Retaining Wall Preliminary Design Report

MSE Walls

SCI-823-10.13
PID No. 79977

Prepared for

Ohio Department of Transportation

November 2007

CH2MHILL

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1. Introduction

A total of six retaining walls are currently scoped to be included as part of the U.S. 23/S.R. 823 Interchange for the SCI-823-10.13, Portsmouth Bypass project. Based on direction received from the Department, following its review of the Retaining Wall Type Study on April 23, 2007, these walls will be constructed as MSE (Mechanically Stabilized Earth) retaining walls. In the accompanying Stage I Design plans, these MSE walls have been numbered consecutively and designated as MSE Wall Nos. 1 through 6. Listed below are the sections included in this Preliminary Design narrative.

Section 1	Introduction
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The MSE wall designations proposed to be used in the final construction plans correspond to the following wall designations and locations:

MSE Wall Plan Designation	Wall Location
No. 1	S.R. 823/Fairground Road
No. 2	S.R. 823/Fairground Road
No. 3	S.R. 823/U.S. 23 & Norfolk Southern Tracks
No. 4	Ramp B/Norfolk Southern Tracks
No. 5	Ramp C/Norfolk Southern Tracks
No. 6	S.R. 823/U.S. 23 & Norfolk Southern Tracks

2. Individual MSE Wall Descriptions

MSE Wall No. 1 will be constructed along the east side of Fairground Road to support the S.R. 823, Ramp B, and Ramp C embankment, and the bridge abutments of SCI-823-1593, SCI-823-1594, and SCI-823-1595. The abutment wall will be located outside the northbound Fairground Road clear zone.

MSE Wall No. 2 will be constructed along the west side of Fairground Road to support the S.R. 823, Ramp B, and Ramp C embankment, and the bridge abutments of SCI-823-1593, SCI-823-1594, and SCI-823-1595. The abutment wall will be located outside the southbound Fairground Road clear zone.

MSE Wall No. 3 will be constructed west of U.S. 23 to support the S.R. 823 embankment, and the forward bridge abutment of SCI-823-1601. The abutment wall will be located outside of the southbound U.S. 23 clear zone. In order to construct this proposed MSE wall, the use of preloading to surcharge the foundation soils prior to construction of the permanent MSE wall is required to maintain the minimum factor of safety against undrained bearing capacity and sliding. Analyses indicate that an embankment using 1H:1V side slopes would sufficiently surcharge the existing foundation soils. A reinforced

soil slope, using a geogrid or geotextile fabric, is required for the stability of the recommended 1H:1V side slopes.

MSE Wall No. 4 will be constructed along both sides of Ramp B to support the ramp embankment and the rear bridge abutment of SCI-823-1598. The abutment wall will be located outside of the Norfolk Southern tracks clear zone.

MSE Wall No. 5 will be constructed along both sides of Ramp C to support the ramp embankment and the forward bridge abutment of SCI-823-1603. The abutment wall will be located outside of the Norfolk Southern tracks clear zone.

MSE Wall No. 6 will be constructed east of the Norfolk Southern Tracks to support the S.R. 823 embankment and the rear bridge abutment of SCI-823-1601. The abutment wall will be located outside of the Norfolk Southern tracks clear zone. This wall will be designed for future drainage conditions between the rear abutment and the railroad due to the future addition of a Norfolk Southern track.

3. MSE Wall Design

Preliminary designs for a total of six MSE walls are included in this Retaining Wall Preliminary Design Report submission. The walls are numbered consecutively as MSE Wall Nos. 1 through 6, as described in Section 2. The design approach, design criteria, design parameters and dimensions, and other relevant aspects of the design, construction, and testing of the MSE walls are discussed in DLZ's final report for Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23/SR 823 Interchange. The MSE wall drawings included with this report are currently based upon the DLZ soils report. Geotechnical engineers at CH2M HILL performed a brief review of the MSE wall recommendations contained in the final subsurface exploration report prepared by DLZ, and provided written comments in a technical memorandum. A copy of DLZ's foundation report and CH2M HILL's review comments are included with this submission in Appendix A.

4. Cost Estimate

An updated wall cost estimate reflecting the proposed MSE walls at the US 23/SR 823 Interchange is included in Appendix B. The estimate and all unit prices used are based upon 2006 costs.

5. Miscellaneous Items

<u>Temporary Shoring</u>

A Preliminary Design submission providing details for all proposed consultant designed temporary shoring on the SCI-823-10.13 project will be included as part of the Stage 2 submission.

<u>Track Settlement</u>

MSE wall construction near the Norfolk Southern tracks will theoretically cause the railroad tracks to settle. A graph of track settlement vs. distance of the wall from the track was prepared by DLZ, assuming ground improvements were not utilized in the construction of the MSE walls. Calculations show that a MSE wall would have to be at least 40 feet from the tracks to have 0.25" or less settlement. These calculations were presented to representatives of Norfolk Southern during a May 2, 2007 meeting at Central Office. Norfolk Southern representatives accepted this theoretical 0.25" settlement of the existing track and 0.75" settlement of the future track, assuming a MSE wall is constructed at the minimum 25′ clear zone distance.

Aesthetics

Aesthetic treatments for these MSE walls and site could include concrete staining or coatings, formliners, railing on MSE walls, etc. At this time, it is ODOT's intent not to provide aesthetic treatments for these MSE walls or site.

6. Retaining Wall Type Study Comment Resolution

The ODOT Structure Type Study review comment number 2 for both Ramp Bridges SCI-823-1598 and SCI-823-1603, dated July 9, 2007 and July 18, 2007, respectively, states to investigate if a 2:1 slope can be utilized between the ramp and the railroad in lieu of extending the MSE wall. At each location, the proposed ditch between the ramp and the railroad determines the MSE wall limits. We are unable to utilize a 2:1 slope at these locations while maintaining the proposed drainage patterns, without incorporating MSE walls. See Stage I Design plans for further details.

For ODOT review comments of the original Fairground Road Retaining Wall Type Study and MSE Wall Embankment Evaluation Report with consultant responses, see Appendix D. For verification of all comment resolutions, see Appendix A.

APPENDIX A

Review Comments to DLZ's Geotechnical Report MSE Walls 1 and 2 - US 23/SR 823 Interchange Portsmouth, Ohio

PREPARED FOR:	Rob Miller/CH2M HILL /COL
	Steve Jirschele/COL
	Shawn Thompson/COL
PREPARED BY:	Christopher Dumas/WDC
DATE:	November 2, 2007
Copy:	Emad Farouz/WDC
PROJECT NUMBER:	SCI-823-10.13

I have reviewed the subject document and provide the following comments.

1. MSE Wall 2: The DLZ design computations in Appendix IV, page 1 of 21, show a geotechnical design profile as follows:
   a. Ground surface of the boring (elevation 566-ft) to elevation 548-ft (18-ft below ground surface) is a silty clayey material with an undrained shear strength of C = 1,500 psf.
   b. From elevation 548-ft down to elevation 544-ft (22-ft below ground surface) is a sandy material.
   c. Top of Rock is encountered at elevation 544 (22-ft below the ground surface).
   d. Water Table is encountered at elevation 550-ft = 16-ft below ground surface.

   However, all the MSE Wall 2 borings show a predominately loose sand (79% sand and gravel) with an estimated friction angle of approximately 28-degree (based on N value corrected for overburden) at a depth of approximately 8-ft (elevation 558-ft). This layer extends down an additional 7-ft to elevation 551-ft. The "sand and gravel" layer encountered is a very loose to loose sandy gravel, also with an estimated friction angle of approximately 28-degress. This layer extends to the top of rock (elevation 544-ft).

   I would recommend re-evaluation of the borings for MSE Wall 2, and performing slope stability analysis using the profile depicted below in Figure 1. In particular, I recommend replacing the friction angle of the gravel sand at the rock interface with a more appropriate value of 28-degrees.

2. Bearing Capacity and Staged Construction for MSE Wall 2: The three phase staged construction concept proposed to accommodate the very low bearing capacity Factor of Safety has several risks:
   a. It is time consuming, complex, and has considerable uncertainty for the contractor. The constructor will need to install instrumentation and avoid damaging the instrumentation while placing the stages. If he damages them during placement, he will have to reinstall them during which time there will be a gap in critical data. In addition, the contractor will not have a defined wait time.
   b. It will require piezometers, settlement platforms, and slope inclinometers to be installed, maintained, read daily (or more) and interpreted. This will require a highly qualified Geotechnical Instrumentation engineer to be on site at all times and be in daily communication with the design engineer.
   c. If the wall moves, the contractor will have to unload the wall. Not only will this create a delay and potential claim, but it will also be difficult to rapidly unload the wall. It is possible the wall could move completely out of tolerances before movement is stopped, and total reconstruction could be needed. Additionally, if the wall moves, it will be risky to try to unload the wall since the last thing we want to do is a) place additional equipment load and b) place workers in a situation that could jeopardize their safety.
   d. Additionally, it was mentioned that ODOT had some challenging experience with wire faced MSE walls. It is our opinion that without the use of wire face MSE wall, the construction of the wall will be very challenging, if not infeasible.

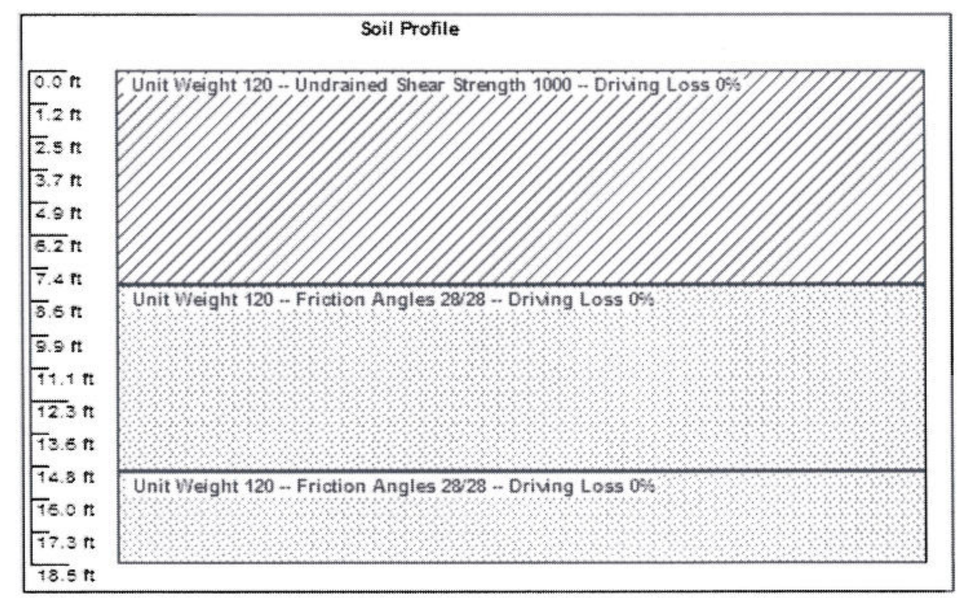


Figure 1 - Soil Profile for MSE Wall 2

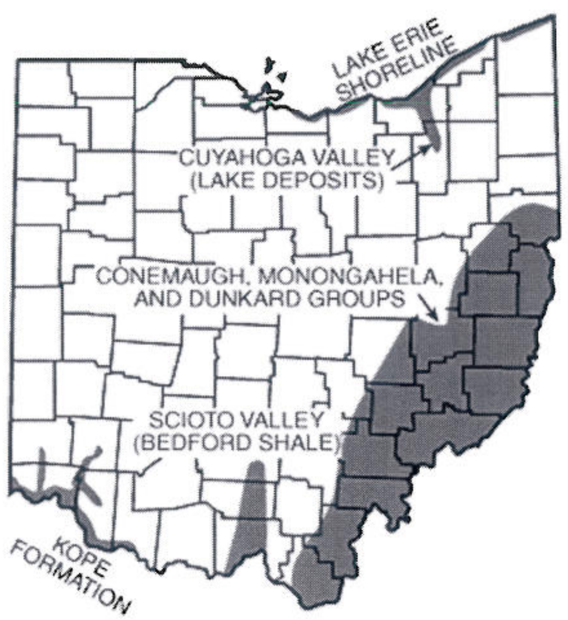
With these considerations in mind, I recommend that the MSE Wall 2 location be over-excavated an additional 2.5-ft from what has been proposed, and backfilled with MSE backfill grade material. The proposed scheme has the bottom of the leveling pad at elevation 560.5 (5.5-ft below grade). Granular soil is at approximately elevation 558-ft or an additional 2.5-ft. See comment 1. In addition, the water table is well below this excavation. Advantages include:

a. Simple and rapid.

b. The backfilled over-excavation will eliminate any bearing capacity problems, improve global stability, and may allow a reduction in the strap length. However, it may require short shoring.

3. Slope Stability: This is a major concern, specifically, a weathered shale layer a few inches thick above competent and hard shale. This is a notoriously common condition in Ohio that results in many landslides annually.

The borings, such as B-47, described severely weathered light gray shale above the competent rock. The weathered seam that causes these frequent failures is typically only a few inches thick, and as such, will not be identified by SPT borings. Typically, these materials have low effective friction angles which could be as low as 12-degrees.



[1]Figure 1 – Areas of Ohio Subject to Severe Slope Failures. *"In the lower part of the Scioto River valley, thick colluvium developed on shales of Mississippian age, particularly the Bedford Shale, is prone to failure."*

This situation applies to both MSE Walls 1 and 2, with it possibly being more acute for MSE Wall 1 where the depth to rock is only 13-ft. The consequences of this occurring on these walls during construction or after the bridge is completed and in use could include:

a. Construction delays while a new design is developed and constructed. The repair cost will likely be nearly double the cost of performing ground improvement or other alternative construction methods (see Conclusion and Recommendations).

b. Delay of improved traffic function.

[1] GeoFacts No. 8, Ohio Geological Survey, September 2003.

c. Road closure and detouring of traffic for 1-12 months, depending on the level of damage.

d. Slip surface will damage or fail the bridge abutment foundations. This could possibly lead to the girders and deck also being damaged or a span falling off the abutment bearings. Repair will require underpinning the bridge, removing the abutment foundation, abutment, MSE wall, and approach embankment, followed by installation of ground improvement, or other alternative methods, and complete reconstruction of the abutment foundations, wall, and approach embankment. If the superstructure is damaged, then the girders and deck may also need to be replaced.

e. The slip and movement could be relatively rapid and cause injury to a motorists or construction workers.

Conclusion and Recommendations

1. The use of over-excavation to improve bearing capacity is preferable to multi-phased staged construction. See comment 2.

2. The consequence of a slip failure of these walls makes avoidance of this risk an overriding priority. It is recommended that alternative construction methods be evaluated. They would include:

i. Ground Improvement such as Controlled Modulus Columns and Vibro-Concrete Columns.

ii. Pile supported embankment. The shallow depth to rock makes this option economical. An example could be HP 12x53 driven to rock on ten foot centers with a small cap placed on top. Approximately three layers of geogrid on 1-2 foot lifts are placed on top. Details of this can be obtained from the FHWA, Virginia Dot, Geogrid Manufacturers, and the British Standards Institute. Several have been constructed in highway applications over the last several years. Details can be provided upon request.

iii. MSE wall supported on two geogrid layers with stone in between and bearing on timber piles driven to rock. Piles are driven on approximately 5 to 10-ft on centers and approximately 2-ft thick stone sandwiched between two layers of geogrid. The wall is then constructed on this stable platform. This has been done successfully on the VA-288 project.

iv. MSE wall built on top of a pile supported raft foundation. Piles are driven on approximately 15-ft centers and an approximately 1-ft thick reinforced slab is poured on top. The wall is then constructed on this stable platform. This has been done successfully in Virginia on the $750-million Springfield Interchange. Key advantages include:

a. Much more economical than extending the bridge. No superstructure girders are required.

b. More economical than CIP walls. The lateral load is taken up by the MSE wall. There is no need to cast a large and expensive CIP vertical face with architectural form liners.

c. Eliminates the need for costly and time consuming geotechnical investigation, lab testing, interpretation, and design.

d. Eliminates the need for Geotechnical Instrumentation.

e. Eliminates the need for full time Geotechnical expertise being present at the site full time.

f. Simple to construct. No new specialized knowledge required in design or construction.

g. Eliminates risk and uncertainty in the short term and long term.

3. It would be advantageous at this stage of project development to complete a geologic report for the site which includes historical landslide information for the project geologic area.

4. Cone Penetrometer Testing (CPT) and soil sampling of the soils at the rock interface should be performed before additional time and effort is expended on the current approaches to MSE Walls 1 & 2. Without certainty regarding the presence of the very soft weathered shale soil interface, significant time and resources could be expended on a scheme that will later be shown to be non applicable. It could be more productive to pursue the alternatives listed above until such data becomes available.

5. <u>Muti-phased staged construction</u>. If this is selected as the preferred alternative, it is essential that:

   a. The preliminary and final design phases establish a detailed Geotechnical Instrumentation plan:

   - Instrumentation types, locations, and frequency of readings. At minimum, the site will likely require:
     - o Several piezometers and settlement platforms for each wall and high fill areas. Redundancy will need to be built into the plan to accommodate instrumentation malfunction/failure/damage.
     - o One to two slope inclinometers (SI) for each wall face. The walls are very tall and long. A single SI will not provide adequate coverage of the long and critical abutment MSE Walls 1 & 2.
     - o Settlement Platforms.
     - o Recommend instrumentation references:
       - ➢ FHWA-NHI-00-043, Mechanically Stabilized Earth Walls and Reinforced Soil Slopes
       - ➢ FHWA-NHI-132034, Ground Improvement Manual
       - ➢ FHWA-HI-98-034, Geotechnical Instrumentation
       - ➢ AASHTO Subsurface Investigation Manual

   - Construction Specifications. These should address issues such as: installation, equipment and methods, qualifications for personnel installing and monitoring the instrumentation, and contractor damaging and replacing instrumentations including liquidated damages.

   b. A highly qualified Geotechnical Instrumentation engineer to oversee instrumentation installation, monitor instruments in the field, reduce data, produce data reports, and communicate (verbal or electronic) with the design and construction engineer on a nearly daily basis.

SUPPLEMENTAL: Review Comments to DLZ's Geotechnical Report
MSE Walls 1 & 2 – US 23/SR 823 Interchange
Portsmouth, Ohio

PREPARED FOR: Rob Miller/CH2M HILL /COL
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Shawn Thompson/COL

PREPARED BY: Christopher Dumas/WDC

DATE: November 5, 2007

Copy: Emad Farouz/WDC

PROJECT NUMBER: SCI-823-10.13

1. Wall 1 & 2: Sheet 12 of 30 of the Retaining Wall Plans dated 8-07 shows cross sections of the abutments. These indicate approximately 10-ft of fill from the bottom of the abutment pile cap to the bottom of the approach slab. Assuming the construction sequence is to build the MSE wall, drive piles through hollow cans, fill the cans with sand, construct the abutment, and then place the ten feet of fill to bottom of the approach slab, and no surcharge load is to be placed, then evaluations of the following should be considered:

    a. How much primary and long term secondary settlement will occur after the piles are driven? This settlement will occur in the soils below the MSE fill and cans. Therefore, downdrag will need to be considered in the portion of the piles below the cans.
    b. If straps are to be placed on the abutment backwall for lateral restraint of the backfill soils, primary and long term secondary settlement could pull the straps downward and cause possible rotation of the backwall, structural distress, and/or break the strap connections.
    c. Impact of primary and long term secondary settlement on the approach slab.

BRIDGE PLANS (June 2007)

2. Rear Abutment Section - Ramp B (Sheet 3 of 3): See comment 1 above.
3. Forward Abutment Section - Ramp B (Sheet 3 of 3): The approach embankment and end slope are approximately 30-ft in height. Since this height of fill is nearly the same as MSE Wall 2, this approach embankment and end slope will likely be constructed in stages. Assuming the construction sequence is to build the embankment in stages, drive piles through hollow cans, fill the cans with sand, construct the abutment, and then place the ten feet of fill to bottom of the approach slab, and no surcharge load is to be placed, then evaluation of how much primary and long term secondary settlement will occur after the piles are driven should be considered:
    a. Bending Stresses in the Battered Piling: The plans show a front row of battered piles. The downward movement of the soil will induce bending in the piles. The magnitude of stress and impact on the performance of these piles will need to be considered.
    b. This settlement will occur in the soils below the cans. Therefore, downdrag will need to be considered in the portion of the piles below the cans.
    c. If straps are to be placed on the abutment backwall for lateral restraint of the backfill soils, the primary and long term secondary settlement could pull the straps downward and cause possible rotation of the backwall, structural distress, and/or break the strap connections.
    d. Impact of primary and long term secondary settlement on the approach slab.

4. Ramp C: Please see comments 1-3 above.

Review Comments to DLZ's Geotechnical Report MSE Walls 3 and 6 – US 23/SR 823 Interchange Portsmouth, Ohio

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DATE: November 4, 2007

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PROJECT NUMBER: SCI-823-10.13

Geotechnical engineers at CH2M HILL have completed a brief review of the MSE wall recommendations contained in the report, prepared by DLZ, for this bridge and have the following comments.

Wall 6 (43.3 feet high)

Page 7 of the report, and the calculations for the wall, show the bottom of the leveling pad to be at elevation 541.2 (3-ft of embedment). Bearing Capacity, Sliding, and Global Stability Analysis show the bottom of the leveling pad being in loose, free draining sand (A-2-6). However:

- Borings TR-52 shows the leveling pad to be in stiff siltly clay (A-6a).
- Boring B-1141 shows the leveling pad to be in loose, dense gray sandy silt (A-4a).
- Page seven of the subject report also states that the leveling pad is placed upon these soils.

As a result,

1. I believe that bearing capacity, sliding and global stability analysis should be evaluated using the two soils encountered in the borings and denoted on page 7 of the report.
2. As per FHWA Manual "Mechanically Stabilized Earth Walls and Slopes", global stability analysis should include circular, deep seated, wedge, and block failures. The analysis provided was only for a deep seated circular failure in the A-2-6 material (granular soil). A block-wedge failure would be the appropriate failure mechanism for this soil.
3. Please clarify if buoyant unit weights of soil were used in the global, bearing, and sliding calculations.
4. Please clarify that the high water table was considered/included in the bearing capacity calculations.
5. Page 4 of 23 of the calculations notes the presence of the A-6a and A-4a material, but states to neglect them for settlement computations. Please clarify.
6. The global stability analysis used a c = 2000 psf for material #3 (A-6b/A-4a). Please clarify and amplify which specific borings and lab tests were used to establish this value.
7. Construction of this wall will require an approximate 15-ft cut into material three. The report doesn't address an acceptable short/long term slope angle to lay back this slope for reinforcement installation.
8. FHWA Manual "Mechanically Stabilized Earth Walls and Slopes" recommends on page 38 that for end slopes at bridges, wall embedment should be H/10 or 4-ft in our case.

Wall 3

1. Global Stability, Bearing Capacity, and Sliding calculation used Layer 4 values of c = 900 psf and an effective phi of 28-degrees. Triaxial tests on Sample ST3 from boring B-54 (at Wall 3) showed c = 336 psf. Please clarify the use of c = 900 psf. In addition, using the c = 900 resulted in a factor of safety of 1.3, which is the minimum allowed. Therefore, please clarify the sensitivity of the factor of safety to 10%-20% variations in c for layer 4.
2. Global Stability evaluations should also consider block and wedge failures along the interface between layer 3 (c = 2000) and layer 4 (c = 900), as well as at the interface with the gravel layer #5.
3. The undrained sliding resistance factor of safety was show as 0.89 on page 10 of 23 of the calculations. In hand-written lettering, it says drained sliding FS = 1.68. Please clarify and expand on this calculation.
4. Page 9 of the report states that staged construction of the wall will not work because of bearing capacity weakness (Factor of Safety as low as 0.8 using c = 900 psf). Therefore, they recommend preloading the wall area with a 1:1 steepened reinforced soil slope (RSS). As per FHWA Manual "Mechanically Stabilized Earth Walls and Slopes", Chapter 7, Section 7.2 Reinforced Slope Design Guidelines, further analysis should be performed:
   - Sliding
   - Stability. Per page 228, use both circular-arc and sliding-wedge methods, and consider failure through the toe, through the face (at several elevations), and deep seated below the toe (circular and wedge).
   - Local Bearing Failure (lateral squeeze). See page 239 for computation and note warning of FS less than 2.
5. Based on the low bearing capacity factor of safety (0.8), I do not believe that the reinforced slope can be constructed in a single stage without local bearing failure occurring.
6. In my opinion, the most technically and economically viable way to construct this wall is staged construction using a wire face MSE wall system with a permanent facing applied after completion of settlement. The settlement has been estimated to be in upwards of 9-inches. I believe that the differential settlement between the wall face and back of the reinforced zone (where the vertical overburden stress is greater) will overstress the strap connections and tilt/damage the panels. Please refer to FHWA manual pages 39, 61-62, and 82.

   I have attached a pdf file containing the pertinent FHWA manual pages.
7. I believe the transverse differential settlement issue (between the wall face and the back of the straps) should be evaluated for each of the walls on this project as per the FHWA

manual. Vertical slip joints only accommodate differential movement along the face of the wall caused by changes in the wall height and/or settlement of foundation soils.

8. Settlement issues contained in my supplemental technical memorandum for Ramps B and C, dated November 5th, 2007, should be resolved with the items within this technical memorandum before proceeding further with the current MSE wall schemes.

Review Comments to DLZ's Geotechnical Report MSE Walls 4 and 5 - US 23/SR 823 Interchange Portsmouth, Ohio

PREPARED FOR: Rob Miller/CH2M HILL /COL
Steve Jirschele/COL
Shawn Thompson/COL

PREPARED BY: Christopher Dumas/WDC

DATE: November 2, 2007

Copy: Emad Farouz/WDC

PROJECT NUMBER: SCI-823-10.13

Geotechnical engineers at CH2M HILL have completed a brief review of the MSE wall recommendations contained in the report, prepared by DLZ, for this bridge and have the following comments.

1. Bearing Capacity and Staged Construction. The *four* phase staged construction concept proposed to accommodate the very low bearing capacity Factor of Safety has several risks:

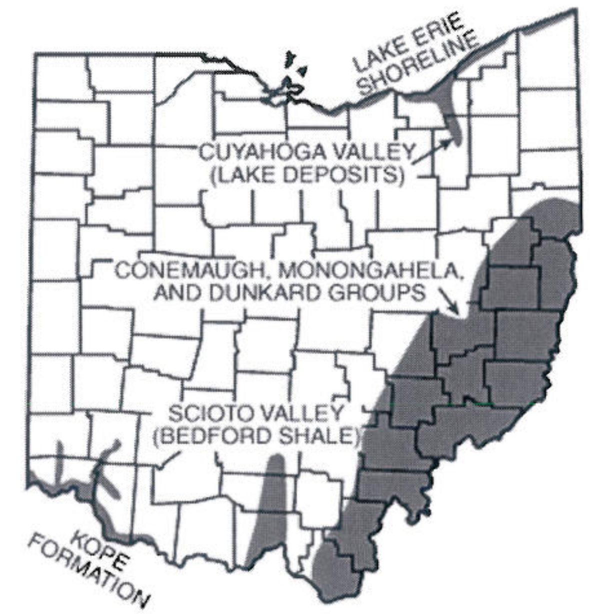
    a. It is time consuming, complex, and has considerable uncertainty for the contractor. The constructor will need to install instrumentation and avoid damaging the instrumentation while placing the stages. If he damages them during placement, he will have to reinstall them during which time there will be a gap in critical data. In addition, the contractor will not have a defined wait time.

    b. It will require piezometers, settlement platforms, and slope inclinometers to be installed, maintained, read daily (or more) and interpreted. This will require a highly qualified Geotechnical Instrumentation engineer to be on site at all times and be in daily communication with the design engineer.

    c. If the wall moves, the contractor will have to unload the wall. Not only will this create a delay and potential claim, but it will also be difficult to rapidly unload the wall. It is possible the wall could move completely out of tolerances before movement is stopped, and total reconstruction could be needed. Additionally, if the wall moves, it will be risky to try to unload the wall since the last thing we want to do is a) place additional equipment load and b) place workers in a situation that could jeopardize their safety.

    d. Additionally, it was mentioned that ODOT had some challenging experience with wire faced MSE walls. It is our opinion that without the use of wire face MSE wall the construction of the wall will be very challenging, if not infeasible.

2. Slope Stability - Ramps B & C. The borings indicate weathered shale at the soil to rock interface. It is very common in Ohio for there to be a very soft weathered shale layer a few inches thick at the soil to rock interface. This is a notoriously common condition in Ohio that results in one hundred or more landslides annually. Typically, these materials have low effective friction angles which could be as low as 12-degrees.



[1]Figure 1 – Areas of Ohio Subject to Severe Slope Failures. *"In the lower part of the Scioto River valley, thick colluvium developed on shales of Mississippian age, particularly the Bedford Shale, is prone to failure."*

The consequences of this occurring on these walls during construction or after the bridge is completed and in use could include:

a. Construction delays while a new design is developed and constructed. The repair cost will likely be nearly double the cost of performing ground improvement or other alternative construction methods (see Conclusion and Recommendations).

b. Delay of improved traffic function.

c. Road closure and detouring of traffic for 1-12 months, depending on the level of damage.

d. Slip surface will damage or fail the bridge abutment foundations. This could possibly lead to the girders and deck also being damaged or a span falling off the abutment bearings. Repair will require underpinning the bridge, removing the abutment foundation, abutment, MSE wall, and approach embankment, followed by installation of ground improvement, or other alternative methods, and complete reconstruction of the abutment foundations, wall, and approach embankment. If the superstructure is damaged, then the girders and deck may also need to be replaced.

[1] GeoFacts No. 8, Ohio Geological Survey, September 2003.

e. The slip and movement could be relatively rapid and cause injury to a motorists or construction workers.

Conclusion and Recommendations

1. The consequence of a slip failure of these walls makes avoidance of this risk an overriding priority. It is recommended that alternative construction be evaluated. They would include:

   i. Ground Improvement such as Controlled Modulus Columns and Vibro-Concrete Columns.

   ii. Pile supported embankment. The shallow depth to rock makes this option economical. An example could be steel HP 12x53 piles driven to rock on ten foot centers with a small cap placed on top. Approximately three layers of geogrid on 1-2 foot lifts are placed on top. Details of this can be obtained from the FHWA, Virginia Dot, Geogrid Manufacturers, and the British Standards Institute. Several have been constructed in highway applications over the last several years. Details can be provided upon request.

   iii. MSE wall supported on two geogrid layers with stone in between and bearing on timber piles driven to rock. Piles are driven on approximately 5 to 10-ft on centers and approximately 2-ft thick stone sandwiched between two layers of geogrid. The wall is then constructed on this stable platform. This has been done successfully on the VA-288 project.

   iv. MSE wall built on top of a pile supported raft foundation. Piles are driven on approximately 15-ft centers and an approximately 1-ft thick reinforced slab is poured on top. The wall is then constructed on this stable platform. This has been done successfully in Virginia on the $750-million Springfield Interchange. Key advantages include:

      a. Much more economical than extending the bridge. No superstructure girders are required.

      b. More economical than CIP walls. The lateral load is taken up by the MSE wall. There is no need to cast a large and expensive CIP vertical face with architectural form liners.

      c. Eliminates the need for costly and time consuming geotechnical investigation, lab testing, interpretation, and design.

      d. Eliminates the need for Geotechnical Instrumentation.

      e. Eliminates the need for full time Geotechnical expertise being present at the site full time.

      f. Simple to construct. No new specialized knowledge required in design or construction.

      g. Eliminates risk and uncertainty in the short term and long term.

2. It would be advantageous at this stage of project development to complete a geologic report for the site which includes historical landslide information for the project geologic area.

3. Cone Penetrometer Testing (CPT) and soil sampling of the soils at the rock interface should be performed before additional time and effort is expended on the current approaches to Walls 4 & 5. Without certainty regarding the presence of the very soft weathered shale soil interface, significant time and resources could be expended on a scheme that will later be shown to be non applicable. It could be more productive to pursue the alternatives listed above until such data becomes available.

4. Muti-phased staged construction. If this is selected as the preferred alternative, it is essential that:

   a. The preliminary and final design phases establish a detailed Geotechnical Instrumentation plan:

      – Instrumentation types, locations, and frequency of readings. At minimum, the site will likely require:
        - Several piezometers and settlement platforms for each wall and high fill areas. Redundancy will need to be built into the plan to accommodate instrumentation malfunction/failure/damage.
        - One to two slope inclinometers (SI) for each wall face. The walls are very tall and long. A single SI will not provide adequate coverage of the long three sided walls on Ramps B & C.
        - Settlement Platforms.
        - Recommend instrumentation references:
          - FHWA-NHI-00-043, Mechanically Stabilized Earth Walls and Reinforced Soil Slopes
          - FHWA-NHI-132034, Ground Improvement Manual
          - FHWA-HI-98-034, Geotechnical Instrumentation
          - AASHTO Subsurface Investigation Manual

      – Construction Specifications. These should address issues such as: installation, equipment and methods, qualifications for personnel installing and monitoring the instrumentation, and contractor damaging and replacing instrumentations including liquidated damages.

   b. A highly qualified Geotechnical Instrumentation engineer to oversee instrumentation installation, monitor instruments in the field, reduce data, produce data reports, and communicate (verbal or electronic) with the design and construction engineer on a nearly daily basis.

The Subsurface Exploration and MSE Wall and Embankment Evaluation report for Proposed US 23/SR 823 Interchange (prepared by DLZ) is separately bound

APPENDIX B

SCI-823-10.13
PRELIMINARY COST ESTIMATE
MSE RETAINING WALL COSTS

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[MSE Retaining Wall Cost_Step 8.xls]MSE Wall Cost Estimate

By: DGS Date: 11/16/2007
Checked: SKT Date: 11/20/2007

WALL DESIGNATION	TOTAL WALL AREA (SQ FT)	WALL TYPE	STATIONS From	STATIONS To	WALL LENGTH (FT)	AVERAGE WALL HEIGHT (FT)	GROUND IMPROVEMENT OR TEMPORARY WALL COST	2006 UNIT Wall COST	2006 MSE WALL COST	15% CONTINGENCY (SEE NOTE 3)	TOTAL 2006 MSE WALL COST
No. 1	5,347	MSE	90+14.00	93+49.00	335	16.0	$0	$97.00	$518,700	$77,800	$596,500
No. 2	5,449	MSE	90+38.00	94+24.00	386	14.1	$0	$97.00	$528,600	$79,300	$607,900
No. 3	3,667	MSE	98+11.00	100+11.00	200	18.3	$257,000	$90.00	$587,000	$88,100	$675,100
No. 4	19,416	MSE	100+54.00	111+00.00	1,046	18.6	$0	$82.00	$1,592,100	$238,800	$1,830,900
No. 5	18,567	MSE	93+87.00	106+31.00	1,244	14.9	$0	$87.00	$1,615,300	$242,300	$1,857,600
No. 6	4,516	MSE	94+57.00	96+69.00	212	21.3	$0	$90.00	$406,400	$61,000	$467,400
TOTALS	**56,962**				**3,423**						**$6,036,000**

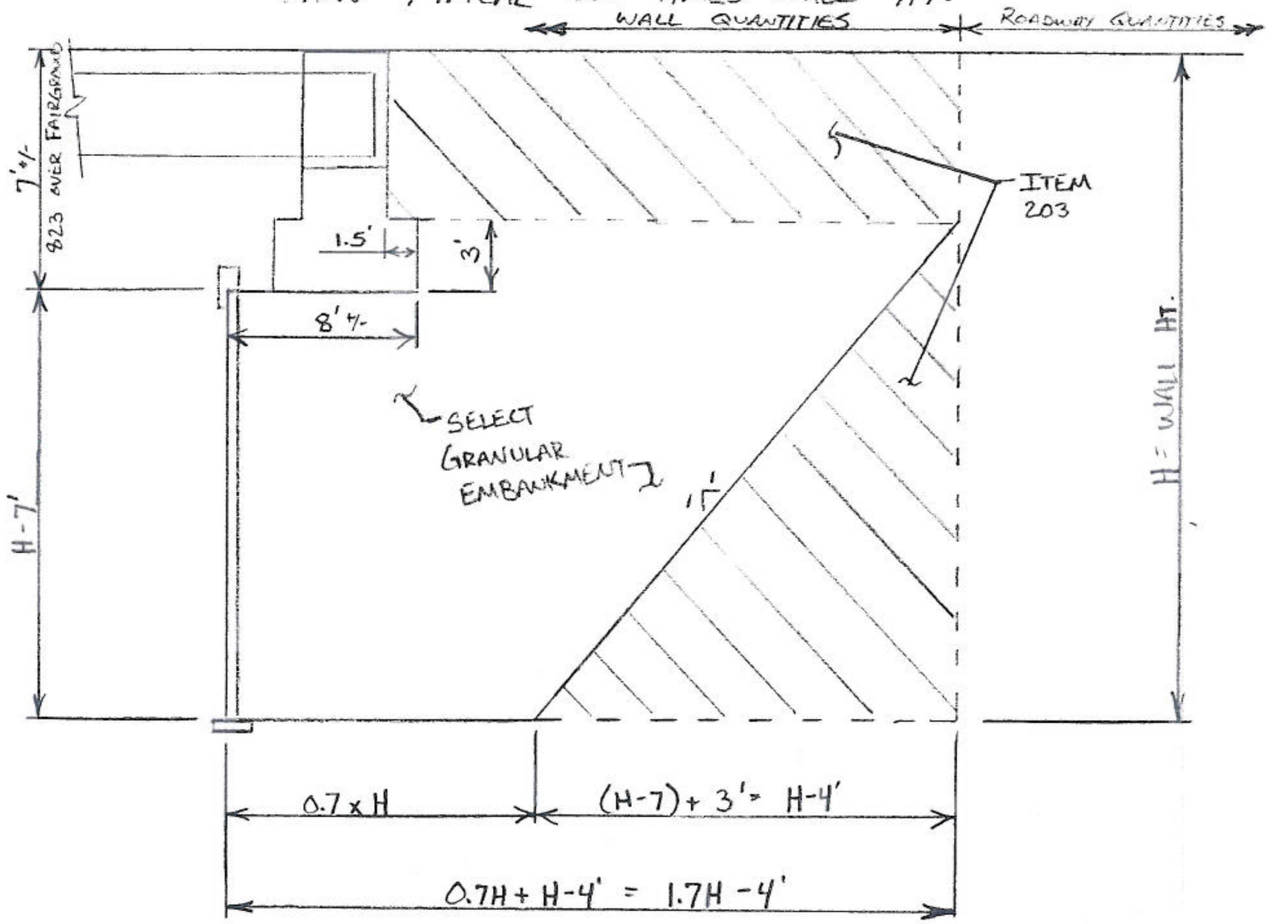
Notes:

1. MSE Wall unit costs for walls 1, 2, 3, & 6 were derived by adjusting typical $85/sq ft for increased strap length for walls 1, 2, 3, & 6. See attached calculations for documentation.

2. MSE Wall unit costs for walls 4 & 5 were derived by adjusting typical $85/sq ft for increased volumes of fill and cost savings associated with overlapping reinforced zones. See attached calculations for documentation.

3. Includes incidental costs. Contingency also includes additional reinforced strap lengths not included in the cost estimate of MSE Walls 4 & 5, since a 70% strap length was assumed in the estimate (subsurface report recommends 100% strap length).

- Adjust Std. Unit Cost of MSE WALLS ($85/SF) For INCREASED STRAP LENGTH
  - ↳ DLZ GEOTECH RECOMMENDATION IS FOR STRAP LENGTH TO BE EQUAL TO 1.1 TIMES WALL HT. RATHER THAN TYPICAL 0.7 TIMES WALL HT.



FOR STRAP LENGTH = 0.7H

↳ CALCULATE A WALL HT. (H) WHICH GIVES A UNIT COST EQUAL TO $85/SF USING THE FOLLOWING ITEMIZED UNIT COSTS:

- WALL PANELS & STRAPS INCLUDING WALL EXCAVATION; FOUNDATION PREPARATION; POROUS BACKFILL w/ FILTER FABRIC & DRAINAGE PIPE; AND CONCRETE COPING	$50/SF
- SELECT GRANULAR EMBANKMENT	$30/CY
- ITEM 203 EMBANKMENT	$8/CY

FOR STRAP LENGTH = 0.7H

AREA OF EXPOSED MSE WALL = $(H-7)' \times 1' = \underline{(H-7')\,SF/FT}$ of WALL

VOLUME OF SELECT GRANULAR:

$$= \left[\left[(0.7H)(H-4) - (8\times3)\right] + \tfrac{1}{2}(H-4)^2\right] \times 1'$$
$$= \left[0.7H^2 - 2.8H - 24 + \tfrac{1}{2}(H^2 - 8H + 16)\right] \times 1'$$
$$= (0.7H^2 - 2.8H - 24 + 0.5H^2 - 4H + 8) \times 1'$$
$$= (1.2H^2 - 6.8H - 16)\,SF \times 1'$$
$$= (1.2H^2 - 6.8H - 16)\,CF \times \frac{1\,CY}{27\,CF} = \underline{(0.04444H^2 - 0.25185H - 0.592592)\,CY}$$

VOLUME OF ITEM 203 EMBANKMENT

$$= \left[4'(1.7H - 4' - 8' + 1.5') + \tfrac{1}{2}(H-4)^2\right] \times 1'$$
$$= \left[4'(1.7H - 10.5') + \tfrac{1}{2}(H^2 - 8H + 16)\right] \times 1'$$
$$= (6.8H - 42' + 0.5H^2 - 4H + 8) \times 1'$$
$$= (0.5H^2 + 2.8H - 34)\,SF \times 1'$$
$$= (0.5H^2 + 2.8H - 34)\,CF \times \frac{1\,CY}{27\,CF} = \underline{(0.0185185H^2 + 0.1037037H - 1.259259)\,CY}$$

FIND HT. THAT RESULTS IN UNIT COST = $85/SF, SOLVE FOR H

$$\$85/SF\,(H-7')SF = \$50/SF\,(H-7)SF + \$30/CY\,(0.04444H^2 - 0.25185H - 0.59259$$
$$+ \$8/CY\,(0.0185185H^2 + 0.1037037H - 1.259259)\,CY$$

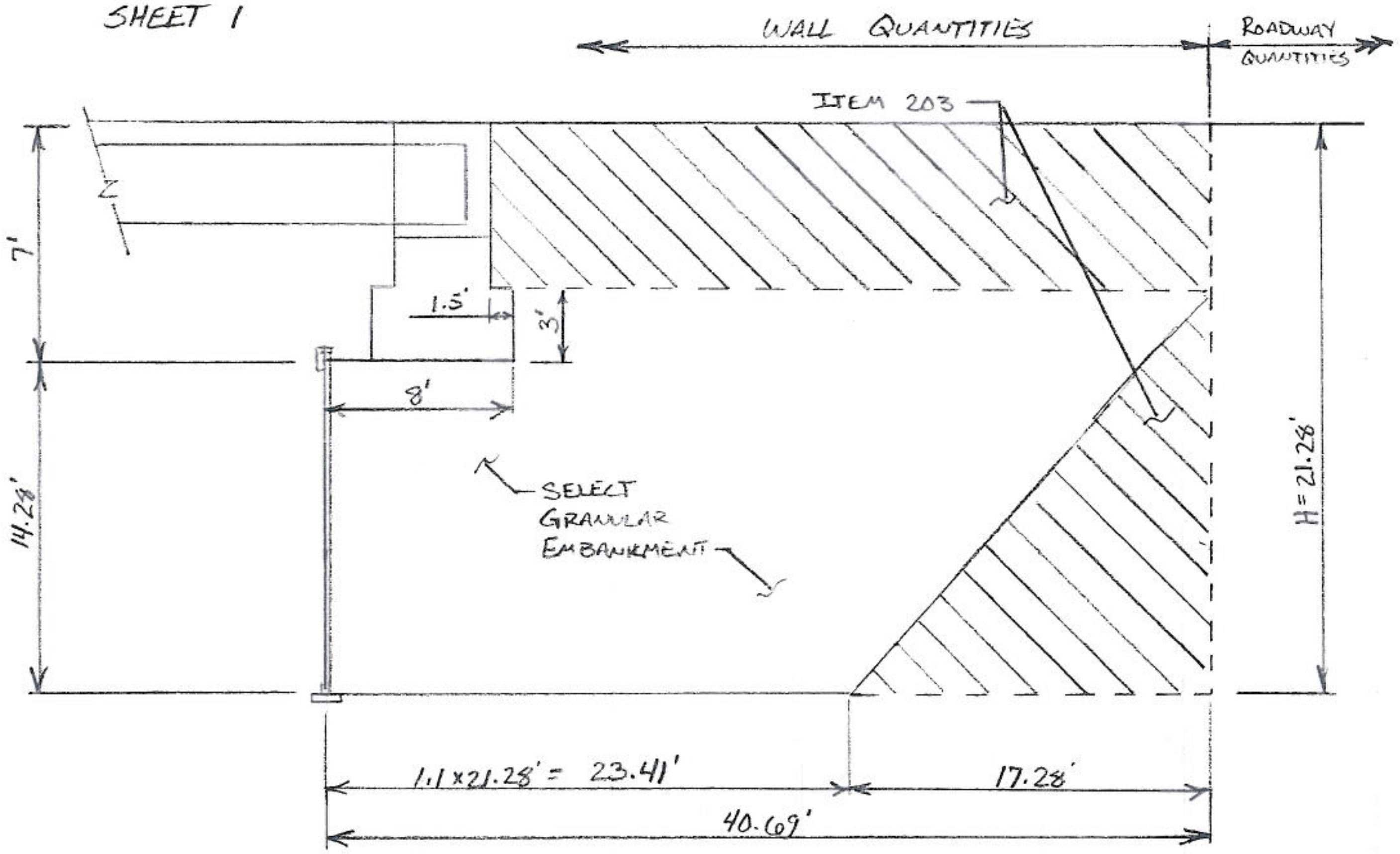
$$85H - 595 = 50H - 350 + 1.333H^2 - 7.5555H - 17.7777 + 0.148148H^2 + 0.82963H - 10.0741$$

$$85H - 595 = 1.4811H^2 + 43.2741H - 377.852$$

$$0 = 1.4811H^2 - 41.7259H + 217.148$$

$\underline{H = 21.28'}$ -- HT. OF RETAINED SOIL THAT RESULTS IN UNIT COST OF $85/SF WHEN COMBINED WITH ASSUMED ITEMIZED UNIT COSTS

- CALCULATE ADJUSTED UNIT WALL COST FOR INCREASING STRAP LENGTH TO 1.1 TIMES WALL HT. USE WALL HT (H) EQUAL TO 21.28' AND USE ITEMIZED UNIT COSTS FROM SHEET 1



WALL PANELS: 14.28' x 1' x $50/SF — $714

SELECT GRANULAR EMBANKMENT:

$23.41'(14.28'+3') - (8'\times 3') + \frac{1}{2}(17.28')^2 = 529.824\ SF$

$529.824\ SF \times 1' \times \frac{1\ CY}{27\ CF} \times \$30/CY$ — $589

ITEM 203 EMBANKMENT:

$(40.69'-8'+1.5')(7'-3') + \frac{1}{2}(17.28')^2 = 286.059\ SF$

$286.059\ SF \times 1' \times \frac{1\ CY}{27\ CF} \times \$8/CY$ — $85

Total: $1388

$$\text{ADJUSTED UNIT COST} = \frac{\$1388}{14.28' \times 1'} = \underline{\$97/SF}$$

- Adjust Std. Unit Cost of MSE Walls ($85/SF) For Increased Strap Length
  - ↳ DLZ GEOTECH RECOMMENDATION IS FOR STRAP LENGTH TO BE EQUAL TO 0.85 TIMES WALL HT. RATHER THAN TYPICAL 0.7 TIMES WALL HT.

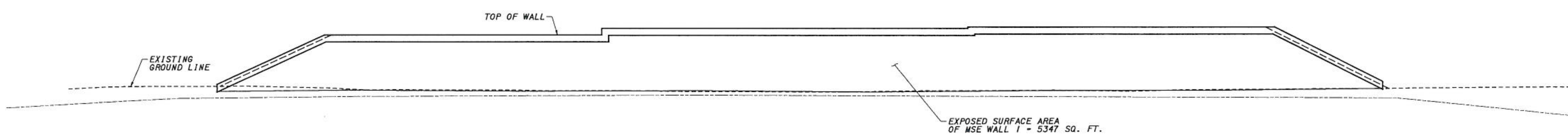
- REFER TO UNIT COST CALCULATION FOR MSE WALLS 1 ; 2 (Sht. 1-3) WHERE STRAP LENGTH = 1.1 TIMES WALL HT. ; UNIT COST = $97/SF

	STRAP LENGTH	WALL UNIT COST
STD. MSE WALL	0.7 · Ht. Wall	$85/SF
MSE WALLS 3 ; 6	0.85 · Ht. Wall	← FIND BY INTERPOLATION
MSE WALLS 1 ; 2	1.1 · Ht. Wall	$97/SF

ADJUSTED UNIT COST WALLS 3 ; 6 = $\$85 + (0.85-0.7)\left(\frac{97-85}{1.1-0.7}\right)$

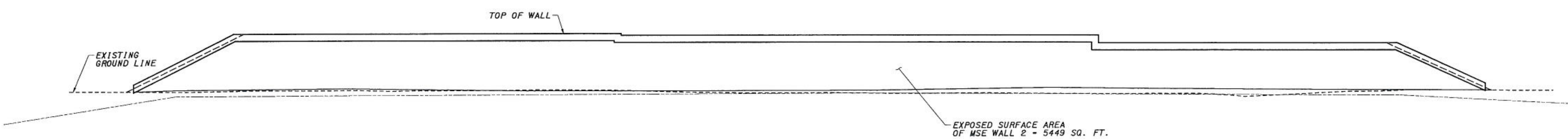
ADJUSTED UNIT COST WALLS 3 ; 6 = $\underline{\$90/SF}$

MSE WALL SURFACE AREA



MSE WALL NO. 1

MSE WALL SURFACE AREA



MSE WALL NO. 2

MSE Wall No. 3 Wall Unit Cost

MSE Wall with Temporary Soil Surcharging

Work Approach:

Calculate the unit cost ($/ft^2) for MSE Wall 3 using the construction method of temporary soil surcharging with reinforced fabric. See attached typical wall section for geometry. Assume sections are 1' long (into the page) in order to calculate exposed surface area of wall and associated quantities.

Item Unit Costs:

Temporary Surcharged Wall = $30 /ft^2 — *unit cost includes cost of select granular within strap length area

Select Granular Embankment = $30 /cy

Item 203 Embankment = $12 /cy

Wick Drains = $1 /ft

Excavation = $10 /cy

Permanent MSE Wall = $85 /ft^2 — *unit cost includes Item 203, select granular, wall panels & straps, and wall excavation below grade per Figure 330 in ODOT BDM

Cost of Temporary Surcharged Wall:

Height = 36.00 ft
Length = 1.00 ft

Area of Wall Face = 36.0 ft^2

Unit Cost = $30 /ft^2

Volume Of Select Granular (included with this cost)
Height = 36.00 ft
Width = 20.00 ft
Length = 1.00 ft
Volume = 26.7 cy

Cost of Temporary Surcharged Wall = $1,080 /ft.

Cost of Item 203 Embankment:

Embankment that is not included with cost of Temporary Surcharged Wall (any embankment outside of strap length required for wall height)

Height = 35.10 ft (Average)
Width = 38.40 ft
Length = 1.00 ft

Volume = 49.9 cy

Unit Cost = $12 /cy

Cost of Item 203 Embankment = $600 /ft.

Cost of Wick Drains:

Assume wick drains are spaced at 7' c/c in order to get 90% consolidation @ 30 days. Account for wick drains that are located within the boundaries of the select granular/embankment being paid for with the Temporary Surcharged Wall. Assume that wick drains are located 15' past the face of the Temporary Surcharged Wall.

Depth of Wick Drains = 20 ft (per final subsurface exploration report)

No. Wick Drains / 1' Wall Length = [(59'+15') / 7' Spa.] * (1' / 7' Spa.) = 1.510

Length = 30.2 ft

Unit Cost = $1 /ft

Cost of Wick Drains = $30 /ft.

Cost of Removing Temporary Surcharged Wall:

Volume to excavate equals total volume of select granular and Item 203 embankment used to construct temporary wall.

Volume of Excavation = 76.6 cy

Unit Cost = $10 /cy

Cost of Removing Temporary Surcharged Wall = $770 /ft.

Total Unit Cost:

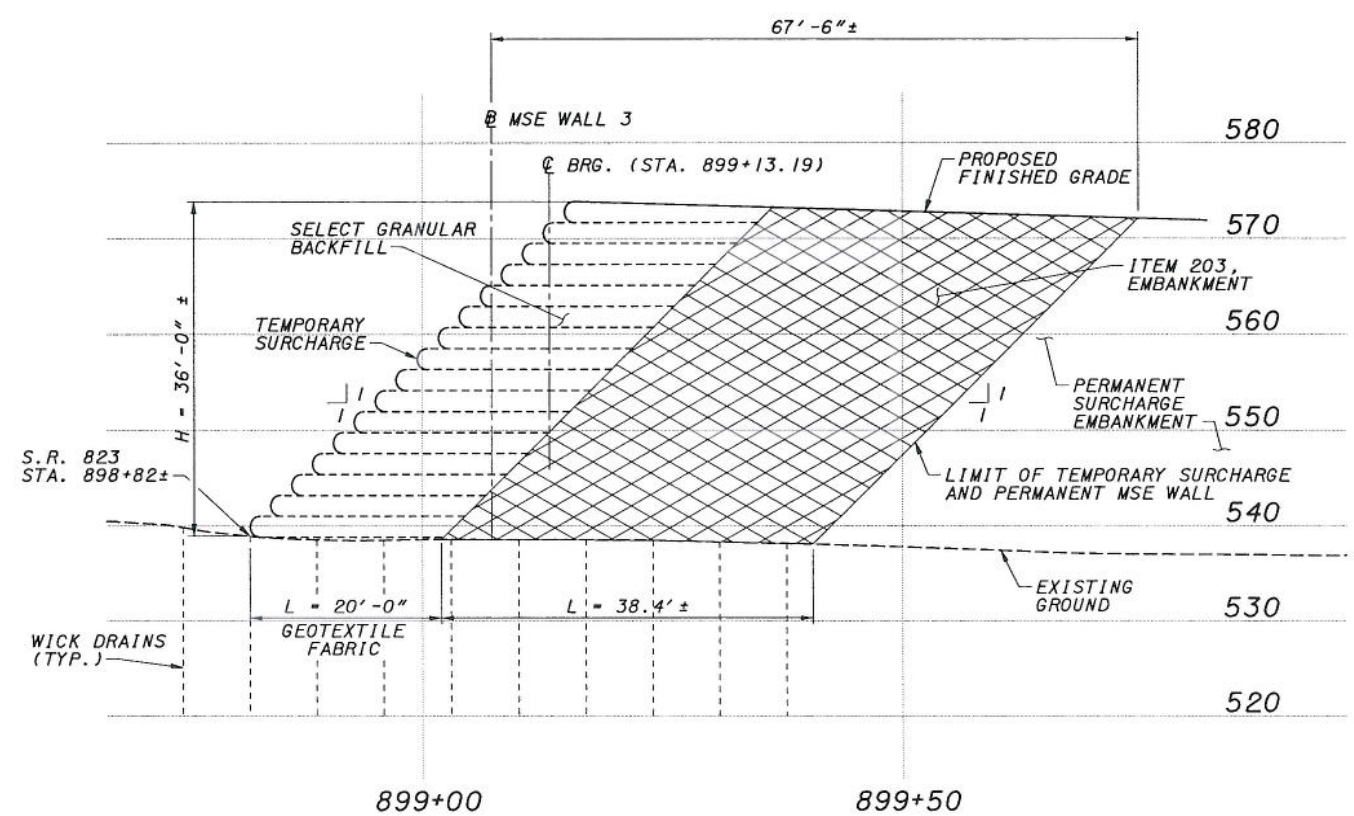
Total Cost to Construct 36 ft^2 of Temporary Surcharged Wall = $2,480 /ft.

Wall Unit Cost for Temporary Surcharged Wall = $70 /ft^2

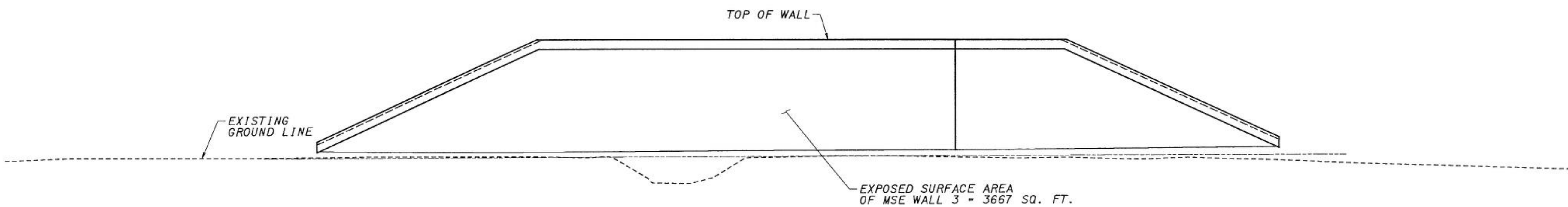
Exposed Area of Temporary Surcharged Wall = 3667 ft^2
Estimated Wall 3 Cost for Temporary Surcharged Wall = $257,000

MSE WALL NO. 3
BUILD SURCHARGE

t90 = 81 DAYS W/O WICK DRAINS
= 30 DAYS W/ WICK DRAINS @ 7' SPA.



MSE WALL SURFACE AREA



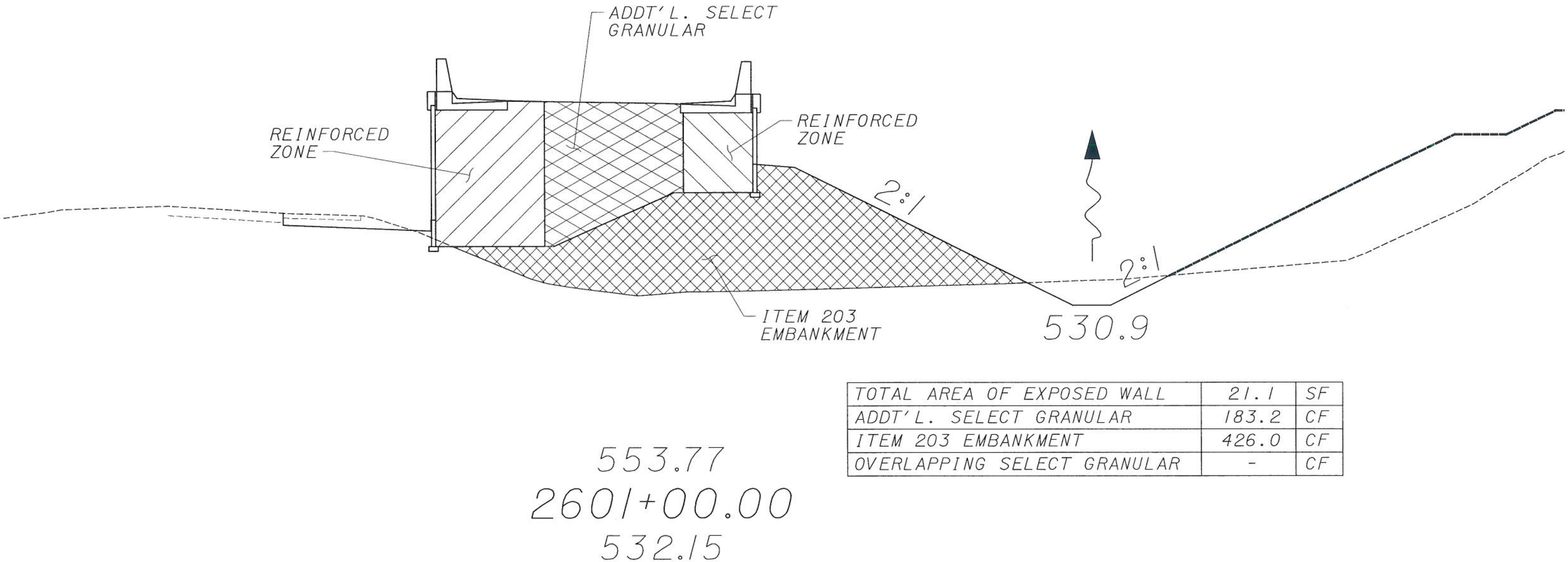
MSE WALL NO. 3

SCI-823-10.13 - PORTSMOUTH BYPASS
Wall 4 Cross-Section Dimensions

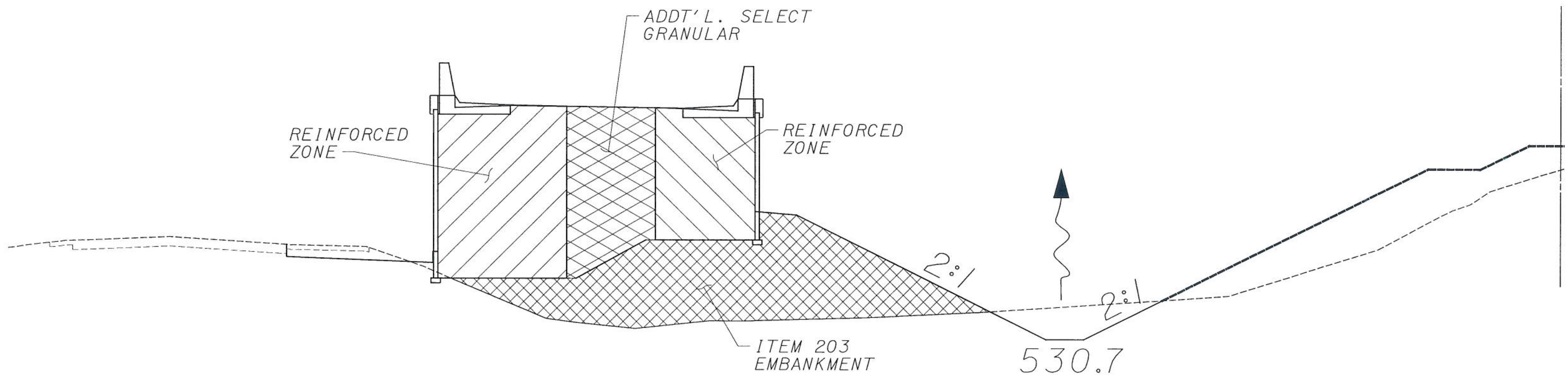
Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[Wall4CrossSectionDims.xls]Sheet1
Designer: DGS Date: 9/27/2007
Checker: SKT Date: 11/20/2007

	WALL 4 RT.			WALL 4 LT.		
RAMP B STA.	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)
2600+62.56	100+54.00	2.00'	1.40'	108+62.42	14.40'	10.08'
2601+00.00	100+91.44	10.54'	7.38'	108+24.98	16.57'	11.60'
2601+50.00	101+41.44	15.10'	10.57'	107+74.98	19.53'	13.67'
2602+00.00	101+91.44	21.01'	14.71'	107+24.98	22.52'	15.76'
2602+50.00	102+41.44	25.12'	17.58'	106+74.98	25.51'	17.86'
2603+00.00	102+91.44	28.57'	20.00'	106+24.98	28.67'	20.07'
2603+50.00	103+41.44	33.00'	23.10'	105+74.98	32.08'	22.46'
2604+00.00	103+90.67	37.81'	26.47'	105+23.16	35.39'	24.77'
2604+48.50	104+38.33	29.71'	20.80'	104+72.67	23.76'	16.63'

NOTES:
1. Length of reinforced zone is assumed to be equal to 0.7 x Wall Height.

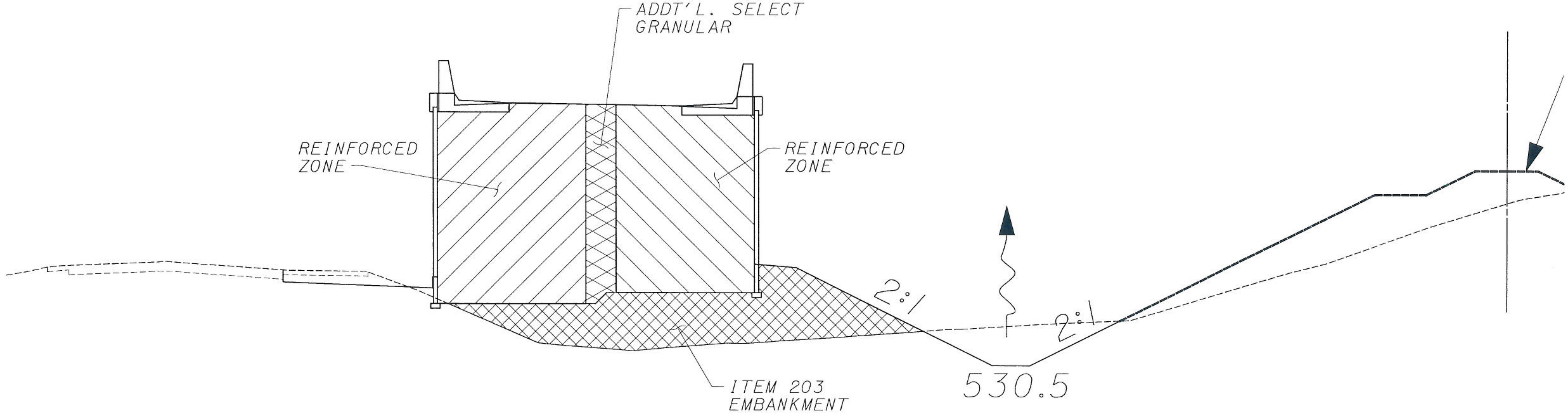


TOTAL AREA OF EXPOSED WALL	21.1	SF
ADDT'L. SELECT GRANULAR	183.2	CF
ITEM 203 EMBANKMENT	426.0	CF
OVERLAPPING SELECT GRANULAR	-	CF



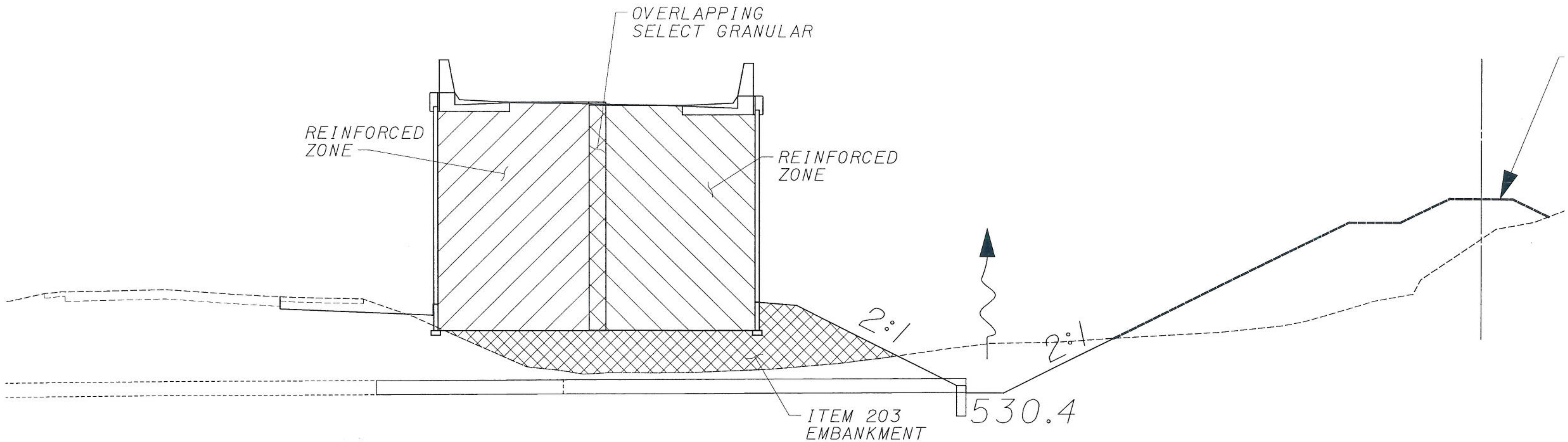
TOTAL AREA OF EXPOSED WALL	28.6	SF
ADDT'L. SELECT GRANULAR	153.3	CF
ITEM 203 EMBANKMENT	353.5	CF
OVERLAPPING SELECT GRANULAR	-	CF

556.65
2601+50.00
532.13



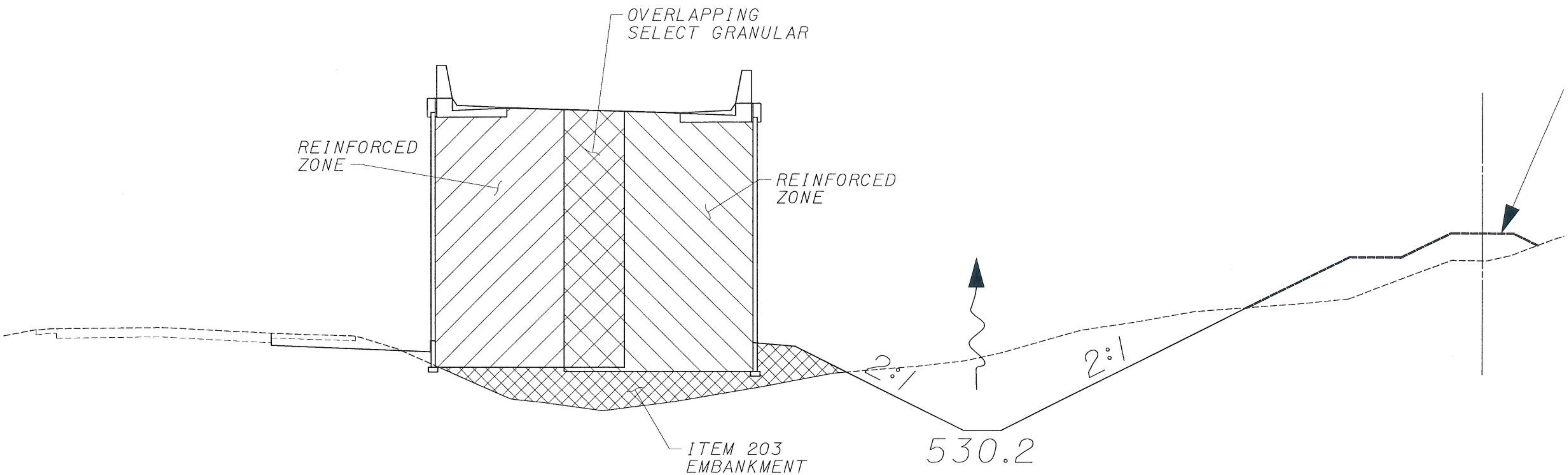
TOTAL AREA OF EXPOSED WALL	37.5	SF
ADDT'L. SELECT GRANULAR	66.1	CF
ITEM 203 EMBANKMENT	228.3	CF
OVERLAPPING SELECT GRANULAR	-	CF

559.53
2602+00.00
532.31



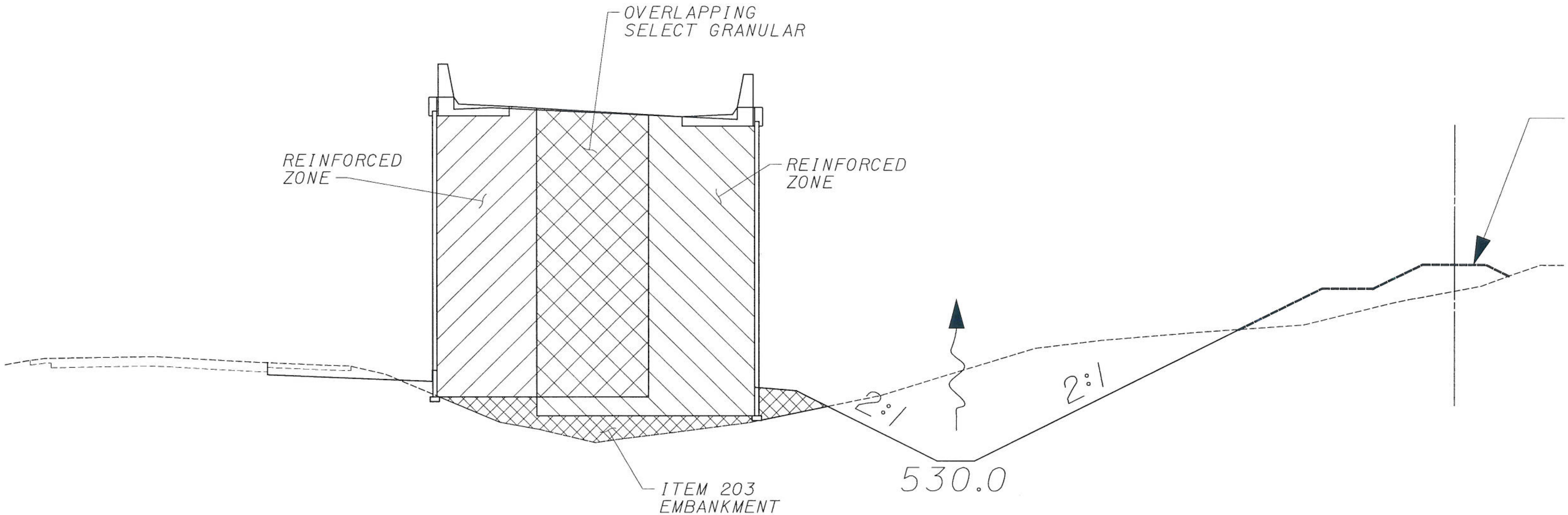
TOTAL AREA OF EXPOSED WALL	44.6	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	187.0	CF
OVERLAPPING SELECT GRANULAR	43.1	CF

562.41
2602+50.00
532.46



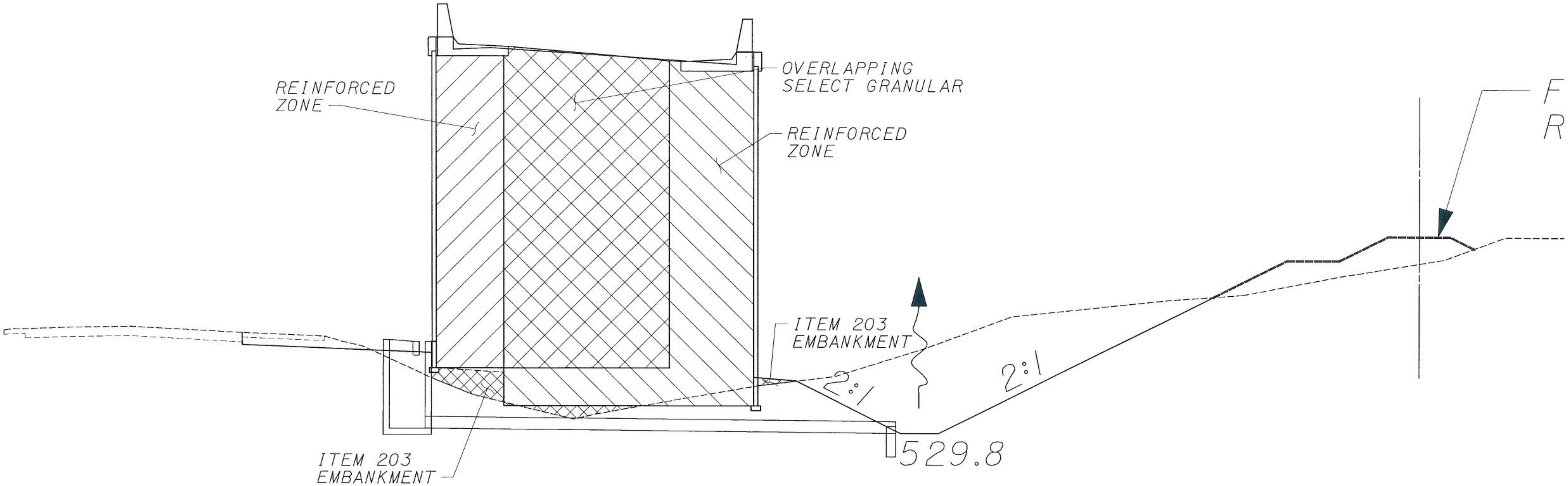
TOTAL AREA OF EXPOSED WALL	51.2	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	123.9	CF
OVERLAPPING SELECT GRANULAR	175.4	CF

565.29
2603+00.00
533.04



TOTAL AREA OF EXPOSED WALL	59.0	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	78.1	CF
OVERLAPPING SELECT GRANULAR	363.3	CF

568.17
2603+50.00
532.86



TOTAL AREA OF EXPOSED WALL	67.2	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	27.8	CF
OVERLAPPING SELECT GRANULAR	591.2	CF

571.05
2604+00.00
533.06

SCI-823-10.13 - PORTSMOUTH BYPASS
Wall 4 Average Unit Costs

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[Wall4AveUnitCosts.xls]Sheet1

Designer: DGS Date: 9/28/2007
Checker: SKT Date: 11/20/2007

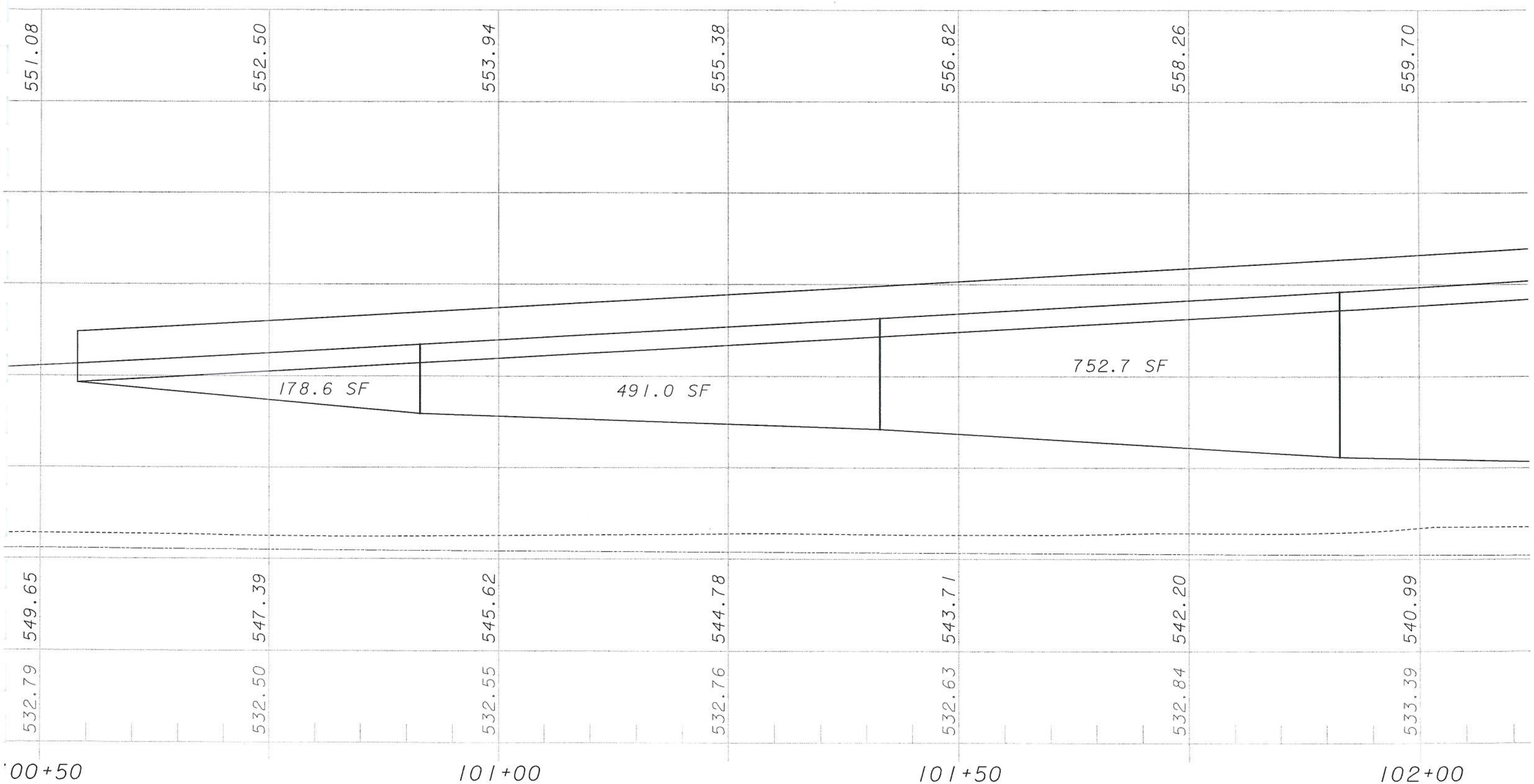
Adjust Standard Unit Cost of MSE Walls ($85/SF) for U-Shaped Back-to-Back MSE Walls. Use the following Unit Costs:

Item	Item Description	Unit Cost
1	Wall Panels & Straps including Wall Excavation; Foundation Preparation; Porous Backfill w/ Filter Fabric and Drainage Pipe; Concrete Coping; and Select Granular in Reinforced Zone	$85 /SF of Wall Face
2	Wall Panels & Straps -- all components included with Item 1 except Select Granular in Reinforced Zone	$50 /SF of Wall Face
3	Select Granular Embankment	$30 /CY
4	Item 203 Embankment	$8 /CY

	CROSS SECTION DIMENSIONS						STANDARD MSE WALL			ADDITIONAL SELECT GRANULAR			ITEM 203 EMBANKMENT			OVERLAPPING SELECT GRANULAR					
	WALL 4 RT.			WALL 4 LT.																	
RAMP B STA.	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)	AREA OF EXPOSED WALL (SF)	UNIT COST OF MSE WALL ($/SF)	COST OF STANDARD MSE WALL	VOLUME OF ADDT'L SELECT GRANULAR (CF)	UNIT COST OF ADDT'L SELECT GRANULAR ($/CY)	COST OF ADDT'L SELECT GRANULAR	VOLUME OF ITEM 203 EMBANKMENT (CF)	UNIT COST OF ITEM 203 EMBANKMENT ($/CY)	COST OF ITEM 203 EMBANKMENT	VOLUME OF OVERLAPPING SELECT GRANULAR (CF)	UNIT COST OF OVERAPPING SELECT GRANULAR ($/CY)	COST SAVINGS OF OVERLAPPING. SELECT GRANULAR	TOTAL COST OF WALL AT SECTION	UNIT COST OF WALL ($/SF) AT SECTION	AVE UNIT COST OF WALL ($/SF) B/W SECTIONS
2600+62.56	100+54.00	2.00'	1.40'	108+62.42	14.40'	10.08'															
2601+00.00	100+91.44	10.54'	7.38'	108+24.98	16.57'	11.60'	21.1	$85	$1,794	183.2	$30	$204	426.0	$8	$126		-$30	$0	$2,124	**$101**	**$101**
2601+50.00	101+41.44	15.10'	10.57'	107+74.98	19.53'	13.67'	28.6	$85	$2,431	153.3	$30	$170	353.5	$8	$105		-$30	$0	$2,706	**$95**	**$98**
2602+00.00	101+91.44	21.01'	14.71'	107+24.98	22.52'	15.76'	37.5	$85	$3,188	66.1	$30	$73	228.3	$8	$68		-$30	$0	$3,329	**$89**	**$92**
2602+50.00	102+41.44	25.12'	17.58'	106+74.98	25.51'	17.86'	44.6	$85	$3,791		$30	$0	187.0	$8	$55	43.1	-$30	-$48	$3,798	**$85**	**$87**
2603+00.00	102+91.44	28.57'	20.00'	106+24.98	28.67'	20.07'	51.2	$85	$4,352		$30	$0	123.9	$8	$37	175.4	-$30	-$195	$4,194	**$82**	**$84**
2603+50.00	103+41.44	33.00'	23.10'	105+74.98	32.08'	22.46'	59.0	$85	$5,015		$30	$0	78.1	$8	$23	363.3	-$30	-$404	$4,634	**$79**	**$81**
2604+00.00	103+90.67	37.81'	26.47'	105+23.16	35.39'	24.77'	67.2	$85	$5,712		$30	$0	27.8	$8	$8	591.2	-$30	-$657	$5,063	**$75**	**$77**
2604+48.50	104+38.33	29.71'	20.80'	104+72.67	23.76'	16.63'															**$75**

NOTES:
1. Length of reinforced zone is assumed to be equal to 0.7 x Wall Height.

WALL 4



551.08
552.50
553.94
555.38
556.82
558.26
559.70
178.6 SF
491.0 SF
752.7 SF
549.65
547.39
545.62
544.78
543.71
542.20
540.99
532.79
532.50
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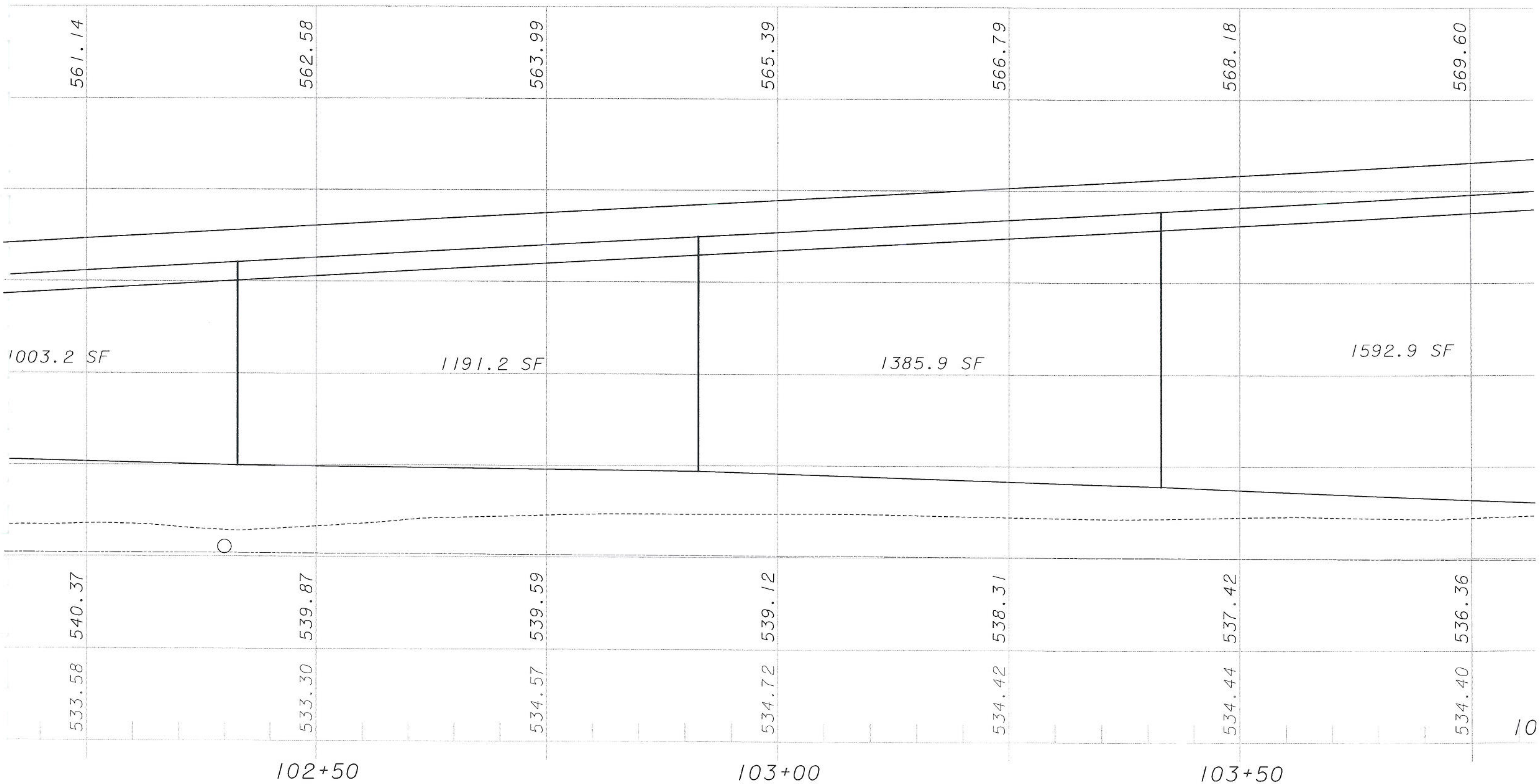
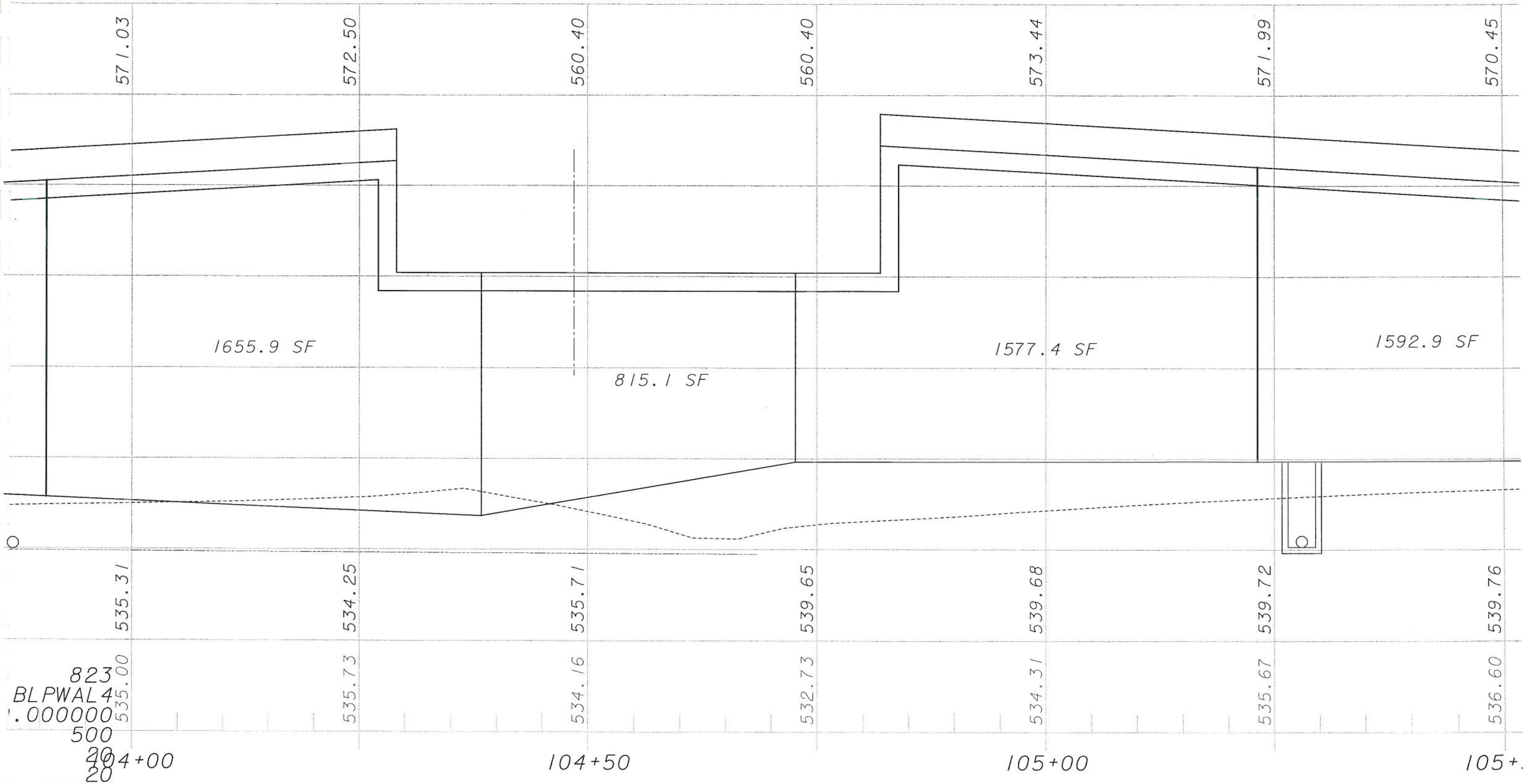
532.76
532.63
532.84
533.39
'00+50
101+00
101+50
102+00

WALL 4


561.14
562.58
563.99
565.39
566.79
568.18
569.60
1003.2 SF
1191.2 SF
1385.9 SF
1592.9 SF
540.37
539.87
539.59
539.12
538.31
537.42
536.36
533.58
533.30
534.57
534.72
534.42
534.44
534.40
10
102+50
103+00
103+50

WALL 4



571.03
572.50
560.40
560.40
573.44
571.99
570.45
1655.9 SF
815.1 SF
1577.4 SF
1592.9 SF
535.31
534.25
535.71
539.65
539.68
539.72
539.76
535.00
535.73
534.16
532.73
534.31
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823
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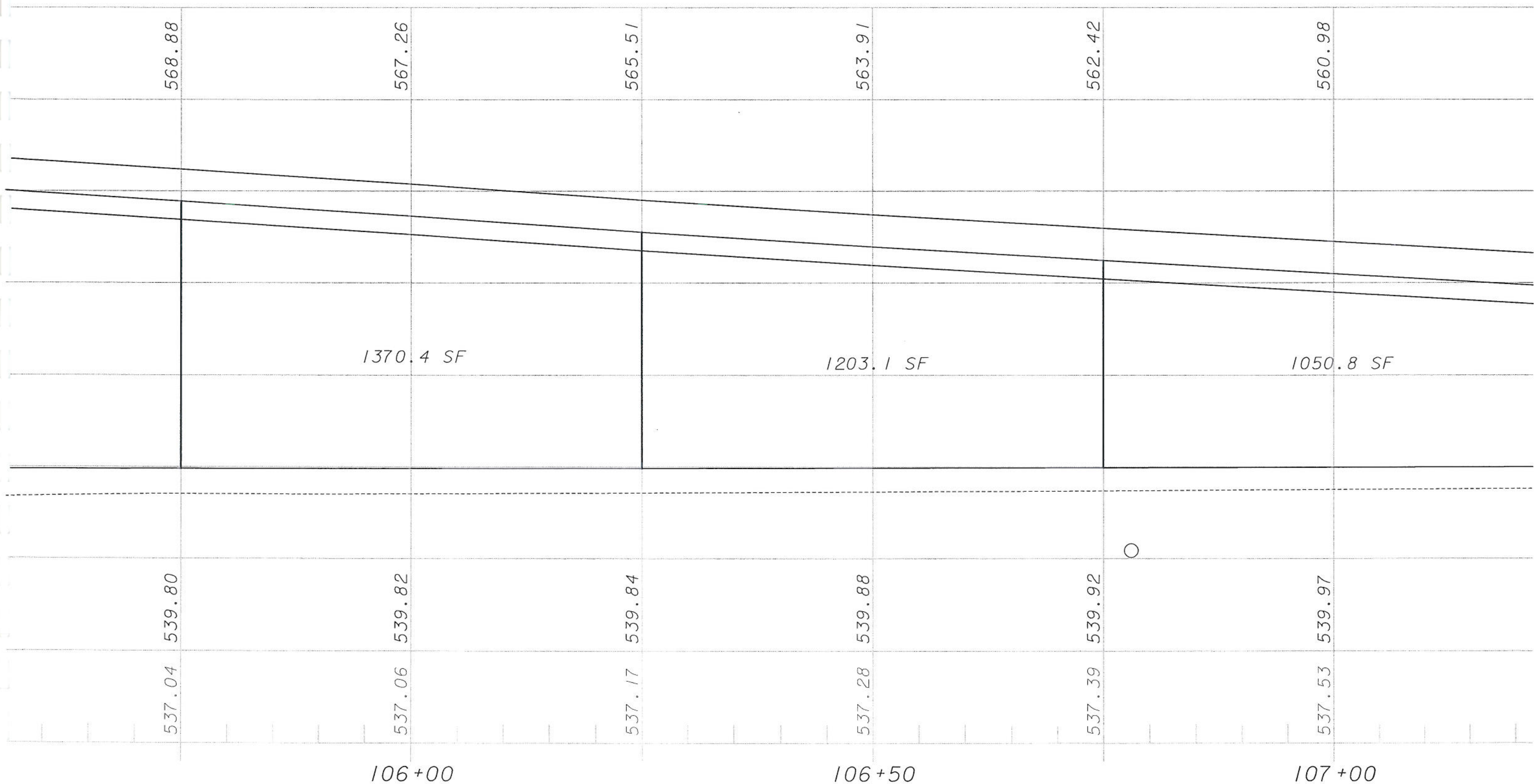
500
20
20
104+00
104+50
105+00
105+

WALL 4



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567.26
565.51
563.91
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1203.1 SF
1050.8 SF
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539.82
539.84
539.88
539.92
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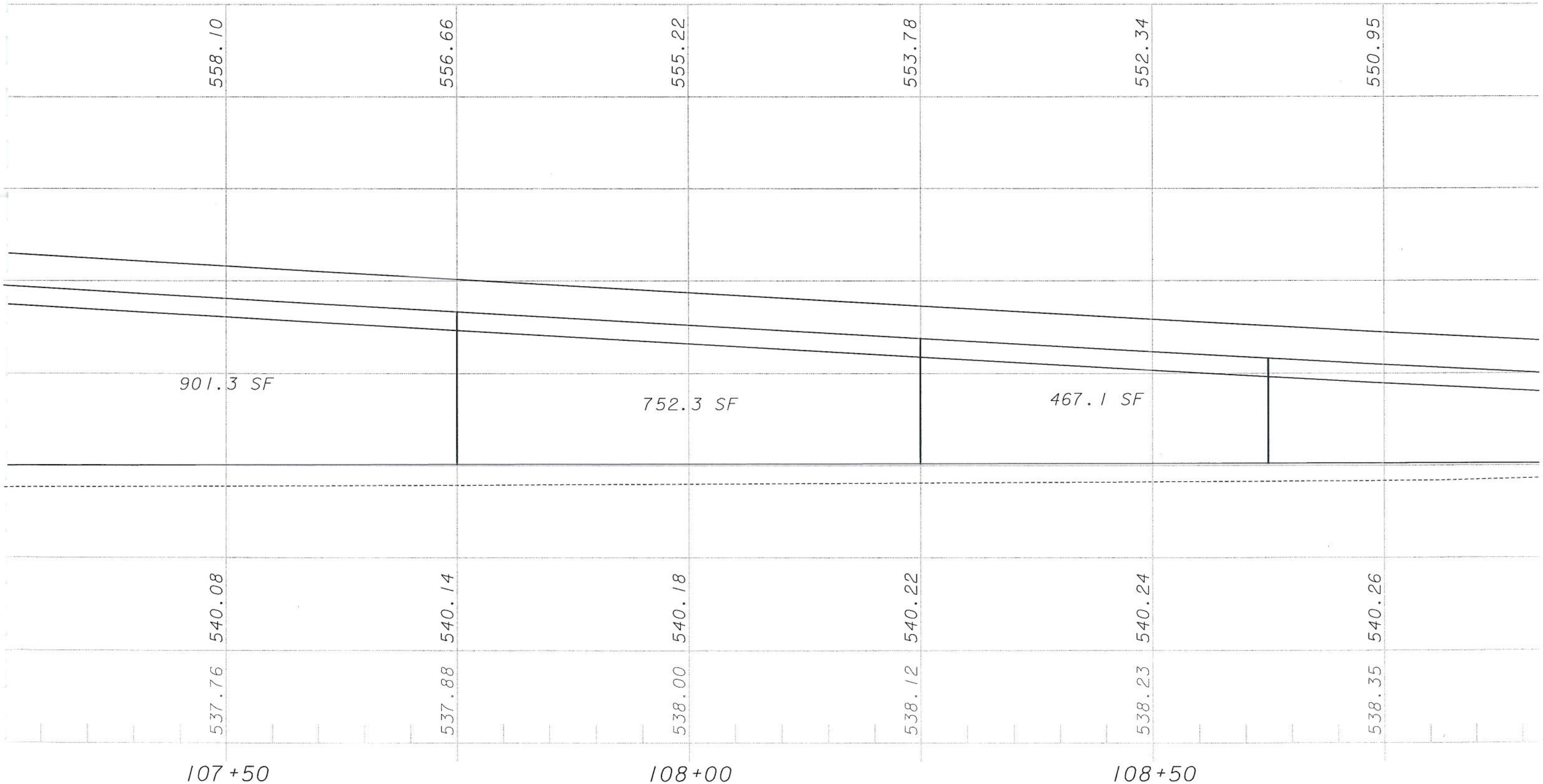
537.28
537.39
537.53
106+00
106+50
107+00

WALL 4



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556.66
555.22
553.78
552.34
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901.3 SF
752.3 SF
467.1 SF
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540.18
540.22
540.24
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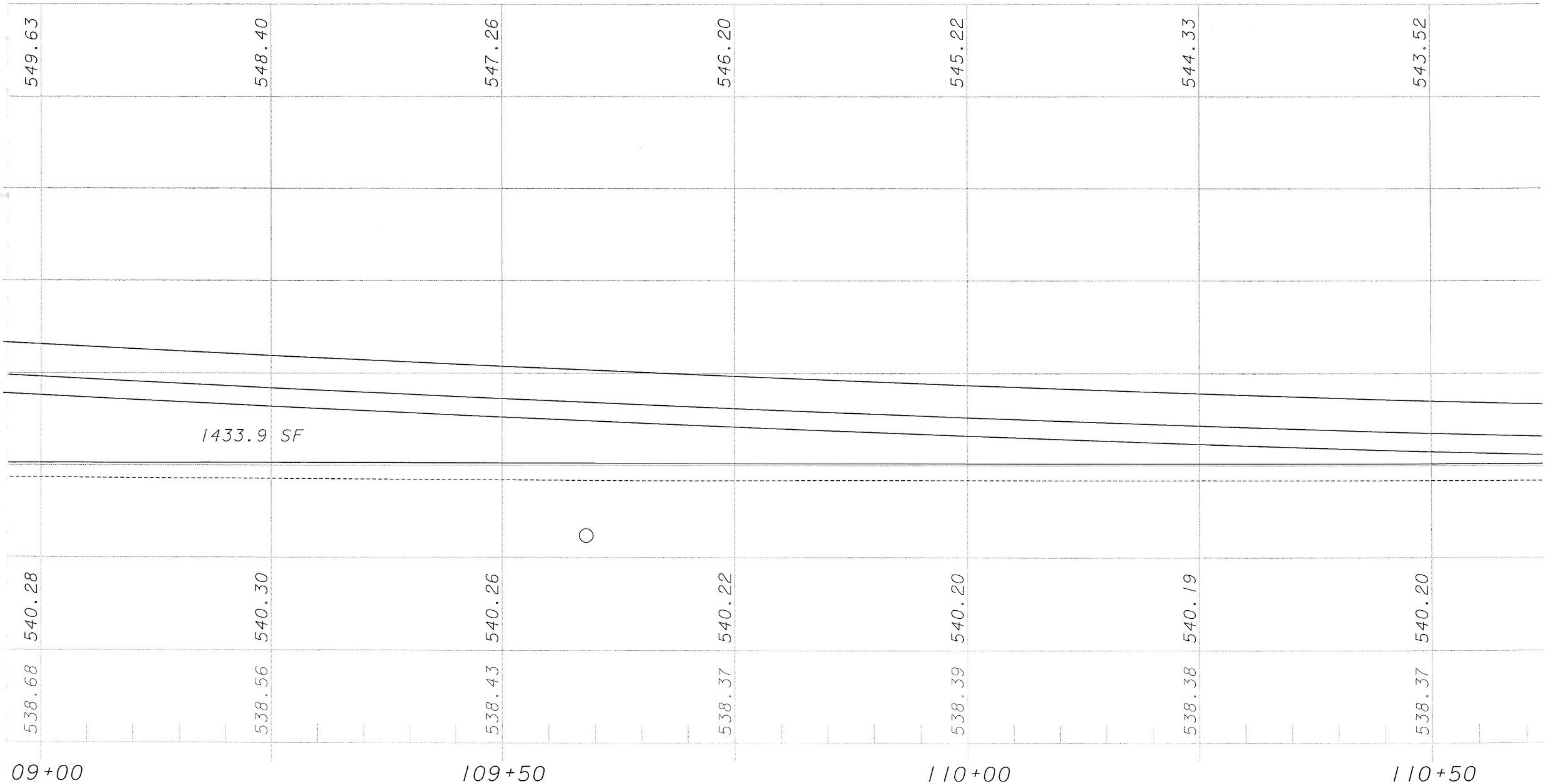
538.35
107+50
108+00
108+50

WALL 4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544.33
543.52
1433.9 SF
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540.20
540.19
540.20
538.68
538.56
538.43
538.37
538.39
538.38
538.37
09+00
109+50
110+00
110+50

WALL 4

EL 590
EL 580
EL 570
EL 560
EL 550
EL 540
EL 530
EL 520
EL 510
542.79
540.21
538.36
538.36
538.48
111+00

COST OF WALL 4

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[Wall4Cost.xls]Sheet1

Designer: DGS Date: 9/27/2007
Checker: SKT Date: 11/20/2007

Wall Area	Wall Station		Unit Cost of Wall ($/SF)	Wall Area (SF)	Cost of Wall Area
	From	To			
Area 1	100+54.00	100+91.44	$101	178.6	$18,039
Area 2	100+91.44	101+41.44	$98	491.0	$48,118
Area 3	101+41.44	101+91.44	$92	752.7	$69,248
Area 4	101+91.44	102+41.44	$87	1003.2	$87,278
Area 5	102+41.44	102+91.44	$84	1191.2	$100,061
Area 6	102+91.44	103+41.44	$81	1385.9	$112,258
Area 7	103+41.44	103+90.67	$77	1592.9	$122,653
Area 8	103+90.67	104+38.33	$75	1655.9	$124,193
Area 9	104+38.33	104+72.67	$50	815.1	$40,755
Area 10	104+72.67	105+23.16	$75	1577.4	$118,305
Area 11	105+23.16	105+74.98	$77	1592.9	$122,653
Area 12	105+74.98	106+24.98	$81	1370.4	$111,002
Area 13	106+24.98	106+74.98	$84	1203.1	$101,060
Area 14	106+74.98	107+24.98	$87	1050.8	$91,420
Area 15	107+24.98	107+74.98	$92	901.3	$82,920
Area 16	107+74.98	108+24.98	$98	752.3	$73,725
Area 17	108+24.98	108+62.42	$101	467.1	$47,177
Area 18	108+62.42	111+00.00	$85	1433.9	$121,882
TOTAL COST OF WALL 4					**$1,592,747**

Total Area of Wall 4 19415.7 ft^2

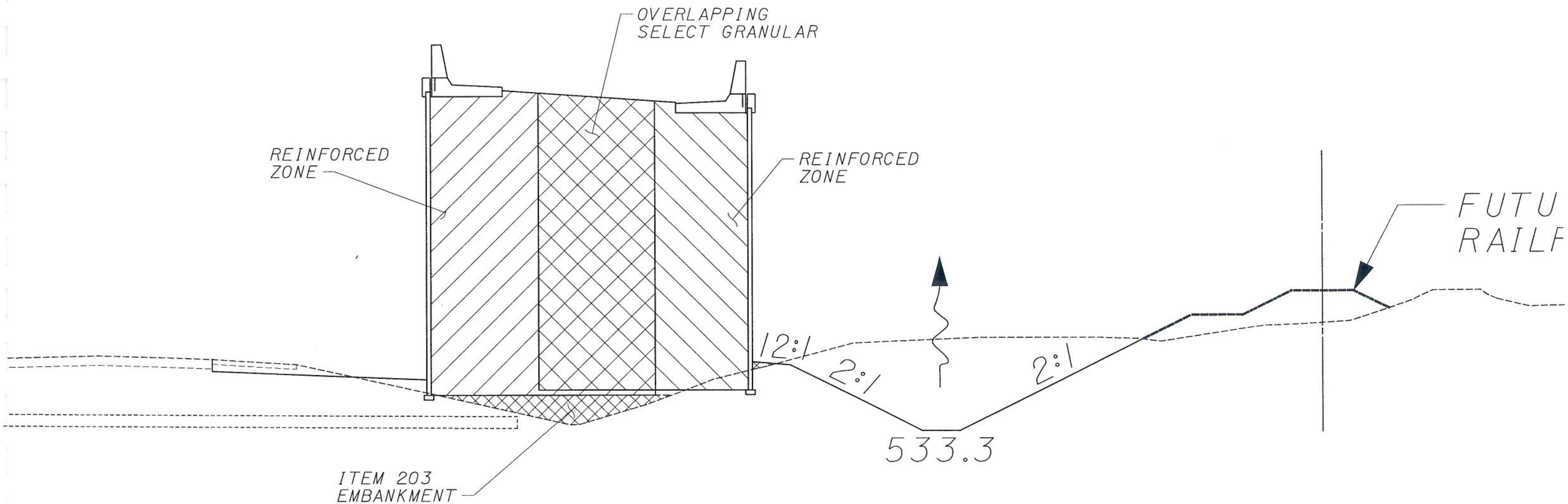
Ave. Unit Cost of Wall 4 $82.00 per ft^2

SCI-823-10.13 - PORTSMOUTH BYPASS
Wall 5 Cross-Section Dimensions

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[Wall5CrossSectionDims.xls]Sheet1
Designer: DGS Date: 9/27/2007
Checker: SKT Date: 11/20/2007

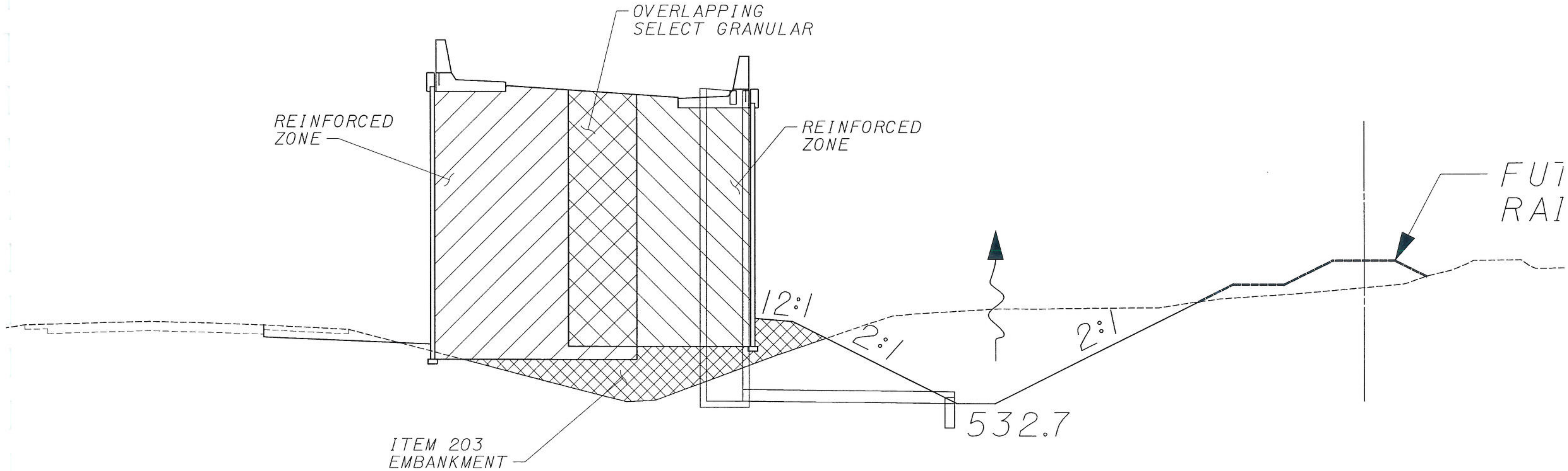
	WALL 5 RT.			WALL 5 LT.		
RAMP C STA.	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)
3906+22.41	106+31.00	2.00'	1.40'	94+00.69	5.28'	3.70'
3906+00.00	106+08.59	6.48'	4.54'	94+23.09	5.81'	4.07'
3905+50.00	105+58.59	7.84'	5.49'	94+73.09	7.18'	5.03'
3905+00.00	105+08.59	10.37'	7.26'	95+23.09	8.81'	6.17'
3904+50.00	104+58.59	13.22'	9.25'	95+73.09	10.77'	7.54'
3904+00.00	104+08.59	16.14'	11.30'	96+23.09	12.94'	9.06'
3903+50.00	103+58.59	17.59'	12.31'	96+73.09	15.42'	10.79'
3903+00.00	103+08.59	19.52'	13.66'	97+23.09	17.98'	12.59'
3902+50.00	102+58.59	21.50'	15.05'	97+73.09	20.77'	14.54'
3902+00.00	102+08.59	23.36'	16.35'	98+23.09	23.98'	16.79'
3901+50.00	101+58.59	25.11'	17.58'	98+73.09	27.35'	19.15'
3901+00.00	101+09.23	27.64'	19.35'	99+24.61	30.78'	21.55'
3900+50.00	100+59.92	31.69'	22.18'	99+76.24	33.99'	23.79'
3900+25.50	100+35.67	19.72'	13.80'	100+01.33	19.83'	13.88'

NOTES:
1. Length of reinforced zone is assumed to be equal to 0.7 x Wall Height.



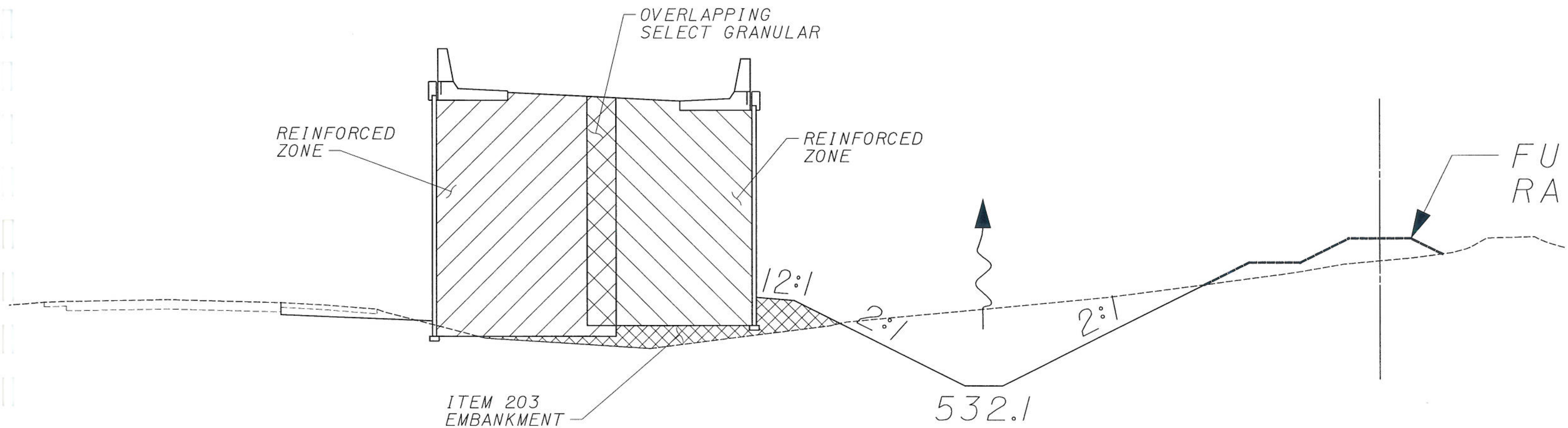
TOTAL AREA OF EXPOSED WALL	59.7	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	42.0	CF
OVERLAPPING SELECT GRANULAR	386.1	CF

569.88
3900+50.00
536.47



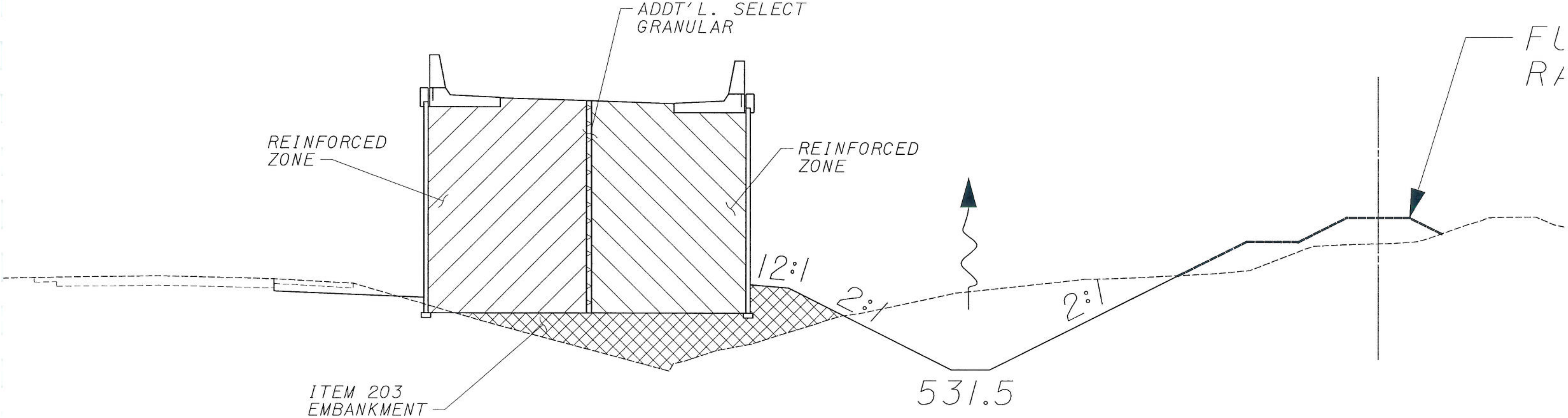
TOTAL AREA OF EXPOSED WALL	52.4	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	115.6	CF
OVERLAPPING SELECT GRANULAR	197.5	CF

566.96
3901+00.00
533.14



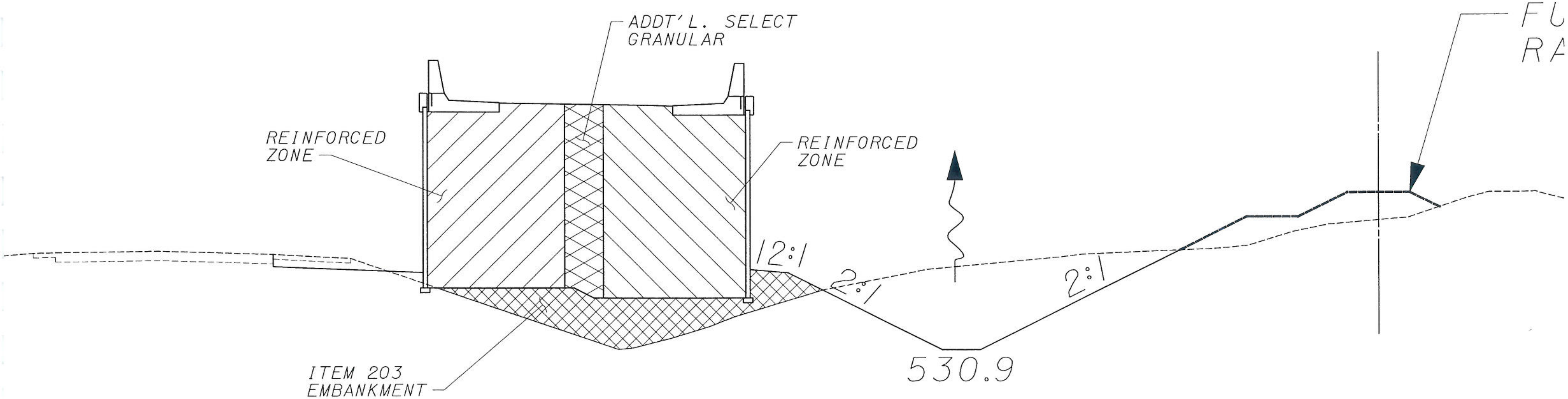
TOTAL AREA OF EXPOSED WALL	46.5	SF
ADDT'L. SELECT GRANULAR	-	CF
ITEM 203 EMBANKMENT	58.5	CF
OVERLAPPING SELECT GRANULAR	75.2	CF

564.03
3901+50.00
536.21



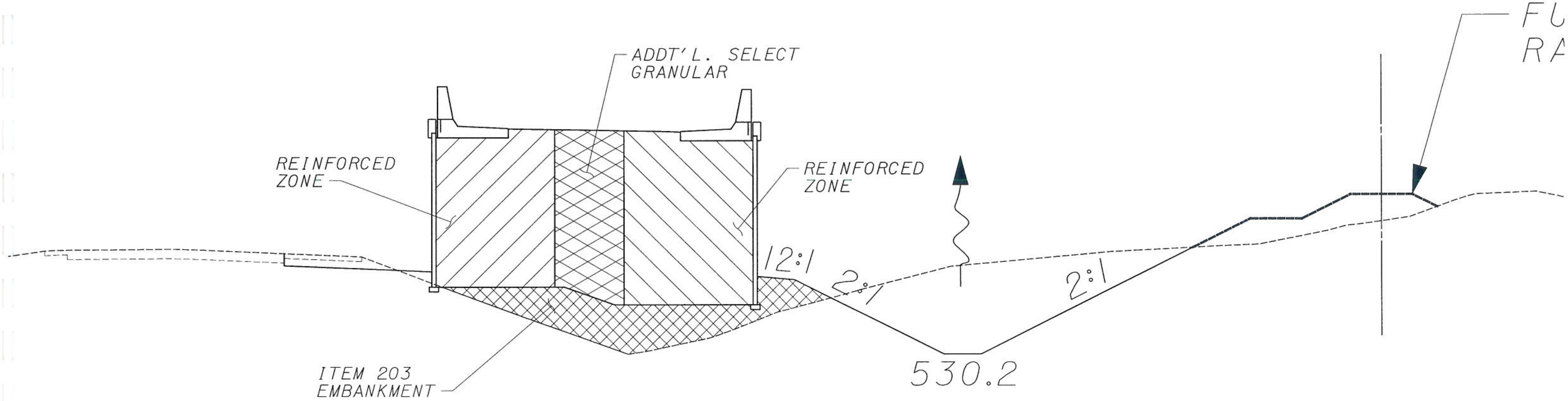
TOTAL AREA OF EXPOSED WALL	41.3	SF
ADDT'L. SELECT GRANULAR	11.9	CF
ITEM 203 EMBANKMENT	141.7	CF
OVERLAPPING SELECT GRANULAR	-	CF

561.11
3902+00.00
531.75



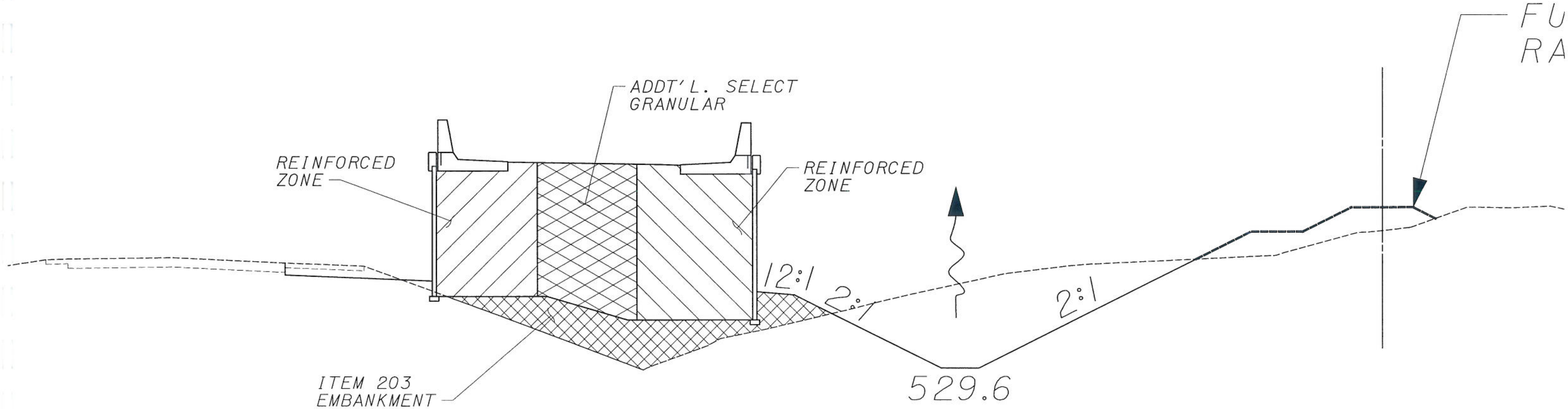
TOTAL AREA OF EXPOSED WALL	36.3	SF
ADDT'L. SELECT GRANULAR	82.0	CF
ITEM 203 EMBANKMENT	129.6	CF
OVERLAPPING SELECT GRANULAR	-	CF

558.19
3902+50.00
531.62



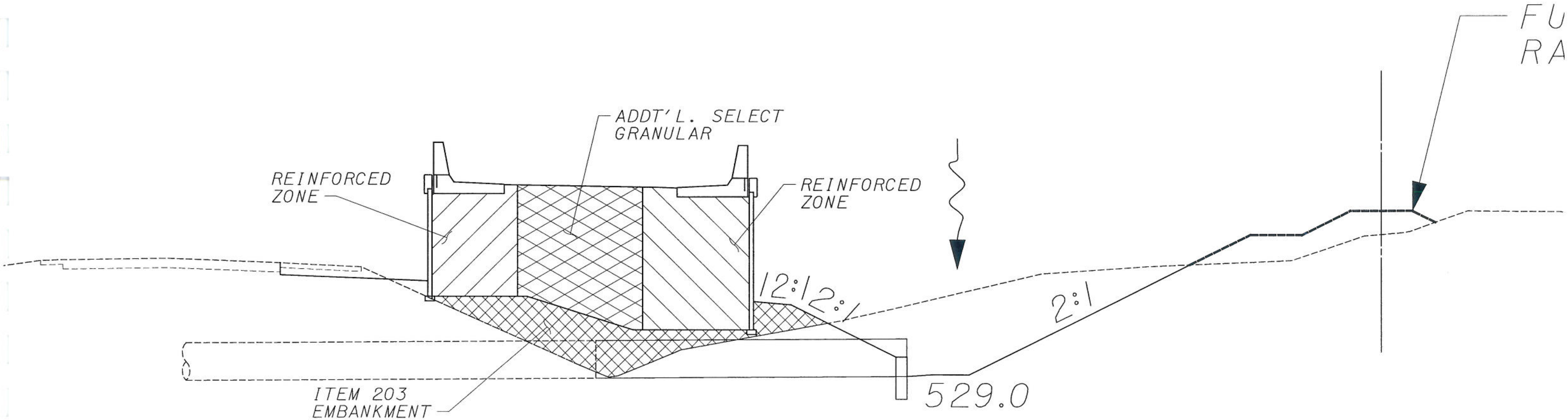
TOTAL AREA OF EXPOSED WALL	31.5	SF
ADDT'L. SELECT GRANULAR	131.5	CF
ITEM 203 EMBANKMENT	135.1	CF
OVERLAPPING SELECT GRANULAR	-	CF

555.29
3903+00.00
530.80



TOTAL AREA OF EXPOSED WALL	27.0	SF
ADDT'L. SELECT GRANULAR	163.7	CF
ITEM 203 EMBANKMENT	122.1	CF
OVERLAPPING SELECT GRANULAR	-	CF

552.63
3903+50.00
530.15



TOTAL AREA OF EXPOSED WALL	23.1	SF
ADDT'L. SELECT GRANULAR	180.0	CF
ITEM 203 EMBANKMENT	129.8	CF
OVERLAPPING SELECT GRANULAR	-	CF

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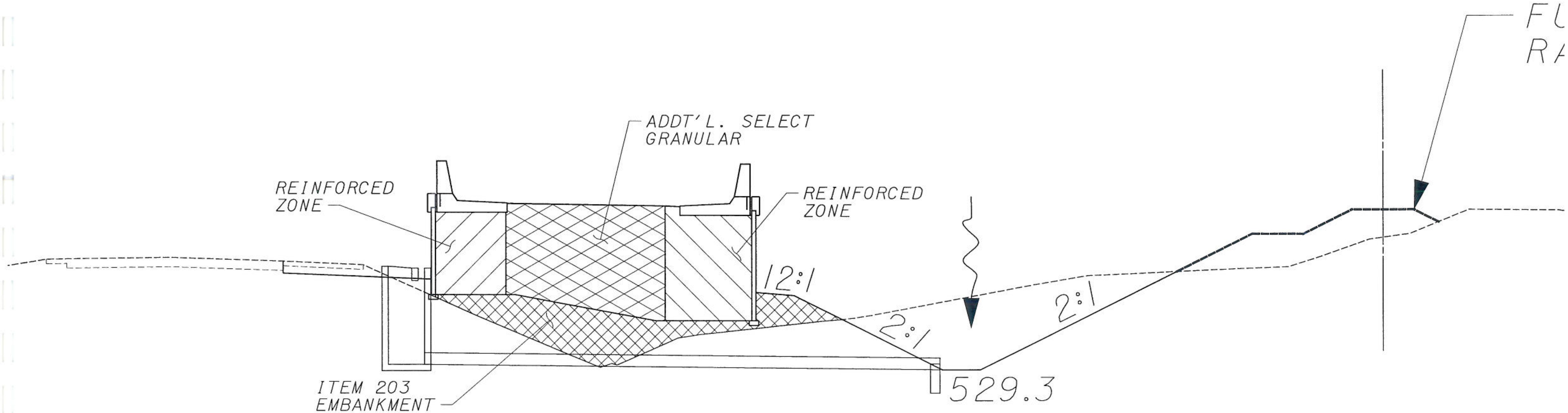
3904+00.00
530.54



TOTAL AREA OF EXPOSED WALL	18.0	SF
ADDT'L. SELECT GRANULAR	185.1	CF
ITEM 203 EMBANKMENT	127.8	CF
OVERLAPPING SELECT GRANULAR	-	CF

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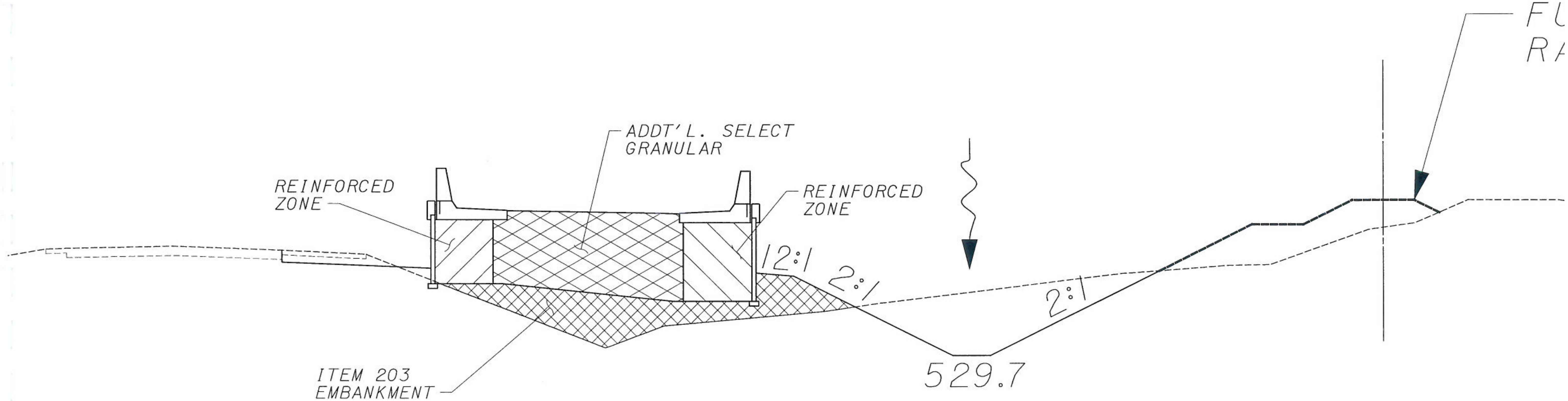
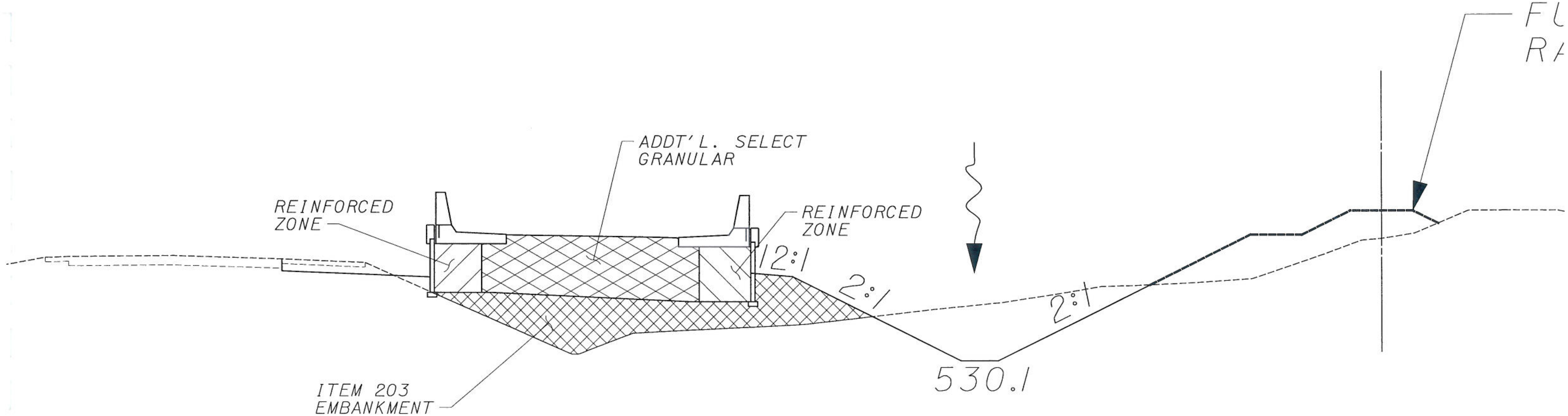
3904+50.00
531.82



TOTAL AREA OF EXPOSED WALL	13.2	SF
ADDT'L. SELECT GRANULAR	171.6	CF
ITEM 203 EMBANKMENT	131.6	CF
OVERLAPPING SELECT GRANULAR	-	CF

546.17
3905+00.00
532.69



TOTAL AREA OF EXPOSED WALL	9.0	SF
ADDT'L. SELECT GRANULAR	145.4	CF
ITEM 203 EMBANKMENT	163.1	CF
OVERLAPPING SELECT GRANULAR	-	CF

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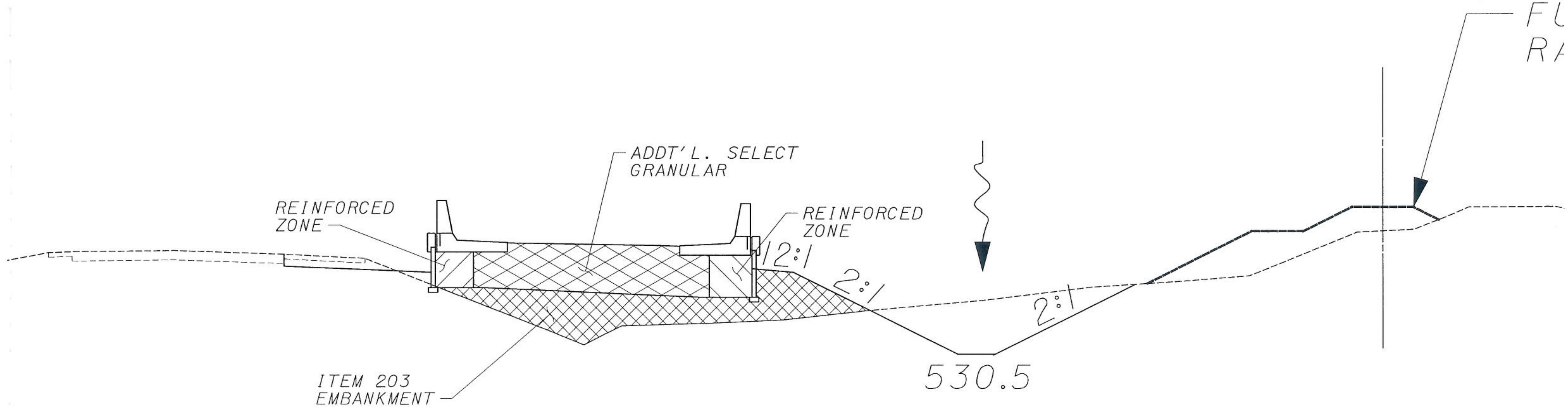
3905+50.00
533.17



TOTAL AREA OF EXPOSED WALL	6.3	SF
ADDT'L. SELECT GRANULAR	121.7	CF
ITEM 203 EMBANKMENT	144.1	CF
OVERLAPPING SELECT GRANULAR	-	CF

543.16
3906+00.00
533.44

SCI-823-10.13 - PORTSMOUTH BYPASS
Wall 5 Average Unit Costs

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[Wall5AveUnitCosts.xls]Sheet1

Designer: DGS Date: 9/27/2007
Checker: DGS Date: 11/20/2007

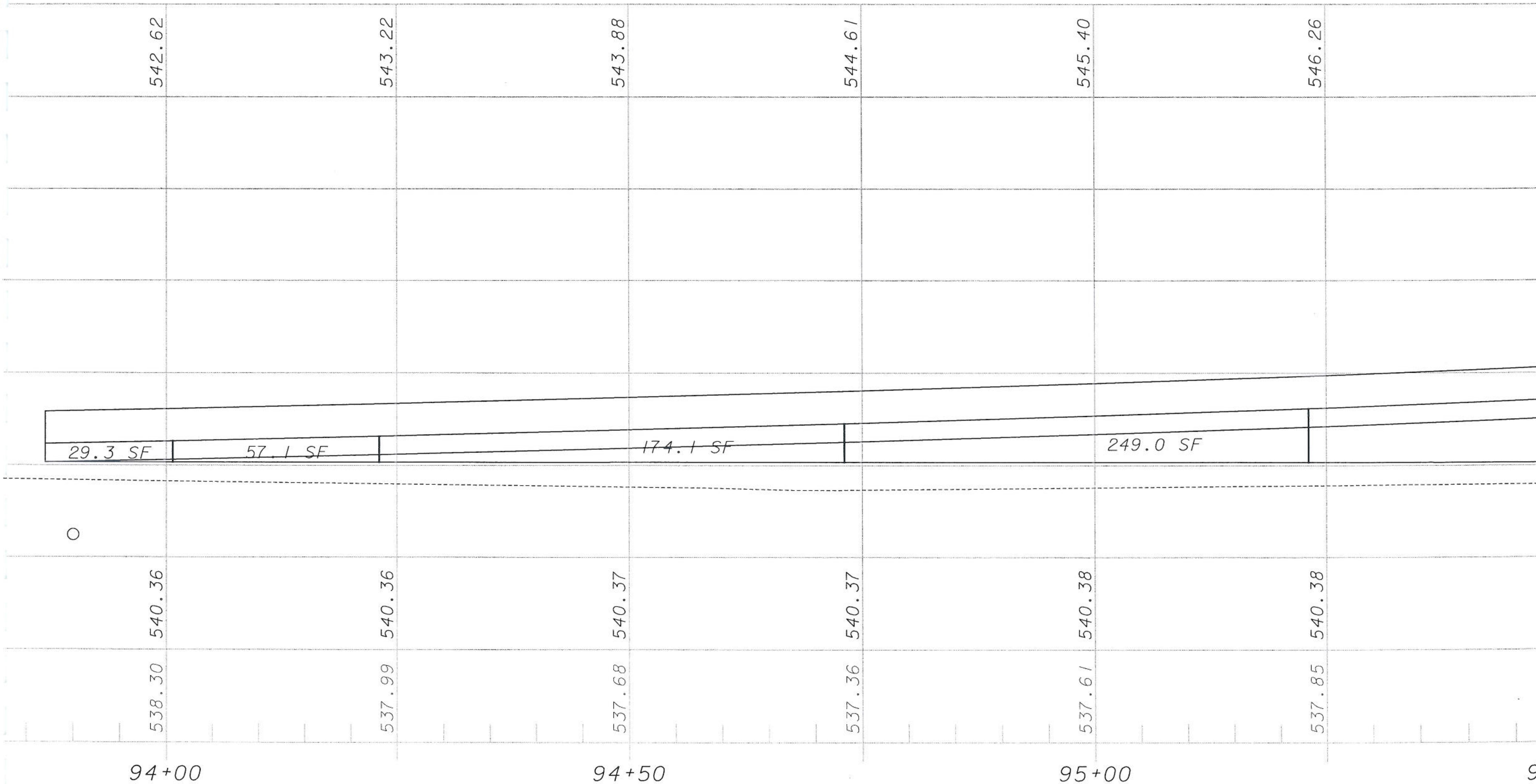
Adjust Standard Unit Cost of MSE Walls ($85/SF) for U-Shaped Back-to-Back MSE Walls. Use the following Unit Costs:

Item	Item Description	Unit Cost
1	Wall Panels & Straps including Wall Excavation; Foundation Preparation; Porous Backfill w/ Filter Fabric and Drainage Pipe; Concrete Coping; and Select Granular in Reinforced Zone	$85 /SF of Wall Face
2	Wall Panels & Straps -- all components included with Item 1 except Select Granular in Reinforced Zone	$50 /SF of Wall Face
3	Select Granular Embankment	$30 /CY
4	Item 203 Embankment	$8 /CY

	CROSS SECTION DIMENSIONS							STANDARD MSE WALL			ADDITIONAL SELECT GRANULAR			ITEM 203 EMBANKMENT			OVERLAPPING SELECT GRANULAR					
	WALL 5 RT.			WALL 5 LT.																		
RAMP C STA.	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)	STA.	WALL HT.	LENGTH OF REINF. ZONE (1)	AREA OF EXPOSED WALL (SF)	UNIT COST OF MSE WALL ($/SF)	COST OF STANDARD MSE WALL	VOLUME OF ADDT'L SELECT GRANULAR (CF)	UNIT COST OF ADDT'L SELECT GRANULAR ($/CY)	COST OF ADDT'L SELECT GRANULAR	VOLUME OF ITEM 203 EMBANKMENT (CF)	UNIT COST OF ITEM 203 EMBANKMENT ($/CY)	COST OF ITEM 203 EMBANKMENT	VOLUME OF OVERLAPPING SELECT GRANULAR (CF)	UNIT COST OF OVERAPPING SELECT GRANULAR ($/CY)	COST SAVINGS OF OVERLAPPING SELECT GRANULAR	TOTAL COST OF WALL AT SECTION	UNIT COST OF WALL ($/SF) AT SECTION	AVE UNIT COST OF WALL ($/SF) B/W SECTIONS
3906+22.41	106+31.00	2.00'	1.40'	94+00.69	5.28'	3.70'															$113
3906+00.00	106+08.59	6.48'	4.54'	94+23.09	5.81'	4.07'	6.3	$85	$536	121.7	$30	$135	144.1	$8	$43		-$30	$0	$714	$113	$111
3905+50.00	105+58.59	7.84'	5.49'	94+73.09	7.18'	5.03'	9.0	$85	$765	145.4	$30	$162	163.1	$8	$48		-$30	$0	$975	$108	$105
3905+00.00	105+08.59	10.37'	7.26'	95+23.09	8.81'	6.17'	13.2	$85	$1,122	171.6	$30	$191	131.6	$8	$39		-$30	$0	$1,352	$102	$101
3904+50.00	104+58.59	13.22'	9.25'	95+73.09	10.77'	7.54'	18.0	$85	$1,530	185.1	$30	$206	127.8	$8	$38		-$30	$0	$1,774	$99	$97
3904+00.00	104+08.59	16.14'	11.30'	96+23.09	12.94'	9.06'	23.1	$85	$1,964	180	$30	$200	129.8	$8	$38		-$30	$0	$2,202	$95	$94
3903+50.00	103+58.59	17.59'	12.31'	96+73.09	15.42'	10.79'	27.0	$85	$2,295	163.7	$30	$182	122.1	$8	$36		-$30	$0	$2,513	$93	$92
3903+00.00	103+08.59	19.52'	13.66'	97+23.09	17.98'	12.59'	31.5	$85	$2,678	131.5	$30	$146	135.1	$8	$40		-$30	$0	$2,864	$91	$90
3902+50.00	102+58.59	21.50'	15.05'	97+73.09	20.77'	14.54'	36.3	$85	$3,086	82	$30	$91	129.6	$8	$38		-$30	$0	$3,215	$89	$88
3902+00.00	102+08.59	23.36'	16.35'	98+23.09	23.98'	16.79'	41.3	$85	$3,511	11.9	$30	$13	141.7	$8	$42		-$30	$0	$3,566	$86	$85
3901+50.00	101+58.59	25.11'	17.58'	98+73.09	27.35'	19.15'	46.5	$85	$3,953		$30	$0	58.5	$8	$17	75.2	-$30	-$84	$3,886	$84	$83
3901+00.00	101+09.23	27.64'	19.35'	99+24.61	30.78'	21.55'	52.4	$85	$4,454		$30	$0	115.6	$8	$34	197.5	-$30	-$219	$4,269	$81	$80
3900+50.00	100+59.92	31.69'	22.18'	99+76.24	33.99'	23.79'	59.7	$85	$5,075		$30	$0	42.0	$8	$12	386.1	-$30	-$429	$4,658	$78	$78
3900+25.50	100+35.67	19.72'	13.80'	100+01.33	19.83'	13.88'															

NOTES:
1. Length of reinforced zone is assumed to be equal to 0.7 x Wall Height.

WALL 5



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544.61
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174.1 SF
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540.36
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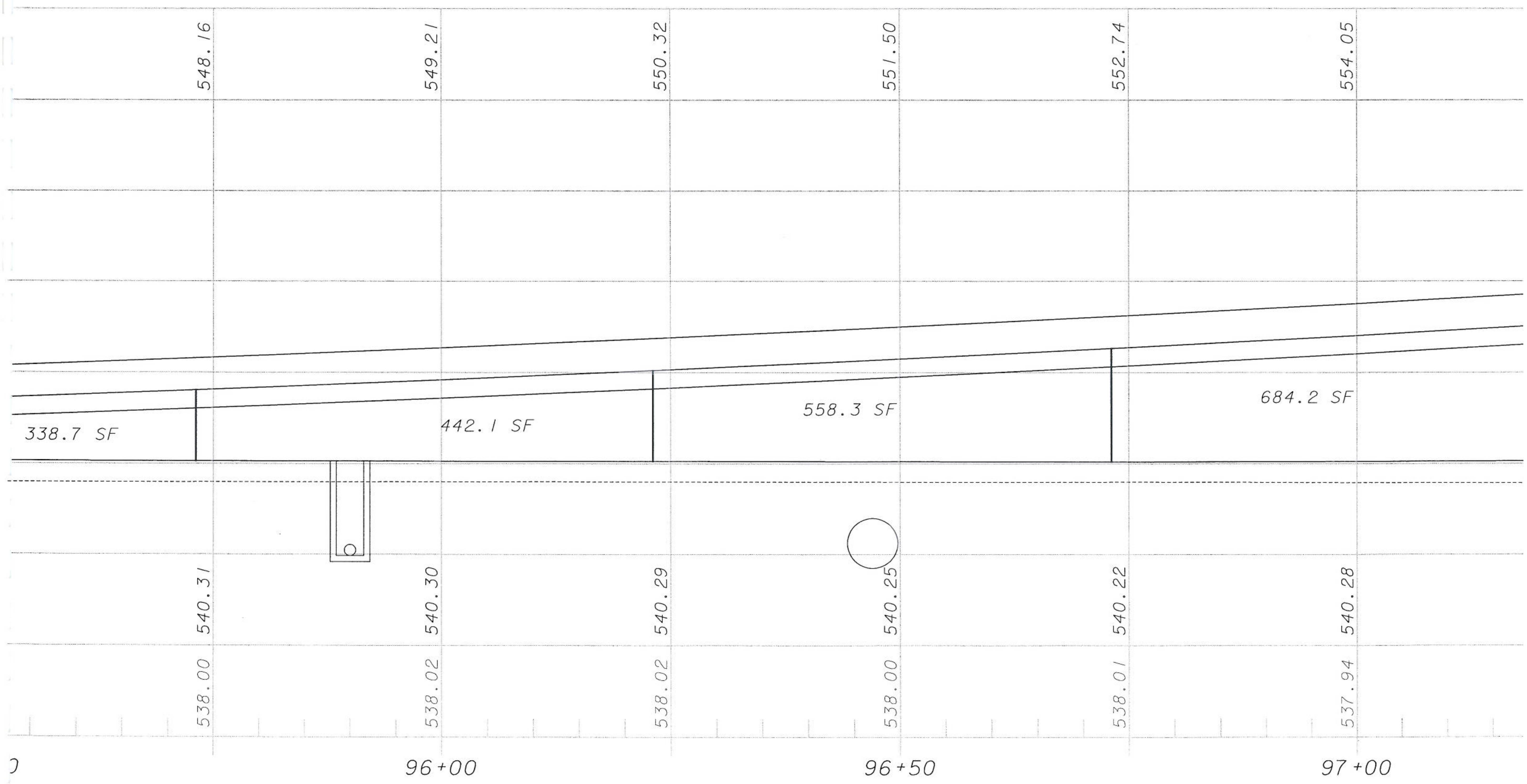
94+00
94+50
95+00

WALL 5



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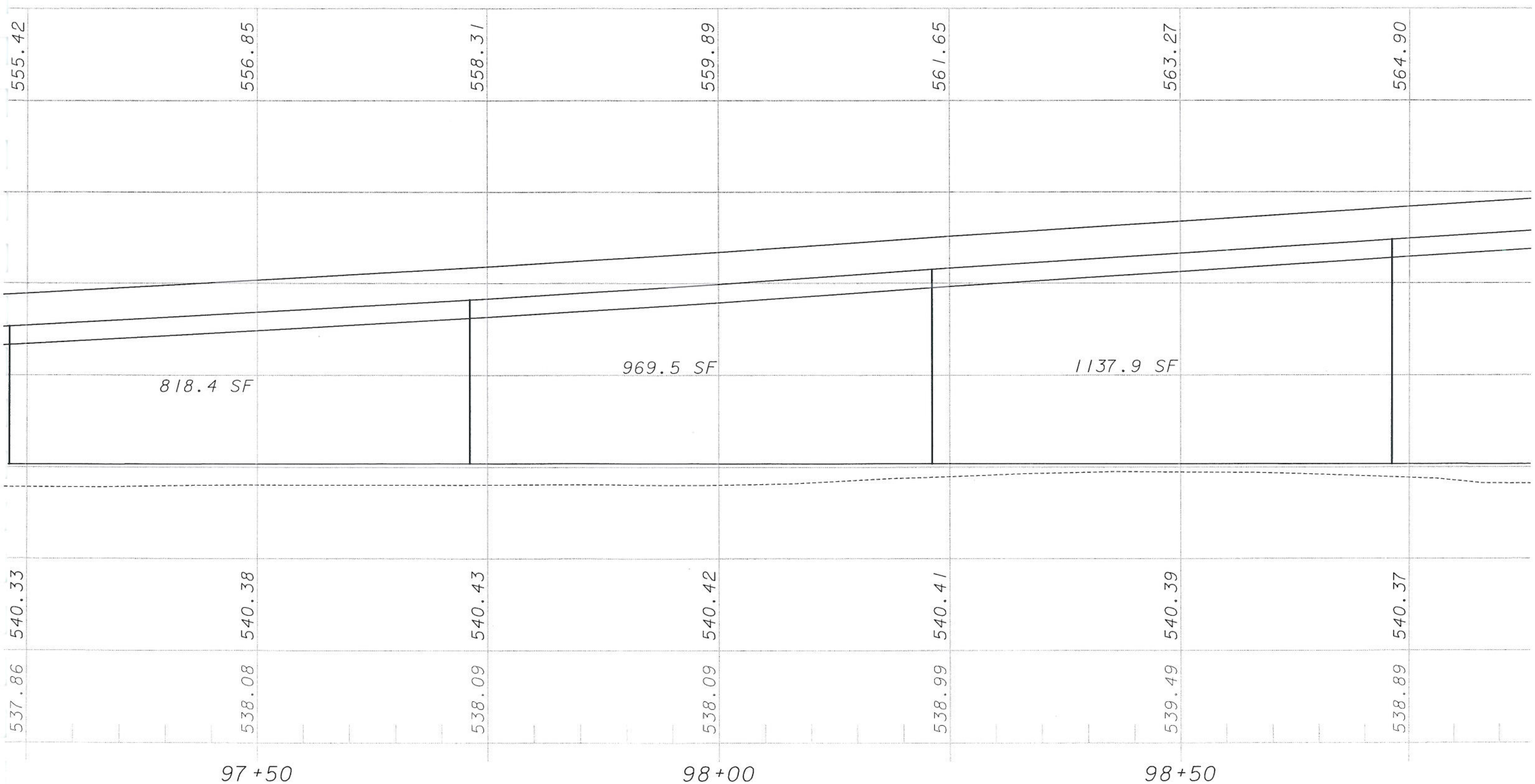
96+50
97+00

WALL 5



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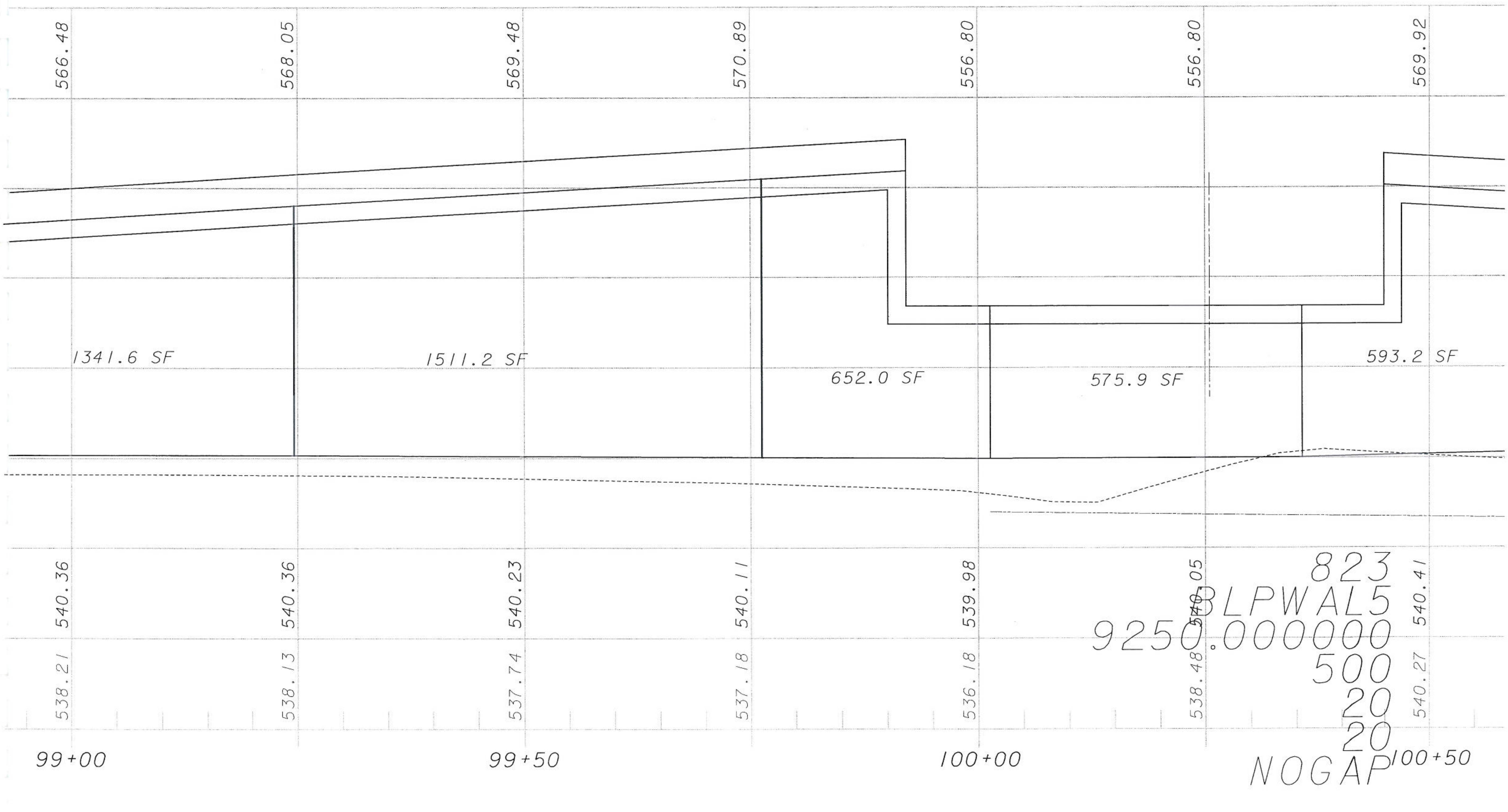
WALL 5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593.2 SF
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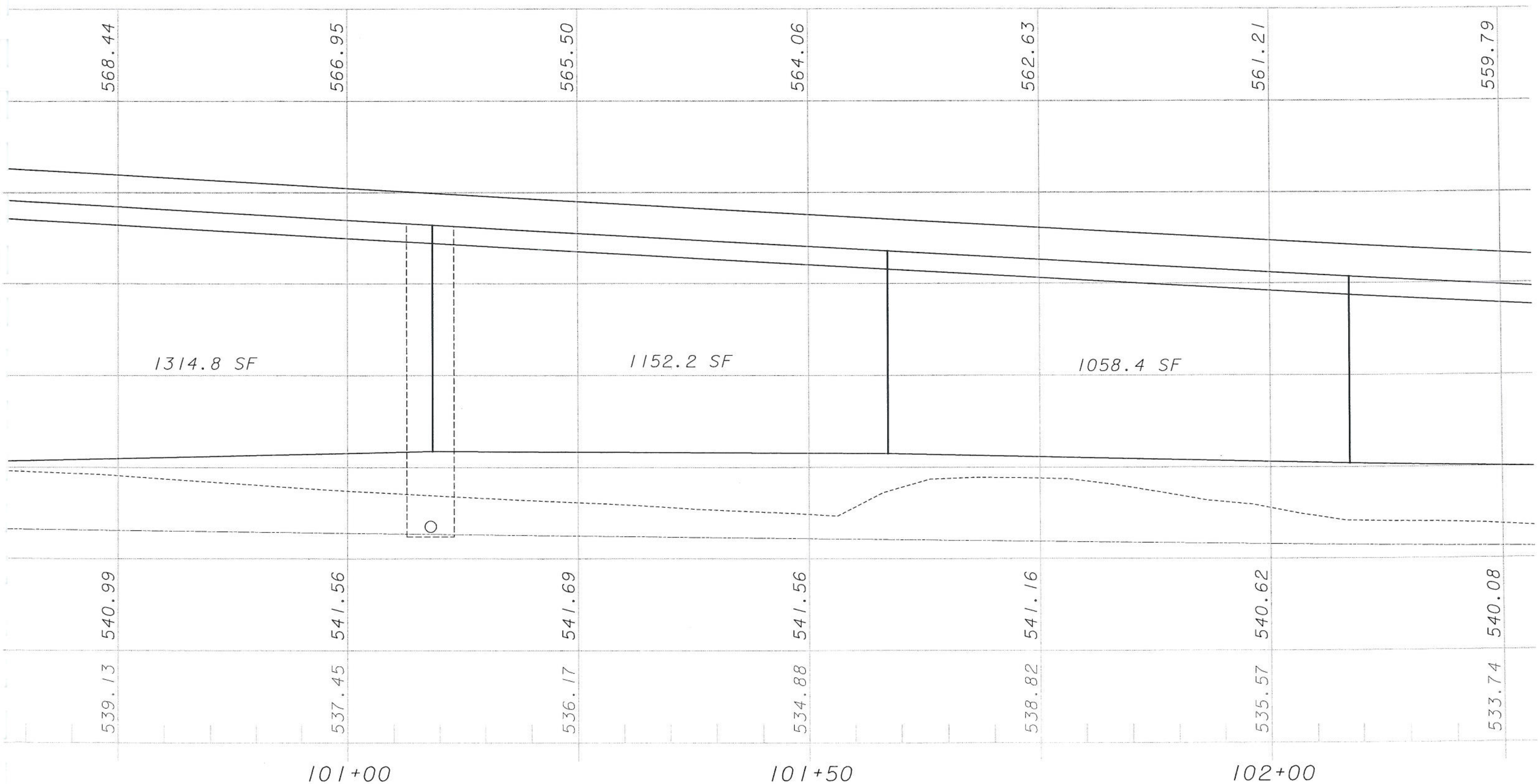
WALL 5



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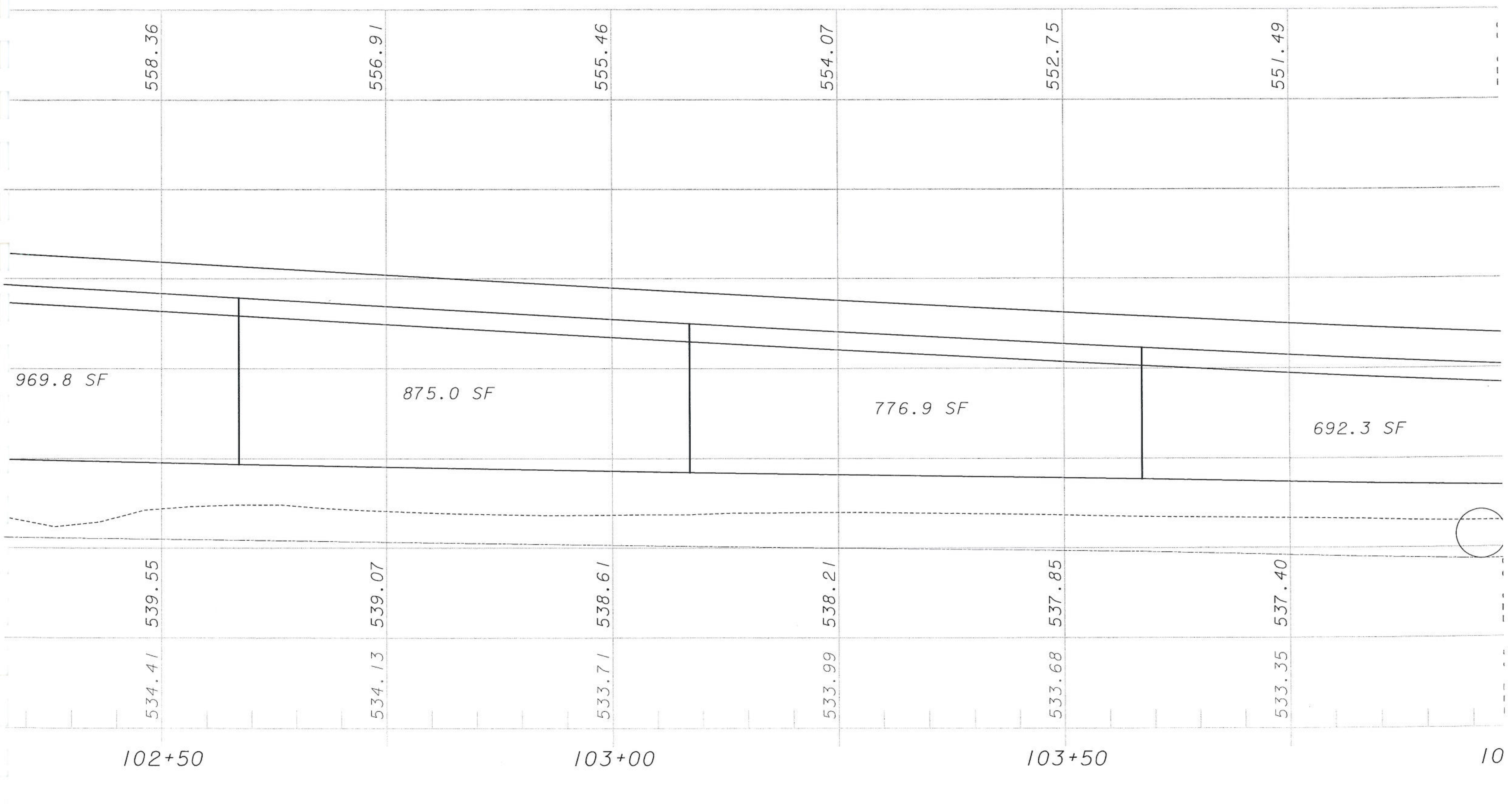
WALL 5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102+50
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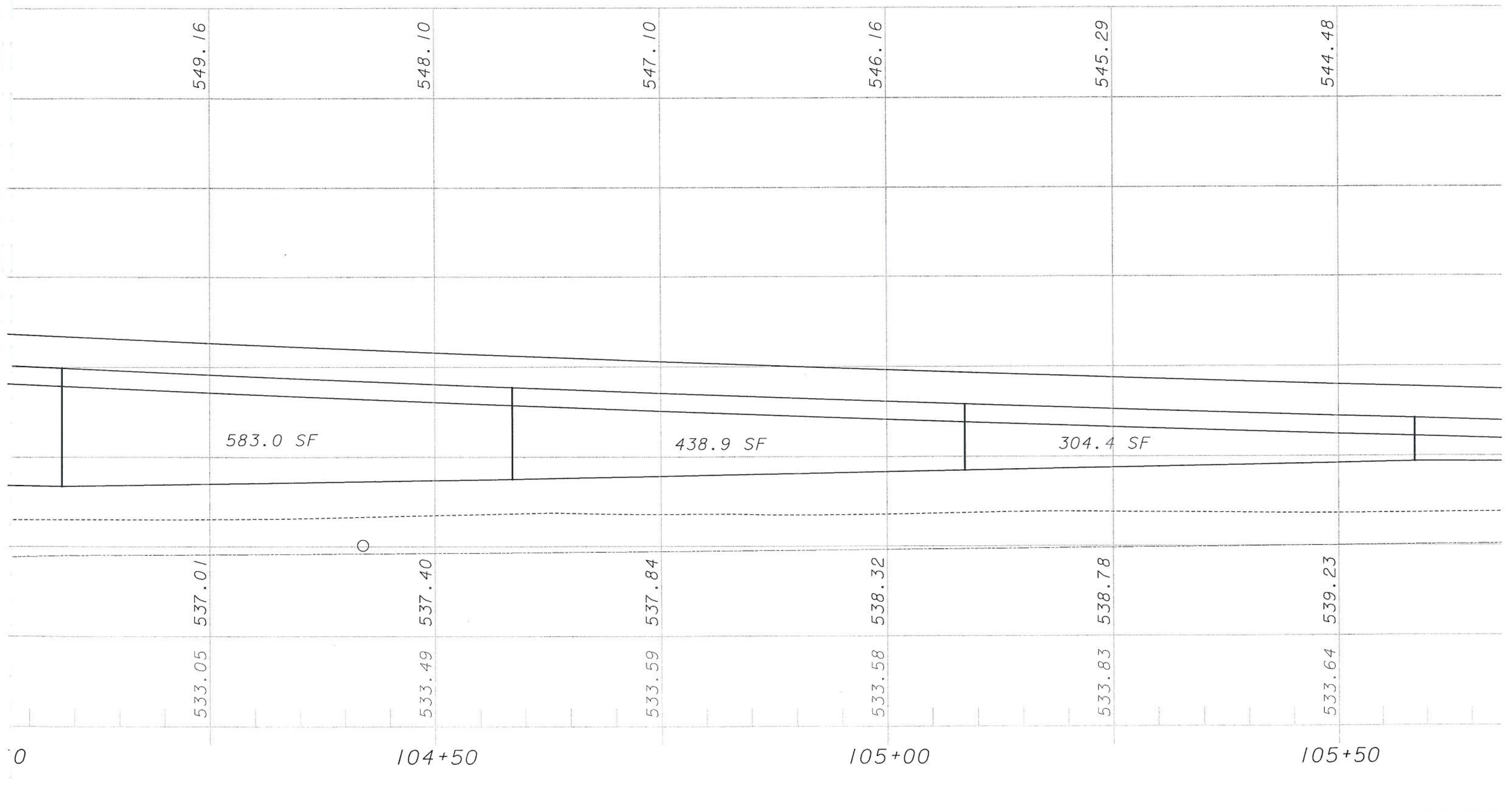
10

WALL 5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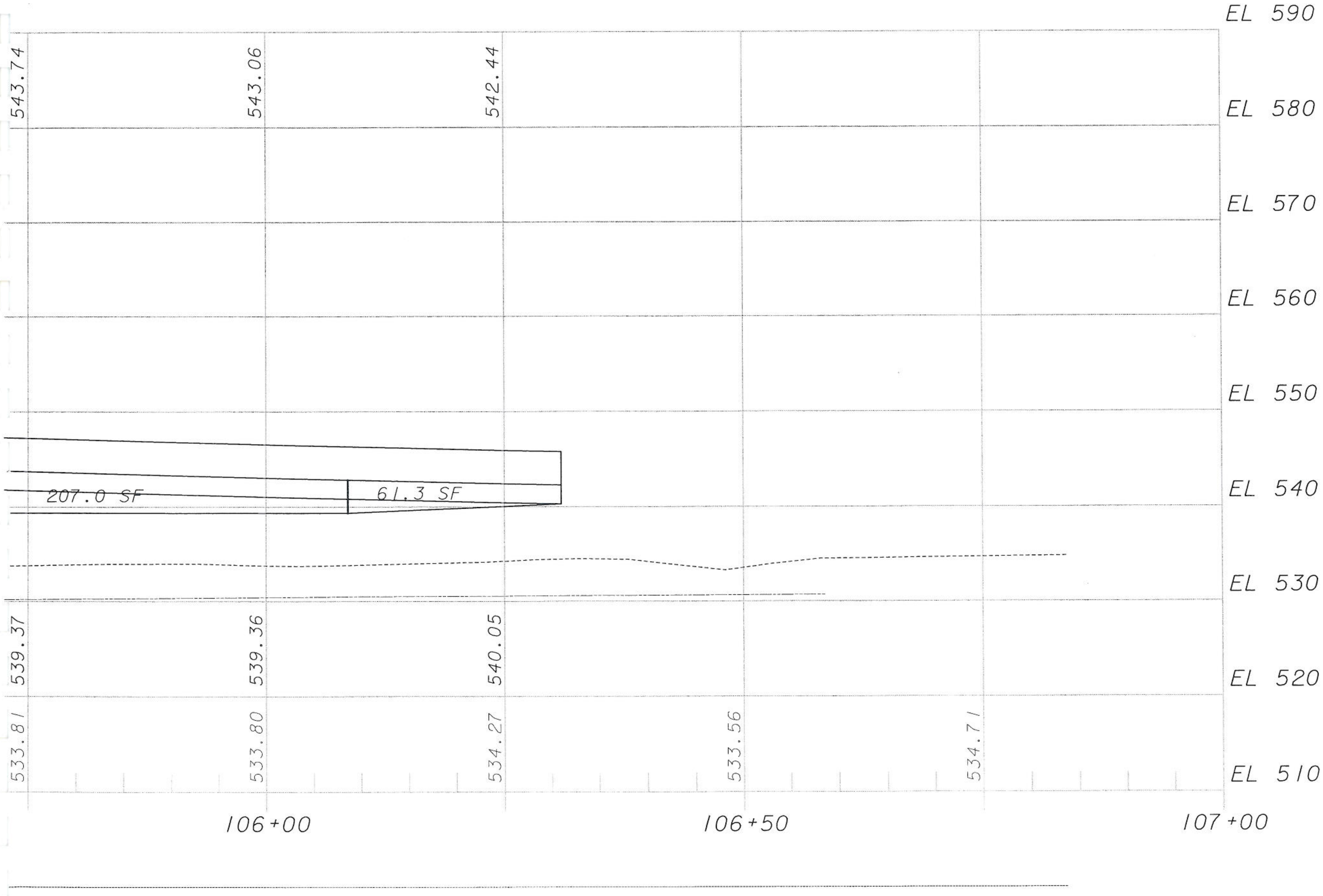
533.49
533.59
533.58
533.83
533.64
104+50
105+00
105+50

WALL 5



EL 590
EL 580
EL 570
EL 560
EL 550
EL 540
EL 530
EL 520
EL 510
543.74
543.06
542.44
207.0 SF
61.3 SF
539.37
539.36
540.05
533.81
533.80
534.27
533.56
534.71
106+00
106+50
107+00

COST OF WALL 5

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 8 - Preliminary Design Report\Wall Preliminary Design\[Wall5Cost.xls]Sheet1

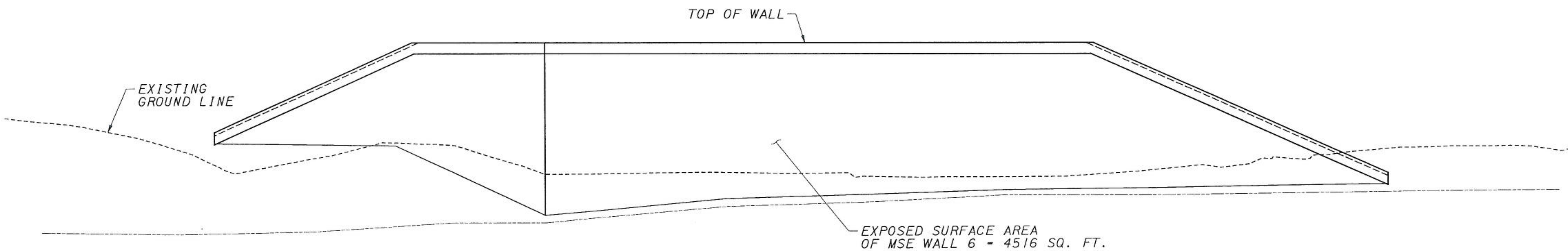
Designer: DGS Date: 9/27/2007
Checker: SKT Date: 11/20/2007

Wall Area	Wall Station		Unit Cost of Wall ($/SF)	Wall Area (SF)	Cost of Wall Area
	From	To			
Area 1	93+87.00	94+00.69	$85	29.3	$2,491
Area 2	94+00.69	94+23.09	$113	57.1	$6,452
Area 3	94+23.09	94+73.09	$111	174.1	$19,325
Area 4	94+73.09	95+23.09	$105	249.0	$26,145
Area 5	95+23.09	95+73.09	$101	338.7	$34,209
Area 6	95+73.09	96+23.09	$97	442.1	$42,884
Area 7	96+23.09	96+73.09	$94	558.3	$52,480
Area 8	96+73.09	97+23.09	$92	684.2	$62,946
Area 9	97+23.09	97+73.09	$90	818.4	$73,656
Area 10	97+73.09	98+23.09	$88	969.5	$85,316
Area 11	98+23.09	98+73.09	$85	1137.9	$96,722
Area 12	98+73.09	99+24.61	$83	1341.6	$111,353
Area 13	99+24.61	99+76.24	$80	1511.2	$120,896
Area 14	99+76.24	100+01.33	$78	652.0	$50,856
Area 15	100+01.33	100+35.67	$50	575.9	$28,795
Area 16	100+35.67	100+59.92	$78	593.2	$46,270
Area 17	100+59.92	101+09.23	$80	1314.8	$105,184
Area 18	101+09.23	101+58.59	$83	1152.2	$95,633
Area 19	101+58.59	102+08.59	$85	1058.4	$89,964
Area 20	102+08.59	102+58.59	$88	969.8	$85,342
Area 21	102+58.59	103+08.59	$90	875.0	$78,750
Area 22	103+08.59	103+58.59	$92	776.9	$71,475
Area 23	103+58.59	104+08.59	$94	692.3	$65,076
Area 24	104+08.59	104+58.59	$97	583.0	$56,551
Area 25	104+58.59	105+08.59	$101	438.9	$44,329
Area 26	105+08.59	105+58.59	$105	304.4	$31,962
Area 27	105+58.59	106+08.59	$111	207.0	$22,977
Area 28	106+08.59	106+31.00	$113	61.3	$6,927
TOTAL COST OF WALL 5					$1,614,966

Total Area of Wall 5 18566.5 ft^2

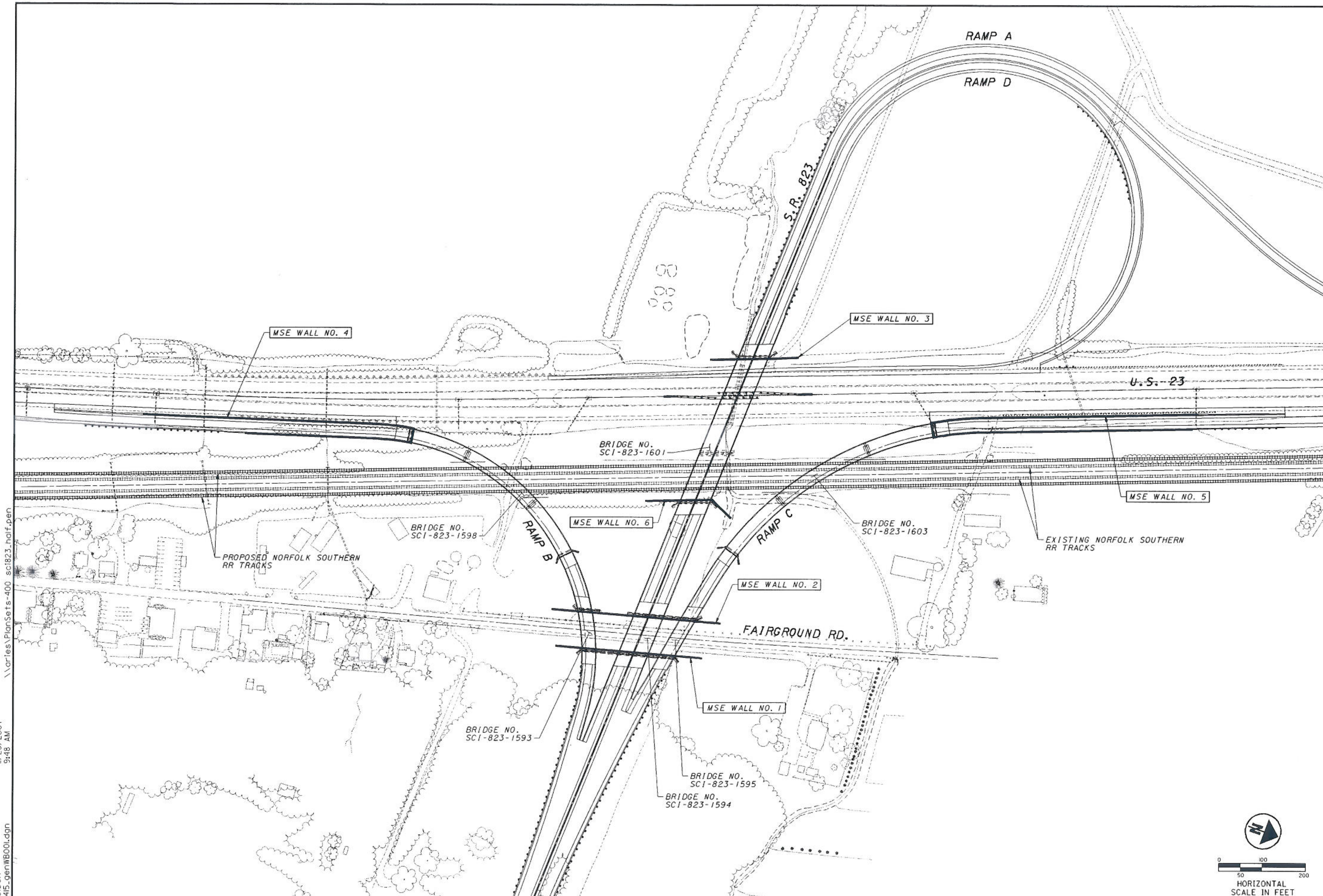
Ave. Unit Cost of Wall 5 $87.00 per ft^2

MSE WALL SURFACE AREA



MSE WALL NO. 6

APPENDIX C



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Dublin, Ohio 43017

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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

RETAINING WALL KEY PLAN

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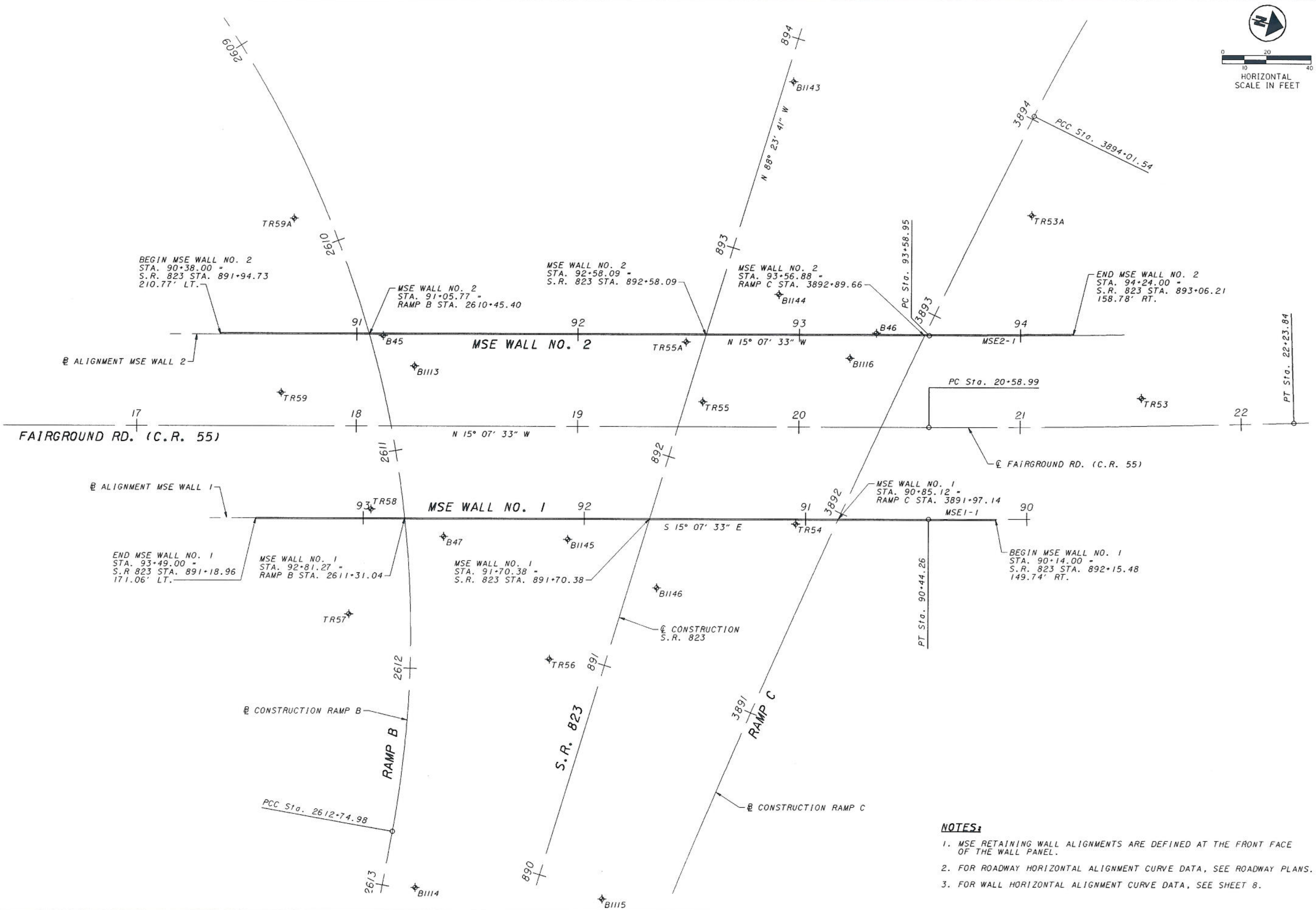

NOTES:

1. MSE RETAINING WALL ALIGNMENTS ARE DEFINED AT THE FRONT FACE OF THE WALL PANEL.
2. FOR ROADWAY HORIZONTAL ALIGNMENT CURVE DATA, SEE ROADWAY PLANS.
3. FOR WALL HORIZONTAL ALIGNMENT CURVE DATA, SEE SHEET 8.

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

DESIGN AGENCY
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Dublin, Ohio 43017

WALL SCHEMATIC PLAN

S.R. 823 STA. 890+00
TO STA. 894+00

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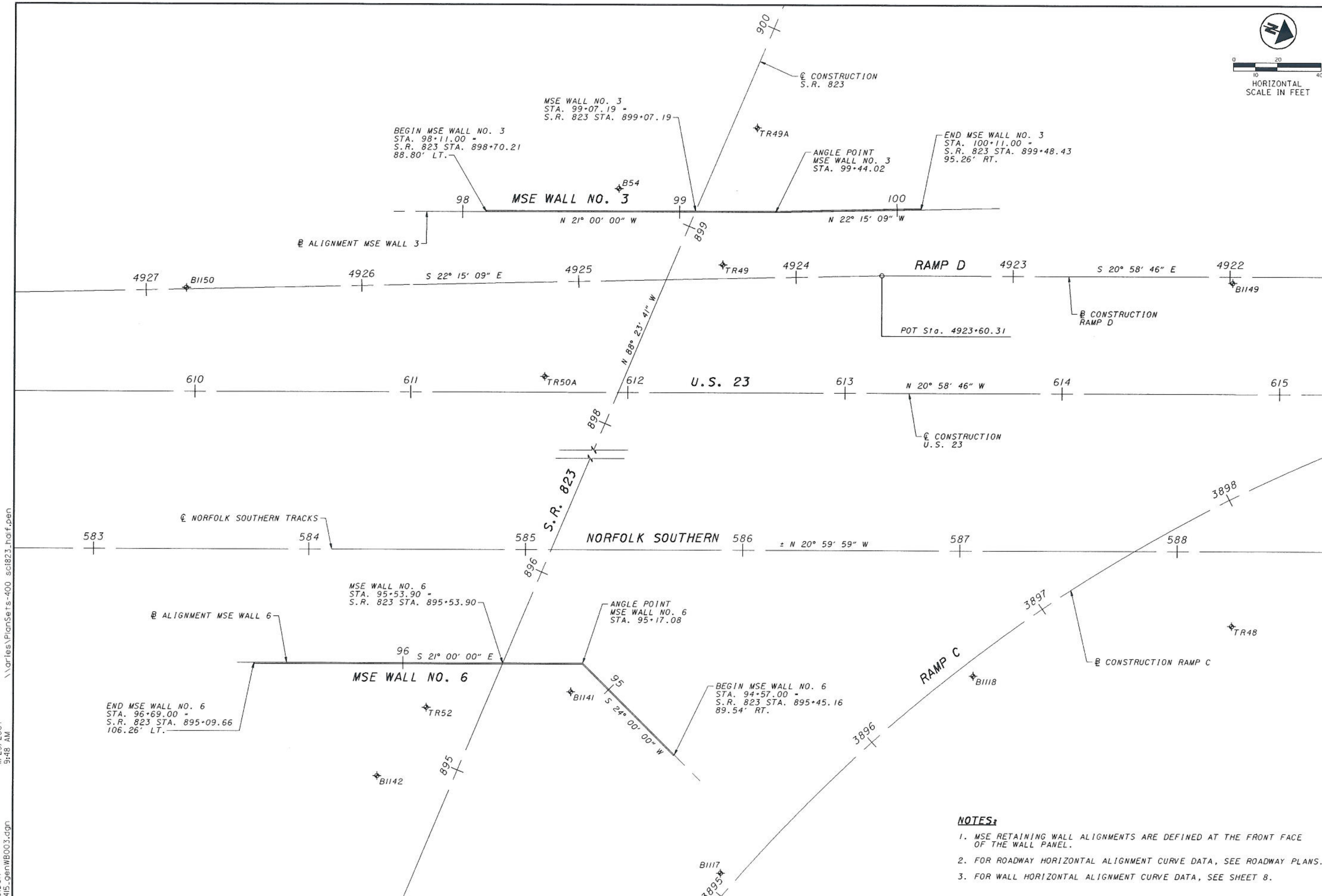

NOTES:

1. MSE RETAINING WALL ALIGNMENTS ARE DEFINED AT THE FRONT FACE OF THE WALL PANEL.
2. FOR ROADWAY HORIZONTAL ALIGNMENT CURVE DATA, SEE ROADWAY PLANS.
3. FOR WALL HORIZONTAL ALIGNMENT CURVE DATA, SEE SHEET 8.

WALL SCHEMATIC PLAN

S.R. 823 STA. 894+50 TO STA. 900+00

DESIGN AGENCY CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017

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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

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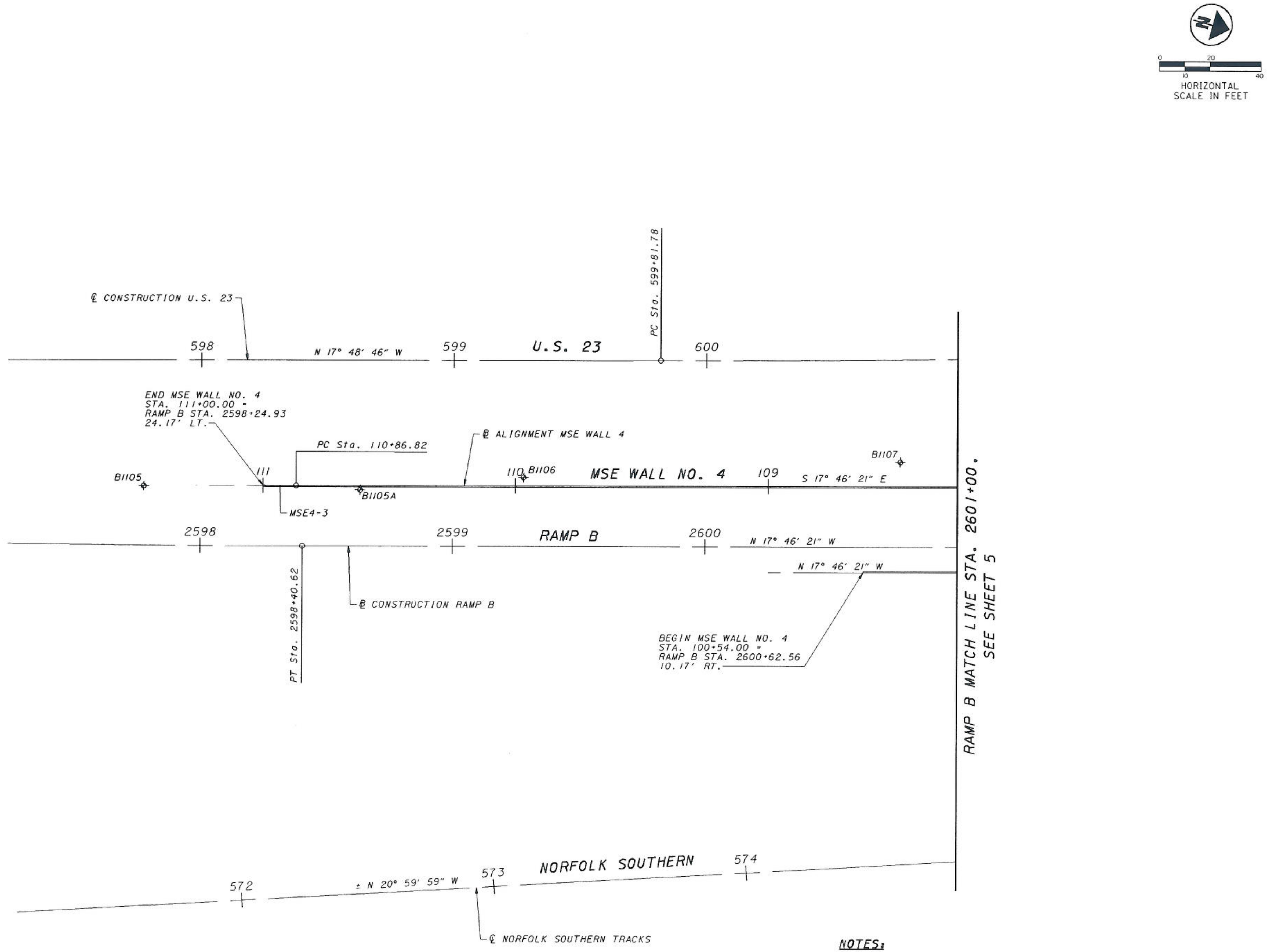

NOTES:

1. MSE RETAINING WALL ALIGNMENTS ARE DEFINED AT THE FRONT FACE OF THE WALL PANEL.
2. FOR ROADWAY HORIZONTAL ALIGNMENT CURVE DATA, SEE ROADWAY PLANS.
3. FOR WALL HORIZONTAL ALIGNMENT CURVE DATA, SEE SHEET 8.

DESIGN AGENCY	DESIGNED	DRAWN	REVIEWED	DATE
CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017	JBA	JBA	SKT	11/07
	CHECKED	REVISED	STRUCTURE FILE NUMBER	
	DGS			

WALL SCHEMATIC PLAN

RAMP B STA. 2597+50 TO STA. 2601+00

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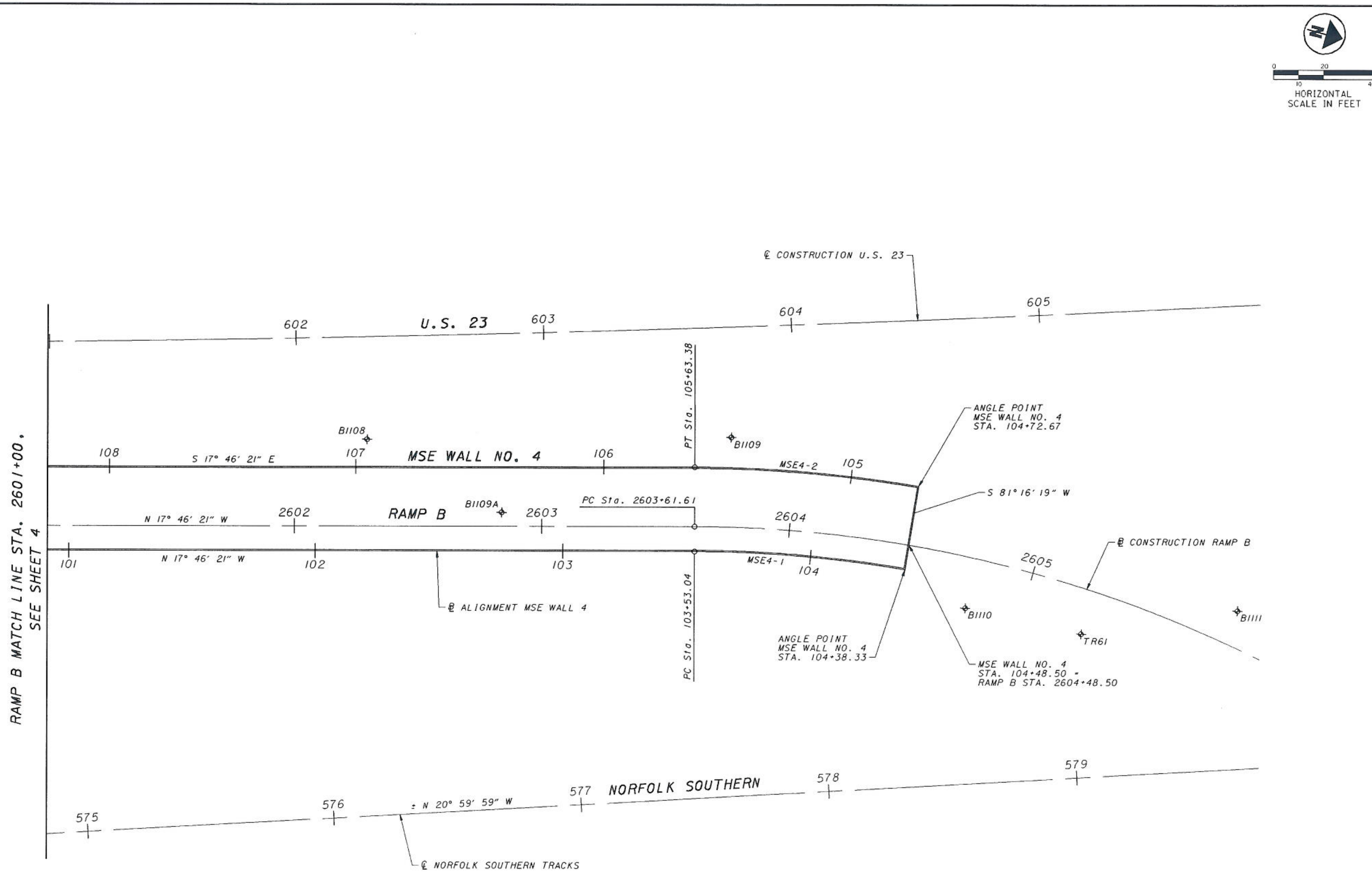

NOTES:

1. MSE RETAINING WALL ALIGNMENTS ARE DEFINED AT THE FRONT FACE OF THE WALL PANEL.
2. FOR ROADWAY HORIZONTAL ALIGNMENT CURVE DATA, SEE ROADWAY PLANS.
3. FOR WALL HORIZONTAL ALIGNMENT CURVE DATA, SEE SHEET 8.

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	CHECKED DGS	REVISED	STRUCTURE FILE NUMBER	

WALL SCHEMATIC PLAN
RAMP B STA. 2601+00 TO STA. 2605+50

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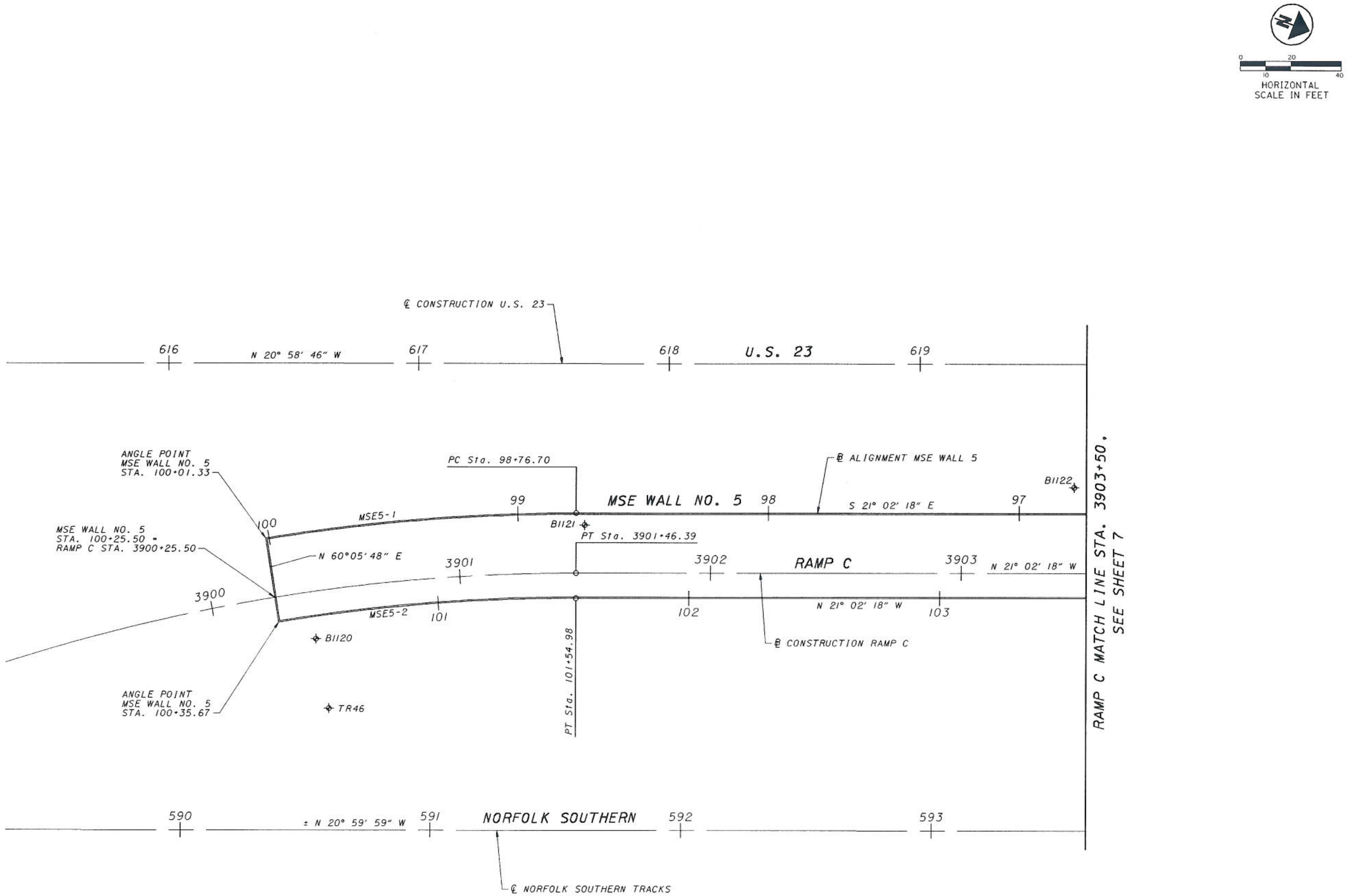

NOTES:

1. MSE RETAINING WALL ALIGNMENTS ARE DEFINED AT THE FRONT FACE OF THE WALL PANEL.
2. FOR ROADWAY HORIZONTAL ALIGNMENT CURVE DATA, SEE ROADWAY PLANS.
3. FOR WALL HORIZONTAL ALIGNMENT CURVE DATA, SEE SHEET 8.

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DGS			

WALL SCHEMATIC PLAN
RAMP C STA. 3899+50
TO STA. 3903+50

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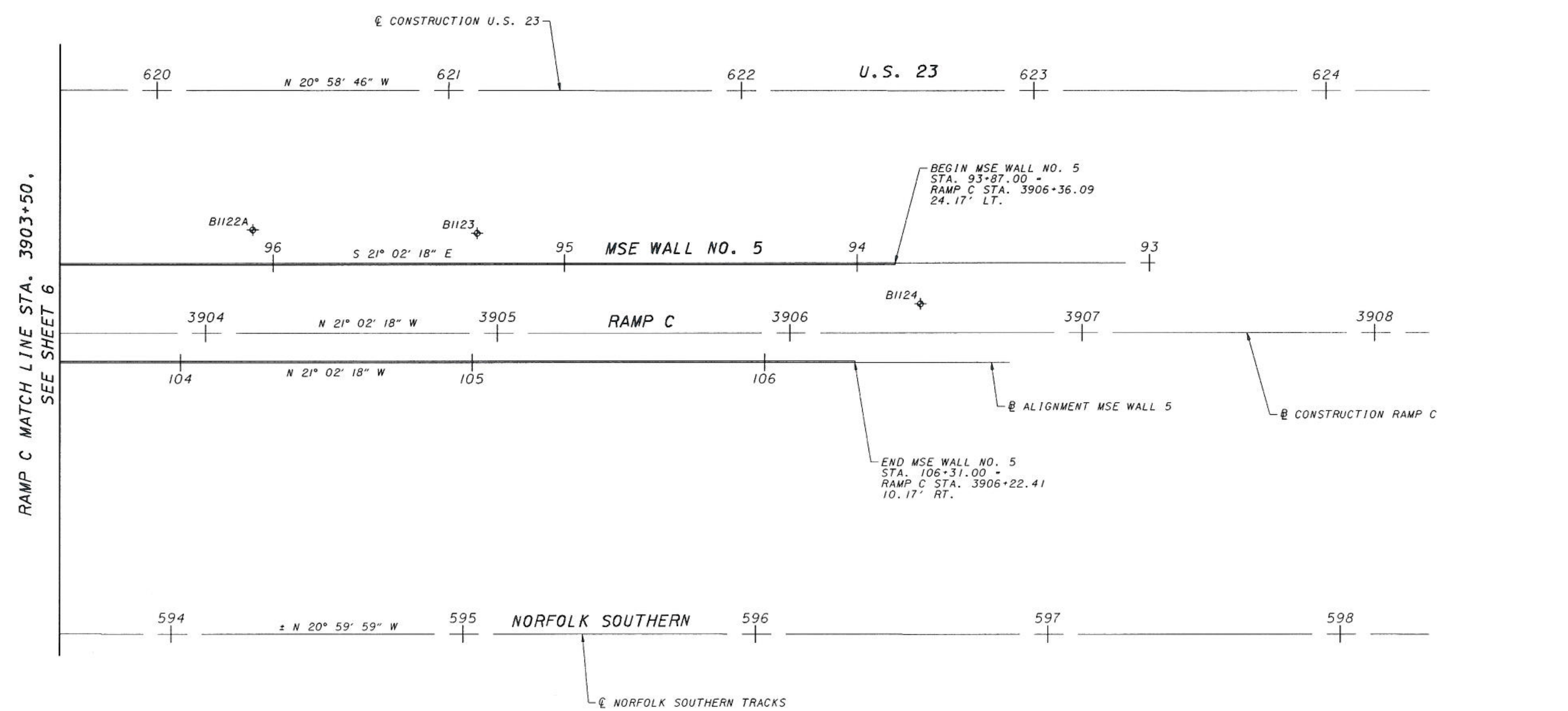

NOTES:

1. MSE RETAINING WALL ALIGNMENTS ARE DEFINED AT THE FRONT FACE OF THE WALL PANEL.
2. FOR ROADWAY HORIZONTAL ALIGNMENT CURVE DATA, SEE ROADWAY PLANS.
3. FOR WALL HORIZONTAL ALIGNMENT CURVE DATA, SEE SHEET 8.

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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL SCHEMATIC PLAN

RAMP C STA. 3903+50
TO STA. 3908+00

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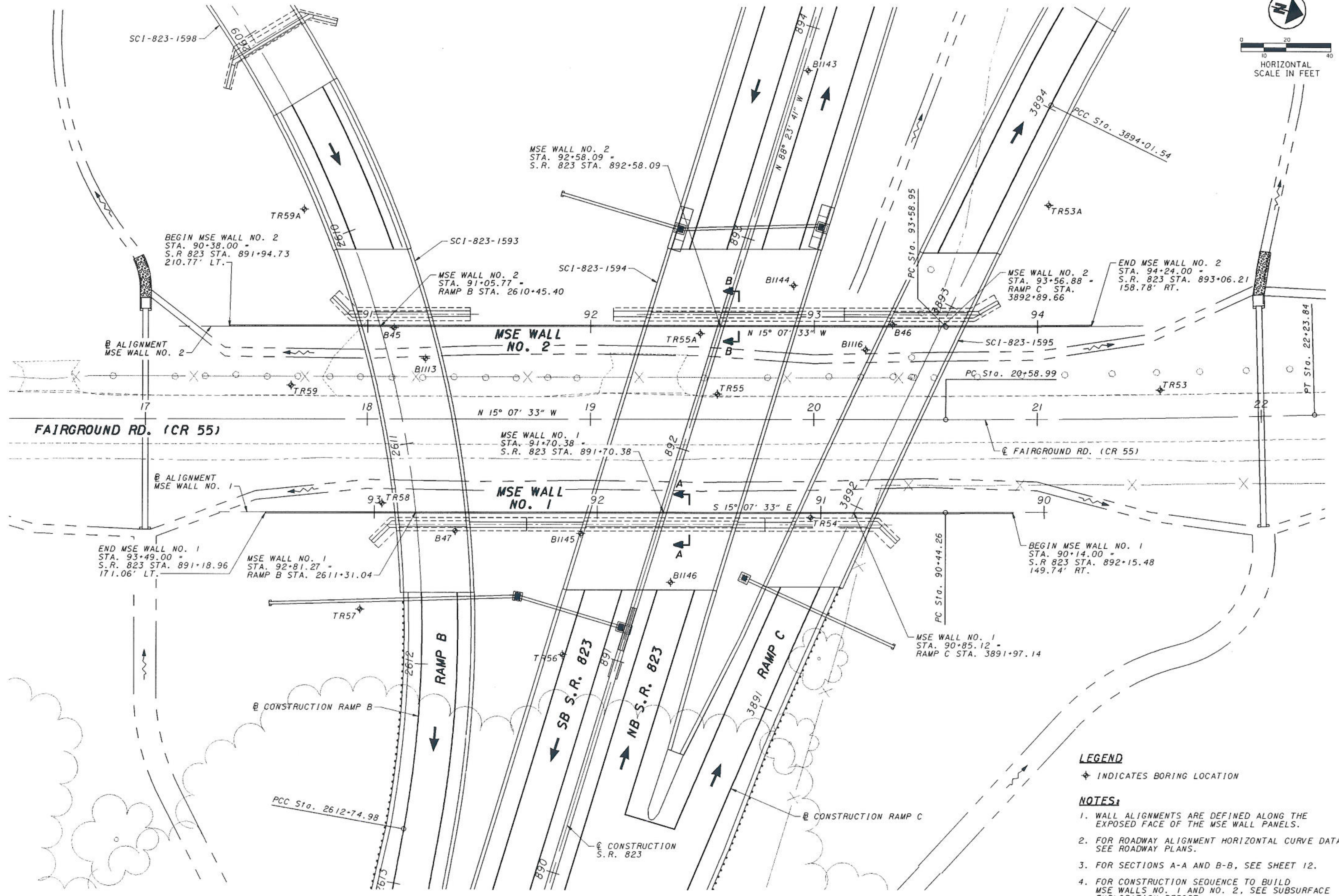
HORIZONTAL CURVE DATA

ALIGNMENT	CURVE NO.	P.I. STATION	P.I. COORDINATES NORTH	P.I. COORDINATES EAST	Δ	Dc	R	T	Lc	L	E	P.C. STATION	P.C. COORDINATES NORTH	P.C. COORDINATES EAST	P.T. STATION	P.T. COORDINATES NORTH	P.T. COORDINATES EAST
MSE WALL 1	MSE1-1	89+97.68	325484.93	1826854.87	0° 55' 31" RT.	0° 59' 36"	5768.58'	46.59'	93.17'	93.17'	0.19'	89+51.10	325529.70	1826841.99	90+44.26	325439.96	1826867.03
MSE WALL 2	MSE2-1	94+21.91	325478.82	1826769.51	1° 16' 09" LT.	1° 00' 29"	5684.58'	62.96'	125.91'	125.91'	0.35'	93+58.95	325418.04	1826785.94	94+84.87	325539.22	1826751.74
MSE WALL 3																	
MSE WALL 4	MSE4-1	103+95.79	324624.73	1826624.78	9° 47' 26" RT.	11° 28' 45"	499.13'	42.75'	85.19'	85.29'	1.83'	103+53.04	324584.02	1826637.83	104+38.33	324667.06	1826618.84
	MSE4-2	105+18.13	324616.83	1826591.26	9° 44' 33" LT.	10° 44' 25"	533.46'	45.46'	90.60'	90.71'	1.93'	104+72.67	324661.85	1826584.91	105+63.38	324573.54	1826605.13
	MSE4-3	111+06.73	324056.12	1826770.99	0° 17' 59" RT.	0° 45' 09"	7615.27'	19.91'	39.82'	39.82'	0.03'	110+86.82	324075.08	1826764.91	111+26.64	324037.13	1826776.96
MSE WALL 5	MSE5-1	99+39.16	325829.52	1826130.43	9° 21' 11" LT.	7° 30' 17"	763.47'	62.45'	124.49'	124.63'	2.55'	98+76.70	325887.81	1826108.01	100+01.33	325775.65	1826162.03
	MSE5-2	100+95.46	325844.33	1826161.52	9° 22' 34" RT.	7° 51' 29"	729.13'	59.79'	119.18'	119.32'	2.45'	100+35.67	325792.77	1826191.79	101+54.98	325900.14	1826140.06
MSE WALL 6																	



LEGEND

✧ INDICATES BORING LOCATION

NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA SEE ROADWAY PLANS.
3. FOR SECTIONS A-A AND B-B, SEE SHEET 12.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALLS NO. 1 AND NO. 2, SEE SUBSURFACE EXPLORATION REPORT.

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CHECKED DGS	REVISED	STRUCTURE FILE NUMBER	

MSE WALLS 1 & 2 PLAN VIEW

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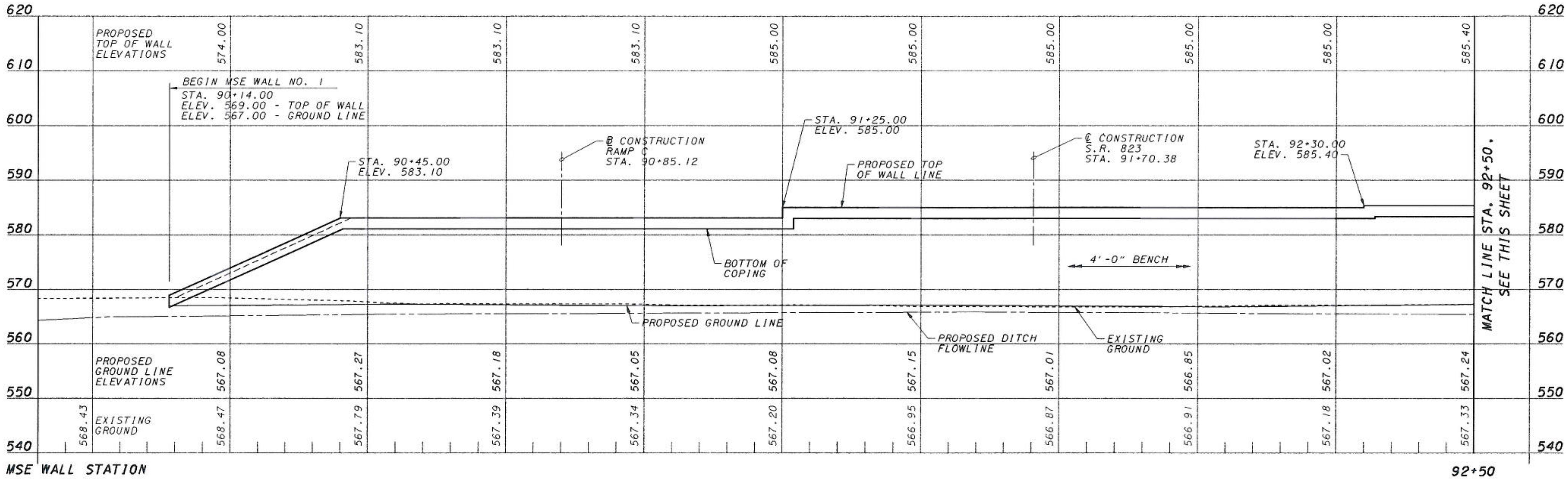

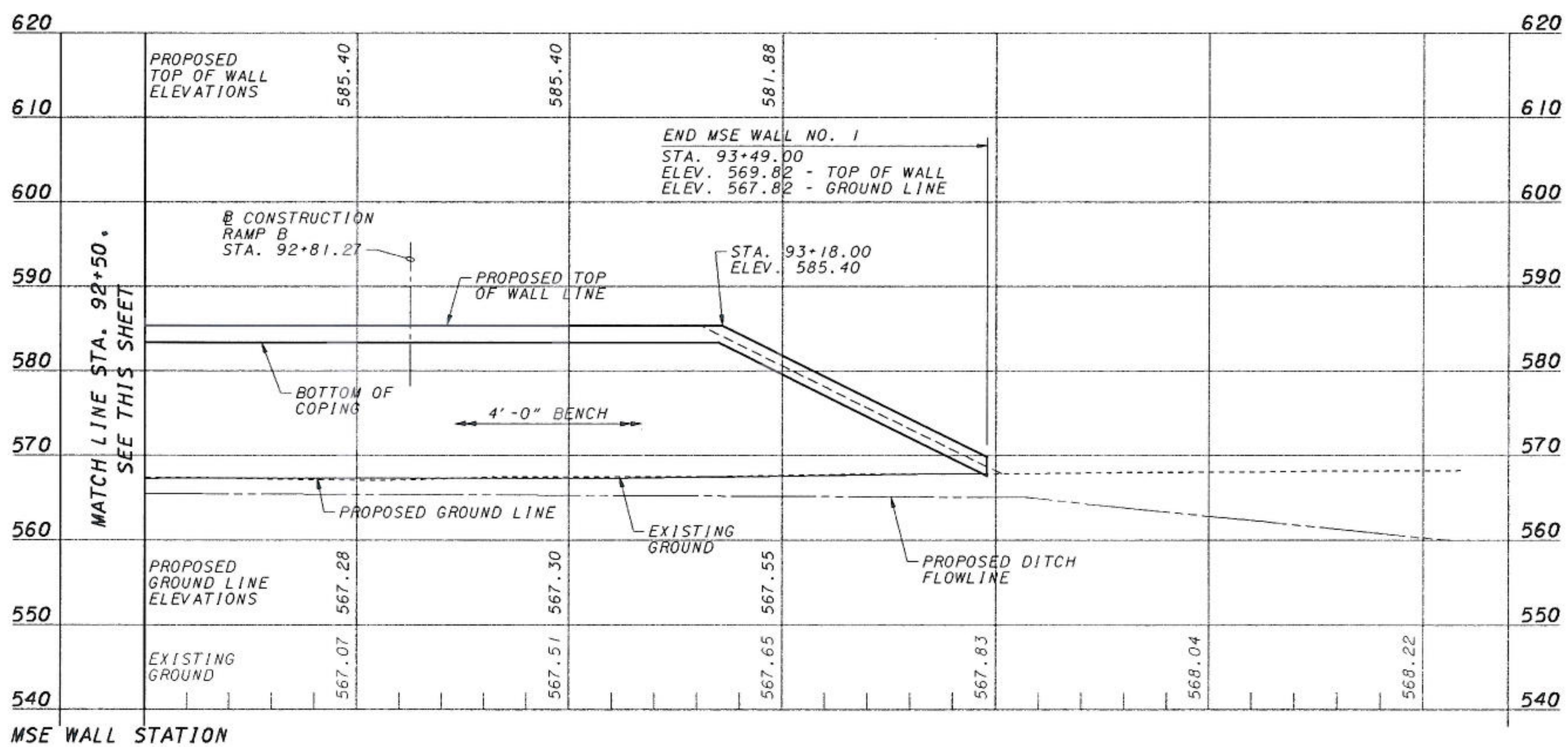

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 12.

DESIGN AGENCY
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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL ELEVATION - MSE WALL NO. 1

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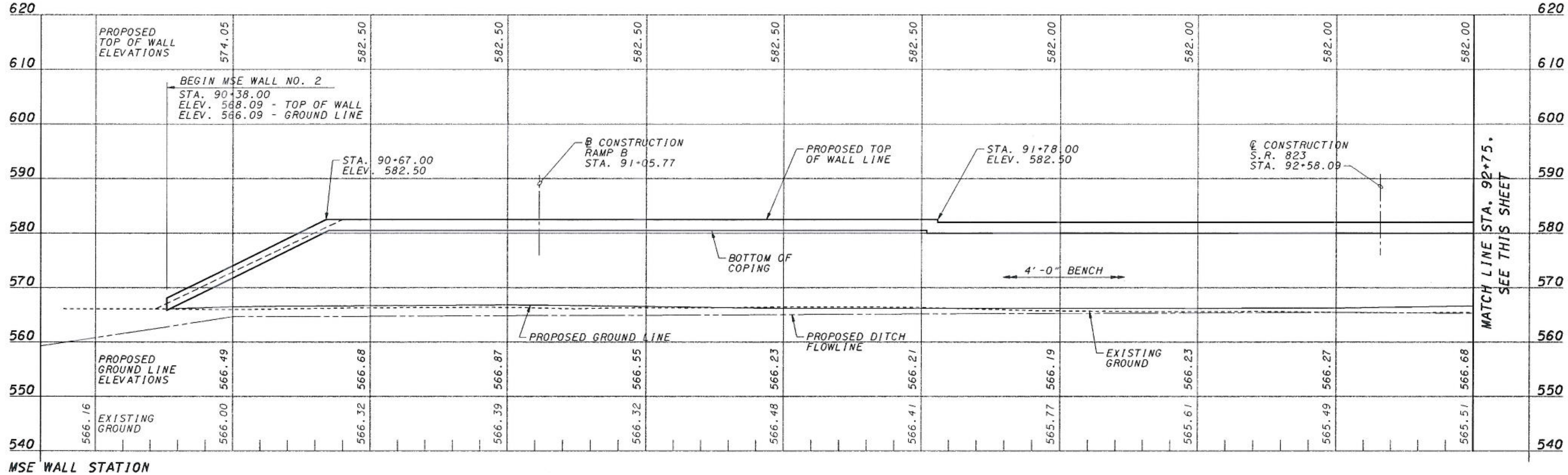

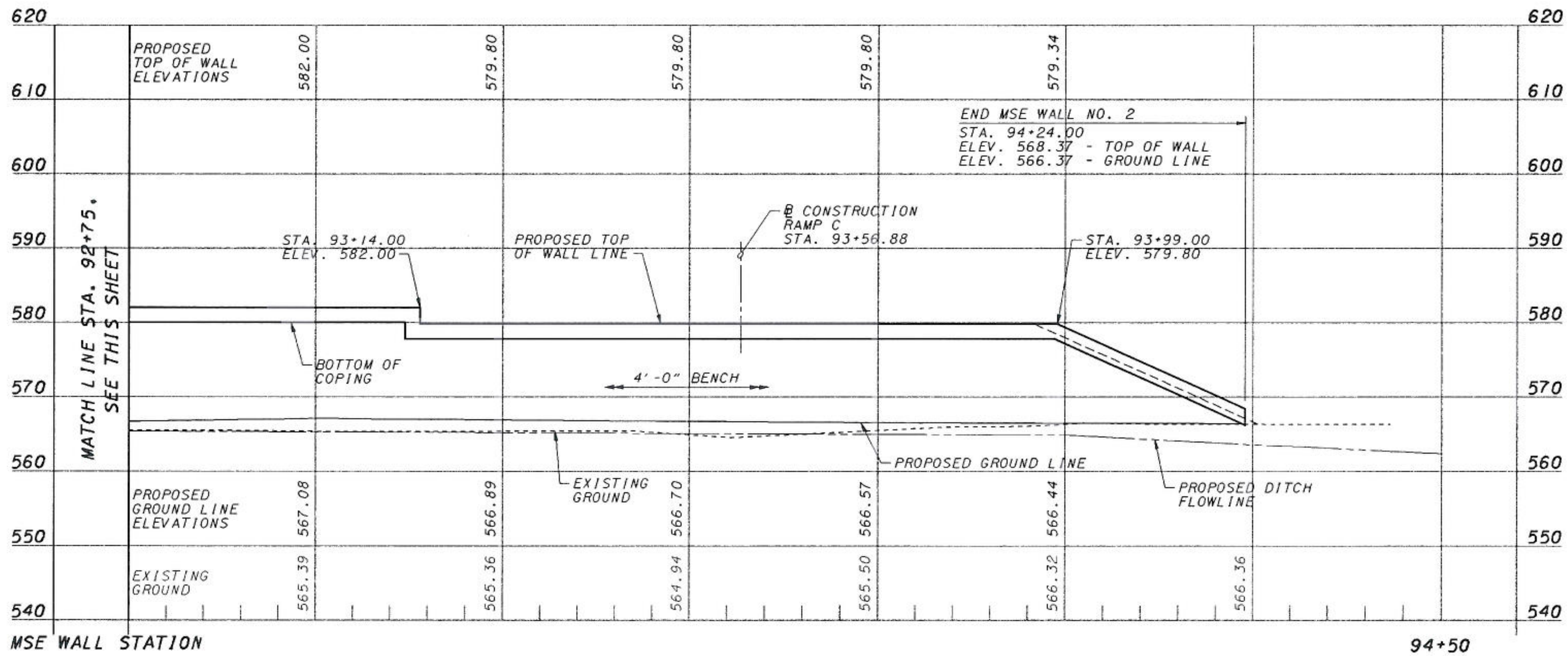

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 12.

DESIGNED	DRAWN	REVIEWED	DATE
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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

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WALL ELEVATION - MSE WALL NO. 2

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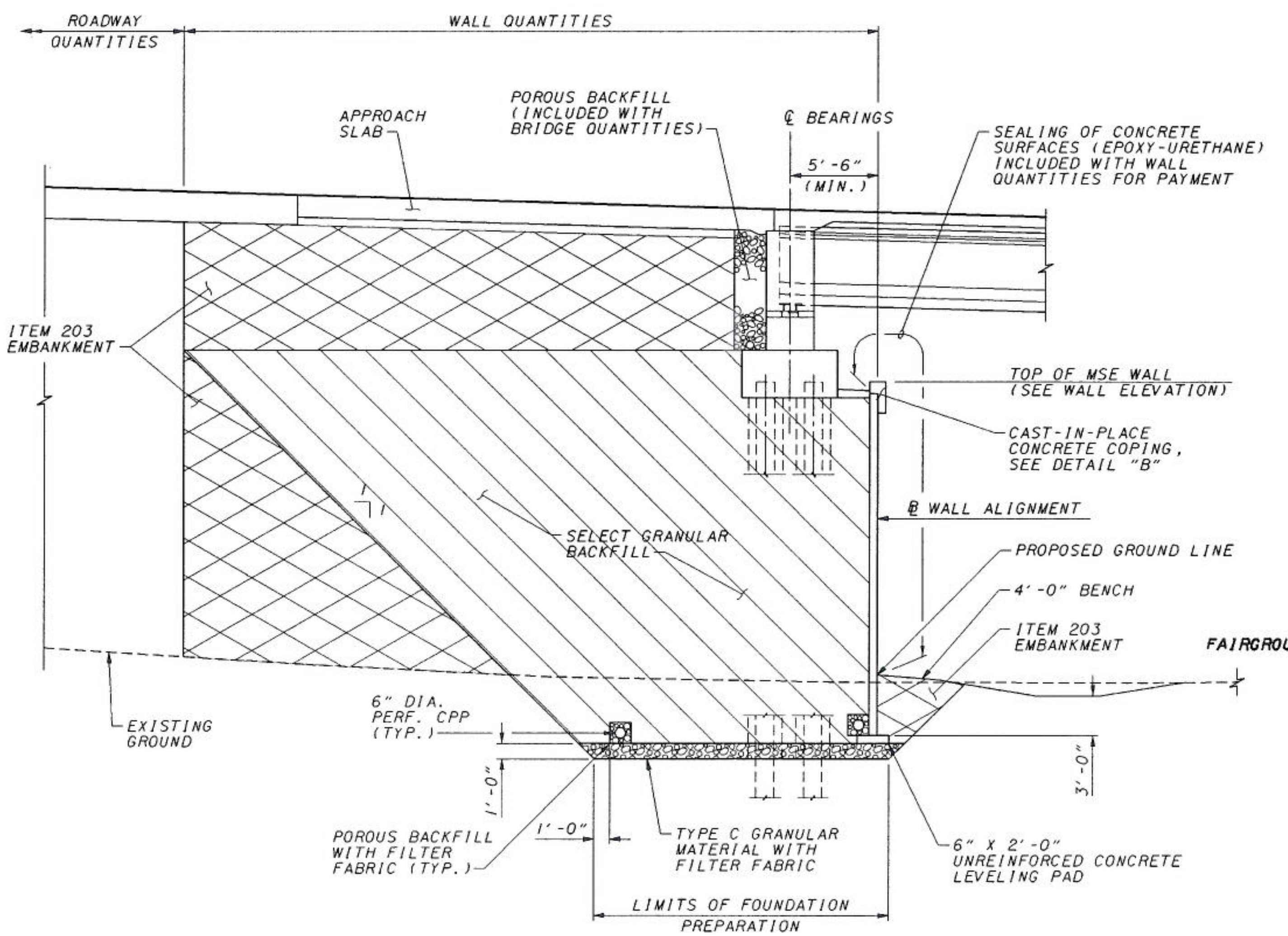
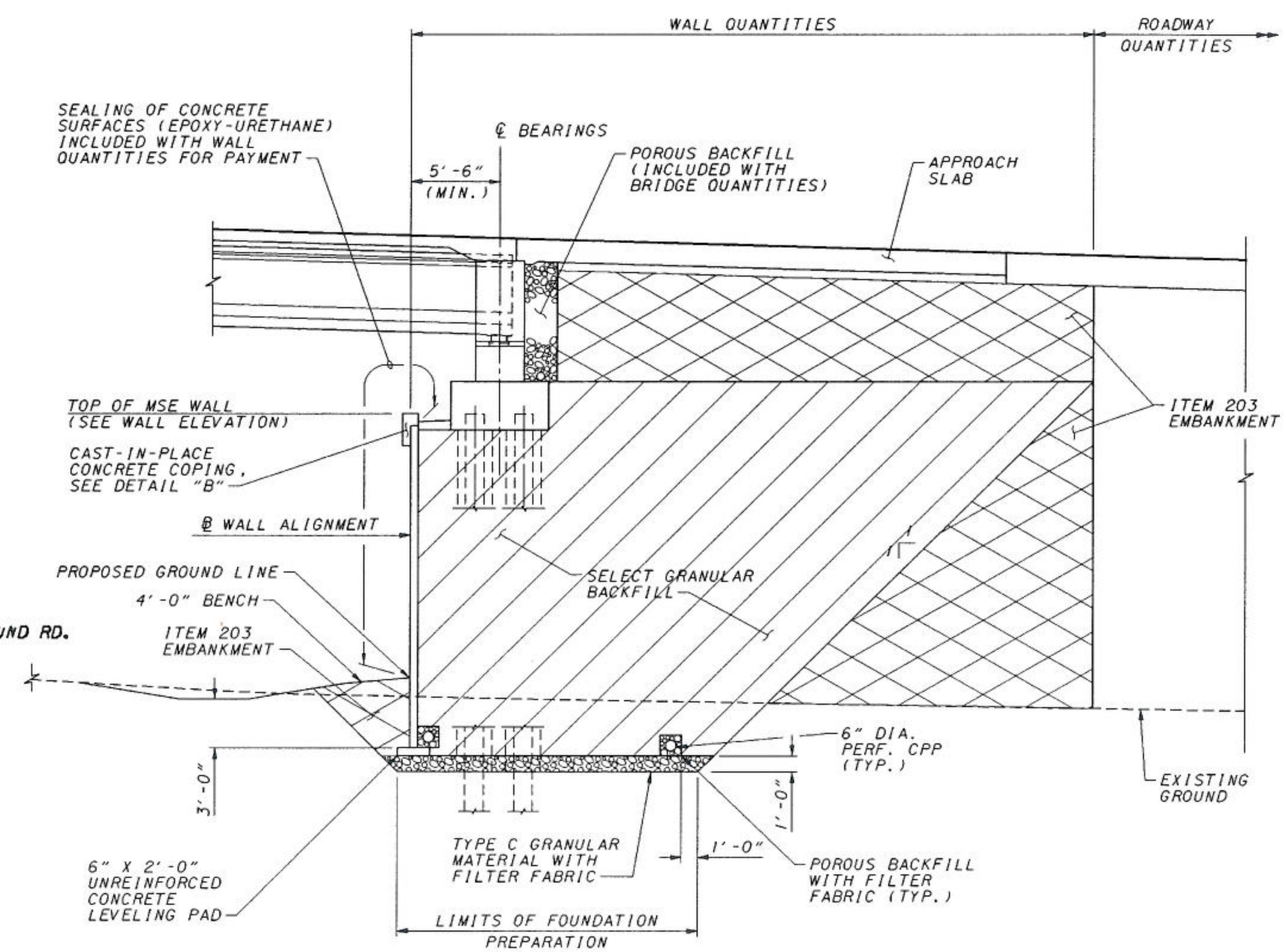


MSE WALL NO. 1
SECTION A-A
SEE SHEET 9

FAIRGROUND RD.



MSE WALL NO. 2
SECTION B-B
SEE SHEET 9

NOTE:
FOR DETAIL "B", SEE SHEET 30.

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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

MSE WALL SECTIONS
MSE WALL NOS. 1 AND 2

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PID 79977

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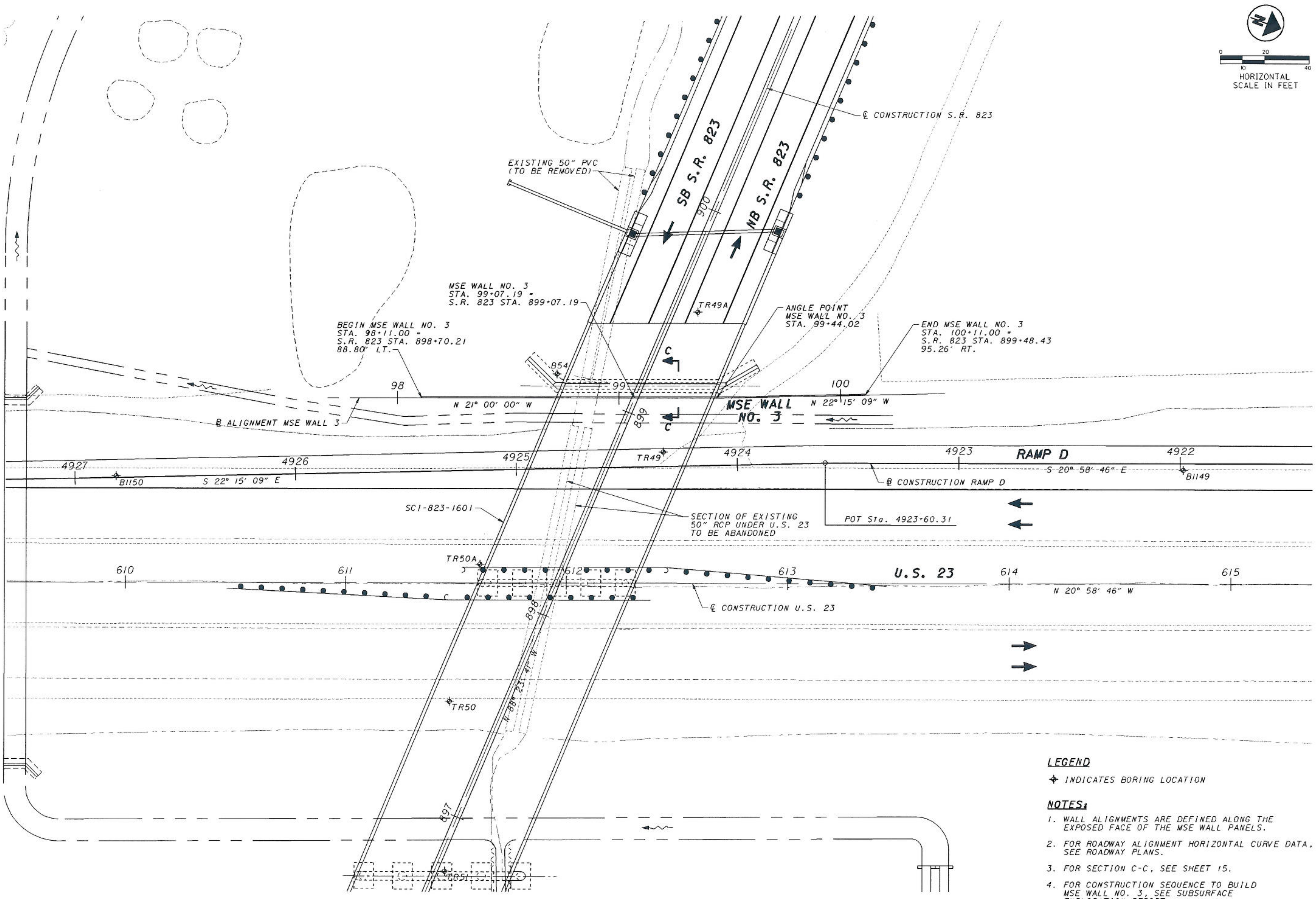

LEGEND

✦ INDICATES BORING LOCATION

NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA, SEE ROADWAY PLANS.
3. FOR SECTION C-C, SEE SHEET 15.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALL NO. 3, SEE SUBSURFACE EXPLORATION REPORT.

DESIGNED JBA	DRAWN JBA	REVIEWED SKT	DATE 11/07
CHECKED DGS	REVISED	STRUCTURE FILE NUMBER	

DESIGN AGENCY: CH2MHILL, 5775 Perimeter Drive, Suite 190, Dublin, Ohio 43017

MSE WALL 3 PLAN VIEW

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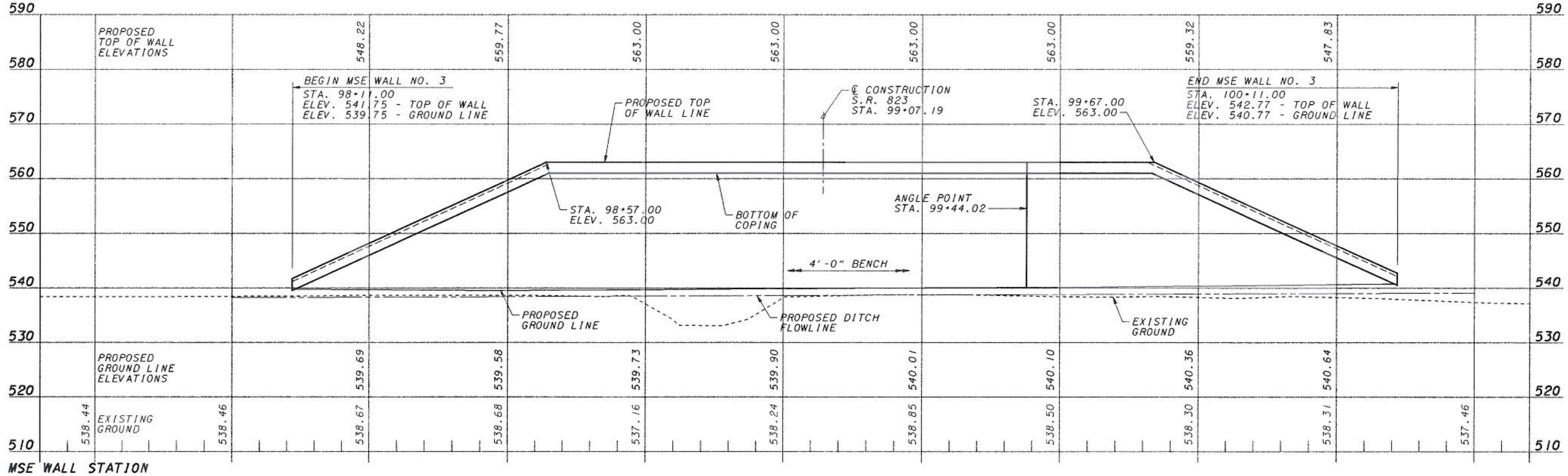

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 15.

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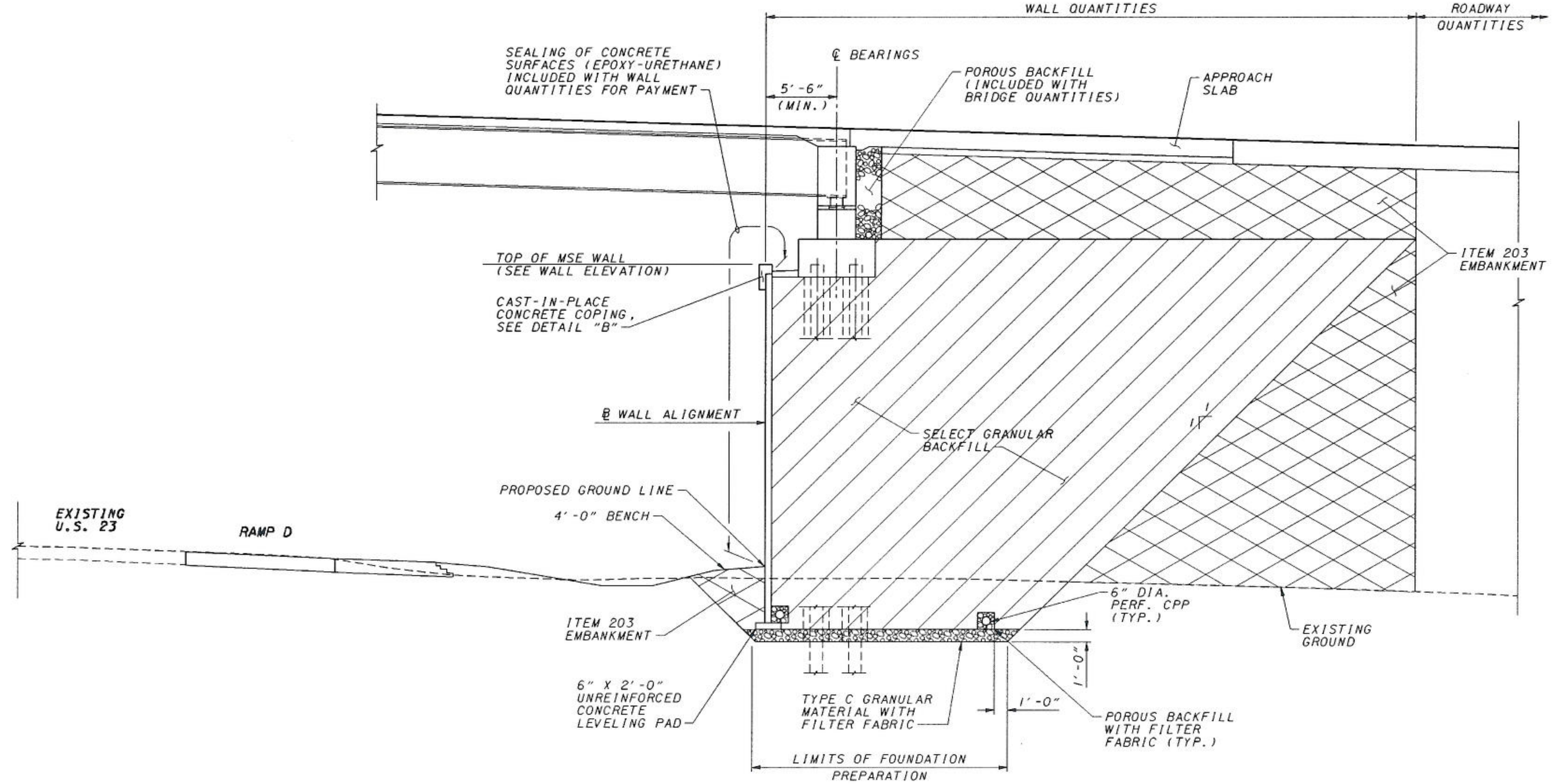
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL ELEVATION - MSE WALL NO. 3



MSE WALL NO. 3

SECTION C-C

SEE SHEET 13

NOTE:
FOR DETAIL "B", SEE SHEET 30.

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED JBA | DRAWN JBA | REVIEWED SKT | DATE 11/07
CHECKED DGS | REVISED | STRUCTURE FILE NUMBER

MSE WALL SECTION
MSE WALL NO. 3

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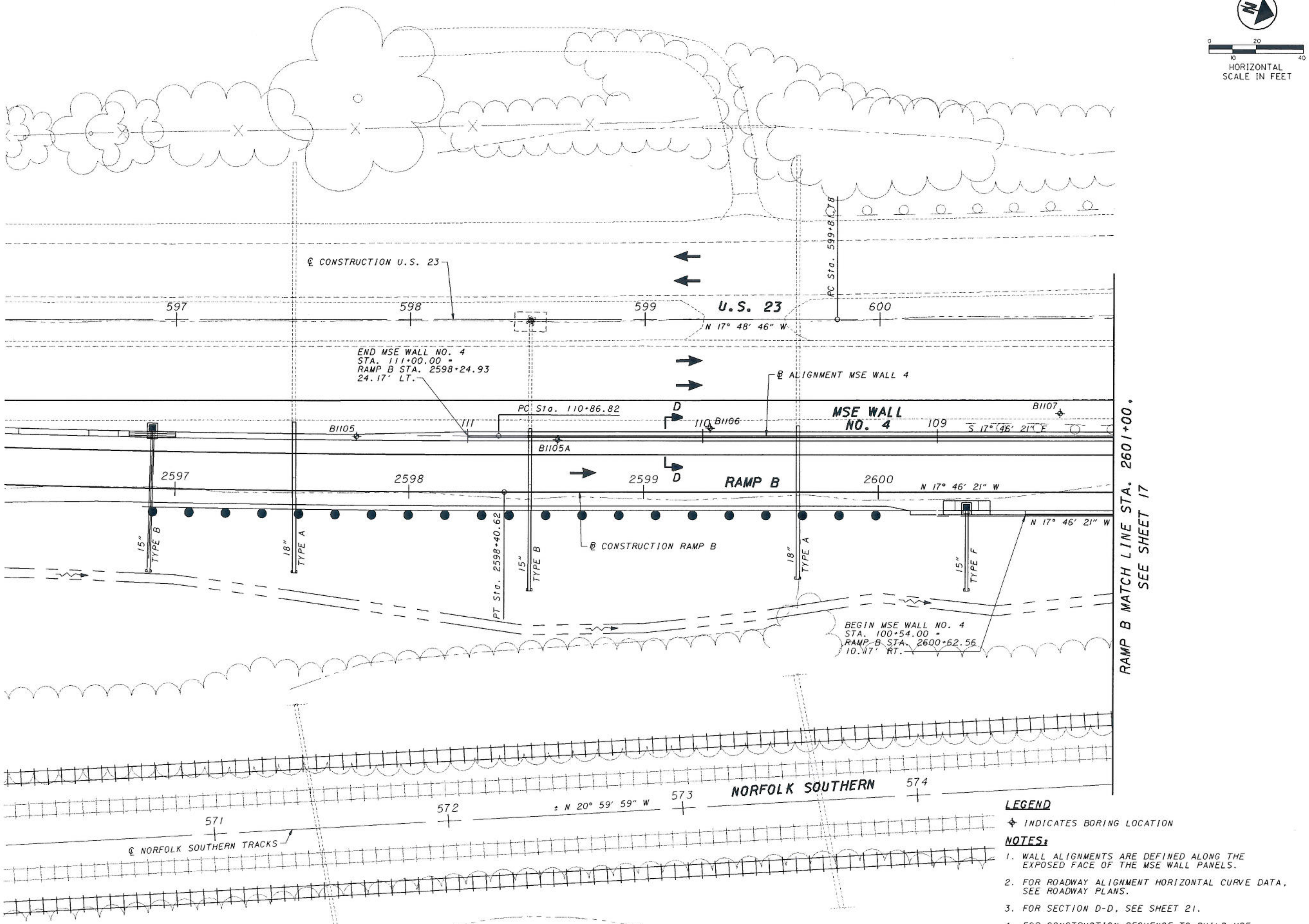

LEGEND

✦ INDICATES BORING LOCATION

NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA, SEE ROADWAY PLANS.
3. FOR SECTION D-D, SEE SHEET 21.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALL NO. 4, SEE SUBSURFACE EXPLORATION REPORT.

DESIGN AGENCY	DESIGNED	DRAWN	REVIEWED	DATE
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	CHECKED: DGS	REVISED	STRUCTURE FILE NUMBER	

MSE WALL 4 PLAN VIEW

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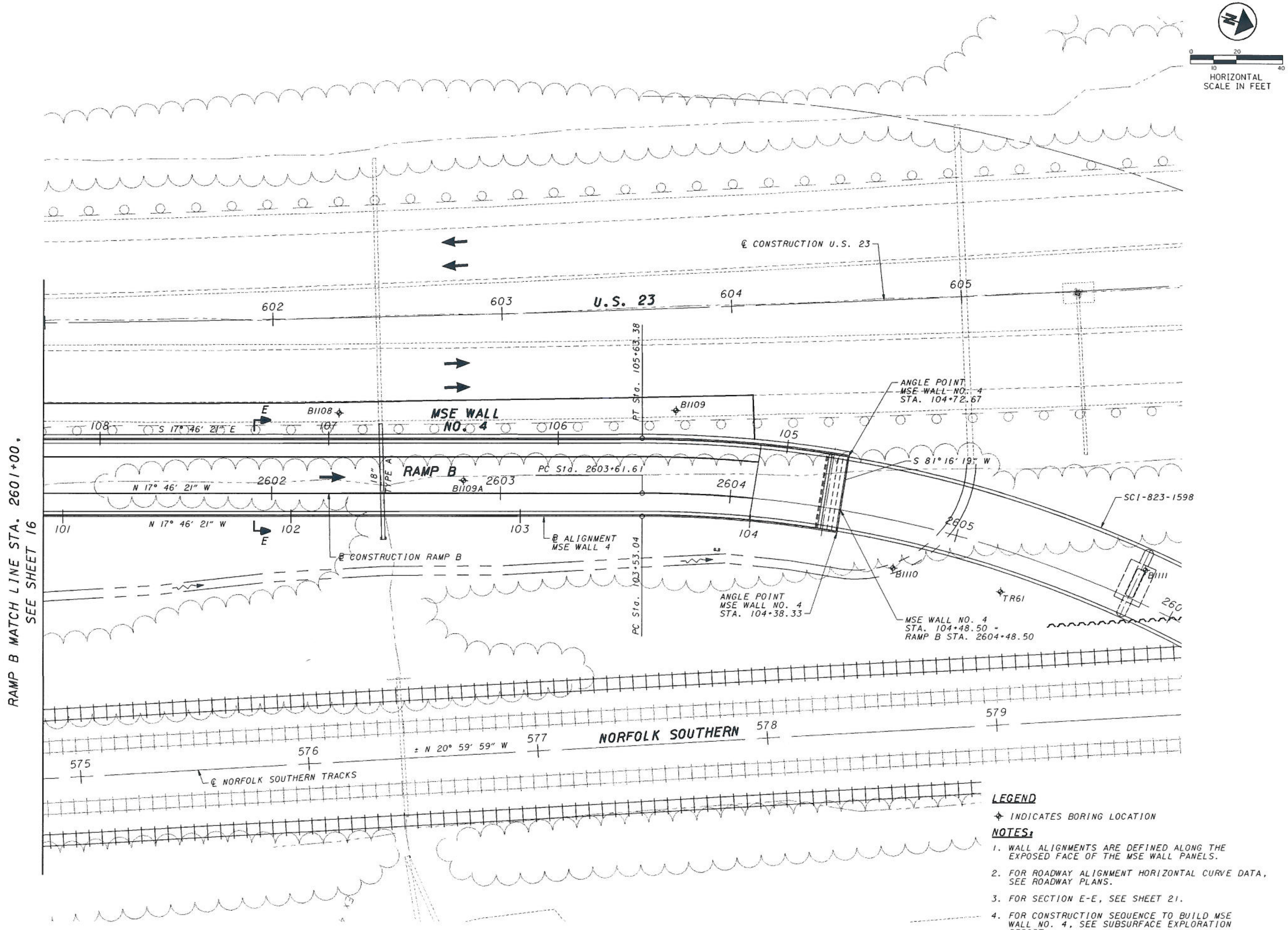

LEGEND

✦ INDICATES BORING LOCATION

NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA, SEE ROADWAY PLANS.
3. FOR SECTION E-E, SEE SHEET 21.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALL NO. 4, SEE SUBSURFACE EXPLORATION REPORT.

DESIGN AGENCY	DESIGNED	DRAWN	REVIEWED	DATE
CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017	JBA	JBA	SKT	11/07
	CHECKED DGS	REVISED	STRUCTURE FILE NUMBER	

MSE WALL 4 PLAN VIEW

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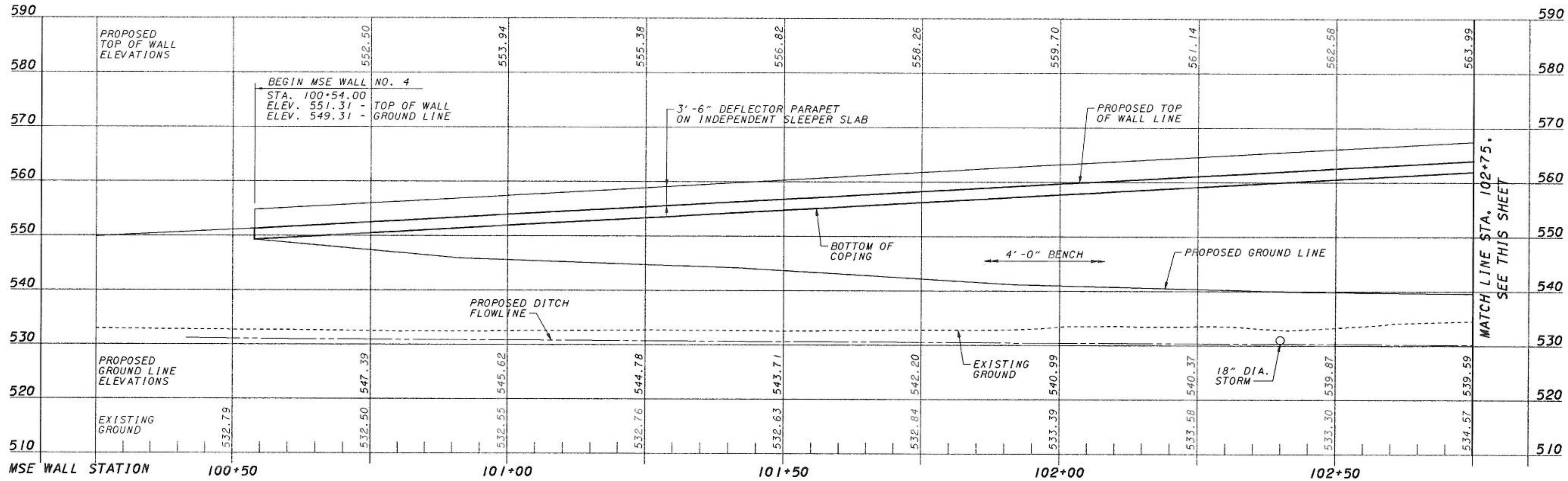

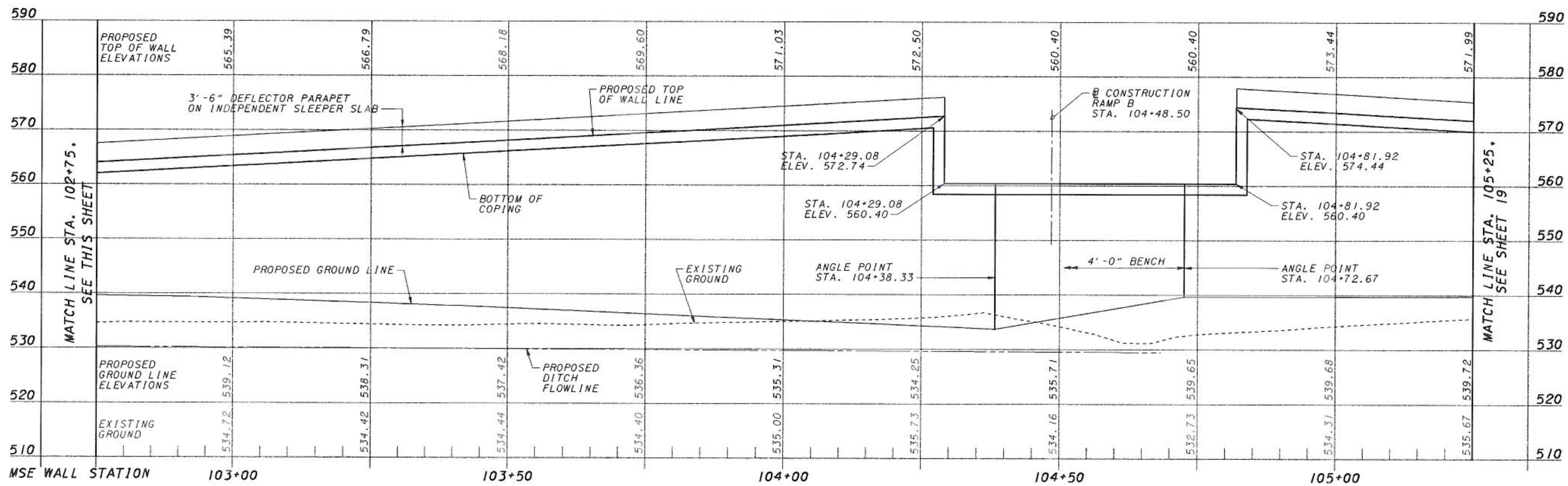

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTIONS ON SHEET 21.

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL ELEVATION - MSE WALL NO. 4

SCI-823-10.13
PID 79977

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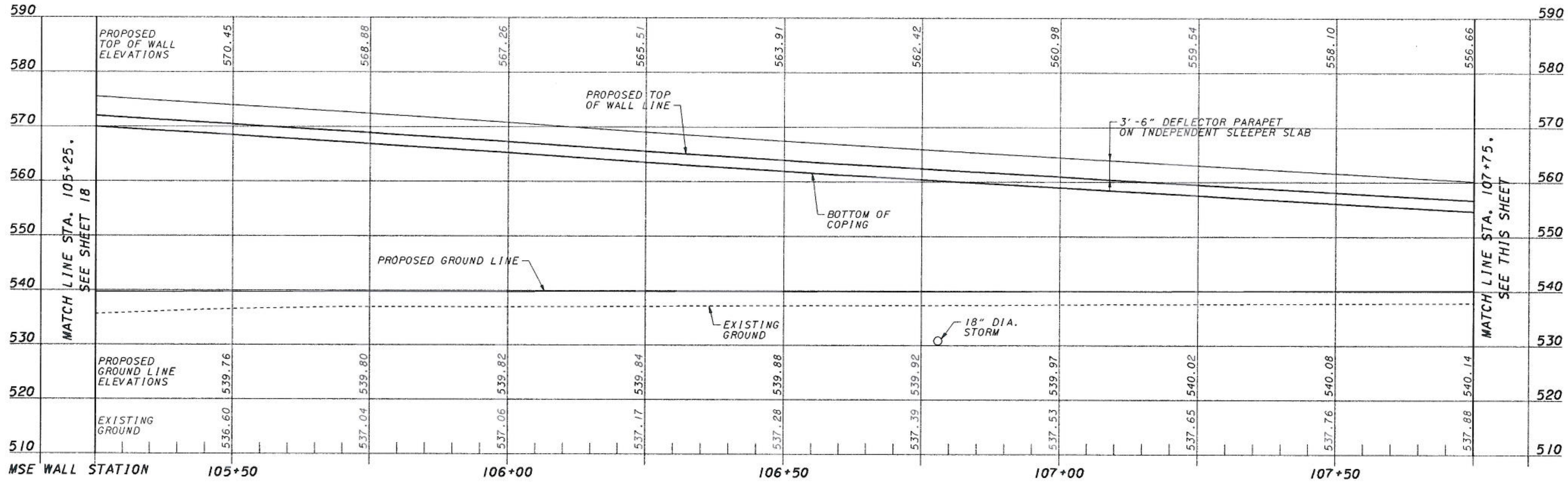

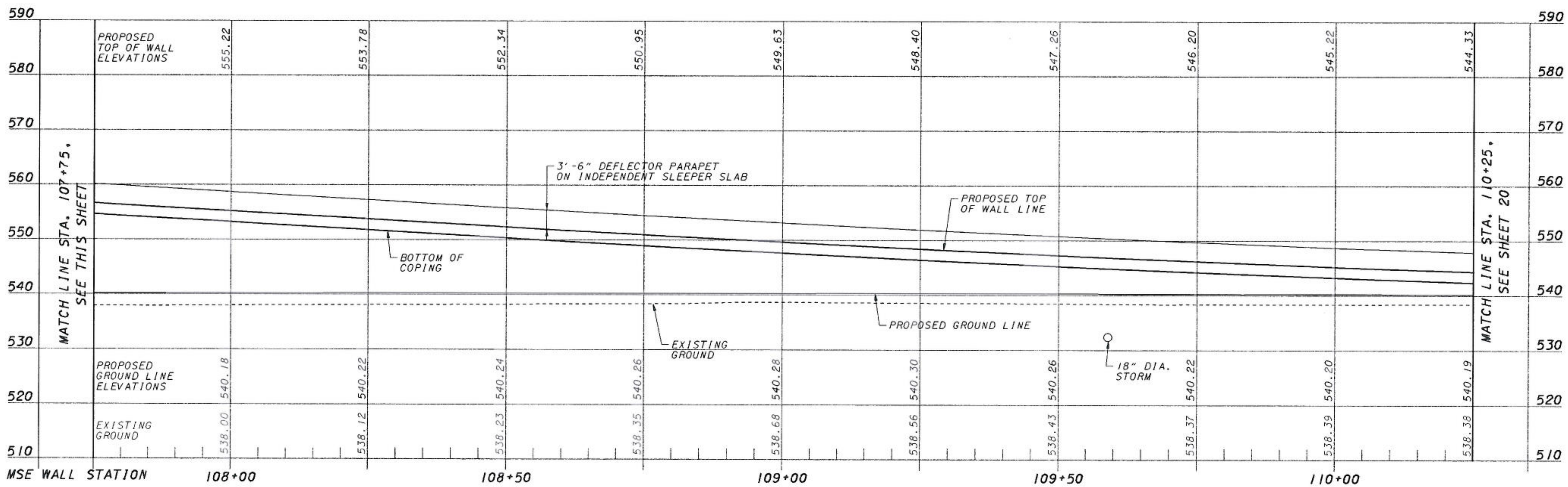

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTIONS ON SHEET 21.

DESIGN AGENCY	CH2MHILL 5775 Perimeter Drive, Suite 180 Dublin, Ohio 43017
DESIGNED	JBA
CHECKED	DGS
DRAWN	JBA
REVISED	
REVIEWED	SKT
DATE	11/07
STRUCTURE FILE NUMBER	

WALL ELEVATION - MSE WALL NO. 4

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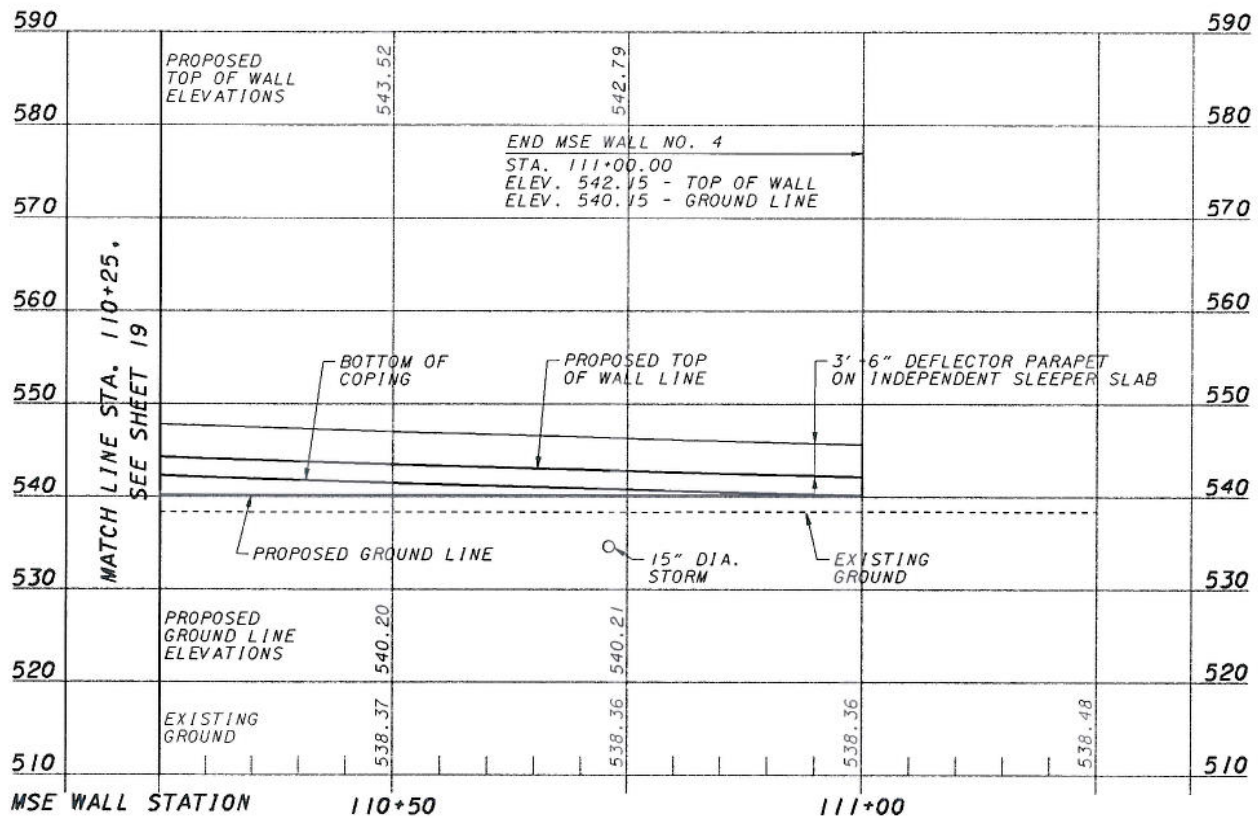

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTIONS ON SHEET 21.

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

WALL ELEVATION - MSE WALL NO. 4

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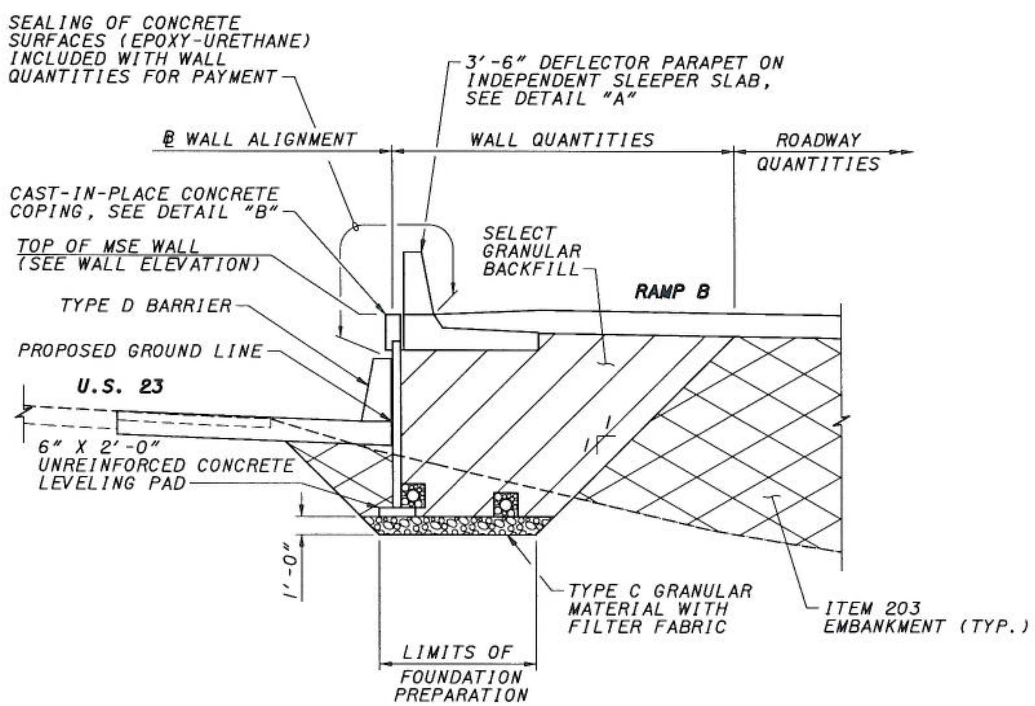
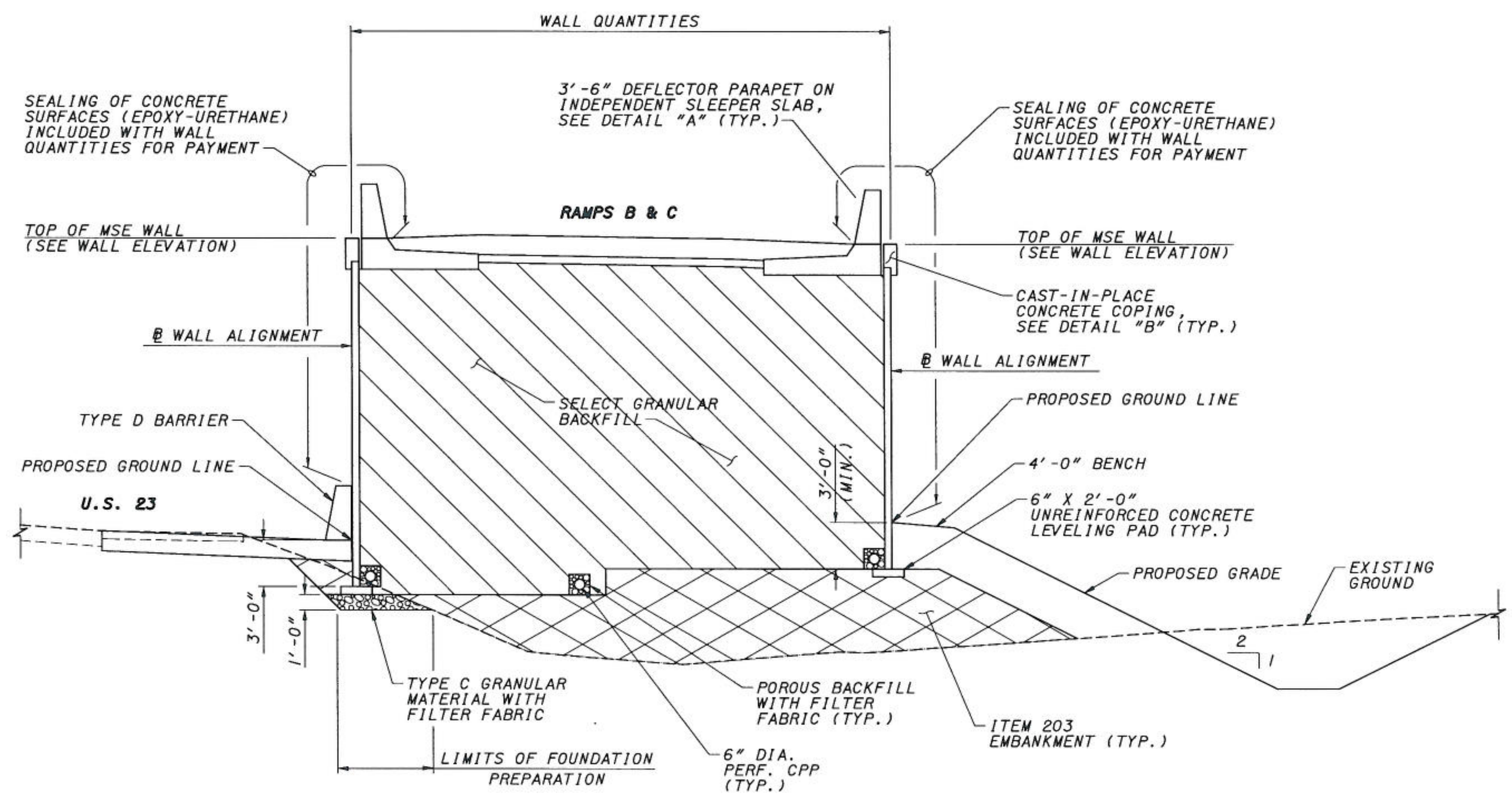


MSE WALL NO. 4
SECTION D-D
SEE SHEET 16



MSE WALL NOS. 4 & 5
SECTION E-E
SEE SHEETS 17, 22, & 23

NOTE:
FOR DETAILS "A" AND "B", SEE SHEET 30.

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

DESIGN AGENCY
CH2MHILL
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Dublin, Ohio 43017

MSE WALL SECTIONS
MSE WALL NOS. 4 AND 5

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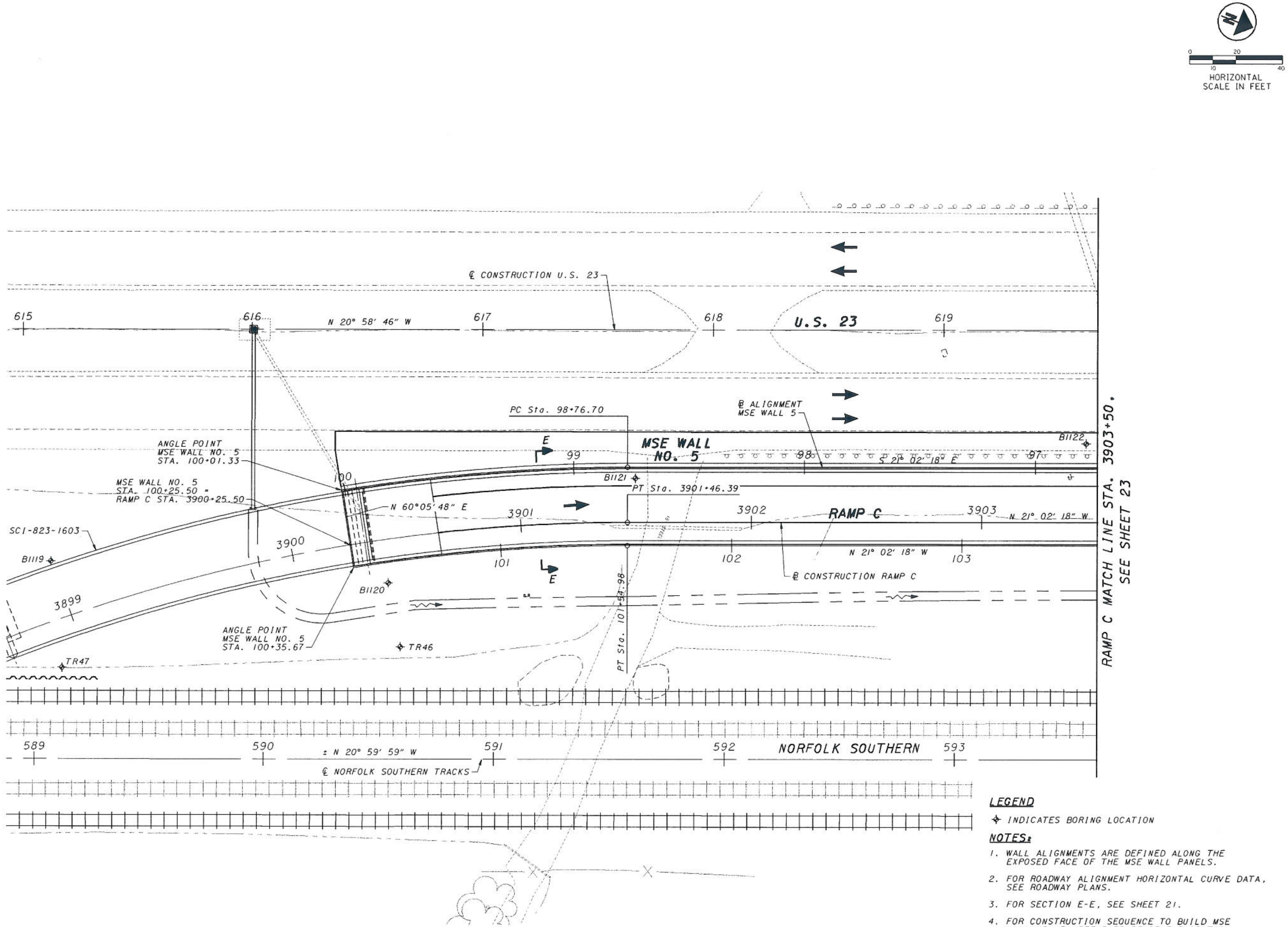

LEGEND

✦ INDICATES BORING LOCATION

NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA, SEE ROADWAY PLANS.
3. FOR SECTION E-E, SEE SHEET 21.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALL NO. 5, SEE SUBSURFACE EXPLORATION REPORT.

DESIGN AGENCY: CH2MHILL, 5775 Perimeter Drive, Suite 190, Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

MSE WALL 5 PLAN VIEW

SCI-823-10.13
PID 79977

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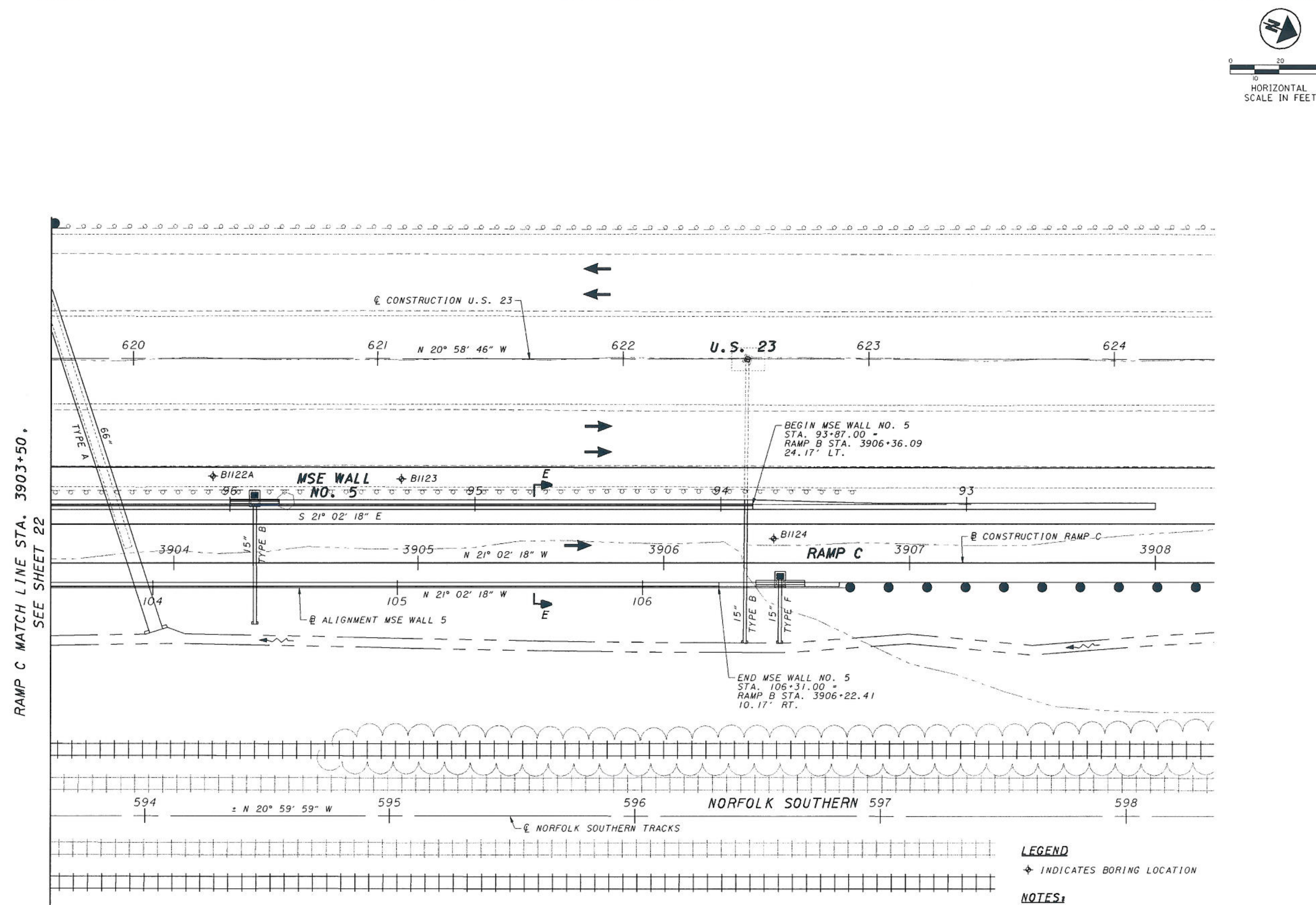


LEGEND

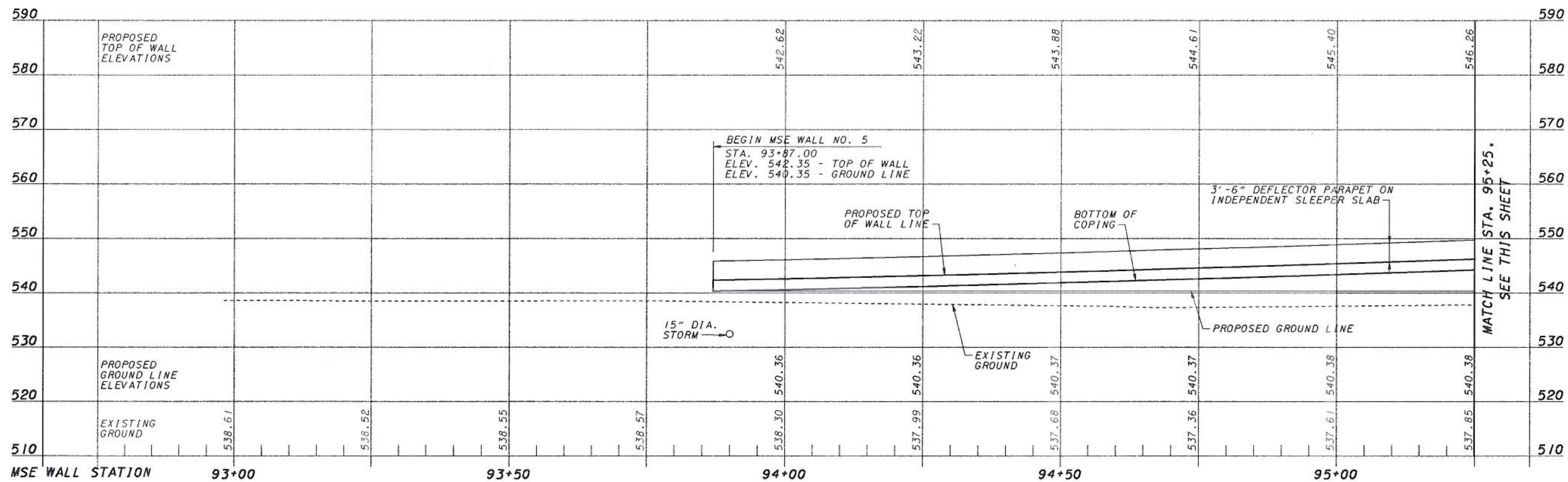
⌖ INDICATES BORING LOCATION

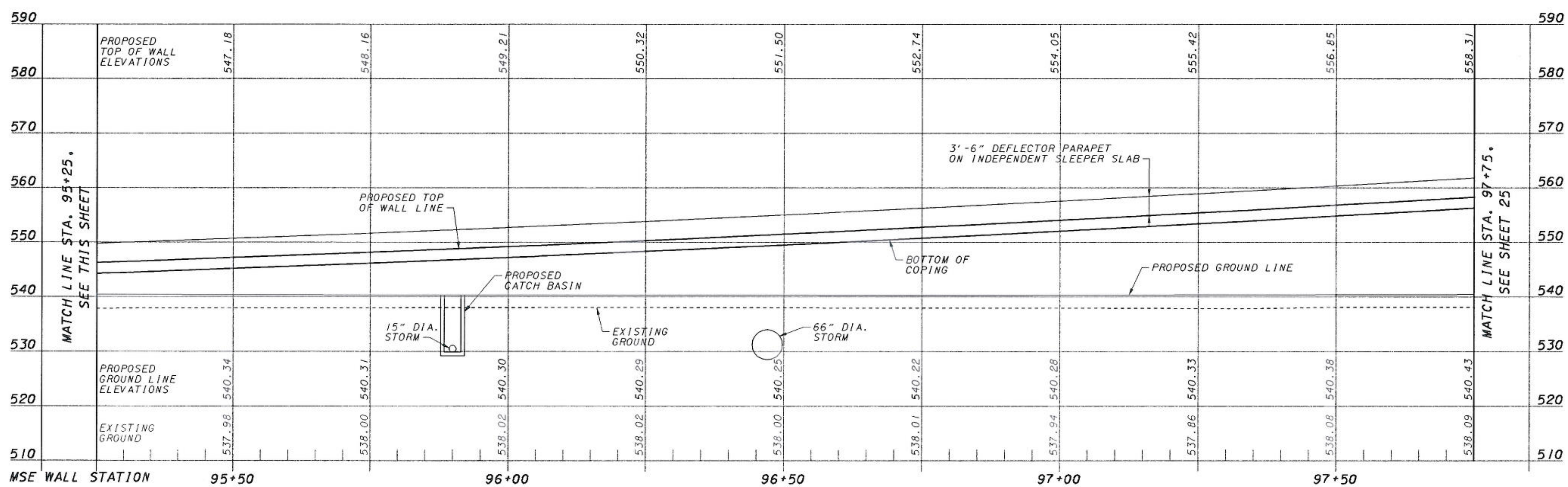
NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA, SEE ROADWAY PLANS.
3. FOR SECTION E-E, SEE SHEET 21.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALL NO. 5, SEE SUBSURFACE EXPLORATION REPORT.

DESIGN AGENCY				
CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017	DESIGNED JBA / CHECKED DGS	DRAWN JBA / REVISED	REVIEWED SKT / DATE 11/07 / STRUCTURE FILE NUMBER	MSE WALL 5 PLAN VIEW

SCI-823-10.13
PID 79977





NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 21.

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL ELEVATION - MSE WALL NO. 5

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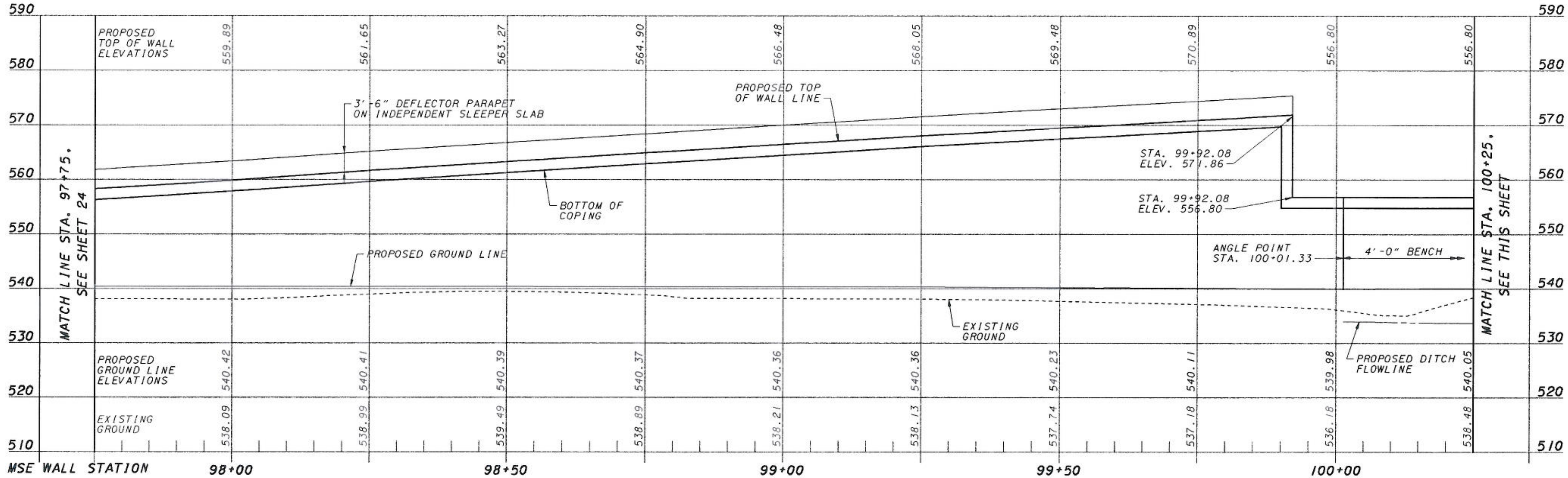

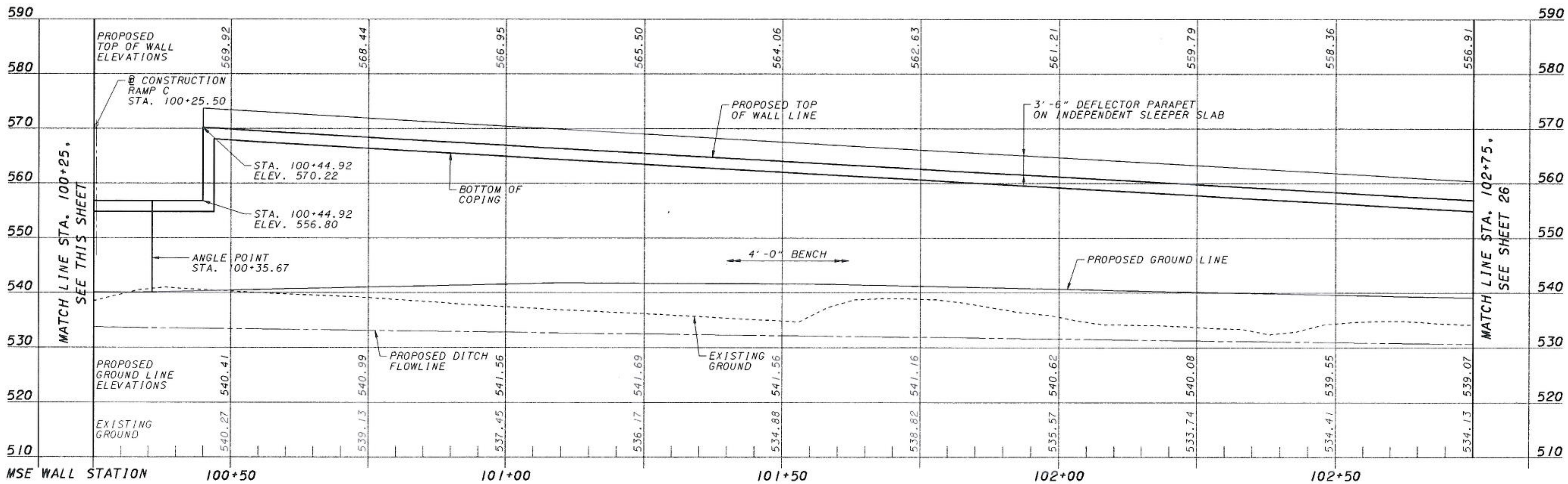

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 21.

DESIGN AGENCY: CH2MHILL
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Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL ELEVATION - MSE WALL NO. 5

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PID 79977

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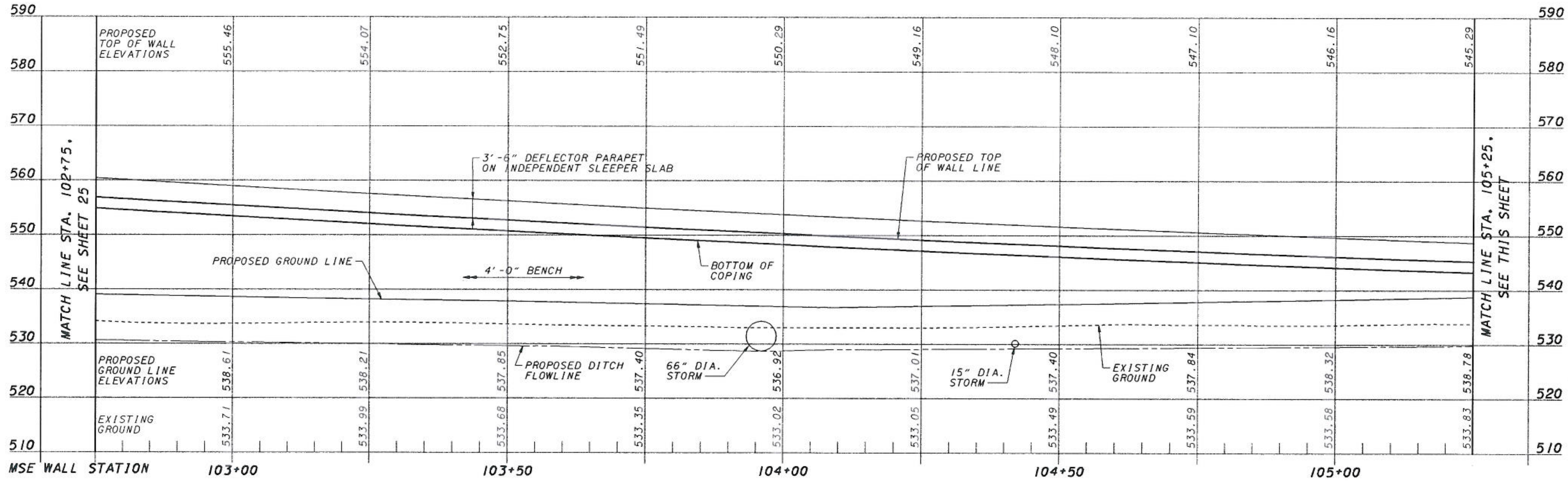
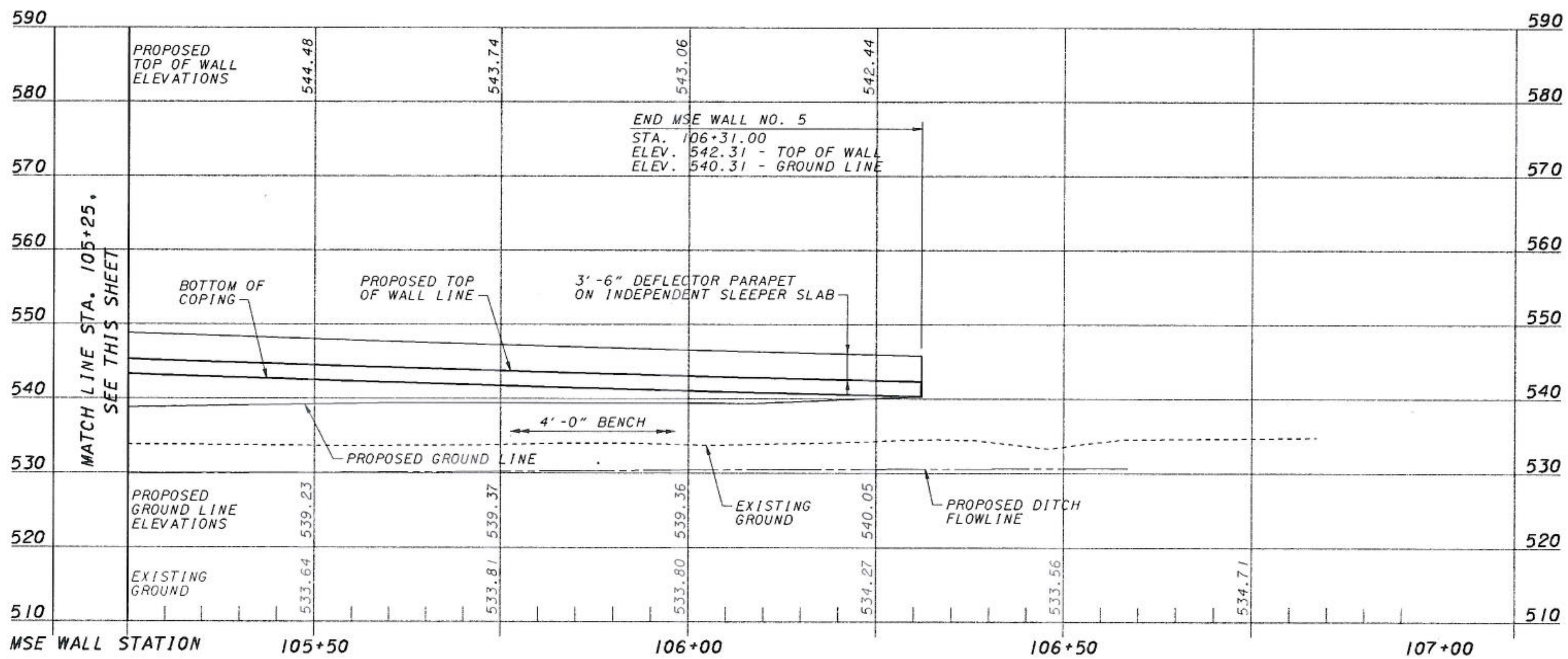
WALL ELEVATION - MSE WALL NO. 5





NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 21.

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
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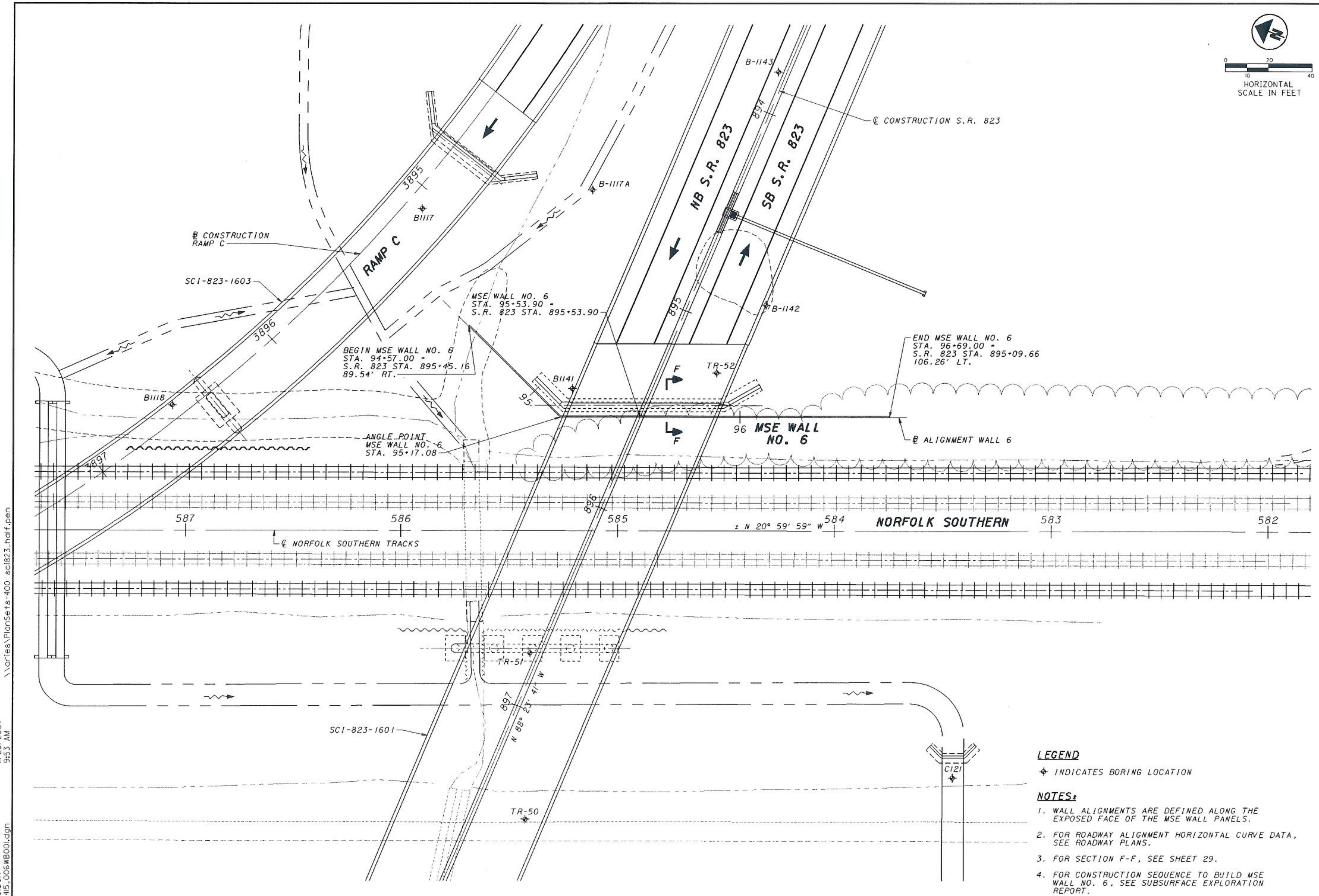
DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

SCI-823-10.13
PID 79977



LEGEND

✧ INDICATES BORING LOCATION

NOTES:

1. WALL ALIGNMENTS ARE DEFINED ALONG THE EXPOSED FACE OF THE MSE WALL PANELS.
2. FOR ROADWAY ALIGNMENT HORIZONTAL CURVE DATA, SEE ROADWAY PLANS.
3. FOR SECTION F-F, SEE SHEET 29.
4. FOR CONSTRUCTION SEQUENCE TO BUILD MSE WALL NO. 6, SEE SUBSURFACE EXPLORATION REPORT.

DESIGN AGENCY	CH2MHILL 5775 Perimeter Drive, Suite 190 Dublin, Ohio 43017
REVIEWED	SKT
DATE	11/07
STRUCTURE FILE NUMBER	
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MSE WALL 6 PLAN VIEW

SCI-823-10.13
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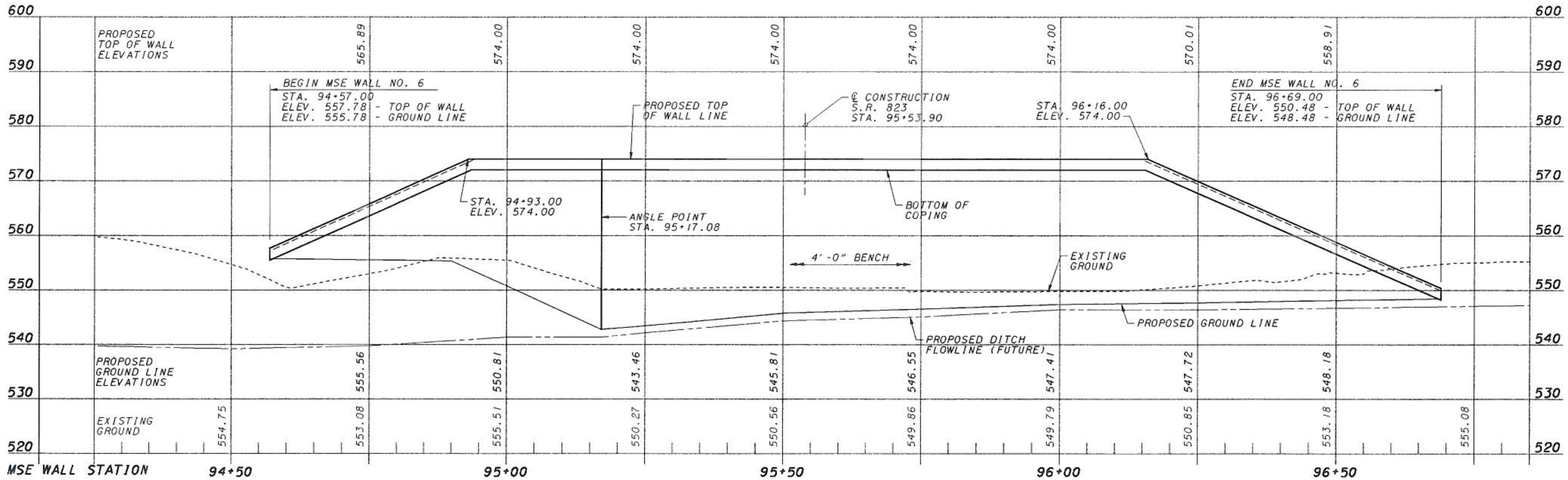

NOTES:

1. MSE WALL ELEVATIONS ARE SHOWN VIEWED FROM THE EXPOSED FACE OF THE WALL.
2. FOR DEFINITION OF MSE WALL TOP AND BOTTOM ELEVATIONS, SEE WALL SECTION ON SHEET 29.

DESIGN AGENCY
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Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
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CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

WALL ELEVATION - MSE WALL NO. 6

SCI-823-10.13
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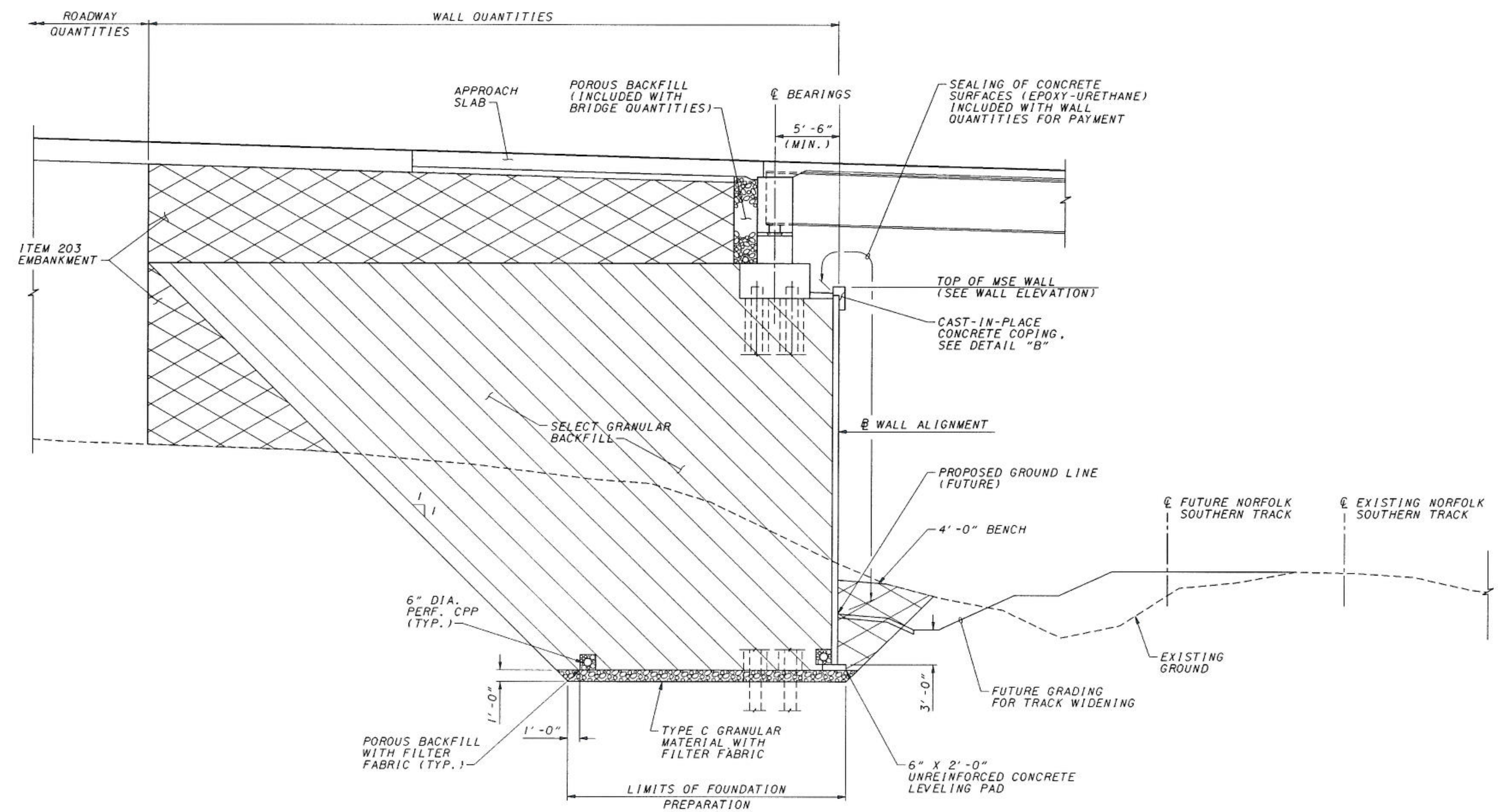

MSE WALL NO. 6

SECTION F-F

SEE SHEET 27

NOTE:
FOR DETAIL "B", SEE SHEET 30.

DESIGNED	DRAWN	REVIEWED	DATE
JBA	JBA	SKT	11/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS			

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

MSE WALL SECTION
MSE WALL NO. 6

SCI-823-10.13
PID 79977

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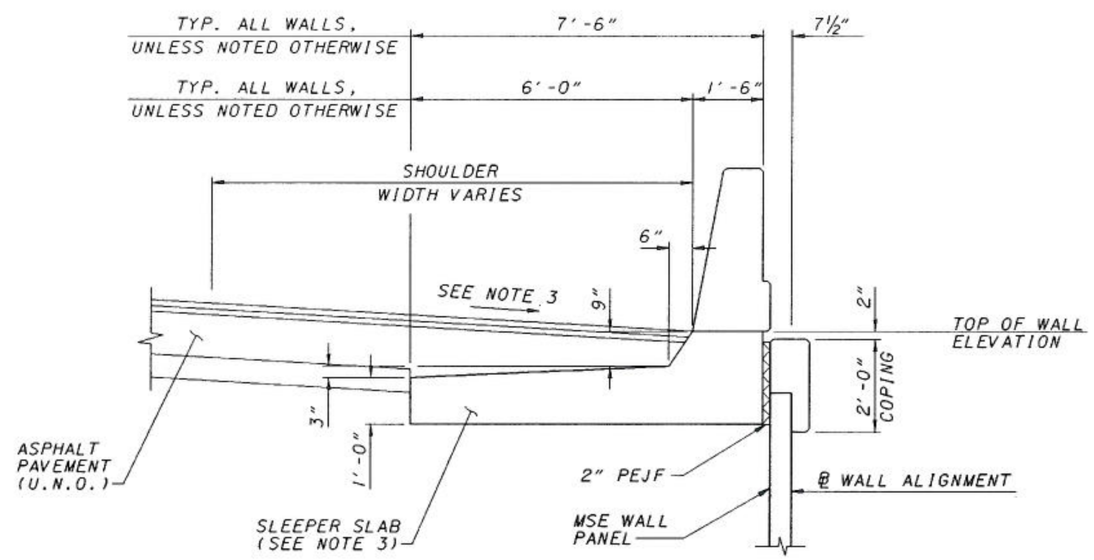
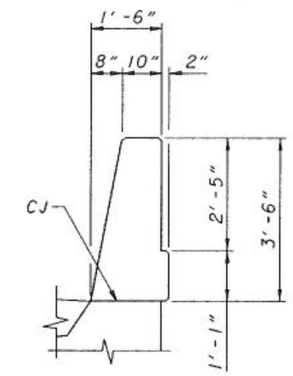
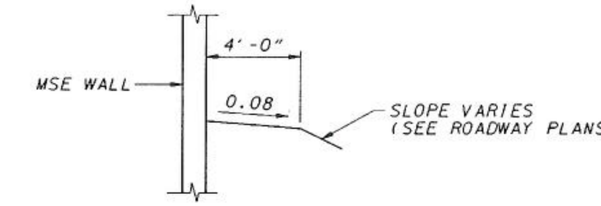


DETAIL "A"

3'-6" DEFLECTOR PARAPET
ON INDEPENDENT SLEEPER SLAB

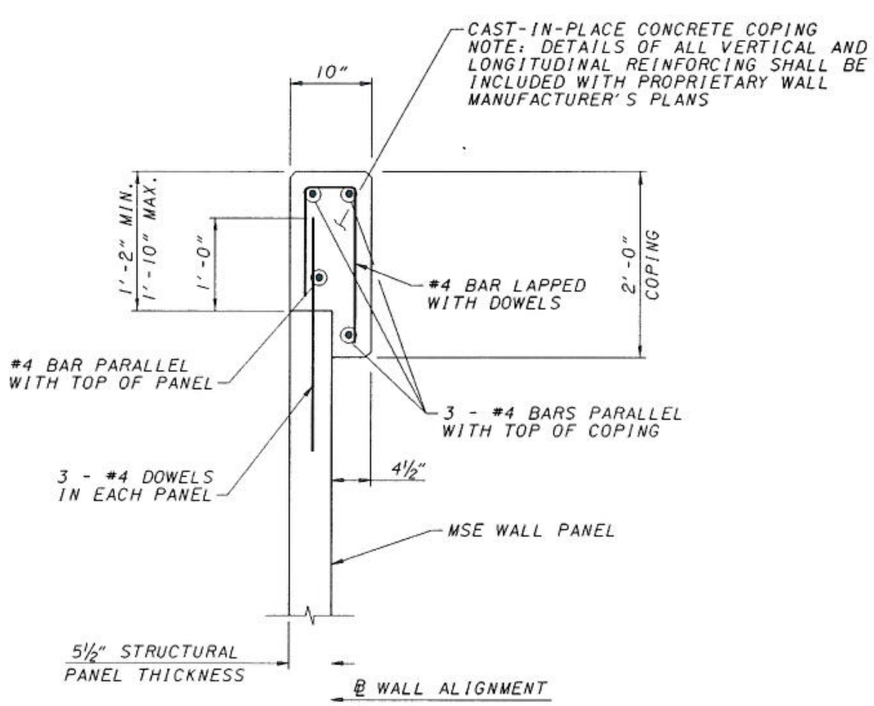


TYPICAL MSE WALL DEFLECTOR PARAPET



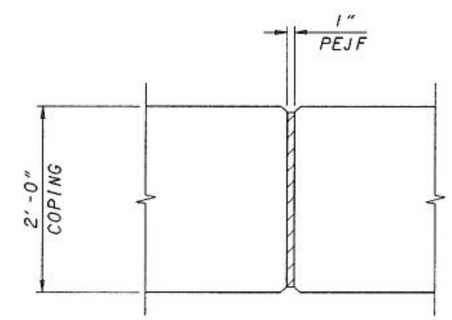
DETAIL "C"

4'-0" BENCH
WHERE SPECIFIED
ON WALL ELEVATIONS



DETAIL "B"

CAST-IN-PLACE CONCRETE COPING



COPING EXPANSION JOINT

(SEE NOTE 5)

NOTES:

1. FOR LOCATIONS OF DETAILS "A" THROUGH "C", SEE SHEETS 9-29.
2. ALL CONSTRUCTION JOINTS ARE LEVEL UNLESS OTHERWISE NOTED.
3. FOR PAVEMENT CONSTRUCTION ABOVE SLEEPER SLAB, SEE ROADWAY PLANS.
4. ALL COPING REINFORCING STEEL SHALL BE EPOXY COATED.
5. COPING JOINTS SHALL ALIGN WITH JOINTS BETWEEN MSE WALL PANELS. COPING JOINTS SHALL NOT BE LOCATED MORE THAN 20 FEET APART. THE CONTRACTOR SHALL COORDINATE JOINT LAYOUT WITH DETAILS OF ACTUAL PROPRIETARY WALL CONSTRUCTED.

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
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MSE WALL DETAILS

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APPENDIX D

inter-office communication

to: District 9 - Jim Brushart, District Deputy Director — date: April 23, 2007
Attn: Tom Barnitz , District Production Administrator

from: Tim Keller, P.E., Administrator, Office of Structural Engineering — by: Peter Narsavage, P.E.

subject: SCI-823-10.13, Portsmouth Bypass Phase 2; PID 79977;
Review of MSE Wall and Embankment Evaluation Report

We have reviewed the *Preliminary Report for Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23 / SR 823 Interchange*, dated October 4, 2007, by DLZ. We received this report after a meeting on February 22, 2007, and we have reviewed it in conjunction with the submittal of the retaining wall type study for the structures over Fairground Road. This report primarily addresses the MSE walls for Ramps B and C, identified as Walls No. 4 and 5 in the *Retaining Wall Type Study* by CH2M Hill, dated March 2007. We offer the following comments.

1. In general, we concur with the analyses and calculations for the MSE walls.

2. The boring identification labels on the Boring Location Plan are obscured by other linework. Either move the labels or mask the lines underneath the labels.

3. From the report, we understand that undrained bearing capacity and differential settlement of the ramp MSE walls are of concern. The other stability checks, such as global stability, sliding, and drained bearing capacity result in acceptable safety factors. We believe that MSE walls could be built in two stages, without any surcharging or ground improvement. Wick drains could be considered to decrease the amount of time required for consolidation of the foundation soil. Where the height of the MSE wall was high enough to cause concern about differential settlement, slip joints can be provided at regular intervals. The top row of facing panels would not be fabricated until after settlement was substantially complete.

Nothing in these comments is to be construed as authorizing extra work for which additional compensation may be claimed. If you believe that these comments require work outside the limits of the Scope of Services for this project, please contact this office before proceeding.

If you should have any questions regarding these comments, please contact our office.

TJK:JS: pan

c: John K. Wetzel, ODOT District 9
Lawrence A. Wills, ODOT District 9
Tim Keller, P.E., Office of Structural Engineering
Jawdat Siddiqi, P.E., Office of Structural Engineering
file

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: SKT/SJR DATE: 05-14-07

MSE Wall and Embankment Evaluation Report

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ NO: 319861.PB.02

REVIEWER: ODOT OSE - Peter Narsavage, P.E. PHASE: Type Study

Reference Page/Sheet No.	Review Comment	Designer Response
	ODOT Comments	
General	1. In general, we concur with the analyses and calculations for the MSE walls.	Will comply.
General	2. The boring identification labels on the Boring Location Plan are obscured by other linework. Either move the labels or mask the lines underneath the labels.	Will comply.
General	3. From the report, we understand that undrained bearing capacity and differential settlement of the ramp MSE walls are of concern. The other stability checks, such as global stability, sliding, and drained bearing capacity results in acceptable safety factors. We believe that MSE walls could be built in two stages, without any surcharging or ground improvement. Wick drains could be considered to decrease the amount of time required for consolidation of the foundation soil. Where the height of the MSE wall was high enough to cause concern about differential settlement, slip joints can be provided at regular intervals. The top row of facing panels would not be fabricated until after settlement was substantially complete.	Pending the results of the final drilling and laboratory testing program, we will incorporate the above comment into our final recommendations.

inter-office communication

to: District 9 - Jim Brushart, District Deputy Director date: April 23, 2007
Attn: Tom Barnitz , District Production Administrator

from: Tim Keller, P.E., Administrator, Office of Structural Engineering by: Peter Narsavage, P.E.

subject: SCI-823-10.13, Portsmouth Bypass Phase 2; PID 79977; Bridges over Fairground Road Retaining Wall Type Study Review

We have reviewed the Retaining Wall Type Study submitted by CH2M Hill for the above referenced project. The proposed retaining walls support the Ramp B, Ramp C, and Mainline bridges over Fairground Road. Included in the studies was the Preliminary Retaining Wall and Bridge Foundation Recommendations (Appendix A) by DLZ. These recommendations are the same for all the structures over Fairground Road. Please note that the project and PID number listed on the covers of the studies were SCI-823-0.00, PID No. 19415. The project has been split into phases and the bridges in these studies are part of Phase 2, which is SCI-823-10.13, PID No. 79977. We offer the following comments.

1. Boring logs were not included with the wall type study. We received the boring logs in the *Preliminary Report for Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23 / SR 823 Interchange*, dated October 4, 2007, by DLZ. We reviewed this report in conjunction with the retaining wall type study.

2. On page 2 of the Preliminary Retaining Wall and Bridge Foundation Recommendations, it states that MSE walls were analyzed using conditions encountered by Boring B-1133. This boring is over 2000 feet away from the bridges being studied. It is along Ramp A. Why is it being used instead of borings located at these bridges? At first we thought this might be a typographical error, as B-1113 is located at the rear abutment of the bridge at Ramp B over Fairground Road. However, the soil profile and soil strength values do appear to represent the soil encountered by B-1133. It is interesting to note that the settlement calculations were based on the soils encountered by B-1113, not B-1133.

3. On page 3, the fourth paragraph, it states that the MSE walls should be constructed in 10-foot stages after the surcharge has been removed. Why would it still be necessary to construct the MSE wall in stages after surcharging?

4. On page 3, the fifth paragraph, it states that "fill material should be selected that can be used for both the surcharge embankment and the conventional MSE wall backfill." The selection of the surcharge material should be left to the contractor, within broad limits. We have had cases where select granular material that met specifications prior to placement did not meet the specifications after placement. It may cause problems if the Department were to specify that the surcharge material was to be reused as MSE wall fill, and it no longer met the SGB specifications.

5. The calculated differential settlement of 1.6% is based on the calculated settlement at the toe of the slope and a point on the wall only 12 feet away. The wall is at its shortest height in this area and it is not a critical location. The differential settlement comparison should be done between a point where the wall is at its highest and the point with the least amount of settlement. Doing it this way results in a differential settlement of 1.1 % [(8.28"-0.35")/(60'x 12")=.011]. This is just slightly greater than the limit of one percent, and could be accommodated using slip joints in the MSE wall. As noted below, the settlement calculation is based on the "worst case" boring, B-1113. Soils encountered by other borings were much better and the anticipated settlements would be much less at these other boring locations.

6. The soils encountered by most of the borings along Fairground Road are suitable for supporting MSE walls using standard construction techniques. We consider the soil encountered by Borings B-1113 and B-1146 to be the "worst case" for these structures, and these "worst case" soils were only an 8-foot layer of stiff silty clay and a 3-foot layer of stiff silt and clay. For the soil encountered by these two borings, we believe that MSE walls could be built in two stages, without any surcharging or ground improvement. Wick drains could be considered to decrease the amount of time required for consolidation of the foundation soil. The top row of facing panels would not be fabricated until after settlement was substantially complete.

7. Because the proposed structures are single spans and the provided vertical clearance is much greater than required, we believe that the abutments could be supported by spread footings on the MSE wall fill. The abutments would be constructed after the substantial completion of primary settlement of the MSE walls.

Please provide our office with disposition of all comments in writing prior to proceeding with the next stage.

Nothing in these comments is to be construed as authorizing extra work for which additional compensation may be claimed. If you believe that these comments require work outside the limits of the Scope of Services for this project, please contact this office before proceeding.

If you should have any questions regarding these comments, please contact our office.

TJK:JS: pan

c: John K. Wetzel, ODOT District 9
Lawrence A. Wills, ODOT District 9
Tim Keller, P.E., Office of Structural Engineering
Jawdat Siddiqi, P.E., Office of Structural Engineering
file

Retaining Wall Type Study at Fairground Road

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ NO: 319861.PB.02

REVIEWER: ODOT OSE - Peter Narsavage, P.E. PHASE: Type Study

Reference Page/Sheet No.	Review Comment	Designer Response
	ODOT Comments	
General	1. Boring logs were not included with the wall type study. We received the boring logs in the *Preliminary Report for Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23/SR 823 Interchange*, dated October 4, 2006, by DLZ. We reviewed this report in conjunction with the retaining wall type study.	Will comply.
General	2. On page 2 of the Preliminary Retaining Wall and Bridge Foundation Recommendations, it states that MSE walls were analyzed using conditions encountered by Boring B-1133. This boring is over 2000 feet away from the bridges being studied. It is along Ramp A. Why is it being used instead of borings located at these bridges? At first we thought this might be a typographical error, as B-1113 is located at the rear abutment of the bridge at Ramp B over Fairground Road. However, the soil profile and soil strength values do appear to represent the soil encountered by B-1133. It is interesting to note that the settlement calculations were based on the soils encountered by B-1113, not B-1133.	Comments received from CH2M HILL on January 4, 2007 expressed concern about an aggressive interpretation of undrained shear strengths. Subsequent discussions have led to the use of B-1133 (considered the most critical boring on the project) to evaluate the bearing capacity of the proposed MSE retaining walls. We used this calculation as a "worst case" analysis. The settlement, and other associated calculations were performed assuming profiles and strengths from borings within the site area. All final calculations and the final design will consider the additional laboratory and in-situ strength testing, which will be obtained before submittal of the preliminary plans.

Retaining Wall Type Study at Fairground Road

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ NO: 319861.PB.02

REVIEWER: ODOT OSE - Peter Narsavage, P.E. PHASE: Type Study

General	3. On page three in the fourth paragraph, it states that the MSE walls should be constructed in 10-foot stages after the surcharge has been removed. Why would it still be necessary to construct the MSE wall in stages after surcharging?	The unknowns of the construction schedule led us to be conservative when making assumptions about the rebound of the soils after unloading. If the MSE wall embankments are preloaded, we will recommend that the final walls be built in a single stage if pore pressures and settlements are monitored during construction.
General	4. On page three in the fifth paragraph, it states that "fill material should be selected that can be used for both the surcharge embankment and the conventional MSE wall backfill." The selection of the surcharge material should be left to the contractor, within broad limits. We have had cases where select granular material that met specifications prior to placement did not meet the specifications after placement. It may cause problems if the Department were to specify that the surcharge material was to be reused as MSE wall fill, and it no longer met the SGB specifications.	Will comply.

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General	5. The calculated differential settlement of 1.6% is based on the calculated settlement at the toe of the slope and a point on the wall only 12 feet away. The wall is at its shortest height in this area and it is not a critical location. The differential settlement comparison should be done between a point where the wall is at its highest and the point with the least amount of settlement. Doing it this way results in a differential settlement of 1.1% [(8.28"-0.35")/ (60'x12") =0.011]. This is just slightly greater than the limit of 1% and could be accommodated using slip joints in the MSE wall. As noted below, the settlement calculation is based upon the "worst case" boring, B-1113. Soils encountered by other borings were much better and the anticipated settlements would be much less at these other boring locations.	We agree with the comments and will comply.
General	6. The soils encountered by most of the borings along Fairground Road are suitable for supporting MSE walls using standard construction techniques. We consider the soil encountered by Borings B-1113 and B-1146 to be the "worst case" for these structures; these "worst case" soils were only an 8-foot layer of stiff, silty clay and a 3-foot layer of stiff silt and clay. For the soil encountered by these two borings, we believe that MSE walls could be built in two stages without any surcharging or ground improvement. Wick drains could be considered to decrease the amount of time required for consolidation of the foundation soil. The top row of facing panels would not be fabricated until after settlement was substantially complete.	In general, we agree with the comments. The final design will also consider the strength values determined from final borings and subsequent testing programs. Wick drains will likely be considered to facilitate faster consolidation of the foundations soils.

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General	7. Because the proposed structures are single spans and the provided vertical clearance is much greater than required, we believe that the abutments could be supported by spread footings on the MSE wall fill. The abutments would be constructed after the substantial completion of primary settlement of the MSE walls.	We will proceed with supporting the Fairground Road bridges on spread (shallow) foundations on top of the MSE wall based on the preliminary evaluation, which is assuming that the final investigation and analysis will show adequate safety factor, adequate bearing capacity, and acceptable long term secondary settlement. We note that our recommendation to use spread footings were in conjunction with ground improvement using deep soil mixing, which will eliminate much of the uncertainties about the subsurface conditions and long term settlement. It is our intention to re-evaluate the ground improvement options and bridge support options based on the final subsurface investigations/analyses.