Del Mar Bluffs Stabilization Project 3 - Preserving Trackbed Support

Submitted to:
SANDAG
401 B Street
San Diego, CA 92101

Preliminary Draft
Type Selection Report

By:
David Evans and Associates

In Association with
Leighton and Associates, Inc.
Helix Environmental Planning, Inc.
Simon Wong Engineering

March 2010

110 West A Street, Suite 1700 ▪ San Diego, CA 92101 ▪ (619) 400-0600 ▪ (619) 400-0599 FAX

TABLE OF CONTENTS

APPENDICES

1.0 Introduction and Purpose

1.1 Project Location

The Del Mar Bluffs Stabilization Project 3 – Preserving Trackbed Support is located along 1.6 miles of North County Transit District (NCTD) railroad right of way on the western edge of the City of Del Mar in southern California. The project area extends from rail Milepost (MP) 244.1 near Coast Boulevard south to MP 245.7 at Torrey Pines State Beach. Within this reach, the NCTD rail alignment runs along the top of coastal bluffs which are 50 to 70 feet high above the beach. Railroad right of way varies between approximately 100 feet and 235 feet in width and, in some places, extends onto the beach below.

1.2 Project Description

The coastal bluffs supporting the rail alignment in the project area have a history of landslides and superficial failures. In addition, the bluffs are subject to ongoing erosion and failures that could threaten the viability of rail service.

In 1998, NCTD initiated a multi-phase approach to preserving the trackbed. To date, significant field investigations and geotechnical studies have been completed which characterize the nature and cause of bluff erosion, identify and prioritize the areas in need of stabilization, and introduce conceptual stabilization alternatives. These reports, prepared by Leighton and Associates, are referenced in Appendix A and serve as a basis for this Type Selection Report.

Several construction projects have been completed as a part of this phased approach. In 1998, approximately $1.8 million in drainage improvements were constructed within the project limits. An emergency repair project was constructed in late 2001 near the terminus of 8th Street after a failure of the bluff in this area. In 2003, additional surface and subsurface drainage improvements were made within the project limits and a landslide warning system was installed within the high-priority areas. The Del Mar Bluffs Stabilization Project 2 (Project 2) was completed in 2008 and included installation of a soldier pile stabilization system at areas of the bluffs identified as high-priority.

Based on the recommendations presented in the report titled “Supplemental Geotechnical Evaluation and Determination of Site Specific Conceptual Repair Alternatives” (Leighton, 2003), the Del Mar Bluffs Stabilization Project 2 instituted stability measures in the top ten (10) priority areas. The specific stabilization areas constructed as a part of the Project 2 are shown in Table A.

Table A - Areas Constructed as a part of Del Mar Bluffs Stabilization Project 2 (Completed 2008)				
Priority	**Stabilization No. (SN)**	**End Station**	**Begin Station**	**Length**
1N	SN-1N	1536+86	1536+54	32
1S	SN-1S	1535+57	1532+60	296
2	SN-2	1532+50	1531+65	85
3	SN-3	1538+85	1536+90	195
4	SN-4	1483+25	1482+75	50
5	SN-5	1544+70	1540+75	395
6	SN-6	1516+57	1515+64	93
7N	SN-7N	1540+66	1540+33	33
7S	SN-7S	1539+69	1539+40	29
8	SN-8	1484+80	1483+55	125
Stabilization Areas Identified by Geotechnical Report (Leighton 2003) but not Constructed as a part of Del Mar Bluffs Stabilization Project 2 (Completed 2008)				
9	SA-6B	1530+25	1529+10	115
10	SA-8A	1494+05	1493+33	72
10	SA-8B	1491+15	1490+80	35
10	SA-10W	1483+55	1482+10	145
11	SA-3	1539+40	1538+85	55
12	SA-9A	1490+80	1484+80	600

The current project is titled “Del Mar Bluffs Stabilization Project 3 – Preserving Trackbed Support” and is a continuation of Project 2. The project involves the design and installation of stabilization measures to provide additional lateral support for the railroad right of way within areas identified in the updated geotechnical report prepared for this project.

Based on the recommendations presented in the report titled “Geotechnical Evaluation Update and Determination of Areas for Stabilization” (Leighton, 2010), this current project will evaluate stabilization measures for construction as a part of the Del Mar Bluffs Stabilization Project 3. The specific stabilization areas considered as a part of the Del Mar Bluffs Stabilization Project 3 are shown in Table B.

This project includes the evaluation of design and installation of stabilization measures intended to preserve trackbed support in high-priority areas and maintain the viability of rail operations for the next 20 years.

Table B - Areas Considered as a part of Del Mar Bluffs Stabilization Project 3				
Implementation Ranking (IR)	**Stabilization Area (SA)**	**End Station**	**Begin Station**	**Length**
IR=1	SA-1	1539+40	1538+85	55
IR=2	SA-2	1530+85	1528+80	205
IR=3	SA-4	1514+55	1513+20	135
IR=3	SA-7	1485+80	1484+80	100
IR=4	SA-6N	1494+40	1490+00	440
IR=4	SA-9	1481+00	1479+40	160
IR=5	SA-8	1483+55	1482+00	155
IR=6	SA-3	1518+55	1516+57	198
IR=6	SA-5	1512+45	1511+65	80
IR=7	SA-6S	1490+00	1485+80	420

1.3 Purpose and Scope

The purpose of this Type Selection Report is to document the selection of an alternative to stabilize each of the existing high-priority areas and to provide a preliminary cost estimate for the project. The report titled "Geotechnical Evaluation Update and Determination of Areas for Stabilization" (Leighton, 2010; hereafter referred to as the geotechnical report) identified and prioritized ten (10) distinct stabilization areas (including N and S area subdivisions) of the bluff that are currently in need of mitigation due to inadequate factors of safety for slope stability. The report also identified three potential alternatives for slope stabilization including a soldier pile wall, soil nail reinforcement and slope re-grading with construction of a soil cement buttress. For each specific stabilization area, not every stabilization alternative applies and a specific alternative was not selected.

In order to evaluate each viable stabilization alternative identified in the geotechnical report, preliminary level structural and geotechnical analyses were performed for each unique stabilization area. Construction cost estimates were generated based on the results of the preliminary analysis. The stabilization alternatives were then evaluated based on constructability, cost and environmental considerations. While the effectiveness of the stabilization alternatives varies to some extent, it was not used as selection criteria. This is because each alternative can be designed to meet the project objectives and provide a similar level of bluff stability. The results of this analysis were used to select the best stabilization alternative for each specific stabilization area.

2.0 Stabilization Alternatives

2.1 Overview

As mentioned, the geotechnical report (Leighton, 2010), identified three alternatives for slope stabilization including a soldier pile wall, a soil cement buttress, and soil nail reinforcement. Not all of these alternatives are viable for each stabilization area. The specific stabilization alternatives considered for each stabilization area are shown in Table C.

Table C – Stabilization Alternatives

Priority	Stabilization Area	Length (ft)	Soldier Piles	Soil Cement Buttress	Soil Nails
IR=1	SA-1	55	X		X
IR=2	SA-2	205	X		X
IR=3	SA-4	135	X	X	
IR=3	SA-7	100	X		X
IR=4	SA-6N	440	X	X	X
IR=4	SA-9	160	X		X
IR=5	SA-8	155	X	X	
IR=6	SA-3	198	X		X
IR=6	SA-5	80	X		X
IR=7	SA-6S	420	X		X
Total Length = 2,033					

Notes:
1. Soil nails alone may not be feasible at the northerly end of SA-2 immediately adjacent to the existing soil cement buttress. One or two soldier piles may need to be added to this area based on a more detailed analysis at the final design stage.
2. The soil cement buttress at SA-6N covers only the 60 foot section of existing seawall and fill slope. The remainder of the bluff face would need an alternative method of stabilization.
3. The soil nails stabilization at SA-6N is not feasible between Station 1493+40 and Station 1494+00 due to the presence of fill material. This area would require and alternative method of stabilization.

Plans identifying the location of each stabilization area are included in Appendix B. A general description of each stabilization alternative and the application to the Del Mar Bluffs Stabilization Project 3 follow.

2.2 Soldier Pile Walls

As shown in Table C, soldier pile walls were identified as a viable stabilization alternative for all stabilization areas. This type of wall consists of vertical piles placed at 6 to 12 feet on-center often with a connecting cast-in-place concrete grade beam at the top. The piles are typically constructed by drilling a 30-inch or 36-inch diameter hole, placing a steel reinforcement cage or steel beam in the hole and filling the hole with concrete and/or sand slurry. If the wall would retain soil, the exposed surface between the piles is in-filled with facing material (lagging) which may be timber, precast concrete planks or shotcrete. For taller walls, tiebacks may be required to anchor the soldier piles into the existing slope. A typical detail is shown in Figure 1.

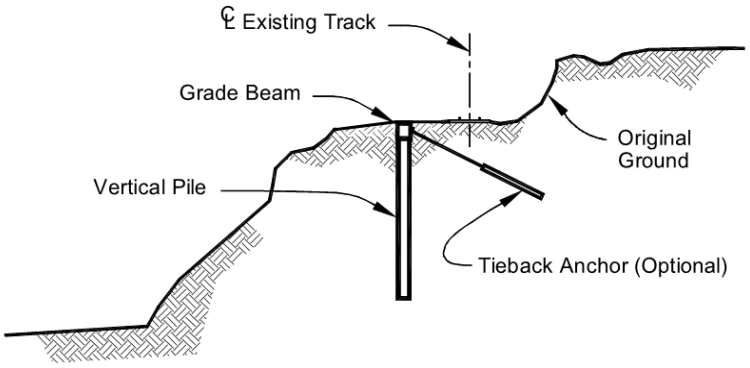


Figure 1 - Typical Soldier Pile Wall Alternative

This is an upper bluff stabilization measure as described in the geotechnical report. For the Del Mar Bluffs Stabilization Project 3, the center of the soldier pile wall should be located approximately 11 to 15 feet west of the centerline of tracks, and the top of wall should be about 1 foot below the top of tie or adjacent finished ground. For purposes of this type selection report analysis, 36-inch diameters piles are considered at all locations. Pile spacing varies between 9 feet and 10 feet on-center depending on site conditions. A grade beam may be necessary to provide an anchorage point for the tiebacks and to locally support the trackbed. Soldier pile design and construction is discussed in greater detail in Sections 3.2.1 and 4.2.1.

2.3 Soil Cement Buttress

As shown in Table C, a soil cement buttress was identified as a viable stabilization alternative for three of the stabilization areas. This option is most viable where the bluffs have previously been graded and fill soils mantle the natural bluff materials.

With this stabilization alternative, the existing slope would be excavated to remove potentially unstable material and replaced with manufactured soil cement. The soil cement could be capped with native soil held in place with pipe and board walls. This would provide a more natural appearance to the bluff face than the manufactured surface and allow for plant growth. At the toe of the slope, a shotcrete facing could be used to control wave erosion.

This is a bluff toe stabilization measure as described in the geotechnical report; however, it also provides bluff face stabilization through re-grading and soil capping. A typical detail is shown in Figure 2.

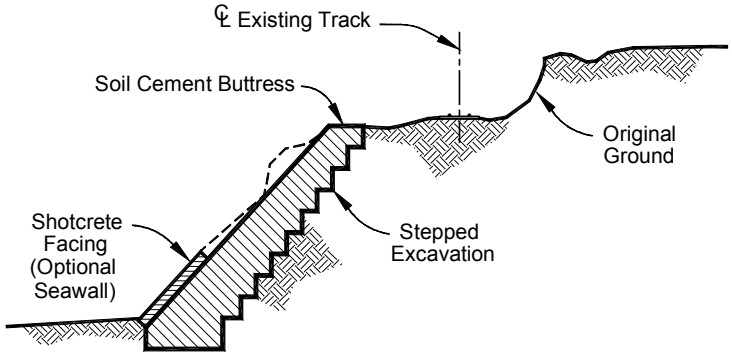


Figure 2 - Typical Soil Cement Buttress Wall Alternative

2.4 Soil Nail Reinforcement

Soil nail reinforcement was identified as a viable stabilization alternative for the majority of the stabilization areas. It is best suited for areas of dense exposed bedrock where the surface is composed of relatively dense materials.

A soil nail reinforcement alternative utilizes steel bars to anchor the bluff face to competent formational material thereby increasing the stability of the slope. The nails are installed by drilling holes approximately 20 to 50 feet deep and grouting a high-strength steel bar in place. A pre-anchor force is not applied to soil nail wall systems (as is done for a tie-back anchor), but test nails must be installed and pull-tested to verify the soil bond stress.

Typically, a soil nail system includes a cast-in-place or shotcrete facing material to stabilize the soil between nails; however, the facing material can be omitted when the surface material is sufficiently dense. In this case, the top of the grouted nail hole would be backfilled with native material. For the Del Mar Bluffs Stabilization Project 3, soil nail reinforcement was selected as a viable stabilization alternative only for areas that predominantly consist of dense exposed natural bluff face. Because the Del Mar Bluffs are highly variable, even within these areas there are localized zones of less stable surface material. As a result, facing is recommended in conjunction with the soil nail system.

This is a bluff top stabilization measure as described in the geotechnical report; however, bluff toe stabilization is also provided by the lower facing wall. A typical detail is shown in Figure 3.

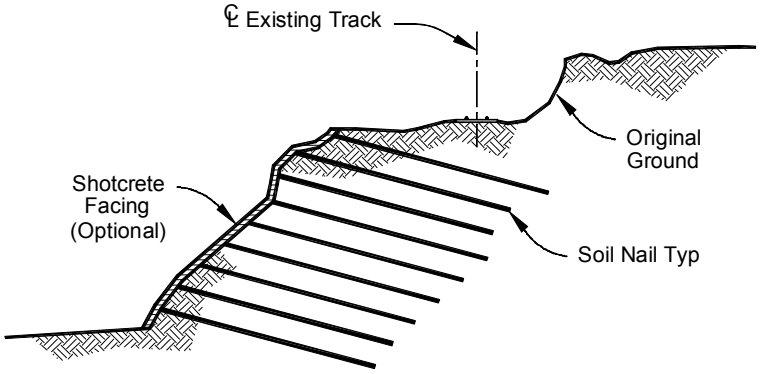


Figure 3 - Typical Soil Nail Alternative

3.0 Preliminary Engineering

3.1 Overview

In order to develop preliminary details and cost estimates, preliminary engineering has been performed for each of the three stabilization alternatives. This has been completed on a site-specific basis for each of the stabilization areas.

3.2 Analysis Methods

The preliminary engineering is based on the specific geologic cross sections provided within the stabilization areas. Each potential stabilization alternative was engineered to provide an equivalent level of slope stability.

For the soil cement buttress and soil nail reinforcement alternatives, the preliminary design effort focused on providing sufficient stabilizing components to develop acceptable global slope stability factors of safety. For the soldier pile wall alternative, preliminary structural analysis was performed to develop acceptable local stability and geotechnical analysis was performed to assess the global slope stability. The soldier pile wall alternative also requires an evaluation of the bluff retreat to assess the wall design height for structural analysis.

A quantity take-off was performed and a cost estimate was developed for each stabilization alternative. Furthermore, local non-uniformities, such as existing structures and geotechnical discontinuities, were considered to assure compatibility with the potential solutions. These exceptions are described in Section 3.3.

3.2.1 Soldier Pile Wall

A soldier pile wall at the bluff top provides trackbed support by retaining the earth behind the wall to prevent both local and global slope failures. For the Del Mar Bluffs Stabilization Project 3, the wall would be placed 11 to 15 feet seaward of the track centerline with the top of wall about 1 foot below the top of tie. Generally, this would result in a wall that is initially buried; however, due to the natural bluff retreat, the top of wall may become exposed over time. The exception to the typical location would be within SA-4. At this location a 1978 project constructed shear pins approximately 13 feet from the track centerline. A new wall would be offset approximately 24 feet from the centerline of the track to avoid conflict with the existing system. The section of the bluff is relatively wide and the wall at this location would initially be buried.

As noted in the geotechnical report, the average bluff retreat rate in the study area is projected to be 10 feet over the project's minimum 20-year design life. Therefore, for design, the bluff face profile has been projected 10 feet inland to represent the future conditions. Furthermore, based on knowledge of the bluff face behavior, a weathered and fractured zone roughly 10 feet in thickness has been assumed parallel to the retreated face. Using these assumptions, a wall design height was calculated for each stabilization area. The wall design height is that portion of the soldier pile wall where active soil pressures, which tend to overturn and or slide the wall laterally (see Appendix D and Figure D-1), are applied. In order to provide stability of the soldier pile wall, the pile must extend below the limits of active pressure. Therefore, the soldier pile length is always greater than the wall design height.

For the local stability analysis of the soldier pile walls, an angle of internal friction (phi angle) of 36 degrees was used for formational materials. The areas within Anderson Canyon are largely comprised of fill material, and therefore a lower phi angle of 32 degrees was used. Preliminary design load cases were based on the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Railway Engineering with provisions for earth, Cooper E-80 and earthquake loads applied to the wall. Preliminary structural calculations were prepared for the cantilever and anchored soldier pile walls to address local stability in accordance with the CALTRANS Trench and Shoring Manual.

A 36-inch diameter CIDH soldier pile was considered for all of the areas. Shorter pile lengths can be constructed without tiebacks while longer piles will require the use of tiebacks. Table D summarizes the maximum design height and pile length for the various conditions within the project area. This preliminary design criteria is established for purposes of assessing the feasibility and cost of the soldier pile option. Exceptions to this criteria would be considered where design heights fluctuate within a given stabilization area or where a different pile size or type might be utilized for consistency or constructability during the final design phase.

Table D - Soldier Pile Wall Types, Maximum Design Height		
(Formational Material: phi = 36°)		
Soldier Pile Wall Type	Maximum Design Height	Pile Length
36” Cantilever (9’-0” o.c.)	8’	40’
36” Cantilever (9’-0” o.c.)	10’	50’
36” Anchored (9”-0” o.c.)	15’	40’
36” Anchored (10’-0” o.c.)	25’	65’
(Fill Material : phi = 32°)		
36” Cantilever (10’-0” o.c.)	10’	60’

The global stability of the soldier pile walls was verified using the computer program Slope/W (Geo-Slope, 2002). The design was based on a minimum factor of safety of 1.5 for static loads with surcharge and 1.0 for pseudo-static loads (k_h = 0.28). In many cases the soldier pile embedment length was governed by the global stability calculations. The governing condition in each stabilization area is given in Section 3.3. See Appendix D for additional preliminary design criteria for soldier pile wall analysis.

3.2.2 Soil Cement Buttress

In general, the soil cement buttress alternative improves stability of the bluff by creating a strong massive block that resists the driving forces of the earth. The preliminary design of the soil cement buttress alternative considered the geometry of the bluff, estimated strength parameters of a soil cement mixture, and anticipated construction equipment and placement practices.

In the preliminary design of the soil cement buttress, an attempt was made to maintain existing top and toe of the bluff and to utilize existing seawalls. The basic components of the soil cement buttress consist of a bottom key up to 18 feet wide embedded at least 5 feet into competent formation or compacted fill, a benched backcut, back drains and a minimum cross section dimension of at least 4 feet. The inclination of finish face slope of

the soil cement buttress would vary depending on its location. Typically, two horizontal back drains, an upper and lower drain, would be installed with outlets at an approximate elevation of 15 feet mean sea level (msl) on the finished buttress face. In addition, the use of temporary shoring would also be needed at some locations to support the existing walls and excavation areas. All shoring within the railroad influence should be designed for Cooper E-80 loading.

Slope/W was again used to develop the preliminary design with acceptable factors of safety for static surcharge loading and pseudo-static (seismic) conditions.

The soil cement mixture or mix design strength parameters used for the preliminary design of the buttresses were assumed to be at least 200 pounds per square inch (psi), a 28-day unconfined compressive strength. These values are typical for soil cement buttress designs. Additional laboratory testing or a treatment study of on-site soils (i.e., various soil and cement mixture ratios) would be required for further analysis and evaluation of final designs. It is anticipated that Type II Portland cement would be used.

3.2.3 Soil Nail Reinforcement

The soil nail alternative improves stability by reinforcing and strengthening the existing bluff through the installation of closely-spaced steel bars (nails) embedded in concrete. The preliminary design of the soil nail alternative considered the existing topography of the bluff, estimated bond strength of the soil nails, and anticipated construction installation practices.

Slope/W was used to develop the preliminary design of the soil nail alternative with acceptable factors of safety for static surcharge loading and pseudo-static (seismic) conditions. In summary, the preliminary design consisted of a series of soil nails, approximately 50 feet long, with an approximate vertical and horizontal spacing of 6 feet (i.e., approximately one nail per 36 square feet of bluff face). The first row of soil nails (i.e., lowest row) would begin at an approximate elevation of 14 feet msl. Subsequent rows of soil nails would progress upward to within roughly five to eight feet of the top of the bluff. Preliminary design of the soil nail consisted of at least a 6-inch diameter bored hole, a number 8 steel reinforcement bar, and 3,000 psi concrete. The soil nail was sloped into the bluff at an approximate angle of 15 degrees from horizontal, and was assumed to be capable of developing a minimum working resistant load of 18 kips. It should be noted that further analysis and field verification testing of the soil nail bond strength, which is dependent on construction methods and equipment, would be required. In addition, the use of a facing material will be required as described in Section 2.4.

3.3 Analysis Results

Within each stabilization area, the stabilization alternatives were analyzed in sufficient detail in order to determine site-specific geometric issues, challenges and preliminary construction costs. The results of these analyses are presented in this section, and the costs are tabulated in Section 4.2.2. As mentioned in Sections 1.3 and 2.1, not all of the three alternatives described in this report are viable or practical for each stabilization area. Only the applicable alternatives, as shown in Table C, are presented in this section.

3.3.1 Stabilization Area 1 (SA-1)

Implementation Ranking Number (IR No.): 1
Location: Station 1539+40 to Station 1538+85
Total Length: 55 feet
Length Recommended for Stabilization: 55 feet
Low Static and Pseudo-Static Factors of Safety, based on Cross Section A2-A2'

Photo 1: SA-1 from Beach

Photo 2: SA-1 from Beach

SA-1 is located between the two previously stabilized areas completed in construction as a part of Project 2, as follows:

Project 2 - Stabilization No. (SN)	End Station	Begin Station	Length	Project 2 - Stabilization Method
SN-3	1538+85	1536+90	195	Soldier Pile
SN-7S	1539+69	1539+40	29	Soldier Pile

The edge of the bluff is roughly 38-feet west of the track centerline at Station 1539+21 (Section A2-A2') with an elevation of approximately 46-feet mean sea level (msl). The bluff face is natural and near vertical at the upper portion of the bluff. There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization and would be consistent with the construction of the existing soldier pile wall systems to the north and south that were constructed as part of Project 2. This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 11-foot offset from track to piles throughout Stabilization Area 1. Thus the offset would match or be similar to the existing

pile offset of Stabilization Number 3 to the south and Stabilization Number 7S to the north that were constructed as part of Project 2.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR) on the slope in this stabilization area or provide for repair/replacement of the system. The tiebacks may be in conflict with existing subdrains on both sides of the track. The westerly subdrain may need to be replaced.

Approximately five 36-inch diameter soldier piles would be required for 55-feet of mitigation. The soldier pile wall design height for this area is 15 feet. The total pile length would be approximately 40 feet with tieback anchors to address both local and global slope stability. See Section A2-A2' of Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $145,000 for the 55-foot length of Stabilization Area 1. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Nail Reinforcement

Soil Nail Reinforcement would also provide the necessary stabilization of the bluff face. Construction of a soil nail alternative at this location would consist of installing approximately seven rows of soil nails (i.e., roughly 70 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

It should be noted that the portions of lower rows of soil nails would be outside of the current NCTD right of way. The NCTD right of way extends approximately 54 feet west of the mainline track. Therefore, the lower soil nail construction work would be outside of the right of way and access from the beach should be anticipated. Some lower and upper soil nails may encounter loose landslide debris. This material is compressible and would require remediation or removal. A shotcrete or permanent concrete facing would be required due to the less stable surface materials. The natural bluff face would be altered as a result of construction.

See Section A2-A2' of Appendix B for a typical section.

During design and construction, attention should be given to avoid placing soil nails directly through existing conduits (TDR) and subdrains within this stabilization area. Repair or replacement of these facilities may be necessary.

The estimated cost for installing soil nail reinforcement as described above (including mobilization and contingencies) is approximately $305,000, for the 55-foot length of Stabilization Area 1. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.2 Stabilization Area 2 (SA-2)

Implementation Ranking Number (IR No.): 2
Location: Station 1530+85 to Station 1528+80
Total Length: 205 feet
Length Recommended for Stabilization: 205 feet
Low Static and Pseudo-Static Factors of Safety, based on Cross Sections B-B' and C-C'

Photo 3: SA-2 from Beach

Photo 4: SA-2 from Beach

The area is located at and north of 11th Street and immediately south of the existing Soil Cement buttress stabilization. The edge of the bluff is roughly 48-feet west of the track centerline at Station 1529+00 (Section C-C') with an elevation of approximately 61-feet mean sea level (msl). The bluff face in this area is natural and near vertical for the upper portion. Considering the natural topography of the bluff and the dense exposed bluff face, there are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization along the bluff top. This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

There is an existing buried wall located approximately 15 feet west of the track centerline. It would be reasonable to maintain a constant 11-foot offset from track to piles throughout Stabilization Area 2 and still maintain clearance from the wall. The existing wall should be uncovered and field located during the design phase to confirm clearances.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR) and existing drainage facilities on the slope in this stabilization area. Repair or replacement of these facilities may be necessary.

Approximately twenty-four 36-inch diameter soldier piles would be required for 205-feet of mitigation. The soldier pile wall design height for this area is approximately 10 feet. The total pile length for a cantilever wall would be approximately 50 feet to address both local and global slope stability. See Section B-B' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $735,000 for the 205-foot length of Stabilization Area 2. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Nail Reinforcement

Soil Nail Reinforcement would also provide the necessary stabilization of the bluff face. Construction of a soil nail alternative at this location would consist of installing approximately nine rows of soil nails (i.e., roughly 315 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

Construction of a soil nail alternative at this location would likely cause additional disturbance of the natural bluff areas. Slope disturbance would probably result in some increased erosion, but this could be reduced by the use of a bluff facing in conjunction with the soil nail system. The construction cost estimate for this alternative is based on facing for the entire height of the bluff.

During design and construction, attention should be given to avoid placing a soil nail directly through existing conduits (TDR) and existing drainage facilities on the slope in this stabilization area. Repair or replacement of these facilities may be required.

The northerly 50 feet of Stabilization Area 2 may not be suitable for the use of soil nails based on the presence of fill or soil cement materials. Further evaluation is necessary to determine the extent of fill. Soldier piles would be an alternative in the fill areas. For purposes of the construction estimate, soil nails are used for the entire length.

The NCTD right of way extends approximately 50 feet west of the mainline track. A significant portion of the bluff face is outside of the current NCTD right of way. Therefore, the lower soil nail construction work would be outside of the right of way and access from the beach should be anticipated. See Section C-C' in Appendix B for a typical section.

The estimated cost for installing soil nail reinforcement as described above (including mobilization and contingencies) is approximately $1,285,000 for the 205-foot length of Stabilization Area 2. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.3 Stabilization Area 3 (SA-3)

Implementation Ranking Numbers (IR No.): 6
Location: Station 1518+55 to Station 1516+57
Total Length: 198 feet
Length Recommended for Stabilization: 198 feet
Low Pseudo-Static Factor of Safety, based on Cross Sections F1-F1' and G-G'

Photo 5: SA-3 from Beach

Photo 6: SA-3 from Beach

SA-3 is located just north of a previously stabilized area completed in construction as a part of Project 2, as follows:

Project 2 - Stabilization No. (SN)	End Station	Begin Station	Length	Project 2 - Stabilization Method
SN-6	1516+57	1515+64	93	Soldier Pile

There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization and would be consistent with the construction of the existing soldier pile wall system to the south. This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 15-foot offset from track centerline to piles throughout Stabilization Area 3. Thus the offset would match the existing Project 2 Stabilization Number 6 to the south.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR), existing drainage facilities, and existing wall on the slope in this stabilization area. A 36-inch diameter and 42-inch diameter storm drain

cross the track alignment. These facilities should be field located during the final design phase and adjustments should be made to the pile location to avoid conflicts. If the pile locations cannot be adjusted to avoid the conflict a site specific design would be necessary to bridge the existing facilities.

Approximately twenty-two 36-inch soldier piles would be required for 198-feet of mitigation. The soldier pile wall design height for this area is approximately 8 feet. The total pile length for a cantilever wall would be approximately 40 feet to address both local and global slope stability. See Section G-G' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $495,000 for the 198-foot length of Stabilization Area 3. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Nail Reinforcement

Soil Nail Reinforcement would also provide the necessary stabilization on the bluff face. Construction of a soil nail alternative at this location would consist of installing approximately eight rows of soil nails (i.e., roughly 272 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

Some lower and upper soil nails may encounter loose landslide debris. This material is compressible and would require remediation or removal. A shotcrete or permanent concrete facing would be required due to the less stable surface materials. The natural bluff face would be altered as a result of construction.

The NCTD right of way extends approximately 72 feet west of the mainline track at station 1516+73. Therefore, the lower soil nail construction work would be outside of the right of way and access from the beach should be anticipated. See Section G-G' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing soil nails directly through existing conduits (TDR), existing drainage facilities, and existing wall on the slope in this stabilization area.

Construction of a soil nail alternative at this location would likely cause additional disturbance of the natural bluff areas. Slope disturbance would probably result in some increased erosion, but this would be reduced by the use of a bluff facing in conjunction with the soil nail system.

The estimated cost for installing soil nail reinforcement as described (including mobilization and contingencies) is approximately $1,140,000 for the 198-foot length of Stabilization Area 3. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.4 Stabilization Area 4 (SA-4)

Implementation Ranking Numbers (IR No.): 3
Location: Station 1514+55 to Station 1513+20
Total Length: 135 feet
Length Recommended for Stabilization: 135 feet
Low Static and Pseudo-Static Factors of Safety, based on Cross Section G3-G3'

Photo 7: SA-4 from Beach

Photo 8: SA-4 from Beach

This area is located south of a previously stabilized area identified as the Eighth Street Emergency Repair done in 2001. The edge of the bluff is approximately 30 feet westerly of the track centerline. It should be noted that this area was also previously stabilized in 1978 with 18-inch diameter shear pins reinforced with two 115 pound rails at 5 foot centers with an approximate depth of 32 feet. There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Cement Buttress

Soldier Pile Wall

This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

The existing shear pin wall is located approximately 15 feet from the track centerline. A new soldier pile wall would be placed approximately 24 feet from the track centerline to avoid conflict with the existing wall. The wall location would transition back to the standard 15 foot offset at the north end to meet the wall constructed as part of the 8th Street emergency repair.

Approximately fourteen 36-inch diameter soldier piles would be required for 135-feet of mitigation. The soldier pile wall design height for this area is approximately 25 feet. The total pile length would be approximately 65 feet with tieback anchors to address both local and global slope stability. The pile spacing will be increased to 10 feet o.c. to allow construction of tiebacks between the existing shear pins. See Section G3-G3' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR), existing drainage facilities, and existing shear pins on the slope in this stabilization area. The existing drainage facilities and shear pins should be field located during the design phase of the project to confirm clearances. The final spacing of the piles and tiebacks would be adjusted for placement between the existing shear pins.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $1,020,000 for the 135-foot length of Stabilization Area 4. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Cement Buttress

Construction of a soil cement buttress in this area would require excavation of the eroded bluff and replacement with compacted cement-treated soil.

Considering that the upper and lower limits of the area are confined by existing shear pins and a timber seawall, respectively, the inclination of the finish slope face of the buttress would be roughly 1.2 to 1 (horizontal to vertical). Section G3-G3' in Appendix B shows a typical section of the proposed soil cement stabilization. The preliminary design for this area results in approximately 6,000 cubic yards of soil cement.

Construction of this alternative would require access from both the beach and the bluff top. The NCTD right of way extends approximately 76 feet west of the mainline track at station 1514+08. Temporary access and portions of the permanent construction would be outside of the NCTD right of way. Temporary shoring between the top of buttress and the railroad tracks would be required.

During design and construction, attention should be given to avoid damaging existing conduits (TDR), existing drainage facilities, and existing shear pins on the slope in this stabilization area.

The estimated cost for installing a soil cement buttress as described above (including mobilization and contingencies) is approximately $1,450,000 for the 135-foot length of Stabilization Area 4. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.5 Stabilization Area 5 (SA-5)

Implementation Ranking Numbers (IR No.): 6
Location: Station 1512+45 to Station 1511+65
Total Length: 80 feet
Length Recommended for Stabilization: 80 feet
Low Pseudo-Static Factor of Safety, based on Cross Section H-H'

Photo 9: SA-5 from Beach

Photo 10: SA-5 from Beach

This area is located 75 feet south of proposed SA-4 (discussed above) and north of Sherrie Lane. The edge of the bluff is roughly 45-feet west of the track centerline at Station 1512+15 (Section H-H') with an elevation of approximately 60-feet mean sea level (msl). The bluff face is natural and near vertical at the mid to lower portion of the bluff. There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization and would be consistent with the construction of a soldier pile wall system in Stabilization Area 4 to the north. This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 15-foot offset from track to piles throughout Stabilization Area 5.

Approximately ten 36-inch diameter soldier piles would be required for 80 feet of mitigation. The soldier pile wall design height for this area would be approximately 8 feet. The total pile length for a cantilever wall would be approximately 40 feet to address both local and global slope stability. See Section H-H' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR) on the slope in this stabilization area.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $225,000 for the 80-foot length of Stabilization Area 5. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Nail Reinforcement

Soil Nail Reinforcement would also provide the necessary stabilization on the bluff face. Construction of a soil nail alternative at this location would consist of installing approximately eight rows of soil nails (i.e., roughly 112 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

Construction of a soil nail alternative at this location would likely cause additional disturbance of the natural bluff areas. Slope disturbance would probably result in some increased erosion, but this could be reduced by the use of a bluff facing in conjunction with the soil nail system. The natural bluff face would be altered as a result of construction.

The NCTD right of way extends approximately 80 feet west of the mainline track. Therefore, the lower soil nail construction work would be outside of the right of way and access from the beach should be anticipated. See Section H-H' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing soil nails directly through existing conduits (TDR), existing drainage facilities, and the existing wall on the slope in this stabilization area.

The estimated cost for installing soil nail reinforcement as described above (including mobilization and contingencies) is approximately $465,000 for the 80 foot length of Stabilization Area 5. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.6 Stabilization Area 6 (North: SA-6N and South: SA-6S)

North
Implementation Ranking Numbers (IR No.): 4
Location: Station 1494+40 to Station 1490+00
Total Length: 440 feet
Length Recommended for Stabilization: 440 feet
Low Pseudo-Static Factor of Safety, based on Cross Sections J-J' and 20-20' from Project 2

South
Implementation Ranking Numbers (IR No.): 7
Location: Station 1490+00 to Station 1485+80
Total Length: 420 feet
Length Recommended for Stabilization: 420 feet
Low Static and Pseudo-Static Factors of Safety, based on Cross Section K-K'

Photo 11: SA-6 from Beach

Photo 12: SA-6 from Beach

Photo 13: SA-6 from Beach

Photo 14: SA-6 from Beach

This long section of bluff has abundant new landslides since the mapping performed in 2003. The northern area also includes a fill area and large retaining wall at the toe of the bluff with a storm drain outlet located at approximately Station 1493+77. Note that the

existing storm drain outlet pipe should be considered in the future design. The bluff face is natural, excluding the fill slope area behind the retaining wall, and is near vertical at the upper portion of the bluff.

There are three stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Cement Buttress
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization and could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 15-foot offset from track to piles throughout Stabilization Area 6N and 6S.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR), existing drainage facilities, and existing wall on the slope in this stabilization area.

Stabilization Area 6N

Approximately fifty 36-inch diameter soldier piles would be required for 440 feet of mitigation. The soldier pile wall design height for this area would be approximately 8 feet. The total pile length for a cantilever wall would be approximately 40 feet to address both local and global slope stability. See Section J-J' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $1,120,000 for the 440 foot length of Stabilization Area 6N. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Stabilization Area 6S

Approximately forty-seven 36-inch diameter soldier piles would be required for 420 feet of mitigation. The soldier pile wall design height for this area would be approximately 8 feet. The total pile length for a cantilever wall would be approximately 40 feet to address both local and global slope stability. See Section K-K' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $1,050,000 for the 420 foot length of Stabilization Area 6S. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Cement Buttress

Stabilization Area 6N

A 60 foot long section of the bluff area (Station 1493+40 to Station1494+00) within Stabilization Area 6N could be stabilized with a buttress fill. There is an existing sea wall at the toe of the slope. Construction of a soil cement buttress in this area would require excavation of the previously placed fill and replacement of the bluff with cement-treated soil. Soldier Piles or Soil Nails would be needed in conjunction with the Soil Cement buttress to stabilize the entire area.

Considering that the lower limits of the area are confined by an existing retaining wall, the inclination of the finish slope face of the buttress would be roughly 1.5 to 1 (horizontal to vertical). Temporary shoring between the top of the buttress excavation and the railroad track would be required. A typical section of the proposed soil cement stabilization is shown in Section 20-20 of Appendix B. The preliminary design for this area results in approximately 4,700 cubic yards of soil cement.

The NCTD right of way extends approximately 120 feet west of the track centerline. Therefore, the lower soil cement buttress work would be completed within the right of way. Temporary access from both the beach and the bluff top should be anticipated.

The estimated cost for installing a soil cement buttress as described above (including mobilization and contingencies) is approximately $980,000 for the 60 foot length of Stabilization Area 6N. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C. The remaining 380 foot length of SA-6N would require stabilization by other methods at additional cost.

Soil Nail Reinforcement

Stabilization Area 6N

Soil Nail Reinforcement would also provide the necessary stabilization along the majority of the bluff face within Stabilization Area 6N. Construction of a soil nail alternative at this location would consist of installing approximately nine rows of soil nails (i.e., roughly 576 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff. The 60 foot portion of the bluff above the existing sea wall between Station 1493+40 and Station 1494+00 is fill and would not be suitable for a soil nail stabilization system. Solder Piles or a Soil Cement Buttress would be needed for this portion of Stabilization Area 6N.

Significant landslides exist along the lower bluff area. The landslide debris is compressible and would require remediation or removal. Slope disturbance would probably result in some increased erosion. A shotcrete or permanent concrete facing would be required due to the less stable surface materials as mitigation for the increase erosion potential. The natural bluff face will be altered as a result of construction.

The NCTD right of way extends approximately 100 feet to 120 feet west of the mainline track. The toe of the existing slope is just within the existing right of way. The permanent wall system would be constructed within the existing right of way; however temporary access and construction activities on the beach should be anticipated. See Section J-J' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing a soil nail directly through existing conduits (TDR), fiber optic line and drainage facilities on the slope in this stabilization area.

The estimated cost for installing soil nail reinforcement as described above (including mobilization and contingencies) is approximately $2,455,000 for the 380 foot portion of Stabilization Area 6N. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C. The remaining 60 foot length would require stabilization by other methods at additional cost.

Stabilization Area 6S

Soil Nail Reinforcement would also provide the necessary stabilization on the bluff face in Stabilization Area 6S. Construction of a soil nail alternative at this location would consist of installing approximately ten rows of soil nails (i.e., roughly 710 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

Significant landslides exist along the lower bluff area. The landslide debris is compressible and would require remediation or removal. Slope disturbance would probably result in some increased erosion. A shotcrete or permanent concrete facing would be required due to the less stable surface materials as mitigation for the increase erosion potential. The natural bluff face would be altered as a result of construction.

The NCTD right of way extends approximately 98 feet west of the mainline track centerline. The toe of the existing slope is just within the existing right of way. The permanent wall system would be constructed within the existing right of way; however temporary access and construction activities on the beach should be anticipated. See Section K-K' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing a soil nail directly through existing conduits (TDR), fiber optic line and drainage facilities on the slope in this stabilization area.

The estimated cost for installing a soil nail reinforcement as described above (including mobilization and contingencies) is approximately $2,995,000 for the 420 foot length of Stabilization Area 6S. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.7 Stabilization Area 7 (SA-7)

Implementation Ranking Numbers (IR No.): 3
Location: Station 1485+80 to Station 1484+80
Total Length: 100 feet
Length Recommended for Stabilization: 100 feet
Low Static and Pseudo-Static Factors of Safety, based on Cross Sections K1-K1'

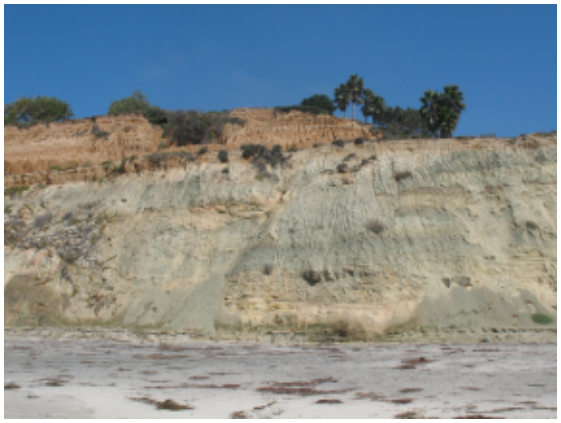


Photo 15: SA-7 from Beach

Photo 16: SA-7 from Beach

SA-7 is located just north of a previously stabilized area constructed as a part of Project 2, as follows:

Project 2 - Stabilization No. (SN)	End Station	Begin Station	Length	Project 2 - Stabilization Method
SN-8	1484+80	1483+55	125	Soldier Pile

The edge of the bluff is roughly 40-feet west of the track centerline at Station 1485+15 (Section K1-K1') with an elevation of approximately 56-feet mean sea level (msl). The bluff face is natural and near vertical at the upper portion of the bluff. There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization and would be consistent with the existing soldier pile wall system to the south. This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 13-foot to 15 foot offset from track to piles throughout Stabilization Area 7. Thus the offset would match the existing Project 2 Stabilization Number 8 to the south.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR) and fiber optic line on the slope in this stabilization area.

Approximately eleven 36-inch soldier piles would be required for 100 feet of mitigation. The soldier pile wall design height for this area is approximately 8 feet. The total pile length for a cantilever wall would be approximately 40 feet to address both local and global slope stability. See Section K1-K1' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described (including mobilization and contingencies) is approximately $250,000 for the 100 foot length of Stabilization Area 7. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Nail Reinforcement

Soil Nail Reinforcement would also provide the necessary stabilization on the bluff face. Construction of a soil nail alternative at this location would consist of installing approximately eight rows of soil nails (i.e., roughly 144 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

Significant landslides exist along the lower bluff area. The landslide debris is compressible and would require remediation or removal. Slope disturbance would probably result in some increased erosion. A shotcrete or permanent concrete facing would be required due to the less stable surface materials as mitigation for the increase erosion potential. The natural bluff face will be altered as a result of construction.

The NCTD right of way extends approximately 87 feet west of the mainline track centerline. The toe of the existing slope is just within the existing right of way. The permanent wall system would be constructed within the existing right of way; however temporary access and construction activities on the beach should be anticipated. See Section K1-K1' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing a soil nail directly through existing conduits (TDR) and fiber optic line on the slope in this stabilization area.

The estimated cost for installing a soil nail reinforcement as described above (including mobilization and contingencies) is approximately $ 630,000 for the 100-foot length of Stabilization Area 6S. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.8 Stabilization Area 8 (SA-8)

Implementation Ranking Numbers (IR No.): 5
Location: Station 1483+55 to Station 1482+00
Total Length: 155 feet
Length Recommended for Stabilization: 155 feet
Low EQ Pseudo-Static, based on Cross Sections L-L'

Photo 17: SA-8 from Beach

Photo 18: SA-8 from Beach

SA-8 is located at Anderson Canyon west of the track and is underlain with fill and a large retaining wall at the toe of the bluff. The area is located just south and west of two previously stabilized areas constructed as part of Project 2, as follows:

Project 2 - Stabilization No. (SN)	End Station	Begin Station	Length	Project 2 - Stabilization Method
SN-8	1484+80	1483+55	125	Soldier Pile
SN-4	1483+25	1482+75	50	Soldier Pile

There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Cement Buttress

Soldier Pile Wall

This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 11-foot offset from track to piles throughout Stabilization Area 8. Thus the offset would match the existing Project 2 Stabilization Number 8 to the north. The existing tiebacks from Project 2 Stabilization Number 4 to the east are potentially in conflict with the new piles. The new piles would be placed in between the existing tiebacks. Drilling into an existing tieback could create a dangerous situation during construction. As part of the design phase for the project the

existing piles should be field located to better estimate the location of the existing tiebacks. The project specifications should give additional guidelines to the contractor for avoiding conflicts with the existing tiebacks. An existing 6 foot high arch culvert crosses the track alignment as shown in Section 1482+85. Special design considerations will be necessary to avoid conflict with the existing culvert. Attention should be given to avoid placing a soldier pile directly through existing conduits (TDR). Repair or replacement of these facilities may be necessary

Approximately sixteen 36-inch diameter soldier piles would be required for 155 feet of mitigation. The soldier pile wall design height for this area is approximately 10 feet. The total pile length for a cantilever wall would be approximately 60 feet to address both local and global slope stability. The pile spacing would be increased to 10 feet o.c. to avoid conflict with existing tiebacks on the east side of the track. See Section L-L' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $690,000 for the 155 foot length of Stabilization Area 7. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Cement Buttress

The railroad track within Stabilization Area 8 is supported to west by a fill slope and concrete sea wall. This area could be stabilized with a buttress fill. Construction of a soil cement buttress in this area would require excavation of a portion of the previously placed fill and replacement of the bluff with cement-treated soil. The existing sea wall would be protected in place.

Considering that the lower limits of the area are confined by an existing retaining wall the inclination of the finish slope face of the buttress would be roughly 1.2 to 1 (horizontal to vertical). Temporary shoring between the top of the buttress excavation and the railroad track may be required. A preliminary review of the existing conditions indicates that the new buttress fill could be constructed without impacting the existing tiebacks from the soldier pile to the east of the track or the existing storm drain below the fill. Potholing of the existing tiebacks would be necessary to confirm that the tiebacks would not be impacted. The existing TDR would be removed and replaced as part of the construction. See Section L-L' in Appendix B for a typical section. The preliminary design for this area results in approximately 5,200 cubic yards of soil cement.

The NCTD right of way extends approximately 84 feet west of the mainline track centerline. Therefore, the lower soil cement buttress work would be completed within the right of way. Temporary access from both the beach and the bluff top should be anticipated.

The estimated cost for installing a soil cement buttress as described above (including mobilization and contingencies) is approximately $1,240,000 for the 155 foot length of Stabilization Area 8. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

3.3.9 Stabilization Area 9 (SA-9)

Implementation Ranking Numbers (IR No.): 4
Location: Station 1481+00 to Station 1479+40
Total Length: 160 feet
Length Recommended for Stabilization: 160 feet
Low Static and Pseudo-Static Factors of Safety, based on Cross Section M1-M1'

Photo 19: SA-9 from Beach

Photo 20: SA-9 from Beach

This area has new landslides since the mapping performed in 2003. The edge of the bluff is roughly 35-feet west of the track centerline at Station 1479+82 (Section M1-M1') with an elevation of approximately 52-feet mean sea level (msl). The bluff face is natural with a general slope inclination of 1 to 1 (horizontal to vertical).

There are two stabilization methods recommended by the geotechnical report (Leighton, 2010), as follows:

- Soldier Pile Wall
- Soil Nail Reinforcement

Soldier Pile Wall

A Soldier Pile Wall System would provide the necessary stabilization. This alternative could be easily constructed on the bluff top within the right of way and with limited disruption of rail operations. The soldier pile wall system could be buried.

It would be reasonable to maintain a constant 15-foot offset from track to piles throughout Stabilization Area 9.

During design and construction, attention should be given to avoid placing a soldier pile directly through existing conduits (TDR) and fiber optic line on the slope in this stabilization area.

Approximately nineteen 36-inch diameter soldier piles would be required for 160 feet of mitigation. The soldier pile wall design height for this area is approximately 15 feet. The total pile length for an anchored wall would be approximately 40 feet to address both local and global slope stability. See Section M1-M1' in Appendix B for a typical section.

The estimated cost for installing a soldier pile system as described above (including mobilization and contingencies) is approximately $535,000 for the 160 foot length of Stabilization Area 9. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

Soil Nail Reinforcement

Soil Nail Reinforcement would also provide the necessary stabilization on the bluff face. Construction of a soil nail alternative at this location would consist of installing approximately eight rows of soil nails (i.e., roughly 224 soil nails). Based on surrounding topography, the construction activities can be performed from both the toe and top of the bluff.

Slope disturbance world probably result in some increased erosion. A shotcrete or permanent concrete facing would be required due to the less stable surface materials as mitigation for the increase erosion potential. The natural bluff face will be altered as a result of construction.

The NCTD right of way extends approximately 82 feet west of the mainline track centerline. The toe of the existing slope is close to the existing right of way. Portions of the permanent wall system may be constructed beyond the existing right of way. Temporary access and construction activities on the beach should be anticipated. See Section M1-M1' in Appendix B for a typical section.

During design and construction, attention should be given to avoid placing a soil nail directly through existing conduits (TDR) and fiber optic line on the slope in this stabilization area.

The estimated cost for installing a soil nail reinforcement as described above (including mobilization and contingencies) is approximately $895,000 for the 160-foot length of Stabilization Area 9. Approximate quantities and unit price assumptions are included in the preliminary construction cost estimates in Appendix C.

4.0 Alternative Evaluation

4.1 Evaluation Approach

Each of the three stabilization alternatives – soldier pile, soil cement buttress, and soil nail reinforcement – were evaluated for their relative suitability for the Del Mar Bluffs Stabilization Project 3. Three categories were selected for this evaluation process that includes:

- Constructability
- Construction Cost
- Environmental Considerations

The stabilization alternatives were evaluated with respect to these three categories and ranked from highest to lowest potential impact. In order to quantify the ranking, the following metrics were applied:

- Best or Lowest Potential Impact
- Mid-Level or Moderate Potential Impact
- Worst or Highest Potential Impact

Note that where effects would likely be similar between alternative measures, more than one measure may be rated as best, mid-level or worst within a given category. The evaluation at the end of this section provides a summary of the evaluation results in a tabular format. This evaluation summary was used to assist in the selection of the most appropriate stabilization alternative for each stabilization area using Table C in Section 2.1 as an initial guide.

4.1.1 Constructability

The constructability for this project is defined as the ability to build within access limitations, with commonly available construction equipment, and with minimal impact to rail operations. The Del Mar Bluffs Stabilization Project 3 involves the construction of trackbed stabilization alternatives at the bluff toe, along the bluff face, or at the bluff top. The primary constructability issues for this project are:

- Construction Access
- Construction Work Area
- Potential Impacts to Rail Operations
- Staging and Phasing of Work
- Potential for Encountering Unforeseen Conditions

4.1.2 Construction Cost

The construction cost for each stabilization alternative and stabilization area was estimated based on the preliminary engineering and was reported in Section 3.3. Since the estimated cost includes provisions for the type and complexity of the work, the costs can be directly compared for each area and alternative.

4.1.3 Environmental Considerations

Each of the potential bluff stabilization alternatives could affect environmental resources along the Del Mar Bluffs with the level of potential effect varying depending on the type of bluff stabilization utilized and the specific location(s) along the bluff. An evaluation of environmental considerations was conducted based on visual resources, noise, biological resources, recreation and coastal processes because these are environmental resource or issue areas with the potential to either constrain and/or be affected by implementation of potential bluff stabilization measures.

The discussion of environmental considerations is followed by a description of environmental regulatory approvals that could be required for the alternative bluff stabilization measures, with the specific approvals that may be required for a given measure described in Section 4.2.3.

4.1.3.1 Visual Resources

The potential visual resource effects of bluff stabilization measures are considered in light of the project area's visual setting, the number of potential viewers that would observe project features and those viewers' sensitivity to change, and applicable policies and guidance. In terms of visual setting, the Del Mar Bluffs offer a range of viewer experiences, with some sections of the bluff appearing relatively natural, and with other sections of the bluff dominated by man-made features such as a large concrete spillway, concrete seawalls, and post-and-beam seawalls. Although the bluffs contribute to the visual setting of the beach, most beach-goers' activities are oriented either along the beach or toward the ocean (i.e., not facing the bluffs).

In terms of applicable policies and guidance, Chapter 3 of the California Coastal Act (PRC §30251) states that:

> The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to… minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas.

Section 4.1.3.6 of this report refers to the applicability of California Coastal Act policies to the proposed bluff stabilization measures.

4.1.3.2 Noise

All of the potential bluff stabilization measures addressed in this report would generate noise during construction. Once a potential bluff stabilization measure has been installed, it would not be expected to result in noise generation, with the minor exception of vehicle noise associated periodic maintenance and inspection visits by NCTD staff. The consideration of construction noise in this report focuses on where the noise would occur (would it occur at the bluff top, toe, or both), when the noise would occur (day or night) and the sensitivity of surrounding land uses to noise impacts. There are no applicable policies that specifically set limits on construction noise. The Federal Transit

Administration (FTA) does state in its *Transit Noise and Vibration Impact Assessment Final Report* (1995) that construction projects generating daytime noise levels over 90 decibels or nighttime noise levels over 80 decibels may generate adverse community reaction (1995:12-6). This Type Selection Report does not quantify potential construction noise levels for the potential bluff stabilization measures, but it does identify their potential to affect residents (bluff top) and/or beach visitors (bluff toe).

4.1.3.3 Biological Resources

The Del Mar Bluffs support habitats of varying sensitivity. Along the bluff top (i.e., where the tracks are located), much of the bluff has been disturbed and is either barren (no vegetation), developed (tracks and ballast) or disturbed (sparse, primarily non-native vegetation). The bluff face supports habitat types ranging from sensitive vegetation communities (e.g., coastal bluff scrub, Diegan coastal sage scrub) to non-sensitive habitat types (e.g., disturbed, developed). Potential effects to biological resources are not quantified in this report; rather, the potential for alternative bluff stabilization measures to affect sensitive resources is described qualitatively based on the level of bluff face disturbance the alternative measures would cause and the extent of that disturbance.

4.1.3.4 Recreation

The beach located below the Del Mar Bluffs is a significant local and regional recreational resource. Effects on beach recreation may be subject to regulation by the California Coastal Commission and, if direct use of the beach is required, the State Lands Commission (which has jurisdiction over some sections of the "dry" beach below the bluffs as well as all of the beach below the mean high tide line; see Section 4.1.3.6). Potential effects on recreation also must be considered in light of applicable Department of Transportation policies (see the discussion of "Section 4(f) Requirements" in Section 4.1.3.6).

Within this report, the potential for effects on recreation is discussed in terms of whether a bluff stabilization alternative would require the temporary use of the beach for construction activity. In contrast to Del Mar Bluffs Stabilization Project 2, none of the alternative stabilization measures carried forward for evaluation in this Type Selection Report would result in the permanent loss of beach through the construction of a protective structure on the beach. Section 4.1.3.5 discusses the potential for stabilization measures to affect beach processes.

4.1.3.5 Coastal Processes

Implementation of the various bluff stabilization measures currently under consideration for the project could impact coastal processes via effects to four primary mechanisms. The four mechanisms are: (1) reduction of the beach width through passive erosion, (2) modification of the near shore wave environment, (3) increase in beach erosion through active erosion, and (4) increase in beach erosion by keeping sand in the bluff from reaching the beach. These four mechanisms are described in more detail below.

(1) Passive erosion is the loss of beach width on an eroding shoreline that can occur by fixing the back beach line. If the back beach line is fixed (e.g., with a seawall) and the shoreline continues to erode, the beach fronting the seawall can continue to erode

vertically thereby reducing the beach area. Passive erosion is usually a significant problem only in reaches of shoreline that receive most of the beach sand from coastal cliff erosion. If most of the sand comes from other sources (e.g., rivers) then fixing the back beach line would not usually have a significant impact on beach width since the beach would continue to be supplied with sand from the other sources. This explains the existence of natural beaches fronting sea cliffs composed of rocky material.

(2) The construction of some bluff stabilization measures (e.g., seawalls) can modify the characteristics of the back beach area, thereby adversely affecting the near-shore wave environment and sediment transport patterns. This is usually a significant impact only in dune and low-lying beach areas with no cliffs or bluffs on the back beach area. In these cases, construction of a hard structure can provide a new vertical surface that allows impacting waves to reflect with greater energy than the waves that would have reflected off the beach or dune area. If the back beach area is already composed of hard material that is vertical or nearly vertical (e.g., sea cliff), then the impact of a new hard structure on the near shore wave environment would be minimal as long the seawall is built in the same location on the beach profile utilizing similar material (i.e., hardness) and similar configurations (i.e., angle relative to vertical).

(3) The construction of some bluff stabilization measures (e.g., seawall) can result in a process known as active erosion that causes a decrease in beach width and height in the localized area immediately adjacent to the stabilization measure. Active erosion is caused by changes in wave energy (e.g., reflection) due to differences between the stabilization measure and surrounding beach area. If the stabilization measure is constructed of material that is substantially different than the surrounding beach area or if the stabilization measure is built in a configuration (plan form and/or section) that is substantially different than the surrounding beach area, then additional erosion may be induced through modifications in the wave energy. However, if the stabilization measure is constructed of material with similar properties to the adjacent beach area (e.g., rock sea cliffs) and it is built in a similar configuration, potential impacts attributed to active erosion can be minimized.

(4) Fixing the location of the cliff line along a shoreline that is actively eroding can result in a depletion of sediment to the shoreline. This depletion is caused by the retention of sediment behind the stabilization measure that would otherwise be deposited in the beach area during erosion events. Since a portion of the sediment contained in sea cliffs is usually sand that would be deposited on the beach, retaining the sand behind a stabilization measure can accelerate beach erosion on an actively eroding shoreline. The significance of this effect is dependent on the portion of sand supplied to the beach that comes from cliff erosion and the rate at which this portion of sand is supplied to the beach.

The bluff stabilization measures under consideration for the project were evaluated to determine the potential to cause substantial impacts on coastal processes via a change in the four mechanisms described above. The bluff stabilization measures were assessed for potential impacts to all four mechanisms and an overall evaluation was then developed based on a relative comparison with the other alternatives using the three comparison metrics described above (i.e., highest, mid-level and lowest).

4.1.3.6 Regulatory Approvals

Potential regulatory approvals (including legal requirements associated with federal funding through the Department of Transportation's FTA) are described below. The requirement that an alternative bluff stabilization measure be addressed pursuant to applicable environmental laws and regulations is not a factor in the type selection process, except where the law or regulation may restrict or prohibit implementing one or more of the potential stabilization measures.

National Environmental Policy Act

The proposed project is subject to evaluation under the National Environmental Policy Act (NEPA; 42 U.S.C. Section 4332) because of the federal funding that would be provided by the FTA. NEPA requires that federal agencies evaluate the potential environmental consequences of their proposed actions. In its role as the lead agency under NEPA, the FTA would determine the appropriate level of required NEPA documentation for the selected bluff stabilization measure(s) (e.g., Categorical Exclusion, Environmental Assessment/Finding of No Significant Impact or Environmental Impact Statement). Because NEPA compliance would be required for any of the potential bluff stabilization measures, the fact that potential measures must be addressed under NEPA is not factored into the type selection process.

Federal Coastal Zone Management Act/California Coastal Act

The proposed bluff stabilization would occur entirely within the California coastal zone, as established by the California Coastal Act (California Public Resources Code Sections 30000 *et seq*.). Because of its location within the coastal zone, the proposed project can only receive federal funding if it is consistent with the coastal resources planning and management policies contained in Chapter 3 of the California Coastal Act. This requirement, described below, stems from the Federal Coastal Zone Management Act (33 United States Code Sections 1451 *et seq*.), as amended through Public Law 104-150 (the Coastal Zone Protection Act of 1996).

The Federal Coastal Zone Management Act (Section 1456(d)) mandates that:

State and local governments submitting applications for Federal assistance under other Federal programs, in or outside of the coastal zone, affecting any land or water use of natural resource of the coastal zone shall indicate the views of the appropriate state or local agency as to the relationship of such activities to the approved management program for the coastal zone. Such applications shall be submitted and coordinated in accordance with the provisions of section 6506 of title 31. Federal agencies shall not approve proposed projects that are inconsistent with the enforceable policies of a coastal state's management program, except upon a finding by the Secretary that such project is consistent with the purposes of this chapter or necessary in the interest of national security.

In California, the referenced "enforceable policies" are contained in Chapter 3 of the California Coastal Act. The Chapter 3 policies address public access, recreation, marine environment, land resources, development and industrial facilities (many of these policies

would not be applicable to a project involving preservation of trackbed support). As applicable, these policies are considered in the assessment of visual resources and recreation (see Sections 4.1.3.1 and 4.1.3.4).

Department of Transportation 4(f) Requirements

Bluff stabilization measures that would affect the public beach at the base of the bluffs would require a Department of Transportation Section 4(f)[1] analysis. In part, Section 4(f) states that:

[T]he Secretary [of the Department of Transportation] shall not approve any program or project which requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance as determined by the Federal, State, or local officials having jurisdiction thereof, or any land from an historic site of national, State, or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreation areas, wildlife and waterfowl refuge, or historic sites resulting from such use….

The public beach at the base of the Del Mar bluffs qualifies as a public recreation area of state or local significance; however, as noted above, none of the potential stabilization measures would permanently encroach onto the beach. Temporary use of the beach could be required for construction of soil nail reinforcement or soil cement buttresses.

Section 4(f) does not apply to a temporary occupancy (including those resulting from a right-of-entry, construction, and other temporary easements and other short-term arrangements) of publicly owned recreation areas where there is documentation that the officials having jurisdiction over the protected resource agree that the temporary occupancy would:
Be of short duration and less than the time needed for construction of the project;
Not change the ownership or result in the retention of long-term or indefinite interests in the land for transportation purposes;
Not result in any temporary or permanent adverse change to the activities, features, or attributes which are important to the purposes or functions that qualify the resource for protection under Section 4(f); and
Include only a minor amount of land.

Thus, to avoid a Section 4(f) alternatives analysis for a temporary construction easement on the beach, NCTD would need to coordinate with the agency having jurisdiction over the affected segment of beach (e.g., City of Del Mar and/or State Parks). The respective jurisdictional agency also would need to agree that construction activities would not result in any temporary adverse change to the activities, features, or attributes that qualify the beach as a recreation area of state or local significance.

[1] The reference to "Section 4(f)" reflects that these requirements originally were contained in Section 4(f) of the Department of Transportation Act of 1966. They since have been codified in Title 49, United States Code (U.S.C.), Section 1653(f). Similar requirements for Federal-Aid Highway projects also are contained in Title 23 U.S.C. Section 138. For purposes of this report (and following convention), the codified requirements are still referred to as "Section 4(f)" requirements.

California Environmental Quality Act

If a local government or state agency (such as the City of Del Mar or State Lands Commission) is required to take a discretionary action in order to allow a bluff stabilization measure to proceed, that local government/state agency may be required to evaluate the proposed bluff stabilization measure under the California Environmental Quality Act (CEQA; California Public Resources Code Sections 21000 et seq.). The potential that other parties may require CEQA compliance prior to making a discretionary action on a specific bluff stabilization measure is not a selection factor considered in this report.

Beach Preservation Initiative

If the City of Del Mar is required to take a discretionary action or make a policy decision on Del Mar Bluffs Stabilization Project 2, the City would act in accordance with their Beach Preservation Initiative (Measure D, February 1, 1993). The Beach Preservation Initiative and its implementing guidelines place severe restrictions on City-approved stabilization structures. Section 17 of "Guidelines Implementing 30.50 Measure D," hereafter referred to as the BPI Implementation Guidelines, specifically addresses the "South Bluff," which runs from the southern boundary of Powerhouse Park south to the City limits. In part, Section 17 states that:

In the event that the owners or operators of the railroad right of way contend that bluff or beach stabilization measures are required to ensure the safety of existing or future rail operations, a variance from the Del Mar Municipal Code and an exception from the foregoing may be considered provided all of the following findings are made in addition to the normal variance findings of the City Code:
A. The applicant for such an exception has presented competent and credible Coastal Engineering/Geotechnical [sic] or information provided by a Licensed Coastal Engineer or Geologist with Specialty in Coastal Processes information to the City clearly showing that:

> i. There is a clear, present threat of collapse endangering the health and safety related to the railroad right of way.
> ii. All feasible alternatives for stabilizing the rail lines with bluff face or beach encroachments have been pursued, including but not limited to, (a) relocating the rails further landward; (b) anchoring, underpinning, or otherwise stabilizing the rails with[out] the need for work on the bluff face or beach; and (c) adjustment in schedules and/or speed of trains.

This section of the BPI Implementation Guidelines indicates that the City of Del Mar could only support a stabilization measure that would affect the bluff face if there were not a feasible underpinning alternative (such as soldier pile walls) that would not affect the bluff face.

Other Regulatory Approvals

Other environmental laws and approvals may be applicable to the project depending on the specific measure(s) selected and the scope of the stabilization effort (e.g., the extent of potential stabilization areas that are funded for implementation). The effect of other environmental laws and required approvals on type selection would be nominal, and no further discussion of regulatory approvals is provided.

4.2 Evaluation Results

A detailed discussion of the evaluation results is included in this section with the results presented for each stabilization alternative.

4.2.1 Constructability

Soldier Piles

Construction of a soldier pile wall would be completed from the bluff top and would require access from existing City of Del Mar street ends (e.g., 8th Street). No access from the beach would be necessary.

The construction work area would be contained entirely within the NCTD right of way that generally extends at least 50 feet west of the current track centerline. Staging and lay-down areas are available on the flat portions of the bluff top near 4th Street, 6th Street and 8th Street. The work area would most likely be limited to one stabilization area at a time with multiple drill rigs, limited earth moving equipment and construction crews.

The center of the soldier pile wall would be located approximately 11 to 15 feet seaward of the centerline of tracks, and the top of wall would be about 1 foot below the top of tie elevation. The selection of this wall location is based on SCRRA maintenance access standards, the requirement to meet CPUC clearances, and previous soldier pile installation projects as noted below:

The California Public Utilities Commission (CPUC) under General Order No. 26-D specifies an 8-foot, 6-inch minimum horizontal clearance (9-feet, 6-inches on curved alignment) to structures above the top of rail. Soldier pile walls constructed below the track elevation are outside of the minimum permanent clearance envelope and, therefore, this criterion does not affect the horizontal wall location. The CPUC also requires a minimum 2-foot-wide level maintenance walkway on each side of the tracks beyond the ballast.

Southern California Regional Rail Authority (SCRRA) Metrolink Standard Plan ES 1801-02 recommends a minimum of 12 feet, 6 inches from the centerline of track to the top of slope or face of wall. This exceeds the CPUC minimum and allows for a minimum 3-foot-wide (3 feet, 11 inches preferred) level maintenance walkway along side of the ballast as shown in Figure 5. Placement of the soldier pile wall grade beam one foot below the top of tie elevation allows a portion of the top of the grade beam to support the maintenance walkway. With a 3-foot, 6-inch-wide grade beam centered at a minimum of 11 feet from the track center, the SCRRA minimum clearance can be achieved.

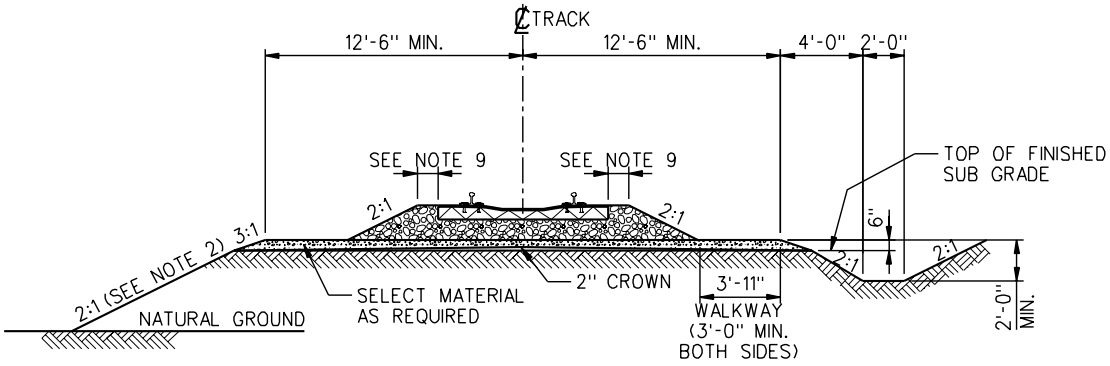


Figure 5 - Roadbed Section from SCRRA ES 1801-02

Construction of the soldier piles requires a drill rig located on or just east of the tracks and the piles should be located within reach of conventional drilling equipment. The emergency repairs done by NCTD near 8th Street were done using a track mounted Watson 2500 drill rig that could reach out about 13 feet from the track centerline. While other drilling equipment exists with longer reach capabilities, an 11- to 15-foot dimension was selected as a baseline for this project.

The soldier pile construction has the potential to impact rail operations. Most of the soldier pile drilling and placing operation would require equipment on or immediately adjacent to the tracks. This must be addressed through specified work windows and with temporary shoring placed between the trackbed and the work area.

Construction of the grade beam requires temporary excavation about 3 feet deep (4 feet from the top of tie). Temporary shoring requirements for previous projects on the Del Mar Bluffs were based on an envelope starting 2 feet horizontally from the bottom of the tie and extending outward at a 1H:1V slope. A grade beam 3 feet, 6 inches wide and 3 feet deep located 13 feet from the track centerline and 1 foot below the top of tie is outside of this temporary clearance envelope and therefore, would not likely require temporary shoring. When the wall is located closer to the tracks or where the existing slope geometry requires a lower grade beam, shoring may be required.

Night work would be required for the soldier pile construction. During the day, the frequency of rail traffic does not allow for any major construction activities along the right of way. The nighttime work window would be determined during the final design phase but normally runs between the last passenger train in the evening and the first passenger train in the morning with an approximate five-hour operation. For the emergency project at 8th Street in 2001, the passengers from the last two trains of the day were bused around this location allowing for an eight hour nighttime work window. Lighting would be required for work done at night and should be aimed at the work area away from the bluff toe and private property.

Many successful soldier pile construction projects have been completed along the Del Mar Bluffs area. The methodology is well understood within the construction industry and is not highly susceptible to unforeseen site conditions. The primary concern is the potential of encountering a buried object during the drilling for the piles or for the tieback anchors. This is typically handled by drilling or coring through the obstruction but maintaining the planned pile or anchor location.

From a constructability standpoint, the soldier pile alternative is ranked as one of the best solutions.

Soil Cement Buttress

Construction of a soil cement buttress would require access from both the beach and the bluff top. It would require a large quantity of earthwork to remove unsuitable soil and provide the necessary minimum width of buttress and must be benched into the existing slope.

The construction work area would extend outside of the NCTD right of way and would require establishing a temporary processing plant (i.e., pugmill), stockpile areas, and haul routes with possible temporary subgrade improvements. For efficiency, large sections of bluff would be excavated and backfilled in a single stage.

Given the extensive earthmoving equipment necessary, staging areas at the bluff top and at the bluff toe (beach) would be required. It should be noted that construction activities associated with this alternative, especially those near the bluff toe, would be affected by high tides, waves, and storm surf.

At the bluff top, this work would likely result in excavations within the temporary railroad clearance envelope and require the grading to be done in short segments with temporary shoring to avoid major disruptions to rail service. Work from the top for grading and soil cement placement would likely be accomplished at night when the rail traffic is reduced.

There have been a few soil cement placement projects at the Del Mar Bluffs area. This earthmoving construction technique is very common in the industry but it is susceptible to unforeseen soil conditions. Typically, this is handled by increasing the extent of the excavation work based on on-site observations and recommendations by the project geotechnical engineer.

From a constructability standpoint, the soil cement buttress alternative is ranked as one of the worst solutions.

Soil Nail Reinforcement

Construction of the soil nail reinforcement includes drilling, installation and grouting of soil nails. At a minimum, the lower portion of the bluff face would be covered with a shotcrete facing that is placed using air-blown mortar over a reinforced wire mesh.

Drilling of the bore hole for the soil-nails could be accomplished from the toe or top of the bluff by using a flight auger attached to the boom of an excavator (i.e., CAT 330 or equivalent). Man-lifts and small cranes would also be needed to install the steel reinforcement and grout, and to perform quality control and assurance testing on the selected soil nails. Access to the construction areas is expected to be from the beach and the top of the bluff depending on the activity and location. The work area would most likely be limited to one section of the bluff. Construction activities near the bluff toe would be affected by high tides, waves, and storm surf.

Without an extended period of beach access, it is anticipated that the equipment required to construct soil nails would impact rail operations forcing night-time construction work and busing traffic around the work. With extended accessibility from the beach, the

impact to rail operations would be significantly reduced but would still require some work to be done at night.

Soil nail reinforcement construction can be staged from the bluff top using the staging areas identified for the soldier pile alternative. The potential for unforeseen conditions is similar to the soldier pile alternative during the nail drilling operation. In addition, the work at the bluff face can cause localized sloughing and erosion depending on the condition of the natural bluff face.

From a constructability standpoint, the soil nail reinforcement alternative is ranked as a mid-level solution.

4.2.2 Construction Costs

The estimated construction costs were presented in Section 3.3. These have been summarized in Table E.

Table E – Comparative Costs by Alternative

Priority Ranking	Stabilization Area	Stabilization Length (ft)	Soldier Pile	Soil Cement Buttress	Soil Nail
IR=1	SA-1	55	$145,000		$305,000
IR=2	SA-2	205	$735,000		$1,285,000
IR=3	SA-4	135	$1,020,00	$1,450,000	
IR=3	SA-7	100	$250,000		$630,000
IR=4	SA-6N	440	$1,120,000	**$1,920,000	*$2,605,000
IR=4	SA-9	160	$535,000		$895,000
IR=5	SA-8	155	$690,000	$1,240,000	
IR=6	SA-3	198	$495,000		$1,140,000
IR=6	SA-5	80	$225,000		$465,000
IR=7	SA-6S	420	$1,050,000		$2,995,000

* Soil nail cost for SA-6N assumes a soldier pile wall for the 60 foot section at the existing seawall (Station 1493+40 to Station 1494+00)

** Soil cement buttress cost for SA-6N assumes a soldier pile wall for the remaining 380 feet of bluff

The soldier pile wall alternative is the least expensive alternative for all areas. Construction of soldier piles within Stabilization Area 8 has the most potential construction challenges because of the existing tie backs from the wall to the east. Use of the soil cement buttress at this location is nearly double the cost, but may be more easily constructed within the existing constraints. The construction cost for the soil nail alternative includes a complete facing of the bluff. Based on the geotechnical review the

presence of landslides and loose materials on the bluff face are typical throughout the area. An option for partial facing of the bluff to reduce costs in not considered feasible due to the increased erosion potential created by the soil nail construction.

4.2.3 Environmental Considerations

An evaluation of environmental considerations for each of the potential stabilization measures is presented below in the same order in which they are addressed in Section 4.1.3 (i.e., visual, noise, biological resources, recreation, coastal processes and regulatory approvals).

4.2.3.1 Soldier Pile Wall

Visual Resources

The vast majority of each soldier pile wall would be located underground and, therefore, out of view. The portion of a soldier pile wall that might be visible would be the grade beam. In most areas (including SA-1 near Seagrove Park), the top of the grade beam would be at or close to the existing ground level, leaving only the top of the grade beam exposed. In some locations, up to approximately three feet of the concrete grade beam might be exposed on its west side.

Views to the grade beam from inland areas would be intermittent. Seagrove Park and the termini of some City of Del Mar streets along the eastern edge of the ROW would allow pedestrian views to the top of the grade beam. Although the top of the grade beam could be visible from these areas, it would not draw viewers' attention because it would be parallel to the existing railroad tracks (which include the rails, ties and ballast rock) and because most views would be directed toward the beach and/or ocean, not the NCTD ROW. Views to the grade beam from residences/back yards inland of the ROW would, for the most part, be obstructed by intervening topography. Views from these residences/back yards would also primarily be directed toward to ocean, not the railroad ROW.

The grade beam may be visible by passengers on passing trains (such as Amtrak or the Coaster), but only for extremely short periods of time for any given passenger and probably only for passengers on the trains' lower levels. With regard to beach-goers, the potential for views to soldier pile walls would depend on the specific stabilization site and the bluff topography between that site and the beach.

In the event that the upper portion of a wall would be visible and would significantly affect the visual environment of the bluffs, SANDAG could apply aesthetic treatments to lessen that effect. Potential aesthetic treatments could include colored concrete, stained concrete, form liners or textured rock-scaping (i.e., a simulated rock face).

Although initially only a portion of the top of the grade beam might be exposed, in the long term the tops of the bluffs would likely erode to the point that some of the soldier piles would be visible. As this occurs, SANDAG could evaluate potential visual effects of the wall's exposure and, if necessary to avoid significant visual impacts, apply one or more of the above-listed aesthetic treatments.

Based on the limited views to soldier pile walls and the variety of measures that would be available to minimize the effects of exposed walls (if necessary), this stabilization measure is assessed with having the lowest potential visual resources effect.

Noise

Because the soldier pile walls would be installed at the top of the bluff at night, construction noise could disturb nearby residents. Although noise might be considered disruptive, this impact would be short term (up to a few weeks near any given residence). Based on the short-term nature of the nighttime construction noise, this stabilization measure is assessed with having a mid-level potential noise effect.

Biological Resources

The majority of soldier pile wall construction would occur at the top of the bluff, which tends to be dominated by barren, disturbed, and developed habitat types. Although some sensitive habitat could be affected by construction, intrusions into sensitive habitat would be small and could be offset by restoring disturbed areas (e.g., hydro-seeding with native species) following construction. Based on these factors, this stabilization measure is assessed with having the lowest potential biological resources effect.

Recreation

The installation of soldier pile walls would require neither temporary beach access during construction nor result in permanent structures on the beach (see Coastal Processes below). Accordingly, this stabilization measure is assessed with having the lowest potential recreation effect.

Coastal Processes

Although the relative contributions of bluff erosion attributed to geotechnical instability of the bluff and wave-induced erosion at the toe are unknown, it is assumed that the largest contribution of bluff erosion is due to wave-induced erosion. Since construction of the soldier pile alternative would not affect the bluff face, wave-induced erosion of the bluff would continue as a natural process. While the soldier piles would increase the geotechnical stability of the bluffs, which would tend to reduce the overall rate of bluff erosion, the bluffs would likely continue to erode at a rate similar to or less than the rate that would occur in the absence of a bluff stabilization project.

The position of the shoreline would not be fixed under the soldier pile alternative so no substantial passive erosion effects would be anticipated to occur. Since the bluff face would not be altered, modification of the near shore wave environment and impacts attributed to active erosion would also not be anticipated to occur under this alternative. Although the improved stability of the bluff would tend to reduce the long-term erosion rate, thereby reducing the volume of sand supplied to the beach, this contribution is likely to be very small given that the greatest contribution to overall bluff erosion is wave-induced erosion of the bluff toe. Therefore, of the three bluff stabilization measures evaluated under this study, the soldier pile alternative would likely have the lowest level of potential impact to coastal processes.

Regulatory Approvals

No conflicts with required regulatory approvals have been identified for the installation of soldier pile walls. The installation of a soldier pile wall would be consistent with the planning and management policies contained in Chapter 3 of the California Coastal Act, provided that any top-of-bluff walls would have only a minor effect on the appearance of the bluffs. This assessment regarding California Coastal Act consistency would require concurrence from the California Coastal Commission, as would any of the California Coastal Act consistency determinations presented in this report. (It should be noted, however, that the soldier pile walls installed for Del Mar Bluffs Stabilization Project 2 were found by the Coastal Commission to be consistent with Chapter 3 of the California Coastal Act.) Because the soldier pile walls would not directly affect the beach or other recreational resources, they would not be subject to Department of Transportation 4(f) restrictions. In addition, because the soldier pile walls would generally "underpin" the railroad tracks and minimize work on the bluff face, this stabilization measure appears to be consistent with the BPI Implementation Guidelines for the City of Del Mar's Beach Preservation Initiative.

4.2.3.2 Soil Cement Buttress

Visual Resources

The soil cement buttress would result in a manufactured slope that could be treated or landscaped. For this project, it is assumed that the soil cement buttress would be landscaped with native material using a pipe and board system to retain the topsoil. The extent of visual resource impacts associated with this measure would depend on the specific bluff section being stabilized. Where man-made structures are present and the pre- and post-construction slope profiles are similar, the use of a soil cement buttress may have a minor visual impact. In areas where the slope is steep (e.g., areas of near-vertical exposed sandstone) and few or no man-made features are present, the change to the bluff's appearance could be considered dramatic. This type of major structural change to the bluff would probably not be consistent with California Coastal Act policies calling for development to "minimize the alteration of natural land forms." Based on the potential for major changes in the appearance of the bluffs, this stabilization method is assessed with having the highest potential visual resources effect.

Noise

Construction noise could be substantial because heavy equipment would be used to remove existing bluff material and replace it with soil cement backfill. Most construction equipment associated with this alternative would operate from the base of the bluff, with the corresponding construction noise affecting visitors to the beach. Due to the amount of excavation required, however, residents at the top of the bluff also would experience construction noise. Based on these factors, this stabilization measure is assessed with having a mid-level potential noise effect.

Biological Resources

Where soil cement buttresses would be installed, there would be an almost total loss of existing vegetation on the affected section of bluff face. Following the installation of a

soil cement buttress, including a pipe and board system to hold imported top soil in place, vegetation could be reestablished. The potential significance of impacts to habitat would vary depending on the specific location where a soil cement buttress is installed. Based on the near total loss of habitat that would occur during construction, however, this stabilization measure is assessed with having the highest potential biological resources effect.

Recreation

At any location where a soil cement buttress is installed, there would be temporary reduction in usable beach area associated with the construction site, including equipment operating areas, staging/lay down areas and temporary spoil piles. Temporary or permanent reduction in usable beach area also would need to be evaluated pursuant to Department of Transportation 4(f) requirements (see "Regulatory Approvals," below). As noted previously (and in contrast to potential soil cement buttresses evaluated for Del Mar Bluffs Stabilization Project 2), the soil cement buttresses would not extend beyond the existing bluff toe onto the beach. Based on the potential temporary effects to the beach, this stabilization measure is assessed with having a mid-level potential recreation effect.

Coastal Processes

Since construction of the soil cement buttress wall would increase the resistance of the bluff face material, wave-induced erosion of the bluff would be reduced relative to existing conditions. In addition, the soil cement buttress wall would increase the overall stability of the bluff. Therefore, implementation of the soil cement buttress wall could substantially reduce bluff erosion over the 20-year project life.

The position of the shoreline would be partially fixed under the soil cement buttress wall so some passive erosion effects could occur depending on the relative contribution of beach sand from bluff erosion versus stream inputs. The near shore wave environment could be impacted under the soil cement buttress wall since the resistance of the bluff face would be increased; however, this impact would be insignificant given that the change in material properties would be relatively minor and the alignment of the soil cement buttress wall would be similar to the alignment of the existing bluff face. Likewise, impacts attributed to active erosion could also occur under this alternative since the erosion processes could be adversely impacted by the soil cement buttress. However, this impact also would be expected to be minor given that the alignment of the soil cement buttress wall would be similar to the alignment of the existing bluff face and the change in bluff material properties would be minor. The reduction of bluff erosion would decrease the volume of sand supplied to the beach. This contribution is likely to be very small given that the greatest contribution to beach sand supply is from stream inputs. Therefore, the soil cement buttress wall would likely have mid-level potential impact.

Regulatory Approvals

As noted above, major grading of the Del Mar Bluffs probably would conflict with applicable policies in the California Coastal Act regarding the alteration of natural land forms. Construction on the beach would be subject to the 4(f) requirements described previously in Section 4.1.3.6., including the requirement for coordination with, and specific findings by, the local government or state agency having jurisdiction over the affected section of beach.

Construction of a soil cement buttress would occur partially outside the NCTD ROW, which could trigger the requirement for discretionary approvals. If the City of Del Mar does need to provide a discretionary approval for Del Mar Bluffs Stabilization Project 3, the City probably would be bound by its voter-approved Beach Preservation Initiative. In general, the Beach Preservation Initiative prohibits the placement of new protective structures along the base of the bluff; however, Section 17 of the City's BPI Implementation Guidelines specifically allows certain exceptions for stabilization of the railroad tracks. These exceptions are only allowed, however, if all feasible alternatives to stabilizing the rail lines with bluff face or beach encroachments have been pursued, including anchoring, underpinning or otherwise stabilizing the rails. Thus, if City approval is required, the City may be mandated to support an underpinning design alternative (such as the use of soldier piles) over a soil cement buttress alternative. See Section 4.1.3.6 for additional discussion of the Beach Preservation Initiative.

4.2.3.3 Soil Nail Reinforcement

Visual Resources

Soil nails and the associated structural facing would alter the appearance of the affected bluff sections. Although treatments can be applied to help the grout around soil nails and associated facing material blend in with the natural surroundings, some (and potentially most) soil nails would still be detectable to viewers on the beach. Views to the soil nails from inland of the tracks would be extremely limited due to the topography of the bluffs. Over time, erosion of the bluffs could lead to soil nails and grout extruding from the bluff and/or the facing material being separated from the bluff by gaps. This would reduce the chances that the soil nails would blend in with the surrounding natural sections of the bluff face. The installation of soil nails and associated facing could conflict with California Coastal Act policies regarding the alteration of natural land forms. Based on these factors, this stabilization method is assessed with having the highest potential visual resources effect.

Noise

Soil nails would probably be installed through a combination of construction activities at the top of the bluff (at night) and at base of the bluff (during the day). Accordingly, construction noise would have the potential to affect both residents and beach-goers. Because construction noise would be temporary, however, this stabilization measure is assessed with having a mid-level potential noise effect.

Biological Resources

Soil nails would affect habitat on the bluff face. The magnitude of this impact would depend on the specific site involved and the extent of facing attached to the soil nails. Areas where facing is attached to the soil nails would not be able to support the reestablishment of vegetation. Based on the potential loss of habitat during construction and the potential constraints on reestablishing vegetation, this stabilization measure is assessed with having the highest potential biological resources effect.

Recreation

Soil nail construction would require beach access, but this stabilization measure would not be expected to result in a permanent reduction in usable beach. Temporary construction use of the beach, which would need to be addressed with regard to Section 4(f) requirements (see Regulatory Approvals below), represents a mid-level potential recreation effect.

Coastal Processes

Construction of the soil nail alternative would increase the resistance of the bluff face material, thereby reducing wave-induced erosion of the bluff relative to existing conditions. The soil nails would also increase the overall stability of the bluff decreasing the potential for erosion attributed to geotechnical instability (e.g., slope failure). Therefore, implementation of the soil nail alternative would tend to reduce bluff erosion over the 20-year project life by a substantial to marginal level. The level of reduction is dependent on whether shotcrete is used on the facing of the bluff. Using shotcrete on the bluff face would substantially reduce the wave-induced erosion rate while implementation of the soil nail alternative without shotcrete would only tend to marginally reduce wave-induced erosion. The discussion below is based on the use of shotcrete to treat the bluff face since this option would yield the greatest potential impact to coastal processes.

The position of the shoreline would be partially fixed under the soil nail alternative so some passive erosion effects could occur depending on the relative contribution of beach sand from bluff erosion versus stream inputs. The near shore wave environment could be impacted under the soil nail alternative since the resistance of the bluff face would be increased; however, this impact would be minor given that the change in material properties would be relatively small and the alignment of the soil nail alternative would be similar to the alignment of the existing bluff face. Likewise, impacts attributed to active erosion could also occur under this alternative since the erosion processes could be adversely impacted by the soil nail alternative. However, this impact also would be expected to be minor given that the alignment of the soil nail alternative would be similar to the alignment of the existing bluff face and the change in bluff material properties would be small. The reduction of bluff erosion would decrease the volume of sand supplied to the beach. Although this contribution is likely to be very small given that the greatest contribution to beach sand supply is from stream inputs, the Coastal Commission typically requires a sand mitigation fee as mitigation for this potentially substantial impact. Therefore, the soil nail alternative would likely have a mid-level potential impact.

Regulatory Approvals

As noted above, the installation of soil nails on the bluff face could result in potential conflicts with California Coastal Act policies regarding the alteration of natural land forms. Similar to other potential measures that would involve construction use of beach areas, coordination would be required with the local government or state agency having jurisdiction over the affected beach pursuant to Section 4(f) requirements (see also Section 4.1.3.6). Similar to the construction of a soil cement buttress, soil nail installation might occur partially outside the NCTD right of way, which could trigger the requirement for discretionary approvals. As noted for the soil cement buttress, the City may be

mandated to support an underpinning design alternative (such as the use of soldier piles) over an alternative such as soil nails that could affect the bluff face.

4.3 Evaluation Summary

The results of Section 4.2 are summarized in Table F. Based on a qualitative analysis, an overall rank has been developed to assist with the selection of the best alternative for the Del Mar Bluffs Stabilization Project 2.

Table F – Summary of Alternative Evaluation

	Evaluation Criteria			
Stabilization Alternative	**Constructability**	**Construction Cost**	**Environmental Considerations**	**Overall Rank**
Soldier Pile	Best	Best	Best	Best
Soil Cement Buttress	Worst	Mid-Level	Worst	Worst
Soil Nail Reinforcement	Mid-Level	Best	Mid-Level	Mid-Level

Notes: Best - Most Constructible, Lower Construction Cost and/or Lowest Potential Environmental Impact
Mid-Level – Moderately Constructible, Mid-Range Construction Cost and/or Mid-Level Potential Environmental Impact
Worst = Least Constructible, Higher Construction Cost and/or Highest Potential Environmental Impact

As noted in Table F, the soldier pile and retaining wall alternatives were rated as “best” with regard to environmental considerations. The identification of these as the environmentally preferable alternatives reflects their comparatively low visibility and that they would have the smallest footprints of disturbance, would not alter the face of the bluffs, would neither require the use of the beach during construction nor result in a long-term reduction of usable beach area, and would not directly affect coastal processes. Construction noise might disturb nearby residents, but this would be a short-term effect. As noted previously, architectural treatments could be utilized to minimize the visual impact of soldier piles in the event that they would be visible from the beach or become visible (due to erosion or other bluff face failure) in the future.

Since the soldier pile alternative was ranked the best for constructability, construction cost and environmental considerations, it is also the best overall solution.

5.0 Conclusions

Based on the alternative evaluation in Section 4.0, the soldier pile wall is the best alternative for the Del Mar Bluffs Stabilization Project 3. It is also a viable solution for all stabilization areas as noted in Section 2.1. Therefore, this alternative is the recommended stabilization method for all stabilization areas.

The amount of funding anticipated to be available for construction is between $3,500,000 and $4,000,000. With a soldier pile alternative, the estimated cost to stabilize the entire 1,948 lineal feet of high-priority area is approximately $6,265,000. Therefore, the entire project cannot be constructed with the currently available funds.

The initial construction project was subsequently established by including stabilization areas, in order of highest priority, that roughly approximate the maximum available construction budget. This includes the six highest priority stabilization areas (1,095 lineal feet of stabilization) at an estimated construction cost of $3,805,000.

The estimated construction costs are based on quantities developed during the preliminary engineering phase and represent the anticipated cost to install soldier pile walls at the Del Mar Bluffs including a mobilization cost of 10% and a contingency of 20%. As the project design continues and cost estimates are refined, the 20% contingency could be reduced enabling other stabilization areas to be added. Stabilization Area 8 is rated 5 in priority. A portion of this area could be added as an alternate to the project. This could extend the construction project to include the next highest priority stabilization areas (1,095 to 1,250 total lineal feet of stabilization). Consequently, the initial construction project could be increased to include the top five priority ranked stabilization areas at an estimated construction cost of between $3,805,000 to $4,495,000 (including 20% contingencies) which then represents the maximum length of bluff stabilization that may be constructed with the currently available funds. The stabilization areas comprising the initial construction project and their associated cost estimates are shown in Table G.

Table G – Initial Construction Project Costs

Priority Ranking	Stabilization Area	Factor of Safety *	Pseudo Static	Stabilization Length (ft)	Construction Cost
IR=1	SA-1	1.17	0.93	55	$145,000
IR=2	SA-2	1.31	0.91	205	$735,000
IR=3	SA-4	1.47	0.86	135	$1,020,000
IR=3	SA-7	1.39	0.91	100	$250,000
IR=4	SA-6N	1.48	0.97	440	$1,120,000
IR=4	SA-9	1.49	0.96	160	$535,000
IR=5	SA-8	1.56	0.96	155	$690,000
			Total	**1,528**	**$4,495,000**

* Lowest calculated factor of safety within the stabilization area for static condition with groundwater.

Note that each of the stabilization areas included in the initial construction project has a calculated pseudo-static factor of safety that is less than 1.0. In addition, each of the top 4 priority ranked areas has less than a 1.50 static factor of safety.

Appendices

Appendix A

References

Appendix A - References

AASHTO, American Association of State Highway and Transportation Officials, LRFD Bridge Design Specifications, 2003, 2nd Edition Interim Revisions.

AREMA, American Railway Engineering and Maintenance-of-Way Association, Manual of Railway Engineering, 2003.

California Department of Transportation, 1996, Trenching and Shoring Manual, dated February 1990, Revised December 1996.

————, 2000, Bridge Design Specifications, dated April 2000, Revised September 2003.

————, 2002, Standard Plans for Construction of Local Streets and Roads, dated July 2002.

Leighton and Associates, 2001, Del Mar Bluffs Geotechnical Report, Part 1 - Geotechnical Evaluation (Volumes 1 and 2), Part 2 – Conceptual Repair Alternatives, Project No. 040151-001, dated January 31, 2001.

————, 2003, Supplemental Geotechnical Evaluation and Determination of Site Specific Conceptual Repair Alternatives, Project No. 040151-009, dated June 2, 2003, Revised November 5, 2003.

————, 2010, Del Mar Bluffs Stabilization Project 3- Preserving Trackbed Support, Geotechnical Evaluation Update and Determination of Areas For Stabilization, Project No. 602576-001, dated January 14, 2010.

Public Utilities Commission of the State of California (CPUC), 1981, General Order No. 26-D, Effective February 1, 1948.

Simon Wong Engineering, 2003, Evaluation of Existing Seawalls (Draft), Project No. 518-109, dated May 7, 2003.

Southern California Regional Rail Authority (SCRRA), 2003, Metrolink Engineering Standards, dated July 1993, Revised October 2003.

U.S. Army Corps of Engineers (USACE), 1989, Engineering and Design, Retaining and Flood Walls, Engineer Manual 1110-2-2502 dated September 29, 1989.

————, 1994, Engineering and Design, Design of Sheet Pile Walls, Engineer Manual 1110-2-2504 dated March 31, 1994.

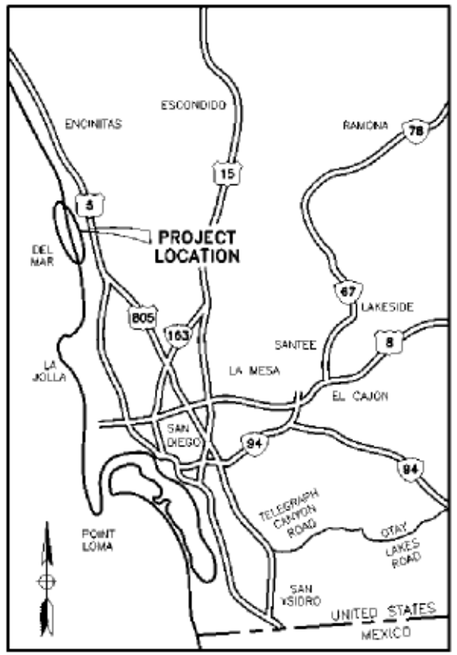
Helix Environmental Planning Inc, 2009, Environmental Constraints Report, dated December 9, 2009

Appendix B

Stabilization Area Plans and Sections

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT – NOT FOR CONSTRUCTION
DATE: 03-08-2010
TIME: 2:42:54 PM
FILENAME: P:\S\SNDG00000002\0400CAD\EC\DWG\SHEETS\DMB3-1-TITLE.DWG



LOCATION MAP

NO SCALE

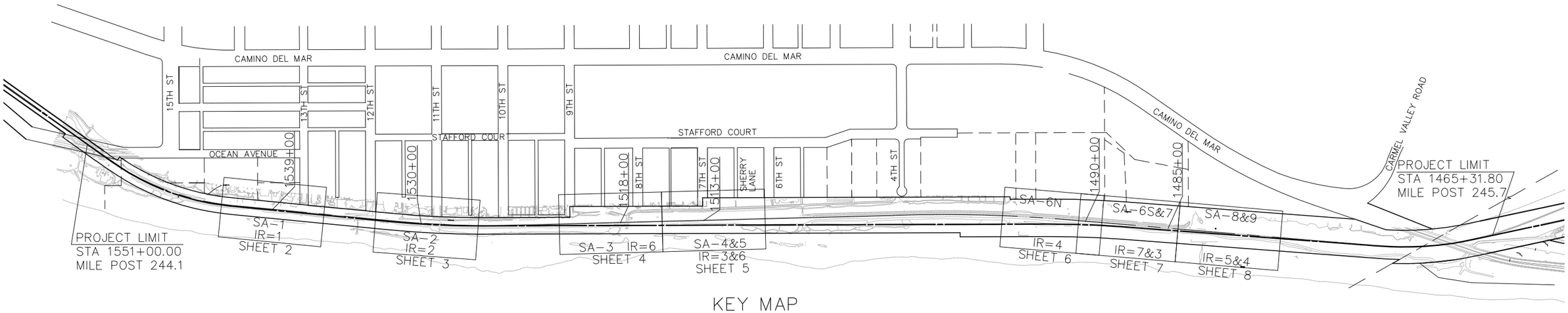
PRELIMINARY PLANS FOR

DEL MAR BLUFFS PROJECT 3
MILE POST 244.10 TO MILE POST 245.39
(STA. 1480+00 TO STA. 1551+00)

PRIORITY TABLE

PRIORITY IMPLEMENTATION RANKING	STABLIZATION AREA	STATION	LENGTH	SHEET
IR = 1	SA-1	1539+40-1538+85	55'	2
IR = 2	SA-2	1530+85-1528+80	205'	3
IR = 3	SA-4	1514+55-1513+20	135'	5
IR = 3	SA-7	1485+80-1484+80	100'	7
IR = 4	SA-6N	1494+40-1490+00	440'	6
IR = 4	SA-9	1481+00-1479+40	160'	8
IR = 5	SA-8	1483+55-1482+00	155'	8
IR = 6	SA-3	1518+55-1516+57	198'	4
IR = 6	SA-5	1512+45-1511+65	80'	5
IR = 7	SA-6S	1490+00-1485+80	420'	7

TOTAL = 2033'



KEY MAP

300 0 300 900

SCALE: 1"=300'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY PMM	DATE 02/10
DRAWN BY AMJA/NYO	02/10
CHECKED BY PMM	02/10
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

KEY MAP

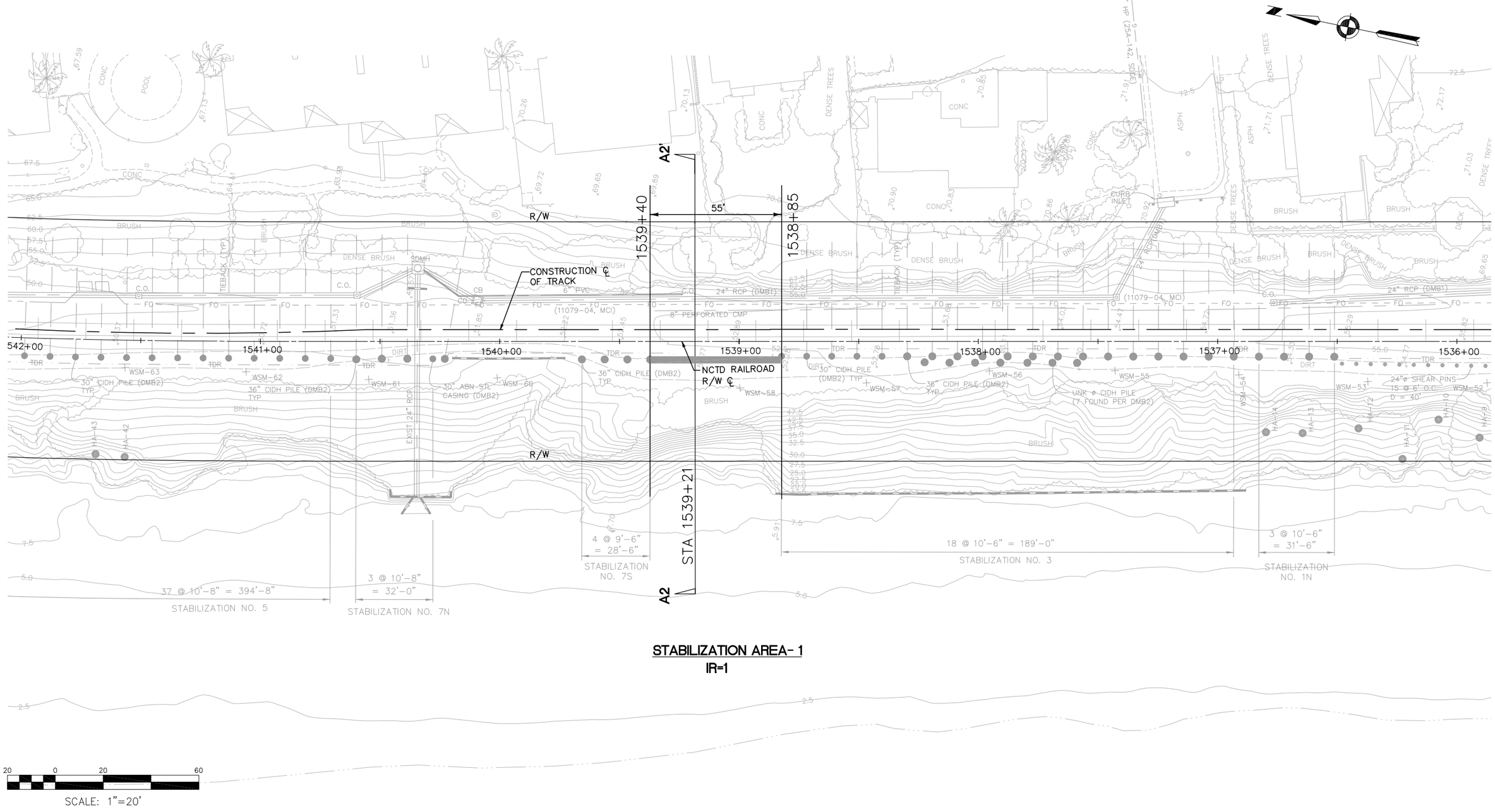
SCALE	1"=300'
SANDAG CONTRACT NO.	5000931
SHEET NO.	1
OF	30

FOR REDUCED PLANS ORIGINAL
SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT –
NOT FOR CONSTRUCTION

DATE: 03-02-2010
TIME: 10:53:48 AM

FILENAME: P:\S\SNDG00000002\04000AD\EC\DWG\SHEETS\DMB3-2-SA-1.DWG



STABILIZATION AREA- 1
IR=1

20 0 20 60
SCALE: 1"=20'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY PMM	DATE 02/10
DRAWN BY AMJA/NYO	02/10
CHECKED BY PMM	02/10
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

STABILIZATION AREA 1

SCALE	1"=20'
SANDAG CONTRACT NO.	5000931
SHEET NO.	2
OF	30

PROGRESS PRINT – NOT FOR CONSTRUCTION

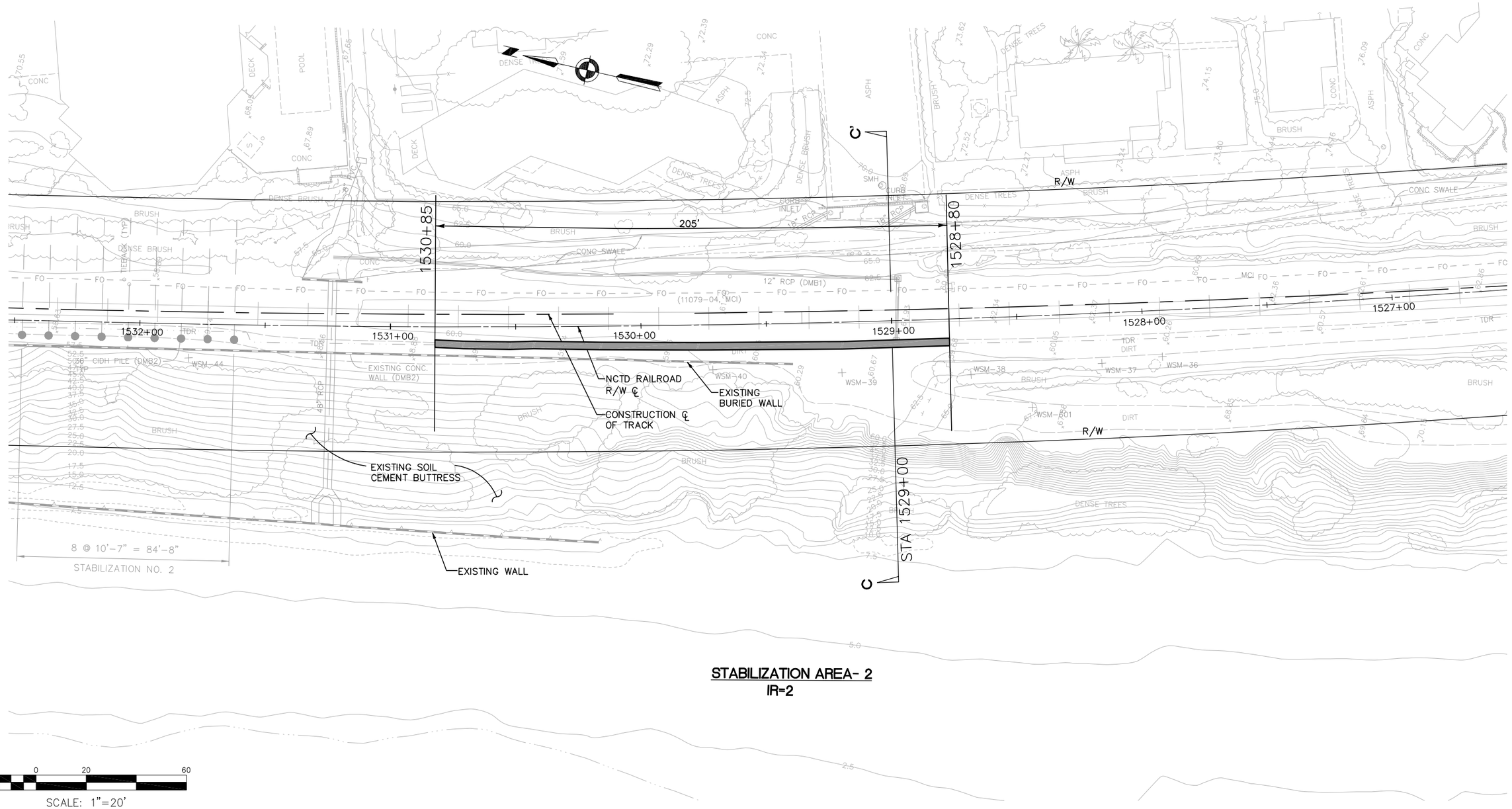
DATE: 03-02-2010

TIME: 10:55:46 AM

FILENAME: P:\S\SNDG00000002\04OCAD\EC\DWG\SHEETS\DMB3-3-SA-2.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES

0 1 2 3



STABILIZATION AREA- 2
IR=2

20 0 20 60

SCALE: 1"=20'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	PMM	DATE 02/10
DRAWN BY	AMJA/NYO	02/10
CHECKED BY	PMM	02/10
SANDAG PRJ. ENG.		

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

STABILIZATION AREA 2

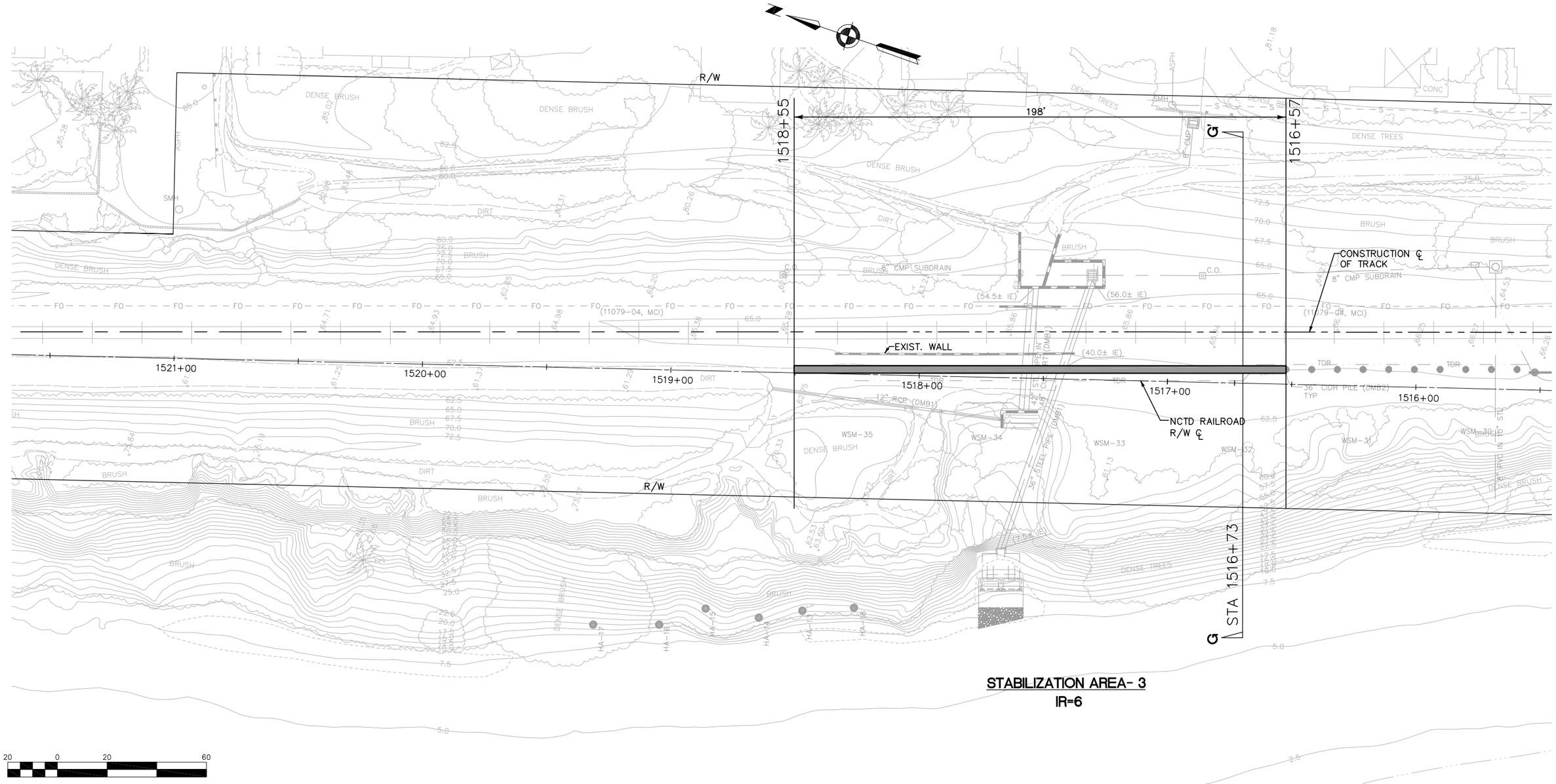
SCALE 1"=20'

SANDAG CONTRACT NO. 5000931

SHEET NO. 3 OF 30

FOR REDUCED PLANS ORIGINAL
SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT –
NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:57:17 AM
FILENAME: P:\S\SND00000002\04000AD\EC\DWG\SHEETS\DMB3-4-SA-3.DWG



STABILIZATION AREA- 3
IR=6

20 0 20 60
SCALE: 1"=20'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY PMM	DATE 02/10
DRAWN BY AMJA/NYO	02/10
CHECKED BY PMM	02/10
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

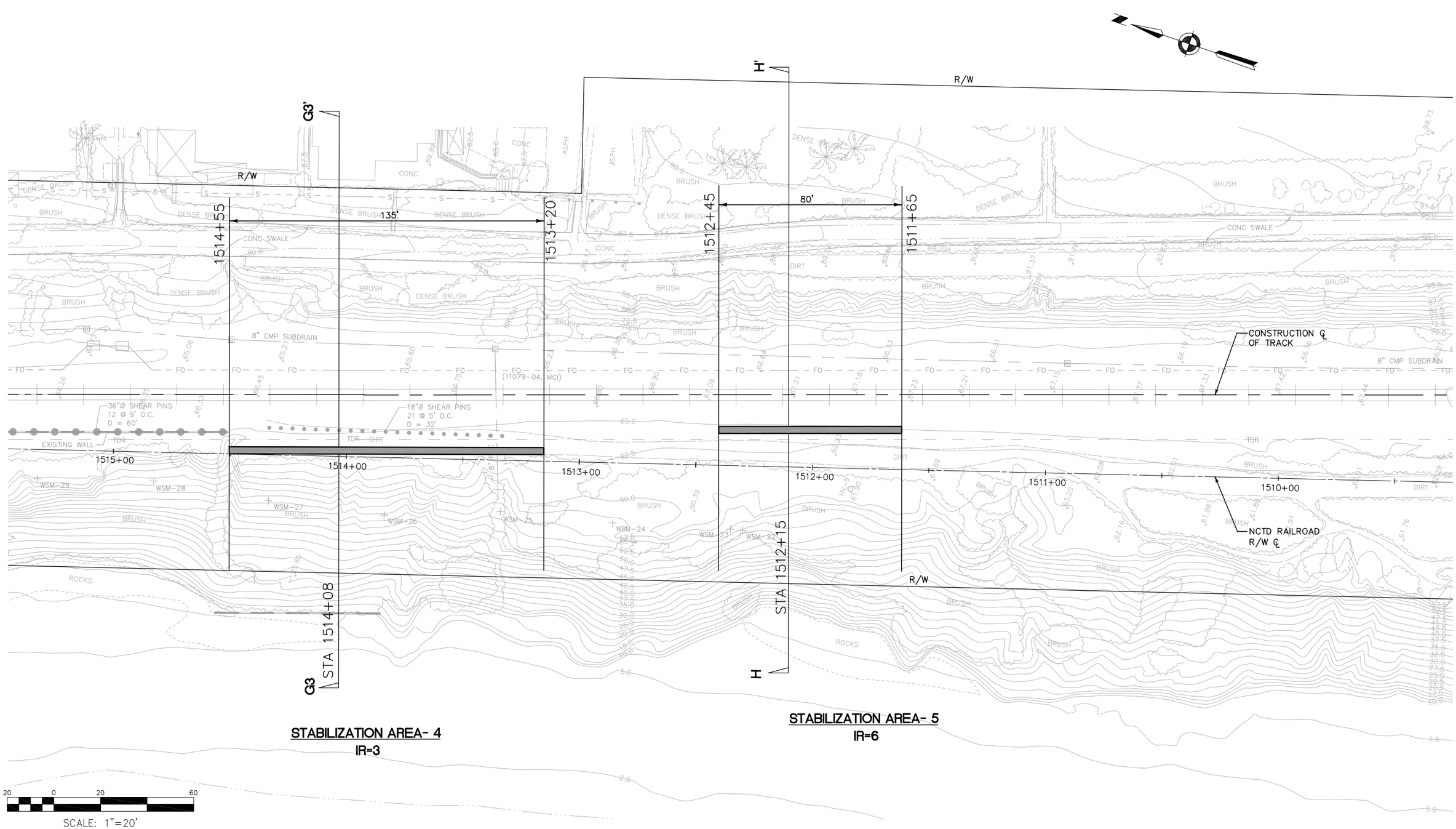
DEL MAR BLUFFS STABILIZATION PROJECT 3

STABILIZATION AREA 3

SCALE 1"=20'
SANDAG CONTRACT NO. 5000931
SHEET NO. 4 OF 8

FOR REDUCED PLANS ORIGINAL
SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT – NOT FOR CONSTRUCTION
TIME: 2:40:20 PM
DATE: 03-08-2010
FILENAME: P:\S\SNDG00000002\04000AD\EC\DWG\SHEETS\DMB3-5-SA-4_5.DWG



NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY PMM	DATE 02/10
DRAWN BY AMJA/NYO	02/10
CHECKED BY PMM	02/10
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

STABILIZATION AREAS 4 & 5

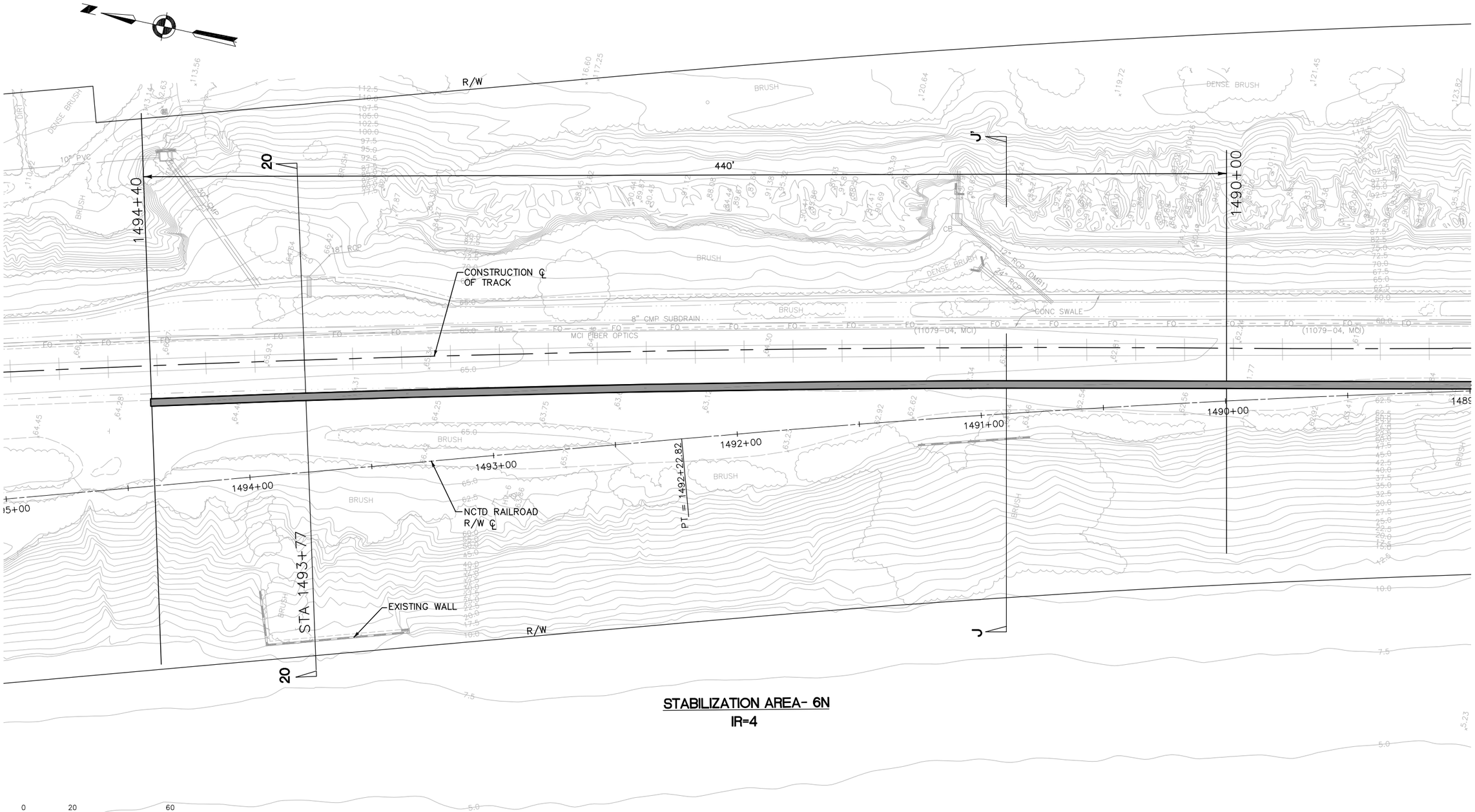
SCALE 1"=20'
SANDAG CONTRACT NO. 5000931
SHEET NO. 5 OF 30

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010 TIME: 11:03:04 AM

FILENAME: P:\S\SND0000000002\04000AD\EC\DWG\SHEETS\DM83-6-SA-6N.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3



STABILIZATION AREA- 6N
IR=4

20 0 20 60
SCALE: 1"=20'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	PMM	DATE 02/10
DRAWN BY	AMJA/NYO	02/10
CHECKED BY	PMM	02/10
SANDAG PRJ. ENG.		

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

STABILIZATION AREA 6N

SCALE 1"=20'
SANDAG CONTRACT NO. 5000931
SHEET NO. 6 OF 30

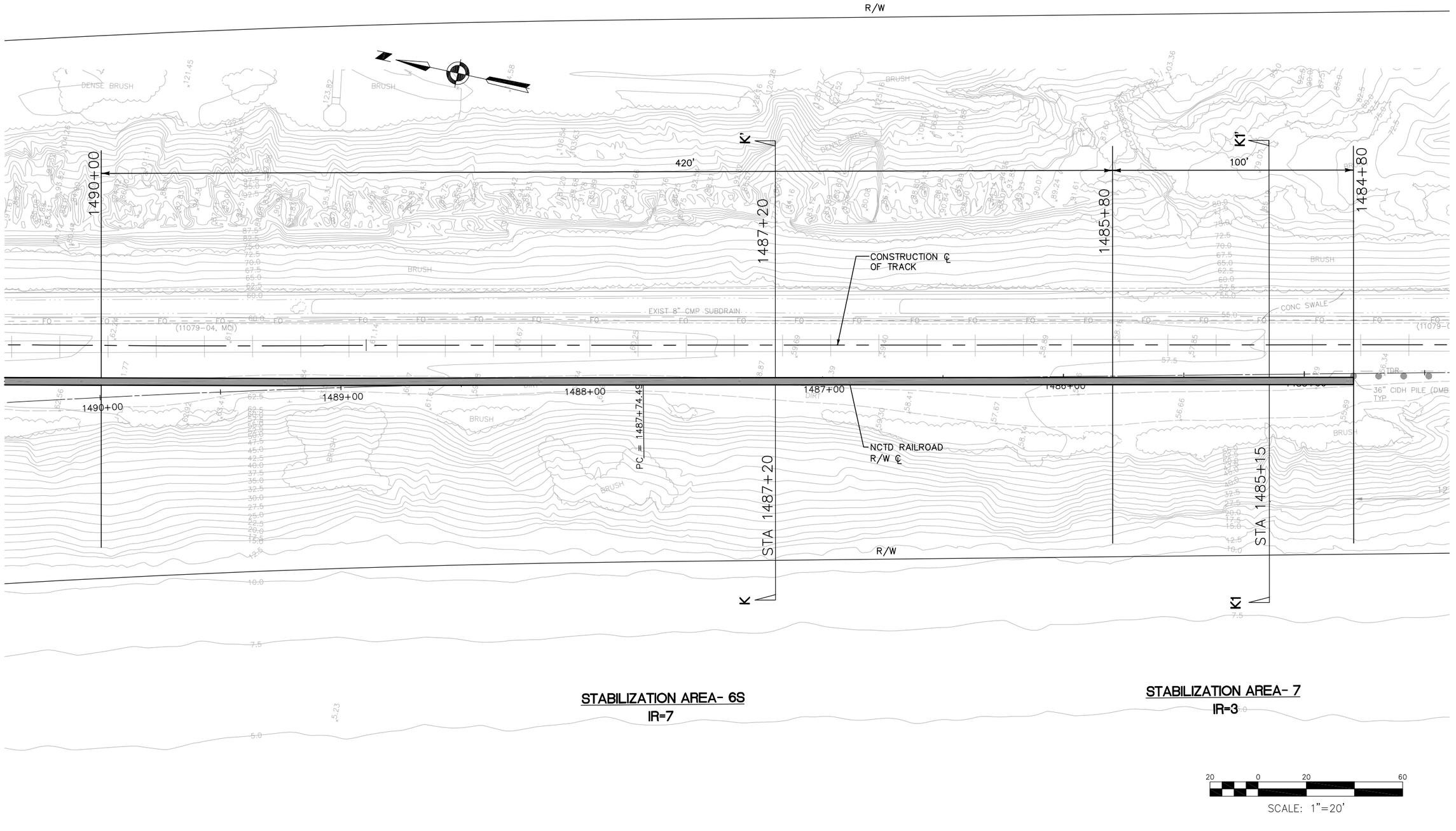
PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 11:04:34 AM

FILENAME: P:\S\SND00000002\04000AD\EA\DWG\SHEETS\DMB3-7-SA-6S_7.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3



STABILIZATION AREA- 6S
IR=7

STABILIZATION AREA- 7
IR=3

20 0 20 60
SCALE: 1"=20'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY PMM	DATE 02/10
DRAWN BY AMJA/NYO	02/10
CHECKED BY PMM	02/10
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

STABILIZATION AREAS 6S & 7

SCALE 1"=20'

SANDAG CONTRACT NO. 5000931

SHEET NO. 7 OF 30

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 11:05:56 AM

FILENAME: P:\S\SND00000002\04OCAD\EC\DWG\SHEETS\DMB3-8-SA-8_9.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES

0 1 2 3

R/W

1483+55

155'

L'

1482+00

160'

1481+00

1479+40

STA 1479+82

MI

STA 1482+85

STA 1482+25

L

(20.35FL)

12 @ 10'-5" = 125'-0"

STABILIZATION NO. 8

5 @ 10'-0" = 50'-0"

SN 4

(19.31FL)

60' ROP

(4.11FL)

DENSE BRUSH

MCI FIBER OPTICS

(11079-04, MCI)

30" CIDH PILE (DMB2) TYP

CONSTRUCTION ℄ OF TRACK

NCTD RAILROAD R/W ℄

CIDH PILE (DMB2)

TDR

TIEBACK

BRUSH

DIRT

1484+00

1483+00

1482+00

1481+00

1480+00

1479+00

R/W

STABILIZATION AREA- 8

IR=5

STABILIZATION AREA- 9

IR=4

20 0 20 60

SCALE: 1"=20'

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY PMM	DATE 02/10
DRAWN BY AMJA/NYO	02/10
CHECKED BY PMM	02/10
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

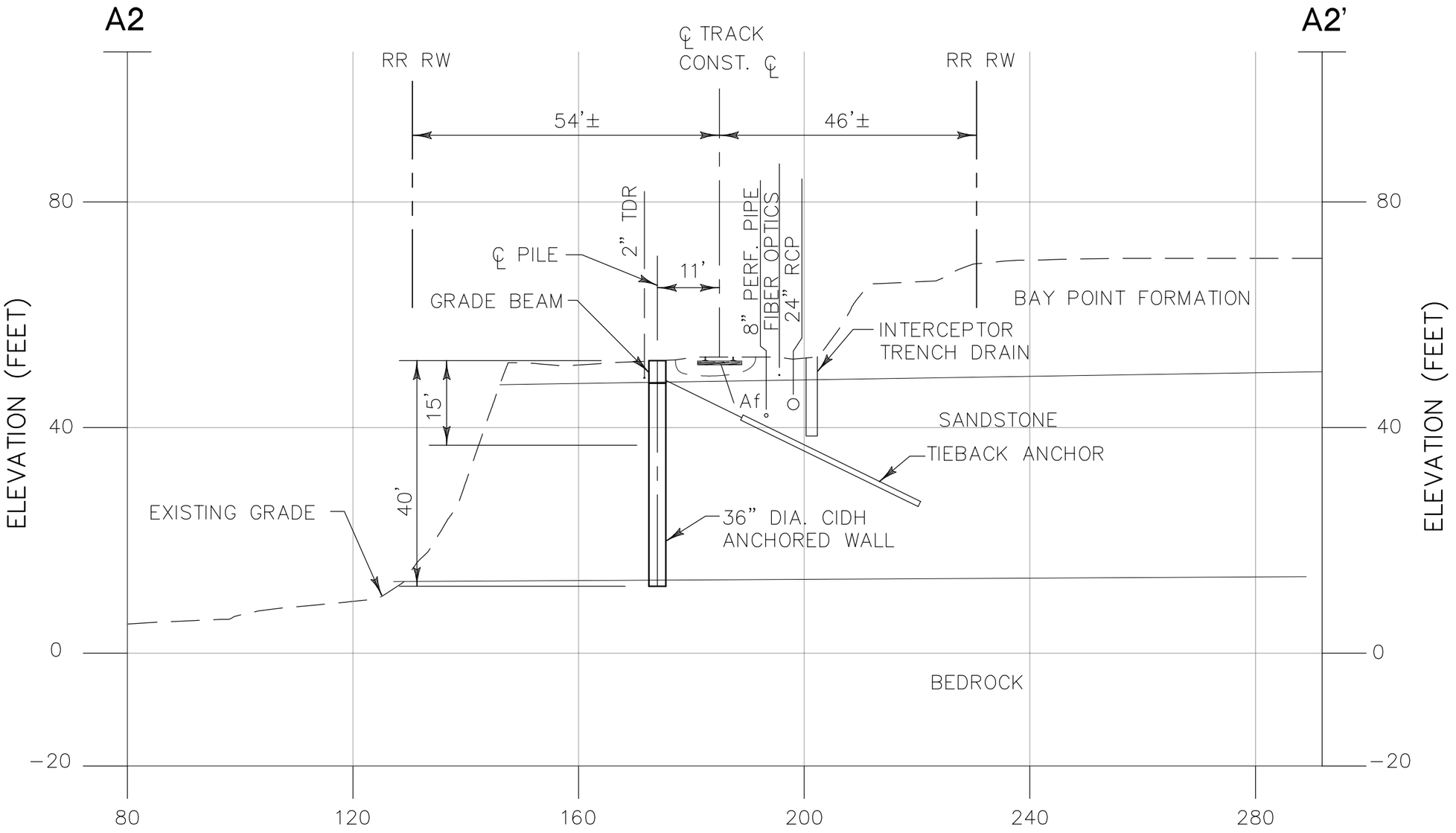
STABILIZATION AREAS 8 & 9

SCALE 1"=20'

SANDAG CONTRACT NO. 5000931

SHEET NO. 8 OF 30

SOLDIER PILE ALTERNATIVE



SECTION A2-A2'
STATION 1539+21

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:28:26 AM

FILENAME: P:\S\SNDG00000002\D400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-1.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY		DATE 12/09
DRAWN BY	AMJA	12/09
CHECKED BY	PMM	12/09
SANDAG PRJ. ENG.		

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

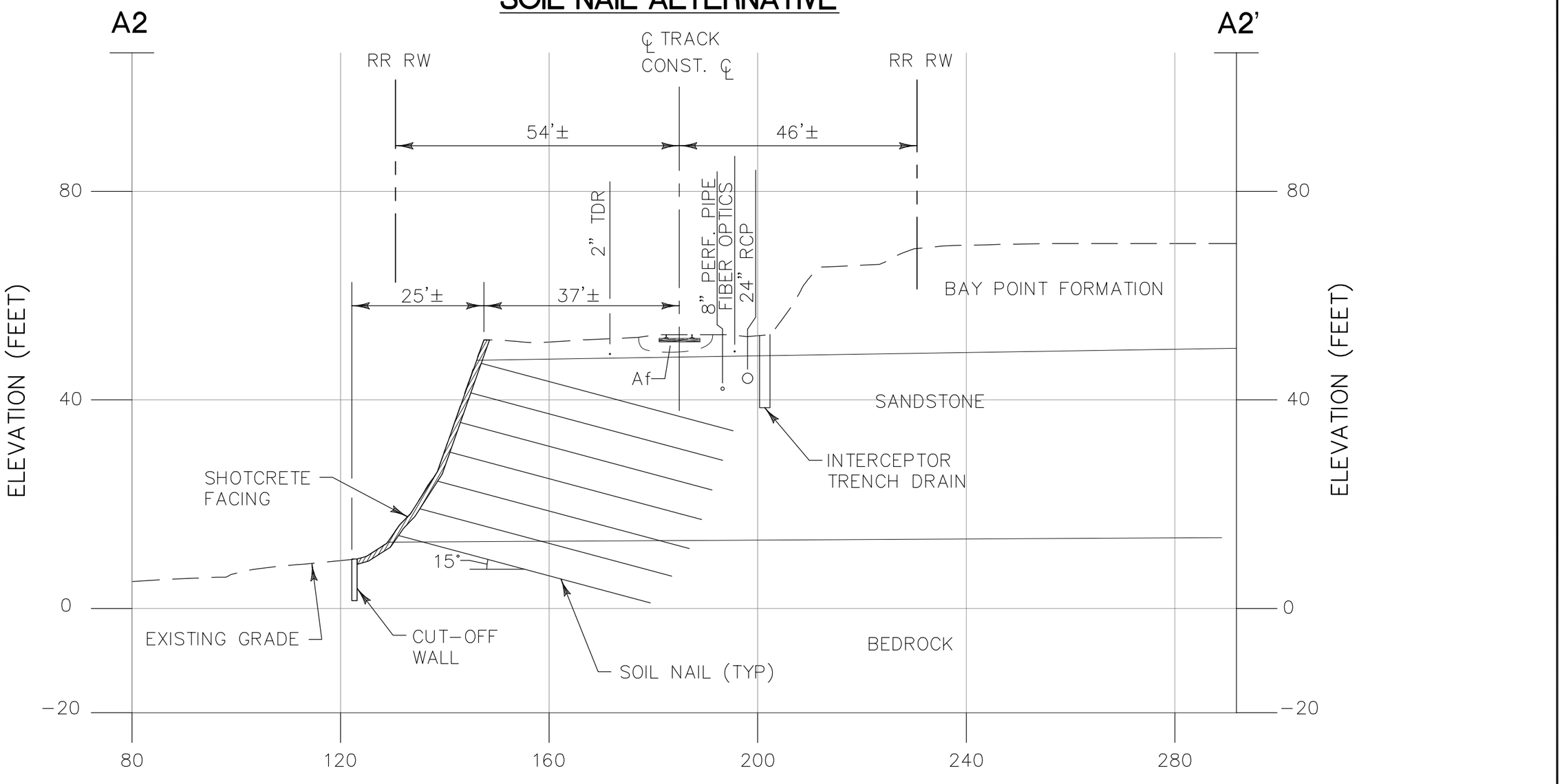
SA–1
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 9 OF 30

SOIL NAIL ALTERNATIVE



SECTION A2-A2'
STATION 1539+21

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:27:45 AM

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

FILENAME: P:\SY\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-1.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

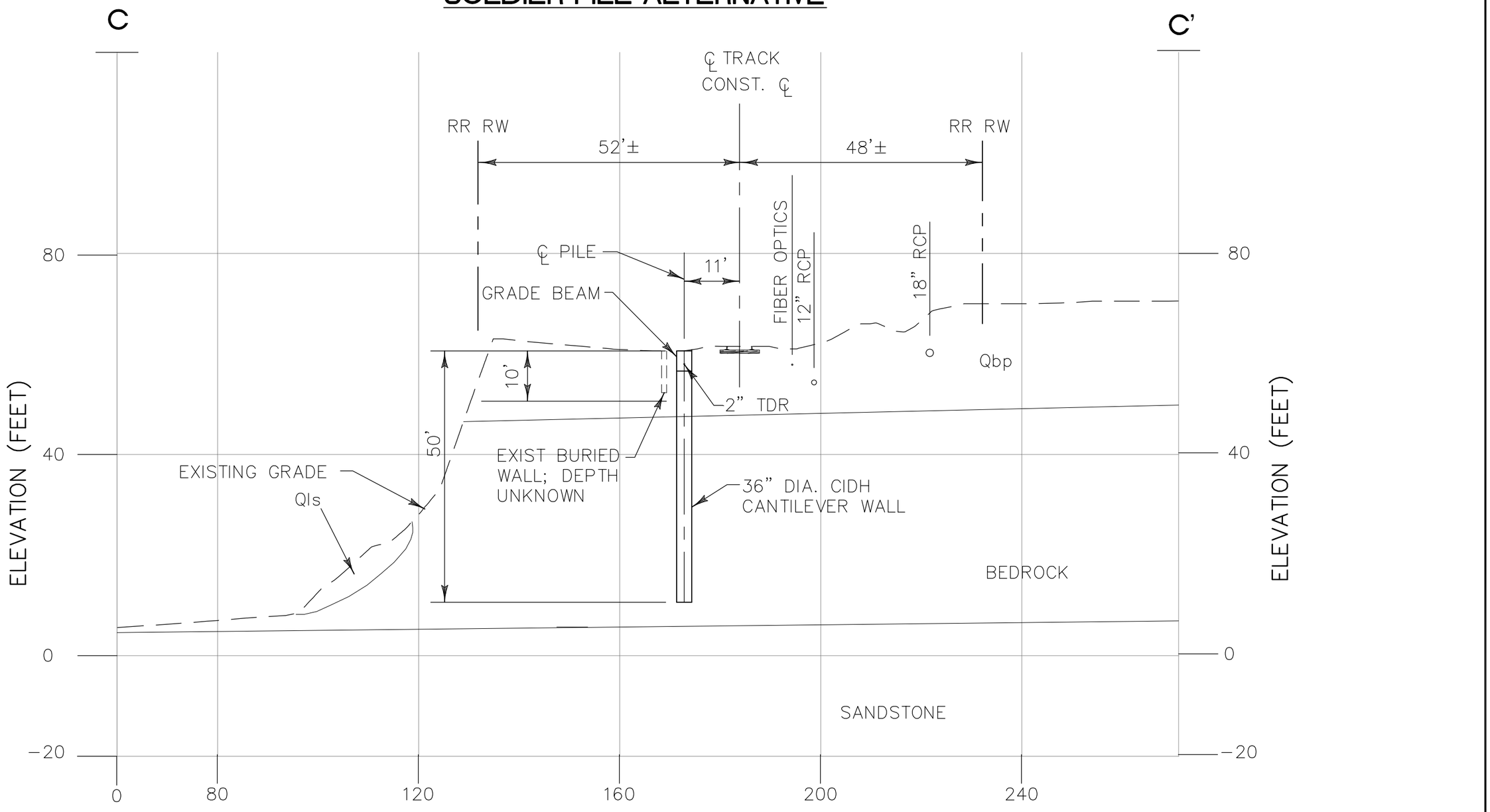
SA-1
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 10 OF 30

SOLDIER PILE ALTERNATIVE



SECTION C-C'
STATION 1529+00

PROGRESS PRINT - NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:30:08 AM
FILENAME: P:\SS\SNDG00000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-2.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

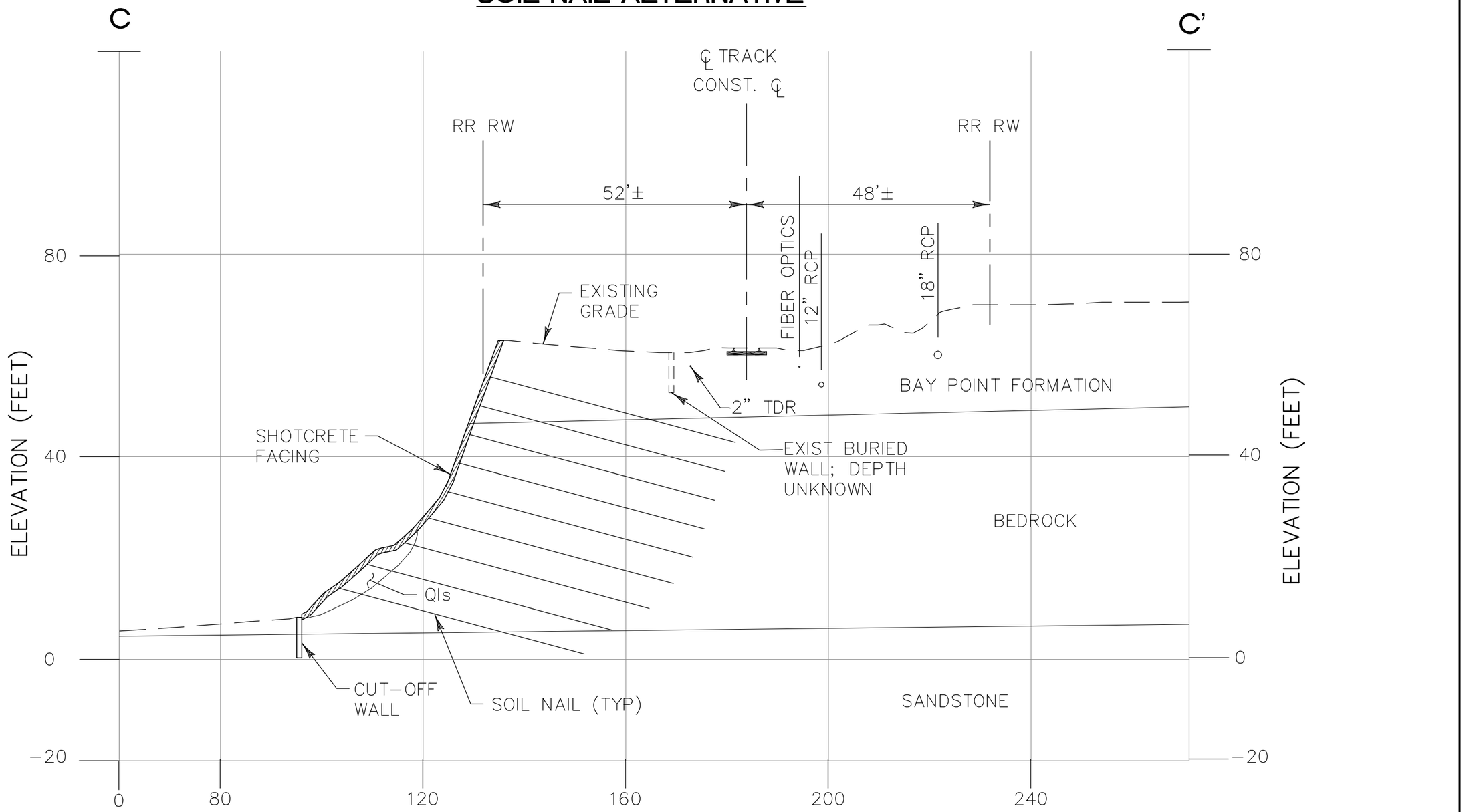
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA-2
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 11 OF 30

SOIL NAIL ALTERNATIVE



SECTION C-C'
STATION 1529+00

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY		DATE 12/09
DRAWN BY	AMJA	12/09
CHECKED BY	PMM	12/09
SANDAG PRJ. ENG.		

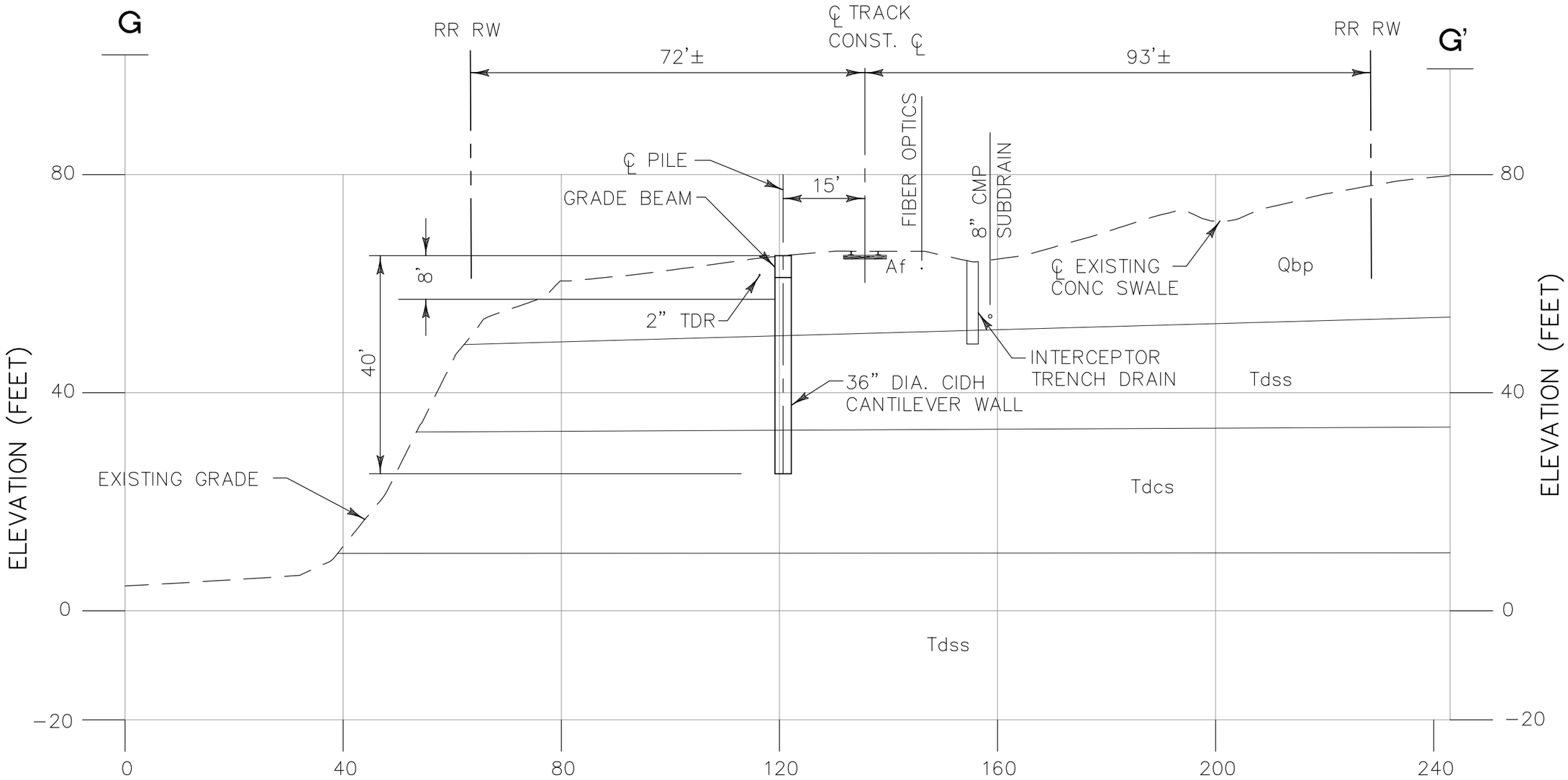
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA–2
CROSS SECTION

SCALE	1"=10'
SANDAG CONTRACT NO.	5000931
SHEET NO.	12
OF	30

SOLDIER PILE ALTERNATIVE



SECTION G-G'
STATION 1516+73

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

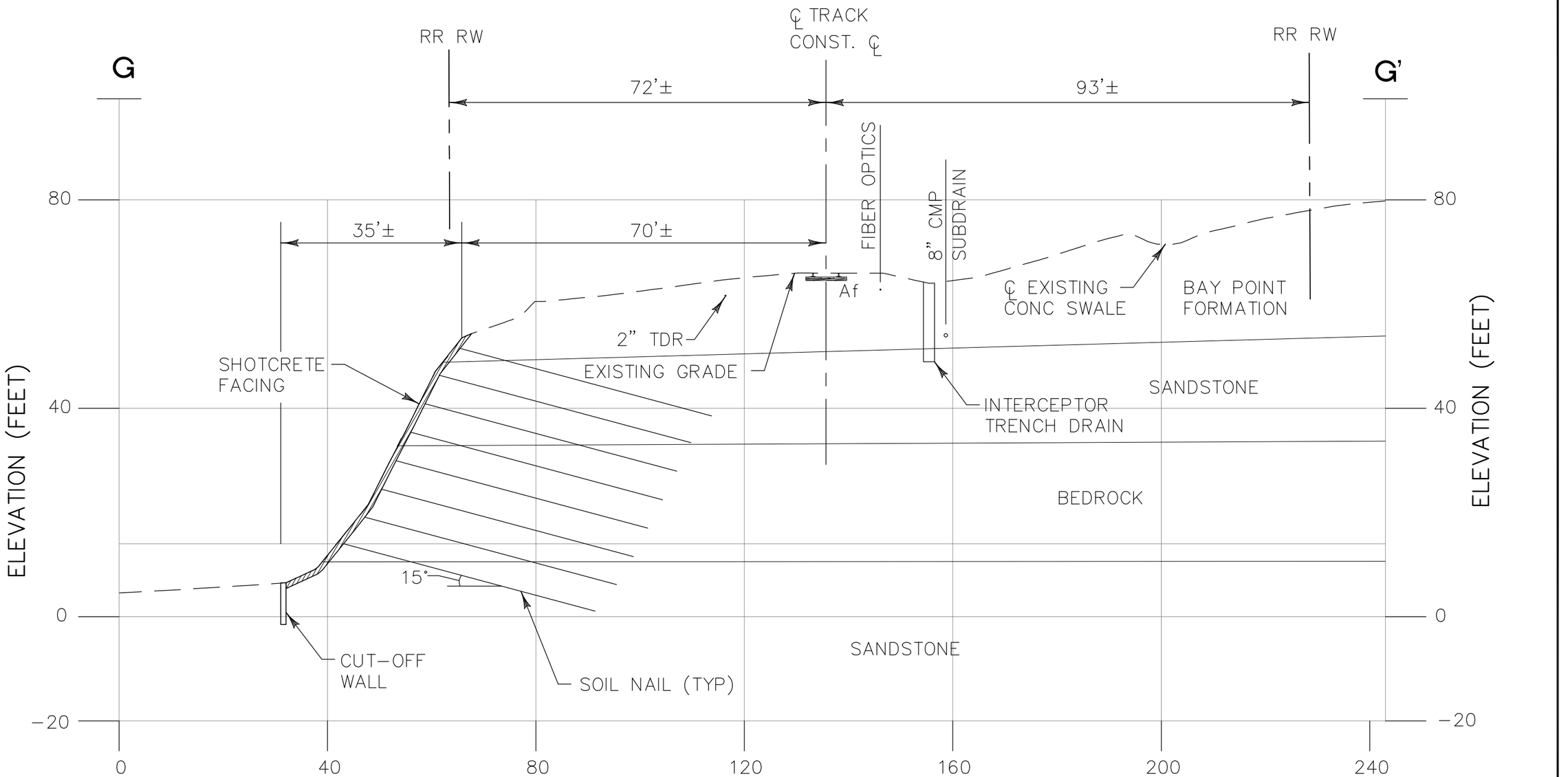
SA-3
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 13 OF 30

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT - NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:31:16 AM
FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-3.DWG

SOIL NAIL ALTERNATIVE



SECTION G-G'
STATION 1516+73

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

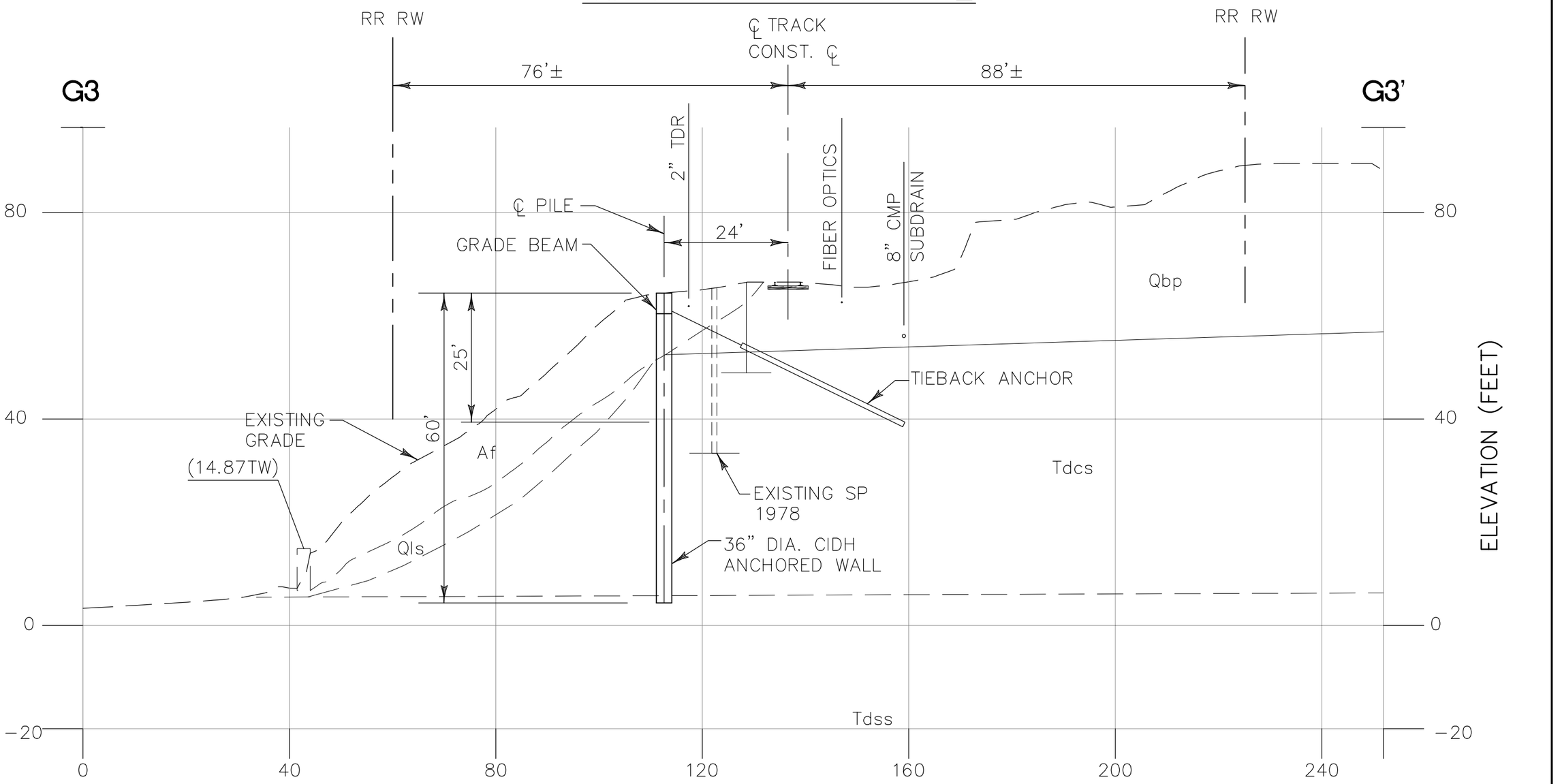
SA–3
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 14 OF 30

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT – NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:30:42 AM
FILENAME: P:\S\SND60000002\04000CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-3.DWG

SOLDIER PILE ALTERNATIVE



SECTION G3-G3'
STATION 1514+08

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

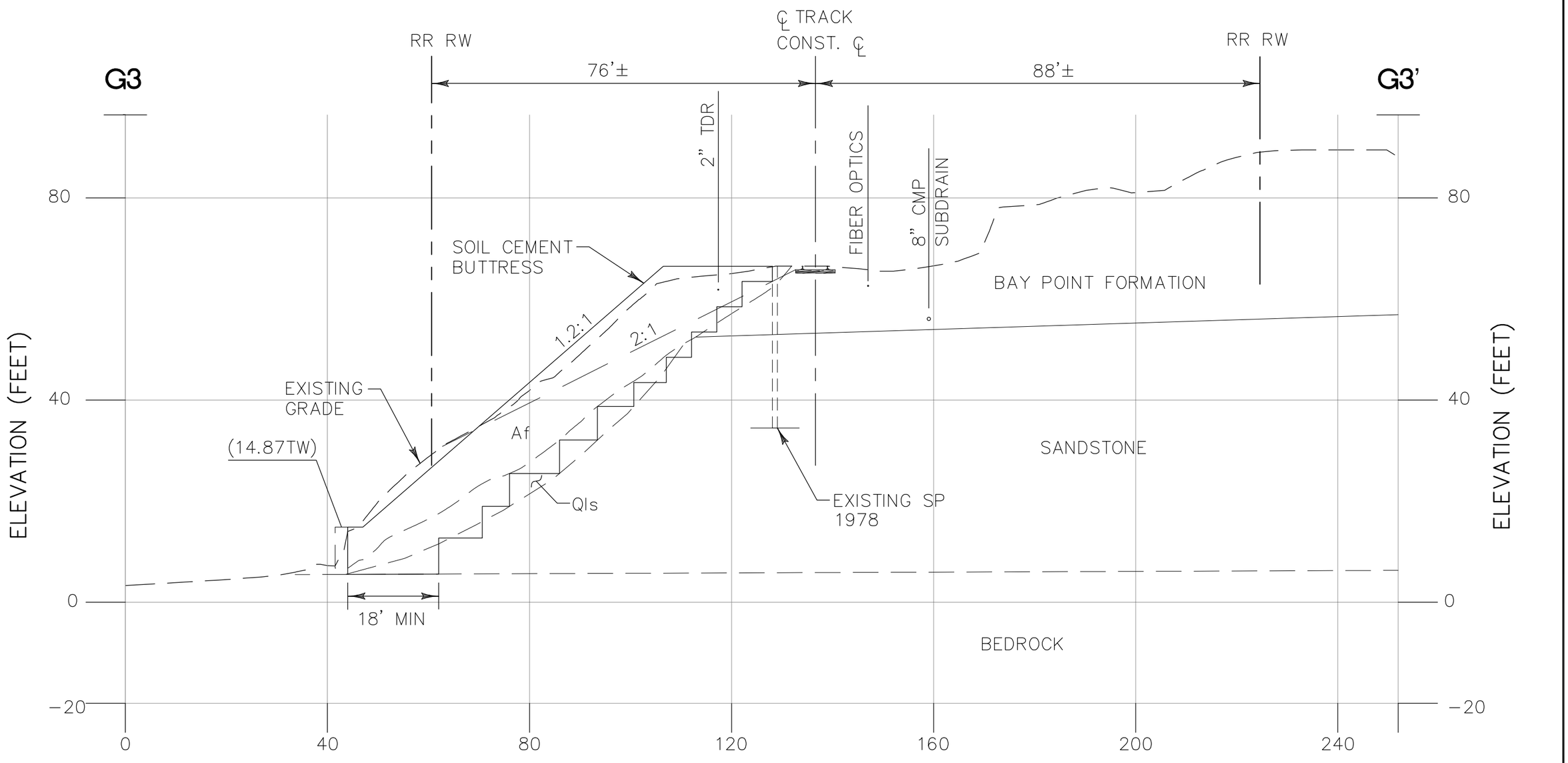
SA-4
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 15 OF 30

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

PROGRESS PRINT - NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:36:08 AM
FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-4.DWG

SOIL CEMENT BUTTRESS ALTERNATIVE



SECTION G3-G3'
STATION 1514+08

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-08-2010 TIME: 12:24:35 PM

FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-4.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

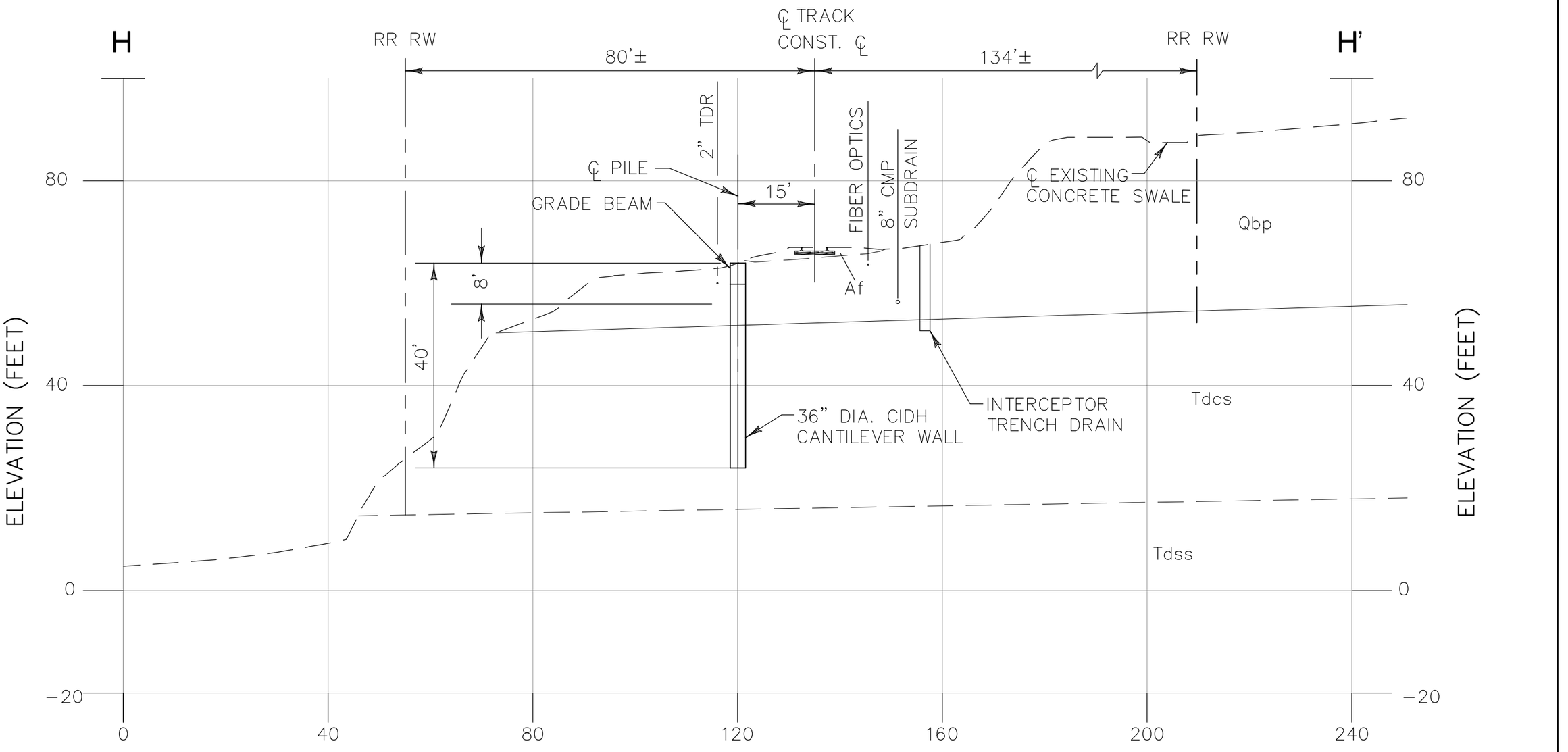
SA-4
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 16 OF 30

SOLDIER PILE ALTERNATIVE



SECTION H-H'
STATION 1512+15

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010 TIME: 10:37:21 AM

FILENAME: P:\SS\SND00000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-5.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

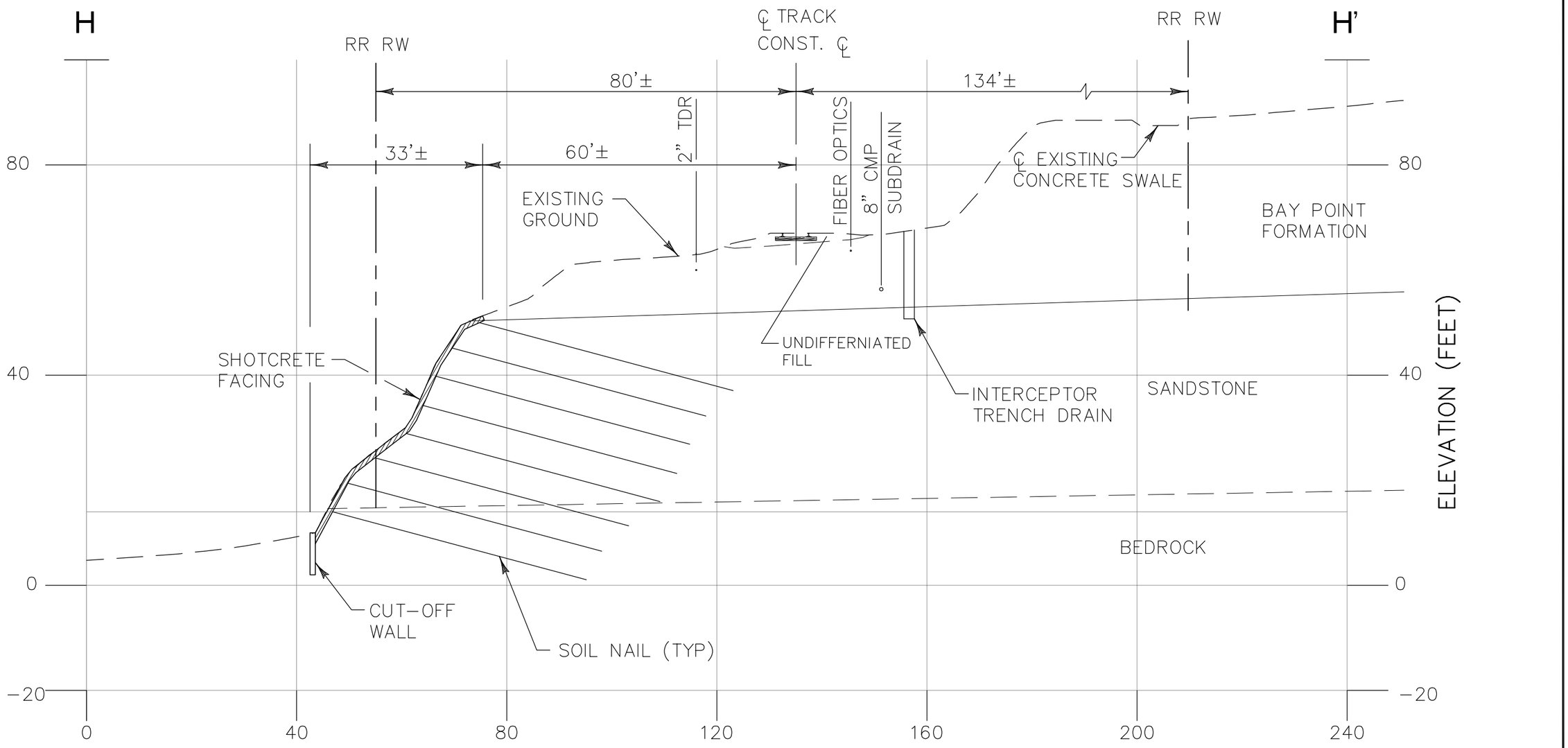
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA-5
CROSS SECTION

SCALE	1"=10'
SANDAG CONTRACT NO.	5000931
SHEET NO.	17
OF	30

SOIL NAIL ALTERNATIVE



SECTION H-H'
STATION 1512+15

PROGRESS PRINT - NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:37:47 AM
FILENAME: P:\S\SND60000002\04000CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-5.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

		DATE
DESIGNED BY		12/09
DRAWN BY	AMJA	12/09
CHECKED BY	PMM	12/09
SANDAG PRJ. ENG.		

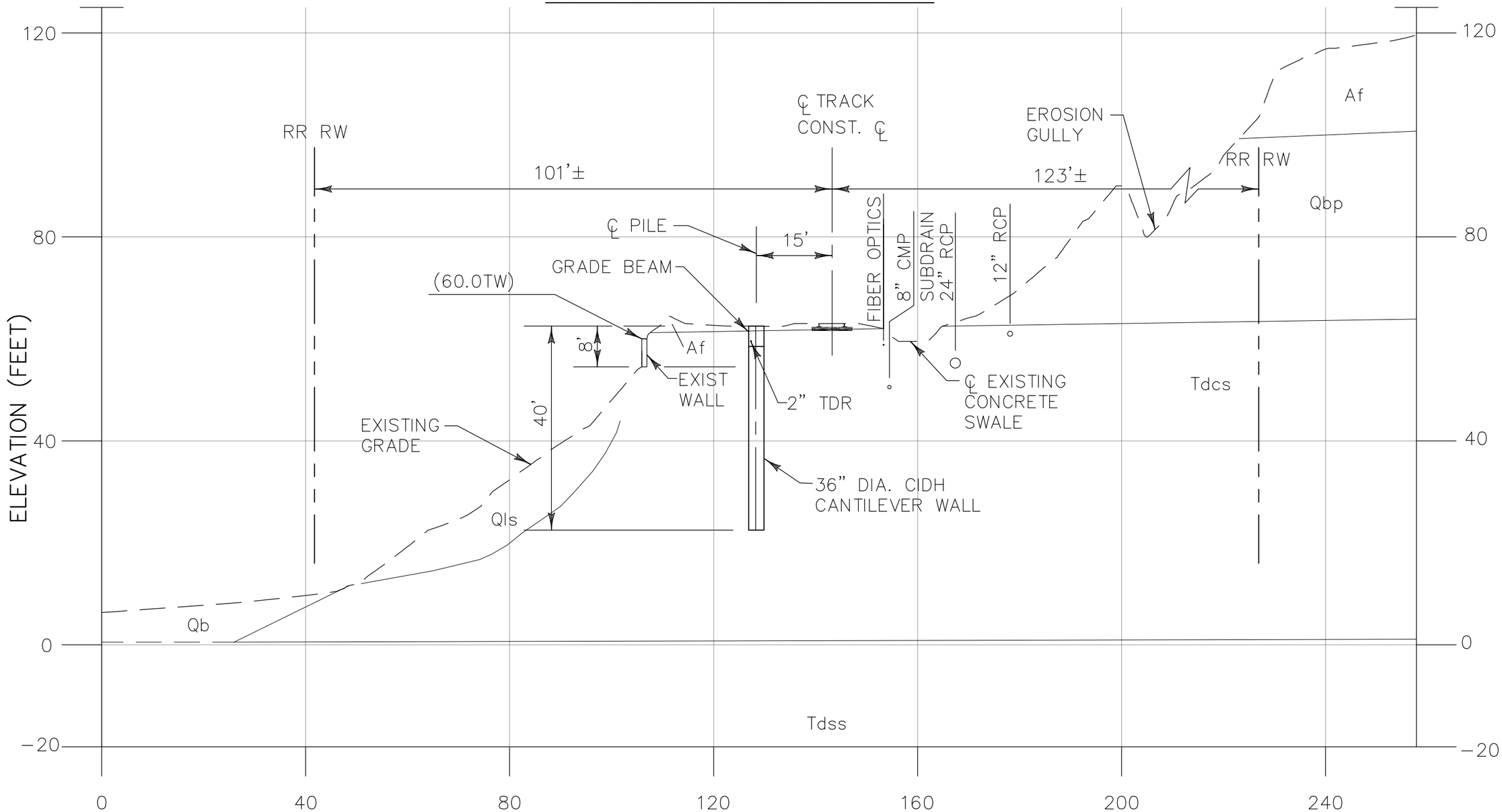
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA-5
CROSS SECTION

SCALE	1"=10'
SANDAG CONTRACT NO.	5000931
SHEET NO.	18
OF	30

SOLDIER PILE ALTERNATIVE



SECTION J-J'
STATION 1490+90

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:38:39 AM

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

FILENAME: P:\S\SND60000002\04000AD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-6N.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

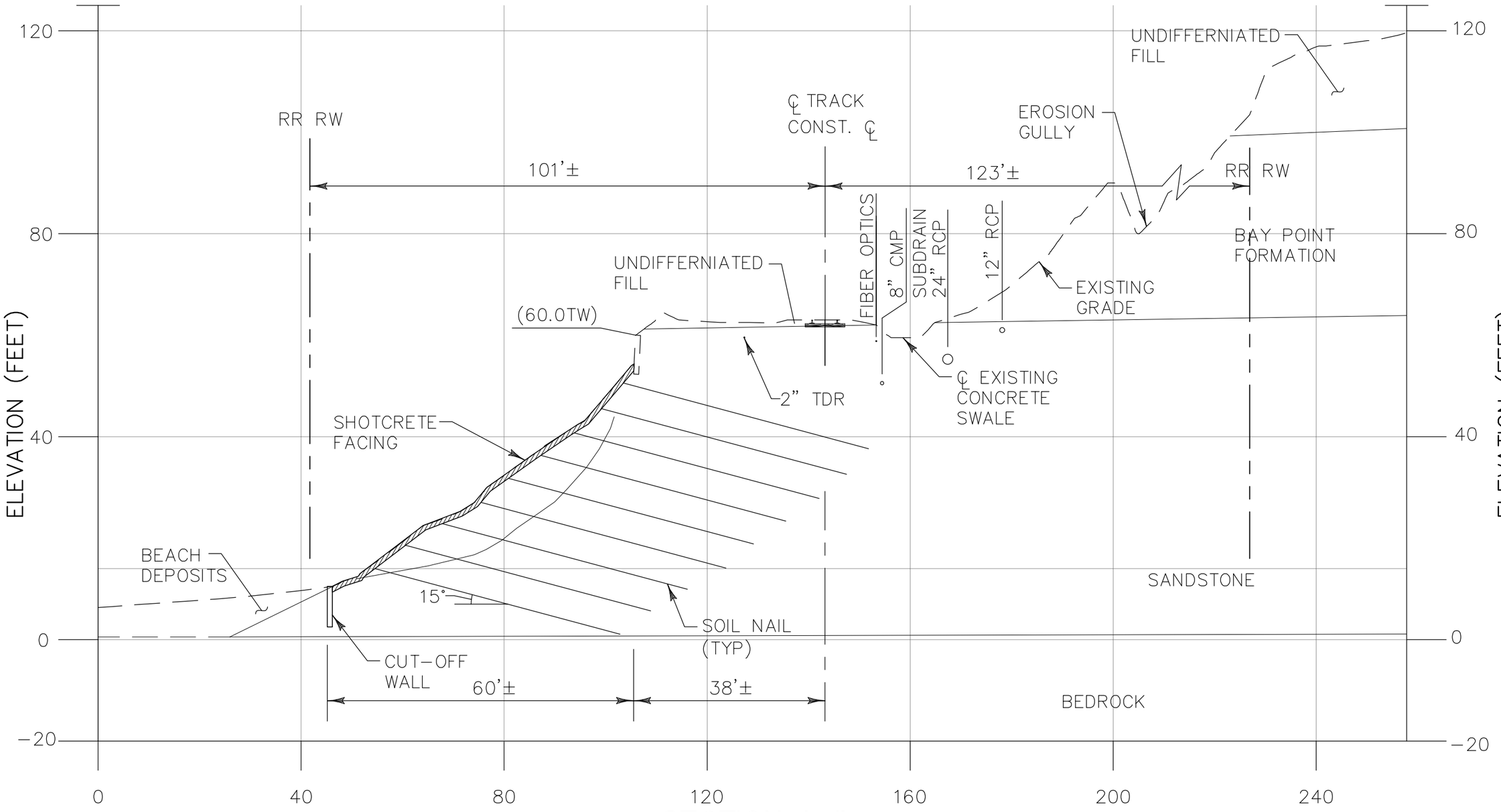
SA-6N
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 19 OF 30

SOIL NAIL ALTERNATIVE



SECTION J-J'
STATION 1490+90

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:39:16 AM

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

FILENAME: P:\S\SNDG00000002\04000CAD\ EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-6N.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY		DATE 12/09
DRAWN BY	AMJA	12/09
CHECKED BY	PMM	12/09
SANDAG PRJ. ENG.		

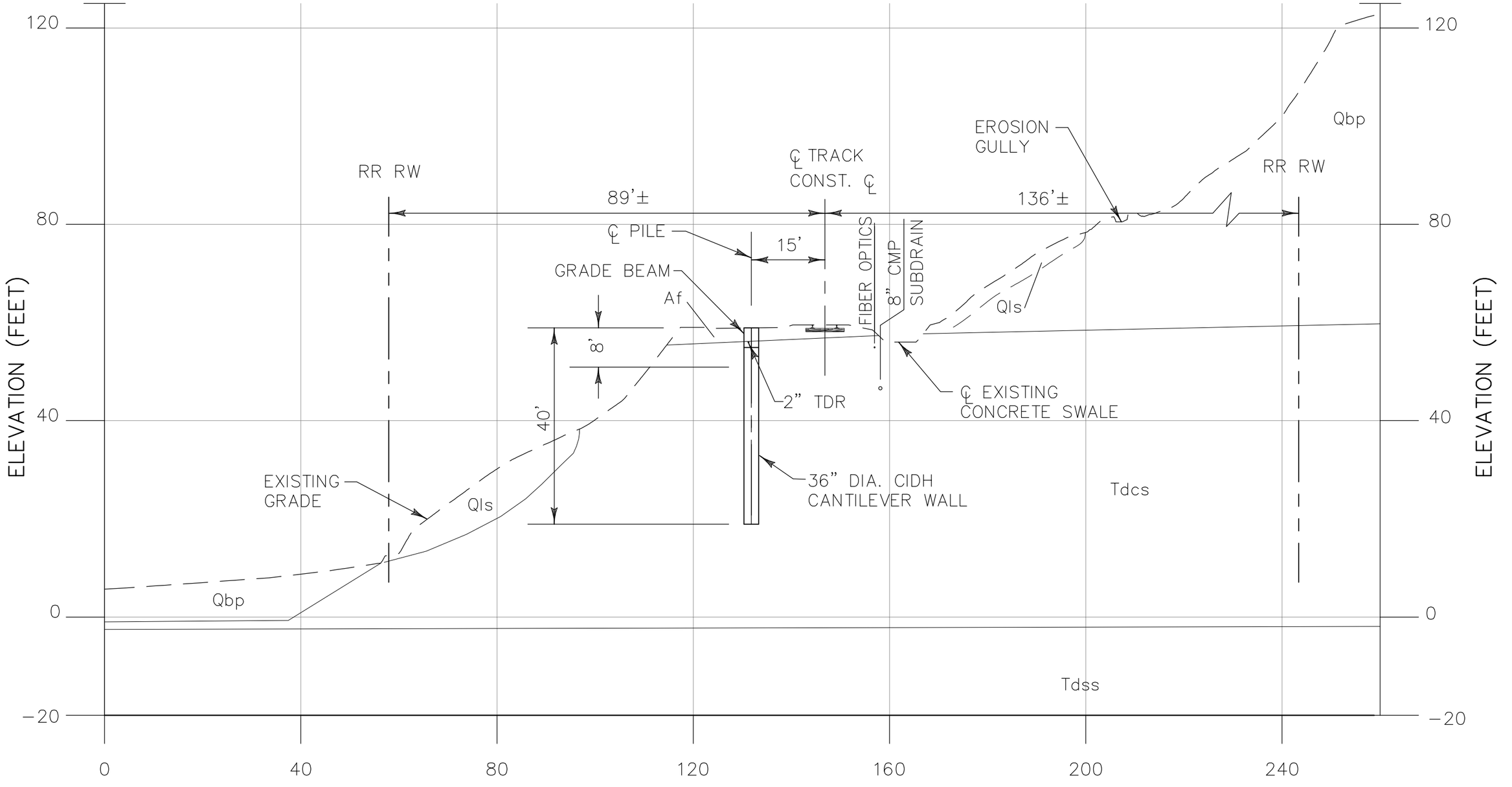
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA−6N
CROSS SECTION

SCALE	1"=10'
SANDAG CONTRACT NO.	5000931
SHEET NO.	20
OF	30

SOLDIER PILE ALTERNATIVE



SECTION K-K'
STATION 1487+20

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:40:43 AM

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-6S.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

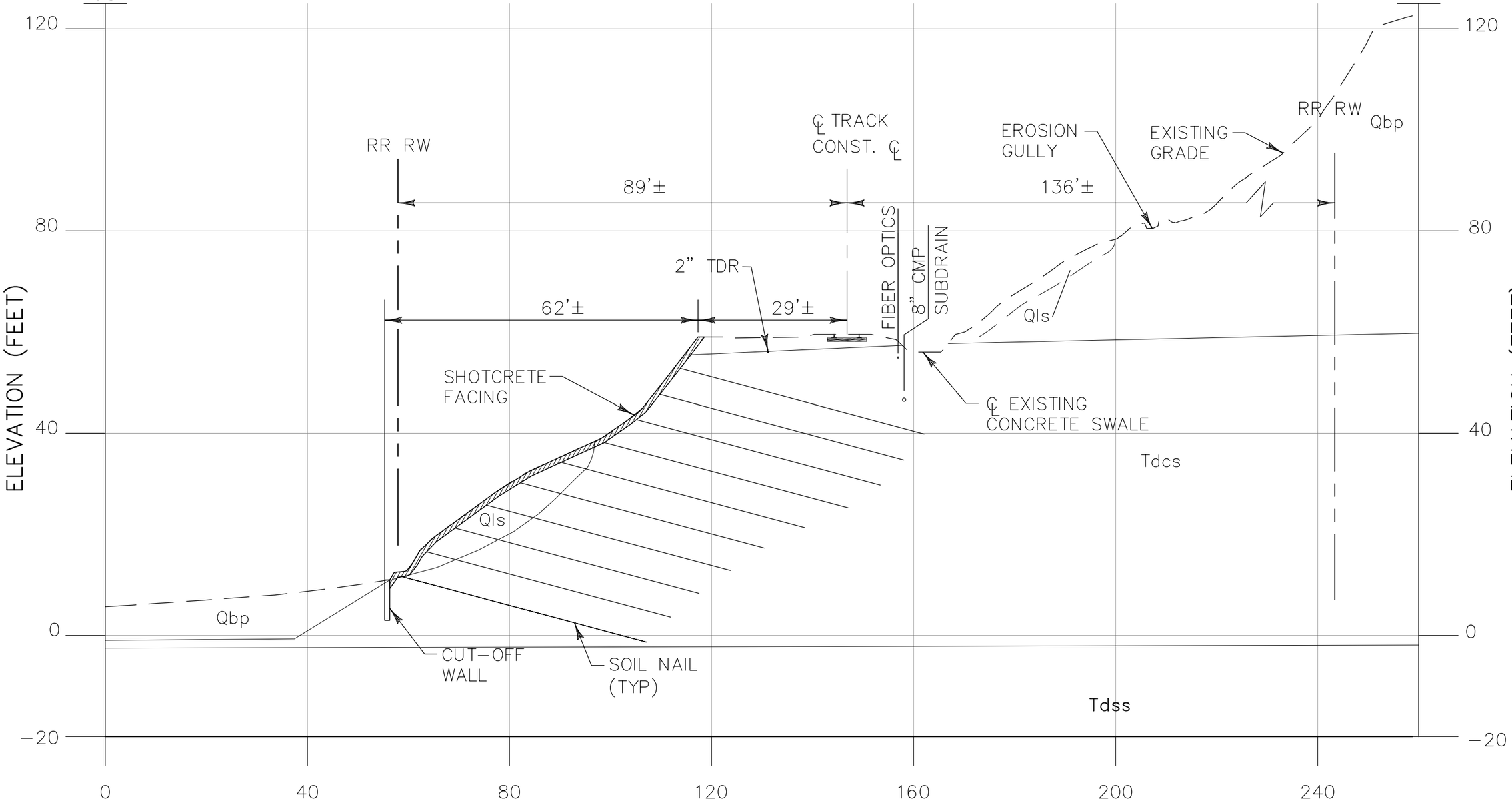
SA-6S
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 22 OF 30

SOIL NAIL ALTERNATIVE



SECTION K-K'
STATION 1487+20

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:41:41 AM

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

FILENAME: P:\S\SND\G00000002\04000AD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-6S.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY		DATE 12/09
DRAWN BY	AMJA	12/09
CHECKED BY	PMM	12/09
SANDAG PRJ. ENG.		

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

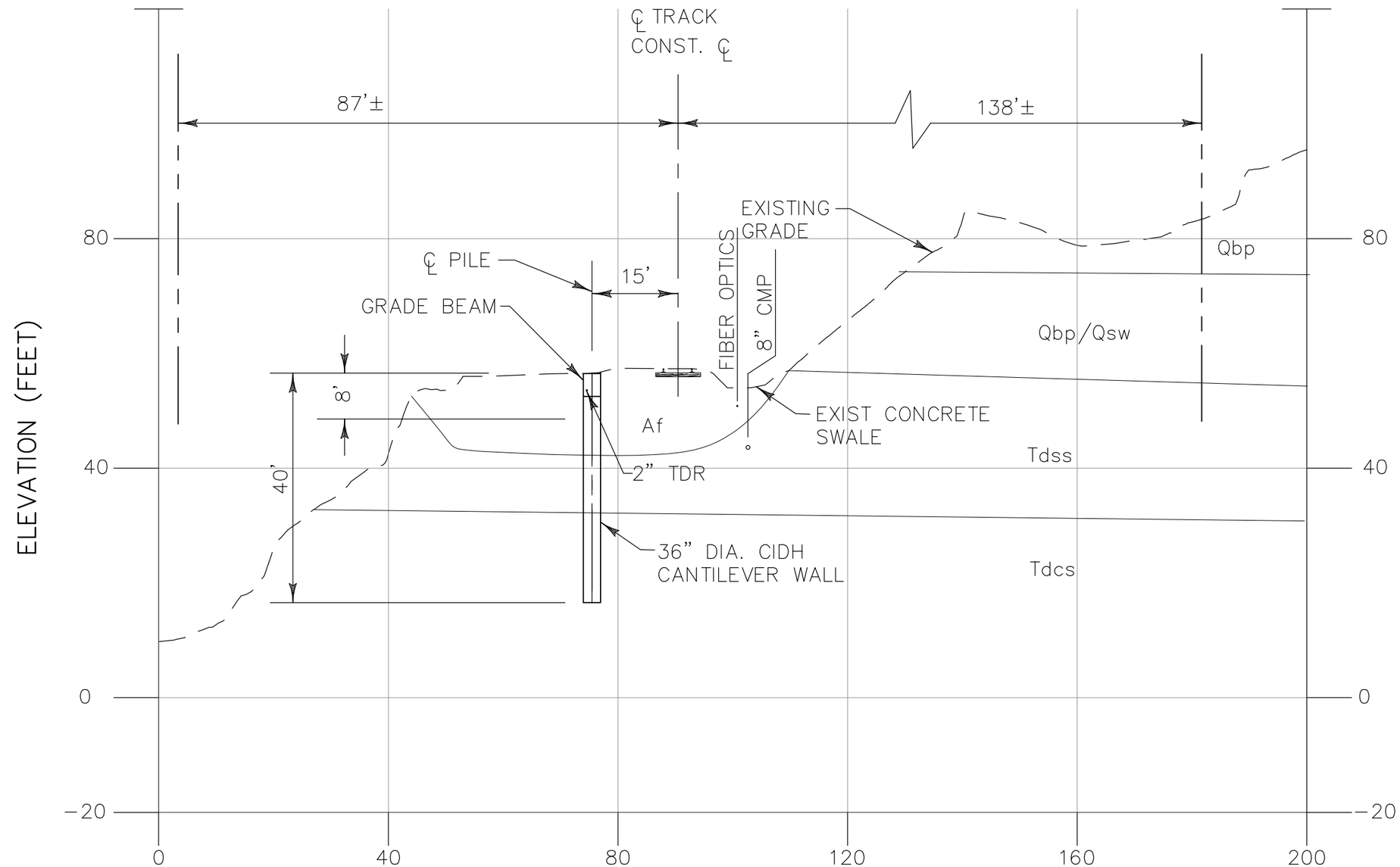
SA−6S
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 23 OF 30

SOLDIER PILE ALTERNATIVE



SECTION K1-K1'
STATION 1485+15

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:42:21 AM

FILENAME: P:\S\SND00000002\04000AD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-7.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES (0, 1, 2, 3)

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

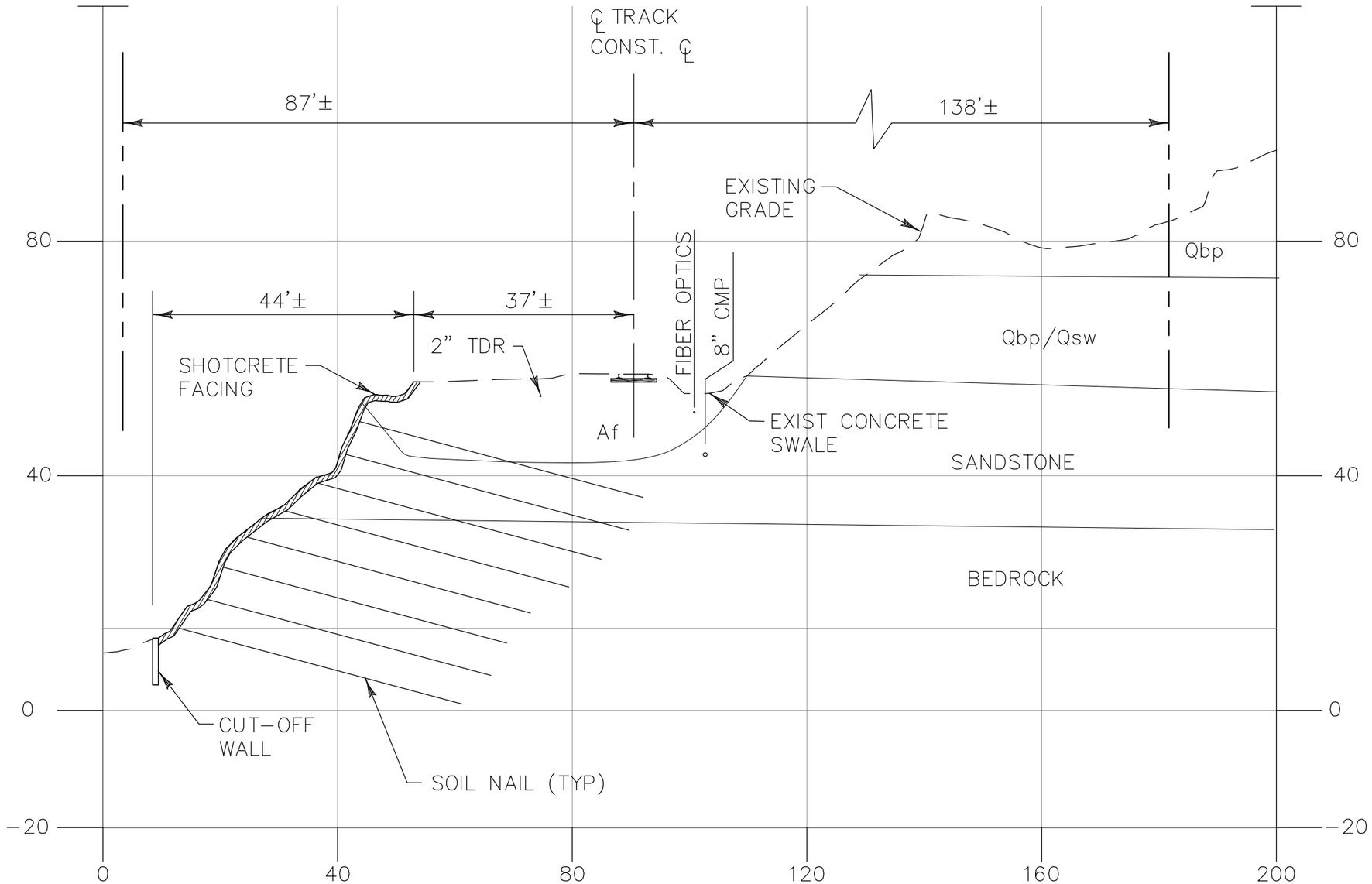
SA-7
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 24 OF 30

SOIL NAIL ALTERNATIVE



SECTION K1-K1'
STATION 1485+15

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA-7
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 25 OF 30

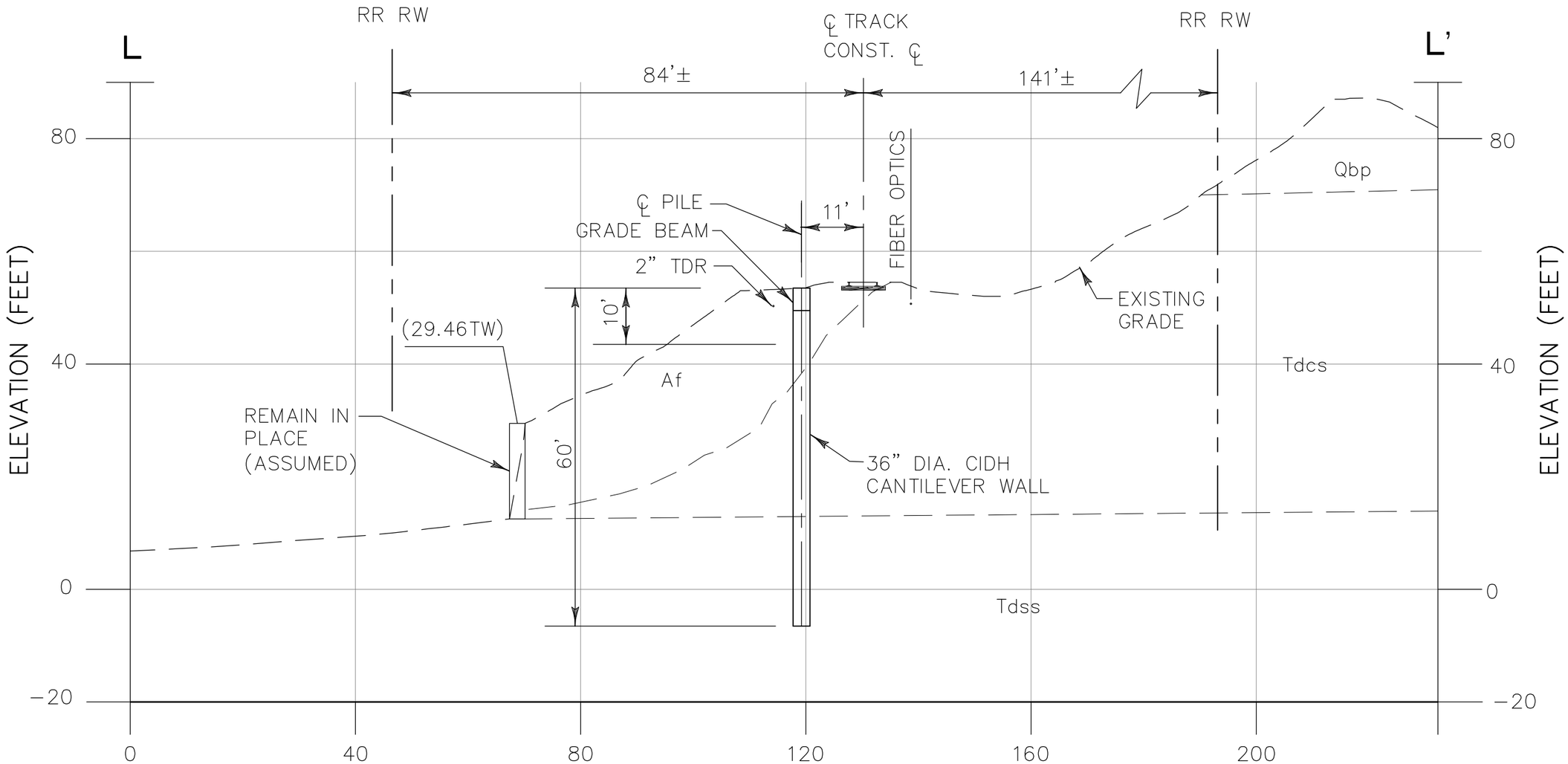
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

PROGRESS PRINT - NOT FOR CONSTRUCTION

DATE: 03-02-2010
TIME: 10:42:47 AM

FILENAME: P:\S\SND60000002\04000CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-7.DWG

SOLDIER PILE ALTERNATIVE



SECTION L-L'
STATION 1482+25

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

	DATE
DESIGNED BY	12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

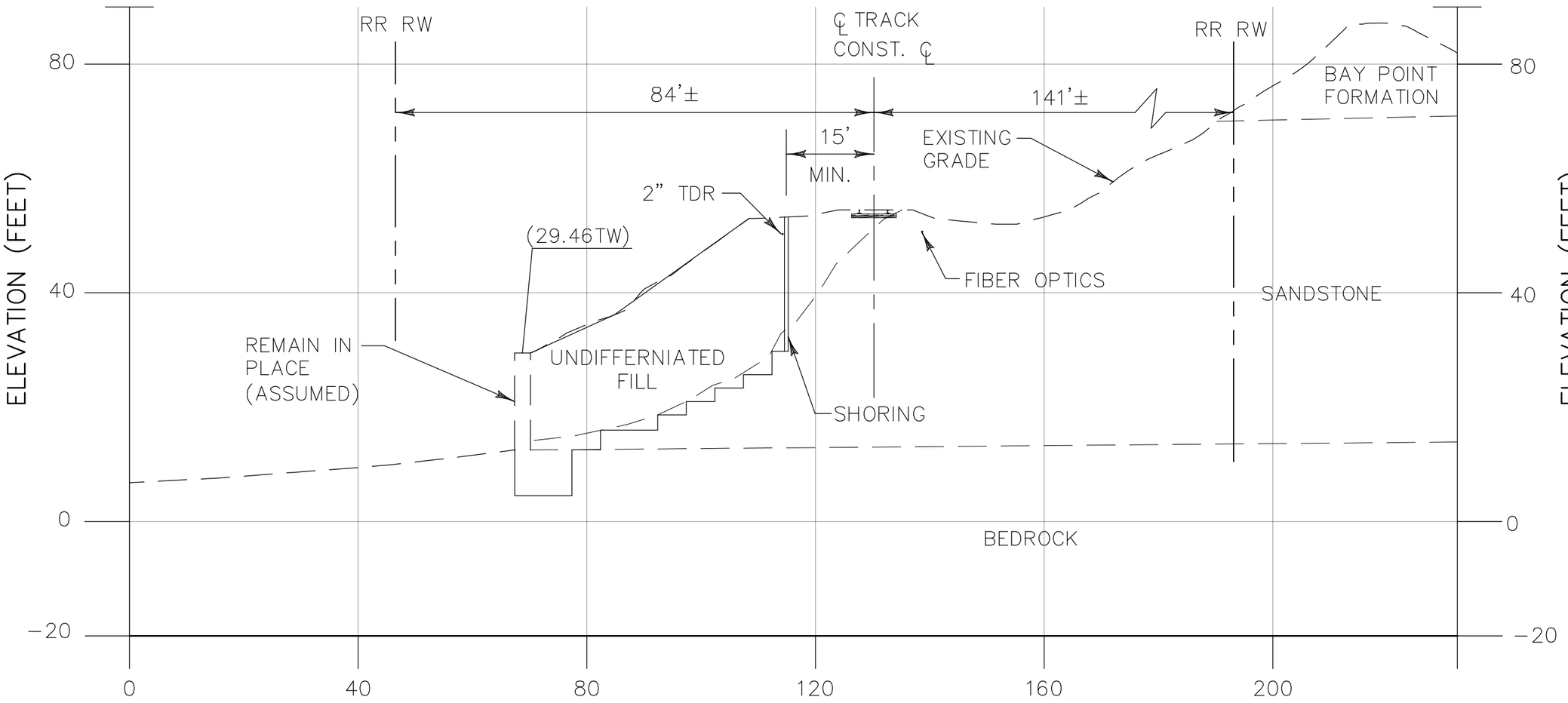
SA–8
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 26 OF 30

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

PROGRESS PRINT – NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:43:44 AM
FILENAME: P:\S\SND5000000002\04000CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-8.DWG

SOIL CEMENT BUTTRESS ALTERNATIVE



SECTION L-L'
STATION 1482+25

PROGRESS PRINT – NOT FOR CONSTRUCTION
DATE: 03-02-2010 TIME: 10:44:36 AM
FILENAME: P:\S\SNDG00000002\04000CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-8.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

		DATE
DESIGNED BY		12/09
DRAWN BY	AMJA	12/09
CHECKED BY	PMM	12/09
SANDAG PRJ. ENG.		

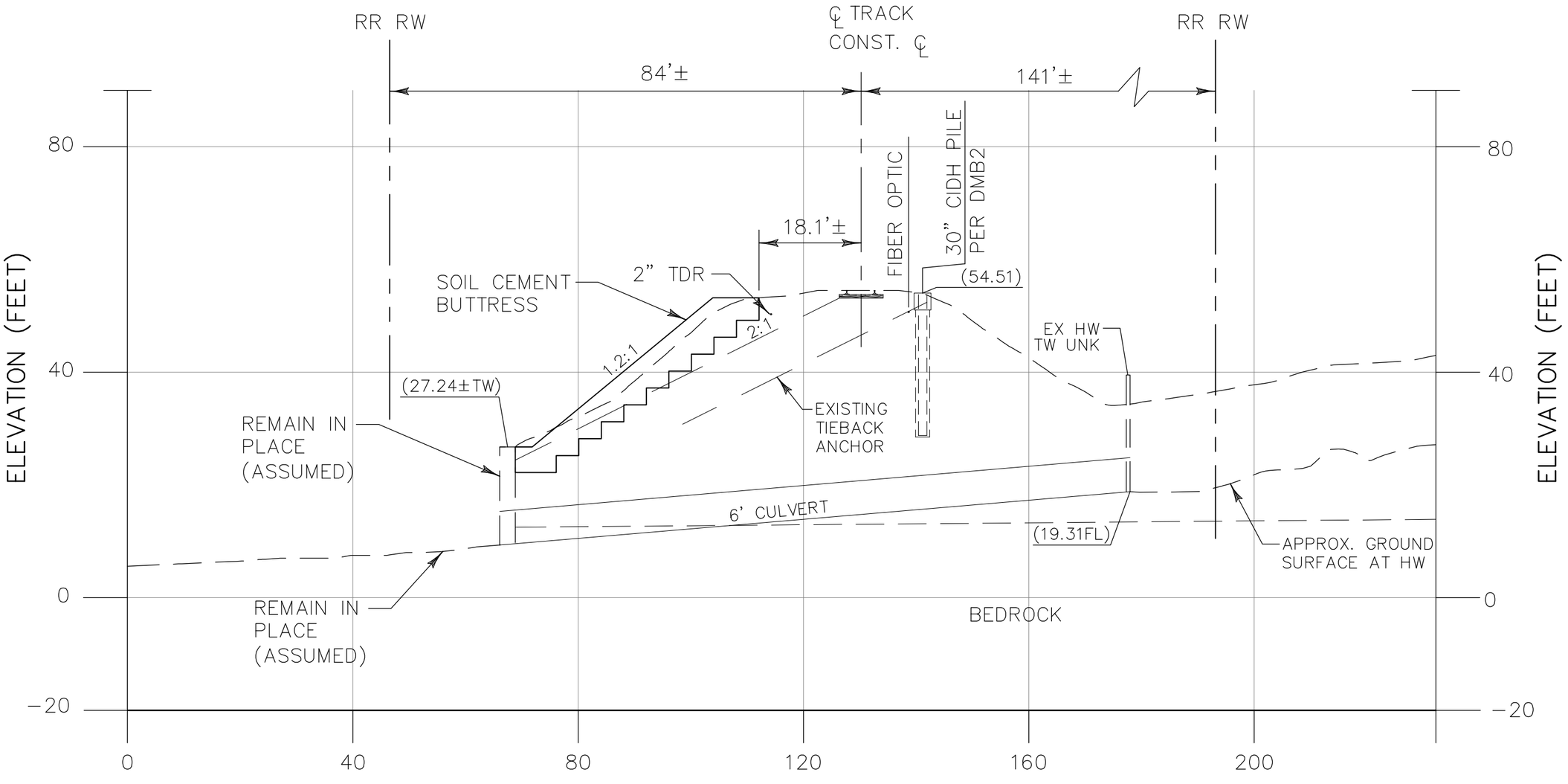
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA–8
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 27 OF 30

SOIL CEMENT BUTTRESS ALTERNATIVE



SECTION NORTH OF L-L'
STATION 1482+85

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

PROGRESS PRINT – NOT FOR CONSTRUCTION
DATE: 03-02-2010
TIME: 10:46:59 AM
FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-8.DWG

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

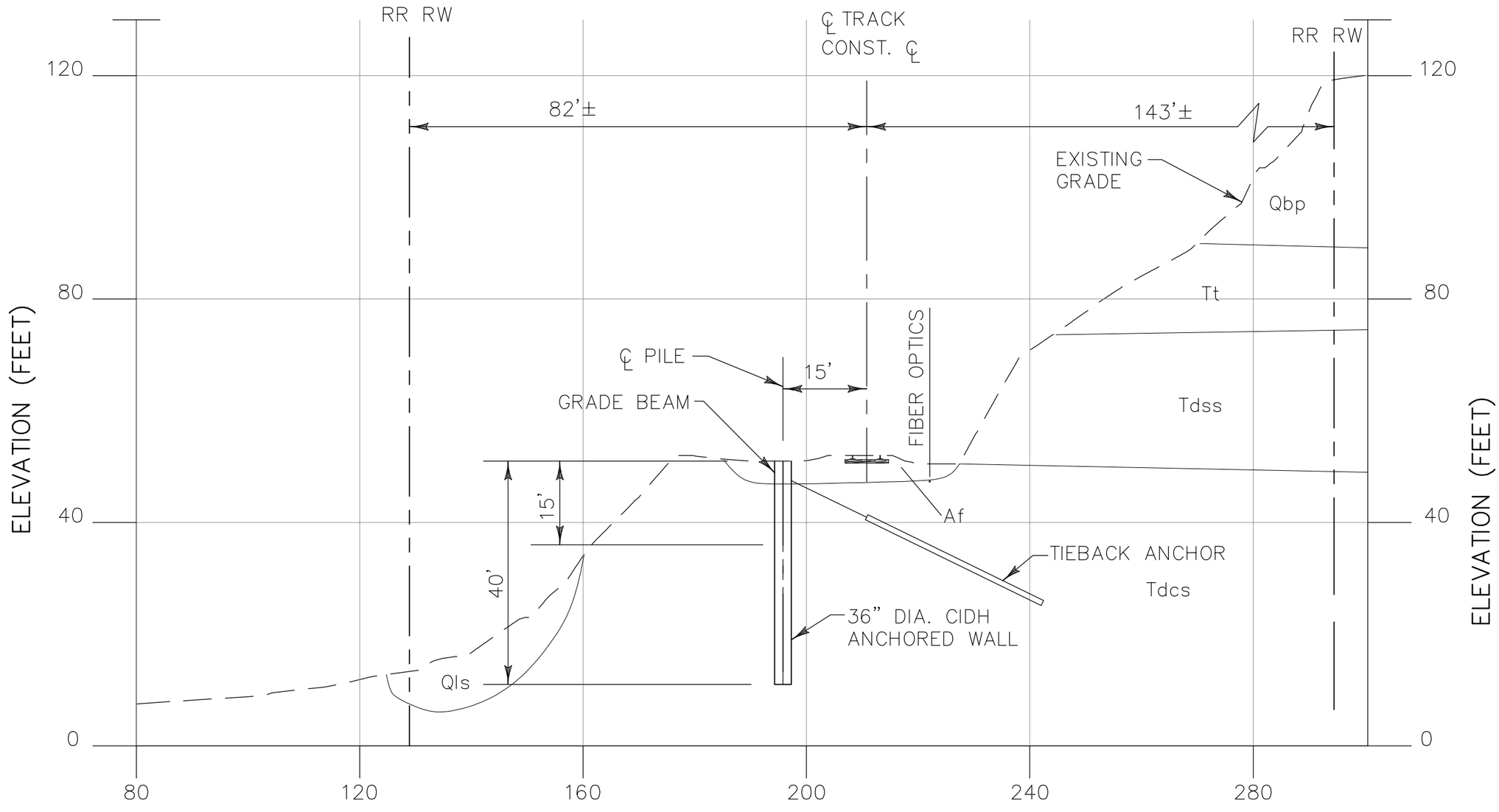
SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA–8
CROSS SECTION

SCALE 1"=10'
SANDAG CONTRACT NO. 5000931
SHEET NO. 28 OF 30

SOLDIER PILE ALTERNATIVE



SECTION M1-M1'
STATION 1479+82

PROGRESS PRINT – NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:47:33 AM

FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-9.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

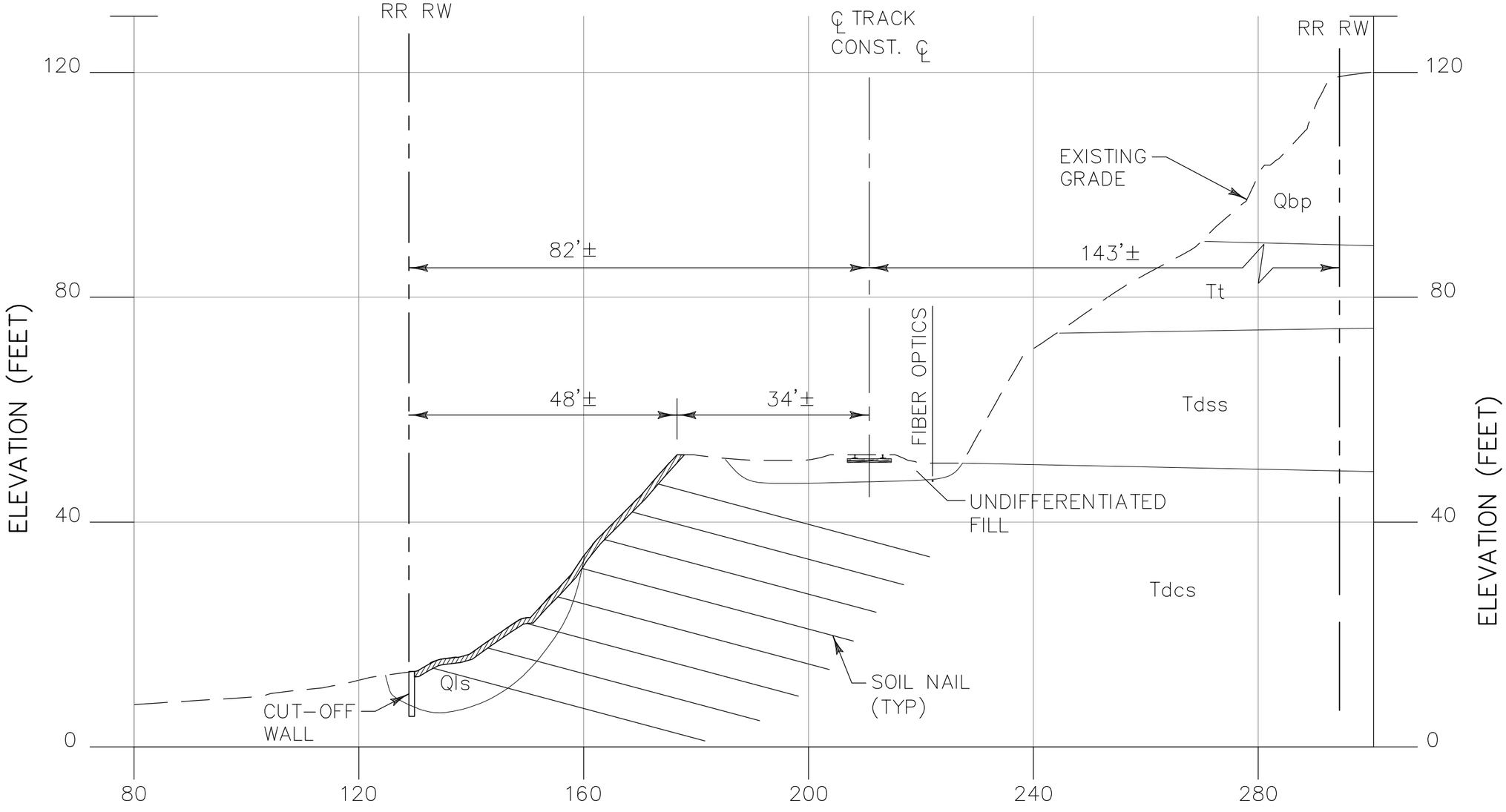
SA–9
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 29 OF 30

SOIL NAIL ALTERNATIVE



SECTION M1-M1'
STATION 1479+82

PROGRESS PRINT - NOT FOR CONSTRUCTION

DATE: 03-02-2010

TIME: 10:48:04 AM

FILENAME: P:\S\SND60000002\0400CAD\EC\DWG\CROSS SECTIONS\CROSS SECTION -SA-9.DWG

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

NO.	DATE	REVISIONS	BY	CHK	APRV

DAVID EVANS AND ASSOCIATES INC.
110 West A Street, Suite 1700
San Diego California 92101
Phone: (619) 400-0600

DESIGNED BY	DATE 12/09
DRAWN BY AMJA	12/09
CHECKED BY PMM	12/09
SANDAG PRJ. ENG.	

SANDAG
San Diego's Regional Planning Agency

DEL MAR BLUFFS STABILIZATION PROJECT 3

SA-9
CROSS SECTION

SCALE 1"=10'

SANDAG CONTRACT NO. 5000931

SHEET NO. 30 OF 30

Appendix C

Preliminary Construction Cost Estimates

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 1 (PRIORITY 1)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	55 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	200	$100.00	$20,000
2	CIDH Concrete	CY	51	$200.00	$10,265
3	Furnish Structural Steel	LB	13679	$1.00	$13,679
4	Erect Structural Steel	LB	13679	$0.50	$6,840
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA	5	$2,600.00	$13,000
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$63,784
SWPP/SWMP LS at 1%	1%	$638
TRAFFIC CONTROL 10%	10%	$6,378
SUB TOTAL		$70,800
NIGHT TIME CONSTRUCTION	50%	$35,400
SUB TOTAL		$106,200
MOBILIZATION	10%	$10,620
SUB TOTAL		$116,820
CONTIGENCIES @	20%	$23,364
TOTAL		$140,184
COST PER UNIT LENGTH OF PILE		$701
FOR BUDGET PRUPOSES - SAY		$145,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 1 (PRIORITY 1)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	55 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	70	$800.00	$56,051
2	Shotcrete Facing with Architectural Finish	SF	3250	$20.00	$65,000
3	Cut Off Wall	LF	65	$240.00	$15,600
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$136,651
SWPP/SWMP LS at 1%	1%	$1,367
TRAFFIC CONTROL 10%	10%	$13,665
SUB TOTAL		$151,683
NIGHT TIME CONSTRUCTION	50%	$75,841
SUB TOTAL		$227,524
MOBILIZATION	10%	$22,752
SUB TOTAL		$250,276
CONTINGENCIES @	20%	$50,055
TOTAL		$300,331
FOR BUDGET PURPOSES - SAY		$305,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 2 (PRIORITY 2)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	205 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	1200	$100.00	$120,000
2	CIDH Concrete	CY	307	$200.00	$61,307
3	Furnish Structural Steel	LB	100858	$1.00	$100,858
4	Erect Structural Steel	LB	100858	$0.50	$50,429
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$332,595
SWPP/SWMP LS at 1%	1%	$3,326
TRAFFIC CONTROL 10%	10%	$33,259
SUB TOTAL		$369,180
NIGHT TIME CONSTRUCTION	50%	$184,590
SUB TOTAL		$553,770
MOBILIZATION	10%	$55,377
SUB TOTAL		$609,147
CONTIGENCIES @	20%	$121,829
TOTAL		$730,977
COST PER UNIT LENGTH OF PILE		$609
FOR BUDGET PRUPOSES - SAY		$735,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 2 (PRIORITY 2)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	205 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	315	$800.00	$252,026
2	Shotcrete Facing with Architectural Finish	SF	14000	$20.00	$280,000
3	Cut Off Wall	LF	215	$240.00	$51,600
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$583,626
SWPP/SWMP LS at 1%	1%	$5,836
TRAFFIC CONTROL 10%	10%	$58,363
SUB TOTAL		$647,825
NIGHT TIME CONSTRUCTION	50%	$323,912
SUB TOTAL		$971,737
MOBILIZATION	10%	$97,174
SUB TOTAL		$1,068,910
CONTINGENCIES @	20%	$213,782
TOTAL		$1,282,693
FOR BUDGET PURPOSES - SAY		$1,285,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 4 (PRIORITY 3)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	135 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	910	$100.00	$91,000
2	CIDH Concrete	CY	225	$200.00	$44,970
3	Furnish Structural Steel	LB	177121	$1.00	$177,121
4	Erect Structural Steel	LB	177121	$0.50	$88,561
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA	14	$4,400.00	$61,600
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$463,252
SWPP/SWMP LS at 1%	1%	$4,633
TRAFFIC CONTROL 10%	10%	$46,325
SUB TOTAL		$514,210
NIGHT TIME CONSTRUCTION	50%	$257,105
SUB TOTAL		$771,315
MOBILIZATION	10%	$77,131
SUB TOTAL		$848,446
CONTIGENCIES @	20%	$169,689
TOTAL		$1,018,135
COST PER UNIT LENGTH OF PILE		$1,119
FOR BUDGET PRUPOSES - SAY		$1,020,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 4 (PRIORITY 3)	BR NO		REC'D BY	
TYPE	**SOIL CEMENT BUTTRESS**	DIST 11	CO SD	RTE	
LENGTH	135 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Cement Buttress	CY	6000	$80.00	$480,000
2	Temporary Shoring	LF	135	$520.00	$70,200
3	Revegetation/Drainage	SF	10800	$10.00	$108,000
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$658,200
SWPP/SWMP LS at 1%	1%	$6,582
TRAFFIC CONTROL 10%	10%	$65,820
SUB TOTAL		$730,602
NIGHT TIME CONSTRUCTION	50%	$365,301
SUB TOTAL		$1,095,903
MOBILIZATION	10%	$109,590
SUB TOTAL		$1,205,493
CONTINGENCIES @	20%	$241,099
TOTAL		$1,446,592
FOR BUDGET PURPOSES - SAY		$1,450,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 7 (PRIORITY 3)			BR NO		REC'D BY	
TYPE	**SOLDIER PILE**			DIST 11	CO SD	RTE	
LENGTH	100 '						

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	440	$100.00	$44,000
2	CIDH Concrete	CY	113	$200.00	$22,583
3	Furnish Structural Steel	LB	30094	$1.00	$30,094
4	Erect Structural Steel	LB	30094	$0.50	$15,047
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$111,725
SWPP/SWMP LS at 1%	1%	$1,117
TRAFFIC CONTROL 10%	10%	$11,172
SUB TOTAL		$124,014
NIGHT TIME CONSTRUCTION	50%	$62,007
SUB TOTAL		$186,022
MOBILIZATION	10%	$18,602
SUB TOTAL		$204,624
CONTIGENCIES @	20%	$40,925
TOTAL		$245,548
COST PER UNIT LENGTH OF PILE		$558
FOR BUDGET PRUPOSES - SAY		$250,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 7 (PRIORITY 3)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	100 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	144	$800.00	$115,213
2	Shotcrete Facing with Architectural Finish	SF	7200	$20.00	$144,000
3	Cut Off Wall	LF	110	$240.00	$26,400
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$285,613
SWPP/SWMP LS at 1%	1%	$2,856
TRAFFIC CONTROL 10%	10%	$28,561
SUB TOTAL		$317,031
NIGHT TIME CONSTRUCTION	50%	$158,515
SUB TOTAL		$475,546
MOBILIZATION	10%	$47,555
SUB TOTAL		$523,101
CONTINGENCIES @	20%	$104,620
TOTAL		$627,721
FOR BUDGET PURPOSES - SAY		$630,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 6N (PRIORITY 4)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	440 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	2000	$100.00	$200,000
2	CIDH Concrete	CY	513	$200.00	$102,652
3	Furnish Structural Steel	LB	136792	$1.00	$136,792
4	Erect Structural Steel	LB	136792	$0.50	$68,396
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$507,839
SWPP/SWMP LS at 1%	1%	$5,078
TRAFFIC CONTROL 10%	10%	$50,784
SUB TOTAL		$563,702
NIGHT TIME CONSTRUCTION	50%	$281,851
SUB TOTAL		$845,553
MOBILIZATION	10%	$84,555
SUB TOTAL		$930,108
CONTIGENCIES @	20%	$186,022
TOTAL		$1,116,129
COST PER UNIT LENGTH OF PILE		$558
FOR BUDGET PRUPOSES - SAY		$1,120,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 6N (PRIORITY 4)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	380 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	576	$800.00	$460,606
2	Shotcrete Facing with Architectural Finish	SF	28000	$20.00	$560,000
3	Cut Off Wall	LF	400	$240.00	$96,000
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$1,116,606
SWPP/SWMP LS at 1%	1%	$11,166
TRAFFIC CONTROL 10%	10%	$111,661
SUB TOTAL		$1,239,433
NIGHT TIME CONSTRUCTION	50%	$619,716
SUB TOTAL		$1,859,149
MOBILIZATION	10%	$185,915
SUB TOTAL		$2,045,064
CONTINGENCIES @	20%	$409,013
TOTAL		$2,454,077
FOR BUDGET PURPOSES - SAY		$2,455,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 6N (PRIORITY 4)			BR NO		REC'D BY	
TYPE	**SOIL CEMENT BUTTRESS**			DIST 11	CO SD	RTE	
LENGTH	60 '						

DESIGN SECTION		QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES		QUANT. CHECKED BY	DATE	PRICE BY
AND $	RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Cement Buttress	CY	4500	$80.00	$360,000
2	Temporary Shoring	LF	60	$520.00	$31,200
3	Revegetation/Drainage	SF	5400	$10.00	$54,000
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$445,200
SWPP/SWMP LS at 1%	1%	$4,452
TRAFFIC CONTROL 10%	10%	$44,520
SUB TOTAL		$494,172
NIGHT TIME CONSTRUCTION	50%	$247,086
SUB TOTAL		$741,258
MOBILIZATION	10%	$74,126
SUB TOTAL		$815,384
CONTINGENCIES @	20%	$163,077
TOTAL		$978,461
FOR BUDGET PURPOSES - SAY		$980,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 6N-SUPPLEMENT (PRIORITY 4)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	380 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	1680	$100.00	$168,000
2	CIDH Concrete	CY	431	$200.00	$86,228
3	Furnish Structural Steel	LB	114905	$1.00	$114,905
4	Erect Structural Steel	LB	114905	$0.50	$57,453
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$426,585
SWPP/SWMP LS at 1%	1%	$4,266
TRAFFIC CONTROL 10%	10%	$42,659
SUB TOTAL		$473,509
NIGHT TIME CONSTRUCTION	50%	$236,755
SUB TOTAL		$710,264
MOBILIZATION	10%	$71,026
SUB TOTAL		$781,291
CONTIGENCIES @	20%	$156,258
TOTAL		$937,549
COST PER UNIT LENGTH OF PILE		$558
FOR BUDGET PRUPOSES - SAY		$940,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 9 (PRIORITY 4)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	160 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	760	$100.00	$76,000
2	CIDH Concrete	CY	195	$200.00	$39,008
3	Furnish Structural Steel	LB	51981	$1.00	$51,981
4	Erect Structural Steel	LB	51981	$0.50	$25,990
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA	19	$2,600.00	$49,400
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$242,379
SWPP/SWMP LS at 1%	1%	$2,424
TRAFFIC CONTROL 10%	10%	$24,238
SUB TOTAL		$269,041
NIGHT TIME CONSTRUCTION	50%	$134,520
SUB TOTAL		$403,561
MOBILIZATION	10%	$40,356
SUB TOTAL		$443,917
CONTIGENCIES @	20%	$88,783
TOTAL		$532,700
COST PER UNIT LENGTH OF PILE		$701
FOR BUDGET PRUPOSES - SAY		$535,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 9 (PRIORITY 4)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	160 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	224	$800.00	$179,200
2	Shotcrete Facing with Architectural Finish	SF	9350	$20.00	$187,000
3	Cut Off Wall	LF	170	$240.00	$40,800
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$407,000
SWPP/SWMP LS at 1%	1%	$4,070
TRAFFIC CONTROL 10%	10%	$40,700
SUB TOTAL		$451,770
NIGHT TIME CONSTRUCTION	50%	$225,885
SUB TOTAL		$677,655
MOBILIZATION	10%	$67,766
SUB TOTAL		$745,421
CONTINGENCIES @	20%	$149,084
TOTAL		$894,505
FOR BUDGET PURPOSES - SAY		$895,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 8 (PRIORITY 5)		BR NO			REC'D BY	
TYPE	**SOLDIER PILE**		DIST 11	CO	SD	RTE	
LENGTH	155 '						

DESIGN SECTION		QUANTIES BY		DATE	ESTIMATE NO.
PROJECT INCLUDES		QUANT. CHECKED BY		DATE	PRICE BY
AND $	RAILWORK	CHG UNIT AND EA			COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	960	$100.00	$96,000
2	CIDH Concrete	CY	243	$200.00	$48,567
3	Furnish Structural Steel	LB	112373	$1.00	$112,373
4	Erect Structural Steel	LB	112373	$0.50	$56,187
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$313,127
SWPP/SWMP LS at 1%	1%	$3,131
TRAFFIC CONTROL 10%	10%	$31,313
SUB TOTAL		$347,571
NIGHT TIME CONSTRUCTION	50%	$173,785
SUB TOTAL		$521,356
MOBILIZATION	10%	$52,136
SUB TOTAL		$573,492
CONTIGENCIES @	20%	$114,698
TOTAL		$688,190
COST PER UNIT LENGTH OF PILE		$717
FOR BUDGET PRUPOSES - SAY		$690,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 8 (PRIORITY 5)	BR NO		REC'D BY	
TYPE	**SOIL CEMENT BUTTRESS**	DIST 11	CO SD	RTE	
LENGTH	155 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Cement Buttress	CY	5167	$80.00	$413,333
2	Temporary Shoring	LF	155	$520.00	$80,600
3	Revegetation/Drainage	SF	6975	$10.00	$69,750
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$563,683
SWPP/SWMP LS at 1%	1%	$5,637
TRAFFIC CONTROL 10%	10%	$56,368
SUB TOTAL		$625,689
NIGHT TIME CONSTRUCTION	50%	$312,844
SUB TOTAL		$938,533
MOBILIZATION	10%	$93,853
SUB TOTAL		$1,032,386
CONTINGENCIES @	20%	$206,477
TOTAL		$1,238,863
FOR BUDGET PURPOSES - SAY		$1,240,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 3 (PRIORITY 6)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	198 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	880	$100.00	$88,000
2	CIDH Concrete	CY	226	$200.00	$45,167
3	Furnish Structural Steel	LB	60188	$1.00	$60,188
4	Erect Structural Steel	LB	60188	$0.50	$30,094
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$223,449
SWPP/SWMP LS at 1%	1%	$2,234
TRAFFIC CONTROL 10%	10%	$22,345
SUB TOTAL		$248,029
NIGHT TIME CONSTRUCTION	50%	$124,014
SUB TOTAL		$372,043
MOBILIZATION	10%	$37,204
SUB TOTAL		$409,247
CONTIGENCIES @	20%	$81,849
TOTAL		$491,097
COST PER UNIT LENGTH OF PILE		$558
FOR BUDGET PRUPOSES - SAY		$495,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 3 (PRIORITY 6)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	198 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	272	$800.00	$217,582
2	Shotcrete Facing with Architectural Finish	SF	12500	$20.00	$250,000
3	Cut Off Wall	LF	208	$240.00	$49,920
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$517,502
SWPP/SWMP LS at 1%	1%	$5,175
TRAFFIC CONTROL 10%	10%	$51,750
SUB TOTAL		$574,428
NIGHT TIME CONSTRUCTION	50%	$287,214
SUB TOTAL		$861,642
MOBILIZATION	10%	$86,164
SUB TOTAL		$947,806
CONTINGENCIES @	20%	$189,561
TOTAL		$1,137,367
FOR BUDGET PURPOSES - SAY		$1,140,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 5 (PRIORITY 6)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	80 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	400	$100.00	$40,000
2	CIDH Concrete	CY	103	$200.00	$20,530
3	Furnish Structural Steel	LB	27358	$1.00	$27,358
4	Erect Structural Steel	LB	27358	$0.50	$13,679
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$101,568
SWPP/SWMP LS at 1%	1%	$1,016
TRAFFIC CONTROL 10%	10%	$10,157
SUB TOTAL		$112,740
NIGHT TIME CONSTRUCTION	50%	$56,370
SUB TOTAL		$169,111
MOBILIZATION	10%	$16,911
SUB TOTAL		$186,022
CONTIGENCIES @	20%	$37,204
TOTAL		$223,226
COST PER UNIT LENGTH OF PILE		$558
FOR BUDGET PRUPOSES - SAY		$225,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 5 (PRIORITY 6)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	80 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	112	$800.00	$89,720
2	Shotcrete Facing with Architectural Finish	SF	5000	$20.00	$100,000
3	Cut Off Wall	LF	90	$240.00	$21,600
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$211,320
SWPP/SWMP LS at 1%	1%	$2,113
TRAFFIC CONTROL 10%	10%	$21,132
SUB TOTAL		$234,565
NIGHT TIME CONSTRUCTION	50%	$117,282
SUB TOTAL		$351,847
MOBILIZATION	10%	$35,185
SUB TOTAL		$387,032
CONTINGENCIES @	20%	$77,406
TOTAL		$464,438
FOR BUDGET PURPOSES - SAY		$465,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 6S (PRIORITY 7)	BR NO		REC'D BY	
TYPE	**SOLDIER PILE**	DIST 11	CO SD	RTE	
LENGTH	420 '				

DESIGN SECTION	QUANTIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CIDH Drilled Shafts 36 inch diameter	LF	1880	$100.00	$188,000
2	CIDH Concrete	CY	482	$200.00	$96,493
3	Furnish Structural Steel	LB	128584	$1.00	$128,584
4	Erect Structural Steel	LB	128584	$0.50	$64,292
5					
6	Construct Tieback Anchor (50 kips)	EA		$2,200.00	
7	Construct Tieback Anchor (100 kips)	EA		$2,600.00	
8	Construct Tieback Anchor (150 kips)	EA		$3,400.00	
9	Construct Tieback Anchor (200 kips)	EA		$4,400.00	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$477,369
SWPP/SWMP LS at 1%	1%	$4,774
TRAFFIC CONTROL 10%	10%	$47,737
SUB TOTAL		$529,880
NIGHT TIME CONSTRUCTION	50%	$264,940
SUB TOTAL		$794,819
MOBILIZATION	10%	$79,482
SUB TOTAL		$874,301
CONTIGENCIES @	20%	$174,860
TOTAL		$1,049,162
COST PER UNIT LENGTH OF PILE		$558
FOR BUDGET PRUPOSES - SAY		$1,050,000

DEL MAR BLUFFS STABILIZATION PROJECT 3 - PRESERVING TRACKBED SUPPORT

General Plan Estimate 20 - yr condition

WALL	STABILIZATION AREA 6S (PRIORITY 7)	BR NO		REC'D BY	
TYPE	**SOIL NAIL WALL**	DIST 11	CO SD	RTE	
LENGTH	420 '				

DESIGN SECTION	QUANTITIES BY	DATE	ESTIMATE NO.
PROJECT INCLUDES	QUANT. CHECKED BY	DATE	PRICE BY
AND $ RAILWORK	CHG UNIT AND EA		COST INDEX

NO.	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	Construct Soil Nail	EA	710	$800.00	$568,010
2	Shotcrete Facing with Architectural Finish	SF	34500	$20.00	$690,000
3	Cut Off Wall	LF	430	$240.00	$103,200
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

SUB TOTAL		$1,361,210
SWPP/SWMP LS at 1%	1%	$13,612
TRAFFIC CONTROL 10%	10%	$136,121
SUB TOTAL		$1,510,944
NIGHT TIME CONSTRUCTION	50%	$755,472
SUB TOTAL		$2,266,415
MOBILIZATION	10%	$226,642
SUB TOTAL		$2,493,057
CONTINGENCIES @	20%	$498,611
TOTAL		$2,991,668
FOR BUDGET PURPOSES - SAY		$2,995,000

Appendix D

Preliminary Design Criteria for Soldier Pile Wall Analysis

Appendix D – Preliminary Design Criteria for Soldier Pile Wall Analysis

The following design criteria were developed for the preliminary design of the soldier pile wall analysis:

A soldier pile wall at the bluff top provides trackbed support by retaining the earth behind the wall to prevent both local and global slope failures. For the Del Mar Bluffs Stabilization Project 2, the wall would be placed 11 to 15 feet seaward of the track centerline with a top of wall elevation about 1 foot below the top of tie elevation. Generally, this results in a wall that is initially buried; however, due to the natural bluff retreat the wall could become exposed over time.

As noted in the Del Mar Bluffs Geotechnical Study – Part 1, Geotechnical Evaluation (Leighton, 2001), the average bluff retreat rate in the study area is projected to be 10 feet over the project's minimum 20-year design life. For design, the bluff face has been projected 10 feet inland to represent the future conditions. With the addition of a soldier pile system at the bluff top, this would result in a flattening of the upper bluff slope in front of the wall with a resulting exposure of the wall face. Furthermore, based on knowledge of the bluff face behavior, a weathered and fractured zone roughly 10 feet in thickness has been assumed parallel to the retreated face. This zone does not provide significant passive resistance and therefore, is neglected for the soldier pile wall analysis. The wall design height is then taken as the distance from top of wall to a depth that satisfies a 10-foot horizontal distance to the back of the sloping fractured zone. The design height defines the point of application of active pressure (not the overall soldier pile length). The 10-foot horizontal offset to slope face assures full passive resistance below the design height. See Figure D-1.

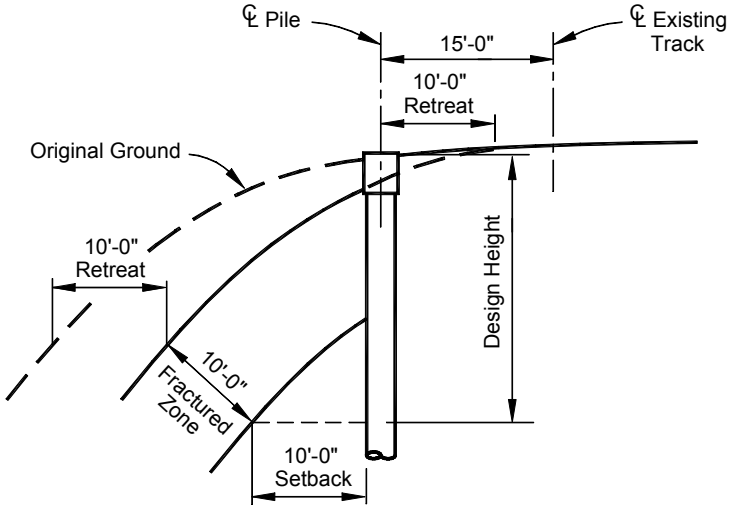


Figure D-1 - Determination of Soldier Pile Wall Design Height

The following table shows the design heights used for the type selection analysis. These heights were determined using the above mentioned criteria and the site specific geological conditions at each stabilization area. Note that the wall offset from the track may vary from 11 to 15 feet and would be determined in final design. This would have a

small effect on the design height used for final design but this would not significantly affect the preliminary design cost estimates.

Table D-1 - Soldier Pile Wall Design Heights

Implementation Ranking (IR)	Stabilization Area (SA)	End Station	Begin Station	Design Height
IR=1	SA-1	1539+40	1538+85	15’
IR=2	SA-2	1530+85	1528+80	10’
IR=3	SA-4	1514+55	1513+20	25’
IR=3	SA-7	1485+80	1484+80	8’
IR=4	SA-6N	1494+40	1490+00	8’
IR=4	SA-9	1481+00	1479+40	15’
IR=5	SA-8	1483+55	1482+00	10’
IR=6	SA-3	1518+55	1516+57	8’
IR=6	SA-5	1512+65	1511+00	8’
IR=7	SA-6S	1490+00	1485+80	8’

For soldier pile stability, an angle of internal friction (phi angle) of 36 degrees was used for all formational materials except Stabilization Areas 8. These areas in Anderson Canyon are largely comprised of fill material, and therefore a lower a phi angle of 32 degrees was used. Earth pressure coefficients were calculated assuming level ground surfaces, and stability calculations were performed using the fixed-earth theory as described in Caltrans Trenching and Shoring Manual (2001). Soil cohesion was neglected in the soldier pile wall local stability and structural analysis (as opposed to the global slope stability analysis) which is a reasonable standard of practice for the design of permanent wall systems with high phi angles (Caltrans, 2000).

The following load combinations were evaluated in accordance with the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Railway Engineering, 2004:

Group 1:	1.4*(Earth) + 2.33*(Live Load)	AREMA 8-2.2.4c
Group 1A:	1.8*(Earth) + 1.80*(Live Load)	AREMA 8-2.2.4c
Seismic:	1.0*(Earth) + 1.0*(Earthquake)	AREMA 9-1.4.6a

Static earth forces were determined using Coulomb’s equations for active and passive pressure for level backfill. Arching factors, based upon pile spacing and diameter, were applied to earth pressure coefficients below the effective ground line (Caltrans 1996, p. 10-4).

Live load forces were determined using Boussinesq’s equations for strip loading, where the strip load was calculated using Cooper E-80 loading centered 13 feet from the wall. Unrestrained wall conditions were assumed for cantilevered piles. Restrained wall conditions were assumed for anchored piles (walls with tieback anchors).

Earthquake accelerations were determined in accordance with AREMA seismic design methodology as described in Section 9 code and commentary, and summarized here

briefly. Using calculated importance factors, three limit state return periods were calculated to determine the magnitude of ground accelerations:

Limit State	Return Period	Acceleration, a
Serviceability	93 years	0.11g
Ultimate	320 years	0.22g
Survivability	2190 years	0.80g

For the serviceability limit state, all members must be designed to perform elastically, whereas for the survivability limit state, a displacement ductility analysis would be used to examine plastic structural behavior with criteria to prevent collapse.

Using the above ground accelerations, the Mononobe-Okabe method (AASHTO, 2003; USACE, 1989) was utilized to determine pseudo-static (seismic + static earth) loads on the walls as recommended by Caltrans Bridge Design Specifications, 2000, Chapter 5, "Retaining Walls." (AREMA does not specifically address seismic loading on retaining walls). Horizontal pressure coefficients were taken as one-third of the peak ground acceleration for cantilevered walls (unrestrained) and one-half of the peak ground acceleration for anchored walls (restrained).

A 36 inch diameter soldier pile was selected for this preliminary analysis. Preliminary cost estimates were compared for cantilever and anchored walls at varying heights. Anchored walls were generally less expensive than the deeper cantilever walls, however the shorter length did not provide adequate depth to address the global stability. The general pile spacing was set to provide a minimum separation of 3 X the diameter or 9 feet minimum between the 36 inch diameter piles. Spacing of 10 feet was used in areas that required greater spacing to avoid conflict with existing facilities.

W24-or W27 series Grade 50 steel beams were selected to reinforce the 36-inch soldier piles. Cost comparisons favor the use of steel beams over bar reinforcement cages. A decrease in pile section modulus to account for time-dependent corrosion was not taken into account due to the limited project service life, the limited actual exposure of the pile during the project service life, and the factors of safety already included in the pile design.

Table D-2 summarizes the maximum design height for each type of soldier pile and the range at which the soldier pile wall type is the best value. Exceptions to this criteria would be considered where design heights fluctuate within a given stabilization area and where a different pile size or type might be utilized for consistency or constructability.

Table D-2 - Soldier Pile Wall Types, Maximum Design Height and Best Value Range			
(Formational Material: phi = 36°)			
Soldier Pile Wall Type	Maximum Design Height	Pile Length	Steel Section
36" Cantilever (9'-0" o.c.)	8'	40'	W24x68
36" Cantilever (9'-0" o.c.)	10'	50'	W24x84
36" Anchored (9"-0" o.c.)	15'	40'	W24x68
36" Anchored (10'-0" o.c.)	25'	65'	W27x194
(Fill Material : phi = 32°)			
36" Cantilever (10'-0" o.c.)	10'	60'	W24x117

The factor of safety applied to the calculated tip embedment was selected as 1.5 for the cantilevered walls and 1.5 for the anchored walls. This should not be considered as an overturning factor of safety, which is more applicable to gravity and semi-gravity walls. Standard practice dictates that the pile embedment may be increased by 20% to 40% depending on ground conditions, event probabilities, and engineering judgment (Caltrans, 1996). Because the fixed earth theory of anchored wall design naturally results in deeper tip elevations than free earth theories, a lower-bound embedment factor was selected for the anchored walls (USACE, 1994).

The global stability of the soldier pile walls was verified using the computer program Slope/W (Geo-Slope, 2002). The design was based on a minimum factor of safety of 1.5 for static loads with surcharge and 1.0 for pseudo-static loads (k_h = 0.28). In many cases the soldier pile length was governed by the global stability calculations. These conditions are discussed in Section 3.3.

Initially, the piles and or grade beams would be buried. In the long-term, the tops of the bluffs would likely erode to the point that the soldier piles would be visible. As this occurs, lagging should be installed between the piles to retain the soil. The lagging may be constructed with treated timber (similar to some of the existing seawalls), precast concrete planks or shotcrete. If the visual impacts are determined to be significant, the precast concrete planks and shotcrete options may include architectural treatment such as colored concrete, stained concrete, form liners or textured "rock-scaping" shotcrete. Typical details for the lagging options are shown in Figure D-2.

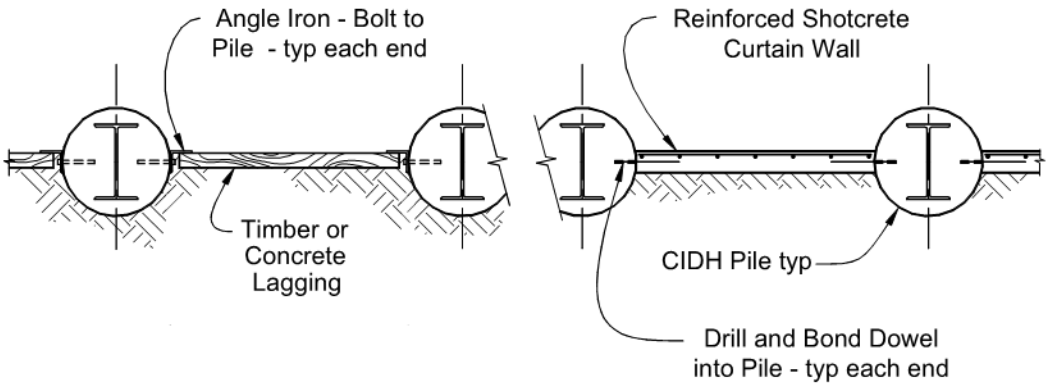


Figure D-2 - Typical Soldier Pile Facing