspection Reports – The bridge inspection reports are dated from either 2017 or 2019 and present the current condition of the bridges along with maintenance and repair recommendations. This information indicates how the structural elements have been performing and shows areas that could be affected by a widening.
    - Bridge Load Ratings – The Load Ratings indicate the live load capacity of the bridge superstructure accounting for damage or changes in traffic patterns if applicable. This information was reviewed to determine if the load capacity had been diminished, which could affect the design of a widening.
- **Seismic Assessment**
    - A plan review seismic assessment was conducted to first check compatibility of the existing structural detailing with proposed widenings. Structural details reviewed included bearing seat lengths, column fixity to superstructure and foundations, and reinforcing details.
    - The seismic parameters used in the original design were compared with the current parameters to determine if there were significant differences between the original and latest seismic parameters. The United States Geological Survey (USGS) updated their Seismic Hazard Models and Mapping in 2018 and this update increased the seismic hazards for Southern Nevada. Most of the existing bridges were designed to a Peak Ground Acceleration (PGA) of 0.15g, while the latest PGA for this area is 0.21g.

ASSESSMENT RESULTS

A matrix of each bridge with details about the existing bridge, the proposed widening configuration, the effects of a widening on the structure and the seismic implications is included in Appendix 1.

Most of the bridges within the Interchange were constructed in 2005-2006 and were designed to the 17th Edition of the AASHTO Bridge Design Specifications. Some of the bridges within the study area along I-515 were constructed in the late 1980's or early 1990's and were designed to earlier editions of AASHTO. Bridges along I-215 were constructed in the 1996-1997 timeframe. Prior to 2007 bridges were designed for a 50-year service life so even the oldest structures have 18-20 years of service life remaining.

Generally, the proposed widenings and modifications should pose little if any problems to the existing structures. Several of the highly skewed bridges exhibit spalling and cracking at the corners of the bridges, due to horizontal rotation of the superstructure from thermal forces. These issues can be repaired during construction and the widening design can address potential mitigations.

Seismic – Widenings or modifications should not have major impacts to most of the bridges constructed after 1996. This is due to NDOT's long standing policy that bridges in Southern Nevada are to be detailed to Seismic Design Category (SDC) C which is one level higher than Southern Nevada's SDC B classification. Despite the USGS' increase in seismic hazards for Southern Nevada, the higher level of detailing should provide adequate seismic capacity for these bridges. There are several bridges along I-515/I-11 that were constructed in the late 1980's that will need verification of the seismic design parameters, which were not noted in the plans. It was noted that these structures were designed to the AASHTO Guide Specifications for Seismic Design 1983.

The H-1460 bridge – I-515 over Gibson Road – appears to have substandard bearing seat lengths at the abutments. The actual length is 23" but the required length should be 36". An extension of the bearing seat may need to be considered for this two-span structure.

Existing Bridge Assessment Matrix and Minimum Support Width Calculations are shown on the following pages.

DISPOSITION OF EXISTING BRIDGES					Bridge Configuration	Abutments	Piers	Superstructure	Bridge Assessment	Seismic Assessment
BRIDGE NUMBER	DESCRIPTION	BRIDGE DISPOSITION								
		OPTION 1	OPTION 2A	OPTION 3						
B-613	I-215 over Dry Wash 1,200' West of Stephanie	Retain	Retain	Retain	Box Culvert				This box culvert is not affected by the project	
B-2121	I-215 over Dry Wash 1,100' East of Stephanie	Retain and extend	Retain	Retain	Box Culvert				The box culvert can be extended according to NDOT standard plans.	
G-1463	I-515 SB over UPRR	Retain and widen	Retain	Retain and widen	98-foot Single Span - Original SB & NB are one structure; constant 145-foot width at 14.77 degree skew: SB widened by 55-ft in 2004.	Diaphragm on Spread Footing on MSE Walls	N/A	PT CIP Box Girder. Original deck width = 145-ft; SB widening added 55-ft for total 200-ft width	SB side widened in 2004 in kind with closure pour at deck level. The widening was a variable width. New widening would require similar construction with closure pour at deck level. NDOT doesn't allow spread footings on top of MSE walls any longer but existing bridge and widening appear to be in good condition despite two different MSE systems.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
G-1463	I-515 NB over UPRR	Retain and widen	Retain and widen	Retain and widen	98-foot Single Span - Original SB & NB are one structure; constant 145-foot width at 14.77 degree skew.	Diaphragm on Spread Footing on MSE Walls	N/A	PT CIP Box Girder. Original deck width = 145-ft	New NB widening would require similar construction with closure pour at deck level. MSE Wall would need to be extended. NDOT doesn't allow spread footings on top of MSE walls any longer but existing bridge and widening appear to be in good condition despite two different MSE systems. Bridge widening should be acceptable.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
G-1465	I-11 SB over UPRR	Retain and widen	Retain	Retain	111-foot Single Span; original was a single structure for NB/SB; SB widened by 24-ft; 39.03 deg skew	Diaphragm on CIP cap with drilled shaft foundations	N/A	PT CIP Box Girder. Original deck width ~ 121-ft; SB widening added 24-ft	The existing bridge is mostly in good condition with some minor repair recommended in the inspection report. This bridge can be retained or widened with similar construction.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required.
G-1465	I-11 NB over UPRR	Retain and widen	Retain	Retain	111-foot Single Span; original was a single structure for NB/SB; NB variable widening of 34+-ft; 39.03 deg skew	Diaphragm on CIP cap with drilled shaft foundations	N/A	PT CIP Box Girder. Original deck width ~ 121-ft; NB widening added 34-ft ±	The existing bridge is mostly in good condition with some minor repair recommended in the inspection report. This bridge can be retained or widened with similar construction.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required.
G-1958	I-215 WB over UPRR	Retain and connect decks	Retain, connect decks and widen	Retain	328-ft, 3-span - 104-132-92 - variable width; 64-59 deg skew	Open high cantilever abutments on spread footings. Abutments are on different bearing lines to each other and to piers.	Reinforced concrete columns/caps on spread footings. Piers are on different bearing lines to each other and abutments	Steel plate girder with CIP concrete deck. Girders have variable spacing. - 6-ft to 8.16-ft and variable lengths. Deck cross slope varies downward to the north.	Plans to connect the deck of the WB & EB structures may present long term issues due to the skew and aspect ratio of the connected decks. Also, the decks have opposite cross slopes and a connected deck induces a crown at an asymmetrical location near the LMD line. A connected deck would change the aspect ratio from principally longitudinal to more equal longitudinal/transverse with the obtuse corners closer to each other than the bridge length. Deck stresses would then tend to occur between the obtuse corners in a more transverse direction, which could lead to cracking, but this should be manageable. Also, the inspection report indicates there is spalling in the deck soffit at the longitudinal joint at the abutments, which is indicative of skewed bridges racking under thermal loading. Despite these issues it should be acceptable to modify and widen this bridge	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA would probably not require seismic retrofits. Connecting the decks also may provide better seismic response through singular horizontal diaphragm action that will be dissipated through the abutment backwall and fill.
G-1958	I-215 EB over UPRR	Retain and connect decks	Retain, connect decks and widen	Retain	328-ft, 3-span - 104-132-92 - variable width; 64-59 deg skew	Open high cantilever abutments on spread footings. Abutments are on different bearings to each other and to piers.	Reinforced concrete columns/caps on spread footings. Piers are on different bearings to each other and abutments	Steel plate girder with CIP concrete deck. Girders at equal spacing of 7.25-ft but have variable length. Cross slope varies downward to the south.		Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA would probably not require seismic retrofits. Connecting the decks also may provide better seismic response through singular horizontal diaphragm action that will be dissipated through the abutment backwall and fill.

DISPOSITION OF EXISTING BRIDGES					Bridge Configuration	Abutments	Piers	Superstructure	Bridge Assessment	Seismic Assessment
BRIDGE NUMBER	DESCRIPTION	BRIDGE DISPOSITION								
		OPTION 1	OPTION 2A	OPTION 3						
H-1460	I-515 SB over Gibson Road	Retain and widen	Retain and widen	Retain and widen	370-ft, 2-span variable width; 185-185; 64 deg skew	Open high cantilever abutment with stub backwall on deep foundations.	Reinforced concrete columns/caps on deep foundations. Columns are flared at top with cont reinforcing into the superstructure. Columns are pinned at the bottom.	CIP PT box girder 7'-6" deep with paving rest at end diaphragm for approach slab.	This bridge has an acute skew angle and the SB and NB are separated by a 1" longitudinal joint. The existing median barrier is wholly located on the SB structure and both structures are variable width due to on/off ramps from the north. Existing bridge exhibits cracking/spalling at the corners due to racking of the superstructure due to the high skew. The bridge is planned to be widened on both NB and SB sides and will probably require variable widths to accommodate the relocated ramps from the north. One additional column will be needed at each structure for the widening and the new decks will need to be connected. With the acute skew the widening could exacerbate the horizontal rotation of the superstructure noted in the inspection report. Potential mitigation for the spalling corners could be to reconfigure the backwall/wingwall to allow more room for the superstructure to rotate horizontally.	Bridge designed to AASHTO Guide Specs for Seismic 1983, but no seismic parameters are noted in the plans. Bridge should be checked for the latest seismic hazard levels. Superstructure support length is substandard 23" provided vs. 35.84" required. A seat extension may need to be considered. Planned widening appears to be 2-lanes SB and NB, which will require new substructure - piers and abutments. If needed, the new substructure can be designed to add seismic resistance to the existing bridge. Existing tops of columns are flared and connected to the superstructure, which is not allowed currently, so recommend separating the flares from the pier cap.
	I-515 NB over Gibson Road	Retain and widen	Retain and widen	Retain and widen	370-ft, 2-span variable width; 185-185; 64 deg skew	Open high cantilever abutment with stub backwall on deep foundations.	Reinforced concrete columns/caps on deep foundations. Columns are flared at top with cont reinforcing into the superstructure. Columns are pinned at the bottom.	CIP PT box girder 7'-6" deep with paving rest at end diaphragm for approach slab.	This bridge has an acute skew angle and the SB and NB are separated by a 1" longitudinal joint. The existing median barrier is wholly located on the SB structure and both structures are variable width due to on/off ramps from the north. Existing bridge exhibits cracking/spalling at the corners due to racking of the superstructure due to the high skew. The bridge is planned to be widened on both NB and SB sides and will probably require variable widths to accommodate the relocated ramps from the north. One additional column will be needed at each structure for the widening and the new decks will need to be connected. With the acute skew the widening could exacerbate the horizontal rotation of the superstructure noted in the inspection report.	Bridge designed to AASHTO Guide Specs for Seismic 1983, but no seismic parameters are noted in the plans. Bridge should be checked for the latest seismic hazard levels. Superstructure support length is substandard 23" provided vs. 35.84" required. A seat extension may need to be considered. Planned widening appears to be 2-lanes SB and NB, which will require new substructure - piers and abutments. If needed, the new substructure can be designed to add seismic resistance to the existing bridge. Existing tops of columns are flared and connected to the superstructure, which is not allowed currently, so recommend separating the flares from the pier cap.
H-1836	I-515 SB over Warm Springs Road	Retain and widen	Retain and widen	Retain and widen	174-ft, single span, NB/SB structures, constant width of 60'-6" each, 22.77 deg skew	Diaphragm abutment on pile cap with shear key and deep foundations	N/A	CIP PT box girder 7'-4" deep with paving rest at end diaphragm for approach slab.	The existing bridge appears to be in good condition. Planned widening appears to be 2 lanes NB/SB and there should be no issues widening in-kind and connecting the decks.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
	I-515 NB over Warm Springs Road	Retain and widen	Retain and widen	Retain and widen	174-ft, single span, NB/SB structures, constant width of 60'-6" each, 22.77 deg skew	Diaphragm abutment on pile cap with shear key and deep foundations	N/A	CIP PT box girder 7'-4" deep with paving rest at end diaphragm for approach slab.	The existing bridge appears to be in good condition. Planned widening appears to be 2 lanes NB/SB and there should be no issues widening in-kind and connecting the decks.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
H-1961	Arroyo Grande Blvd. over I-215	Retain	Retain	Retain	251-ft 2-span; 82-ft constant width; 10.7 deg skew	CIP concrete, short seat abutments on spread footing	CIP concrete multi-columns on spread footing fixed top and bottom; pier cap integral with superstructure	CIP PT box girder 5'-3" with integral end diaphragm	The existing bridge is in good condition with only minor repairs recommended for crack sealing, bridge mounted signs and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits.

DISPOSITION OF EXISTING BRIDGES					Bridge Configuration	Abutments	Piers	Superstructure	Bridge Assessment	Seismic Assessment
BRIDGE NUMBER	DESCRIPTION	BRIDGE DISPOSITION								
		OPTION 1	OPTION 2A	OPTION 3						
H-2799S	Ramp AS3 over Ramp SE/W	Demolish and replace	Retain	Retain	522-ft, 4-span ramp; constant width of 31-ft; no skew	CIP concrete, high cantilever seat abutment on spead footings	Piers 1&3 are CIP concrete single column piers on large diameter drilled shafts fixed top & bottom; Pier 2 is a 2-column outrigger pier on drilled shafts fixed at the bottom but pinned at the top with outrigger cap integral with superstructure	CIP PT box girder 6'-9" deep with integral end diapragms	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
H-2799N	Ramp AS2 over Ramp EN	Demolish and replace	Retain	Retain	443-ft, 4-span ramp; constant width of 31-ft; no skew	CIP concrete, high cantilever seat abutment on spead footings	Piers 1&3 are CIP concrete single column piers on large diameter drilled shafts fixed top & bottom; Pier 2 is a 2-column outrigger pier on drilled shafts fixed at the bottom but pinned at the top with outrigger cap integral with superstructure	CIP PT box girder 5'-9" deep with integral end diapragms	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
H-2879N	Ramp GD2 over Ramp SD1	Retain	Retain	Retain	178-ft, single span ramp; constant width of 31-ft; 45.3 deg skew	CIP concrete, high cantilever seat abutment on spead footings	N/A	CIP PT box girder 7'-9" deep with integral end diapragms	The existing bridge is in good condition with only minor repairs recommended for deck spall and approach railing repair.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
H-2879S	Ramp GD3 over Ramp SD4	Retain	Retain	Retain	443-ft, 4-span ramp; constant width of 31-ft; no skew	CIP concrete, high cantilever seat abutment on spead footings	Piers 1&3 are CIP concrete single column piers on large diameter drilled shafts fixed top & bottom; Pier 2 is a 2-column outrigger pier on drilled shafts fixed at the bottom but pinned at the top with outrigger cap integral with superstructure	CIP PT box girder 5'-9" deep with integral end diapragms	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
I-1459	I-515 SB over Sunset Road	Retain and widen	Retain and widen	Retain and widen	185-ft single span, one structure for both SB/NB; 121-ft constant width; 25.89 deg skew	Diaphragm abutment on pile cap with shear key and deep foundations	N/A	CIP PT box girder 8'0" deep with paving rest at end diaphragm for approach slab.	The existing bridge appears to be in good condition. Planned widening appears to be 1 lane NB/SB and there should be no issues widening in-kind and connecting the decks. Current Critical Clearance is 16'-10" and a widening at 2% cross-slope will maintain the required 16'-6" critical clearance	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
	I-515 NB over Sunset Road	Retain and widen	Retain and widen	Retain and widen	185-ft single span, one structure for both SB/NB; 121-ft constant width; 25.89 deg skew	Diaphragm abutment on pile cap with shear key and deep foundations	N/A	CIP PT box girder 8'0" deep with paving rest at end diaphragm for approach slab.	The existing bridge appears to be in good condition. Planned widening appears to be 1 lane NB/SB and there should be no issues widening in-kind and connecting the decks. Current Critical Clearance is 16'-10" and a widening at 2% cross-slope will maintain the required 16'-6" critical clearance	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
I-1459R	Ramp GD2 over Sunset Road	Demolish and replace	Retain	Retain	141-ft single span; 31-ft constant width; 20.8 deg skew	CIP concrete high cantilever abutments on spread footings	N/A	Steel plate girder, 6'-9" deep	The existing bridge is in good condition with only minor repairs recommended for soffit spalling and joint and drain cleaning.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.

DISPOSITION OF EXISTING BRIDGES					Bridge Configuration	Abutments	Piers	Superstructure	Bridge Assessment	Seismic Assessment
BRIDGE NUMBER	DESCRIPTION	BRIDGE DISPOSITION								
		OPTION 1	OPTION 2A	OPTION 3						
I-1459L	Ramp GD3 over Sunset Road	Retain	Retain	Retain	152-ft single span; 31-ft constant width; 29.8 deg skew	CIP concrete high cantilever abutments on spread footings	N/A	Steel plate girder, 6'-11" deep	The existing bridge is mostly in good condition with the exception of deck overhang soffit spalling at the NE/SW corners. Repairs are recommended in the inspection report.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
I-1464	I-515 SB over I-215	Retain	Retain	Retain	227-ft two-span; 60'-6" constant width original with 24-ft widening;32.4 deg skew	CIP diaphragm abutment on spread footing. A tie-back wall was constructed in front of Abut 1 during the 2003 widening.	Multi-column CIP pier fixed on top and pinned on bottom on spread footings. Pier in widening has joint separation between top of column and superstructure.	Original is CIP PT box girder and widening is precast U-girders with CIP deck 5'-1" deep. Precast u-girders were post-tensioned for continuity.	The existing bridge is in good condition with only minor repairs recommended for expansion joint header, soffit spalling and joint cleaning.	Bridge widening designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. 1993 as-builts unavailable to determine original seismic criteria used. Current seismic parameters have increased PGA to 0.212g, but since the bridge widening was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
	I-515 NB over I-215	Retain and widen	Retain	Retain	227-ft two-span; 60'-6" constant width;32.4 deg skew	CIP diaphragm abutment on spread footing. A tie-back wall was constructed in front of Abut 1 during the 2003 widening.	Multi-column CIP pier fixed on top and pinned on bottom on spread footings	Original is CIP PT box girder and widening is precast U-girders with CIP deck 5'-1" deep. Precast u-girders were post-tensioned for continuity.	The existing bridge is in good condition with only minor repairs recommended for expansion joint header, soffit spalling and joint cleaning. The bridge can be widened with similar construction.	1993 as-builts unavailable to determine original seismic criteria used.
I-1466	Horizon Drive over I-515	Retain	Retain	Retain	235-ft two-span; 102-ft constant width; no skew	CIP diaphragm abutment on spread footing	Multi-column CIP pier fixed on top and pinned on bottom on spread footings. Columns are flared at the top.	CIP PT box girder 5'-6" deep	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to AASHTO Guide Specs for Seismic 1983, but no seismic parameters are noted in the plans. Bridge should be checked for the latest seismic hazard levels. Abutment seat length exceeds required. Existing tops of columns are flared and connected to the superstructure, which is not allowed currently, so recommend separating the flares from the pier cap.
I-1959	I-215 WB over Gibson Road	Retain, connect decks and widen	Retain and widen	Retain and widen	164-ft single span, one structure for SB/NB, 125-ft constant width, 12.36 degree skew	CIP concrete high cantilever abutments on spread footings	N/A	CIP PT box girder 7'-4" deep	The existing bridge is in good condition. Proposed widening appears to be 4 lanes WB for Option 1; 2 lanes WB and 1 lane EB for Option 2 and 2 lanes WB for Option 3. The widenings can be accomplished in-kind but may consider using a precast box for the 1-lane widening. Current critical clearance is 18'-7" so widening should not a problem for the critical clearance.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
	I-215 EB over Gibson Road		Retain and widen	Retain and widen	164-ft single span, one structure for SB/NB, 125-ft constant width, 12.36 degree skew	CIP concrete high cantilever abutments on spread footings	N/A	CIP PT box girder 7'-4" deep	The existing bridge is in good condition. Proposed widening appears to be 2 lanes WB and 1 lane EB for Option 2 and 2 lanes WB for Option 3. Either widening can be accomplished in-kind but may consider using a precast box for the 1-lane widening. Current critical clearance is 18'-7" so widening is not a problem for the critical clearance.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceed required. Widening should not affect the seismic response of this structure.
I-1960	Stephanie Street over I-215	Retain	Retain	Retain	240-ft two-span; 140-ft constant width; 10.4 deg skew	CIP concrete short seat abutments on spread footings	CIP concrete multi-columns on spread footing fixed top and bottom; pier cap integral with superstructure	CIP PT box girder 5'-3" deep	The existing bridge is in good condition with only minor repairs recommended for joint replacement and fence repairs	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
I-1962	Valle Verde Drive over I-215	Retain	Retain	Retain	182-ft two-span; variable width 131-ft to 188-ft SPDI bridge; no skew	CIP concrete high cantilever abutments on spread footings	CIP concrete multi-columns on spread footing fixed top and bottom; pier cap integral with superstructure	CIP PT box girder 5'-6" deep	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Bridge designated with Seismic Importance Classification 1. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.

DISPOSITION OF EXISTING BRIDGES					Bridge Configuration	Abutments	Piers	Superstructure	Bridge Assessment	Seismic Assessment
BRIDGE NUMBER	DESCRIPTION	BRIDGE DISPOSITION								
		OPTION 1	OPTION 2A	OPTION 3						
I-2108	Ramp ES/EN Flyover	Demolish and replace	Demolish	Retain	687-ft 5-span variable width for the ES/EN segment; 958-ft 6-span, 31-ft constant width for the ES Ramp; no skew	CIP concrete short seat abutments on spread footings	CIP concrete multi-columns on drilled shaft foundations; pier cap integral with superstructure	CIP PT box girder 6'-6" deep	The existing bridge is generally in good condition with recommended replacement of the expansion joints and cleaning of clogged drains. Other minor repairs are recommended.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
I-2109	Ramp EN Flyover	Demolish and replace	Demolish	Retain Spans 1-9, Demolish & Reconstruct Spans 10-15	2502-ft, 15-span viaduct, 35-foot constant width curved ramp bridge	CIP concrete high cantilever abutments on spread footings	CIP Concrete single column, hammer head piers on single 8-foot diameter drilled shafts.	Curved/tangent welded steel plate girders made continuous. Superstructure depth is 6'-8" for Spans 1-3 and 8'-2" for all other spans.	The ramp is proposed to be realigned for approximately the last 1000-ft requiring new construction for Spans 10-15. Current plan is to use the first splice north of Pier 9 as the point between the existing and new construction. The existing girders are curved in this immediate area and the proposed alignment appears to maintain this curvature for a short distance up station before the alignment becomes tangent. The proposed reconfiguration should not pose problems to this structure.	Reconstructing Spans 10-15 should not change the seismic characteristics of this bridge. Seat width at the ES/EN Pier 5 exceeds requirements.
I-2110	Ramp NW Flyover to WB I-215	Demolish and replace	Demolish	Retain	1673-ft, 12-span; 35-ft constant width; no skew	Abut 1 - CIP concrete short seat abutments on spread footings; Abut 2 - CIP concrete high cantilever seat abutments on spread footings	CIP Concrete single column, hammer head piers on single 7-foot diameter drilled shafts.	Curved/tangent welded steel plate girders made continuous. Superstructure depth is 6'-6".	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
I-2111	Ramp SW over Ramp SE	Demolish	Demolish	Retain	679-ft, 6-span; 35-ft constant width; no skew	Abut 1 - CIP concrete short seat abutments on spread footings; Abut 2 - CIP concrete high cantilever seat abutments on spread footings	CIP Concrete single column, hammer head piers on single 7-foot diameter drilled shafts.	Curved/tangent welded steel plate girders made continuous. Superstructure depth is 6'-0".	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint replacement.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
I-2112	I-215 over Ramp SE	Retain and widen	Demolish	Retain	Variable length (61-ft to 116-ft), single-span; variable width (nominal 97-ft); variable skew (~25 - 45 deg) due to curved abutment	CIP concrete curved high cantilever abutments on spread footings	N/A	CIP PT Box Girder 4'-6" deep; Due to skew web lengths vary from shortest at north edge (60-ft) to longest at south edge (107-ft)	The existing bridge is in good condition with only minor repairs recommended for crack sealing, joint cleaning and spall repairs. Widening may present issues due to the skew and curved Ramp SE. Widening the EB side of the bridge where the girder web lengths are the longest side could require a deeper structure depth or thicker webs with more P-T. Plus, it's in close proximity to other structures, slopes and walls.	Single span bridges are designed to SDC A requirements. Abutment seat support lengths provided exceeds required.
I-2747	Auto Show Drive over I-515	Retain	Retain	Retain	208-ft, 2-span; variable width 86-ft to 91-ft ; no skew	CIP concrete high cantilever abutments on spread footings	Multi-column CIP piers on 6-ft dia drilled shafts; fixed top&bot	Tangent steel plate girders made continuous; 3'-11" depth	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.
I-2881	Galleria Drive over I-515	Retain	Retain	Retain	220-ft, 2-span; 150-ft constant width; 24.9 deg skew	CIP concrete high cantilever abutments on spread footings	Multi-column CIP piers on continuous spread footing; fixed top&bot	Tangent steel plate girders made continuous; 4'-5" depth	The existing bridge is in good condition with only minor repairs recommended for crack sealing and joint cleaning.	Bridge designed to SDC B with PGA = 0.15g and detailed to SDC C requirements. Current seismic parameters have increased PGA to 0.212g, but since the bridge was detailed to SDC C, the higher PGA should not require seismic retrofits. Abutment seat length exceeds required.

Minimum Support Width Check

AASHTO Guide Spec for Seismic - 4.12.2-1 N = (8+0.02L+0.08H)(1+ 0.000125S^2)

		G-1463	G-1465	G-1958	H-1460	H-1836	I-1459	I-2109	I-2109	I-1959	H-1961	H-2799S	H-2799N	H-2899S	H-2899N	I-1459R	I-1459L	I-1464	I-1466	I-1960	I-1962	I-2108	I-2110	I-2111 A1	I-2112	I-2747	I-2881
L (ft)	Length of bridge deck to Exp Jt	98	111	328.08	370	174	185	445	711	164	251	522	423	442	178	141	152	227	235	254	182	489	479	679	73	208	220
H (ft)	Avg Height of columns	25	25	25	21	17	17	50	23	19	18	19	19	35	19	22	22	18	24	23	22	45	60	18	18	18	18
S (deg)	Skew Angle	14.9	39.03	64	64	22.8	25.89	0	0	12.36	10.7	0	0	0	45.3	20.8	29.8	32.4	0	10.4	0	0	0	0	0	0	24.9
N (in)	Min support length	12.29	14.55	25.04	25.82	13.67	14.15	20.90	24.06	13.04	14.67	19.96	17.98	19.64	16.44	13.26	14.22	15.81	14.62	15.12	13.40	21.38	22.38	23.02	10.90	13.60	14.91
	150% for SDC B	18.44	21.82	37.56	38.74	20.51	21.23	31.35	36.09	19.57	22.00	29.94	26.97	29.46	24.65	19.89	21.33	23.72	21.93	22.68	20.10	32.07	33.57	34.53	16.35	20.40	22.37
Nprov (in)	Provided support length	65	32	48	21	39	25	51	36	36	42	30	30	30	48	34	34	70	52	40	39	39	36	36	36	30	30
		OK	**OK**	**OK**	**NG**	**OK**	**OK**	**OK**	**NG**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**
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Appendix 3

VA Study Report

Value Analysis Study Report

Nevada Department of Transportation Henderson Interchange Feasibility Study

Workshop Dates: June 15-18, 2020

Contact: Patrice Miller, CVS
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August 14, 2020

Value Analysis Study
Nevada Department of Transportation
Henderson Interchange Feasibility Study

Contents

Contents (continued)

SECTION

1

EXECUTIVE SUMMARY

Section 1: Executive Summary

Background

A Value Analysis (VA) Study was conducted virtually June 15-18, 2020 on the *Henderson Interchange Feasibility Study* (dated February 2020) for the Nevada Department of Transportation Henderson Interchange project. The Henderson Interchange connects I-515 from the north, I-215 from the west, I-11 from the south, and Lake Mead Parkway (SR-564) from the east. Each of the four routes begin or end at the interchange. A goal of the project would be to achieve the purpose as efficiently as practical with a satisfactory cost:benefit ratio.

The purpose of the proposed project (excerpted from the *Feasibility Study*) is to:

- Resolve existing roadway deficiencies, such as weaving and congestion areas, and areas of higher accident frequency and severity.
- Provide transportation improvements to serve existing and future growth areas to meet anticipated growth of the Las Vegas area, as forecast by the Regional Transportation Commission of Southern Nevada.
- Restore local traffic connectivity such as access from Lake Mead Parkway to Gibson Road.
- Accommodate regional and local plans including future high-occupancy vehicle (HOV) lanes and a future Interstate 11. A Tier 1 EIS is currently being developed by NDOT to investigate potential alignments for I-11 from the southern state line to the northwest side of Las Vegas, and the potential exists for the I-11 alignment to pass through this interchange.

Build Option 1: Widening and construction of new bridges to maintain a similar look and feel of the interchange. Improvement would modify adjacent service interchange access and be constructed primarily within the existing right-of-way.

Build Option 2: Requires substantial demolition and reconstruction of the interchange to develop a double crossover layout which provides direct access from each freeway without large direct-connection bridge structures. More unique bridge structures are required for the crossing of the mainline freeway to create the "crossover" layout.

For the purposes of the VA Study, Build Options 1 and 2 (shown above) were the initial focus of the analysis.

VA Study Objective

The value study team's objective was to develop recommendations that support the Nevada Department of Transportation and CA Group in making informed decisions that will yield the best value for the project. The value study team identified alternate ways to effectively meet the Project Purpose and Need at the most efficient cost as compared to the baseline Build Options 1 and 2.

Value Methodology

The value study team followed SAVE International's value methodology—using the SAVE Job Plan, which includes six phases of analysis. Please see Section 4, Support Data, for more detailed information.

Value Study Results

Creative Ideas

The value study team generated 55 creative ideas, and initially developed 15 value analysis proposals to improve the project (IG-10 was later dropped by the value study team and not fully developed but included in the report under Section 3, Value Analysis Workbooks). A complete list of all of the creative ideas generated is included in Section 4, Support Data.

Value Analysis Proposals

Fifteen of the creative ideas that best met the project purpose and need and value definition (function and performance over cost) were selected for development into value analysis proposals that range from $2M to $49M in cost savings. The balance of enhancing project function and performance while saving money is the foundation of the value methodology. Of these 15 developed value analysis proposals, one was later dropped (IG-10) and not all were costed due to the short duration of the study. For those that were costed, they could potentially apply to either Build Option 1, Build Option 2, or both, creating an improved Option and new Option 3. Please see Section 2, Summary Results and Section 3, Value Analysis

Workbooks for a summary of results and detailed value analysis workbooks, respectively. The disposition of the VA proposals is included in Section 5, Implementation.

Design Comments

Fifteen ideas were considered design comments and are for the design team's consideration during the next phase of design development.

Recommendations

Accepted proposals as listed in the Summary of Value Analysis Proposals in Section 5: Implementation, would result in improvements to Option 2, and when applied to Option 1, would result in a new Option 3.

It is anticipated that the accepted proposals from the VA Study will result in a current year construction cost for Option 2 of approximately $188 M and a current year construction cost for Option 3 of approximately $211 M. These costs are approximately $50 M less than estimated construction costs provided in the Henderson Interchange Feasibility Study for both Options 1 and 2.

Connectivity for the improved Option 2 would be comparable to Option 2 as configured in the Feasibility Study, with full access provided to Gibson Road and Auto Show Drive. Connectivity for new Option 3 would be better than Option 1 as configured in the Feasibility Study, with full access provided to Auto Show Drive that was not provided by Option 1.

Results of the VA Study report were presented to NDOT Management on July 27 and to City of Henderson Management on July 30. Based on the results of this study, NDOT Management recommendations for the Henderson Interchange project include:

- Improved Option 2 and new Option 3 should be studied further in NEPA because they are the most economically feasible while accommodating 2040 traffic volumes with full connectivity to local roads,
- Perform further study to confirm cost estimates and to document satisfactory traffic operations performance including the westbound Lake Mead Parkway movement to Gibson Road for Option 3, and
- Accommodate future HOV connectivity between I-215 and I-515.

Value Study Team

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- Michael Taylor (NDOT)
- Lynnette Russel (NDOT)
- Shawn Paterson (NDOT)
- Brian Deal (NDOT)
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SECTION

2

SUMMARY INFORMATION

Section 2: Summary Information

Introduction

The value study team brainstormed 55 ideas. A total of 15 ideas were developed as Value Analysis Proposals (with cost impacts, when possible). The description and further discussion of these are included in Section 3: Value Analysis Workbooks. Several of the proposals overlap or represent different ways of approaching the same issue. As a result, the cost avoidance may not be cumulative. Please note that one of the ideas, IG-10, was later dropped by the value study team.

The Summary of Value Analysis Proposals (table) identifies cost impacts; savings is shown as positive costs while any added costs are noted in parenthesis. The table summarizes the 14 VA Proposals that were fully developed and does not include IG-10.

The value study team also identified 15 design comments to be considered in the next phase of design development.

The Value Analysis (VA) Proposals are categorized by function as follows:

- Improve Geometry (IG) - 11 proposals (originally 12, but IG-10 was later dropped)
- Improve Access (IA) - 2 proposals
- Improve Mainline-operations (IM) - 1 proposal

Although not specifically noted in the table, the VA proposals may be used in combination with one or more other VA proposals to achieve the goals of the value study.

When ideas applicable to Build Option 1 are implemented to create a new Option 3, a preliminary estimate of savings from Option 1 is $80,367,000. When ideas applicable to Build Option 2 are implemented to create an improved Option 2, a preliminary estimate of savings from Option 2 is $69,417,000.

Summary of Value Analysis Proposals (table)

The following pages list the VA proposals and design comments in table format.

Summary of Value Analysis (VA) Proposals						
Idea No.	**Idea Title**	**Initial Cost Avoidance / (Cost Add)**	**VA Team Recommended Package - Option 1**	**VA Team Comments**	**VA Team Recommended Package - Option 2**	**VA Team Comments**
IG	**Improve Geometry**					
IG-01	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment	$15,671,000	N/A		$15,671,000	
IG-09	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)	$0	Not Costed	Implementation of elements from IG-26 into Option 2 may preclude the need for a westbound braided ramp and implementation of this idea should be considered only if IG-26 is found to not be feasible.	Not Costed	Implementation of elements from IG-26 into Option 2 may preclude the need for a westbound braided ramp and implementation of this idea should be considered only if IG-26 is found to not be feasible.
IG-11	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-515 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway	$21,686,000	Included with IG-26	This idea is incorporated into IG-26 that is recommended for implementation and should be considered only if IG-26 is found to not be feasible.	N/A	
IG-20	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp	$2,049,000	$2,049,000	This idea appears to have merit and should be investigated further in the traffic model to ascertain whether satisfactory traffic operations performance can be achieved with one lane.	$2,049,000	This idea appears to have merit and should be investigated further in the traffic model to ascertain whether satisfactory traffic operations performance can be achieved with one lane, and whether the existing structure geometry can be accommodated with the widening of NB I-515.

Idea No.	Idea Title	Initial Cost Avoidance / (Cost Add)	VA Team Recommended Package - Option 1	VA Team Comments	VA Team Recommended Package - Option 2	VA Team Comments
IG-21	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515	$25,590,000	$25,590,000		$15,945,000	
IG-22	Option 1: Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)	$0	Not Costed	This idea would add cost to the project and could provide partial access to Auto Show that does not currently exist in Option 1. It appears that IG-26 could provide the same benefit at a lower cost, therefore it is recommended that this idea not move forward unless IG-26 is found to not be feasible.	N/A	
IG-23	Options 1: Shift the I-215 EB diverge for north/south movements to I-C25515 & I-11 further east to allow more merging area from the Gibson on-ramp, tighten ramp radii based on offset shortening structure length	$0	Not Costed		N/A	
IG-25	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated	$0	Not Costed	Implementation of this idea would result in the inability to enter I-215 from Gibson and then travel south on I-11. It is recommended that this idea not be implemented.	N/A	

Idea No.	Idea Title	Initial Cost Avoidance / (Cost Add)	VA Team Recommended Package - Option 1	VA Team Comments	VA Team Recommended Package - Option 2	VA Team Comments
IG-26	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)	$49,251,000	$49,251,000	This idea appears to have merit and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower. Reuse of the existing Ramp NW structure would require that the structure be widened to two lanes or restriped for two lanes with a Design Exception for Stopping Sight Distance with a narrow left shoulder around the curve.	$6,377,000	When the central system-to-system connection of this idea is applied to Option 2, it appears to have merit and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower. Braided ramps to and from Gibson Road could be avoided.
IG-27	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design	$20,670,000	N/A		$20,670,000	
IG-28	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps	$3,477,000	$3,477,000	This idea could be implemented to defer some expenditures to a later phase of the work, as determined by NDOT Management.	$3,184,000	This idea could be implemented to defer some expenditures to a later phase of the work, as determined by NDOT Management.
IA	**Improve Access (re-establish access at Gibson and/or Auto Show)**		$0			
IA-04	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV connection shown in the current Southern Nevada HOV Plan; this would shorten the flyover ramp considerably	$8,784,000	Included with IG-26	This idea is incorporated into IG-26 that is recommended for implementation and should be considered only if IG-26 is found to not be feasible.	N/A	

Idea No.	Idea Title	Initial Cost Avoidance / (Cost Add)	VA Team Recommended Package - Option 1	VA Team Comments	VA Team Recommended Package - Option 2	VA Team Comments
IA-06	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)	$0	Not Costed	This idea should be investigated further to ascertain whether implementation of a loop ramps could eliminate the need for eastbound braided ramps from Gibson to access I-515, I-11 and LMP.	Not Costed	Eastbound braided ramps from Gibson are not required by Option 2, therefore this idea is not applicable to Option 2.
IM	**Improve Mainline-operations**		$0			
IM-01	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure	$5,521,000	N/A		$5,521,000	This idea appears to have merit when combined with Ideas IG-01 and IG-26; and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower because a more expensive crossover structure could be replaced by a traditional bridge type. It would need to be determined whether the vertical profile geometry could be made to work in order to create a grade separation between Ramp EN and Ramp SE. It appears that this idea would be compatible with the ideas contained in IG-26.
	Potential Project Cost Avoidance		**$80,367,000**		**$69,417,000**	
			Option 1		**Option 2**	

Design Comments (table)

Idea No.	Idea Title
IG	**Improve Geometry**
IG-03	Option 2. NB I-11 exit to Lake Mead Parkway (LMP) exit, improve forced merge onto LMP
IG-05	Option 2. NB I-11 to Gibson off ramp creates a complicated weave; eliminate or improve by only allowing 1100' to cross 3 lanes of traffic
IG-08	Option 1. Regarding traffic demand, concern with the weave with the Gibson on ramp EB 215 to NB I-11; only 830' to get over 3 lanes of traffic; potential breakdown of mainline operations
IG-12	Lower design speeds for smaller radius ramp curves (optimize radius design accordingly)
IG-13	Increase design speeds for larger radius ramp curves (optimize radius design accordingly)
IG-14	Option 2. LMP, was there a reason for the tighter curves for EB and WB just west of the I-11 mainline; straighten out to avoid footprint over existing ground level roads
IG-17	Option 1. The Gibson on-ramp to EB LMP acceleration lane appears to be only 500' long, that would meet a 40 mph design speed. Is this appropriate for the 2040 volume?
IG-18	Option 1. The Gibson EB I-215 to LMP accel lane appears to be 500' this is a 40 MPH design. Is this appropriate for the traffic volume?
IG-24	There should be a 3rd option that is brought forward into the NEPA process that maintains some of the existing structures and still meets the P&N. NEPA process prefers 3 options with a No Build alternative. Two alternatives can be brought into the NEPA process but if either option is not feasible then a No Build alternative can be the chosen alternative.
IC	**Improve Capacity (reduce congestion, reduce delay, improve safety)**
IC-02	Use ramp metering
IC-03	Options 1 & 2. Identify bottleneck locations that limit capacity
IA	**Improve Access (re-establish access at Gibson and/or Auto Show)**
IA-05	Build a different direct access road from Lake Mead to Gibson that does not impact the Interstate
IM	**Improve Mainline-operations**
IM-02	General concept: Phased approach to the design. Determine which ramp improvements have the most effect on delay (I-215 has highest volumes) and which can utilize the most existing structures. Limit improvements to these areas and determine if capacity is the more important aspect of the project versus connectivity given the limited resources
IM-04	Ensure 4500 feet from the I-11 CL to Gibson CL and 5400 feet from the Gibson CL to Stephanie CL, so we are close to a mile spacing
AF	**Accommodate Future-expansion**
AF-01	Future Connections: The Southern Nevada HOV Study shows HOV on the I-515 and I-215, but not on I-11 or LMP with no flyover ramp connecting I-215 to I-515. So if HOV ends at the Henderson Interchange, we don't need to preserve future HOV alignments thru the interchange unless the future network is changing. What savings are there if the EB/WB and NB/SB alignments can be tightened with a narrower median? I am an HOV advocate, so the real answer is connecting the I-215 and I-515 but that is not shown in the plan.

SECTION

3

VALUE ANALYSIS WORKBOOKS

Section 3: Value Analysis Workbooks

Introduction

The following pages detail the Value Analysis (VA) proposals developed as part of the VA study by the VA team and include the following information when applicable:

- Unique Identifying Number (XX-##)
- Creative Idea Title
- Function Identification
- Baseline Assumption
- Proposed Alternative
- Benefits of Proposed Alternative
- Risks/Challenges of Proposed Alternative
- Cost Impact Summary, if applicable
- Proposed Alternative Discussion/Justification, including any implementation considerations
- Baseline Assumption and Proposed Alternative Sketches, if applicable
- Cost Detail, if applicable

The costs used are those provided by CA Group. Where the VA team has offered alternate costs, they are provided for information only, reflective of the short duration of the VA study. VA proposals are provided for their evaluation and implementation exclusively by the Nevada Department of Transportation and CA Group..

VALUE ANALYSIS PROPOSAL
IG-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

The baseline I-11 northbound alignment shifts west of the existing freeway. This alignment requires a series of long straddle bent cap structures and long skew lengths to span over proposed roadway alignments below.

Proposed Alternative

This alternative proposes to re-align the northbound alignment back in its basic existing alignment. This alternative eliminates the need for straddle bent cap structures and utilizes conventional single span structures. This alternative also reduces the span length because the proposed alignment crosses at a normal skew to the roadway alignments below. The northbound I-515 ramp to westbound I-215 still can still be accomplished as it departs from the median of I-515 using retaining walls and a small fly over structure. This alternative reduces the overall footprint and allows adjacent ramps to be pulled in closer to the mainline alignment.

BENEFITS	RISKS/CHALLENGES
● Cost savings by reducing complicated bridge structures and span lengths	● None apparent
● Improves driver expectancy	●
● Less roadway footprint allowing adjacent ramps to be pulled closer to main line alignments thereby reducing drainage structures	●
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$28,150,000	$0	$28,150,000
Proposed Alternative	$12,479,000	$0	$12,479,000
TOTAL (Baseline less Proposed)	$15,671,000	$0	$15,671,000
			SAVINGS

VALUE ANALYSIS PROPOSAL

IG-01

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment

DISCUSSION/JUSTIFICATION:

Baseline bridges
Area=37,966 + 11,316 + 61,306=110,588

Alternative bridges
Area= 16,790 + 14,915 = 31,705

Baseline Roadway
Area=26,511+ 7,380 + 46,330=80,221

Alternative Walls
None

Alternative Roadway
Area=40,595+14,783+87452=142,830

Baseline Walls
Area=11,760 + 1,920= 13,680

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

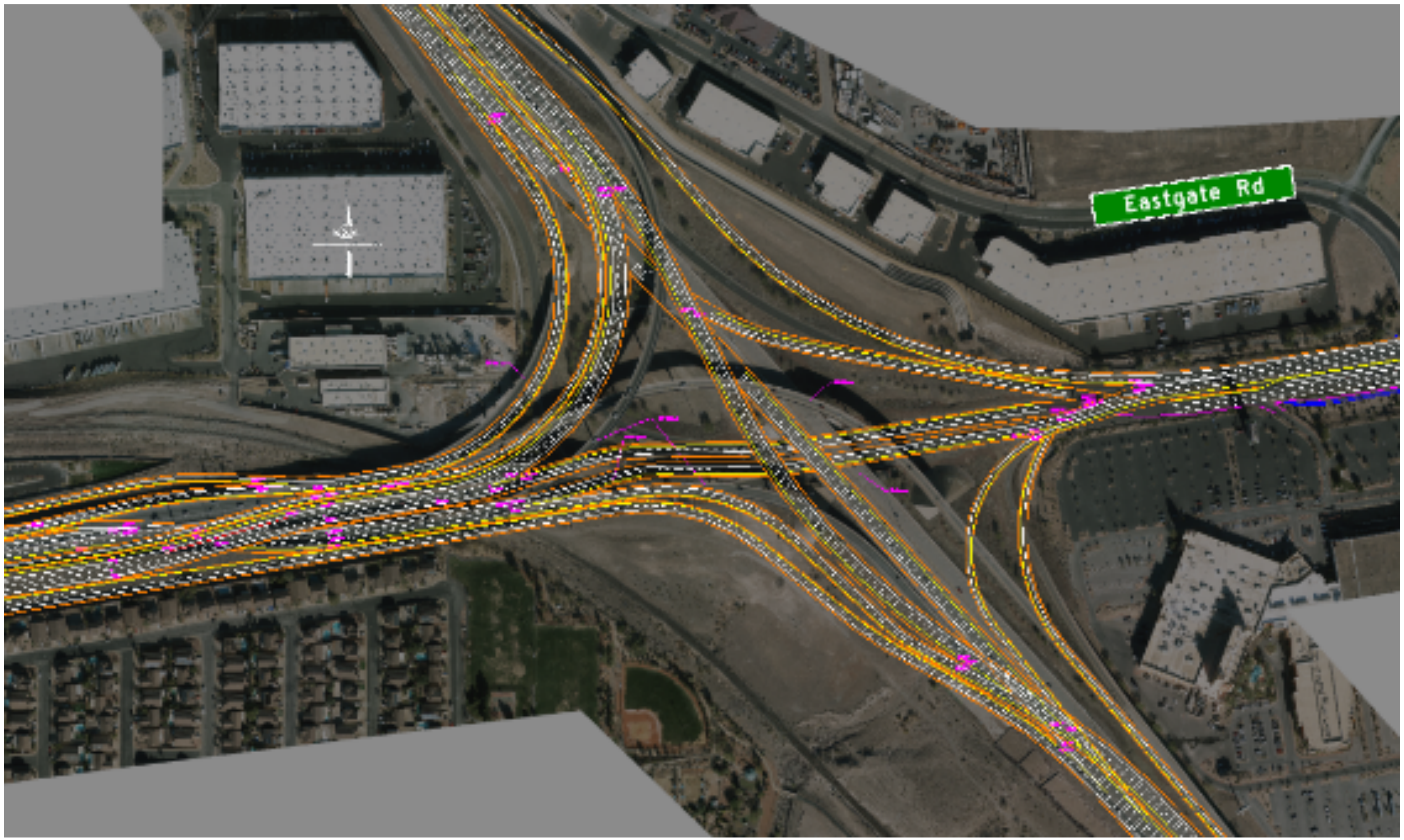
VALUE ANALYSIS PROPOSAL
IG-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment						
DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF	80,221	$25	$2,005,525	142,830	$25	$3,570,750
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF	13,680	$85	$1,162,800		$85	$0
Bridge - typical basic bridge	SF		$210	$0	31,705	$210	$6,658,050
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the substructure area; about double the superstructure area)	SF	110,588	$180	$19,905,840		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$23,074,165			$10,228,800
Construction Engineering/ Inspection - 15%				$3,461,125			$1,534,320
Other Project Development Costs - 7%				$1,615,192			$716,016
TOTAL				$28,150,000			$12,479,000
						CWE (BASELINE LESS PROPOSED)	$15,671,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

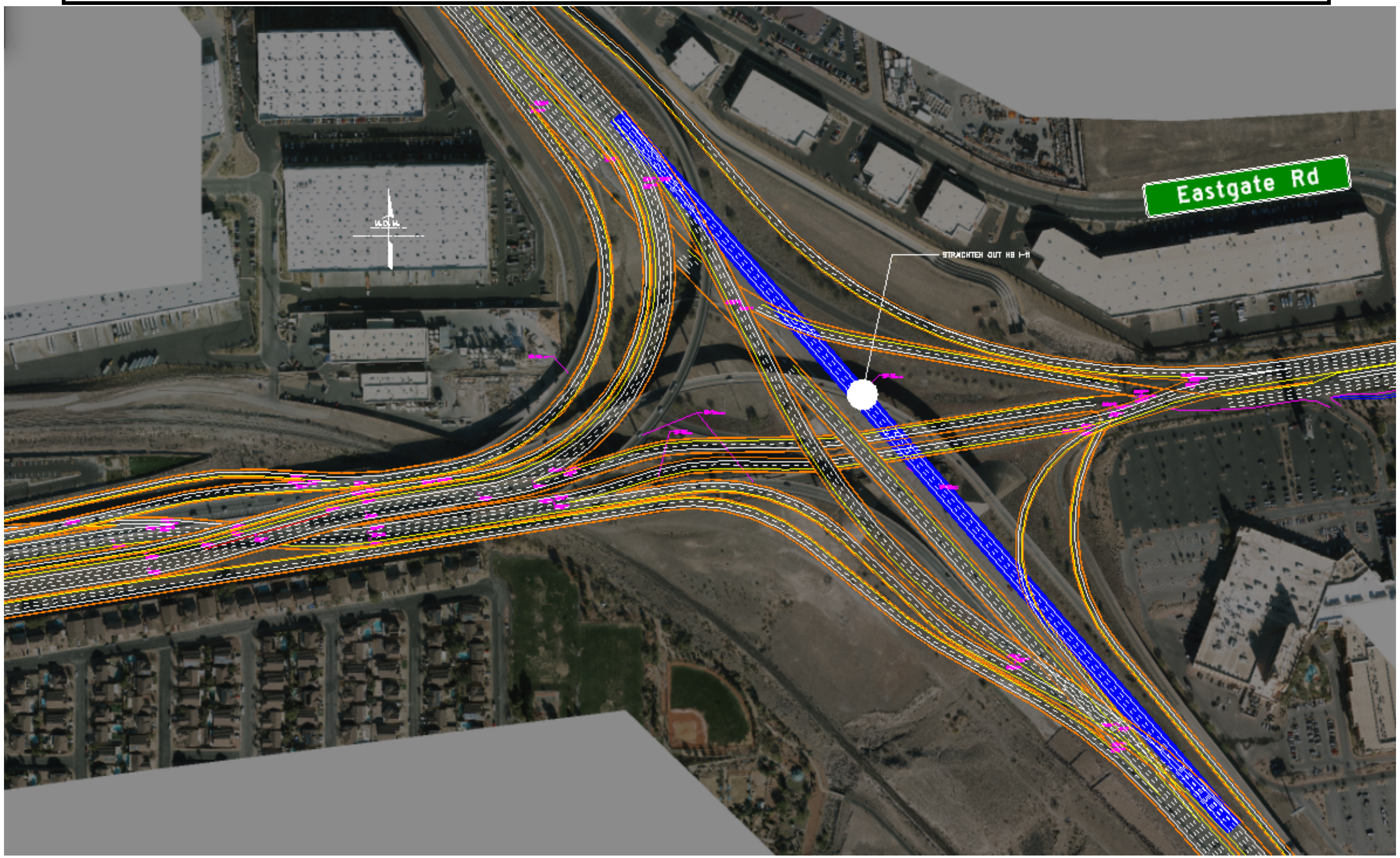
TITLE	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment

SKETCH OF BASELINE ASSUMPTION



TITLE	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-09
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

At the I-215/Gibson interchange the WB off ramp is only 2500' from the interchange. This close proximity causes weaving issues.

PROPOSED ALTERNATIVE:

By replacing the proposed traditional off ramp, a loop ramp can be constructed in the NW quadrant of the interchange. This will provide an additional 1500' of weaving distance before exiting the WB I-215.

BENEFITS	RISKS/CHALLENGES
● Provides additional spacing for the WB I-215 traffic to exit Gibson Rd	● Limited right-of-way may require acquisitions
●	●
●	●
●	●
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$0	$0	$0
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$0	$0	$0
			NOT COSTED

VALUE ANALYSIS PROPOSAL

IG-09

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)

DISCUSSION/JUSTIFICATION:

VA alternative IG-09 does not provide cost savings, but it does provide a safer merge by adding an additional 1500' of weaving distance for the cars travelling from NB I-515. This idea would may need to acquire a small amount of right-of-way for the loop ramp in the NW quadrant of the interchange.

The construction cost of the new ramp and demolition of the old ramp are not included in the price. This would be a safety improvement but at a greater cost.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IG-09
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)						
DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF		$25	$0		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$0			$0
Construction Engineering/ Inspection - 15%				$0			$0
Other Project Development Costs - 7%				$0			$0
TOTAL				$0			$0
						CWE (BASELINE LESS PROPOSED)	
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL

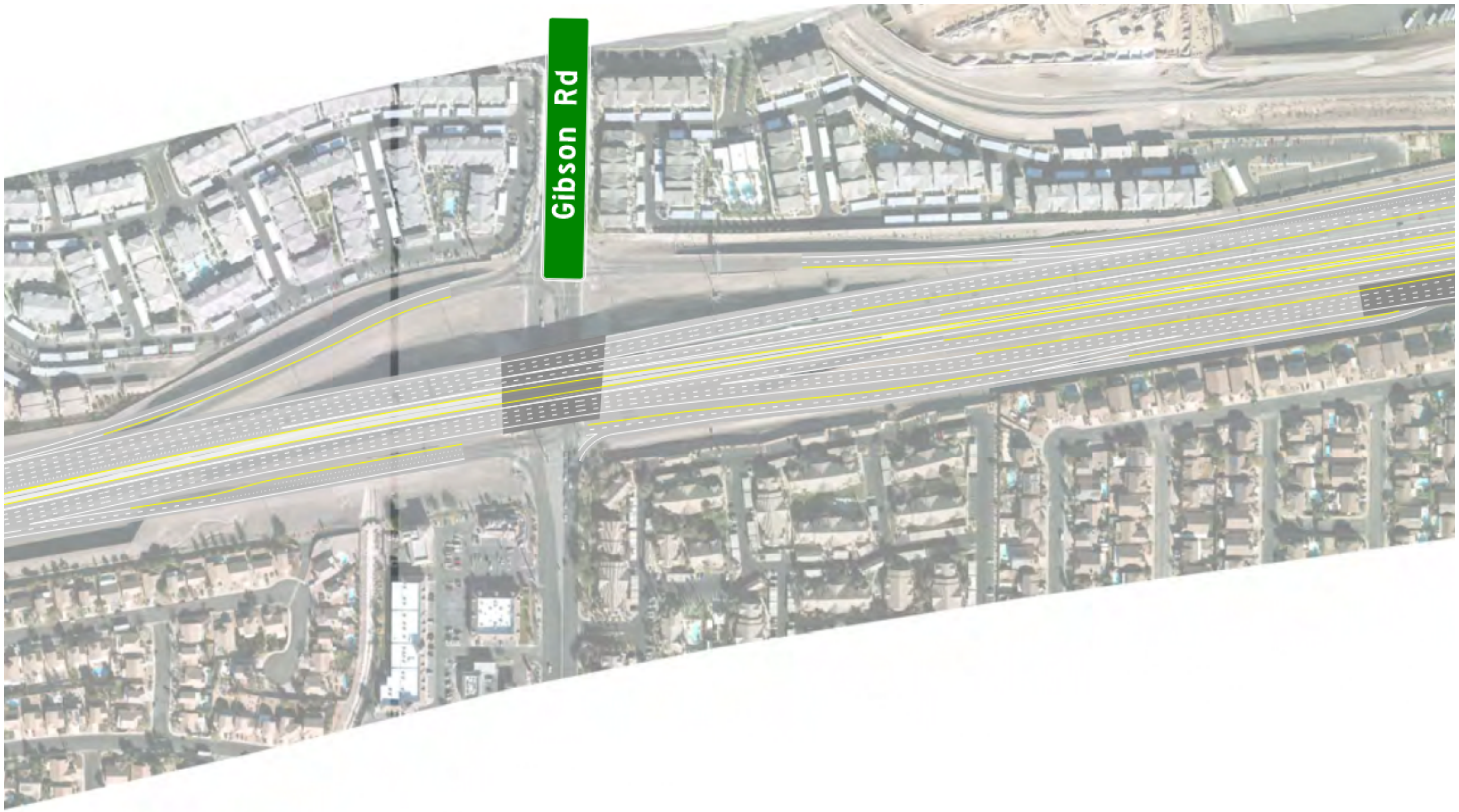
IG-09

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)

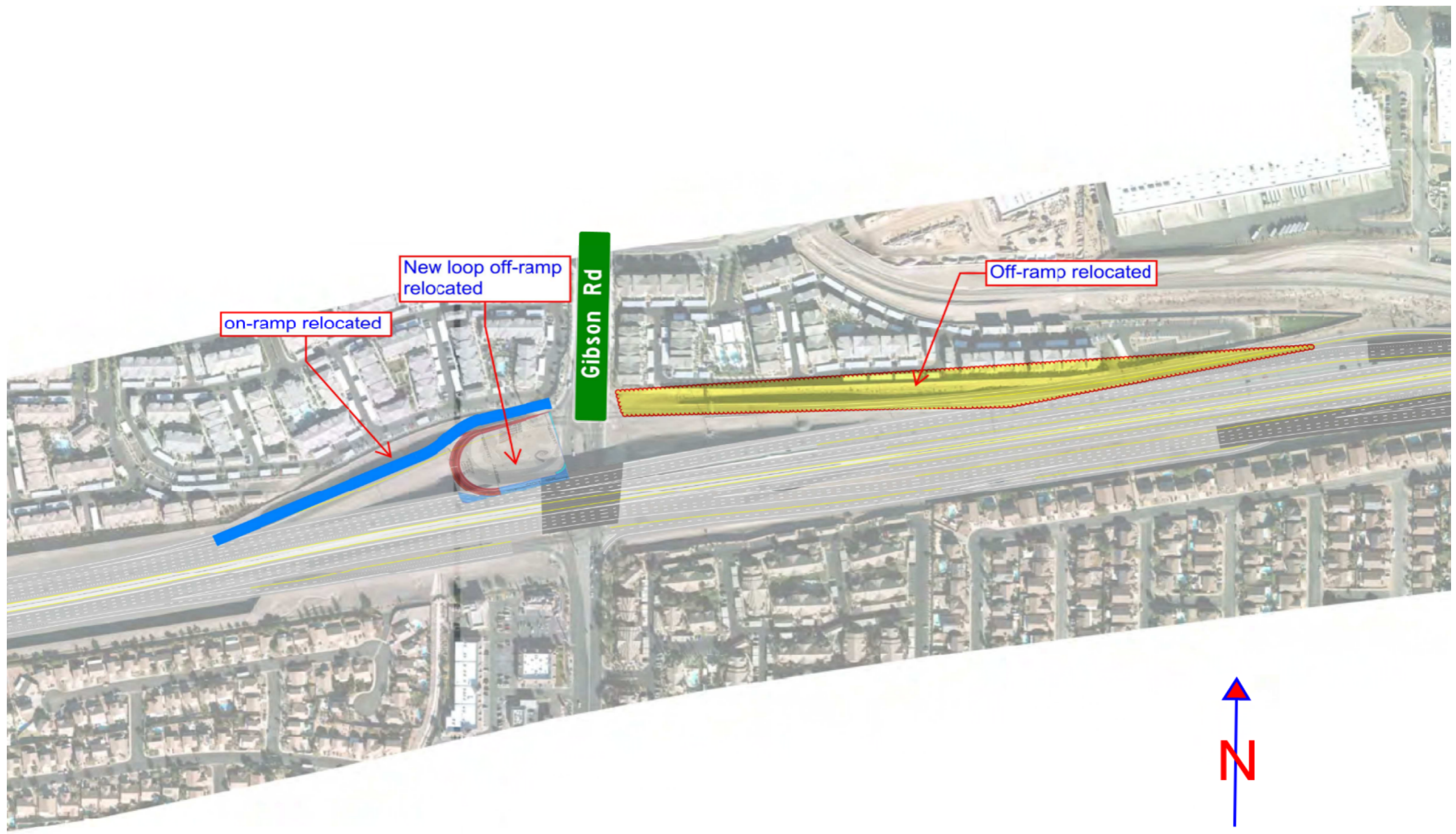
SKETCH OF BASELINE ASSUMPTION



VALUE ANALYSIS PROPOSAL
IG-09
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-11
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Overall, the baseline design requires eastbound I-215 traffic to cross over to opposite sides of the road to get in the proper lane assignments in order utilize fly over structures.

PROPOSED ALTERNATIVE:

The proposed alternative re-arranges eastbound mainline I-215 lane assignments by putting emphasis on the direct connect movements.

BENEFITS	RISKS/CHALLENGES
● Reduces length of flyover structure	● Vertical profiles will need to be run to validate proposed alternative
● Improves driver expectations	●
● Increases weave distances	●
● Would be forward compatible with IG-26 (median to median flyover)	●
● Decreases upstream weaving to obtain lane assignments	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$30,375,000	$0	$30,375,000
PROPOSED ALTERNATIVE:	$8,689,000	$0	$8,689,000
TOTAL (Baseline less Proposed)	$21,686,000	$0	$21,686,000
			SAVINGS

VALUE ANALYSIS PROPOSAL

IG-11

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway

DISCUSSION/JUSTIFICATION:

Overall, the baseline design requires eastbound I-215 traffic to cross over to opposite sides of the road to get in the proper lane assignments in order utilize flyover structures. This may result outside lane traffic to speed up to jockey for lane position, while competing with traffic merging on to the freeway from the on-ramps. The baseline places traffic heading eastbound I-215 to northbound I-11 in the outer three lanes. EB Gibson enters the I-215 freeway in these outer lanes and must cross two lanes of traffic to continue southbound to I-11, potentially degrading mainline operations because of a relatively short 800' gore to gore distance to make the weave. In addition, eastbound Gibson to Henderson travel along I-215 in a separate lane that slips under the mainline freeway, merging with the two travel lanes. This also may potentially degrade mainline operations for traffic heading into Henderson because of a relatively short 500' merge lane into through traffic.

The proposed alternative re-arranges eastbound mainline I-215 lane assignments by putting emphasis on the direct connect movements. It eliminates upstream crossover maneuvers for lane assignments that occur on the opposite side of I-215 in the baseline design. The new arrangement places eastbound I-215 to northbound I-11 traffic in the inner 3-lanes (fast lanes) allowing the large volume movement to stay in those lanes and not crossing over the opposite side of I-215 compared to baseline. The flyover would touch down in the median along I-11 (this is a mirror image of SB I-11 to WB I-215). This improves driver expectations and reduces up stream weaving because traffic heading north stay in the left lanes, traffic in the middle lanes go straight along I-215 and head directly into Henderson, traffic on the right of I-215 stay right and head southbound on I-515. Gibson traffic heading east along I-215 to southbound I-515 would have a dedicated lane (compared to a 800' merge lane over baseline). Gibson traffic heading east into Henderson also enjoy a 1200' merge lane over the 500' base line. Gibson eastbound I-215 to northbound I-11 would be would be perpetuated by providing a drop ramp in the median of I-215 (shown in red on sketch). This also improves the existing 500' merge lane in the baseline design to 1200' merge lane to meet standards. It also eliminates, or reduces. the bridge structure to accommodate the "Fly under" movement under I-215.

NOTES:

1. There may be an opportunity to to utilize the existing EB I-215 to SB I-515 structure with further design examination. This would also result in further cost savings not shown on this worksheet.

Baseline structure over the Gibson on ramp to NB I-11 = 118,561 (to be eliminated).

Alternative Items:
Wall=1400' X 20'=28,000 (Additional wall area along right-of-way)
Roadway=118,561

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

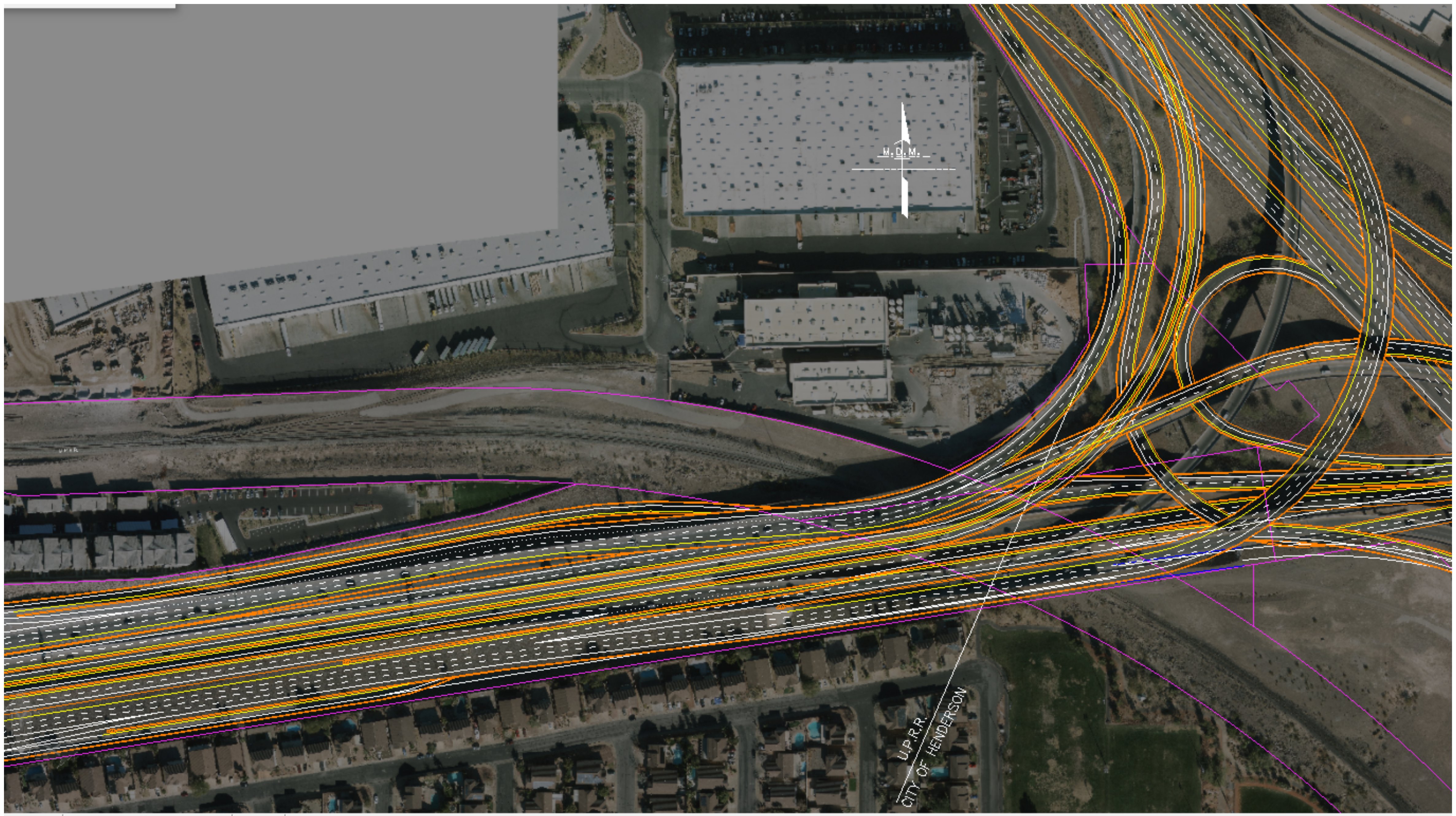
VALUE ANALYSIS PROPOSAL
IG-11
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway

DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF		$25	$0		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0	118,561	$40	$4,742,440
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0	28,000	$85	$2,380,000
Bridge - typical basic bridge	SF	118,561	$210	$24,897,810		$210	$0
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$24,897,810			$7,122,440
Construction Engineering/ Inspection - 15%				$3,734,672			$1,068,366
Other Project Development Costs - 7%				$1,742,847			$498,571
TOTAL				$30,375,000			$8,689,000
						CWE (BASELINE LESS PROPOSED)	$21,686,000
Note: Total costs are rounded to the nearest thousand dollars.							**SAVINGS**

TITLE	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway

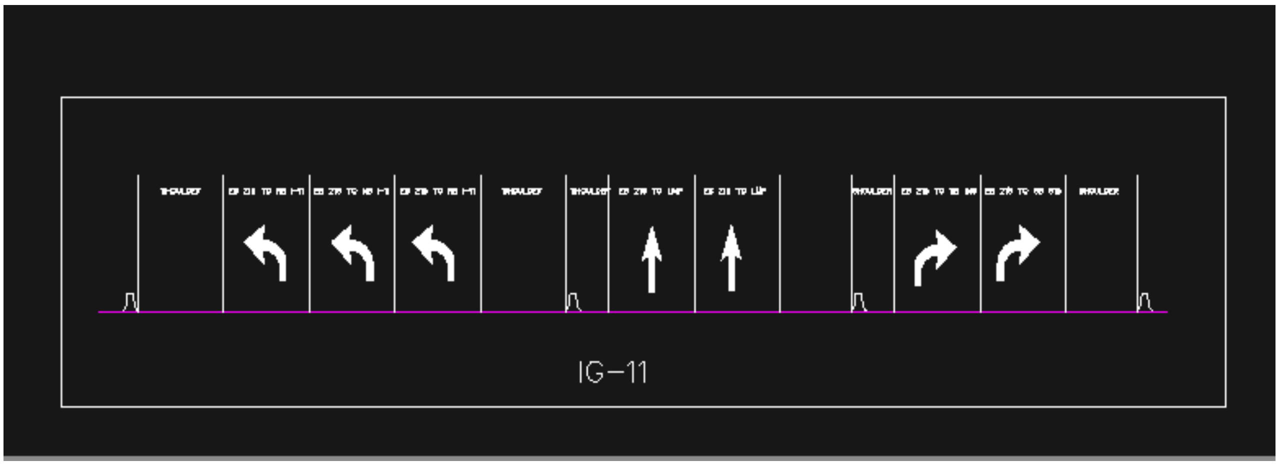
SKETCH OF BASELINE ASSUMPTION



VALUE ANALYSIS PROPOSAL
IG-11
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway

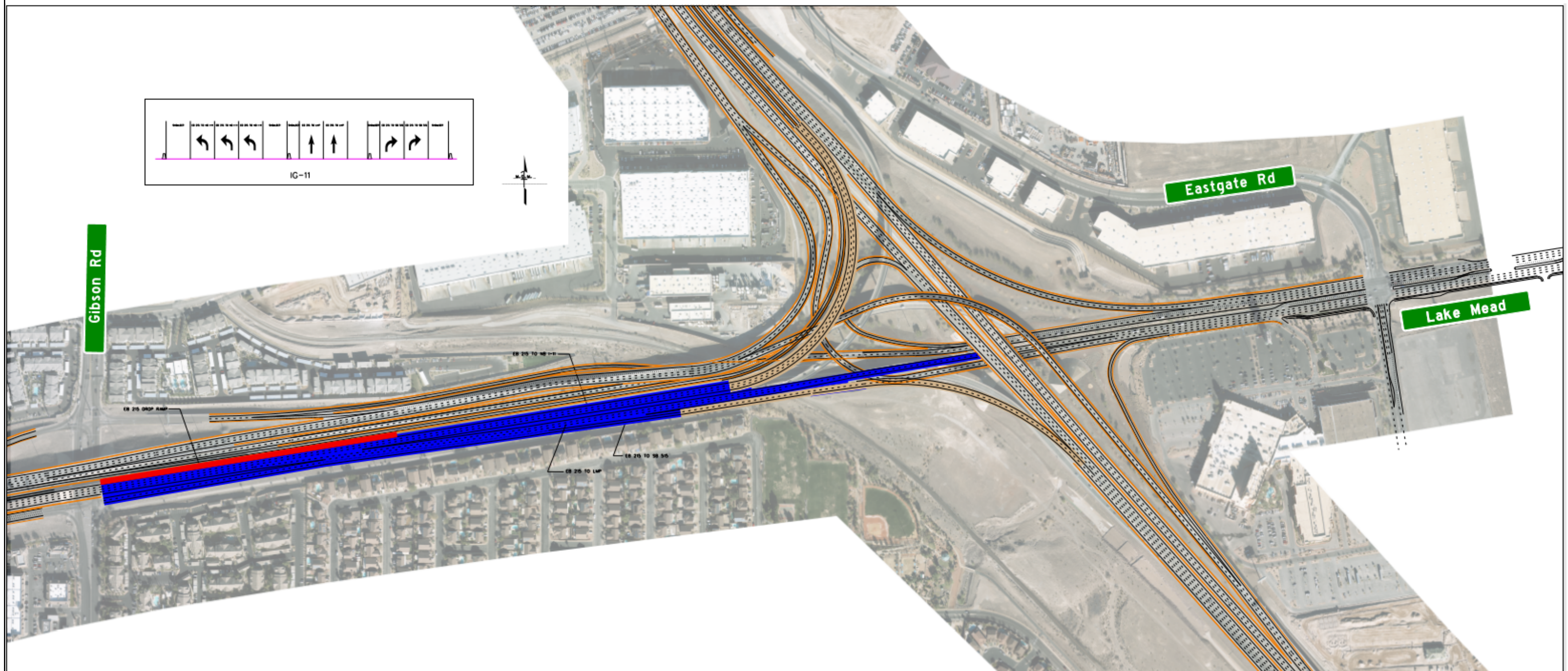
SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-11
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-20
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Both proposed alternatives developed as part of the Henderson IC Feasibility study reconfigure the NB off-ramp to Auto Show Drive to a two lane ramp. To accomplish this work, the existing braided ramp structure is replaced to widen the off- ramp and accommodate the realigned EB I-215 to NB I-515 ramp.

PROPOSED ALTERNATIVE:

The proposed alternative would perpetuate a single lane off ramp to reduce the cost of the braided ramp grade separation and associated roadway work. The VA IG-20 proposal would still require replacement of the H-2799N braided ramp structure to accommodate the modifications being proposed to the EN ramp to handle projected traffic volumes. Peak hourly traffic forecasts (2040) for the NB Auto Show off ramp are 570 vehicles/hour in the pm. With an adequate total ramp length, a single lane should be sufficient for the forecasted traffic.

BENEFITS	RISKS/CHALLENGES
● Cost savings by reducing width of new grade separation structure/approach roadway	● Less storage and potential of backups affecting mainline traffic
●	●
●	●
●	●
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$9,340,000	$0	$9,340,000
PROPOSED ALTERNATIVE:	$7,291,000	$0	$7,291,000
TOTAL (Baseline less Proposed)	$2,049,000	$0	$2,049,000
			SAVINGS

VALUE ANALYSIS PROPOSAL

IG-20

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp

DISCUSSION/JUSTIFICATION:

The proposed alternatives developed during the Henderson IC feasibility study recommend the addition of a second lane to the existing I-515 NB to Auto Show Drive off-ramp. Additionally, forecasted traffic volumes for the EB I-215 to NB I-515 system-to-system ramp show the need for two lanes where one exists in the current configuration. The NB Auto Show off-ramp is braided with the existing EN ramp with a four-span grade separation structure with an outrigger bent due to the tight skew. Proposed changes to both ramps necessitate replacement of the existing structure due to the increase in lanes and limited horizontal clearance between the columns of the outrigger bent. Review of the forecasted traffic volumes led to the recommendation of reducing the number of lanes on the NB Auto Show off-ramp to a single lane to save structure cost. With the total estimated project costs exceeding $250M, this proposal would help reduce project costs by eliminating improvements that are not justified by the current traffic analysis.

The main benefit of proposed changes is a reduction in project cost.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL

IG-20

Nevada Department of Transportation

Henderson Interchange Feasibility Study

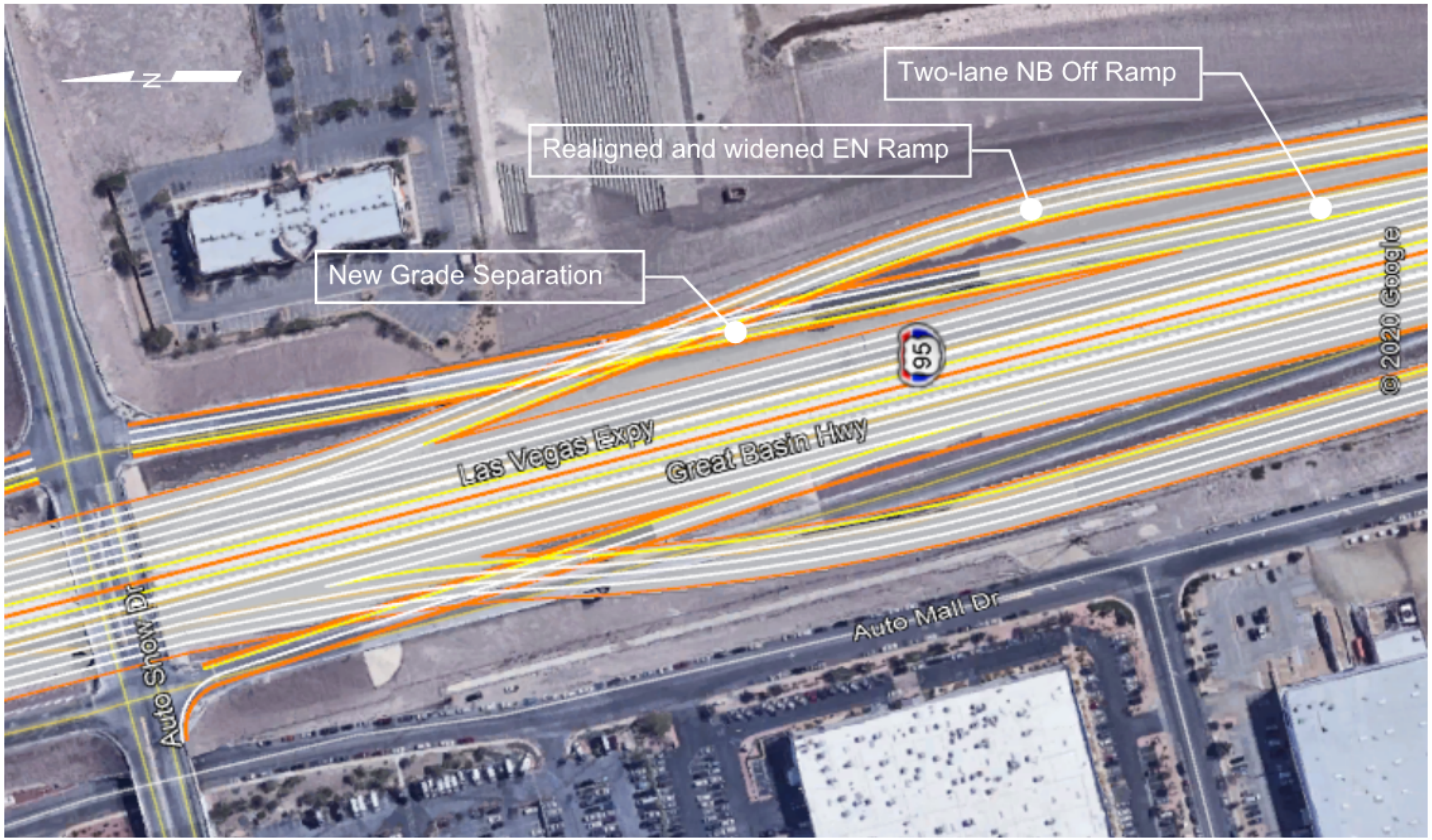
TITLE	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp						
DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF	33,600	$25	$840,000	24,000	$25	$600,000
Roadway on I-215 (closed drainage)	SF	0	$40	$0	0	$40	$0
Earthwork greater than 3' cut or fill	CY	0	$14	$0	0	$14	$0
Retaining wall	LF	0	$1,700	$0	0	$1,700	$0
Retaining wall	SF	15,730	$85	$1,337,050	15,730	$85	$1,337,050
Bridge - typical basic bridge	SF	22,840	$210	$4,796,400	15,988	$210	$3,357,480
Bridge - elevated/complex flyover bridge	SF	0	$240	$0	0	$240	$0
Bridge - steel bridge (western UPRR)	SF	0	$340	$0	0	$340	$0
Bridge - crossover bridge (measured as the	SF	0	$180	$0	0	$180	$0
Bridge demolition	SF	13,640	$50	$682,000	13,640	$50	$682,000
SUBTOTAL				$7,655,450			$5,976,530
Construction Engineering/ Inspection - 15%				$1,148,318			$896,480
Other Project Development Costs - 7%				$535,882			$418,357
TOTAL				$9,340,000			$7,291,000
						CWE (BASELINE LESS PROPOSED)	$2,049,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL
IG-20
Nevada Department of Transportation
Henderson Interchange Feasibility Study

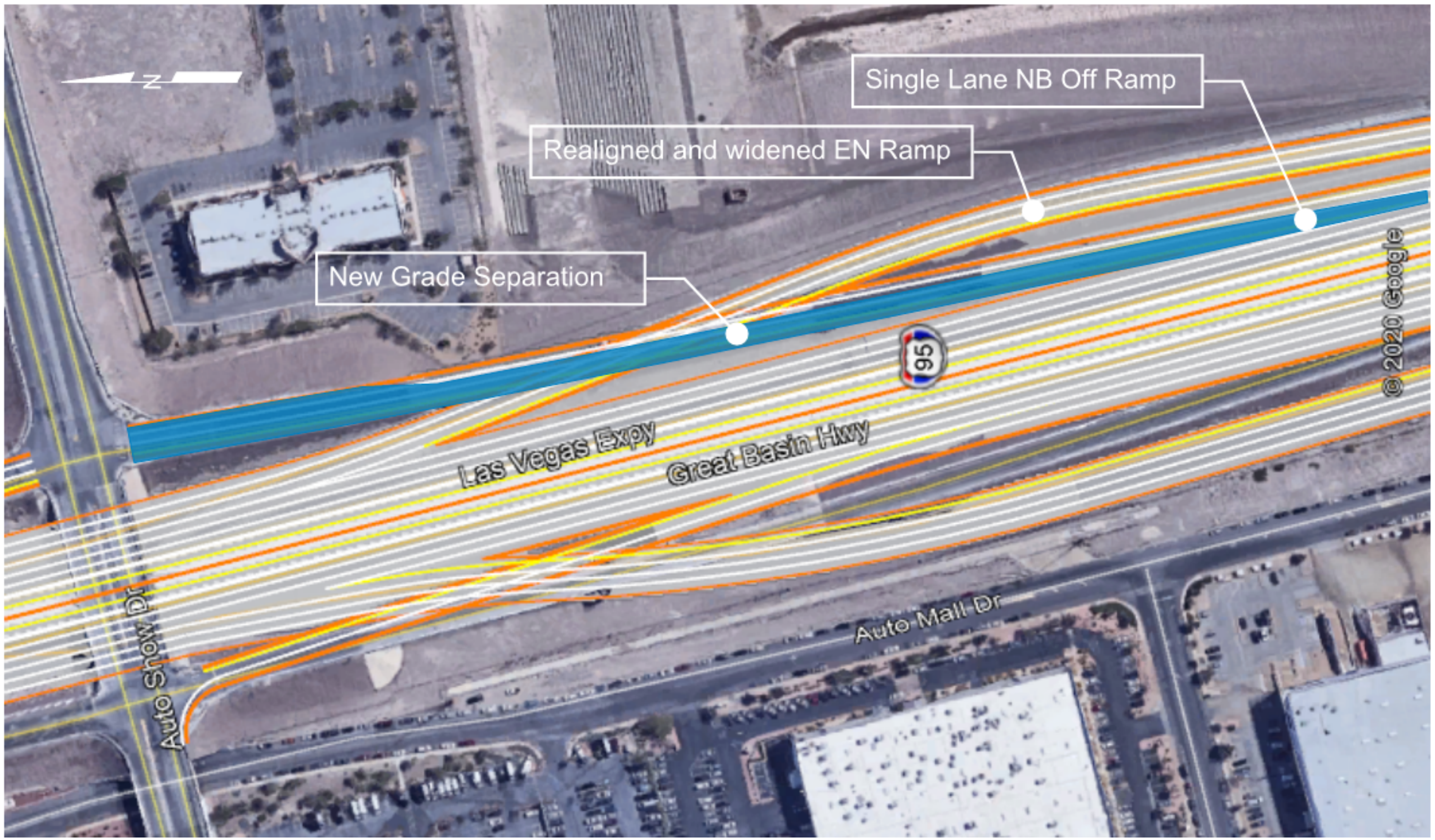
TITLE	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp

SKETCH OF BASELINE ASSUMPTION



TITLE	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL

IG-21

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Option 1 requires the deconstruction of the existing structure that carries 2 lanes of traffic over structure that bottle necks down to 1 lane prior to landing and merging onto NB I-515. Option 1 would construct another flyover in the same location with similar take off and land points but would have the capacity to carry 3 lanes of traffic over the structure that would bottleneck down to 2 lanes prior to landing and merging onto NB I-515. On existing foundations would need to be replace for the new struture. New Structure is $17.5M; Demo is 1400' (long) x 30' (wide) x $50/sqft = $2.1M

PROPOSED ALTERNATIVE:

The proposed alternative would maintain the existing structure. Furthermore, it would restripe existing structure to 2 lanes for the entire length of the flyover to the landing point on NB I-515 which would continuous free flow movement from EB I-215 over the flyover to NB I-515 (removing the 2 lanes to 1 lane bottleneck merge that occurs on the flyover prior to landing on NB I-515.

BENEFITS	RISKS/CHALLENGES
● Saves the Existing EB to NB flyover that has many more years of life left in the structure	● Removes third lane on structure that would have queue space (capAcity)
● Provides continuous free flow traffic	● Design Exceptions may be needed for shoulder and lane width
●	●
●	●

COST SUMMARY - OPTION 1	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$26,078,000	$0	$26,078,000
PROPOSED ALTERNATIVE:	$488,000	$0	$488,000
TOTAL (Baseline less Proposed)	$25,590,000	$0	$25,590,000
			SAVINGS

COST SUMMARY - OPTION 2	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$35,922,000	$0	$35,922,000
PROPOSED ALTERNATIVE:	$19,977,000	$0	$19,977,000
TOTAL (Baseline less Proposed)	$15,945,000	$0	$15,945,000
			SAVINGS

VALUE ANALYSIS PROPOSAL
IG-21
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515

DISCUSSION/JUSTIFICATION:

Option #1 requires the deconstruction of the I-215 EB to I-515 NB flyover structure that is currently is striped for 2 lanes then merges into 1 lane prior to touching down on I-515 NB. Option #1 would then construct a new structure in the same location that is 3 lanes wide then merges into 2 lanes prior to touching down on I-515 NB. Since the new structure is larger in size and in loading capacity then the existing structure foundations would also need to be remove as well. The existing structure was construction in 2005 with a lifespan of 75 years. It is currently in great condition and has at the minimum of 60 years left in life. This suggestion is to maintain the existing structure but restripe the lanes to maintain 2 lanes completely through the flyover structure touching down onto I-515 NB. Addition cost would be to restripe and any additional incidental cost associated to tieing in both lanes into I-515 NB. Cost savings will be for deconstruction of the existing bridge and adding a new structure. Cost of the new structure was $17M based on the CRA. Cost to deconstruct existing bridge = 2501' (Bridge Length) x 35' (Bridge width) x $50/sqft (Cost per sqft to demo) = $4.1M.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL

IG-21

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515

DESIGN ELEMENT	OPTION 1: BASELINE ASSUMPTION				OPTION 1: PROPOSED ALTERNATIVE		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Demo of Exisiting I-215EB to I-515NB flyover structure	SF	87,500	$50.00	$4,375,000	0	$0.00	$0
Construction of new I-215EB to I-515NB flyover structure	LS	1	$17,000,000.00	$17,000,000	0	$0.00	$0
Restripe to 2 lanes to touch down on I-515 NB	LS				1	$400,000.00	$400,000
Roadway on I-11/I-515 (open drainage)	SF		$25	$0		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$21,375,000			$400,000
Construction Engineering/ Inspection - 15%				$3,206,250			$60,000
Other Project Development Costs - 7%				$1,496,250			$28,000
TOTAL				$26,078,000			$488,000
						CWE (BASELINE LESS PROPOSED)	$25,590,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL
IG-21
Nevada Department of Transportation
Henderson Interchange Feasibility Study

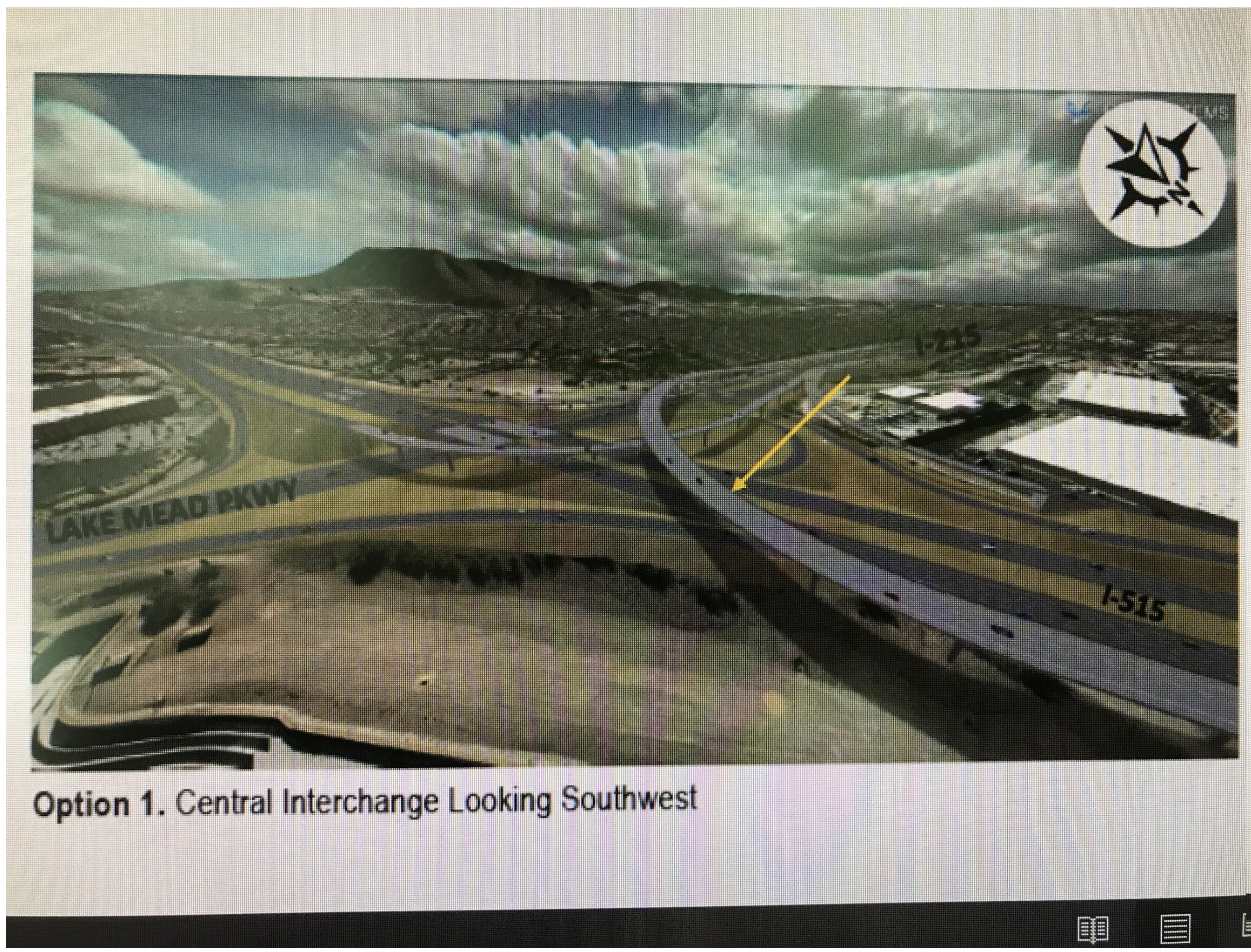
TITLE	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515						
DESIGN ELEMENT	**OPTION 2: BASELINE ASSUMPTION**				**OPTION 2: PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Demo of Exisiting I-215EB to I-515NB flyover structure	SF	0	$50	$0	0	$0	$0
Construction of new I-215EB to I-515NB flyover structure	LS	0	$0.00	$0	0	$0	$0
Restripe to 2 lanes to touch down on I-515 NB	LS	0	$0.00	$0	0	$0	$0
Roadway on I-515	SF	100,800	$25	$2,520,000	0	$25	$0
Roadway on I-215	SF	93,600	$40	$3,744,000	0	$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (north)	SF	56,460	$180	$10,162,800	46,110	$180	$8,299,800
Bridge - crossover bridge (west)	SF	72,320	$180	$13,017,600	44,862	$180	$8,075,160
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$29,444,400			$16,374,960
Construction Engineering/ Inspection - 15%				$4,416,660			$2,456,244
Other Project Development Costs - 7%				$2,061,108			$1,146,247
TOTAL				$35,922,000			$19,977,000
						CWE (BASELINE LESS PROPOSED)	$15,945,000
							SAVINGS

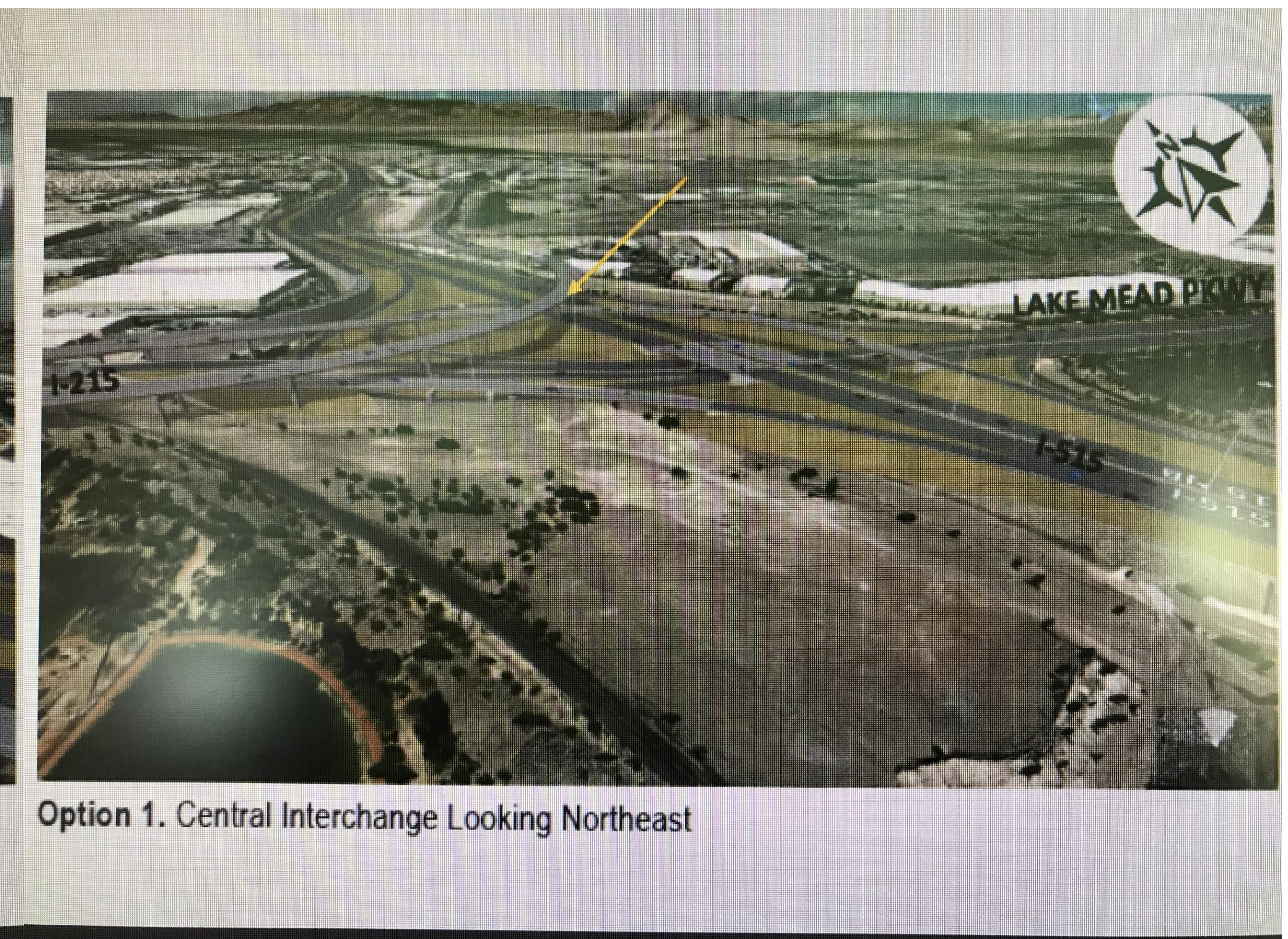
Note: Total costs are rounded to the nearest thousand dollars.

TITLE	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515

SKETCH OF BASELINE ASSUMPTION

Option 1 removes existing 2-lane flyover structure from I-215 EB to I-515 NB and replaces it with a 3-lane flyover structure that merges to 2 lanes prior to touching down on I-515 NB



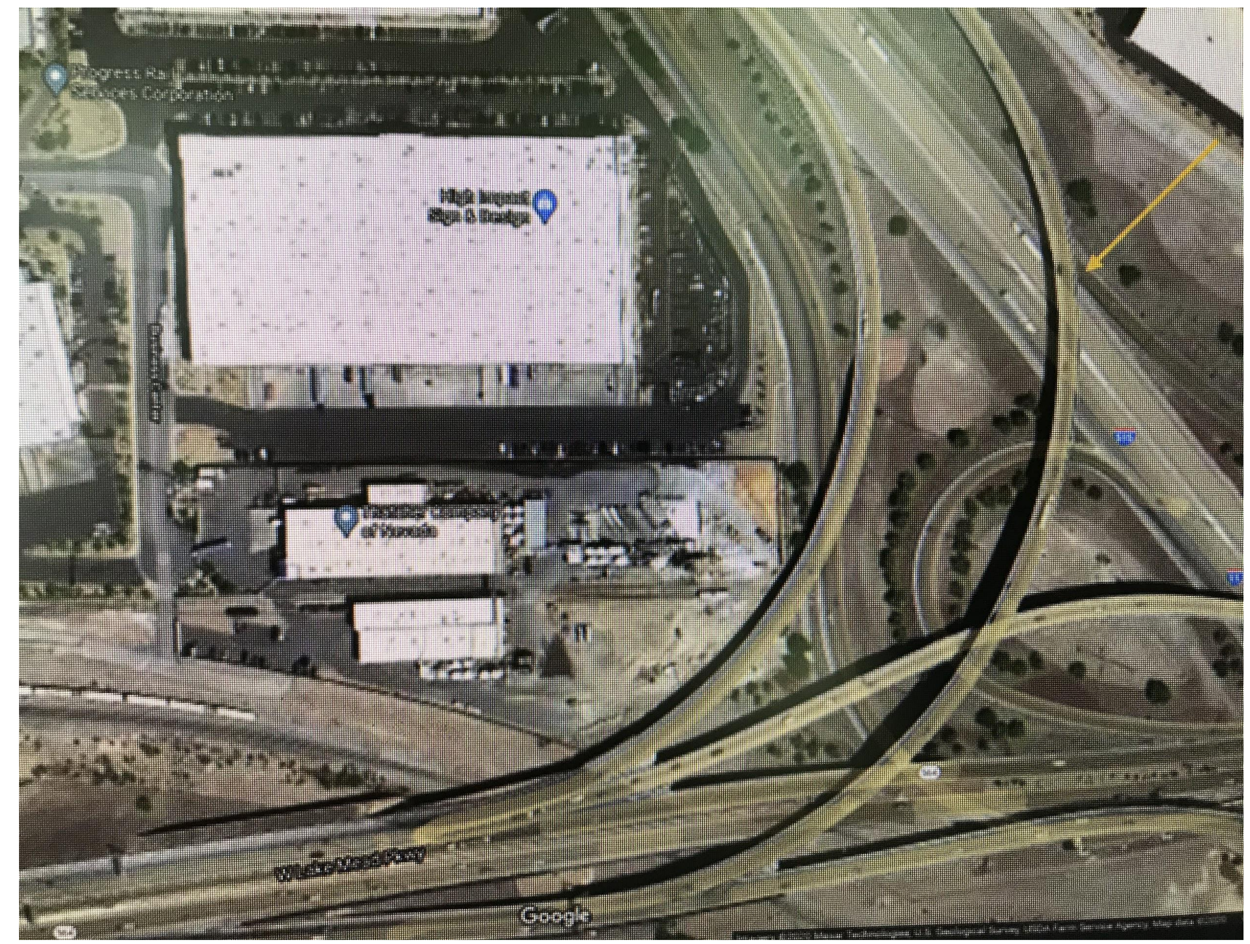


TITLE	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515

SKETCH OF PROPOSED ALTERNATIVE

Remove 2 to 1 lane merge at the touch down point on to I-515 NB. Maintain 2 through lanes on I-515 NB

Maintain Existing Structure



VALUE ANALYSIS PROPOSAL
IG-22
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1: Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Proposed Option 1 EB I-215 to NB I-515 is a three-lane flyover that merges into two lanes prior to touching down adjacent to I-515 NB and adding in with mainline I-515, restricting EB I-215 access to Auto Show Drive. According to projected traffic numbers, the third lane seems to be on the border of being warranted. It was suggested that the decision was made to go with three lanes to improve the traffic flows and speed through the curve on the flyover structure.

PROPOSED ALTERNATIVE:

This alternative is an opportunity to improve access by using the third lane to create an exit for EB I-215 to NB I-515 to exit at Auto Show Drive. Providing a slip ramp for flyover traffic to access Auto Show NB exit. This alternative would depend on the outcome of VA proposal IG-21. If VA proposal IG-21 is accepted, this opportunity may be void.

BENEFITS	RISKS/CHALLENGES
● Improve access to Auto Show Drive from EB I-215 to NB I-515 ramp	● Geometric changes may be needed to adjust/realign NBCD,WN to provide appropriate distance between ingress, egress locations to allow this ramp to be incorporated
● Improving access to allow delivery truck and customers to improve commerce	● Large detention basin east of roadway may be impacted
●	● This would likely result in cost add; benefit analysis would be needed
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$0	$0	$0
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$0	$0	$0
			NOT COSTED

VALUE ANALYSIS PROPOSAL
IG-22
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1: Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)

DISCUSSION/JUSTIFICATION:

If VA proposal IG-21 is determined to be a benefit to the performance of the EN flyover ramp rather than merge 3 lanes to 2 prior to the entering the I-515 corridor, maintain the third lane and create a slip ramp. Allowing access to the Auto Show Exit from the EB I-215/NB I-515. This likely would create the need to tighten the "WN" ramp radius and merge traffic sooner to allow gap spacing to introduce an additional exit point. Even though 2040 Projected Traffic counts are only 390 (AM) and 570 (PM) this would allow better access to auto dealers for a minimal increase in cost. Cost Benefit analysis would need to be considered.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IG-22
Nevada Department of Transportation
Henderson Interchange Feasibility Study

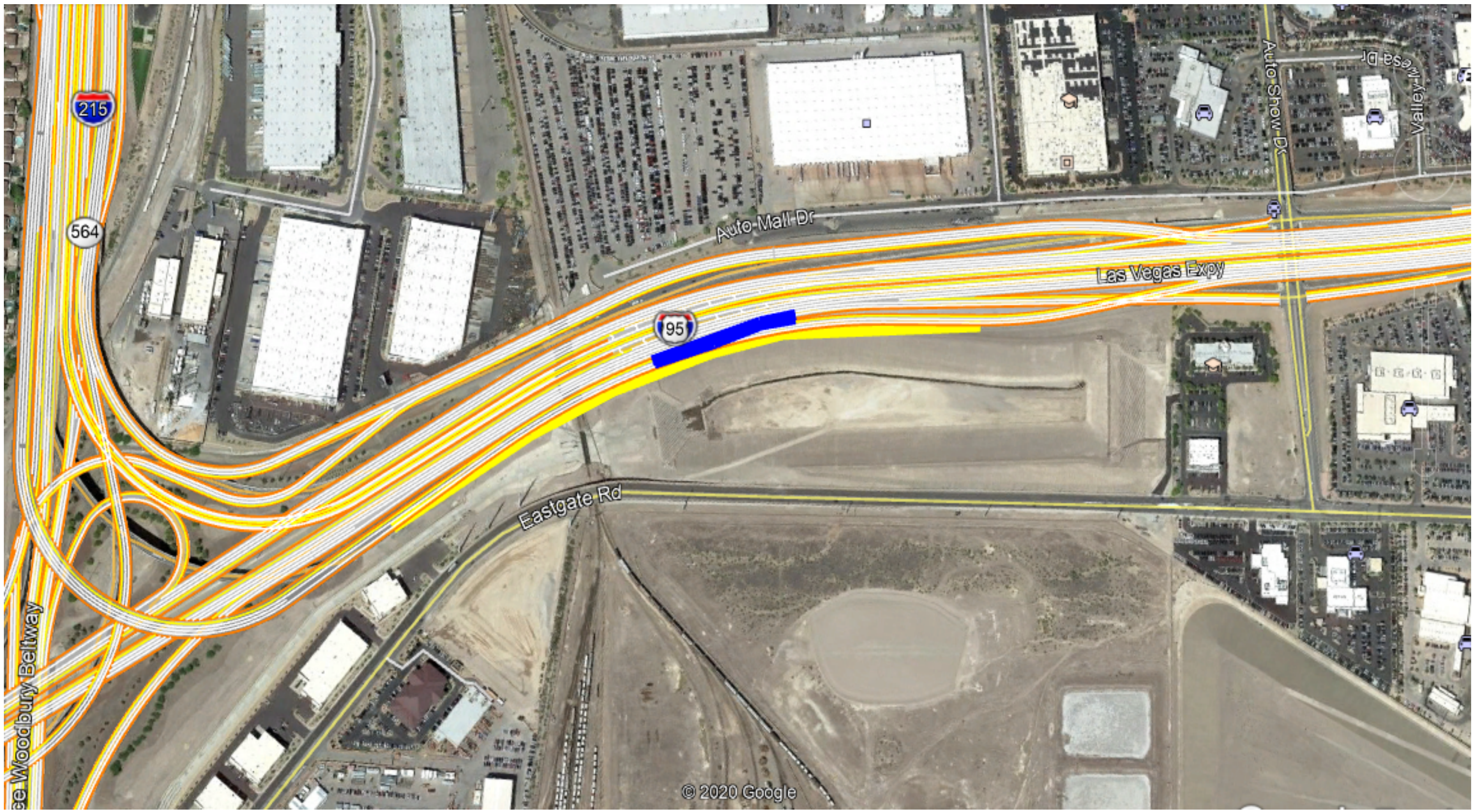
TITLE	Option 1: Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)

SKETCH OF BASELINE ASSUMPTION

VALUE ANALYSIS PROPOSAL
IG-22
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1: Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-23
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Shift the I-215 EB further east to allow more merging area from the Gibson off-ramp; tighten ramp radii based on offset shortening structure length; I-215 to I-515 and I-11
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Option 1: In the current design the eastbound on-ramp from Gibson has ~750 feet of weaving distance to merge over 2 lanes if they wish to use the I-215 East to I-11 South ramp.

PROPOSED ALTERNATIVE:

The alternative suggests moving the diverge point for the I-11 ramps further to the East, roughly 700-1000 feet, to allow for more weaving room with the intention of improving safety and speeds as a byproduct. The improvement could potentially be at low cost, no or low costs savings depending on final geometrics. The current proposed sketch shows a weaving area of approximately 1430 feet.

BENEFITS	RISKS/CHALLENGES
● Increased weaving length reducing drivers aggressive behavior	● Ensure that new diverge points allow for the proper vertical clearance of adjacent ramps
● Improved safety	●
● Improved speed and time savings	●
●	●
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$0	$0	$0
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$0	$0	$0
			NOT COSTED

VALUE ANALYSIS PROPOSAL

IG-23

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Shift the I-215 EB further east to allow more merging area from the Gibson off-ramp; tighten ramp radii based on offset shortening structure length; I-215 to I-515 and I-11

DISCUSSION/JUSTIFICATION:

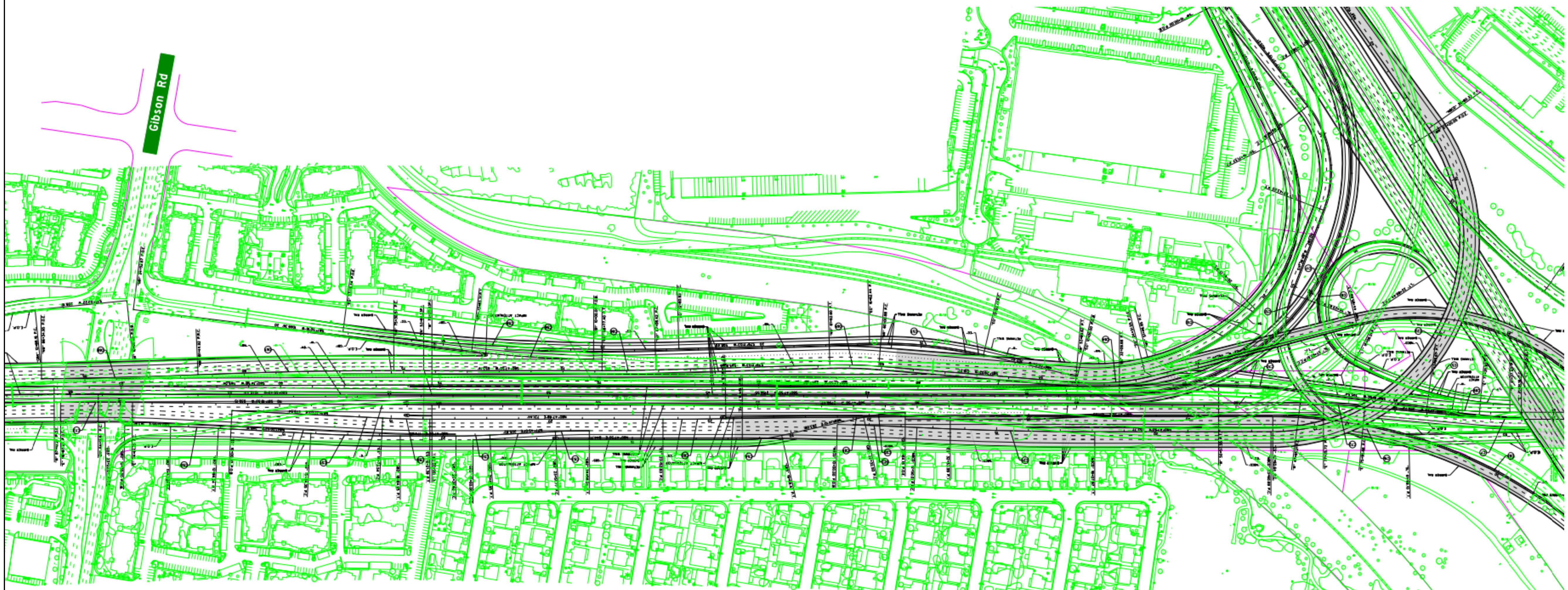
For Option 1 design on the I-215 eastbound, the eastbound on-ramp from Gibson Road current has a weaving length of ~750 feet to merge over two lanes to make the connection to the ramp for I-11 southbound. The proposed alternative calls for the elongation of the straightaway length before the ramps diverge adding in an additional 700-1000 feet to the weaving length. The additional weaving length will provide more decision time, reducing driver aggression, improving safety, and increasing speeds.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

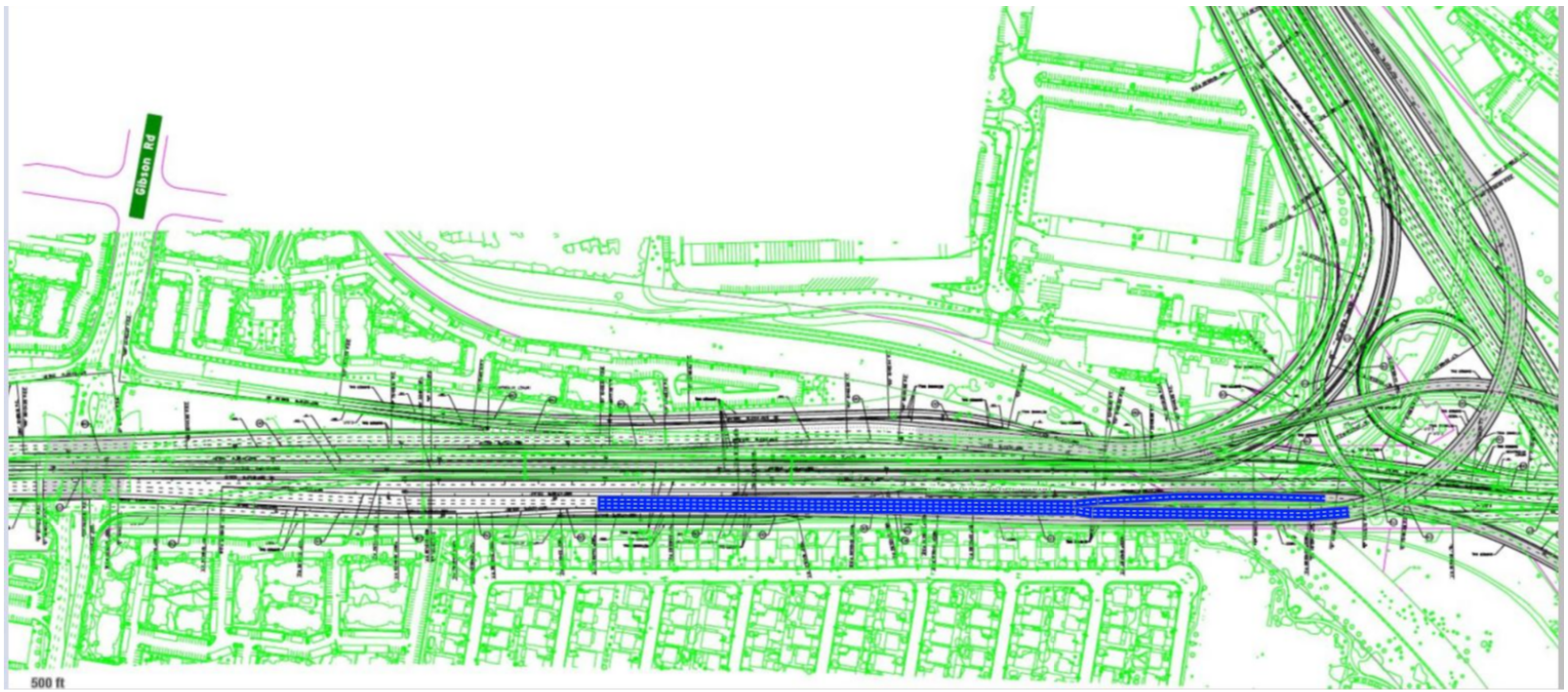
TITLE	Options 1 & 2. Shift the I-215 EB further east to allow more merging area from the Gibson off-ramp; tighten ramp radii based on offset shortening structure length; I-215 to I-515 and I-11

SKETCH OF BASELINE ASSUMPTION



TITLE	Options 1 & 2. Shift the I-215 EB further east to allow more merging area from the Gibson off-ramp; tighten ramp radii based on offset shortening structure length; I-215 to I-515 and I-11

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-25
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

The EB on-ramp from Gibson Rd enters EB I-215 approximately 800 feet west of the gore for the EN (right lanes) and ES (left lanes) ramp diverge. A vehicle entering EB I-215 at Gibson Rd would be required to make two lane changes in less than 800 feet to access the ES ramp. A separate ramp is provided from the EB on-ramp to connect to EB LMP.

PROPOSED ALTERNATIVE:

Shift the gore for the EN/ES ramp further west and/or the gore the Gibson EB on-ramp further east to eliminate the opportunity for a vehicle to enter at Gibson Rd and access the ES ramp, forcing this traffic to use the EN ramp. Traffic from Gibson Rd that wants to travel south on I-11 can travel further north to Auto Show Drive to enter SB I-515 or travel south to Horizon Drive to access I-11.

BENEFITS	RISKS/CHALLENGES
● Remove a potentially unsafe weave, 2 lane changes in 800 feet on EB I-215 approaching the Henderson Interchange	● Does not allow traffic entering EB I-215 at Gibson Rd to access the EB to SB system ramp to go south on I-11
●	●
●	●
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$0	$0	$0
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$0	$0	$0
			NOT COSTED

VALUE ANALYSIS PROPOSAL

IG-25

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated

DISCUSSION/JUSTIFICATION:

This is mostly a proposed change in pavement marking with minimal impact to roadway and structure quantities and is not expected to impact project cost.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL

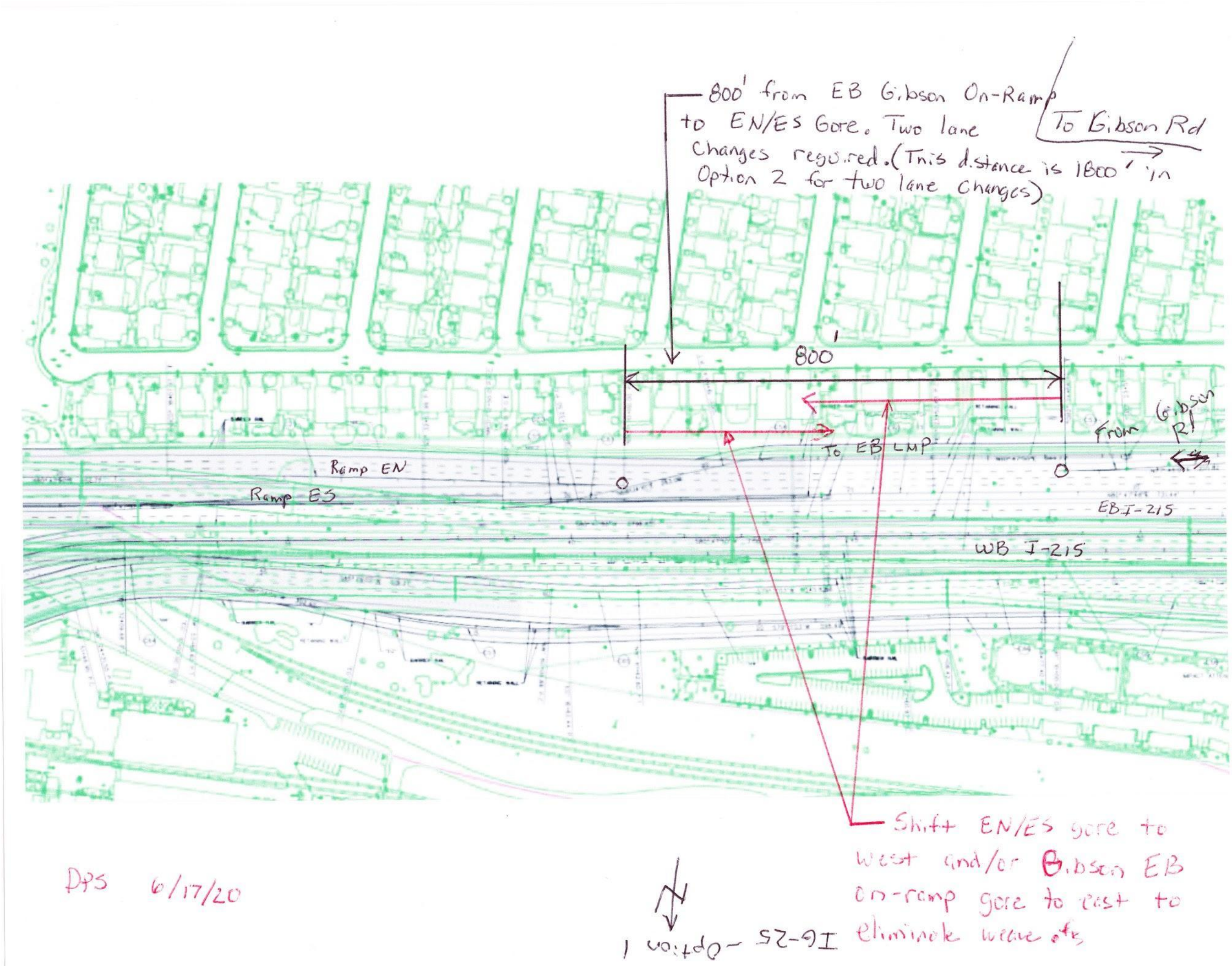
IG-25

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-26
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

The SB I-515 to WB I-215 and the EB I-215 to NB I-515 are two of the largest movements in the Henderson Spaghetti Bowl. There is also the issue of local connections that introduce unwanted weaving on the mainline and some of these connections are eliminated completely in the two options. Also have issue of designing new interchange but yet allowing for future (if approved) HOV improvements.

PROPOSED ALTERNATIVE:

The proposed alternative consists of constructing a 6-lane median flyover that goes from I-515 to I-215. This would include three general purpose lanes in each direction and in the future the third general purpose lane would become an HOV lane. This alternative would also incorporate several of the existing structures as a collector/distributor system that would allow for all local connections.

BENEFITS	RISKS/CHALLENGES
● Takes heaviest movements out of the interchange and places them on a single flyover	● Flyover costs could be extremely expensive ($50 to $60 million)
● Maintains all four of the existing flyovers and converts two of them to CD roadways	● Retrofits some of the old structures by shortening them
● Constructability is simpler due to less demo of the old structures. Also by using the existing flyovers, the new flyover can be constructed in the median with minimal impacts to the traveling public	● Because the local connections will be taken off the main line, this will increase traffic on the new CD system that will be incorporated
● Maintains all existing local connections, but mostly takes them out of mainline traffic which will decrease and eliminate unwanted weaving on mainline	●

COST SUMMARY - OPTION 1	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$137,091,000	$0	$137,091,000
PROPOSED ALTERNATIVE:	$87,840,000	$0	$87,840,000
TOTAL (Baseline less Proposed)	$49,251,000	$0	$49,251,000
			SAVINGS

COST SUMMARY - OPTION 2	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$9,200,000	$0	$9,200,000
PROPOSED ALTERNATIVE:	$2,823,000	$0	$2,823,000
TOTAL (Baseline less Proposed)	$6,377,000	$0	$6,377,000
			SAVINGS

VALUE ANALYSIS PROPOSAL

IG-26

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)

DISCUSSION/JUSTIFICATION:

This idea is a new option that takes the proposed ramps SB I-515 to WB i-215 and EB i-215 to NB I-515 from the outside of the proposed interchange and relocate it to the median. The proposed SB I-515 to WB i-215 has a peak hour count of 2690 in 2040 and the EB I-215 to NB I-515 has a peak hour count of 3530 in 2040. Both of these ramps border on being 2 or 3 lanes. There is also the idea of HOV maybe being implemented into the interchange in the future. So what this concept does is takes three general purpose (GP) lanes in each direction and places them in a flyover that goes from I-215 median to the I-515 median. The length is approx 2500' and is 120' wide. This results in a 300,000 sq ft bridge at a cost of $72 million. However, by building this structure all the existing flyovers and ramps can be used for the local connections. If the HOV plan is introduced, simply change the inside lane from GP to HOV. Also, costs for the constructing the following structures are not incurred: EB to NB (213,000 sq ft X $240 = $51 million); NB to WB (127,000 sq ft X $240 = $31 million); EB to SB (78,000 sq ft X $240 = $19 million). The bridge demo costs save approx $12 million. The best part about this option though is the ease of construction since all of the detours are already in place with the existing ramps, the flyover can be constructed in the median. The value team did not evaluate any of the verticals; this will have to be looked at more closely.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IG-26
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)

DESIGN ELEMENT	**OPTION 1: BASELINE ASSUMPTION**				**OPTION 1: PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF		$25	$0		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF	418,000	$240	$100,320,000	300,000	$240	$72,000,000
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF	241,000	$50	$12,050,000	0	$50	$0
SUBTOTAL				$112,370,000			$72,000,000
Construction Engineering/ Inspection - 15%				$16,855,500			$10,800,000
Other Project Development Costs - 7%				$7,865,900			$5,040,000
TOTAL				$137,091,000			$87,840,000
						CWE (BASELINE LESS PROPOSED)	$49,251,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL
IG-26
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)

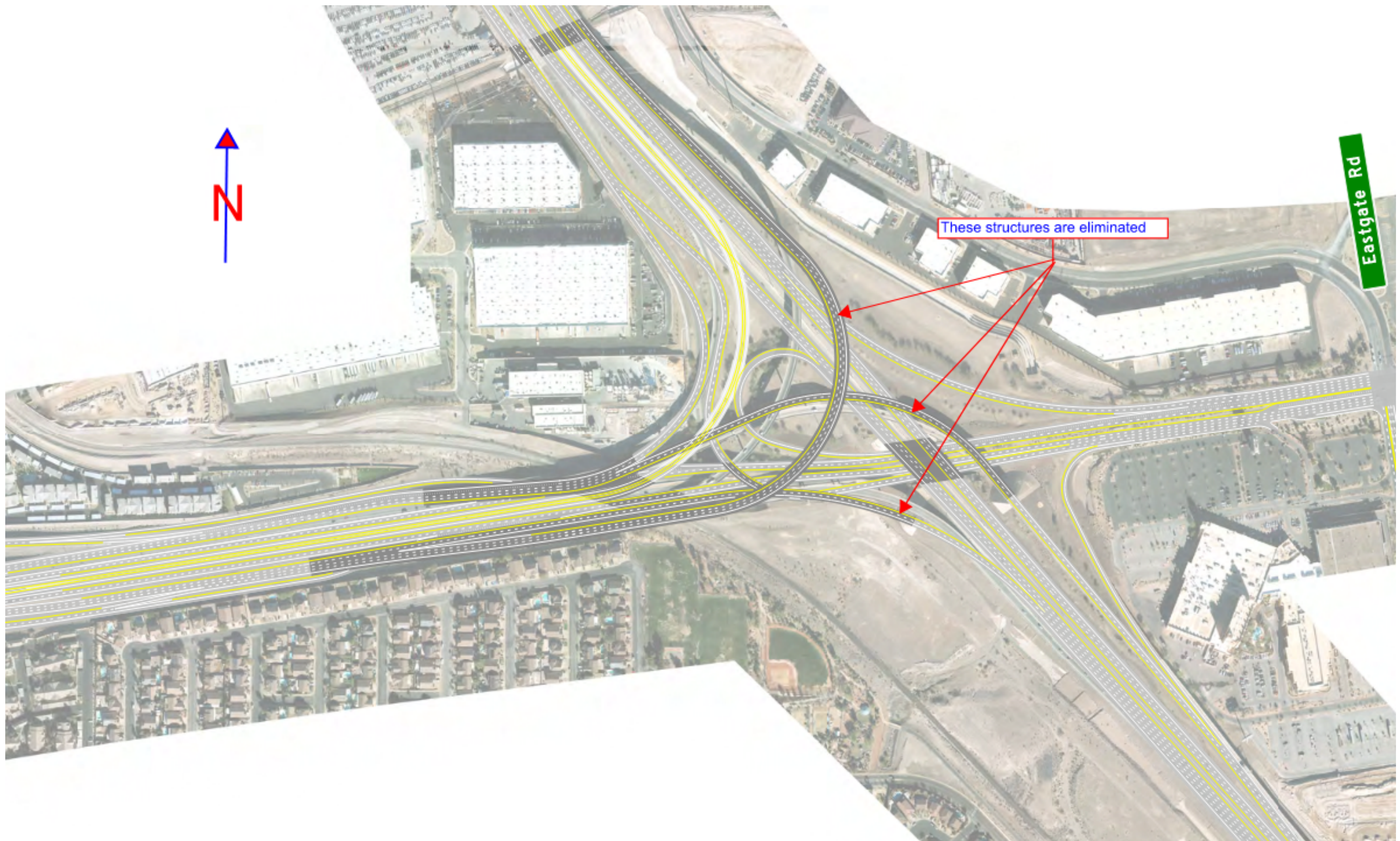
DESIGN ELEMENT	**OPTION 2: BASELINE ASSUMPTION**				**OPTION 2: PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF		$25	$0		$25	$0
Roadway on I-215	SF	18,000	$40	$720,000	0	$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF	37,500	$85	$3,187,500	0	$85	$0
Bridge - west braid crossover	SF	12,480	$180	$2,246,400	0	$180	$0
Bridge - north crossover	SF	0	$180	$0	5,175	$180	$931,500
Bridge - west crossover	SF	0	$180	$0	7,680	$180	$1,382,400
Bridge - west UPRR	SF	4,080	$340	$1,387,200	0	$180	$0
Bridge demolition	SF	0	$50	$0	0	$50	$0
SUBTOTAL				$7,541,100			$2,313,900
Construction Engineering/ Inspection - 15%				$1,131,165			$347,085
Other Project Development Costs - 7%				$527,877			$161,973
TOTAL				$9,200,000			$2,823,000
						CWE (BASELINE LESS PROPOSED)	$6,377,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL
IG-26
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 3 (new). Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)

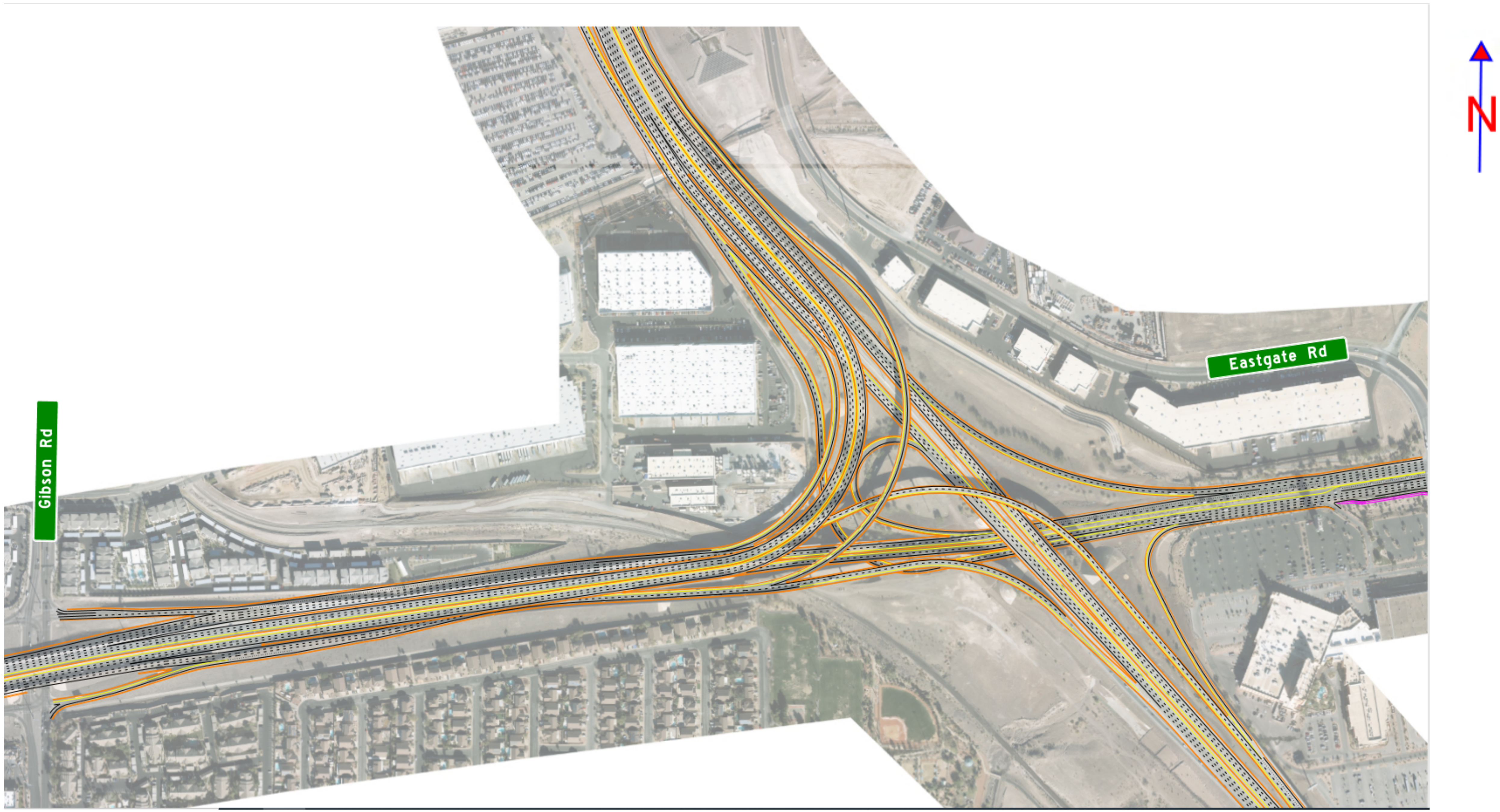
SKETCH OF BASELINE ASSUMPTION



VALUE ANALYSIS PROPOSAL
IG-26
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 3 (new). Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-27
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

In the Option 2 configuration, northbound I-11/I-515 crosses over southbound I-11/I-515. The northbound I-11 to westbound I-215 movement is constructing a new roadway with retaining walls via a left-hand exit just north of the crossover of the northbound I-11 lanes. The westbound Lake Mead Parkway to southbound I-11 uses a left-hand merge.

PROPOSED ALTERNATIVE:

Remove the crossover concept from the northbound/southbound I-11/I-515 roadway. Intercept the existing eastbound I-215 to southbound I-11 structure and utilize it for the northbound I-11 to westbound I-215 movement. Realign westbound Lake Mead Parkway to westbound I-215 and realign the westbound Lake Mead Parkway to southbound I-15 ramp to provide a more standard right-hand merge of traffic.

BENEFITS	RISKS/CHALLENGES
● Utilizes existing structure	● Vertical tie in of new northbound I-11 to existing structure elevation
● Provides more standard right-hand merge to prevent possible slower traffic in the left-hand lanes	● Vertical tie of existing structure and realigned Lake Mead Parkway at westbound I-215
● Removes the need for crossover structures in northbound/southbound directions	● Current conceptual layout does go outside of right-of-way in the southwest quadrant
●	● Left-hand exiting structure from northbound I-11 over southbound I-11
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$84,433,000	$0	$84,433,000
PROPOSED ALTERNATIVE:	$63,763,000	$0	$63,763,000
TOTAL (Baseline less Proposed)	$20,670,000	$0	$20,670,000
			SAVINGS

VALUE ANALYSIS PROPOSAL

IG-27

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design

DISCUSSION/JUSTIFICATION:

Under the Option 2 Design, the two movements that appear to benefit from the crossover of the northbound/southbound I-11/I-515 roadways are the northbound I-11 to westbound I-215 and the westbound Lake Mead Parkway to southbound I-11. The alternative design is to remove the proposed crossover of the northbound/southbound I-11/I-515 roadways and continue the northbound lanes in a straight line from the south proposed crossover location to the north proposed crossover location. A left-hand departure from the northbound I-11 lanes would then be utilized to carry the northbound I-11 to westbound I-215 movement. This structure would then tie back into the the existing eastbound I-215 to southbound I-11 structure. This existing bridge ties in at roughly the same proposed location as the proposed Option 2 movement. This adds benefit to the project by utilizing an existing bridge that already spans the railroad corridor and reducing the roadway, retaining wall, and new bridge costs of the proposed Option 2 alignment, but will require a new bridge over I-11 southbound and retaining walls to facilitate the movement.

By utilizing the existing bridge, we also open the opportunity to address the proposed Option 2 left-hand merge from westbound Lake Mead Parkway to southbound I-11 by utilizing the existing space under the structure to bring the movement under the northbound/southbound lanes and the existing structure (adjacent to where the existing eastbound Lake Mead Parkway alignment is today) to create a small loop ramp that will merge traffic onto the westbound I-215 to southbound I-11 ramp. Doing this will provide a more standard right-hand merge for the southbound traffic and possibly remove the potential for conflict of slow moving vehicles merging into the left-hand lanes.

In order to tie in the eastbound I-215 to southbound I-11 movement and the westbound Lake Mead Parkway to westbound I-215 movement, the eastbound I-215 to southbound I-11 ramp was shifted slightly south towards some existing single family homes and a park, but appears to be outside of the current Right of Way. Design refinement may be able to pull this back within the Right of Way. Utilizing the existing bridge also requires a slight realignment of the proposed Option 2 westbound Lake Mead Parkway to westbound I-215 movement in order to avoid existing bridge columns.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IG-27
Nevada Department of Transportation
Henderson Interchange Feasibility Study

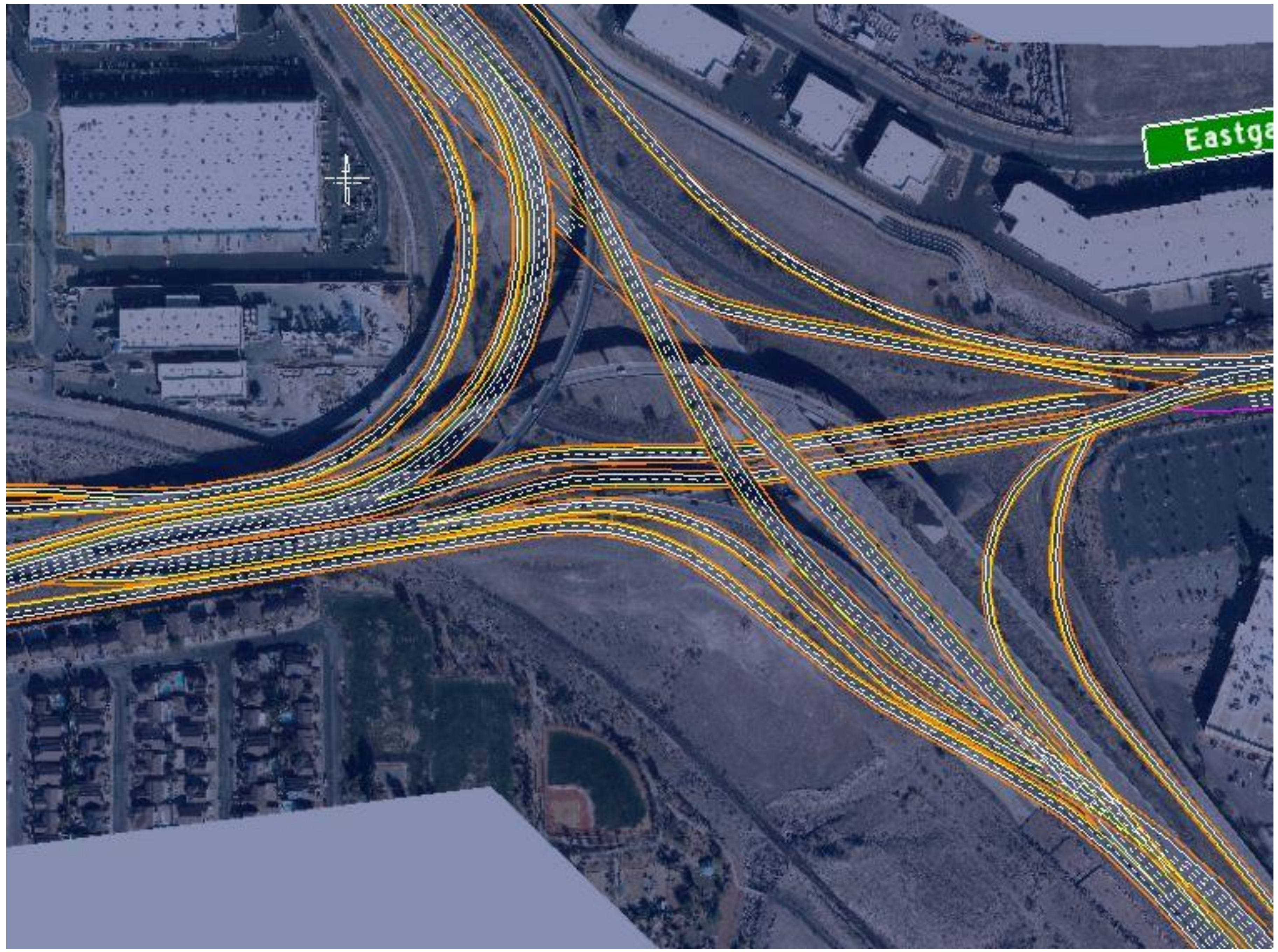
TITLE	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design

DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF	293,894	$25	$7,347,350	319,730	$25	$7,993,250
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY	87,268	$14	$1,221,752	74,032	$14	$1,036,448
Retaining wall	LF	6,136	$1,700	$10,431,200	3,980	$1,700	$6,766,000
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF	11,317	$210	$2,376,570	31,707	$210	$6,658,470
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF	82,396	$340	$28,014,640	62,739	$340	$21,331,260
Bridge - crossover bridge (measured as the	SF	99,273	$180	$17,869,140	26,384	$180	$4,749,120
Bridge demolition	SF	38,931	$50	$1,946,550		$50	$0
Right of Way Acquisition.	SF		$50	$0	248,657	$15	$3,729,855
SUBTOTAL				$69,207,202			$52,264,403
Construction Engineering/ Inspection - 15%				$10,381,080			$7,839,660
Other Project Development Costs - 7%				$4,844,504			$3,658,508
TOTAL				$84,433,000			$63,763,000
						CWE (BASELINE LESS PROPOSED)	$20,670,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

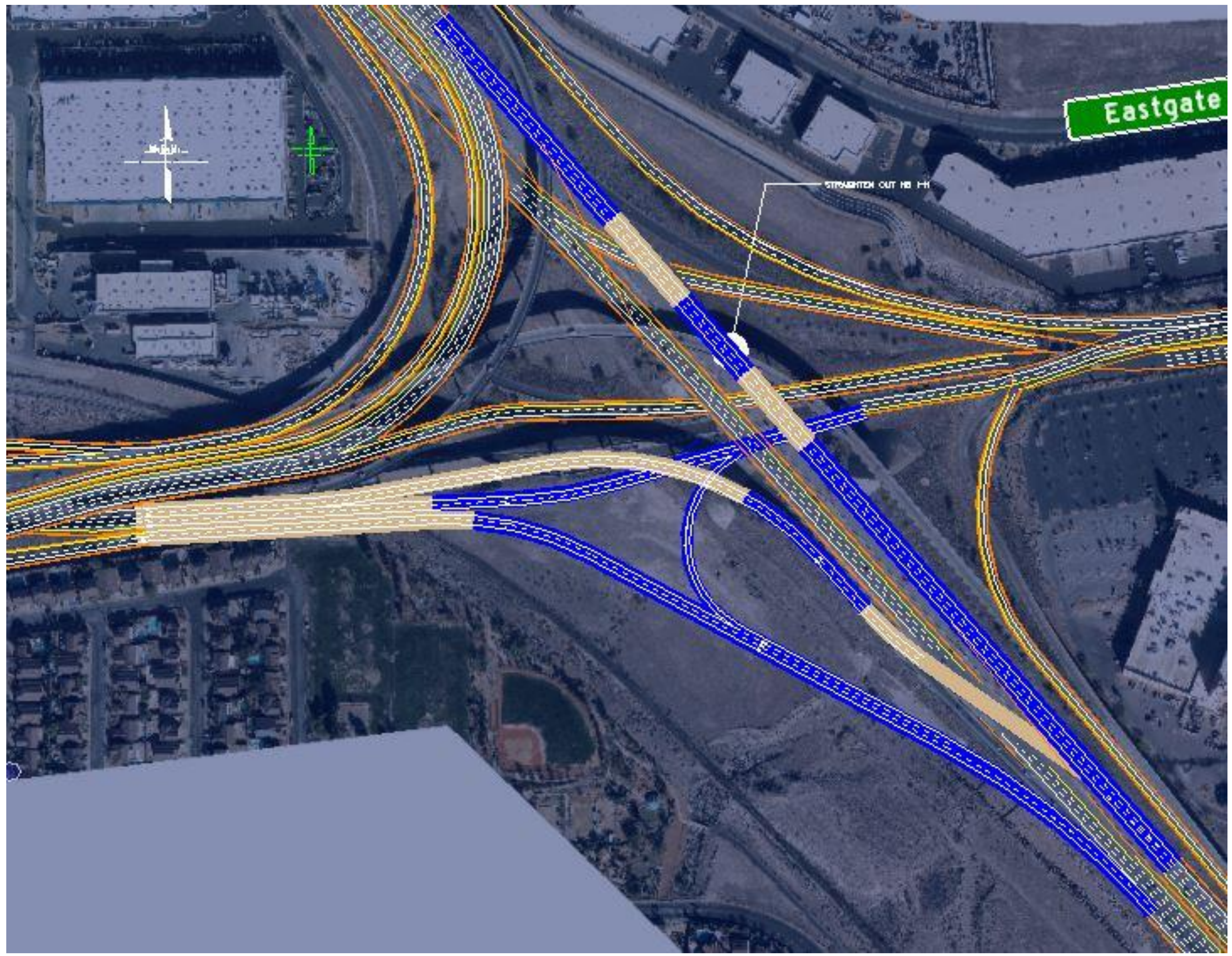
TITLE	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue

SKETCH OF BASELINE ASSUMPTION



TITLE	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue east

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IG-28
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Options 1 and 2 provide two-lane entrance ramps for the ES ramp onto SB I-11 and a two-lane exit ramp at Horizon Dr with a long auxiliary lane between the two ramp gores (8300 feet in Option 1 and 7700 feet in Option 2). Similarly in the NB direction, Options 1 and 2 provide a two-lane entrance ramp at Horizon Dr with a two-lane exit for the Lake Meade Parkway ramp with a long auxiliary lane between the two ramp gores (6400 feet in Option 1 and 6200 feet in Option 2).

PROPOSED ALTERNATIVE:

As an alternative to the auxiliary lane, provide a two-lane entrance ramp for the ES ramp onto SB I-11 and drop one lane, then provide a flare to add a second lane for the two-lane exit at Horizon Dr. Similarly in the NB direction, provide a two-lane entrance ramp for the Horizon Dr on-ramp, drop one lane, then provide a flare to add a second lane for the two-lane Lake Mead Parkway exit ramp.

BENEFITS	RISKS/CHALLENGES
● Save several thousand feet of 12-foot lane in both directions on I-11	● I-11 mainline operations may decrease with only 4 lanes instead of 4 lanes plus auxiliary lane
● Auxiliary lane if needed can be added at a later date	● Construction cost may increase in the future
● Current ramps at Horizon Dr are one-lane ramps, additional pavement could be saved if the two-lane ramp construction was also deferred to a later date	● Will have to close one lane in each direction to construct the auxiliary lanes in the future

COST SUMMARY - OPTION 1	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$3,477,000	$0	$3,477,000
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$3,477,000	$0	$3,477,000
			SAVINGS

COST SUMMARY - OPTION 2	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$3,184,000		$3,184,000
PROPOSED ALTERNATIVE:	$0		$0
TOTAL (Baseline less Proposed)	$3,184,000	$0	$3,184,000
			SAVINGS

VALUE ANALYSIS PROPOSAL

IG-28

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps

DISCUSSION/JUSTIFICATION:

A ramp acceleration/deceleration distance of 1,000 feet was estimated for the ramp prior to the ramp entrance exit/entrance gore. A distance of 300 feet was used for the ramp tamper for entrance ramps and 300 feet for exit ramps. The auxiliary lane distance between the entrance and exit gore distance was reduced by 2,600 feet to estimate the length of the auxiliary lane that could be eliminated/deferred. No reduction in shoulder width was assumed.

The traffic analysis indicates that the NB and SB segments of I-11 are forecast to operate at or above 65 mph during the AM and PM peak hours in 2040, removing the auxiliary lane from this segment but still providing 4 general purpose lanes may be sufficient.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IG-28
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps						
DESIGN ELEMENT	**OPTION 1: BASELINE ASSUMPTION**				**OPTION 1: PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage) - SB I-11 Auxiliary Lane - **Option 1**	SF	68,400	$25	$1,710,000		$25	$0
Roadway on I-11/I-515 (open drainage) - NB I-11 Auxillary Lane - **Option 1**	SF	45,600	$25	$1,140,000		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$2,850,000			$0
Construction Engineering/ Inspection - 15%				$427,500			$0
Other Project Development Costs - 7%				$199,500			$0
TOTAL				$3,477,000			$0
CWE (BASELINE LESS PROPOSED)							$3,477,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL
IG-28
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps

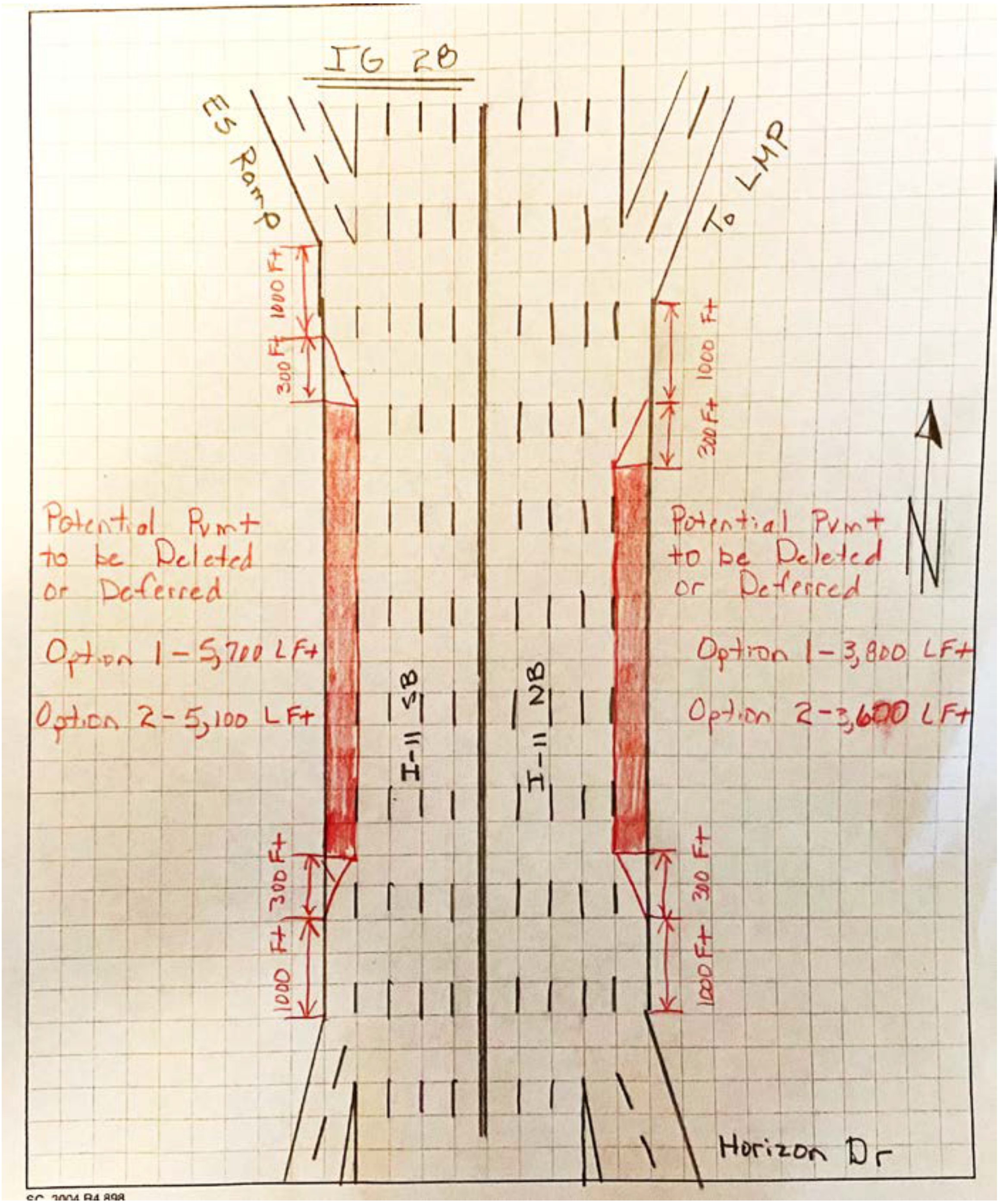
DESIGN ELEMENT	OPTION 2: BASELINE ASSUMPTION				OPTION 2: PROPOSED ALTERNATIVE		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage) - SB I-11 Auxiliary Lane - **Option 2**	SF	61,200	$25	$1,530,000		$25	$0
Roadway on I-11/I-515 (open drainage) - NB I-11 Auxillary Lane - **Option 2**	SF	43,200	$25	$1,080,000		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$2,610,000			$0
Construction Engineering/ Inspection - 15%				$391,500			$0
Other Project Development Costs - 7%				$182,700			$0
TOTAL				$3,184,000			$0
CWE (BASELINE LESS PROPOSED)							$3,184,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL
IG-28
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IA-04
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV proposed on the future; this would shorten the flyover ramp considerably
FUNCTION	**Improve Access**

BASELINE ASSUMPTION:

The proposed EB I-215 to NB I-515 is on the outside of the proposed interchange.

PROPOSED ALTERNATIVE:

By relocating the proposed flyover to the median, this will shorten the proposed flyover by an approximate length of 500 feet.

BENEFITS	RISKS/CHALLENGES
● Shorter structure will provide savings of 500' of structure costs	● Idea could impact the HOV plan if implemented
●	● Non-preferred left-hand exit and entrance
●	●
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$35,136,000	$0	$35,136,000
PROPOSED ALTERNATIVE:	$26,352,000	$0	$26,352,000
TOTAL (Baseline less Proposed)	$8,784,000	$0	$8,784,000
			SAVINGS
			NOT RECOMMENDED

VALUE ANALYSIS PROPOSAL
IA-04
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV proposed on the future; this would shorten the flyover ramp considerably

DISCUSSION/JUSTIFICATION:

This is the simple concept of relocating the proposed EB to NB flyover from the outside of the interchange to the median. The proposed structure is 2000' long and the new proposed structure would be 1500' long. This would provide savings of 500' X 60' wide = 30,000 sq ft @ $240 per sq feet ($7.2 million).

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IA-04
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV proposed on the future; this would shorten the flyover ramp considerably

DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF		$25	$0		$25	$0
Roadway on I-215 (closed drainage)	SF		$40	$0		$40	$0
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF		$210	$0		$210	$0
Bridge - elevated/complex flyover bridge	SF	120,000	$240	$28,800,000	90,000	$240	$21,600,000
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0		$180	$0
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$28,800,000			$21,600,000
Construction Engineering/ Inspection - 15%				$4,320,000			$3,240,000
Other Project Development Costs - 7%				$2,016,000			$1,512,000
TOTAL				$35,136,000			$26,352,000
CWE (BASELINE LESS PROPOSED)							$8,784,000
							SAVINGS

Note: Total costs are rounded to the nearest thousand dollars.

VALUE ANALYSIS PROPOSAL

IA-04

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV proposed on the future; this would shorten the flyover ramp considerably

SKETCH OF BASELINE ASSUMPTION

VALUE ANALYSIS PROPOSAL

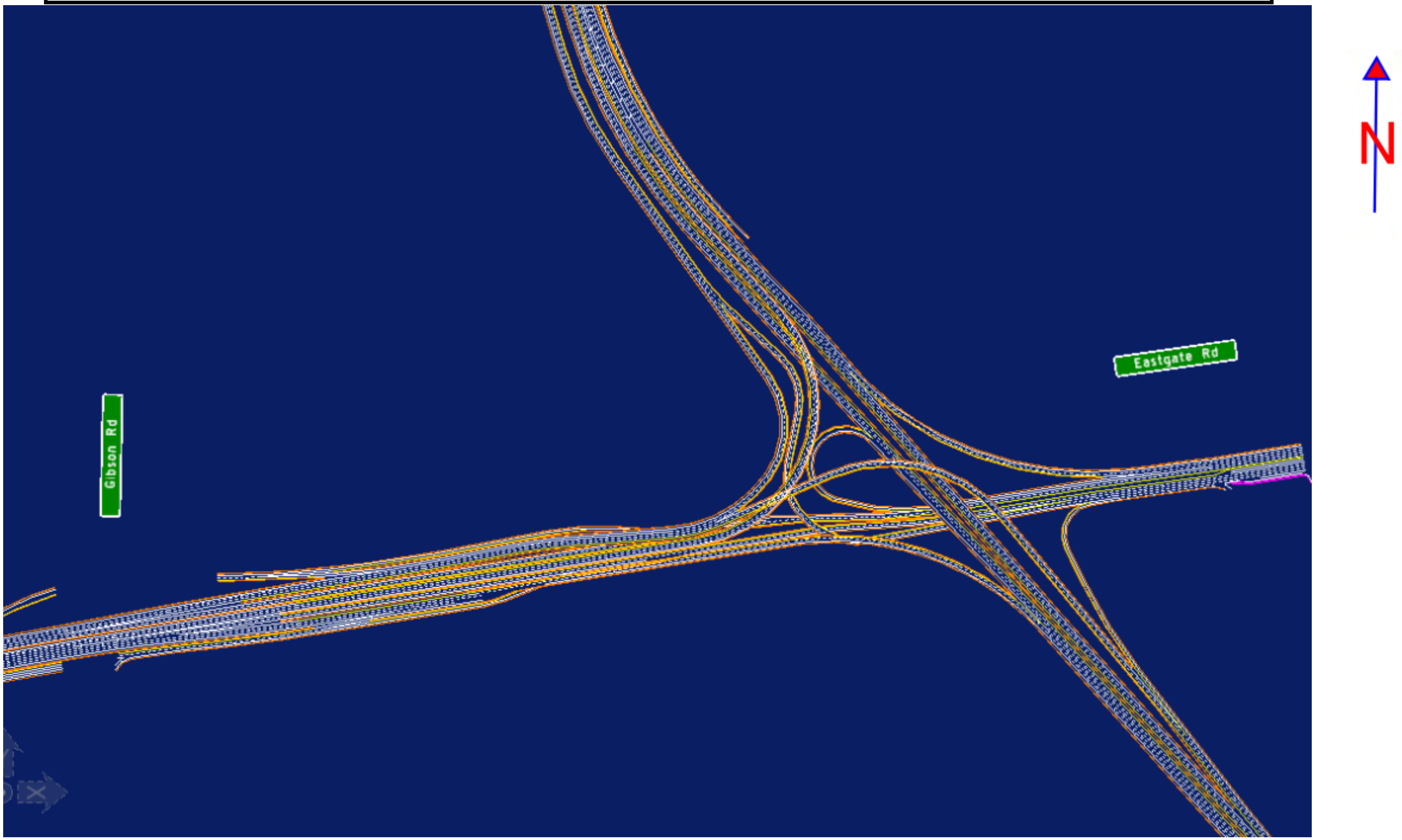
IA-04

Nevada Department of Transportation

Henderson Interchange Feasibility Study

TITLE	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV proposed on the future; this would shorten the flyover ramp considerably

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IA-06
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)
FUNCTION	**Improve Access**

BASELINE ASSUMPTION:

At the I-215 Gibson Road Interchange, the two-lane EB on-ramp access the I-215 with one lane and the one lane goes to EB Lake Mead Parkway. When accessing the EB I-215, there is only 800' to merge over two lanes to get to the SB I-11 ramp.

PROPOSED ALTERNATIVE:

By shifting the the entire I-215 footprint to the north, this would allow a loop ramp to be constructed in the SW quadrant of the interchange and would provide approximately 1200' more space to get to the SB I-11 ramp.

BENEFITS	RISKS/CHALLENGES
● Would provide adequate distance for EB on-ramp to access the SB I-11 ramp	● Would still need need to have ramp in the SE quadrant to access Lake Mead Parkway
●	● Right-of-way would be a concern as the geometry needed for the loop ramp may require acquisitions
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$0	$0	$0
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$0	$0	$0

NOT COSTED

NOT RECOMMENDED

VALUE ANALYSIS PROPOSAL
IA-06
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)

DISCUSSION/JUSTIFICATION:

VA Alternative IG-06 does not provide cost savings, but it does provide a safer merge by adding an additional 1500' of weaving distance for the cars travelling to SB I-11. This idea also requires an acquisition of approx. 57,000 sq ft of commercial real estate in the SW quadrant of the interchange.

The value team noted that while this idea allows time for the weave (safety benefit), there may be a right-of-way cost impact that was not costed. Furthermore, this idea was not recommended by the value team.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL

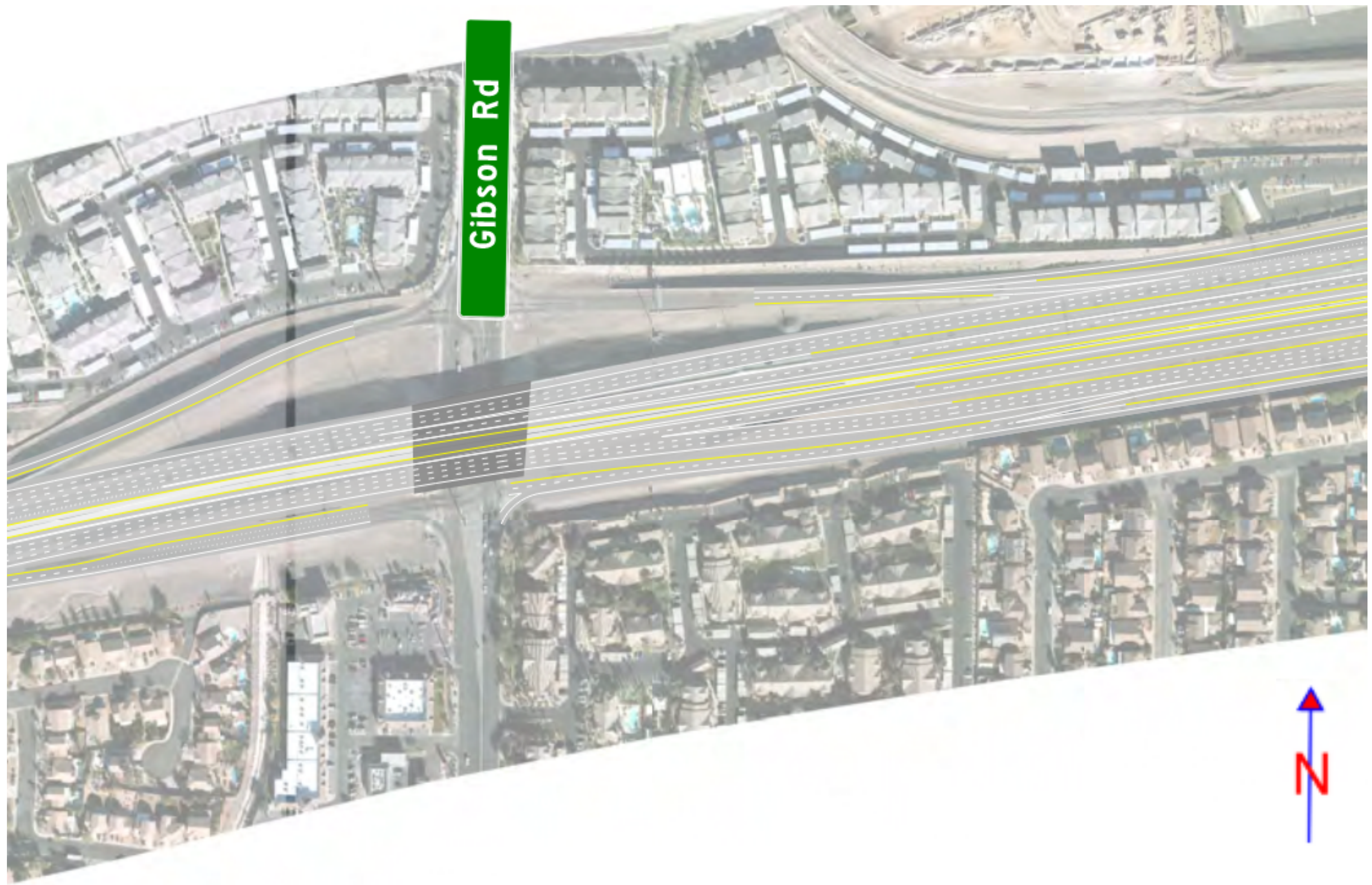
IA-06

Nevada Department of Transportation

Henderson Interchange Feasibility Study

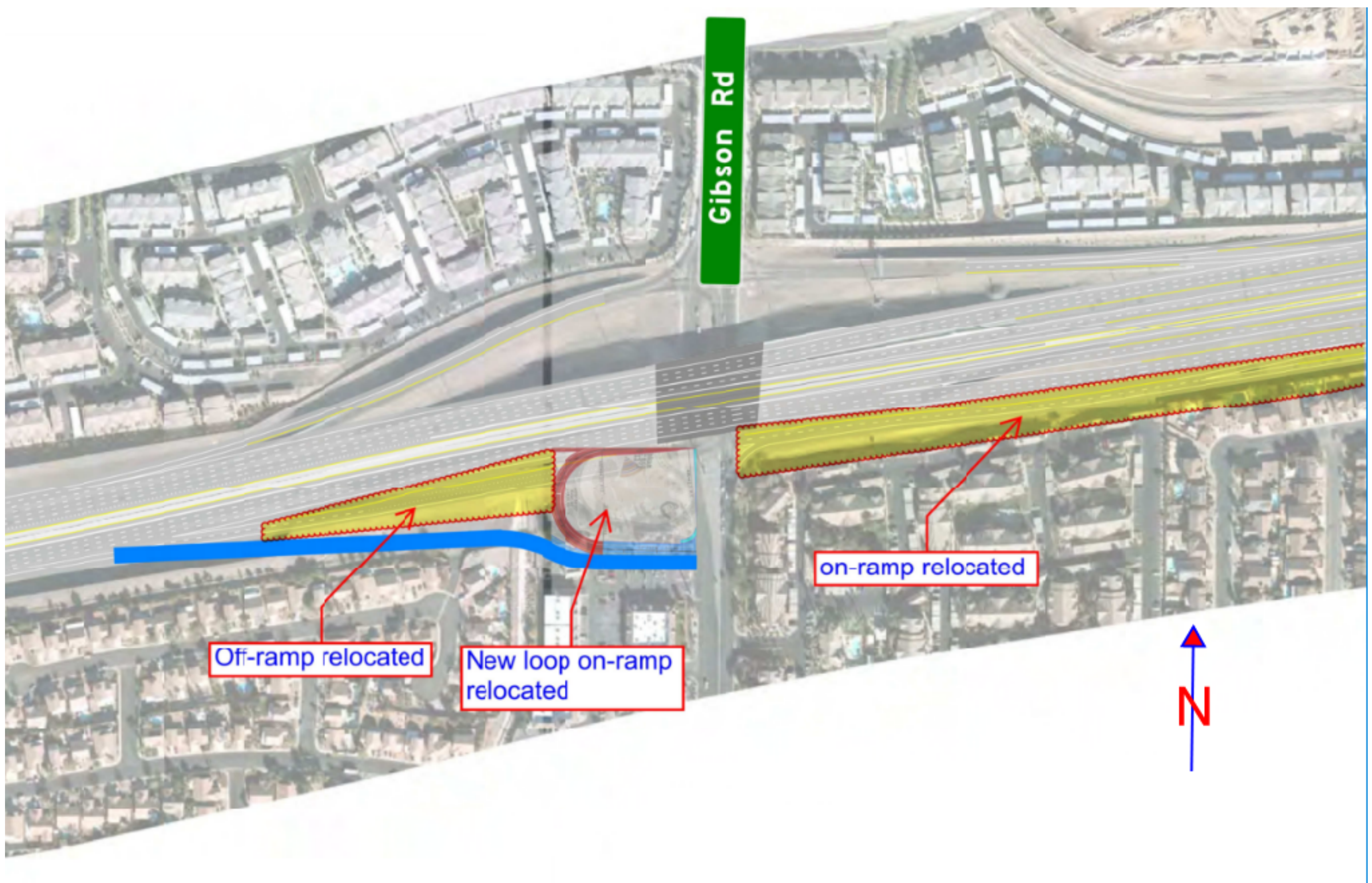
TITLE	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)

SKETCH OF BASELINE ASSUMPTION



TITLE	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)

SKETCH OF PROPOSED ALTERNATIVE



VALUE ANALYSIS PROPOSAL
IM-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure
FUNCTION	**Improve Mainline-operations**

BASELINE ASSUMPTION:

Option 2 design calls for a two-lane left-hand off-ramp from the I-515 Southbound to Lake Mead Blvd (LMB) eastbound, counter intuitive to driver expectation. The structure is currently located on the I-515 to I-11 elevated bridge connection, over the eastbound I-215 to LMB connection.

PROPOSED ALTERNATIVE:

Increase the number of lanes from the proposed 2 to 3 on the I-515 southbound to I-215 westbound ramp. Continue 2 lanes to the westbound and split two lanes off to connect to the eastbound Lake Mead Parkway (LMP) connection, tying in to LMP further to the west than the current connection, making the roadway slightly longer but at grade. This would expand the length of the crossover bridge component of the I-515 to I-11 southbound as it will crossover the new 40-foot width segment on the ramp to LMP.

BENEFITS	RISKS/CHALLENGES
● Eliminate new bridge/elevated structure in favor of a shorter near ground level ramp	● New alignment will have to fit vertically with the new structures
● Eliminate left-side diverge on I-515 mainline, shifting the diverge point to a ramp in line with driver expectation	● Addition of new tunnel to pass under the I-215 to I-515
●	● I-515 to I-215 ramp near capacity. Adding additional movements even with lane addition may cause spillback (Microsimulation required)
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$15,898,000	$0	$15,898,000
PROPOSED ALTERNATIVE:	$10,377,000	$0	$10,377,000
TOTAL (Baseline less Proposed)	$5,521,000	$0	$5,521,000
			SAVINGS

VALUE ANALYSIS PROPOSAL
IM-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure

DISCUSSION/JUSTIFICATION:

Option 1 calls for the construction of a left-side diverge from the I-515 southbound to Lake Mead Parkway (LMP). This diverging ramp is located on the I-515 southbound to I-11 southbound connection. The proposed alternative will allow removal of the currently designed left-side diverge ramp from the I-515 mainline, relocating the I-515 southbound to the Lake Mead Parkway connection ramp onto the I-515 southbound to I-215 westbound connection ramps, eliminating potential driver confusion and bringing the I-515 southbound to Lake Mead Parkway traffic to the at-grade connection sooner, potentially removing large quantities of earthwork.

The cost savings of this alternative will be directly related to the amount of earthwork or structures saved which will require a more in depth analysis than what was available during the VA study.

SPECIAL IMPLEMENTATION CONSIDERATIONS:

None apparent.

VALUE ANALYSIS PROPOSAL
IM-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure

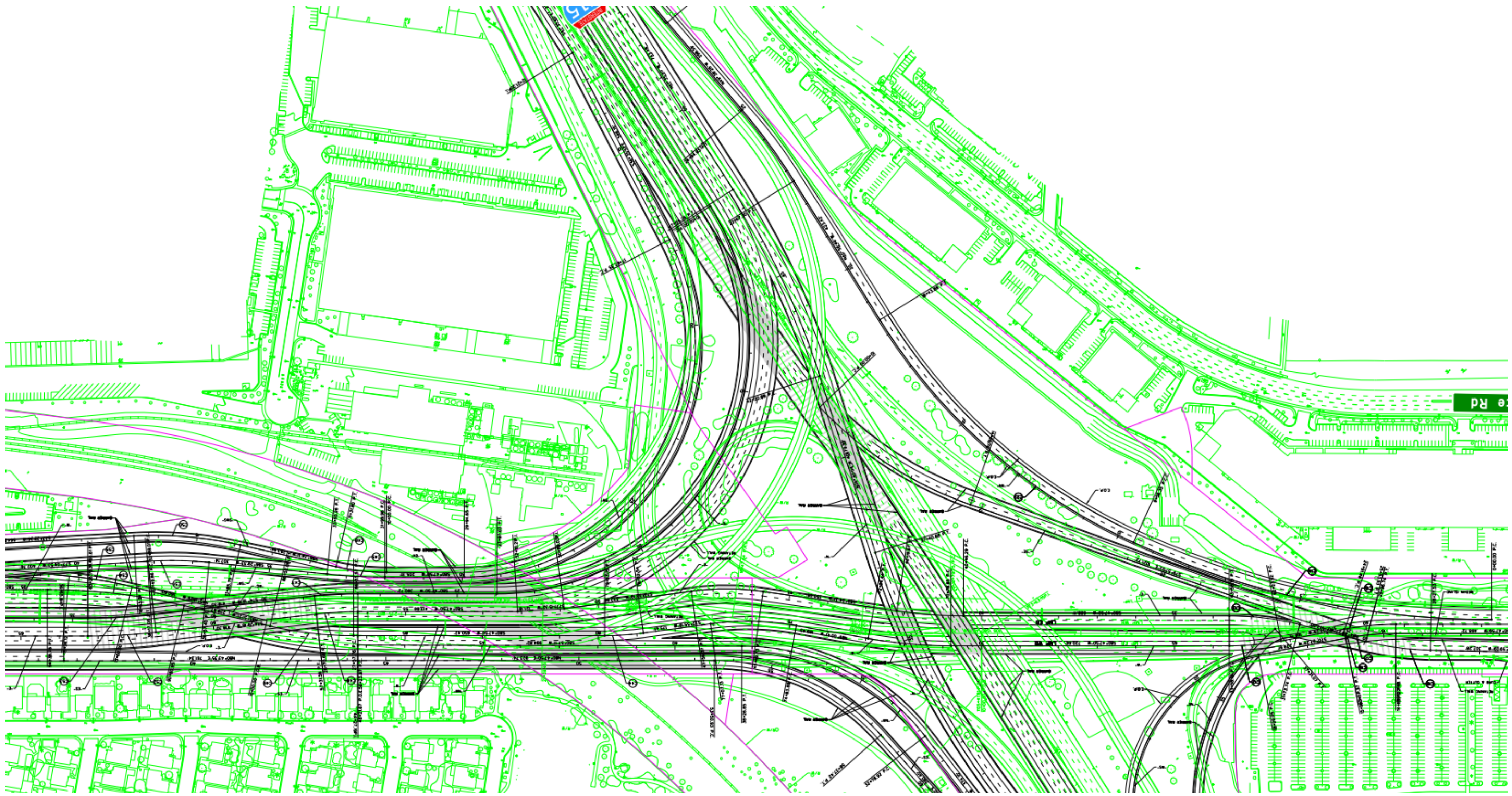
DESIGN ELEMENT	**BASELINE ASSUMPTION**				**PROPOSED ALTERNATIVE**		
Description	Unit	Qty	Unit Cost $	TOTAL $	Qty	Unit Cost $	TOTAL $
Roadway on I-11/I-515 (open drainage)	SF	13,872	$25	$346,800	13,836	$25	$345,900
Roadway on I-215 (closed drainage)	SF		$40	$0	42,800	$40	$1,712,000
Earthwork greater than 3' cut or fill	CY		$14	$0		$14	$0
Retaining wall	LF		$1,700	$0		$1,700	$0
Retaining wall	SF		$85	$0		$85	$0
Bridge - typical basic bridge	SF	60,400	$210	$12,684,000	29,880	$210	$6,274,800
Bridge - elevated/complex flyover bridge	SF		$240	$0		$240	$0
Bridge - steel bridge (western UPRR)	SF		$340	$0		$340	$0
Bridge - crossover bridge (measured as the	SF		$180	$0	960	$180	$172,800
Bridge demolition	SF		$50	$0		$50	$0
SUBTOTAL				$13,030,800			$8,505,500
Construction Engineering/ Inspection - 15%				$1,954,620			$1,275,825
Other Project Development Costs - 7%				$912,156			$595,385
TOTAL				$15,898,000			$10,377,000
						CWE (BASELINE LESS PROPOSED)	$5,521,000

Note: Total costs are rounded to the nearest thousand dollars. **SAVINGS**

VALUE ANALYSIS PROPOSAL
IM-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure

SKETCH OF BASELINE ASSUMPTION

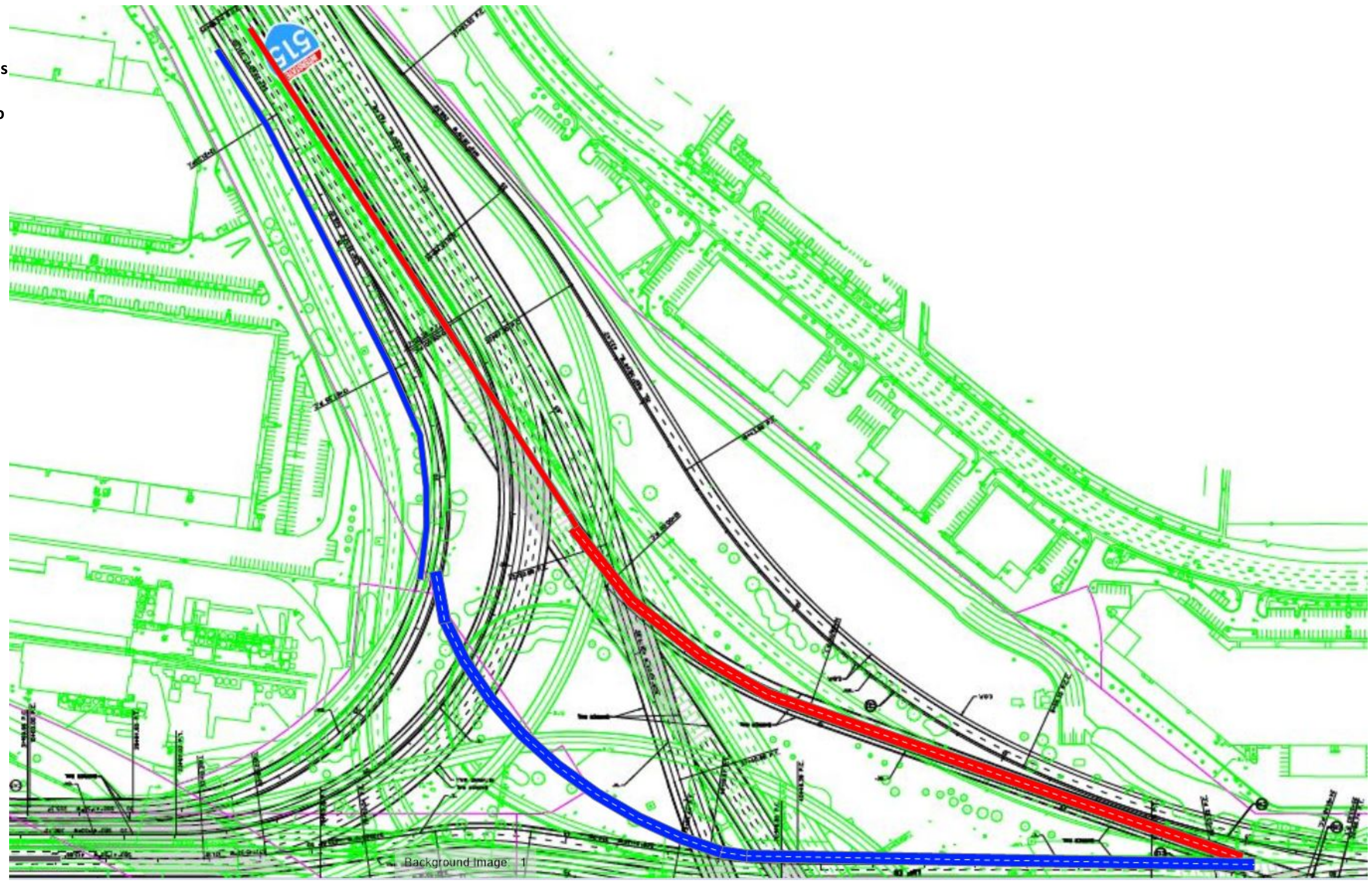


VALUE ANALYSIS PROPOSAL
IM-01
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure

SKETCH OF PROPOSED ALTERNATIVE

Blue lanes indicate alternative design. Red lanes indicate current option 1 design no longer required to be constructed.



VALUE ANALYSIS PROPOSAL
IG-10
Nevada Department of Transportation
Henderson Interchange Feasibility Study

TITLE	Options 1 & 2. Delete ramp from WB LMP to Gibson, keep existing NB I-11 to WB I-215 flyover; add Texas U-turn at Stephanie to restore access to Gibson
FUNCTION	**Improve Geometry**

BASELINE ASSUMPTION:

Option 1 includes a single lane ramp that diverges from WB LMP approximately 900 feet west of the SB I-151/I-11 mainline. The ramp goes under the SW system ramp and merges onto the right side of the SW ramp and connecting to the WB I-215 off-ramp to Gibson Rd.

PROPOSED ALTERNATIVE:

Eliminate the ramp from WB LMP to Gibson Rd and construct a Texas style U-turn. Traffic on WB I-215 could exist at the WB off-ramp to Stephanie St, utilize the U-turn and EB on-ramp from Stephanie St to proceed EB on I-215 in the auxiliary lane to Gibson Rd.

BENEFITS	RISKS/CHALLENGES
● Reduces the separate ramp from WB LMP to Gibson Rd	● This adds approximately two miles of mis-directed travel for WB LMP traffic exiting at Gibson Rd
● Potentially reduces the size/cost of the SW and NW ramp structure	● The structure for the SW and NW ramp is still required to provide grade-separation over WB LMP to WB I-215 mainline
●	● Adds additional traffic to Stephanie St interchange WB off-ramp and EB on-ramps
●	●
●	●
●	●

COST SUMMARY	Initial Costs	O&M Costs	Total Life Cycle Cost
BASELINE ASSUMPTION:	$0	$0	$0
PROPOSED ALTERNATIVE:	$0	$0	$0
TOTAL (Baseline less Proposed)	$0	$0	$0
			DROPPED

SECTION

4

SUPPORT DATA

Section 4: Support Data

Value Methodology

The value methodology (Synonyms: value analysis, value engineering and value management) is a function-oriented, systematic, team approach to add customer value to a program, facility, system, or service. Improvements like performance, quality, initial and life cycle cost are paramount in the value methodology. The workshop is conducted in accordance with the methodology as established by SAVE International, the value society, and is structured using the Job Plan as shown in the table below.

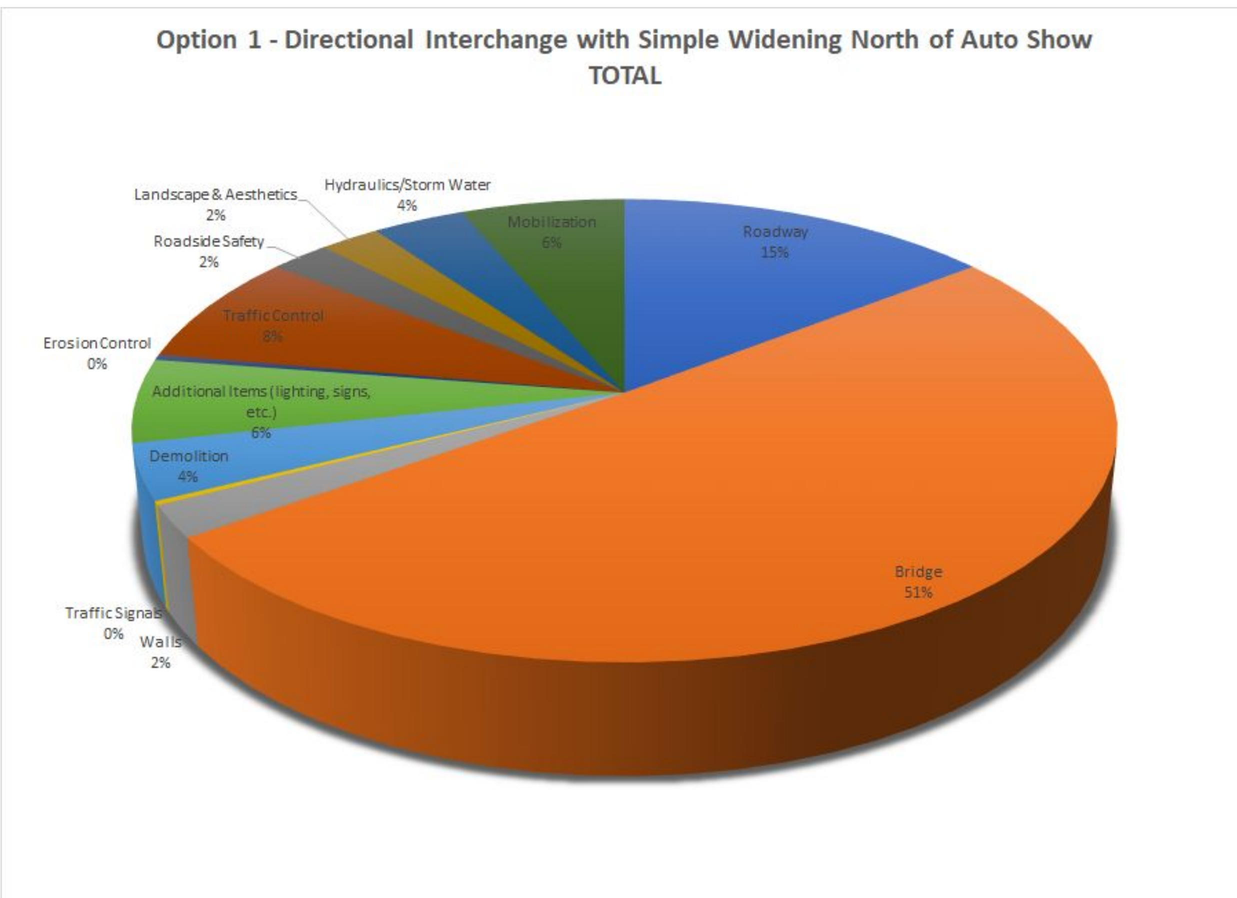
Value Methodology Stage / Phase	Objectives of this Phase	Outcomes of this Phase
Stage 1: Pre-workshop Study (Preparation)	▪ Identify study project ▪ Identify study roles and responsibilities ▪ Define study scope, goals and objectives ▪ Select team leader ▪ Conduct pre-study meeting ▪ Select value study team members ▪ Identify stakeholders, decision-makers, and technical reviewers ▪ Obtain time commitment ▪ Identify data collection ▪ Select study dates ▪ Determine study logistics, agenda ▪ Collect and distribute data ▪ Perform technology dry-run for virtual workshop ▪ Send team primer to value study team ▪ Value team members to complete Key Issues Memos (KIM)	▪ Fosters understanding of value study priorities ▪ Defines and manages expectations ▪ Organizes the value study ▪ Offers a thorough review of the project ▪ Tests meeting platform and virtual tools to maximize engagement and collaboration ▪ Primes the team for the value workshop
Stage 2: Workshop Study		
Phase 1: Information Phase	▪ Present design concept ▪ Present stakeholders' interests ▪ Review project issues and objectives ▪ Discuss deviation from design standards ▪ Define project performance metrics ▪ Discuss problems the project must solve; identify issues the design may not address ▪ Visit project site / virtual site tour	▪ Brings all value study team members to a common understanding of the project, including its challenges and constraints ▪ Establishes the benchmark for which to identify alternatives ▪ Gains a real-world perspective of the project and builds foundation for function analysis
Function Analysis Phase	▪ Identify and classify functions ▪ Apply cost and risk relative to performance ▪ Prioritize functions ▪ Select specific functions for study	▪ Provides a comprehensive understanding by focusing on what the project does rather than what it is ▪ Identifies what the project must do to satisfy needs and objectives ▪ Focuses on functions with the greatest opportunity for project improvements
Creative Phase	▪ Brainstorm to generate performance-focused ideas for alternative ways to perform functions ▪ Discuss, build-on and clarify ideas	▪ Value team develops a broad array of ideas that provides a wide variety of possible alternative components or methods to improve project value
Evaluation Phase	▪ Eliminate obvious "fatal flaw" ideas ▪ Score ideas based on meeting performance criteria, value key and project/study goals ▪ Discuss conflicting rankings, further clarify ideas and determine final rankings ▪ Discuss ideas with client and decision-makers (midpoint review) ▪ Assign alternatives for development phase	▪ Prioritizes ideas for development, focusing on those with the highest potential for performance improvement and cost savings ▪ Determine value: performance/cost ▪ Focuses team's effort to develop alternatives that best meet client study objectives
Development Phase	▪ Validate and refine idea concepts ▪ Compare to original design concept ▪ Define implementation considerations ▪ Prepare sketches and calculations ▪ Measure performance ▪ Estimate costs, life-cycle cost benefits/costs	▪ Provides side-by-side comparison of baseline and alternative—concepts, initial costs, life-cycle costs, sketches, performance metrics
Presentation Phase	▪ Present developed ideas to client, designers, decision-makers, stakeholders ▪ Document feedback ▪ Produce draft report	▪ Ensures management and other key stakeholders understand the rationale of the value alternatives and design suggestions
Stage 3: Post-workshop Study (Implementation)	▪ Document process and study findings ▪ Develop and distribute VE study summary report ▪ Review study summary report ▪ Assess alternatives for acceptance ▪ Prepare draft implementation dispositions ▪ Resolve conditionally accepted alternatives ▪ Develop implementation plan with project manager ▪ Project manager sign-off on VE implementation plan ▪ Final presentation of study results	▪ Involves those who will implement and increases likelihood of implementation ▪ Improves actual value of the project

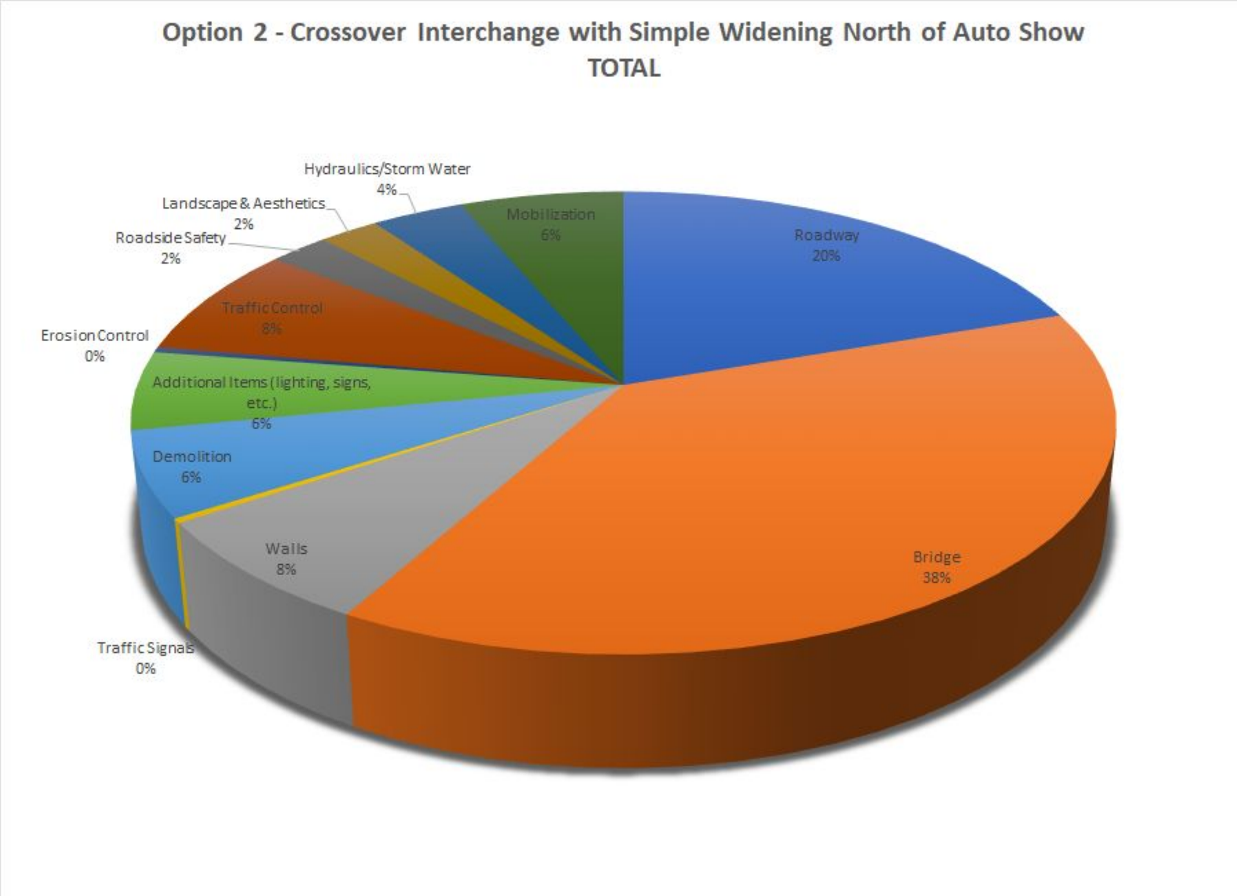
Preparation

On Tuesday, June 9, 2020, a VA workshop pre-meeting was held to perform a technology dry-run for hosting the meeting in a virtual environment; this included the introduction of the Henderson Workroom and collaboration tools that would be used during the workshop. In addition, Jim Mischler with CA Group, in an effort to "prime the pump" reviewed the resource documents available with the VA study team for their use before and during the workshop.

Information Phase

At the kickoff meeting on Monday, June 15, Jim Mischler and other representatives from CA Group, performed a virtual site tour of Build Options 1 and 2. Following the virtual site tour, cost data was discussed. A graphic representation of project costs is shown below and on the following page.





Value Study Team Observations

To close-out the Information Phase, the value study team identified key observations from their review of resource documents, virtual site tour and discussion.

- Build Option 1: I-215 EB to I-515 NB system ramp has three lanes that merge into two prior to joining I-515, at or near capacity in 2040. Would a two-lane ramp with no lane drop work better?
- Build Option 1 & 2: Lake Mead Pkwy and Eastgate Rd intersection at capacity in 2040 with concerns regarding pedestrian crossings across the widened roadway.
- Bottlenecks on I-215 EB W/O Stephanie St limit the number of vehicles processed in the model in the PM peak hour (>4,000 Latent Vehicles). This location is outside the scope of this project.
- Build Option 1 & 2: The Horizon Dr and I-11 NB and I-11 SB ramp intersections operate at LOS F during the PM peak hour.
- Build Option 1 & 2: The Eastgate Rd/Lake Mead Pkwy intersection operates at LOS F with N-S Ped Phase, LOS E without the Ped Phase. How important is the ped phase?

- Is there an opportunity to "save" existing bridges?
- Weaving appears to cause many structures. Are there ways to reduce weaving conflicts and reduce structures?
- Option 1 - Concerned about removal of structures that have many more years of life left in them.
- Option 2 is a better design; however, not in favor of taking the northbound 515 traffic to the west side of the interchange. A hybrid between Option 1 and Option 2 seems to be the best scenario
- The HOV direct connect is not required in any of our planning studies. Not in Southern Nevada Traffic Study and not in the HOV master plan. It can be removed from consideration which may give us more room for other things or opportunity to save existing structures.
- Relatively new interchange--infrastructure is in good condition. Main issues seem relatively straight forward (weaving, interchange spacing, etc) but solutions become involved and costly. Cost to please everyone (Gibson, LMP, Auto Show) substantial. Would like to look at solutions to preserve existing structures, develop options for phased approach. Intrigued by HOV improvements to help operations (looking at you EN ramp!)
- The Lake Mead Parkway to Gibson required a lot of design changes with more grade separation than the current configuration has. That connection is only predicted to service 290 vehicles at most during the PM peak hour. Option G-1 in the alternatives screen was advanced but not considered in any of the modeled options. This kept the limited access at Gibson and put a Texas U-turn at the next western interchange.
- Due to budget constraints (COVID-19), this project may not be NDOT's highest concern in the near future especially with the Downtown Access Project (DAP) and those I-515 structures in bad shape.
- So all of the analysis is for 2040 and the entire Option 1 and Option 2. We do not have information for how each of the individual improvements impacted the overall traffic operations. We also do not have any analysis but existing and 2040 which makes it challenging to discuss what elements are needed, and which ones can be deferred. This limitation is understandable, not every increment in the project development can be documented and analysis can not be conducted in five-year increments.
- Since we've already gone through this exercise once and come up with some options that are viable, and then gotten major pushback from our senior management at NDOT, we may need to modify the evaluation criteria to include a cost criteria as a more heavily weighted item.
- Option 2 advances 3 lanes from the EB to NB across the entire ramp, with Option 1 having 3 lanes tapering to 2. Could Option 2 taper to save on bridge width as well?

- It is important to maintain NDOT's ability to implement an HOV connection, don't box themselves in from future expansion. Traffic Operations will be conducting an occupancy study of the HOV lanes to determine vehicles and violator percentages to see how viable they really are in the area.
- Is there an option to just leave everything as it is but just widen to add another lane? No access changes, just one additional lane on the mainline and ramps?
- Do these alternatives meet the P&N for the project? P&N needs to be vetted through the NDOT environment to ensure all parties are on the same page.
- Option 1 probably wouldn't need a Federal Change in Control of Access. Option #2 will need FHWA HQ concurrence.
- Cost is included in the implementability element. High cost was not considered as a fatal flaw. Turns out high cost was a fatal flaw. Now we know.
- Typically our construction estimates also include the CE, so it might need to be the above the line items and the Construction Engineering cost.

Function Analysis

Function definition and analysis is the heart of Value Analysis (VA). It is the primary activity that separates VA from all other "improvement" programs. The objective of this phase is to ensure the entire team agrees upon the purposes for the project elements. Furthermore, this phase assists with development of the most beneficial areas for continuing study. The VA study team identified the functions of the Lukachukai Project using active verbs and measurable nouns. This process allowed the team to truly understand the functions associated with the project.

The value study team randomly generated functions the project must perform consist of active verbs and measurable nouns. After the functions were discussed, the functions were classified into one of three classifications: Higher Order Function, Basic Function and Secondary Function. These classifications are defined as follows:

- ***Higher Order Function:*** The specific goals for which the basic function exists; outside scope of study; what the user wants; an effect resulting from the project; not necessarily of highest importance.
- ***Basic Function:*** The specific purpose for which a project exists and conveys a sense of "need"; what the project must do; satisfies only the users' needs, not desires; answers the question, "what must it do?"
- ***Secondary Function:*** A function that supports the basic function and results from the specific design approach used to achieve the basic function; what else the project can do.

The value study team identified **Improve Mainline-operations** as the Basic Function of the project. After classifying functions, functions were identified in terms of cost and risk impacts to the project using risk discussion from the previous phase, Information, provided cost data and the value study team's expertise. Functions were prioritized for brainstorming based on factors including value study goals and objectives, high associated cost and/or high associated risk.

The Random Function Analysis Worksheet below lists the functions identified, classified, prioritized (high/medium/low cost and high/medium/low risk) and selected (highlighted rows) for brainstorming value alternatives during the next phase, Creative.

IDENTIFY FUNCTIONS		CLASSIFY FUNCTIONS	PRIORITIZE FUNCTION		
Active Verb	**Measurable Noun**	**Higher Order Basic Secondary**	**COST**	**RISK**	**SELECT FOR CREATIVE PHASE**
Manage	Traffic-Conflicts	Secondary	High		
Improve	Safety	Secondary		High	
Reduce	Congestion	Secondary			
Improve	Mainline-Operations	Basic			
Improve	Capacity	Secondary			
Reduce	Delay	Secondary			
Connect	Communities	Secondary			
Accommodate	Movement	Secondary			
Improve	Geometry	Secondary	High		YES
Improve	Access	Secondary	High		YES
Convey	Traffic	Higher Order			
Improve	Air-Quality	Secondary			
Manage	Traffic-Flow	Secondary			
Reduce	Weaving	Secondary			
Maintain	Traffic	Secondary			
Accommodate	Future-Expansion	Secondary	High		YES
Minimize	Throw-away-improvements	Secondary			
Manage	Stormwater	Secondary			
Support	Commerce	Higher Order			

IDENTIFY FUNCTIONS		CLASSIFY FUNCTIONS	PRIORITIZE FUNCTION		
Active Verb	Measurable Noun	Higher Order Basic Secondary	COST	RISK	SELECT FOR CREATIVE PHASE
Support	Economic-Activity	Higher Order			
Maintain	Access	Secondary	High		YES
Maintain	Facility	Secondary			
Preserve	Infrastructure	Secondary			
Meet	Standards	Secondary			
Meet	Budget	Secondary			
Achieve	Public-Acceptance	Secondary			

Creative Phase

The objective of the Creative Phase is to generate a large quantity of ideas on alternate ways to perform each function selected for study. It uses common brainstorming techniques, including ideation that is unconstrained by habit, tradition, negative attitudes, assumed restrictions, and specific criteria. No judgment takes place during this phase of the study, though ideas are discussed for clarification purposes.

What makes the Creative Phase of the value methodology successful is for the team not to conceive ways to design a project, but to develop ways to perform the functions selected for study. Past experience is combined and recombined to form new combinations that will perform the desired functions, regardless of what is included in the original project concept, and improve the value of the project compared to what was originally considered attainable.

The list of ideas is shown below and on the following pages

Idea No.	Idea Title
IG	**Improve Geometry**
IG-01	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment
IG-02	Option 2. Use some of the existing structures (NB I-515 and I-11 over Lake Mead Parkway) to remove 3 structures; maintain existing profile as much as possible

Idea No.	Idea Title
IG-03	Option 2. NB I-11 exit to Lake Mead Parkway (LMP) exit, improve forced merge onto LMP
IG-04	Realign EN/ES ramps by pulling those off I-215 west of Gibson to eliminate weave of Gibson EB traffic
IG-05	Option 2. NB I-11 to Gibson off ramp creates a complicated weave; eliminate or improve by only allowing 1100' to cross 3 lanes of traffic
IG-06	Option 2. Realign WB LMP to SB I-11 so it creates a right-hand merge
IG-07	Option 2. Locate the NB directly above the SB approach to reduce the footprint
IG-08	Option 1. Regarding traffic demand, concern with the weave with the Gibson on ramp EB 215 to NB I-11; only 830' to get over 3 lanes of traffic; potential breakdown of mainline operations
IG-09	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)
IG-10	Options 1 & 2. Delete ramp from WB LMP to Gibson, keep existing NB I-11 to WB I-215 flyover; add Texas U-turn at Stephanie to restore access to Gibson
IG-11	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-515 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway
IG-12	Lower design speeds for smaller radius ramp curves (optimize radius design accordingly)
IG-13	Increase design speeds for larger radius ramp curves (optimize radius design accordingly)
IG-14	Option 2. LMP, was there a reason for the tighter curves for EB and WB just west of the I-11 mainline; straighten out to avoid footprint over existing ground level roads
IG-15	Option 2. There is a lot of room to work with on the south side of the existing interchange; shift LMP south to get out of the existing infrastructure and potential construction impacts, vertical profiles, etc.
IG-16	Have ES/EN as left exists or the "thru" EB movements, and have the lanes to EB LMP continue through on the right
IG-17	Option 1. The Gibson on-ramp to EB LMP acceleration lane appears to be only 500' long, which would meet a 40 mph design speed. Is this appropriate for the 2040 volume?
IG-18	Option 1. The Gibson EB I-215 to LMP accel lane appears to be 500' this is a 40 MPH design. Is this appropriate for the traffic volume?

Idea No.	Idea Title
IG-19	Keep the Gibson EB I-215 slip lane on the south side of I-215 and swing it back in somewhere around the interchange to eliminate the bridge
IG-20	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp
IG-21	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515
IG-22	Option 1. Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)
IG-23	Option 1. Shift the I-215 EB diverge for north/south movements to I-515 & I-11 further east to allow more merging area from the Gibson on-ramp, tighten ramp radii based on offset shortening structure length
IG-24	There should be a 3rd option that is brought forward into the NEPA process that maintains some of the existing structures and still meets the P&N. NEPA process prefers 3 options with a No Build alternative. Two alternatives can be brought into the NEPA process but if either option is not feasible then a No Build alternative can be the chosen alternative.
IG-25	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated
IG-26	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)
IG-27	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto the mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design
IG-28	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps
IC	**Improve Capacity (reduce congestion, reduce delay, improve safety)**
IC-01	Introduce HOV connectors for EN/SW movements to add relief/capacity and act as third lanes; preserves existing bridges (2 lanes)
IC-02	Use ramp metering
IC-03	Options 1 & 2. Identify bottleneck locations that limit capacity

Idea No.	Idea Title
IC-04	Change Gibson Interchange to a diverging diamond (DDI) to improve capacity
IC-05	Use DDIs for intersections with heavy left-turn volumes; would need the turning movement counts at the intersection
IC-06	Have grade separation for Fiesta Henderson to Las Palmas Blvd (i.e., UPRR trail grade separation); would provide community connectivity to and reduce freeway congestion
IC-07	Option 1. Eliminate lane drop on EB to NB ramp, merge all three lanes onto NB I-515
IC-08	Delay and speed breakdown of all sections would be helpful in general; ramps and weaving area if possible
IC-09	Option 2. Bring EB Gibson traffic to NB I-515 under the existing I-515 bridges and then bring them on with the WB LMP to NB I-515 traffic; envisioning this with a hybrid concept that only uses a crossover for I-215/LMP but not I-11/I-515
IC-10	Extending the EB Gibson Ramp further east and tie it into LMP under the I-515 structure
IC-11	High capacity Texas U-turn at Stephanie and eliminate EB on-ramp/WB off-ramp at Gibson
IC-12	Change WB Gibson off-ramp to a button hook to provide additional spacing between I-215/I-515 and Gibson Interchange
IC-13	Eliminate the placeholder median area for the future HOV and build there now
IA	**Improve Access (re-establish access at Gibson and/or Auto Show)**
IA-01	Pull NB off-ramp to Auto Show further south, merge off-ramp with EB to NB flyover ramp to allow access from EB I-215 to Auto Show Drive
IA-02	Move the Gibson on- and off-ramps from the outside (right side ramps) to the inside (left side ramps) ramps, restoring all four connections to Gibson
IA-03	Option 1. Split the Gibson EB ramps so the LMP access is from the left and I-515/I-11 is in the traditional location
IA-04	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV connection shown in the current Southern Nevada HOV Plan; this would shorten the flyover ramp considerably
IA-05	Build a different direct access road from Lake Mead to Gibson that does not impact the Interstate
IA-06	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)

Idea No.	Idea Title
MA	**Maintain Access**
MA-01	The Gibson Road EB on and WB off are relatively low volume; kill those movements (but maintain access to LMP); shift EB I-215 to the south and use the median for Gibson access to LMP
MA-02	Set Lake Mead Parkway into the median similar to HOV lanes with the terminus at Gibson between the EB and WB bridges; maintain access on the right of the EB structure to I-515/I-11 and access right of the WB structure from I-215/I-515
IM	**Improve Mainline-operations**
IM-01	Option 2. Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure
IM-02	General concept: Phased approach to the design. Determine which ramp improvements have the most effect on delay (I-215 has highest volumes) and which can utilize the most existing structures. Limit improvements to these areas and determine if capacity is the more important aspect of the project versus connectivity given the limited resources
IM-03	Eliminate ramps at the Gibson-LMP connection
IM-04	Ensure 4500 feet from the I-11 CL to Gibson CL and 5400 feet from the Gibson CL to Stephanie CL, so we are close to a mile spacing
IM-05	Consolidate Gibson and Stephanie interchanges into one interchange to remove the interchange spacing issue between I-215/515 and Gibson
AF	**Accommodate Future-expansion**
AF-01	Future Connections: The Southern Nevada HOV Study shows HOV on the I-515 and I-215, but not on I-11 or LMP with no flyover ramp connecting I-215 to I-515. So if HOV ends at the Henderson Interchange, we don't need to preserve future HOV alignments through the interchange unless the future network is changing. What savings are there if the EB/WB and NB/SB alignments can be tightened with a narrower median? I am an HOV advocate, so the real answer is connecting the I-215 and I-515 but that is not shown in the plan.

Evaluation Phase

The VE team members evaluated the ideas using a simultaneous, two-step process. The first step, to shorten the list, identified ideas that scored as follows:

Evaluation Score	**Definition**	**Key**
Out-of-Scope	Not part of this project	O/S
Already Being Done	Included in the baseline project	ABD
Design Comment	Stand-alone comment that needs no further explanation; a list of these will be given to the design team	DC
Design Suggestion	More than a DC, requires further explanation	DS
Fatal Flaw	Violates a code or standard	FF

This first step evaluation scored the ideas as appropriate to eliminate them from further evaluation. The second step scored the ideas using the Value Relationship Key along with the idea's alignment with previously identified project goals, functions and performance criteria. The prioritization for further development and documentation is as follows:

The second step scored the remaining ideas using the Value Relationship Key along with the idea's alignment with previously identified project goals, functions and performance criteria. The prioritization for further development and documentation is as follows:

Score =

- 5 – Great Value meeting the criteria (Workbook)
- 4 – Good Value meeting the criteria (Workbook)
- 3 – Moderate Value meeting the criteria (No Workbook)
- 2 – Poor Value (No Workbook)

Rating

Value Relationship	Value (Function / Cost)				
5. Great Opportunity	F C--	F+ C--	F++ C	F++ C-	F++ C+
4. Good Opportunity	F- C--	F C--	F+ C	F+ C-	F++(*) C++
3. Moderate Value	F-- C-	F- C-	F++(*) C++		
2. Poor Value	F-- C	F-- C--	F C+	F C++	F++(*) C++
1. Unacceptable Impacts/Fatal Flaw					

****Is the Function improved to the point that it overcomes the high cost?***

VALUE CUE KEY – MAGNITUDE OF CHANGE

F = No impact to function	C = No impact to cost
F- = Small negative impact to function	C- = Small decrease in cost
F-- = Large negative impact to function	C-- = Large decrease in cost
F+ = Small increase in function	C+ = Small increase in cost
F++ = Large increase in function	C++ = Large increase in cost

Idea No.	Idea Title	Score
IG	**Improve Geometry**	
IG-01	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment	4
IG-02	Option 2. Use some of the existing structures (NB I-515 and I-11 over Lake Mead Parkway) to remove 3 structures; maintain existing profile as much as possible	3
IG-03	Option 2. NB I-11 exit to Lake Mead Parkway (LMP) exit, improve forced merge onto LMP	DC
IG-04	Realign EN/ES ramps by pulling those off I-215 west of Gibson to eliminate weave of Gibson EB traffic	2

Idea No.	Idea Title	Score
IG-05	Option 2. NB I-11 to Gibson off ramp creates a complicated weave; eliminate or improve by only allowing 1100' to cross 3 lanes of traffic	DC
IG-06	Option 2. Realign WB LMP to SB I-11 so it creates a right-hand merge	w/IG-27
IG-07	Option 2. Locate the NB directly above the SB approach to reduce the footprint	w/IG-01
IG-08	Option 1. Regarding traffic demand, concern with the weave with the Gibson on ramp EB 215 to NB I-11; only 830' to get over 3 lanes of traffic; potential breakdown of mainline operations	DC
IG-09	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)	4
IG-10	Options 1 & 2. Delete ramp from WB LMP to Gibson, keep existing NB I-11 to WB I-215 flyover; add Texas U-turn at Stephanie to restore access to Gibson	2
IG-11	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-515 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway	4
IG-12	Lower design speeds for smaller radius ramp curves (optimize radius design accordingly)	DC
IG-13	Increase design speeds for larger radius ramp curves (optimize radius design accordingly)	DC
IG-14	Option 2. LMP, was there a reason for the tighter curves for EB and WB just west of the I-11 mainline; straighten out to avoid footprint over existing ground level roads	DC
IG-15	Option 2. There is a lot of room to work with on the south side of the existing interchange; shift LMP south to get out of the existing infrastructure and potential construction impacts, vertical profiles, etc.	w/IG-27
IG-16	Have ES/EN as left exists or the "thru" EB movements, and have the lanes to EB LMP continue through on the right	w/IG-11
IG-17	Option 1. The Gibson on-ramp to EB LMP acceleration lane appears to be only 500' long, which would meet a 40 mph design speed. Is this appropriate for the 2040 volume?	DC
IG-18	Option 1. The Gibson EB I-215 to LMP accel lane appears to be 500' this is a 40 MPH design. Is this appropriate for the traffic volume?	DC
IG-19	Keep the Gibson EB I-215 slip lane on the south side of I-215 and swing it back in somewhere around the interchange to eliminate the bridge	w/IG-06

Idea No.	Idea Title	Score
IG-20	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp	4
IG-21	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515	4
IG-22	Option 1. Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)	4
IG-23	Option 1. Shift the I-215 EB diverge for north/south movements to I-515 & I-11 further east to allow more merging area from the Gibson on-ramp, tighten ramp radii based on offset shortening structure length	4
IG-24	There should be a 3rd option that is brought forward into the NEPA process that maintains some of the existing structures and still meets the P&N. NEPA process prefers 3 options with a No Build alternative. Two alternatives can be brought into the NEPA process but if either option is not feasible then a No Build alternative can be the chosen alternative.	C
IG-25	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated	4
IG-26	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)	5
IG-27	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto the mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design	5
IG-28	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps	4
IC	**Improve Capacity**	
IC-01	Introduce HOV connectors for EN/SW movements to add relief/capacity and act as third lanes; preserves existing bridges (2 lanes)	3
IC-02	Use ramp metering	DC
IC-03	Options 1 & 2. Identify bottleneck locations that limit capacity	DC
IC-04	Change Gibson Interchange to a diverging diamond (DDI) to improve capacity	OS

Idea No.	Idea Title	Score
IC-05	Use DDIs for intersections with heavy left-turn volumes; would need the turning movement counts at the intersection	OS
IC-06	Have grade separation for Fiesta Henderson to Las Palmas Blvd (i.e., UPRR trail grade separation); would provide community connectivity to and reduce freeway congestion	2
IC-07	Option 1. Eliminate lane drop on EB to NB ramp, merge all three lanes onto NB I-515	w/IG-22
IC-08	Delay and speed breakdown of all sections would be helpful in general; ramps and weaving area if possible	w/IC-03
IC-09	Option 2. Bring EB Gibson traffic to NB I-515 under the existing I-515 bridges and then bring them on with the WB LMP to NB I-515 traffic; envisioning this with a hybrid concept that only uses a crossover for I-215/LMP but not I-11/I-515	w/IG-27
IC-10	Extending the EB Gibson Ramp further east and tie it into LMP under the I-515 structure	w/IG-27
IC-11	High capacity Texas U-turn at Stephanie and eliminate EB on-ramp/WB off-ramp at Gibson	w/IG-10
IC-12	Change WB Gibson off-ramp to a button hook to provide additional spacing between I-215/I-515 and Gibson Interchange	w/IG-09
IC-13	Eliminate the placeholder median area for the future HOV and build there now	w/IG-27
IA	**Improve Access (re-establish access at Gibson and/or Auto Show)**	
IA-01	Pull NB off-ramp to Auto Show further south, merge off-ramp with EB to NB flyover ramp to allow access from EB I-215 to Auto Show Drive	2
IA-02	Move the Gibson on- and off-ramps from the outside (right side ramps) to the inside (left side ramps) ramps, restoring all four connections to Gibson	w/IA-03
IA-03	Option 1. Split the Gibson EB ramps so the LMP access is from the left and I-515/I-11 is in the traditional location	w/IG-11
IA-04	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV connection shown in the current Southern Nevada HOV Plan; this would shorten the flyover ramp considerably	4
IA-05	Build a different direct access road from Lake Mead to Gibson that does not impact the Interstate	DC
IA-06	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)	4

Idea No.	Idea Title	Score
MA	**Maintain Access**	
MA-01	The Gibson Road EB on and WB off are relatively low volume; kill those movements (but maintain access to LMP); shift EB I-215 to the south and use the median for Gibson access to LMP	w/IA-03
MA-02	Set Lake Mead Parkway into the median similar to HOV lanes with the terminus at Gibson between the EB and WB bridges; maintain access on the right of the EB structure to I-515/I-11 and access right of the WB structure from I-215/I-515	w/IA-03
IM	**Improve Mainline-operations**	
IM-01	Option 2. Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure	4
IM-02	General concept: Phased approach to the design. Determine which ramp improvements have the most effect on delay (I-215 has highest volumes) and which can utilize the most existing structures. Limit improvements to these areas and determine if capacity is the more important aspect of the project versus connectivity given the limited resources	DC
IM-03	Eliminate ramps at the Gibson-LMP connection	w/other IC alternatives
IM-04	Ensure 4500 feet from the I-11 CL to Gibson CL and 5400 feet from the Gibson CL to Stephanie CL, so we are close to a mile spacing	DC
IM-05	Consolidate Gibson and Stephanie interchanges into one interchange to remove the interchange spacing issue between I-215/515 and Gibson	w/other IC alternatives
AF	**Accommodate Future-expansion**	
AF-01	Future Connections: The Southern Nevada HOV Study shows HOV on the I-515 and I-215, but not on I-11 or LMP with no flyover ramp connecting I-215 to I-515. So if HOV ends at the Henderson Interchange, we don't need to preserve future HOV alignments through the interchange unless the future network is changing. What savings are there if the EB/WB and NB/SB alignments can be tightened with a narrower median? I am an HOV advocate, so the real answer is connecting the I-215 and I-515 but that is not shown in the plan.	DC

Development Phase

The objective of the Development Phase is to credibly document the details of those ideas selected during the Evaluation Phase as having the most potential to improve the value of the project. Ideas that received the highest scores were developed into Value Analysis Proposals. Please see Section 3, Value Analysis Workbooks..

Presentation Phase

The objective of the presentation phase is to put forward the results of the VA study. This involves a live oral presentation to the study stakeholders and decision makers followed by a complete written report documenting the study. During the live presentation, the VA study team highlighted aspects of featured VA Proposals, providing an opportunity for discussion and/or clarification of the concepts presented. This report has been created to document the VA study.

On Thursday, June 18, 2020, an out-brief presentation was given to representatives from NDOT, FHWA and the CA Group design team. A copy is included for reference.

PLEASE NOTE THAT THE FOLLOWING OUT-BRIEF PRESENTATION WAS GIVEN ON JUNE 18, 2020. INFORMATION CONTAINED THEREIN MAY DIFFER FROM WHAT IS PRESENTED IN EARLIER SECTIONS OF THIS REPORT THAT HAVE BEEN MORE FULLY VETTED POST-WORKSHOP.

Value Study

OUT-BRIEF PRESENTATION

Henderson Interchange Feasibility VA Study

Virtual Workshop

18 June 2020
1230 PDT

Value Study Team

- Jeff Bickett (NDOT) – VA Team Member
- Michael Taylor (NDOT) – VA Team Member
- Lynnette Russel (NDOT) – VA Team Member
- Shawn Paterson (NDOT) – VA Team Member
- Brian Deal (NDOT) – VA Team Member
- Jacob Waclaw (FHWA) – VA Team Member
- Chris Petersen (CA Group) – VA Team Member
- Steve Bird (CA Group) – VA Team
- Dave Sabers (CA Group) – VA Team
- Kaitlyn Stewart (RHA) – Technical Assistant
- Pat Miller (RHA) - Facilitator

Project Overview – Option 1

Project Overview – Option 2

Value Methodology Job Plan

Adding Value. Enhancing Ideas.

Information – Analyze Information

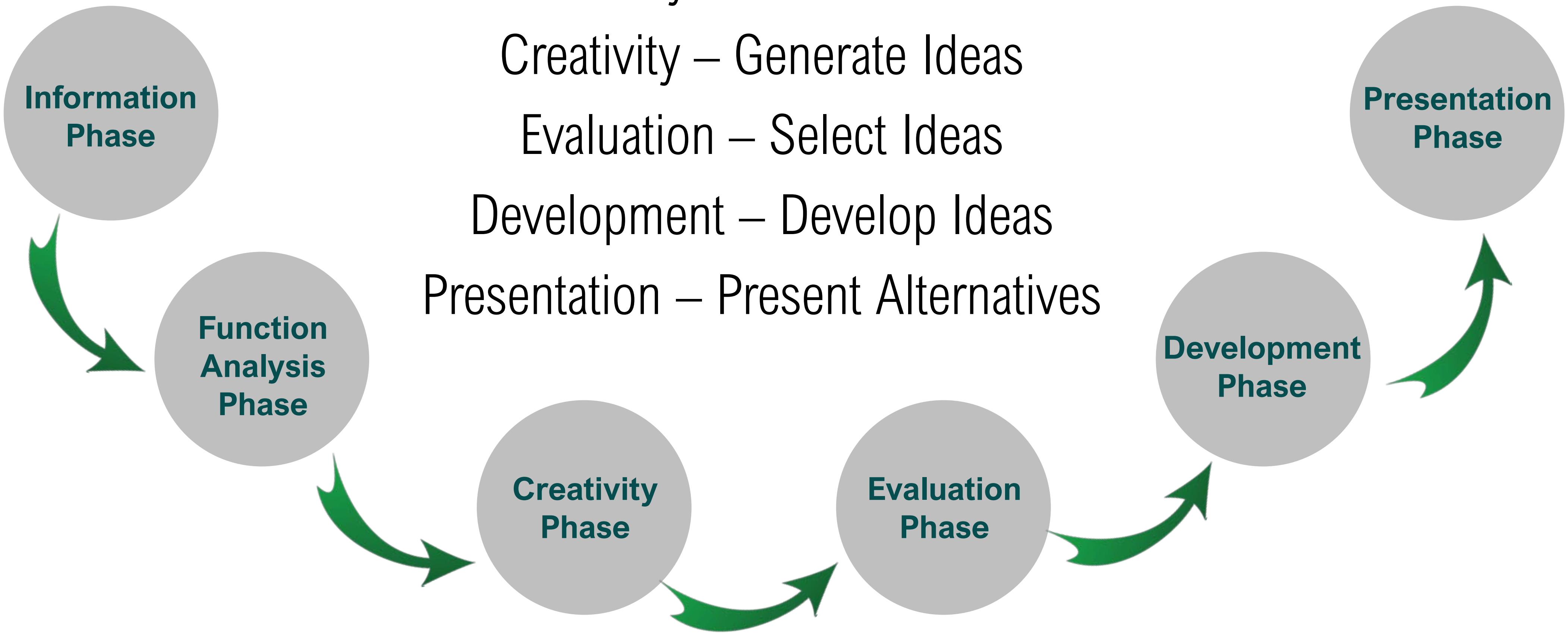
Function Analysis – Define Functions

Creativity – Generate Ideas

Evaluation – Select Ideas

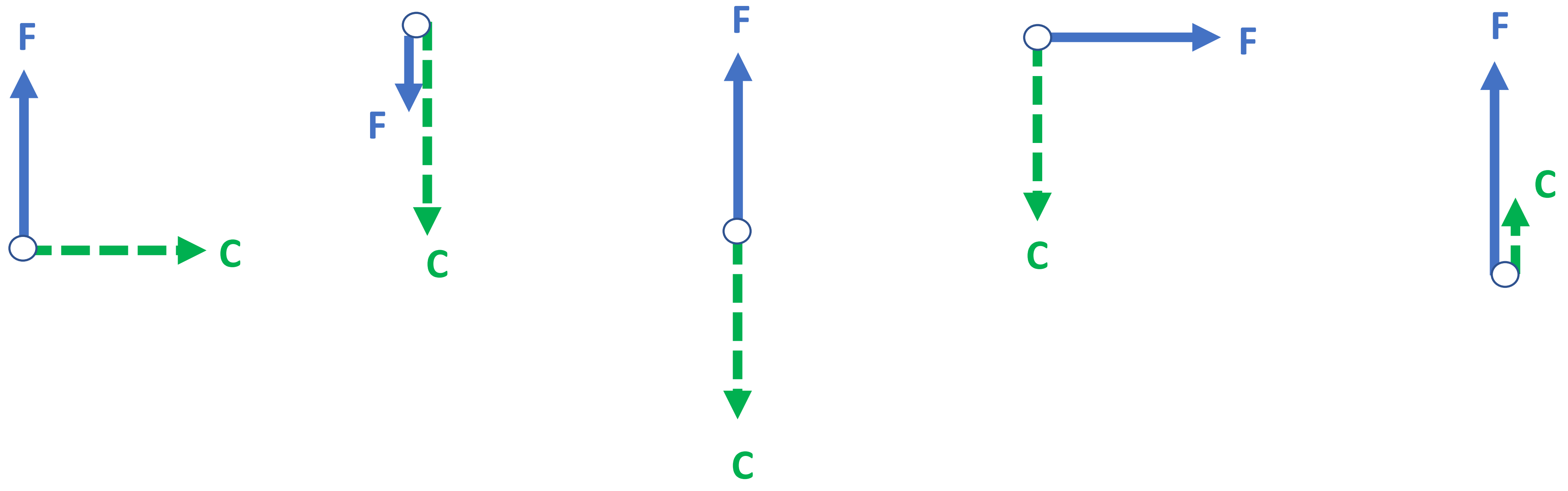
Development – Develop Ideas

Presentation – Present Alternatives



Value Defined

$$\text{Value} = \frac{\text{Function}}{\text{Cost}}$$



Project Goals

- Satisfy purpose and need at the most efficient cost
- Resolve existing roadway deficiencies (Purpose)
- Provide transportation improvements to serve existing and future growth areas (Purpose)
- Restore local traffic connectivity (Purpose)
- Accommodate regional and local plans

Workshop Objectives

- Validate that the best possible project at the most efficient cost is achieved through value analysis
  - Identify value alternatives for consideration in the next phase of design development
  - Consider effective and efficient use of scarce funding resources

Performance Considerations

Project Functions

Brainstormed alternatives to baseline by key (combination of cost and risk) functions that support the Basic Function—

Basic Function (What must this project do?):

Improve Mainline-Operations

HOW?

Manage Traffic-Conflicts

Improve Geometry

Improve Access

Accommodate Future-Expansion

Maintain Access

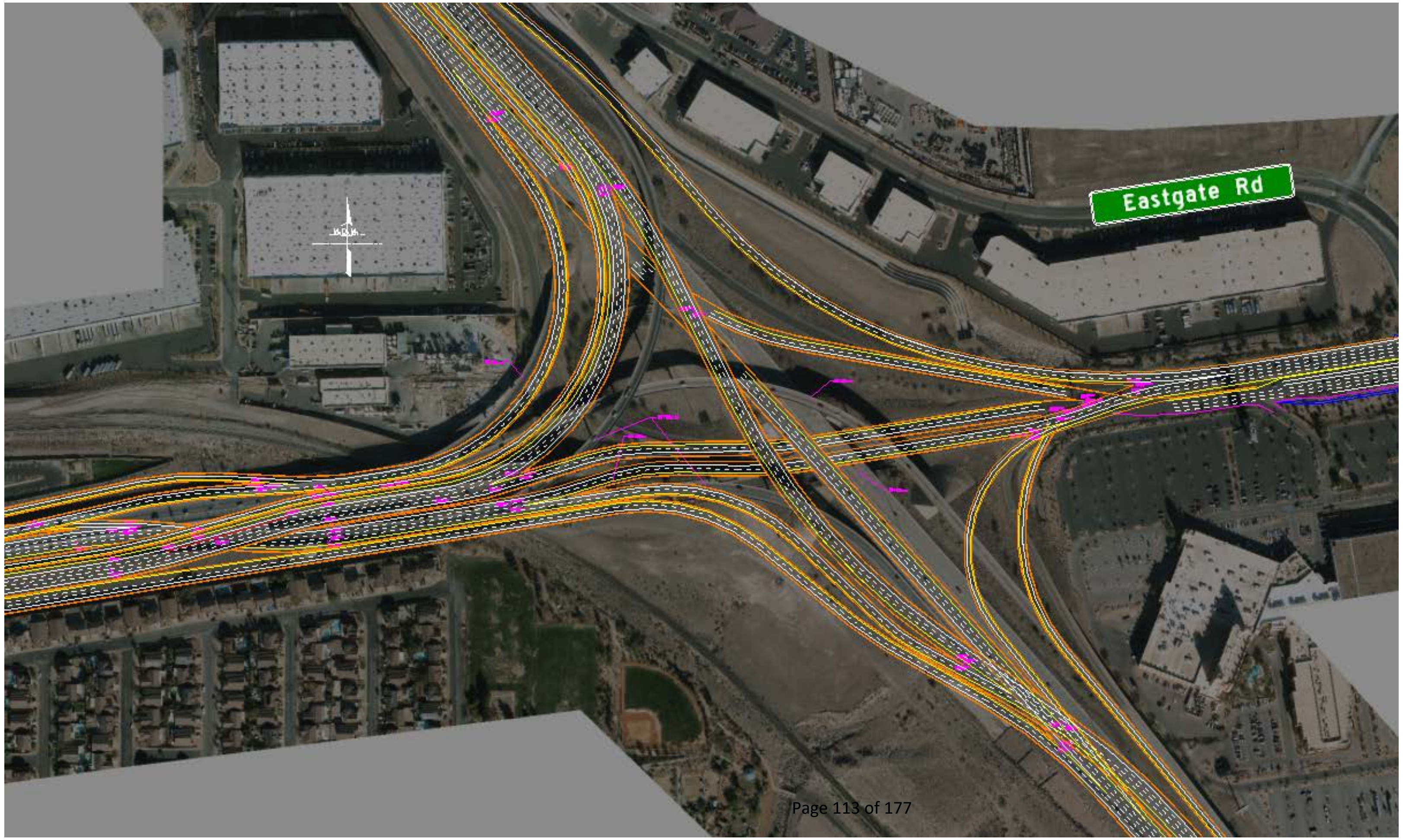
Creative Ideas

- 55 Ideas Brainstormed

  - 15 Value Alternatives developed, costed
  - 1 Design Suggestion developed, not costed
  - 15 Design Comments identified

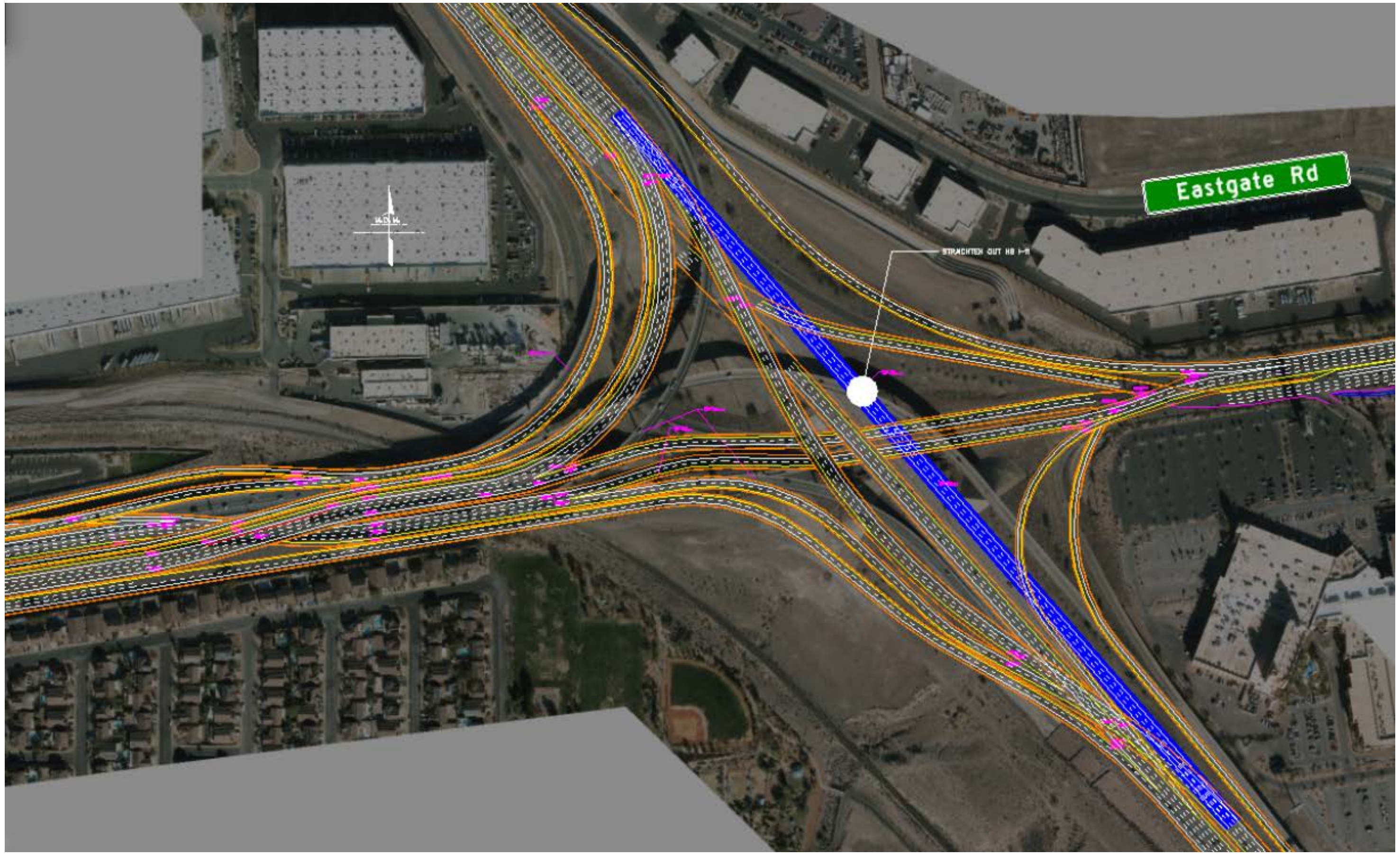
Value Alternatives

IG-01 Option 2. The baseline I-11 northbound alignment diverges and is relocated on the westside of existing I-11. This alternative proposes to re-align the northbound alignment back in its current alignment.



BASELINE ASSUMPTION

IG-01 Option 2. The baseline I-11 northbound alignment diverges and is relocated on the westside of existing I-11. This alternative proposes to re-align the northbound alignment back in its current alignment.



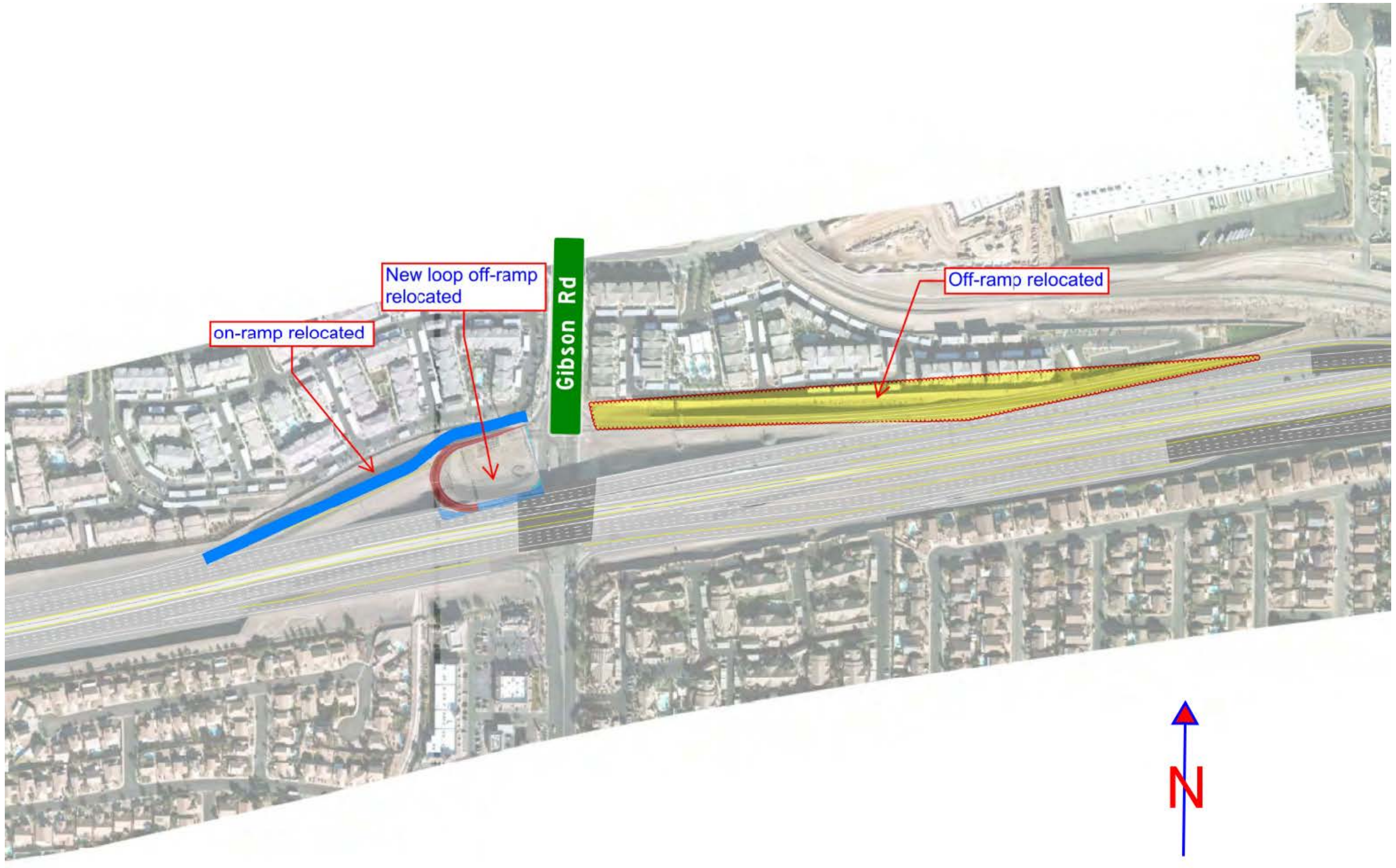
Avoids Cost: $15.7M

PROPOSED ALTERNATIVE

IG-09 Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)

BASELINE ASSUMPTION

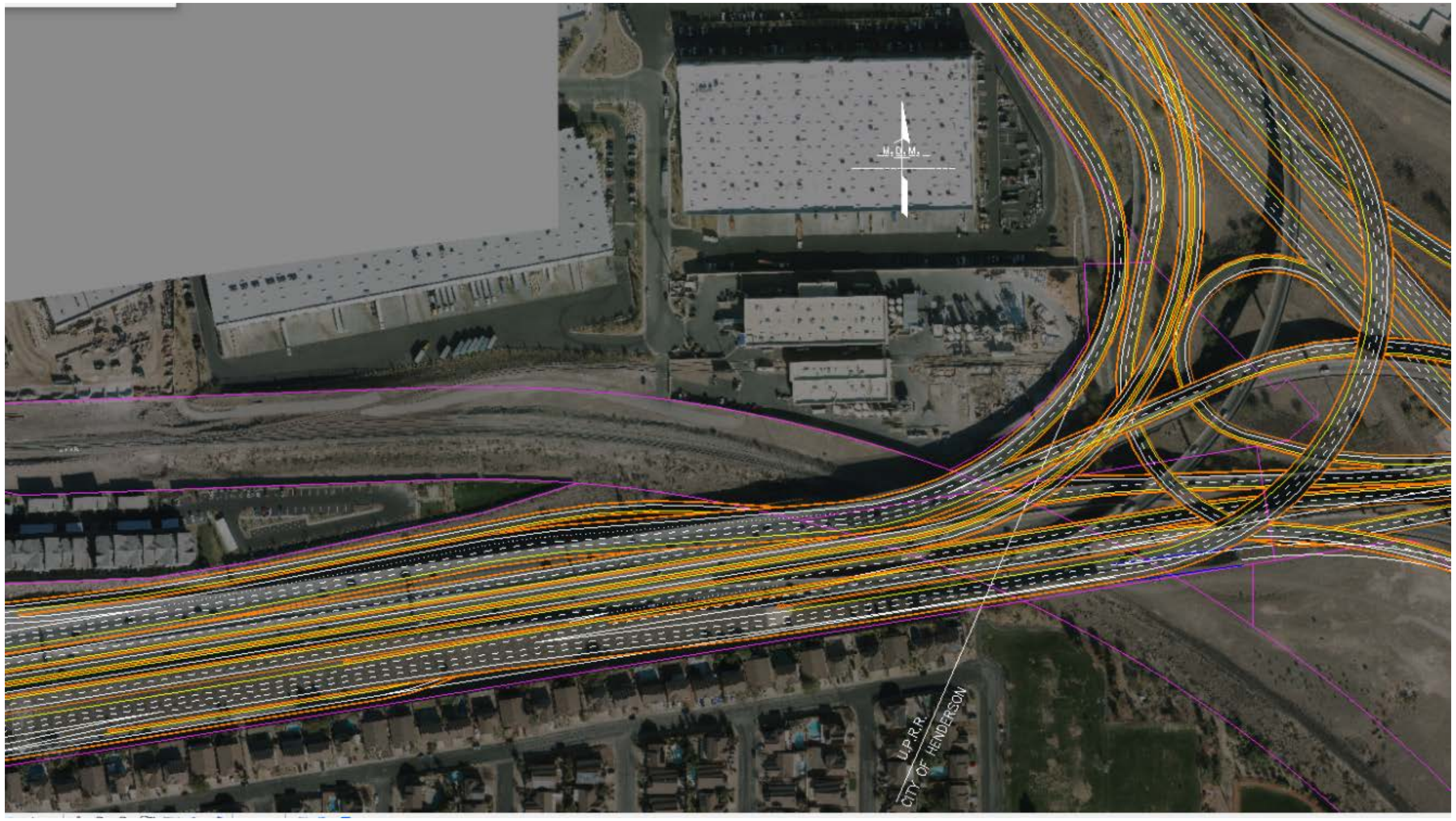
IG-09 Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)



Avoids Cost: $0

PROPOSED ALTERNATIVE

IG-11 Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB 215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over LMP



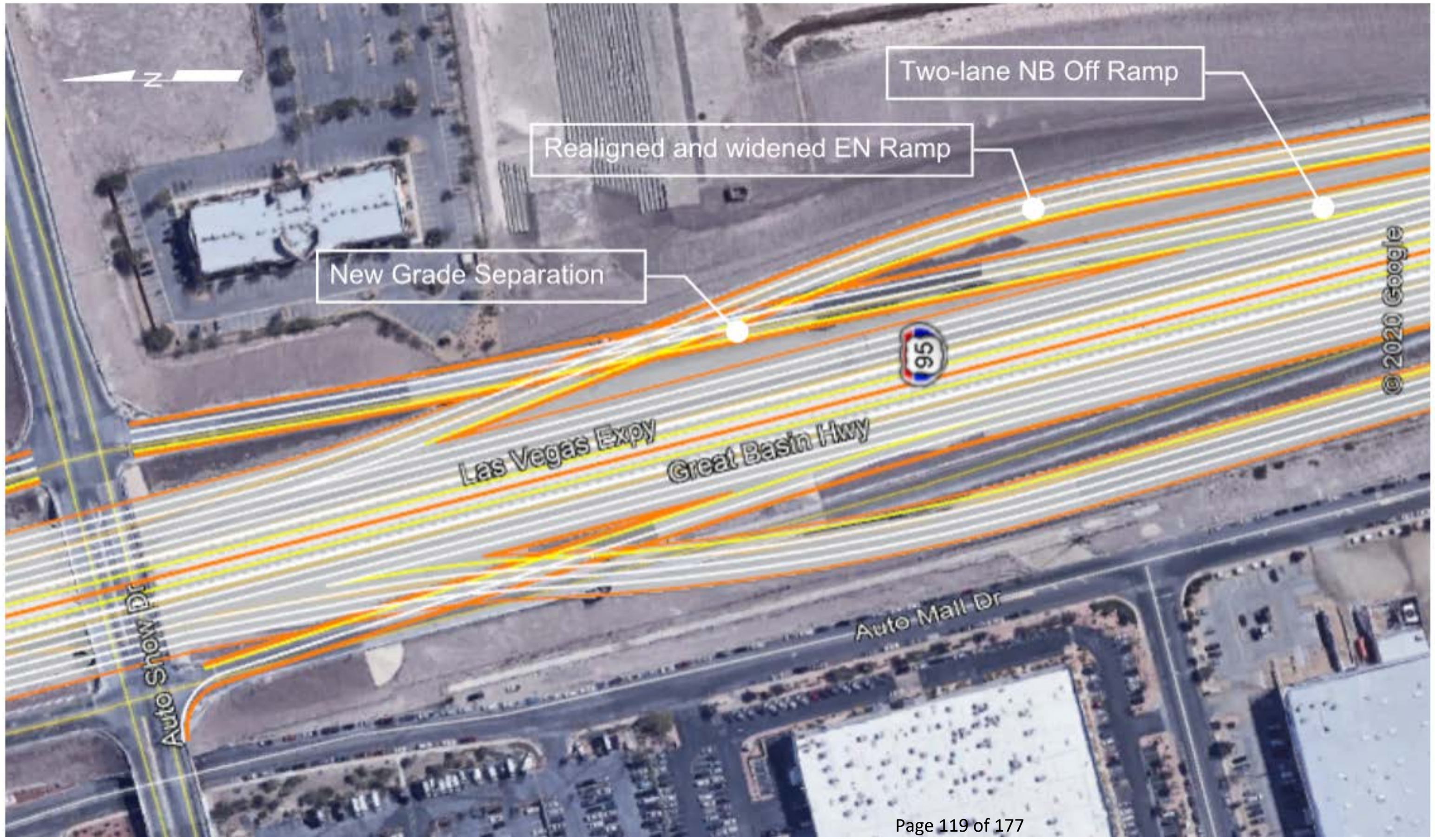
BASELINE ASSUMPTION

IG-11 Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-11 a left-hand exit and move the EB 215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over LMP

Avoids Cost: $28.9M

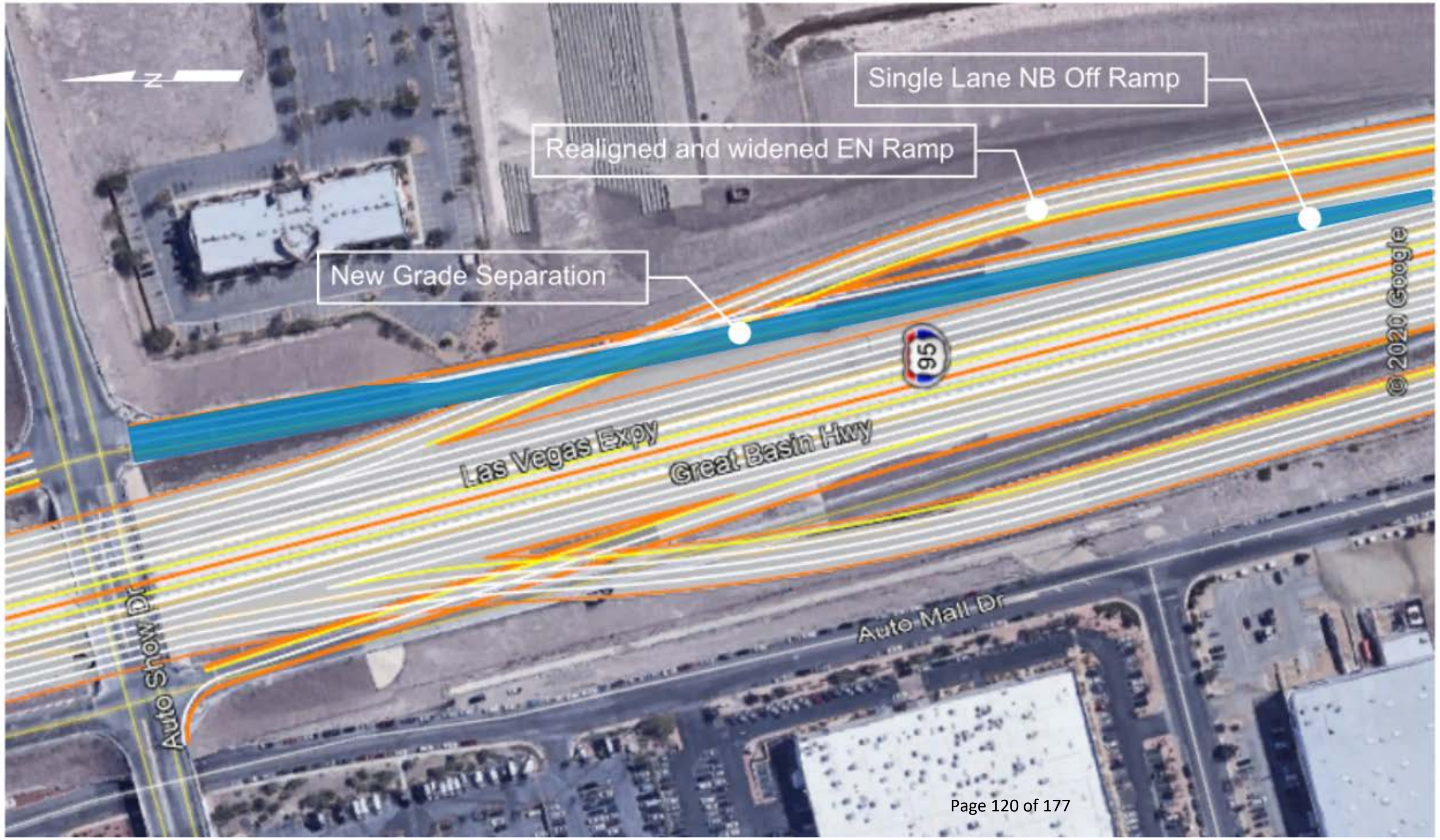
PROPOSED ALTERNATIVE

IG-20 Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp



BASELINE ASSUMPTION

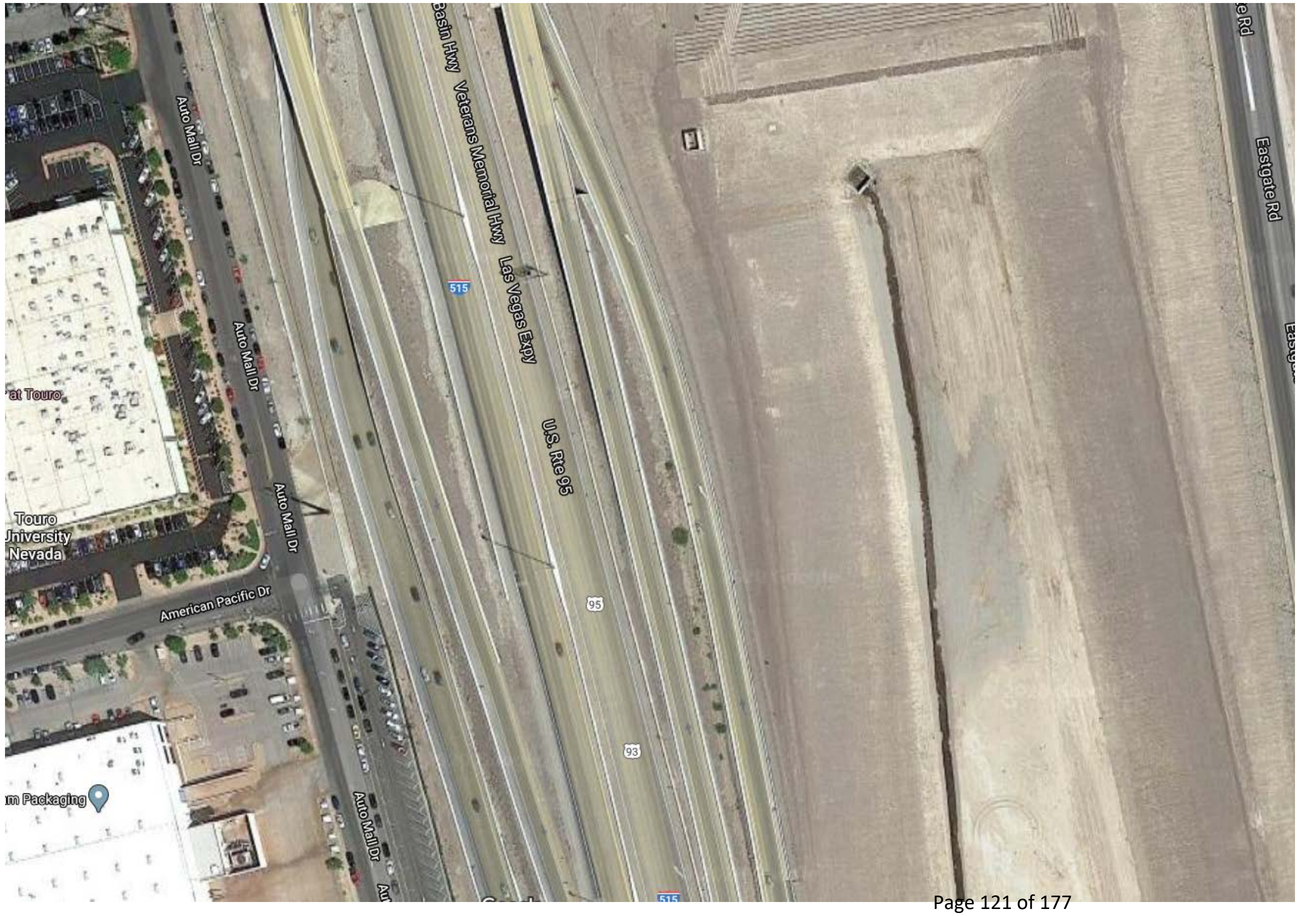
IG-20 Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp



Avoids Cost: $2M

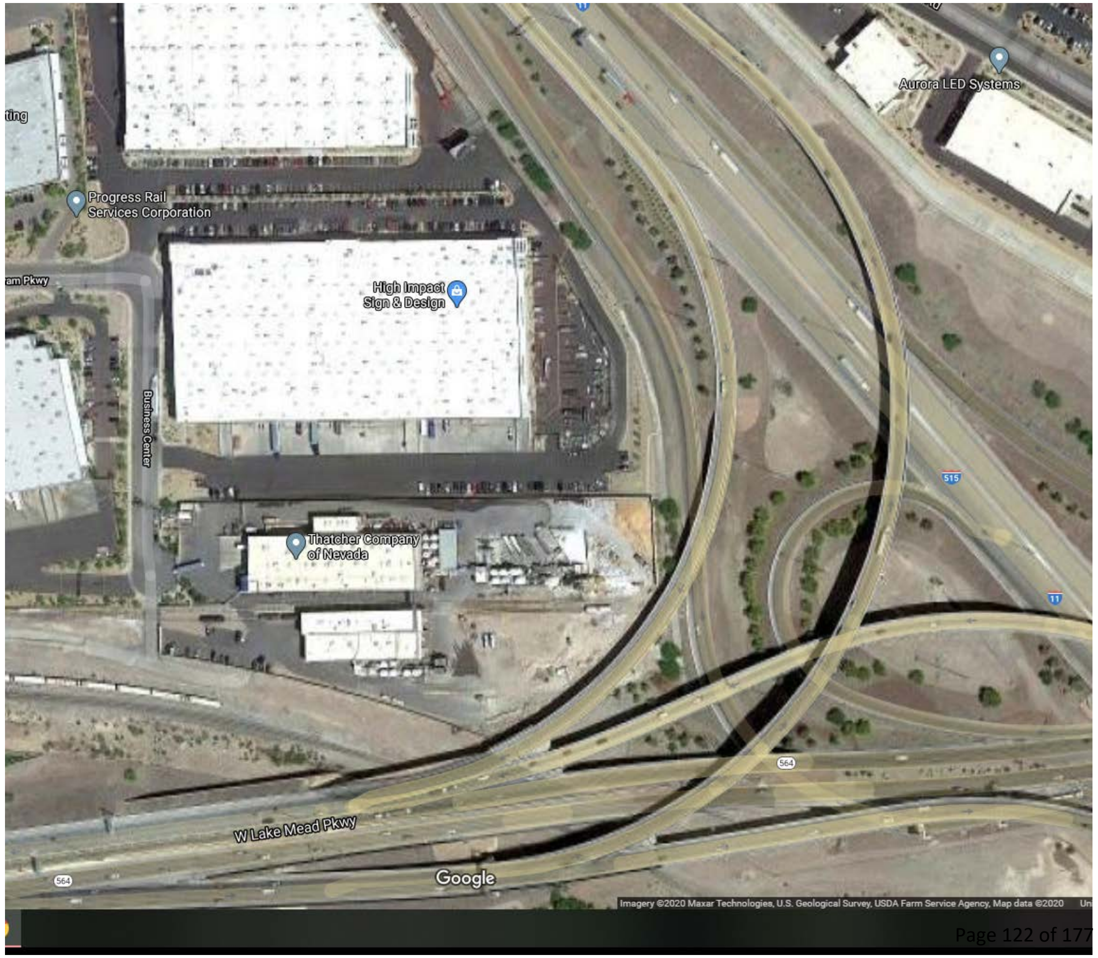
PROPOSED ALTERNATIVE

IG-21 Option 1. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515



BASELINE ASSUMPTION

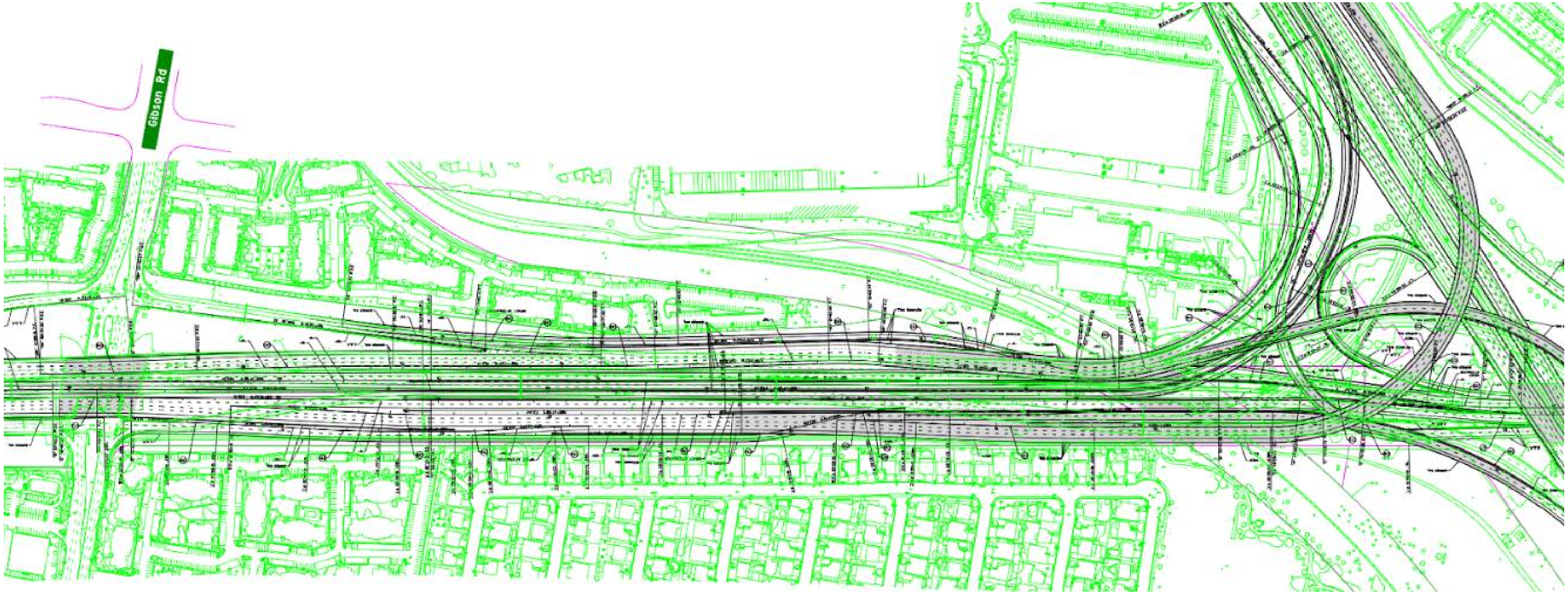
IG-21 Option 1. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515



Avoids Cost $25.6M

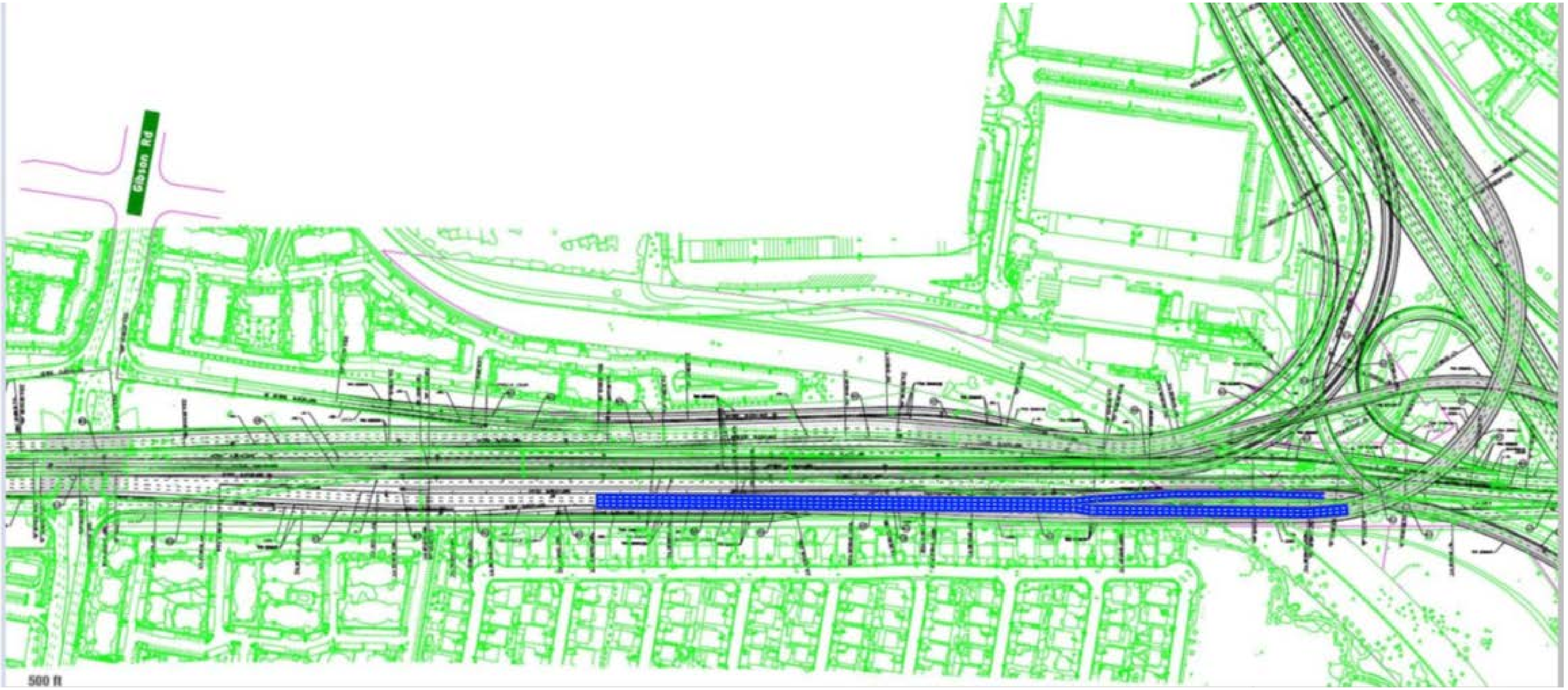
PROPOSED ALTERNATIVE

IG-23 Options 1 & 2. Shift the I-215 EB further east to allow more merging area from the Gibson off-ramp; tighten ramp radii based on offset shortening structure length; I-215 to I-515 and I-11



BASELINE ASSUMPTION

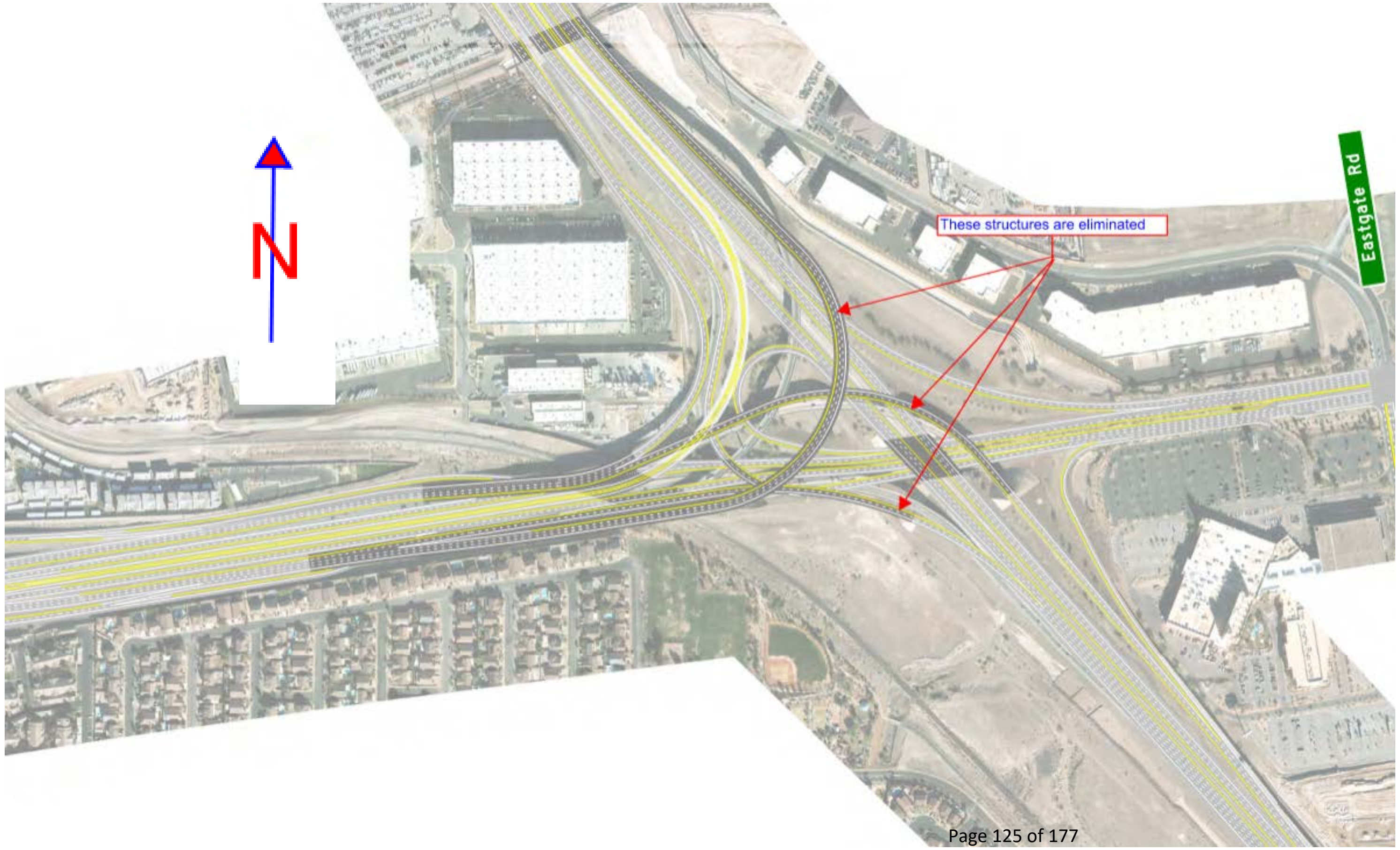
IG-23 Options 1 & 2. Shift the I-215 EB further east to allow more merging area from the Gibson off-ramp; tighten ramp radii based on offset shortening structure length; I-215 to I-515 and I-11



Avoids Cost: $0

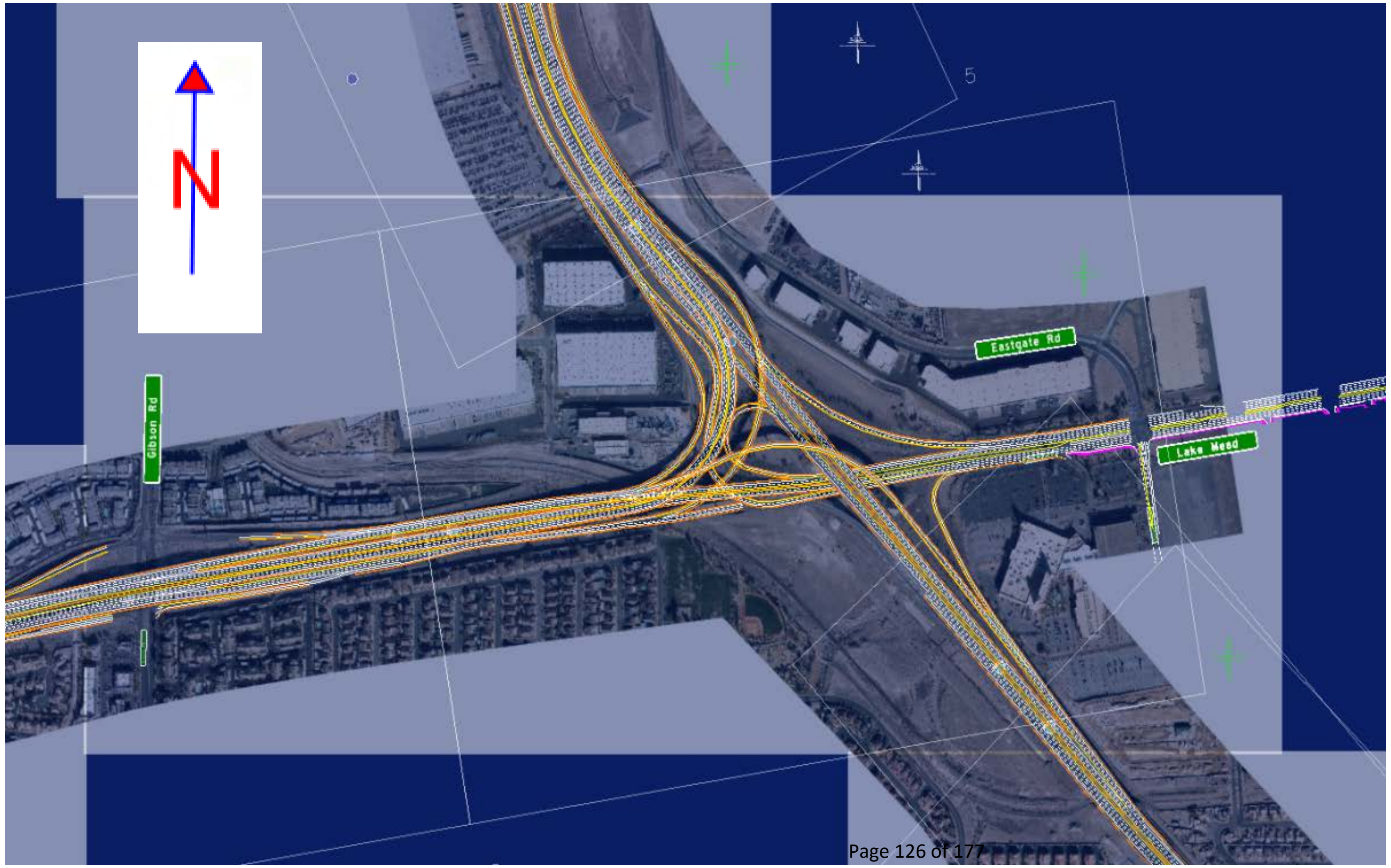
PROPOSED ALTERNATIVE

IG-26 Options 2 & 3. Since the SB to WB connection is a borderline 2 or 3 lane design and the EB to NB connection is a borderline 2 or 3 lane design; build a 3 lane in each direction flyover median to median. In the future you can take one of the GP lanes and make it HOV (addresses all issues)



BASELINE ASSUMPTION

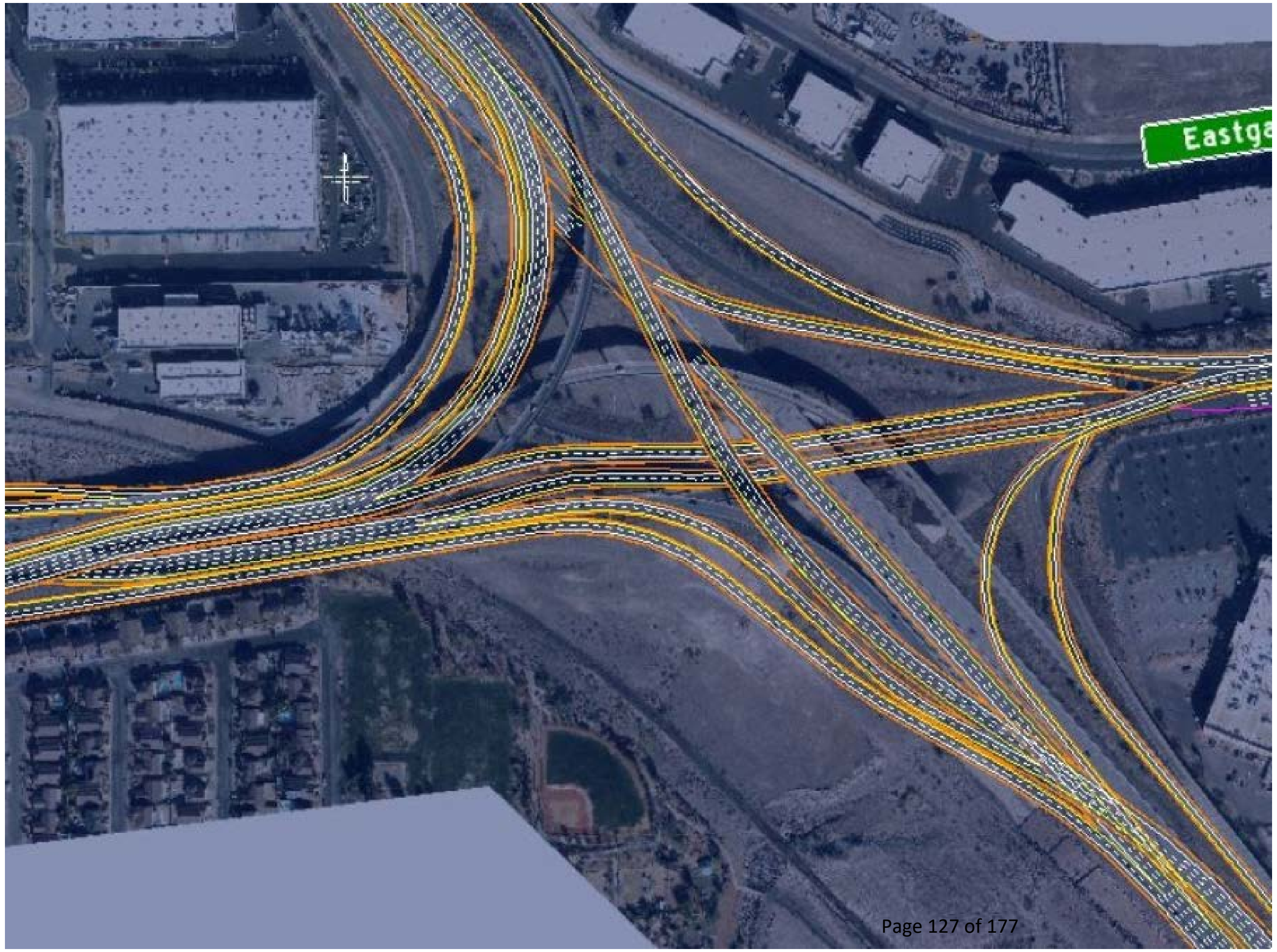
IG-26 Options 2 & 3. Since the SB to WB connection is a borderline 2 or 3 lane design and the EB to NB connection is a borderline 2 or 3 lane design; build a 3 lane in each direction flyover median to median. In the future you can take one of the GP lanes and make it HOV (addresses all issues)



Avoids Cost: $49M

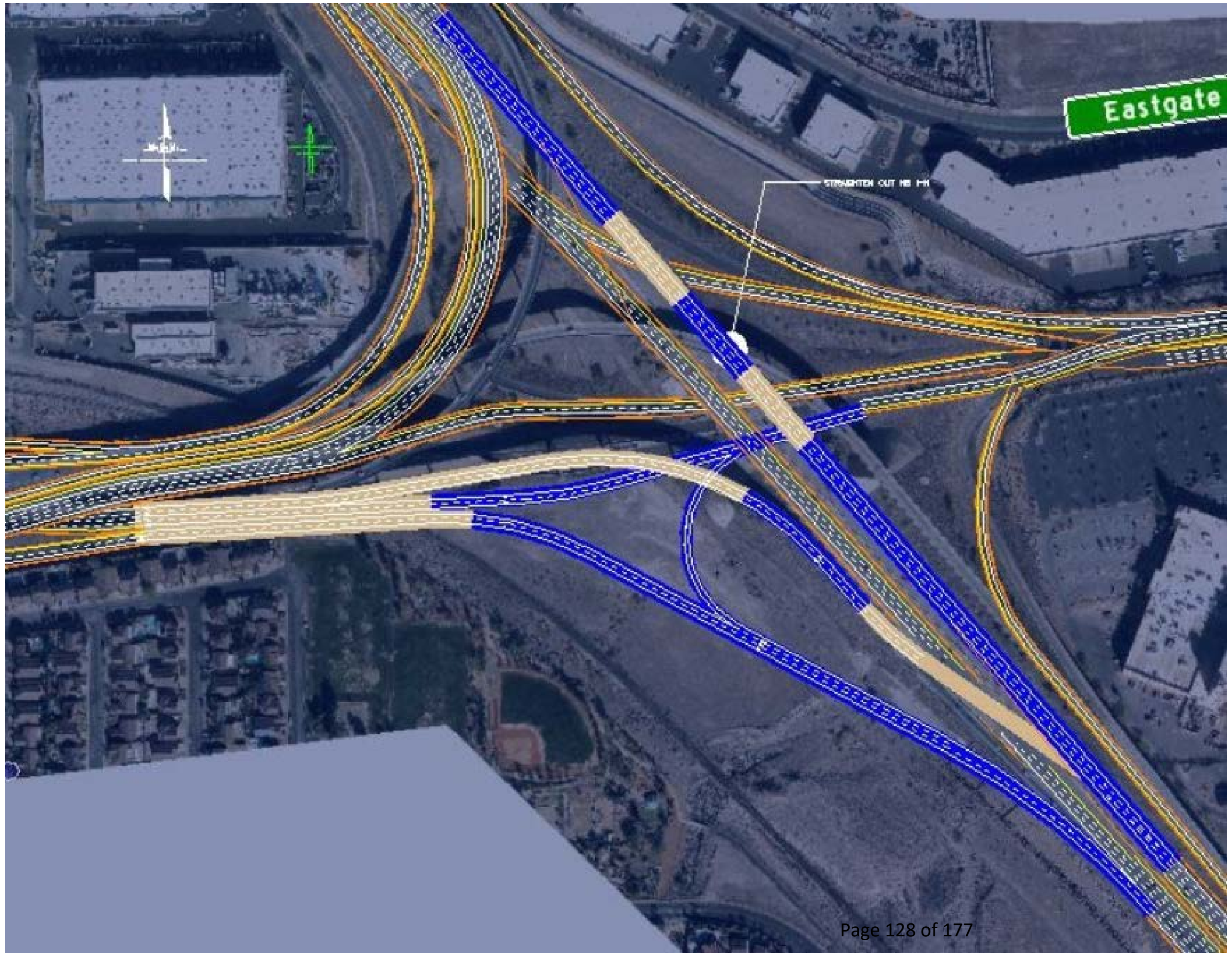
PROPOSED ALTERNATIVE

IG-27 Option 2. Utilize existing EB 215 to SB 515 structure; NB 515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction.



BASELINE ASSUMPTION

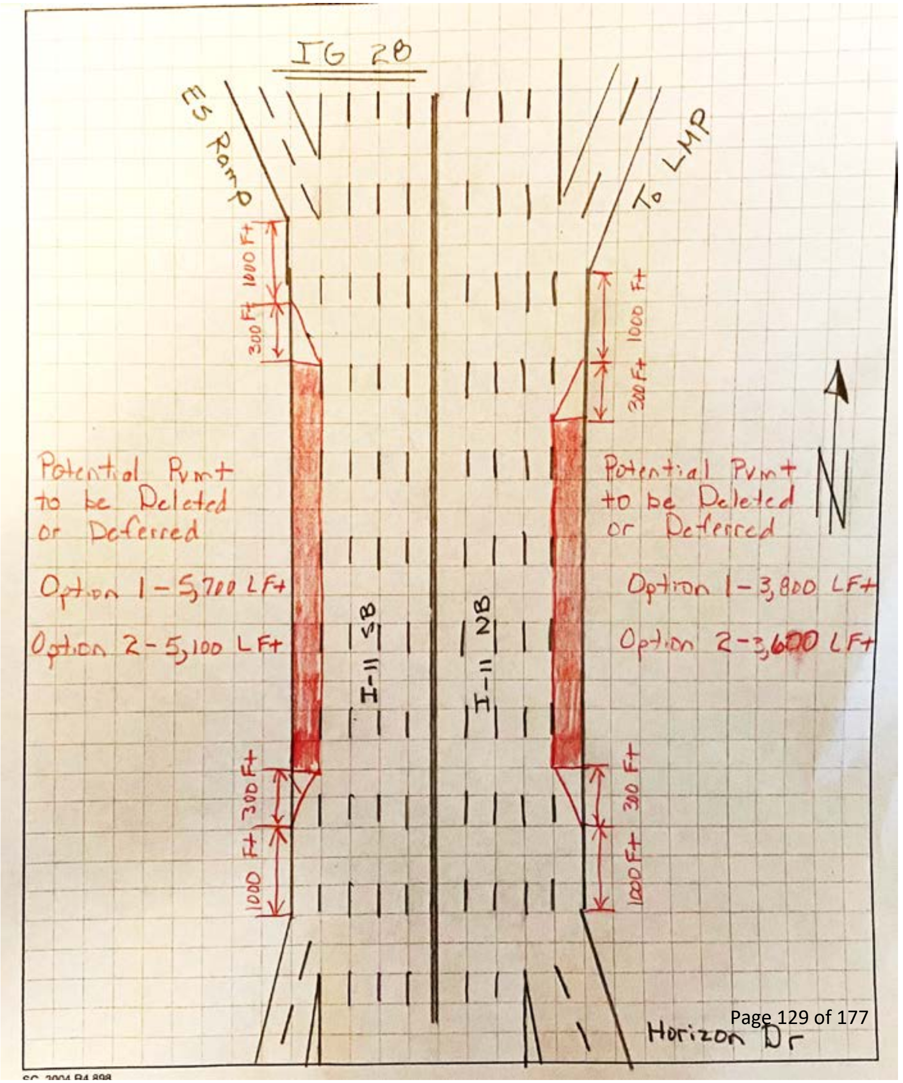
IG-27 Option 2. Utilize existing EB 215 to SB 515 structure; NB 515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction.



Avoids Cost: $20.7M

PROPOSED ALTERNATIVE

IG-28 Options 1 & 2. Delete or Delay NB and/or SB I-11 Aux Lanes between Horizon Drive and Henderson Interchange Ramps



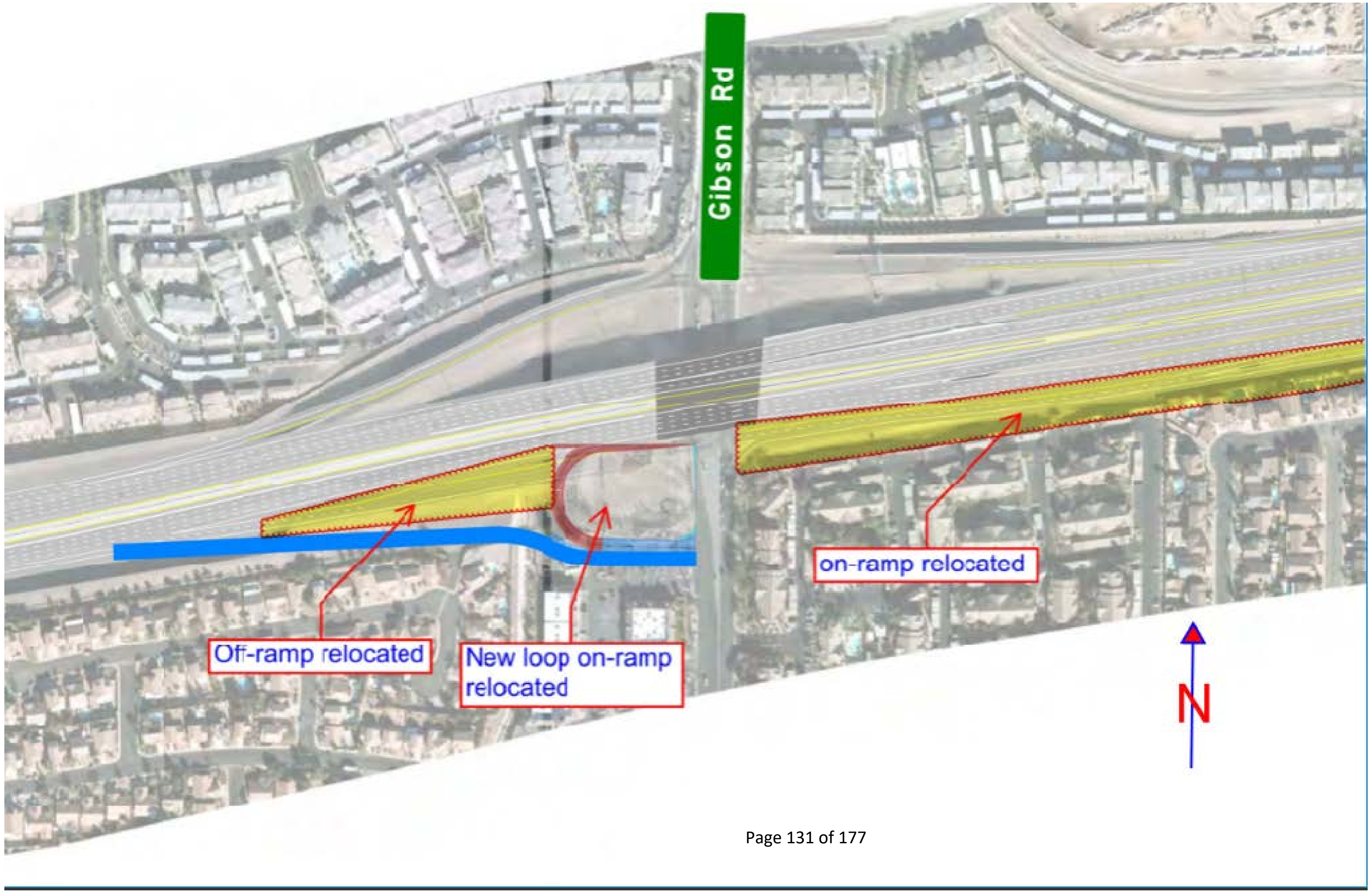
Option 1: Avoids Cost: $3.6M
Option 2: Avoids Cost: $3.2M

PROPOSED ALTERNATIVE

IA-06 Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)

BASELINE ASSUMPTION

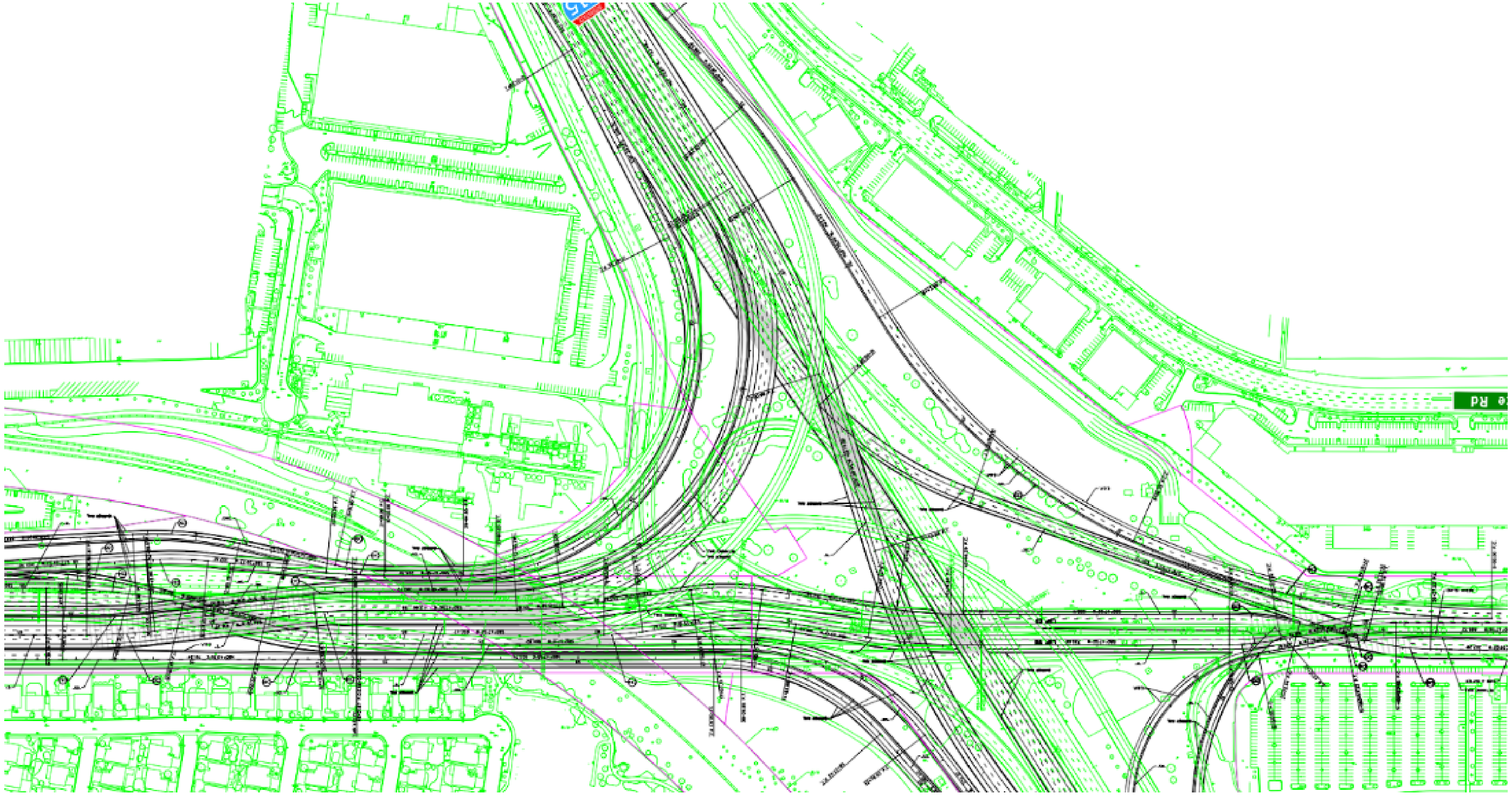
IA-06 Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)



Avoids Cost: $0

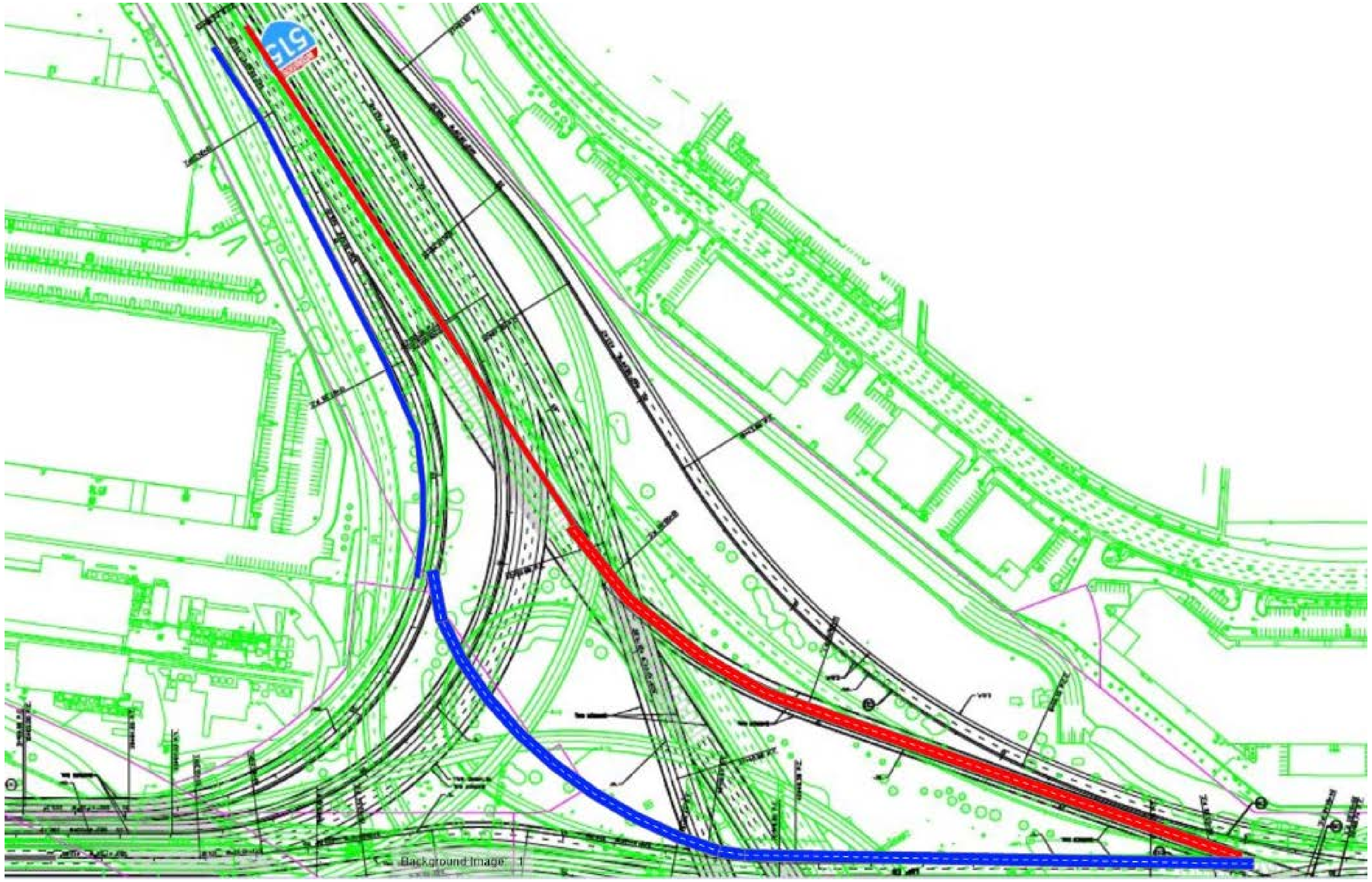
PROPOSED ALTERNATIVE

IM-01 Option 2: Widen the I-515 to I-215 ramp, have the I-515 to LMP ramp split off of this location removing the left-hand departure



BASELINE ASSUMPTION

IM-01 Option 2: Widen the I-515 to I-215 ramp, have the I-515 to LMP ramp split off of this location removing the left-hand departure



Avoids Cost: $0

PROPOSED ALTERNATIVE

Next Steps

- Draft Report due 2 July 2020
- Implementation Decisions - ?
- Final Report due 1 week after comments received


Thank
you

Agenda

A copy of the workshop agenda is included for reference.

Value Analysis (VA) Workshop Agenda

Project Name: Nevada Department of Transportation, Henderson Interchange Feasibility Study
Dates/Time: VA Workshop Pre-meeting (Technology Dry-Run & Review of Resource Documents)
Tuesday, June 9, 2020 – 1400-1600 PDT (2 hours)
VA Workshop
Monday-Thursday, June 15-18, 2020 – 0800-1600 PDT (4 7-hour days)
Study Location: Virtual

Day 1: Tuesday, June 9, 2020, 1400-1600 PDT

Time	VA Activity	Participants	Comments
1400	Welcome & Introductions	All	
1420	Technology Dry-run ▪ Protocols ▪ WebEx Meeting Platform ▪ Henderson Interchange Workshop Room ▪ SME Accounts ▪ SME Account "Test Drive" ▪ Q&A	All	
1500	Review of Resource Documents	All	
1600	Adjourn	All	

Day 2: Monday, June 15, 2020, 0800-1600 PDT

Time	VA Activity	Participants	Comments
0800	Welcome & Introductions	All	
0820	Brief Overview of Value Process (CVS Facilitator)	All	
	INFORMATION PHASE		
0840	Virtual Site Tour (Project Manager, Design Lead/s)	All	
1000	Short Break		
1020	Review: ▪ Project Goals ▪ VA Study Objectives (Focus of VA Study) ▪ VA Study Constraints Identify Performance Attributes	All	
1100	Review Cost Model, Schedule, Project Risks Team Observations	VA Team	
1200	Long Break *(dismiss all but the VA Team)*	All	
1300	Function Identification of Project Elements ▪ Identify/Classify Project Functions ▪ Apply Risks/Resources to Functions ▪ Select Specific Functions for Study	VA Team	

Time	VA Activity	Participants	Comments
1400	Short Break		
	CREATIVE PHASE		
1420	Brainstorm Ideas / Alternatives	VA Team	
1600	Adjourn		

Day 3: Tuesday, June 16, 2020, 0800-1600 PDT

Time	VA Activity	Participants	Comments
0800	Check-in	VA Team	
0810	Brainstorm Ideas / Alternatives	VA Team	
1000	Short Break		
1020	Brainstorm Ideas / Alternatives	VA Team	
1200	Long Break		
1300	Brainstorm Ideas / Alternatives	VA Team	
	EVALUATION PHASE		
1400	Short Break		
1420	Two-step Evaluation Process (Shortlist Ideas for Development) Team Assignments for Development, Review Workbook	VA Team	
1600	Adjourn	VA Team	

Day 4: Wednesday, June 17, 2020, 0800-1600 PDT

Time	VA Study Activity	Participants	Comments
0800	Check-in	VA Team	
	DEVELOPMENT PHASE		
0810	Develop / Cost Alternatives	VA Team	
0900	Mid-point Review	Mid-point Review Team	
1000	Short Break & Check-in		
1020	Develop / Cost Alternatives	VA Team	
1200	Long Break		
1300	Develop / Cost Alternatives	VA Team	
1400	Short Break & Check-in		
1420	Develop / Cost Alternatives	VA Team	
1600	Adjourn		

Day 5: Thursday, June 18, 2020, 0800-1600 PDT

Time	VA Study Activity	Participants	Comments
0800	Check-in	VA Team	
DEVELOPMENT PHASE *(continued)*			
0805	Develop / Cost Alternatives (complete) Group Review of VA Alternatives Prepare Presentation	VA Team	
1000	Short Break	VA Team	
1015	Group Review of VA Alternatives (complete) Prepare Presentation (complete)	VA Team	
1130	Long Break	VA Team	
PRESENTATION PHASE			
1230	Practice Presentation	VA Team	
1330	Presentation of Key Finding/VA Alternatives to Stakeholders/Decision-makers	All	
1530	Workshop Close-out	VA Team	
1600	Adjourn	VA Team	

All: Decision-makers, Design Team, Stakeholders, VA Team
VA Team: Subject Matter Experts and others serving as full-time VA team members
Midpoint Review Team: Subset of All

Workshop Attendee List

A copy of the workshop attendee list is included for reference.

VALUE ANALYSIS STUDY
Henderson Interchange Feasibility Study
Virtual VA Workshop
VA Workshop Pre-meeting (Technology Dry-Run & Review of Resource Documents)
Tuesday, June 9, 2020 – 1400-1600 PDT (2 hours)
VA Workshop
Monday-Thursday, June 15-18, 2020 – 0800-1600 PDT (4 7-hour days)

Workshop Attendance										Workshop Attendee List					
6/9 DR	6/15 AM	6/15 PM	6/16 AM	6/16 PM	6/17 AM	6/17 PM	6/18 AM	6/18 PM	6/18 OBP	Name	Full-time (FT)	Organization	Position	Office Phone Cell Phone	Email
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Jeff Bickett	FT	NDOT	VA Team Member		jbickett@dot.nv.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Michael Taylor	FT	NDOT	VA Team Member		michael.taylor@dot.nv.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Lynnette Russell	FT	NDOT	VA Team Member		LRussell@dot.nv.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Shawn Paterson	FT	NDOT	VA Team Member		spaterson@dot.nv.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Brian Deal	FT	NDOT	VA Team Member		bdeal@dot.nv.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Jacob Waclaw	FT	FHWA	VA Team Member		jacob.waclaw@dot.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Chris Petersen	FT	CA Group	VA Team Member		Chris.Petersen@c-agroup.com
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Steve Bird	FT	CA Group	VA Team Member		Steve.Bird@c-agroup.com
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Dave Sabers	FT	CA Group	VA Team Member		David.Sabers@c-agroup.com
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Jim Mischler	FT	CA Group	VA Resource		James.Mischler@c-agroup.com
☑	☑	☐	☐	☐	☐	☐	☐	☐	☑	Jim Caviola		CA Group	VA Resource		James.Caviola@c-agroup.com
☑	☑	☐	☐	☐	☐	☐	☐	☐	☑	Dave Bowers		NDOT	VA Resource		DBowers@dot.nv.gov
☑	☑	☐	☐	☐	☐	☐	☐	☐	☑	Tom Davy		City of Henderson	VA Resource		thomas.davy@cityofhenderson.com
☑	☑	☐	☐	☐	☐	☐	☐	☐	☑	Sam Ahiamadi		NDOT	VA Resource		sahiamadi@dot.nv.gov
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Pat Miller	FT	RHA	VA Team Leader, CVS	602-493-1947	patrice@teamrha.com
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	Kaitlyn Stewart	FT	RHA	VA Technical Assistant	602-493-1947	kaitlyn@teamrha.com
☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	Andrea Gutierrez		FHWA			andrea.gutierrez@dot.gov
☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	Abdelmoez Abdalla		FHWA			Abdelmoez.Abdalla@dot.gov
☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	Iyad Alattar		FHWA			iyad.alattar@dot.gov
☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	Christopher E. Young		NDOT	VA Resource	775-888-7687	CYoung@dot.nv.gov
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	Jack Sjostrom		CA Group	Visual Model for In-brief Meeting		Jack.Sjostrom@c-agroup.com
☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	John Karachepone		Jacobs	Traffic Q&A with VA Team		John.Karachepone@jacobs.com
☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	Sharan Dhanaraju		Jacobs	Traffic Q&A with VA Team		sharan.dhanaraju@jacobs.com

SECTION

5

IMPLEMENTATION

Section 5: Implementation

Introduction

There were three post-workshop meetings to discuss the alternatives presented in the Value Analysis Study; dates and attendees are listed below.

- July 15, 2020 - Henderson Interchange NEPA VA Study Responses virtual meeting
  - Lynnette Russell, NDOT
  - David Bowers, NDOT
  - Chris Young, NDOT
  - Sam Ahiamadi, NDOT
  - Andrea Gutierrez, FHWA
  - Iyad Alattar, FHWA
  - Del Abdalla, FHWA
  - Tom Davy, COH
  - James Caviola, CA Group
  - James Mischler, CA Group
  - Pat Miller, RHA
- July 27, 2020 - NDOT Management virtual meeting
  - Tracy Larkin-Thomason, NDOT
  - Nick Johnson, NDOT
  - Lynnette Russell, NDOT
  - David Bowers, NDOT
  - Mike Yates, NDOT
  - Mario Gomez, NDOT
  - Chris Young, NDOT
  - Scott Hein, NDOT
  - Jessen Mortensen, NDOT
  - Cliff Lawson, NDOT
  - Sam Ahiamadi, NDOT
  - Hoang Hong, NDOT
  - Jeff Bickett, NDOT
  - Jim Caviola, CA Group
  - Jim Mischler, CA Group
- July 30, 2020 - City of Henderson Management virtual meeting
  - Rob Herr, COH
  - Ed McGuire, COH
  - Tom Davy, COH
  - Lynnette Russell, NDOT
  - David Bowers, NDOT
  - Jim Caviola, CA Group
  - Jim Mischler, CA Group

Presentations for the July 27 and July 30 meetings are included at the end of this section.

Disposition Summary

The following table summarizes the disposition of the VA proposals:

Disposition	VA Proposals
Accept (5)	IG-01, IG-20, IG-26, IG-27, IM-01
Further Study (6)	IG-09, IG-11, IG-22, IG-23, IA-04, IA-06
Reject (3)	IG-21, IG-25, IG-28

Disposition Table

Details of the decisions and comments on each VA proposal are included on the following pages.

Recommendations

Accepted (A) proposals as listed in the Summary of Value Analysis Proposals would result in improvements to Option 2, and when applied to Option 1, would result in a new Option 3.

It is anticipated that the accepted proposals from the VA Study will result in a current year construction cost for Option 2 of approximately $188 M and a current year construction cost for Option 3 of approximately $211 M. These costs are approximately $50 M less than estimated construction costs provided in the Henderson Interchange Feasibility Study for both Options 1 and 2.

Proposals recommended for Further Study (FS) would only be implemented in the event that the ideas contained in Proposal IG-26 were found to not be feasible. It is anticipated that IG-26 will be found to be feasible, and that implementation of IG-26 would result in greater cost savings than the ideas denoted as FS.

Rejected (R) proposals would result in revisions to the project that would lessen the degree to which the alternatives satisfy the purpose and need for the project by removing or reducing access and/or capacity that is identified by the Feasibility Study to be warranted.

Connectivity for the improved Option 2 would be comparable to Option 2 as configured in the Feasibility Study, with full access provided to Gibson Road and Auto Show Drive. Connectivity for new Option 3 would be better than Option 1 as configured in the Feasibility Study, with full access provided to Auto Show Drive that was not provided by Option 1.

Based on the results of this study, NDOT Management recommendations for the Henderson Interchange project include:

- Improved Option 2 and new Option 3 should be studied further in NEPA because they are the most economically feasible while accommodating 2040 traffic volumes with full connectivity to local roads,
- Perform further study to confirm cost estimates and to document satisfactory traffic operations performance including the westbound Lake Mead Parkway movement to Gibson Road for Option 3, and
- Accommodate future HOV connectivity between I-215 and I-515.

Summary of Value Analysis (VA) Proposals							Disposition of VA Proposals	
Idea No.	Idea Title	Initial Cost Avoidance / (Cost Add)	VA Team Recommended Package - Option 1	VA Team Comments	VA Team Recommended Package - Option 2	VA Team Comments	A=Accept, AM=Accept with Modification(s), FS=Further Study, R=Reject	Comments
IG	**Improve Geometry**							
IG-01	Option 2. The baseline I-11 northbound alignment diverges and is relocated on the west side of existing I-11; this alternative proposes to realign the northbound alignment back in its current alignment	$15,671,000	N/A		$15,671,000		A	This idea appears to have merit and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower. Futher to this idea, there is no advantage in staying on the same alignment because the roadway would be elevated from existing, and there may be further reductions in structure cost by swinging the northbound lanes further to the east as space permits to reduce the skew of the ramp grade separations.
IG-09	Options 1 & 2. Relocate WB off-ramp to Gibson further to the west and add a loop ramp (similar to SBX Project in Reno)	$0	Not Costed	Implementation of elements from IG-26 into Option 2 may preclude the need for a westbound braided ramp and implementation of this idea should be considered only if IG-26 is found to not be feasible.	Not Costed	Implementation of elements from IG-26 into Option 2 may preclude the need for a westbound braided ramp and implementation of this idea should be considered only if IG-26 is found to not be feasible.	FS	This idea should be investigated only in the event that IG-26 is not found to be feasible
IG-11	Option 1. Driver expectancy - driver demand; make the EB I-215 to NB I-515 a left-hand exit and move the EB I-215 to SB I-11 in its place (i.e., fast lanes should be arranged to exit on the left to the NB flyover); this would create a simple fork and eliminate structure over Lake Mead Parkway	$21,686,000	Included with IG-26	This idea is incorporated into IG-26 that is recommended for implementation and should be considered only if IG-26 is found to not be feasible.	N/A		FS	This idea should be investigated only in the event that IG-26 is not found to be feasible
IG-20	Options 1 & 2. Reduce the NB off-ramp to Auto Show to one lane to reduce width of braided structure with EB to NB ramp	$2,049,000	$2,049,000	This idea appears to have merit and should be investigated further in the traffic model to ascertain whether satisfactory traffic operations performance can be achieved with one lane.	$2,049,000	This idea appears to have merit and should be investigated further in the traffic model to ascertain whether satisfactory traffic operations performance can be achieved with one lane, and whether the existing structure geometry can be accommodated with the widening of NB I-515.	A	If the traffic, safety, or operations analyses show that two lanes are advisable, another option to take advantage of the potential cost savings would be to restrip the existing 28' face/face of barrier bridge with two lanes and 2' shoulders
IG-21	Options 1 & 2. EB to NB flyover ramp - rather than add the third lane that merges back into two lanes, keep the two-lane configuration and perpetuate that two lanes tie-in at NB I-515	$25,590,000	$25,590,000		$15,945,000		R	Acceptance of this idea would preclude the option of a system to system HOV connection between I-215 and I-515, and would result in borderline traffic capacity in the design year that may be only 13 years from start of construction. The design team recommends that three lanes in each direction be accommodated, either as two general purpose lanes plus HOV, or as three general purpose lanes.

Idea No.	Idea Title	Initial Cost Avoidance / (Cost Add)	VA Team Recommended Package - Option 1	VA Team Comments	VA Team Recommended Package - Option 2	VA Team Comments	A=Accept, AM=Accept with Modification(s), FS=Further Study, R=Reject	Comments
IG-22	Option 1: Continue the 3 lanes from the flyover and drop the 3rd lane so it exits at Auto Show (IG-22 is an if/then to IG-21)	$0	Not Costed	This idea would add cost to the project and could provide partial access to Auto Show that does not currently exist in Option 1. It appears that IG-26 could provide the same benefit at a lower cost, therefore it is recommended that this idea not move forward unless IG-26 is found to not be feasible.	N/A		FS	This idea should be investigated only in the event that IG-26 is not found to be feasible
IG-23	Options 1: Shift the I-215 EB diverge for north/south movements to I-C25515 & I-11 further east to allow more merging area from the Gibson on-ramp, tighten ramp radii based on offset shortening structure length	$0	Not Costed		N/A		FS	This idea should be investigated only in the event that IG-26 is not found to be feasible
IG-25	Option 1. If the diverge gore point is moved back, forcing the Gibson EB traffic to use the NB ramp, the weave could be eliminated	$0	Not Costed	Implementation of this idea would result in the inability to enter I-215 from Gibson and then travel south on I-11. It is recommended that this idea not be implemented.	N/A		R	The design team concurs with the VA Team recommendation that this idea not be implemented
IG-26	Options 1 & 2. Since the SB to WB connection is a borderline 2- or 3-lane design and the EB to NB connection is a borderline 2- or 3-lane design; build a 3-lane in each direction flyover median to median. In the future, one of the general purpose lanes can be made into an HOV (addresses all issues)	$49,251,000	$49,251,000	This idea appears to have merit and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower. Reuse of the existing Ramp NW structure would require that the structure be widened to two lanes or restriped for two lanes with a Design Exception for Stopping Sight Distance with a narrow left shoulder around the curve.	$6,377,000	When the central system-to-system connection of this idea is applied to Option 2, it appears to have merit and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower. Braided ramps to and from Gibson Road could be avoided.	A	This idea appears to have merit for both options and should be implemented into the design.
IG-27	Option 2. Utilize existing EB I-215 to SB I-515 structure; NB I-515 crossover would touch down back at the existing roadway and bridge structure but going in the opposite direction. The WB I-215 to SB I-515 traffic would be realigned under the existing structure as a loop ramp and provide a traditional left-hand merge onto mainline. EB I-215 would also slip under the existing structure continue east as a grade separated over the railroad and tie into the baseline Option 2 Design	$20,670,000	N/A		$20,670,000		A	This idea appears to have merit and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower. Futher to this idea with potential for additional savings, there may be an opportunity to construct Ramp NW using portions of the existing ramp similar to the existing configuration, with a northbound to wesbound traditional flyover structure in lieu of the southern crossover structure.
IG-28	Options 1 & 2. Delete or delay NB and/or SB I-11 Auxiliary Lanes between Horizon Drive and Henderson Interchange Ramps	$3,477,000	$3,477,000	This idea could be implemented to defer some expenditures to a later phase of the work, as determined by NDOT Management.	$3,184,000	This idea could be implemented to defer some expenditures to a later phase of the work, as determined by NDOT Management.	R	The design team recommends that improvements to I-11 between the interchange and Horizon Drive be included with the project for NEPA, while recognizing that these and other elements of the project could be phased to address funding constraints.

Idea No.	Idea Title	Initial Cost Avoidance / (Cost Add)	VA Team Recommended Package - Option 1	VA Team Comments	VA Team Recommended Package - Option 2	VA Team Comments	A=Accept, AM=Accept with Modification(s), FS=Further Study, R=Reject	Comments
IA	**Improve Access (re-establish access at Gibson and/or Auto Show)**		$0					
IA-04	Option 1. Instead of having the EB I-215 to NB I-515 exit from the outside, shift it to the median since there is no HOV connection shown in the current Southern Nevada HOV Plan; this would shorten the flyover ramp considerably	$8,784,000	Included with IG-26	This idea is incorporated into IG-26 that is recommended for implementation and should be considered only if IG-26 is found to not be feasible.	N/A		FS	This idea should be investigated only in the event that IG-26 is not found to be feasible
IA-06	Options 1 & 2. Shift the mainline I-215 to the north, use MSE walls to hug the WB ramps, then make the Gibson EB on-ramp into a left turn with loop ramp to gain more distance for the weaving (similar to 95 SB ramp @ Jones)	$0	Not Costed	This idea should be investigated further to ascertain whether implementation of a loop ramps could eliminate the need for eastbound braided ramps from Gibson to access I-515, I-11 and LMP.	Not Costed	Eastbound braided ramps from Gibson are not required by Option 2, therefore this idea is not applicable to Option 2.	FS	This idea should be investigated only in the event that IG-26 is not found to be feasible
IM	**Improve Mainline-operations**		$0					
IM-01	Option 2: Widen the I-515 to I-215 ramp, have the I-515 to Lake Mead Parkway ramp split off of this location removing the left-hand departure	$5,521,000	N/A		$5,521,000	This idea appears to have merit when combined with Ideas IG-01 and IG-26; and should be investigated further. Based on inspection, traffic operations would be comparable and construction costs would be lower because a more expensive crossover structure could be replaced by a traditional bridge type. It would need to be determined whether the vertical profile geometry could be made to work in order to create a grade separation between Ramp EN and Ramp SE. It appears that this idea would be compatible with the ideas contained in IG-26.	A	This idea appears to have merit and should be incorporated into the design of Option 2
	Potential Project Cost Avoidance		**$80,367,000**		**$69,417,000**			
			Option 1		**Option 2**			

HENDERSON INTERCHANGE

Henderson Interchange NEPA

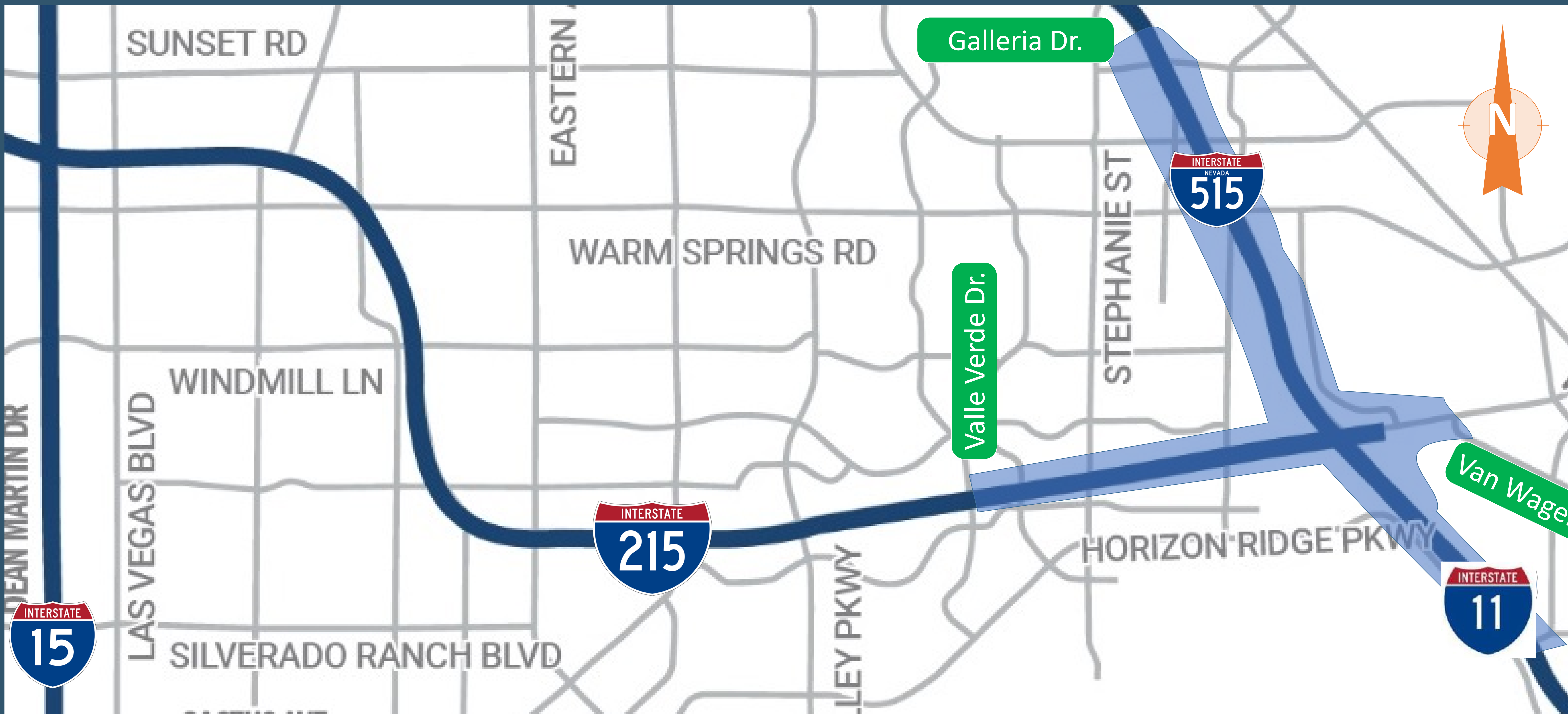
Presentation to NDOT Management July 27, 2020

NEVADA DOT SAFE AND CONNECTED

THE CITY OF HENDERSON

A Place To Call Home

Proposed Project Information and Timeline



HENDERSON INTERCHANGE STUDY AREA

- 515 / 11: Galleria Drive to Horizon Drive
- 215: Valle Verde Drive to Van Wagenen Street
- Project Study Limits

FEASIBILITY STUDY	NEPA PROCESS	ENGINEERING/ CONSTRUCTION PHASE 1	ENGINEERING/ CONSTRUCTION PHASE 2 (IF NEEDED)
December 2018 to January 2020	May 2020 to May 2022 **WE ARE HERE**	August 2022 to April 2026	May 2026 to April 2031

All information presented is preliminary and subject to revision

Scope of Feasibility Study by City of Henderson

Traffic analysis using calibrated SNTS Aimsun Next Model

Public Meeting in March 2019

Alternatives Workshop in April 2019 attended by NDOT, City of Henderson, and the consultant team:

David Bowers	Tom Davy	Jim Caviola	John Karachepone
Jeff Lerud	Scott Jarvis	Chad Anson	Matt Horrocks
Michelle Castro	Al Jankowiak	Jack Sjostrom	Jared Olsen
Jesse Smithson	Eric Hawkins	Sri Bala	Irene Lam
Marc Cutler	Michael Kidd	Christine Klimek	Heidi Dexheimer
Maylinn Rosales	Alyssa Rodriguez		

Alternatives Screening, Refinement, and Estimates

Public Meeting in December 2019

Feasibility Study in February 2020 resulted in two alternatives recommended for further consideration

Followed PEL process so Feasibility Study work will apply to NEPA

Option 1 – Traditional $262M current year

All information presented is preliminary and subject to revision

Option 1 – LMP Dual Braided Access to Gibson Road

All information presented is preliminary and subject to revision

Option 2 – Crossover $238M current year

All information presented is preliminary and subject to revision

Option 2 – LMP Dual Braided Access to Gibson Road

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Value Study

Held June 15-18 2020

OUT-BRIEF PRESENTATION

Henderson Interchange Feasibility VA Study

Virtual Workshop

18 June 2020
1230 PDT

Participants: Lynnette Russell, Shawn Paterson, Brian Deal, Jeff Bickett, Michael Taylor (NDOT)
Jake Waclaw (FHWA)
Chris Petersen, Steve Bird & Dave Sabers (CA Group)
Resources: David Bowers, Sam Ahiamadi, Andrea Gutierrez, Del Abdalla, Iyad Alattar, Tom Davy
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VA Study generated 55 creative ideas that led to 14 value analysis proposals for improvements to Options 1 and 2.

Option 1 proposals yielded a new Option 3 with Option 1 remaining a viable alternative

Option 2 proposals yielded an improved Option 2

Option 1 Remains Viable with Braided Access to Gibson Rd - $262 M Current Year

<u>35 EXISTING BRIDGES IN PROJECT AREA</u>

13 Retained as-is

15 Retained and widened

6 Demolished and replaced

1 Demolished (no longer needed)

BRIDGE DEMO & CONSTRUCTION COST $145 M

All information presented is preliminary and subject to revision

Improved Option 2 – $188 M Current Year

35 EXISTING BRIDGES IN PROJECT AREA
15 Retained as-is
13 Retained and widened
1 Demolished and replaced
6 Demolished (no longer needed)
BRIDGE DEMO & CONSTRUCTION COST $74 M

Combined VA Study Savings of $50 M
- Don't cross over I-11/I-515
- Move I-515/I-215 connection to median and make it 3 lanes to accommodate future HOV
- Reconfigure Ramps WS & SE to be west of the core
- Retain the existing NB braid bridge to Auto Show (Design Exception needed for shoulder width)

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New Option 3 - $211 M Current Year

Restores LMP access to Gibson similar to pre-2017 configuration but with less traffic conflict. Microsimulation modeling would be needed to ascertain whether performance would be satisfactory.

Combined VA Study Savings of $51 M

- Retain existing core interchange structures
- Move I-515/I-215 connection to median to accommodate future HOV
- Restripe Ramp NW bridge to two lanes (Design Exception for SSD)
- Retain the existing NB braid bridge to Auto Show (Design Exception needed for shoulder width)

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15 Retained and widened
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2 New flyover bridges
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BRIDGE DEMO & CONSTRUCTION COST $133 M

Additional Cost Saving Proposals
Reduce I-515/I-215 mainline connections to 2 lanes in each direction (Round down instead of up to 3)
Precludes future HOV connection from I-515 to I-215

Potential Savings

Option 1	$20.3 M
Improved Option 2	$15.9 M
New Option 3	$25.6 M

Additional Cost Saving Proposals

Eliminate or defer auxiliary lanes between Horizon Drive and the system interchange

Potential Cost Savings

Option 1	$3.5 M
Improved Option 2	$3.2 M
New Option 3	$3.5 M

Auxiliary lanes could be included with NEPA and deferred to later construction if dictated by constrained funding

RECOMMENDATIONS

Option 1 $262 M
Improved Option 2 $188 M
New Option 3 $211 M

The Design Team recommends that improved Option 2 be studied further in NEPA because it has the least cost, least structure area for future maintenance, and has been shown to provide satisfactory traffic operations performance including the LMP to Gibson movement. Option 2 accommodates future HOV. New Option 3, which also accommodates future HOV, remains a feasible alternative in the event a fatal flaw is discovered in Option 2.

The Design Team recommends that 15% plans, cost estimate, and detailed traffic operations analysis using Aimsun Next microsimulation software be developed for Option 2 incorporating the recommended VA Study improvement proposals

THANK YOU!
QUESTIONS?

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HENDERSON INTERCHANGE

Henderson Interchange NEPA

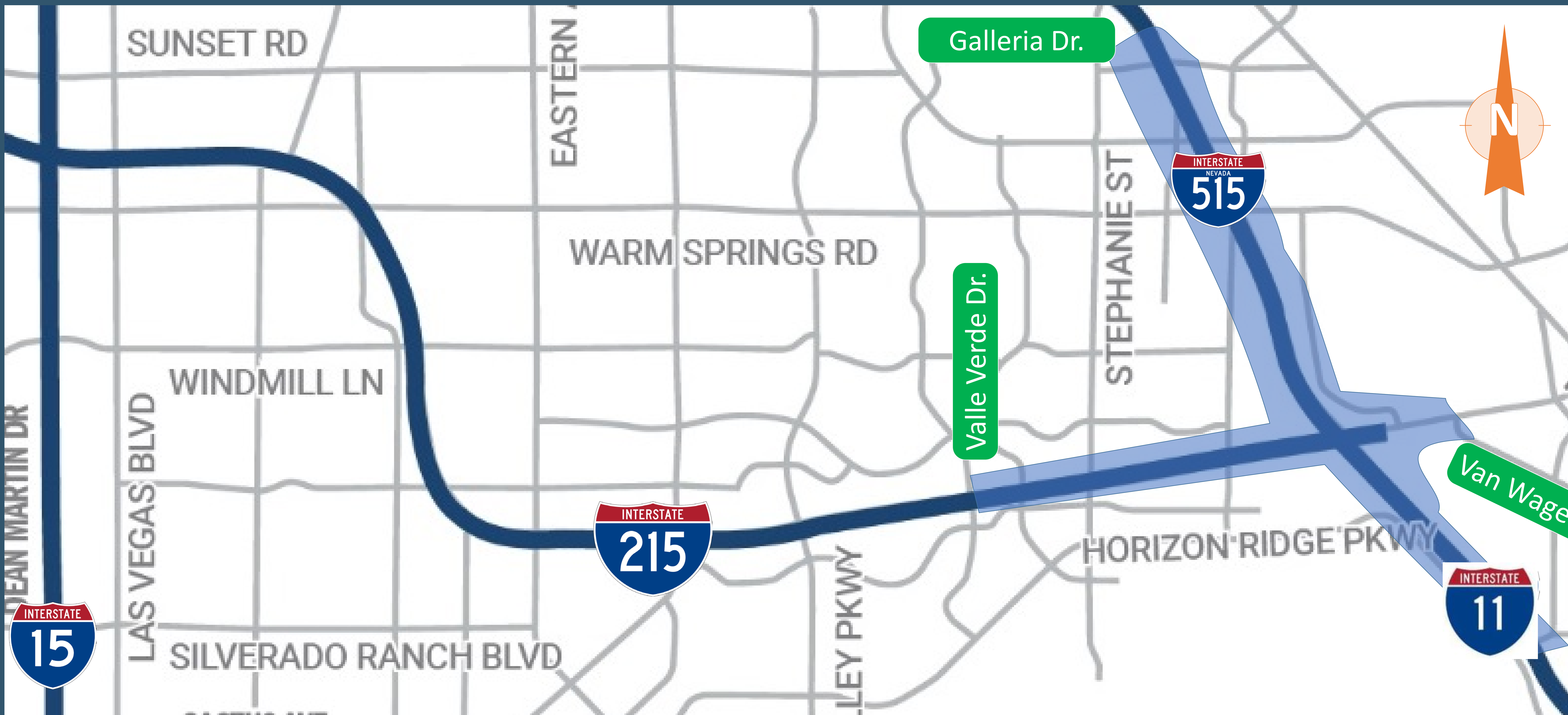
Presentation to City of Henderson Management July 30, 2020

NEVADA DOT SAFE AND CONNECTED

THE CITY OF HENDERSON

A Place To Call Home

Proposed Project Information and Timeline



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BRIDGE DEMO & CONSTRUCTION COST $133 M

All information presented is preliminary and subject to revision

RECOMMENDATIONS

NDOT recommends that improved Option 2 ($188 M estimated current year construction cost) and new Option 3 ($211 M estimated current year construction cost) be studied further in NEPA because they are the most economically feasible while accommodating 2040 traffic volumes with full connectivity to local roads.

Further study will be needed to confirm cost estimates and to document satisfactory traffic operations performance including the LMP to Gibson movement for Option 3. Both Options 2 & 3 accommodate future HOV.

THANK YOU!
QUESTIONS?

All information presented is preliminary and subject to revision

Appendix 4

Design Standards Memorandum

HENDERSON INTERCHANGE NEPA

DESIGN STANDARDS MEMO

PREPARED FOR:

NEVADA DEPARTMENT OF TRANSPORTATION

PREPARED BY:

CA GROUP, INC.
2785 S. RAINBOW BOULEVARD
LAS VEGAS, NV 89146

SEPTEMBER 28, 2020

Technical Memorandum

TO: David Bowers, P.E., NDOT **DATE:** September 28, 2020

FROM: James Mischler, CA Group, Inc.

SUBJECT: Design Standards Memo

COPIES:

1. Introduction and Background

The purpose of this memo is to document the design standards that will be used in the development of the preliminary design for the Henderson Interchange NEPA Project.

These standards, as of September 2020, are in effect. Should new standards become available during the design progress, the design team will present the new standard to the Department for consideration. Any change in standards will be reviewed for scope and fee adjustments and a decision will be made whether or not to incorporate new standards into the project development. Additional standards not listed may be required for the full development of the work. Those standards may be added to the list below at the discretion of the Department's Project Manager.

Two alternatives are being developed to address the Purpose and Need for the Henderson Interchange project. Project limits include I-215 east of Valle Verde Drive, I-515 south of Galleria Drive, I-11 north of Horizon Drive, and Lake Mead Parkway west of Van Wagenen. Each of the four highways converge at the Henderson Interchange.

One alternative retains the existing core interchange while adding a median-to-median connection between I-215 and I-515 along with additional appurtenant improvements to add capacity within the project area. Another alternative reconstructs the interchange as a crossover style along with appurtenant improvements to add capacity within the project area.

Both alternatives strive to retain and reuse existing structures and pavement to the maximum extent practical, and in some cases design exceptions would be needed to retain existing structures and pavement. The alternatives evaluation process will identify and consider the need for design exceptions as part of the evaluation process between alternatives.

2. Guidelines and Standards

2.1 Roadway/Traffic

- Nevada Department of Transportation Road Design Guide, 2019 Ed.
- Nevada Access Management System and Standards, 2017 Ed.

- AASHTO, A Policy on Geometric Design of Highways and Streets, 7th Edition, 2018
- AASHTO, Roadside Design Guide, 4th Edition, 2011
- FHWA, Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 Edition, including revisions 1 and 2 dated May 2012
- Nevada Department of Transportation, Sign Supplement 2006
- AASHTO, Guide for the Development of Bicycle Facilities, 2012, Fourth Edition (updated edition expected in 2020)
- Nevada Department of Transportation, Work Zone Safety & Mobility Implementation Guide, April 26, 2019
- National Cooperative Highway Research Program (NCHRP), Report 581, Design of Construction Work Zones on High-Speed Highways
- Nevada Department of Transportation, Right-of-Way Manual, 2016
- Nevada Department of Transportation, Standard Specifications for Road and Bridge Construction, 2014
- Nevada Department of Transportation, Standard Plans for Road and Bridge Construction, 2017 Edition
- Uniform Standard Drawings, Clark County Area
- Uniform Standard Specifications, Clark County Area

2.2 *Drainage and Stormwater Quality*

- Includes above roadway Standards
- Separate Drainage Criteria Memo to be prepared as Appendix B prior to drainage design work

2.3 *Structures*

- Includes above roadway and Drainage Standards
- See Appendix C

2.4 *Geotechnical*

- Includes above Roadway, Drainage and Structures Standards
- NDOT Materials Division will be providing the pavement design for the project using the requisite standards

2.5 *Landscape Architecture*

- Includes above Roadway, Drainage and Structures Standards
- Pattern and Palette to be developed in a subsequent phase of project development

3. *Miscellaneous*

- 2014 Nevada Transportation Programmatic Agreement and Nevada Department of Transportation Cultural Resources Handbook, July 21, 2014
- State of Nevada Department of Transportation, Special Instructions for Location Consultants, Survey, Utility Database, LiDAR, Imagery, Photogrammetric Mapping, and GIS, January 2015
- Nevada Department of Transportation, Qualified Product List (QPL), current version

- State of Nevada Department of Transportation Construction Division Construction Survey Manual, November 2017

4. *Design Criteria*

Generally, all project design criteria will conform to the requirements of the above listed standards, with specifics to the project as noted in Appendices to this memo. Additional criteria may be required to define the entirety of the work, including analysis for decision sight distance for non-typical or more complex maneuvers included with each alternative. Such necessary criteria will be developed along with the project design and confirmed by NDOT counterparts in each of the affected design departments.

5. *Closing*

This is a compilation of the criteria anticipated for use in the project. This is not the final source of the design criteria. The list of references above and criteria in Appendix A are for quick reference, and do not absolve any party of responsibility of knowing and checking the referenced or other applicable standards. The following Parties agree that the list of standards above constitutes a majority of the required design standards and guidelines that will be followed in the development of the Henderson Interchange NEPA preliminary design. Additional standards may be necessary to complete the work.

Signed by:

James E Mischler

James E Mischler, P.E.
Consultant Design/Engineering Lead
CA Group

Signed by:

DocuSigned by:
David Bowers 09/29/2020
1B20850CE3794C4...

David Bowers, P.E.
NDOT Project Manager
Nevada Department of Transportation

APPENDIX A – Roadway

DESIGN STANDARDS	HENDERSON INTERCHANGE					
	I-11 & I-515	I-215	HOV Lane	Directional Ramps	Loop Ramps	Lake Mead Parkway
Functional Classification	Interstate	Interstate	Interstate	Ramp	Ramp	Major Arterial
Ownership	NDOT	NDOT	NDOT	NDOT	NDOT	NDOT
Control of Access	Full	Full	Full	Full	Full	Limited
Design Speed (mph)	70	70	Match adjacent roadway	45	25	45
Posted Speed (mph)	65	65	65	45	25	45
Design Vehicle	WB-67	WB-67	N/A	WB-67	WB-67	Bus-40
Minimum Stopping Sight Distance	730’	730’	Match adjacent roadway	360’	155’	360’
Stopping Sight Distance Adjustments for Grades > 3%	AASHTO 2018 Table 3-2[a]	AASHTO 2018 Table 3-2[a]	AASHTO 2018 Table 3-2[a]	AASHTO 2018 Table 3-2[a]	AASHTO 2018 Table 3-2[a]	AASHTO 2018 Table 3-2[a]
GEOMETRY – HORIZONTAL ALIGNMENT						
Minimum Radius	1,810 for e=8%	1,810’ for e=8%	Match adjacent roadway	587’ for e=8%	134’ for e=8%	711’ for e=4%
Maximum Superelevation (%)	8	8	8	8	8	4
Design Superelevation Rate	AASHTO 2018 Table 3-10	AASHTO 2018 Table 3-10	AASHTO 2018 Table 3-10	AASHTO 2018 Table 3-10	AASHTO 2018 Table 3-10	AASHTO 2018 Table 3-8
Minimum Length of Runoff	AASHTO 2018 Table 3-16a Equation 3-23	AASHTO 2018 Table 3-16a Equation 3-23	AASHTO 2018 Table 3-16a Equation 3-23	AASHTO 2018 Table 3-16a Equation 3-23	AASHTO 2018 Table 3-16a Equation 3-23	AASHTO 2018 Table 3-16a Equation 3-23
Minimum Length of Runout	AASHTO 2018 Equation 3-24	AASHTO 2018 Equation 3-24	AASHTO 2018 Equation 3-24	AASHTO 2018 Equation 3-24	AASHTO 2018 Equation 3-24	AASHTO 2018 Equation 3-24
% of Runoff on Tangent	67	67	67	67	67	67
GEOMETRY – VERTICAL ALIGNMENT						
Terrain classification	Rolling	Rolling	Rolling	Rolling	Rolling	Level
Maximum Grade (%)	5	5	5	6	6	6
Minimum Grade (%)	0.5	0.5	0.5	0.5	0.5	0.3 (0.2 min)
Desired Rate of Vertical Curvature (Ksag – Design)	AASHTO 2018 Figure 3-37 and Table 3-37	AASHTO 2018 Figure 3-37 and Table 3-37	AASHTO 2018 Figure 3-37 and Table 3-37	AASHTO 2018 Figure 3-37 and Table 3-37	AASHTO 2018 Figure 3-37 and Table 3-37	AASHTO 2018 Figure 3-37 and Table 3-37
Minimum Rate of Vertical Curvature (Ksag – Design) for lighted roadways	AASHTO 2018 Comfort per Eq. 3-52	AASHTO 2018 Comfort per Eq. 3-52	AASHTO 2018 Comfort per Eq. 3-52	AASHTO 2018 Comfort per Eq. 3-52	AASHTO 2018 Comfort per Eq. 3-52	AASHTO 2018 Comfort per Eq. 3-52
Minimum Rate of Vertical Curvature (Kcrest – Design)	AASHTO 2018 Figure 3-36 and Table 3-35	AASHTO 2018 Figure 3-36 and Table 3-35	AASHTO 2018 Figure 3-36 and Table 3-35	AASHTO 2018 Figure 3-36 and Table 3-35	AASHTO 2018 Figure 3-36 and Table 3-35	AASHTO 2018 Figure 3-36 and Table 3-35
Min. Length of Vertical Curve (feet)	3 x Design speed	3 x Design speed	Match adjacent roadway	3 x Design speed	3 x Design speed	3 x Design speed

DESIGN STANDARDS	HENDERSON INTERCHANGE					
	I-11 & I-515	I-215	HOV Lane	Directional Ramps	Loop Ramps	Lake Mead Parkway
Minimum Vertical Clearance - New Bridges	16'-6"	16'-6"	16'-6"	16'-6"	16'-6"	16'-6"
CROSS SECTION						
Travel Lane Width	12'	12'	12'	12'	12'	12'
Turn Lane Width	N/A	N/A	N/A	N/A	N/A	
Minimum Right Shoulder Width						
1-2 Lanes	N/A	N/A	N/A	8'	8'	N/A
3 or More Lanes	12' Preferred 10' Minimum	12' Preferred 10' Minimum	N/A	12' Preferred 10' Minimum	N/A	4'
Left Shoulder Width						
1-2 Lanes	N/A	N/A	12' Preferred 10' Minimum 8' with high-mast	4'	4'	N/A
3 or More Lanes	12' Preferred 10' Minimum 8' with high-mast	12' Preferred 10' Minimum 8' with high-mast	N/A	12' Preferred 10' Minimum	N/A	0
Normal Crown Cross Slope (%)	2	2	2	2	2	2
New Bridge Shoulder Width	Match Road Pref; 4' Minimum	Match Road Pref; 4' Minimum	Match Road Pref; 4' Minimum	Match Road Pref; 4' Minimum	Match Road Pref; 4' Minimum	Match Road Pref; 4' Minimum
Retained Bridge Shoulder Width						
Right	2'	2'	N/A	2'	N/A	N/A
Left	2'	2'	N/A	2'	N/A	N/A
Roadside Slopes	2019 NDOT Road Design Guide Section 3.12					
Roadside Barrier	Single Slope per NDOT 2020 Standard Plans/Retain existing barriers where not impacted by design					
Roadside Guardrail	NDOT 2020 Standard Plans					
Roadside Cable Rail	Not used on this project					
Roadside Safety – Clear Zone	AASHTO Roadside Design Guide 2011, Table 3-1					

APPENDIX B - Drainage

Drainage Design Memorandum will be developed in a later design development phase

APPENDIX C - Structures

Structures Design Criteria

As this project moves forward into preliminary and final design, the following criteria should be used to further evaluate and refine the bridge configurations and types as more information becomes available. As the project moves from preliminary to final design, a formal Basis of Technical Design memorandum will be prepared to guide the detailed design.

Structures Standard References

LRFD Bridge Design Specifications, Customary U.S. Units, 8th Edition, by the American Association of State Highway and Transportation Officials (AASHTO). This document, referred to as the LRFD Specifications, serves as the basis for the design of new bridges.

Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition, by the American Association of State Highway and Transportation Officials (AASHTO)

Structures Manual, 2008 with revisions through 2019. Nevada Department of Transportation. This document defines NDOT policy and procedures as they are applied to the design of structures.

Project-Specific Structures Criteria

As described in Article 1.3.5 of the LRFD Specifications, new bridge structures will be considered "typical" with an operational importance factor of 1.00 for the strength limit state. For the Extreme Event I limit state, γ_{EQ} shall be set equal to 0.25.

Design live loading for the new bridges will be HL-93 per the LRFD Specifications with overload provisions accommodating a Caltrans P13 permit vehicle.

Structures Clearance Requirements

The following minimum vertical clearances are to be provided, consistent with NDOT's 2008 *Structures Manual*, Figure 11.9-A.

TABLE
Minimum Vertical Bridge Clearance
See Structures Manual Figure 11.9-A for additional information

Facility Type	New/Replaced Bridges	Rehabilitated/ Existing Bridges to Remain	Temporary Structures (Falsework)
Freeway, Arterial, Collector or Local Road Under	16'-6"	16'-0"	16'-0" *

* Temporary structures with 18'-0" clearance or less shall be required to have a protective system in place during construction.

Maintenance and Serviceability

Long term maintenance and serviceability need to be considered during the type selection process, and conditions resulting in unusual long-term maintenance requirements or inhibiting access for bridge inspections should be avoided. Critical components must be accessible for inspection either from ground level or by utilizing the Department's under bridge inspection vehicle. Components should be durable, and those anticipated requiring service during the life of the structure (joint seals and bearings, for example) should be designed to be easily removed and replaced without extraordinary measures.

Aesthetics

Bridge aesthetics will be consistent with guidelines established in a subsequent development phase for this project.

Seismicity

Seismic design shall be in accordance with the AASHTO LRFD Bridge Design Specifications and the AASHTO Guide Specifications for LRFD Seismic Bridge Design. Seismic detailing shall be in accordance with Seismic Design Category C (minimum) regardless of computed category.

For Clark County, NDOT Structures Manual defines a minimum peak ground acceleration (PGA) of 0.15g, a short period spectral acceleration coefficient (S_s) of 0.40 and a long period spectral acceleration coefficient (S_l) of 0.15. Site soil class and site-specific response spectra will be established during final design through field explorations performed at that time. Site-specific procedures will be required if any one of the following conditions are determined to exist during preliminary or final design:

- The site is located within 6 miles of an active fault
- The site is classified as Site Class F
- Long-duration earthquakes are expected in the region

Appendix 5

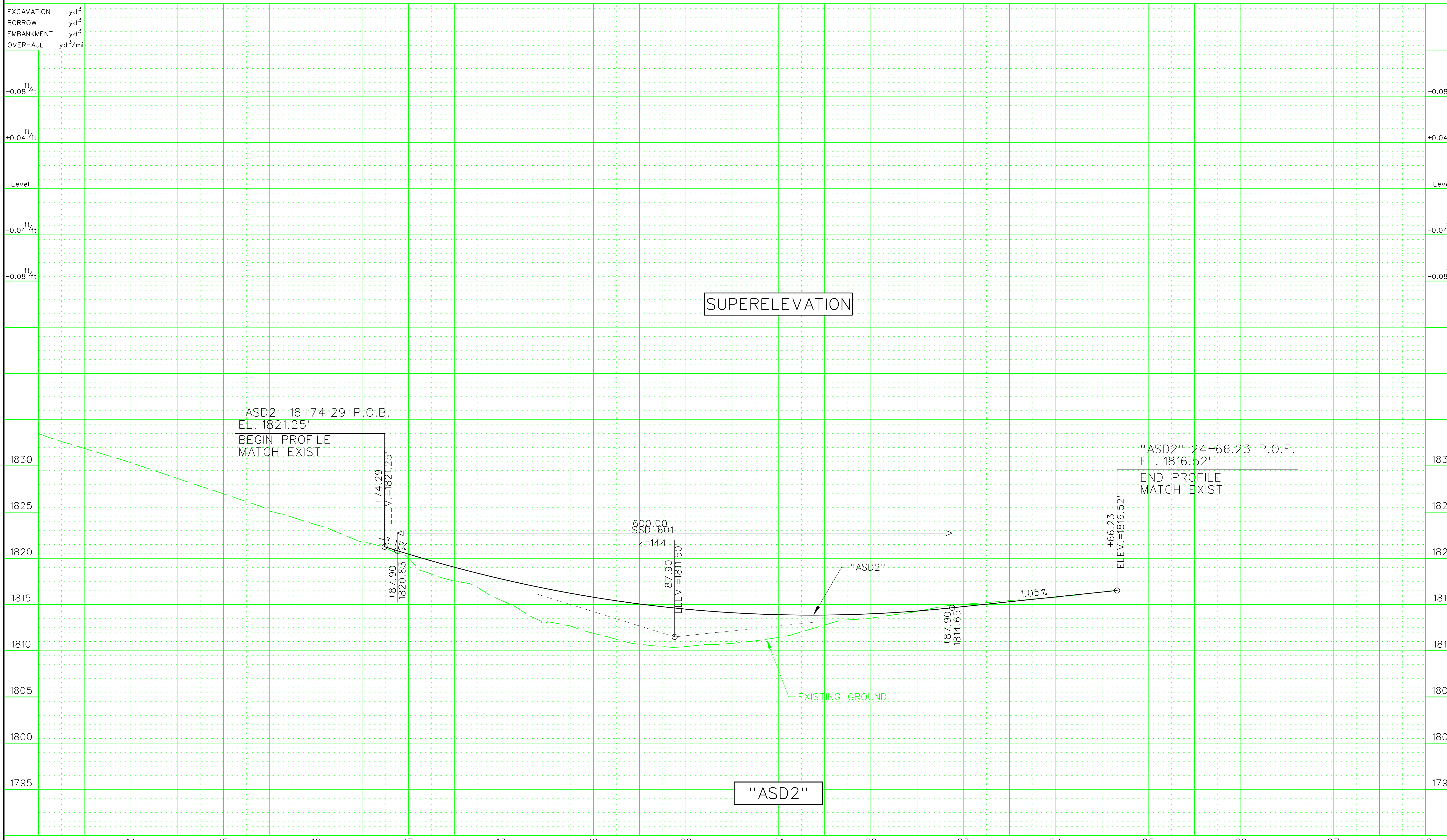
Option 2A Profiles

c:\pw-cagworkdir\ghirmai.eman\dms08937\ASD2_Opt2_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	01

PRELIMINARY

SUBJECT TO REVISION
1/15/2021

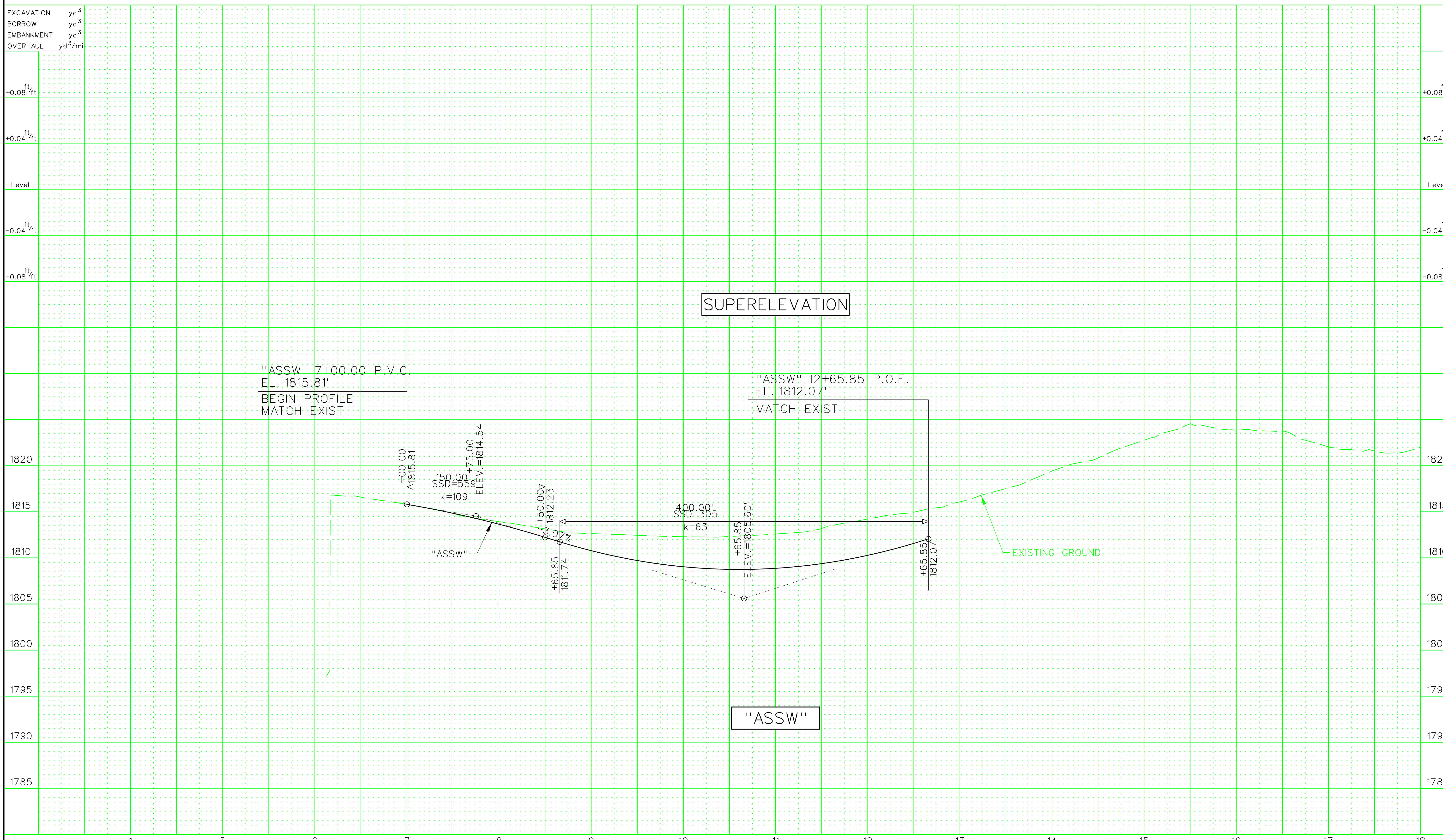


1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\ASSW_Opt2_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	02

PRELIMINARY
SUBJECT TO REVISION
1/15/2021

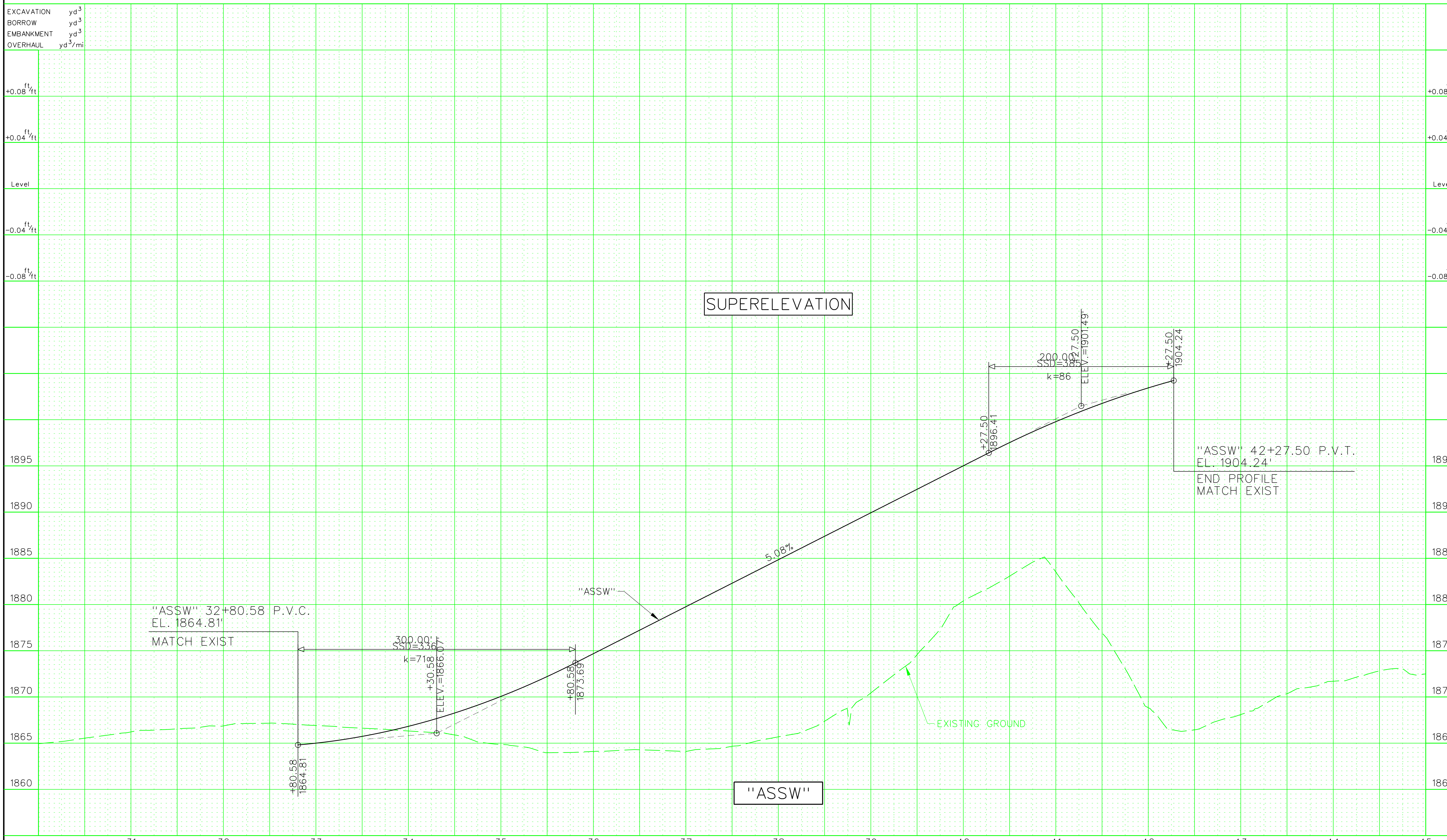


1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	03

PRELIMINARY

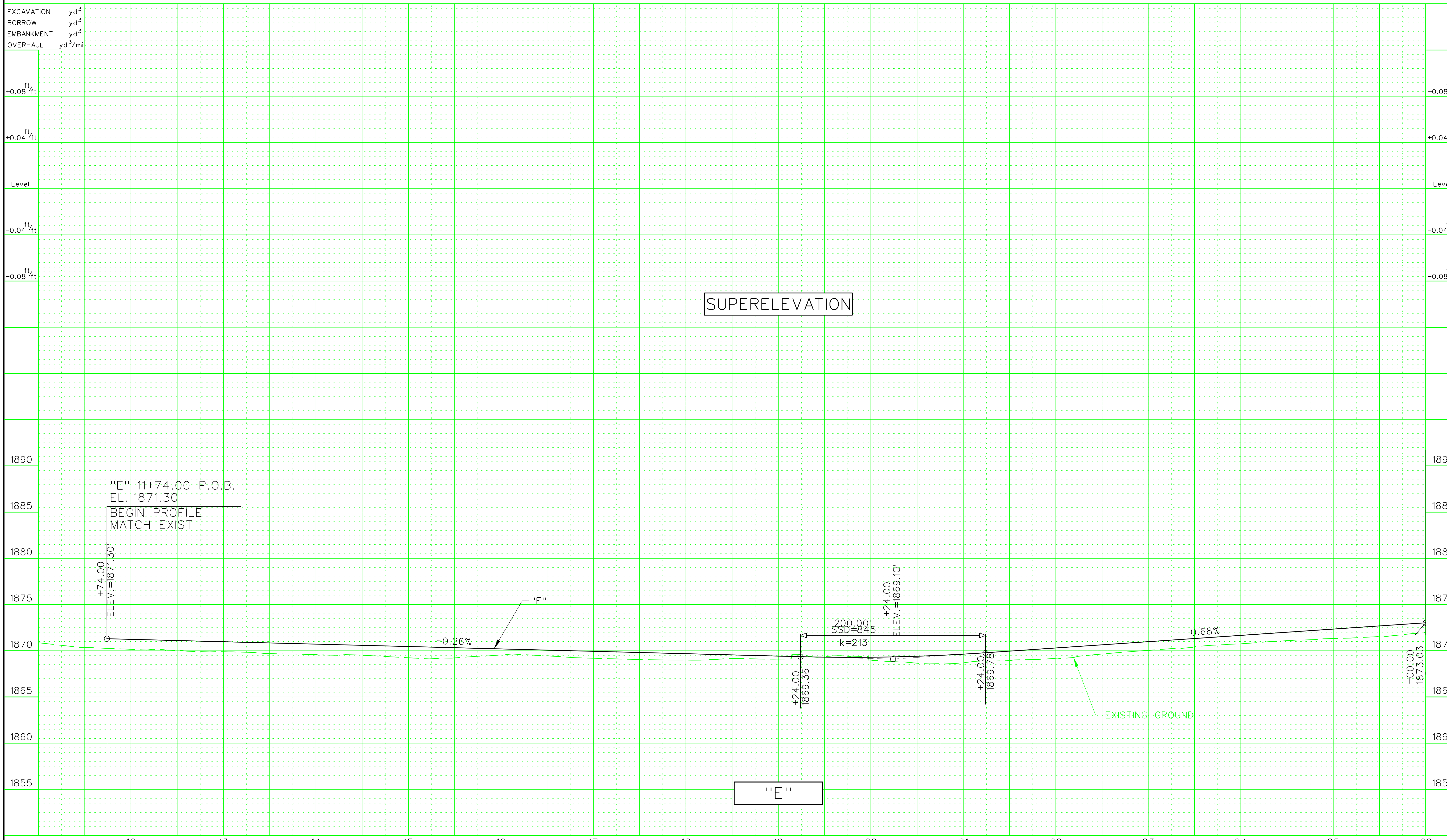
SUBJECT TO REVISION
1/15/2021



STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	04

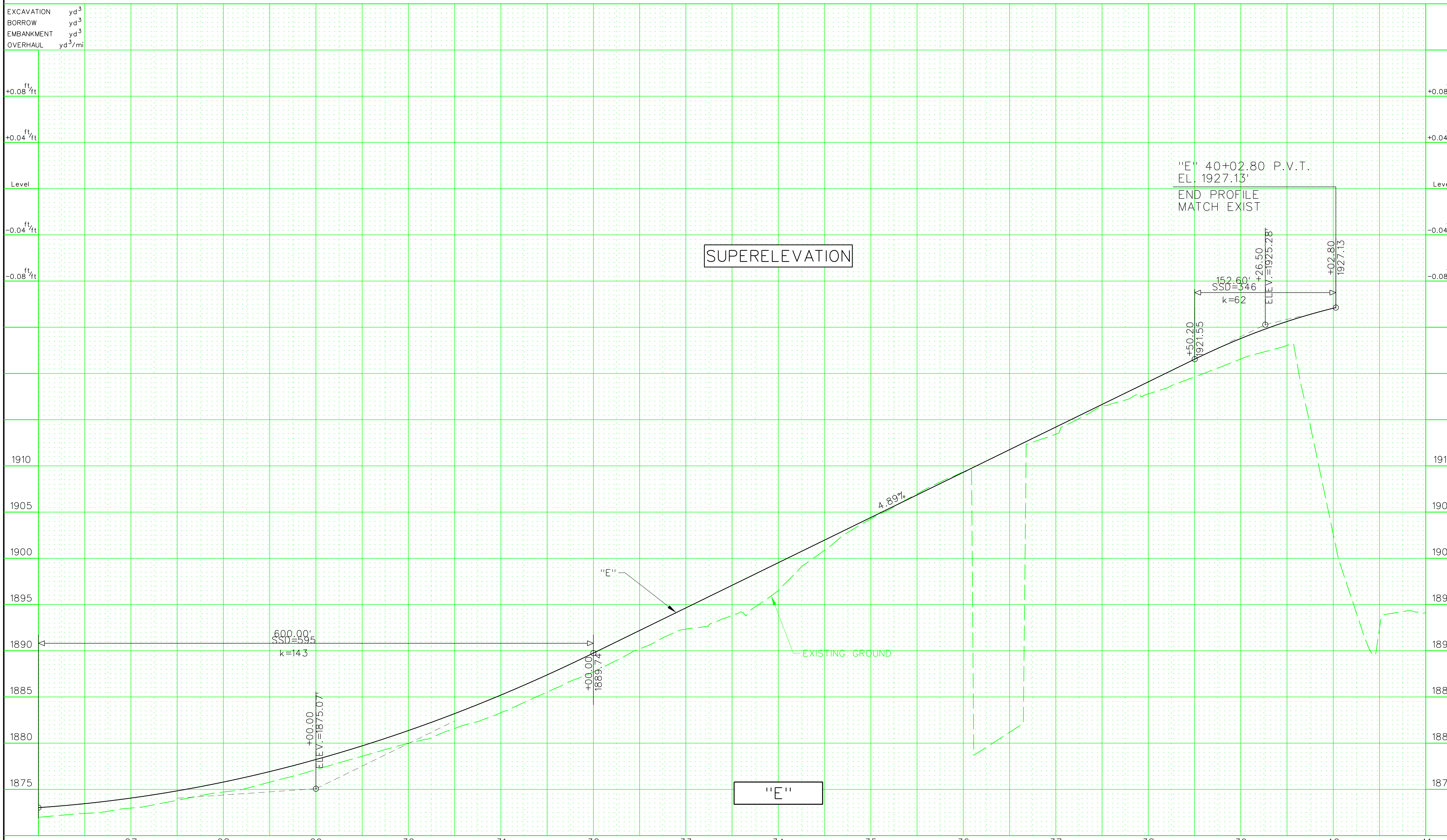
PRELIMINARY

SUBJECT TO REVISION
1/15/2021



STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	05

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



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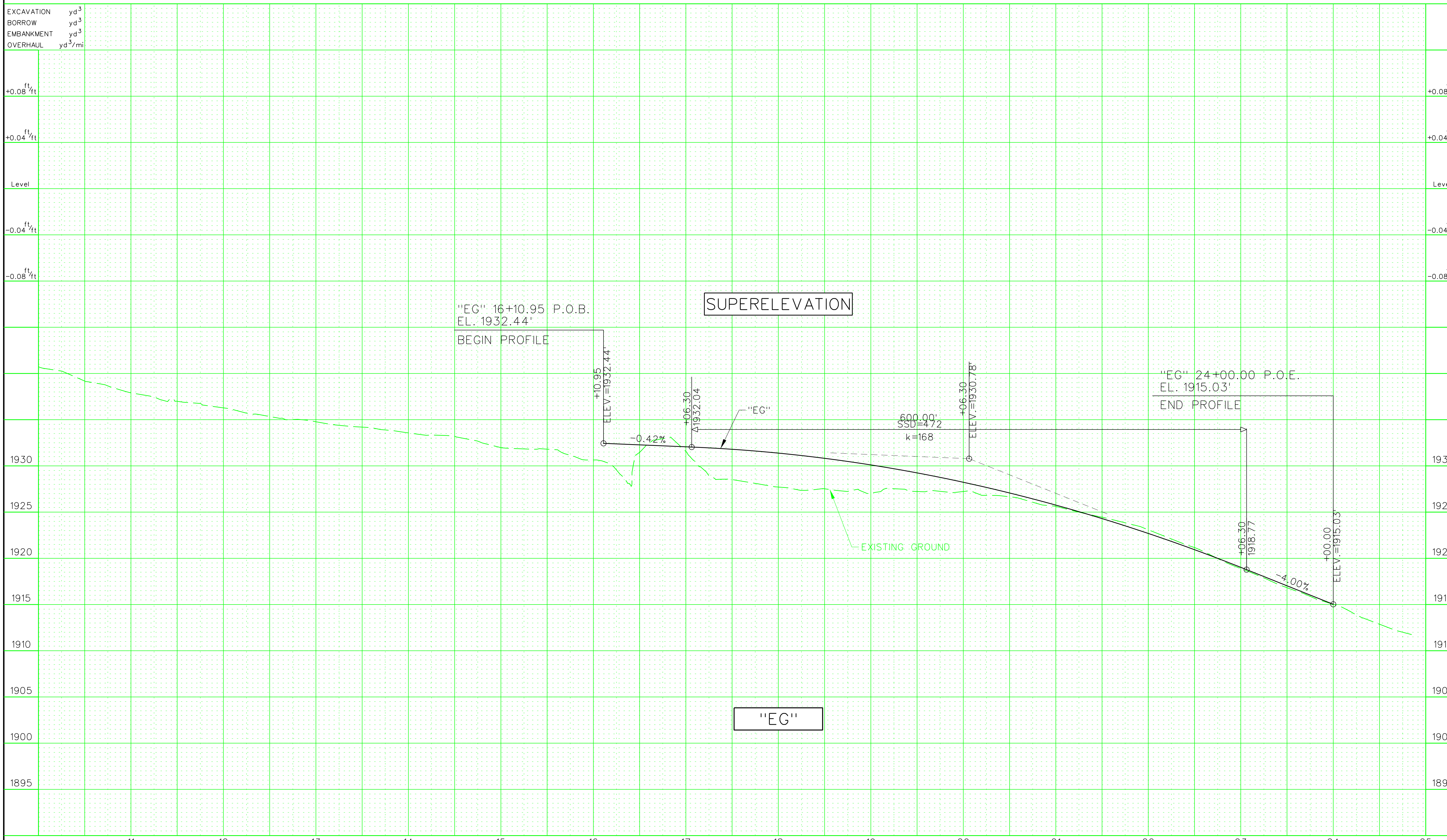
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	06

PRELIMINARY
SUBJECT TO REVISION
1/15/2021

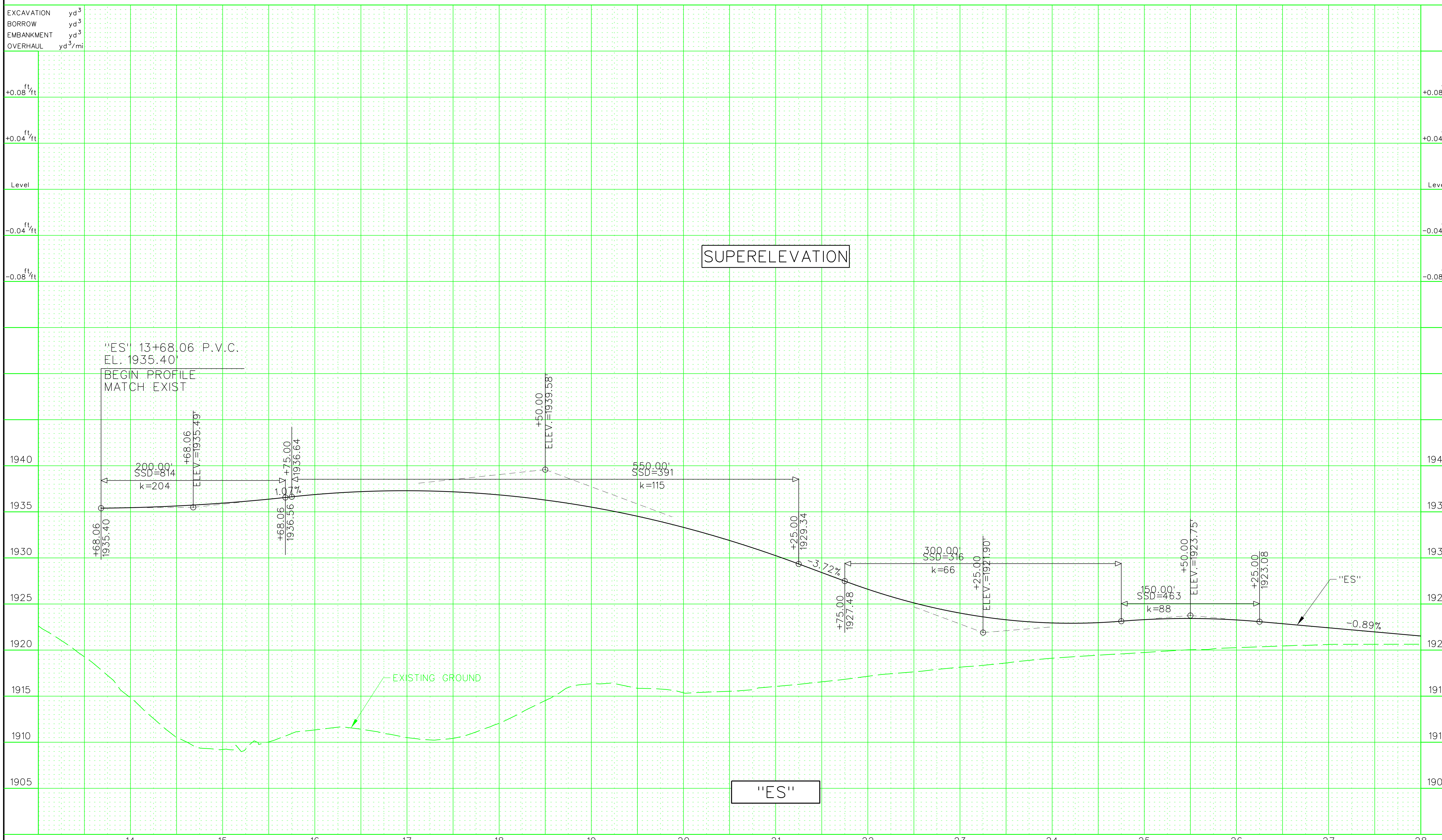


1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\ES_Opt2_Profile_01.dgn

PRELIMINARY
SUBJECT TO REVISION
1/15/2021

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	07



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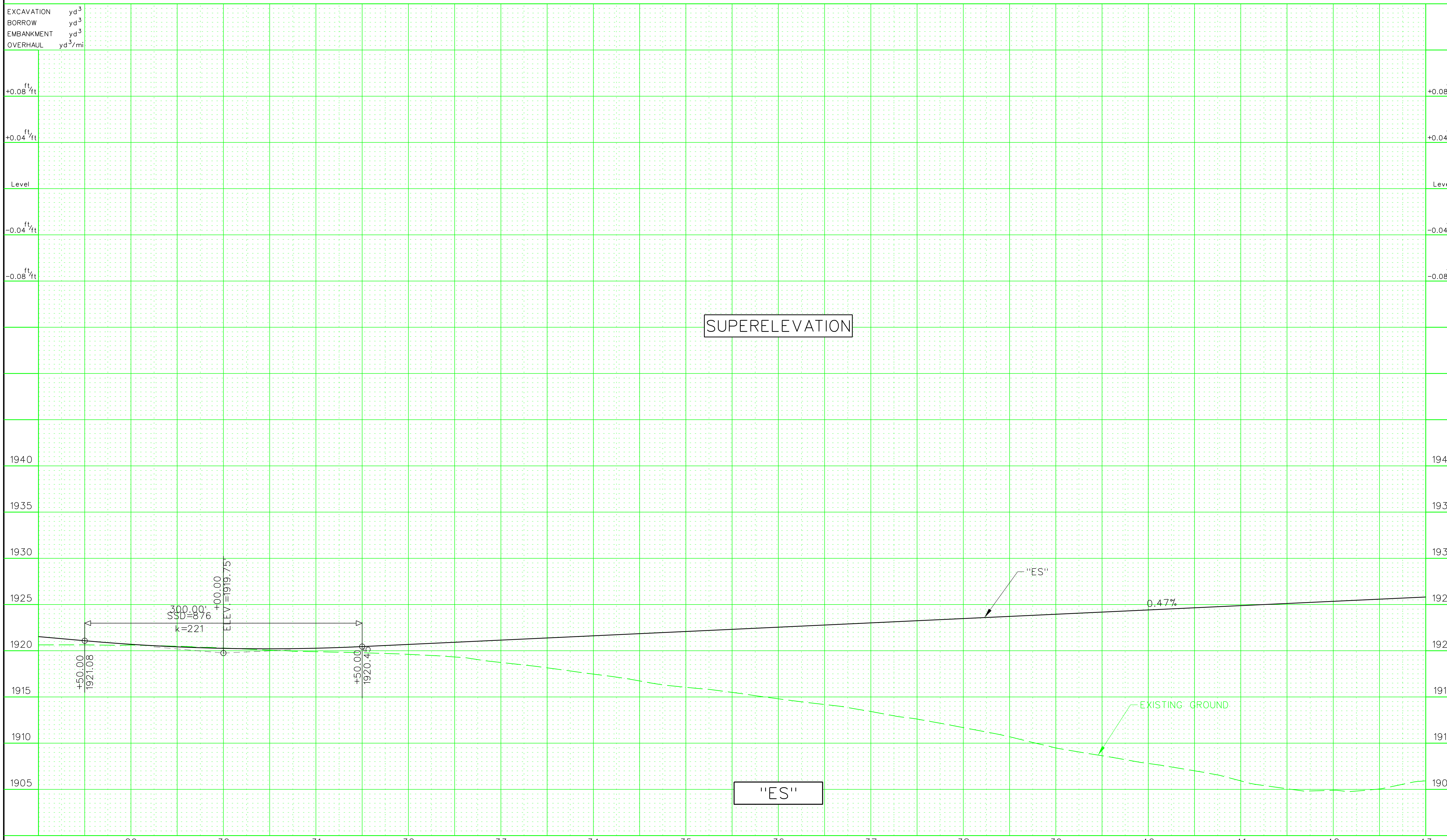
c:\pw-cagworkdir\ghirmai.eman\dms08937\ES_Opt2_Profile_02.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	08

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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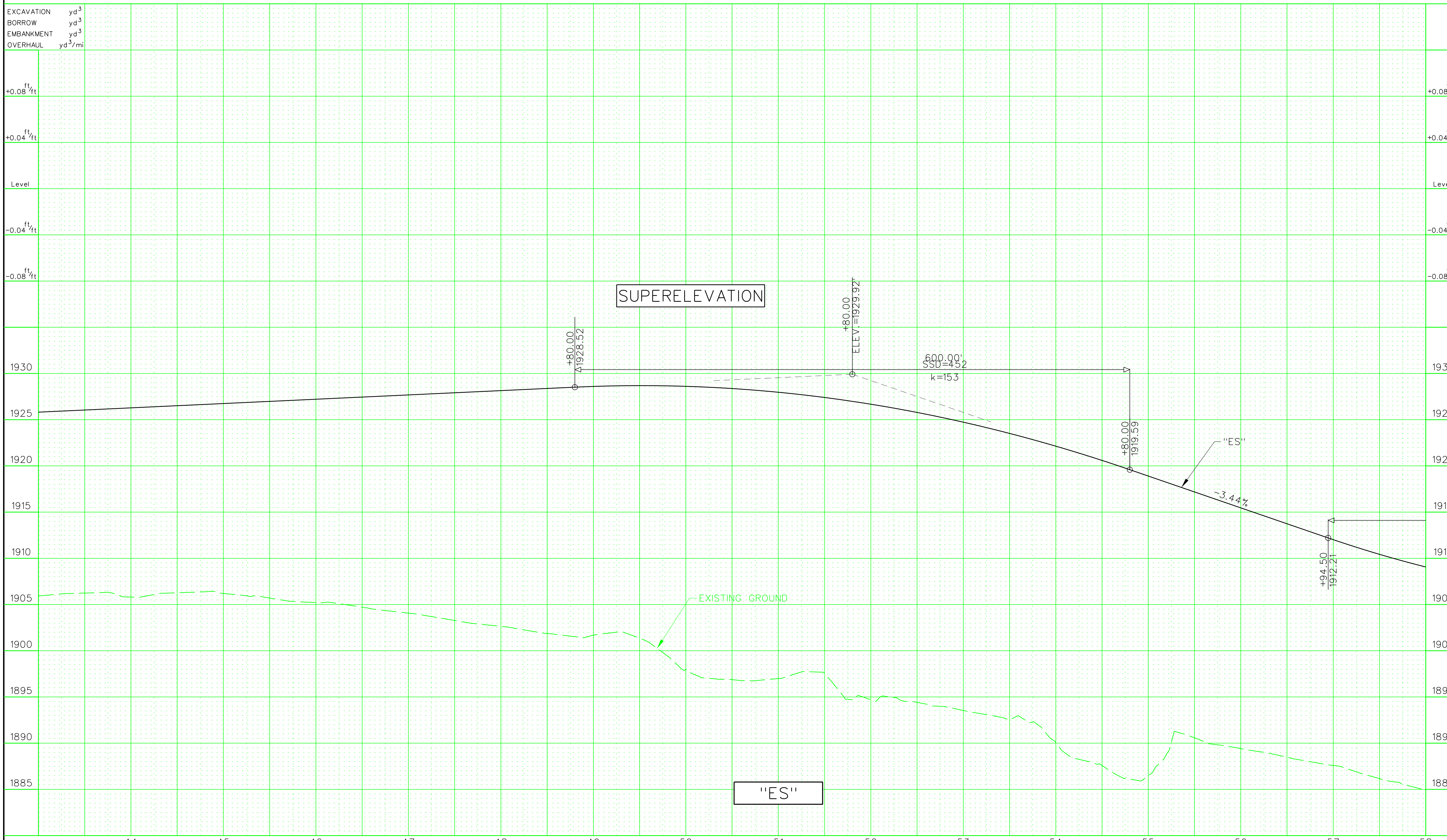
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	09

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



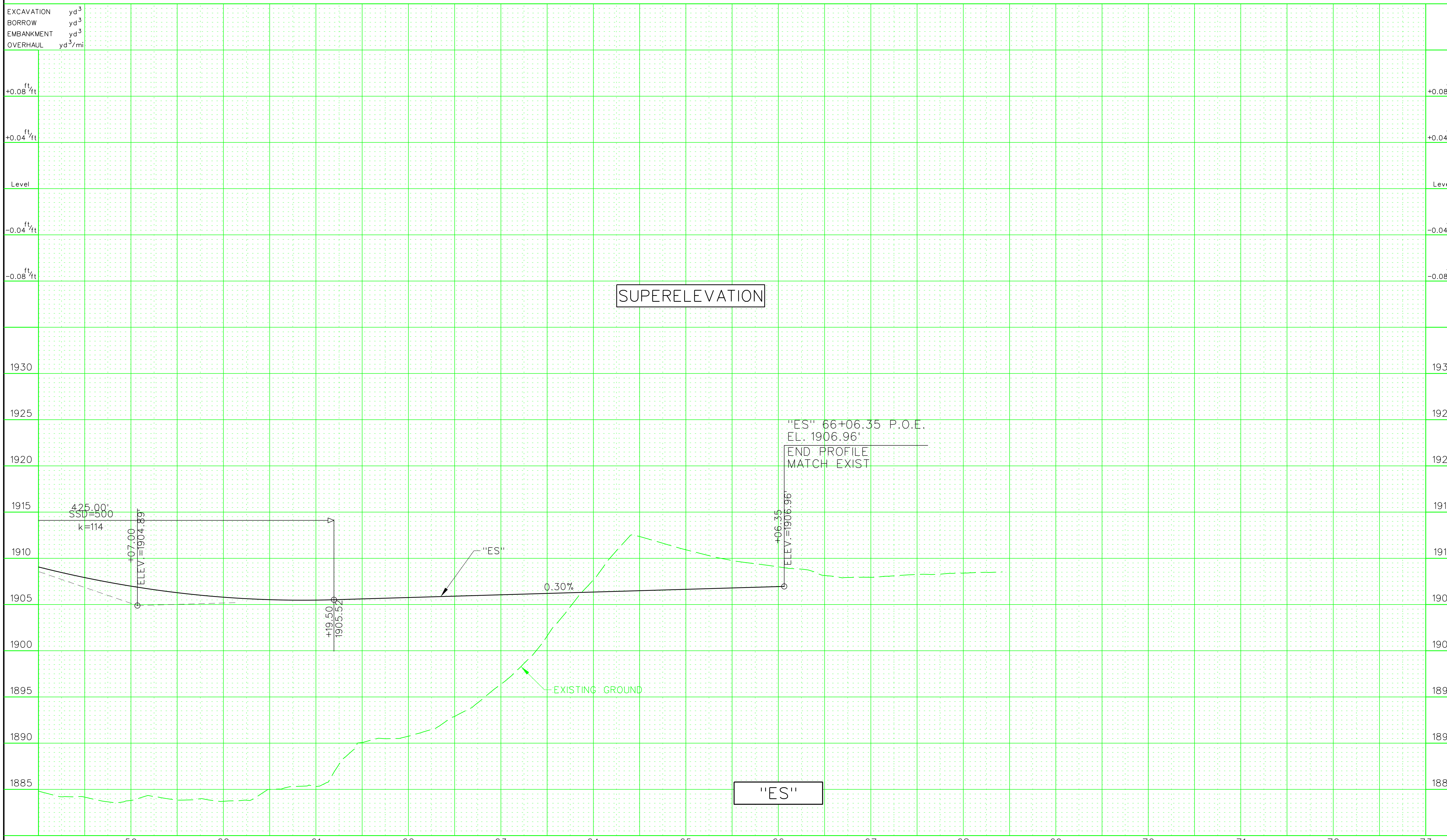
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\ES_Opt2_Profile_04.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	10

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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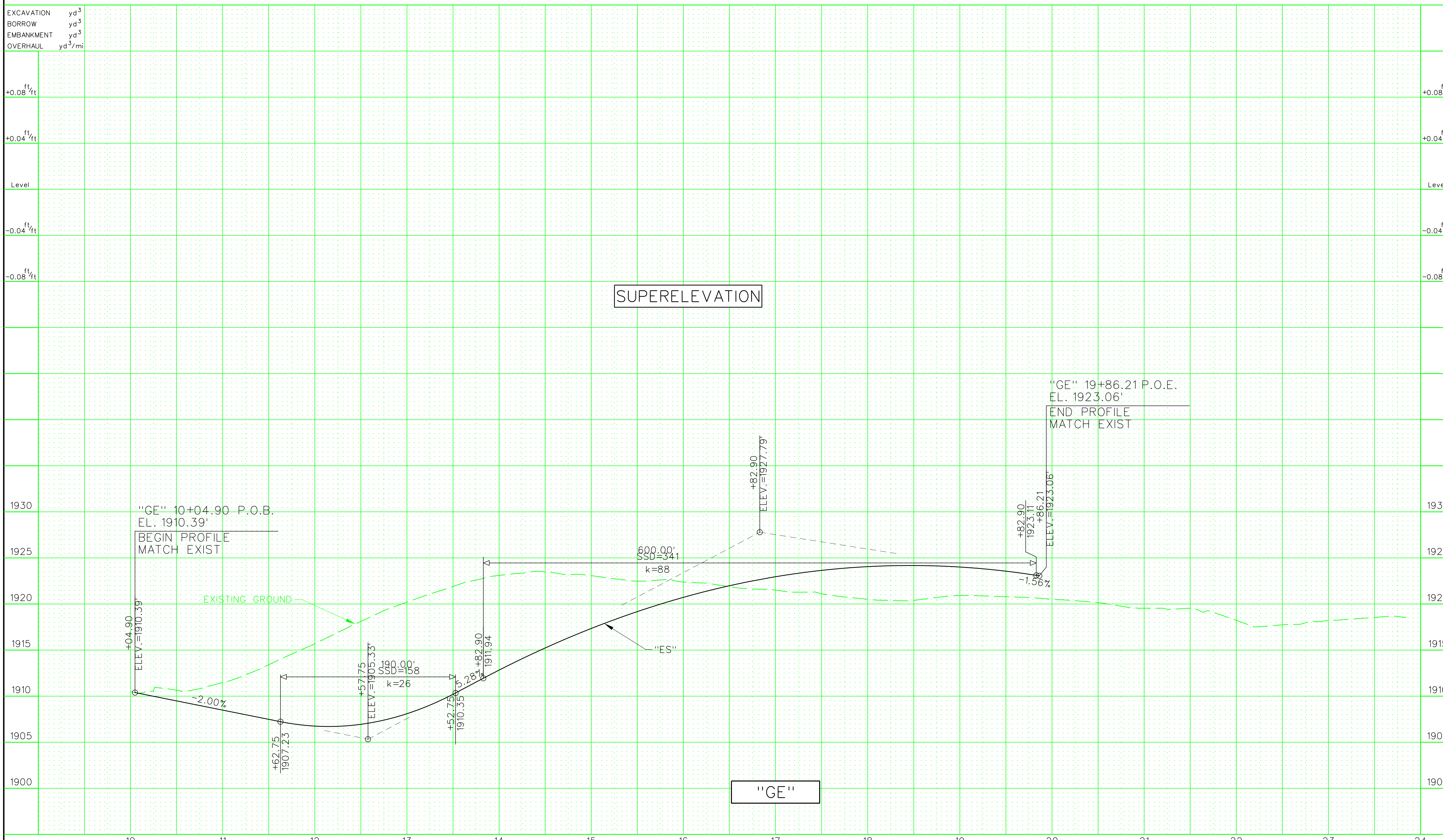
c:\pw-cagworkdir\ghirmai.eman\dms08937\GE_Opt2_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	11

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



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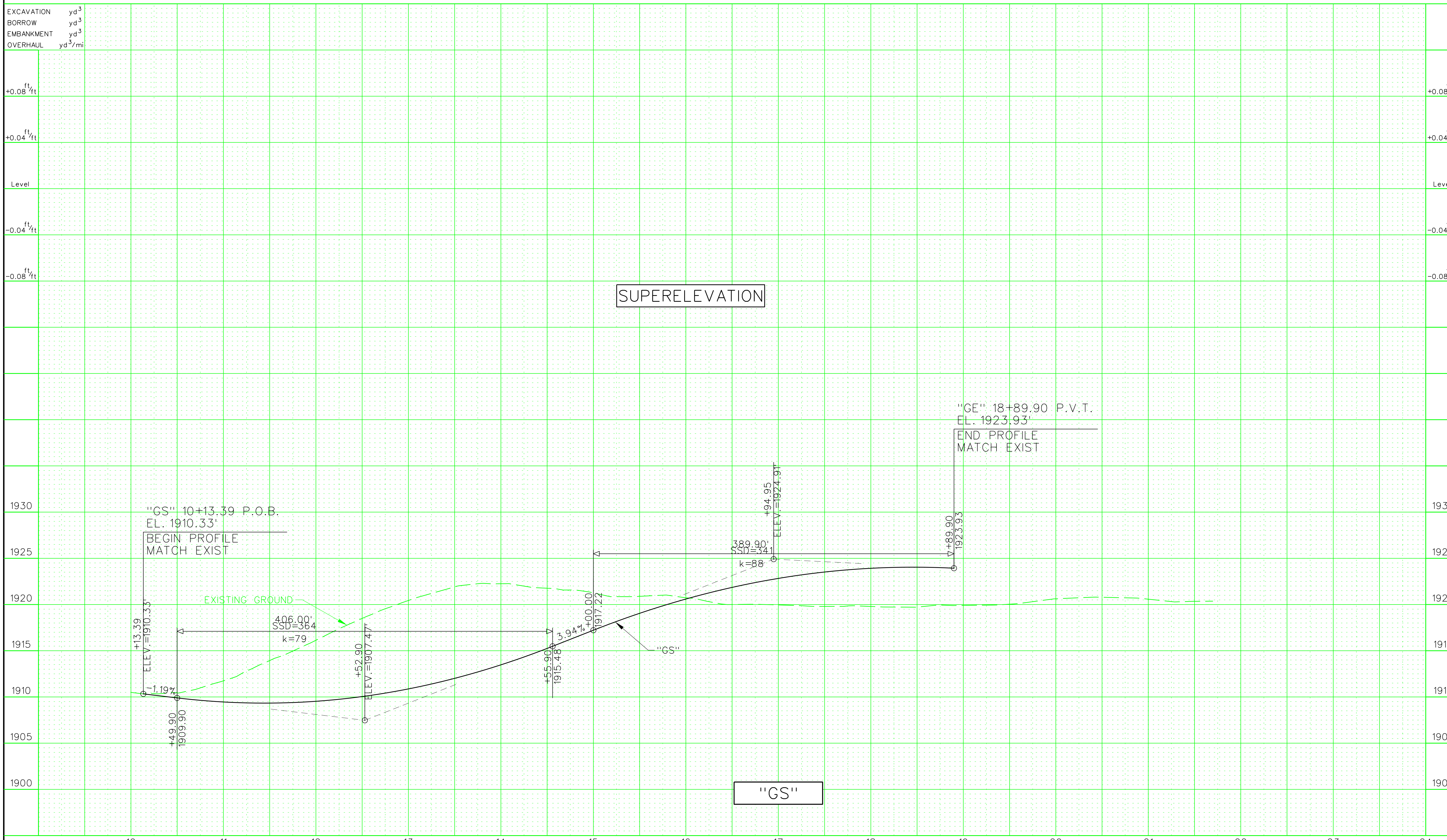
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	12

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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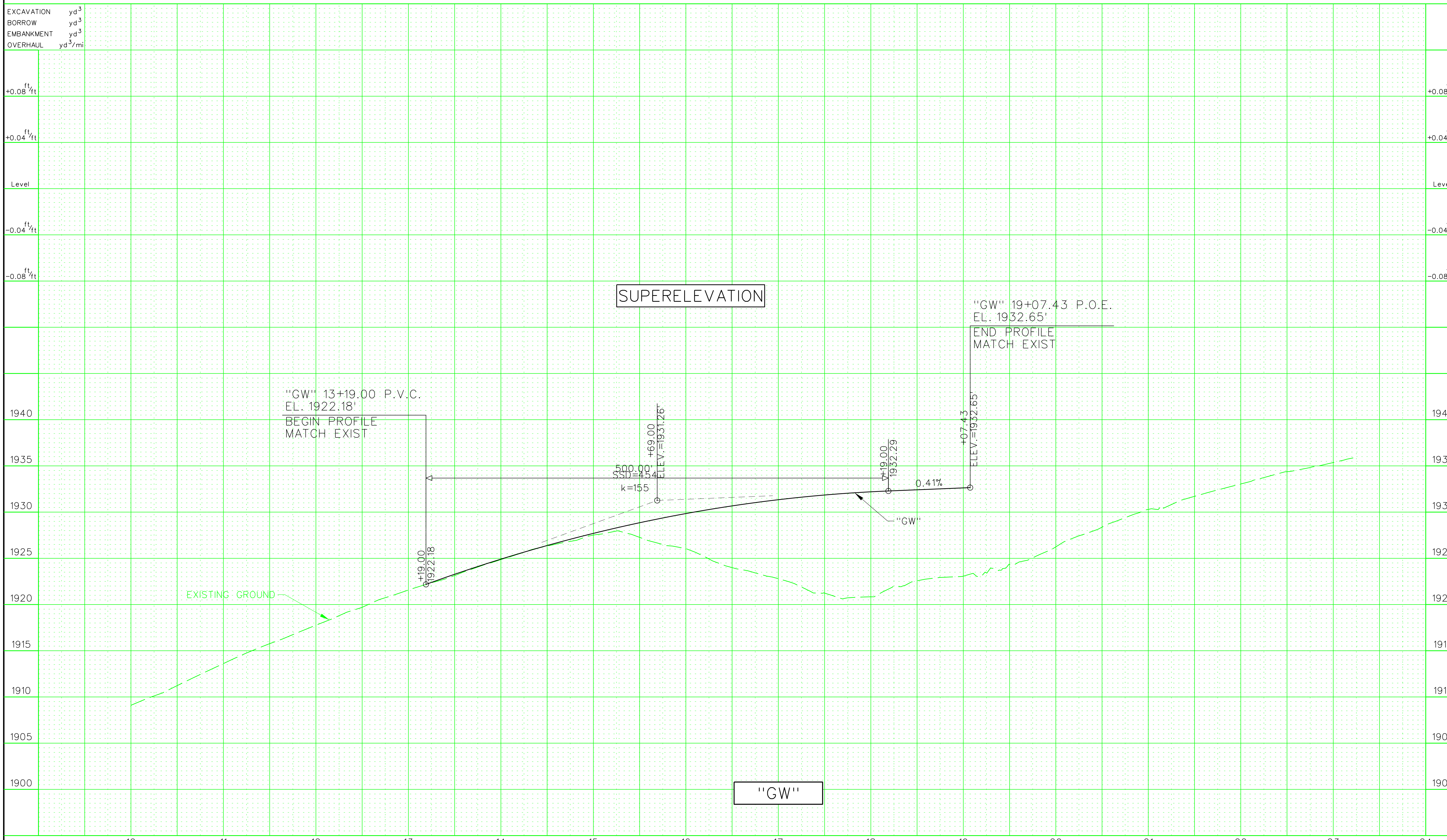
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	13

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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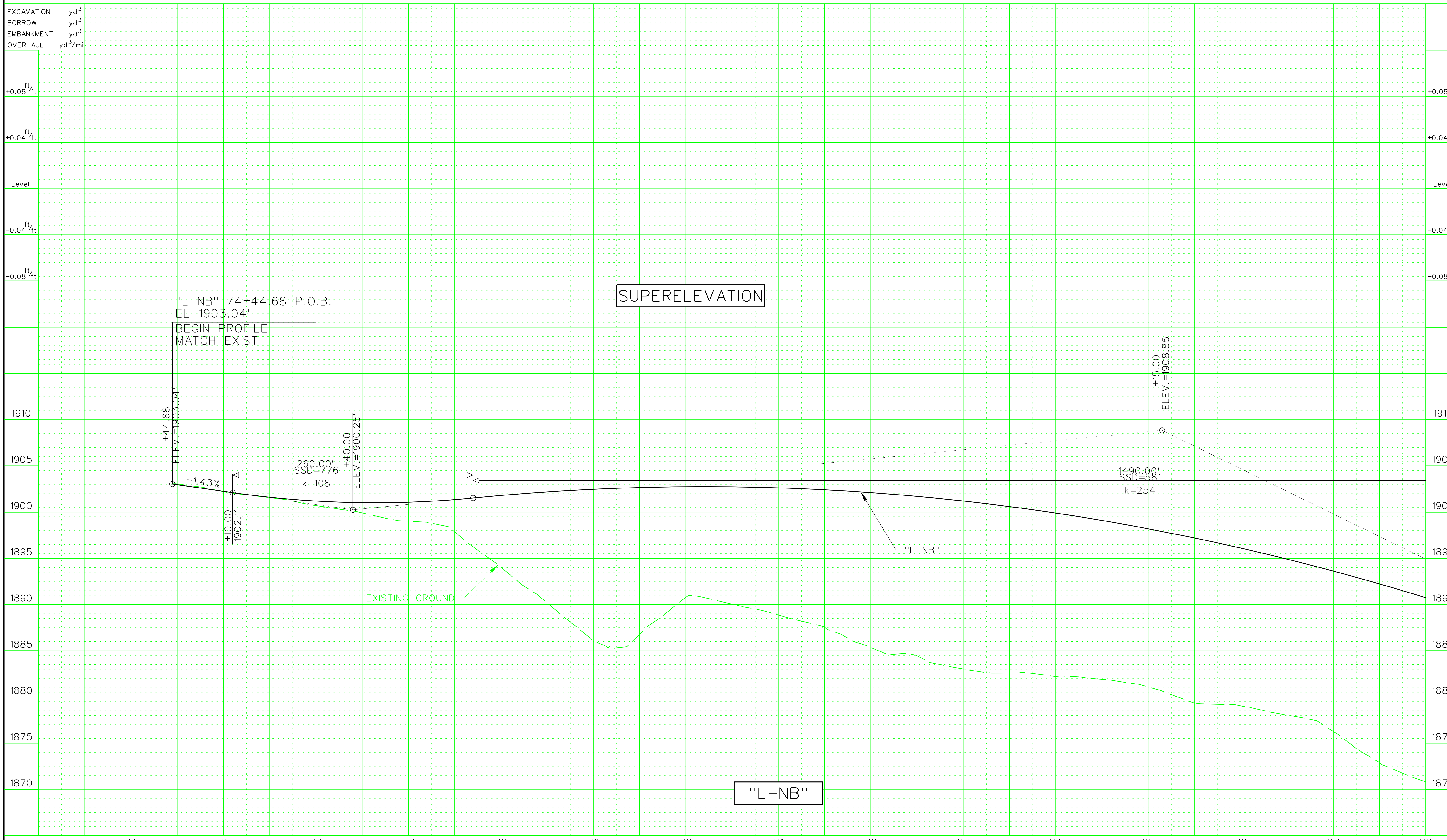
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	14

PRELIMINARY
SUBJECT TO REVISION
1/15/2021

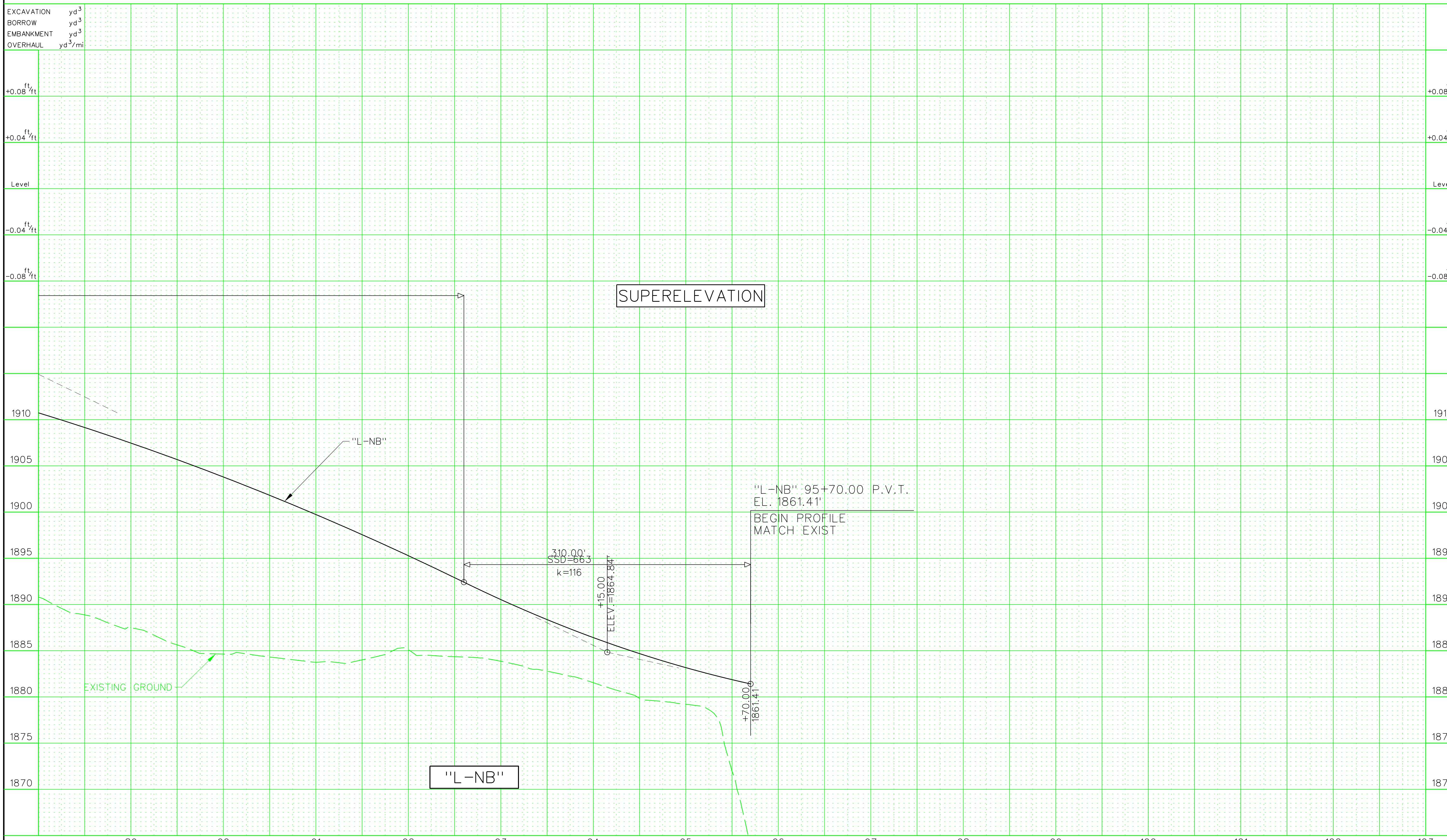


1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	15

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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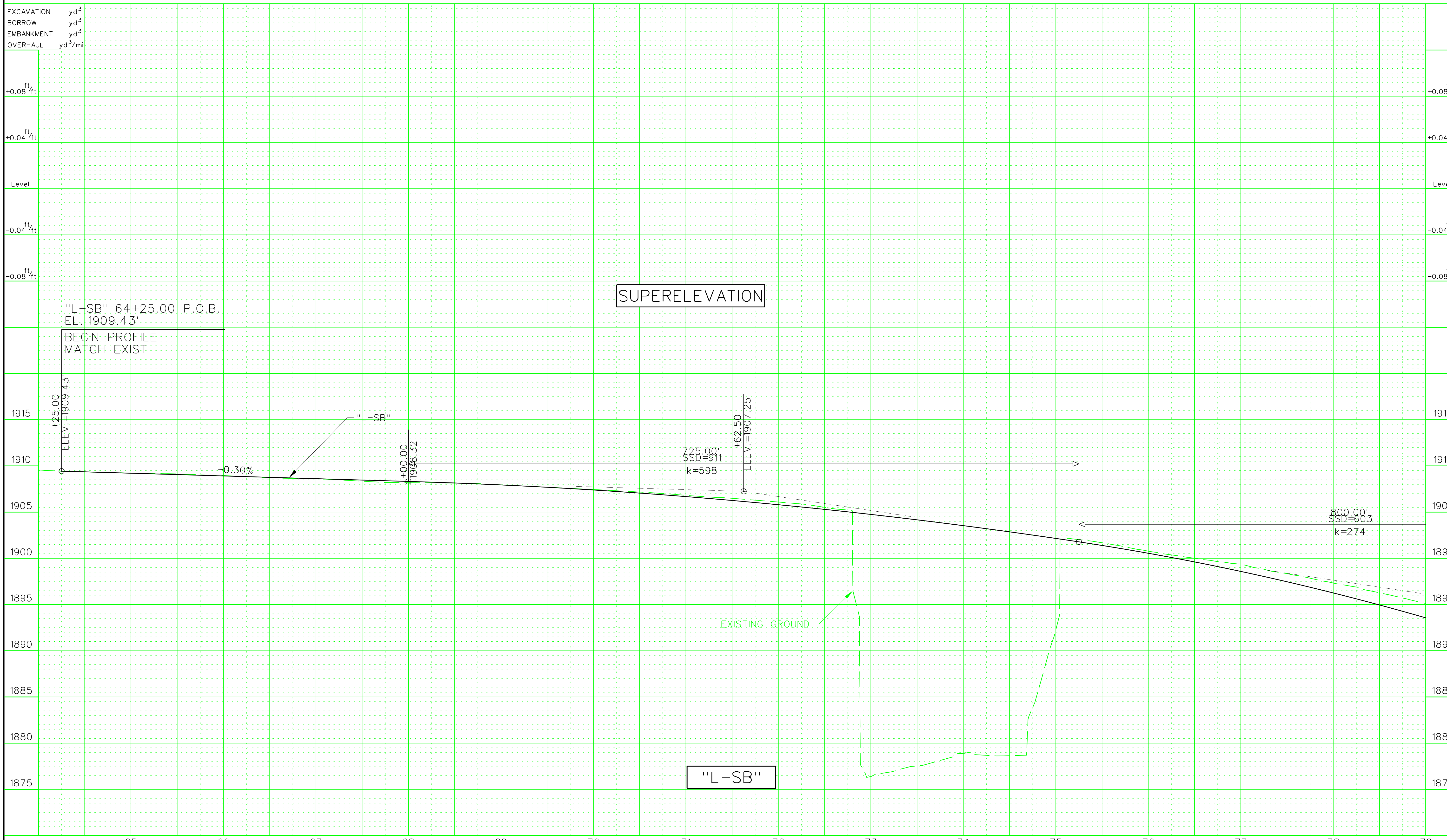
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	16

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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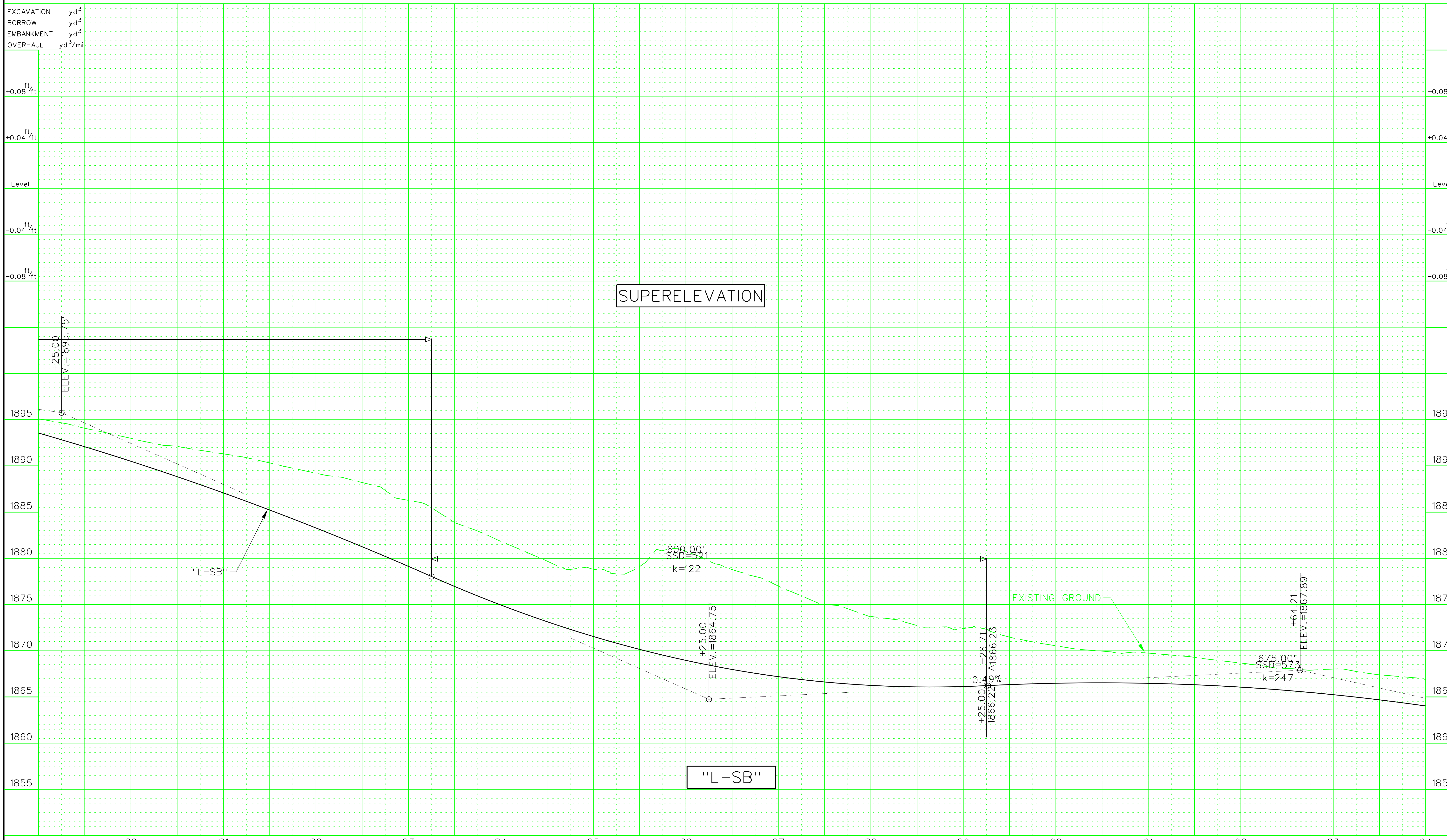
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	17

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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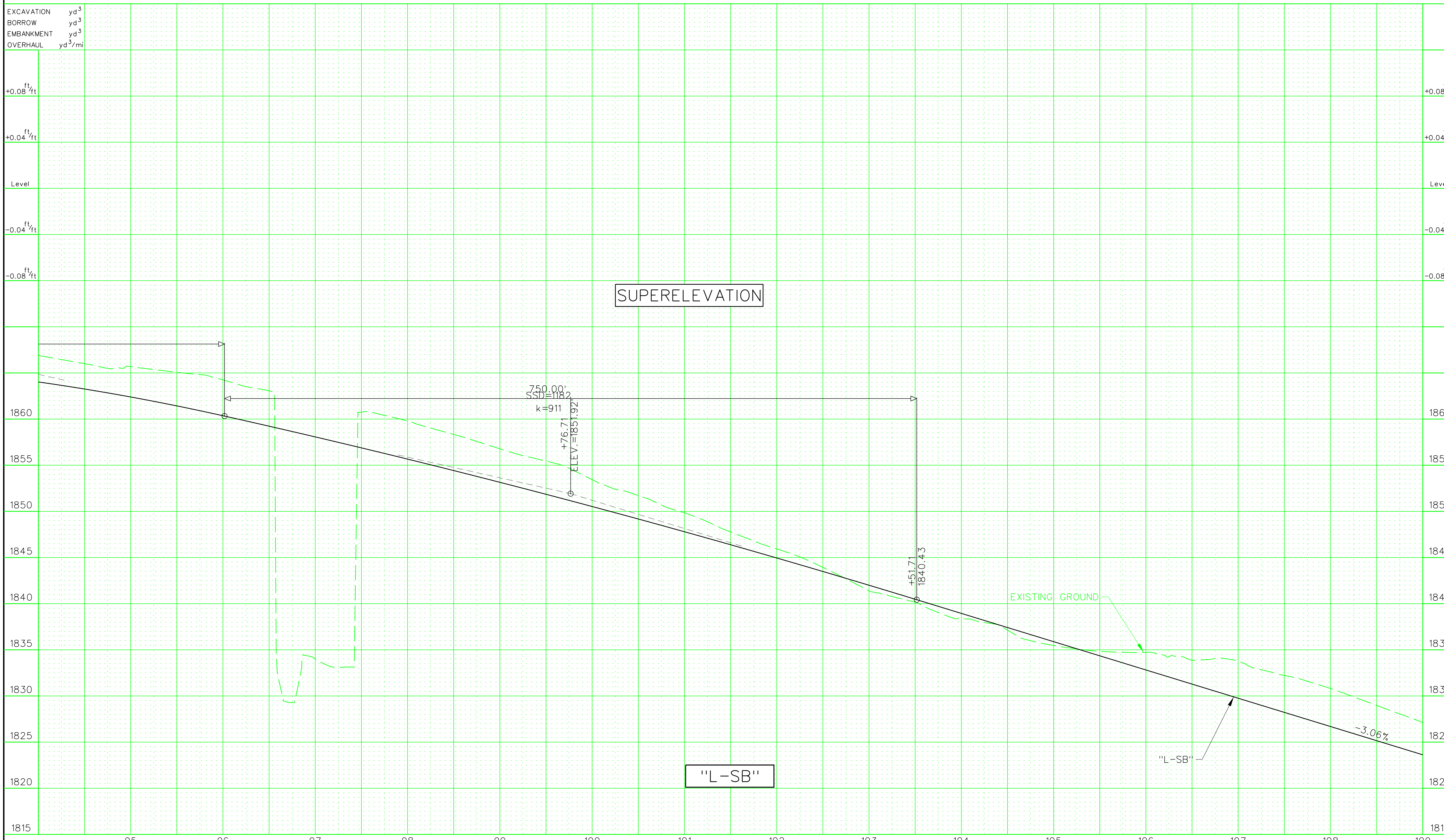
c:\pw-cagworkdir\ghirmai.eman\dms08937\LSB_Opt2_Profile_03.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	18

PRELIMINARY

SUBJECT TO REVISION
1/15/2021

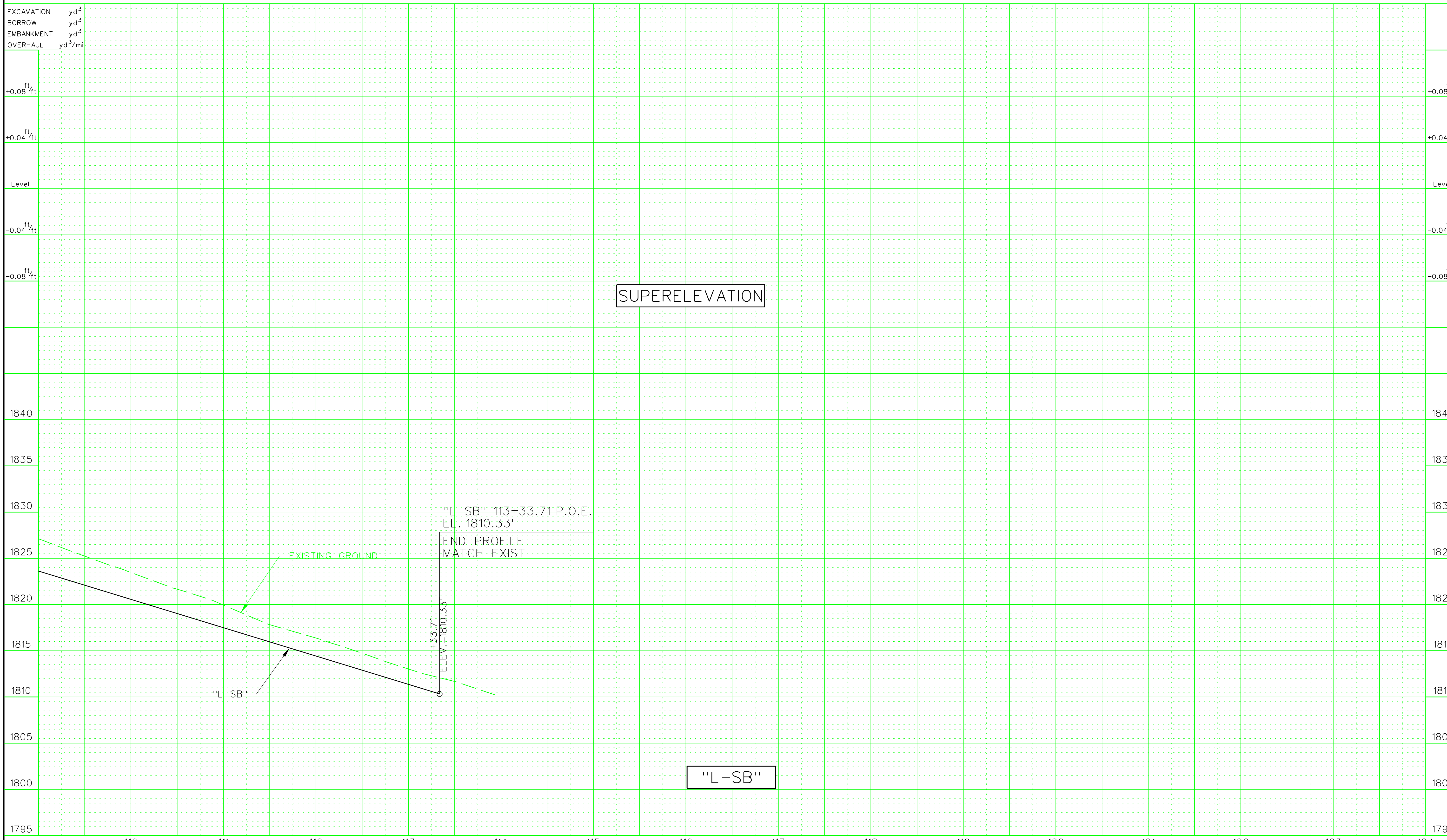


1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\LSB_Opt2_Profile_04.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	19

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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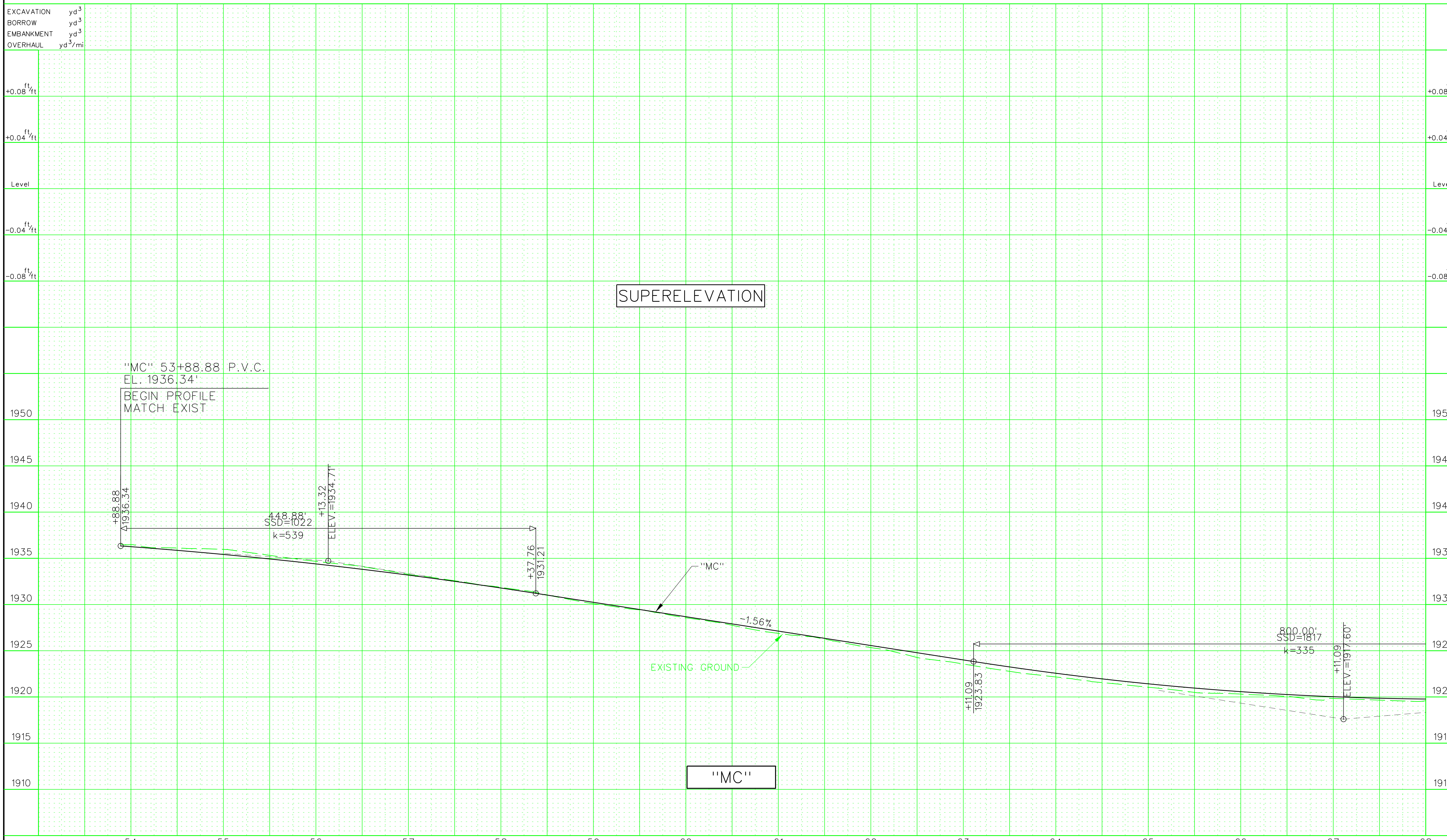
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	20

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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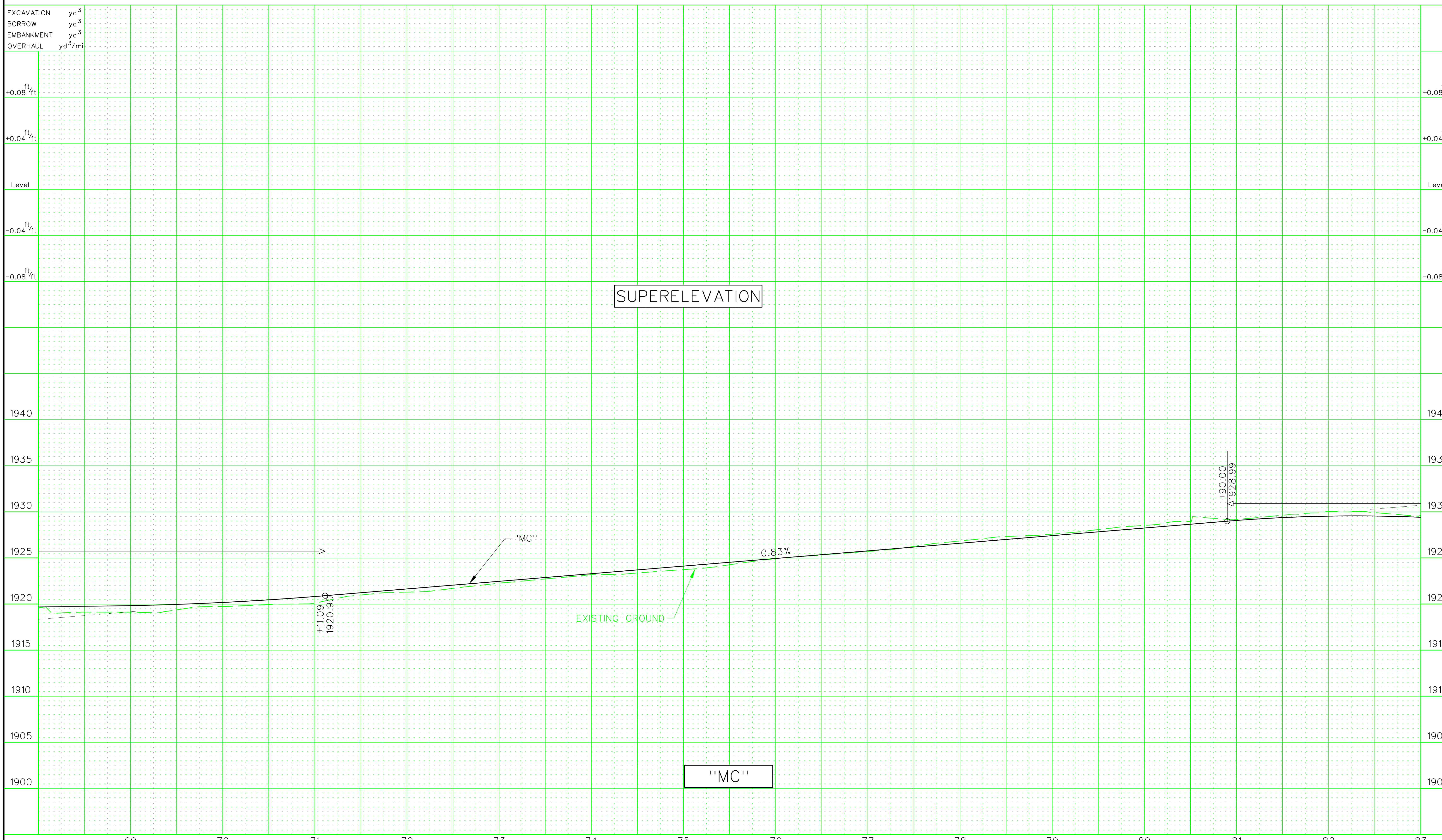
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	21

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



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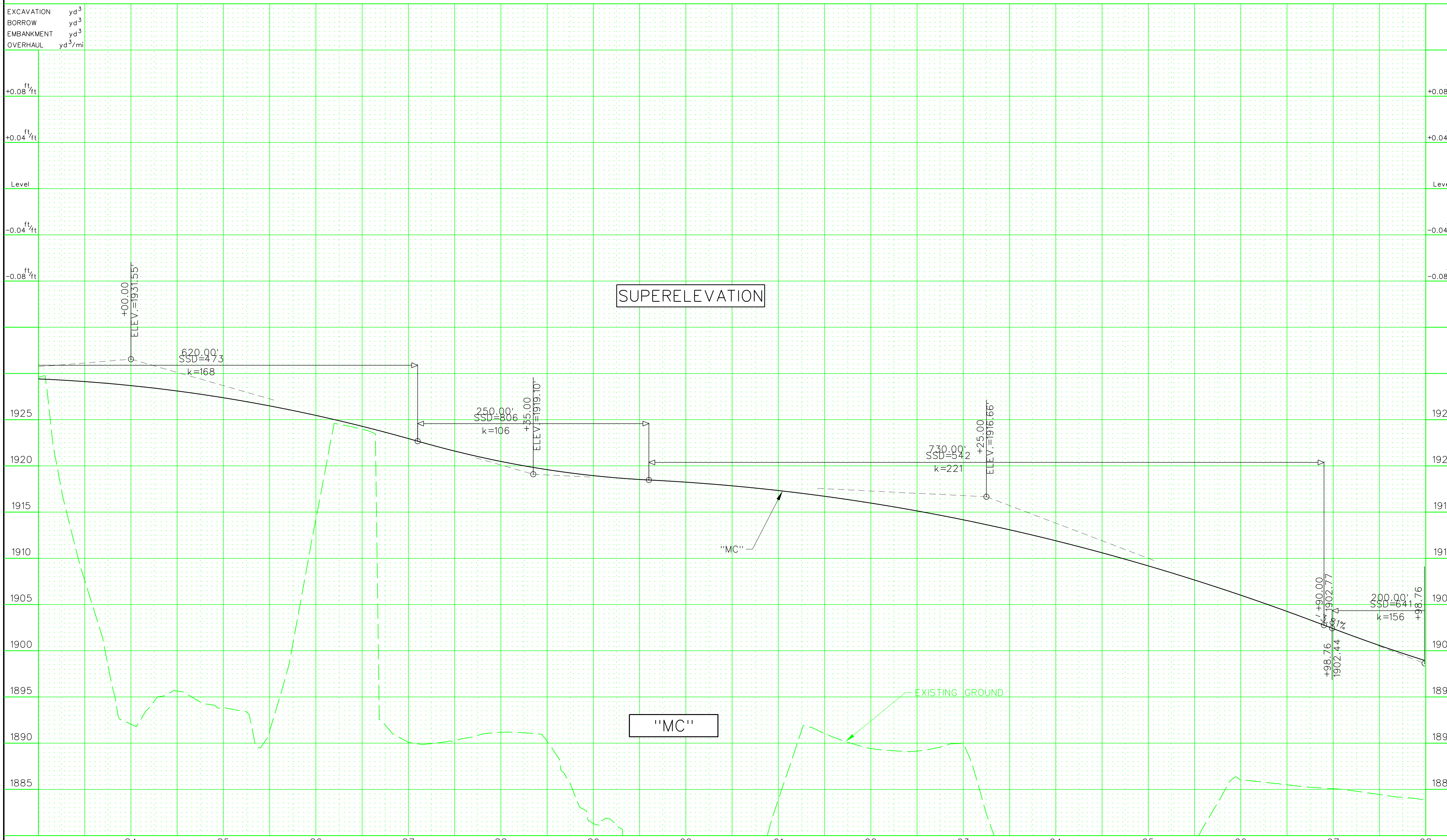
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	22

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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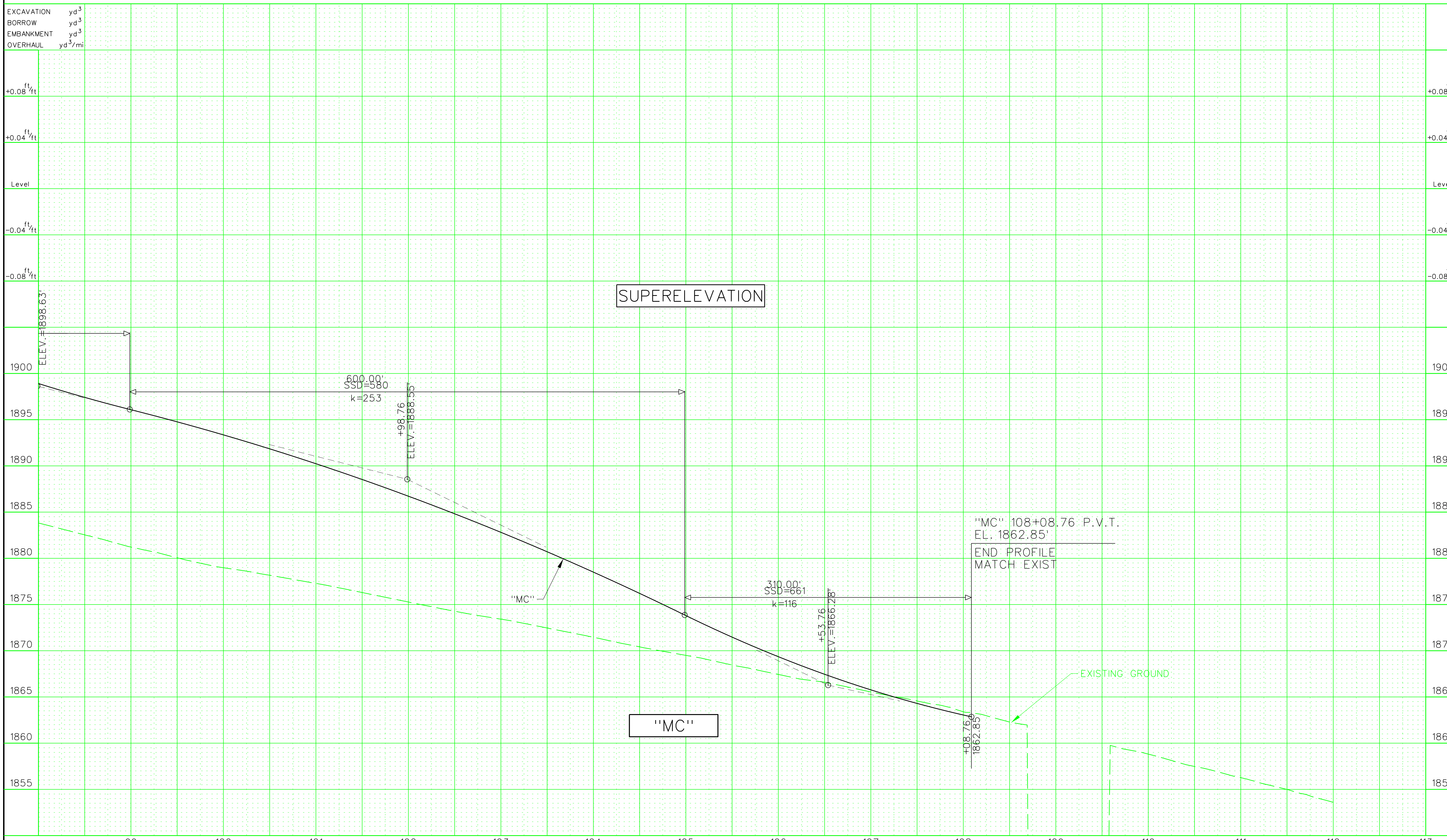
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	23

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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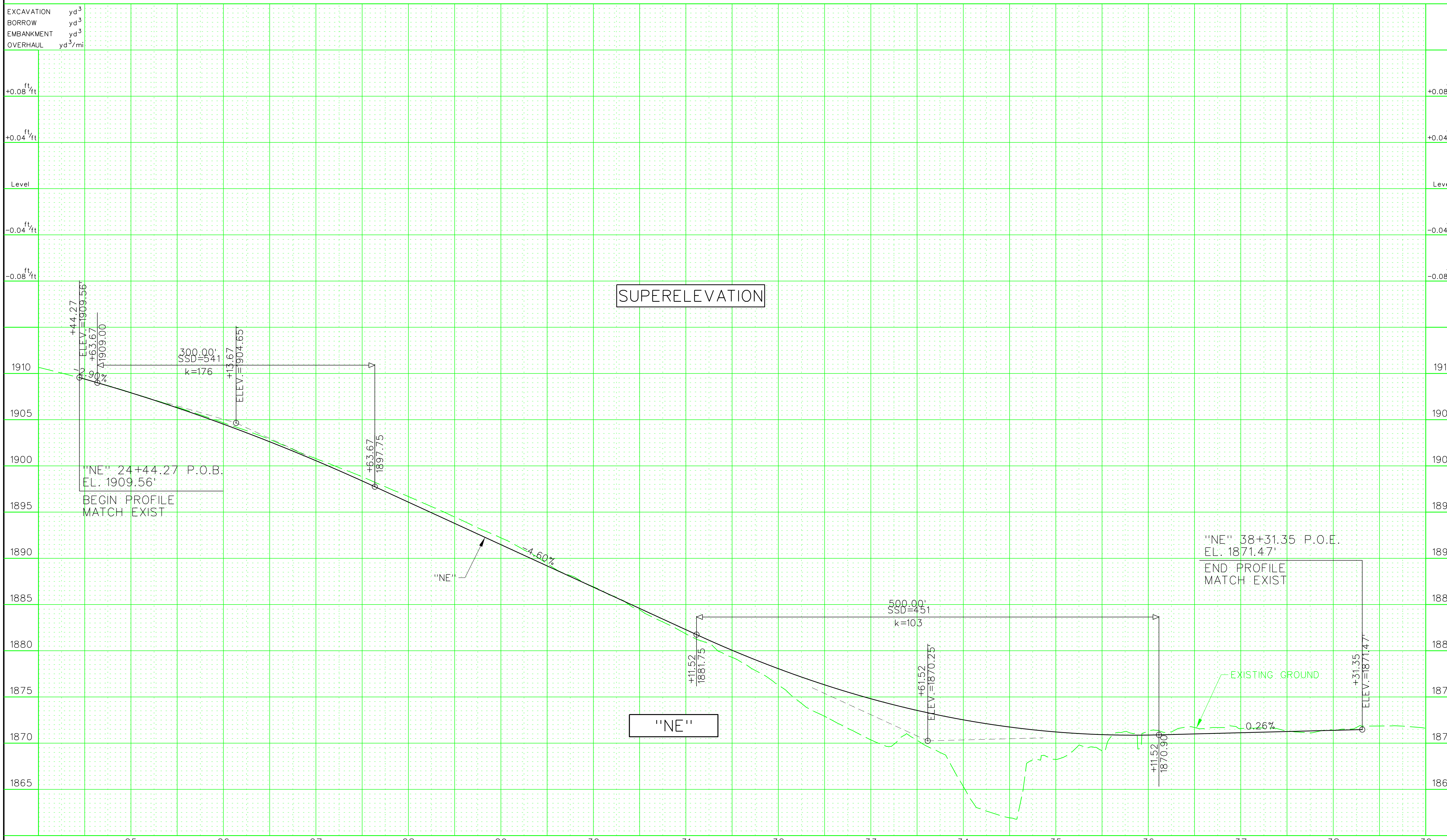
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	24

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



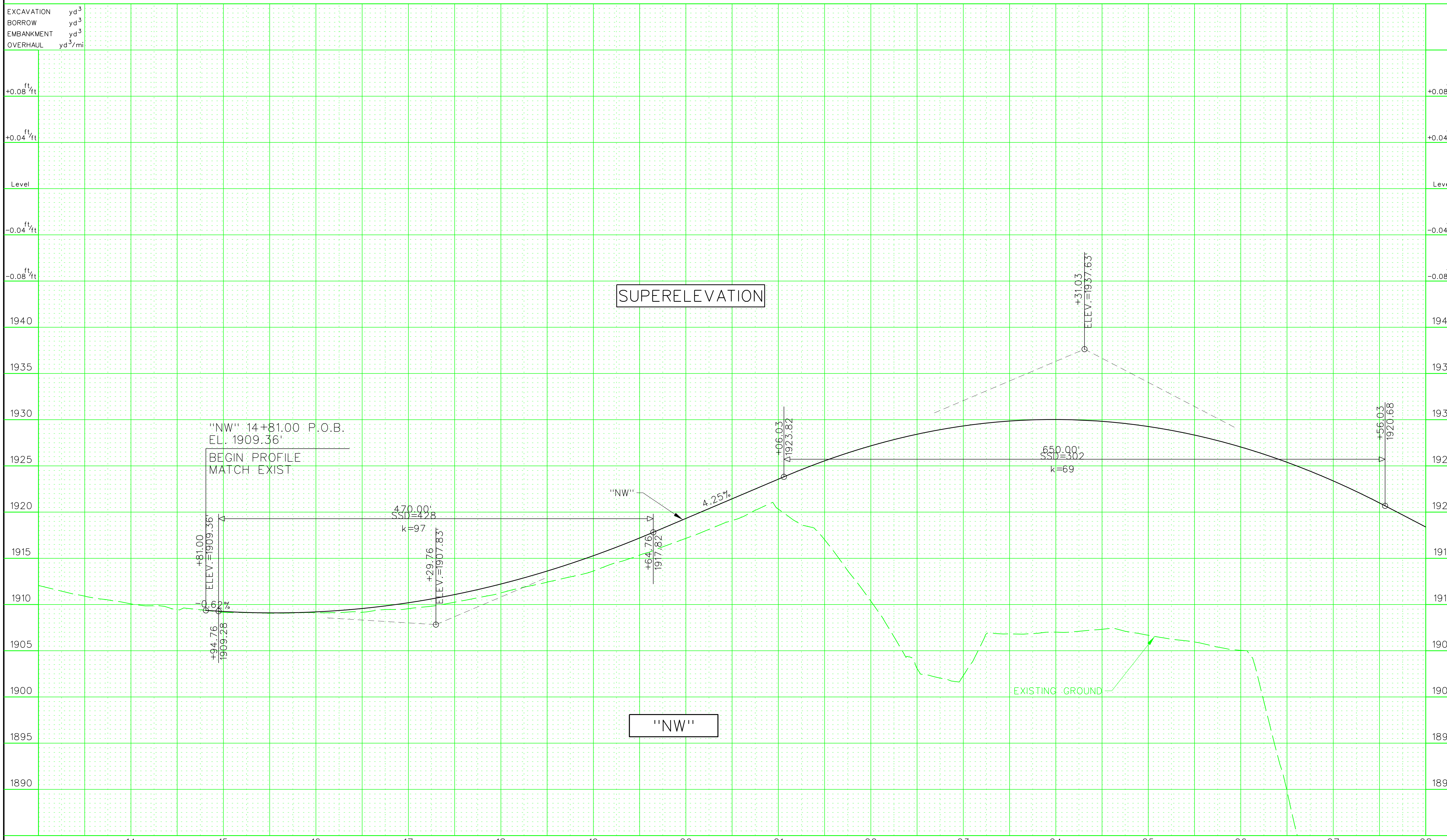
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\NW_Opt2_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	25

PRELIMINARY

SUBJECT TO REVISION
1/15/2021

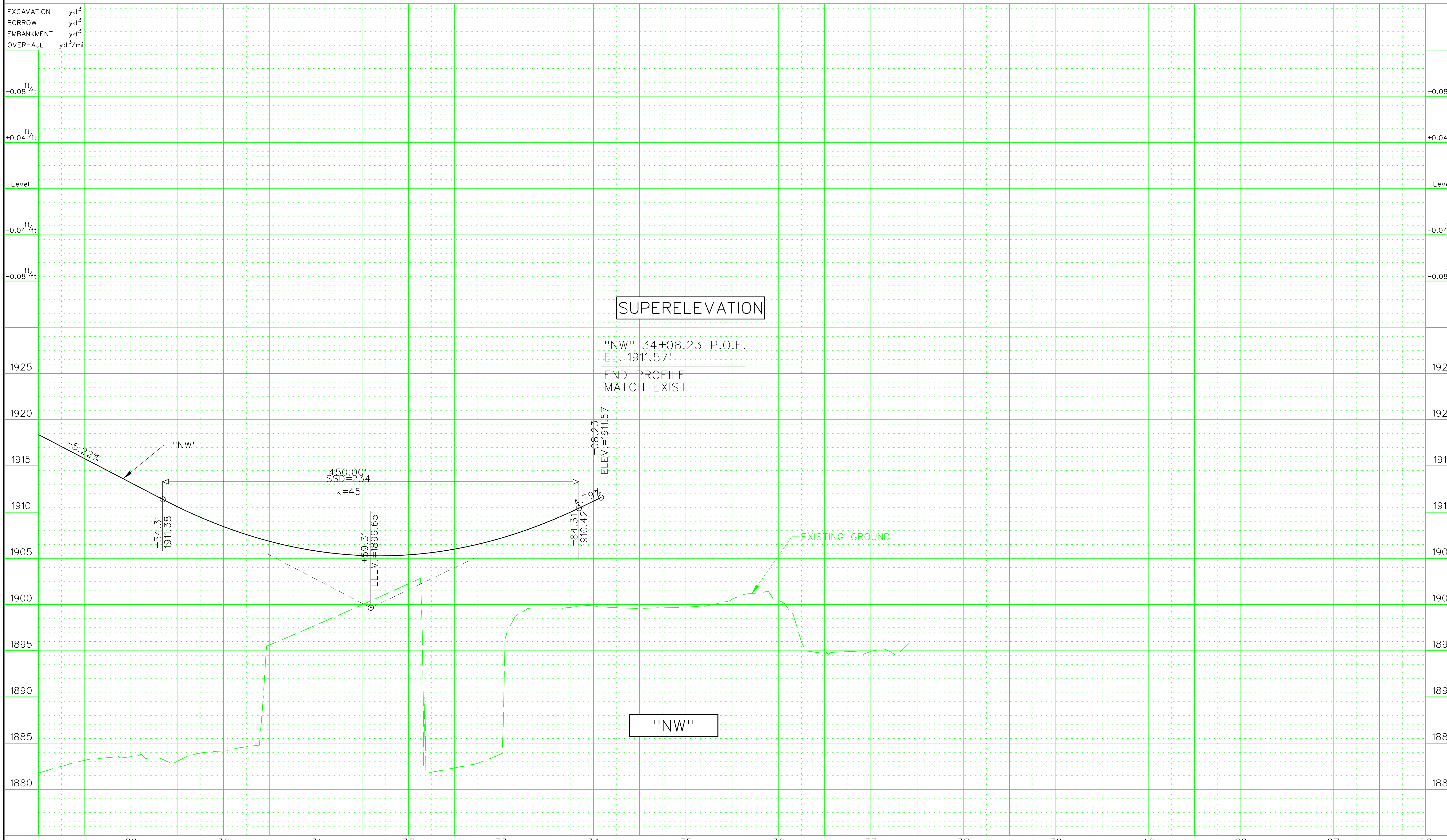


1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\NW_Opt2_Profile_02.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	26

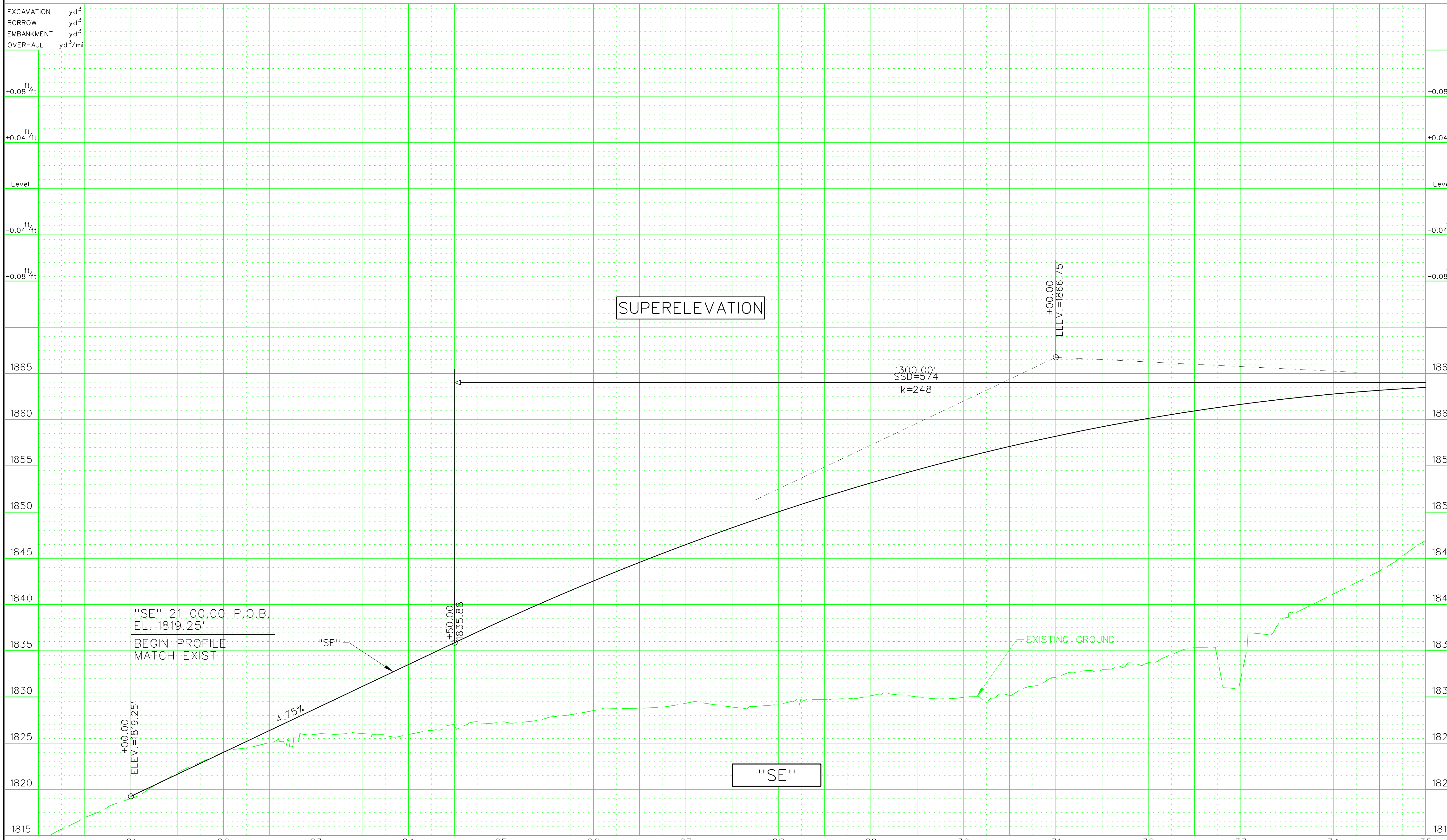
PRELIMINARY
SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	27

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



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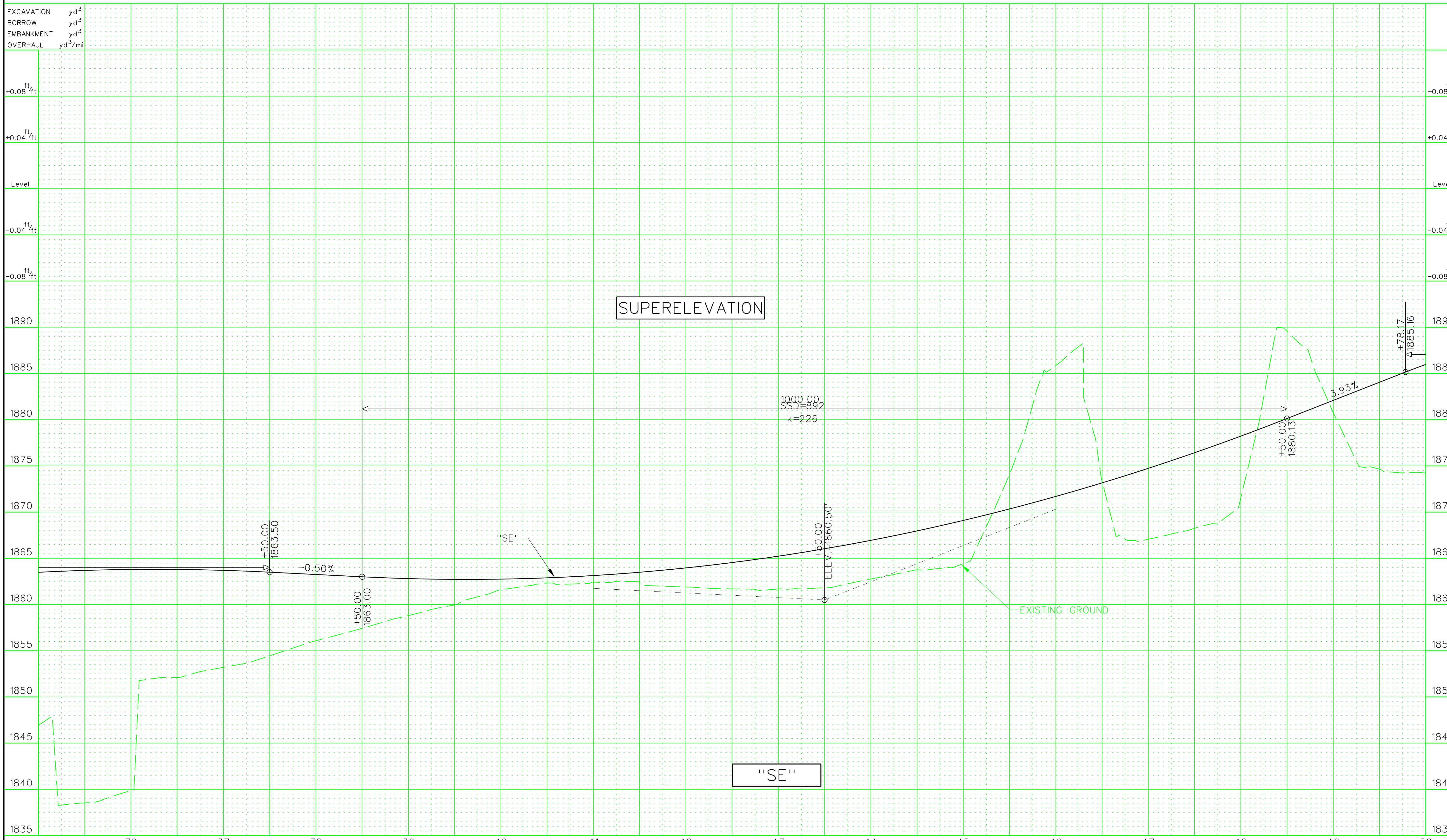
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	28

PRELIMINARY
SUBJECT TO REVISION
1/15/2021

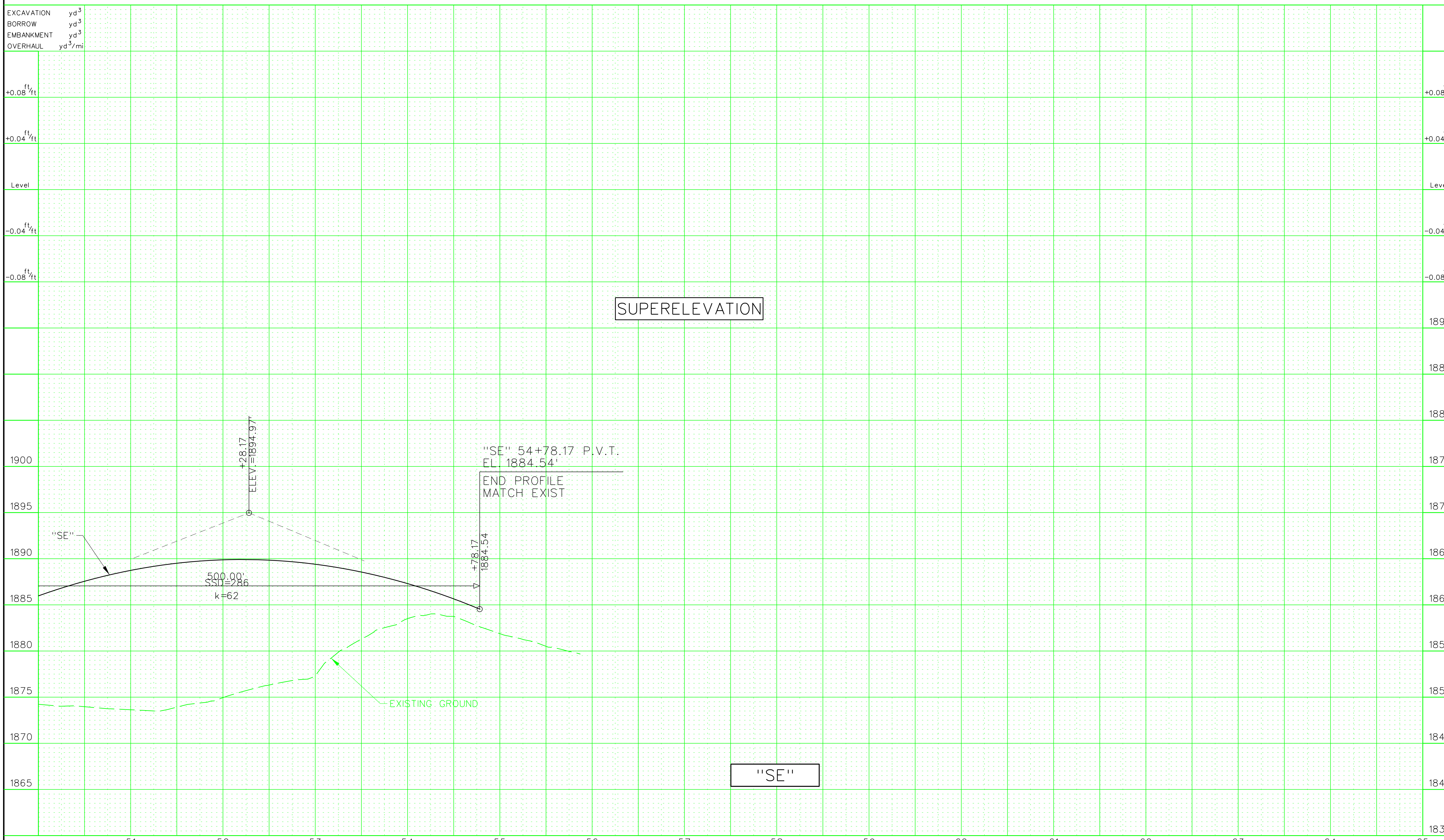


1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	29

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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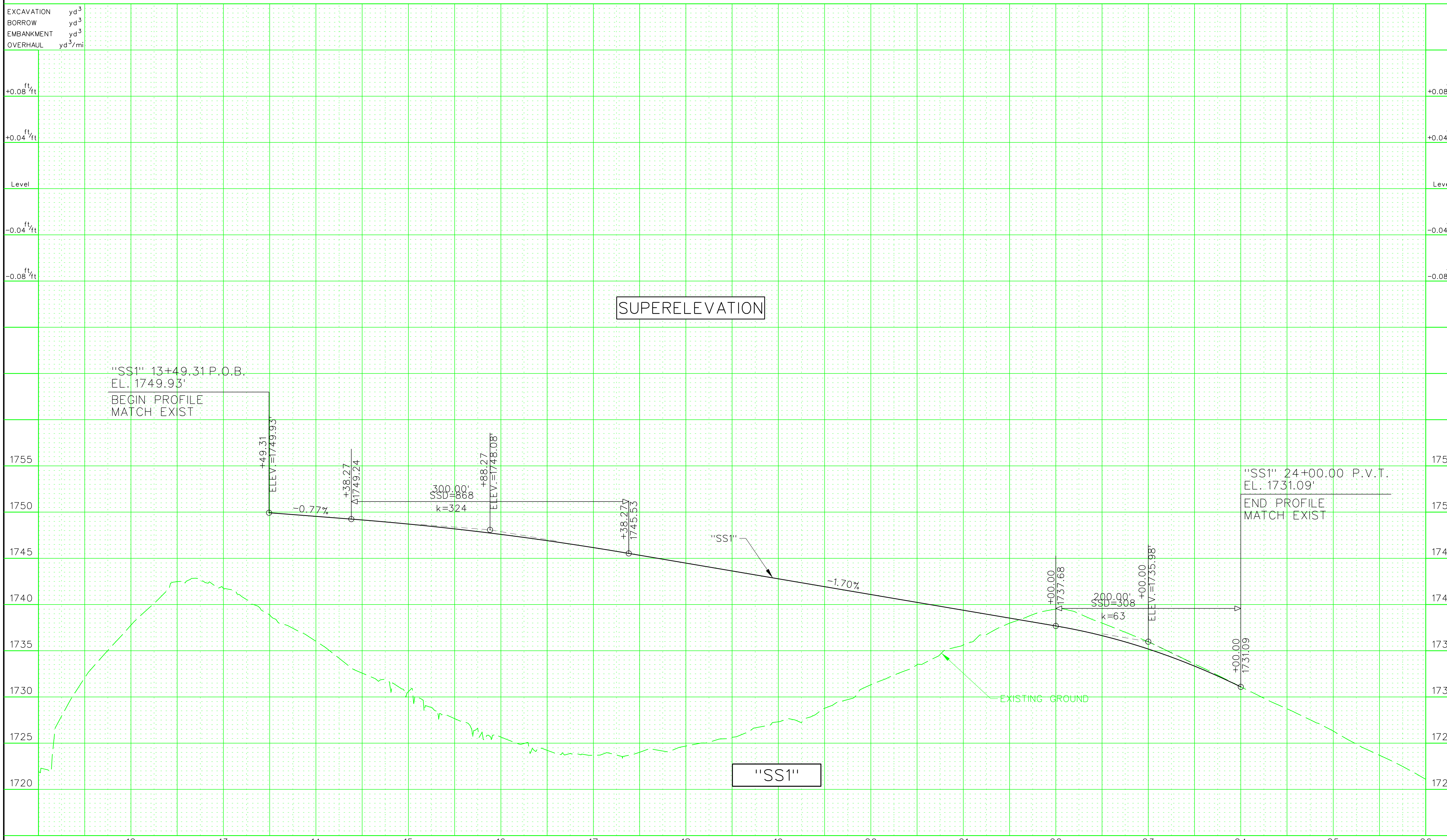
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	30

PRELIMINARY

SUBJECT TO REVISION
1/15/2021

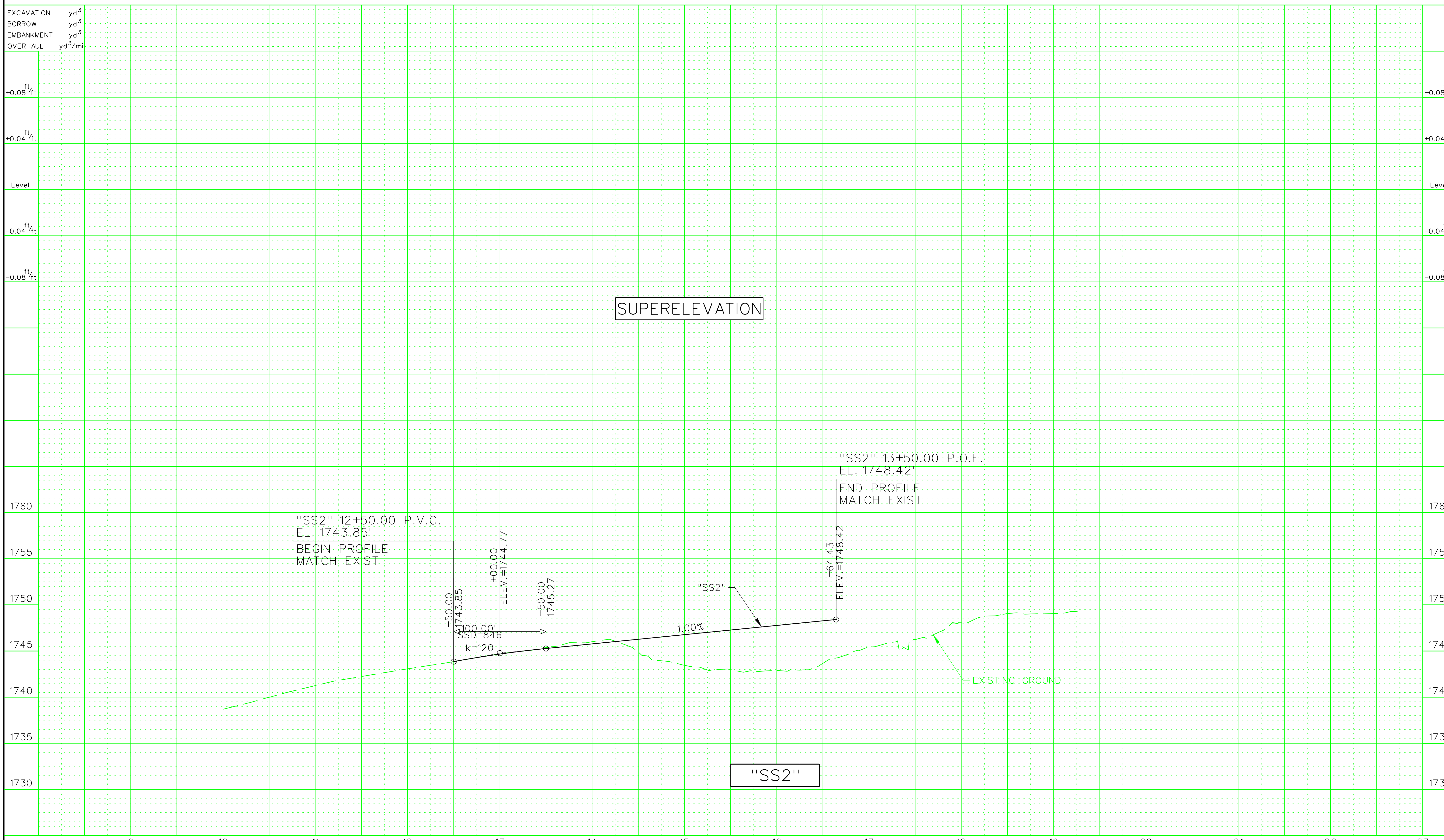


1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\SS2_Opt2_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	31

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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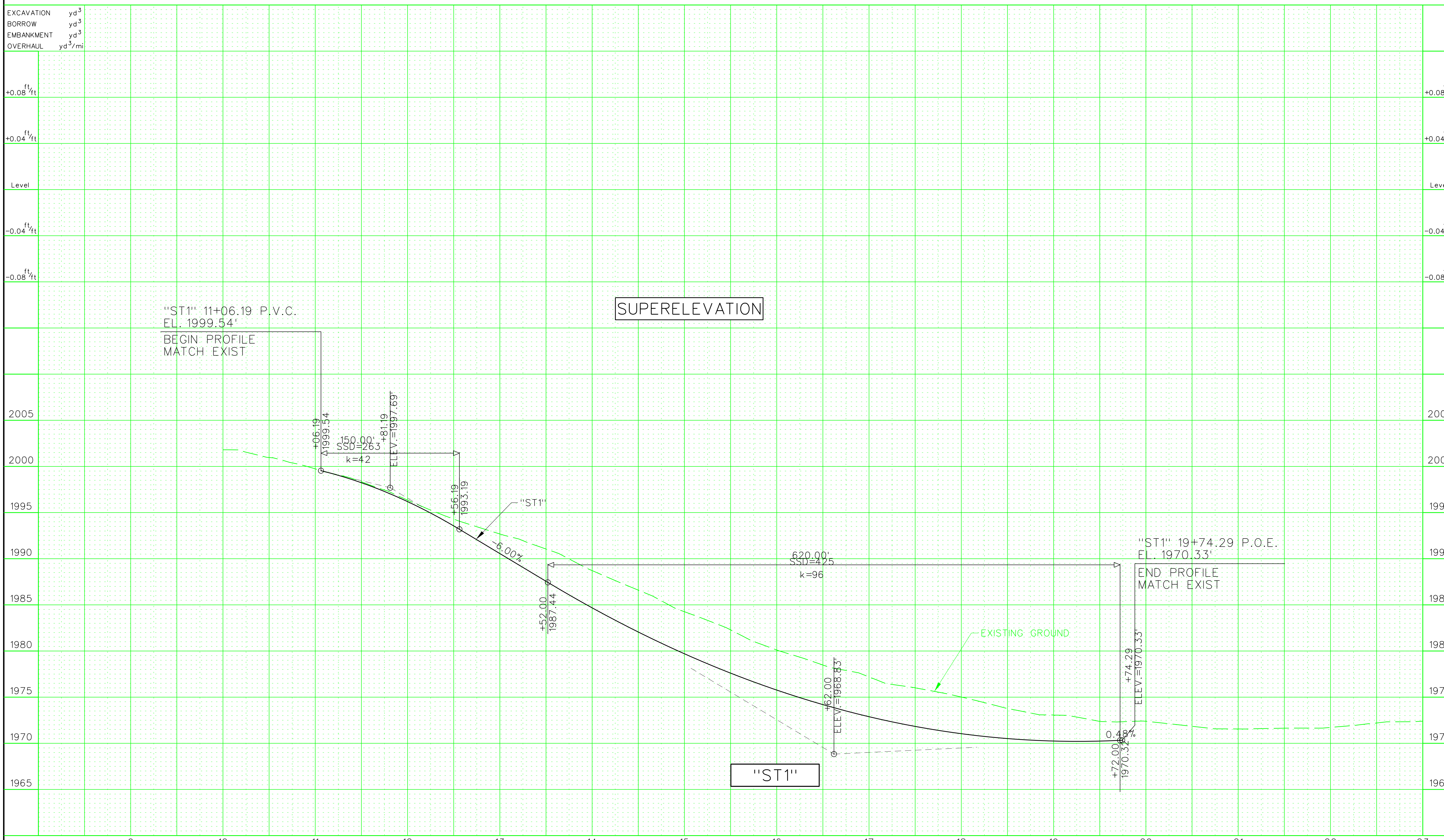
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	32

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



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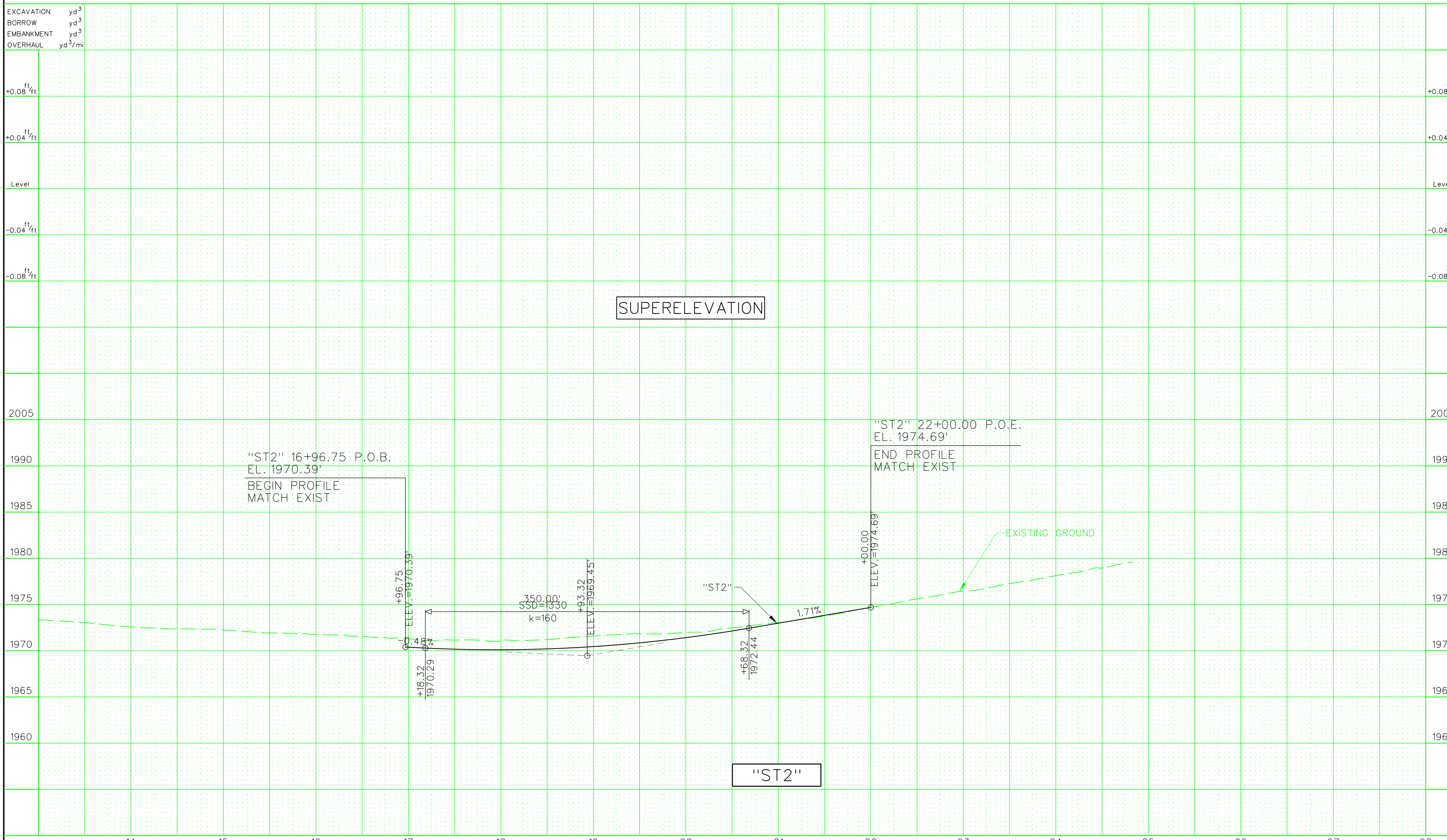
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	33

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

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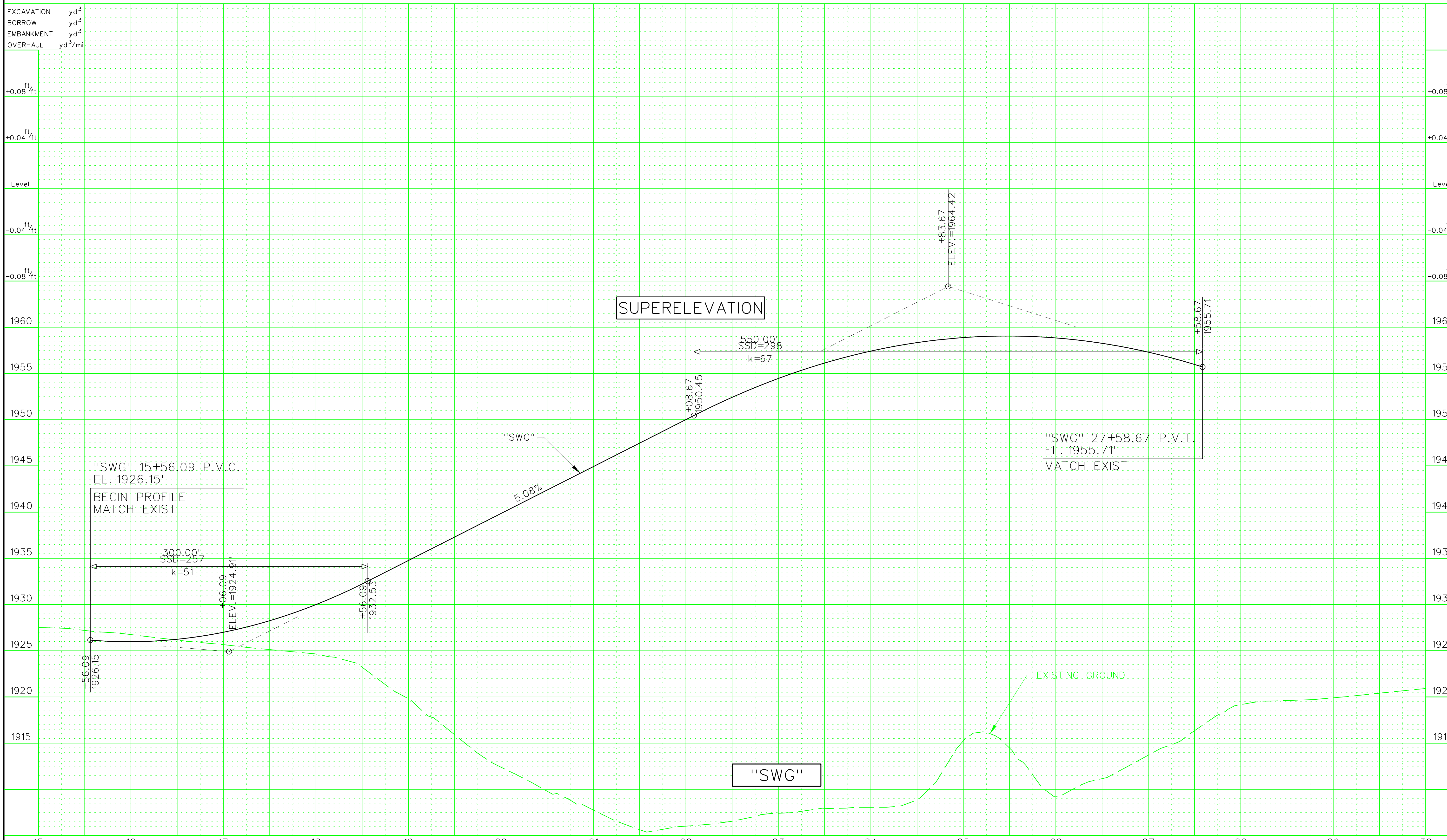
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	34

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



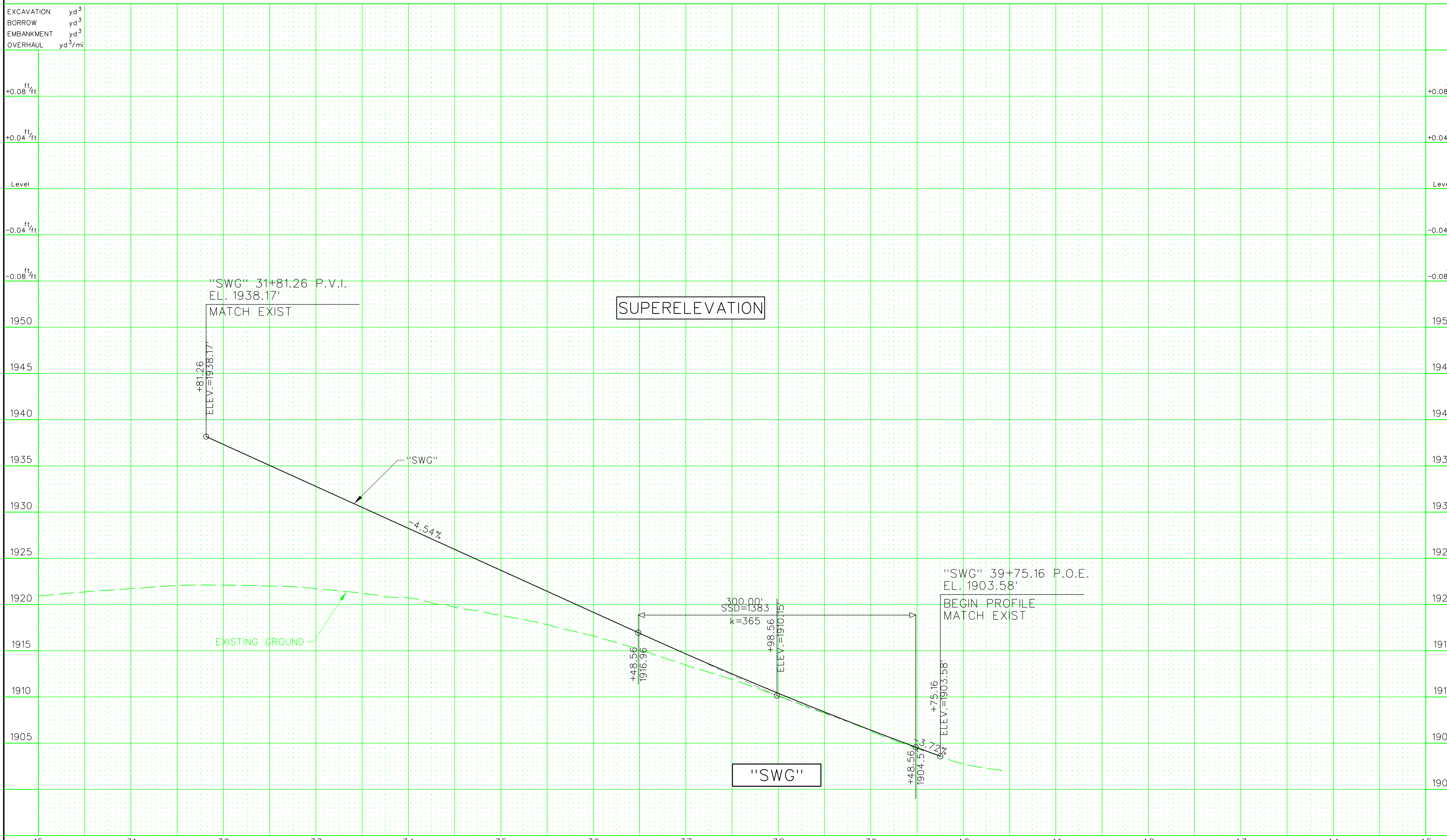
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\SWG_Opt2_Profile_02.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	35

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



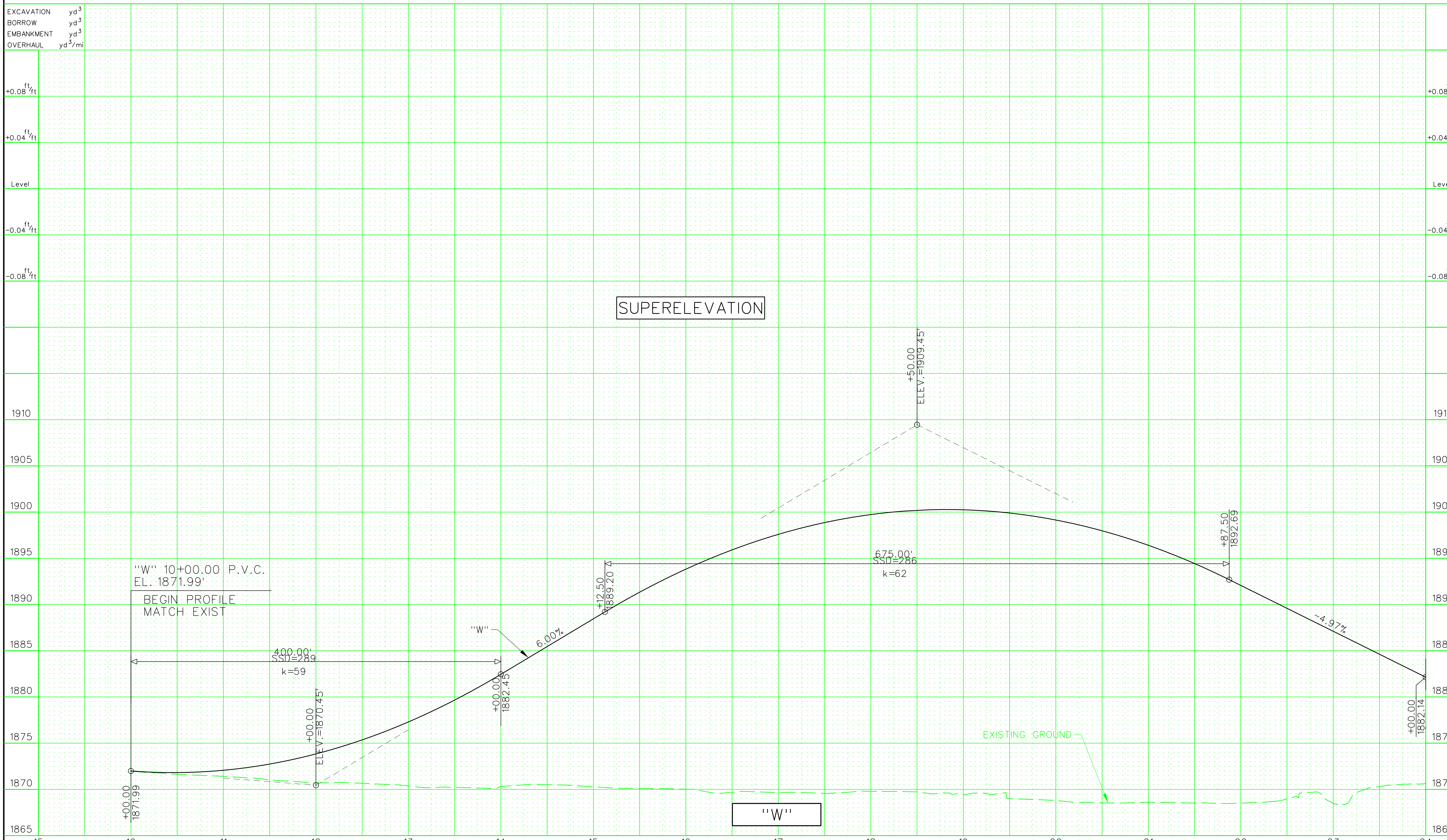
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\W_Opt2_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	36

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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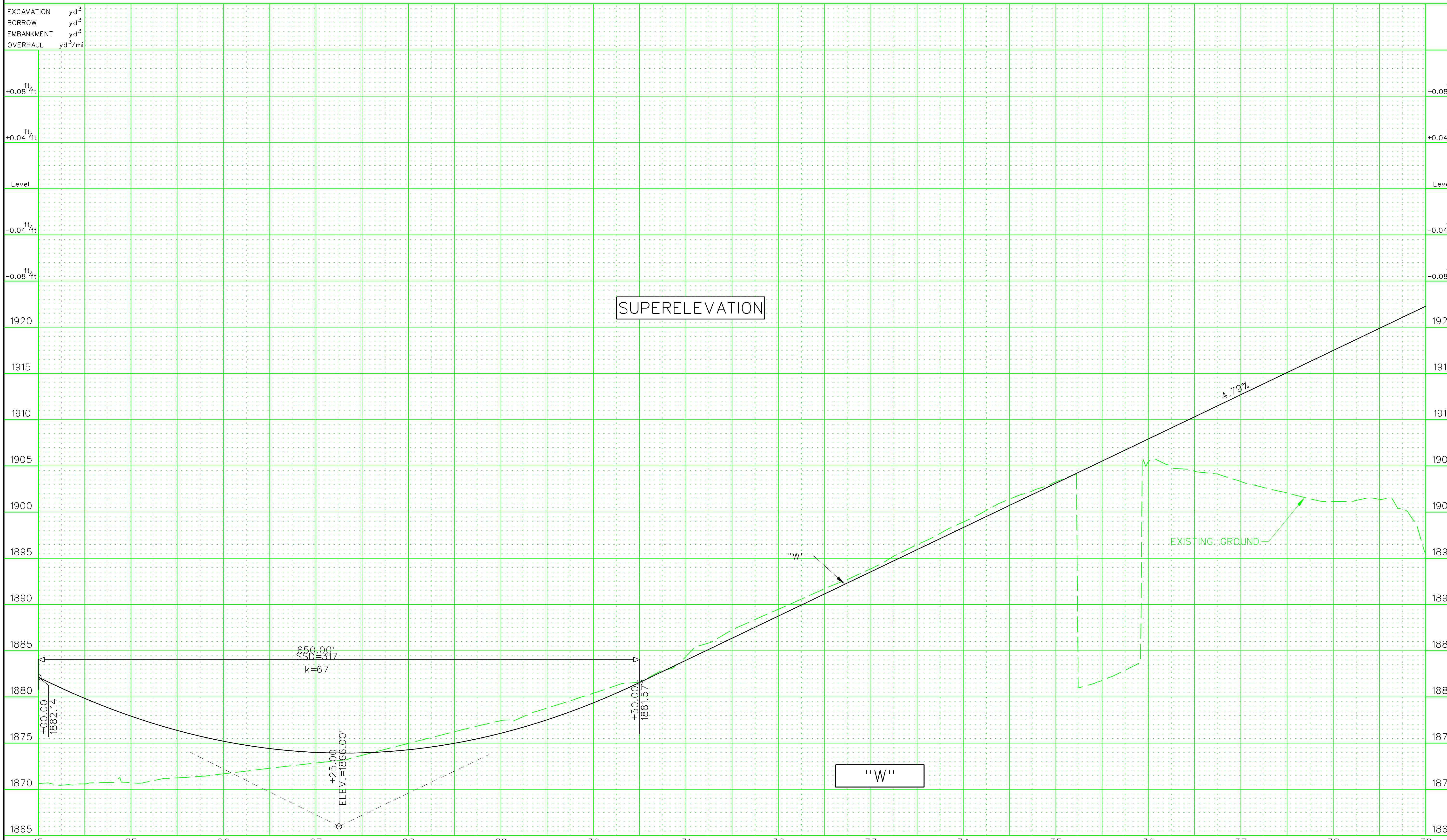
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	37

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



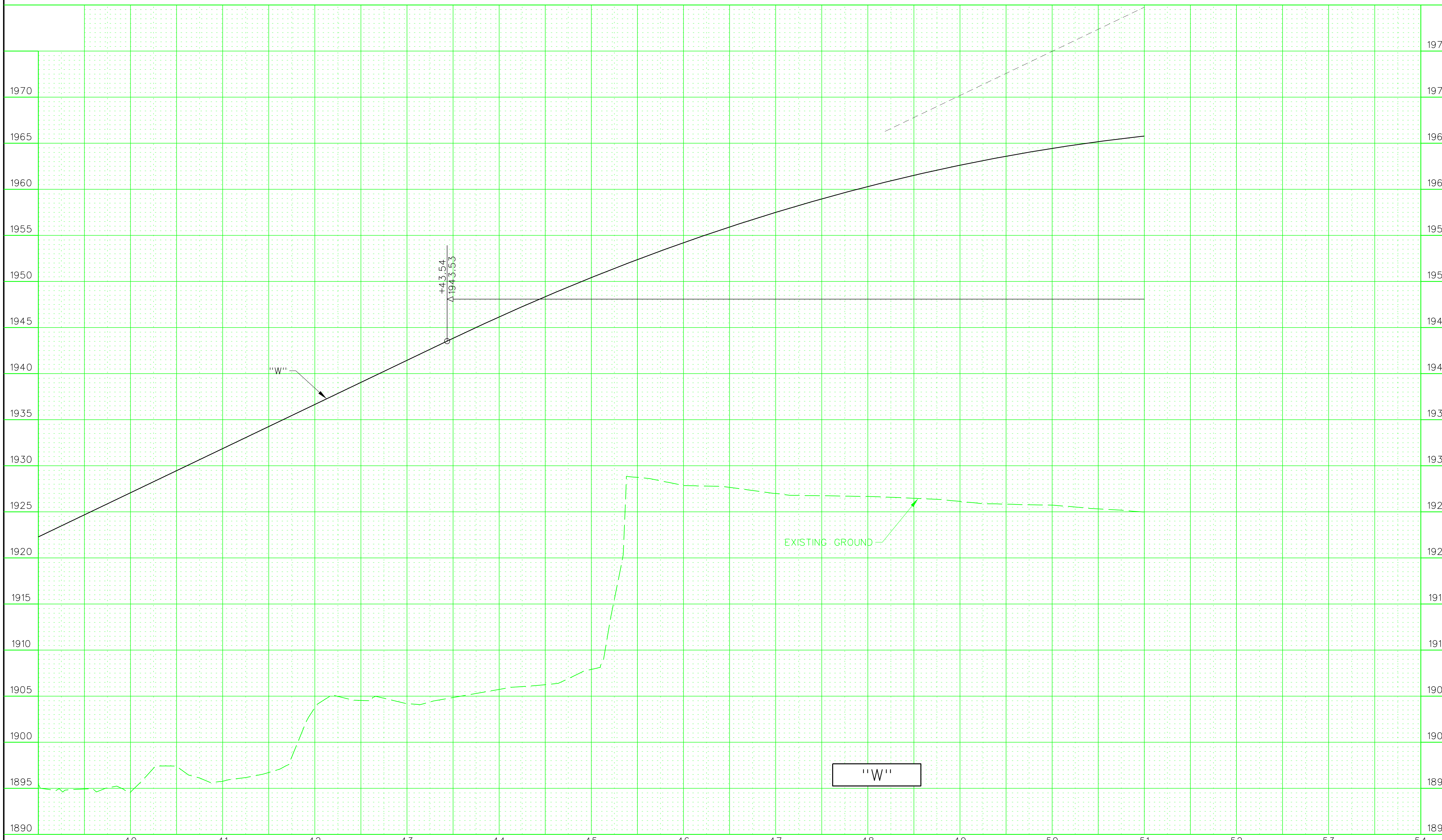
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08937\W_Opt2_Profile_03.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	38

PRELIMINARY

SUBJECT TO REVISION
1/15/2021

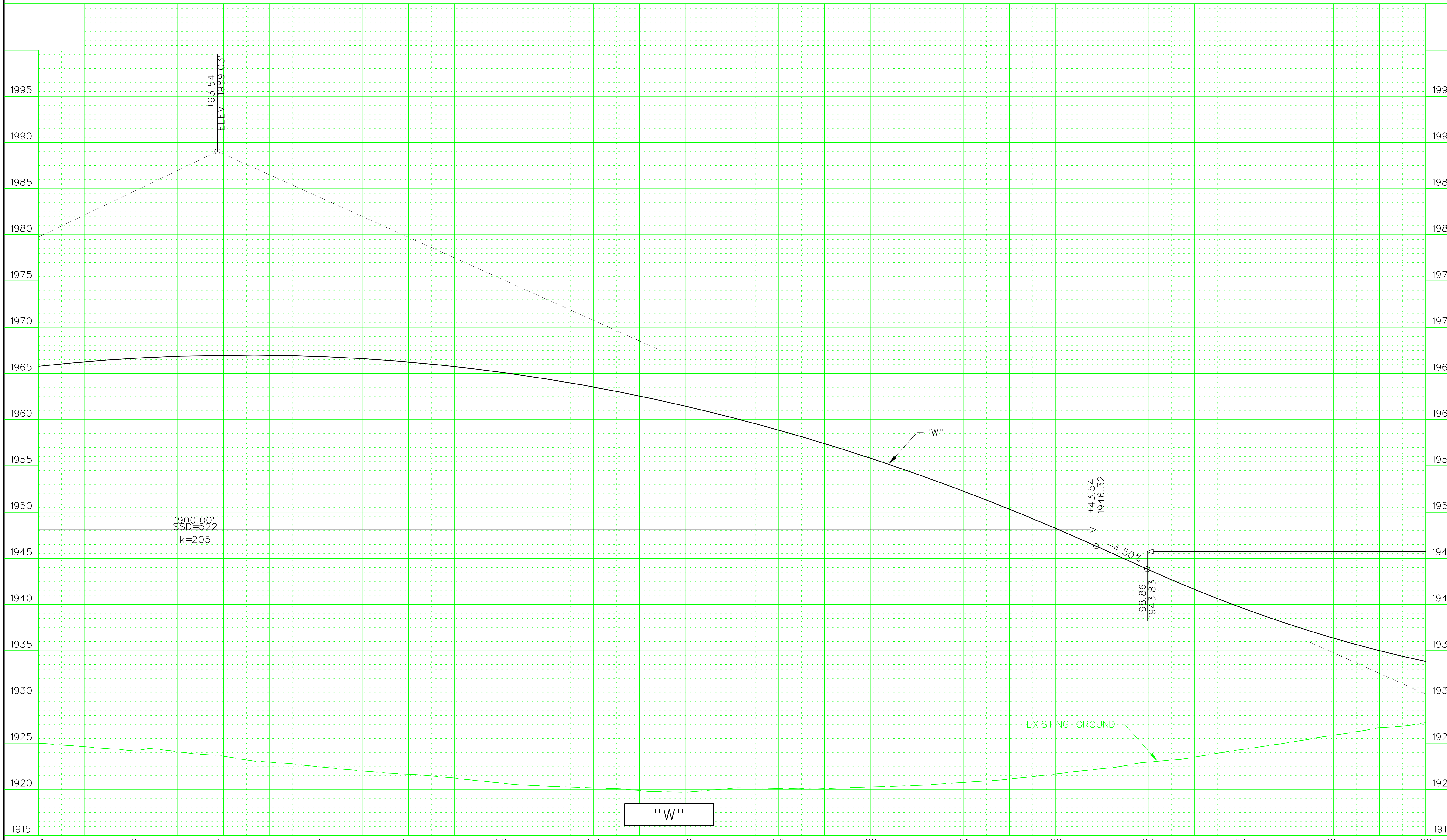


1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	39

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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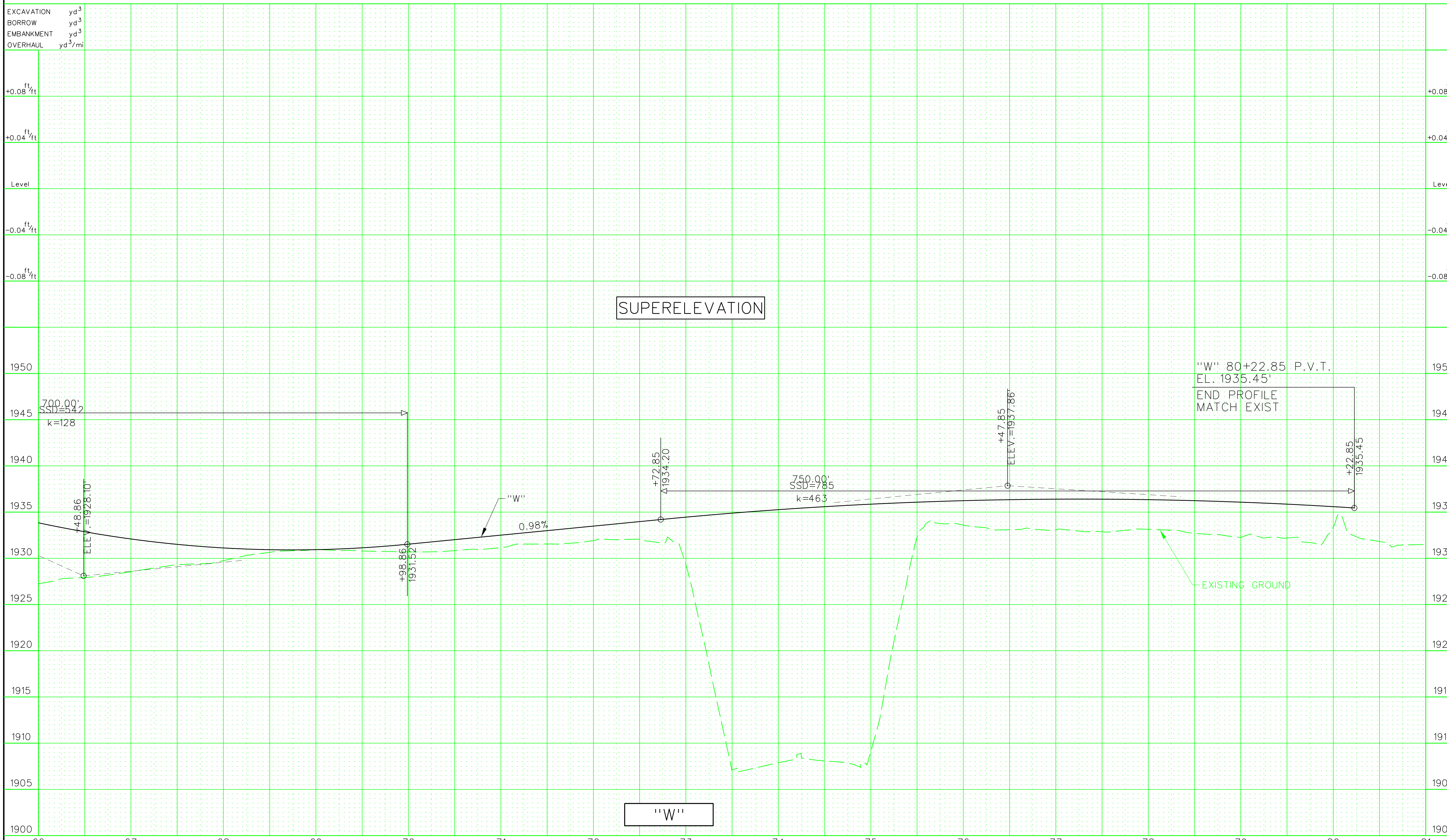
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	40

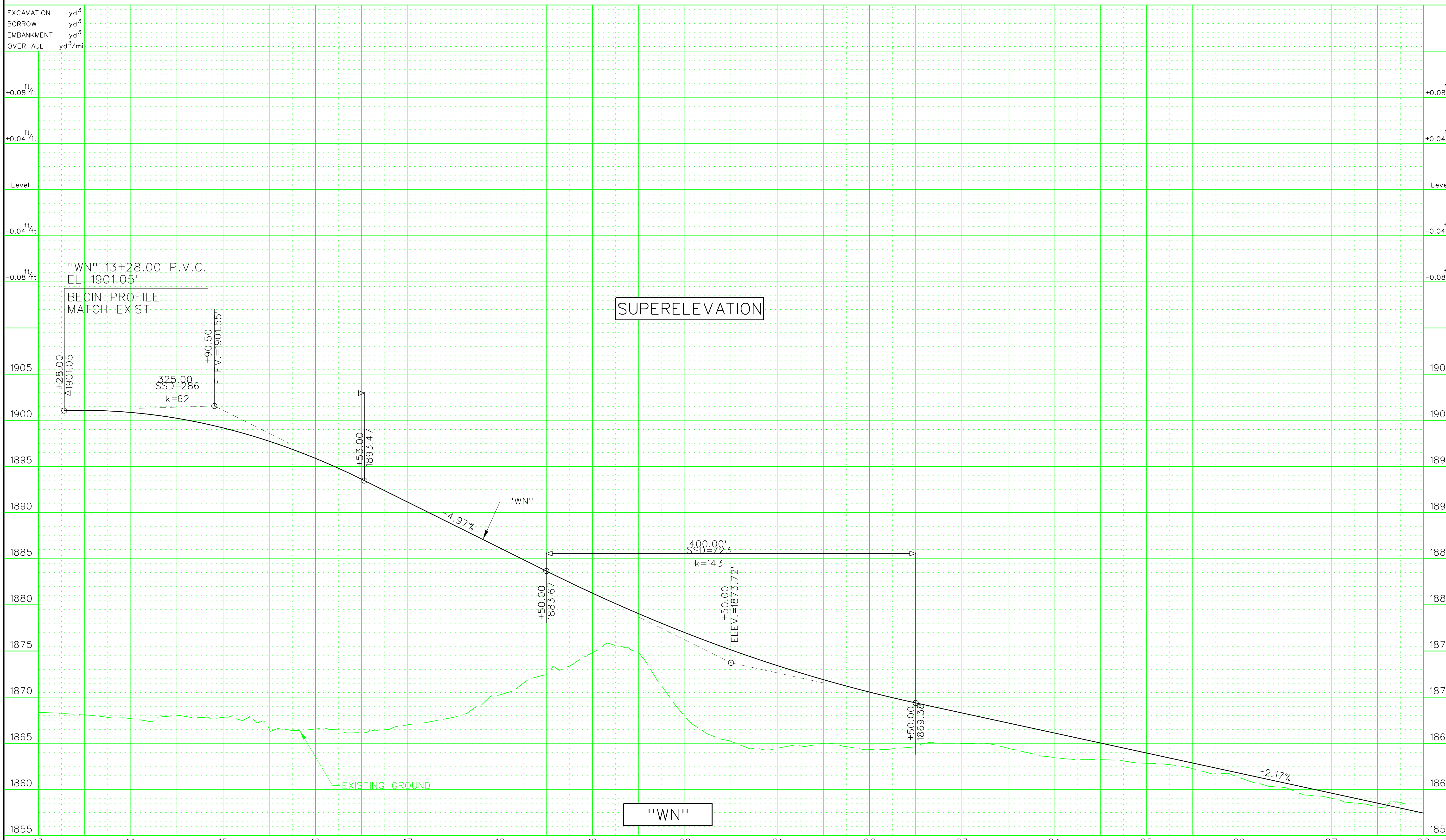
PRELIMINARY
SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	41

PRELIMINARY
SUBJECT TO REVISION
1/15/2021



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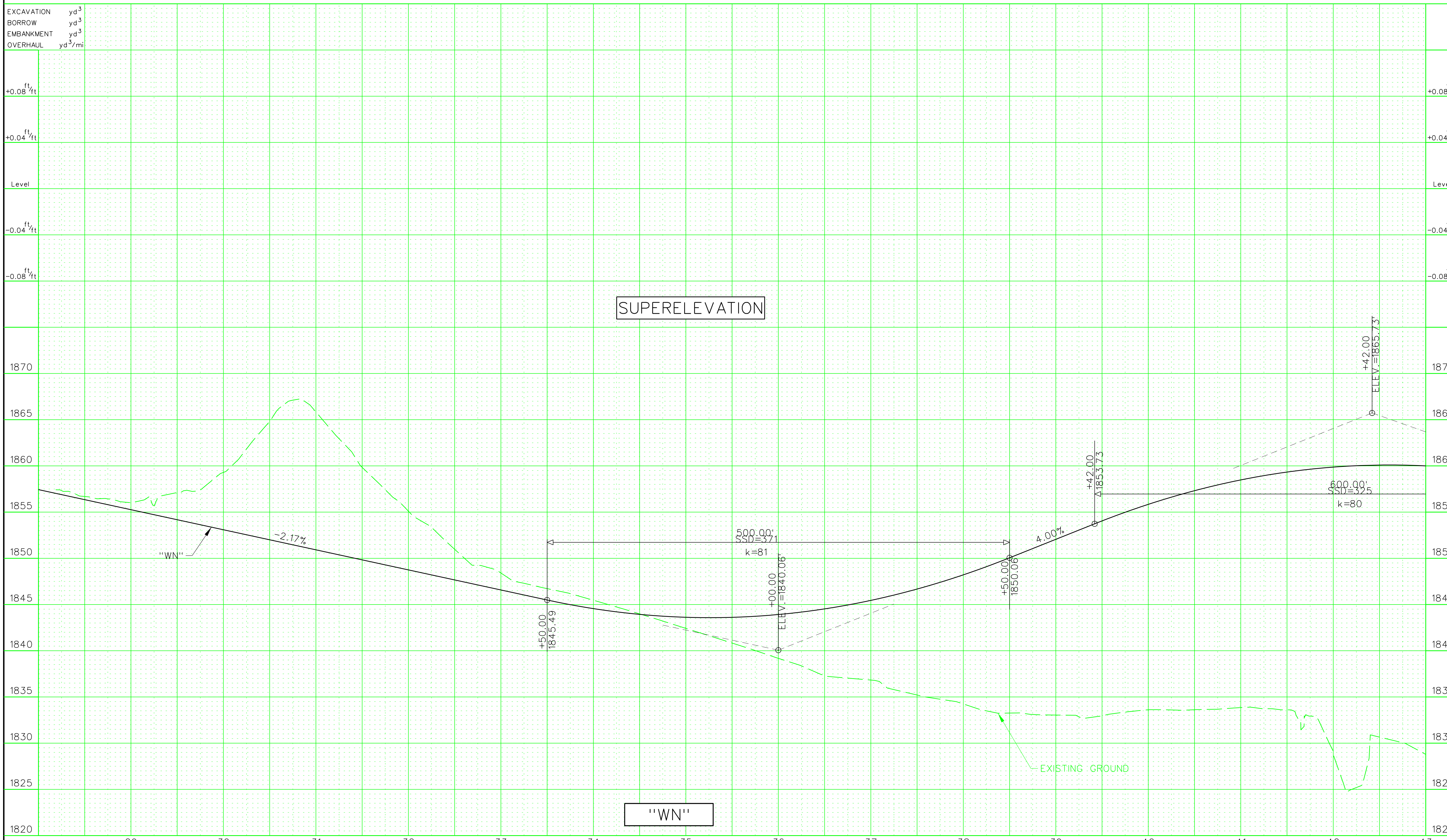
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	42

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



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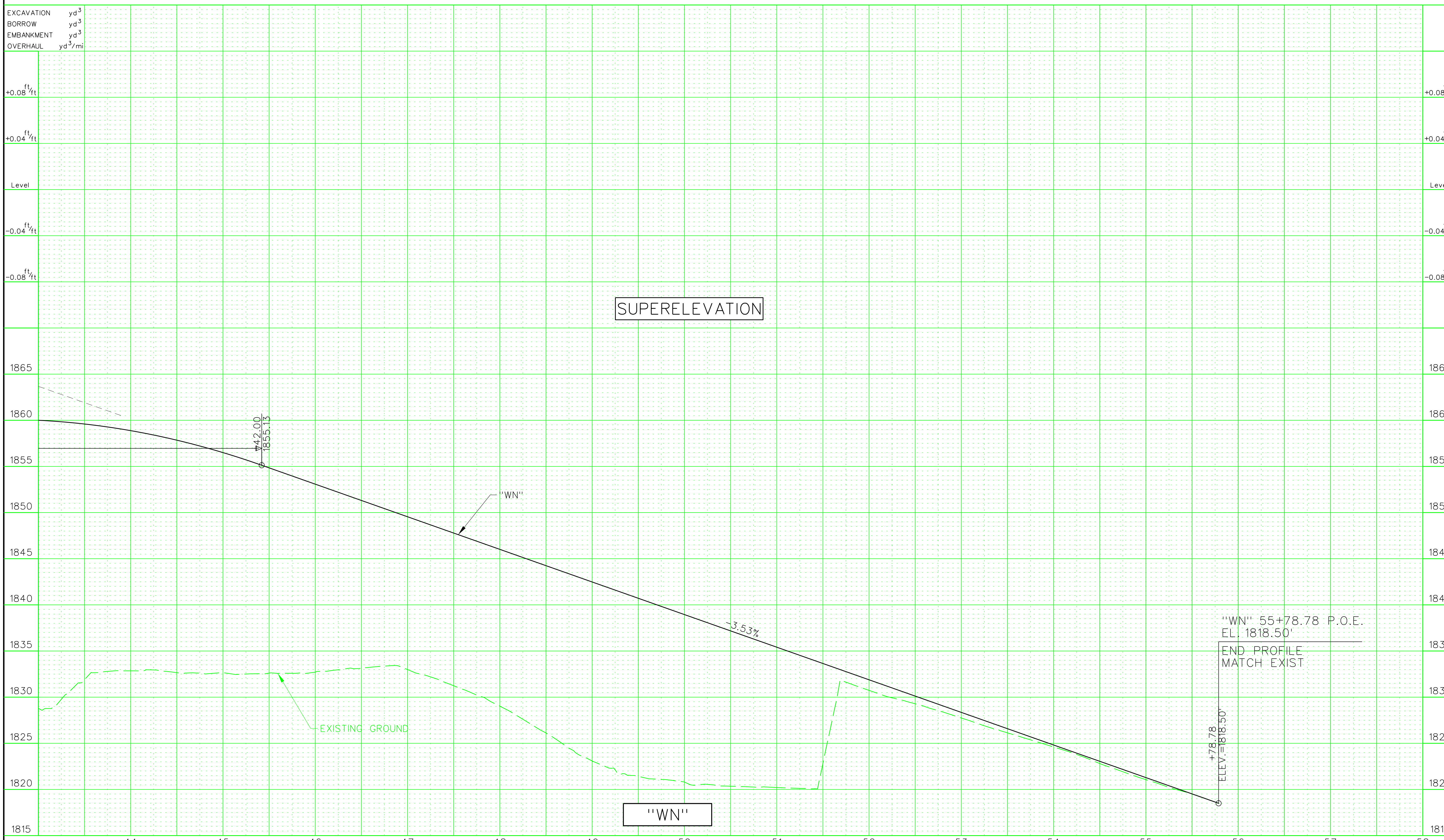
PRELIMINARY

SUBJECT TO REVISION
1/15/2021

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	43



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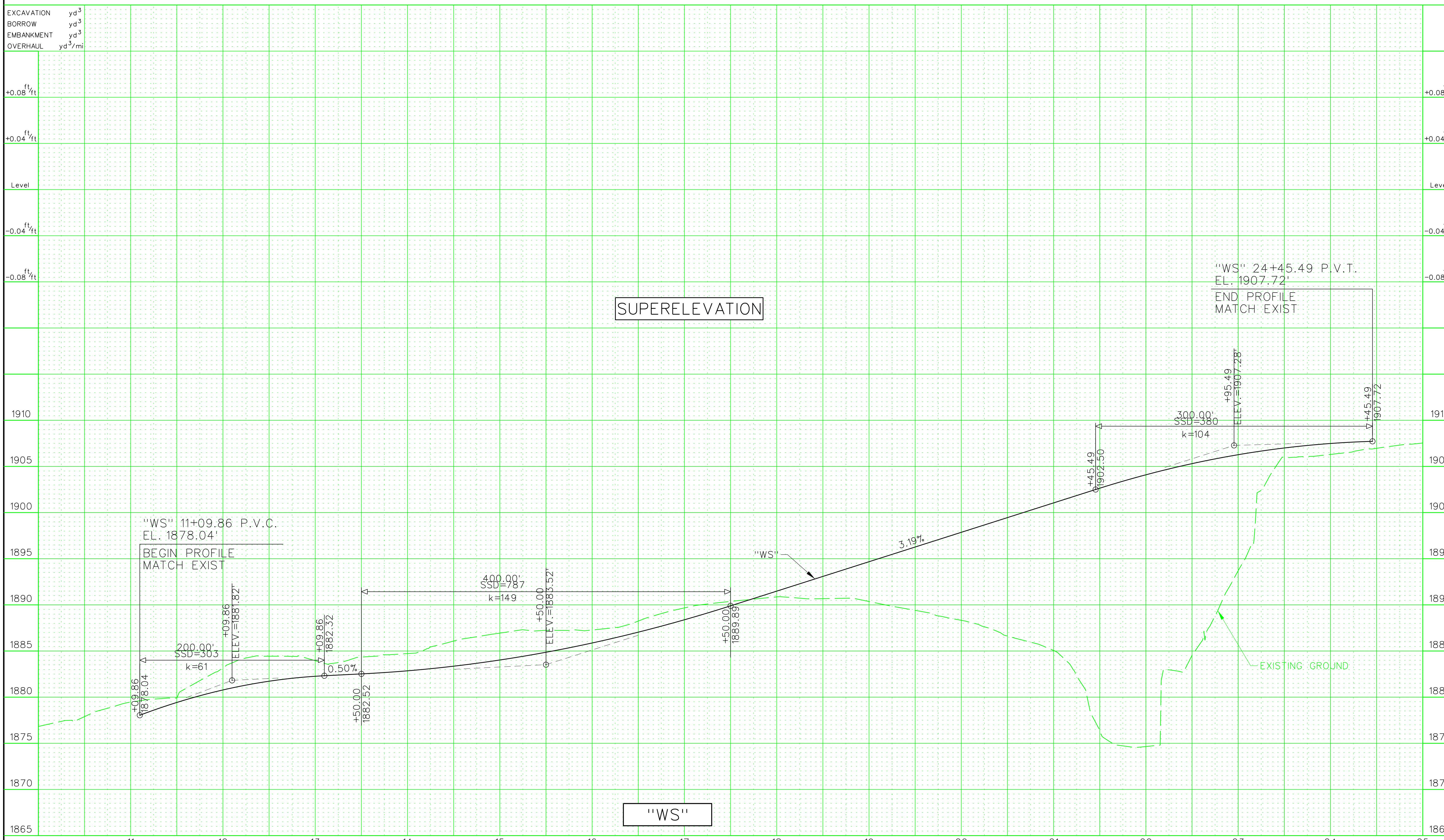
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	44

PRELIMINARY

SUBJECT TO REVISION
1/15/2021



1:100 PLOT SCALE ghirmai.eman

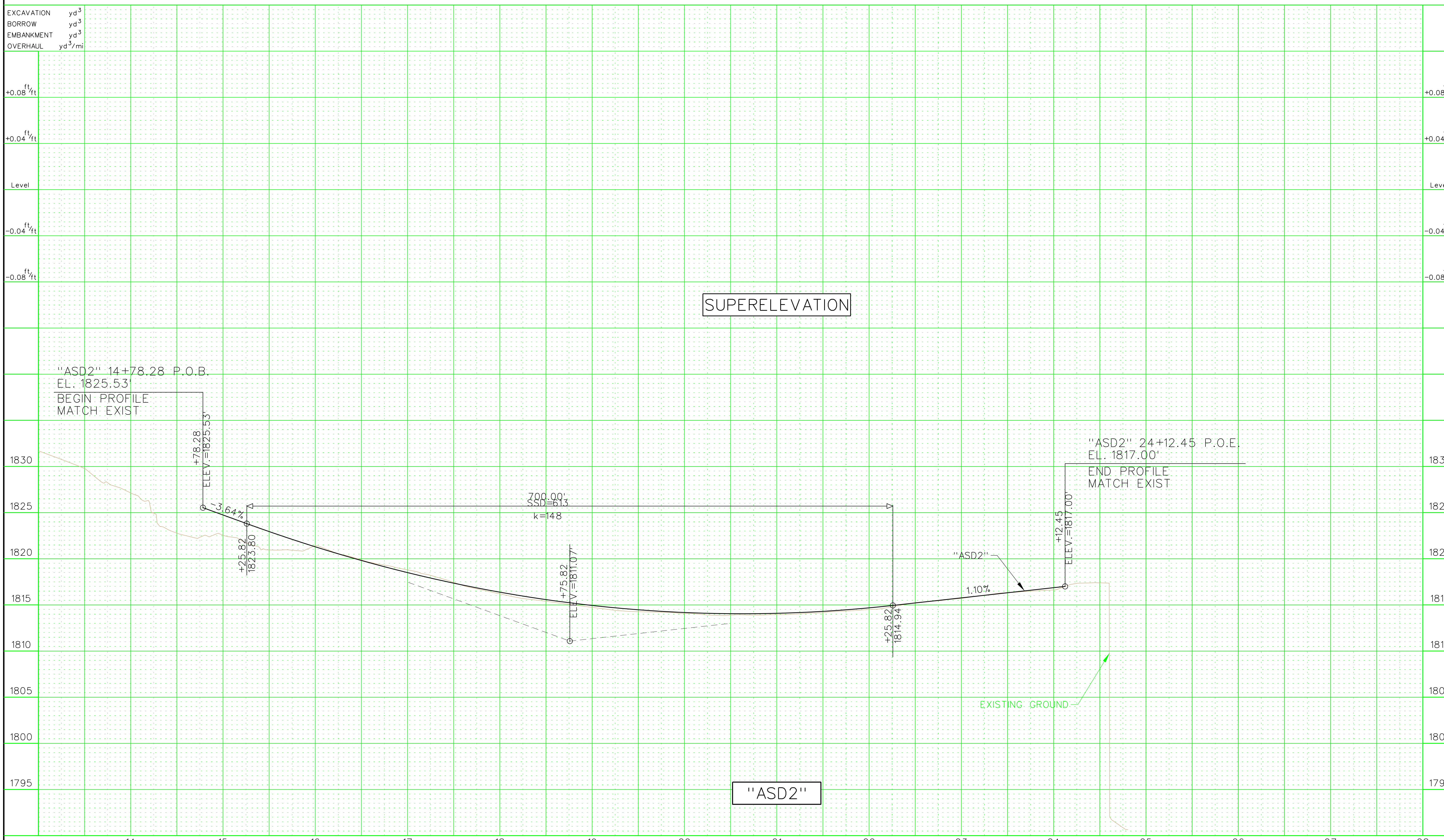
Appendix 6

Option 3 Profiles

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	01

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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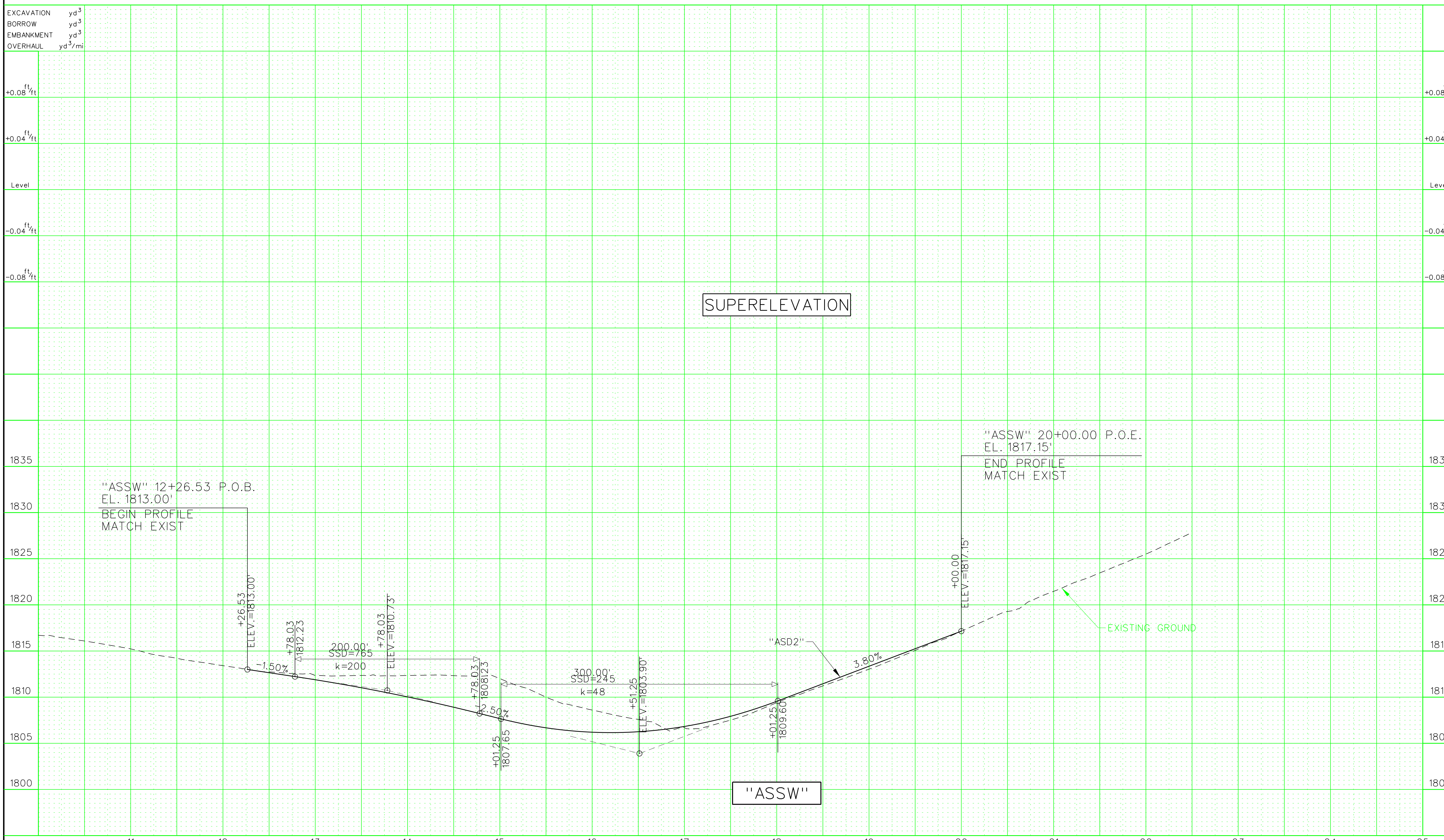
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	02

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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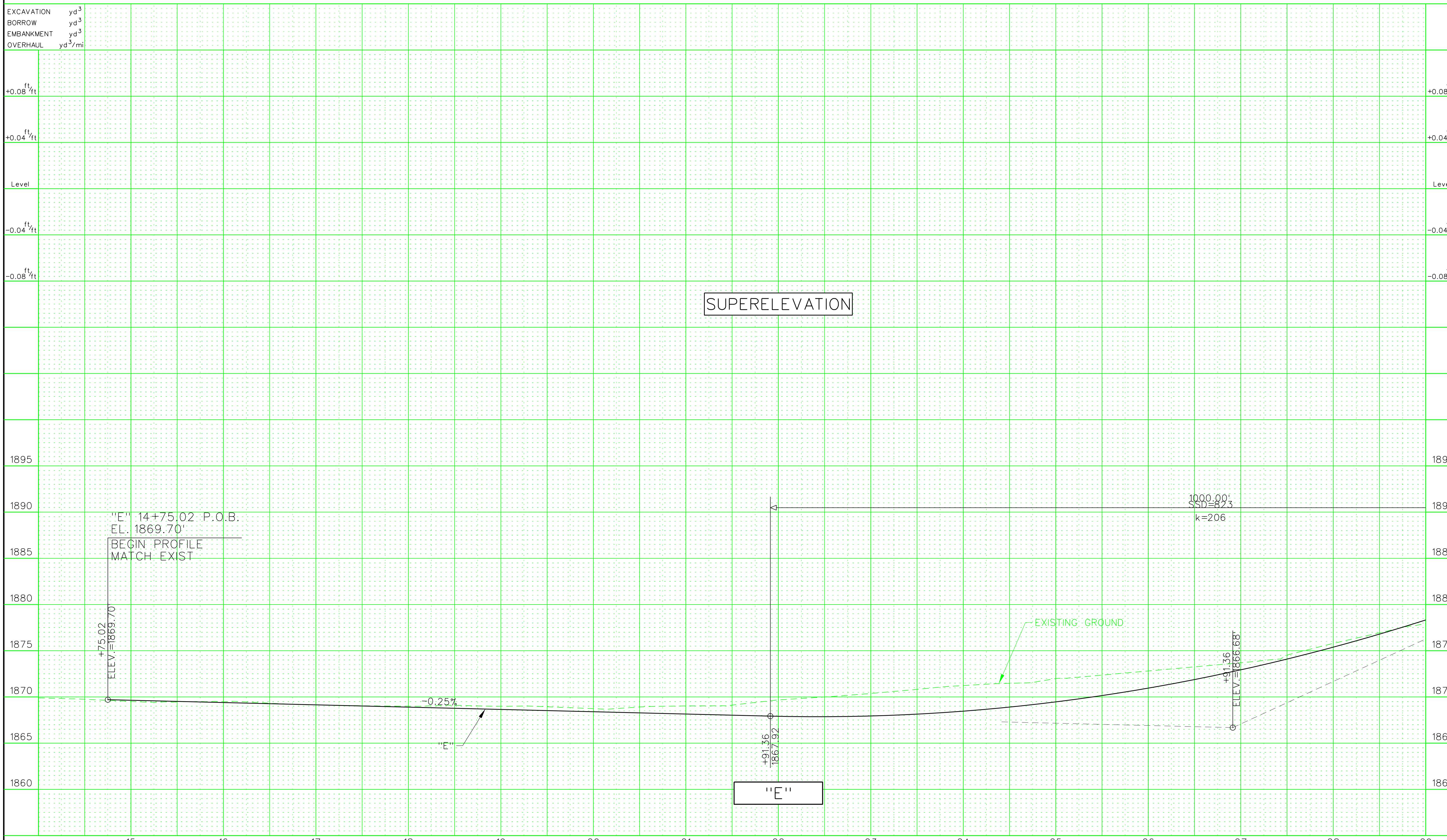
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	03

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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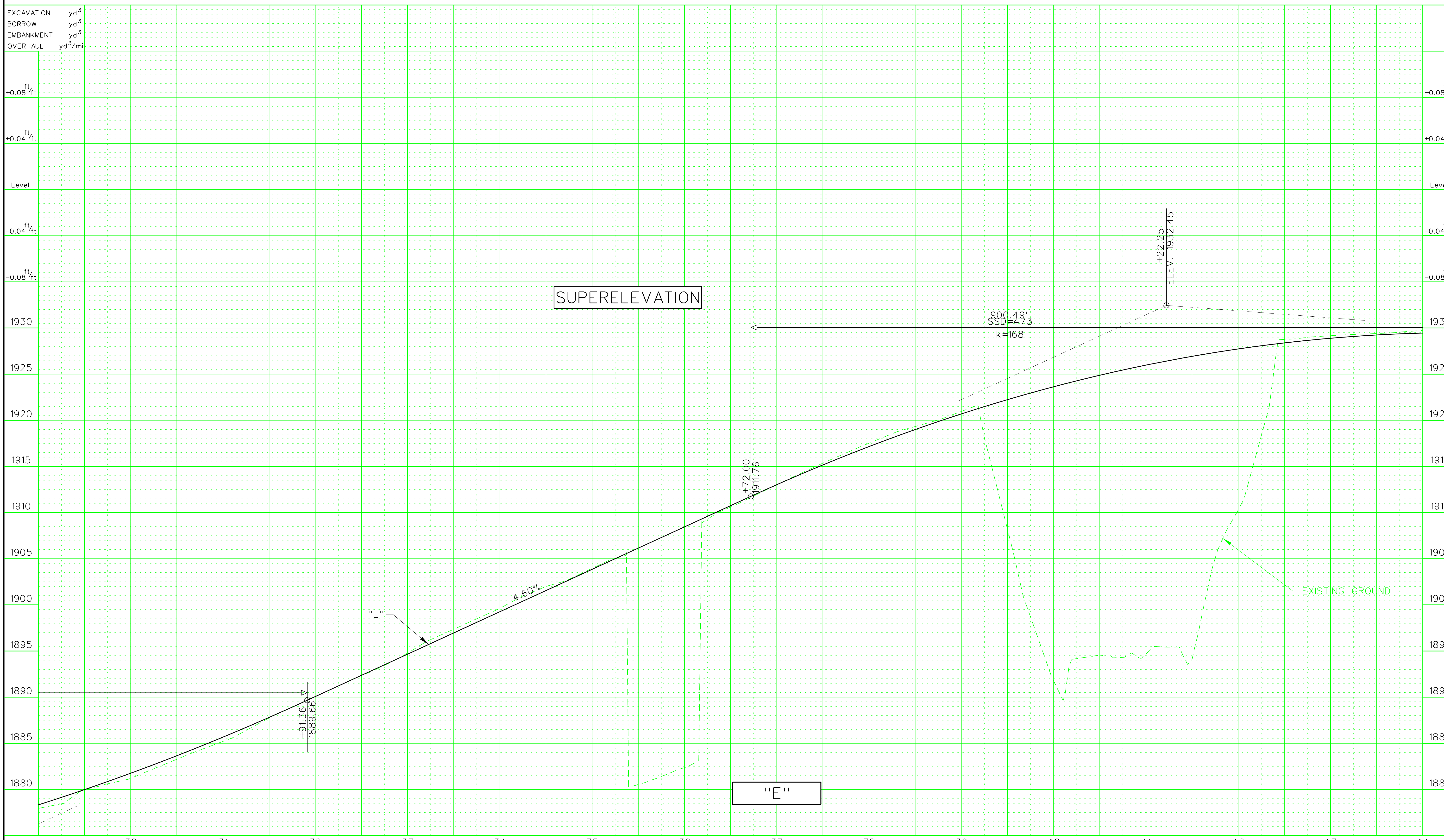
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	04

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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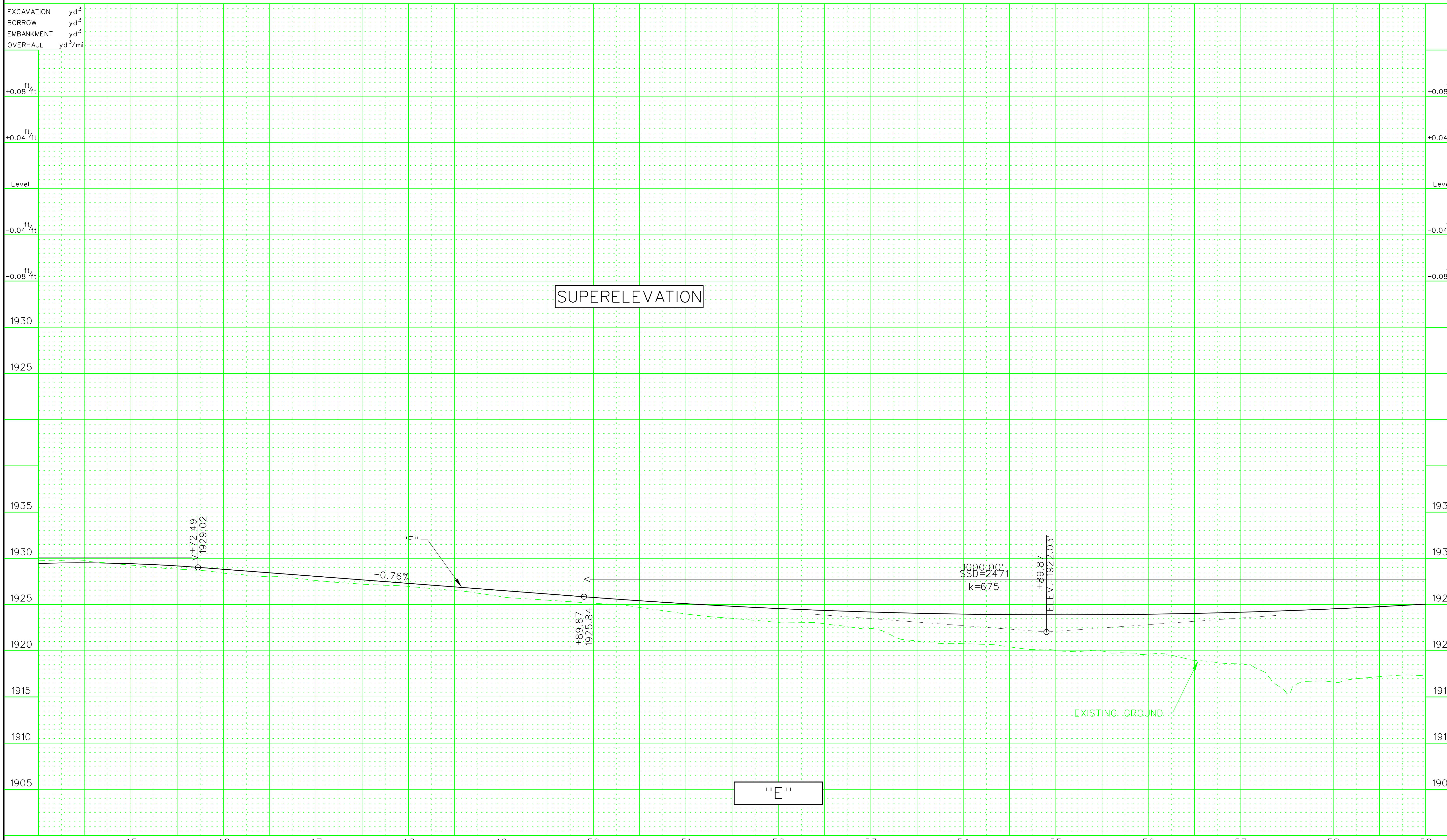
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	05

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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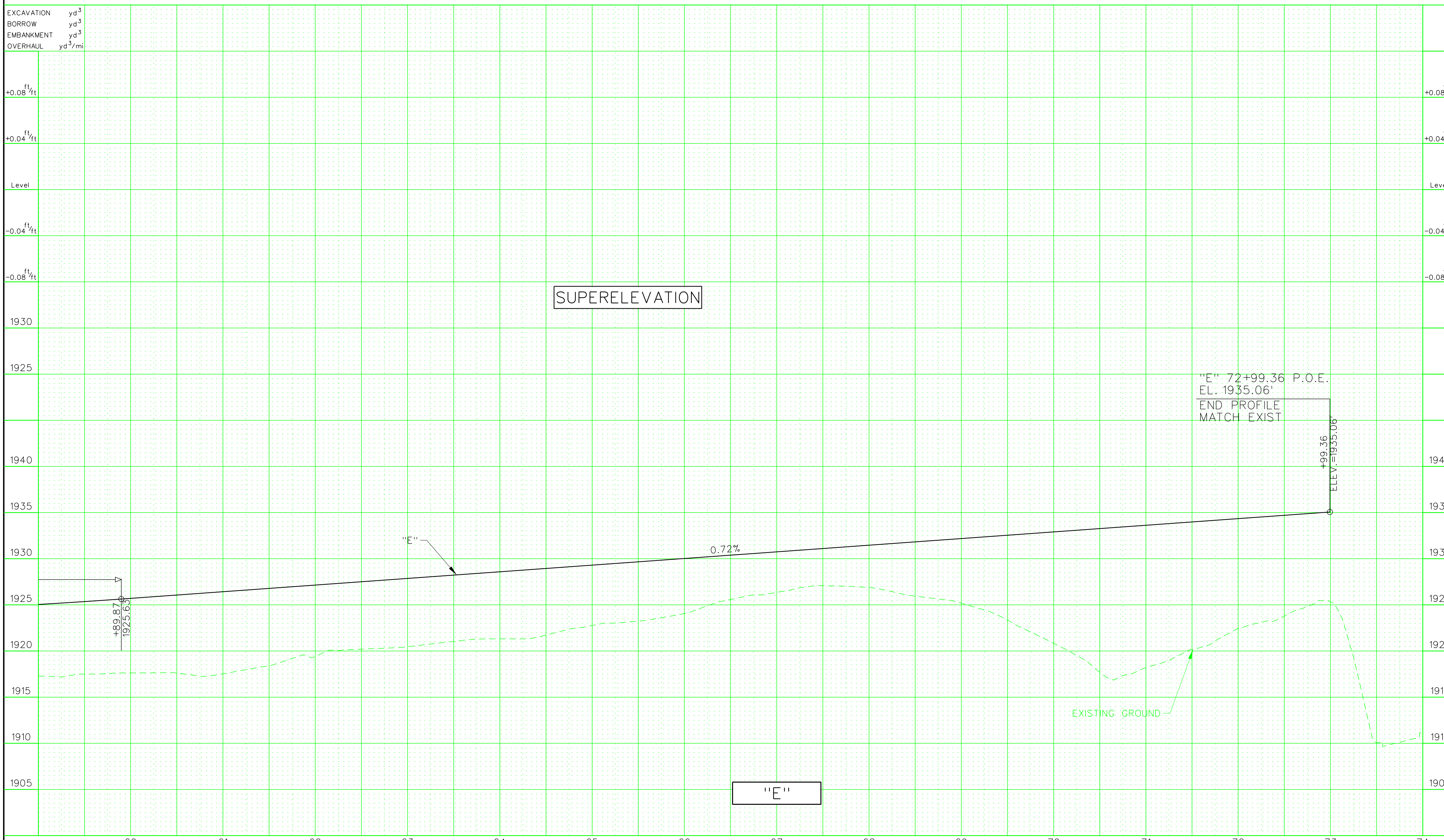
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	06

PRELIMINARY

SUBJECT TO REVISION
1/18/2021

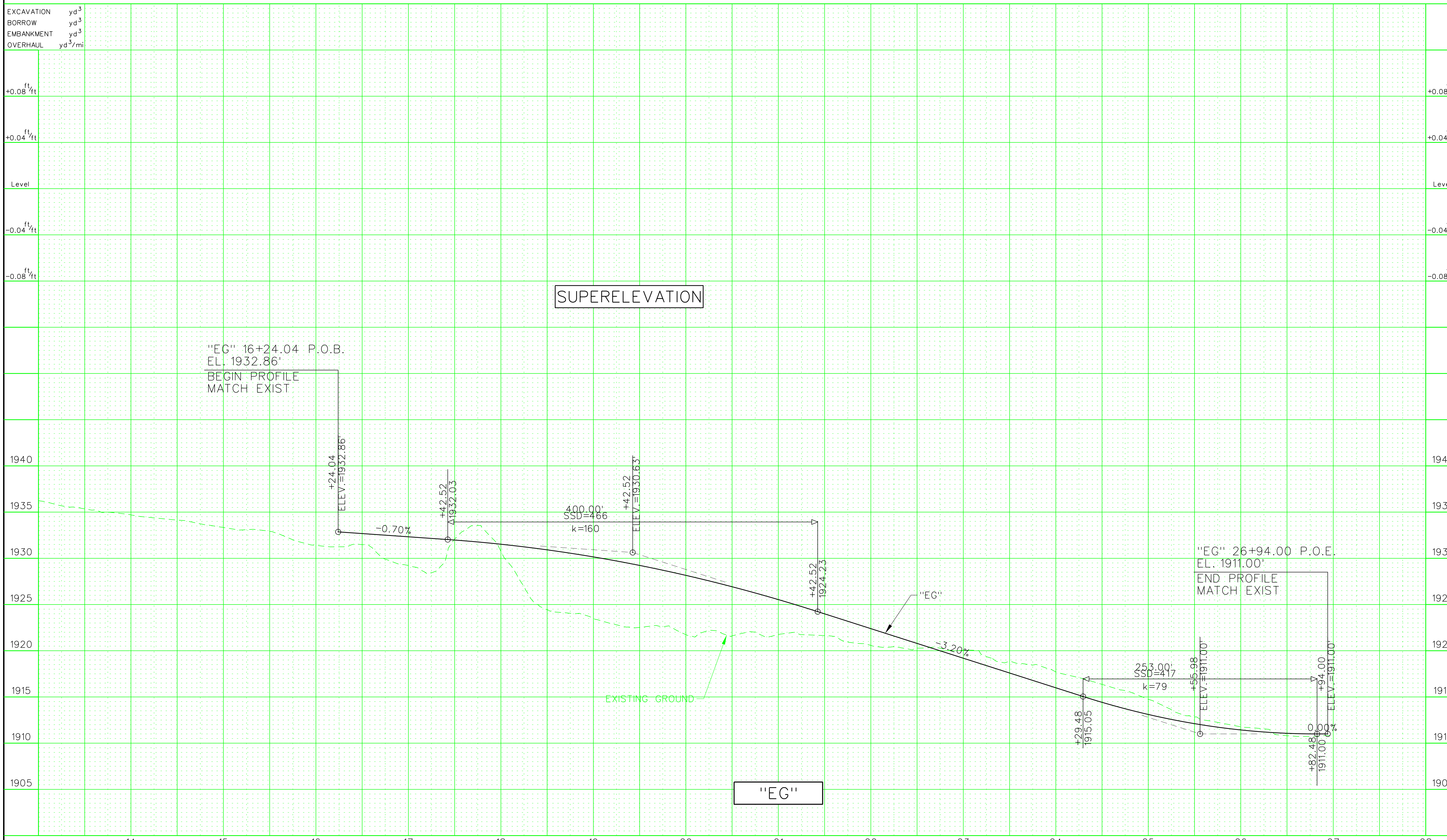


1:100 PLOT SCALE ghirmai.eman

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	07

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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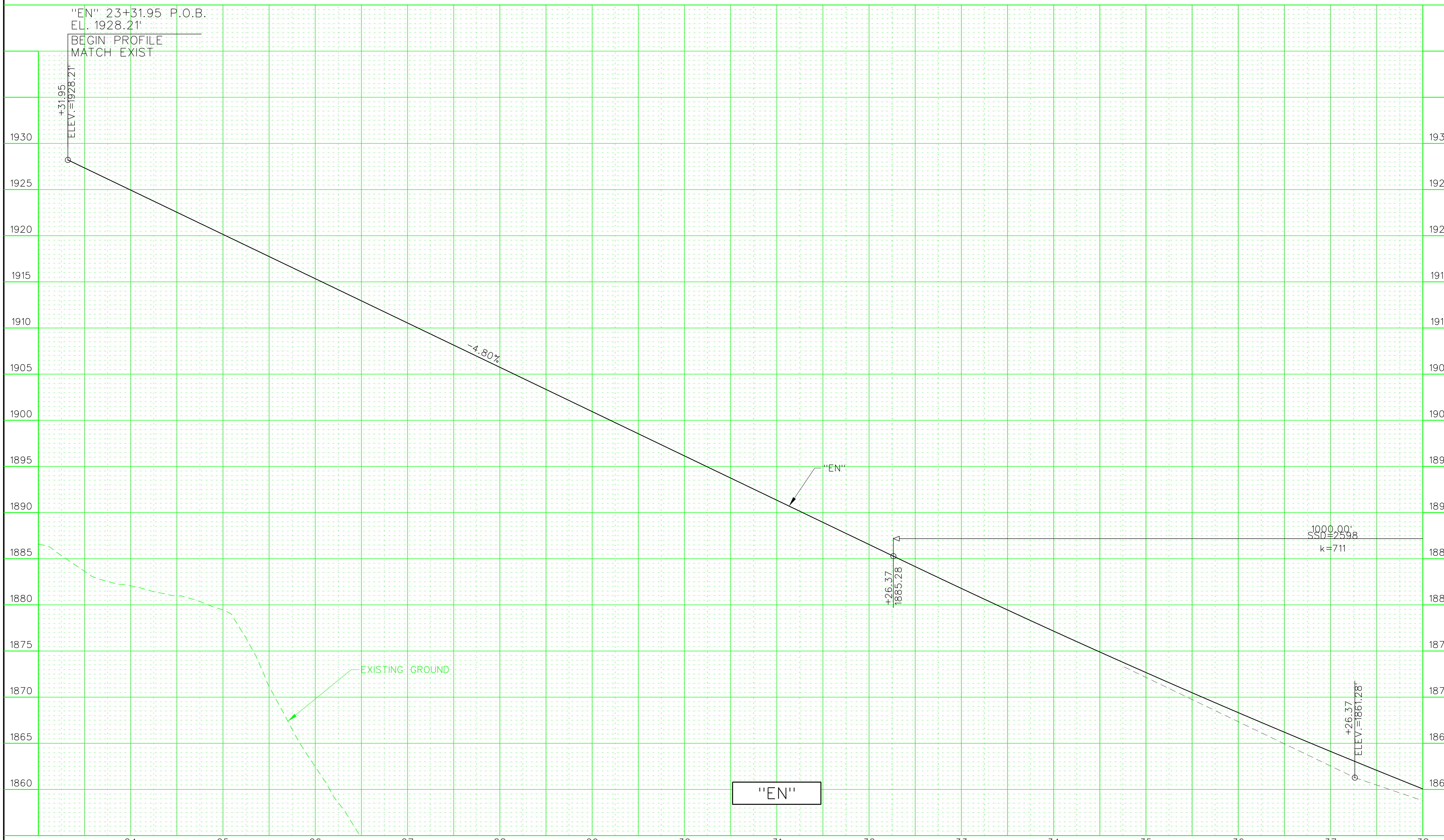
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	08

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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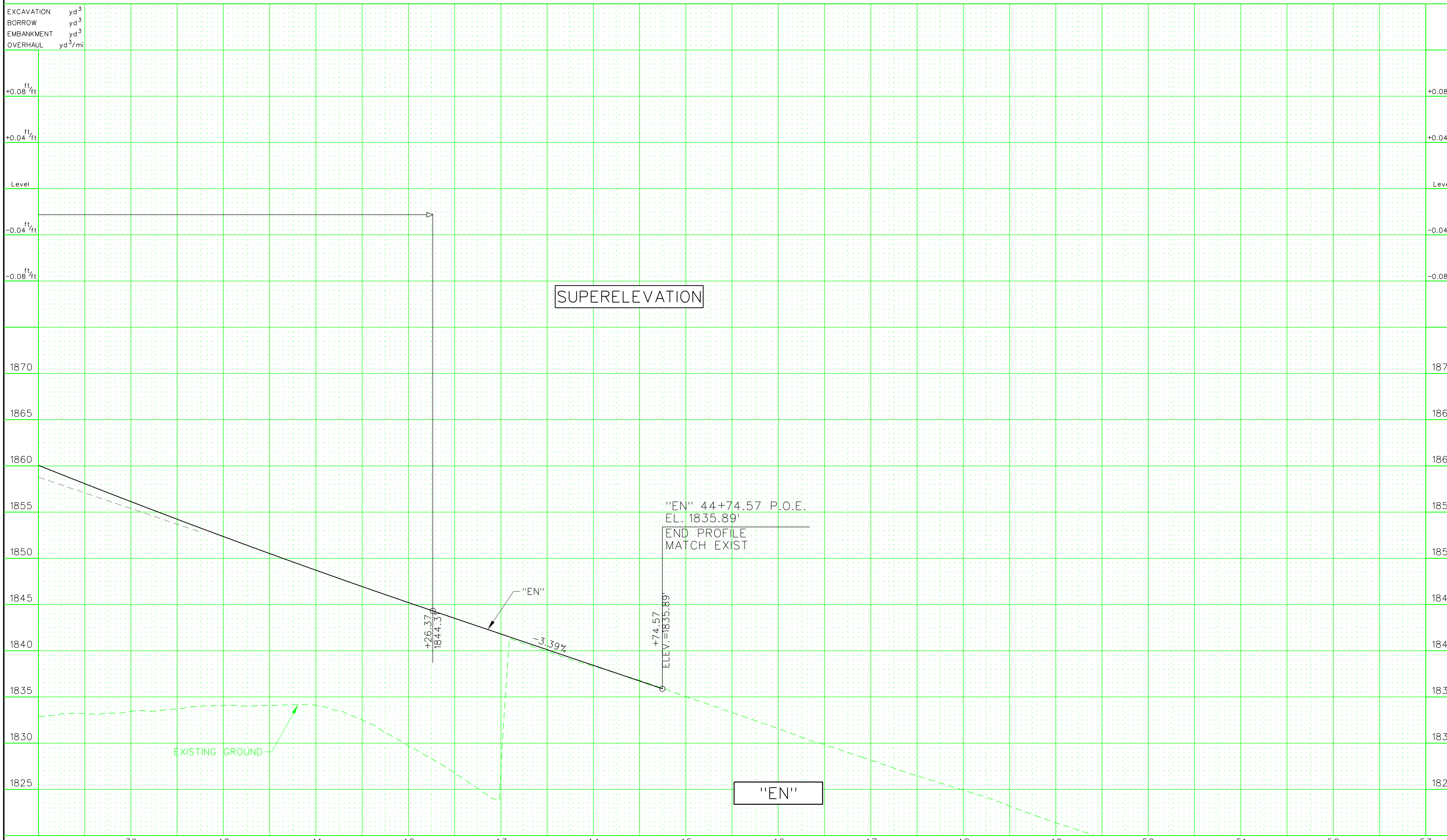
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	09

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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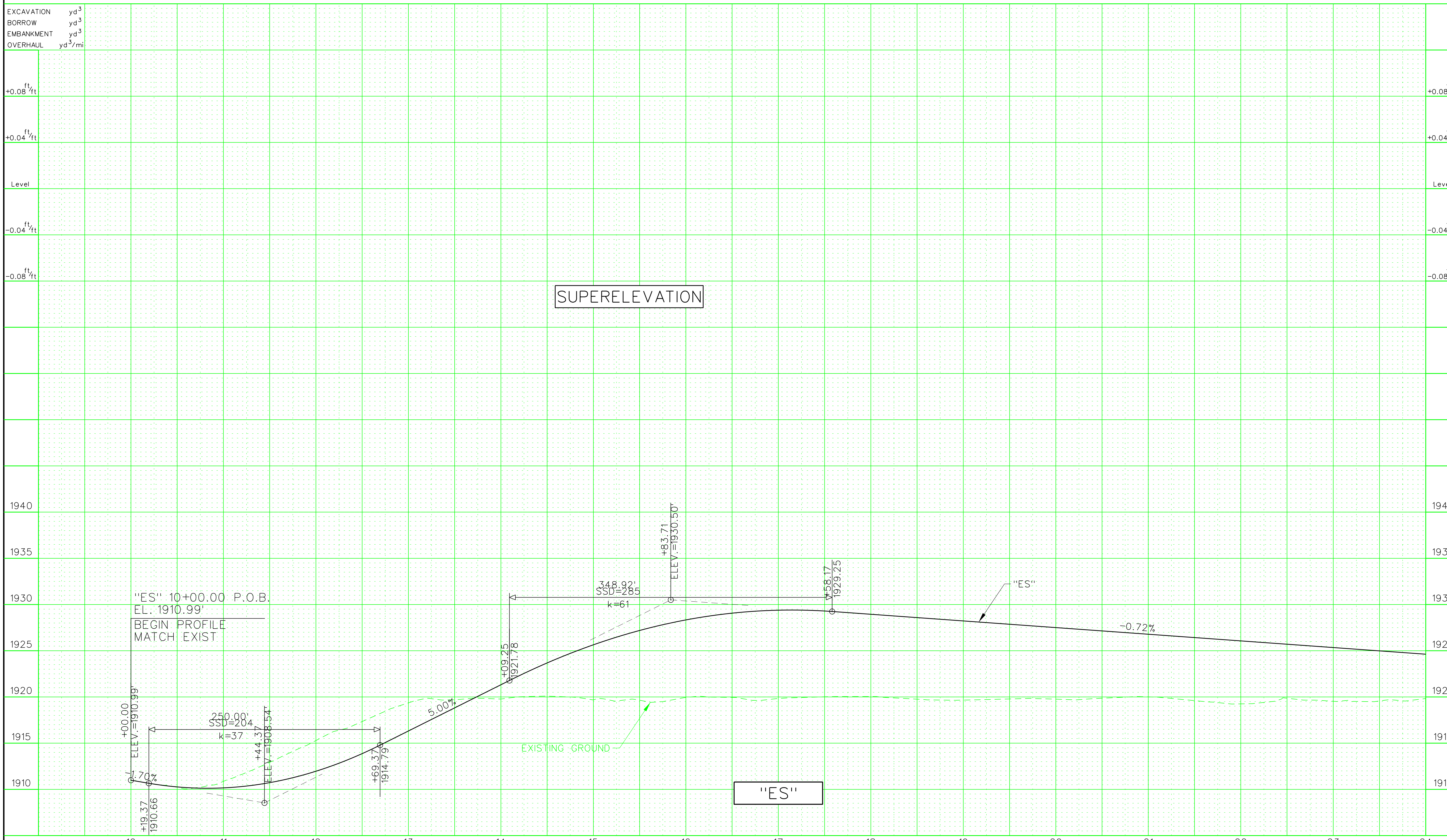
c:\pw-cagworkdir\ghirmai.eman\dms08942\ES_Opt3_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	10

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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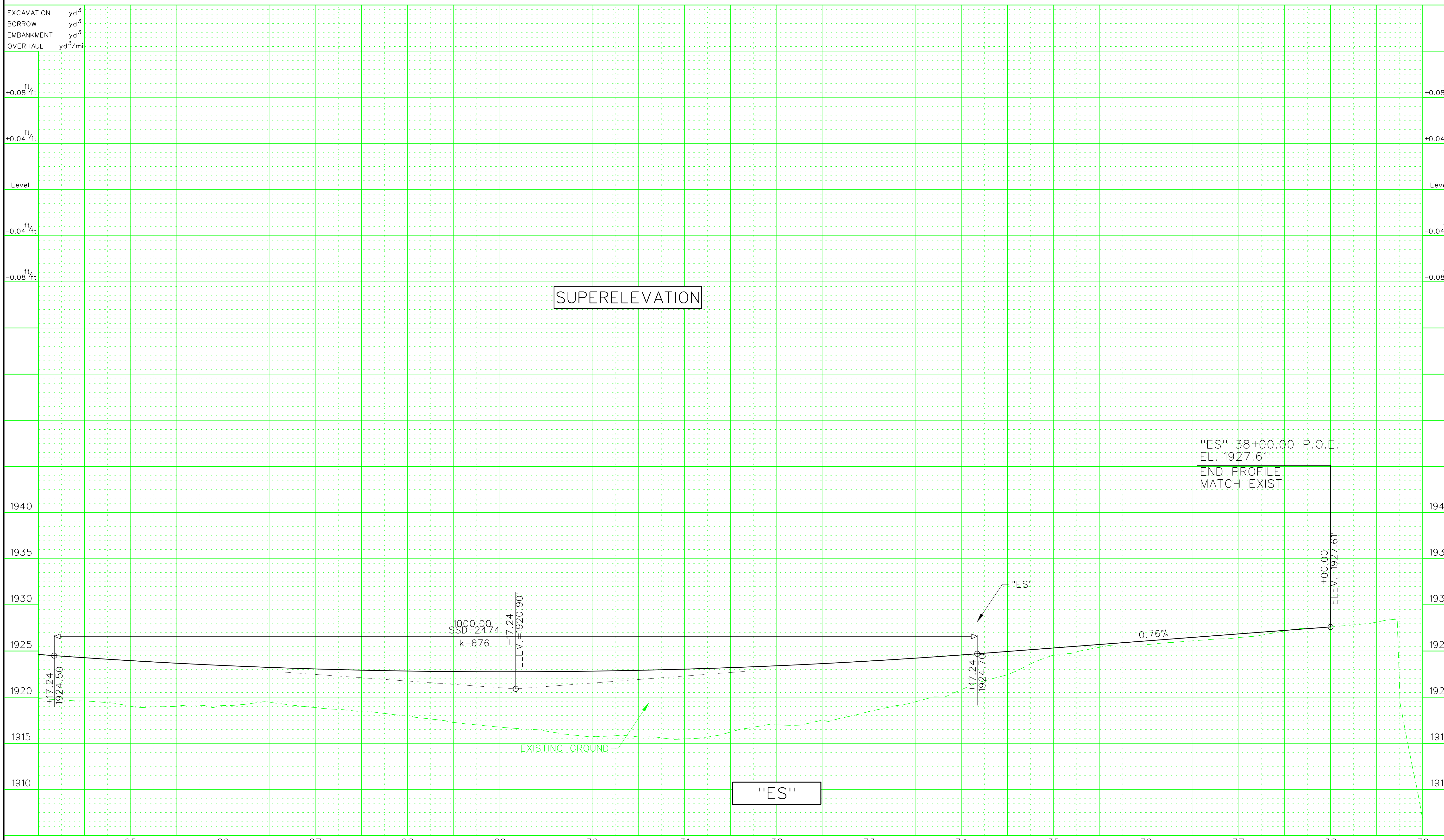
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	11

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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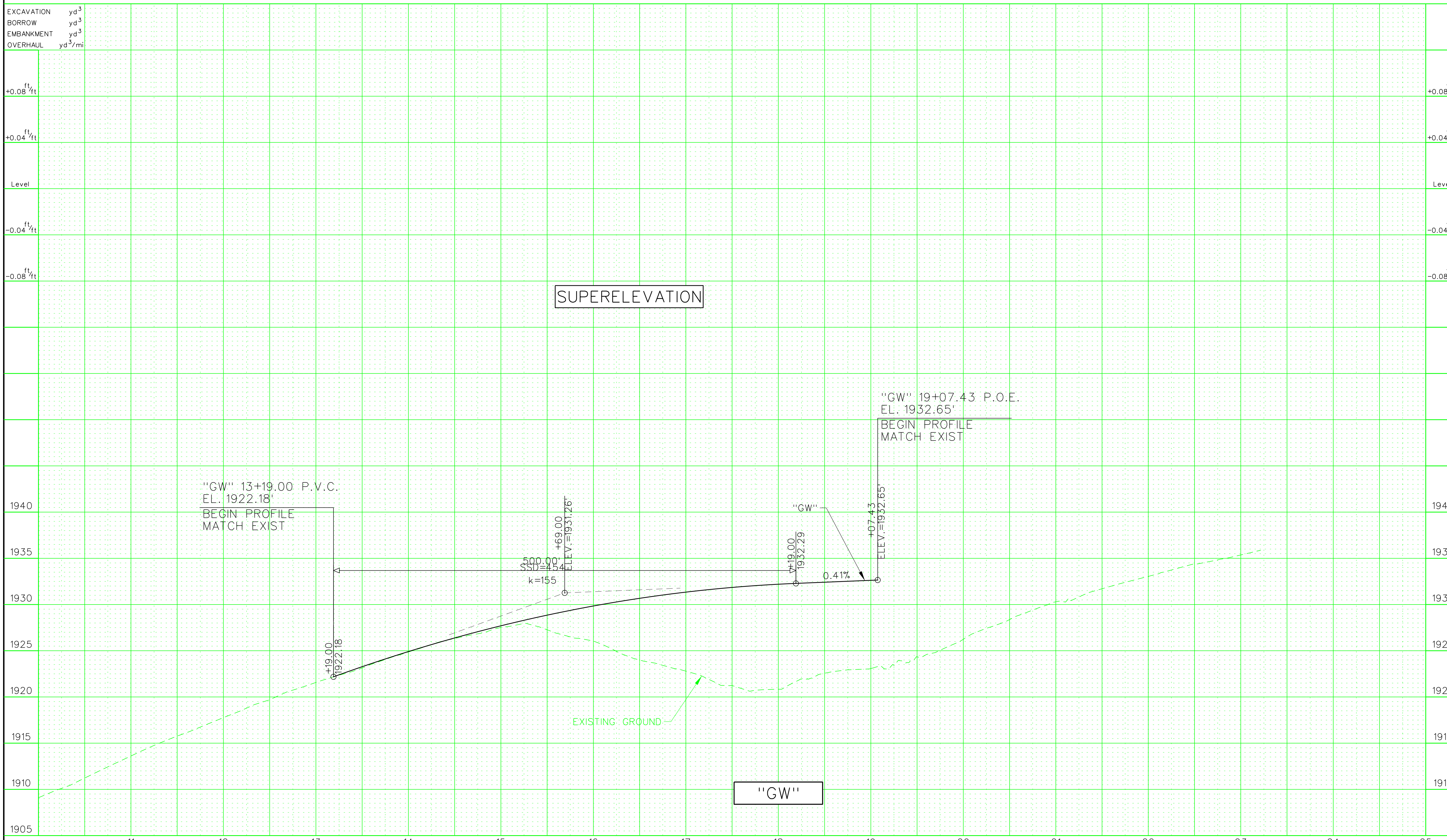
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	12

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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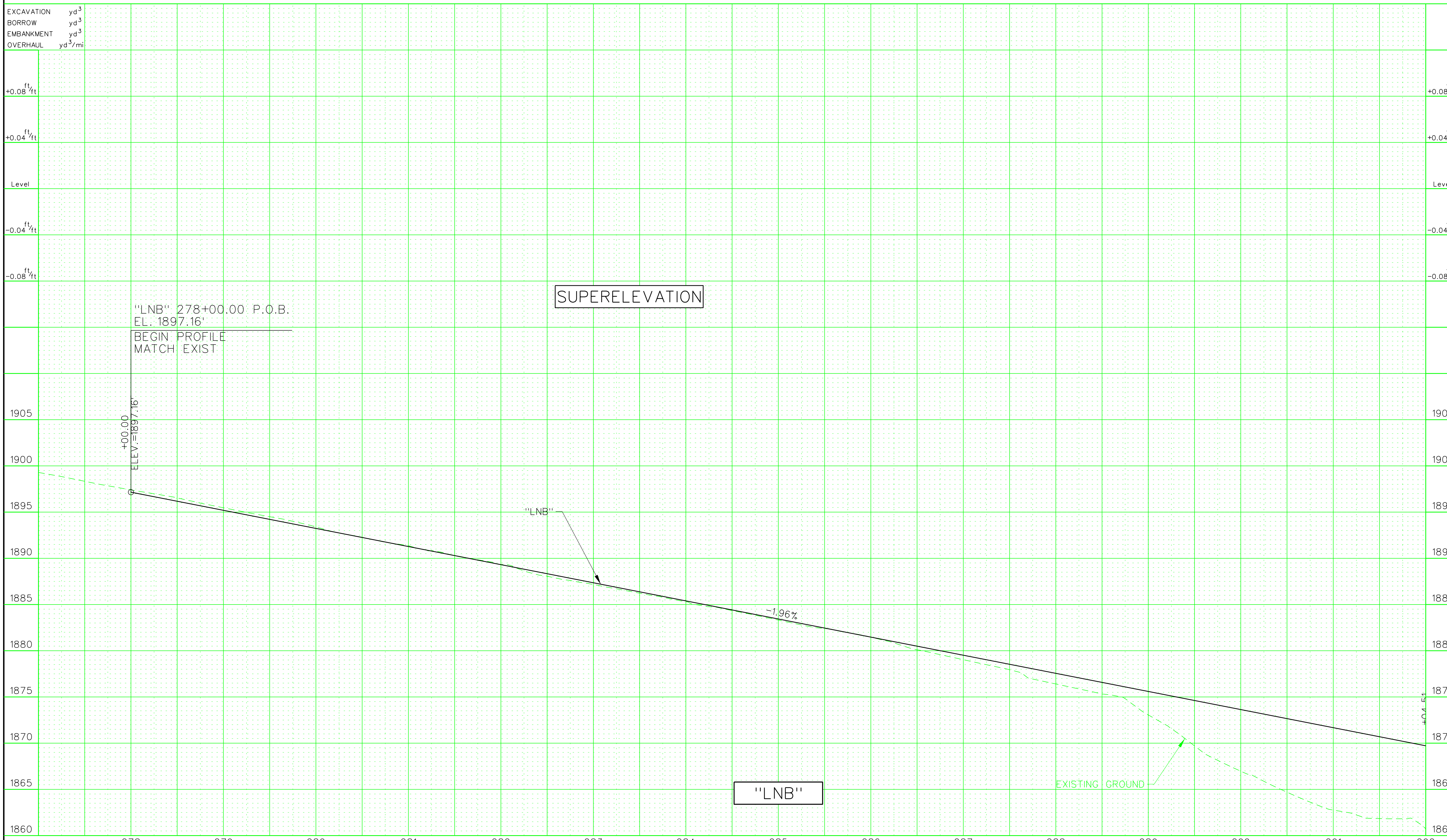
c:\pw-cagworkdir\ghirmai.eman\dms08942\LNB_Opt3_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	13

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



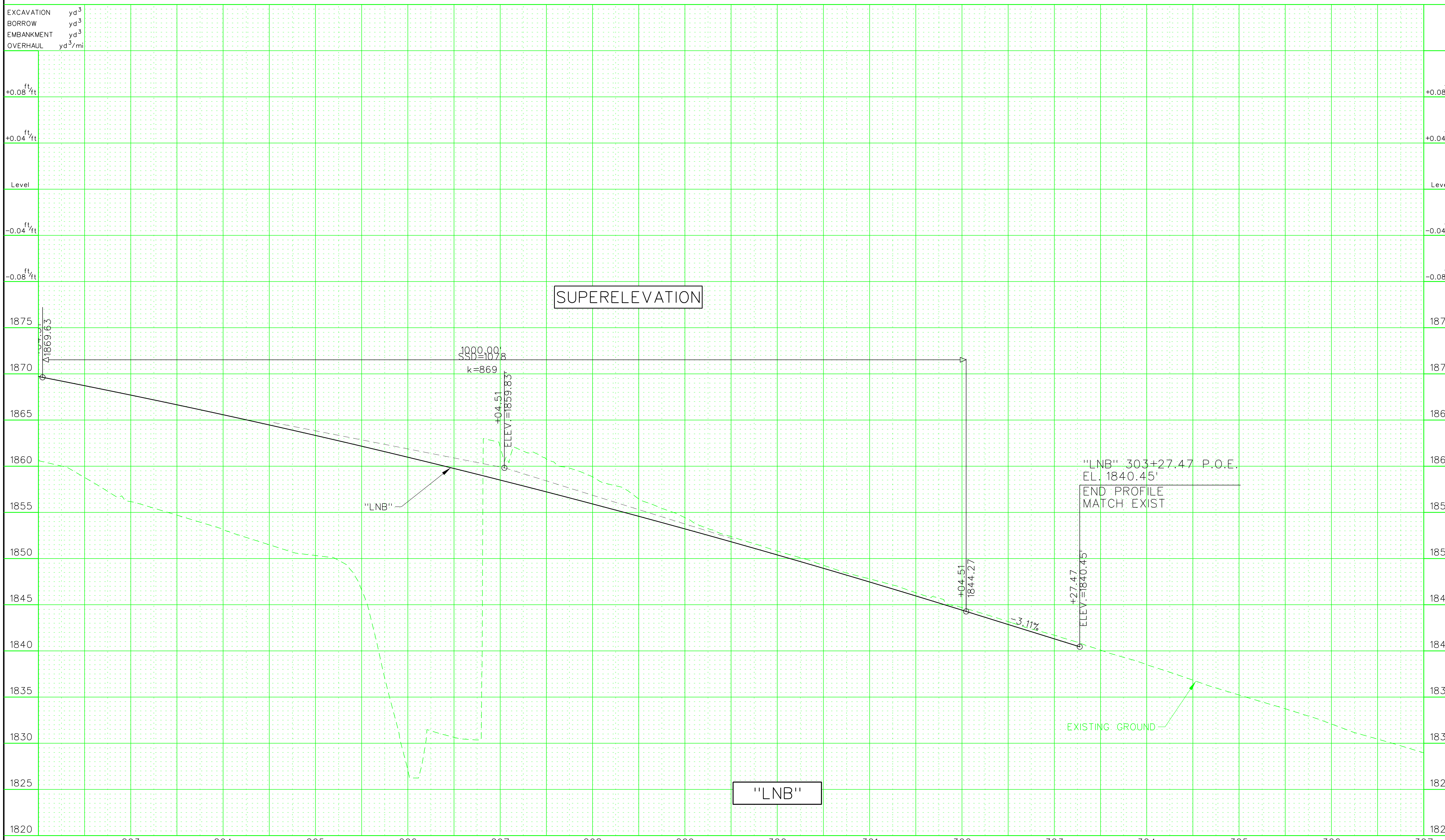
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08942\LNB_Opt3_Profile_02.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	14

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



1:100 PLOT SCALE ghirmai.eman

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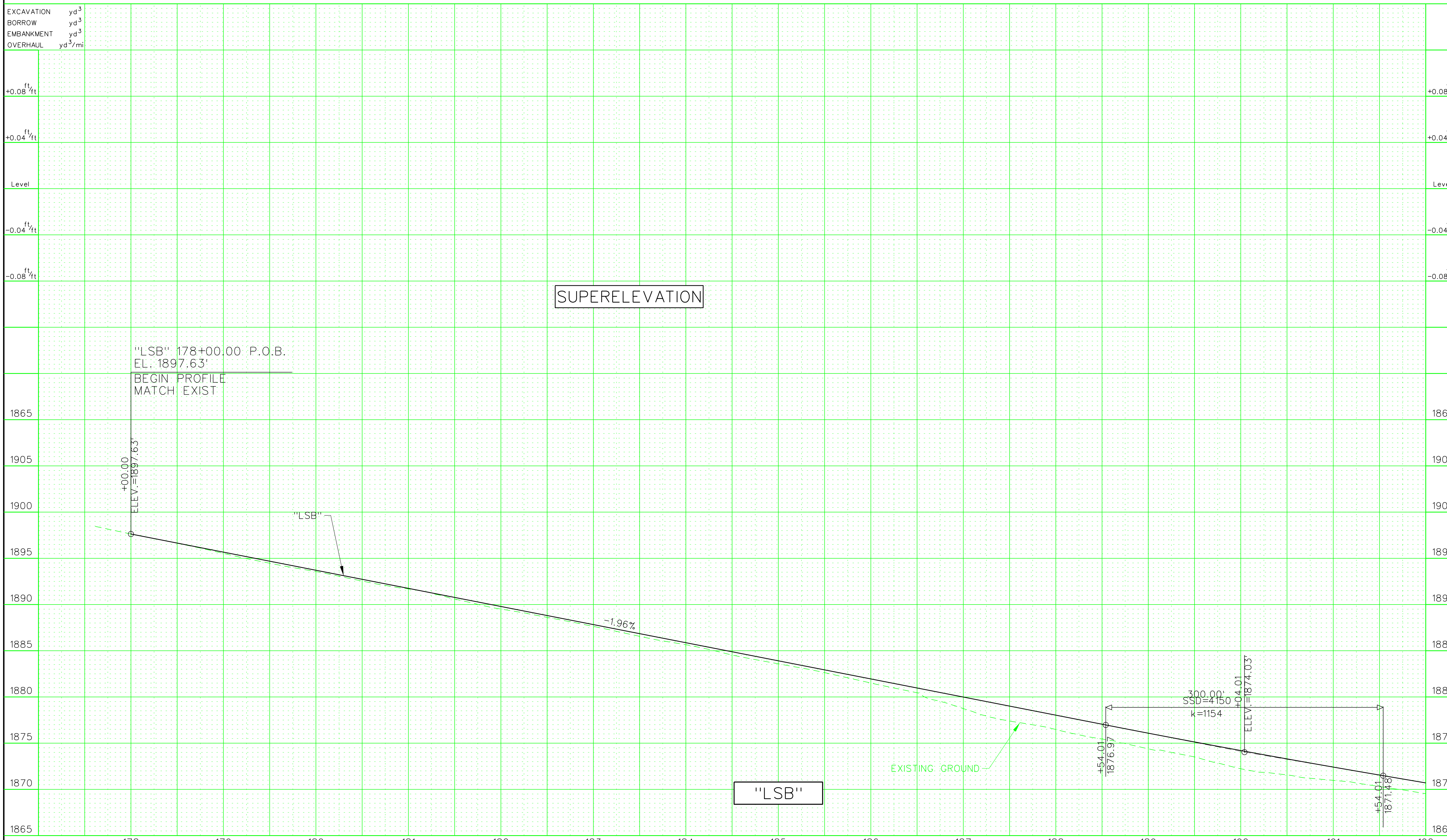
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	15

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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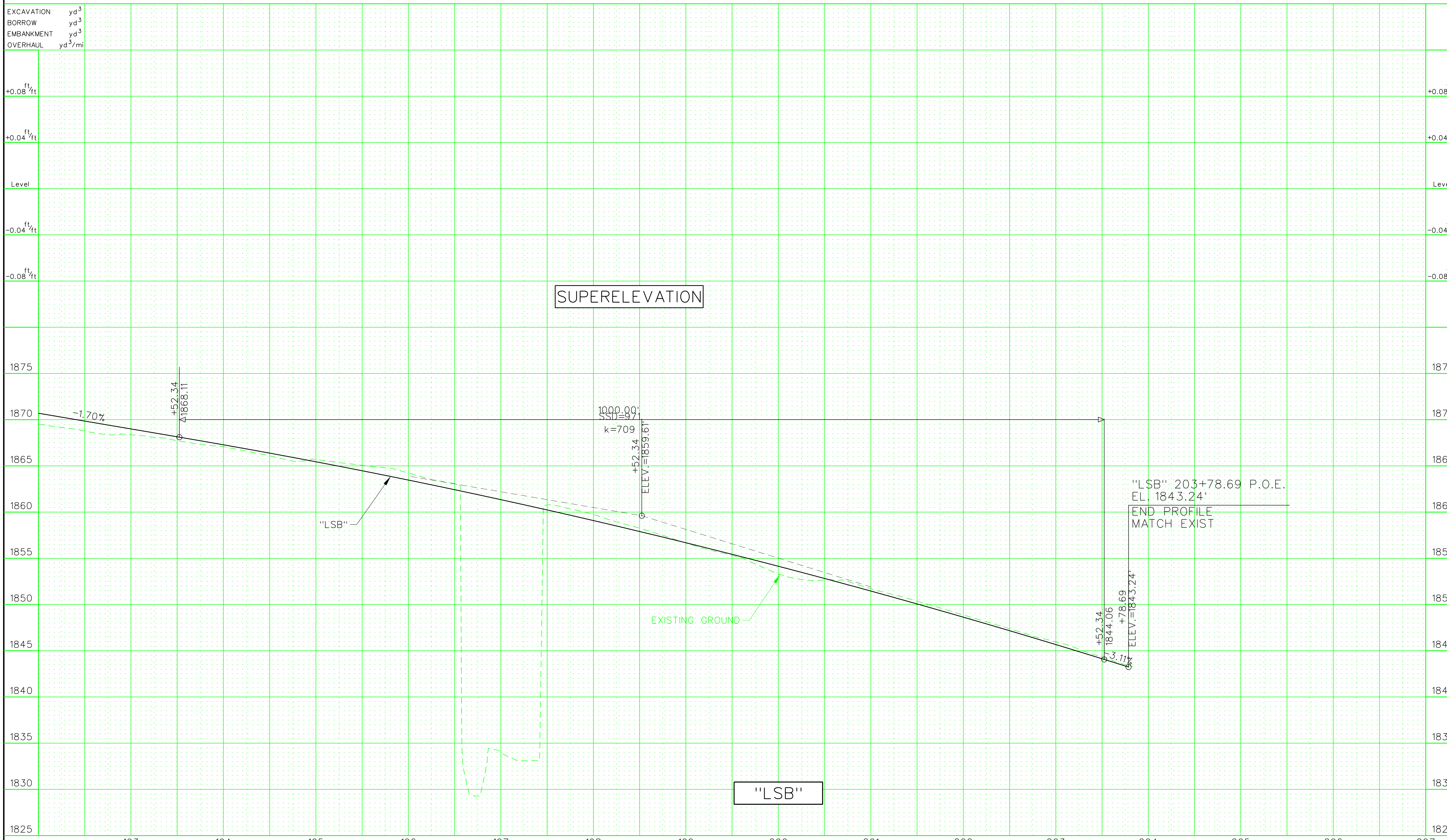
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	16

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



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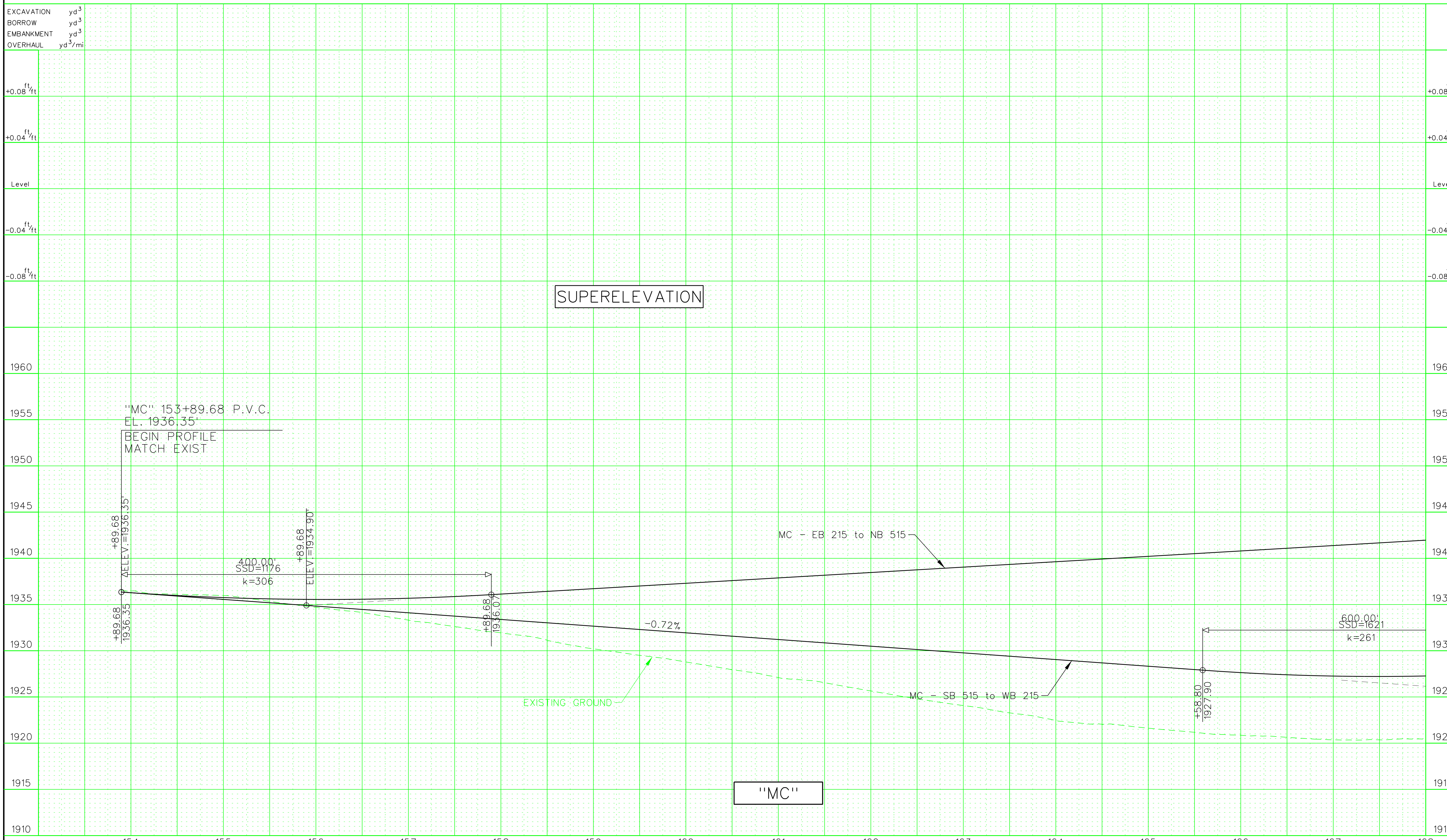
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	17

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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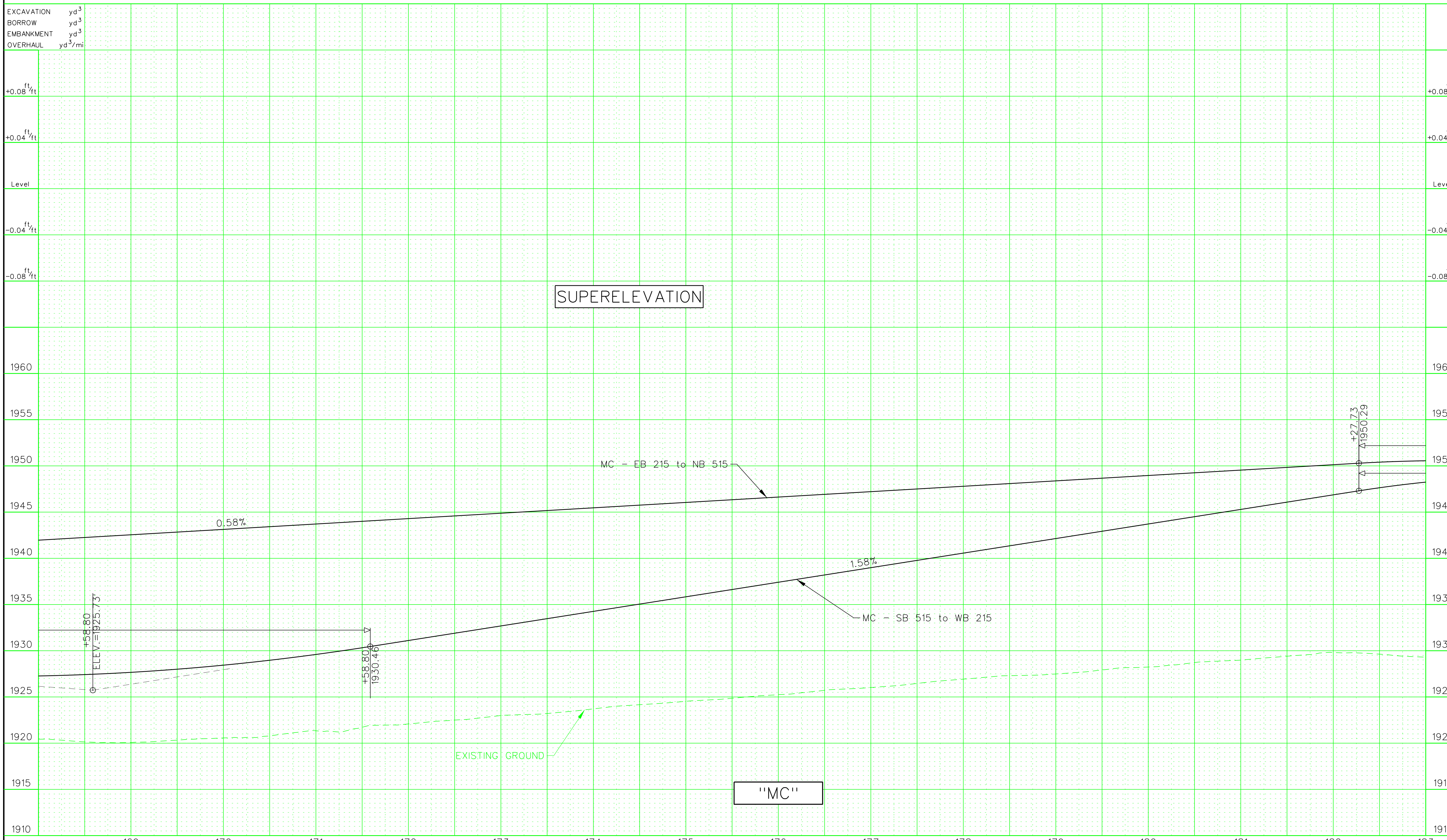
c:\pw-cagworkdir\ghirmai.eman\dms08942\MC_Opt3_Profile_02.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	18

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



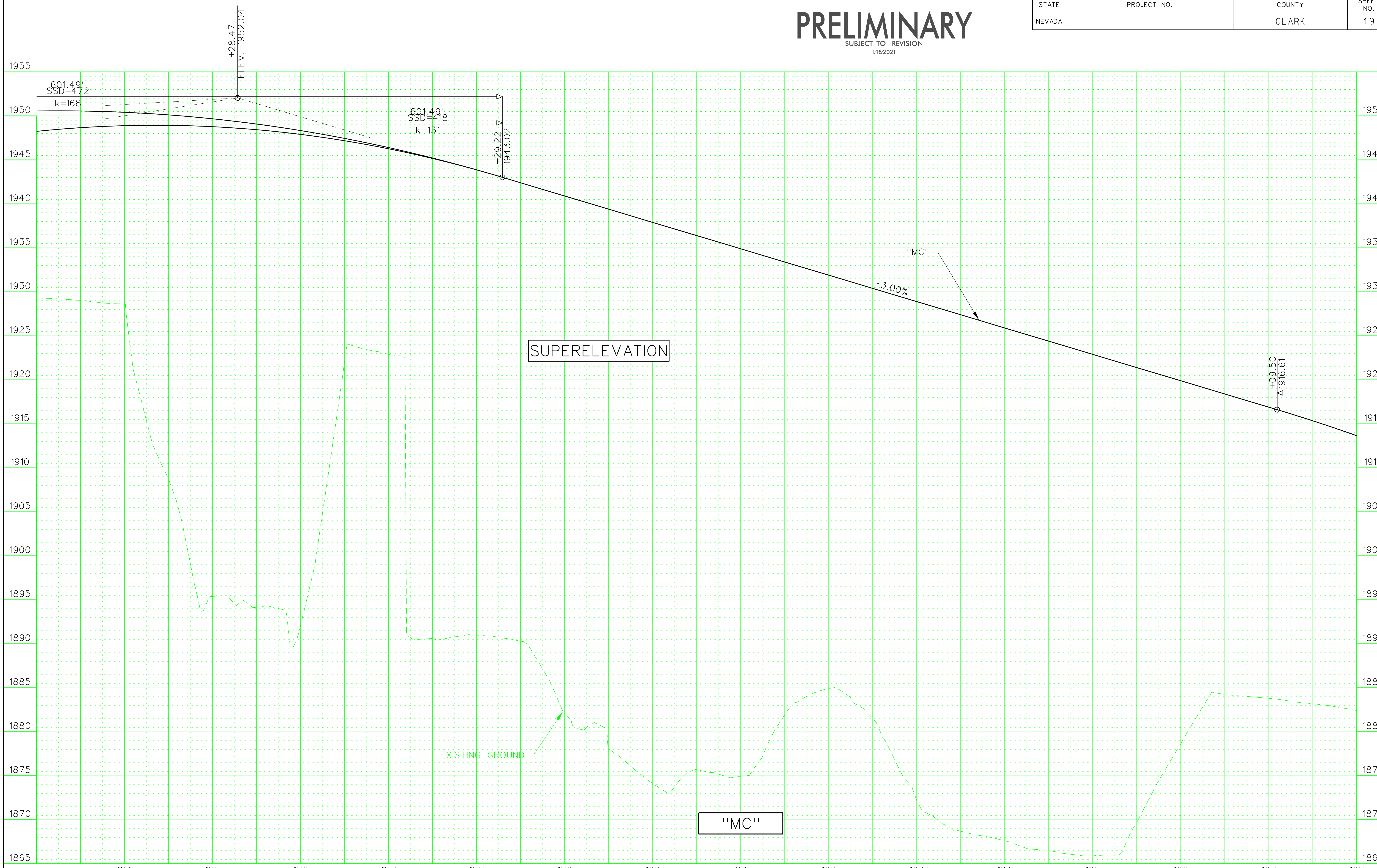
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08942\MC_Opt3_Profile_03.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	19

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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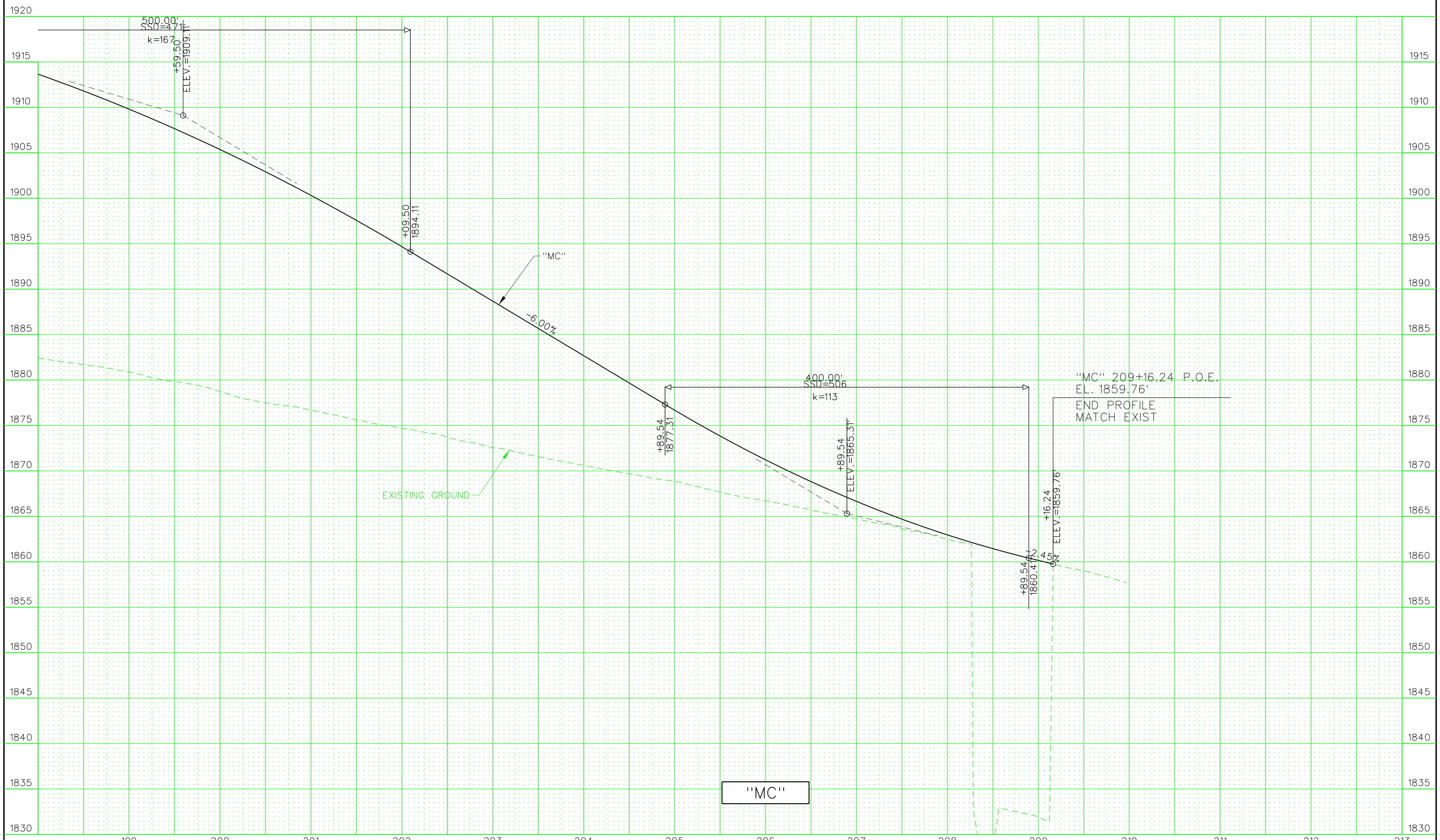
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	20

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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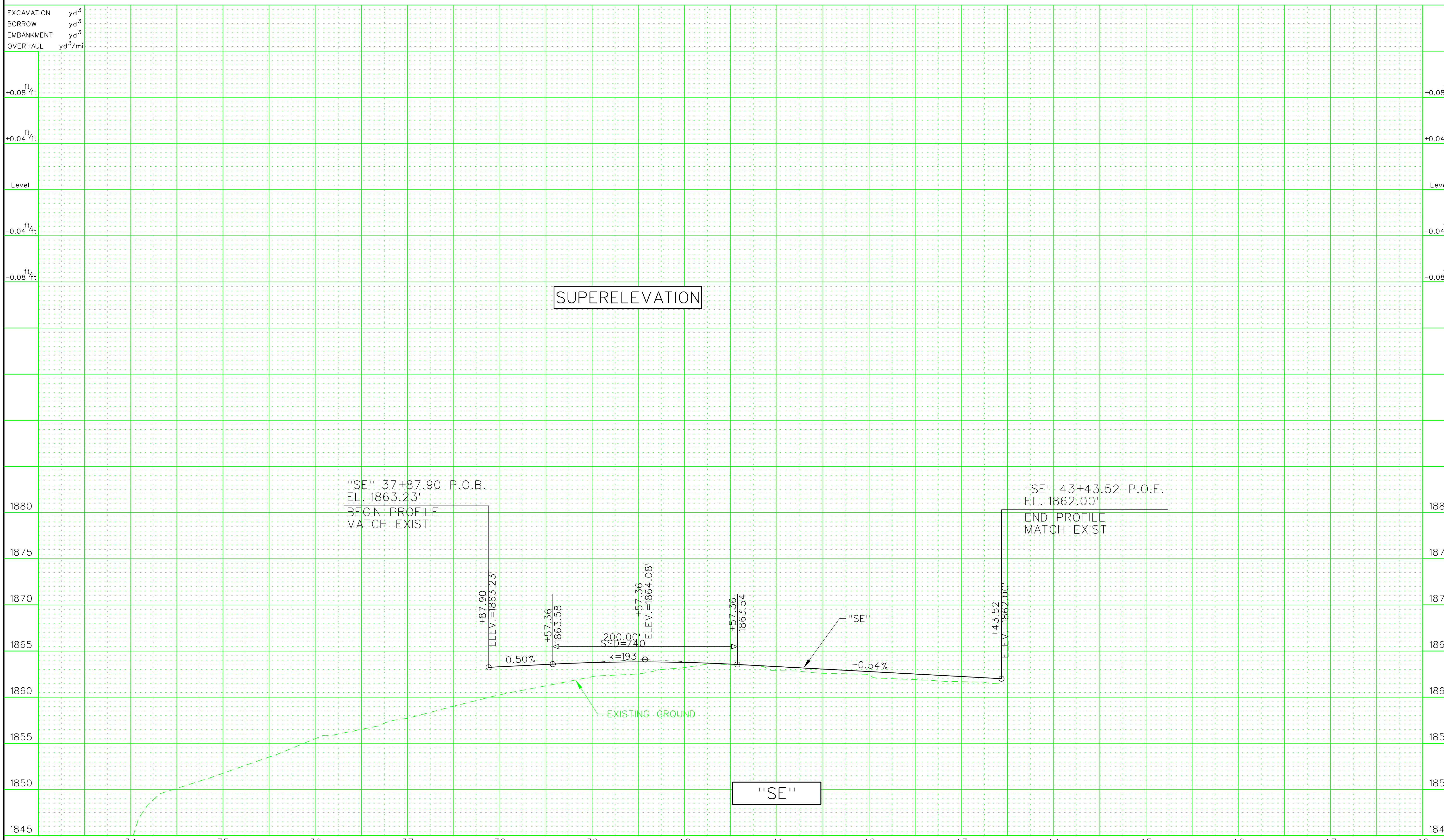
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	21

PRELIMINARY
SUBJECT TO REVISION
1/18/2021



1:100 PLOT SCALE ghirmai.eman

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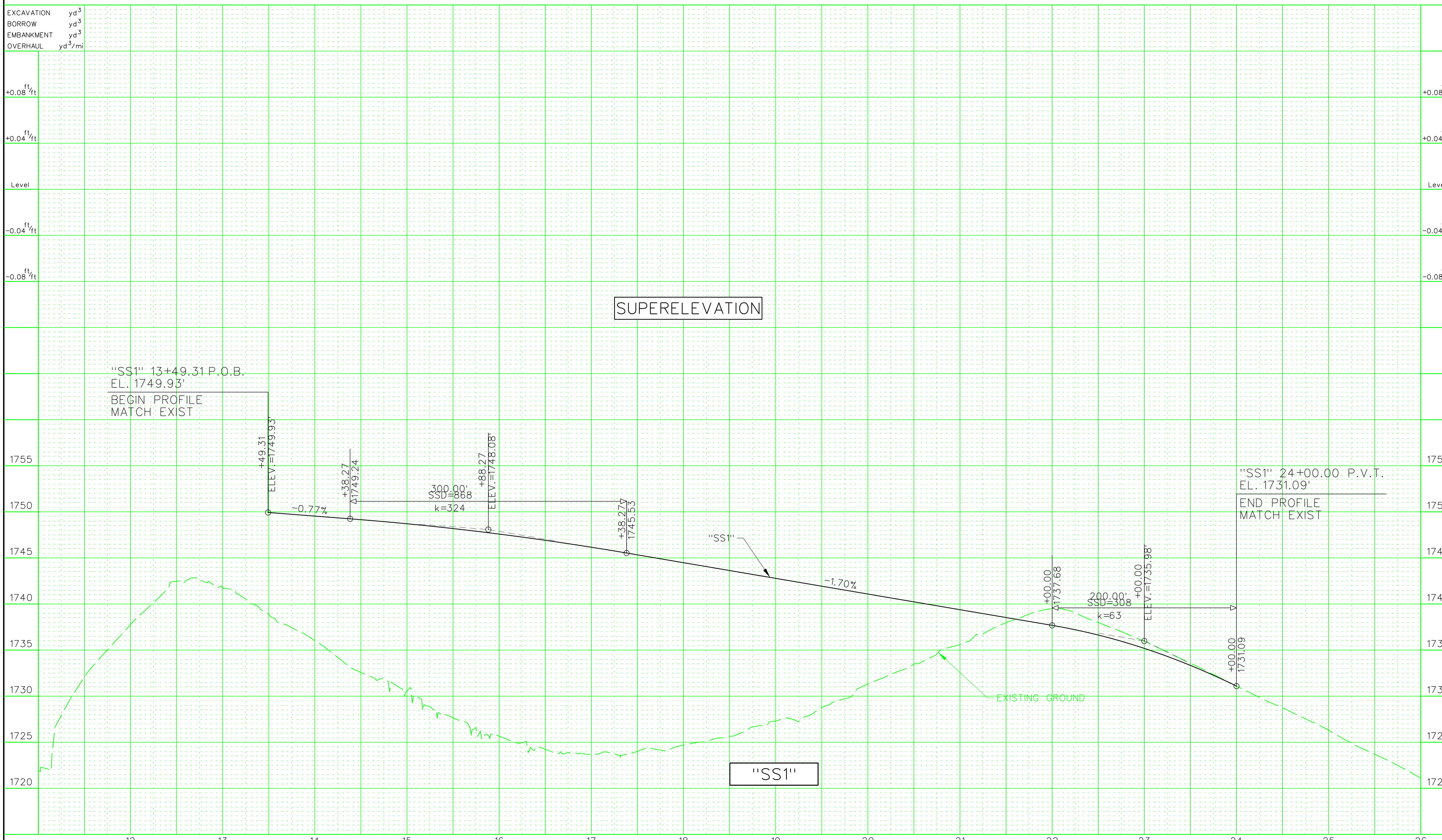
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	22

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



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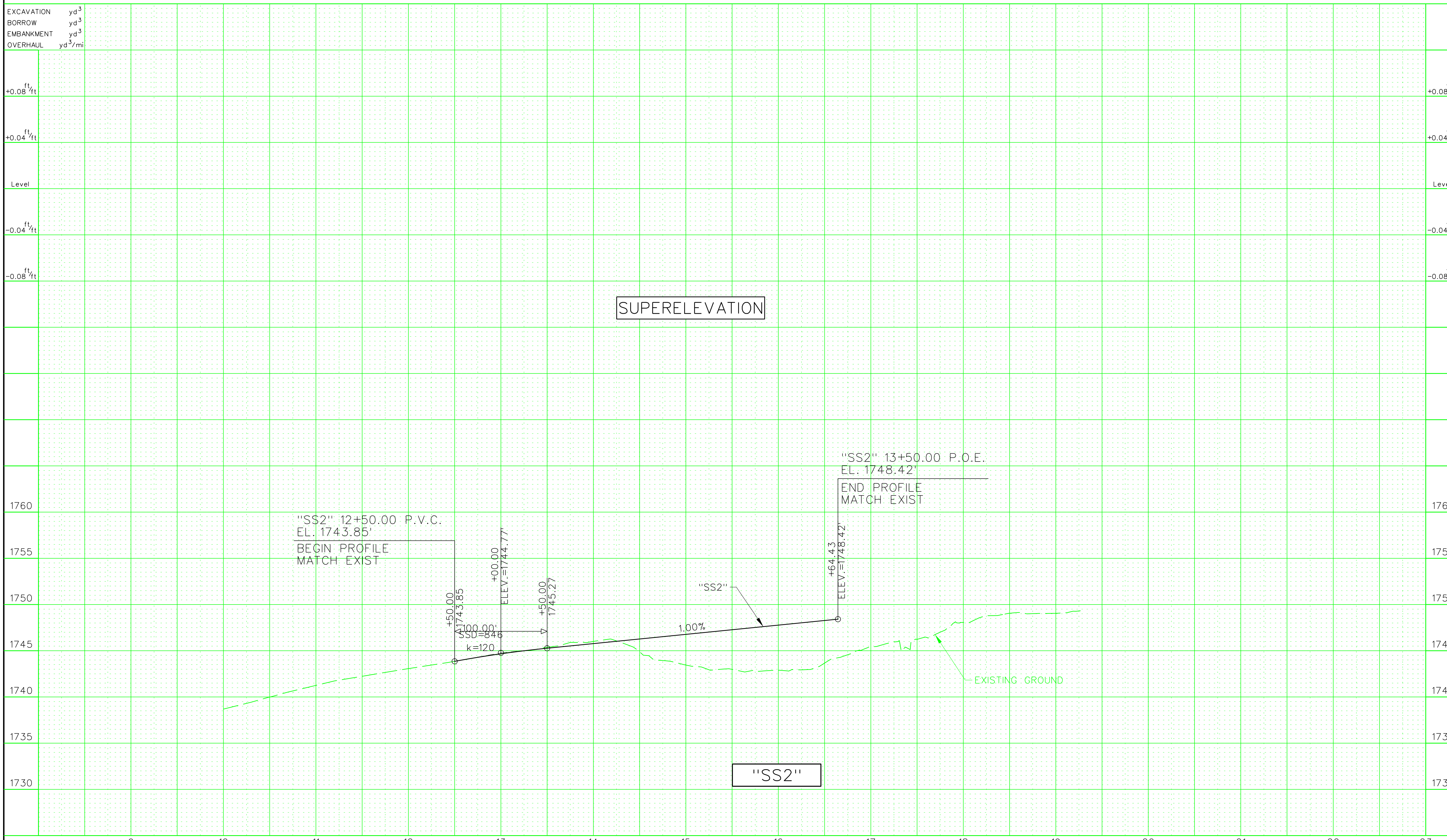
STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	23

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



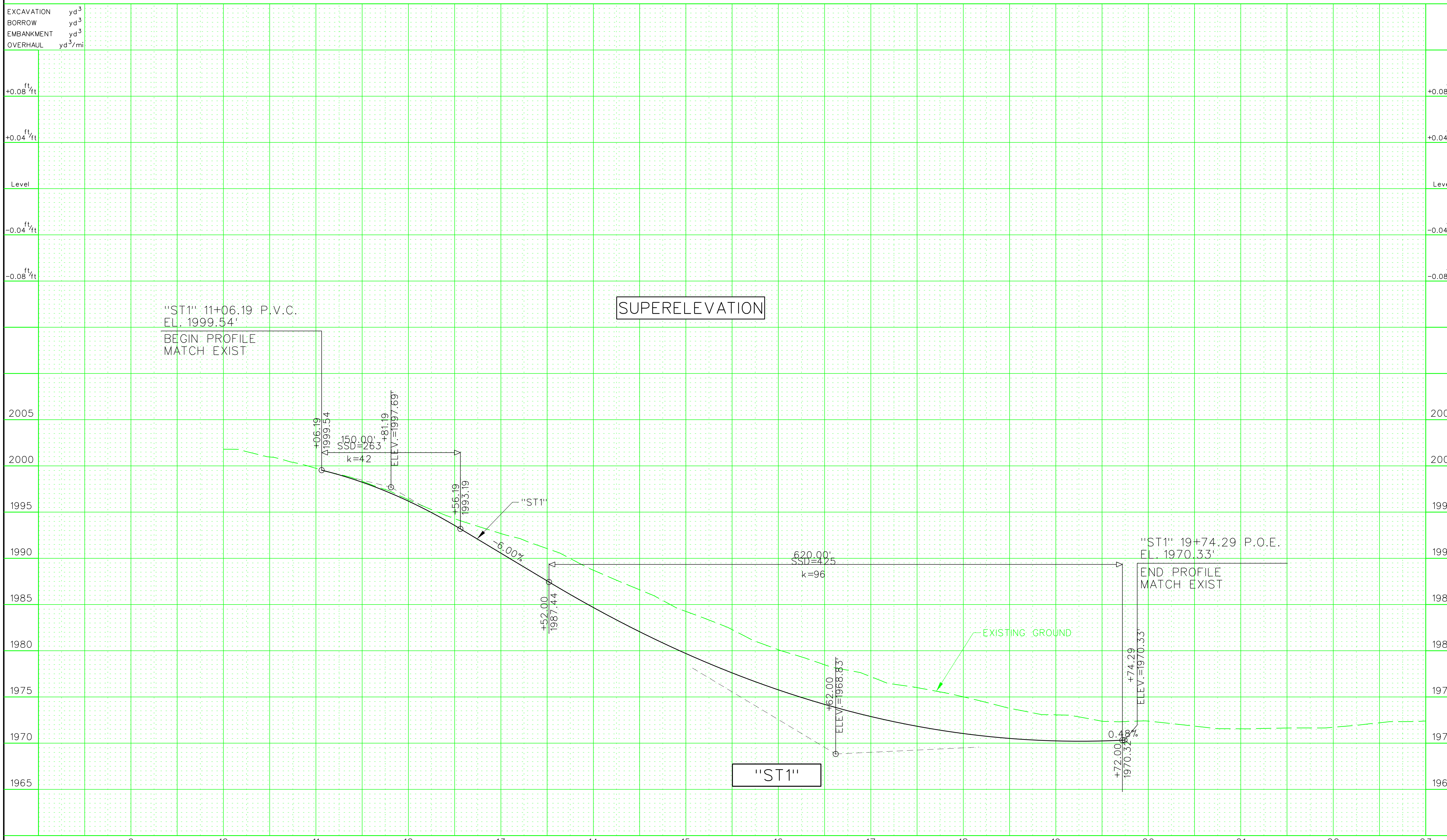
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08942\ST1_Opt3_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	24

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



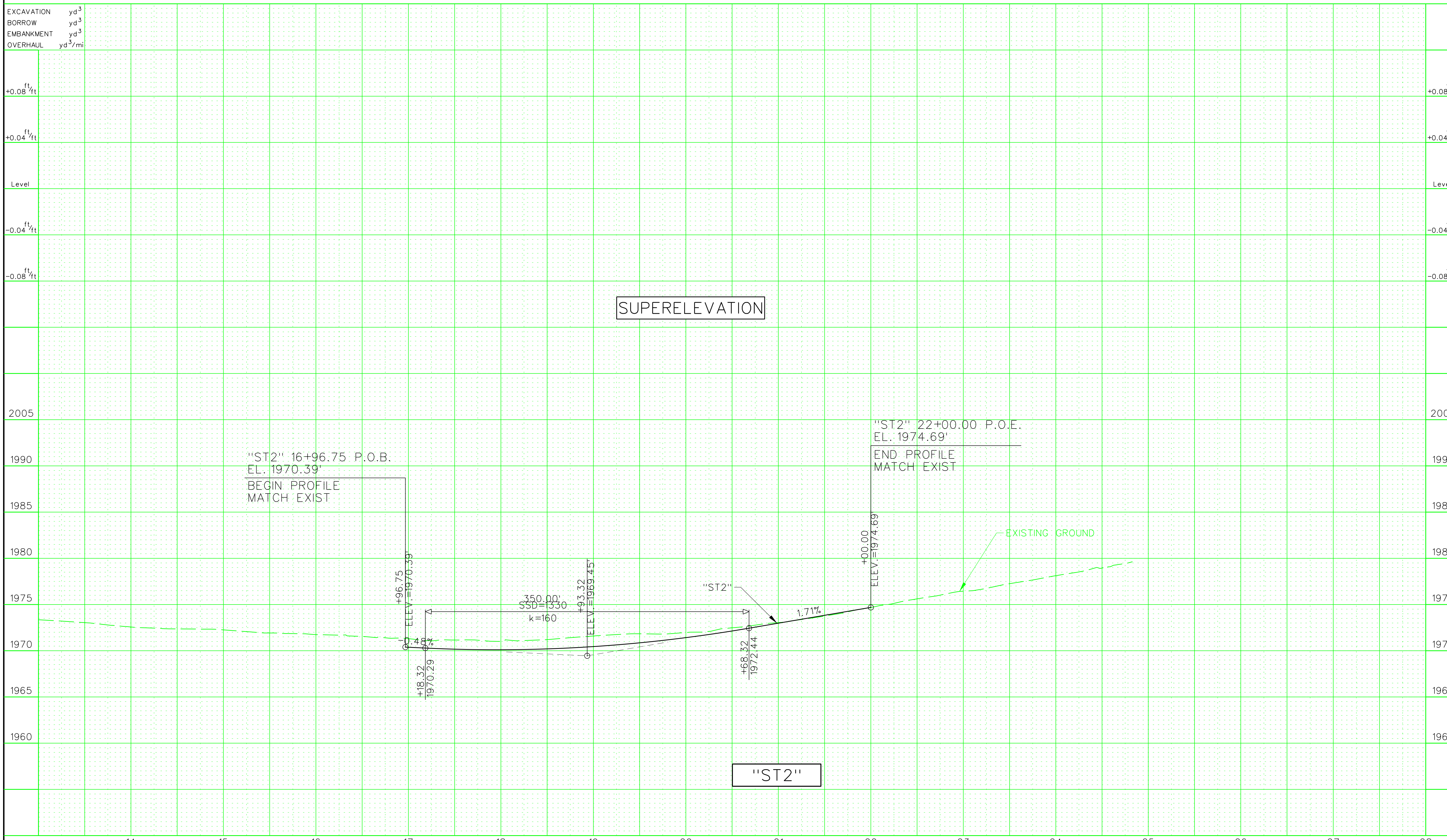
1:100 PLOT SCALE ghirmai.eman

c:\pw-cagworkdir\ghirmai.eman\dms08942\ST2_Opt3_Profile_01.dgn

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA		CLARK	25

PRELIMINARY

SUBJECT TO REVISION
1/18/2021



1:100 PLOT SCALE ghirmai.eman

Appendix 7

Option 2A Superelevation Diagrams

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	3.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	27.35	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

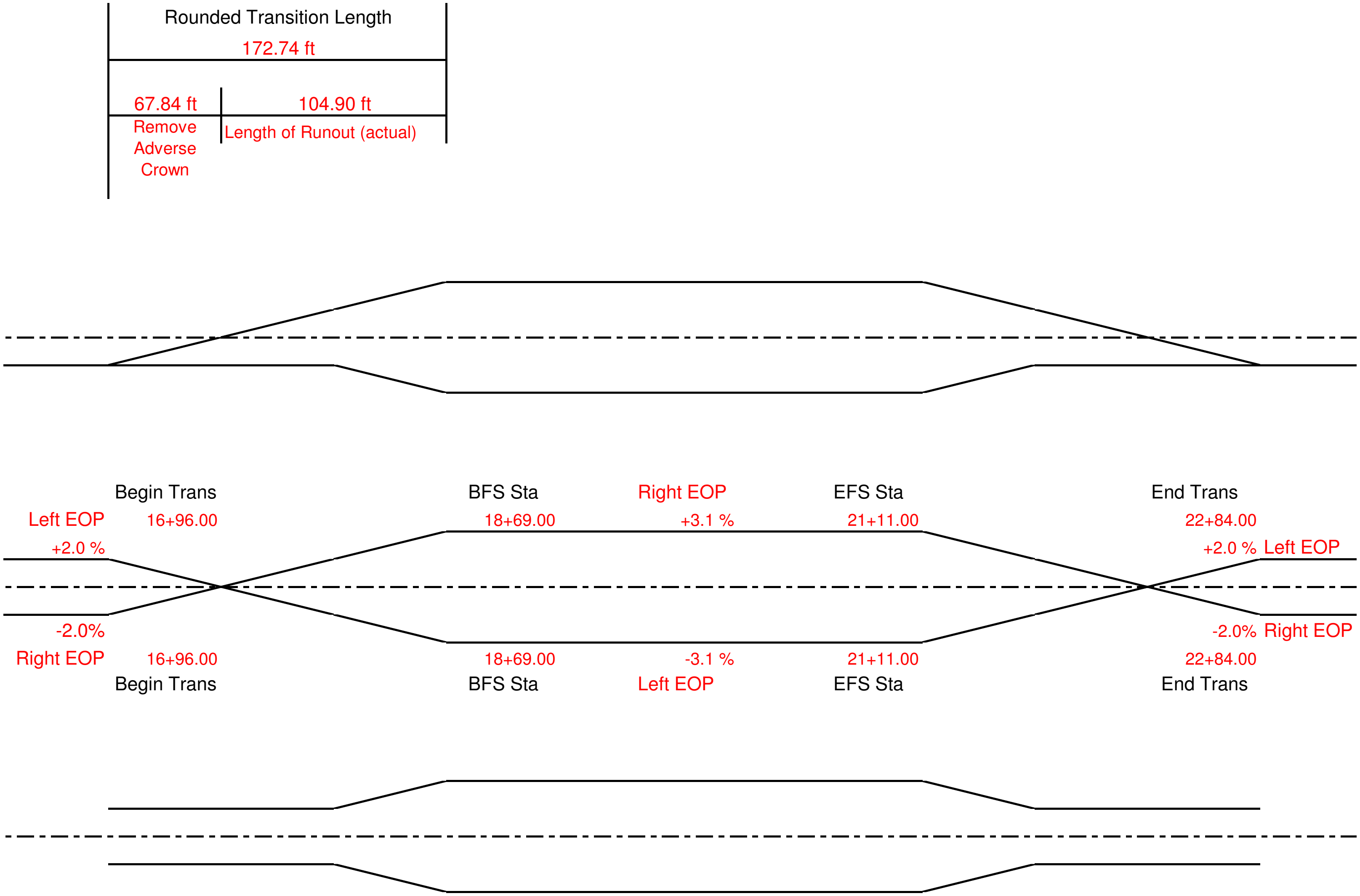
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.1%=	172.74	ft	
Rounded to Nearest 0.01 ft	172.74	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	94.50	ft	
* Distance from 0 point to Start of Transition	-67.74	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	17+64.32		
Begin Transition Sta	16+96.00		16+96.00
PC Sta	18+58.82		
Begin Full Super	18+69.00		18+69.00

			Use
End Full Super	21+11.00		21+11.00
PT Sta	21+21.64		
End Transiton Sta	22+84.00		22+84.00
Theoretical Point of Intersection (0% Super) Sta	22+16.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2500	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	105.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	84.55	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

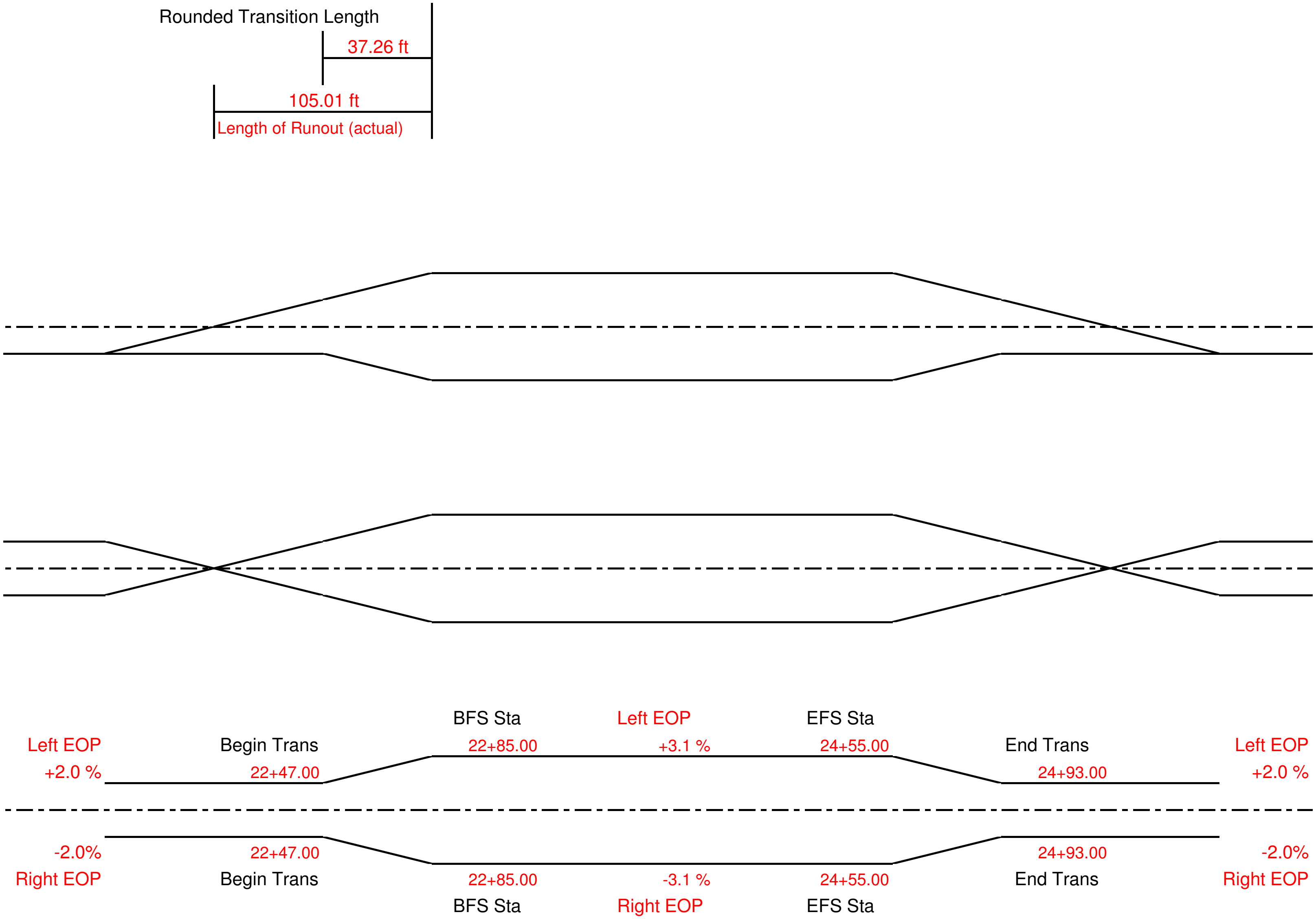
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.1%=	37.26	ft	
Rounded to Nearest 0.01 ft	37.26	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	94.50	ft	
* Distance from 0 point to Start of Transition	67.74	ft	

		Use
Theoretical Point of Intersection (0% Super) Sta	21+79.86	
Begin Transition Sta	22+47.00	22+47.00
PC Sta	22+74.36	
Begin Full Super	22+85.00	22+85.00

		Use
End Full Super	24+55.00	24+55.00
PT Sta	24+66.23	
End Transiton Sta	24+93.00	24+93.00
Theoretical Point of Intersection (0% Super) Sta	25+60.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5860	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	60.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

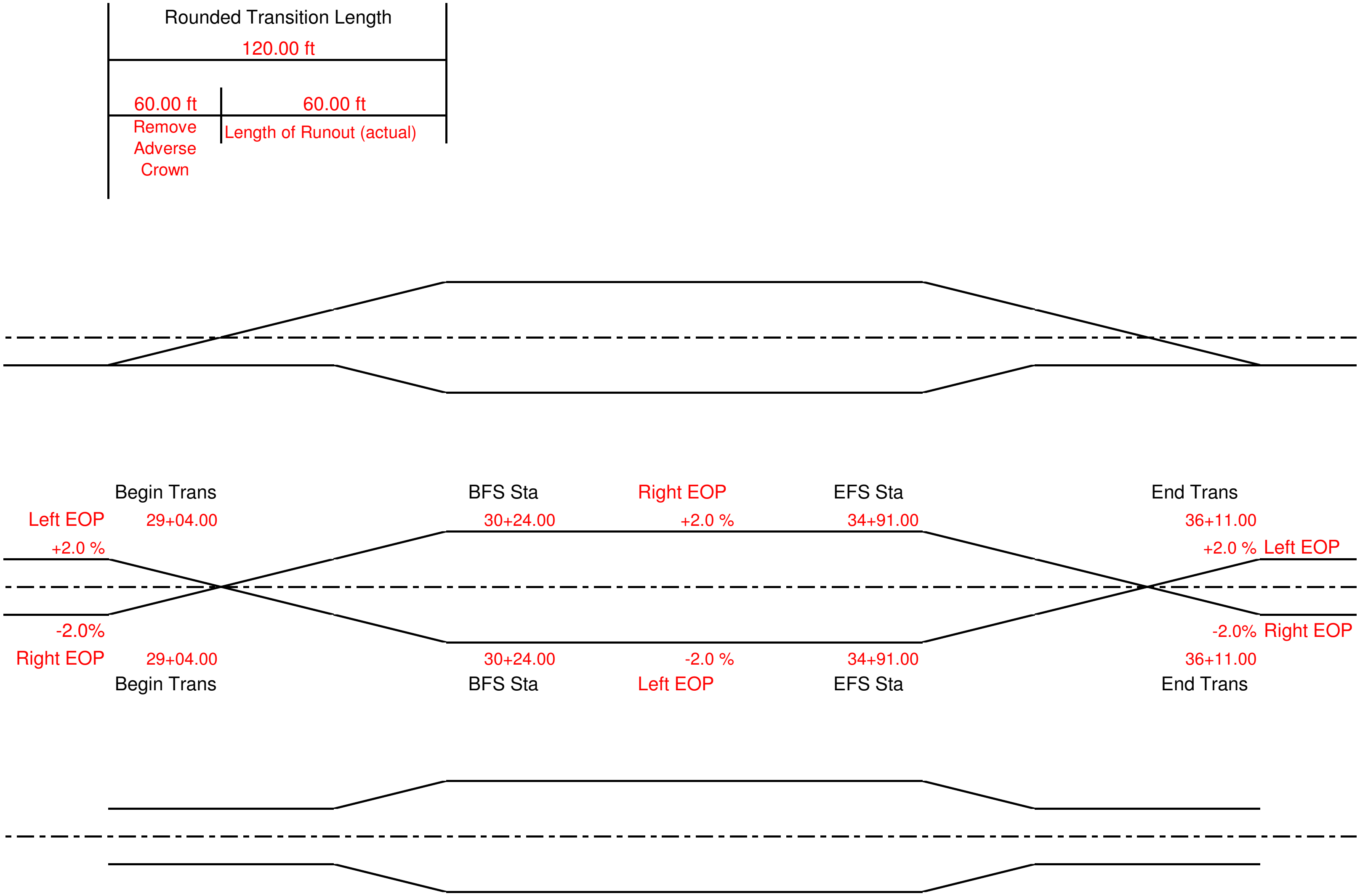
Needed Lr to Fit 50 ft Vert Curve	25.00	ft
Calculated Lr	60.00	ft
Use Calculated Lr	60.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	120.00	ft	
Rounded to Nearest 0.01 ft	120.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	42.00	ft	
* Distance from 0 point to Start of Transition	-60.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	29+64.07		
Begin Transition Sta	29+04.00		29+04.00
PC Sta	30+06.07		
Begin Full Super	30+24.00		30+24.00
			Use
End Full Super	34+91.00		34+91.00
PT Sta	35+08.45		
End Transiton Sta	36+11.00		36+11.00
Theoretical Point of Intersection (0% Super) Sta	35+51.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	444	ft
Design Speed	35	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	7.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	150.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	103	ft
Max Spiral Curve Length	188	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**150**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

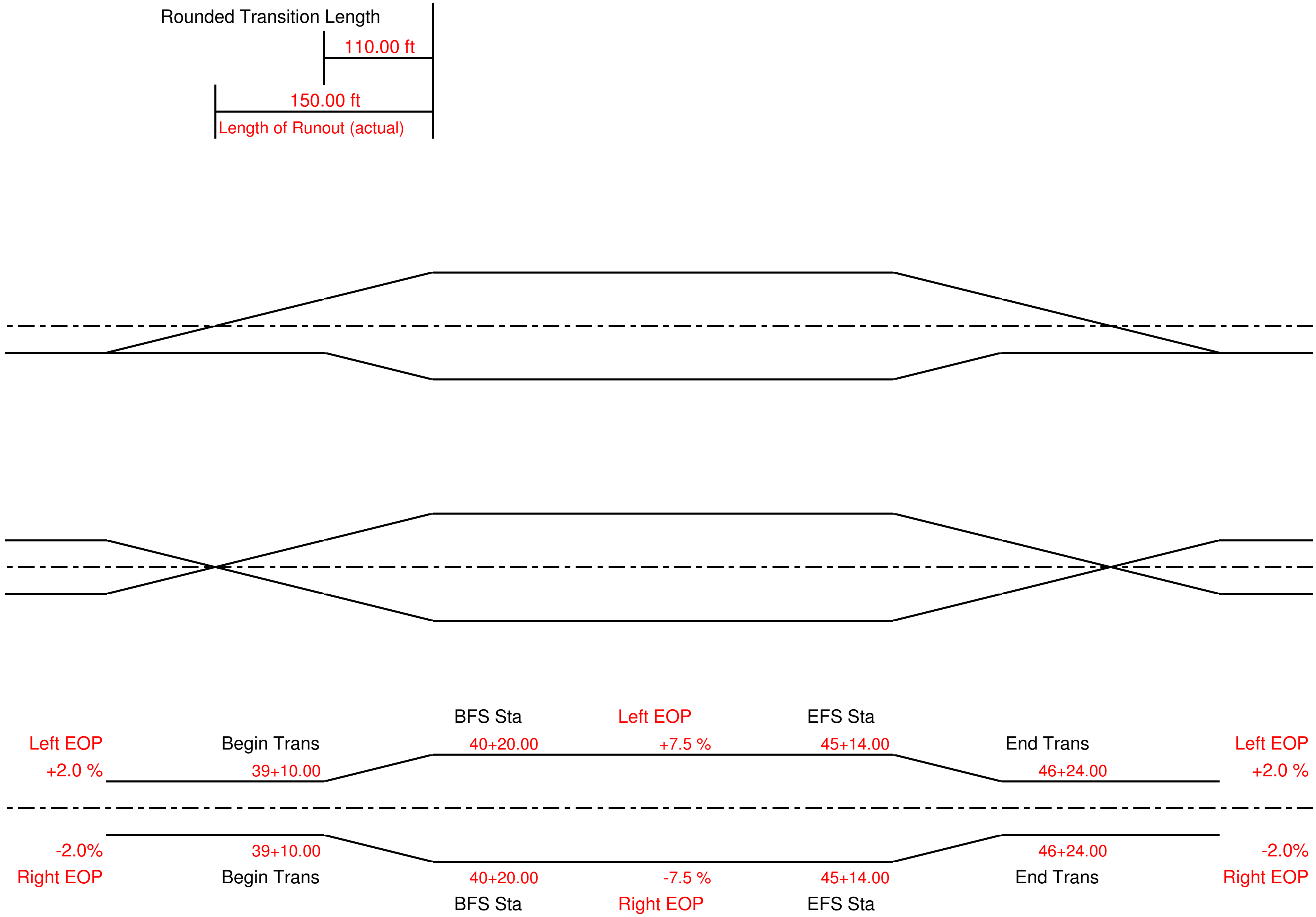
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 35 ft Vert Curve	40.91	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)?	No		
Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.5%=	110.00	ft	
Rounded to Nearest 0.01 ft	110.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	120.00	ft	
* Distance from 0 point to Start of Transition	40.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	38+70.33		
Begin Transition Sta	39+10.00		39+10.00
PC Sta	39+90.33		
Begin Full Super	40+20.00		40+20.00
			Use
End Full Super	45+14.00		45+14.00
PT Sta	45+43.41		
End Transiton Sta	46+24.00		46+24.00
Theoretical Point of Intersection (0% Super) Sta	46+64.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	735	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.7	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	270.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	362	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	270	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

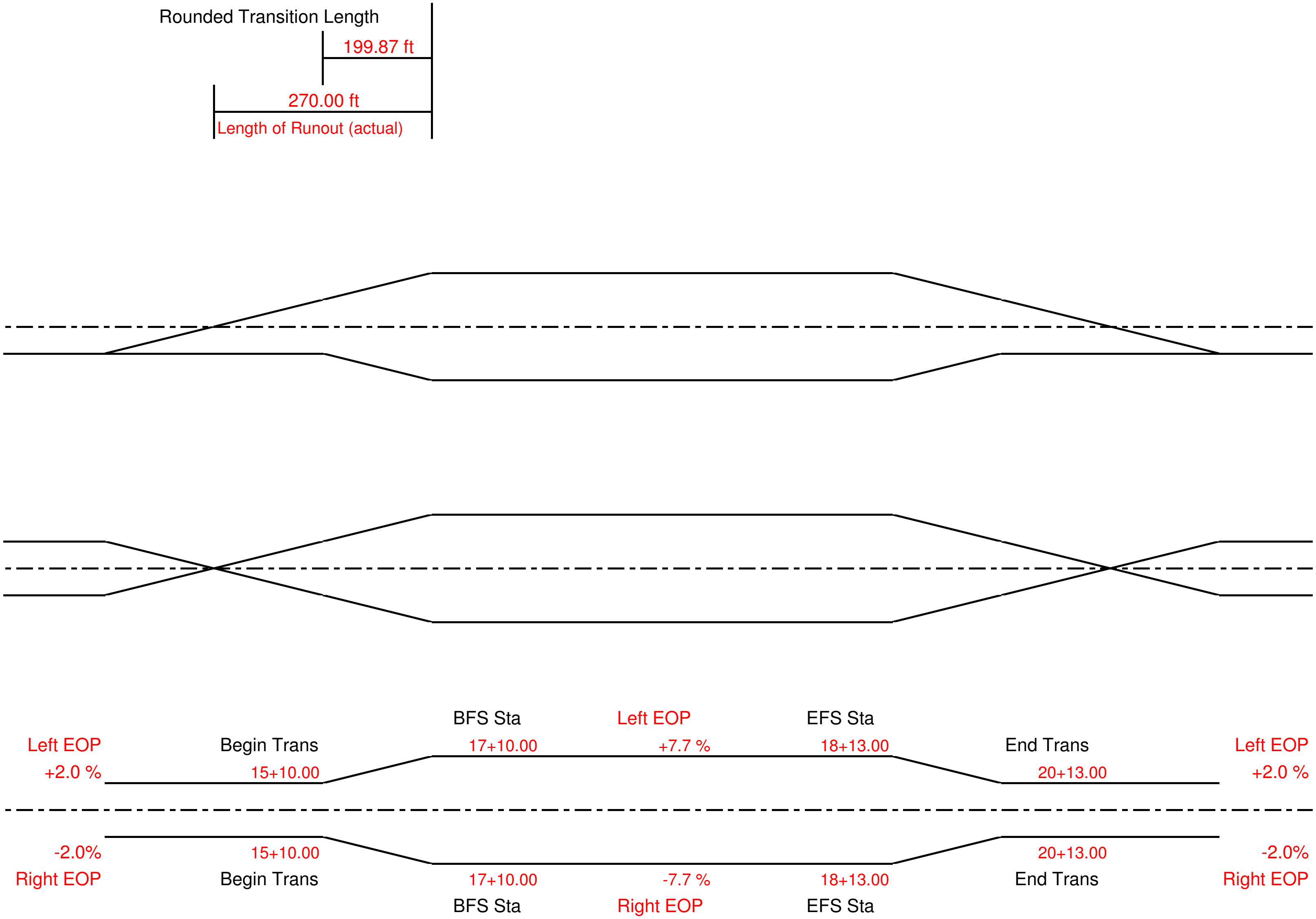
Needed Lr to Fit 45 ft Vert Curve	54.04	ft
Calculated Lr	270.00	ft
Use Calculated Lr	270.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.7%=	199.87	ft	
Rounded to Nearest 0.01 ft	199.87	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	243.00	ft	
* Distance from 0 point to Start of Transition	70.13	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	14+39.91		
Begin Transition Sta	15+10.00		15+10.00
PC Sta	16+82.91		
Begin Full Super	17+10.00		17+10.00
			Use
End Full Super	18+13.00		18+13.00
PT Sta	18+39.77		
End Transiton Sta	20+13.00		20+13.00
Theoretical Point of Intersection (0% Super) Sta	20+83.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	735	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	7.7	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	270.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	362	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**270**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

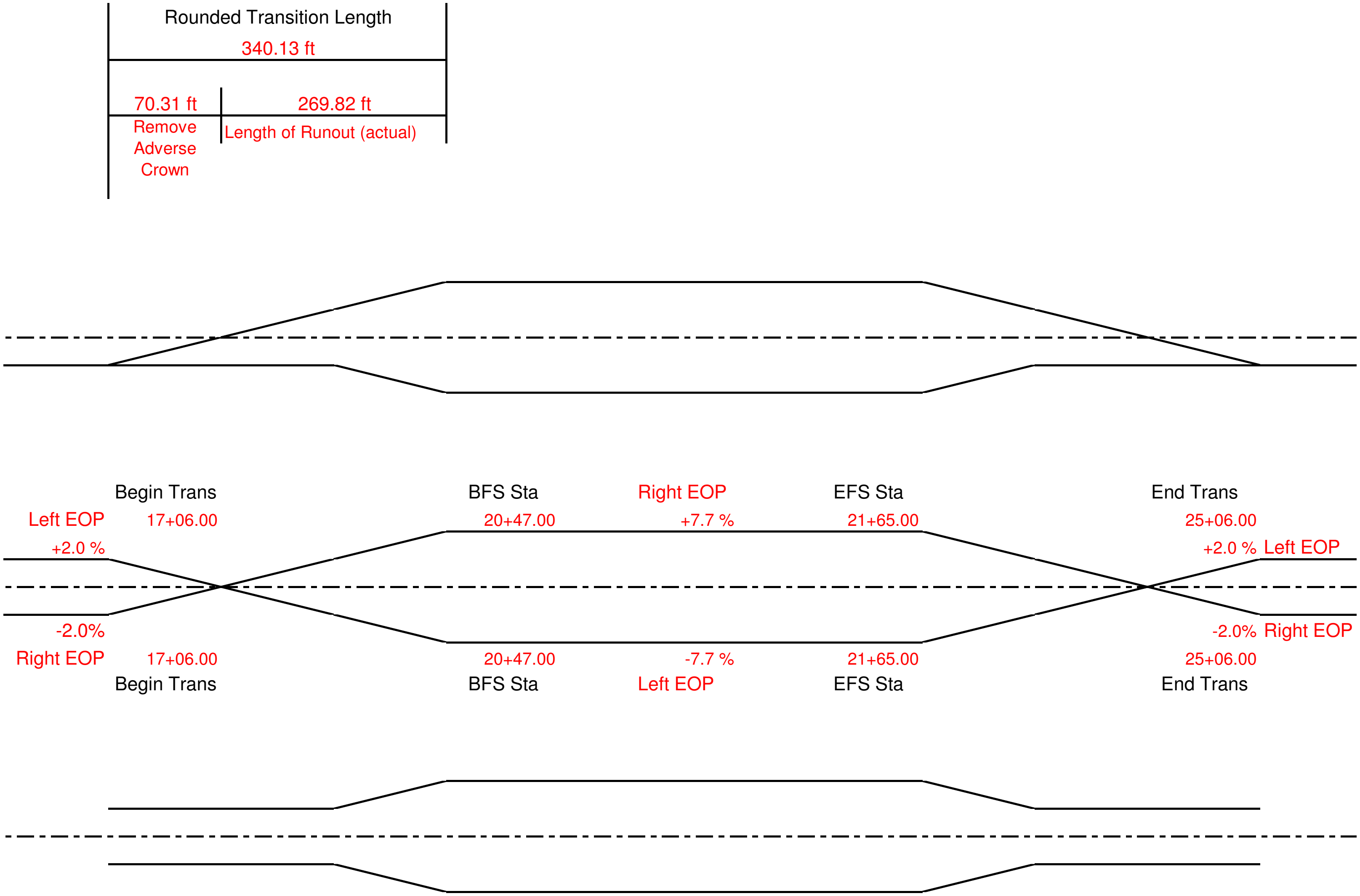
Needed Lr to Fit 45 ft Vert Curve	35.72	ft
Calculated Lr	270.00	ft
Use Calculated Lr	270.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 7.7%=	340.13	ft	
Rounded to Nearest 0.01 ft	340.13	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	243.00	ft	
* Distance from 0 point to Start of Transition	-70.13	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	17+76.41		
Begin Transition Sta	17+06.00		17+06.00
PC Sta	20+19.41		
Begin Full Super	20+47.00		20+47.00
			Use
End Full Super	21+65.00		21+65.00
PT Sta	21+91.92		
End Transiton Sta	25+06.00		25+06.00
Theoretical Point of Intersection (0% Super) Sta	24+35.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	1208	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	6.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	210.00	ft
Spiral Curves Recommended Check	No	

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 6.1%=	141.15	ft
Rounded to Nearest 0.01 ft	141.15	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	189.00	ft
* Distance from 0 point to Start of Transition	68.85	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	27+22.23	
Begin Transition Sta	27+91.00	27+91.00
PC Sta	29+11.23	
Begin Full Super	29+33.00	29+33.00

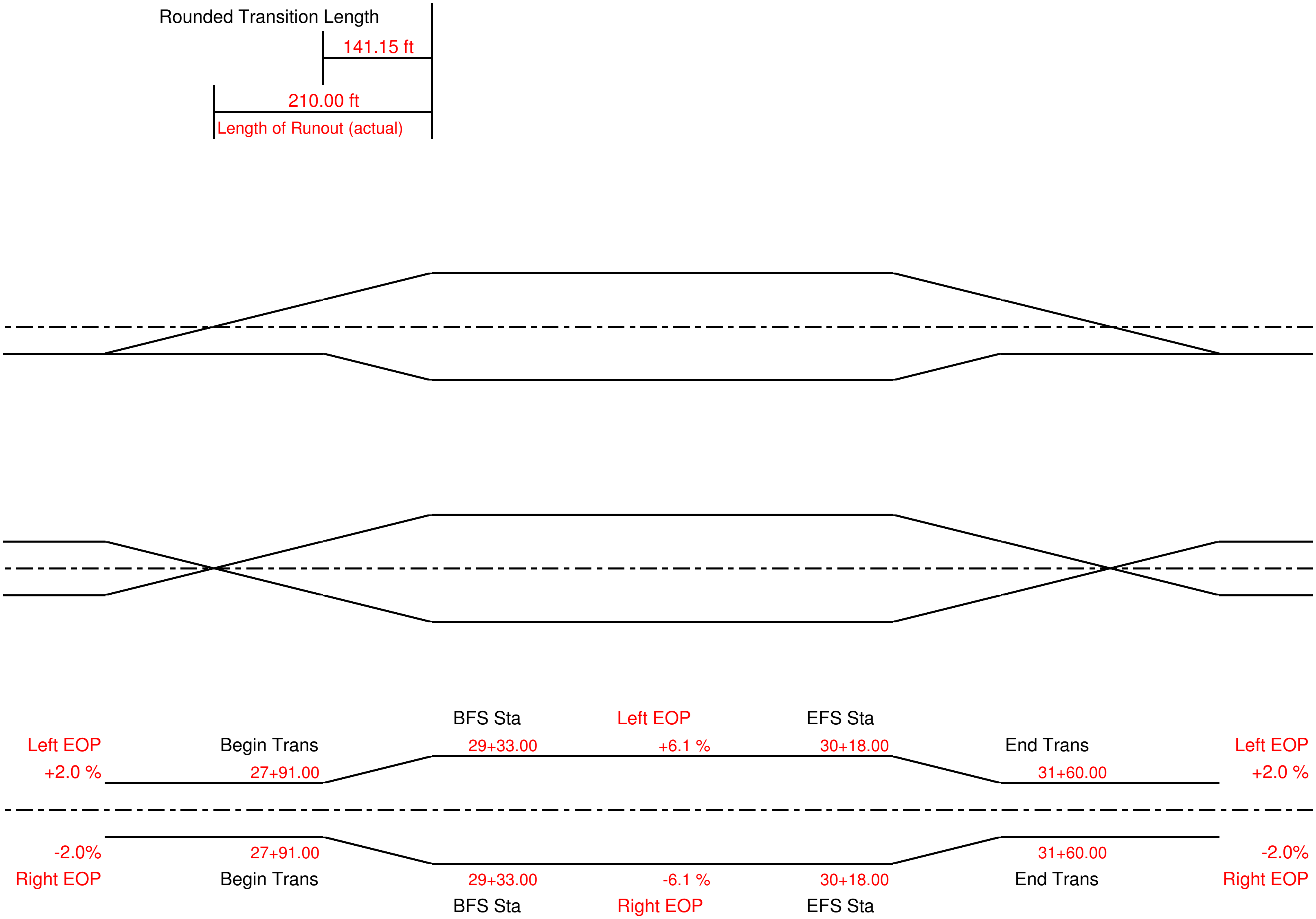
		Use
End Full Super	30+18.00	30+18.00
PT Sta	30+39.28	
End Transiton Sta	31+60.00	31+60.00
Theoretical Point of Intersection (0% Super) Sta	32+28.00	

Design Speed Rounding Curve Length 40

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	59.51	ft
Calculated Lr	210.00	ft
Use Calculated Lr	210.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1208	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	180.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

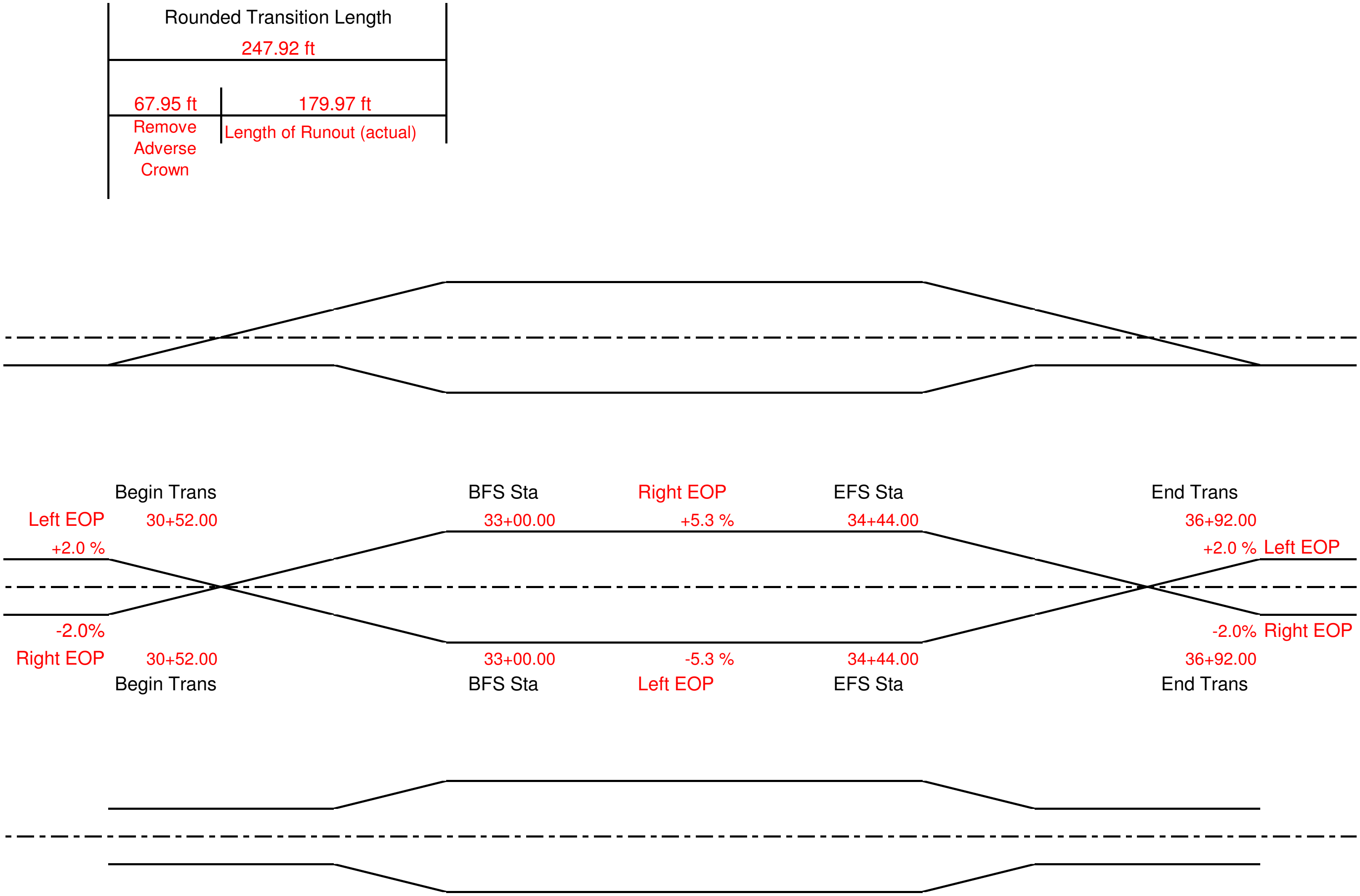
Needed Lr to Fit 45 ft Vert Curve	32.67	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0 %		
Super Elevation Transition Length from -2%to 5.3%=	247.92 ft		
Rounded to Nearest 0.01 ft	247.92 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	162.00 ft		
* Distance from 0 point to Start of Transition	-67.92 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	31+20.70		
Begin Transition Sta	30+52.00	30+52.00	
PC Sta	32+82.70		
Begin Full Super	33+00.00	33+00.00	
		Use	
End Full Super	34+44.00	34+44.00	
PT Sta	34+61.51		
End Transiton Sta	36+92.00	36+92.00	
Theoretical Point of Intersection (0% Super) Sta	36+24.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.50	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

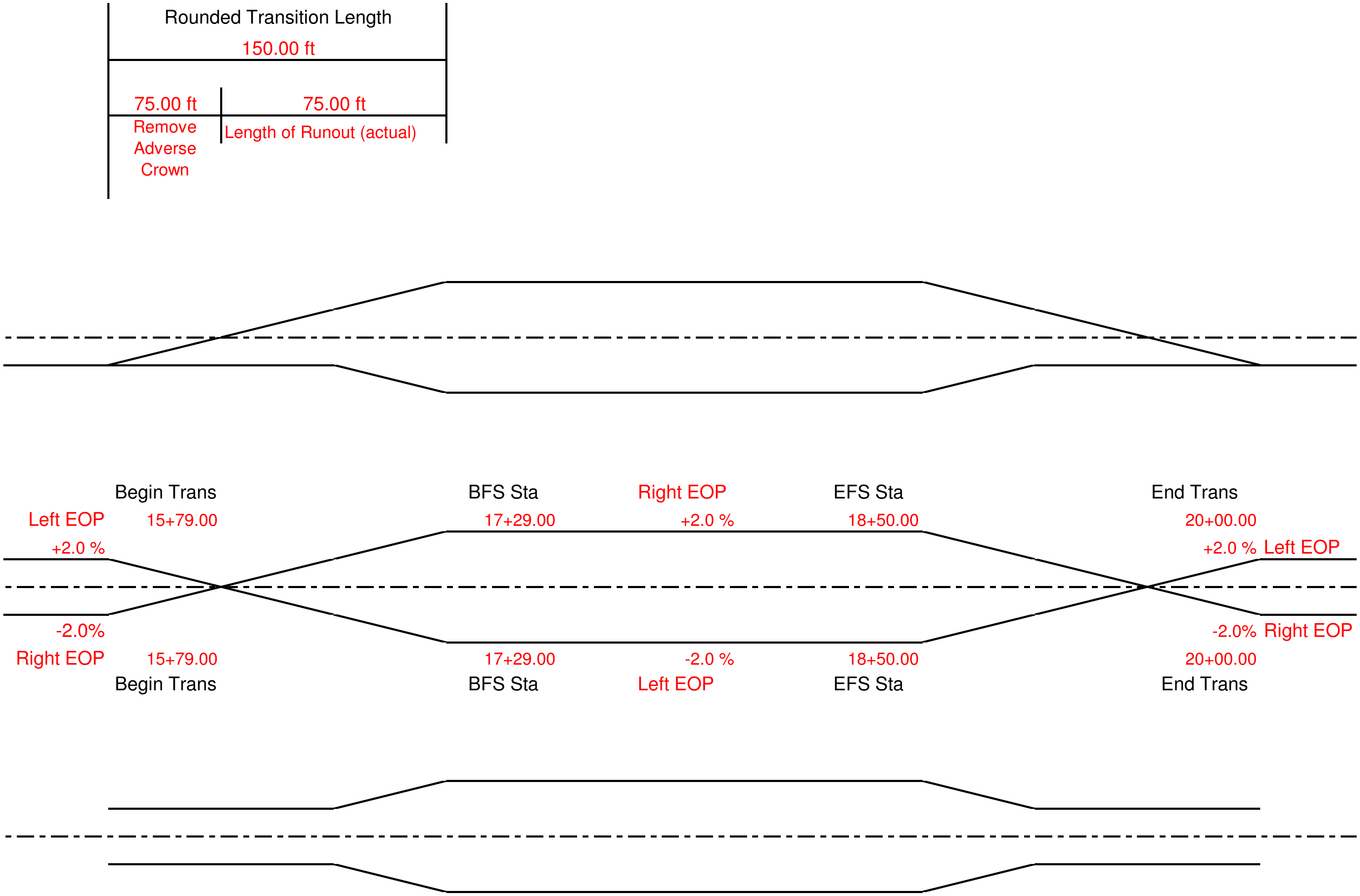
Needed Lr to Fit 50 ft Vert Curve	25.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0 %		
Super Elevation Transition Length from -2%to 2%=	150.00 ft		
Rounded to Nearest 0.01 ft	150.00 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00 ft		
* Distance from 0 point to Start of Transition	-75.00 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	16+54.24		
Begin Transition Sta	15+79.00	15+79.00	
PC Sta	17+14.24		
Begin Full Super	17+29.00	17+29.00	
		Use	
End Full Super	18+50.00	18+50.00	
PT Sta	18+64.12		
End Transiton Sta	20+00.00	20+00.00	
Theoretical Point of Intersection (0% Super) Sta	19+25.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.50	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	195.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

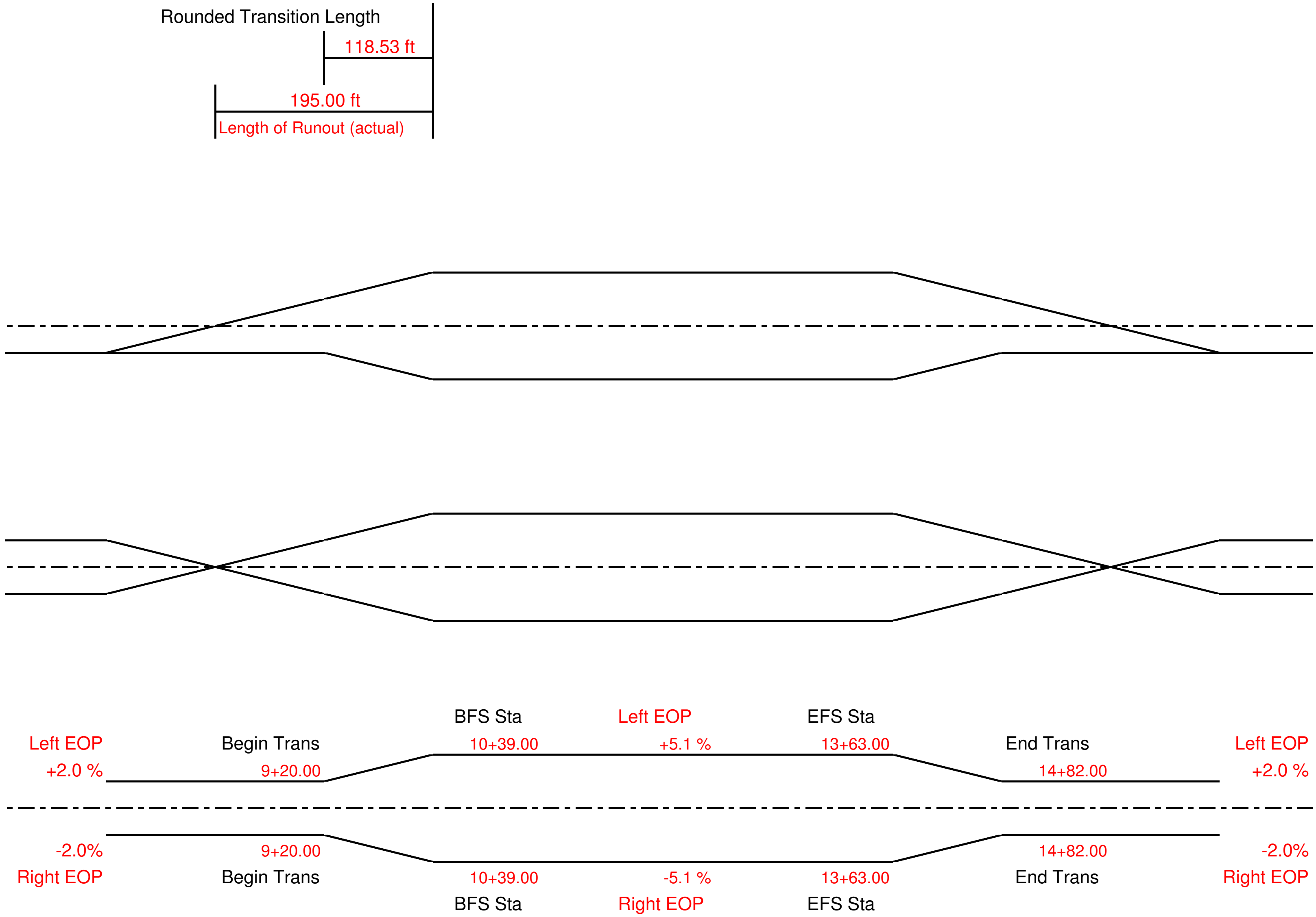
Needed Lr to Fit 50 ft Vert Curve	65.81	ft
Calculated Lr	195.00	ft
Use Calculated Lr	195.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.1%=	118.53	ft	
Rounded to Nearest 0.01 ft	118.53	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	156.00	ft	
* Distance from 0 point to Start of Transition	76.47	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	8+44.00		
Begin Transition Sta	9+20.00		9+20.00
PC Sta	10+00.00		
Begin Full Super	10+39.00		10+39.00
			Use
End Full Super	13+63.00		13+63.00
PT Sta	14+02.15		
End Transiton Sta	14+82.00		14+82.00
Theoretical Point of Intersection (0% Super) Sta	15+58.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	5.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.50	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	195.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	35.92	ft
Calculated Lr	195.00	ft
Use Calculated Lr	195.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 5.1%=	271.47	ft	
Rounded to Nearest 0.01 ft	271.47	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	156.00	ft	
* Distance from 0 point to Start of Transition	-76.47	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	17+50.28		
Begin Transition Sta	16+73.00		16+73.00
PC Sta	19+06.28		
Begin Full Super	19+45.00		19+45.00
			Use
End Full Super	21+04.00		21+04.00
PT Sta	21+43.25		
End Transiton Sta	23+76.00		23+76.00
Theoretical Point of Intersection (0% Super) Sta	22+99.00		

CA Group

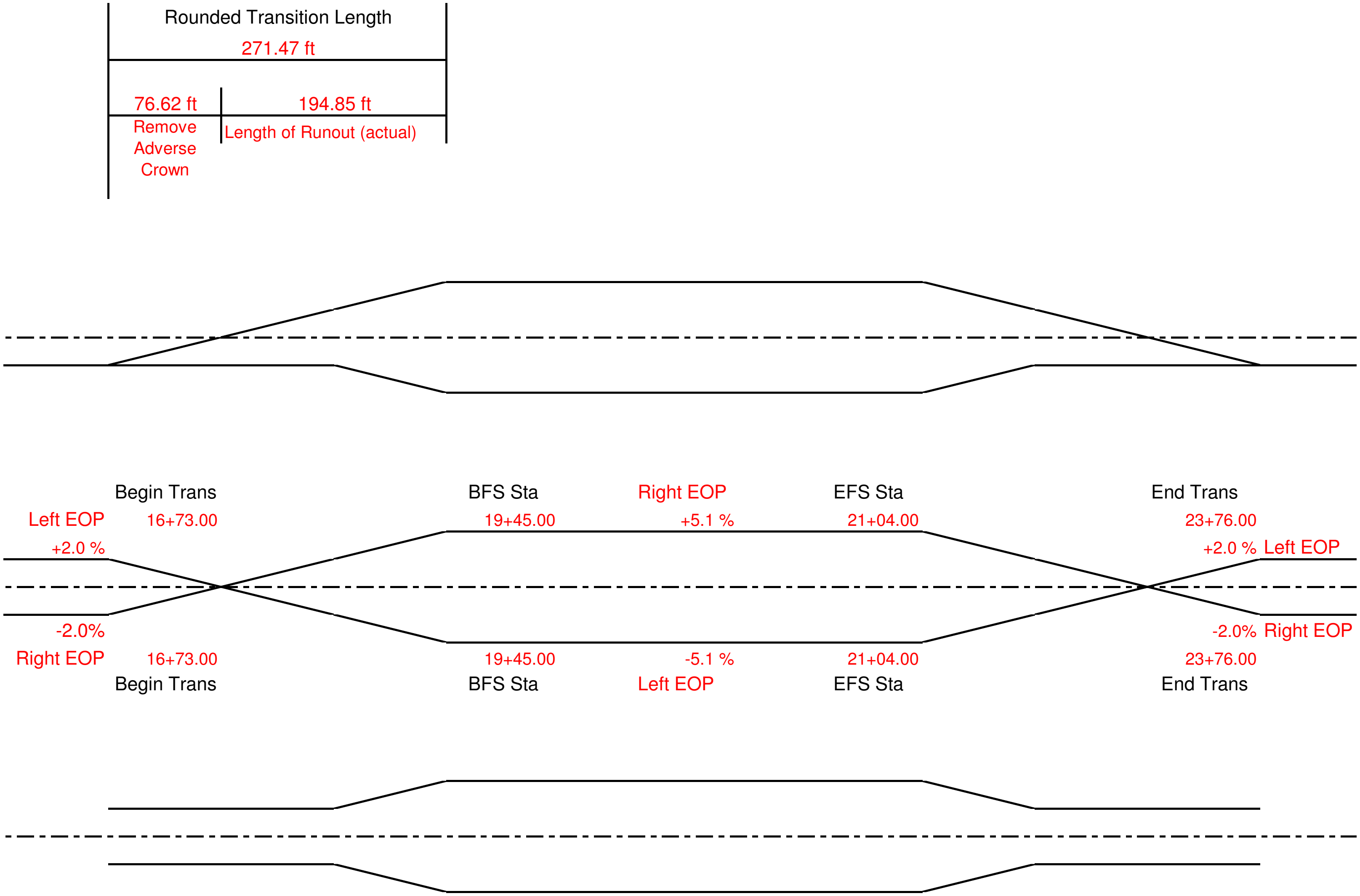
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"ES"-2

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5970	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.50	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	25.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

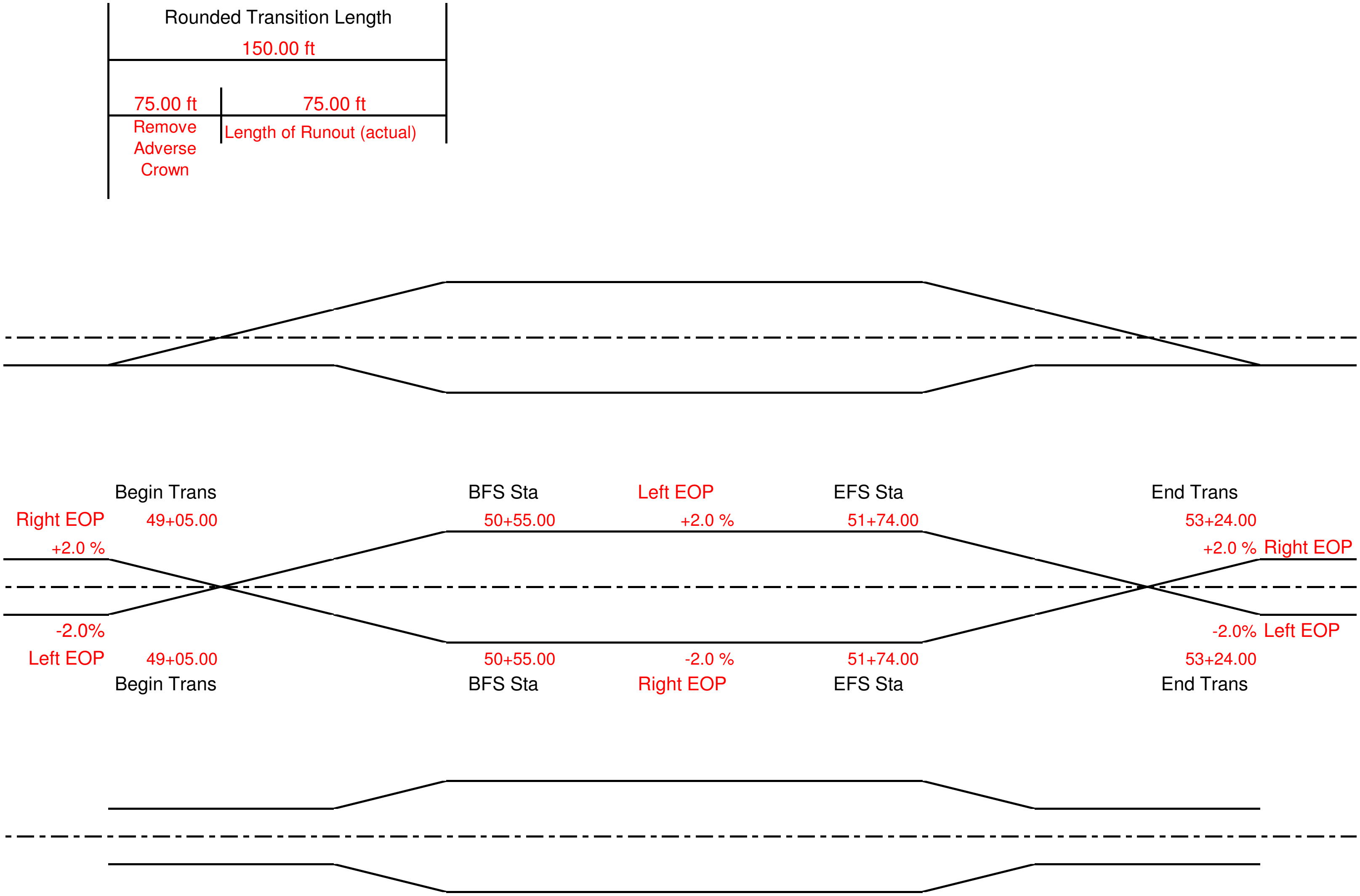
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	150.00	ft	
Rounded to Nearest 0.01 ft	150.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	-75.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	49+80.63		
Begin Transition Sta	49+05.00		49+05.00
PC Sta	50+40.63		
Begin Full Super	50+55.00		50+55.00

		Use
End Full Super	51+74.00	51+74.00
PT Sta	51+88.50	
End Transiton Sta	53+24.00	53+24.00
Theoretical Point of Intersection (0% Super) Sta	52+49.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1272	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	6.8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	240.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	56.67	ft
Calculated Lr	240.00	ft
Use Calculated Lr	240.00	ft

SUPER ELEVATION TRANSITION CALCULATION

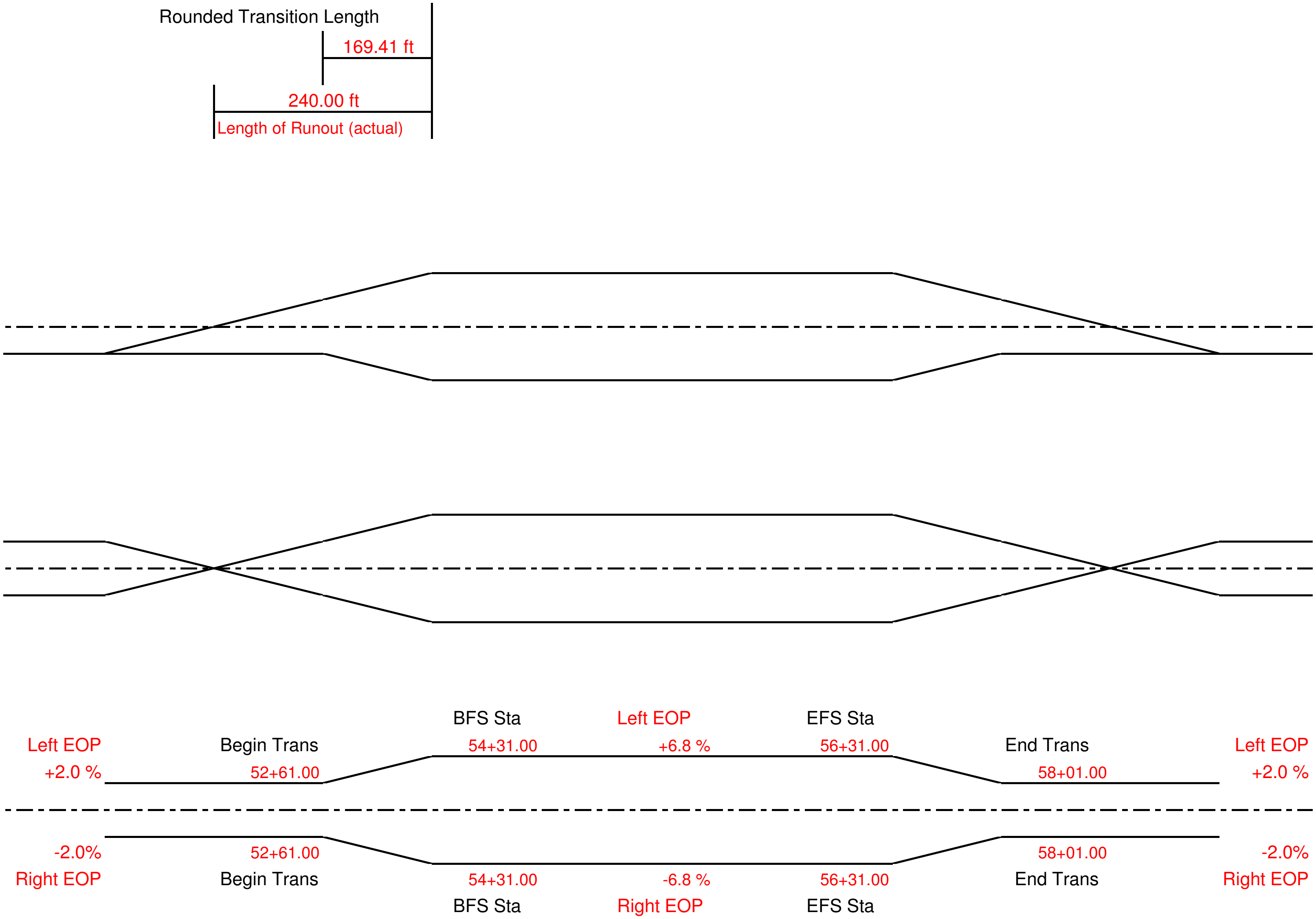
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 6.8%=	169.41	ft
Rounded to Nearest 0.01 ft	169.41	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	216.00	ft
* Distance from 0 point to Start of Transition	70.59	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	51+90.47	
Begin Transition Sta	52+61.00	52+61.00
PC Sta	54+06.47	
Begin Full Super	54+31.00	54+31.00

		Use
End Full Super	56+31.00	56+31.00
PT Sta	56+54.69	
End Transiton Sta	58+01.00	58+01.00
Theoretical Point of Intersection (0% Super) Sta	58+71.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1556	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	210.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	60.00	ft
Calculated Lr	210.00	ft
Use Calculated Lr	210.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 6%=	140.00	ft
Rounded to Nearest 0.01 ft	140.00	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	189.00	ft
* Distance from 0 point to Start of Transition	70.00	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	54+65.69	
Begin Transition Sta	55+35.00	55+35.00
PC Sta	56+54.69	
Begin Full Super	56+75.00	56+75.00

		Use
End Full Super	68+21.00	68+21.00
PT Sta	68+41.91	
End Transiton Sta	69+61.00	69+61.00
Theoretical Point of Intersection (0% Super) Sta	70+31.00	

CA Group

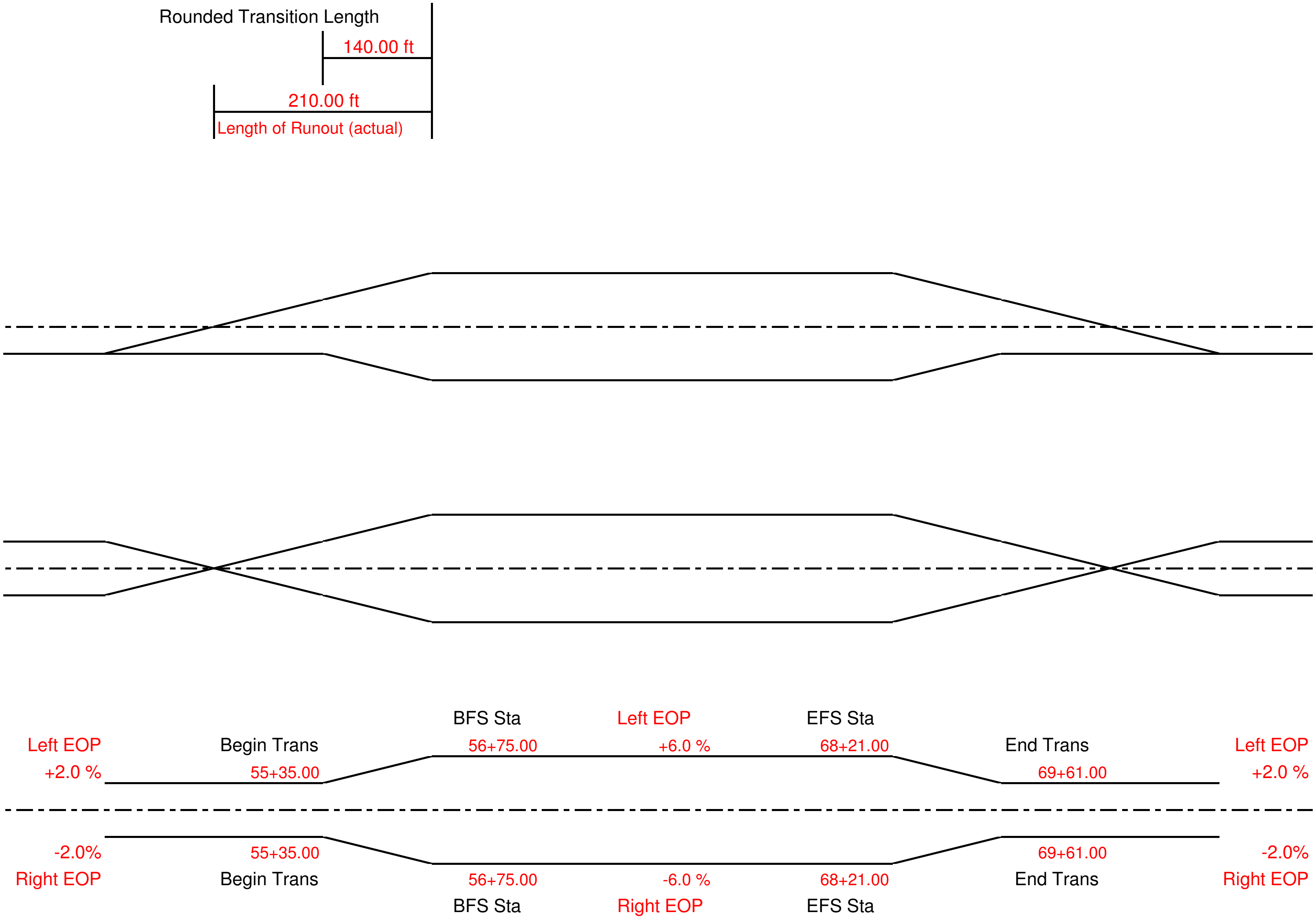
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"ES"-5

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1235	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	135.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	75.00	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)?	No		
Right EOP Begin Transition Cross Slope (pos or neg)	2.8	%	
Super Elevation Transition Length from 2.8%to 6%=	72.00	ft	
Rounded to Nearest 0.01 ft	72.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	63.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	8+92.00		
Begin Transition Sta	9+55.00		9+55.00
PC Sta	10+00.00		
Begin Full Super	10+27.00		10+27.00
			Use
End Full Super	11+88.00		11+88.00
PT Sta	12+14.51		
End Transiton Sta	12+60.00		12+60.00
Theoretical Point of Intersection (0% Super) Sta	13+23.00		

CA Group

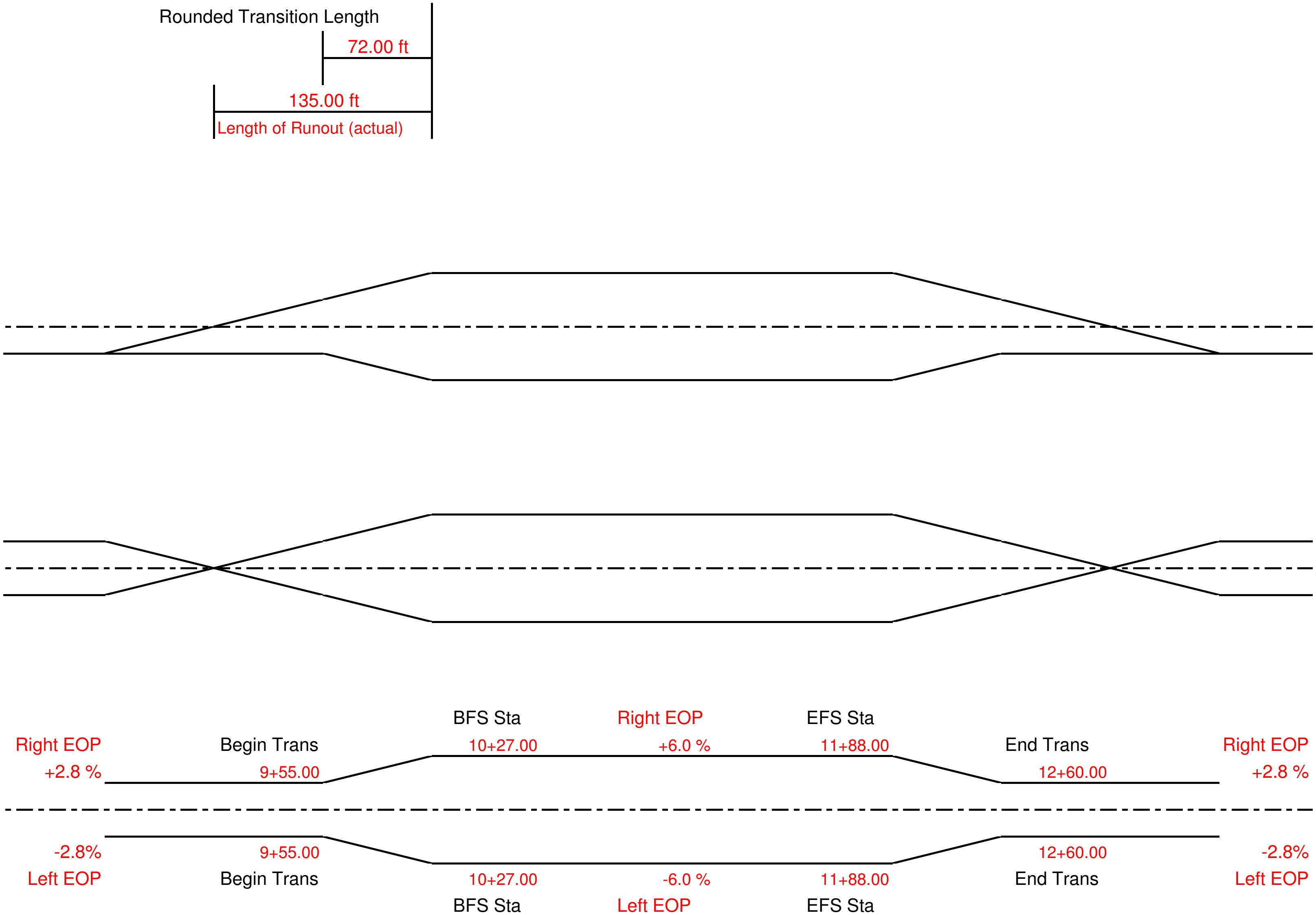
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Option 2_Super Elevation Transition Length v3.xlsx
"GW"-1

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3330	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	2.8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	14.32	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-6.0 %		
Super Elevation Transition Length from -6%to 2.8%=	235.71 ft		
Rounded to Nearest 0.01 ft	235.71 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00 ft		
* Distance from 0 point to Start of Transition	-160.71 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	11+54.51		
Begin Transition Sta	9+93.00	9+93.00	
PC Sta	12+14.51		
Begin Full Super	12+29.00	12+29.00	
		Use	
End Full Super	16+76.00	16+76.00	
PT Sta	16+90.53		
End Transiton Sta	19+12.00	19+12.00	
Theoretical Point of Intersection (0% Super) Sta	17+51.00		

CA Group

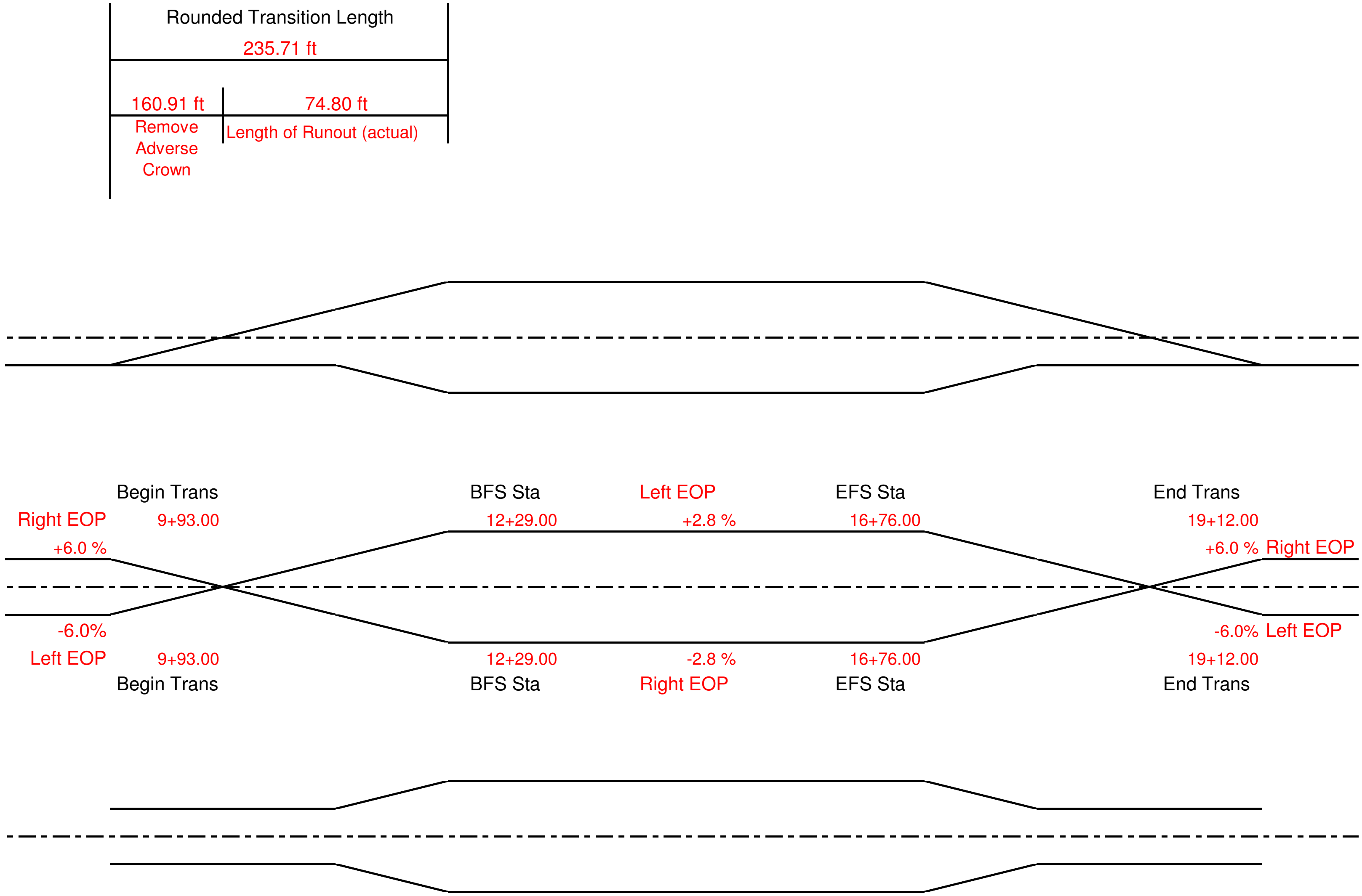
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"GW"-2

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4279	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	2.7	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.50	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

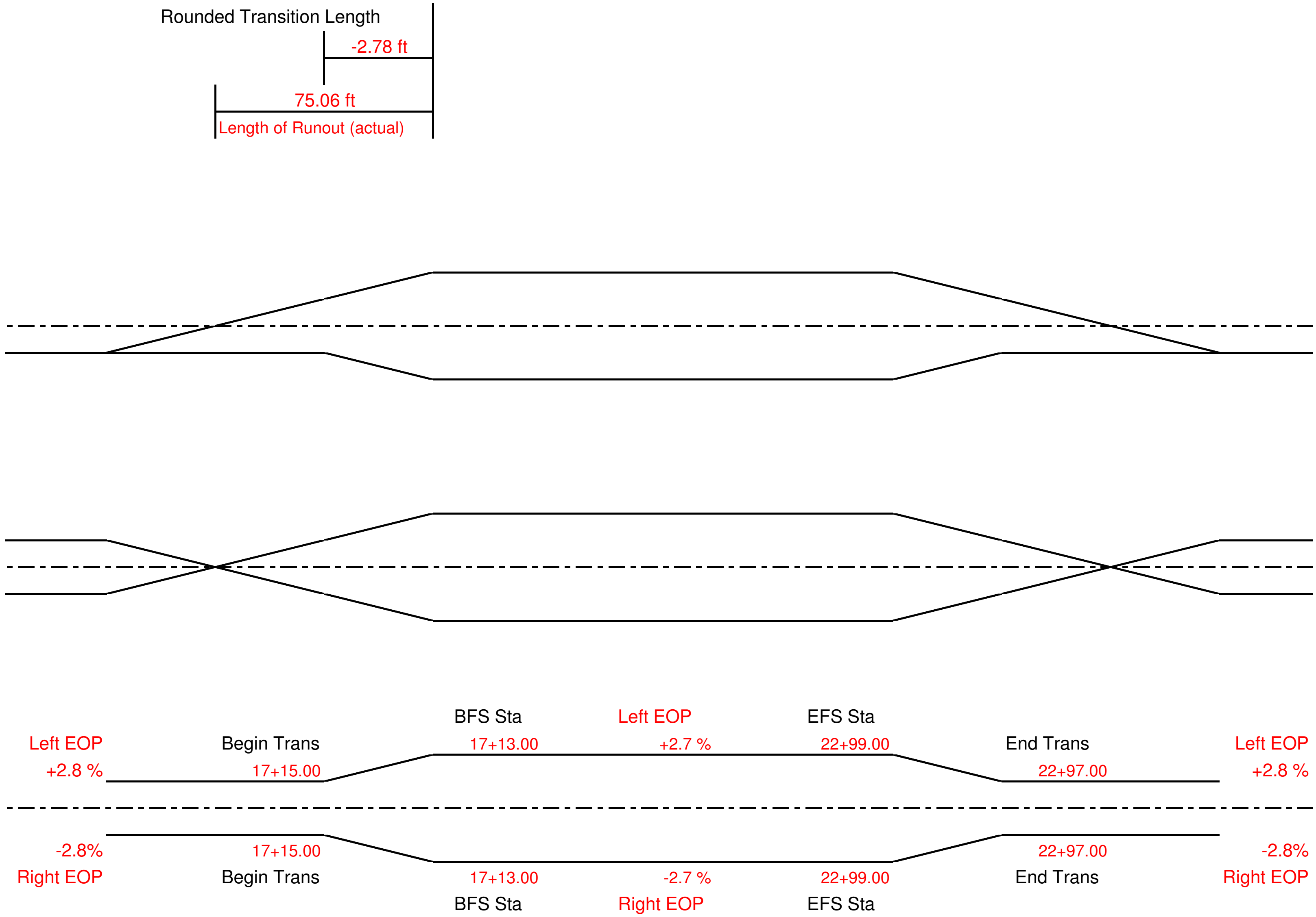
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.8	%
Super Elevation Transition Length from 2.8%to 2.7%=	-2.78	ft
Rounded to Nearest 0.01 ft	-2.78	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.7	
Transition Length on Tangent	52.50	ft
* Distance from 0 point to Start of Transition	77.78	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	16+38.03	
Begin Transition Sta	17+15.00	17+15.00
PC Sta	16+90.53	
Begin Full Super	17+13.00	17+13.00

		Use
End Full Super	22+99.00	22+99.00
PT Sta	23+21.58	
End Transiton Sta	22+97.00	22+97.00
Theoretical Point of Intersection (0% Super) Sta	23+74.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	240.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

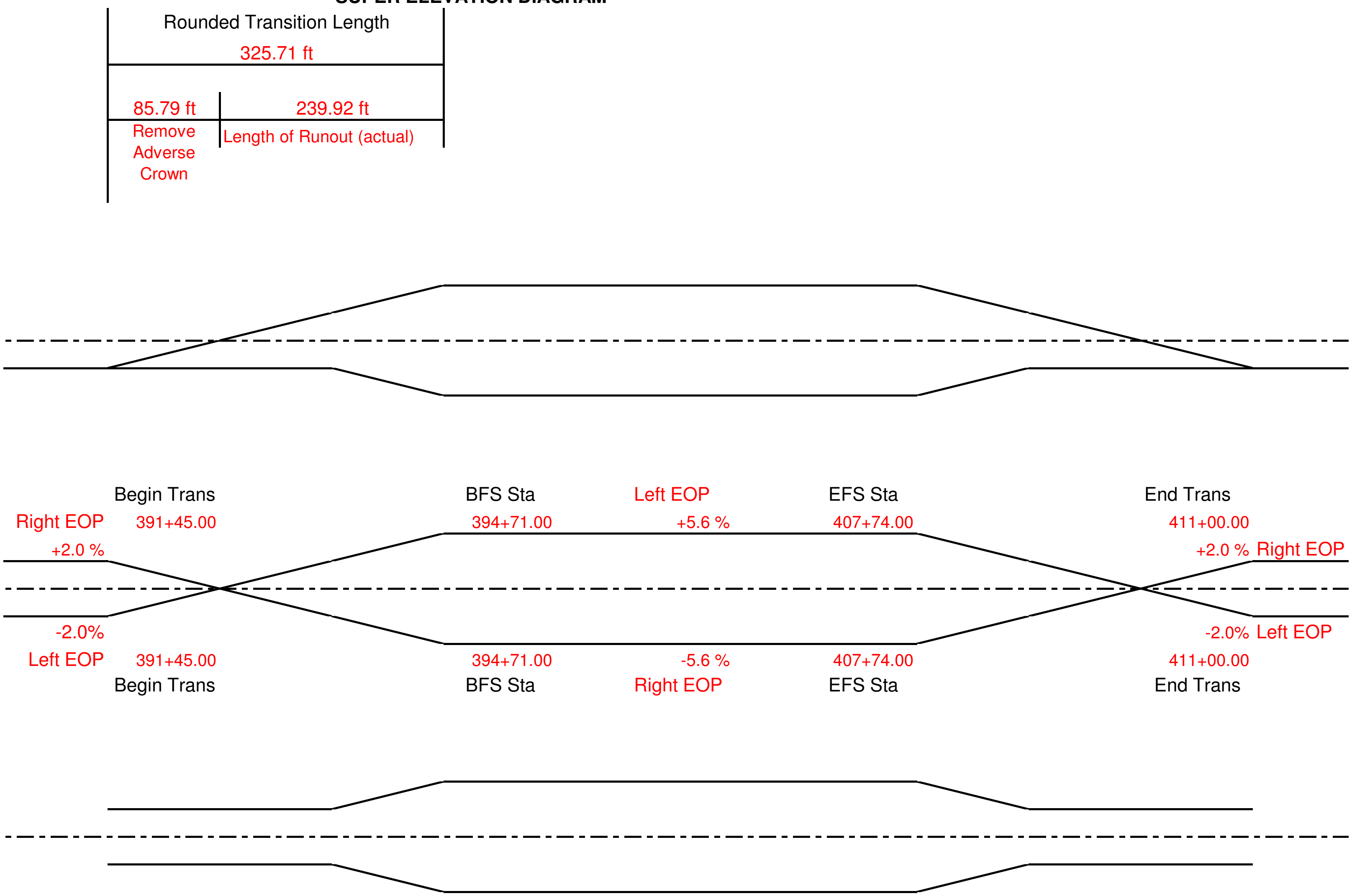
Needed Lr to Fit 65 ft Vert Curve	47.89	ft
Calculated Lr	240.00	ft
Use Calculated Lr	240.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 5.6%=	325.71	ft	
Rounded to Nearest 0.01 ft	325.71	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	192.00	ft	
* Distance from 0 point to Start of Transition	-85.71	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	392+31.48		
Begin Transition Sta	391+45.00		391+45.00
PC Sta	394+23.48		
Begin Full Super	394+71.00		394+71.00
			Use
End Full Super	407+74.00		407+74.00
PT Sta	408+21.62		
End Transiton Sta	411+00.00		411+00.00
Theoretical Point of Intersection (0% Super) Sta	410+14.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	5966	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	135.00	ft
Spiral Curves Recommended Check	No	

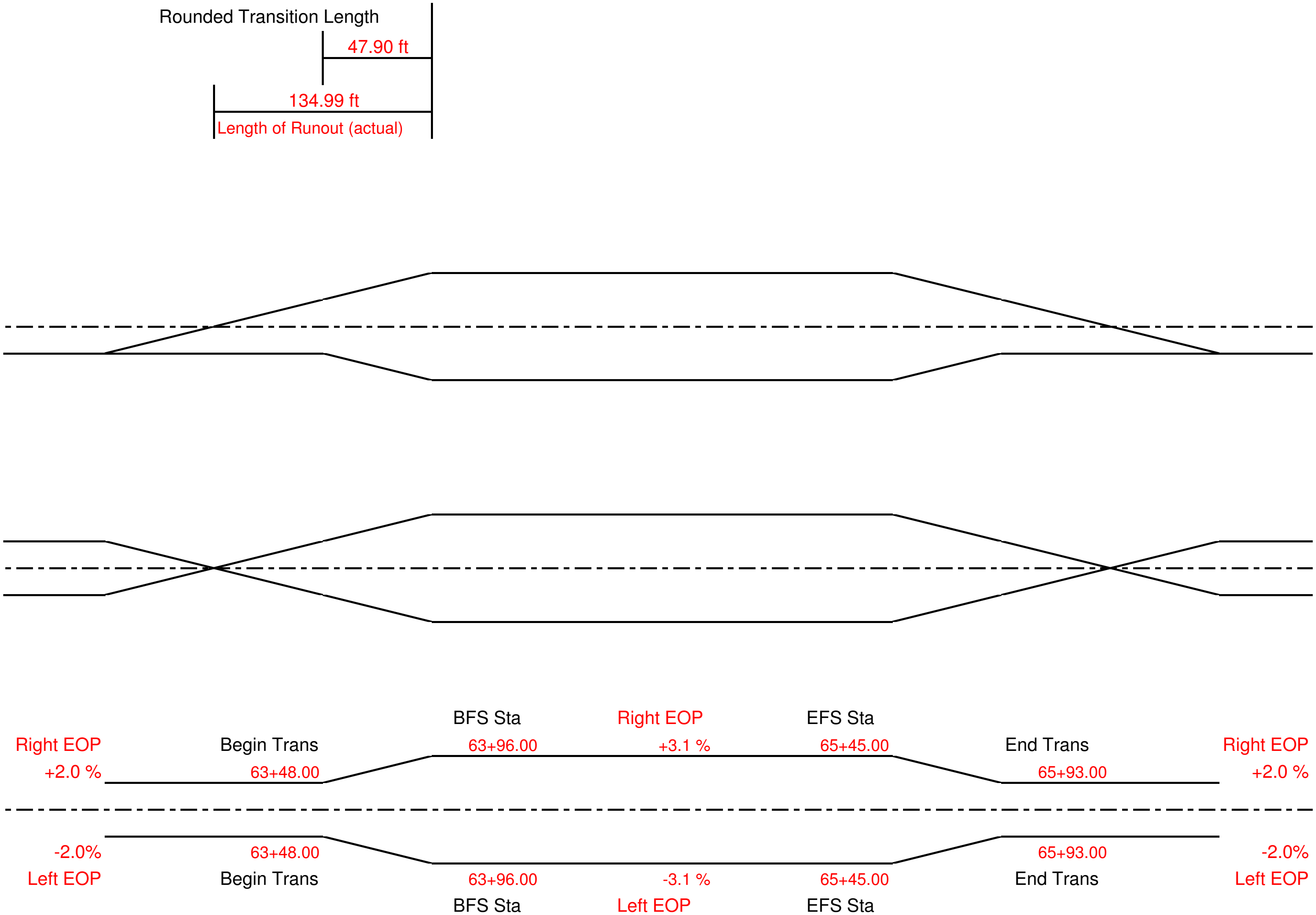
Right EOP Begin Transition Cross Slope (pos or neg)	2.0 %		
Super Elevation Transition Length from 2%to 3.1%=	47.90 ft		
Rounded to Nearest 0.01 ft	47.90 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	108.00 ft		
* Distance from 0 point to Start of Transition	87.10 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	62+61.26		
Begin Transition Sta	63+48.00	63+48.00	
PC Sta	63+69.26		
Begin Full Super	63+96.00	63+96.00	
		Use	
End Full Super	65+45.00	65+45.00	
PT Sta	65+71.98		
End Transiton Sta	65+93.00	65+93.00	
Theoretical Point of Intersection (0% Super) Sta	66+80.00		

Design Speed Rounding Curve Length 30

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	84.55	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6034	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	3.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	135.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

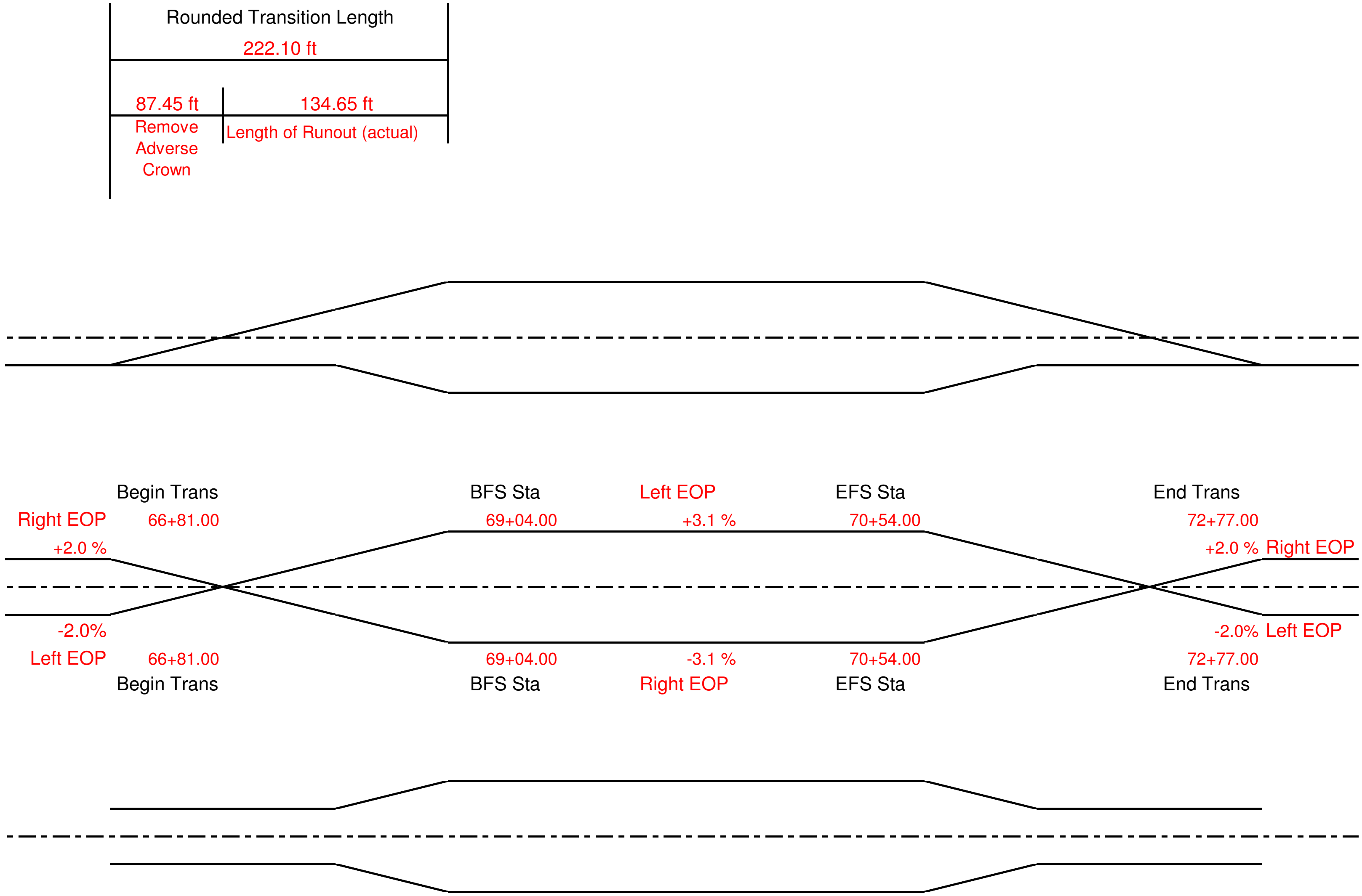
Needed Lr to Fit 65 ft Vert Curve	39.51	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.1%=	222.10	ft	
Rounded to Nearest 0.01 ft	222.10	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	-87.10	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	67+68.45		
Begin Transition Sta	66+81.00		66+81.00
PC Sta	68+76.45		
Begin Full Super	69+04.00		69+04.00
			Use
End Full Super	70+54.00		70+54.00
PT Sta	70+81.48		
End Transiton Sta	72+77.00		72+77.00
Theoretical Point of Intersection (0% Super) Sta	71+89.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6012	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	135.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

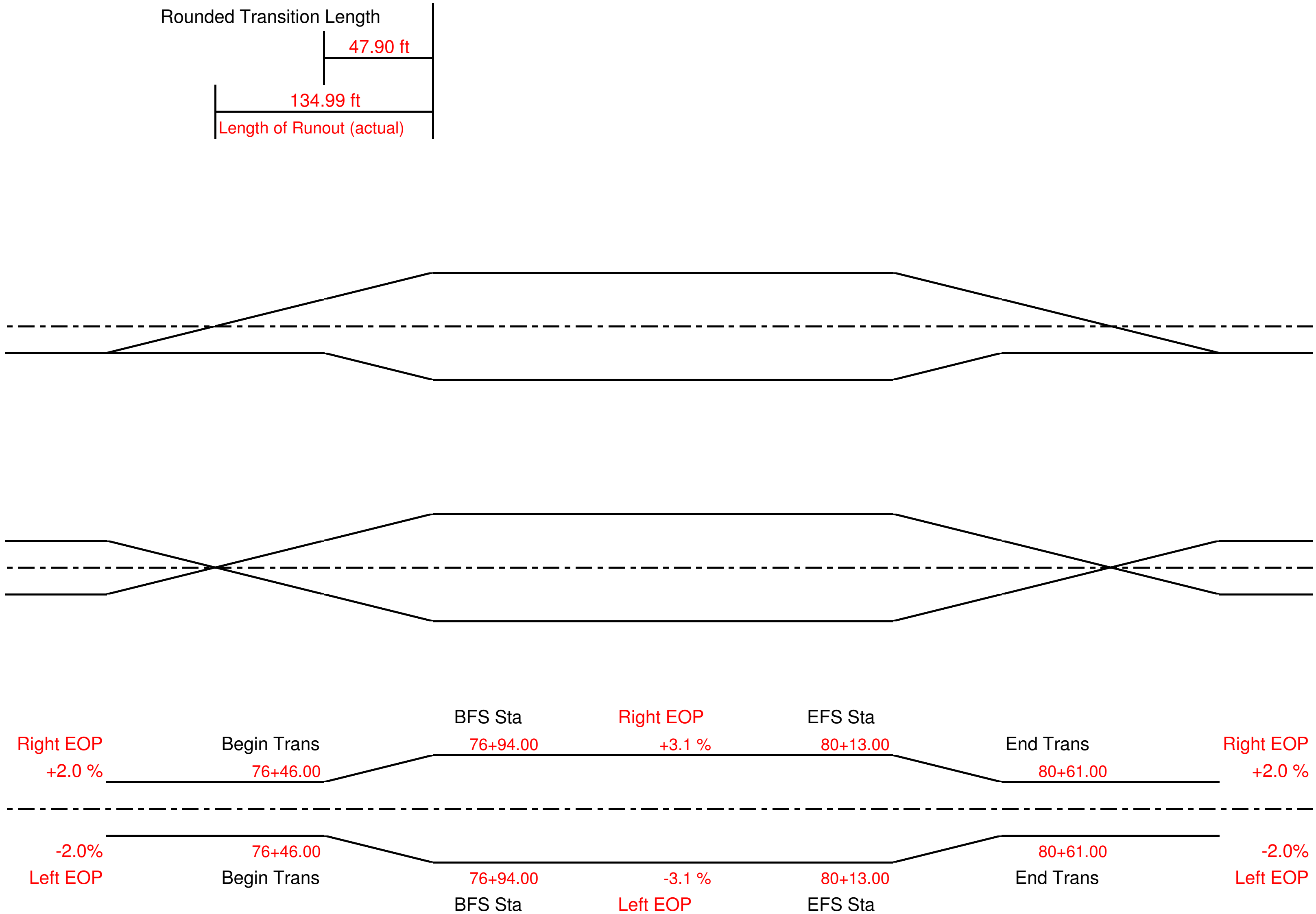
Needed Lr to Fit 65 ft Vert Curve	84.55	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.1%=	47.90	ft	
Rounded to Nearest 0.01 ft	47.90	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	87.10	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	75+58.94		
Begin Transition Sta	76+46.00		76+46.00
PC Sta	76+66.94		
Begin Full Super	76+94.00		76+94.00
			Use
End Full Super	80+13.00		80+13.00
PT Sta	80+39.32		
End Transiton Sta	80+61.00		80+61.00
Theoretical Point of Intersection (0% Super) Sta	81+48.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	9584	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	2	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	90.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

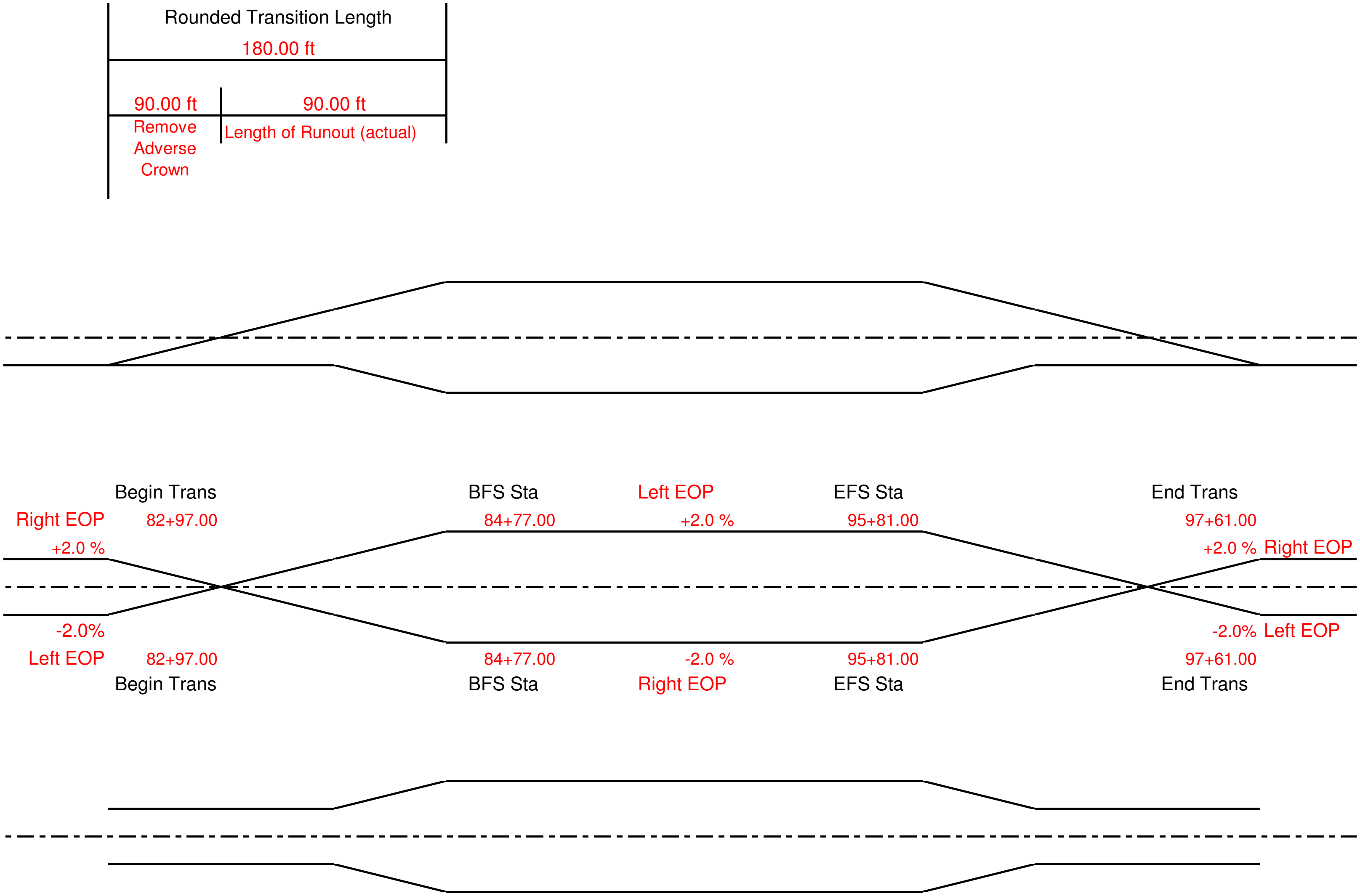
Needed Lr to Fit 65 ft Vert Curve	32.50	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	180.00	ft	
Rounded to Nearest 0.01 ft	180.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	-90.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	83+87.51		
Begin Transition Sta	82+97.00		82+97.00
PC Sta	84+59.51		
Begin Full Super	84+77.00		84+77.00
			Use
End Full Super	95+81.00		95+81.00
PT Sta	95+98.65		
End Transiton Sta	97+61.00		97+61.00
Theoretical Point of Intersection (0% Super) Sta	96+71.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2824	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	5.8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	255.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	45.79	ft
Calculated Lr	255.00	ft
Use Calculated Lr	255.00	ft

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.8%=	167.07	ft	
Rounded to Nearest 0.01 ft	167.07	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	204.00	ft	
* Distance from 0 point to Start of Transition	87.93	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	93+94.65		
Begin Transition Sta	94+82.00		94+82.00
PC Sta	95+98.65		
Begin Full Super	96+50.00		96+50.00
			Use
End Full Super	107+82.00		107+82.00
PT Sta	108+33.85		
End Transiton Sta	109+50.00		109+50.00
Theoretical Point of Intersection (0% Super) Sta	110+37.00		

CA Group

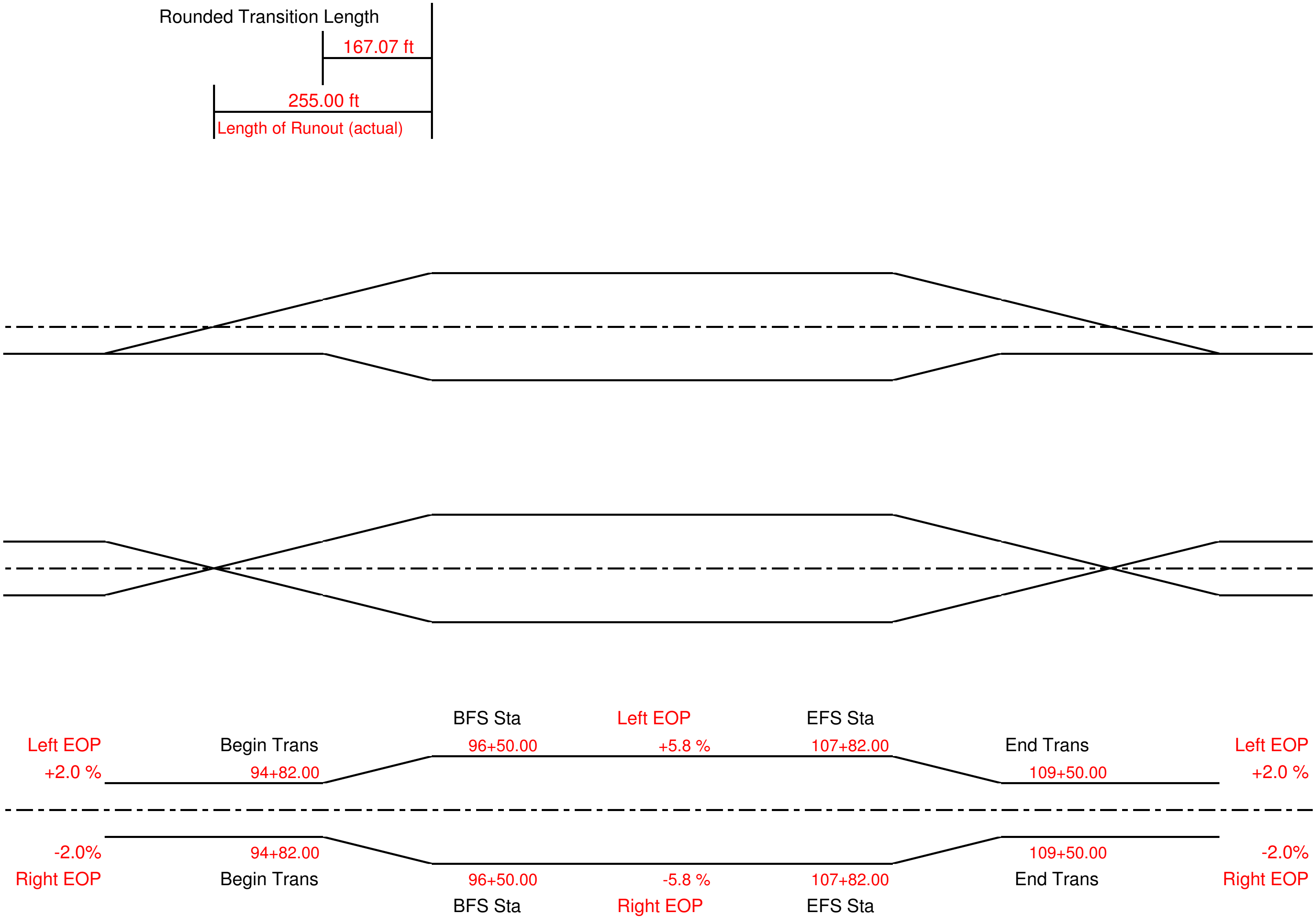
Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"L-SB"-5

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	7976	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	4	
Design Super (e_d) positive value	2.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.63	
Lr=	180.00	ft
Spiral Curves Recommended Check	No	

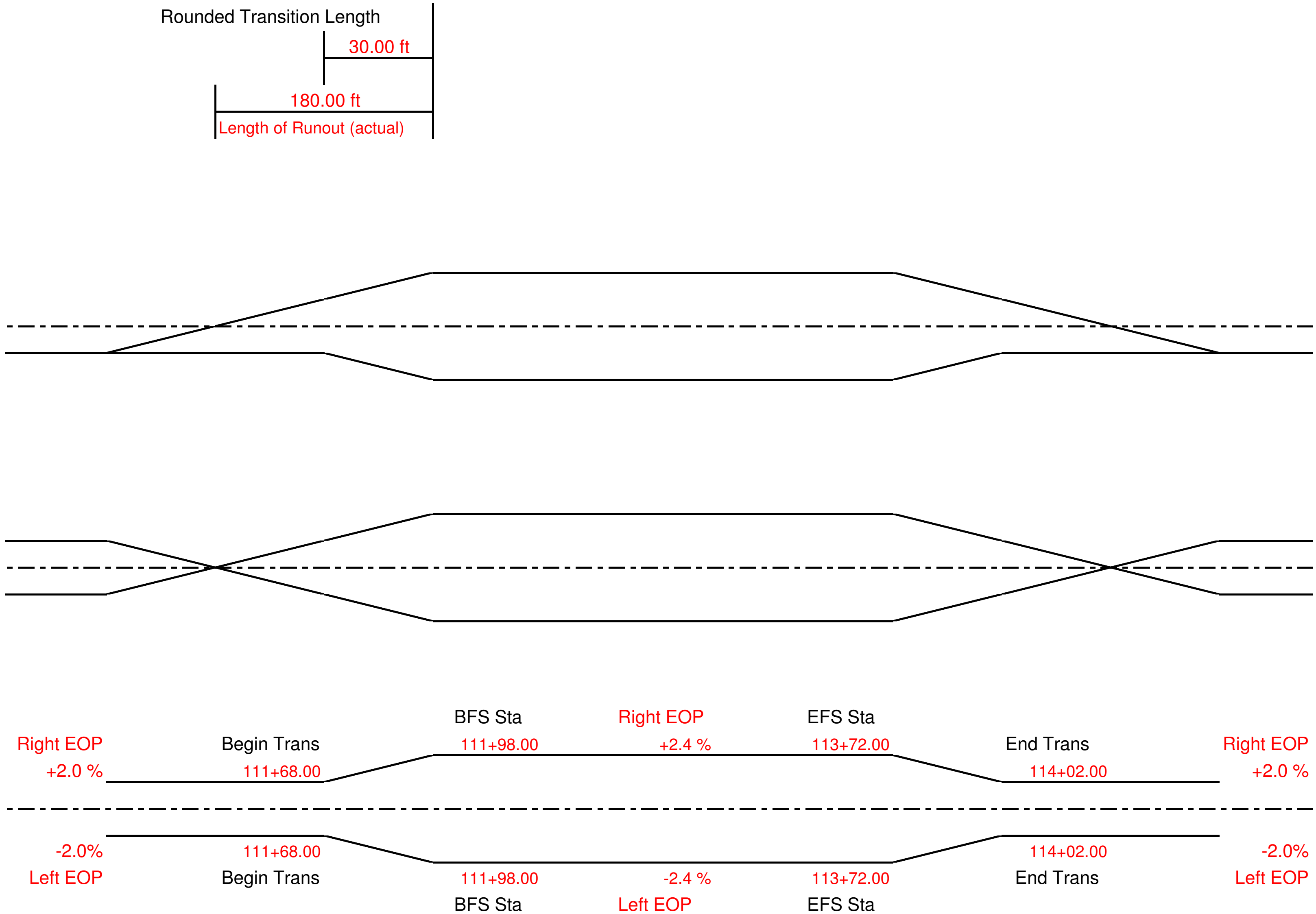
Right EOP Begin Transition Cross Slope (pos or neg)	2.0 %		
Super Elevation Transition Length from 2%to 2.4%=	30.00 ft		
Rounded to Nearest 0.01 ft	30.00 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	153.00 ft		
* Distance from 0 point to Start of Transition	150.00 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	110+18.24		
Begin Transition Sta	111+68.00	111+68.00	
PC Sta	111+71.24		
Begin Full Super	111+98.00	111+98.00	
		Use	
End Full Super	113+72.00	113+72.00	
PT Sta	113+98.55		
End Transiton Sta	114+02.00	114+02.00	
Theoretical Point of Intersection (0% Super) Sta	115+52.00		

Design Speed Rounding Curve Length 30

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	180.00	ft
Calculated Lr	180.00	ft
Use Modified Lr	180.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	3	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

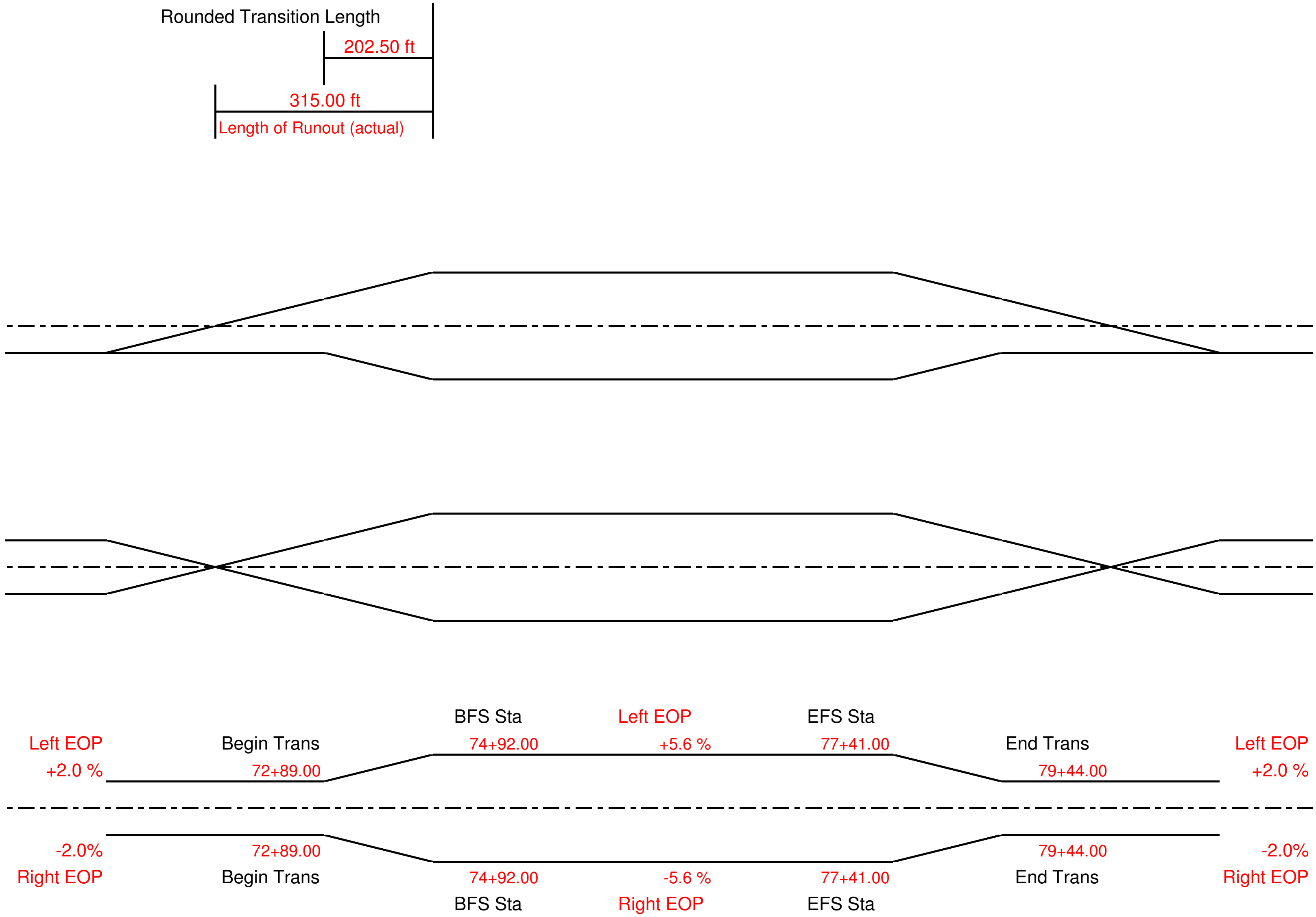
Needed Lr to Fit 65 ft Vert Curve	46.67	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.6%=	202.50	ft	
Rounded to Nearest 0.01 ft	202.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	267.75	ft	
* Distance from 0 point to Start of Transition	112.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	71+76.93		
Begin Transition Sta	72+89.00		72+89.00
PC Sta	74+44.68		
Begin Full Super	74+92.00		74+92.00
			Use
End Full Super	77+41.00		77+41.00
PT Sta	77+88.71		
End Transiton Sta	79+44.00		79+44.00
Theoretical Point of Intersection (0% Super) Sta	80+56.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	3	
Design Super (e_d) positive value	5.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

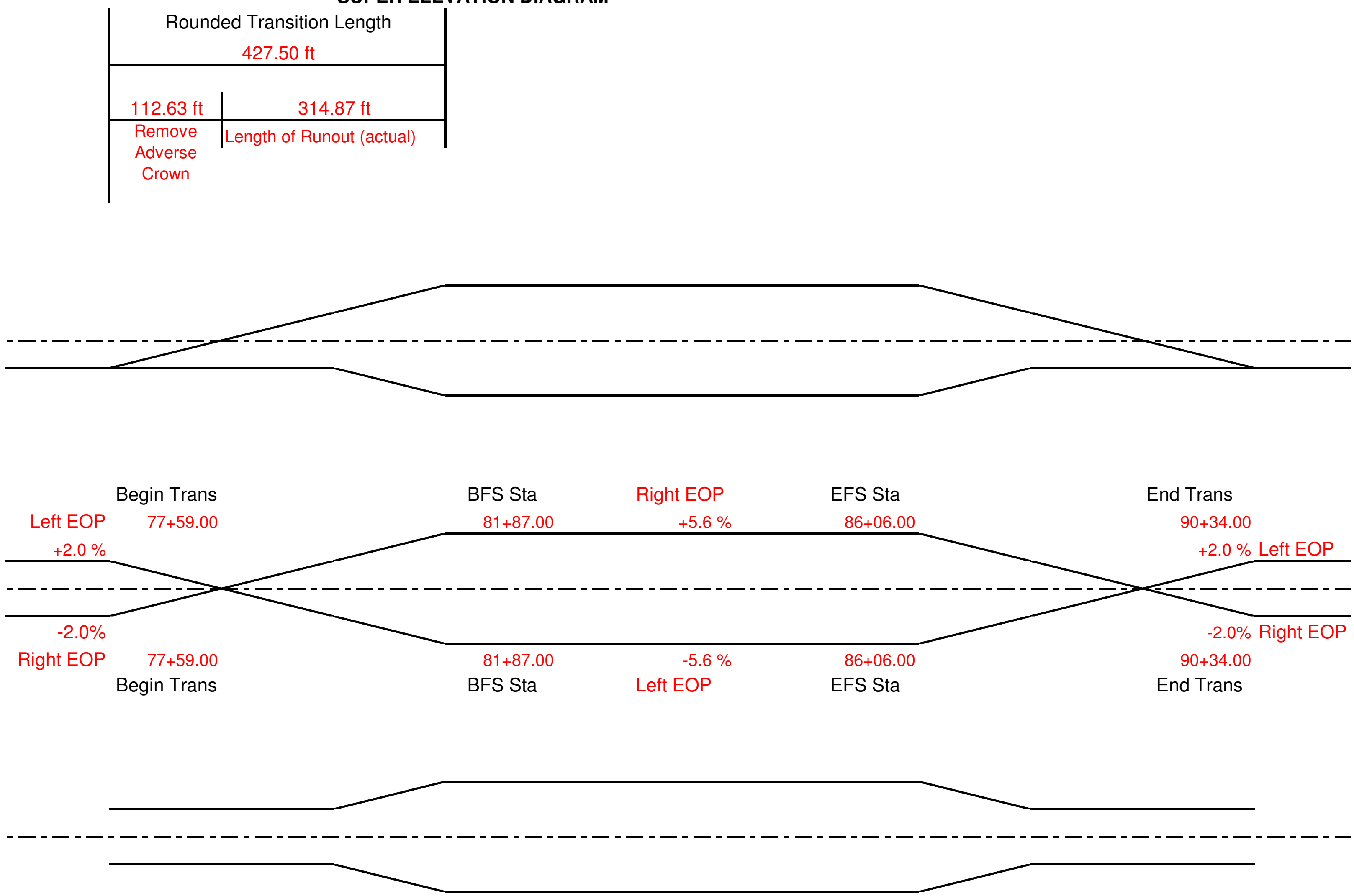
Needed Lr to Fit 65 ft Vert Curve	47.89	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 5.6%=	427.50	ft	
Rounded to Nearest 0.01 ft	427.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	267.75	ft	
* Distance from 0 point to Start of Transition	-112.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	78+71.65		
Begin Transition Sta	77+59.00		77+59.00
PC Sta	81+39.40		
Begin Full Super	81+87.00		81+87.00
			Use
End Full Super	86+06.00		86+06.00
PT Sta	86+53.25		
End Transiton Sta	90+34.00		90+34.00
Theoretical Point of Intersection (0% Super) Sta	89+21.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	5.7	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	330.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

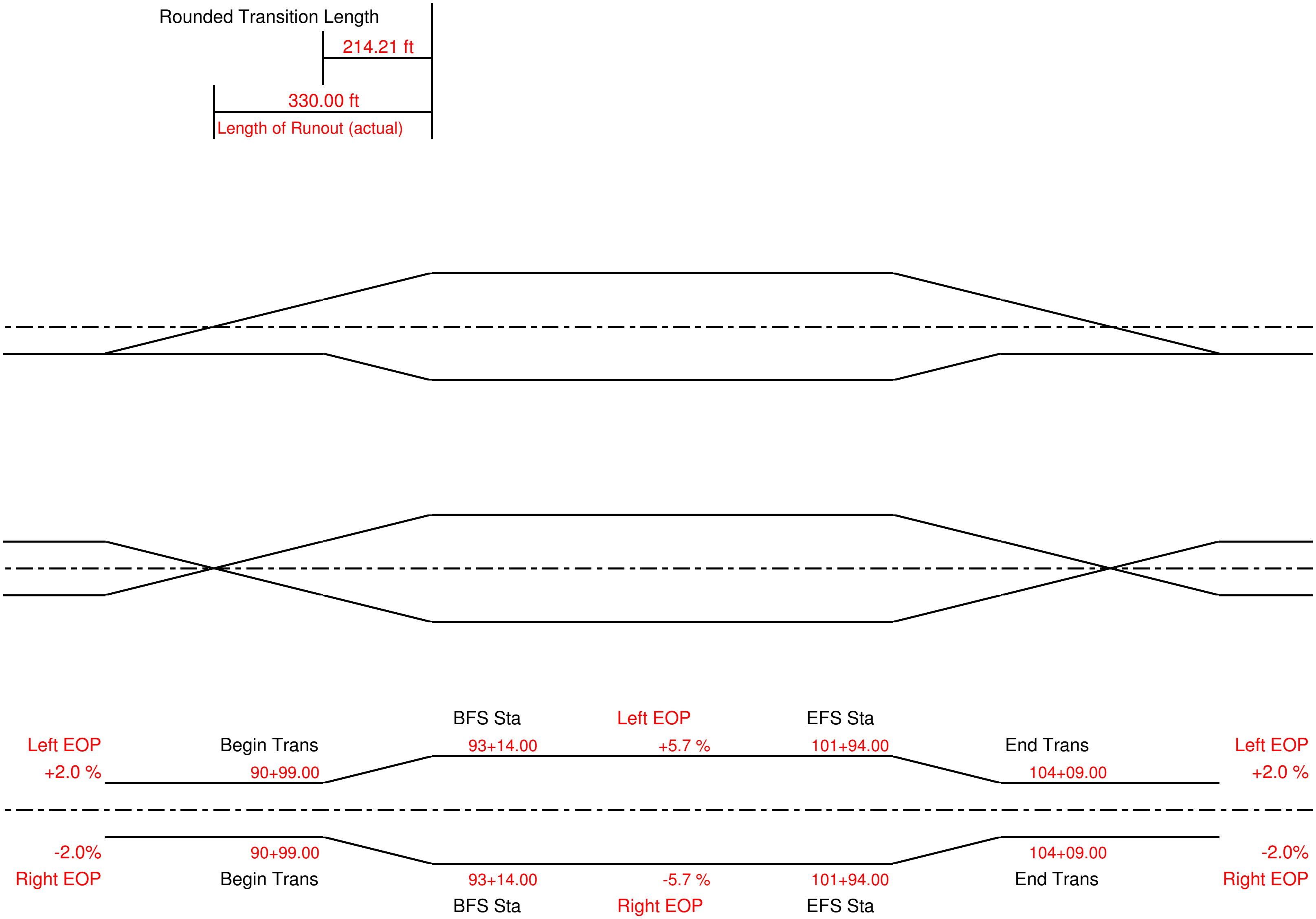
Needed Lr to Fit 65 ft Vert Curve	46.22	ft
Calculated Lr	330.00	ft
Use Calculated Lr	330.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.7%=	214.21	ft	
Rounded to Nearest 0.01 ft	214.21	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	280.50	ft	
* Distance from 0 point to Start of Transition	115.79	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	89+83.51		
Begin Transition Sta	90+99.00		90+99.00
PC Sta	92+64.01		
Begin Full Super	93+14.00		93+14.00
			Use
End Full Super	101+94.00		101+94.00
PT Sta	102+44.08		
End Transiton Sta	104+09.00		104+09.00
Theoretical Point of Intersection (0% Super) Sta	105+24.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3001	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	4	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.63	
Lr=	405.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

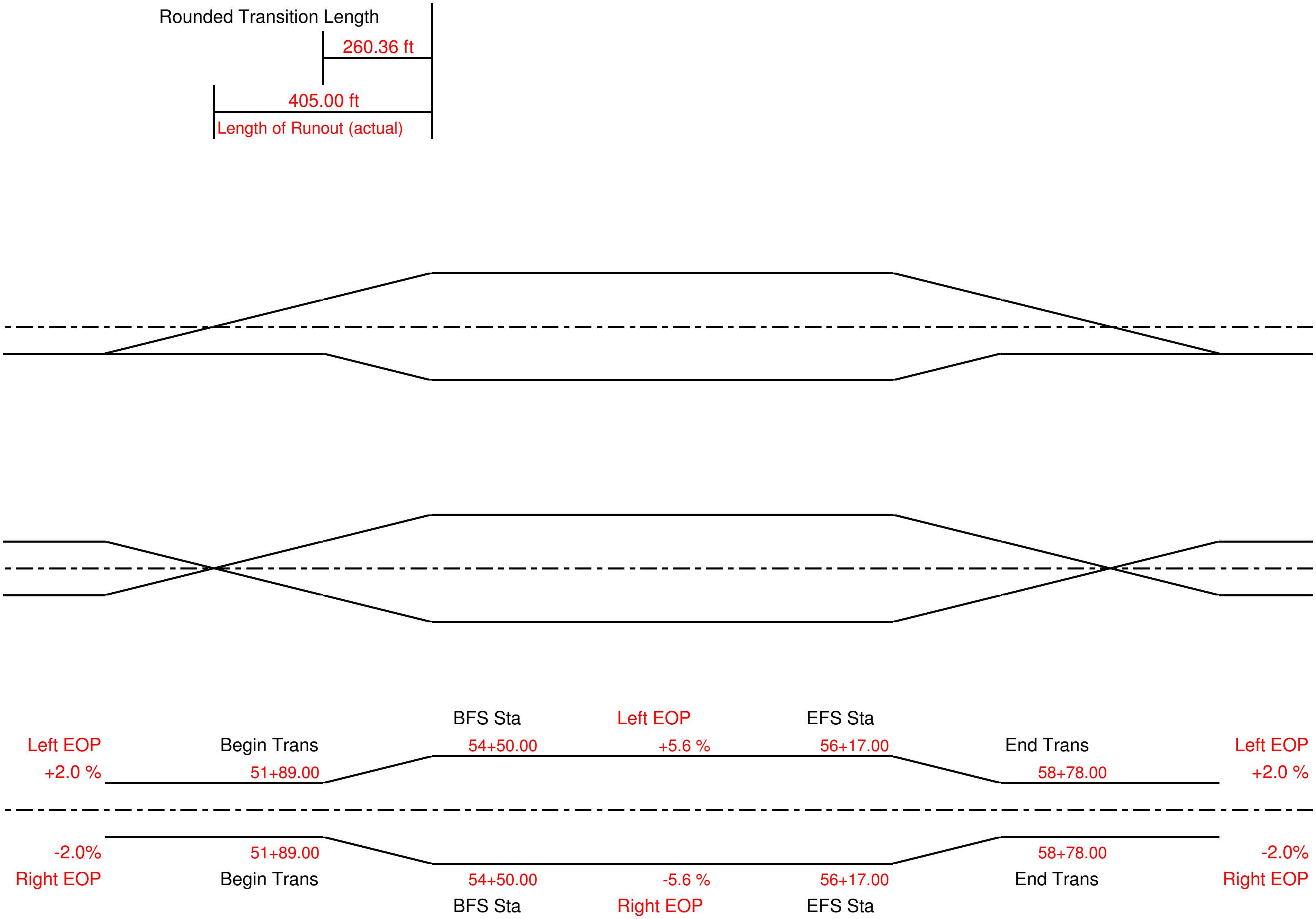
Needed Lr to Fit 65 ft Vert Curve	46.67	ft
Calculated Lr	405.00	ft
Use Calculated Lr	405.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.6%=	260.36	ft	
Rounded to Nearest 0.01 ft	260.36	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	344.25	ft	
* Distance from 0 point to Start of Transition	144.64	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	50+44.63		
Begin Transition Sta	51+89.00		51+89.00
PC Sta	53+88.88		
Begin Full Super	54+50.00		54+50.00
			Use
End Full Super	56+17.00		56+17.00
PT Sta	56+77.81		
End Transiton Sta	58+78.00		58+78.00
Theoretical Point of Intersection (0% Super) Sta	60+22.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6247	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of :	4	
Design Super (e_d) positive value	3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.63	
Lr=	210.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

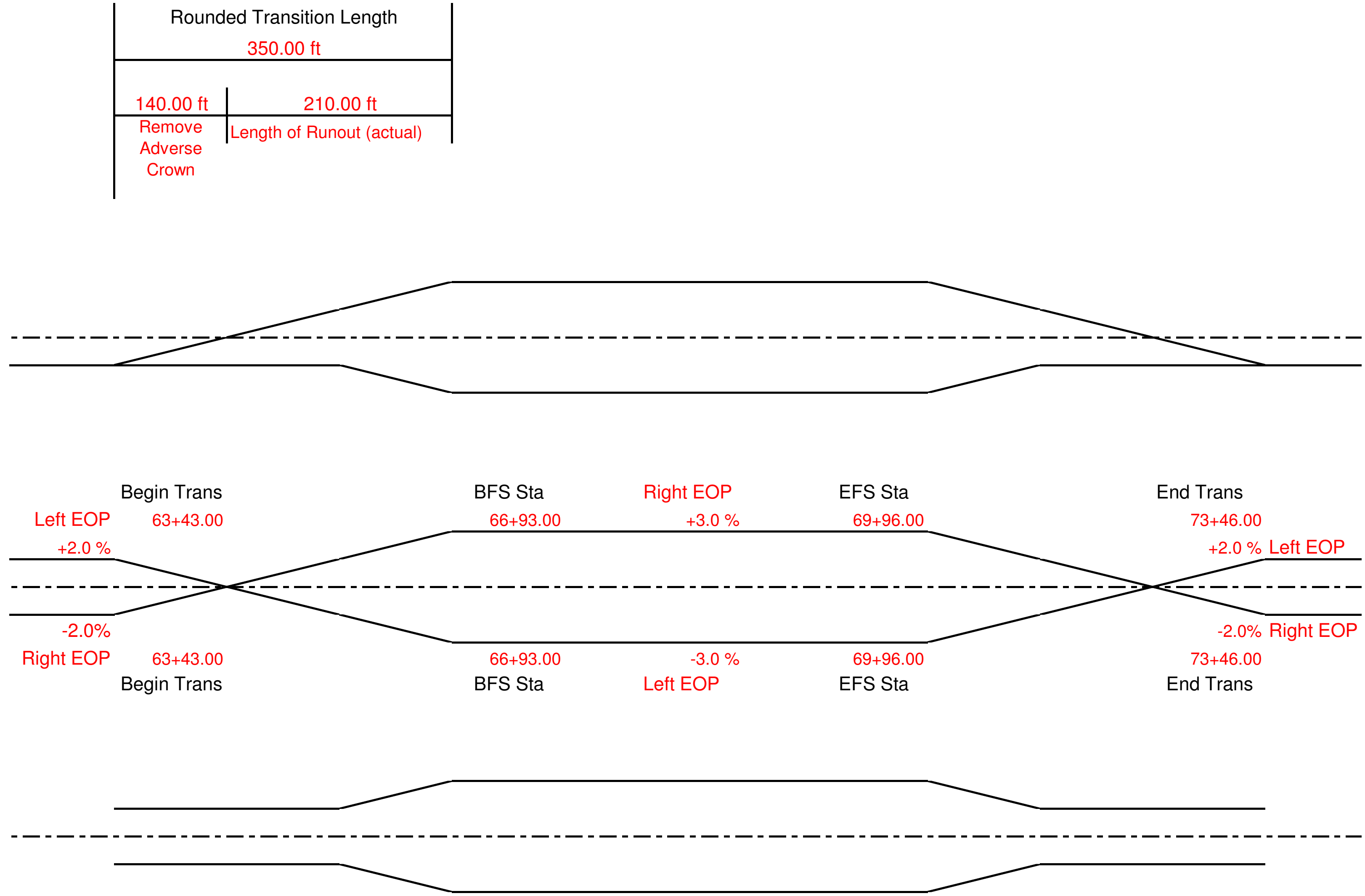
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	39.00	ft
Calculated Lr	210.00	ft
Use Calculated Lr	210.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3%=	350.00	ft	
Rounded to Nearest 0.01 ft	350.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	178.50	ft	
* Distance from 0 point to Start of Transition	-140.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	64+83.19		
Begin Transition Sta	63+43.00		63+43.00
PC Sta	66+61.69		
Begin Full Super	66+93.00		66+93.00
			Use
End Full Super	69+96.00		69+96.00
PT Sta	70+27.32		
End Transiton Sta	73+46.00		73+46.00
Theoretical Point of Intersection (0% Super) Sta	72+06.00		

SUPER ELEVATION DIAGRAM



$$L_r = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2387	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	4	
Design Super (e_d) positive value	6.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.63	
Lr=	465.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

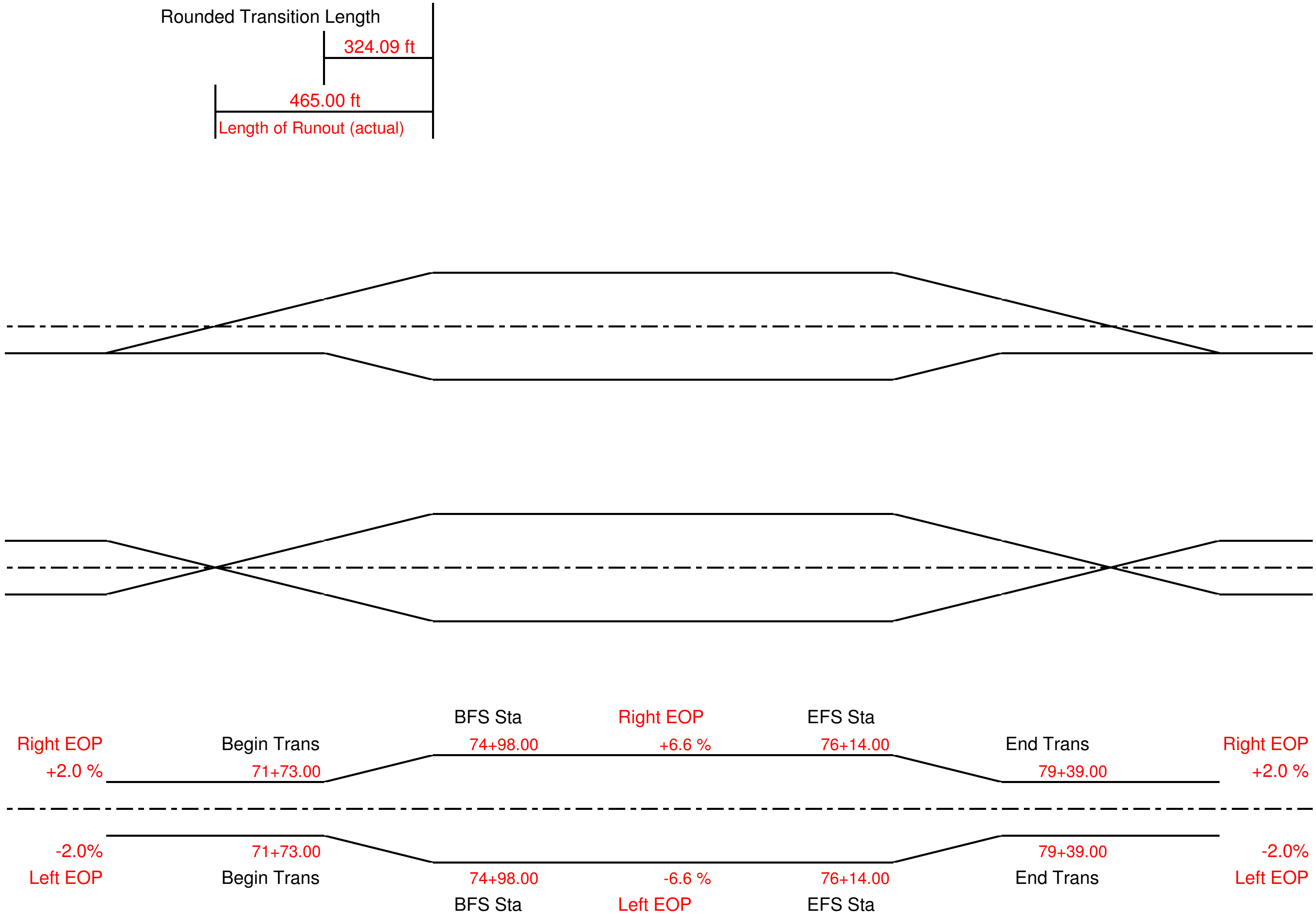
Needed Lr to Fit 65 ft Vert Curve	43.04	ft
Calculated Lr	465.00	ft
Use Calculated Lr	465.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 6.6%=	324.09	ft	
Rounded to Nearest 0.01 ft	324.09	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	395.25	ft	
* Distance from 0 point to Start of Transition	140.91	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	70+32.26		
Begin Transition Sta	71+73.00		71+73.00
PC Sta	74+27.51		
Begin Full Super	74+98.00		74+98.00
			Use
End Full Super	76+14.00		76+14.00
PT Sta	76+83.93		
End Transiton Sta	79+39.00		79+39.00
Theoretical Point of Intersection (0% Super) Sta	80+79.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2399	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	4	
Design Super (e_d) positive value	6.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.63	
Lr=	465.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	49.88	ft
Calculated Lr	465.00	ft
Use Calculated Lr	465.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 6.6%=	605.91	ft	
Rounded to Nearest 0.01 ft	605.91	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	395.25	ft	
* Distance from 0 point to Start of Transition	-140.91	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	76+88.57		
Begin Transition Sta	75+47.00		75+47.00
PC Sta	80+83.82		
Begin Full Super	81+53.00		81+53.00

		Use
End Full Super	81+61.00	81+61.00
PT Sta	82+30.38	
End Transiton Sta	87+67.00	87+67.00
Theoretical Point of Intersection (0% Super) Sta	86+26.00	

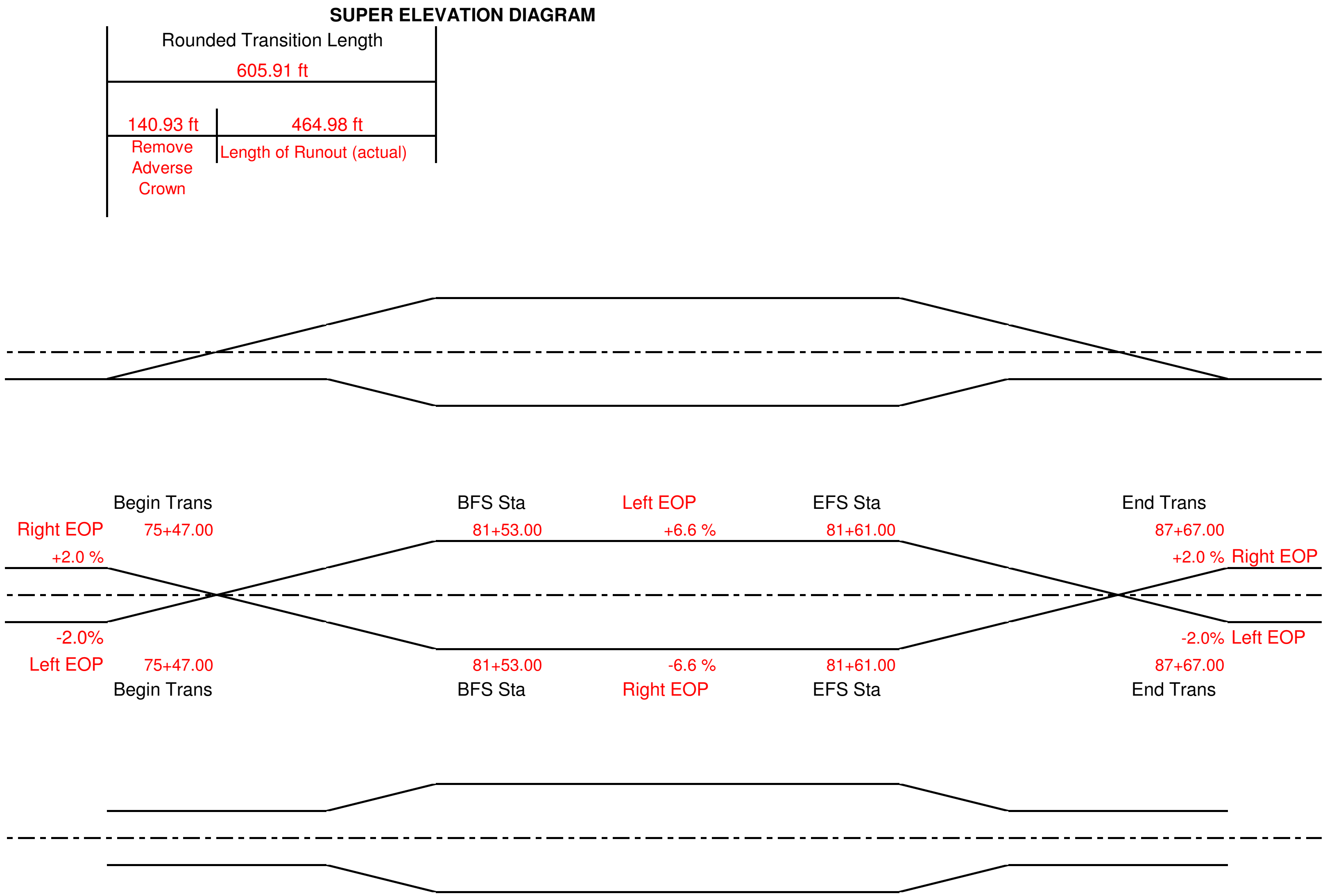
CA Group

Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"MC"-4



SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

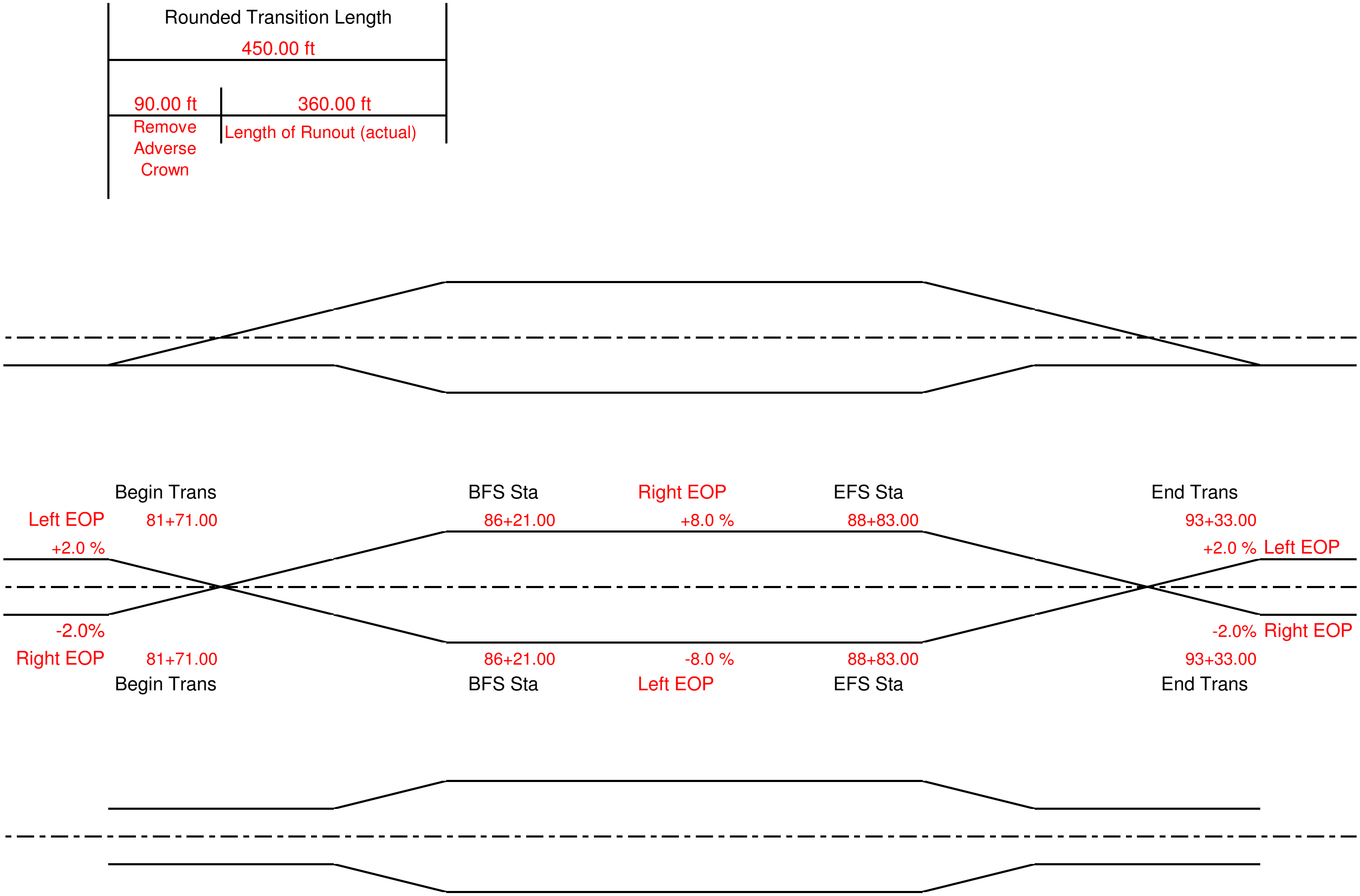
Radius	571	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	3	
Design Super (e_d) positive value	8	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	360.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	264	ft
Max Spiral Curve Length	425	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**360**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	36.00	ft
Calculated Lr	360.00	ft
Use Calculated Lr	360.00	ft

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 8%=	450.00	ft	
Rounded to Nearest 0.01 ft	450.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	324.00	ft	
* Distance from 0 point to Start of Transition	-90.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	82+61.35		
Begin Transition Sta	81+71.00		81+71.00
PC Sta	85+85.35		
Begin Full Super	86+21.00		86+21.00
			Use
End Full Super	88+83.00		88+83.00
PT Sta	89+18.39		
End Transiton Sta	93+33.00		93+33.00
Theoretical Point of Intersection (0% Super) Sta	92+43.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	686	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	7.9	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	360.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	264	ft
Max Spiral Curve Length	466	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**360**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

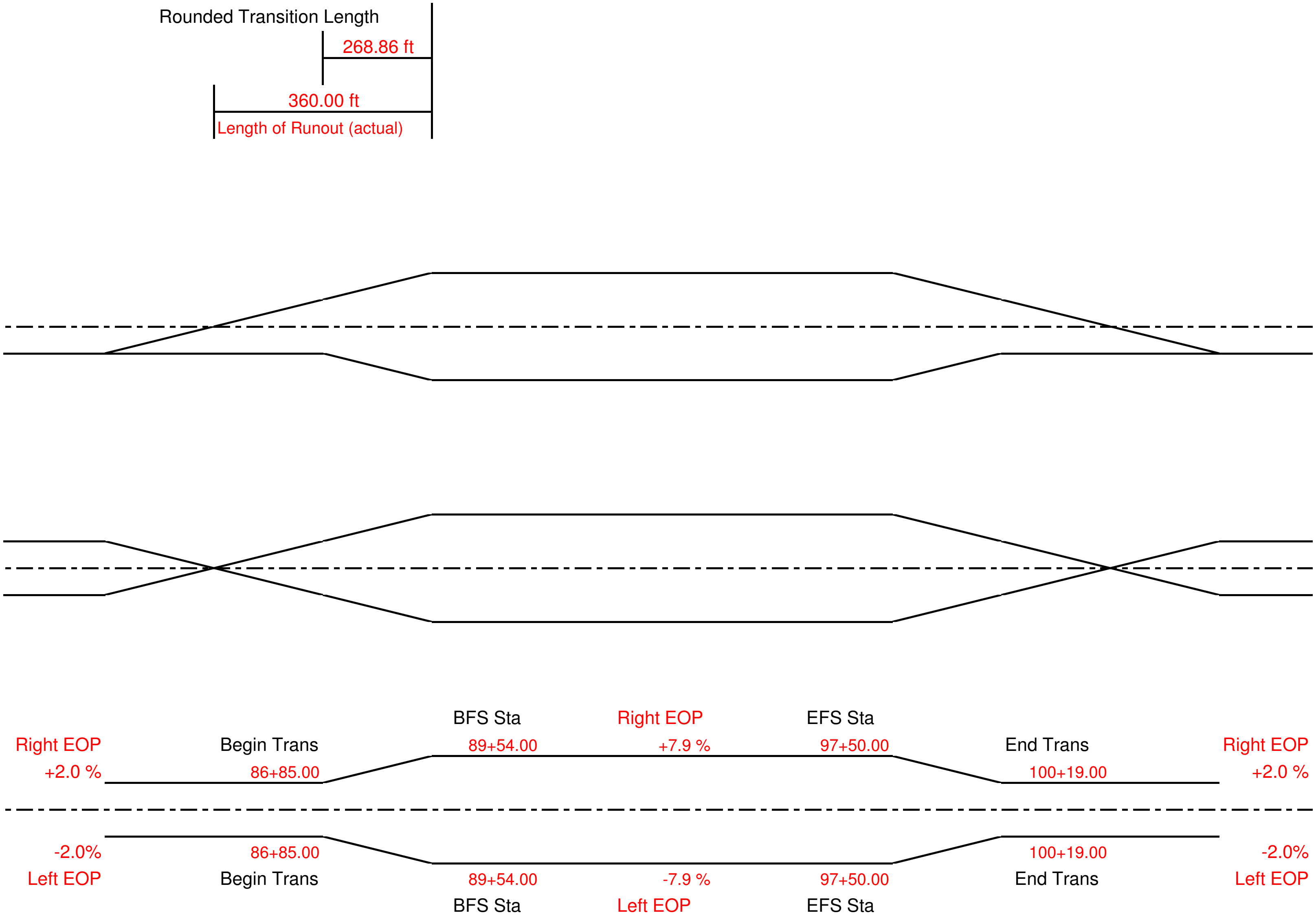
Needed Lr to Fit 45 ft Vert Curve	40.17	ft
Calculated Lr	360.00	ft
Use Calculated Lr	360.00	ft

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 7.9%=	268.86	ft
Rounded to Nearest 0.01 ft	268.86	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	324.00	ft
* Distance from 0 point to Start of Transition	91.14	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	85+94.39	
Begin Transition Sta	86+85.00	86+85.00
PC Sta	89+18.39	
Begin Full Super	89+54.00	89+54.00

		Use
End Full Super	97+50.00	97+50.00
PT Sta	97+85.29	
End Transiton Sta	100+19.00	100+19.00
Theoretical Point of Intersection (0% Super) Sta	101+10.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	964	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	6.9	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	264	ft
Max Spiral Curve Length	553	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**315**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

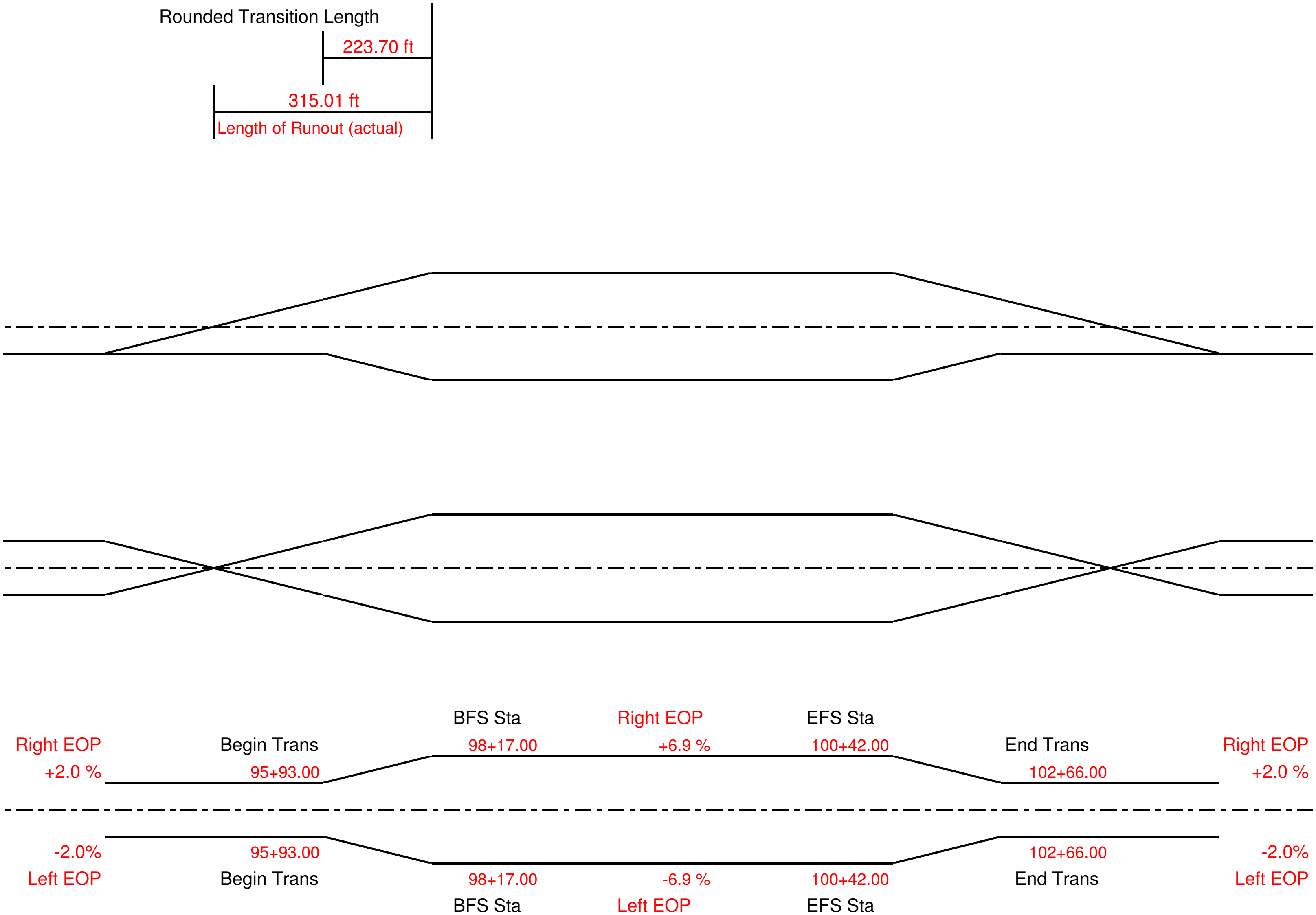
Needed Lr to Fit 45 ft Vert Curve	42.24	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 6.9%=	223.70	ft	
Rounded to Nearest 0.01 ft	223.70	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	283.50	ft	
* Distance from 0 point to Start of Transition	91.30	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	95+01.79		
Begin Transition Sta	95+93.00		95+93.00
PC Sta	97+85.29		
Begin Full Super	98+17.00		98+17.00
			Use
End Full Super	100+42.00		100+42.00
PT Sta	100+73.62		
End Transiton Sta	102+66.00		102+66.00
Theoretical Point of Intersection (0% Super) Sta	103+57.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	**No**	

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 5.6%=	202.50	ft
Rounded to Nearest 0.01 ft	202.50	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.85	
Transition Length on Tangent	267.75	ft
* Distance from 0 point to Start of Transition	112.50	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	102+51.61	
Begin Transition Sta	103+64.00	103+64.00
PC Sta	105+19.36	
Begin Full Super	105+67.00	105+67.00

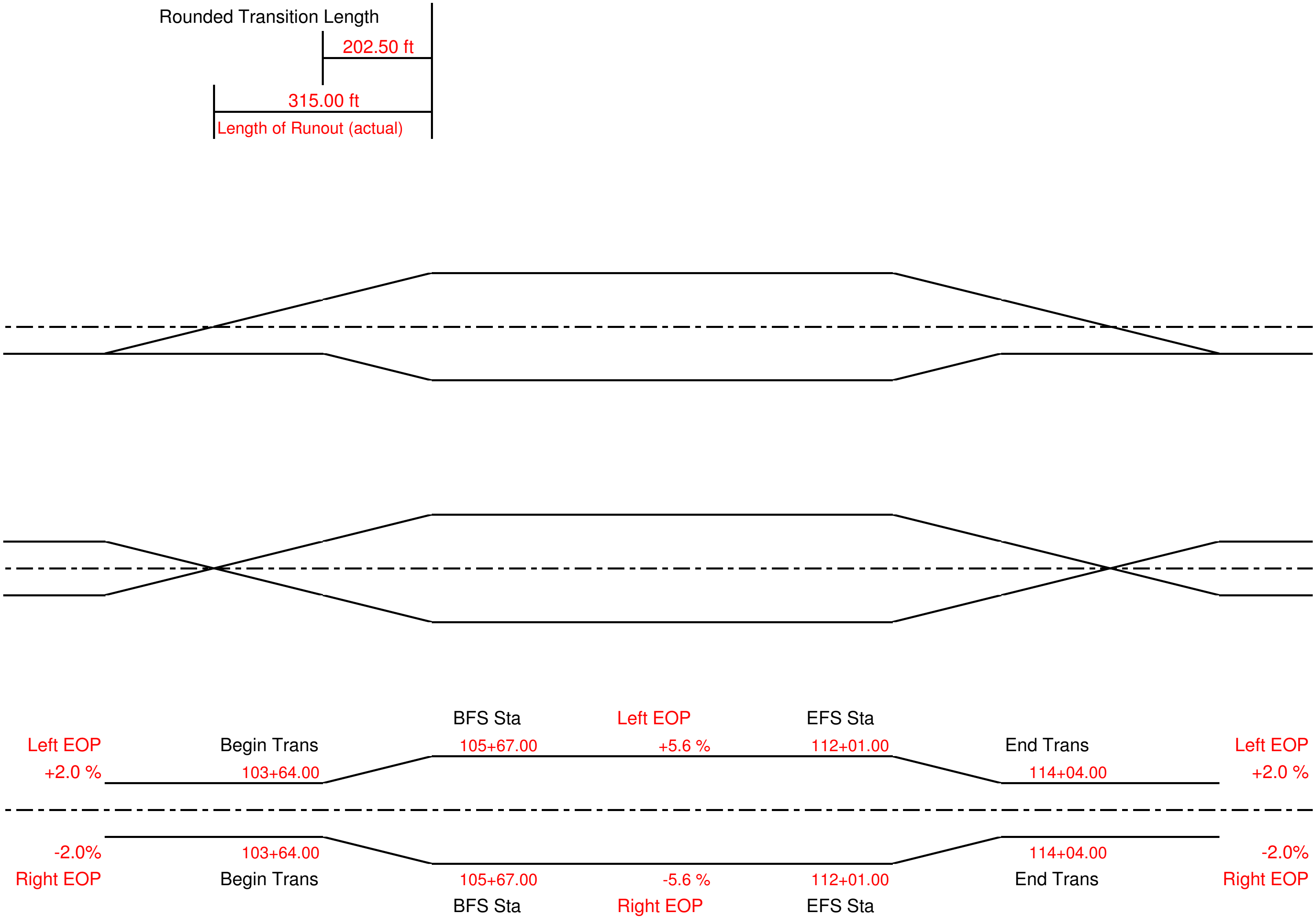
		Use
End Full Super	112+01.00	112+01.00
PT Sta	112+47.93	
End Transiton Sta	114+04.00	114+04.00
Theoretical Point of Intersection (0% Super) Sta	115+16.00	

Design Speed Rounding Curve Length 30

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	46.67	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	2	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	25.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

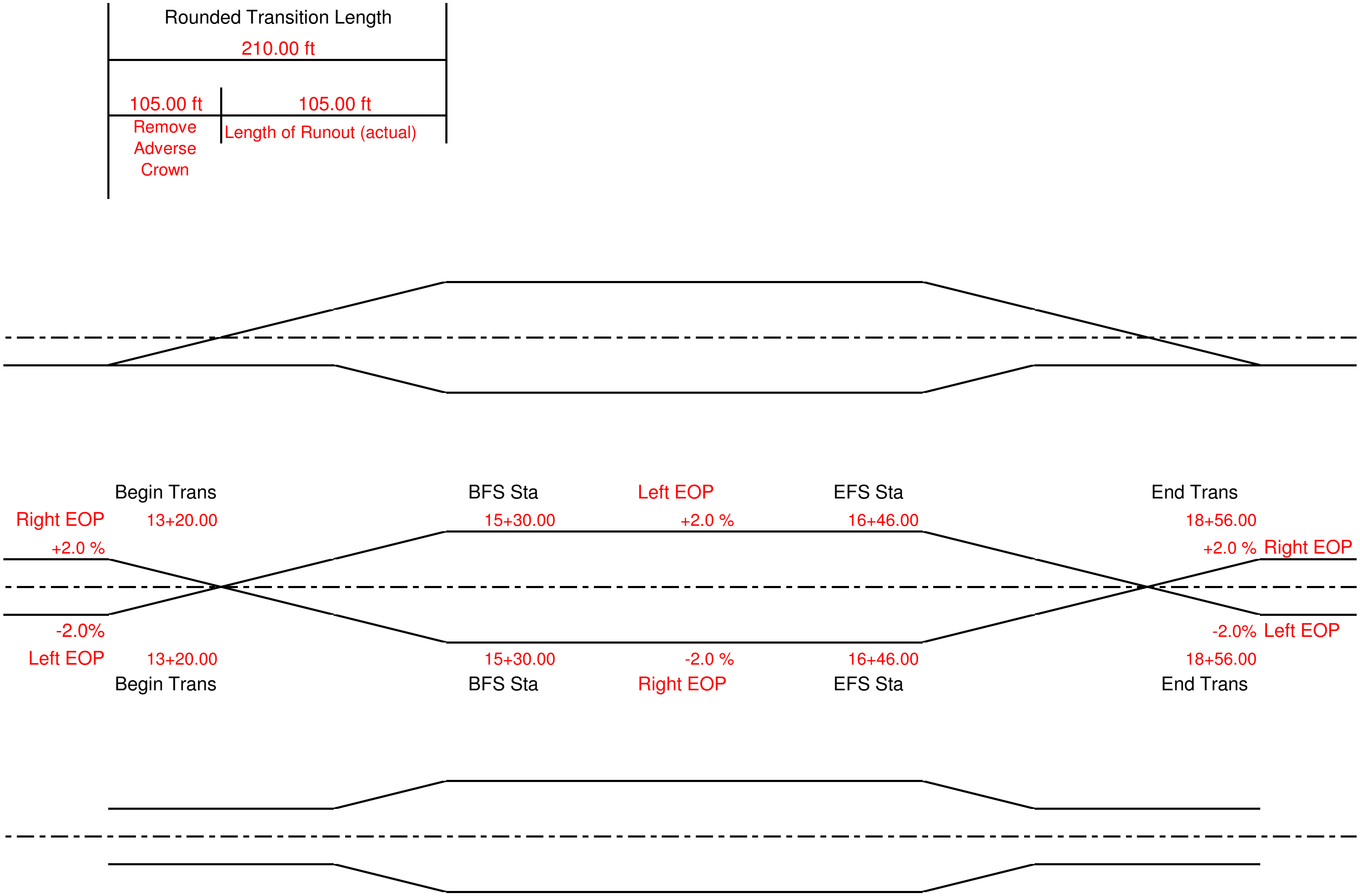
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	210.00	ft	
Rounded to Nearest 0.01 ft	210.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	89.25	ft	
* Distance from 0 point to Start of Transition	-105.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	14+25.07		
Begin Transition Sta	13+20.00		13+20.00
PC Sta	15+14.32		
Begin Full Super	15+30.00		15+30.00

		Use
End Full Super	16+46.00	16+46.00
PT Sta	16+61.74	
End Transiton Sta	18+56.00	18+56.00
Theoretical Point of Intersection (0% Super) Sta	17+51.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3030	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	3.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Use Modified Lr =	85.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

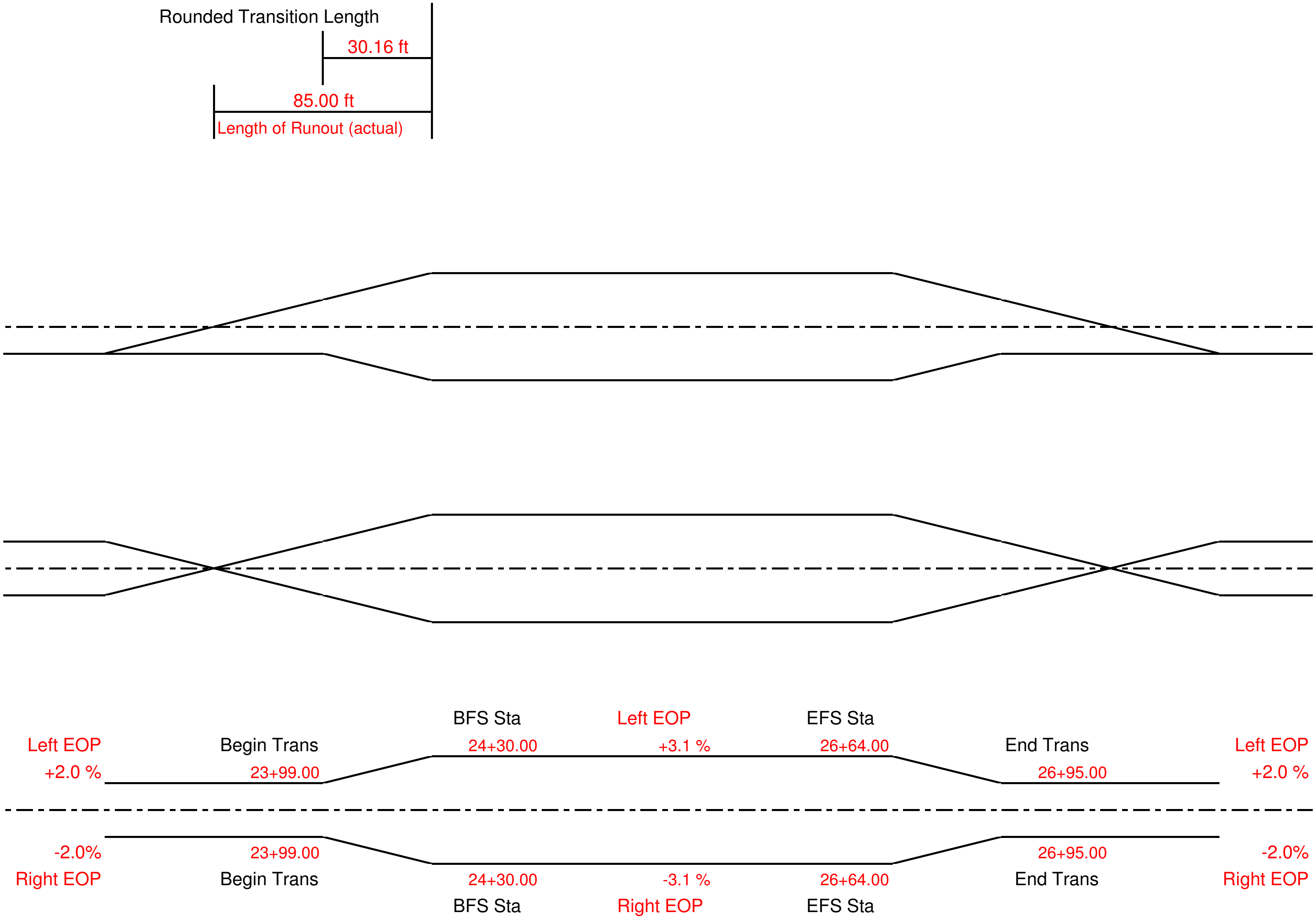
Needed Lr to Fit 45 ft Vert Curve	84.55	ft
Calculated Lr	75.00	ft
Use Modified Lr	85.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.1%=	30.16	ft	
Rounded to Nearest 0.01 ft	30.16	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	68.00	ft	
* Distance from 0 point to Start of Transition	54.84	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	23+44.36		
Begin Transition Sta	23+99.00		23+99.00
PC Sta	24+12.36		
Begin Full Super	24+30.00		24+30.00
			Use
End Full Super	26+64.00		26+64.00
PT Sta	26+80.94		
End Transiton Sta	26+95.00		26+95.00
Theoretical Point of Intersection (0% Super) Sta	27+49.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	3.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

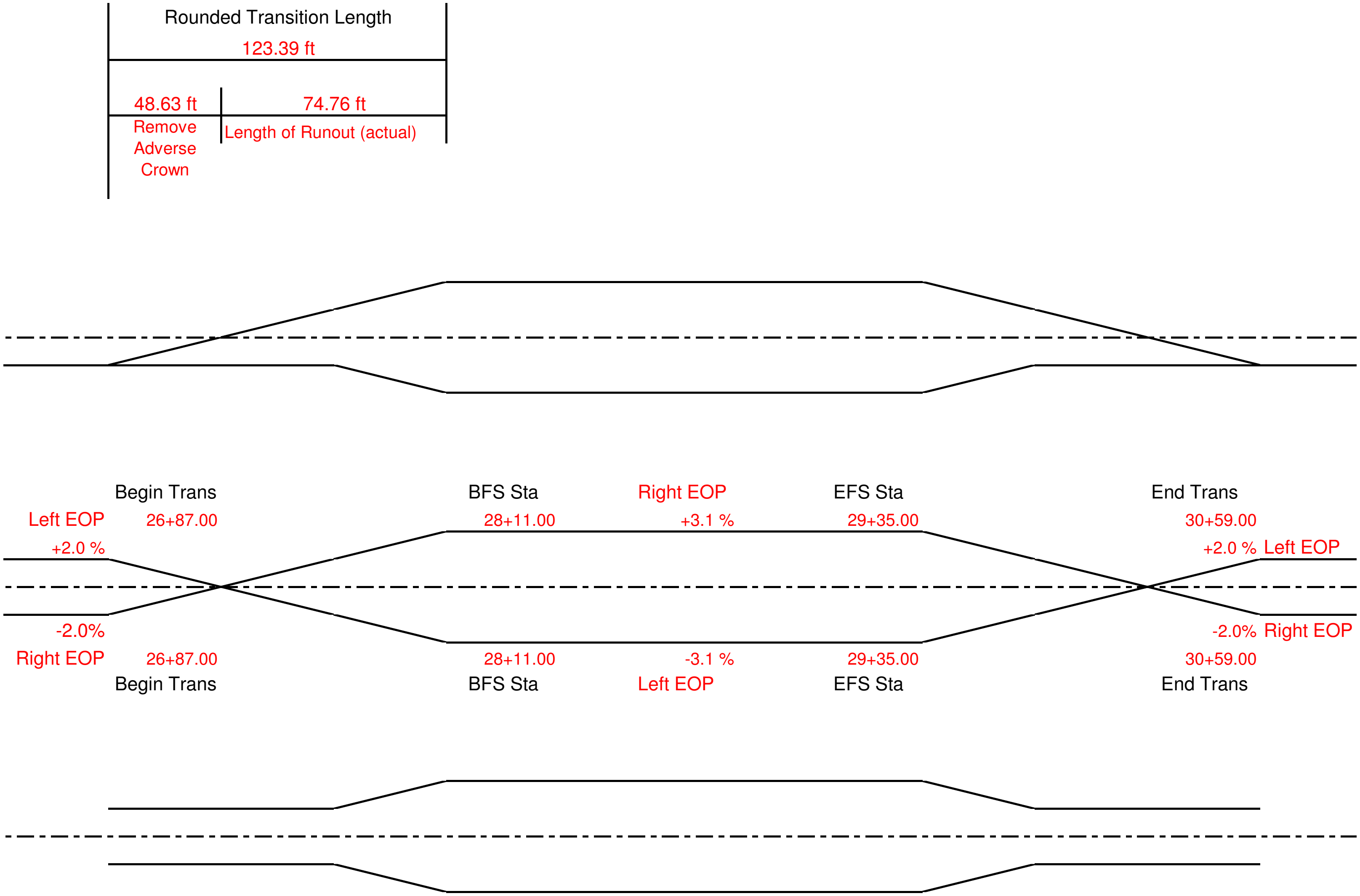
Needed Lr to Fit 45 ft Vert Curve	27.35	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.1%=	123.39	ft	
Rounded to Nearest 0.01 ft	123.39	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	-48.39	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	27+35.53		
Begin Transition Sta	26+87.00		26+87.00
PC Sta	27+95.53		
Begin Full Super	28+11.00		28+11.00
			Use
End Full Super	29+35.00		29+35.00
PT Sta	29+50.50		
End Transiton Sta	30+59.00		30+59.00
Theoretical Point of Intersection (0% Super) Sta	30+10.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	200	ft
Design Speed	25	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	7.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.7	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	135.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	73	ft
Max Spiral Curve Length	126	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**135**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 25 ft Vert Curve	41.11	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION TRANSITION CALCULATION

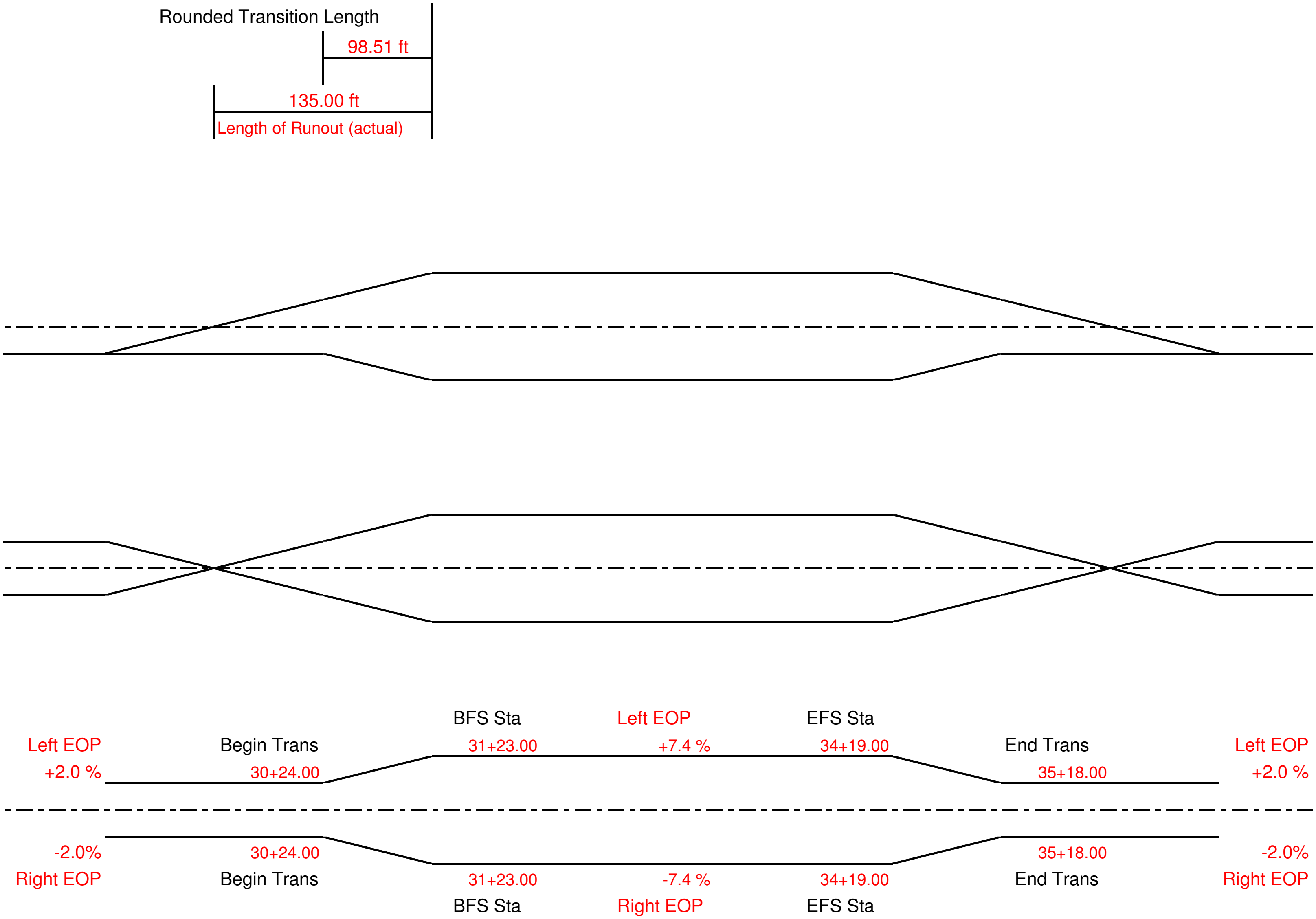
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 7.4%=	98.51	ft
Rounded to Nearest 0.01 ft	98.51	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	108.00	ft
* Distance from 0 point to Start of Transition	36.49	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	29+87.53	
Begin Transition Sta	30+24.00	30+24.00
PC Sta	30+95.53	
Begin Full Super	31+23.00	31+23.00

		Use
End Full Super	34+19.00	34+19.00
PT Sta	34+45.93	
End Transiton Sta	35+18.00	35+18.00
Theoretical Point of Intersection (0% Super) Sta	35+54.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	839	ft
Design Speed	25	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	3.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.7	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 25 ft Vert Curve	67.50	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

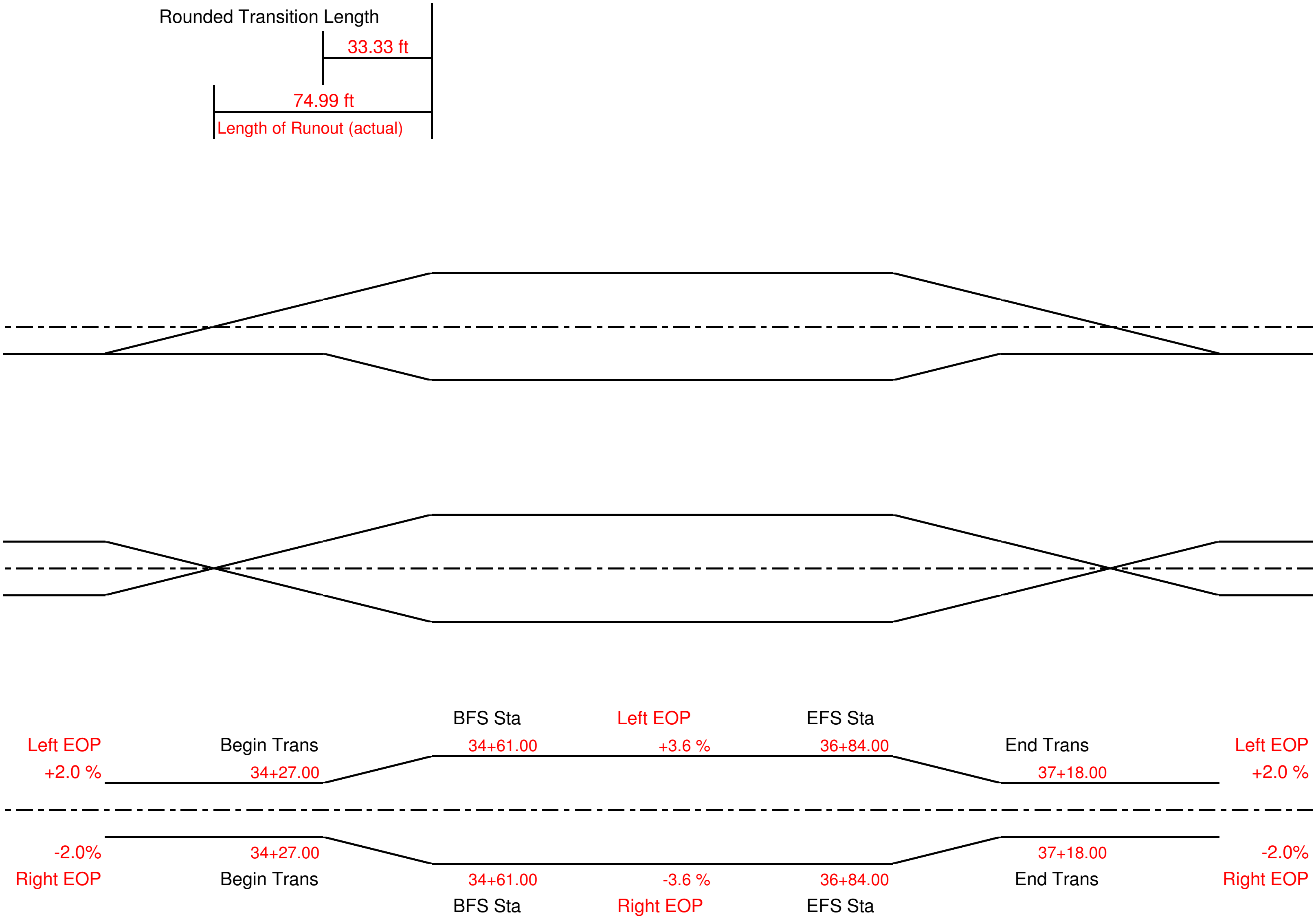
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.6%=	33.33	ft	
Rounded to Nearest 0.01 ft	33.33	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	41.67	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	33+85.93		
Begin Transition Sta	34+27.00		34+27.00
PC Sta	34+45.93		
Begin Full Super	34+61.00		34+61.00

		Use
End Full Super	36+84.00	36+84.00
PT Sta	36+99.29	
End Transiton Sta	37+18.00	37+18.00
Theoretical Point of Intersection (0% Super) Sta	37+59.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

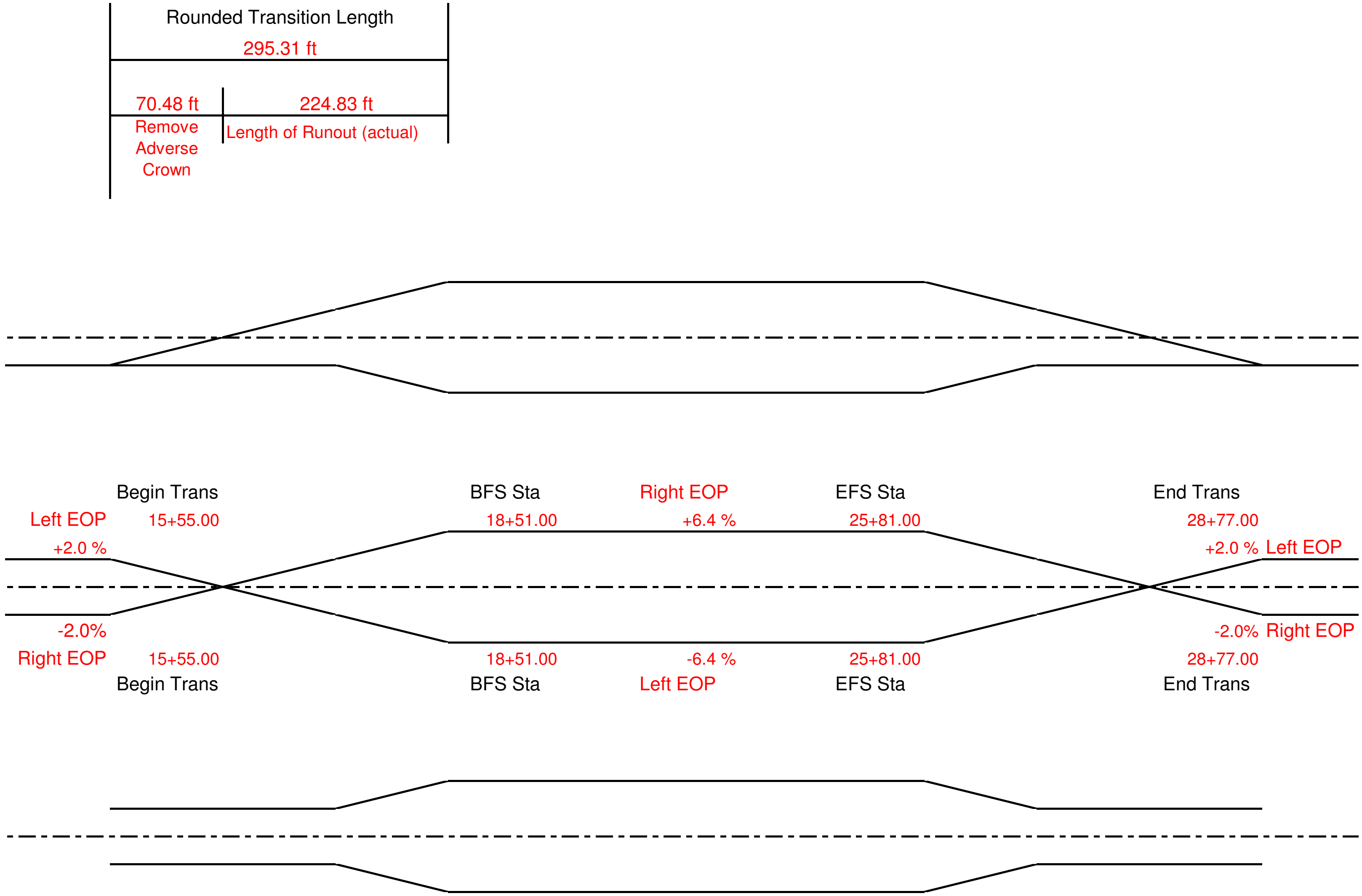
$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1100 ft	2 Way Direction of Travel about Axis of Rotation (Normal Crown)?	No		
Design Speed	45 mph	Right EOP Begin Transition Cross Slope (pos or neg)	-2.0 %		
W	12 ft				
n (greatest no. of lanes on one side of	2	Super Elevation Transition Length from -2%to 6.4%=	295.31 ft		
Design Super (e_d) positive value	6.4 %				
Curve Direction	Left	Rounded to Nearest 0.01 ft	295.31 ft		
Δ (Max Relative Gradient	0.5 %	Pick Agency for Portion of Super on Tangent Rules	AASHTO		
b_w (Lane Adjustment Factor)	0.75	Portion of Runoff Prior to Curve	0.9		
		Transition Length on Tangent	202.50 ft		
Lr=	225.00 ft	* Distance from 0 point to Start of Transition	-70.31 ft		
				Use	
Spiral Curves Recommended Check	**No**	Theoretical Point of Intersection (0% Super) Sta	16+25.93		
		Begin Transition Sta	15+55.00	15+55.00	
		PC Sta	18+28.43		
		Begin Full Super	18+51.00	18+51.00	
				Use	
		End Full Super	25+81.00	25+81.00	
		PT Sta	26+03.79		
		End Transiton Sta	28+77.00	28+77.00	
Design Speed Rounding Curve Length	30	Theoretical Point of Intersection (0% Super) Sta	28+06.00		

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	34.29 ft
Calculated Lr	225.00 ft
Use Calculated Lr	225.00 ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2024	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	56.09	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	80.23	ft	
Rounded to Nearest 0.01 ft	80.23	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	69.77	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	24+68.79		
Begin Transition Sta	25+38.00		25+38.00
PC Sta	26+03.79		
Begin Full Super	26+19.00		26+19.00

		Use
End Full Super	33+03.00	33+03.00
PT Sta	33+18.02	
End Transiton Sta	33+84.00	33+84.00
Theoretical Point of Intersection (0% Super) Sta	34+53.00	

CA Group

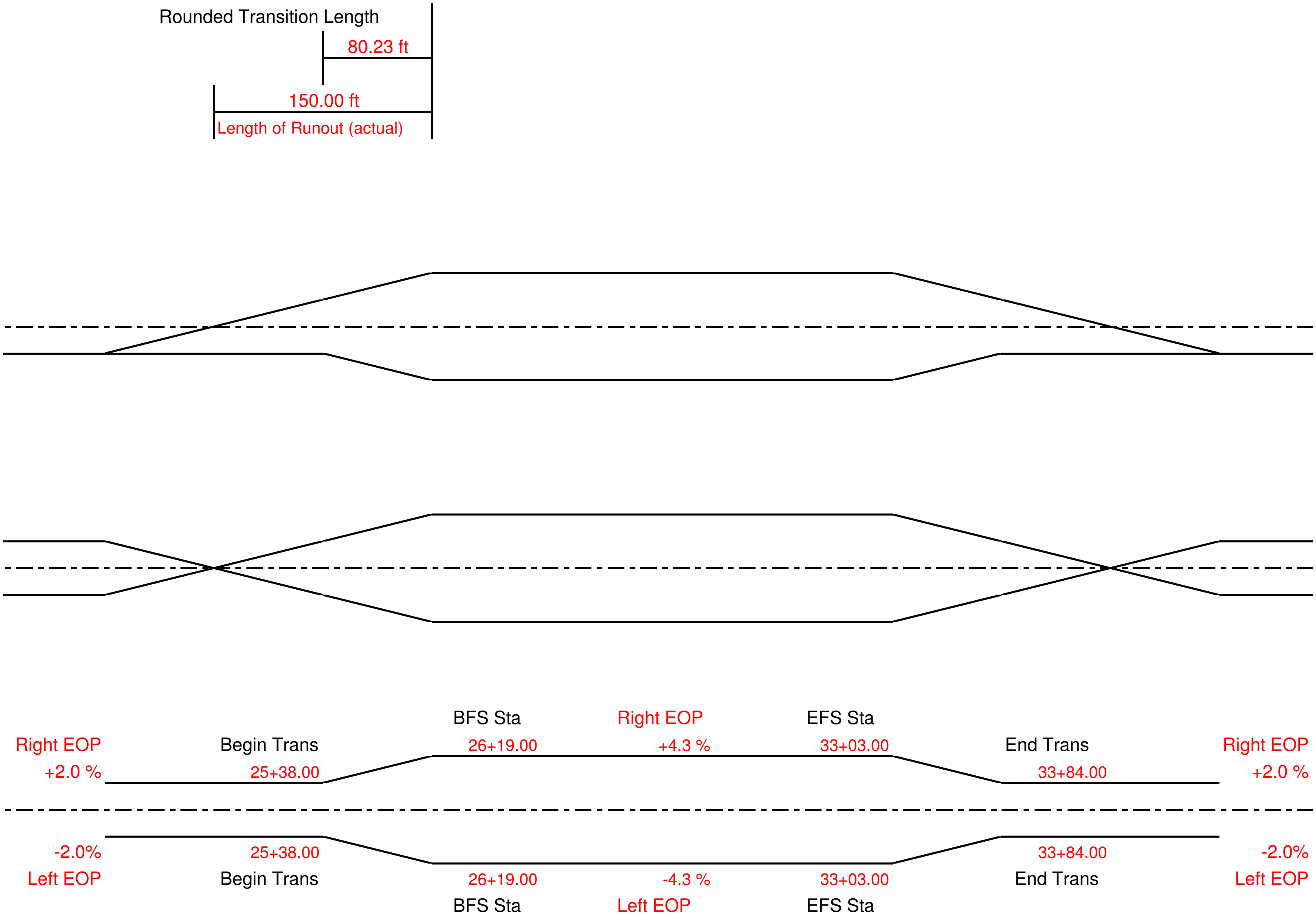
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"NW"-2

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2909	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

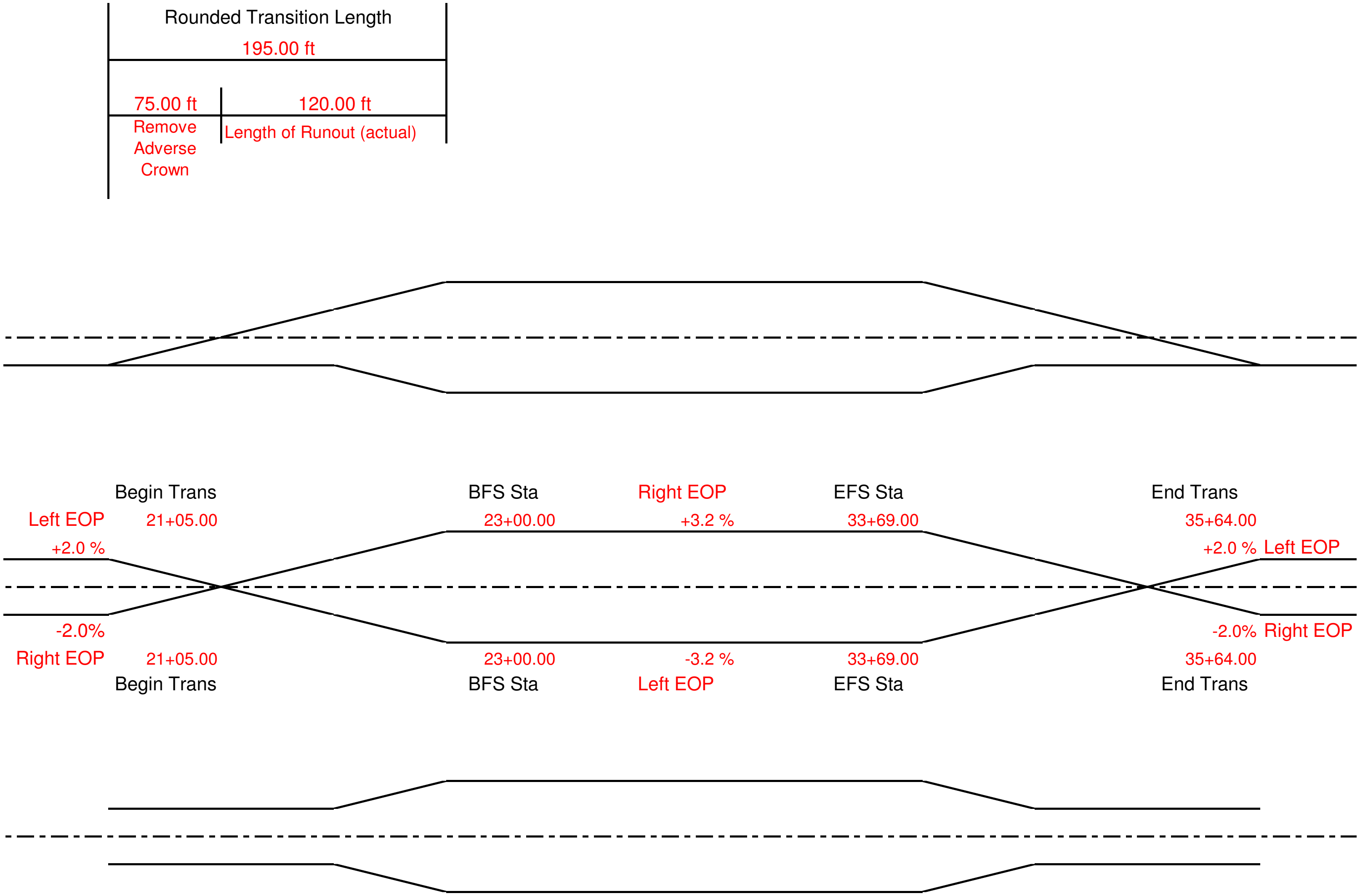
Needed Lr to Fit 45 ft Vert Curve	27.69	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.2%=	195.00	ft	
Rounded to Nearest 0.01 ft	195.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	-75.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	21+80.13		
Begin Transition Sta	21+05.00		21+05.00
PC Sta	22+88.13		
Begin Full Super	23+00.00		23+00.00
			Use
End Full Super	33+69.00		33+69.00
PT Sta	33+80.88		
End Transiton Sta	35+64.00		35+64.00
Theoretical Point of Intersection (0% Super) Sta	34+89.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	509	ft
Design Speed	25	mph
W	12	ft
n (greatest no. of lanes on one side of	2	
Design Super (e_d) positive value	5	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.7	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	135.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 25 ft Vert Curve	50.00	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION TRANSITION CALCULATION

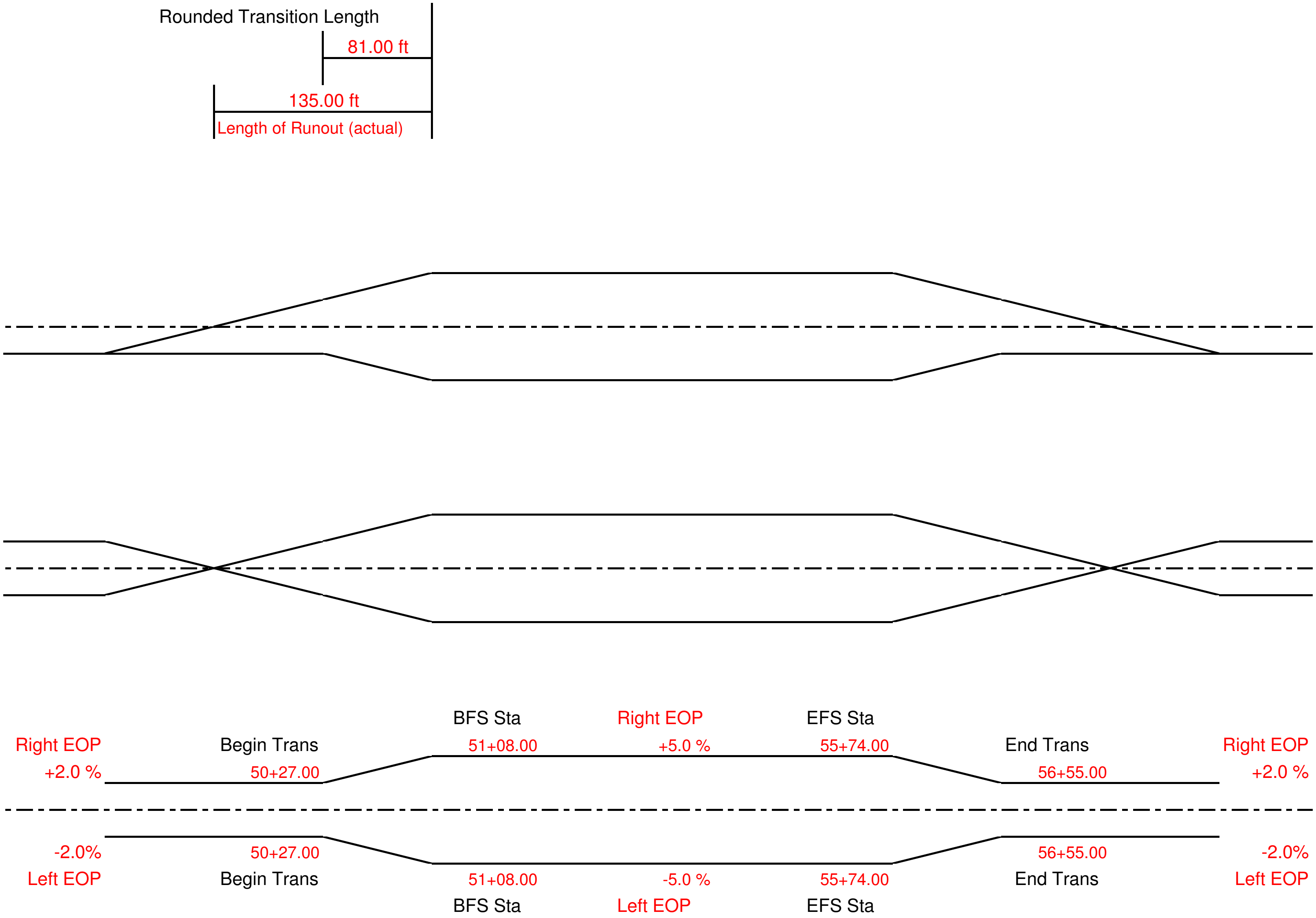
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 5%=	81.00	ft
Rounded to Nearest 0.01 ft	81.00	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	121.50	ft
* Distance from 0 point to Start of Transition	54.00	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	49+73.87	
Begin Transition Sta	50+27.00	50+27.00
PC Sta	50+95.37	
Begin Full Super	51+08.00	51+08.00

		Use
End Full Super	55+74.00	55+74.00
PT Sta	55+87.25	
End Transiton Sta	56+55.00	56+55.00
Theoretical Point of Intersection (0% Super) Sta	57+09.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

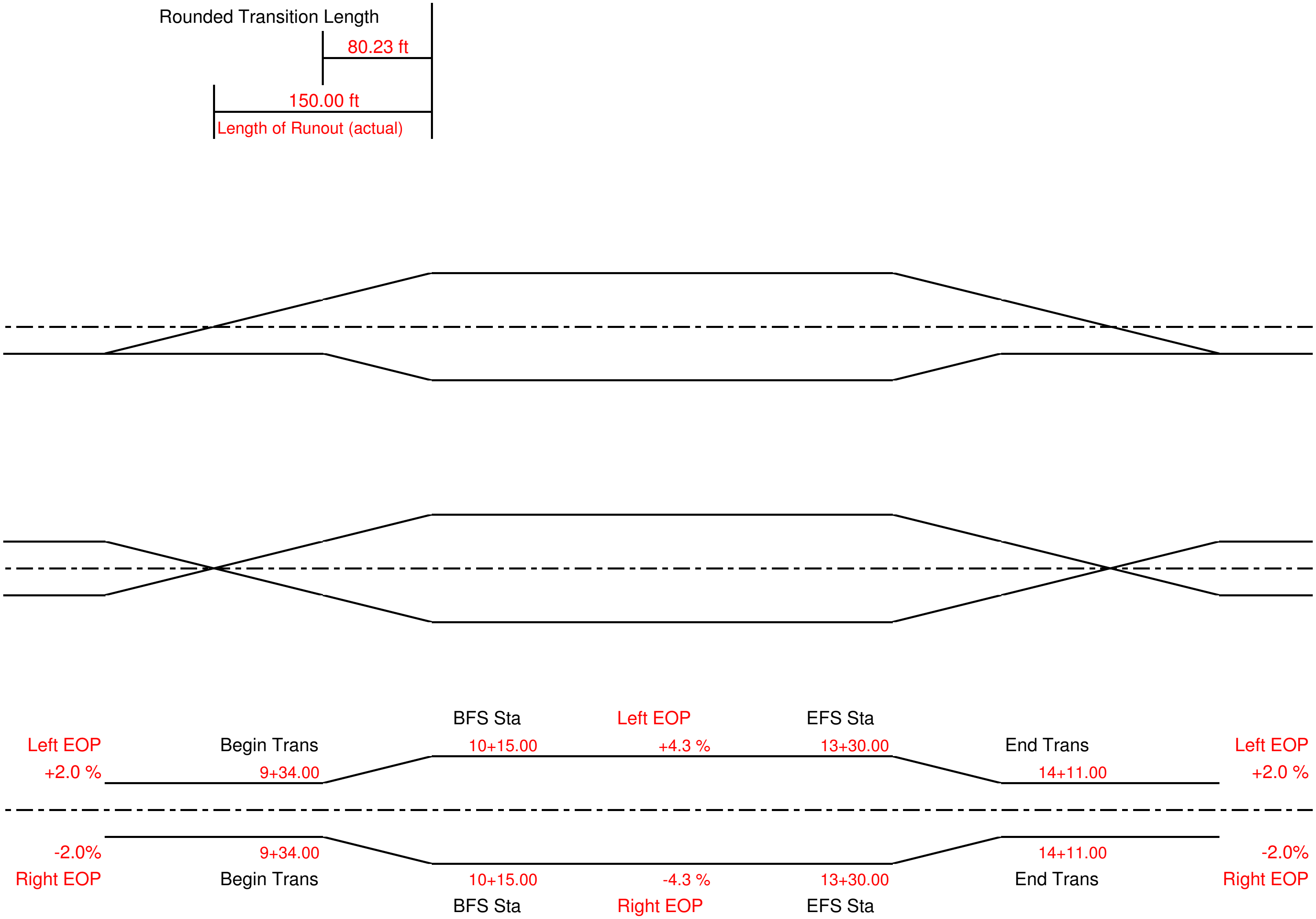
Needed Lr to Fit 45 ft Vert Curve	56.09	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	80.23	ft	
Rounded to Nearest 0.01 ft	80.23	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	69.77	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	8+65.00		
Begin Transition Sta	9+34.00		9+34.00
PC Sta	10+00.00		
Begin Full Super	10+15.00		10+15.00
			Use
End Full Super	13+30.00		13+30.00
PT Sta	13+45.73		
End Transiton Sta	14+11.00		14+11.00
Theoretical Point of Intersection (0% Super) Sta	14+80.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

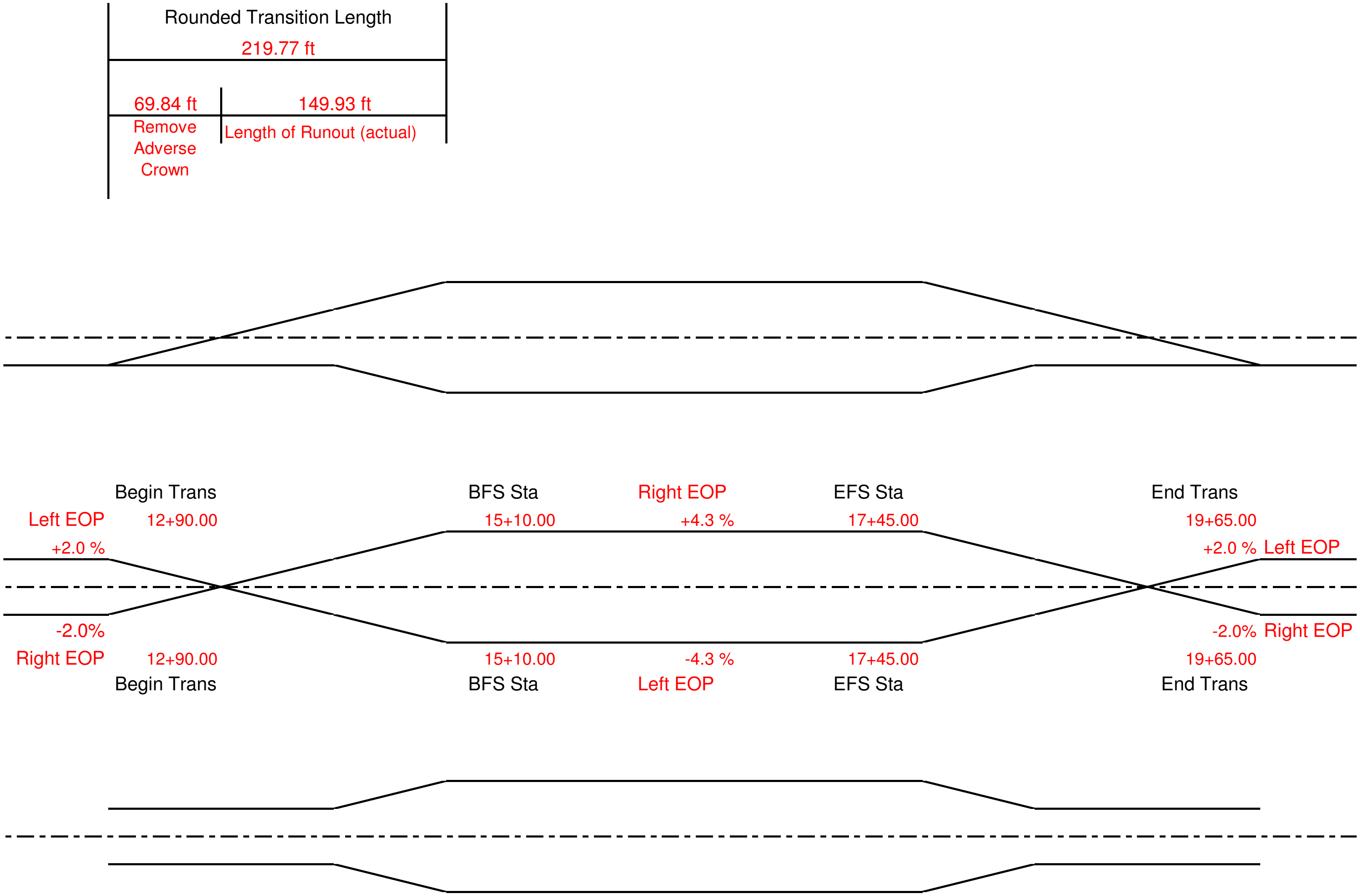
Needed Lr to Fit 45 ft Vert Curve	30.71	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 4.3%=	219.77	ft	
Rounded to Nearest 0.01 ft	219.77	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	-69.77	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	13+60.43		
Begin Transition Sta	12+90.00		12+90.00
PC Sta	14+95.43		
Begin Full Super	15+10.00		15+10.00
			Use
End Full Super	17+45.00		17+45.00
PT Sta	17+59.26		
End Transiton Sta	19+65.00		19+65.00
Theoretical Point of Intersection (0% Super) Sta	18+95.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1225	ft
Design Speed	35	mph
W	12	ft
n (greatest no. of lanes on one side of ;	3	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	180.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 35 ft Vert Curve	56.09	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

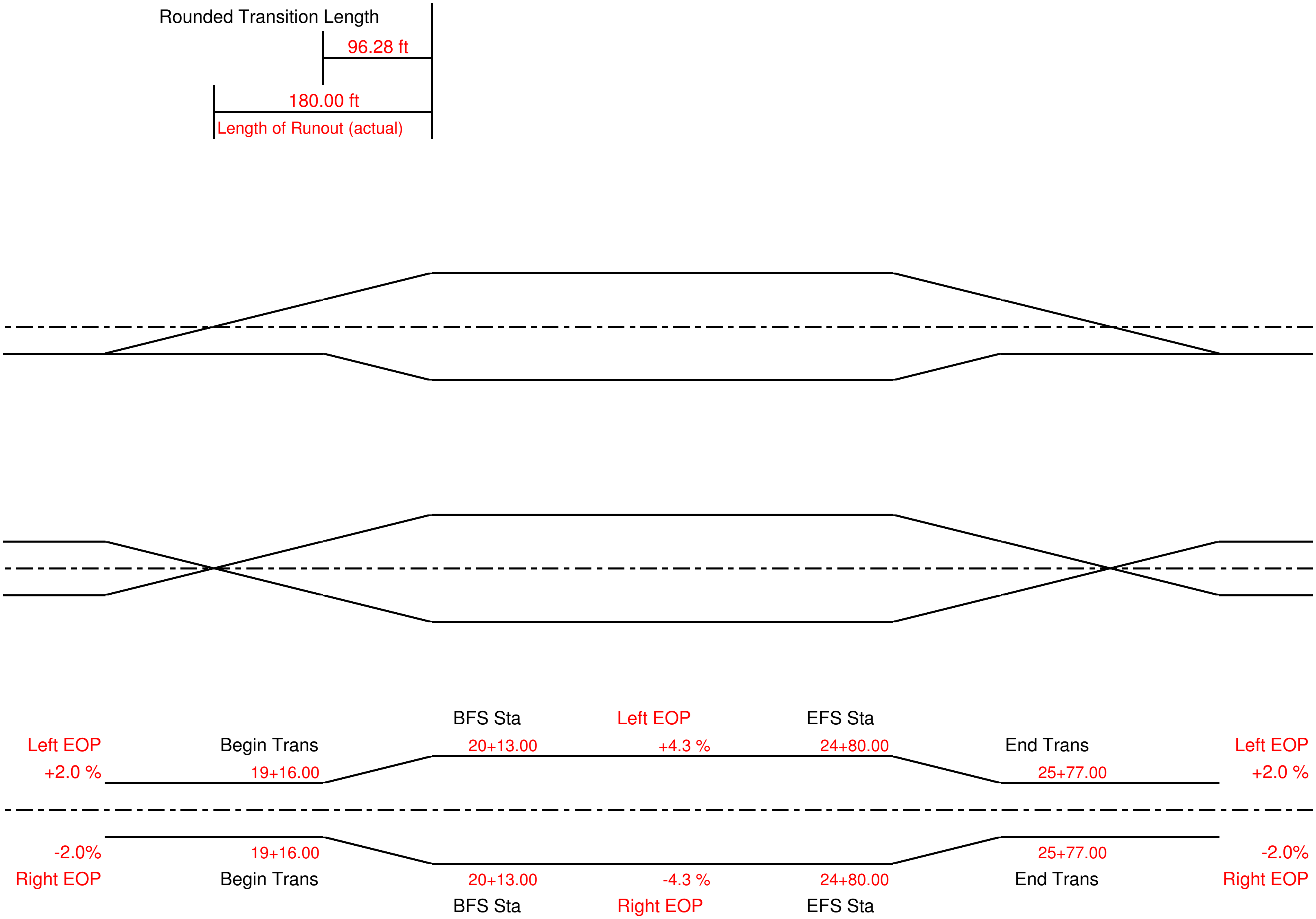
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	96.28	ft	
Rounded to Nearest 0.01 ft	96.28	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	162.00	ft	
* Distance from 0 point to Start of Transition	83.72	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	18+32.50		
Begin Transition Sta	19+16.00		19+16.00
PC Sta	19+94.50		
Begin Full Super	20+13.00		20+13.00

			Use
End Full Super	24+80.00		24+80.00
PT Sta	24+98.45		
End Transiton Sta	25+77.00		25+77.00
Theoretical Point of Intersection (0% Super) Sta	26+60.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1435	ft
Design Speed	35	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	5.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	165.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

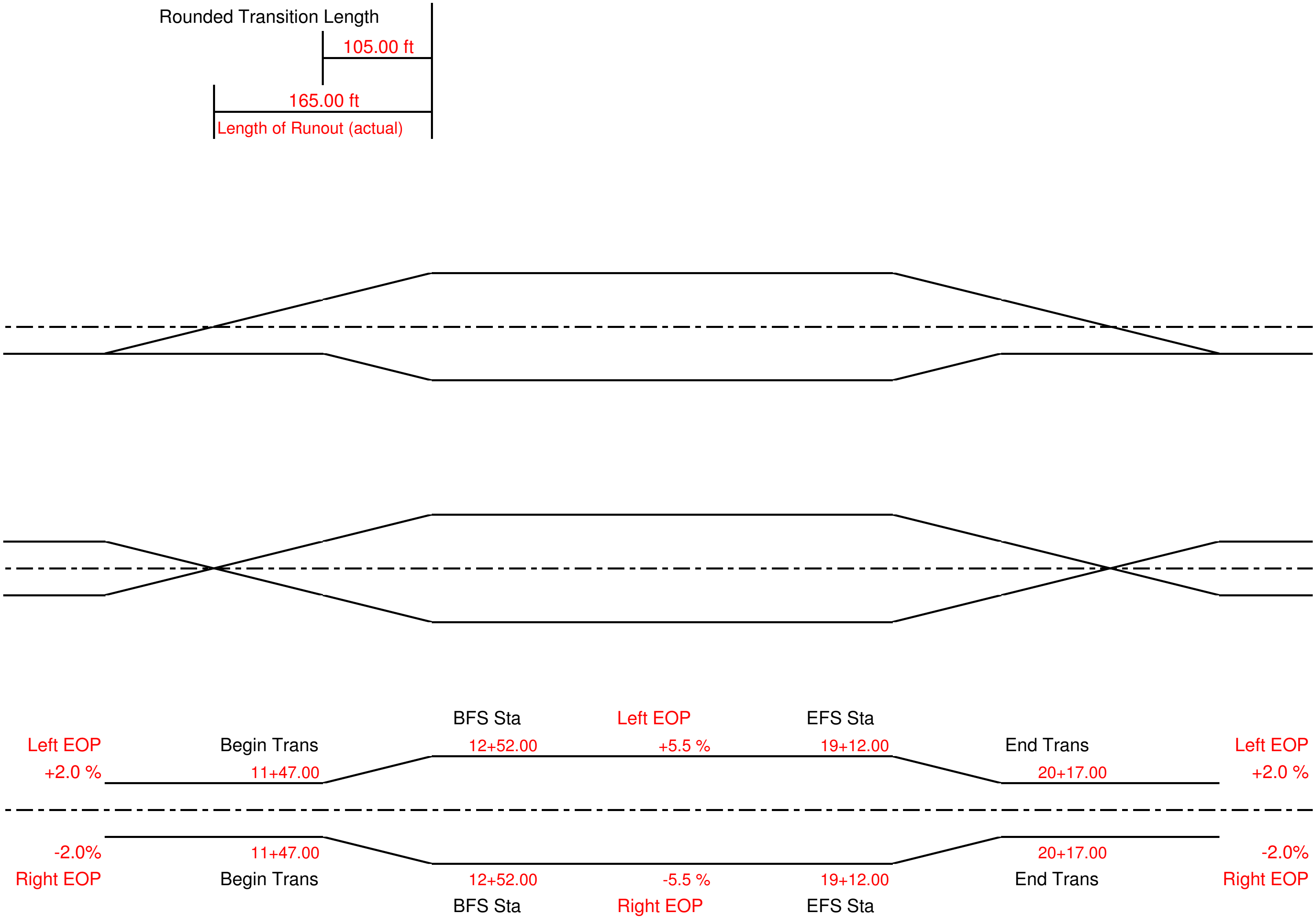
Needed Lr to Fit 35 ft Vert Curve	47.14	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.5%=	105.00	ft	
Rounded to Nearest 0.01 ft	105.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	148.50	ft	
* Distance from 0 point to Start of Transition	60.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	10+87.65		
Begin Transition Sta	11+47.00		11+47.00
PC Sta	12+36.15		
Begin Full Super	12+52.00		12+52.00
			Use
End Full Super	19+12.00		19+12.00
PT Sta	19+28.41		
End Transiton Sta	20+17.00		20+17.00
Theoretical Point of Intersection (0% Super) Sta	20+77.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	658	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.9	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	270.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	342	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**270**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

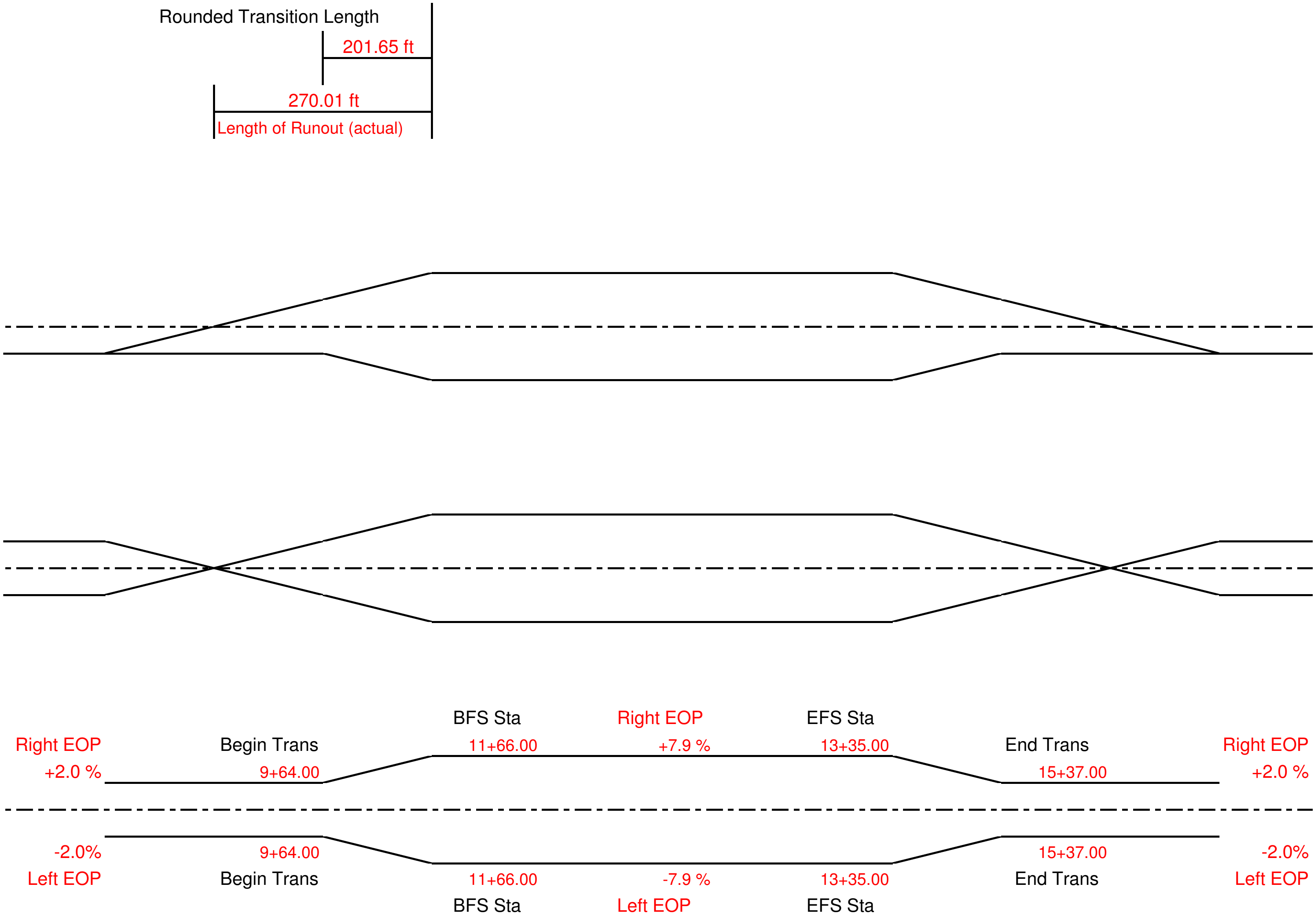
Needed Lr to Fit 45 ft Vert Curve	53.56	ft
Calculated Lr	270.00	ft
Use Calculated Lr	270.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.9%=	201.65	ft	
Rounded to Nearest 0.01 ft	201.65	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	243.00	ft	
* Distance from 0 point to Start of Transition	68.35	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	8+96.25		
Begin Transition Sta	9+64.00		9+64.00
PC Sta	11+39.25		
Begin Full Super	11+66.00		11+66.00
			Use
End Full Super	13+35.00		13+35.00
PT Sta	13+62.01		
End Transiton Sta	15+37.00		15+37.00
Theoretical Point of Intersection (0% Super) Sta	16+05.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1856	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	4.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

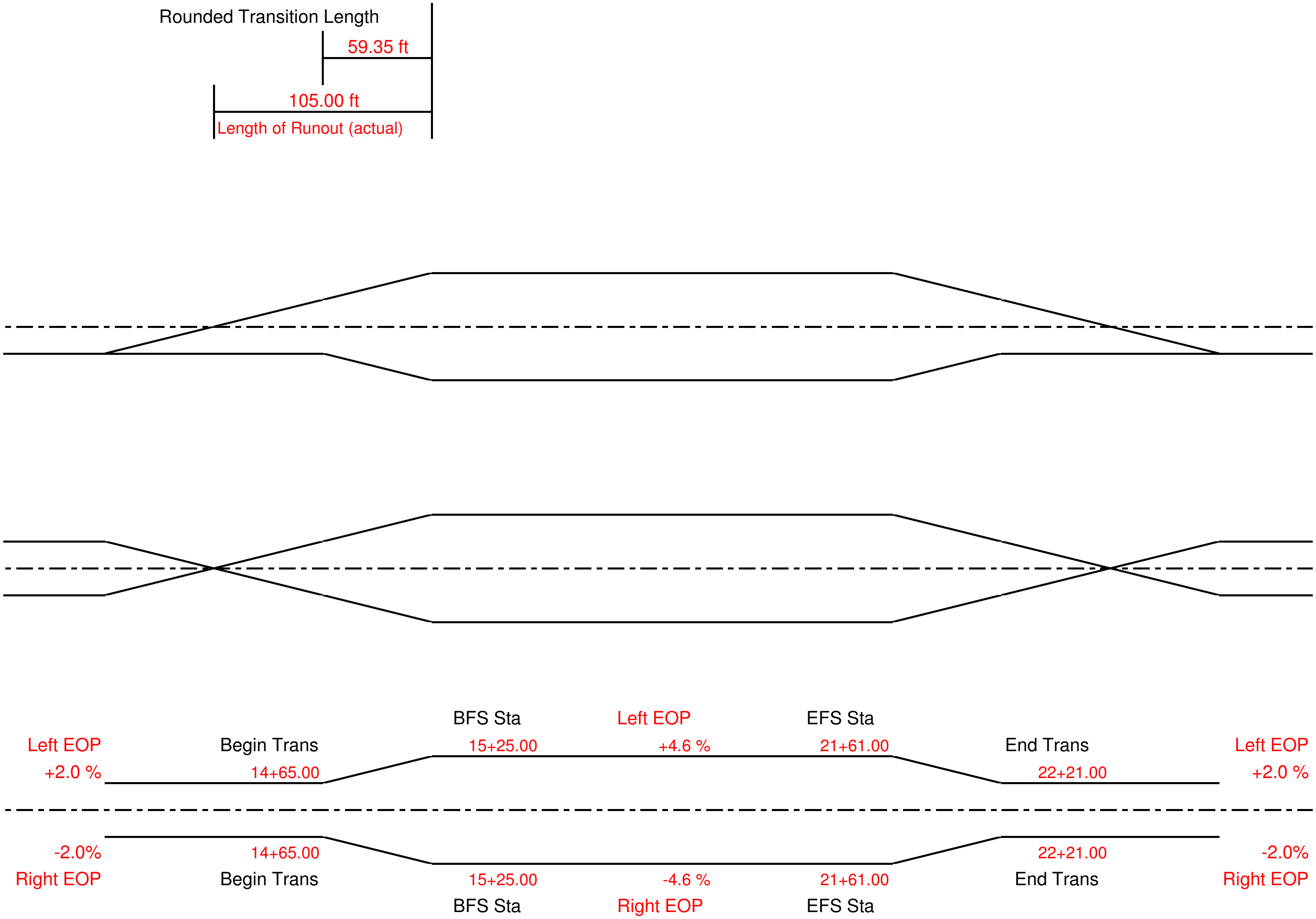
Needed Lr to Fit 45 ft Vert Curve	70.77	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.6%=	59.35	ft	
Rounded to Nearest 0.01 ft	59.35	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	45.65	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	14+19.49		
Begin Transition Sta	14+65.00		14+65.00
PC Sta	15+03.49		
Begin Full Super	15+25.00		15+25.00
			Use
End Full Super	21+61.00		21+61.00
PT Sta	21+82.43		
End Transiton Sta	22+21.00		22+21.00
Theoretical Point of Intersection (0% Super) Sta	22+66.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2590	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	3.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

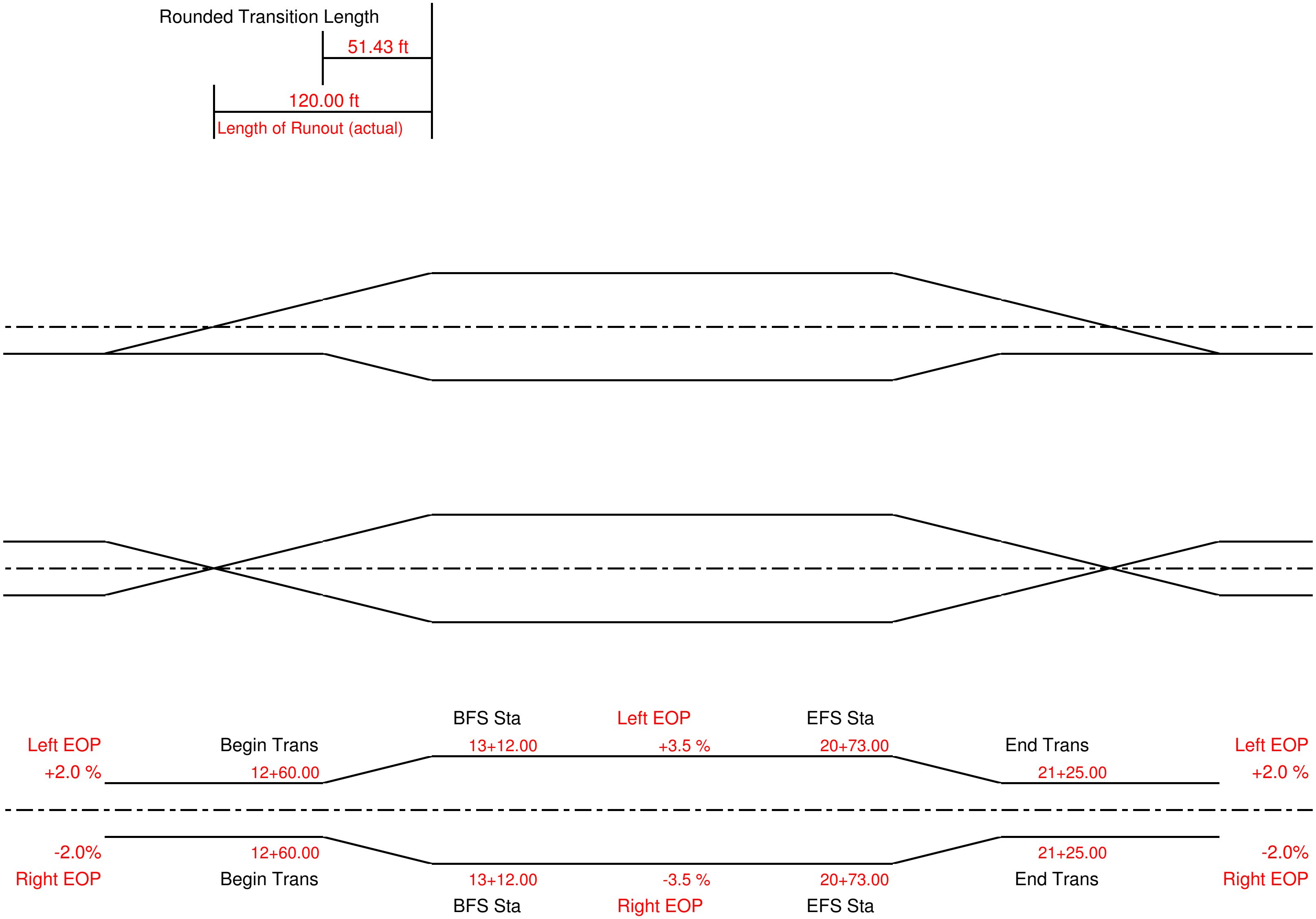
Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0 %		
Super Elevation Transition Length from 2%to 3.5%=	51.43 ft		
Rounded to Nearest 0.01 ft	51.43 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	108.00 ft		
* Distance from 0 point to Start of Transition	68.57 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	11+92.00		
Begin Transition Sta	12+60.00	12+60.00	
PC Sta	13+00.00		
Begin Full Super	13+12.00	13+12.00	
		Use	
End Full Super	20+73.00	20+73.00	
PT Sta	20+85.32		
End Transiton Sta	21+25.00	21+25.00	
Theoretical Point of Intersection (0% Super) Sta	21+93.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	

Design Speed Rounding Curve Length 30

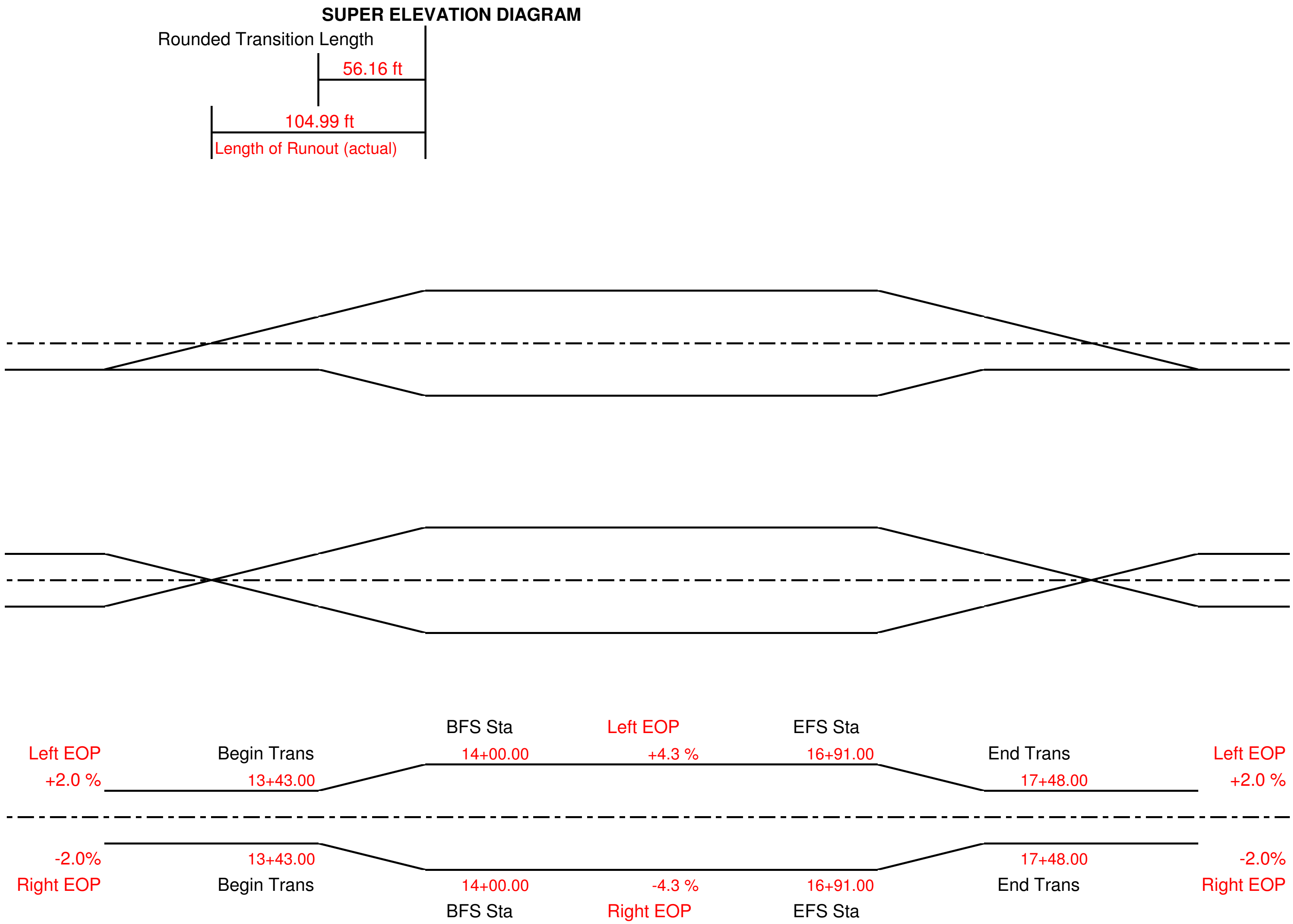
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	56.09	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	56.16	ft	
Rounded to Nearest 0.01 ft	56.16	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	48.84	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	12+94.28		
Begin Transition Sta	13+43.00		13+43.00
PC Sta	13+78.28		
Begin Full Super	14+00.00		14+00.00
			Use
End Full Super	16+91.00		16+91.00
PT Sta	17+12.12		
End Transiton Sta	17+48.00		17+48.00
Theoretical Point of Intersection (0% Super) Sta	17+96.00		


SUPER ELEVATION DIAGRAM
Rounded Transition Length
56.16 ft
104.99 ft
Length of Runout (actual)
BFS Sta
Left EOP
EFS Sta
Left EOP
+2.0 %
Begin Trans
13+43.00
14+00.00
+4.3 %
16+91.00
End Trans
17+48.00
Left EOP
+2.0 %
-2.0%
Right EOP
13+43.00
Begin Trans
14+00.00
-4.3 %
16+91.00
17+48.00
End Trans
-2.0%
Right EOP
BFS Sta
Right EOP
EFS Sta

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	3.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

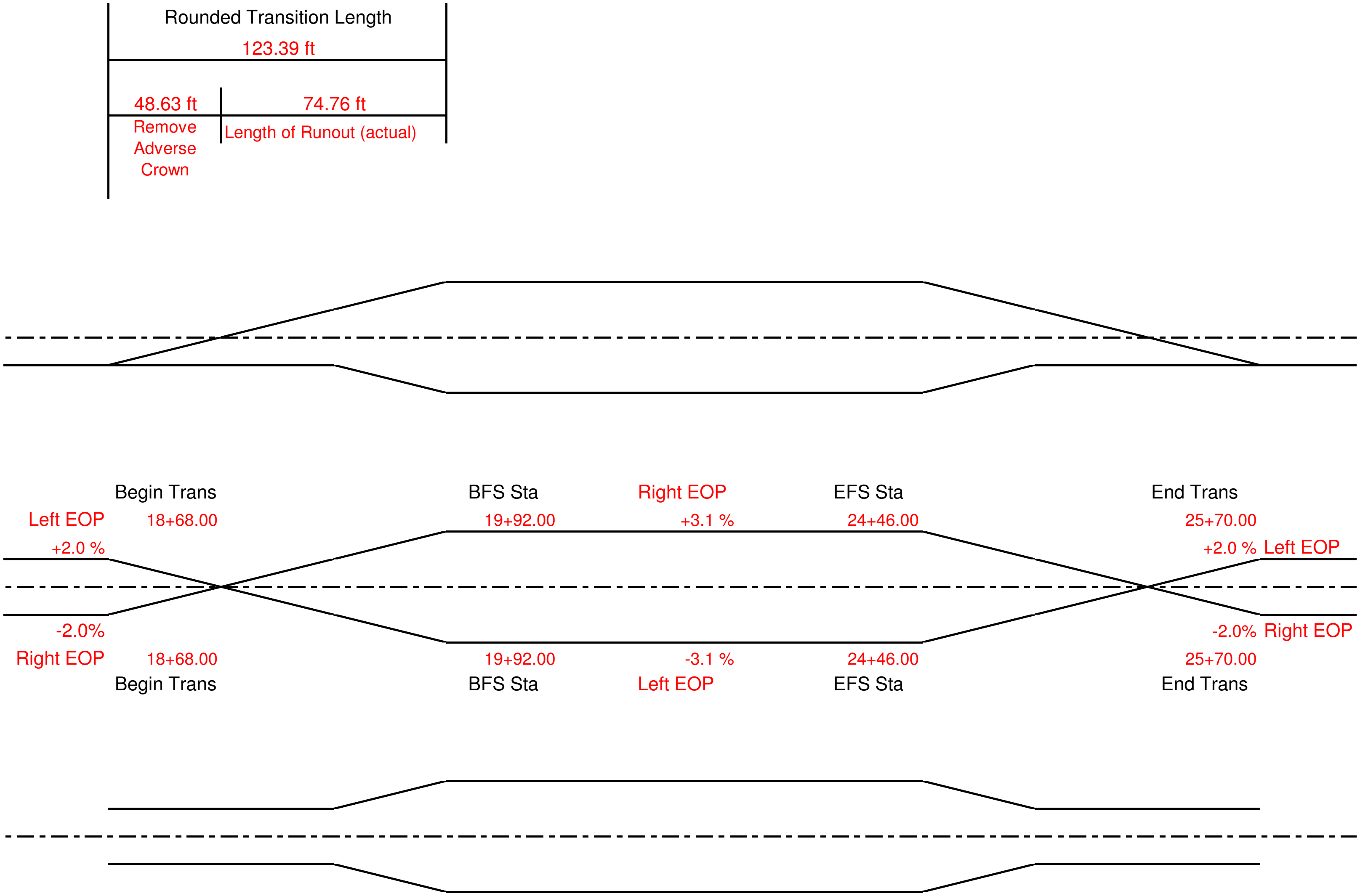
Needed Lr to Fit 45 ft Vert Curve	27.35	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.1%=	123.39	ft	
Rounded to Nearest 0.01 ft	123.39	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	-48.39	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	19+16.83		
Begin Transition Sta	18+68.00		18+68.00
PC Sta	19+76.83		
Begin Full Super	19+92.00		19+92.00
			Use
End Full Super	24+46.00		24+46.00
PT Sta	24+60.65		
End Transiton Sta	25+70.00		25+70.00
Theoretical Point of Intersection (0% Super) Sta	25+21.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

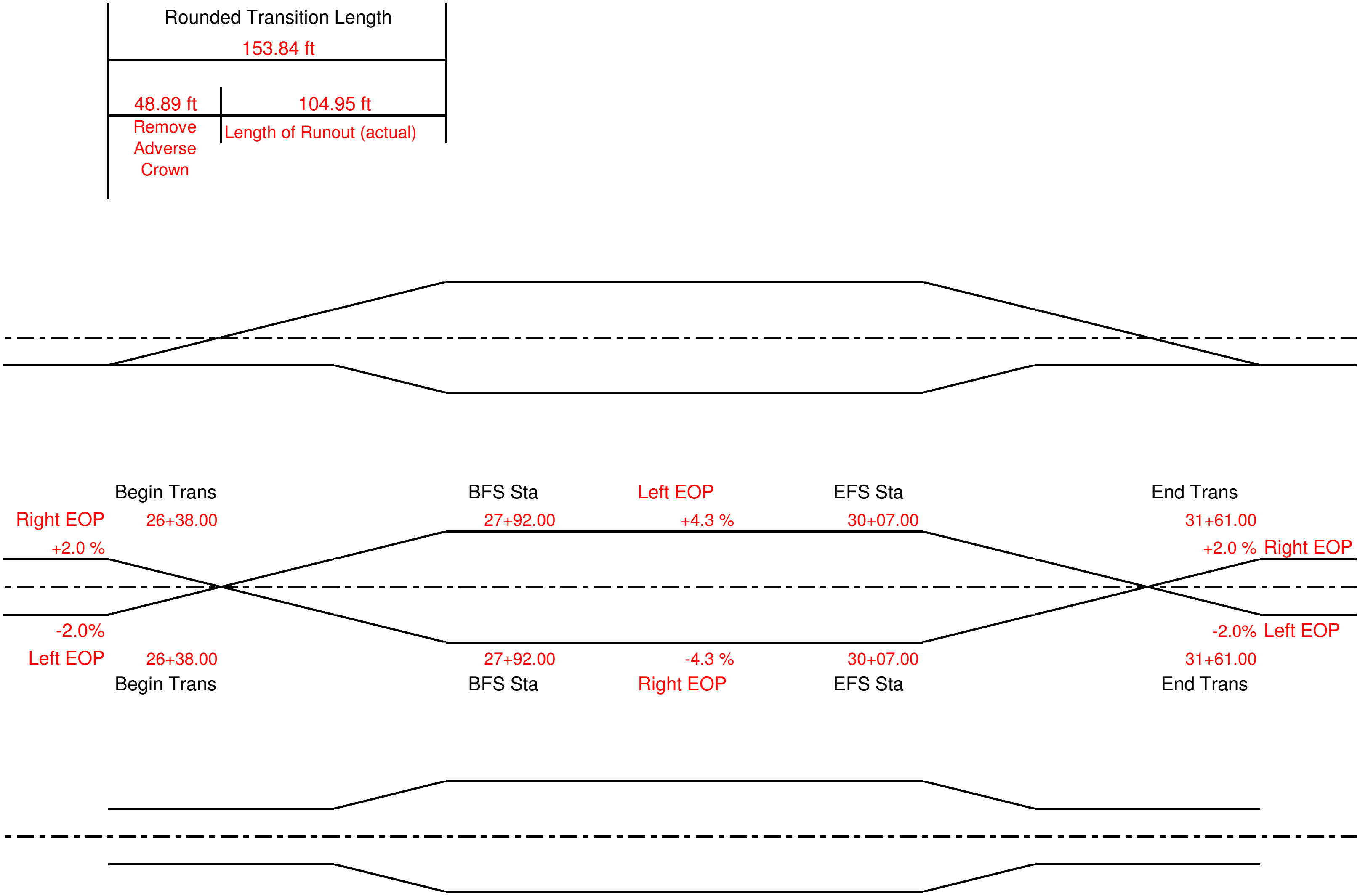
Needed Lr to Fit 45 ft Vert Curve	30.71	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 4.3%=	153.84	ft	
Rounded to Nearest 0.01 ft	153.84	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	-48.84	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	26+87.73		
Begin Transition Sta	26+38.00		26+38.00
PC Sta	27+71.73		
Begin Full Super	27+92.00		27+92.00
			Use
End Full Super	30+07.00		30+07.00
PT Sta	30+28.01		
End Transiton Sta	31+61.00		31+61.00
Theoretical Point of Intersection (0% Super) Sta	31+12.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	712	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	7.8	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	270.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	356	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**270**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

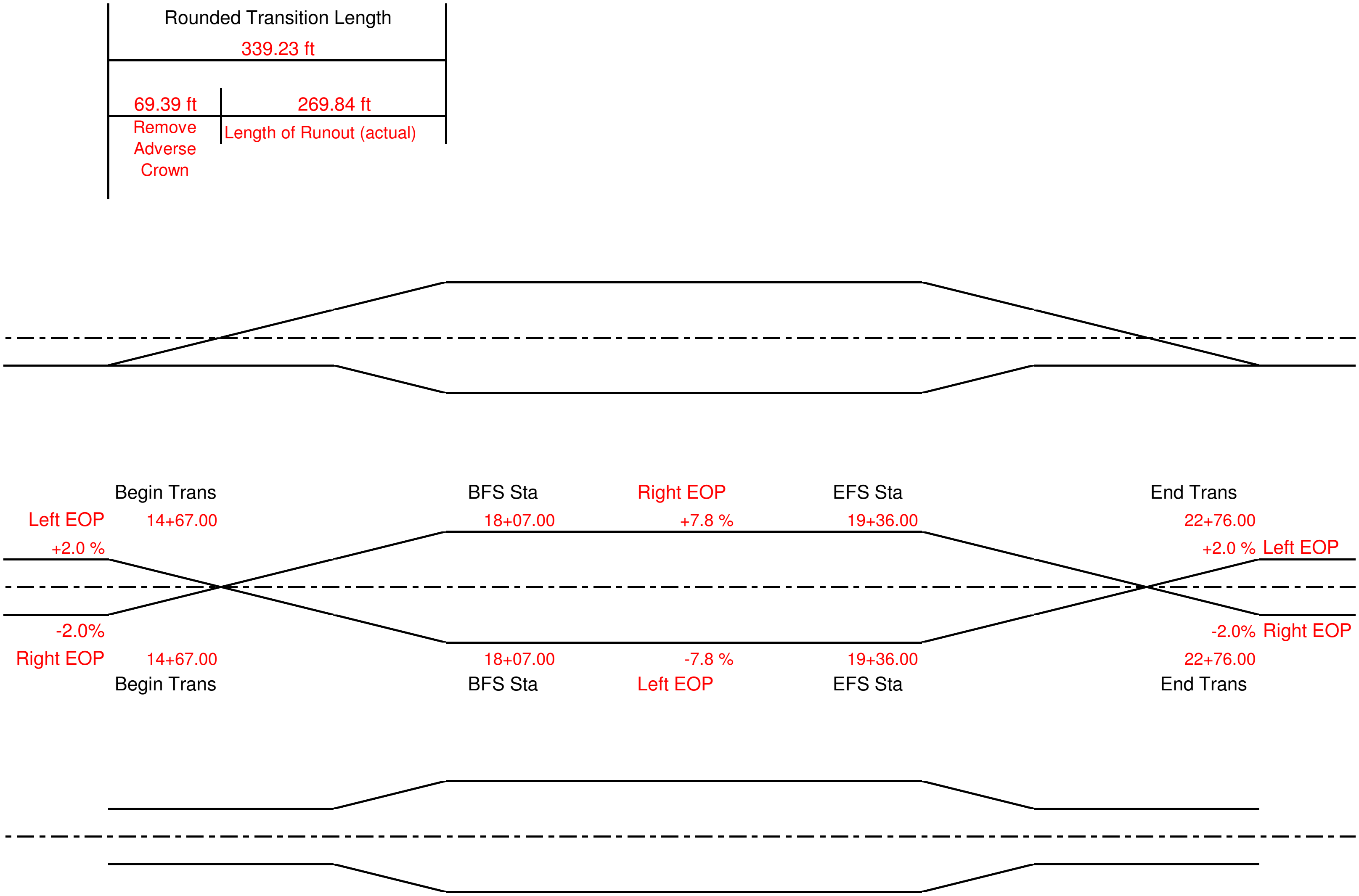
Needed Lr to Fit 45 ft Vert Curve	35.82	ft
Calculated Lr	270.00	ft
Use Calculated Lr	270.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 7.8%=	339.23	ft	
Rounded to Nearest 0.01 ft	339.23	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	243.00	ft	
* Distance from 0 point to Start of Transition	-69.23	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	15+36.91		
Begin Transition Sta	14+67.00		14+67.00
PC Sta	17+79.91		
Begin Full Super	18+07.00		18+07.00
			Use
End Full Super	19+36.00		19+36.00
PT Sta	19+63.67		
End Transiton Sta	22+76.00		22+76.00
Theoretical Point of Intersection (0% Super) Sta	22+06.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	759	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	255.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	368	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**255**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

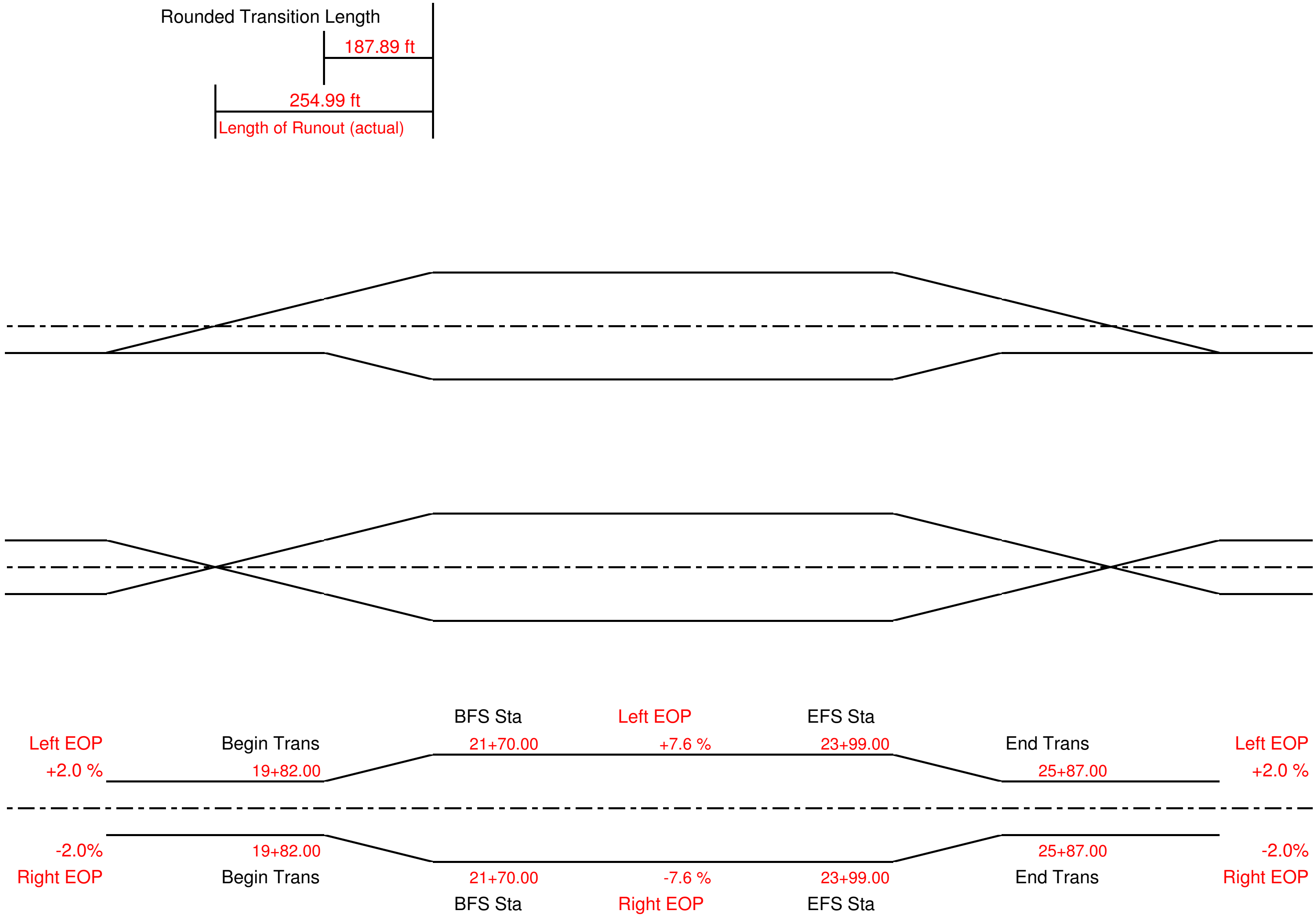
Needed Lr to Fit 45 ft Vert Curve	40.71	ft
Calculated Lr	255.00	ft
Use Calculated Lr	255.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.6%=	187.89	ft	
Rounded to Nearest 0.01 ft	187.89	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	229.50	ft	
* Distance from 0 point to Start of Transition	67.11	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	19+15.09		
Begin Transition Sta	19+82.00		19+82.00
PC Sta	21+44.59		
Begin Full Super	21+70.00		21+70.00
			Use
End Full Super	23+99.00		23+99.00
PT Sta	24+23.68		
End Transiton Sta	25+87.00		25+87.00
Theoretical Point of Intersection (0% Super) Sta	26+54.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1776	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	4.7	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	165.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

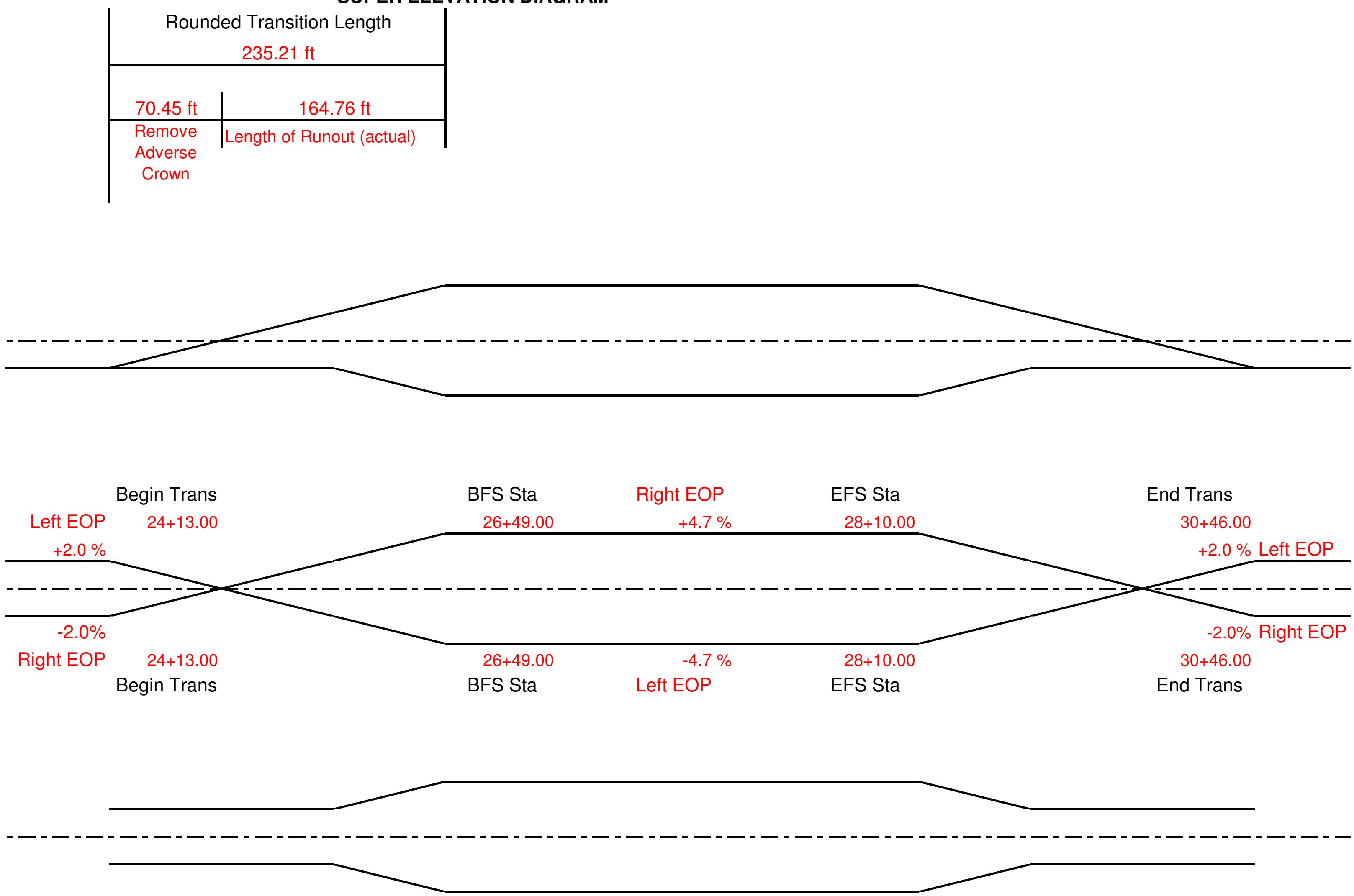
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	31.57	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)?	No		
Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 4.7%=	235.21	ft	
Rounded to Nearest 0.01 ft	235.21	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	148.50	ft	
* Distance from 0 point to Start of Transition	-70.21	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	24+83.98		
Begin Transition Sta	24+13.00		24+13.00
PC Sta	26+32.48		
Begin Full Super	26+49.00		26+49.00
			Use
End Full Super	28+10.00		28+10.00
PT Sta	28+27.22		
End Transiton Sta	30+46.00		30+46.00
Theoretical Point of Intersection (0% Super) Sta	29+75.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1224	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	6.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	210.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

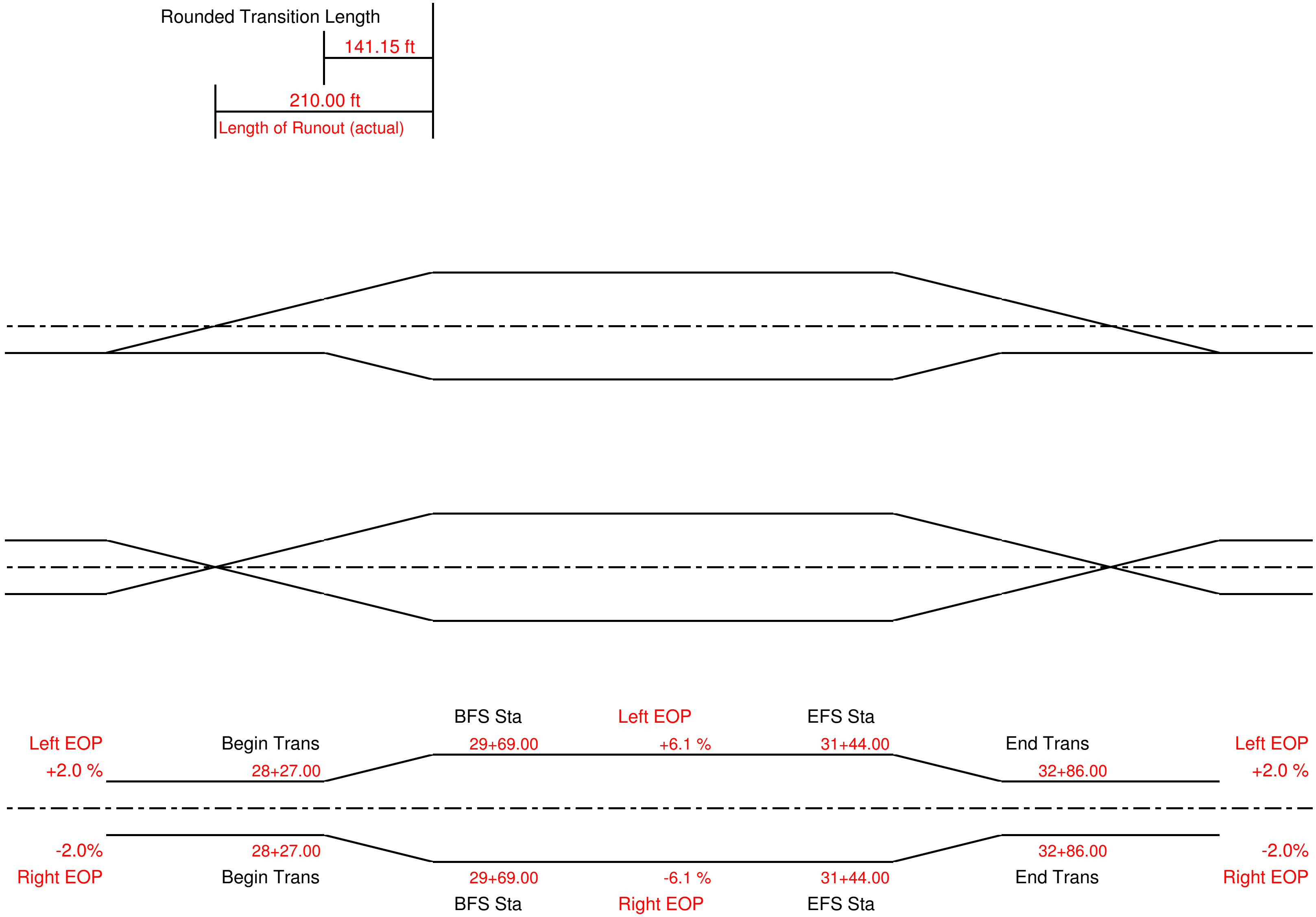
Needed Lr to Fit 45 ft Vert Curve	44.63	ft
Calculated Lr	210.00	ft
Use Calculated Lr	210.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 6.1%=	141.15	ft	
Rounded to Nearest 0.01 ft	141.15	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	189.00	ft	
* Distance from 0 point to Start of Transition	68.85	ft	
Theoretical Point of Intersection (0% Super) Sta	27+58.64		
Begin Transition Sta	28+27.00		28+27.00
PC Sta	29+47.64		
Begin Full Super	29+69.00		29+69.00

		Use
End Full Super	31+44.00	31+44.00
PT Sta	31+65.36	
End Transiton Sta	32+86.00	32+86.00
Theoretical Point of Intersection (0% Super) Sta	33+54.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	800	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.5	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	255.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	378	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**255**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

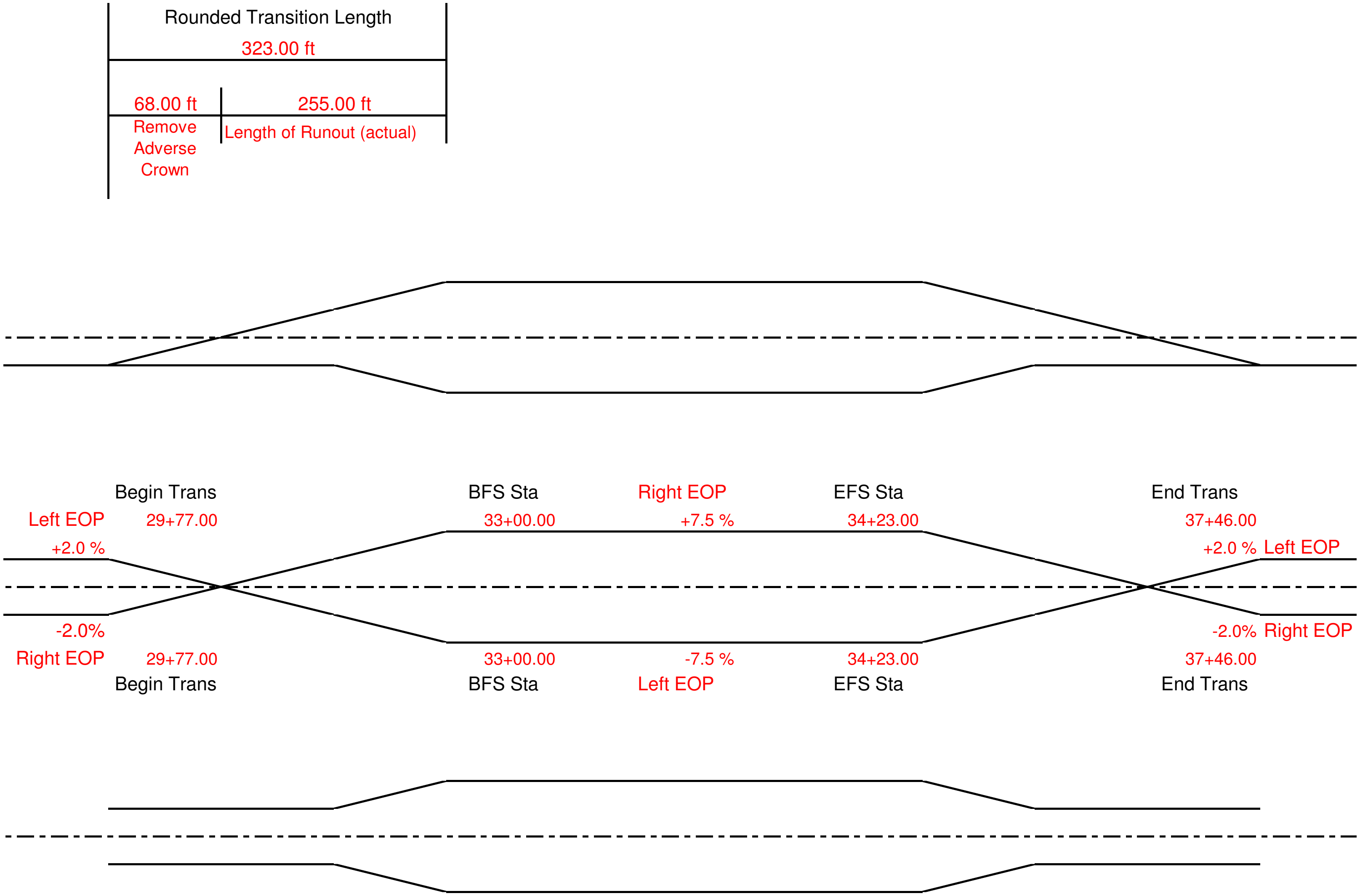
Needed Lr to Fit 45 ft Vert Curve	35.53	ft
Calculated Lr	255.00	ft
Use Calculated Lr	255.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 7.5%=	323.00	ft	
Rounded to Nearest 0.01 ft	323.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	229.50	ft	
* Distance from 0 point to Start of Transition	-68.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	30+45.14		
Begin Transition Sta	29+77.00		29+77.00
PC Sta	32+74.64		
Begin Full Super	33+00.00		33+00.00
			Use
End Full Super	34+23.00		34+23.00
PT Sta	34+48.47		
End Transiton Sta	37+46.00		37+46.00
Theoretical Point of Intersection (0% Super) Sta	36+78.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	3.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

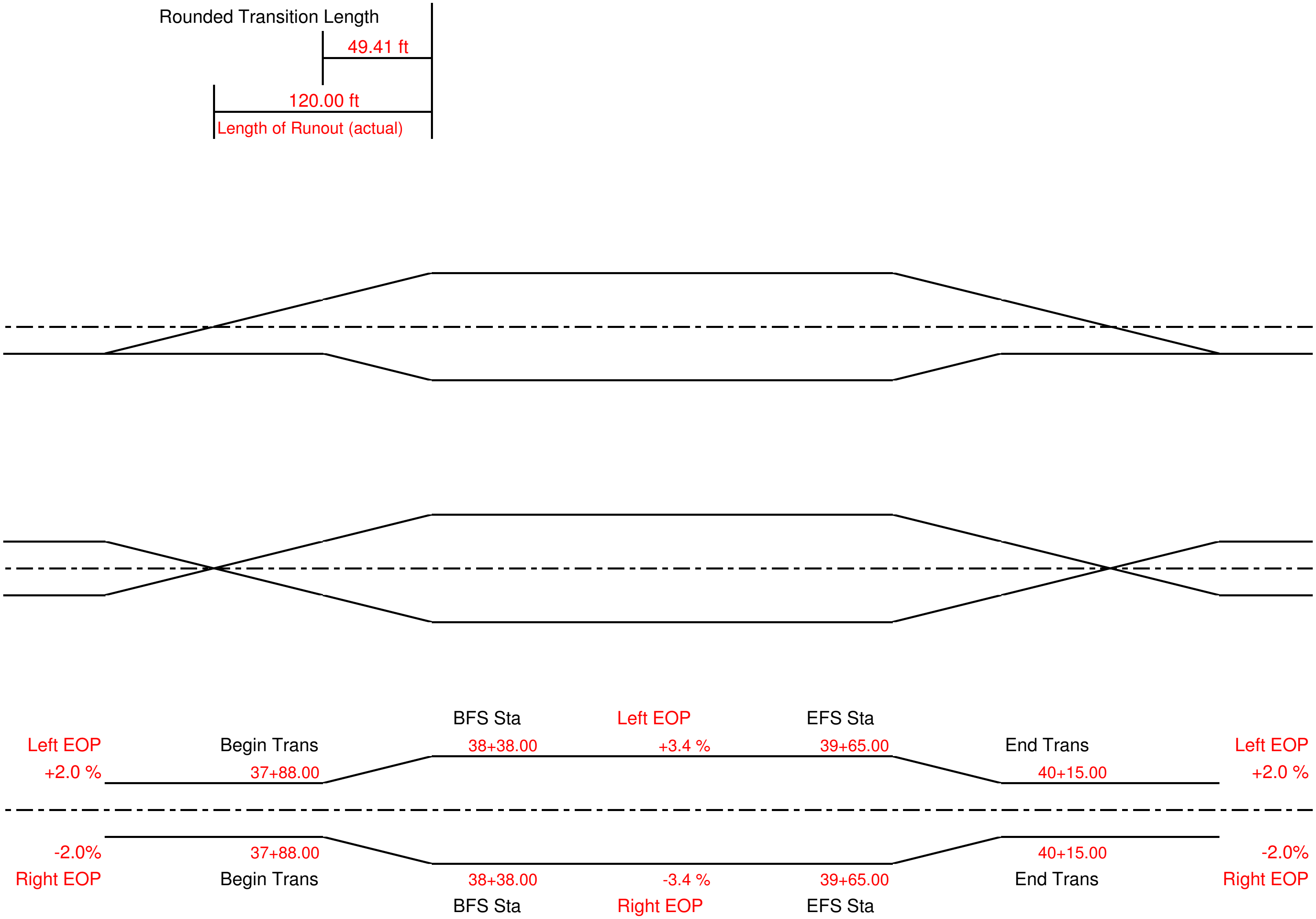
Needed Lr to Fit 45 ft Vert Curve	72.86	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.4%=	49.41	ft	
Rounded to Nearest 0.01 ft	49.41	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	70.59	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	37+18.00		
Begin Transition Sta	37+88.00		37+88.00
PC Sta	38+26.00		
Begin Full Super	38+38.00		38+38.00
			Use
End Full Super	39+65.00		39+65.00
PT Sta	39+76.98		
End Transiton Sta	40+15.00		40+15.00
Theoretical Point of Intersection (0% Super) Sta	40+85.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1840	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	330.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	286	ft
Max Spiral Curve Length	573	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**330**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	40.71	ft
Calculated Lr	330.00	ft
Use Calculated Lr	330.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0 %		
Super Elevation Transition Length from 2%to 7.6%=	243.16 ft		
Rounded to Nearest 0.01 ft	243.16 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	264.00 ft		
* Distance from 0 point to Start of Transition	86.84 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	41+43.77		
Begin Transition Sta	42+30.00	42+30.00	
PC Sta	44+07.77		
Begin Full Super	44+74.00	44+74.00	
		Use	
End Full Super	46+97.00	46+97.00	
PT Sta	47+63.17		
End Transiton Sta	49+41.00	49+41.00	
Theoretical Point of Intersection (0% Super) Sta	50+27.00		

CA Group

Job No. 0199

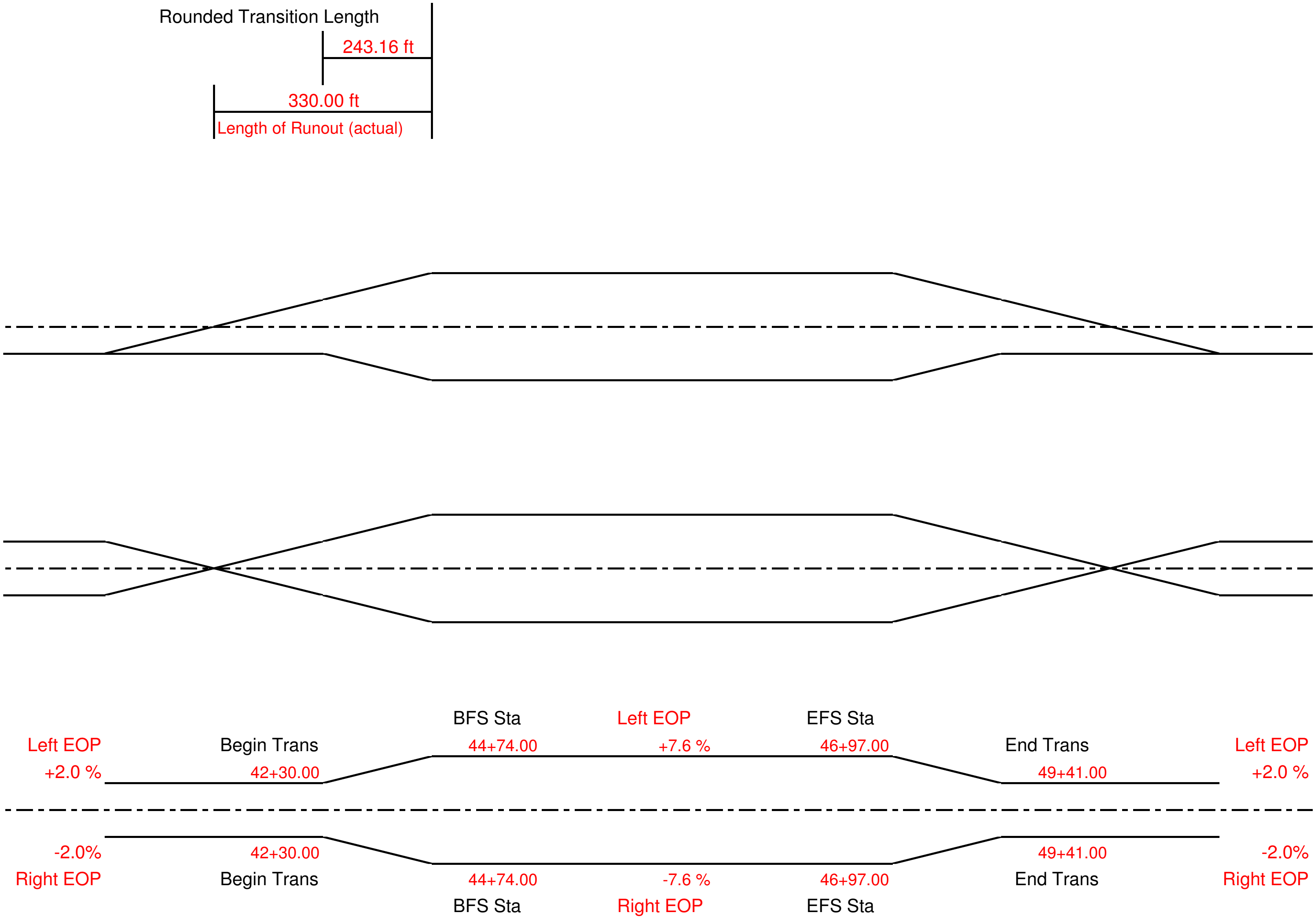
Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"W"-7

Sheet No. 122 of 136

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1840	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	330.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	286	ft
Max Spiral Curve Length	573	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**330**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

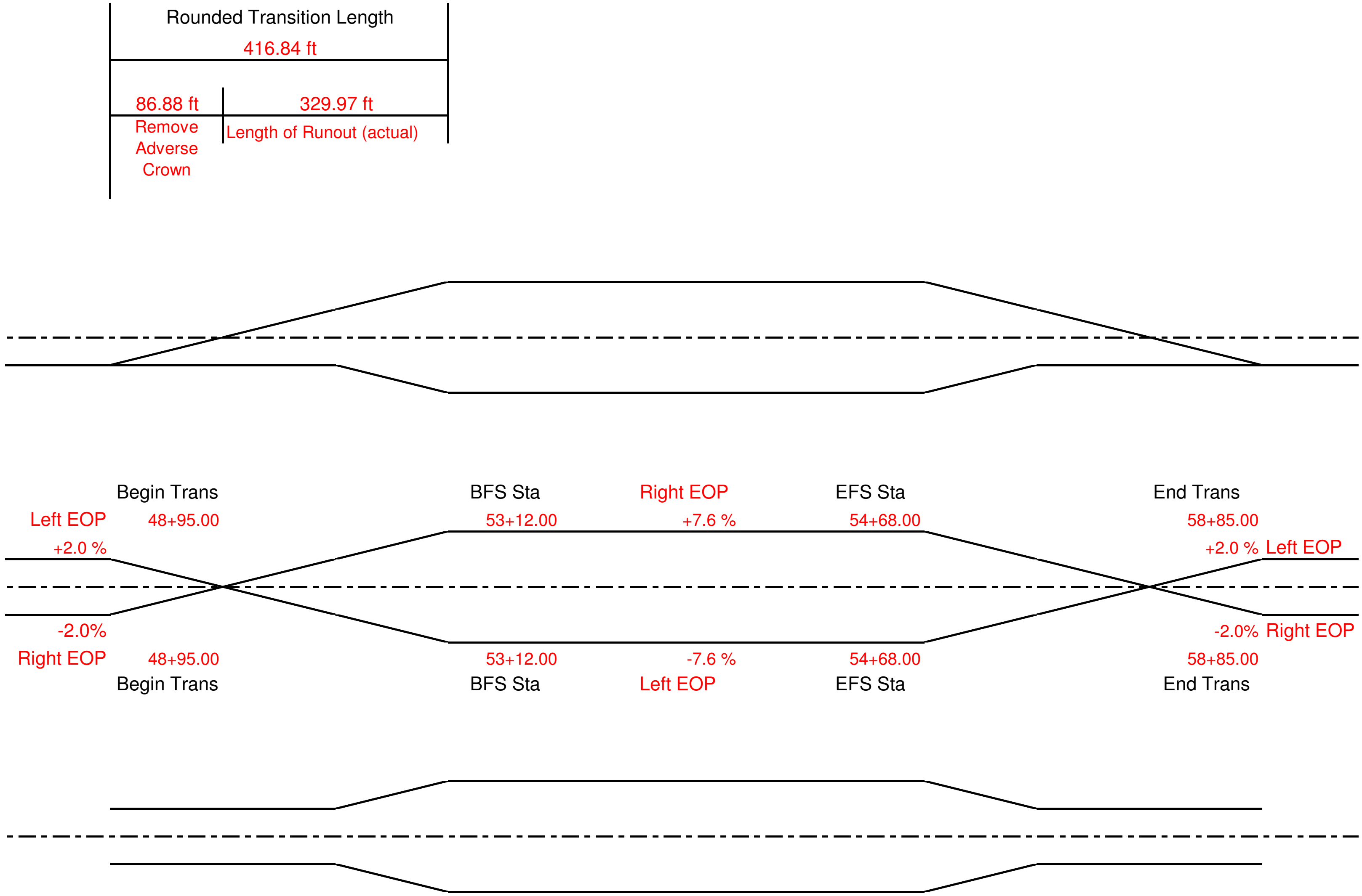
Needed Lr to Fit 65 ft Vert Curve	51.46	ft
Calculated Lr	330.00	ft
Use Calculated Lr	330.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 7.6%=	416.84	ft	
Rounded to Nearest 0.01 ft	416.84	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	264.00	ft	
* Distance from 0 point to Start of Transition	-86.84	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	49+82.50		
Begin Transition Sta	48+95.00		48+95.00
PC Sta	52+46.50		
Begin Full Super	53+12.00		53+12.00
			Use
End Full Super	54+68.00		54+68.00
PT Sta	55+33.92		
End Transiton Sta	58+85.00		58+85.00
Theoretical Point of Intersection (0% Super) Sta	57+98.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1753	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	165.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

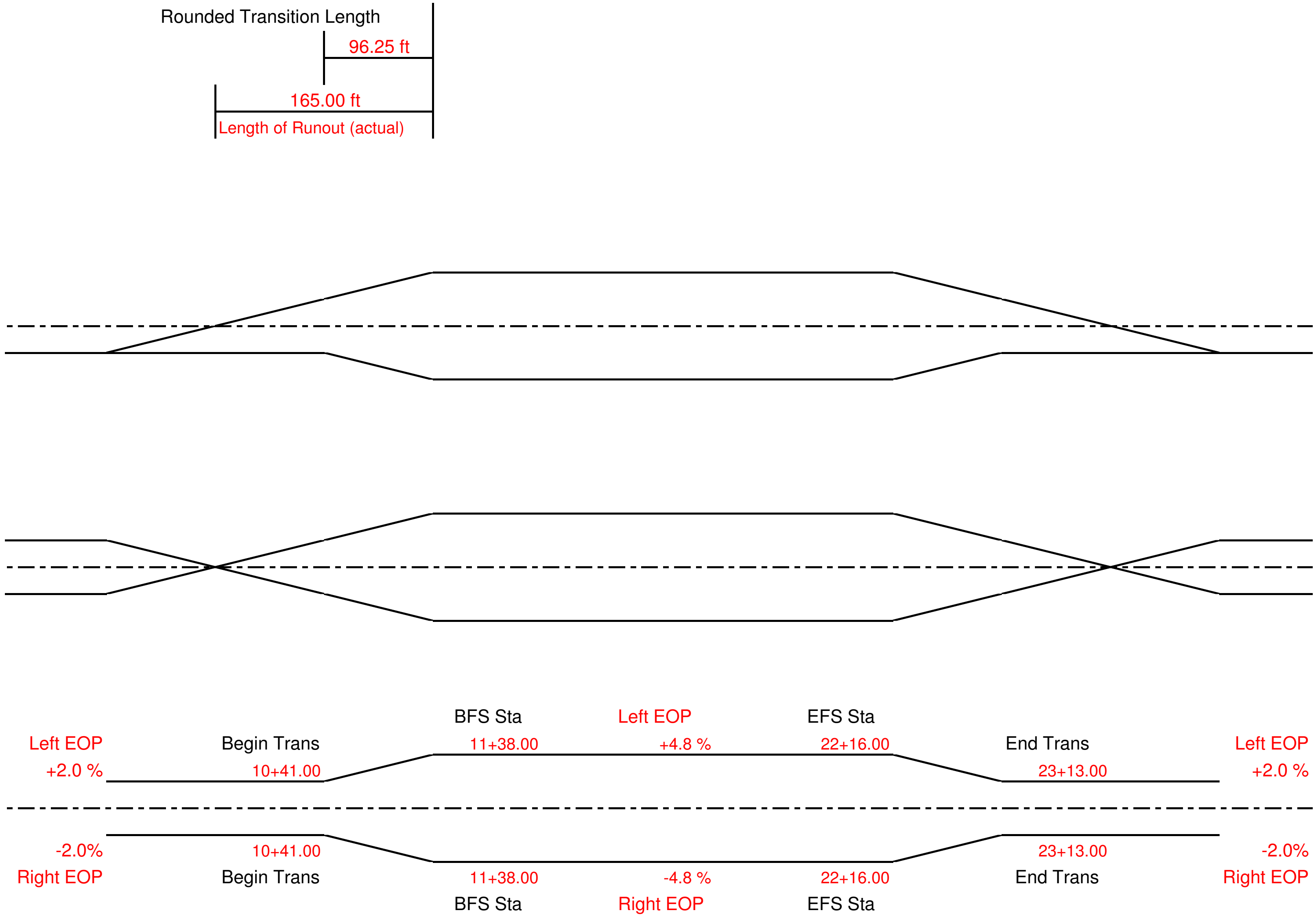
Needed Lr to Fit 45 ft Vert Curve	51.43	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.8%=	96.25	ft	
Rounded to Nearest 0.01 ft	96.25	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	148.50	ft	
* Distance from 0 point to Start of Transition	68.75	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+73.03		
Begin Transition Sta	10+41.00		10+41.00
PC Sta	11+21.53		
Begin Full Super	11+38.00		11+38.00
			Use
End Full Super	22+16.00		22+16.00
PT Sta	22+32.42		
End Transiton Sta	23+13.00		23+13.00
Theoretical Point of Intersection (0% Super) Sta	23+81.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1753	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.7	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	165.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	52.22	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.7%=	94.79	ft	
Rounded to Nearest 0.01 ft	94.79	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	148.50	ft	
* Distance from 0 point to Start of Transition	70.21	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	20+83.92		
Begin Transition Sta	21+54.00		21+54.00
PC Sta	22+32.42		
Begin Full Super	22+49.00		22+49.00
			Use
End Full Super	27+71.00		27+71.00
PT Sta	27+86.95		
End Transiton Sta	28+66.00		28+66.00
Theoretical Point of Intersection (0% Super) Sta	29+36.00		

CA Group

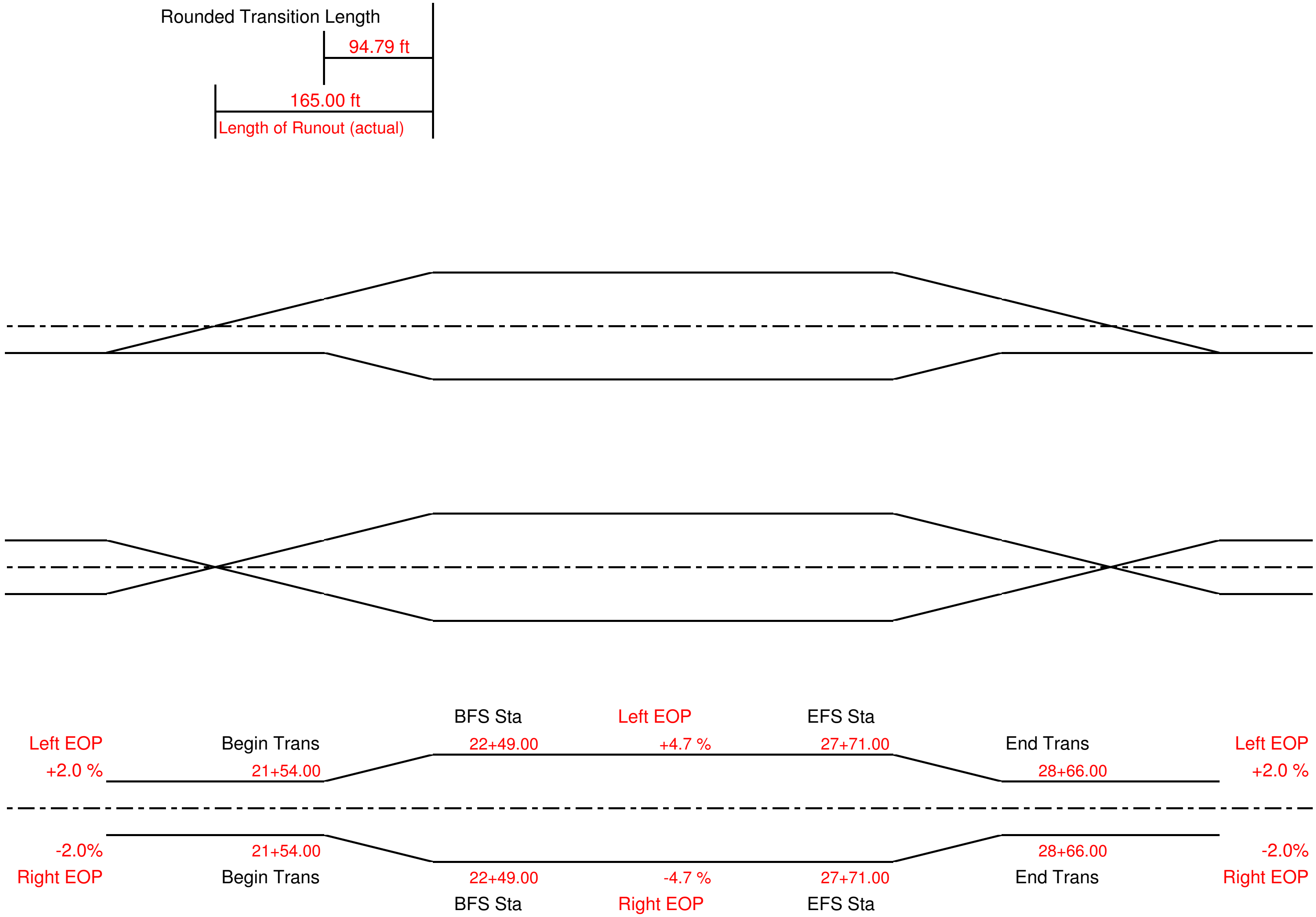
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"WN"-2

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2665	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	3.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	90.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

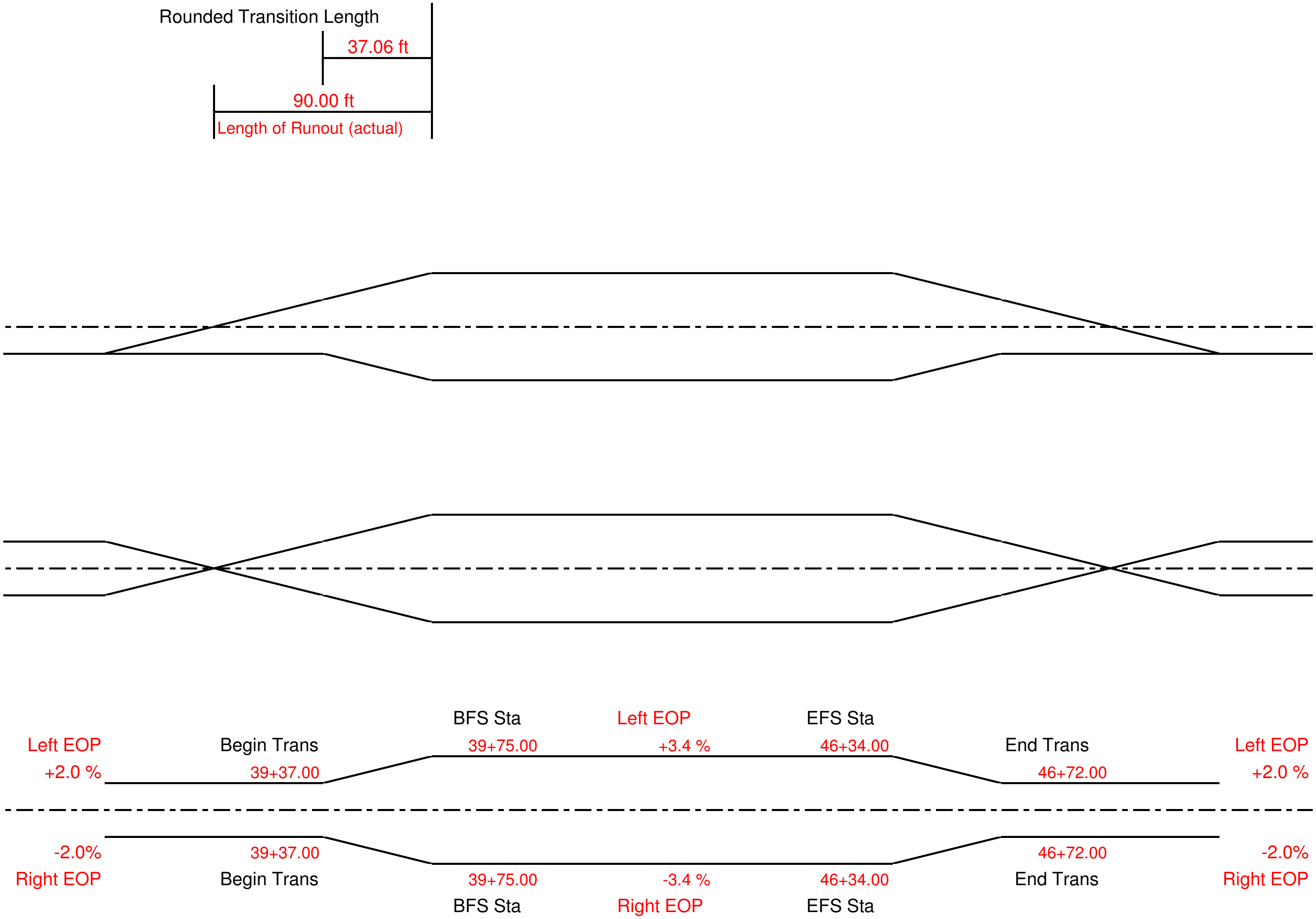
Needed Lr to Fit 45 ft Vert Curve	72.86	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.4%=	37.06	ft	
Rounded to Nearest 0.01 ft	37.06	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	52.94	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	38+84.57		
Begin Transition Sta	39+37.00		39+37.00
PC Sta	39+56.57		
Begin Full Super	39+75.00		39+75.00
			Use
End Full Super	46+34.00		46+34.00
PT Sta	46+52.00		
End Transiton Sta	46+72.00		46+72.00
Theoretical Point of Intersection (0% Super) Sta	47+24.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2300	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	3.9	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	90.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

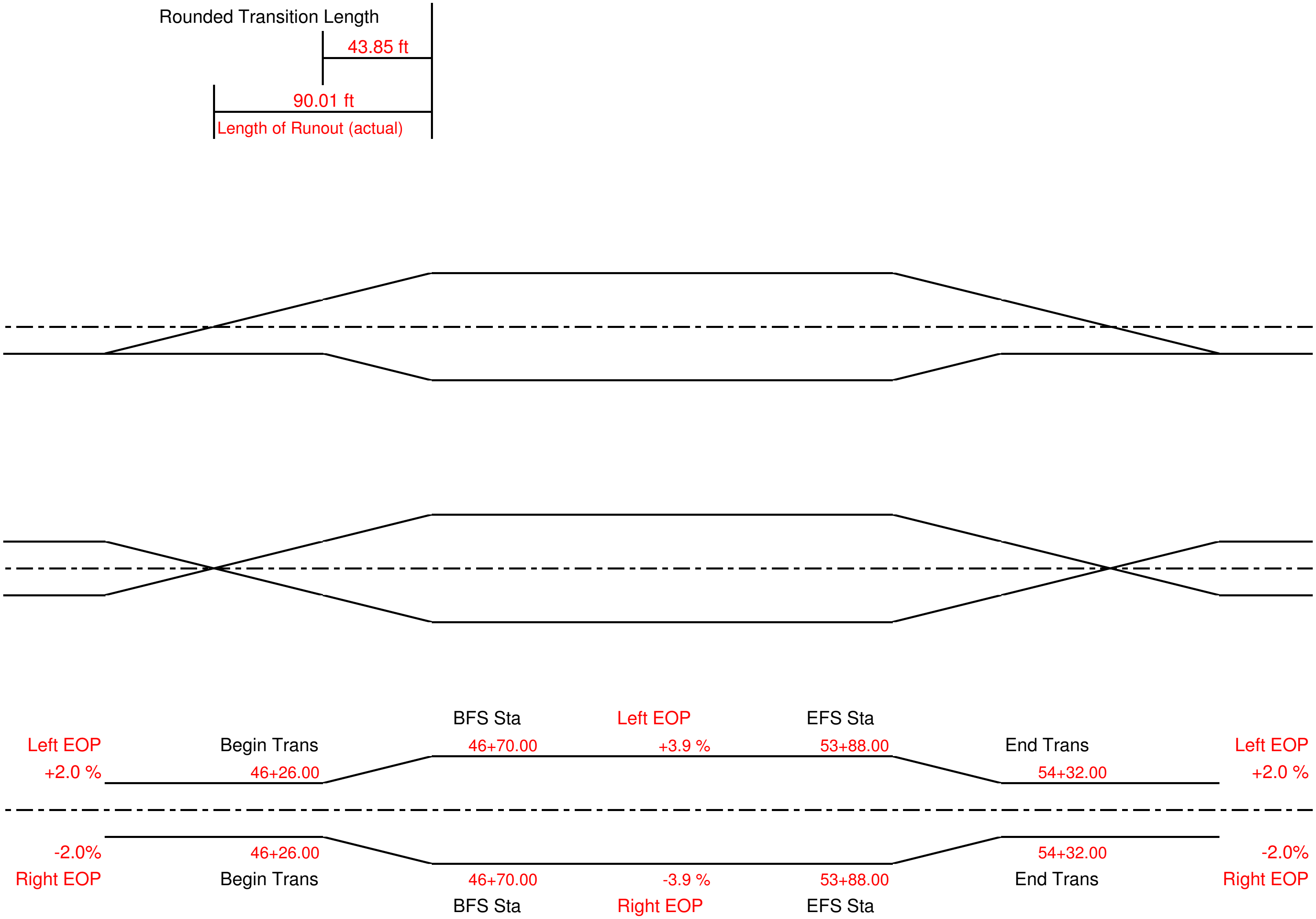
Needed Lr to Fit 45 ft Vert Curve	61.58	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.9%=	43.85	ft	
Rounded to Nearest 0.01 ft	43.85	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	46.15	ft	
Theoretical Point of Intersection (0% Super) Sta	45+80.20		
Begin Transition Sta	46+26.00		46+26.00
PC Sta	46+52.20		
Begin Full Super	46+70.00		46+70.00

		Use
End Full Super	53+88.00	53+88.00
PT Sta	54+05.75	
End Transiton Sta	54+32.00	54+32.00
Theoretical Point of Intersection (0% Super) Sta	54+78.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	304	ft
Design Speed	25	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	6.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.70	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	120.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	73	ft
Max Spiral Curve Length	155	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**120**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 25 ft Vert Curve	58.60	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 6.3%=	81.90	ft	
Rounded to Nearest 0.01 ft	81.90	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	96.00	ft	
* Distance from 0 point to Start of Transition	38.10	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+04.00		
Begin Transition Sta	9+42.00		9+42.00
PC Sta	10+00.00		
Begin Full Super	10+24.00		10+24.00
			Use
End Full Super	18+65.00		18+65.00
PT Sta	18+88.99		
End Transiton Sta	19+47.00		19+47.00
Theoretical Point of Intersection (0% Super) Sta	19+85.00		

CA Group

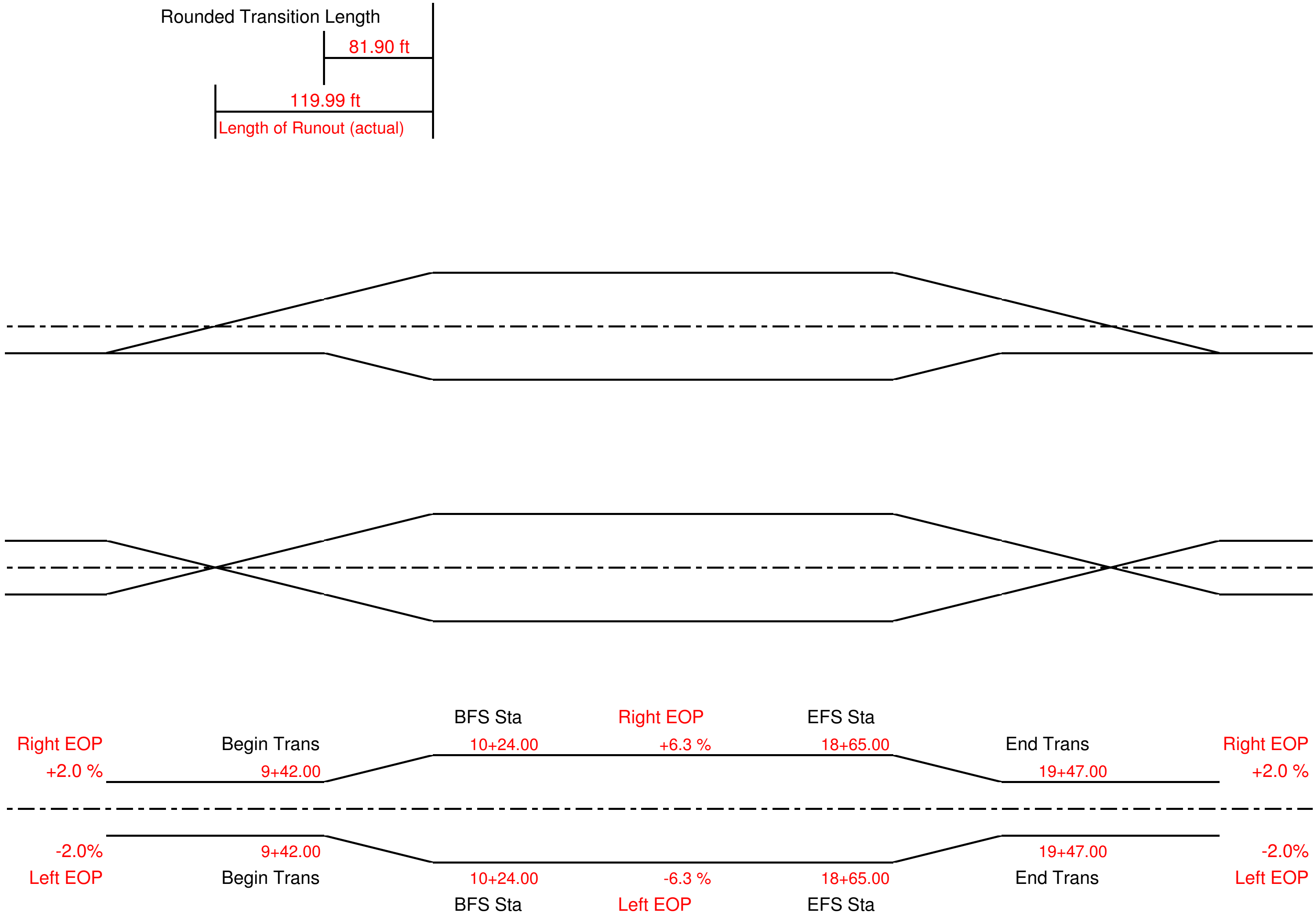
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"WS"-1

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	588	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	180.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	132	ft
Max Spiral Curve Length	216	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**180**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	36.00	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 8%=	225.00	ft	
Rounded to Nearest 0.01 ft	225.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	144.00	ft	
* Distance from 0 point to Start of Transition	-45.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	19+41.63		
Begin Transition Sta	18+96.00		18+96.00
PC Sta	20+85.63		
Begin Full Super	21+21.00		21+21.00
			Use
End Full Super	24+49.00		24+49.00
PT Sta	24+84.24		
End Transiton Sta	26+74.00		26+74.00
Theoretical Point of Intersection (0% Super) Sta	26+29.00		

CA Group

Job No. 0199

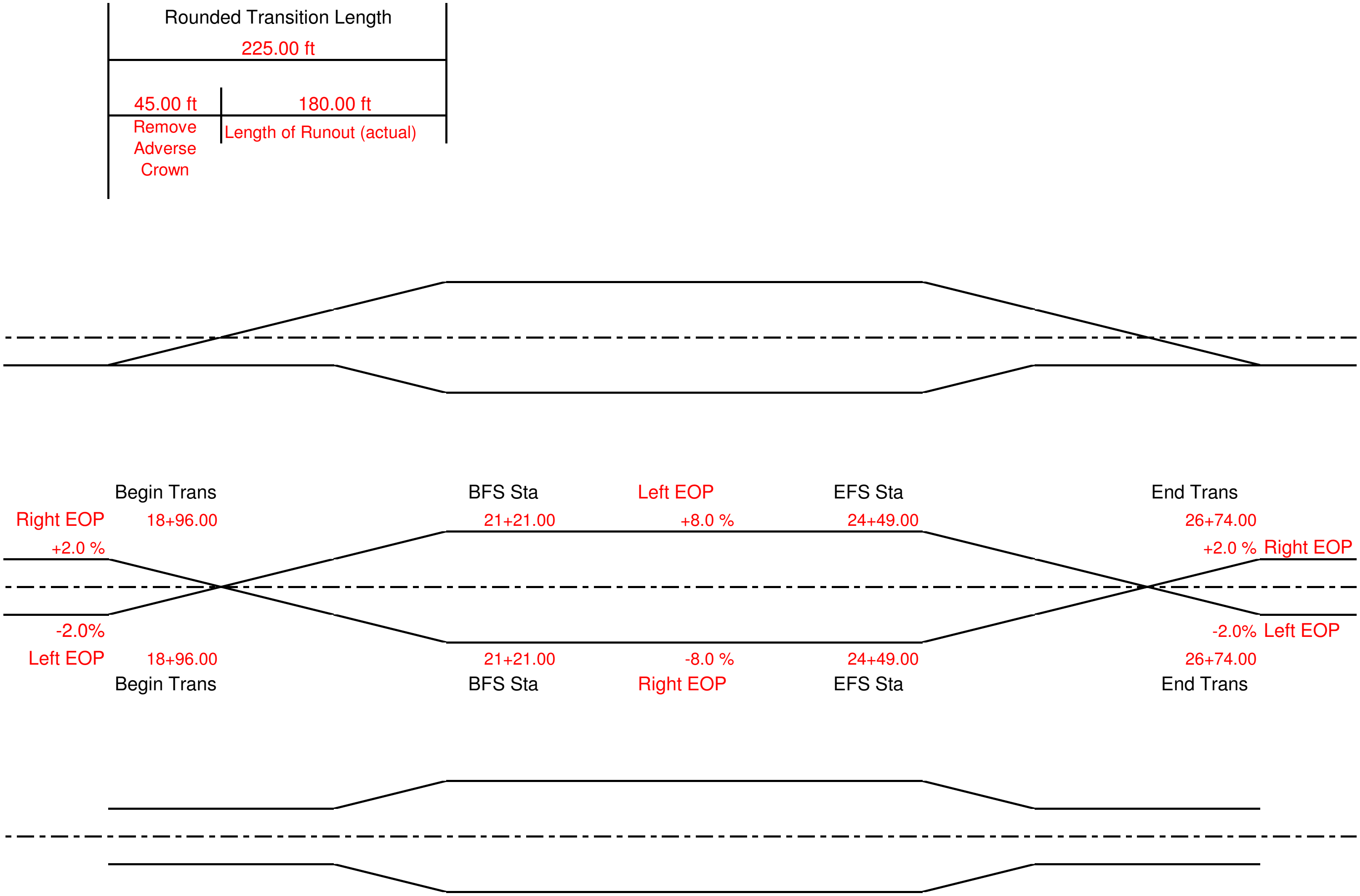
Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Super Elevation Transition Length v3.xlsx
"WS"-2

Sheet No. 136 of 136

SUPER ELEVATION DIAGRAM



Appendix 8

Option 3 Superelevation Diagrams

SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1275	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	5.9	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	135.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

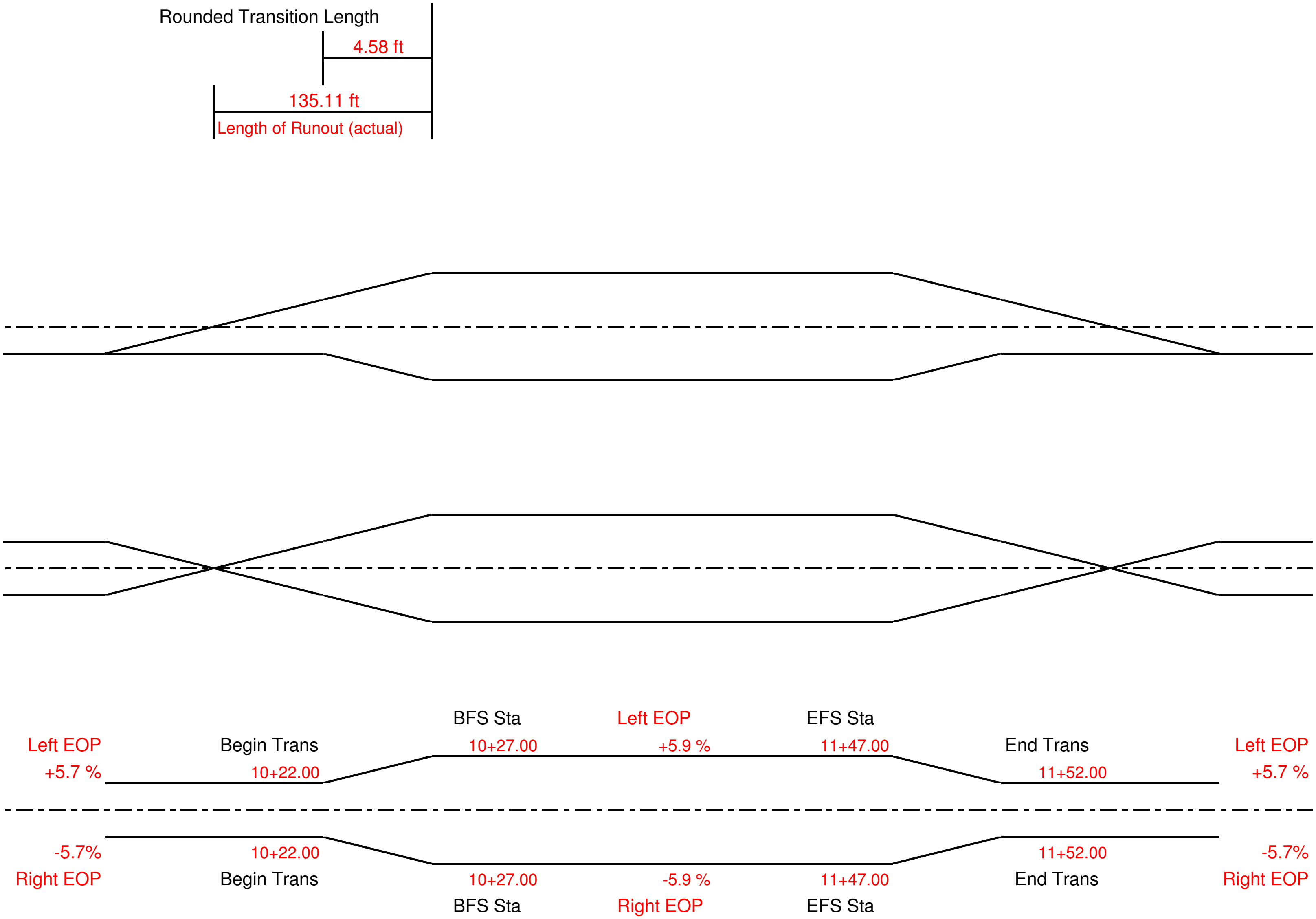
Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Left EOP Begin Transition Cross Slope (pos or neg)	5.7	%	
Super Elevation Transition Length from 5.7%to 5.9%=	4.58	ft	
Rounded to Nearest 0.01 ft	4.58	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	130.42	ft	
Theoretical Point of Intersection (0% Super) Sta	8+92.00		
Begin Transition Sta	10+22.00		10+22.00
PC Sta	10+00.00		
Begin Full Super	10+27.00		10+27.00

		Use
End Full Super	11+47.00	11+47.00
PT Sta	11+73.83	
End Transiton Sta	11+52.00	11+52.00
Theoretical Point of Intersection (0% Super) Sta	12+82.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	3.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

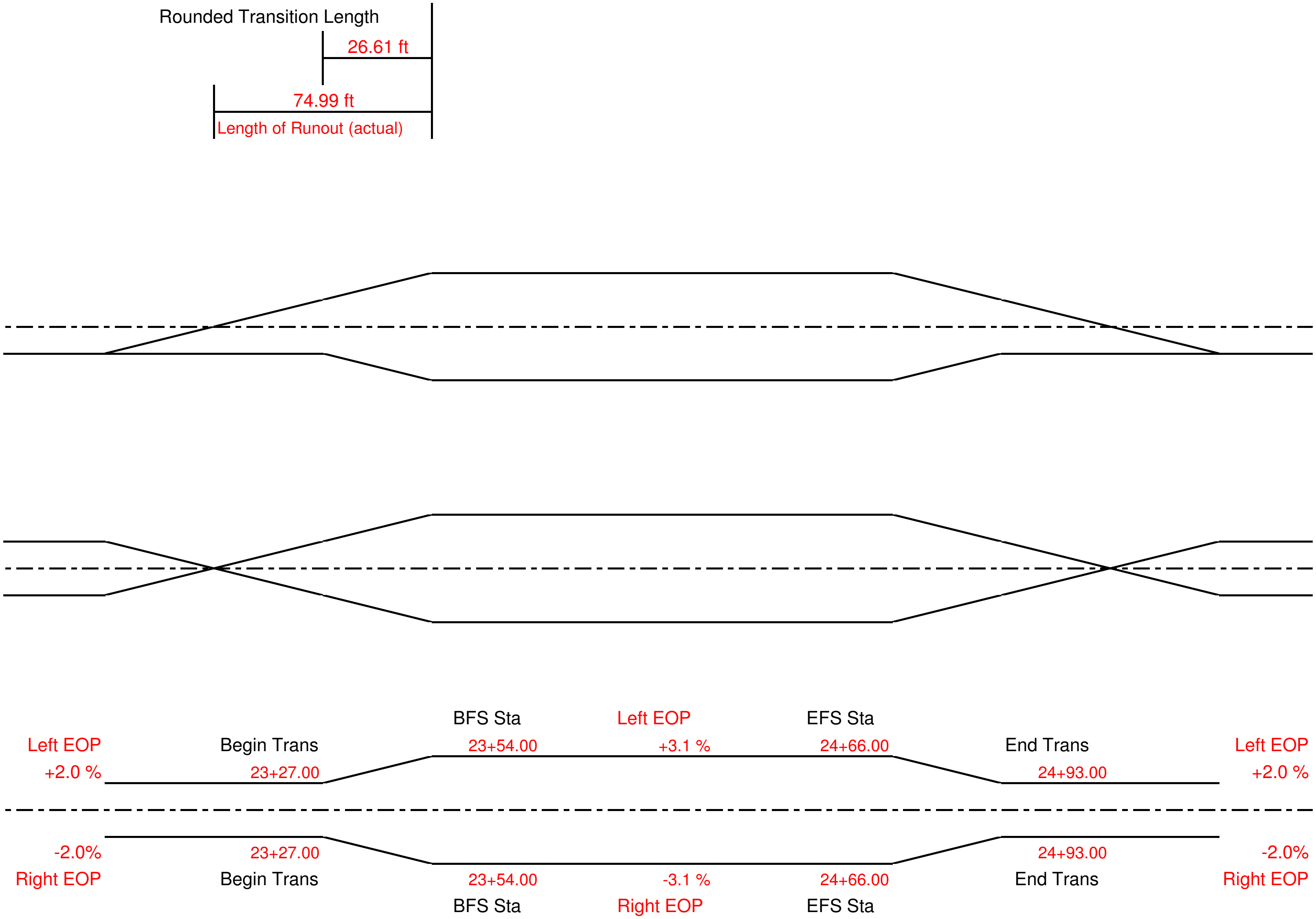
Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.1%=	26.61	ft	
Rounded to Nearest 0.01 ft	26.61	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	48.39	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	22+79.03		
Begin Transition Sta	23+27.00		23+27.00
PC Sta	23+39.03		
Begin Full Super	23+54.00		23+54.00
			Use
End Full Super	24+66.00		24+66.00
PT Sta	24+80.62		
End Transiton Sta	24+93.00		24+93.00
Theoretical Point of Intersection (0% Super) Sta	25+41.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	8000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	45.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

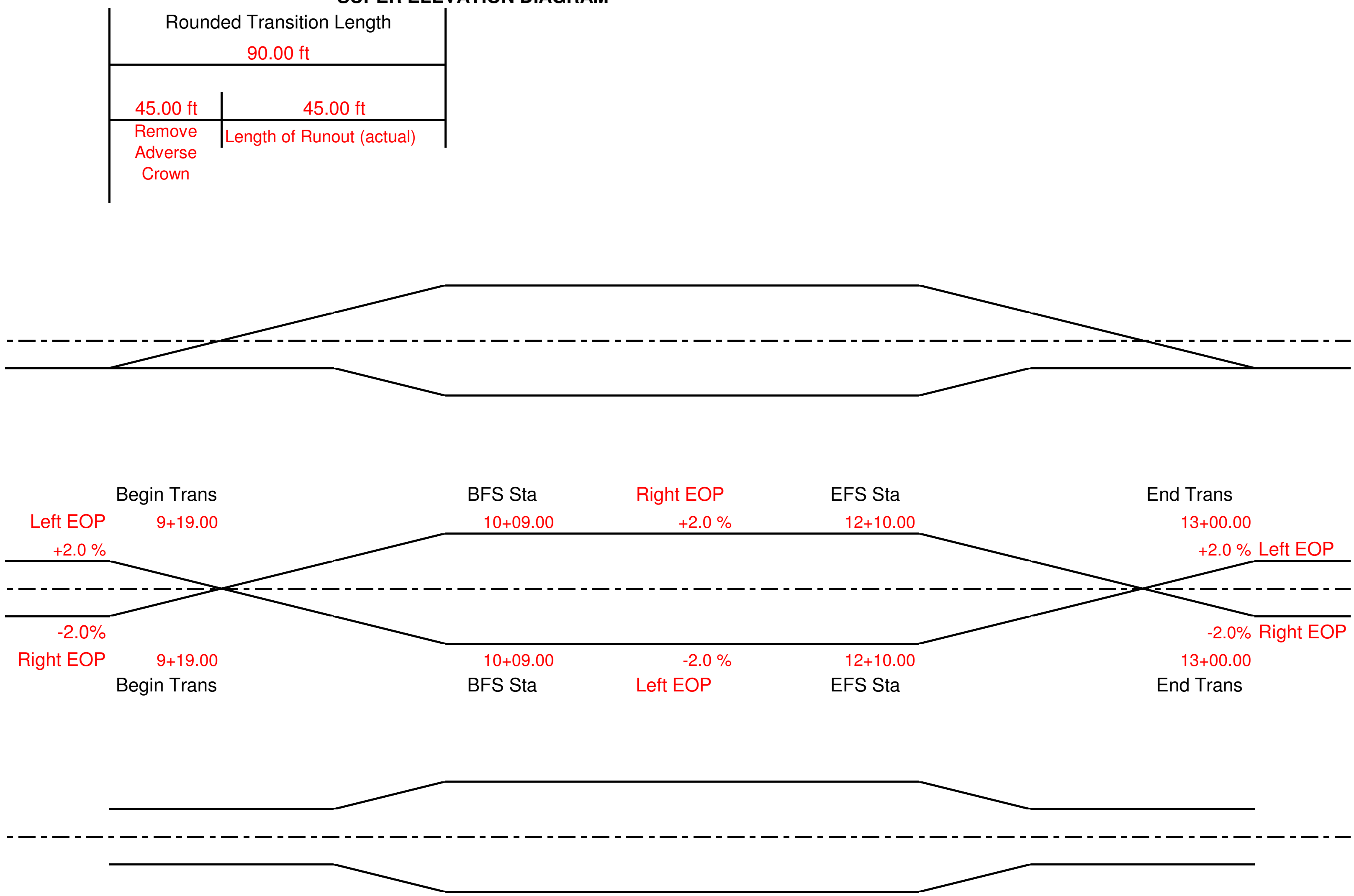
Needed Lr to Fit 45 ft Vert Curve	22.50	ft
Calculated Lr	45.00	ft
Use Calculated Lr	45.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	90.00	ft	
Rounded to Nearest 0.01 ft	90.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	36.00	ft	
* Distance from 0 point to Start of Transition	-45.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+64.00		
Begin Transition Sta	9+19.00		9+19.00
PC Sta	10+00.00		
Begin Full Super	10+09.00		10+09.00
			Use
End Full Super	12+10.00		12+10.00
PT Sta	12+18.02		
End Transiton Sta	13+00.00		13+00.00
Theoretical Point of Intersection (0% Super) Sta	12+55.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

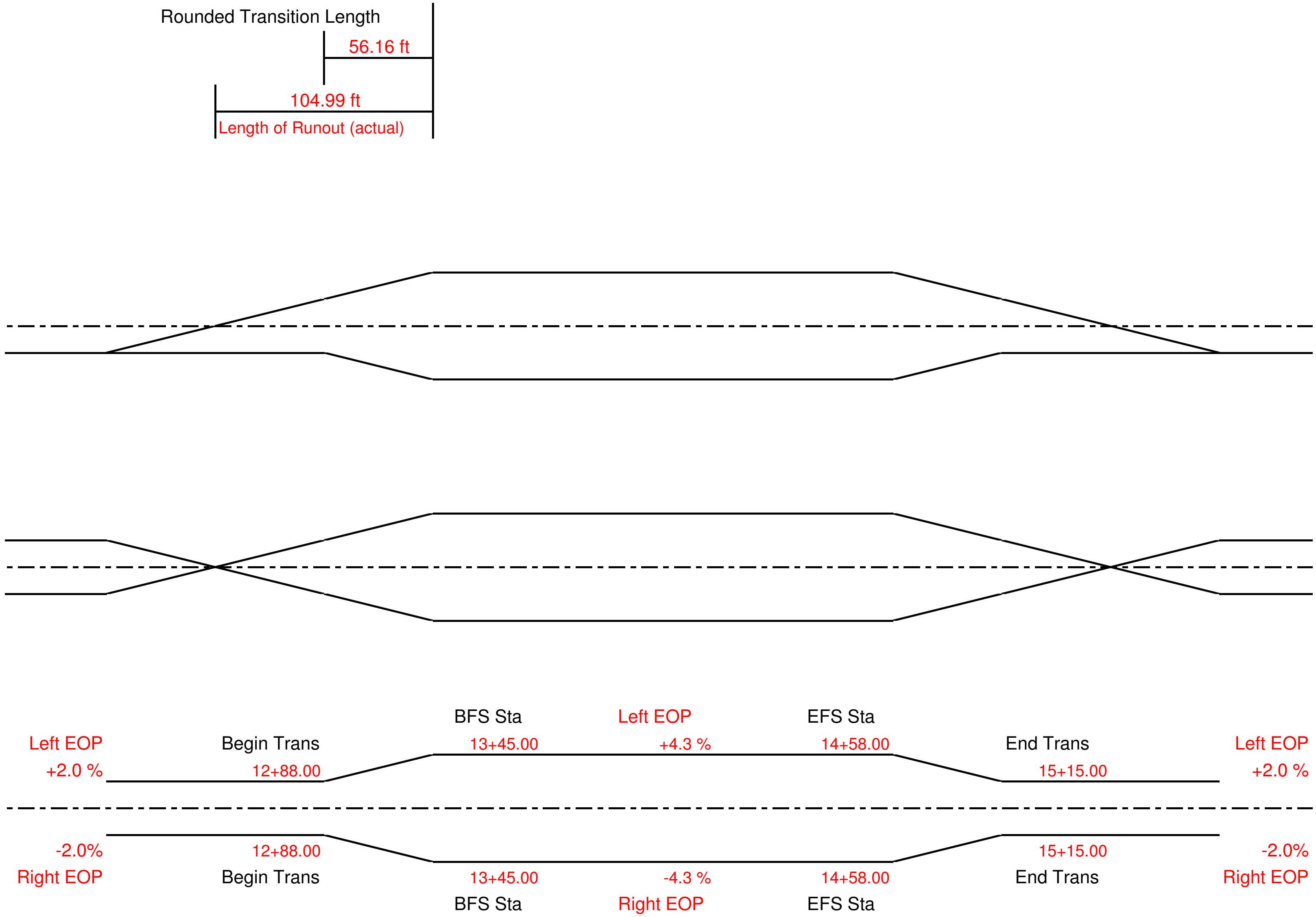
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	56.16	ft	
Rounded to Nearest 0.01 ft	56.16	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	48.84	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	12+39.90		
Begin Transition Sta	12+88.00		12+88.00
PC Sta	13+23.90		
Begin Full Super	13+45.00		13+45.00

		Use
End Full Super	14+58.00	14+58.00
PT Sta	14+79.62	
End Transiton Sta	15+15.00	15+15.00
Theoretical Point of Intersection (0% Super) Sta	15+63.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4441	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	2.2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	60.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

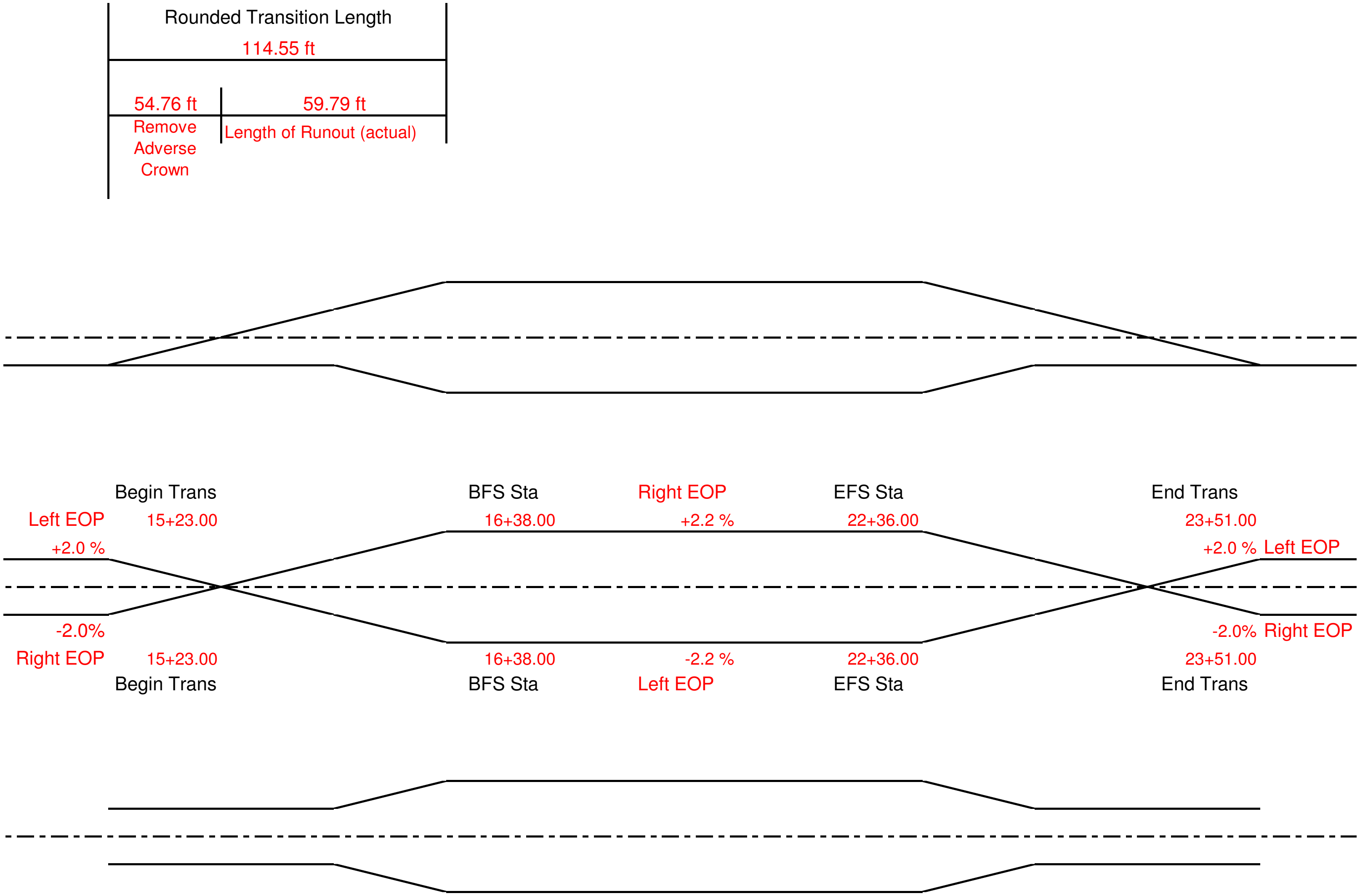
Needed Lr to Fit 45 ft Vert Curve	23.57	ft
Calculated Lr	60.00	ft
Use Calculated Lr	60.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.2%=	114.55	ft	
Rounded to Nearest 0.01 ft	114.55	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	48.00	ft	
* Distance from 0 point to Start of Transition	-54.55	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	15+77.58		
Begin Transition Sta	15+23.00		15+23.00
PC Sta	16+25.58		
Begin Full Super	16+38.00		16+38.00
			Use
End Full Super	22+36.00		22+36.00
PT Sta	22+47.97		
End Transiton Sta	23+51.00		23+51.00
Theoretical Point of Intersection (0% Super) Sta	22+96.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	4982	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	3	
Design Super (e_d) positive value	3.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.43	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	210.00	ft
Spiral Curves Recommended Check	No	

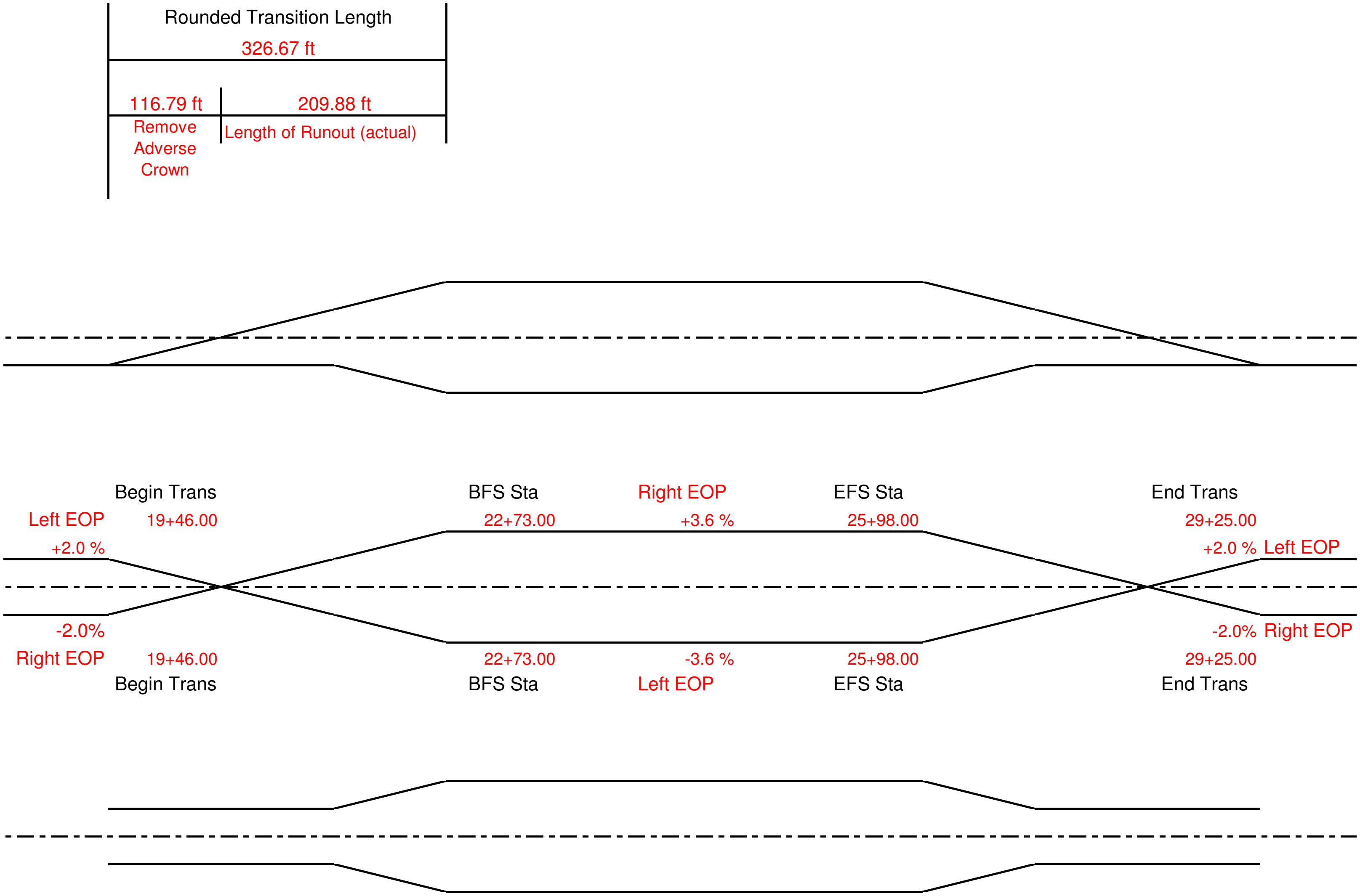
Right EOP Begin Transition Cross Slope (pos or neg)	-2.0 %		
Super Elevation Transition Length from -2%to 3.6%=	326.67 ft		
Rounded to Nearest 0.01 ft	326.67 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	178.50 ft		
* Distance from 0 point to Start of Transition	-116.67 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	20+63.24		
Begin Transition Sta	19+46.00	19+46.00	
PC Sta	22+41.74		
Begin Full Super	22+73.00	22+73.00	
		Use	
End Full Super	25+98.00	25+98.00	
PT Sta	26+29.70		
End Transiton Sta	29+25.00	29+25.00	
Theoretical Point of Intersection (0% Super) Sta	28+08.00		

Design Speed Rounding Curve Length 0

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	41.79	ft
Calculated Lr	210.00	ft
Use Calculated Lr	210.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4988	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	3.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.43	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

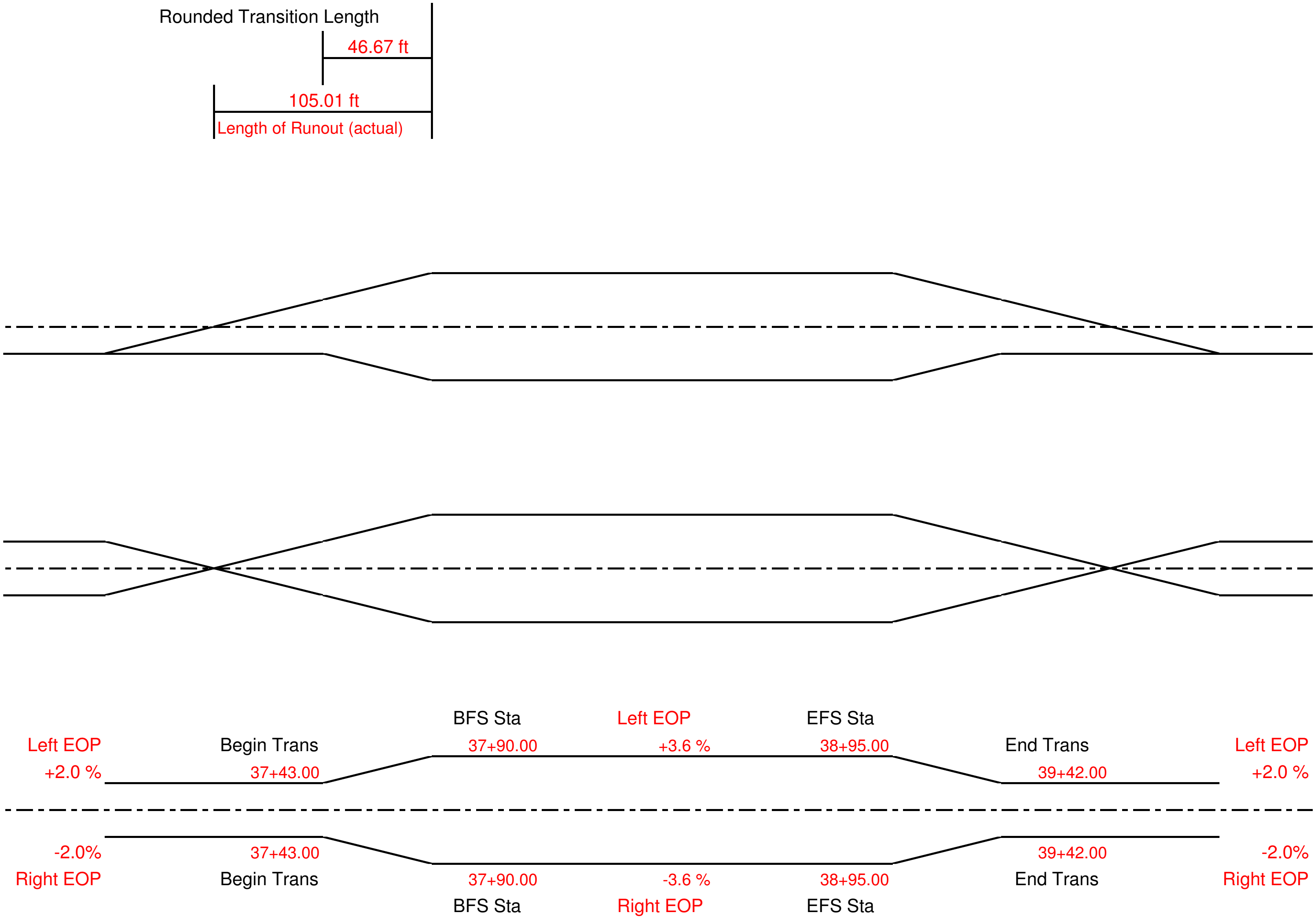
Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.6%=	46.67	ft	
Rounded to Nearest 0.01 ft	46.67	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	73.50	ft	
* Distance from 0 point to Start of Transition	58.33	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	36+84.68		
Begin Transition Sta	37+43.00		37+43.00
PC Sta	37+58.18		
Begin Full Super	37+90.00		37+90.00
			Use
End Full Super	38+95.00		38+95.00
PT Sta	39+26.81		
End Transiton Sta	39+42.00		39+42.00
Theoretical Point of Intersection (0% Super) Sta	40+00.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	15488	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	2	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	45.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

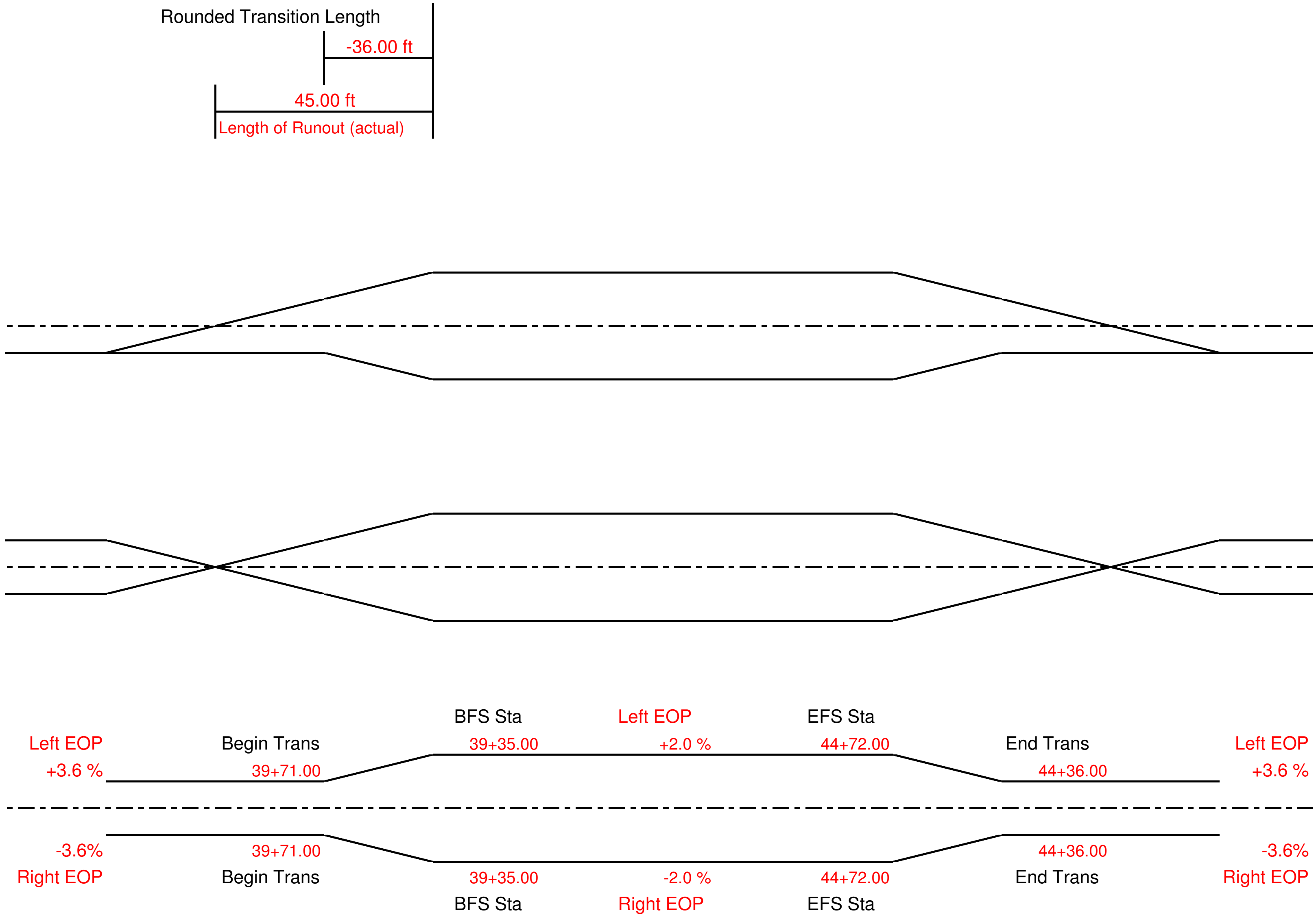
Needed Lr to Fit 45 ft Vert Curve	-50.00	ft
Calculated Lr	45.00	ft
Use Calculated Lr	45.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	3.6	%	
Super Elevation Transition Length from 3.6%to 2%=	-36.00	ft	
Rounded to Nearest 0.01 ft	-36.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	36.00	ft	
* Distance from 0 point to Start of Transition	81.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	38+90.81		
Begin Transition Sta	39+71.00		39+71.00
PC Sta	39+26.81		
Begin Full Super	39+35.00		39+35.00
			Use
End Full Super	44+72.00		44+72.00
PT Sta	44+80.68		
End Transiton Sta	44+36.00		44+36.00
Theoretical Point of Intersection (0% Super) Sta	45+17.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4475	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of :	1	
Design Super (e_d) positive value	4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	90.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	80.00	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

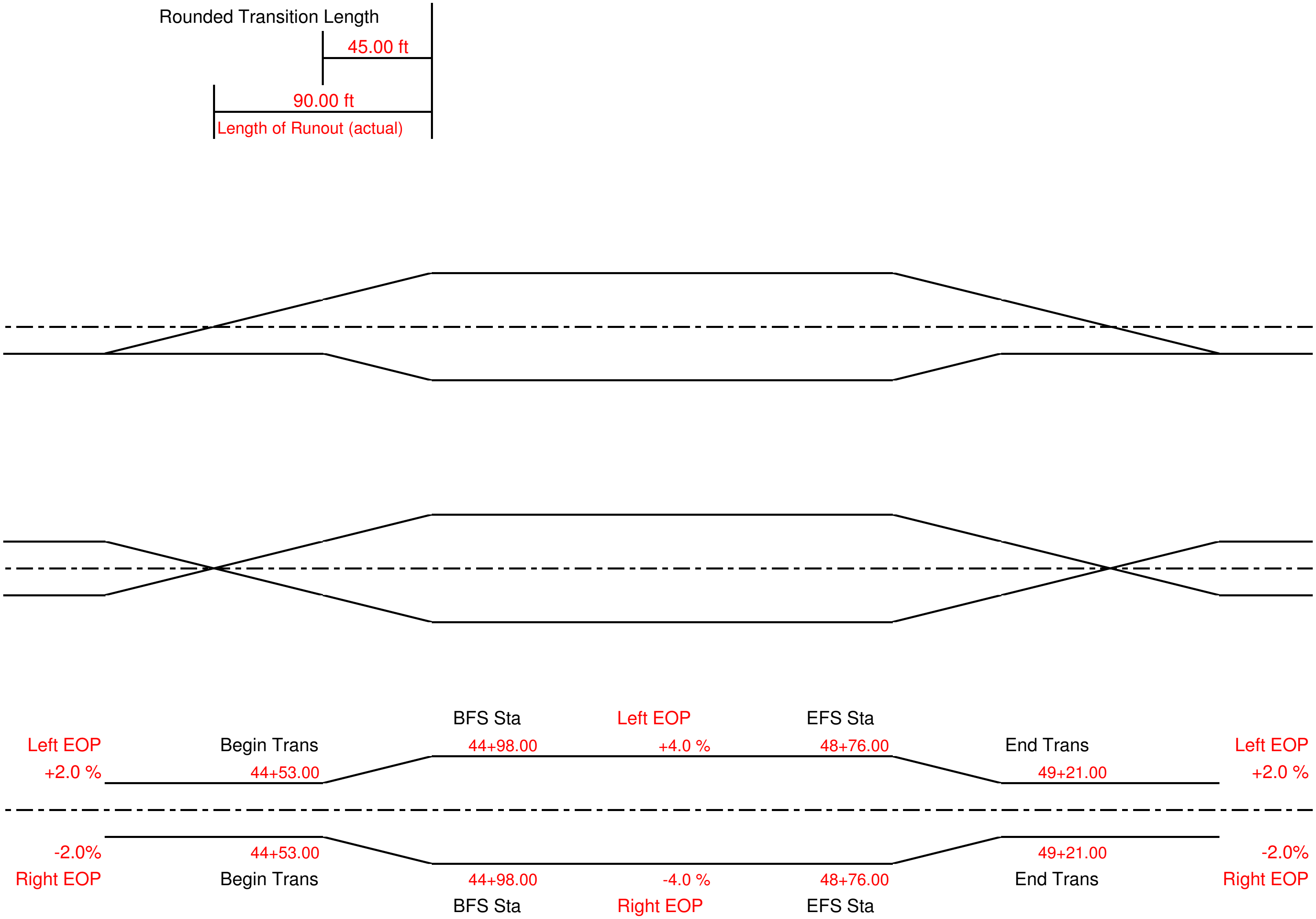
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 4%=	45.00	ft
Rounded to Nearest 0.01 ft	45.00	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	72.00	ft
* Distance from 0 point to Start of Transition	45.00	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	44+08.68	
Begin Transition Sta	44+53.00	44+53.00
PC Sta	44+80.68	
Begin Full Super	44+98.00	44+98.00

		Use
End Full Super	48+76.00	48+76.00
PT Sta	48+93.98	
End Transiton Sta	49+21.00	49+21.00
Theoretical Point of Intersection (0% Super) Sta	49+66.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	3555	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	4.8	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	120.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%
Super Elevation Transition Length from -2%to 4.8%=	170.00	ft
Rounded to Nearest 0.01 ft	170.00	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	96.00	ft
* Distance from 0 point to Start of Transition	-50.00	ft

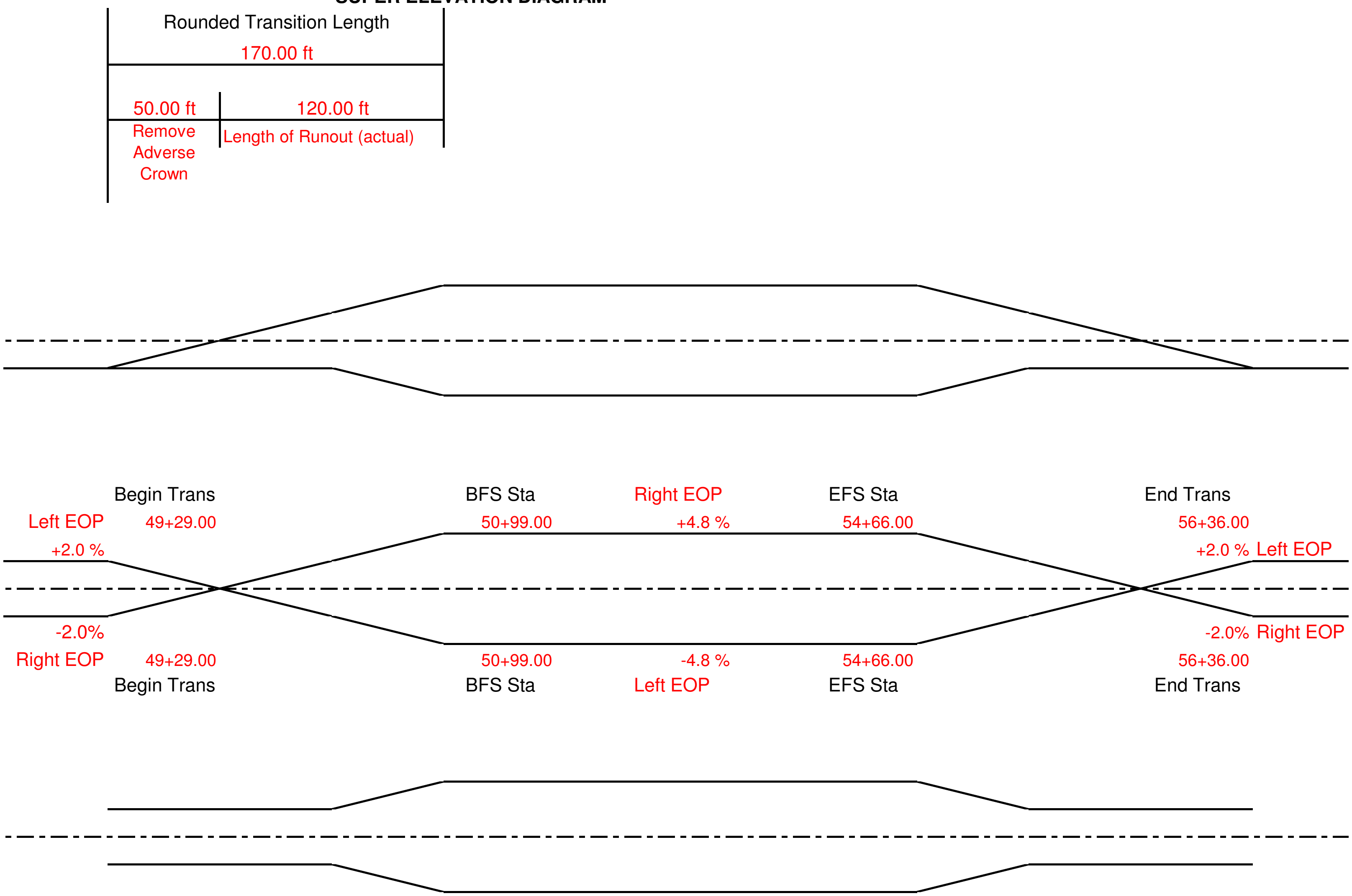
		Use
Theoretical Point of Intersection (0% Super) Sta	49+79.23	
Begin Transition Sta	49+29.00	49+29.00
PC Sta	50+75.23	
Begin Full Super	50+99.00	50+99.00

		Use
End Full Super	54+66.00	54+66.00
PT Sta	54+89.88	
End Transiton Sta	56+36.00	56+36.00
Theoretical Point of Intersection (0% Super) Sta	55+86.00	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	31.76	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

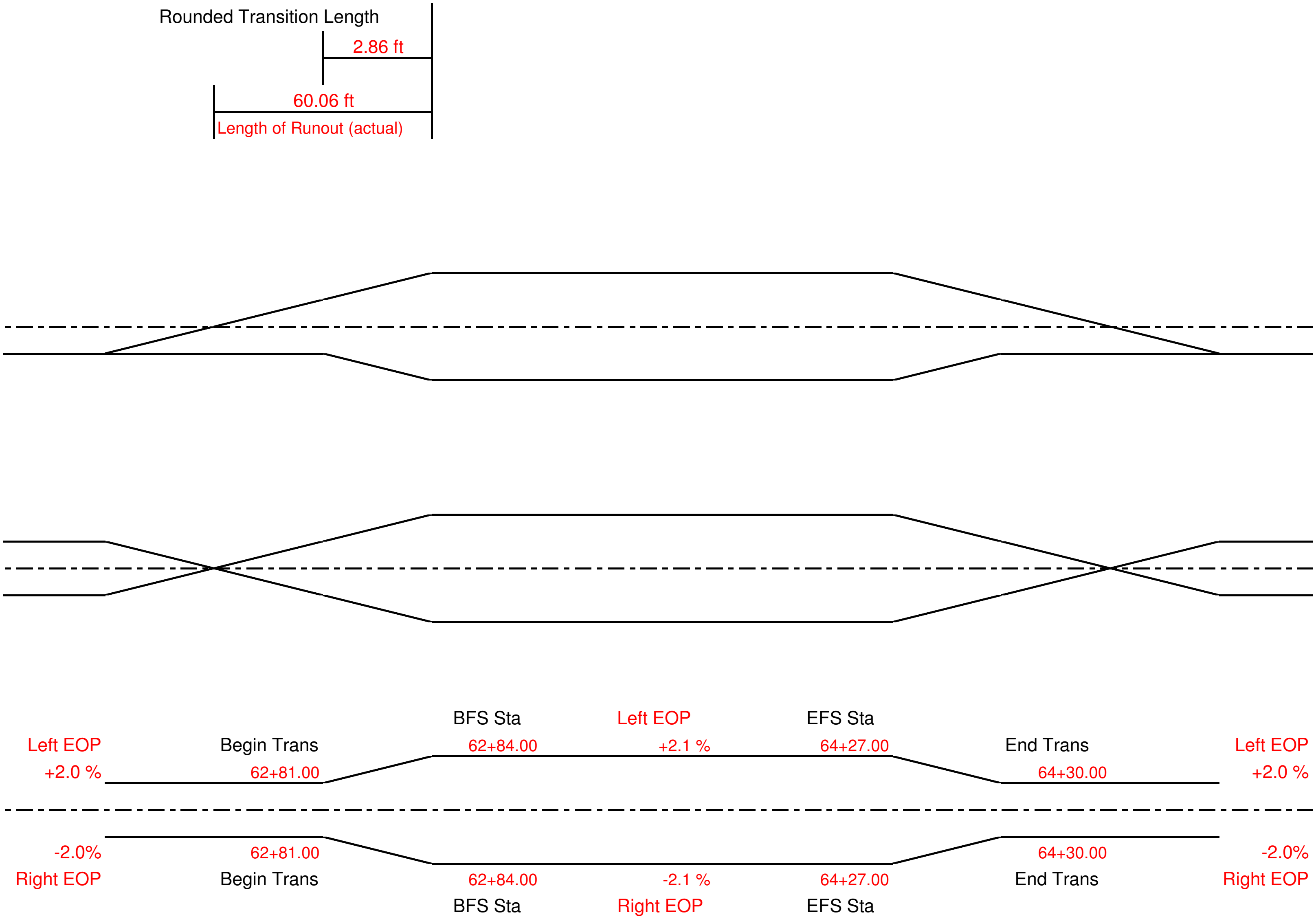
Radius	8012	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	2.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.50	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	60.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	60.00	ft
Use Calculated Lr	60.00	ft

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.1%=	2.86	ft	
Rounded to Nearest 0.01 ft	2.86	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	42.00	ft	
* Distance from 0 point to Start of Transition	57.14	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	62+24.70		
Begin Transition Sta	62+81.00		62+81.00
PC Sta	62+66.70		
Begin Full Super	62+84.00		62+84.00
			Use
End Full Super	64+27.00		64+27.00
PT Sta	64+44.59		
End Transiton Sta	64+30.00		64+30.00
Theoretical Point of Intersection (0% Super) Sta	64+87.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	8000	ft
Design Speed	55	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	2.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.47	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	105.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

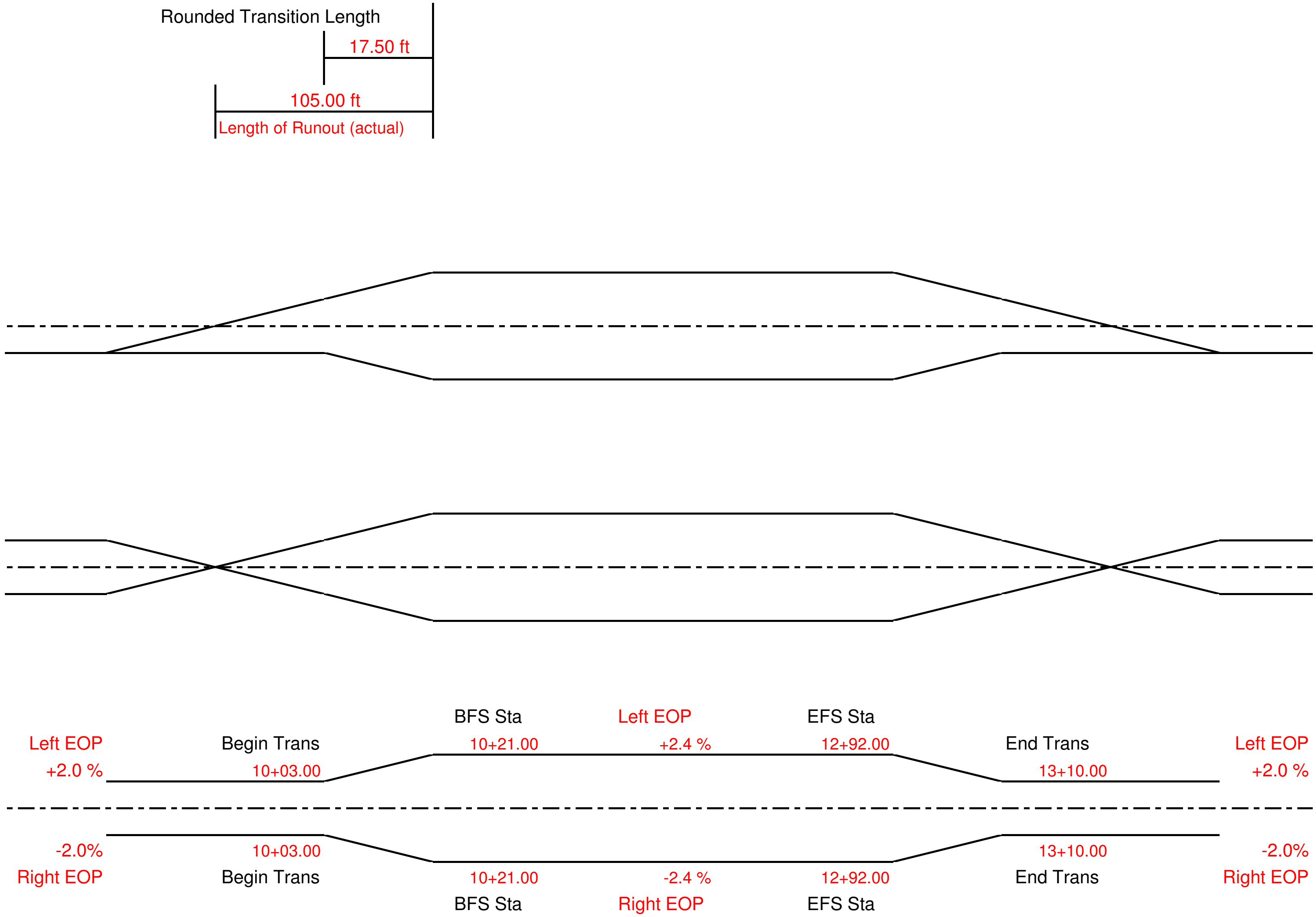
Needed Lr to Fit 55 ft Vert Curve	0.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.4%=	17.50	ft	
Rounded to Nearest 0.01 ft	17.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	87.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+16.00		
Begin Transition Sta	10+03.00		10+03.00
PC Sta	10+00.00		
Begin Full Super	10+21.00		10+21.00
			Use
End Full Super	12+92.00		12+92.00
PT Sta	13+13.29		
End Transiton Sta	13+10.00		13+10.00
Theoretical Point of Intersection (0% Super) Sta	13+97.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5000	ft
Design Speed	55	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	2.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.47	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

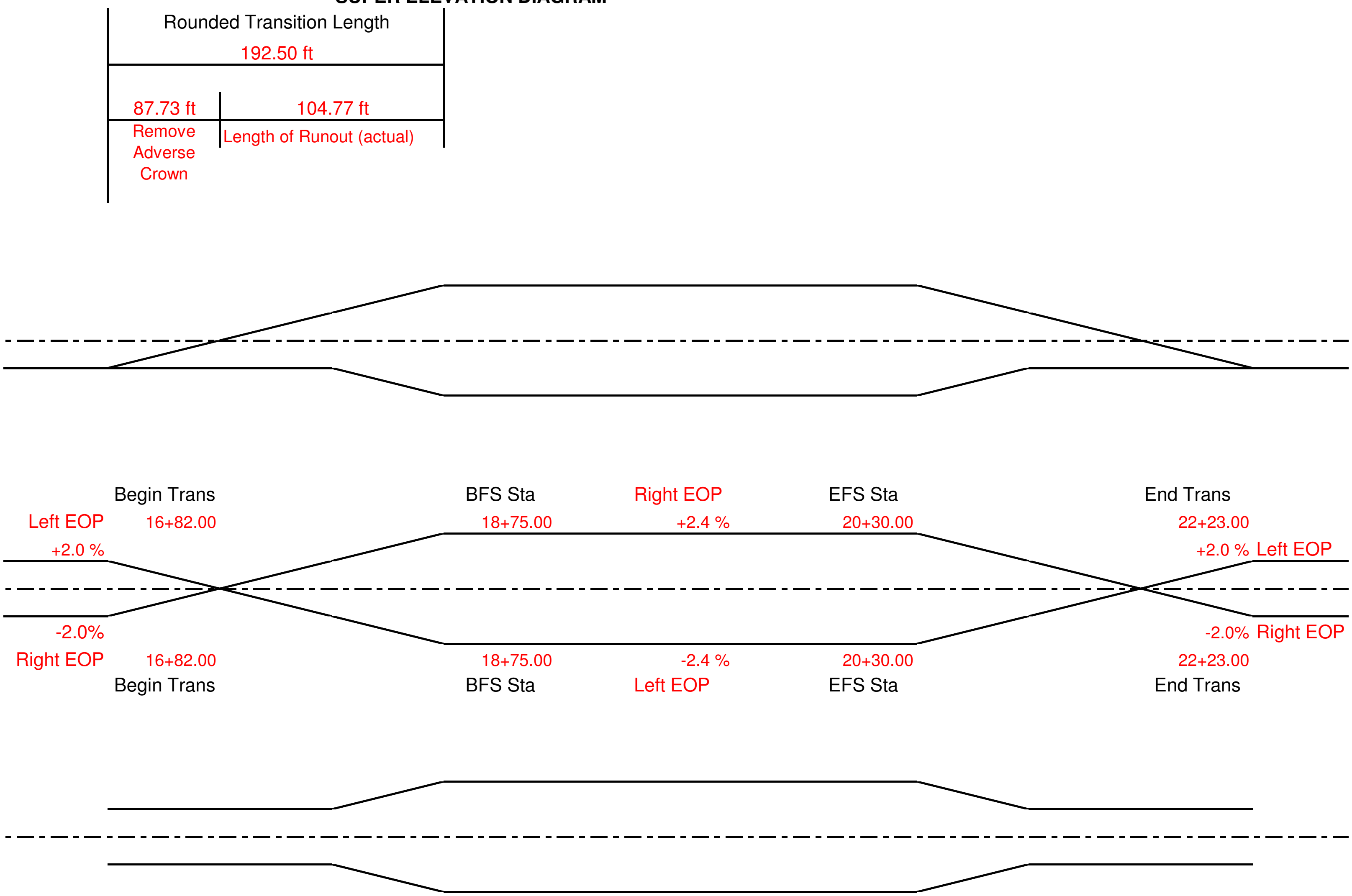
Needed Lr to Fit 55 ft Vert Curve	30.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.4%=	192.50	ft	
Rounded to Nearest 0.01 ft	192.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	-87.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	17+69.67		
Begin Transition Sta	16+82.00		16+82.00
PC Sta	18+53.67		
Begin Full Super	18+75.00		18+75.00
			Use
End Full Super	20+30.00		20+30.00
PT Sta	20+50.98		
End Transiton Sta	22+23.00		22+23.00
Theoretical Point of Intersection (0% Super) Sta	21+35.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

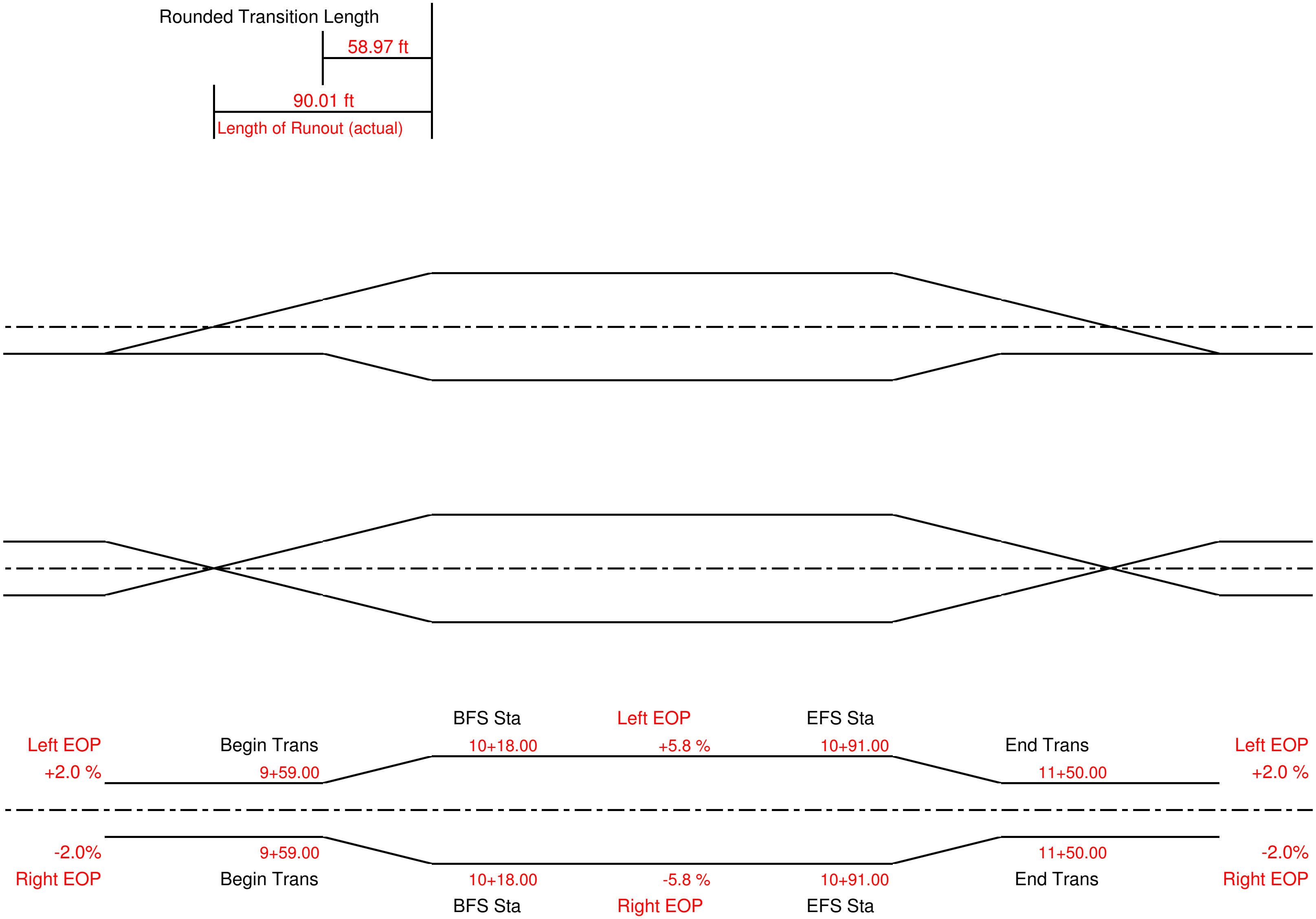
Radius	110	ft
Design Speed	15	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	5.8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.78	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	90.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	44	ft
Max Spiral Curve Length	93	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**90**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 15 ft Vert Curve	0.00	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.8%=	58.97	ft	
Rounded to Nearest 0.01 ft	58.97	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	31.03	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+28.00		
Begin Transition Sta	9+59.00		9+59.00
PC Sta	10+00.00		
Begin Full Super	10+18.00		10+18.00
			Use
End Full Super	10+91.00		10+91.00
PT Sta	11+08.45		
End Transiton Sta	11+50.00		11+50.00
Theoretical Point of Intersection (0% Super) Sta	11+81.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6000	ft
Design Speed	55	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	2.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.47	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

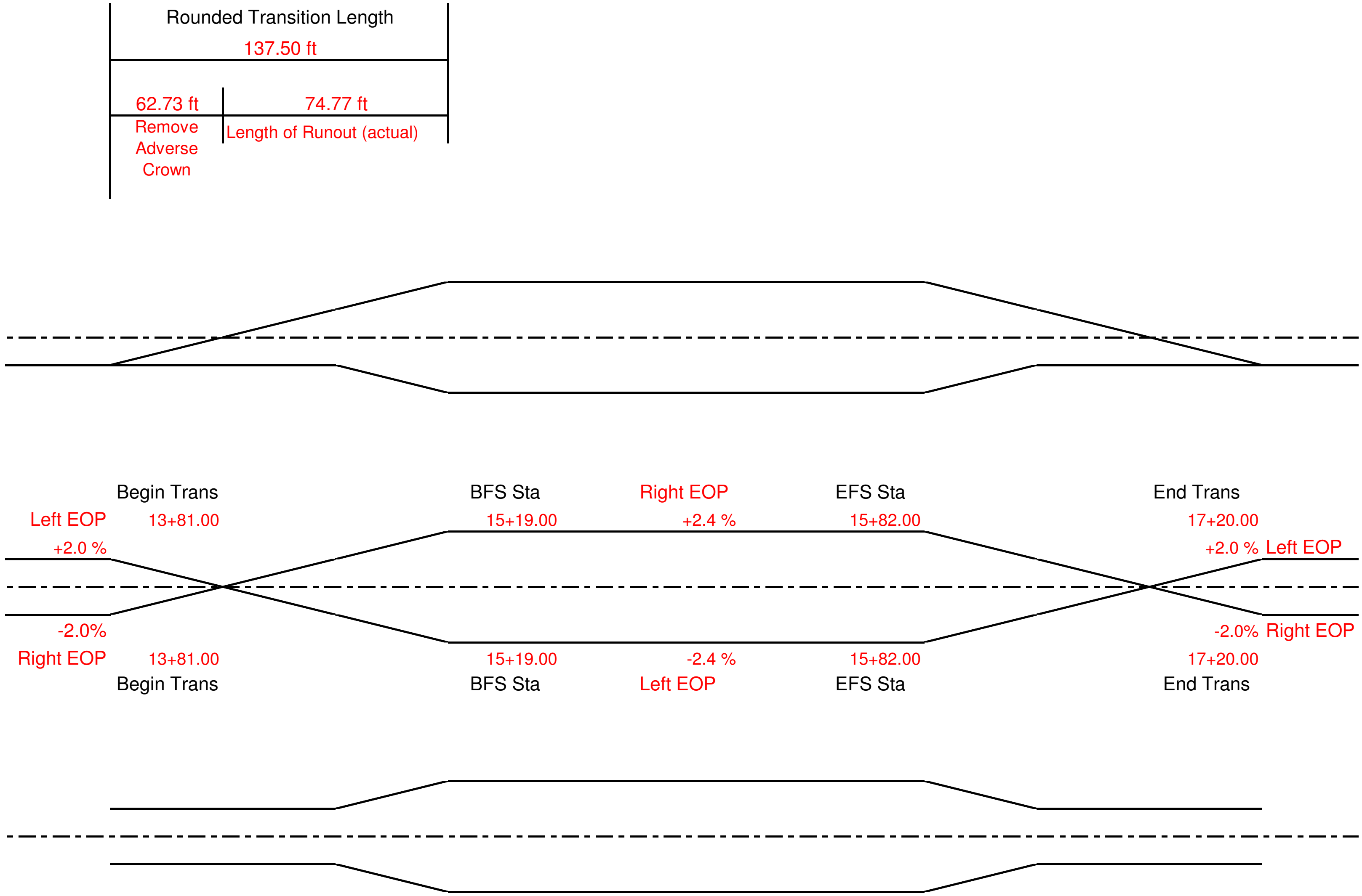
Needed Lr to Fit 55 ft Vert Curve	30.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.4%=	137.50	ft	
Rounded to Nearest 0.01 ft	137.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	52.50	ft	
* Distance from 0 point to Start of Transition	-62.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	14+44.32		
Begin Transition Sta	13+81.00		13+81.00
PC Sta	14+96.82		
Begin Full Super	15+19.00		15+19.00
			Use
End Full Super	15+82.00		15+82.00
PT Sta	16+04.55		
End Transiton Sta	17+20.00		17+20.00
Theoretical Point of Intersection (0% Super) Sta	16+57.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	2988	ft
Design Speed	60	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.45	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	135.00	ft
Spiral Curves Recommended Check	No	

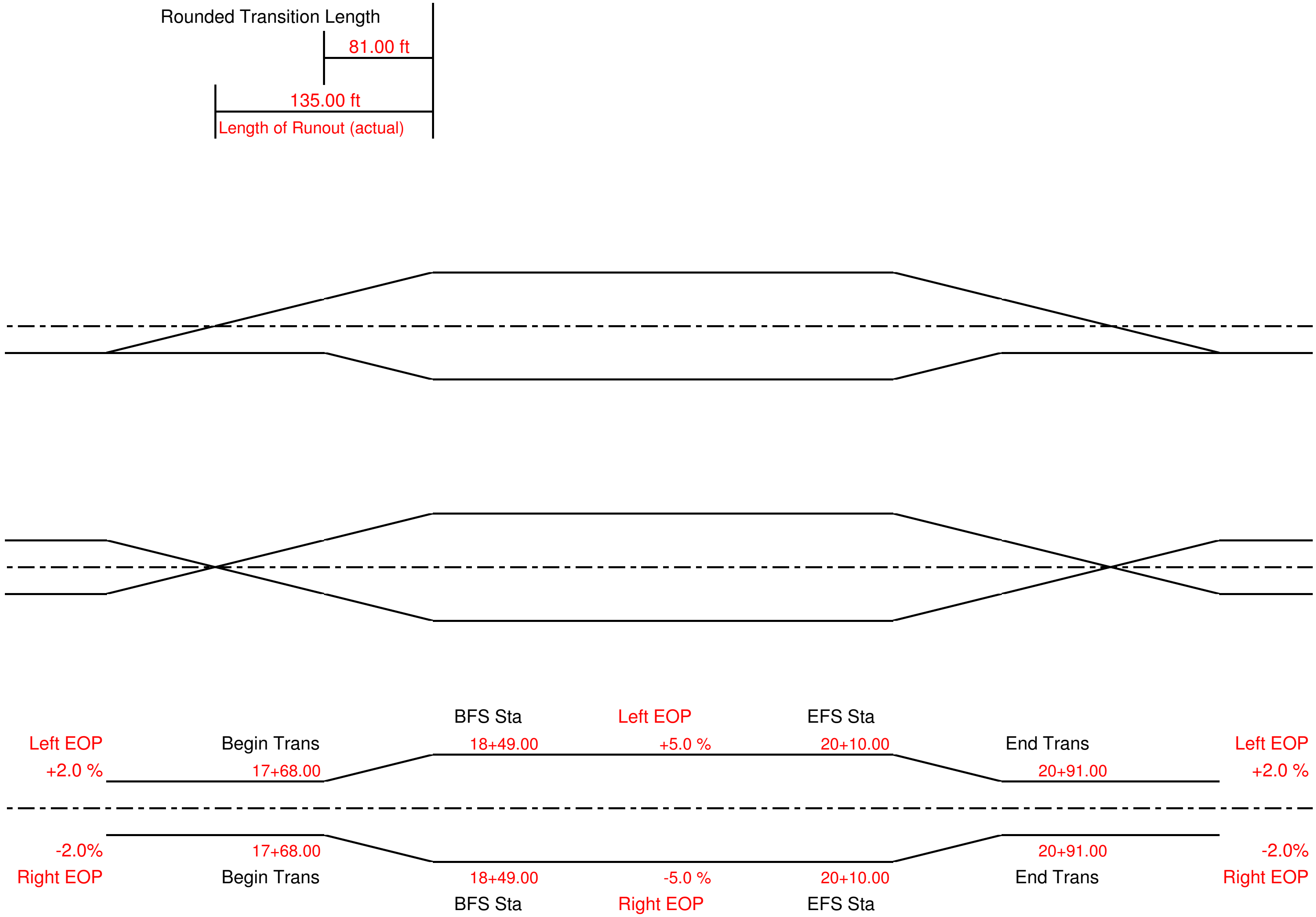
Left EOP Begin Transition Cross Slope (pos or neg)	2.0 %		
Super Elevation Transition Length from 2%to 5%=	81.00 ft		
Rounded to Nearest 0.01 ft	81.00 ft		
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	94.50 ft		
* Distance from 0 point to Start of Transition	54.00 ft		
		Use	
Theoretical Point of Intersection (0% Super) Sta	17+14.55		
Begin Transition Sta	17+68.00	17+68.00	
PC Sta	18+09.05		
Begin Full Super	18+49.00	18+49.00	
		Use	
End Full Super	20+10.00	20+10.00	
PT Sta	20+49.74		
End Transiton Sta	20+91.00	20+91.00	
Theoretical Point of Intersection (0% Super) Sta	21+45.00		

Design Speed Rounding Curve Length 40

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 60 ft Vert Curve	66.67	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5018	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	3.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.43	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

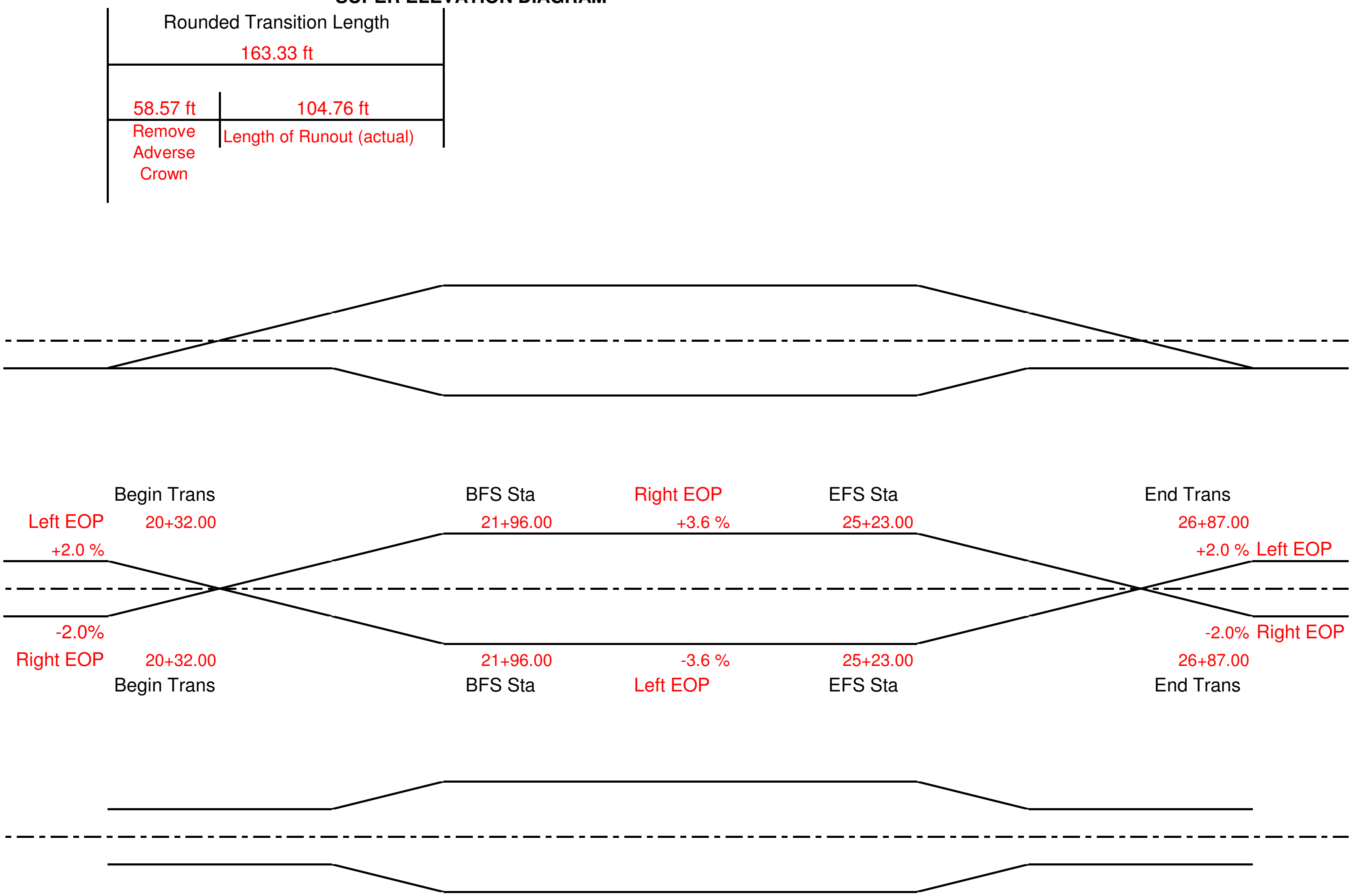
Needed Lr to Fit 65 ft Vert Curve	41.79	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.6%=	163.33	ft	
Rounded to Nearest 0.01 ft	163.33	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	73.50	ft	
* Distance from 0 point to Start of Transition	-58.33	ft	
Theoretical Point of Intersection (0% Super) Sta	20+90.44		
Begin Transition Sta	20+32.00		20+32.00
PC Sta	21+63.94		
Begin Full Super	21+96.00		21+96.00

		Use
End Full Super	25+23.00	25+23.00
PT Sta	25+54.70	
End Transiton Sta	26+87.00	26+87.00
Theoretical Point of Intersection (0% Super) Sta	26+28.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	55	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.47	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

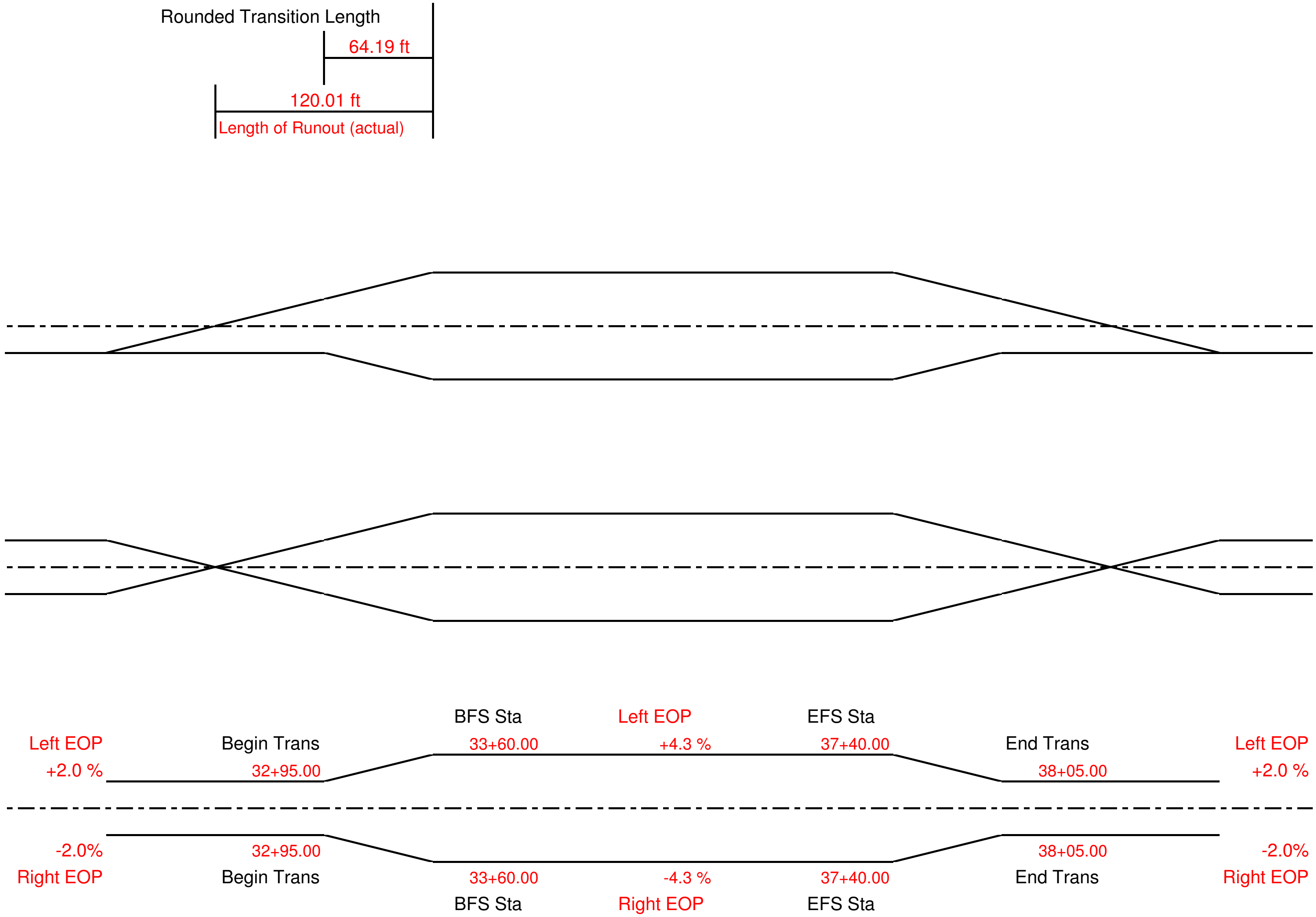
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 55 ft Vert Curve	0.00	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	64.19	ft	
Rounded to Nearest 0.01 ft	64.19	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	55.81	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	32+39.39		
Begin Transition Sta	32+95.00		32+95.00
PC Sta	33+23.39		
Begin Full Super	33+60.00		33+60.00
			Use
End Full Super	37+40.00		37+40.00
PT Sta	37+75.88		
End Transiton Sta	38+05.00		38+05.00
Theoretical Point of Intersection (0% Super) Sta	38+60.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2825	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	3.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

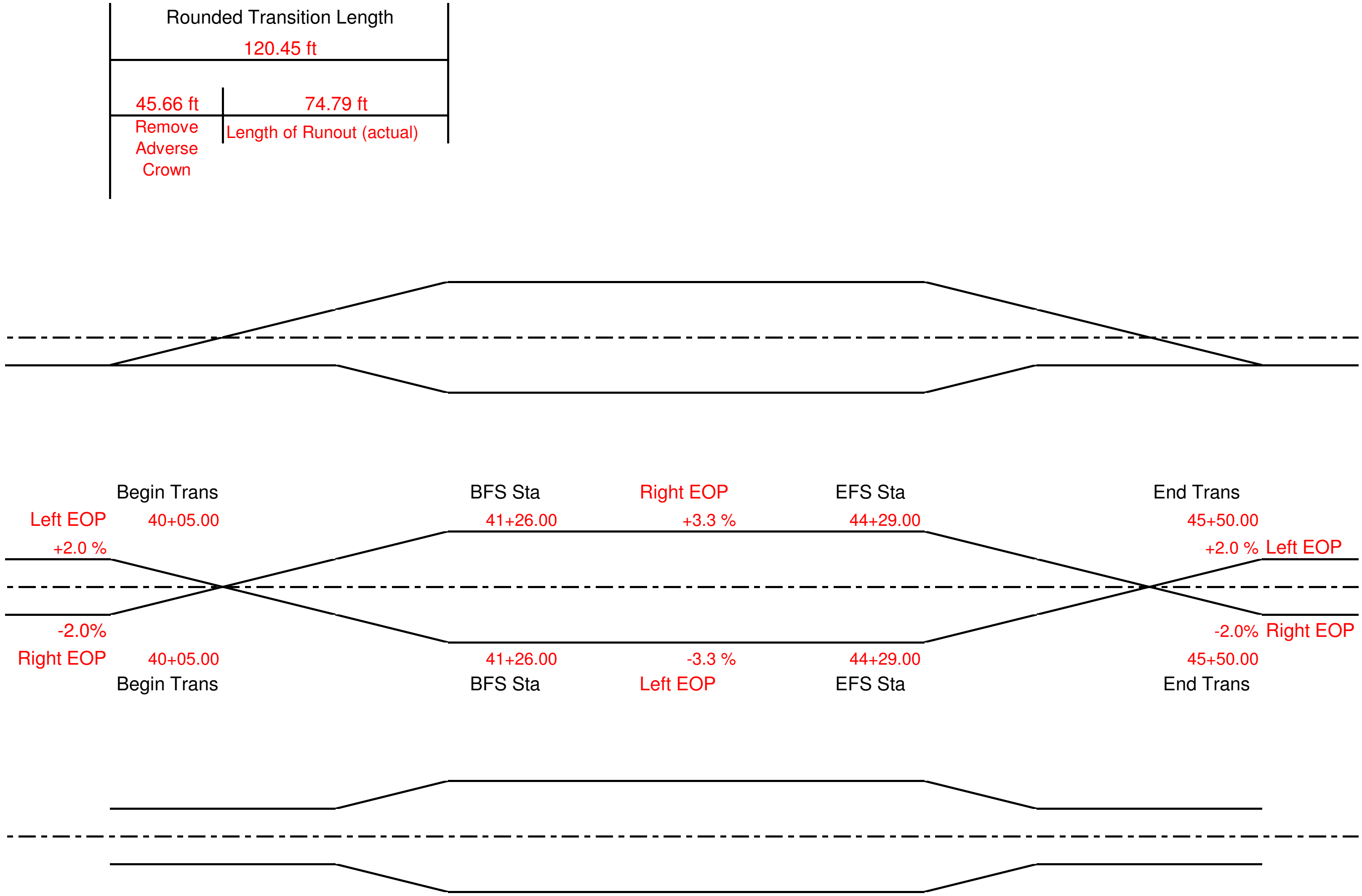
Needed Lr to Fit 45 ft Vert Curve	28.02	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.3%=	120.45	ft	
Rounded to Nearest 0.01 ft	120.45	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	-45.45	ft	
Theoretical Point of Intersection (0% Super) Sta	40+50.81		
Begin Transition Sta	40+05.00		40+05.00
PC Sta	41+10.81		
Begin Full Super	41+26.00		41+26.00

		Use
End Full Super	44+29.00	44+29.00
PT Sta	44+44.22	
End Transiton Sta	45+50.00	45+50.00
Theoretical Point of Intersection (0% Super) Sta	45+04.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$L_r = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

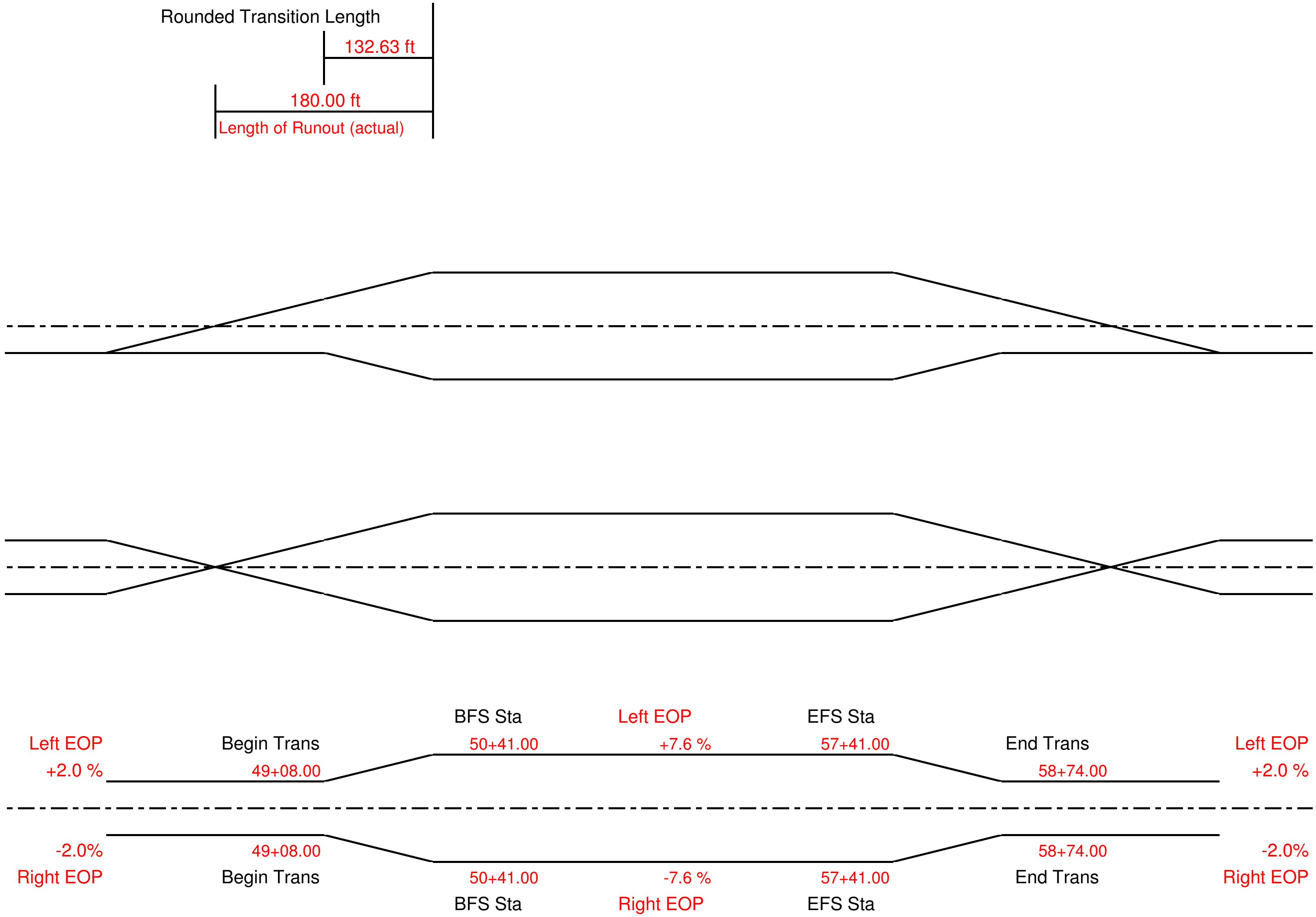
Radius	762	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	7.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	180.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	132	ft
Max Spiral Curve Length	246	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**180**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)?	No		
Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.6%=	132.63	ft	
Rounded to Nearest 0.01 ft	132.63	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	144.00	ft	
* Distance from 0 point to Start of Transition	47.37	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	48+60.94		
Begin Transition Sta	49+08.00		49+08.00
PC Sta	50+04.94		
Begin Full Super	50+41.00		50+41.00
			Use
End Full Super	57+41.00		57+41.00
PT Sta	57+76.64		
End Transiton Sta	58+74.00		58+74.00
Theoretical Point of Intersection (0% Super) Sta	59+21.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

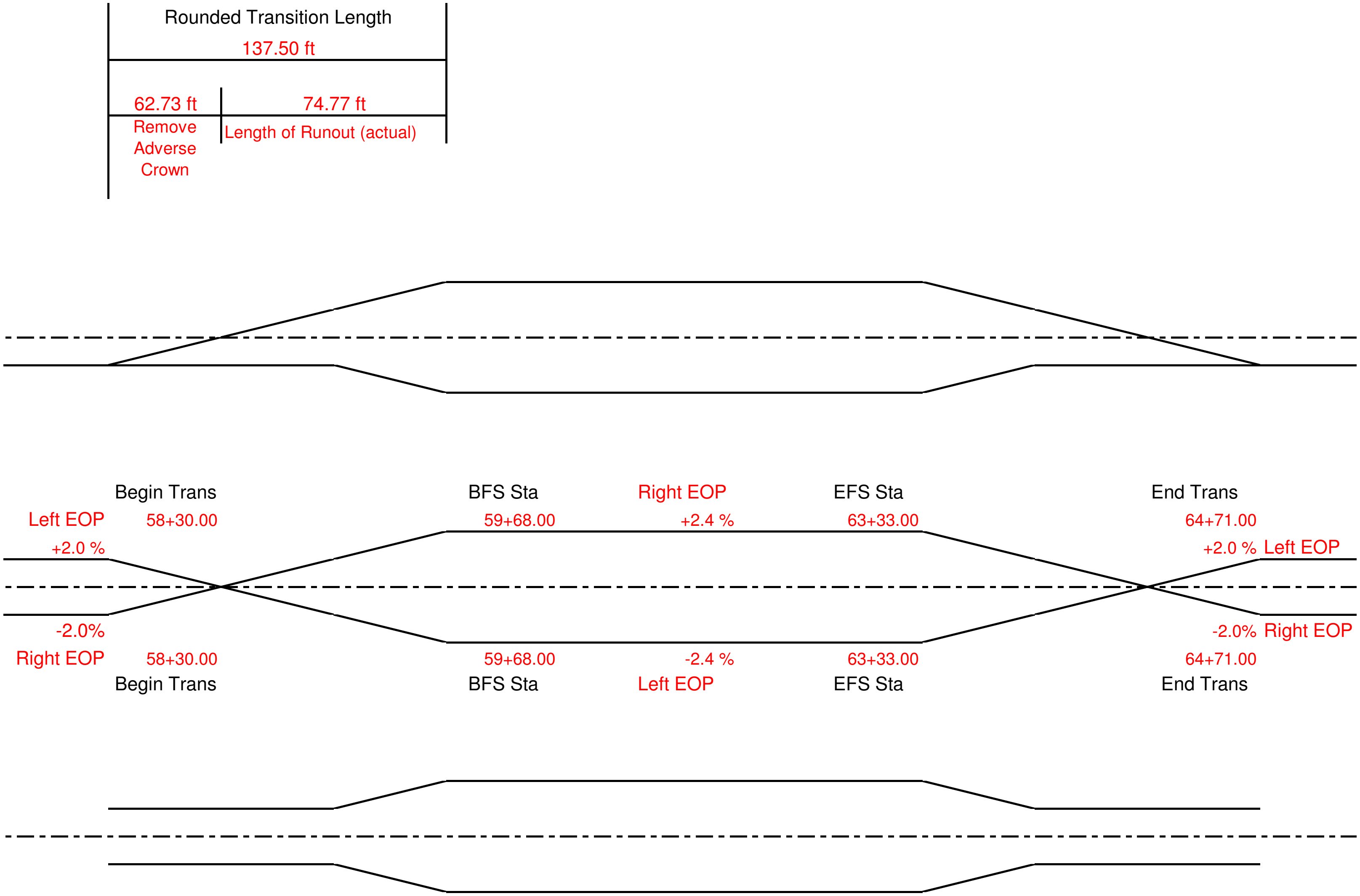
Radius	7050	ft
Design Speed	60	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	2.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.45	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 60 ft Vert Curve	32.73	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.4%=	137.50	ft	
Rounded to Nearest 0.01 ft	137.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	52.50	ft	
* Distance from 0 point to Start of Transition	-62.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	58+92.76		
Begin Transition Sta	58+30.00		58+30.00
PC Sta	59+45.26		
Begin Full Super	59+68.00		59+68.00
			Use
End Full Super	63+33.00		63+33.00
PT Sta	63+55.30		
End Transiton Sta	64+71.00		64+71.00
Theoretical Point of Intersection (0% Super) Sta	64+08.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	8000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	2.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.43	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

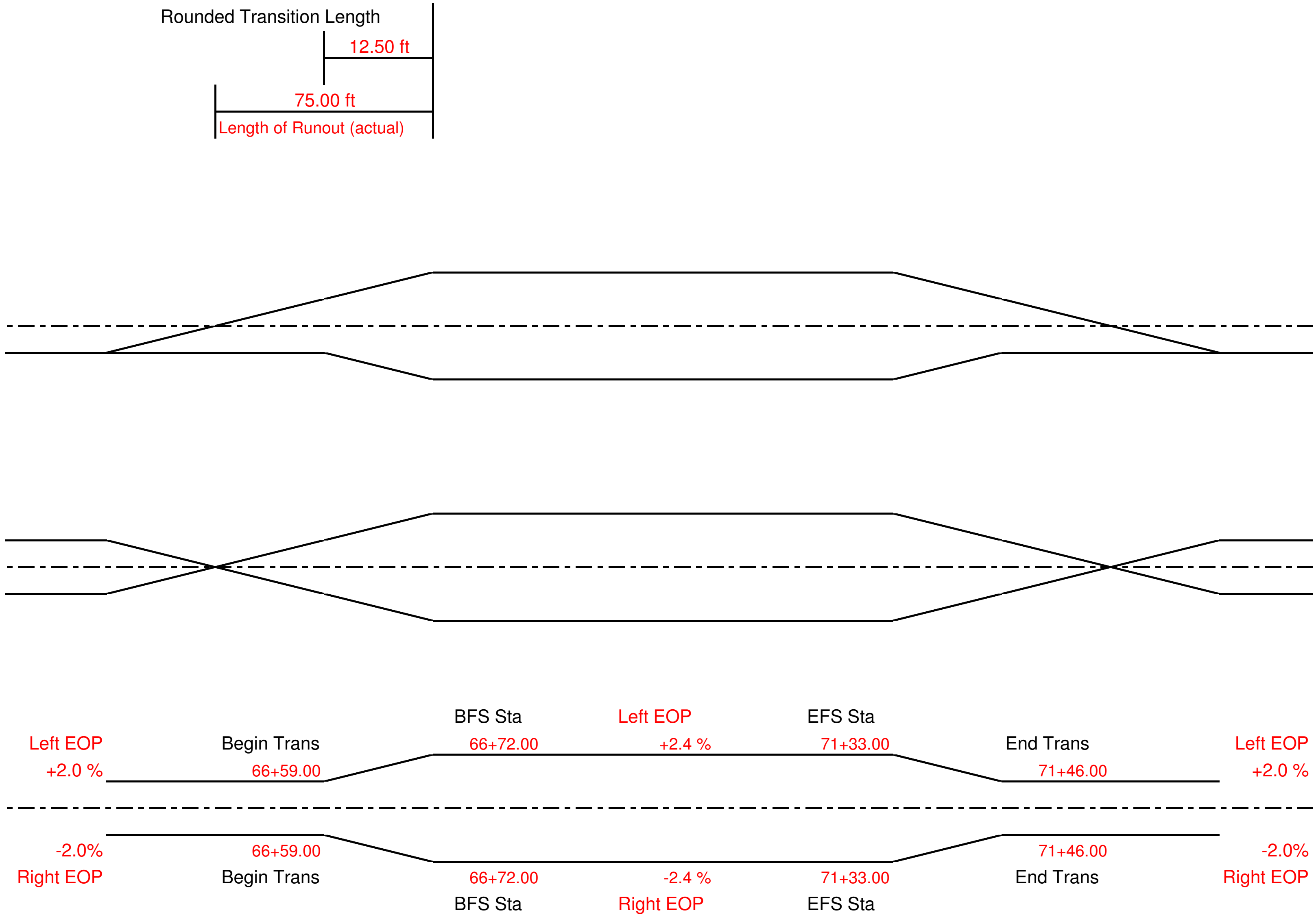
Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.4%=	12.50	ft	
Rounded to Nearest 0.01 ft	12.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	52.50	ft	
* Distance from 0 point to Start of Transition	62.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	65+97.00		
Begin Transition Sta	66+59.00		66+59.00
PC Sta	66+49.50		
Begin Full Super	66+72.00		66+72.00
			Use
End Full Super	71+33.00		71+33.00
PT Sta	71+55.74		
End Transiton Sta	71+46.00		71+46.00
Theoretical Point of Intersection (0% Super) Sta	72+08.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3012	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	240.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 5.5%=	152.73	ft
Rounded to Nearest 0.01 ft	152.73	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	192.00	ft
* Distance from 0 point to Start of Transition	87.27	ft

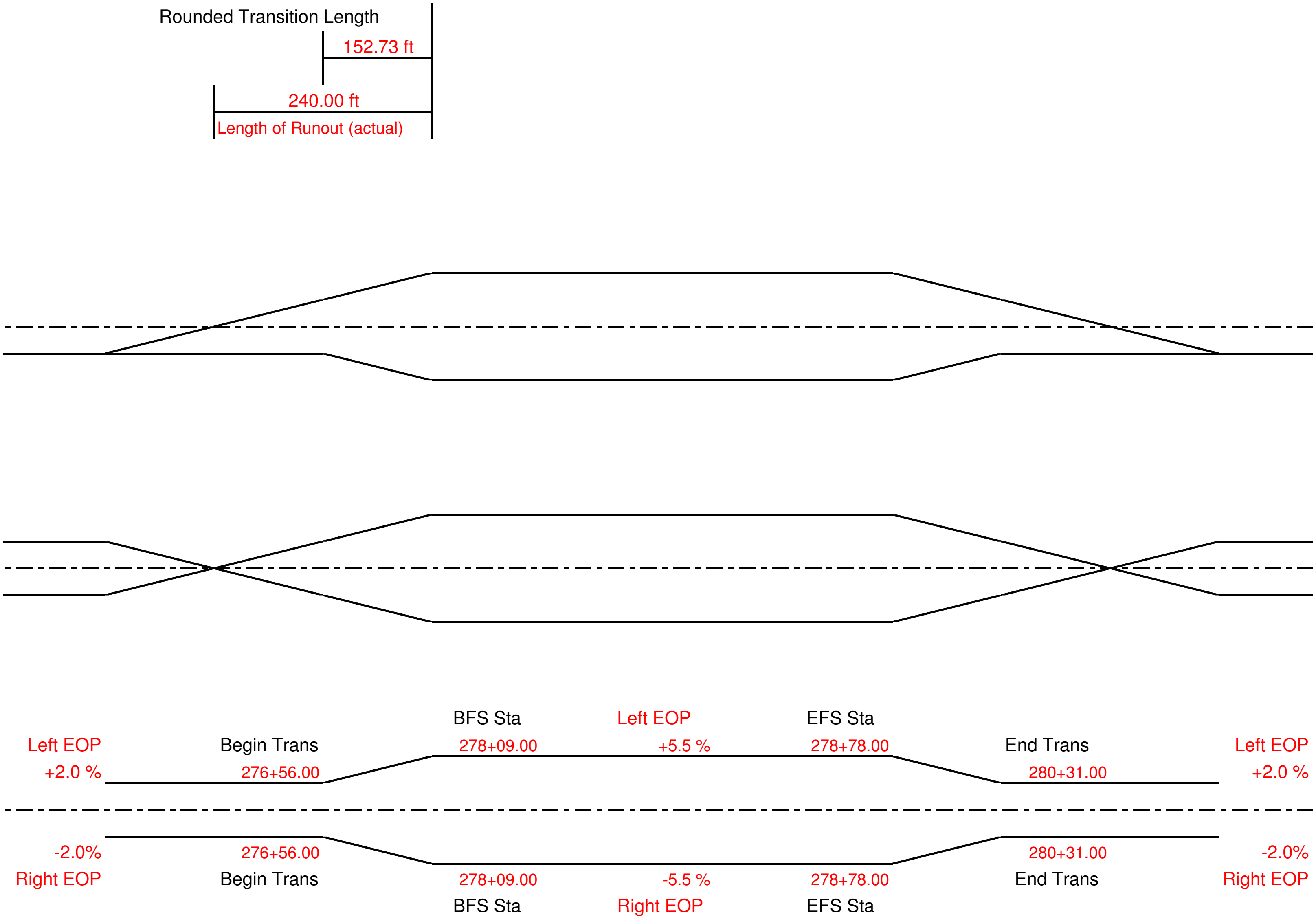
		Use
Theoretical Point of Intersection (0% Super) Sta	275+69.40	
Begin Transition Sta	276+56.00	276+56.00
PC Sta	277+61.40	
Begin Full Super	278+09.00	278+09.00

		Use
End Full Super	278+78.00	278+78.00
PT Sta	279+26.20	
End Transiton Sta	280+31.00	280+31.00
Theoretical Point of Intersection (0% Super) Sta	281+18.00	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	240.00	ft
Use Calculated Lr	240.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2976	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	240.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	47.89	ft
Calculated Lr	240.00	ft
Use Calculated Lr	240.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)?	No		
Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 5.6%=	325.71	ft	
Rounded to Nearest 0.01 ft	325.71	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	192.00	ft	
* Distance from 0 point to Start of Transition	-85.71	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	287+40.65		
Begin Transition Sta	286+54.00		286+54.00
PC Sta	289+32.65		
Begin Full Super	289+80.00		289+80.00
			Use
End Full Super	290+48.00		290+48.00
PT Sta	290+95.48		
End Transiton Sta	293+74.00		293+74.00
Theoretical Point of Intersection (0% Super) Sta	292+88.00		

CA Group

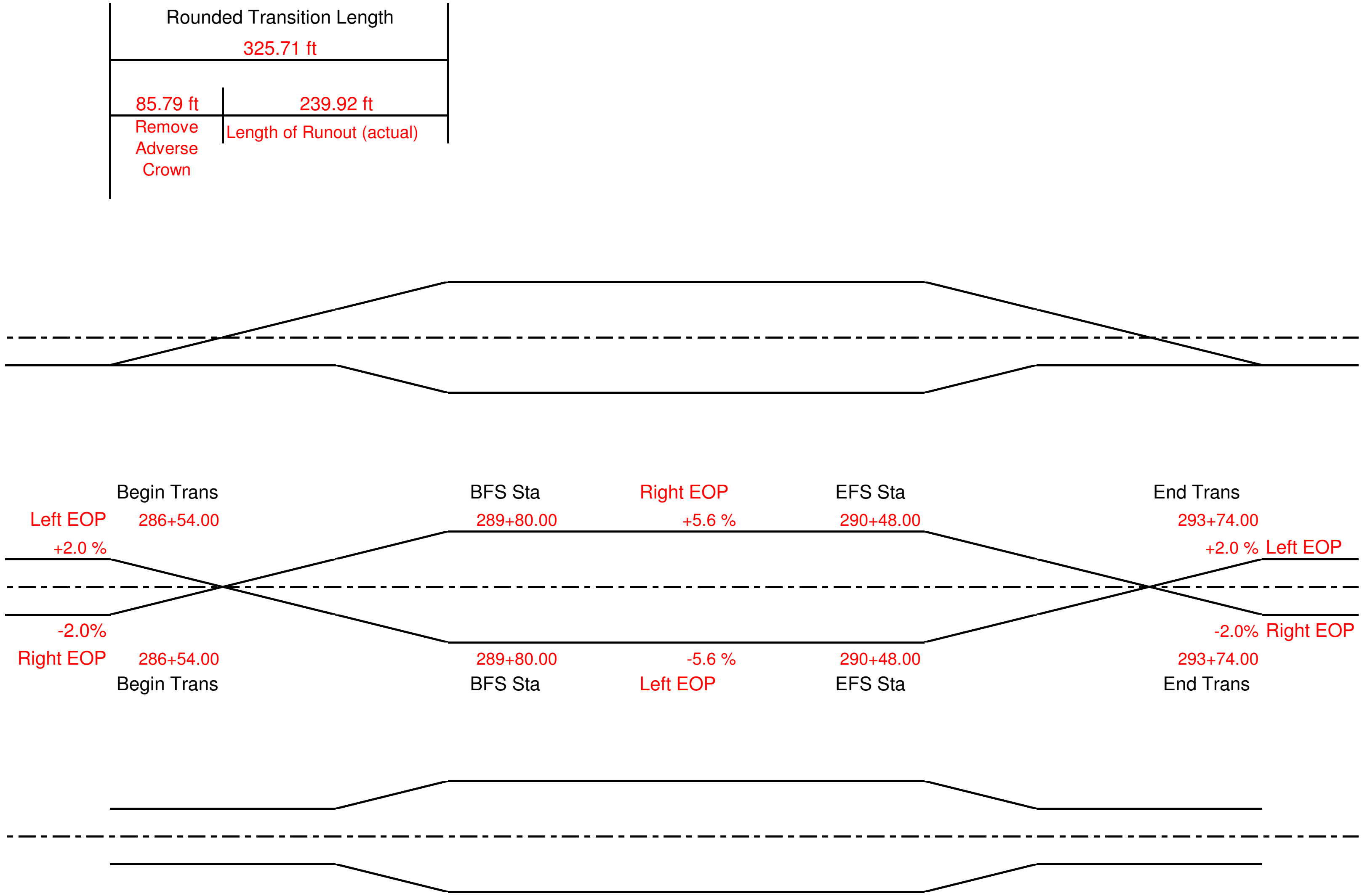
Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"L-NB"-2

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1976	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	7.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	315.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	286	ft
Max Spiral Curve Length	593	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**315**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.4%=	229.86	ft	
Rounded to Nearest 0.01 ft	229.86	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	252.00	ft	
* Distance from 0 point to Start of Transition	85.14	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	294+02.46		
Begin Transition Sta	294+87.00		294+87.00
PC Sta	296+54.46		
Begin Full Super	297+17.00		297+17.00
			Use
End Full Super	300+72.00		300+72.00
PT Sta	301+34.64		
End Transiton Sta	303+02.00		303+02.00
Theoretical Point of Intersection (0% Super) Sta	303+87.00		

CA Group

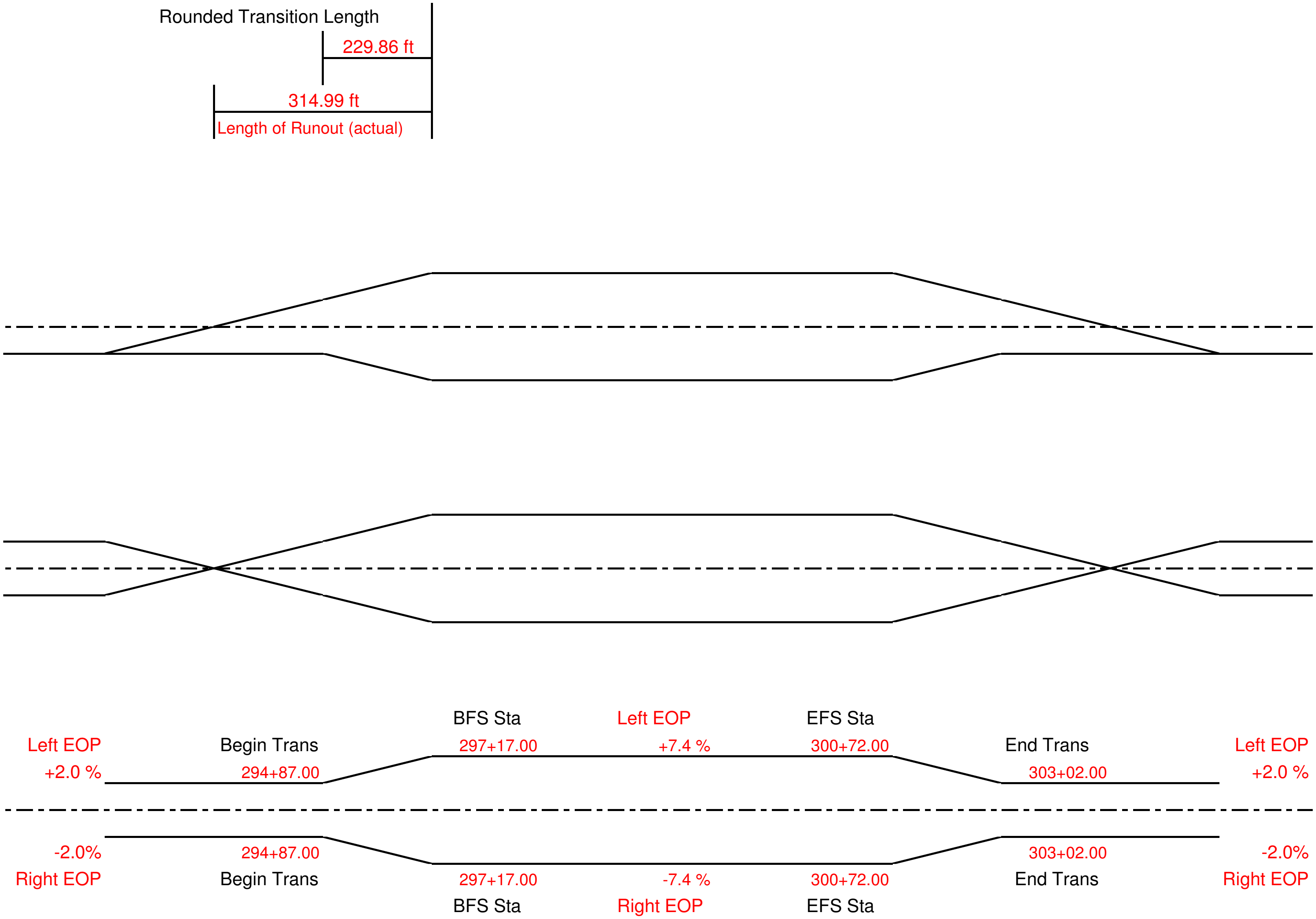
Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"L-NB"-3

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$L_r = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	2929	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	315.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

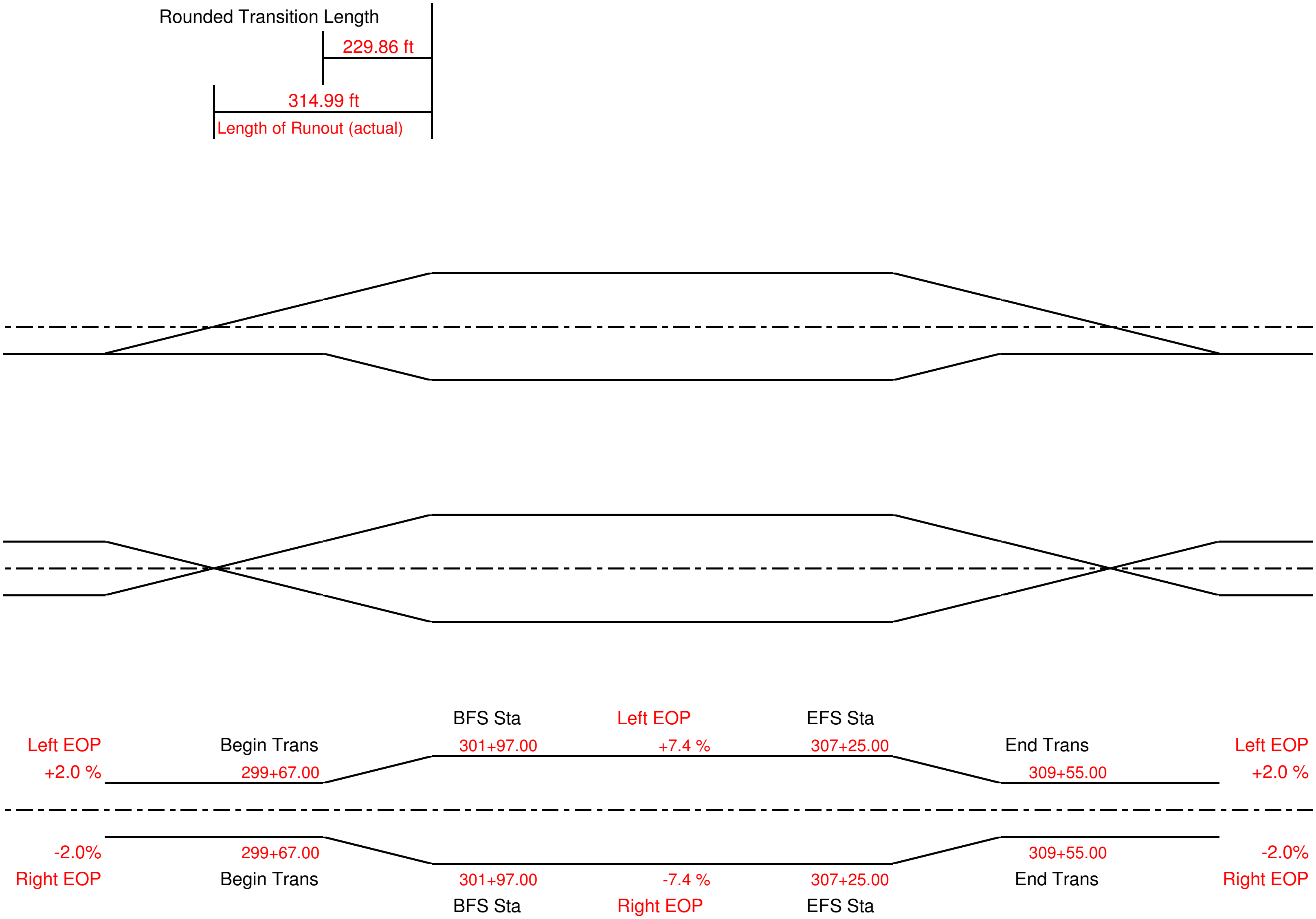
Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 7.4%=	229.86	ft
Rounded to Nearest 0.01 ft	229.86	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	252.00	ft
* Distance from 0 point to Start of Transition	85.14	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	298+82.64	
Begin Transition Sta	299+67.00	299+67.00
PC Sta	301+34.64	
Begin Full Super	301+97.00	301+97.00

		Use
End Full Super	307+25.00	307+25.00
PT Sta	307+87.93	
End Transiton Sta	309+55.00	309+55.00
Theoretical Point of Intersection (0% Super) Sta	310+40.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3976	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	4.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	195.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	195.00	ft
Use Calculated Lr	195.00	ft

SUPER ELEVATION TRANSITION CALCULATION

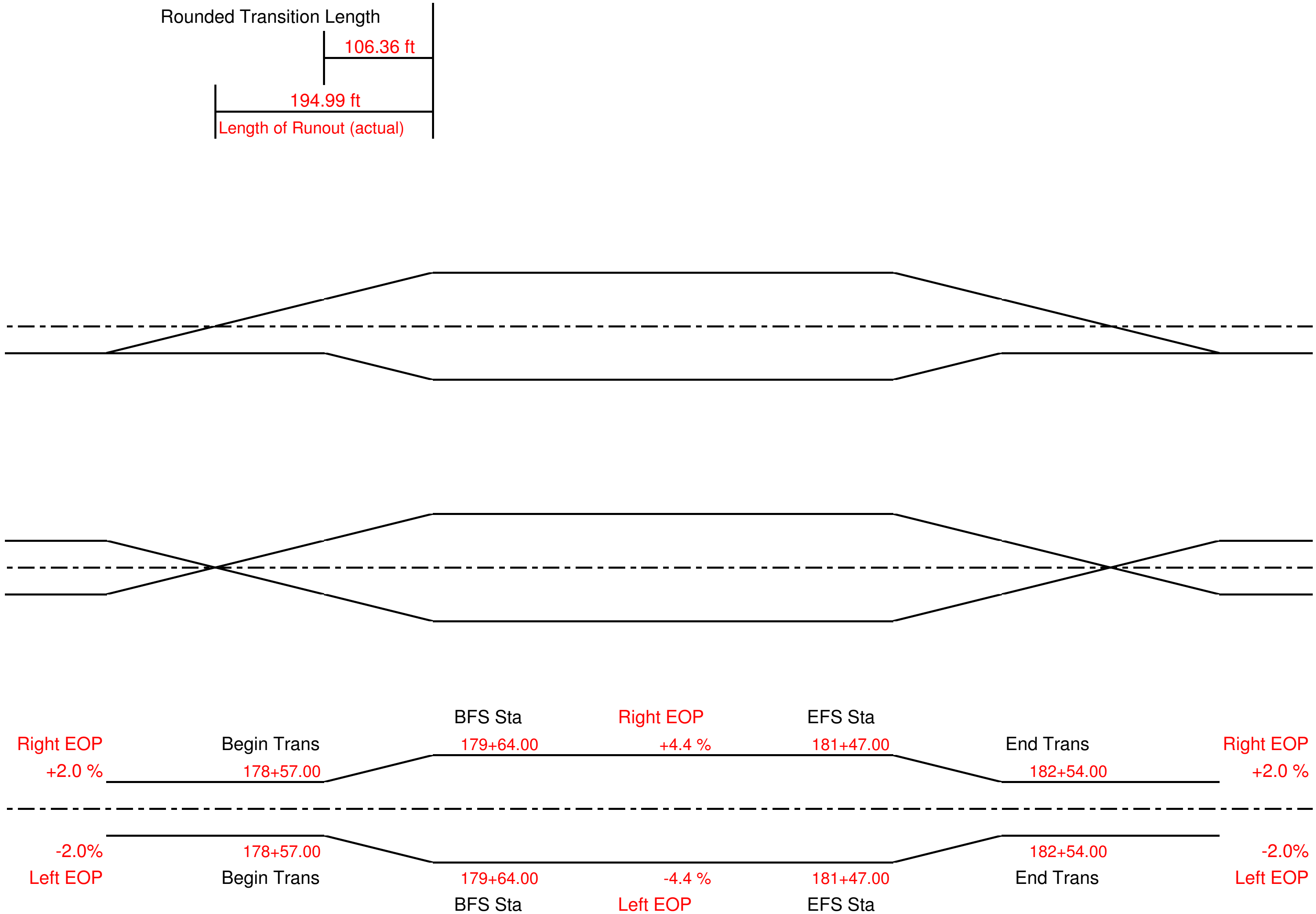
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 4.4%=	106.36	ft
Rounded to Nearest 0.01 ft	106.36	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	156.00	ft
* Distance from 0 point to Start of Transition	88.64	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	177+68.91	
Begin Transition Sta	178+57.00	178+57.00
PC Sta	179+24.91	
Begin Full Super	179+64.00	179+64.00

		Use
End Full Super	181+47.00	181+47.00
PT Sta	181+85.99	
End Transiton Sta	182+54.00	182+54.00
Theoretical Point of Intersection (0% Super) Sta	183+42.00	

SUPER ELEVATION DIAGRAM



$$L_r = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4988	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	3.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	165.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	41.79	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

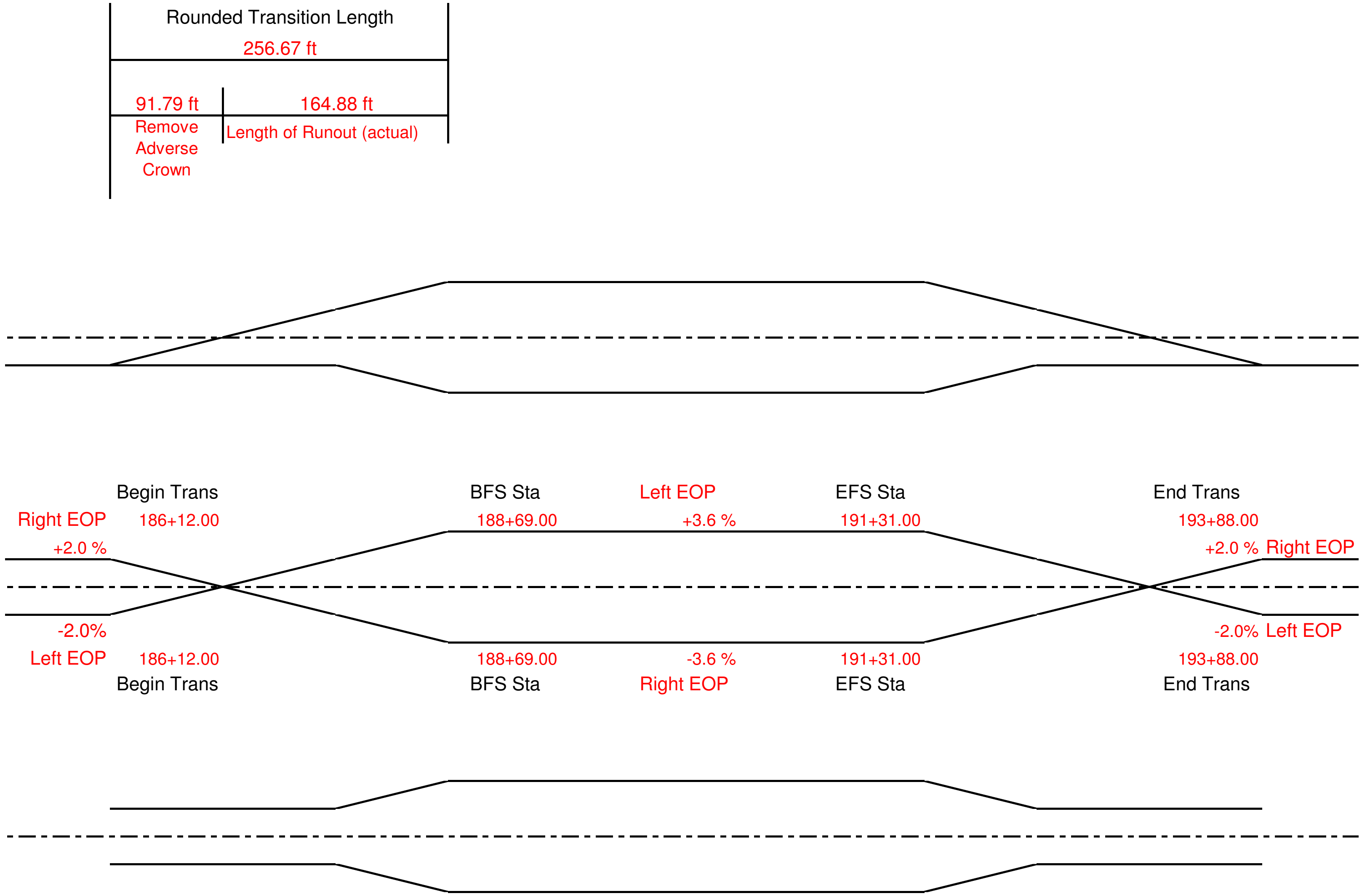
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 3.6%=	256.67	ft	
Rounded to Nearest 0.01 ft	256.67	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	132.00	ft	
* Distance from 0 point to Start of Transition	-91.67	ft	
Theoretical Point of Intersection (0% Super) Sta	187+04.46		
Begin Transition Sta	186+12.00		186+12.00
PC Sta	188+36.46		
Begin Full Super	188+69.00		188+69.00

		Use
End Full Super	191+31.00	191+31.00
PT Sta	191+63.99	
End Transiton Sta	193+88.00	193+88.00
Theoretical Point of Intersection (0% Super) Sta	192+96.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1988	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	7.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	315.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	286	ft
Max Spiral Curve Length	595	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**315**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

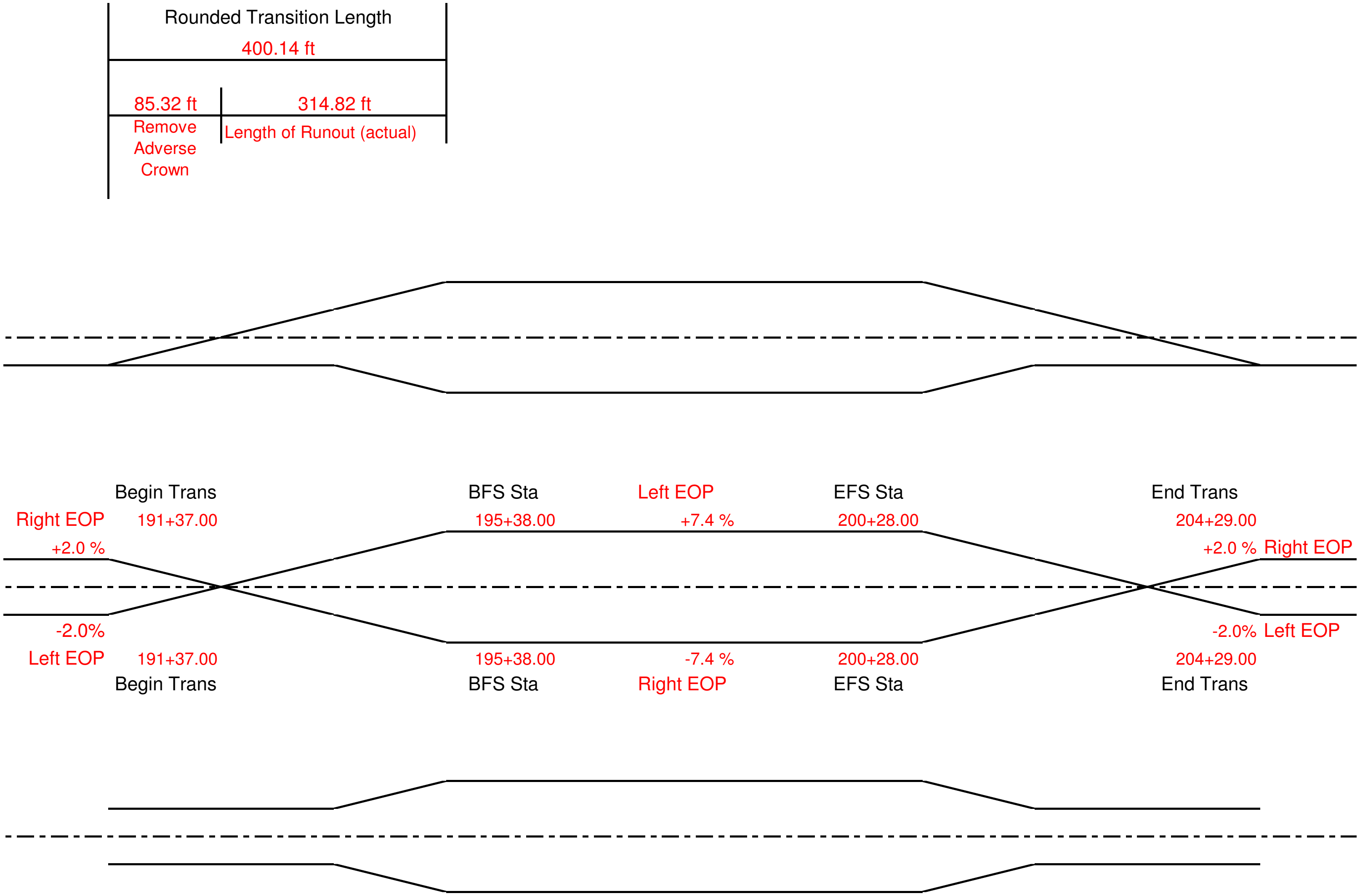
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	51.17	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 7.4%=	400.14	ft	
Rounded to Nearest 0.01 ft	400.14	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	252.00	ft	
* Distance from 0 point to Start of Transition	-85.14	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	192+22.41		
Begin Transition Sta	191+37.00		191+37.00
PC Sta	194+74.41		
Begin Full Super	195+38.00		195+38.00
			Use
End Full Super	200+28.00		200+28.00
PT Sta	200+91.50		
End Transiton Sta	204+29.00		204+29.00
Theoretical Point of Intersection (0% Super) Sta	203+43.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2999	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	3	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

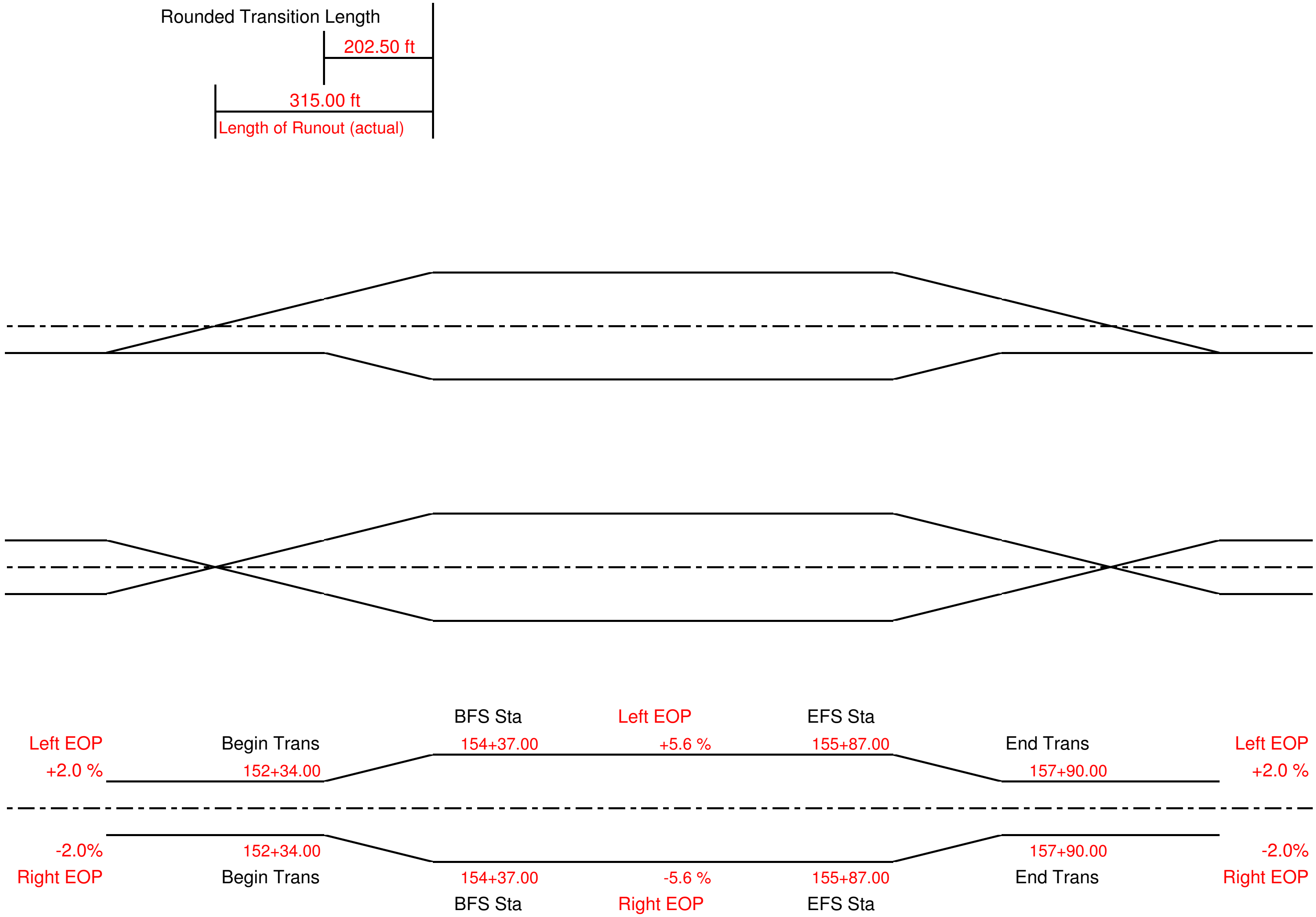
Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.6%=	202.50	ft	
Rounded to Nearest 0.01 ft	202.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	267.75	ft	
* Distance from 0 point to Start of Transition	112.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	151+21.93		
Begin Transition Sta	152+34.00		152+34.00
PC Sta	153+89.68		
Begin Full Super	154+37.00		154+37.00
			Use
End Full Super	155+87.00		155+87.00
PT Sta	156+34.61		
End Transiton Sta	157+90.00		157+90.00
Theoretical Point of Intersection (0% Super) Sta	159+02.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	12049	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	120.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

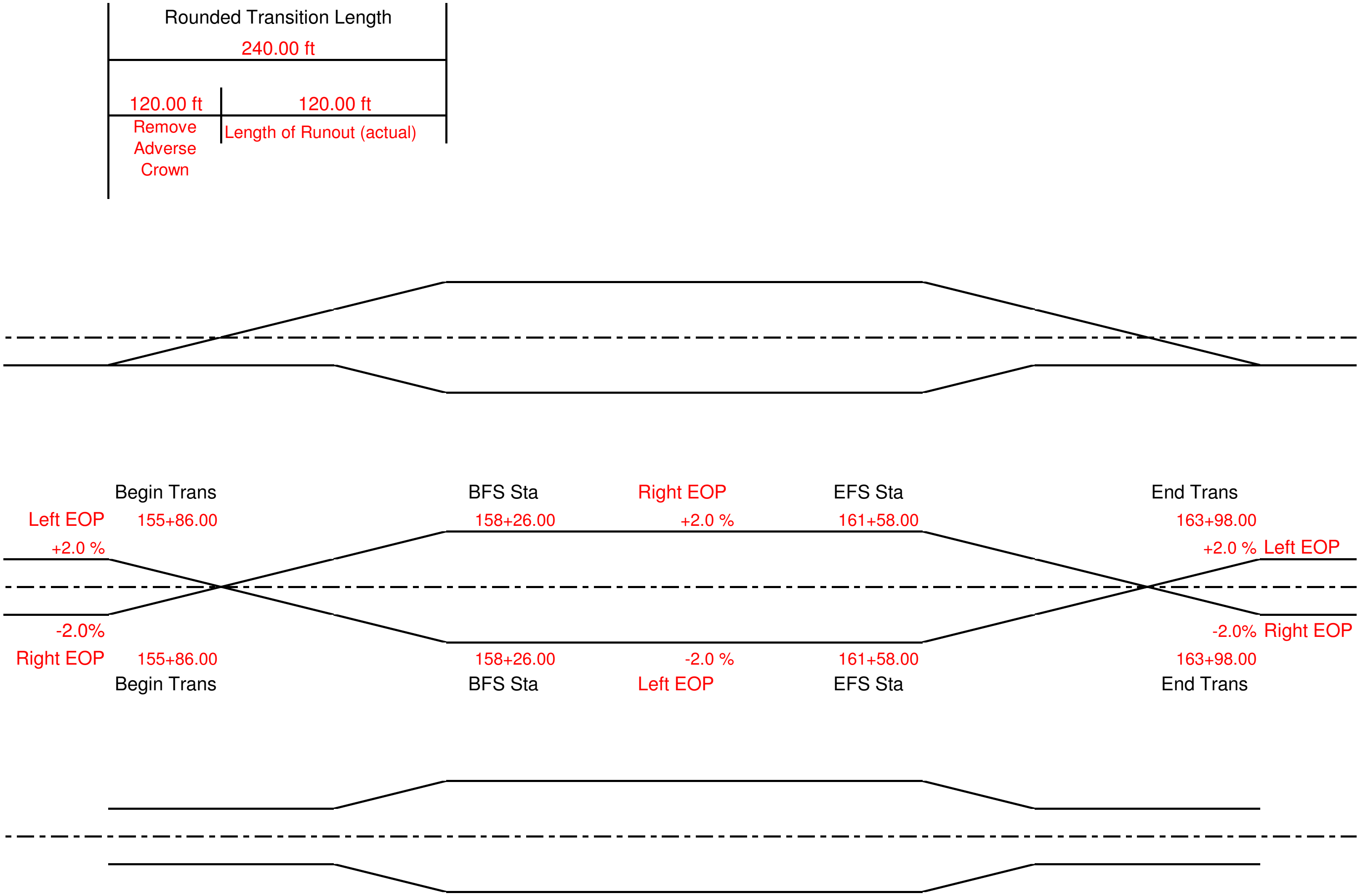
Needed Lr to Fit 65 ft Vert Curve	32.50	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	240.00	ft	
Rounded to Nearest 0.01 ft	240.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	102.00	ft	
* Distance from 0 point to Start of Transition	-120.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	157+06.64		
Begin Transition Sta	155+86.00		155+86.00
PC Sta	158+08.64		
Begin Full Super	158+26.00		158+26.00
			Use
End Full Super	161+58.00		161+58.00
PT Sta	161+75.19		
End Transiton Sta	163+98.00		163+98.00
Theoretical Point of Intersection (0% Super) Sta	162+78.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	738	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of :	3	
Design Super (e_d) positive value	7.7	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	345.00	ft
Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	264	ft
Max Spiral Curve Length	484	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**345**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 7.7%=	255.39	ft
Rounded to Nearest 0.01 ft	255.39	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	310.50	ft
* Distance from 0 point to Start of Transition	89.61	ft

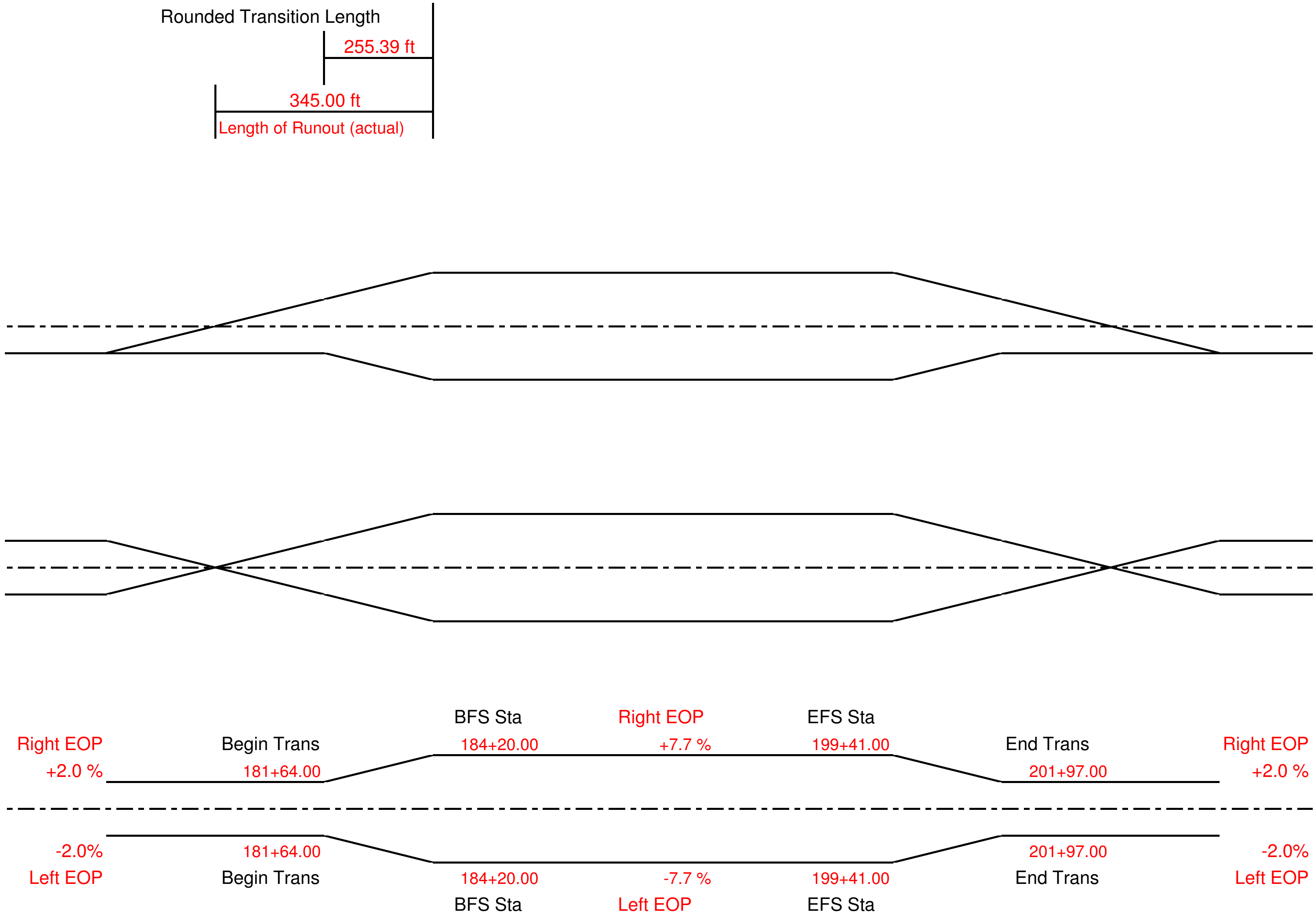
		Use
Theoretical Point of Intersection (0% Super) Sta	180+74.48	
Begin Transition Sta	181+64.00	181+64.00
PC Sta	183+84.98	
Begin Full Super	184+20.00	184+20.00

		Use
End Full Super	199+41.00	199+41.00
PT Sta	199+75.50	
End Transiton Sta	201+97.00	201+97.00
Theoretical Point of Intersection (0% Super) Sta	202+86.00	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	345.00	ft
Use Calculated Lr	345.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	46.67	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

SUPER ELEVATION TRANSITION CALCULATION

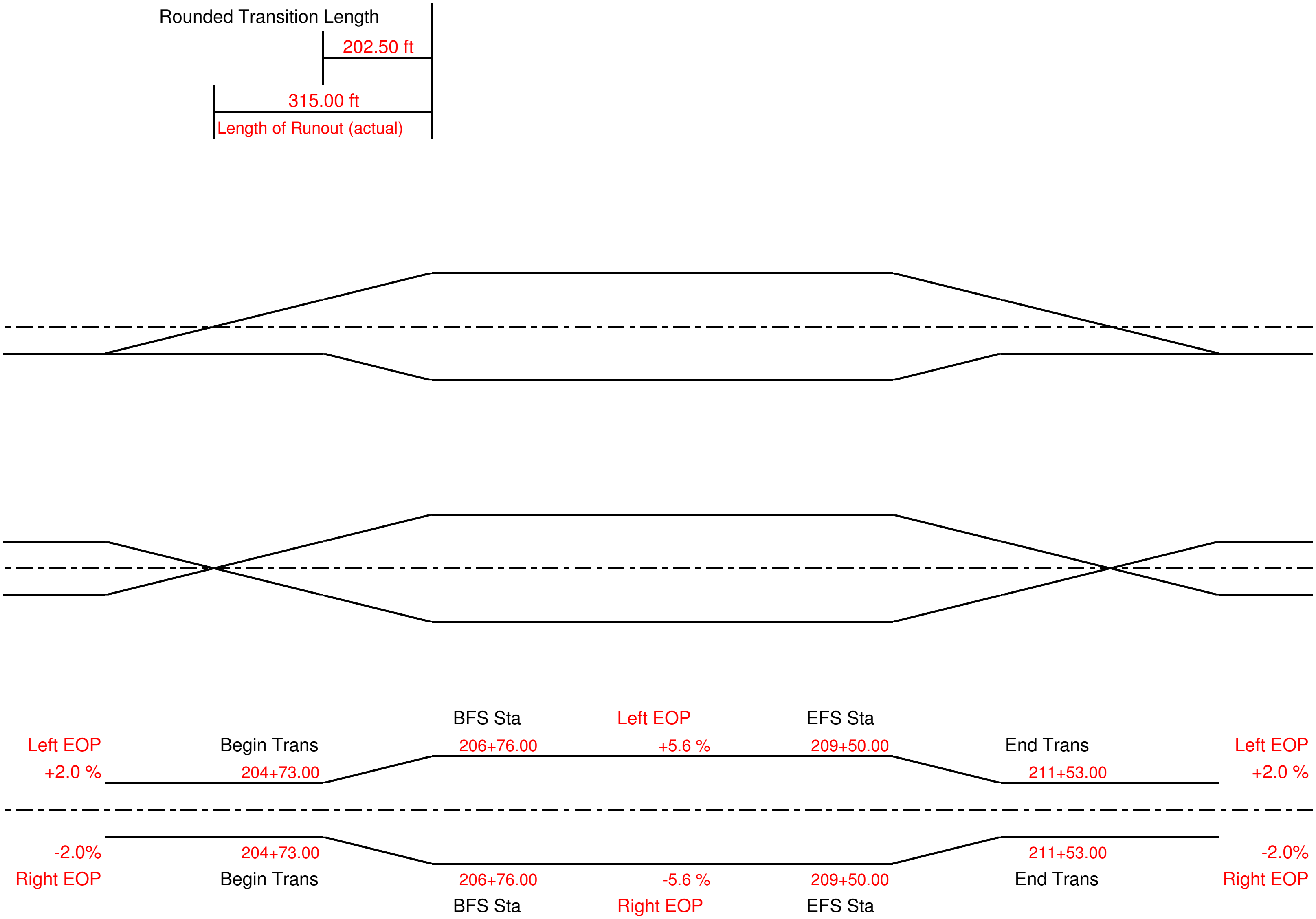
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 5.6%=	202.50	ft
Rounded to Nearest 0.01 ft	202.50	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.85	
Transition Length on Tangent	267.75	ft
* Distance from 0 point to Start of Transition	112.50	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	203+61.10	
Begin Transition Sta	204+73.00	204+73.00
PC Sta	206+28.85	
Begin Full Super	206+76.00	206+76.00

		Use
End Full Super	209+50.00	209+50.00
PT Sta	209+97.02	
End Transiton Sta	211+53.00	211+53.00
Theoretical Point of Intersection (0% Super) Sta	212+65.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3000	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	5.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	315.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	46.67	ft
Calculated Lr	315.00	ft
Use Calculated Lr	315.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.6%=	202.50	ft	
Rounded to Nearest 0.01 ft	202.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.85		
Transition Length on Tangent	267.75	ft	
* Distance from 0 point to Start of Transition	112.50	ft	
Theoretical Point of Intersection (0% Super) Sta	102+51.61		
Begin Transition Sta	103+64.00		103+64.00
PC Sta	105+19.36		
Begin Full Super	105+67.00		105+67.00

		Use
End Full Super	112+01.00	112+01.00
PT Sta	112+47.93	
End Transiton Sta	114+04.00	114+04.00
Theoretical Point of Intersection (0% Super) Sta	115+16.00	

CA Group

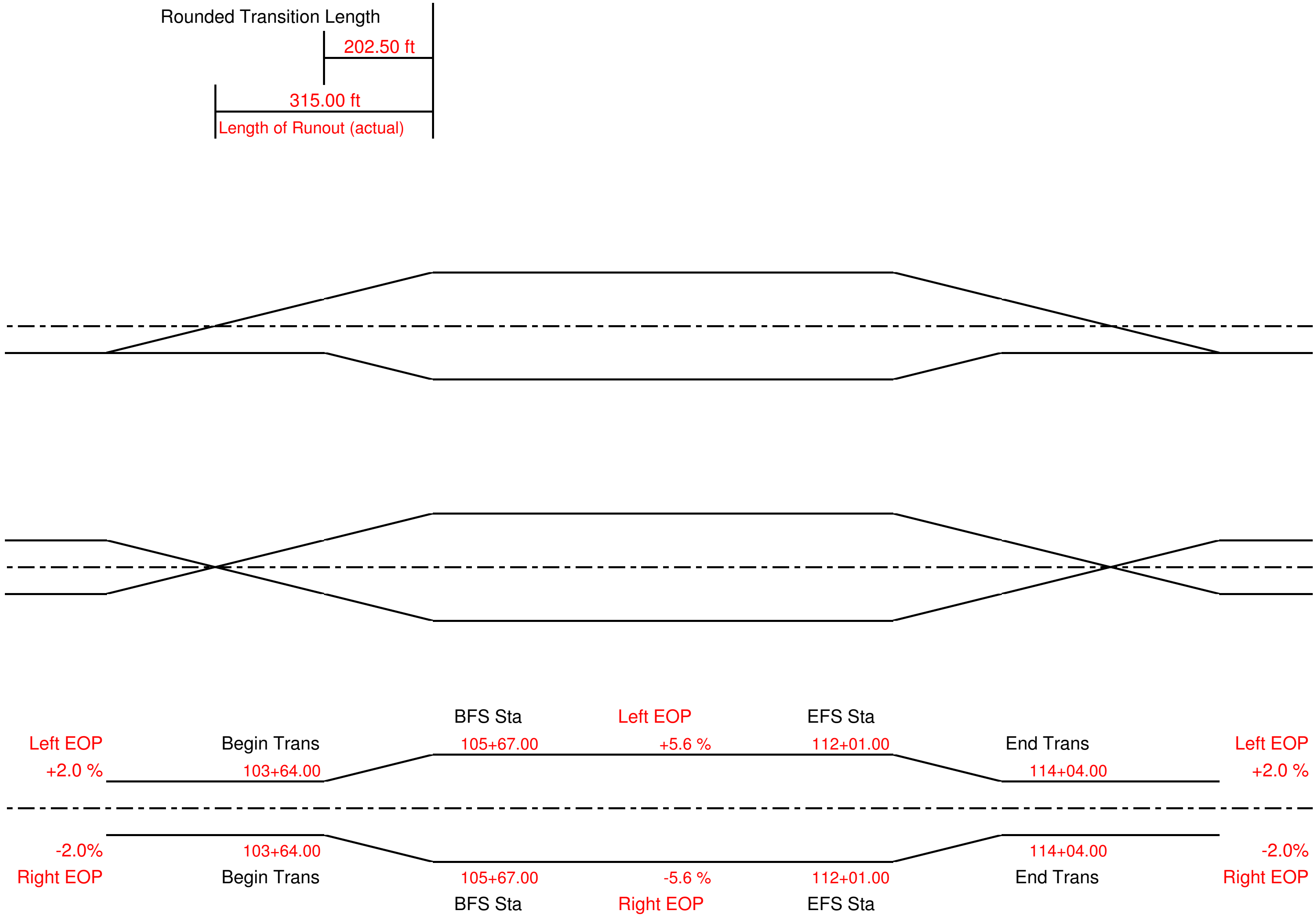
Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"MC"-8

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	3500	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.2	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

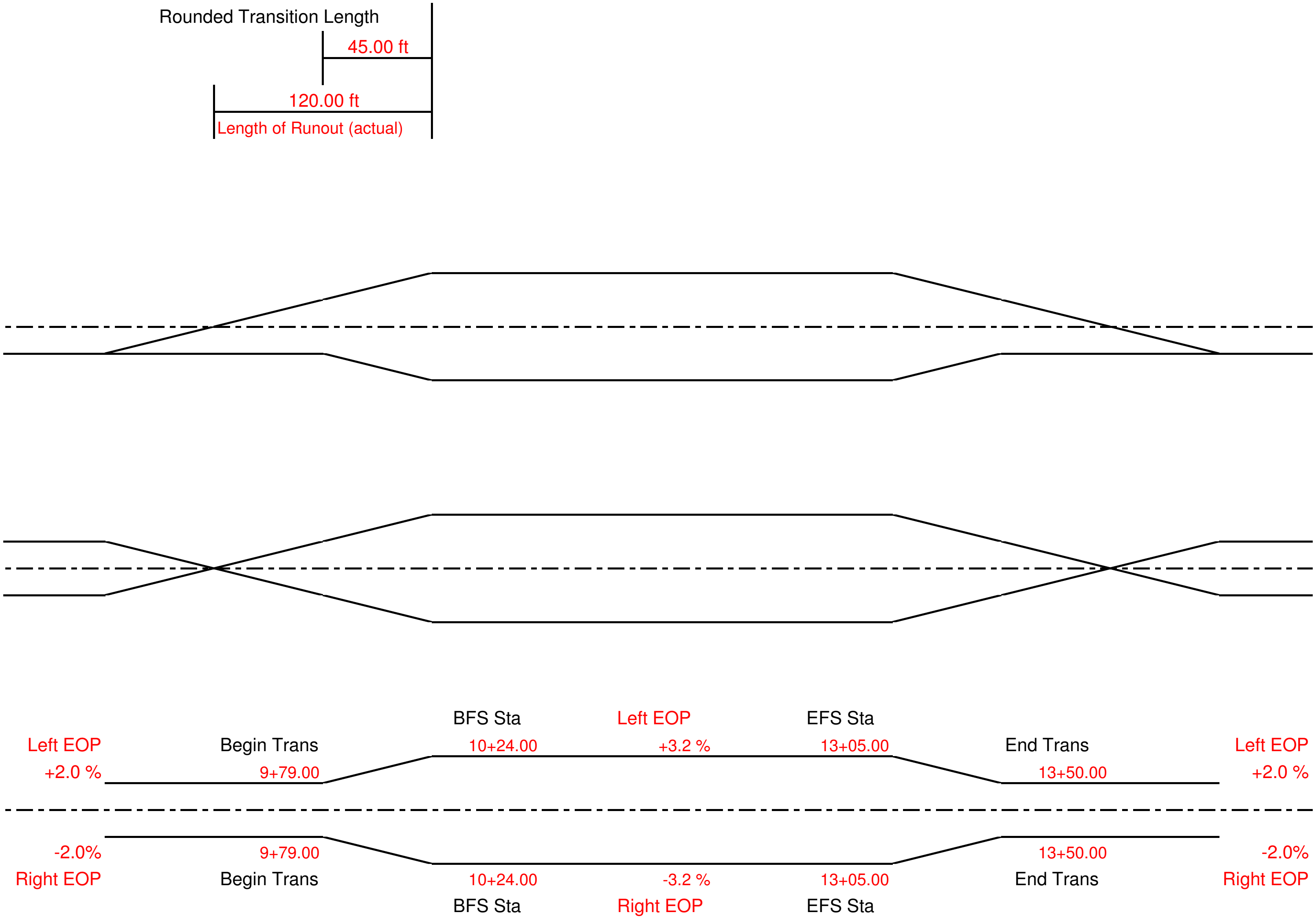
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.2%=	45.00	ft	
Rounded to Nearest 0.01 ft	45.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	96.00	ft	
* Distance from 0 point to Start of Transition	75.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+04.00		
Begin Transition Sta	9+79.00		9+79.00
PC Sta	10+00.00		
Begin Full Super	10+24.00		10+24.00
			Use
End Full Super	13+05.00		13+05.00
PT Sta	13+28.73		
End Transiton Sta	13+50.00		13+50.00
Theoretical Point of Intersection (0% Super) Sta	14+25.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	6000	ft
Design Speed	55	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	2.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	135.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 55 ft Vert Curve	0.00	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

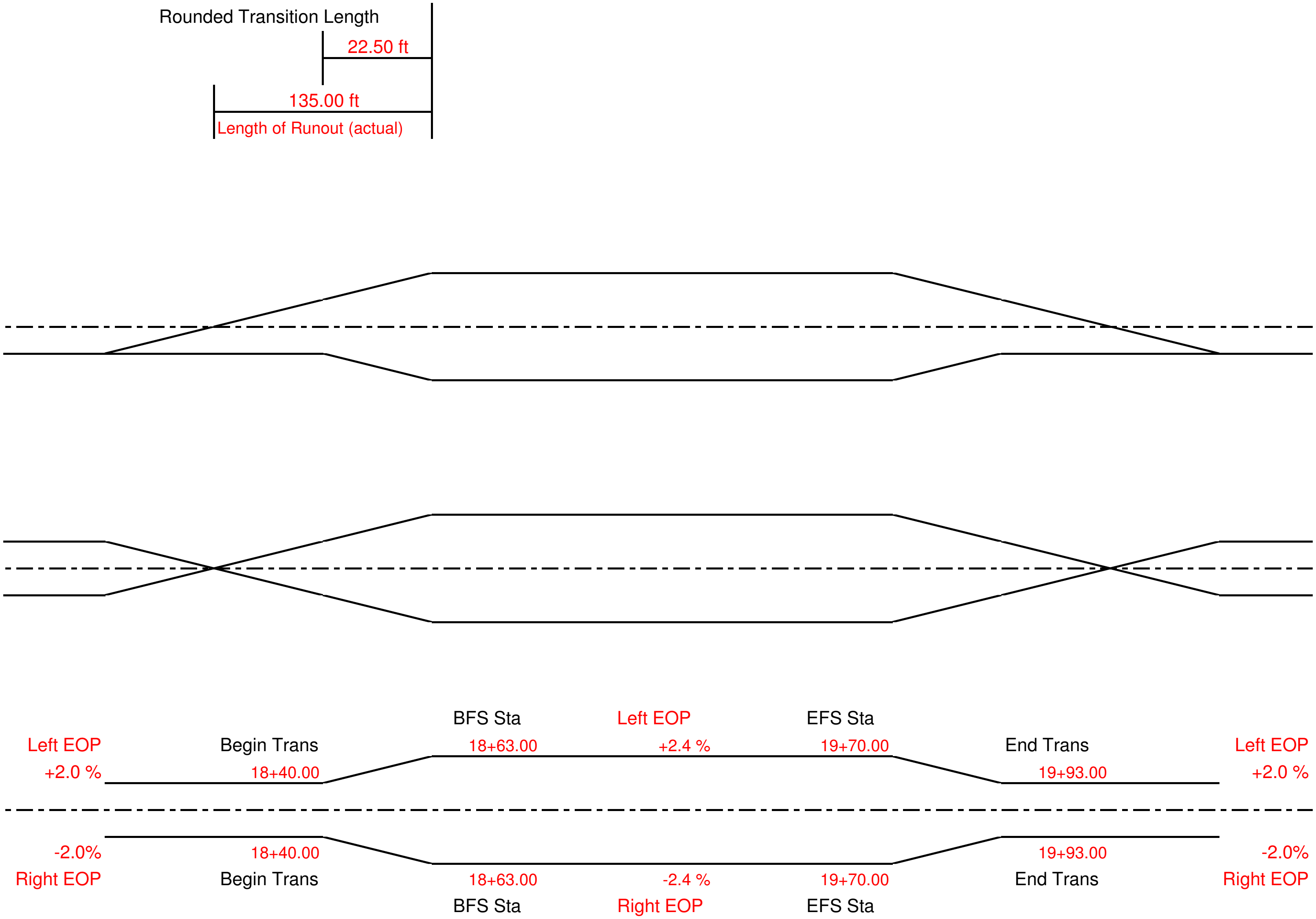
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 2.4%=	22.50	ft
Rounded to Nearest 0.01 ft	22.50	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.85	
Transition Length on Tangent	114.75	ft
* Distance from 0 point to Start of Transition	112.50	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	17+28.30	
Begin Transition Sta	18+40.00	18+40.00
PC Sta	18+43.05	
Begin Full Super	18+63.00	18+63.00

		Use
End Full Super	19+70.00	19+70.00
PT Sta	19+90.48	
End Transiton Sta	19+93.00	19+93.00
Theoretical Point of Intersection (0% Super) Sta	21+05.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2765	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	4.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

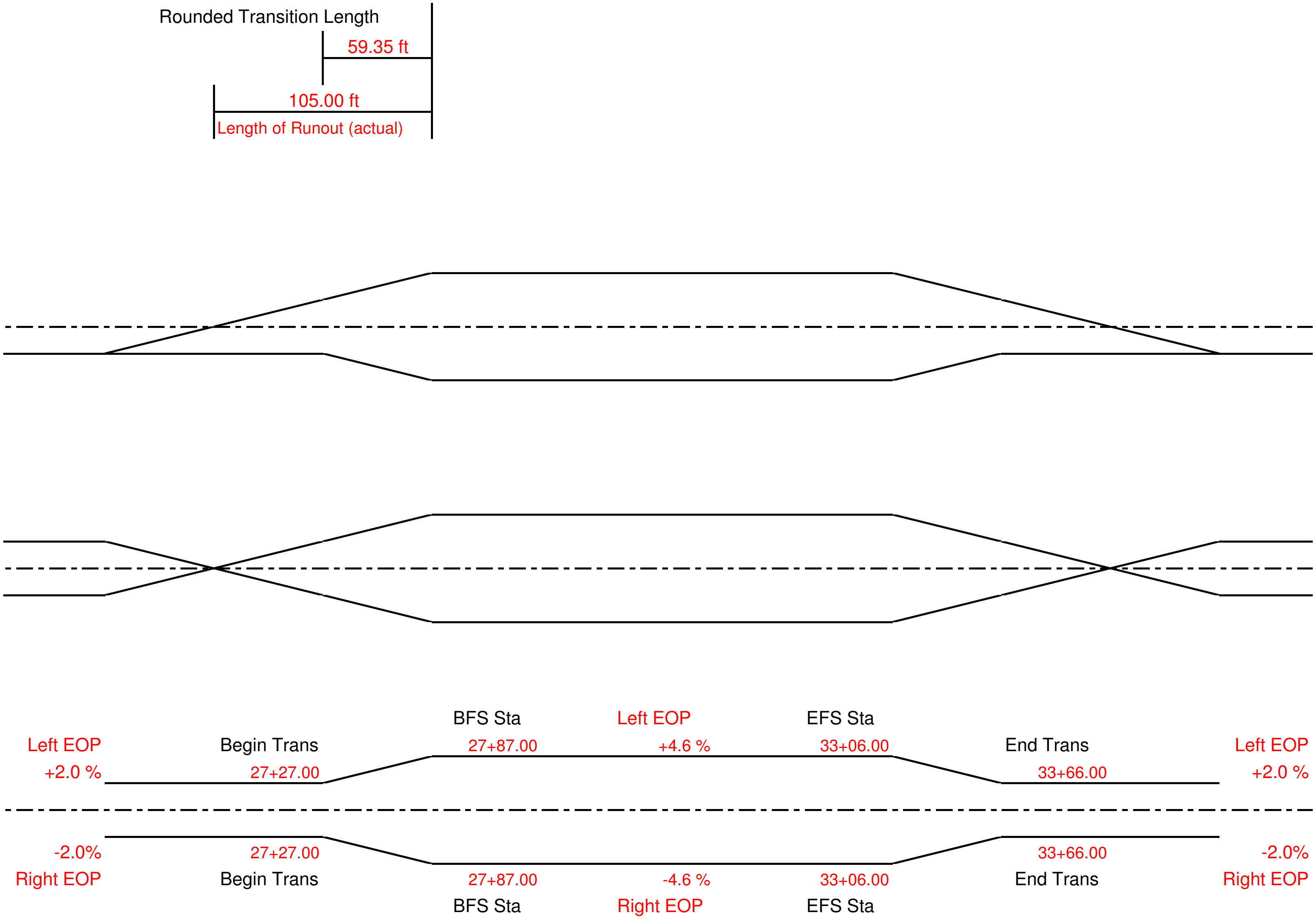
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

			Use
Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.6%=	59.35	ft	
Rounded to Nearest 0.01 ft	59.35	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	45.65	ft	
Theoretical Point of Intersection (0% Super) Sta	26+81.79		
Begin Transition Sta	27+27.00		27+27.00
PC Sta	27+65.79		
Begin Full Super	27+87.00		27+87.00

		Use
End Full Super	33+06.00	33+06.00
PT Sta	33+27.57	
End Transiton Sta	33+66.00	33+66.00
Theoretical Point of Intersection (0% Super) Sta	34+11.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	163	ft
Design Speed	25	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	7.8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.7	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	135.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	73	ft
Max Spiral Curve Length	114	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**135**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 7.8%=	100.38	ft
Rounded to Nearest 0.01 ft	100.38	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	108.00	ft
* Distance from 0 point to Start of Transition	34.62	ft

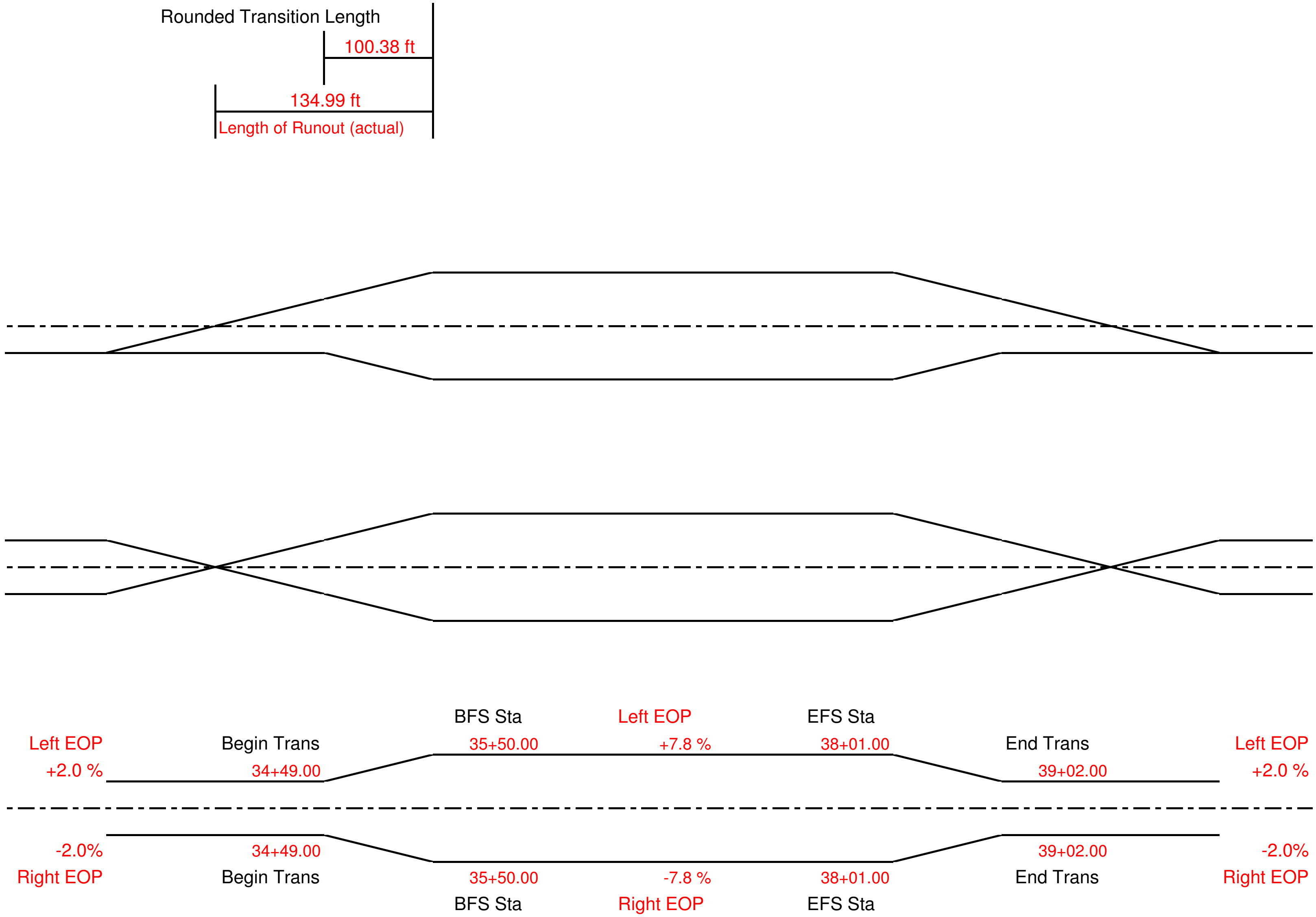
		Use
Theoretical Point of Intersection (0% Super) Sta	34+15.22	
Begin Transition Sta	34+49.00	34+49.00
PC Sta	35+23.22	
Begin Full Super	35+50.00	35+50.00

		Use
End Full Super	38+01.00	38+01.00
PT Sta	38+28.26	
End Transiton Sta	39+02.00	39+02.00
Theoretical Point of Intersection (0% Super) Sta	39+36.00	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 25 ft Vert Curve	0.00	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

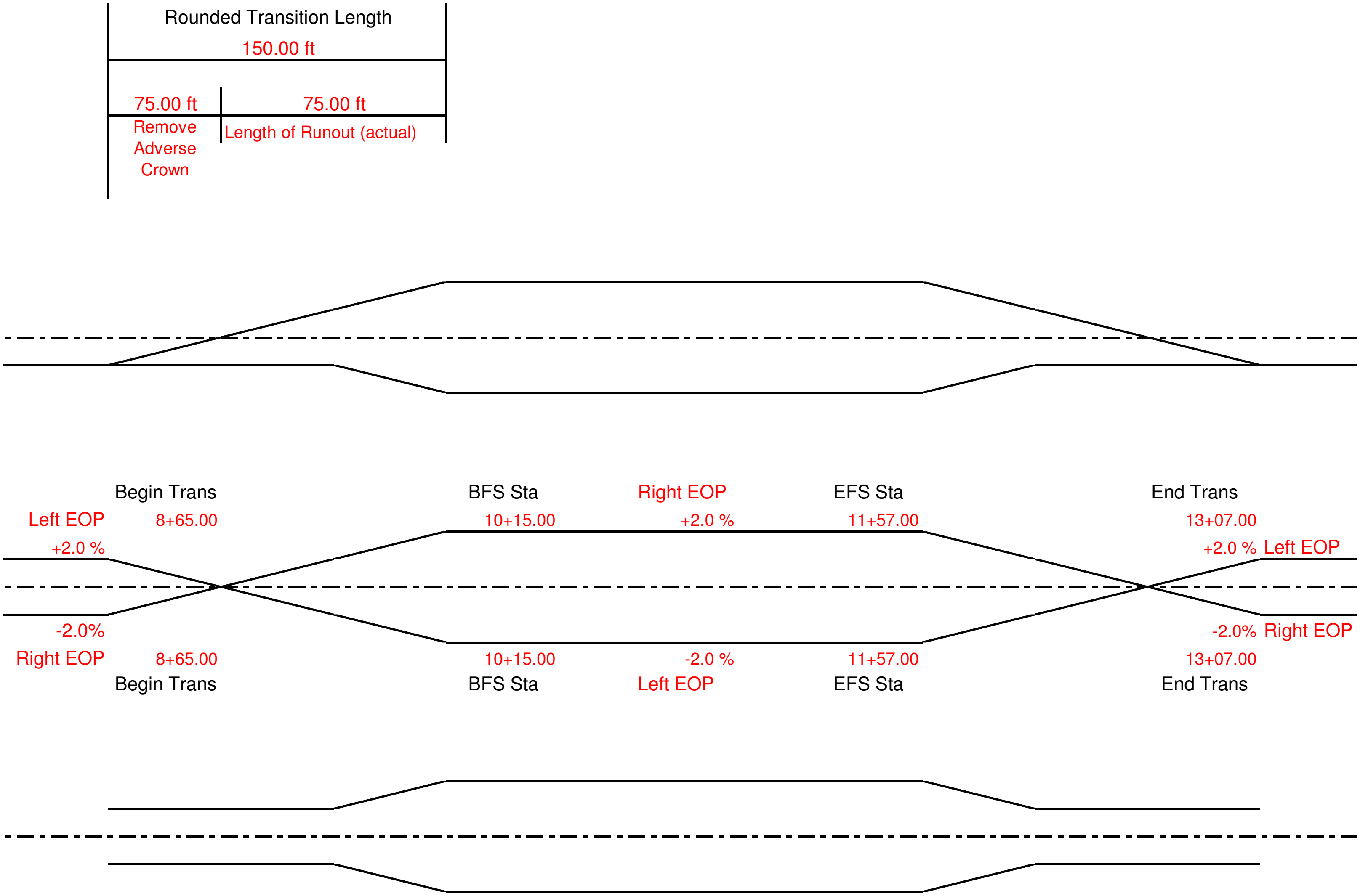
Needed Lr to Fit 50 ft Vert Curve	25.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2%=	150.00	ft	
Rounded to Nearest 0.01 ft	150.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	60.00	ft	
* Distance from 0 point to Start of Transition	-75.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+40.00		
Begin Transition Sta	8+65.00		8+65.00
PC Sta	10+00.00		
Begin Full Super	10+15.00		10+15.00
			Use
End Full Super	11+57.00		11+57.00
PT Sta	11+71.22		
End Transiton Sta	13+07.00		13+07.00
Theoretical Point of Intersection (0% Super) Sta	12+32.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	912	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	7.1	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	240.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	403	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**240**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

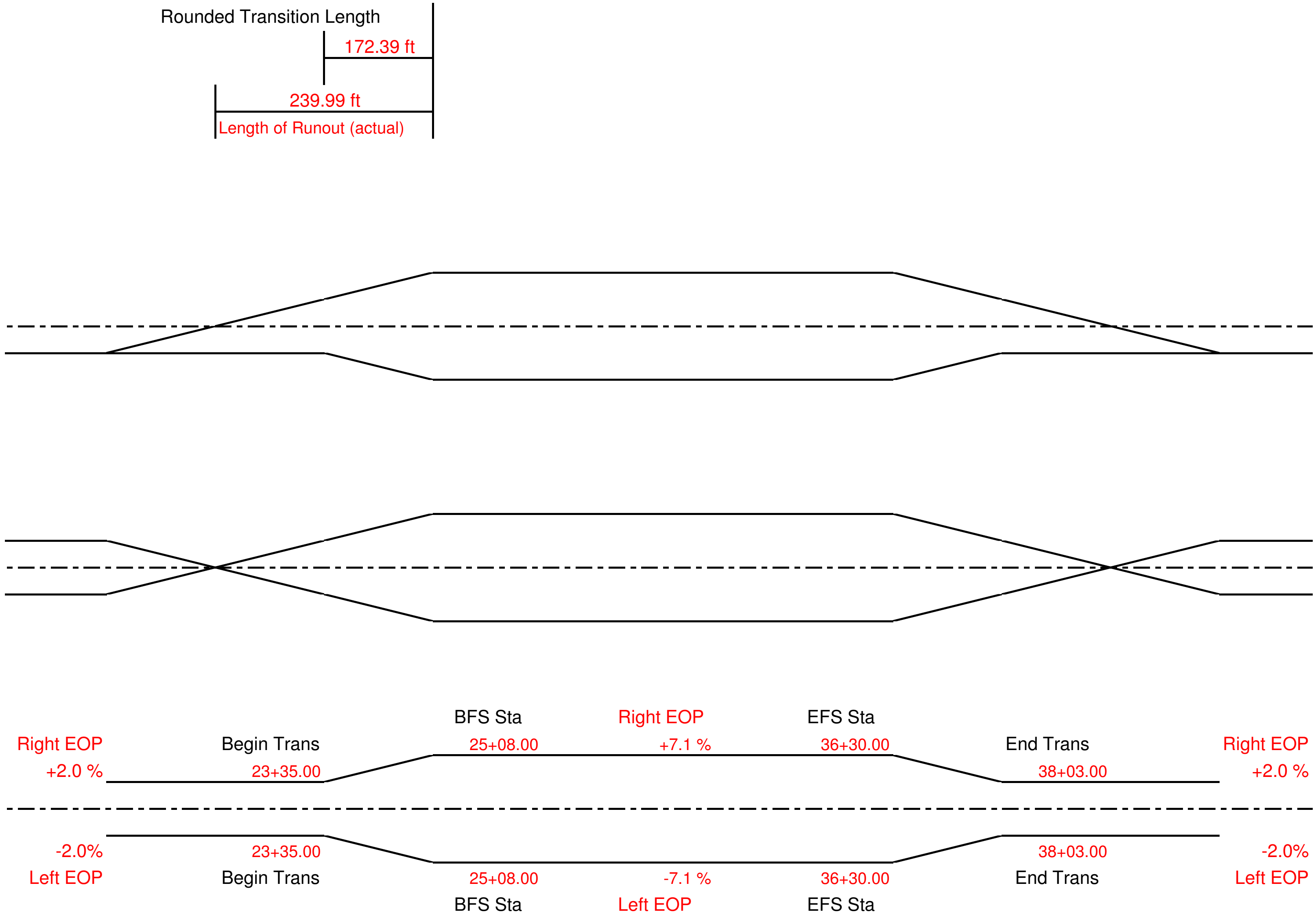
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	240.00	ft
Use Calculated Lr	240.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.1%=	172.39	ft	
Rounded to Nearest 0.01 ft	172.39	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	216.00	ft	
* Distance from 0 point to Start of Transition	67.61	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	22+67.62		
Begin Transition Sta	23+35.00		23+35.00
PC Sta	24+83.62		
Begin Full Super	25+08.00		25+08.00
			Use
End Full Super	36+30.00		36+30.00
PT Sta	36+54.00		
End Transiton Sta	38+03.00		38+03.00
Theoretical Point of Intersection (0% Super) Sta	38+70.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1766	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	210.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

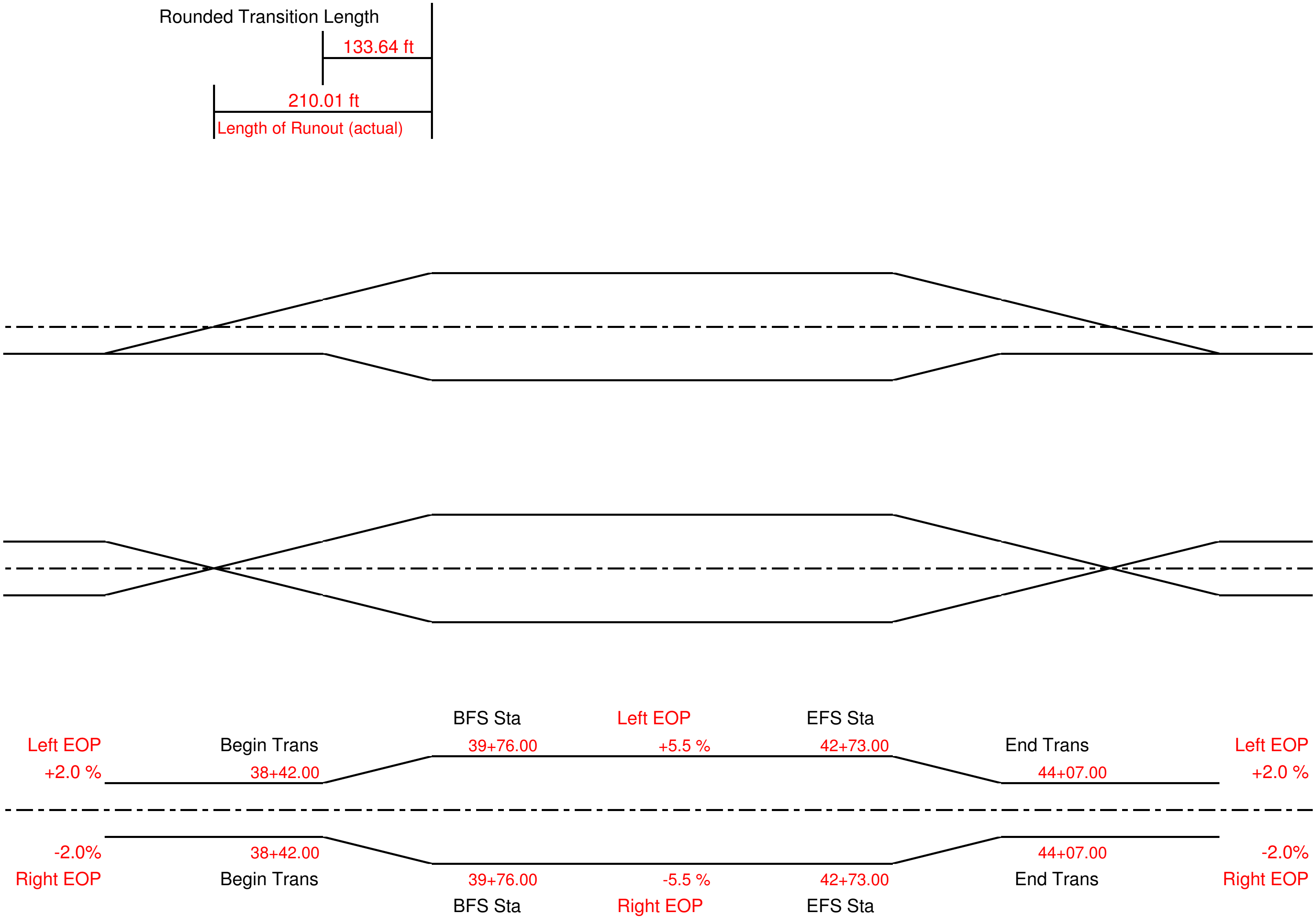
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	210.00	ft
Use Calculated Lr	210.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.5%=	133.64	ft	
Rounded to Nearest 0.01 ft	133.64	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	168.00	ft	
* Distance from 0 point to Start of Transition	76.36	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	37+66.58		
Begin Transition Sta	38+42.00		38+42.00
PC Sta	39+34.58		
Begin Full Super	39+76.00		39+76.00
			Use
End Full Super	42+73.00		42+73.00
PT Sta	43+14.37		
End Transiton Sta	44+07.00		44+07.00
Theoretical Point of Intersection (0% Super) Sta	44+83.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2280	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	180.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

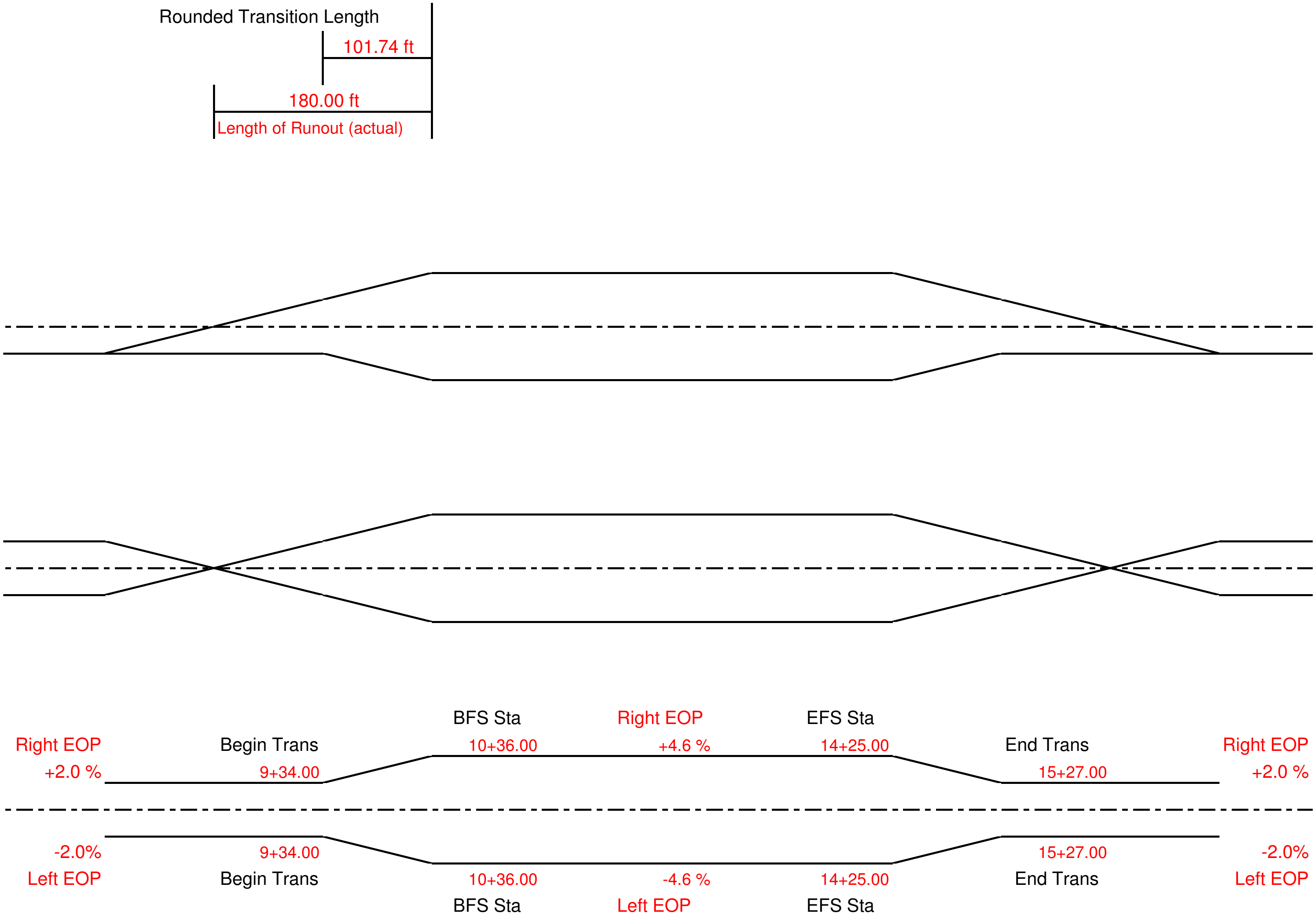
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.6%=	101.74	ft	
Rounded to Nearest 0.01 ft	101.74	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	144.00	ft	
* Distance from 0 point to Start of Transition	78.26	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	8+56.00		
Begin Transition Sta	9+34.00		9+34.00
PC Sta	10+00.00		
Begin Full Super	10+36.00		10+36.00
			Use
End Full Super	14+25.00		14+25.00
PT Sta	14+60.85		
End Transiton Sta	15+27.00		15+27.00
Theoretical Point of Intersection (0% Super) Sta	16+05.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4465	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

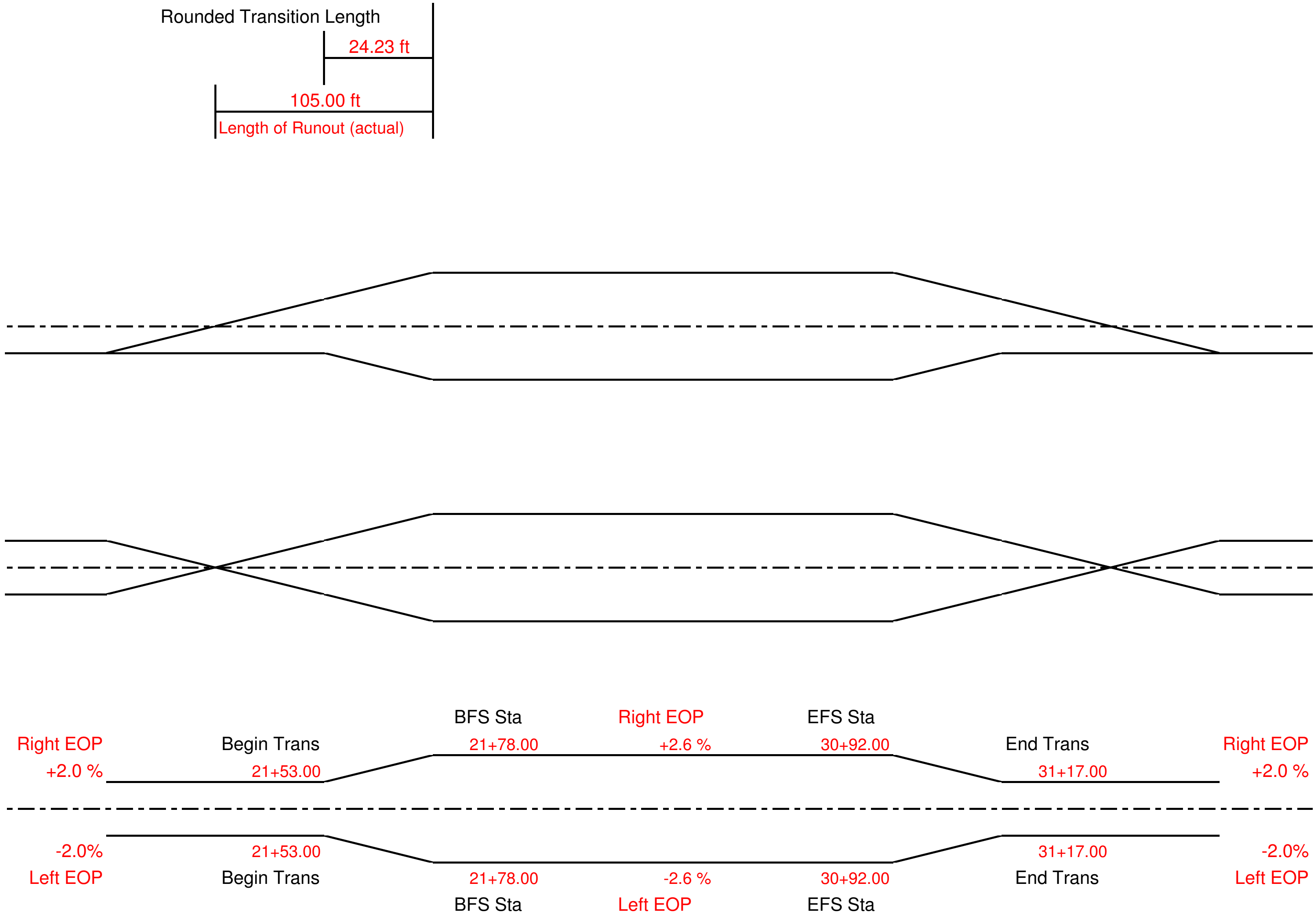
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 2.6%=	24.23	ft
Rounded to Nearest 0.01 ft	24.23	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	84.00	ft
* Distance from 0 point to Start of Transition	80.77	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	20+72.34	
Begin Transition Sta	21+53.00	21+53.00
PC Sta	21+56.34	
Begin Full Super	21+78.00	21+78.00

		Use
End Full Super	30+92.00	30+92.00
PT Sta	31+13.41	
End Transiton Sta	31+17.00	31+17.00
Theoretical Point of Intersection (0% Super) Sta	31+97.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2058	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	5	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	180.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

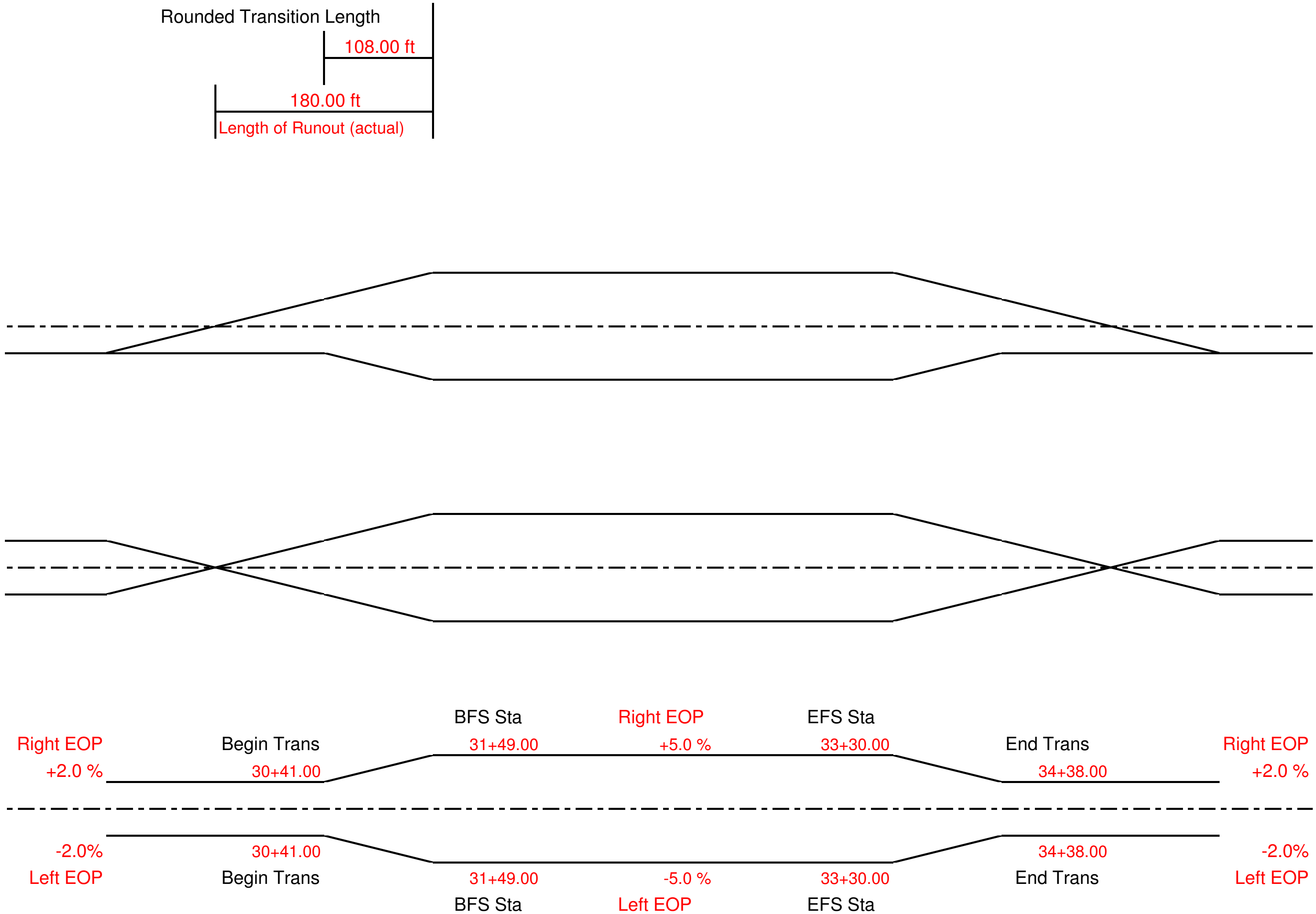
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5%=	108.00	ft	
Rounded to Nearest 0.01 ft	108.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	144.00	ft	
* Distance from 0 point to Start of Transition	72.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	29+69.41		
Begin Transition Sta	30+41.00		30+41.00
PC Sta	31+13.41		
Begin Full Super	31+49.00		31+49.00
			Use
End Full Super	33+30.00		33+30.00
PT Sta	33+65.59		
End Transiton Sta	34+38.00		34+38.00
Theoretical Point of Intersection (0% Super) Sta	35+10.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2012	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	5.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	135.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

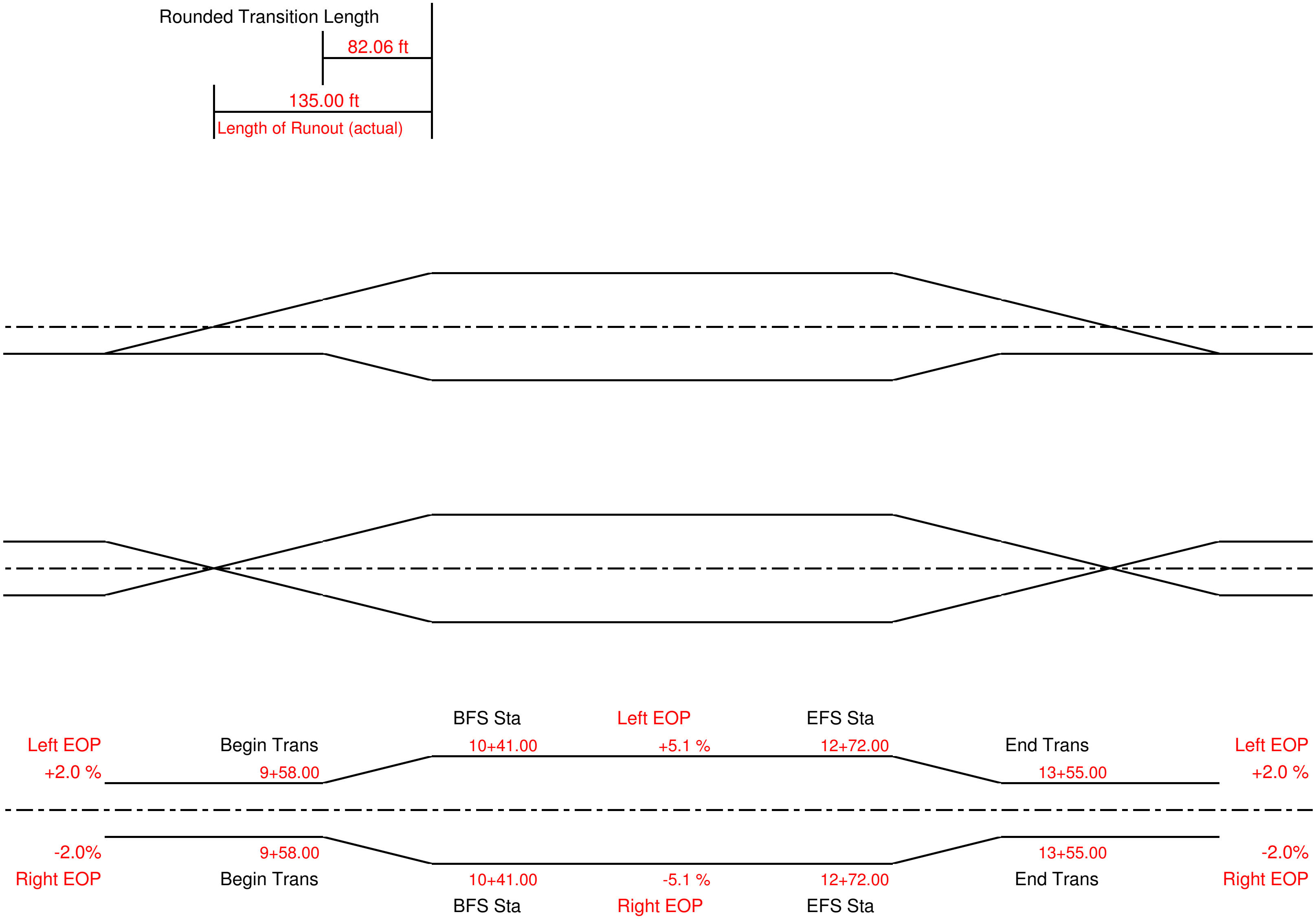
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	135.00	ft
Use Calculated Lr	135.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.1%=	82.06	ft	
Rounded to Nearest 0.01 ft	82.06	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	94.50	ft	
* Distance from 0 point to Start of Transition	52.94	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+05.50		
Begin Transition Sta	9+58.00		9+58.00
PC Sta	10+00.00		
Begin Full Super	10+41.00		10+41.00
			Use
End Full Super	12+72.00		12+72.00
PT Sta	13+12.76		
End Transiton Sta	13+55.00		13+55.00
Theoretical Point of Intersection (0% Super) Sta	14+07.00		

SUPER ELEVATION DIAGRAM



$$L_r = \frac{(w \cdot n) \cdot e_d \cdot (b_w)}{\Delta}$$

Radius	2268	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	4.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

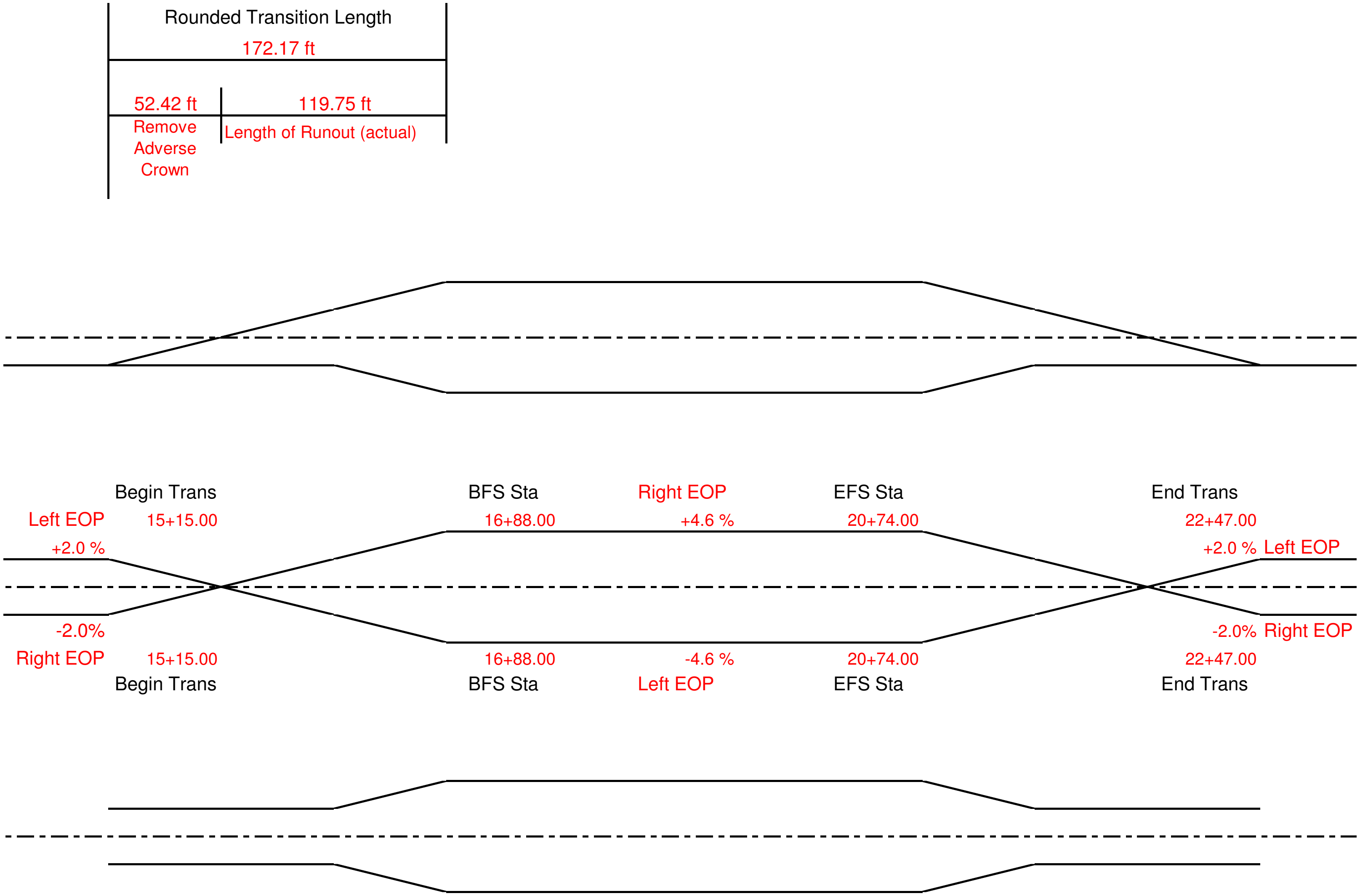
Transition Length Check to fit Design Speed Rounding Curves		
Needed Lr to Fit 50 ft Vert Curve	34.85	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 4.6%=	172.17	ft	
Rounded to Nearest 0.01 ft	172.17	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	-52.17	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	15+67.58		
Begin Transition Sta	15+15.00		15+15.00
PC Sta	16+51.58		
Begin Full Super	16+88.00		16+88.00
			Use
End Full Super	20+74.00		20+74.00
PT Sta	21+10.01		
End Transiton Sta	22+47.00		22+47.00
Theoretical Point of Intersection (0% Super) Sta	21+94.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4453	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	2.6	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

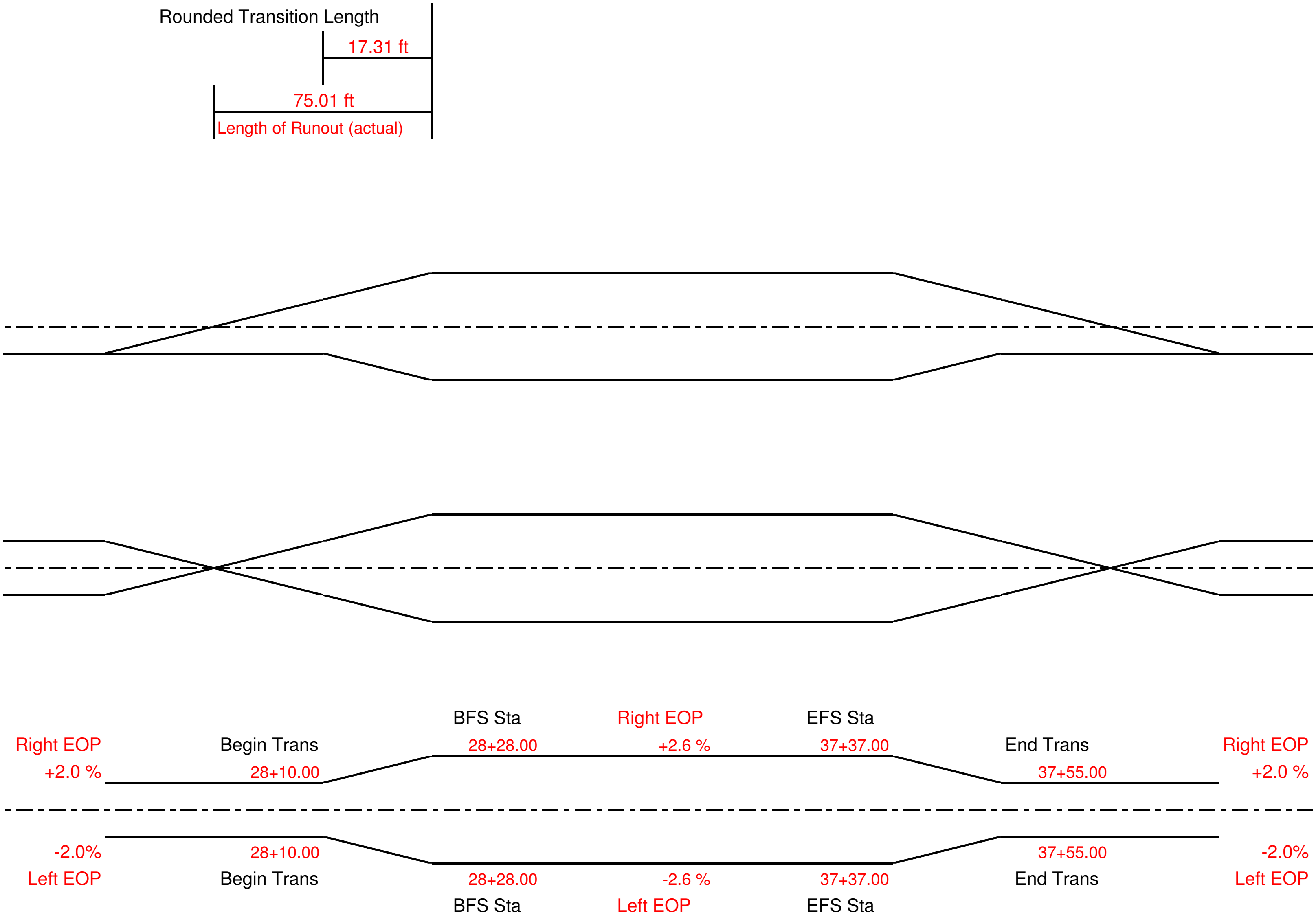
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.6%=	17.31	ft	
Rounded to Nearest 0.01 ft	17.31	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	52.50	ft	
* Distance from 0 point to Start of Transition	57.69	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	27+52.99		
Begin Transition Sta	28+10.00		28+10.00
PC Sta	28+05.49		
Begin Full Super	28+28.00		28+28.00
			Use
End Full Super	37+37.00		37+37.00
PT Sta	37+59.99		
End Transiton Sta	37+55.00		37+55.00
Theoretical Point of Intersection (0% Super) Sta	38+12.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2046	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of :	1	
Design Super (e_d) positive value	5	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5%=	72.00	ft	
Rounded to Nearest 0.01 ft	72.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.7		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	48.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	36+75.99		
Begin Transition Sta	37+23.00		37+23.00
PC Sta	37+59.99		
Begin Full Super	37+95.00		37+95.00

		Use
End Full Super	41+46.00	41+46.00
PT Sta	41+81.93	
End Transiton Sta	42+18.00	42+18.00
Theoretical Point of Intersection (0% Super) Sta	42+66.00	

CA Group

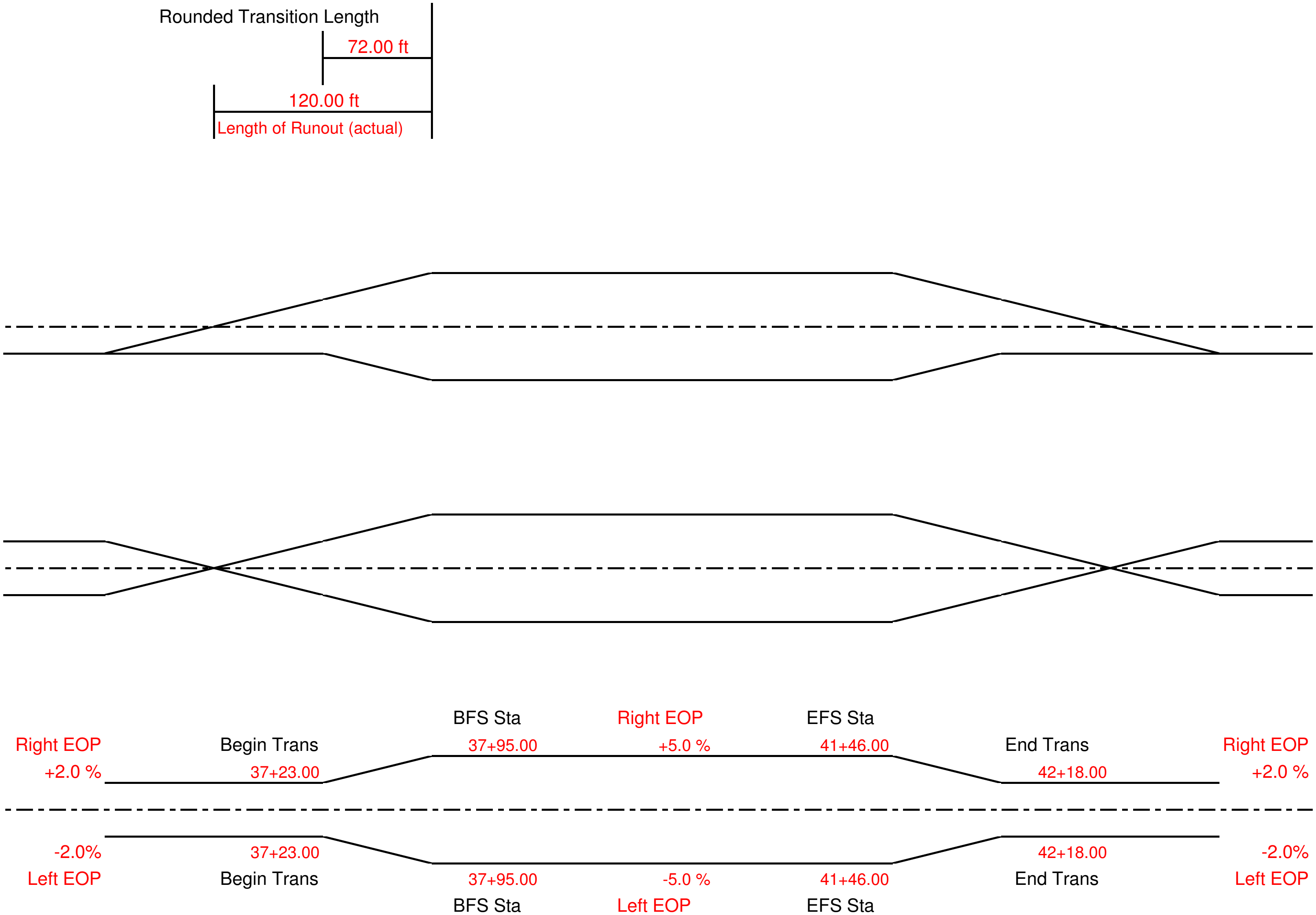
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"SW"-4

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	444	ft
Design Speed	35	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	7.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	150.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	103	ft
Max Spiral Curve Length	188	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**150**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

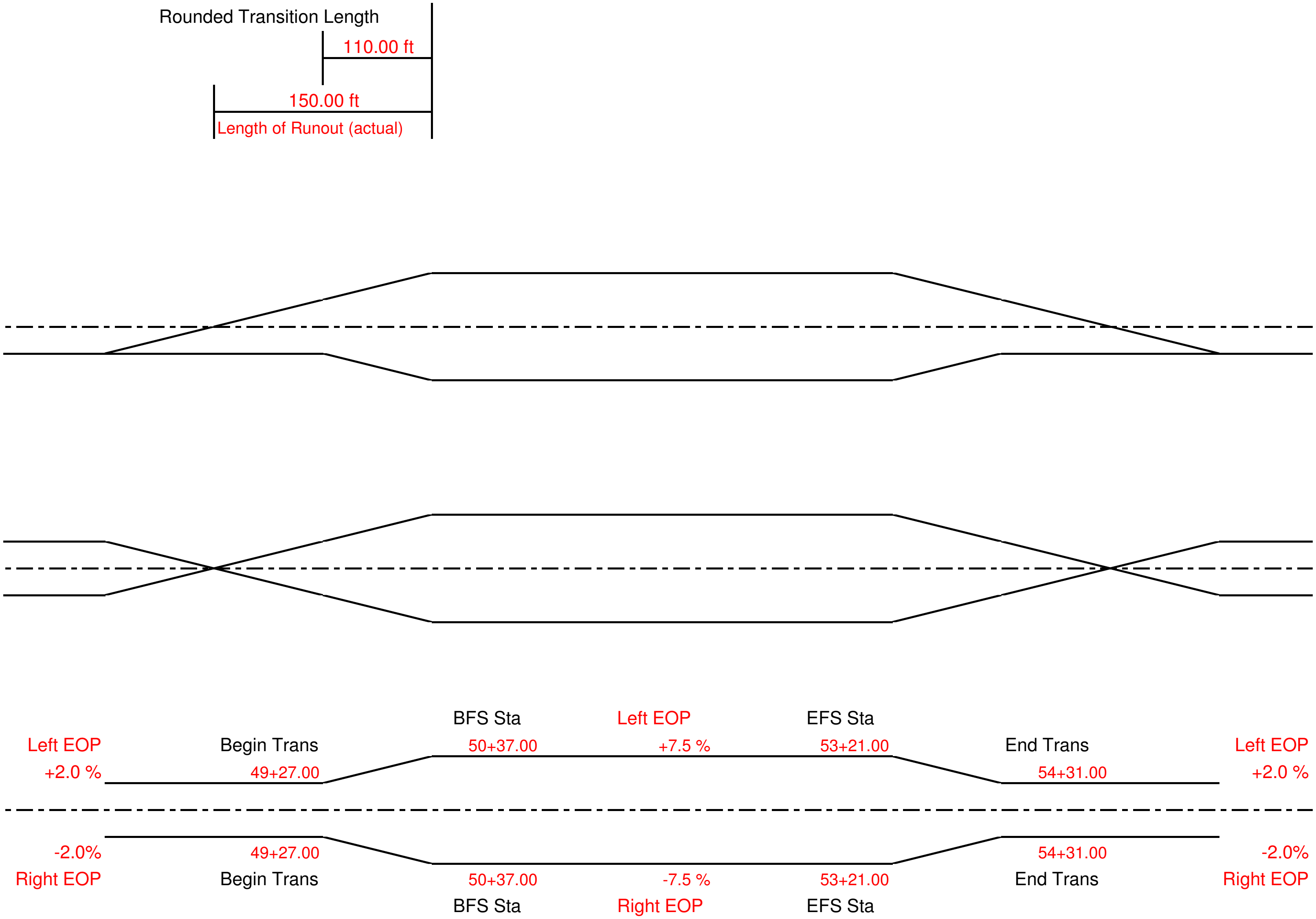
Needed Lr to Fit 35 ft Vert Curve	0.00	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 7.5%=	110.00	ft	
Rounded to Nearest 0.01 ft	110.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	120.00	ft	
* Distance from 0 point to Start of Transition	40.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	48+87.12		
Begin Transition Sta	49+27.00		49+27.00
PC Sta	50+07.12		
Begin Full Super	50+37.00		50+37.00
			Use
End Full Super	53+21.00		53+21.00
PT Sta	53+50.29		
End Transiton Sta	54+31.00		54+31.00
Theoretical Point of Intersection (0% Super) Sta	54+71.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	589	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	1	
Design Super (e_d) positive value	8	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	180.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	132	ft
Max Spiral Curve Length	216	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**180**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

SUPER ELEVATION TRANSITION CALCULATION

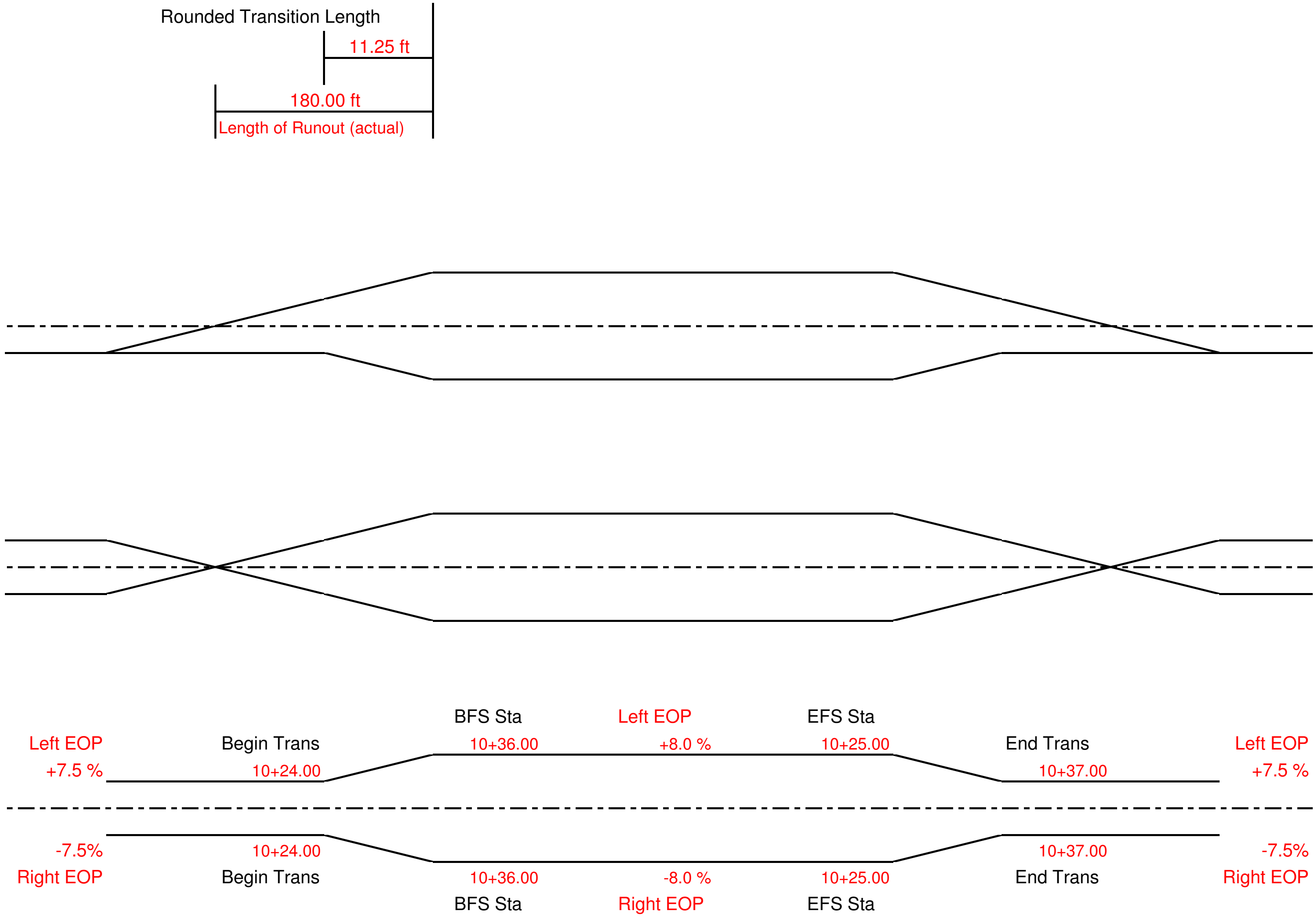
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	7.5	%
Super Elevation Transition Length from 7.5%to 8%=	11.25	ft
Rounded to Nearest 0.01 ft	11.25	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	144.00	ft
* Distance from 0 point to Start of Transition	168.75	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	8+56.00	
Begin Transition Sta	10+24.00	10+24.00
PC Sta	10+00.00	
Begin Full Super	10+36.00	10+36.00

		Use
End Full Super	10+25.00	10+25.00
PT Sta	10+61.46	
End Transiton Sta	10+37.00	10+37.00
Theoretical Point of Intersection (0% Super) Sta	12+05.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	560	ft
Design Speed	40	mph
W	12	ft
n (greatest no. of lanes on one side of :	1	
Design Super (e_d) positive value	7.7	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	165.00	ft
Spiral Curves Recommended Check	**Yes**	
Spiral Curve Calc	117	ft
Max Spiral Curve Length	211	ft
Is Spiral Curve Length> Lr?	**No**	
Use Spiral Curve Length=	**165**	ft
Are Spiral Transitions Being Used?	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

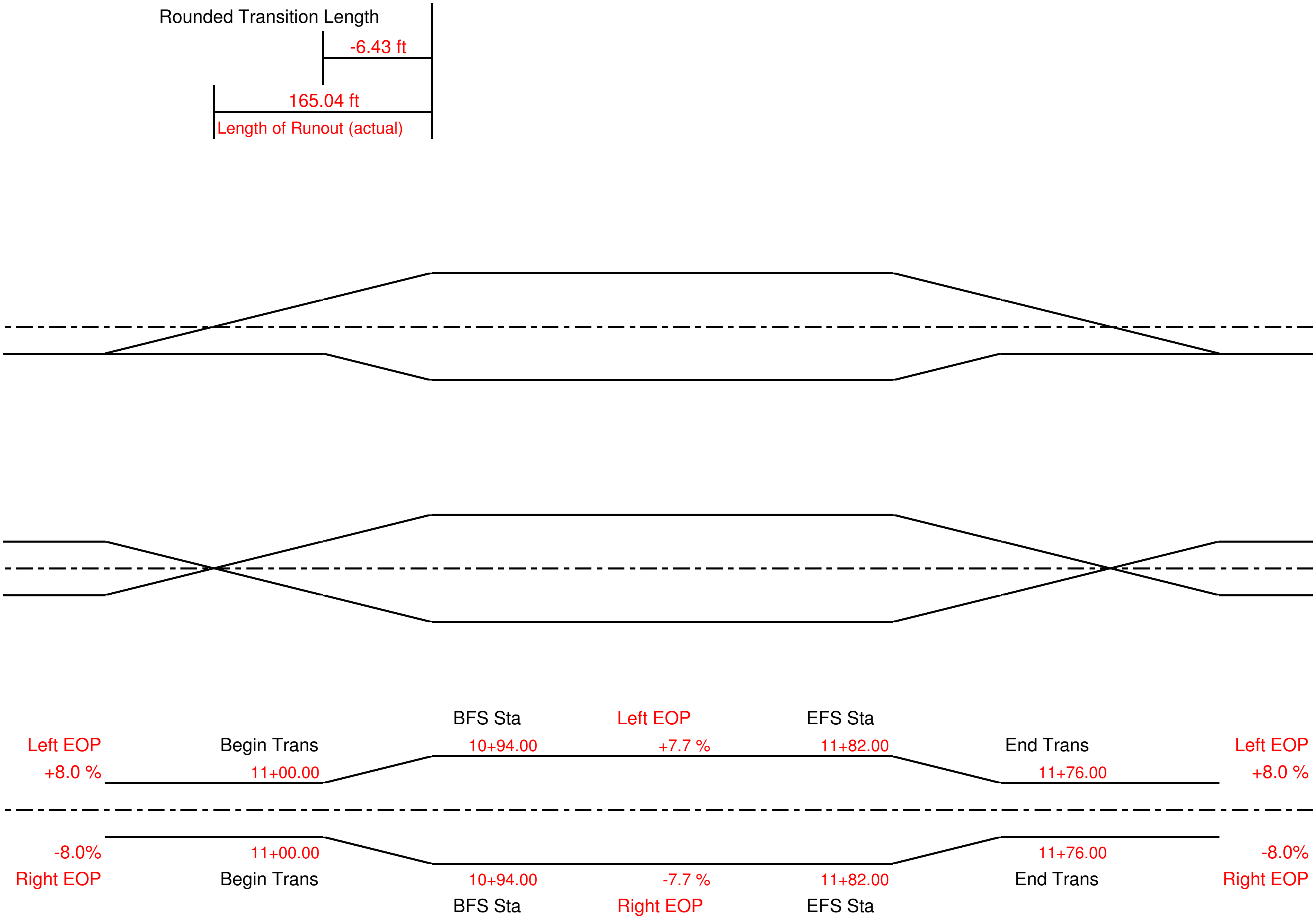
Needed Lr to Fit 40 ft Vert Curve	0.00	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	8.0	%	
Super Elevation Transition Length from 8%to 7.7%=	-6.43	ft	
Rounded to Nearest 0.01 ft	-6.43	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	132.00	ft	
* Distance from 0 point to Start of Transition	171.43	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+29.46		
Begin Transition Sta	11+00.00		11+00.00
PC Sta	10+61.46		
Begin Full Super	10+94.00		10+94.00
			Use
End Full Super	11+82.00		11+82.00
PT Sta	12+14.91		
End Transiton Sta	11+76.00		11+76.00
Theoretical Point of Intersection (0% Super) Sta	13+47.00		

SUPER ELEVATION DIAGRAM



$$L_r = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2755	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

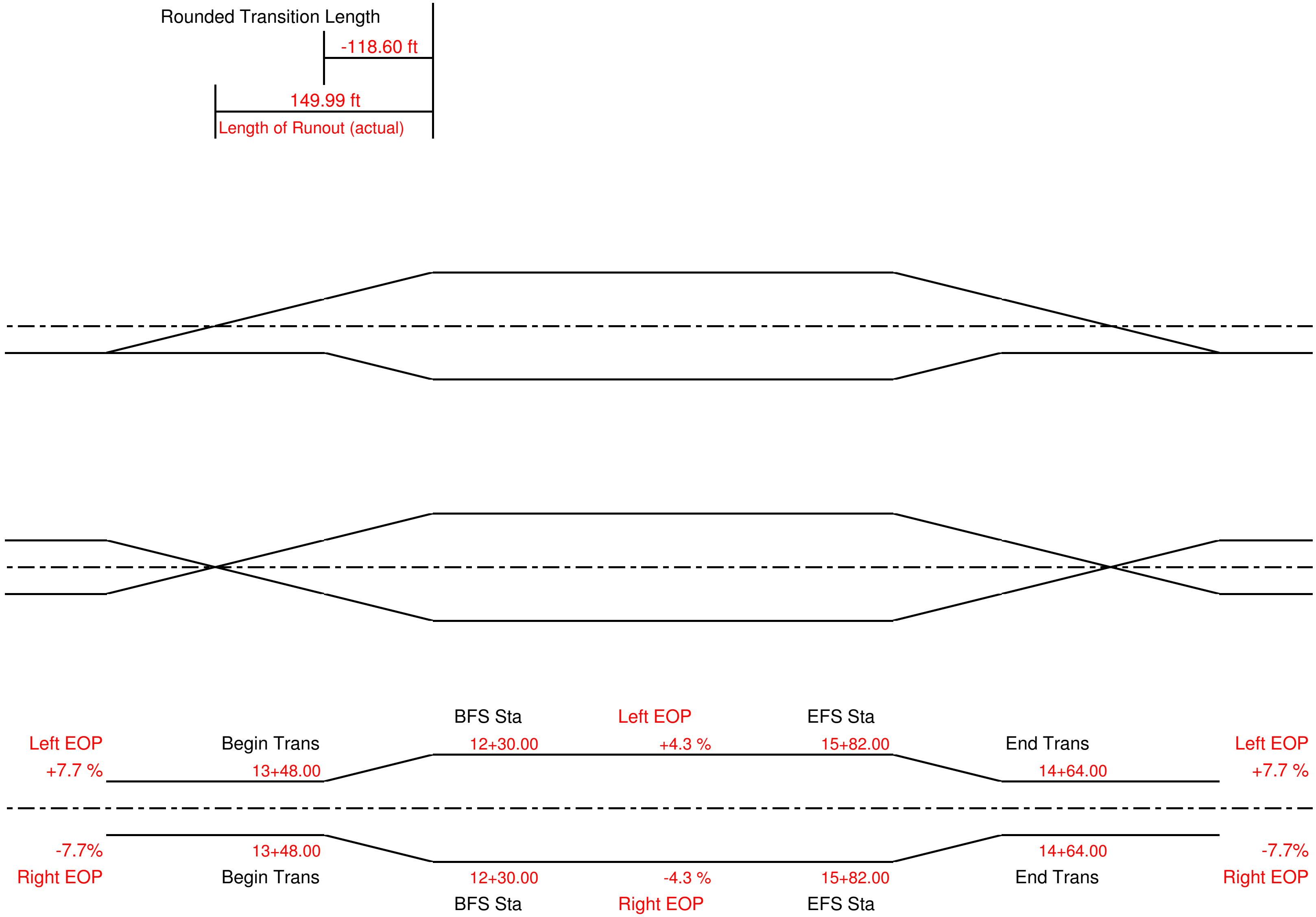
Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	7.7	%	
Super Elevation Transition Length from 7.7%to 4.3%=	-118.60	ft	
Rounded to Nearest 0.01 ft	-118.60	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	268.60	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	10+79.91		
Begin Transition Sta	13+48.00		13+48.00
PC Sta	12+14.91		
Begin Full Super	12+30.00		12+30.00
			Use
End Full Super	15+82.00		15+82.00
PT Sta	15+97.50		
End Transiton Sta	14+64.00		14+64.00
Theoretical Point of Intersection (0% Super) Sta	17+32.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	2.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	90.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

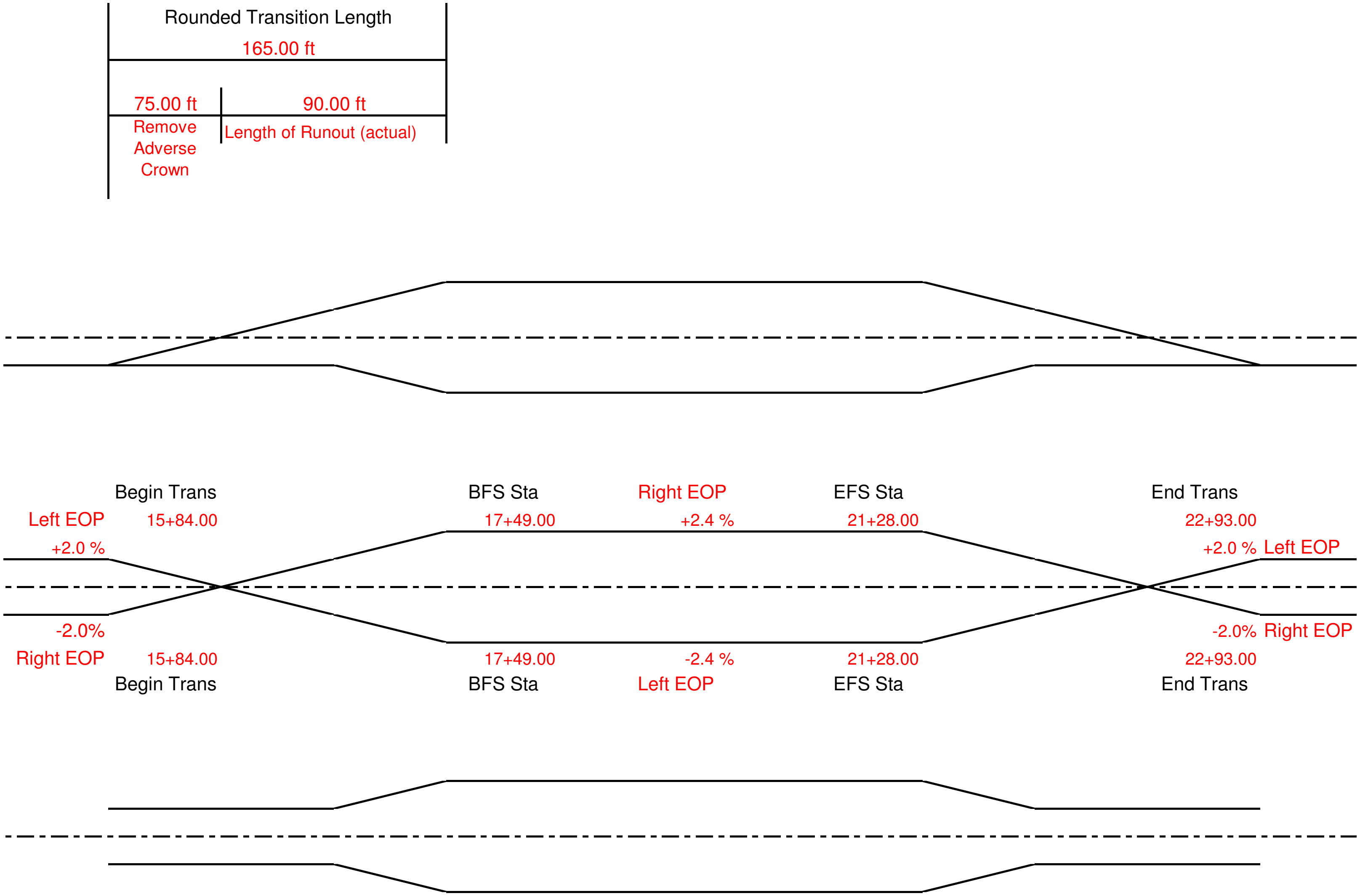
Needed Lr to Fit 50 ft Vert Curve	27.27	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.4%=	165.00	ft	
Rounded to Nearest 0.01 ft	165.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	-75.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	16+59.60		
Begin Transition Sta	15+84.00		15+84.00
PC Sta	17+31.60		
Begin Full Super	17+49.00		17+49.00
			Use
End Full Super	21+28.00		21+28.00
PT Sta	21+45.06		
End Transiton Sta	22+93.00		22+93.00
Theoretical Point of Intersection (0% Super) Sta	22+18.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	2000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	5.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	195.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

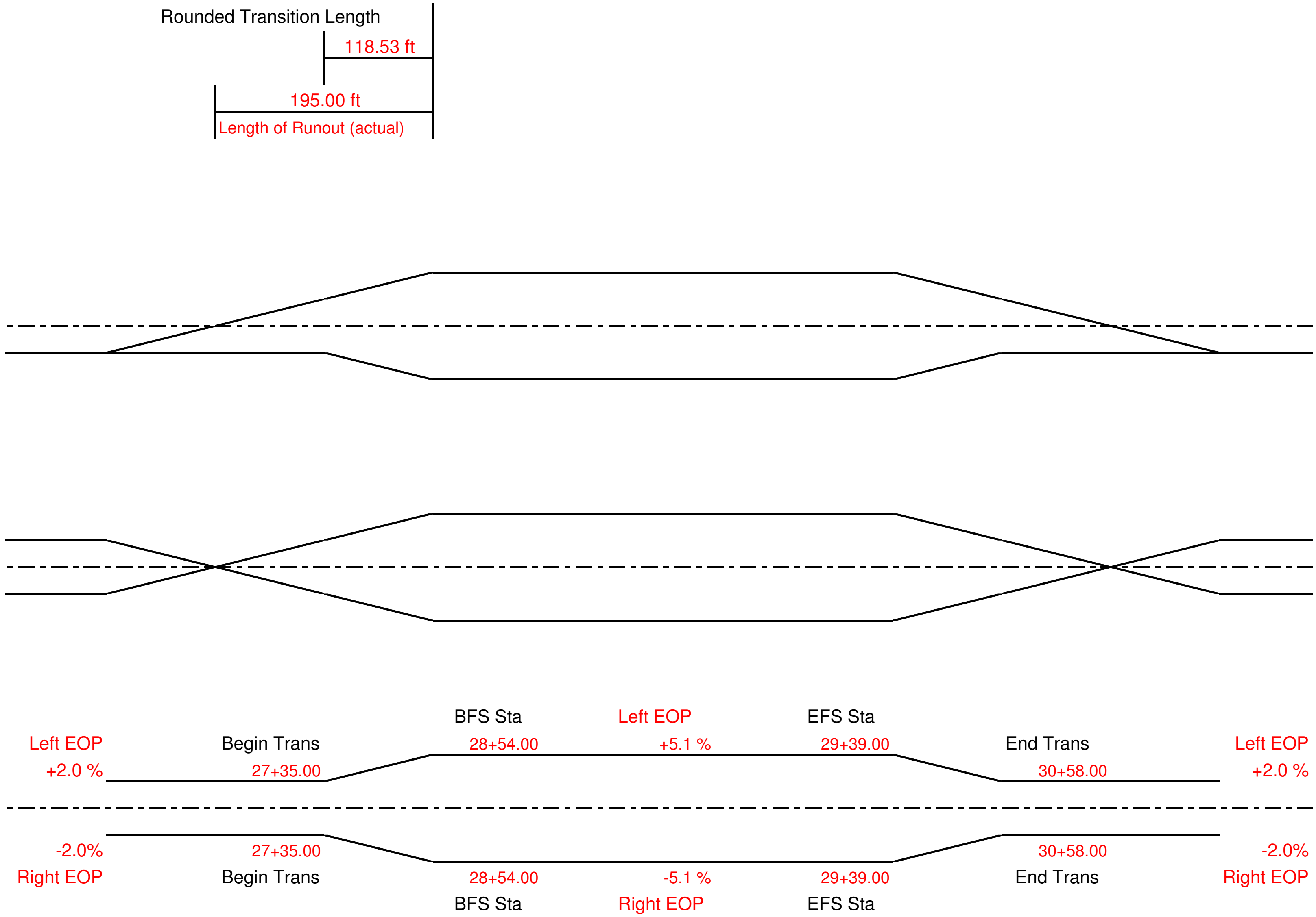
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	195.00	ft
Use Calculated Lr	195.00	ft

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 5.1%=	118.53	ft
Rounded to Nearest 0.01 ft	118.53	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	156.00	ft
* Distance from 0 point to Start of Transition	76.47	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	26+59.52	
Begin Transition Sta	27+35.00	27+35.00
PC Sta	28+15.52	
Begin Full Super	28+54.00	28+54.00

		Use
End Full Super	29+39.00	29+39.00
PT Sta	29+77.96	
End Transiton Sta	30+58.00	30+58.00
Theoretical Point of Intersection (0% Super) Sta	31+34.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	90.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.1%=	4.29	ft	
Rounded to Nearest 0.01 ft	4.29	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	85.71	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	37+59.91		
Begin Transition Sta	38+45.00		38+45.00
PC Sta	38+31.91		
Begin Full Super	38+50.00		38+50.00
			Use
End Full Super	39+63.00		39+63.00
PT Sta	39+81.05		
End Transiton Sta	39+68.00		39+68.00
Theoretical Point of Intersection (0% Super) Sta	40+53.00		

CA Group

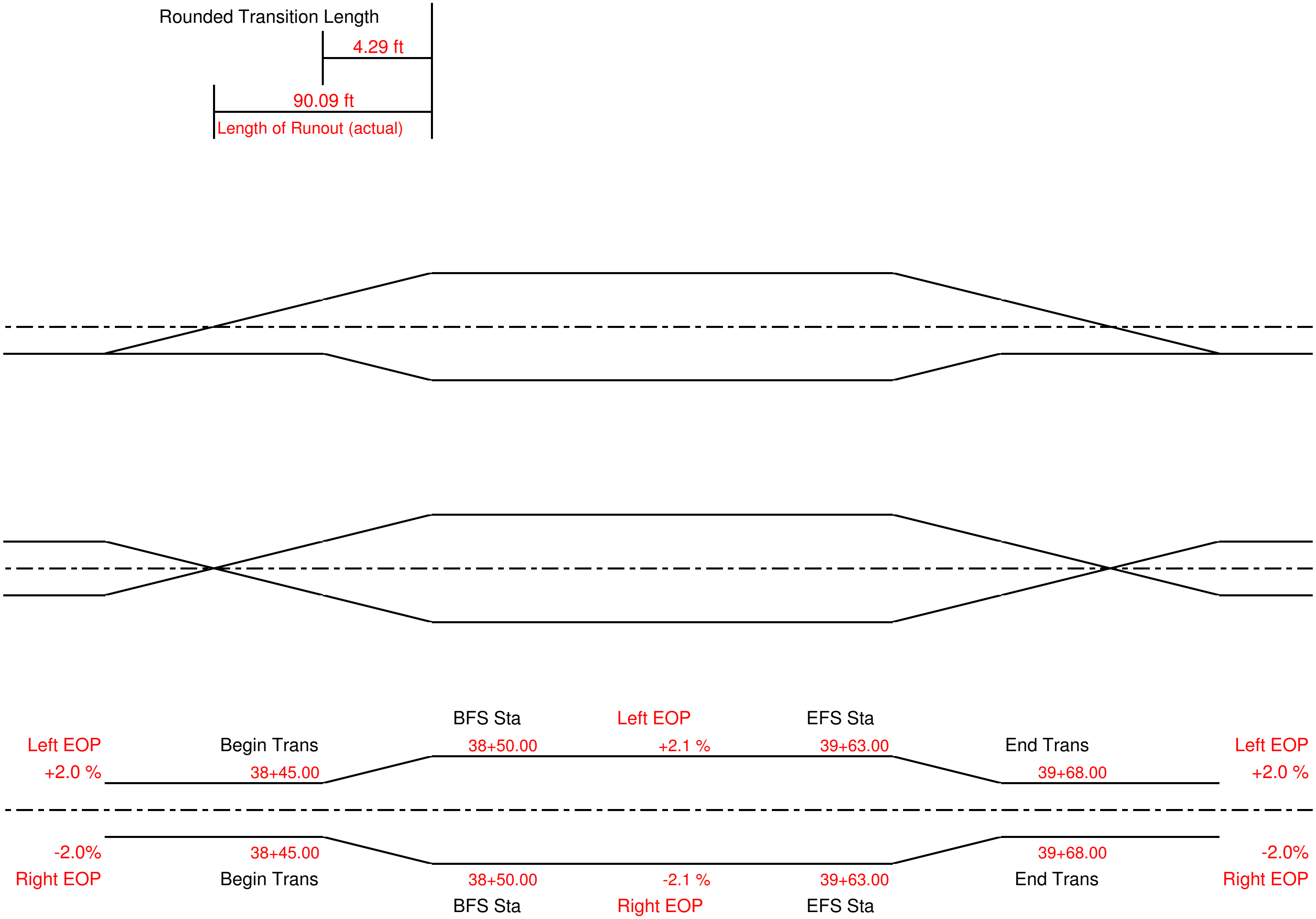
Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"SWG"-6

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	15000	ft
Design Speed	50	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	90.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

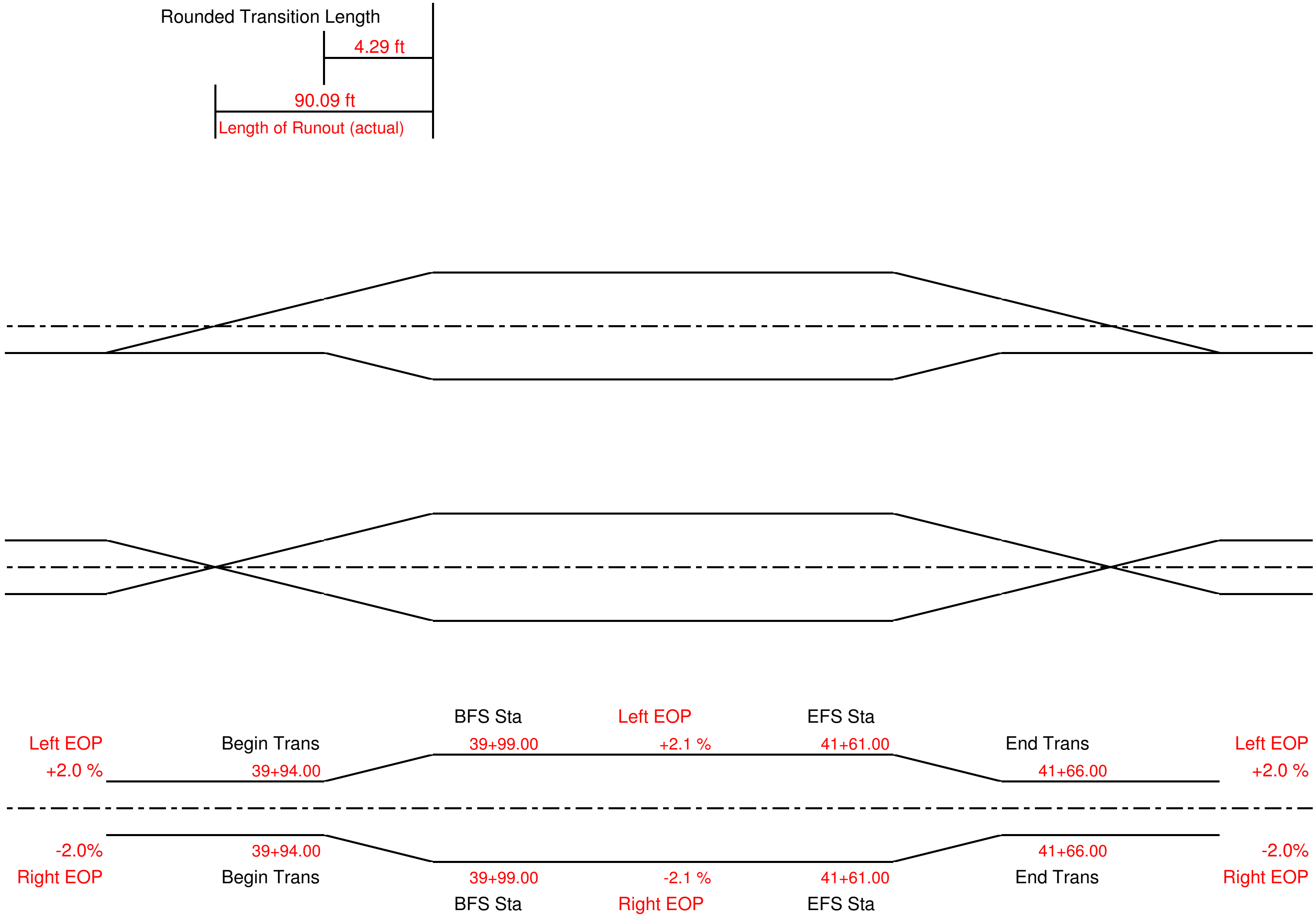
Needed Lr to Fit 50 ft Vert Curve	0.00	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.1%=	4.29	ft	
Rounded to Nearest 0.01 ft	4.29	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	72.00	ft	
* Distance from 0 point to Start of Transition	85.71	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	39+09.05		
Begin Transition Sta	39+94.00		39+94.00
PC Sta	39+81.05		
Begin Full Super	39+99.00		39+99.00
			Use
End Full Super	41+61.00		41+61.00
PT Sta	41+79.40		
End Transiton Sta	41+66.00		41+66.00
Theoretical Point of Intersection (0% Super) Sta	42+51.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	56.09	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

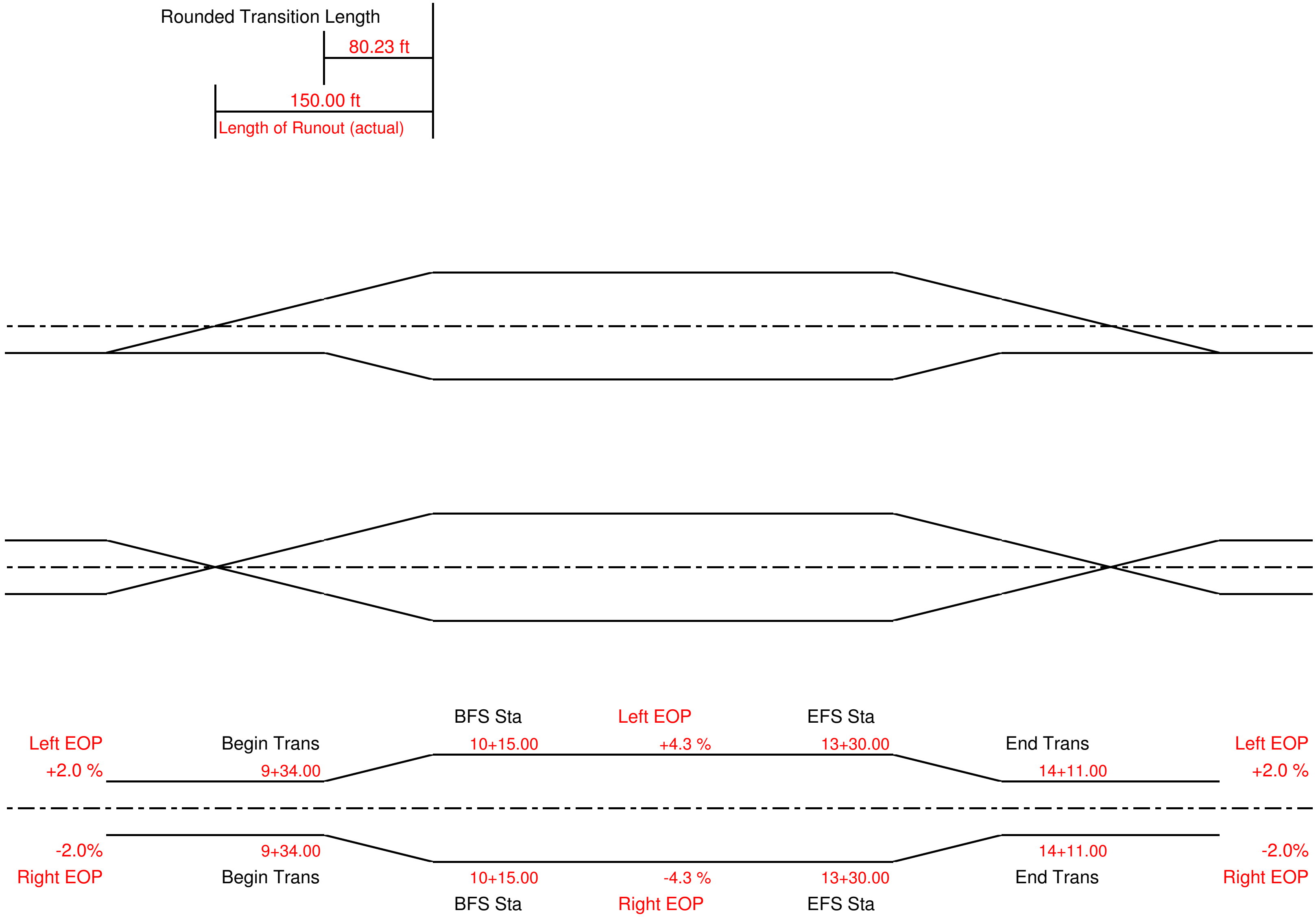
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	80.23	ft	
Rounded to Nearest 0.01 ft	80.23	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	69.77	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	8+65.00		
Begin Transition Sta	9+34.00		9+34.00
PC Sta	10+00.00		
Begin Full Super	10+15.00		10+15.00

		Use
End Full Super	13+30.00	13+30.00
PT Sta	13+45.73	
End Transiton Sta	14+11.00	14+11.00
Theoretical Point of Intersection (0% Super) Sta	14+80.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

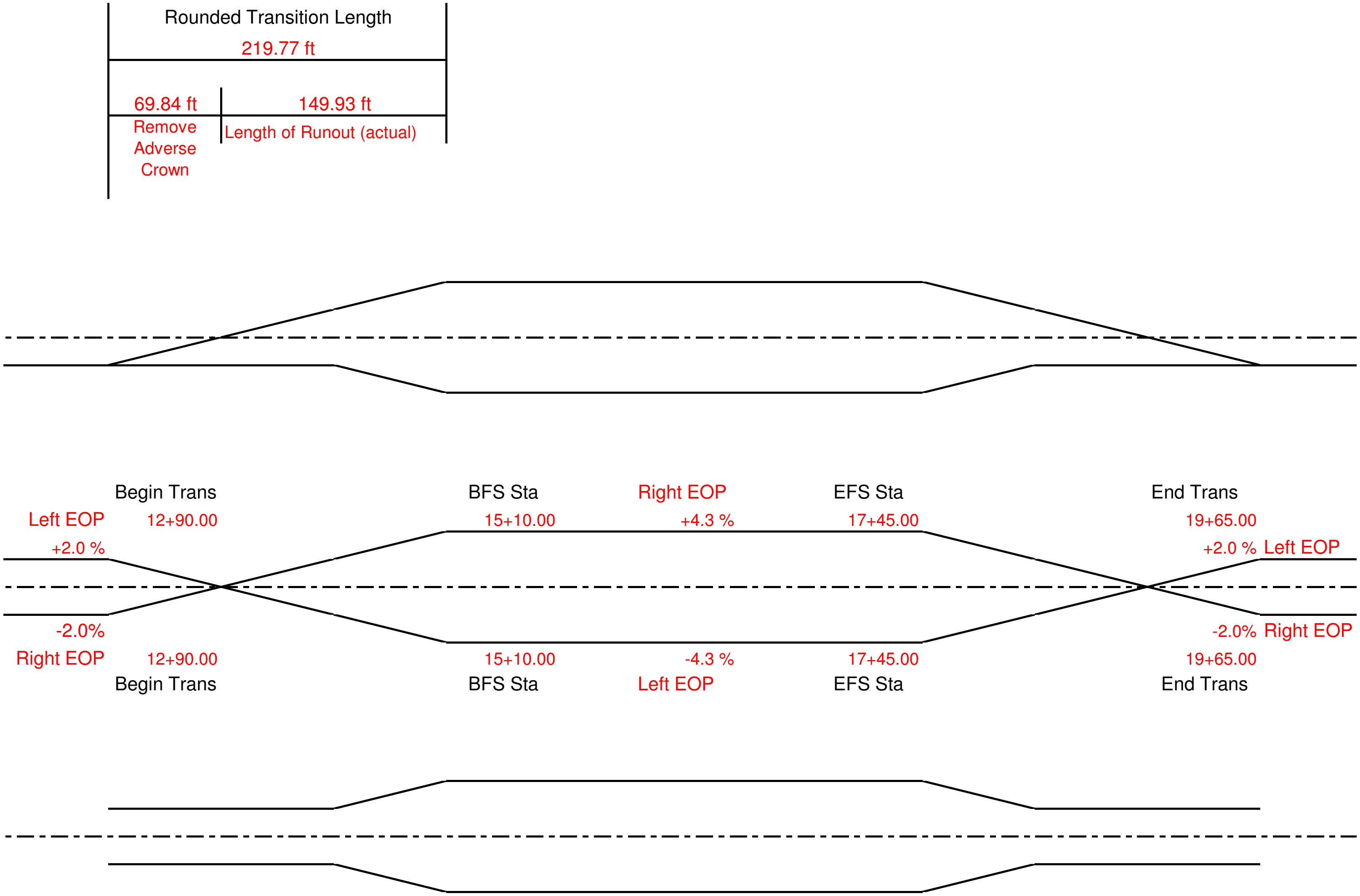
Radius	2000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	30.71	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 4.3%=	219.77	ft	
Rounded to Nearest 0.01 ft	219.77	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	-69.77	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	13+60.43		
Begin Transition Sta	12+90.00		12+90.00
PC Sta	14+95.43		
Begin Full Super	15+10.00		15+10.00
			Use
End Full Super	17+45.00		17+45.00
PT Sta	17+59.26		
End Transiton Sta	19+65.00		19+65.00
Theoretical Point of Intersection (0% Super) Sta	18+95.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1225	ft
Design Speed	35	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	4.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	180.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

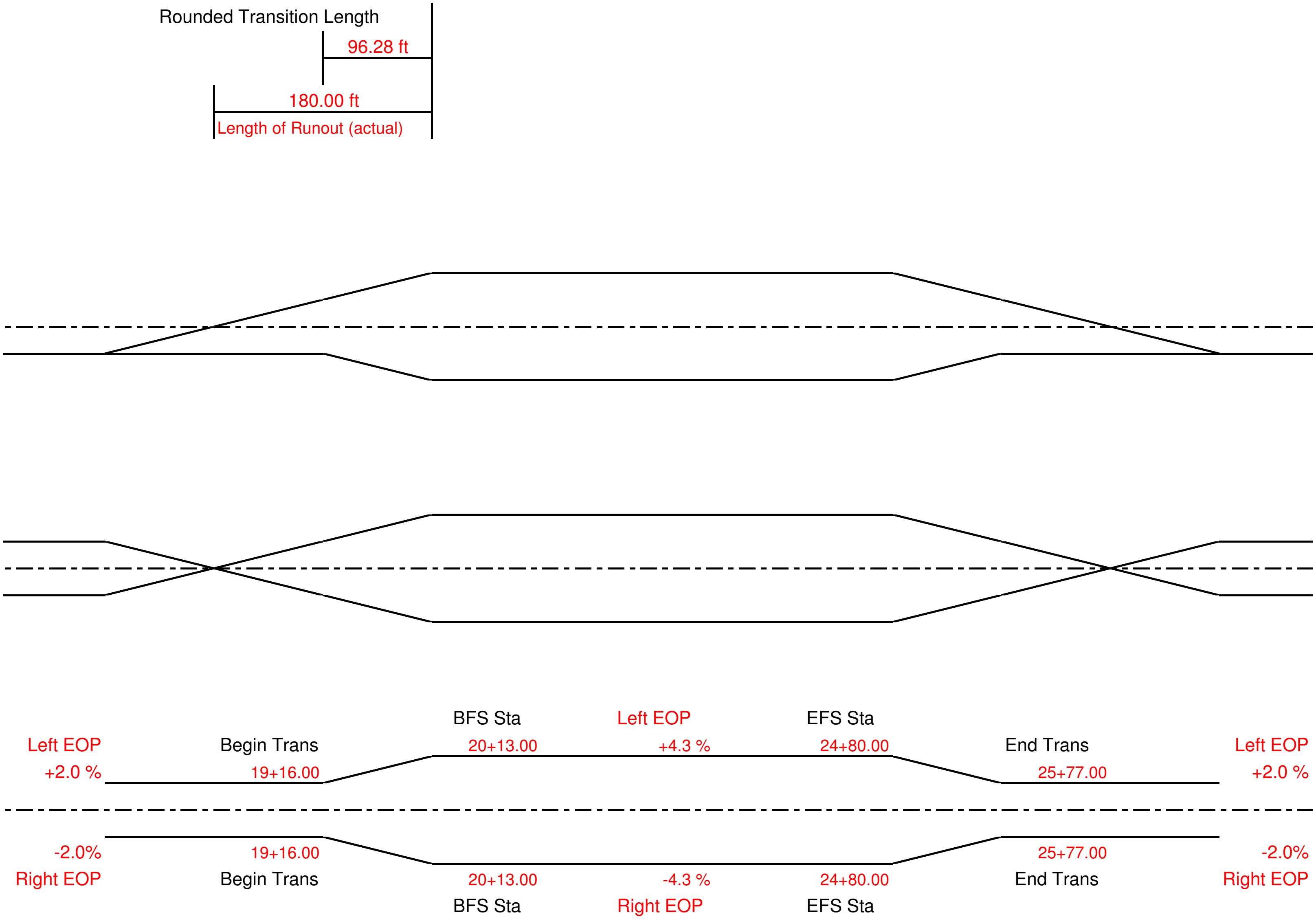
Needed Lr to Fit 35 ft Vert Curve	56.09	ft
Calculated Lr	180.00	ft
Use Calculated Lr	180.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.3%=	96.28	ft	
Rounded to Nearest 0.01 ft	96.28	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	162.00	ft	
* Distance from 0 point to Start of Transition	83.72	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	18+32.50		
Begin Transition Sta	19+16.00		19+16.00
PC Sta	19+94.50		
Begin Full Super	20+13.00		20+13.00
			Use
End Full Super	24+80.00		24+80.00
PT Sta	24+98.45		
End Transiton Sta	25+77.00		25+77.00
Theoretical Point of Intersection (0% Super) Sta	26+60.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1435	ft
Design Speed	35	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	5.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.6	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	165.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	30	

Transition Length Check to fit Design Speed Rounding Curves

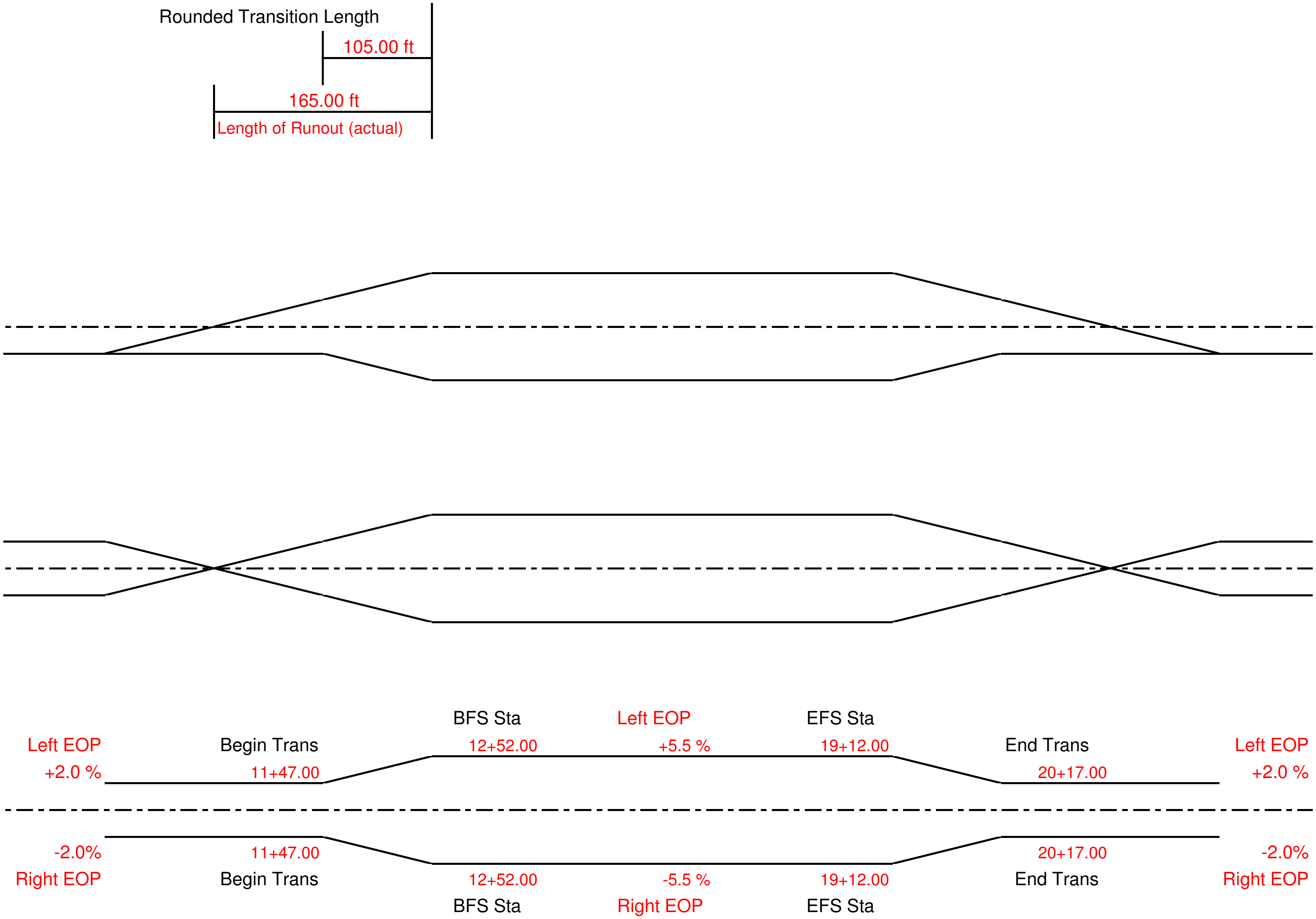
Needed Lr to Fit 35 ft Vert Curve	47.14	ft
Calculated Lr	165.00	ft
Use Calculated Lr	165.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 5.5%=	105.00	ft	
Rounded to Nearest 0.01 ft	105.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	148.50	ft	
* Distance from 0 point to Start of Transition	60.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	10+87.65		
Begin Transition Sta	11+47.00		11+47.00
PC Sta	12+36.15		
Begin Full Super	12+52.00		12+52.00
			Use
End Full Super	19+12.00		19+12.00
PT Sta	19+28.41		
End Transiton Sta	20+17.00		20+17.00
Theoretical Point of Intersection (0% Super) Sta	20+77.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	658	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of	2	
Design Super (e_d) positive value	7.9	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	270.00	ft

Spiral Curves Recommended Check	Yes	
Spiral Curve Calc	198	ft
Max Spiral Curve Length	342	ft
Is Spiral Curve Length> Lr?	No	
Use Spiral Curve Length=	**270**	ft

Are Spiral Transitions Being Used? No

Design Speed Rounding Curve Length 40

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	53.56	ft
Calculated Lr	270.00	ft
Use Calculated Lr	270.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 7.9%=	201.65	ft
Rounded to Nearest 0.01 ft	201.65	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	243.00	ft
* Distance from 0 point to Start of Transition	68.35	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	8+96.25	
Begin Transition Sta	9+64.00	9+64.00
PC Sta	11+39.25	
Begin Full Super	11+66.00	11+66.00

		Use
End Full Super	13+35.00	13+35.00
PT Sta	13+62.01	
End Transiton Sta	15+37.00	15+37.00
Theoretical Point of Intersection (0% Super) Sta	16+05.00	

CA Group

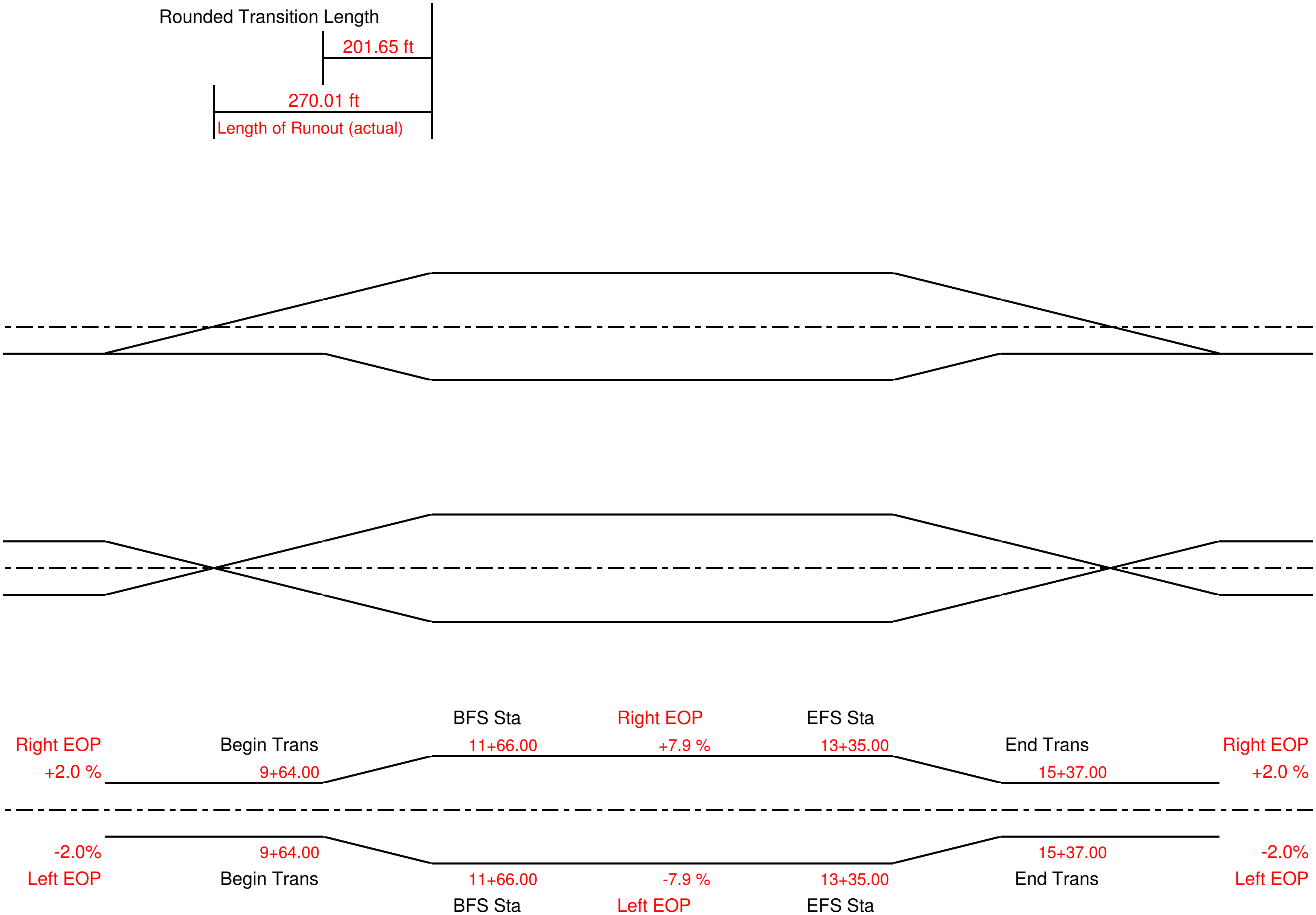
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"ST1"-1

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1856	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	1	
Design Super (e_d) positive value	4.6	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	1.00	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	40	

Transition Length Check to fit Design Speed Rounding Curves

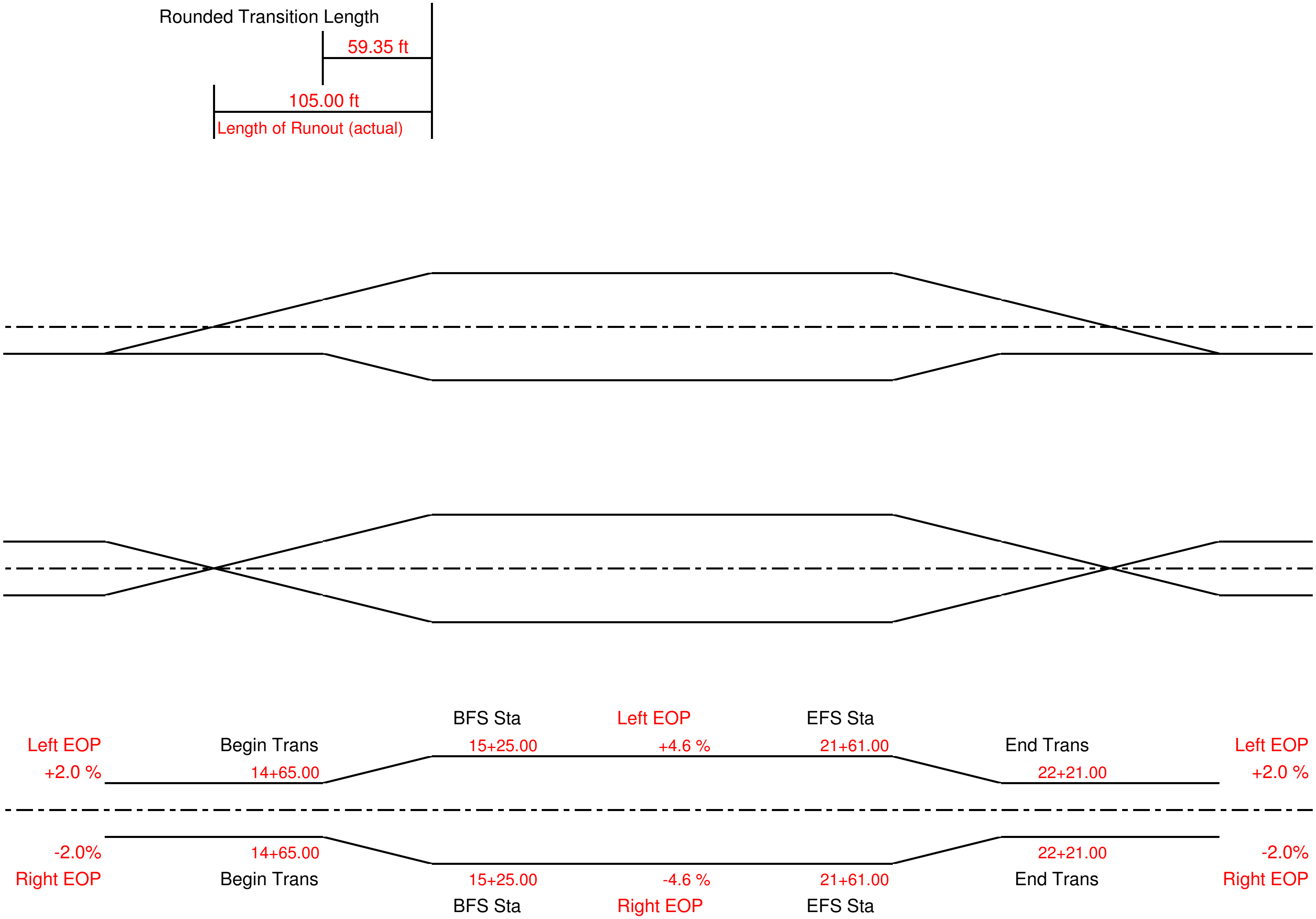
Needed Lr to Fit 45 ft Vert Curve	70.77	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 4.6%=	59.35	ft	
Rounded to Nearest 0.01 ft	59.35	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	45.65	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	14+19.49		
Begin Transition Sta	14+65.00		14+65.00
PC Sta	15+03.49		
Begin Full Super	15+25.00		15+25.00
			Use
End Full Super	21+61.00		21+61.00
PT Sta	21+82.43		
End Transiton Sta	22+21.00		22+21.00
Theoretical Point of Intersection (0% Super) Sta	22+66.00		

SUPER ELEVATION DIAGRAM



$$L_r = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2590	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.5	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.54	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.5%=	51.43	ft	
Rounded to Nearest 0.01 ft	51.43	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	68.57	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	11+92.00		
Begin Transition Sta	12+60.00		12+60.00
PC Sta	13+00.00		
Begin Full Super	13+12.00		13+12.00

		Use
End Full Super	20+73.00	20+73.00
PT Sta	20+85.32	
End Transiton Sta	21+25.00	21+25.00
Theoretical Point of Intersection (0% Super) Sta	21+93.00	

Design Speed Rounding Curve Length 0

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

CA Group

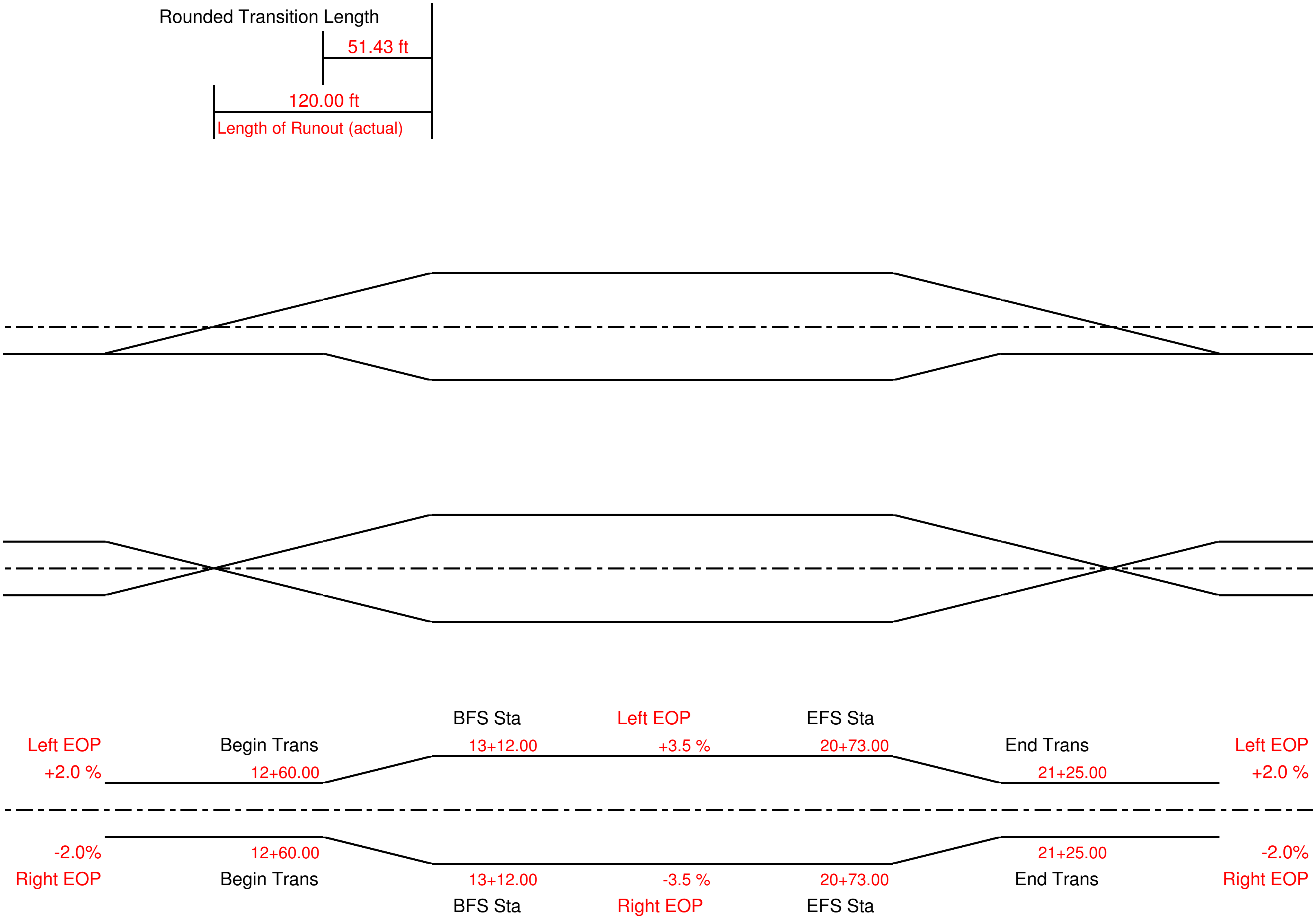
Job No. 0199

Made By: GE Date: 01/07/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"ST2"-1

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	7976	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	3	
Design Super (e_d) positive value	2.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.67	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 2.1%=	5.00	ft
Rounded to Nearest 0.01 ft	5.00	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	94.50	ft
* Distance from 0 point to Start of Transition	100.00	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	12+94.57	
Begin Transition Sta	13+94.00	13+94.00
PC Sta	13+89.07	
Begin Full Super	13+99.00	13+99.00

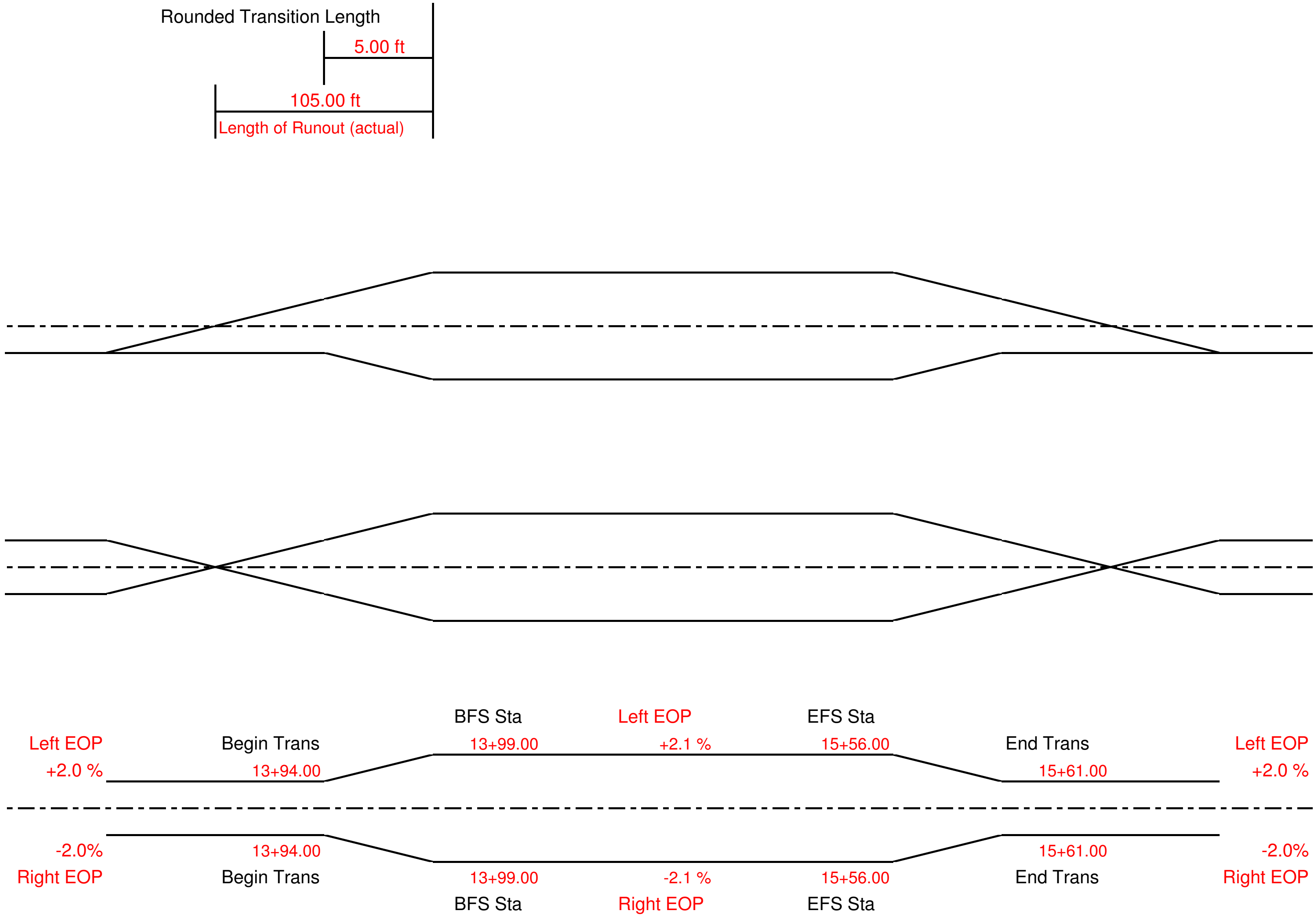
		Use
End Full Super	15+56.00	15+56.00
PT Sta	15+66.28	
End Transiton Sta	15+61.00	15+61.00
Theoretical Point of Intersection (0% Super) Sta	16+61.00	

Design Speed Rounding Curve Length 0

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	7988	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	2.1	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	75.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

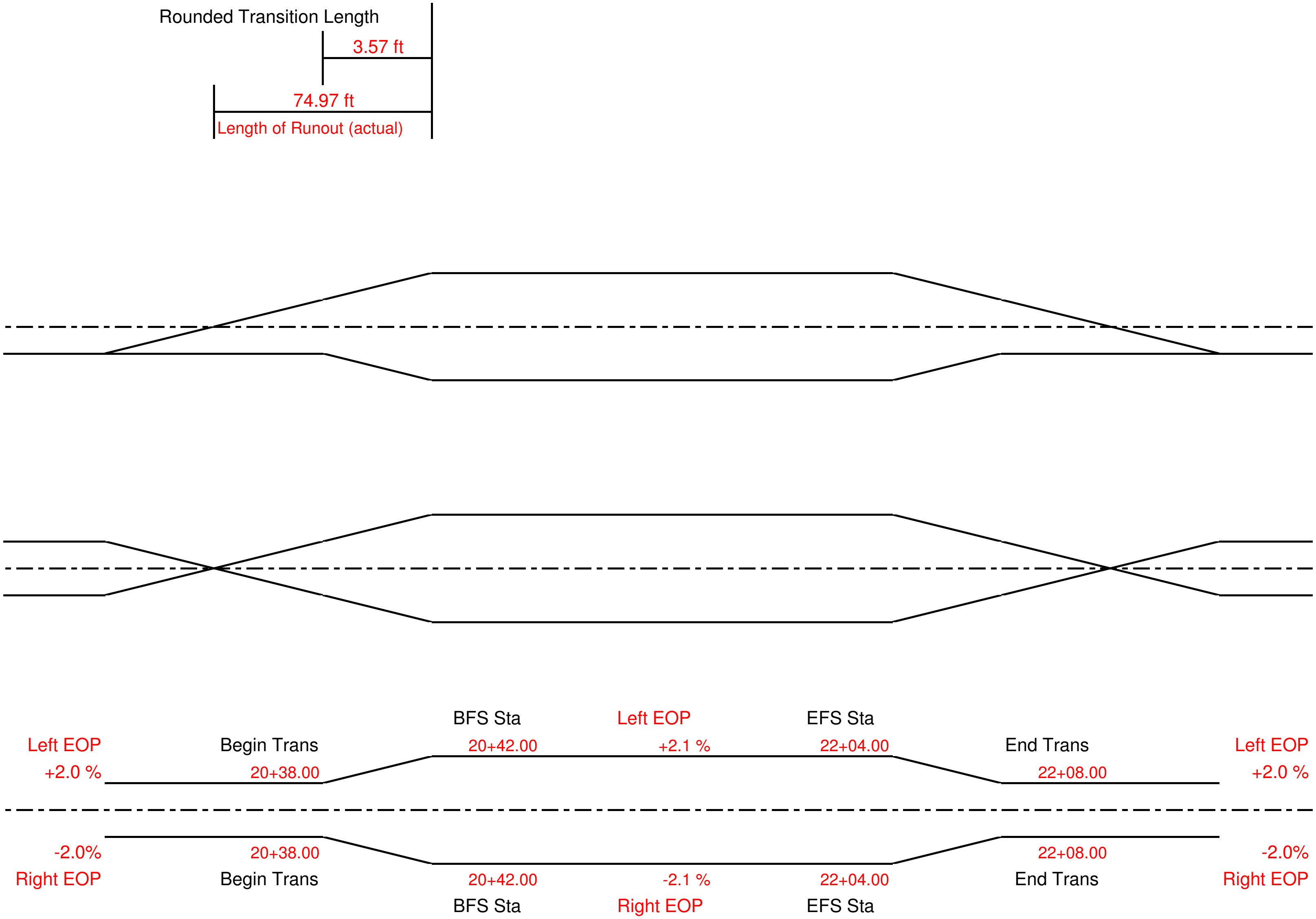
Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	75.00	ft
Use Calculated Lr	75.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.1%=	3.57	ft	
Rounded to Nearest 0.01 ft	3.57	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	67.50	ft	
* Distance from 0 point to Start of Transition	71.43	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	19+66.63		
Begin Transition Sta	20+38.00		20+38.00
PC Sta	20+34.13		
Begin Full Super	20+42.00		20+42.00
			Use
End Full Super	22+04.00		22+04.00
PT Sta	22+11.61		
End Transiton Sta	22+08.00		22+08.00
Theoretical Point of Intersection (0% Super) Sta	22+79.00		

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	1976	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%
Super Elevation Transition Length from 2%to 4.4%=	81.82	ft
Rounded to Nearest 0.01 ft	81.82	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.9	
Transition Length on Tangent	135.00	ft
* Distance from 0 point to Start of Transition	68.18	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	28+76.69	
Begin Transition Sta	29+44.00	29+44.00
PC Sta	30+11.69	
Begin Full Super	30+26.00	30+26.00

		Use
End Full Super	32+19.00	32+19.00
PT Sta	32+33.69	
End Transiton Sta	33+01.00	33+01.00
Theoretical Point of Intersection (0% Super) Sta	33+69.00	

CA Group

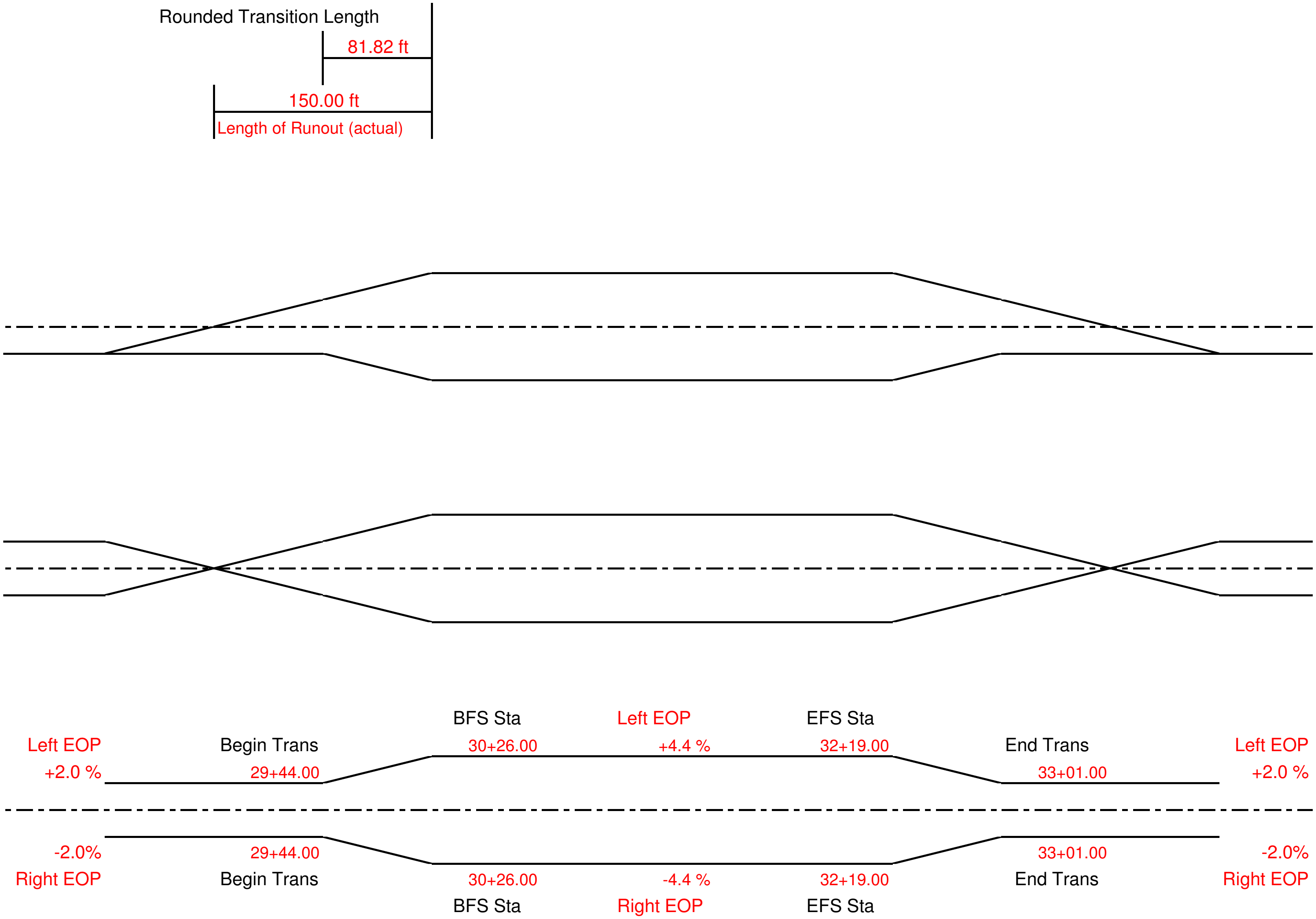
Job No. 0199

Made By: GE Date: 01/06/21

Checked By:______ Date:______

Subject:Option 3_Super Elevation Transition Length v3.xlsx
"W"-3

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2024	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	4.3	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	150.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

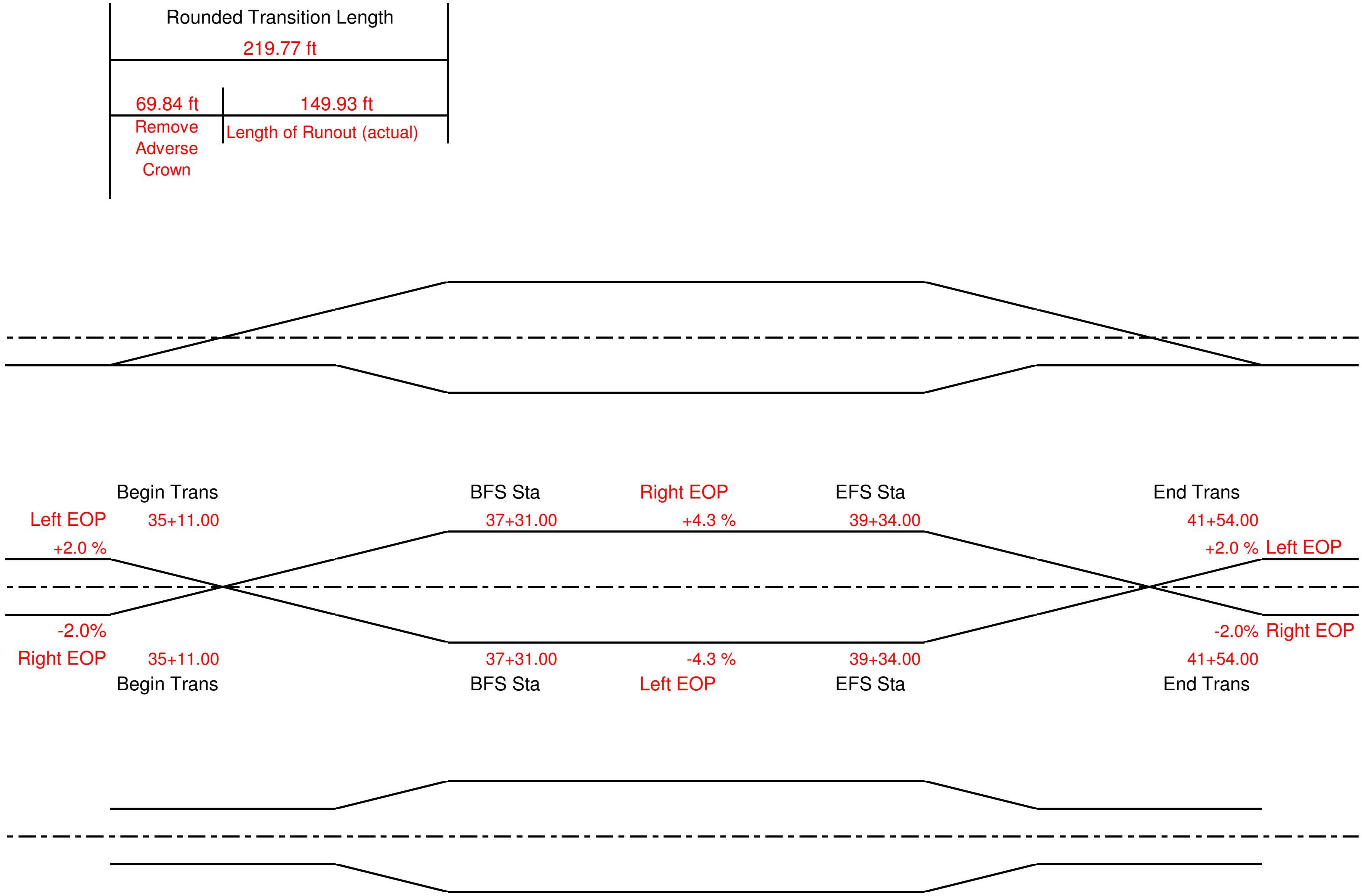
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	30.71	ft
Calculated Lr	150.00	ft
Use Calculated Lr	150.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 4.3%=	219.77	ft	
Rounded to Nearest 0.01 ft	219.77	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	135.00	ft	
* Distance from 0 point to Start of Transition	-69.77	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	35+81.65		
Begin Transition Sta	35+11.00		35+11.00
PC Sta	37+16.65		
Begin Full Super	37+31.00		37+31.00
			Use
End Full Super	39+34.00		39+34.00
PT Sta	39+49.11		
End Transiton Sta	41+54.00		41+54.00
Theoretical Point of Intersection (0% Super) Sta	40+84.00		

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	2791	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	3.3	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

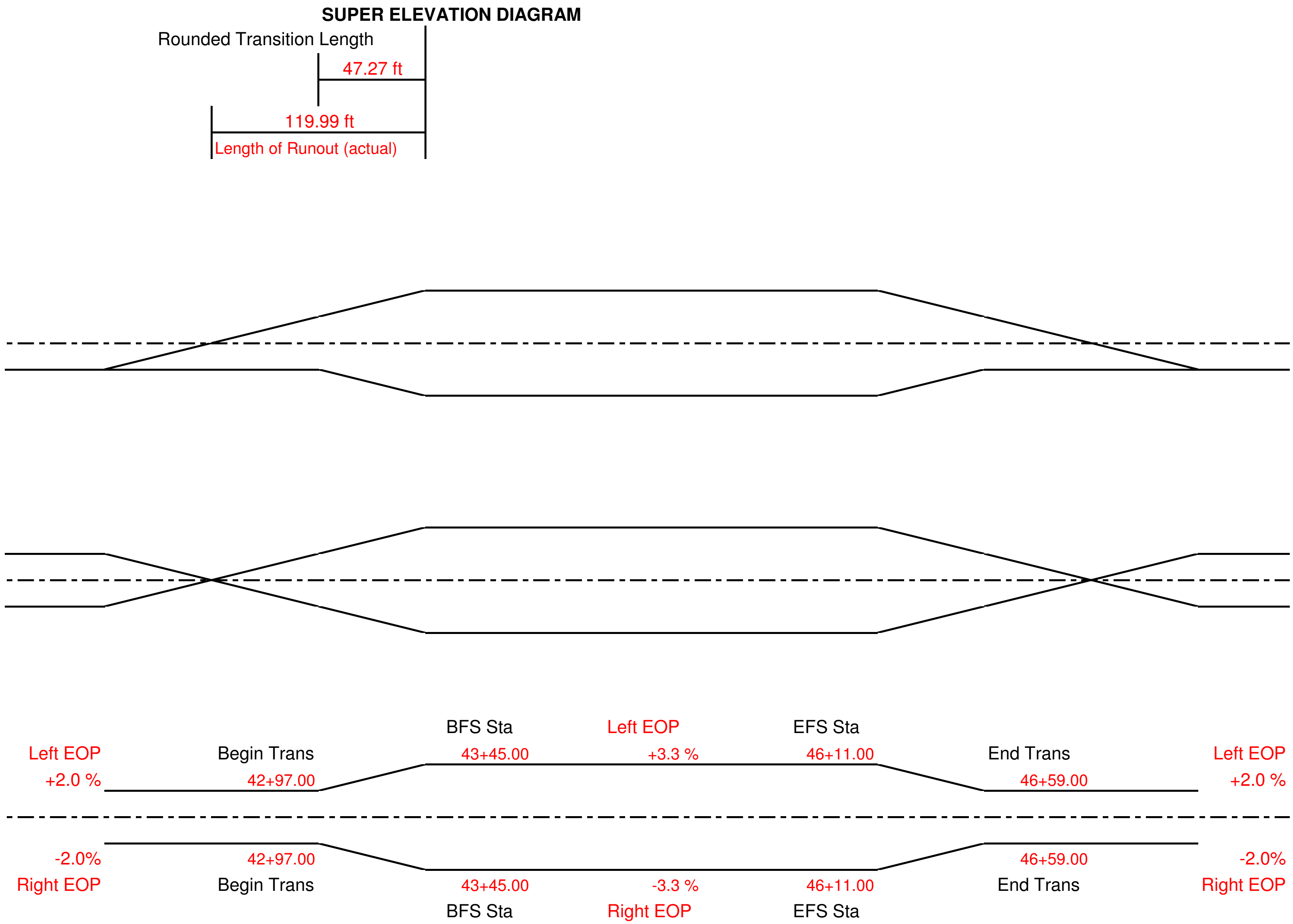
Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 3.3%=	47.27	ft	
Rounded to Nearest 0.01 ft	47.27	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	108.00	ft	
* Distance from 0 point to Start of Transition	72.73	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	42+24.63		
Begin Transition Sta	42+97.00		42+97.00
PC Sta	43+32.63		
Begin Full Super	43+45.00		43+45.00
			Use
End Full Super	46+11.00		46+11.00
PT Sta	46+23.40		
End Transiton Sta	46+59.00		46+59.00
Theoretical Point of Intersection (0% Super) Sta	47+31.00		


SUPER ELEVATION DIAGRAM
Rounded Transition Length
47.27 ft
119.99 ft
Length of Runout (actual)
BFS Sta
Left EOP
EFS Sta
Left EOP
Begin Trans
43+45.00
+3.3 %
46+11.00
End Trans
Left EOP
+2.0 %
42+97.00
46+59.00
+2.0 %
-2.0%
42+97.00
46+59.00
-2.0%
Right EOP
Begin Trans
43+45.00
-3.3 %
46+11.00
End Trans
Right EOP
BFS Sta
Right EOP
EFS Sta

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	4964	ft
Design Speed	55	mph
W	12	ft
n (greatest no. of lanes on one side of a	2	
Design Super (e_d) positive value	2.8	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	120.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 55 ft Vert Curve	32.08	ft
Calculated Lr	120.00	ft
Use Calculated Lr	120.00	ft

SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.8%=	205.71	ft	
Rounded to Nearest 0.01 ft	205.71	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	96.00	ft	
* Distance from 0 point to Start of Transition	-85.71	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	46+61.51		
Begin Transition Sta	45+75.00		45+75.00
PC Sta	47+57.51		
Begin Full Super	47+81.00		47+81.00
			Use
End Full Super	51+44.00		51+44.00
PT Sta	51+67.99		
End Transiton Sta	53+50.00		53+50.00
Theoretical Point of Intersection (0% Super) Sta	52+64.00		

CA Group

Job No. 0199

Made By: GE Date: 01/06/21

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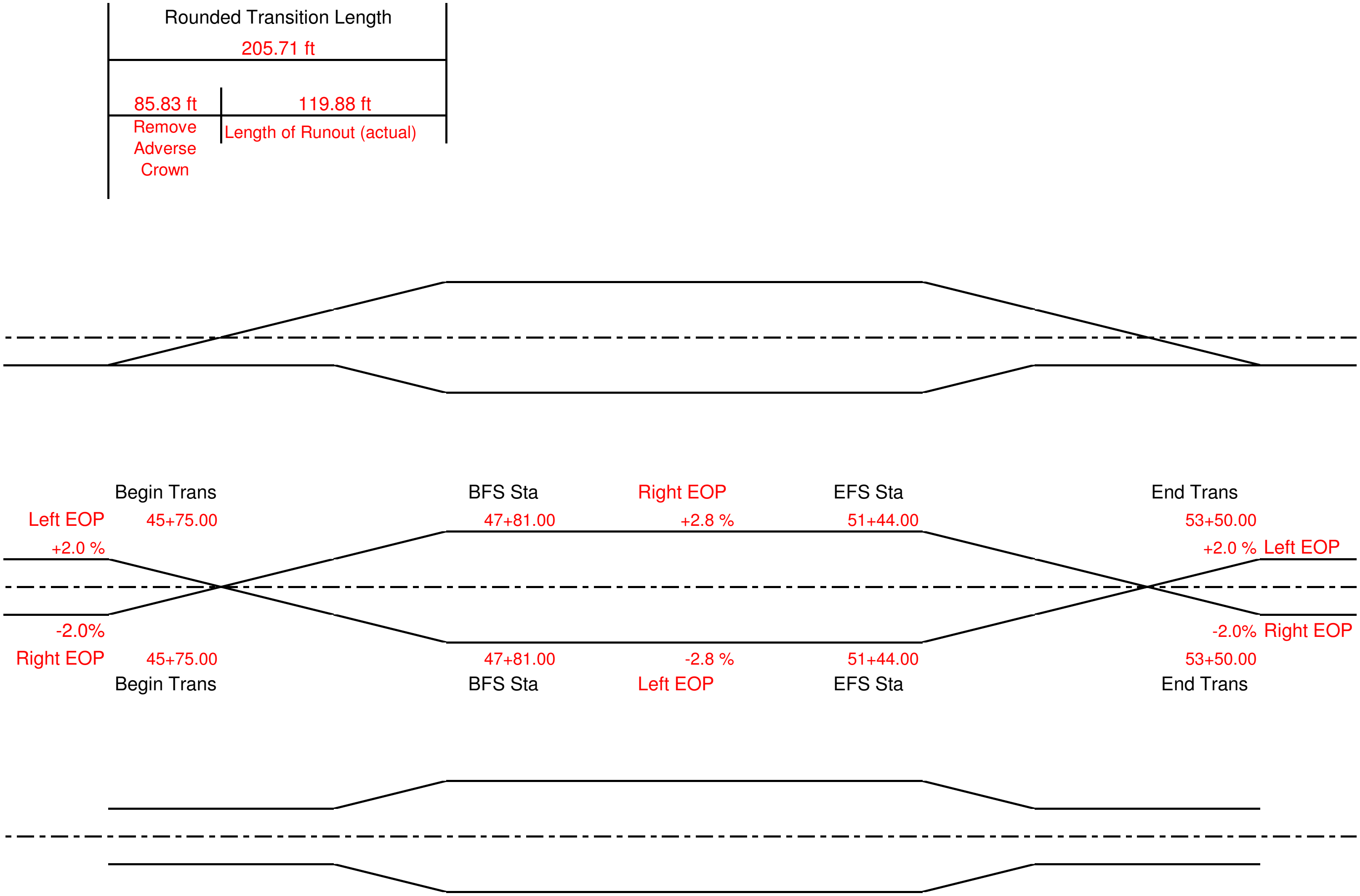
Subject:Option 3_Super Elevation Transition Length v3.xlsx
"W"-6

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Radius	7988	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of :	2	
Design Super (e_d) positive value	2.4	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	105.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	35.45	ft
Calculated Lr	105.00	ft
Use Calculated Lr	105.00	ft

Right EOP Begin Transition Cross Slope (pos or neg)	-2.0	%	
Super Elevation Transition Length from -2%to 2.4%=	192.50	ft	
Rounded to Nearest 0.01 ft	192.50	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.8		
Transition Length on Tangent	84.00	ft	
* Distance from 0 point to Start of Transition	-87.50	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	65+78.46		
Begin Transition Sta	64+90.00		64+90.00
PC Sta	66+62.46		
Begin Full Super	66+83.00		66+83.00
			Use
End Full Super	68+82.00		68+82.00
PT Sta	69+03.21		
End Transiton Sta	70+75.00		70+75.00
Theoretical Point of Intersection (0% Super) Sta	69+87.00		

CA Group

Job No. 0199

Made By: GE Date: 01/06/21

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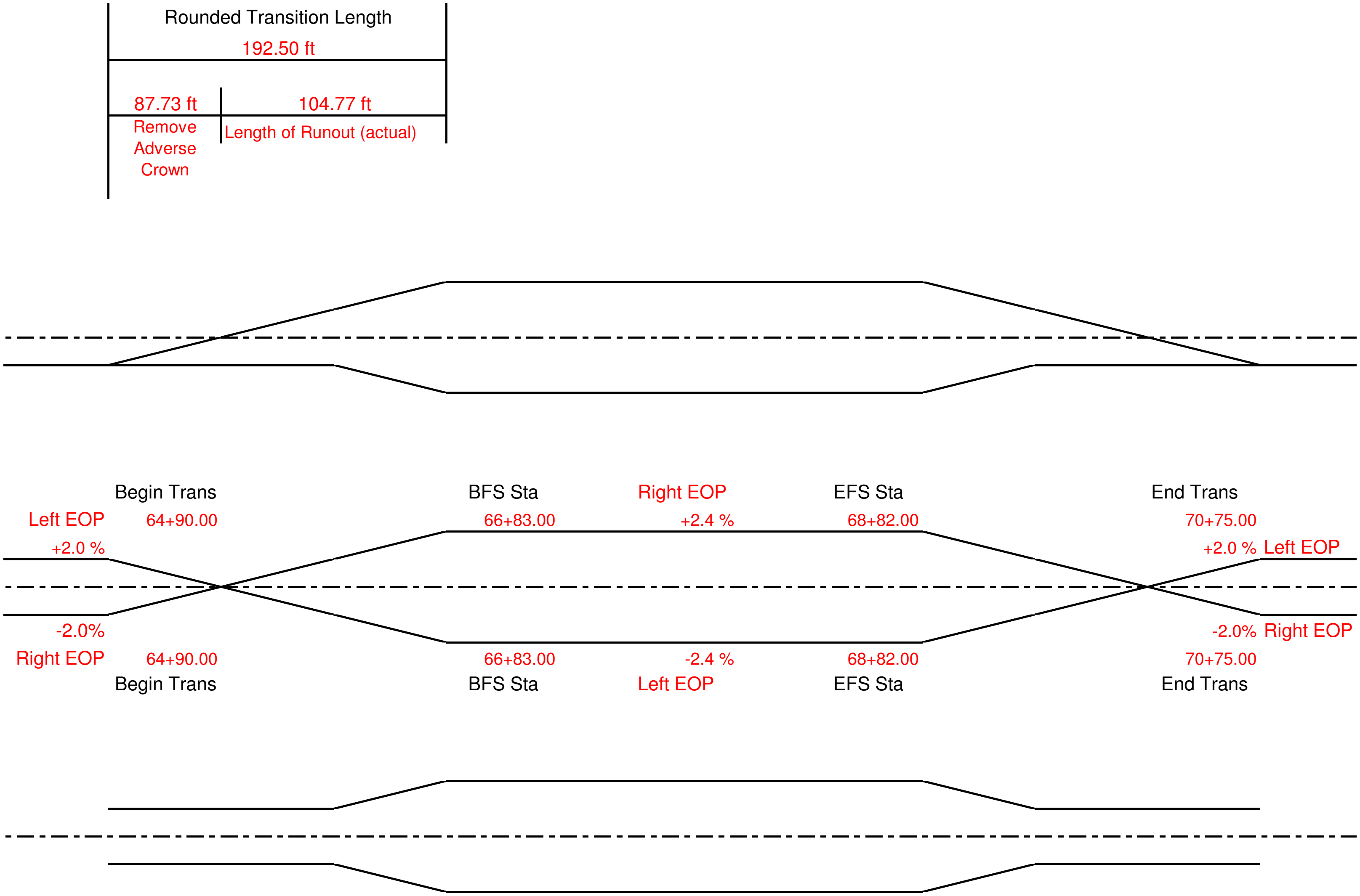
Subject:Option 3_Super Elevation Transition Length v3.xlsx
"W"-7

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	16471.61	ft
Design Speed	65	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	2	%
Curve Direction	Left	
Δ (Max Relative Gradient	0.4	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	90.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 65 ft Vert Curve	0.00	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

SUPER ELEVATION TRANSITION CALCULATION

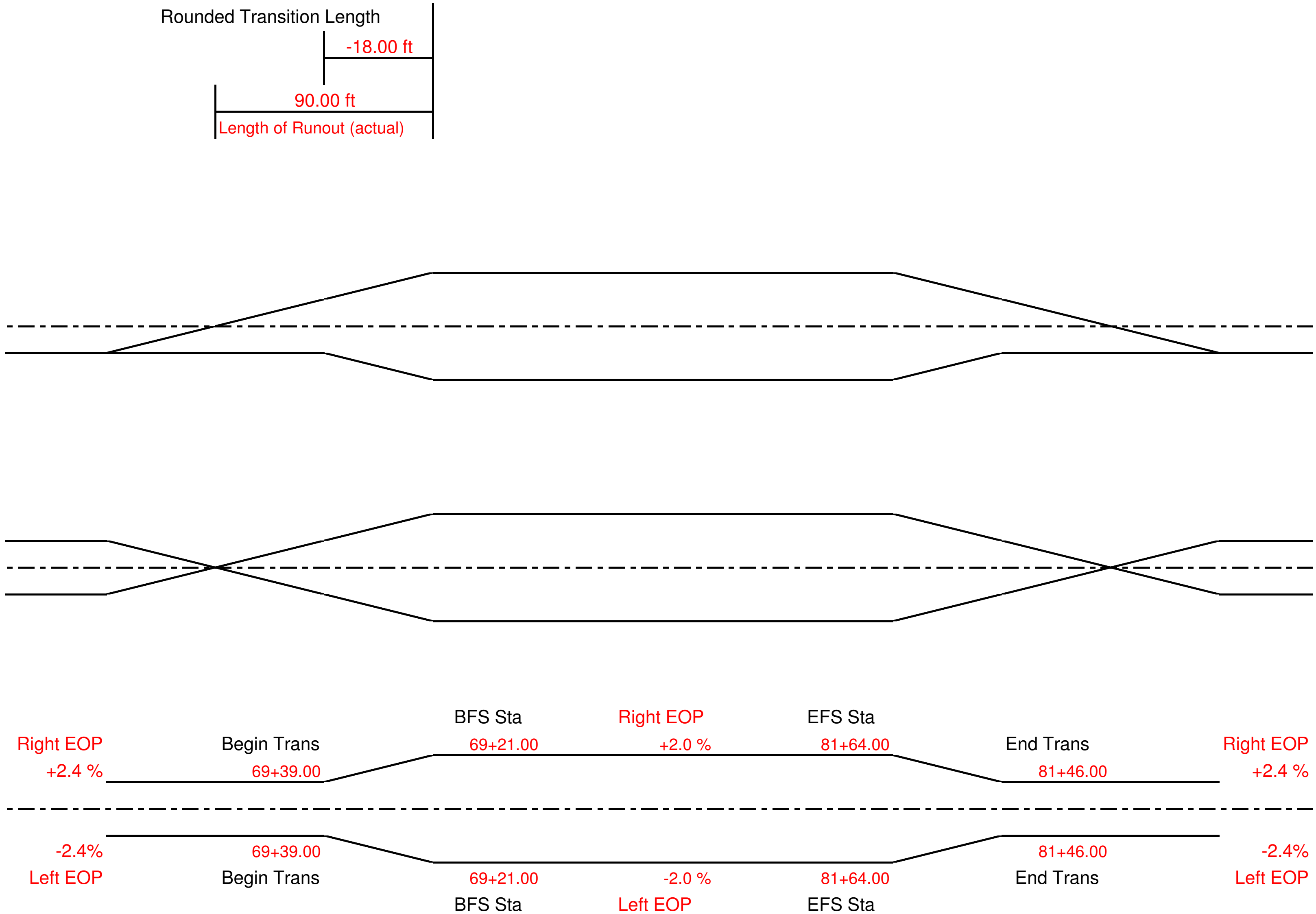
2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Right EOP Begin Transition Cross Slope (pos or neg)	2.4	%
Super Elevation Transition Length from 2.4%to 2%=	-18.00	ft
Rounded to Nearest 0.01 ft	-18.00	ft
Pick Agency for Portion of Super on Tangent Rules	AASHTO	
Portion of Runoff Prior to Curve	0.8	
Transition Length on Tangent	72.00	ft
* Distance from 0 point to Start of Transition	108.00	ft

		Use
Theoretical Point of Intersection (0% Super) Sta	68+31.21	
Begin Transition Sta	69+39.00	69+39.00
PC Sta	69+03.21	
Begin Full Super	69+21.00	69+21.00

		Use
End Full Super	81+64.00	81+64.00
PT Sta	81+81.17	
End Transiton Sta	81+46.00	81+46.00
Theoretical Point of Intersection (0% Super) Sta	82+54.00	

SUPER ELEVATION DIAGRAM



$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	5000	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of	2	
Design Super (e_d) positive value	2.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	90.00	ft
Spiral Curves Recommended Check	**No**	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	90.00	ft
Use Calculated Lr	90.00	ft

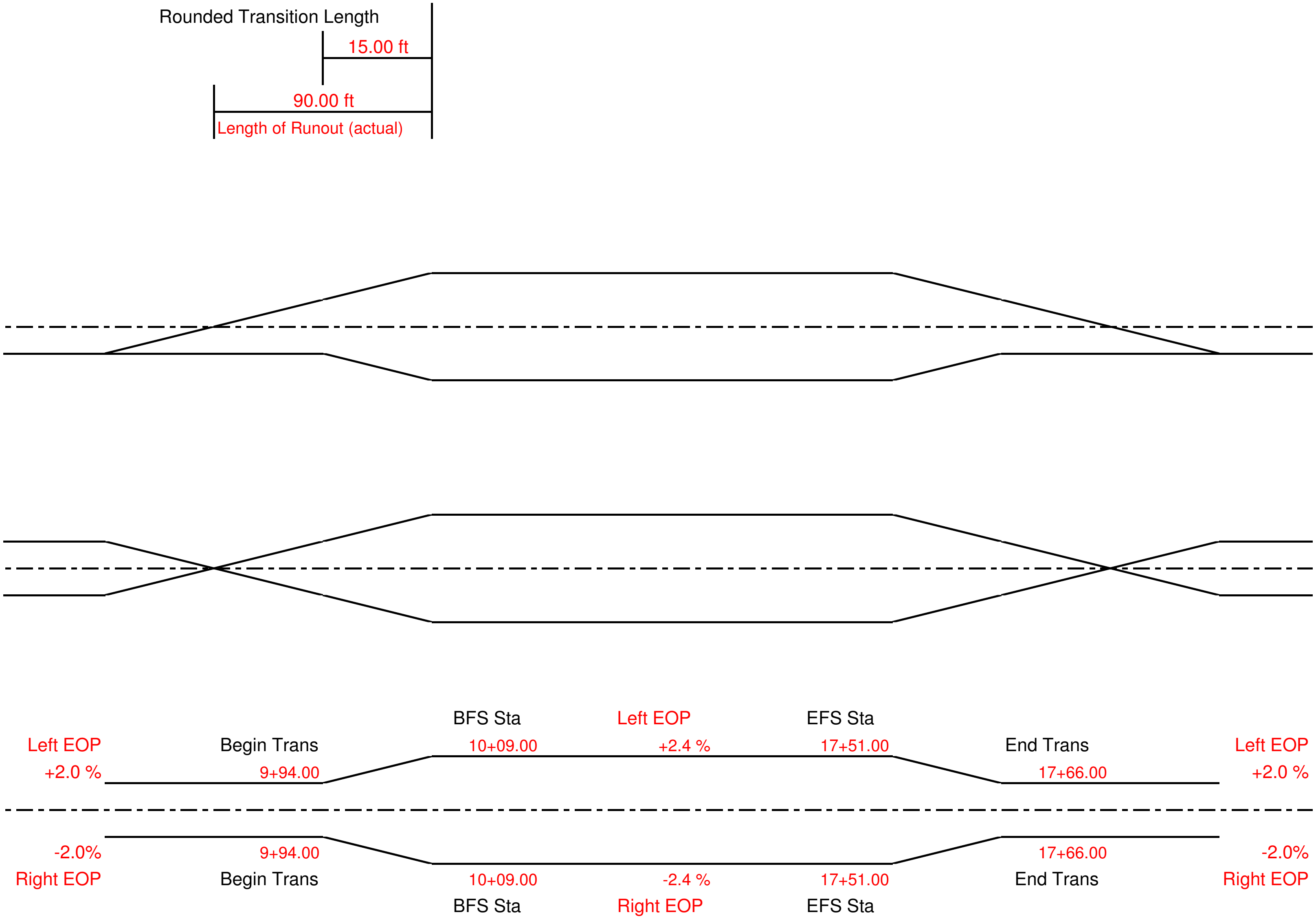
SUPER ELEVATION TRANSITION CALCULATION

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.0	%	
Super Elevation Transition Length from 2%to 2.4%=	15.00	ft	
Rounded to Nearest 0.01 ft	15.00	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	81.00	ft	
* Distance from 0 point to Start of Transition	75.00	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	9+19.00		
Begin Transition Sta	9+94.00		9+94.00
PC Sta	10+00.00		
Begin Full Super	10+09.00		10+09.00

		Use
End Full Super	17+51.00	17+51.00
PT Sta	17+59.50	
End Transiton Sta	17+66.00	17+66.00
Theoretical Point of Intersection (0% Super) Sta	18+41.00	

SUPER ELEVATION DIAGRAM



SUPER ELEVATION TRANSITION CALCULATION

$$Lr = \frac{(w*n)*e_d*(b_w)}{\Delta}$$

Radius	1100	ft
Design Speed	45	mph
W	12	ft
n (greatest no. of lanes on one side of ;	2	
Design Super (e_d) positive value	6.4	%
Curve Direction	Right	
Δ (Max Relative Gradient	0.5	%
b_w (Lane Adjustment Factor)	0.75	
Lr=	225.00	ft
Spiral Curves Recommended Check	No	
Design Speed Rounding Curve Length	0	

Transition Length Check to fit Design Speed Rounding Curves

Needed Lr to Fit 45 ft Vert Curve	0.00	ft
Calculated Lr	225.00	ft
Use Calculated Lr	225.00	ft

2 Way Direction of Travel about Axis of Rotation (Normal Crown)? No

Left EOP Begin Transition Cross Slope (pos or neg)	2.4	%	
Super Elevation Transition Length from 2.4%to 6.4%=	140.63	ft	
Rounded to Nearest 0.01 ft	140.63	ft	
Pick Agency for Portion of Super on Tangent Rules	AASHTO		
Portion of Runoff Prior to Curve	0.9		
Transition Length on Tangent	202.50	ft	
* Distance from 0 point to Start of Transition	84.38	ft	
			Use
Theoretical Point of Intersection (0% Super) Sta	15+57.00		
Begin Transition Sta	16+41.00		16+41.00
PC Sta	17+59.50		
Begin Full Super	17+82.00		17+82.00
			Use
End Full Super	27+12.00		27+12.00
PT Sta	27+34.11		
End Transiton Sta	28+53.00		28+53.00
Theoretical Point of Intersection (0% Super) Sta	29+37.00		

SUPER ELEVATION DIAGRAM