ROCKERY RETAINING WALL DESIGN

2410 LA MANCHA DRIVE

WASHOE COUNTY, NEVADA

Prepared For

Jon Rabe

jon@skyhighcaraudio.com

Prepared By

WESTEX
Consulting Engineers

P.O. Box 18871; Reno, Nevada 89511

File No. 2204.002-B
February 15, 2023

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Consulting Engineers

P.O. Box 18871
Reno, NV 89511
Locally Owned & Operated

February 15, 2023

Jon Rabe
Via Email: jon@skyhighcaraudio.com

Re: Rockery Retaining Wall Design
2410 La Mancha Drive (APN 076-381-53)
Washoe County, Nevada
File No.: 2204.002-B

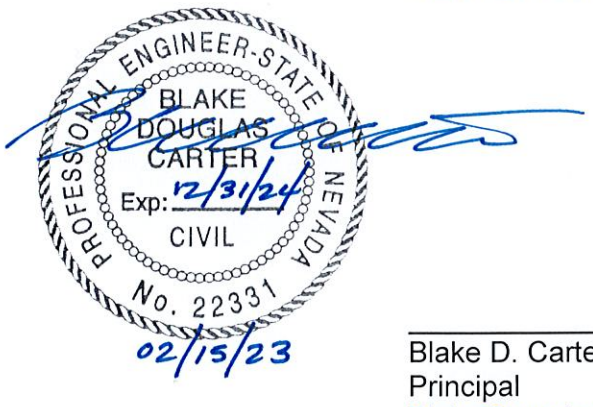
Gentlemen,

The rockery walls for the subject project have been designed in accordance with local standards and are included in this package. The design has been made for the rockery retaining walls at each wall location (Plates 1) as shown on the Grading Plans prepared by Monte Vista Consulting, dated 1/11/2023.

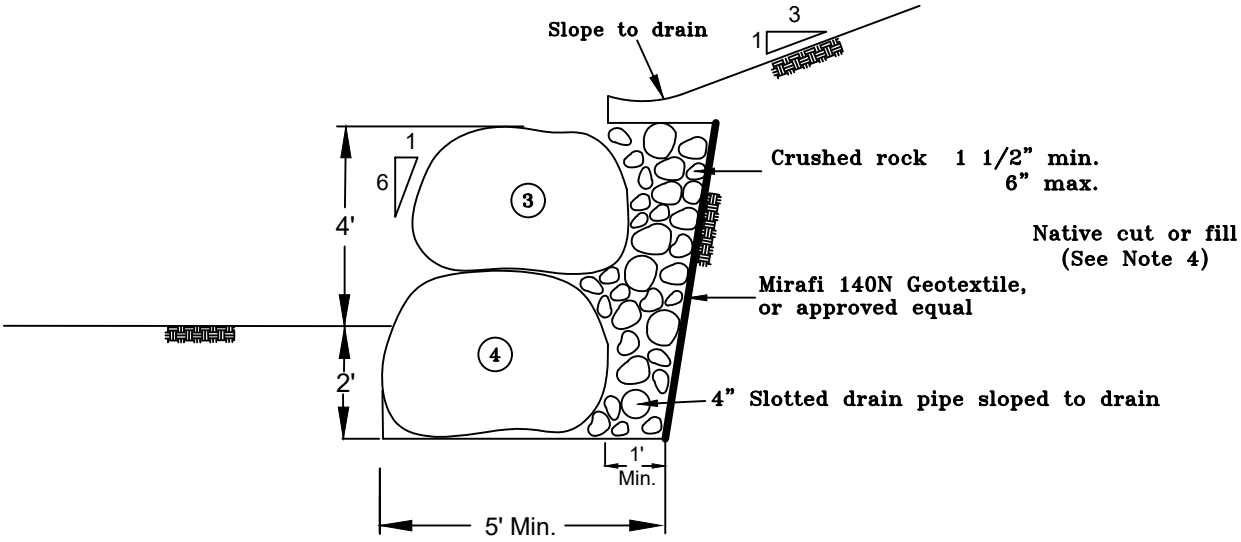
All materials shall conform to the latest edition of the Standard Specifications for Public Works Construction "Orange Book". Special Inspection is required per IBC Section 1807.2, as included in the Northern Nevada Building Code Amendments, and adopted by Washoe County.

We trust this provides the needed information. If you have any questions or require further assistance with design or inspection needs, please do not hesitate to contact us.

Respectfully,
WESTEX Consulting Engineers, LLC



Blake D. Carter, P.E.
Principal
Blake@westexconsulting.com
Ph: (775) 771-9539



Size	Diameter	Approx. Weight, lbs.
3	28"–36"	955–2029
4	36"–48"	2029–4809

Notes:

1. Fill voids larger than 3 inch diameter in front face of wall (within 6" of the face) with smaller rock full height of the wall.

2. Setback from top back of wall to any structure at or above the top of wall should be greater than, or equal to the total wall height.

3. Setback from bottom face of wall to any structure should be greater than or equal to the above-ground wall height.

4. All fill material shall be compacted to a minimum relative compaction of 90% per ASTM D1557.

5. A fence should be considered along the top of the wall for safety.

6. The grading and drainage are to ensure no water flows over the proposed walls.

4 ft Above Ground
WALL A
3:1 Surcharge

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Rockery Retaining Wall Design

Rabe Residence
2410 La Mancha Drive
Washoe County, Nevada

Date: 2-15-2023

File No: 2204.002-B

Figure 1

SOIL DATA

Soil Type: Silty Sand (SM)

H_w = Wall height from ground surface, ft.	4.0
H_e = Wall embedment below ground, ft.	2.0
ϕ = Angle of internal friction, ^{o}	30
γ = Unit weight of soil, pcf	120
C = Cohesion, psf	0
b = Base rock width, ft	3.5
d = Footing depth below undist. ground, ft	2.0
β = Angle of backfill slope, ^{o}	18.5

FOR β CALCULATION		
H (Run)		V (Rise)
3		1

ROCK DATA [1]

Absorption < 4.2%
Accelerated Expansion < 15% breakdown
Soundness < 5% loss
Unconfined Compressive Strength > 6000 psi
S.G.= 2.30 min 144 pcf

[1] ARC Rock Wall Construction Guidelines

BEARING CAPACITY FACTORS [2,3]

GENERAL	N_q	18.40
	N_c	30.14
	N_γ	22.40

$N_q = e^{\pi \tan\phi} \tan^2(45^o+\phi/2)$
$N_c = (N_q-1)\cot\phi$
$N_\gamma = 2(N_q+1)\tan\phi$

[2] Foundation Engineering Handbook, Winterkorn and Fang, 1975
[3] Soil Mechanics in Engineering Practice, Terzaghi and Peck, 1967

Active Pressure (Coulomb)

$(\cos^2\omega\cos(\delta+\omega))*((1+((\sin(\delta+\phi)\sin(\phi-\beta)/(\cos(\delta+\omega)\cos(\omega-\beta))^{0.5})^2$

Passive Pressure (Coulomb)

$((\csc\omega\sin(\omega+\phi)/(\sin(\omega+\delta))^{0.5}-(((\sin(\phi-\delta)\sin(\phi+\beta))/\sin(\omega-\beta))^{0.5}))^2$

Sliding

$f=\tan\phi$ (for irregular rock surface)

Bearing Capacity

$q_u = C(N_c)+\gamma b(N_\gamma/2)+\gamma d(N_q)$

ULTIMATE SOIL BEARING CAPACITY, q_u	**4500** psf	(For S.F. of 3.0)
SLIDING COEFFICIENT, f	**0.55**	
ACTIVE PRESSURE, EQUIVALENT FLUID PRESSURE	**35.0** pcf	
PASSIVE PRESSURE, EQUIVALENT FLUID PRESSURE	**350.0** pcf	

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ROCKERY WALL DESIGN, H= 4.0 18.5 ^{o} UPSLOPE

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Wall A
Washoe County, Nevada

DATE	2/15/2023
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ROCK SIZING

ROCK SIZE	USE	APPR. WT., lbs		APPR. DIA., in		AVG.	WALL
		FROM	TO	FROM	TO	DIA., in	HT., in
1		75	254	12	18		
2		254	955	18	28		
3	**1**	955	2029	28	36	**32**	**32**
4	**1**	2029	4809	36	48	**42**	**42**
5		4809	6848	48	54		
6		6848	9393	54	60		

JURISDICTION	**LIMITS**
City of Reno	
Washoe County	x
City of Sparks	
Douglas County	
Storey County	

WALL COMPONENTS

DO ROCK SIZES MATCH WALL HEIGHT (H_e+H_w)? **YES**

DOES HEIGHT (H_e+H_w) MATCH JURISDICTION LIMITS? **YES**

ACTUAL BEARING PRESSURE **1021 psf**

S.F.$_{bearing}$ = 4.41 **>3.0, OK**

OVERTURNING MOMENT (RESISTING)

FOR BATTER CALC.		
H (Run)		V (Rise)
1		6

		W	r	Wr	
TOP		no		0	ft-lbs
MID		no		0	ft-lbs
MID		no		0	ft-lbs
MID	3	2.67	1491.8	1.78	2652 ft-lbs
BOTTOM	4	3.50	3419.2	1.75	5984 ft-lbs
		6.17	4911		8636 ft-lbs

OVERTURNING MOMENT (ACTIVE) **422 ft-lbs**

S.F.$_{overturning}$ = 20.47 **>2.0, OK**

SLIDING

TOTAL WEIGHT/FT=	3573
RESISTING FORCE=	2665
ACTIVE FORCE=	665

S.F.$_{sliding}$ = 4.00 **>1.5, OK**

To Improve Allowable Soil Bearing Capacity and/or Sliding Coefficient, use 6" Min. Thickness of Crushed Rock

ϕ = Angle of internal friction, ^{o}

GENERAL		
	N_q	0.00
	N_c	0.00
	N_γ	0.00

SLIDING COEFFICIENT, f RESISTING FORCE= **0.94**

ALLOWABLE SOIL BEARING CAPACITY, q_u **7910**

S.F. $_{sliding}$ =	
S.F. $_{bearing}$ =	

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ROCKERY WALL DESIGN, H= 4.0 **18.5 ^{o} UPSLOPE**

2410 La Mancha Drive

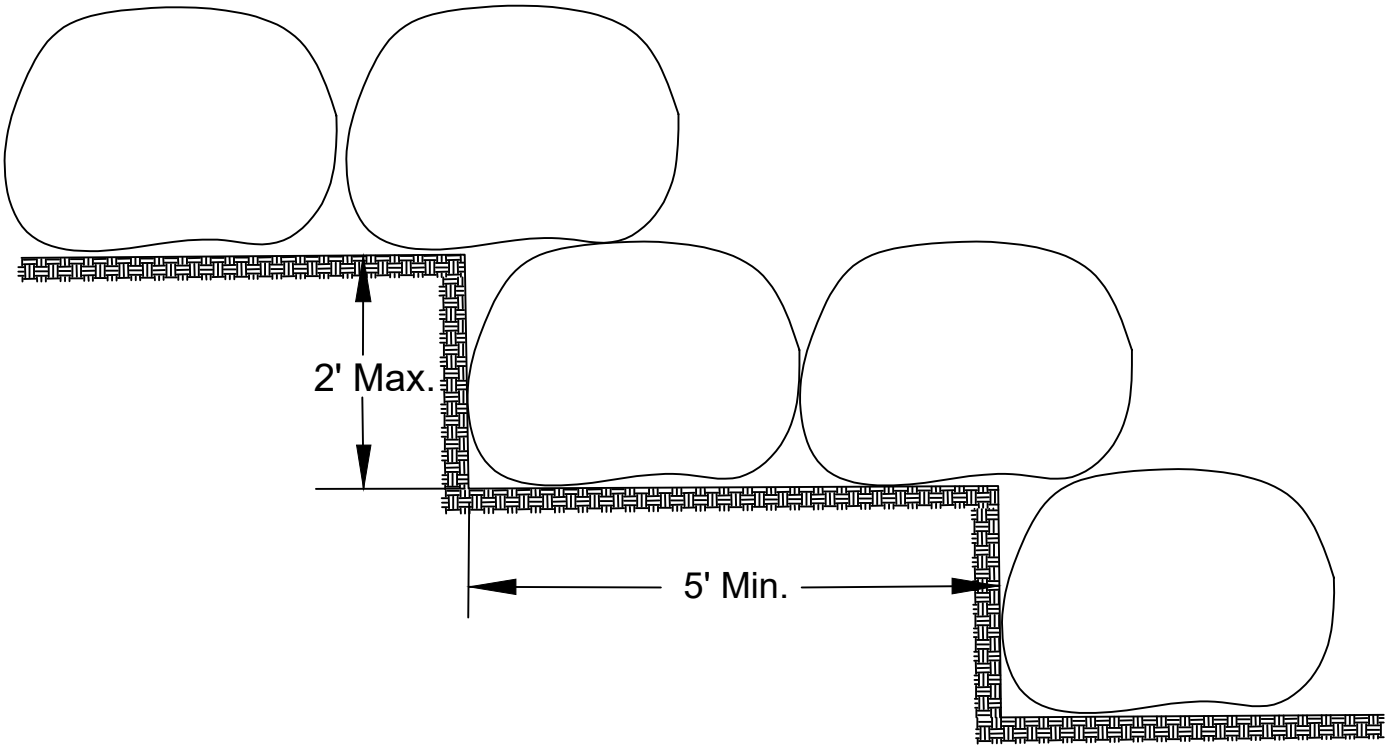
Wall A

Washoe County, Nevada

DATE 2/15/2023

FILE NO. 2204.004-B

CALC. BY KLM



Notes:

1. The bottom of keyways are to be near level. When the slope of the bottom of the keyway is 5:1 or greater. Then the keyway is to be stepped a maximum of 2 feet vertical and a minimum of 5 feet horizontal.
2. All fill material shall be compacted to a minimum relative compaction of 90%.

Typical Keyway Step

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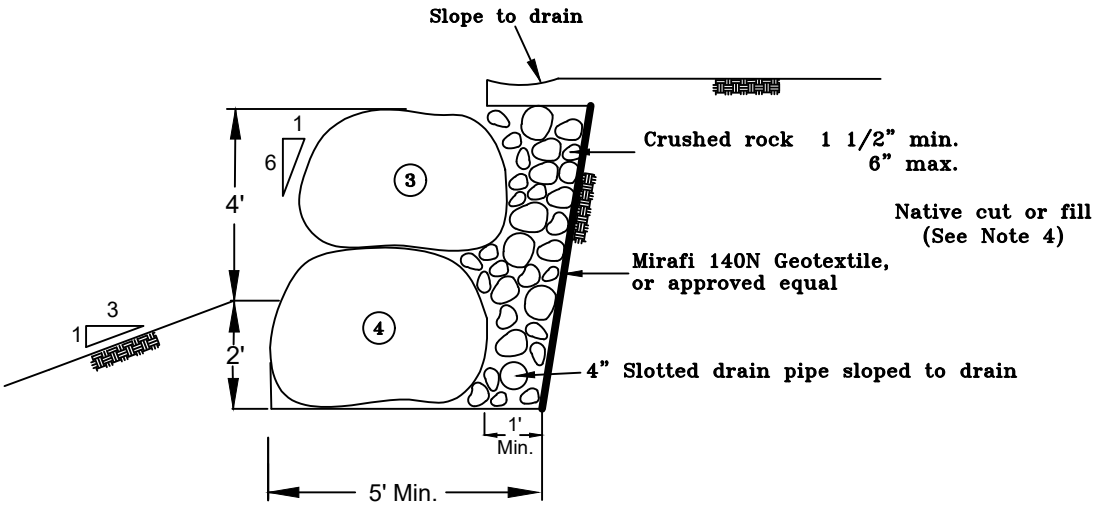
Rockery Retaining Wall Design

Rabe Residence
2410 La Mancha Drive
Washoe County , Nevada

Date: 2-15-2023

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Figure 2



Size	Diameter	Approx. Weight, lbs.
3	28"–36"	955–2029
4	36"–48"	2029–4809

Notes:

1. Fill voids larger than 3 inch diameter in front face of wall (within 6" of the face) with smaller rock full height of the wall.

2. Setback from top back of wall to any structure at or above the top of wall should be greater than, or equal to the total wall height.

3. Setback from bottom face of wall to any structure should be greater than or equal to the above–ground wall height.

4. All fill material shall be compacted to a minimum relative compaction of 90% per ASTM D1557.

5. A fence should be considered along the top of the wall for safety.

6. The grading and drainage are to ensure no water flows over the proposed walls.

4 ft Above Ground
WALL B
No Surcharge

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Rockery Retaining Wall Design

Rabe Residence
2410 La Mancha Drive
Washoe County, Nevada

Date: 2-15-2023

File No: 2204.002-B

Figure 3

SOIL DATA

Soil Type: Silty Sand (SM)

H_w = Wall height from ground surface, ft.	4.0
H_e = Wall embedment below ground, ft.	2.0
ϕ = Angle of internal friction, ^{o}	30
γ = Unit weight of soil, pcf	120
C = Cohesion, psf	0
b = Base rock width, ft	3.5
d = Footing depth below undist. ground, ft	2.0
β = Angle of backfill slope, ^{o}	0.0

FOR β CALCULATION		
H (Run)		V (Rise)
0		1

ROCK DATA [1]

Absorption < 4.2%
Accelerated Expansion < 15% breakdown
Soundness < 5% loss
Unconfined Compressive Strength > 6000 psi
S.G.= 2.30 min 144 pcf

[1] ARC Rock Wall Construction Guidelines

BEARING CAPACITY FACTORS [2,3]

GENERAL	N_q	18.40
	N_c	30.14
	N_γ	22.40

$N_q = e^{\pi \tan\phi} \tan^2(45^o + \phi/2)$
$N_c = (N_q - 1)\cot\phi$
$N_\gamma = 2(N_q + 1)\tan\phi$

[2] Foundation Engineering Handbook, Winterkorn and Fang, 1975
[3] Soil Mechanics in Engineering Practice, Terzaghi and Peck, 1967

Active Pressure (Coulomb)

$(\cos^2\omega\cos(\delta+\omega))*((1+((\sin(\delta+\phi)\sin(\phi-\beta)/(\cos(\delta+\omega)\cos(\omega-\beta))^{0.5})^2$

Passive Pressure (Coulomb)

$((\csc\omega\sin(\omega+\phi)/(\sin(\omega+\delta))^{0.5}-(((\sin(\phi-\delta)\sin(\phi+\beta))/\sin(\omega-\beta))^{0.5}))^2$

Sliding

$f=\tan\phi$ (for irregular rock surface)

Bearing Capacity

$q_u = C(N_c)+\gamma b(N_\gamma/2)+\gamma d(N_q)$

ULTIMATE SOIL BEARING CAPACITY, q_u	**4500** psf	(For S.F. of 3.0)
SLIDING COEFFICIENT, f	**0.55**	
ACTIVE PRESSURE, EQUIVALENT FLUID PRESSURE	**35.0** pcf	
PASSIVE PRESSURE, EQUIVALENT FLUID PRESSURE	**350.0** pcf	

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ROCKERY WALL DESIGN, H= 4.0 0.0 ^{o} UPSLOPE

2410 La Mancha Drive

Wall B

Washoe County, Nevada

DATE	2/15/2023
FILE NO.	2204.004-B
CALC. BY	KLM

ROCK SIZING

ROCK SIZE	USE	APPR. WT., lbs		APPR. DIA., in		AVG.	WALL
		FROM	TO	FROM	TO	DIA., in	HT., in
1		75	254	12	18		
2		254	955	18	28		
3	**1**	955	2029	28	36	**32**	**32**
4	**1**	2029	4809	36	48	**42**	**42**
5		4809	6848	48	54		
6		6848	9393	54	60		

JURISDICTION	**LIMITS**
City of Reno	
Washoe County	x
City of Sparks	
Douglas County	
Storey County	

WALL COMPONENTS

DO ROCK SIZES MATCH WALL HEIGHT (H_e+H_w)? **YES**

DOES HEIGHT (H_e+H_w) MATCH JURISDICTION LIMITS? **YES**

ACTUAL BEARING PRESSURE **1021 psf**

S.F.$_{bearing}$ = 4.41 **>3.0, OK**

OVERTURNING MOMENT (RESISTING)

FOR BATTER CALC.		
H (Run)		V (Rise)
1		6

		W	r	Wr	
TOP		no		0	ft-lbs
MID		no		0	ft-lbs
MID		no		0	ft-lbs
MID	3	2.67	1491.8	1.78	2652 ft-lbs
BOTTOM	4	3.50	3419.2	1.75	5984 ft-lbs
		6.17	4911		8636 ft-lbs

OVERTURNING MOMENT (ACTIVE) **422 ft-lbs**

S.F.$_{overturning}$ = 20.47 **>2.0, OK**

SLIDING

TOTAL WEIGHT/FT=	3573
RESISTING FORCE=	2665
ACTIVE FORCE=	665

S.F.$_{sliding}$ = 4.00 **>1.5, OK**

To Improve Allowable Soil Bearing Capacity and/or Sliding Coefficient, use 6" Min. Thickness of Crushed Rock

ϕ = Angle of internal friction, ^{o}

GENERAL		
	N_q	0.00
	N_c	0.00
	N_γ	0.00

SLIDING COEFFICIENT, f RESISTING FORCE= **0.94** **S.F. $_{sliding}$ =**

ALLOWABLE SOIL BEARING CAPACITY, q_u **7910** **S.F. $_{bearing}$ =**

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ROCKERY WALL DESIGN, H= 4.0 **0.0 ^{o} UPSLOPE**

2410 La Mancha Drive

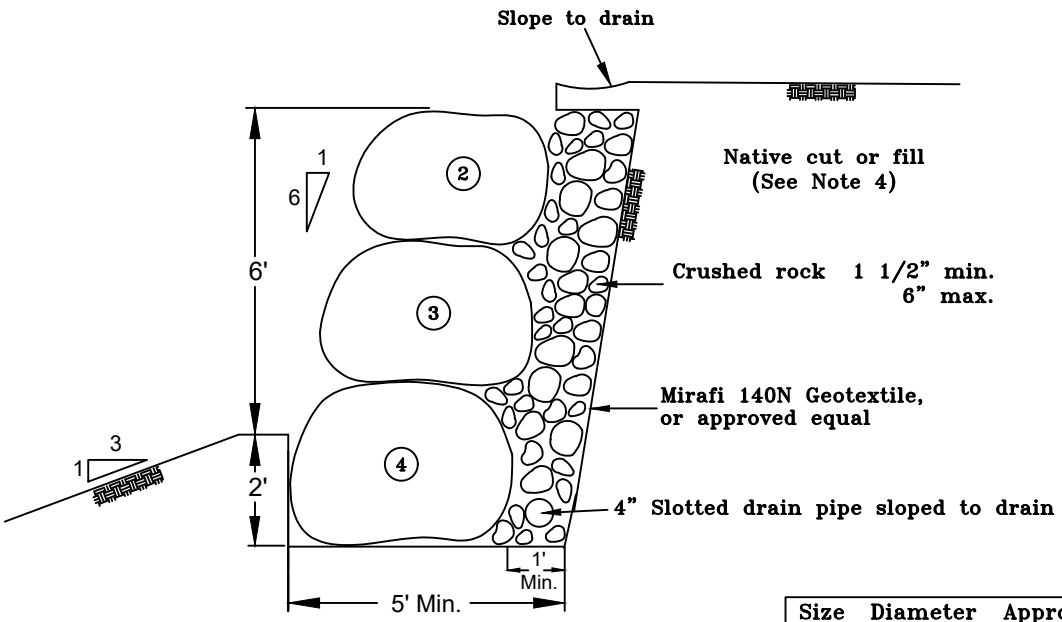
Wall B

Washoe County, Nevada

DATE 2/15/2023

FILE NO. 2204.004-B

CALC. BY KLM



Size	Diameter	Approx. Weight, lbs.
2	18"–28"	254–955
3	28"–36"	955–2029
4	36"–48"	2029–4809

Notes:

1. Fill voids larger than 3 inch diameter in front face of wall (within 6" of the face) with smaller rock full height of the wall.

2. Setback from top back of wall to any structure at or above the top of wall should be greater than, or equal to the total wall height.

3. Setback from bottom face of wall to any structure should be greater than or equal to the above–ground wall height.

4. All fill material shall be compacted to a minimum relative compaction of 90% per ASTM D1557.

5. A fence should be considered along the top of the wall for safety.

6. The grading and drainage are to ensure no water flows over the proposed walls.

6 ft Above Ground
Wall B
No Surcharge

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Rockery Retaining Wall Design

Rabe Residence
2410 La Mancha Drive
Washoe County, Nevada

Date: 2-15-2023

File No: 2204.002-B

Figure 4

SOIL DATA

Soil Type: Silty Sand (SM)

H_w = Wall height from ground surface, ft.	6.0
H_e = Wall embedment below ground, ft.	2.0
ϕ = Angle of internal friction, ^{o}	30
γ = Unit weight of soil, pcf	120
C = Cohesion, psf	0
b = Base rock width, ft	3.5
d = Footing depth below undist. ground, ft	2.0
β = Angle of backfill slope, ^{o}	0.0

FOR β CALCULATION		
H (Run)		V (Rise)
0		1

ROCK DATA [1]

Absorption < 4.2%
Accelerated Expansion < 15% breakdown
Soundness < 5% loss
Unconfined Compressive Strength > 6000 psi
S.G.= 2.30 min 144 pcf

[1] ARC Rock Wall Construction Guidelines

BEARING CAPACITY FACTORS [2,3]

GENERAL	N_q	18.40
	N_c	30.14
	N_γ	22.40

$N_q = e^{\pi \tan\phi} \tan^2(45^o+\phi/2)$
$N_c = (N_q-1)\cot\phi$
$N_\gamma = 2(N_q+1)\tan\phi$

[2] Foundation Engineering Handbook, Winterkorn and Fang, 1975
[3] Soil Mechanics in Engineering Practice, Terzaghi and Peck, 1967

Active Pressure (Coulomb)

$(\cos^2\omega\cos(\delta+\omega))*((1+((\sin(\delta+\phi)\sin(\phi-\beta)/(\cos(\delta+\omega)\cos(\omega-\beta))^{0.5})^2$

Passive Pressure (Coulomb)

$((\csc\omega\sin(\omega+\phi)/(\sin(\omega+\delta))^{0.5}-(((\sin(\phi-\delta)\sin(\phi+\beta))/\sin(\omega-\beta))^{0.5}))^2$

Sliding

$f=\tan\phi$ (for irregular rock surface)

Bearing Capacity

$q_u = C(N_c)+\gamma b(N_\gamma/2)+\gamma d(N_q)$

ALLOWABLE SOIL BEARING CAPACITY, q_u	**3500** psf	(For S.F. of 3.0)
SLIDING COEFFICIENT, f	**0.45**	
ACTIVE PRESSURE, EQUIVALENT FLUID PRESSURE	**35.0** pcf	
PASSIVE PRESSURE, EQUIVALENT FLUID PRESSURE	**350.0** pcf	

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ROCKERY WALL DESIGN, H= 6.0 0.0 ^{o} UPSLOPE

2410 La Mancha Drive

Wall B

Washoe County, Nevada

DATE	5/10/2022
FILE NO.	2204.002-B
CALC. BY	BDC

ROCK SIZING

ROCK SIZE	USE	APPR. WT., lbs		APPR. DIA., in		AVG.	WALL
		FROM	TO	FROM	TO	DIA., in	HT., in
1		75	254	12	18		
2	1	254	955	18	28	23	23
3	1	955	2029	28	36	32	32
4	1	2029	4809	36	48	42	42
5		4809	6848	48	54		
6		6848	9393	54	60		

JURISDICTION	LIMITS
City of Reno	
Washoe County	x
City of Sparks	
Douglas County	
Storey County	

WALL COMPONENTS

DO ROCK SIZES MATCH WALL HEIGHT (H_e+H_w)? **YES**

DOES HEIGHT (H_e+H_w) MATCH JURISDICTION LIMITS? **YES**

BEARING PRESSURE **1146 psf**

S.F.$_{bearing}$ = 3.05 **>3.0, OK**

OVERTURNING MOMENT (RESISTING)

FOR BATTER CALC.		
H (Run)		V (Rise)
1		6

		W	r	Wr
TOP		no		0 ft-lbs
MID		no		0 ft-lbs
MID	2	1.92	604.13	1.72	1040 ft-lbs
MID	3	2.67	1491.8	1.78	2652 ft-lbs
BOTTOM	4	3.50	3419.2	1.75	5984 ft-lbs
		8.08	5515.1		9676 ft-lbs

OVERTURNING MOMENT (ACTIVE) **1313 ft-lbs**

S.F.$_{overturning}$ = 7.37 **>2.0, OK**

SLIDING

TOTAL WEIGHT/FT=	4013
RESISTING FORCE=	2506
ACTIVE FORCE=	1143

S.F.$_{sliding}$ = 2.19 **>1.5, OK**

To Improve Allowable Soil Bearing Capacity and/or Sliding Coefficient, use 6" Min. Thickness of Crushed Rock

ϕ = Angle of internal friction, ^{o}

GENERAL		
	N_q	0.00
	N_c	0.00
	N_γ	0.00

SLIDING COEFFICIENT, f RESISTING FORCE= **0.94**

ALLOWABLE SOIL BEARING CAPACITY, q_u **7910**

S.F. $_{sliding}$ =	
S.F. $_{bearing}$ =	

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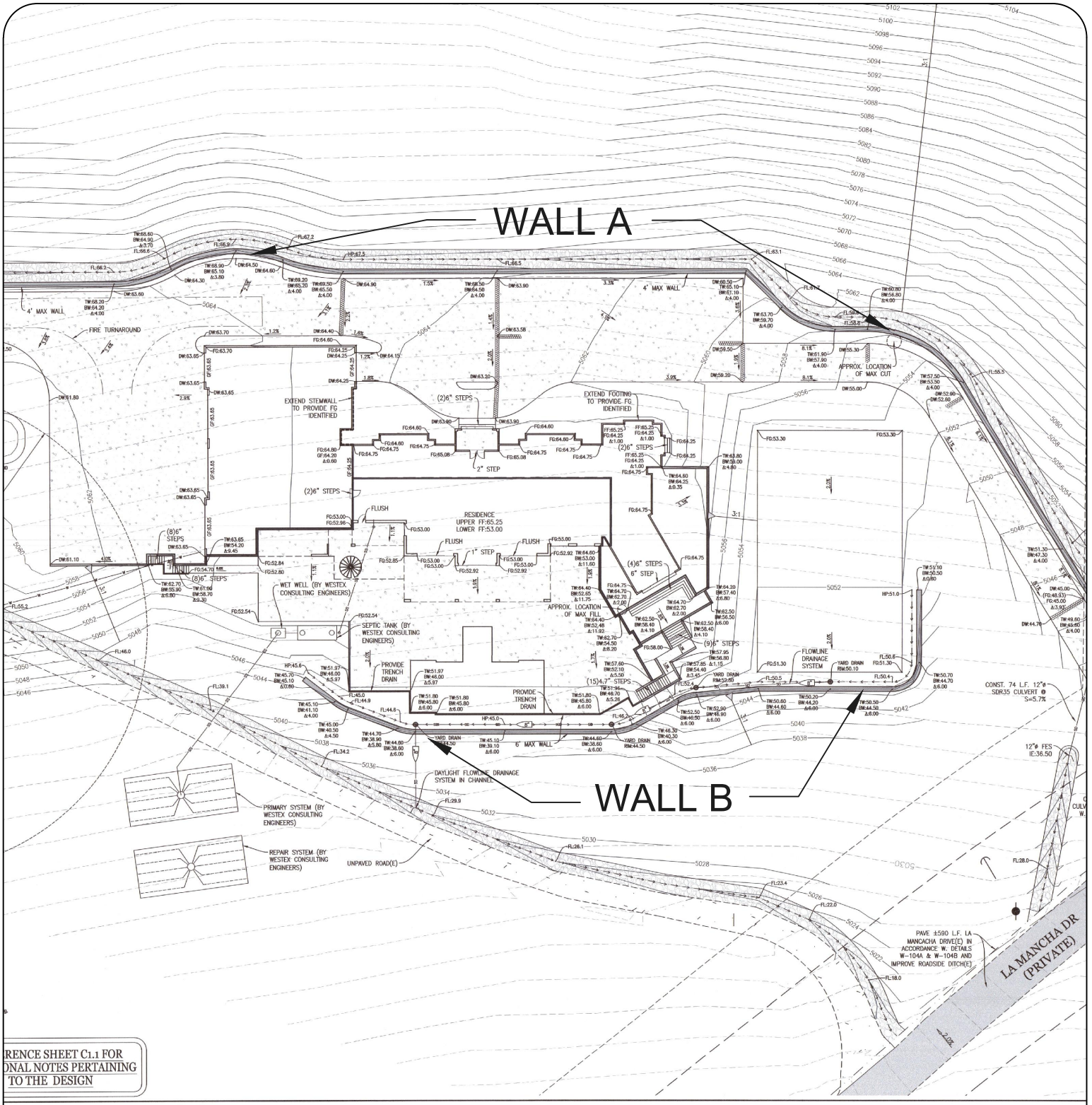
ROCKERY WALL DESIGN, H= 6.0 **0.0 ^{o} UPSLOPE**

2410 La Mancha Drive

Wall B

Washoe County, Nevada

DATE
2/15/2023
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CALC. BY
BDC



ROCKERY WALL LOCATIONS

Site Plan by Monte Vista Consulting dated 1/11/2023

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Plate 1