

Fort Worth Central City Preliminary Design

Civil/Structural Preliminary Design

Draft Environmental Impact Statement

Appendix C

May 2005

Volume VI – Stability Analysis Retaining Walls





STABILITY ANALYSES FOR RETAINING WALLS

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Section 1 Lower Level Retaining Walls -Computer Runs for the Retaining Walls



Lower Level Retaining Walls: I1NSLL Normal pool condition

- 1. Short-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at normal pool level, El 524.3, on resisting side
- 4. Passive soil pressure neglected on resisting side
- 5. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 13.33.33 Flood Wall Stability Analysis Using CTWALL Filename: I1NSLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft Height of stem (HTS) = 12.00 ft Thickness top of stem (TTS) = Thickness bottom of stem (TBS) = 1.17 ft 1.17 ft Dist. of batter at bot. of stem (TBSR)= .00 1.50 ft .00 ft Depth of heel (THEEL) = .00 ft Distance of batter for heel (BTRH) = Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) 2.00 ft = Distance of batter for toe (BTRT) = .00 ft Distance of batter for toe (BTRT) = .00 ft Width of base (BWIDTH) = 10.00 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft

Structure coordinates:

x (ft)	y (fc)
.00	516.50
.00	518.00
6.83	518.00
6.83	530.00
8.00	530.00
8.00	518.00
10.00	518.00
10.00	516.50

NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used.

Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data: Moist Saturated Elev. c Unit wt. unit wt. Delta soil (ksf) (kcf) (kcf) (deg) (ft) Phi (deg) .00 1.000 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:lft) (ft) _______ .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil x v point (ft) (ft) _____ 1 -1493.17 530.00 2 6.83 530.00 Resisting side soil property data: Moist Saturated _ Unit wt. unit wt. soil Batter (bof) (ft) (in:lft) Moist Saturated Elev. Phi С (deg) (kcf) (kcf) (ft) (ksf) _____ .00 1.000 .100 .130 516.50 .00 Resisting side soil profile: х Soil v point (ft) (ft) _____ 1 10.00 516.50 2 510.00 516.50 Foundation property data: phi for soil-structure interface = .00 (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 530.00 ft Resisting side elevation = 524.30 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 100.00 % Actual base in comp. = 100.00 % Overturning ratio = 1.57 * * * * * * * * * * * * * * * Xr (measured from toe) = 3.58 ft Resultant ratio = .3584 = .2000 Stem ratio Base pressure at heel = .1477 ksf Base pressure at toe = 1.8173 ksf ***** *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 2.64

Date: **/11/14 Time: 13.33.33 Flood Wall Stability Analysis Using CTWALL Filename: I1NSLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ****** ** Overturning Results ** **** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000.0000 Driving side at rest Kc = Resisting side at rest K = Resisting side at rest K = .0000 Resisting side at rest Kc = .0000 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 530.00 .0000 516.50 .8438 Surcharge pressures: Elev. Press. (ft) (ksf) ______

** Resisting side pressures **

Water pressures: Elevation Pressure (ft) (ksf) ______ 524.30 .0000 516.50 .4875 516.50 .4875 ** Uplift pressures ** Water pressures: x-coord. Pressure (f:) (ksf) _____ .00 .8438 10.00 .4875 ** Forces and moments ** Force (kips) | Mom. Arm | Part Moment Vert. Horiz. (ft) (ft-k) Structure: Structure weight..... 4.356 -3.83 -16.69 Structure, driving side: Moist soil.... .000 .00 .00 Saturated soil..... 10.655 -6.58 -70.16 Water above structure..... .000 .00 .00 Water above soil..... .000 .00 .00 External vertical loads.... .683 -6.59 -4.50 Ext. horz. pressure loads.. .000 .00 .00 Ext. horz. line loads..... .000 .00 .00 Structure, resisting side: Moist soil..... .000 .00 .00 Saturated soil..... .000 .00 .00 Water above structure..... .000 .00 .00 Water above soil..... .787 -1.00 -.79 Driving side: Effective earth loads..... .000 .00 .00 Shear (due to delta)..... .000 .00 .00 Horiz. surcharge effects... .00 .000 .00 Water loads..... 5.695 4.50 25.63 Resisting side: Effective earth loads..... .000 .00 .00 Water loads..... -1.901 2.60 -4.95 Foundation: Vertical force on base.... -9.825 -3.58 35.21 Shear on base.... -3.794 .00 .00 Uplift..... -6.656 -5.45 36.25 ** Statics Check ** SUMS = .000 .000 .00

Angle of base = .00 degrees Normal force on base = 9.825 kips Shear force on base = 3.794 kips Max. available shear force = 10.000 kips Base pressure at heel = .1477 ksf Base pressure at toe = 1.8173 ksf Xr (measured from toe) = 3.58 ft Resultant ratio = .3584 Stem ratio = .2000 Base in compression = 100.00 % Overturning ratio = 1.57 Volume of concrete = 1.08 cubic yds/ft of wall NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the

bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) _____ .000 .000 1 3.794 1.470 .000 .000 2 3 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) _____ .0000 .0000 1 2 .0000 .8438 10.0000 .4875 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 10.00 ft, y = 516.50 ft Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. Failure Weight Total Submerged Uplift angle length of wedge length force Wedqe number (deq) (ft) (kips) (ft) (kips)
 1
 .000
 .000
 .000
 .000

 2
 .000
 10.000
 15.011
 10.000
 6.656

 3
 .000
 .000
 .000
 .000
 .000
Wedge Net force number (kips) ______ 1 .000 2 .000 3 .000 _______ SUM = .000 +------+ | Factor of safety = 2.635 | +-----+



Lower Level Retaining Walls: I1NLLL Normal pool condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at normal pool level, El 524.3, on resisting side
- 4. Passive soil pressure neglected on resisting side
- 5. 100 psf vertical surcharge pressure applied

Time: 13.37.21 Date: **/11/14 Flood Wall Stability Analysis Using CTWALL Filename: I1NLLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of term Height of stem (HTS) = 1.17 ft Thickness top of stem (TTS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Dist. of heel (THEEL) = 1.50 ft .00 ft 1.50 ft Elevation of top of stem (ELTS) = 530.00 ft Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) = 2.00 ft Distance of batter for toe (BTRT) = .00 ft Width of base (BWIDTH) = 16.00 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft Structure coordinates: x (ft) y (ft) _____ .00 516.50 .00 518.00 12.83 518.00 12.83 530.00 14.00 530.00 14.00 518.00 16.00 518.00 16.00 516.50 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta (kcf) (kcf) (deg) Phi С soil (ksf) (ft) (deg) ______ 27.00 .000 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:lft) (ft) _____ .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil x v point (ft) (ft) ______ 1 -1487.17 530.00 530.00 2 12.83 Resisting side soil property data: Moist Saturated Elev. Unit wt. unit wt. soil Batter Phi С (in:1ft) (deq) (ksf) (kcf) (kcf) (ft) 27.00 .000 .100 .130 516.50 .00 Resisting side soil profile: Soil x У point (ft) (ft) _____ 16.00 516.50 516.00 516.50 1 2 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .100 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .100 (ksf) Water data: Driving side elevation = 530.00 ft Resisting side elevation = 524.30 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis. ***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

Date: **/11/14 Time: 13.37.21 Flood Wall Stability Analysis Using CTWALL Filename: I1NLLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ***** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4285Calculated earth pressure coefficients: Driving side at rest K = .5133 .7164 Driving side at rest Kc = Resisting side at rest K = .0000 Resisting side at rest Kc = .0000 Resisting side at rest K =Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ksf) (ft) _______ 530.00 .0000 516.50 .6807 Earth pressures: Elevation Pressure (ft) (ksf) 530.00 .0000 516.50 .5514

Surcharge pressures: Elev. Press. (ft) (ksf) ------530.00 .051 516.50 .051 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 524.30.0000516.50.4875516.50.4875 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) .00 .6807 16.00 .4875

** Forces and moments **

Part	Force Vert.	(kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight	5 706		-6 00	~ 31 21
Structure driving side:	5.700		0.00	J4.24
Moist soil	000		0.0	0.0
Rotac soli	20 015			.00
Matan above structure	20.015		-9.58	-191.84
water above structure	.000		.00	.00
water above soll	.000		.00	.00
External vertical loads	1.283		-9.59	-12.30
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.787		-1.00	79
Driving side:				
Effective earth loads		3.722	4.50	16.75
Shear (due to delta)	.000		. 0.0	.00
Horiz, surcharge effects		. 693	6 75	4 68
Water loads		4.595	4 50	20 67
Resisting side:		1,000	1.50	20.07
Effective earth loads		000	0.0	0.0
Water loads		-1 901	2.60	.00
Foundation.		-1.901	2.00	-4.95
Vertical force on bace	10 116		6 60	100 10
Choor on have	-10.440	7 100	-0.68	123.13
Indifr	0 246	-7.109	.00	.00
Opiiic	-9.346		-8.44	78.89
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = 18.4	46 kips			
Shear force on base = 7.1	09 kips			
Max. available shear force =	10.998 k	ips		
Base pressure at heel = .5	802 ksf			
Base pressure at toe = 1.7	255 ksf			
Xr (measured from tce) =	6.68 ft			
Resultant ratio = .	4172			
Stem ratio = .	1250			
Base in compression = 10	0.00 %			
Overturning ratio =	2.02			
2				
Volume of concrete = 1.41	cubic yds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****** ** Sliding Results ** ********* Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads (kips) (kips) Number ______ .000 .973 1 -1.901 .000 2 2.070 3 .000 Water pressures on wedges: goT Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) .0000 .6807 1 2 .0000 .6807 16.0000 2 .4875 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 16.00 ft, y = 516.50 ft Depth of cracking = .00 ft Failure Total Weight Submerged Uplift angle length of wedge length force Wedge (ft) (kips) number (deg) (ft) (kips) 1 -54.230 16.638 8.534 16.638 5.663 2 .000 16.000 25.721 16.000 9.346 16.000 25.721 16.000 .000 .000 .000 3 .000 .000 Wedge Net force number (kips) ______ -9.073 1 2 9.073 3 .000 SUM = .000 Factor of safety = 1.534



Lower Level Retaining Walls: I1FLLL

Flood / Drawdown condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at El 516.50 on resisting side
- 4. Passive soil pressure neglected on resisting side (conservative)
- 5. No surcharge pressure applied

Time: 17.34.23 Date: **/01/06 Flood Wall Stability Analysis Using CTWALL Filename: I1FLLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft Height of stem (HTS) = 12.00 ft Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft Depth of heel (THEEL)=1.50 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.50 ftWidth of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=13.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) .00 516.50
 .00
 516.50

 .00
 518.00

 9.83
 518.00

 9.83
 530.00

 11.00
 530.00

 11.00
 518.00

 13.00
 518.00
13.00 516.50 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi soil С (kcf) (kcf) (deg) (ft) (deq) (ksf) -27.00 .000 .100 .130 .00 530.00 Driving side soil geometry: Distance Soil Batter point (in:1ft) (ft) 1.00500.002.00.003.00500.00 Driving side soil profile: Soil Soil x point (ft) x У (ft) 1 -1490.17 530.00 2 9.83 530.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil С Batter (deg) (ksf) (kcf) (kcf) (ft) (in:1ft) 27.00 .000 .100 .130 516.50 .00 Resisting side soil profile: Soil x point (ft) (ft) 1 13.00 516.50 2 513.00 516.50 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .100 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .100 (ksf) Water data: Driving side elevation = 526.00 ft Resisting side elevation = 522.00 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 100.00 % Actual base in comp. = 100.00 % Overturning ratio = 2.20 ****** Xr (measured from toe) = 5.40 ft Resultant ratio = .4155 Stem ratio = .1538 Base pressure at heel = .5416 ksf Base pressure at toe = 1.6551 ksf *** Satisfied *** * * * * * * * * * * * * Sliding * Min. Required = 1.50 ********* Actual FS = 1.53

Date: **/01/06 Time: 17.34.23 Flood Wall Stability Analysis Using CTWALL Filename: I1FLLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS ** Overturning Results ** ****** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4285Calculated earth pressure coefficients: Driving side at rest K = .5133.7164 Driving side at rest Kc = Resisting side at rest K = Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 526.00 .0000 516.50 .4882 Earth pressures: Elevation Pressure (ft) (ksf) 530.00 .0000 .2053 526.00 .2053 516.50 .5886 ** Resisting side pressures **

Water pressures: Elevation Pressure (ft) (ksf) 522.00 .0000 516.50 .3438 516.50 .3438 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) .00 .4882 .3438 13.00 ** Forces and moments ** Force (kips) | Mom. Arm Part Moment Vert. Horiz. (ft) (ft-k) Structure: 5.031 Structure weight..... -4.86 -24.46 Structure, driving side: Moist soil..... -8.08 3.932 -31.79 Saturated soil..... 10.223 -8.09 -82.65 .000 Water above structure..... .00 .00 Water above soil..... .000 .00 .00 External vertical loads.... .000 .00 .00 .000 .00 Ext. horz. pressure loads.. .00 Ext. horz. line loads..... .000 .00 .00 Structure, resisting side: Moist soil..... .00 .000 .00 Saturated soil..... .000 .00 .00 Water above structure..... .000 .00 .00 Water above soil..... .500 -1.00 -.50 Driving side: Effective earth loads..... 4.182 4.66 19.48 Shear (due to delta)..... .000 .00 .00 Horiz. surcharge effects... .000 .00 .00 7.34 Water lcads..... 2.319 3.17 Resisting side: Effective earth loads..... .000 .00 .00 Water loads..... -.945 1.83 -1.73 Foundation: Vertical force on base..... -14.279 -5.40 77.13 .00 -5.555 Shear on base..... .00 -6.88 37.18 ** Statics Check ** SUMS = .000 .000 .00

Angle of base = .00 degrees Normal force on base = 14.279 kips Shear force on base = 5.555 kips Max. available shear force = 8.575 kips Base pressure at heel = .5416 ksf Base pressure at toe = 1.6551 ksf Xr (measured from toe) = 5.40 ft Resultant ratio = .1538 Base in compression = 100.00 % Overturning ratio = 2.20 Volume of concrete = 1.24 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

**** ** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Loads (kips) Wedge Number (kips) ______ .000 .000 -.945 .500 .000 .000 1 2 3 Water pressures on wedges: Top Bottom press. press. press. x-coord. Wedge (ksf) number (ksf) (ksf) (ft) 1 .0000 .4882 .0000 .4882 13.000C .3438 2 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 13.00 ft, y = 516.50 ft Depth of cracking = .00 ft Submerged Failure Total Weight Uplift Wedge angle length of wedge length number (deg) (ft) (kips) (ft) force (kips) 1 -54.339 16.616 7.510 11.693 2.854 13.000 19.186 13.000 .000 .000 .000 .000 2 5.408 .000 3 .000 Net force Wedge number (kips) ______ 1 -6.552 2 6.553 .000 3 SUM = .001 +-----Factor of safety = 1.529



Lower Level Retaining Walls: I1FSLL Flood / Drawdown condition

- 1. Short-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at El 516.50 on resisting side
- 4. Passive soil pressure neglected on resisting side (conservative)
- 5. No surcharge pressure applied
Date: **/01/06 Time: 17.24.35 Flood Wall Stability Analysis Using CTWALL Filename: I1FSLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft Height of stem (HTS) = 12.00 ft 1.17 ft Thickness top of stem (TTS) = Thickness top of stem (TTS)=1.17 ftThickness bottom of stem (TBS)=1.17 ftDist. of batter at bot. of stem (TBSR)=.00 ftDepth of heel (THEEL)=1.50 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.50 ftWidth of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=.00 ftDistance of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Thickness bottom of stem (TBS) = Structure coordinates: x (ft) y (ft) .00 516.50 .00 518.00 8.83 518.00 8.83 530.00 10.00 530.00 10.00 518.00 12.00 518.00 12.00 516.50 NOTE: X=0 is located at the left-hand side cf the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Moist Saturated Unit wt. unit wt. Delta soil Phi С (deg) (ksf) (kcf) (kcf) (deg) (ft) .00 1.000 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) ______ 1 .00 500.00 .00 .00 .00 500.00 2 3 Driving side soil profile: Soil x У point (ft) (ft) 1 -1491.17 530.00 2 8.83 530.00 Resisting side soil property data: Moist Saturated Elev. Dhi Unit wt

Phi (deg)	c (ksf)	Unit wt. (kcf)	unit wt. (kcf)	soil (ft)	Batter (in:1ft)
.00	1.000	.100	.130	516.50	.00
Resisting	side soil	profile:			

Elev.

Soil point	x (ft)	y (ft)			
1 2	12.00 512.00	516.50 516.50			
Foundatio phi for c for s phi for c for s	n property soil-structo soil-soil oil-soil	data: cture inter ure interfa interface nterface	rface = ace = = =	.00 1.000 .00 1.000	(deg) (ksf) (deg) (ksf)
Water dat Driving Resisti Unit we Seepage	a: side eleva ng side ele ight of wat pressures	ation = evation = ter = computed k	530.00 516.51 .0625 by Line o	ft ft kcf f Creep	method.

Driving side soil property data:

Date: **/01/06 Time: 17.24.35 Flood Wall Stability Analysis Using CTWALL Filename: I1FSLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS ****** ** Overturning Results ** ****** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 .0000 Driving side at rest Kc = Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 530.00 .0000 516.50 .8438 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 516.51 .0000 516.50 516.50 .0006 .0006

** Uplift pressures **				
Water pressures.				
x-coord. Pressure				
(ft) (ksf)				
.00 .8438				
12.00 .0006				
** Forces and mcments **				
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(1t)	(It-k)
Structure:				
Structure weight	4.806		-4.50	-21.64
Structure. driving side:				
Moist soil	.000		.00	.00
Saturated soil	13.775		-7.59	-104.48
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.000		.00	.00
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soll	.000		.00	.00
Driving side:		0.00	0.0	0.0
Effective earth loads	000	.000	.00	.00
Shear (due to deita)	.000	000	.00	.00
Water loads		5 695	4 50	25 63
Resisting side.		5.095	4.50	23.05
Effective earth loads		000	0.0	0.0
Water loads		.000	2.33	.00
Foundation:			1.55	
Vertical force on base	-13.515		-4.44	59.99
Shear on base		-5.695	. 00	.00
Uplift	-5.066		-8.00	40.52
	*********			***********
** Statics Check ** SUMS =	.000	.000		.00
Angle of base =) dearees			
Normal force on base = 13.51	5 kips			
Shear force on base = 5.69	95 kips			
Max. available shear force =	12.000 k	ips		
		-		
Base pressure at heel = .24 Base pressure at toe = 2.00	170 ksf 154 ksf			

Xr (measured from toe) = 4.44 ft
Resultant ratio = .3699
Stem ratio = .1667
Base in compression = 100.00 %
Overturning ratio = 1.91
Volume of concrete = 1.19 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Wedge Loads (kips) (kips) Number ______ .000 .000 1 5.695 .000 .000 2 3 Water pressures on wedges: Bottom Top Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) 1 .0000 .0000 2 .0000 .8438 12.0000 .0006 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 12.00 ft, y = 516.50 ft Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. Weight Submerged Uplift Failure Total angle length of wedge length force (deg) (ft) (kips) (ft) (kips) Wedqe number (deq) (ft) (kips) (ft) (kips)
 1
 .000
 .000
 .000
 .000
 .000

 2
 .000
 12.000
 18.581
 12.000
 5.066

 3
 .000
 .000
 .000
 .000
 .000
 Wedge Net force number (kips) ______ .000 1 .000 2 3 .000 SUM = .000 Factor of safety = 2.107



Lower Level Retaining Walls: I3ESLL Earthquake condition

- 1. Short-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at normal pool level, El 524.3, on resisting side
- 4. Passive soil pressure neglected on resisting side
- 5. No surcharge pressure
- 6. Lateral seismic forces included

Date: **/11/18 Time: 14.55.54 Flood Wall Stability Analysis Using CTWALL Filename: I3ESLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft Height of stem (HTS) -Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft .00 ft 1.50 ft .00 ft Depth of heel (THEEL) = 1.50 ft Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) = 1.00 ft Distance of batter for toe (BTRT) = .00 ft Width of base (BWIDTH) = 16.00 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft Structure coordinates: x (ft) y (ft) ____________ .00 516.50 .00516.50.00518.0013.83518.0013.83530.0015.00530.0015.00518.0016.00518.0016.00516.50 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deg) (ft) .00 1.000 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) ______ .00 500.00 1 .00 2 .00 .00 3 500.00 Driving side soil profile: Soil х У point (ft) (ft) ______ 1 -1486.17 530.00 2 13.83 530.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter С (kcf) (kcf) (ft) (deq) (ksf) (in:1ft) .00 1.000 .100 .130 516.50 .00 Resisting side soil profile: Soil x Y point (ft) (ft) 1 16.00 516.50 2 516.00 516.50 Foundation property data: phi for soil-structure interface = .00 (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 530.00 ft Resisting side elevation = 524.30 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Time: 14.55.54 Date: **/11/18 Flood Wall Stability Analysis Using CTWALL Filename: I3ESLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS ** Overturning Results ** ************* Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 .0000 Driving side at rest Kc = Resisting side at rest K = Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) ______ 530.00 .0000 516.50 .8438 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 524.30 .0000 516.50 .4875 516.50 .4875

** Uplift pressures **					
Water pressures: x-coord. Pressure (ft) (ksf)					
.00 .8438 16.00 .4875					
** Forces and moments **					
Part	Force Vert.	(kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)	
Structure weight	5.706		-5.63	-32.14	11
<pre>Structure, driving side: Moist soil Saturated soil Water above structure Water above soil External vertical loads Ext. horz. pressure loads Ext. horz. line loads</pre>	.000 21.575 .000 .000 .000	.000 1.360	.00 -9.09 .00 .00 .00 .00 6.75	.00 -196.01 .00 .00 .00 .00 9.18	
Structure, resisting side: Moist soil Saturated soil Water above structure Water above soil	.000 .000 .000 .394		.00 .00 .00 50	.00 .00 .00 20	
Effective earth loads Shear (due to delta) Horiz. surcharge effects Water loads	.000	.000 .000 5.695	.00 .00 .00 4.50	.00 .00 .00 25.63	
Resisting side: Effective earth loads Water loads Foundation:		.000 -1.901	.00 2.60	.00 -4.95	
Vertical force on base Shear on base Uplift	-17.025	-5.154	-6.21 .00 -8.71	105.68 .00 92.80	_
** Statics Check ** SUMS =	.000	.000		.00	•
Angle of base = . Normal force on base = 17.0 Shear force on base = 5.1 Max. available shear force =	00 degrees 25 kips 54 kips 16.000 k	ips			
Base pressure at heel = .3 Base pressure at toe = 1.7	489 ksf 792 ksf				

Xr (measured from toe) = 6.21 ft
Resultant ratio = .3880
Stem ratio = .0625
Base in compression = 100.00 %
Overturning ratio = 1.83
Volume of concrete = 1.41 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Summation of forces = 0. Solution converged. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) ______ .000 .000 1 .394 2 5.154 3 .000 .000 Water pressures on wedges: Тор Bottom press. Wedge press. x-coord. press. number (ksf) (ksf) (ft) (ksf) .0000 .0000 1 2 .0000 .8438 2 16.0000 .4875 3 .0000 .0000 Points of sliding plane: Point 1 (left), x =Point 2 (right), x =.00 ft, y = 16.00 ft, y = 516.50 ft 516.50 ft Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. Failure Total Weight Submerged Uplift Wedge angle length of wedge length force number (deg) (ft) (ft) (kips) (kips) .000 .000 .000 .000 1 .000 16.000 27.281 16.000 .000 .000 .000 .000 2 10.650 3 .000 .000 Wedge Net force number (kips) ______ 1 .000 2 .000 3 .000 _____ SUM = .000 +------Factor of safety = 3.104



Lower Level Retaining Walls: I3ELLL Earthquake condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at normal pool level, El 524.3, on resisting side
- 4. Passive soil pressure neglected on resisting side
- 5. No surcharge pressure
- 6. Lateral seismic forces included

Time: 15.02.05 Date: **/11/18 Flood Wall Stability Analysis Using CTWALL Filename: I3ELLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft Height of stem (HTS) = 12.00 ft 1.17 ft Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) = 1.00 ft Width of base (BWIDTH) = .00 ft Width of base (BWIDTH) = .00 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft = Thickness top of stem (TTS) Structure coordinates: x (ft) y (ft) .00 516.50 .00 518.00 13.83 518.00 13.83 530.00 15.00530.0015.00518.0016.00518.00 16.00 516.50 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Phi Unit wt. unit wt. Delta С soil (kcf) (kcf) (deg) (deg) (ksf) (ft) 27.00 .100 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) .00 500.00 1 2 .00 .00 .00 500.00 3 Driving side soil profile: Soil х У point (ft) (ft) -1486.17 530.00 13.83 530.00 1 2 Resisting side scil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter С (kcf) (kcf) (ft) (in:1ft) (deg) (ksf) 27.00 .100 .100 .130 516.50 .00 Resisting side soil profile: Soil x У point (ft) (ft) _____ 16.00 516.50 1 2 516.00 516.50 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .100 (ksf) phi for soil-soil interface = c for soil-soil interface = 27.00 (deg) .100 (ksf) Water data: Driving side elevation = 530.00 ft Resisting side elevation = 524.30 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Date: **/11/18 Time: 15.02.05 Flood Wall Stability Analysis Using CTWALL Filename: I3ELLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: WCS ****** ** Overturning Results ** ***** Solution converged in 1 iterations. SMF used to calculate K's = .6667 = -54.1821 Alpha for the SMF Calculated earth pressure coefficients: Driving side at rest K = .5133.7164 Driving side at rest Kc = Resisting side at rest K = Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = -1.22 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) ------530.00 .0000 531.22 -.0763 516.50 .6807 Earth pressures: Elevation Pressure (ft)(ksf) .0000 531.22 530.00 .0000 516.50 .4559

** Resisting side pressures **

Water pressures: Elevation Pressure (ft) (ksf) 524.30 .0000 516.50 .4875 516.50 .4875 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) ______ .00 .6807 16.00 .4875 ** Forces and moments ** Force (kips) Mom. Arm Part Moment Vert. | Horiz. (ft) (ft-k) Structure: Structure weight..... 5.706 -5.63 -32.14Structure, driving side: Moist soil..... .000 .00 .00 Saturated soil..... 21.575 -9.09 -196.01 Water above structure..... .000 .00 .00 Water above soil..... .000 .00 .00 External vertical loads.... .000 .00 .00 Ext. horz. pressure loads.. .000 .00 .00 Ext. horz. line lcads..... 3.920 4.12 16.15 Structure, resisting side: Mcist soil..... .000 . 00 .00 Saturated soil..... .000 .00 .00 Water above structure..... .000 .00 .00 Water above soil..... .394 -.50 -.20 Driving side: Effective earth loads..... 3.077 4.50 13.85 Shear (due to delta)..... .00 .000 .00 Horiz. surcharge effects... .000 .00 .00 Water loads..... 4.495 4.39 19.74 Resisting side: Effective earth loads..... .000 .00 .00 Water loads..... -1.901 2.60 -4.95 Foundation: Vertical force on base..... -18.329 -5.71 104.67 Shear on base..... -9.591 .00 .00 -9.346 Uplift.... -8.44 78.89 ** Statics Check ** SUMS = .000 .000 .00

Angle of base = .00 degrees Normal force on base = 18.329 kips Shear force on base = 9.591 kips Max. available shear force = 10.939 kips Base pressure at heel = .1620 ksf Base pressure at toe = 2.1291 ksf Xr (measured from toe) = 5.71 ft Resultant ratio = .3569 Stem ratio = .0625 Base in compression = 100.00 % Overturning ratio = 1.81 Volume of concrete = 1.41 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Stationary solution. Static sum of forces. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) .000 .000 2.019 .394 1 2.019 .000 2 3 .000 Water pressures on wedges: Top Bottom press. press. x-coord. Wedqe press. number (ksf) (ksf) (ft) (ksf) ______ 1 .0000 .6807 2 .0000 .6807 2 16.0000 .4875 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 16.00 ft, y = 516.50 ft Depth of cracking = -1.26 ft Failure Weight Submerged Uplift Total angle length of wedge length force Wedge (ft) number (deg) (ft) (kips) (kips) 1-57.90817.4217.36417.4215.9292.00016.00027.28116.0009.3463.000.000.000.000.000 Wedge Net force number (kips) _____ -6.051 1 2 7.926 3 .000 SUM = 1.875 NOTE: Forces are calculated for the FS specified below. +------+

| Factor of safety = 1.100 |



Lower Level Retaining Walls: I4CSLL Construction / Maintenance condition

- 1. Short-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at base of wall on resisting side
- 4. Passive soil pressure neglected on resisting side
- 5. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 13.38.09 Flood Wall Stability Analysis Using CTWALL Filename: I4CSLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall lccation: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft = 12.00 ft Height of stem (HTS) 1.17 ft Thickness top of stem (TTS) = Thickness top of stem (115) = 1.1. 15 Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft 0.0 ft .00 ft Distance of batter for heel (BTRH) = Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) = 2.00 ft Distance of batter for toe (BTRT) = .00 ft Width of base (BWIDTH) = 10.50 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft Structure coordinates: x (ft) y (ft) _____ .00 516.50 .00516.50.00518.007.33518.007.33530.008.50530.008.50518.0010.50518.0010.50516.50 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta soil Phi С (ksf) (kcf) (kcf) (deg) (ft) (deq) .00 1.000 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) ______ .00 500.00 1 .00 .00 .00 500.00 2 3 Driving side soil profile: Soil х (ft) point (ft) ______ 1 -1492.67 530.00 2 7.33 530.00 Resisting side soil property data: Moist Saturated Elev. Unit wt. unit wt. soil Phi С Batter (kcf) (kcf) (ft) (deq) (in:1ft) (ksf) .00 1.000 .100 .130 516.50 .00 Resisting side soil profile: Soil х v point (ft) (ft) _____ 1 10.50 516.50 2 510.50 516.50 Foundation property data: phi for soil-structure interface = .0C (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 530.00 ft Resisting side elevation = 516.51 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

Minimum required factors of safety: Sliding FS = 1.33 Overturning = 75.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 75.00 % Actual base in comp. = 100.00 % Overturning ratio = 1.78 * * * * * * * * * * * * * * * Xr (measured from toe) = 3.64 ft Resultant ratio = .3463 Stem ratio = .1905 Base pressure at heel = .0902 ksf Base pressure at toe = 2.2342 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ******** Actual FS = 1.84

Date: **/11/14 Time: 13.38.09 Flood Wall Stability Analysis Using CTWALL Filename: I4CSLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 Driving side at rest Kc = .0000 Resisting side at rest K = .0000 Resisting side at rest Kc = .0000 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) ___________ 530.00 .0000 516.50 .8438 Surcharge pressures: Elev. Press. (ft) (ksf) _____

** Resisting side pressures **

```
Water pressures:
   Elevation Pressure
     (ft)
             (ksf)
   ______
     516.51
               .0000
     516.50
              .0006
     516.50
              .0006
** Uplift pressures **
 Water pressures:
    x-coord. Pressure
     (ft)
             (ksf)
   _____
       .00 .8438
      10.50
              .0006
** Forces and moments **
Part
                         Force (kips) | Mom. Arm
                                                 Moment
                        Vert. Horiz. (ft)
                                                 (ft-k)
Structure:
 Structure weight.....
                         4.469
                                          -3.99
                                                 -17.85
Structure, driving side:
 Moist soil.....
                          .000
                                            .00
                                                    .00
 Saturated soil.....
                                          -6.84
                        11.435
                                                 -78.16
 Water above structure.....
                          .000
                                            .00
                                                    .00
 Water above soil.....
                          .000
                                            .00
                                                    .00
 External vertical loads....
                          .733
                                          -6.84
                                                  -5.01
 Ext. horz. pressure loads..
                                   .000
                                           .00
                                                   .00
 Ext. horz. line loads.....
                                   .000
                                            .00
                                                    .00
Structure, resisting side:
 Moist soil.....
                          .000
                                            .00
                                                    .00
 Saturated soil.....
                                            .00
                          .000
                                                    .00
                                            .00
 Water above structure.....
                          .000
                                                   .00
 Water above soil.....
                          .000
                                            .00
                                                   .00
Driving side:
 Effective earth loads.....
                                   .000
                                            .00
                                                   .00
 Shear (due to delta).....
                          .000
                                            .00
                                                   .00
 Horiz. surcharge effects...
                                  .000
                                                   .00
                                            .00
 Water loads.....
                                  5.695
                                           4.50
                                                  25.63
Resisting side:
 Effective earth loads.....
                                   .000
                                           .00
                                                   .00
 Water loads.....
                                   .000
                                           2.17
                                                   .00
Foundation:
 Vertical force on base..... -12.203
                                          -3.64
                                                  44.37
 Shear on base.....
                                 -5.695
                                           .00
                                                   .00
 Uplift.....
                       -4.433
                                          -7.00
                                                  31.02
** Statics Check ** SUMS = .000 .000
                                                   .00
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Angle of base = .00 degrees Normal force on base = 12.203 kips Shear force on base = 5.695 kips Max. available shear force = 10.500 kips Base pressure at heel = .0902 ksf Base pressure at toe = 2.2342 ksf Xr (measured from toe) = 3.64 ft Resultant ratio = .3463 Stem ratio = .1905 Base in compression = 100.00 % Overturning ratio = 1.78 Volume of concrete = 1.10 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****** ** Sliding Results ** ***************** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) .000 1 .000 5.695 .733 2 3 Water pressures on wedges: Top Bottom press. press. (ksf) (ksf) x-coord. press. Wedge number (ft) (ksf) 7 .0000 .0000 2 .0000 .8438 10.5000 .0006 2 .0000 .0000 3 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 10.50 ft, y = 516.50 ft Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. Failure Total Weight Submerged Uplift angle length of wedge length force Wedge (ft) (kips) (ft) number (deq) (kips) 1 .000 .000 .000 .000 .000 .000 10.500 15.903 10.500 .000 .000 .000 .000 2 4.433 3 .000 Wedge Net force number (kips) 1 .000 2 .000 3 .000 ______

=======

SUM = .000

+	 -	-	-	-	-	-	 -		-	-	-	-		-		-	-			-	-	-	-	-			-	+
ļ	F	а	С	t	0	r	0	f		s	а	f	e	t	У		=					1		8	4	4		
+	 _	_	_	-		_	 _	-		-	-	-	_	-	_		-	_	-	_	-	-		-	-	-	-	+



Lower Level Retaining Walls: I4CLLL Construction / Maintenance condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 530 on driving side
- 3. Water at base of wall on resisting side
- 4. Passive soil pressure neglected on resisting side
- 5. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 13.51.29 Flood Wall Stability Analysis Using CTWALL Filename: I4CLLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 530.00 ft Height of stem (HTS) = 12.00 ft 1.17 ft Thickness top of stem (TTS) -Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft .00 ft Distance of batter for heel (BTRH) = .00 ft Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) = 2.00 ft Distance of batter for toe (BTRT) = .00 ft Width of base (BWIDTH) = 12.50 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft Structure coordinates: x (ft) y (ft) ______ .00 516.50 .00 518.00 9.33518.009.33530.0010.50530.0010.50518.0012.50518.0012.50516.50 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta soil Phi С (deq) (ksf) (kcf) (kcf) (deg) (ft) _____ 27.00 .000 .100 .130 .00 530.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) .00 500.00 .00 .00 1 2 .00 500.00 3 Driving side soil profile: Soil x У point (ft) (ft) ______ 1 -1490.67 530.00 2 9.33 530.00 Resisting side soil property data: Moist Saturated Elev. Unit wt. unit wt. soil Batter Phi С (in:1ft) (ksf) (kcf) (kcf) (ft) (deq) 27.00 .000 .100 .130 516.50 .00 Resisting side soil profile: Soil х У point (ft) (ft) _____ 1 12.50 516.50 2 512.50 516.50 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .100 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .100 (ksf) Water data: Driving side elevation = 530.00 ft Resisting side elevation = 516.51 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 75.00 % Actual base in comp. = 100.00 % Overturning ratio = 2.44 *********** Xr (measured from toe) = 4.77 ft Resultant ratio = .3814 = .1600 Stem ratio Base pressure at heel = .4118 ksf Base pressure at toe = 2.4466 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ********** Actual FS = 1.34

Time: 13.51.29 Date: **/11/14 Flood Wall Stability Analysis Using CTWALL Filename: I4CLLL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ****** ** Overturning Results ** ******* Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4285Calculated earth pressure coefficients: Driving side at rest K = .5133 .7164 Driving side at rest Kc = Resisting side at rest K =Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 530.00 .0000 516.50 .4060 Earth pressures: Elevation Pressure (ft) (ksf) ______ 530.00 .0000 516.50 .6924

** Forces and moments **

	===========		==============	
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
Structure				
Structure:	4 010		4 60	00.00
Structure weight	4.919		-4.68	-23.02
Structure, driving side:				
Moist soil	.000		.00	.00
Saturated soil	14.555		-7.83	-114.04
Water above structure	.000		.00	. 00
Water above soil	000		0.0	0.0
External vertical loads			-7.84	.00
External vertical loads	. 200	0.00	-7.04	-7.31
Ext. norz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.000		.00	.00
Water above structure	000		0.0	0.0
Water above soil				.00
Driving gide.	.000		.00	.00
Driving side:			4 5 9	
Effective earth loads		4.6/4	4.50	21.03
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.693	6.75	4.68
Water loads		2.740	4.50	12.34
Resisting side:				
Effective earth loads		000	0.0	0.0
Water loads		.000	2 2 2	.00
Foundation.		.000	2.55	.00
Foundation:			4 55	05.44
vertical force on base	-17.865		-4.77	85.16
Shear on base		-8.107	.00	.00
Uplifi	-2.541		-8.33	21.16
	=========			==========
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = 17.8	65 kips			
Shear force on base $-$ 8 1	07 king			
Max available abear force	10 2E2 P	ina		
Max. available shear force =	10.353 K	ips		
Base pressure at heel = .41	118 ksí			
Base pressure at toe = 2.4	466 ksf			
Xr (measured from toe) =	4.77 ft			
Regultant ratio -	3814			
Ctom matio	1600			
D = a + a = a + a = a + a = a = a = a = a				
base in compression = 100	J.UU 8			
Overturning ratio =	2.44			
Volume of concrete = 1.21	cubic yds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ******************* Summation of forces = 0. Solution converged. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) _____ .000 .930 1 .000 .933 .000 2 3 Water pressures on wedges: Тор Bottom press. Wedge press. press. x-coord. number (ksf) (ksf) (ft) (ft) (ksf) 1 .0000 .4060 2 .0000 .4060 12.5000 .0006 2 3 .0000 .0000 Points of sliding plane: .00 ft, y = 516.50 ft Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 12.50 ft, y = 516.50 ft Depth cf cracking = .00 ft Failure Total Weight Submerged Uplift length of wedge length angle Wedge force (ft) number (deg) (ft) (kips) (kips) 1-55.43716.3938.16116.3933.3282.00012.50019.47312.5002.5413.000.000.000.000.000 Wedge Net force number (kips) __________ 1 -7.717 7.716 2 3 .000 _____ SUM = -.001Factor of saf

ety = 1.342 |



Section 2 Mid - Level Retaining Walls -Computer Runs for the Retaining Walls



Mid-Level Retaining Walls: I1NLML Normal condition

- 1. Long-term soil properties assumed
- 2. Drained soil above drainage pipe on driving side
- 3. Passive soil pressure included on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 13.44.38 Flood Wall Stability Analysis Using CTWALL Filename: I1NLML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 540.00 ft Height of stem (HTS) Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft .00 ft .00 ft = 11.50 ft Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft Width of toe (TWIDTH) = 2.00 ft Distance of batter for toe (BTRT) = .00 ft Width of base (BWIDTH) = 10.00 ft Depth of key (HK) = .00 ft Width of bottom of key (TK) = .00 ft Dist. of batter at bot. of key (BTRK) = .00 ft Structure coordinates: x (ft) y (ft) __________ .00 527.00 .00527.00.00528.506.83528.506.83540.008.00540.008.00528.5010.00528.5010.00527.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	C (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	. 000	.100	.130	.00	540.00
Driving s	side soil ge	eometry:			
Soil point	Batter (in:1ft)	Distance (ft)	2		
1 2 3	.00 .00 .00	500.00 .00 500.00			
Driving s	side soil pr	ofile:			
Soil point	x (ft)	y (ft)			
1 2	-1493.17 6.83	540.00 540.00	_		
Resisting	g side soil	property d	lata:		
Phi (aeg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	530.00	.00
Resisting	g side soil	profile:			
Soil point	x (ft)	y (ft)			
1 2	8.00 508.00	530.00 530.00	-=		
Foundation phi for c for s phi for c for s	on property soil-structu soil-structu soil-soil soil-soil in	data: ture inter re interfa interface terface	face = .ce = = =	27.00 (.100 (27.00 (.100 (deg) ksf) deg) ksf)
Water dat Driving Resisti Unit we Seepage	ta: g side eleva ing side ele eight of wat e pressures	tion = vation = er = computed b	530.50 ft 527.01 ft .0625 kc y Line of	f Creep m	ethod.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 100.00 % Actual base in comp. = 100.00 % Overturning ratio = 2.93 * * * * * * * * * * * * * * * Xr (measured from toe) = 3.94 ft Resultant ratio = .3935 Stem ratio = .2000 Base pressure at heel = .4341 ksf Base pressure at toe = 1.9694 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 1.72

Date: **/11/14 Time: 13.44.38 Flocd Wall Stability Analysis Using CTWALL Filename: I1NLML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ****** Solution converged in 1 iterations. SMF used to calculate K's = .6667 = -54.5245 Alpha for the SMF Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 530.50 .0000 527.00 .1622 Earth pressures: Elevation Pressure (ft) (ksf) ______ 540.00 .0000 530.50 .4876 527.00 .6379 ** Resisting side pressures **

** Forces and moments **

Part	Force	(kips)	Mom. Arm	Moment				
	Vert.	Horiz.	(ft)	(ft-k)				
	============							
Structure:								
Structure weight	4 268		-3.86	-16 47				
Structure driving side:	1.200		5.00	10.17				
Moist soil	6 190		6 50	10 70				
MOISE SOIL	0.409		-6.59	-42.73				
Saturated soll	1.776		-6.58	-11.69				
Water above structure	.000		.00	.00				
Water above soil	.000		.00	.00				
External vertical loads	.000		.00	.00				
Ext. horz. pressure loads		.000	.00	.00				
Ext. horz. line loads		.000	.00	.00				
Structure, resisting side:								
Moist soil	.300		-1.00	- 30				
Saturated soil			00	.50				
Water above structure	.000		.00	.00				
Water above structure	.000		.00	.00				
Water above soll	.000		.00	.00				
Driving side:								
Effective earth loads		4.286	4.37	18.74				
Shear (due to delta)	.000		.00	.00				
Horiz. surcharge effects		.000	.00	.00				
Water loads		.284	1.17	.33				
Resisting side:								
Effective earth loads		598	1.00	60				
Water loads		.000	.55	. 00				
Foundation:								
Vertical force on base	-12 017		-3 94	47 29				
Chorr on base	12.01/	-3 971	00	17.20				
Unlift	- 915	J. J / I	-6 65	5.42				
opiiic	015		-0.05	5.42				
** Station Check ** SIMS -		000						
- Statics check - Soms -	.000	.000		.00				
Angle of bogo	oo daamaaa							
Angle of base = .	17 hiss							
Normal force on base = 12.0	I/ Kips							
Shear force on base $=$ 3.9	/l kips							
Max. available shear force =	7.123 k	ips						
Base pressure at heel = .4	341 ksf							
Base pressure at toe $=$ 1.9	694 ksf							
Xr (measured from toe) =	3.94 ft							
Resultant ratio = .	3935							
Stem ratio =	2000							
Base in compression $=$ 10	0 00 %							
Overturning ratio -	2 93							
overcutining facto -								
Volume of concrete - 1 05	cubic vde	/ft of wall						
VOLUME OF CONCLESE - 1.03	cubic yus	/ IC OI WAII						

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) _____ .000 1 .000 .000 .000 .000 2 3 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ft) (ksf) ______ 1 .0000 .1622 2 .1622 .0000 10.0000 2 .0008 3 .0000 .0008 Points of sliding plane: Point 1 (left), x = .00 ft, y = ... $p_{int} 2$ (right), x = 10.00 ft, y = ...Depth of cracking = .00 ft Failure Total Weight Submerged Uplift length Wedge angle length of wedge force (£ こ) number (deq) (kips) (ft) (kips) 1 -53.386 16.196 6.415 4.360 .354 .000 10.000 12.833 10.000 .815 36.912 4.995 .599 .017 .000 2 3 Weage Net force number (kips) ==================== 1 -4.943 2 4.136 3 .807 ______ SUM = .000 +-----+ Factor of safety = 1.722



Mid-Level Retaining Walls: I1FLML Flood / Drawdown condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 535.5 on driving side
- 3. Water at El 531 on resisting side
- 4. Passive soil pressure included on resisting side
- 5. No surcharge pressure applied

Date: **/11/14 Time: 13.55.26 Flood Wall Stability Analysis Using CTWALL Filename: I1FLML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 540.00 ft = 11.50 ft Height of stem (HTS) Height of stem (HTS)=11.50 ftThickness top of stem (TTS)=1.17 ftThickness bottom of stem (TBS)=1.17 ftDist. of batter at bot. of stem (TBSR)=.00 ftDepth of heel (THEEL)=1.50 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.50 ftWidth of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Thickness top of stem (TTS) Structure coordinates: x (ft) y (ft) _____________ .00 527.00 .00 528.50 8.33 528.50 8.33 540.00 9.50 540.00 9.50 528.50 11.50 528.50 11.50 527.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Phi Unit wt. unit wt. Delta soil С (kcf) (kcf) (deg) (deq) (ksf) (ft) _____ 27.00 .000 .100 .130 .00 540.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) _____ 1 .00 500.00 .00 .00 .00 500.00 2 3 Driving side soil profile: Scil х V point (ft) (ft) _____ 1 -1491.67 540.00 2 8.33 540.00 Resisting side soil property data: Moist Saturated Elev. Jnit wt. unit wt. soil Phi С Batter (in:lft) (deq) (ksf) (kcf) (kcf) (ft) _____ 27.00 .000 .100 .130 530.00 .00 Resisting side soil profile: Soil х V point (ft) (fz)_____ 2 9.50 530.00 509.50 2 530.00 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .100 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .100 (ksf) Water data: Driving side elevation = 535.50 ft Resisting side elevation = 531.00 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

Date: **/11/14 Time: 13.55.26 Flood Wall Stability Analysis Using CTWALL Filename: I1FLML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ****** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.5386 Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ksf) (ft) 535.50 .0000 527.00 .4273 Earth pressures: Elevation Pressure (ft) (ksf) ______ 540.00 .0000 535.50 .2310 527.00 .5788 ** Resisting side pressures **

** Forces and moments **

	=============	============	==================	===========
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
				==========
Structure:				
Structure weight	4,606		-4.36	-20 09
Structure driving side:	1.000		1.00	20.05
Mojet cojl	2 740			
Moist Soil	3.740		- 7.34	-27.50
Saturated soll	7.580		- / . 33	-55.60
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.000		.00	.00
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	. 000		. 00	.00
Saturated soil	390		-1.00	- 39
Water above structure			1.00	
Water above sciuccuic	.000		.00	.00
Water above sorr	.125		-1.00	13
Driving side:		2 0 6 1	4 4 7	10 00
Effective earth loads	0.0.0	3.961	4.4/	1/./2
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.000	. 00	.00
Water loads		1.816	2.83	5.15
Resisting side:				
Effective earth loads		331	1.00	33
Water loads		555	1.30	72
Foundation:				
Vertical force on base	-12.344		-4.60	56.73
Shear on base		-4.891	.00	.00
Uplift	-4.105		-6.13	25.16
	=======================================	=============	=======================================	============
** Statics Check ** SUMS =	. 000	. 000		0.0
beautieb enteen send				
Angle of base -	00 degrees			
Normal force on base = 12.3	11 king			
Normal force on base = 12.3	A4 Kips			
Shear torce on base = 4.0	JI KIDS	ing		
Max. available shear force =	7.440 K	tps		
Base pressure at heel = .4	271 ksi			
Base pressure at toe $=$ 1.7	197 ksf			
Xr (measured from toe) =	4.60 ft			
Resultant ratio = .	3996			
Stem ratio = .	1739			
Base in compression $=$ 10	0.00 %			
Overturning ratio =	2.18			
Volume of concrete = 1.14	cubic vds	/fr of wall		
	CUDIC JUD	, LC OL WALL		
NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) ______ 1 .000 .000 -.031 .000 .125 2 3 .259 Water pressures on wedges: goT Bottom Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ft) (ksf) .0000 .4273 1 2 .0000 .4273 11.5000 .2867 2 3 .0625 .2867 Points of sliding plane: .00 ft, y = Point 1 (left), x = .00 ft, y = 527.00 ft Point 2 (right), x = 11.50 ft, y = 527.00 ft Depth cf cracking = .00 ft Failure Total Weight Submerged Uplift length of wedge length angle Wedge force (deq) (ft) (kips) (ft) number (kips) 1-54.30116.0086.85110.4672.2362.00011.50016.32511.5004.105335.9085.115.8085.115.893 4.105 .893 Wedge Net force number (kips) _____ 1 -5.850 2 4.851 3 1.000 _____ SUM = .000 +-----+ Factor of safety = 1.544 +----



Mid-Level Retaining Walls: I1FSML Flood / Drawdown condition

- 1. Short-term soil properties assumed "Study" case
- 2. Full-depth water filled crack on driving side
- 3. Water at El 531 on resisting side
- 4. Passive soil pressure included on resisting side
- 5. No surcharge pressure applied

Date: **/11/14 Time: 14.05.31 Flood Wall Stability Analysis Using CTWALL Filename: I1FSML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of been Height of stem (HTS) = 1.17 ft Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft Distance of batter for heel (BTRH) = .00 ft Depth of toe (TTOE) = 1.50 ft .00 ft .00 ft .00 ft .00 ft Elevation of top of stem (ELTS) = 540.00 ft Distance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=7.50 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) ______ .00 527.00 .00 528.50 4.33 528.50 4.33 540.00 5.50 540.00 5.50 528.50 7.50 528.50 7.50 527.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (kcf) (kcf) (deq) (ksf) (deq) (ft) _____ 1.000 .100 .130 .00 540.00 .00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) 1 .00 500.00 2 .00 .00 3 .00 500.00 Driving side soil profile: Soil х У (ft) point (ft) ______ 1 -1495.67 540.00 2 4.33 540.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil С Batter (kcf) (kcf) (ft) (deq) (ksf) (in:lft) .00 1.000 .100 .130 530.00 .00 Resisting side soil profile: Soil х У point (ft) (ft) _____ 5.50 530.0C 505.50 530.0C 1 2 Foundation property data: phi for soil-structure interface = .00 (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 535.50 ft Resisting side elevation = 531.00 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis. ***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

Date: **/11/14 Time: 14.05.31 Flood Wall Stability Analysis Using CTWALL Filename: I1FSML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA * * ** Overturning Results Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 Driving side at rest Kc = .0000 Resisting side at rest K = 1.0000Resisting side at rest Kc = 1.0000 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 13.00 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 540.00 .0000 527.00 .5313 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) ______ 531.00 .0000 .0625 530.00 527.00 .1295

Earth pressures: Elevation Pressure (ft) (ksf) ______ .0000 530.00 527.00 1.0209 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) ================================ .00 .5313 7.50 .1295 ** Forces and moments ** Force (kips) | Mom. Arm Part Moment Vert. Horiz. (ft) (ft-k) Structure: Structure weight..... 3.706 -3.12 -11.55 Structure, driving side: Moist soil..... 1.949 -5.33 -10.40Saturated soil..... 3.940 -5.33 -21.02 Water above structure..... .000 .00 .00 Water above soil..... .000 .00 .00 External vertical loads.... .000 .00 .00 Ext. horz. pressure loads.. .000 .00 Ext. horz. line loads..... .000 .00 Structure, resisting side: Moist soil..... .000 .00 .00 Saturated soil..... .390 -1.00 -.39 Water above structure..... .000 .00 .00 Water above soil..... -1.00 .125 -.13 Driving side: Effective earth loads..... .000 .00 .00 Shear (due to delta)..... .000 .00 .00 Horiz. surcharge effects... .000 .00 .00 Water loads..... 3.453 4.33 14.96 Resisting side: Effective earth loads..... -1.531 1.00 -1.54 Water loads..... -.319 1.52 ~.49 Foundation: Vertical force on base.... -7.632 -2.54 19.37 Shear on base.... -1.603 .00 .00 Uplift..... -2.478 -4.51 11.17 ** Statics Check ** SUMS = .000 .000 .00

.00

.00

Angle of base = .00 degrees Normal force on base = 7.632 kips Shear force on base = 1.603 kips Max. available shear force = 7.500 kips Base pressure at heel = .0305 ksf Base pressure at toe = 2.0047 ksf Xr (measured from toe) = 2.54 ft Resultant ratio = .3383 Stem ratio = .2667 Base in compression = 100.00 % Overturning ratio = 1.74 Volume of concrete = .92 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) _____ .000 .000 1 5.250 .000 2 .125 .187 3 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) 1 .0000 .0000 .0000 .5313 7.5000 .1295 2 7.5000 2 .0625 .1295 3 Points of sliding plane: Point 1 (left), x = .00 ft, y = 527.00 ft Point 2 (right), x = 7.50 ft, y = 527.00 ft Depth of cracking = 13.00 ft Crack extends to bottom of base of structure. Failure Total Weight Submerged Uplift angle length of wedge length force (deg) (ft) (kips) (ft) (kips) Wedge number 1.000.000.000.0002.0007.5009.9857.5002.478345.0364.240.5844.240.407 Wedge Net force number (kips) _____ 1 .000 2 -2.762 3 2.763

SUM = .000

+	_	_	-	-	-	-	-	-	~	_	-	-	-	-	-	-	-	-	-		-	-	-	_	-	-	-	-	-	+
		F	а	С	t	0	r		0	f		S	а	f	е	t	У		=					3	-	0	1	5		
+	-	-		-	-	-	-	-	-	-	-		_	-	-	-	_	-		-	-				-	-	-		-	+

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Mid-Level Retaining Walls: I3ELML Earthquake condition

- 1. Long-term soil properties assumed
- 2. Drained soil above drainage pipe on driving side
- 3. Passive soil pressure included on resisting side
- 4. No surcharge pressure
- 5. Lateral seismic forces accounted for

Date: **/11/16 Time: 10.18.38 Flood Wall Stability Analysis Using CTWALL Filename: I3ELML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 540.00 ft Height of stem (HTS) = 11.50 ft 1.17 ft Thickness top of stem (TTS) = Thickness bottom of stem (TBS) = Thickness bottom of stem (TBS)=1.17 ftDist. of batter at bot. of stem (TBSR) =.00 ftDepth of heel (THEEL)=1.50 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.50 ftWidth of toe (TWIDTH)=1.00 ftDistance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=11.50 ftDepth of key (HX)=.00 ftWidth of bottom of key (TX)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft 1.17 ft Structure coordinates: x (ft) y (ft) _____ .00 527.00 .00 528.50 9.33 528.50 9.33 540.00 9.33 10.50540.0010.50528.5011.50527.00 NCTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt (kcf)	Saturate . unit wt (kcf)	d . Delta (deg)	Elev. a soil (ft)									
27.00	.100	.100	.130	.00	540.00									
Driving	side soil	geometry:												
Soil point ======	Batter (in:1ft	Distan) (ft)	ce ===											
1 2 3	.00 .00 .00	500.00 .00 500.00												
Driving side soil profile:														
Soil point ====== 1 2	x (ft) -1490.67 9.33	Y (ft) 540.00 540.00	===											
Resistir	ng side soi	l property	data:											
Phi (deg) ========	c (ksf)	Moist Unit wt (kcf)	Saturated . unit wc (kcf)	d Elev. . soil (ft)	Batter (in:1ft)									
Resistir	ng side soi	l profile:	. ± 3 0	550.00										
Soil point ====== 1 2	x (ft) 10.50 510.50	y (ft) 530.00 530.00	===											
Foundati phi fo c for phi fo c for Water da Drivin	on propert soil-struc or soil-soi soil-soil soil-soil ata:	y data: nucture inter ture inter l interface interface	erface = face = = = 530.50 f	27.00 .100 27.00 .100	(deg) (ksf) (deg) (ksf)									
Resist Unit w Seepag	ing side e weight of w ge pressure	<pre>levation = vater = s computed</pre>	527.10 f .0625 k by Line of	it sof Creep	method.									

Minimum required factors of safety: Sliding FS = 1.10 Overturning = .10% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** Required base in comp. = .10 % * Overturning * Actual base in comp. = 100.00 % Overturning ratio = 4.17 ******** Xr (measured from toe) = 4.86 ft Resultant ratio = .4228 Stem ratio = .0870 Base pressure at heel = .7016 ksf Base pressure at toe = 1.9117 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.10 ********* Actual FS = 2.36

Date: **/11/16 Time: 10.18.38 Flood Wall Stability Analysis Using CTWALL Filename: I3ELML.DAT Company name: CDMProject name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ********************** Solution converged in 1 iterations. SMF used to calculate K's = .6667 = -52.7738 Alpha for the SMF Calculated earth pressure coefficients: Driving side at rest K = .5127 Driving side at rest Kc = .7173 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = -.88 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) __________________ 530.50 .000C 527.00 .1695 Earth pressures: Elevation Pressure (ft) (ksf) 540.88 .0000 540.00.0000530.50.3914527.00.5378 ** Resisting side pressures **

** Forces and moments **

Part	Force	(kips)	Mom. Arm	Moment								
	Vert.	Horiz.	(ft)	(ft-k)								
	==========		=================									
Structure:												
Structure weight	4.606		-3.92	-18.08								
Structure, driving side:												
Moist soil	8.864		-6.84	-60.58								
Saturated soil	2.426		-6.84	-16.58								
Water above structure	.000		.00	.00								
Water above soil	.000		.00	.00								
External vertical loads	.000		.00	.00								
Ext. horz. pressure loads		.000	.00	.00								
Ext. horz. line loads		.000	.00	.00								
Structure, resisting side:												
Moist soil	.150		50	08								
Saturated soil	.000		.00	.00								
Water above structure	.000		.00	.00								
Water above soil	.000		.00	.00								
Driving side:												
Effective earth loads		3.485	4.33	15.10								
Shear (due to delta)	.000		.00	.00								
Horiz. surcharge effects		.000	.00	.00								
Water loads		.297	1.17	.35								
Resisting side:												
Effective earth loads		835	1.00	84								
Water loads		.000	.24	.00								
Foundation:												
Vertical force on base	-15.026		-4.86	73.07								
Shear on base		-2.947	.00	.00								
Uplift	-1.019		-7.50	7.64								
	=========	===============		===============								
** Statics Check ** SUMS =	.000	.000		.00								
Angle of base -	n dogroog											
Normal force on base - 15 0	o degrees											
Shear force on base $=$ 2.9	17 kips											
Max available shear force -	8 806 F	ing										
Max. available Shear force -	0.000 K	трв										
Base pressure at heel = $.70$)16 ksf											
Base pressure at toe = 1.9	117 ksf											
Xr (measured from toe) =	1.86 ft											
Resultant ratio = .4	1228											
Stem ratio = .(0870											
Base in compression = 100).00 %											
Overturning ratio = 4	1.17											
_												
Volume cf concrete = 1.14	cubic yds,	/ft of wall										

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

***** ** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads (kips) (kips) Number ______ .000 .000 .000 .000 .000 .000 1 2 3 Water pressures on wedges: Top Bottom press. press. x-coord. (ksf) (ksf) (ft) Wedge press. number (ksf) _____ 1 .0000 .1695 .0000 .1695 2 11.5000 2 .0077 3 .0000 .0077 Points of sliding plane: Point 1 (left), x = .00 ft, y = 527.00 ft Point 2 (right), x = 11.50 ft, y = 527.00 ft Depth of cracking = -.96 ft Failure Total Weight Submerged Uplift angle length of wedge length force (deg) (ft) (kips) (ft) (kips) Wedge number (kips) -

 1
 -48.736
 18.567
 7.535
 4.656
 .395

 2
 .000
 11.500
 16.045
 11.500
 1.019

 3
 39.143
 4.752
 .553
 .158
 .001

 Wedge Net force number (kips) ------4.735 1 2 3.729 3 1.005 _______ SUM = .000 Factor of safety = 2.361



Mid-Level Retaining Walls: I4CSML Construction condition

- 1. Short-term soil properties assumed
- 2. Fully drained soil on driving side
- 3. Passive soil pressure neglected on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 14.20.21 Flood Wall Stability Analysis Using CTWALL Filename: I4CSML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 540.00 ft = 11.50 ft Height of stem (HTS) Thickness top of stem (TTS)=11.50 ftThickness top of stem (TTS)=1.17 ftThickness bottom of stem (TBS)=1.17 ftDist. of batter at bot. of stem (TBSR)=.00 ftDepth of heel (THEEL)=1.50 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.50 ft 2.00 ft Width of toe (TWIDTH) = Width of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=10.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) .00 527.00

 .00
 527.00

 .00
 528.50

 6.83
 528.50

 6.83
 540.00

 8.00
 540.00

 8.00
 528.50

 10.00
 528.50

 10.00
 527.00

 NCTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deq) (ft) _____ 1.000 .100 .130 .00 540.00 .00 Driving side soil geometry: Batter Distance Soil point (in:1ft) (ft) ______ .00 500.00 1 .00 .00 2 .00 500.00 3 Driving side soil profile: Soil х У point (ft) (ft) _____ 1 -1493.17 540.00 2 6.83 540.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil С Batter (kcf) (kcf) (ft) (in:1ft) (deq) (ksf) .00 1.000 .100 .130 527.00 .00 Resisting side soil profile: Soil x У point (ft) (ft) _____ 1 10.00 527.00 510.00 527.00 2 Foundation property data: phi for soil-structure interface = .00 (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 540.00 ft Resisting side elevation = 527.01 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

Minimum required factors of safety: Sliding FS = 1.33 Overturning = 75.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 75.00 % ************ Actual base in comp. = 100.00 % Overturning ratio = 1.76 Xr (measured from toe) = 3.44 fc Resultant ratio = .3445 Stem ratio = .2000 Base pressure at heel = .0743 ksf Base pressure at toe = 2.1450 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ********* Actual FS = 1.89

Date: **/11/14 Time: 14.20.21 Flood Wall Stability Analysis Using CTWALL Filename: I4CSML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ****** ** Overturning Results * * ***** Solution converged in 1 iterations. SMF used to calculate K's = .6667 = Alpha for the SMF .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 .0000 Driving side at rest Kc = Resisting side at rest K =Resisting side at rest K = .0000 Full passive K coloritation (.0000 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 13.00 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 540.00 .0000 527.00 .8125 Surcharge pressures: Elev. Press. (ft) (ksf) ===============================

** Resisting side pressures **

Water pressures: Elevation Pressure (ft) (ksf) _____ 527.01 .0000 527.00 .0006 527.00 .0006 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) _____ .00 .8125 10.00 .0006 ** Forces and moments ** Force (kips) | Mom. Arm Part Moment Vert. Horiz. (ft) (ft-k) Structure: Structure weight..... 4.268 -3.86 -16.47 Structure, driving side: Moist soil..... .000 .00 .00 Saturated soil..... 10.211 -6.58 -67.24 .000 Water above structure..... .00 .00 Water above soil..... .000 .00 .00 External vertical loads.... .683 -6.59 -4.50 Ext. horz. pressure loads.. .000 .00 .00 Ext. horz. line loads..... .000 .00 .00 Structure, resisting side: Moist soil..... .000 .00 .00 Saturated soil..... .000 .00 .00 Water above structure..... .000 .00 .00 Water above soil..... .000 .00 .00 Driving side: Effective earth loads..... .000 .00 .00 Shear (due to delta)..... .000 .00 .00 Horiz. surcharge effects... .000 .00 .00 Water loads.... 5.281 4.33 22.88 Resisting side: .00 Effective earth loads..... .000 .00 Water loads..... .000 .70 .00 Foundation: Vertical force on base..... -11.096 -3.44 38.23 Shear on base..... -5.281 .00 .00 -4.066 -6.66 Uplift..... 27.09 ** Statics Check ** SUMS = .000 .000 .00

Angle of base = .00 degrees Normal force on base = 11.096 kips Shear force on base = 5.281 kips Max. available shear force = 10.000 kips Base pressure at heel = .0743 ksf Base pressure at toe = 2.1450 ksf Xr (measured from toe) = 3.44 ft Resultant ratio = .3445 Stem ratio = .2000 Base in compression = 100.00 % Overturning ratio = 1.76 Volume of concrete = 1.05 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Loads Wedge Number (kips) (kips) _____ .000 .000 1 5.281 .683 .000 .000 2 3 Water pressures on wedges: Bottom Top Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ksf) 1 .0000 .0000 2 .00C0 .8125 10.0000 .0006 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 527.00 ft Point 2 (right), x = 10.00 ft, y = 527.00 ft Depth of cracking = 13.00 ft Crack extends to bottom of base of structure. Total Weight Submerged Uplift Failure length of wedge length force angle Wedge number (deq) (ft) (kips) (ft) (kips) .000. .000 .000 .000 .000 1 .00010.00014.47910.0004.066.000.000.000.000.000 2 3 Wedge Net force number (kips) _____ .000 7 .000 2 3 .000 _____

SUM = .000

+ -		-	-		-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	+
	F	a	С	t	0	r		0	f		s	a	f	е	t	У		=					1		8	9	3		
+ -		_	-		-		-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+


Mid-Level Retaining Walls: I4CLML Construction condition

- 1. Long-term soil properties assumed
- 2. Fully drained soil on driving side
- 3. Passive soil pressure neglected on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 14.07.57 Flood Wall Stability Analysis Using CTWALL Filename: I4CLML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 540.00 ft = 11.50 ft Height of stem (HTS) 1.17 ft Thickness top of stem (TTS)=1.17 ftThickness bottom of stem (TBS)=1.17 ftDist. of batter at bot. of stem (TBSR)=00 ftDepth of heel (THEEL)=1.50 ftDistance of batter for heel (BTRH)=00 ftDepth of toe (TTOE)=1.50 ftWidth of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=0.0 ftDistance of batter for toe (BTRT)=0.0 ftWidth of base (BWIDTH)=9.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Thickness top of stem (TTS) = Structure coordinates: x (ft) y (ft) _____ .00 527.00

 .00
 527.00

 .00
 528.50

 5.83
 528.50

 5.83
 540.00

 7.00
 540.00

 7.00
 528.50

 9.00
 527.00

NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	540.00
Driving si	de soil ge.	ometry:			
Soil point	Batter (in:1ft)	Distance (ft)	e ==		
1 2 3	.00 .00 .00	500.00 .00 500.00			
Driving si	de soil pr.	ofile:			
Soil point =======	x (ft)	y (ft)	= =		
1 - 2	1494.17 5.83	540.00 540.00			
Resisting	side soil	property o	data:		
Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	. 000	.100	.130	527.00	.00
Resisting	side soil	profile:			
Soil point	x (ft)	Y (ft)			
1 2	9.00 509.00	527.00 527.00			
Foundation phi for c for so phi for c for so	property soil-struc il-structu soil-soil il-soil in	data: ture inter re interfa interface terface	rface = ace = = =	27.00 (.100 (27.00 (.100 (deg) ksf) deg) ksf)
Water data Driving Resistin Unit wei Seepage	: side eleva g side ele ght of wate pressures e	tion = vation = er = computed a	527.01 ft 527.01 ft .0625 kc are hydrost	f atic.	
Uniform lo Magnitud	ad data: e of load :	= .10) k/ft		

Minimum required factors of safety: Sliding FS = 1.33 Overturning = 75.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 75.00 % Actual base in comp. = 100.00 % Overturning ratio = 2.53 * * * * * * * * * * * * * * * Xr (measured from toe) = 3.14 ft Resultant ratio = .3486 = .2222 Stem ratio Base pressure at heel = .1149 ksf Base pressure at toe = 2.4017 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ********* Actual FS = 1.40

Date: **/11/14 Time: 14.07.57 Flood Wall Stability Analysis Using CTWALL Filename: I4CLML.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ********************* Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.5245Calculated earth pressure coefficients: Driving side at rest K = .5133 .7164 Driving side at rest Kc = Resisting side at rest K = .0000 Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 fc ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) ______ 527.01 .0000 527.00 .0006 Earth pressures: Elevation Pressure (ksf) (ft) 540.00 .000 527.01 .6667 527.00 .6671

Surcharge pressures: Elev. Press. (ft) (ksf) 540.00 .051 527.00 .051 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 527.01.0000527.00.0006527.00.0006 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) _____ .00 .0006 9.00 .0006

** Forces and moments **

=======================================	=======================================	=================		
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
			=======================================	
Structure:				
Structure weight	4.043		-3.54	-14.33
Structure, driving side:				
Moist soil	6.704		-6.08	-40.80
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	. 583		-6.09	-3.55
Ext horz pressure loads		000	00	0.00
Ext horz line loads		000	.00	.00
Structure resisting side:		.000	.00	.00
Moist soil	000		0.0	0.0
Seturated coil	.000		.00	.00
Water above structure	.000		.00	.00
Water above structure	.000		.00	.00
Water above sol	.000		.00	.00
Driving side:		4 225		
Effective earth loads		4.337	4.33	18.78
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.667	6.50	4.34
Water loads		.000	37	.00
Resisting side:				
Effective earth loads		.000	.00	.00
Water loads		.000	37	.00
Foundation:				
Vertical force on base	-11.325		-3.14	35.53
Shear on base		-5.004	.00	.00
Uplift	006		-4.50	.03
				=============
** Statics Check ** SUMS =	.000	.000		.00
Angle of bogs				
Angle of base = .	00 degrees			
Normal force on base = 11.3	25 Kips			
Shear force on base = 5.0	04 Kips			
Max. available shear force =	6.670 k	ips		
Base pressure at neel = .1	149 KSI			
Base pressure at toe $= 2.4$	017 ksi			
	2 24 55			
<pre>Xr (measured from toe) =</pre>	3.14 IC			
Resultant ratio = .	3486			
Stem ratio = .	2222			
Base in compression = 10	0.00 %			
Overturning ratio =	2.53			
Volume of congrets	aubia vela	/ft of wall		
volume of concrete = 1.00	cubic yas	/it of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Loads Wedge (kips) (kips) Number ______ .910 .000 1 .000 .000 .583 2 .000 3 Water pressures on wedges: Bottom Top number press. press. (ksf) (ksf) press. x-coord. (ksf) (ft) _____ 1 .0000 .0006 .0000 .0006 9.0000 .0006 2 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 527.00 ft Point 2 (right), x = 9.00 ft, y = 527.00 ft Depth of cracking = .00 ft Failure Total Weight Submerged Uplift force Wedge angle length of wedge length number (deg) (ft) (kips) (ft) (kips) _____ 1-55.00315.8705.916.012.0002.0009.00010.7489.000.0063.000.000.000.000.000 Wedge Net force number (kips) _____ 1 -4.774 4.774 2 3 .000 ______ SUM = .000

| Factor of safety = 1.397 |

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Section 3 Upper Level Retaining Walls -Computer Runs for the Retaining Walls



Upper Level Retaining Walls: I1NL14UL (14-ft clear height)

Normal condition

- 1. Long-term soil properties assumed
- 2. Drained soil above drainage pipe on driving side
- 3. Passive soil pressure included on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 14.10.26 Flood Wall Stability Analysis Using CTWALL Filename: I1NL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Width of toe (IWIDIA)=4.00 ftDistance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=16.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00 538.83 10.25 538.83 10.25 554.00 12.00 554.00 12.00538.8316.00538.8316.00537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	C (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	554.00
Driving si	de soil ge	ometry:			
Soil point =======	Batter (in:1ft)	Distance (ft)	2		
1 2 3	.00 .00 .00	500.00 .00 500.00			
Driving si	de soil pr	ofile:			
Soil point	x (ft)	y (ft)			
1 - 2	1489.75 10.25	554.00 554.00			
Resisting	side soil ;	property o	lata:		
Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	540.00	.00
Resisting	side soil]	profile:			
Soil point	x (ft)	y (ft)			
1 2	12.00 512.00	540.00 540.00			
Foundation phi for c for so phi for c for so	soil-structu soil-structu soil-soil soil soil-soil int	data: ture inter re interfa interface terface	face = ice = = =	27.00 (.250 (27.00 (.250 (deg) ksf) deg) ksf)
Water data Driving Resistin Unit wei Seepage	side elevat g side elev ght of wate pressures o	tion = vation = er = computed b	540.50 ft 537.01 ft .0625 kc by Line of	f Creep m	ethod.
Uniform lo Magnitud	ad data: le of load =	= .10	k/ft		

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mcbilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** Required base in comp. = 100.00 % * Overturning * ******** Actual base in comp. = 100.00 % Overturning ratio = 3.72 Xr (measured from toe) = 7.22 ft Resultant ratio = .4513 = .2500 Stem ratio Base pressure at heel = 1.0831 ksf Base pressure at toe = 1.9777 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 1.86

Date: **/11/14 Time: 14.10.26 Flood Wall Stability Analysis Using CTWALL Filename: I1NL14UL.DAT Company name: CDMProject name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** **** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4205Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 540.50 .0000 537.00 .1796 Earth pressures: Elevation Pressure (ft) (ksf) _____ 554.00 .0000 540.50 .6929 537.00 .8343

Surcharge pressures: Elev. Press. (ft) (ksf) 554.00 .051 537.00 .051 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 537.01 .0000 537.00 .0007 Earth pressures: Elevation Pressure (ft) (ksf) _____ 540.00 .0000 537.00 .3989 ** Jplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) _____ .00 .1796 16.00 .0007

** Forces and moments **

	=======================================			
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
			=======================================	============
Structure:				
Structure weight	8.374		-6.51	-54.55
Structure, driving side:				
Moist soil	13.838		-10.88	-150.48
Saturated soil	2.225		-10.87	-24.20
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	1.025		-10.88	-11.15
Ext. horz. pressure loads		. 000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.468		-2.00	94
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
Driving side:				
Effective earth loads		7.350	5.71	41.96
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.873	8.50	7.42
Water loads		.314	1.16	.37
Resisting side:				
Effective earth loads		598	.99	59
Water loads		.000	10	.00
Foundation:				
Vertical force on base	-24.487		-7.22	176.81
Shear on base		-7.938	.00	.00
Uplift	-1.443		-10.64	15.36
	========	==========		=======================================
** Statics Check ** SUMS =	.000	.000		.00
	o			
Angle of base $=$.0	u degrees 7 king			
Normal force on base = 24.48	/ Kips			
Shear Lorce on base = 7.93	8 KIPS			
Max. available shear force =	16.4// K	lps		
Base pressure at heal -1.08	31 kaf			
Base pressure at toe = 1.97	77 ksf			
base pressure de coe = 1.97	II ROL			
Xr (measured from toe) = 7	22 ft			
Resultant ratio $= 43$	513			
Stem ratio = .2	500			
Base in compression $=$ 100	.00 %			
Overturning ratio = 3	.72			
Volume of concrete = 2.07 d	cubic yds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

***** ** Sliding Results ** **** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Loads Wedge Number (kips) (kips) _____ .000 1.295 1 .000 2 1.025 3 .000 Water pressures on wedges: Top Bottom number (kar) press. press. x-coord. (ksf) (ksf) (ft) press. (ksf) .0000 .1796 1 .0000 .1796 16.0000 .0007 2 2 3 .0000 .0007 Points of sliding plane: .00 ft, y = 537.00 ftPoint 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 16.00 ft, y = 537.00 ft Depth of cracking = .00 ft TotalWeightSubmergedUpliftlengthof wedgelengthforce(ft)(kips)(ft)(kips) Failure Wedge angle number (deg) _____ 1-52.70221.37011.1474.400.3952.00016.00024.90516.0001.443337.7774.897.581.016.000 Wedge Net force number (kips) _____ 1 -9.636 8.863 2 3 .773 ================================ SUM = .000 +-----+ Factor of safety = 1.859



517-

Upper Level Retaining Walls: I1FL14UL (14-ft clear height)

Flood / Drawdown condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 549 on driving side
- 3. Water at El 544 on resisting side
- 4. Passive soil pressure included on resisting side
- 5. No surcharge pressure applied

Date: **/11/14 Time: 14.29.12 Flood Wall Stability Analysis Using CTWALL Filename: I1FL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 554.00 ft = 15.17 ft Height of stem (HTS)=15.17 ftThickness top of stem (TTS)=1.75 ftThickness bottom of stem (TBS)=1.75 ftDist. of batter at bot. of stem (TBSR)=.00 ftDepth of heel (THEEL)=1.83 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.83 ftWidth of toe (TWIDTH)=4.00 ftDistance of batter for toe (BTRT)=.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Height of stem (HTS) Structure coordinates: x (ft) y (ft) _____ .00 537.00

 .00
 537.00

 .00
 538.83

 8.75
 538.83

 8.75
 554.00

 10.50
 554.00

 10.50
 538.83

 14.50
 537.00

NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	C (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	554.00
Driving si	de soil ge.	ometry:			
Soil point	Batter (in:1ft)	Distanc (ft)	e ==		
1 2 3	.00 .00 .00	500.00 .00 500.00			
Driving si	de soil pr.	ofile:			
Soil point	x (ft)	y (ft)			
1 - 2	1491.25 8.75	554.00 554.00			
Resisting	side soil	property o	data:		
Phi (deg)	C (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	540.00	.00
Resisting	side soil	profile:			
Soil point	x (ft)	y (ft)			
1 2	10.50 510.50	540.00 540.00	= =		
Foundation phi for c for so phi for c for so	property soil-struc il-structu soil-soil il-soil in	data: ture inter re interfa interface terface	rface = ace = =	27.00 (0 .250 (1 27.00 (0 .250 (1	deg) ksf) deg) ksf)
Water data Driving Resistin Unit wei Seepage	: side eleva g side ele ght of wat pressures	tion = vation = er = computed b	549.00 ft 544.00 ft .0625 kc by Line of	f Creep me	ethod.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 100.00 % Actual base in comp. = 100.00 % Overturning ratio = 1.91 ***** Xr (measured from toe) = 5.86 ft Resultant ratio = .4039 Stem ratio = .2759 Base pressure at heel = .5134 ksf Base pressure at toe = 1.9136 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.50 ********** Actual FS = 1.51

Date: **/11/14 Time: 14.29.12 Flood Wall Stability Analysis Using CTWALL Filename: I1FL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ******* Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4202Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 549.00 .0000 537.00 .6229 Earth pressures: Elevation Pressure (ít) (ksf) ______ 554.00 .0000 .2566 549.00 537.00 .7376 ** Resisting side pressures **

** Forces and moments **

			=======================================	
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
			=======================================	
Structure:				
Structure weight	7.962		-6.06	-48.27
Structure, driving side:				
Moist soil	4.375		-10.12	-44.30
Saturated soil	11.568		-10.12	-117.13
Water above structure	.000		.00	.00
Water above soil	.000		.00	
External vertical loads	.000		.00	
Ext horz pressure loads		000	.00	.00
Ext horz line loads		000	.00	.00
Structure registing side:		.000	.00	.00
Mojet soil	000		0.0	0.0
Saturated soil	.000		2.00	.00
Water above structure	.608		-2.00	-1.22
Water above structure	.000		.00	.00
Water above soll	1.000		-2.00	-2.00
Driving side:		6 600	- 0 -	
Effective earth loads		6.607	5.87	38.79
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.000	.00	.00
Water loads		3.737	4.00	14.95
Resisting side:				
Effective earth loads		341	1.00	34
Water loads		-1.579	2.29	-3.62
Foundation:				
Vertical force on base	-17.596		-5.86	103.04
Shear on base		-8.425	.00	.00
Uplift	-7.918		-7.59	60.10
		==========		===========
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = $1/.5$	96 Kips			
Shear force on base = 8.4	25 Kips			
Max. available shear force =	12.591 k	ips		
Base pressure at heel = .5.	134 ksi			
Base pressure at toe $=$ 1.9	136 ksi			
Xr (measured from toe) =	5.86 IT			
Resultant ratio = .4	4039			
Stem ratio = .2	2759			
Base in compression $=$ 100	0.00 %			
Overturning ratio =	1.91			
Volume of concrete - 1 07	cubia reda	/ft of mall		
volume of concrete = 1.97	cubre yas	IL OL WALL		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** Solution converged. Summation of forces = 0. Horizontal Vertical Wedqe Loads Loads (kips) (kips) Number _____ .000 1.000 .000 1 2 -.500 3 .000 1.013 Water pressures on wedges: Bottom Тор Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ksf) 1 .0000 .6229 .0000 .6229 14.5000 .4693 2 2 .2500 .4693 3 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 14.50 ft, y = 537.00 ft Depth of cracking = .00 ft Failure Total Weight Submerged Uplift angle length of wedge length force (deg) (ft) (kips) (ft) (kips) Wedge number (deq) 1-54.34520.92211.91614.7694.6002.00014.50024.51414.5007.918336.5135.042.7905.0421.813 Wedge Net force number (kips) ______ 1 -10.386 2 8.812 3 1.575 _____ SUM = .000 _____ Factor of safety = 1.515 +---------



Upper Level Retaining Walls: I1FS14UL (14-ft clear height)

Flood / Drawdown condition

- 1. Short-term soil properties assumed "Study" case
- 2. Full-depth water filled crack on driving side
- 3. Water at El 544 on resisting side
- 4. Passive soil pressure included on resisting side
- 5. No surcharge pressure applied
Date: **/11/14 Time: 14.54.15 Flood Wall Stability Analysis Using CTWALL Filerame: I1FS14UL.DAT Company name: CDMProject name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 554.00 ft Height of stem (HTS) = 15.17 ft Height of stem (HTS)=15.17 ftThickness top of stem (TTS)=1.75 ftThickness bottom of stem (TBS)=1.75 ftDist. of batter at bot. of stem (TBSR)=.00 ftDepth of heel (THEEL)=1.83 ftDistance of batter for heel (BTRH)=.00 ftDepth of toe (TTOE)=1.83 ftWidth of toe (TWIDTH)=4.00 ftDistance of batter for toe (BTRT)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00537.00.00538.835.25538.835.25554.007.00554.007.00538.8311.00537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deg) (ft) _____ .00 1.000 .100 .130 .00 554.00 Driving side soil geometry: Soil Batter Distance point (in:lft) (ft) ______ .00 500.00 1 .00 2 .00 .00 500.00 3 Driving side soil profile: Soil х У point (ft) (ft) ______ Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter С (kcf) (kcf) (ft) (in:1ft) (deq) (ksf) .00 1.000 .100 .130 540.00 .00 Resisting side soil profile: Soil х У (ft) point (ft) _____ 7.00 540.00 1 2 507.00 540.00 Foundation property data: phi for soil-structure interface = .00 (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 549.00 ft Resisting side elevation = 544.00 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 100.00 % ***** Actual base in comp. = 100.00 % Overturning ratio = 1.73 Xr (measured from toe) = 4.17 ft Resultant ratio = .3788 = .3636 Stem ratio Base pressure at heel = .3130 ksf Base pressure at toe = 1.9828 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 2.36

Date: **/11/14 Time: 14.54.15 Flood Wall Stability Analysis Using CTWALL Filename: I1FS14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ***** ** Overturning Results ** **** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 Driving side at rest Kc = .0000 Resisting side at rest K = 1.0000Resisting side at rest Kc = 1.0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 17.00 fc Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 554.00.0000537.00.7500 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 544.00 .0000 540.00 .2500 537.00 .2589

Earth pressures: Elevation Pressure (ft) (ksf) _____ 540.00 .0000 537.00 1.0343 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) .7500 .00 11.00 .2589 ** Forces and moments ** Part Force (kips) | Mom. Arm Moment Vert. Horiz. (ft) (ft-k) Structure: Structure weight.... 7.002 -5.14 -36.02 Structure, driving side: Moist soil..... 2.625 -8.38 -21.98 Saturated soil..... 6.941 -8.37 -58.13 Water above structure..... .000 .00 .00 Water above soil..... .000 .00 .00 External vertical loads.... .000 .00 .00 Ext. horz. pressure loads.. .000 .00 .00 Ext. horz. line loads..... .000 .00 .00 Structure, resisting side: Moist soil..... .000 .00 .00 Saturated soil..... -2.00 -1.22 .608 .00 Water above structure..... .000 .00 Water above soil..... 1.000 -2.00 -2.00 Driving side: Effective earth loads..... .00 .000 .00 Shear (due to delta)..... .000 .00 .00 Horiz. surcharge effects... .000 .00 .00 Water loads..... 6.375 5.67 36.13 Resisting side: Effective earth loads..... -1.551 1.00 -1.55 Water loads..... -1.263 2.62 -3.31 Foundation: Vertical force cn base..... -12.627 -4.17 52.61 Shear on base.... -3.560 .00 .00 Uplift.....--5.549 -6.39 35.47 ** Statics Check ** SUMS = .000 .000 .00

Angle of base = .00 degrees Normal force on base = 12.627 kips Shear force on base = 3.560 kips Max. available shear force = 11.000 kips Base pressure at heel = .3130 ksf Base pressure at toe = 1.9828 ksf Xr (measured from toe) = 4.17 ft Resultant ratio = .3788 Stem ratio = .3636 Base in compression = 100.00 % Overturning ratio = 1.73 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) .000 1 .000 2 8.531 1.000 .000 3 .746 Water pressures on wedges: Тор Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) .0000 .0000 1 2 .0000 .7500 2 11.0000 .2589 3 .2500 .2589 Points of sliding plane: Point 1 (left), x =Point 2 (right), x =.00 ft, y = 537.00 ft 11.00 ft, Y = 537.00 ft Depth of cracking = 17.00 ft Crack extends to bottom of base of structure. Failure Total Weight Submerged Uplift Wedge angle length of wedge length force number (deq) (kips) (ft) (ft) (kips) 1 .000 .000 .000 .000 .000 11.000 17.176 .000 2 11.000 5.549 4.230 45.169 3 4.230 .582 1.076 Wedge Net force number (kips) _____ 1 .000 -3.875 2 3.875 3

SUM = .000

+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	 t
		F	a	С	t	0	r		0	f		s	а	f	e	t	У		÷					2		3	6	2	
+	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-				-	-	-	-	-	-	-	 ł



Upper Level Retaining Walls: I3EL14UL (14-ft clear height)

Earthquake condition

- 1. Long-term soil properties assumed
- 2. Drained soil above drainage pipe on driving side
- 3. Passive soil pressure included on resisting side
- 4. No surcharge pressure
- 5. Lateral seismic forces accounted for

Date: **/11/17 Time: 10.08.01 Flood Wall Stability Analysis Using CTWALL Filename: I3EL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA tructural geometry data:= 554.00 ftHeight of stem (HTS)= 15.17 ftThickness top of stem (TTS)= 1.75 ftThickness bottom of stem (TBS)= 1.75 ftDist. of batter at bot. of stem (TBSR)= 00 ftDepth of heel (THEEL)= 1.83 ftDistance of batter for heel (BTRH)= 00 ftDepth of toe (TTOE)= 1.83 ftWidth of toe (TWIDTH)= 1.00 ftDistance of batter for toe (BTRT)= 00 ftDist. of batter at bot. of key (BTRK)= 00 ftDist. of batter at bot. of key (BTRK)= 00 ft Structural geometry data: Structure coordinates: x (ft) y (ft) _____ .00 537.00 .30537.00.30538.8313.25538.8313.25554.0015.00554.0015.00538.8316.00537.00 NCTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Phi Unit wt. unit wt. Delta С soil (deq) (ksf) (kcf) (kcf) (deq) (ft) 27.00 .000 .100 .130 .00 554.00 Driving side soil geometry: Soil Batter Distance point (in:lft) (ft) ______ .00 500.00 1 .00 2 .00 .00 500.00 3 Driving side soil profile: Soil х V point (ft) (ft) ______ 1 -1486.75 554.00 2 13.25 554.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil С Batter (kcf) (kcf) (deq) (ksf) (ft) (in:lft) 27.00 .000 .100 .130 540.00 .00 Resisting side soil profile: Soil х У point (ft) (ft) 1 15.00 540.00 515.00 540.00 2 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .250 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .250 (ksf) Water data: Driving side elevation = 540.50 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

```
***** Summary of Results *****
Flood Wall Stability Analysis Using CTWALL
Project name: TRWD-FWCC
* * * * * * * * * * * * * * *
                     *** Satisfied ***
* Overturning *
                      Required base in comp. = .10 %
************
                      Actual base in comp. = 100.00 %
Overturning ratio = 4.12
Xr (measured from toe) = 6.48 ft
Resultant ratio = .4050
                         = .0625
Stem ratio
Base pressure at heel = .7478 ksf
Base pressure at toe = 2.7288 ksf
* * * * * * * * * * *
               *** Satisfied ***
* Sliding * Min. Required = 1.10
********* Actual FS = 2.13
```

Date: **/11/17 Time: 10.08.01 Flood Wall Stability Analysis Using CTWALL Filename: I3EL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ******* ** Overturning Results ** ******* Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4205Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ksf) (ft) ------540.50 .0000 537.00 .1796 Earth pressures: Elevation Pressure (ft) (ksf) _____ 554.00 .0000 540.50 537.00 .6929 .8343

** Resisting side pressures **

** Forces and moments **

	==========	=======================================	================	
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
	============	=======================================	=================	
Structure:				
Structure weight	8.374		~5.09	-42.60
Structure, driving side:				
Moist soil	17.888		-9.38	-167.70
Saturated soil	2.877		~9.38	-26.97
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.000		.00	.00
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.117		50	06
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
Driving side:				
Effective earth loads		7.350	5.71	41 96
Shear (due to delta)	.000		. 00	00
Horiz, surcharge effects		.000	. 00	.00
Water loads		.314	1,16	37
Resisting side:				
Effective earth loads		598	99	- 59
Water loads		.000	10	.00
Foundation:			0	
Vertical force on base	-27.812		-6.48	180 24
Shear on base		-7.066	.00	00
Uplift	-1.443		-10.64	15.36
	=========			==========
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = 27.83	12 kips			
Shear force on base = 7.0	66 kips			
Max. available shear force =	18.171 k	ips		
		L		
Base pressure at heel = .74	478 ksf			
Base pressure at toe = 2.72	288 ksf			
-				
Xr (measured from toe) =	6.48 ft			
Resultant ratio = .4	4050			
Stem ratio = .(0625			
Base in compression = 100	0.00 %			
Overturning ratio = 4	4.12			
-				
Volume of concrete = 2.07	cubic yds	/ft cf wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) ______ .000 .000 1 .000 2 .000 .000 3 .000 Water pressures on wedges: Bottom Top Wedge press. press. x-coord. press. (ksf) number (ksf) (ft) (ksf) _____ 1 .0000 .1796 .1796 2 . 0000 2 16.0000 .0007 .0000 3 .0007 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 16.00 ft, y = 537.00 ft Depth of cracking = .00 ft Failure Total Weight Submerged Uplift angle length of wedge length force Wedqe number (deg) (ft) (ft) (kips) (kips) 1 -51.739 21.651 11.541 4.457 .400 .000 2 16.000 29.255 16.000 1.443 38.535 4.815 .565 .016 3 .000 Wedge Net force number (kips) ------------------9.237 1 2 8.514 3 .722 _____ SUM = .000 Factor of safety = 2.134



517-

Upper Level Retaining Walls: I4CS14UL (14-ft clear height)

Construction condition

- 1. Short-term soil properties assumed
- 2. Fully drained soil on driving side
- 3. Passive soil pressure neglected on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 14.33.59 Flood Wall Stability Analysis Using CTWALL Filename: I4CS14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 554.00 ft Height of stem (HTS) = 15.17 fc Interness cop of stem (TTS)=1.75 ftThickness bottom of stem (TBS)=1.75 ftDist. of batter at bot. of stem (TBSR)=.00 ftDepth of heel (THEEL)=1.83 ftDistance of batter for heel (BTRH)-.00 ft 1.83 ft Depth of toe (TTOE) = Width of toe (TWIDTH)=1.05 ftDistance of batter for toe (BTRT)=0.0 ftWidth of base (BWIDTH)=12.50 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) .00 537.00 .00 538.83 6.75 538.83 6.75 554.00 8.50554.008.50538.8312.50538.8312.50537.00 NOTE: X=C is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)					
.00	1.000	.100	.130	.00	554.00					
Driving si	de soil ge	ometry:								
Soil point	Batter (in:1ft)	Distanc (ft)	e 							
1 2 3	.00 .00 .00	500.00 .00 500.00								
Driving si	de soil pr	ofile:								
Soil point	x (ft)	y (ft)								
1 - 2	1493.25 6.75	554.00 554.00								
Resisting side soil property data:										
Phi (deg)	C (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:lft)					
.00	1.000	.100	.130	537.00	.00					
Resisting	side soil	profile:								
Soil point 1 2	x (ft) 12.50 512.50	y (ft) 537.00 537.00								
Foundation phi for so c for so phi for so c for so	property soil-struc il-structu: soil-soil il-soil in	data: ture inte: re interfa interface terface	rface = ace = = =	.00 (1.000 (.00 (1.000 (deg) ks±) deg) ksf)					
Water data: Driving side elevation = 554.00 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.										
Uniform loa Magnitude	ad data: e of load :	= .10	0 k/ft							

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** Required base in comp. = 75.00 % * Overturning * Actual base in comp. = 100.00 % Overturning ratio = 1.83 ********* Xr (measured from toe) = 4.46 ft Resultant ratio = .3569 = .3200 Stem ratio Base pressure at heel = .1930 ksf Base pressure at toe = 2.5401 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ********** Actual FS = 1.38

Date: **/11/14 Time: 14.33.59 Flood Wall Stability Analysis Using CTWALL Filename: I4CS14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ***** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -45.0845Calculated earth pressure coefficients: Driving side at rest K = 1.0000 Driving side at rest Kc = 1.0000 Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 10.26 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 554.00.0000543.74.6410537.00.6904 Earth pressures: Elevation Pressure (ft) (ksf) _____ 554.00.0000543.74.0000537.00.7522

** Resisting side pressures **

** Uplift pressures **

** Forces and moments **

			============	=============
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
	=============		=======================================	=================
Structure:				
Structure weight	7.413		-5.51	-40.86
Structure, driving side:				
Moist soil	.000		.00	.00
Saturated soil	13.312		-9.13	-121.47
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.675		-9.13	-6.16
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
Driving side:				
Effective earth loads		2.536	2.25	5.70
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.674	3.37	2.27
Water loads		7.777	6.22	48.34
Resisting side:				
Effective earth loads		.000	.00	.00
Water loads		.000	1.01	.00
Foundation:				
Vertical force on base	-17.081		-4.46	76.20
Shear on base		-10.987	.00	.00
Uplift	-4.319		-8.33	35.97
the Chapting Chapter att CINC	==========	==========		
** Statics check ** SUMS =	.000	.000		- 00
Angle of base = $($)0 degrees			
Normal force on base = 17.08	R1 king			
Shear force on base = 10.98	Rips			
Max, available shear force =	12500 k	ing		
	12.500 %	160		
Base pressure at heel = .19	930 ksf			
Base pressure at toe = 2.54	101 ksf			
-				
Xr (measured from toe) = 4	1.46 ft			
Resultant ratio = .3	3569			
Stem ratio = .3	3200			
Base in compression = 100).00 응			
Overturning ratio = 1	L.83			
_				
Volume of concrete = 1.83	cubic yds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Loads Wedge Number (kips) (kips) ______ .000 .000 9.031 .675 .000 .000 1 2 3 Water pressures on wedges: TopBottomWedgepress.press.x-ccord.press.number(ksf)(ksf)(ft)(ksf) 1 .0000 .0000 2 .0000 1.0625 12.5000 .0006 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 12.50 ft, y = 537.00 ft Depth of cracking = 17.00 ft Crack extends to bottom of base of structure. Failure Total Weight Submerged Uplift Wedge angle length of wedge number (deg) (ft) (kins) length of wedge length force
 (ft) (kips) (ft) (kips)
 1
 .000
 .000
 .000
 .000
 .000

 2
 .000
 12.500
 20.725
 12.500
 6.645

 3
 .000
 .000
 .000
 .000
 .000
 Wedge Net force number (kips) 1 .000 2 .000 3 .000 SUM = .000 +-----+ | Factor of safety = 1.384 |



Upper Level Retaining Walls: I4CL14UL (14-ft clear height)

Construction condition

- 1. Long-term soil properties assumed
- 2. Fully drained soil on driving side
- 3. Passive soil pressure neglected on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 14.52.08 Flood Wall Stability Analysis Using CTWALL Filename: I4CL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 554.00 ft .00 ft Distance of batter for heel (BTRH) = 1.83 ft Depth of toe (TTOE) = 4.00 ft .00 ft Width of toe (TWIDTH) = Distance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00 538.83 5.25 538.83 5.25 554.00 7.00 554.00 7.00 538.83 11.00 538.83 11.00 537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data:

Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deg) (ft) 27.00 .000 .100 .130 .00 554.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) _____ .00 500.00 .00 .00 1 2 3 .00 500.00 Driving side soil profile: Soil х point (ft) (ft) _____ 1 -1494.75 554.00 2 5.25 554.00 Resisting side soil property data: Moist Saturated Elev. Unit wt. unit wt. soil Phi С Batter (deq) (ksf) (kcf) (kcf) (ft) (in:1ft) .100 .130 537.00 27.00 .0C0 .00 Resisting side soil profile: Soil х У point (ft) (ft) ______ 11.00 537.00 511.00 537.00 1 2 Foundation property data: phi for soil-structure interface =27.00 (deg)c for soil-structure interface =.250 (ksf)phi for soil-soil interface =27.00 (deg)c for soil-soil interface =.250 (ksf) Water data: Driving side elevation = 537.01 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed are hydrostatic. Uniform load data: Magnitude of load = .10 k/ft
***** Summary of Results *****

Date: **/11/14 Time: 14.52.08 Flood Wall Stability Analysis Using CTWALL Filename: I4CL14UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** **** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4205Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = Driving side at rest Kc = .7164 Resisting side at rest K = .0000 Resisting side at rest Kc = .0000 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 537.01 .0000 537.00 .0006 Earth pressures: Elevation Pressure (ft) (ksf) ______ 554.00 .0000 537.01 .8721 537.00 .8724

** Forces and moments **

	=========================			================
Part	Force Vert	(kips)	Mom. Arm	Moment (ft-k)
	·		·	
Structure .				
Structure, woight	7 002		_ 5 1/	26 02
Structure weight	7.002		-5.14	-30.02
Maiat apil	7 0 6 4		0 27	
Moist soll	7.964		-8.37	-66.70
Saturated soll	.000		.00	.00
Water above structure	.000		.00	.00
Water above soll	.000		.00	.00
External vertical loads	.525		-8.38	-4.40
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. lire loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
Driving side:				
Effective earth loads		7.417	5.67	42.03
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.873	8.50	7.42
Water loads		.000	62	.00
Resisting side:				
Effective earth loads		.000	.00	.00
Water loads		.000	62	.00
Foundation:				
Vertical force on base	-15.484		-3.72	57.64
Shear on base		-8.289	.00	.00
Uplift	007		-5.50	.04
		============		
** Statics Check ** SUMS =	.000	.000		.00
Angle of base =	00 degrees			
Normal force on base = 15.4	84 kips			
Shear force on base $=$ 8.2	89 kips			
Max available shear force =	10 639 k	ing		
Max. available Shear 10100 -	10.000 K	100		
Base pressure at heel = $.0$	427 ksf			
Base pressure at toe = 2.7	725 ksf			
Xr (measured from toe) =	3.72 ft			
Resultant ratio = .	3384			
Stem ratio = .	3636			
Base in compression = 10	0.CO %			
Overturning ratio =	2.16			
Volume of concrete = 1.73	cubic yds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** **** Summation of forces = 0. Solution converged. Horizontal Vertical Wedge Loads Loads (kips) (kips) Number _____ .000 1.177 1 .525 2 .000 3 .000 .000 Water pressures on wedges: Тор Bottom x-coord. press. Wedge press. press. (ft) (ksf) (ksf) (ksf) number .0000 .0006 1 .0000 .0006 2 11.0000 2 .0006 .0000 .0000 3 Points of sliding plane: .00 ft, y = 537.00 ft 11.00 ft, y = 537.00 ft Point 1 (left), x =Point 2 (right), x =.00 ft Depth of cracking = Failure Total Weight Submerged Uplift length force angle length of wedge Wedge (ft) (kips) (ft) number (deg) (kips) .
 1
 -55.311
 20.675
 10.002
 .012

 2
 .000
 11.000
 14.966
 11.000
.000 .007 .000 .000 .000 3 .000 .000 Wedge Net force (kips) number _____ -7.787 1 2 7.786 3 .000 _____ SJM = .000

| Factor of safety = 1.366 |

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Upper Level Retaining Walls: I1NL6UL (6-ft clear height)

Normal condition

- 1. Long-term soil properties assumed
- 2. Drained soil above drainage pipe on driving side
- 3. Passive soil pressure included on resisting side
- 4. 100 psf vertical surcharge pressure applied

Time: 14.56.36 Date: **/11/14 Flood Wall Stability Analysis Using CTWALL Filename: I1NL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 546.00 ft Height of stem (HTS) = 7.50 ft = Thickness top of stem (TTS) 1.17 ft Thickness bottom of stem (TBS) = .00 ft Dist. of batter at bot. of stem (TBSR) = .00 ft 1.50 ft Thickness bottom of stem (TBS) = .00 ft Distance of batter for heel (BTRH) = .00 ft 1.50 ft Depth of toe (TTOE) = 2.00 ft Width of toe (TWIDTH) = = Distance of batter for toe (BTRT) .00 ft Distance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=6.50 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00 538.50 3.33 538.50 3.33 546.00 4.50 546.00 4.50 538.50 6.50 538.50 6.50 537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used.

Structural property data: Unit weight of concrete = .150 kcf Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deg) (ft) 27.00 .000 .100 .130 .00 546.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) _____ .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil х У Soil x y point (ft) (ft) _____ 1 -1496.67 546.00 2 3.33 546.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter С (ksf) (kcf) (kcf) (ft) (in:1ft) (deq) 27.00 .000 .100 .130 540.00 .00 Resisting side soil profile: Soil x У point (ft) (ft) ______ 1 4.50 540.00 2 504.50 540.00 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .250 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .250 (ksf) Water data: Driving side elevation = 540.50 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** Required base in comp. = 100.00 % * Overturning * ***** Actual base in comp. = 100.00 % Overturning ratio = 2.24 Xr (measured from toe) = 2.33 ft Resultant ratio = .3580 Stem ratio = .3077 Base pressure at heel = .1285 ksf Base pressure at toe = 1.6079 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 1.90

Date: **/11/14 Time: 14.56.36 Flood Wall Stability Analysis Using CTWALL Filename: I1NL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4214Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 540.50 .0000 537.00 .1425 .1425 Earth pressures: Elevation Pressure (ft) (ksf) _____ 546.00.0000540.50.2823537.00.4427

Surcharge pressures: Elev. Press. (ft) (ksf) 546.00 .051 537.00 .051 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 537.01 .0000 537.00 .0008 Earth pressures: Elevation Pressure (ft) (ksf) ________________ 540.00 .0000 537.00 .3987 ** Uplif: pressures ** Water pressures: x-coord. Pressure (ft) (ksf) _____ .00 .1425 6.50 .0008

** Forces and moments **

	===========			=============
Part	Force Vert.	(kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
====================================				
Structure:				
Structure weight	2 779		-2 94	-8 16
Structure driving side:	2.119		2.71	0.10
Maiat anil	1 0 0 1		4 0 4	0.00
Moist soll	1.831		-4.84	-8.86
Saturated soll	.866		-4.84	-4.19
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.333		-4.84	-1.61
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	. 300		-1.00	- 30
Saturated soil	000		100	.50
Water above structure	.000		.00	.00
Water above structure	.000		.00	.00
Water above soll	.000		.00	.00
Driving side:		0 0 4 5	2	C D D
Effective earth loads		2.045	3.03	6.20
Shear (due to delta)	.000		.00	.00
Horiz. surcharge effects		.462	4.50	2.08
Water loads		.249	1.16	.29
Resisting side:				
Effective earth loads		598	1.01	60
Water loads		.000	2.15	.00
Foundation:				
Vertical force on base	-5.643		-2.33	13 13
Shear on base		-2 158	00	00
Uplifr	- 466	01100	-4 32	2 01
				==========
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = 5.6	43 kips			
Shear force on base = 2.1	58 kips			
Max. available shear force =	4.500 k	ips		
Base pressure at heel = .1	285 ksf			
Base pressure at toe = 1.6	079 ksf			
1				
Xr (measured from toe) =	2.33 ft			
Resultant ratio =	3580			
Stem ratio =	3077			
$\frac{10}{100} = \frac{10}{100}$	0 00 2			
Overturning ratio - 10	0.00 ¹ 0			
overcutining facto =	2.24			
Volume of concrete = .69	cubic yds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ******* Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) .000 .688 1 .333 2 .000 .000 3 .000 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ksf) 1 .0000 .1425 2 .0000 .1425 6.5000 2 .0008 3 .0000 .0008 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 6.50 ft, y = 537.00 ft Depth of cracking = .00 ft Failure Total Weight Submerged Uplift angle length of wedge length force (ft) (kips) Wedge (ft) (kips) (kips) number (deq) 1-52.60811.3283.2364.4052.0006.5005.7766.500337.7174.904.582.016 .314 .466 .000 Wedge Net force number (kips) ____________ -3.127 1 2 2.364 3 .764 _____ SUM = .000 +-----+ Factor of safety = 1.904



Upper Level Retaining Walls: I1FL6UL (6-ft clear height)

Flood / Drawdown condition

- 1. Long-term soil properties assumed
- 2. Hydrostatic pressure to El 543.5 on driving side
- 3. Water at El 541 on resisting side
- 4. Passive soil pressure included on resisting side
- 5. No surcharge pressure applied

Date: **/11/14 Time: 14.58.57 Flood Wall Stability Analysis Using CTWALL Filename: I1FL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 546.00 ft Height of stem (HTS) = 7.50 ft Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft Distance of batter for heel (BTPH) = .00 ft .00 ft Distance of batter for heel (BTRH) = 1.50 ft Depth of toe (TTOE) = 2.00 ft .00 ft Width of toe (TWIDTH) = Distance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00 538.50 3.33 538.50 3.33 546.00 4.50546.004.50538.506.50538.506.50537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used.

Structural property data: Unit weight of concrete = .150 kcf Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi soil С (deq) (ksf) (kcf) (kcf) (deq) (ft) _____ 27.00 .000 .100 .130 .00 546.00 Driving side soil geometry: Soil Batter Distance point (in:lft) (ft) .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil х У point (ft) (ft) _____ 1 -1496.67 546.00 2 3.33 546.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter С (kcf) (kcf) (ft) (in:1ft) (ksf) (deq) 27.00 .000 .100 .130 540.00 .00 Resisting side soil profile: Soil х У point (ft) (ft) ______ 4.50540.00504.50540.00 1 2 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .250 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .250 (ksf) Water data: Driving side elevation = 543.50 ft Resisting side elevation = 541.00 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack depth is to be calculated o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Sacisfied *** Required base in comp. = 100.00 % * Overturning * Actual base in comp. = 100.00 % Overturning ratio = 1.62 ******** Xr (measured from toe) = 2.18 ft Resultant ratio = .3352 = .3077 Stem ratio Base pressure at heel = .0074 ksf Base pressure at toe = 1.3062 ksf ****** *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 1.78

Date: **/11/14 Time: 14.58.57 Flood Wall Stability Analysis Using CTWALL Filename: I1FL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ******* Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4214Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest X = 2.6629 Resisting side at rest Xc = 1.6319 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 543.50 .0000 537.00 .3428 Earth pressures: Elevation Pressure (ft) (ksf) _____ 546.00 .0000 .1283 543.50 537.00 .3861 ** Resisting side pressures **

** Forces and moments **

=======================================			=======================================	================================
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
		.===========	=======================================	· · · ·
Structure:				
Structure weight	2 779		-2 94	-8 16
Structure driving side:	21119		2.91	0.20
Moist soil	832		-1 81	_1 02
Saturated coil	2 165		-4.04	-4.03
Water above structure	2.105		-4.04	-10.47
Water above structure	.000		.00	.00
Water above soll	.000		.00	.00
External vertical loads	.000		.00	.00
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.390		-1.00	39
Water above structure	.000		.00	.00
Water above soil	.125		-1.00	13
Driving side:				. 2.0
Effective earth loads		- 832	3 12	5 71
Shear (due to delta)	000	2.052	0.12	0.0
Horiz surcharge effects	.000	000	.00	.00
Water loade		.000	.00	.00
Posisting side.		1.114	2.17	∠.4⊥
Resiscing side:		240	1 00	2.5
Mater leads		346	1.00	35
water loads		544	1.31	71
Foundation:				
Vertical force on base	-4.269		-2.18	9.30
Shear on base		-2.056	.00	.00
Uplift	-2.022		-3.36	6.79
				================
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .(00 degrees			
Normal force on base = 4.26	59 kips			
Shear force on base = 2.05	56 kips			
Max. available shear force =	3.800 k	ips		
		2		
Base pressure at heel = .00)74 ksf			
Base pressure at toe = 1.30)62 ksf			
Xr (measured from toe) = 2	2 18 ft			
Regultant ratio	2352			
Stom matio				
Stem fatto = .5				
Dase III compression = 100				
overcurning racio = 1	1.62			
Valuma of accesta				
volume of concrete = .69	cubic yds	/IT OF WALL		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ****** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) .000 .000 1 -.031 .000 2 .125 .245 3 Water pressures on wedges: TopBottomWedgepress.press.x-coord.press.number(ksf)(ksf)(ft)(ksf) _____ 1 .0000 .3428 .0000 .3428 6.5000 .2793 2 2 .0625 .2793 3 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 6.50 ft, y = 537.00 ft Depth of cracking = .00 ft Failure Total Weight angle length of wedge Weight Submerged Uplift length force (ft) (kips) Wedge (deq) (ft) (kips) number 1-53.09111.2563.5188.1291.3932.0006.5006.1666.5002.022337.4044.939.7654.939.844 Wedge Net force number (kips) ___________ 1 -3.141 2.170 2 3 .970 _____ SUM = .000 Factor of safety = 1.776 +-----



Upper Level Retaining Walls: I1FS6UL (6-ft clear height)

Flood / Drawdown condition

- 1. Short-term soil properties assumed "Study" case
- 2. Full-depth water filled crack on driving side
- 3. Water at El 541 on resisting side
- 4. Passive soil pressure included on resisting side
- 5. No surcharge pressure applied

Time: 15.06.36 Date: **/11/14 Flood Wall Stability Analysis Using CTWALL Filename: I1FS6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 546.00 ft Height of stem (HTS) = 7.50 ft Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft .00 ft Distance of batter for heel (BTRH) = 1.50 ft Depth of toe (TTOE) = 2.00 ft .00 ft Width of toe (TWIDTH) = Width of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=4.50 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00 538.50 1.33 538.50 1.33 546.00 2.50 546.00 2.50548.002.50538.504.50538.504.50537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deg) (ft) _____ .00 1.000 .100 .130 .00 546.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) _____ .00 500.00 .00 .00 .00 500.00 2 3 Driving side soil profile: Soil х У Soll x y point (ft) (ft) _____ 1 -1498.67 546.00 2 1.33 546.00 Resisting side soil property data: Moist Saturated Elev. Unit wt. unit wt. soil Batter Phi С (deg) (ksf) (kcf) (kcf) (ft) (in:1ft) .00 1.000 .100 .130 540.00 .00 Resisting side soil profile: Soil х V point (ft)(ft) _____ 1 2.50 540.00 502.50 540.00 2 Foundation property data: phi for soil-structure interface = .00 (deg) c for soil-structure interface = 1.000 (ksf) phi for soil-soil interface = .00 (deg) c for soil-soil interface = 1.000 (ksf) Water data: Driving side elevation = 543.50 ft Resisting side elevation = 541.00 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

Minimum required factors of safety: Sliding FS = 1.50 Overturning = 100.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Do* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** * Overturning * Required base in comp. = 100.00 % *********** Actual base in comp. = 100.00 % Overturning ratio = 1.45 Xr (measured from toe) = 1.52 ft Resultant ratio = .3378 Stem ratio = .4444 = .4444 Base pressure at heel = .0159 ksf Base pressure at toe = 1.1550 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.50 ********* Actual FS = 6.08

Date: **/11/14 Time: 15.06.36 Flood Wall Stability Analysis Using CTWALL Filename: I1FS6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ***** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF Ξ .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 Driving side at rest Kc = .0000 Resisting side at rest K = 1.0000Resisting side at rest Kc = 1.0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 9.00 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 546.00 .0000 537.00 .4063 ** Resisting side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 541.00 .0000 .0625 540.00 537.00 .2188
Earth pressures: Elevation Pressure (ft) (ksf) ______ 540.00 .0000 537.00 1.0387 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) _____ .00 .4063 .2188 4.50 ** Forces and moments ** _____________ Force (kips) | Mom. Arm Part Vert. | Horiz. (ft) Structure: Structure weight..... 2.329 Structure, driving side: Moist soil..... .332 Saturated soil..... .865 Water above structure..... .000 Water above soil..... .000 External vertical loads.... .000 Ext. horz. pressure loads.. Ext. horz. line loads..... Structure, resisting side: Moist soil..... .000 Saturated soil..... .390 Water above structure..... .000 Water above soil..... .125 Driving side: Effective earth loads..... Shear (due to delta)..... .000

.00 .00 -1.00 -.39 .00 .00 -1.00 -.13 .000 .00 .00 .00 .00 Horiz. surcharge effects... .000 .00 .00 Water loads..... 3.00 1.828 5.48 Resisting side: Effective earth loads..... -1.558 1.00 -1.56 Water loads..... -.453 1.37 -.62 Foundation: Vertical force on base.... -2.634-1.52 4.01 Shear on base..... .183 .00 .00 Uplift..... -1.406 -2.47 3.48 ** Statics Check ** SUMS = .000 .000 .00

Moment

(ft-k)

-5.68

-1.28

-3.32

.00

.00

.00

.00

.00

-2.44

-3.83

-3.84

.00

.00

.00

.00

.00

.000

.000

Angle of base = .00 degrees Normal force on base = 2.634 kips Shear force on base = -.183 kips Max. available shear force = 4.500 kips Base pressure at heel = .0159 ksf Base pressure at toe = 1.1550 ksf Xr (measured from toe) = 1.52 ft Resultant ratio = .3378 Stem ratio = .4444 Base in compression = 100.00 % Overturning ratio = 1.45 Volume of concrete = .57 cubic yds/ft of wall NOTE: The engineer shall verify that the computed

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) .000 .000 1 .125 2 2.500 .000 3 .186 Water pressures on wedges: Тор Bottom press. press. x-coord. Wedge press. number (ksf) (ksf) (ft) (ksf) .0000 .0000 1 2 .0000 .4063 4.5000 2 .2188 3 .0625 .2188 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 4.50 ft, y = 537.00 ft Depth of cracking = 9.00 ft Crack extends to bottom of base of structure. Weight Submerged Uplift Failure Total length angle length of wedge (deg) (ft) (kips) Wedge force (ft) (kips) (ft) number (kips) _____ 1.000.000.000.0002.0004.5003.9164.5001.406345.1594.231.5824.231.595 Wedge Net force number (kips) ______ 1 .000 2 -1.759 1.760 3 _____

| Factor of safety = 6.077 |



Upper Level Retaining Walls: I3EL6UL (6-ft clear height)

Earthquake condition

- 1. Long-term soil properties assumed
- 2. Drained soil above drainage pipe on driving side
- 3. Passive soil pressure included on resisting side
- 4. No surcharge pressure
- 5. Lateral seismic forces included

Date: **/11/17 Time: 9.40.21 Flood Wall Stability Analysis Using CTWALL Filename: I3EL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 546.00 ft = .50 ft = 1.50 ft = 1.00 = Distance of batter for toe (BTRT) .00 ft Distance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=6.50 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) ______ .00 537.00 .00 538.50 4.33 538.50 4.33 546.00 5.50 546.00 5.50 538.50 6.50 538.50 6.50 537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data:

Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. c Unit wt. unit wt. Delta soil (ksf) (kcf) (kcf) (deg) (ft) Phi (deq) 27.00 .000 .100 .130 .00 546.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) _____ .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil х V point (ft) (ft) _____ 1 -1495.67 546.00 4.33 546.00 2 Resisting side soil property data: Moist Saturated Elev. Unit wt. unit wt. soil Batter (kcf) (kcf) (ft) (in:1ft) Phi С (deg) (ksf) _____ 27.00 .000 .100 .130 540.00 .00 Resisting side soil profile: Soil х V point (ft) (ft) _____ 15.50540.002505.50540.00 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .250 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .250 (ksf) Water data: Driving side elevation = 540.50 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method.

***** Summary of Results *****

Time: 9.40.21 Date: **/11/17 Flood Wall Stability Analysis Using CTWALL Filename: I3EL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** ***** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = -54.4214Calculated earth pressure coefficients: Driving side at rest K = .5133 Driving side at rest Kc = .7164 Resisting side at rest K = 2.6629Resisting side at rest Kc = 1.6319Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) ------540.50 .0000 537.00 .1425 Earth pressures: Elevation Pressure (ft) (ksf) _____ 546.00 .0000 .2823 540.50 537.00 .4427 ** Resisting side pressures **

Water pressures: Elevation Pressure (ft) (ksf) ------537.01.0000537.00.0008 Earth pressures: Elevation Pressure (ft) (ksf) _____ 540.00 .0000 537.00 .3987 ** Uplift pressures ** Water pressures: x-coorà. Pressure (ft) (ksf) _____ .00 .1425 6.50 .0008

** Forces and moments **

			=======================================	
Part	Force Vert.	(kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
			=======================================	, ==============
Structure:				
Structure weight	2.779		-2.46	-6.84
Structure, driving side:				0.01
Moist soil	2 382		-4 34	-10 32
Saturated soil	1 126		-4 33	_/ 99
Water above structure	1.120		-4.55 00	-4.00
Water above structure	.000		.00	.00
Ruter above Sorr	.000		.00	.00
External vertical loads	.000	0.0.0	.00	.00
Ext. norz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.150		50	08
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
Driving side:				
Effective earth loads		2.045	3.03	6.20
Shear (due to delta)	.000		.00	.00
Horiz, surcharge effects		.000	.00	. 0.0
Water loads		.249	1.16	. 29
Resisting side:				
Effective earth loads		598	1.01	- 60
Water loads		000	2 15	.00
Foundation		.000	2.10	.00
Vertical force on base	-5 970		-2.38	14 22
Shear on base	5.270	-1 60¢	2.50	14.22
Unlift	- 166	~1.090	-4 33	.00
opiiic	.400			2.01
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = 5.9	70 kips			
Shear force on base = 1.6	96 kips			
Max. available shear force =	4.667 k	ips		
		- T		
Base pressure at heel = .1	827 ksf			
Base pressure at toe = 1.6	543 ksf			
	010 1101			
Xr (measured from toe) =	2 38 ft			
Resultant ratio =	3665			
Srem ratio -	1538			
Base in compression - 10	0 00 %			
Oversurning ratio -	2 67			
overcutning facto =	2.07			
Volume of concrete = .69	cubic yds	/ft of wall		
	-			

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

***** ** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Wedge Loads Number (kips) (kips) 1 .000 .000 .000 2 .000 .000 3 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) .0000 .1425 1 2 .0000 .1425 6.5000 .0008 2 3 .0000 .0008 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 6.50 ft, y = 537.00 ft Depth of cracking = .00 ft Total Weight Submerged Uplift length of wedge length force (ft) (kips) (ft) (kips) Failure Total Wedge angle length of wedge number (deg) (ft) (kips) 1-51.45211.5083.3744.475.3192.0006.5006.4366.500.466338.6864.800.562.016.000 Wedge Net force number (kips) ______ 1 -2.788 2.082 2 3 .706 __________ SUM = .000 +------+ Factor of safety = 2.242 +-----+



Upper Level Retaining Walls: I4CS6UL (6-ft clear height)

Construction condition

- 1. Short-term soil properties assumed
- 2. Fully drained soil on driving side
- 3. Passive soil pressure neglected on resisting side
- 4. 100 psf vertical surcharge pressure applied

Time: 15.02.32 Date: **/11/14 Flood Wall Stability Analysis Using CTWALL Filename: I4CS6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 546.00 ft 7.50 ft Height of stem (HTS) = Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft .00 ft Distance of batter for heel (BTRH) = Depth of toe (TTOE) 1.50 ft = 2.00 ft .00 ft Width of toe (TWIDTH) = Width of toe (TWIDTH)=2.00 ftDistance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=6.50 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) _____ .00 537.00 .00 538.50 3.33 538.50 3.33 546.00 4.50546.004.50538.506.50538.506.50537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data: Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (deq) (ksf) (kcf) (kcf) (deg) (ft) _____ .00 1.000 .100 .130 .00 546.00 Driving side soil geometry: Soil Batter Distance point (in:1ft) (ft) .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil x У point (ft) (ft) _____ L -1496.67 546.00 2 3.33 546.00 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter С (deg) (ksf) (kcf) (kcf) (ft) (in:1ft) .00 1.000 .100 .130 537.00 .00 Resisting side soil profile: Soil point x У (ft) (ft) _____ 1 6.50 537.00 2 506.50 537.00 Foundation property data: phi for soil-structure interface =.00 (deg)c for soil-structure interface =1.000 (ksf)phi for soil-soil interface =.00 (deg)c for soil-soil interface =1.000 (ksf) Water data: Driving side elevation = 546.00 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed by Line of Creep method. Uniform load data: Magnitude of load = .10 k/ft

Minimum required factors of safety: Sliding FS = 1.33 Overturning = 75.00% base in compression Crack options: o Crack *is* down to bottom of heel o Computed cracks *will* be filled with water Strength mobilization factor = .6667 50% of full passive *is used* in the overturning analysis. Forces on the resisting side *are used* in the sliding analysis. *Dc* iterate in overturning analysis.

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** Required base in comp. = 75.00 % * Overturning * Actual base in comp. = 100.00 % Overturning ratio = 1.64 * * * * * * * * * * * * * * * Xr (measured from toe) = 2.20 ft Resultant ratio = .3378 Stem ratio = .3077 Base pressure at heel = .0188 ksf Base pressure at toe = 1.3745 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ********* Actual FS = 2.57

Date: **/11/14 Time: 15.02.32 Flood Wall Stability Analysis Using CTWALL Filename: I4CS6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ** Overturning Results ** Solution converged in 1 iterations. SMF used to calculate K's = .6667 Alpha for the SMF = .0000 Calculated earth pressure coefficients: Driving side at rest K = .0000 Driving side at rest Kc = Driving side at rest Kc = .0000 Resisting side at rest K = .0000 Resisting side at rest Kc = .0000 Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = 9.00 ft Crack extends to bottom of base of structure. ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) _____ 546.00 .0000 537.00 .5625 Surcharge pressures: Elev. Press. (ft) (ksf) _____ ** Resisting side pressures **

Water pressures: Elevation Pressure (ft) (ksf) ______ 537.01 .0000 537.00 .0006 537.00 .0006 ** Uplift pressures ** Water pressures: x-coord. Pressure (ft) (ksf) ______ .00 .5625 6.50 .0006 ** Forces and moments ** ______ Force (kips) | Mom. Arm Moment Part Vert. | Horiz. (ft) (ft-k) Structure: Structure weight..... 2.779 -2.94 -8.16 Structure, driving side: Moist soil..... .00 .000 .00 3.247 -4.84 Saturated soil..... -15.70 .00 Water above structure..... .000 .00 .00 Water above soil..... .000 .00 External vertical loads.... -4.84 .333 -1.61 Ext. horz. pressure loads.. .000 .00 .00 Ext. horz. line loads..... .000 .00 .00 Structure, resisting side: Moist soil..... .000 .00 .00 Saturated soil..... .00 .000 .00 Water above structure..... .000 .00 .00 Water above soil..... .00 .000 .00 Driving side: Effective earth loads..... .000 .00 .ຜິຜິ Shear (due to delta)..... .ûû0 .ûû .00 Horiz. surcharge effects... .000 .00 .00 Water loads..... 2.531 3.00 7.59 Resisting side: .00 Effective earth loads..... .000 .00 Water loads..... .000 1.68 .00 Foundation: -2.20 Vertical force on base..... -4.528 9.94 Shear on base..... -2.531 .ប៉ូប៊ូ .00 -1.830 -4.33 7.93 Uplift.... ______ ** Statics Check ** SUMS = .000 .000 .00

Angle of base = .00 degrees Normal force on base = 4.528 kips Shear force on base = 2.531 kips Max. available shear force = 6.500 kips Base pressure at heel = .0188 ksf Base pressure at toe = 1.3745 ksf Xr (measured from toe) = 2.20 ft Resultant ratio = .3378 Stem ratio = .3077 Base in compression = 100.00 % Overturning ratio = 1.64 Volume of concrete = .69 cubic yds/ft of wall NOTE: The engineer shall verify that the computed

bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Wedge Loads (kips) (kips) Number _____ .000 .000 1 2.531 .000 .333 .000 2 3 Water pressures on wedges: Top Bottom Wedqe press. press. x-coord. press. (ft) (ksf) (ksf) (ksf) number _____ .0000 .0000 1 .0000 .5625 6.5000 .0006 2 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 6.50 ft, y = 537.00 ft Depth of cracking = 9.00 ft Crack extends to bottom of base of structure. Total Weight Submerged Uplift Failure length of wedge length force Wedge anqle number (deg) (ft) (kips) (ft) (kips) _____
 .000
 .000
 .000
 .000

 .000
 6.500
 6.025
 6.500
 1.830

 .000
 .000
 .000
 .000
 .000
1 2 3 Wedge Net force number (kips) ______ .000 1 2 .000 3 .000 _____

======

| Factor of safety = 2.568 |



Upper Level Retaining Walls: I4CL6UL (6-ft clear height)

Construction condition

- 1. Long-term soil properties assumed
- 2. Fully drained soil on driving side
- 3. Passive soil pressure neglected on resisting side
- 4. 100 psf vertical surcharge pressure applied

Date: **/11/14 Time: 15.04.28 Flood Wall Stability Analysis Using CTWALL Filename: I4CL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA Structural geometry data: Elevation of top of stem (ELTS) = 546.00 ft Height of stem (HTS) = 7.50 ft Thickness top of stem (TTS) = 1.17 ft Thickness bottom of stem (TBS) = 1.17 ft Dist. of batter at bot. of stem (TBSR) = .00 ft Depth of heel (THEEL) = 1.50 ft Distance of batter for heel (BTRH) = .00 ft Distance of batter for heel (BTRH) = .00 ft 1.50 ft Depth of toe (TTOE) = 2.00 ft .00 ft Width of toe (TWIDTH) = Distance of batter for toe (BTRT)=.00 ftWidth of base (BWIDTH)=6.00 ftDepth of key (HK)=.00 ftWidth of bottom of key (TK)=.00 ftDist. of batter at bot. of key (BTRK)=.00 ft Structure coordinates: x (ft) y (ft) .00 537.00 .00 538.50 2.83 538.50 2.83 546.00 4.00 546.00 4.00538.506.00538.506.00537.00 NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used. Structural property data:

Unit weight of concrete = .150 kcf

Driving side soil property data:

Moist Saturated Elev. Unit wt. unit wt. Delta Phi С soil (kcf) (kcf) (deg) (deq) (ksf) (ft) 27.00 .000 .100 .130 .00 546.00 Driving side soil geometry: Soil Batter Distance point (in:lft) (ft) _____ .00 500.00 .00 .00 .00 500.00 1 2 3 Driving side soil profile: Soil x V (ft) point (ft) _____ 1 -1497.17 546.00 2.83 546.00 2 Resisting side soil property data: Moist Saturated Elev. Phi Unit wt. unit wt. soil Batter C (deq) (ksf) (kcf) (kcf) (ft) (in:1ft) _____ 27.00 .000 .100 .130 537.00 .00 Resisting side soil profile: Soil Soil x point (ft) x У (ft) _____ 6.C0 537.00 506.C0 537.00 1 2 Foundation property data: phi for soil-structure interface = 27.00 (deg) c for soil-structure interface = .250 (ksf) phi for soil-soil interface = 27.00 (deg) c for soil-soil interface = .250 (ksf) Water data: Driving side elevation = 537.01 ft Resisting side elevation = 537.01 ft Unit weight of water = .0625 kcf Seepage pressures computed are hydrostatic. Uniform load data: Magnitude of load = .10 k/ft

***** Summary of Results ***** Flood Wall Stability Analysis Using CTWALL Project name: TRWD-FWCC * * * * * * * * * * * * * * * *** Satisfied *** Required base in comp. = 75.00 % * Overturning * Actual base in comp. = 100.00 % Overturning ratio = 2.22 * * * * * * * * * * * * * * * Xr (measured from toe) = 2.00 ft Resultant ratio = .3339 = .3333 Stem ratio Base pressure at heel = .0030 ksf Base pressure at toe = 1.6864 ksf * * * * * * * * * * * *** Satisfied *** * Sliding * Min. Required = 1.33 ********** Actual FS = 1.56

Date: **/11/14 Time: 15.04.28 Flood Wall Stability Analysis Using CTWALL Filename: I4CL6UL.DAT Company name: CDM Project name: TRWD-FWCC Project location: Fort Worth, TX / Tarrant Regional Water District Wall location: Walls at bypass channel Computed by: BDA ****** ** Overturning Results ** ****** Solution converged in 1 iterations. SMF used to calculate K's = .6667 = -54.4214 Alpha for the SMF Calculated earth pressure coefficients: Driving side at rest K = .5133Driving side at rest Kc = Driving side at rest Kc = .7164Resisting side at rest K = .0000Resisting side at rest Kc = .0000Full passive K calculated for resisting side. 50% of full passive will be used. Depth of cracking = .00 ft ** Driving side pressures ** Water pressures: Elevation Pressure (ft) (ksf) 537.01 .0000 537.00 .0006 Earth pressures: Elevation Pressure (ft) (ksf) ______ 546.00 .0000 537.01 .4614 537.00 .4618

** Forces and moments **

	=======================================		=======================================	===========
Part	Force Vert.	(kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
	=============		=======================================	=======================================
Structure:				
Structure weight	2.666		-2.80	-7 45
Structure driving side:	2.000		2.00	1.15
Moist soil	2 1 2 3			0 70
Saturated coil	2.123		~4.59	-9.73
	.000		.00	.00
Water above structure	.000		.00	.00
Water above soll	.000		.00	.00
External vertical loads	.283		-4.59	-1.30
Ext. horz. pressure loads		.000	.00	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				
Moist soil	.000		.00	.00
Saturated soil	.000		.00	.00
Water above structure	.000		. 00	.00
Water above soil	.000		.00	00
Driving side:				.00
Effective earth loads		2 079	3 00	6 24
Shear (due to dolta)	000	2.075	5.00	0.24
Unit aurabargo offosta	.000	4.60	.00	.00
Horiz. Surcharge effects		.462	4.50	2.08
Water loads		.000	62	.00
Resisting side:				
Effective earth loads		.000	.00	.00
Water loads		.000	62	.00
Foundation:				
Vertical force on base	-5.068		-2.00	10.15
Shear on base		-2.541	.00	.00
Uplift	004		-3.00	.01
	==========			
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .	00 degrees			
Normal force on base = 5.0	68 kips			
Shear force on base = 2.5	41 kips	-		
Max. available shear force =	4.082 k	ips		
Base pressure at heel = .0	03C ksf			
Base pressure at toe = 1.6	864 ksf			
Xr (measured from toe) =	2.00 ft			
Resultant ratio = .	3339			
Stem ratio =	3333			
Base in compression = 10	0.00 %			
Overturning ratio =	2.22			
	• = =			
Volume of concrete = .66	cubic vds	/ft of wall		

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.
** Sliding Results ** ***************** Solution converged. Summation of forces = 0. Horizontal Vertical Loads Wedge Loads Number (kips) (kips) _______ .000 .650 1 .000 .000 .283 2 3 Water pressures on wedges: Тор Bottom Juge press. number (kar) press. press. x-coord. (ksf) (ksf) (ft) press. (ft) (ksf) _____ .0000 .0006 1 2 .0000 .0006 6.0000 .0006 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 6.00 ft, y = 537.00 ft Depth of cracking = .00 ft Weight Submerged Uplift of wedge length force Failure Total Uplift angle length of wedge Wedge (deg) (ft) (kips) (ft) number (kips) 1-54.14811.1042.927.012.0002.0006.0004.7896.000.0043.000.000.000.000.000 Wedge Net force number (kips) _____ 1 -2.609 2 2.609 3.000 _____ SUM = .000 +----

| Factor of safety = 1.565 |

+



Section 4 Calculations for Retaining Walls (Manual Calculations)





CLIENT	TEWD	JOB NO.	42275	COMPUTED BY BDA
PROJECT	FWCC	DATE CHECKED	11-18-04	DATE 11-16-04
DETAIL	FLOOD WALL SEISMIC	CHECKED BY	wer	PAGE NO

SEISMIC ANALYSIS

EFFECTIVE GROUND ACCELERATION BASED
ON 2000 IBC (EQ 16-20 FOR To=0)

$$5_{A} = 0.405_{3} = 0.40(0.12g) = 0.048g$$

 $say 0.05g$,
PER EM 1110 - 2 - 2502 (3-26)
FOR $K_{h} = 0.05$ Ky CAN BE NEGLECTED
 $L 0.2g$
 $\Psi = TAN^{-1}(K_{h}) = 2.86$
FOR $K_{y} = J = D = B = 0^{\circ}$
 $Q_{1} = TAN^{-1}(\frac{TAN}{1.1}) = 24.85^{\circ}$
(3-48) $K_{AE} = \frac{CO5^{2}(24.85^{\circ} - 2.86)}{(LOS^{2} 2.86)\left[1 + \sqrt{51N}\frac{24.85}{2.86} - 2.86\right]^{-1}}^{2}$

= 0.442 -

$$(3-15)$$
 STATIC: $V_{0} = \frac{1-51024.85}{1+51024.85} = 0.580 = 0.408$

DKAE = KAE - KA = 0.442 - 0.408 = 0.034 /

EM 1110-2-2502 29 Sep 89

(3) Simplifying Conditions. For the usual case where $~k_{\rm v}$, $~\delta$, and $~\theta$ are taken to be zero, the equations reduce to:

$$K_{\text{PE}} = \frac{\cos^2 (\phi - \Psi)}{\cos^2 \Psi \left[1 - \sqrt{\frac{\sin \phi \sin (\phi - \Psi + \beta)}{\cos \beta \cos \Psi}}\right]^2}$$
[3-49]

where

$$\Psi = \tan^{-1} (k_h)$$

and

$$P_{AE} = 1/2 K_{AE} \gamma h^2$$
$$P_{PE} = 1/2 K_{PE} \gamma h^2$$

For the case when the water table is above the backfill, P_{AE} and P_{PE} must be divided into static and dynamic components for computing the lateral forces. Buoyant soil weight is used for computing the static component below the water table, with the hydrostatic force added, and saturated soil weight is used for computing the dynamic component (see paragraph 3-26c(3)).

(4) Observations. General observations from using Mononobe-Okabe analysis are as follows:

(a) As the seismic inertia angle Ψ increases, the values of K_{AE} and K_{PE} approach each other and, for a vertical backfill face ($\theta = 0$), become equal when $\Psi = \phi$.

(b) The locations of P_{AE} and P_{PE} are not given by the Mononobe-Okabe analysis. Seed and Whitman (1970) suggest that the dynamic component ΔP_{AE} be placed at the upper one-third point, ΔP_{AE} being the difference between P_{AE} and the total active force from Coulomb's active wedge without the earthquake. The general wedge earthquake analysis described in paragraph 3-26c places the dynamic component ΔP_{AE} at the upper one-third point also, but computes ΔP_{AE} as being the difference between P_{AE} and the total active

where

$$K_{A} = \frac{\sin^{2} (\theta + \phi) \cos \phi}{\sin \theta \sin (\theta - \phi) \left[1 + \sqrt{\frac{\sin (\phi + \delta) \sin (\phi - \beta)}{\sin (\theta - \delta) \sin (\theta + \beta)}}\right]^{2}}$$
[3-12]

Examples 1 and 2 in Appendix M and the examples in Appendix N demonstrate the use of Equation 3-12.

(2) When wall friction is neglected ($\delta = 0$), Equation 3-12 reduces to:

$$K_{A} = \frac{\sin^{2} (\theta + \phi)}{\sin^{2} \theta \left[1 + \sqrt{\frac{\sin \phi \sin (\phi - \beta)}{\sin \theta \sin (\theta + \beta)}}\right]^{2}}$$
[3-13]

(3) For the case of is no wall friction ($\delta = 0$) and a vertical wall ($\theta = 90$ degrees),

$$K_{A} = \frac{\cos^{2} \phi}{\left[1 + \sqrt{\frac{\sin \phi \sin (\phi - \beta)}{\cos \beta}}\right]^{2}}$$
[3-14]

(4) For the special case of no wall friction, horizontal backfill surface, and a vertical wall, Coulomb's equation for K_A reduces to:

$$K_{A} = \frac{1 - \sin \phi}{1 + \sin \phi} = \tan^{2} \left(45^{\circ} - \frac{\phi}{2}\right)$$
[3-15]

which is identical to Rankine's equation for this special case.

(5) As stated in paragraph 3-llc and demonstrated in Figure 3-6 and Appendix E, a developed ϕ angle computed by Equation 3-10 using an SMF of 2/3 can be used in Coulomb's equation to compute an earth pressure coefficient close to that given by the Jaky or Danish Code equations.

CLIENT	TEWD	JOB NO. 422	15 COMPUTED BY	SUM
PROJECT	FWCC	DATE CHECKED	18-04 DATE	11-16-04
DETAIL	FLOOD WALL SEISMIC	CHECKED BY	MAL PAGE NO.	· · · · ·

SEISMIC ANALYSIS

CDM

$$\begin{aligned} & \text{EFFEZTIVE GROUND ACCELERATION BASED} \\ & \text{ON 2000 IBC. (EQ 16-20 FOR To=0)} \\ & \text{Sa = 0.40(5)} = 0.40(0.12g) = 0.048g \\ & \text{Say 0.05g}, \\ & \text{FOR EM 1110-2-2502 (3-26)} \\ & \text{FOR } K_n = 0.05 \quad K_v \text{ CAN BE NEGLECTED} \\ & \text{ Ko.2g} \\ & \text{Y} = \text{TAN}^{-1}(K_n) = 2.86 \\ & \text{FOR } K_v = J = \pm = \beta = 0^{\circ} \\ & \text{O} = \text{TAN}^{-1}(\frac{\text{TAN } 27^{\circ}}{1.1}) = 24.85^{\circ} \\ & \text{O} = \frac{(0.52 (24.55^{\circ} - 2.86))}{(105^{\circ} 2.86)} \left[1 + \int \frac{51N (24.85^{\circ} - 2.86)}{1.05 2.86} \right]^2 \\ & = \frac{0.860}{0.998(1.95)} \end{aligned}$$

= 0.442- -



CLIENT	TRUD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	FWCC	DATE CHECKED	11-18-04	DATE	11-16-04
DETAIL	FLOOD WALL SEISMIC	CHECKED BY	Wes	PAGE NO.	

CASE: I 325LL, DAT

INERTIA OF CONCRETE WALL PLUS SOIL MASS ABOVE HEEL = Kn W

W= 5.706 + 21.575 = 27.28 K

Ics = Kn W = 0.05 (27.28) = 1.36K

NOTE

FULL DEPTH, WATER FILLED CRACK. BO NO LATERAL EARTH PRESSURE AND NO DYNAMIC SOIL PRESSURE

ADD WALL INERTIA FORCE

APPLY 1.36 @ h/z = 13.5/z = 6.75' ABOVE BASE => EL 523.25'

** Uplift pressures **				
Water pressures: x-coord. Pressure (ft) (ksf)				
.CO .8438 16.00 .4875				
** Forces and moments **				
Par:	Force Force Vert.	(kips) Horiz.	Mom. Arm (ft)	======================================
Structure:			============	==================
Structure weight Structure, driving side:	5.706		-5.63	-32.14
Moist soil Saturated soil Water above structure Water above soil External vertical loads Ext. horz. pressure loads Ext. horz. line loads	.000 21.575 .000 .000 .000	.000 1.360	.00 -9.09 .00 .00 .00 .00 6.75	.00 -196.01 .00 .00 .00 9.18
Structure, resisting side: Moist soil Saturated soil Water above structure Water above soil	.000 .000 .000 .394		.00 .00 .00 50	.00 .00 .00 20
Effective earth loads Shear (due to delta) Horiz. surcharge effects Water loads	.000	.000 .000 5.695	.00 .00 .00 4.50	.00 .00 .00 25.63
Resisting side: Effective earth loads Water loads		.000 -1.901	.00 2.60	.00 -4.95
Vertical force on base Shear on base Uplift	-17.025 -10.650	-5.154	-6.21 .00 -8.71	105.68 .00 92.80
** Statics Check ** SUMS =	 .000	.000	**=========	.00
Angle of base = Normal force on base = 17.0 Shear force on base = 5.1 Max. available shear force = Base pressure at heel = .3 Base pressure at toe = 1.7	00 degrees 25 kips 54 kips 16.000 k 489 ksf 792 ksf	ips		

** Sliding Results ** ***** Solution converged. Summation of forces = C. Horizontal Vertical Loads Loads Wedge Number (kips) (kips) ______ .000 .000 5.154 .394 .000 .000 2 3 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) 1 .0000 .0000 2 .0000 .8438 16.0000 .4875 2 3 .0000 .0000 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 16.00 ft, y = 516.50 ft Depth of cracking = 13.50 ft Crack extends to bottom of base of structure. Failure Total Weight Submerged Uplift Wedge angle length of wedge length force number (deg) (ft) (kips) (ft) (kips)
 1
 .000
 .000
 .000
 .000
 .000

 2
 .000
 16.000
 27.281
 16.000
 10.650

 3
 .000
 .000
 .000
 .000
 .000
 Wedge Net force rumber (kips) 1 .000 2 .000 .000 3 _____ SUM = .000 4------| Factor of safety = 3.104 |



CLIENT	TRWD	JCB NO.	42275	COMPUTED BY	BDA
PROJECT	FLUCC	DATE CHECKED	11-18-04	DATE	11-16-04
DETAIL	FLOOD WALL SEISMIK	CHECKED BY	Wer	PAGE NO.	

CASE: I BELLL. DAT

INERTIA OF CONCRETE MASS PLUS SOIL MASS ABOVE HEEL = K. W W = 5.706 + 21.575 = 27.28 -In 0.05 (27.28 K) = 1.36K PAE = Pa + Pws + APAE = 1/2 KA 76 H2 + 1/2 to July + 1/2 AKAE 8 H2 = $\frac{1}{2} (0.408) (\frac{130-62.5}{13.5})^2 + \frac{1}{2} (.025) (13.5)^2$ + 1/2 (0.034) (0.130) (13.5)2 = 2.51 + 5.70 + 0.40 = 8.61 × / WEDGE NET FORCE = 6.051" (FROM CTWALL - F.S. = 1.10) CFORCE CALLWLATED FOR F.S. READ. NET ADD'L FORCE 8.61× + 1.36× - 6.05 = 3.92× ~ PA+PWS = 2.51×+5.7× = 8.21× APAE = 0.40× TOTAL SEISMIC MOMENT Mg= Bizl (13.5'/3) + 0.40 (.67)(13.5') + 1.36 (13.5'/2) = 36.95"+ + 3.62"+ 9.18"K = 49.75% AM = 49.75" - (13.85" + 19.74") = 16.16" ne = 16.16" / 3.924 = 4.12'

00 AFFLY 3.924 @ 4.12' FROM BASE => EL 520.62'-

(TWALL ANTALYSIS

FOR USE WIJBELLL, DAT

Elevation Pressure

** Uplift pressures **

Water pressures:

Water pressu	res:
x-coord.	Pressure
(ft)	(ksf)
.00	.6807
15.00	.4875

** Forces and moments **

=======================================	============		============		=
Part	Force Vert.	(kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)	
	=======================================		=======================================	===========	; =
Structure:					
Structure weight	5.706		-5.63	-32.14	
Structure, driving side:		- /		02121	
Moist soil	.000		.00	.00	
Saturated soil	21.575	~	-9.09	-195.0	
Water above structure	.000		.00	.00	
Water above soil	.000		.00	.00	
External vertical loads	.000		. 00	.00	
Ext. horz. pressure loads		.000	.00	. 00	
Ext. horz. line loads		3.920	4.12	16.15	
Structure, resisting side:					
Moist soil	.000		.00	.00	
Saturated soil	.000		.00	.00	
Water above structure	.000		.00	.00	
Water above soil	.394		50	20	
Driving side:					
Effective earth loads		3.077	4.50	13.85	~
Shear (due to delta)	.000		.00	.00	
Horiz. surcharge effects		.000	.00	.00	
Water loads		4.495	4.39	19.74	~
Resisting side:					
Effective earth loads		.000	.00	.00	
Water loads		-1.901	2.60	-4.95	
Foundation:					
Vertical force on base	-18.329		-5.71	104.67	
Shear on base		-9.591	.00	.00	
Uplift	-9.346		-8.44	78.89	
				=======================================	
** Statics Check ** SUMS =	.000	.000		.00	

* RESISTING SIDE FORCES

TO BE NEGLELTED

** Sliding Results ** **** Stationary solution. Static sum of forces. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) ______ .000 .000 1 .394 2.019 2 3 .000 .000 Water pressures on wedges: Τορ Bottom Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ksí) _____ 1 .0000 .6807 .0000 .6807 16.0000 .4875 2 2 .0000 .0000 3 Points of sliding plane: Point 1 (left), x = .00 ft, y = 516.50 ft Point 2 (right), x = 16.00 ft, y = 516.50 ft Depth of cracking = -1.26 ft FailureTotalWeightSubmergedUpliftWedgeanglelengthof wedgelengthforcenumber(deg)(ft)(kips)(ft)(kips) _____ 1-57.90817.4217.36417.4215.9292.00016.00027.28116.0009.3463.000.000.000.000.000 Wedge Net force number (kips) _____ Wedge No. 2 FIRST > Wedge No. 1 FORCE, -6.051 1 7.926 2 d¥ 3 .000 _____ SUM = 1.875 NOTE: Forces are calculated for the FS specified below. Factor of safety = 1.100 . _____

CLIENT	TRWD	JOB NO42275	COMPUTED BY BDA
PROJECT	FWCC	DATE CHECKED 11-18-04	DATE 11-16-04
DETAIL	FLOOD WALL SEISMIC	CHECKED BY NON	PAGE NO.

CASE: ISELML, DAT

540,00

6

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10

530.50

川三川三

5

W = 4.606 + 8.864 + 2.426 = 15.90 K

Ies = 0.05 (15.90") = 0.79"

WEDGE NET FORCE = 4.735"



527.0

NET ADD'L FORCE

NOTE: NEGLECT VERY SMALL NET ADDITIONIAL FORCE DUE TO EARTHQUAKE, NO ADDITIONAL SURCHARGE LOAD REQUIRED.

CTWALL ANALYSIS

WO EQ FORCES FOR

** Forces and moments **

USE W/ I. JELML, DAT

	=========			
Part	Force	(kips)	Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
			====================================	
Structure:				
Structure weight	4.606		-3.92	-18.08
Structure, driving side:		-		
Moist soil	8.864	۵. ^{۲۰}	-6.84	-60.58
Saturated soil	2.426	2	-5.84	-16.58
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.000		.00	.00
Ext. horz. pressure loads		.000	. 0 0	.00
Ext. horz. line loads		.000	.00	.00
Structure, resisting side:				.00
Moist soil	.150		- 50	- 08
Saturated soil	. 000		.00	.00
Water above structure	. 000		00	.00
Water above soil	.000		.00	
Driving side:			.00	
Effective earth loads		3 485	4 33	15 10
Shear (due to delta)	0.00	5.105	1.55	
Foriz, surcharge effects		000	.00	.00
Water loads		297	1 17	.00
Resisting side:		.257	1.17	
Effective earth loads		- 835	- 00	- 84
Water loads		000	2.00	0.0
Foundation:		.000	• 2 1	.00
Vertical force on base	-15.026		-4 86	73 07
Shear on base	201020	-2 947	20	.0.0
Uplift	-1.019		-7.50	7 64
	=======================================			
** Statics Check ** SUMS =	.000	.000		.00
Angle of base = .:	00 degrees			
Normal force on base = 15.02	26 kips			
Shear force on base = 2.94	47 kips			
Max. available shear force =	8.806 ki	ips ⊁	RESISTING	SIDE
		1	FORCES TO	BE
Base pressure at heel = .70	016 ksf		MER I -	
Base pressure at toe = 1.93	117 ksf		NEGLECIE	J FOR
			EQ ANALY	SIS
Xr (measured from toe) = 4	4.86 It			
Resultant ratio = .4	4228			
Stem ratio = .(0870			
Base in compression = 100	0.00 %			
Overturning ratio = 4	1.17			
Volume of concrete = 1.14	cubic yds/	ft of wall		

** Sliding Results ** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) _____ 1 .000 .000 .000 .000 .000 .000 2 3 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) _____ .0000 .1695 1 2 .0000 .1695 11.5000 .0077 2 3 .0000 .0077 Points of sliding plane: Point 1 (left), x = .00 ft, y = 527.00 ft Point 2 (right), x = 11.50 ft, y = 527.00 ft Depth of cracking = -.96 ft Failure Total Weight Submerged Uplift Wedge angle length of wedge length force number (deg) (ft) (kips) (ft) (kips) ______ 1-48.73618.5677.5354.656.3952.00011.50016.04511.5001.019339.1434.752.553.158.001 Wedge Net force number (kips) _____ 1 -4.735 3.729 2 1.005 3 _____ SUM = .000 Factor of safety = 2.361



CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	FWCC	DATE CHECKED	11-12-04	DATE	11-16-04
DETAIL	FLOOD WALL SEISMIC	CHECKED BY	mar	PAGE NO.	

CASE IJELIAUL. DAT



$$\begin{aligned} P_{AE} &= \frac{1}{2} \left(.442 \right) (.100) (13.5)^{2} + (.442) (.100) (13.5) (3.5) \\ &+ \frac{1}{2} \left(.442 \right) (130 - 62.5) (3.5)^{2} + \frac{1}{2} \left(\frac{62.5}{1000} \right) (3.5)^{2} \\ &= 4.03^{2} + 2.09^{2} + 0.18^{2} + 0.38^{2} \\ &= 6.68^{2} - \Delta P_{AE} = 6.68^{2} - 9.237^{2} = -2.56^{2} \end{aligned}$$

NOTÉ :

CTWALL ANALYSIS

** Forces and moments **

USE W/ I JELI 4UL, DAT

W/O EQ FORCES FOR

	===============			============
Part	Force	(kips)	Mom. Arm	Moment
	Vert	Horiz	(f-)	$(f \vdash -k)$
		=======================================	===================	
Structure				
Structure, woight	0 271		F 00	12 60
Structure weight	0.3/4		-5.09	-42.60
Structure, ariving side:				
Moist soil	. 17.888		-9.38	-167.70
Saturated soil	2.877		-9.38	-26.97
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
External vertical loads	.000		.00	. 00
Fxt borz pressure loads		0.0.0	00	00
Ext horz line loade	•	000	.00	.00
Chrysterro registing gide.		.000	.00	.00
Structure, resisting side:	1 - 7		5.0	0.5
Moist soll	. 1 1 7		50	06
Saturated soil	.000		.00	.00
Water above structure	.000		.00	.00
Water above soil	.000		.00	.00
Driving side:				
Effective earth loads		7.350	5.71	41.96
Shear (due to delta)	.000		. 00	.00
Horiz surcharge effects		000	00	.00
Water loads		214	1 16	.00
Registing gide.		.514	1.10	. 57
Resiscing side:		500	0.0	50
Effective earth Loads		~.598	.99	59
Water loads		.000	10	.00
Foundation:				
Vertical force on base	-27.812		-6.48	180.24
Shear on base		-7.066	.00	.00
Uplift	-1.443		-10.64	15.36
	=======================================			===========
** Statics Check ** SUMS =	.000	.000		. 00
Angle of base -	00 degrees			
Normal force on base = 27.9	12 king			
Normal force on base $=$ 27.5	CC kips			
Shear lorce on base = 7.0	bo KIPS		Dec. 1	
Max. available snear force =	18.171 K	ips 🛪	KEDISTING	SIDE
			FORIES +	ID BE
Base pressure at heel = .7	478 ksf		100000 1	UE VE
Base pressure at toe = 2.7	288 ksf		NEGLECTE	y for
			E/2 A.14.	
Ar (measured from toe) =	6.48 IC		ELL ANAL	15'5
Resultant ratio = .	4050			
Stem ratio = .	0625			
Base in compression = 10	0.00 %			
Overturning ratio =	4.12			
<u> </u>				
Volume of concrete = 2.07	cubic yds,	ft of wall		

***** ** Sliding Results ** ***** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) ______ .000 .000 1 .000. .000 .000. .000 .000 2 3 Water pressures on wedges: Bottom Тор Wedge press. press. x-coord. number (ksf) (ksf) (ft) press. (ksf) ______ .0000 .1796 1 .1796 2 .0000 2 16.0000 .0007 3 .0000 .0007 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 16.00 ft, y = 537.00 ft Depth of cracking = .00 ft Failure Total Weight Submerged Jplift Wedge angle length of wedge length force number (deg) (ft) (kips) (ft) (kips) 1-51.73921.65111.5414.457.4002.00016.00029.25516.0001.443338.5354.815.565.016.000 Wedge Net force number (kips) ===================================== 1 -9.237 2 8.514 3 .722 _____ SUM = .000 +------+ Factor of safety = 2.134



CLIENT	TIZWD	JOB NO.	42215	COMPLITED BY	BDA.
PROJECT	FWCC	DATE CHECKED	11-18-04	DATE	11-16-04
DETAIL	FLOOD WALL SESMIC	CHECKED BY	WCA	PAGE NO.	·

CASE: IJELGUL, DAT



$$P_{ME} = \frac{1}{2} (.442) (.100) (5.5)^{2} + (.442) (.100) (5.5') (3.5') + \frac{1}{2} (.442) (130 - 62.5) (3.5')^{2} + \frac{1}{2} (\frac{62.5}{1000}) (3.5)^{2} + \frac{1}{2} (\frac{62.5}{1000}$$

NOTE:

CT WALL ANALYSIS

W/O ER FORCES FOR

** Forces and moments **

USE WITSELGUL, DAT

				=======================================	
Part	Force	(kips)	Mom. Arm	Moment	
	Vert.	Horiz.	(主し)	(ft-k)	
Structure .	==========				
Structure weight	2 779		-2 16	6 94	
Structure driving side	2.115		-2.40	-5.04	
Moier coil	2 382		-1 31	- C C D -	
Saturated coil	1 1 26		-4.34	0.32	
Water above structure	1.120		-4.33	-4.00	
Water above soll	000.		.00	.00	
External vertical loads	000.		.00	.00	
Excernar vertical idads	.000	0.00	.00	.00	
Ext. horz. pressure roads		.000	.00	.00	
Ext. noiz. The loads		.000	.00	.00	
Moist soil	150		FO	0.0	
Coturated coil	. 150		50	08	
Water above arrugture	.000		.00	.00	
Water above sciucluie	.000		.00	.00	
Water above soll	.000		.00	.00	
Effortive orrth lorde		2 045	2 0 2	C 20	
Ellective earth loads	000	2.045	3.03	6.20	
Upriz surcharge offorts	.000	000	0	.00	
Water loada		.000	.00	.00	
Posisting side.		.249	1.10	. 29	
Effortive earth loade		500	1 01	C 0	
Water loads		000	2 - 5	60	
Foundation.		.000	4.20	.00	
Vertical force on base	-5 970		-0.38	14 22	
Shear on hace	-3.570	-1 696	-2.30	14.22	
Unlift	- 466	1.000	-4 32	2 01	
	=======================================		=======================================	2.01	
** Statics Check ** SUMS =	.000	.000		.00	
Angle of base = .	00 degrees				
Normal force on base = 5.9	70 kips				
Shear force on base $=$ 1.6	96 kips				
Max. available shear force =	4.667 k:	ips			
Base pressure at heel - 1827 kef		* R	* RESISTING SIDE		
Base pressure at toe = 1.6543 ksf		F	FORCES to BE		
-		h	NEGLECTED FOR		
Xr (measured from toe) = 2.38 ft					
Resultant ratio = .	3665	E	EQ ANALYSIS		
Stem ratio = .	1538				
Base in compression = 10	0.00 %				
overturning ratio =	2.67				
Volume of concrete = .69	cubic yds,	ft of wall			

******* ** Sliding Results ** **** Solution converged. Summation of forces = 0. Horizontal Vertical Wedge Loads Loads Number (kips) (kips) ______ 1 .000 .000 .000 .000 2 .000 3 .000 Water pressures on wedges: Top Bottom Wedge press. press. x-coord. press. number (ksf) (ksf) (ft) (ksf) -.0000 .1425 .0000 .1425 6.5000 .0008 2 2 6.5000 3 .0000 .0008 Points of sliding plane: Point 1 (left), x = .00 ft, y = 537.00 ft Point 2 (right), x = 6.50 ft, y = 537.00 ft Depth of cracking = .00 ft Failure Total Weight Submerged Uplift Wedge angle length of wedge length force number (deg) (ft) (kips) (ft) (kips) 1-51.45211.5083.3744.475.3192.0006.5006.4366.500.466338.6864.800.562.016.000 Wedge Net force number (kips) _____ 1 -2.788 2 2.082 3 .705 _____ SUM = .000 **+**---------+ Factor of safety = 2.242 +-----