



THURBER ENGINEERING LTD.

MEMORANDUM

To: Rob Kleine, P.Eng.
Andrew Hachborn, P.Eng.
WSP

Date: March 11, 2019

From: Keli Shi, P.Eng.
(Reviewed by P.K. Chatterji, P.Eng.)

File: 22459

RIVER BANK STABILITY ASSESSMENT BLANCHE RIVER BRIDGE REPLACEMENT (SITE 47-038)

1. INTRODUCTION

This memo presents a summary of a global stability analysis for the Blanche River valley slopes during bridge construction. It is understood that the results of this analysis will only be used to assess feasibility of use of heavy lift cranes in erecting new bridge girders and demolishing the existing bridge.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. BACKGROUND INFORMATION

The subsurface conditions used in the analysis were based on Thurber's Foundation Investigation Report for Blanche River Bridge Replacement, Highway 569, New Liskeard District, Ontario (Geocres 31M-120).

Highway profiles for the new and existing bridges, embankment cross-sections behind the new and existing abutments and the potential crane loading were supplied to Thurber by WSP.

3. LOADING SCENARIOS AND ASSUMPTIONS

Four loading scenarios were analyzed, respectively, for a pile driving crane, a wick drain installation rig, a girder lifting crane and a demolition crane. The following assumptions were made when estimating ground pressures for different cranes:

- A 100-ton Kobelco crawler crane CK1000-III equipped with Berminghammer B-4505 to drive H-piles at the abutments and piers.
- A single Manitowoc 18000 crawler crane was envisaged for lifting new girders.



- Two Manitowoc 2250 crawler cranes, one sitting behind each of the existing abutment, were proposed to demolish the existing bridge.
- A 90-ton wick drain installation rig to install 40 to 45 long wick drains on benched slope.
- Uniform ground pressure distribution was assumed at crane pad/ground contact.
- All crane pads are assumed to be rigid and capable of distributing uniform ground pressure over the pad area.

The contractor may opt to use different types of cranes for pile driving and/or girder lifting. The actual ground contact pressures must be assessed by the contractor's geotechnical consultant based on a review of the crane types and lifting plan. The actual ground pressures during crane lifting will deviate from a uniform distribution which typically results in load eccentricity on the crane pad. The contractor's geotechnical consultant must base river valley slope stability analysis on their own assessment of the loading of the cranes used by the contractor. It should be noted that river valley slope instability is present along this stretch of the river and accordingly the impact of crane loading on the river bank stability must be assessed by the contractor.

4. RESULTS OF ANALYSIS

Global stability analyses were carried out for valley slopes and side slopes behind the south and north abutments using limit equilibrium program Slope/w in conjunction with Morgenstern-Price method. The minimum pad dimensions and setback distance behind abutments were investigated using an iterative approach in order to achieve an acceptable factor of safety of 1.3 for short term loading conditions. The results of the analysis are summarized in a table included in Appendix A. A discussion of the results is provided in the following sections.

4.1. Pile Driving Crane

Based on a discussion with a local piling contractor, a fully-dressed Kobelco CK1000-III Crawler Crane equipped with a Berminghammer B-4505 will apply an approximate vertical load of 900 kN shared by both tracks during pile driving. With a reach distance of 8 to 10 m, pile driving at the pier locations is considered more critical than at the abutment locations. The results of the analysis, as shown in Figures 1 to 5, indicate that a minimum 8 m by 8 m size crane pad will distribute the crane load to approximately 15 kPa to meet the target factor of safety at the both piers.

At the south valley slope, due to the proposed Pier 1 location, the crane will need to increase its reach distance to 18 m from axis of rotation in order to drive the sheet piles farthest from the shore while staying above the normal river level (Figure 3). A crane sitting at the normal river level will not meet the minimum factor of safety (Figure 2). In both cases, a 4 m deep cut into the valley slope would be required to construct a horizontal bench for the crane pad.

At the north valley slope, a 2 m deep cut into the valley slope will allow the 8 m x 8 m crane pad to be placed close enough to the Pier 2 location for driving H-piles and sheet piles (Figure 5).

Driving piles from a barge for the piers will mitigate the bank stability issues.



4.2. Girder Lifting Crane

Based on the crane loading information provided by WSP, a 1,300-ton capacity Manitowoc 18000 Crawler Crane or equivalent is likely to be required to lift the new bridge girders and this crane will exert an approximate maximum vertical load of 13,000 kN shared on both tracks during girder lifting. Both valley slopes and side slopes were analyzed for the existing conditions and under the crane load.

The results of the analysis, as illustrated in Figures 6 to 11, indicate that a minimum 12 m x 12 m crane pad is required to reduce the ground pressure to about 90 kPa. To achieve a factor of safety of 1.3 for the valley slopes, a minimum setback distance of 4 m should be maintained behind the new abutments with a sub-excavation of 1 to 2 m below the existing ground surface or to approximate elevation 185 m within the crane pad footprint (Figure 6 and Figure 9). To maintain the side slope stability at the south approach, the crane pad must be placed a minimum 5 m away from the crest of the east slope after the widening embankments have been constructed to elevation 185 m (Figure 8). At the north approach, the crane pad placed immediately against the temporary roadway protection achieves a satisfactory minimum factor of safety (Figure 11).

4.3. Demolition Cranes

Based on the crane loading information provided by WSP, two Manitowoc 2250 Crawler Cranes, one at each of the south and north approaches, or equivalent is likely to be required to demolish the existing bridge and each of these cranes will exert an approximate maximum vertical load of 4,200 kN shared on both tracks during demolition. Both valley slopes and side slopes were analyzed for the existing conditions and under the crane load. Contribution of the existing foundation timber piles to the valley slope stability has been taken into consideration.

The results of the analysis, as illustrated in Figures 12 to 19, indicate that a minimum 8 m x 8 m crane pad is required to reduce the ground pressure to about 65 kPa. To achieve a factor of safety of 1.3 for the valley slopes, a minimum setback distance of 4 m should be maintained behind the existing abutments. In addition, it will require a 2 m sub-excavation at the south approach to elevation 184 m (Figure 13) and a 1.5 m sub-excavation at the north approach to approximate elevation 184.5 m (Figure 17) within the crane pad footprint. To maintain the side slope stability, the crane pad should be placed a minimum 5 m away from the centreline of the new alignment at the south approach (Figure 15). Due to the presence of ground slope west of the existing north abutment, the crane pad must be set back a minimum 2.5 m away from the west crest of the existing embankment after sub-excavating to elevation 184.5 m (Figure 19).

4.4. Wick Drain Installation Rig

In discussion with a specialty wick drain contractor, a 200,000 lb or 90-ton crawler crane will likely be required to install the 40 to 45 m long wick drains at the abutment locations. The rig can reach typically 3 to 4 m in front of the crawler tracks. The south abutment is considered more critical than the north abutment due to the existing 7 m high east side slopes. It is assumed that the valley slope in front of the new abutment will be excavated to approximately elevation 184 m or the final grade. The top of the existing east side slope will be excavated to approximately elevation 185 m prior to benching the slope.



The results of this analysis, as illustrated in Figures 20 to 22, indicate that a minimum crane pad measuring 5.5 m x 5.5 m in plan is required to reduce the ground pressure to about 30 kPa. A minimum setback distance of 7 m (Figure 20) should be maintained between the edge of crane pad and the crest of valley slope. To achieve a minimum factor of safety of 1.3, it is recommended that wick drain installation start from the lower benches as the rig sits at the bottom of the benched slope. After the wick installation at the lower benches has been completed, new fill should be placed over the wick drains at the lower benches to the extent of the final embankment (Figure 22) to a minimum elevation 181 m before the rig moves to the top of the benched slope at elevation 185 m to install wick drains on the upper benches. The pad should be placed a minimum 1 m back from the edge of the benched slope (Figures 21 and 22). An NSSP for “Wick Drain Installation” is included in Appendix B.

At the north approach, wick drains will be installed from the existing ground surface at approximate elevation 185 to 184 m, stability issue is not anticipated provided the wick drain installation rig operates to the east of the existing highway embankment.

5. DISCUSSIONS

It should be noted that the current slope stability assessment is preliminary in nature and should be only used by the design team for planning and feasibility purposes. The contractor must retain a geotechnical consultant to carry out an independent assessment of the river bank stability during pile driving, girder lifting and demolition operation, and provide the contractor with engineering recommendations that include but are not limited to depths of sub-excavation, allowable ground bearing pressures and safe setback distances behind the new/existing abutments.

An NSSP addressing “Geotechnical Assessment” is included in Appendix B.

Based on the results of the stability analyses, a pile driving crane with a minimum 18 m reach will be needed to install all foundation H-piles and cofferdam sheet piles at the Pier 1 from the valley slope. Alternatively, all H-piles and sheet piles may be driven from a barge. Driving pier piles from a barge will mitigate the bank stability issues.

Installation of wick drains at the south approach should start from the toe of slope. Embankment fill should be placed to improve global stability of the benched slope as soon as installation on the lower benches is complete and before the rig moves to the top of embankment for wick installation on the upper benches.

Large size crane pads in combination with sub-excavation will be required to distribute the crane loads under girder lifting crane and demolition cranes.

The setback distances behind the new abutments during girder lifting are determined solely based on the global stability of the valley slopes. Any adverse effects of the crane loading on the new abutment piles should be evaluated from a structural perspective.

Stockpiling of excavated soils, construction materials, and/or demolition debris from the existing bridge shall not be permitted anywhere on the river valley slopes. An NSSP addressing “Work on Valley Slopes” is included in Appendix B.



6. CLOSURE

The memorandum was prepared by Keli Shi, P.Eng. and reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Keli Shi, P.Eng.
Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.
Designated MTO Principal Contact

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

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5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

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7. INDEPENDENT JUDGEMENTS OF CLIENT

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Appendix A

Results of Stability Analysis

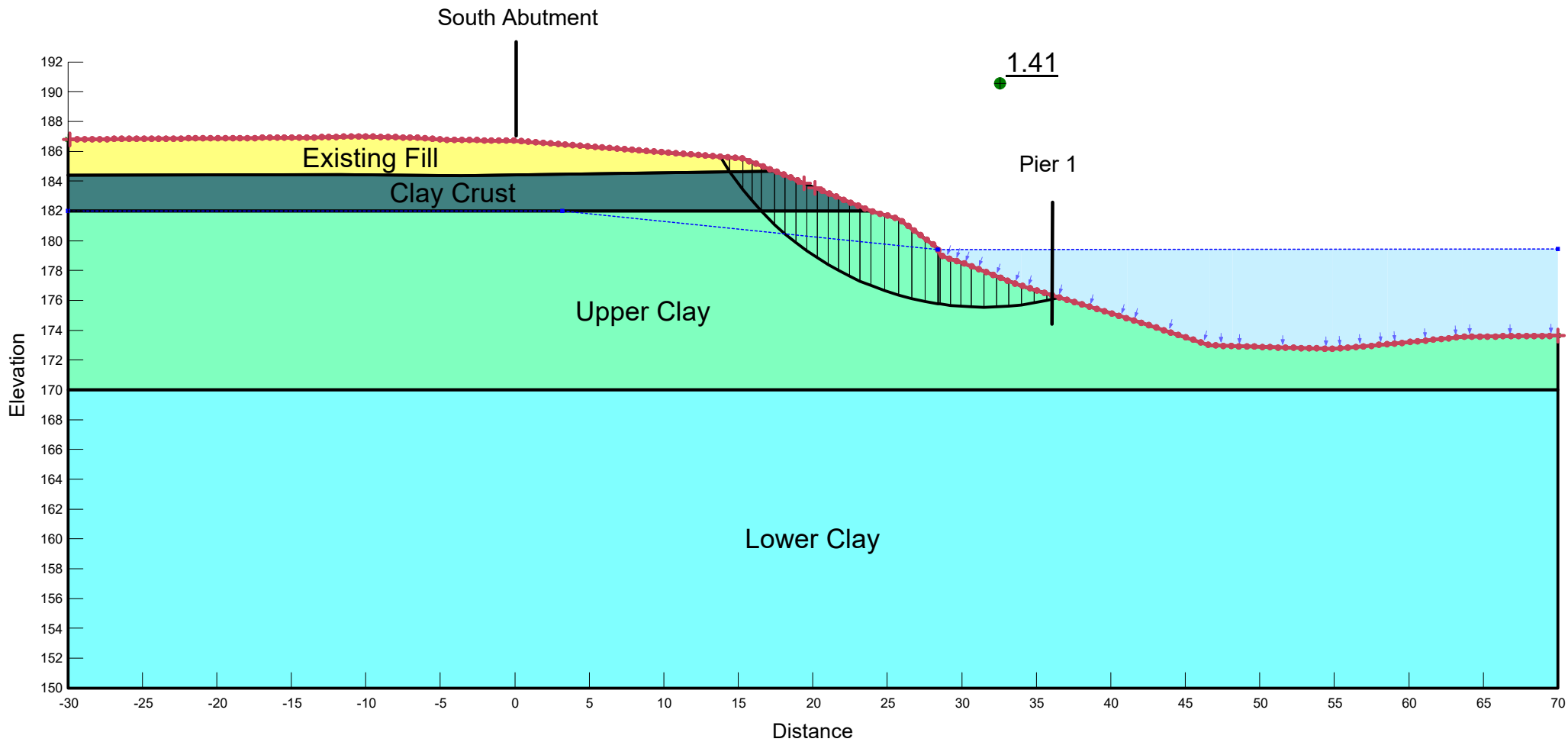
Highway 569 Blanche River Bridge Replacement
Summary of River Bank Stability Analyses

Structure	Location	Slope	Crane Loading	Ground Pressure	Crane Pad Size	Analysis Case	Figure No.	Factor of Safety
New Bridge	Pier 1	Valley Slope	-	-	-	Existing Condition	1	1.41
			Pile Driving	15 kPa	8 m x 8 m	6 m from Farthest Sheet pile (Crane at normal river level)	2	1.10
						14 m from Farthest Sheet pile (Crane 2 m above normal river level)	3	1.31
						-	-	-
			Pile Driving	15 kPa	8 m x 8 m	6 m from Farthest Sheet pile (Crane at normal river level)	5	1.34
	South Abutment	Valley Slope	Girder Lifting	90 kPa	12 m x 12 m	4 m Behind New South Abutment	6	1.45
		Side Slope	-	-	-	Proposed Approach Embankment	7	1.54
			Girder Lifting	90 kPa	12 m x 12 m	Crane Load at EL. 185 m	8	1.30
	South Approach	Valley Slope	Wick Drain Rig	30 kPa	5.5 m x 5.5 m	7 m behind crest of valley slope at EL. 184 m	20	1.40
		Side Slope	Wick Drain Rig	30 kPa	5.5 m x 5.5 m	1 m behind crest of benched slope at EL. 185 m	21	1.24
						1 m behind crest of benched slope at EL. 185 m Toe of slope placed with new fill to EL. 181 m	22	1.32
	North Abutment	Valley Slope	Girder Lifting	90 kPa	12 m x 12 m	4 m Behind New North Abutment	9	1.33
		Side Slope	-	-	-	Proposed Approach Embankment	10	2.28
			Girder Lifting	90 kPa	12 m x 12 m	Crane Load at EL. 185 m	11	1.76
Existing Bridge	South Abutment	Valley Slope	-	-	-	Existing Condition	12	1.48
			Demolition	65 kPa	8 m x 8 m	4 m Behind Existing South Abutment	13	1.30
		Side Slope	-	-	-	Existing Condition	14	1.31
			Demolition	65 kPa	8 m x 8 m	Crane Load at EL. 184 m Subexcavate to EL. 183.6 m below new bridge	15	1.45
	North Abutment	Valley Slope	-	-	-	Existing Condition	16	1.72
			Demolition	65 kPa	8 m x 8 m	4 m Behind Existing North Abutment	17	1.38
		Side Slope	-	-	-	Existing Condition	18	2.00
			Demolition	65 kPa	8 m x 8 m	Crane Load at EL. 184.5 m	19	1.30

BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 VALLEY SLOPE - EXISTING CONDITION
 PROFILE OF HWY 569 - NEW BRIDGE
 PILE DRIVING

FIGURE 1

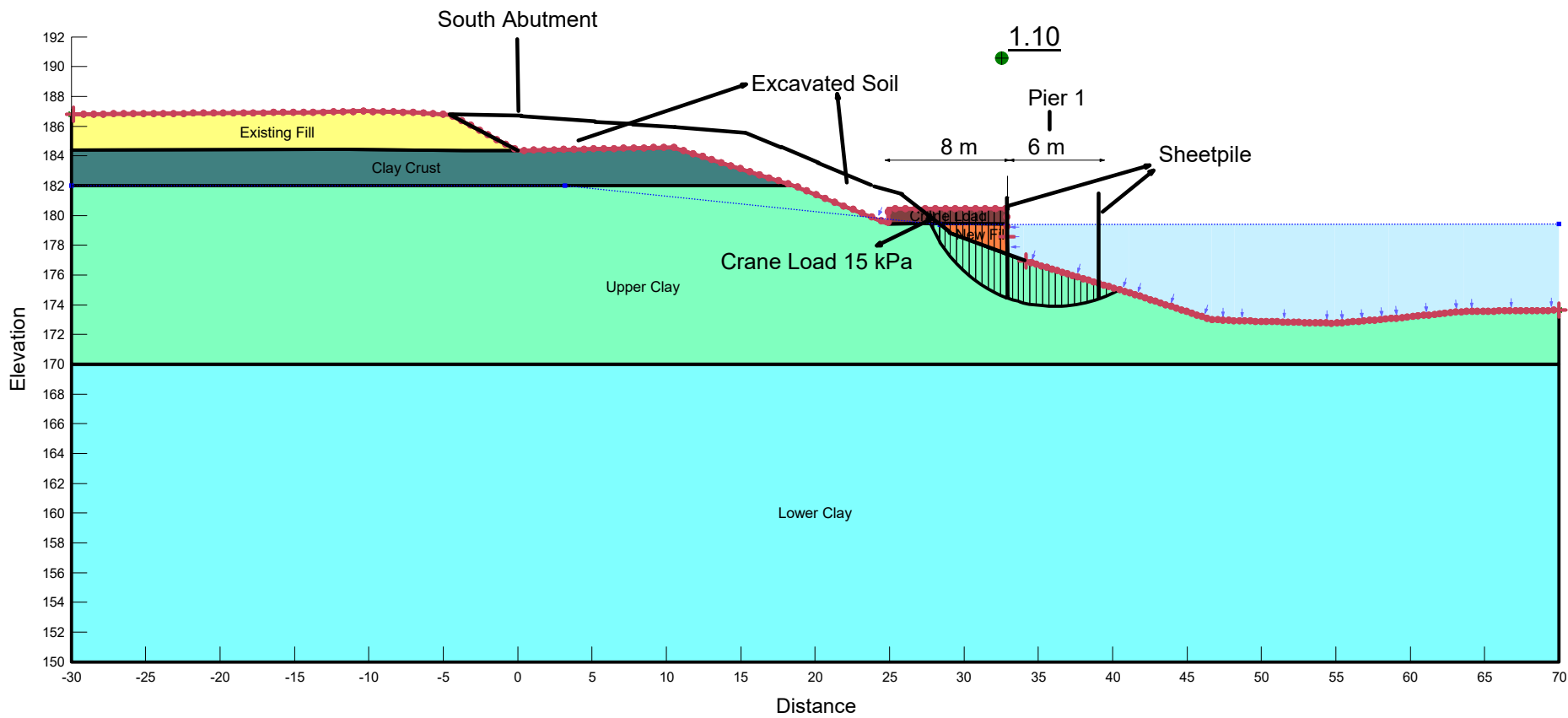
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Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °
Name: Lower Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °



BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 VALLEY SLOPE - SOUTH ABUTMENT
 PROFILE OF HWY 569
 PILE DRIVING

FIGURE 2

Name: New Fill	Model: Mohr-Coulomb	Unit Weight: 21 kN/m ³	Cohesion: 0 kPa	Phi: 35 °	Add Weight: Yes
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Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 0.5
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1
Name: Lower Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 15 kN/m ³	Cohesion: 1 kPa	Phi: 1 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 VALLEY SLOPE - SOUTH ABUTMENT
 PROFILE OF HWY 569
 PILE DRIVING

FIGURE 3

Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m³	Cohesion: 0 kPa	Phi: 32 °	
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 0.5
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1
Name: Lower Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 15 kN/m³	Cohesion: 1 kPa	Phi: 1 °	Add Weight: Yes

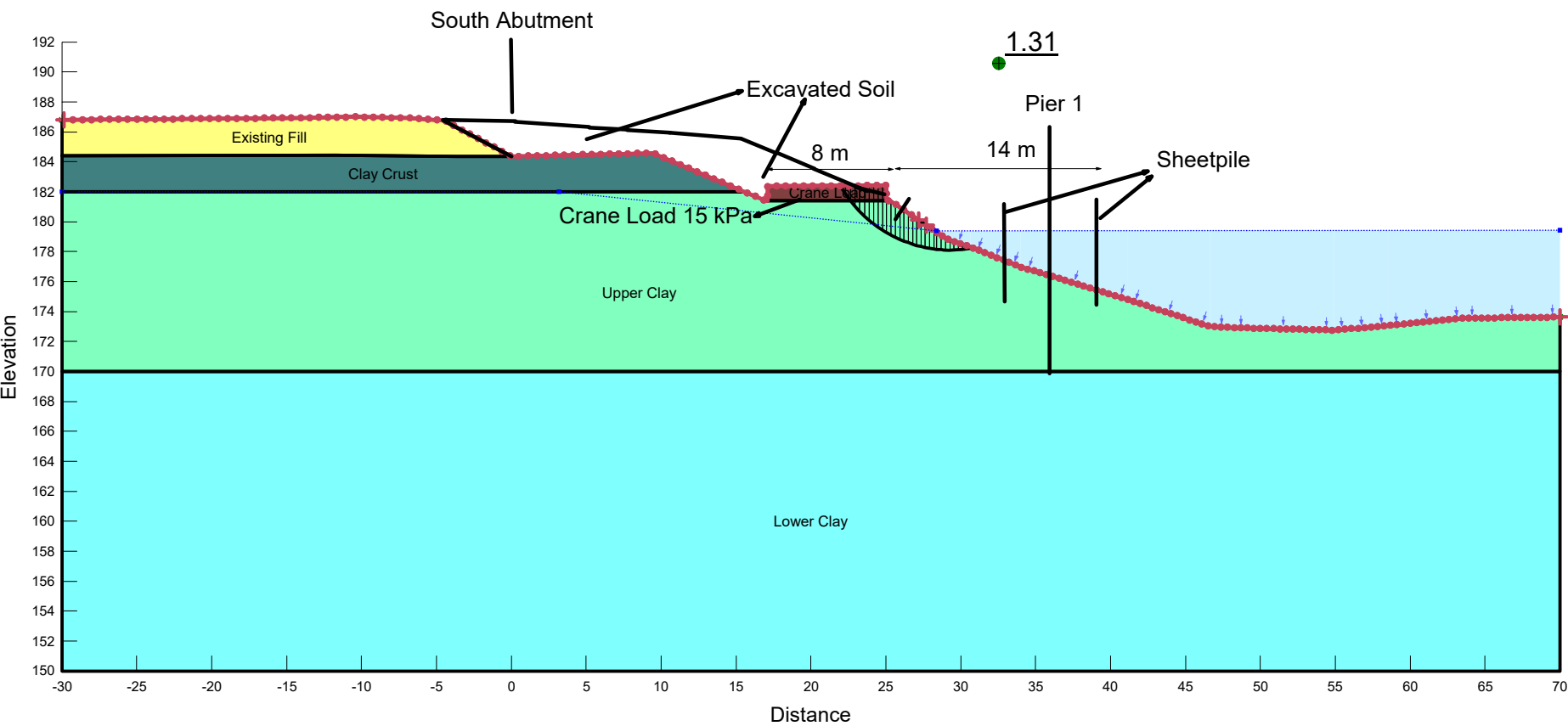
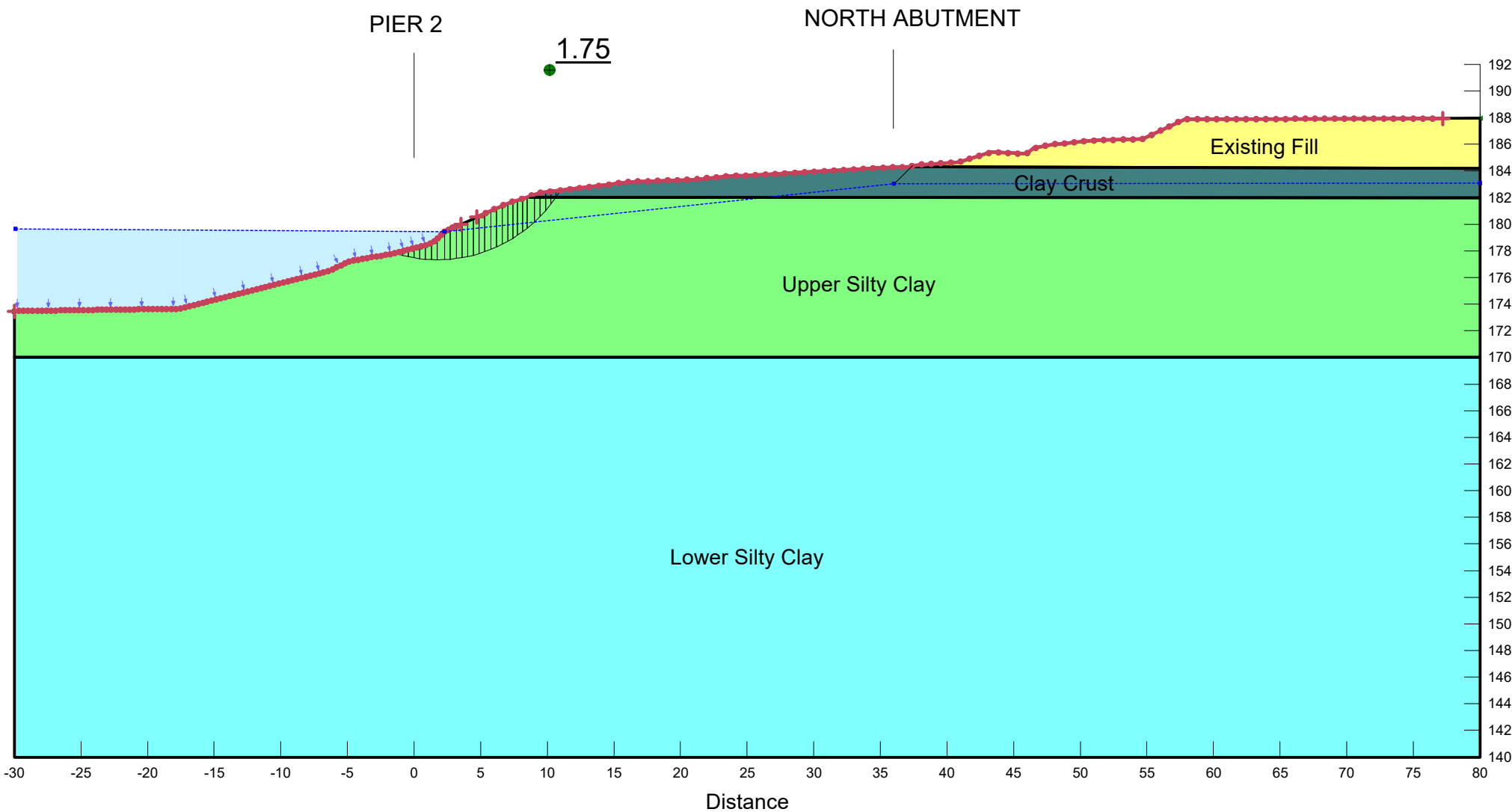


FIGURE 4

BLANCHE RIVER BRIDGE - EXISTING CONDITION
VALLEY SLOPE - NORTH ABUTMENT
PROFILE OF HWY 569 - NEW BRIDGE
PILE DRIVING

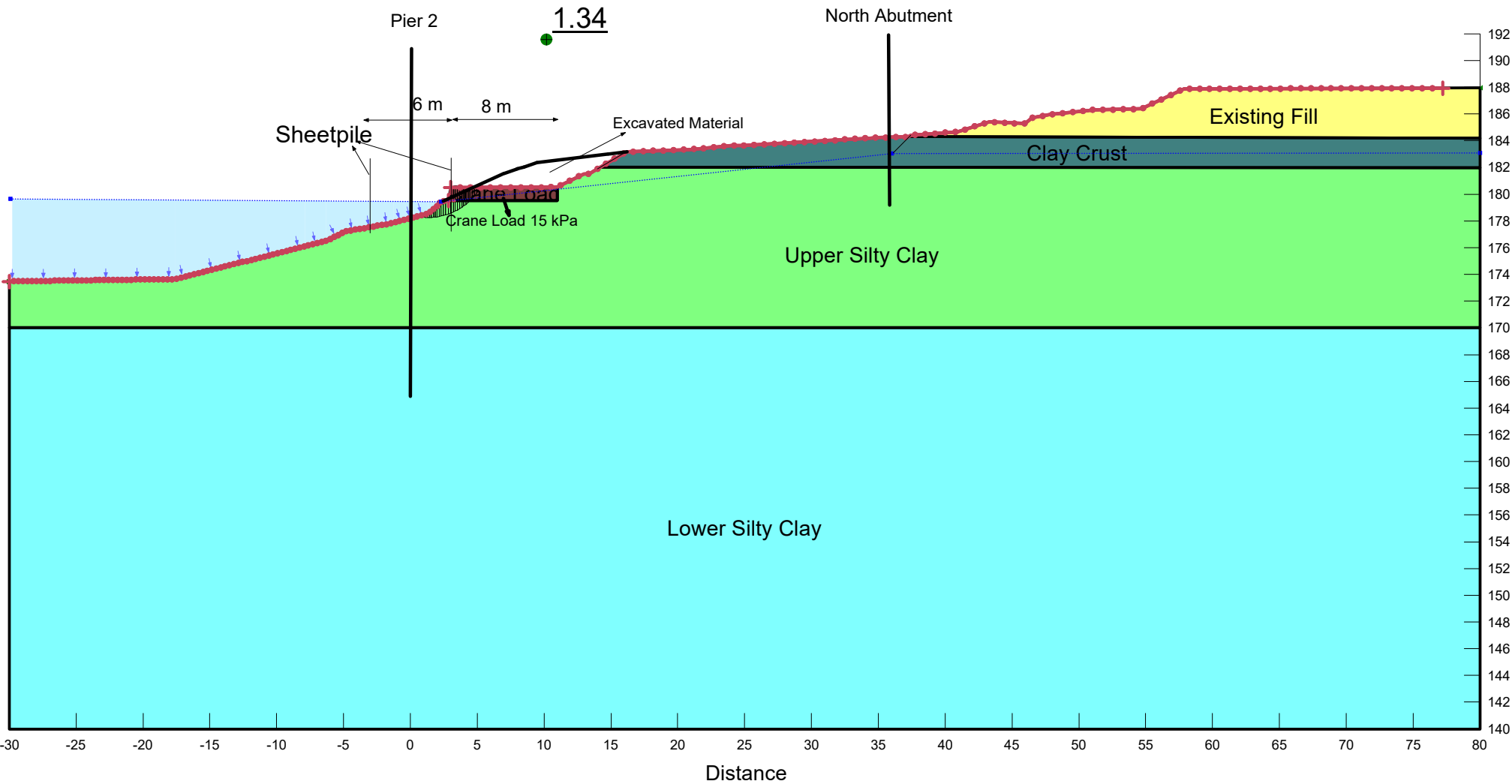
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Name: Lower Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °
Name: Clay Crust Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °



BLANCHE RIVER BRIDGE
 VALLEY SLOPE - NORTH ABUTMENT
 PROFILE OF HWY 569
 PILE DRIVING CRANE

FIGURE 5

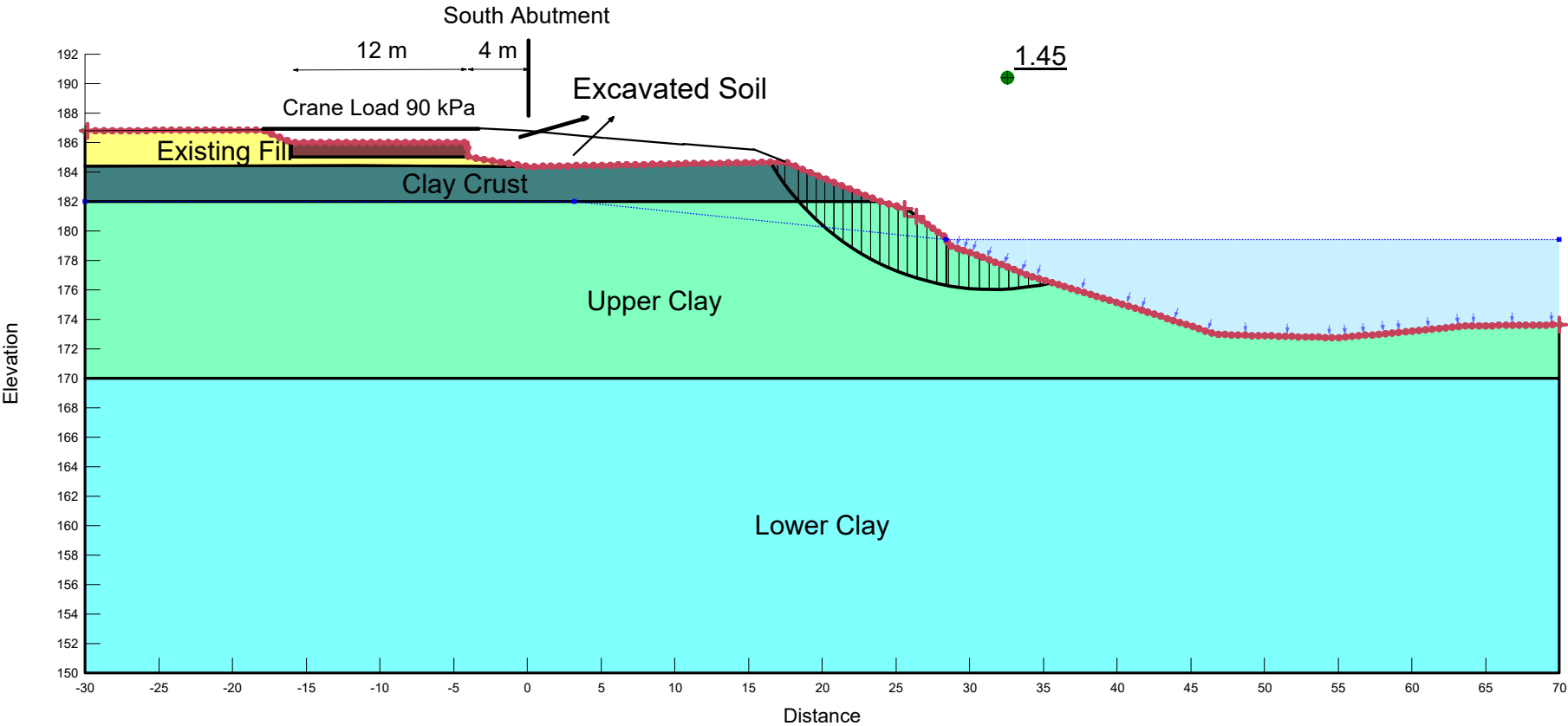
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 Name: Clay Crust Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 ° B-bar: 0.5 Add Weight: No
 Name: Crane Load Model: Mohr-Coulomb Unit Weight: 15 kN/m³ Cohesion: 1 kPa Phi: 1 ° Add Weight: Yes



BLANCHE RIVER BRIDGE
 VALLEY SLOPE - SOUTH ABUTMENT
 PROFILE OF HWY 569
 GIRDER LIFTING

FIGURE 6

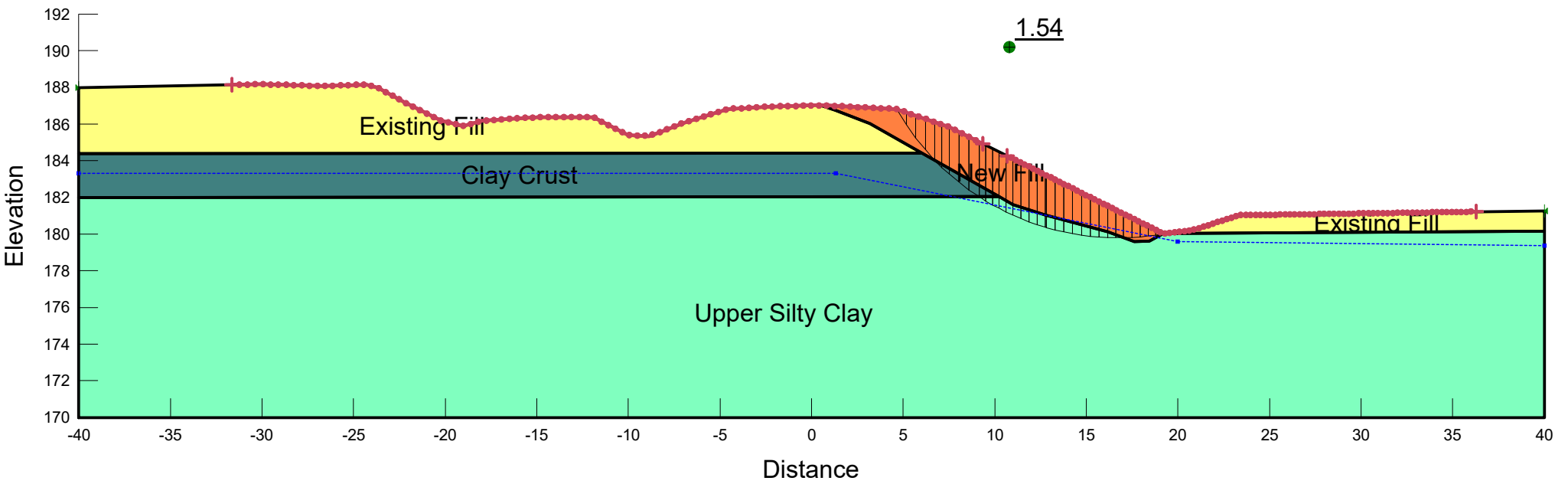
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Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1 Add Weight: No
Name: Lower Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 90 kN/m ³	Cohesion: 1 kPa	Phi: 1 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 SIDE SLOPE - SOUTH ABUTMENT
 EXISTING CONDITION WITH NEW FILL

FIGURE 7

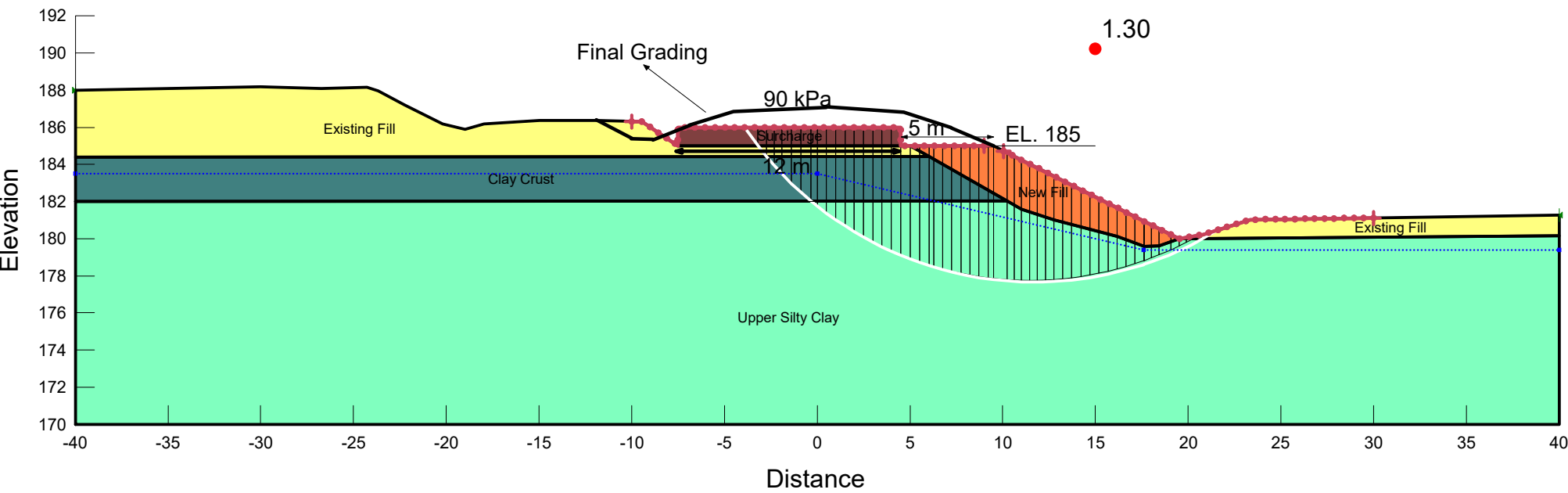
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 Name: Clay Crust Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °
 Name: Upper Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °



BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 SIDE SLOPE - SOUTH ABUTMENT
 GIRDER LIFTING CRANE

FIGURE 8

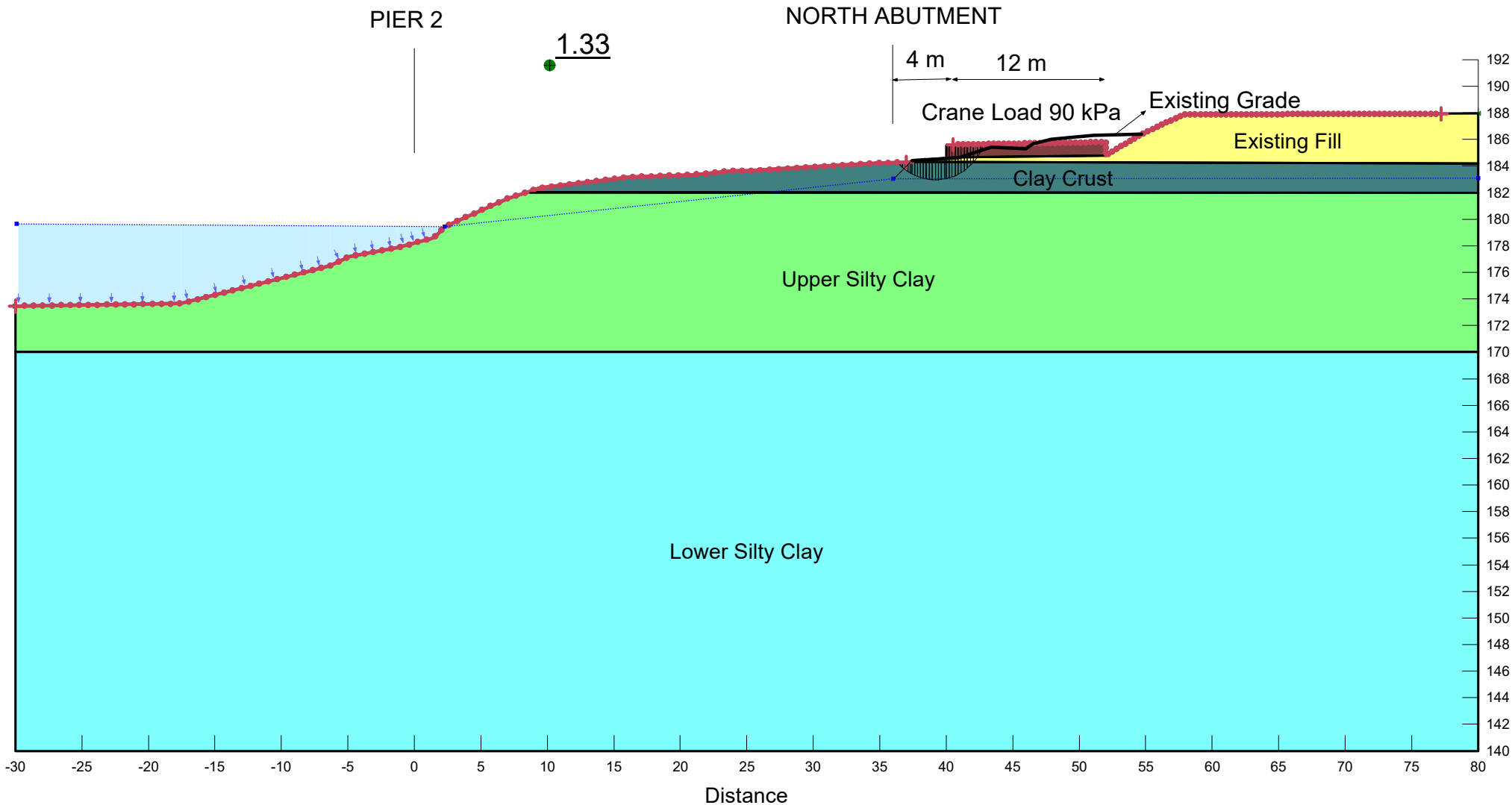
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 Name: Upper Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion': 5 kPa Phi': 28 ° B-bar: 1 Add Weight: No
 Name: Surcharge Model: Mohr-Coulomb Unit Weight: 90 kN/m³ Cohesion': 1 kPa Phi': 1 ° Add Weight: Yes



BLANCHE RIVER BRIDGE - NORTH ABUTMENT
 VALLEY SLOPE - EXISTING CONDITION
 PROFILE OF HWY 569 - NEW BRIDGE
 GIRDER LIFTING CRANE

FIGURE 9

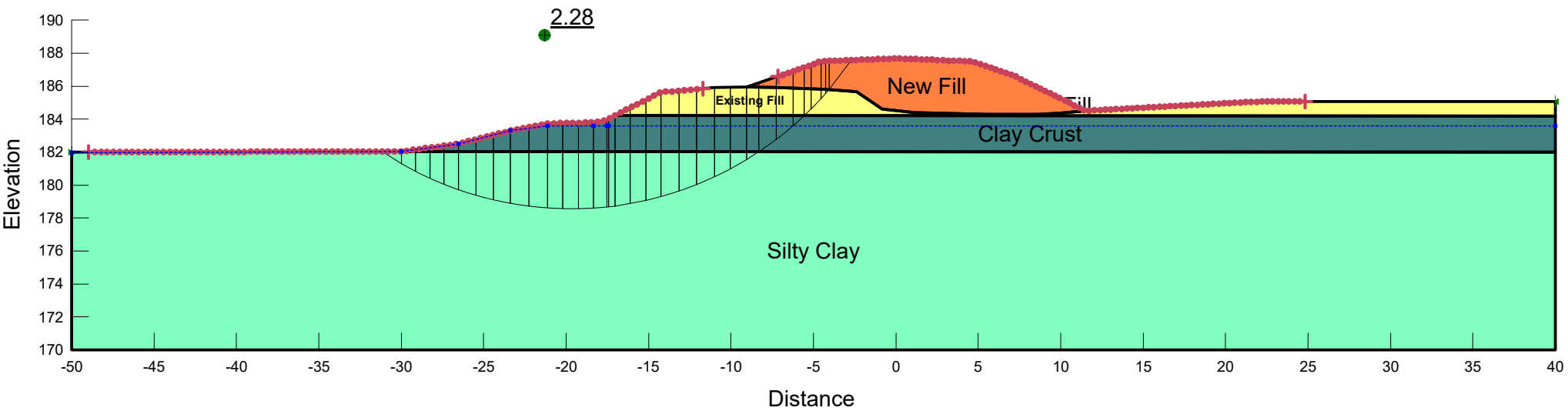
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m³	Cohesion: 0 kPa	Phi: 32 °	Add Weight: No
Name: Upper Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1 Add Weight: No
Name: Lower Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1 Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 0.5 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 90 kN/m³	Cohesion: 1 kPa	Phi: 1 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - NORTH ABUTMENT
 SIDE SLOPE - STATION 17+090
 EXISTING CONDITION WITH NEW FILL

FIGURE 10

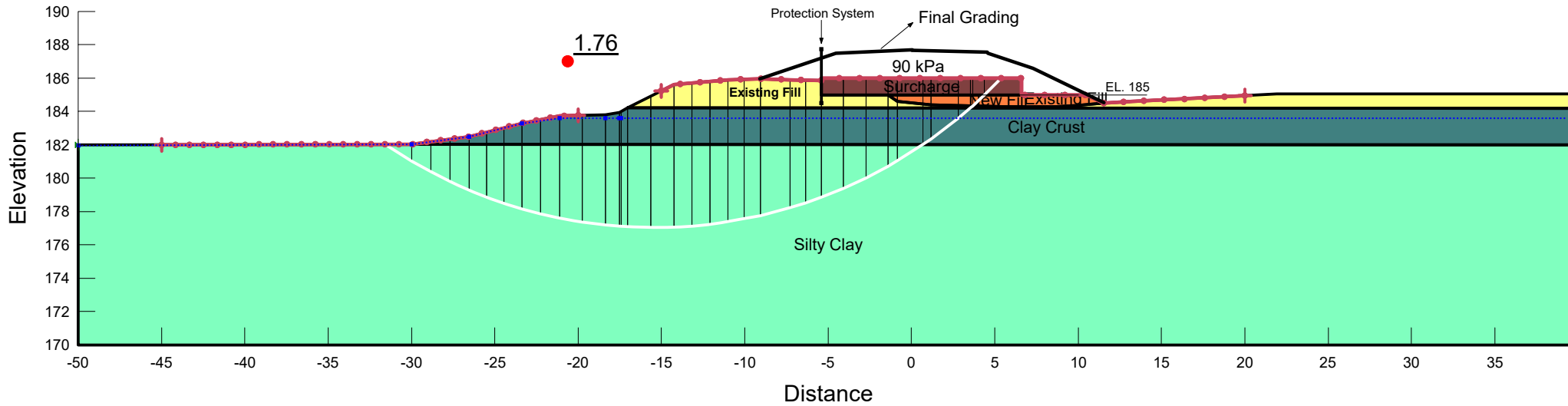
Name: New Fill Model: Mohr-Coulomb Unit Weight: 21 kN/m³ Cohesion: 0 kPa Phi: 35 °
 Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 0 kPa Phi: 32 °
 Name: Clay Crust Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °
 Name: Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °



BLANCHE RIVER BRIDGE - NORTH ABUTMENT
 SIDE SLOPE - STATION 17+090
 GIRDER LIFTING CRANE

FIGURE 11

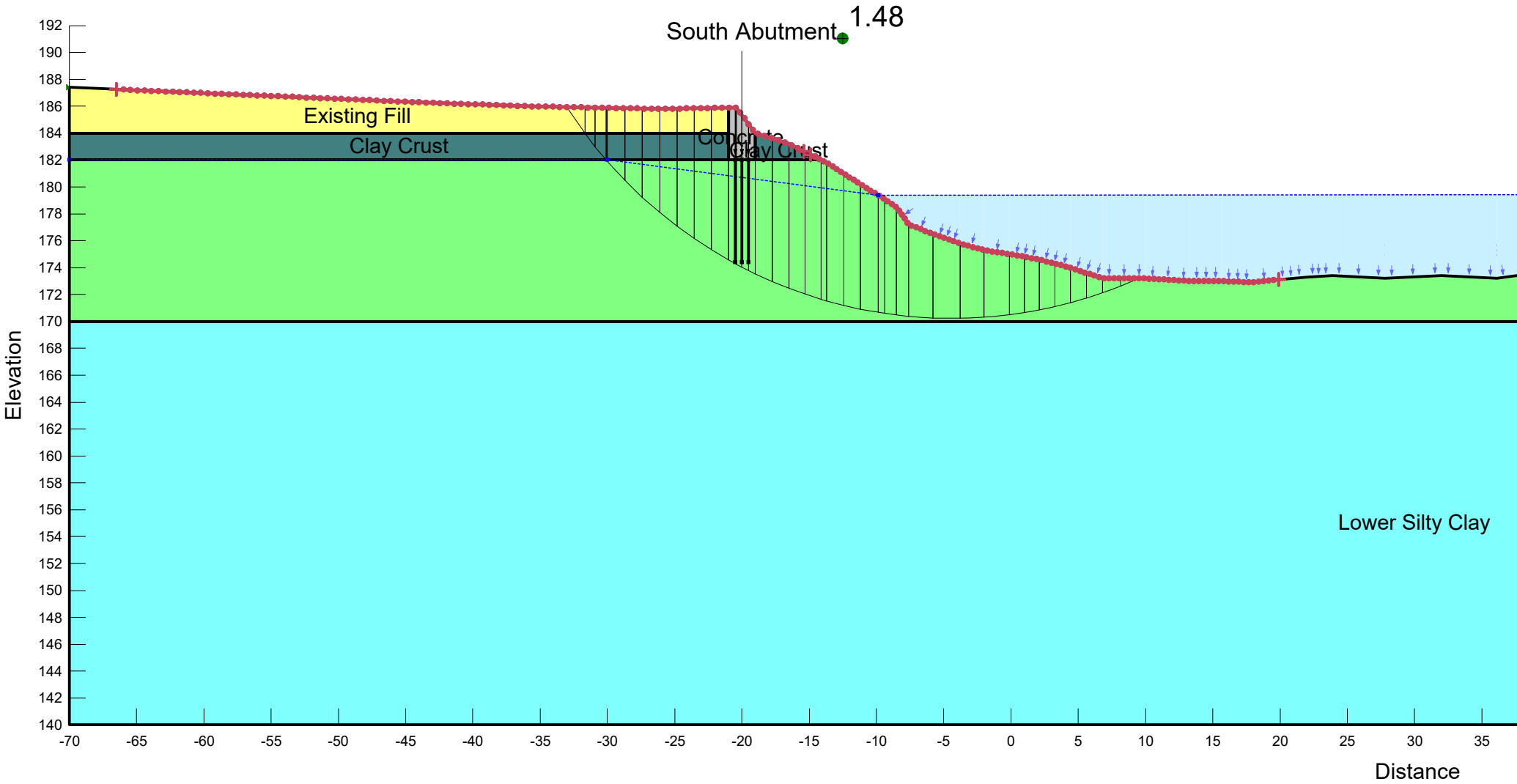
Name: New Fill	Model: Mohr-Coulomb	Unit Weight: 21 kN/m ³	Cohesion': 0 kPa	Phi': 35 °	Add Weight: No
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Surcharge	Model: Mohr-Coulomb	Unit Weight: 90 kN/m ³	Cohesion': 1 kPa	Phi': 0 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 VALLEY SLOPE - SOUTH ABUTMENT
 PROFILE ALONG EXISTING HWY 569 ALIGNMENT
 EXISTING CONDITION

FIGURE 12

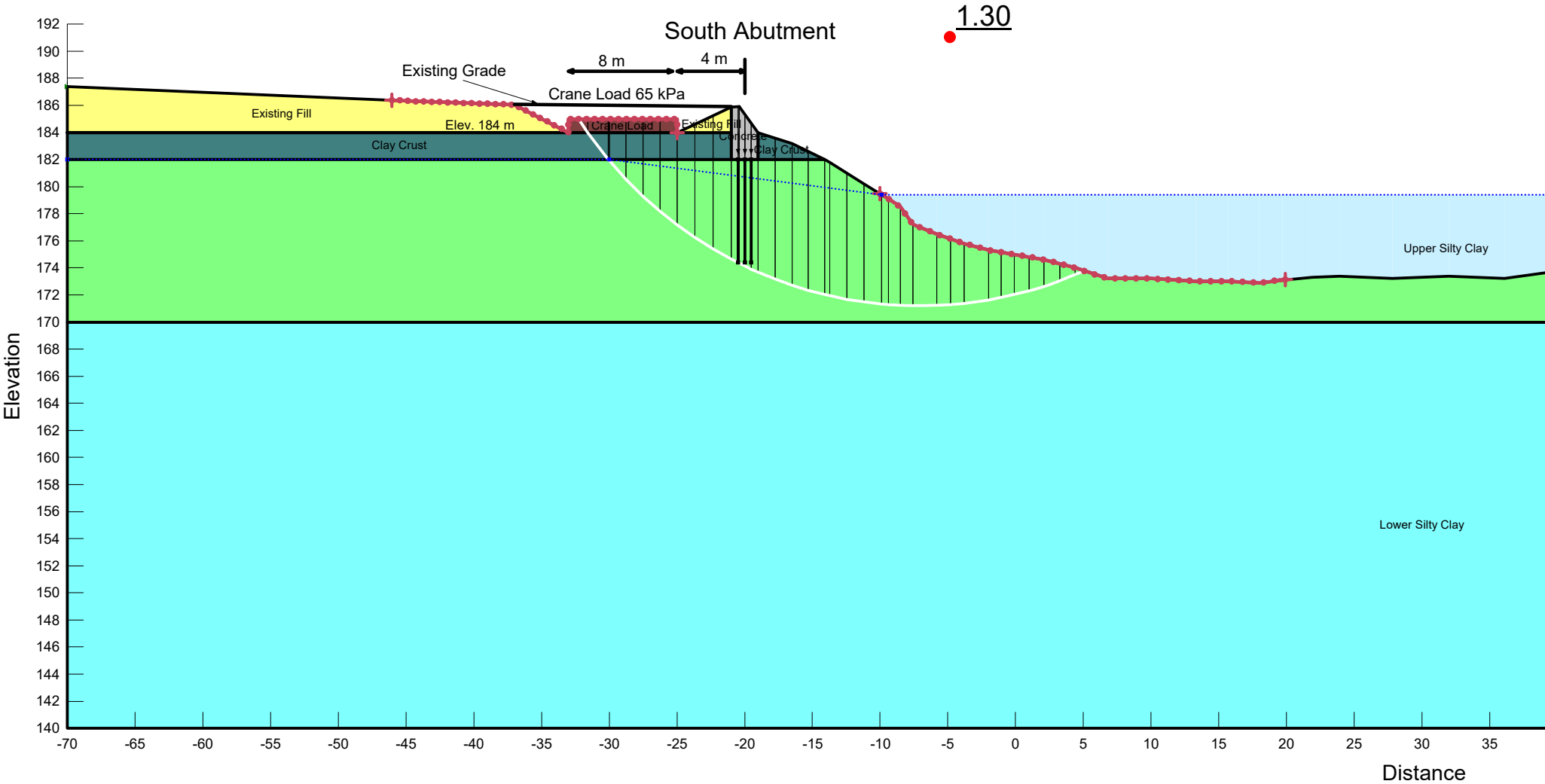
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 0 kPa Phi: 32 °
 Name: Upper Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °
 Name: Lower Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °
 Name: Clay Crust Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 °
 Name: Concrete Model: Mohr-Coulomb Unit Weight: 25 kN/m³ Cohesion: 100 kPa Phi: 0 °



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 VALLEY SLOPE - SOUTH ABUTMENT
 PROFILE ALONG EXISTING HWY 569
 DEMOLITION CRANE

FIGURE 13

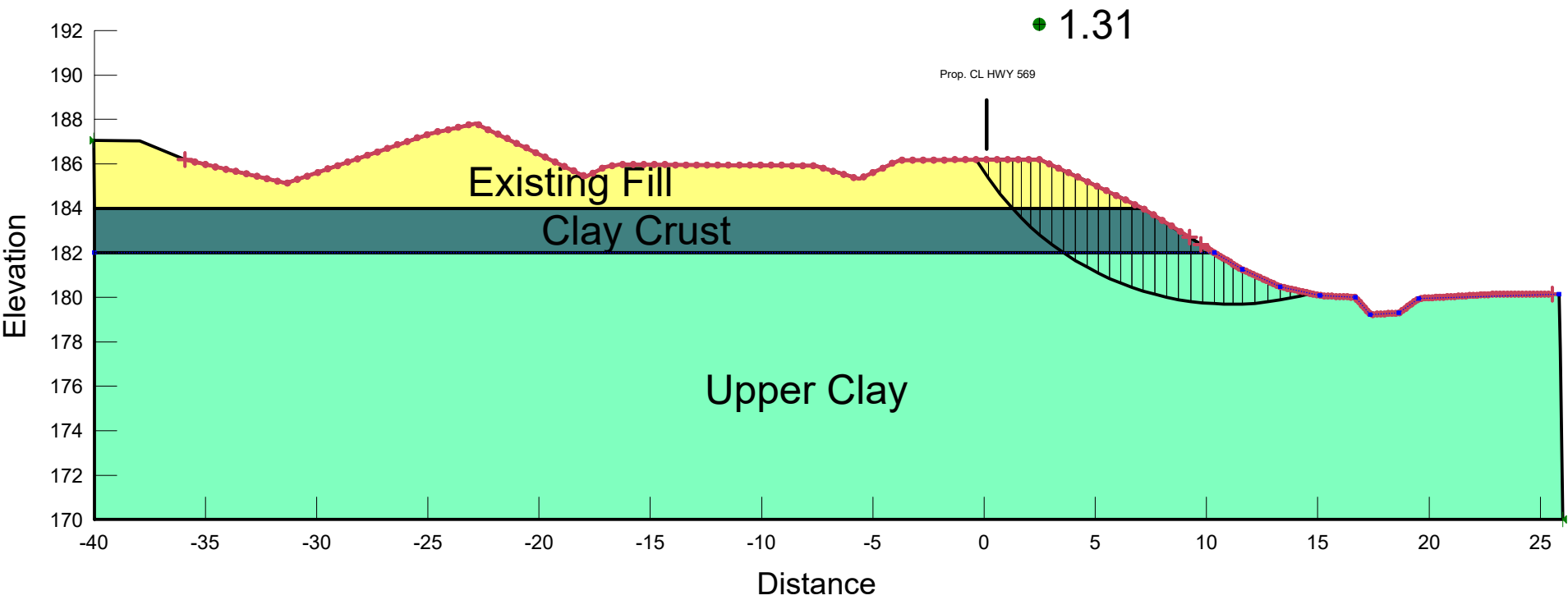
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °
Name: Upper Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °
Name: Lower Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °
Name: Concrete	Model: Mohr-Coulomb	Unit Weight: 25 kN/m ³	Cohesion': 100 kPa	Phi': 0 °
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 65 kN/m ³	Cohesion': 1 kPa	Phi': 1 °



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 SIDE SLOPE - SOUTH OF THE BRIDGE
 EXISTING CONDITION

FIGURE 14

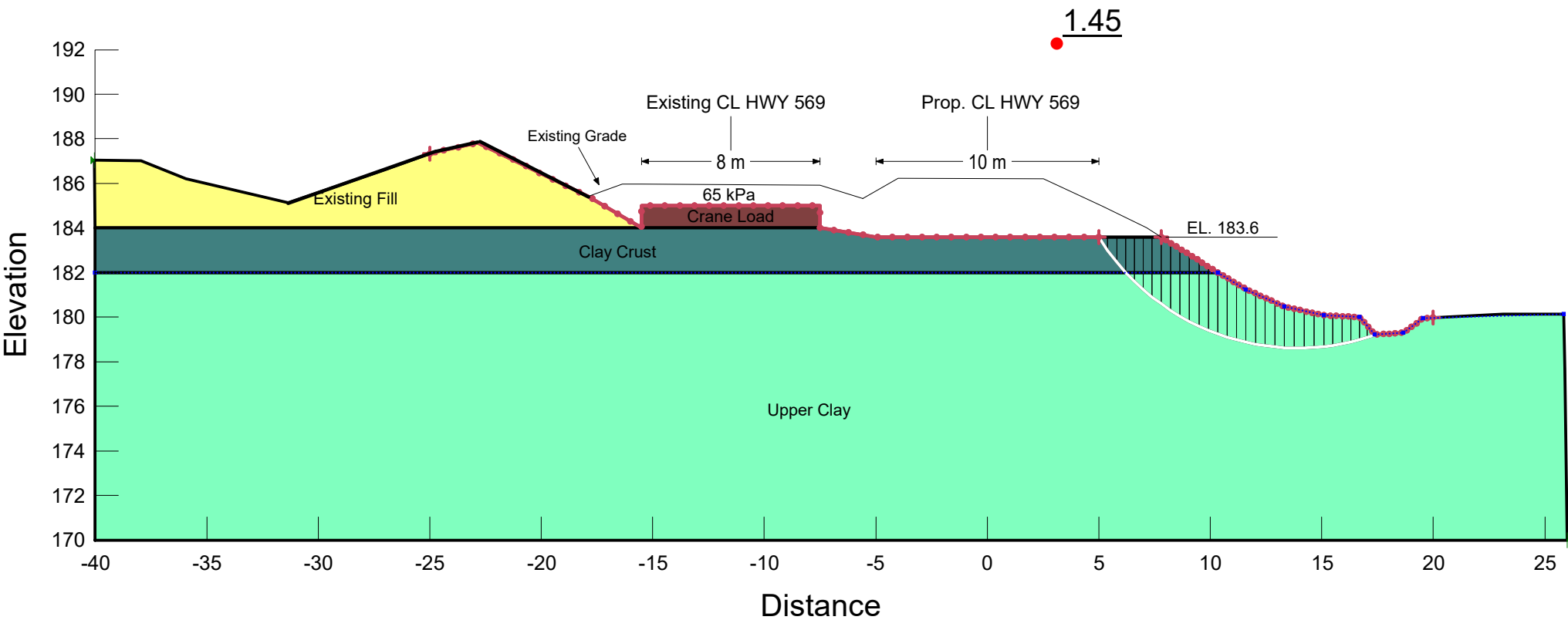
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion: 0 kPa	Phi: 32 °	Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 0.5 Add Weight: No
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion: 5 kPa	Phi: 28 °	B-bar: 1 Add Weight: No



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 SIDE SLOPE - SOUTH OF THE BRIDGE
 DEMOLITION CRANE

FIGURE 15

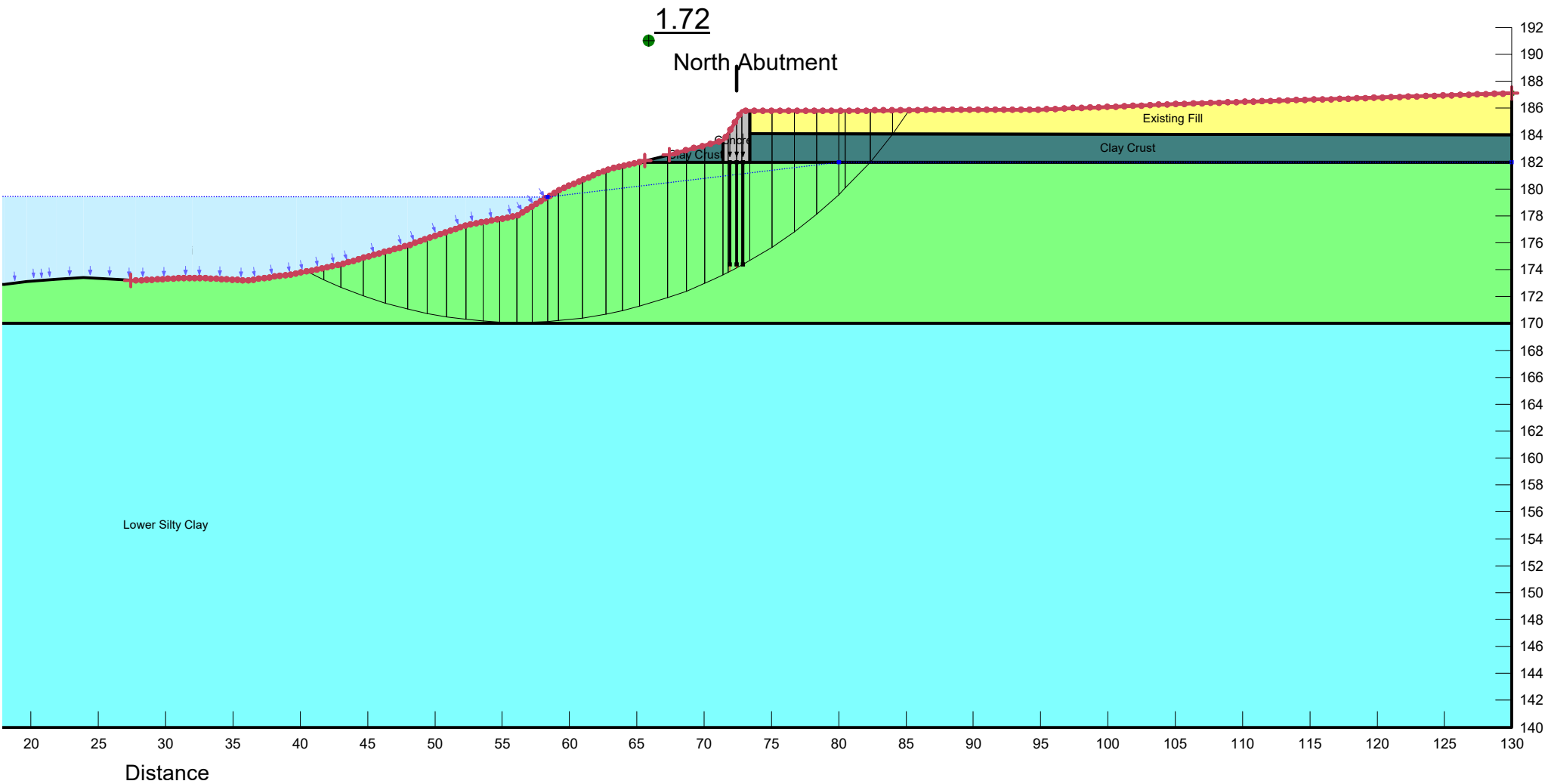
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 65 kN/m ³	Cohesion': 1 kPa	Phi': 1 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 VALLEY SLOPE - NORTH ABUTMENT
 PROFILE ALONG EXISTING HWY 569 ALIGNMENT
 EXISTING CONDITION

FIGURE 16

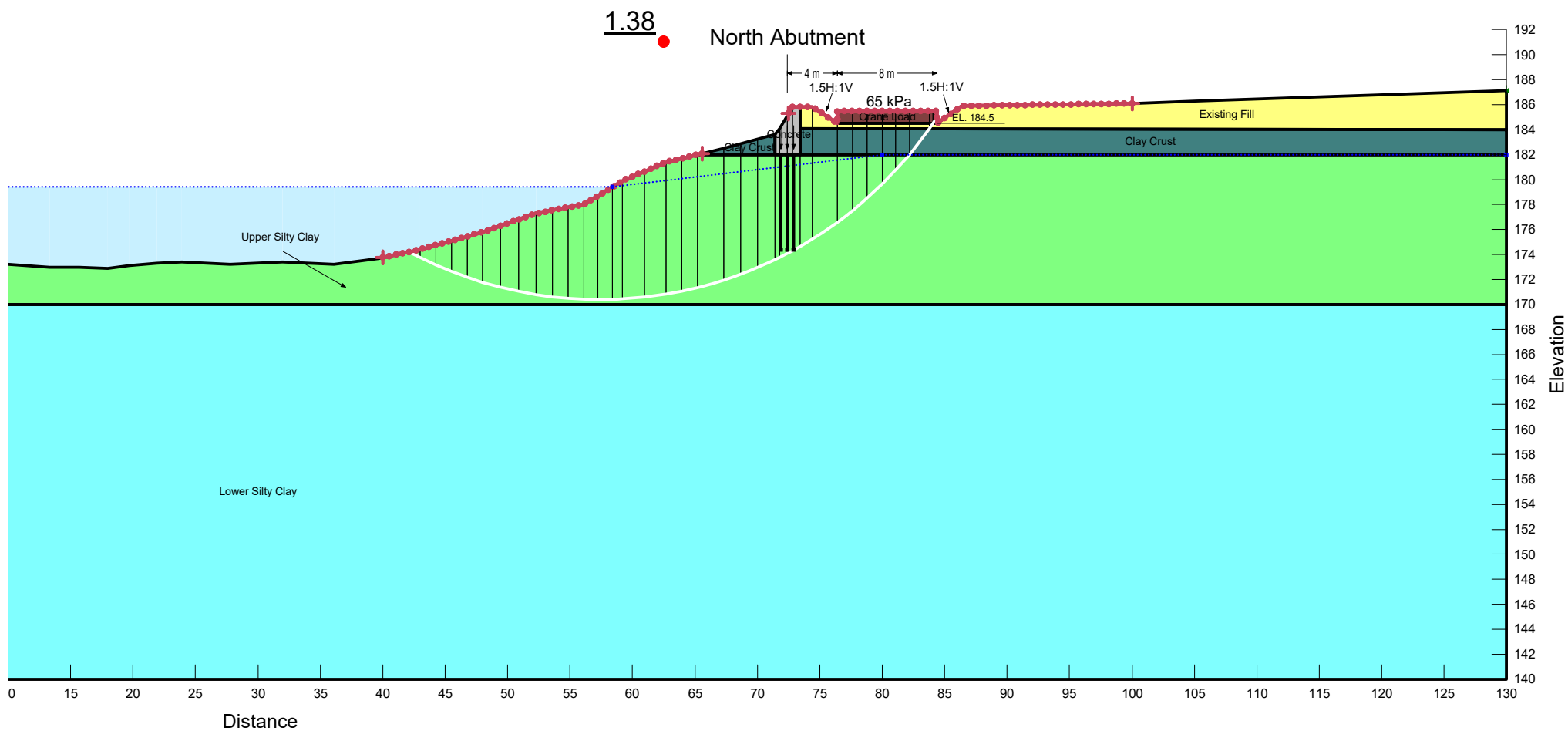
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 0 kPa Phi: 32 ° Add Weight: No
 Name: Upper Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 ° B-bar: 1 Add Weight: No
 Name: Lower Silty Clay Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 ° B-bar: 1 Add Weight: No
 Name: Clay Crust Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion: 5 kPa Phi: 28 ° B-bar: 0.5 Add Weight: No
 Name: Concrete Model: Mohr-Coulomb Unit Weight: 25 kN/m³ Cohesion: 100 kPa Phi: 0 ° Add Weight: No



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 VALLEY SLOPE - NORTH ABUTMENT
 PROFILE ALONG OF EXISTING HWY 569 ALIGNMENT
 DEMOLITION CRANE

FIGURE 17

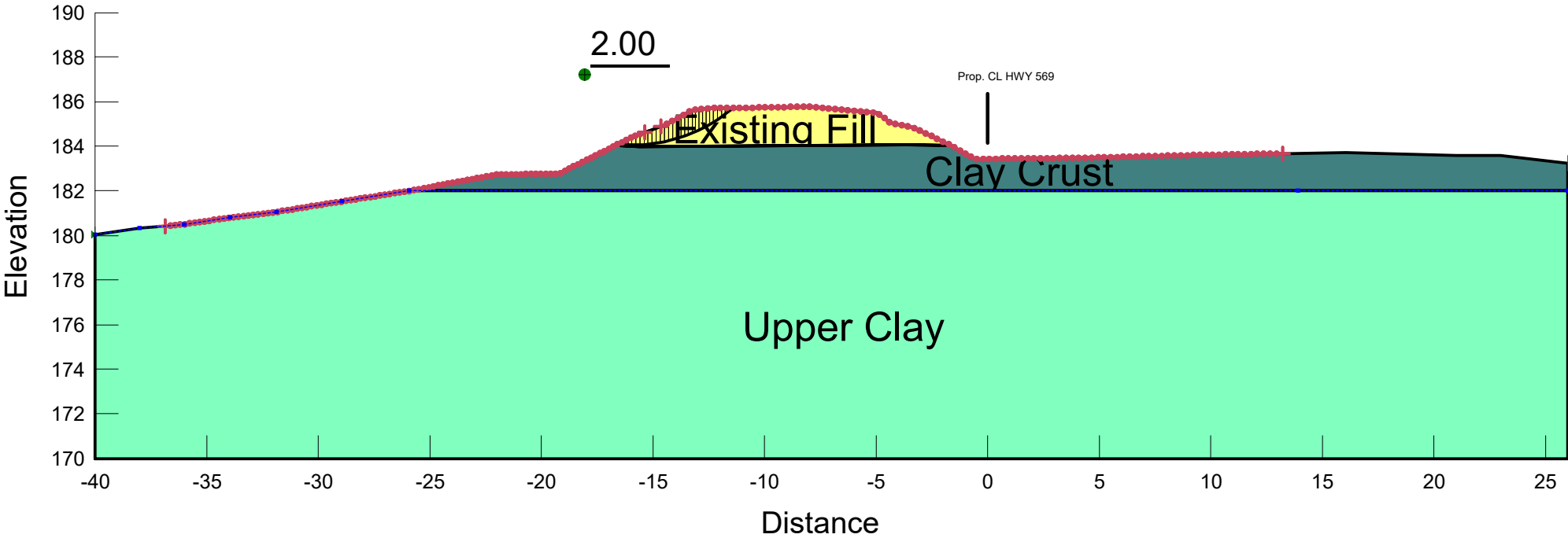
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Upper Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Lower Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Concrete	Model: Mohr-Coulomb	Unit Weight: 25 kN/m ³	Cohesion': 100 kPa	Phi': 0 °	Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 65 kN/m ³	Cohesion': 1 kPa	Phi': 1 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 SIDE SLOPE - NORH OF THE BRIDGE
 EXISTING CONDITION

FIGURE 18

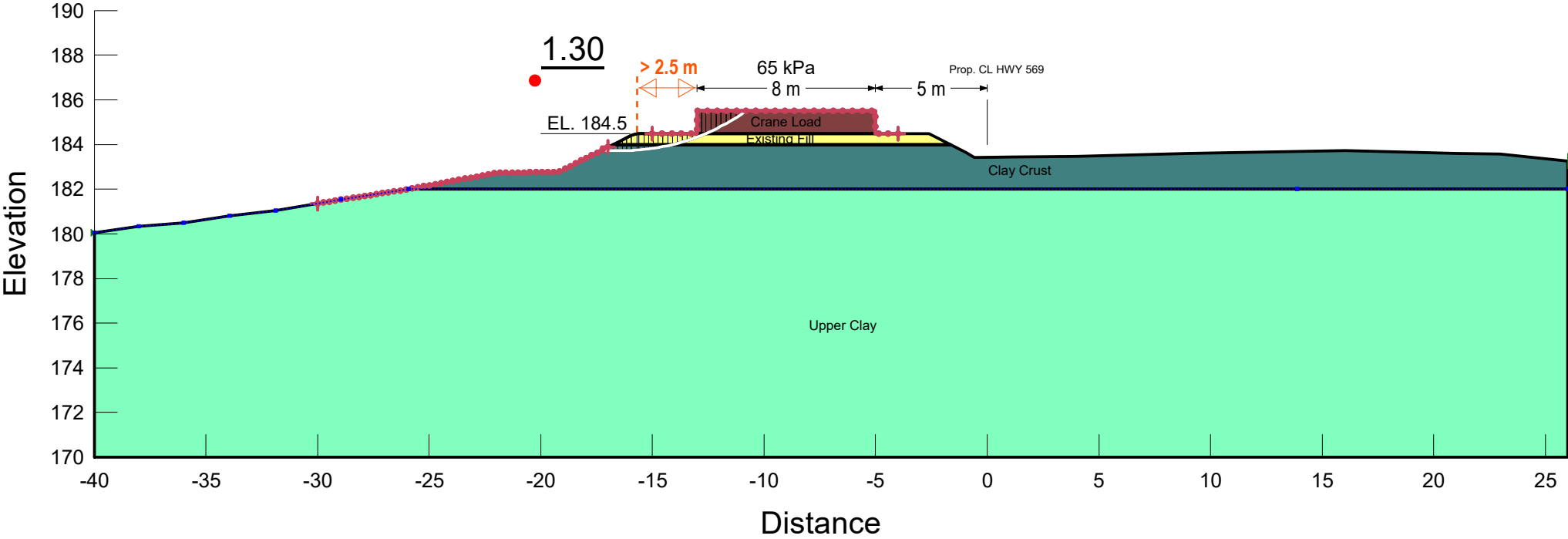
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m³	Cohesion: 0 kPa	Phi: 32 °
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m³	Cohesion: 5 kPa	Phi: 28 °



BLANCHE RIVER BRIDGE - EXISTING BRIDGE
 SIDE SLOPE - NORH OF THE BRIDGE
 DEMOLITION CRANE

FIGURE 19

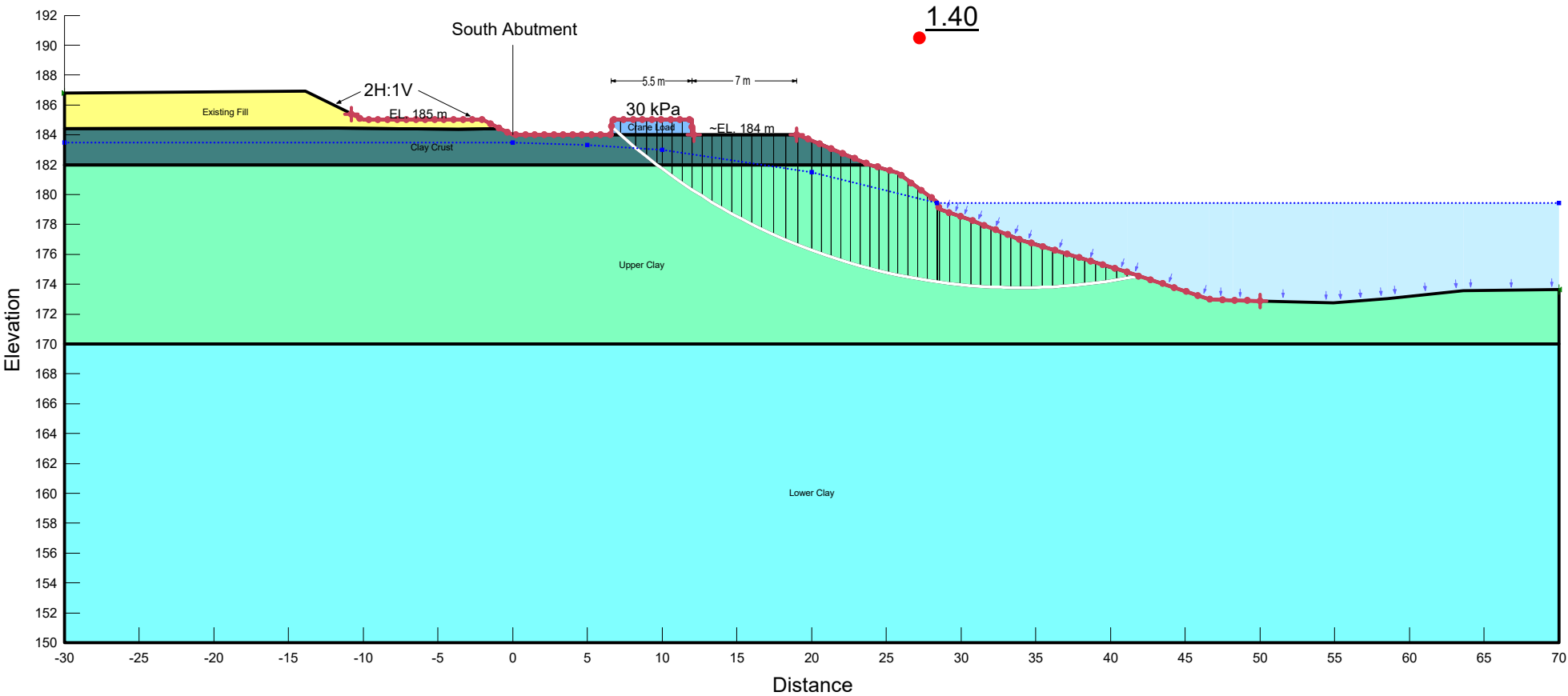
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 65 kN/m ³	Cohesion': 1 kPa	Phi': 1 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 PROFILE OF HWY 569 - VALLEY SLOPE
 WICK DRAIN INSTALLATION RIG

FIGURE 20

Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Upper Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Lower Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 30 kN/m ³	Cohesion': 1 kPa	Phi': 0 °	Add Weight: Yes



BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
 STATION 16+950 - WICK DRAIN INSTALLATION RIG
 BENCHED SIDE SLOPE

FIGURE 21

Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 30 kN/m ³	Cohesion': 1 kPa	Phi': 0 °	Add Weight: Yes

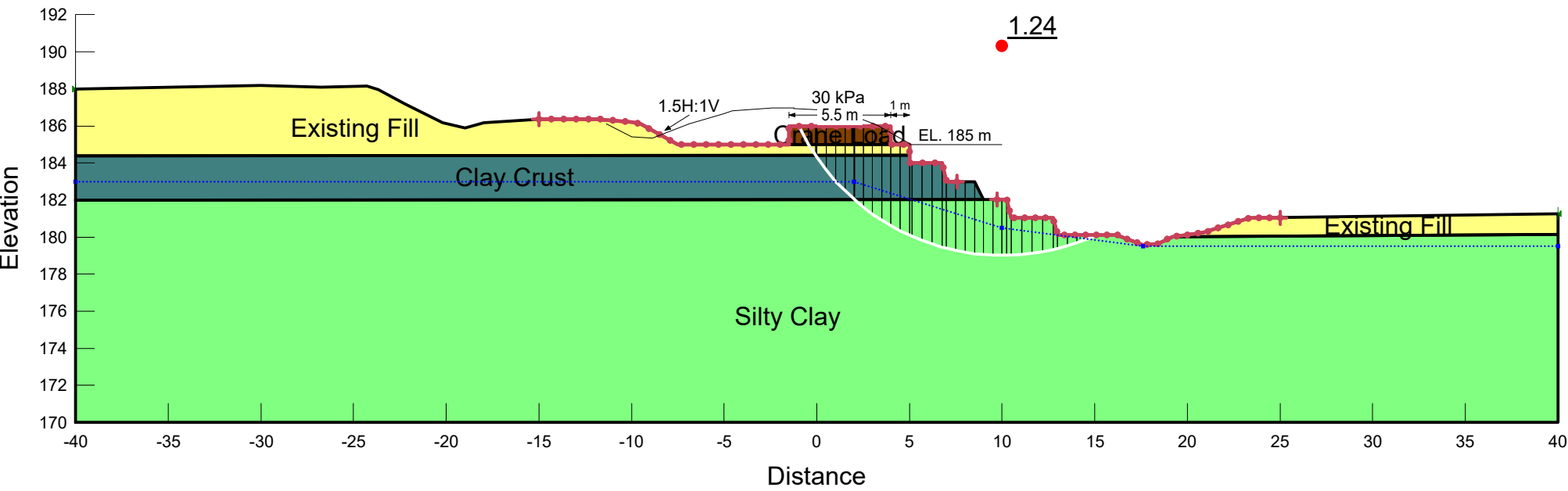
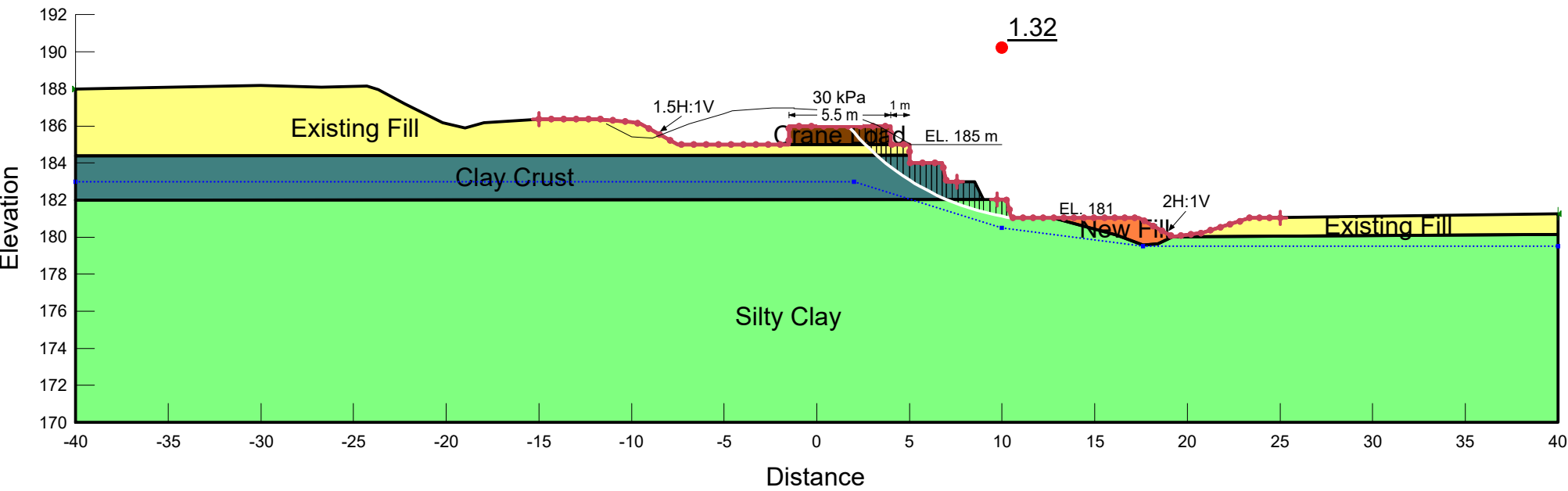


FIGURE 22

BLANCHE RIVER BRIDGE - SOUTH ABUTMENT
STATION 16+950 - WICK DRAIN INSTALLATION RIG
BENCHED SIDE SLOPE - BASE OF SLOPE FILLED TO ELEV. 181 m

Name: New Fill	Model: Mohr-Coulomb	Unit Weight: 21 kN/m ³	Cohesion': 0 kPa	Phi': 35 °	Add Weight: No
Name: Existing Fill	Model: Mohr-Coulomb	Unit Weight: 19 kN/m ³	Cohesion': 0 kPa	Phi': 32 °	Add Weight: No
Name: Silty Clay	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 1 Add Weight: No
Name: Clay Crust	Model: Mohr-Coulomb	Unit Weight: 18 kN/m ³	Cohesion': 5 kPa	Phi': 28 °	B-bar: 0.5 Add Weight: No
Name: Crane Load	Model: Mohr-Coulomb	Unit Weight: 30 kN/m ³	Cohesion': 1 kPa	Phi': 0 °	Add Weight: Yes





Appendix B

NSSP – “Geotechnical Assessment”

NSSP – “Wick Drain Installation”

NSSP – “Work on Valley Slopes”



1) NSSP – “Geotechnical Assessment”

The use of all construction equipment and in particular heavy construction equipment such as pile driving equipment and lifting cranes may be required during demolition of the existing bridge and construction of the new bridge. The global stability and settlement impact of the heavy equipment loads on the river valley slopes and the silty clay underlying the embankment and the existing bridge foundations must be considered during selection of the methodology and equipment employed for construction. For bidding purposes:

- Any excavation and/or material stockpiles, including excavated soils, construction materials and/or demolition debris, shall not be permitted anywhere between the crest of existing river valley slope and the edge of water on both sides of the Blanche River;
- The ground pressures applied by the project specific equipment which requires analysis, which includes but shall not be limited to pile driving equipment or wick drain installation equipment, shall not exceed 15 kPa on the river valley slopes and 30 kPa on the existing and new approach embankments, respectively;
- The girder lifting cranes shall not be permitted on the river valley slopes and shall be placed on the new or existing approach embankments. The ground pressures applied by girder lifting cranes for erecting the new bridge or demolishing the existing bridge shall not exceed 90 kPa on the new approach embankments and 65 kPa on the existing approach embankments, respectively;
- Minimum safe crane pad setback distances from the abutments to be maintained during construction must be assessed and established by the Contractor's Geotechnical Consultant to avoid any adverse stability and settlement effect on the new and existing abutment foundation piles during girder lifting.

The Contractor shall retain a Geotechnical Consultant to assess the stability and settlement impact of the proposed equipment loads and construction methodology and determine requirements and/or restrictions necessary to safely support these loads without a foundation or slope failure. All Foundation Engineering services required for this project shall be performed by consultant(s) listed as accepted under the MTO's RAQS for providing services under the specialty of Geotechnical (Structures and Embankments) – High Complexity.

The assessment shall include, but not be limited to, the following:

1. Review of available geotechnical information and supplementing with additional subsurface information as required in the equipment pad/access road areas;
2. Determining appropriate setback distances for heavy equipment from the existing and new bridge abutments/piers and their foundations, and from the crests of the river valley slopes and existing/new embankment side slopes;
3. Determining permissible ground pressure that may be applied to the foundation soils by the equipment, such as through a combination of crane pad design and sub-excavation;
4. Providing recommendations for distribution of equipment loads to limit the lateral deflections of foundation piles of the existing and new bridges;
5. If use of a crane pad and sub-excavation is not feasible, an alternative pile-supported platform system may be considered. The Contractor shall provide recommendations for crane pad design to transfer the crane loads for lifting girders to the ground during



construction of the new bridge or demolition of the existing bridge through the alternative pile-supported platform system, if necessary.

At least two (2) weeks prior to mobilization of lifting cranes, pile drivers or wick drain installation equipment to the site, the Contractor shall submit a report detailing the findings of the geotechnical assessment to the Contract Administrator. The report shall be signed and sealed by the Geotechnical Consultant and provide the following, as a minimum:

- Appropriate setback distances for heavy equipment from existing/new structures and river valley slopes;
- Permissible ground pressures which may be applied to the foundation soils by heavy equipment;
- Recommendations for distribution of equipment loads to limit lateral deflections of existing and new foundation piles;
- Recommendations for pile-supported platform systems to support heavy equipment, if required.

A separate report may be provided in advance of each operation or a full report detailing all operation may be provided.

2) NSSP – “Wick Drain Installation”

Wick drain installation shall start from the toe of embankment slope and proceed towards the top of the slope. The wick drains installed on the lower portion of the slope shall be covered and protected with embankment fill placed to the design extent before wick drain installation continues on the upper portion of the slope.

3) NSSP – “Work on Valley Slopes”

The following shall not be permitted minimize the potential for valley slope instability.

- Excavation of south valley slope, beyond Sta. 16+975, for access to the pier.
- Stockpiling of excavated soils, construction materials, and/or demolition debris from the existing bridge shall not be permitted anywhere on the river valley.