VALUE ENGINEERING STUDIES
FINAL REPORT

Portsmouth Bypass, Phase 1
SCI-823-6.81
PID 19415

PREPARED FOR:
Ohio Department of Transportation
District 9
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1.0 Introduction

A second Value Engineering (VE) Study was held for the entire Portsmouth Bypass Project on December 3-6, 2007. This Study was based on the Stage 1 plans submitted by TranSystems. At this meeting, thirty VE Alternatives were identified as either a potential cost savings item or a design suggestion. ODOT reviewed each of these alternatives electing to implement three and instructed HDR Engineering, Inc. (HDR) to study four others for potential inclusion in Phase 1 of the project, which is under final design by HDR. This report summarizes HDR's study and findings of the following four VE Alternatives as they relate to Phase 1 (PID #19415):

- Alternative 2/30 – Adjust the profile to reduce the volume of excavation and waste material by allowing high fill culverts.
- Alternative 5 – Raise the culverts in high fill areas to shorten the pipe by filling in the upstream basin and constructing a lined channel down the fill slope.
- Alternative 11A/11B – Steepen the fill slopes by holding the toe of slope and extending the break point at the top of slope away from the centerline, or by holding the top of slope break point and bringing the toe in towards the centerline. The aforementioned method would reduce waste and the later method would reduce culvert length and stream impacts.
- Alternative 45/52 – Provide a crushed rock subgrade to minimize pavement thickness, reduce the number of underdrain runs required, and reduce the volume of waste material.

A benefit/cost ratio was generated for each of these alternatives utilizing the unit costs that were used by HDR for the Revised Stage 1 Cost Estimate dated July 2008. Each benefit/cost analysis compares the Stage 1 design to the alternative being studied. The following unit costs were used in this report:

Excavation	$ 3.35 per cubic yard
Embankment	$ 0.74 per cubic yard (avg. haul ½ mile)
Embankment	$ 0.85 per cubic yard (avg. haul 1¼ mile)
Waste Material	$ 1.10 per cubic yard
60" Culvert	$ 262.00 per linear foot
72" Culvert	$ 205.00 per linear foot
78" Culvert	$ 288.00 per linear foot
90" Culvert	$ 325.00 per linear foot
Stream Mitigation	$ 250.00 per linear foot
Asphalt Pavement	$ 102.00 per cubic yard
Type C Granular Matl.	$ 25.00 per cubic yard
Excavation, As Per Plan	$ 3.35 per cubic yard
Embankment, As Per Plan	$ 10.00 per cubic yard
6" Base Pipe UD	$ 4.05 per linear foot
6" Shallow Pipe UD	$ 4.25 per linear foot
6" Rock Cut UD	$ 5.75 per linear foot
Bridge Impacts	$ 72.00 per square foot (no add'l piers req'd.)

Each of the alternatives was studied as a stand alone measure. Care must be taken when combining the cost saving effects of two or more alternatives since the net savings may not equal the sum of the individual savings presented herein.

2.0 Alternative No. 2/30

2.1 Description

The purpose of this study was to investigate raising the profile in critical areas to reduce the volume of waste material by increasing the embankment volume and reducing the excavation volume. The ODOT Drainage Design Manual (General Notes – Figures 1008-10 through 1008-14) states that the maximum cover over any culvert is 100 feet, unless a special design is performed. The Stage 1 profile was set based on using standard culverts with a cover less than 100 feet. For this study, the requirement for using standard culverts has been waived.

2.2 Advantages / Disadvantages

The Value Engineering Report identified the following advantages/disadvantages:

Advantages:

- Reduces cost
- Improves the profile
- Reduces project cut and waste

Disadvantages:

- May require non-standard culverts
- Delays project schedule
- Increases design cost

2.3 Study Approach

The following parameters were established and used to develop alternative profiles:

- Design Speed of SR 823 is 70 mph
- Set reduction of excavation as target
- Minimize bridge impacts
- Minimize additional project footprint
- Use a maximum grade of 4.5% on SR 823
- Profile can change in key areas or throughout the complete Phase 1 limits
- Investigate options with and without bridge impacts

Utilizing these parameters, HDR developed eight conceptual profiles as alternatives. Two of these profiles (VE-1 and VE-2) were spot improvements focusing on the deep rock cut between stations 415+00 and 433+00 and did not impact the bridge structures. The other six profiles (VE-3 through VE-8) covered the majority of the Phase 1 limits. These profiles were developed using an iterative approach, modifying each subsequent profile to increase the earthwork savings while minimizing the increased structure cost. VE-7 and VE-8 provide the greatest potential earthwork cost savings and are presented in this report for consideration. The difference between VE-7 and VE-8 can be found in the grade north of TR234 through the first major cut, with VE-7 featuring a 2.9% grade and VE-8 using the maximum 4.5%. While the latter results in additional earthwork savings, it will impact the northern ramps for the TR234 Interchange. This impact will likely require additional acceleration length for the northbound on-ramp due to significantly slower truck speeds.

Since the vast majority of cross sections along SR 823 were modified by hand due to geotechnical design, HDR developed a simplified template (criteria file) within Geopak that could be easily processed for the alternative profiles. The simplified template was calibrated against the earthwork volumes from the Stage 1 plans until the margin of error was within one percent. Once calibrated, the simplified template was run for the alternative profiles. The comparison of earthwork volumes used the calibrated run versus the alternative runs. Calibration tables can be found in Appendix A for the presented profile alternatives (VE-7 and VE-8).

When developing the template in fill sections, barrier grading was used in lieu of safety grading in many locations. Most of the roadway is protected by guardrail in the Stage 1 plans, so safety grading was not required, and changing to barrier grading with the higher fills would limit the amount of additional impacts. The construction limits of the alternatives (VE-7 and VE-8) stay within the environmental footprint for the project and should have minimal impacts to the current right-of-way design; the exceptions are primarily at culvert locations where some additional right-of-way may be required. If a profile modification is implemented, the final design slopes can be refined as much as possible to use additional waste material while staying within the current right-of-way limits.

The culvert and stream impacts were estimated using the culvert drawings and raising the edge of the graded shoulder a distance equal to the alternative profile elevation minus the Stage 1 profile elevation. The proper side slope for the revised height of fill was then applied to the raised edge of graded shoulder and the culvert length revision was calculated. The stream impact equaled the change in culvert length.

The bridge impacts were calculated on an additional square foot of deck basis since no additional spans were required. The square footage was calculated by lengthening the bridge two times the difference in profile elevations on each end of the bridge. This represents the added bridge length to get the 2:1 spill slope in front of the bridge abutment.

The estimated engineering cost for all design changes was based on engineering judgment.

2.4 Benefit / Cost Analysis

The two profile alternatives with the greatest earthwork savings were carried into the benefit/cost analysis. Both Alternatives (VE-7 and VE-8) revise the majority of the Phase 1 profile length, with the difference between the two being the first major cut as described previously. See Appendix A for profile output data and profile drawings comparing Stage 1, VE-7 and VE-8 profiles. Also included in Appendix A are typical cross sections demonstrating the impact of raising the profile in key locations.

Both VE-7 and VE-8 present savings by reducing the excavation required and increasing the embankment, which reduces the waste material. The added costs associated with the alternatives include: increased embankment, culvert lengths, stream impacts, bridge lengths, wick drains, and engineering costs. Tables 2-1 through 2-4 show the estimated savings and costs associated with each alternative. Please note that the volumes shown in these tables do not include the side roads as they have not been modified as part of the profile changes and do not affect the cost comparison. For all earthwork volumes along the project, including side roads, see Table 2-5.

An additional cost feature with VE-8 is a change in the unit cost for embankment (from $0.74 / CY to $0.85 / CY). This is due to an increase in the average haul distance required to move material from excavation in one part of the project to where embankment is needed in another. A detailed analysis was undertaken that examined the location of the various cuts and fills and where material would need to be hauled. VE-8 requires a large amount of material to be moved from north of SR139 southward and across Swauger Valley Road, resulting in a significant increase in the average haul distance for the project. For VE-8, the average roundtrip haul distance is 1¼ miles, whereas both Stage 1 and VE-7 have an average roundtrip haul distance of approximately ½ mile.

Alternative VE-7

Table 2-1: New Profile Savings, Alt. 2/30 (VE-7)

Item	Stage 1 Calibrated	VE-7	Difference	Unit Cost	Savings
Excavation	5,351,000	4,498,000	853,000	$3.35	$2,858,000
Waste	2,922,000	1,569,000	1,353,000	$1.10	$1,488,000
				Total Excavation/Waste Savings	$4,346,000

Table 2-2: New Profile Cost, Alt. 2/30 (VE-7)

Item	Stage 1 Calibrated	VE-7	Difference	Unit Cost	Cost
Embankment	3,232,000	3,604,000	372,000	$0.74	$275,000
78” Culverts			24	$288.00	$6,912
72” Culvert			56	$205.00	$11,480
60” Culvert			39	$262.00	$10,218
48” Culvert			28	$139.00	$3,892
Stream Mitigation			147	$250.00	$36,750
Bridge Impacts					$305,000
Wick Drains					$616,000
Engineering					$500,000
				Total Cost	$1,768,000

As illustrated in the tables above, the benefit/cost ratio for VE-7 is 2.4. The total savings realized by implementing profile VE-7 is approximately $ 2.5 million.

Alternative VE-8

Table 2-3: New Profile Savings, Alt. 2/30 (VE-8)

Item	Stage 1 Calibrated	VE-8	Difference	Unit Cost	Savings
Excavation	5,351,000	4,264,000	1,087,000	$3.35	$3,641,000
Waste	2,922,000	345,000	2,577,000	$1.10	$2,835,000
				Total Excavation/Waste Savings	$6,476,000

Table 2-4: New Profile Cost, Alt. 2/30 (VE-8)

Item	Stage 1 Calibrated	VE-8	Difference	Unit Cost	Cost
Embankment	3,232,000	4,559,000	1,327,000	$0.85	$1,128,000
Embankment (uc Δ)*	3,232,000			$0.11	$356,000
78" Culverts			157	$288.00	$45,216
72" Culvert			225	$205.00	$46,125
60" Culvert			39	$262.00	$10,218
48" Culvert			28	$139.00	$3,892
Stream Mitigation			449	$250.00	$112,250
Bridge Impacts					$305,000
Wick Drains					$616,000
Extended Accel Lane					$200,000
Engineering					$500,000
				Total Cost	$3,323,000

* Denotes the change in unit cost from Stage 1 ($0.74) to VE-8 ($0.85) due to haul distance

As illustrated in the tables above, the benefit/cost ratio for VE-8 is 1.9. The total savings realized by implementing profile VE-8 is approximately $3.1 million.

2.5 Additional Information

There are elements to consider that can not be quantified in the benefit/cost analysis. Stream mitigation costs are included in the analysis; however, the value associated with an untouched natural stream has been forfeited. Another element to consider is the location of the environmental footprint and the construction limits. The construction limits for Alternatives VE-7 and VE-8 remain within the environmental footprint for the project and are anticipated to have minimal impacts to the current right-of-way design. The exception is at culvert or other locations where a 2:1 slope already exists and any profile change will push the new toe out of the Stage 1 construction limits.

The profiles of the northbound entrance ramp (Ramp A) and the southbound exit ramp (Ramp D) at the Shumway Hollow Road (TR234) Interchange will be impacted by the VE-8 profile. For earthwork calculations, a conceptual design was utilized for the revised ramp profiles. Due to the 4.5% mainline grade and steeper ramp grade required with VE-8, additional ramp acceleration length/auxiliary lane to the top of the hill may be required as significant slowing of truck traffic is likely due to the steeper grades. A lump sum cost has been included in the above analysis for an increased lane length. The potential negative impact to truck speed in this area should be taken into consideration when evaluating VE-8.

Currently the earthwork in the vicinity of the TR234 interchange north of TR234 will consist of staged embankment construction (two stages) with a maximum wick drain spacing of five feet in order to complete the earthwork in a two year construction schedule. This design was based on a maximum fill height of 57 feet. The proposed profiles VE-7 and VE-8 both increase the embankment height, with VE-8 increased to just less than 100 feet. Slope stability and wick drain analyses were performed with a maximum embankment height of 100 feet with 2:1 side slopes. With the new earthwork in this area, three stages will be required for embankment construction

with reduced wick drain spacing of four feet in order to complete the earthwork in a two year construction schedule. The cost shown in Tables 2-2 and 2-4 reflect the change in wick drain spacing from five feet to four feet. If VE-7 is selected for implementation, additional analysis would be undertaken to determine if up to five foot spacing could be used in all or part of the embankment. For the purposes of this study, the more conservative four foot spacing was utilized for both alternatives.

As mentioned previously, VE-8 would result in an increase in the average haul distance for the project. Shown in Table 2-5 is a breakdown of the cut and fill volumes along the project for each of the three distinct sections for Stage 1, VE-7 and VE-8. The table shows all earthwork volumes for the project, including side roads. This provides a snapshot of the amount of material in each section and how much would need to move between sections. As indicated in the table, the section from SR139 to CR28 features the greatest amount of waste for the project. Raising the mainline (and ramp) profiles at the CR28 interchange with VE-7 and VE-8 has provided over a 20% reduction in the amount of waste generated in this section. As with TR234, conceptual layouts of the revised CR 28 interchange ramp profiles were undertaken to determine the potential earthwork savings and feasibility of the profile change.

Table 2-5: Earthwork By Project Section

	Stage1		
	*Cut	Fill	Delta
Start to Swauger Valley	2,591,950	1,601,750	990,200
Swauger Valley to SR139	510,600	1,012,000	-501,400
SR139 to CR28	3,587,300	689,500	2,897,800
Total	6,689,850	3,303,250	3,386,600

	VE-7		
	*Cut	Fill	Delta
Start to Swauger Valley	2,319,350	1,731,650	587,700
Swauger Valley to SR139	377,200	1,157,000	-779,800
SR139 to CR28	3,019,900	789,550	2,230,350
Total	5,716,450	3,678,200	2,038,250

	VE-8		
	*Cut	Fill	Delta
Start to Swauger Valley	2,049,800	2,685,850	-636,050
Swauger Valley to SR139	377,200	1,157,000	-779,800
SR139 to CR28	3,019,900	789,550	2,230,350
Total	5,446,900	4,632,400	814,500

*Cut with 15% swell factor applied (payment is based on raw excavation)

Please note that profiles VE-7 and VE-8 are conceptual and may be modified slightly to maximize savings or minimize impacts once final cross sections are developed if either of these profiles were adopted into final design. Detailed design activities would also be required for the interchange

ramp profiles. Because neither profile VE-7 or VE-8 require a height of cover over the culverts greater than 100 feet, standard culverts can still be used on the project. In addition, if either VE-7 or VE-8 is incorporated into the final design, further savings may be achieved by shifting the southbound ramps at the CR 28 interchange toward the north to further reduce the amount of cut within this interchange. As more detailed interchange design would be required to determine any potential savings, it was not included as part of this VE Study.

Implementation of either VE-7 or VE-8 would require a design change to the Stage 1 plans, resulting in a schedule shift for the Stage 2 submission. This would ultimately impact the proposed letting schedule currently shown for 2011. A shift into the following calendar year would likely result in additional inflationary cost increases. If prompt decisions can be made throughout the process, design changes can likely be made in a timeframe that would keep the proposed letting schedule in the same calendar year (2011), thus minimizing or eliminating any inflationary increases.

3.0 Alternative No. 5

3.1 Description

The purpose of this study is to raise the culverts in high fill areas to shorten the pipe and construct a lined channel down the fill slope. In order to raise the culverts, the upstream flow line would need to be raised by filling the stream channel.

3.2 Advantages / Disadvantages

The Value Engineering Report identified the following advantages/disadvantages:

Advantages:

- Shortens culvert length
- Easier to replace culvert
- Reduces culvert cost
- Allows project waste to be placed in fills

Disadvantages:

- Requires maintenance of outlet ditch
- Increased stream impacts on inlet side
- Increased right of way impacts on inlet side

3.3 Study Approach

Each culvert was reviewed to determine if there were any constraints upstream or downstream that would prohibit raising the pipe. Three of the nine mainline culverts could not be raised due to invert elevation restraints. The culverts at station 466+45 and 473+92 have a pond at the upstream end that can not be filled. The invert of the culvert at station 535+50 is controlled by the upstream drainage on CR 28; therefore, this culvert can not be raised.

The remaining six culverts were investigated in more detail. The first step was to look at the controlling factors which determine how high the culverts could be raised. Since the premise was to fill the upstream channel, the control had to come from the SR 823 roadside ditch on the upstream side of the culvert. With the culvert naturally being the low point of the ditch, the control became the high points of the ditch on either side of the culvert. The high point was held in order to maintain the natural drainage patterns. The lower elevation of the two high points was used to calculate the new culvert elevation by providing a minimum 0.5% slope from the high point to the culvert invert. The characteristics of the stream were then checked to determine if achieving this invert was possible and if the stream would be the controlling factor in setting the invert elevation. Minimum cover requirements were also a determining factor in setting the invert elevation. See Appendix B for a schematic of this strategy. To maximize cost savings, a balance needed to be determined between shortening the culvert by raising it in the fill versus increasing right-of-way and mitigation impacts.

3.4 Benefit / Cost Analysis

Since none of the culverts in Phase 1 are special designs, the only savings in this study are reduced culvert length and reduced waste to fill in the upstream basin. The reduced waste quantity has been deemed negligible in regards to this study because for every cubic yard reduced waste

savings is an increase in fill cost. The unit cost for waste is $1.10 while the unit cost for fill is $0.74; therefore, each cubic yard of material used to fill in the upstream basin would only result in a $0.36 savings and without extremely deep culverts, the amount of fill is relatively small.

Table 3-1 shows the maximum savings in culvert length by raising the culvert as high in the fill as the controlling factors allow, which would give the maximum savings. Table 3-2 shows the additional cost in stream mitigation in order to raise the culvert in the fill.

Table 3-1: Culvert Savings, Alt. 5

Culvert	Culvert Size	Reduced Length	Unit	Unit Cost	Savings
353+88	72"	117	LF	$205	$23,985
364+36	72"	151	LF	$205	$30,955
375+08	90"	111	LF	$325	$36,075
404+06	78"	126	LF	$288	$36,288
412+07	72"	107	LF	$205	$21,935
504+60	60"	119	LF	$262	$31,178
Total					$180,000

Table 3-2: Mitigation Costs, Alt. 5

Culvert	Additional Length	Unit	Unit Cost	Cost
353+88	135	LF	$250	$33,750
364+36	300	LF	$250	$75,000
375+08	370	LF	$250	$92,500
404+06	690	LF	$250	$172,500
412+07	160	LF	$250	$40,000
504+60	315	LF	$250	$78,750
Total				$493,000

According to the tables, the benefit/cost ratio for this study is 0.4 resulting in an approximate cost of $313,000 to implement. This benefit/cost ratio does not include the additional cost of rock channel protection down the fill slope and the additional right-of-way required to fill in the upstream basin. Adding these values would only result in a higher cost to implement. In addition, the benefit/cost ratio does not exceed 1.0 for any of the individual culvert locations.

There are elements to consider that can not be quantified in the benefit/cost analysis. Stream mitigation costs are included in the analysis; however, the value associated with an untouched natural stream has been forfeited. Another element to consider is the location of the environmental footprint and the construction limits. Modifications associated with Alternative 5 stay within the environmental footprint for the project but will impact the current construction limits and right-of-way design on the upstream side of the culverts.

4.0 Alternative No. 11A/11B

4.1 Description

The purpose of this study is twofold. Alternative 11A intends to reduce the waste volume and maintain the construction limits by holding the Stage 1 toe of slope as a hinge point and using steepened fill slopes of 1½:1 at culvert locations in place of the current 2:1 slopes. Alternative 11B intends to reduce culvert and stream impact lengths by using the hinge point at the top of the current 2:1 design slope and using a 1½:1 slope in place of the current 2:1 slope. Both of these alternatives would require the use of processed durable rock to create the 1½:1 slope.

4.2 Advantages / Disadvantages

The Value Engineering Report identified the following advantages/disadvantages:

Advantages 11A:

- Allows project waste to be placed in fills
- Reduces cost

Disadvantages 11A:

- Special controlled fill (1½ :1)

Advantages 11B:

- Reduces length of culverts
- Reduces stream impacts
- Reduces right-of-way impacts
- Reduces cost

Disadvantages 11B:

- Creates additional waste material
- Special controlled fill (1½ :1)

4.3 Study Approach

Alternative 11A

Since the intent of this alternative was to use more waste in the fill slope areas without changing the toe of the slope location, there are no impacts to culvert length, stream mitigation or right-of-way. This alternative was investigated at the culvert locations in addition to all other fill areas along the project length. In areas where existing slopes are protected by guardrail the slopes were changed to 2:1, and at all culvert locations the slopes were changed to 1½:1. The only mainline culvert that did not have this slope change evaluated was the culvert at station 535+50 because it is located in close proximity to the structure over CR28.

Most fill slopes on this project follow safety grading criteria which requires a 6:1 or flatter foreslope through the clear zone and then a 3:1 or flatter slope beyond the clear zone. The Stage 1 design used 6:1 through the clear zone and 4:1 beyond the clear zone. In an effort to reduce waste, the intent of Alternative 11A was applied in all areas of fill with a 4:1 slope by changing the slope to 3:1 from the toe until meeting the 6:1 slope. This approach could be incorporated in the Stage 2 plans without implementing this Value Engineering Alternative. It is important to note however that

changing the slope design from the toe up will provide an inconsistent offset for the break from 6:1 to 3:1. The break will no longer be located at the clear zone offset and will vary from station to station. Although all break points will be located outside of the clear zone, this may create an unusual sight for drivers since the break line is not parallel to the edge of the shoulder.

The average end area method was used to determine the quantity of additional fill which equals the quantity of waste reduced. This method was used at the culvert locations in addition to the safety grading locations. Schematics and the average end area calculations for both these situations can be found in Appendix C.

Alternative 11B

This alternative holds the top of the current 2:1 as a hinge point and steepens the slope to 1½:1 which will bring the toe of slope in towards the centerline. This alternative actually increases the amount of waste; therefore, the only location that this alternative would result in a cost savings is at the culvert locations due to the reduction in culvert length, stream mitigation and right-of-way.

The average end area method was used to determine the quantity of fill reduced, which equals the quantity of additional waste. A schematic and the average end area calculations for this situation can be found in Appendix C. Each culvert location was evaluated to determine the length that the culvert could be reduced, which would equal the reduction in stream mitigation. Finally, the right-of-way impacts were investigated and found to be insignificant. Only a minimal reduction in right-of-way could be realized since the controlling points are typically located outside of the culvert locations.

4.4 Benefit / Cost Analysis

Alternative 11A

The savings associated with Alternative 11A came from the reduction of project waste. With this reduction comes an increase in fill material. Table 4-1 shows the values associated with each culvert. While the fill required in the 1½:1 slope is special controlled fill, the change in unit cost from regular fill has been deemed negligible due to the small fraction of total earthwork involved. Table 4-2 shows the values associated with the safety grading locations.

Table 4-1: Earthwork Cost / Savings at Culvert Locations, Alt. 11A

Culvert	Fill Vol. (CY)	Cost $0.74/CY	Waste Vol. (CY)	Savings $1.10/CY
353+88	1,280	$947	1,280	$1,408
364+36	4,090	$3,027	4,090	$4,499
375+08	8,130	$6,016	8,130	$8,943
404+06	15,530	$11,492	15,530	$17,083
412+07	13,420	$9,931	13,420	$14,762
466+45	58,620	$43,379	58,620	$64,482
473+92	32,830	$24,294	32,830	$36,113
504+60	2,520	$1,865	2,520	$2,772
Total	136,420	$101,000	136,420	$150,000

Table 4-2: Earthwork Cost / Savings at Safety Grading Locations, Alt. 11A

Street Name	Fill Vol. (CY)	Cost @ $0.74/CY	Waste Vol. (CY)	Savings @ $1.10/CY
SR823	240,340	$177,852	240,340	$264,374
TR234 Ramp A	9,400	$6,956	9,400	$10,340
TR234 Ramp B	2,760	$2,042	2,760	$3,036
TR234 Ramp C	900	$666	900	$990
TR234 Ramp D	1,470	$1,088	1,470	$1,617
CR28 Ramp A	600	$444	600	$660
Total	255,470	$189,000	255,470	$281,000

The total savings realized by Alternative 11A is $431,000 and the total cost associated with this savings is $340,000 (Embankment cost plus a $50,000 engineering cost). The resulting benefit/cost ratio is 1.3 resulting in a net savings of approximately $91,000.

Alternative 11B

The cost associated with Alternative 11B comes from the increase in project waste. With this increase comes a reduction in fill material. Table 4-3 shows the values associated with each culvert. While the fill required in the 1½:1 slope is special controlled fill, the change in unit cost from regular fill has been deemed negligible due to the small fraction of total earthwork involved.

Table 4-3: Earthwork Cost / Savings at Culvert Locations, Alt. 11B

Culvert	Fill Vol. (CY)	Savings $0.74/CY	Waste Vol. (CY)	Cost $1.10/CY
353+88	1,250	$925	1,250	$1,375
364+36	4,320	$3,197	4,320	$4,752
375+08	8,600	$6,364	8,600	$9,460
404+06	16,530	$12,232	16,530	$18,183
412+07	13,880	$10,271	13,880	$15,268
466+45	65,030	$48,122	65,030	$71,533
473+92	36,050	$26,677	36,050	$39,655
504+60	2,740	$2,028	2,740	$3,014
Total	148,400	$110,000	148,400	$163,000

The major savings associated with Alternative 11B comes from the reduction of culvert and stream mitigation length. Table 4-4 and Table 4-5 show the culvert and mitigation savings respectively.

Table 4-4: Culvert Savings, Alt. 11B

Culvert	Culvert Size	Reduced Length	Unit	Unit Cost	Savings
353+88	72"	32	LF	$205	$6,560
364+36	72"	43	LF	$205	$8,815
375+08	90"	76	LF	$325	$24,700
404+06	78"	57	LF	$288	$16,416
412+07	72"	75	LF	$205	$15,375
466+45	78"	148	LF	$288	$42,624
473+92	72"	149	LF	$205	$30,545
504+60	60"	36	LF	$262	$9,432
Total					$154,000

Table 4-5: Mitigation Savings, Alt. 11B

Culvert	Reduced Length	Unit	Unit Cost	Savings
353+88	32	LF	$250	$8,000
364+36	43	LF	$250	$10,750
375+08	76	LF	$250	$19,000
404+06	57	LF	$250	$14,250
412+07	75	LF	$250	$18,750
466+45	148	LF	$250	$37,000
473+92	149	LF	$250	$37,250
504+60	36	LF	$250	$9,000
Total				$154,000

The total savings realized by Alternative 11B is $418,000 and the total cost is $213,000 (Waste cost plus a $50,000 engineering cost). The resulting benefit/cost ratio is 2.0 resulting in a net savings of approximately $205,000. This benefit/cost ratio does not include the additional savings in right-of-way. Due to the nature of long right-of-way tangents, the shortening of the culverts will have a minimal impact on the right-of-way savings.

There are elements to consider that can not be quantified in the benefit/cost analysis. Both Alternative 11A and 11B utilize 1½:1 slopes. Some issues need to be considered when using this steep of a slope in high fill areas. The first issue is the above average inspection time to ensure the proper material and compaction is used for slope stabilization. The second issue is the negative visual effect (aesthetics) of a high rock slope that will grow little to no vegetation for many years. In addition, 1½:1 slopes were previously proposed in order to reduce costs at bridge locations, but it was ultimately decided by ODOT to maintain the 2:1 slopes as originally designed.

5.0 Alternative No. 45/52

5.1 Description

The purpose of Alternative No. 45 is to utilize durable rock from the project excavations to provide a layer of graded aggregate that can improve the strength of the subgrade, which would result in a reduced asphalt pavement thickness. The purpose of study 52 is to eliminate the underdrains at the outside edge of the traveled lanes. This study will incorporate both ideas into one set of analyses to reduce pavement and underdrain costs.

5.2 Advantages / Disadvantages

The Value Engineering Report identified the following advantages/disadvantages:

Advantages:

- Improves drainage of the subgrade
- Improves subgrade strength resulting in reduced pavement thickness
- Eliminates some underdrains
- Reduces cost

Disadvantages:

- Not a common department solution
- Increases construction management effort
- Possible learning curve for unfamiliar contractors

5.3 Study Approach

The first step in this study was to determine the amount of durable rock available from the project excavations that could be used for the aggregate base. The total volume of rock excavation was determined by the average end area method in proposed rock cut locations. Based on test borings performed at various locations within these cuts, approximately 75% of the rock cut excavation is anticipated to be comprised of sandstone. Table 5-1 shows the estimate of total durable rock available. The Sandstone Volume is 75% of the Cut Volume listed in the table.

Table 5-1: Durable Rock Available, Alt. 45/52

Street Name	Begin Station	End Station	Cut Vol. (CY)	Sandstone Vol. (CY)
SR823	415+50	433+50	1,269,500	952,100
SR823	449+50	457+50	305,400	229,100
SR823	479+50	482+75	88,200	66,200
SR823	497+75	503+50	247,400	185,600
SR823	508+50	528+00	1,680,900	1,260,700
TR234	18+00	26+00	340,800	255,600
TR234 - Ramp D	385+00	387+00	55,700	41,800
CR28 - Ramp A	519+00	528+00	413,800	310,400
CR28 - Ramp B	523+50	527+00	68,300	51,200
CR28 - Ramp C	522+00	528+00	213,600	160,200
CR28 - Ramp D	520+00	526+50	326,000	244,500
Total				3,757,000

Since it is anticipated that a large portion of the savings under this alternative would come from reducing the pavement thickness, a potential new pavement buildup was determined for the project. The Stage 1 pavement buildup for SR 823 is 11" of 880 Warranty Pavement on 6" of Aggregate Base with underdrains at the edges of pavement, edges of shoulder and median. Currently TR 234 ramps and CR 28 ramps have 9" of 880 Warranty Pavement on 6" of Aggregate Base with underdrains at the edges of shoulder. The ODOT Pavement Design & Rehabilitation Manual was used to determine the current structural number of 5.0 for the SR 823 pavement section. The calculation to determine a proposed pavement buildup that provides an equal structure number can be found in Appendix D. HDR chose to use a minimum pavement buildup of 8" of 880 Warranty Pavement on 6" of Aggregate Base on 12" of Type C Granular Material for SR 823, TR 234 ramps and CR 28 ramps. This minimum pavement section provides a higher structural number than the Stage 1 pavement section, but was held as a minimum for serviceability reasons. Underdrains were considered only at the edges of shoulder to collect any water within the aggregate base and the Type C Granular Material. This typical section provides adequate pavement structural stability and subgrade drainage. It was determined that there is adequate durable rock through excavation to supply the Type C Granular Material for a 12" lift throughout the project limits.

The new pavement buildup was analyzed to determine the cost and savings associated with the design change. The project was divided into three typical sections: fill, cut and rock cut. The quantities for each typical section were impacted differently by the change in pavement design. In addition, locations where the earthwork will be constructed but not paved until later design phases (SR 823 Station 352+00 to 396+50, TR 234 ramps B & C, SR 823 Station 520+00 to 537+00 and CR 28 ramps B & C) will also be impacted differently by the change in pavement design. There are six different scenarios that were analyzed. Typical sections and a written description of each scenario can be found in Appendix D.

5.4 Benefit / Cost Analysis

The majority of savings in this study came from the reduced pavement thickness and the removal of the majority of underdrains. The major cost of this study is the Type C Granular Material required for the new drainage layer under the pavement. The Type C Granular Material will be processed on site from the sandstone excavated for the project. There are other costs and savings regarding different changes in earthwork quantities, but they are minimal in comparison to the Type C Granular Material, reduced pavement and reduced underdrains. Table 5-2 and Table 5-3 show the results of the benefit/cost analysis based on the six typical section scenarios applied to their applicable station ranges.

Table 5-2: New Pavement Design Savings, Alt. 45/52

Item	Quantity	Unit	Unit Cost	Savings
Reduced Pavement	11,100	CY	$102.00	$1,132,200
Reduced Fill	36,400	CY	$0.74	$26,936
Reduced Waste	11,100	CY	$1.10	$12,210
Reduced Cut APP	6,800	CY	$3.35	$22,780
Reduced Embankment APP	26,700	CY	$10.00	$267,000
Reduced 6" Base Pipe Underdrains	7,500	LF	$4.05	$30,375
Reduced 6" Shallow Pipe Underdrains	21,350	LF	$4.25	$90,738
Reduced 6" Rock Cut Underdrains	16,800	LF	$5.75	$96,600
			Total Savings	$1,679,000

Table 5-3: New Pavement Design Cost, Alt. 45/52

Item	Quantity	Unit	Unit Cost	Cost
Type C Granular Material	50,600	CY	$25.00*	$1,265,000
Additional Cut	8,600	CY	$3.35	$28,810
Additional Waste	21,000	CY	$1.10	$23,100
Engineering				$100,000
			Total Cost	$1,417,000

According to the tables, the benefit/cost ratio of this alternative is 1.2 resulting in an approximate savings of $262,000.

* To determine the unit cost of the Type C Granular Material, the quantities and associated unit costs were reviewed from ODOT bid tabulations from 2003 through 2007. As very little data was available for Type C Granular Material, the data set was expanded to include both Type B and Type D Granular Material. The bid quantities were plotted against their associated unit cost to determine the relationship between project size and unit cost. A power function was then fit to the data in order to determine an average unit cost for the approximate 50,000 cubic yards (CY) of granular material, resulting in a unit cost of $22.50/CY. Bringing this amount forward to 2008 dollars results in a unit cost of $25.00/CY. While on site processing may result in a lower unit cost, for this study a conservative approach was utilized so as to not over estimate potential savings.

6.0 VE Studies Summary

This report presents the results of an engineering study for the four value engineering alternatives identified by ODOT to determine their feasibility for inclusion in the SCI-823-6.81 (Portsmouth Bypass, Phase 1) project. The report presents the benefit/cost ratio and net savings for each alternative. These alternatives were analyzed individually as stand alone measures. Care must be taken when combining the cost saving effects of two or more of the alternatives since the net savings may not equal the sum of the individual savings presented herein.

It should also be understood that while the analyses presented herein were thorough, they do not represent final design cost analyses. When reviewing the savings and costs presented in this report, the magnitude of the numbers are what is important. The exact numbers may change if any of these alternatives are incorporated into the final design of the project, based on a more detailed design. In general, a conservative approach was undertaken so as to not over estimate any potential cost savings.

Table 6-1 is a summary of each alternative with their benefit/cost ratio and the estimated net savings.

Table 6-1: Value Engineering Study Results

Alternative	Description	Benefit/Cost	Estimated Savings
2/30	Revised Profile VE-7 Revised Profile VE-8	2.4 1.9	$2,500,000 $3,100,000
5	Raise Culverts	0.4	$313,000*
11A	Steepen Slope/Hold Toe	1.3	$91,000
11B	Steepen Slope/Hold Top	2.0	$205,000
45/52	Rock Subgrade	1.2	$262,000

* This alternative presents a net increase in project costs.

Appendix A – Alternative No. 2/30 Supporting Material

PROFILE-SR823
STA. 352+00 TO STA. 364+50

CALCULATED | CHECKED

PHASE-3
PID 77366
BY OTHERS

MATCH LINE STA. 352+00 SR823 BEGIN PHASE 1

P.V.I. STA. 347+50.00
ELEV. 641.14
1200' V.C.

EXISTING GROUND AT ℄

PROPOSED PROFILE (STAGE 1)
PROPOSED PROFILE (ALTERNATIVE VE-7)
PROPOSED PROFILE (ALTERNATIVE VE-8) +1.50 %

MATCH LINE STA. 364+50 SR823

STAGE 1 PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

352+00	353+00	354+00	355+00	356+00	357+00	358+00	359+00	360+00	361+00	362+00	363+00	364+00
664.0	658.7	648.9	633.5	626.4	638.9	647.8	657.3	664.5	670.7	673.0	675.2	676.5
678.3	680.1	682.1	682.1	680.2	675.9	673.7	665.3	656.6	650.0	640.9	623.4	634.4

820	800	780	760	740	720	700	680	660	640	620	600	580	560	540	520	500

648.47	648.67	648.90	649.16	649.46	649.78	650.14	650.89	651.64	652.39	653.14	653.89	654.64	655.39	656.14	656.89	657.64	658.39	659.14	659.89	660.64	661.39	662.14	662.89	663.64	664.39	665.14	665.89	666.64

SCI-823-6.81

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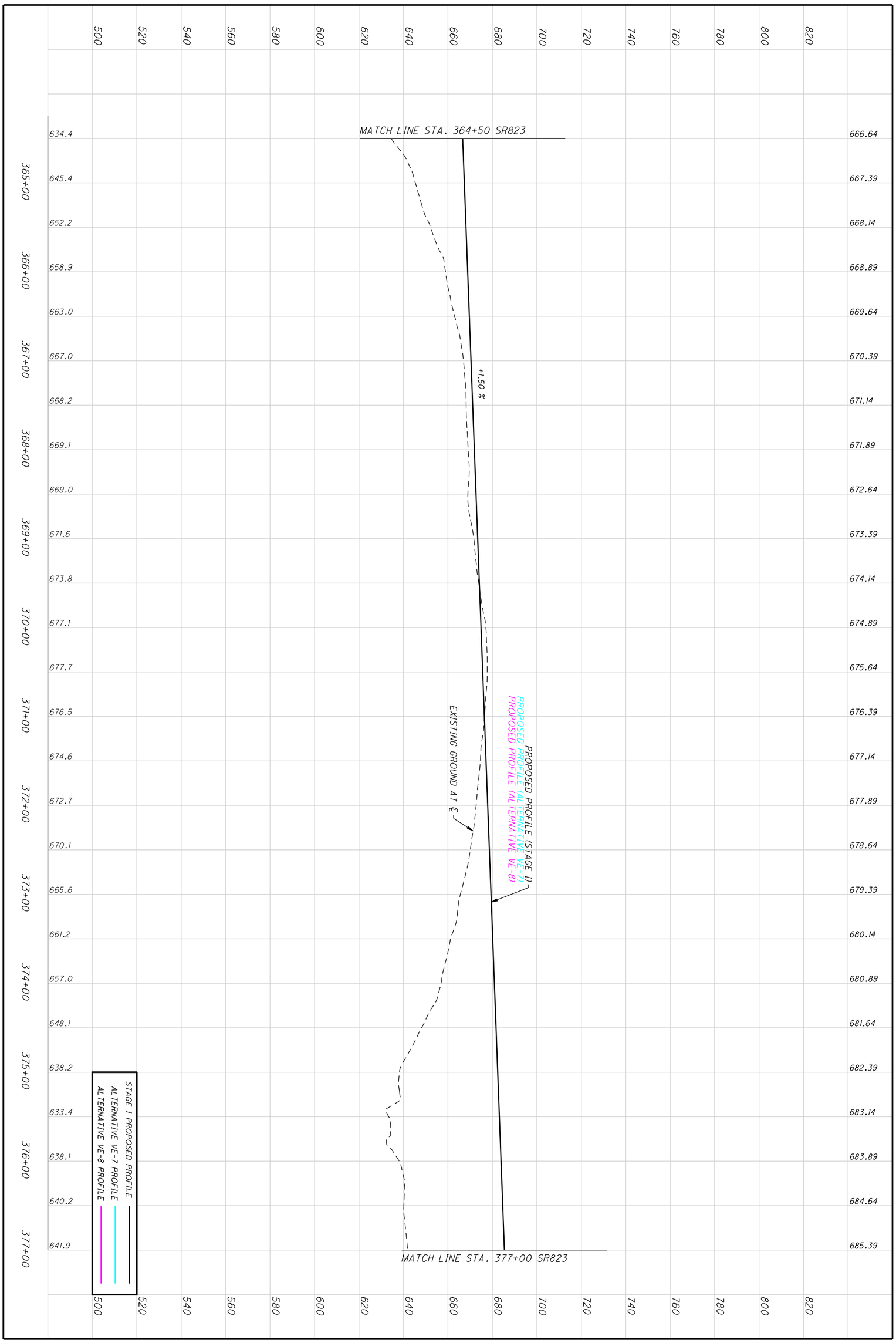

2 / 15	**SCI-823-6.81**	**PROFILE-SR823** **STA. 364+50 TO STA. 377+00**

CALCULATED

CHECKED

PROFILE-SR823
STA. 377+00 TO STA. 389+50

CALCULATED | CHECKED

PROPOSED PROFILE (STAGE 1)
PROPOSED PROFILE (ALTERNATIVE VE-7)
PROPOSED PROFILE (ALTERNATIVE VE-8)

EXISTING GROUND AT ℄

MATCH LINE STA. 377+00 SR823

MATCH LINE STA. 389+50 SR823

+1.50 % +1.50 % +1.50 %

685.39 686.14 686.89 687.64 688.39 689.14 689.89 690.64 691.39 692.14 692.89 693.64 694.39 695.14 695.89 696.64 697.39 698.14 698.89 699.64 700.39 701.14 701.89 702.64 703.39 704.14

699.64 700.43 701.29 702.23 703.24 704.33 705.49

820 800 780 760 740 720 700 680 660 640 620 600 580 560 540 520 500

641.9 644.8 648.7 654.1 660.1 662.4 661.7 662.2 663.9 665.0 665.9 667.2 669.2 671.0 673.1 674.5 675.3 676.1 678.8 682.3 684.0 684.9 688.1 690.4 691.9 692.3

377+00 378+00 379+00 380+00 381+00 382+00 383+00 384+00 385+00 386+00 387+00 388+00 389+00

STAGE 1 PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

SCI-823-6.81

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PROFILE-SR823
STA. 389+50 TO STA. 402+00

CALCULATED | CHECKED

PROPOSED PROFILE (ALTERNATIVE VE-8)

PROPOSED PROFILE (ALTERNATIVE VE-7)

PROPOSED PROFILE (STAGE I)

+1.50 %

+4.50 %

+1.50 %

+4.50 %

+1.50 %

P.V.I. STA 391+50.00 ELEV = 707.14'
1,000.00' VC

P.V.I. STA 402+00.00 ELEV = 722.89'
1,000.00' VC

EXISTING GROUND AT ℄

MATCH LINE STA. 389+50 SR 823

MATCH LINE STA. 402+00 SR 823

STAGE I PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

704.14 704.89 705.64 706.39 707.14 707.89 708.64 709.39 710.14 710.89 711.64 712.39 713.14 713.89 714.64 715.39 716.14 716.89 717.64 718.39 719.14 719.89 720.64 721.39 722.14 722.89

705.49 706.73 708.04 709.43 710.89 712.43 714.04 715.73 717.49 719.33 721.24 723.23 725.29 727.43 729.64 731.89 734.14 736.39 738.64 740.89 743.14 745.39 747.64 749.89 752.14 754.39

715.39 716.16 716.96 717.79 718.66 719.57 720.50 721.48 722.48 723.52 724.60

692.3 693.2 694.6 692.8 693.7 694.9 695.6 696.4 697.1 695.8 691.9 690.7 690.7 690.7 690.7 690.4 688.5 688.5 687.9 686.6 687.3 687.6 687.5 687.4 687.6 687.1

870 850 830 810 790 770 750 730 710 690 670 650 630 610 590 570 550

390+00 391+00 392+00 393+00 394+00 395+00 396+00 397+00 398+00 399+00 400+00 401+00 402+00

SCI-823-6.81

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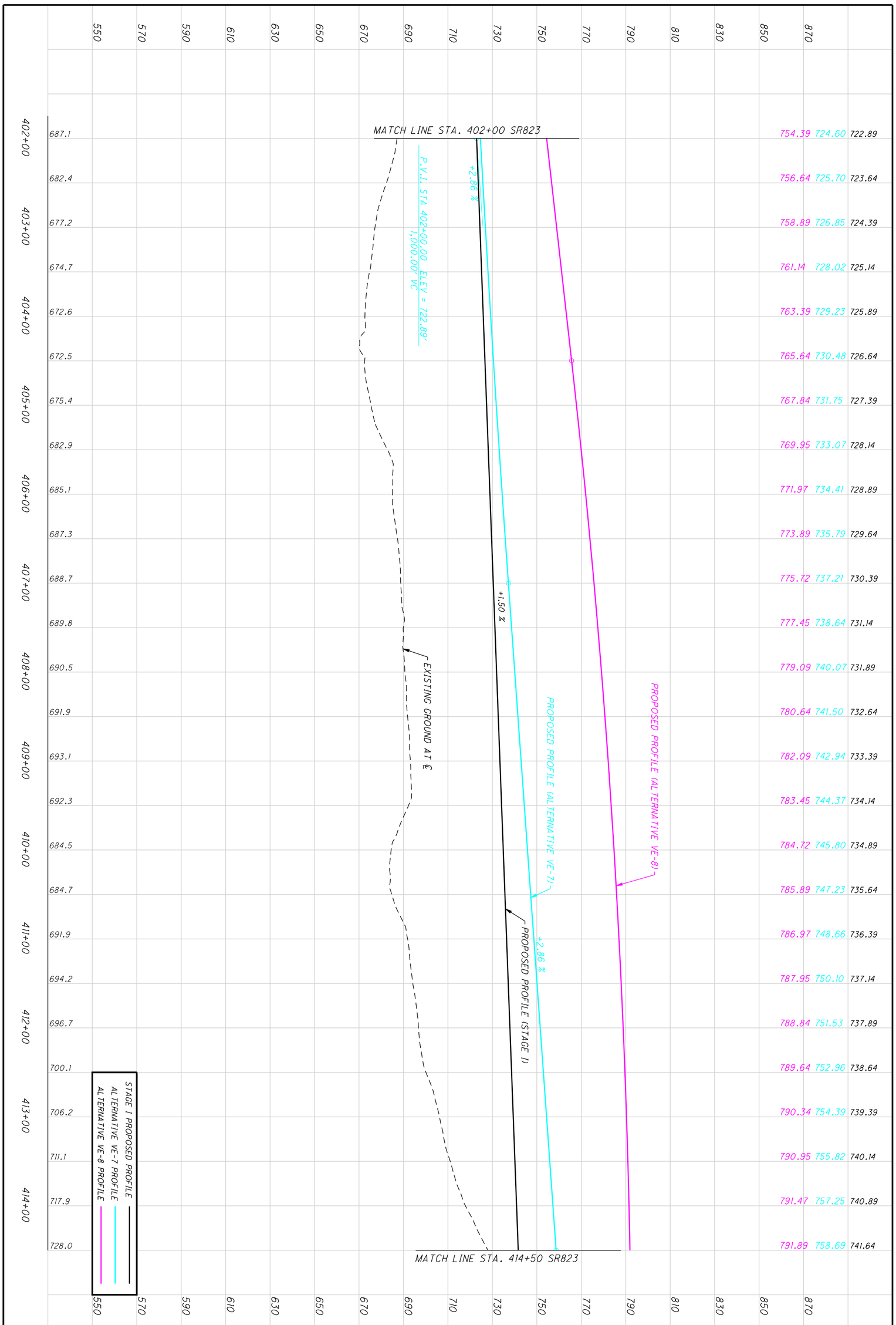

5 / 15	**SCI-823-6.81**	**PROFILE-SR823** **STA. 402+00 TO STA. 414+50**
		CALCULATED CHECKED

PROFILE-SR823
STA. 414+50 TO STA. 427+00

CALCULATED | CHECKED

P.V.I. STA 416+50.00 ELEV = 819.64'
2,400.00' VC

+4.50 % -4.50 %

EXISTING GROUND AT ℄

P.V.I. STA 424+00.00 ELEV = 785.89'
1,900.00' VC

+2.86 % -4.50 %

PROPOSED PROFILE (ALTERNATIVE VE-8)

PROPOSED PROFILE (ALTERNATIVE VE-7)

PROPOSED PROFILE (STAGE I)

+1.50 %

MATCH LINE STA. 414+50 SR823

MATCH LINE STA. 427+00 SR823

	415+00	416+00	417+00	418+00	419+00	420+00	421+00	422+00	423+00	424+00	425+00	426+00	427+00
EXISTING GROUND	741.64	742.39	743.14	743.89	744.64	745.39	746.14	746.89	747.64	748.39	749.14	749.89	750.64
PROPOSED PROFILE (ALTERNATIVE VE-8)	791.89	792.22	792.45	792.59	792.64	792.59	792.45	792.22	791.89	791.47	790.95	790.34	789.64
PROPOSED PROFILE (ALTERNATIVE VE-7)	758.69	760.07	761.36	762.55	763.64	764.63	765.53	766.33	767.04	767.65	768.16	768.57	768.89
PROPOSED PROFILE (STAGE I)	728.0	739.5	756.2	770.1	783.0	798.6	808.0	816.8	822.9	828.5	835.7	841.6	843.9

	751.39	752.14	752.51	752.84	753.16	753.44	753.71	753.94	754.16	754.34	754.51	754.64	754.76	754.84	754.91	754.94	754.96	754.94	754.91	754.84	754.76	754.64	754.51	754.34
EXISTING GROUND	788.84	787.95	786.97	785.89	784.72	783.45	782.09	780.64	779.09	777.45	775.72	773.89	771.97											
PROPOSED PROFILE (ALTERNATIVE VE-8)	769.11	769.24	769.26	769.19	769.03	768.76	768.40	767.94	767.39	766.74	765.99	765.14	764.20											
PROPOSED PROFILE (ALTERNATIVE VE-7)	769.11	769.24	769.26	769.19	769.03	768.76	768.40	767.94	767.39	766.74	765.99	765.14	764.20											
PROPOSED PROFILE (STAGE I)	851.4	822.4	813.1	800.7	788.0	785.6	794.8	809.5	819.7	829.2	840.4	856.3												

STAGE I PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

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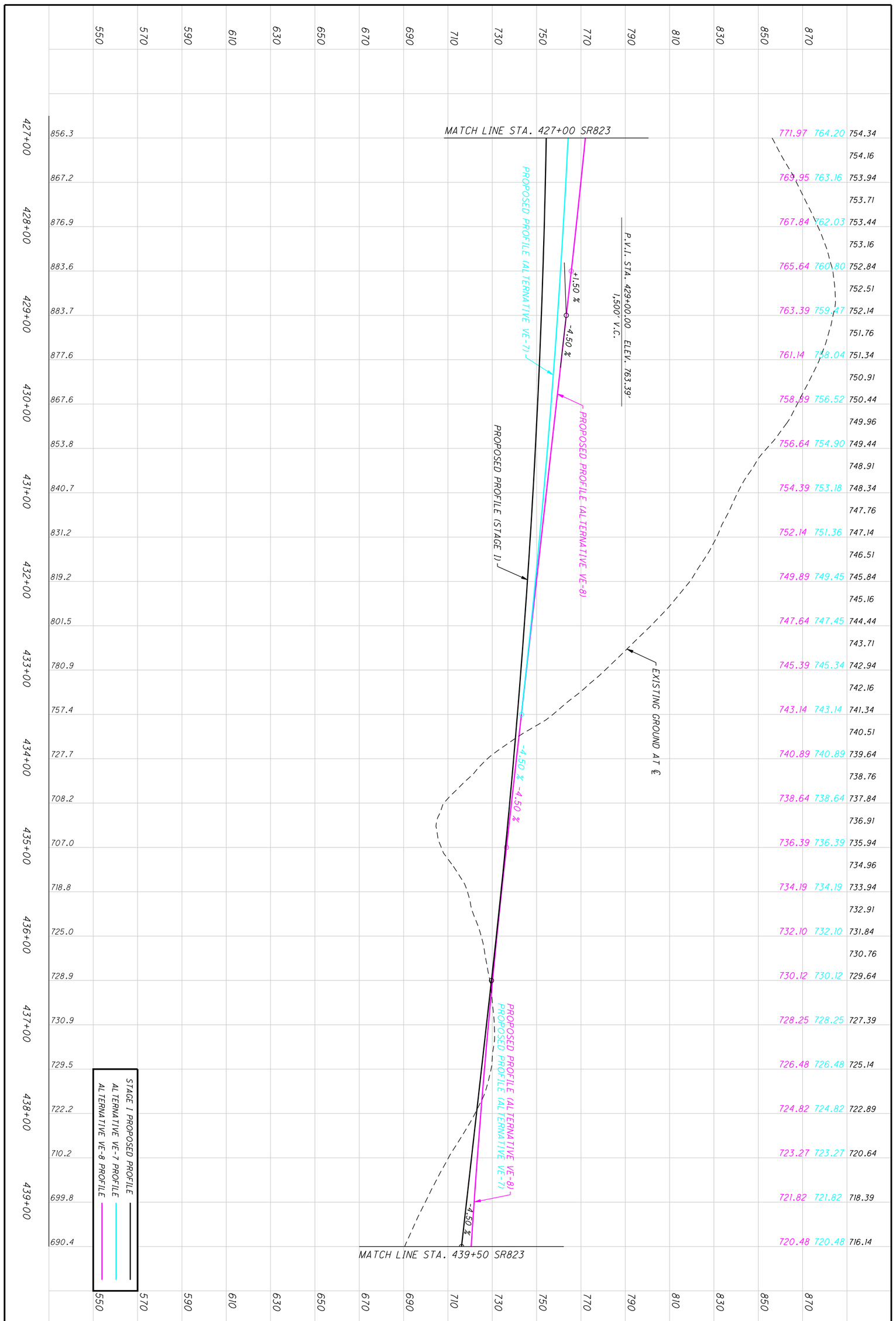

7 / 15	**SCI-823-6.81**	**PROFILE-SR823** **STA. 427+00 TO STA. 439+50**
		CALCULATED CHECKED

PROFILE-SR823
STA. 439+50 TO STA. 452+00

CALCULATED | CHECKED

SCI-823-6.81

716.14 715.04 713.96 712.92 711.92 710.95 710.01 709.10 708.24 707.40 706.60 705.83 705.10 704.40 703.74 703.11 702.51 701.95 701.42 700.93 700.47 700.05 699.65 699.30 698.97 698.69 698.43 698.21 698.02 697.87 697.75 697.67 697.62 697.60 697.62 697.68 697.76 697.88 698.04 698.23 698.45 698.71 699.00 699.33 699.69 700.08 700.51 700.97 701.47 702.00 702.56

720.48 719.25 718.12 717.10 716.19 715.39 714.69 714.10 713.62 713.25 712.98 712.82 712.77 712.82 712.98 713.25 713.62 714.10 714.69 715.39 716.14 716.89 717.64 718.39 719.14 719.89

870 850 830 810 790 770 750 730 710 690 670 650 630 610 590 570 550

MATCH LINE STA. 439+50 SR823

MATCH LINE STA. 452+00 SR823

PROPOSED PROFILE (ALTERNATIVE VE-8)
PROPOSED PROFILE (ALTERNATIVE VE-7)

PROPOSED PROFILE (STAGE I)

-4.50 % -4.50 % +1.50 % +1.50 %

P.V.I. STA 442+00.00 ELEV = 704.89'
1,400.00' VC

P.V.I. STA 442+00.00 ELEV = 704.89'
1,400.00' VC

+1.50 % +1.50 %

-4.50 % +2.60 %

P.V.I. STA. 446+00.00 ELEV. 686.89'
1300' V.C.

EXISTING GROUND AT ℄

STAGE I PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

690.4 683.1 675.7 665.1 656.2 648.9 639.1 636.1 636.1 648.6 659.4 658.2 659.8 664.0 667.6 676.0 688.0 691.3 693.7 695.8 701.1 714.1 725.7 739.5 752.7 766.9

440+00 441+00 442+00 443+00 444+00 445+00 446+00 447+00 448+00 449+00 450+00 451+00 452+00

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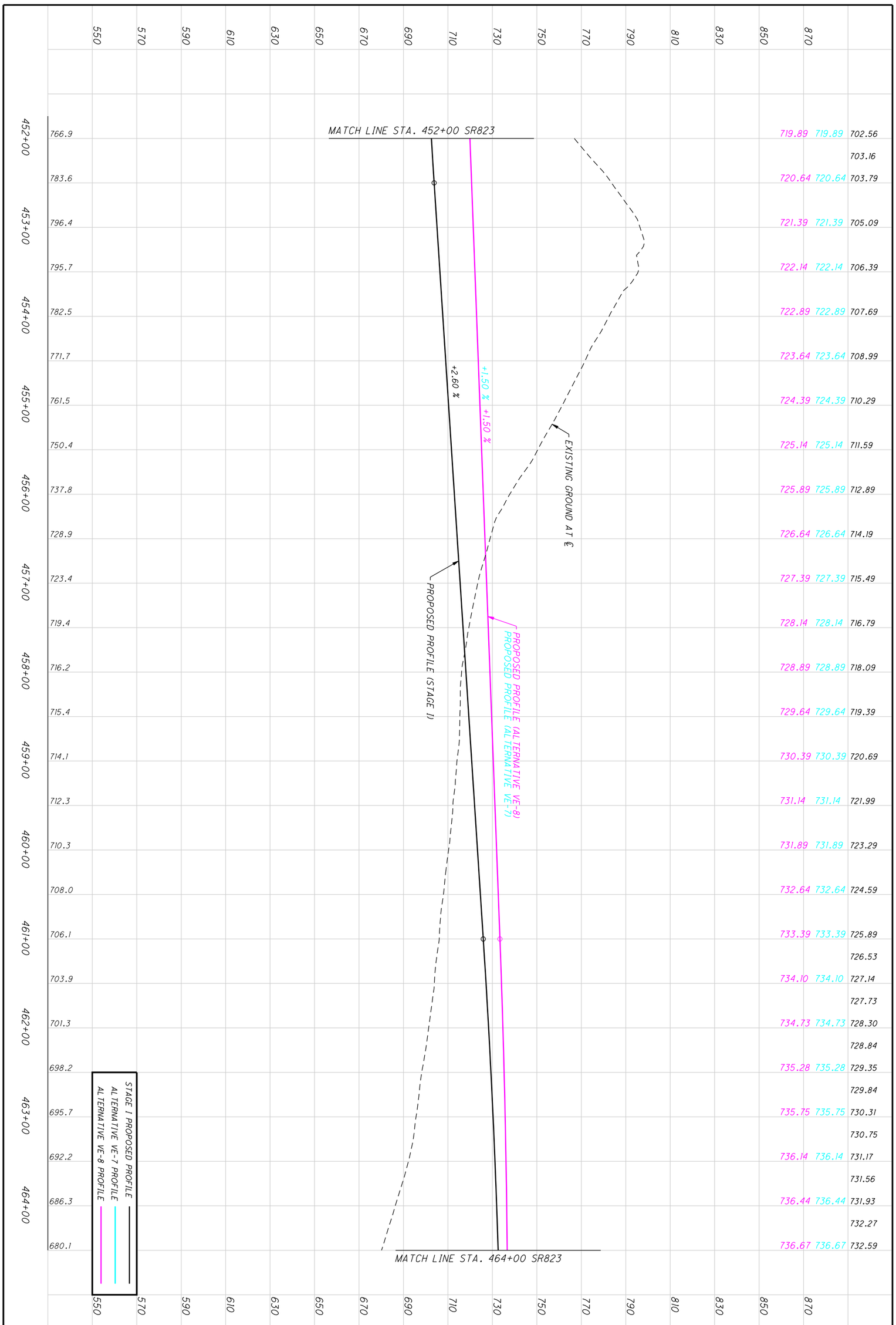

9 / 15	SCI-823-6.81	PROFILE-SR823 STA. 452+50 TO STA. 464+00	CALCULATED CHECKED

PROFILE-SR823
STA. 464+50 TO STA. 477+00

CALCULATED | CHECKED

SCI-823-6.81

10
15

P.V.I. STA. 468+00.00 ELEV. 744.09'
1400' V.C.

P.V.I. STA 468+00.00 ELEV = 743.89'
1,400.00' VC

P.V.I. STA 468+00.00 ELEV = 743.89'
1,400.00' VC

+1.50 % +1.50 % +2.60 % -2.90 % -3.00 % -3.00 %

PROPOSED PROFILE (STAGE 1)

PROPOSED PROFILE (ALTERNATIVE VE-8)
PROPOSED PROFILE (ALTERNATIVE VE-7)

-2.90 %
-3.00 % -3.00 %

EXISTING GROUND AT ℄

MATCH LINE STA. 464+00 SR823

MATCH LINE STA. 477+00 SR823

STAGE 1 PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

732.59	732.88	733.15	733.40	733.62	733.81	733.98	734.13	734.25	734.35	734.42	734.47	734.49	734.49	734.47	734.42	734.34	734.25	734.12	733.97	733.80	733.60	733.38	733.14	732.87	732.57
736.67	736.82	736.89	736.87	736.78	736.60	736.35	736.02	735.60	735.10	734.53	733.87	733.14	732.32	731.42	730.44	729.39	728.25	727.03	725.73	724.35	722.89	721.39	719.89	718.39	716.89
736.67	736.82	736.89	736.87	736.78	736.60	736.35	736.02	735.60	735.10	734.53	733.87	733.14	732.32	731.42	730.44	729.39	728.25	727.03	725.73	724.35	722.89	721.39	719.89	718.39	716.89

732.25	731.91	731.54	731.14	730.73	730.28	729.82	729.32	728.81	728.27	727.70	727.11	726.50	725.86	725.19	724.51	723.79	722.34	720.89	719.44	717.99					
732.32	731.42	730.44	729.39	728.25	727.03	725.73	724.35	722.89	721.39	719.89	718.39	716.89													
732.32	731.42	730.44	729.39	728.25	727.03	725.73	724.35	722.89	721.39	719.89	718.39	716.89													

680.1	669.7	661.6	661.6	661.6	663.9	667.1	668.1	669.6	673.1	675.0	675.6	675.7	676.1	676.9	676.7	666.8	662.9	663.6	671.8	680.5	685.1	686.1	686.9	687.6	689.0

465+00 466+00 467+00 468+00 469+00 470+00 471+00 472+00 473+00 474+00 475+00 476+00 477+00

870 850 830 810 790 770 750 730 710 690 670 650 630 610 590 570 550

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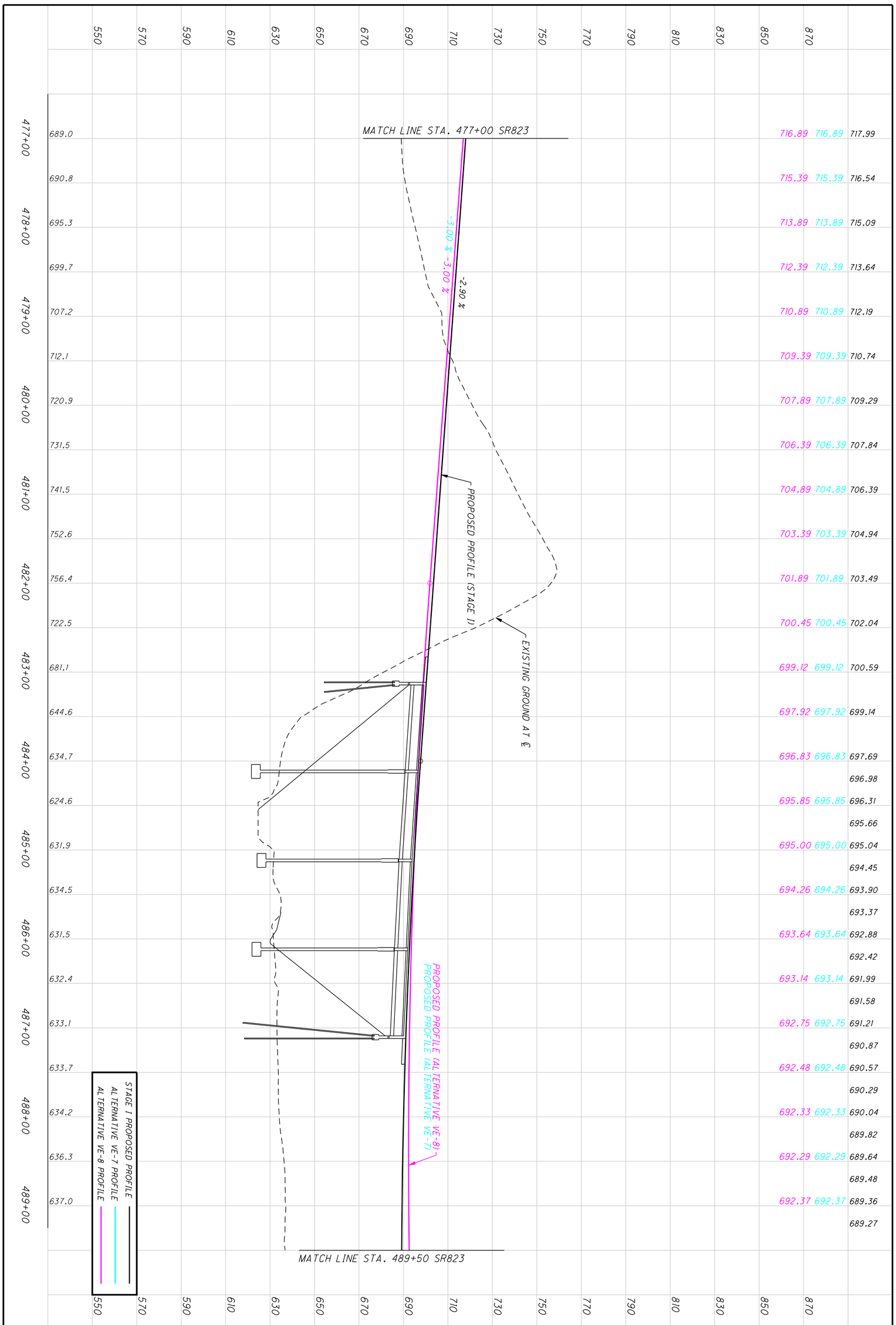
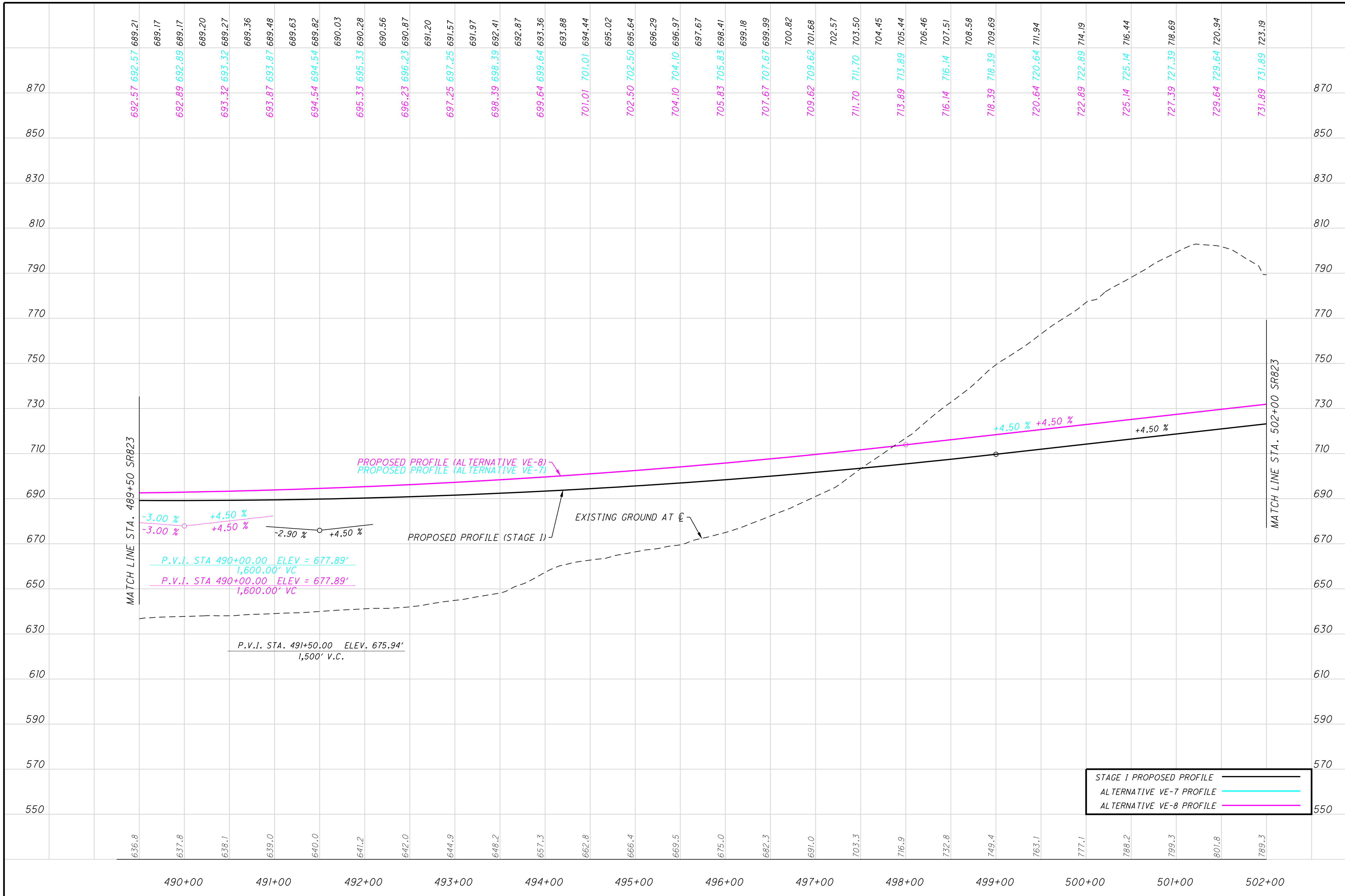


11 / 15	SCI-823-6.81	PROFILE-SR823 STA. 477+00 TO STA. 489+50	CALCULATED CHECKED



CALCULATED

CHECKED

PROFILE-SR823
STA. 489+50 TO STA. 502+00

SCI-823-6.81

12 / 15

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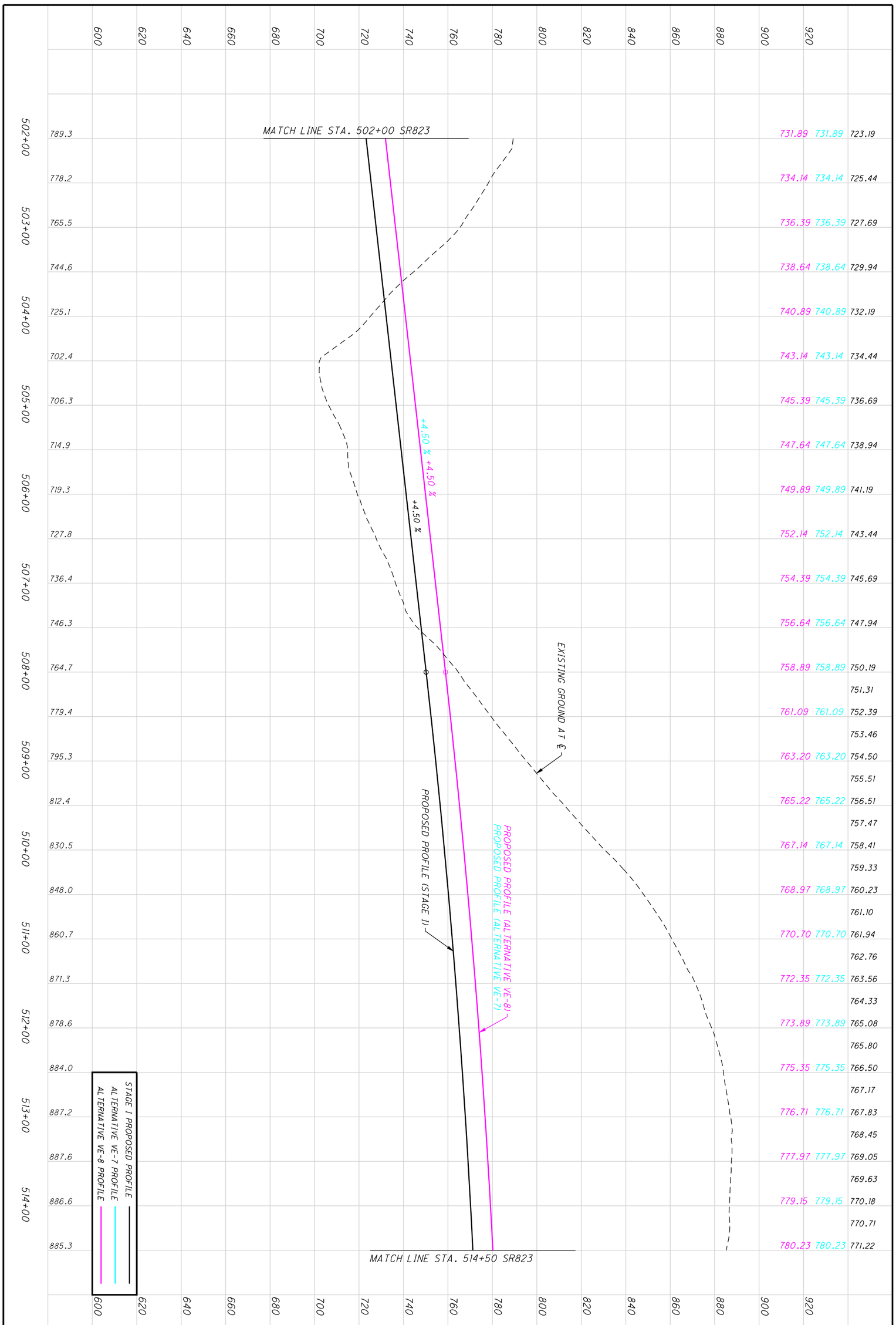
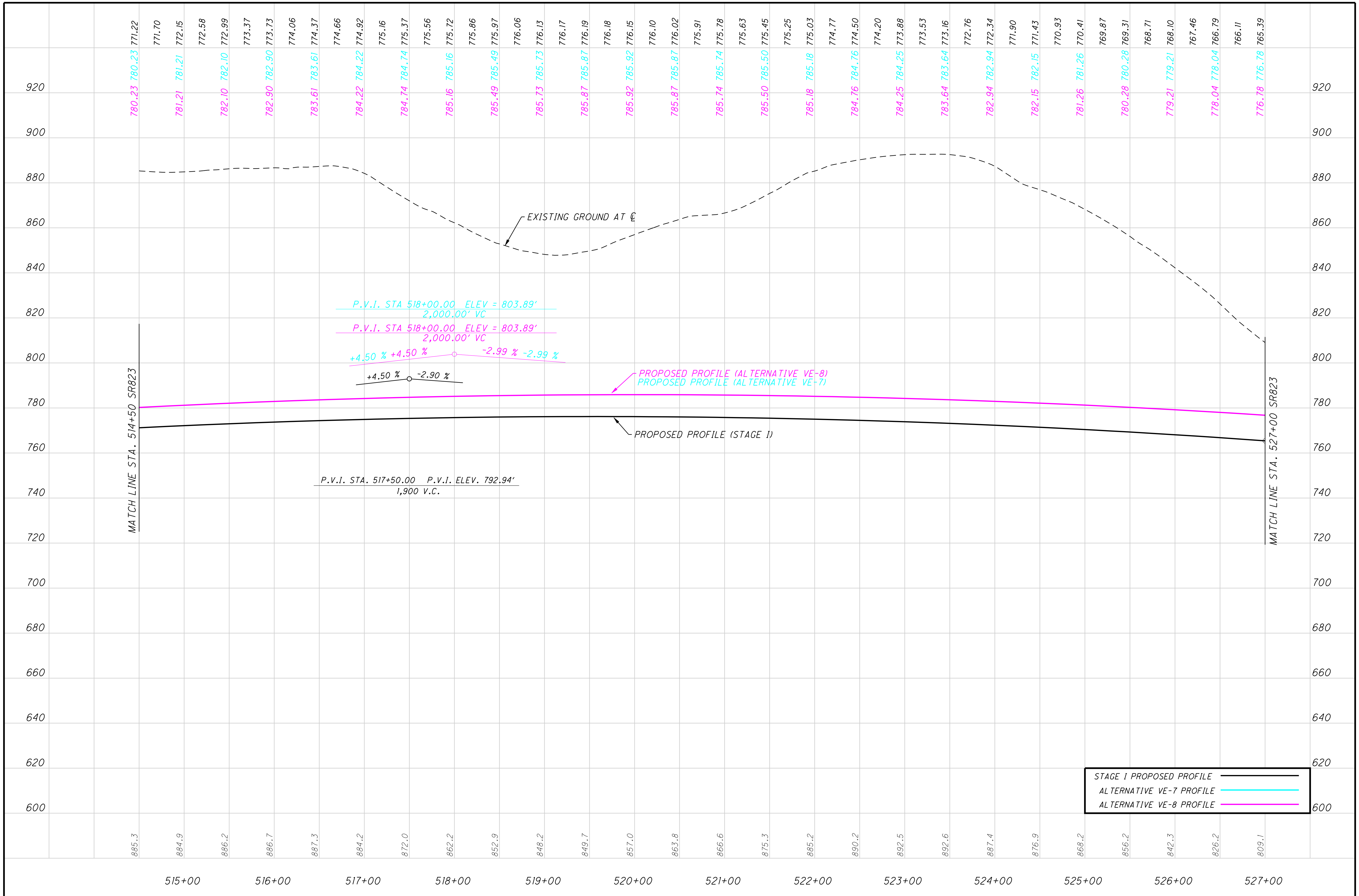


13 / 15	SCI-823-6.81	PROFILE-SR823 STA. 502+00 TO STA. 514+50	CALCULATED CHECKED



CALCULATED
CHECKED

PROFILE-SR823
STA. 514+50 TO STA. 527+00

SCI-823-6.81

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765.39 776.78 776.78 763.94 775.42 775.42 762.49 773.97 773.97 761.04 772.47 772.47 760.34 770.98 770.98 759.66 769.48 769.48 759.02 768.04 768.04 758.41 766.72 766.72 757.83 765.52 765.52 757.29 764.45 764.45 756.78 763.50 763.50 756.31 762.68 762.68 755.86 761.98 761.98 755.45 761.41 761.41 755.08 760.96 760.96 754.73 760.64 760.64 754.42 760.44 760.44 754.14 753.56 760.37 760.37 753.90 753.75 760.42 760.42 753.69 754.22 760.60 760.60 753.51 754.51 755.18 760.90 760.90 753.37 754.83 755.57 761.33 761.33 753.26 755.99 756.44 761.88 761.88 753.18 756.93 757.44 762.56 762.56 753.13 758.00 758.58 763.36 763.36 753.12 759.20 759.85 764.29 764.29 753.14 760.54 761.26 753.20 753.29 753.41 753.56 753.75 753.97 754.22 754.51 754.83 755.18 755.57 755.99 756.44 756.93 757.44 758.00 758.58 759.20 759.85 760.54 761.26

920 900 880 860 840 820 800 780 760 740 720 700 680 660 640 620 600

MATCH LINE STA. 527+00 SR823

-2.90 %

-2.99 %

-2.99 %

PROPOSED PROFILE (ALTERNATIVE VE-8)
PROPOSED PROFILE (ALTERNATIVE VE-7)

PROPOSED PROFILE (STAGE I)

EXISTING GROUND AT ℄

-2.90 %

+4.00 %

-2.99 %

-2.99 %

+4.00 %

+4.00 %

P.V.I. STA 536+55.00 ELEV = 748.39'
1,400.00' VC

P.V.I. STA 536+55.00 ELEV = 748.39'
1,400.00' VC

P.V.I. STA. 535+00.00 ELEV. 742.19'
1,300' V.C.

END PROJECT
PHASE-1
STA. 536+50.00
SLM = 10.16

PHASE-2
PID 79977
BY OTHERS

STAGE I PROPOSED PROFILE
ALTERNATIVE VE-7 PROFILE
ALTERNATIVE VE-8 PROFILE

809.1 796.7 786.1 779.0 771.3 763.6 758.4 753.2 747.2 747.4 738.8 734.1 728.5 723.6 722.8 721.3 718.8 716.9 716.8 718.0 717.7 714.4 712.7 714.6 713.8 717.0

527+00 528+00 529+00 530+00 531+00 532+00 533+00 534+00 535+00 536+00 537+00 538+00 539+00

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CALCULATED CHECKED

PROFILE-SR823
STA. 527+00 TO STA. 539+50

SCI-823-6.81

15
15

VE Study 2/30 – Profile (Stage 1 Design)

Beginning profile PSR823 description:

```
============================================================
          STATION      ELEV     GRADE    TOTAL L    BACK L    AHEAD L

VPC          341+50.00    669.344     -4.700  K =  193.5
VPI    10    347+50.00    641.144          1,200.000   600.000   600.000
Low Point     350+59.68    647.966
VPT          353+50.00    650.144      1.500

VPC          421+50.00    752.144      1.500  K =  250.0  SSD = 734.5
High Point    425+25.00    754.956
VPI    11    429+00.00    763.394          1,500.000   750.000   750.000
VPT          436+50.00    729.644     -4.500

VPC          439+50.00    716.144     -4.500  K =  183.1
VPI    12    446+00.00    686.894          1,300.000   650.000   650.000
Low Point     447+73.94    697.605
VPT          452+50.00    703.794      2.600

VPC          461+00.00    725.894      2.600  K =  254.5  SSD = 741.2
High Point    467+61.82    734.497
VPI    13    468+00.00    744.094          1,400.000   700.000   700.000
VPT          475+00.00    723.794     -2.900

VPC          484+00.00    697.694     -2.900  K =  202.7
Low Point     489+87.84    689.170
VPI    14    491+50.00    675.944          1,500.000   750.000   750.000
VPT          499+00.00    709.694      4.500

VPC          508+00.00    750.194      4.500  K =  256.8  SSD = 744.4
VPI    15    517+50.00    792.944          1,900.000   950.000   950.000
High Point    519+55.41    776.190
VPT          527+00.00    765.394     -2.900

VPC          528+50.00    761.044     -2.900  K =  188.4
Low Point     533+96.38    753.121
VPI    16    535+00.00    742.194          1,300.000   650.000   650.000
VPT          541+50.00    768.194      4.000

VPC          551+50.00    808.194      4.000  K =  257.6  SSD = 745.6
VPI    17    560+00.00    842.194          1,700.000   850.000   850.000
High Point    561+80.30    828.800
VPT          568+50.00    820.094     -2.600
============================================================================
```

Ending profile PSR823 description

VE Study 2/30 – Profile VE-7

Beginning profile VE_7 description:

```
============================================================
          STATION      ELEV     GRADE    TOTAL L    BACK L    AHEAD L

VPC          341+50.00    669.344     -4.700  K =  193.6
VPI    10    347+50.00    641.144          1,200.000   600.000   600.000
Low Point     350+59.69    647.966
VPT          353+50.00    650.143      1.500

VPC          397+00.00    715.391      1.500  K =  733.3
VPI    11    402+00.00    722.891          1,000.000   500.000   500.000
VPT          407+00.00    737.209      2.864

VPC          414+50.00    758.686      2.864  K =  258.0  SSD = 746.2
High Point    421+88.88    769.265
VPI    12    424+00.00    785.890          1,900.000   950.000   950.000
VPT          433+50.00    743.140     -4.500

VPC          435+00.00    736.390     -4.500  K =  233.3
VPI    13    442+00.00    704.890          1,400.000   700.000   700.000
Low Point     445+50.00    712.765
VPT          449+00.00    715.390      1.500

VPC          461+00.00    733.390      1.500  K =  311.1  SSD = 819.4
High Point    465+66.67    736.890
VPI    14    468+00.00    743.890          1,400.000   700.000   700.000
VPT          475+00.00    722.890     -3.000

VPC          482+00.00    701.890     -3.000  K =  213.3
Low Point     488+40.00    692.290
VPI    15    490+00.00    677.890          1,600.000   800.000   800.000
VPT          498+00.00    713.890      4.500

VPC          508+00.00    758.890      4.500  K =  267.0  SSD = 759.0
VPI    16    518+00.00    803.890          2,000.000 1,000.000 1,000.000
High Point    520+01.30    785.919
VPT          528+00.00    773.971     -2.992

VPC          529+55.00    769.333     -2.992  K =  200.2
Low Point     535+54.08    760.371
VPI    17    536+55.00    748.390          1,400.000   700.000   700.000
VPT          543+55.00    776.390      4.000

VPC          551+50.00    808.190      4.000  K =  257.6  SSD = 745.6
VPI    18    560+00.00    842.190          1,700.001   850.000   850.000
High Point    561+80.30    828.796
VPT          568+50.00    820.090     -2.600
============================================================
```

Ending profile VE_7 description

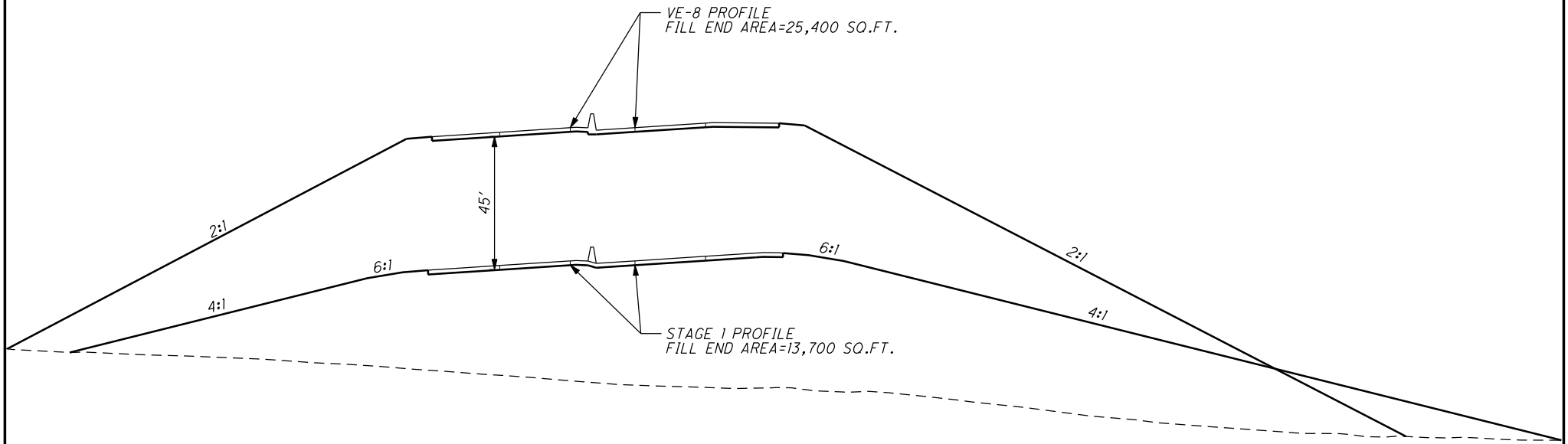
VE Study 2/30 – Profile VE-8

Beginning profile VE_8 description:

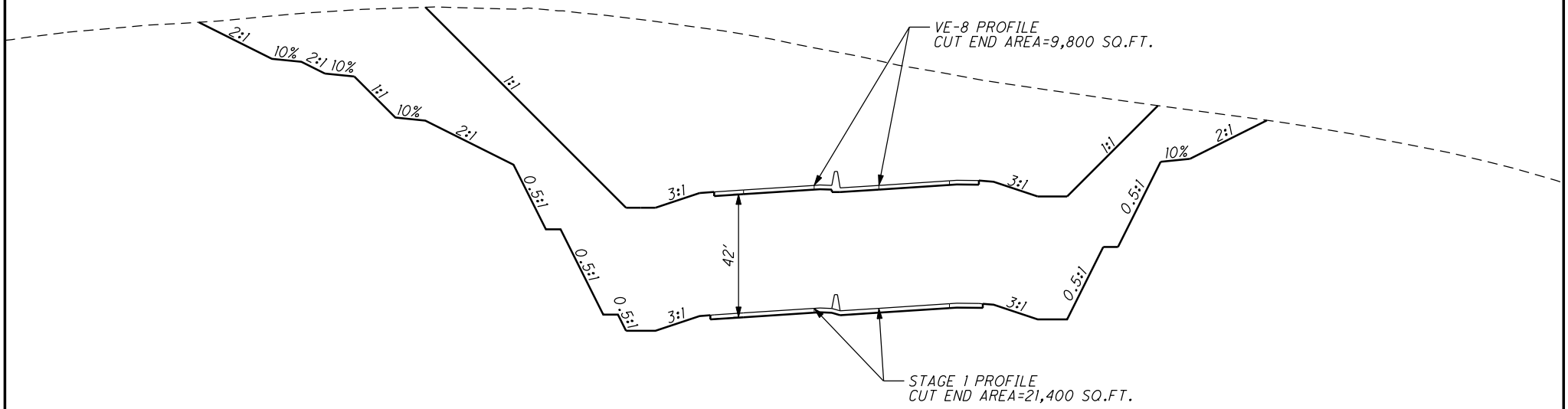
```
================================================================================
          STATION      ELEV      GRADE    TOTAL L    BACK L    AHEAD L

VPC          341+50.00    669.344     -4.700  K =  193.6
VPI    10    347+50.00    641.144          1,200.000   600.000   600.000
Low Point     350+59.69    647.966
VPT          353+50.00    650.143      1.500

VPC          386+50.00    699.642      1.500  K =  333.3
VPI    11    391+50.00    707.141          1,000.000   500.000   500.000
VPT          396+50.00    729.641      4.500

VPC          404+50.00    765.641      4.500  K =  266.7  SSD = 758.6
High Point    416+49.99    792.640
VPI    12    416+50.00    819.640          2,399.999 1,199.999 1,199.999
VPT          428+50.00    765.640     -4.500

VPC          435+00.00    736.390     -4.500  K =  233.3
VPI    13    442+00.00    704.890          1,400.000   700.000   700.000
Low Point     445+50.00    712.765
VPT          449+00.00    715.390      1.500

VPC          461+00.00    733.390      1.500  K =  311.1  SSD = 819.4
High Point    465+66.67    736.890
VPI    14    468+00.00    743.890          1,400.000   700.000   700.000
VPT          475+00.00    722.890     -3.000

VPC          482+00.00    701.890     -3.000  K =  213.3
Low Point     488+40.00    692.290
VPI    15    490+00.00    677.890          1,600.000   800.000   800.000
VPT          498+00.00    713.890      4.500

VPC          508+00.00    758.890      4.500  K =  267.0  SSD = 759.0
VPI    16    518+00.00    803.890          2,000.000 1,000.000 1,000.000
High Point    520+01.30    785.919
VPT          528+00.00    773.971     -2.992

VPC          529+55.00    769.333     -2.992  K =  200.2
Low Point     535+54.08    760.371
VPI    17    536+55.00    748.390          1,400.000   700.000   700.000
VPT          543+55.00    776.390      4.000

VPC          551+50.00    808.190      4.000  K =  257.6  SSD = 745.6
VPI    18    560+00.00    842.190          1,700.001   850.000   850.000
High Point    561+80.30    828.796
VPT          568+50.00    820.090     -2.600
================================================================================
```

Ending profile VE_8 description

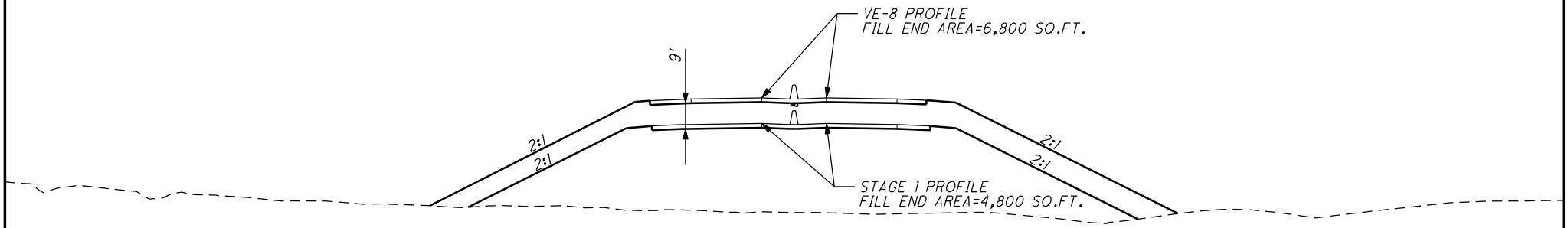
VE STUDY 2/30 - SAMPLE FILL SECTION
STATION - 407+00.00



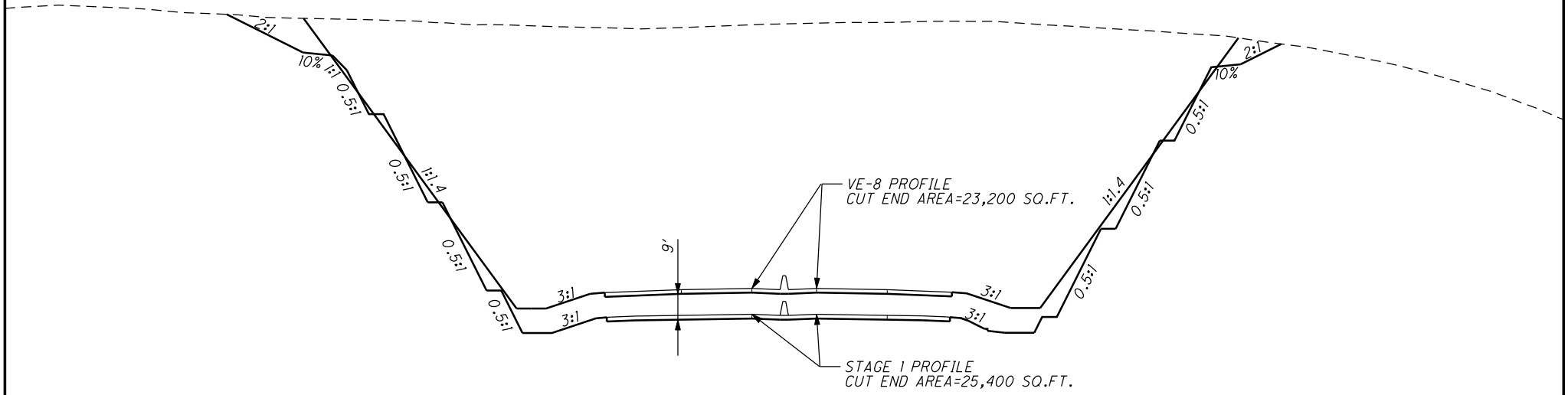
VE STUDY 2/30 - SAMPLE CUT SECTION
STATION - 419+50.00



VE STUDY 2/30 - SAMPLE FILL SECTION
STATION - 505+00.00



VE STUDY 2/30 - SAMPLE CUT SECTION
STATION - 511+00.00



VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
352+00	4926	0	0	0	352+00	4926	0	0	0	352+00	4926	0	0	0
352+50	3149	0	7477	0	352+50	3149	0	7477	0	352+50	3149	0	7477	0
353+00	1428	137	4237	127	353+00	1428	137	4237	127	353+00	1428	137	4237	127
353+50	540	2082	1821	2055	353+50	540	2082	1821	2055	353+50	540	2082	1821	2055
354+00	460	4541	925	6133	354+00	460	4541	925	6133	354+00	460	4541	925	6133
354+50	290	1623	694	5708	354+50	290	1623	694	5708	354+50	290	1623	694	5708
355+00	606	294	829	1775	355+00	606	294	829	1775	355+00	606	294	829	1775
355+50	1689	0	2125	273	355+50	1689	0	2125	273	355+50	1689	0	2125	273
356+00	2678	0	4044	0	356+00	2678	0	4044	0	356+00	2678	0	4044	0
356+50	4221	0	6388	0	356+50	4221	0	6388	0	356+50	4221	0	6388	0
357+00	4594	0	8162	0	357+00	4594	0	8162	0	357+00	4594	0	8162	0
357+50	5087	0	8964	0	357+50	5087	0	8964	0	357+50	5087	0	8964	0
358+00	5283	0	9601	0	358+00	5283	0	9601	0	358+00	5283	0	9601	0
358+50	5649	0	10122	0	358+50	5649	0	10122	0	358+50	5649	0	10122	0
359+00	6075	0	10856	0	359+00	6075	0	10856	0	359+00	6075	0	10856	0
359+50	6483	0	11627	0	359+50	6483	0	11627	0	359+50	6483	0	11627	0
360+00	6095	0	11646	0	360+00	6095	0	11646	0	360+00	6095	0	11646	0
360+50	5346	0	10593	0	360+50	5346	0	10593	0	360+50	5346	0	10593	0
361+00	4043	0	8693	0	361+00	4043	0	8693	0	361+00	4043	0	8693	0
361+50	3032	0	6551	0	361+50	3032	0	6551	0	361+50	3032	0	6551	0
362+00	1587	65	4277	60	362+00	1587	65	4277	60	362+00	1587	65	4277	60
362+50	713	1094	2130	1073	362+50	713	1094	2130	1073	362+50	713	1094	2130	1073
363+00	51	2842	707	3644	363+00	51	2842	707	3644	363+00	51	2842	707	3644
363+50	272	5239	299	7483	363+50	272	5239	299	7483	363+50	272	5239	299	7483
364+00	249	8284	482	12521	364+00	249	8284	482	12521	364+00	249	8284	482	12521
364+50	176	6269	394	13475	364+50	176	6269	394	13475	364+50	176	6269	394	13475
365+00	246	4521	391	9991	365+00	246	4521	391	9991	365+00	246	4521	391	9991
365+50	84	3214	305	7162	365+50	84	3214	305	7162	365+50	84	3214	305	7162
366+00	46	1881	120	4718	366+00	46	1881	120	4718	366+00	46	1881	120	4718
366+50	86	1297	123	2942	366+50	86	1297	123	2942	366+50	86	1297	123	2942
367+00	241	659	302	1811	367+00	241	659	302	1811	367+00	241	659	302	1811
367+50	630	566	806	1134	367+50	630	566	806	1134	367+50	630	566	806	1134
368+00	975	804	1486	1269	368+00	975	804	1486	1269	368+00	975	804	1486	1269
368+50	1218	896	2030	1574	368+50	1218	896	2030	1574	368+50	1218	896	2030	1574
369+00	1567	700	2579	1478	369+00	1567	700	2579	1478	369+00	1567	700	2579	1478
369+50	1991	523	3295	1133	369+50	1991	523	3295	1133	369+50	1991	523	3295	1133
370+00	2629	379	4278	836	370+00	2629	379	4278	836	370+00	2629	379	4278	836
370+50	2894	462	5114	779	370+50	2894	462	5114	779	370+50	2894	462	5114	779
371+00	2556	873	5046	1237	371+00	2556	873	5046	1237	371+00	2556	873	5046	1237
371+50	196	307	2548	1093	371+50	196	307	2548	1093	371+50	196	307	2548	1093
372+00	128	626	300	865	372+00	128	626	300	865	372+00	128	626	300	865
372+50	34	1039	150	1542	372+50	34	1039	150	1542	372+50	34	1039	150	1542
373+00	0	1581	32	2426	373+00	0	1581	32	2426	373+00	0	1581	32	2426
373+50	0	2380	0	3668	373+50	0	2380	0	3668	373+50	0	2380	0	3668
374+00	0	3499	0	5443	374+00	0	3499	0	5443	374+00	0	3499	0	5443
374+50	0	5076	0	7940	374+50	0	5076	0	7940	374+50	0	5076	0	7940

VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
375+00	0	7084	0	11259	375+00	0	7084	0	11259	375+00	0	7084	0	11259
375+50	0	8080	0	14040	375+50	0	8080	0	14040	375+50	0	8080	0	14040
376+00	0	8838	0	15665	376+00	0	8838	0	15665	376+00	0	8838	0	15665
376+50	0	8840	0	16368	376+50	0	8840	0	16368	376+50	0	8840	0	16368
377+00	0	8893	0	16420	377+00	0	8893	0	16420	377+00	0	8893	0	16420
377+50	0	8761	0	16347	377+50	0	8761	0	16347	377+50	0	8761	0	16347
378+00	0	8389	0	15880	378+00	0	8389	0	15880	378+00	0	8389	0	15880
378+50	0	7630	0	14833	378+50	0	7630	0	14833	378+50	0	7630	0	14833
379+00	0	6723	0	13290	379+00	0	6723	0	13290	379+00	0	6723	0	13290
379+50	0	6533	0	12274	379+50	0	6533	0	12274	379+50	0	6533	0	12274
380+00	0	7290	0	12799	380+00	0	7290	0	12799	380+00	0	7290	0	12799
380+50	0	7963	0	14123	380+50	0	7963	0	14123	380+50	0	7963	0	14123
381+00	0	7790	0	14586	381+00	0	7790	0	14586	381+00	0	7790	0	14586
381+50	0	7152	0	13835	381+50	0	7152	0	13835	381+50	0	7152	0	13835
382+00	0	5612	0	11819	382+00	0	5612	0	11819	382+00	0	5612	0	11819
382+50	0	4601	0	9457	382+50	0	4601	0	9457	382+50	0	4601	0	9457
383+00	0	3678	0	7666	383+00	0	3678	0	7666	383+00	0	3678	0	7666
385+50	2434	3634	1960	5309	385+50	2434	3634	1960	5309	385+50	2434	3634	1960	5309
386+00	11	3761	2264	6848	386+00	11	3761	2264	6848	386+00	11	3761	2264	6848
386+50	14	3713	23	6920	386+50	14	3713	23	6920	386+50	14	3713	23	6920
387+00	18	2962	29	6181	387+00	18	2962	29	6181	387+00	18	2962	29	6181
387+50	14	2826	30	5359	387+50	14	2826	30	5359	387+50	14	2826	30	5359
388+00	64	2432	72	4868	388+00	64	2432	72	4868	388+00	64	2432	72	4868
388+50	20	2171	77	4262	388+50	20	2171	77	4262	388+50	20	2171	77	4262
389+00	21	1977	38	3842	389+00	21	1977	38	3842	389+00	21	1977	38	3842
389+50	21	2072	39	3750	389+50	21	2072	39	3750	389+50	21	2072	39	3750
390+00	44	2411	60	4151	390+00	44	2411	60	4151	390+00	44	2411	60	4151
390+50	119	2214	151	4282	390+50	119	2214	151	4282	390+50	119	2214	151	4282
391+00	8	2740	118	4588	391+00	8	2740	118	4588	391+00	8	2740	118	4588
391+50	0	2484	7	4838	391+50	0	2484	7	4838	391+50	0	2484	7	4838
392+00	25	2214	23	4351	392+00	25	2214	23	4351	392+00	25	2214	23	4351
392+50	29	2105	50	3999	392+50	29	2105	50	3999	392+50	29	2105	50	3999
393+00	16	2046	42	3844	393+00	16	2046	42	3844	393+00	16	2046	42	3844
393+50	8	2120	22	3858	393+50	8	2120	22	3858	393+50	8	2120	22	3858
394+00	11	2374	18	4161	394+00	11	2374	18	4161	394+00	11	2374	18	4161
394+50	33	2813	41	4803	394+50	33	2813	41	4803	394+50	33	2813	41	4803
395+00	0	3274	31	5635	395+00	0	3274	31	5635	395+00	0	3274	31	5635
395+50	0	3535	0	6304	395+50	0	3535	0	6304	395+50	0	3535	0	6304
396+00	0	3442	0	6461	396+00	0	3442	0	6461	396+00	0	3442	0	6461
396+50	0	3206	0	6156	396+50	0	3206	0	6156	396+50	0	3206	0	6156
397+00	0	3466	0	6178	397+00	0	3466	0	6178	397+00	0	3466	0	6178
397+50	0	3521	0	6469	397+50	0	3521	0	6469	397+50	0	3521	0	6469
398+00	0	3532	0	6530	398+00	0	3532	0	6530	398+00	0	3532	0	6530
398+50	0	3556	0	6563	398+50	0	3556	0	6563	398+50	0	3556	0	6563
399+00	0	3607	0	6632	399+00	0	3607	0	6632	399+00	0	3607	0	6632
399+50	0	3622	0	6694	399+50	0	3622	0	6694	399+50	0	3622	0	6694
400+00	0	3448	0	6547	400+00	0	3448	0	6547	400+00	0	3448	0	6547

VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
400+50	0	7943	0	10548	400+50	0	7943	0	10548	400+50	0	7943	0	10548
401+00	0	7872	0	14644	401+00	0	7872	0	14644	401+00	0	7872	0	14644
401+50	0	7798	0	14509	401+50	0	7798	0	14509	401+50	0	7798	0	14509
402+00	52	10938	48	17348	402+00	52	10938	48	17348	402+00	52	10938	48	17348
402+50	52	12601	97	21795	402+50	52	12601	97	21795	402+50	52	12601	97	21795
403+00	212	14085	244	24710	403+00	212	14085	244	24710	403+00	212	14085	244	24710
			169,000	608,000				169,000	608,000				169,000	608,000

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Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
		Original					VE_CX					VE_7X		
403+50	30	14297	224	26279	403+50	38	15016	82	26654	403+50	0	15011	0	27614
404+00	109	13776	129	25993	404+00	31	16380	64	29071	404+00	0	16210	0	28908
404+50	100	14857	194	26512	404+50	54	16684	79	30615	404+50	16	16573	15	30355
405+00	149	14681	230	27350	405+00	61	15705	107	29990	405+00	58	16756	68	30861
405+50	144	14695	271	27200	405+50	90	13646	140	27177	405+50	39	15004	90	29407
406+00	117	14366	242	26909	406+00	6	11744	89	23510	406+00	58	13555	90	26443
406+50	75	14105	178	26363	406+50	18	11257	22	21298	406+50	25	13142	77	24719
407+00	143	13726	202	25770	407+00	67	11300	79	20886	407+00	0	12345	23	23598
407+50	155	13352	276	25072	407+50	0	10816	62	20478	407+50	0	12305	0	22823
408+00	126	12938	261	24342	408+00	34	10589	32	19819	408+00	32	12417	30	22890
408+50	126	13142	234	24148	408+50	63	10531	90	19556	408+50	51	12993	77	23527
409+00	148	12512	254	23754	409+00	100	10157	152	19156	409+00	93	12925	133	23998
409+50	196	11746	319	22461	409+50	111	10090	196	18747	409+50	136	13158	212	24151
410+00	252	12130	415	22108	410+00	131	11886	224	20348	410+00	235	15265	344	26318
410+50	239	11259	455	21656	410+50	197	12778	304	22837	410+50	326	16249	519	29180
411+00	177	10692	385	20325	411+00	215	10842	382	21870	411+00	229	16412	514	30242
411+50	256	9491	401	18689	411+50	177	11735	363	20904	411+50	242	15691	437	29725
412+00	236	8669	455	16815	412+00	158	11388	310	21410	412+00	149	15676	362	29043
412+50	279	9659	477	16970	412+50	112	11014	249	20743	412+50	101	14441	232	27886
413+00	0	10022	258	18223	413+00	60	9799	159	19271	413+00	75	13546	163	25914
413+50	74	8428	69	17083	413+50	81	7453	131	15974	413+50	70	11526	134	23215
414+00	83	6091	145	13443	414+00	19	4600	93	11160	414+00	0	8233	65	18296
414+50	246	4159	304	9490	414+50	152	3943	159	7909	414+50	0	6494	0	13637
415+00	1063	2390	1212	6064	415+00	1071	2195	1133	5683	415+00	59	3890	54	9615
415+50	2876	701	3647	2863	415+50	3016	473	3784	2470	415+50	816	1568	810	5053
416+00	5249	0	7523	649	416+00	5487	0	7874	438	416+00	2179	265	2774	1698
416+50	7826	0	12106	0	416+50	8035	0	12521	0	416+50	4053	0	5770	246
417+00	10408	0	16883	0	417+00	10698	0	17345	0	417+00	6334	0	9618	0
417+50	12845	0	21531	0	417+50	13310	0	22230	0	417+50	8553	0	13785	0
418+00	15394	0	26147	0	418+00	15868	0	27017	0	418+00	10720	0	17845	0
418+50	17717	0	30658	0	418+50	18098	0	31450	0	418+50	12601	0	21593	0
419+00	19403	0	34370	0	419+00	19929	0	35211	0	419+00	14211	0	24826	0
419+50	21400	0	37780	0	419+50	21850	0	38684	0	419+50	15984	0	27958	0
420+00	23216	0	41311	0	420+00	23583	0	42068	0	420+00	17616	0	31111	0
420+50	24371	0	44062	0	420+50	24285	0	44323	0	420+50	18340	0	33292	0
421+00	23838	0	44638	0	421+00	23244	0	44009	0	421+00	17484	0	33170	0
421+50	21772	0	42231	0	421+50	20770	0	40753	0	421+50	15397	0	30446	0
422+00	18869	0	37631	0	422+00	17668	0	35591	0	422+00	12736	0	26049	0
422+50	14785	0	31162	0	422+50	14541	0	29823	0	422+50	10126	0	21168	0
423+00	11393	0	24239	0	423+00	11350	0	23973	0	423+00	7482	0	16304	0
423+50	7227	0	17240	0	423+50	7674	0	17615	0	423+50	4680	1887	11261	1747
424+00	7017	0	13188	0	424+00	7270	0	13837	0	424+00	4344	1388	8356	3032
424+50	8482	0	14350	0	424+50	9017	0	15081	0	424+50	5851	0	9440	1286
425+00	11624	0	18616	0	425+00	12197	0	19643	0	425+00	8934	0	13690	0
425+50	15135	0	24777	0	425+50	15841	0	25961	0	425+50	12434	0	19785	0
426+00	18335	0	30991	0	426+00	19354	0	32588	0	426+00	15812	0	26154	0

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Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
426+50	21638	0	37012	0	426+50	23104	0	39313	0	426+50	19548	0	32741	0
427+00	25358	0	43515	0	427+00	27516	0	46870	0	427+00	23977	0	40300	0
427+50	29416	0	50717	0	427+50	31755	0	54880	0	427+50	28228	0	48338	0
428+00	33445	0	58204	0	428+00	35940	0	62680	0	428+00	32466	0	56199	0
428+50	36288	0	64568	0	428+50	38910	0	69306	0	428+50	35605	0	63029	0
429+00	36732	0	67611	0	429+00	38833	0	71984	0	429+00	35819	0	66133	0
429+50	35238	0	66638	0	429+50	36585	0	69831	0	429+50	33898	0	64553	0
430+00	32096	0	62346	0	430+00	33105	0	64527	0	430+00	30732	0	59843	0
430+50	28584	0	56185	0	430+50	29096	0	57594	0	430+50	27057	0	53508	0
431+00	24812	0	49441	0	431+00	25527	0	50577	0	431+00	23810	0	47098	0
431+50	21001	0	42420	0	431+50	21820	0	43840	0	431+50	20401	0	40936	0
432+00	16940	0	35131	0	432+00	18035	0	36903	0	432+00	16929	0	34564	0
432+50	13066	0	27784	0	432+50	13683	0	29369	0	432+50	12854	0	27577	0
433+00	9031	0	20460	0	433+00	8721	0	20744	0	433+00	8142	0	19441	0
433+50	4332	126	12373	117	433+50	4863	178	12578	165	433+50	4492	257	11698	238
434+00	1918	992	5786	1035	434+00	993	998	5422	1089	434+00	844	1099	4940	1255
434+50	1267	2074	2949	2839	434+50	1154	2110	1988	2878	434+50	1095	2219	1795	3072
435+00	2077	2577	3095	4307	435+00	530	2618	1559	4378	435+00	500	2681	1477	4537
435+50	4009	2772	5634	4953	435+50	1179	2943	1582	5150	435+50	1157	2981	1534	5242
436+00	5724	2872	9011	5226	436+00	1886	3208	2838	5696	436+00	1835	3074	2770	5606
436+50	6179	2785	11021	5238	436+50	3493	3101	4981	5842	436+50	3412	3179	4859	5789
437+00	5977	2904	11256	5267	437+00	3390	3302	6374	5929	437+00	3123	2865	6051	5596
437+50	4432	3276	9638	5722	437+50	2923	3873	5846	6644	437+50	2593	3301	5292	5709
438+00	2416	3763	6341	6518	438+00	1826	4609	4397	7854	438+00	1443	3928	3737	6693
438+50	1041	4588	3201	7733	438+50	809	4468	2440	8405	438+50	667	5146	1953	8402
439+00	385	5633	1320	9464	439+00	318	5503	1043	9233	439+00	324	6570	917	10848
439+50	307	6956	641	11656	439+50	243	7016	520	11592	439+50	225	8550	508	14000
440+00	153	8289	426	14116	440+00	97	8699	315	14551	440+00	95	10501	297	17640
440+50	156	8838	287	15859	440+50	180	10212	256	17511	440+50	98	12258	179	21073
441+00	288	8544	412	16094	441+00	112	12382	270	20921	441+00	89	13276	173	23642
441+50	253	9445	501	16656	441+50	89	12829	186	23344	441+50	49	14280	128	25514
			1,349,000	650,000				1,358,000	650,000				1,112,000	781,000
								9,000	-				(246,000)	131,000
								0.7%	0.0%				-18.1%	20.2%

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Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
		Original					VE_CY					VE_7Y		
444+50	279	6969	26	1357	444+50	0	11932	0	23111	444+50	0	0	0	0
445+00	366	6991	597	12926	445+00	0	9240	0	19604	445+00	36	10255	33	9495
445+50	382	6125	692	12145	445+50	29	7103	27	15132	445+50	41	8403	70	17276
446+00	215	5022	552	10321	446+00	69	5800	91	11946	446+00	68	8598	101	15742
446+50	124	4030	313	8382	446+50	94	4586	151	9616	446+50	83	7805	140	15188
447+00	75	2680	184	6214	447+00	172	2953	246	6980	447+00	106	6062	175	12840
447+50	392	1006	433	3413	447+50	312	1119	448	3771	447+50	136	4003	224	9319
448+00	1773	382	2005	1285	448+00	1028	370	1241	1379	448+00	157	2708	272	6214
448+50	1667	306	3185	637	448+50	1761	282	2582	603	448+50	438	2172	551	4519
449+00	2398	153	3764	424	449+00	2183	157	3651	407	449+00	491	1778	860	3657
449+50	3827	0	5764	142	449+50	3008	0	4807	146	449+50	395	931	820	2508
450+00	4342	0	7564	0	450+00	4415	0	6873	0	450+00	977	394	1271	1227
450+50	5643	0	9245	0	450+50	6209	0	9837	0	450+50	2320	125	3054	481
451+00	8269	0	12881	0	451+00	8530	0	13647	0	451+00	4509	0	6324	116
451+50	11019	0	17859	0	451+50	11582	0	18622	0	451+50	7429	0	11054	0
452+00	13778	0	22960	0	452+00	14292	0	23958	0	452+00	10067	0	16200	0
452+50	15464	0	27075	0	452+50	16186	0	28220	0	452+50	11978	0	20411	0
453+00	16766	0	29842	0	453+00	17284	0	30991	0	453+00	13173	0	23288	0
453+50	17439	0	31672	0	453+50	17748	0	32437	0	453+50	13705	0	24887	0
454+00	16935	0	31828	0	454+00	17051	0	32221	0	454+00	13103	0	24822	0
454+50	15201	0	29756	0	454+50	15194	0	29856	0	454+50	11407	0	22694	0
455+00	12435	0	25589	0	455+00	12352	0	25505	0	455+00	8793	0	18704	0
455+50	8873	0	19730	0	455+50	9036	0	19803	0	455+50	5854	0	13562	0
456+00	6369	0	14114	0	456+00	5780	0	13719	0	456+00	3173	264	8359	245
456+50	3738	12	9359	11	456+50	3701	0	8779	0	456+50	1787	1193	4593	1349
457+00	2520	349	5794	334	457+00	2648	214	5879	198	457+00	1124	2090	2695	3040
457+50	2199	1013	4369	1261	457+50	1974	746	4280	889	457+50	779	3045	1762	4755
458+00	1573	1771	3492	2579	458+00	1498	1364	3215	1954	458+00	565	2960	1244	5560
458+50	1237	2289	2602	3759	458+50	1406	2039	2689	3151	458+50	527	3633	1011	6105
459+00	950	2606	2025	4532	459+00	1124	2361	2342	4073	459+00	403	3902	861	6977
459+50	765	2800	1588	5006	459+50	899	2562	1873	4558	459+50	329	4064	677	7376
460+00	1046	3804	1677	6115	460+00	777	3530	1552	5640	460+00	288	4924	571	8322
460+50	964	4702	1861	7876	460+50	622	4419	1296	7360	460+50	229	5715	478	9851
461+00	1034	5748	1850	9676	461+00	420	5445	966	9133	461+00	132	6573	334	11378
461+50	330	6727	1262	11551	461+50	232	6398	604	10965	461+50	58	7364	176	12905
462+00	51	7472	353	13147	462+00	127	5073	332	10621	462+00	43	7882	94	14117
462+50	210	8453	242	14745	462+50	72	5823	184	10089	462+50	235	8700	257	15354
463+00	170	8017	352	15250	463+00	349	6596	390	11499	463+00	205	9426	408	16783
463+50	307	9145	441	15891	463+50	324	10066	624	15428	463+50	221	10625	394	18566
464+00	388	10881	643	18543	464+00	282	12030	561	20459	464+00	249	12521	435	21431
464+50	505	13350	827	22437	464+50	170	12603	418	22808	464+50	138	15452	358	25901
465+00	385	16302	825	27456	465+00	606	16455	719	26905	465+00	499	19427	589	32295
465+50	438	18530	762	32252	465+50	99	20741	653	34440	465+50	52	20995	510	37428
466+00	45	19273	447	35003	466+00	0	19003	91	36800	466+00	39	21625	84	39463
466+50	58	19804	95	36183	466+50	0	19630	0	35771	466+50	74	22180	104	40560
467+00	159	20868	201	37659	467+00	35	19304	33	36049	467+00	29	21660	95	40593

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Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
467+50	225	22516	356	40170	467+50	31	19335	61	35776	467+50	37	24475	61	42718
468+00	189	22679	383	41847	468+00	106	17733	127	34322	468+00	105	24633	131	45470
468+50	455	22591	596	41917	468+50	509	17916	569	33009	468+50	489	24130	550	45151
469+00	861	20715	1219	40098	469+00	1309	15962	1684	31369	469+00	1294	22292	1651	42983
469+50	463	19370	1226	37116	469+50	1444	14934	2550	28608	469+50	1459	20546	2549	39665
470+00	427	18443	824	35013	470+00	1179	14330	2429	27096	470+00	1189	19398	2452	36985
470+50	432	17696	795	33462	470+50	1273	16077	2270	28155	470+50	1277	18584	2283	35169
471+00	493	17159	856	32273	471+00	1146	15635	2240	29363	471+00	1148	17956	2245	33833
471+50	294	14838	729	29627	471+50	1135	15732	2112	29043	471+50	1135	15743	2113	31203
472+00	258	14802	512	27445	472+00	983	14406	1961	27906	472+00	979	15666	1957	29082
472+50	151	16548	379	29027	472+50	689	16309	1548	28440	472+50	683	17498	1539	30707
473+00	195	16410	320	30516	473+00	640	18823	1231	32530	473+00	622	17718	1209	32607
473+50	257	15283	418	29344	473+50	568	18595	1119	34646	473+50	553	17386	1088	32504
474+00	73	13297	305	26463	474+00	185	16747	697	32724	474+00	182	15606	681	30548
474+50	93	11334	154	22806	474+50	188	14061	345	28526	474+50	201	12366	355	25900
475+00	0	10057	86	19806	475+00	24	12909	197	24972	475+00	41	12443	224	22971
475+50	560	8779	518	17441	475+50	0	10722	23	21881	475+50	0	10242	38	21005
476+00	209	8057	712	15589	476+00	0	8589	0	17881	476+00	0	8624	0	17468
476+50	175	7497	356	14402	476+50	60	7825	55	15199	476+50	46	7408	43	14844
477+00	190	6943	338	13371	477+00	72	7039	122	13764	477+00	72	6635	110	13002
477+50	29	6509	203	12455	477+50	106	6452	165	12492	477+50	104	6022	163	11719
478+00	151	4803	167	10474	478+00	127	4696	216	10323	478+00	31	4297	125	9555
478+50	325	3495	441	7683	478+50	225	3374	326	7472	478+50	274	3028	283	6783
479+00	1129	2289	1346	5356	479+00	719	2080	874	5050	479+00	826	1783	1018	4455
479+50	2654	1050	3503	3091	479+50	1905	942	2429	2798	479+50	2083	709	2693	2308
480+00	5417	61	7473	1028	480+00	3850	130	5328	992	480+00	4120	0	5744	657
480+50	6605	0	11131	56	480+50	6309	0	9407	120	480+50	6656	0	9977	0
481+00	9047	0	14492	0	481+00	8733	0	13928	0	481+00	9119	0	14606	0
481+50	10376	0	17985	0	481+50	10587	0	17889	0	481+50	10983	0	18613	0
482+00	11045	0	19834	0	482+00	10258	0	19301	0	482+00	10648	0	20029	0
482+50	3824	0	13768	0	482+50	3828	0	13043	0	482+50	4147	0	13699	0
483+00	22	3205	3561	2967	483+00	107	4603	3643	4262	483+00	93	4094	3926	3791
483+50	221	10142	225	12359	483+50	62	11769	156	15159	483+50	77	11364	158	14313
			444,000	1,012,000				445,000	1,016,000				328,000	1,157,000
								1,000	4,000				(117,000)	141,000
								0.2%	0.4%				-26.3%	13.9%

VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
		Original					VE_CZ					VE_7Z		
487+00	302	12537	260	21899	487+00	44	15038	103	29118	487+00	40	14416	92	13348
487+50	271	12193	531	22898	487+50	45	14987	83	27801	487+50	47	14510	81	26783
488+00	288	13260	518	23567	488+00	0	14512	42	27314	488+00	0	14026	44	26422
488+50	110	14153	369	25382	488+50	19	13788	17	26204	488+50	18	12631	17	24682
489+00	89	14641	184	26661	489+00	75	14850	87	26517	489+00	59	14295	72	24931
489+50	49	14950	128	27400	489+50	93	14451	155	27131	489+50	84	14747	133	26891
490+00	39	15036	81	27766	490+00	34	12945	117	25367	490+00	8	14494	85	27075
490+50	52	15267	84	28059	490+50	24	13713	54	24683	490+50	18	14388	24	26743
491+00	34	14963	79	27991	491+00	0	13336	23	25046	491+00	41	14243	54	26510
491+50	60	14355	87	27146	491+50	34	12747	32	24150	491+50	37	14055	72	26202
492+00	43	13751	95	26024	492+00	36	12186	65	23086	492+00	21	13636	54	25640
492+50	44	13497	80	25230	492+50	19	11898	51	22300	492+50	26	13424	43	25056
493+00	51	12722	87	24277	493+00	58	11158	72	21348	493+00	44	12739	64	24225
493+50	110	11499	149	22427	493+50	0	10059	54	19645	493+50	53	11782	90	22705
494+00	78	9413	174	19362	494+00	31	9168	29	17803	494+00	46	10013	92	20181
494+50	88	7585	154	15738	494+50	0	7388	29	15330	494+50	49	8436	88	17082
495+00	94	6387	169	12937	495+00	0	6214	0	12595	495+00	21	7460	64	14719
495+50	79	5386	161	10901	495+50	16	5235	14	10601	495+50	7	6691	25	13103
496+00	102	4279	168	8949	496+00	53	4445	63	8963	496+00	38	5627	41	11406
496+50	32	2799	124	6554	496+50	26	2915	73	6815	496+50	54	4189	85	9089
497+00	75	1411	99	3898	497+00	77	1421	96	4015	497+00	36	2778	84	6451
497+50	778	167	790	1461	497+50	772	350	786	1640	497+50	190	1127	209	3616
498+00	2781	0	3296	154	498+00	2564	0	3089	324	498+00	1129	39	1221	1080
498+50	5430	0	7603	0	498+50	5099	0	7096	0	498+50	3433	0	4224	36
499+00	8184	0	12605	0	499+00	8033	0	12159	0	499+00	6178	0	8899	0
499+50	11478	0	18205	0	499+50	11068	0	17686	0	499+50	9020	0	14072	0
500+00	15099	0	24608	0	500+00	14312	0	23500	0	500+00	12076	0	19533	0
500+50	17592	0	30269	0	500+50	17125	0	29109	0	500+50	14764	0	24852	0
501+00	18775	0	33673	0	501+00	19023	0	33470	0	501+00	16609	0	29049	0
501+50	18531	0	34543	0	501+50	18569	0	34807	0	501+50	16220	0	30397	0
502+00	15152	0	31189	0	502+00	15029	0	31109	0	502+00	12842	0	26909	0
502+50	11203	0	24403	0	502+50	10738	0	23858	0	502+50	8778	0	20018	0
503+00	7218	0	17056	0	503+00	6831	0	16267	0	503+00	5102	0	12852	0
503+50	3501	0	9925	0	503+50	2915	0	9024	0	503+50	1563	173	6172	160
504+00	484	1046	3690	968	504+00	201	2357	2886	2182	504+00	24	2743	1470	2700
504+50	238	5186	669	5770	504+50	113	7065	291	8723	504+50	139	7234	151	9238
505+00	318	4845	515	9288	505+00	92	6305	190	12380	505+00	98	6828	219	13020
505+50	231	3896	509	8093	505+50	32	4596	115	10094	505+50	79	5142	163	11083
506+00	253	3094	448	6472	506+00	44	3633	70	7620	506+00	47	4222	116	8670
506+50	96	1964	323	4684	506+50	60	2186	96	5388	506+50	35	3269	76	6936
507+00	114	784	194	2545	507+00	77	768	127	2735	507+00	53	1938	82	4821
507+50	1180	16	1198	741	507+50	946	17	948	727	507+50	105	702	146	2444
508+00	4027	0	4821	15	508+00	3291	0	3924	16	508+00	1617	1	1594	651
508+50	6394	0	9648	0	508+50	5879	0	8491	0	508+50	4055	0	5252	1
509+00	9583	0	14794	0	509+00	9069	0	13841	0	509+00	7046	0	10279	0
509+50	13177	0	21075	0	509+50	13054	0	20484	0	509+50	10819	0	16542	0

VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
510+00	17722	0	28611	0	510+00	17979	0	28735	0	510+00	15473	0	24344	0
510+50	22224	0	36987	0	510+50	22797	0	37756	0	510+50	20069	0	32909	0
511+00	25411	0	44106	0	511+00	26088	0	45264	0	511+00	23248	0	40109	0
511+50	27731	0	49205	0	511+50	28473	0	50519	0	511+50	25564	0	45197	0
512+00	29576	0	53062	0	512+00	30289	0	54409	0	512+00	27309	0	48957	0
512+50	30894	0	55990	0	512+50	31535	0	57245	0	512+50	28516	0	51690	0
513+00	30722	0	57052	0	513+00	31698	0	58549	0	513+00	28669	0	52950	0
513+50	30427	0	56619	0	513+50	31202	0	58241	0	513+50	28189	0	52647	0
514+00	29910	0	55867	0	514+00	30601	0	57225	0	514+00	27604	0	51660	0
514+50	29598	0	55100	0	514+50	30249	0	56343	0	514+50	27237	0	50779	0
515+00	29778	0	54978	0	515+00	30318	0	56080	0	515+00	27270	0	50470	0
515+50	30459	0	55775	0	515+50	31007	0	56782	0	515+50	27879	0	51064	0
516+00	31025	0	56929	0	516+00	31526	0	57900	0	516+00	28322	0	52038	0
516+50	31358	0	57762	0	516+50	31703	0	58545	0	516+50	28440	0	52558	0
517+00	30837	0	57588	0	517+00	31166	0	58212	0	517+00	27861	0	52131	0
517+50	28945	0	55353	0	517+50	29263	0	55953	0	517+50	25929	0	49806	0
518+00	26557	0	51391	0	518+00	28625	0	53600	0	518+00	25089	0	47239	0
518+50	24545	0	47317	0	518+50	18640	0	43764	0	518+50	15946	0	37995	0
			1,240,000	476,000				1,240,000	478,000				1,081,000	504,000
								-	2,000				(159,000)	26,000
								0.0%	0.4%				-12.8%	5.4%

VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
519+00	17582	0	39007	0	519+00	17582	0	39007	0	519+00	15375	0	29001	0
519+50	18213	0	33144	0	519+50	18213	0	33144	0	519+50	15908	0	28965	0
520+00	9267	0	25445	0	520+00	9267	0	25445	0	520+00	8158	0	22283	0
520+50	11094	0	18853	0	520+50	11094	0	18853	0	520+50	9867	0	16690	0
521+00	12819	0	22141	0	521+00	12819	0	22141	0	521+00	11451	0	19738	0
521+50	15566	0	26282	0	521+50	15566	0	26282	0	521+50	13994	0	23560	0
522+00	19265	0	32252	0	522+00	19265	0	32252	0	522+00	17431	0	29097	0
522+50	24008	0	40068	0	522+50	24008	0	40068	0	522+50	21790	0	36316	0
523+00	28491	0	48610	0	523+00	28491	0	48610	0	523+00	25846	0	44108	0
523+50	32667	0	56628	0	523+50	32667	0	56628	0	523+50	29587	0	51327	0
524+00	34743	0	62417	0	524+00	34743	0	62417	0	524+00	31225	0	56308	0
524+50	34642	0	64246	0	524+50	34642	0	64246	0	524+50	30792	0	57423	0
525+00	31267	0	61027	0	525+00	31267	0	61027	0	525+00	27406	0	53887	0
525+50	26749	0	53718	0	525+50	26749	0	53718	0	525+50	23164	0	46824	0
526+00	19637	0	42950	0	526+00	19637	0	42950	0	526+00	16593	0	36813	0
526+50	13875	0	31029	0	526+50	13875	0	31029	0	526+50	11265	0	25795	0
527+00	10454	0	22527	0	527+00	10454	0	22527	0	527+00	7900	0	17745	0
527+50	6370	0	15578	0	527+50	6370	0	15578	0	527+50	4239	0	11240	0
528+00	4177	0	9766	0	528+00	4177	0	9766	0	528+00	2332	0	6084	0
528+50	2969	0	6616	0	528+50	2969	0	6616	0	528+50	1283	0	3347	0
529+00	1698	0	4321	0	529+00	1698	0	4321	0	529+00	290	0	1456	0
529+50	2045	0	3466	0	529+50	2045	0	3466	0	529+50	147	483	405	447
530+00	1043	10	2860	9	530+00	1043	10	2860	9	530+00	57	1092	189	1458
530+50	339	332	1280	317	530+50	339	332	1280	317	530+50	34	1921	84	2790
531+00	112	796	418	1044	531+00	112	796	418	1044	531+00	38	2507	67	4100
531+50	44	1150	144	1802	531+50	44	1150	144	1802	531+50	35	2922	68	5027
532+00	43	3430	81	4241	532+00	43	3430	81	4241	532+00	35	6354	65	8589
532+50	58	4504	94	7346	532+50	58	4504	94	7346	532+50	38	7533	68	12858
533+00	72	5447	121	9214	533+00	72	5447	121	9214	533+00	49	8558	80	14900
533+50	116	6316	175	10892	533+50	116	6316	175	10892	533+50	92	9262	130	16501
534+00	148	7041	245	12368	534+00	148	7041	245	12368	534+00	128	9794	203	17645
534+50	205	7082	327	13077	534+50	205	7082	327	13077	534+50	174	9633	280	17988
535+00	552	6791	701	12845	535+00	552	6791	701	12845	535+00	153	8830	303	17095
535+50	2010	7353	2372	13097	535+50	2010	7353	2372	13097	535+50	503	9280	608	16768
536+00	1575	7360	3319	13624	536+00	1575	7360	3319	13624	536+00	704	9154	1118	17069
536+50	1319	7228	2680	13508	536+50	1319	7228	2680	13508	536+50	661	8888	1264	16706
537+00	1042	7545	2186	13679	537+00	1042	7545	2186	13679	537+00	609	9102	1176	16657
			738,000	128,000				738,000	128,000				625,000	187,000
													(113,000)	59,000
													-15.3%	46.1%

VE Study 2/30 - Calibration Tables VE-7

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
			3,940,000	2,874,000				3,950,000	2,880,000				3,315,000	3,237,000
			Waste	1,657,000				Waste	1,663,000				Waste	576,000
		Excavation		$ 13,200,000					$ 13,240,000					$ 11,110,000
		Embankment		$ 2,130,000					$ 2,140,000					$ 2,400,000
		Waste		$ 1,830,000					$ 1,830,000					$ 640,000
				$ 17,160,000					$ 17,210,000					$ 14,150,000
													Cost Savings	**$ (3,100,000)**
			TR234 Ramps											
			280,000	315,000				280,000	315,000				280,000	315,000
			Waste	7,000				Waste	7,000				Waste	7,000
			CR28 Ramps											
			1,121,000	37,000				1,121,000	37,000				903,000	52,000
			Waste	1,253,000				Waste	1,253,000				Waste	987,000

	Cut Volume	Fill Volume	Cut Volume	Fill Volume	Cut Volume	Fill Volume
Total	5,341,000	3,226,000	5,351,000	3,232,000	4,498,000	3,604,000
	Waste	2,917,000	Waste	2,922,000	Waste	1,569,000
Excavation		$ 17,900,000		$ 17,930,000		$ 15,070,000
Embankment		$ 2,390,000		$ 2,400,000		$ 2,670,000
Waste		$ 3,210,000		$ 3,220,000		$ 1,730,000
		$ 23,500,000		$ 23,550,000		$ 19,470,000
					Cost Savings	**$ (4,100,000)**

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
352+00	4926	0	0	0	352+00	4926	0	0	0	352+00	4926	0	0	0
352+50	3149	0	7477	0	352+50	3149	0	7477	0	352+50	3149	0	7477	0
353+00	1428	137	4237	127	353+00	1428	137	4237	127	353+00	1428	137	4237	127
353+50	540	2082	1821	2055	353+50	540	2082	1821	2055	353+50	540	2082	1821	2055
354+00	460	4541	925	6133	354+00	460	4541	925	6133	354+00	460	4541	925	6133
354+50	290	1623	694	5708	354+50	290	1623	694	5708	354+50	290	1623	694	5708
355+00	606	294	829	1775	355+00	606	294	829	1775	355+00	606	294	829	1775
355+50	1689	0	2125	273	355+50	1689	0	2125	273	355+50	1689	0	2125	273
356+00	2678	0	4044	0	356+00	2678	0	4044	0	356+00	2678	0	4044	0
356+50	4221	0	6388	0	356+50	4221	0	6388	0	356+50	4221	0	6388	0
357+00	4594	0	8162	0	357+00	4594	0	8162	0	357+00	4594	0	8162	0
357+50	5087	0	8964	0	357+50	5087	0	8964	0	357+50	5087	0	8964	0
358+00	5283	0	9601	0	358+00	5283	0	9601	0	358+00	5283	0	9601	0
358+50	5649	0	10122	0	358+50	5649	0	10122	0	358+50	5649	0	10122	0
359+00	6075	0	10856	0	359+00	6075	0	10856	0	359+00	6075	0	10856	0
359+50	6483	0	11627	0	359+50	6483	0	11627	0	359+50	6483	0	11627	0
360+00	6095	0	11646	0	360+00	6095	0	11646	0	360+00	6095	0	11646	0
360+50	5346	0	10593	0	360+50	5346	0	10593	0	360+50	5346	0	10593	0
361+00	4043	0	8693	0	361+00	4043	0	8693	0	361+00	4043	0	8693	0
361+50	3032	0	6551	0	361+50	3032	0	6551	0	361+50	3032	0	6551	0
362+00	1587	65	4277	60	362+00	1587	65	4277	60	362+00	1587	65	4277	60
362+50	713	1094	2130	1073	362+50	713	1094	2130	1073	362+50	713	1094	2130	1073
363+00	51	2842	707	3644	363+00	51	2842	707	3644	363+00	51	2842	707	3644
363+50	272	5239	299	7483	363+50	272	5239	299	7483	363+50	272	5239	299	7483
364+00	249	8284	482	12521	364+00	249	8284	482	12521	364+00	249	8284	482	12521
364+50	176	6269	394	13475	364+50	176	6269	394	13475	364+50	176	6269	394	13475
365+00	246	4521	391	9991	365+00	246	4521	391	9991	365+00	246	4521	391	9991
365+50	84	3214	305	7162	365+50	84	3214	305	7162	365+50	84	3214	305	7162
366+00	46	1881	120	4718	366+00	46	1881	120	4718	366+00	46	1881	120	4718
366+50	86	1297	123	2942	366+50	86	1297	123	2942	366+50	86	1297	123	2942
367+00	241	659	302	1811	367+00	241	659	302	1811	367+00	241	659	302	1811
367+50	630	566	806	1134	367+50	630	566	806	1134	367+50	630	566	806	1134
368+00	975	804	1486	1269	368+00	975	804	1486	1269	368+00	975	804	1486	1269
368+50	1218	896	2030	1574	368+50	1218	896	2030	1574	368+50	1218	896	2030	1574
369+00	1567	700	2579	1478	369+00	1567	700	2579	1478	369+00	1567	700	2579	1478
369+50	1991	523	3295	1133	369+50	1991	523	3295	1133	369+50	1991	523	3295	1133
370+00	2629	379	4278	836	370+00	2629	379	4278	836	370+00	2629	379	4278	836
370+50	2894	462	5114	779	370+50	2894	462	5114	779	370+50	2894	462	5114	779
371+00	2556	873	5046	1237	371+00	2556	873	5046	1237	371+00	2556	873	5046	1237
371+50	196	307	2548	1093	371+50	196	307	2548	1093	371+50	196	307	2548	1093
372+00	128	626	300	865	372+00	128	626	300	865	372+00	128	626	300	865
372+50	34	1039	150	1542	372+50	34	1039	150	1542	372+50	34	1039	150	1542
373+00	0	1581	32	2426	373+00	0	1581	32	2426	373+00	0	1581	32	2426
373+50	0	2380	0	3668	373+50	0	2380	0	3668	373+50	0	2380	0	3668
374+00	0	3499	0	5443	374+00	0	3499	0	5443	374+00	0	3499	0	5443
374+50	0	5076	0	7940	374+50	0	5076	0	7940	374+50	0	5076	0	7940

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
375+00	0	7084	0	11259	375+00	0	7084	0	11259	375+00	0	7084	0	11259
375+50	0	8080	0	14040	375+50	0	8080	0	14040	375+50	0	8080	0	14040
376+00	0	8838	0	15665	376+00	0	8838	0	15665	376+00	0	8838	0	15665
376+50	0	8840	0	16368	376+50	0	8840	0	16368	376+50	0	8840	0	16368
377+00	0	8893	0	16420	377+00	0	8893	0	16420	377+00	0	8893	0	16420
377+50	0	8761	0	16347	377+50	0	8761	0	16347	377+50	0	8761	0	16347
378+00	0	8389	0	15880	378+00	0	8389	0	15880	378+00	0	8389	0	15880
378+50	0	7630	0	14833	378+50	0	7630	0	14833	378+50	0	7630	0	14833
379+00	0	6723	0	13290	379+00	0	6723	0	13290	379+00	0	6723	0	13290
379+50	0	6533	0	12274	379+50	0	6533	0	12274	379+50	0	6533	0	12274
380+00	0	7290	0	12799	380+00	0	7290	0	12799	380+00	0	7290	0	12799
380+50	0	7963	0	14123	380+50	0	7963	0	14123	380+50	0	7963	0	14123
381+00	0	7790	0	14586	381+00	0	7790	0	14586	381+00	0	7790	0	14586
381+50	0	7152	0	13835	381+50	0	7152	0	13835	381+50	0	7152	0	13835
382+00	0	5612	0	11819	382+00	0	5612	0	11819	382+00	0	5612	0	11819
382+50	0	4601	0	9457	382+50	0	4601	0	9457	382+50	0	4601	0	9457
383+00	0	3678	0	7666	383+00	0	3678	0	7666	383+00	0	3678	0	7666
385+50	2434	3634	1960	5309	385+50	2434	3634	1960	5309	385+50	10	3634	8	5300
386+00	11	3761	2264	6848	386+00	11	3761	2264	6848	386+00	11	3761	20	6848
386+50	14	3713	23	6920	386+50	14	3713	23	6920	386+50	14	3713	23	6920
387+00	18	2962	29	6181	387+00	18	2962	29	6181	387+00	17	2970	29	6188
387+50	14	2826	30	5359	387+50	14	2826	30	5359	387+50	11	2862	26	5400
388+00	64	2432	72	4868	388+00	64	2432	72	4868	388+00	10	2516	19	4980
388+50	20	2171	77	4262	388+50	20	2171	77	4262	388+50	8	2315	16	4473
389+00	21	1977	38	3842	389+00	21	1977	38	3842	389+00	4	2196	11	4176
389+50	21	2072	39	3750	389+50	21	2072	39	3750	389+50	17	2389	20	4245
390+00	44	2411	60	4151	390+00	44	2411	60	4151	390+00	16	2566	31	4588
390+50	119	2214	151	4282	390+50	119	2214	151	4282	390+50	20	2778	33	4948
391+00	8	2740	118	4588	391+00	8	2740	118	4588	391+00	18	3471	35	5786
391+50	0	2484	7	4838	391+50	0	2484	7	4838	391+50	0	3340	17	6306
392+00	25	2214	23	4351	392+00	25	2214	23	4351	392+00	12	3206	12	6061
392+50	29	2105	50	3999	392+50	29	2105	50	3999	392+50	13	3265	24	5991
393+00	16	2046	42	3844	393+00	16	2046	42	3844	393+00	12	3402	23	6173
393+50	8	2120	22	3858	393+50	8	2120	22	3858	393+50	0	3688	11	6565
394+00	11	2374	18	4161	394+00	11	2374	18	4161	394+00	0	4213	0	7316
394+50	33	2813	41	4803	394+50	33	2813	41	4803	394+50	0	4946	0	8480
395+00	0	3274	31	5635	395+00	0	3274	31	5635	395+00	0	5530	0	9700
395+50	0	3535	0	6304	395+50	0	3535	0	6304	395+50	0	5861	0	10548
396+00	0	3442	0	6461	396+00	0	3442	0	6461	396+00	0	5813	0	10809
396+50	0	3206	0	6156	396+50	0	3206	0	6156	396+50	0	5675	0	10637
397+00	0	3466	0	6178	397+00	0	3466	0	6178	397+00	0	6007	0	10817
397+50	0	3521	0	6469	397+50	0	3521	0	6469	397+50	0	6057	0	11171
398+00	0	3532	0	6530	398+00	0	3532	0	6530	398+00	0	6187	0	11337
398+50	0	3556	0	6563	398+50	0	3556	0	6563	398+50	0	6289	0	11552
399+00	0	3607	0	6632	399+00	0	3607	0	6632	399+00	0	6380	0	11730
399+50	0	3622	0	6694	399+50	0	3622	0	6694	399+50	0	6516	0	11940
400+00	0	3448	0	6547	400+00	0	3448	0	6547	400+00	0	6332	0	11896

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
400+50	0	7943	0	10548
401+00	0	7872	0	14644
401+50	0	7798	0	14509
402+00	52	10938	48	17348
402+50	52	12601	97	21795
403+00	212	14085	244	24710
			169,000	608,000

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
400+50	0	7943	0	10548
401+00	0	7872	0	14644
401+50	0	7798	0	14509
402+00	52	10938	48	17348
402+50	52	12601	97	21795
403+00	212	14085	244	24710
			169,000	608,000

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
400+50	0	13044	0	17940
401+00	0	13203	0	24302
401+50	0	13328	0	24565
402+00	36	19964	33	30825
402+50	36	22237	67	39074
403+00	31	24910	62	43654
			164,000	758,000
			(5,000)	150,000
			-3.0%	24.7%

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
		Original					VE_CX					VE_8X		
403+50	30	14297	224	26279	403+50	38	15016	82	26654	403+50	42	28506	67	49721
404+00	109	13776	129	25993	404+00	31	16380	64	29071	404+00	28	30612	64	54739
404+50	100	14857	194	26512	404+50	54	16684	79	30615	404+50	38	31569	61	57575
405+00	149	14681	230	27350	405+00	61	15705	107	29990	405+00	73	31137	103	58061
405+50	144	14695	271	27200	405+50	90	13646	140	27177	405+50	35	29379	101	56033
406+00	117	14366	242	26909	406+00	6	11744	89	23510	406+00	52	27845	81	52986
406+50	75	14105	178	26363	406+50	18	11257	22	21298	406+50	0	27836	48	51557
407+00	143	13726	202	25770	407+00	67	11300	79	20886	407+00	60	27519	56	51255
407+50	155	13352	276	25072	407+50	0	10816	62	20478	407+50	0	27348	56	50804
408+00	126	12938	261	24342	408+00	34	10589	32	19819	408+00	0	27246	0	50551
408+50	126	13142	234	24148	408+50	63	10531	90	19556	408+50	0	27563	0	50749
409+00	148	12512	254	23754	409+00	100	10157	152	19156	409+00	129	29081	119	52448
409+50	196	11746	319	22461	409+50	111	10090	196	18747	409+50	207	28769	311	53565
410+00	252	12130	415	22108	410+00	131	11886	224	20348	410+00	323	31060	491	55397
410+50	239	11259	455	21656	410+50	197	12778	304	22837	410+50	364	32700	636	59037
411+00	177	10692	385	20325	411+00	215	10842	382	21870	411+00	166	30721	490	58724
411+50	256	9491	401	18689	411+50	177	11735	363	20904	411+50	135	28942	279	55244
412+00	236	8669	455	16815	412+00	158	11388	310	21410	412+00	125	28524	241	53209
412+50	279	9659	477	16970	412+50	112	11014	249	20743	412+50	86	28245	195	52564
413+00	0	10022	258	18223	413+00	60	9799	159	19271	413+00	43	26810	120	50977
413+50	74	8428	69	17083	413+50	81	7453	131	15974	413+50	44	24086	81	47126
414+00	83	6091	145	13443	414+00	19	4600	93	11160	414+00	0	20061	41	40877
414+50	246	4159	304	9490	414+50	152	3943	159	7909	414+50	0	18143	0	35374
415+00	1063	2390	1212	6064	415+00	1071	2195	1133	5683	415+00	0	14334	0	30071
415+50	2876	701	3647	2863	415+50	3016	473	3784	2470	415+50	0	9325	0	21906
416+00	5249	0	7523	649	416+00	5487	0	7874	438	416+00	21	5553	19	13776
416+50	7826	0	12106	0	416+50	8035	0	12521	0	416+50	441	2494	427	7451
417+00	10408	0	16883	0	417+00	10698	0	17345	0	417+00	1532	589	1827	2855
417+50	12845	0	21531	0	417+50	13310	0	22230	0	417+50	2974	0	4172	545
418+00	15394	0	26147	0	418+00	15868	0	27017	0	418+00	4893	0	7284	0
418+50	17717	0	30658	0	418+50	18098	0	31450	0	418+50	6558	0	10603	0
419+00	19403	0	34370	0	419+00	19929	0	35211	0	419+00	8086	0	13559	0
419+50	21400	0	37780	0	419+50	21850	0	38684	0	419+50	9826	0	16585	0
420+00	23216	0	41311	0	420+00	23583	0	42068	0	420+00	11475	0	19723	0
420+50	24371	0	44062	0	420+50	24285	0	44323	0	420+50	12330	0	22042	0
421+00	23838	0	44638	0	421+00	23244	0	44009	0	421+00	11796	0	22339	0
421+50	21772	0	42231	0	421+50	20770	0	40753	0	421+50	10182	0	20350	0
422+00	18869	0	37631	0	422+00	17668	0	35591	0	422+00	8048	0	16880	0
422+50	14785	0	31162	0	422+50	14541	0	29823	0	422+50	6005	0	13012	0
423+00	11393	0	24239	0	423+00	11350	0	23973	0	423+00	3983	0	9248	0
423+50	7227	0	17240	0	423+50	7674	0	17615	0	423+50	2428	1720	5936	1593
424+00	7017	0	13188	0	424+00	7270	0	13837	0	424+00	2206	2782	4291	4169
424+50	8482	0	14350	0	424+50	9017	0	15081	0	424+50	3122	8	4933	2584
425+00	11624	0	18616	0	425+00	12197	0	19643	0	425+00	6187	0	8620	8
425+50	15135	0	24777	0	425+50	15841	0	25961	0	425+50	9617	0	14634	0
426+00	18335	0	30991	0	426+00	19354	0	32588	0	426+00	12933	0	20880	0

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
426+50	21638	0	37012	0	426+50	23104	0	39313	0	426+50	16759	0	27492	0
427+00	25358	0	43515	0	427+00	27516	0	46870	0	427+00	21329	0	35266	0
427+50	29416	0	50717	0	427+50	31755	0	54880	0	427+50	25745	0	43588	0
428+00	33445	0	58204	0	428+00	35940	0	62680	0	428+00	30200	0	51801	0
428+50	36288	0	64568	0	428+50	38910	0	69306	0	428+50	33652	0	59122	0
429+00	36732	0	67611	0	429+00	38833	0	71984	0	429+00	34245	0	62868	0
429+50	35238	0	66638	0	429+50	36585	0	69831	0	429+50	32681	0	61969	0
430+00	32096	0	62346	0	430+00	33105	0	64527	0	430+00	29825	0	57876	0
430+50	28584	0	56185	0	430+50	29096	0	57594	0	430+50	26417	0	52076	0
431+00	24812	0	49441	0	431+00	25527	0	50577	0	431+00	23386	0	46114	0
431+50	21001	0	42420	0	431+50	21820	0	43840	0	431+50	20144	0	40306	0
432+00	16940	0	35131	0	432+00	18035	0	36903	0	432+00	16797	0	34204	0
432+50	13066	0	27784	0	432+50	13683	0	29369	0	432+50	12801	0	27406	0
433+00	9031	0	20460	0	433+00	8721	0	20744	0	433+00	8130	0	19381	0
433+50	4332	126	12373	117	433+50	4863	178	12578	165	433+50	4492	257	11687	238
434+00	1918	992	5786	1035	434+00	993	998	5422	1089	434+00	844	1099	4940	1255
434+50	1267	2074	2949	2839	434+50	1154	2110	1988	2878	434+50	1095	2219	1795	3072
435+00	2077	2577	3095	4307	435+00	530	2618	1559	4378	435+00	500	2681	1477	4537
435+50	4009	2772	5634	4953	435+50	1179	2943	1582	5150	435+50	1157	2981	1534	5242
436+00	5724	2872	9011	5226	436+00	1886	3208	2838	5696	436+00	1835	3074	2770	5606
436+50	6179	2785	11021	5238	436+50	3493	3101	4981	5842	436+50	3412	3179	4859	5789
437+00	5977	2904	11256	5267	437+00	3390	3302	6374	5929	437+00	3123	2865	6051	5596
437+50	4432	3276	9638	5722	437+50	2923	3873	5846	6644	437+50	2593	3301	5292	5709
438+00	2416	3763	6341	6518	438+00	1826	4609	4397	7854	438+00	1443	3928	3736	6693
438+50	1041	4588	3201	7733	438+50	809	4468	2440	8405	438+50	667	5146	1953	8402
439+00	385	5633	1320	9464	439+00	318	5503	1043	9233	439+00	324	6570	917	10849
439+50	307	6956	641	11656	439+50	243	7016	520	11592	439+50	185	7388	471	12924
440+00	153	8289	426	14116	440+00	97	8699	315	14551	440+00	193	9338	350	15487
440+50	156	8838	287	15859	440+50	180	10212	256	17511	440+50	143	10928	311	18765
441+00	288	8544	412	16094	441+00	112	12382	270	20921	441+00	89	13276	215	22411
441+50	253	9445	501	16656	441+50	89	12829	186	23344	441+50	49	14280	128	25516
			1,349,000	650,000				1,358,000	650,000				909,000	1,442,000
								9,000	-				(449,000)	792,000
								0.7%	0.0%				-33.1%	121.8%

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
		Original					VE_CY					VE_8Y		
444+50	279	6969	26	1357	444+50	0	11932	0	23111	444+50	0	0	0	0
445+00	366	6991	597	12926	445+00	0	9240	0	19604	445+00	36	10255	33	9495
445+50	382	6125	692	12145	445+50	29	7103	27	15132	445+50	41	8403	70	17276
446+00	215	5022	552	10321	446+00	69	5800	91	11946	446+00	68	8598	101	15742
446+50	124	4030	313	8382	446+50	94	4586	151	9616	446+50	83	7805	140	15188
447+00	75	2680	184	6214	447+00	172	2953	246	6980	447+00	106	6062	175	12840
447+50	392	1006	433	3413	447+50	312	1119	448	3771	447+50	136	4003	224	9319
448+00	1773	382	2005	1285	448+00	1028	370	1241	1379	448+00	157	2708	272	6214
448+50	1667	306	3185	637	448+50	1761	282	2582	603	448+50	438	2172	551	4519
449+00	2398	153	3764	424	449+00	2183	157	3651	407	449+00	491	1778	860	3657
449+50	3827	0	5764	142	449+50	3008	0	4807	146	449+50	395	931	820	2508
450+00	4342	0	7564	0	450+00	4415	0	6873	0	450+00	977	394	1271	1227
450+50	5643	0	9245	0	450+50	6209	0	9837	0	450+50	2320	125	3054	481
451+00	8269	0	12881	0	451+00	8530	0	13647	0	451+00	4509	0	6324	116
451+50	11019	0	17859	0	451+50	11582	0	18622	0	451+50	7429	0	11054	0
452+00	13778	0	22960	0	452+00	14292	0	23958	0	452+00	10067	0	16200	0
452+50	15464	0	27075	0	452+50	16186	0	28220	0	452+50	11978	0	20411	0
453+00	16766	0	29842	0	453+00	17284	0	30991	0	453+00	13173	0	23288	0
453+50	17439	0	31672	0	453+50	17748	0	32437	0	453+50	13705	0	24887	0
454+00	16935	0	31828	0	454+00	17051	0	32221	0	454+00	13103	0	24822	0
454+50	15201	0	29756	0	454+50	15194	0	29856	0	454+50	11407	0	22694	0
455+00	12435	0	25589	0	455+00	12352	0	25505	0	455+00	8793	0	18704	0
455+50	8873	0	19730	0	455+50	9036	0	19803	0	455+50	5854	0	13562	0
456+00	6369	0	14114	0	456+00	5780	0	13719	0	456+00	3173	264	8359	245
456+50	3738	12	9359	11	456+50	3701	0	8779	0	456+50	1787	1193	4593	1349
457+00	2520	349	5794	334	457+00	2648	214	5879	198	457+00	1124	2090	2695	3040
457+50	2199	1013	4369	1261	457+50	1974	746	4280	889	457+50	779	3045	1762	4755
458+00	1573	1771	3492	2579	458+00	1498	1364	3215	1954	458+00	565	2960	1244	5560
458+50	1237	2289	2602	3759	458+50	1406	2039	2689	3151	458+50	527	3633	1011	6105
459+00	950	2606	2025	4532	459+00	1124	2361	2342	4073	459+00	403	3902	861	6977
459+50	765	2800	1588	5006	459+50	899	2562	1873	4558	459+50	329	4064	677	7376
460+00	1046	3804	1677	6115	460+00	777	3530	1552	5640	460+00	288	4924	571	8322
460+50	964	4702	1861	7876	460+50	622	4419	1296	7360	460+50	229	5715	478	9851
461+00	1034	5748	1850	9676	461+00	420	5445	966	9133	461+00	132	6573	334	11378
461+50	330	6727	1262	11551	461+50	232	6398	604	10965	461+50	58	7364	176	12905
462+00	51	7472	353	13147	462+00	127	5073	332	10621	462+00	43	7882	94	14117
462+50	210	8453	242	14745	462+50	72	5823	184	10089	462+50	235	8700	257	15354
463+00	170	8017	352	15250	463+00	349	6596	390	11499	463+00	205	9426	408	16783
463+50	307	9145	441	15891	463+50	324	10066	624	15428	463+50	221	10625	394	18566
464+00	388	10881	643	18543	464+00	282	12030	561	20459	464+00	249	12521	435	21431
464+50	505	13350	827	22437	464+50	170	12603	418	22808	464+50	138	15452	358	25901
465+00	385	16302	825	27456	465+00	606	16455	719	26905	465+00	499	19427	589	32295
465+50	438	18530	762	32252	465+50	99	20741	653	34440	465+50	52	20995	510	37428
466+00	45	19273	447	35003	466+00	0	19003	91	36800	466+00	39	21625	84	39463
466+50	58	19804	95	36183	466+50	0	19630	0	35771	466+50	74	22180	104	40560
467+00	159	20868	201	37659	467+00	35	19304	33	36049	467+00	29	21660	95	40593

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
467+50	225	22516	356	40170	467+50	31	19335	61	35776	467+50	37	24475	61	42718
468+00	189	22679	383	41847	468+00	106	17733	127	34322	468+00	105	24633	131	45470
468+50	455	22591	596	41917	468+50	509	17916	569	33009	468+50	489	24130	550	45151
469+00	861	20715	1219	40098	469+00	1309	15962	1684	31369	469+00	1294	22292	1651	42983
469+50	463	19370	1226	37116	469+50	1444	14934	2550	28608	469+50	1459	20546	2549	39665
470+00	427	18443	824	35013	470+00	1179	14330	2429	27096	470+00	1189	19398	2452	36985
470+50	432	17696	795	33462	470+50	1273	16077	2270	28155	470+50	1277	18584	2283	35169
471+00	493	17159	856	32273	471+00	1146	15635	2240	29363	471+00	1148	17956	2245	33833
471+50	294	14838	729	29627	471+50	1135	15732	2112	29043	471+50	1135	15743	2113	31203
472+00	258	14802	512	27445	472+00	983	14406	1961	27906	472+00	979	15666	1957	29082
472+50	151	16548	379	29027	472+50	689	16309	1548	28440	472+50	683	17498	1539	30707
473+00	195	16410	320	30516	473+00	640	18823	1231	32530	473+00	622	17718	1209	32607
473+50	257	15283	418	29344	473+50	568	18595	1119	34646	473+50	553	17386	1088	32504
474+00	73	13297	305	26463	474+00	185	16747	697	32724	474+00	182	15606	681	30548
474+50	93	11334	154	22806	474+50	188	14061	345	28526	474+50	201	12366	355	25900
475+00	0	10057	86	19806	475+00	24	12909	197	24972	475+00	41	12443	224	22971
475+50	560	8779	518	17441	475+50	0	10722	23	21881	475+50	0	10242	38	21005
476+00	209	8057	712	15589	476+00	0	8589	0	17881	476+00	0	8624	0	17468
476+50	175	7497	356	14402	476+50	60	7825	55	15199	476+50	46	7408	43	14844
477+00	190	6943	338	13371	477+00	72	7039	122	13764	477+00	72	6635	110	13002
477+50	29	6509	203	12455	477+50	106	6452	165	12492	477+50	104	6022	163	11719
478+00	151	4803	167	10474	478+00	127	4696	216	10323	478+00	31	4297	125	9555
478+50	325	3495	441	7683	478+50	225	3374	326	7472	478+50	274	3028	283	6783
479+00	1129	2289	1346	5356	479+00	719	2080	874	5050	479+00	826	1783	1018	4455
479+50	2654	1050	3503	3091	479+50	1905	942	2429	2798	479+50	2083	709	2693	2308
480+00	5417	61	7473	1028	480+00	3850	130	5328	992	480+00	4120	0	5744	657
480+50	6605	0	11131	56	480+50	6309	0	9407	120	480+50	6656	0	9977	0
481+00	9047	0	14492	0	481+00	8733	0	13928	0	481+00	9119	0	14606	0
481+50	10376	0	17985	0	481+50	10587	0	17889	0	481+50	10983	0	18613	0
482+00	11045	0	19834	0	482+00	10258	0	19301	0	482+00	10648	0	20029	0
482+50	3824	0	13768	0	482+50	3828	0	13043	0	482+50	4147	0	13699	0
483+00	22	3205	3561	2967	483+00	107	4603	3643	4262	483+00	93	4094	3926	3791
483+50	221	10142	225	12359	483+50	62	11769	156	15159	483+50	77	11364	158	14313
			444,000	1,012,000				445,000	1,016,000				328,000	1,157,000
								1,000	4,000				(117,000)	141,000
								0.2%	0.4%				-26.3%	13.9%

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
		Original					VE_CZ					VE_8Z		
487+00	302	12537	260	21899	487+00	44	15038	103	29118	487+00	40	14416	92	13348
487+50	271	12193	531	22898	487+50	45	14987	83	27801	487+50	47	14510	81	26783
488+00	288	13260	518	23567	488+00	0	14512	42	27314	488+00	0	14026	44	26422
488+50	110	14153	369	25382	488+50	19	13788	17	26204	488+50	18	12631	17	24682
489+00	89	14641	184	26661	489+00	75	14850	87	26517	489+00	59	14295	72	24931
489+50	49	14950	128	27400	489+50	93	14451	155	27131	489+50	84	14747	133	26891
490+00	39	15036	81	27766	490+00	34	12945	117	25367	490+00	8	14494	85	27075
490+50	52	15267	84	28059	490+50	24	13713	54	24683	490+50	18	14388	24	26743
491+00	34	14963	79	27991	491+00	0	13336	23	25046	491+00	41	14243	54	26510
491+50	60	14355	87	27146	491+50	34	12747	32	24150	491+50	37	14055	72	26202
492+00	43	13751	95	26024	492+00	36	12186	65	23086	492+00	21	13636	54	25640
492+50	44	13497	80	25230	492+50	19	11898	51	22300	492+50	26	13424	43	25056
493+00	51	12722	87	24277	493+00	58	11158	72	21348	493+00	44	12739	64	24225
493+50	110	11499	149	22427	493+50	0	10059	54	19645	493+50	53	11782	90	22705
494+00	78	9413	174	19362	494+00	31	9168	29	17803	494+00	46	10013	92	20181
494+50	88	7585	154	15738	494+50	0	7388	29	15330	494+50	49	8436	88	17082
495+00	94	6387	169	12937	495+00	0	6214	0	12595	495+00	21	7460	64	14719
495+50	79	5386	161	10901	495+50	16	5235	14	10601	495+50	7	6691	25	13103
496+00	102	4279	168	8949	496+00	53	4445	63	8963	496+00	38	5627	41	11406
496+50	32	2799	124	6554	496+50	26	2915	73	6815	496+50	54	4189	85	9089
497+00	75	1411	99	3898	497+00	77	1421	96	4015	497+00	36	2778	84	6451
497+50	778	167	790	1461	497+50	772	350	786	1640	497+50	190	1127	209	3616
498+00	2781	0	3296	154	498+00	2564	0	3089	324	498+00	1129	39	1221	1080
498+50	5430	0	7603	0	498+50	5099	0	7096	0	498+50	3433	0	4224	36
499+00	8184	0	12605	0	499+00	8033	0	12159	0	499+00	6178	0	8899	0
499+50	11478	0	18205	0	499+50	11068	0	17686	0	499+50	9020	0	14072	0
500+00	15099	0	24608	0	500+00	14312	0	23500	0	500+00	12076	0	19533	0
500+50	17592	0	30269	0	500+50	17125	0	29109	0	500+50	14764	0	24852	0
501+00	18775	0	33673	0	501+00	19023	0	33470	0	501+00	16609	0	29049	0
501+50	18531	0	34543	0	501+50	18569	0	34807	0	501+50	16220	0	30397	0
502+00	15152	0	31189	0	502+00	15029	0	31109	0	502+00	12842	0	26909	0
502+50	11203	0	24403	0	502+50	10738	0	23858	0	502+50	8778	0	20018	0
503+00	7218	0	17056	0	503+00	6831	0	16267	0	503+00	5102	0	12852	0
503+50	3501	0	9925	0	503+50	2915	0	9024	0	503+50	1563	173	6172	160
504+00	484	1046	3690	968	504+00	201	2357	2886	2182	504+00	24	2743	1470	2700
504+50	238	5186	669	5770	504+50	113	7065	291	8723	504+50	139	7234	151	9238
505+00	318	4845	515	9288	505+00	92	6305	190	12380	505+00	98	6828	219	13020
505+50	231	3896	509	8093	505+50	32	4596	115	10094	505+50	79	5142	163	11083
506+00	253	3094	448	6472	506+00	44	3633	70	7620	506+00	47	4222	116	8670
506+50	96	1964	323	4684	506+50	60	2186	96	5388	506+50	35	3269	76	6936
507+00	114	784	194	2545	507+00	77	768	127	2735	507+00	53	1938	82	4821
507+50	1180	16	1198	741	507+50	946	17	948	727	507+50	105	702	146	2444
508+00	4027	0	4821	15	508+00	3291	0	3924	16	508+00	1617	1	1594	651
508+50	6394	0	9648	0	508+50	5879	0	8491	0	508+50	4055	0	5252	1
509+00	9583	0	14794	0	509+00	9069	0	13841	0	509+00	7046	0	10279	0
509+50	13177	0	21075	0	509+50	13054	0	20484	0	509+50	10819	0	16542	0

VE Study 2/30 - Calibration Tables VE-8

Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
510+00	17722	0	28611	0	510+00	17979	0	28735	0	510+00	15473	0	24344	0
510+50	22224	0	36987	0	510+50	22797	0	37756	0	510+50	20069	0	32909	0
511+00	25411	0	44106	0	511+00	26088	0	45264	0	511+00	23248	0	40109	0
511+50	27731	0	49205	0	511+50	28473	0	50519	0	511+50	25564	0	45197	0
512+00	29576	0	53062	0	512+00	30289	0	54409	0	512+00	27309	0	48957	0
512+50	30894	0	55990	0	512+50	31535	0	57245	0	512+50	28516	0	51690	0
513+00	30722	0	57052	0	513+00	31698	0	58549	0	513+00	28669	0	52950	0
513+50	30427	0	56619	0	513+50	31202	0	58241	0	513+50	28189	0	52647	0
514+00	29910	0	55867	0	514+00	30601	0	57225	0	514+00	27604	0	51660	0
514+50	29598	0	55100	0	514+50	30249	0	56343	0	514+50	27237	0	50779	0
515+00	29778	0	54978	0	515+00	30318	0	56080	0	515+00	27270	0	50470	0
515+50	30459	0	55775	0	515+50	31007	0	56782	0	515+50	27879	0	51064	0
516+00	31025	0	56929	0	516+00	31526	0	57900	0	516+00	28322	0	52038	0
516+50	31358	0	57762	0	516+50	31703	0	58545	0	516+50	28440	0	52558	0
517+00	30837	0	57588	0	517+00	31166	0	58212	0	517+00	27861	0	52131	0
517+50	28945	0	55353	0	517+50	29263	0	55953	0	517+50	25929	0	49806	0
518+00	26557	0	51391	0	518+00	28625	0	53600	0	518+00	25089	0	47239	0
518+50	24545	0	47317	0	518+50	18640	0	43764	0	518+50	15946	0	37995	0
			1,240,000	476,000				1,240,000	478,000				1,081,000	504,000
								-	2,000				(159,000)	26,000
								0.0%	0.4%				-12.8%	5.4%

VE Study 2/30 - Calibration Tables VE-8

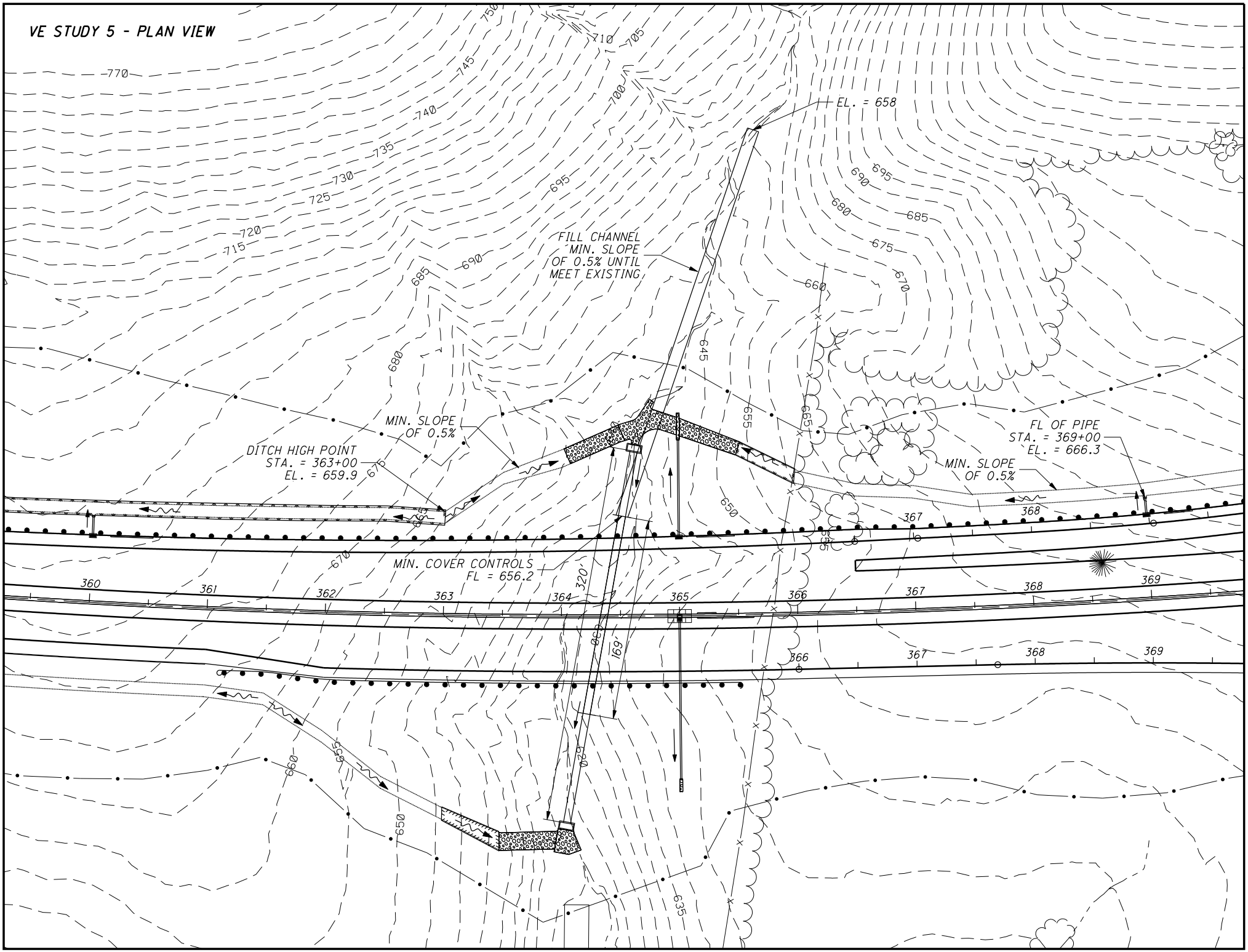
Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
519+00	17582	0	39007	0	519+00	17582	0	39007	0	519+00	15375	0	29001	0
519+50	18213	0	33144	0	519+50	18213	0	33144	0	519+50	15908	0	28965	0
520+00	9267	0	25445	0	520+00	9267	0	25445	0	520+00	8158	0	22283	0
520+50	11094	0	18853	0	520+50	11094	0	18853	0	520+50	9867	0	16690	0
521+00	12819	0	22141	0	521+00	12819	0	22141	0	521+00	11451	0	19738	0
521+50	15566	0	26282	0	521+50	15566	0	26282	0	521+50	13994	0	23560	0
522+00	19265	0	32252	0	522+00	19265	0	32252	0	522+00	17431	0	29097	0
522+50	24008	0	40068	0	522+50	24008	0	40068	0	522+50	21790	0	36316	0
523+00	28491	0	48610	0	523+00	28491	0	48610	0	523+00	25846	0	44108	0
523+50	32667	0	56628	0	523+50	32667	0	56628	0	523+50	29587	0	51327	0
524+00	34743	0	62417	0	524+00	34743	0	62417	0	524+00	31225	0	56308	0
524+50	34642	0	64246	0	524+50	34642	0	64246	0	524+50	30792	0	57423	0
525+00	31267	0	61027	0	525+00	31267	0	61027	0	525+00	27406	0	53887	0
525+50	26749	0	53718	0	525+50	26749	0	53718	0	525+50	23164	0	46824	0
526+00	19637	0	42950	0	526+00	19637	0	42950	0	526+00	16593	0	36813	0
526+50	13875	0	31029	0	526+50	13875	0	31029	0	526+50	11265	0	25795	0
527+00	10454	0	22527	0	527+00	10454	0	22527	0	527+00	7900	0	17745	0
527+50	6370	0	15578	0	527+50	6370	0	15578	0	527+50	4239	0	11240	0
528+00	4177	0	9766	0	528+00	4177	0	9766	0	528+00	2332	0	6084	0
528+50	2969	0	6616	0	528+50	2969	0	6616	0	528+50	1283	0	3347	0
529+00	1698	0	4321	0	529+00	1698	0	4321	0	529+00	290	0	1456	0
529+50	2045	0	3466	0	529+50	2045	0	3466	0	529+50	147	483	405	447
530+00	1043	10	2860	9	530+00	1043	10	2860	9	530+00	57	1092	189	1458
530+50	339	332	1280	317	530+50	339	332	1280	317	530+50	34	1921	84	2790
531+00	112	796	418	1044	531+00	112	796	418	1044	531+00	38	2507	67	4100
531+50	44	1150	144	1802	531+50	44	1150	144	1802	531+50	35	2922	68	5027
532+00	43	3430	81	4241	532+00	43	3430	81	4241	532+00	35	6354	65	8589
532+50	58	4504	94	7346	532+50	58	4504	94	7346	532+50	38	7533	68	12858
533+00	72	5447	121	9214	533+00	72	5447	121	9214	533+00	49	8558	80	14900
533+50	116	6316	175	10892	533+50	116	6316	175	10892	533+50	92	9262	130	16501
534+00	148	7041	245	12368	534+00	148	7041	245	12368	534+00	128	9794	203	17645
534+50	205	7082	327	13077	534+50	205	7082	327	13077	534+50	174	9633	280	17988
535+00	552	6791	701	12845	535+00	552	6791	701	12845	535+00	153	8830	303	17095
535+50	2010	7353	2372	13097	535+50	2010	7353	2372	13097	535+50	503	9280	608	16768
536+00	1575	7360	3319	13624	536+00	1575	7360	3319	13624	536+00	704	9154	1118	17069
536+50	1319	7228	2680	13508	536+50	1319	7228	2680	13508	536+50	661	8888	1264	16706
537+00	1042	7545	2186	13679	537+00	1042	7545	2186	13679	537+00	609	9102	1176	16657
			738,000	128,000				738,000	128,000				625,000	187,000
													(113,000)	59,000
													-15.3%	46.1%

VE Study 2/30 - Calibration Tables VE-8

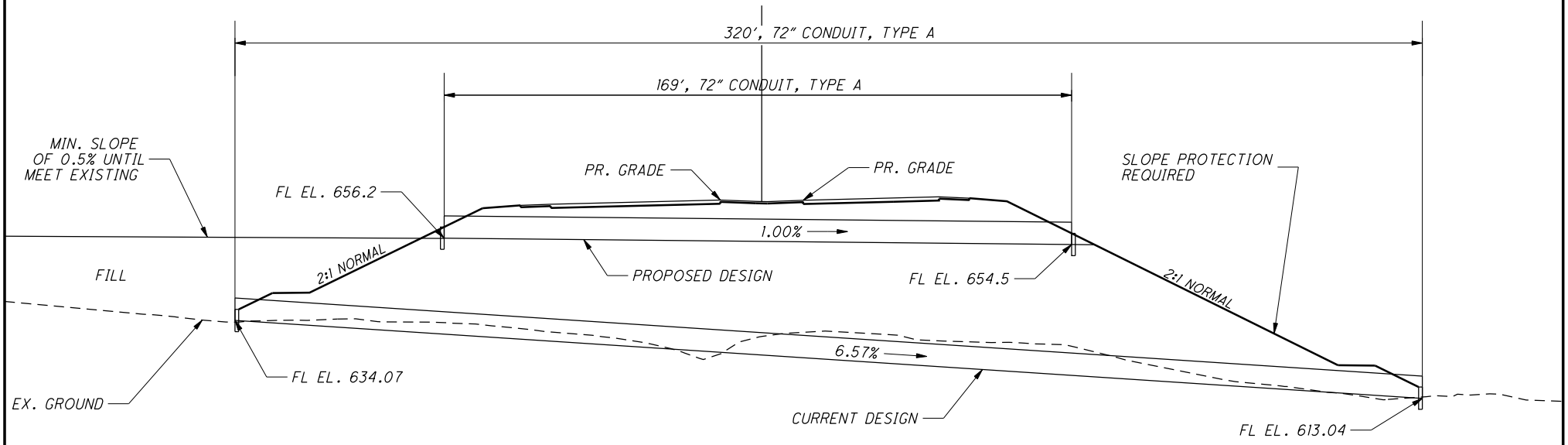
Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY	Station	Cut End Area (SF)	Fill End Area (SF)	Cut Vol. CY	Fill Vol. CY
			3,940,000	2,874,000				3,950,000	2,880,000				3,107,000	4,048,000
			Waste	1,657,000				Waste	1,663,000				Waste	(475,000)
		Excavation		$ 13,200,000					$ 13,240,000					$ 10,410,000
		Embankment		$ 2,130,000					$ 2,140,000					$ 3,000,000
		Waste		$ 1,830,000					$ 1,830,000					$ (530,000)
				$ 17,160,000					$ 17,210,000					$ 12,880,000
													Cost Savings	**$ (4,300,000)**
			TR234 Ramps											
			280,000	315,000				280,000	315,000				254,000	459,000
			Waste	7,000				Waste	7,000				Waste	(167,000)
			CR28 Ramps											
			1,121,000	37,000				1,121,000	37,000				903,000	52,000
			Waste	1,253,000				Waste	1,253,000				Waste	987,000

	Cut Volume	Fill Volume	Cut Volume	Fill Volume	Cut Volume	Fill Volume
Total	5,341,000	3,226,000	5,351,000	3,232,000	4,264,000	4,559,000
	Waste	2,917,000	Waste	2,922,000	Waste	345,000
Excavation		$ 17,900,000		$ 17,930,000		$ 14,290,000
Embankment		$ 2,390,000		$ 2,400,000		$ 3,380,000
Waste		$ 3,210,000		$ 3,220,000		$ 380,000
		$ 23,500,000		$ 23,550,000		$ 18,050,000
					Cost Savings	**$ (5,500,000)**

Appendix B – Alternative No. 5 Supporting Material

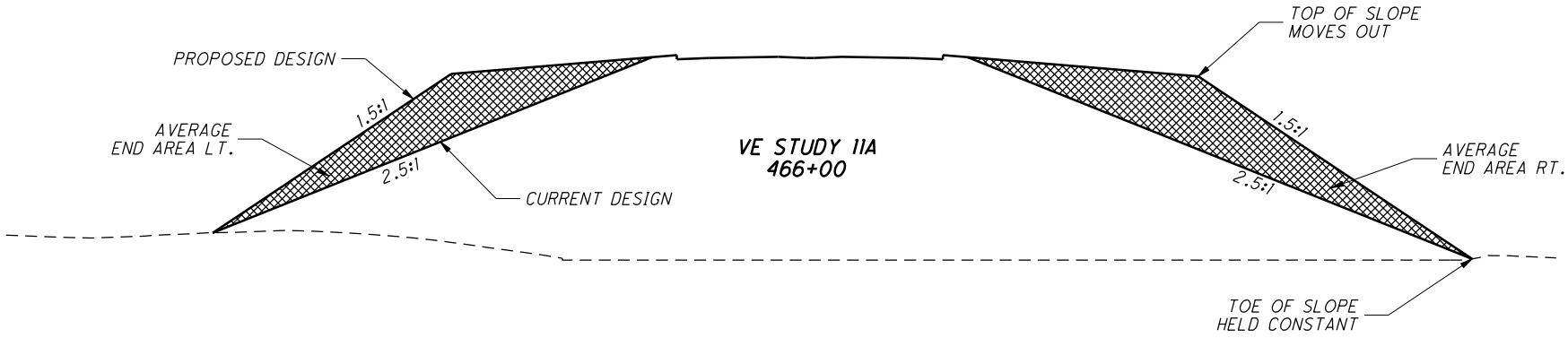

VE STUDY 5 - PLAN VIEW
EL. = 658
FILL CHANNEL
MIN. SLOPE
OF 0.5% UNTIL
MEET EXISTING
MIN. SLOPE
OF 0.5%
DITCH HIGH POINT
STA. = 363+00
EL. = 659.9
FL OF PIPE
STA. = 369+00
EL. = 666.3
MIN. SLOPE
OF 0.5%
MIN. COVER CONTROLS
FL = 656.2
320'
169'

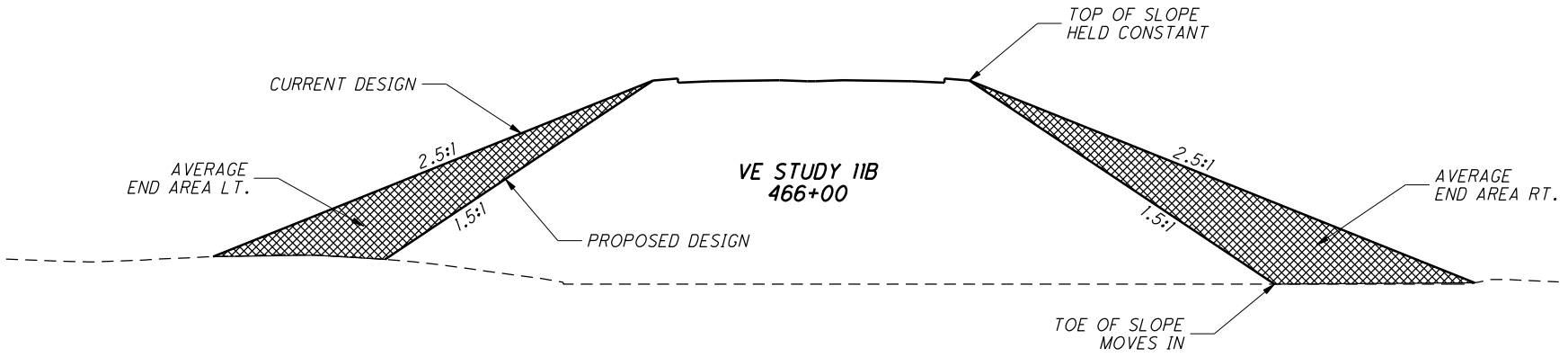
VE STUDY 5 - PROFILE VIEW



Appendix C – Alternative No. 11A/11B Supporting Material

VE STUDY 11A/11B - SCHEMATIC





VE STUDY 11A - AVERAGE END AREA METHOD AT CULVERTS

Station	End Area Left	Volume Left	End Area Right	Volume Right
Culvert at 353+88				
35300	0		0	
35350	14	13	100	93
35400	64	72	394	458
35450	15	73	99	456
35500	0	14	0	91
Subtotal		173		1098
Total			1,280	

Culvert at 364+36				
36300	0		0	
36350	30	28	532	492
36400	64	88	623	1070
36450	160	208	359	910
36500	161	297	274	586
36550	0	149	0	254
Subtotal		770		3312
Total			4,090	

Culvert at 375+08 (Ramp B)				
37250	0		0	
37300	0	0	465	430
37350	0	0	563	951
37400	0	0	753	1219
37450	0	0	655	1304
37500	0	0	801	1348
37550	0	0	0	742
Subtotal		0		5994
Total			6,000	

Culvert at 375+08 (Ramp C)				
37500	0		0	
37550	63	58	0	0
37600	72	125	0	0
37650	121	178	0	0
37700	254	347	0	0
37750	231	449	0	0
37800	406	590	0	0
37850	0	376	0	0
Subtotal		2122		0
Total			2,130	

Culvert at 404+06				
40250	0		0	
40300	607	562	0	0
40350	451	980	1600	1482
40400	444	829	910	2325
40450	805	1156	1028	1795
40500	0	746	966	1846
40550	0	0	1574	2351
40600	0	0	0	1457
Subtotal		4273		11256
Total			15,530	

Station	End Area Left	Volume Left	End Area Right	Volume Right
Culvert at 412+07				
40950	0		0	
41000	0	0	1238	1147
41050	0	0	687	1783
41100	0	0	861	1433
41150	405	375	697	1442
41200	309	661	674	1269
41250	311	575	1649	2150
41300	249	519	0	1526
41350	163	382	0	0
41400	0	151	0	0
Subtotal		2663		10750
Total			13,420	

Culvert at 466+45				
46200	0		0	
46250	0	0	2588	2396
46300	0	0	2138	4376
46350	0	0	2083	3908
46400	0	0	2116	3888
46450	0	0	2223	4017
46500	0	0	2212	4106
46550	994	920	2183	4069
46600	1695	2490	2237	4093
46650	1931	3357	2280	4183
46700	1964	3606	2392	4326
46750	1640	3337	0	2214
46800	979	2425	0	0
46850	0	906	0	0
Subtotal		17041		41575
Total			58,620	

Culvert at 473+92				
47100	0		0	
47150	0	0	2042	1890
47200	0	0	2606	4303
47250	0	0	2475	4704
47300	0	0	1821	3978
47350	761	705	1618	3185
47400	1188	1805	1381	2777
47450	1091	2111	1168	2360
47500	896	1840	0	1081
47550	419	1218	0	0
47600	258	627	0	0
47650	0	239	0	0
Subtotal		8544		24279
Total			32,830	

Culvert at 504+60				
50350	0		0	
50400	0	0	141	131
50450	90	83	319	427
50500	172	243	229	508
50550	134	283	274	465
50600	0	124	0	253
Subtotal		732		1784
Total			2,520	

VE STUDY 11A - AVERAGE END AREA METHOD AT SAFETY GRADING LOCATIONS

Left Side				
Street Name	Begin Station	End Station	Average End Area	Volume CY
TR234 Ramp C	37400	37500	89	330
TR234 Ramp C	37850	37950	153	570
TR234 Ramp D	39750	40210	86	1470
SR823	40200	40250	437	810
SR823	40500	41100	224	4980
SR823	43550	44000	842	14040
SR823	44550	44700	161	900
SR823	46250	46500	240	2230
SR823	46850	47300	675	11250
SR823	47650	47800	121	680
SR823	48850	49650	686	20330
SR823	50600	50700	54	200
SR823	53200	53400	148	1100
			Subtotal	58,890

Right Side				
Street Name	Begin Station	End Station	Average End Area	Volume CY
SR823	36250	36300	228	430
SR823	36550	37100	47	960
TR234 Ramp B	37100	37250	149	830
TR234 Ramp B	37550	38350	65	1930
TR234 Ramp A	38850	40035	214	9400
SR823	38600	38950	315	4090
SR823	40050	40300	585	5420
SR823	40600	40950	3003	38930
SR823	41300	41550	2247	20810
SR823	43900	44050	171	950
SR823	44600	44850	122	1130
SR823	46750	47100	4651	60300
SR823	47500	47950	1700	28340
SR823	49050	49700	820	19750
SR823	50600	50700	154	580
SR823	53100	53400	191	2130
CR28 Ramp A	53000	53300	47	530
CR28 Ramp A	53450	53600	11	70
			Subtotal	196,580

Total= 255,470 CY of additional fill and reduced waste

Denotes where safety grading was changed to barrier grading (guardrail locations) to waste additional material

VE STUDY 11B - AVERAGE END AREA METHOD AT CULVERTS

Station	End Area Left	Volume Left	End Area Right	Volume Right
Culvert at 353+88				
35300	0		0	
35350	15	14	101	93
35400	64	73	385	450
35450	8	66	101	450
35500	0	7	0	93
Subtotal		161		1086
Total			1,250	

Culvert at 364+36				
36300	0		0	
36350	40	37	607	562
36400	74	105	664	1176
36450	174	229	342	931
36500	128	280	300	595
36550	0	119	0	278
Subtotal		770		3542
Total			4,320	

Culvert at 375+08 (Ramp B)				
37250	0		0	
37300	0	0	520	481
37350	0	0	536	978
37400	0	0	752	1193
37450	0	0	690	1335
37500	0	0	932	1501
37550	0	0	0	863
Subtotal		0		6351
Total			6,360	

Culvert at 375+08 (Ramp C)				
37500	0		0	
37550	82	75	0	0
37600	82	152	0	0
37650	140	205	0	0
37700	269	379	0	0
37750	248	479	0	0
37800	384	585	0	0
37850	0	355	0	0
Subtotal		2230		0
Total			2,240	

Culvert at 404+06				
40250	0		0	
40300	707	655	0	0
40350	477	1096	1549	1434
40400	475	881	942	2307
40450	922	1293	1010	1808
40500	0	854	999	1860
40550	0	0	1842	2630
40600	0	0	0	1706
Subtotal		4779		11744
Total			16,530	

Station	End Area Left	Volume Left	End Area Right	Volume Right
Culvert at 412+07				
40950	0		0	
41000	0	0	1301	1205
41050	0	0	743	1892
41100	0	0	804	1432
41150	500	463	701	1394
41200	342	779	677	1276
41250	329	620	1690	2191
41300	218	506	0	1565
41350	188	376	0	0
41400	0	174	0	0
Subtotal		2917		10955
Total			13,880	

Culvert at 466+45				
46200	0		0	
46250	0	0	2242	2076
46300	0	0	2294	4200
46350	0	0	2428	4371
46400	0	0	2416	4485
46450	0	0	2517	4568
46500	0	0	2443	4592
46550	1205	1116	2444	4525
46600	1870	2848	2500	4578
46650	2185	3755	2476	4607
46700	2422	4266	2610	4709
46750	1818	3926	0	2417
46800	1246	2837	0	0
46850	0	1154	0	0
Subtotal		19901		45129
Total			65,030	

Culvert at 473+92				
47100	0		0	
47150	0	0	2250	2084
47200	0	0	2709	4592
47250	0	0	2761	5065
47300	0	0	2049	4453
47350	992	919	1751	3518
47400	1440	2252	1451	2964
47450	1239	2480	1220	2473
47500	833	1919	0	1130
47550	467	1204	0	0
47600	301	710	0	0
47650	0	278	0	0
Subtotal		9762		26279
Total			36,050	

Culvert at 504+60				
50350	0		0	
50400	0	0	133	124
50450	99	91	335	433
50500	178	256	253	544
50550	151	304	327	537
50600	0	140	0	303
Subtotal		792		1941
Total			2,740	

Appendix D – Alternative No. 45/52 Supporting Material

VE Study 45/52 - Pavement Reduction By Using Crushed Rock SubBase

Structural Coeffients from Fig. 401-1 in the Pavement Design Manual

Item	Description	Coefficient	
Item 880	Warranty Pavement, Top 3"	0.43	
Item 880	Warranty Pavement,Below Top 3"	0.36	
Item 304	Aggregate Base	0.14	
	Crushed Rock (Granular Material, Type C)	0.11	use 0.11 as granular subbase (per AASHTO)

Current Design As Per Stage 1 Plans

Item	Description	Coefficient	Thickness	SN
Item 880	Warranty Pavement, Top 3"	0.43	3	1.29
Item 880	Warranty Pavement,Below Top 3"	0.36	8	2.88
Item 304	Aggregate Base	0.14	6	0.84
			SN =	5.01

Minimum Pavement Section Desired

Item	Description	Coefficient	Thickness	SN
Item 880	Warranty Pavement, Top 3"	0.43	3	1.29
Item 880	Warranty Pavement,Below Top 3"	0.36	5	1.8
Item 304	Aggregate Base	0.14	6	0.84
			SN =	3.93

Required SN for the Crushed Rock subbase

5.01
-3.93
1.08

Required Thickness of Crushed Rock

1.08 Divided By 0.11 = 9.82 inches

Use 12 inches of Granular Material, Type C
(set 12 inches as the minimum value)

Savings **3** inches of Asphalt

Cost **12** inches of Granular Material, Type C

VE Study 45/52 – Typical Section Descriptions

Fill Sections with Pavement

SR823
Asphalt: 3" Savings
Waste: 3" Savings
Type C : 12" Cost
Fill: 9" Savings

Ramps
Asphalt: 1" Savings
Waste: 1" Savings
Type C : 12" Cost
Fill: 11" Savings

Fill Sections without Pavement

SR823
Fill: 9" Savings
Waste: 9" Cost

Ramps
Fill: 11" Savings
Waste: 11" Cost

Cut Sections with Pavement

SR823
Asphalt: 3" Savings
Waste: 3" Savings
Type C : 12" Cost
Cut: 9" Cost

Ramps
Asphalt: 1" Savings
Waste: 1" Savings
Type C : 12" Cost
Cut: 11" Cost

Cut Sections without Pavement

SR823
Cut: 9" Cost
Waste: 9" Cost

Ramps
Cut: 11" Cost
Waste: 11" Cost

Rock Cut Sections with Pavement

SR823
Asphalt: 3" Savings
Waste: 3" Savings
Cut, APP: 3" Savings
Type C : 12" Cost
Fill, APP: 12" Savings

Ramps
Asphalt: 1" Savings
Waste: 1" Savings
Cut, APP: 1" Savings
Type C : 12" Cost
Fill, APP: 13" Savings

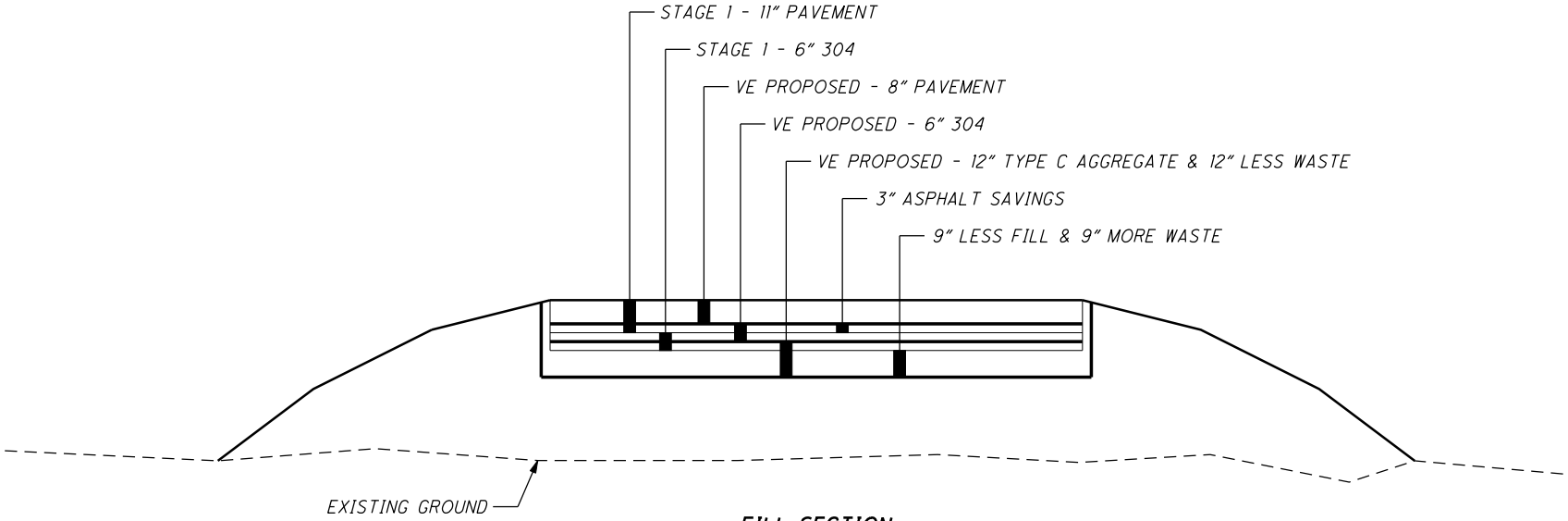
Rock Cut Sections without Pavement

SR823
Cut, APP: 3" Savings
Fill, APP: 3" Savings

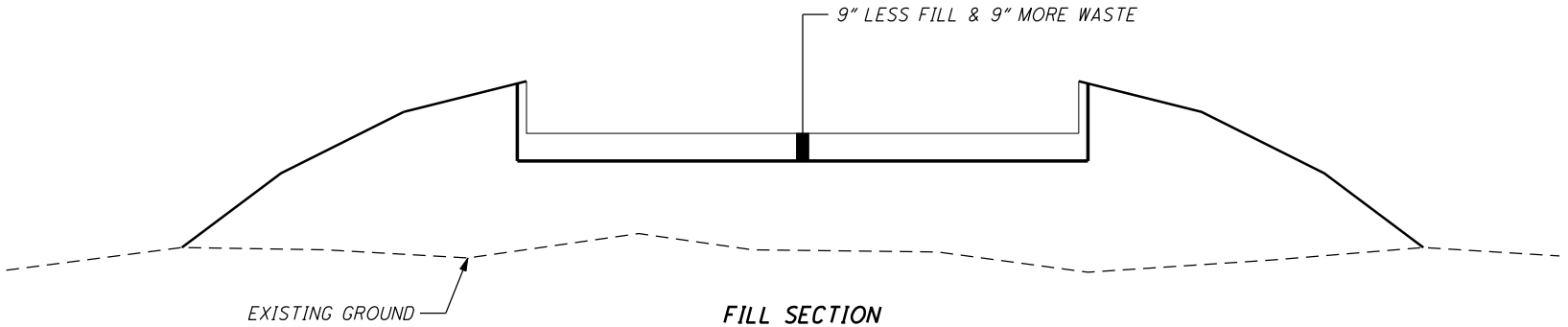
Ramps
Cut, APP: 1" Savings
Fill, APP: 1" Savings

VE STUDY 45/52 - FILL TYPICAL SECTIONS
(REPRESENTS PAVEMENT SECTION ONLY)

STAGE 1 LAYER
VE PROPOSED LAYER



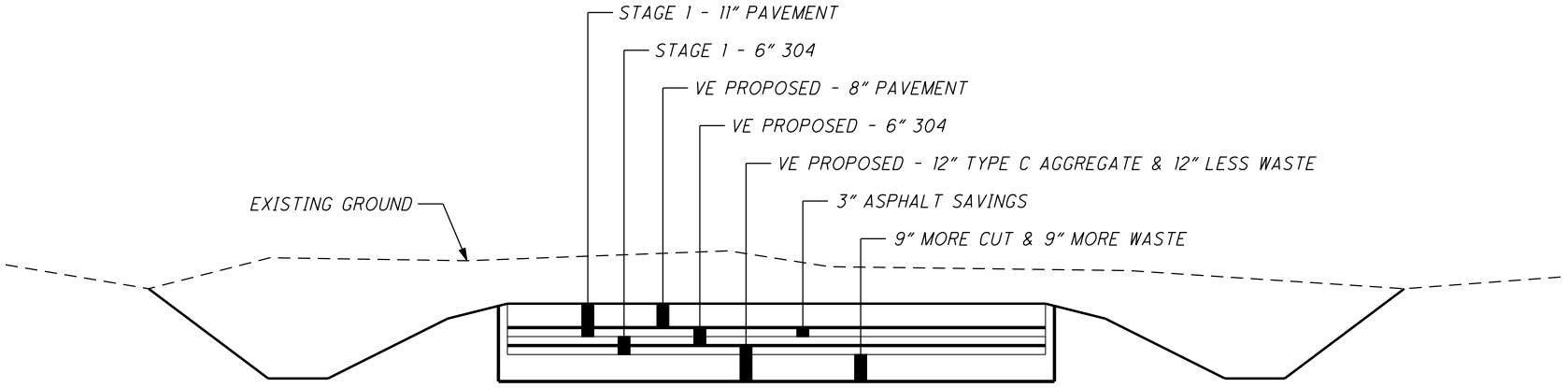
FILL SECTION WITH PAVEMENT



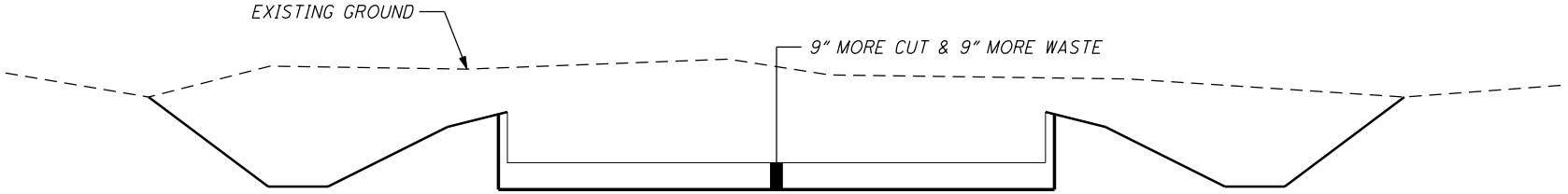
FILL SECTION WITHOUT PAVEMENT

VE STUDY 45/52 - CUT TYPICAL SECTIONS
(REPRESENTS PAVEMENT SECTION ONLY)

STAGE 1 LAYER
VE PROPOSED LAYER



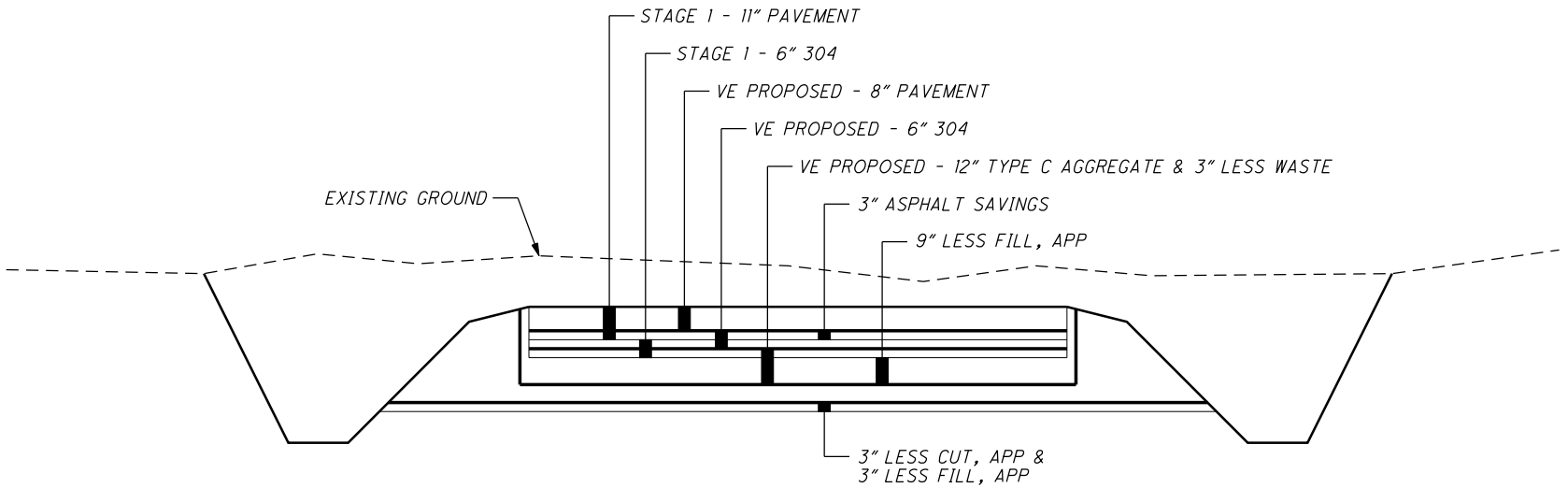
CUT SECTION
WITH PAVEMENT



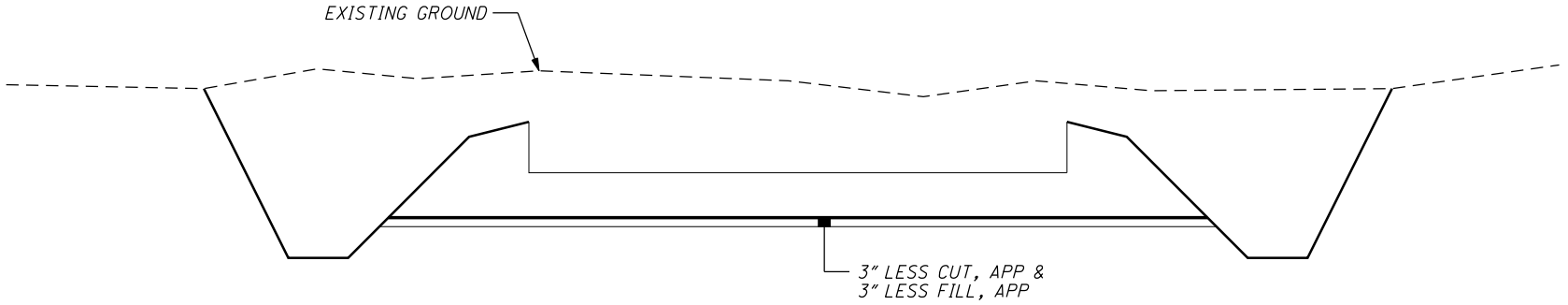
CUT SECTION
WITHOUT PAVEMENT

VE STUDY 45/52 - ROCK CUT TYPICAL SECTIONS
(REPRESENTS PAVEMENT SECTION ONLY)

STAGE 1 LAYER
VE PROPOSED LAYER



ROCK CUT SECTION WITH PAVEMENT



ROCK CUT SECTION WITHOUT PAVEMENT