Cross Mine (M1977-410)
Technical Revision No. 9

Submitted by:

Grand Island Resources, LLC

Prepared for:

Colorado Division of Reclamation, Mining and Safety

May 6, 2021

COLORADO DIVISION OF RECLAMATION, MINING AND SAFETY
1313 Sherman Street, Room 215, Denver, Colorado 80203 ph(303) 866-3567

REQUEST FOR TECHNICAL REVISION (TR) COVER SHEET

File No.: M- 1977-410 Site Name: Cross Gold Mine

County Boulder TR# ____________ *(DRMS Use only)*

Permittee: Grand Island Resources, LLC

Operator (If Other than Permittee): ____________

Permittee Representative: Richard Mittasch

Please provide a brief description of the proposed revision:

The purpose of this TR is to address the stipulation in the Division's TR-7 approval letter dated December 3, 2020 (attached).

As defined by the Minerals Rules, a Technical Revision (TR) is: "a change in the permit or application which does not have more than a minor effect upon the approved or proposed Reclamation or Environmental Protection Plan." The Division is charged with determining if the revision as submitted meets this definition. If the Division determines that the proposed revision is beyond the scope of a TR, the Division may require the submittal of a permit amendment to make the required or desired changes to the permit.

The request for a TR is not considered "filed for review" until the appropriate fee is received by the Division (as listed below by permit type). Please submit the appropriate fee with your request to expedite the review process. After the TR is submitted with the appropriate fee, the Division will determine if it is approvable within 30 days. If the Division requires additional information to approve a TR, you will be notified of specific deficiencies that will need to be addressed. If at the end of the 30 day review period there are still outstanding deficiencies, the Division must deny the TR unless the permittee requests additional time, in writing, to provide the required information.

There is no pre-defined format for the submittal of a TR; however, it is up to the permittee to provide sufficient information to the Division to approve the TR request, including updated mining and reclamation plan maps that accurately depict the changes proposed in the requested TR.

Required Fees for Technical Revision by Permit Type - Please mark the correct fee and submit it with your request for a Technical Revision.

Permit Type	**Required TR Fee**	**Submitted** (mark only one)
110c, 111, 112 construction materials, and 112 quarries	$216	☐
112 hard rock (not DMO)	$175	☐
110d, 112d(1, 2 or 3)	$1006	☐

December 3, 2020

Richard Mittasch
Grand Island Resources LLC
4415 Caribou Rd
Nederland, CO 80466

RE: Cross Gold Mine, Permit No. M-1977-410, Technical Revision Approval, Revision No. TR-7

Mr. Mittasch:

On December 3, 2020, the Division of Reclamation, Mining and Safety (Division) approved the Technical Revision application (TR-7) submitted to the Division on May 7, 2020, addressing the following:

To present geotechnical stability analyses for the slopes adjacent to the Idaho Tunnel Portal

The Division's approval of TR-7 includes the following stipulation:

Stipulation No. 1:

1) Once the Idaho Tunnel has been sufficiently stabilized to allow the necessary information to be collected and analyzed, the operator shall submit a Technical Revision application that includes an updated engineering stability analysis which demonstrates the portal slope meets the stability requirements of the Mined Land Reclamation Board (as described in the Memorandum from Peter Hays, DRMS, dated May 27, 2020).

The terms of the Technical Revision No. 7 approved by the Division are hereby incorporated into Permit No. M-1977-410. All other conditions and requirements of Permit No. M-1977-410 remain in full force and effect.

Please be advised, the Division's approval of this revision does not authorize any surface disturbances to occur outside of the approved affected land boundary. To increase the affected area for the mine site, the operator must submit an Amendment application (for up to 9.9 acres) or a Conversion application (for 10 acres or more). These application forms can be downloaded from the Division's website at: https://www.colorado.gov/pacific/drms/minerals-program-forms.

If you have any questions, you may contact me by telephone at (303) 866-3567, ext. 8129, or by email at amy.eschberger@state.co.us.

Sincerely,

Amy Eschberger
Environmental Protection Specialist

Cc: Peter Hays, DRMS
Michael Cunningham, DRMS

Technical Memorandum

DATE:	3 May, 2021	**PROJECT:**	Cross Mine
ATTENTION:	Richard Mittasch	**COMPANY:**	Grand Island Resources, LLC
PREPARED BY:	Dave Hallman, PE, PG	**REVIEWED BY:**	RM

SUBJECT: Idaho Tunnel Portal – Slope Stability Analysis

1.0 INTRODUCTION

This Technical Memorandum has been prepared to present geotechnical stability analyses for the slopes adjacent to the Idaho Tunnel Portal in response to a stipulation presented in the TR-7 authorization from DRMS dated December 3, 2020 in conjunction with the Cross Mine, DRMS Permit No. M-1977-410. The Idaho Tunnel (at the Caribou Mine) was in a collapsed condition creating potential slope stability issues near the northern permit boundary and the adjacent Caribou Road. This is a concern pursuant to Rule 3.1.5(3) and C.R.S. 34-32-116(7)(h) which require areas outside of the affected land to be protected from slides or damage occurring during the mining operation and reclamation. In order to address this concern the portal slope has been stabilized, reinforced and will be backfilled to a final slope of 3H:1V below the county road for reclamation using waste rock.

As indicated in the authorization letter from DRMS, once the Idaho Tunnel was sufficiently stabilized to allow the necessary information to be collected and analyzed, the operator is required to submit updated engineering stability analysis which demonstrates the portal slope meets the stability requirements of the Mined Land Reclamation Board (as described in the Memorandum from Peter Hays, DRMS, dated May 27, 2020). This memorandum presents the required stability evaluation based on updated engineering data now that the tunnel has been adequately stabilized. The analyses were conducted by Mr. David Hallman, a geological engineer with 38 years of experience and licensed as Colorado Professional Engineer (Civil) 26076, as affirmed by the stamp and signature affixed at the end of this document.

1.1 BACKGROUND

1.1.1. Location

The Cross Mine site is located approximately 3 miles west of Nederland, Colorado adjacent to the Roosevelt National Forest, at an elevation of 9700 feet above mean sea level (MSL). The general location is parcels of land in Section 9, Township 1 South, Range 73 West of the 6 Principal Meridian, County of Boulder, State of Colorado. This is an existing hard rock mining operation owned by Grand Island Resources Inc. (GIR), although at present, no active mining is being conducted.

1.1.2. Idaho Tunnel

The Idaho Tunnel provides access to the Caribou Mine portion of the site. The timbered tunnel entrance and area around the opening were excavated in order to stabilize the historic tunnel portal. This effort involved excavating approximately 25 feet into the hillside, installing soil anchors, and applying a layer of fiber-reinforced shotcrete. The excavated slopes stood unsupported following excavation and were dry at the time. The maximum height at the taller left (south) wing wall excavation is 28 ft, sloping at an angle of 70-80 degrees from horizontal.

The top of the excavation is approximately 40 ft from County Road 128 (Caribou Road) at the closest point and 20 ft lower in elevation.

1.1.3. Portal Rehabilitation

Entrance to the Idaho Tunnel at the mine site was in such a state of neglect and disrepair from long-term gradual deterioration that it was not safe to enter and operate the mine water system per the approved permit. In particular, the timber ground supports at the portal were tilted dangerously askew and the ground slopes adjacent to the portal exhibited signs of shallow slope failures and sloughing.

In December 2019 a roof collapse occurred a short distance into the tunnel during initial rehabilitation efforts. The roof failure occurred in an 11-12 ft section of unsupported ground as the tunnel opening was being enlarged through a section of mixed soil and decomposed gneiss. The collapse completely blocked the mine opening, crushed the pipe carrying the flow of mine water, and daylighted in the slope below County Road 128 (Caribou Road), leaving a large remnant void above the tunnel opening.

As described in TR-7, the remaining void created by the portal collapse was backfilled with pervious cellular concrete to provide permanent ground support to stabilize the slope and allow drainage. The cellular concrete backfill is significantly stronger than the soil which originally comprised the slope while imposing only a fraction of the weight.

Placing the cellular concrete backfill within the initial collapse void was completed on May 19, 2020. This increased stability of the slope below the county road. Tunnel rehabilitation was resumed approximately a week later and additional sloughing into the tunnel occurred, daylighting in the slope immediately west of the previous backfill material. Additional cellular concrete backfill was placed and again more sloughing occurred when rehabilitation was resumed. This occurred repeatedly as tunnel rehabilitation advanced for each of the next four steel sets (16 ft). Additionally, high strength grout was used immediately above the tunnel crown in several areas, and riprap subsequently infilled with cellular concrete was used to backfill one of the larger voids. The end result is that 447 cubic yards of the disturbed ground overlying the old adit has now been replaced with substantially stronger cellular concrete, riprap and high strength grout, a significant amount. Table 1 provides a summary of the final quantity of each of these materials used.

Table 1 – Summary of Backfill Materials

Material Type	Quantity (yd^3)
Cellular concrete	299
Riprap	100
High Strength Grout	48

The flowable nature of the cellular concrete backfill allowed it to flowed forward within the ground disturbed above the historic tunnel opening. This served to encapsulate loose blocks of rock and previous ground supports in a solid mass to provide support during the remaining rehabilitation efforts.

1.2 Geology

The Idaho tunnel has been rehabilitated sufficiently to allow the geology to be examined up to and beyond the county road. GIR has explored the first 200 ft of the Idaho Tunnel in order to investigate the corresponding ground conditions. Starting at the portal the first 60 ft of tunnel consist of regolith and colluvial soils. Next is a 28 ft section of fractured and weathered blocky gneiss which extends beyond the county road.

Grouted threadbar drilled into the slope to further anchor the cellular concrete into the hillside encountered refusal of the jack-leg drill 15 to 20 ft into the hillside. This is interpreted as indicating the transition into relatively intact rock comprising the blocky gneiss unit.

The Caribou Road (County Road 126) above the Idaho tunnel is located entirely in mixed soil and rock colluvium and regolith materials. Fresh gneiss of the Idaho Springs formation is present a short distance above the road and to the south of the tunnel portal.

Figure 1 presents a schematic cross section of the tunnel and slope which depicts these conditions.

2.0 STABILITY ANALYSIS

2.1 Approach

The stability analyses were conducted using the RocScience SLIDE2 software, a 2D slope stability program for evaluating the safety factor or probability of failure, of circular and non-circular failure surfaces in soil or rock slopes. Slide2 analyzes the stability of slip surfaces using vertical slice or non-vertical slice limit equilibrium methods like Bishop, Janbu, Spencer, and Sarma, among others. Search methods can be applied to locate the critical slip surface for a given slope. The Bishop method of slices for circular failures surfaces while the Janbu method of slices for satisfying both moment and force equilibrium was adopted for non-circular surfaces.

SLIDE2 supports a comprehensive list of soil material models including Mohr-Coulomb, undrained, impenetrable, bilinear, strength as a function of depth, anisotropic strength, generalized shear-normal function, SHANSEP), and more. Typical rock material models supported by SLIDE2 include generalized Hoek-Brown (Hoek, et. al, 2018), Barton and Choubey (1977), and Miller (1988) can be handled by SLOPE/W using the generalized shear-normal function with or without an anisotropic modifier function. Analyses for the portal slope were performed using Mohr-Coulomb strength criteria for the soil materials, Hoek Brown (2018) for the regolith and block gneiss and a shear-normal strength function based on Leps (1970) for the waste rock.

2.2 Model Input

3.3.1. Slope Geometry

An idealized representative two-dimensional cross-section was considered for analysis. This section consisted of the profile along the axis of the tunnel included on Figure 1, consisting of a 28-ft high excavation at an angle of 75-degrees then natural ground sloping at approximately 40 ft to the edge of the 20-ft wide County Road. Starting below the road the slope will be backfilled to 3H:1V using compacted rock fill. A pair of Connex shipping containers and steel supports will be used to maintain the tunnel opening through the waste rock. A reinforced concrete retaining structure will be used to create a vertical face around the portal opening. The surface of the waste rock will be covered with growth media and revegetated. The previous nature of the cellular concrete, waste rock backfill and presence of the tunnel will allow groundwater to freely drain from the slope in order to ensure long-term stability.

3.3.2. Material Properties

The analyses incorporated conservative shear strength parameters for the colluvial soil material, regolith and blocky rock mass separately. Since the slope height is not great, the shear stresses will be low. For the low range of stresses present, equivalent linear Mohr-Coulomb shear strength parameters were assumed.

During excavation the regolith and colluvium was observed to stand near-vertical for up to 28 ft without ground support. The colluvium material consists of poorly-graded sandy gravel with cobbles, silt and clay (GP). For the purposes of the stability analysis this material was assigned a friction angle of 38 degrees and 500 psf (3.47 psi) cohesion with a moist unit weight of 125 pcf. Areas which contain a higher proportion of coarse rock fragments will exhibit higher shear strength, and the overall average strength is likely higher, however, if failure were to occur it will tend to pass through the weaker materials which offer less resistance.

In some areas the underlying bedrock is quite weathered and grades into fully decomposed regolith, while in other areas it more closely resembles fractured hard rock with little weathering present.

The regolith consists of decomposed gneiss which has been weathered and decomposed in situ, but has not been disturbed and retains the original rock fabric. The feldspar minerals have been largely altered to clay and can be readily excavated using the pick point of a geologic hammer. Portions of the rock which contain a high percentage of quartz require one or more blows of a rock hammer to fracture, but exhibit a high degree of jointing. The regolith material represents a weak rock mass for which the Hoek-Brown criterion[1] was used to estimate the average rock mass strength across this material based on a large body of empirical data. Conservative rock mass parameters adopted for Decomposed Gneiss:

Intact Rock UCS = 1000 -2000 ksf (7,000 – 14,000 psi)
GSI = 15 (Disintegrated with highly weathered surfaces with soft clay coatings or infilling)
mi = 25
D = 0

The fractured and weathered blocky gneiss represents highly fractured rock with some weathering and is quite variable. Conservative rock mass parameters adopted for the Blocky Gneiss:

Intact Rock UCS = 1000 -2000 ksf (7,000 – 14,000 psi)

[1] E.Hoek and E.T.Brown, 2018; "The Hoek–Brown Failure Criterion and GSI – 2018 Edition." Journal of Rock Mechanics and Geotechnical Engineering, Volume 11, Issue 3, June 2019, Pages 445-463

GSI = 45 (Blocky/Disturbed/Seamy with rough, slightly weathered, iron stained surfaces -or- Very Blocky with smooth, moderately weathered and altered surfaces)
mi = 25
D = 0

The cellular concrete void fill is much stronger than the soil and regolith material it replaces. Laboratory testing results on test cylinders cast during the pours exhibited an average 28-day strength of 109 psi. This material was modeled with a unit weight of 35 pcf and shear strength of 50 psi. Riprap which was infilled with cellular concrete was modeled as cellular concrete.

Since the precise source for the waste rock is unknown, the material properties adopted for the waste rock fill material were conservatively modeled using the lower bound shear strength envelop presented by Leps (1970)[2] for rock fill composed non-compacted, weak or poorly graded particles. The Leps approach models the variance in material strengths relative to varying confining pressures and the degree of particle interlocking or crushing that results. Table 1 presents the shear-normal parameters used for the waste rock fill.

Table 1 – Shear Strength of Waste Rock Fill

Normal Stress (psf)	Shear Stress (psf)
144	205
288	376
720	858
1441	1600
2880	3035
7201	6834
14405	12744
28807	23747

3.3.3. Ground Support Elements

Due to their relatively short length and irregular pattern of placement, the soil anchors were neglected in the analyses. The shotcrete will have little overall effect on global stability of the slope and was also neglected in the analyses for conservatism. The primary purpose of the shotcrete is to control shallow surface sloughing and raveling.

3.3.4. Idaho Tunnel

Due to the ground support elements that will be employed and its small size relative to the scale of the slope, the tunnel opening was not included in the stability section. Spillings installed above the top of the tunnel opening will become integrated with the cellular concrete void fill to help stabilize the opening and face of the excavation below the County Road.

[2] Leps, T.M., 1970; "Review of Shearing Strength of Rock Fill" ASCE Journal of the Soil Mechanics and Foundations Division, Vol. 96, No. SM4, July, pp 1159 – 1170.

3.3.5. Groundwater Conditions

The slope was modeled as drained, without groundwater to reflect drainage provided by the pervious cellular concrete, the Idaho Tunnel and coarse rock fill placed to reconfigure the slope.

3.0 ANALYSIS RESULTS

The minimum FoS for a failure surface which intersects the County Road was found to be 3.6. Figure 2 presents a summary of these stability analysis results and includes the critical failure surface. These analyses demonstrate that the lower FoS failure surfaces pass entirely through the colluvium and waste rock fill materials due to the slope geometry. The cellular concrete beneath the slope prevents deep seated instability.

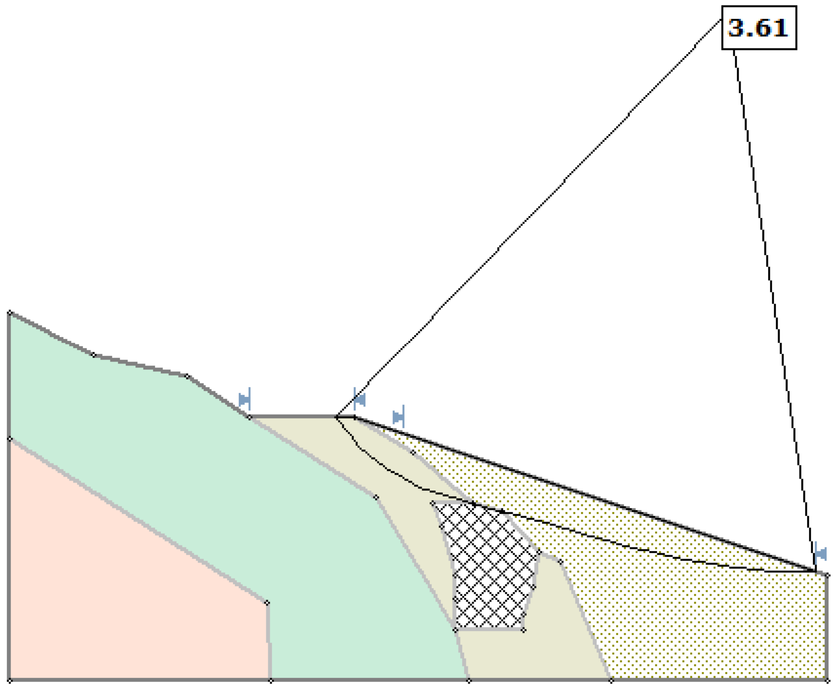


Figure 2 – Stability Analysis Summary

4.0 CONCLUSIONS

Where there is the potential for off-site impacts due to failure of any geologic structure or constructed earthen facility, which may be caused by mining or reclamation activities, the Operator is required to demonstrate through appropriate geotechnical and stability analyses that off-site areas will be protected with appropriate factors of safety incorporated into the analysis. For geotechnical stability of the Country Road a required minimum FoS is not defined by the current Boulder County Multimodal Transportation Standards[3]. In accordance with the Recommended Minimum Factors of Safety for Slope Stability Analyses for Operations and Reclamation within Section 30.4 of the Policies of the Mined Land Reclamation Board

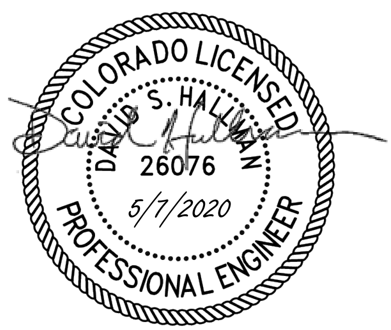
[3] https://assets.bouldercounty.org/wp-content/uploads/2017/02/multi-modal-standards.pdf

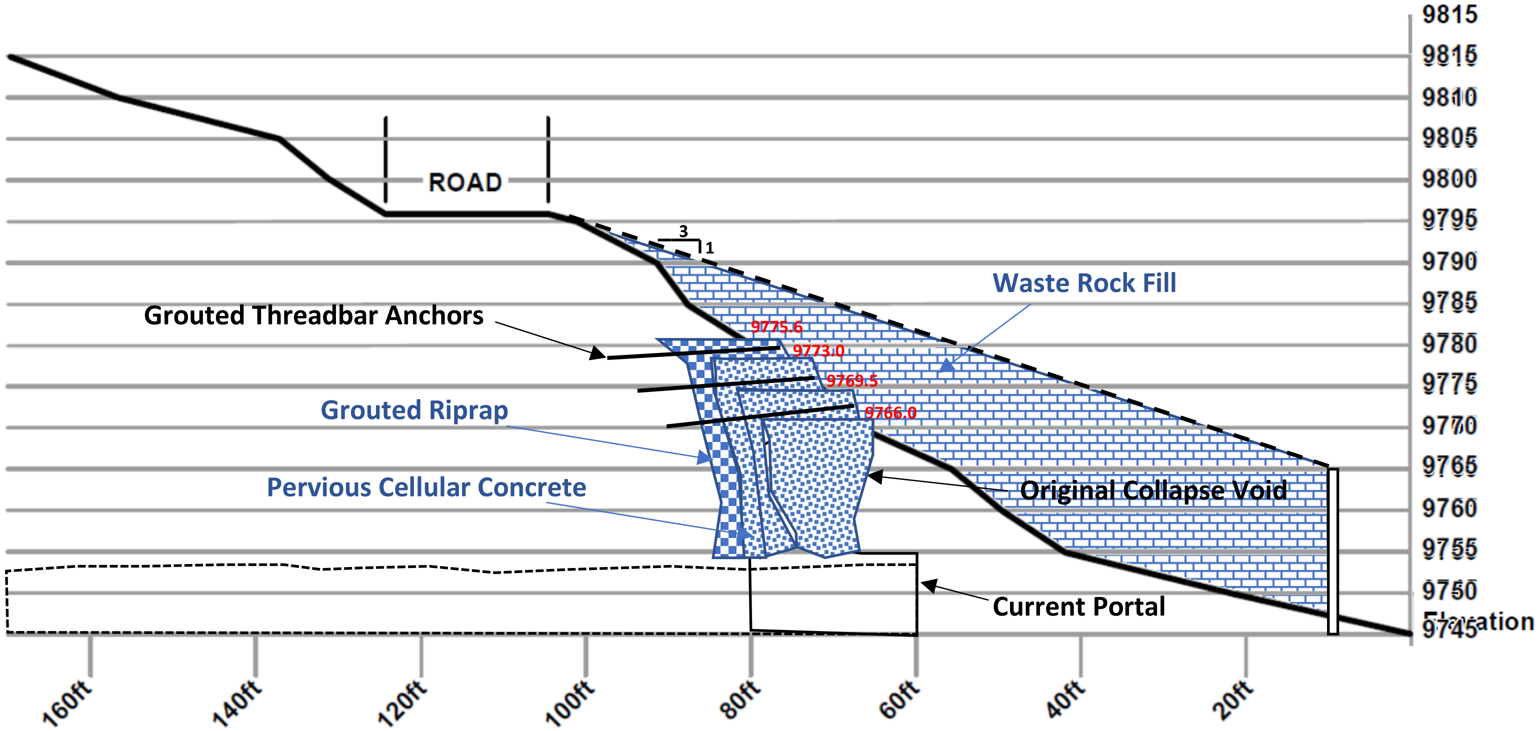
(MLRB), effective May 16, 2018, the Division requires the Operator to comply with a minimum factor of safety (FOS) of 1.5 for critical structures (roads) in static conditions since the Operator utilized limited engineering data in the current analysis. With a calculated minimum FoS of 3.6 using conservative input parameters the results of the analyses are sufficient to demonstrate that the slope meets the Division criteria for long-term static loading conditions.

Spillings and soil anchors installed through the cellular concrete void fill serve to underpin the portion of the slope directly above the Idaho Tunnel and below the County Road, although these anchors were neglected in the analyses. Permanent tunnel lining ground support installed as the tunnel is rehabilitated will ensure that stability of the tunnel itself does not impact the road.

This study updates previous analyses based on additional data such as the as-built slope geometry. Due to the difficulty of trying to accurately characterize the highly variable geologic conditions within the slope due to weathering of the gneiss bedrock, rather conservative material properties were adopted. For the final 3H:1V slope configuration the critical least factor of safety failure surfaces lie entirely within the waste rock fill and the strength of the underlying soil and regolith make little difference in the analyses.

Stability analysis of the Idaho Tunnel portal slopes was conducted by Mr. David S. Hallman, licensed as Colorado Professional Engineer (Civil) 26076, as affirmed by the stamp and signature affixed below.





ROAD
3
1
Waste Rock Fill
Grouted Threadbar Anchors
9775.6
9773.0
9769.5
9766.0
Grouted Riprap
Pervious Cellular Concrete
Original Collapse Void
Current Portal
9815
9815
9810
9805
9800
9795
9790
9785
9780
9775
9770
9765
9760
9755
9750
Elevation
9745
160ft
140ft
120ft
100ft
80ft
60ft
40ft
20ft