Attachment I-12: ND Diversion Channel Phase 4 Results

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers

Fargo-Moorhead Metro Feasibility Study
Phase 4.1 Geotechnical Design/Analyses of ND Diversion with LPP Version #4 Invert Raise

Compiled By: KAH Revised By: KAH
Date: 12/9/2010 Date: 2/24/2011

Target Factor of Safety	1.400	1.400	1.200	1.200	1.300
variation	0.050	0.050	0.050	0.050	0.050
	1.350	1.350	1.150	1.150	1.250

North Dakota Diversion Channel, Section 1 STA 120+00 0+00 375+00 37,500 7.1

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 1	100	854				882	7	28										246		8354	
FM_P4_ND_Div_Sect-01_P4_vr4	**250**	**865**				**882**	**7**	**17**	**50**	**8**		1.554	1.558	1.702	2.206	1.345	8	244	-0.8%	6339	-24%

North Dakota Diversion Channel, Section 2 STA 530+00 375+00 656+00 28,100 5.3

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 2	100	862				890	7	28										246		8354	
FM_P4_ND_Div_Sect-02_P4_vr4	**250**	**868**	**15**	**8**	**7**	**890**	**7**	**22**	**50**	**11**		1.431	1.437	1.508	1.957	1.315	3	294	19.5%	9374	12%

North Dakota Diversion Channel, Section 3 STA 940+00 656+00 1000+00 34,400 6.5

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 3	100	870				900	7	30										260		9366	
FM_P3_ND_Div_Sect-03_P4_vr4	**250**	**877**	**25**	**8**	**7**	**900**	**7**	**23**	**50**	**15**		1.421	1.411	1.710	1.791	1.332	4	311	19.6%	10269	10%

North Dakota Diversion Channel, Section 4 STA 1080+00 1000+00 1150+00 15,000 2.8

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 4	100	873				900	7	27										239		7869	
FM_P3_ND_Div_Sect-04_P4_vr4	**250**	**879**	**20**	**8**	**7**	**900**	**7**	**21**	**50**	**15**		1.429	1.425	1.611	1.880	1.364	3	292	22.2%	8923	13%

North Dakota Diversion Channel, Section 5 STA 1225+00 1150+00 1300+00 15,000 2.8

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 5	100	876				903	7	27										239		7869	
FM_P3_ND_Div_Sect-05_P4_vr4	**250**	**881**	**40**	**8**	**7**	**903**	**7**	**22**	**50**	**12**		1.411	1.412	1.418	1.640	1.306	2	319	33.5%	10074	28%

North Dakota Diversion Channel, Section 5B STA 1445+00 1300+00 1490+00 19,000 3.6

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 5B	100	880				913	7	33										281		10989	
FM_P3_ND_Div_Sect-05B_P4_vr4	**250**	**885**	**40**	**8**	**7**	**913**	**7**	**28**	**50**			1.416	1.415	1.208	1.409	1.507	2	361	28.5%	14154	29%

North Dakota Diversion Channel, Section 6B STA 1550+00 1490+00 1670+00 18,000 3.4

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 6B	100	882				920	7	38										316		13974	
FM_P3_ND_Div_Sect-06B_P4_vr4	250	903				920	7	17	50			1.512	1.513	1.636	2.146	1.563	18	244	-22.8%	6339	-55%

St. Paul District GEOLOGY GEOTECHNICAL
US Army Corps of Engineers

Fargo-Moorhead Metro Feasibility Study
Phase 4.1 Geotechnical Design/Analyses of ND Diversion with LPP Version #4 Invert Raise

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Target Factor of Safety	1.400	1.400	1.200	1.200	1.300
variation	0.050	0.050	0.050	0.050	0.050
	1.350	1.350	1.150	1.150	1.250

North Dakota Diversion Channel, Section 6C STA 1720+00 1670+00 1770+00 10,000 1.9

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 6C	100	886				913	7	27										239		7869	
FM_P3_ND_Div_Sect-06C_P4_vr4	**250**	**905**				**913**	**7**	**8**	**50**			2.353	2.350	2.565	4.330	2.092	16	181	-24.3%	2514	-68%

North Dakota Diversion Channel, Section 7 STA 1810+00 1770+00 1915+00 14,500 2.7

	Channel Configuration								Spoil Pile Surcharge			Stability Analysis: Min FS								
Filename	Bottom Width	Bottom Elev.	Bench Width	Bench Height	Bench Slope	Ground Surface	Channel Slope	Depth	Setback	Height	Other Changes	(A) Global Entry/Exit	(B) Wedge	(C) Lower Localized	(D) Upper Localized	(2) Undrained Global	P4 vs P3 Invert Elev	Top of slope	% Increase	X-Sectional Area	% Increase
Original ND Sect 7	225	893				912	7	19										245.5		6868	
FM_P3_ND_Div_Sect-07_P4_vr4	**250**	**901**				**912**	**7**	**11**	**50**			2.201	2.173	2.274	3.116	2.000	8	202	-17.7%	3663	-47%

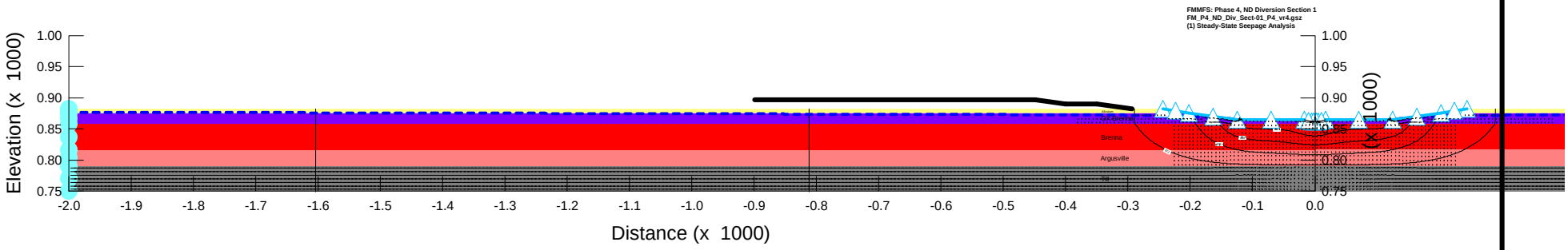
File Name: FM_P4_ND_Div_Sect-01_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 1

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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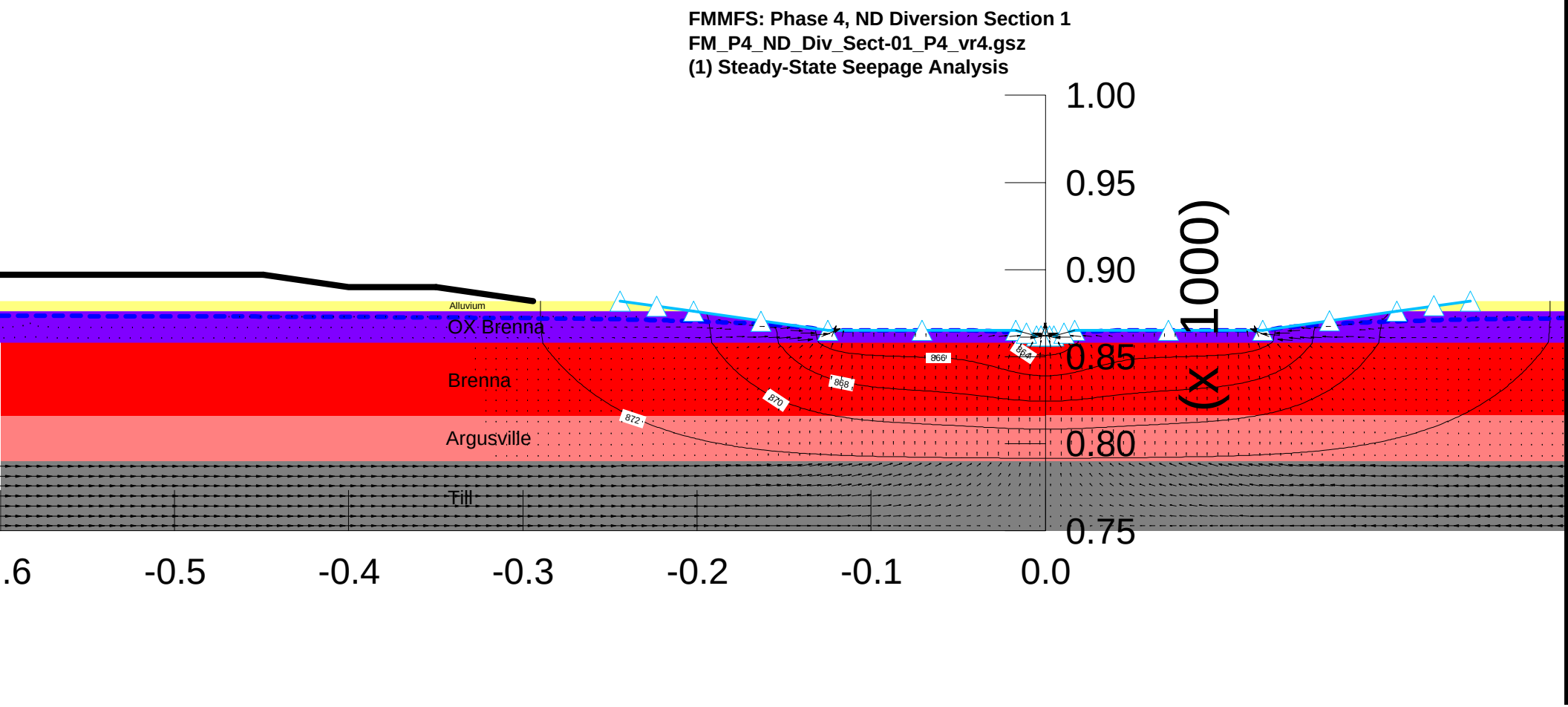
Last Edited By: Heckendorf, Kurt A MVP
Date: 1/18/2011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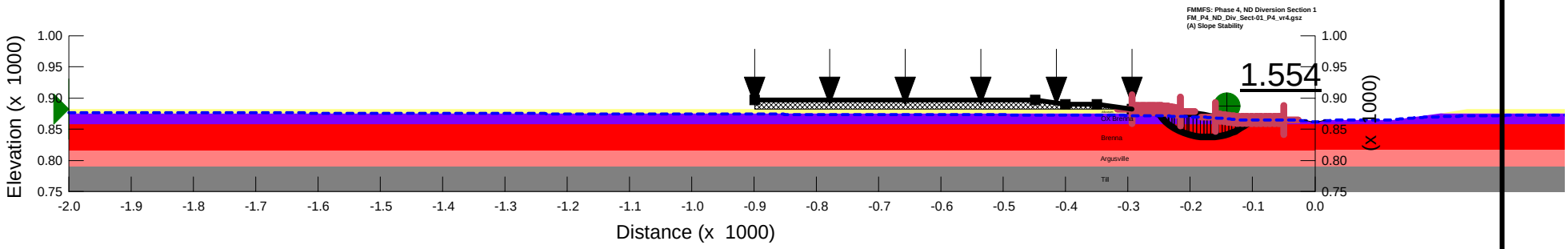
FM_P4_ND_Div_Sect-01_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Argusville
Till
866
868
870
872
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-01_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 1
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



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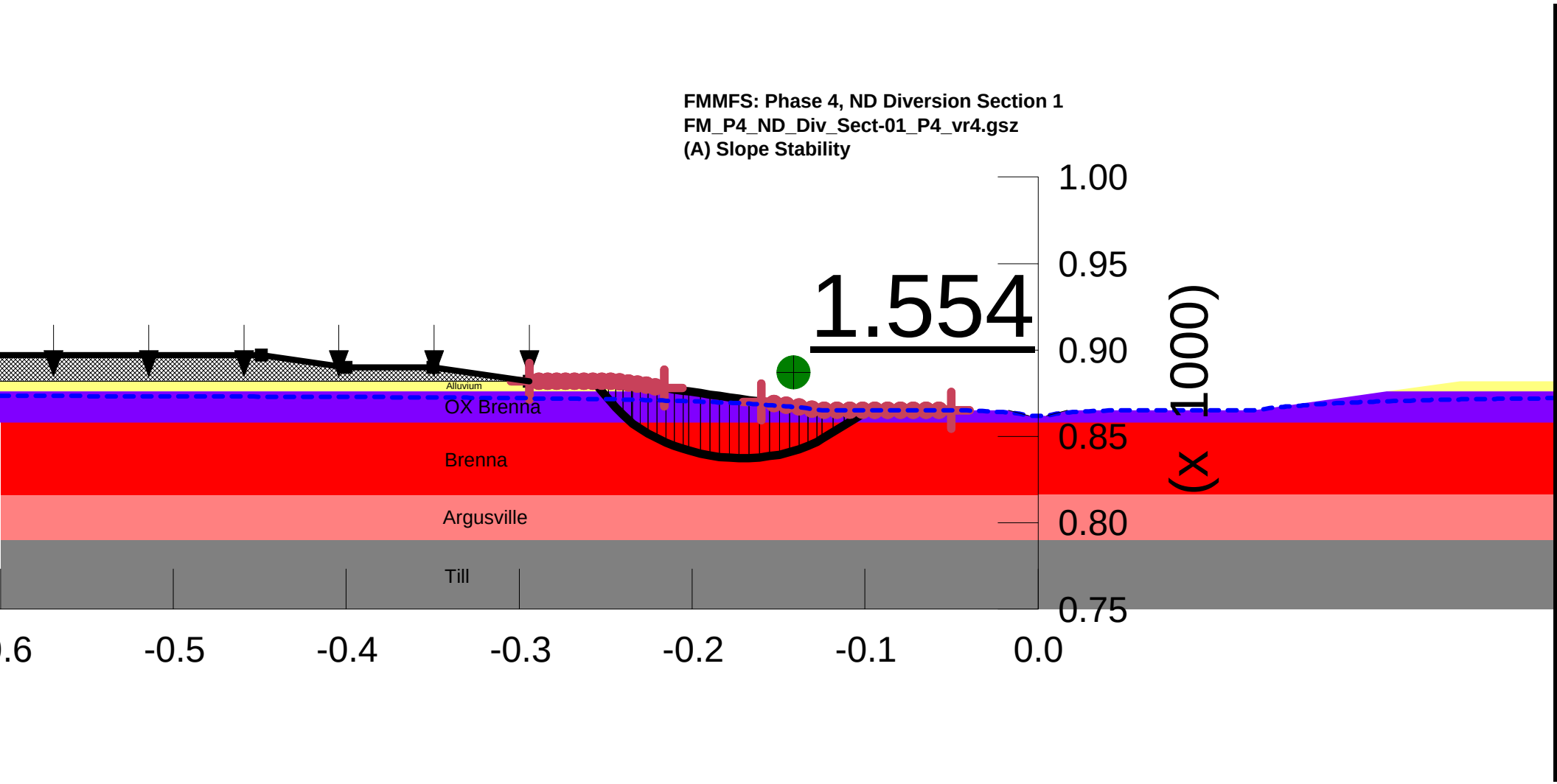
Date: 2/11/2011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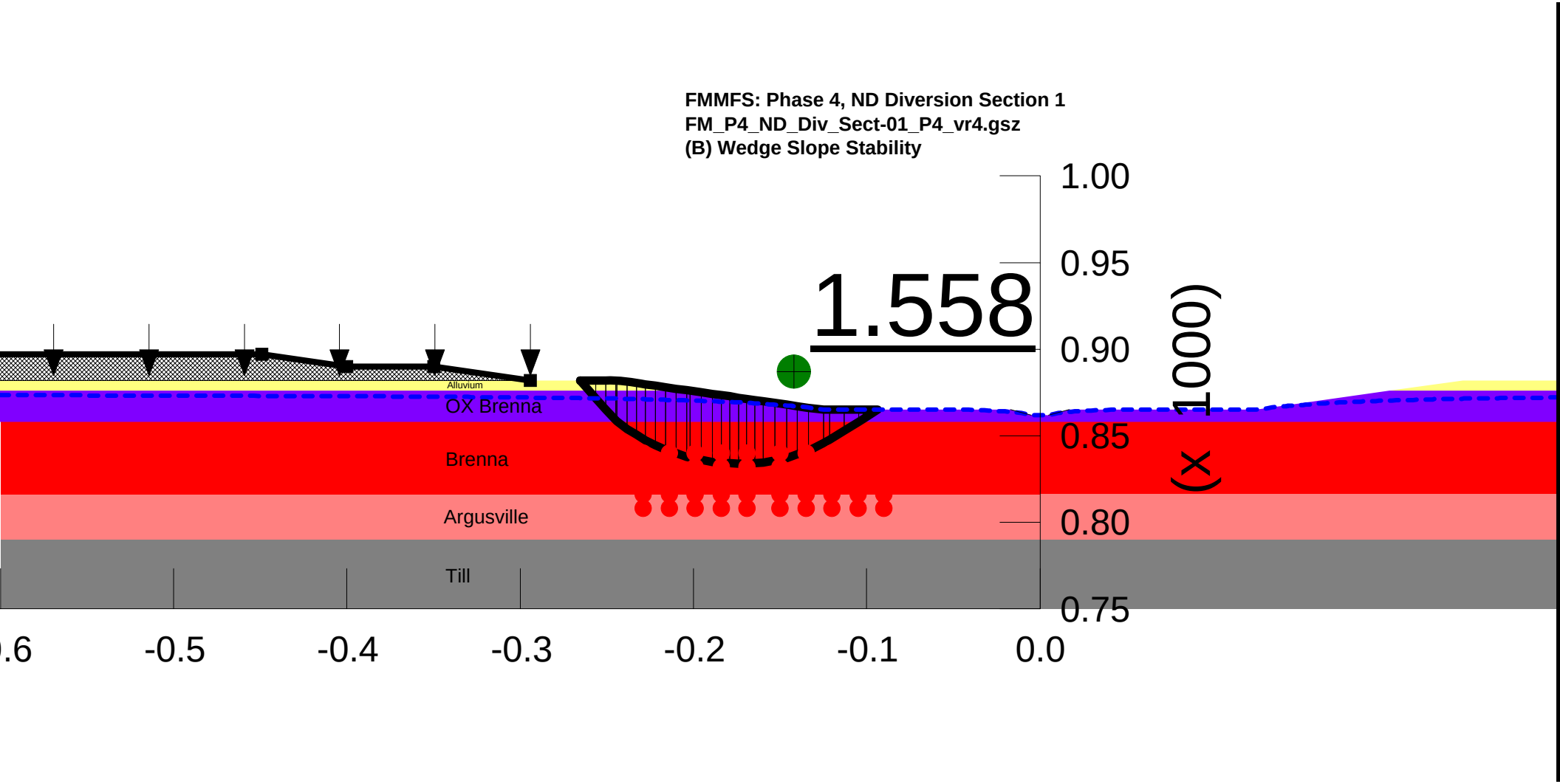
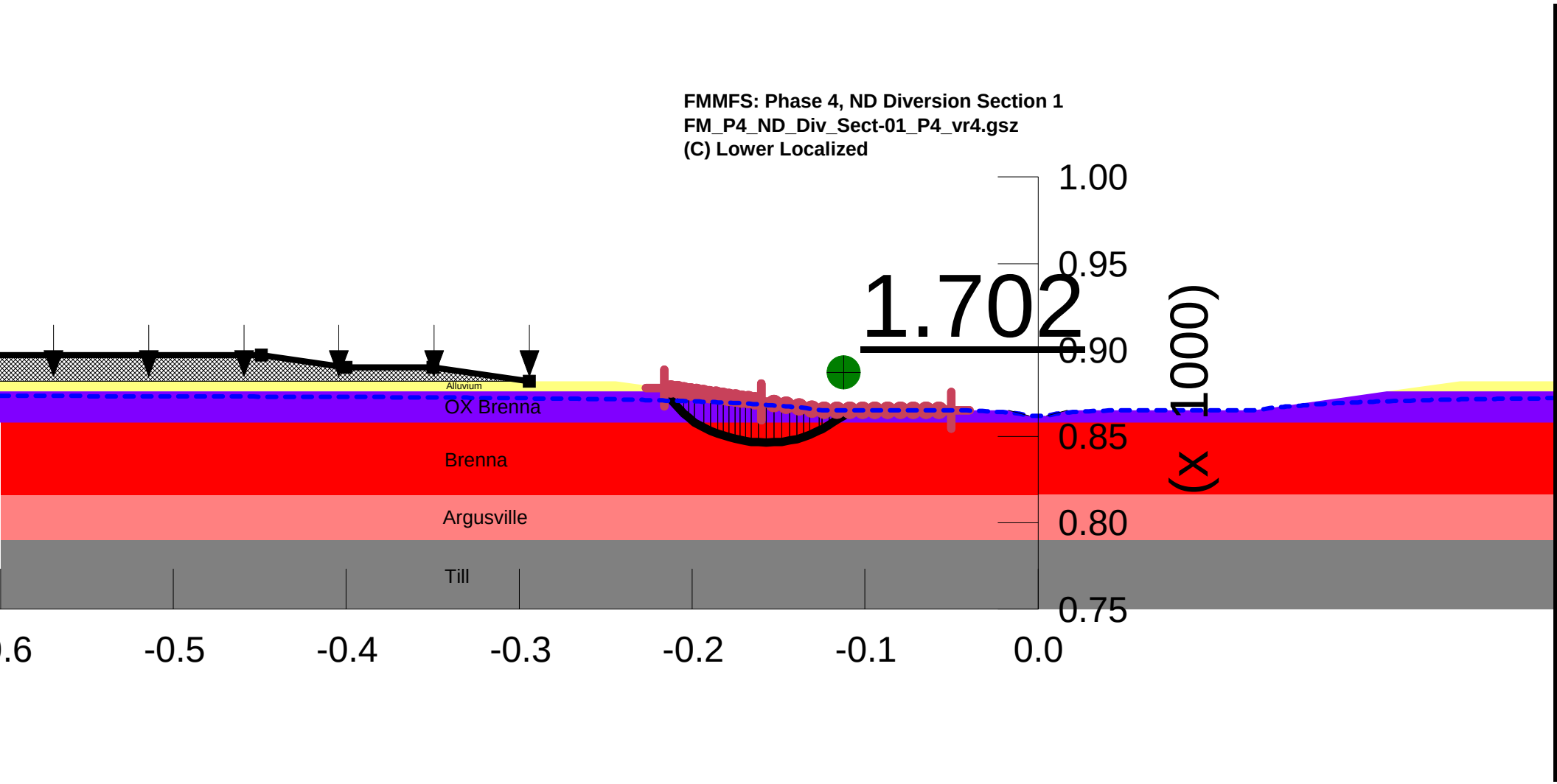
(A) Slope Stability
1.554
1.00
0.95
0.90
0.85
0.80
0.75
(1000)
(x
Alluvium
OX Brenna
Brenna
Argusville
Till
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 1
FM_P4_ND_Div_Sect-01_P4_vr4.gsz
(B) Wedge Slope Stability
1.558
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
OX Brenna
Brenna
Argusville
Till
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0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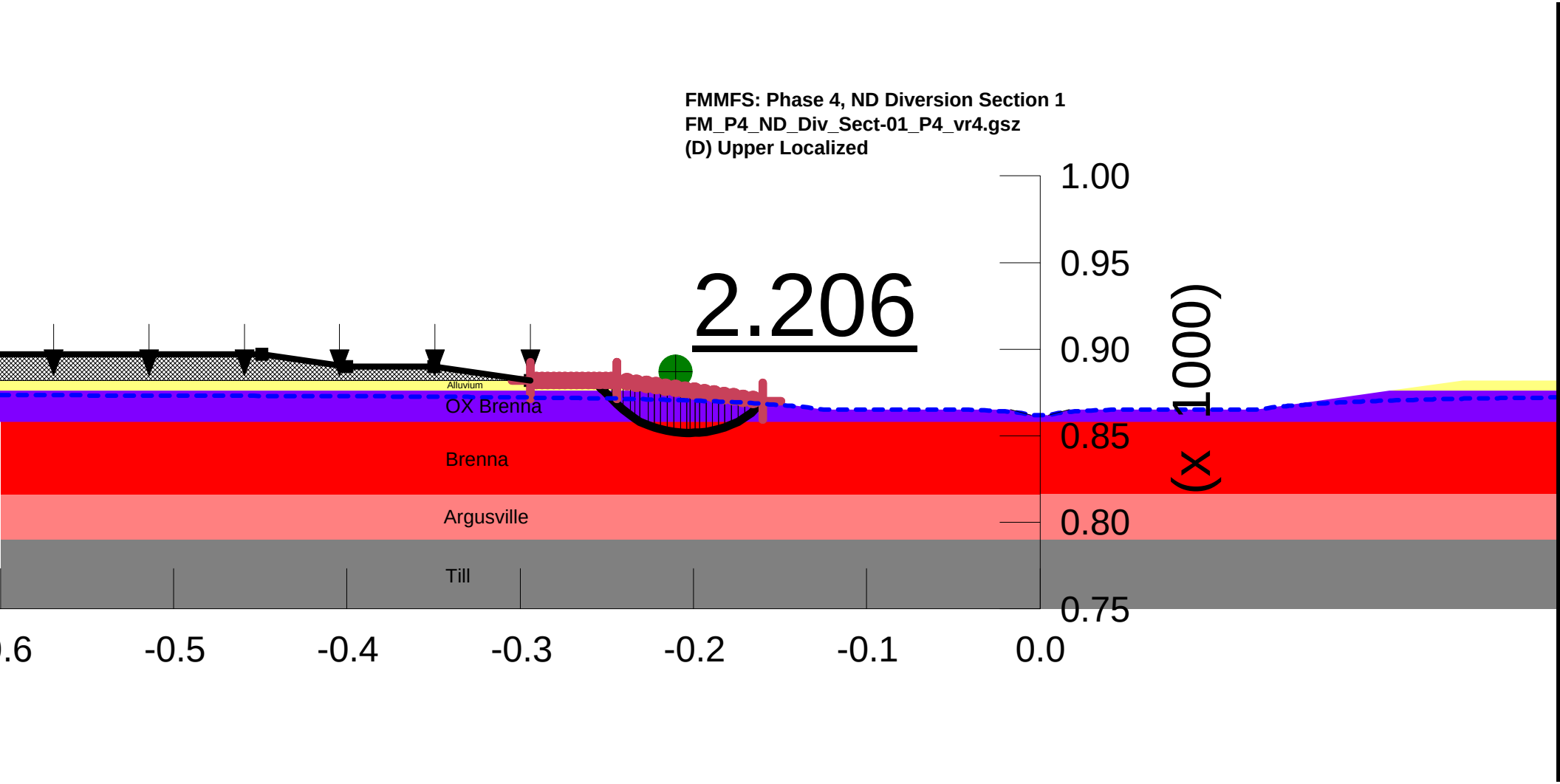
(C) Lower Localized
1.702
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0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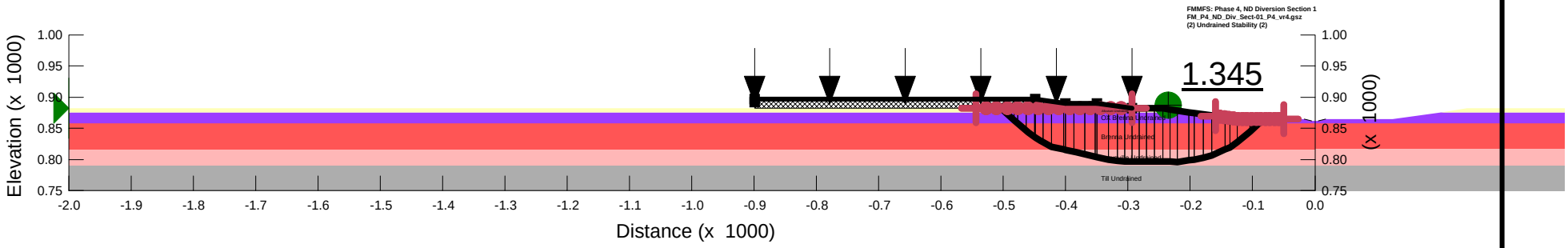
(D) Upper Localized
2.206
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(1000)
(x)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-01_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 1
(2) Undrained Stability (2)

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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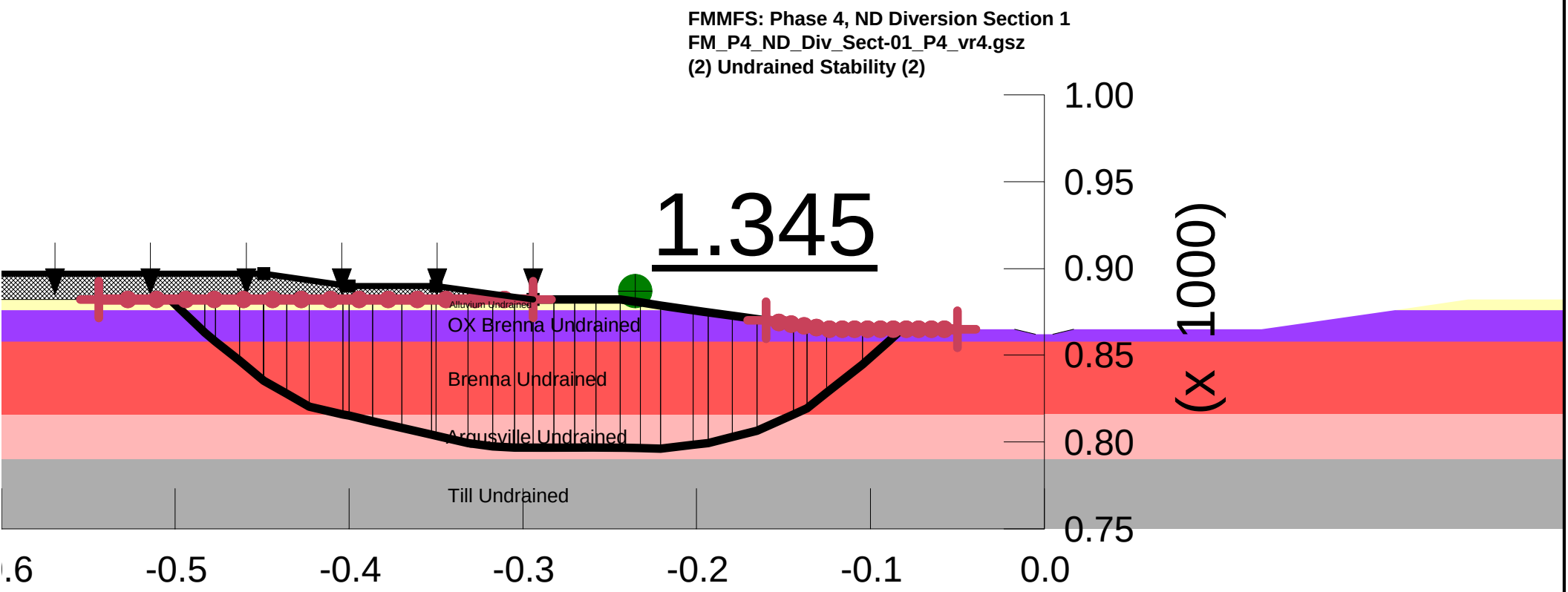
Date: 1/18/2011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FM_P4_ND_Div_Sect-01_P4_vr4.gsz
(2) Undrained Stability (2)
1.345
Alluvium Undrained
OX Brenna Undrained
Brenna Undrained
Argusville Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

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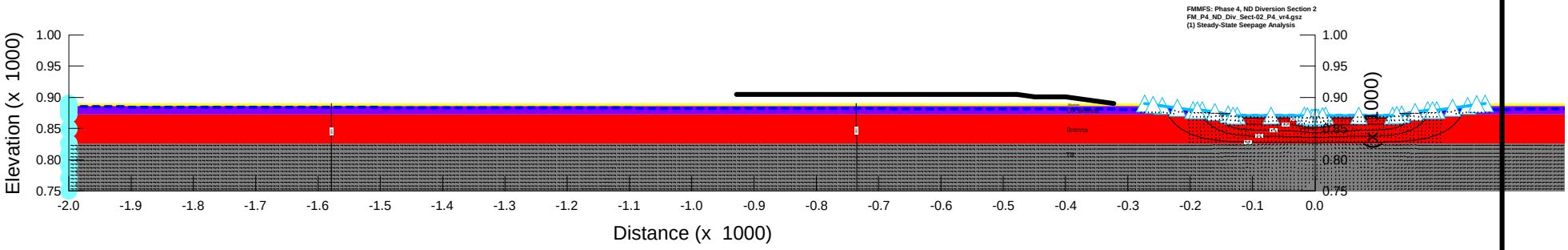
Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 2

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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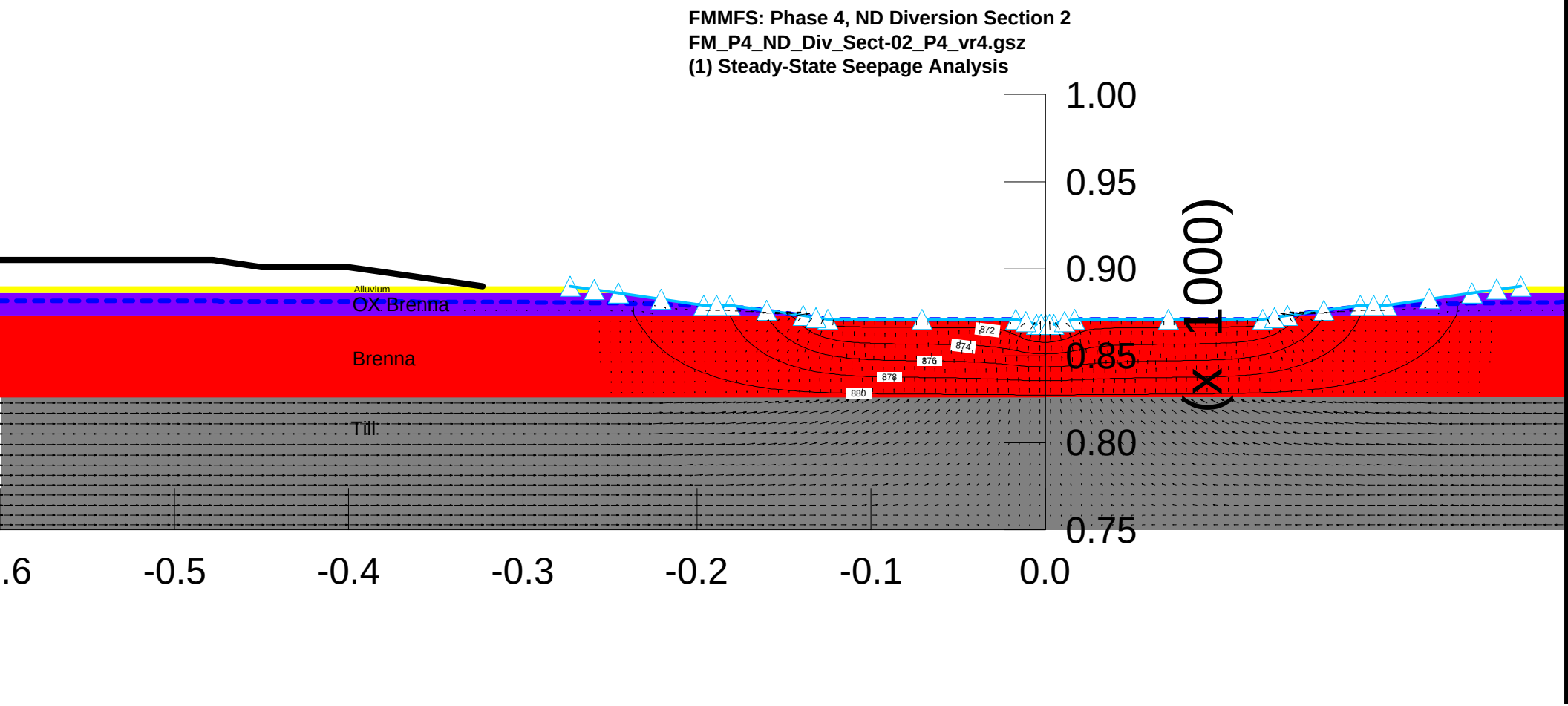
Last Edited By: Heckendorf, Kurt A MVP
Date: 1/18/2011

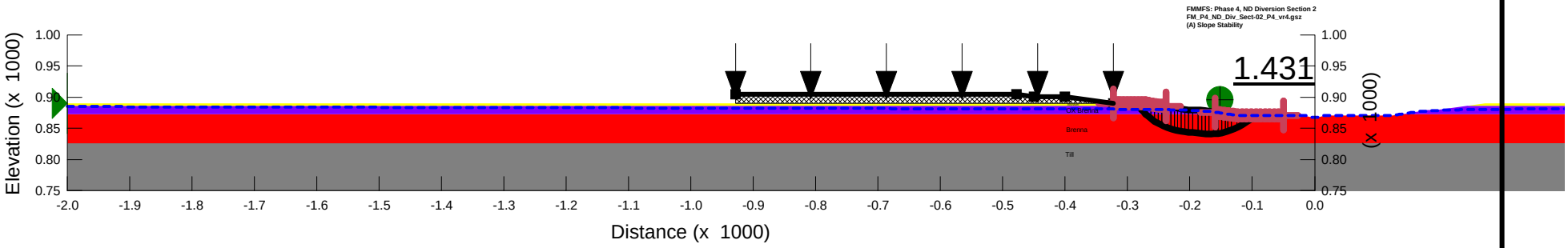

FMMFS: Phase 4, ND Diversion Section 2
FM_P4_ND_Div_Sect-02_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Till
872
874
876
878
880
1.00
0.95
0.90
0.85
0.80
0.75
(1000 x)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-02_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 2
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



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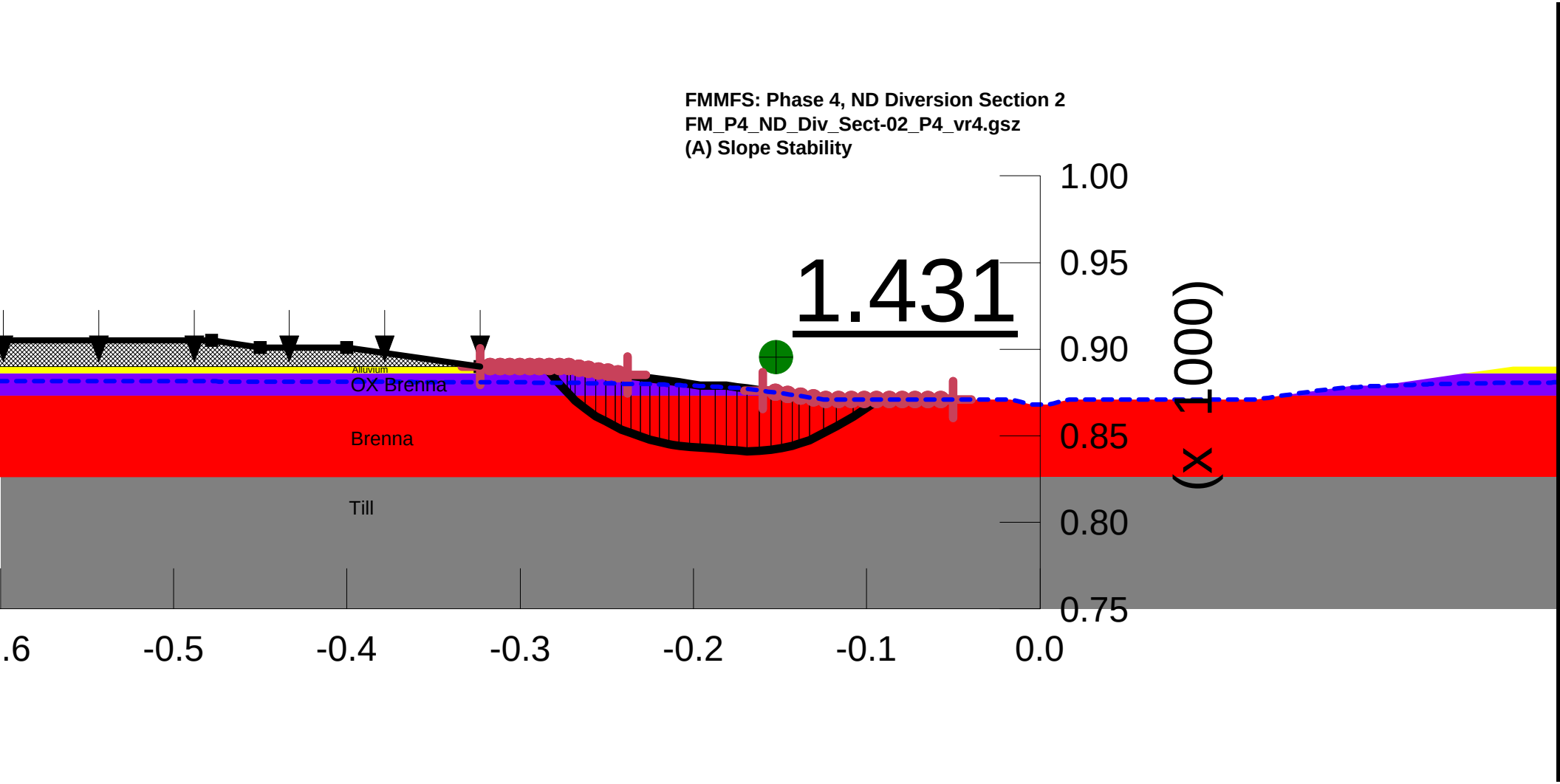
Date: 2/11/2011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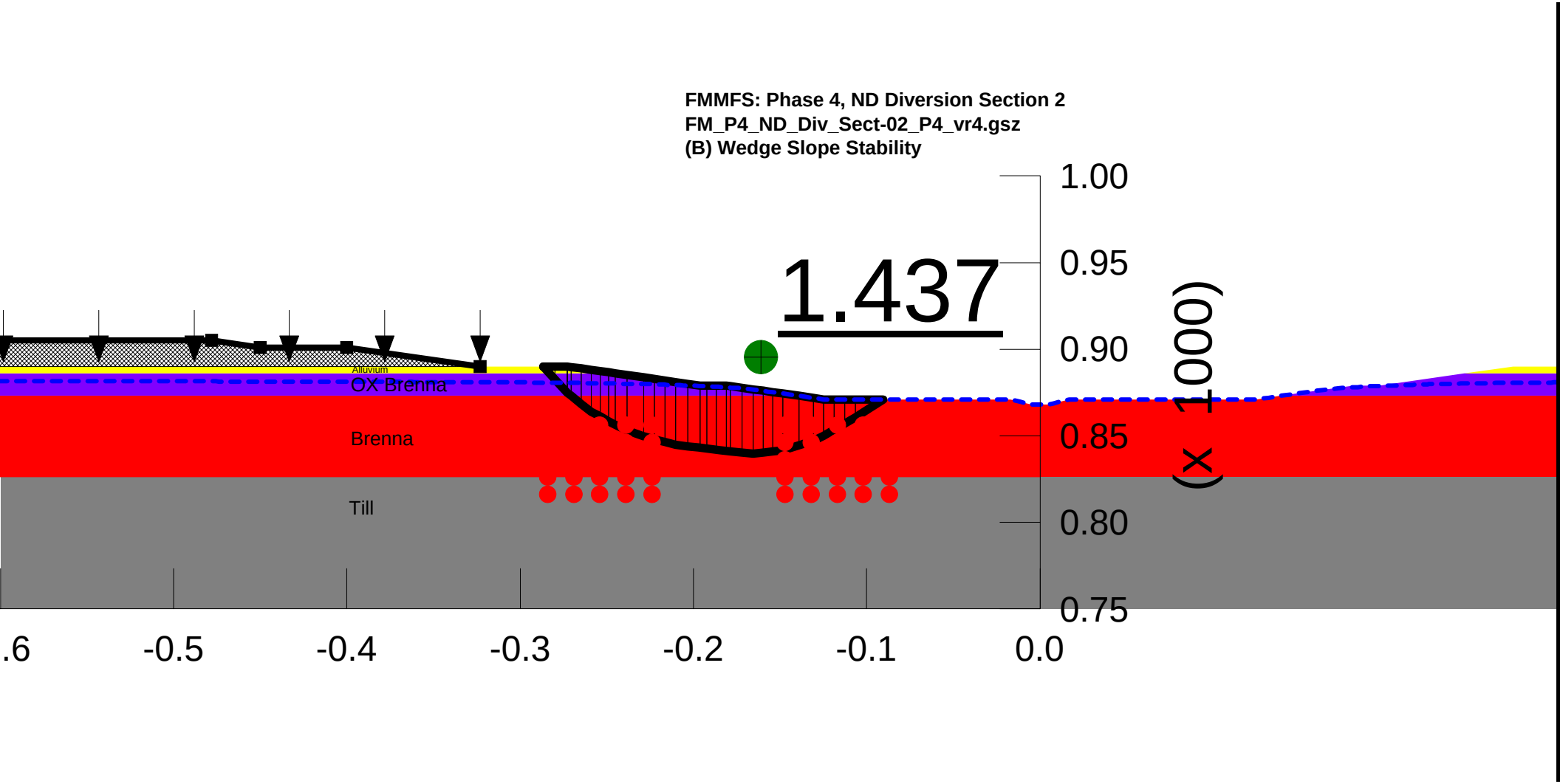
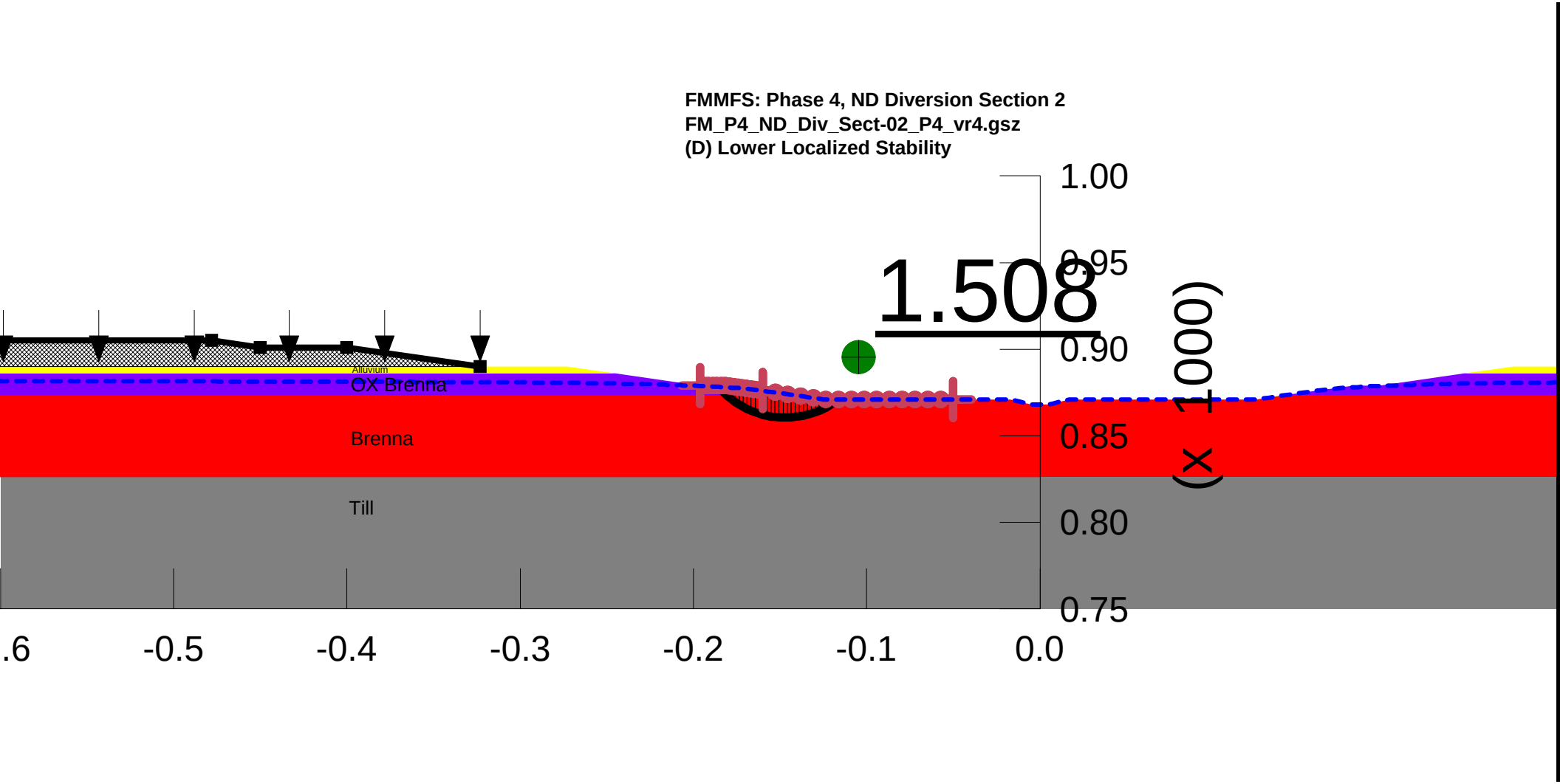
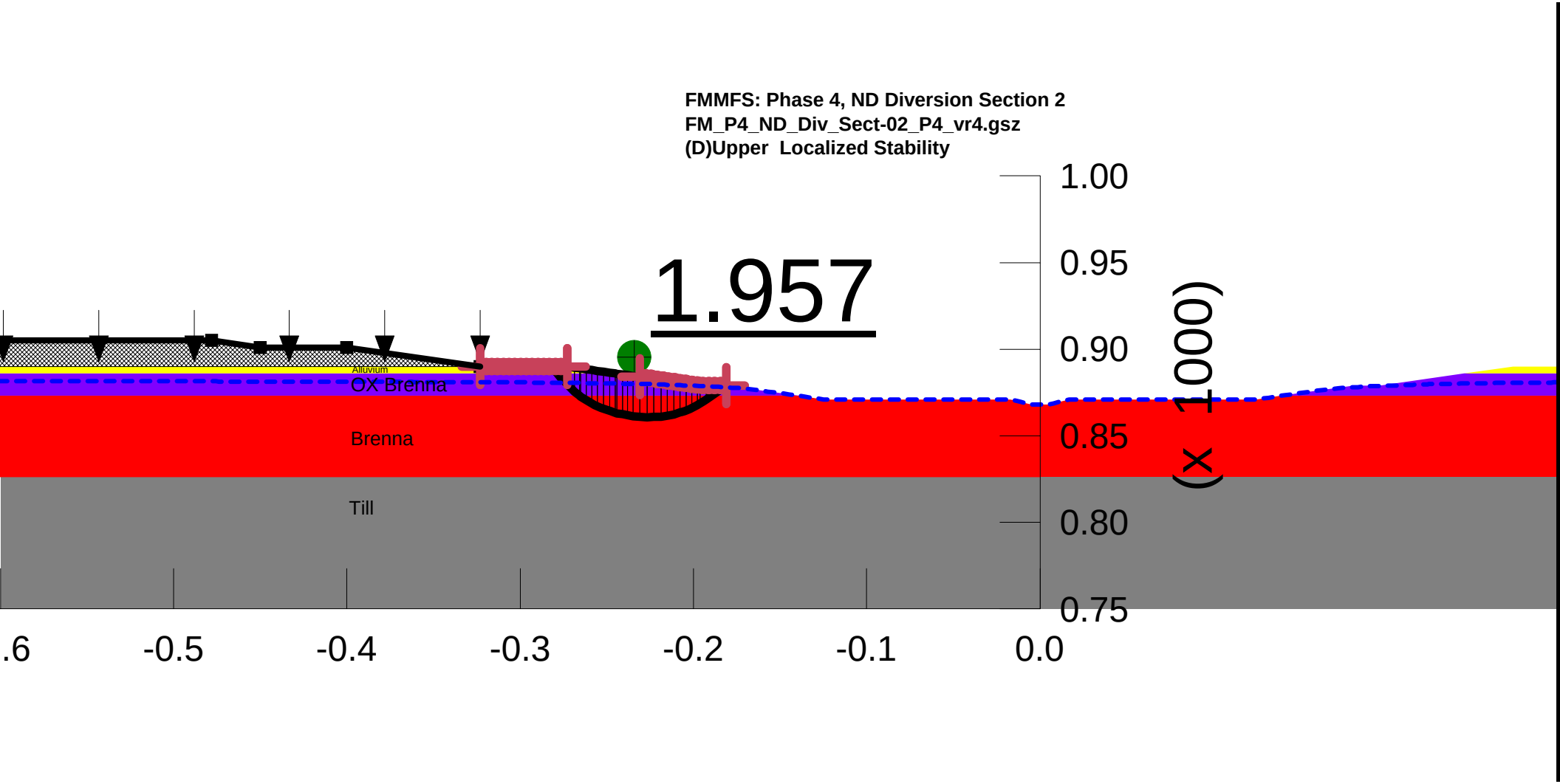
FM_P4_ND_Div_Sect-02_P4_vr4.gsz
(A) Slope Stability
1.431
Alluvium
OX Brenna
Brenna
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 2
FM_P4_ND_Div_Sect-02_P4_vr4.gsz
(B) Wedge Slope Stability
1.437
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
OX Brenna
Brenna
Till
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 2
FM_P4_ND_Div_Sect-02_P4_vr4.gsz
(D) Lower Localized Stability
1.508
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
OX Brenna
Brenna
Till
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

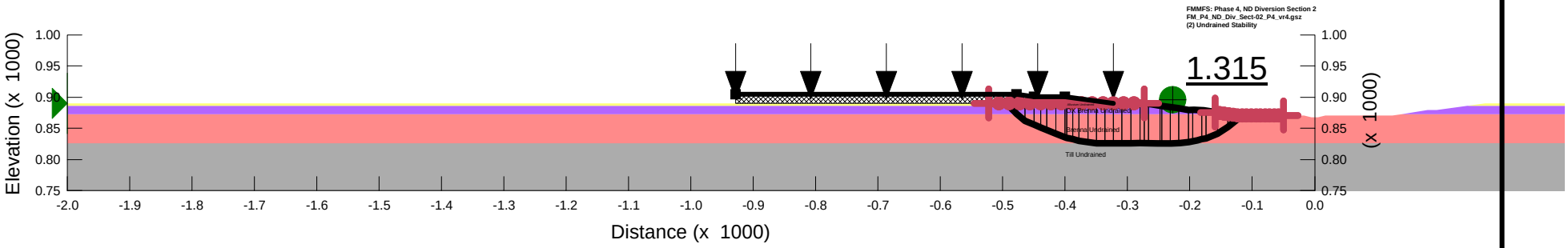

FMMFS: Phase 4, ND Diversion Section 2
FM_P4_ND_Div_Sect-02_P4_vr4.gsz
(D)Upper Localized Stability
1.957
Alluvium
OX Brenna
Brenna
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-02_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 2
(2) Undrained Stability

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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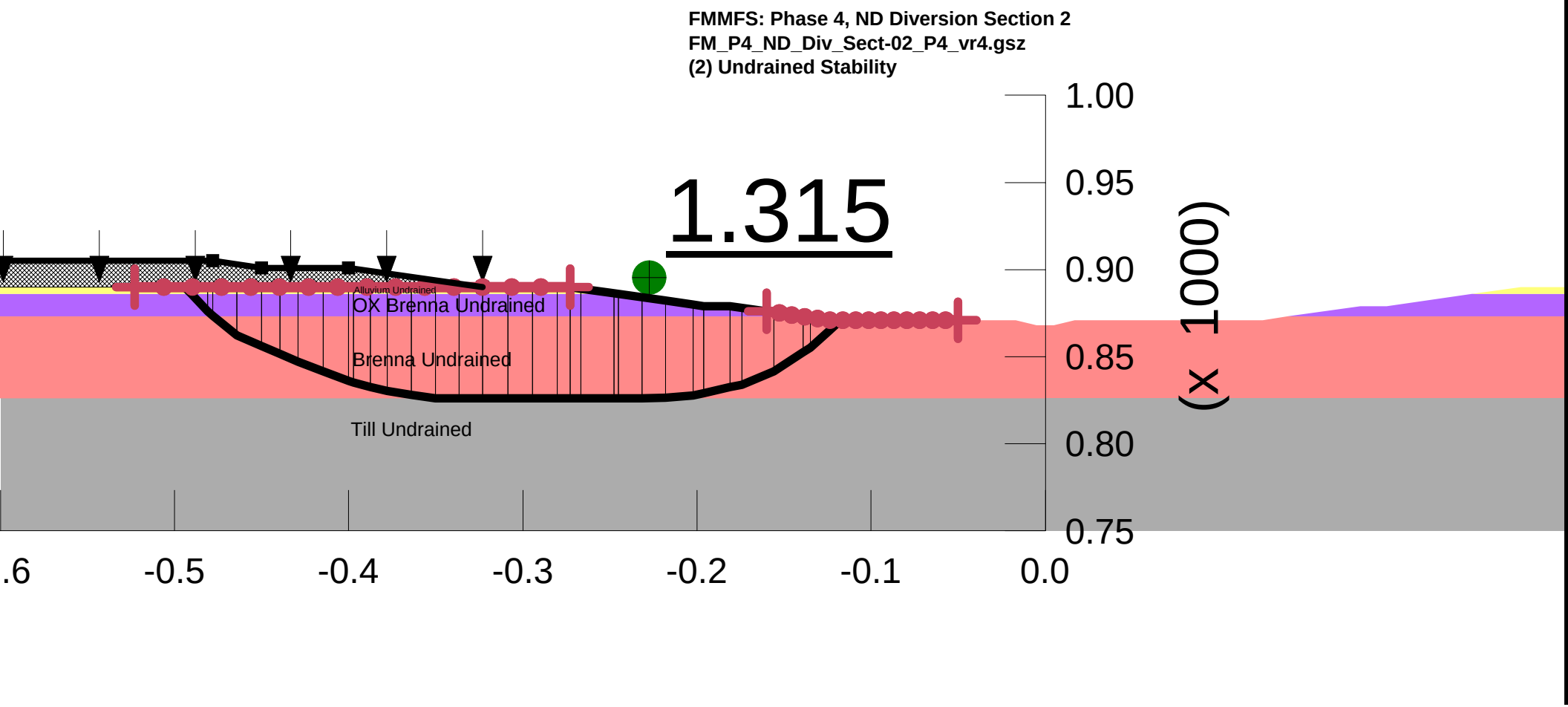

FMMFS: Phase 4, ND Diversion Section 2
FM_P4_ND_Div_Sect-02_P4_vr4.gsz
(2) Undrained Stability
1.315
Alluvium Undrained
OX Brenna Undrained
Brenna Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

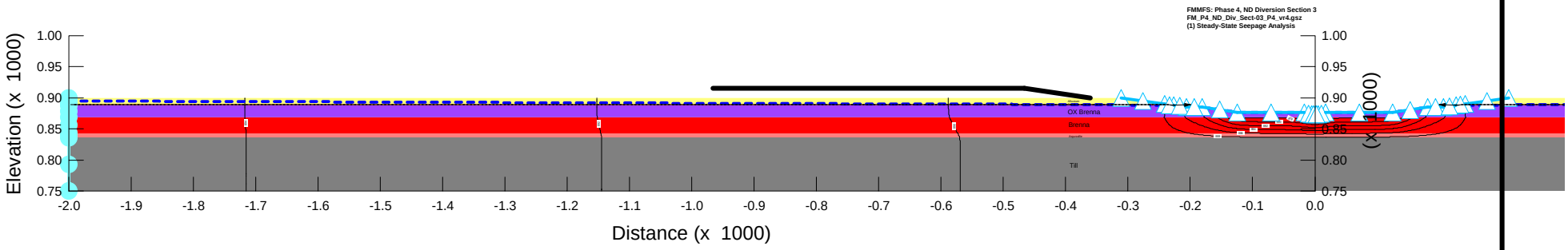
File Name: FM_P4_ND_Div_Sect-03_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 3

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °
Name: Sand Model: Saturated / Unsaturated K-Function: Sand Vol. WC. Function: Sand K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °



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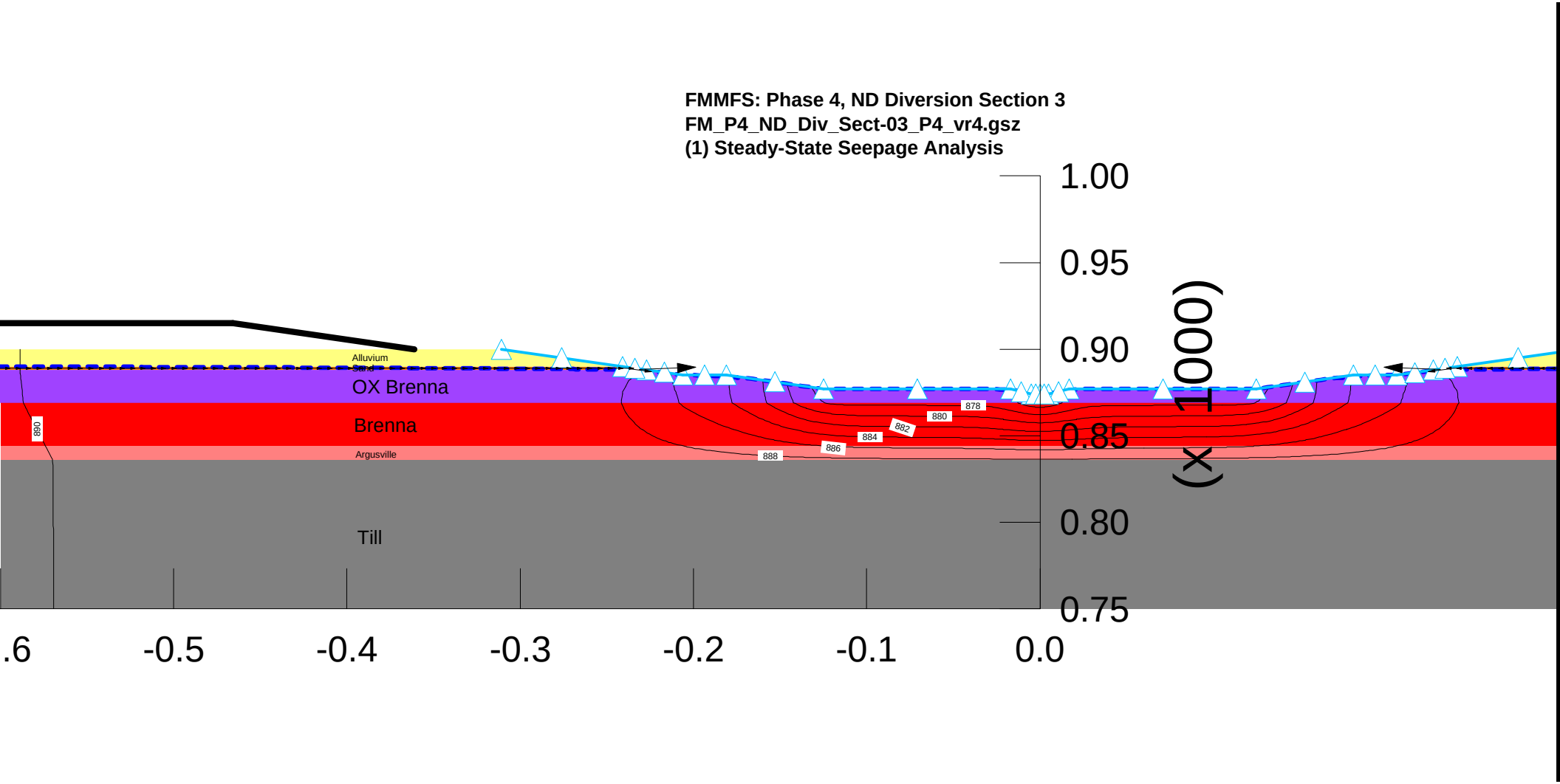
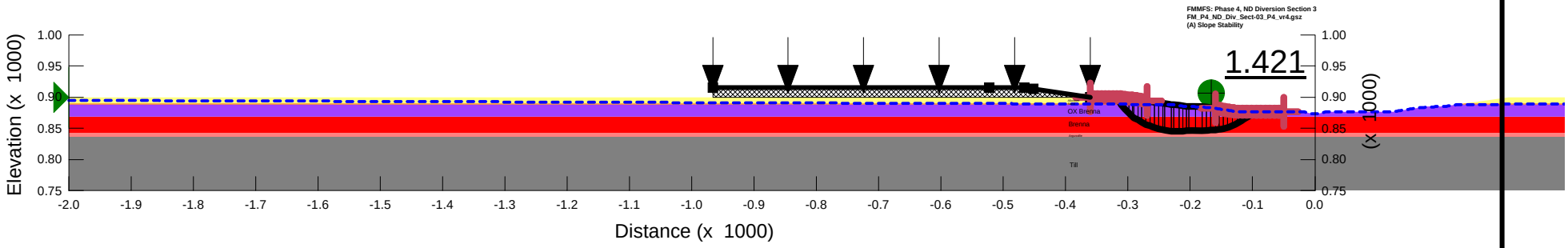

FMMFS: Phase 4, ND Diversion Section 3
FM_P4_ND_Div_Sect-03_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
Sand
OX Brenna
Brenna
Argusville
Till
878
880
882
884
886
888
890
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-03_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 3
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 32 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °



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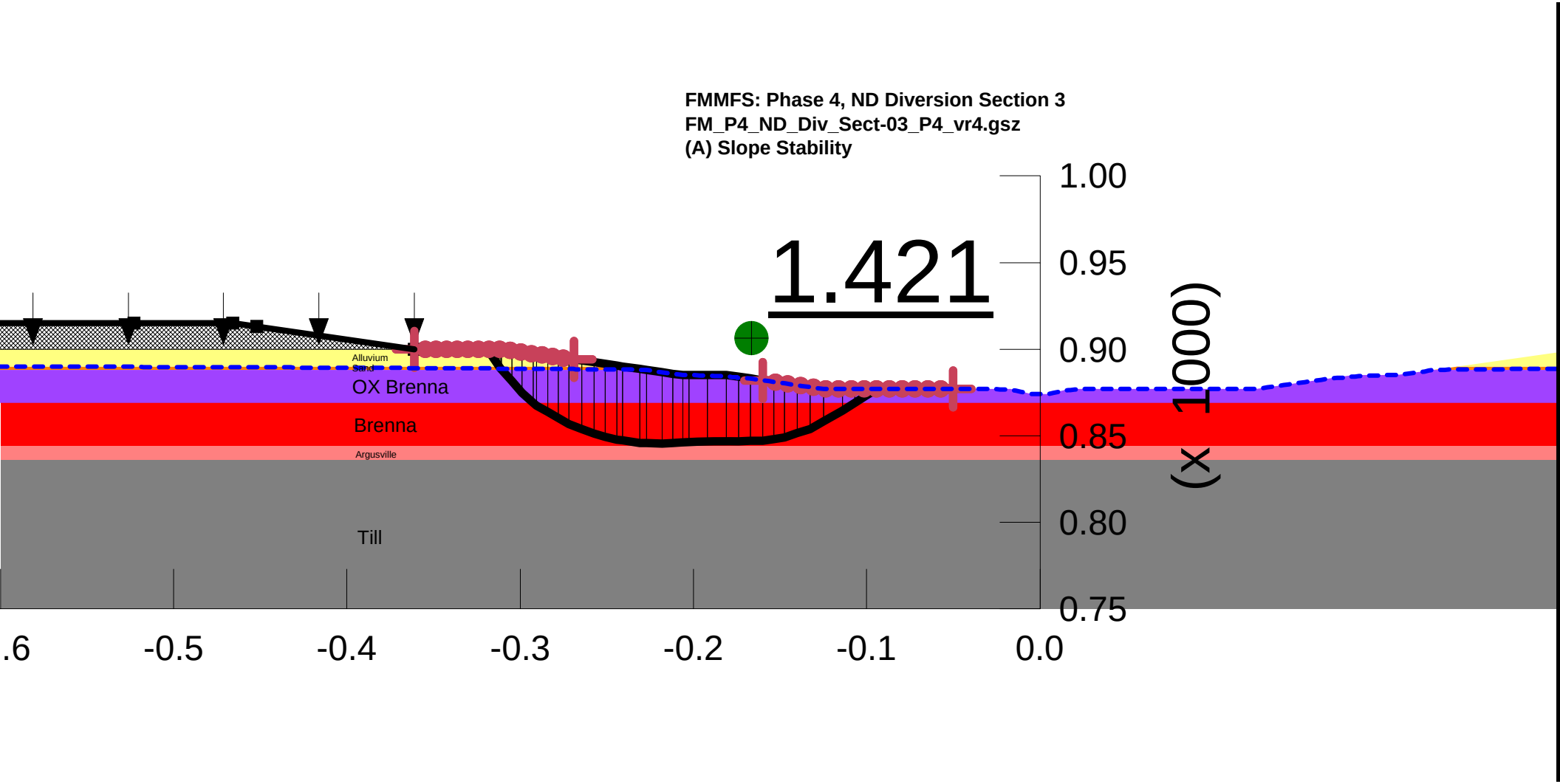
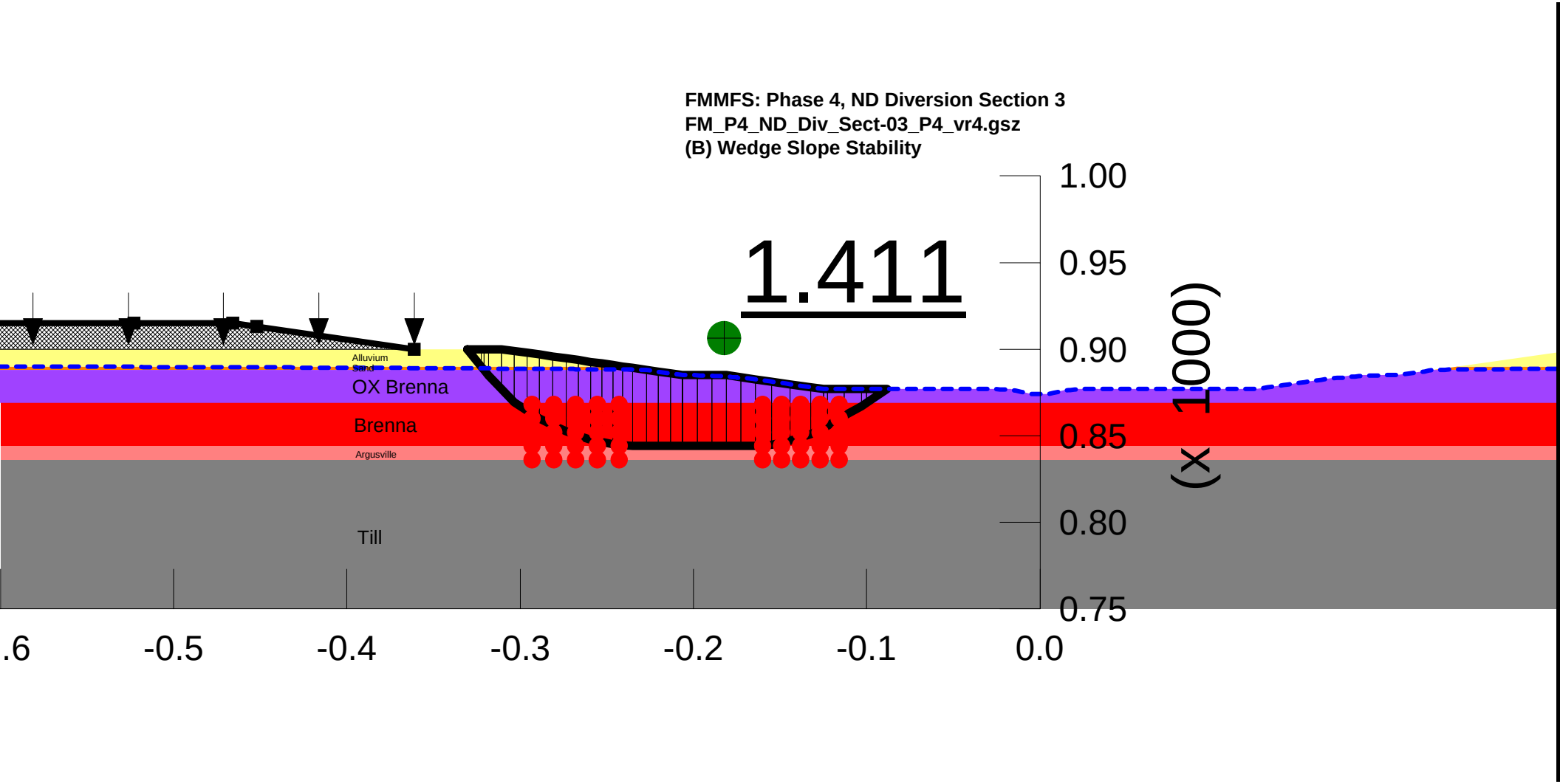
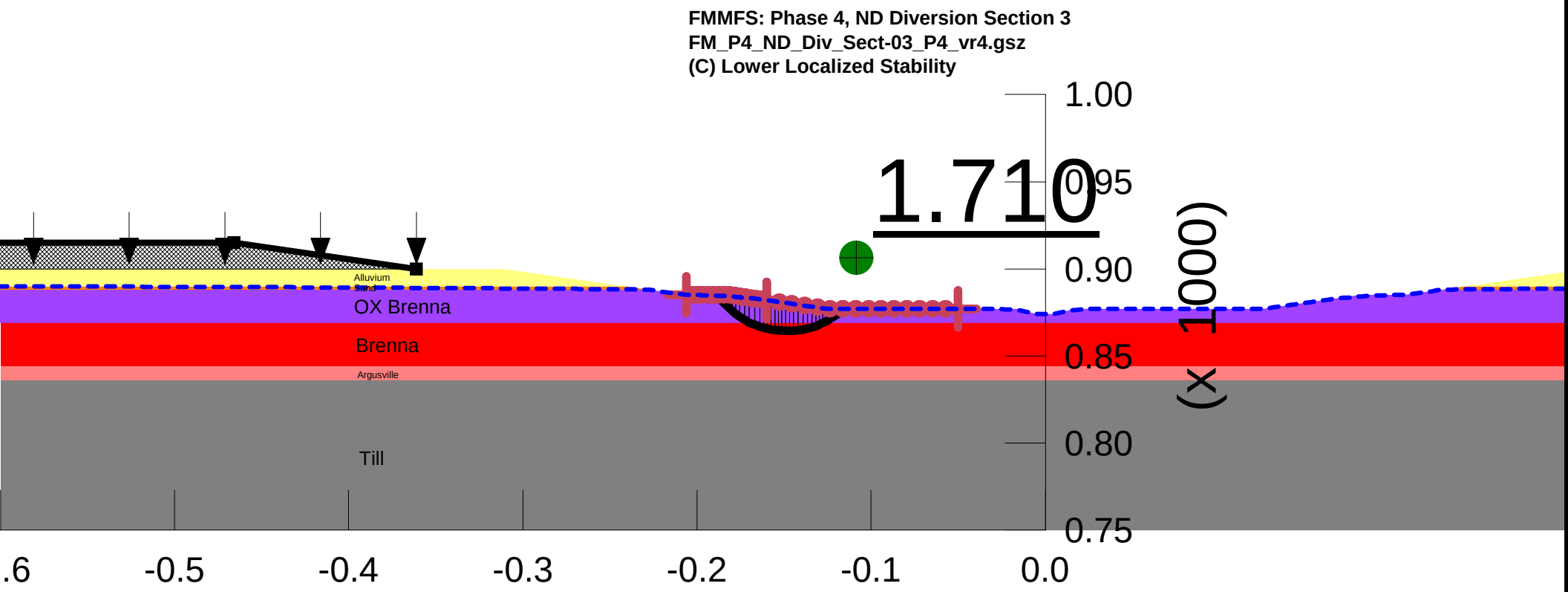
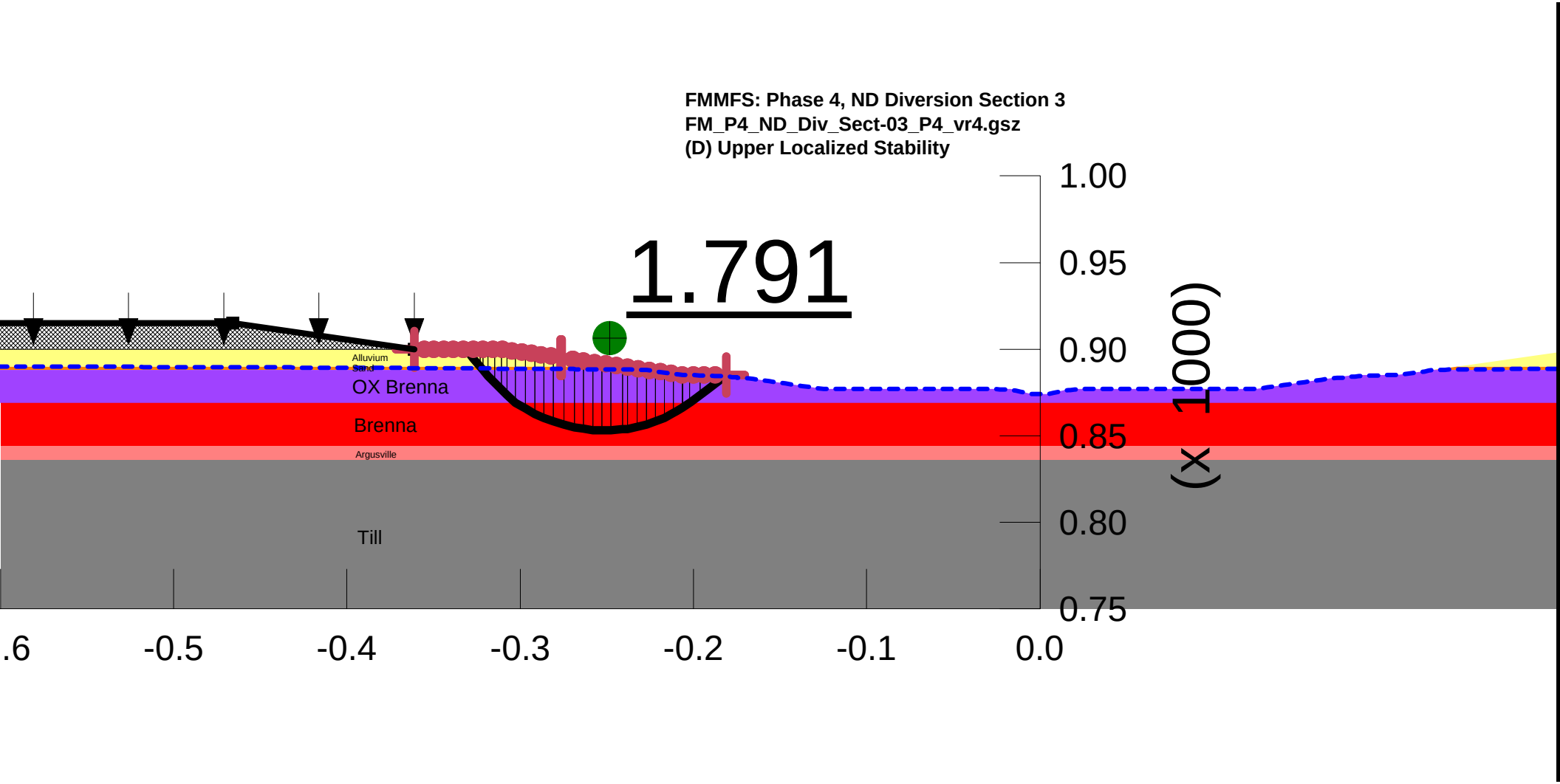

FMMFS: Phase 4, ND Diversion Section 3
FM_P4_ND_Div_Sect-03_P4_vr4.gsz
(A) Slope Stability
1.421
Alluvium
Sand
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 3
FM_P4_ND_Div_Sect-03_P4_vr4.gsz
(B) Wedge Slope Stability
1.411
Alluvium
Sand
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 3
FM_P4_ND_Div_Sect-03_P4_vr4.gsz
(C) Lower Localized Stability
1.710
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
Sand
OX Brenna
Brenna
Argusville
Till
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 3
FM_P4_ND_Div_Sect-03_P4_vr4.gsz
(D) Upper Localized Stability
1.791
Alluvium
Sand
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

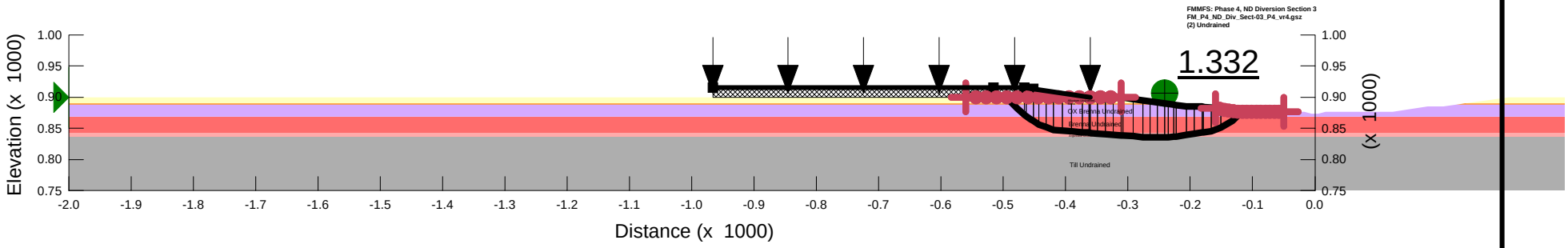
File Name: FM_P4_ND_Div_Sect-03_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 3

(2) Undrained

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf
Name: Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 32 ° Phi-B: 0 °
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf



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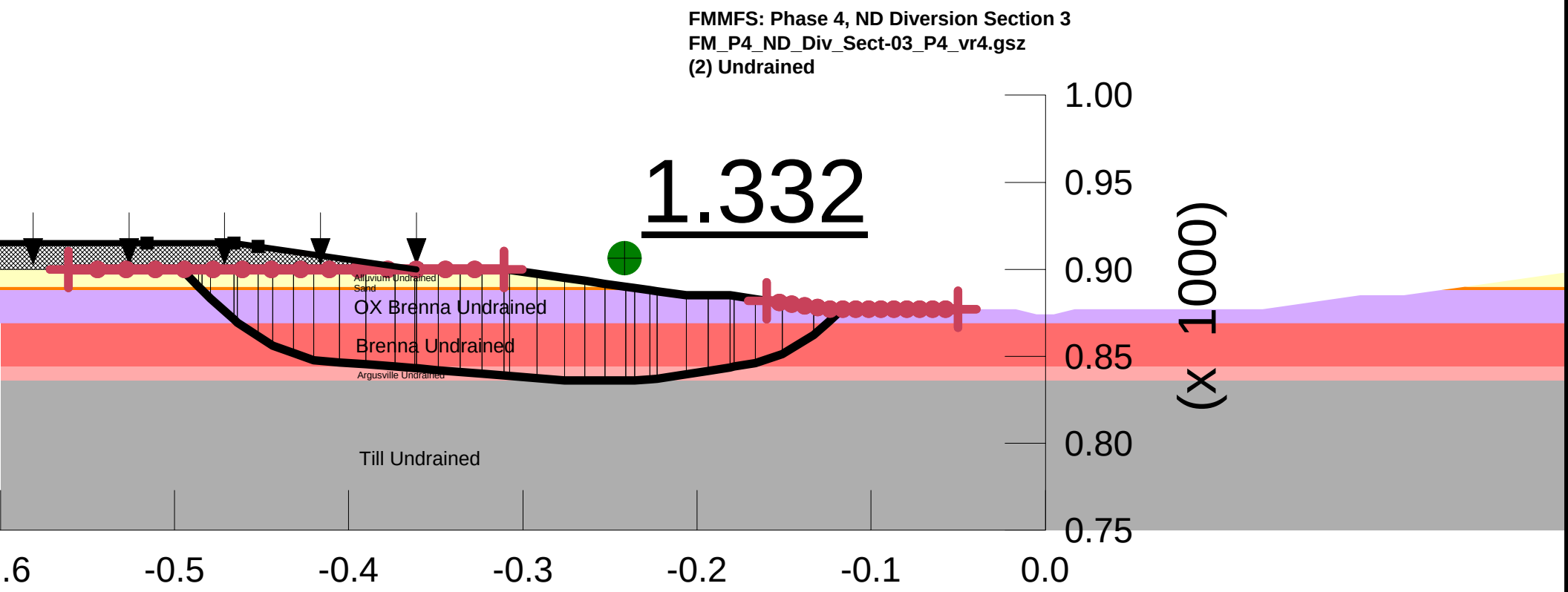

FMMFS: Phase 4, ND Diversion Section 3
FM_P4_ND_Div_Sect-03_P4_vr4.gsz
(2) Undrained
1.332
Alluvium Undrained
Sand
OX Brenna Undrained
Brenna Undrained
Argusville Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

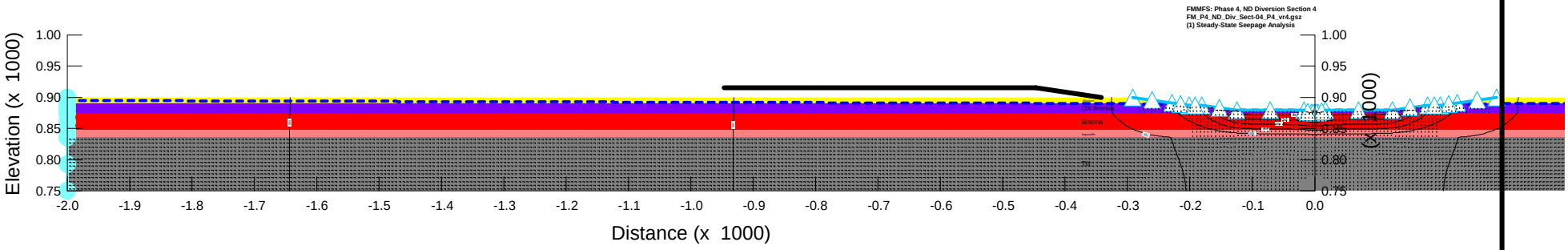
File Name: FM_P4_ND_Div_Sect-04_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 4

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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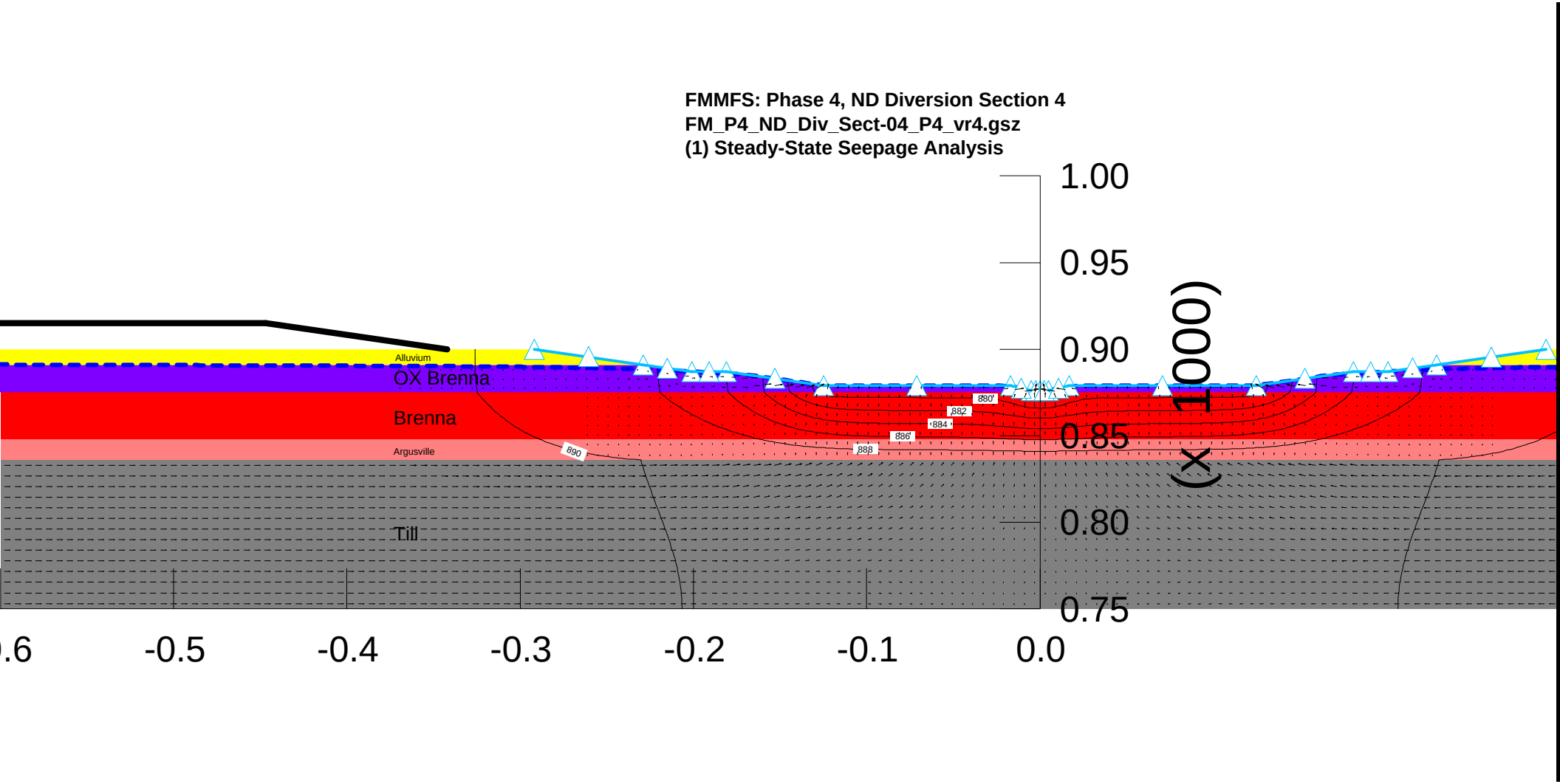
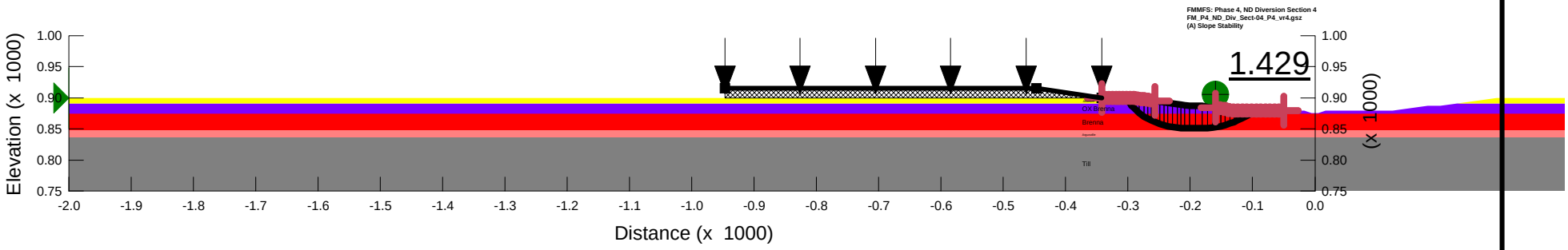

FMMFS: Phase 4, ND Diversion Section 4
FM_P4_ND_Div_Sect-04_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Argusville
Till
880
882
884
886
888
890
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-04_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 4
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



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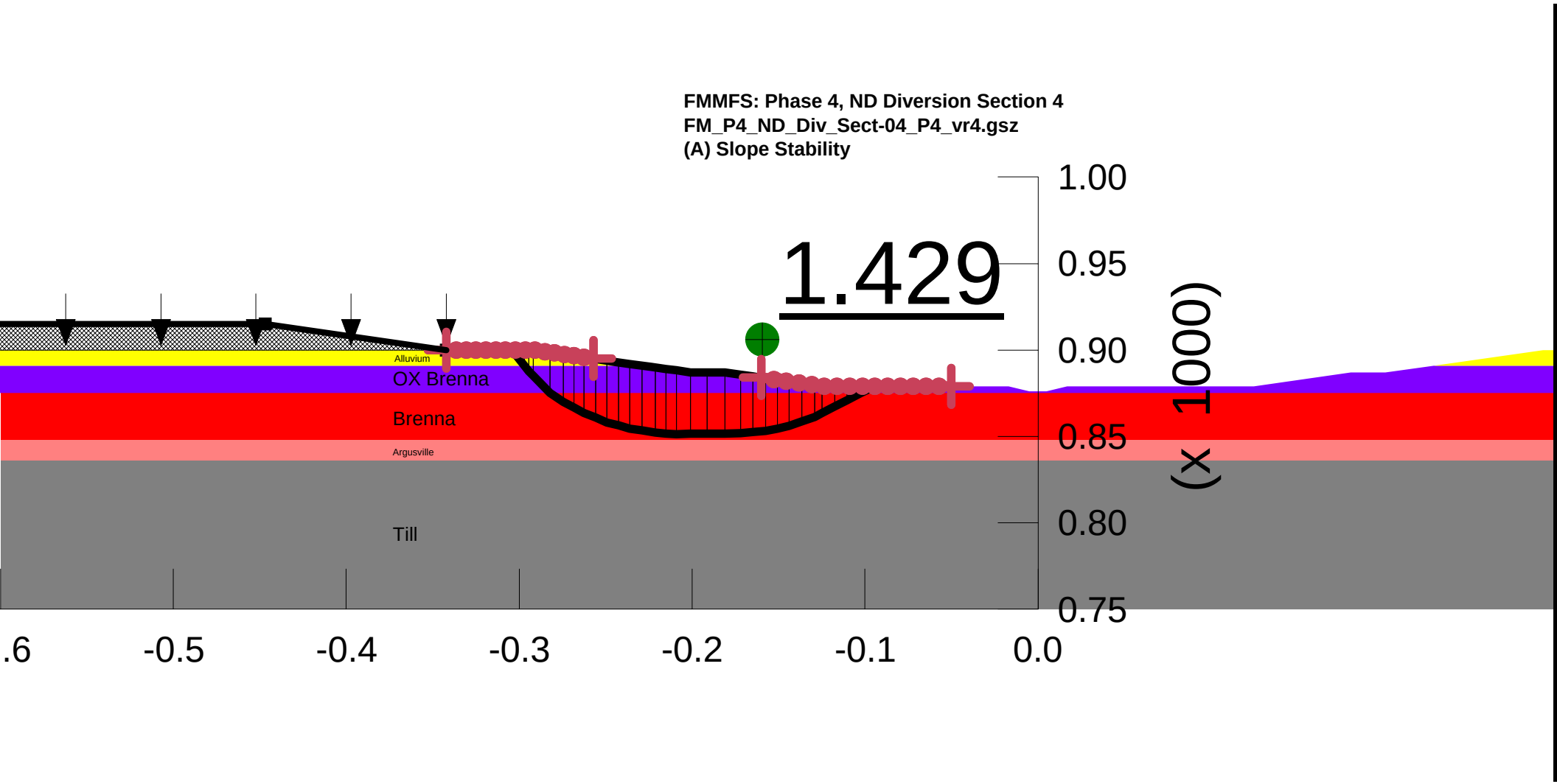
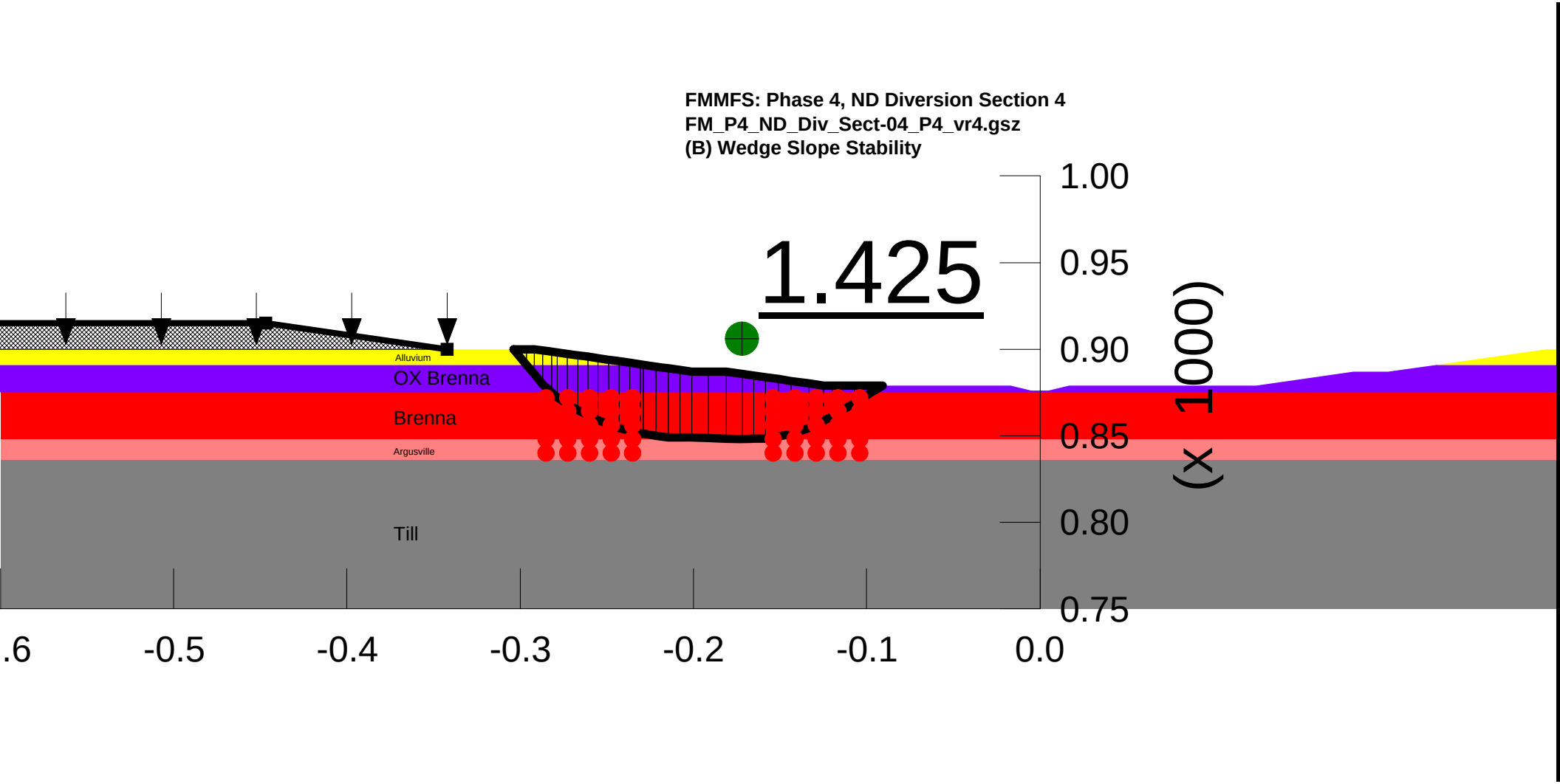
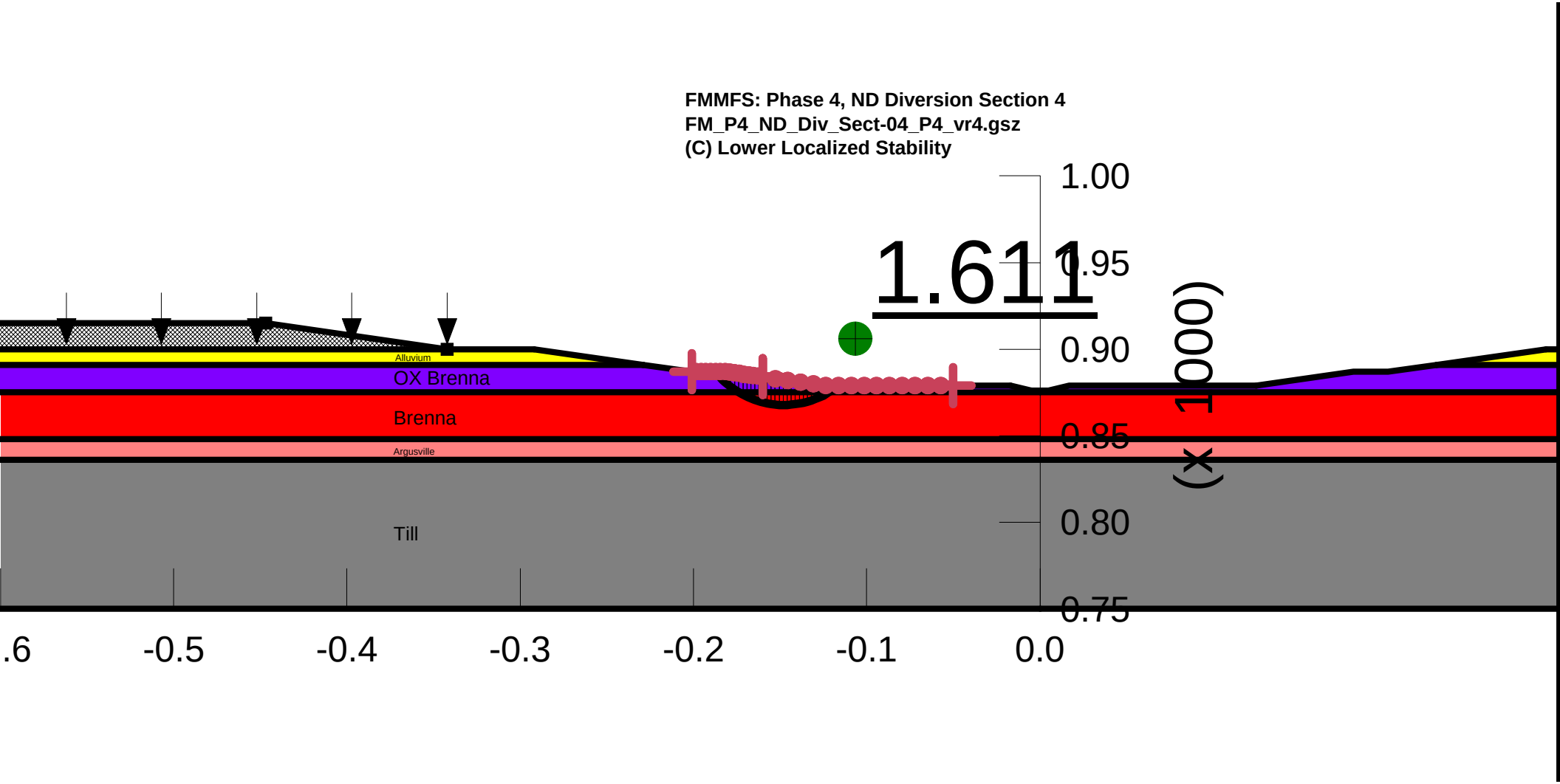
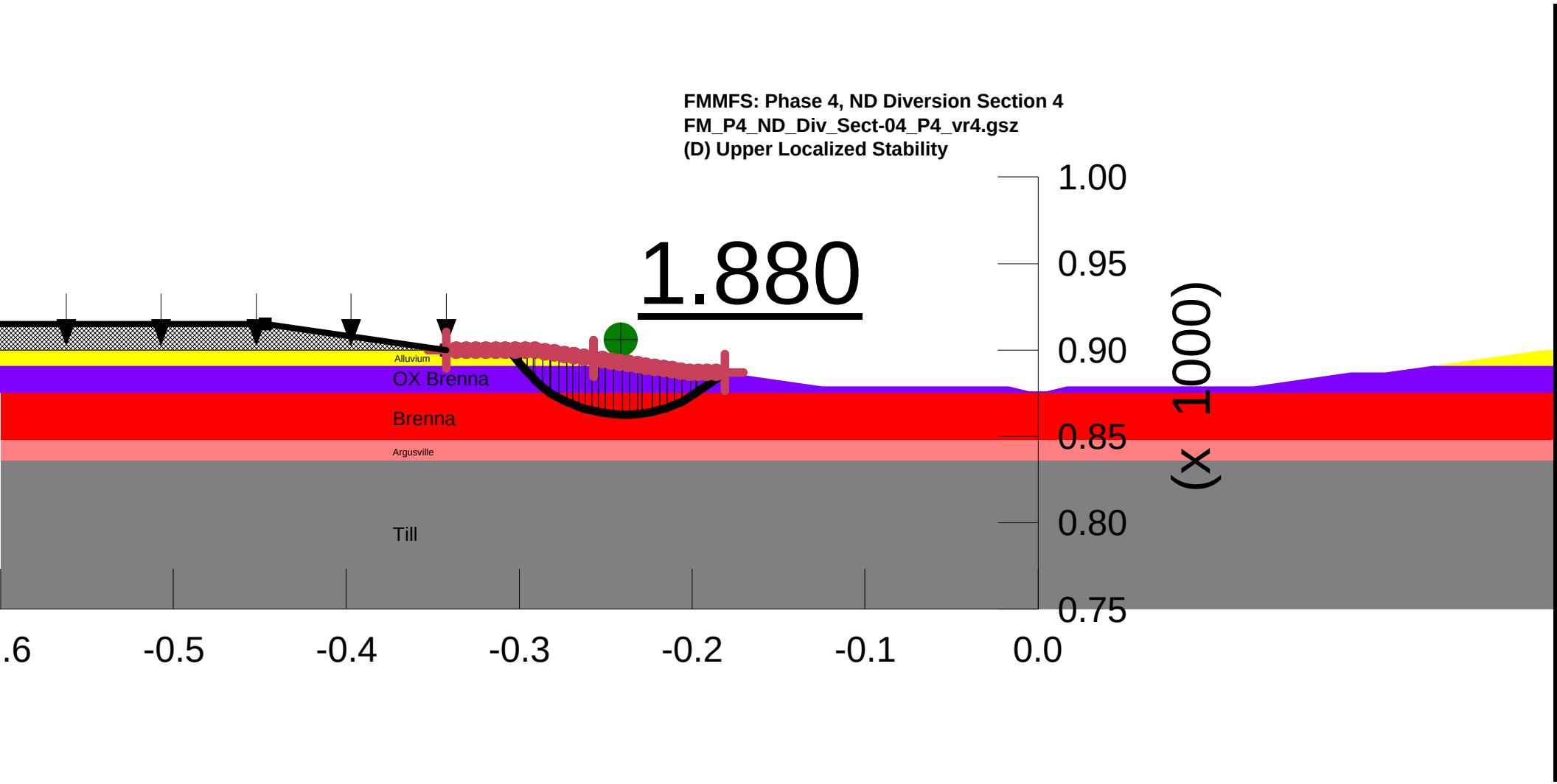

FMMFS: Phase 4, ND Diversion Section 4
FM_P4_ND_Div_Sect-04_P4_vr4.gsz
(A) Slope Stability
1.429
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 4
FM_P4_ND_Div_Sect-04_P4_vr4.gsz
(B) Wedge Slope Stability
1.425
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 4
FM_P4_ND_Div_Sect-04_P4_vr4.gsz
(C) Lower Localized Stability
1.611
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
OX Brenna
Brenna
Argusville
Till
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

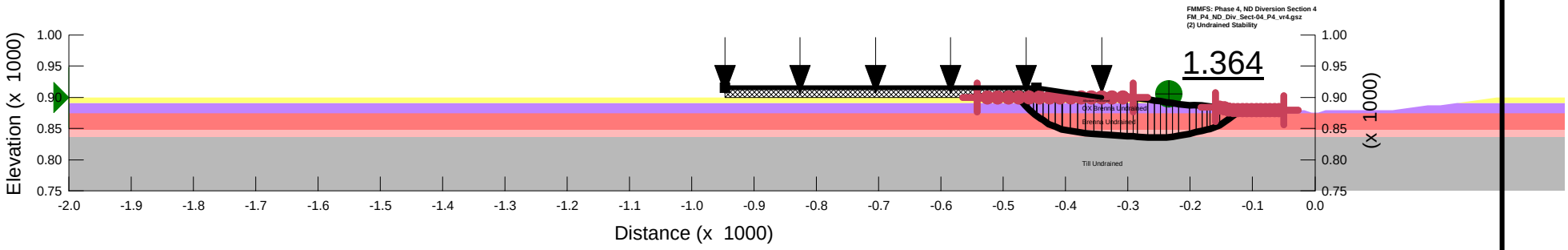

FMMFS: Phase 4, ND Diversion Section 4
FM_P4_ND_Div_Sect-04_P4_vr4.gsz
(D) Upper Localized Stability
1.880
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-04_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 4
(2) Undrained Stability

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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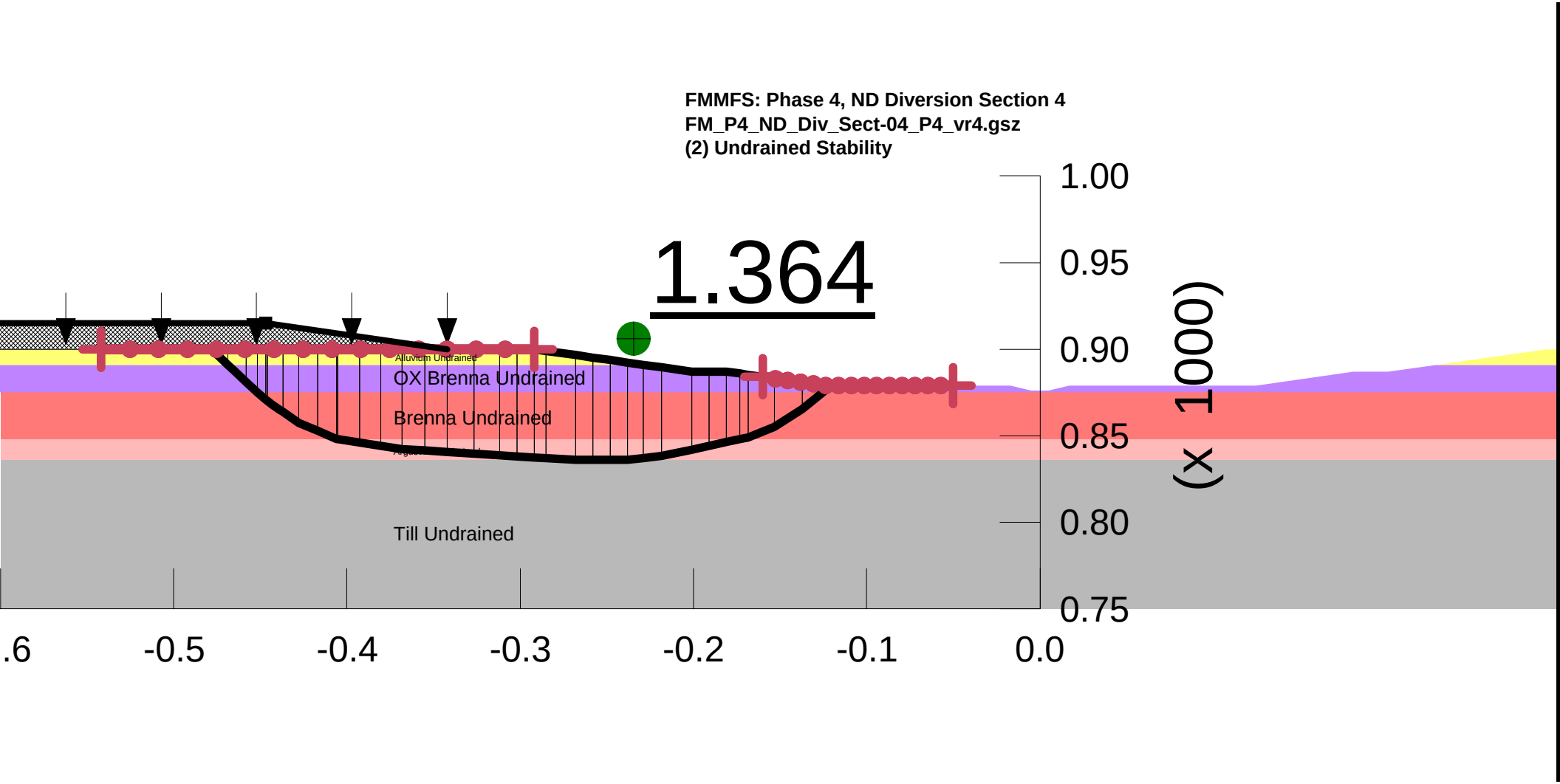

FMMFS: Phase 4, ND Diversion Section 4
FM_P4_ND_Div_Sect-04_P4_vr4.gsz
(2) Undrained Stability
1.364
Alluvium Undrained
OX Brenna Undrained
Brenna Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

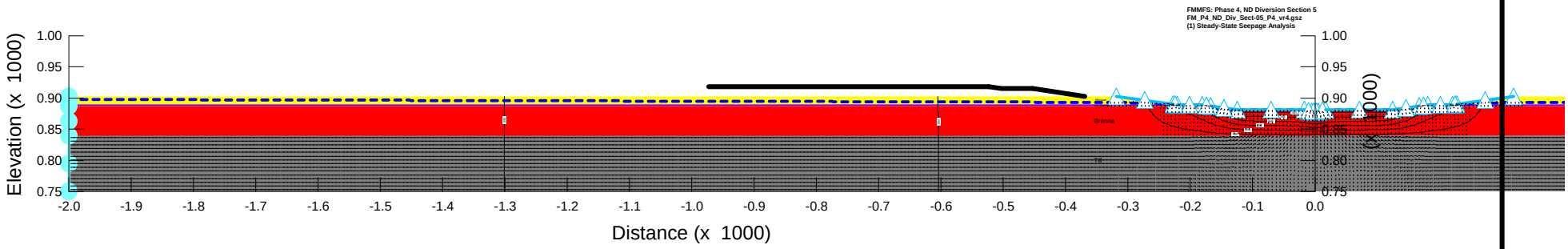
File Name: FM_P4_ND_Div_Sect-05_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 5

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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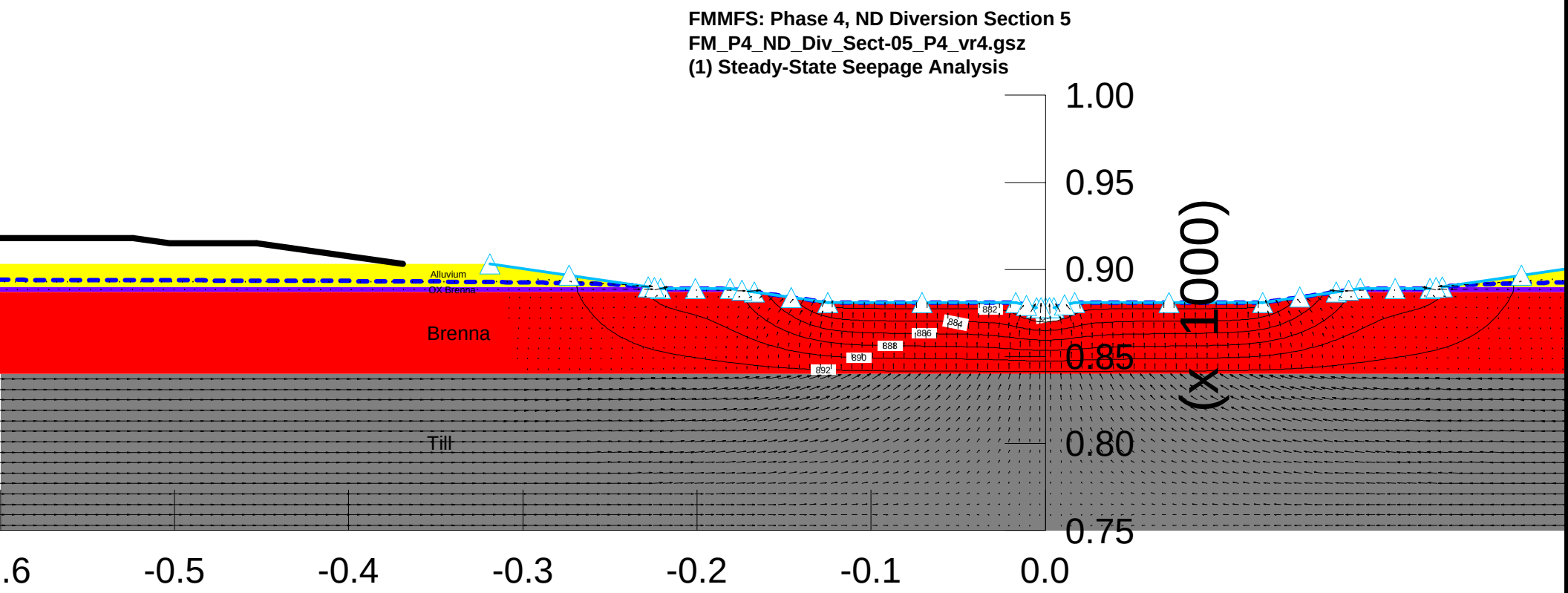
Date: 1/18/2011

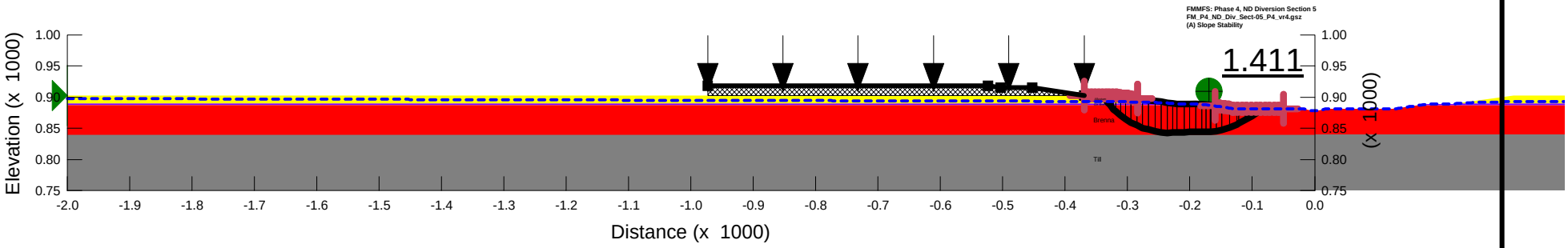

FMMFS: Phase 4, ND Diversion Section 5
FM_P4_ND_Div_Sect-05_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Till
882
884
886
888
890
892
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-05_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 5
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



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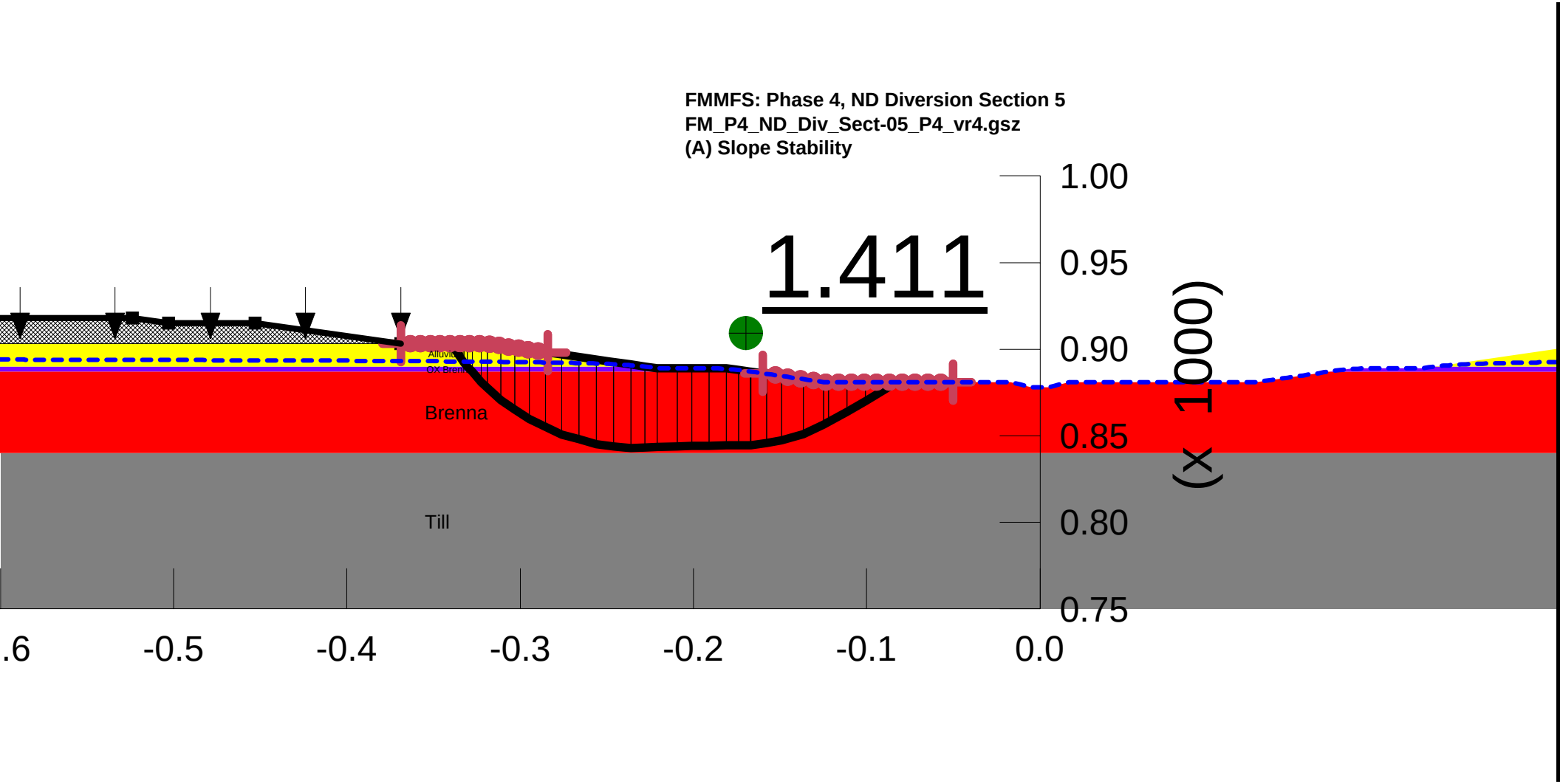
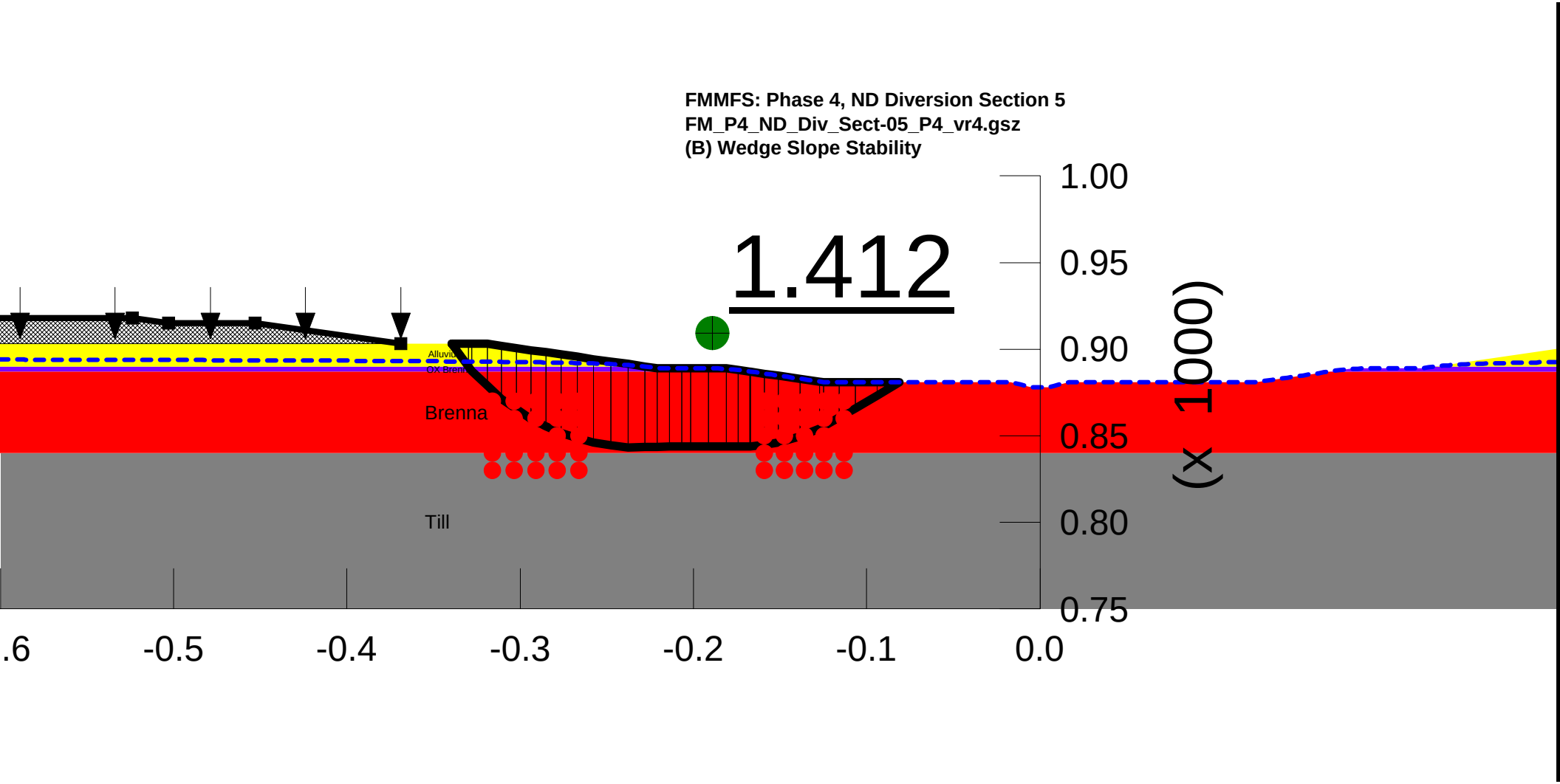
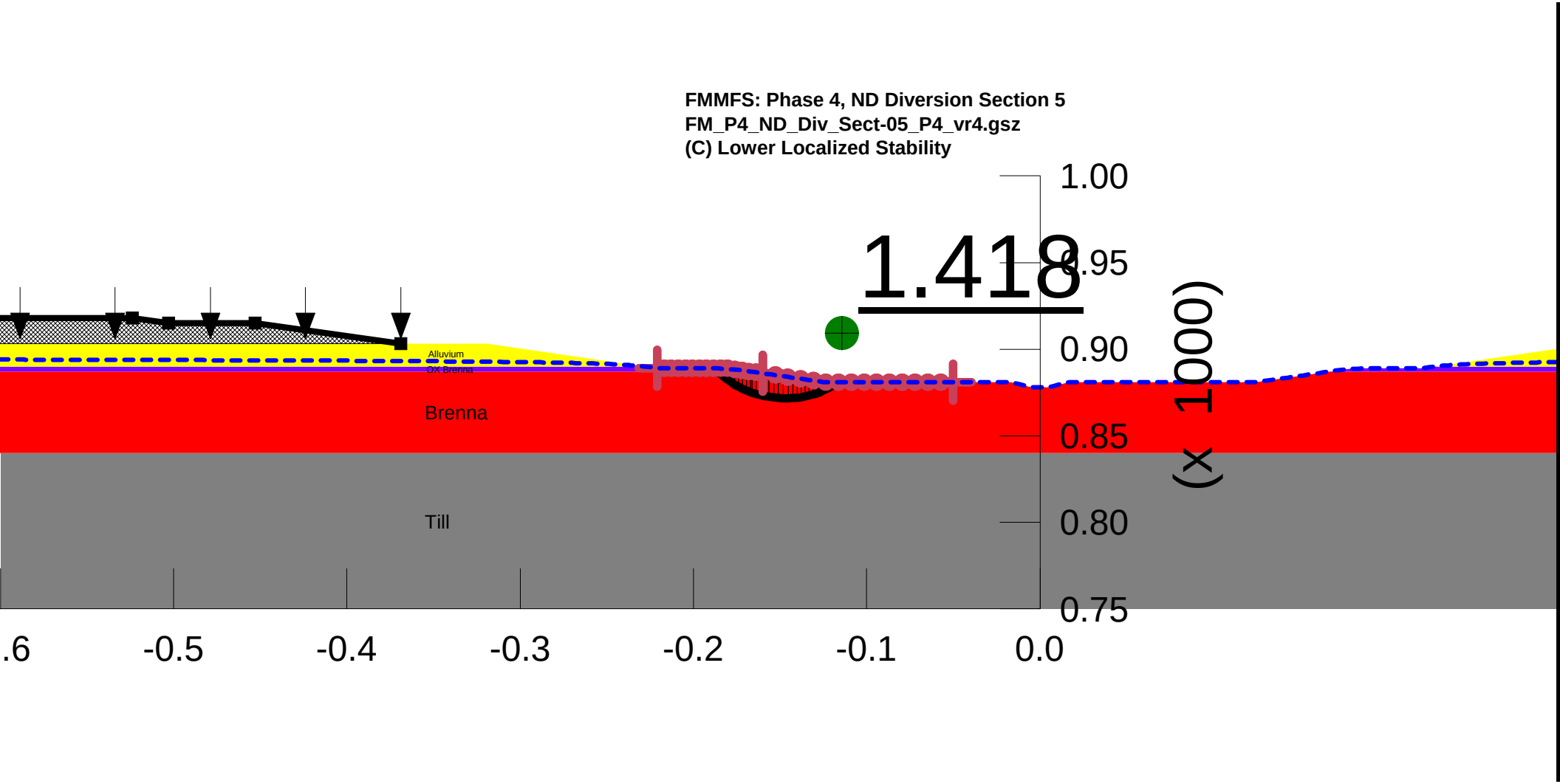
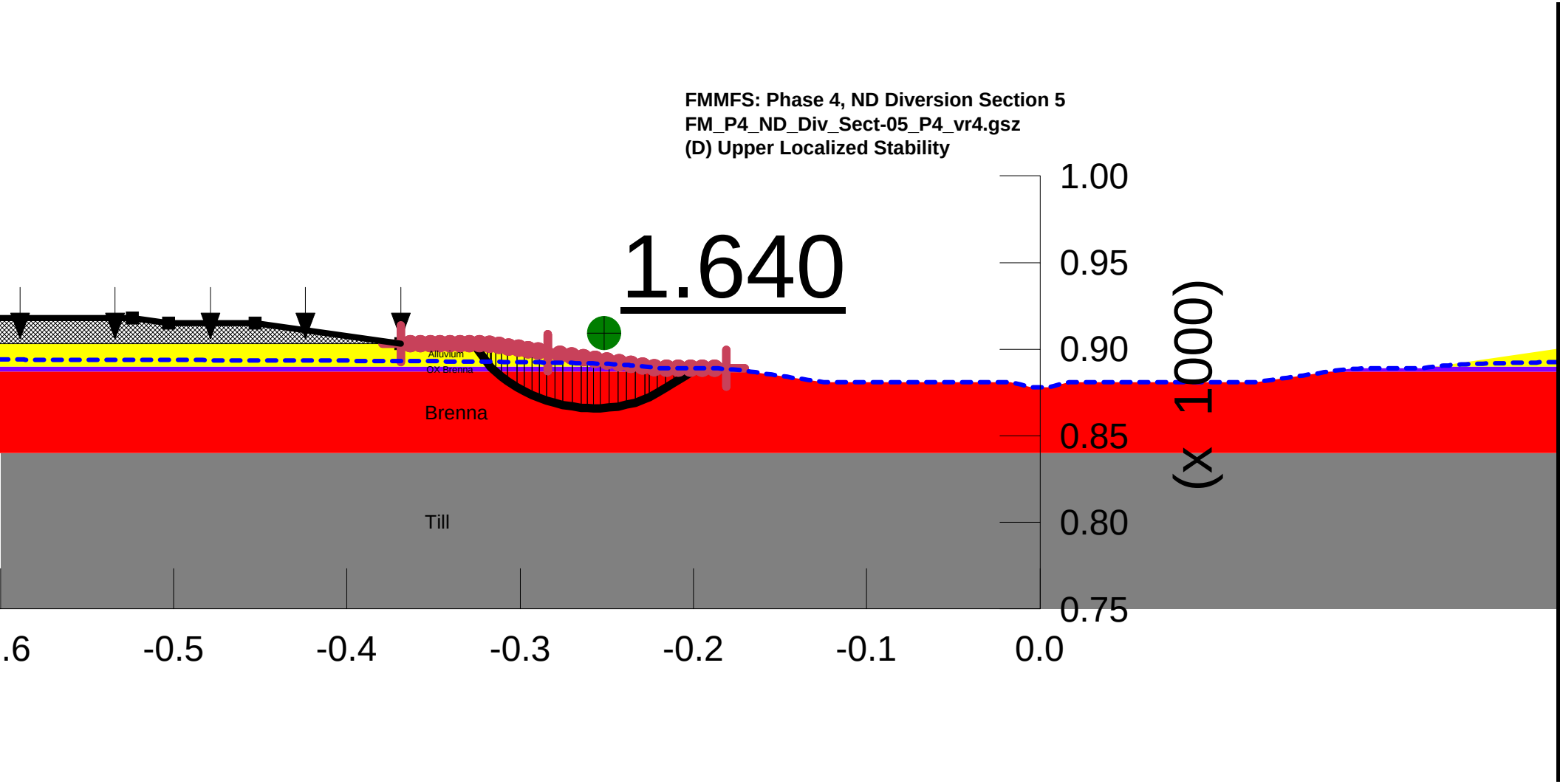
Date: 2/11/2011


FMMFS: Phase 4, ND Diversion Section 5
FM_P4_ND_Div_Sect-05_P4_vr4.gsz
(A) Slope Stability
1.411
Brenna
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 5
FM_P4_ND_Div_Sect-05_P4_vr4.gsz
(B) Wedge Slope Stability
1.412
Brenna
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 5
FM_P4_ND_Div_Sect-05_P4_vr4.gsz
(C) Lower Localized Stability
1.418
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
OX Brenna
Brenna
Till
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

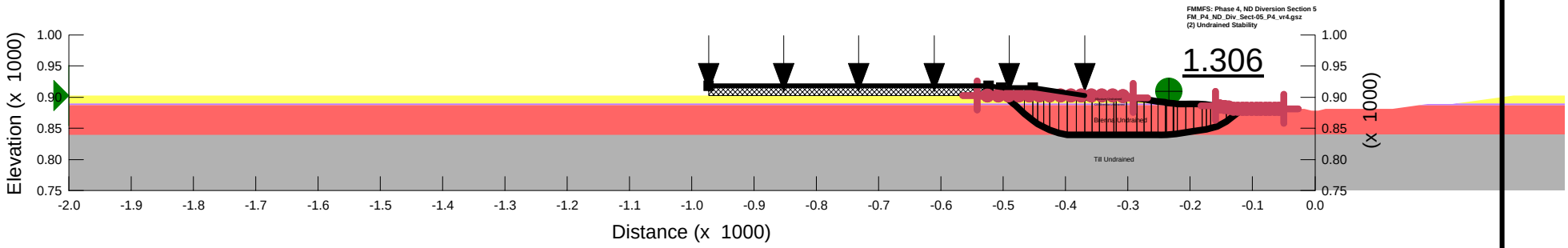

FMMFS: Phase 4, ND Diversion Section 5
FM_P4_ND_Div_Sect-05_P4_vr4.gsz
(D) Upper Localized Stability
1.640
Alluvium
OX Brenna
Brenna
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-05_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 5
(2) Undrained Stability

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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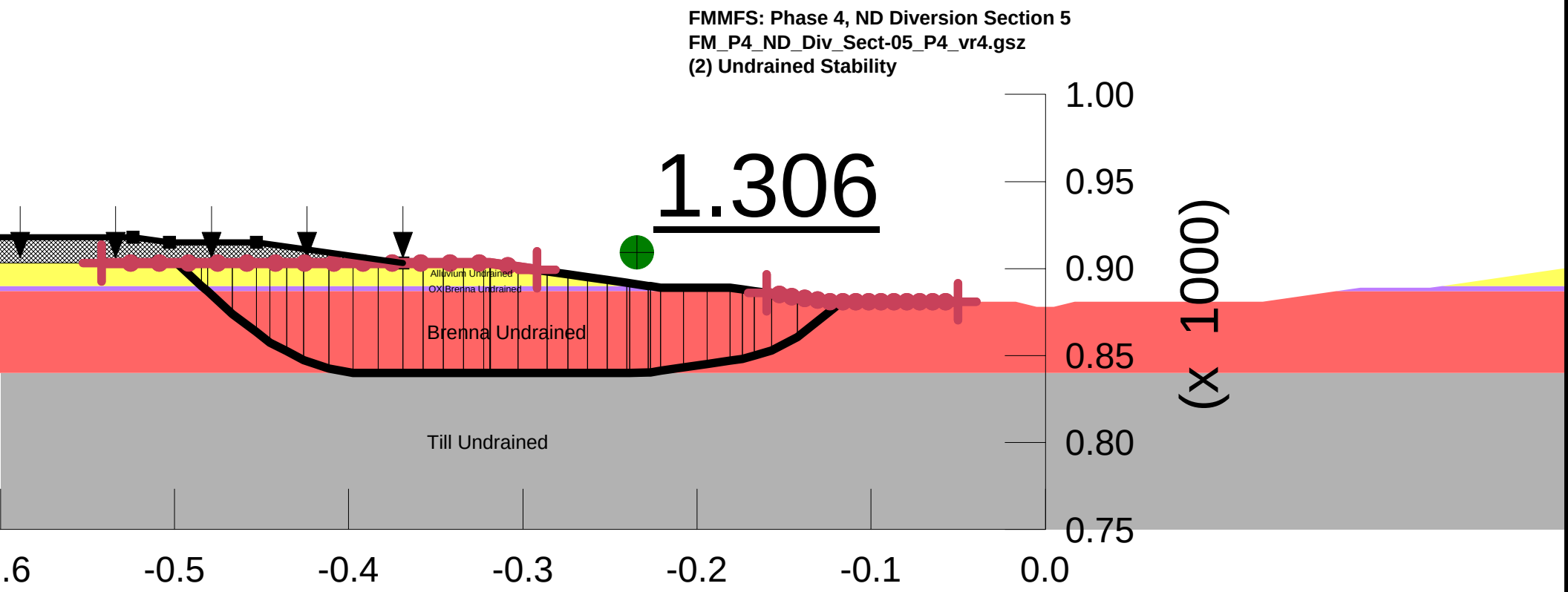

FMMFS: Phase 4, ND Diversion Section 5
FM_P4_ND_Div_Sect-05_P4_vr4.gsz
(2) Undrained Stability
1.306
Alluvium Undrained
OX Brenna Undrained
Brenna Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

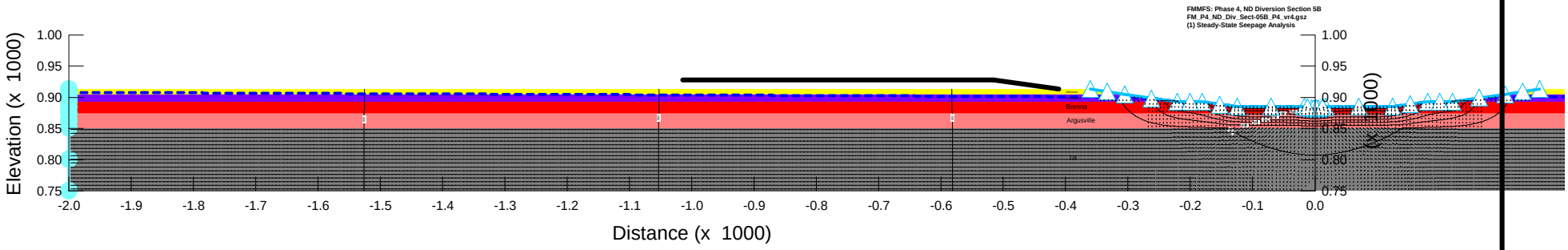
File Name: FM_P4_ND_Div_Sect-05B_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 5B

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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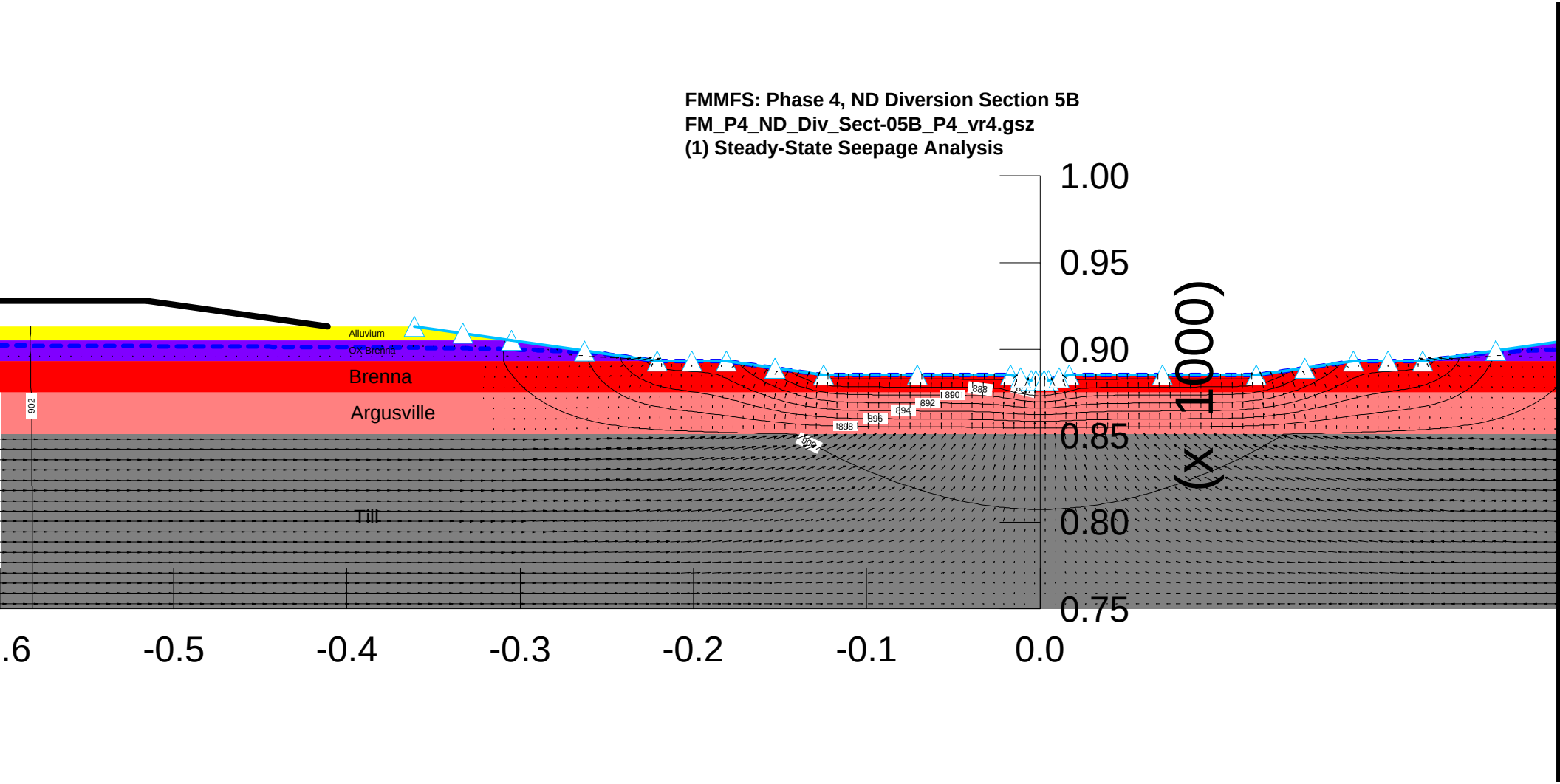
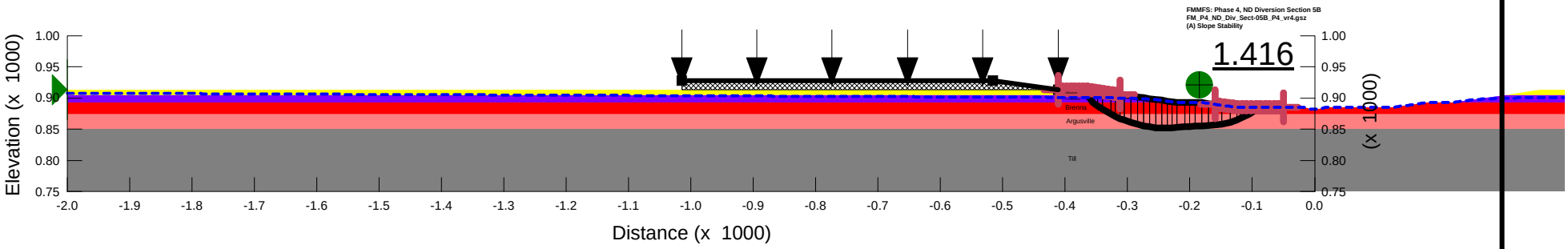

FMMFS: Phase 4, ND Diversion Section 5B
FM_P4_ND_Div_Sect-05B_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Argusville
Till
902
888
890
892
894
896
898
900
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-05B_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 5B
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



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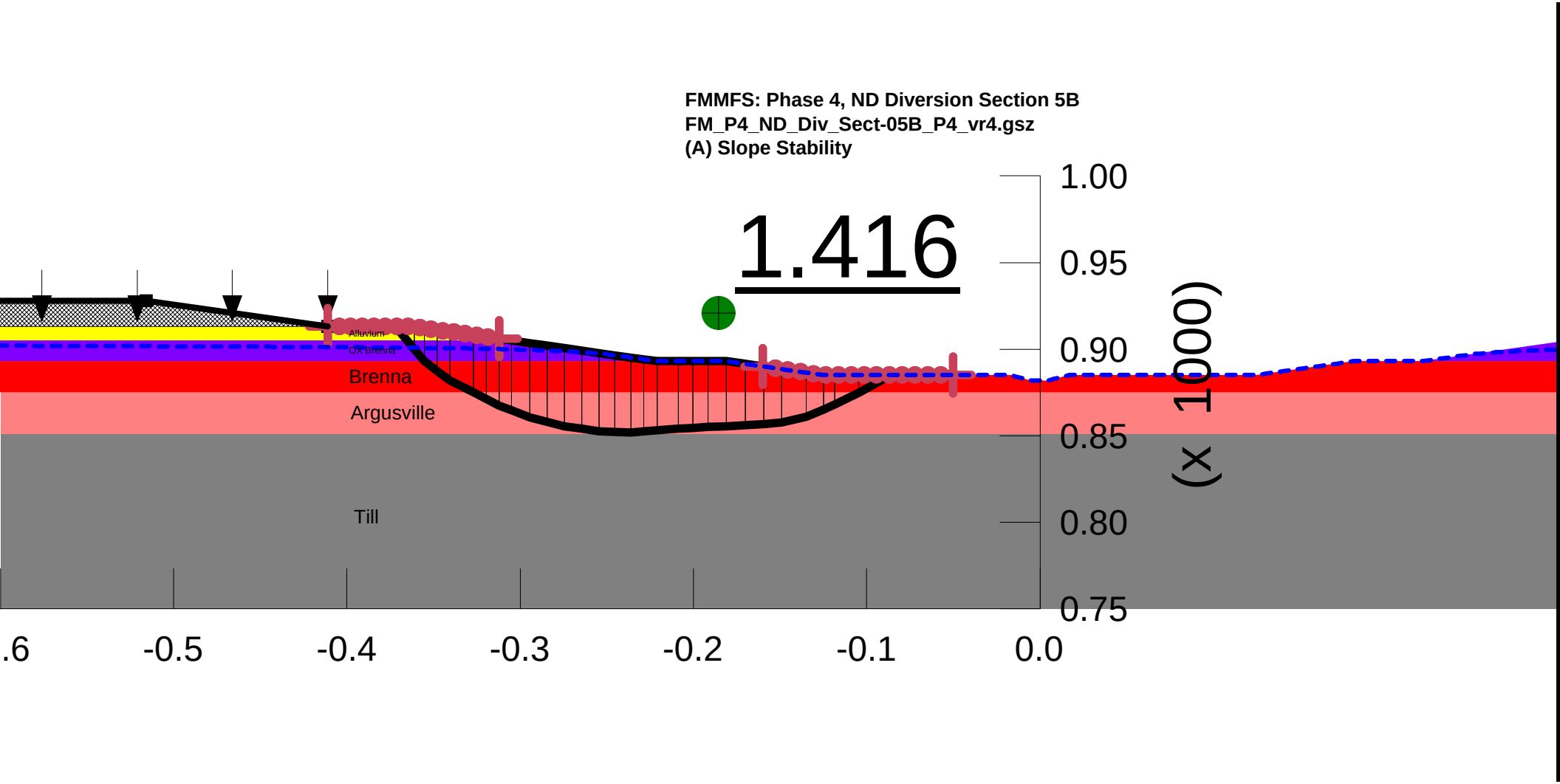
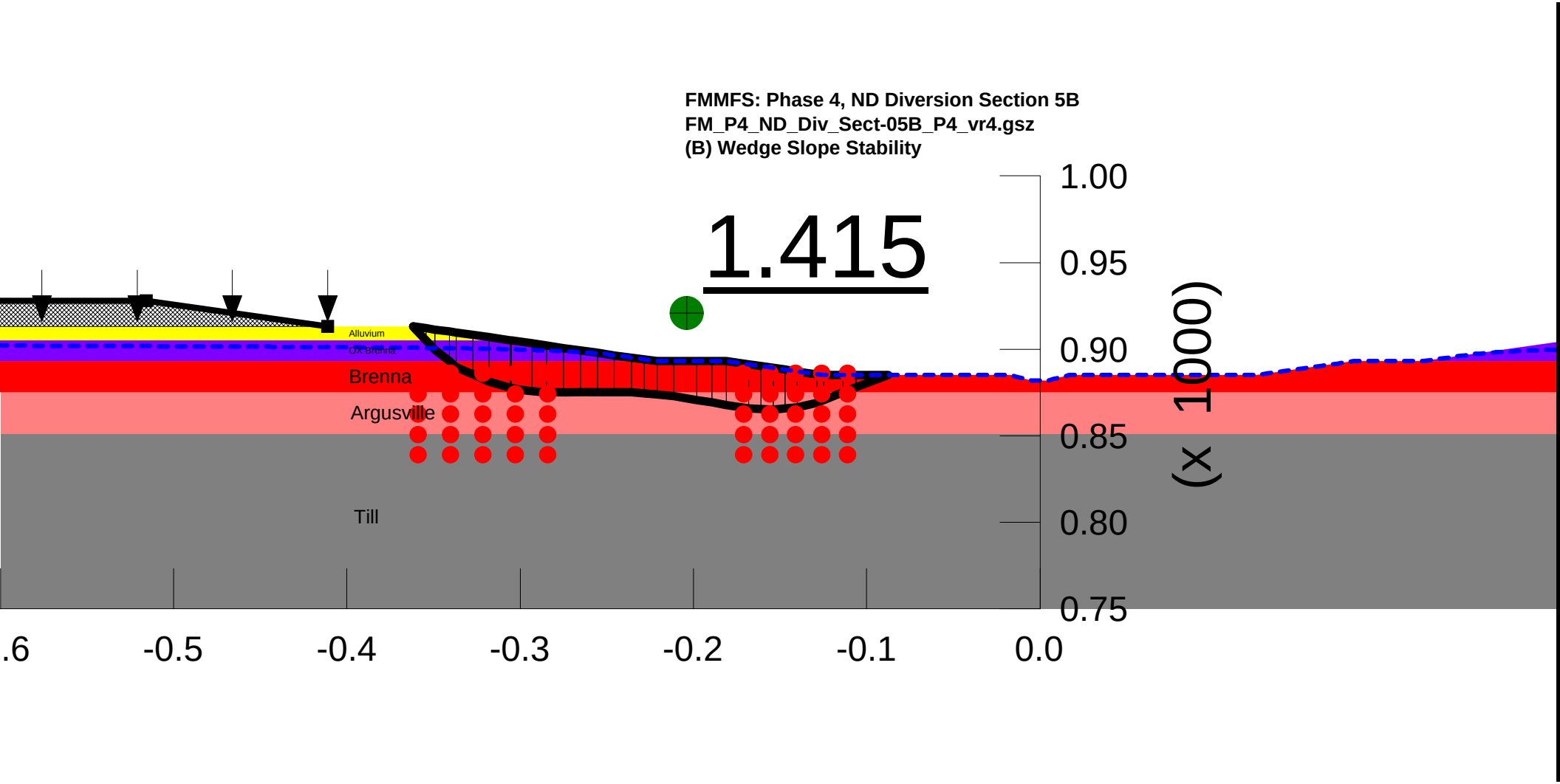
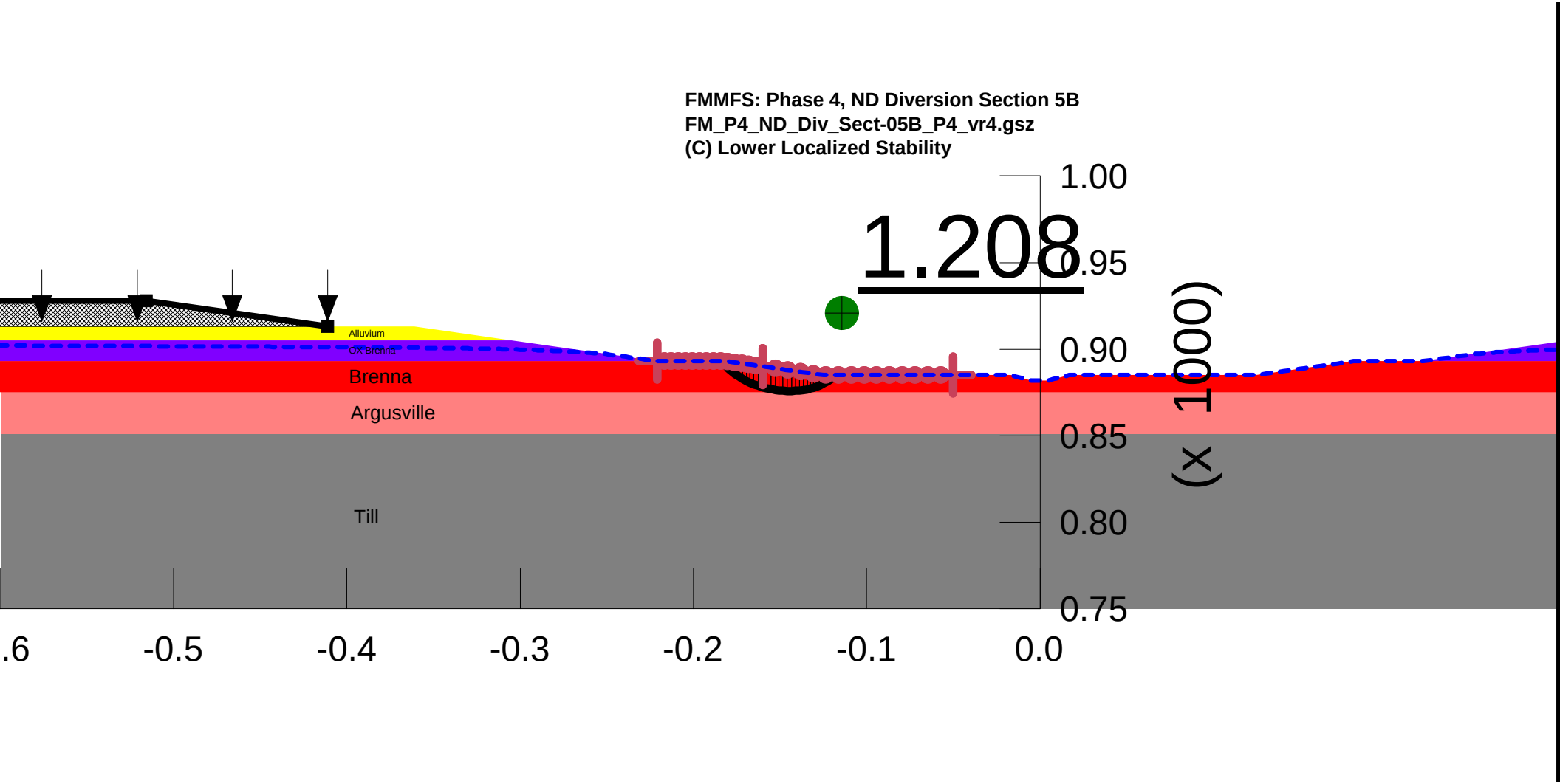
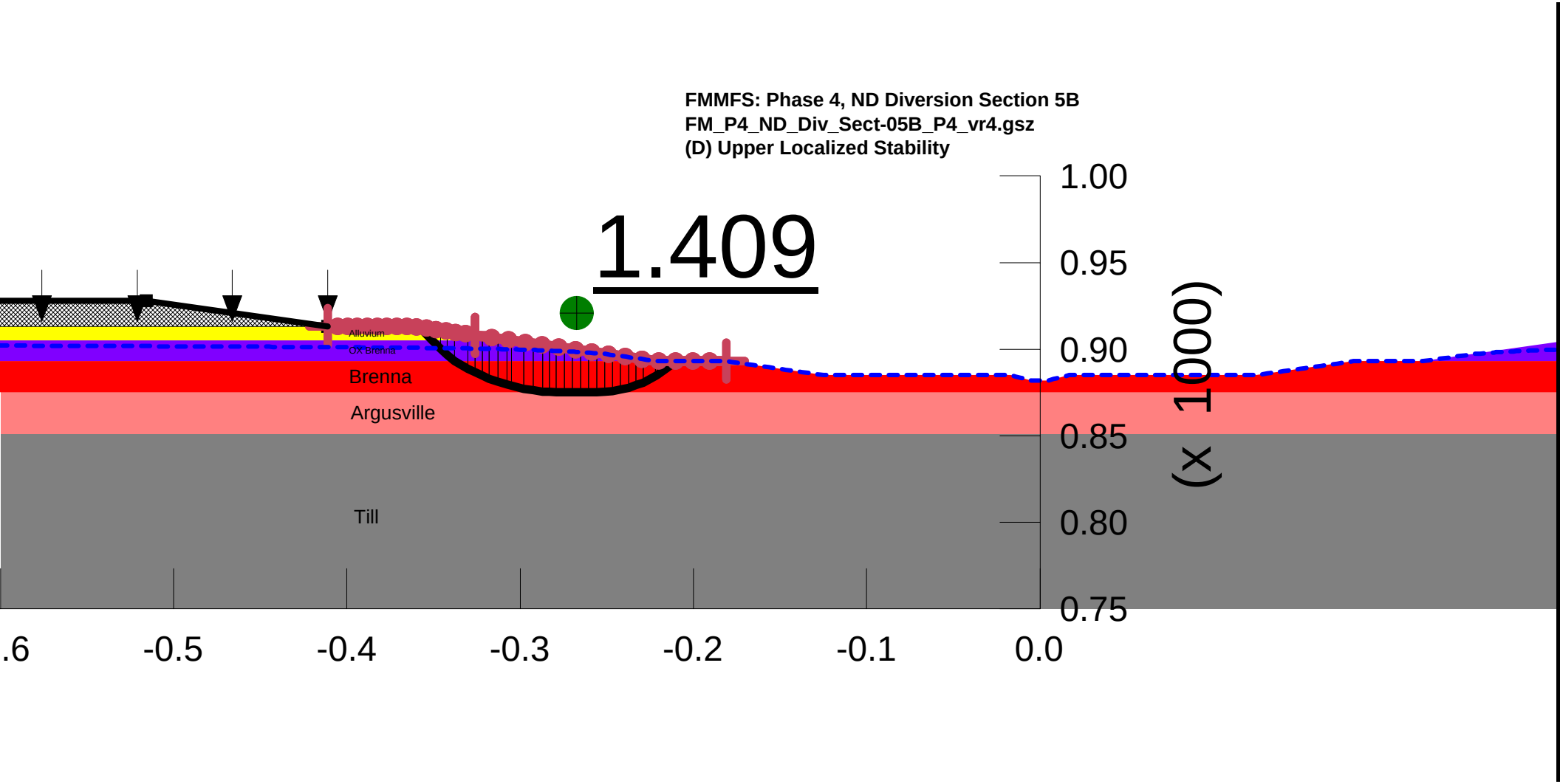

FMMFS: Phase 4, ND Diversion Section 5B
FM_P4_ND_Div_Sect-05B_P4_vr4.gsz
(A) Slope Stability
1.416
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 5B
FM_P4_ND_Div_Sect-05B_P4_vr4.gsz
(B) Wedge Slope Stability
1.415
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 5B
FM_P4_ND_Div_Sect-05B_P4_vr4.gsz
(C) Lower Localized Stability
1.208
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

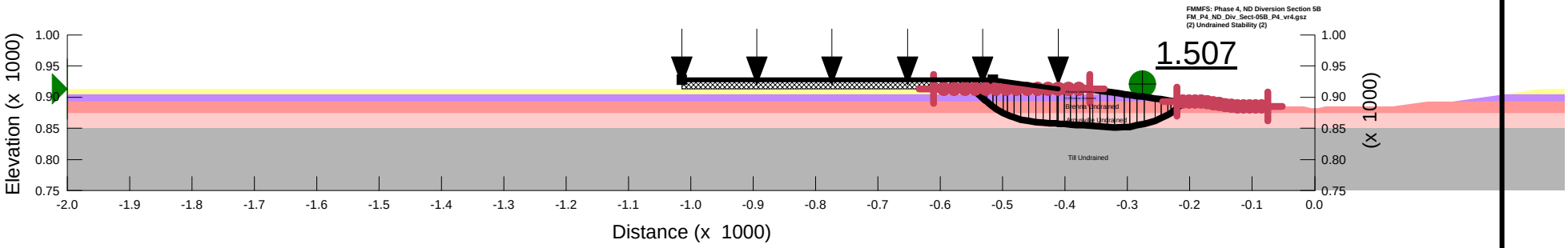

FMMFS: Phase 4, ND Diversion Section 5B
FM_P4_ND_Div_Sect-05B_P4_vr4.gsz
(D) Upper Localized Stability
1.409
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-05B_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 5B
(2) Undrained Stability (2)

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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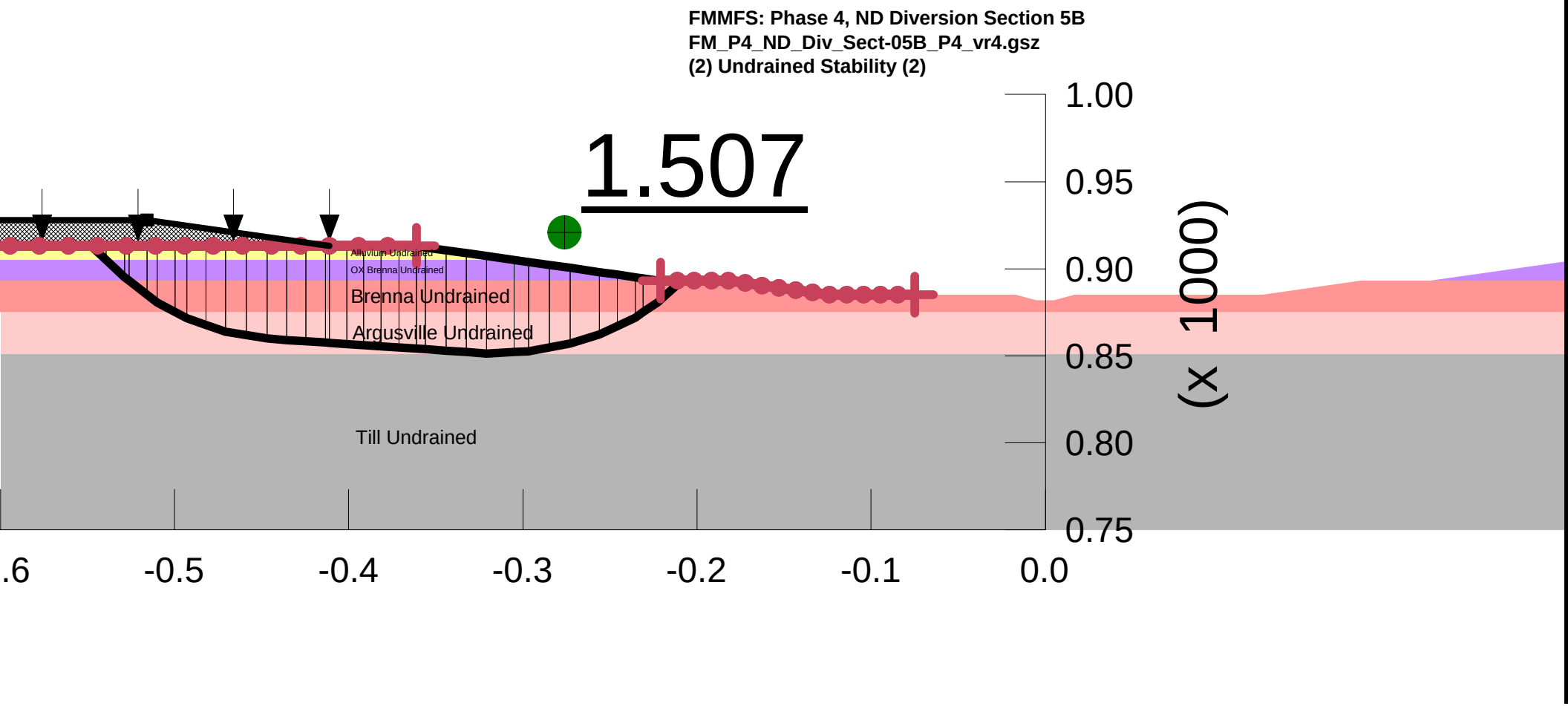

FMMFS: Phase 4, ND Diversion Section 5B
FM_P4_ND_Div_Sect-05B_P4_vr4.gsz
(2) Undrained Stability (2)
1.507
Alluvium Undrained
OX Brenna Undrained
Brenna Undrained
Argusville Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

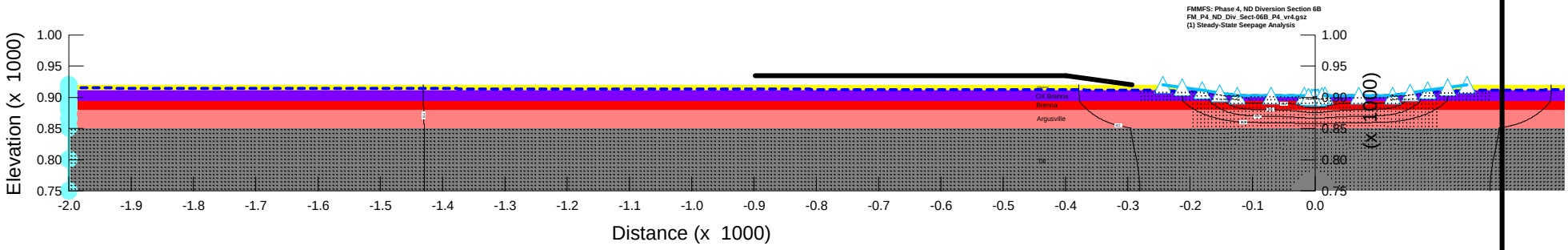
File Name: FM_P4_ND_Div_Sect-06B_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 6B

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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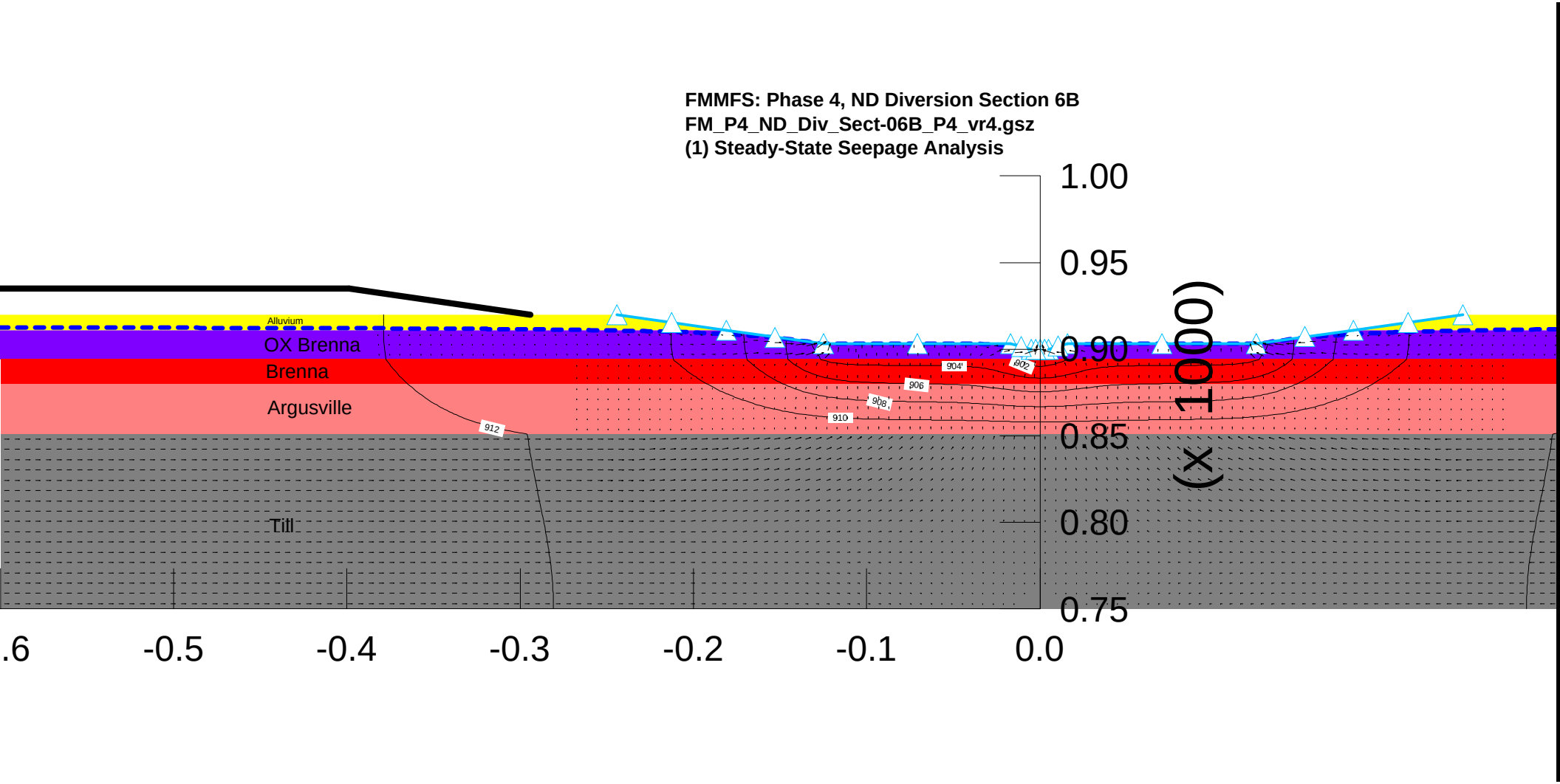
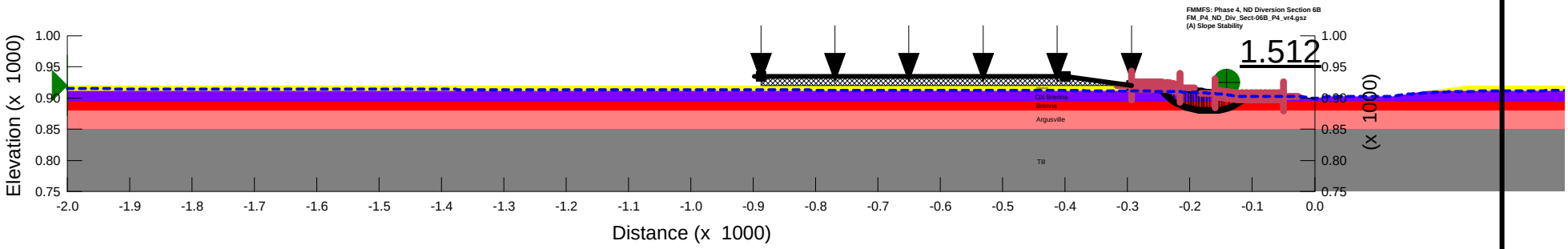

FMMFS: Phase 4, ND Diversion Section 6B
FM_P4_ND_Div_Sect-06B_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Argusville
Till
902
904
906
908
910
912
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-06B_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 6B
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



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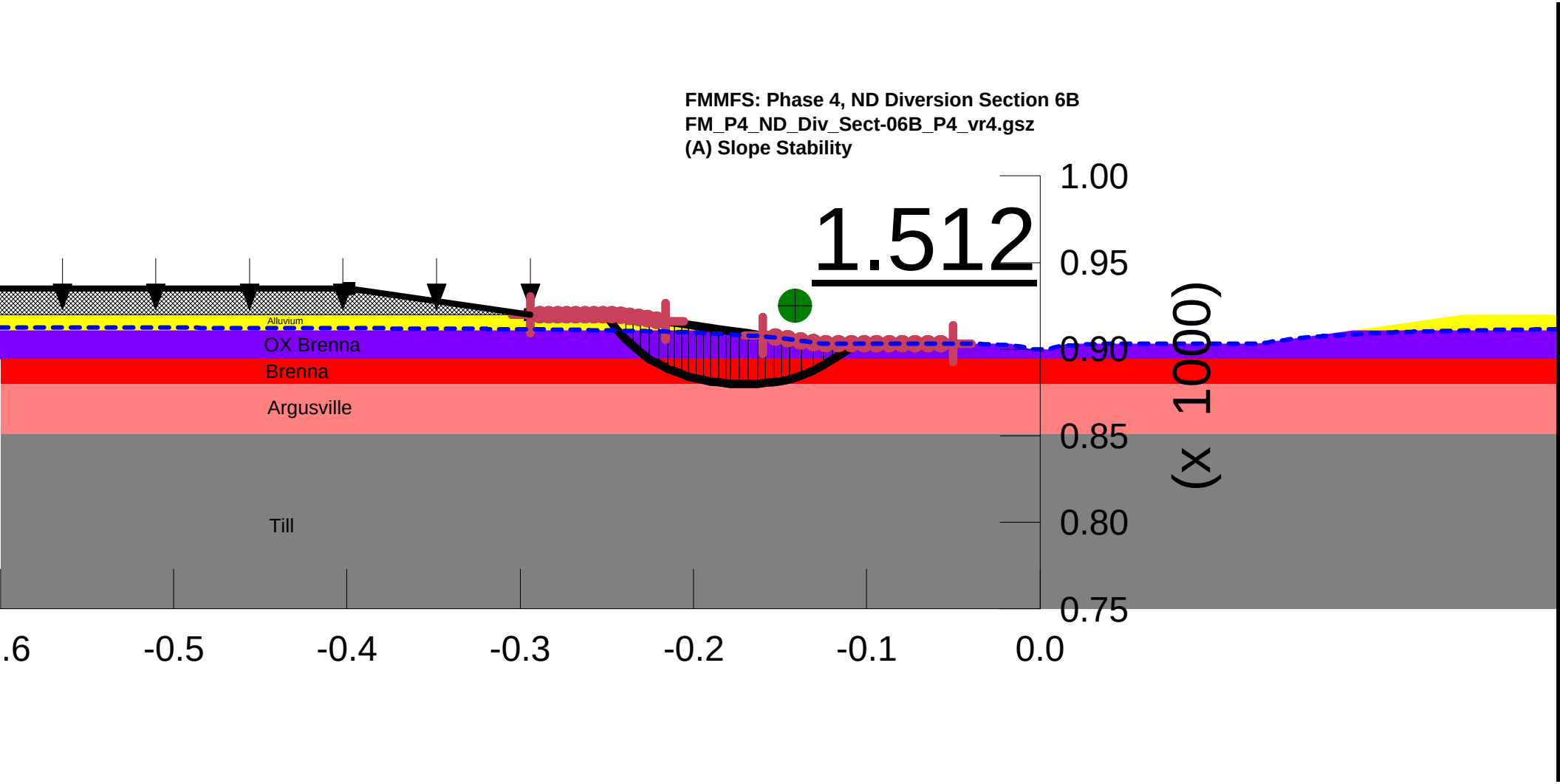
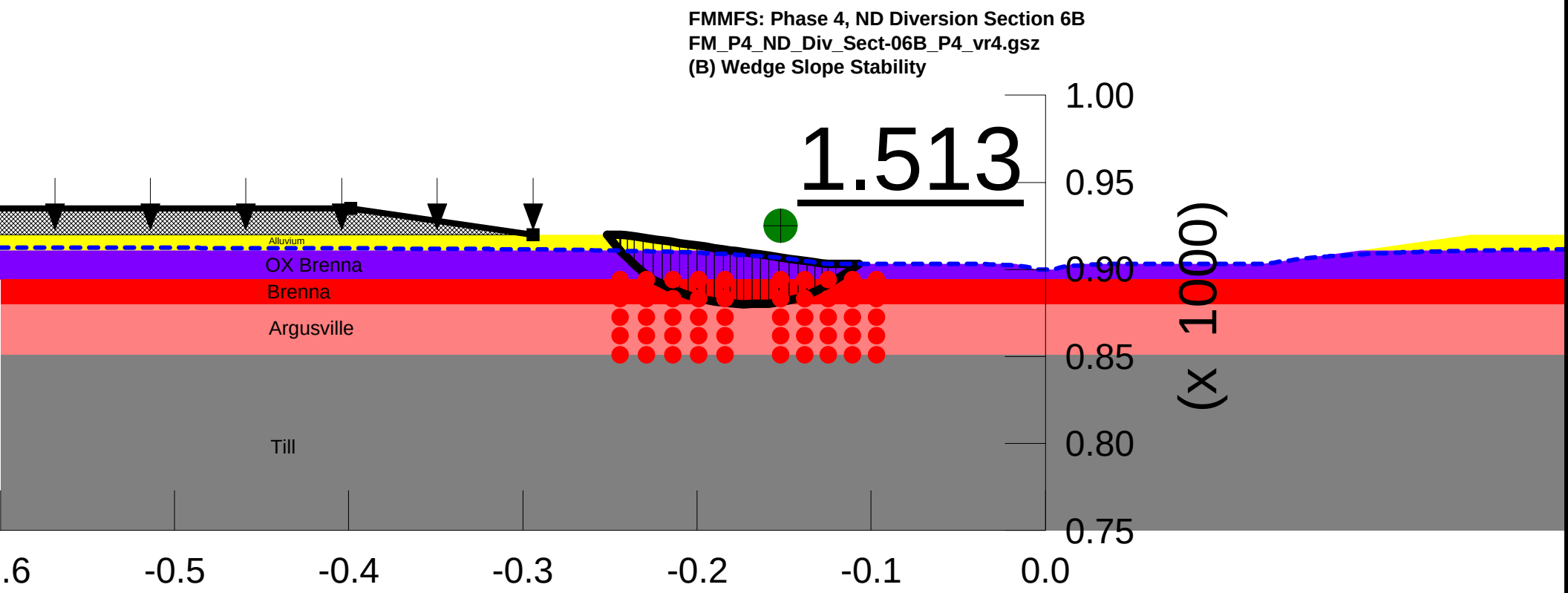
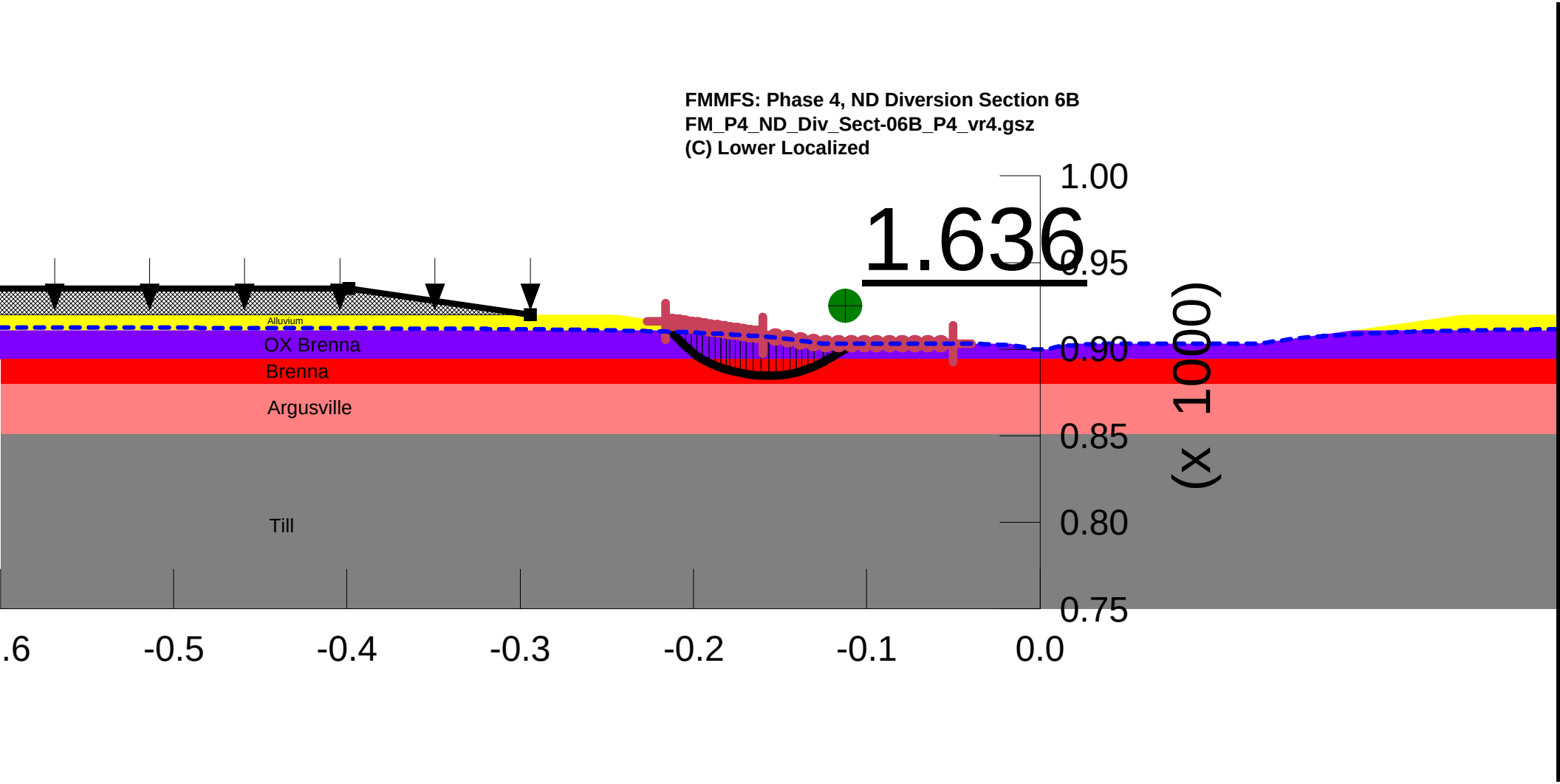
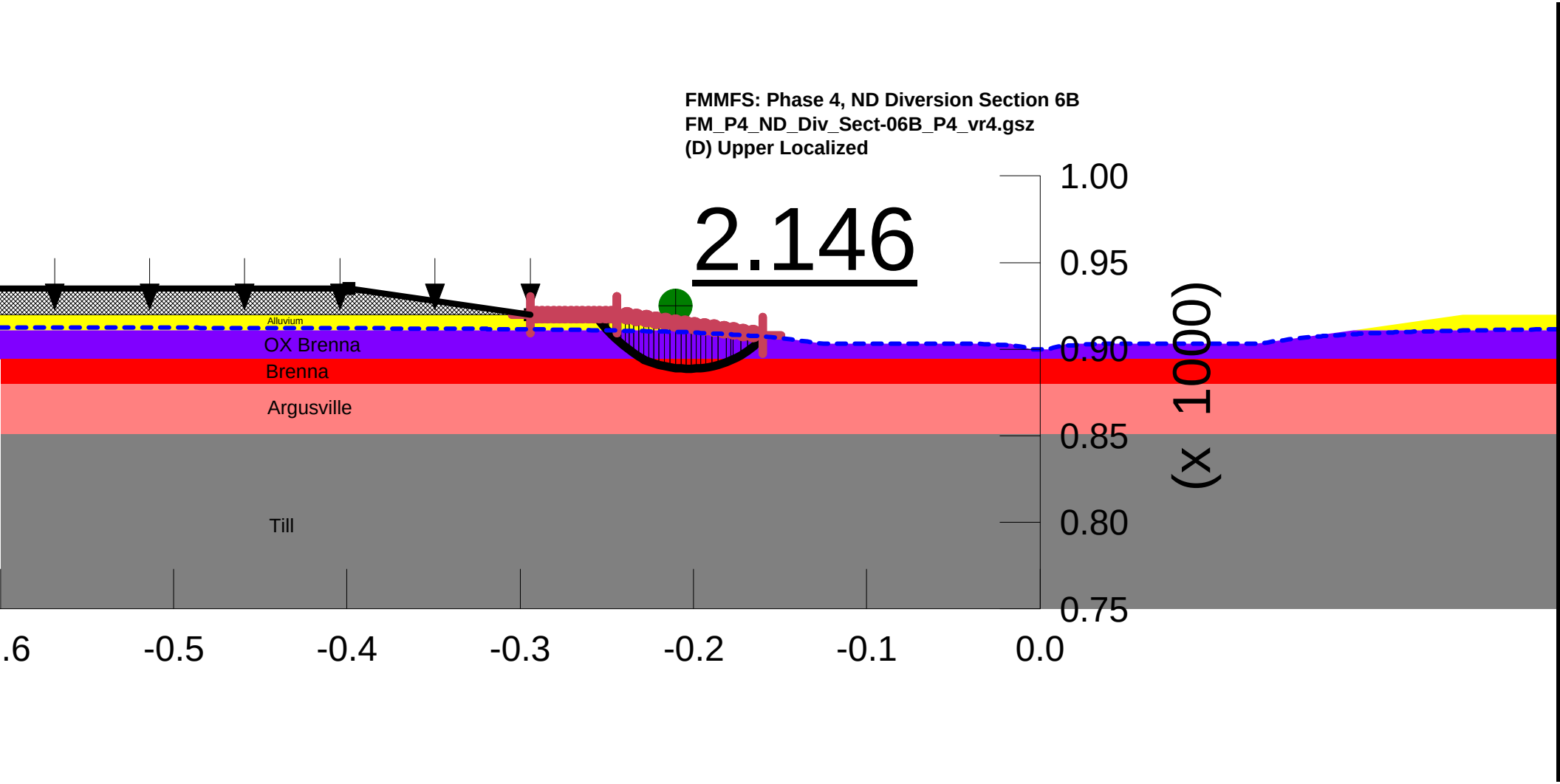

FMMFS: Phase 4, ND Diversion Section 6B
FM_P4_ND_Div_Sect-06B_P4_vr4.gsz
(A) Slope Stability
1.512
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 6B
FM_P4_ND_Div_Sect-06B_P4_vr4.gsz
(B) Wedge Slope Stability
1.513
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 6B
FM_P4_ND_Div_Sect-06B_P4_vr4.gsz
(C) Lower Localized
1.636
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

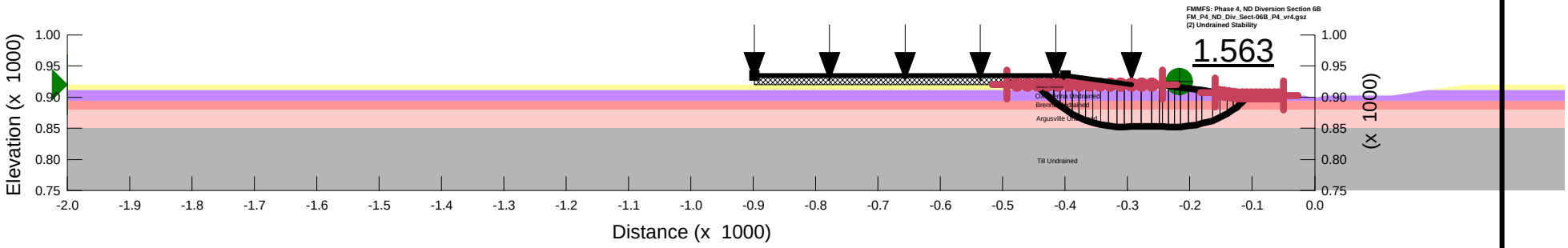

FMMFS: Phase 4, ND Diversion Section 6B
FM_P4_ND_Div_Sect-06B_P4_vr4.gsz
(D) Upper Localized
2.146
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-06B_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 6B
(2) Undrained Stability

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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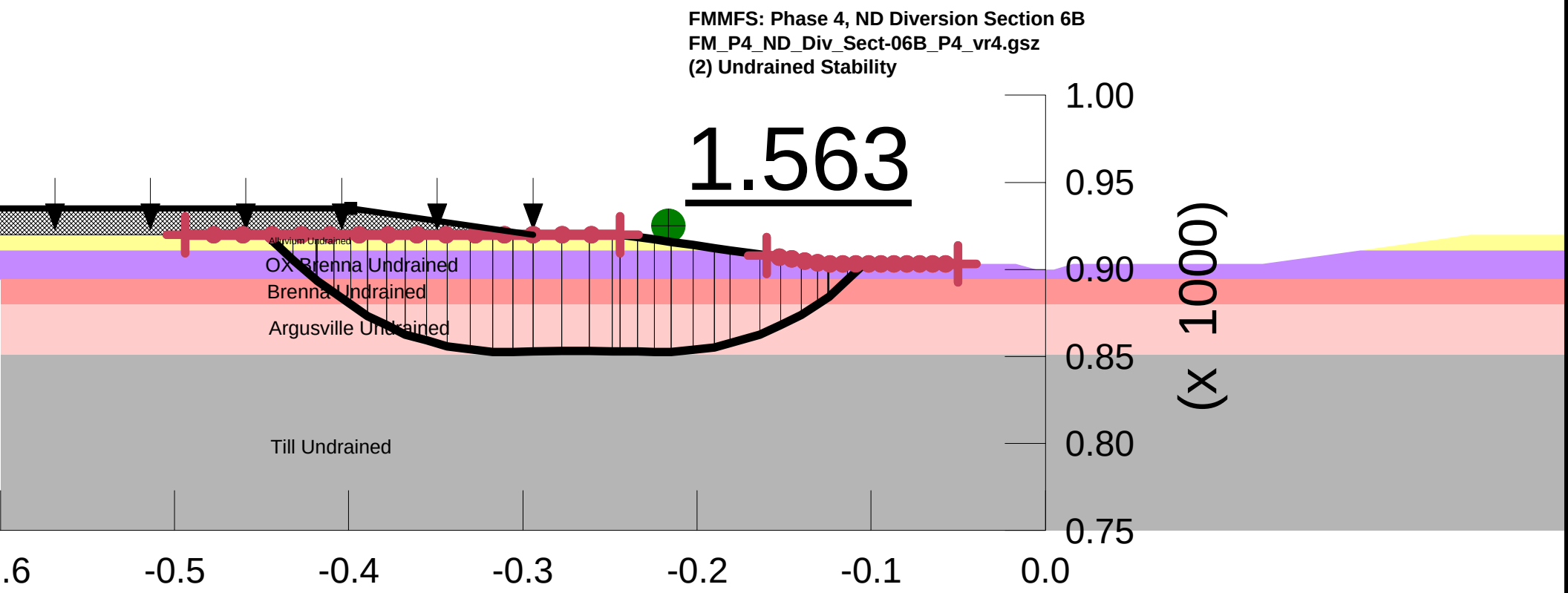

FMMFS: Phase 4, ND Diversion Section 6B
FM_P4_ND_Div_Sect-06B_P4_vr4.gsz
(2) Undrained Stability
1.563
Alluvium Undrained
OX Brenna Undrained
Brenna Undrained
Argusville Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

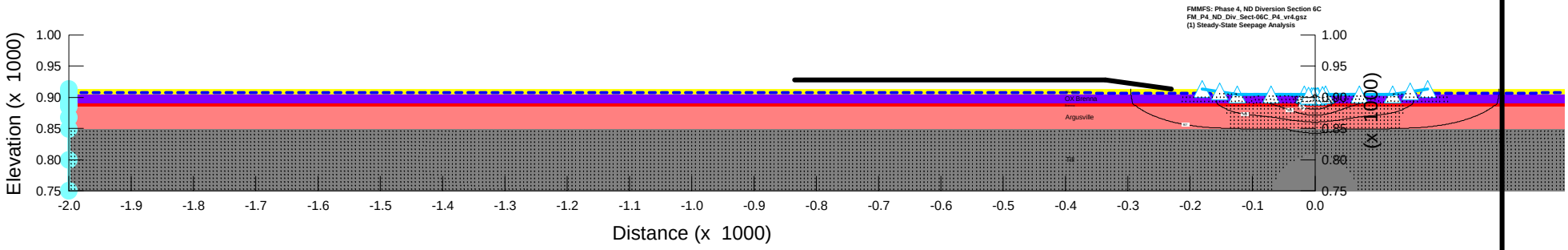
File Name: FM_P4_ND_Div_Sect-06C_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 6C

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Brenna Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.63 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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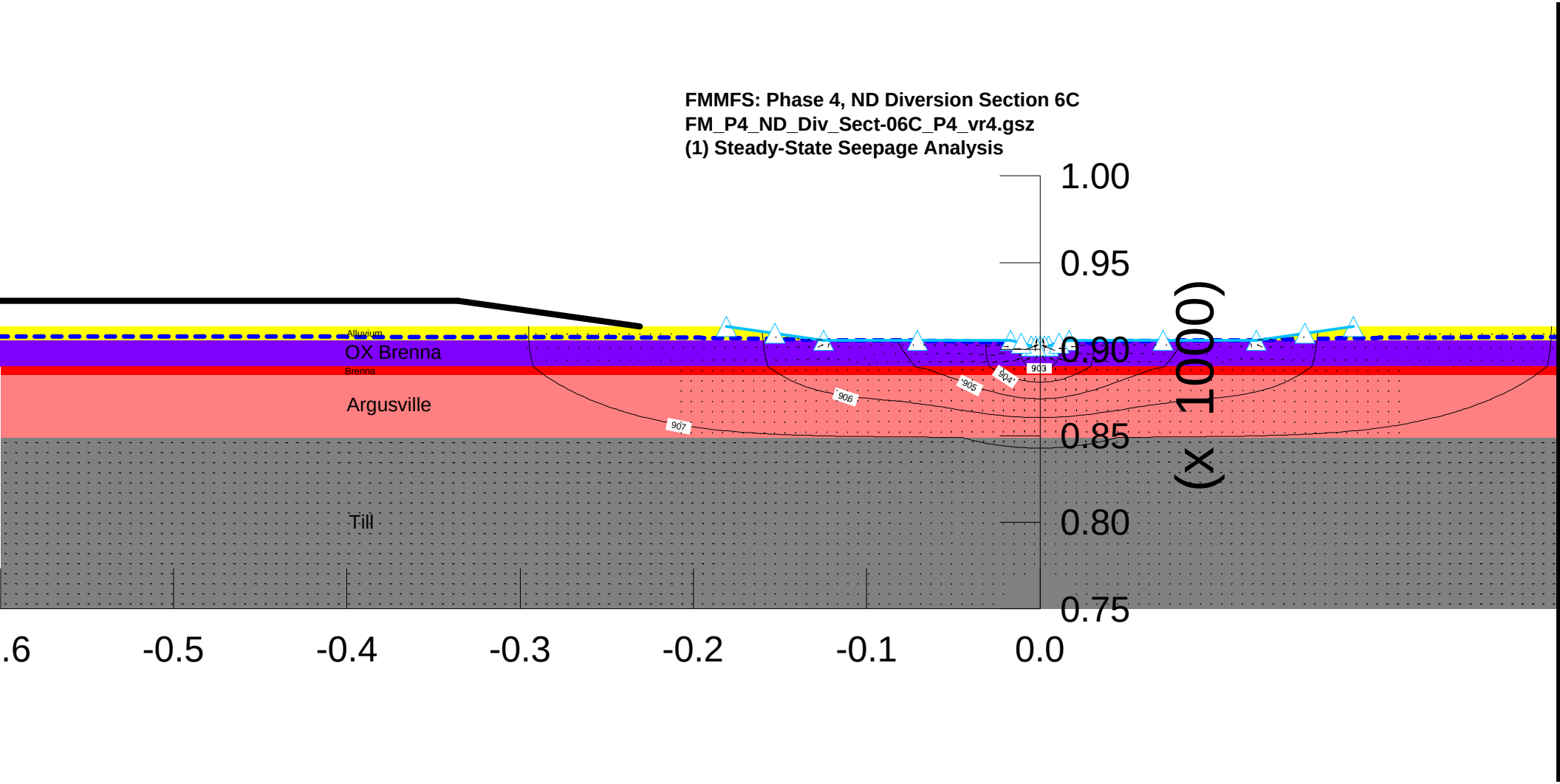
Date: 1/18/2011

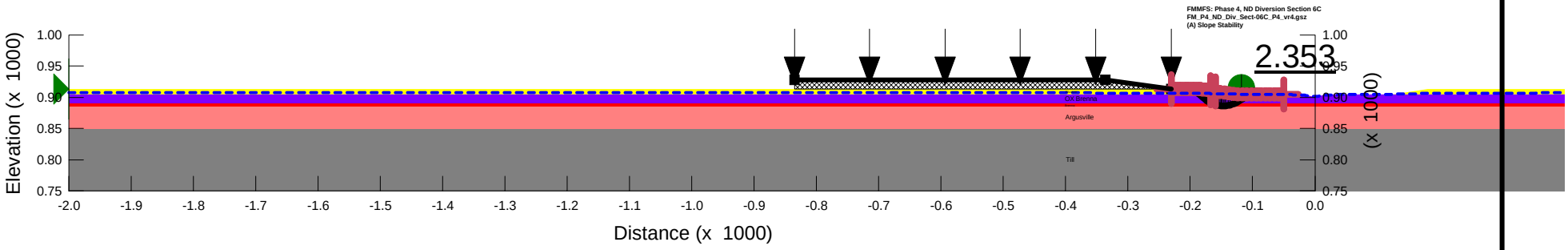

FMMFS: Phase 4, ND Diversion Section 6C
FM_P4_ND_Div_Sect-06C_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Brenna
Argusville
Till
903
904
905
906
907
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-06C_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 6C
(A) Slope Stability

Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Brenna Model: Shear/Normal Fn. Unit Weight: 104 pcf Strength Function: Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



Created By: Heckendorf, Kurt A MVP
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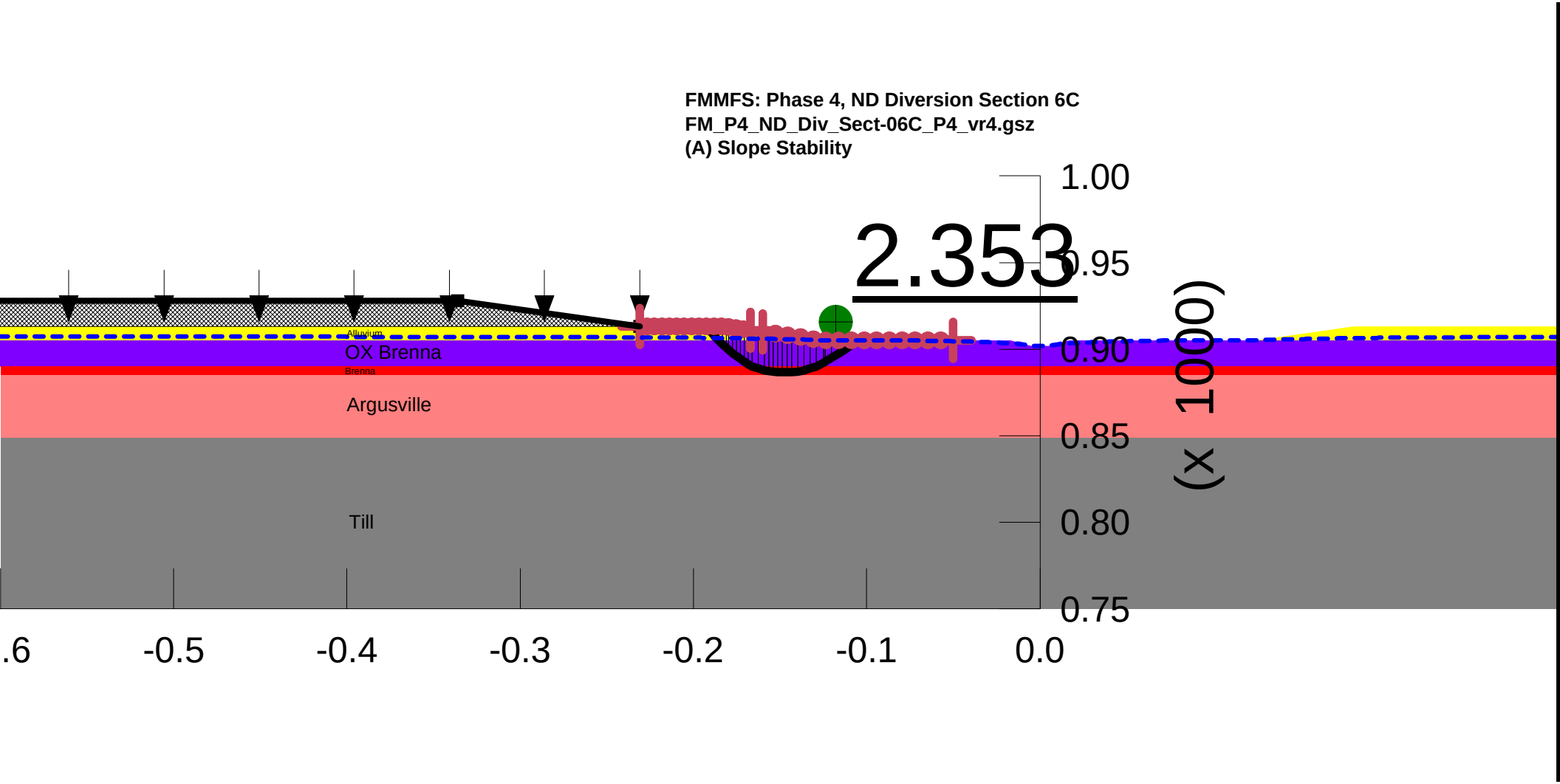
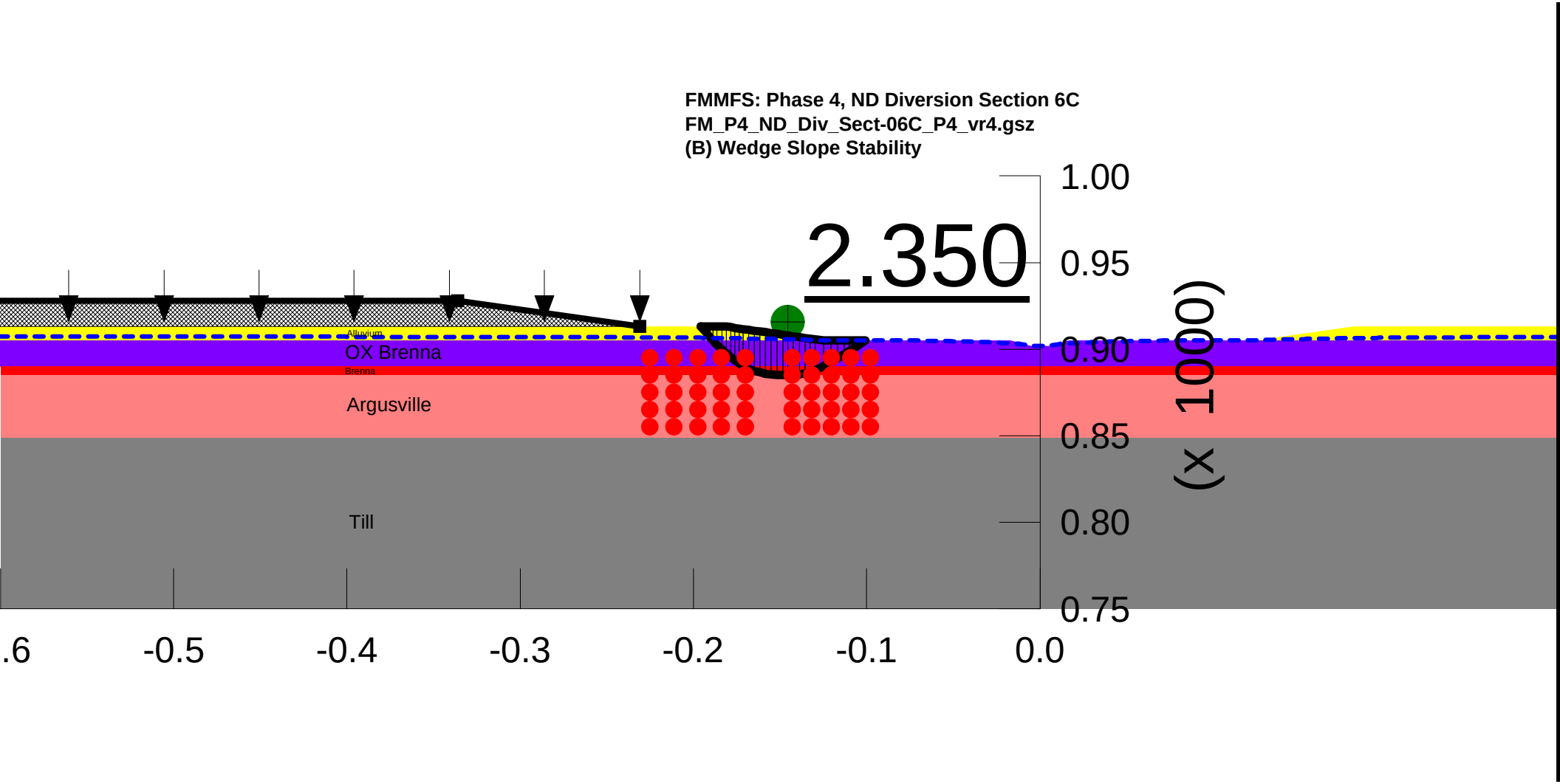
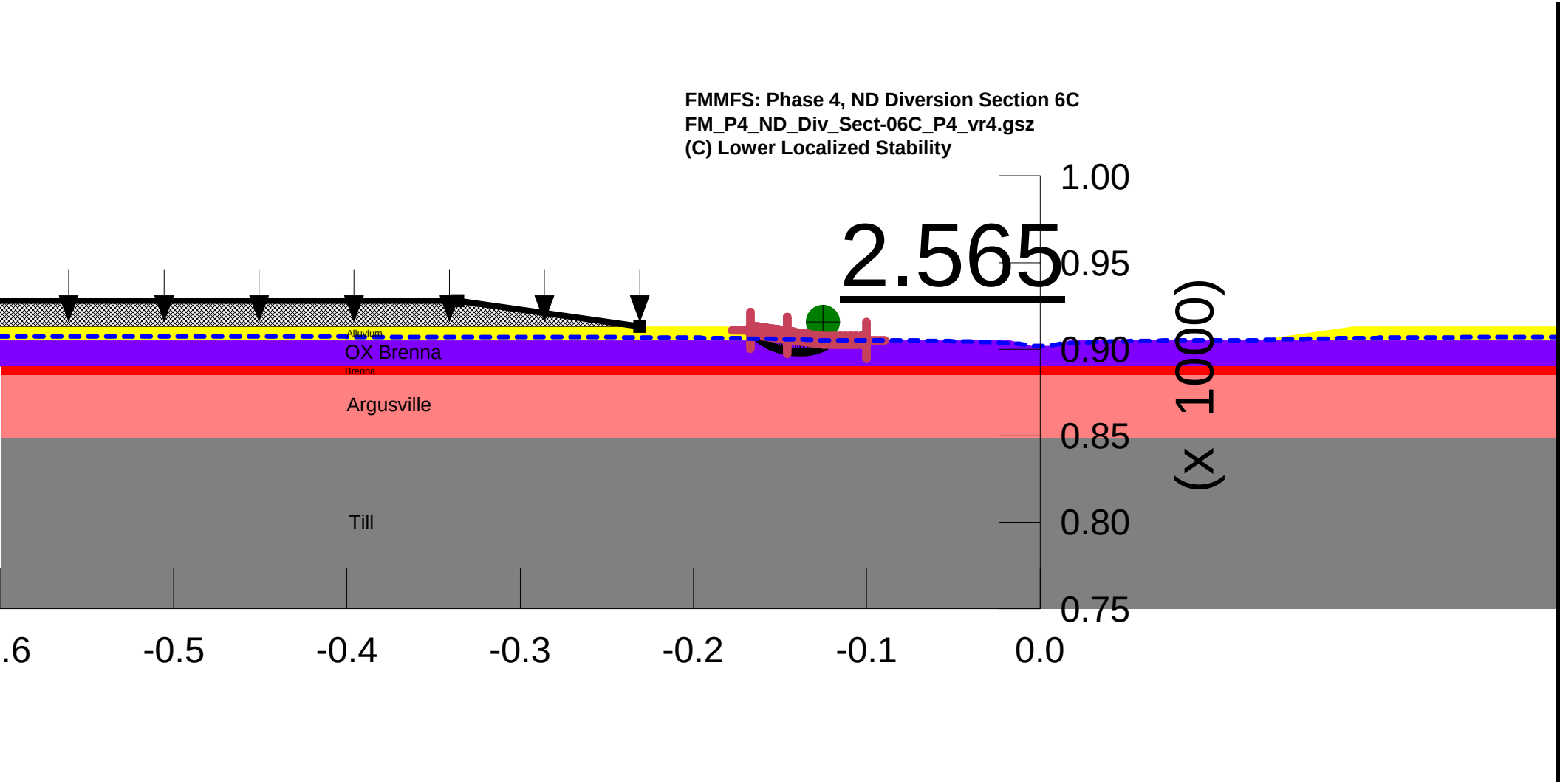
Date: 1/18/2011


FMMFS: Phase 4, ND Diversion Section 6C
FM_P4_ND_Div_Sect-06C_P4_vr4.gsz
(A) Slope Stability
2.353
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 6C
FM_P4_ND_Div_Sect-06C_P4_vr4.gsz
(B) Wedge Slope Stability
2.350
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0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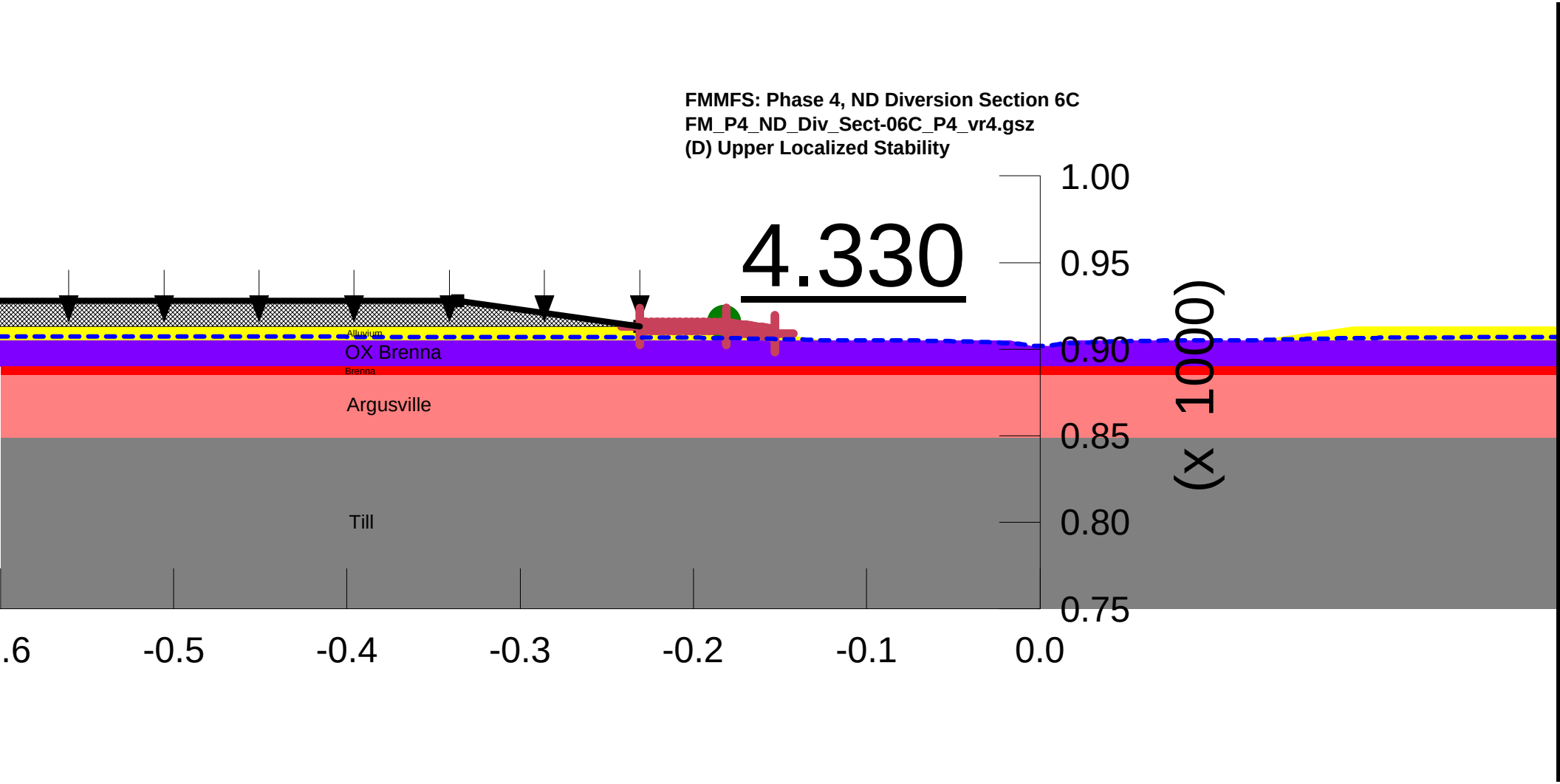
FM_P4_ND_Div_Sect-06C_P4_vr4.gsz
(C) Lower Localized Stability
2.565
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0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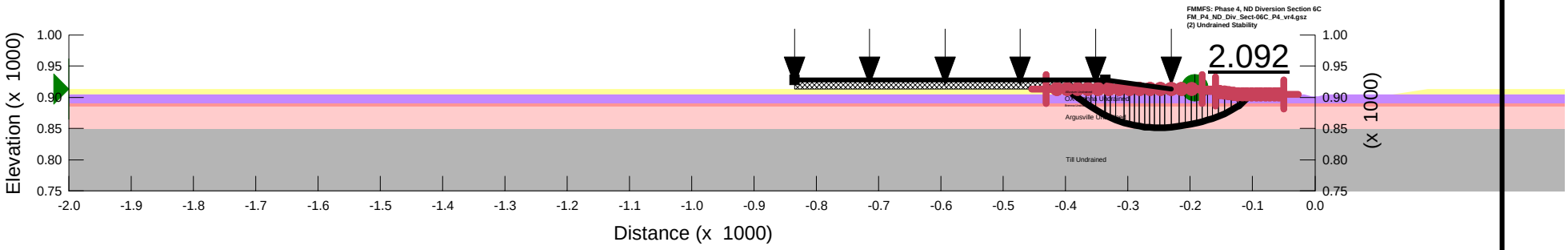
FM_P4_ND_Div_Sect-06C_P4_vr4.gsz
(D) Upper Localized Stability
4.330
Alluvium
OX Brenna
Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-06C_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 6C
(2) Undrained Stability

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 104 pcf Cohesion: 525 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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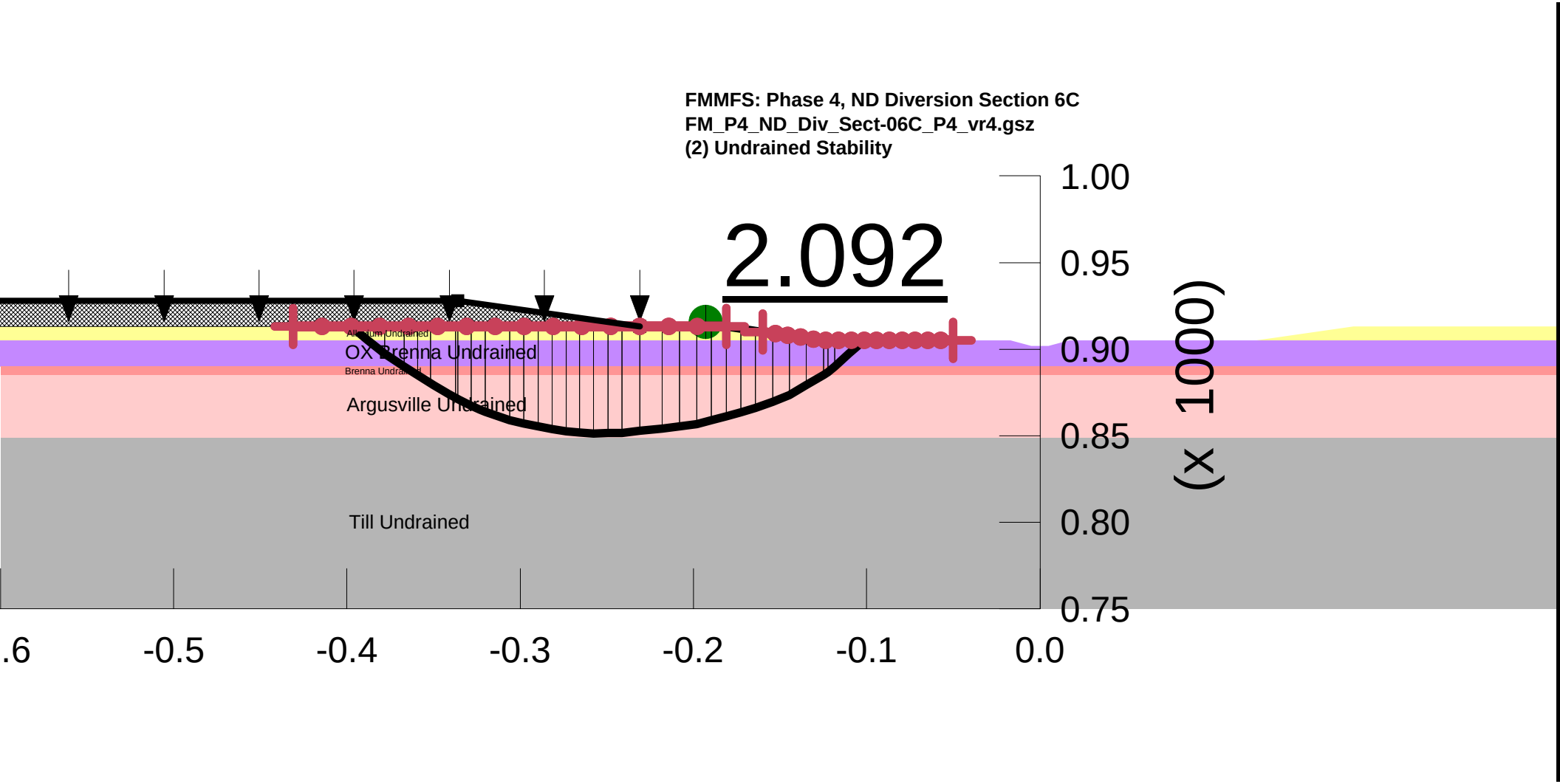
Date: 1/18/2011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FM_P4_ND_Div_Sect-06C_P4_vr4.gsz
(2) Undrained Stability
2.092
OX Brenna Undrained
Argusville Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

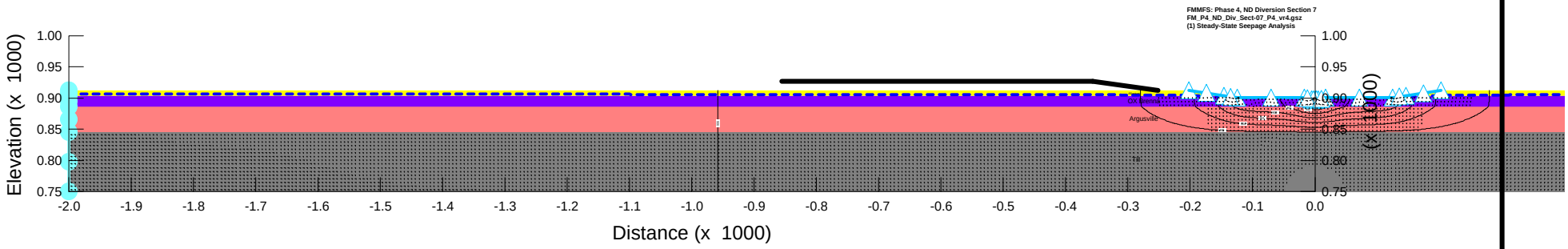
File Name: FM_P4_ND_Div_Sect-07_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 7

(1) Steady-State Seepage Analysis

Soil Properties

Name: Alluvium Model: Saturated / Unsaturated K-Function: Alluv/Sherack Vol. WC. Function: Alluv/Sherack K-Ratio: 1 K-Direction: 0 °
Name: OX Brenna Model: Saturated / Unsaturated K-Function: OX Brenna Vol. WC. Function: OX Brenna K-Ratio: 1 K-Direction: 0 °
Name: Argusville Model: Saturated Only K-Sat: 0.00028 ft/days Volumetric Water Content: 0.6 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 1 K-Direction: 0 °
Name: Till Model: Saturated Only K-Sat: 0.057 ft/days Volumetric Water Content: 0.45 ft³/ft³ Mv: 3e-005 /psf K-Ratio: 0.25 K-Direction: 0 °



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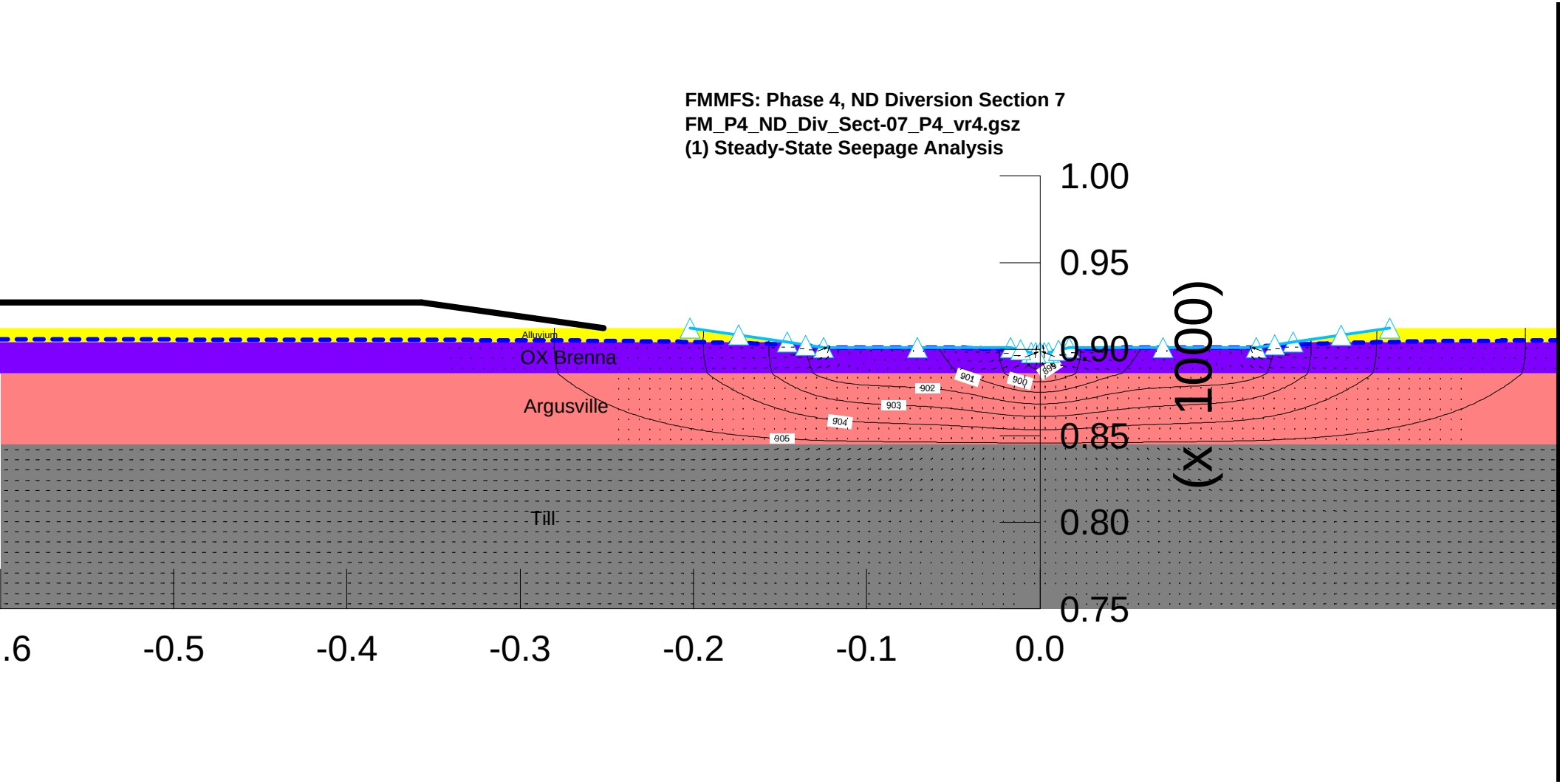
Last Edited By: Heckendorf, Kurt A MVP
Date: 1/18/2011

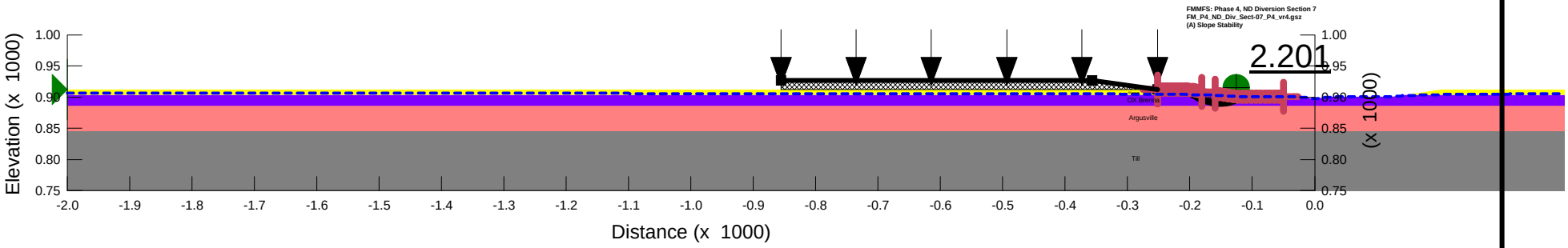

FMMFS: Phase 4, ND Diversion Section 7
FM_P4_ND_Div_Sect-07_P4_vr4.gsz
(1) Steady-State Seepage Analysis
Alluvium
OX Brenna
Argusville
Till
899
900
901
902
903
904
905
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-07_P4_vr4.gsz

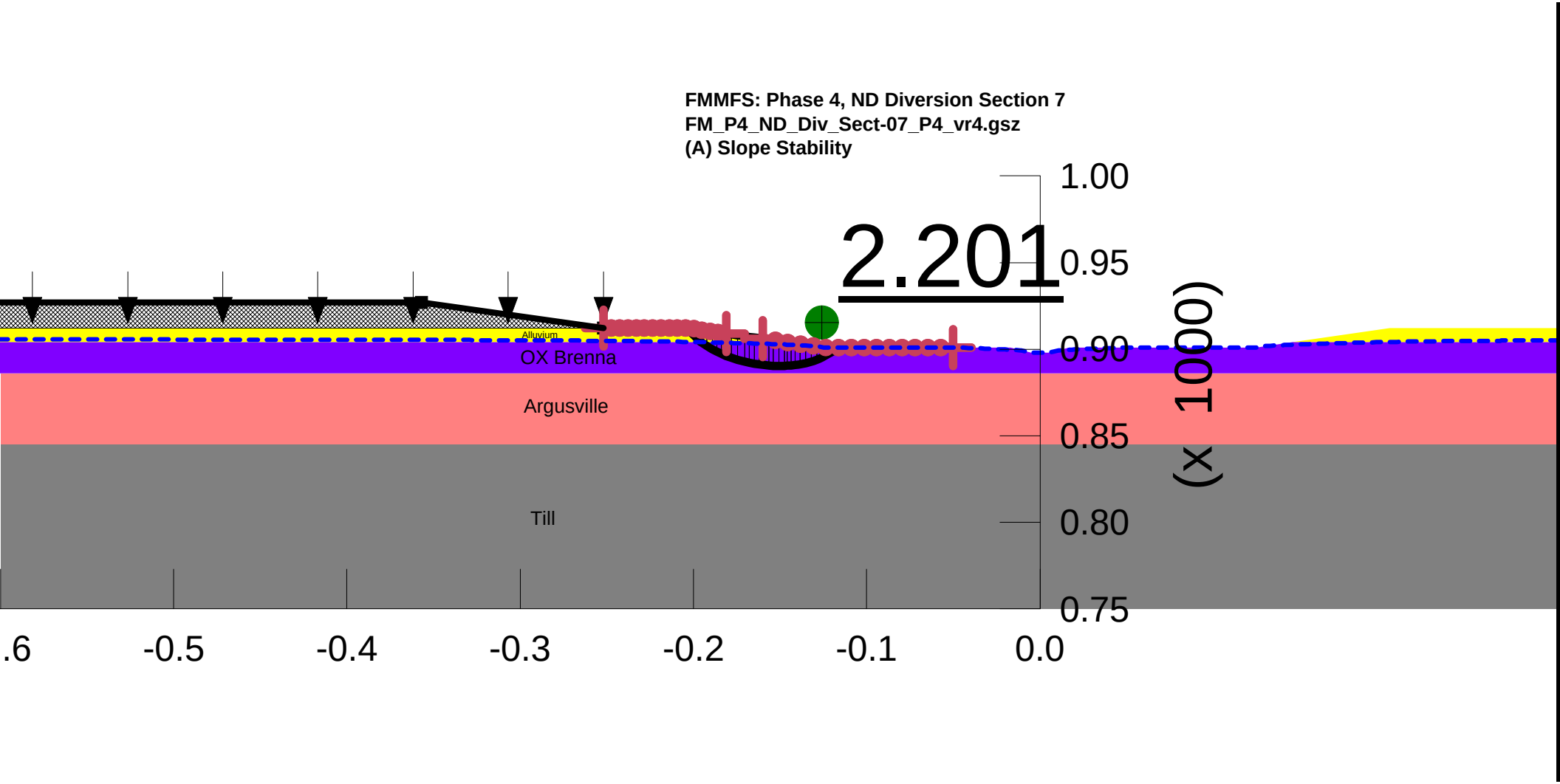
Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 7
(A) Slope Stability

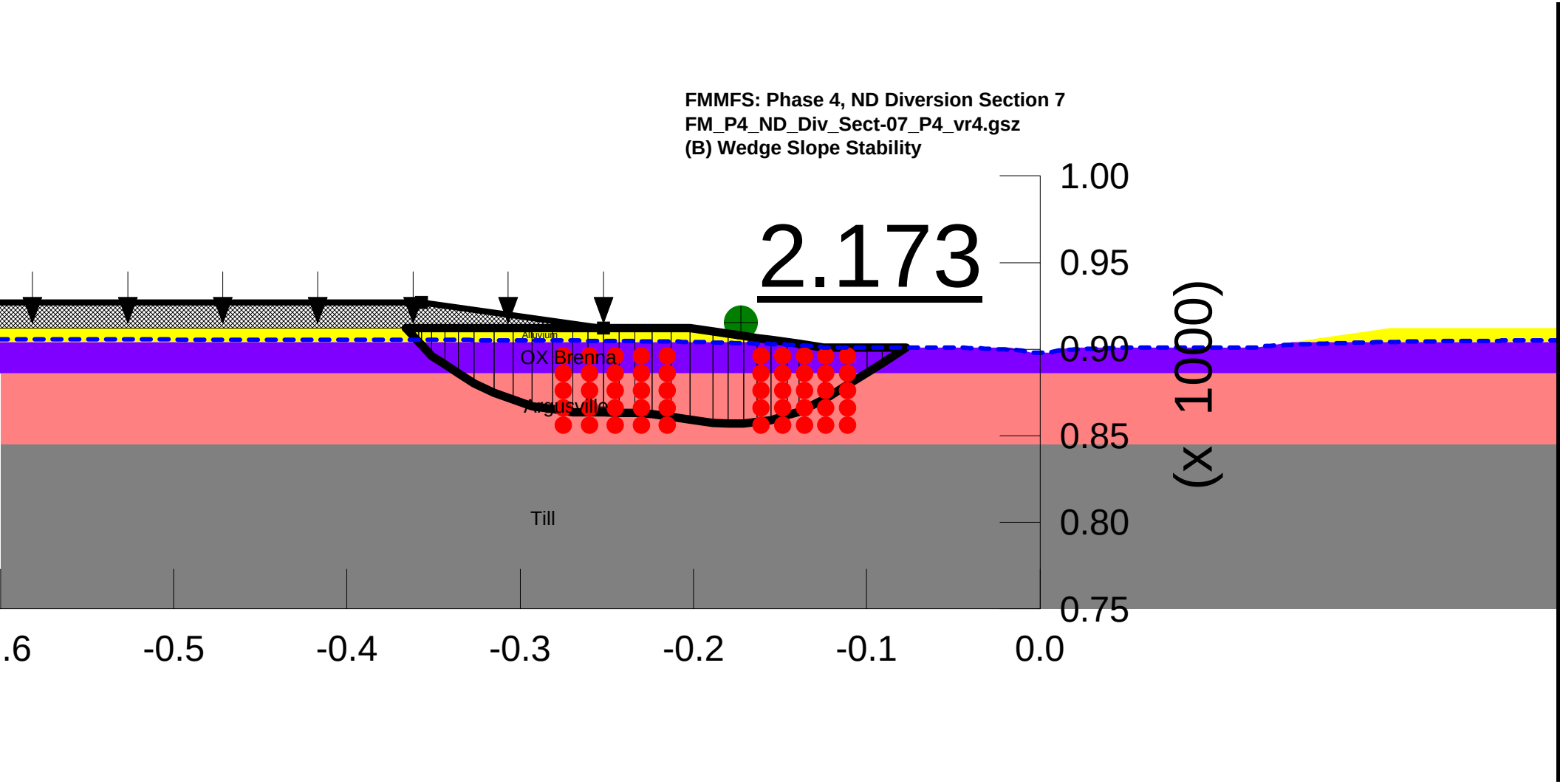
Soil Properties

Name: Alluvium Model: Mohr-Coulomb Unit Weight: 119 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °
Name: OX Brenna Model: Shear/Normal Fn. Unit Weight: 111 pcf Strength Function: OX Brenna Phi-B: 0 °
Name: Argusville Model: Shear/Normal Fn. Unit Weight: 106 pcf Strength Function: Argusville Phi-B: 0 °
Name: Till Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 31 ° Phi-B: 0 °



Created By: Heckendorf, Kurt A MVP
Last Edited By: Heckendorf, Kurt A MVP
Date: 1/18/2011


FMMFS: Phase 4, ND Diversion Section 7
FM_P4_ND_Div_Sect-07_P4_vr4.gsz
(A) Slope Stability
2.201
Alluvium
OX Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0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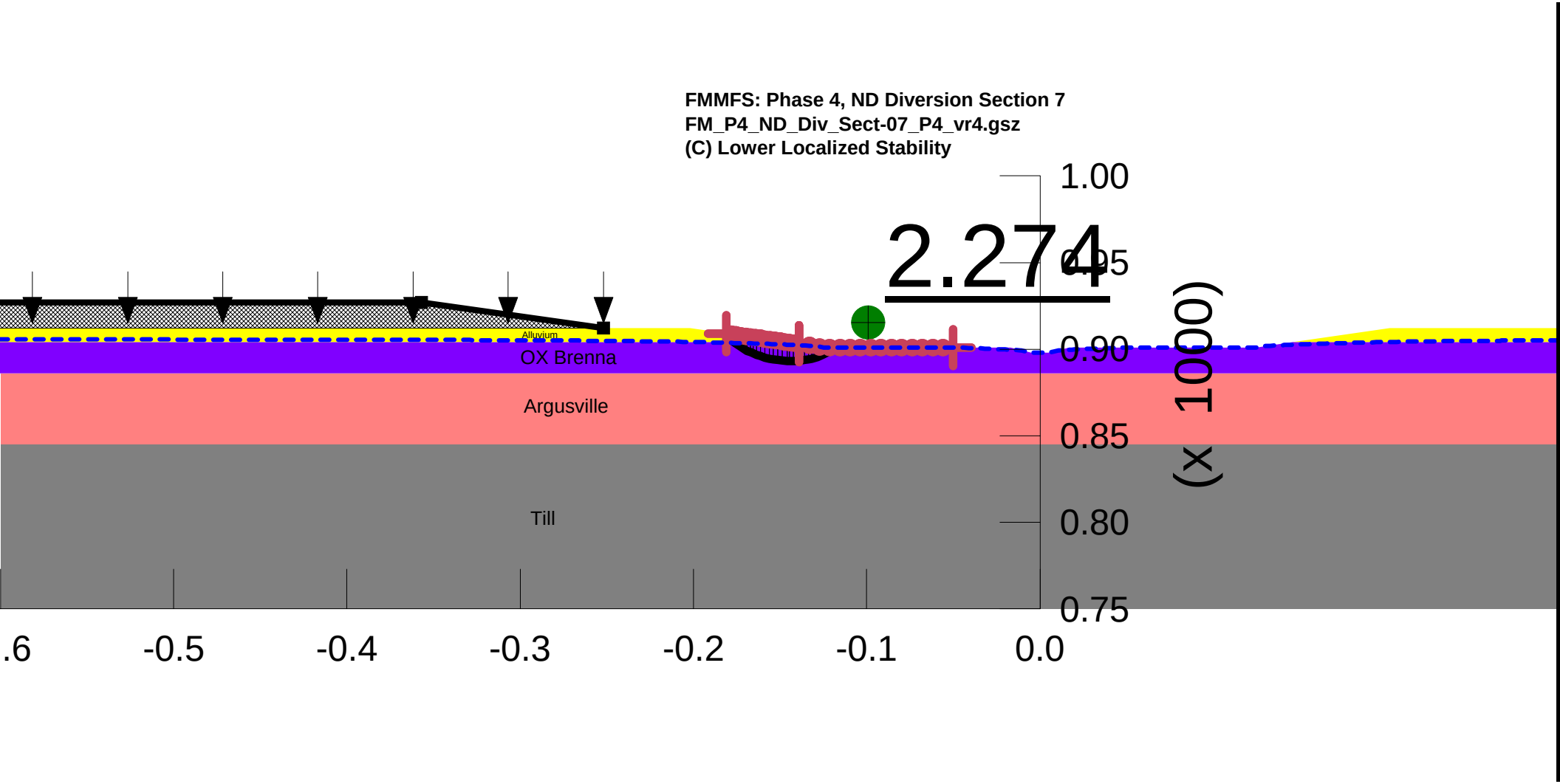
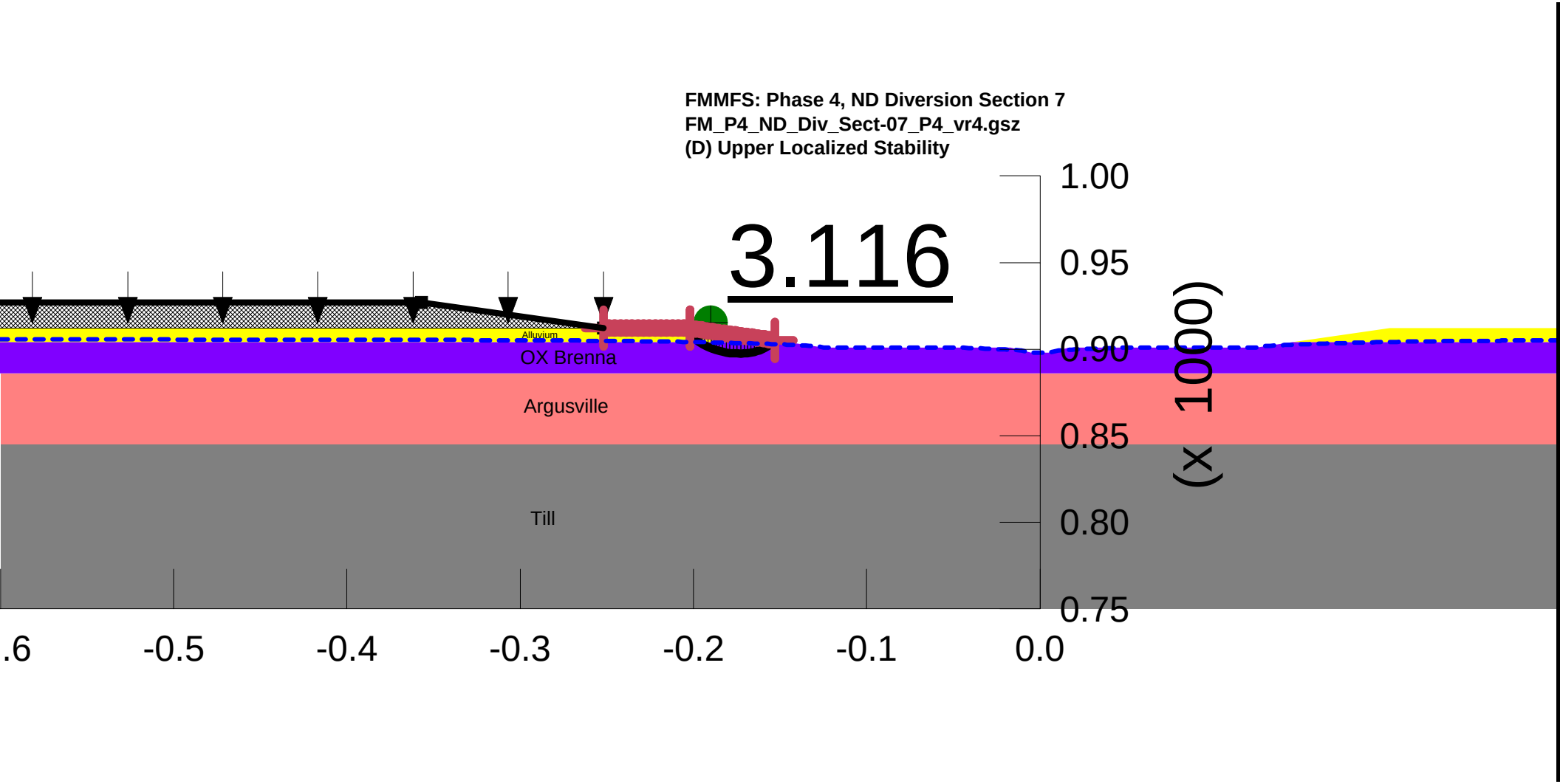
FM_P4_ND_Div_Sect-07_P4_vr4.gsz
(B) Wedge Slope Stability
2.173
Alluvium
OX Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 4, ND Diversion Section 7
FM_P4_ND_Div_Sect-07_P4_vr4.gsz
(C) Lower Localized Stability
2.274
Alluvium
OX Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0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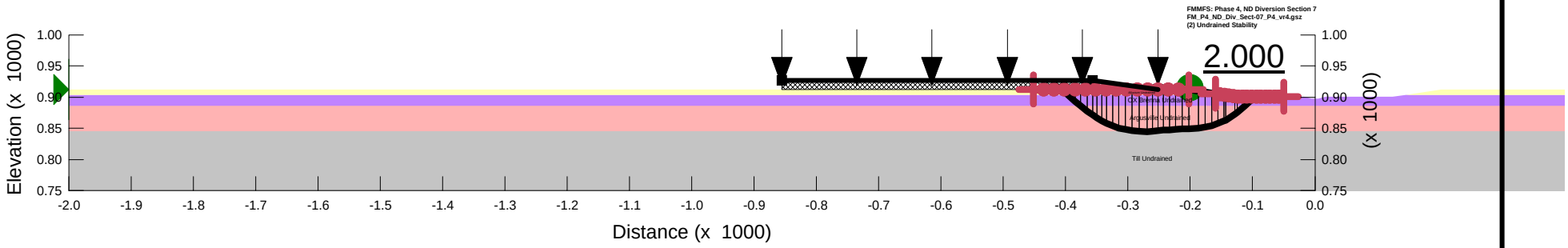
FM_P4_ND_Div_Sect-07_P4_vr4.gsz
(D) Upper Localized Stability
3.116
Alluvium
OX Brenna
Argusville
Till
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

File Name: FM_P4_ND_Div_Sect-07_P4_vr4.gsz

Fargo-Moorhead Metro Feasibilty Study
Phase 4 Analysis
ND Diversion Channel Stability
Section 7
(2) Undrained Stability

Soil Properties

Name: Alluvium Undrained Model: Undrained (Phi=0) Unit Weight: 119 pcf Cohesion: 900 psf
Name: OX Brenna Undrained Model: Undrained (Phi=0) Unit Weight: 111 pcf Cohesion: 900 psf
Name: Argusville Undrained Model: S=f(depth) Unit Weight: 106 pcf C-Top of Layer: 525 psf C-Rate of Change: 10 psf/ft Limiting C: 1025 psf
Name: Till Undrained Model: Undrained (Phi=0) Unit Weight: 122 pcf Cohesion: 1900 psf



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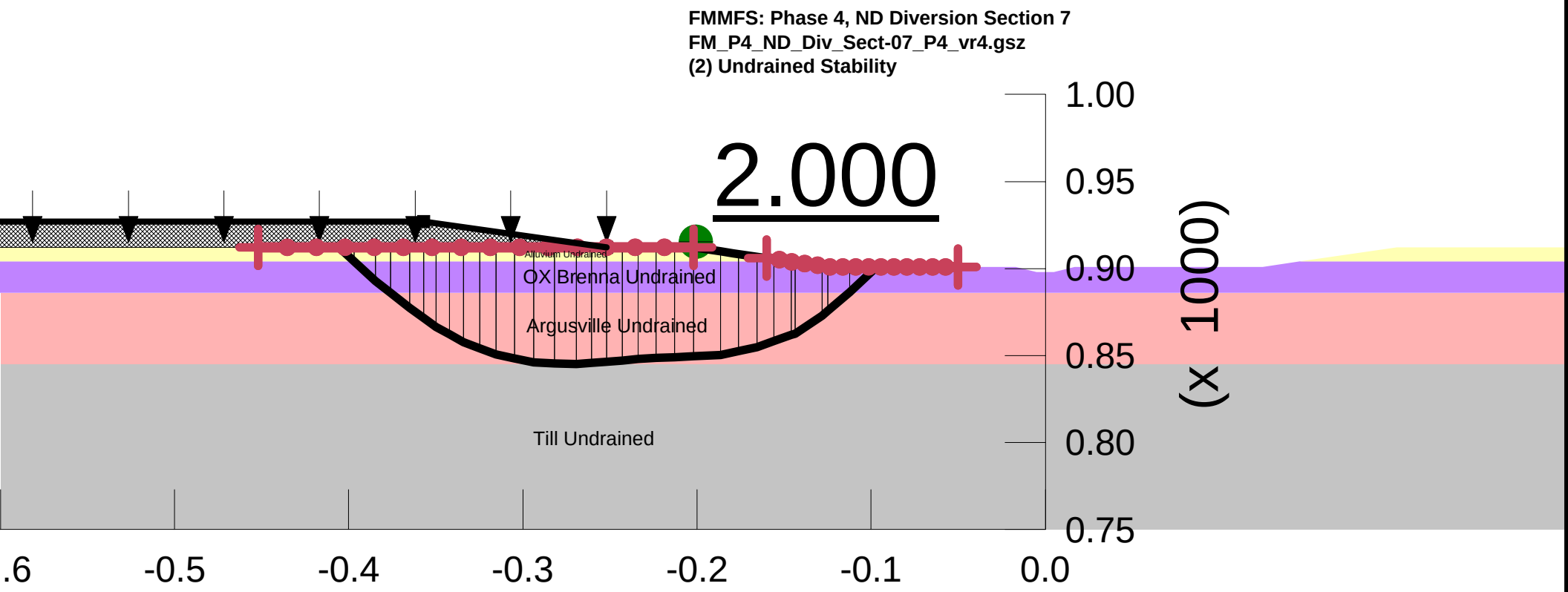
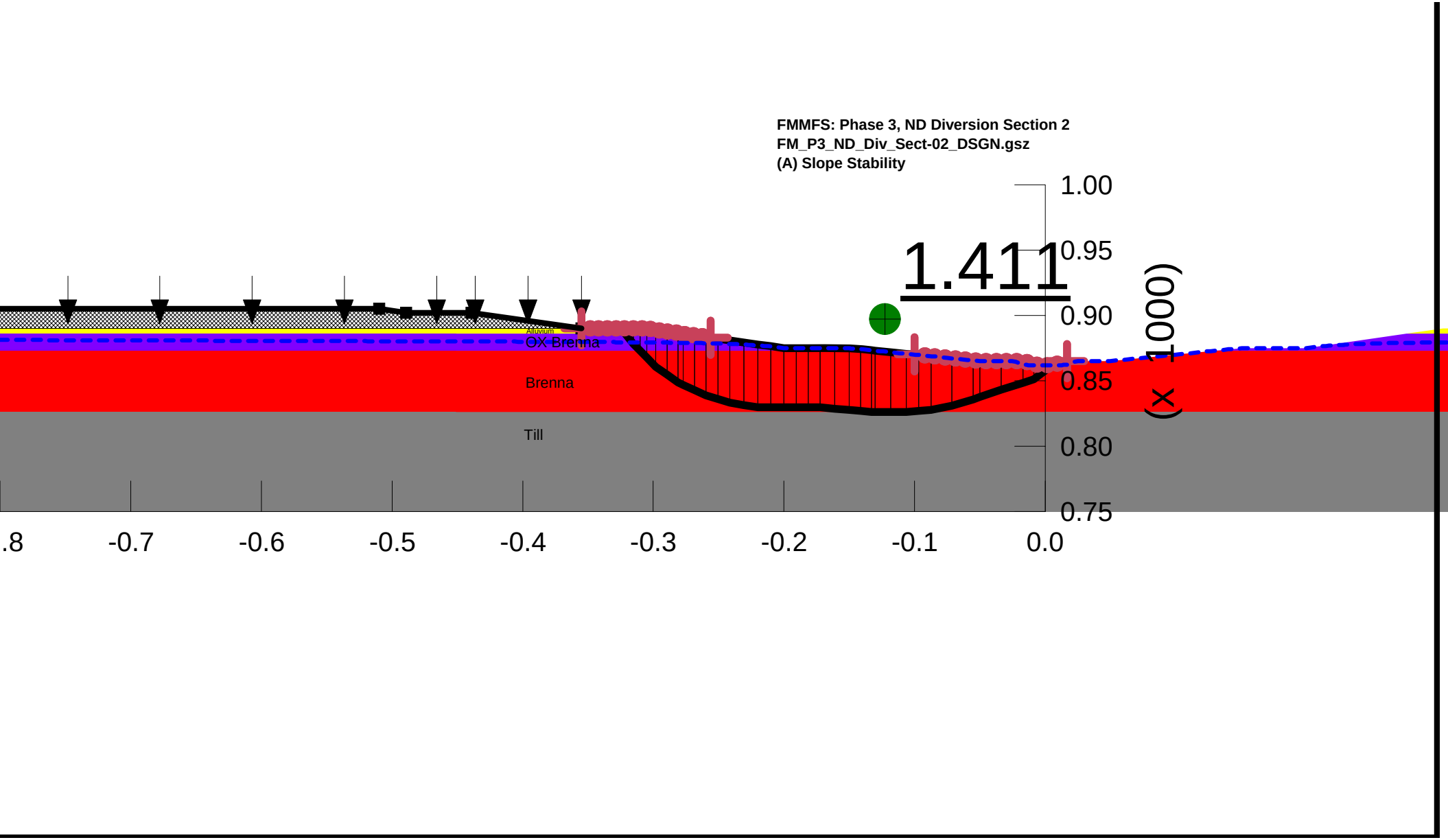
Last Edited By: Heckendorf, Kurt A MVP
Date: 1/18/2011

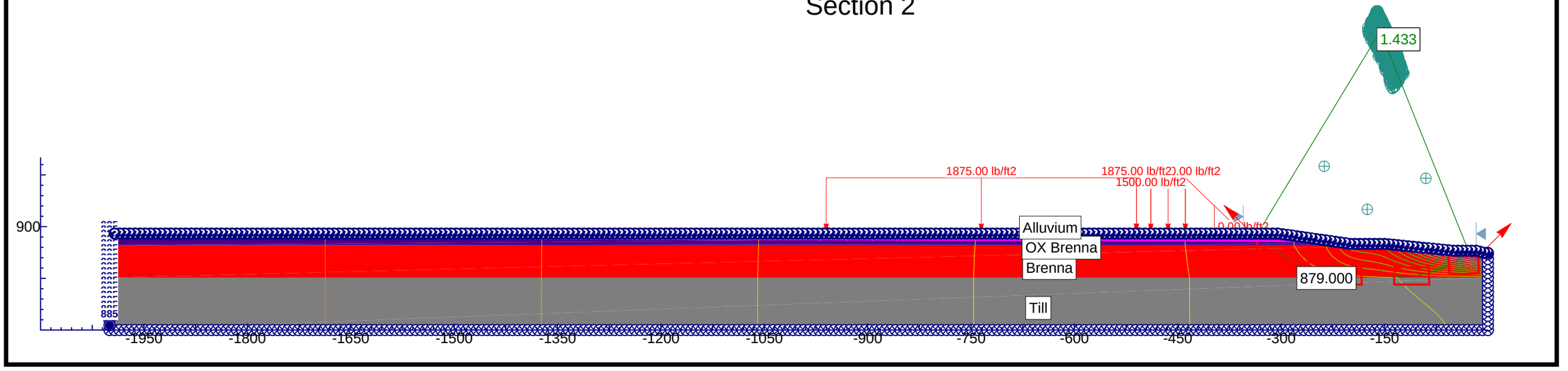

FMMFS: Phase 4, ND Diversion Section 7
FM_P4_ND_Div_Sect-07_P4_vr4.gsz
(2) Undrained Stability
2.000
Alluvium Undrained
OX Brenna Undrained
Argusville Undrained
Till Undrained
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0


FMMFS: Phase 3, ND Diversion Section 2
FM_P3_ND_Div_Sect-02_DSGN.gsz
(A) Slope Stability
1.411
1.00
0.95
0.90
0.85
0.80
0.75
(x 1000)
Alluvium
OX Brenna
Brenna
Till
.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0

Created By: Killian, Elizabeth A MVP
Last Editied By: Killian, Elizabeth A MVP
Date: 9/1/2010

Fargo - Moorhead Metro Feasibilty Study
Phase 3 Analysis
ND Diversion Channel Stability
Section 2

Document Name
File Name: Slide_ND_Sec_2_DSGN.slw



Slide Analysis Information

Document Name

File Name: Slide_ND_Sec_2_DSGN.sli

Project Settings

Project Title: SLIDE - ND Section 2
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Finite Element Analysis
Tolerance (groundwater): 1e-006
Maximum number of iterations (groundwater): 500
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Spencer

Number of slices: 30
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 1500
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 135
Left Projection Angle (End Angle): 135
Right Projection Angle (Start Angle): 45
Right Projection Angle (End Angle): 45
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

4 Distributed Loads present:
Distributed Load #1 Constant Distribution, Orientation: Normal to boundary, Magnitude: 1500 lb/ft2
Distributed Load #2 Triangular Distribution, Orientation: Vertical, Magnitudes 1,2: 0 and 1500 lb/ft2
Distributed Load #3 Triangular Distribution, Orientation: Vertical, Magnitudes 1,2: 1500 and 1875 lb/ft2
Distributed Load #4 Constant Distribution, Orientation: Vertical, Magnitude: 1875 lb/ft2

Groundwater Analysis

Maximum Number of Iterations: 500
Iteration Tolerance: 1e-006
Mesh Element Type: 4 noded quadrilaterals
Number of Elements: 9904
Number of Nodes: 9952

Material Properties

Material: Alluvium
Strength Type: Mohr-Coulomb
Unit Weight: 119 lb/ft3
Cohesion: 0 psf
Friction Angle: 31 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 3.24074e-008
K2/K1: 1
K Angle: 0

Model: User Defined - Alluv/Sherack

Material: OX Brenna
Strength Type: Shear Normal function
Unit Weight: 111 lb/ft3
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 1.62037e-008
K2/K1: 1
K Angle: 0

Model: User Defined - OX Brenna

Material: Brenna
Strength Type: Shear Normal function
Unit Weight: 104 lb/ft3
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 3.3e-009
K2/K1: 1
K Angle: 0

Model: Simple

Material: Till
Strength Type: Mohr-Coulomb
Unit Weight: 122 lb/ft3
Cohesion: 0 psf
Friction Angle: 31 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 6.6e-007
K2/K1: 0.25
K Angle: 0

Model: Simple

Material: Sand
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Unsaturated Shear Strength Angle: 0 degrees
Air Entry Value: 0 psf
Ks: 0.000324074
K2/K1: 1
K Angle: 0

Model: User Defined - Sand

Global Minimums

Method: spencer
FS: 1.433130
Axis Location: -156.180, 1183.327
Left Slip Surface Endpoint: -334.094, 890.000
Right Slip Surface Endpoint: -28.267, 865.000
Resisting Moment=4.878e+007 lb-ft
Driving Moment=3.40375e+007 lb-ft
Resisting Horizontal Force=128787 lb
Driving Horizontal Force=89864.1 lb

Valid / Invalid Surfaces

Method: spencer
Number of Valid Surfaces: 1501
Number of Invalid Surfaces: 3
Error Codes:
Error Code -1000 reported for 3 surfaces

Error Codes

The following errors were encountered during the computation:

-1000 = No valid slip surfaces are generated
at a grid center. Unable to draw a surface.

List of All Coordinates

Non-Circ. Failure Surface
-305.000 890.000
-200.000 875.000

Non-Circ. Failure Surface
-200.000 875.000
-150.000 875.000

Non-Circ. Failure Surface
-150.000 875.000
-50.000 865.000

Material Boundary
-2000.000 886.000
-277.000 886.000

Material Boundary
-2000.000 873.000
-130.000 873.000

Material Boundary
-17.000 865.000
-17.000 863.000
-5.000 860.000
0.000 860.000

Material Boundary
-2000.000 826.000
0.000 826.000

External Boundary
0.000 862.000
-5.000 862.000
-17.000 865.000
-50.000 865.000
-130.000 873.000
-150.000 875.000
-200.000 875.000
-277.000 886.000
-305.000 890.000
-2000.000 890.000
-2000.000 886.000
-2000.000 873.000
-2000.000 826.000
-2000.000 750.000
0.000 750.000
0.000 826.000
0.000 860.000

Distributed Load
-439.000 890.000
-489.000 890.000

Distributed Load
-355.000 890.000
-439.000 890.000

Distributed Load
-489.000 890.000
-510.000 890.000

Distributed Load
-510.000 890.000
-960.000 890.000

Focus/Block Search Window
-335.000 883.000
-335.000 848.000

-257.000 848.000
-262.231 883.890

Focus/Block Search Window
-242.000 841.000
-241.000 816.000
-183.000 816.000
-184.000 842.000

Focus/Block Search Window
-136.000 841.000
-136.000 816.000
-85.000 816.000
-86.000 841.000

Focus/Block Search Window
-57.000 858.000
-56.000 831.000
-13.000 832.000
-14.000 857.000