GROUND
ENGINEERING

January 6, 2023

Subject: Engineering Design, Proposed Lock + Load Retaining Wall, **2125 NW O'Brien Road**, Lee's Summit, Missouri

Job No. 22-3673

Mr. Tim Jordan
Raintree Landscaping, LLC
4072 SW Normandy Dr
Lee's Summit, MO 64082

Dear Mr. Jordan,

This report presents engineering design for the proposed Lock + Load (L+L) wall to be constructed for the residence located at 2125 NW O'Brien Road, Lee's Summit, Missouri. To complete our design work, GROUND was provided with the following documents:

(1) PDF copy of the Construction Stake Plot Plan, prepared by Construction Engineering Services, Inc., dated May 4, 2022 and provided on October 13, 2022.

(2) Digital image of a hand sketch of the wall alignment and exposed wall elevation provided on October 13, 2022.

Proposed Construction and Design Assumptions

The proposed project will consist of the construction of one (1) L+L wall in a single-tier configuration to support grade separation in the back yard. The L+L wall will have a maximum exposed wall height of approximately 9 feet. We understand that the proposed L+L walls will be constructed with L+L concrete panel units and counterforts, Solmax Miragrid reinforcement, select granular backfill in the reinforced zone, and on-site soil in the retained zone.

Anticipated Subsurface Conditions

Geotechnical information was not available at the time of our design, and soil parameters are based on IBC presumptive soil bearing values and our experience. We anticipate that the wall subgrade and on-site backfill materials will typically consist of lean clay soils. Retaining wall subgrade soil types including mud, organic silt, organic clays, peat, and unprepared fill are unacceptable and should be addressed by the Geotechnical Engineer if encountered. We also assume that groundwater will not impact wall construction or the long-term stability of the wall. The assumed soil parameters used in the retaining wall design are summarized below, and **must** be verified prior to and during the wall construction.

The assumed soil parameters below and the assumed groundwater conditions shall be evaluated by the Geotechnical Engineer, who shall provide alternate values and subgrade improvement recommendations, if applicable or necessary.

Material Type	Unit Weight *(pcf)*	Friction Angle *(degree)*	Cohesion *(psf)*
On-Site Soil (Lean Clay)	120	26	50
Select Granular Fill	135	34	0

Cohesion values in the above table were used in the global stability analysis only. It should be noted that soil strength could be significantly reduced, if the soils become wet. Therefore, surface drainage should be properly constructed and the wall drain should be properly installed in the retaining wall.

Lock+Load Retaining Wall Design

L+L retaining wall design was performed for various design wall heights (including exposed wall height and required toe embedment) of the proposed retaining wall. The design calculations were performed in general accordance with AASHTO ASD 2002 design procedures by using the MSEW+® computer program. Surcharges, representing pedestrian live loads, were included in the calculations.

The L+L wall design calculations evaluated the external stability (including base sliding, overturning, bearing capacity, and base eccentricity), internal stability (including geogrid length, over stress, pullout resistance, and internal sliding), and facing stability (including facing overturning, shear, and connection stress) to determine the required geogrid strengths, number of layers, and reinforcement lengths. Results of the L+L wall design calculations are presented in Appendix A.

Global Stability Analysis

Global stability analysis was performed on one (1) critical wall section. The Global stability analysis was performed by using the Slope-W® computer program. The Morgenstern-Price Method was used to calculate the factor of safety. The lowest factor of safety is above the typically accepted minimum value of 1.3. The result of the global stability analysis is presented in Appendix B.

Additional Retaining Wall Recommendations

A properly constructed wall drain system should be included in the retaining wall. Drainage systems in retaining walls are intended to collect and divert water infiltration or natural seepage. Wall drain systems are not intended to handle surface runoff or

concentrated water at the top of walls, which should be collected and diverted by properly designed and constructed storm drainage features. The areas surrounding the retaining wall should be carefully graded to provide positive surface drainage away from the wall. Landscape irrigation around retaining wall should be reduced to a minimum throughout the life of the retaining wall. The wall systems and the surrounding areas must be kept relatively dry at all times during and after the construction to prevent water from infiltrating into the wall systems. In no case shall surface runoff be allowed to enter the wall construction areas, or water be allowed to pond above the wall. Temporary and permanent slopes and other stripped areas shall be adequately protected against erosion. Erosion along the wall and slopes will result in sloughing and could lead to a wall failure.

L+L walls are flexible retention systems, and should be anticipated to move both laterally and vertically after construction. If surface improvements, such as flatworks, sidewalks, curbs and gutters, pavements, fences, guardrails, utility pads, storm features, and manholes are installed near the wall, the anticipated wall movement often results in movement of the nearby surface improvements. Surface runoff infiltrating through joints of these surface improvements into wall backfill can aggravate movements of these surface improvements and the wall. Therefore, surface improvements and storm features should be located away from the wall systems. All of the joints of surface improvements must be properly sealed and maintained throughout the life of the wall systems.

Underground wet utility lines, such as waterlines, storm sewers, sanitary sewers, irrigation lines, and water features installed within or near retaining wall backfill are susceptible to leak due to potential wall movements. Utility line leaks can also induce retaining wall movements and result in wall failures. Therefore, we strongly recommend that wet utility lines be installed away from retaining wall systems. In the event that wet utility lines or water features are installed within or near retaining wall backfill, the bottom of utility trenches or water features shall be properly lined to prevent water from infiltrating into the wall systems.

Closure

Based on the provided information, necessary assumptions, results of the retaining wall design calculations, and the nature of the proposed construction, the Drawings including Cover Sheet (Sheet 1), General Notes (Sheets 2), Wall Elevation (Sheet 3), and Typical Wall Section and Details (Sheets 4 and 5) are included in this submittal. The proposed retaining wall must also be constructed in accordance with the geogrid and panel manufacturers' guidelines, unless otherwise noted on the Drawings.

Retaining wall design provided herein was developed based on the provided information, available geotechnical data, and other necessary assumptions. Actual conditions exposed during construction may be anticipated to differ, somewhat, from those described above. If during construction, surface, soil, bedrock, or groundwater conditions appear to be at variance with those described above, GROUND should be advised at once, so that re-evaluation of the wall design may be made in a timely manner.

The retaining wall design provided herein was prepared exclusively for Raintree Landscaping LLC. The engineering design and Drawings may only be used by Raintree Landscaping LLC and authorized contractors. This wall design and report was prepared in a manner consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under the same or similar circumstances with the same or similar scope of services. No warranty is expressed or implied, and no outcome is guaranteed. GROUND is not responsible for the variations in the actual surface conditions, subsurface conditions, and grades at the site. If you have any questions, please contact our office.

Sincerely,
GROUND Engineering Consultants, Inc.

Matthew Jensen, P.E.

Reviewed by Carl Henderson, P.E.

APPENDIX A

LOCK+LOAD RETAINING WALL DESIGN CALCULATIONS

GROUND
ENGINEERING

AASHTO 2002 ASD DESIGN METHOD
2125 NW O'Brien Road

MSEW+: Update # 2022.03

PROJECT IDENTIFICATION

Title: 2125 NW O'Brien Road
Project Number: 22-3673
Client: Raintree Landscaping LLC
Designer: GROUND
Station Number:

Description:

DH=9.33'

Company's information:

Name: GROUND Engineering Consultants, Inc.
Street: 41 Inverness Drive East

Englewood , CO 80112
Telephone #: 303-289-1989
Fax #:
E-Mail:

File path and name: K:\2022 Jobs\Engineering\22-3673 2125 NW O'Brien RD L+L.....
.....ts\MSEW\DH=9.33.BENp

Original date and time of creating this file: December 2022

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	135.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	34.0 °

RETAINED SOIL

Unit weight,	γ	120.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	26.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	120.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	26.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 62.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3905 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 22.25 N γ = 12.54

SEISMICITY

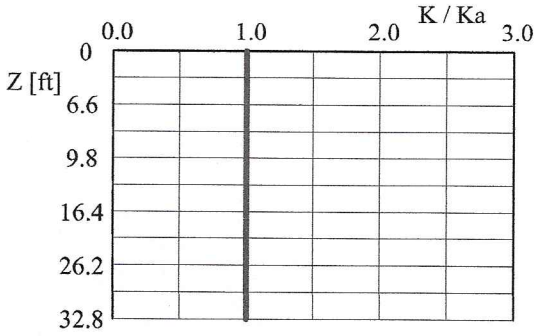
Not Applicable

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0				
Durability reduction factor, RFd	1.15				
Installation-damage reduction factor, RFid	1.15				
Creep reduction factor, RFc	1.45	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	24.22				
Pullout resistance factor, F*	$0.67 \cdot \tan\phi$	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	0.8				

Variation of Lateral Earth Pressure Coefficient With Depth

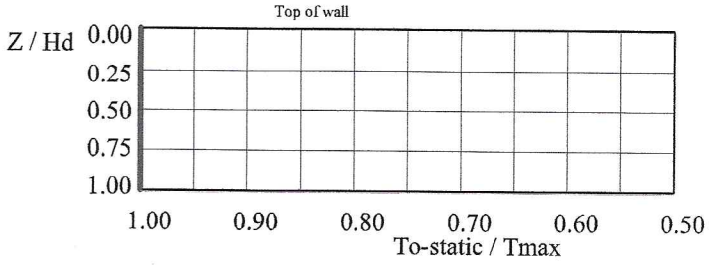
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (according to revised Demo 82) (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 2.50/1.30 ft. Horizontal distance to Center of Gravity of block is: 1.25 ft.
Average unit weight of block is: $\gamma_F = 135.00$ lb/ft ^{3}

Z / Hd	To-static / Tmax
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



Geogrid Type #1 σ (1)	Geogrid Type #1 CRult (2)	Geogrid Type #2 σ	Geogrid Type #2 CRult	Geogrid Type #3 σ	Geogrid Type #3 CRult	Geogrid Type #4 σ	Geogrid Type #4 CRult	Geogrid Type #5 σ	Geogrid Type #5 CRult
100.0	0.31								
133.6	0.60	N/A		N/A		N/A		N/A	
217.2	0.76								
275.6	0.90								

Geogrid Type #1 3) σ	Geogrid Type #1 CRcr	Geogrid Type #2 σ	Geogrid Type #2 CRcr	Geogrid Type #3 σ	Geogrid Type #3 CRcr	Geogrid Type #4 σ	Geogrid Type #4 CRcr	Geogrid Type #5 σ	Geogrid Type #5 CRcr
0.0	0.00								
750.0	0.63	N/A		N/A		N/A		N/A	

(1) σ = Confining stress in between stacked blocks [lb/ft ^{2}]
(2) CRult = Tc-ult / Tult
(3) CRcr = Tcre / Tult

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Mira5XT	N/A	N/A	N/A	N/A
Connection strength reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 9.33 [ft] { Embedded depth is E = 0.00 ft, and height above top of finished bottom grade is H = 9.33 ft }

Soil in front of wall is Horizontal.

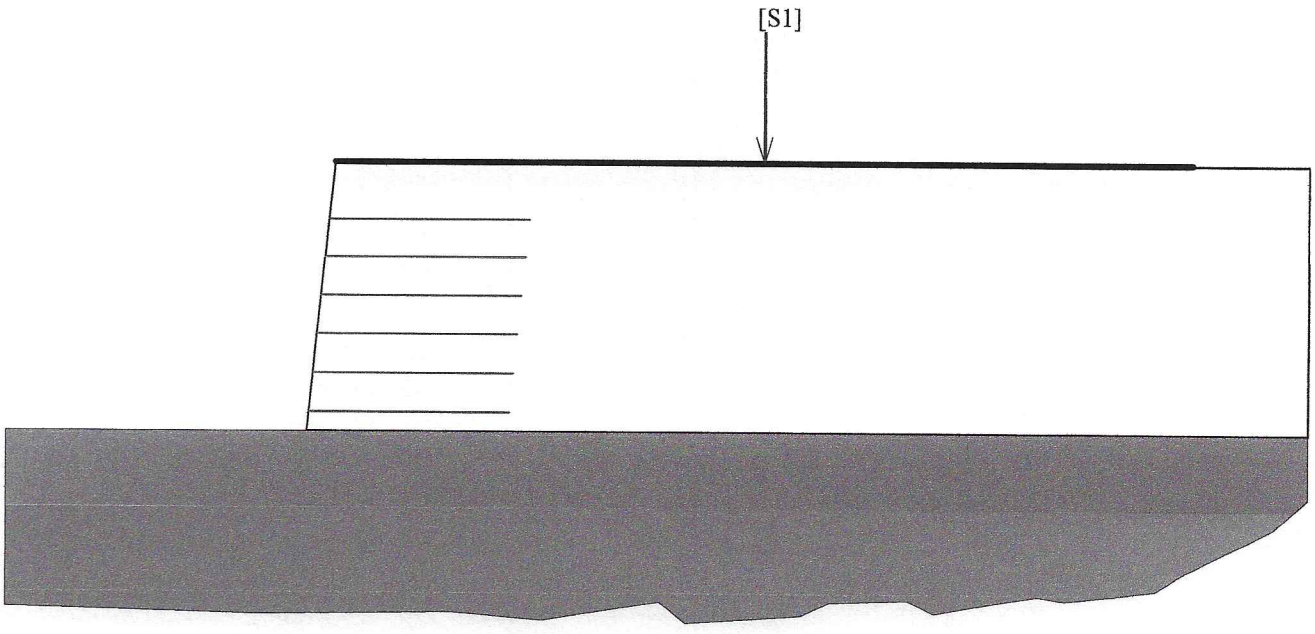
Batter, ω	5.8	[deg]
Backslope, β	0.0	[deg]
Backslope rise	0.0	[ft]

Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 100.0 [lb/ft ²].
Footing width, b=30.0 [ft]. Distance of center of footing from wall face, d = 15.0 [ft] @ depth of 0.0 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.72, Meyerhof stress = 1561 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.689, Eccentricity, e/L = 0.1081, Fs-overturning = 3.78

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	7.00	1	5.44	5.18	5.176	11.575	1.667	0.0924	Mira5XT
2	2.00	7.00	1	6.36	6.05	6.054	10.798	1.933	0.0651	Mira5XT
3	3.33	7.00	1	7.59	7.22	7.224	9.560	2.291	0.0428	Mira5XT
4	4.67	7.00	1	7.94	9.01	9.008	8.298	2.803	0.0251	Mira5XT
5	6.00	7.00	1	7.55	12.00	11.997	6.992	3.581	0.0124	Mira5XT
6	7.33	7.00	1	4.44	11.73	11.729	3.571	4.920	0.0041	Mira5XT

GROUND
ENGINEERING

AASHTO 2002 ASD DESIGN METHOD
2125 NW O'Brien Road

MSEW+: Update # 2022.03

PROJECT IDENTIFICATION

Title: 2125 NW O'Brien Road
Project Number: 22-3673
Client: Raintree Landscaping LLC
Designer: GROUND
Station Number:

Description:

DH=6.67'

Company's information:

Name: GROUND Engineering Consultants, Inc.
Street: 41 Inverness Drive East

Englewood , CO 80112
Telephone #: 303-289-1989
Fax #:
E-Mail:

File path and name: K:\2022 Jobs\Engineering\22-3673 2125 NW O'Brien RD L+L.....
.....ts\MSEW\DH=6.67.BENp

Original date and time of creating this file: December 2022

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	135.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	34.0 °

RETAINED SOIL

Unit weight,	γ	120.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	26.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	120.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	26.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 62.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3905 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 22.25 N γ = 12.54

SEISMICITY

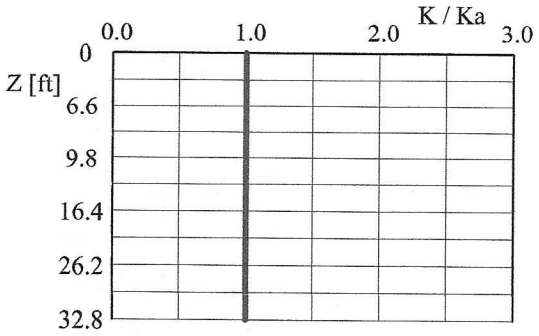
Not Applicable

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0				
Durability reduction factor, RFd	1.15				
Installation-damage reduction factor, RFid	1.15				
Creep reduction factor, RFc	1.45	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	24.22				
Pullout resistance factor, F*	$0.67 \cdot \tan\phi$	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	0.8				

Variation of Lateral Earth Pressure Coefficient With Depth

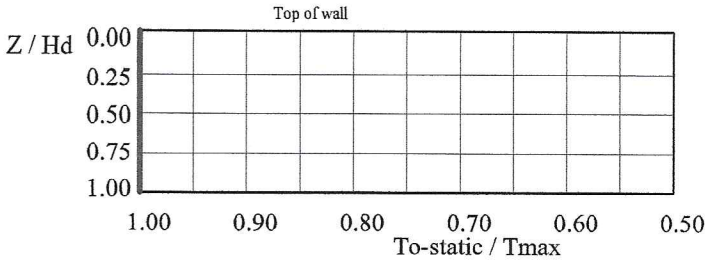
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (according to revised Demo 82) (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 2.50/1.30 ft. Horizontal distance to Center of Gravity of block is: 1.25 ft.
Average unit weight of block is: γ_f = 135.00 lb/ft ^{3}

Z / Hd	To-static / Tmax
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [1]	CRult [2]	σ	CRult	σ	CRult	σ	CRult	σ	CRult
100.0	0.31								
133.6	0.60	N/A		N/A		N/A		N/A	
217.2	0.76								
275.6	0.90								

Geogrid Type #1[3]		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr
0.0	0.00								
750.0	0.63	N/A		N/A		N/A		N/A	

[1] σ = Confining stress in between stacked blocks [lb/ft ^{2}]
[2] CRult = Tc-ult / Tult
[3] CRcr = Tcre / Tult

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Mira5XT	N/A	N/A	N/A	N/A
Connection strength reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 6.67 [ft] { Embedded depth is E = 0.00 ft, and height above top of finished bottom grade is H = 6.67 ft }

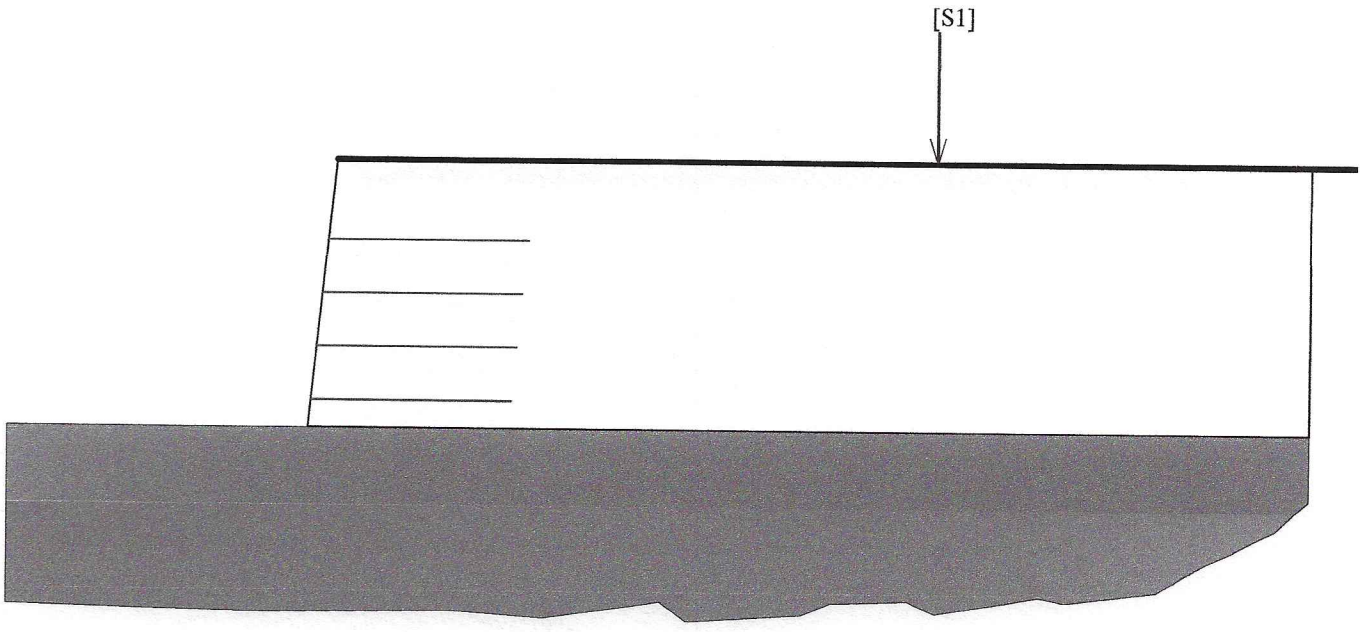
Soil in front of wall is Horizontal.

Batter, ω 5.8 [deg]
Backslope, β 0.0 [deg]
Backslope rise 0.0 [ft] Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 100.0 [lb/ft ²].
Footing width, b=30.0 [ft]. Distance of center of footing from wall face, d = 15.0 [ft] @ depth of 0.0 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.55, Meyerhof stress = 1169 lb/ft².

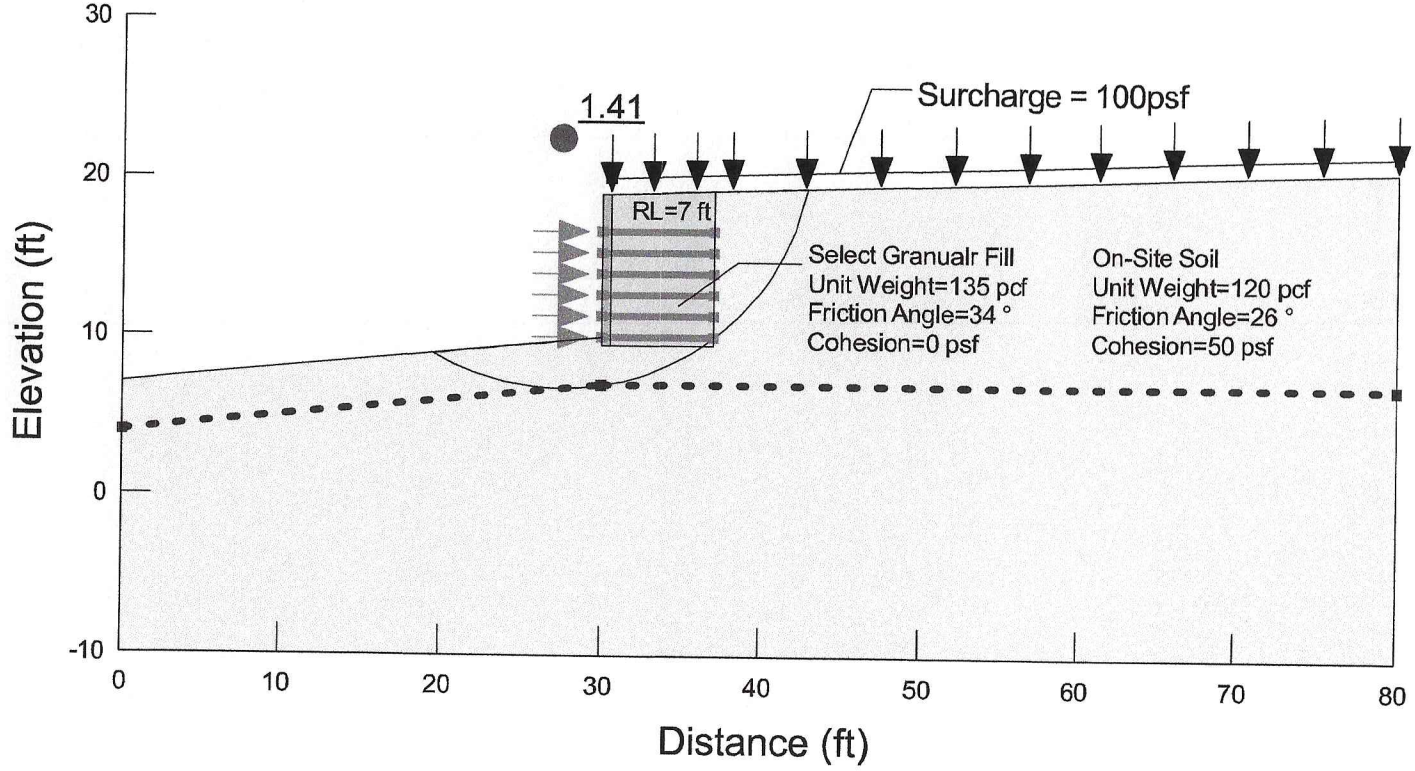
Foundation Interface: Direct sliding, Fs = 1.589, Eccentricity, e/L = 0.1214, Fs-overturning = 3.46

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	5.00	1	7.58	7.22	7.218	7.948	1.606	0.0983	Mira5XT
2	2.00	5.00	1	7.97	9.03	9.029	6.917	1.969	0.0602	Mira5XT
3	3.33	5.00	1	7.53	11.93	11.930	5.631	2.526	0.0316	Mira5XT
4	4.67	5.00	1	4.42	11.69	11.693	2.770	3.492	0.0123	Mira5XT

APPENDIX B

RESULT OF GLOBAL STABILITY ANALYSIS

2125 NW O'Brien Road



GROUND
ENGINEERING

2125 NW O'Brien Road

L+L Wall Panels, Backfill, and Geogrid Quantities 1/6/2023

Wall	Wall Length	Face Area	Select Granular Backfill	On-Site Soil	Facing Gravel Fill	Miragrid
			Reinforced	Retained	No. 57/67	5XT
	LF	SF	CY	CY	CY	SY
A	112	971	204	163	84	548
Totals	**112**	**971**	**204**	**163**	**84**	**548**

Notes:

1) Quantities are based on a digital image of a hand sketch of the wll alignment and exposed wall elavation provided on 10/13/2022.
2) Quantities are neat line quantities and do not include waste or overlap.
3) Reinforced backfill measured to top of pannel, not including top slope.
4) Assumed soil properties:
   Select Granular Backfill: unit weight - 135 pcf, friction angle - 34°
   On-Site Soil and Foundation: unit weight - 120 pcf, friction angle - 26°
   Soil Properited shall be evaluated by the Geotechnical Engineer as shall provide alternate values, if applicable.

PROPOSED
LOCK+LOAD RETAINING WALL
2125 NW O'BRIEN ROAD
LEE'S SUMMIT, MISSOURI 64081

Index of Drawings

STATE OF MISSOURI
MATTHEW T. JENSEN
NUMBER
PE-2022031142
1/6/2023
PROFESSIONAL ENGINEER

Matthew T. Jensen
MO No. PE-2022031142

GROUND ENGINEERING
GROUND Engineering Consultants, Inc.
41 Inverness Drive East
Englewood, CO 80112
www.groundeng.com - (303) 289-1989
Missouri State Certificate of Authority No.: E-2022036929

Sheet Revisions

Date:	Comments	Init.

Initial Date: 1/6/2023
Issue Date: 1/6/2023
Project No.: 22-3673
Design By: MTJ
Approved By: CBH
Horiz. Scale:
Vert. Scale:

Raintree Landscaping LLC
4072 SW Normandy Drive
Lee's Summit, Missouri 64082
Tim Jordan (816) 646-9401

L+L RETAINING WALL
2125 NW O'Brien Road
Lee's Summit, Missouri 64081

COVER SHEET

SHEET NUMBER 1 OF 5

1. General

1.1 The designpresented herein is based on a PDF of the Construction Stake Plot flan prepared by Construction Engineering Services, Inc., dated May i, 2022 and provided on October 13, 2022 and a digital image of a hand sketch of the wall alignment and exposed wall elevation povided on October 13, 2022. Geotechnical information was not availabh at the time of this design and design values are based on IBC Presumptive Load Bearing Values. The Geotechnical Engineer should review the soil parameters used and provide alternate values, if applicable.

1.2 The designpresented herein is prepared exclusively for Raintree Landscaping LLC and may only be used by Raintree Landscaping LLC and the authorized Contractor.

1.3 Alignment of the proposed segmental retaining wall shall be based on the provided wall alignment.

1.4 The Contractor shall verify the location of proposed and existing underground features prior to any grading or excavation.

1.5 Locations and elevations of panels, counterforts, reinforcement, and wall drain shall be periodically verified by a surveyor during and at completion of construction.

2. Materials

2.1 Panels and counterforts shall be Lock+Load panel and counterfort units complying with manufacturer's specifications and produced by an authorized licensee.

2.2 Geogrid shall be Solmax Miragrid. Minimum average roll value (MARV) of ultimate wide width tensile strength (ASTM D6637) shall be:

Miragid 5XT 4,700 lbs/ft

2.3 All panels and counterforts shall be sound and free of cracks or any other defects that would not allow proper construction or affect the strength of the wall. All panels shall be free of imperfections when viewed froma distance of 10 feet.

2.4 All panels, counterforts, and geogrid shall be stored, handled, and installed according to manufacturers' specifications.

2.5 Panel and counterfort gravel fill, leveling pad, and wall drain material shall consistof free draining ASTM C33 No. 57/67 crushed rock, and be constructed to the dimensions provided on the Drawings.

2.6 Reinforced backfill shall consist of select granular backfill with a minimum friction angle of 34 degrees. Retained backfill shall consist of on-site soil with a minimum friction angle of 26 degrees. The gradation, plasticity, and friction angle of fill materials **MUST** be verified prior to and during construction.

2.7 The underdrain pipe shall be 4-inch perforated HDPE pipe with perforations sized to prevent migration of wall backfill. Discharge pipe shall be 4-inch non-perforated HDPE pipe.

2.8 Filter fabric shall be Mirafi 140N or approved equivalent.

3. Excavation and Subgrade Preparation

3.1 The excavation shall be carried to the extents necessary to place geogrid at the required lengths.

3.2 Temporary excavation slopes shall be graded in accordance with OSHA's guidelines.

3.3 Subgrade shall be excavated as required for placement of the leveling pad, wall drain, geogrid reinforcement, and wall backfill as shown on the Drawings or as directed by the Design Engineer.

3.4 Wall subgrade shall be verified by the Geotechnical Engineer, and shall not contain mud, organic silt, organic clays, peat, or unclassified fill.

4. Construction

4.1 Panels, counterforts, leveling pad, geogrid reinforcement, backfill, and wall drains shall be installed in accordance with the Drawings and the manufacturers' construction guidelines.

4.2 Backfill shall be placed in uniform lifts not to exceed 8 inches in compacted thickness and graded to nearly level. Select granular backfill shall be compacted to at least 95 percent of maximum modified Proctor density (ASTM D1557) within 2 percent of the optimum moisture content. Retained backfill shall be compacted to at least 95 percent of the maximum standard Proctor density (ASTM D698) within 2 percent of the optimum moisture content. ASTM C33 No. 57/67 crushed rock shall be vibratory compacted.

4.3 Materials placed as backfill in front of the wall or below the bottom of wall shall be compacted to at least 95 percent of the maximum standard Proctor density (ASTM D698) within 2 percent of the optimum moisture content.

4.4 Only light weight hand-operated compaction equipment shall be used within 3 feet behind the back of panels.

4.5 The first course of panels and counterforts shall be placed level on the leveling pad. All panels and counterforts shall be checked for proper elevations and levelness.

4.6 All underdrain pipes shall be graded at a minimum 2 percent continuous slope to discharge pipes.

4.7 All discharge pipes shall be installed at a minimum of 2 percent slope to daylight at the locations indicated in the Drawings and at low points.

4.8 Geogrid shall be orientated with the highest strength axis perpendicular to the wall alignment.

4.9 Geogrid reinforcement shall be placed according to the Drawings and manufacturer's recommendations.

4.10 Geogrid reinforcement shall be laid horizontally on properly compacted level backfill. The geogrid must be pulled taut and anchored prior to backfill material placement on the geogrid.

4.11 Geogrid reinforcement will be continuous for their embedment length. Spliced connections will not be allowed in the high strength axis.

4.12 A 2-inch layer of compacted backfill shall be placed between two layers of geogrid in the overlapping areas.

4.13 Tracked construction equipment shall not be allowed to operate directly on geogrid. A minimum 6 inches of backfill must be placed prior to operations of vehicles over the geogrid. Turning of vehicles shall be prohibited to prevent displacing the backfill and damaging geogrid.

4.14 Any damage to the geogrid that affects the anticipated strength or life of the geogrid shall be removed and replaced.

4.15 No changes to the geogrid layout, length, type, or elevation shall be made without approval from the Design Engineer.

5. Drainage

5.1 The wall system and the surrounding areas must be kept relatively dry at all times during and after the construction as much as is feasible.

5.2 In no case should surface runoff be allowed to enter the wall construction areas or water be ponded around the wall during construction.

5.3 At the end of each construction day, the Contractor shall slope the last lift of backfill away from the wall face to direct runoff away from the wall.

5.4 Excavation slopes shall also be protected against erosion to reduce the potential for sloughing and slope failure.

6. Quality Assurance

6.1 The Owner shall retain a qualified engineer and testing agency to perform inspection and materials testing during construction.

6.2 The Owner shall specify the type and minimum frequency of material testing prior to the beginning of wall construction.

6.3 If conformance by the Design Engineer is required, the Wall Contractor shall notify the Design Engineer before initiating construction to coordinate on-site observation and inspection services, and associated fees.

7. Design Criteria

7.1 AASHTO ASD, 2002.

7.2 Design soil parameters:

Material Type	Friction Angle (degrees)	Cohesion (psf) *	Unit Weight (pcf)
Select Granular Backfill	34	0	135
On-site Soil	26	50	120

* Cohesion values were used in global stability analysis only.

7.3 Internal Stability

Criteria	Min. Factor of Safety
Overstress	1.5
Pullout	1.5

7.4 External Stability

Criteria	Min. Factor of Safety
Base Sliding	1.5
Overturning	2.0
Bearing	2.0

7.5 Facing Stability

Criteria	Min. Factor of Safety
Connection	1.5

7.6 Global Stability: Min. Factor of Safety = 1.3

8. Abbreviations

BG	Finished grade at bottom of wall
BW	Bottom of wall at top of leveling pad
DH	Design wall height
DIA	Diameter
EL	Elevation (ft)
EQU	Equivalent
MAX	Maximum
MIN	Minimum
MOD	Modified
NTS	Not to scale
OC	On centers
PPD	Per project documents
RL	Reinforcement length
STA	Station
STD	Standard
TG	Finished grade at top of wall
TW	Top of wall at top of panels
TYP	Typical

811 **Know what's below.** **Call 811 before you dig.**

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Sheet Revisions

Date:	Comments	Init.

Initial Date: 1/6/2023
Issue Date: 1/6/2023
Project No.: 22-3673
Design By: MTJ
Approved By: CBH
Horiz. Scale:
Vert. Scale:

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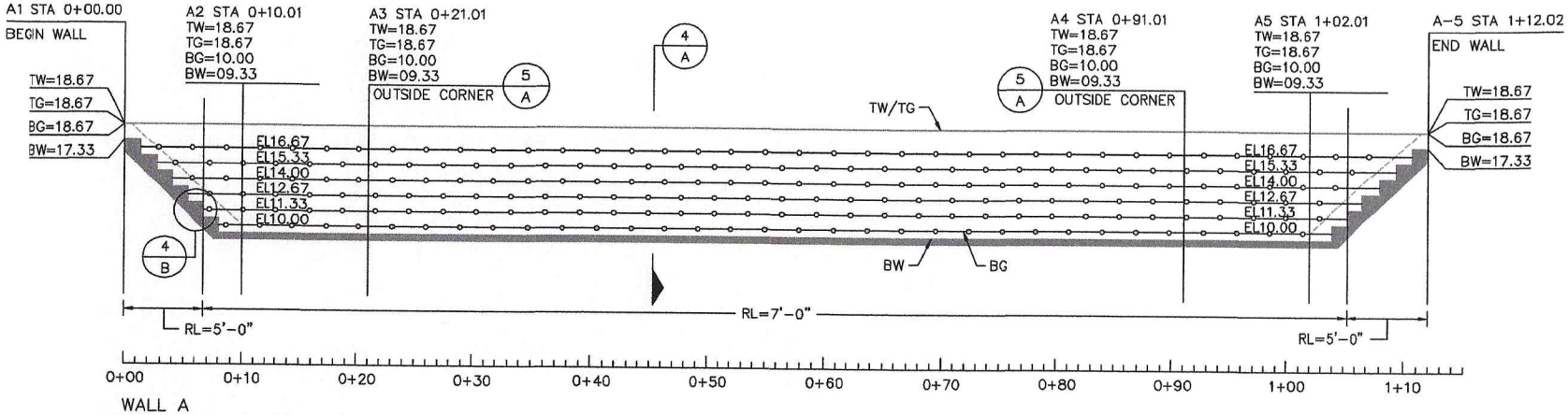
GENERAL NOTES

SHEET NUMBER 2 OF 5



WALL A

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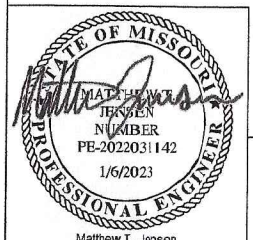

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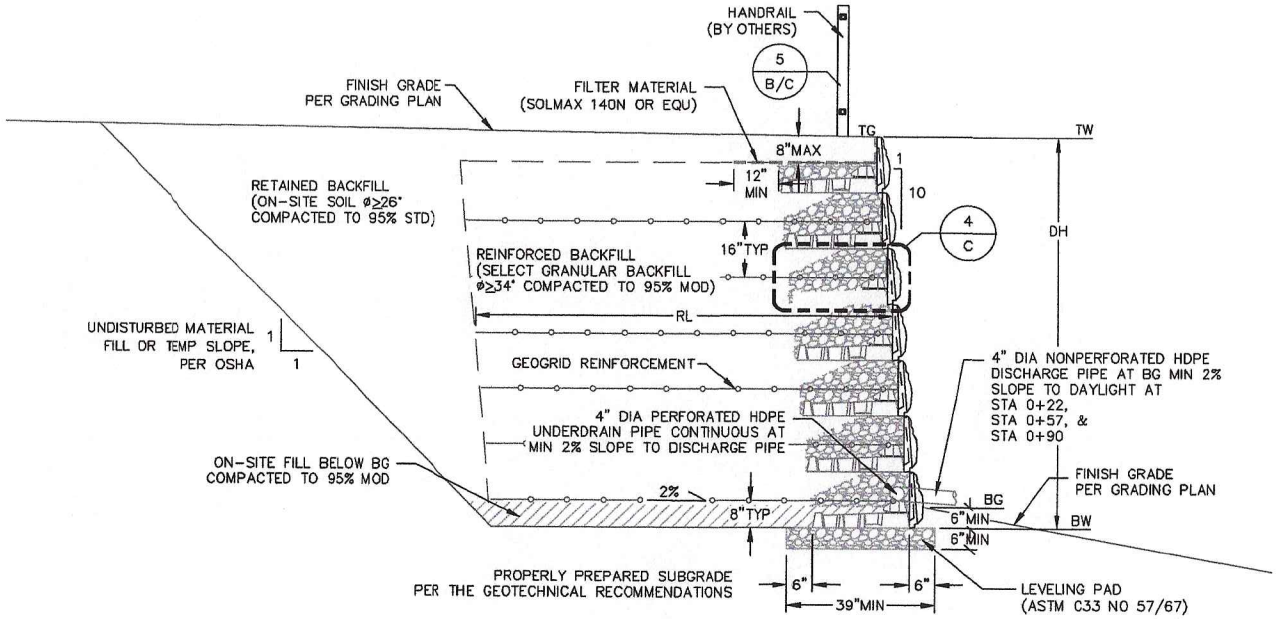
WALL A ELEVATION

SHEET NUMBER
3 OF 5



4 / A — TYPICAL SINGLE-TIER WALL SECTION
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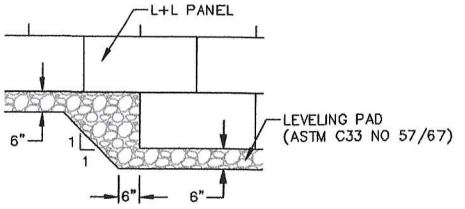

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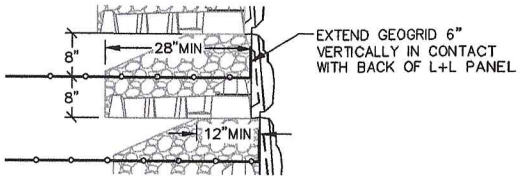

4 / C — TYPICAL GRAVEL FILL AND GEOGRID AT PANEL DETAIL
NTS

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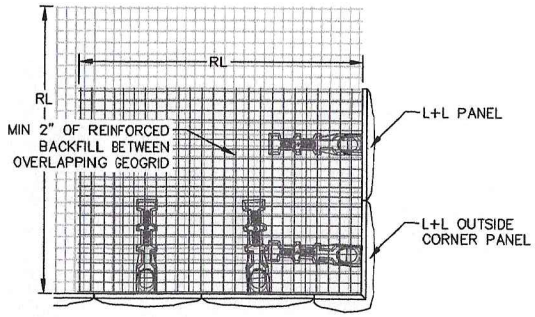
TYPICAL SINGLE-TIER WALL SECTION AND
TYPICAL WALL DETAILS 01

SHEET NUMBER
4 OF 5



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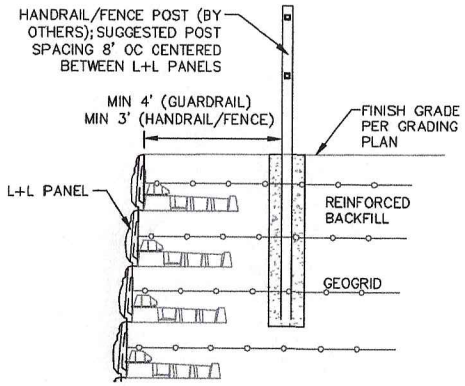
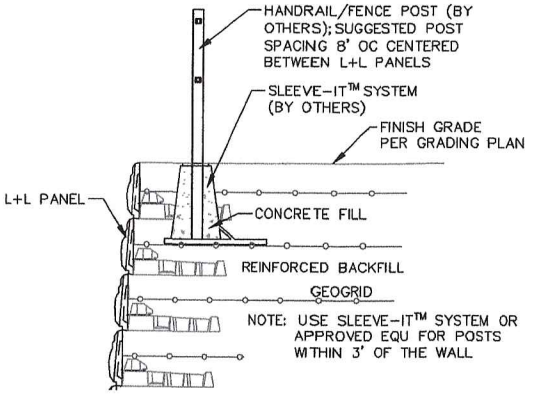


5 / B — TYPICAL HANDRAIL/FENCE DETAILS
NTS — OPTION 1



5 / C — TYPICAL HANDRAIL/FENCE DETAILS
NTS — OPTION 2

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TYPICAL WALL DETAILS 02

SHEET NUMBER 5 OF 5