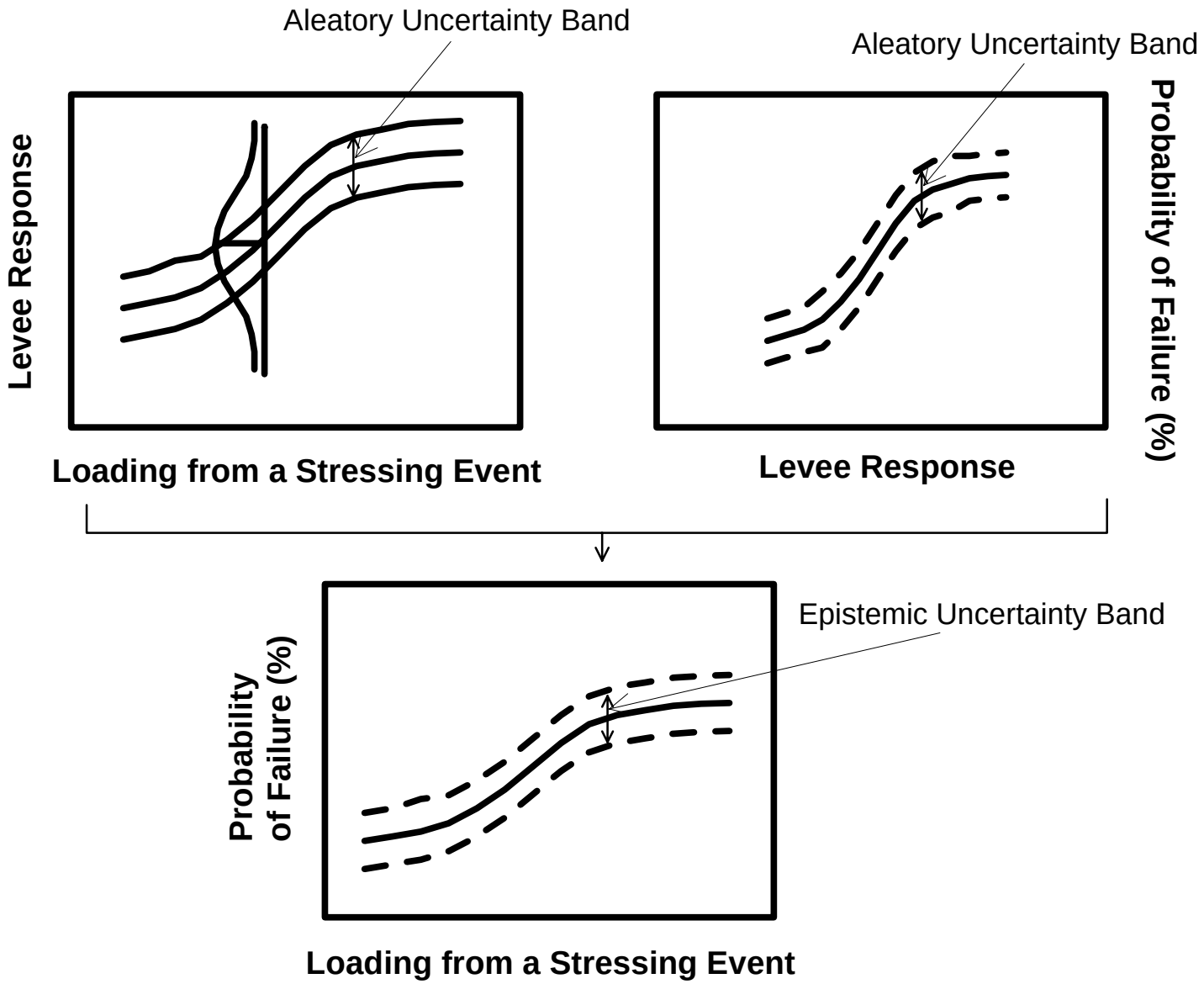
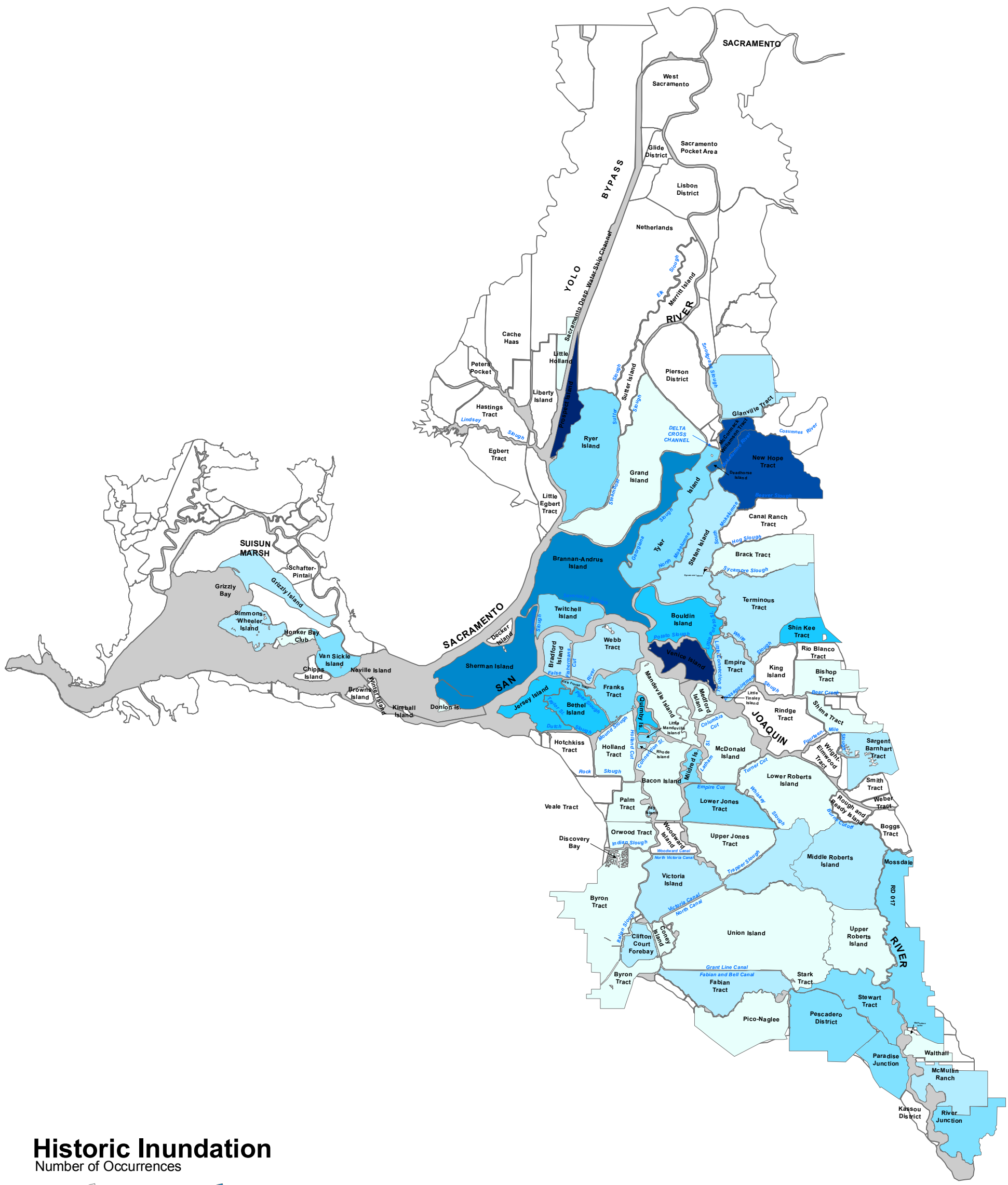
Figures



Delta Risk Management Strategy (DRMS) Levee Fragility		Approach of Evaluating Probability of Levee Failure	Figure 2-1
URS	Project No. 26815621		



Historic Inundation

Number of Occurrences

0
1
2
3
4
5
6
7
8

0 2.5 5 10 Miles

URS	DRMS	Historic Island Flooding in the Delta and Suisun Marsh Since 1900	Figure 3-1
	26815431		

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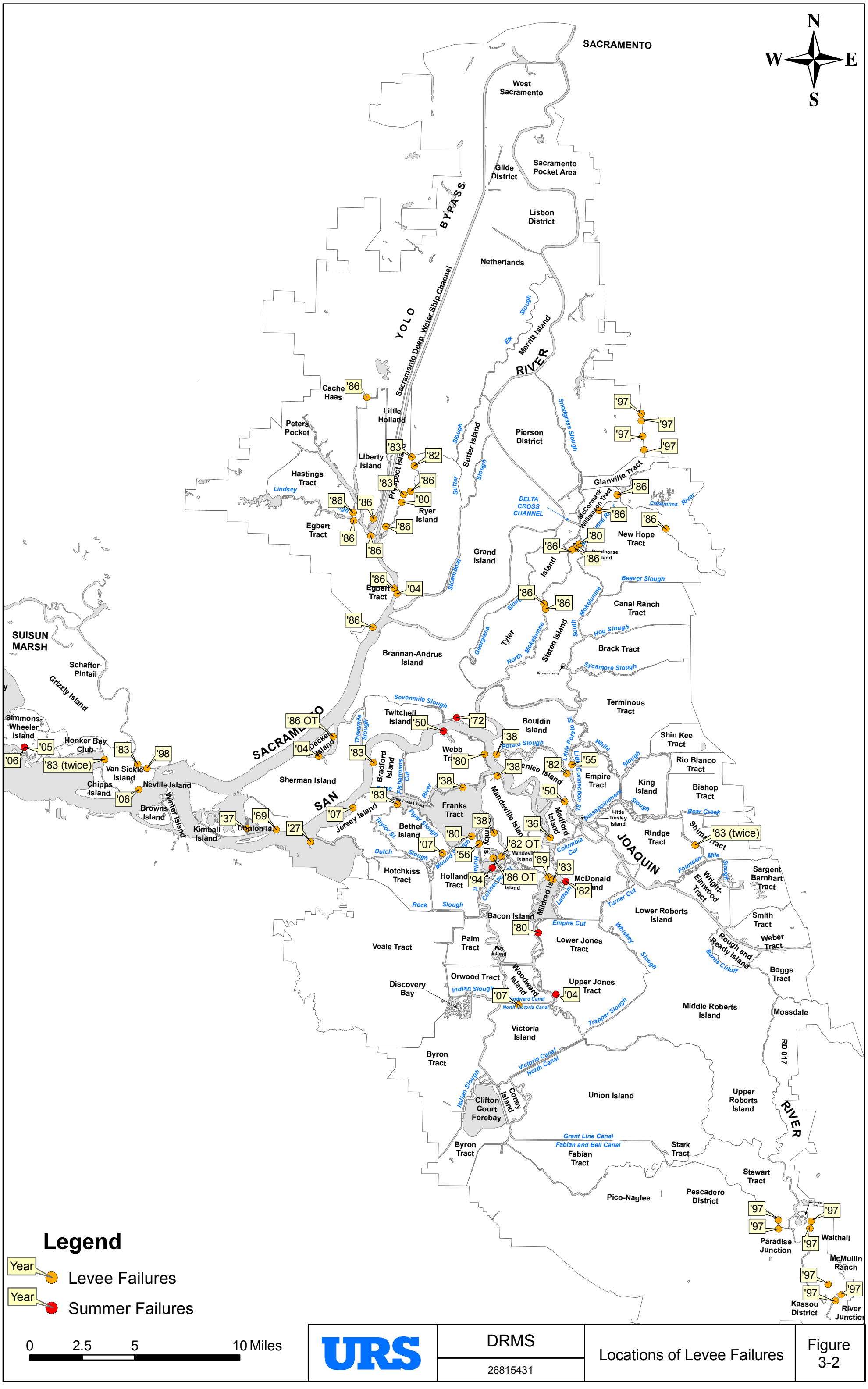

URS	DRMS	Locations of Levee Failures	Figure 3-2
	26815431		

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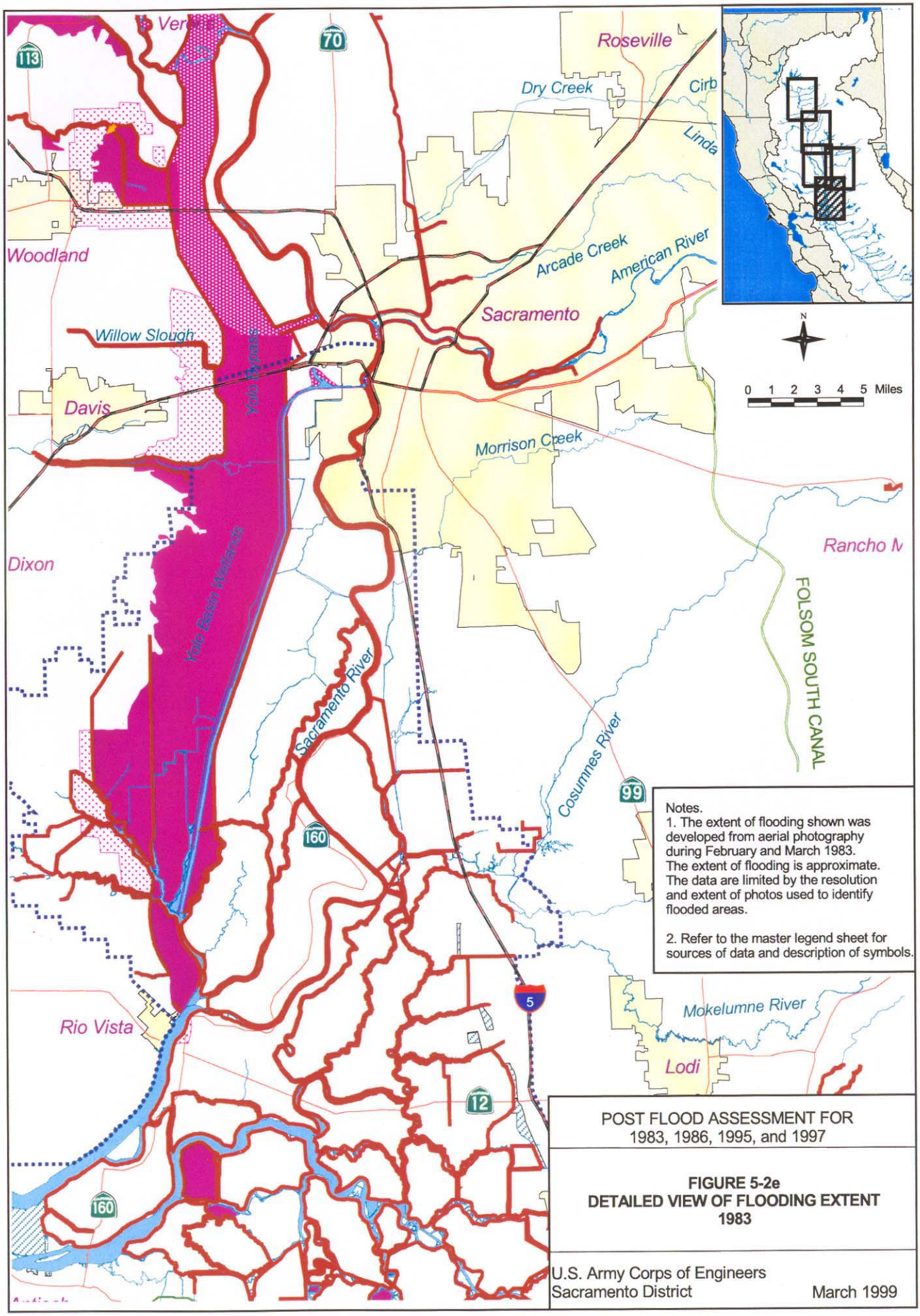
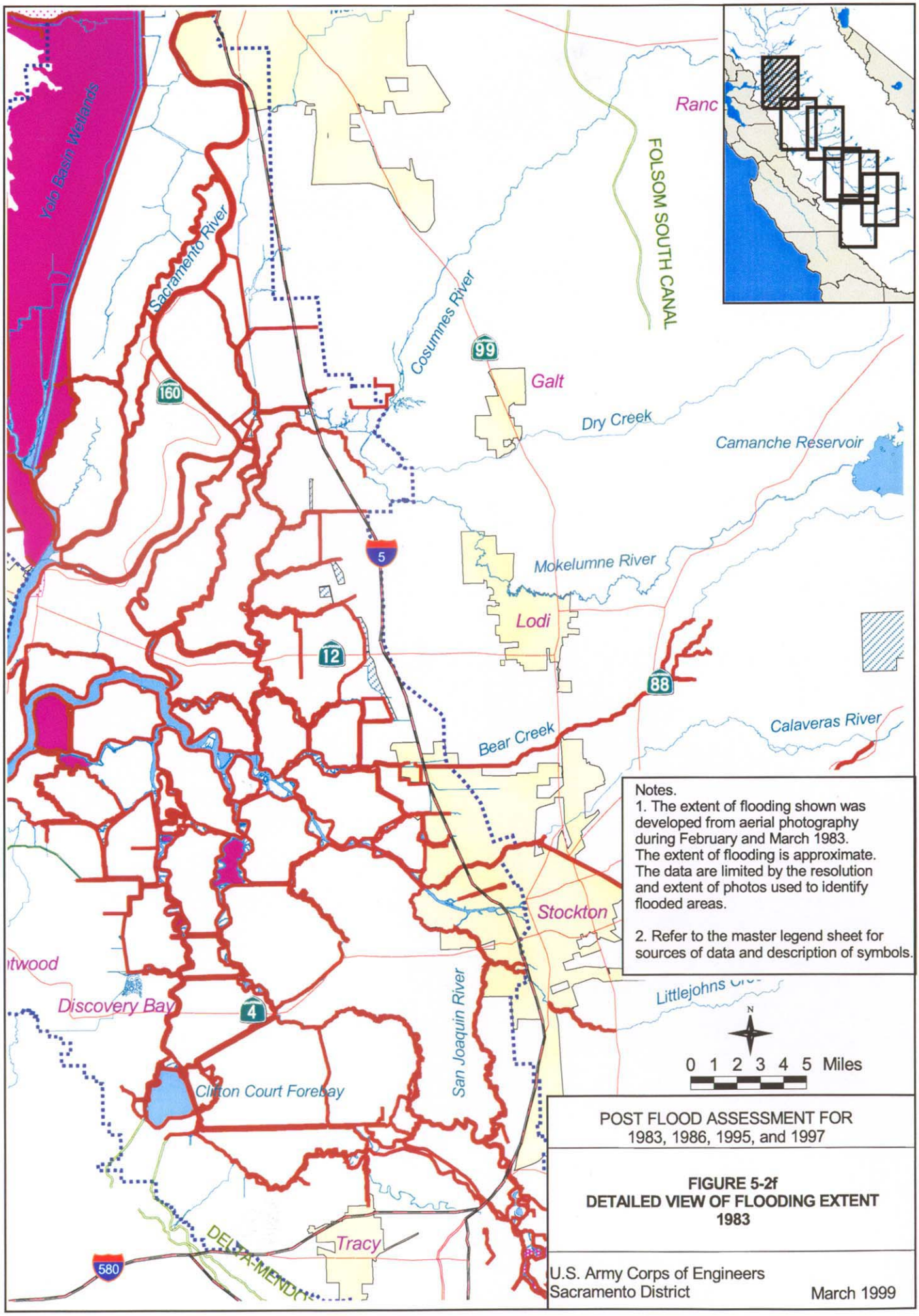
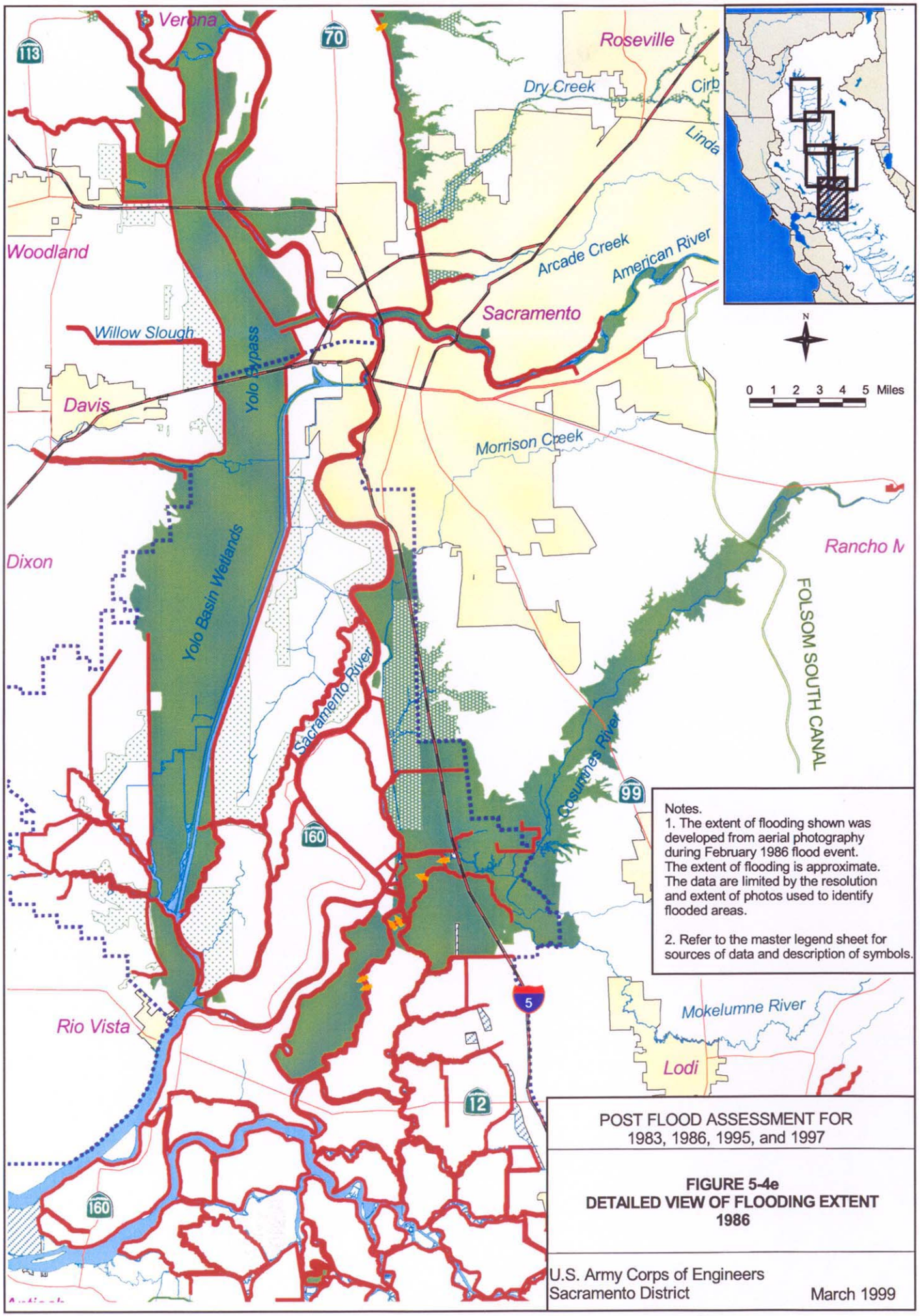


From USACE (1999) Figure 3-6



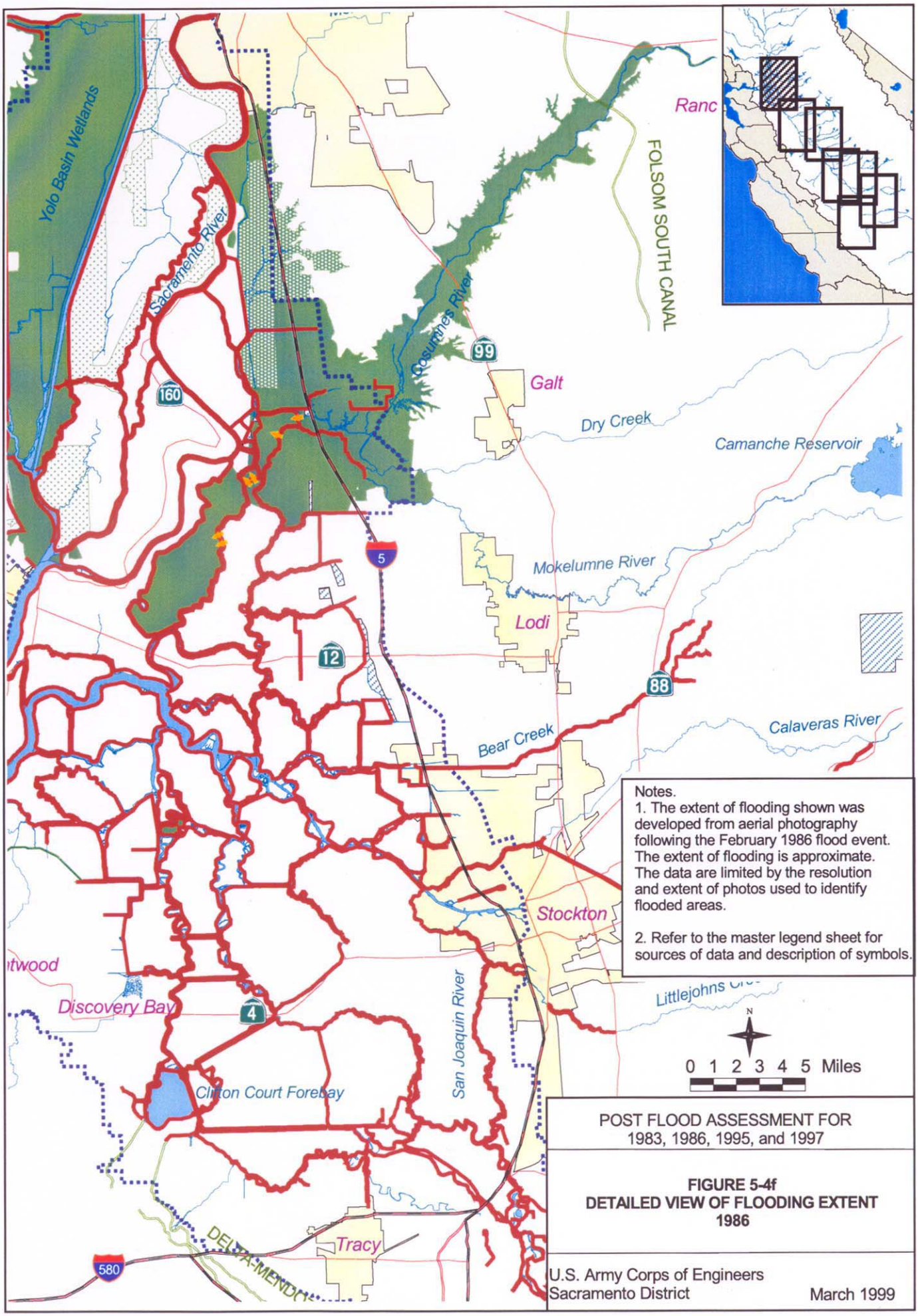
From USACE (1999)

Figure 3-7



From USACE (1999)

Figure 3-8



From USACE (1999)

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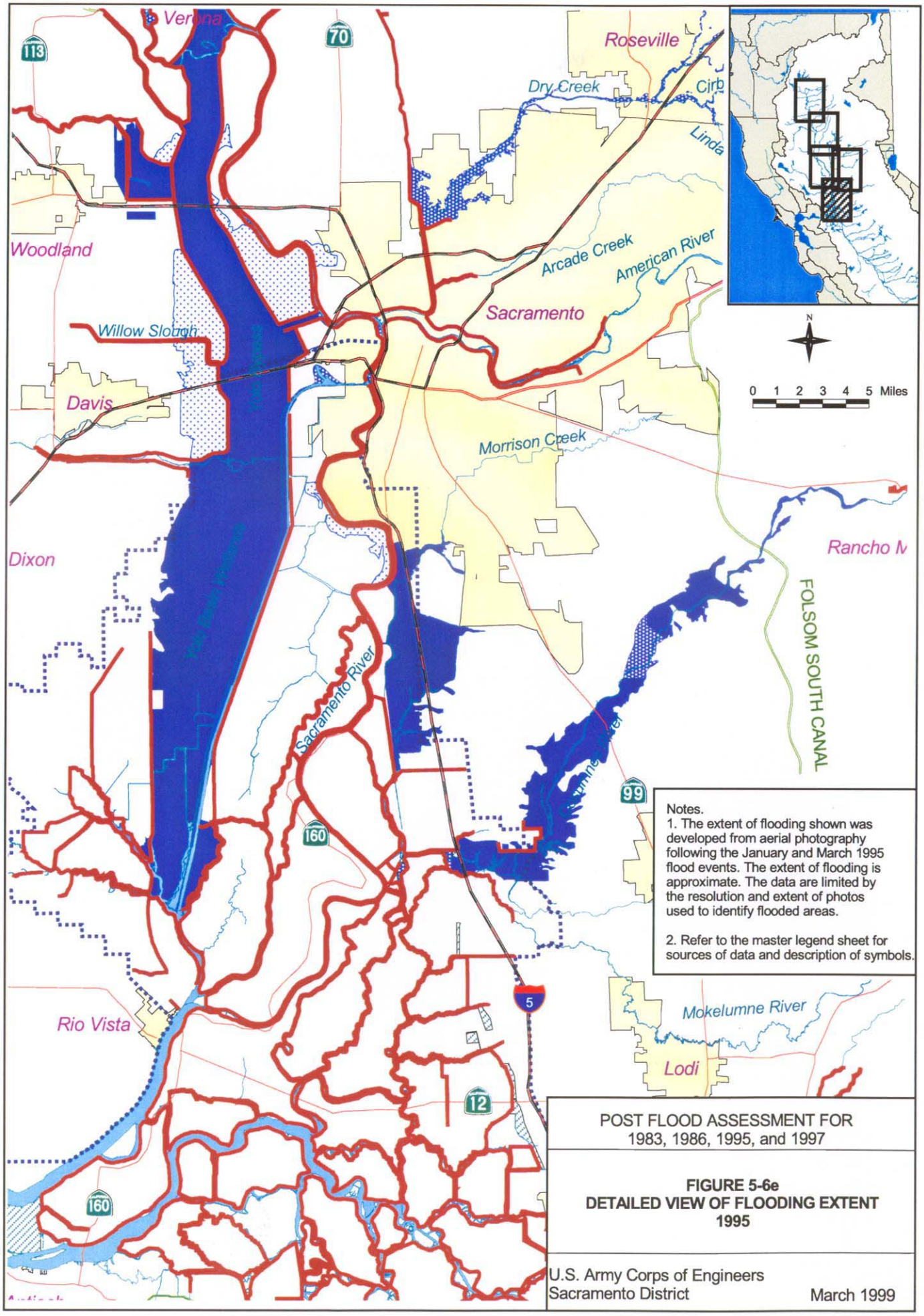
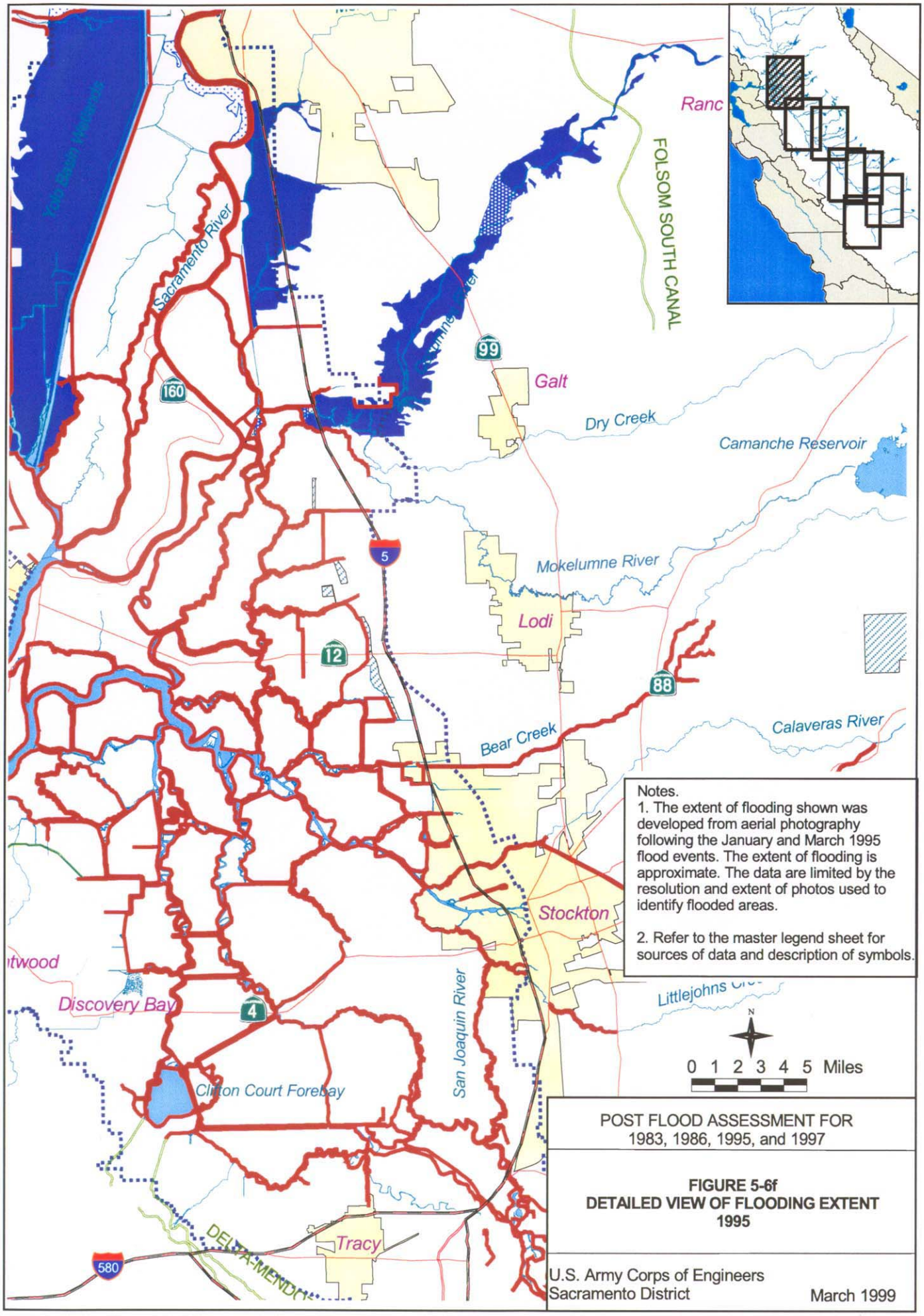


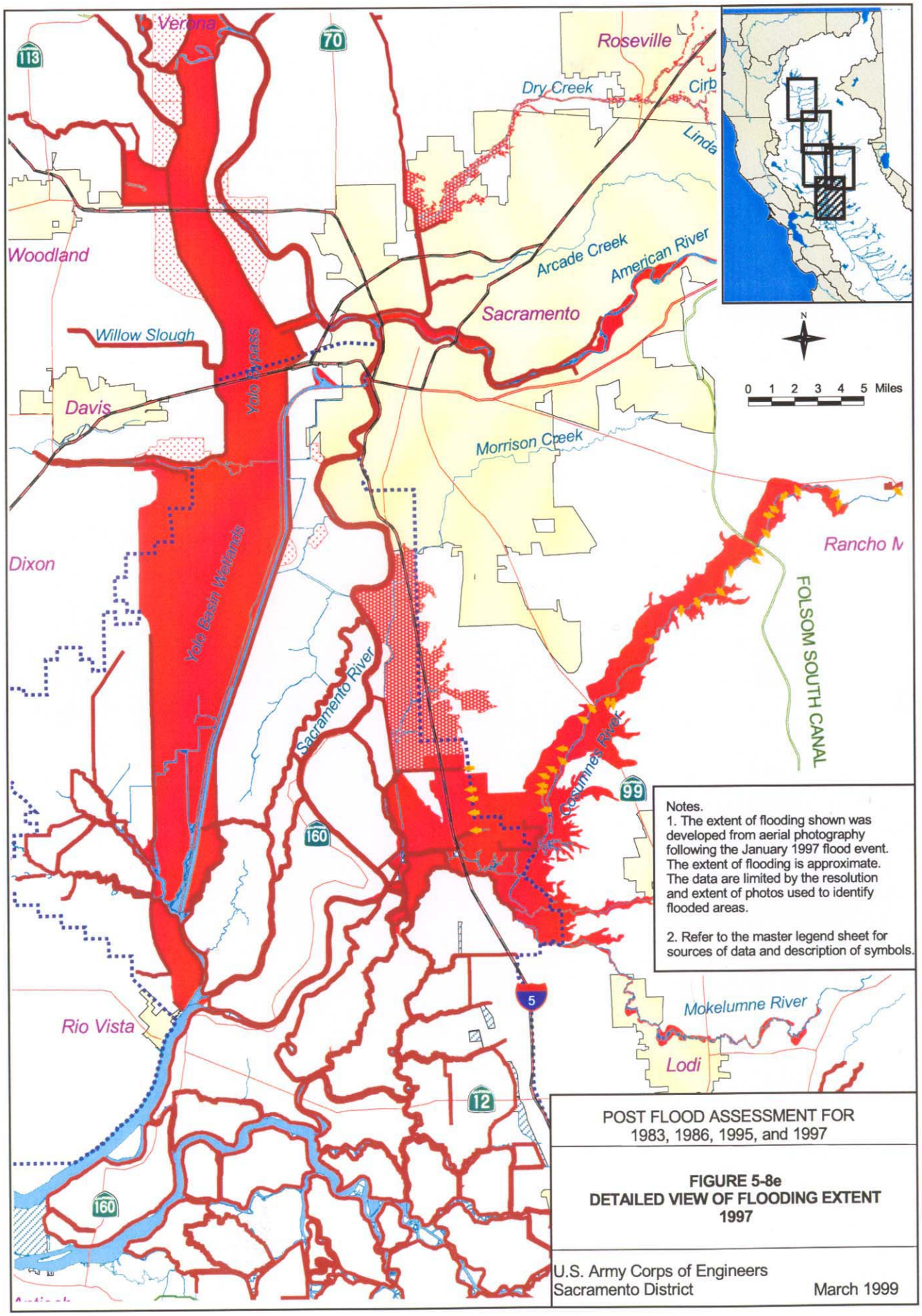
From USACE (1999)

Figure 3-10



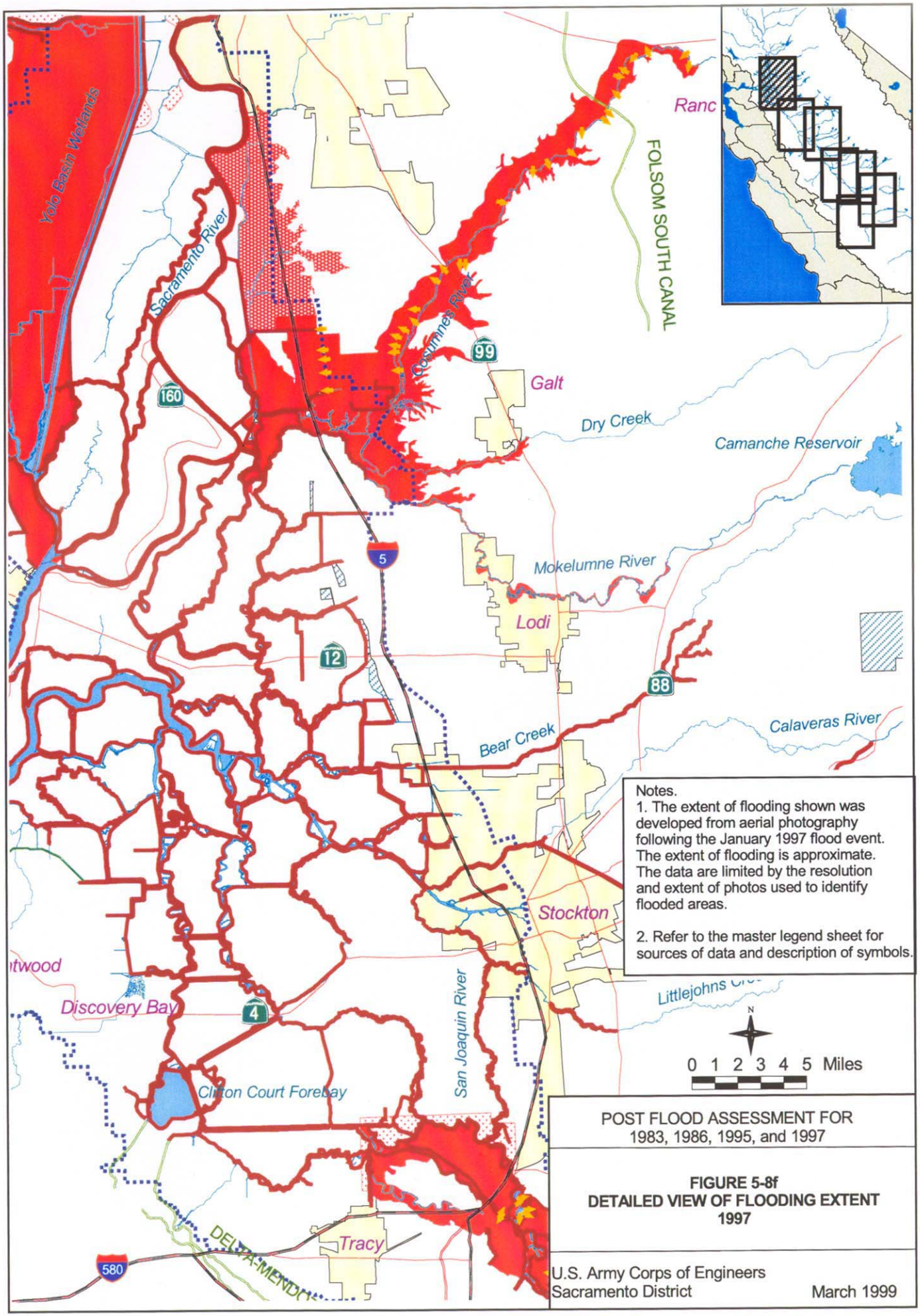
From USACE (1999)

Figure 3-11



From USACE (1999)

Figure 3-12



From USACE (1999)

Figure 3-13

Figure 3-15: Jones Tract Breach June 3, 2004

Figure 3-16: Jones Tract Breach June 3, 2004 – Peat Blocks at Edge of Scour Pond

Figure 3-17: Jones Tract Breach June 3, 2004 – Peat Blocks at Edge of Scour Pond

Figure 3-18: Venice Island Aerial View of Scour Holes

Figure 3-19: Venice Island – East Scour Hole (Nov. 30, 1982)

Figure 3-20: Venice Island – South-East Scour Hole (1950)

Figure 3-21: Venice Island South Scour Hole (1938)

Figure 3-22: Location of Scour Holes - Webb Tract

Figure 3-22: Webb Tract East Scour Hole (Jan. 18, 1980)

Figure 3-23: Webb Tract North Scour Hole (1950)

Figure 3-24: Tyler Island (Feb. 19, 1986)

Figure 3-25: Bradford Island East Scour Hole (Dec. 3, 1983)

Figure 3-26: Bradford Island East Scour Hole (Dec. 3, 1983)

Figure 3-27: Ryer Island S-W Scour Hole (Feb. 1986)

Figure 3-28: Holland Tract- N-E Scour Hole (Jan.18, 1980)

Figure 3-29: MacCormack-Williamson-East (Jan 1997)

Figure 3-30: Quimby Island-West (Dec. 26, 1955)

Figure 3-31: Sherman Island-South (Jan. 20, 1969)

Figure 3-32: Empire Tract Breach (Dec. 26, 1955)

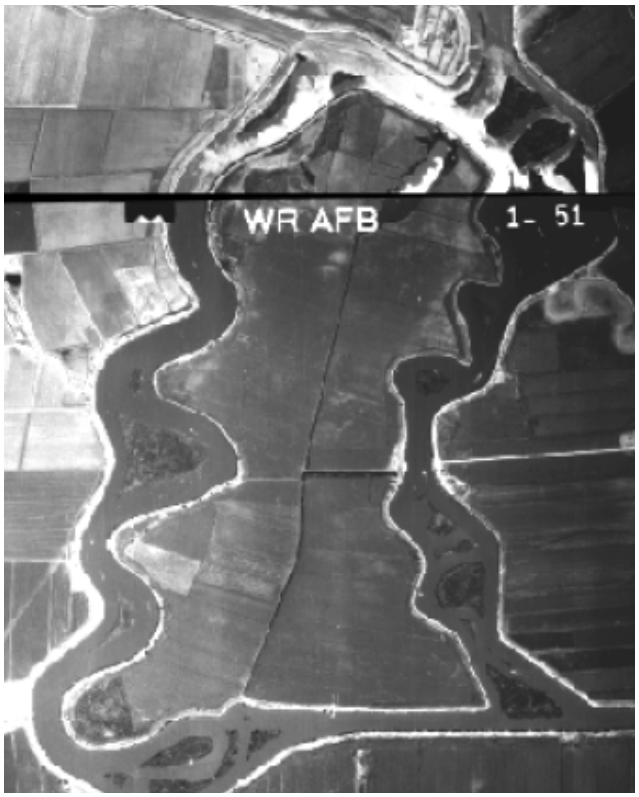


Figure 3-33: Mildred Island (1975)

Figure 3-34a: Mildred Island (Flooded Jan. 27, 1983)

Figure 3-34b: Mildred Island (Flooded in Jan 27, 1983)

Figure 3-34c: Mildred Island – N-E Breach (Jan 27, 1983)

Figure 3-35: Little Franks Flooded (1983)

Figure 3-36a: Little Mandeville Island (Flooded August 2, 1994)

Figure 3-36b: Little Mandevillle Breach (Flooded august 2, 1994)

Figure 3-37a: Rhode Island (Flooded 1971)

Figure 3-37b: Rhode Island Breach – E (Flooded 1971)

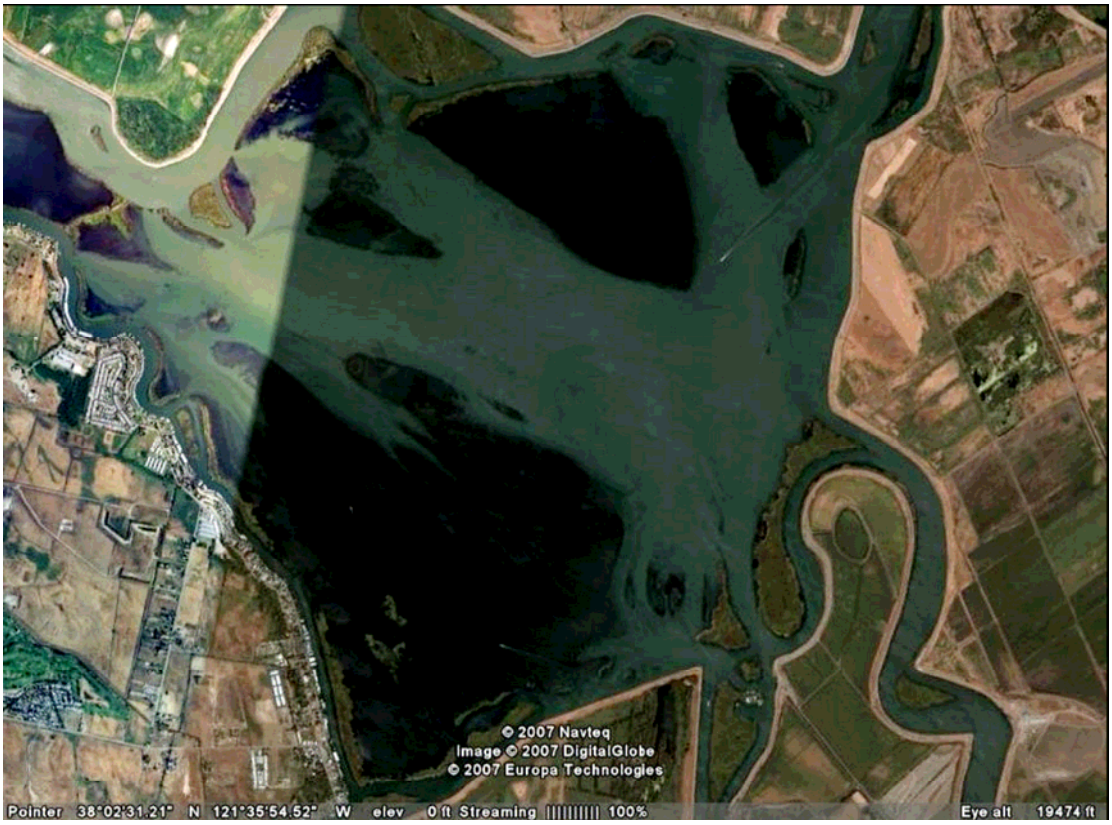


Figure 3-38a: Franks Tract (Flooded 1938)

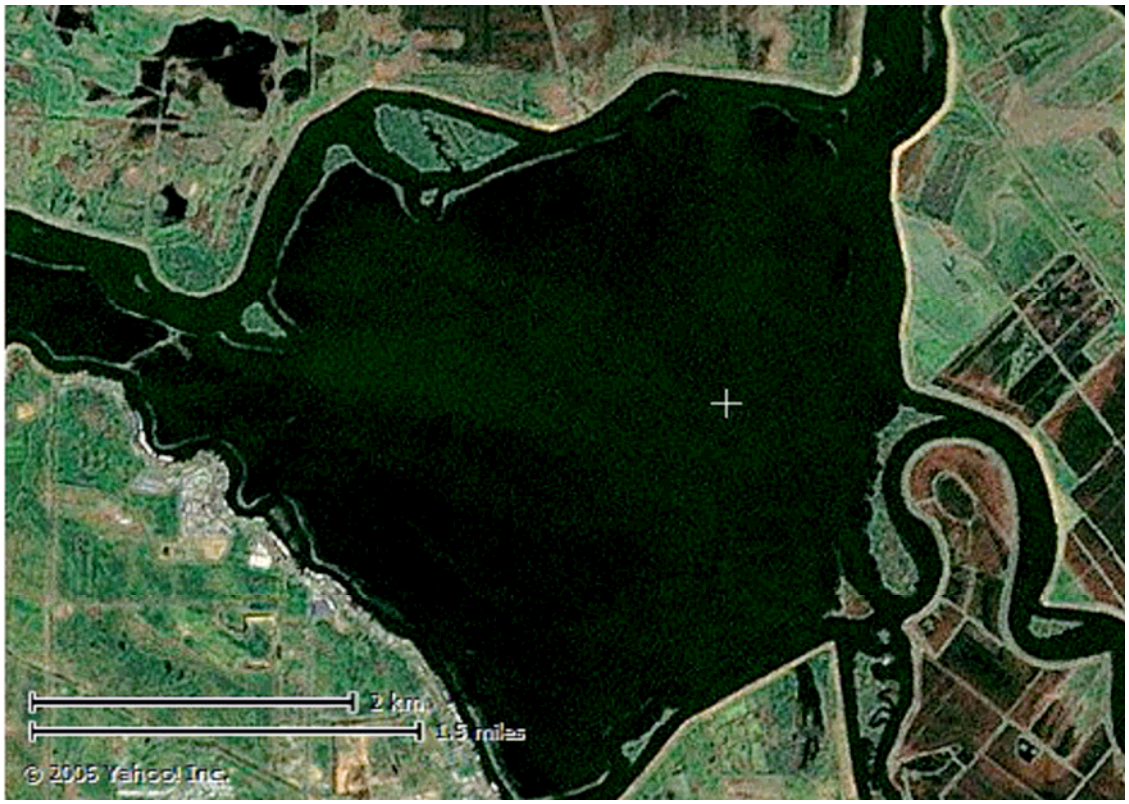
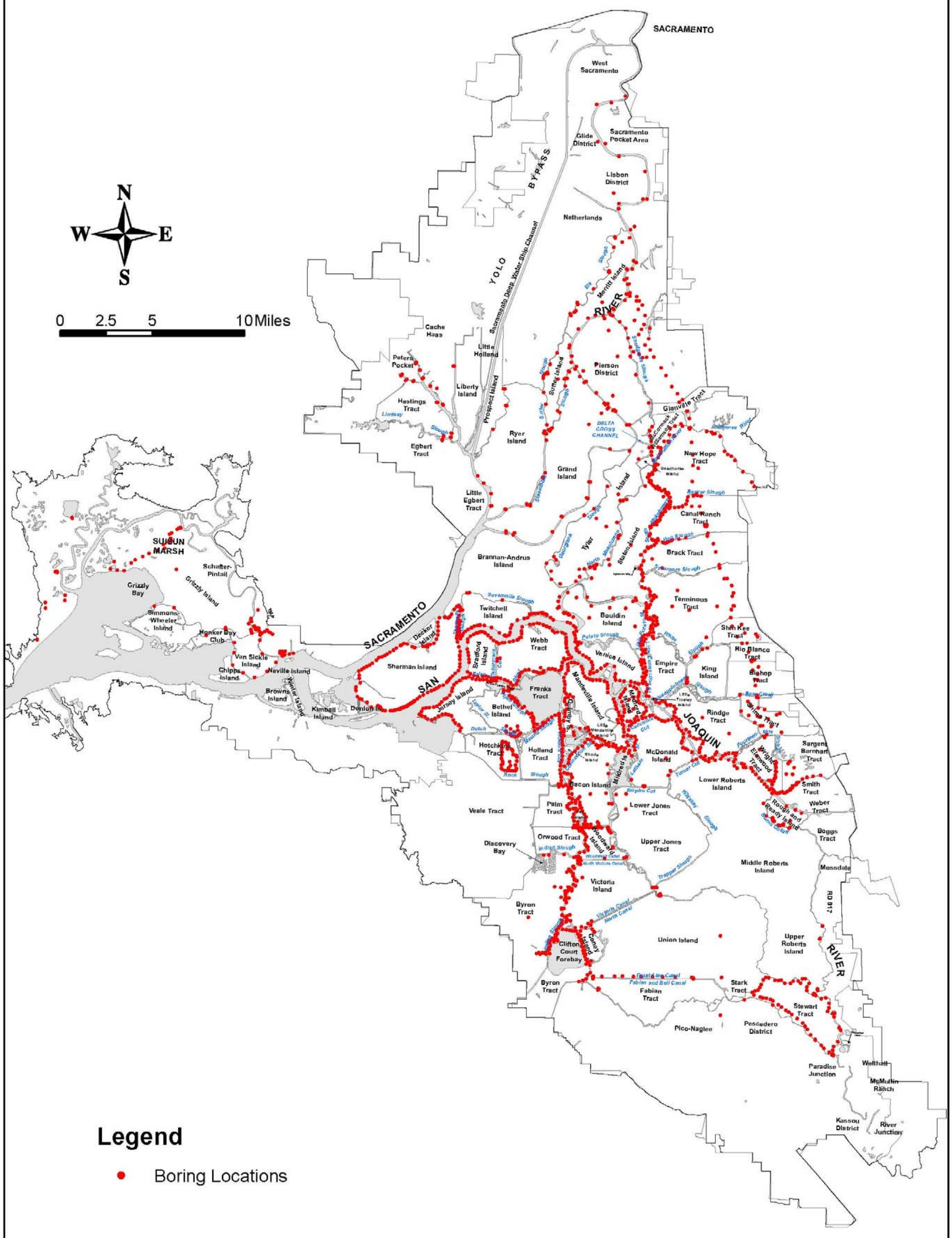


Figure 3-38b: Franks Tract (Flooded 1938)

DRAFT



Legend

- Boring Locations

Delta Risk Management Strategy (DRMS) Levee Fragility		Boring Location Map	Figure 4-1
URS	Project No. 26815621		

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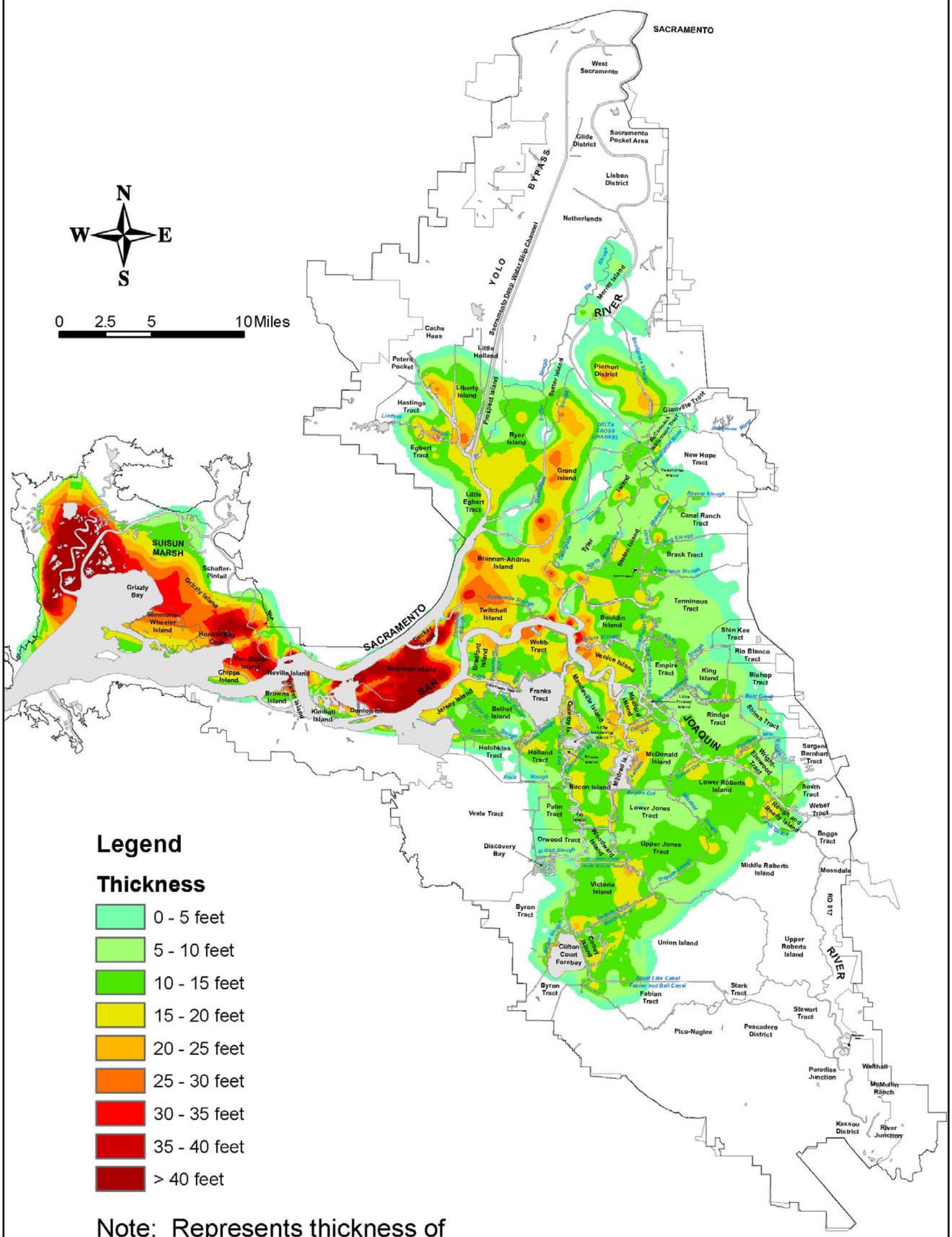
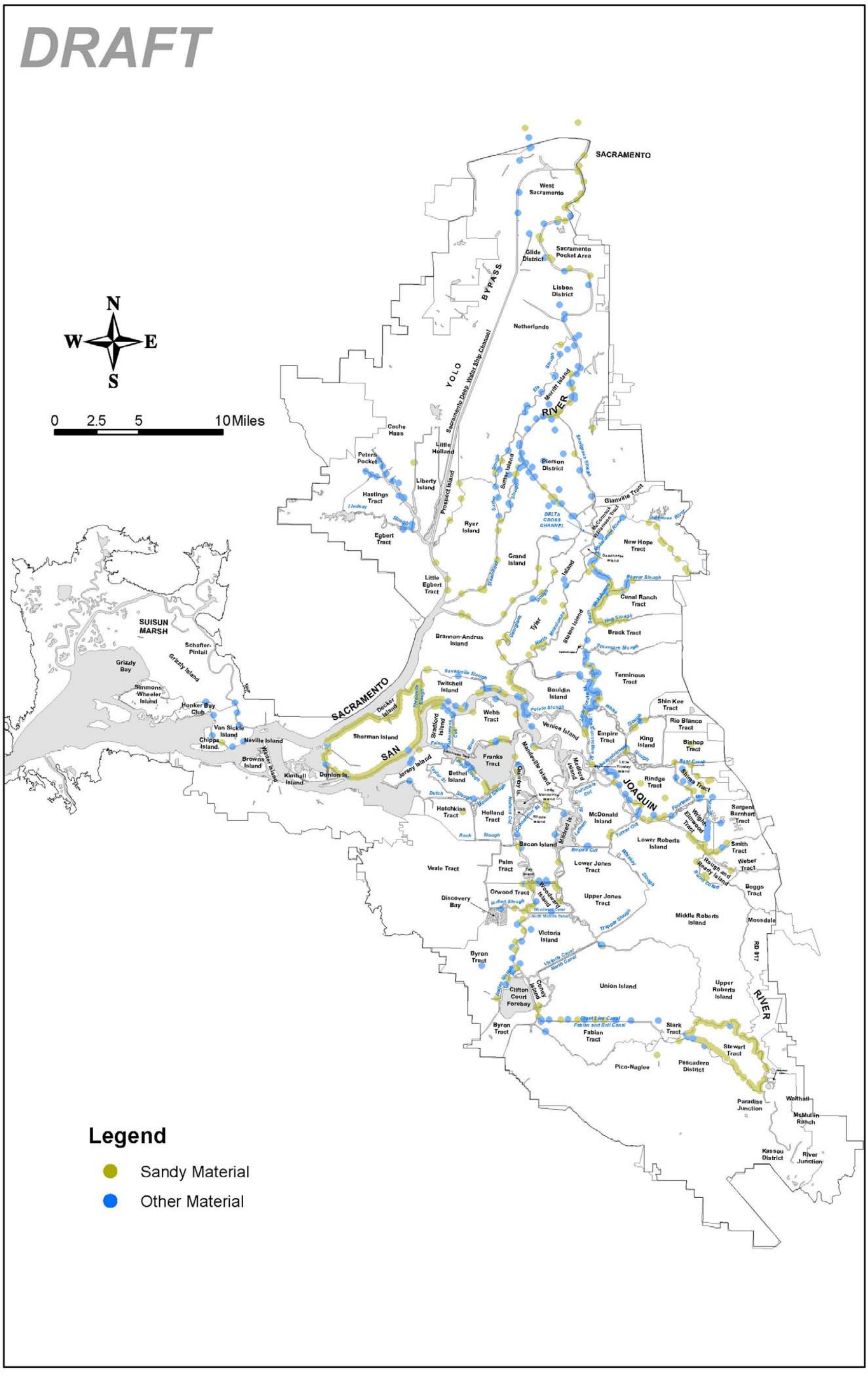


Note: Represents thickness of organic materials near levee toe.

Delta Risk Management Strategy (DRMS) Levee Fragility		Thickness of Organic Materials	Figure 4-2
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Type of Levee Materials	Figure 4-3
URS	Project No. 26815621		

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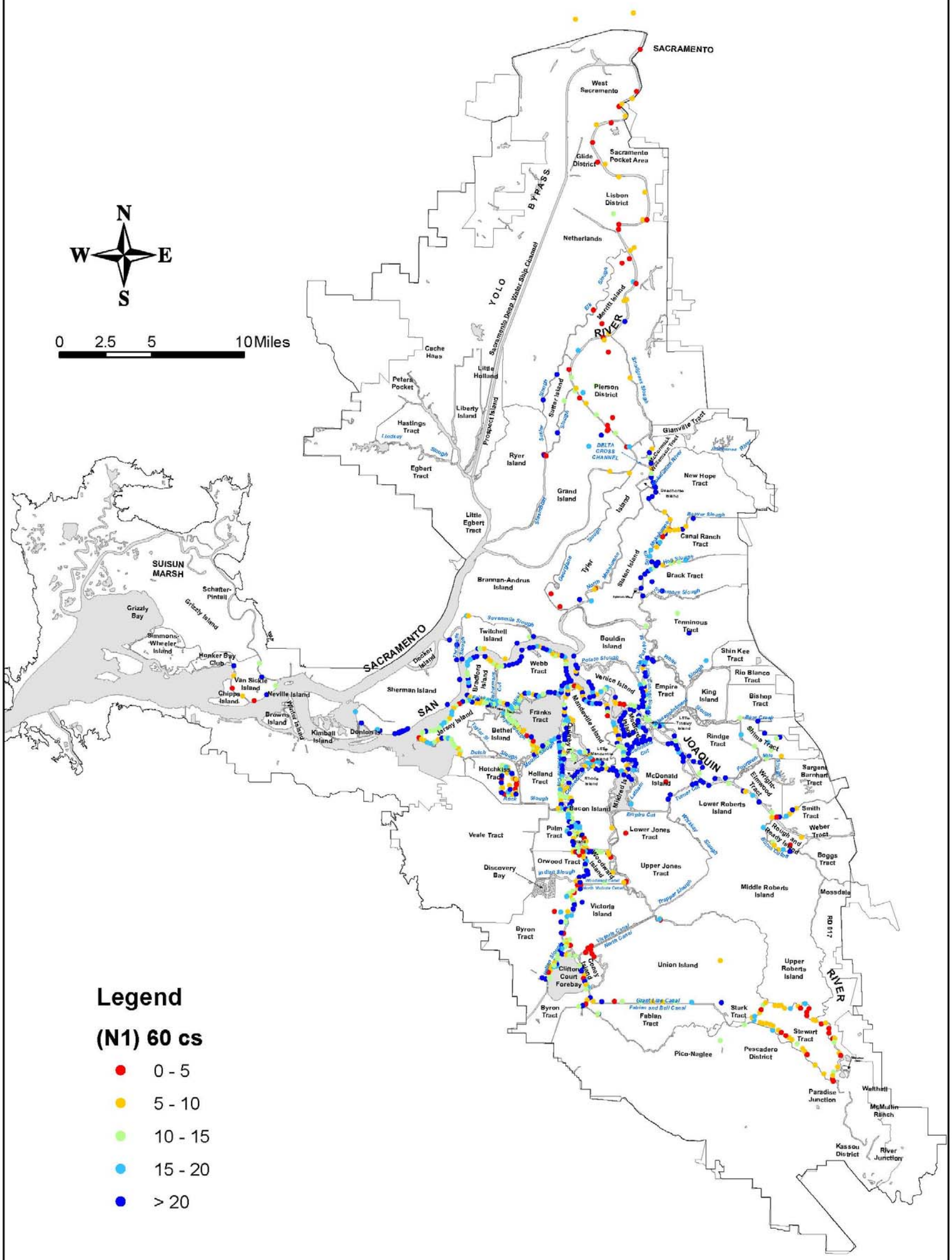

Delta Risk Management Strategy (DRMS) Levee Fragility		Corrected Blow Count, $(N1)_{60\text{-}cs}$ Distribution for Foundation Sand	Figure 4-4
URS	Project No. 26815621		

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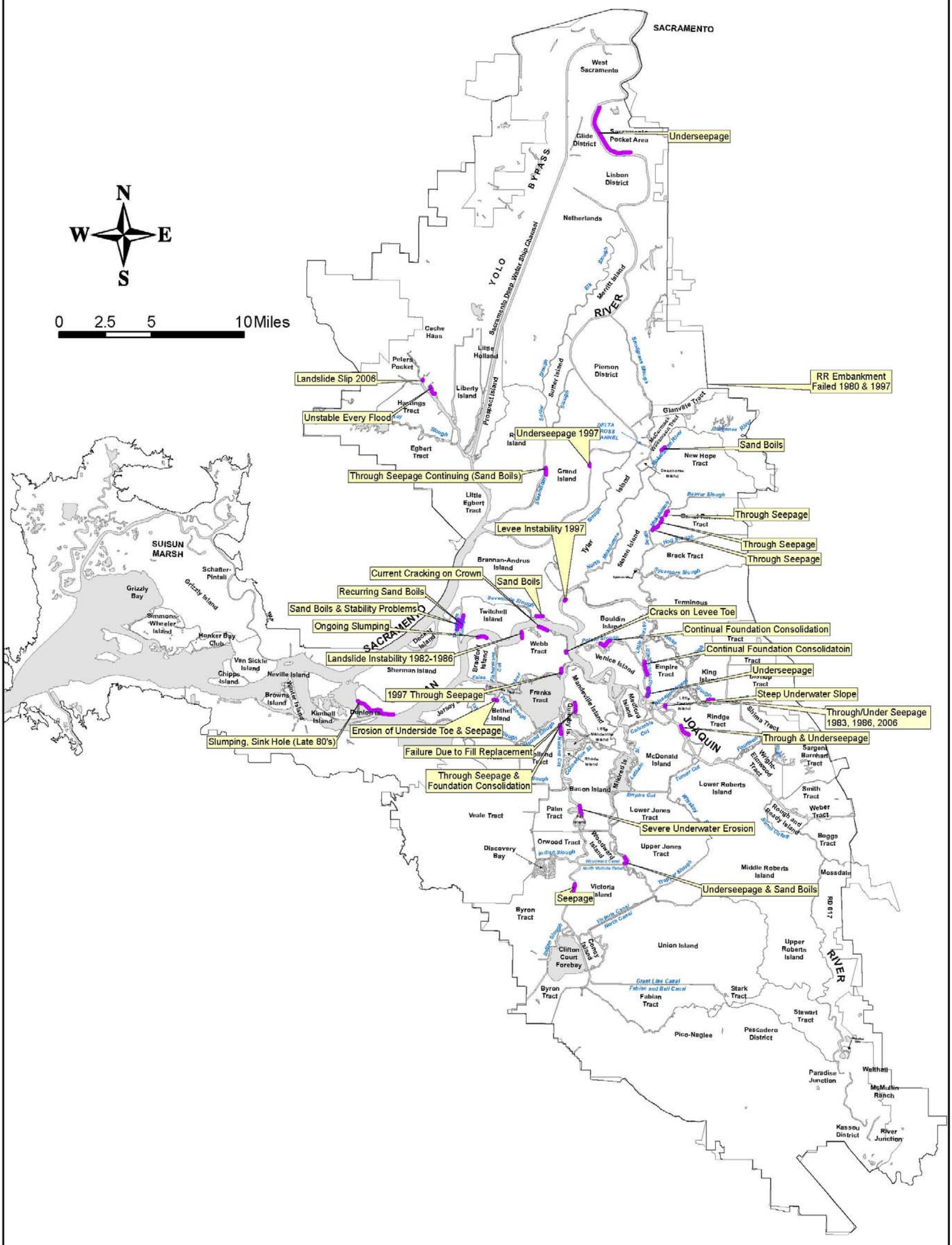
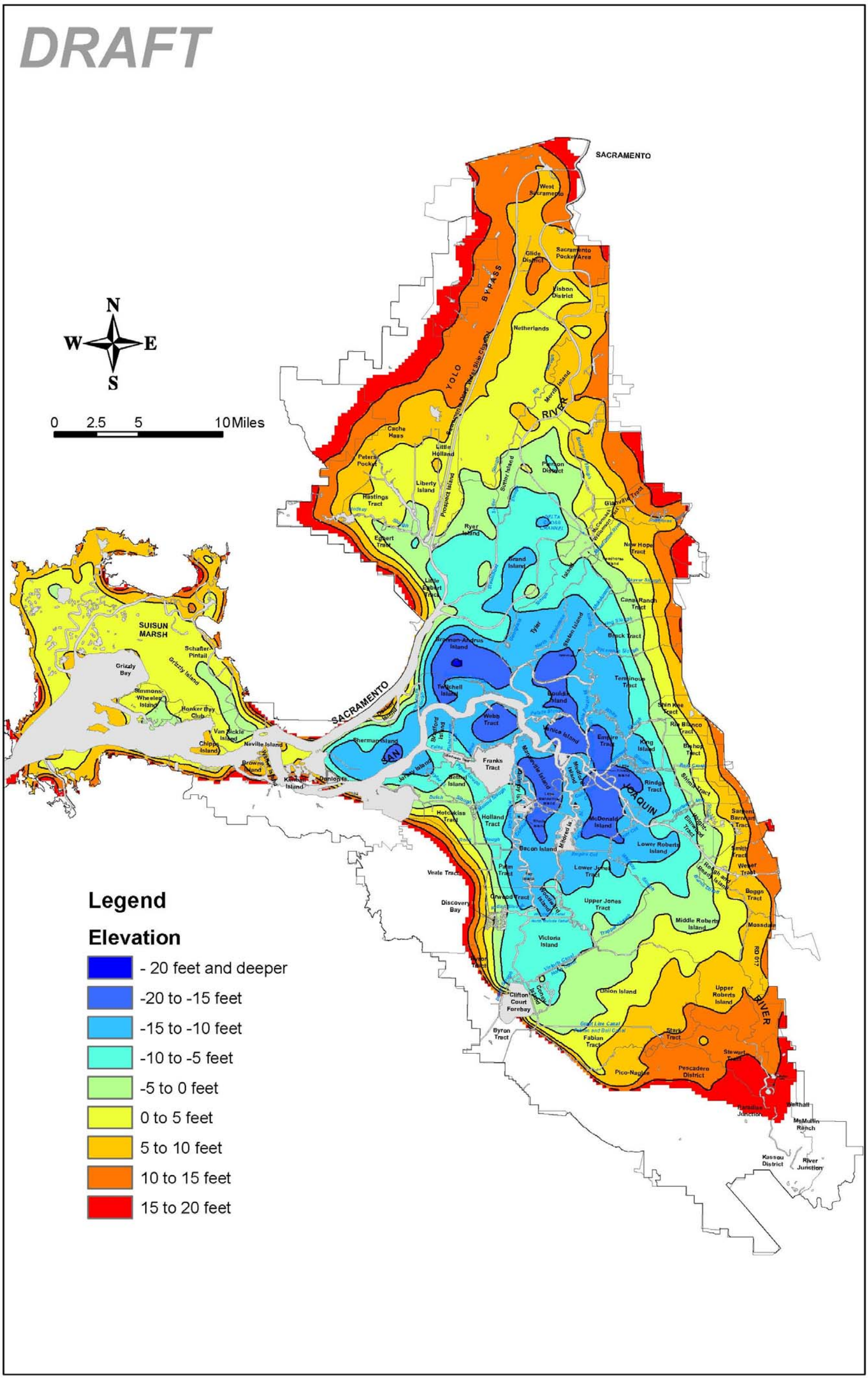


Delta Risk Management Strategy (DRMS) Levee Fragility		Reported Problem Areas	Figure 4-5
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Surface Elevation Map	Figure 4-6
URS	Project No. 26815621		

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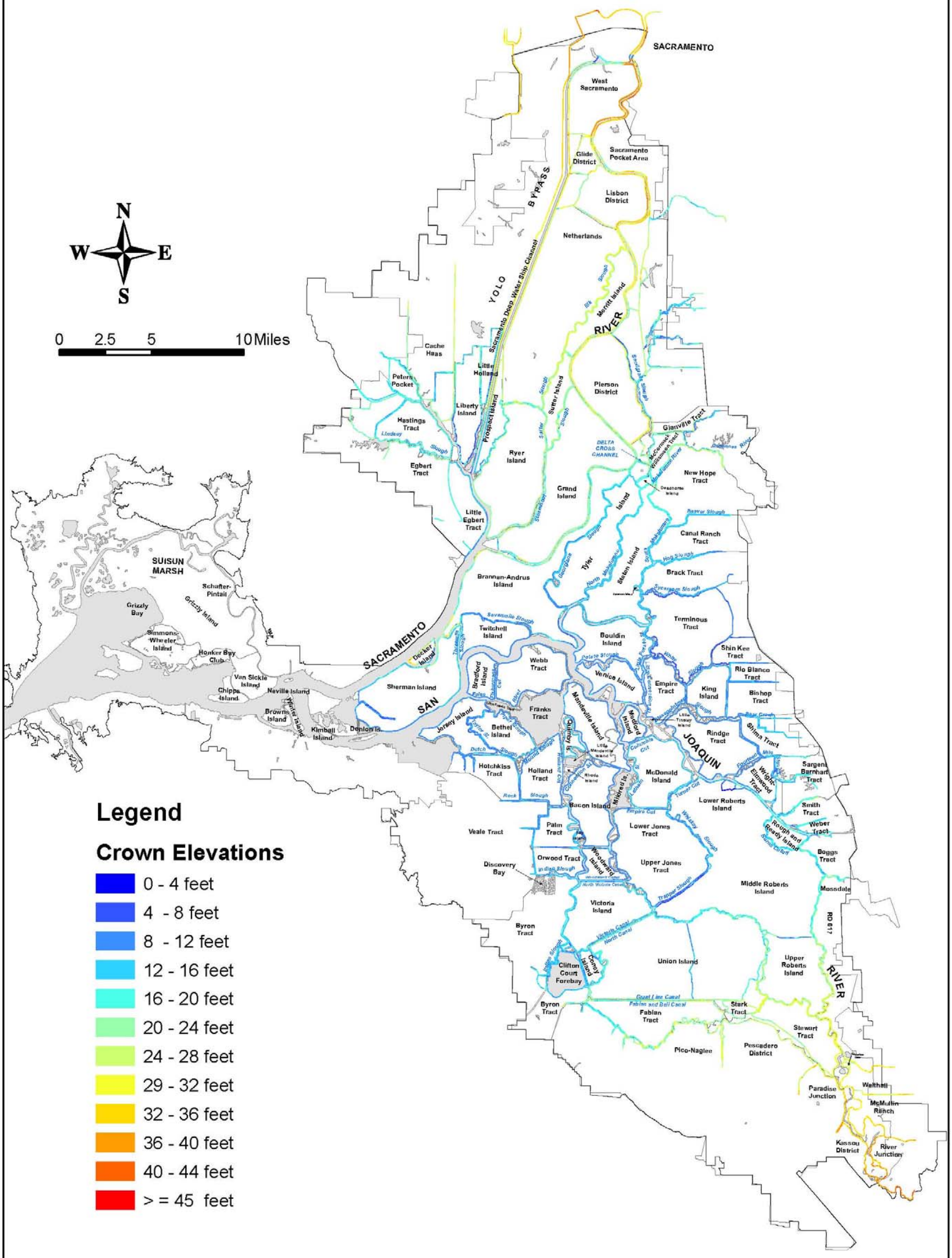
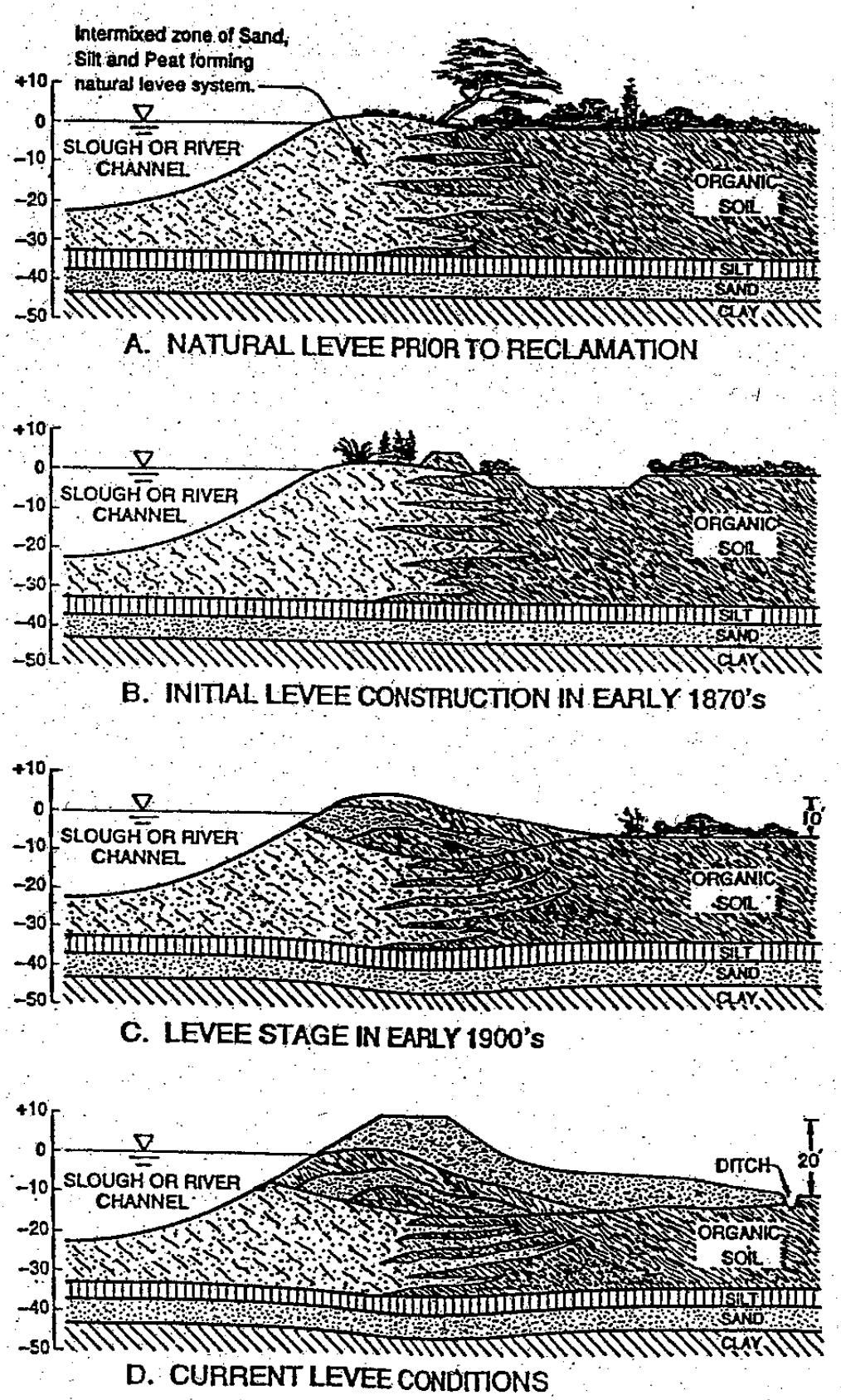
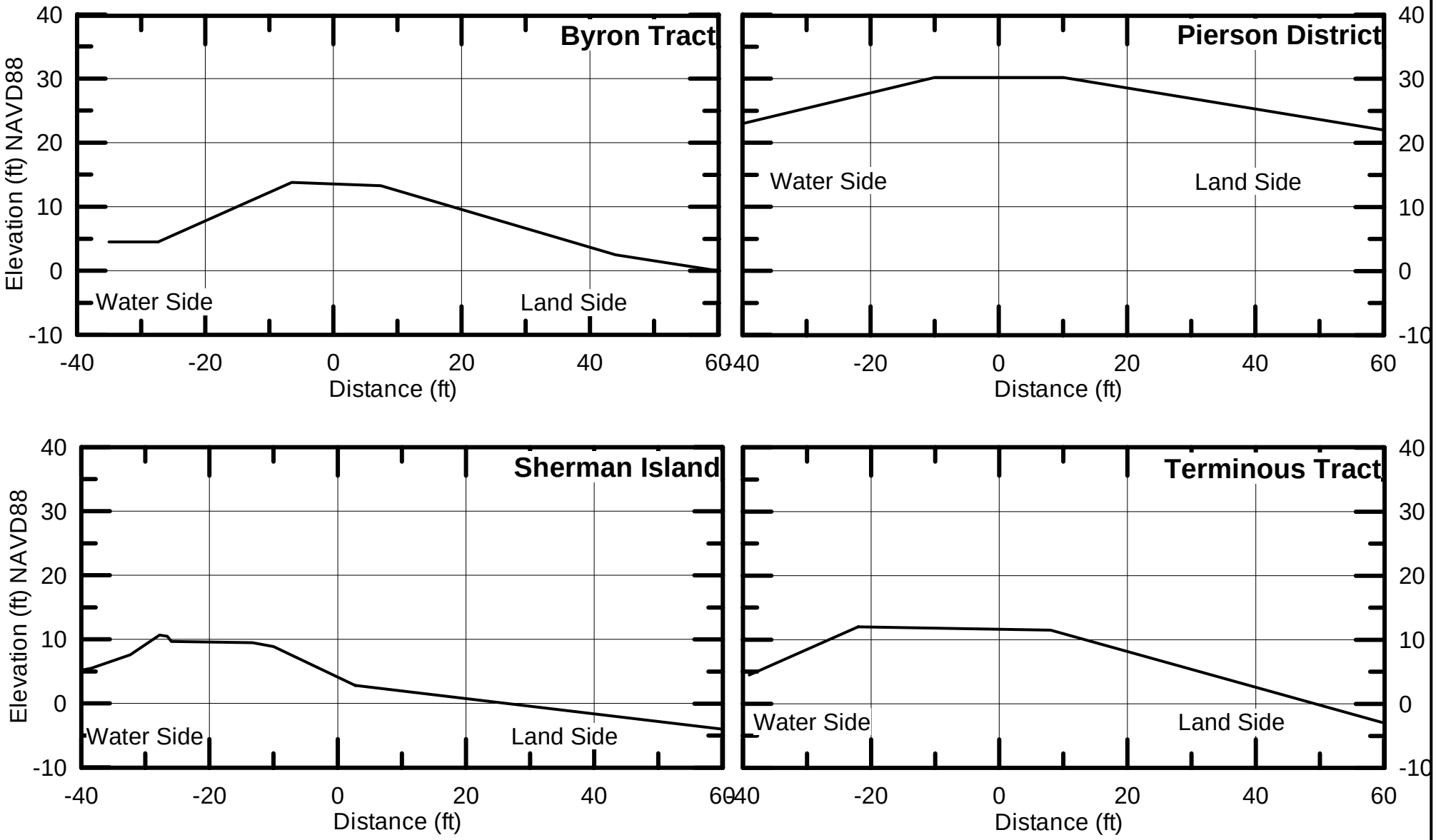


Delta Risk Management Strategy (DRMS) Levee Fragility		Crown Elevation Map	Figure 4-7
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Schematic Illustration of Development of Delta Levees (DWR, 1992)	Figure 4-8
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Typical Delta Levee Cross Sections	Figure 4-9
URS	Project No. 26815621		

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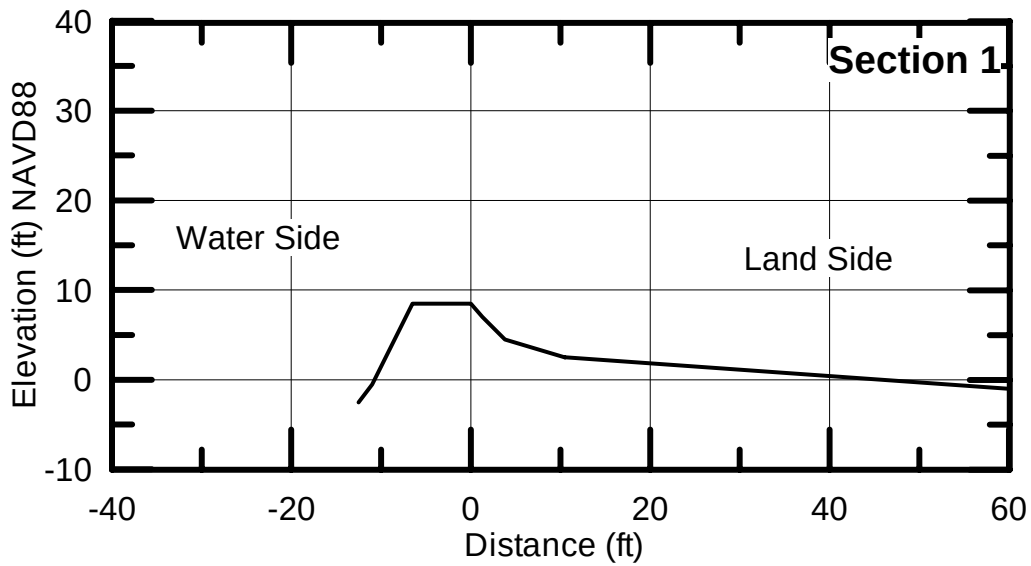

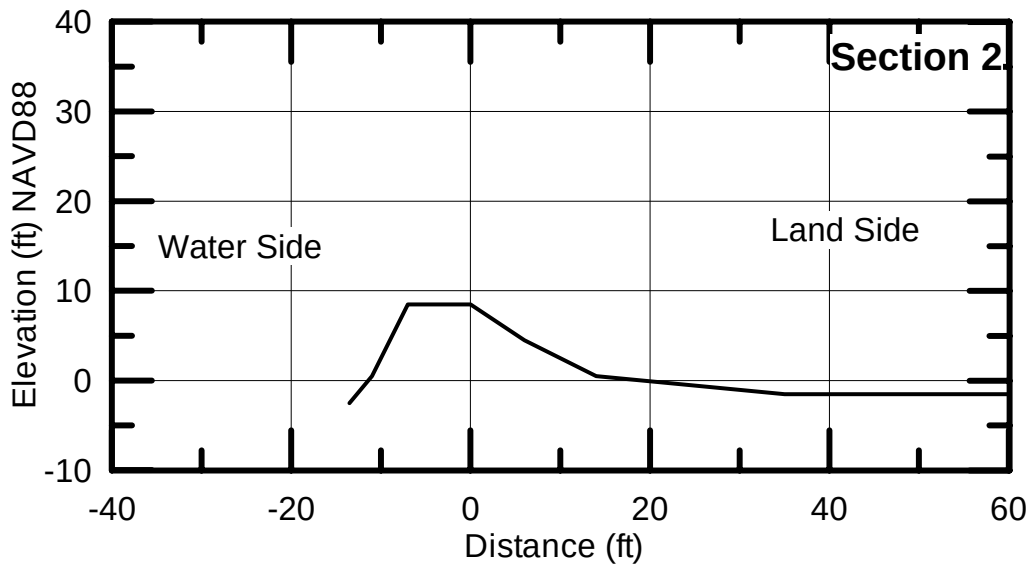

Delta Risk Management Strategy (DRMS) Levee Fragility	Typical Suisun Marsh Levee Cross Sections	Figure 4-10
URS / Project No. 26815621		

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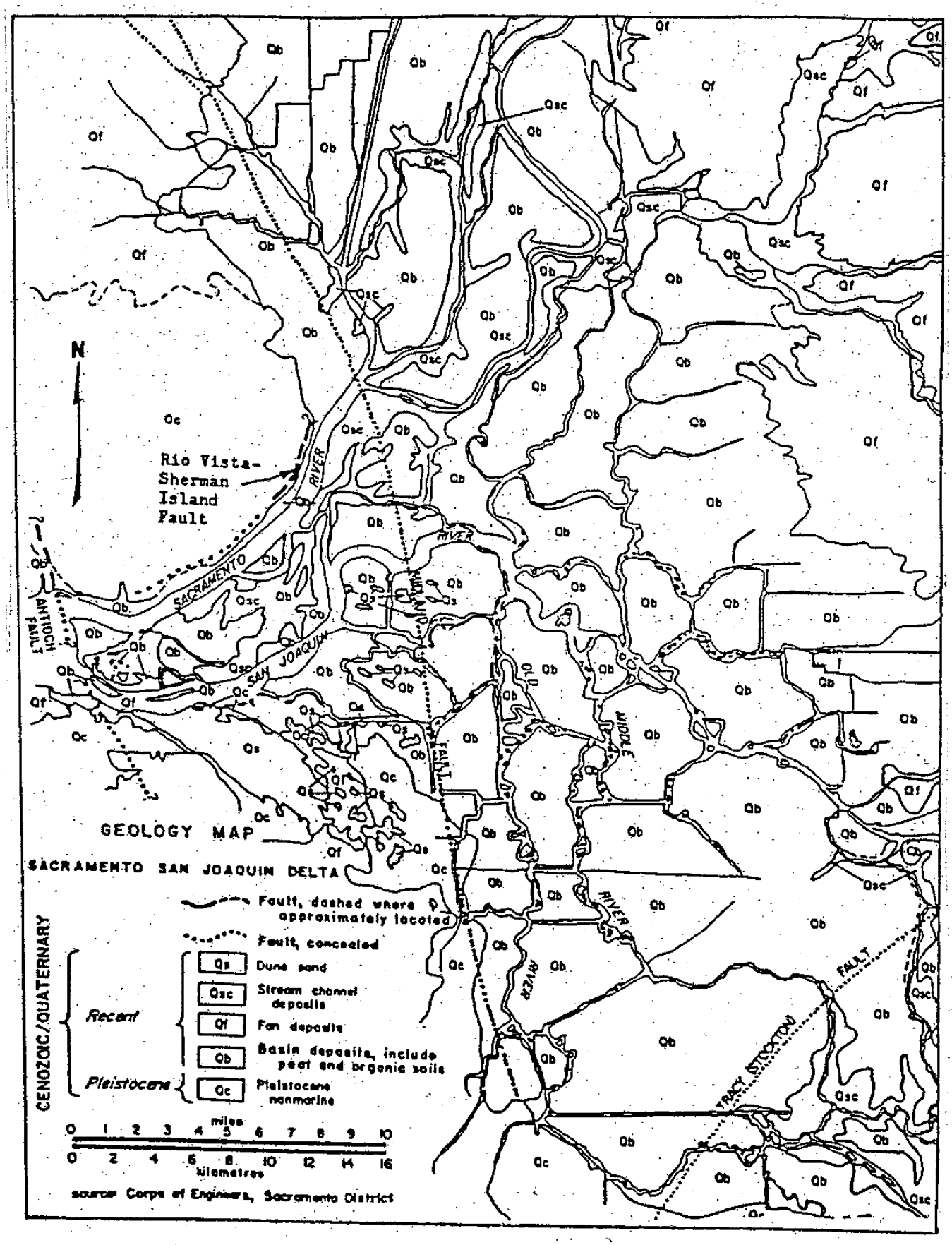

Delta Risk Management Strategy (DRMS) Levee Fragility		Geology of Delta (DWR, 1992)	Figure 4-11
URS	Project No. 26815621		

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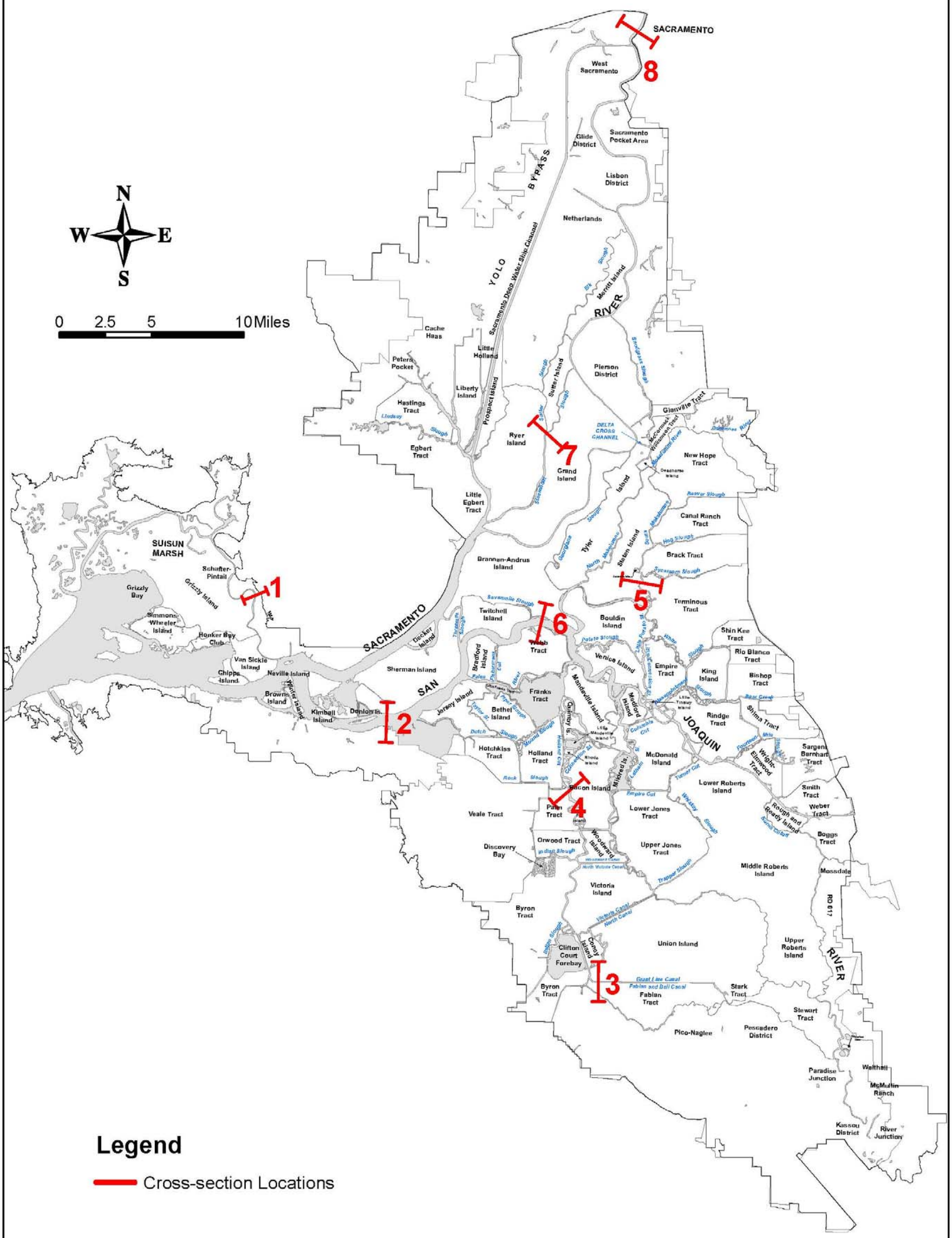
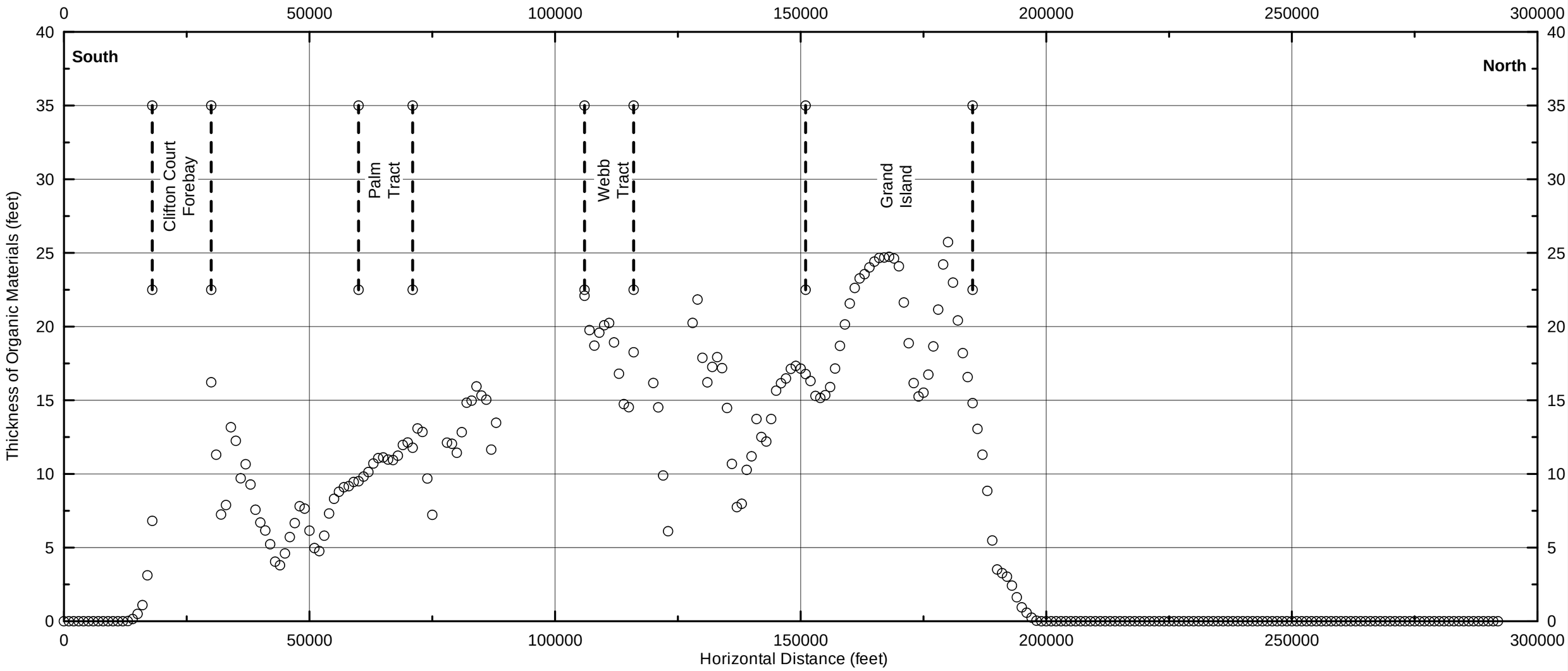
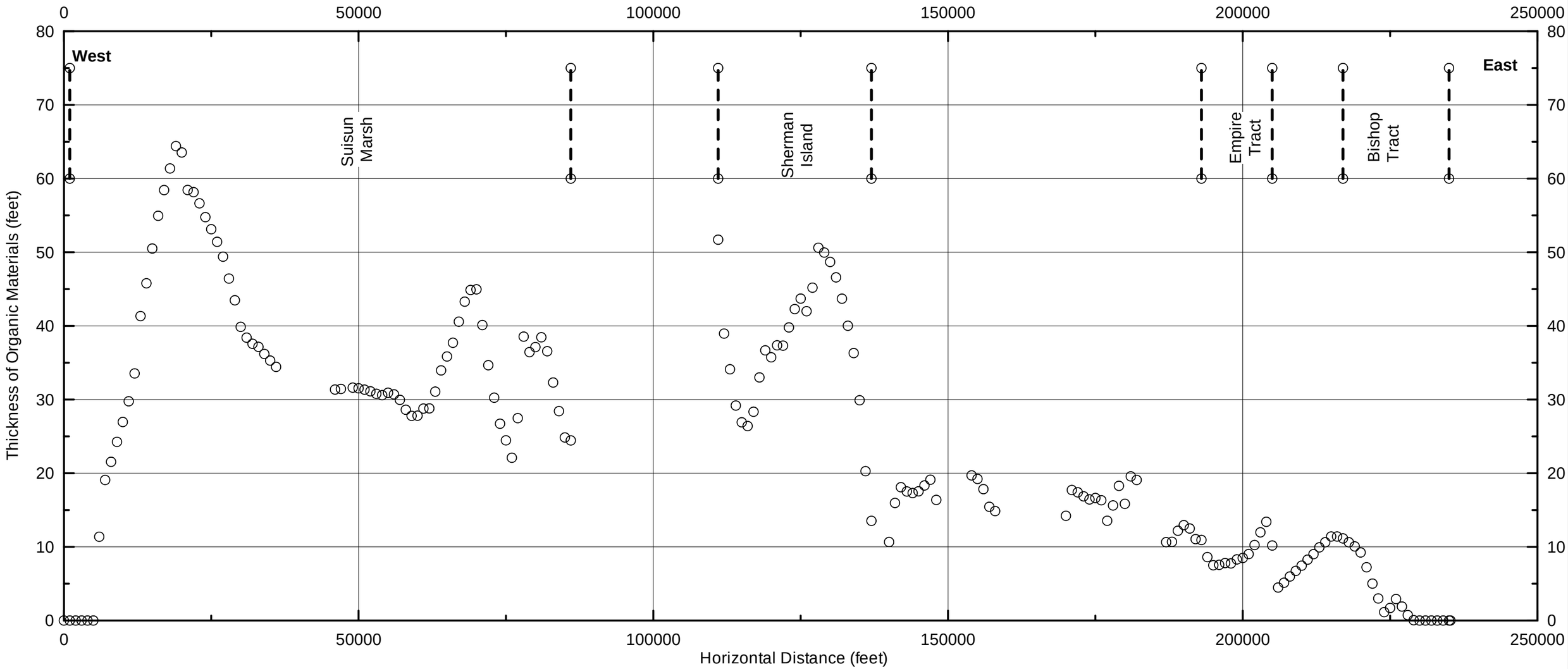


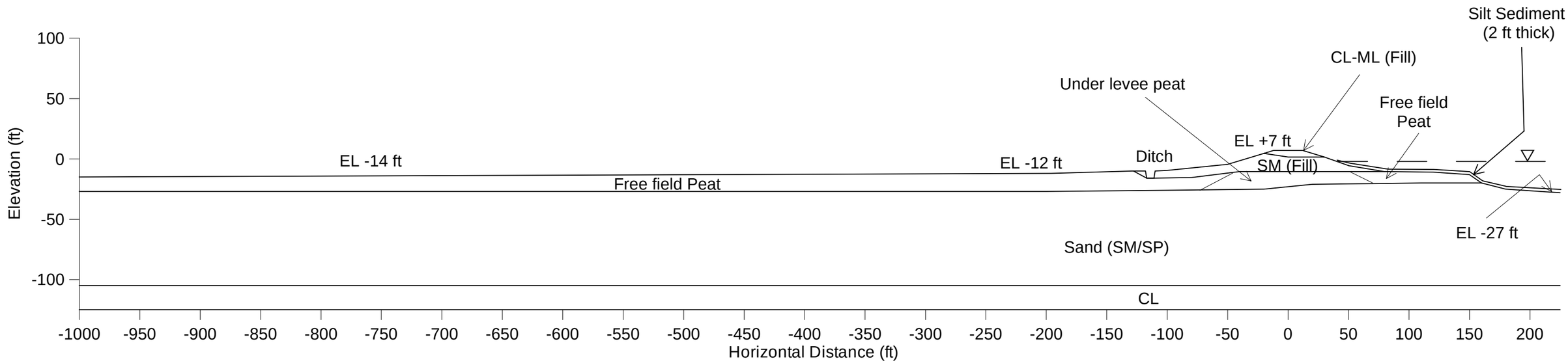
Delta Risk Management Strategy (DRMS) Levee Fragility		Locations of Reviewed Cross Sections	Figure 4-12
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Vaiation of Thickness of Organic Materials Along S-N Direction	Figure 4-13
URS	Project No. 26815621		

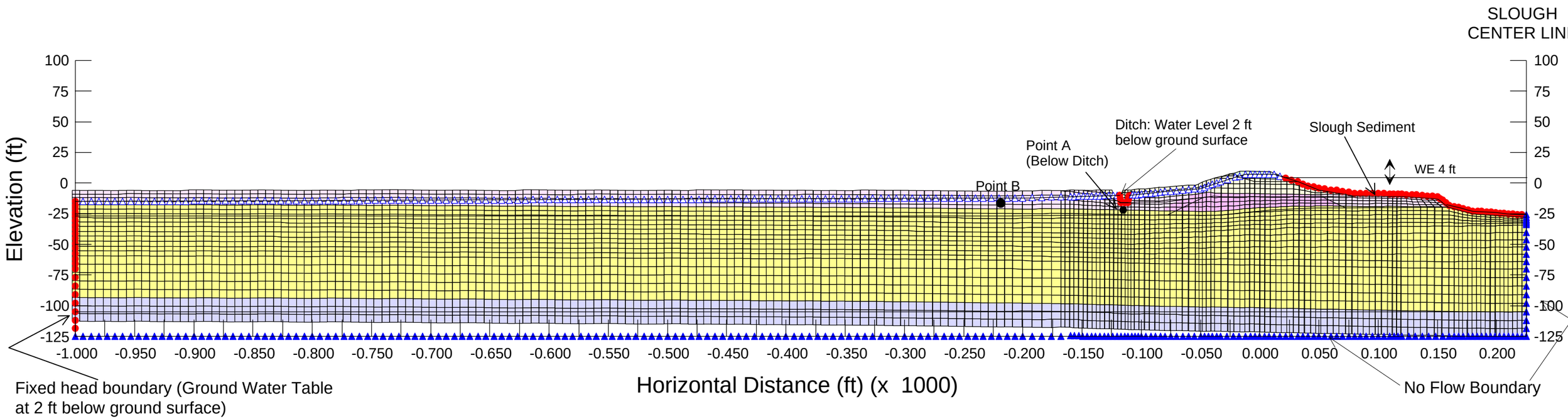


Delta Risk Management Strategy (DRMS) Levee Fragility		Vaiation of Thickness of Organic Materials Along W-E Direction	Figure 4-14
URS	Project No. 26815621		



Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Soil Profile - Terminous Tract	Figure 5-1
URS	Project No. 26815621		



Legend

Boundary Conditions

- No flow
- Fixed head
- Review

Material Type

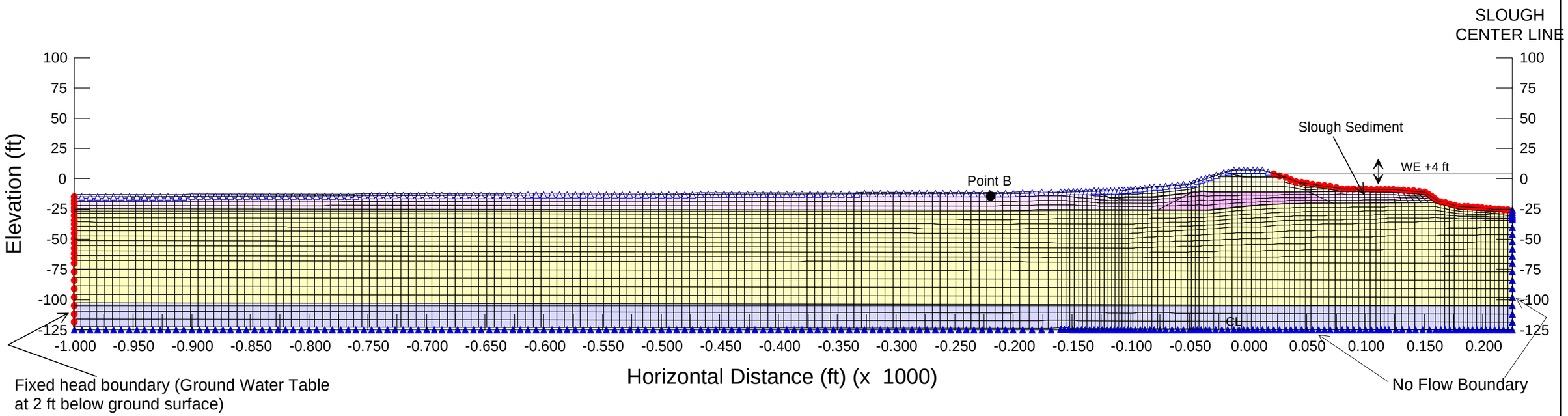
- CL-ML (Levee Fill)
- Sandy Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand (SP/SM)
- Clay
- Slough Sediment

Hydraulic conductivities used for preliminary seepage analysis

Material	k_h (cm/s)			k_h/k_v
	Mean - σ	Mean	Mean + σ	
Fill				
CL-ML (fill)	-	1×10^{-5}	-	4
SM (fill)	-	1×10^{-3}	-	4
Peat & Organics				
Free Field	1×10^{-5}	1×10^{-4}	1×10^{-3}	10
Under Levee	1×10^{-6}	1×10^{-5}	1×10^{-4}	10
Other Foundation Soils				
Sand (SM/SP)	5×10^{-4}	1×10^{-3}	5×10^{-3}	4
ML	-	1×10^{-4}	-	4
CL	-	1×10^{-6}	-	4
Sediment (at slough bottom)	-	1×10^{-5}	-	1

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Mesh and Boundary Conditions - Model with Drainage Ditch Terminous Tract	Figure 5-2
URS	Project No. 26815621		



Legend

Boundary Conditions

- No flow
- Fixed head
- Review

Material Type

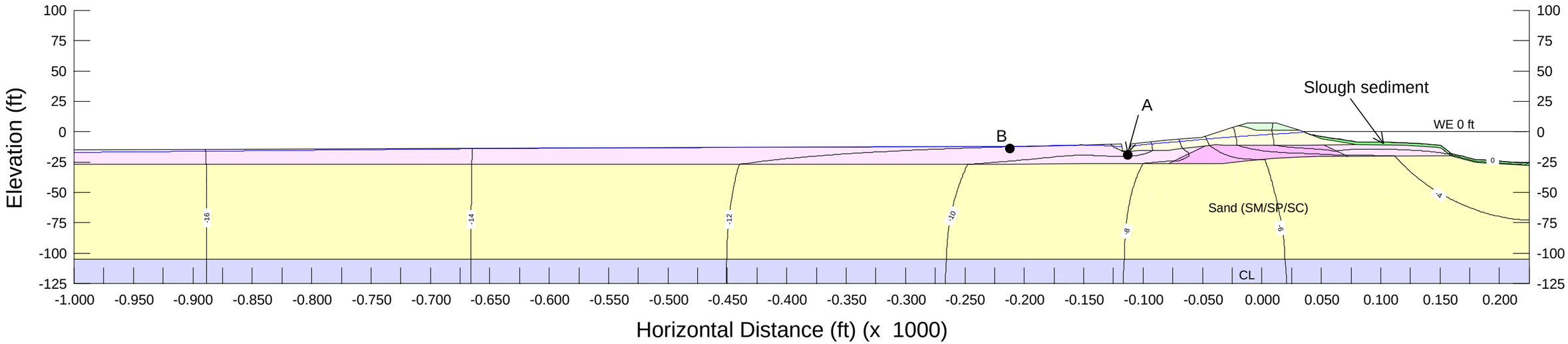
- CL-ML (Levee Fill)
- Sandy Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand (SP/SM)
- Clay
- Slough Sediment

Hydraulic conductivities used for preliminary seepage analysis

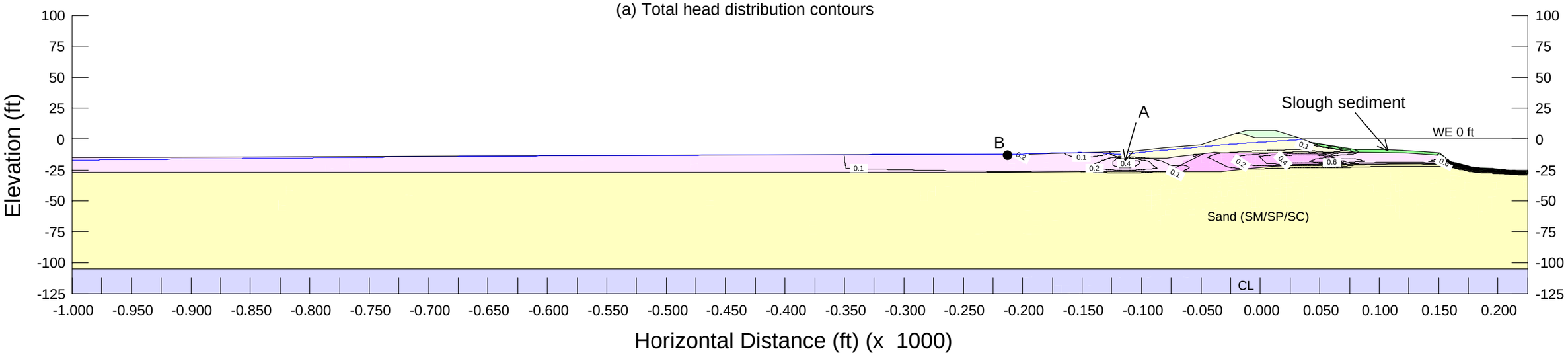
Material	k_h (cm/s)			k_h/k_v
	Mean - σ	Mean	Mean + σ	
Fill				
CL-ML (fill)	-	1×10^{-5}	-	4
SM (fill)	-	1×10^{-3}	-	4
Peat & Organics				
Free Field	1×10^{-5}	1×10^{-4}	1×10^{-3}	10
Under Levee	1×10^{-6}	1×10^{-5}	1×10^{-4}	10
Other Foundation Soils				
Sand (SM/SP)	5×10^{-4}	1×10^{-3}	5×10^{-3}	4
ML	-	1×10^{-4}	-	4
CL	-	1×10^{-6}	-	4
Sediment (at slough bottom)	-	1×10^{-5}	-	1

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Mesh and Boundary Conditions - Model without Drainage Ditch Terminous Tract	Figure 5-3
URS	Project No. 26815621		



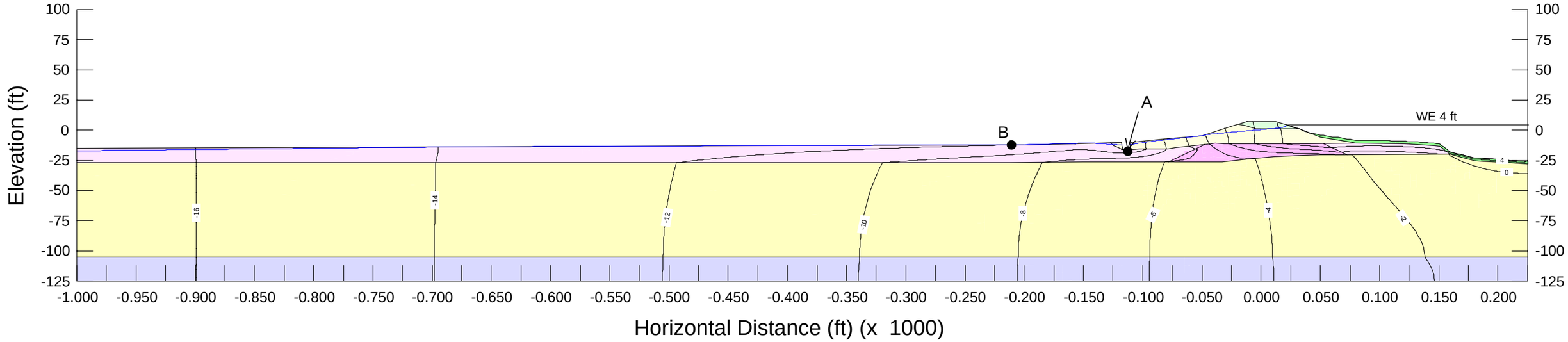
(a) Total head distribution contours



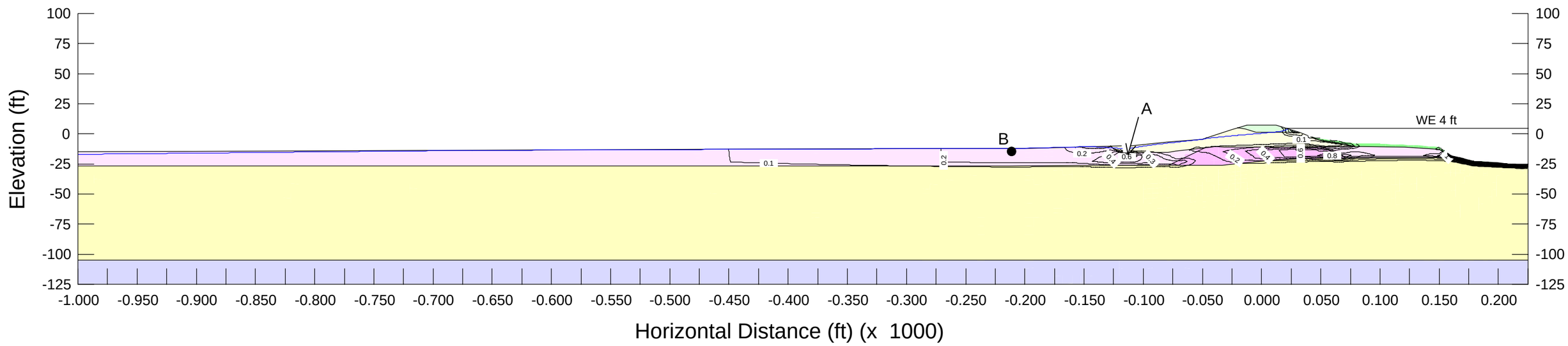
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head and Vertical Gradient Contours for Slough Water EL: 0 ft Terminous Tract	Figure 5-4
URS	Project No. 26815621		



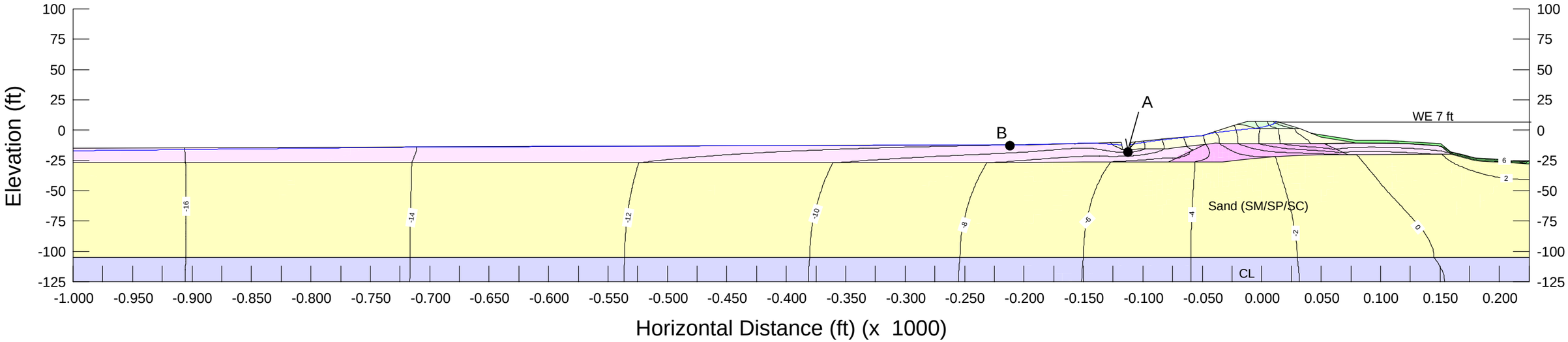
(a) Total head distribution contours



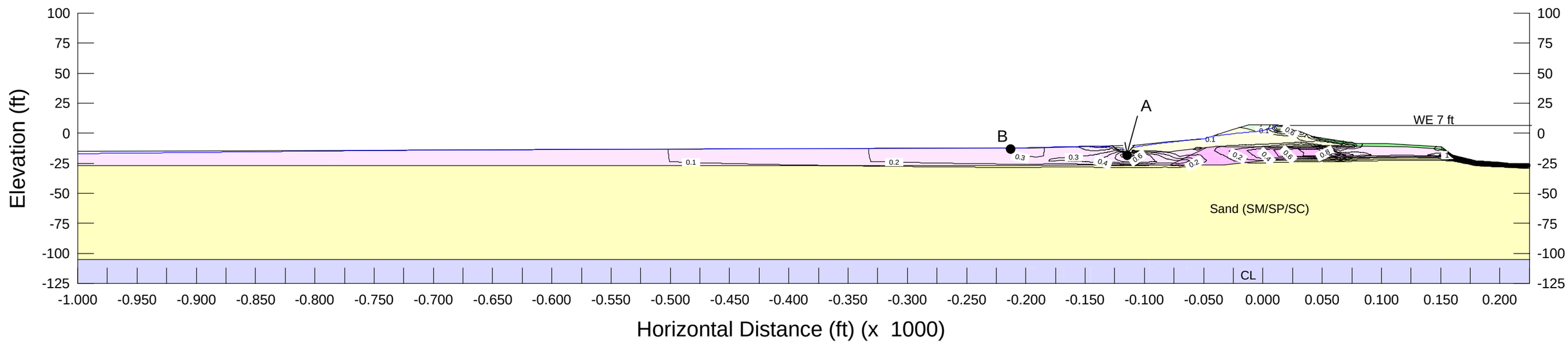
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head and Vertical Gradient Contours for Slough Water EL: +4 ft Terminous Tract	Figure 5-5
URS	Project No. 26815621		



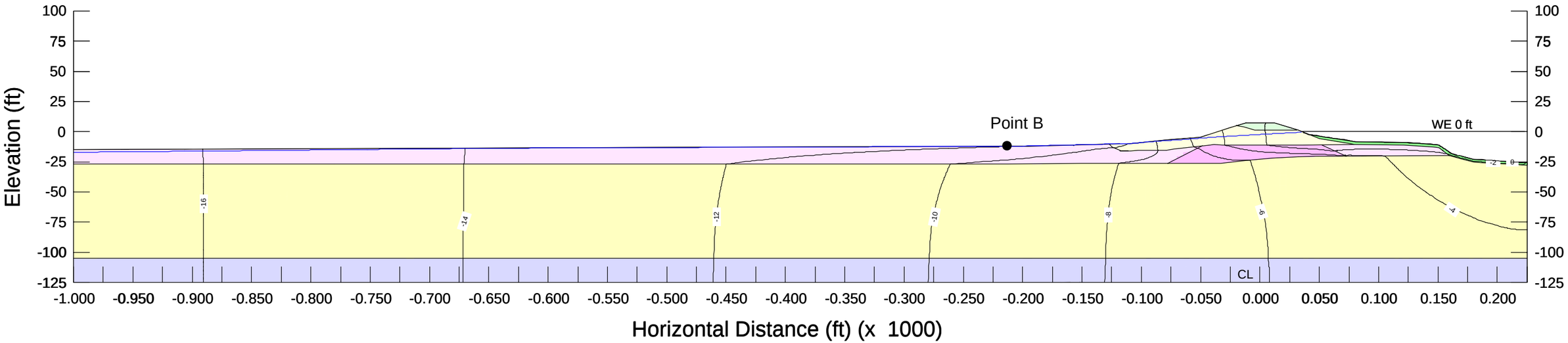
(a) Total head distribution contours



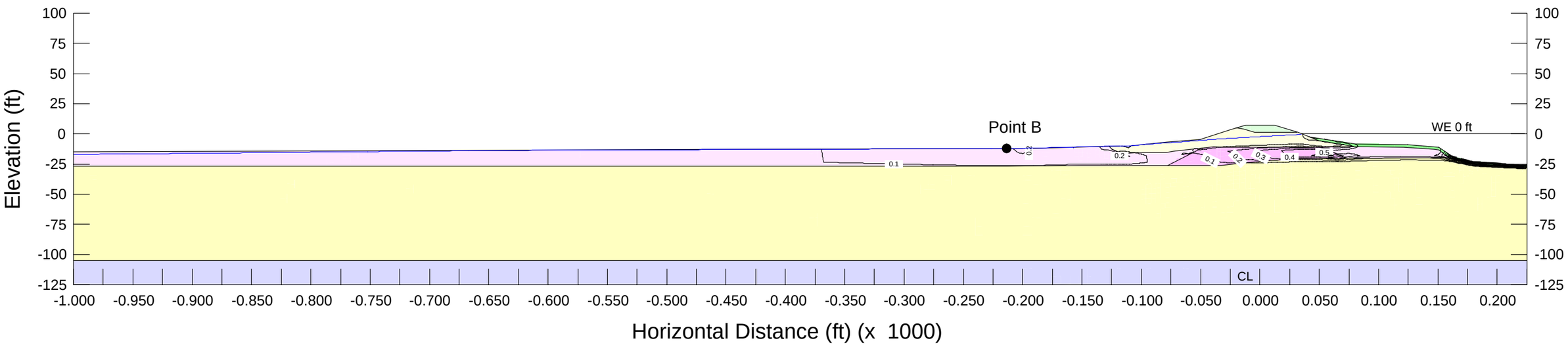
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head and Vertical Gradient Contours for Slough Water EL: +7 ft Terminous Tract	Figure 5-6
URS	Project No. 26815621		



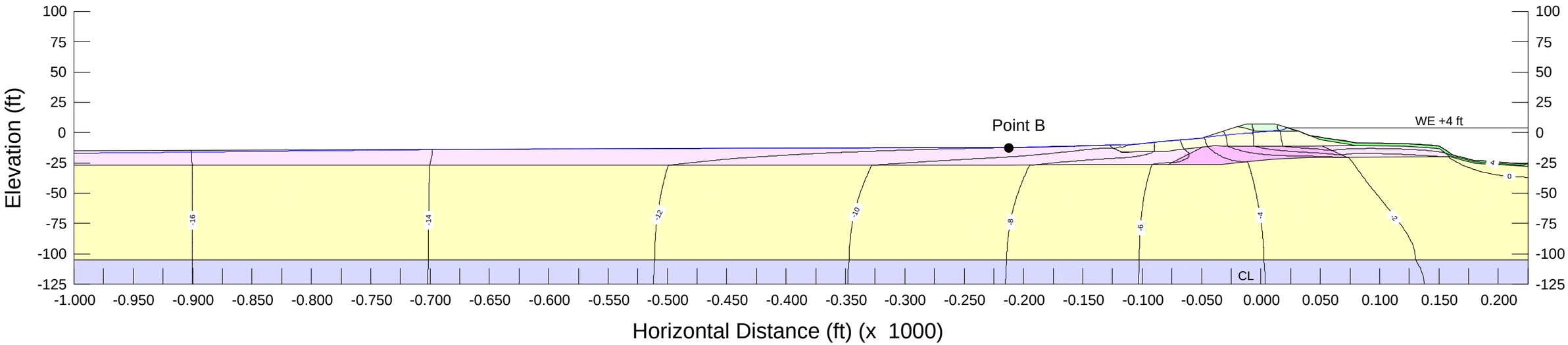
(a) Total head distribution contours



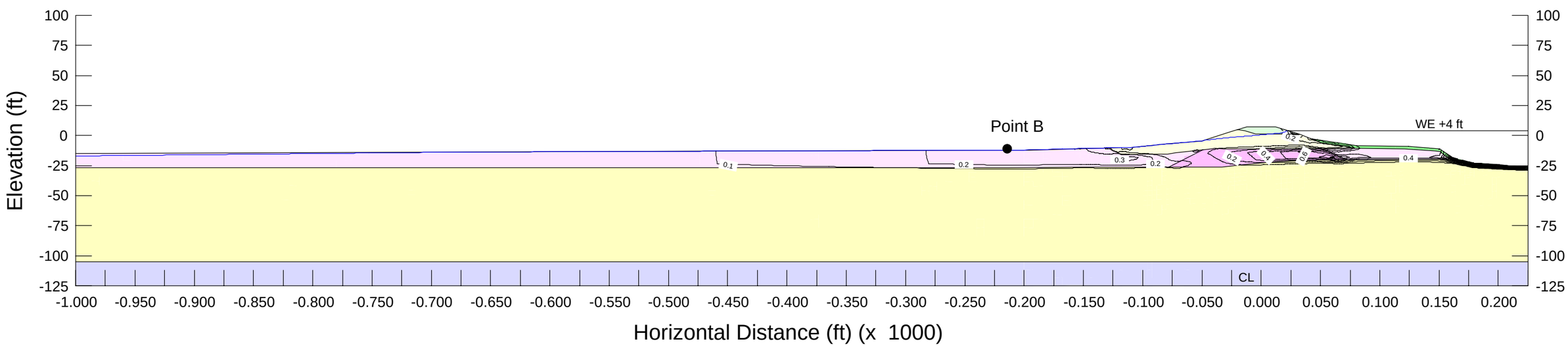
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head and Vertical Gradient Contours for Slough Water EL: 0 ft - Model without Drainage Ditch Terminous Tract	Figure 5-7
URS	Project No. 26815621		



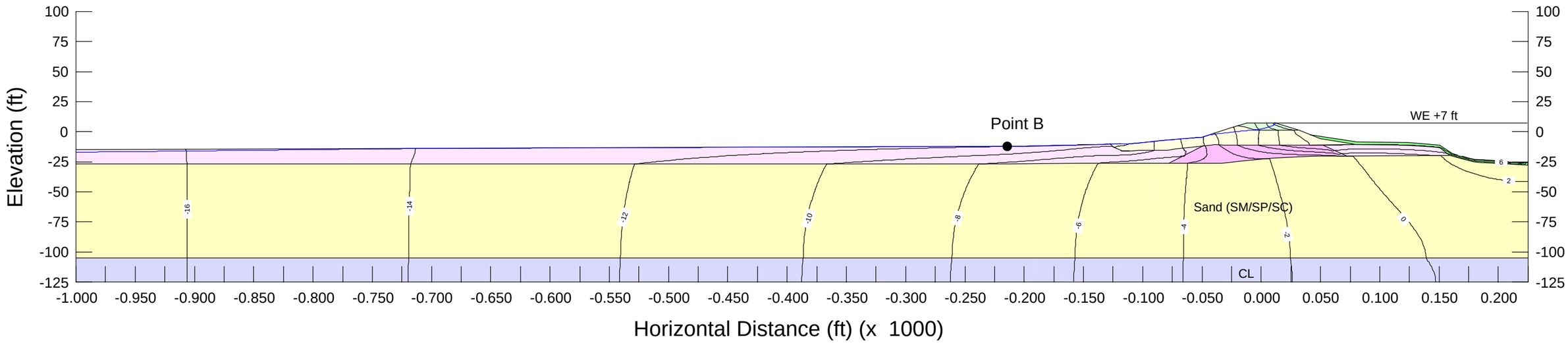
(a) Total head distribution contours



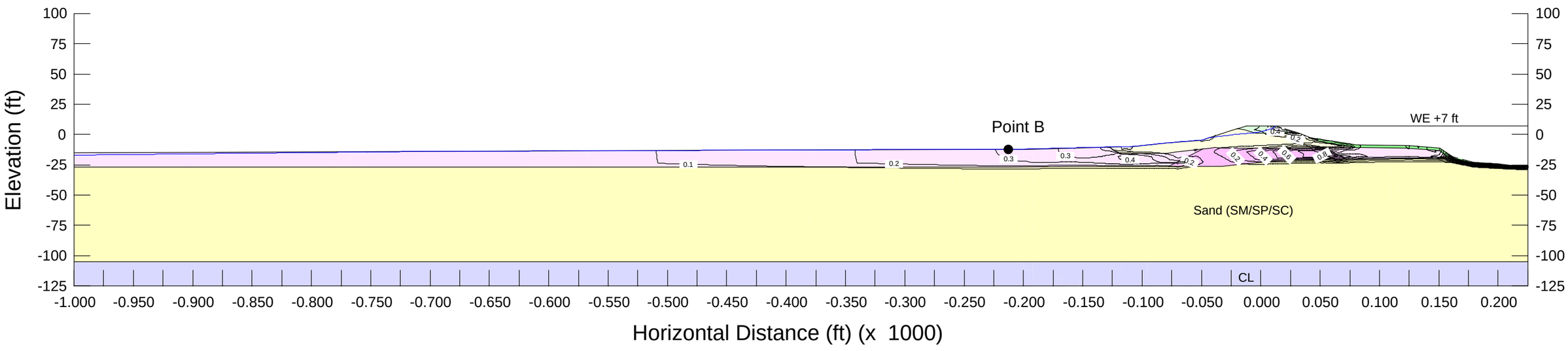
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head and Vertical Gradient Contours for Slough Water EL: +4 ft - Model without Drainage Ditch Terminous Tract	Figure 5-8
URS	Project No. 26815621		



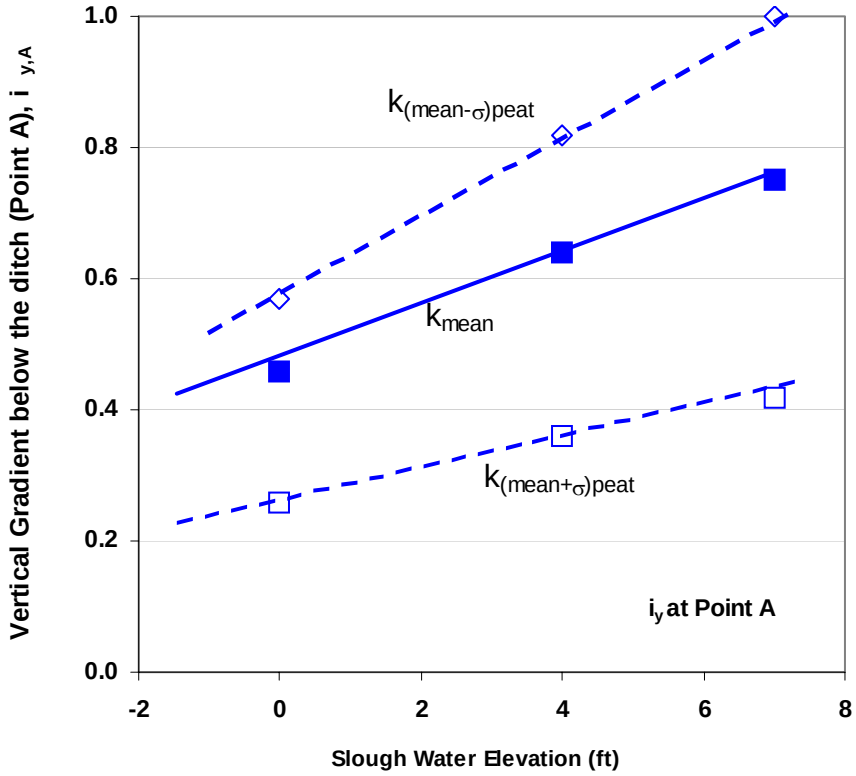
(a) Total head distribution contours

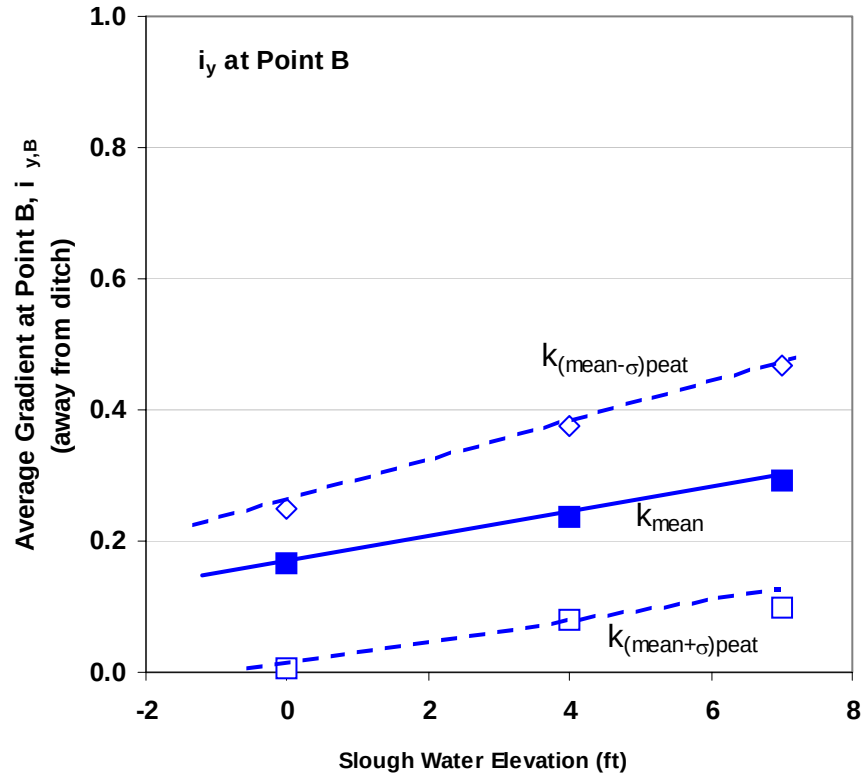


(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head and Vertical Gradient Contours for Slough Water EL: +7 ft - Model without Drainage Ditch Terminous Tract	Figure 5-9
URS	Project No. 26815621		

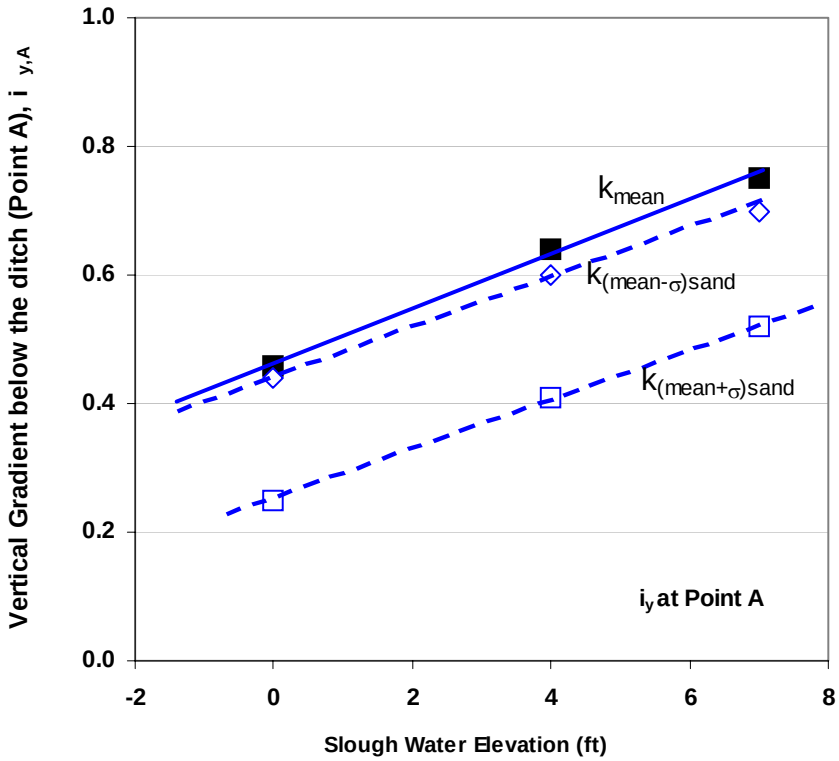


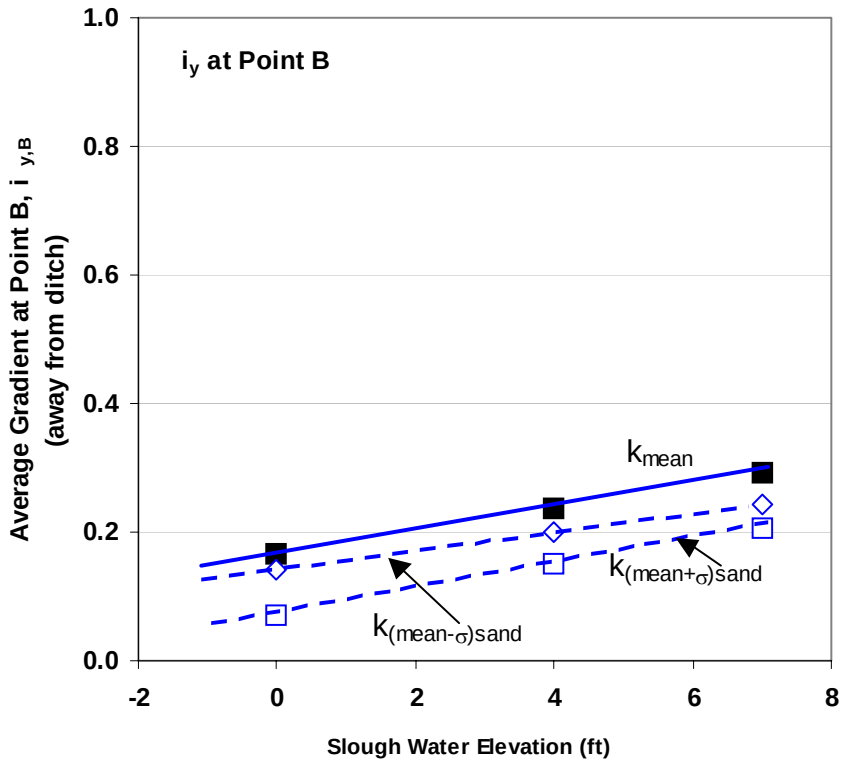


Note:

1. Gradients were calculated for seepage model with ditch and 2 ft silt sediment deposit at slough bottom.
2. All elevations are referenced to NAVD88 (NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Permeability of Peat Initial Analysis -Terminous Tract	Figure 5-10
URS	Project No. 26815621		

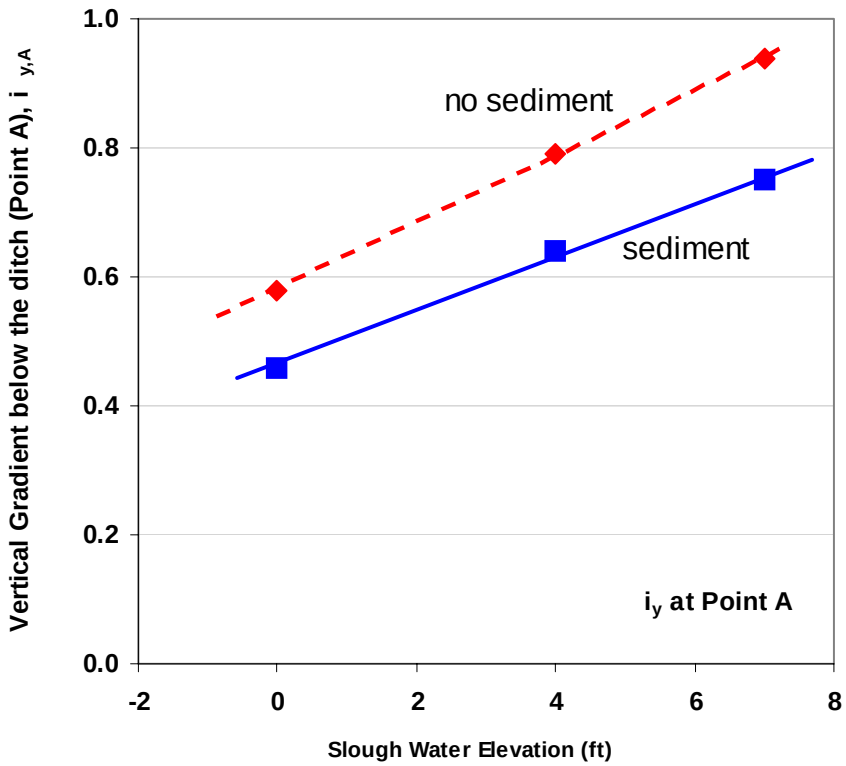


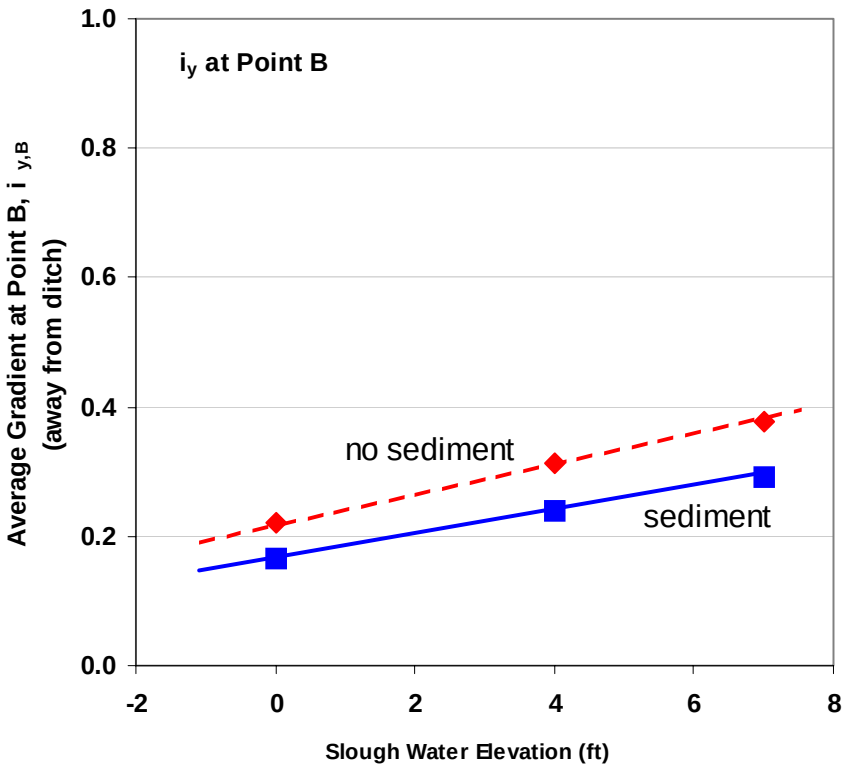


Note:

1. Gradients were calculated for seepage model with ditch and 2 ft silt sediment deposit at slough bottom.
2. All elevations are referenced to NAVD88
   (NAVD88 = NGVD29 + 2.5 ft)

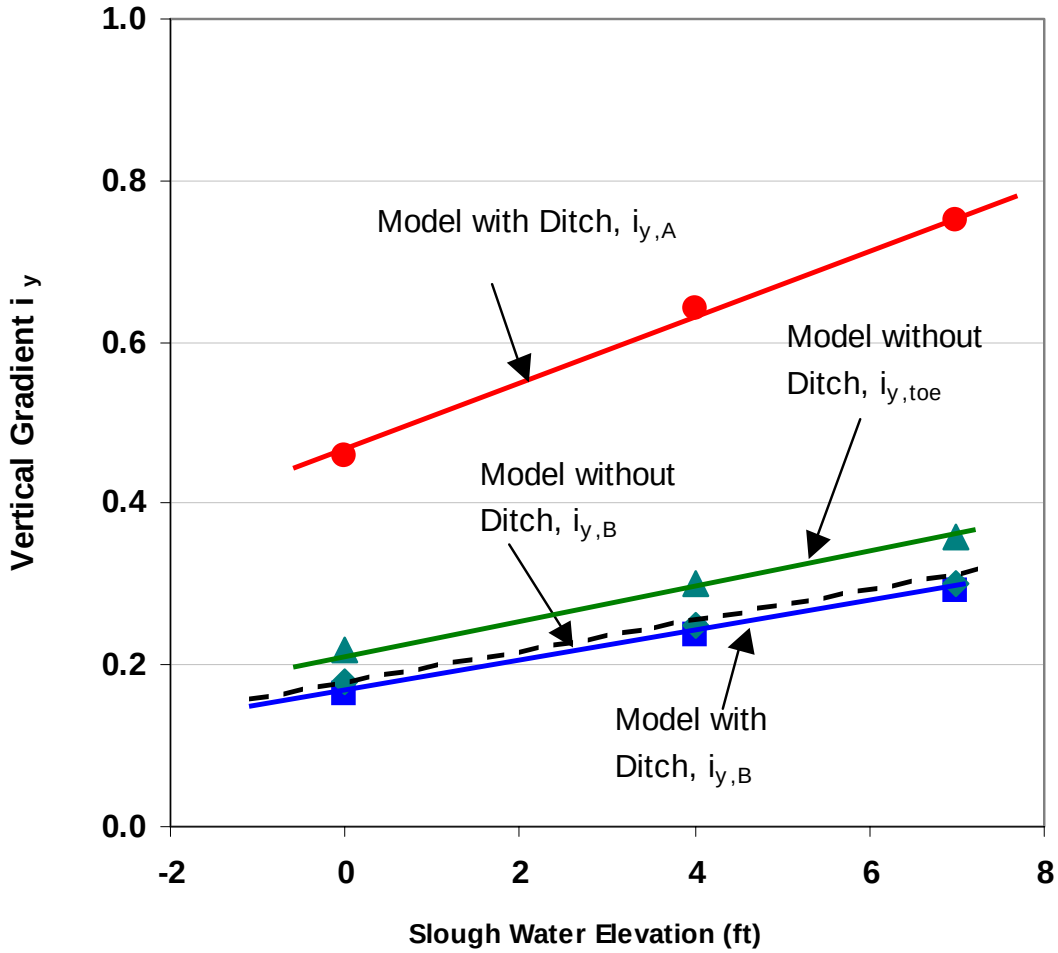
Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Permeability of Sand Aquifer Initial Analysis -Terminous Tract	Figure 5-11
URS	Project No. 26815621		





Note:
1. Gradients were calculated for seepage model with ditch.
2. All elevations are referenced to NAVD88
   (NAVD88 = NGVD29 + 2.5 ft)

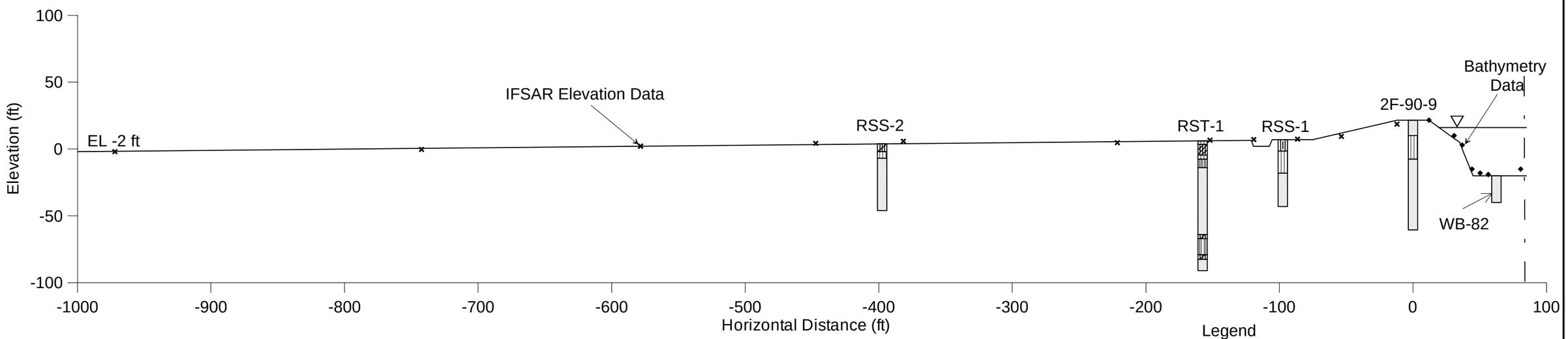
Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Slough Sediment Initial Analysis -Terminous Tract	Figure 5-12
URS	Project No. 26815621		



Note:
Gradients were calculated for seepage model with 2 ft silt sediment deposit at slough bottom.

Elevations are referenced to NAVD88

Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Drainage Ditch Initial Analysis -Terminous Tract	Figure 5-13
URS	Project No. 26815621		



Legend

- Sand
- Silty Clay
- Silt
- Silty Sand
- Organic Silt

Note:
The above cross section was constructed based on boring data collected at/near the site.

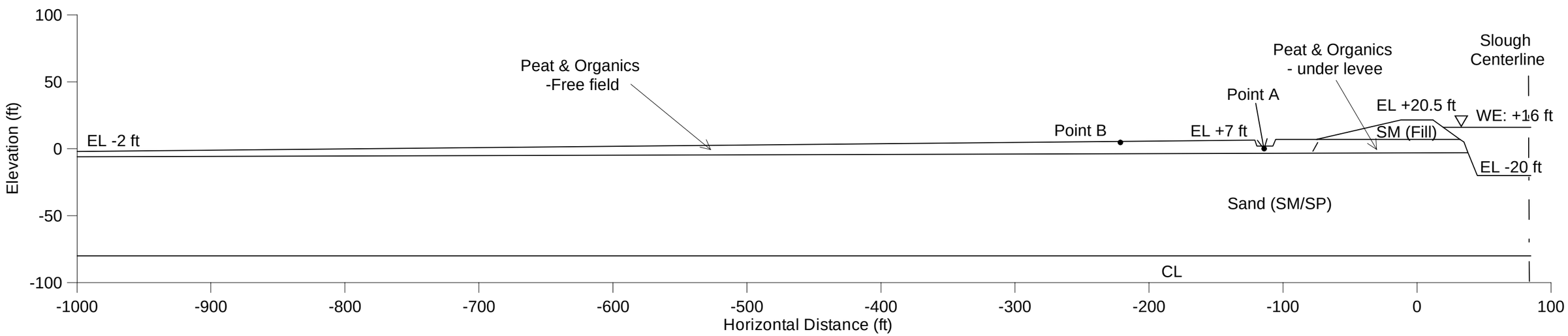
Borings WB-82, RSS-1, RST-1, and RSS-2 were collected from "Salinity Control Barrier Investigation", DWR, 1958.

Boring 2F-90-9 was collected from "Sacramento River Flood Control System Evaluation, Lower Sacramento Area", COE, 1993.

Based on boring RSS-1 and Organic Thickness Map, it was conservatively assumed that the top foundation layer has 10 ft thick peat/organic material.

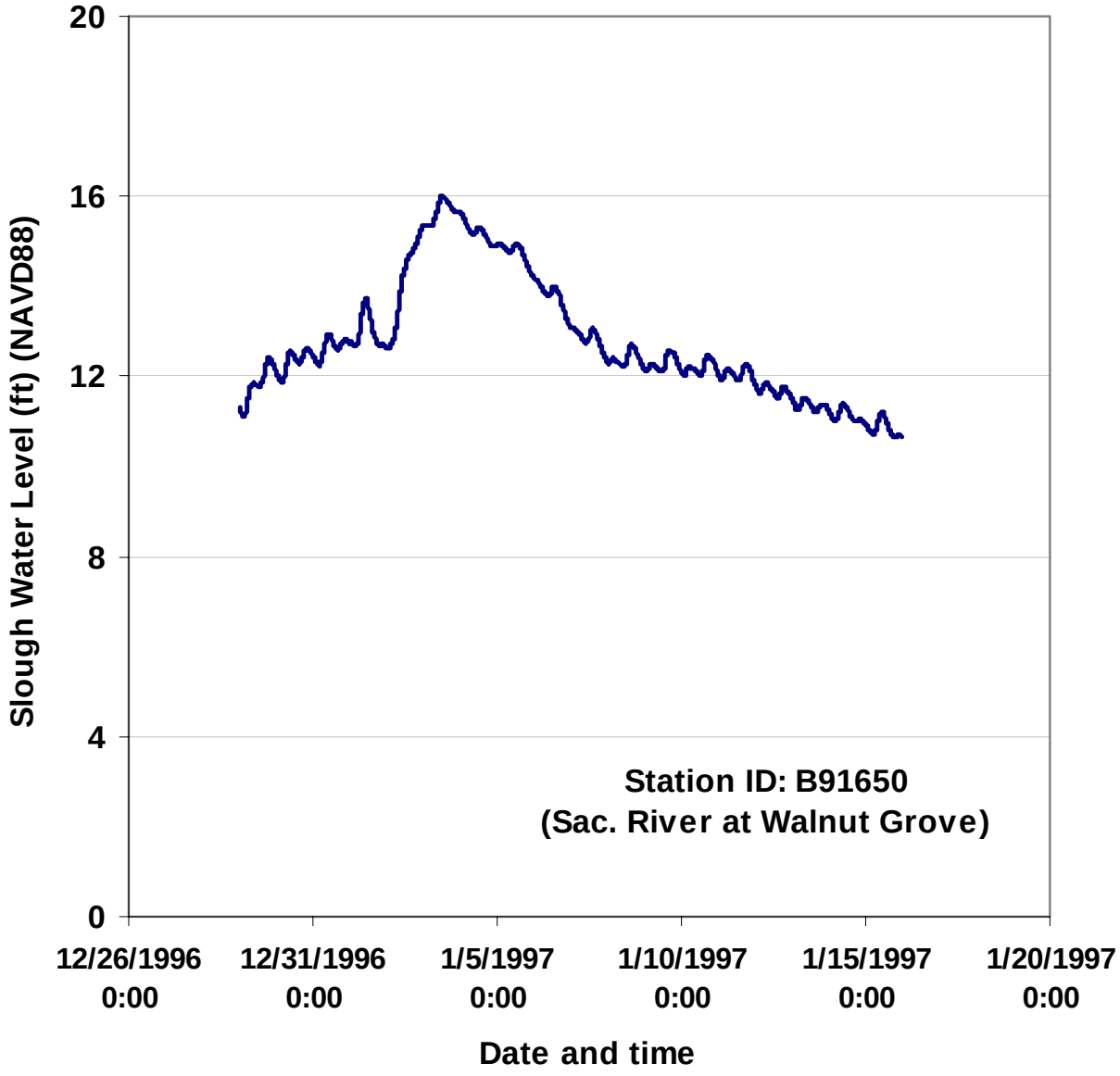
All elevations are referenced to NAVD88 (NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Topography and Boring Data Grand Island	Figure 5-14
URS	Project No. 26815621		

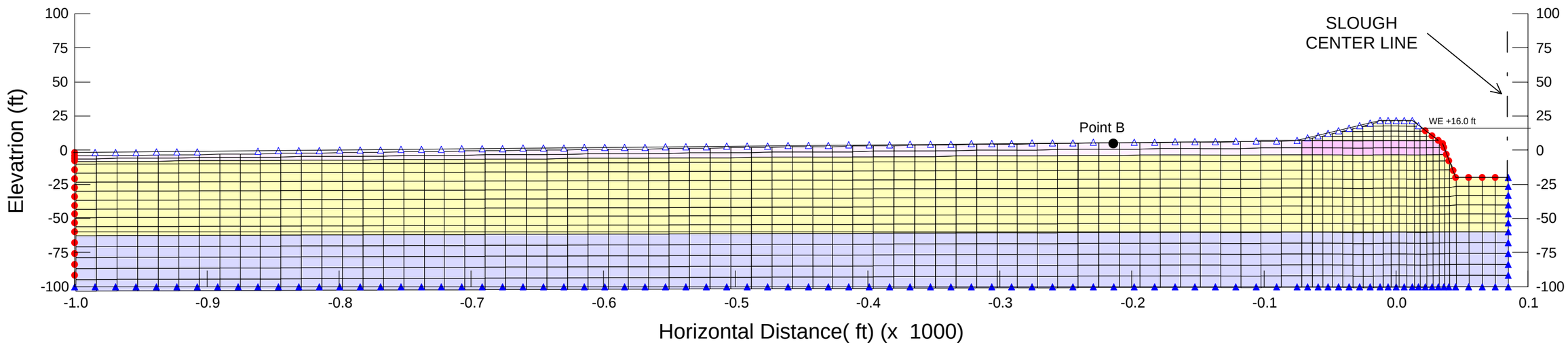


Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)
Water Elevation: +16 ft (NAVD88)

Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Cross section Grand Island	Figure 5-15
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Monitored Slough Water Level at Walnut Grove Station (ID:91650)	Figure 5-16
URS	Project No. 26815621		



Seepage Model without Ditch

Legend

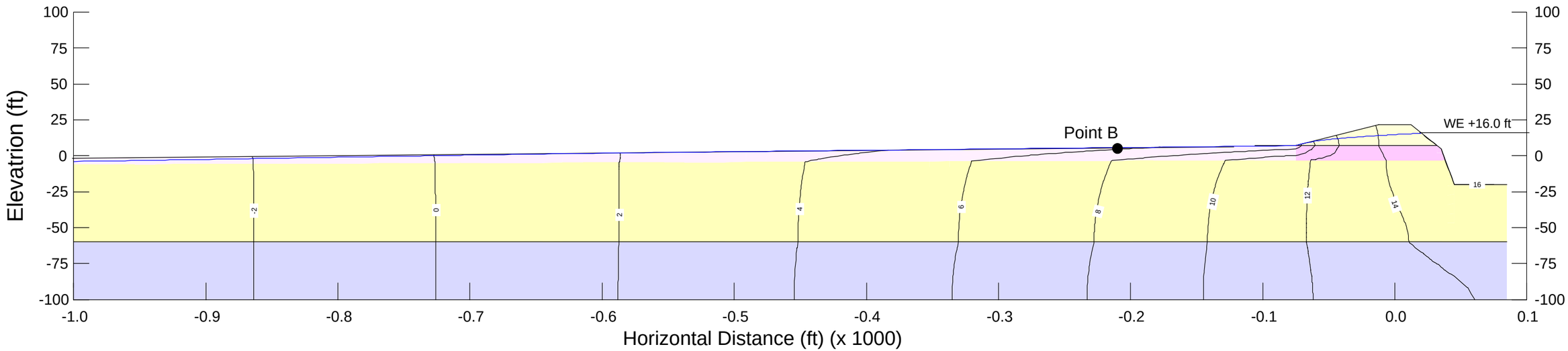
Boundary Conditions

- No flow
- Fixed head
- Review

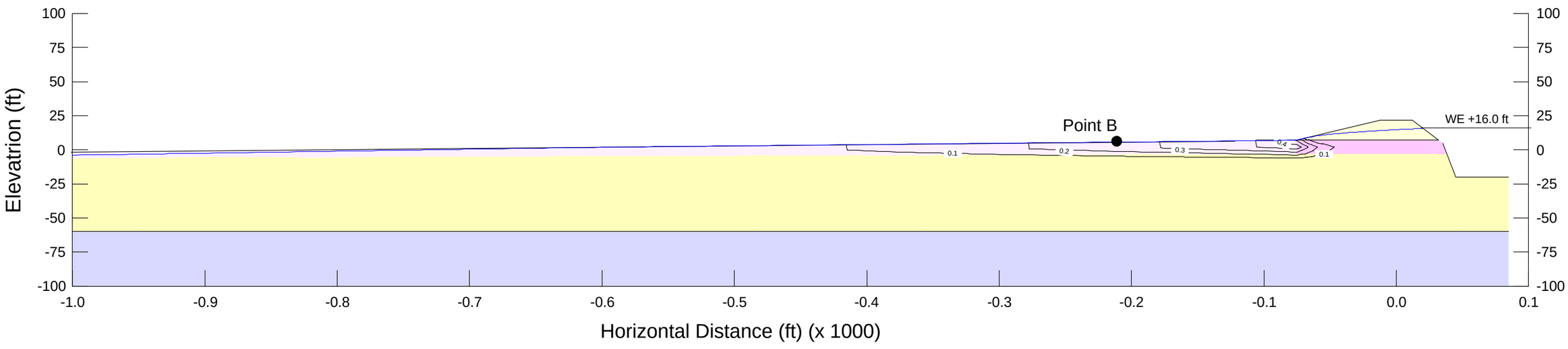
Material Type

- Sandy Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand (SP/SM)
- Clay

Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Mesh and Boundary Conditions Grand Island Underseepage Problem	Figure 5-17
URS	Project No. 26815621		



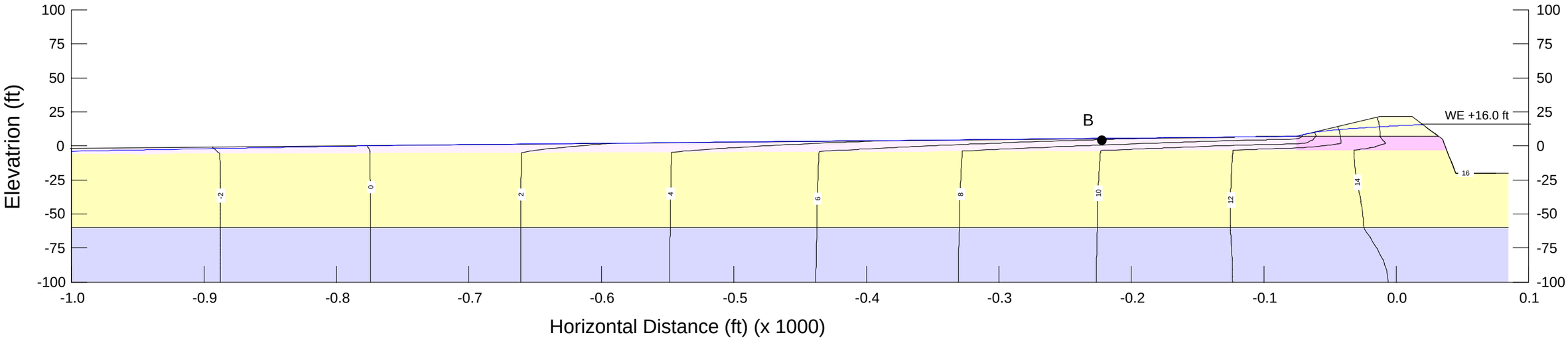
(a) Total head distribution contours



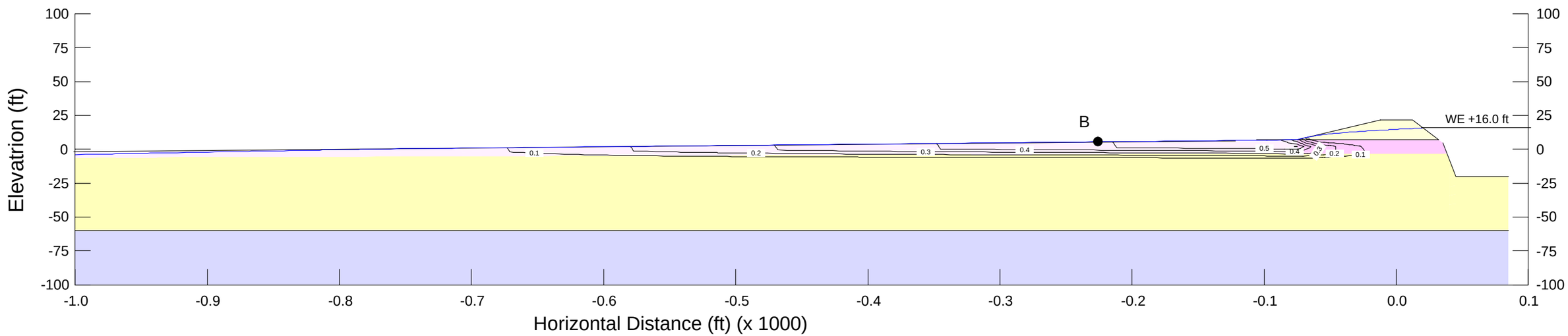
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours for $(k_h/k_v)_{peat}$ = 10 Grand Island Underseepage Problem	Figure 5-18
URS	Project No. 26815621		



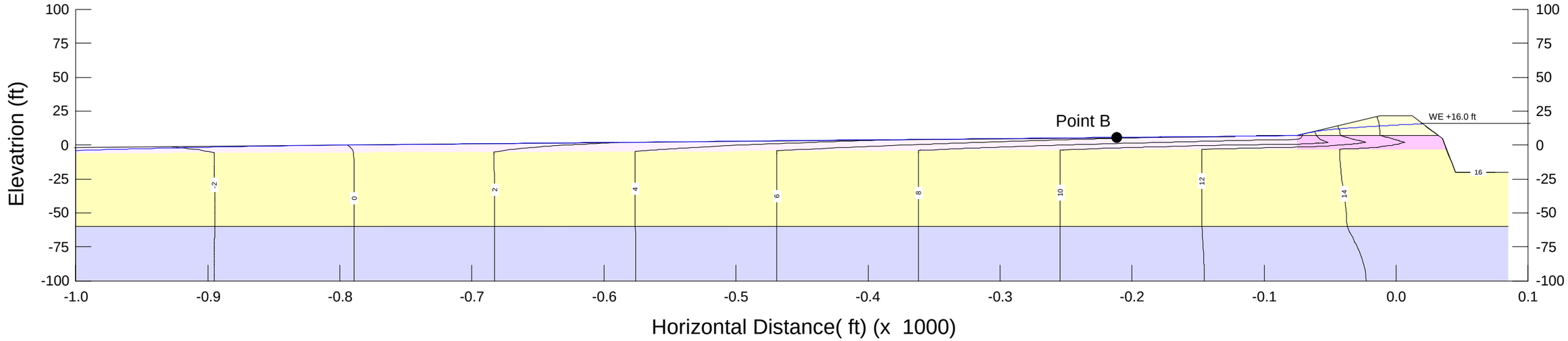
(a) Total head distribution contours



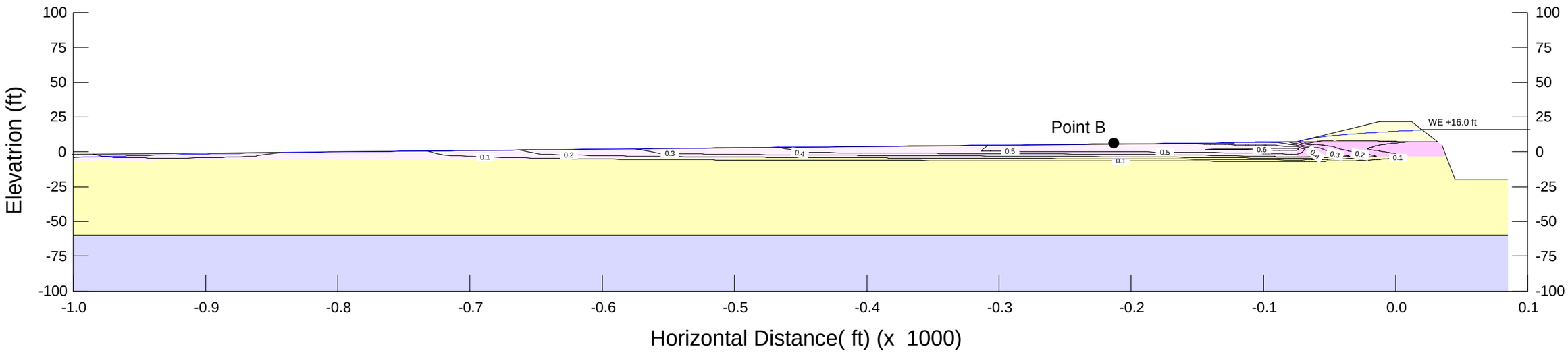
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours for $(k_h/k_v)_{peat}$ = 100 Grand Island Underseepage Problem	Figure 5-19
URS	Project No. 26815621		



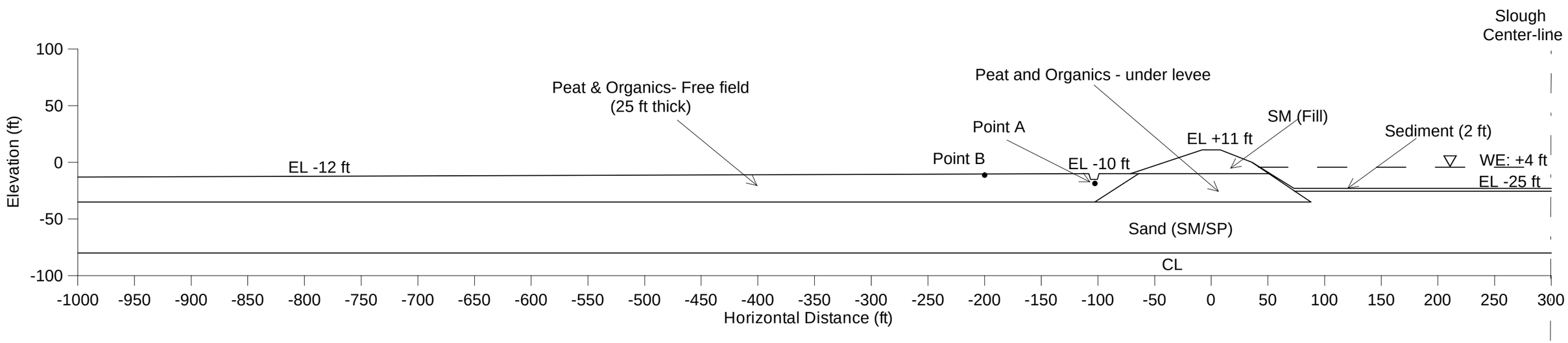
(a) Total head distribution contours



(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

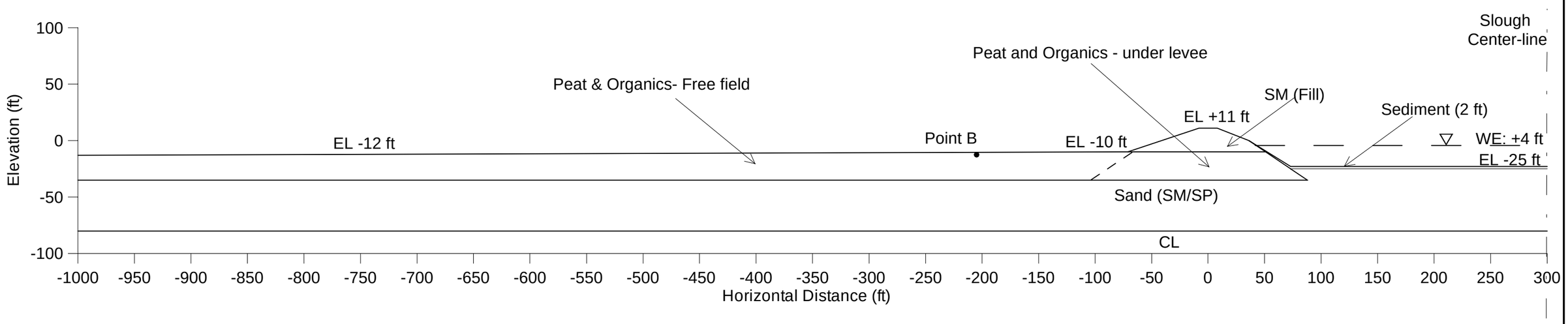
Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours fro $(k_h/k_v)_{peat}$ = 1000 Grand Island Underseepage Problem	Figure 5-20
URS	Project No. 26815621		



Note:
Typical cross section with drainage ditch and slough sediment
Landside slope: 3:1
Waterside slope: 2.5:1 from crest to EL 0 ft, and then 1.5:1
Crest width: 16 ft

All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

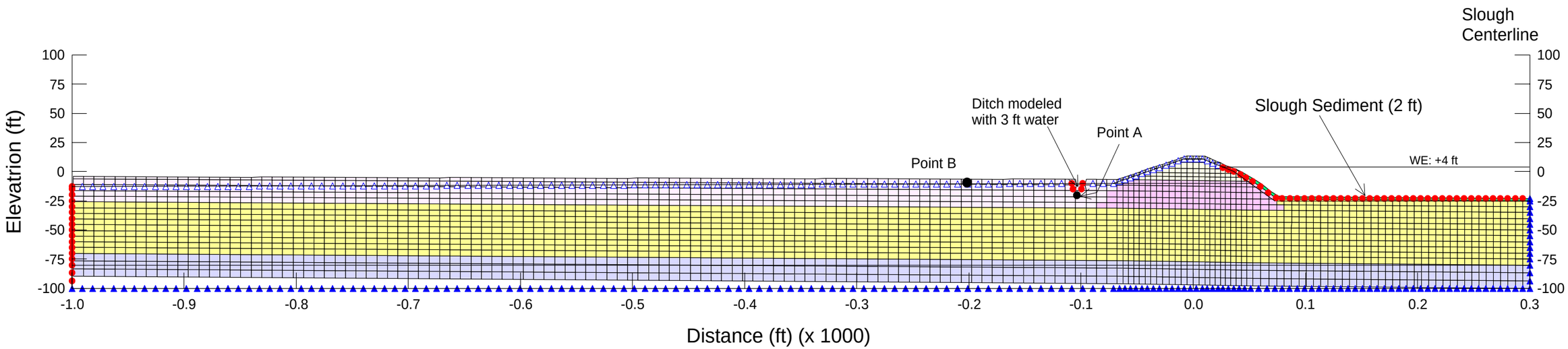
Delta Risk Management Strategy (DRMS) Levee Fragility		Typical Cross Section with Drainage Ditch and 25 ft Peat & Organic Layer	Figure 5-21
URS	Project No. 26815621		



Note:
Model without drainage ditch and with slough sediment
Landside slope: 3:1
Waterside slope: 2.5:1 from crest to EL 0 ft, and then 1.5:1
Crest Width: 16 ft

All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Typical Cross Section without Drainage Ditch and 25 ft Peat & Organic Layer	Figure 5-22
URS	Project No. 26815621		



Legend

Boundary Conditions

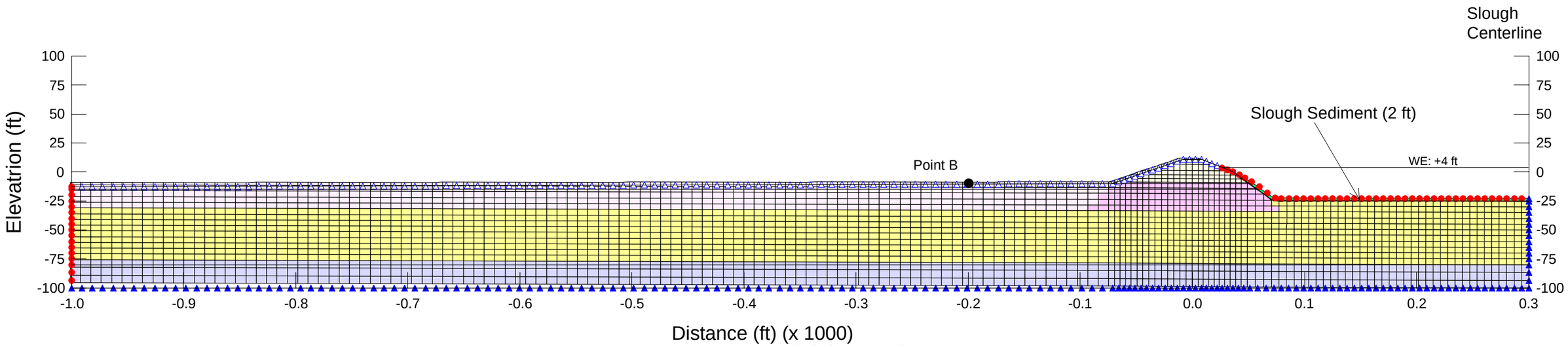
- No flow
- Fixed head
- Review

Material Type

- Sandy Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand (SP/SM)
- Clay
- Slough Sediment

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Mesh & Boundary Conditions Typical Cross Section with Drainage Ditch and 25 ft Peat & Organic Layer	Figure 5-23
URS	Project No. 26815621		



Legend

Boundary Conditions

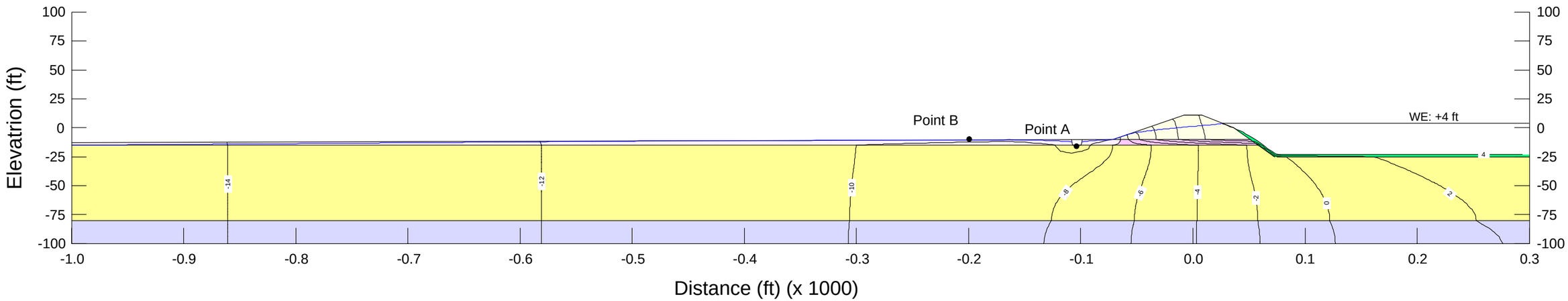
- No flow
- Fixed head
- Review

Material Type

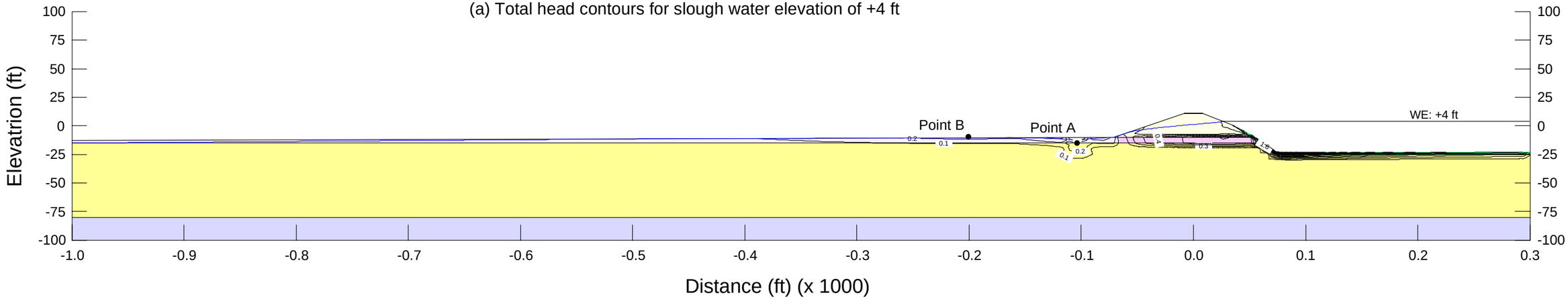
- Sandy Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand (SP/SM)
- Clay
- Slough Sediment

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Mesh & Boundary Conditions Typical Cross Section witout Ditch and 25 ft Peat & Organic Layer	Figure 5-24
URS	Project No. 26815621		



(a) Total head contours for slough water elevation of +4 ft

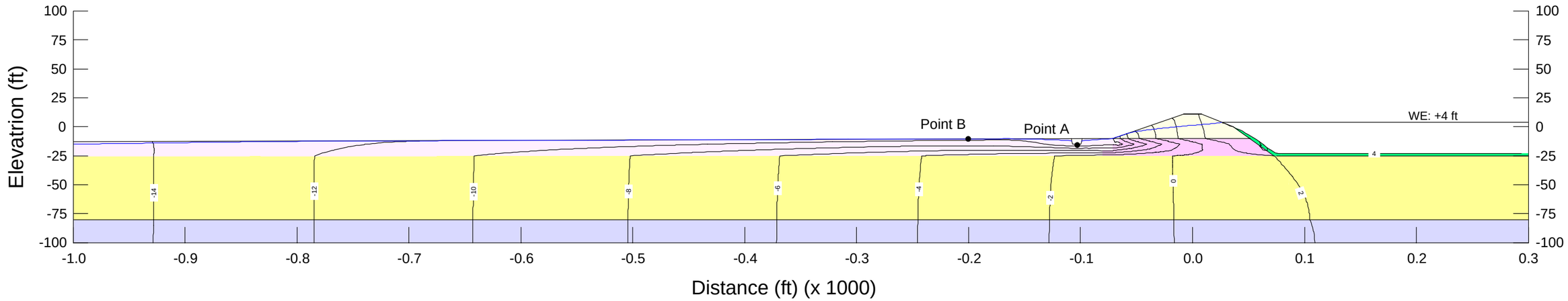


(b) Vertical exit gradient contours for slough water elevation of +4 ft

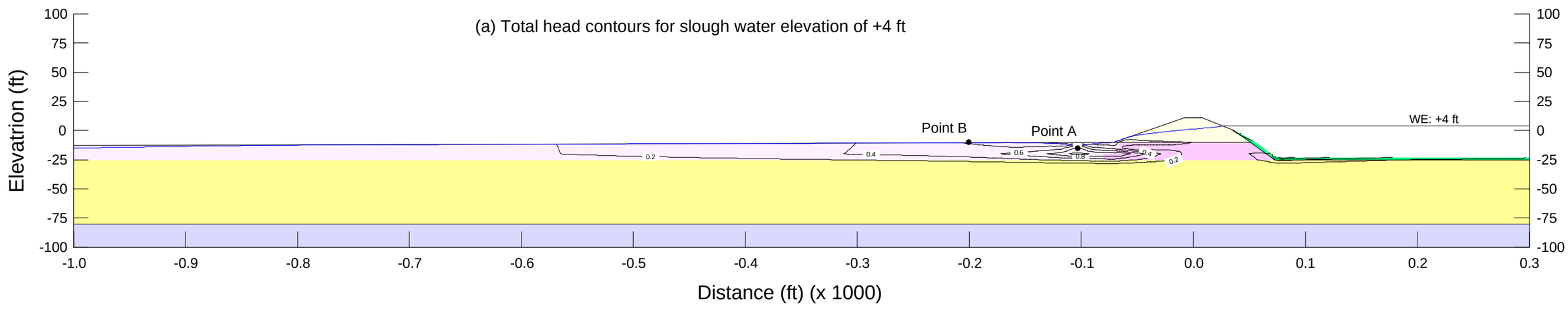
Note:
Analysis CAse:
Mean Permeability values, 5 feet peat/organics,
model with drainage ditch and with slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours Typical Cross Section with Drainage Ditch for 5 ft Peat	Figure 5-25
URS	Project No. 26815621		



(a) Total head contours for slough water elevation of +4 ft

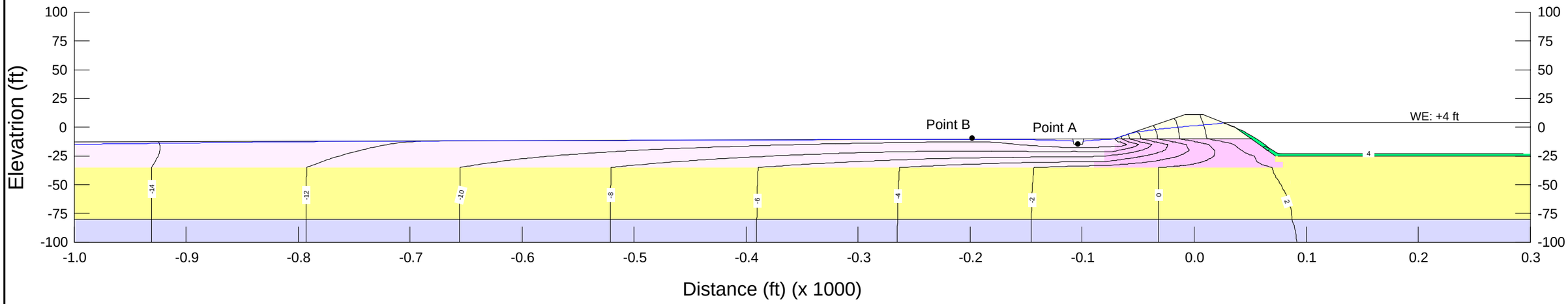


(b) Vertical exit gradient contours for slough water elevation of +4 ft

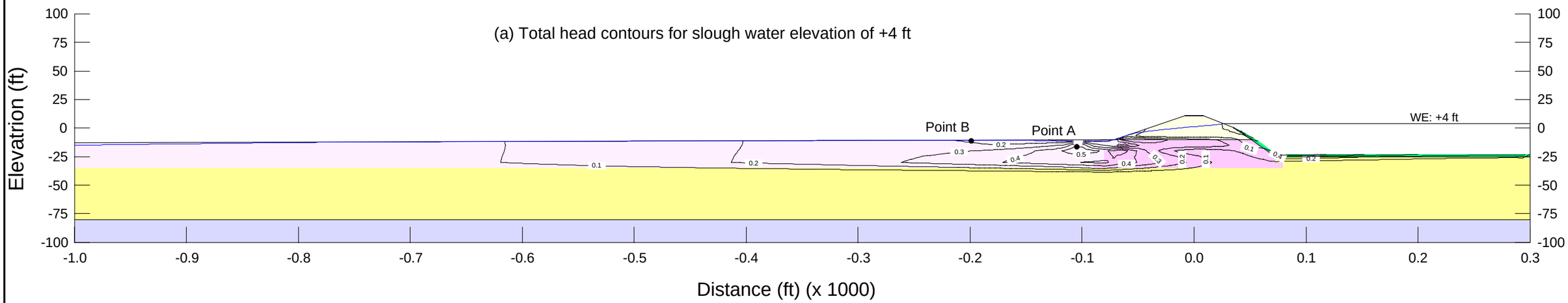
Note:
Analysis CAse:
Mean Permeability values, 15 feet peat/organics,
model with drainage ditch and with slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours Typical Cross Section with Drainage Ditch for 15 ft Peat	Figure 5-26
URS	Project No. 26815621		



(a) Total head contours for slough water elevation of +4 ft

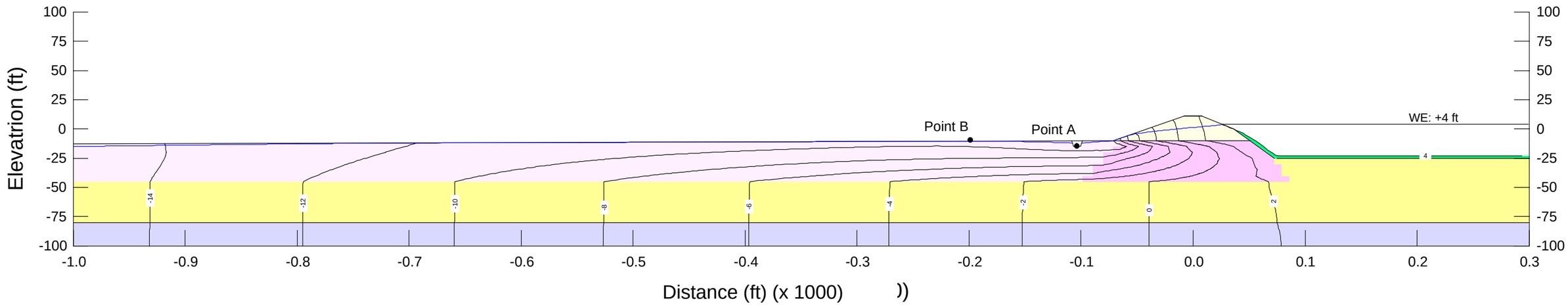


(b) Vertical exit gradient contours for slough water elevation of +4 ft

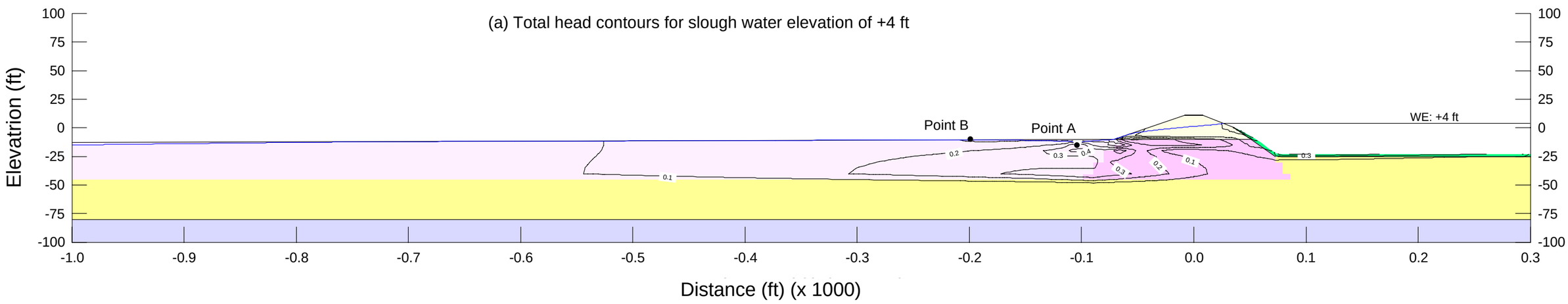
Note:
Analysis CAse:
Mean Permeability values, 25 feet peat/organics,
model with drainage ditch and with slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours Typical Cross Section with Drainage Ditch for 25 ft Peat	Figure 5-27
URS	Project No. 26815621		



(a) Total head contours for slough water elevation of +4 ft

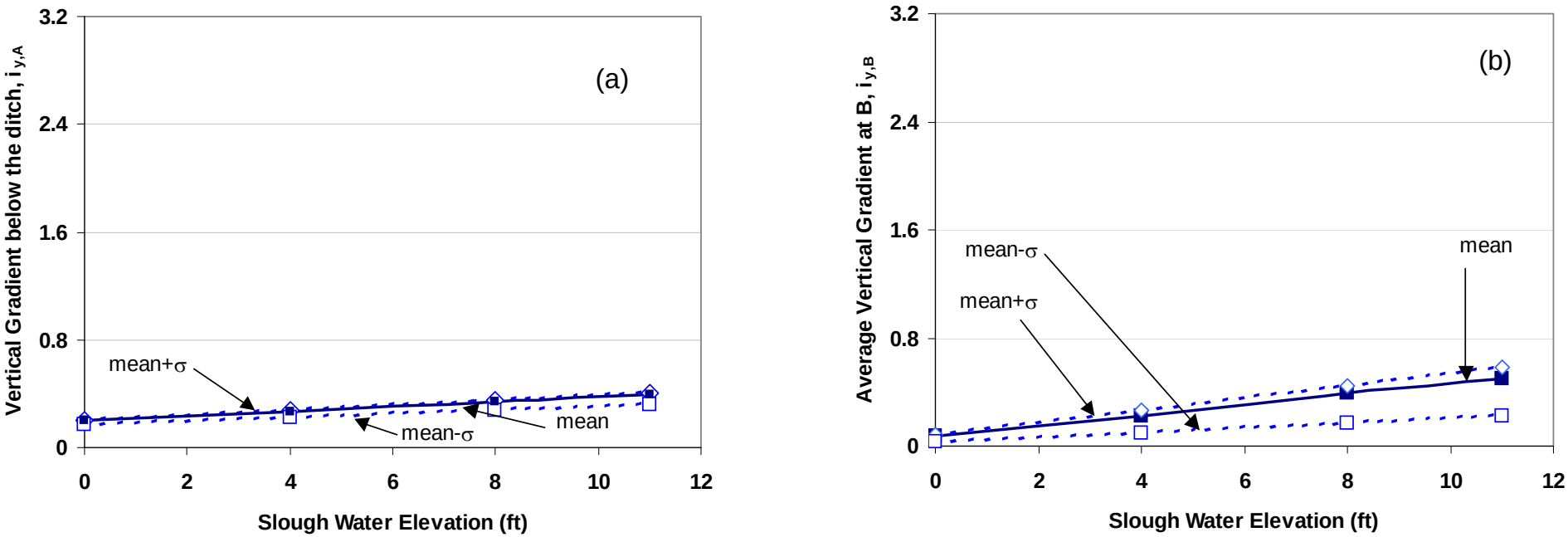


(b) Vertical exit gradient contours for slough water elevation of +4 ft

Note:
Analysis CAse:
Mean Permeability values, 35 feet peat/organics,
model with drainage ditch and with slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

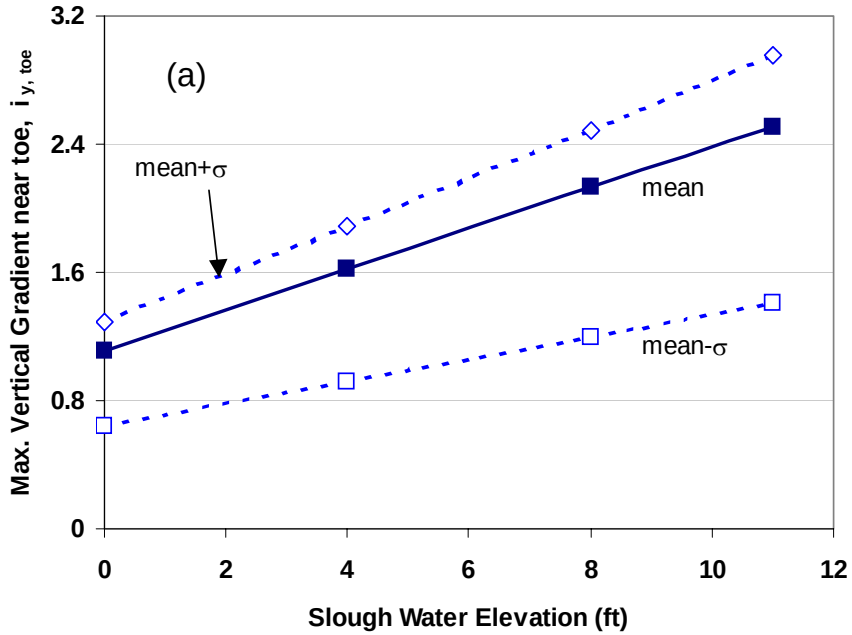
Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours Typical Cross Section with Drainage Ditch for 35 ft Peat	Figure 5-28
URS	Project No. 26815621		

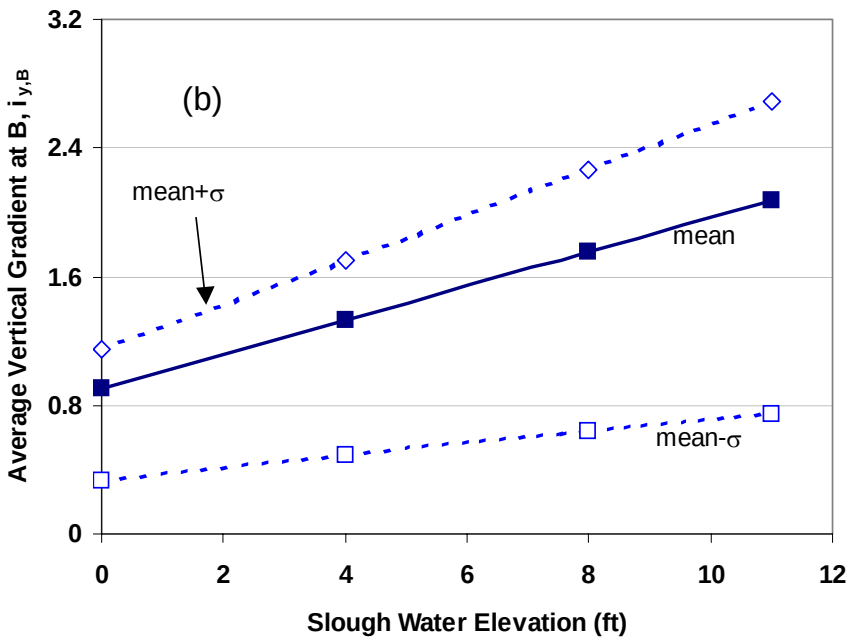


Note:
Analysis model: Typical cross section for Delta, 5 ft peat & organic layer, model with drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 5 ft Peat/Organics - Typical Cross Section with Ditch	Figure 5-29
URS	Project No. 26815621		

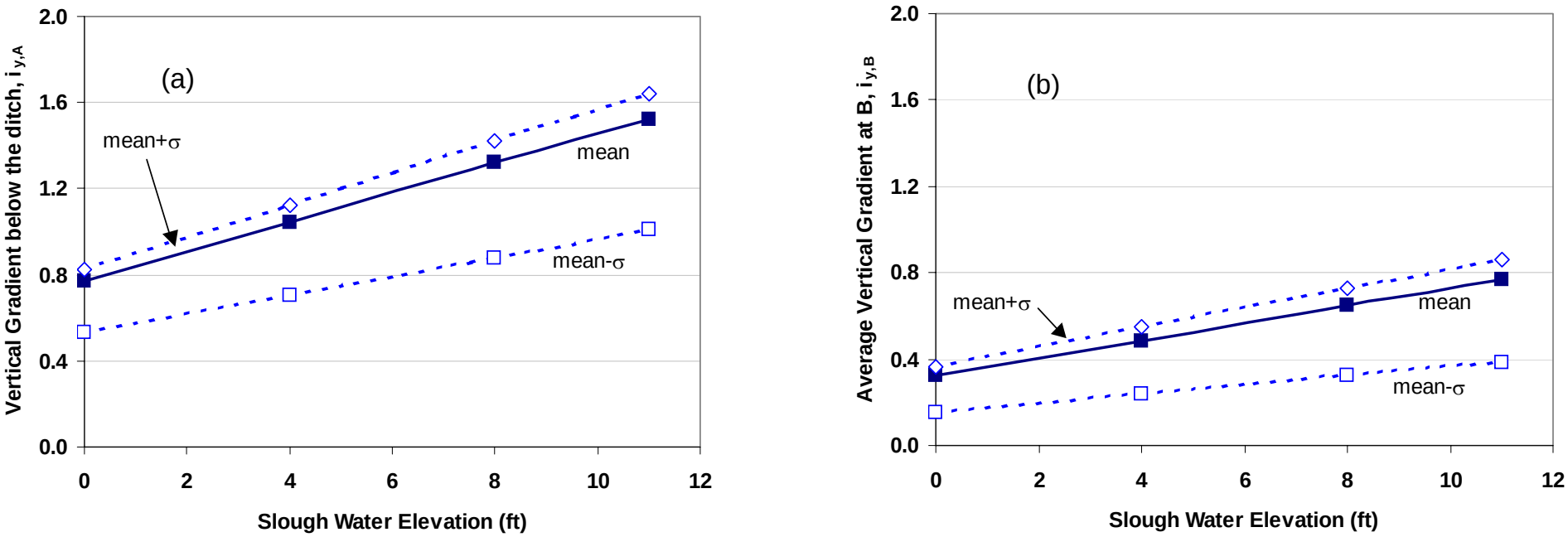




Note:
Analysis model: Typical cross section for Delta, 5 ft peat & organic layer, model without drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

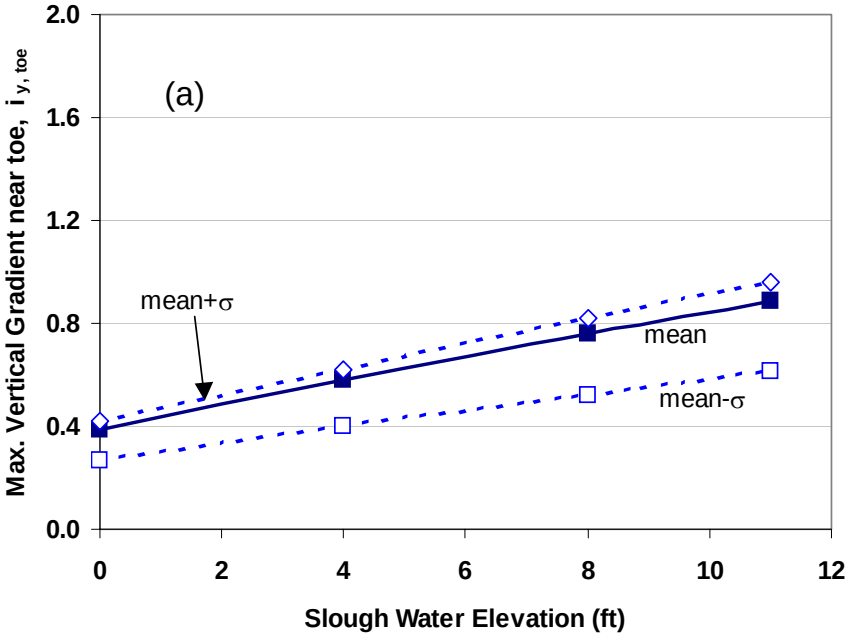
Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 5 ft Peat/Organics - Typical Cross Section without Ditch	Figure 5-30
URS	Project No. 26815621		

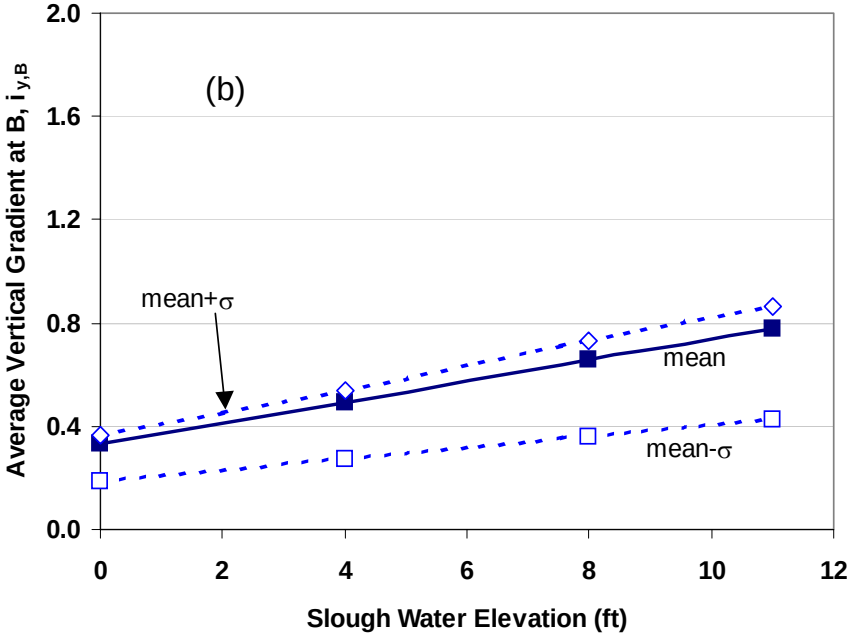


Note:
Analysis model: Typical cross section for Delta, 15 ft peat & organic layer, model with drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 15 ft Peat/Organics - Typical Cross Section with Ditch	Figure 5-31
URS	Project No. 26815621		

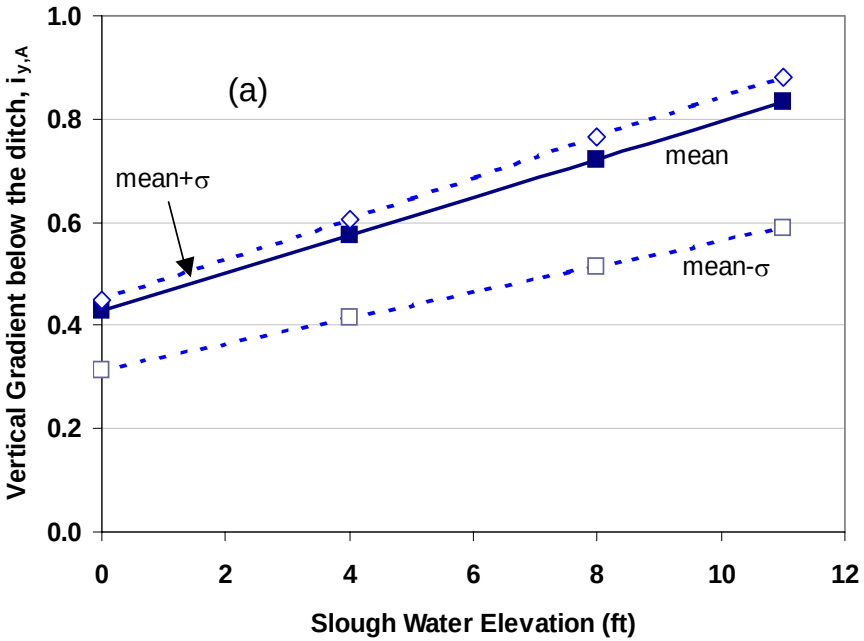


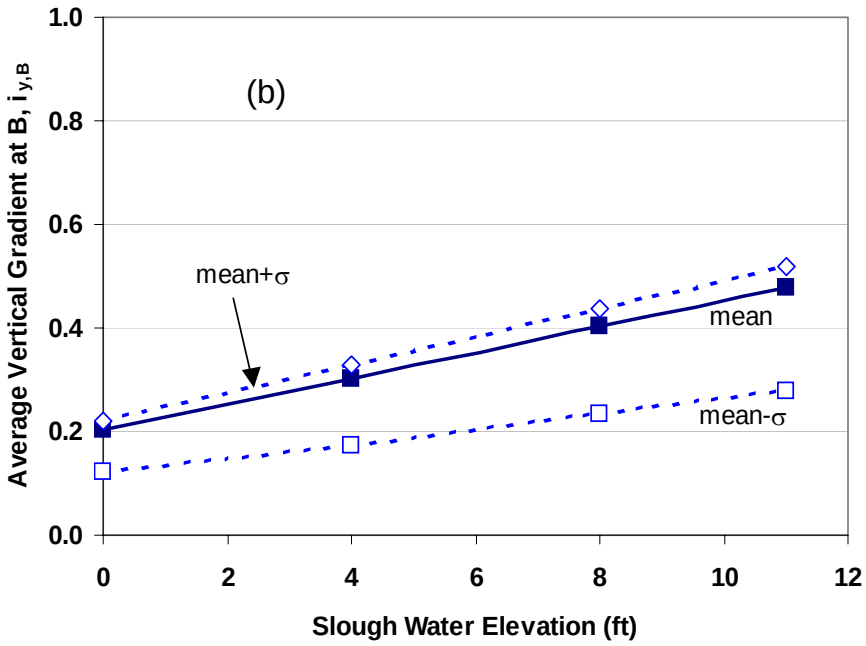


Note:
Analysis model: Typical cross section for Delta, 15 ft peat & organic layer, model without drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 15 ft Peat/Organics - Typical Cross Section without Ditch	Figure 5-32
URS	Project No. 26815621		

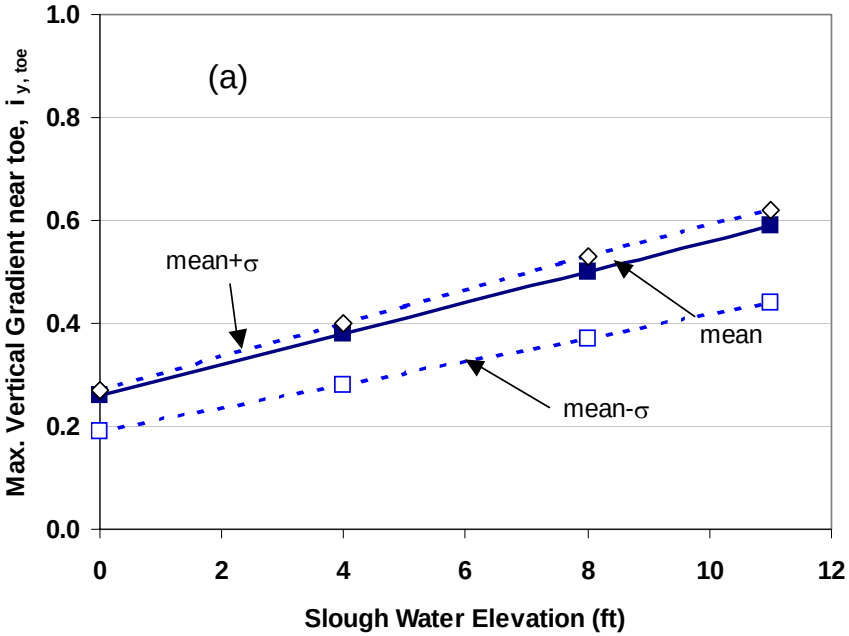


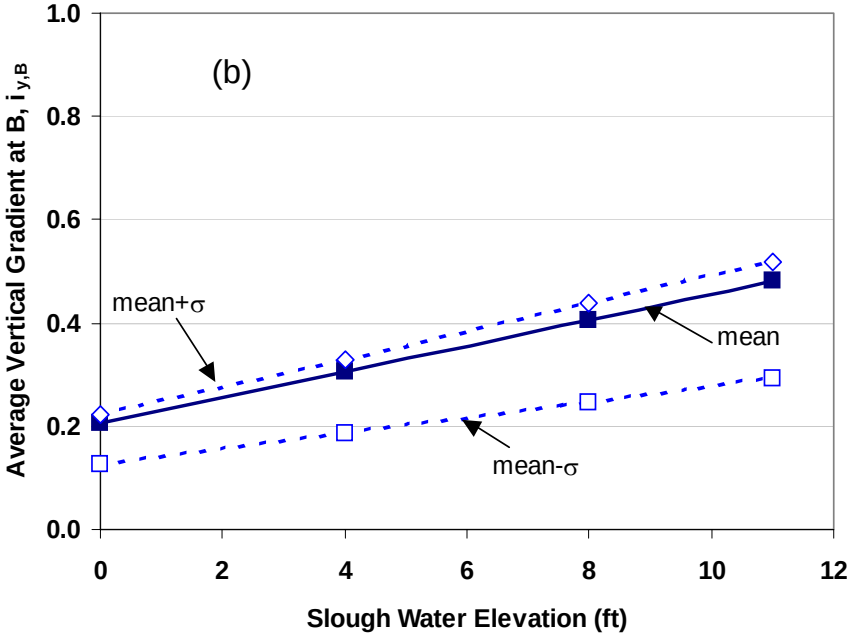


Note:
Analysis model: Typical cross section for Delta, 25 ft peat & organic layer, model with drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 25 ft Peat/Organics - Typical Cross Section with Ditch	Figure 5-33
URS	Project No. 26815621		

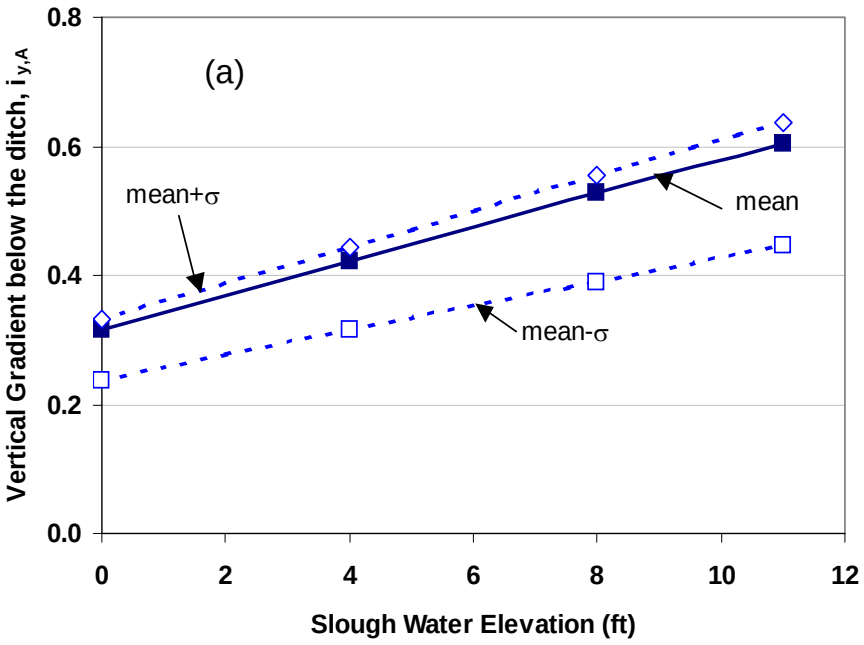


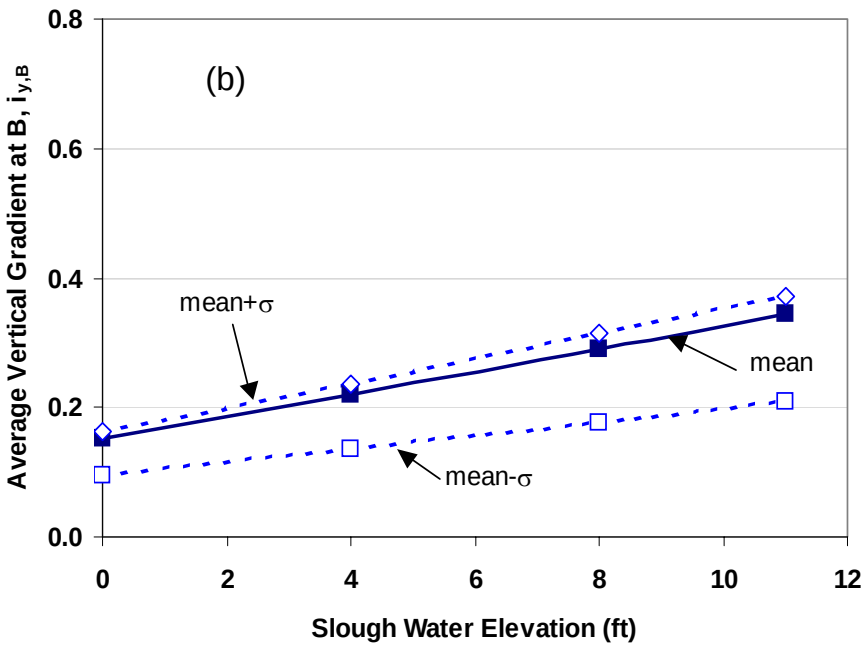


Note:
Analysis model: Typical cross section for Delta, 25 ft peat & organic layer, model without drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 25 ft Peat/Organics - Typical Cross Section without Ditch	Figure 5-34
URS	Project No. 26815621		

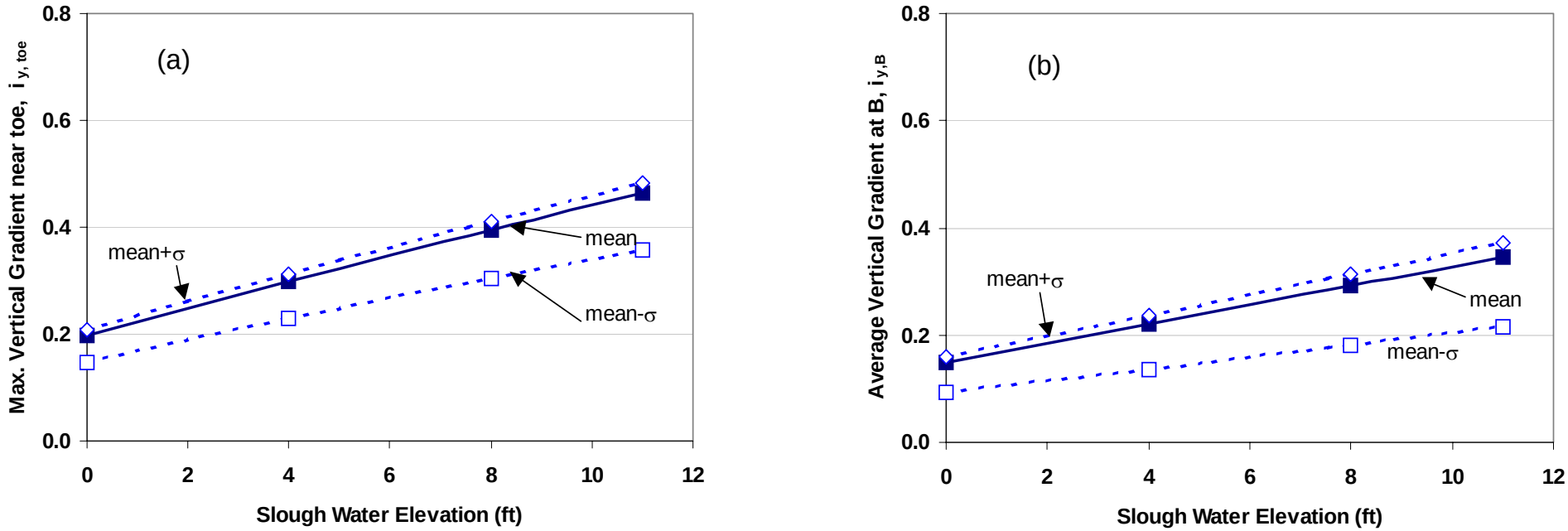




Note:
Analysis model: Typical cross section for Delta, 35 ft peat & organic layer, model with drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

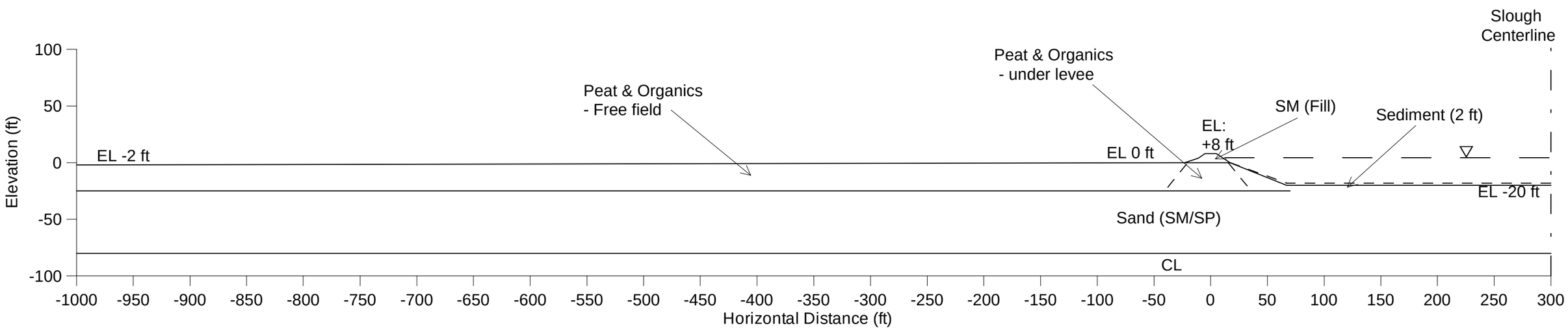
Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 35 ft Peat/Organics - Typical Cross Section with Ditch	Figure 5-35
URS	Project No. 26815621		



Note:
Analysis model: Typical cross section for Delta, 35 ft peat & organic layer, model without drainage ditch and slough sediment

All elevations are referenced to NAVD88
(NAVD88 = NGVD29+2.5 ft)

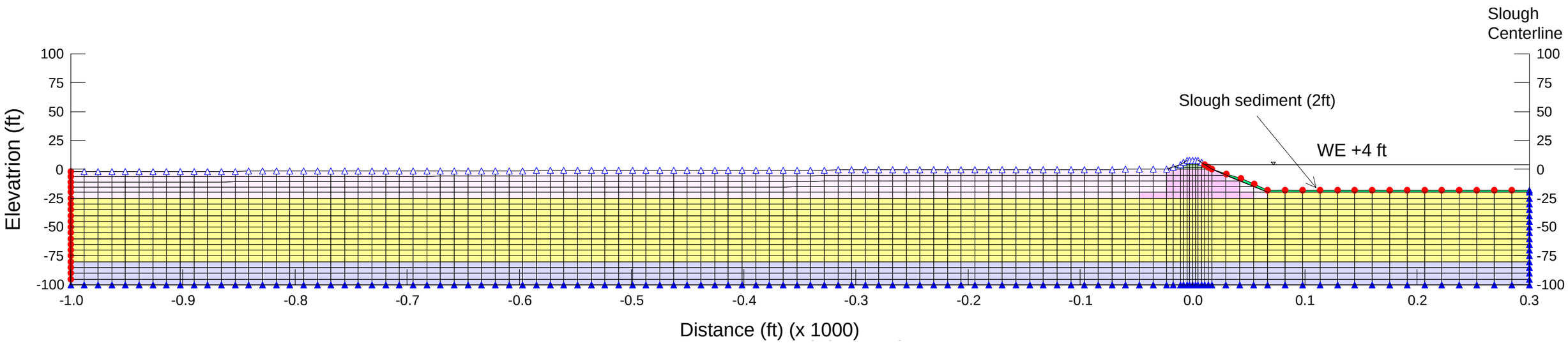
Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 35 ft Peat/Organics - Typical Cross Section without Ditch	Figure 5-36
URS	Project No. 26815621		



Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Levee Geometry
Crest elevation +8 ft
Landside slope - From levee crest to EL+4 ft:1.5H:1V, followed by 3H:1V
Waterside slope - From levee crest to EL0 ft:1.5H:1V, followed by 2.5H:1V

Delta Risk Management Strategy (DRMS) Levee Fragility		Typical Cross Section for Suisun Marsh Levees	Figure 5-37
URS	Project No. 26815621		



Legend

Boundary Conditions

- No flow
- Fixed head
- Review

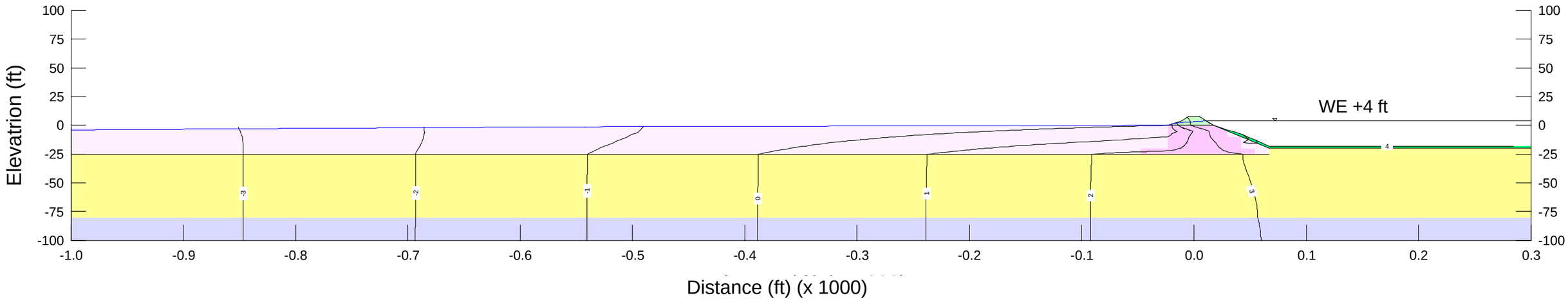
Material Type

- Sandy Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand (SP/SM)
- Clay
- Slough Sediment

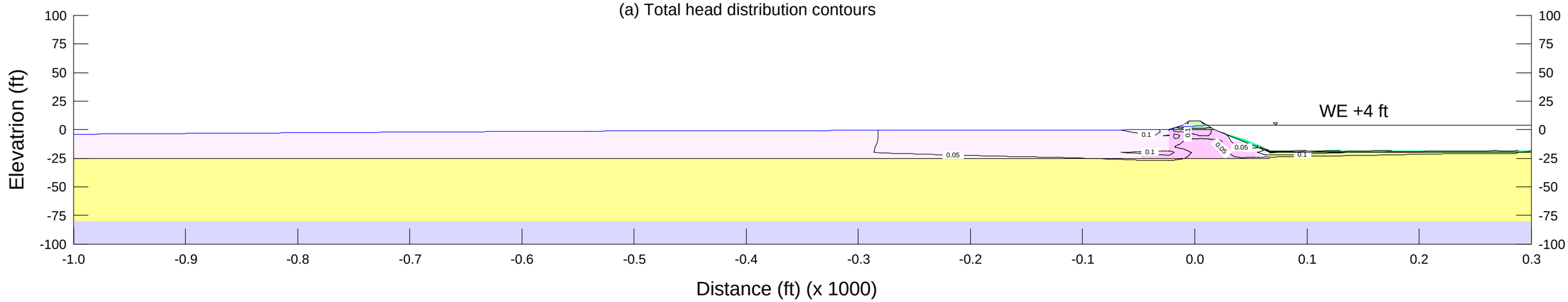
Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Model: Typical cross section for Suisun Marsh
with 25 ft peat & organics
(Case- with slough sediment and without ditch)

Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Mesh & Boundary Conditions Typical Cross Section for Suisun Marsh	Figure 5-38
URS	Project No. 26815621		



(a) Total head distribution contours



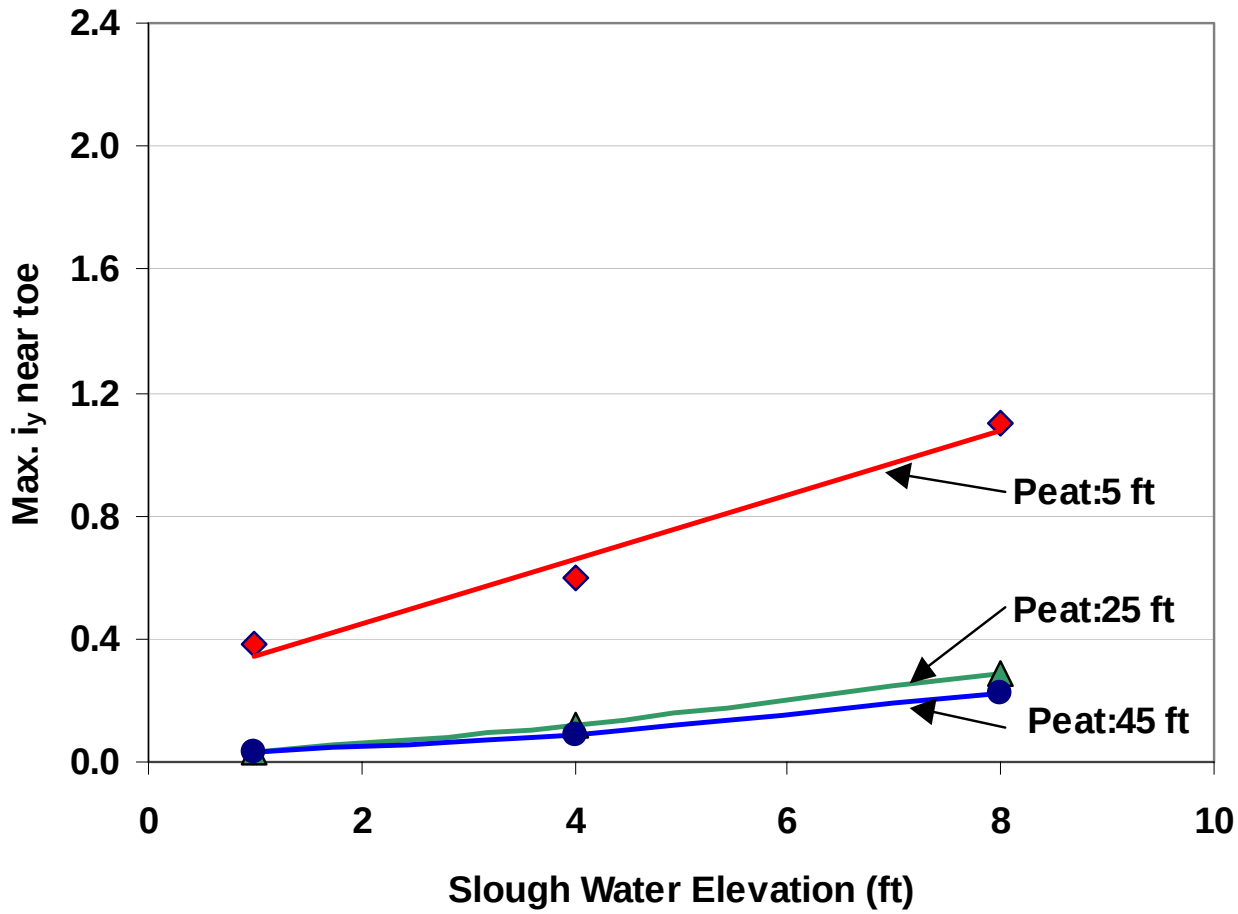
(b) Vertical gradient contours

Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Analysis Case: Mean permeability veaues, Slough Water Elevation +4 ft,
Peat and Organic Thickness 25 ft, Model without Ditch , and
2 ft silt sediment presents at slough bottom

For Suisun Marsh,
Mean High Tide ~ +5.5 ft
Mean Low Tide ~ +0.3 ft

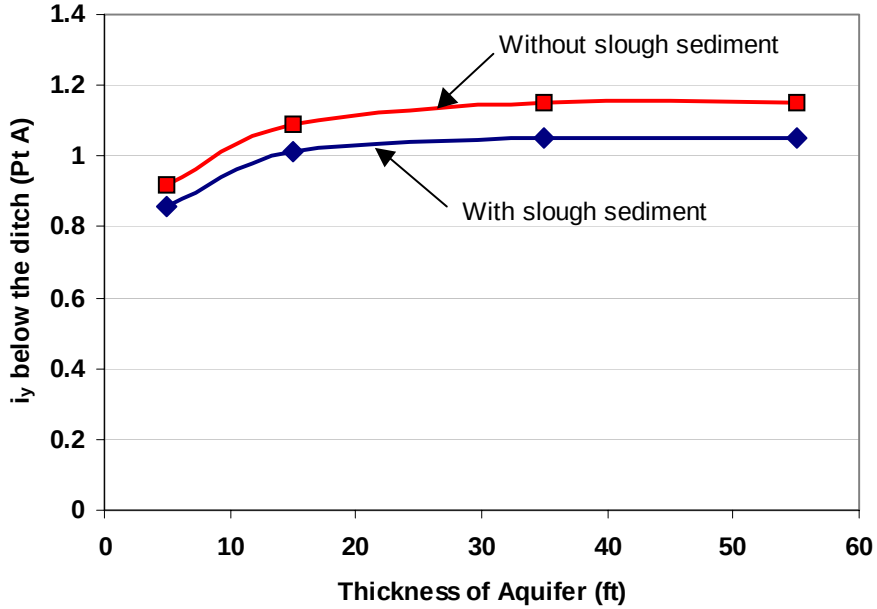
Delta Risk Management Strategy (DRMS) Levee Fragility		Total Head & Vertical Gradient Contours for 25 ft Peat & Organics Typical Cross Section for Suisun Marsh	Figure 5-39
URS	Project No. 26815621		



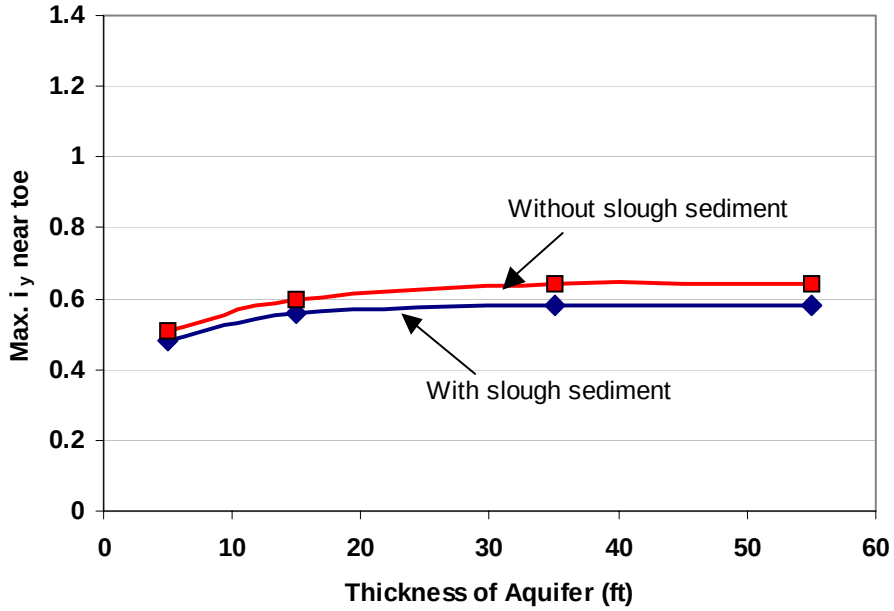
Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Analisis Case: Model without ditch and with slough sediment

Delta Risk Management Strategy (DRMS) Levee Fragility		Vertical Gradients for 5, 25, and 45 ft Peat/Organics Typical Cross section for Suisun Marsh	Figure 5-40
URS	Project No. 26815621		

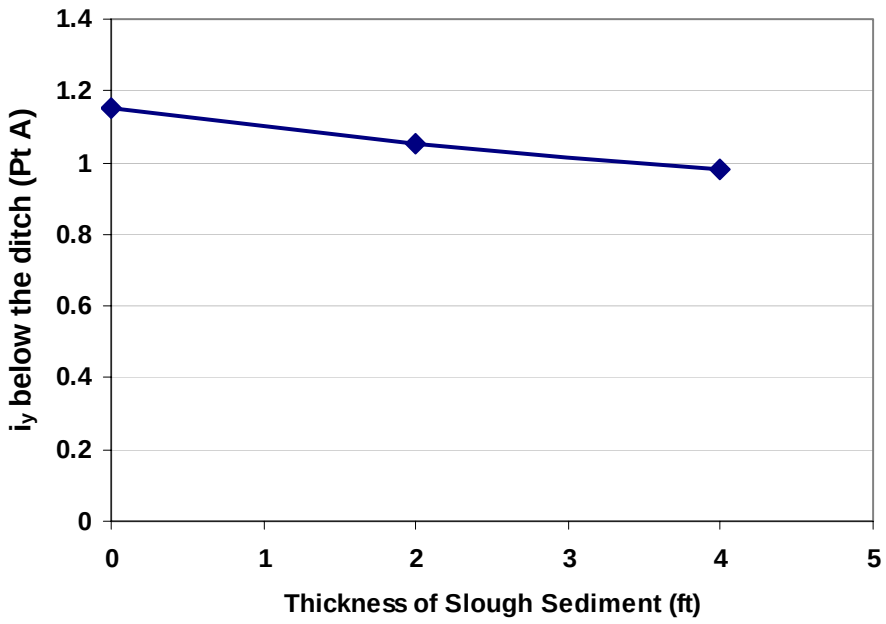


(a) Model with Ditch

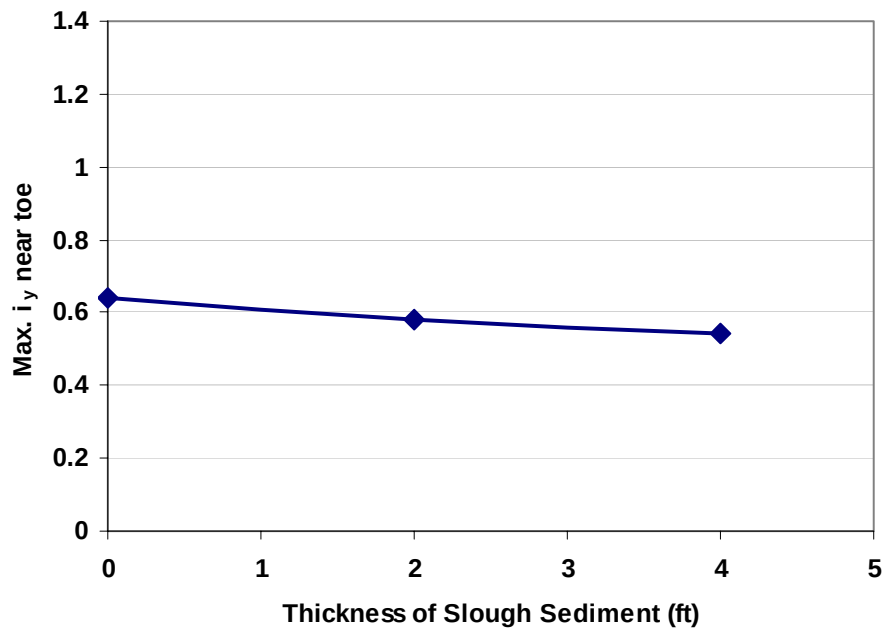


(b) Model without Ditch

Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Aquifer Thickness on Vertical Gradient	Figure 5-41
URS	Project No. 26815621		

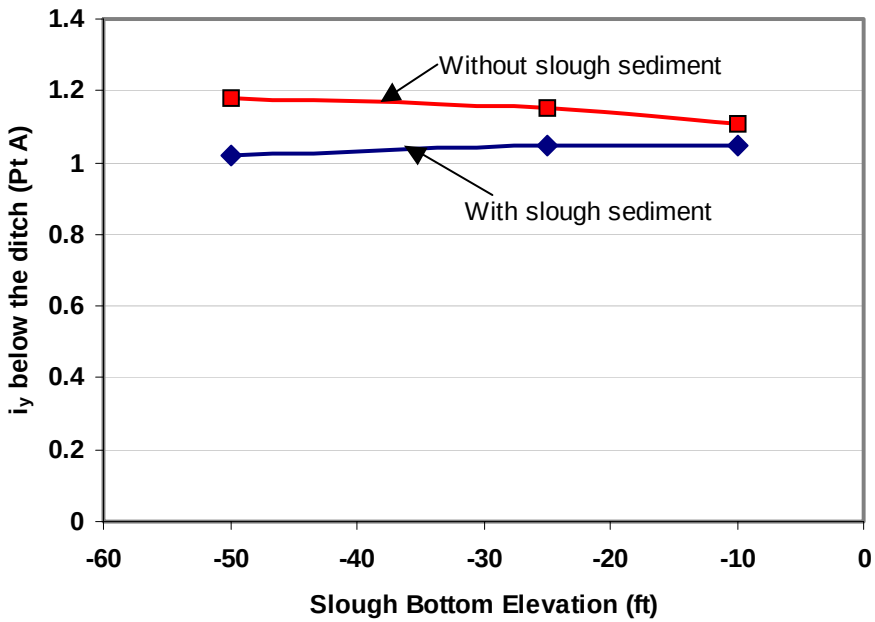


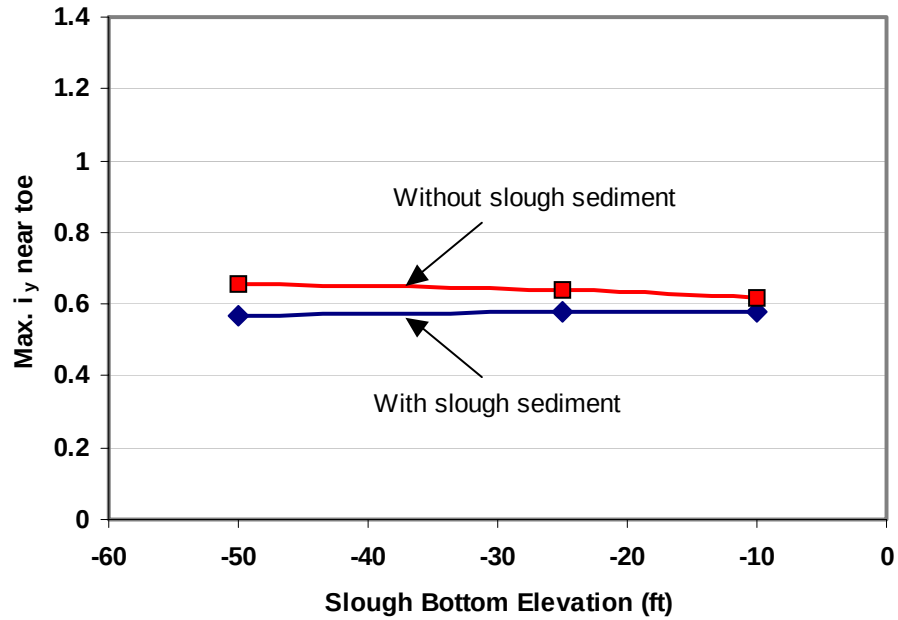
(a) Model with Ditch



(b) Model without Ditch

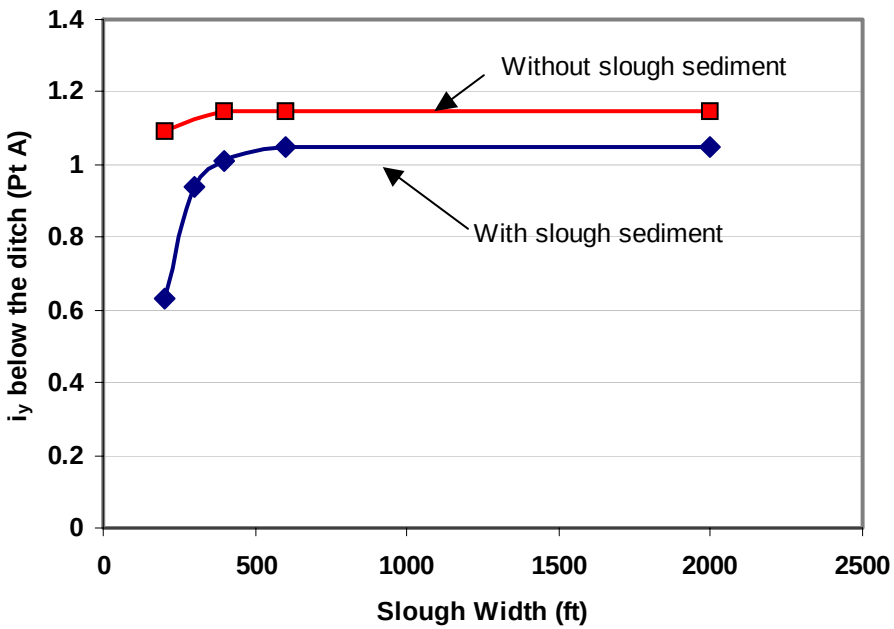
Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Slough Sediment Thickness on Vertical Gradient	Figure 5-42
URS	Project No. 26815621		



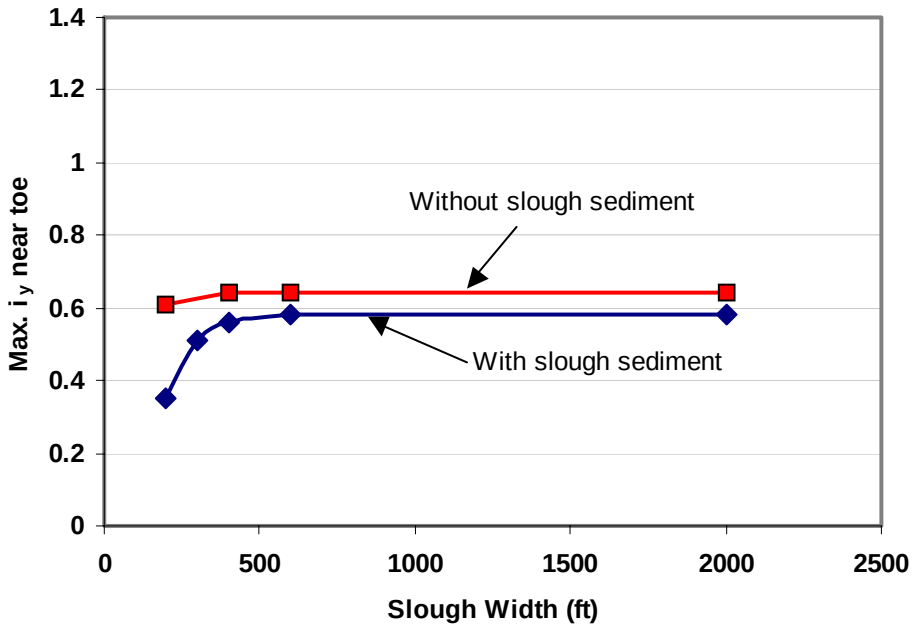


Note:
All elevations are referenced to NAVD88
(NAVD88 = NGVD29 + 2.5 ft)

Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Slough Bottom Elevation on Vertical Gradient	Figure 5-43
URS	Project No. 26815621		

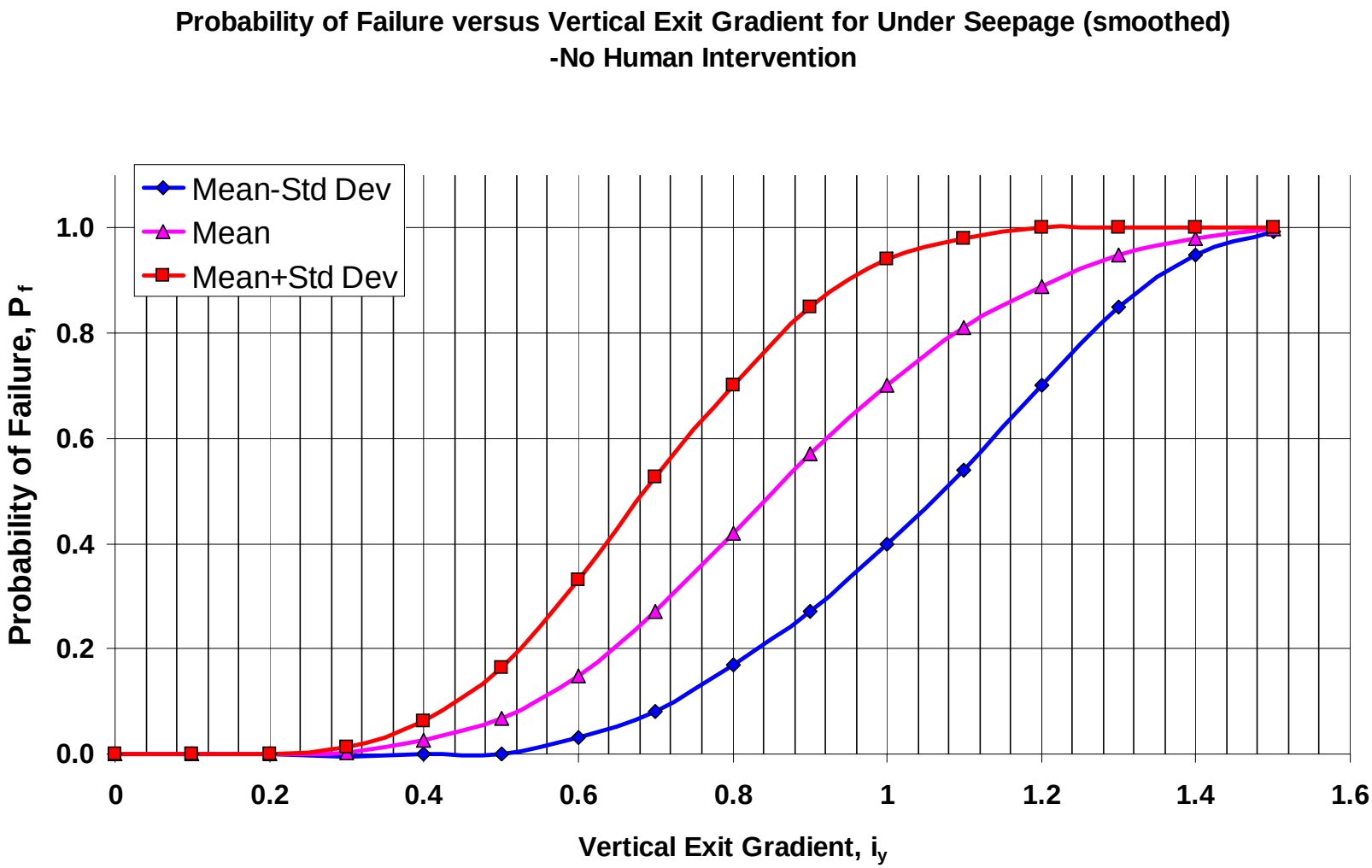


(a) Model with Ditch



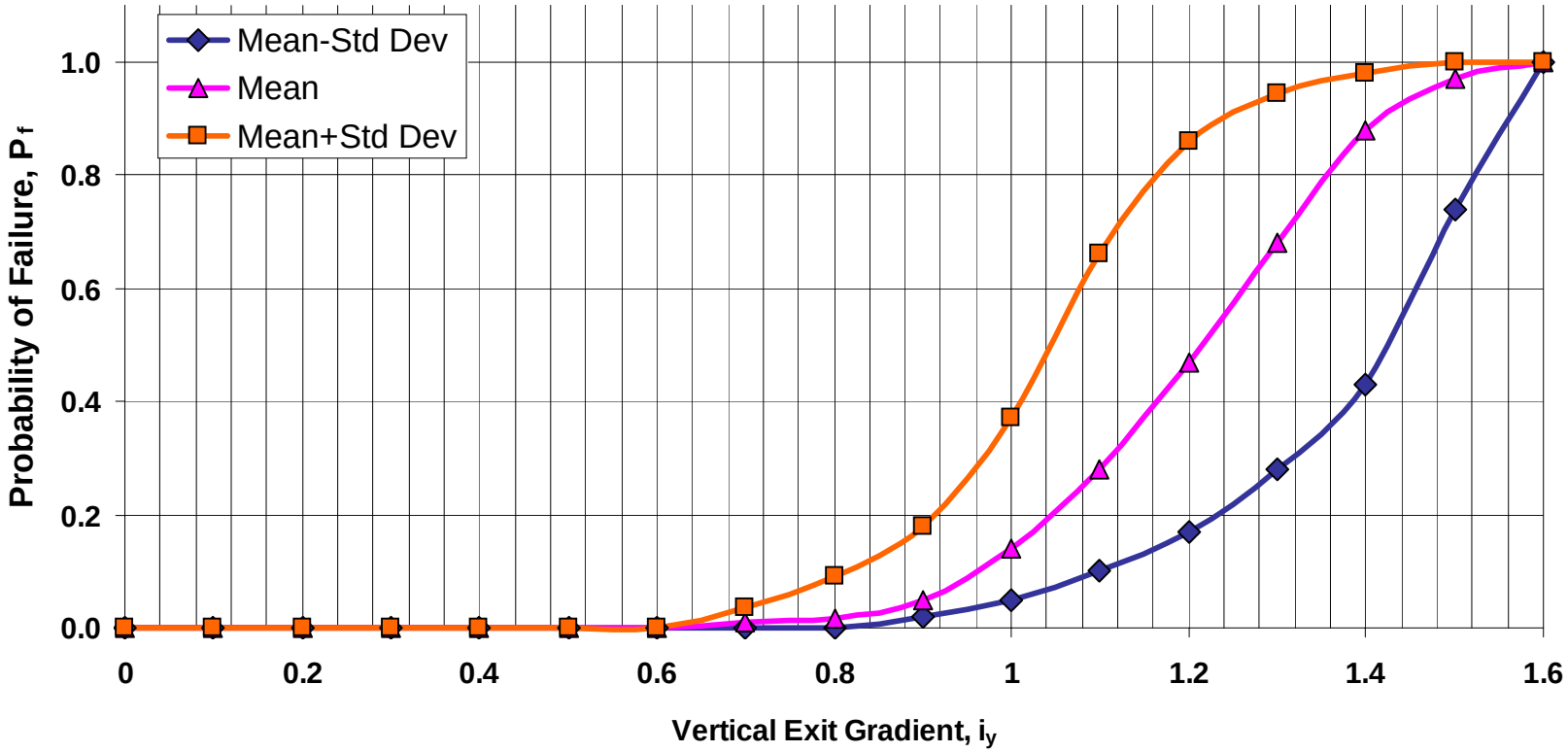
(b) Model without Ditch

Delta Risk Management Strategy (DRMS) Levee Fragility		Effect of Slough Width on Vertical Gradient	Figure 5-44
URS	Project No. 26815621		



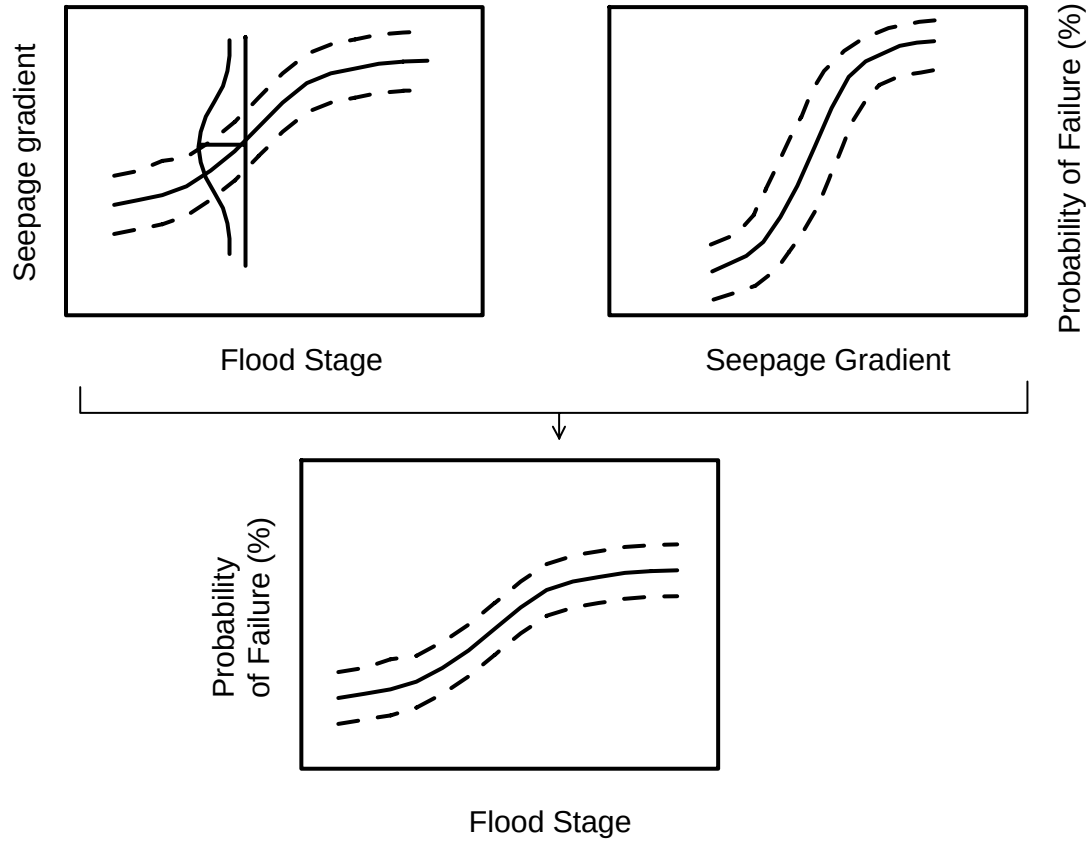
Delta Risk Management Strategy (DRMS) Levee Fragility		Probability of Failure versus Exit Gradient -No Human Intervention	Figure 5-45
URS	Project No. 26815621		

Probability of Failure versus Vertical Exit Gradient for Under-seepage (Smoothed) - With Human Intervention

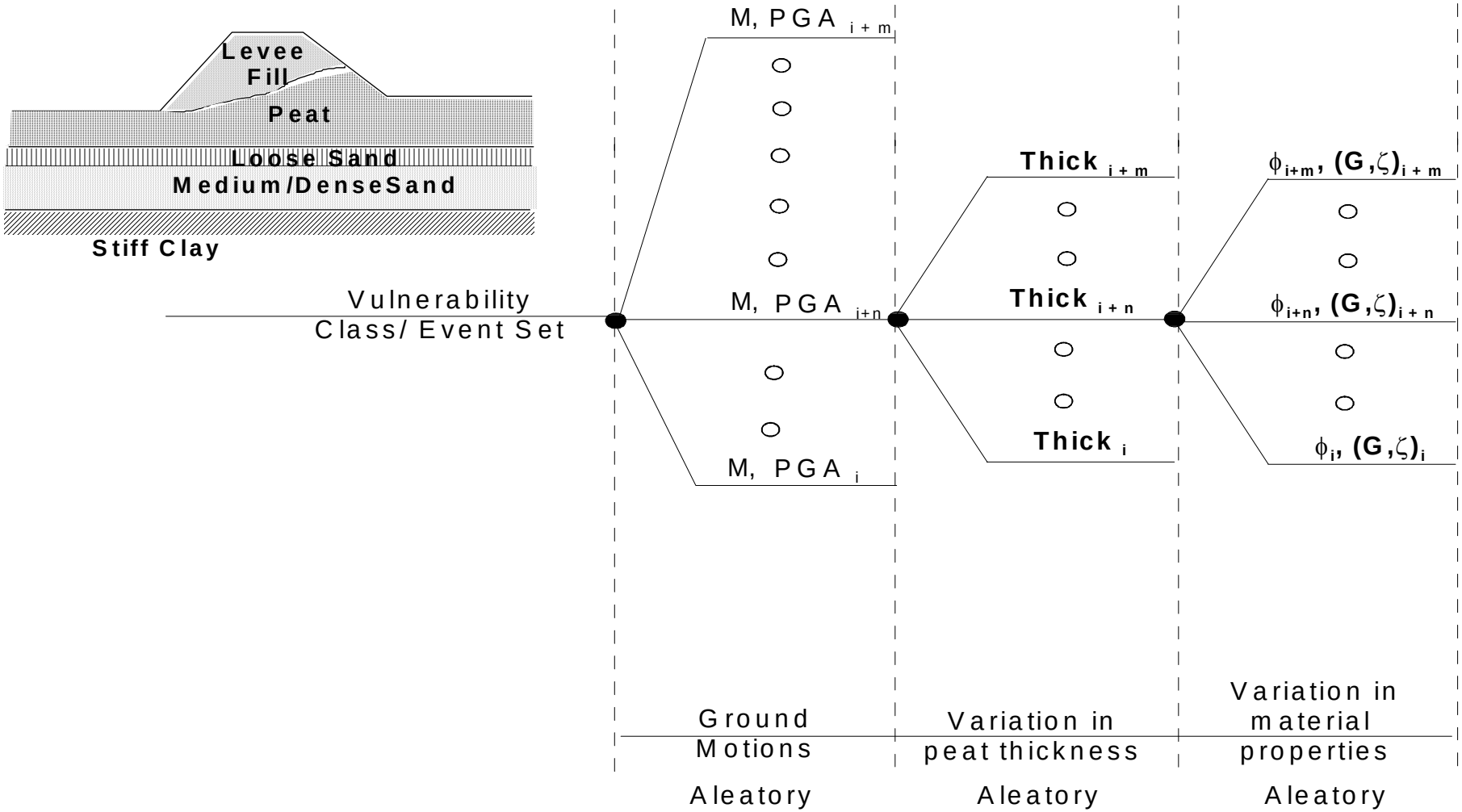


Delta Risk Management Strategy (DRMS) Levee Fragility		Probability of Failure versus Exit Gradient - With Human Intervention	Figure 5-46
URS	Project No. 26815621		

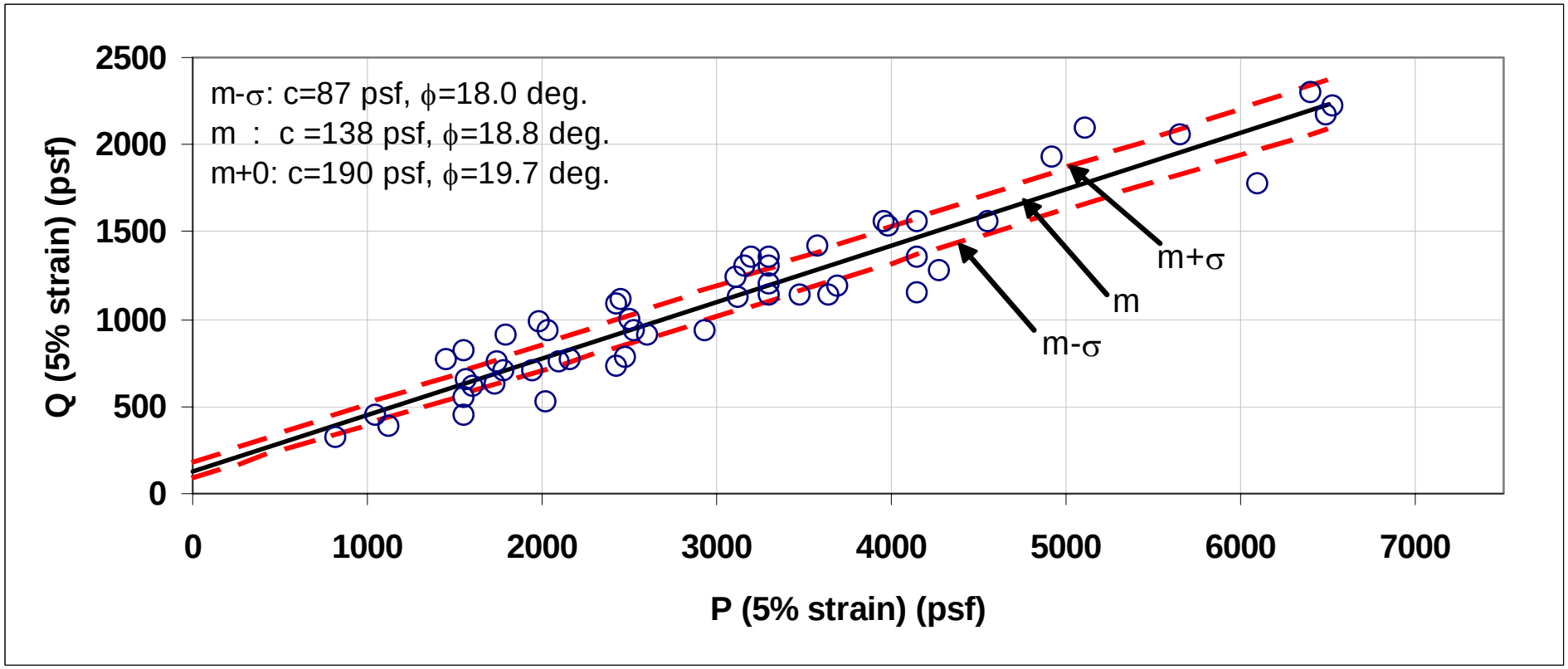
For Vulnerability Class i,



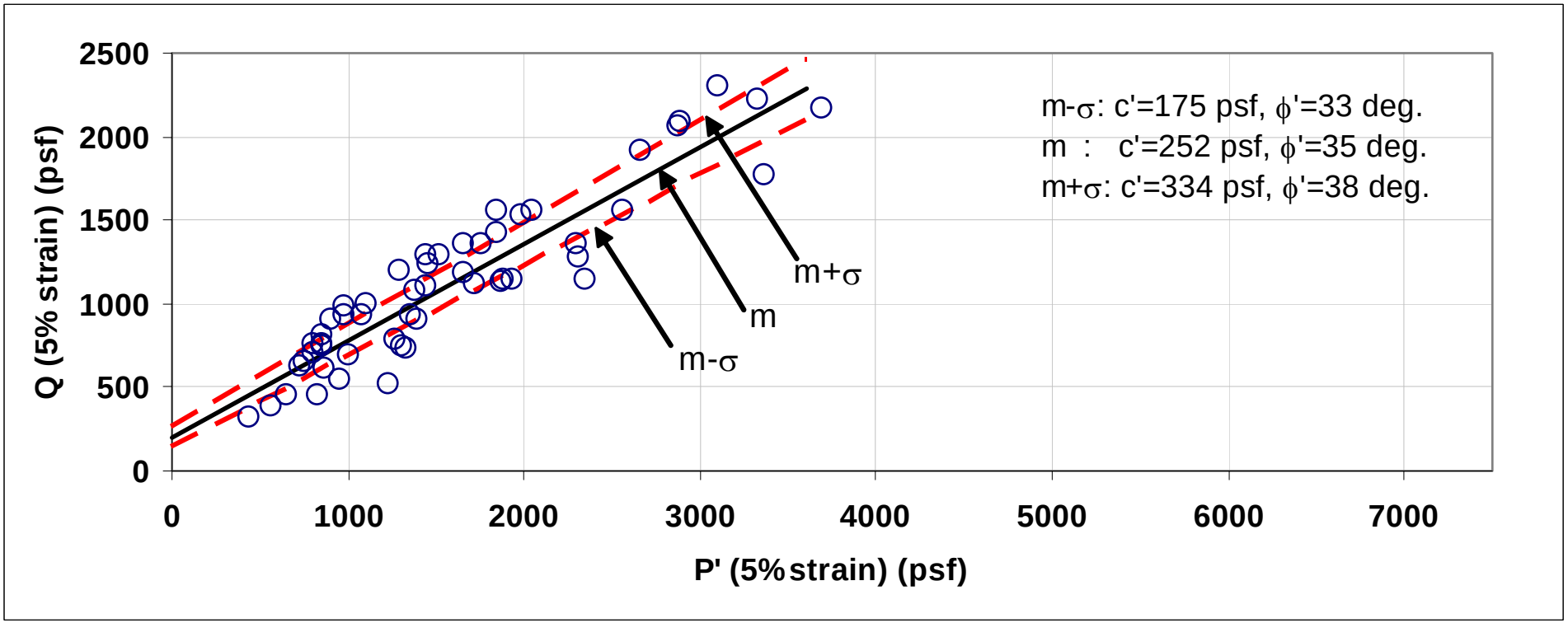
Delta Risk Management Strategy (DRMS) Levee Fragility		Probability of Failure versus. Flood Stage	Figure 5-47
URS	Project No. 26815621		



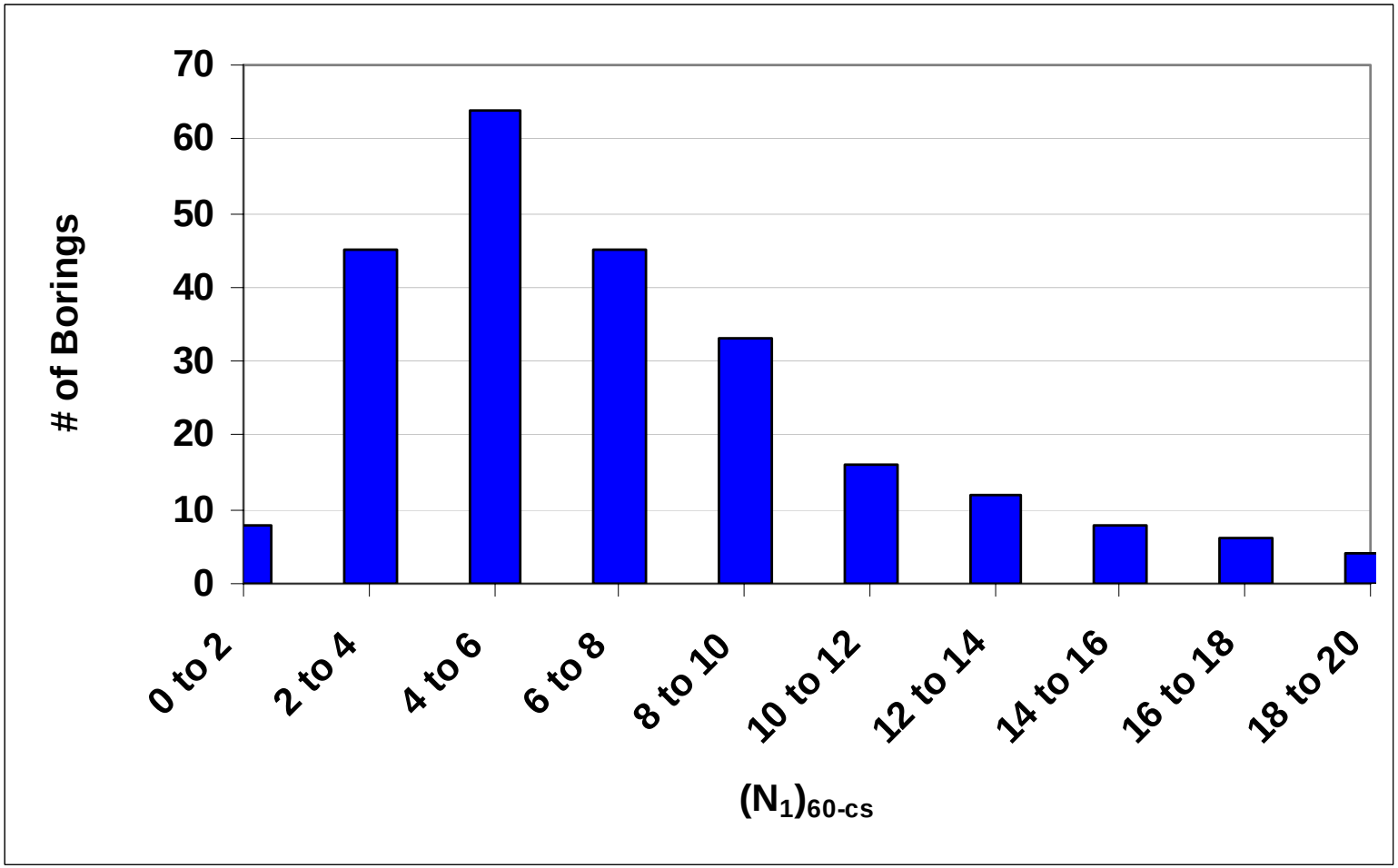
Delta Risk Management Strategy (DRMS) Levee Fragility		LogicTree Approach to Estimate Deformation under Seismic Loading	Figure 6-1
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		P-Q Plot at 5% Shear Strain for Peat Total Stress	Figure 6-2
URS	Project No. 26815621		

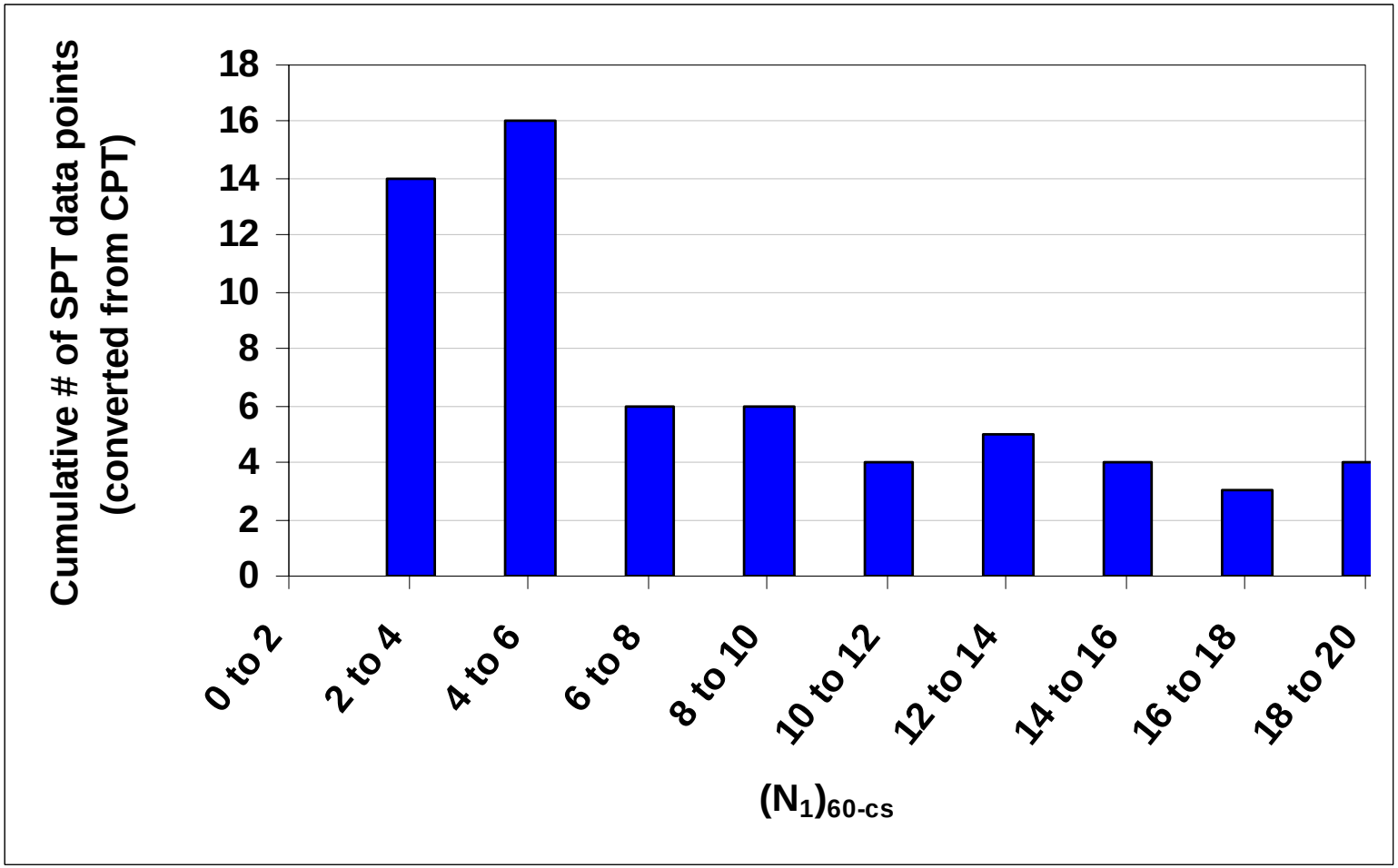


Delta Risk Management Strategy (DRMS) Levee Fragility		P'-Q Plot at 5% Shear Strain for Peat Effective Stress	Figure 6-3
URS	Project No. 26815621		



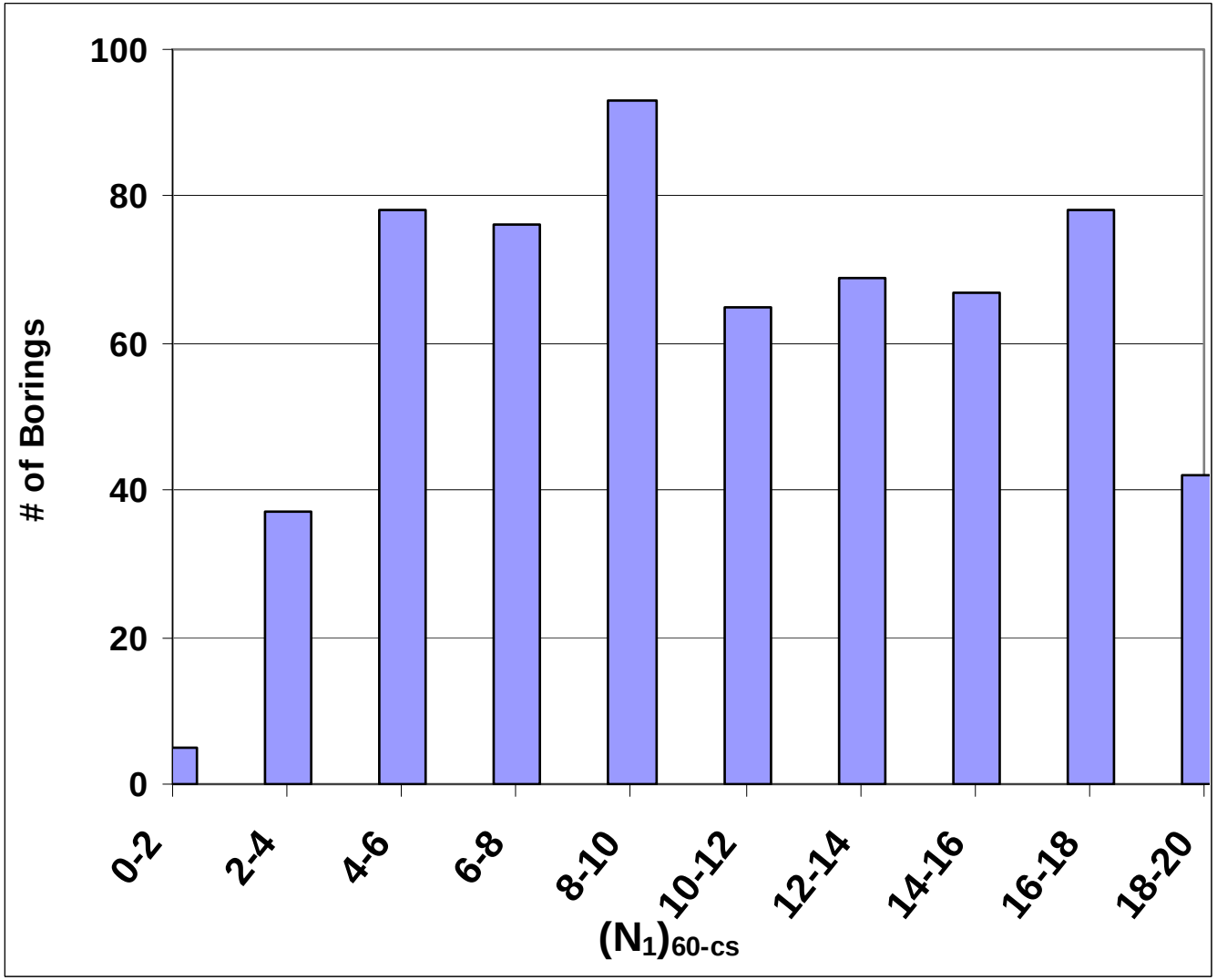
Mean = 8
Mean + σ = 12
Mean - σ = 4

Delta Risk Management Strategy (DRMS) Levee Fragility		$(N1)_{60\text{-}CS}$ Distribution for Levee Sand with $(N1)_{60\text{-}CS} < 20$ (using SPT data)	Figure 6-4a
URS	Project No. 26815621		



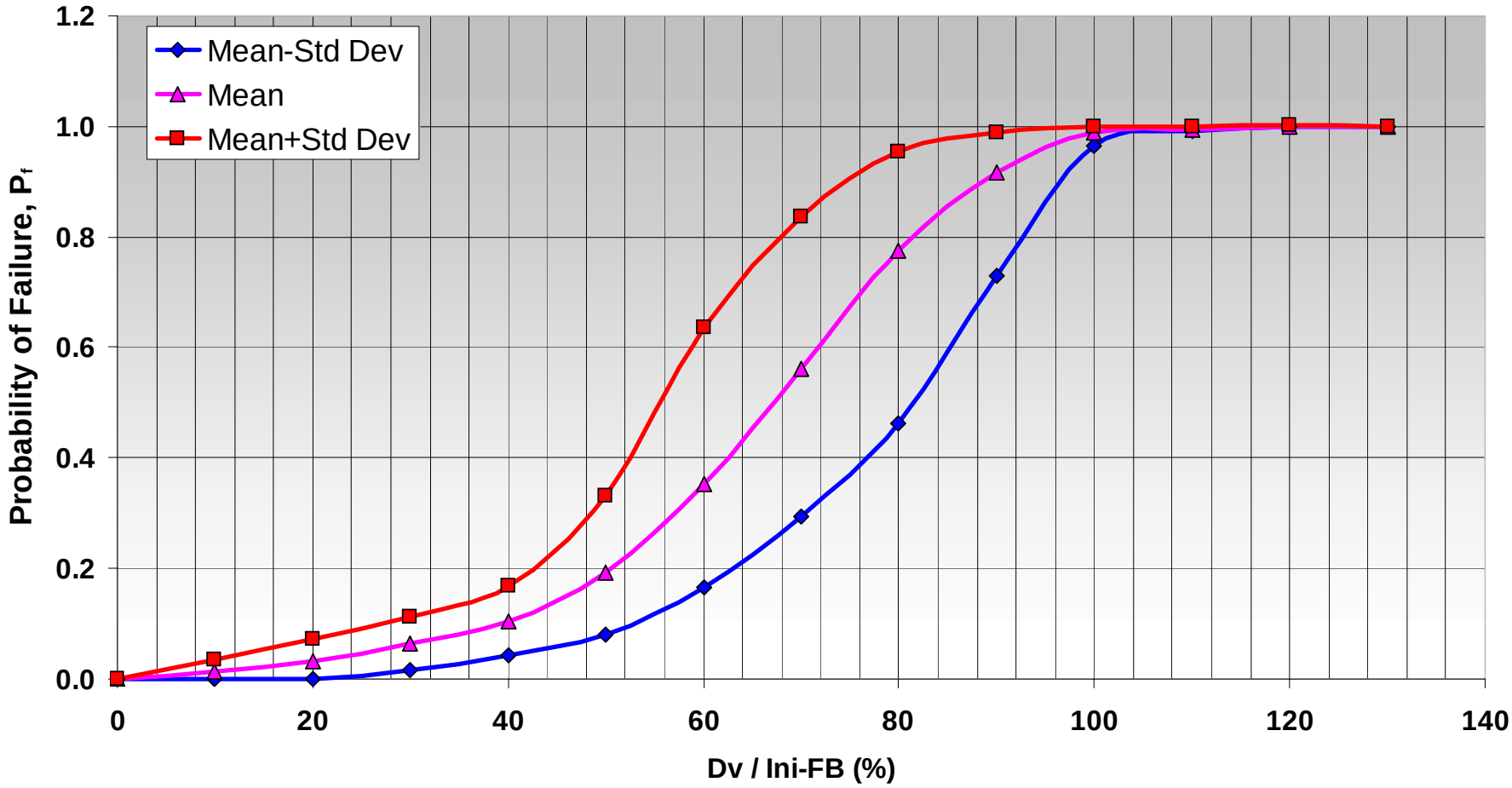
Mean = 9
Mean + σ = 14
Mean - σ = 5

Delta Risk Management Strategy (DRMS) Levee Fragility		$(N1)_{60\text{-}CS}$ Distribution for Levee Sand with $(N1)_{60\text{-}CS} < 20$ (using CPT data)	Figure 6-4b
URS	Project No. 26815621		

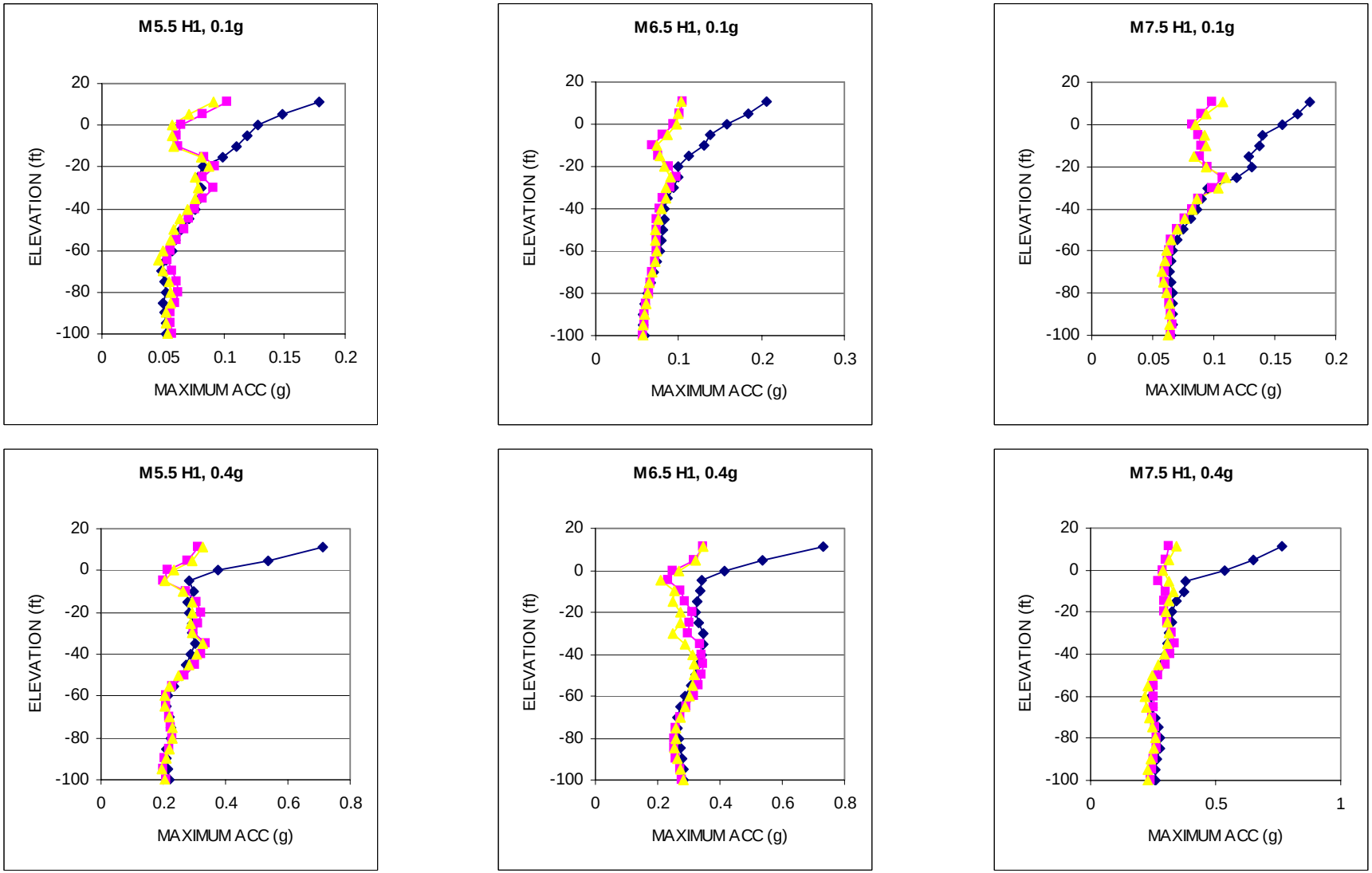


Mean = 11
Mean + σ = 16
Mean - σ = 6

Delta Risk Management Strategy (DRMS) Levee Fragility		$(N1)_{60\text{-}CS}$ Distribution for Foundation Sand with $(N1)_{60\text{-}CS} < 20$	Figure 6-5
URS	Project No. 26815621		



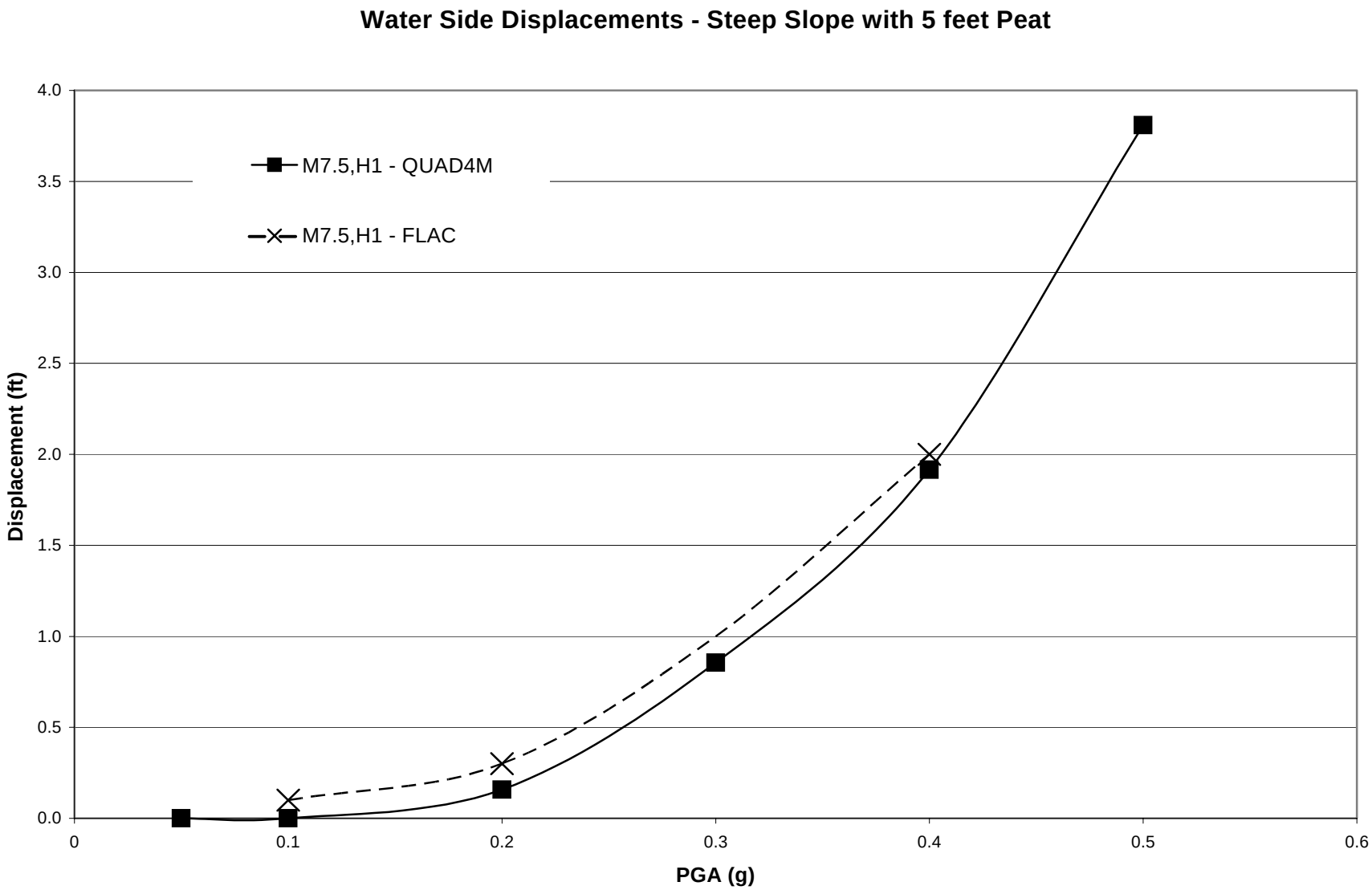
Delta Risk Management Strategy (DRMS) Levee Fragility	Probability of Failure vs D_v / Ini-FB (Vertical Displacement / Initial Free Board)	Figure 6-6
URS Project No. 26815621		



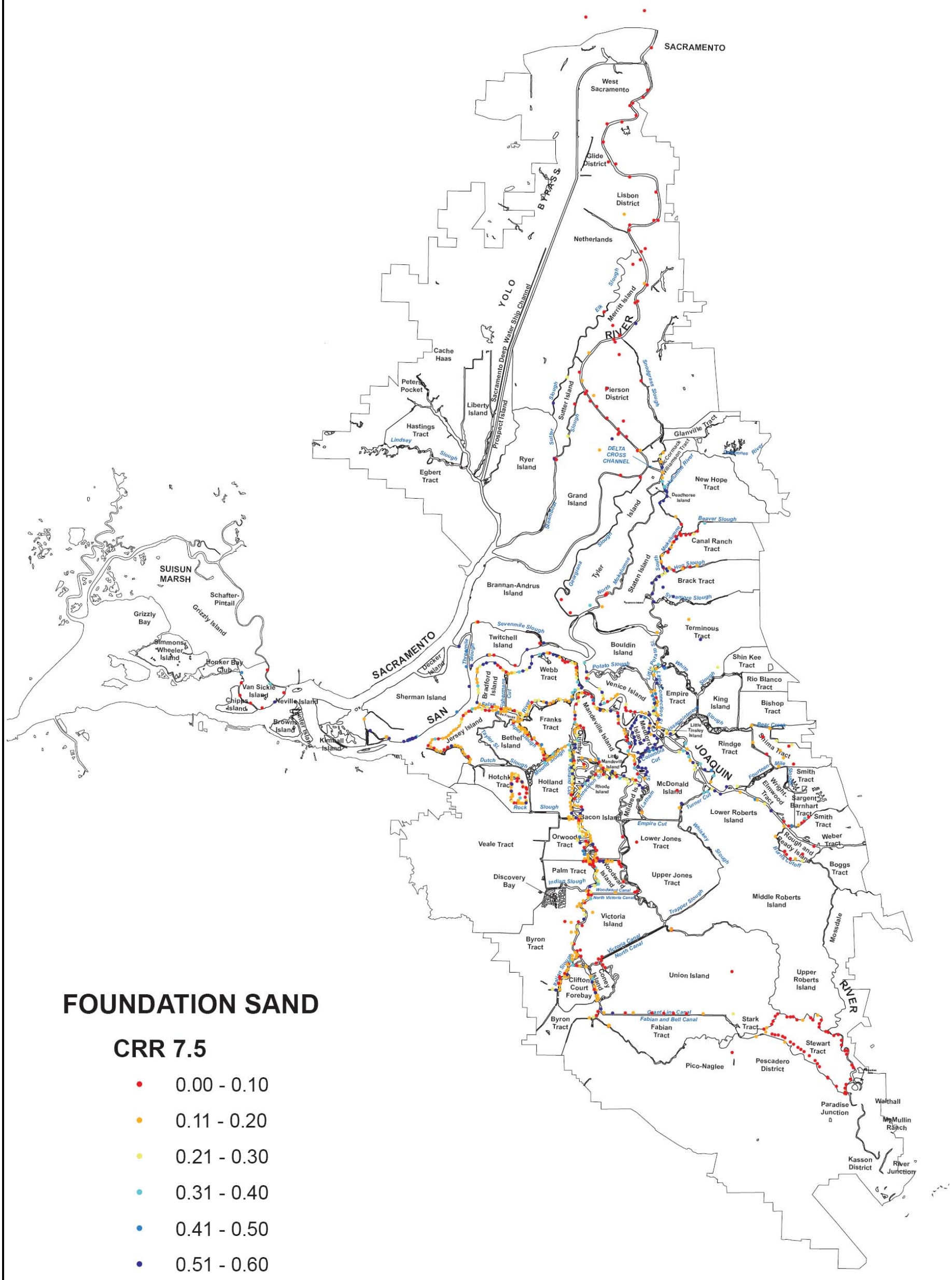
Legend:

- QUAD4M - 2D
- QUAD4M - 1D
- SHAKE

Delta Risk Management Strategy (DRMS) Levee Fragility		Comparison of Maximum Acceleration Profile QUAD4M 2D, 1D and SHAKE Idealized Section 25 Feet of Peat	Figure 6-7
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Displacements for Validation QUAD4M vs FLAC Steep Slope Water Side Slope 5 Feet of Peat	Figure 6-8
URS	Project No. 26815621		

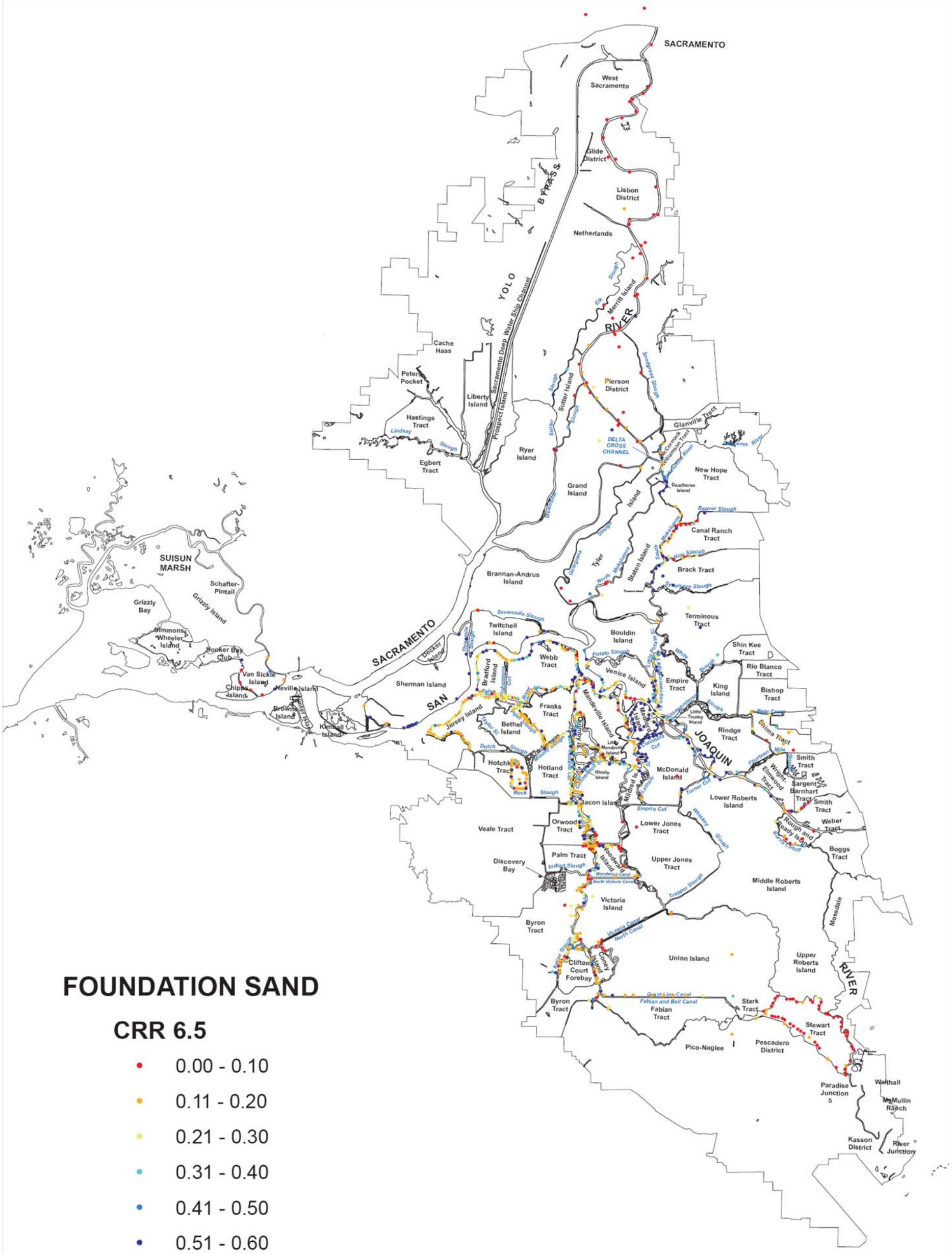


FOUNDATION SAND

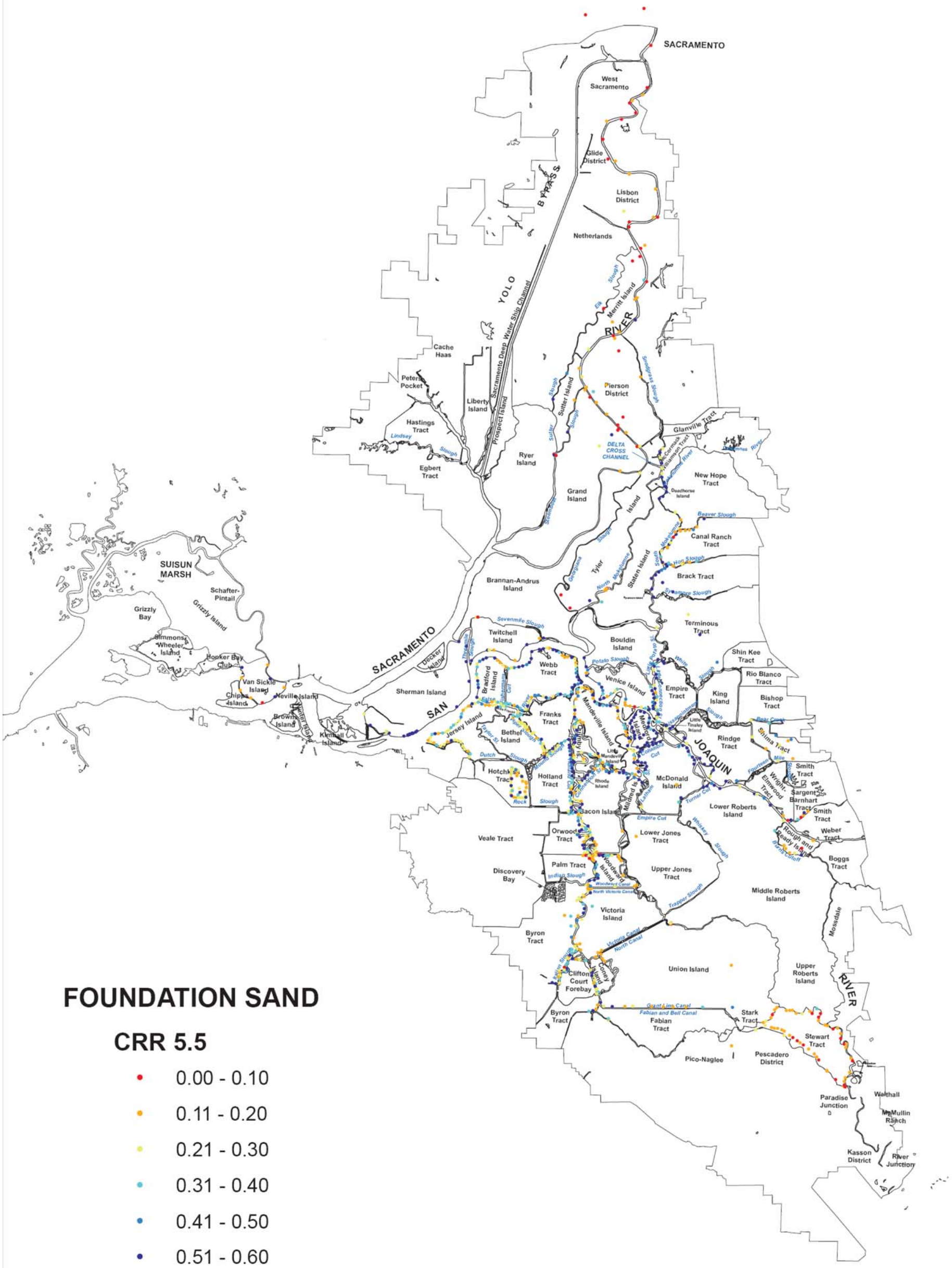
CRR 7.5

- 0.00 - 0.10
- 0.11 - 0.20
- 0.21 - 0.30
- 0.31 - 0.40
- 0.41 - 0.50
- 0.51 - 0.60

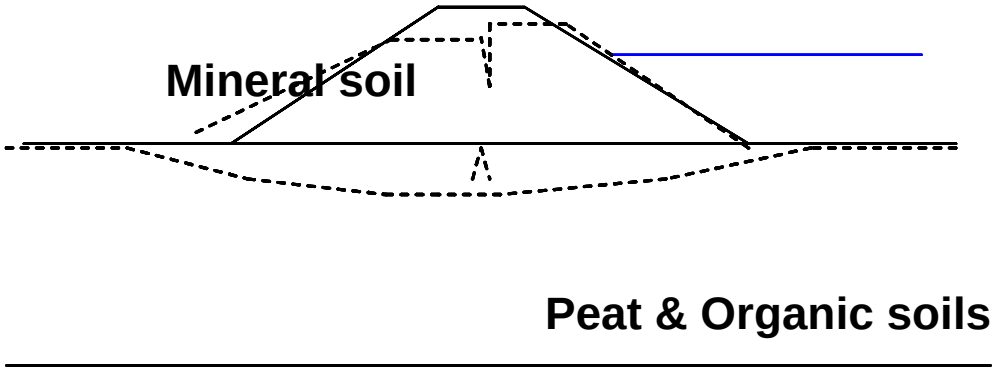
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated CRR for Foundation Sand Layer M 7.5	Figure 6-9
URS	Project No. 26815621		

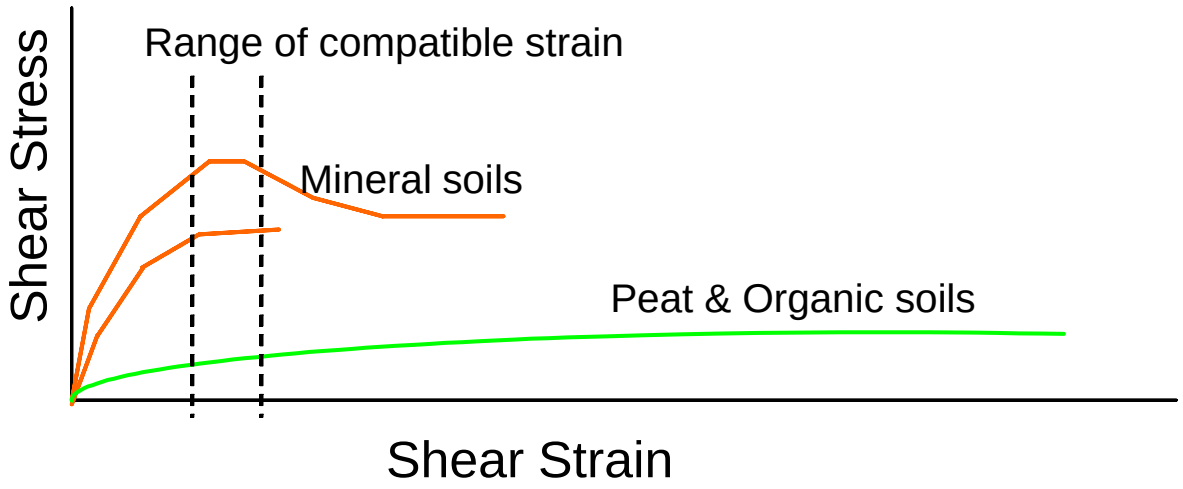


Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated CRR for Foundation Sand Layer M 6.5	Figure 6-10
URS	Project No. 26815621		

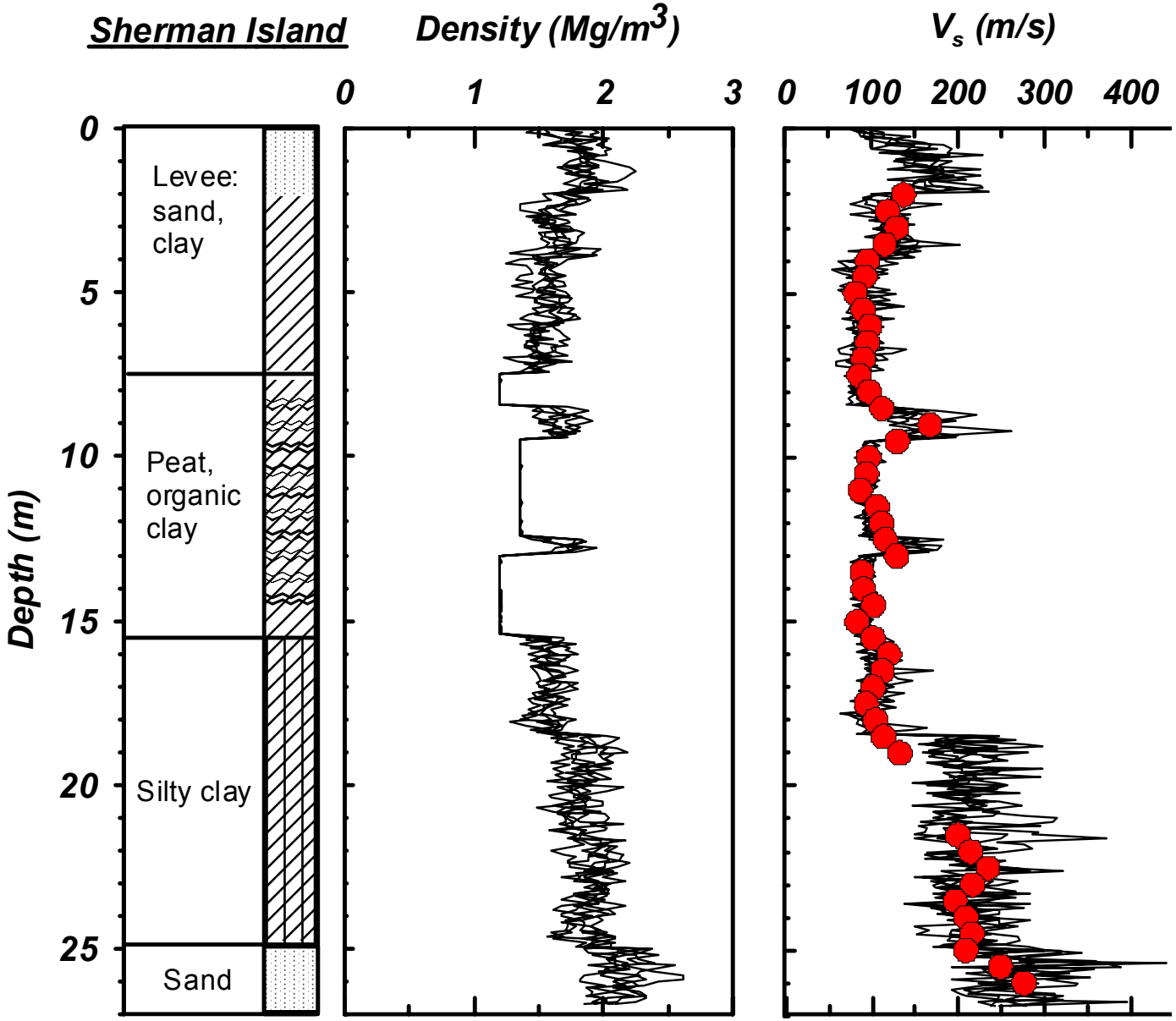


Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated CRR for Foundation Sand Layer M 5.5	Figure 6-11
URS	Project No. 26815621		

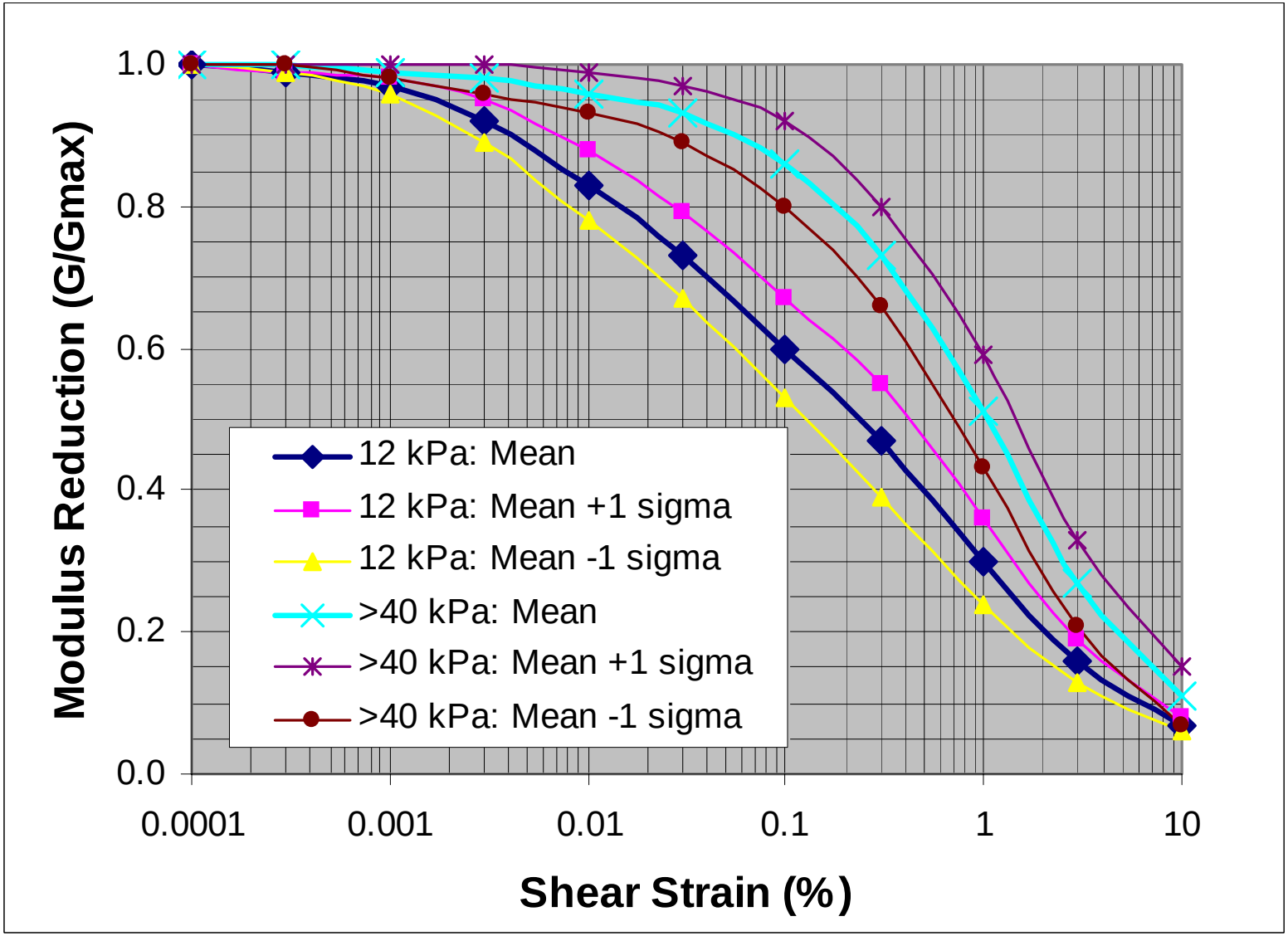




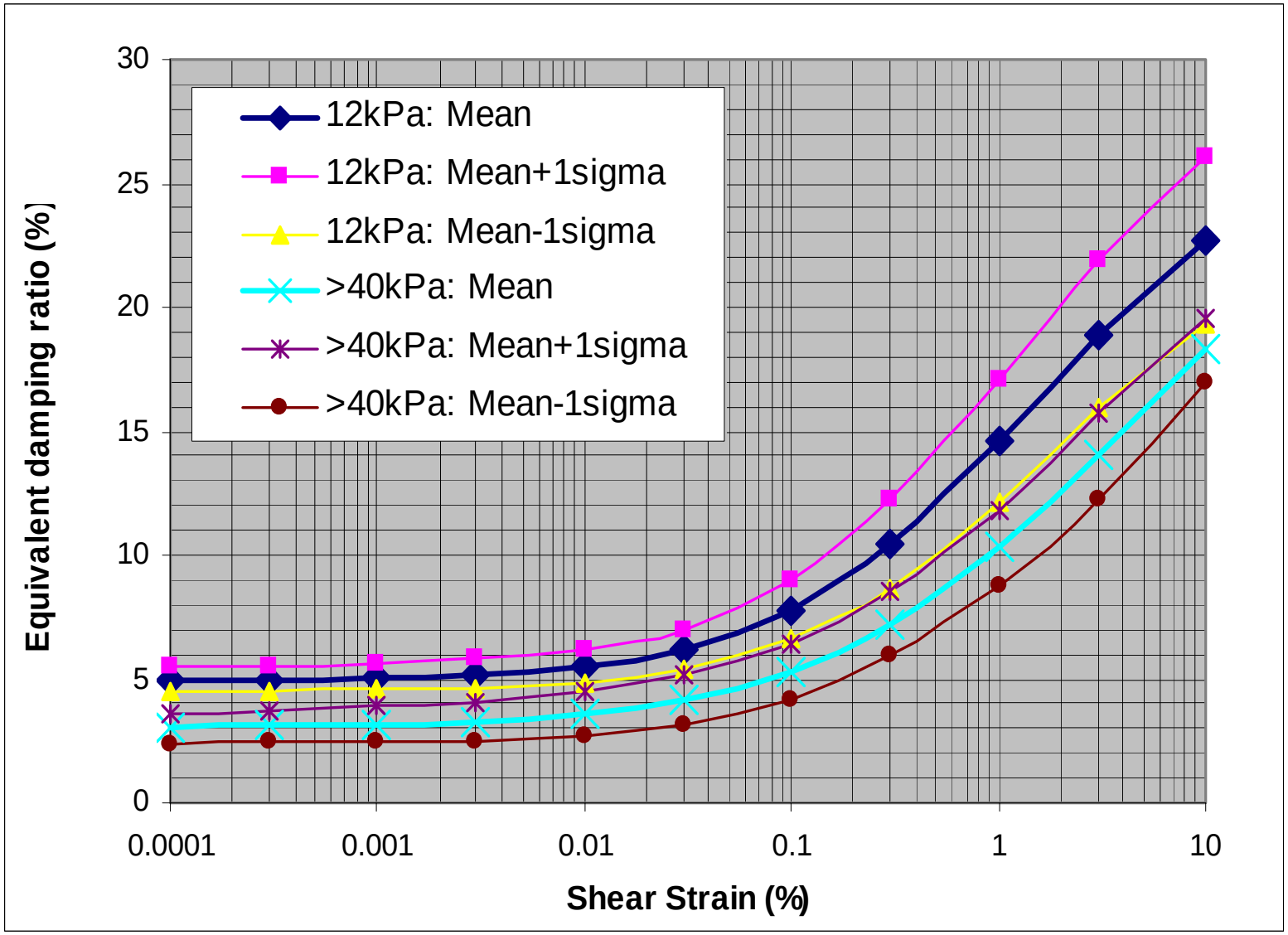
Delta Risk Management Strategy (DRMS) Levee Fragility		Strain Compatible Strength Peat vs Mineral Soil	Figure 6-12
URS	Project No. 26815621		



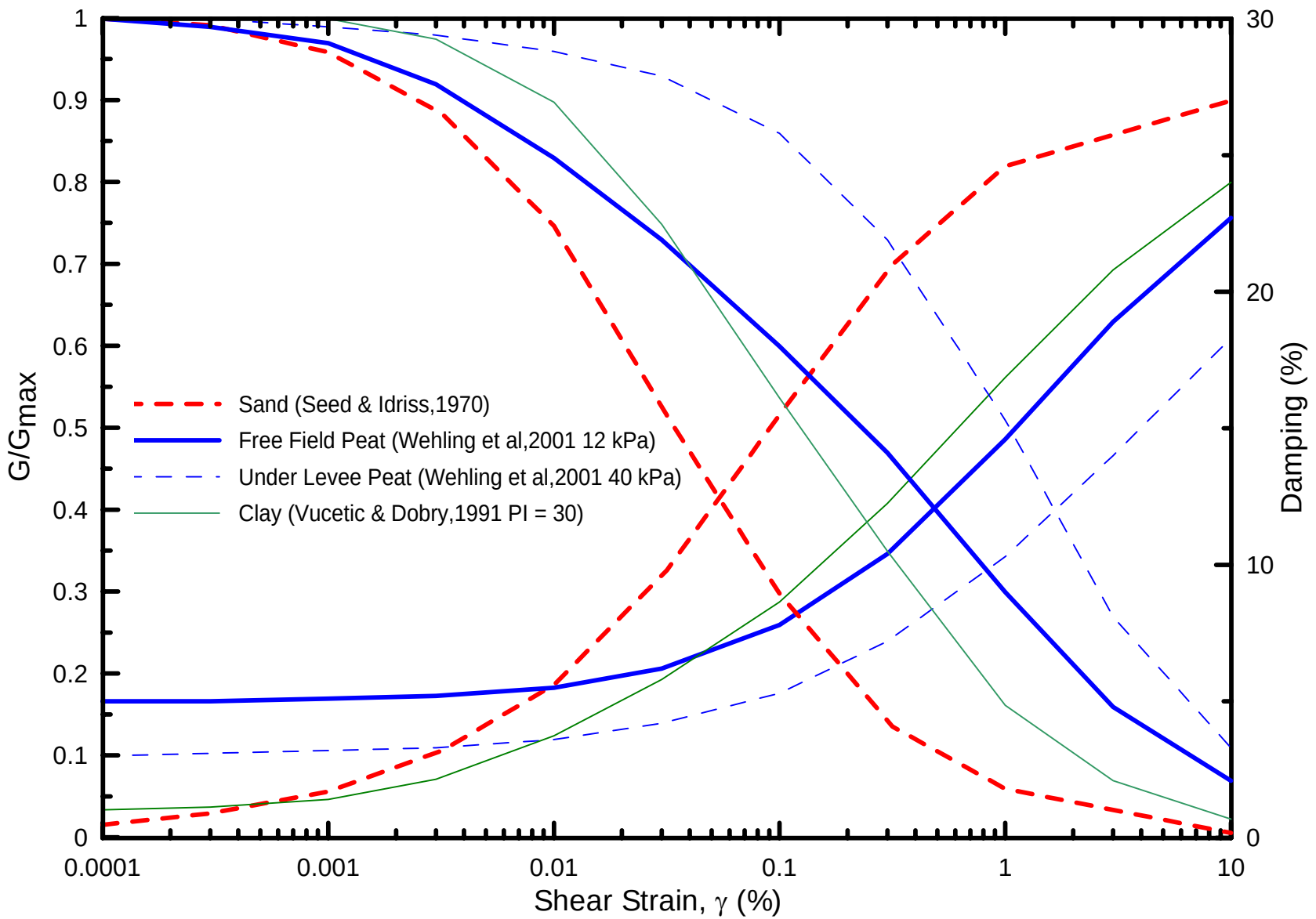
Delta Risk Management Strategy (DRMS) Levee Fragility		Typical Vs Profile Sherman Island	Figure 6-13
URS	Project No. 26815621		



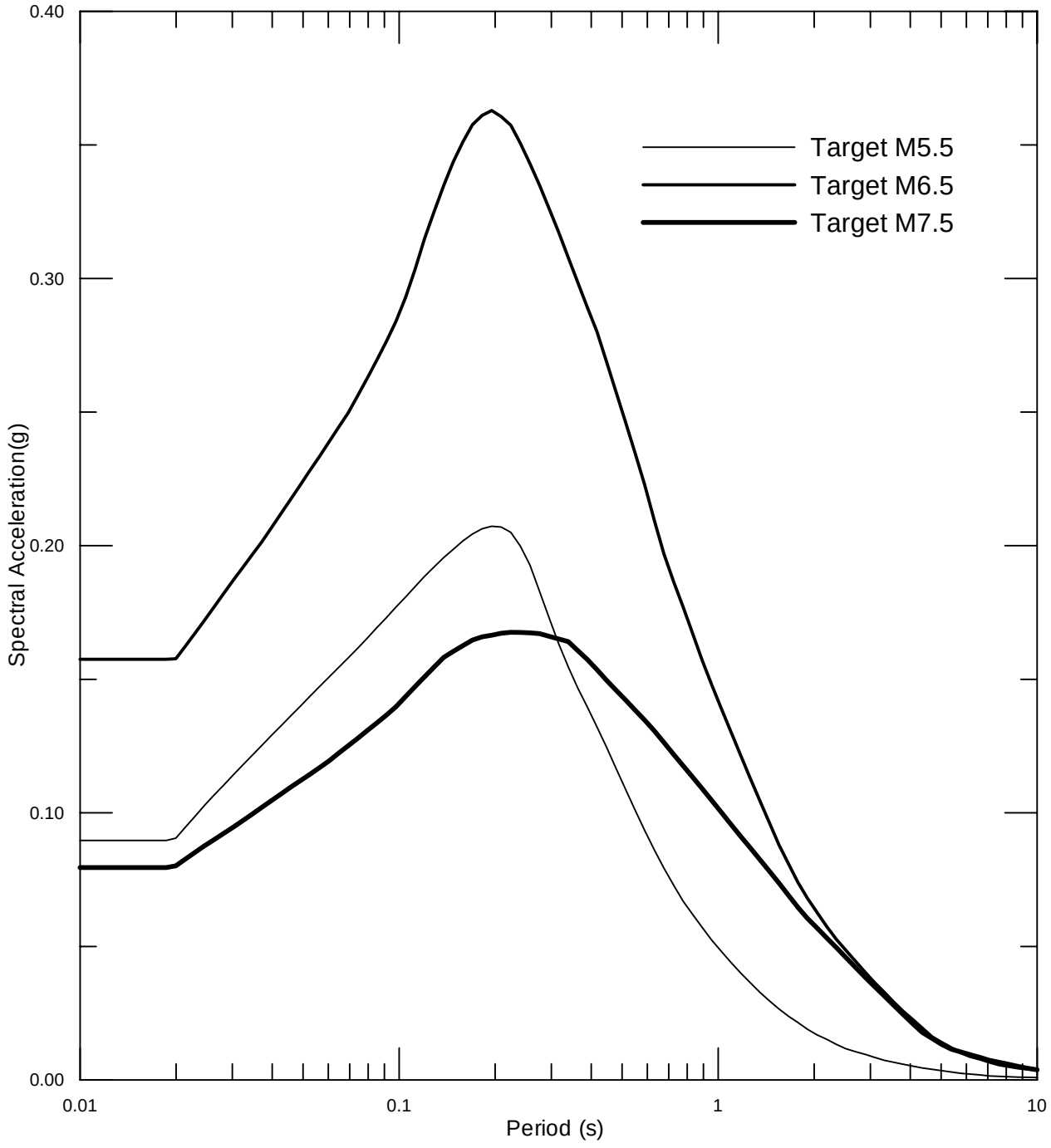
Delta Risk Management Strategy (DRMS) Levee Fragility		G/G_{max} Curves for Peat (Wehling et al., 2001)	Figure 6-14a
URS	Project No. 26815621		



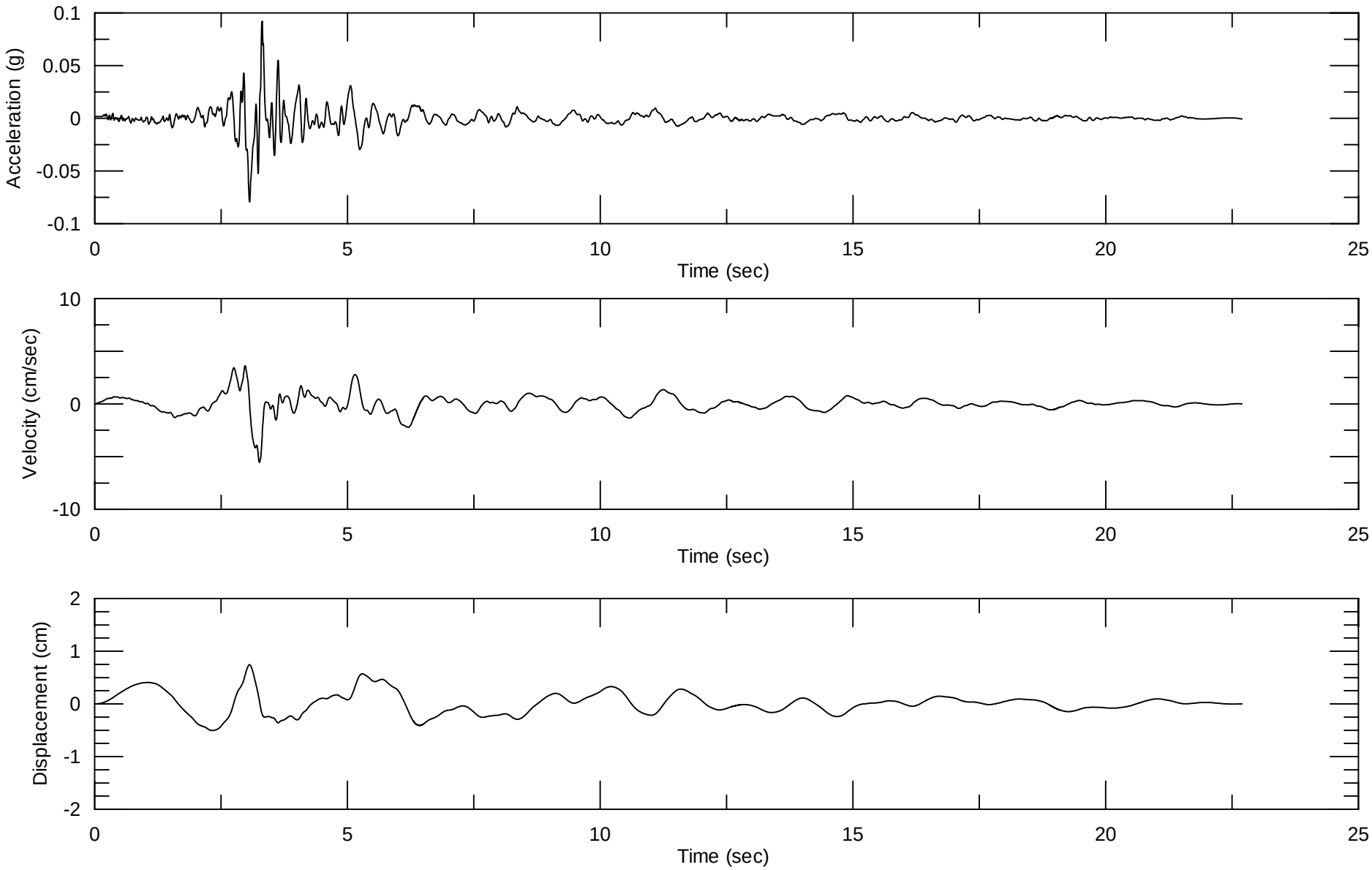
Delta Risk Management Strategy (DRMS) Levee Fragility		Damping Curves for Peat (Wehling et al., 2001)	Figure 6-14b
URS	Project No. 26815621		



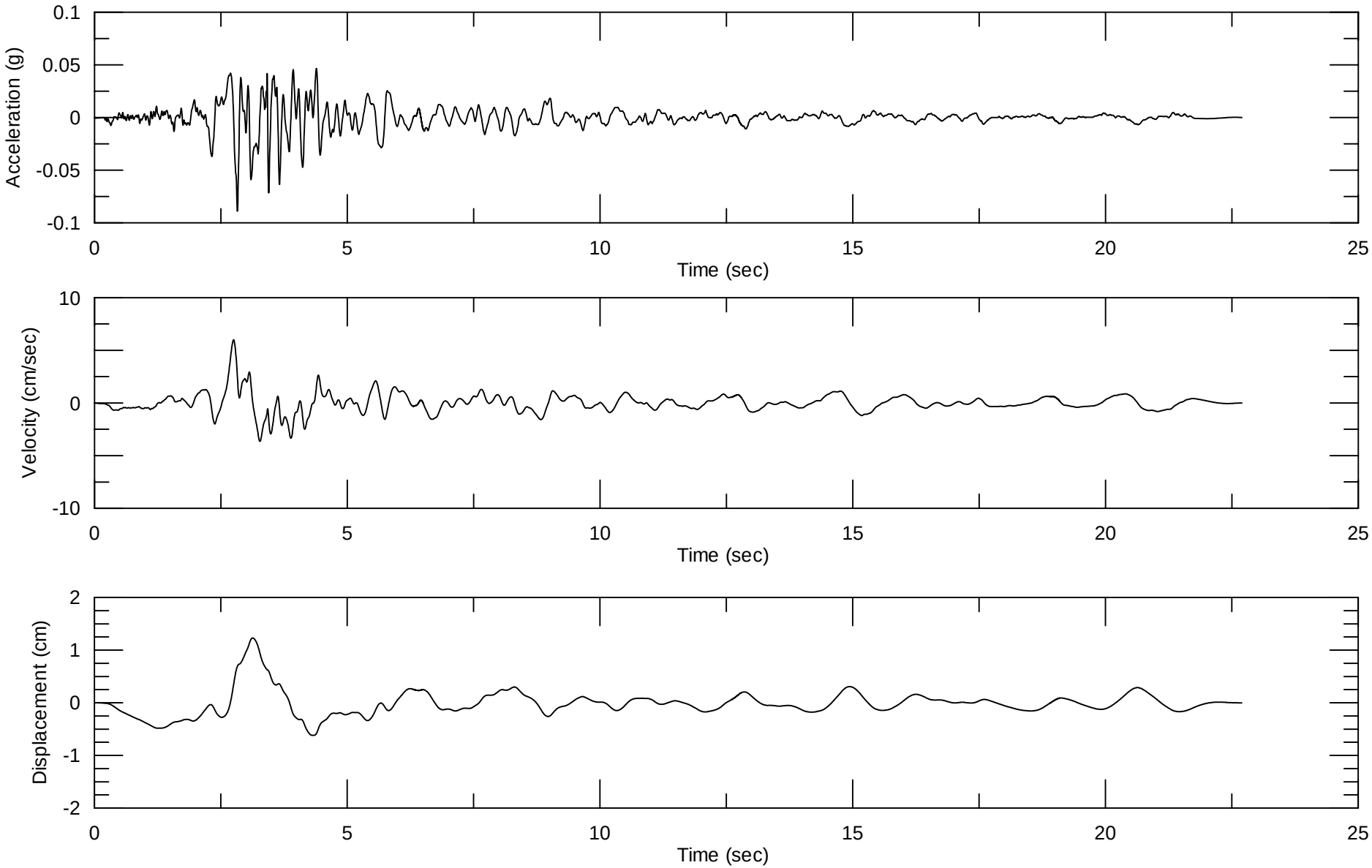
Delta Risk Management Strategy (DRMS) Levee Fragility		Modulus and Damping Curves used in Dynamic Analysis	Figure 6-15
URS	Project No. 26815621		



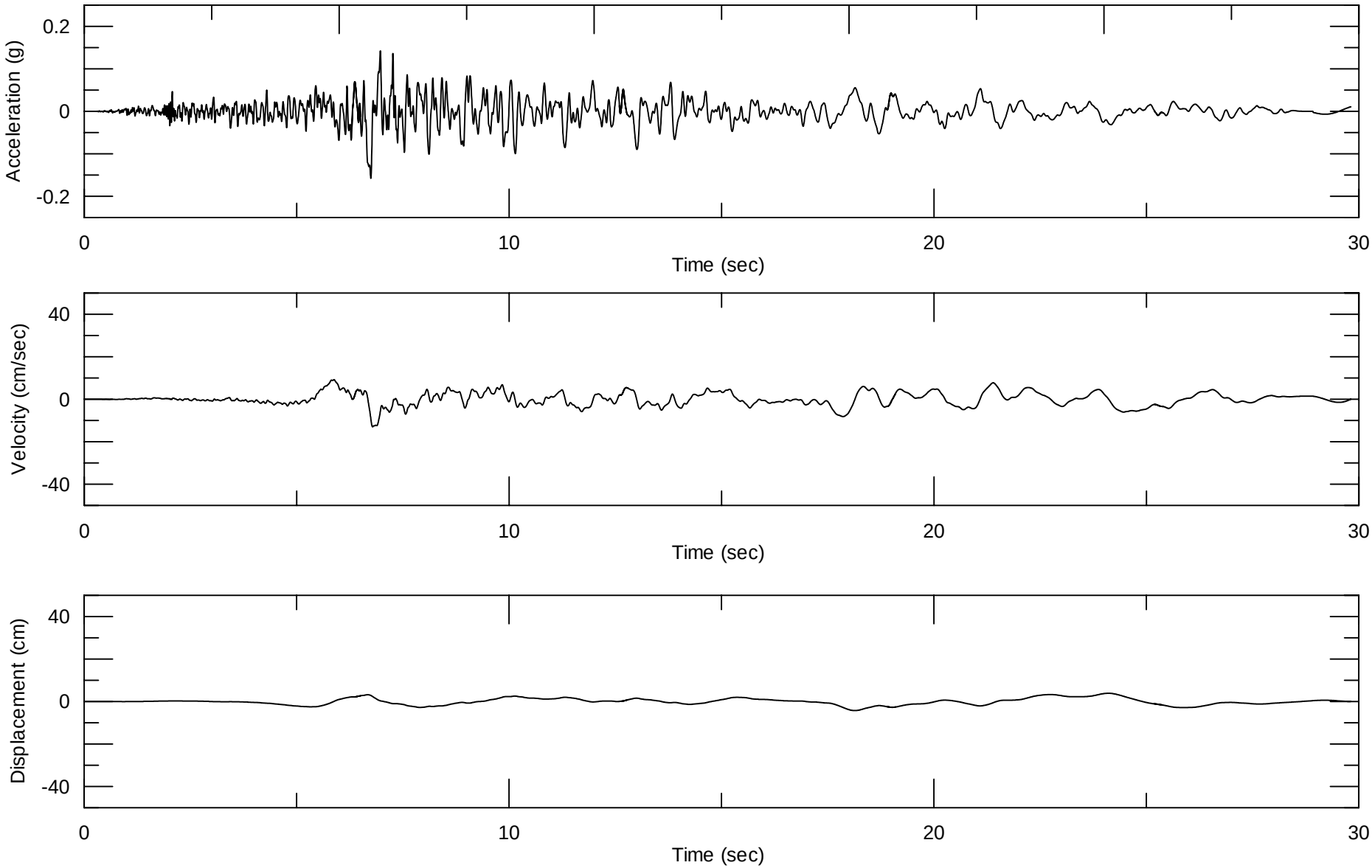
Delta Risk Management Strategy (DRMS) Levee Fragility		Target Response Spectra for M5.5 @ 20km, M6.5 @ 20km, and M7.5 @ 75km	Figure 6-16
URS	Project No. 26815621		



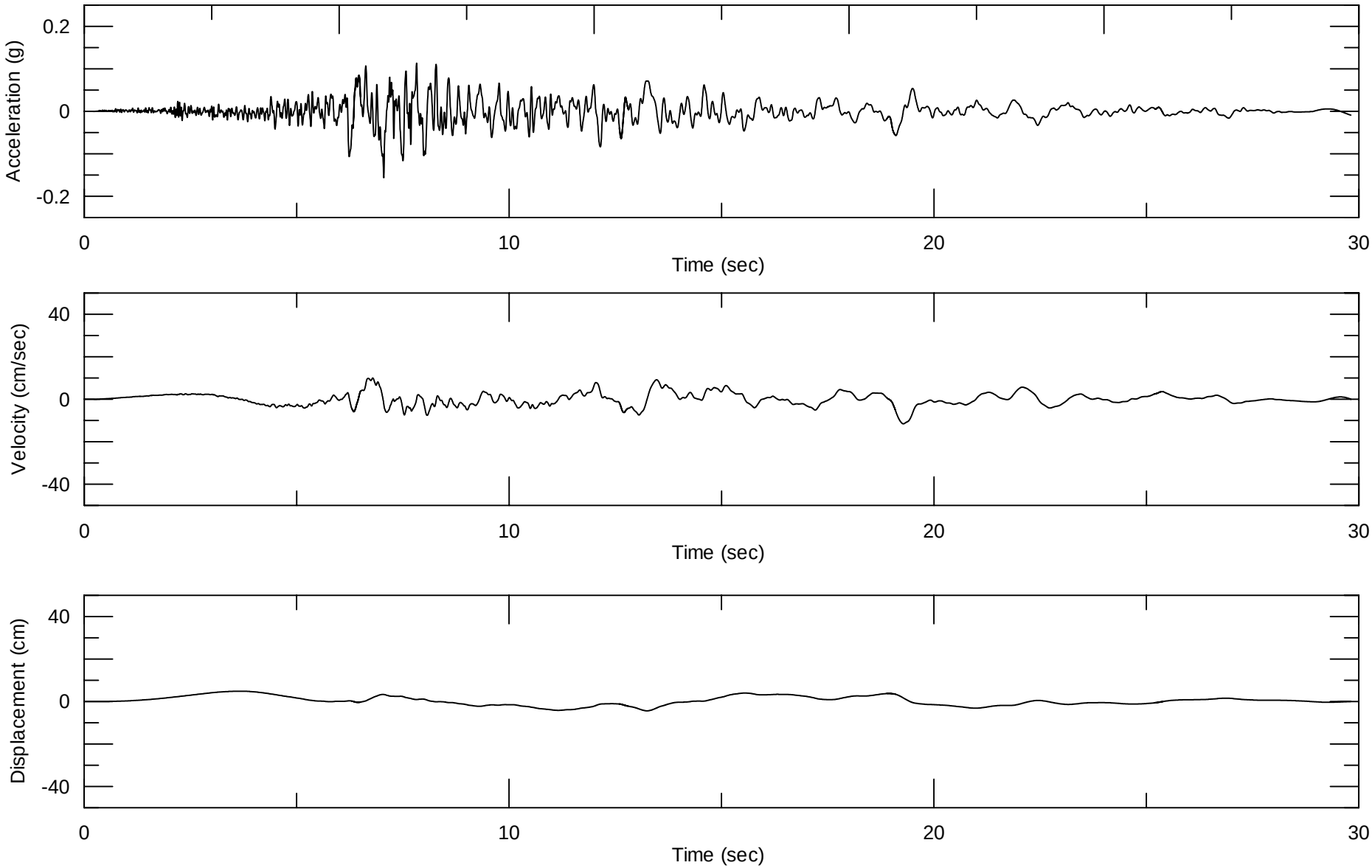
Delta Risk Management Strategy (DRMS) Levee Fragility		Spectrally-Matched Time history for M 5.5 Event for 1991 Sierra Madre Earthquake at Station USGS 4734, 360 deg Component	Figure 6-17
URS	Project No. 26815621		



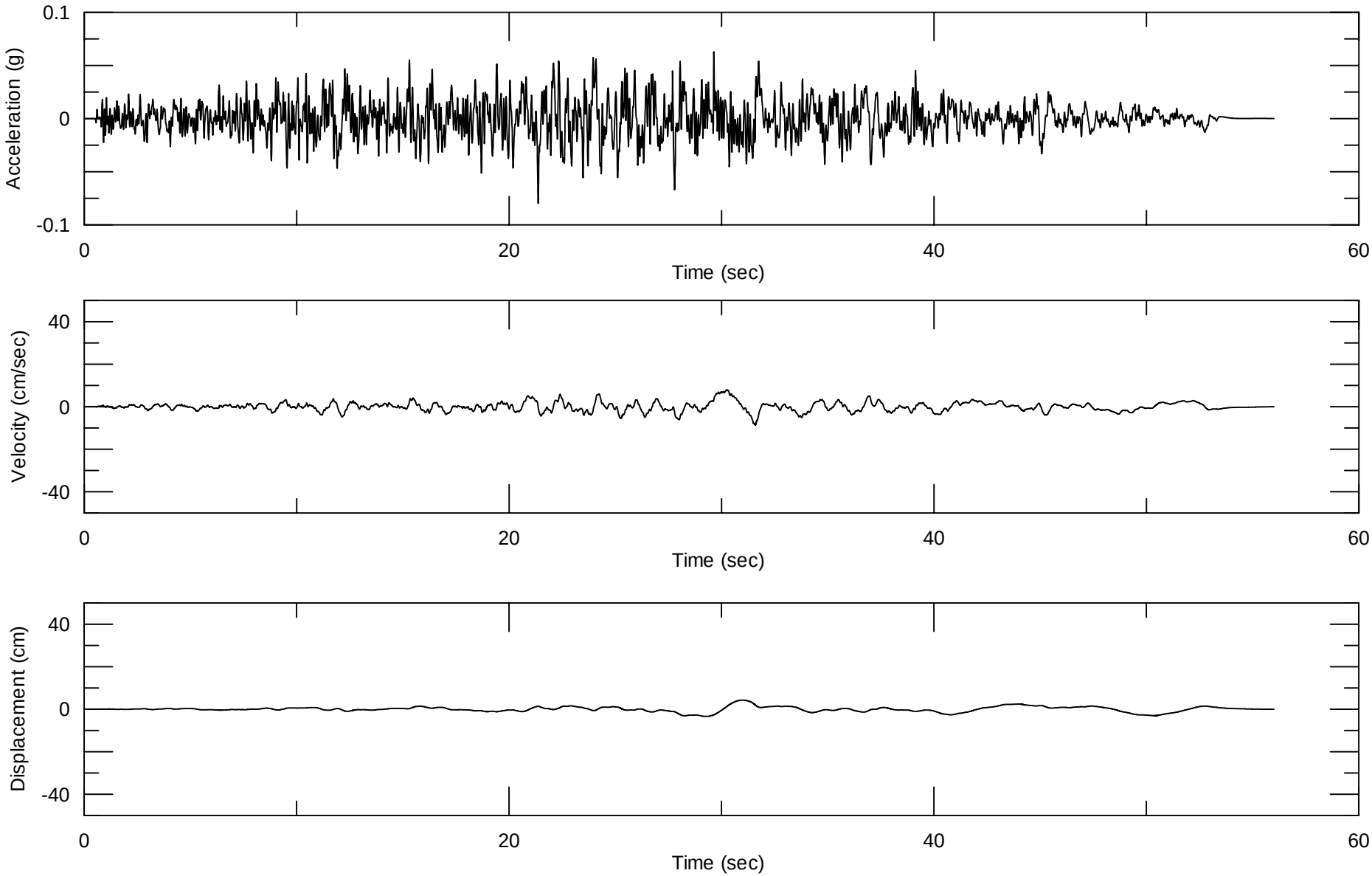
Delta Risk Management Strategy (DRMS) Levee Fragility		Spectrally-Matched Time History for M 5.5 Event for 1991 Sierra Madre Earthquake at Station USGS 4734, 270 deg Component	Figure 6-18
URS	Project No. 26815621		



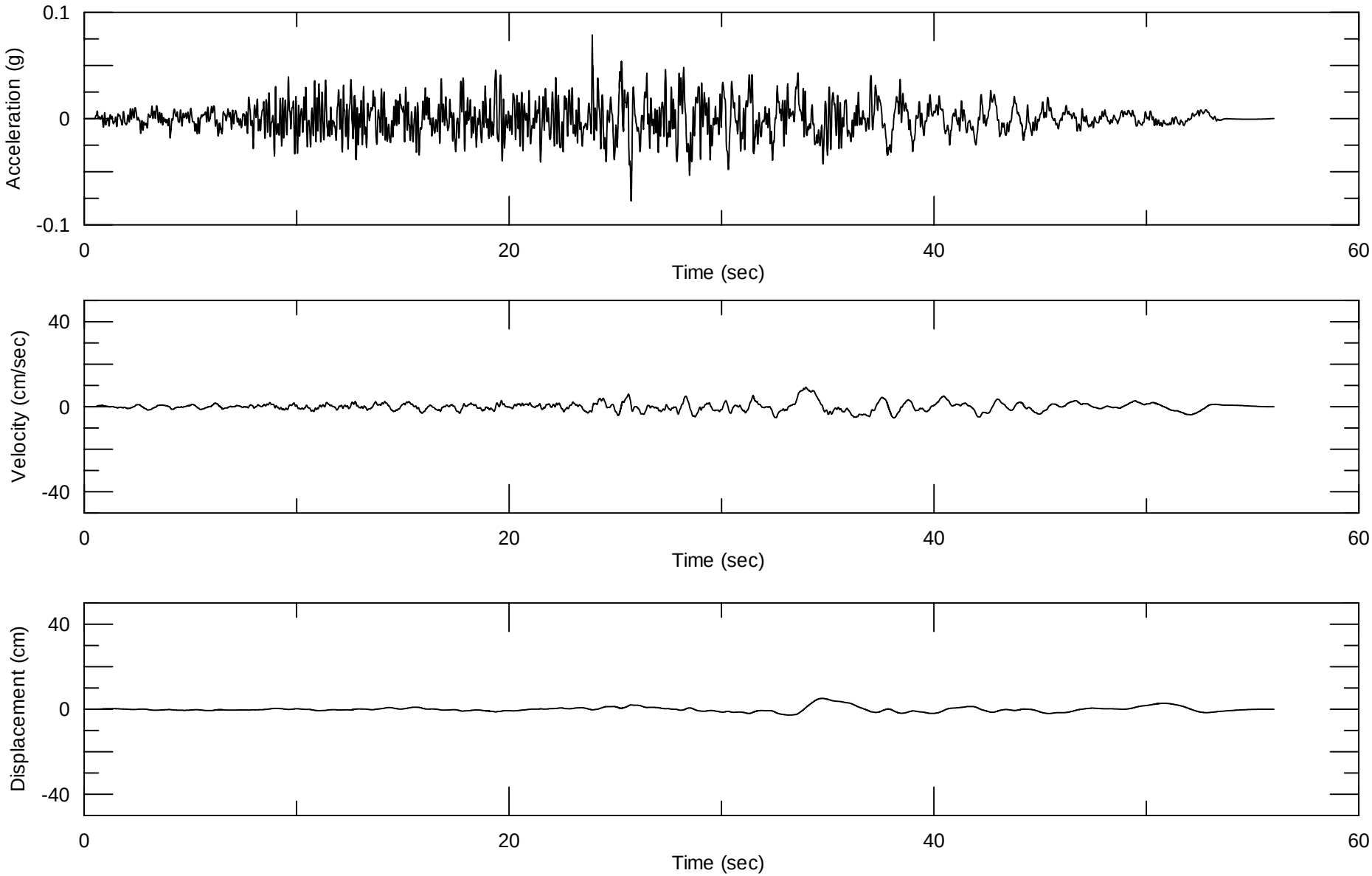
Delta Risk Management Strategy (DRMS) Levee Fragility		Spectrally-Matched Time History for M 6.5 Event for 1987 Superstition Hills Earthquake at Station Wildlife Liquefaction Array, 090 deg Component	Figure 6-19
URS	Project No. 26815621		



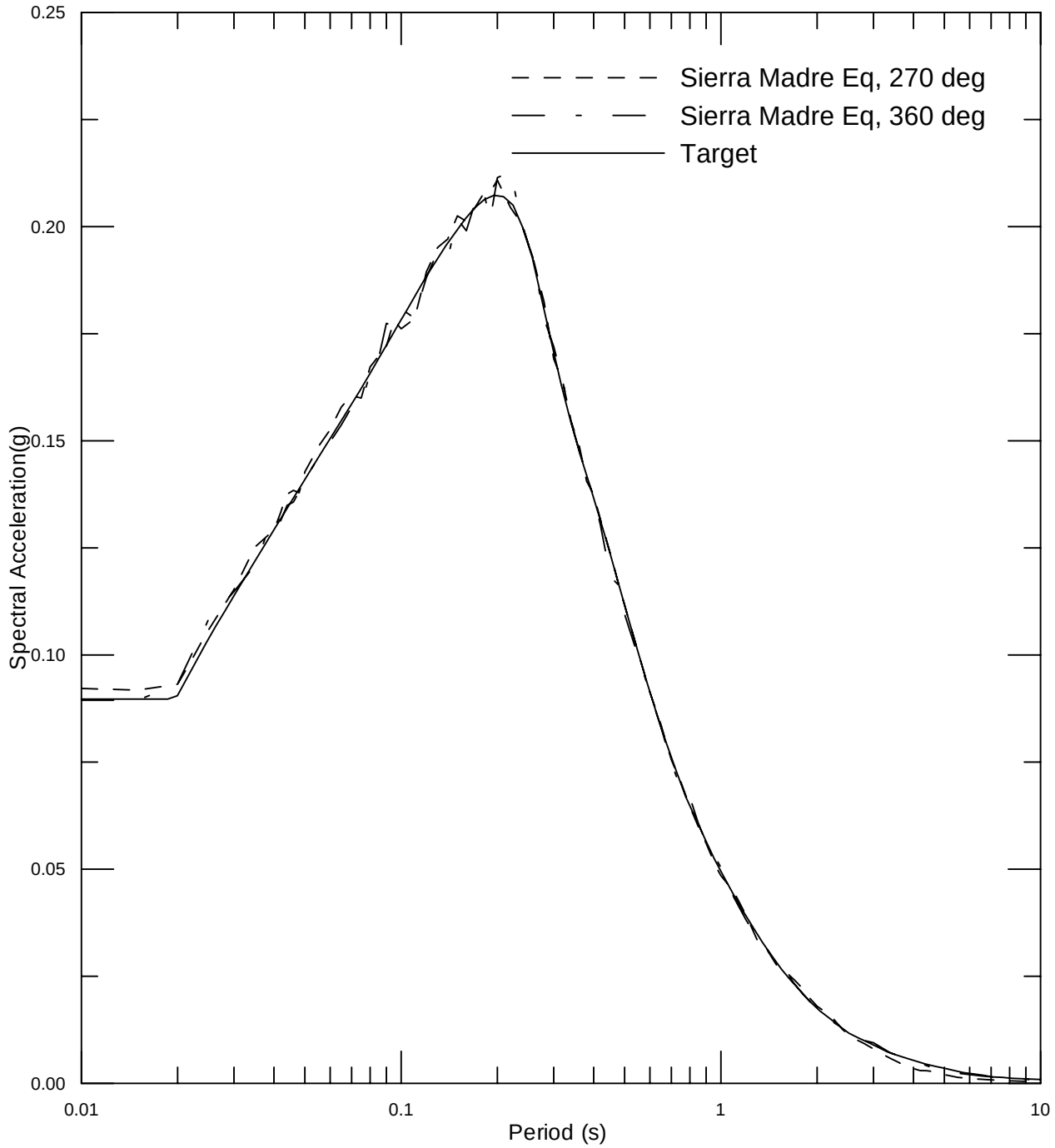
Delta Risk Management Strategy (DRMS) Levee Fragility		Spectrally-Matched Time History for M 6.5 Event for 1987 Superstition Hills Earthquake at Station Wildlife Liquefaction Array, 360 deg Component	Figure 6-20
URS	Project No. 26815621		



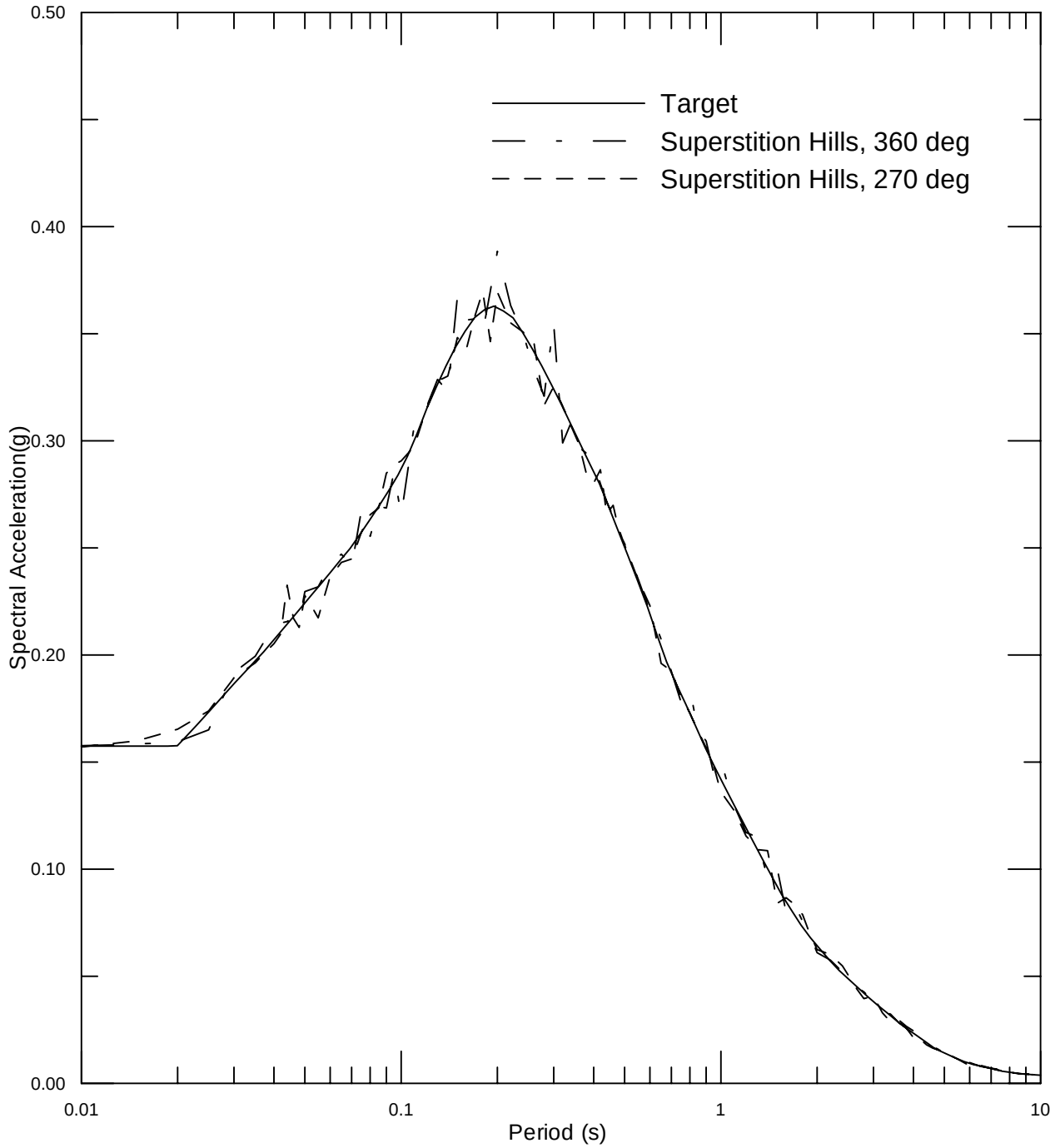
Delta Risk Management Strategy (DRMS) Levee Fragility		Spectrally-Matched Time History for M 7.5 Event for 1992 Landers Earthquake at Station Hemet Fire Station, 000 deg Component	Figure 6-21
URS	Project No. 26815621		



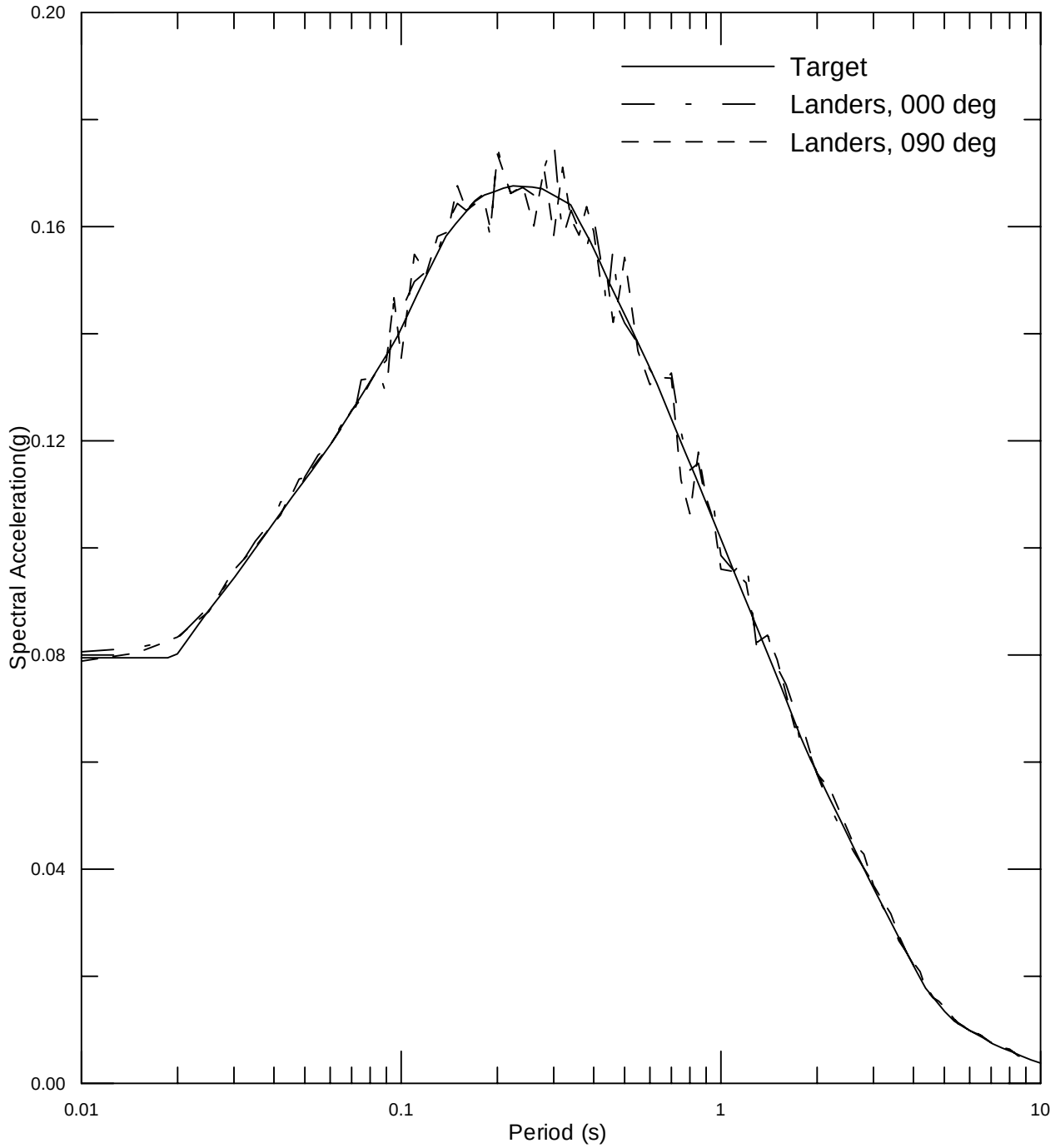
Delta Risk Management Strategy (DRMS) Levee Fragility		Spectrally-Matched Time History for M 7.5 Event for 1992 Landers Earthquake at Station Hemet Fire Station, 090 deg Component	Figure 6-22
URS	Project No. 26815621		



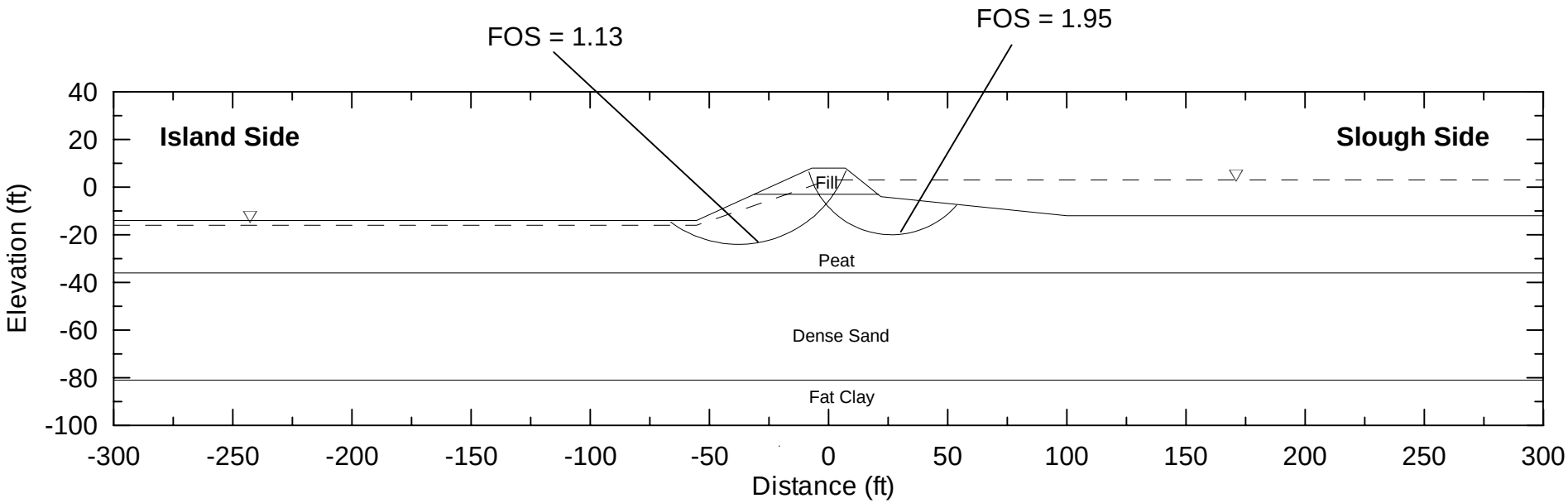
Delta Risk Management Strategy (DRMS) Levee Fragility	Comparison of Response Spectra for M 5.5 Event	Figure 6-23
URS Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Comparison of Response Spectra for M 6.5 Event	Figure 6-24
URS	Project No. 26815621		

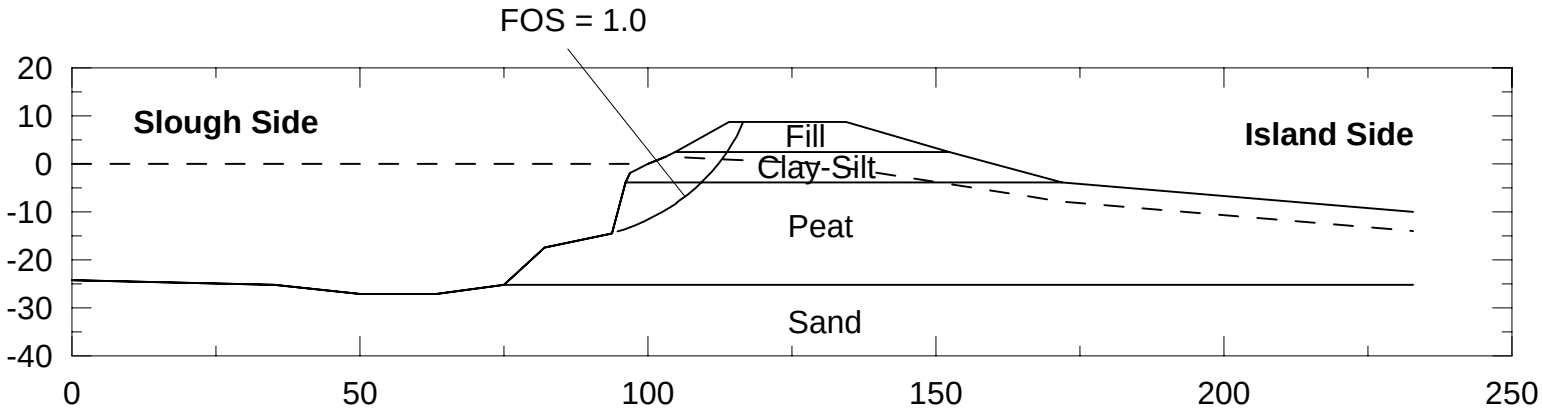


Delta Risk Management Strategy (DRMS) Levee Fragility	Comparison of Response Spectra for M 7.5 Event	Figure 6-25
URS Project No. 26815621		



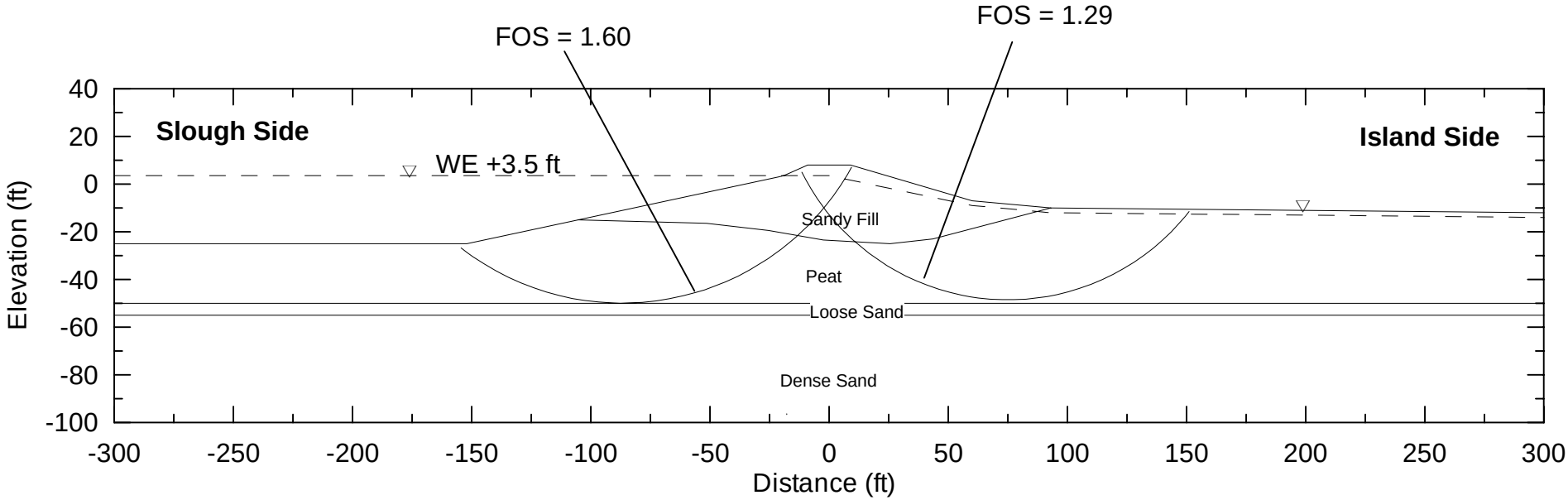
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Fill	115	32	50	-	-
Peat	70	28	120	18	140
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Bradford Island - Station 169+00 Stability Analysis - Long Term	Figure 6-26
URS	Project No. 26815621		



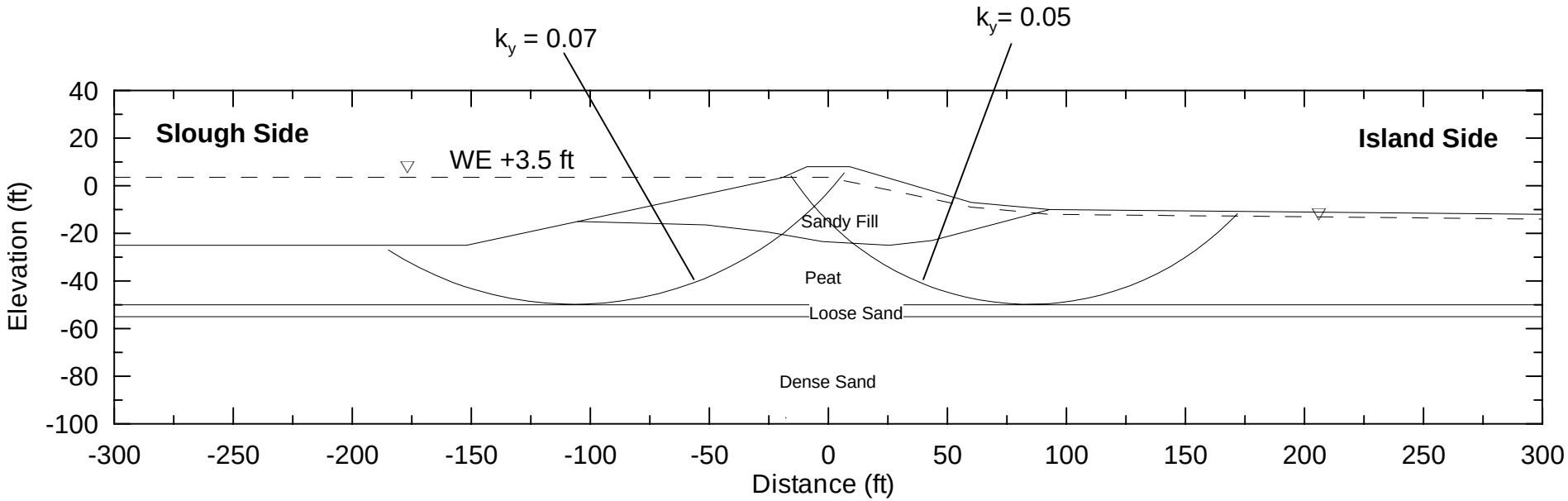
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Fill	115	35	50	-	-
Clay-Silt	90	32	100	-	-
Peat	70	28	120	18	140
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Holland Island - Station156+00 Stability Analysis - Long Term	Figure 6-27
URS	Project No. 26815621		



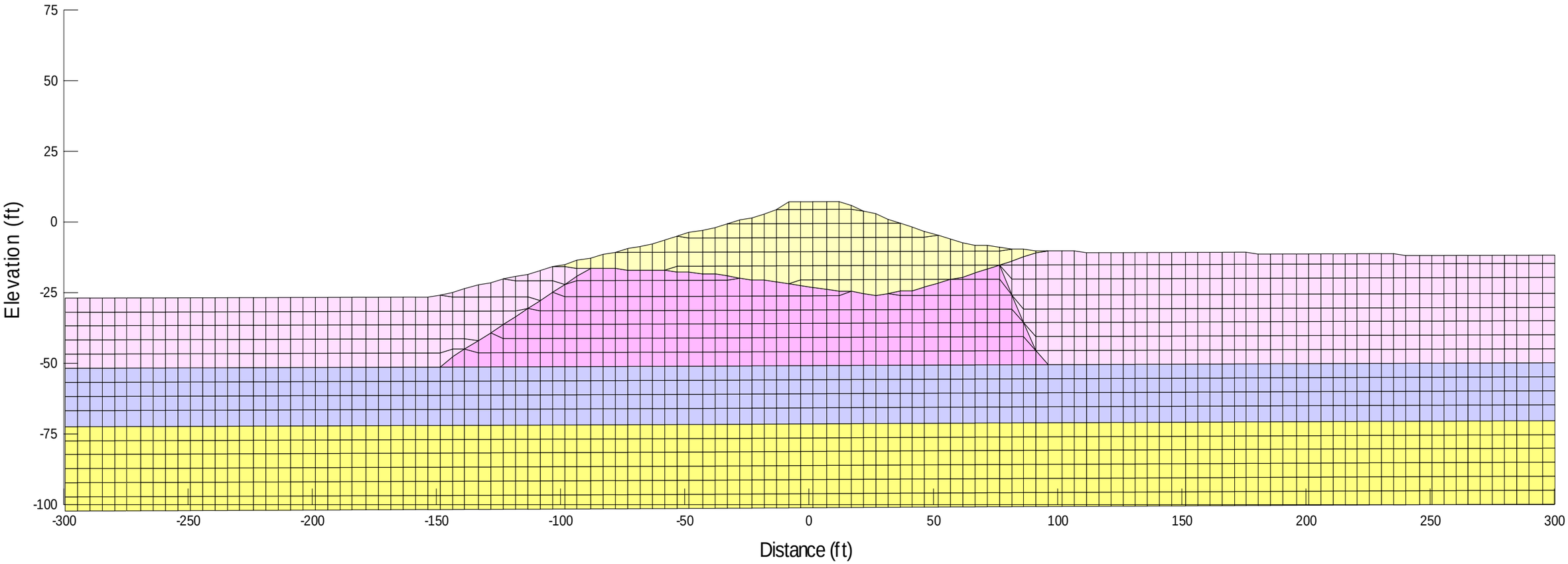
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Sandy Fill	115	30	0	-	-
Peat	70	28	120	18	140
Loose sand	125	32	0	-	-
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Sherman Island - Station 650+00 Stability Analysis - Long Term	Figure 6-28
URS	Project No. 26815621		



Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Sandy Fill	115	30	0	-	-
Peat	70	28	120	18	140
Loose sand	125	32	0	-	-
Dense Sand	125	38	0	-	-

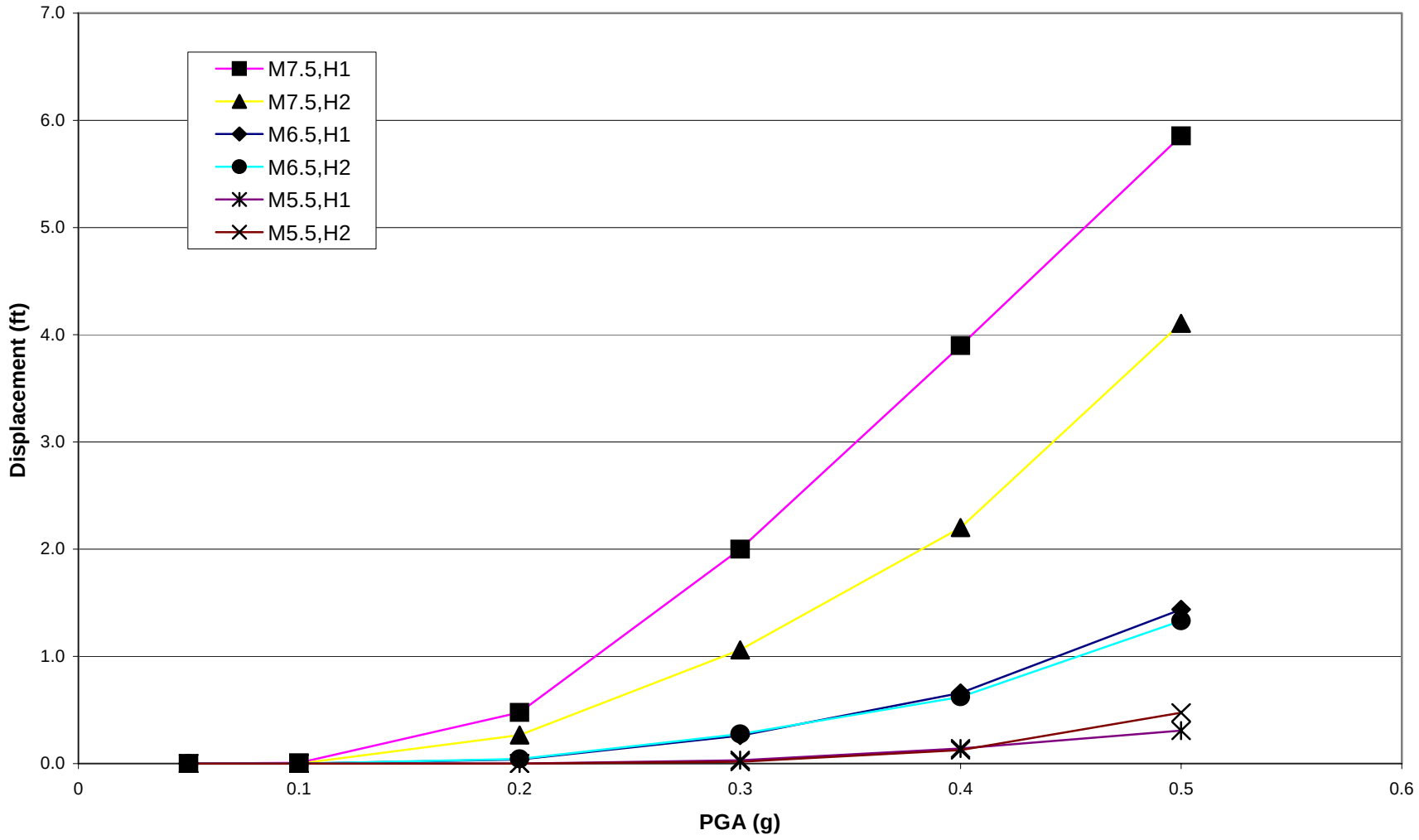
Delta Risk Management Strategy (DRMS) Levee Fragility		Sherman Island - Station 650+00 Stability Analysis - Seismic	Figure 6-29
URS	Project No. 26815621		



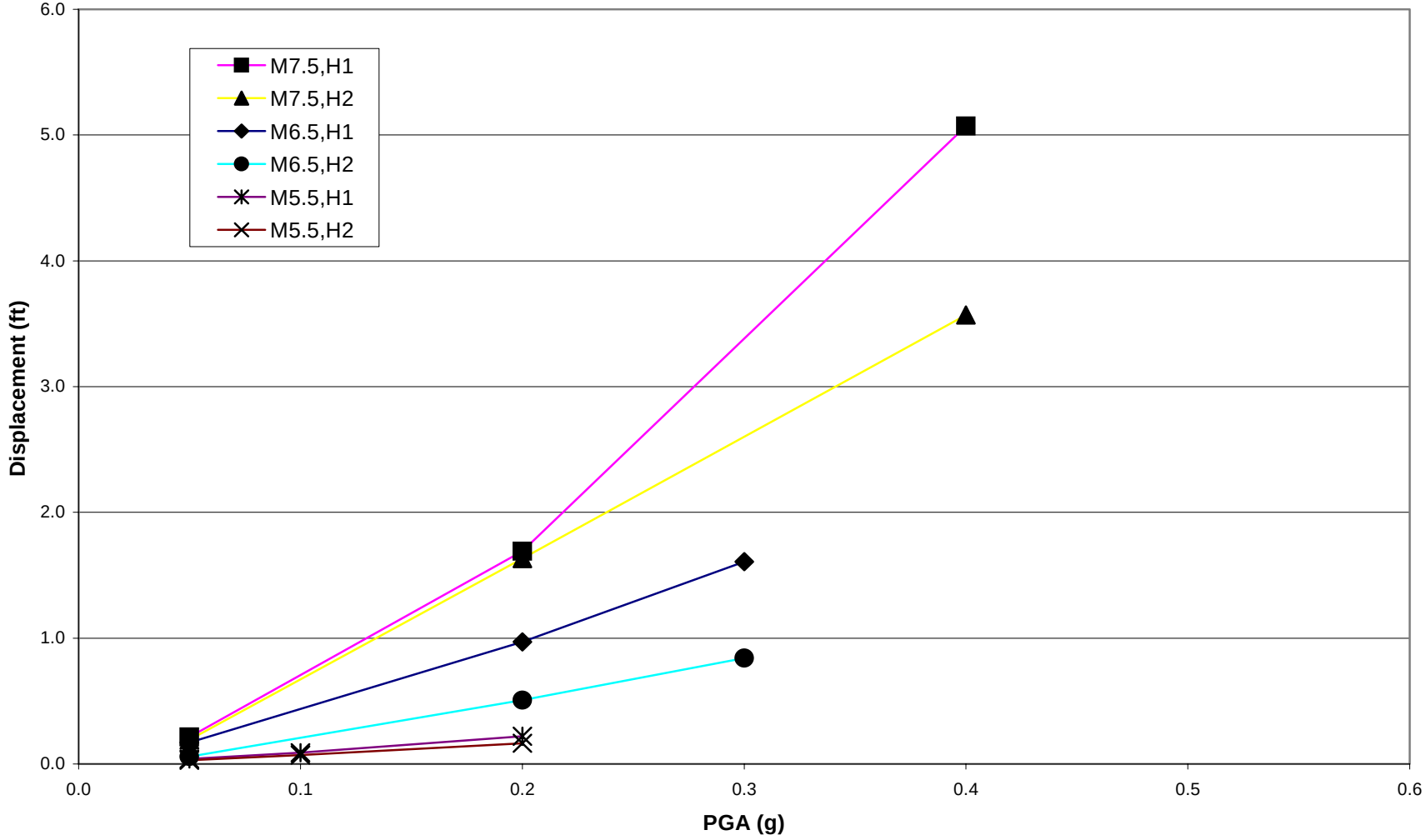
Legend

- Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand
- Dense Sand

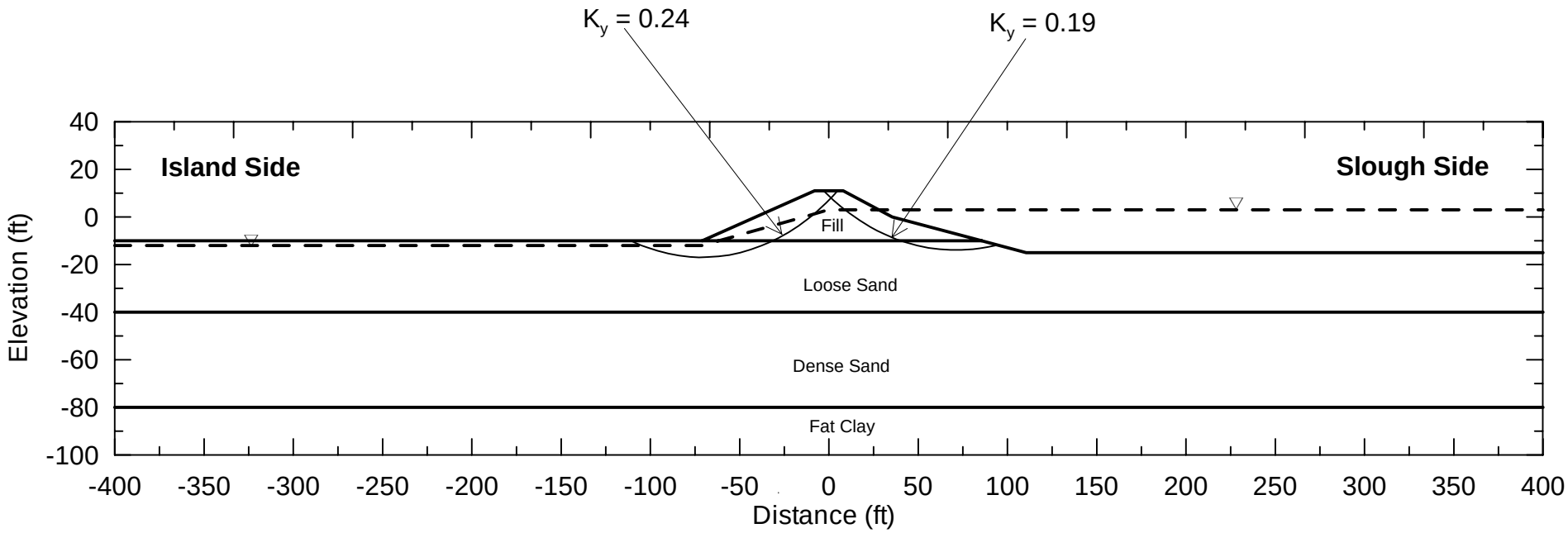
Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Model for Seismic Analysis sherman Island - Station 650+00	Figure 6-30
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Sherman Island - Sta. 650+00 35 Feet of Peat	Figure 6-31
URS	Project No. 26815621		

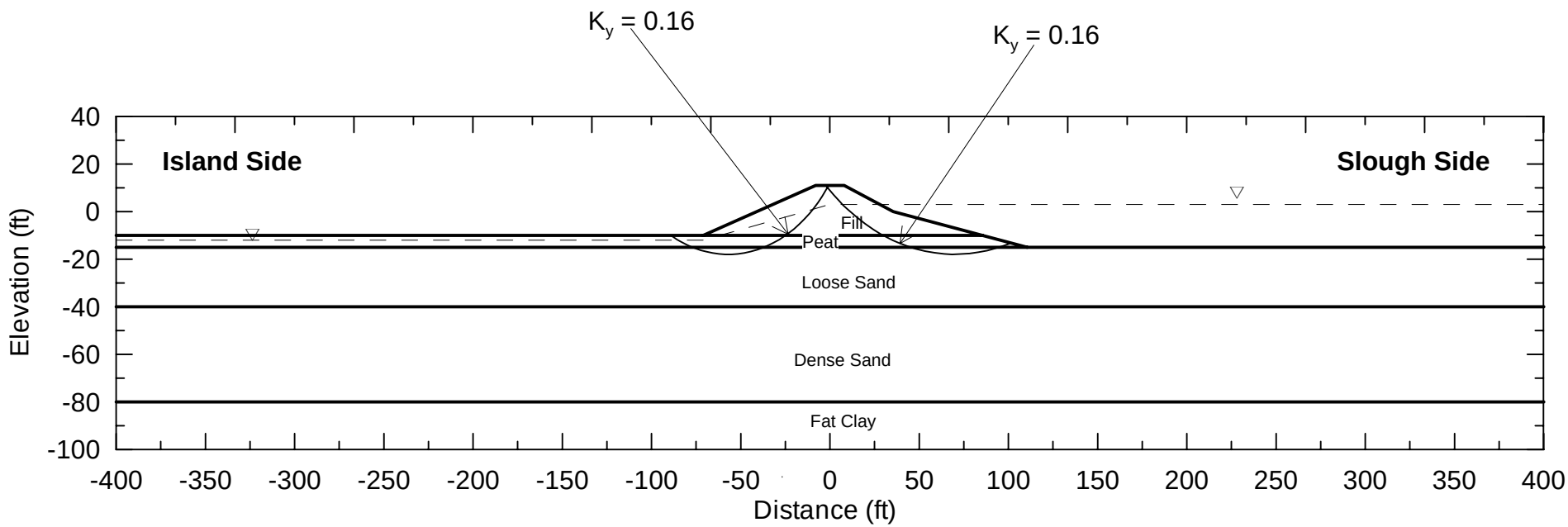


Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated FLAC Displacements Sherman Island - Sta. 650+00 35 Feet of Peat	Figure 6-32
URS	Project No. 26815621		



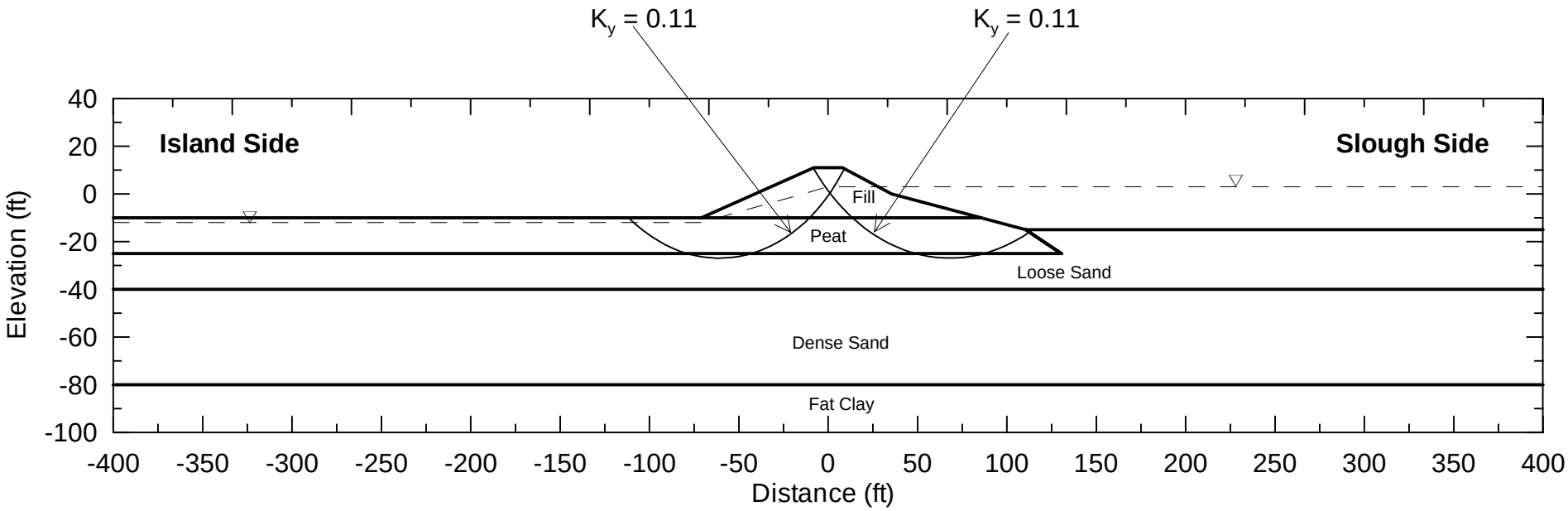
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Fill	115	32	50	-	-
Loose Sand	125	32	0	-	-
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Section Stability Analysis - Seismic No Peat	Figure 6-33
URS	Project No. 26815621		



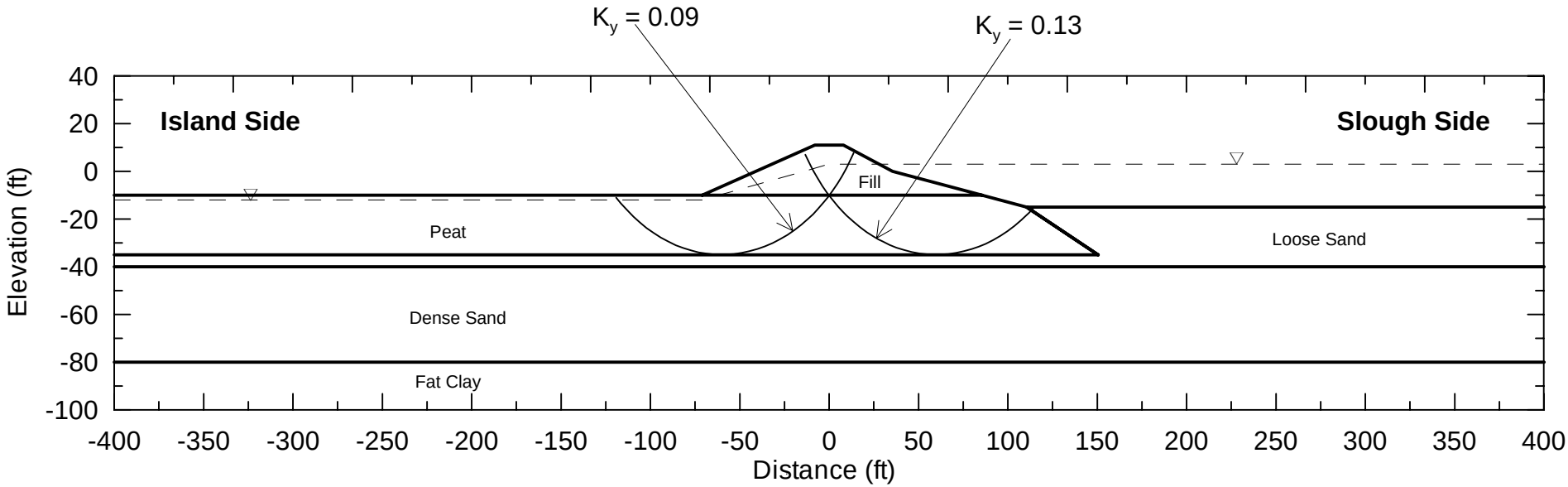
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Fill	115	32	50	-	-
Peat	70	28	120	18	140
Loose Sand	125	32	0	-	-
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Section Stability Analysis - Seismic 5 Feet of Peat	Figure 6-34
URS	Project No. 26815621		



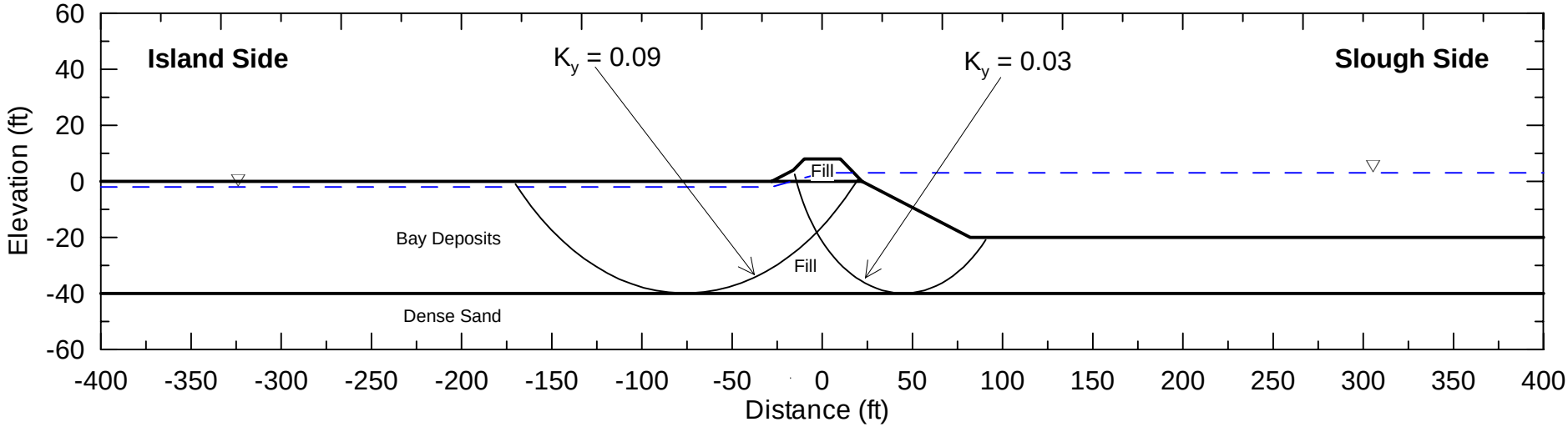
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Fill	115	32	50	-	-
Peat	70	28	120	18	140
Loose Sand	125	32	0	-	-
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Section Stability Analysis - Seismic 15 Feet of Peat	Figure 6-35
URS	Project No. 26815621		



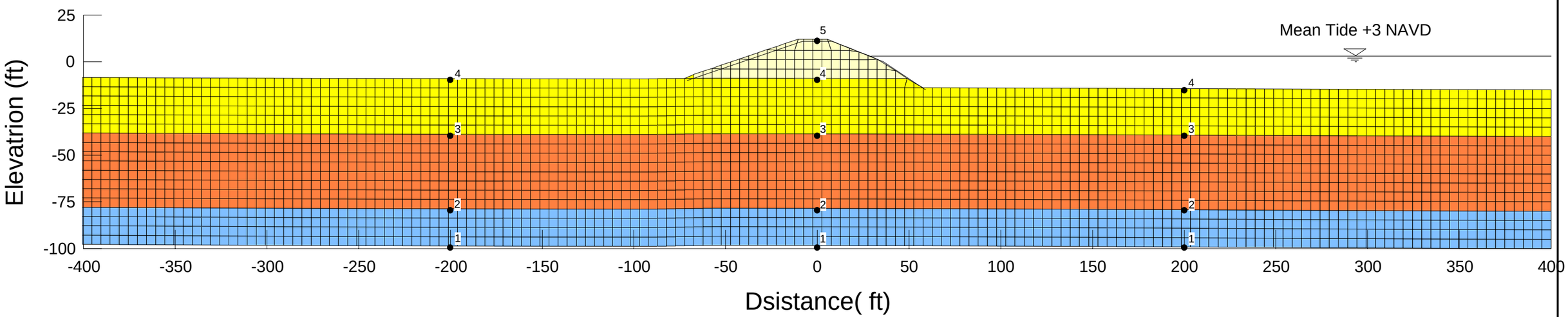
Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Fill	115	32	50	-	-
Peat	70	28	120	18	140
Loose Sand	125	32	0	-	-
Dense Sand	125	38	0	-	-

Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Section Stability Analysis - Seismic 25 Feet of Peat	Figure 6-36
URS	Project No. 26815621		



Type	Unit Weight (pcf)	ϕ'	c' (psf)	ϕ	c (psf)
Sandy Fill	115	30	50	-	-
Bay Deposit	110	0	300	0	300
Sand	125	38	0	-	-

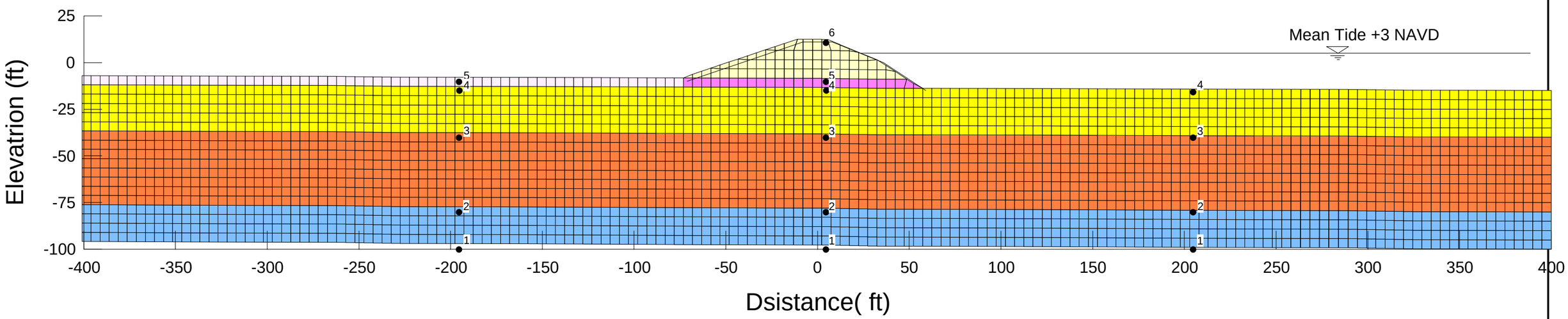
Delta Risk Management Strategy (DRMS) Levee Fragility		Idealized Section Stability Analysis - Seismic Suisun Marsh	Figure 6-37
URS	Project No. 26815621		



Legend

- Levee Fill
- Sand
- Dense Sand
- Stiff Clay

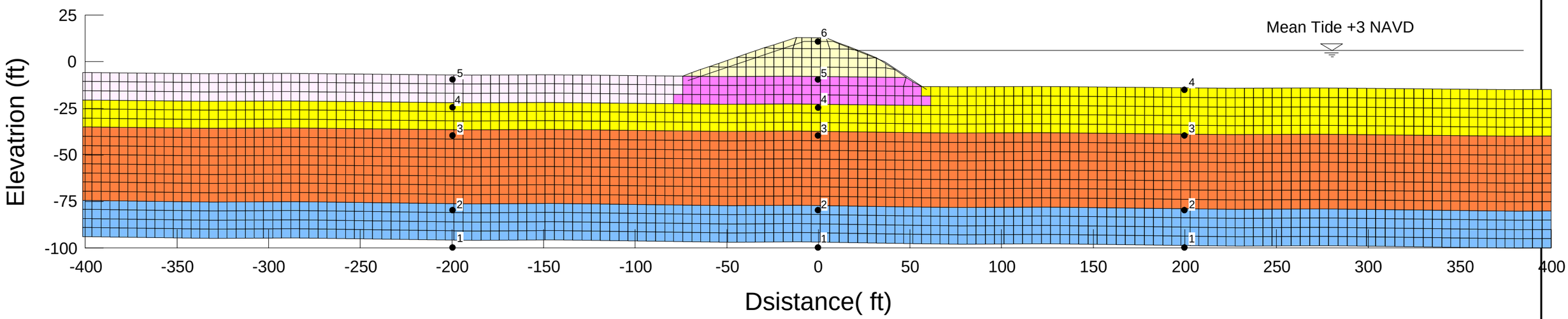
Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Model for Seismic Analysis Idealized Section - No Peat	Figure 6-38
URS	Project No. 26815621		



Legend

- Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand
- Dense Sand
- Stiff Clay

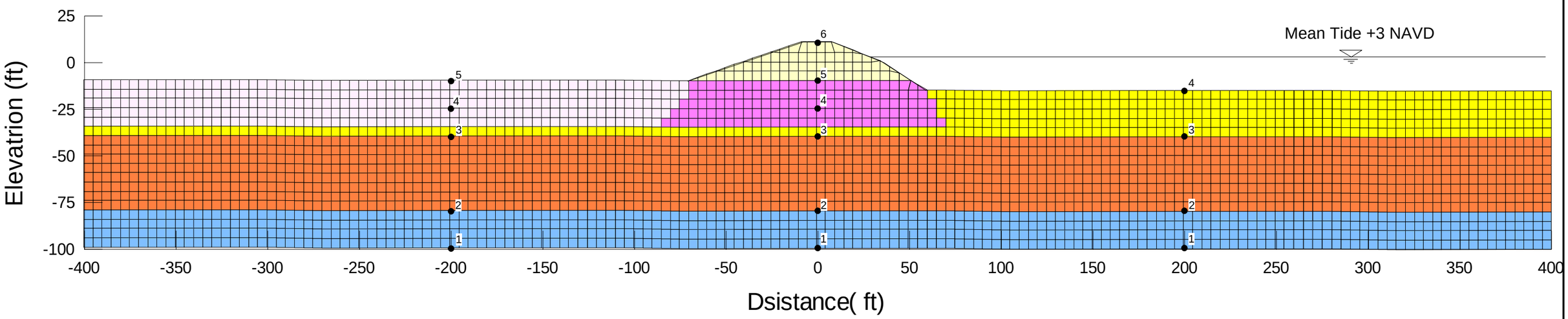
Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Model for Seismic Analysis Idealized Section - 5 ft Peat	Figure 6-39
URS	Project No. 26815621		



Legend

- Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand
- Dense Sand
- Stiff Clay

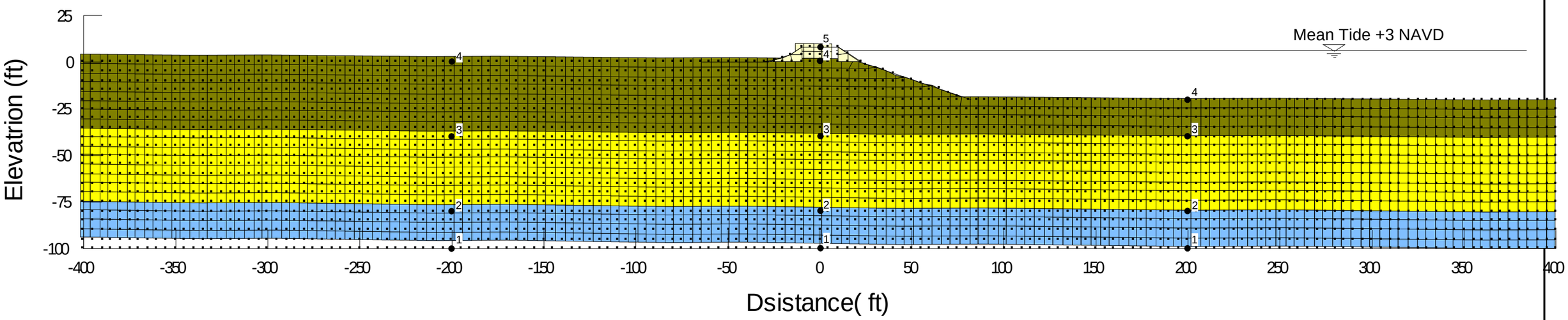
Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Model for Seismic Analysis Idealized Section - 15 ft Peat	Figure 6-40
URS	Project No. 26815621		



Legend

- Levee Fill
- Free Field Peat
- Under Levee Peat
- Sand
- Dense Sand
- Stiff Clay

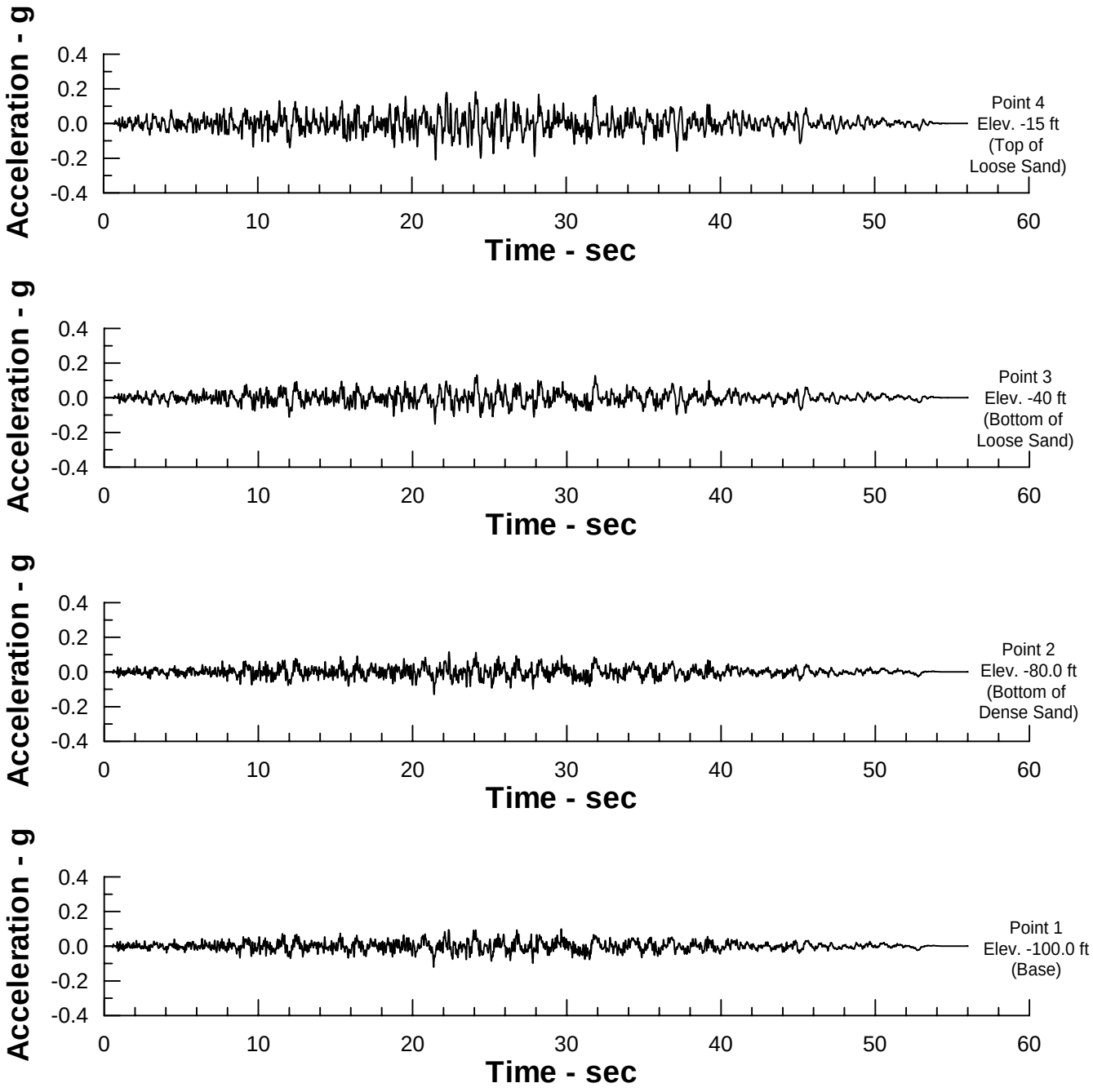
Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Model for Seismic Analysis Idealized Section - 25 ft Peat	Figure 6-41
URS	Project No. 26815621		



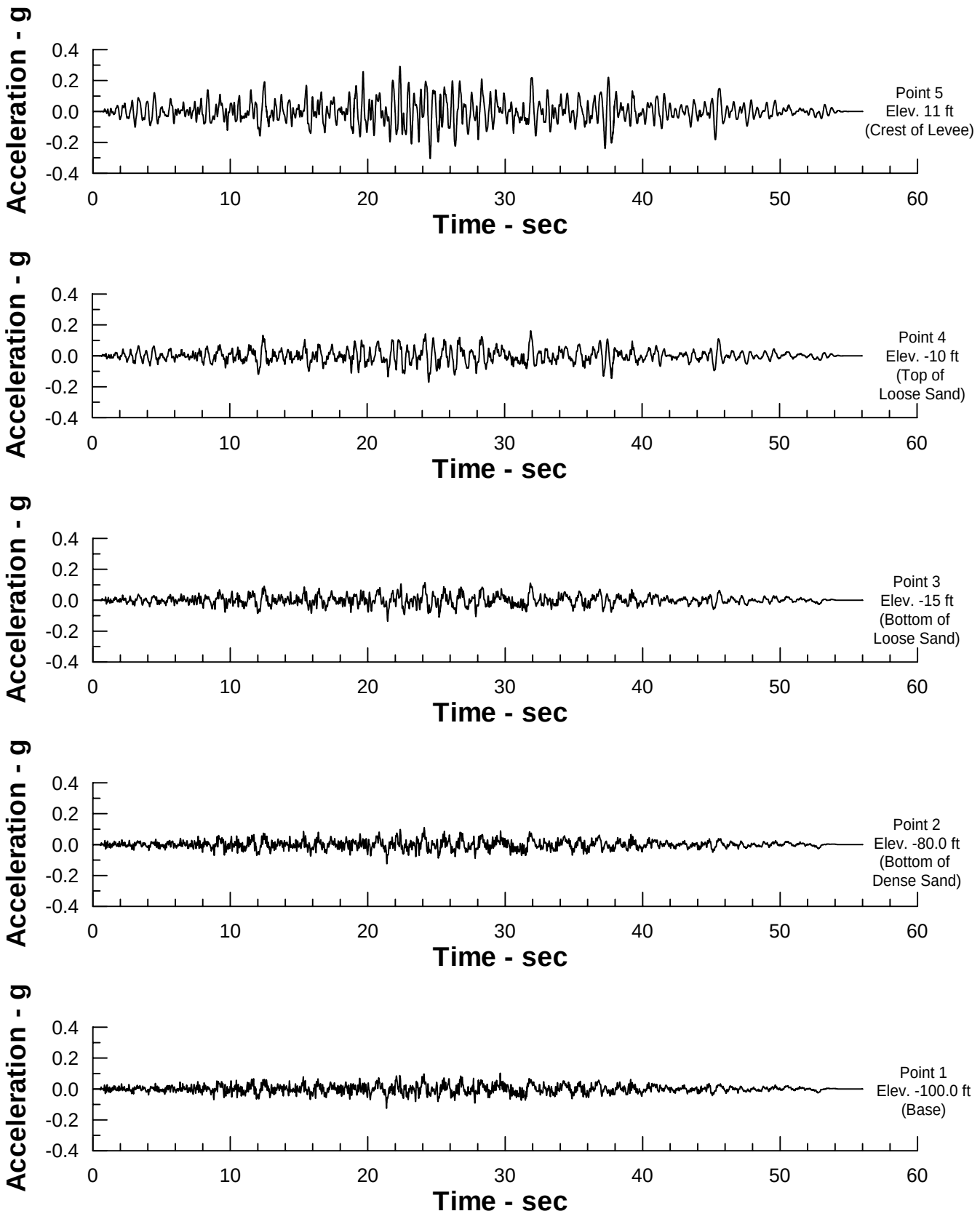
Legend

- Levee Fill
- Bay Deposits
- Sand
- Stiff Clay

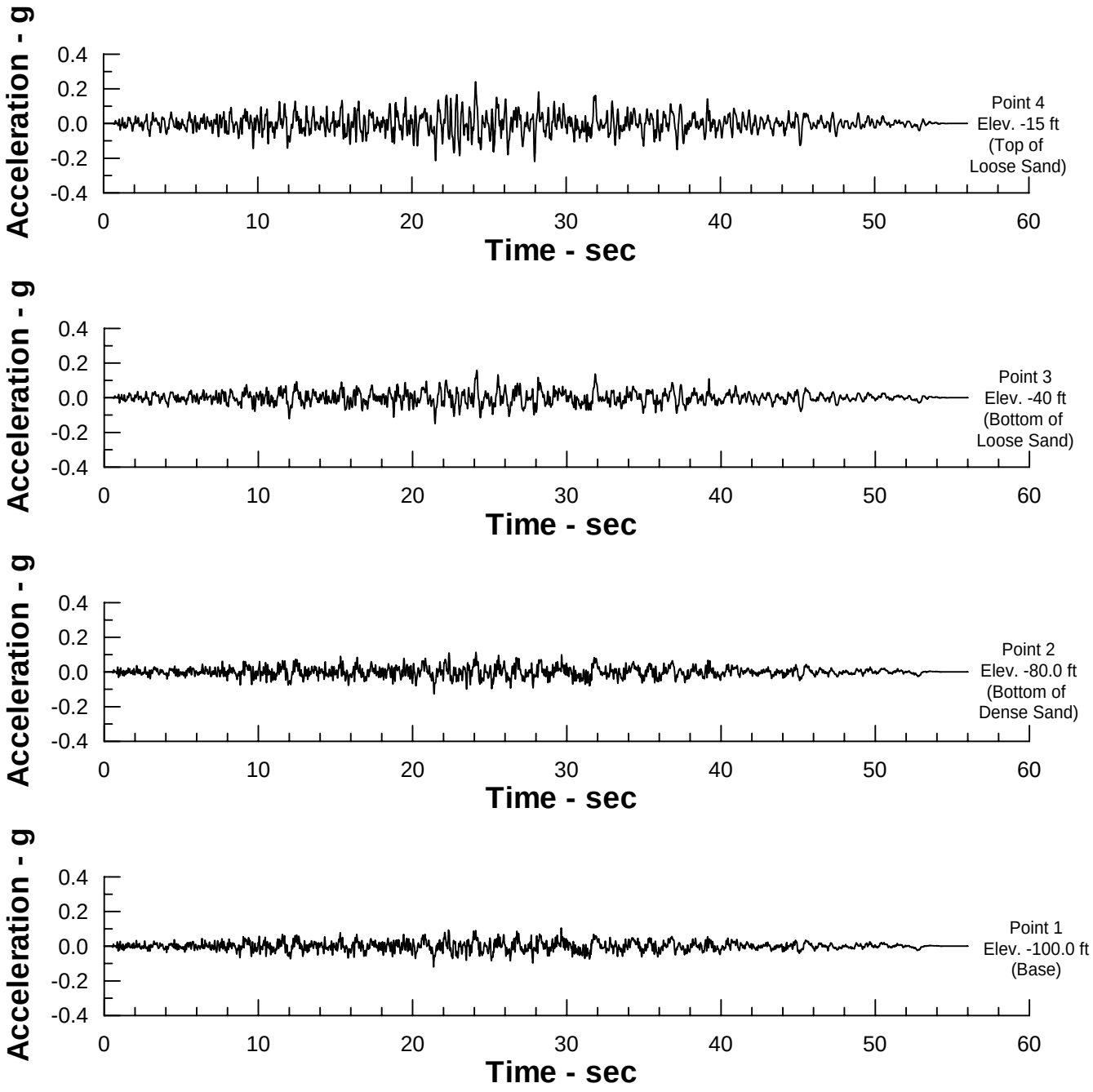
Delta Risk Management Strategy (DRMS) Levee Fragility		Finite Element Model for Seismic Analysis Suisun Marsh Section	Figure 6-42
URS	Project No. 26815621		



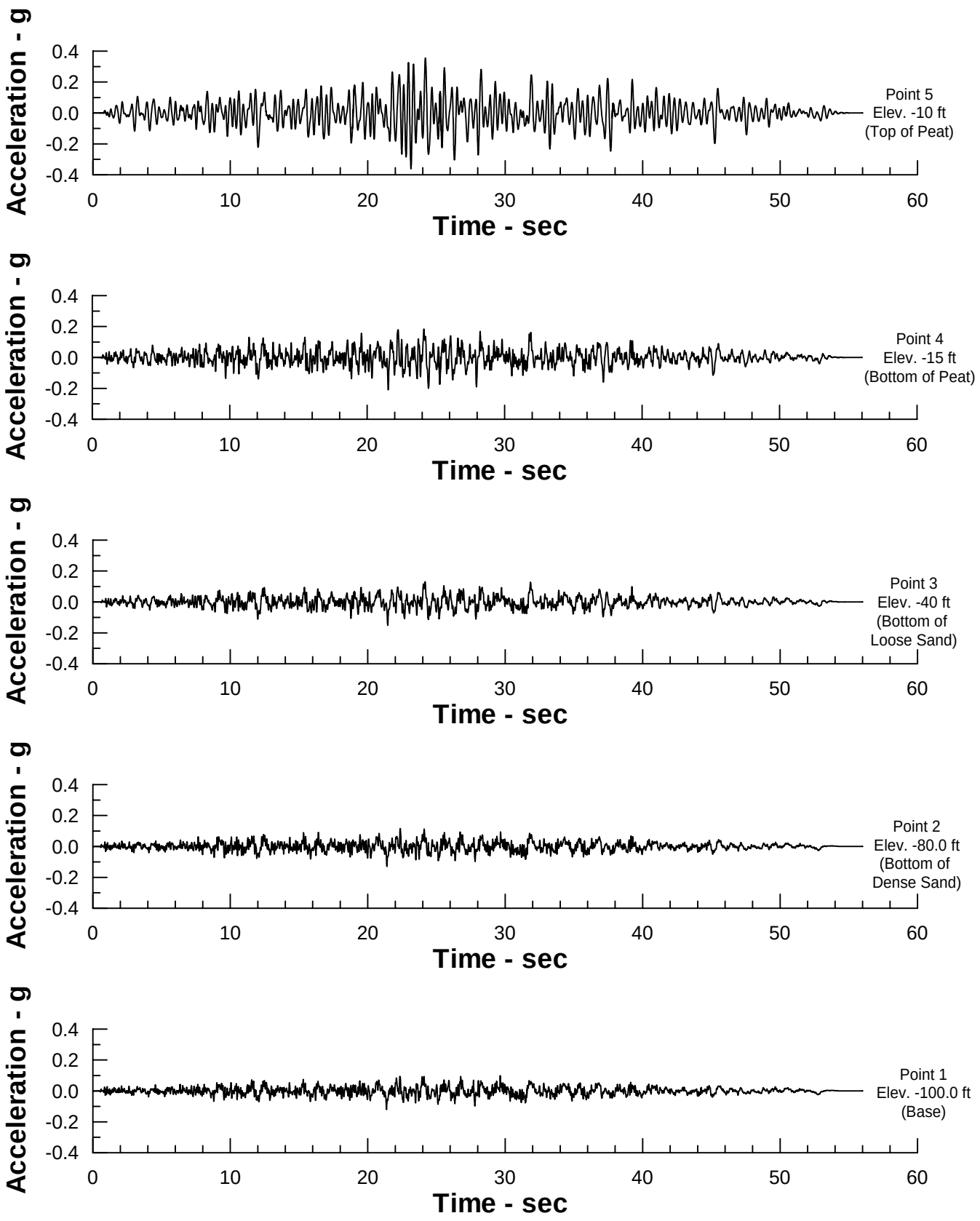
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Island Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - No Peat	Figure 6-43
URS	Project No. 26815621		



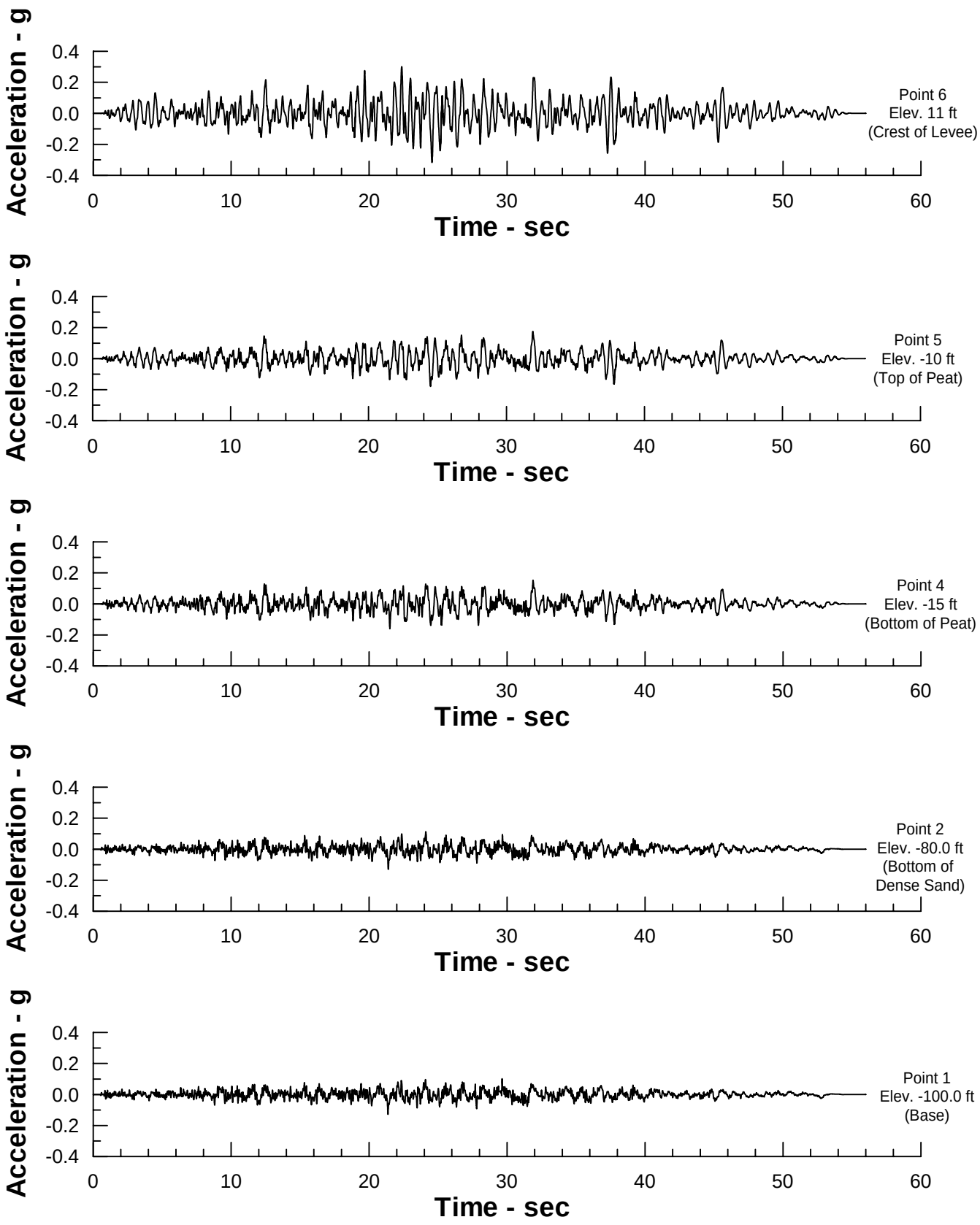
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along the Center Line of Levee (M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - No Peat	Figure 6-44
URS	Project No. 26815621		



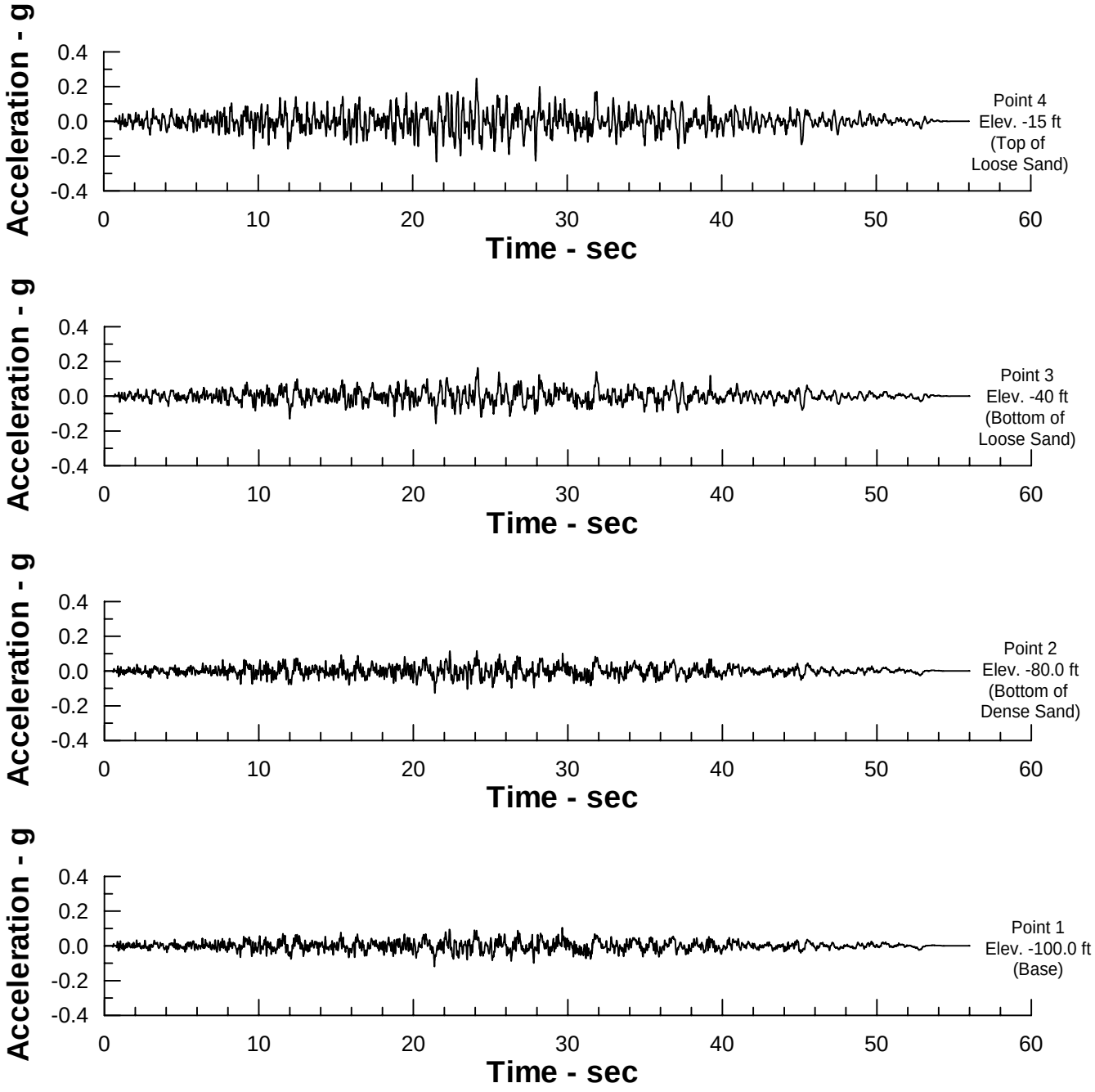
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Water Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - No Peat	Figure 6-45
URS	Project No. 26815621		



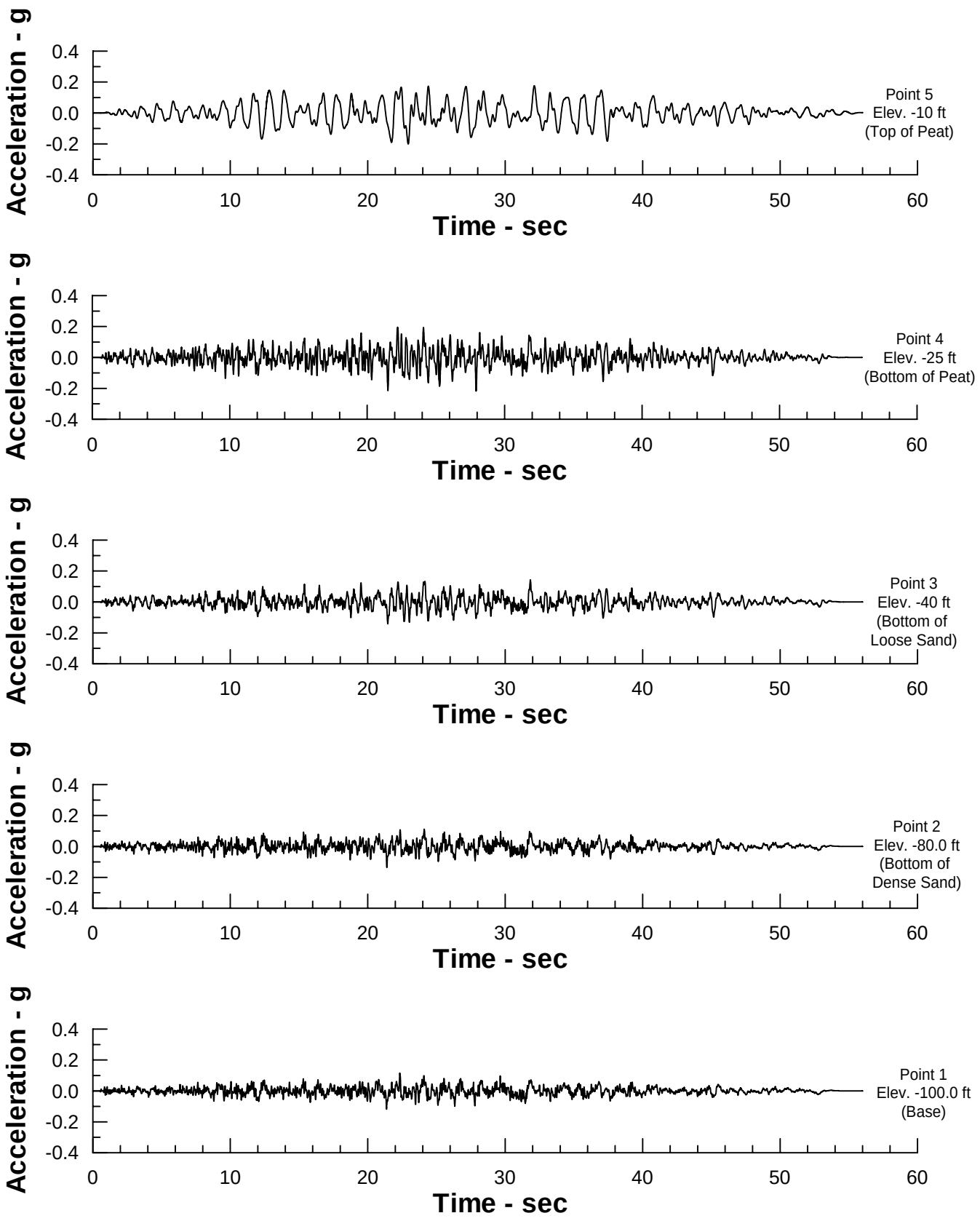
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Island Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 5 Feet of Peat	Figure 6-46
URS	Project No. 26815621		



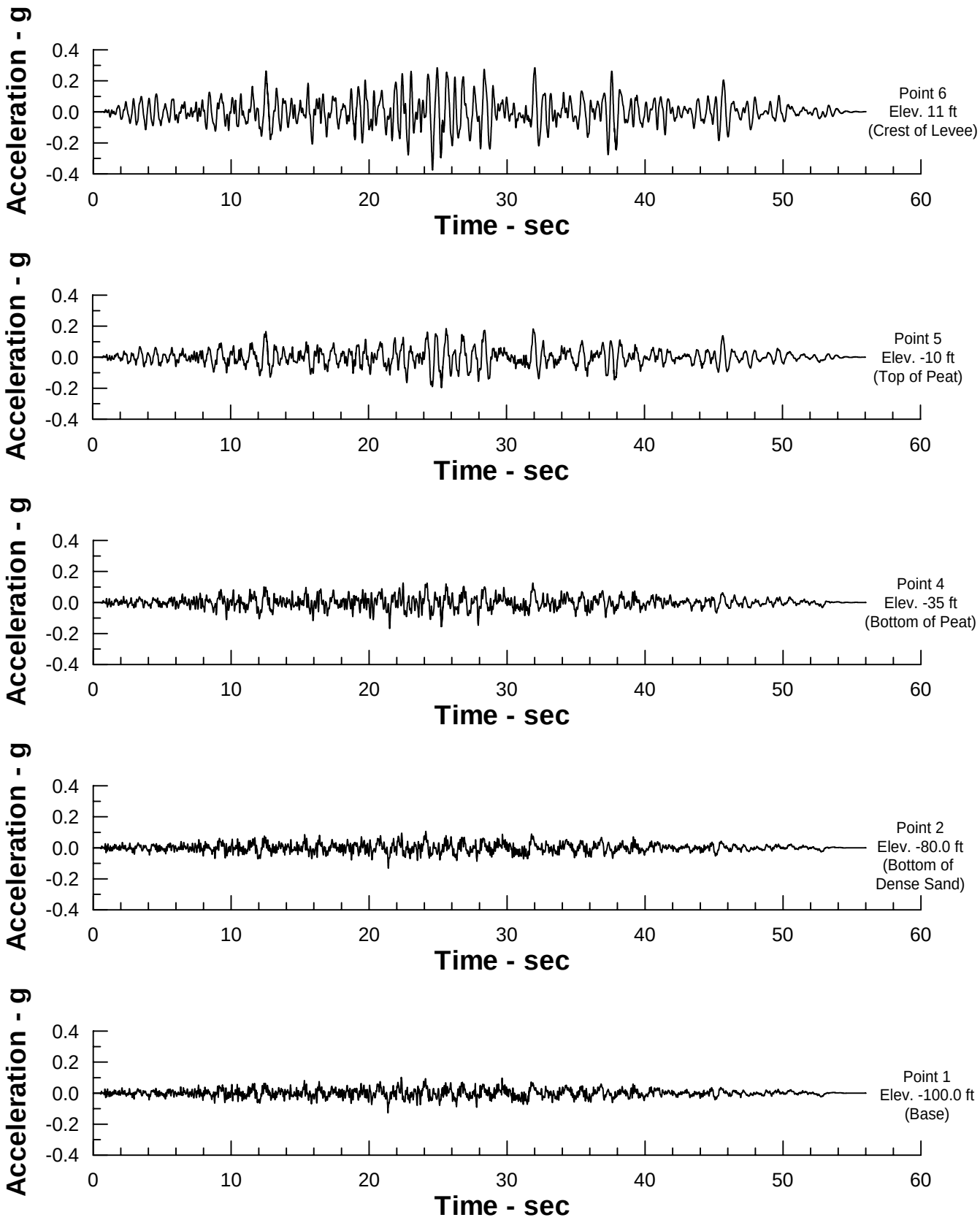
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along the Center Line of Levee (M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 5 Feet of Peat	Figure 6-47
URS	Project No. 26815621		



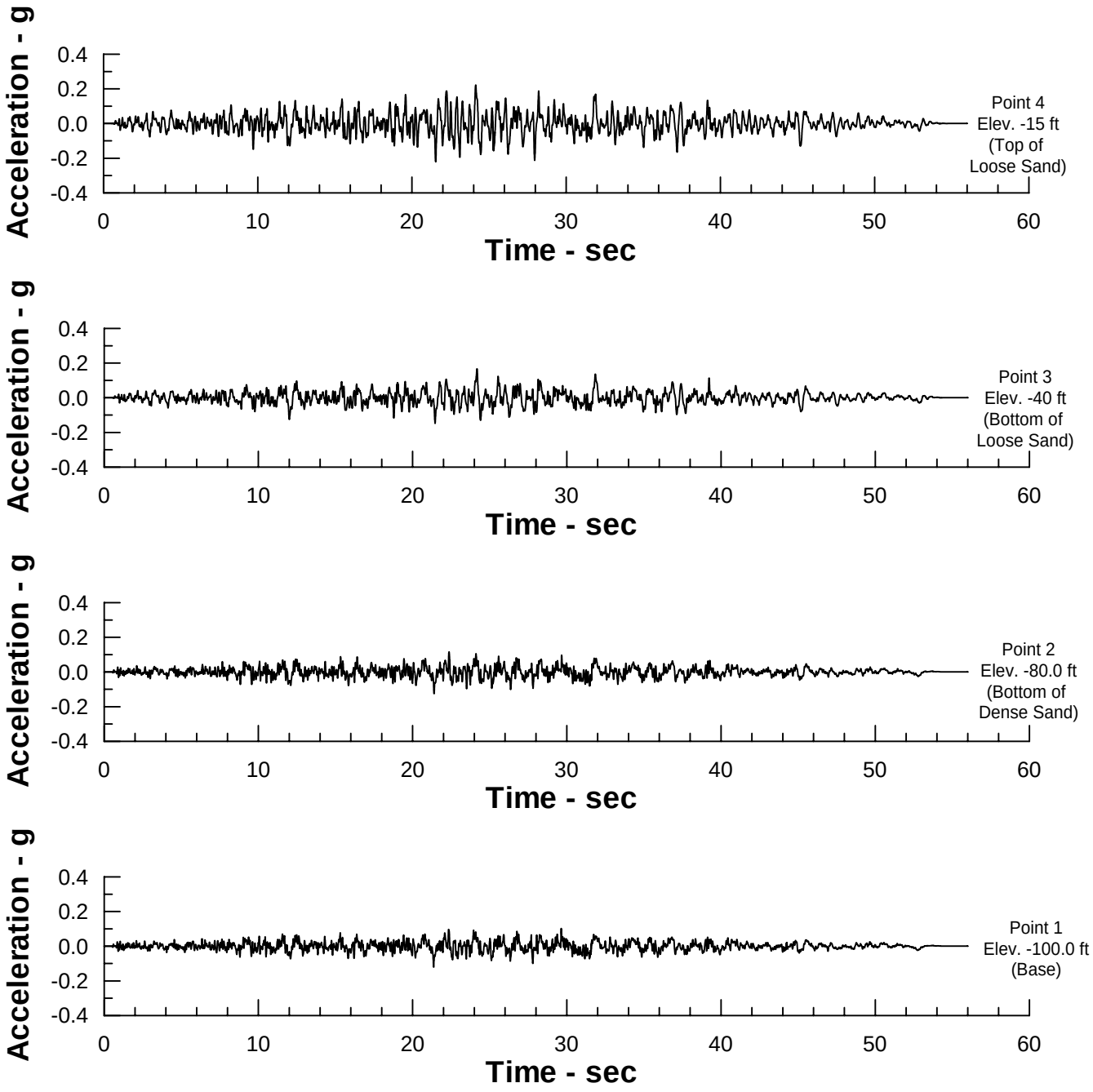
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Water Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 15 Feet of Peat	Figure 6-48
URS	Project No. 26815621		



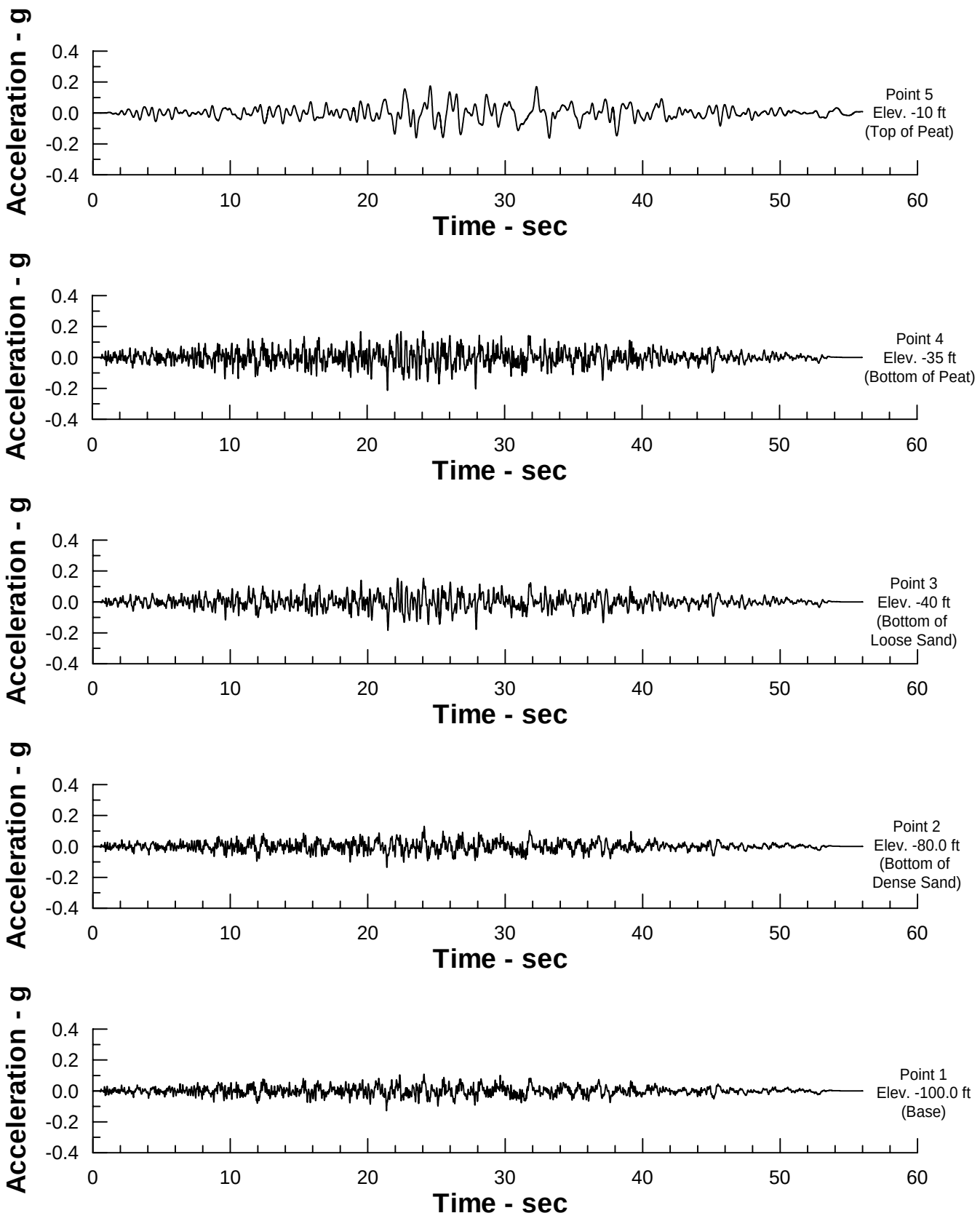
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Island Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 15 Feet of Peat	Figure 6-49
URS	Project No. 26815621		



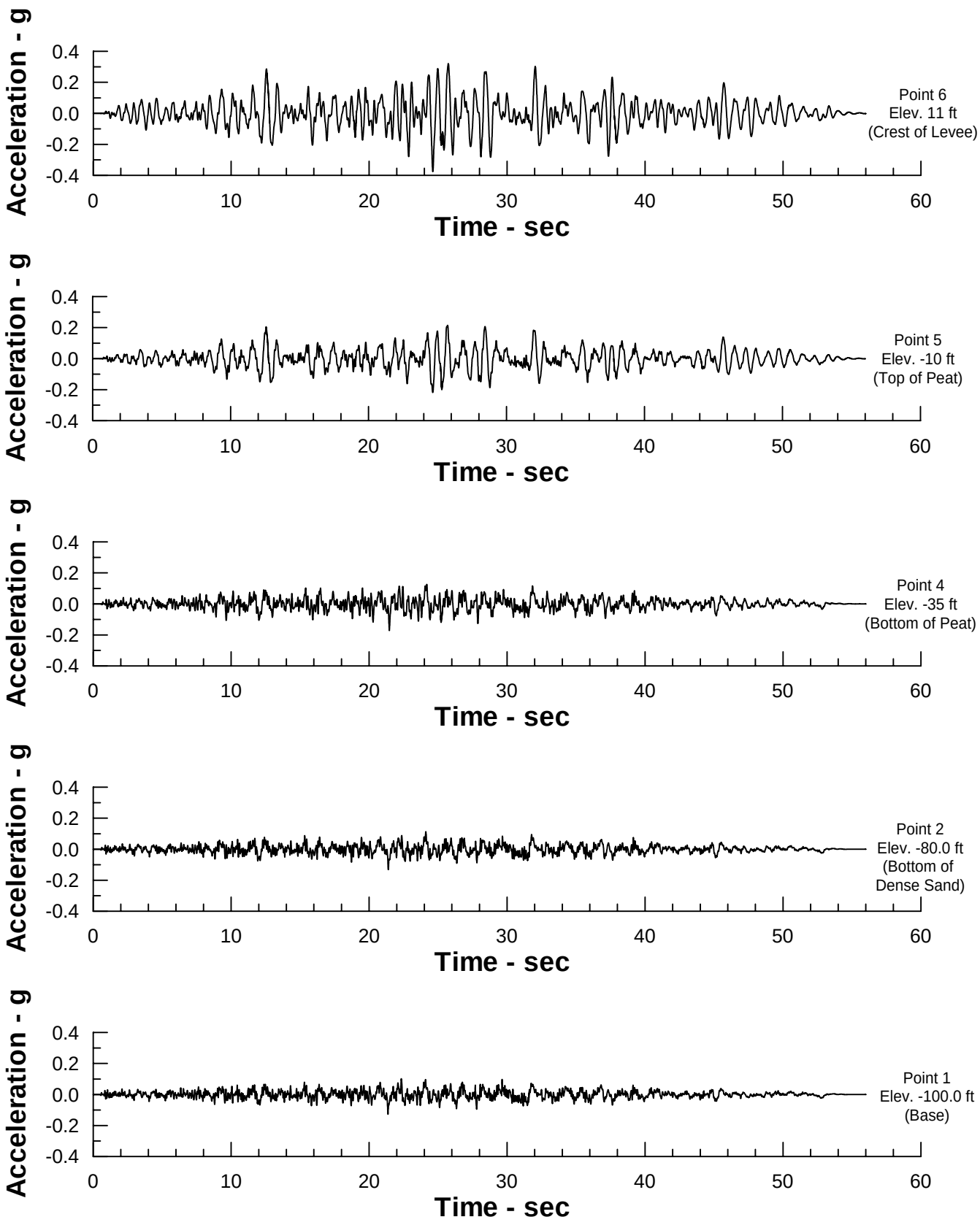
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along the Center Line of Levee (M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 15 Feet of Peat	Figure 6-50
URS	Project No. 26815621		



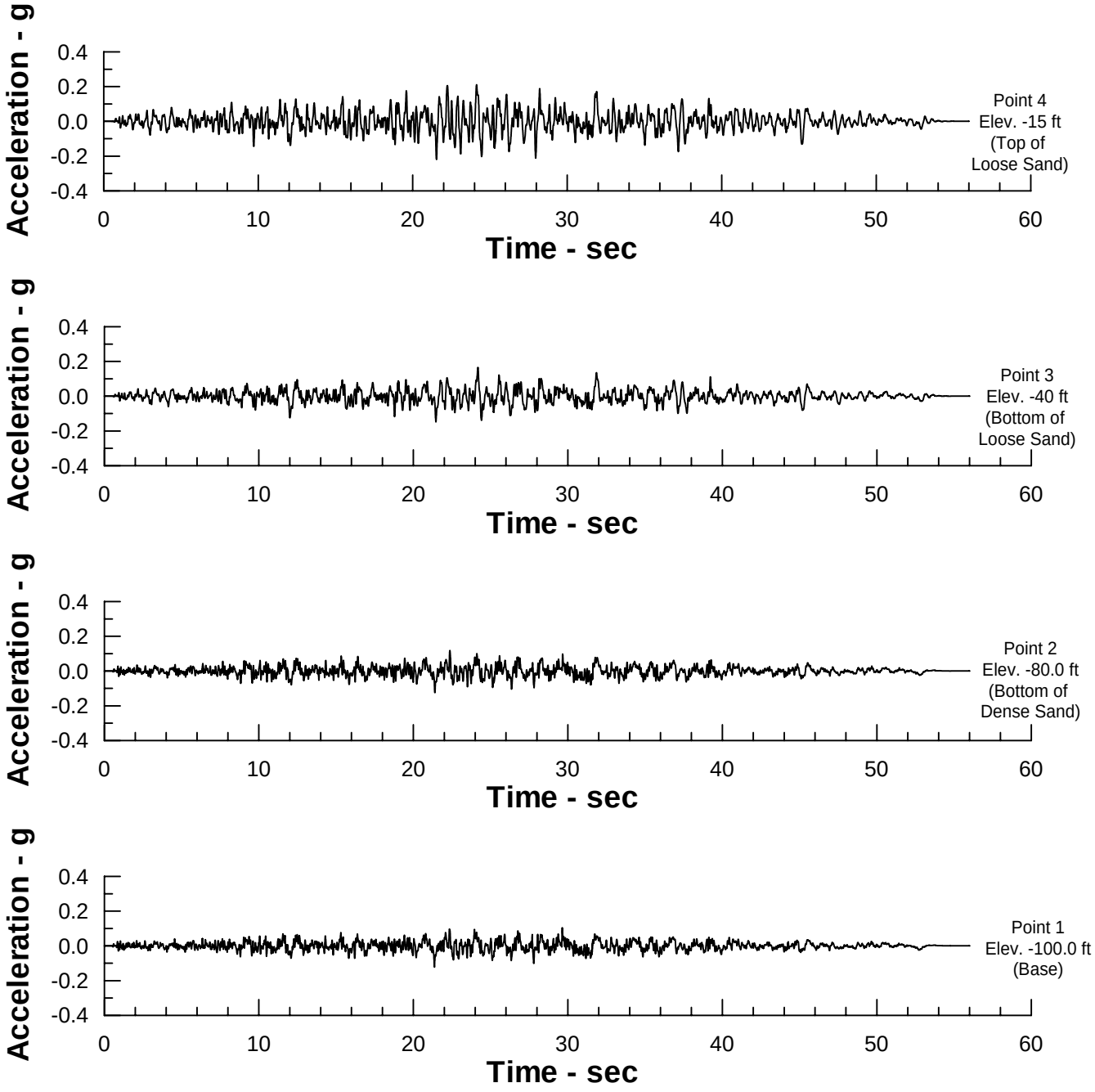
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Water Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 15 Feet of Peat	Figure 6-51
URS	Project No. 26815621		



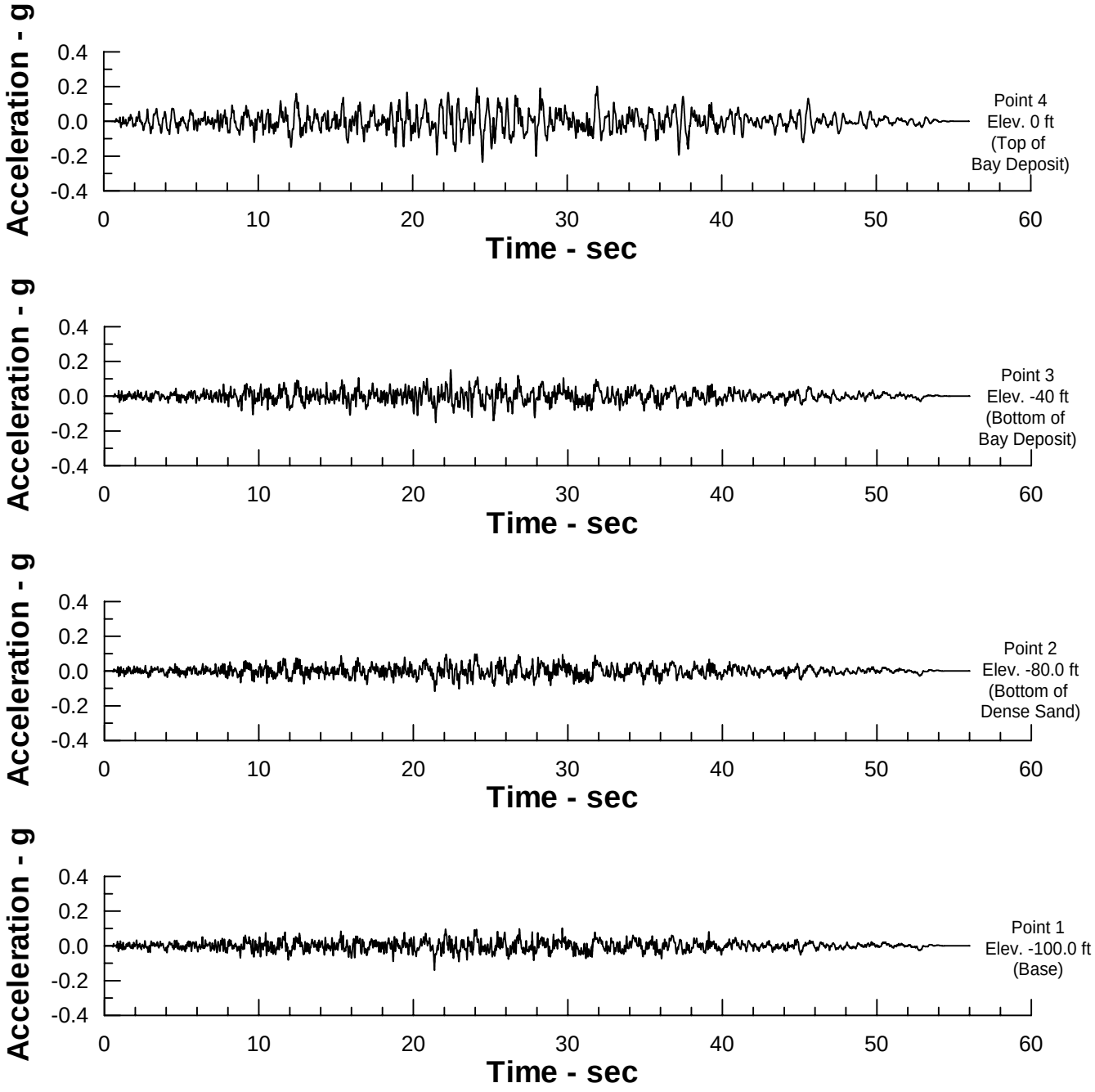
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Island Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 25 Feet of Peat	Figure 6-52
URS	Project No. 26815621		



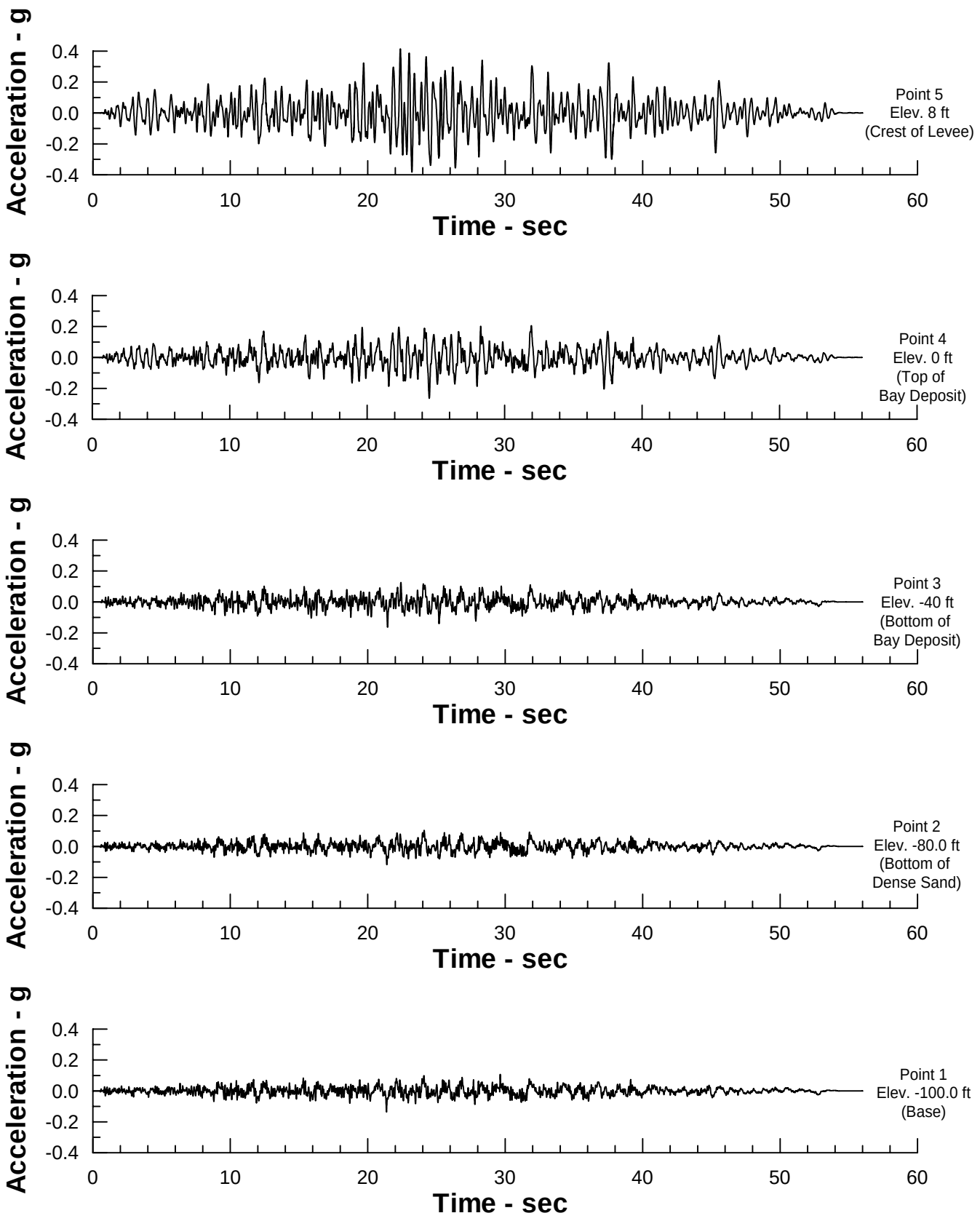
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along the Center Line of Levee (M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 25 Feet of Peat	Figure 6-53
URS	Project No. 26815621		



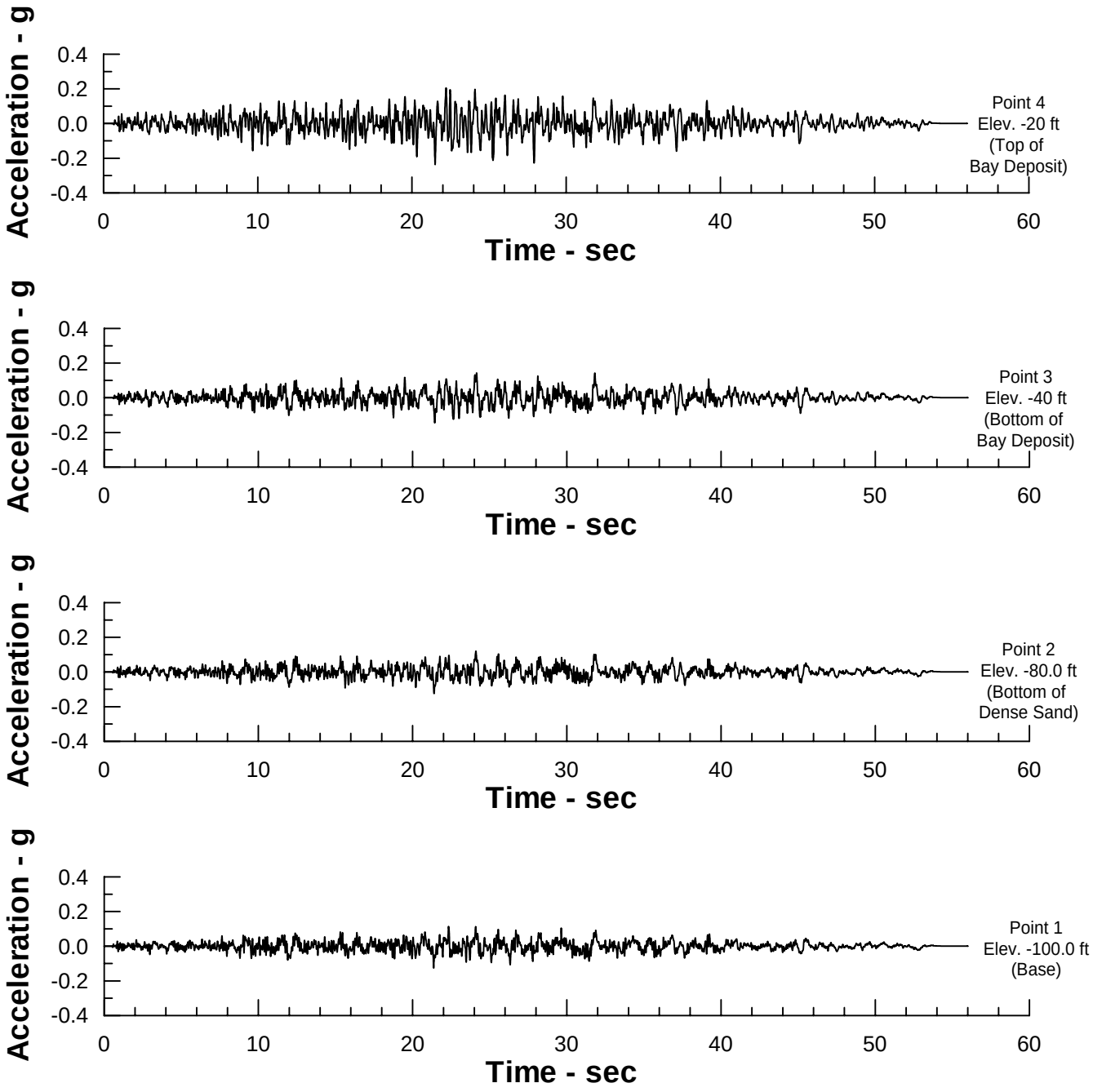
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Water Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Idealized Section - 25 Feet of Peat	Figure 6-54
URS	Project No. 26815621		



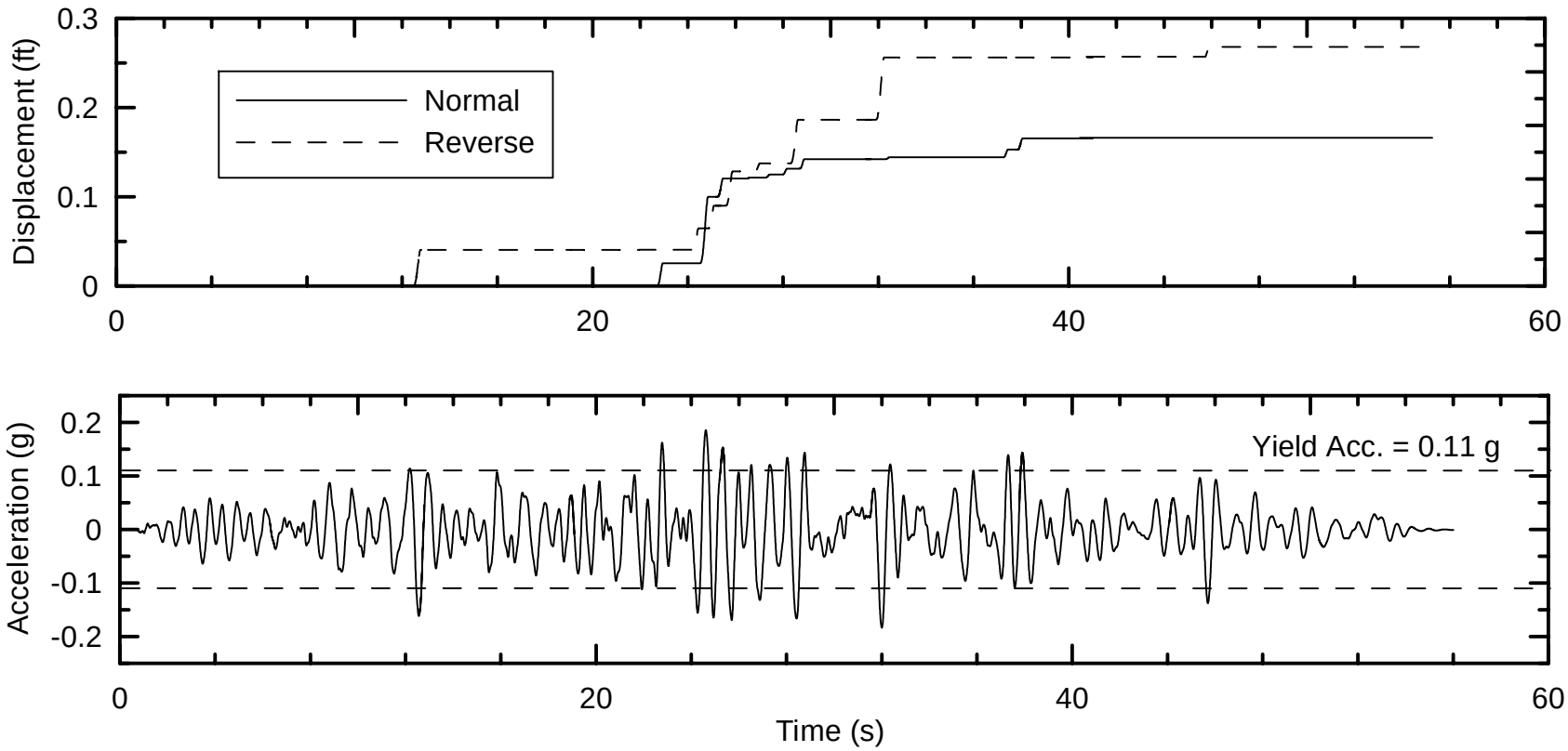
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Island Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Suisun Marsh Section	Figure 6-55
URS	Project No. 26815621		



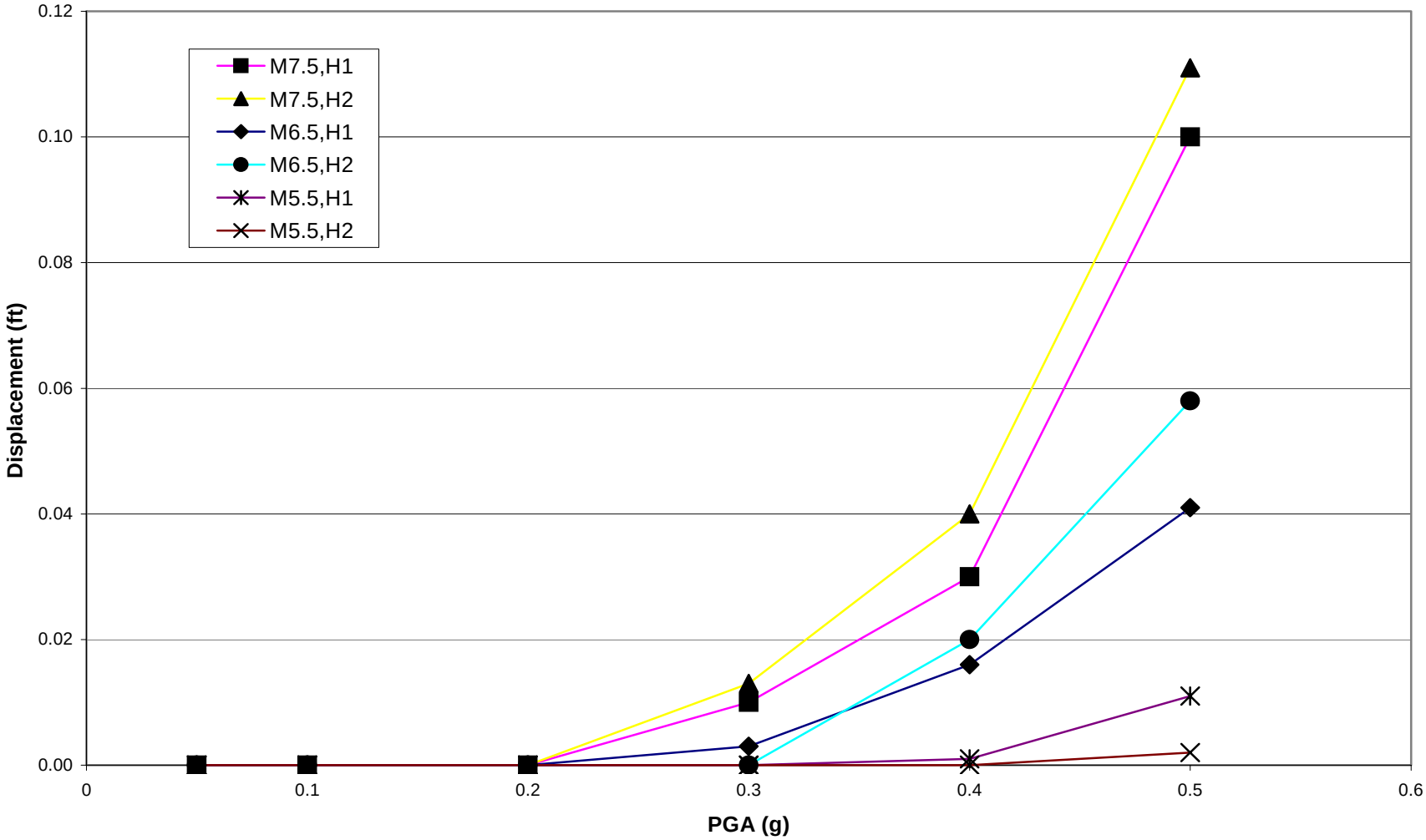
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along the Center Line of Levee (M 7.5 Horizontal-1 PGA 0.20g) Suisun Marsh Section	Figure 6-56
URS	Project No. 26815621		



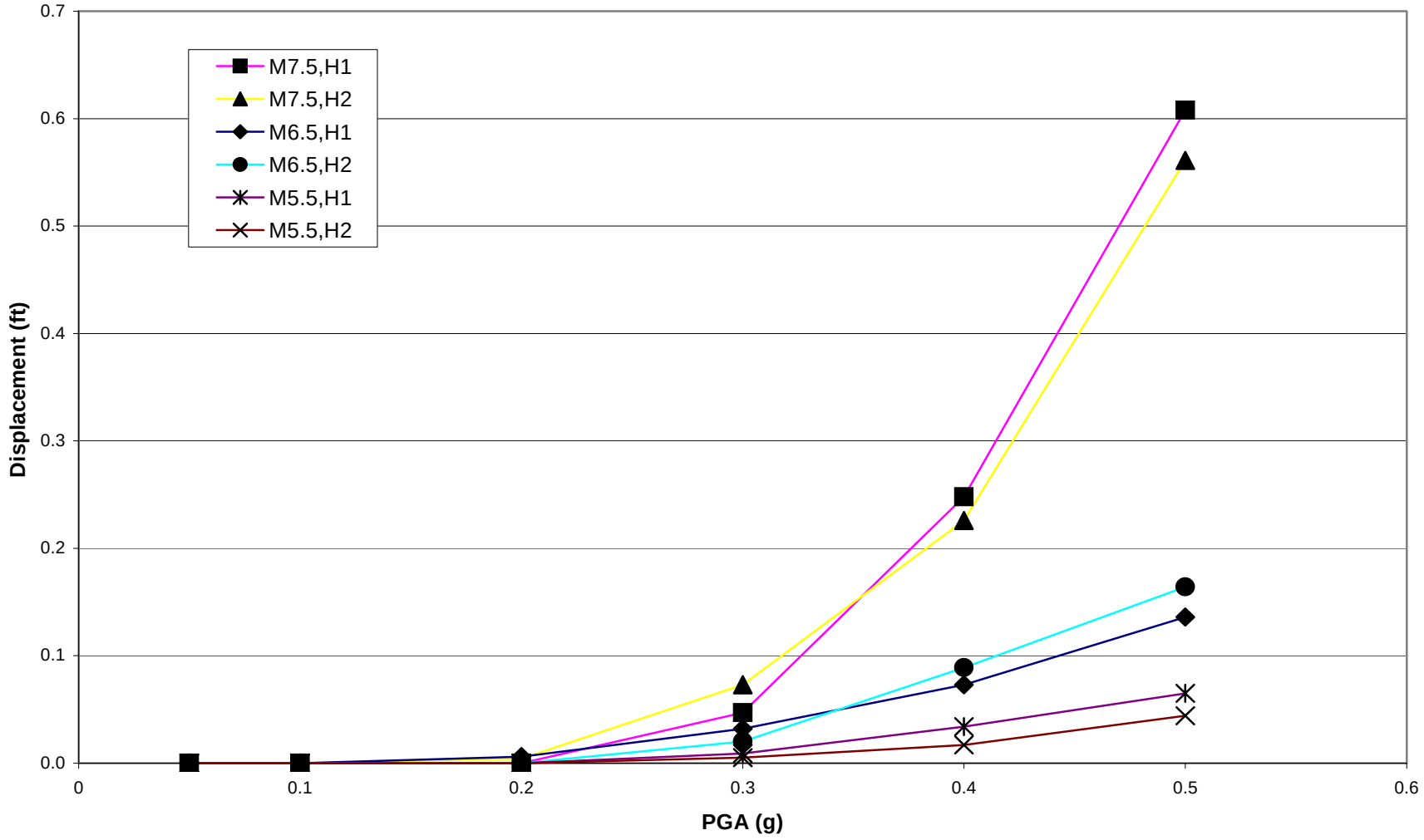
Delta Risk Management Strategy (DRMS) Levee Fragility		Horizontal Acceleration Time Histories Along Free Field Column: Water Side (Input Motion: M 7.5 Horizontal-1 PGA 0.20g) Suisun Marsh Section	Figure 6-57
URS	Project No. 26815621		



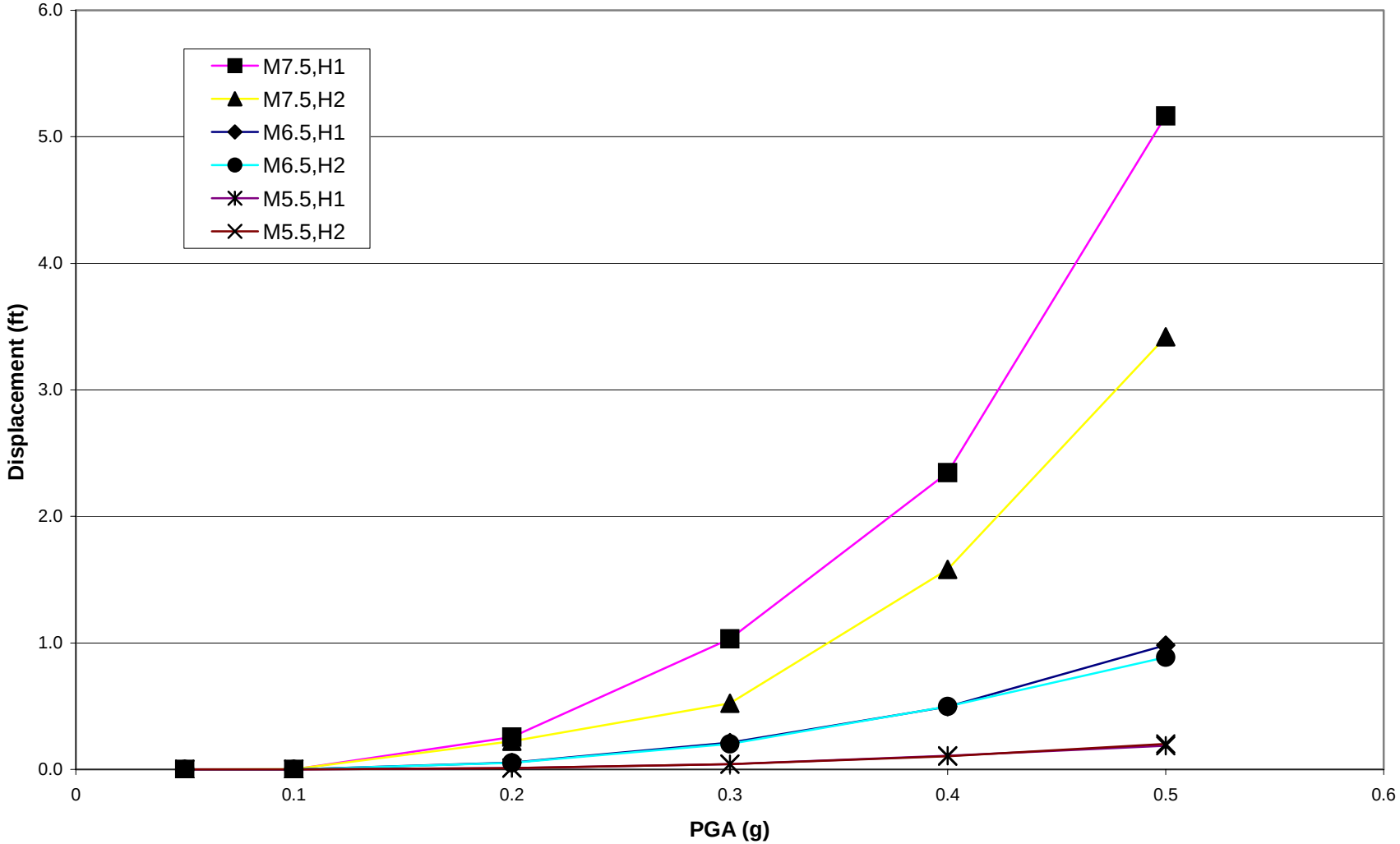
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements M7.5 Horizontal #1 Time History, 0.2g PGA Idealized Section 15 Feet of Peat	Figure 6-58
URS	Project No. 26815621		



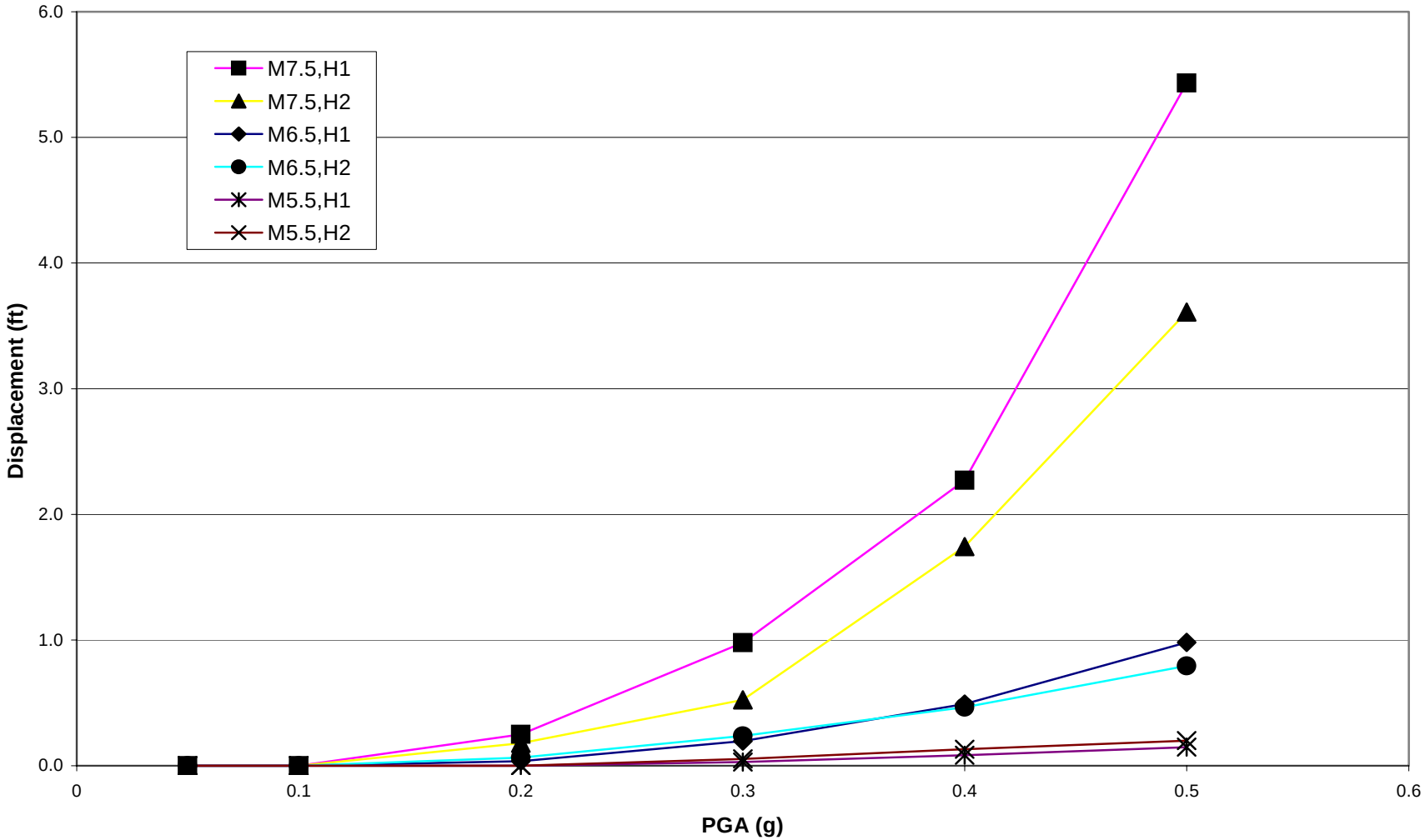
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section No Peat	Figure 6-59
URS	Project No. 26815621		



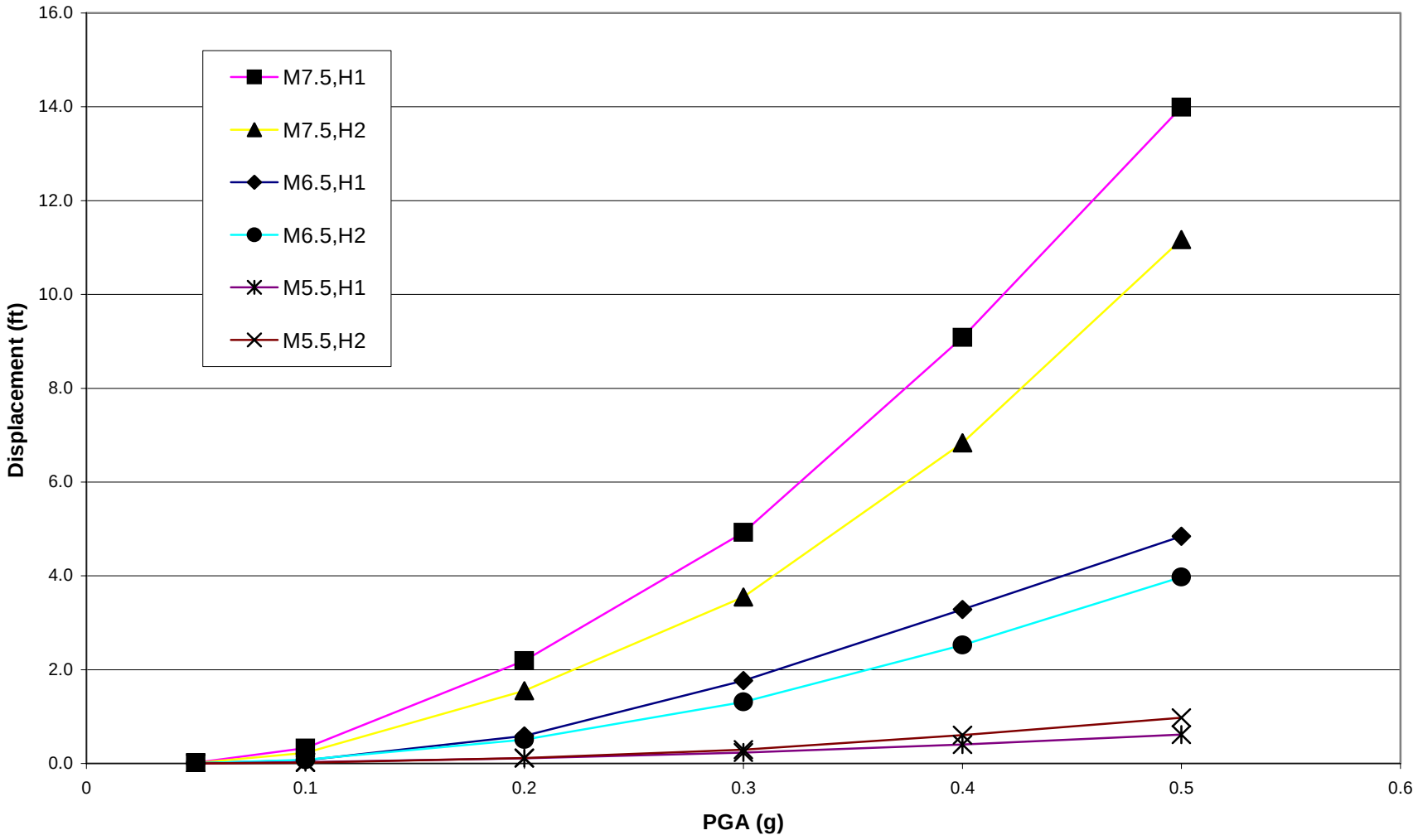
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section 5 Feet of Peat	Figure 6-60
URS	Project No. 26815621		



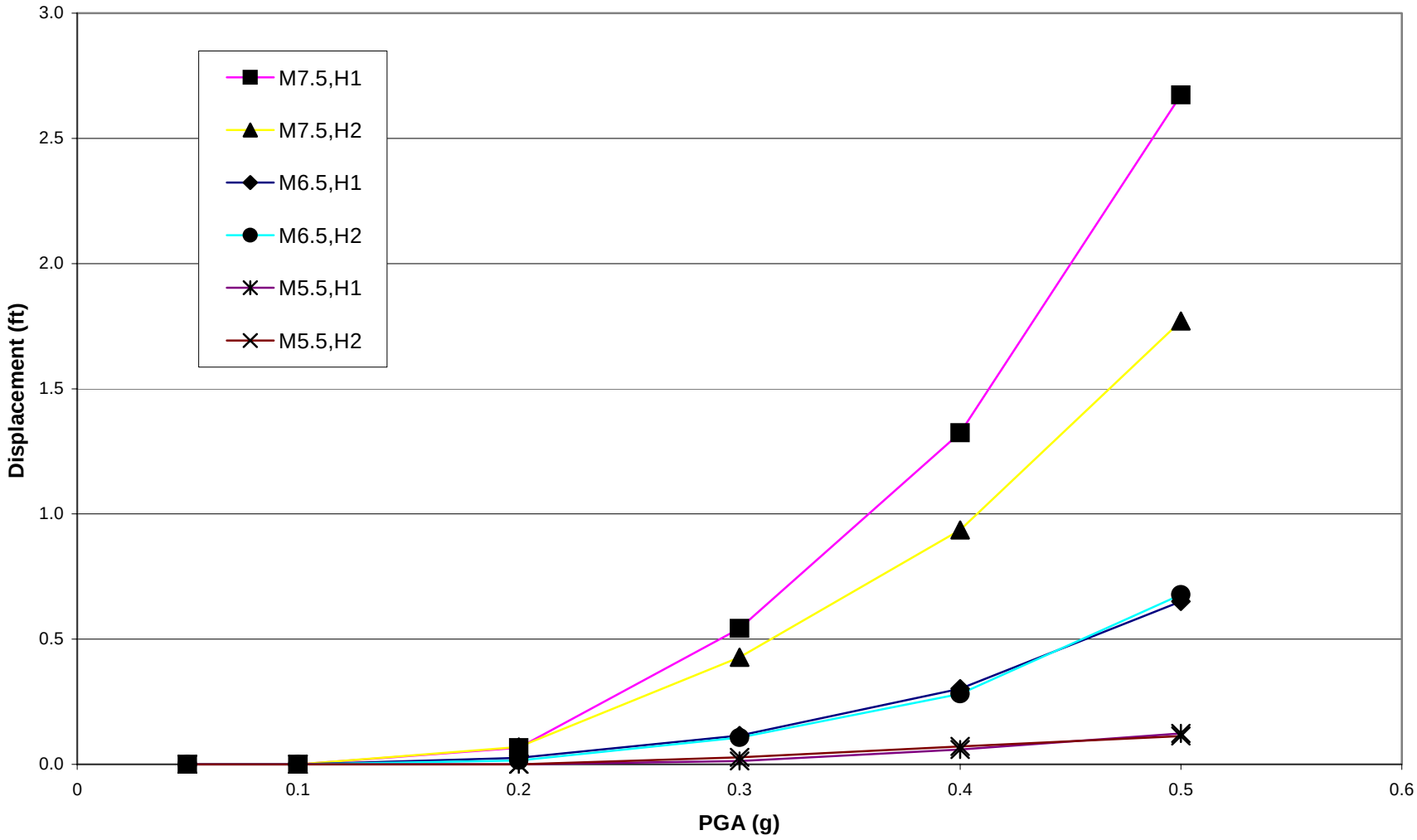
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section 15 Feet of Peat	Figure 6-61
URS	Project No. 26815621		



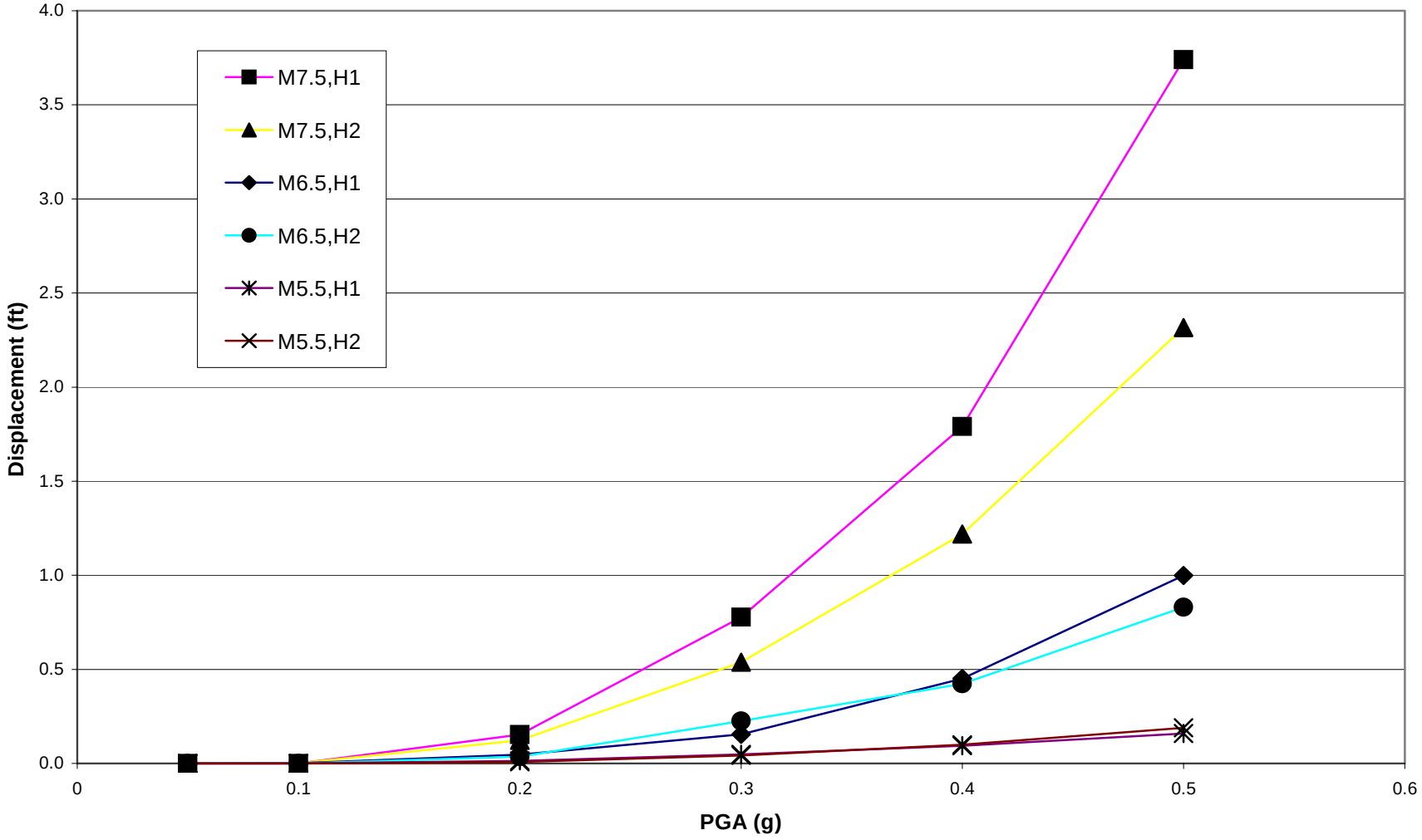
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section 25 Feet of Peat	Figure 6-62
URS	Project No. 26815621		



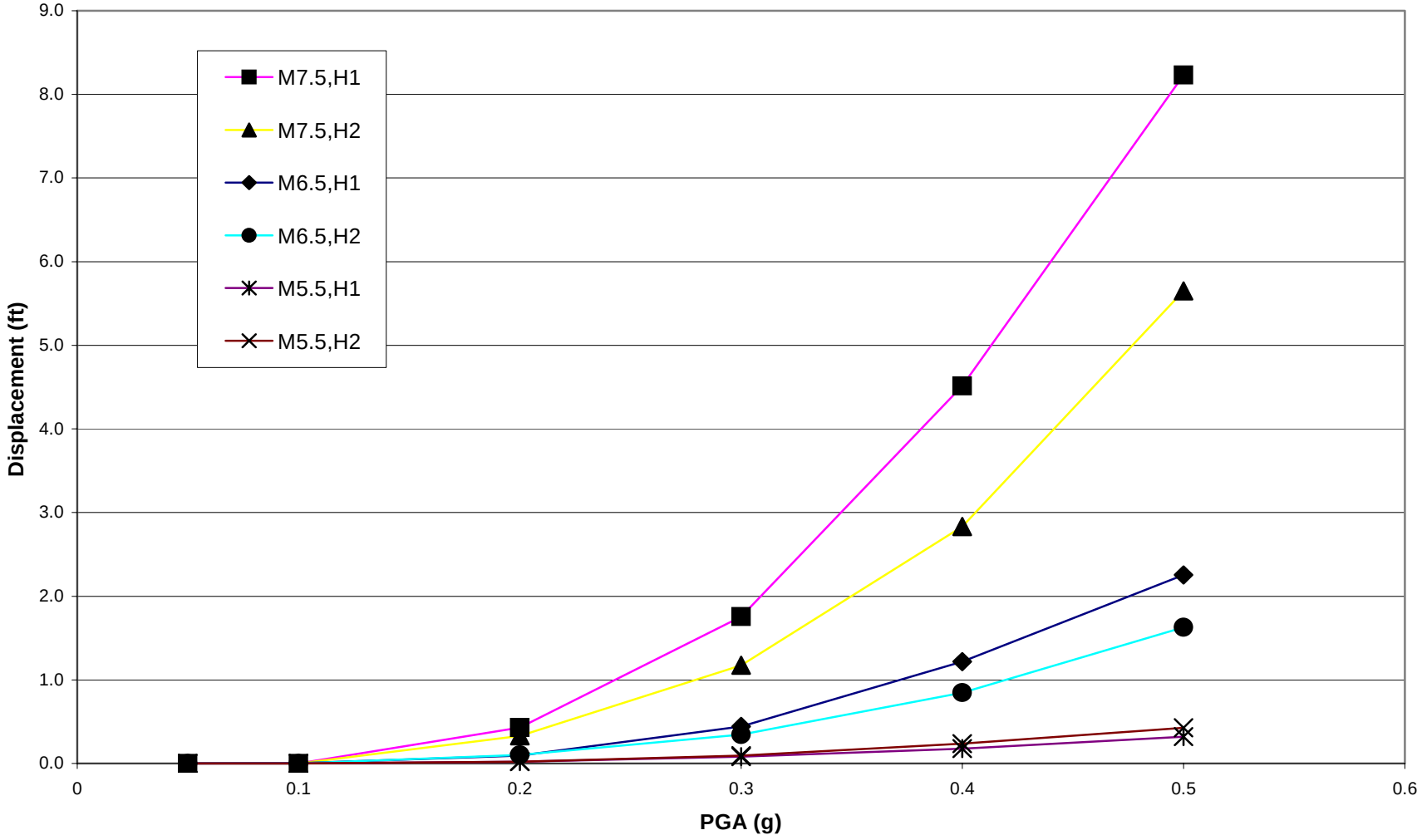
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section Suisun Marsh	Figure 6-63
URS	Project No. 26815621		



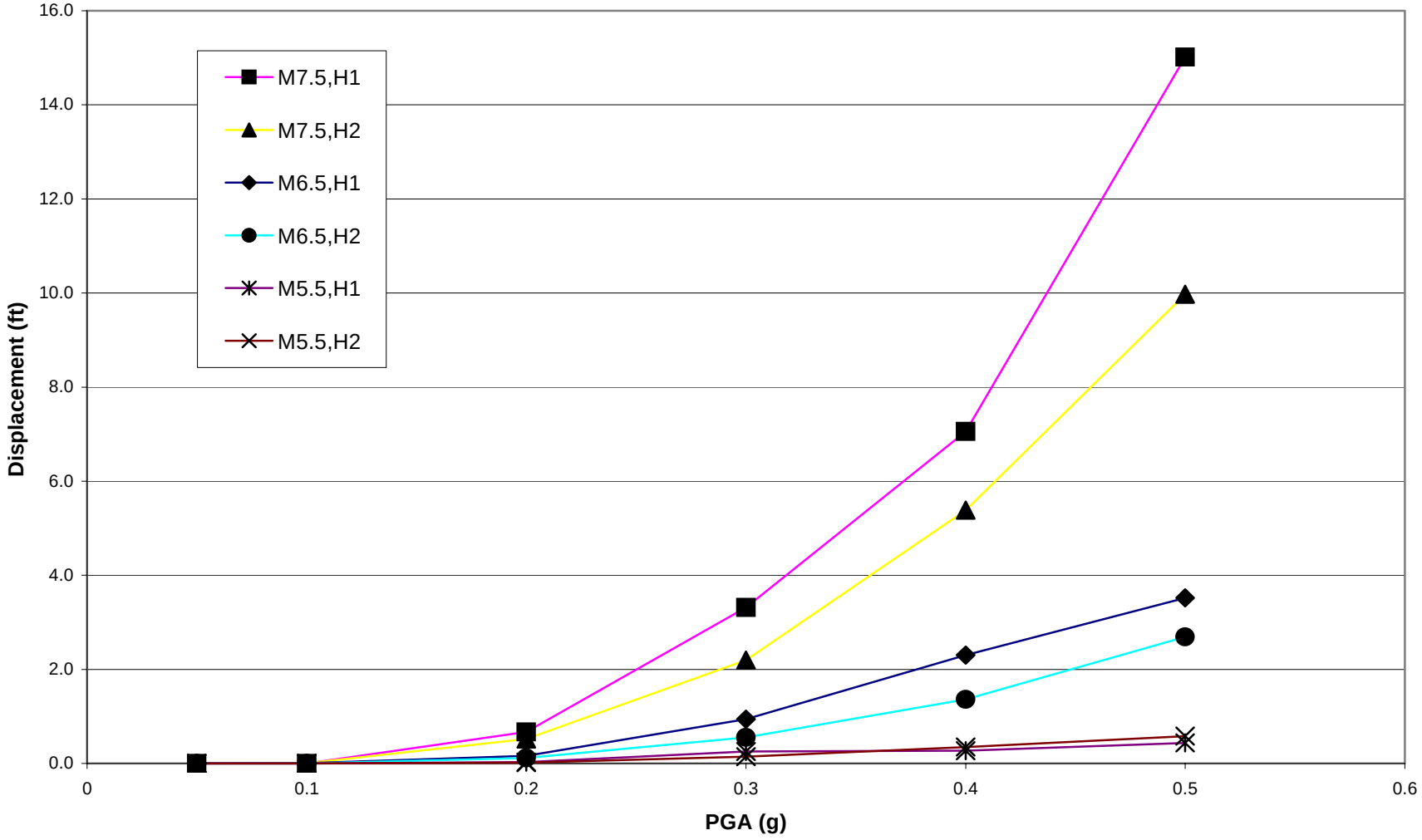
Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section with Steep Water Side Slope No Peat	Figure 6-64
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section with Steep Water Side Slope 5 ft Peat	Figure 6-65
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section with Steep Water Side Slope 15 ft Peat	Figure 6-66
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated Newmark Displacements Idealized Section with Steep Water Side Slope 25 ft Peat	Figure 6-67
URS	Project No. 26815621		

JOB TITLE : FLAC Mesh, No PEAT

FLAC (Version 5.00)

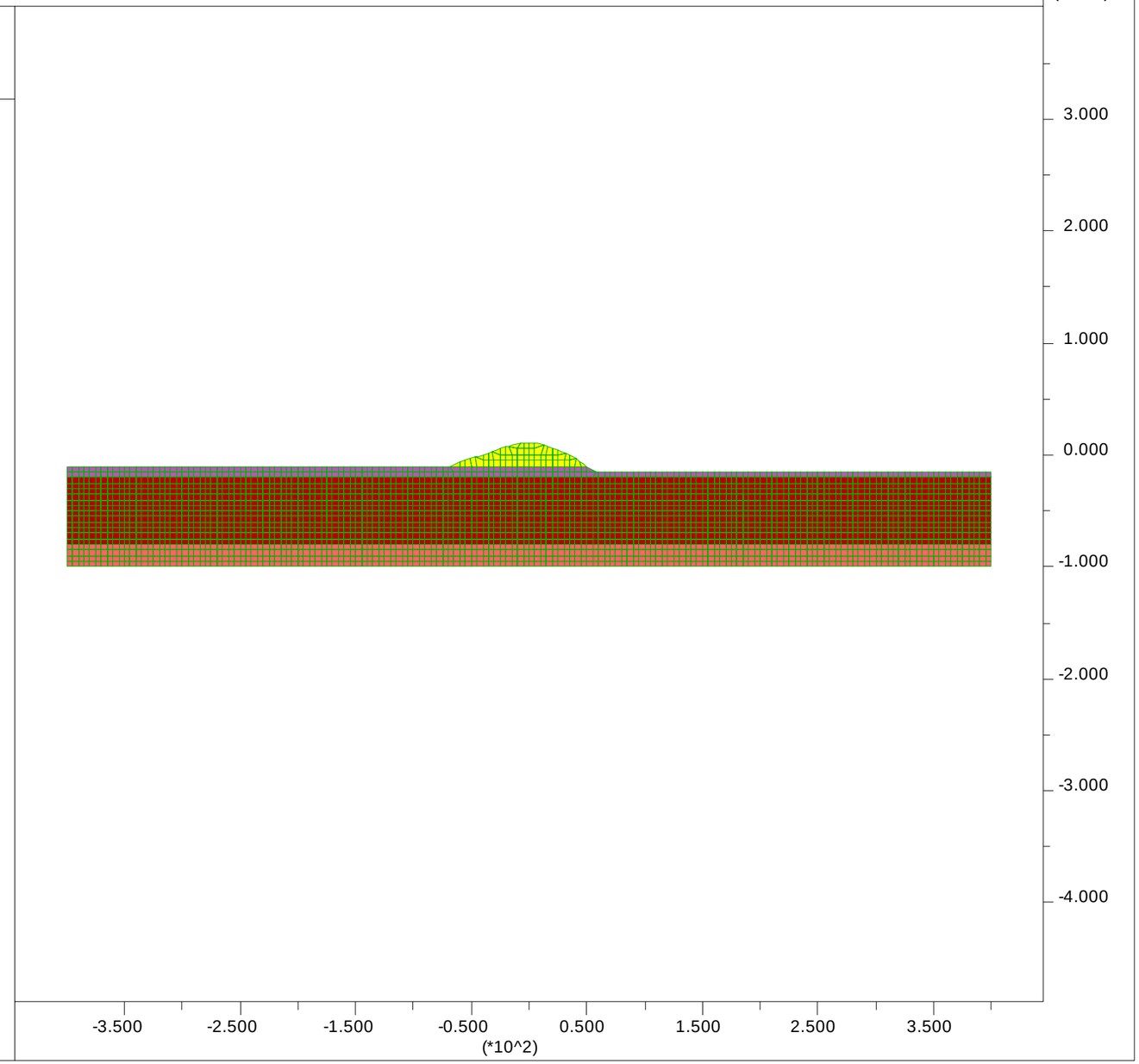
LEGEND

22-Jan-07 13:38
step 13052
-4.444E+02 <x< 4.444E+02
-4.889E+02 <y< 3.999E+02

User-defined Groups
- CL
- SPSM2
- SPSM1
- FILL

Grid plot

0 2E 2



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Delta Risk Management Strategy (DRMS) Levee Fragility		FLAC Finite Element Model for Seismic Analysis Idealized Section - No Peat	Figure 6-68
URS	Project No. 26815621		

JOB TITLE : FLAC Mesh, 5 ft PEAT

FLAC (Version 5.00)

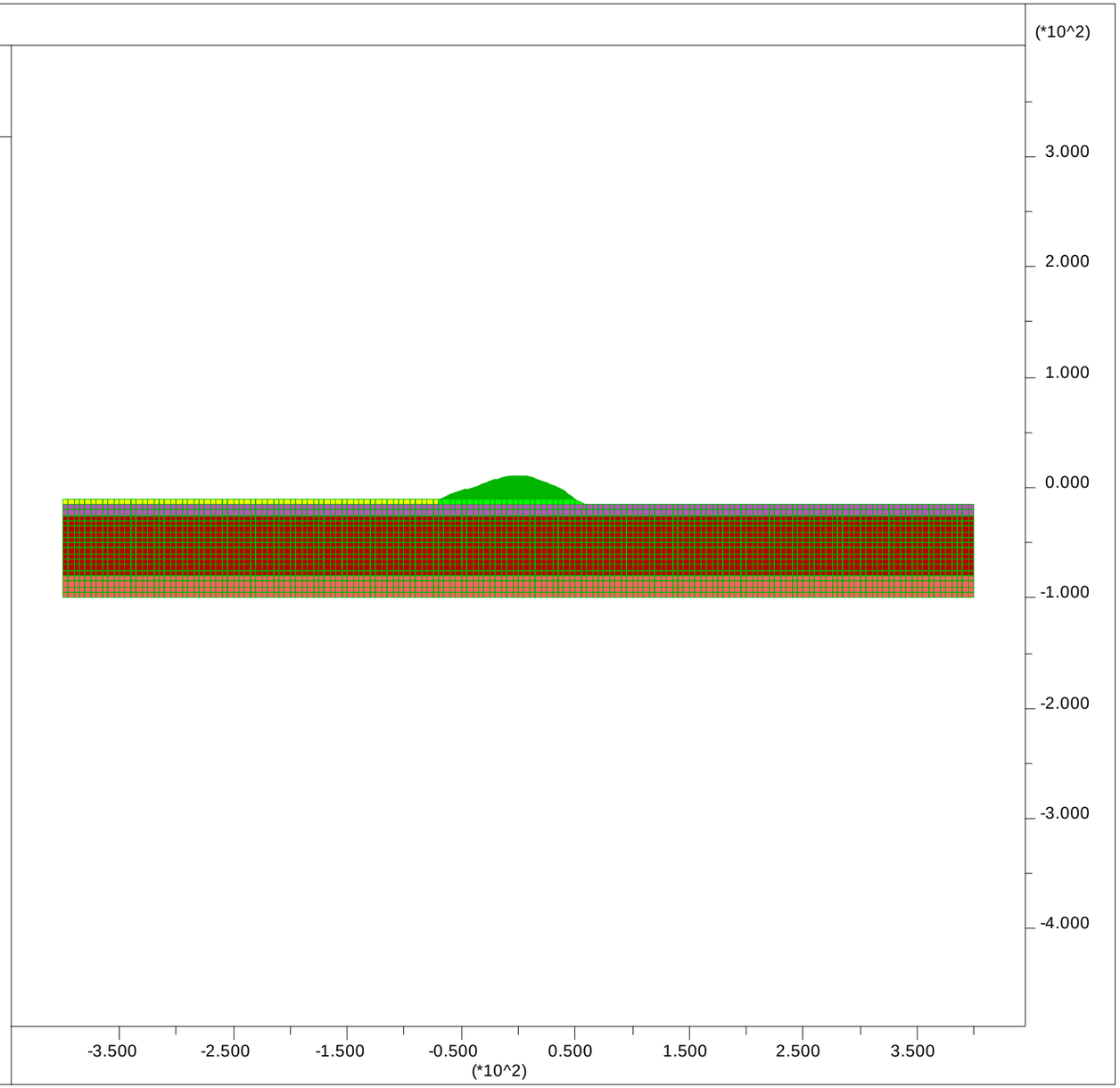
LEGEND

9-Dec-06 19:22
step 12048
-4.444E+02 <x< 4.444E+02
-4.889E+02 <y< 3.999E+02

User-defined Groups
- CL
- SPSM2
- SPSM1
- PEAT
- ULPEAT
- FILL

Grid plot

0 2E 2



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Delta Risk Management Strategy (DRMS) Levee Fragility		FLAC Finite Element Model for Seismic Analysis Idealized Section - 5 ft Peat	Figure 6-69
URS	Project No. 26815621		

JOB TITLE : FLAC Mesh, 15 ft PEAT

FLAC (Version 5.00)

LEGEND

5-Dec-06 11:51
step 130350
Dynamic Time 5.6000E+01
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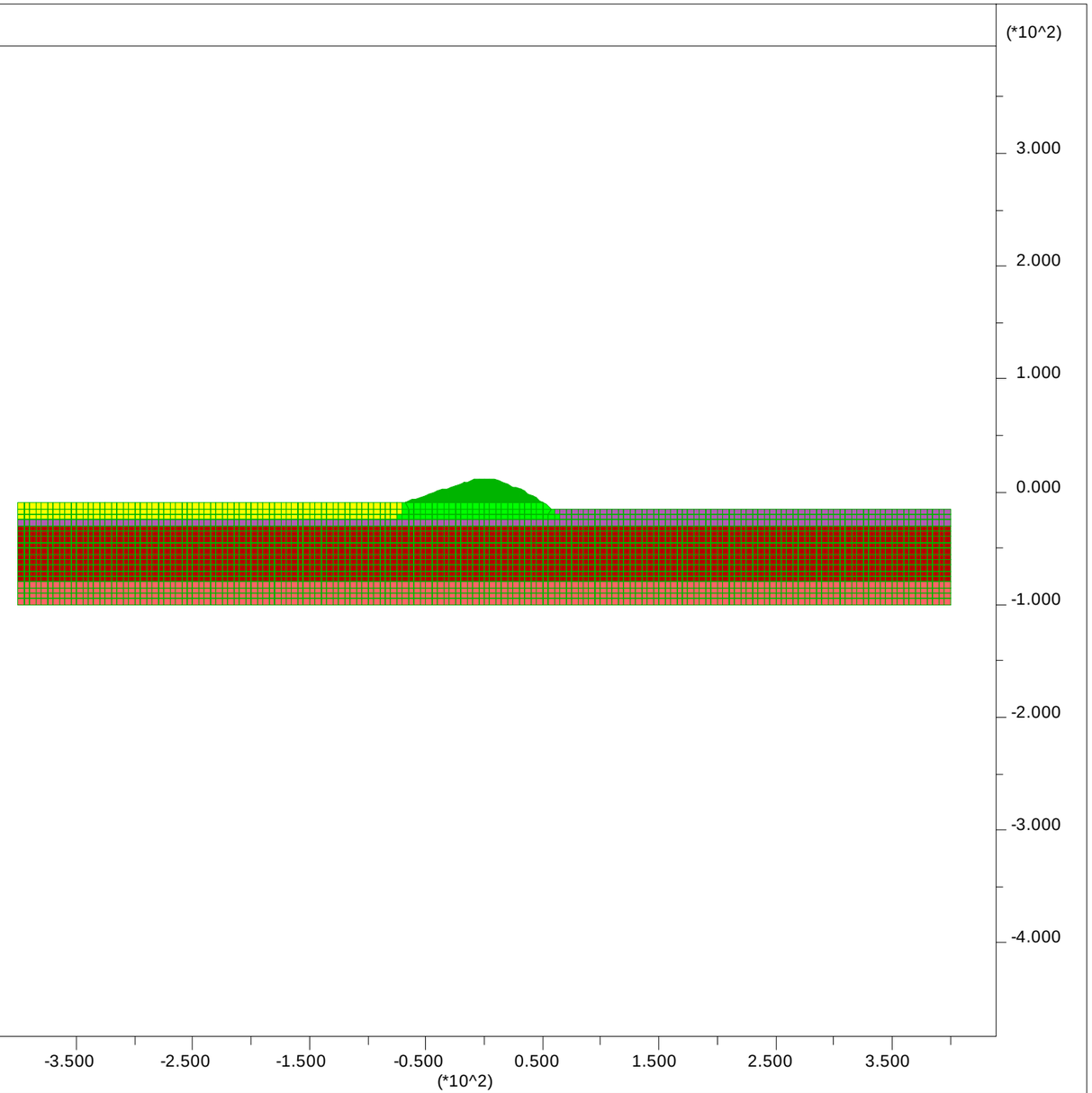
-4.836E+02 <y< 3.946E+02

User-defined Groups
- CL
- SPSM2
- SPSM1
- PEAT
- ULPEAT
- FILL

Grid plot

0 2E 2



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Delta Risk Management Strategy (DRMS) Levee Fragility	FLAC Finite Element Model for Seismic Analysis Idealized Section - 15 ft Peat	Figure 6-70
URS Project No. 26815621		

JOB TITLE : FLAC Mesh, 25 ft PEAT

FLAC (Version 5.00)

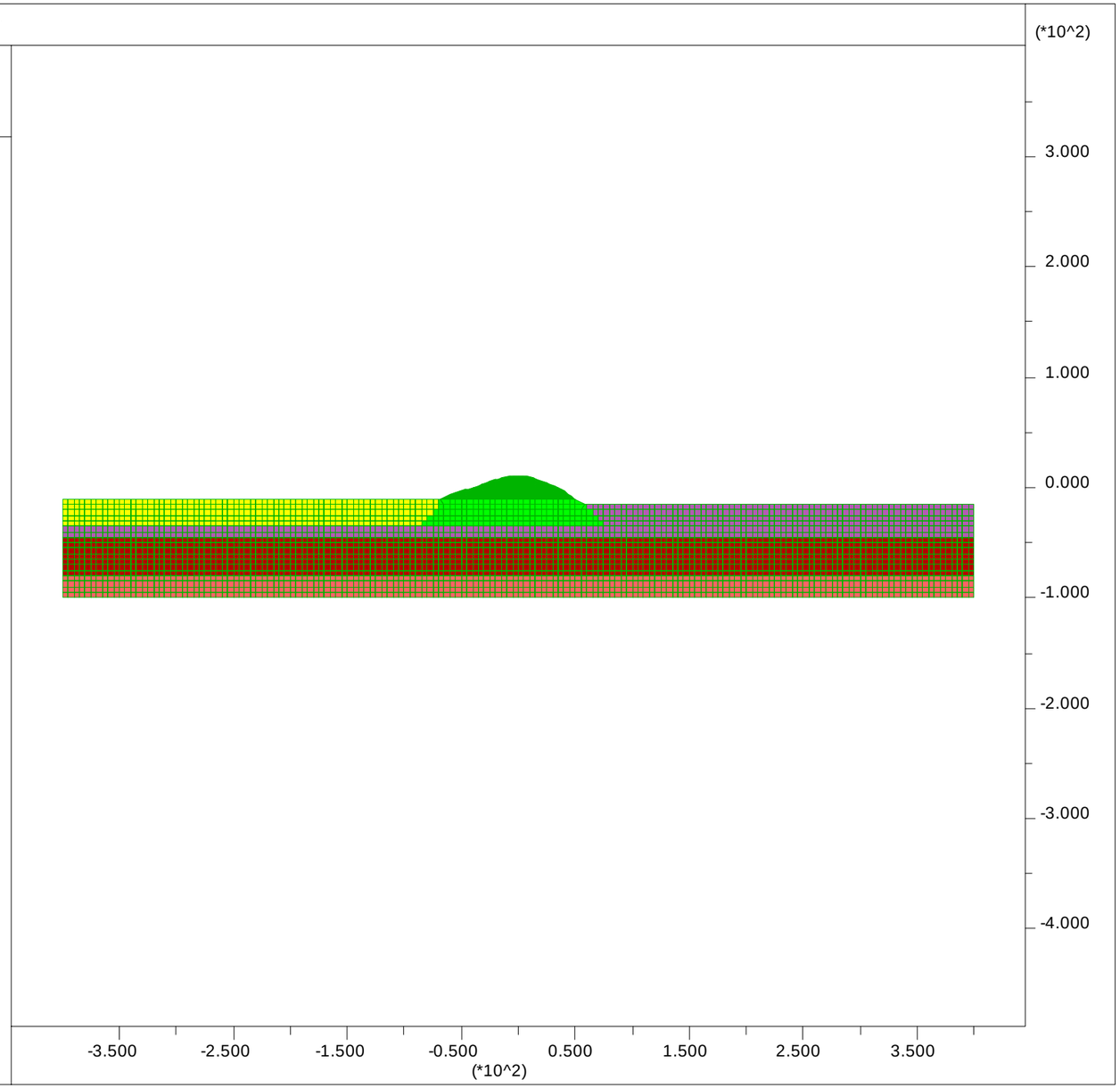
LEGEND

9-Dec-06 18:58
step 11028
-4.444E+02 <x< 4.444E+02
-4.889E+02 <y< 3.999E+02

User-defined Groups
- CL
- SPSM2
- SPSM1
- PEAT
- ULPEAT
- FILL

Grid plot

0 2E 2



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Delta Risk Management Strategy (DRMS) Levee Fragility		FLAC Finite Element Model for Seismic Analysis Idealized Section - 25 ft Peat	Figure 6-71
URS	Project No. 26815621		

JOB TITLE : CSR Time History, Input Motion M5.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 18:42
step 62526
Dynamic Time 2.3000E+01

HISTORY PLOT
Y-axis :
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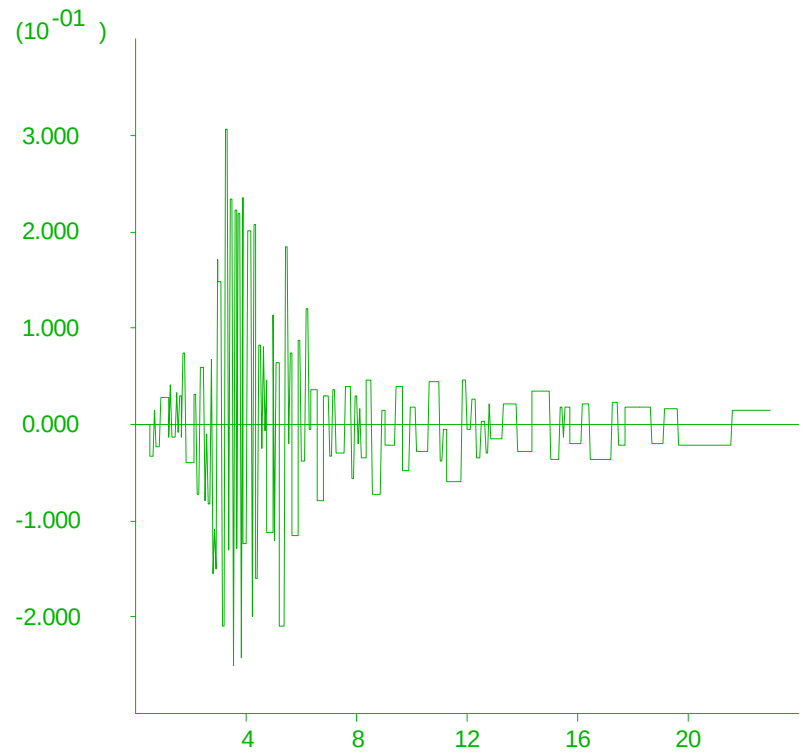
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 5 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-72
URS	Project No. 26815621		

JOB TITLE : Pore Pressur Time History, Input Motion M5.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 18:42
step 62526
Dynamic Time 2.3000E+01

HISTORY PLOT
Y-axis :
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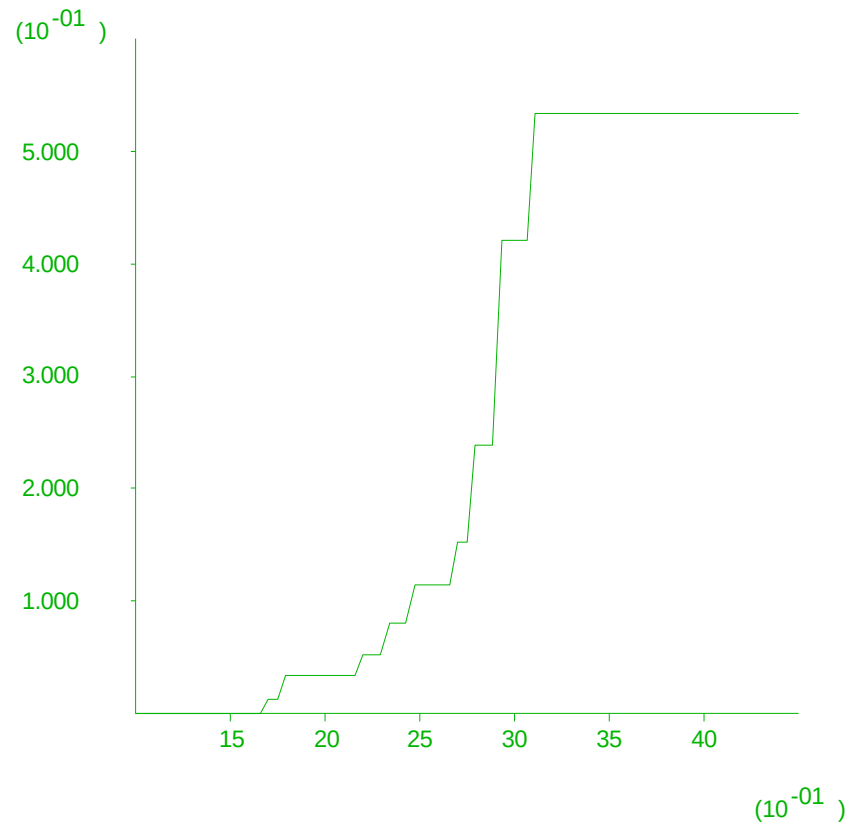
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 5 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-73
URS	Project No. 26815621		

JOB TITLE : CSR Time History, Input Motion M6.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 21:49
step 99815
Dynamic Time 4.0000E+01

HISTORY PLOT
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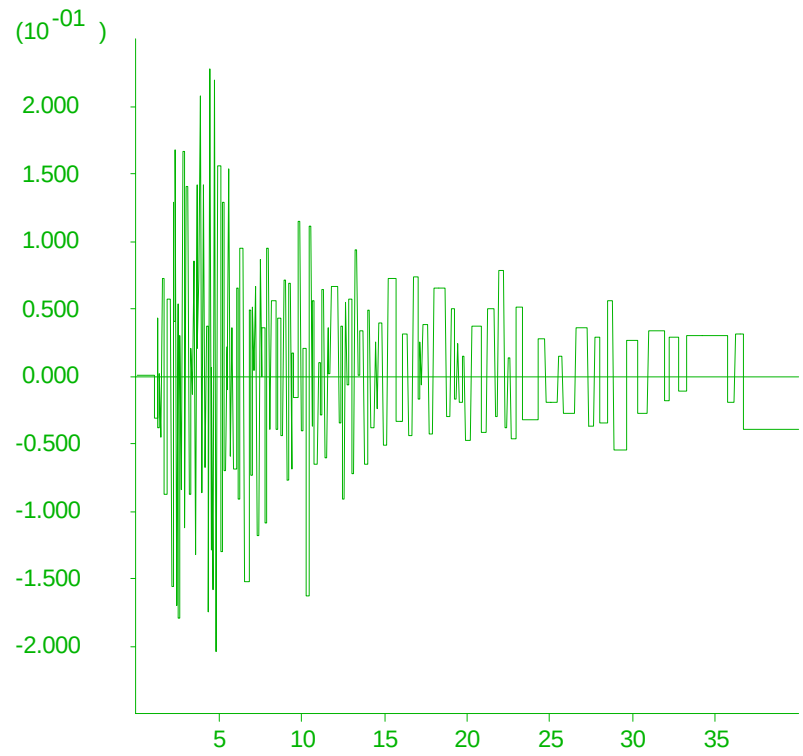
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 5 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-74
URS	Project No. 26815621		

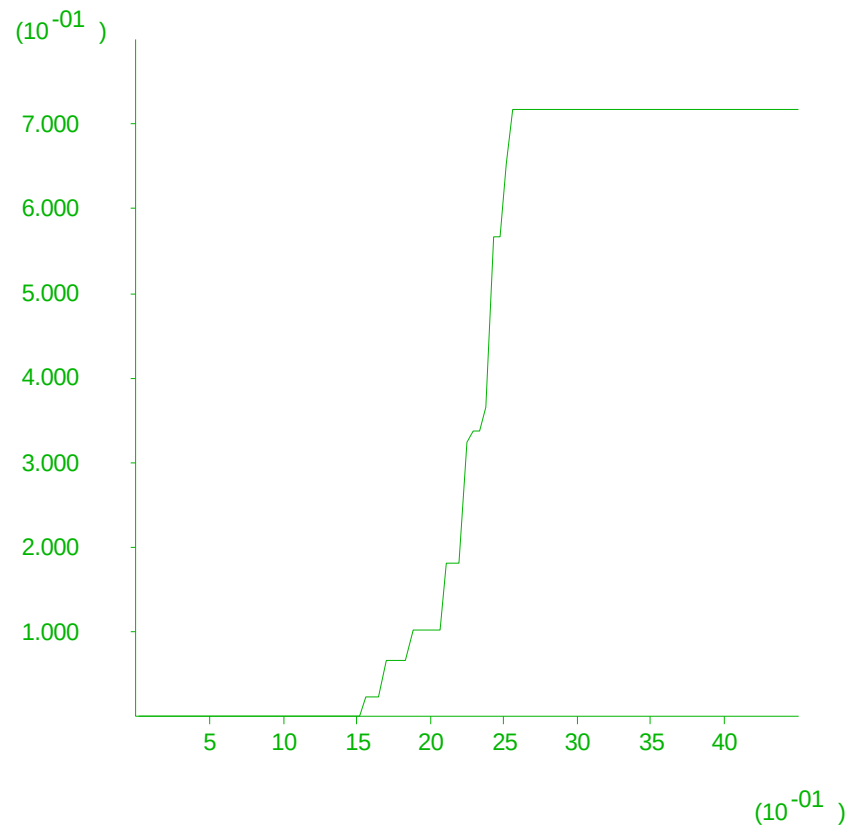
JOB TITLE : Pore Pressur Time History, Input Motion M6.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 21:49
step 99815
Dynamic Time 4.0000E+01

HISTORY PLOT
Y-axis :
67 sd_pore_pres (141, 17) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 5 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-75
URS	Project No. 26815621		

JOB TITLE : CSR Time History, Input Motion M7.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

10-Jan-07 2:35
step 134912
Dynamic Time 5.6000E+01

HISTORY PLOT
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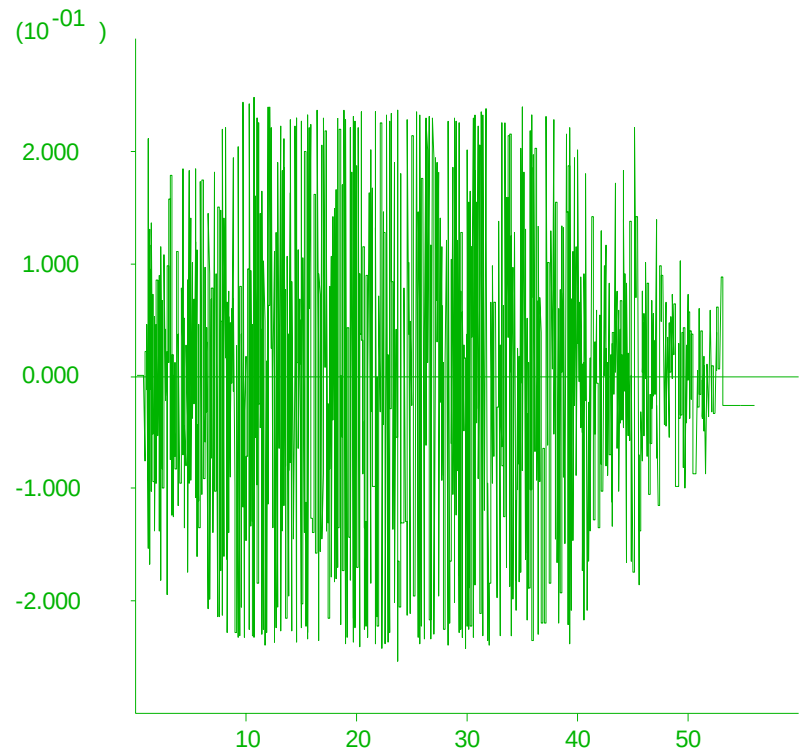
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 5 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-76
URS	Project No. 26815621		

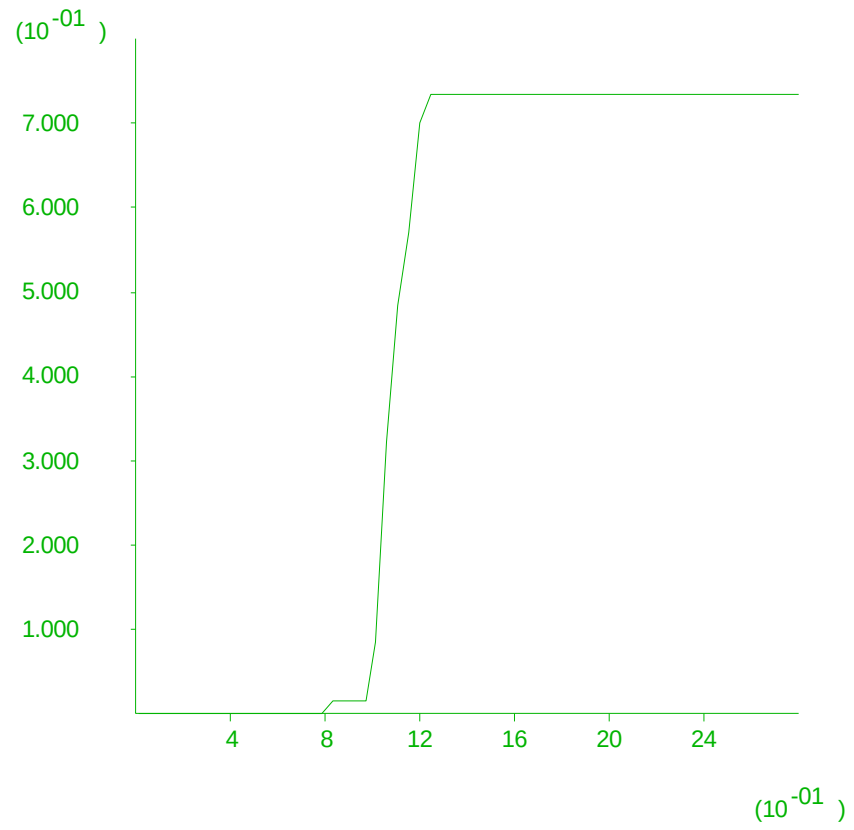
JOB TITLE : Pore Pressur Time History, Input Motion M7.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

10-Jan-07 2:35
step 134912
Dynamic Time 5.6000E+01

HISTORY PLOT
Y-axis :
67 sd_pore_pres (141, 17) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 5 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-77
URS	Project No. 26815621		

JOB TITLE : CSR Time History, Input Motion M5.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

8-Jan-07 23:18
step 59332
Dynamic Time 2.3000E+01

HISTORY PLOT
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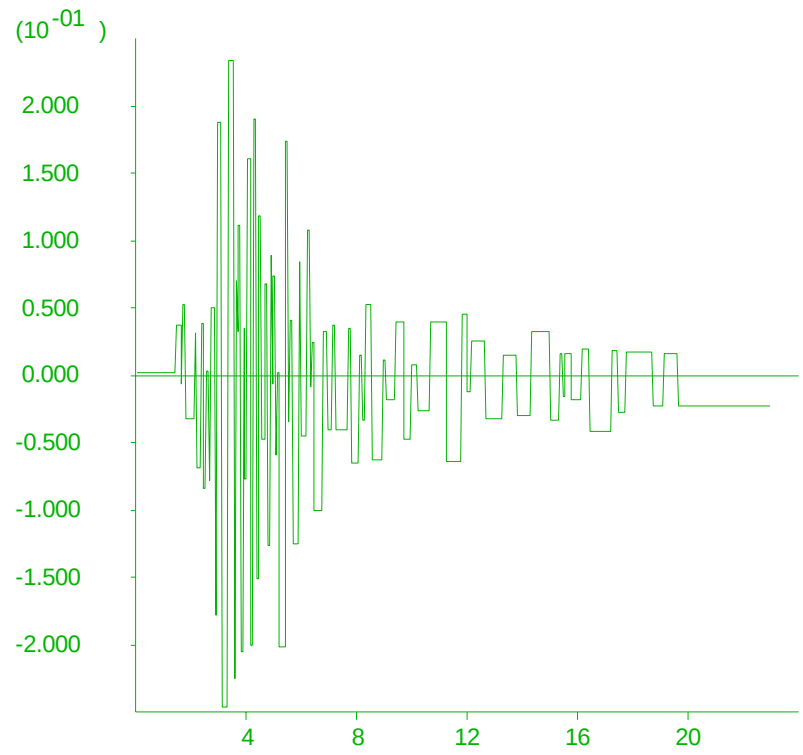
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 15 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-78
URS	Project No. 26815621		

JOB TITLE : Pore Pressure Time History, Input Motion M5.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

8-Jan-07 23:18
step 59332
Dynamic Time 2.3000E+01

HISTORY PLOT
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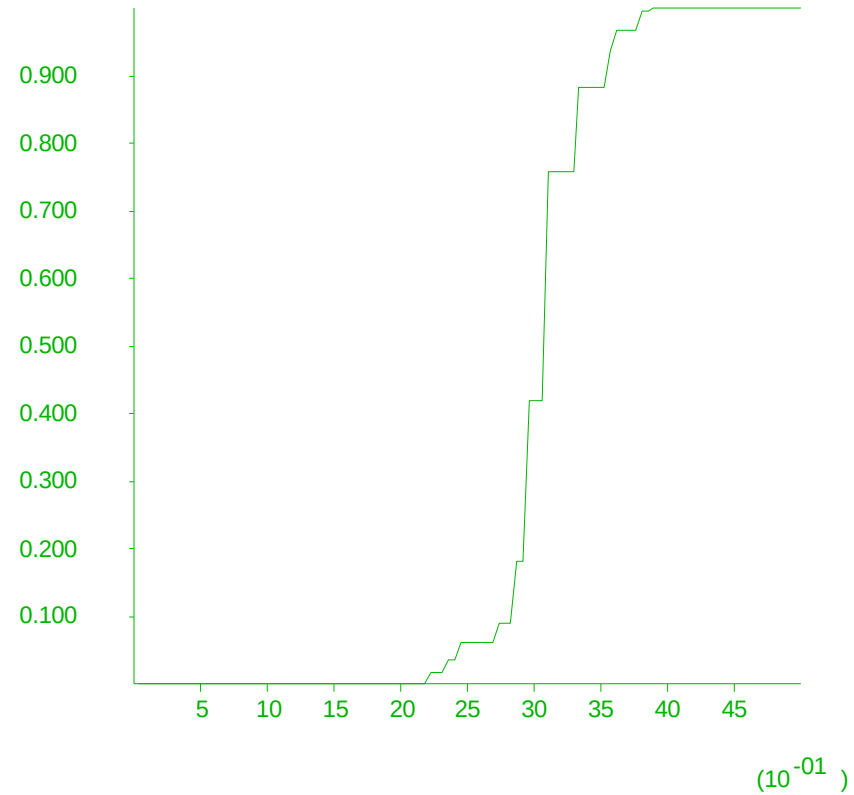
67 sd_pore_pres (141, 15) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 15 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-79
URS	Project No. 26815621		

JOB TITLE : CSR Time History, Input Motion M6.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 21:58
step 95763
Dynamic Time 4.0000E+01

HISTORY PLOT
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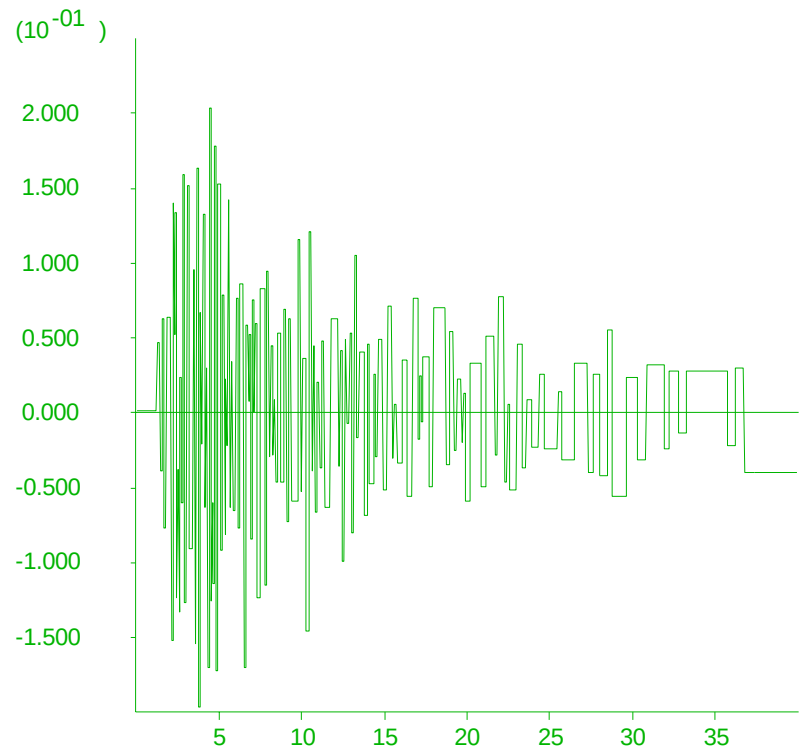
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 15 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-80
URS	Project No. 26815621		

JOB TITLE : Pore Pressure Time History, Input Motion M6.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 21:58
step 95763
Dynamic Time 4.0000E+01

HISTORY PLOT
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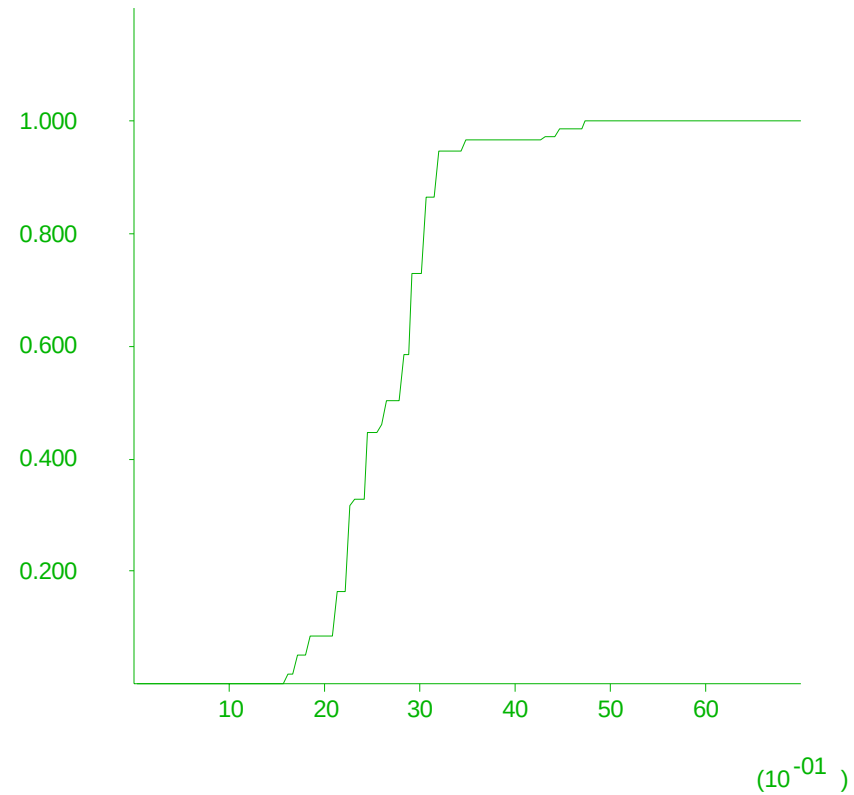
67 sd_pore_pres (141, 15) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 15 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-81
URS	Project No. 26815621		

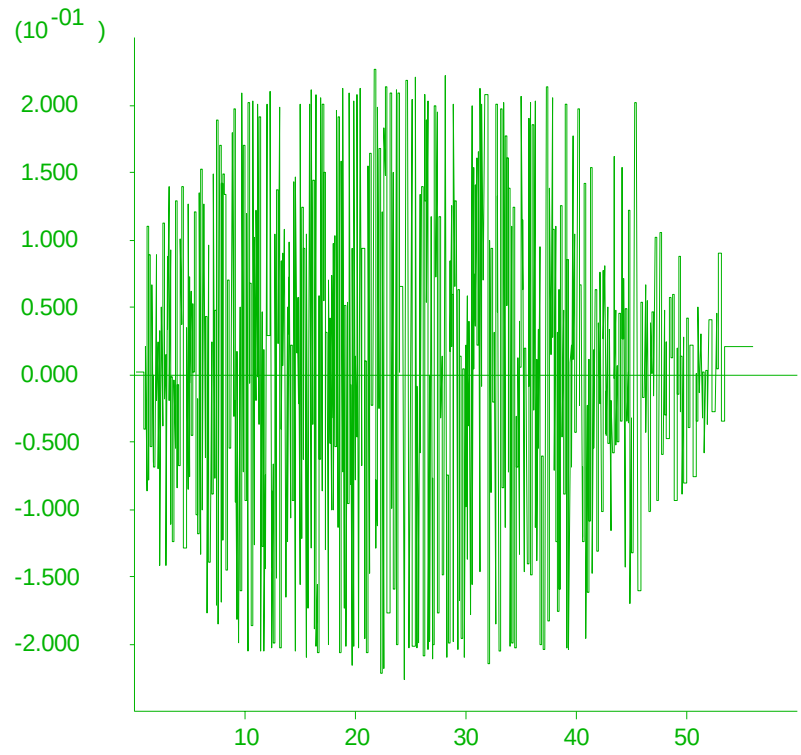
JOB TITLE : CSR Time History, Input Motion M7.5 H1 0.2g

FLAC (Version 5.00)

LEGEND

10-Jan-07 3:37
step 130051
Dynamic Time 5.6000E+01

HISTORY PLOT
Y-axis :
68 sd_csr_zero (141, 15) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 15 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-82
URS	Project No. 26815621		

JOB TITLE : Pore Pressure Time History, Input Motion M7.5, H1 0.2g

FLAC (Version 5.00)

LEGEND

10-Jan-07 3:37
step 130051
Dynamic Time 5.6000E+01

HISTORY PLOT
Y-axis :
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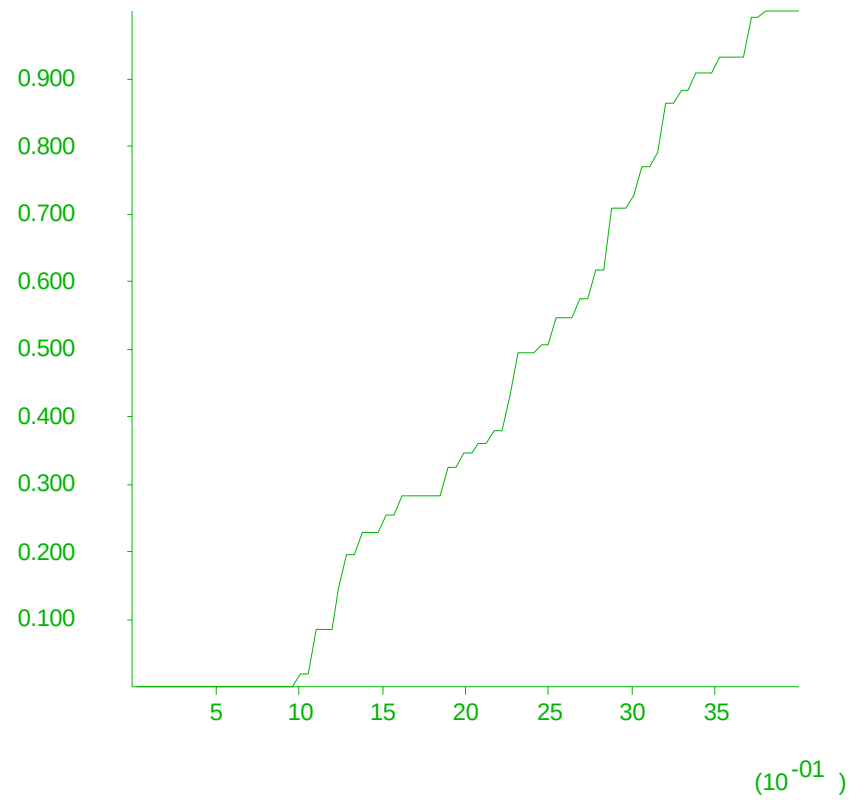
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 15 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-83
URS	Project No. 26815621		

JOB TITLE : CSR Time Histoory, Input Motion M5.5 H1, 0.2g

FLAC (Version 5.00)

LEGEND

8-Jan-07 20:07
step 59058
Dynamic Time 2.3000E+01

HISTORY PLOT
Y-axis :
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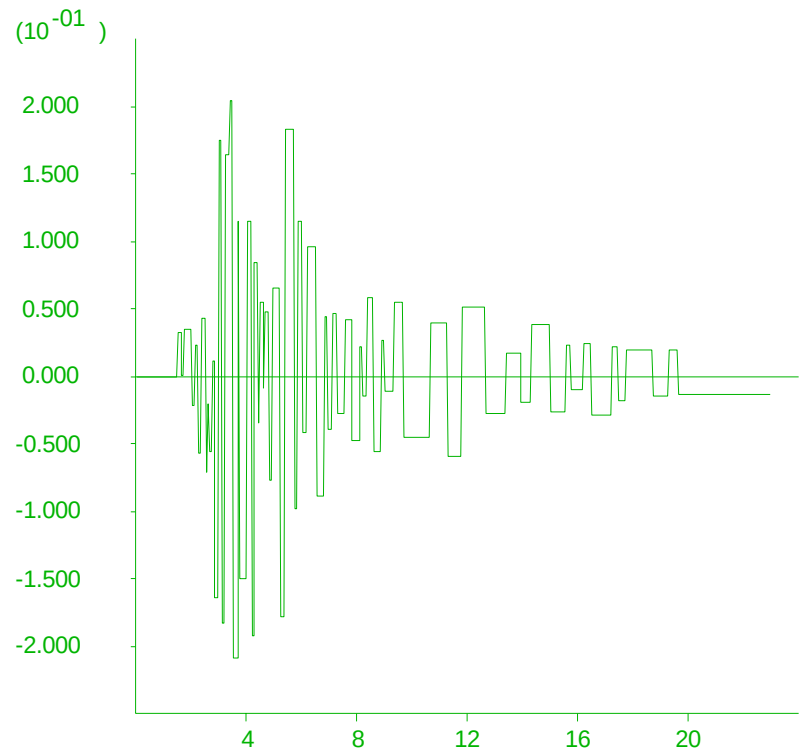
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 25 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-84
URS	Project No. 26815621		

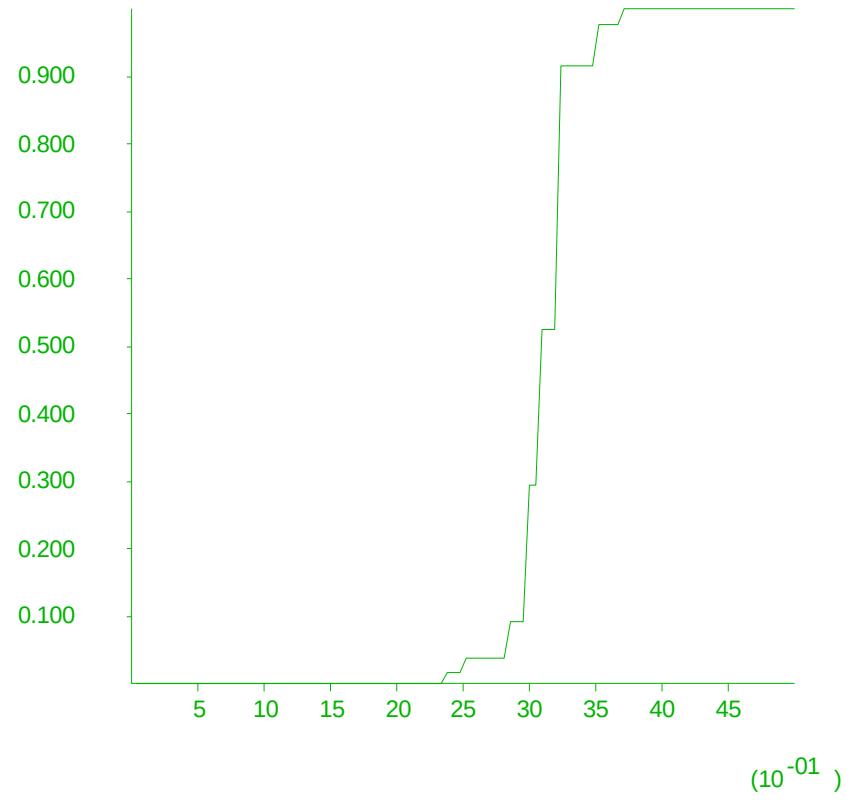
JOB TITLE : Pore Pressure Time Histoory, Input Motion M5.5 H1, 0.2g

FLAC (Version 5.00)

LEGEND

8-Jan-07 20:07
step 59058
Dynamic Time 2.3000E+01

HISTORY PLOT
Y-axis :
67 sd_pore_pres (141, 13) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 25 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-85
URS	Project No. 26815621		

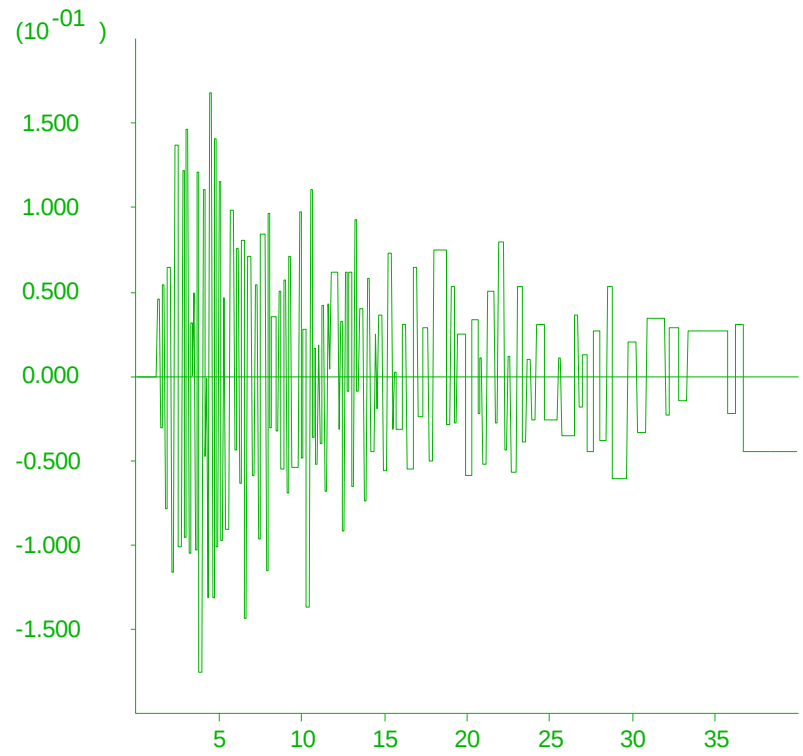
JOB TITLE : CSR Time Histoory, Input Motion M6.5 H1, 0.2g

FLAC (Version 5.00)

LEGEND

8-Jan-07 23:49
step 94557
Dynamic Time 4.0000E+01

HISTORY PLOT
Y-axis :
68 sd_csr_zero (141, 13) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 25 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-86
URS	Project No. 26815621		

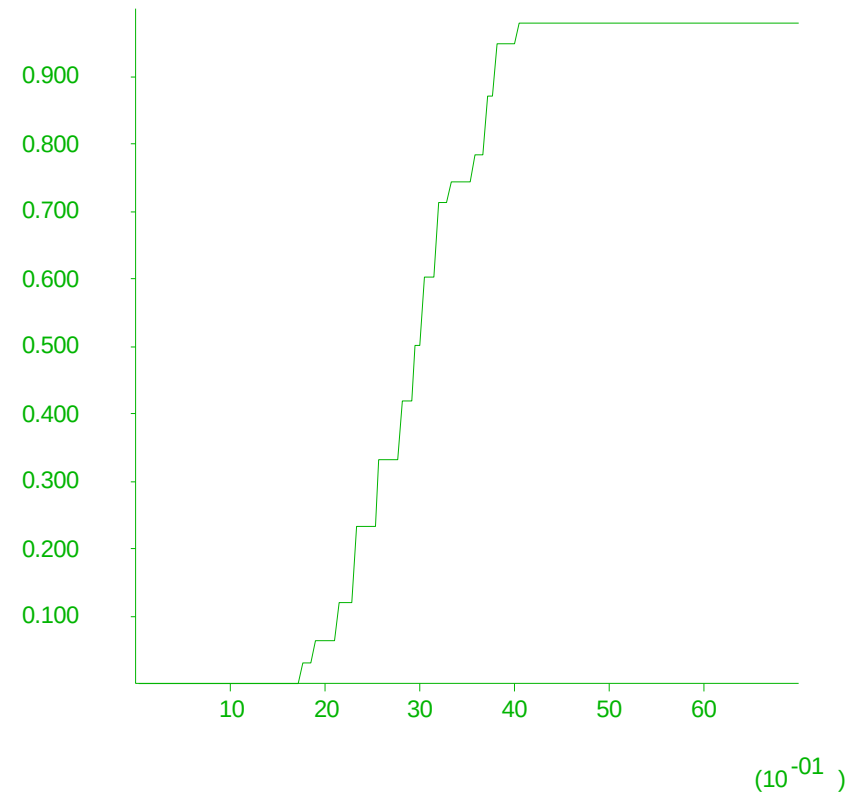
JOB TITLE : Pore Pressure Time Histoory, Input Motion M6.5 H1, 0.2g

FLAC (Version 5.00)

LEGEND

8-Jan-07 23:49
step 94557
Dynamic Time 4.0000E+01

HISTORY PLOT
Y-axis :
67 sd_pore_pres (141, 13) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 25 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-87
URS	Project No. 26815621		

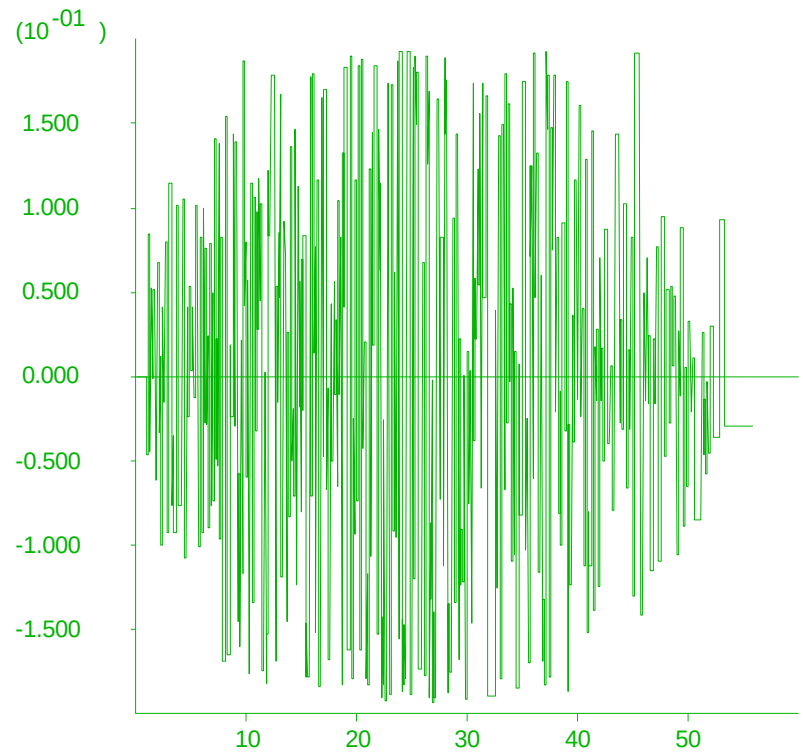
JOB TITLE : CSR Time Histoory, Input Motion M7.5 H1, 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 5:27
step 127967
Dynamic Time 5.6000E+01

HISTORY PLOT
Y-axis :
68 sd_csr_zero (141, 13) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		CSR Time History at Liquefiable Sand Layer Idealized Section - 25 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-88
URS	Project No. 26815621		

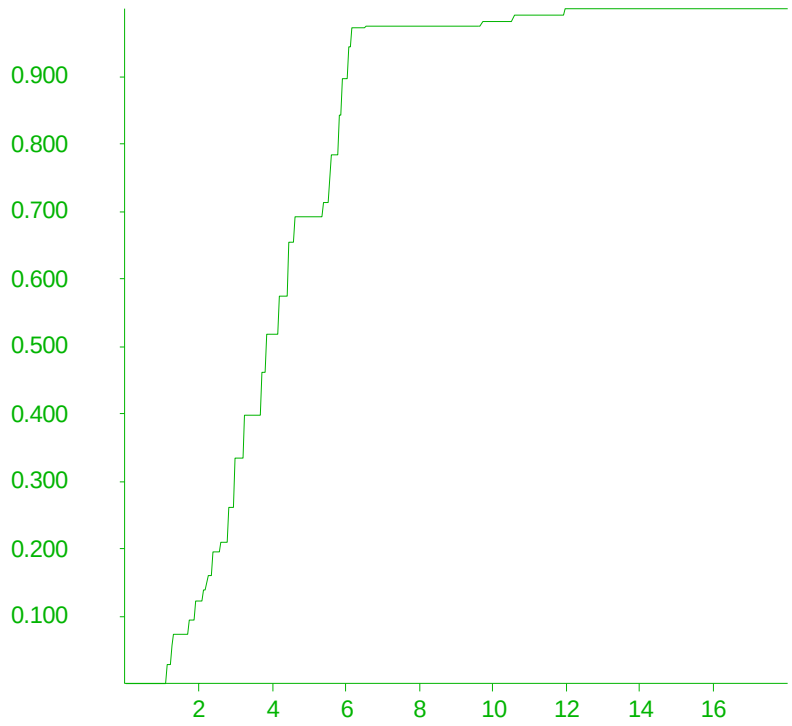
JOB TITLE : Pore Pressure Time Histoory, Input Motion M7.5 H1, 0.2g

FLAC (Version 5.00)

LEGEND

9-Jan-07 5:27
step 127967
Dynamic Time 5.6000E+01

HISTORY PLOT
Y-axis :
67 sd_pore_pres (141, 13) PRP
X-axis :
1 Dynamic time



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Delta Risk Management Strategy (DRMS) Levee Fragility		Pore Pressure Time History at Liquefiable Sand Layer Idealized Section - 25 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-89
URS	Project No. 26815621		

JOB TITLE : Horizontal Displacement Contours, Input Motion M5.5, H1 0.2g

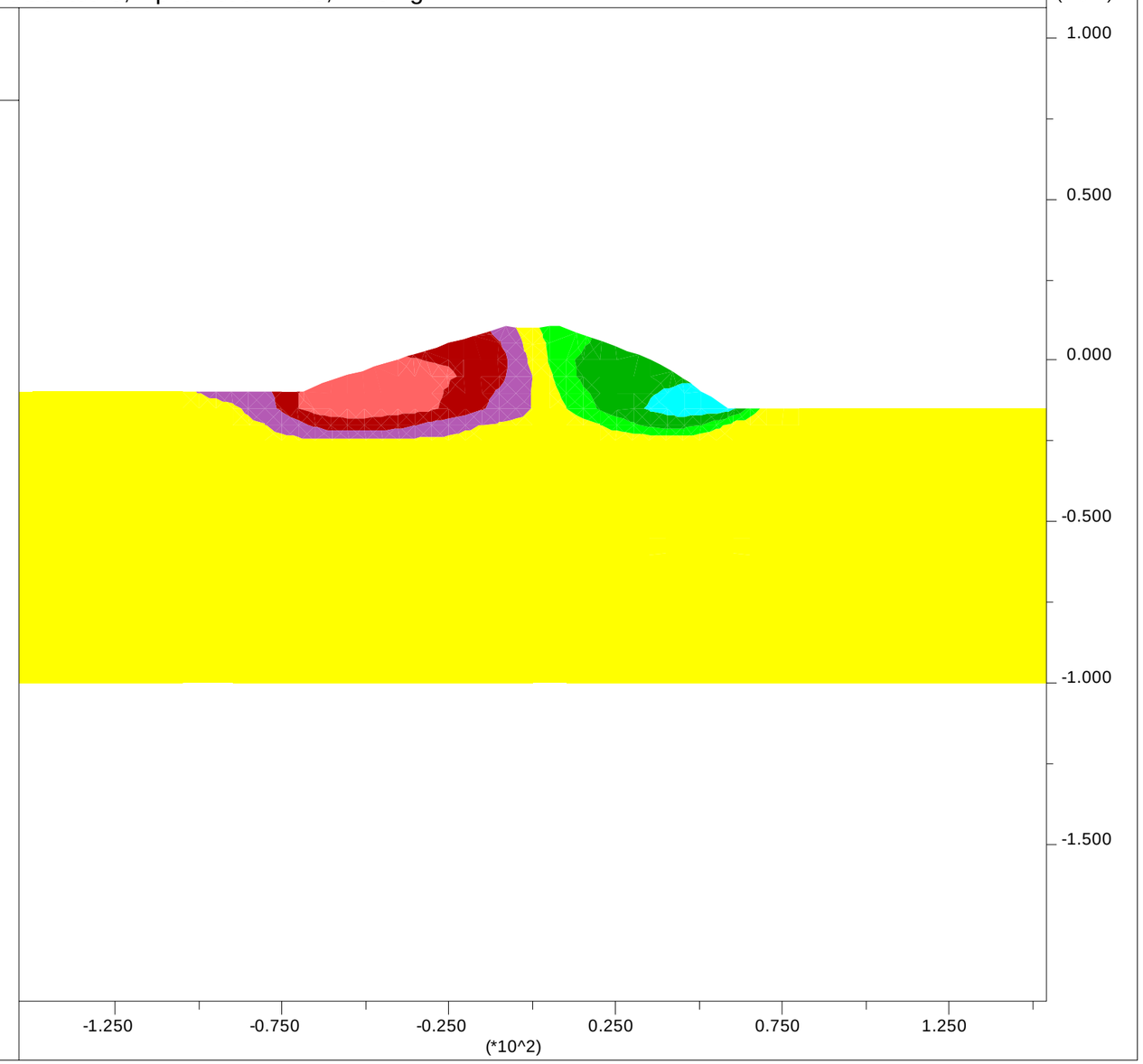
FLAC (Version 5.00)

LEGEND

9-Jan-07 18:42
step 62526
Dynamic Time 2.3000E+01
-1.538E+02 <x< 1.540E+02
-1.988E+02 <y< 1.090E+02

X-displacement contours
-4.00E-01
-2.00E-01
0.00E+00
2.00E-01
4.00E-01
6.00E-01

Contour interval= 2.00E-01



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Delta Risk Management Strategy (DRMS) Levee Fragility	Displacement Contours Idealized Section - 5 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-90
URS Project No. 26815621		

JOB TITLE : Horizontal Displacement Contours, Input Motion M6.5, H1 0.2g

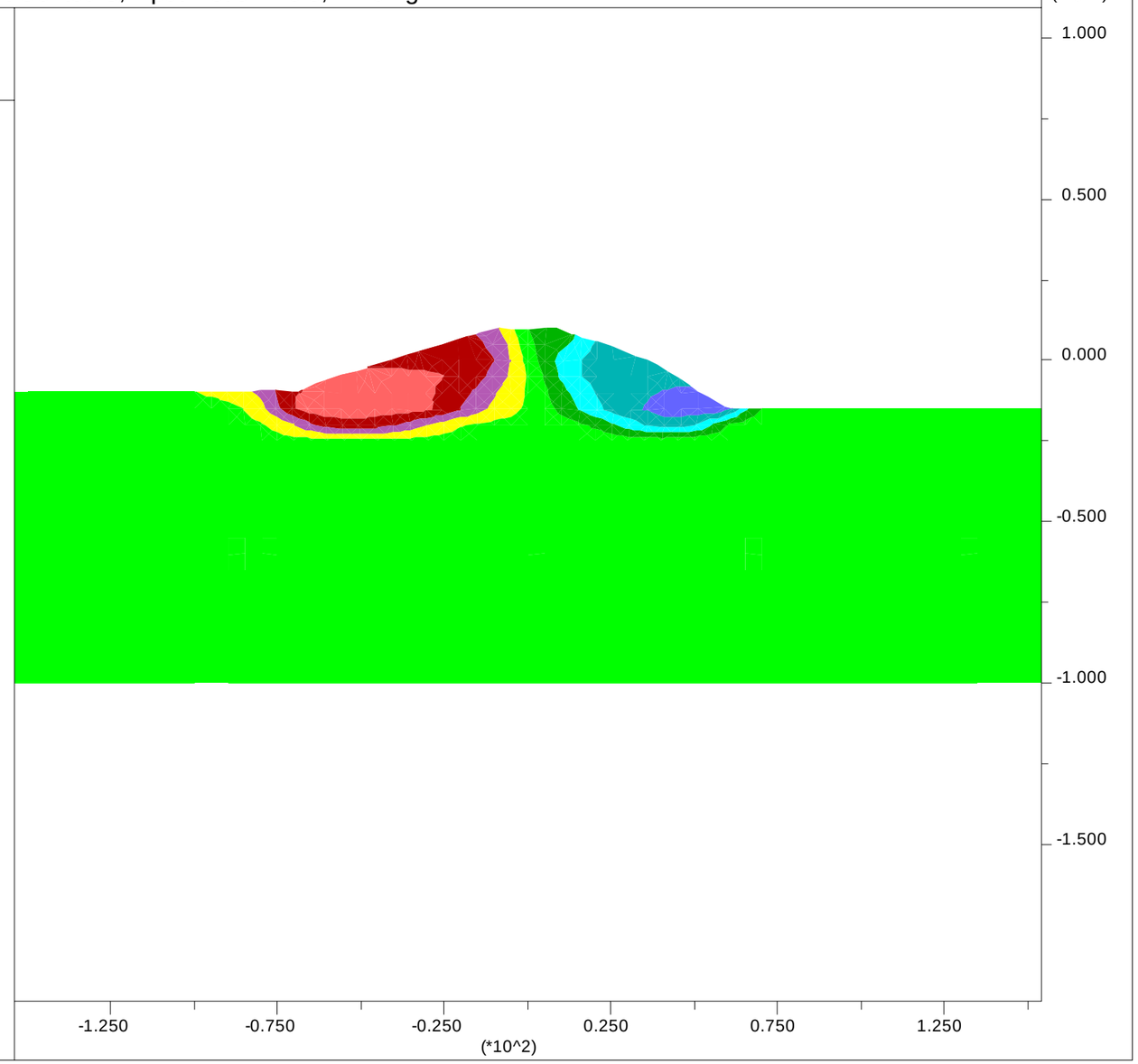
FLAC (Version 5.00)

LEGEND

9-Jan-07 21:49
step 99815
Dynamic Time 4.0000E+01
-1.538E+02 <x< 1.540E+02
-1.988E+02 <y< 1.090E+02

X-displacement contours
-7.50E-01
-5.00E-01
-2.50E-01
0.00E+00
2.50E-01
5.00E-01
7.50E-01
1.00E+00

Contour interval= 2.50E-01



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Delta Risk Management Strategy (DRMS) Levee Fragility		Displacement Contours Idealized Section - 5 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-91
URS	Project No. 26815621		

JOB TITLE : Horizontal Displacement Contours, Input Motion M7.5, H1 0.2g

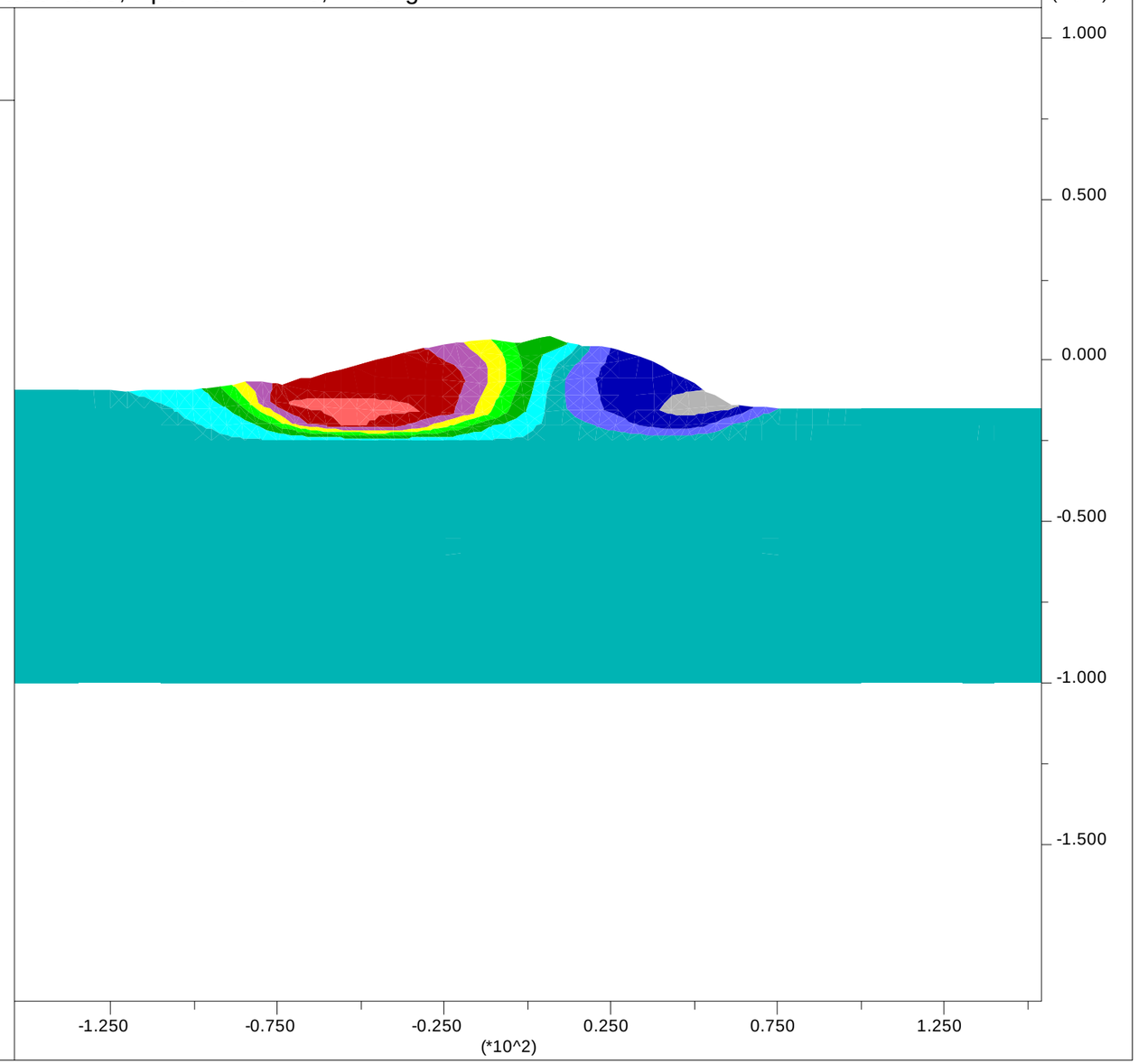
FLAC (Version 5.00)

LEGEND

10-Jan-07 2:35
step 134912
Dynamic Time 5.6000E+01
-1.538E+02 <x< 1.540E+02
-1.988E+02 <y< 1.090E+02

X-displacement contours
-6.00E+00
-5.00E+00
-4.00E+00
-3.00E+00
-2.00E+00
-1.00E+00
0.00E+00
1.00E+00
2.00E+00
3.00E+00

Contour interval= 1.00E+00



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Delta Risk Management Strategy (DRMS) Levee Fragility		Displacement Contours Idealized Section - 5 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-92
URS	Project No. 26815621		

JOB TITLE : Displacement Contours, Input Motion M5.5, H1 0.2g

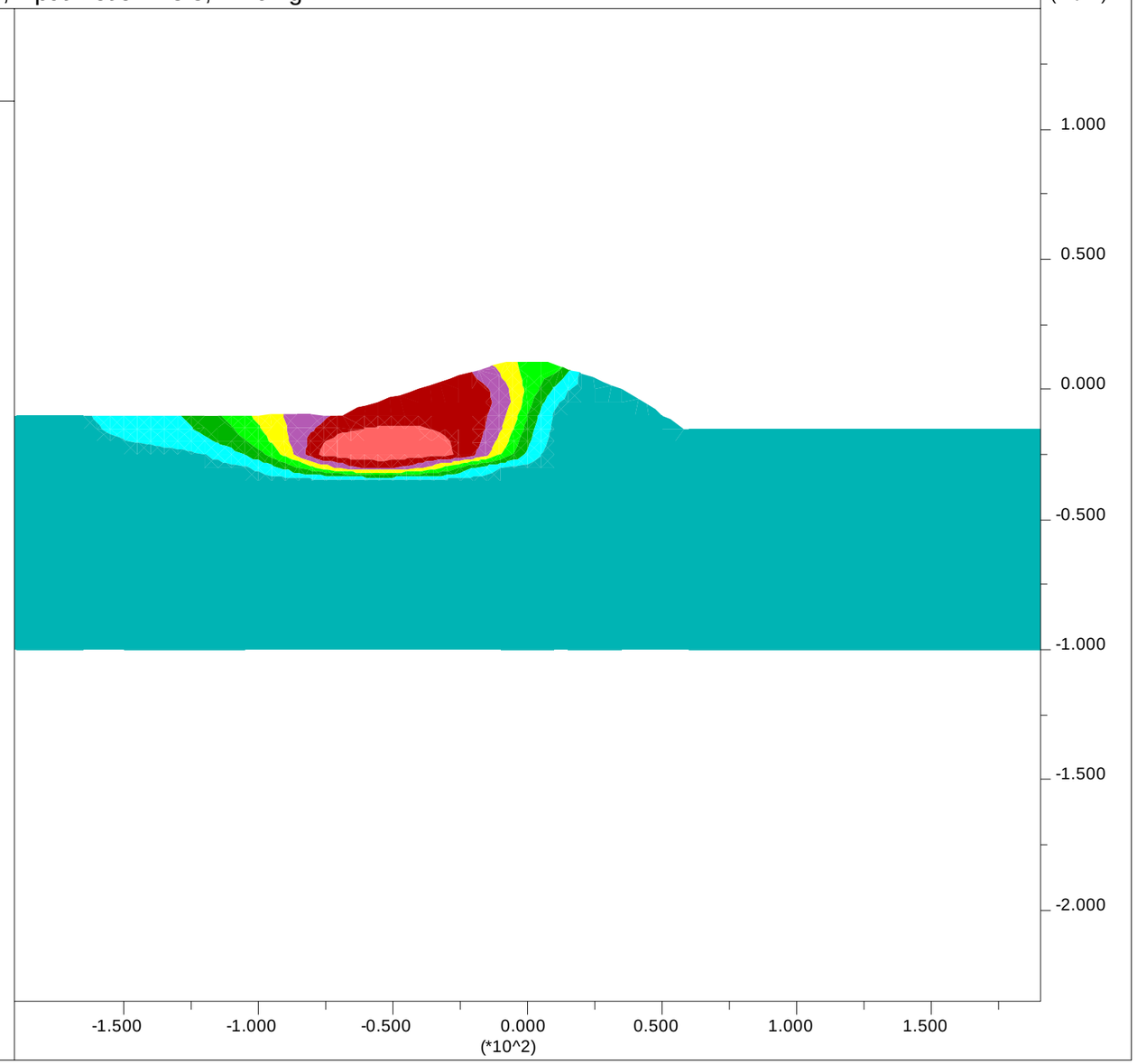
FLAC (Version 5.00)

LEGEND

8-Jan-07 23:18
step 59332
Dynamic Time 2.3000E+01
-1.906E+02 <x< 1.907E+02
-2.353E+02 <y< 1.460E+02

X-displacement contours
-6.00E-01
-5.00E-01
-4.00E-01
-3.00E-01
-2.00E-01
-1.00E-01
0.00E+00

Contour interval= 1.00E-01



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Delta Risk Management Strategy (DRMS) Levee Fragility		Displacement Contours Idealized Section - 15 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-93
URS	Project No. 26815621		

JOB TITLE : Displacement Contours, Input Motion M6.5, H1 0.2g

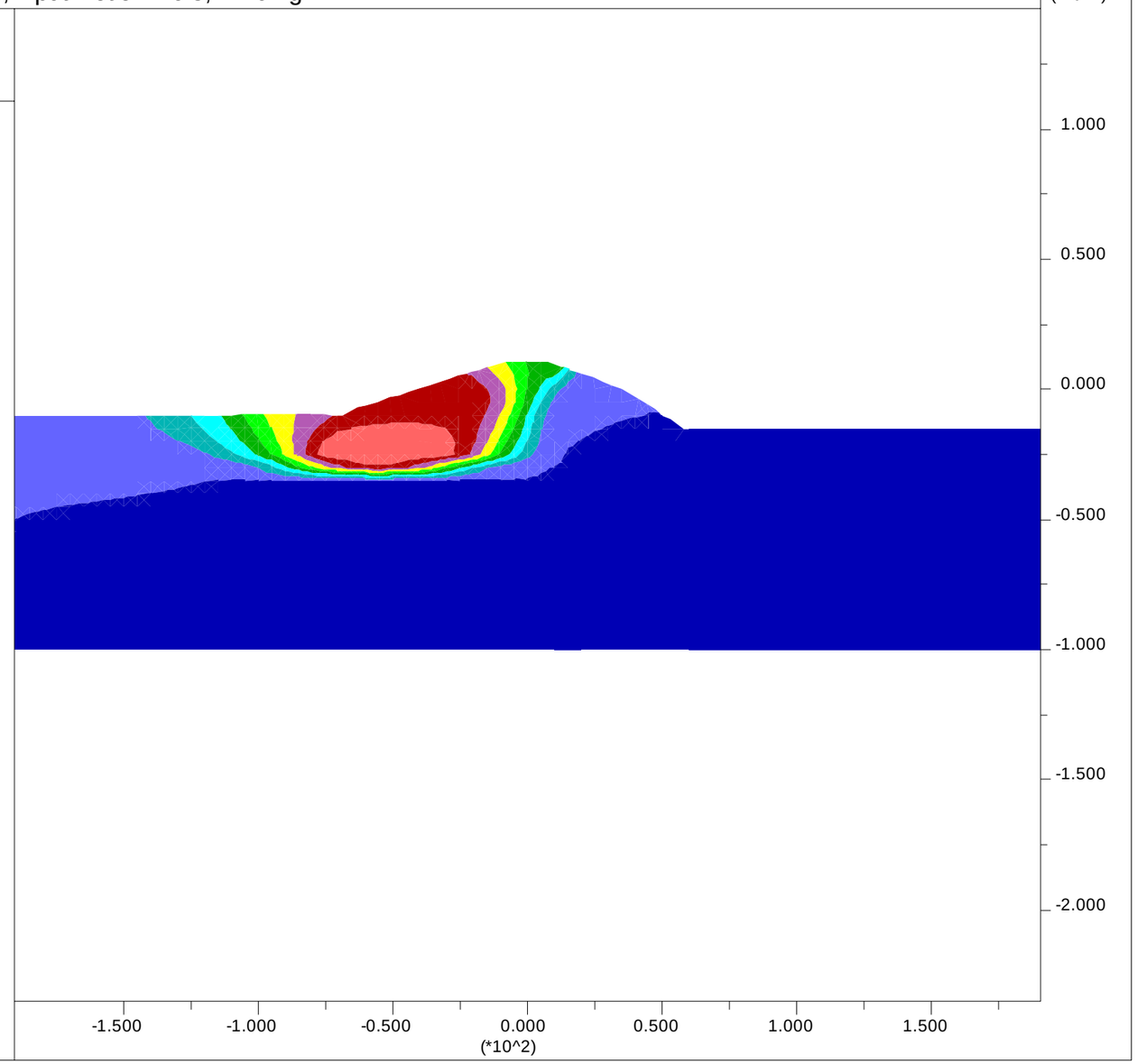
FLAC (Version 5.00)

LEGEND

9-Jan-07 21:58
step 95763
Dynamic Time 4.0000E+01
-1.906E+02 <x< 1.907E+02
-2.353E+02 <y< 1.460E+02

X-displacement contours
-7.00E-01
-6.00E-01
-5.00E-01
-4.00E-01
-3.00E-01
-2.00E-01
-1.00E-01
0.00E+00
1.00E-01

Contour interval= 1.00E-01



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Delta Risk Management Strategy (DRMS) Levee Fragility	Displacement Contours Idealized Section - 15 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-94
URS Project No. 26815621		

JOB TITLE : Displacement Contours, Input Motion M7.5, H1 0.2g

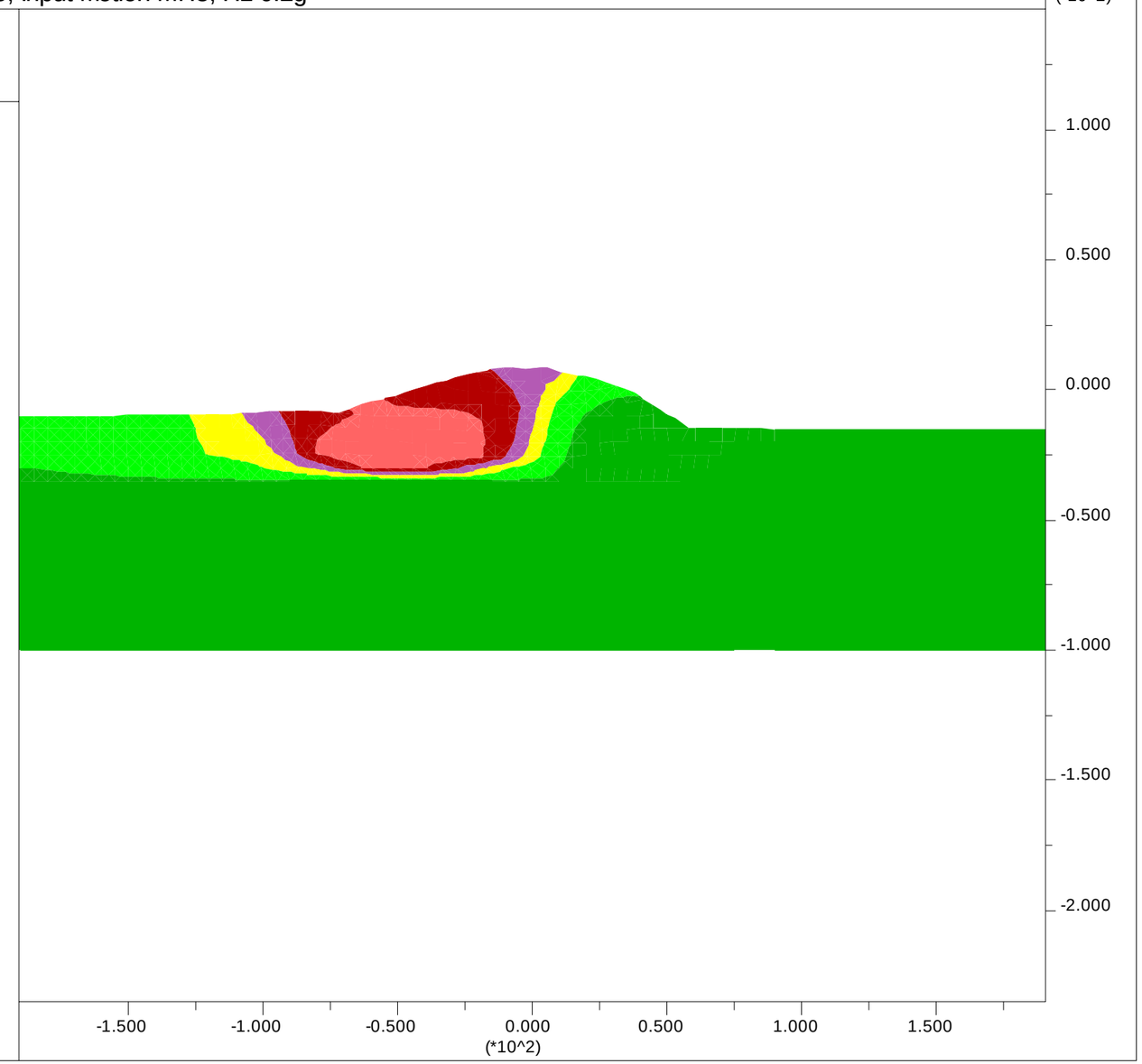
FLAC (Version 5.00)

LEGEND

10-Jan-07 3:37
step 130051
Dynamic Time 5.6000E+01
-1.906E+02 <x< 1.907E+02
-2.353E+02 <y< 1.460E+02

X-displacement contours
-4.00E+00
-3.00E+00
-2.00E+00
-1.00E+00
0.00E+00

Contour interval= 1.00E+00



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Delta Risk Management Strategy (DRMS) Levee Fragility	Displacement Contours Idealized Section - 15 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-95
URS Project No. 26815621		

JOB TITLE : Displacement Contours, Input Motion M5.5 H1, 0.2g

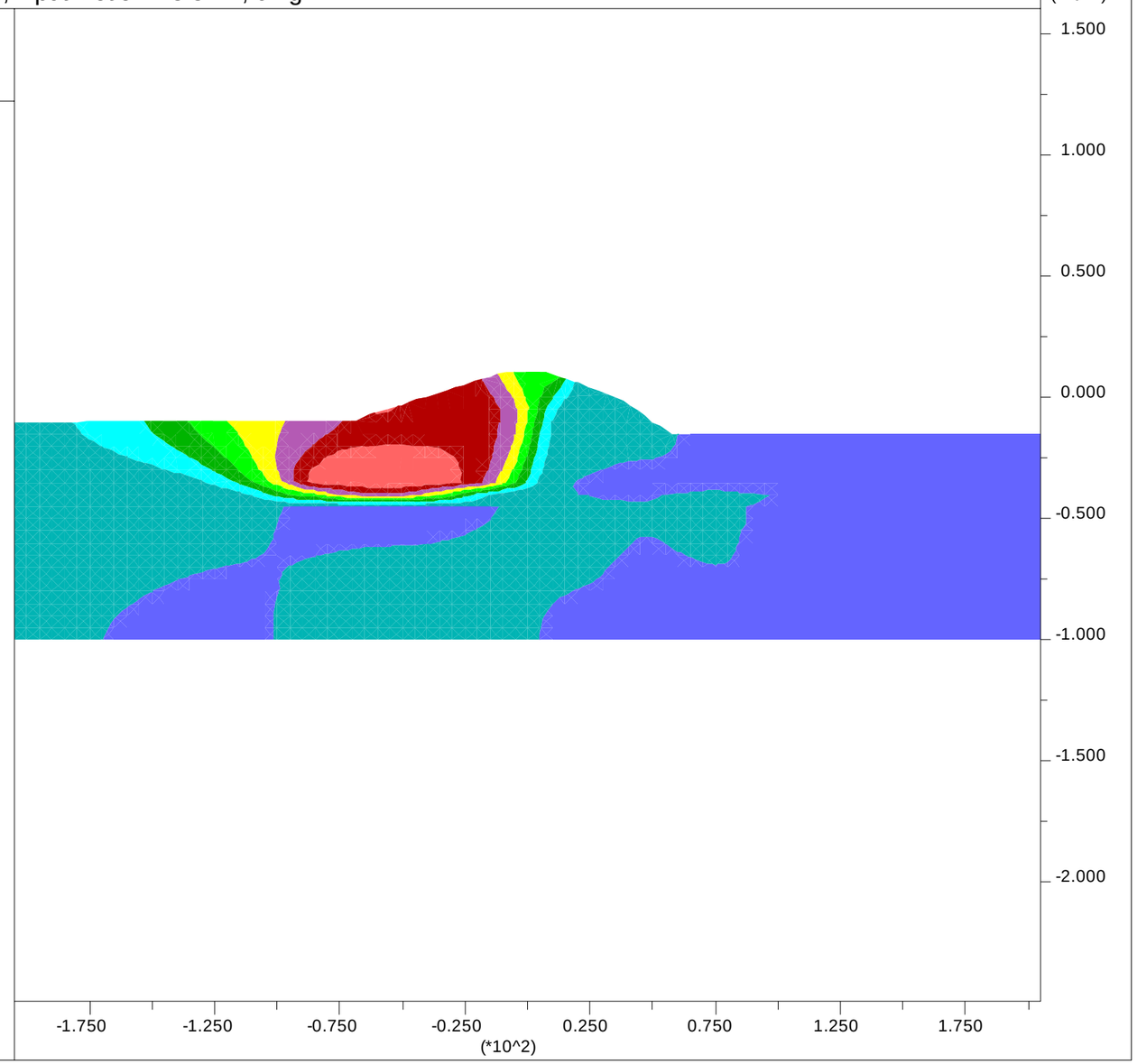
FLAC (Version 5.00)

LEGEND

8-Jan-07 20:07
step 59058
Dynamic Time 2.3000E+01
-2.049E+02 <x< 2.049E+02
-2.495E+02 <y< 1.602E+02

X-displacement contours
-7.00E-01
-6.00E-01
-5.00E-01
-4.00E-01
-3.00E-01
-2.00E-01
-1.00E-01
0.00E+00

Contour interval= 1.00E-01



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Delta Risk Management Strategy (DRMS) Levee Fragility		Displacement Contours Idealized Section - 25 ft Peat Input Motion M 5.5 H1, 0.2g	Figure 6-96
URS	Project No. 26815621		

JOB TITLE : Displacement Contours, Input Motion M6.5 H1, 0.2g

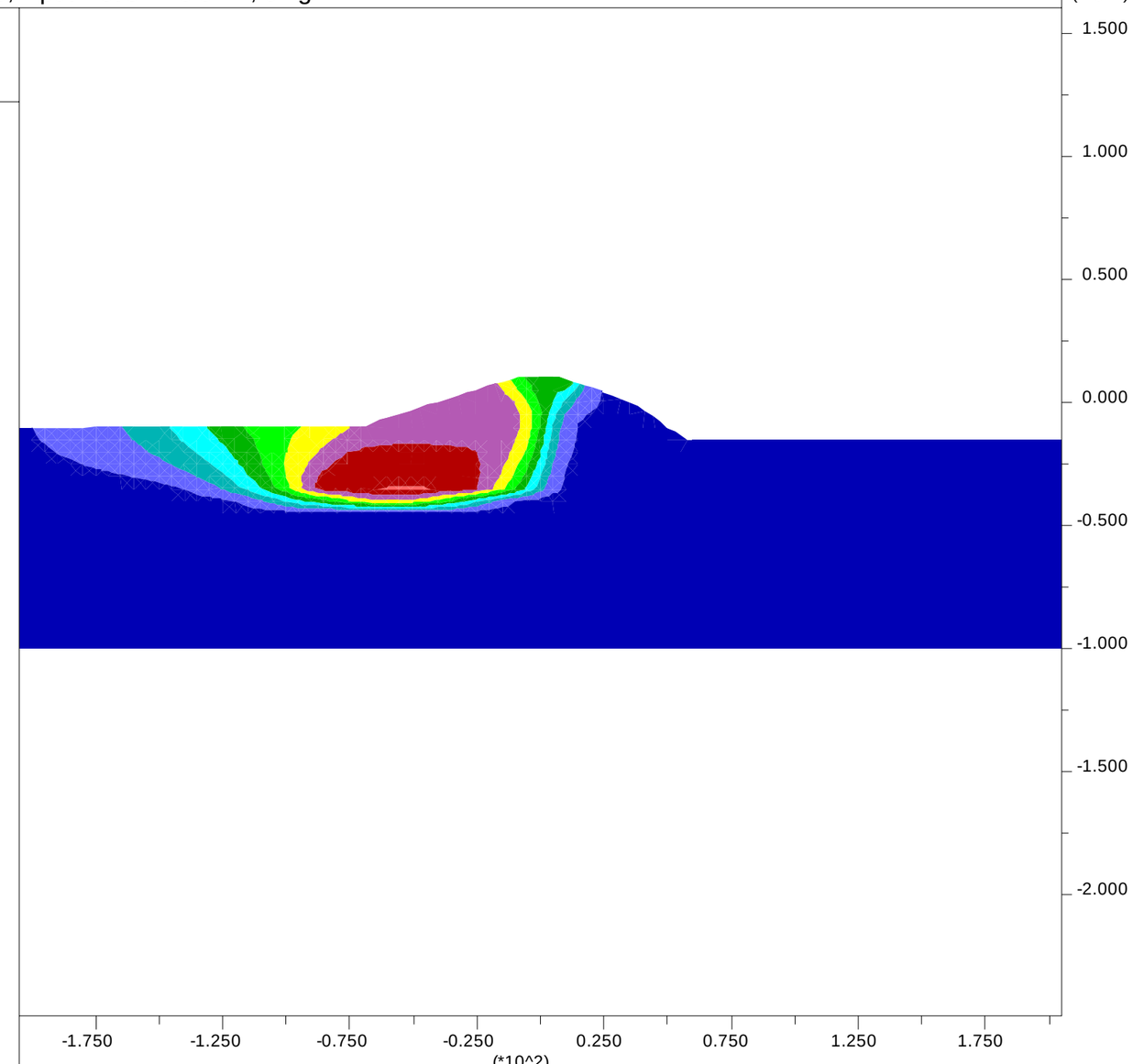
FLAC (Version 5.00)

LEGEND

8-Jan-07 23:49
step 94557
Dynamic Time 4.0000E+01
-2.049E+02 <x< 2.049E+02
-2.495E+02 <y< 1.602E+02

X-displacement contours
-8.00E-01
-7.00E-01
-6.00E-01
-5.00E-01
-4.00E-01
-3.00E-01
-2.00E-01
-1.00E-01
0.00E+00

Contour interval= 1.00E-01



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Delta Risk Management Strategy (DRMS) Levee Fragility		Displacement Contours Idealized Section - 25 ft Peat Input Motion M 6.5 H1, 0.2g	Figure 6-97
URS	Project No. 26815621		

JOB TITLE : Displacement Contours, Input Motion M7.5 H1, 0.2g

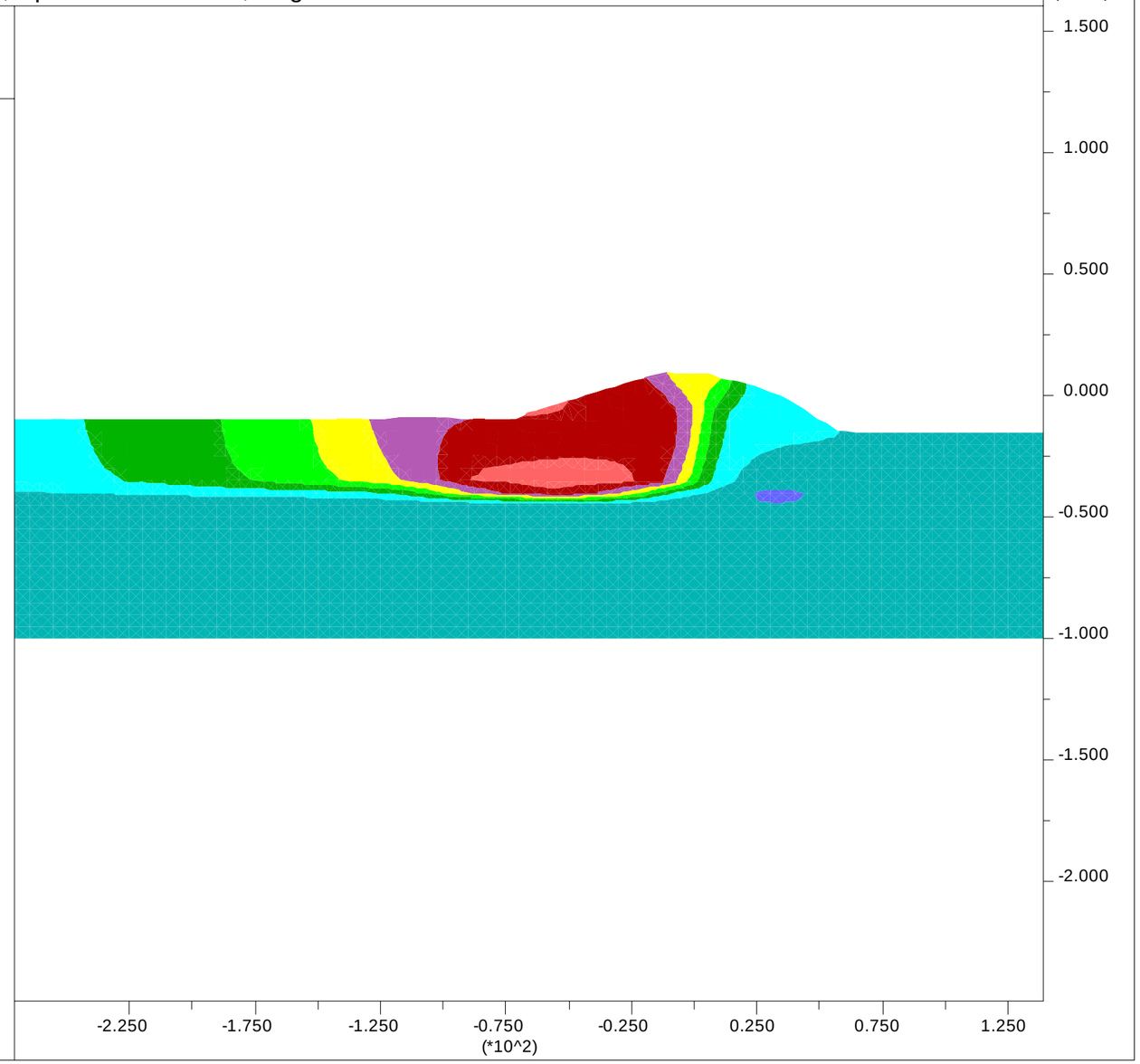
FLAC (Version 5.00)

LEGEND

9-Jan-07 5:27
step 127967
Dynamic Time 5.6000E+01
-2.707E+02 <x< 1.391E+02
-2.495E+02 <y< 1.602E+02

X-displacement contours
-3.50E+00
-3.00E+00
-2.50E+00
-2.00E+00
-1.50E+00
-1.00E+00
-5.00E-01
0.00E+00

Contour interval= 5.00E-01



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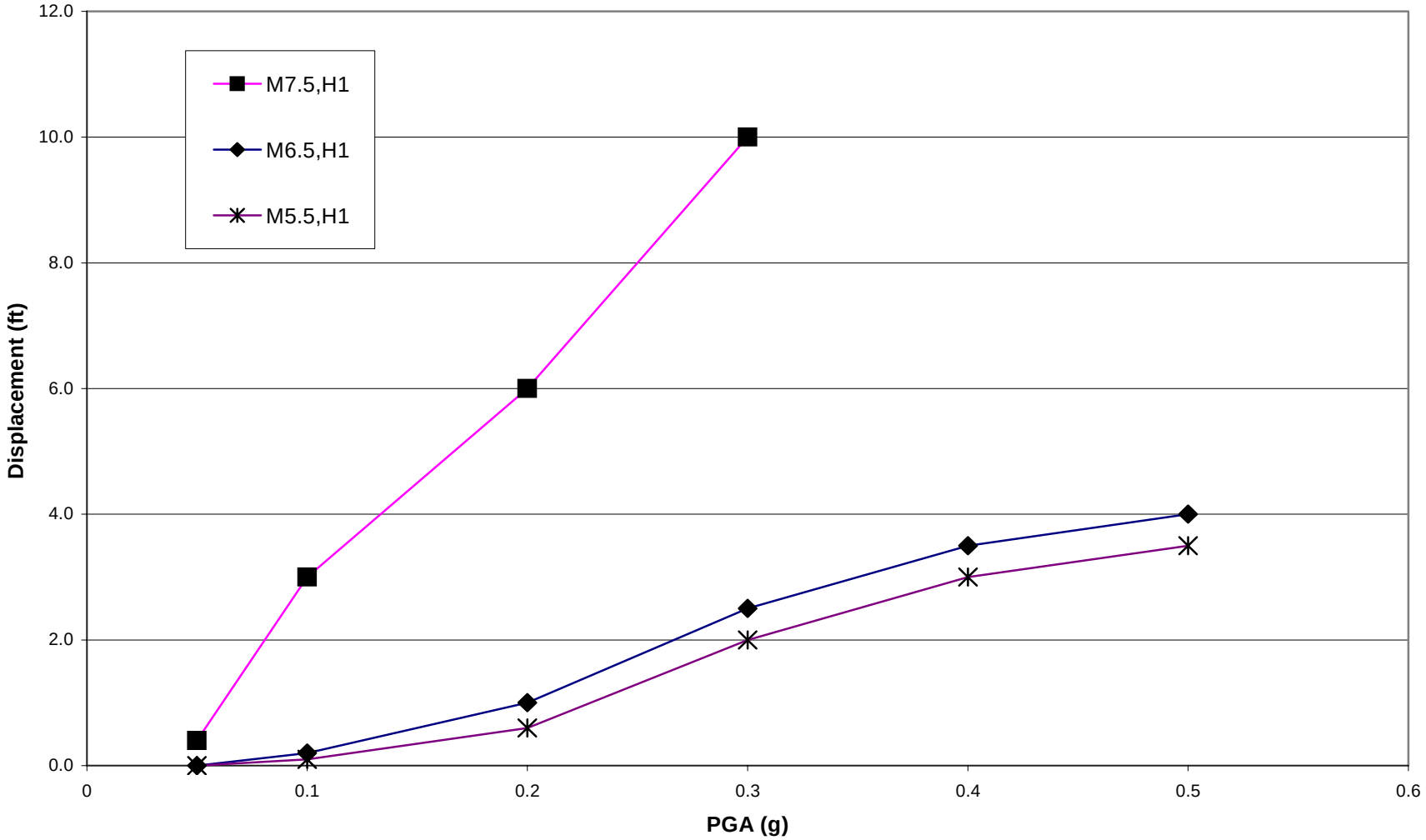
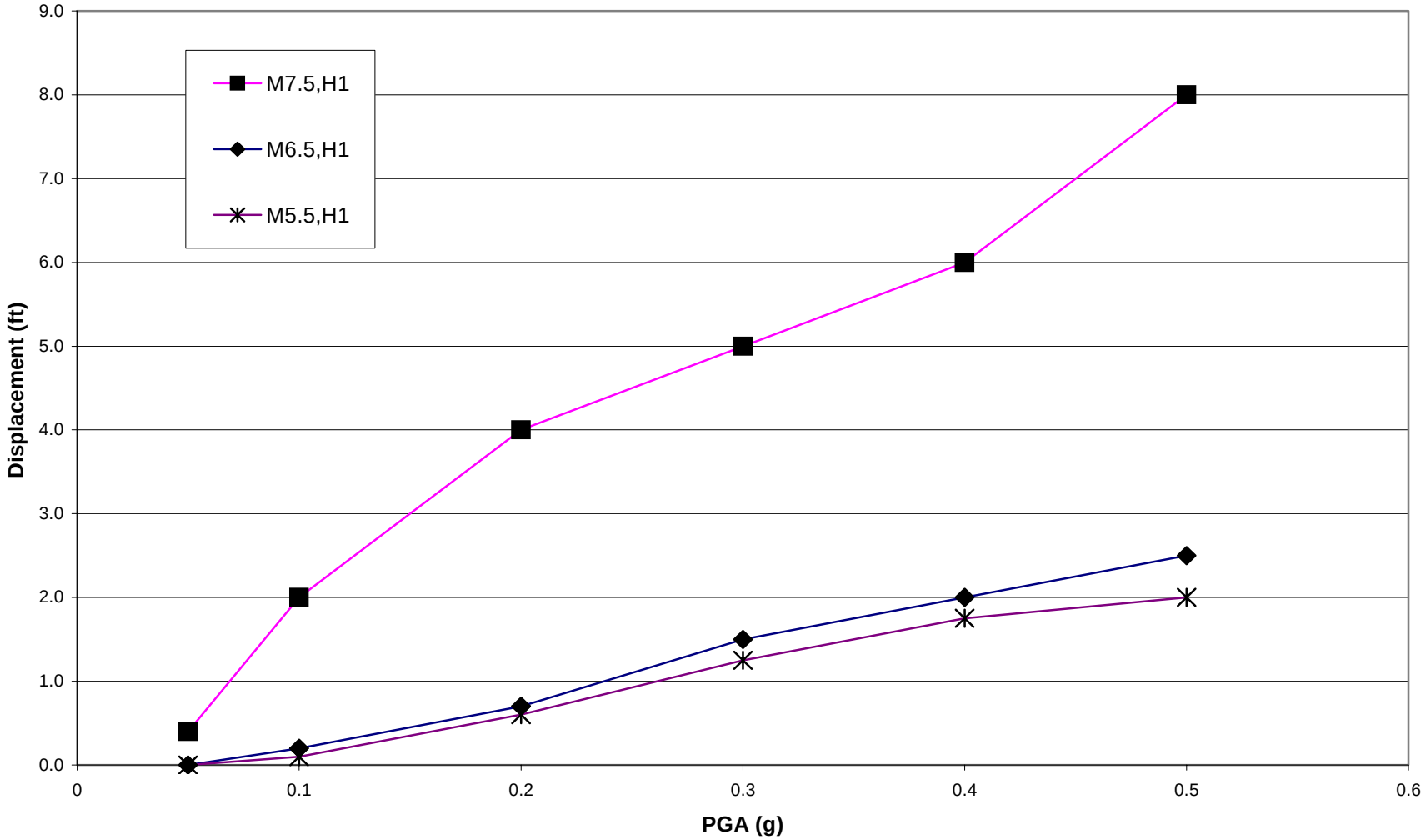
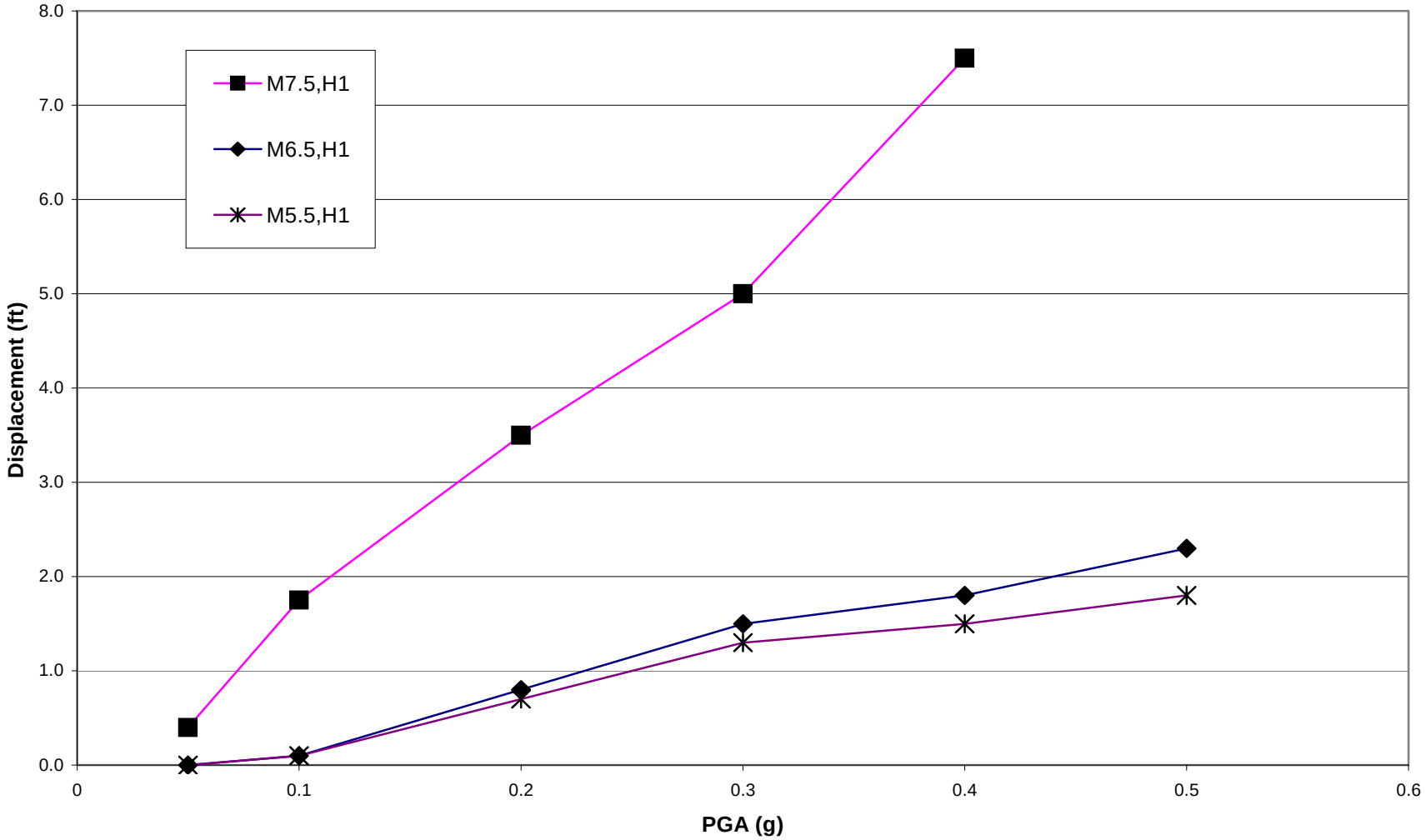
Delta Risk Management Strategy (DRMS) Levee Fragility		Displacement Contours Idealized Section - 25 ft Peat Input Motion M 7.5 H1, 0.2g	Figure 6-98
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated FLAC Displacements Idealized Section with Liquefiable Foundation Sand Layer 5 Feet of Peat	Figure 6-99
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated FLAC Displacements Idealized Section with Liquefiable Foundation Sand Layer 15 Feet of Peat	Figure 6-100
URS	Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Calculated FLAC Displacements Idealized Section with Liquefiable Foundation Sand Layer 25 Feet of Peat	Figure 6-101
URS	Project No. 26815621		

JOB TITLE : Deformed Mesh, Liquefied Fill, Su = 230 psf

FLAC (Version 5.00)

LEGEND

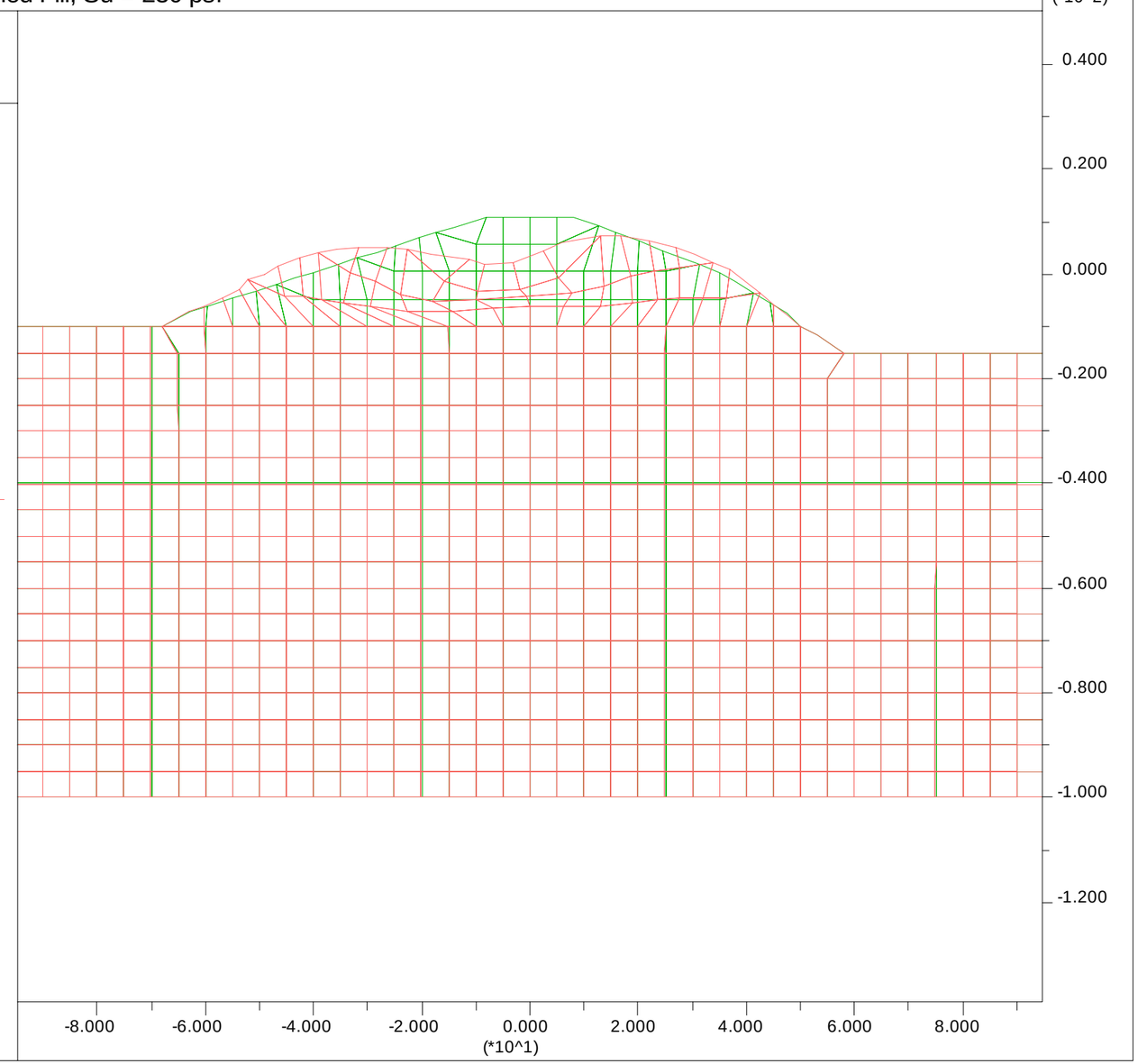
27-Nov-06 18:59
step 10365
-9.464E+01 <x< 9.464E+01
-1.391E+02 <y< 5.014E+01

Grid plot

0 5E 1

Exaggerated Grid Distortion

Magnification = 1.000E+00
Max Disp = 1.001E+01



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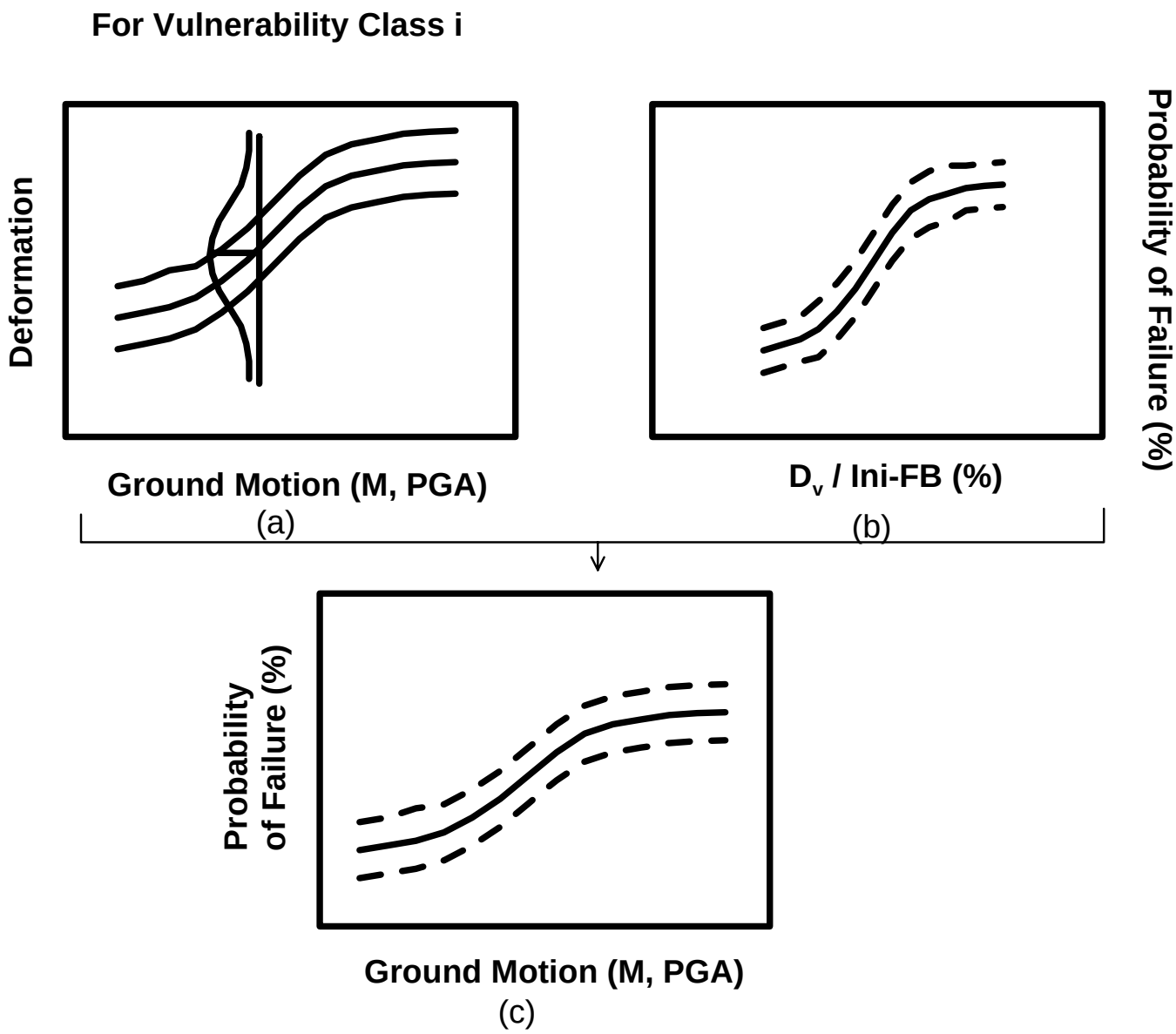
Delta Risk Management Strategy (DRMS) Levee Fragility	FLAC Deformed Mesh for Post Seismic Static Slumping Analysis Residual Strength of Embankment 230 psf	Figure 6-102
URS Project No. 26815621		



Delta Risk Management Strategy (DRMS) Levee Fragility		Development of Seismic Vulnerability Curve	Figure 6-103
URS	Project No. 26815621		