GSE Engineering & Consulting, Inc.

April 18, 2023

Thomas Mahoney
c/o Jack Charnas, E.I.
NGI Acquisitions, LLC
1545 Peachtree Street NE, Suite 260
Atlanta, Georgia 30309

Subject: Slope Stability and Background Seepage Analysis
Lullwater Berm Stability
Gainesville, Alachua County, Florida
GSE Project No. 14185B

GSE Engineering & Consulting, Inc. (GSE) is pleased to submit this report summarizing our slope stability and background seepage analyses for the Basin 1 and 2 berms at the proposed Lullwater development in Gainesville, Alachua County, Florida.

BACKGROUND INFORMATION

The site is located southwest of the NW 15th Place and Fort Clarke Boulevard intersection in Gainesville, Alachua County, Florida.

Jack Charnas, E.I., with JBPro, provided information on the project including Stormwater Report, Basin Stage Storage, Post Development Time Series Report, C4.2 DRAINAGE PLAN - BASIN 1, and C4.3 DRAINAGE PLAN - BASIN 2.

GSE previously completed geotechnical explorations for the project and presented our findings and recommendations in our reports dated August 29, 2019 (GSE Project No. 14185) and November 7, 2022 (GSE project No. 14185A). These reports included auger and SPT borings spread across the site. SPT borings for strength parameters were performed in and around the proposed basins.

From the provided plans, the critical slopes appear to be located in the northern portions of Basins 1 and 2 identified by your cross sections A-A and B-B, respectively.

Elevation grades for the Basin 1 berm range from 111 feet to 115 feet, and the berm has a 4:1 slope on the interior and exterior slopes. The pond bottom elevation is 111 feet.

Elevation grades for the Basin 2 berm range from 117.25 feet to 120 feet, and the berm has a 4:1 slope on the interior and exterior slopes. The pond bottom elevation is 117.25 feet.

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GSE performed auger and SPT borings in and around Basins 1 and 2 as part of our previous geotechnical site explorations. The SPT borings were performed to depths of 20 feet below land surface (bls). These SPT borings were used in order to determine soil strength parameters for the analysis. The locations of the borings are shown in Figures 2A and 2B. Please refer to the previous report for additional information. GSE also reviewed the provided plans and information in the preparation of this analysis and report. We used the previously performed borings to perform two slope stability analyses for the portions of the Basins 1 and 2 berms. In addition to the slope stability analyses, GSE performed background seepage analyses to determine the pore pressure within the two berms at the critical storm flood stage elevations.

PURPOSE

The purpose of this analysis was to evaluate the provided berm geometries for stability using the soil and groundwater data collected at the site. Our work was performed in general accordance with our experience with similar projects. You authorized our services.

SEEPAGE EVALUATION

GSE performed background seepage analyses using "SLIDE" a Rocscience software program with user-friendly, 2D limit equilibrium slope stability analysis program for all types of soil and rock slopes, embankments, earth dams, and retaining walls. Slide2 includes built-in finite element groundwater seepage analysis, probabilistic analysis, multi-scenario modeling, and support design. GSE evaluated the worst-case scenarios. Basin 1 is the 100-year, 168-hour storm event with a stage elevation of 114.70 ft. Basin 2 is the 25-year, 96-hour storm event with a stage elevation of 119.75 ft. GSE evaluated a transient condition in Basin 1 with 12 stage elevations over an approximate 33-day analysis. GSE evaluated a transient condition in Basin 2 with 13 stage elevations over an approximate 33-day analysis. The results of this are included in the slope stability of the embankment berms and are shown in the attachments.

We used the soil data collected from the previous geotechnical explorations in our model of the subgrade soils beneath the berms. Borings B-4, B-6, B-22, B-23, and P-22 were used in our analysis of the subsurface soils below the berms. Borings B-4, B-6, and P-22 were used for Basin 1 and borings B-22 and B-23 were used for Basin 2.

SPT boring B-4 initially penetrated 11.5 feet of poorly graded sand, sand with clay, and silty sand (SP, SP-SC, SM) overlying clay-rich soils consisting of sandy clay and clay with sand (CL/CH) to the explored depth of 20 feet bls.

SPT boring B-6 initially penetrated 4.5 feet of poorly graded sand and sand with clay (SP, SP-SC) overlying clayey sand (SC) to a depth of 6 feet bls. This was underlain by clay-rich soils consisting of sandy clay and clay with sand (CL/CH) to a depth of 17 feet bls. This was underlain by sand with clay (SP-SC) to the explored depth of 20 feet bls.

SPT boring B-22 initially penetrated 6 feet of sand with clay (SP-SC) overlying clayey sand (SC) to a depth of 12 feet bls. This was underlain by clay-rich soils consisting of clay (CL/CH) to the explored depth of 20 feet bls.

SPT boring B-23 initially penetrated 4.5 feet of poorly graded sand and sand with clay (SP, SP-SC) overlying clayey sand (SC) to the explored depth of 20 feet bls. There is an interbedded stratum of clay-rich soils consisting of clay with sand and clay (CL/CH) from 7 to 11.5 feet bls.

Auger boring P-22 initially penetrated 10 feet of sand with clay (SP-SC) overlying clayey sand (SC) to the explored depth of 15 feet bls.

The approximate boring locations are indicated on Figures 2A and 2B for Basins 1 and Basins 2.

EMBANKMENT STABILITY ANALYSIS

Stability against rotational failure was analyzed using “SLIDE”, an application that can apply any one of several well established, widely accepted two-dimensional limit state equilibrium theories independently of wall configuration, subsurface conditions and external loading. In this case, the Bishop Simplified Method was used.

SLIDE was configured to generate and analyze stability against rotation on more than 150 potential failure surfaces. The analyses incorporated the results of the background seepage analysis mentioned above.

The slope stability and background seepage analyses were required for two scenarios: immediately after construction and during full reservoir steady seepage. Referring to Duncan, J. M., Wright, S. G., & Brandon, T. L. (2014). *Soil strength and slope stability*. John Wiley & Sons Inc., the minimum factor of safety for slope stability analysis of the different conditions is shown in Table 1.

Table 1: Factor of Safety Criteria for Slope Stability Analysis	
For end of construction	1.3
For long-term seepage	1.5

The following are evaluations and recommendations corresponding to each scenario.

Scenario 1: Immediately after construction

GSE evaluated design parameters to achieve a minimum FS of 1.3 for the end of construction condition. GSE recommends the berms be constructed under GSE observation. If soil conditions are encountered that are different from those used in our analysis, additional recommendations may be warranted.

Considering the soil parameters, the potential failure surface with the lowest factor of safety for stability against rotational failure (FS_{min}) of the embankment berms was 2.793 for Basin 1 and 2.762 for Basin 2 just after construction.

Scenario 2: During full reservoir seepage (100YR-168HR stage elevation of 114.70 feet for Basin 1; 25YR-96HR stage elevation of 119.75 feet for Basin 2)

GSE evaluated design parameters to achieve a minimum FS of 1.5 for the long-term seepage condition. GSE recommends the berms be constructed under GSE observation. If soil conditions are encountered that are different from those used in our analysis, additional recommendations may be warranted.

Considering the soil parameters, the potential failure surface with the lowest factor of safety for stability against rotational failure (FS_{min}) of the embankment berms was 2.050 for Basin 1 and 1.695 for Basin 2. Tables 2 and 3 summarize this information.

Table 2. Summary of Slope Stability Results – Basin 1 (East Berm)

Stages	Stage Elevation	Hour	FS
1	111.00	0.00	2.793
2	111.00	109.52	2.439
3	111.61	130.02	2.370
4	112.71	150.02	2.243
5	113.44	155.02	2.207
6	114.21	158.02	2.140
7	114.70	160.52	2.090
8	114.00	192.52	2.050
9	113.00	240.02	2.158
10	112.00	313.27	2.256
11	111.00	616.27	2.357
12	111.00	800.27	2.363

Table 3. Summary of Slope Stability Results – Basin 2 (East Berm)

Stages	Stage Elevation	Hour	FS
1	117.25	0.00	2.762
2	117.25	53.02	1.989
3	117.76	59.02	1.950
4	118.61	59.75	1.940
5	119.70	60.25	1.923
6	119.09	62.01	1.776
7	118.79	66.01	1.695
8	118.46	80.01	1.800
9	118.00	152.26	1.883
10	117.58	260.26	1.943
11	117.25	377.26	1.987
12	117.25	500.26	1.988
13	117.25	800.00	1.988

GSE recommends a QA/QC program be implemented to ensure the berms are constructed in accordance with the soil parameters used in the modeling. Any deviation could result in a reduced performance of the stormwater management facilities.

BERM CONSTRUCTION RECOMMENDATIONS

The soils at this site should be suitable for supporting the proposed construction using normal, good practice site preparation procedures. The following recommendations are our general guidelines for site preparation.

Stripping

Strip the construction limits and 10 feet beyond the perimeter of all grass, roots, topsoil, and other deleterious materials. You should expect to strip to depths of 12 or more inches. Deeper stripping will likely be necessary due to major root systems present at the site.

Dewatering

Temporary dewatering is not likely necessary for this project. However, if needed, we anticipate dewatering can be accomplished with sumps placed near the construction area, or with underdrains connected to a vacuum pump.

In any case, the site should always be graded to promote runoff and limit the amount of ponding. Localized ponding of stormwater is expected without proper grading during construction, and could render previously acceptable surfaces unacceptable.

Proof-Rolling

Proof-roll the subgrade with heavy rubber-tired equipment, such as a loaded front-end loader or dump truck, to identify any loose or soft zones not found by the soil borings. The proof-rolling should be monitored by a geotechnical engineer or qualified technician. Undercut or otherwise treat these zones as recommended by the geotechnical engineer in this report.

Fill Placement and Compaction

The fill to construct the berm may consist of silty sands (A-2-4). The berm should be constructed with consistent material so that drainage pathways are not created with layers of more permeable material. Silty sands (A-2-4) should be placed in maximum 6-inch loose lifts that are compacted to at least 98 percent of the Standard Proctor maximum dry density. A-2-6 and A-2-7 materials can also be used if compaction (98 percent Standard Proctor) can be achieved. These (A-2-4, A-2-6, and A-2-7) materials will be moisture sensitive and difficult to compact. They should be placed and compacted within 2 percent of the optimum moisture content. If lighter "walk-behind" compaction equipment is used, this may require lifts of 4 inches or less to achieve the required degree of compaction.

We recommend planting the slopes of the berm with grass, sod, or other material as soon as possible in order to control erosion.

LIMITATIONS

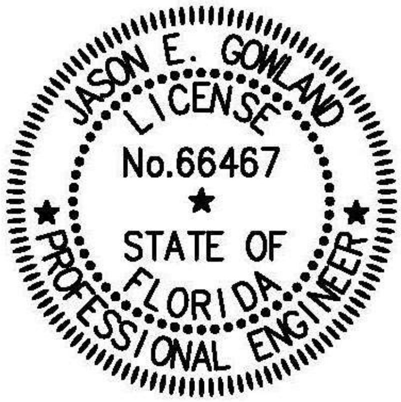
This report has been prepared for our client for his exclusive use, in accordance with generally accepted engineering practices, and makes no other warranty either expressed or implied as to the professional advice provided in the report.

CLOSING

GSE appreciates the opportunity to have assisted you on this project. If you have any questions or comments concerning this report or if we may be of further assistance, please contact us.

Sincerely,

GSE Engineering & Consulting, Inc.



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Digitally signed by Jason E Gowland
Date: 2023.04.18 16:27:42 -04'00'
on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Kevin P. Fisher, E.I.
Staff Engineer

Jason E. Gowland, P.E.
Principal Engineer
Florida Registration Number 66467

KPF/JEG:hmp
Z:General\Projects\14815B Lullwater Berm Stability\14815B.doc

Attachments: Figure 1 Project Site Location Map
Figure 2A - Site Plan Showing Approximate Locations of Field Tests – Basin 1
Figure 2B - Site Plan Showing Approximate Locations of Field Tests – Basin 2
Slide Input/Output Figures

Distribution: Addressee (1 - Electronic)
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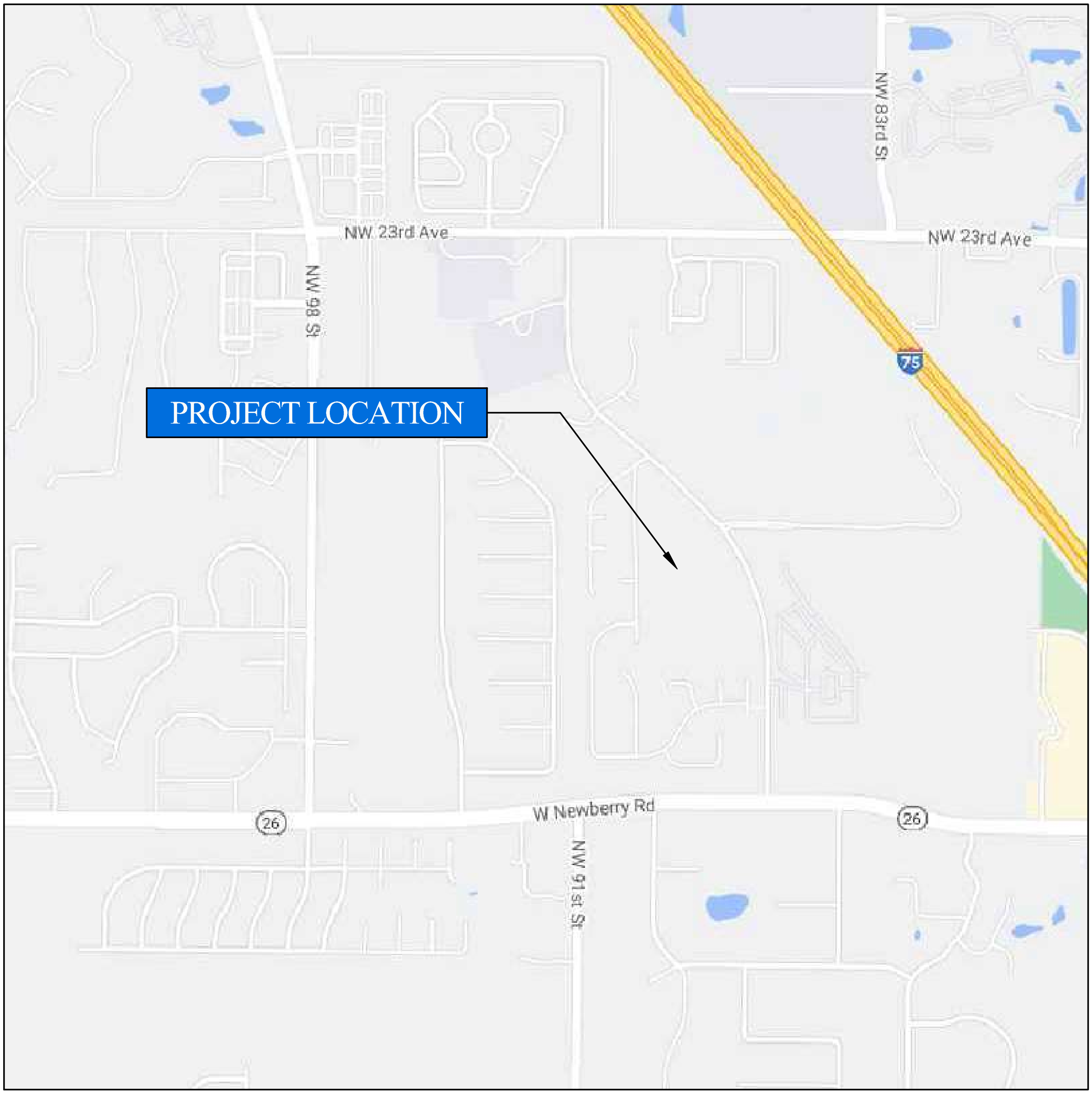
ATTACHMENTS



NORTH

NOT TO SCALE

LULLWATER BERM STABILITY
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14185B

PROJECT SITE LOCATION MAP

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : EEW

GSE Engineering & Consulting, Inc.

FIGURE 1

NORTH

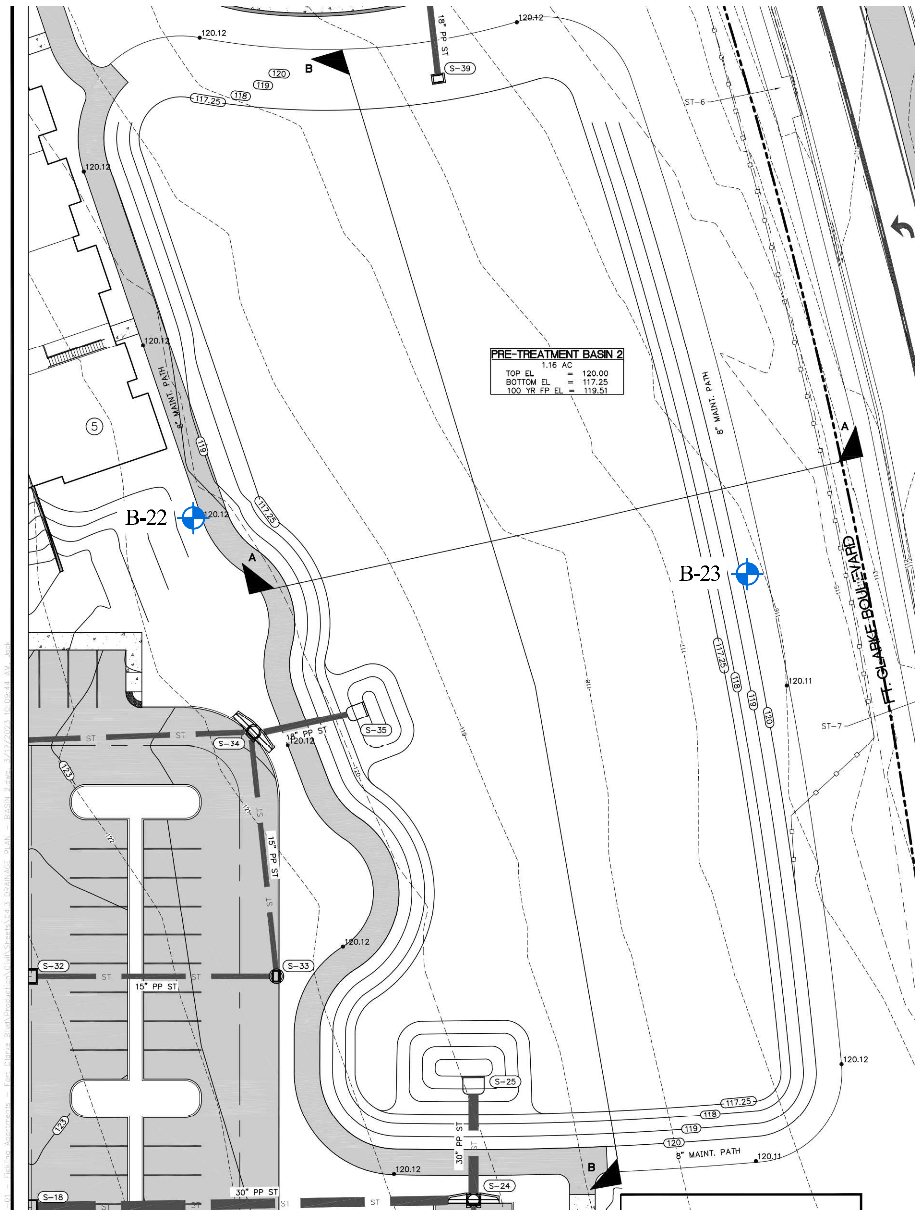
0 100'

SCALE: 1" = 100' APPROX.

LEGEND:

- SPT BORING
- AUGER BORING

LULLWATER BERM STABILITY GAINESVILLE, ALACHUA COUNTY, FLORIDA GSE PROJECT NO. 14185B	SITE PLAN SHOWING APPROXIMATE LOCATIONS OF FIELD TESTS – BASIN 1		
	DESIGNED BY: JEG CHECKED BY: JEG DRAWN BY: JNM	GSE Engineering & Consulting, Inc.	FIGURE 2A



LEGEND:

SPT BORING

SITE PLAN SHOWING APPROXIMATE LOCATIONS OF FIELD TESTS – BASIN 2

LULLWATER BERM STABILITY
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14185B

DESIGNED BY: JEG
CHECKED BY: JEG
DRAWN BY: JNM

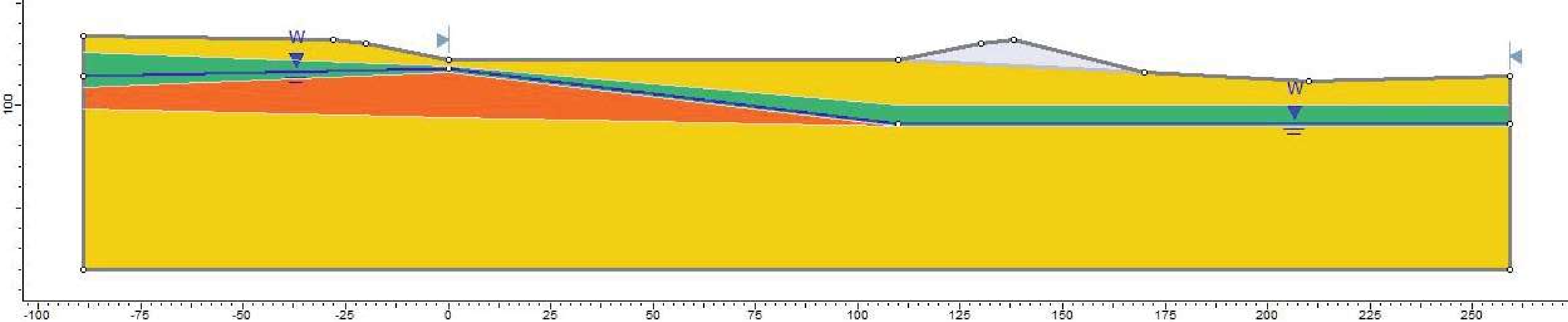
GSE Engineering & Consulting, Inc.

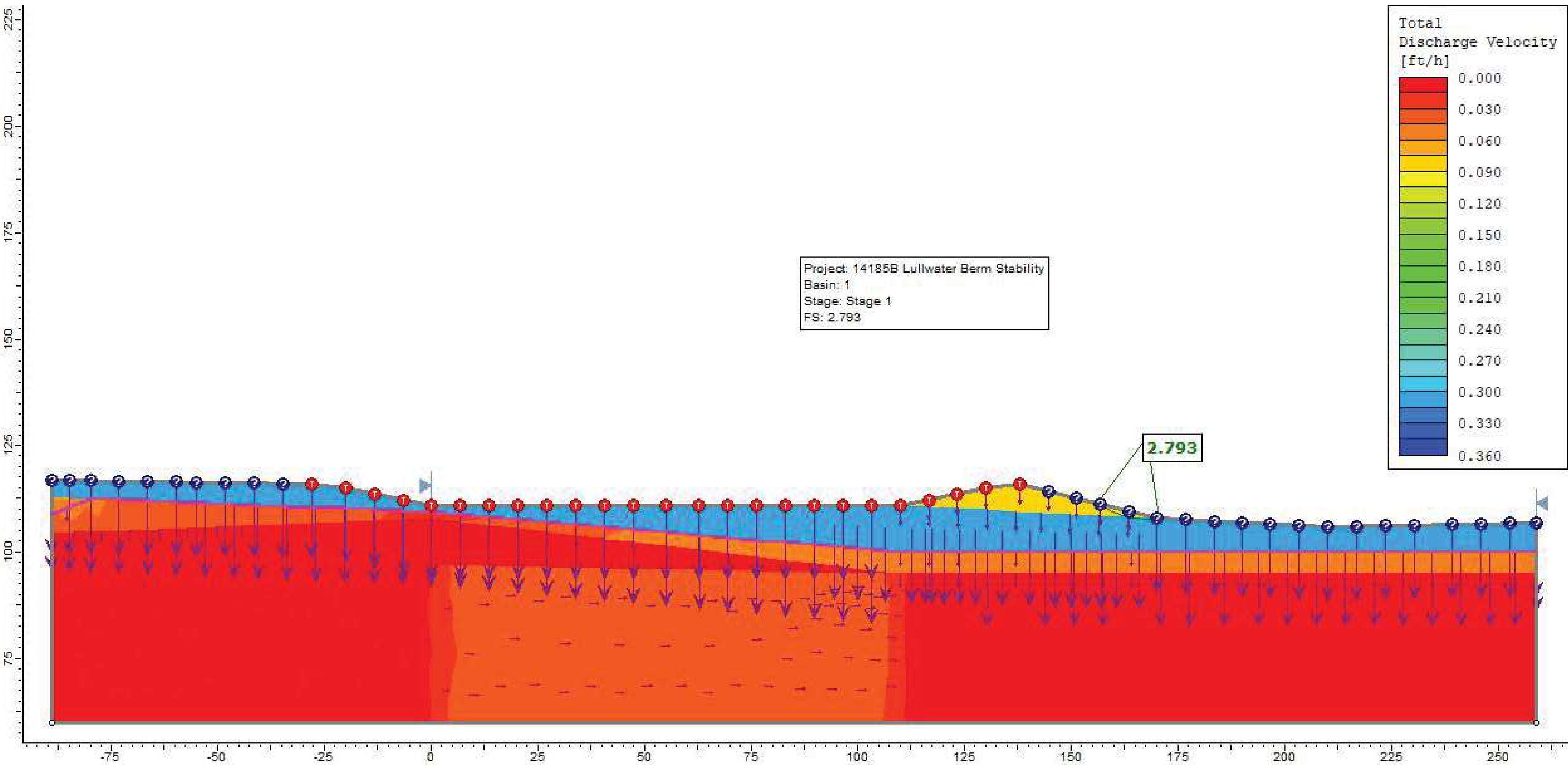
FIGURE

2B

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
SP, SP-SM		118	Mohr-Coulomb	0	32	Water Surface	Custom	1
SC		120	Mohr-Coulomb	0	32	Water Surface	Custom	1
CL/CH		125	Mohr-Coulomb	2000	0	Water Surface	Custom	1
Berm		125	Mohr-Coulomb	0	35	Water Surface	Custom	1

Material Name	Color	Model	KS (ft/d)	Soil Type
SP, SP-SM		Simple	7.5	Sand
SC		Simple	1.5	Sand
CL/CH		Simple	1e-07	Clay
Berm		Simple	2	Sand

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Discharge Velocity
[ft/h]
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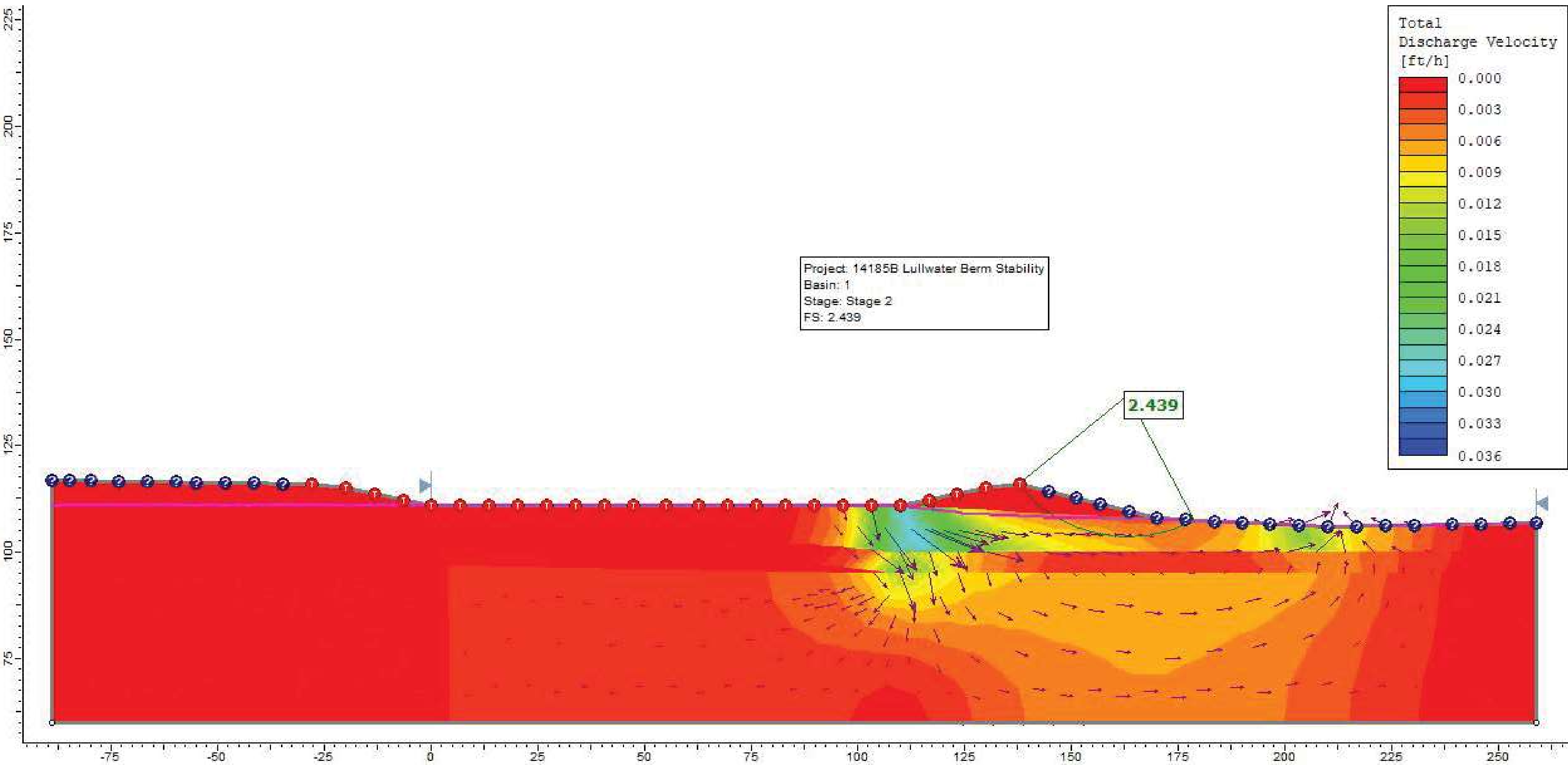
0.030
0.060
0.090
0.120
0.150
0.180
0.210
0.240
0.270
0.300
0.330
0.360
2.793
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 1
FS: 2.793
225
200
175
150
125
100
75
-75
-50
-25
0
25
50
75
100
125
150
175
200
225
250



Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 2
FS: 2.439
2.439
Total
Discharge Velocity
[ft/h]
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0.009
0.012
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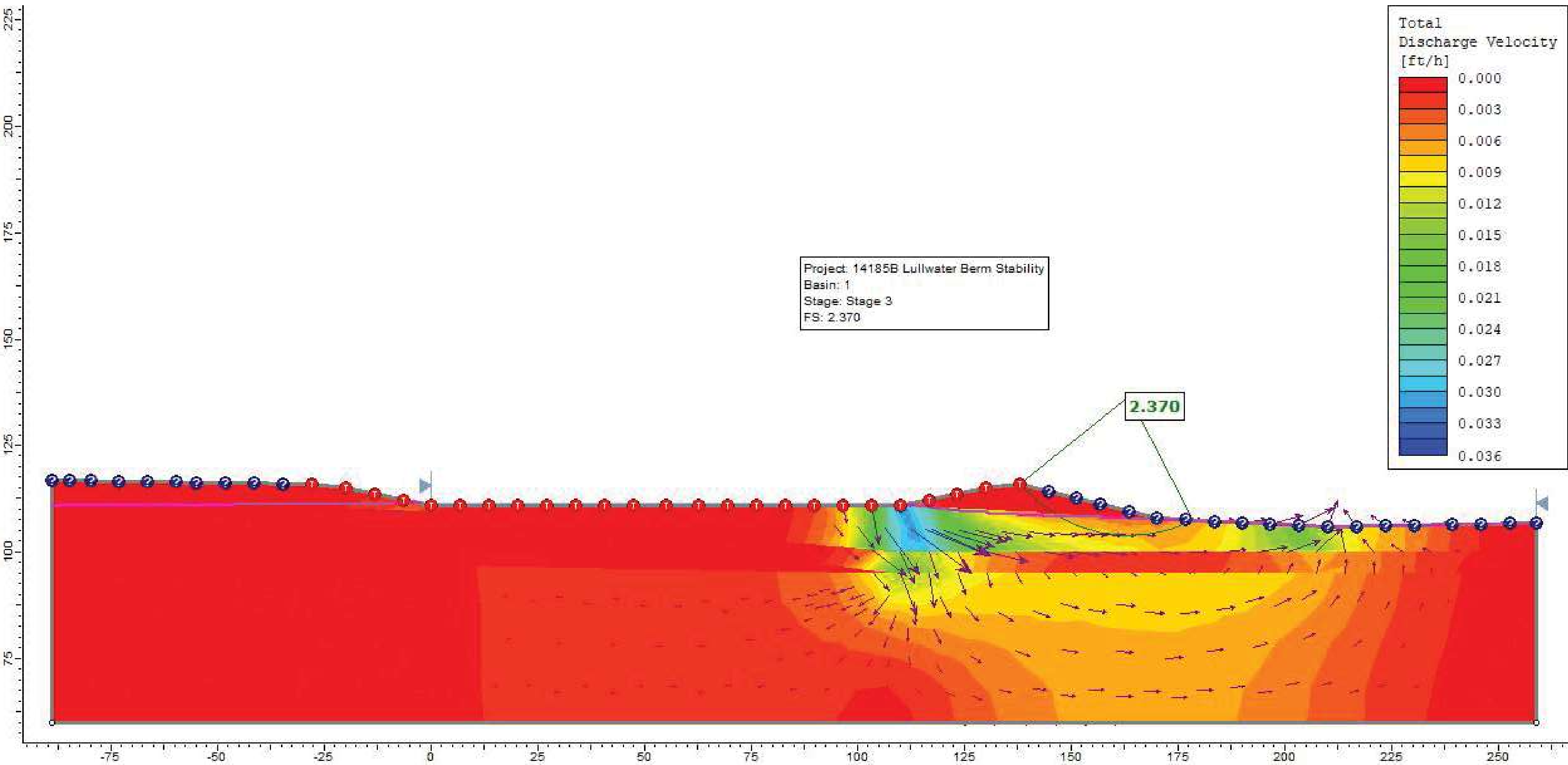
0.018
0.021
0.024
0.027
0.030
0.033
0.036


Total
Discharge Velocity
[ft/h]
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0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 3
FS: 2.370
2.370
225
200
175
150
125
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75
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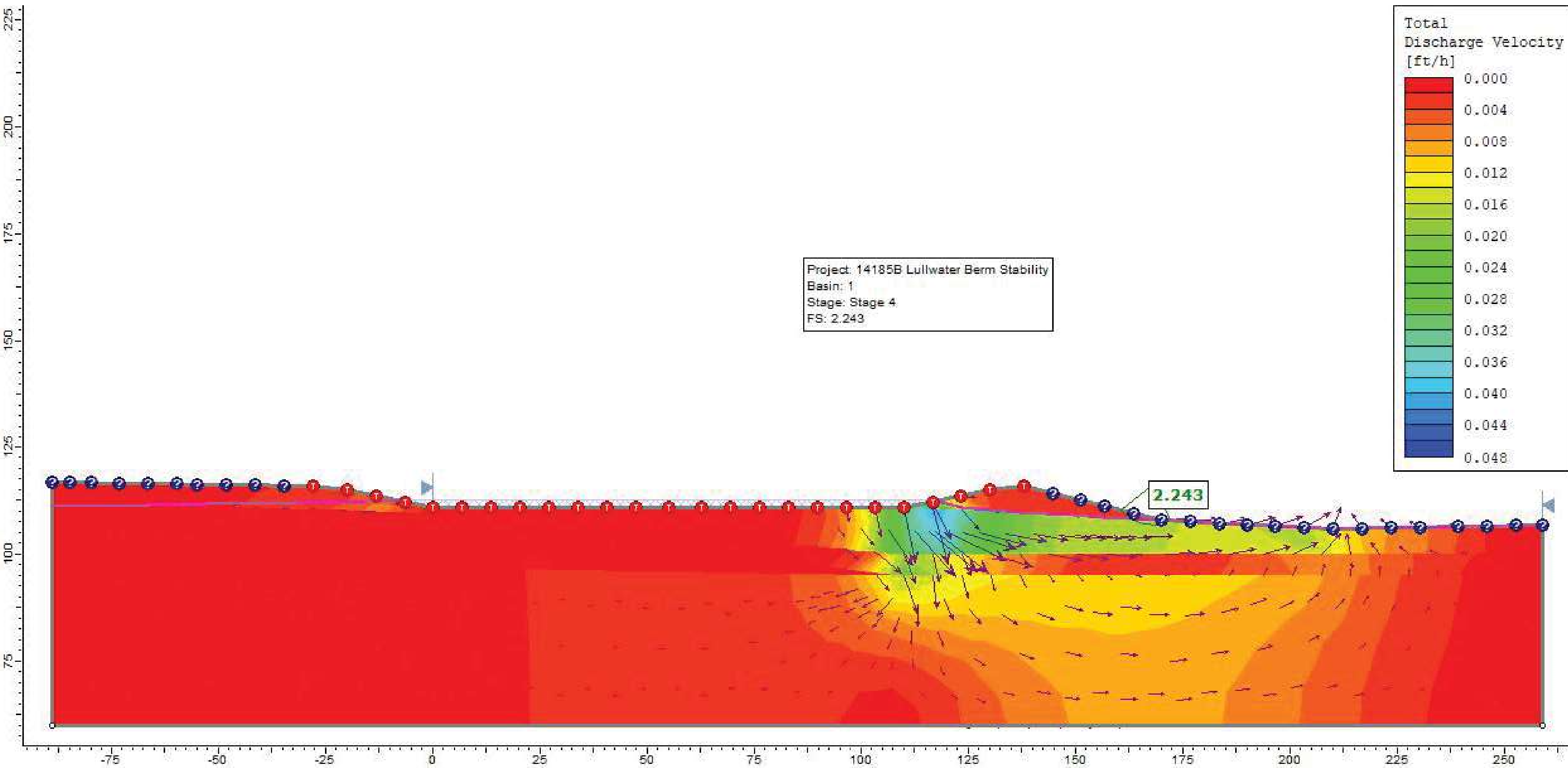
75
100
125
150
175
200
225
250


Total
Discharge Velocity
[ft/h]
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0.008
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0.016
0.020
0.024
0.028
0.032
0.036
0.040
0.044
0.048
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 4
FS: 2.243
2.243
225
200
175
150
125
100
75
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150
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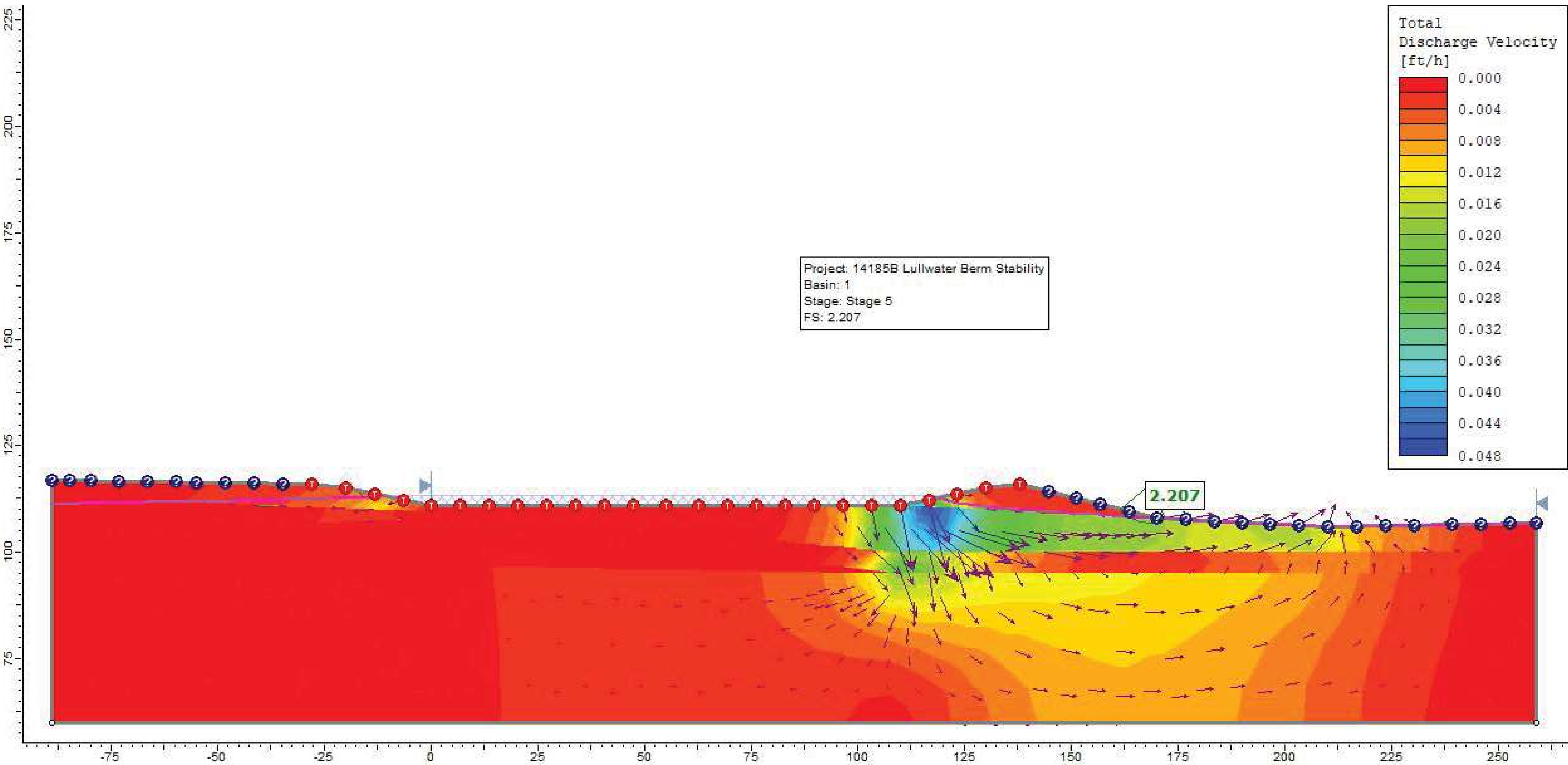
200
225
250



Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 5
FS: 2.207
2.207
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Discharge Velocity
[ft/h]
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0.004
0.008
0.012
0.016
0.020
0.024
0.028
0.032
0.036
0.040
0.044
0.048
225
200
175
150
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75
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200
225
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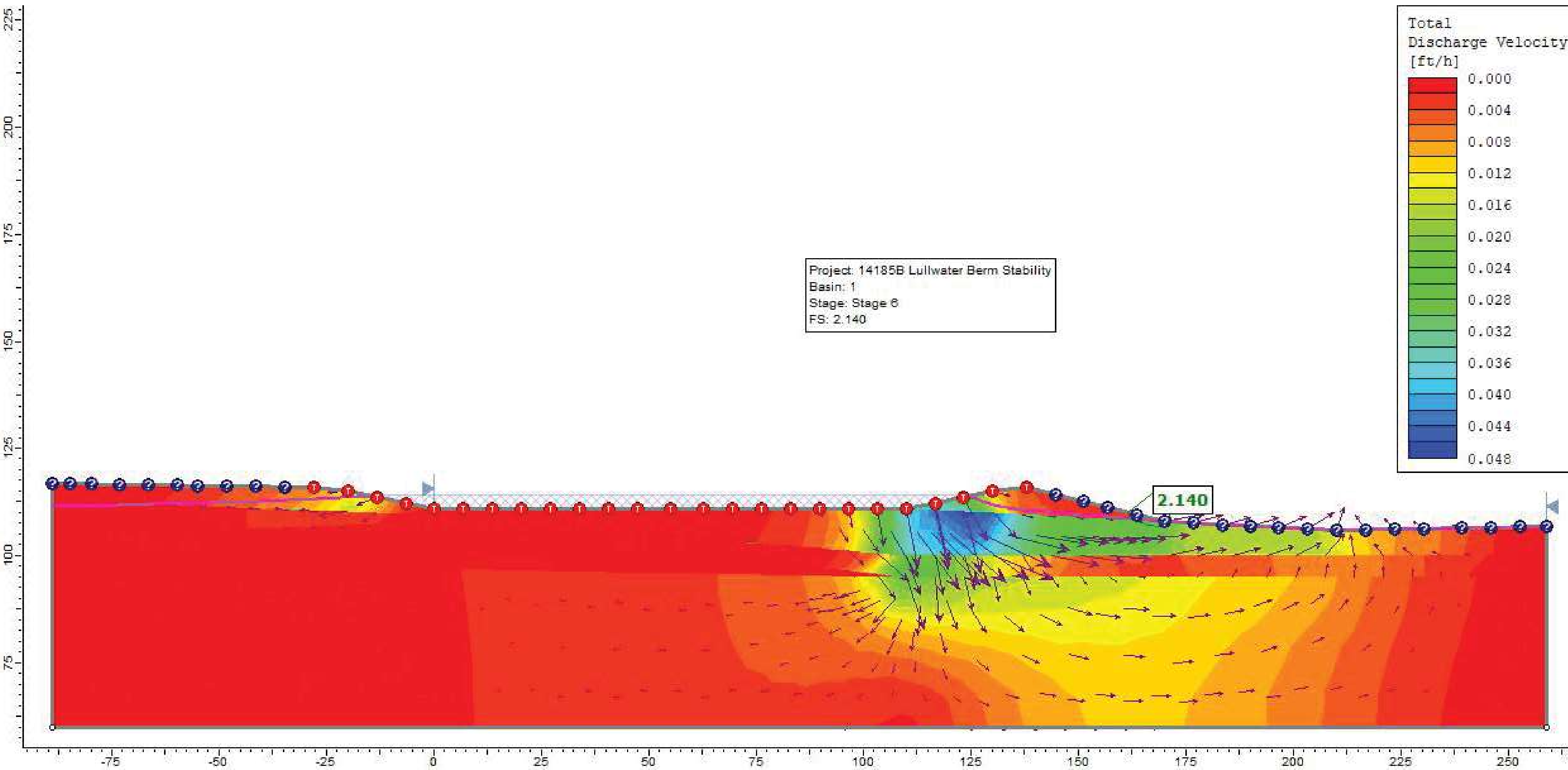
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[ft/h]
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Basin: 1
Stage: Stage 6
FS: 2.140
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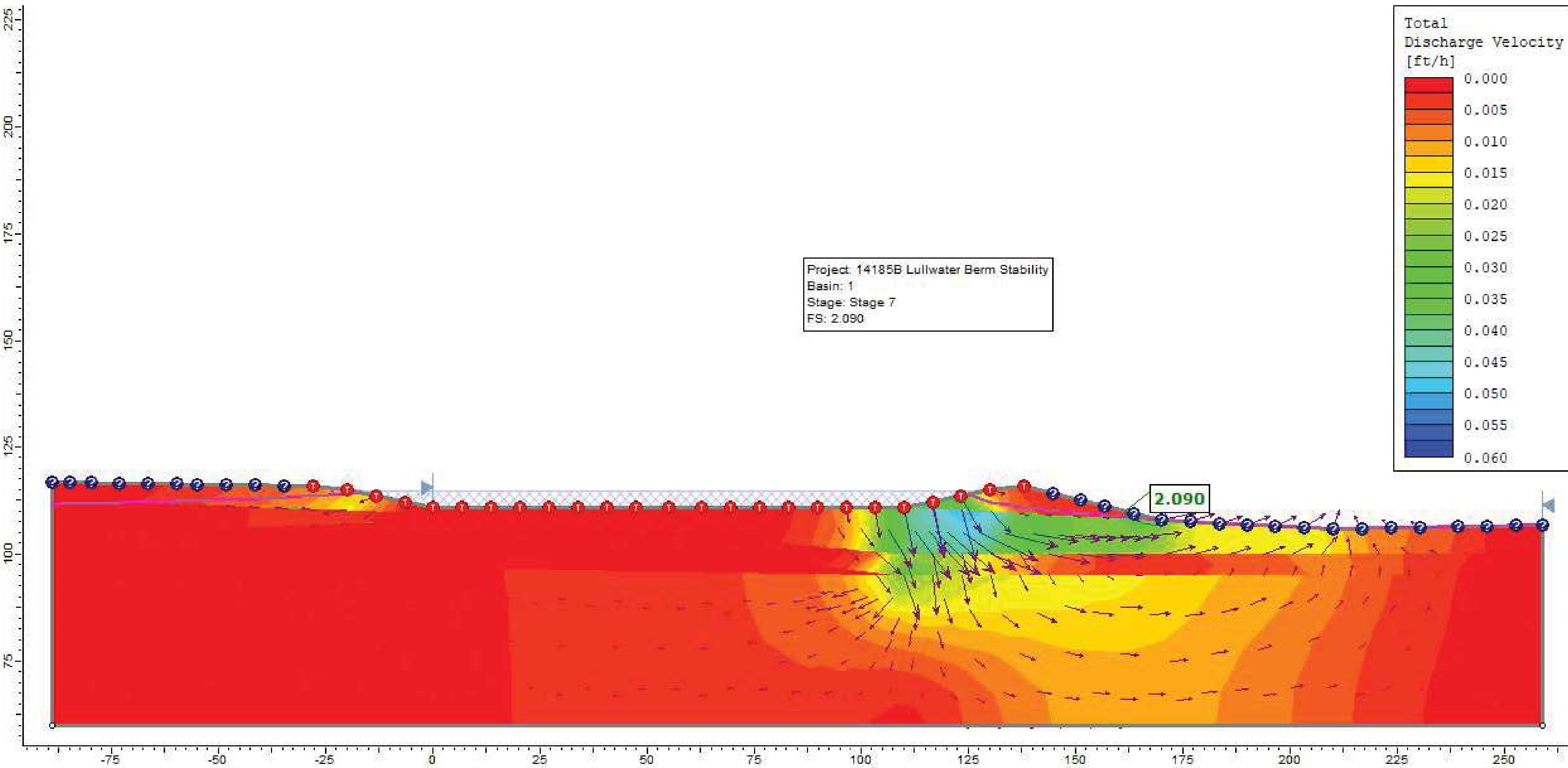

Total
Discharge Velocity
[ft/h]
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0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
0.055
0.060
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 7
FS: 2.090
2.090
225
200
175
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75
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25
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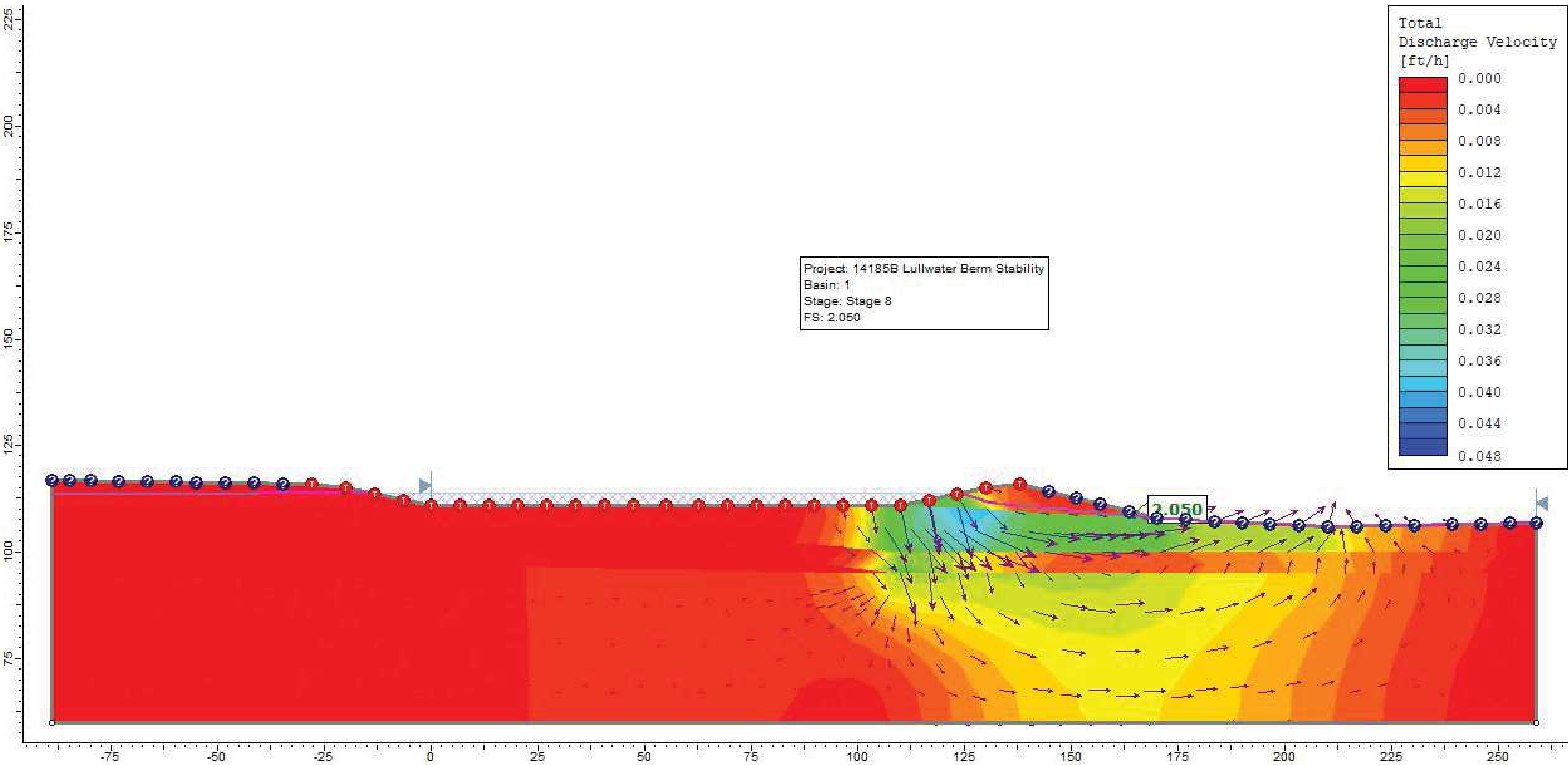
75
100
125
150
175
200
225
250


Total
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[ft/h]
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0.012
0.016
0.020
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0.028
0.032
0.036
0.040
0.044
0.048
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 8
FS: 2.050
2.050
225
200
175
150
125
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75
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150
175
200
225
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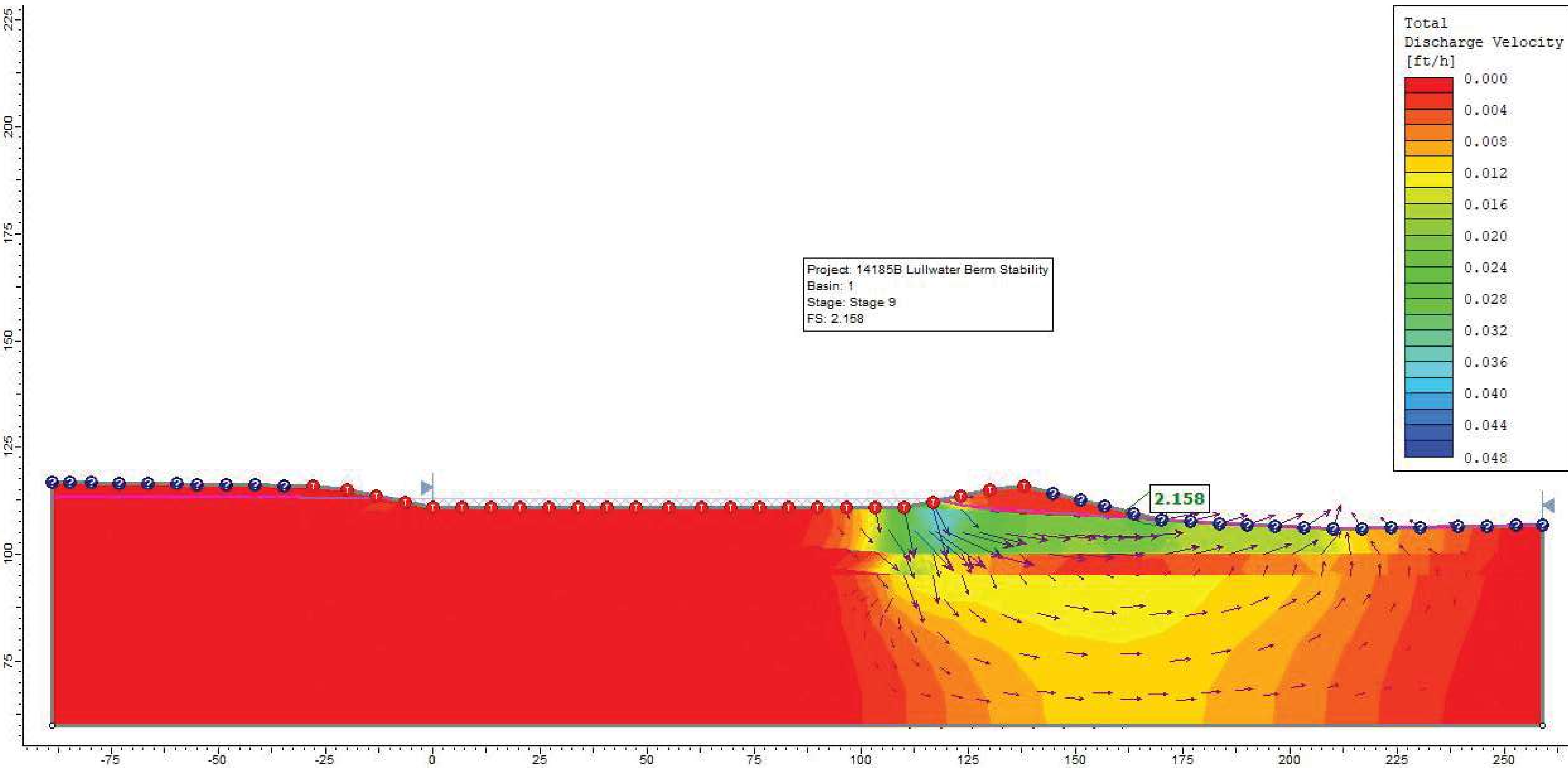

Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 9
FS: 2.158
2.158
Total
Discharge Velocity
[ft/h]
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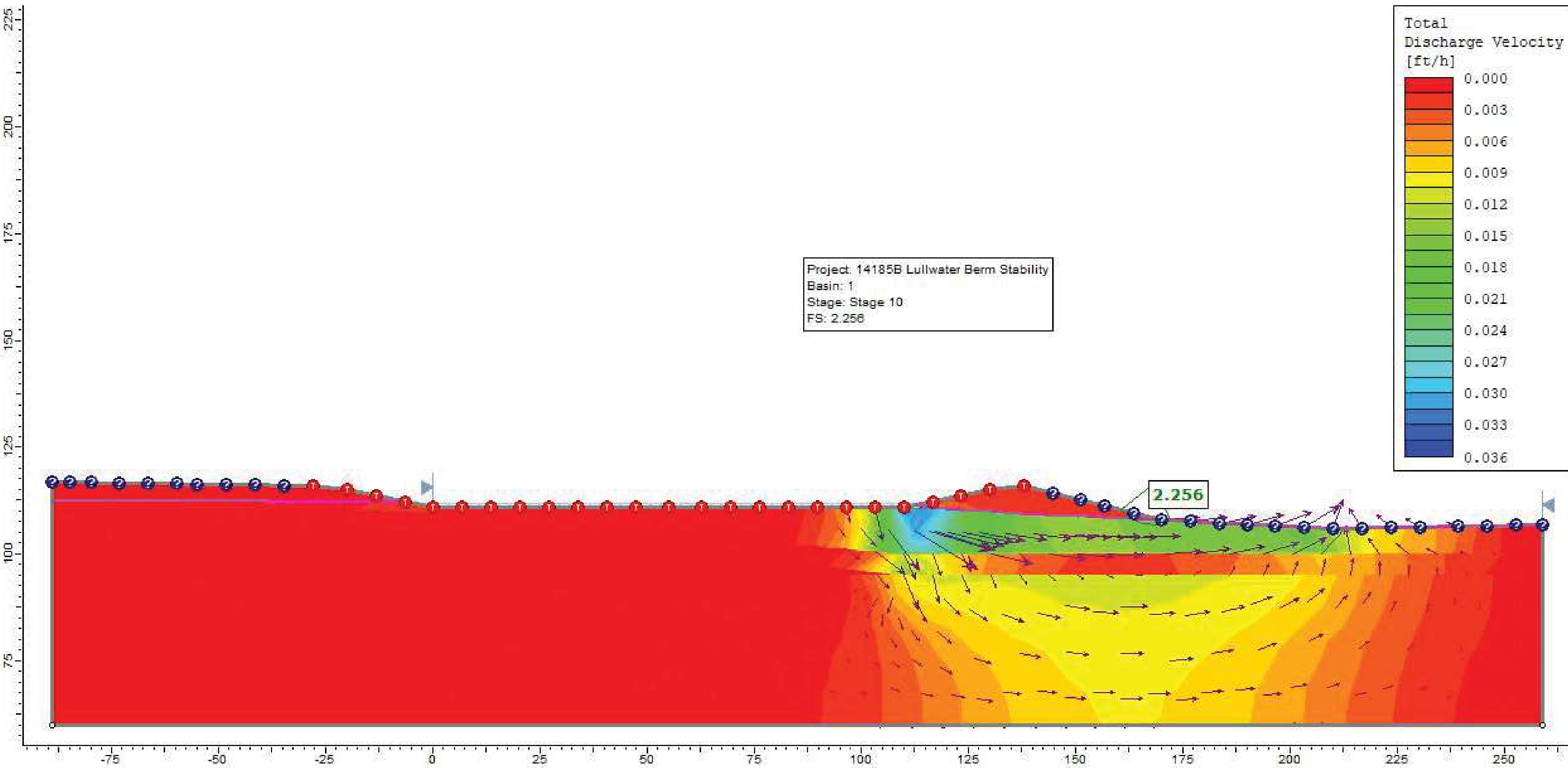
0.044
0.048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[ft/h]
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0.012
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0.018
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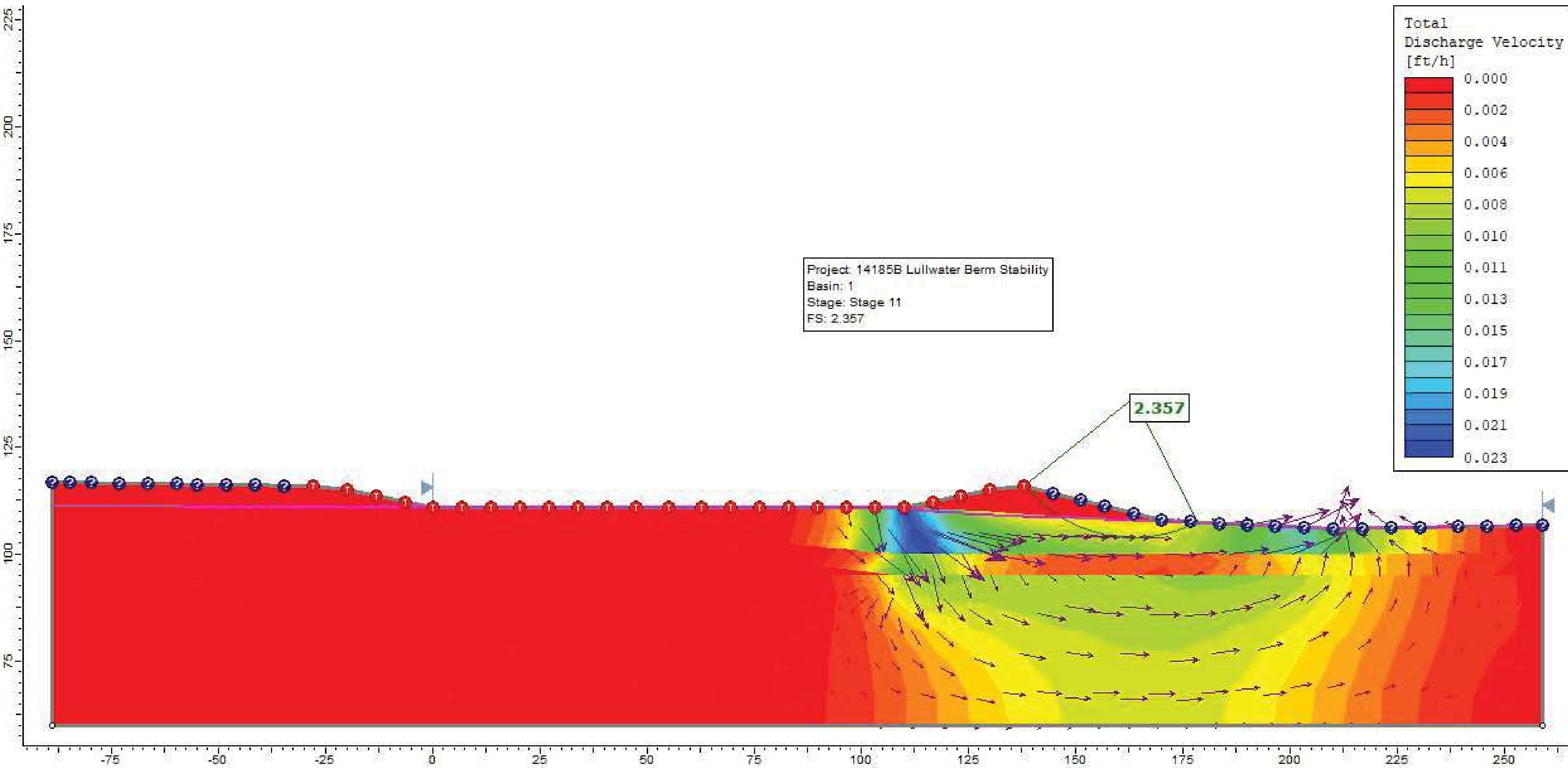
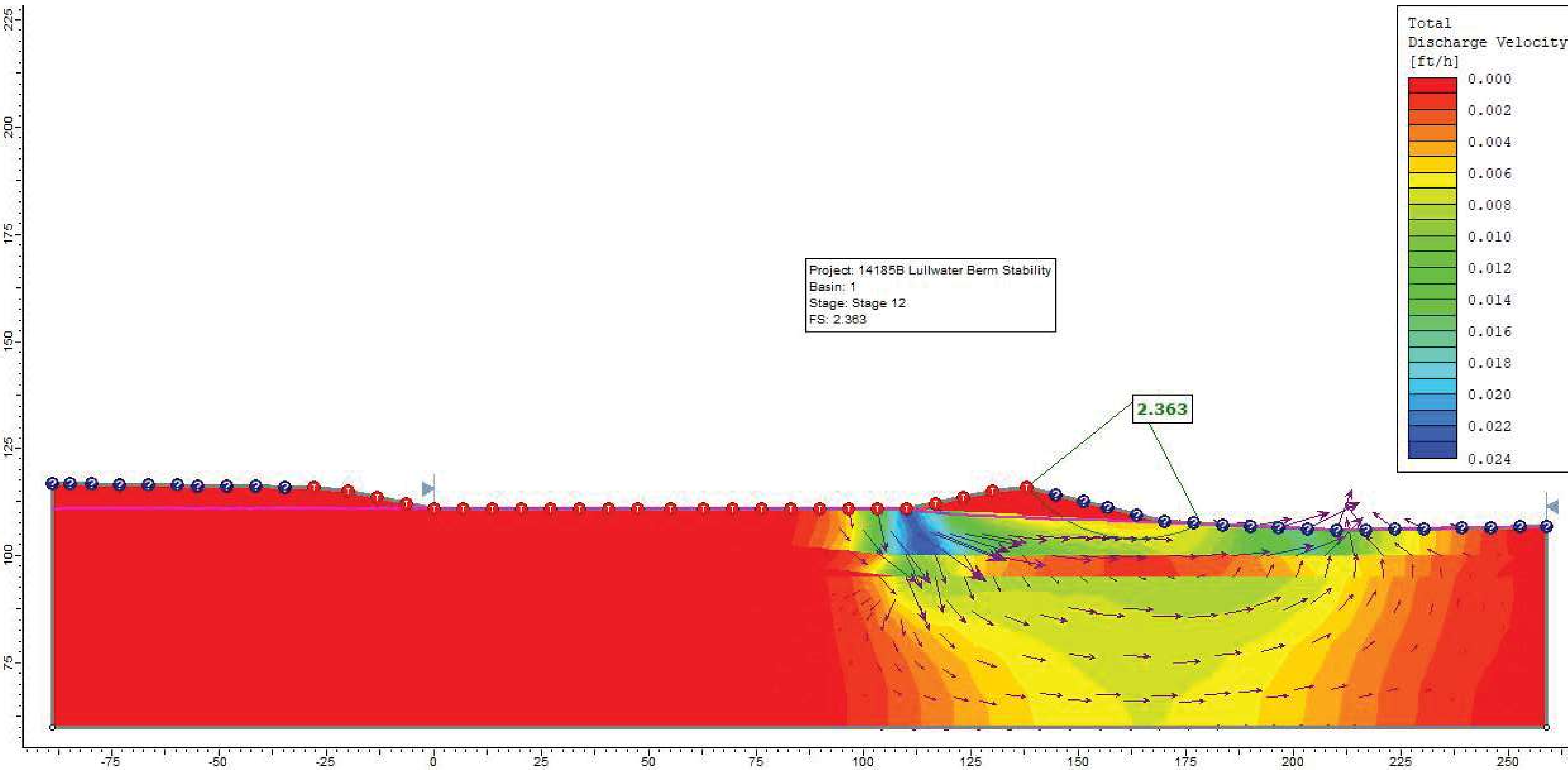
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 10
FS: 2.256
2.256
225
200
175
150
125
100
75
-75
-50
-25
0
25
50
75
100
125
150
175
200
225
250



Total
Discharge Velocity
[ft/h]
0.000
0.002
0.004
0.006
0.008
0.010
0.011
0.013
0.015
0.017
0.019
0.021
0.023
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 11
FS: 2.357
2.357
225
200
175
150
125
100
75
-75
-50
-25
0
25
50
75
100
125
150
175
200
225
250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Discharge Velocity
[ft/h]
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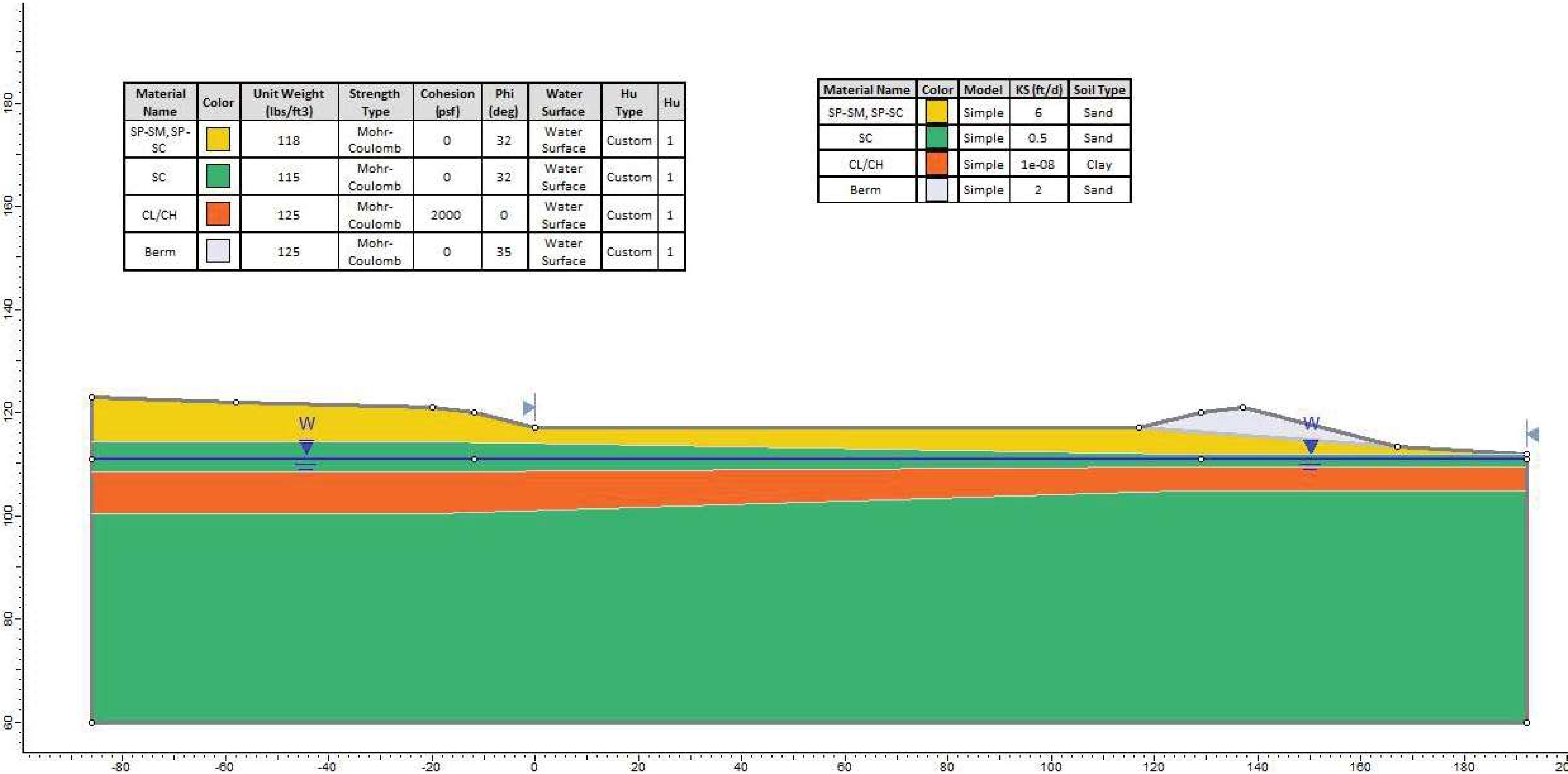
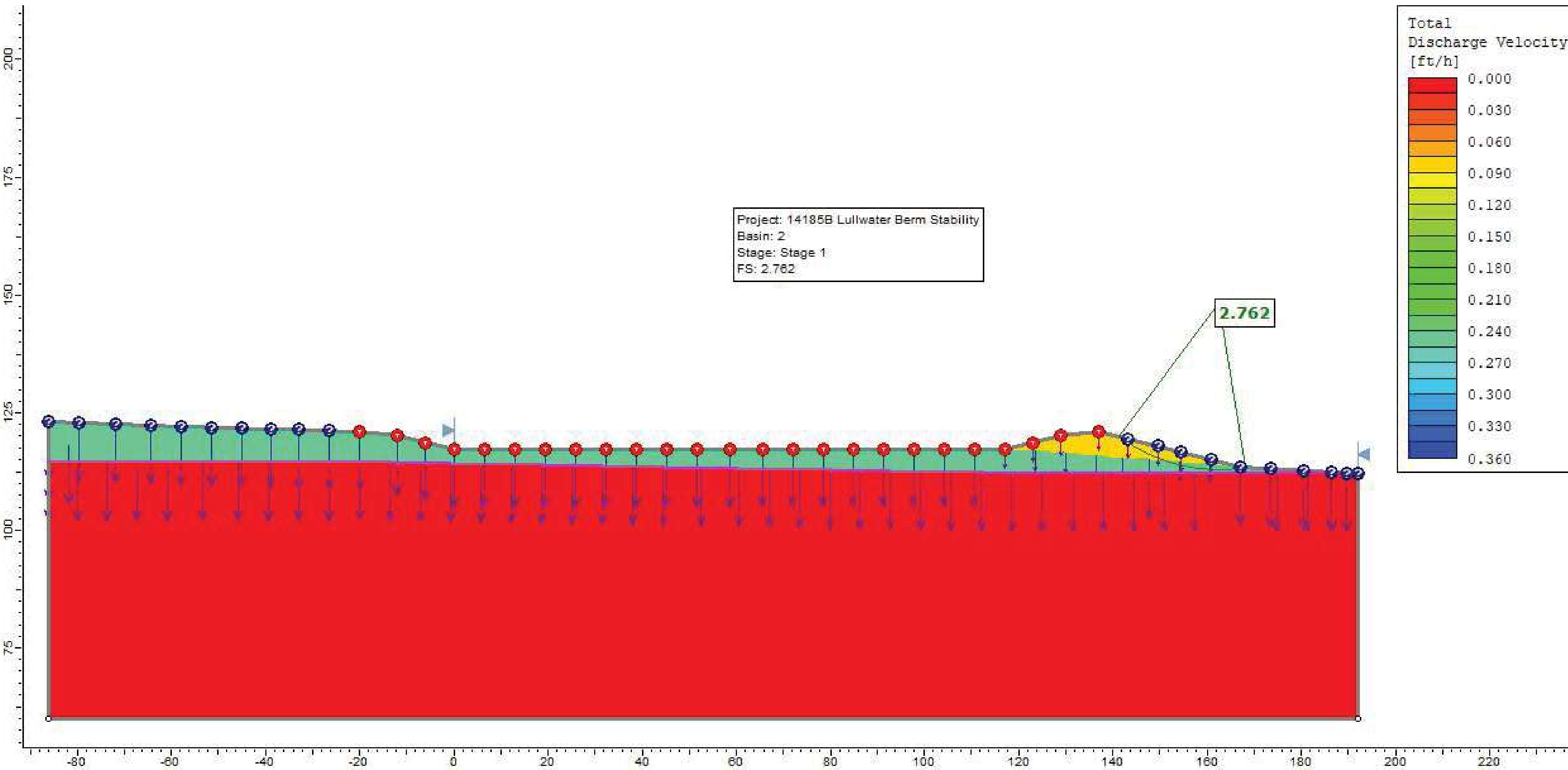
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
0.018
0.020
0.022
0.024
Project: 14185B Lullwater Berm Stability
Basin: 1
Stage: Stage 12
FS: 2.363
2.363
225
200
175
150
125
100
75
-75
-50
-25
0
25
50
75
100
125
150
175
200
225
250

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
SP-SM, SP-SC		118	Mohr-Coulomb	0	32	Water Surface	Custom	1
SC		115	Mohr-Coulomb	0	32	Water Surface	Custom	1
CL/CH		125	Mohr-Coulomb	2000	0	Water Surface	Custom	1
Berm		125	Mohr-Coulomb	0	35	Water Surface	Custom	1

Material Name	Color	Model	KS (ft/d)	Soil Type
SP-SM, SP-SC		Simple	6	Sand
SC		Simple	0.5	Sand
CL/CH		Simple	1e-08	Clay
Berm		Simple	2	Sand




Total
Discharge Velocity
[ft/h]
0.000
0.030
0.060
0.090
0.120
0.150
0.180
0.210
0.240
0.270
0.300
0.330
0.360
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 1
FS: 2.762
2.762
200
175
150
125
100
75
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-20
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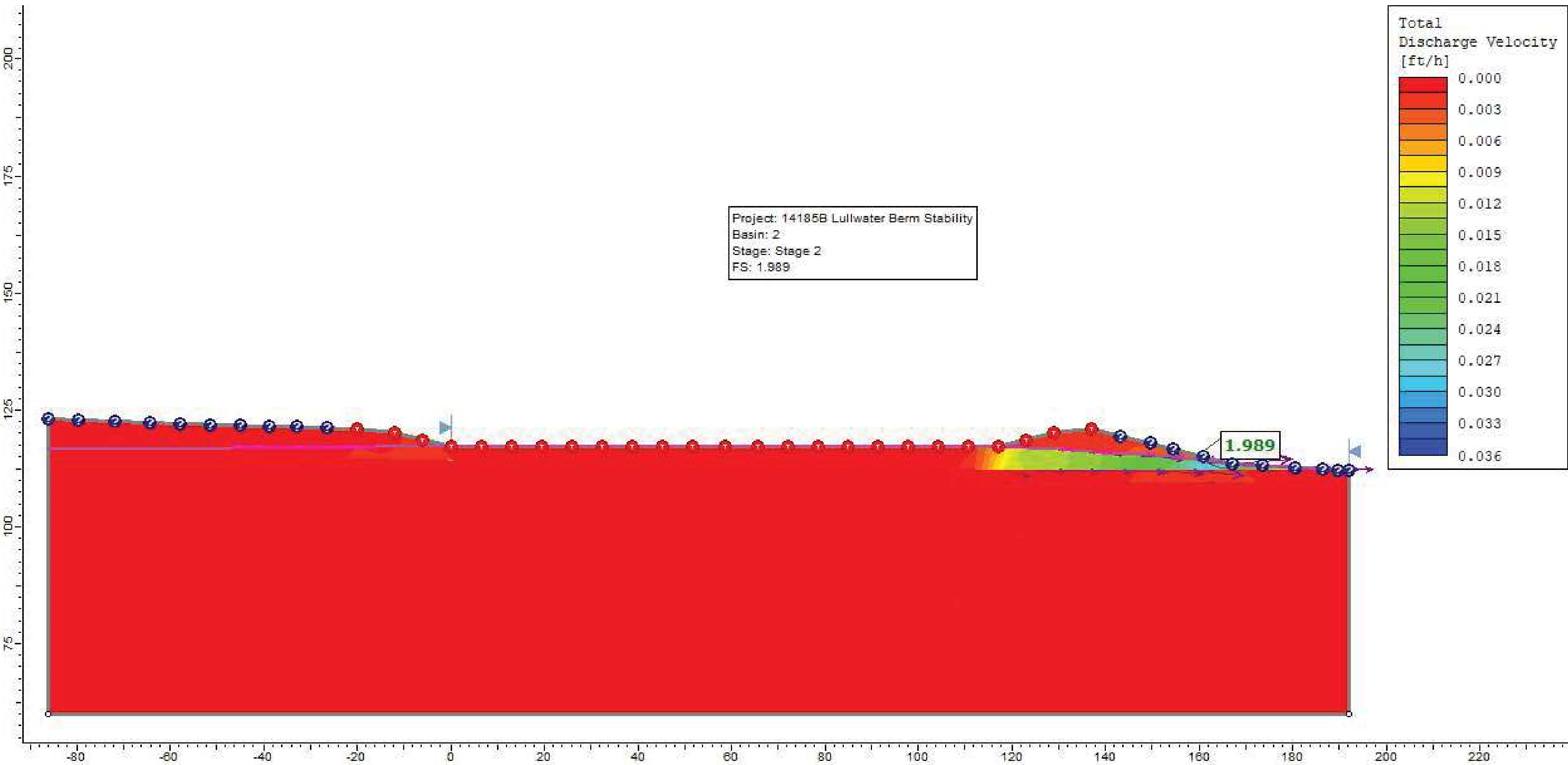
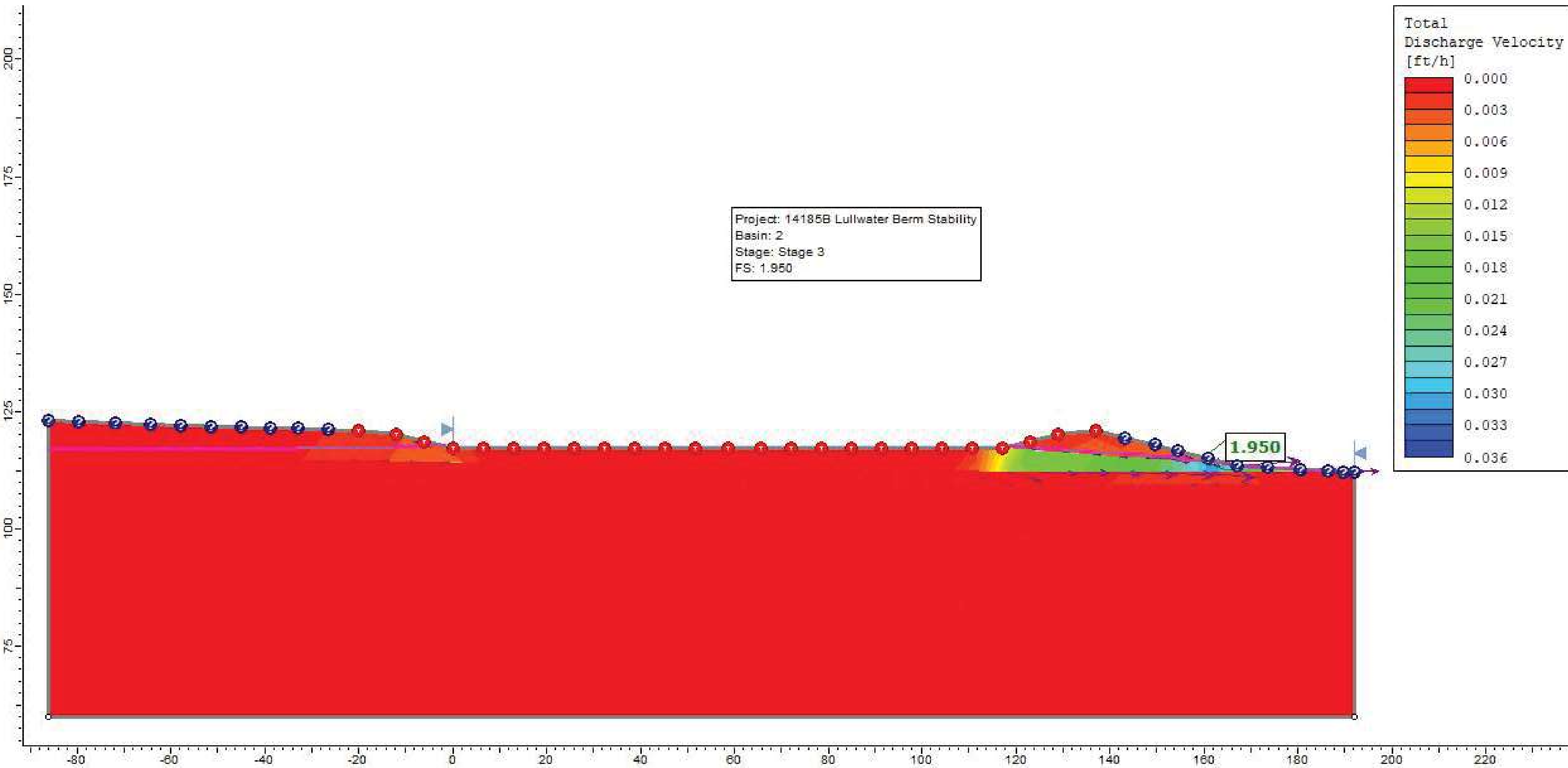
100
120
140
160
180
200
220


Total
Discharge Velocity
[ft/h]
0.000
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 2
FS: 1.989
1.989
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Total
Discharge Velocity
[ft/h]
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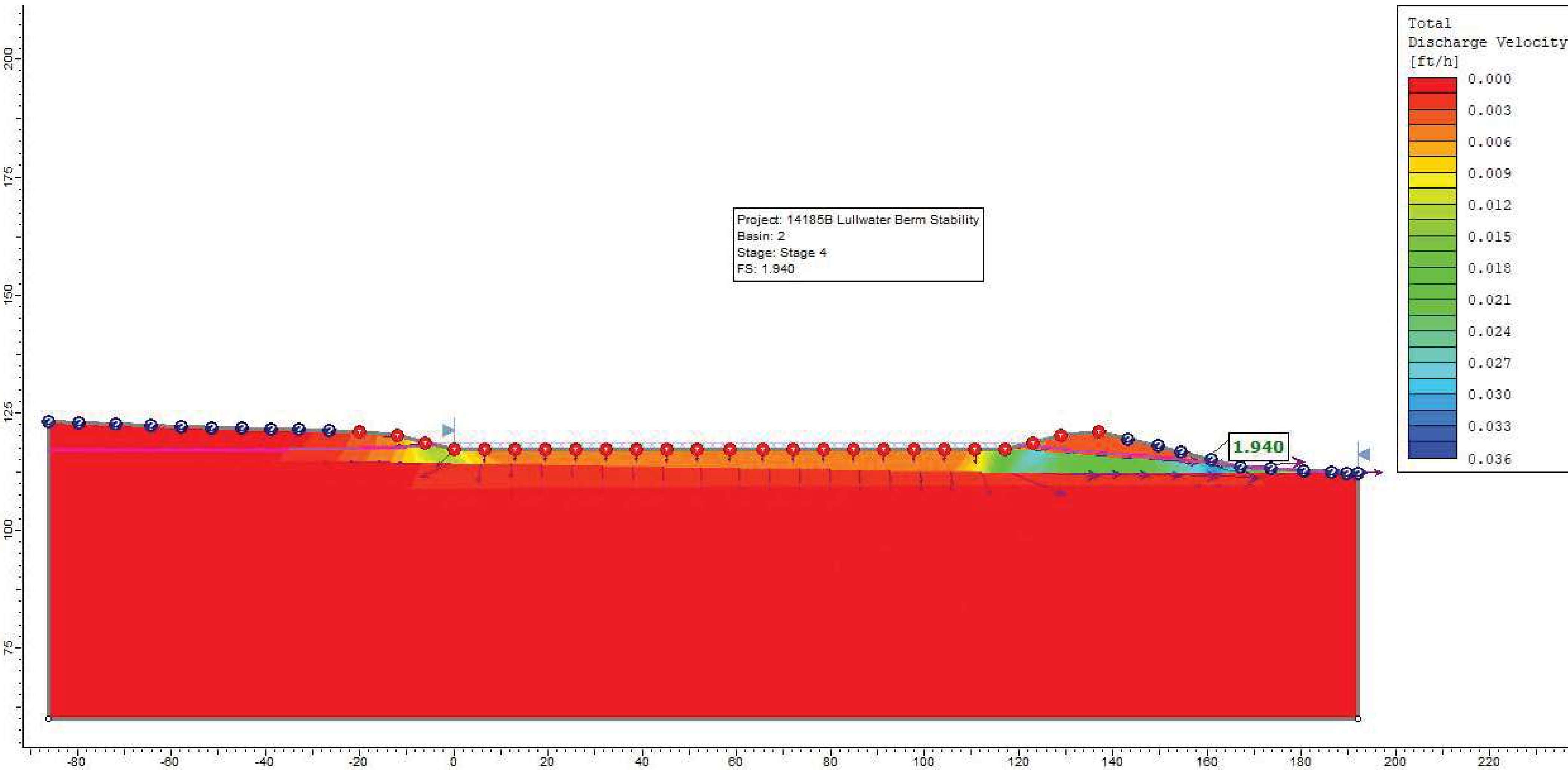
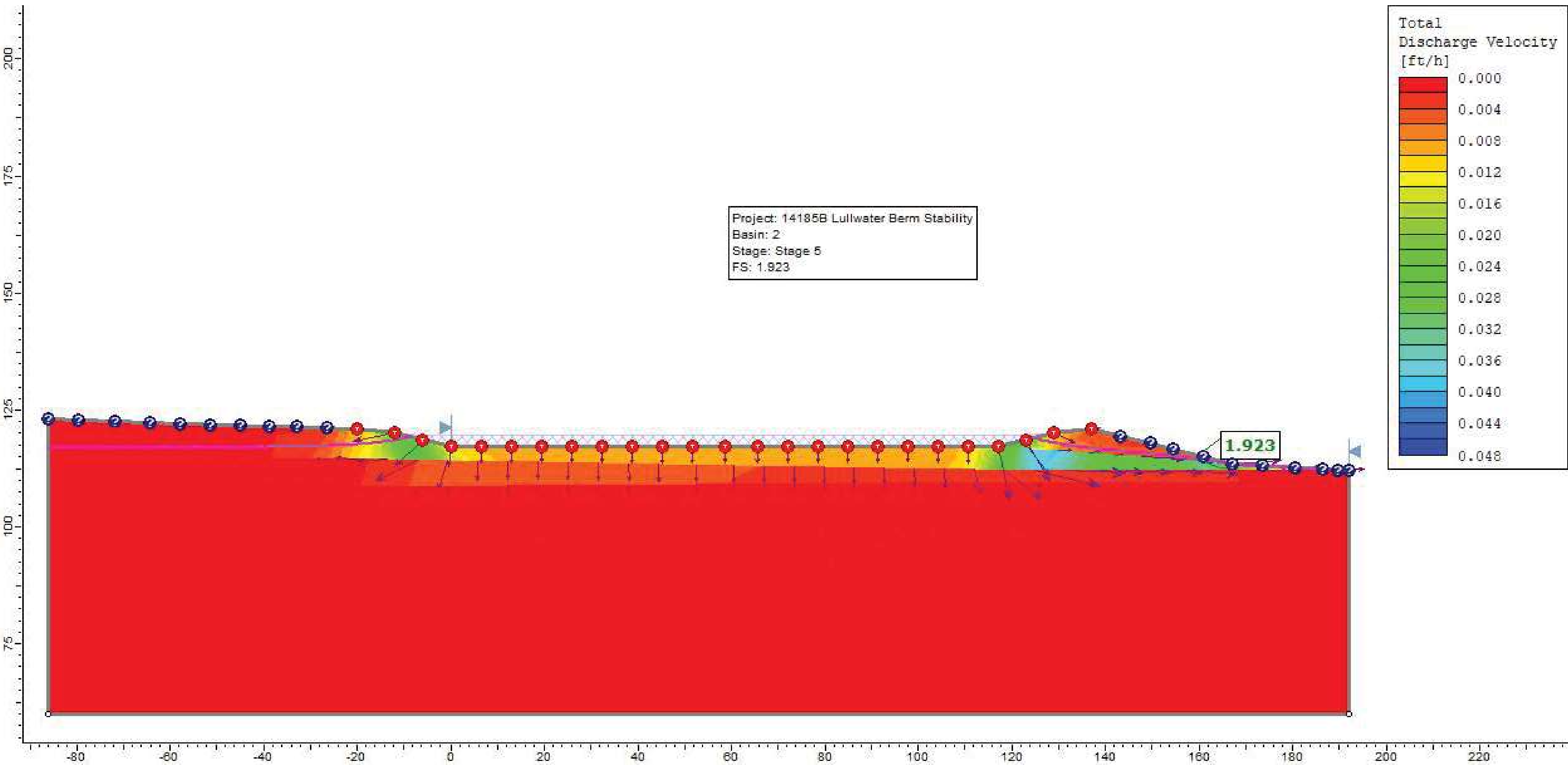
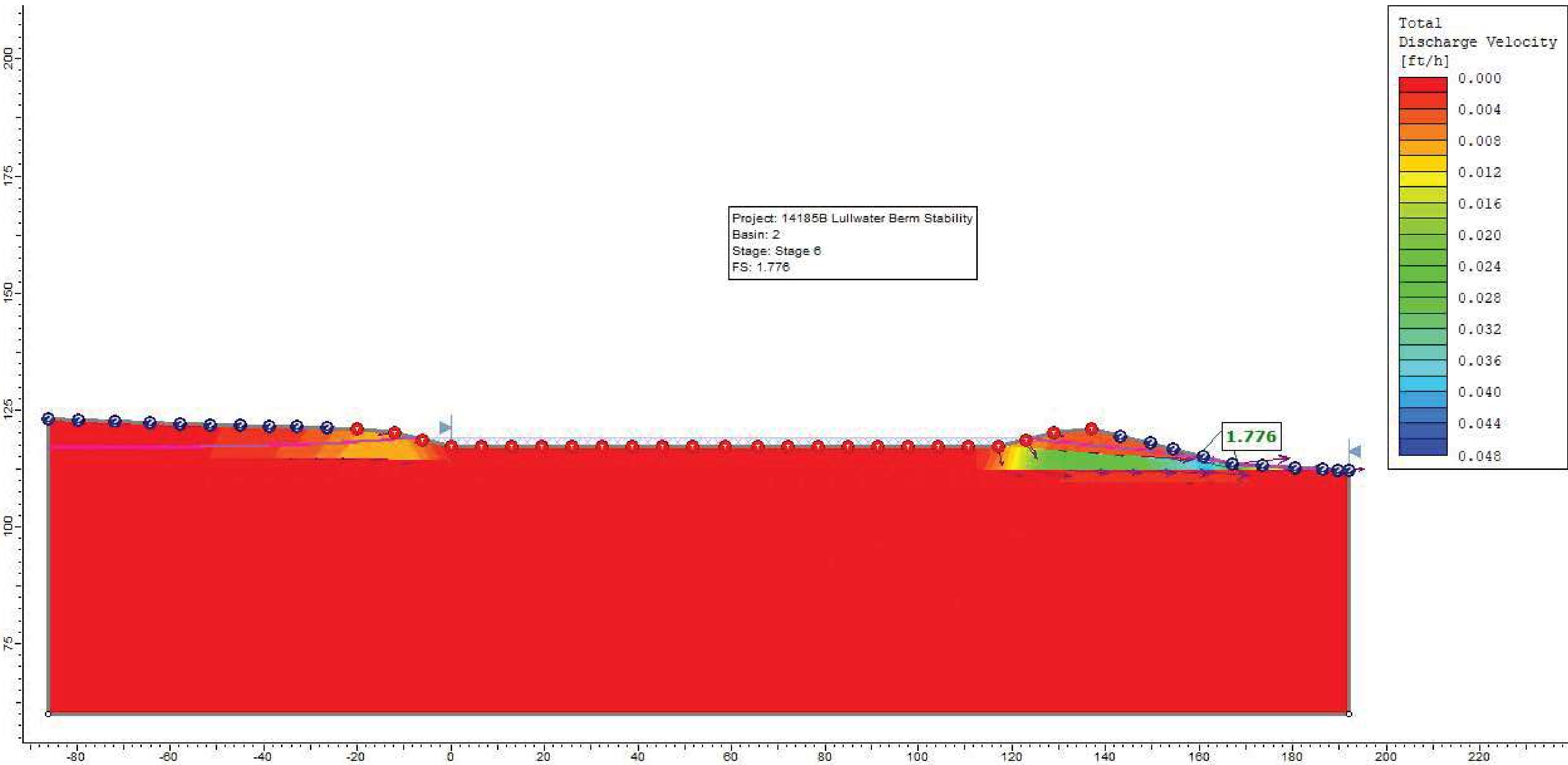
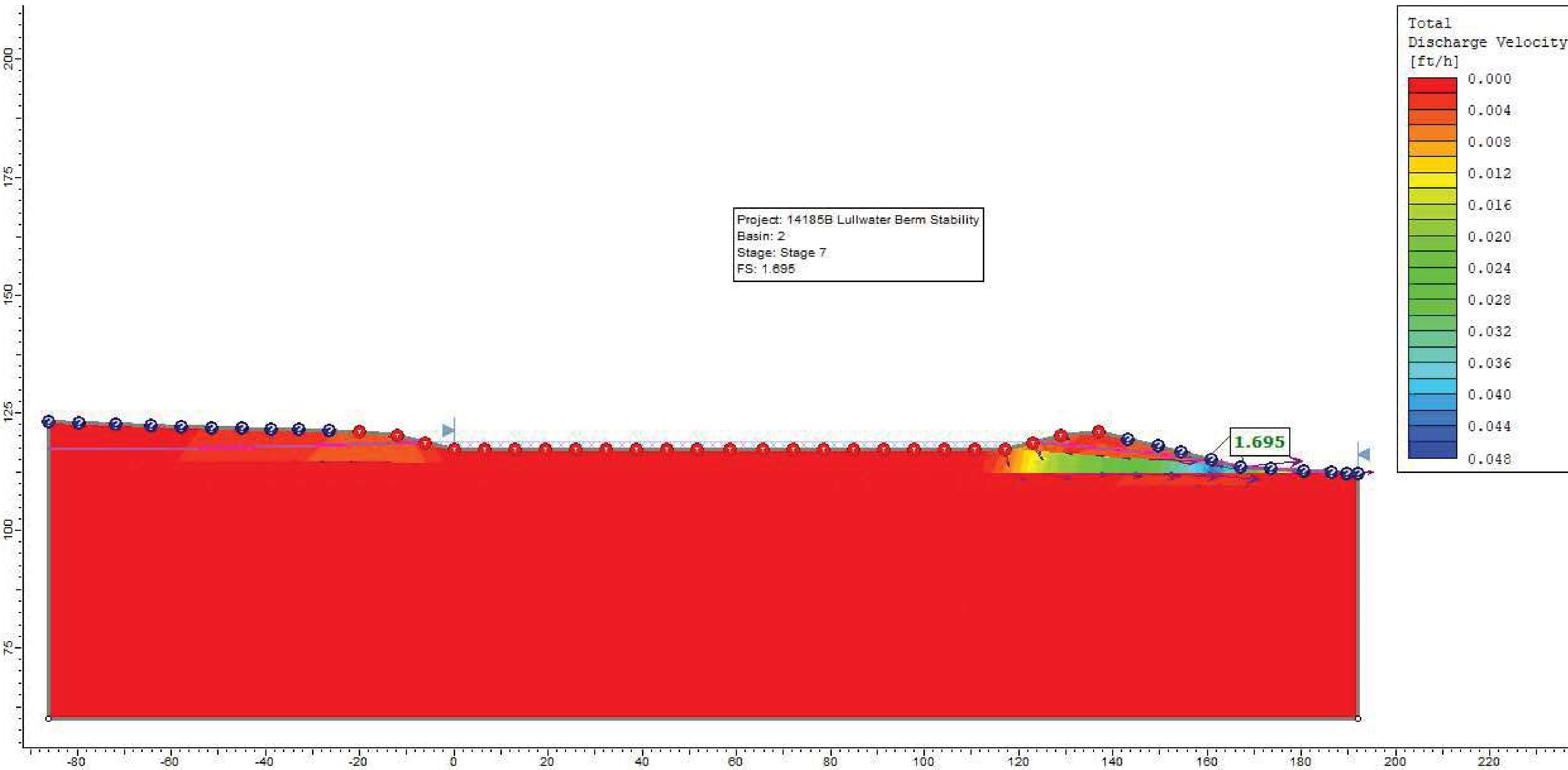
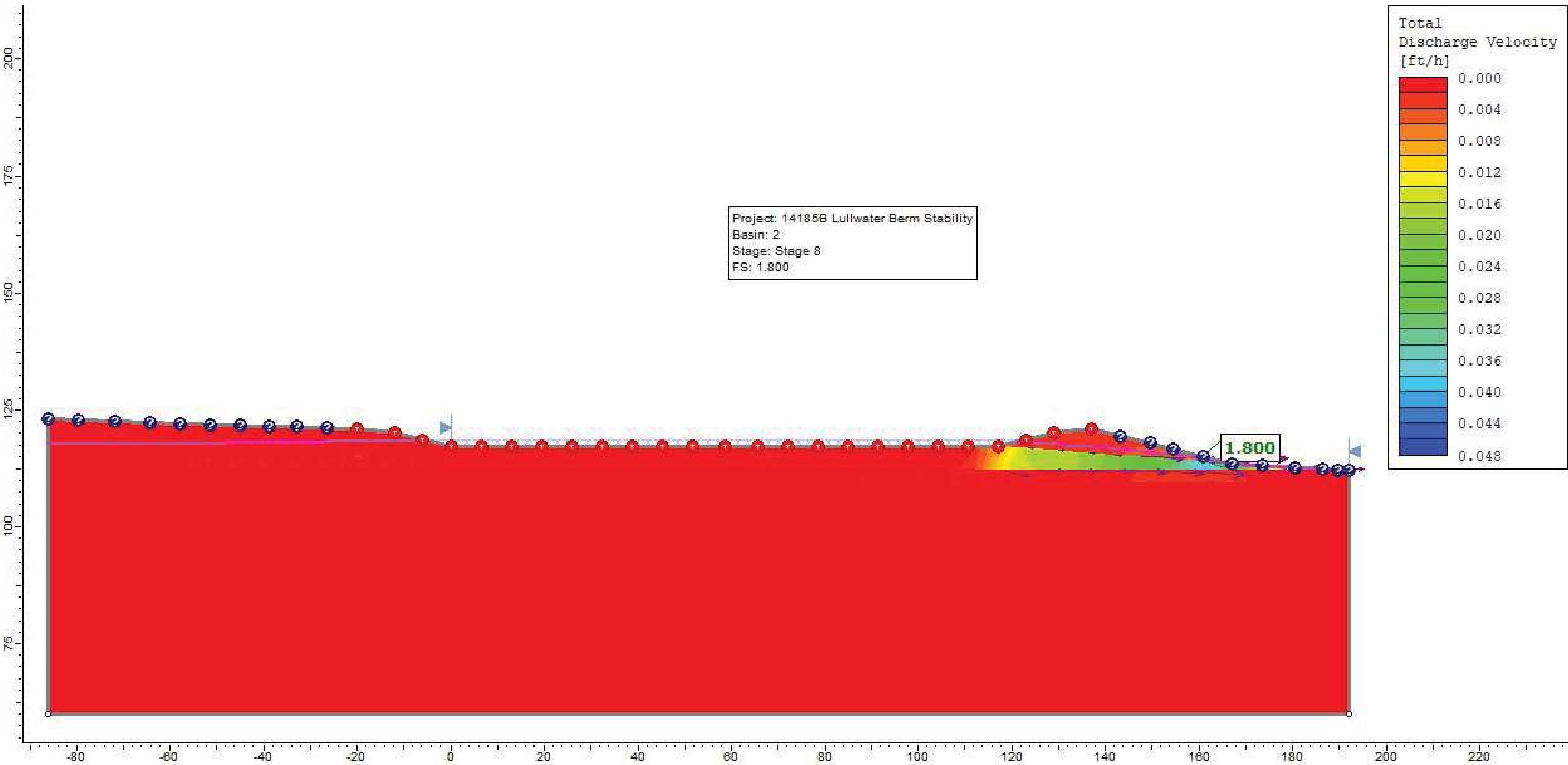
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 3
FS: 1.950
1.950
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 4
FS: 1.940
1.940
Total
Discharge Velocity
[ft/h]
0.000
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Total
Discharge Velocity
[ft/h]
0.000
0.004
0.008
0.012
0.016
0.020
0.024
0.028
0.032
0.036
0.040
0.044
0.048
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 5
FS: 1.923
1.923
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Total
Discharge Velocity
[ft/h]
0.000
0.004
0.008
0.012
0.016
0.020
0.024
0.028
0.032
0.036
0.040
0.044
0.048
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 6
FS: 1.776
1.776
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Total
Discharge Velocity
[ft/h]
0.000
0.004
0.008
0.012
0.016
0.020
0.024
0.028
0.032
0.036
0.040
0.044
0.048
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 7
FS: 1.695
1.695
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220



Total
Discharge Velocity
[ft/h]
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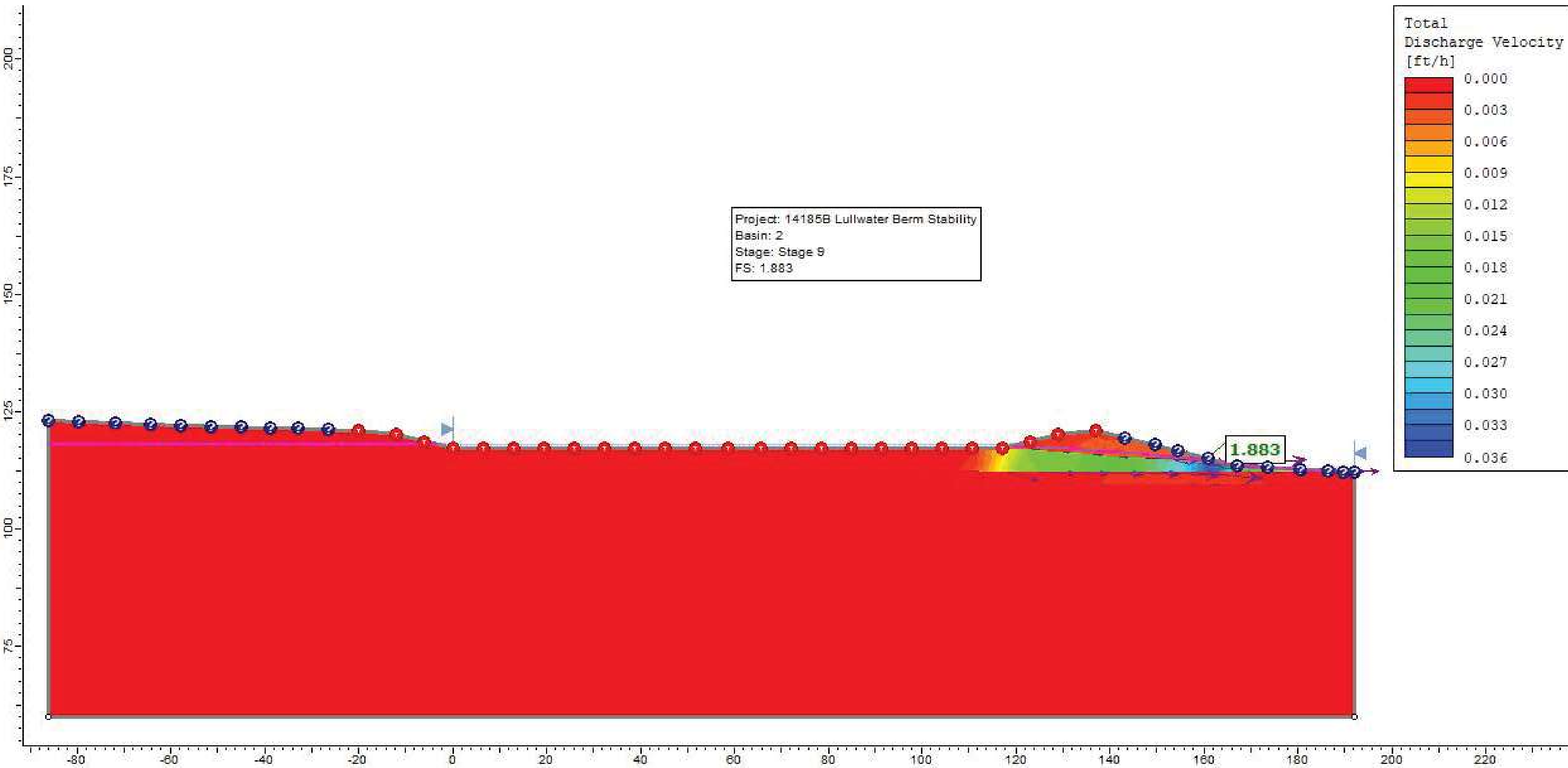
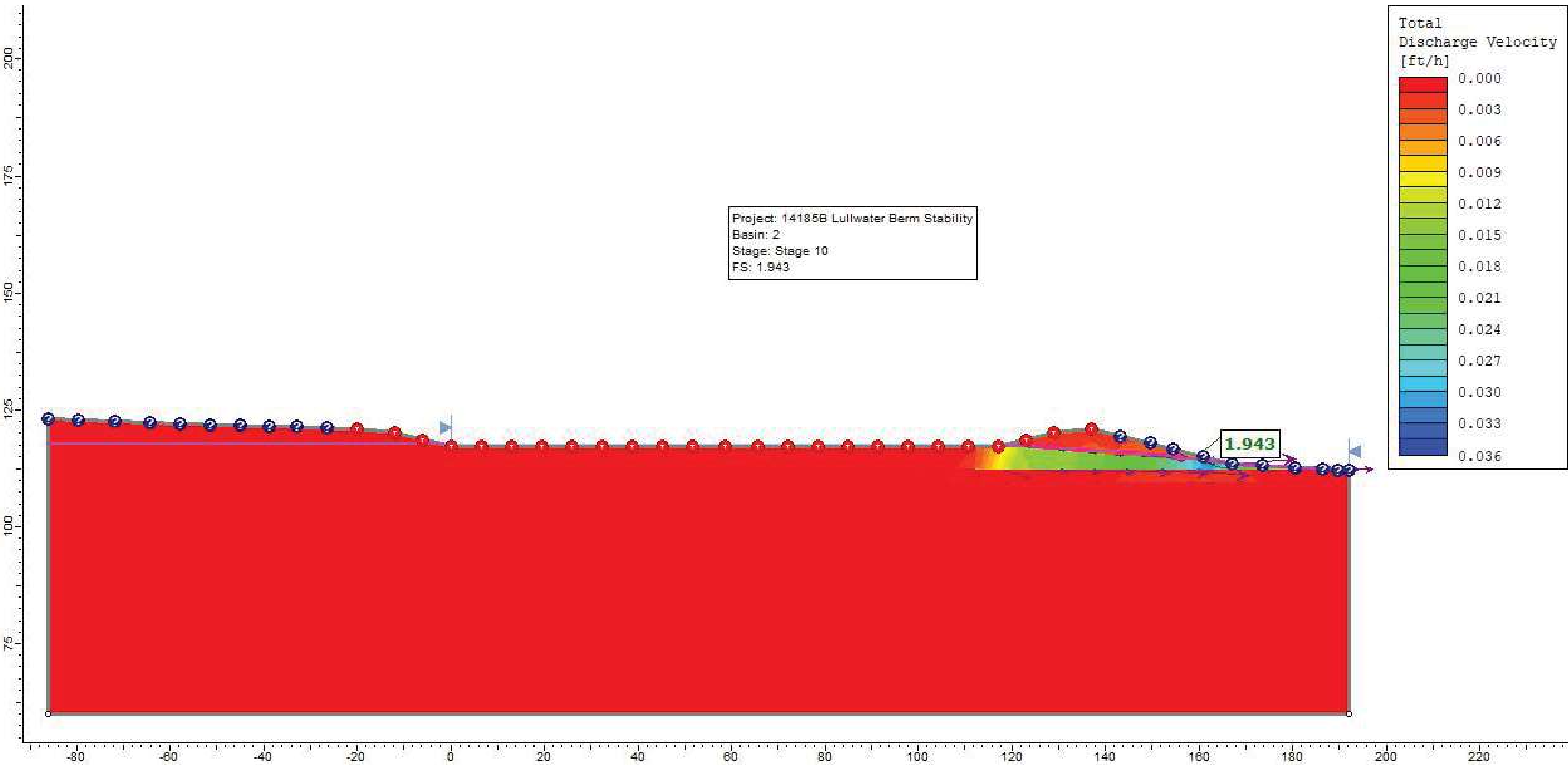
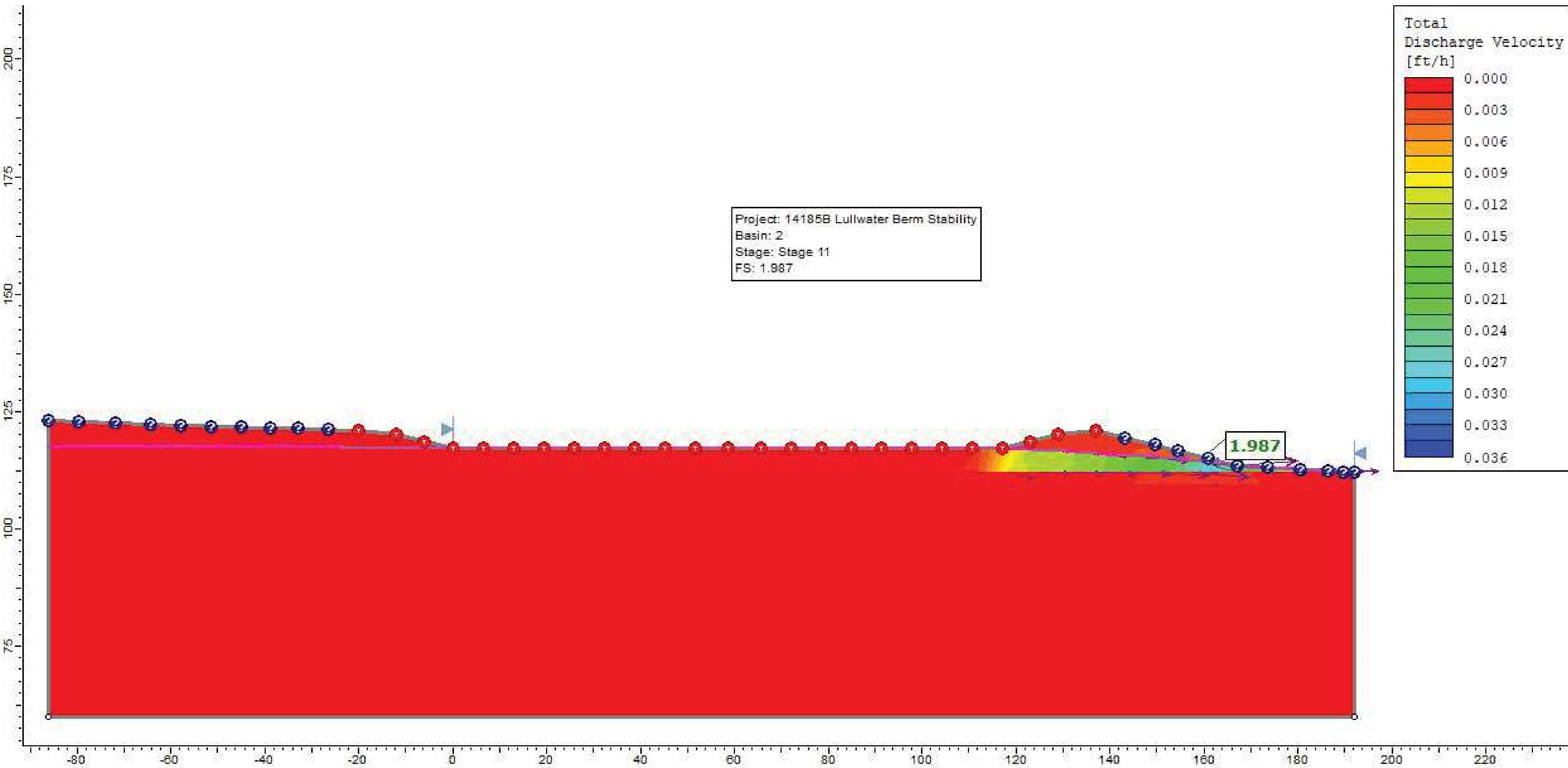
0.004
0.008
0.012
0.016
0.020
0.024
0.028
0.032
0.036
0.040
0.044
0.048
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 8
FS: 1.800
1.800

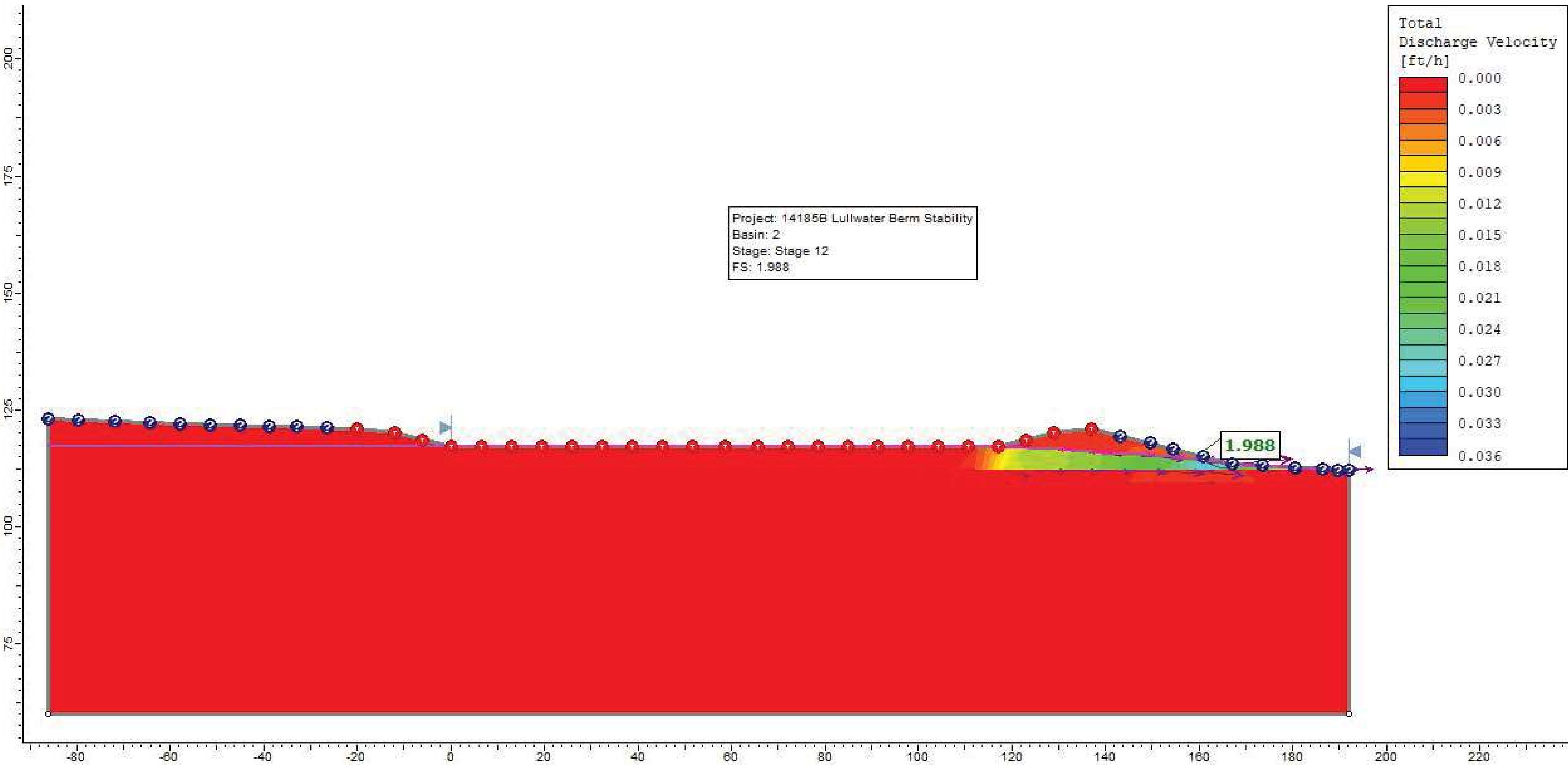


Total
Discharge Velocity
[ft/h]
0.000
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 9
FS: 1.883
1.883



Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 10
FS: 1.943
1.943
Total
Discharge Velocity
[ft/h]
0.000
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Total
Discharge Velocity
[ft/h]
0.000
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 11
FS: 1.987
1.987
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220


Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 12
FS: 1.988
1.988
Total
Discharge Velocity
[ft/h]
0.000
0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
200
175
150
125
100
75
-80
-60
-40
-20
0
20
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60
80
100
120
140
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180
200
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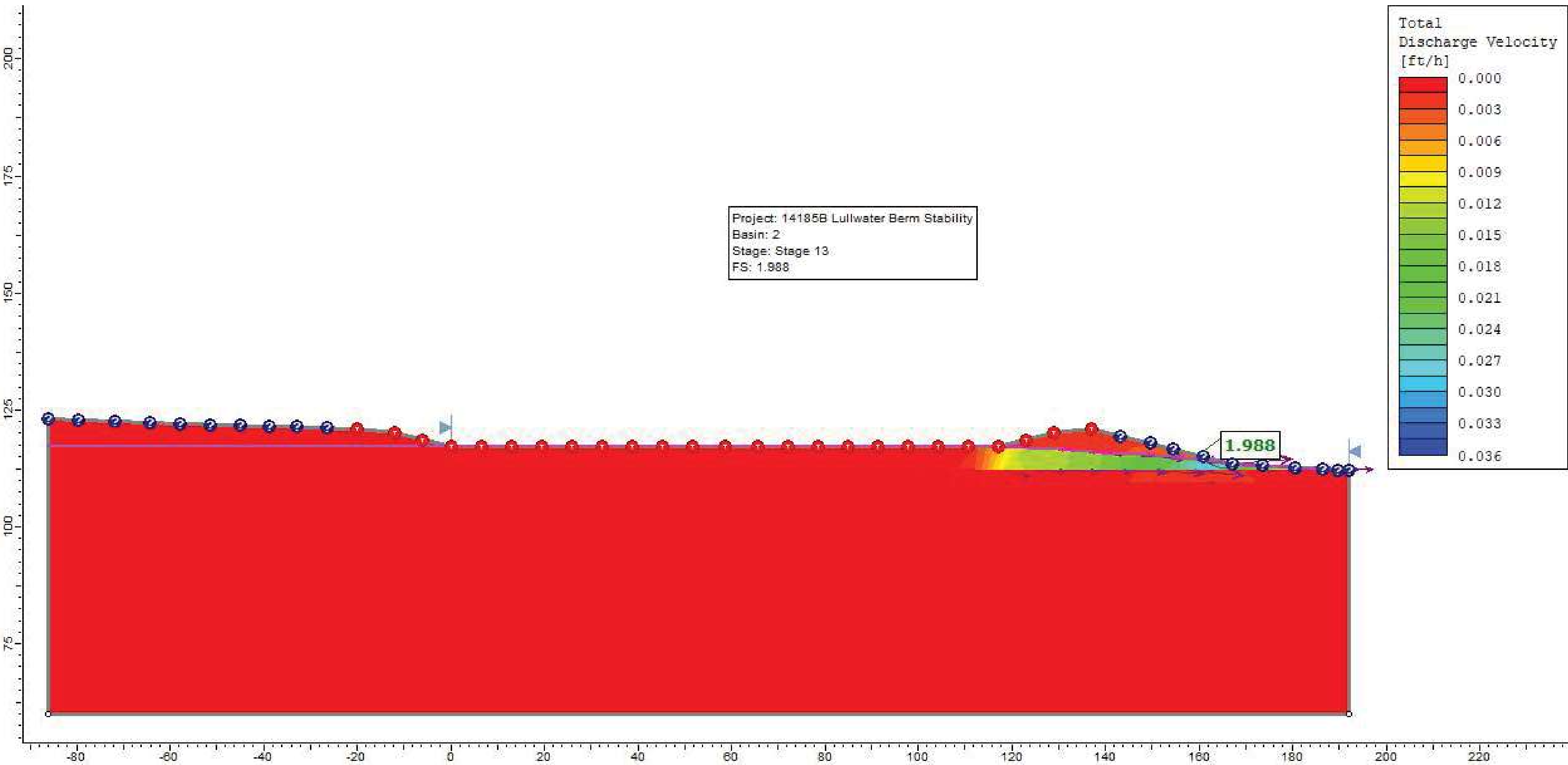

Total
Discharge Velocity
[ft/h]
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0.003
0.006
0.009
0.012
0.015
0.018
0.021
0.024
0.027
0.030
0.033
0.036
Project: 14185B Lullwater Berm Stability
Basin: 2
Stage: Stage 13
FS: 1.988
1.988
200
175
150
125
100
75
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220