EXHIBIT IV.11

LYMAN HENN INC

MEMORANDUM

FROM: Kent Pease, P.E.

TO: File

DATE: January 22, 2008

SUBJECT: Parkdale Quarry Slope Stability Summary

This memorandum summarizes results of slope stability evaluations and calculations for the proposed granite quarry of Front Range Aggregate's Parkdale Quarry. Calculations by Lyman Henn evaluated the stability of rock slopes and the stability of fill placed on individual benches as part of mine reclamation. Calculation sets for both these evaluations are attached. A summary of Lyman Henn recommended approach to slope stability, is included in our report presenting the maximum build out configurations for the proposed mine and intermediate phases.

Rock Slopes

The rock slopes were evaluated based the kinematic stability of rock blocks, slabs, and wedges defined by the rock joint patterns. Evaluation of rock mapping data by Lyman Henn and J A Cesare shows that the most prevalent joints are vertical to sub-vertical in two to three sets. Additionally, several sets of random joints at different strike orientations and dip angles were noted to be present. Most of the joints were determined to be fresh to slightly weathered, and moderately rough to stepped. With these characteristics, the joints were determined to have a friction angle of between 39 and 50 degrees.

For the vertical and sub-vertical jointing, there is the potential for toppling and sliding of slivers, but these are expected to be limited to individual benches and highwalls. Large scale instabilities involving multiple benches and the overall quarry slopes are not expected as a result of these joints.

For the non-vertical random jointing, there is the potential for sliding of blocks, slabs, and wedges in situations where the potential slide angle is steeper than the joint friction angle. This condition is not likely in the upper portion of the quarry, above elevation 5800 where the quarry walls are inclined at a dip angle of 39 degrees; which is the lower bound of the likely joint friction angle. For the lower portion of the quarry, below elevation 5800 the quarry walls are steeper, with a dip angle of 51 degrees and rock instabilities are kinematically possible. However, for a slide to occur, the joint would have to be relatively continuous and connected to other release joints to isolate a free block or wedge. Because these joints are random, it is not expected that these conditions would be persistent throughout the quarry. As such, there could be isolated areas of slope instability, but it is not expected that the random joints would result in slope instabilities on a large scale that would cause persistent problems.

For any rock mass there is the possibility of large scale random joints with a low strength such as from historic sliding, weathering, or clay infilling. If such a joint or several joints exist and if these joints

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MEMORANDUM

have a disadvantageous orientation and location, then there could be a large scale slope instability. However, field observations by Lyman Henn and by J A Cesare did not reveal any such joints. Based on current information there is no reason to believe that there would be a high risk for such events.

As verification of these slope stability evaluations, an Observational Approach will be used to develop the quarry. Using this approach, a small area of the mine in the first phase and away from the limit of mining will be excavated first and used to observe actual ground conditions and rock slope behavior. Providing that observed conditions are consistent with the basis of these slope stability evaluations and that the rock slopes do not show unexpected behavior, the mine will be developed to the maximum extents as proposed in the mine plan. Additionally, with the upper portion of the mine at a more gentle slope inclination than the lower portion of the mine, a similar reassessment of the rock slope stability can be made and appropriate changes to the rock slopes made when the mine is extended below elevation 5800.

Soil Backfill Slopes

Soil will be placed on benches as part of mine reclamation. This soil is expected to be overburden removed from above mineable rock, weathered rock, and unsaleable rock and fines as a byproduct rock processing. It is further expected that this soil would receive a low to moderate degree of compaction, except for weathered and waste rock containing large particles which is impractical to compact. These soils are all granular with angular to sub-angular particles and no more than approximately 25 percent fines (material finer than the number 200 sieve).

Soil slope stability calculations are based on a purely frictional analysis neglecting cohesion, which is a conservative assumption. Soil friction angles were estimated from correlations based on soil type and density. A safety factor of 1.1 was chosen by Lyman Henn to be the design criteria. Based on these analyses, it calculated that fill derived from overburden and unsaleable material cold be placed on slopes of 1.75H to 1V or flatter, and that weathered rock could be placed on slopes of 1.5H to 1V or flatter. With a high level of compaction and with laboratory testing to verify the soil strength, it is expected that any of these materials could be meet the design safety factor on a slope with an inclination of 1.5H to 1V.

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Subject	Rock Slope Stability	Checked By	8D

I <u>General</u> Rock slope stability will be approached using an observational approach. With this method initial data are used to obtain an estimation or base case for likeley stable slopes. Quarry development will then proceed starting with a trial phase in which the actual stability of the slopes will be observed. Results of these observations will be used to confirm or adjust the original design as needed. This approach is being used because it is very difficult to determine the strength of rock joints on a scale appropriate for a quarry. Joint testing is not practical at this scale, and estimations have a high uncertainty.

II <u>Basis</u> Calculations based on the kinematic stability of rock blocks, slabs and wedges. Evaluations are only for the stability of a large mass of rock involving more than 1 or 2 benches/highwalls. It is understood and expected that there will be some rock blocks dislocating from the outside edges of individual benches.

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Checked By	SD

Client: Front Range Agg

Project: Parkdale Quarry

Subject:

III <u>Rock Mass Properties</u> Rock mass properties are based on joint orientations and joint shear strength. Although the strength of the parent rock material could be a factor, it controls behavior only for weak rock, and the granite in the quarry is considered medium to strong rock.

Joint Orientations There are two sources of joint data: Information in the JA Cesare report and data collected by Lyman Henn.

1.) JA Cesare: A plot of the data (attached) indicates that there are the following four family of joints. All numbers approx averages

Set	Dip Vector (Azim)	Plane Strike	Dip Angle (deg)
1	315°	N 45° E	Near Vert
2	35°	N 55° W	Near Vert
3	40°	N 50° W	67° NE
4	228°	N 42° W	49° SW

Note that almost all joints were recorded to range betw mod rough to stepped, and the side walls as mod hard or better, and mod weathered or better. Three of the 26 were noted to have clay on the joint surface.

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2) Lyman Henn: From stereonet plot (attached) four families of joints were noted

Set	Normals to planes		Planes		
	Azim	Dip	Azim	Dip	
1	323	61	N53°E	29° SE	
2	141	4	N51° E	86°	Major Set
3	29	9	N61° W	81°	
4	242	4	N28°W	86°	Major Set

Joints were noted to be planar to stepped, moderately rough to rough, and fresh to slightly weathered.

3) Compilation of data from both sources. The main joint sets are near vertical, with three other joint sets dipping at between 29° and 61°. Visual observations (not recorded) of rock outcrops with several miles of the site reveals a majority of the joints as vertical, often in 2 sets perpend. to each other, with occasional joints at different orientations.

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	Checked By [illegible]

In general the joints were noted to be relatively rough or stepped with moderate to no weathering. A few weathered joints and joints with clay were observed.

IV Highwall Stability

1) With the major joint sets being near vertical it is expected that vertical highwalls will have good performance. The two failure modes associated with the vertical joints are toppling and sliver sliding

Toppling: slabs and columns may topple where a joint is near to the free face. This will be especially prevalent where the joints dip into the face rather than being vertical or having an outward dip

Sliver sliding: where the joints dip slightly out of a vertical face the wedge of rock will slide out. It is also possible that the thin toe of these wedges could fail (crush) allowing the remainder of the wedge to slide out

Assessment: Both of these failure modes result in localized problems limited to individual benches. There are not expected

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the behaviors associated with the vertical joints alone which would result in instability of the mine on a large scale beyond individual benches.

2) Three non-vertical joint sets were observed having strikes of N 42° W, N 50° W and N 53° E, and dips between 29° and 67°. Additionally the core photos show joints diagonal to the core, but these are not oriented. Whether or not these joints result in instabilities depends on continuity, the dip, joint strength, and highwall/bench geometry.

A) Continuit: not known. Non-vertical joints were observed with a range of lengths varying from 10 feet to over 100 feet. Longer joints may be present but not exposed.

B) Dip: Variable. Observed joints at 29° to 67° but other joint orientations and dips could be present.

C.) Joint strength. Joint shear strength can be estimated from the parent rock mat'l and joint character. The base friction angle for granite is between 29° & 35° (Putnam 1981) This is applicable for joints without significant alteration or weathering, and is characteristic of most of the joints observed at the site. Additionally to account for joint roughness and geometry this angle is increased. Using Barton, 1978 a Joint Roughness Coef (JRC) of 8 to 12 is estimated, corresponding to an asperity (dilation) angle of 10° to 15°. Although there are many angles and scales for angles and roughness this analysis uses one standard deviation of the dilation angle from a flat plane as the effective dilation angle (Williams, 1980). Therefore, the total friction angle may range from 39° to 50°

D) Sliding along the non vertical joint sets will depend on the geometry and steepness of mine slopes relative to the dip of joints and wedges formed by intersecting joints.

- For the upper part of the quarry, the slope is defined by 50' benches and 40' highwalls; an inclination (dip) of 39° from horizontal. Note that the joint friction angle is estimated to be between 39° and 50°. Therefore, any joint that is steep enough to slide would be steeper than the overall quarry slope and would plunge into the ground. Although individual benches could be affected, no large scale slope instabilities are expected for these conditions.

- For the lower part of the quarry, the slope is defined by 40' benches and 50' highwalls; an inclination (dip) of 51° from horizontal. For this condition it may be kinematically possible for joint controlled slabs, blocks, and wedges to slide. Whether or not a slide actually occurs will depend on the actual joint friction angle, joint dip, continuity of the joint, and presence of sympathetic joints to isolate a rock mass. It is not practical to evaluate these variables with a reasonable exploration program. Therefore, an observational approach is used to evaluate the rock mass characteristics during early mining phases. Results of

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these evaluations will then be used to evaluate likeley stability for the final mining phase where steeper mine slopes are proposed.

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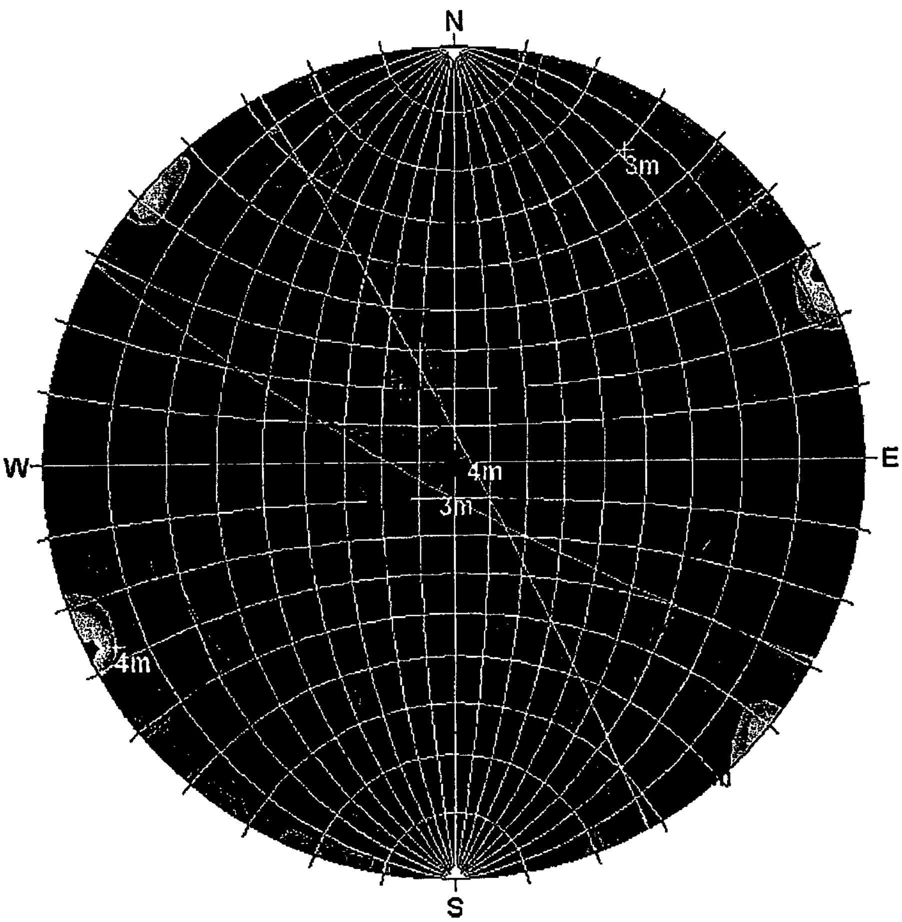
Appendix A

Joint Data

Lyman Henn Data

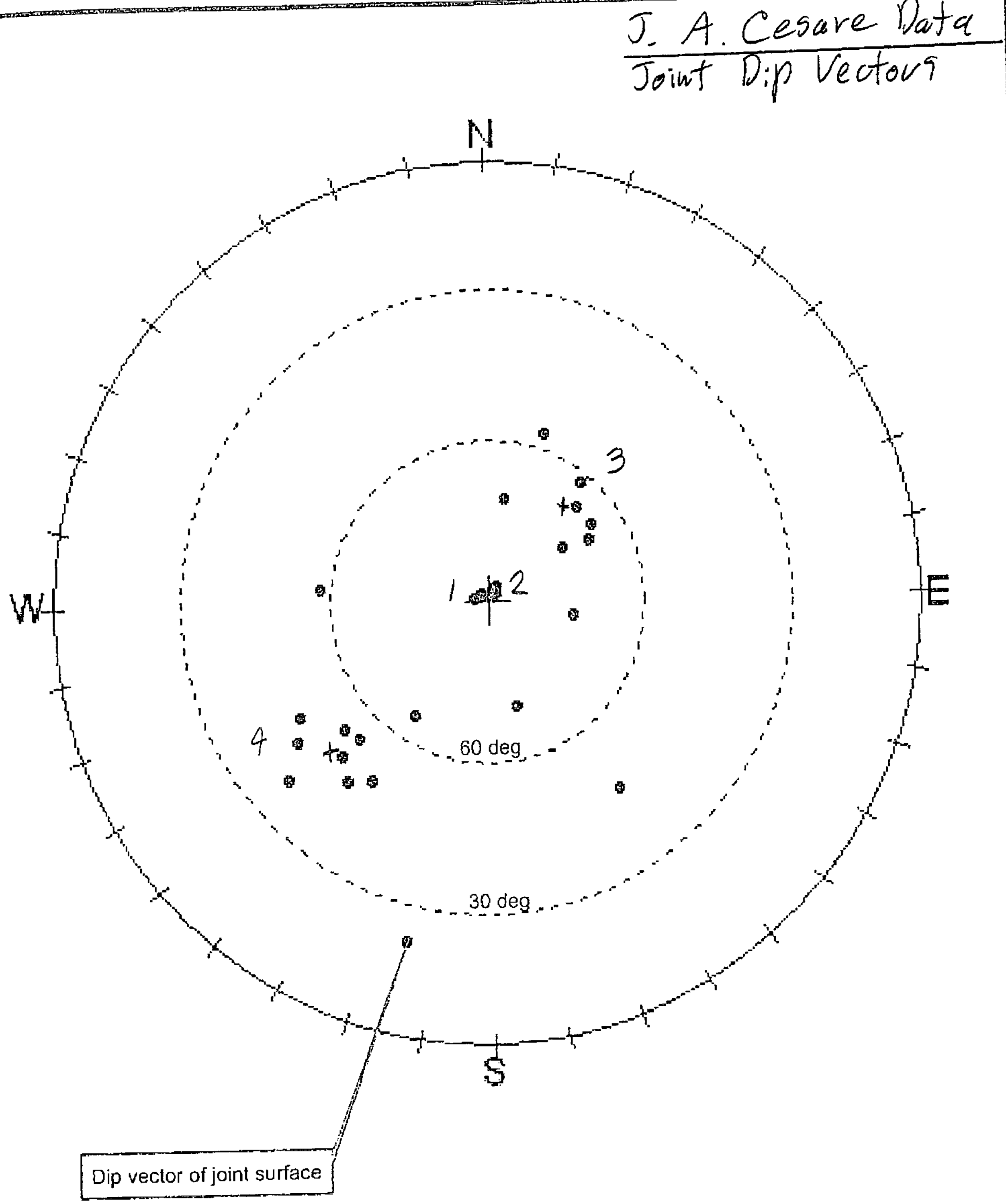
Vectors perpendicular to joints and joint planes



Orientations

ID		Trend / Plunge
1	m	323 / 61
2	m	141 / 04
3	m	029 / 09
4	m	242 / 04

Equal Angle
Lower Hemisphere
48 Poles
48 Entries



JA CESARE

Geotechnical Engineering Consultants

FIGURE 1- APPENDIX I
STEREOGRAPHIC PLOT OF JOINT DIP VECTORS FROM GRANITE QUARRY
PARKDALE PROJECT
PROJECT D04.033

DISCONTINUITY LOG

Project PARKDALE D04.033	Company J. A. CESARE & ASSOCIATES	Date: 2-22-04 Sheet _1_ of _2_
		Geologist: FWL
Feature Joint Survey	Location Granite quarry	Assisted by:
		Units: English

Traverse	Northing	Easting	Elevation	Trend	Plunge		Traverse Length				# of Observ			
	Set										26			
Number	Distance	Lithology	Dip Azimuth	Dip	Stru	Cont	End	Roug	Mois	Hard	Wea	Open	Thk	Heal	Notes and Comments
1		Granite	100	74	Jt	2	1	3	2	4	5	2	0	3	
2		Granite	60	68	Jt	1	2	1	2	4	5	2	0	3	
3	1	Granite	355	89	Jt	3	2	3	2	4	5	2	2	3	Clay on joint surface
4	1	Granite	280	87	Jt	2	1	1	2	3	4	1	0	3	
5		Granite	45	66	Jt	3	2	2	2	4	4	1	0	3	
6		Granite	275	58	Jt	2	1	1	2	4	4	1	0	3	
7	2	Granite	40	88	Jt	3	1	2	2	3	4	1	0	3	
8		Granite	165	70	Jt	2	1	3	2	4	5	2	2	3	Clay on joint surface
9	2	Granite	30	87	Jt	3	2	2	2	4	4	1	0	3	
10		Granite	10	71	Jt	2	1	2	2	4	4	1	0	3	
11		Granite	20	57	Jt	2	1	1	2	4	5	1	0	3	
12		Granite	230	54	Jt	3	1	2	2	4	4	1	0	3	
13		Granite	240	48	Jt	3	2	2	2	4	4	1	0	3	
14		Granite	235	45	Jt	3	1	2	2	4	4	1	0	3	
15	1	Granite	310	88	Jt	2	1	4	2	4	4	1	0	3	Clay on joint surface
16		Granite	215	65	Jt	2	1	3	2	4	4	1	0	3	
17		Granite	225	50	Jt	2	1	3	2	4	4	1	0	3	
18		Granite	225	55	Jt	3	1	3	2	3	4	1	0	3	
19		Granite	220	47	Jt	2	1	3	2	2	3	1	0	3	
20		Granite	40	62	Jt	1	0	2	2	2	2	1	0	3	

Structure: Bd-Bedding, Bx-Breccia, Cl-Cleavage, Co-Contact, Fl-Fault, Fo-Foliation, Jt-Joint, Sh-Shear

Roughness: R1 - Stepped, R2 - Rough, R3 - Mod Rough, R4 - Sl rough, R5 - Smooth, R6 - Polished

Wall Hardness: H1-Extremely hard, H2-Very hard, H3-Hard, H4- Moderately hard, H5- Moderately soft, H6-Soft, H7-Very soft

Openness: O0-Tight, O1 - <1 mm, O2 - 1-3 mm, O3 - 3-10 mm, O4 - 10-30 mm, O5 - > 30 mm

Thickness: T0 - None, T1 - < 1 mm, T2 - 1-3 mm, T3 - 3-10 mm, T4 - 10-30 mm, T5 - > 30 mm

Continuity: C1 - < 1 m, C2 - 1-3 m, C3 - 3-10 m, C4 - 10-30 m, C5 - > 30 m

Moisture: M1-Dry, not possible, M2-Dry, no evidence, M3-Dry, some evidence, M4-Damp, no free water, M5-Wet, some drops, M6-Cont flow, low press, M7-Cont flow, hi press

Wall Weathering: W1-Fresh, W2-Sl weathered to fresh, W3-Slightly weathered, W4-Mod to sl weathered, W5-Moderately weathered, W6-Int to mod weathered, W7-Intensely weathered, W8-Very int weathered, W9-Decomposed

Ends: E0-None visible, E1-One visible, E2-Both visible

Healing: HL0 - completely, to strength of wall rock, HL1 > 50%, or weaker than wall rock, HL2 < 50%, HL3 - No induration

DISCONTINUITY LOG

Project	Company	Date: 2-22-04 Sheet _2_ of _2_
PARKDALE D04.033	J. A. CESARE & ASSOCIATES	Geologist: FWL
Feature	Location	Assisted by:
Joint Survey	Granite quarry	Units: English

Traverse	Northing	Easting	Elevation	Trend	Plunge		Traverse Length				# of Observ			
											26			
Number	**Distance**	**Lithology**	**Dip Azimuth**	**Dip**	**Stru**	**Cont**	**End**	**Roug**	**Mois**	**Hard**	**Wea**	**Open**	**Thk**	**Heal**
21		Granite	55	66	Jt	3	1	2	2	4	4	2	0	3
22		Granite	230	39	Jt	3	1	2	2	4	5	2	0	3
23		Granite	215	50	Jt	2	1	2	2	5	5	2	0	3
24		Granite	55	73	Jt	2	1	3	2	4	4	2	0	3
25		Granite	195	22	Jt	2	1	3	2	3	3	2	0	3
26		Granite	145	47	Jt	2	1	3	2	3	3	2	0	3

Notes and Comments

Structure: Bd-Bedding, Bx-Breccia, Cl-Cleavage, Co-Contact, Fl-Fault, Fo-Foliation, Jt-Joint, Sh-Shear

Roughness: R1 - Stepped, R2 - Rough, R3 - Mod Rough, R4 - Sl rough, R5 - Smooth, R6 - Polished

Wall Hardness: H1-Extremely hard, H2-Very hard, H3-Hard, H4- Moderately hard, H5- Moderately soft, H6-Soft, H7-Very soft

Openness: O0-Tight, O1 - <1 mm, O2 - 1-3 mm, O3 - 3-10 mm, O4 - 10-30 mm, O5 - > 30 mm

Thickness: T0 - None, T1 - < 1 mm, T2 - 1-3 mm, T3 - 3-10 mm, T4 - 10-30 mm, T5 - > 30 mm

Continuity: C1 - < 1 m, C2 - 1-3 m, C3 - 3-10 m, C4 - 10-30 m, C5 - > 30 m

Moisture: M1-Dry, not possible, M2-Dry, no evidence, M3-Dry, some evidence, M4-Damp, no free water, M5-Wet, some drops, M6-Cont flow, low press, M7-Cont flow, hi press

Wall Weathering: W1-Fresh, W2-Sl weathered to fresh, W3-Slighly weathered, W4-Mod to sl weathered, W5-Moderately weathered, W6-Int to mod weathered, W7-Intensely weathered, W8-Very int weathered, W9-Decomposed

Ends: E0-None visible, E1-One visible, E2-Both visible

Healing: HL0 - completely, to strength of wall rock, HL1 > 50%, or weaker than wall rock, HL2 < 50%, HL3 - No induration

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Client	Front Range Agg	Date	7/19/07
Project	Parkdale Quarry	Computed By	K. Pease
Subject	Rock Slope Stability	Checked By	

Appendix B

References

CAL02AFH.FRP 20 November 1997

JA CESARE
AND ASSOCIATES, INC.
Geotechnical Engineering Consultants

1060 52-000
12 10

AGGREGATE RESOURCE INVESTIGATION
Parkdale Project
Fremont County, Colorado

Project No. D04.033

Report Prepared for:

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Prepared by:

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FRED W. LIMBACH
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4/27/04
PROFESSIONAL ENGINEER

Fred W. Limbach, P.E.

Reviewed by:

Darin R. Duran, P.E.

April 27, 2004

DISCONTINUITY LOG

Project	Company	Date: 2-22-04	Sheet _1_ of _2_
PARKDALE D04.033	J. A. CESARE & ASSOCIATES	Geologist: FWL	
Feature	**Location**	Assisted by:	
Joint Survey	Granite quarry	Units: English	

Traverse	Northing	Easting	Elevation	Trend	Plunge			Traverse Length				# of Observ			
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Bd-Bedding
Bx-Breccia
Cl-Cleavage
Co-Contact
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Jt-Joint
Sh-Shear

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C1 - < 1 m
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C3 - 3-10 m
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C5 - > 30 m

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R1 - Stepped
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DISCONTINUITY LOG

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H1-Extremely hard
H2-Very hard
H3-Hard
H4- Moderately hard
H5- Moderately soft
H6-Soft
H7-Very soft

Wall Weathering
W1-Fresh
W2-Sl weathered to fresh
W3-Slighly weathered
W4-Mod to sl weathered
W5-Moderately weathered
W6-Int to mod weathered
W7-Intensely weathered
W8-Very int weathered
W9-Decomposed

Openness
O0-Tight
O1 - <1 mm
O2 - 1-3 mm
O3 - 3-10 mm
O4 - 10-30 mm
O5 - > 30 mm

Thickness
T0 - None
T1 - < 1 mm
T2 - 1-3 mm
T3 - 3-10 mm
T4 - 10-30 mm
T5 - > 30 mm

Healing
HL0 - completely, to strength of wall rock
HL1 > 50%, or weaker than wall rock
HL2 < 50%
HL3 - No induration

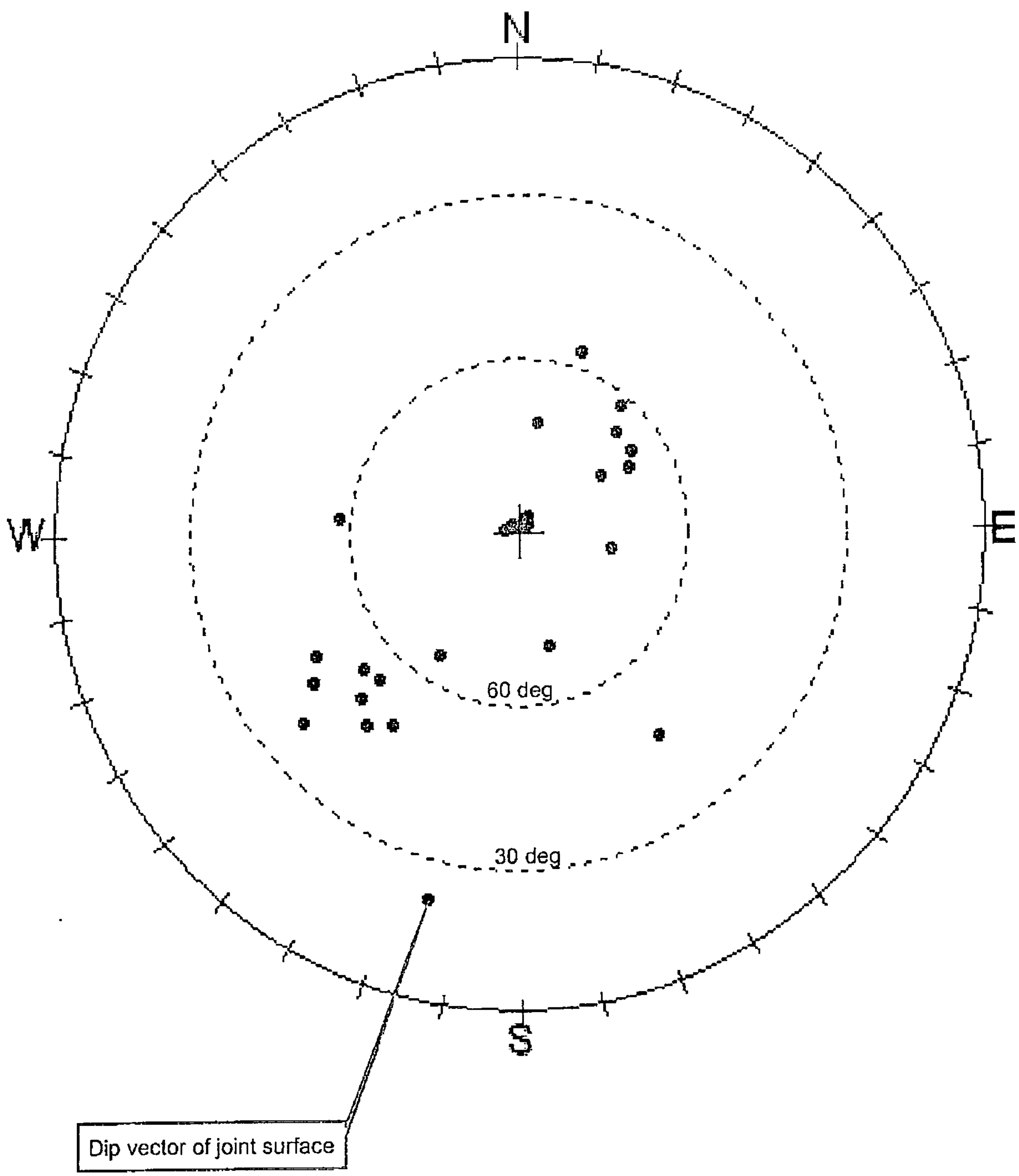

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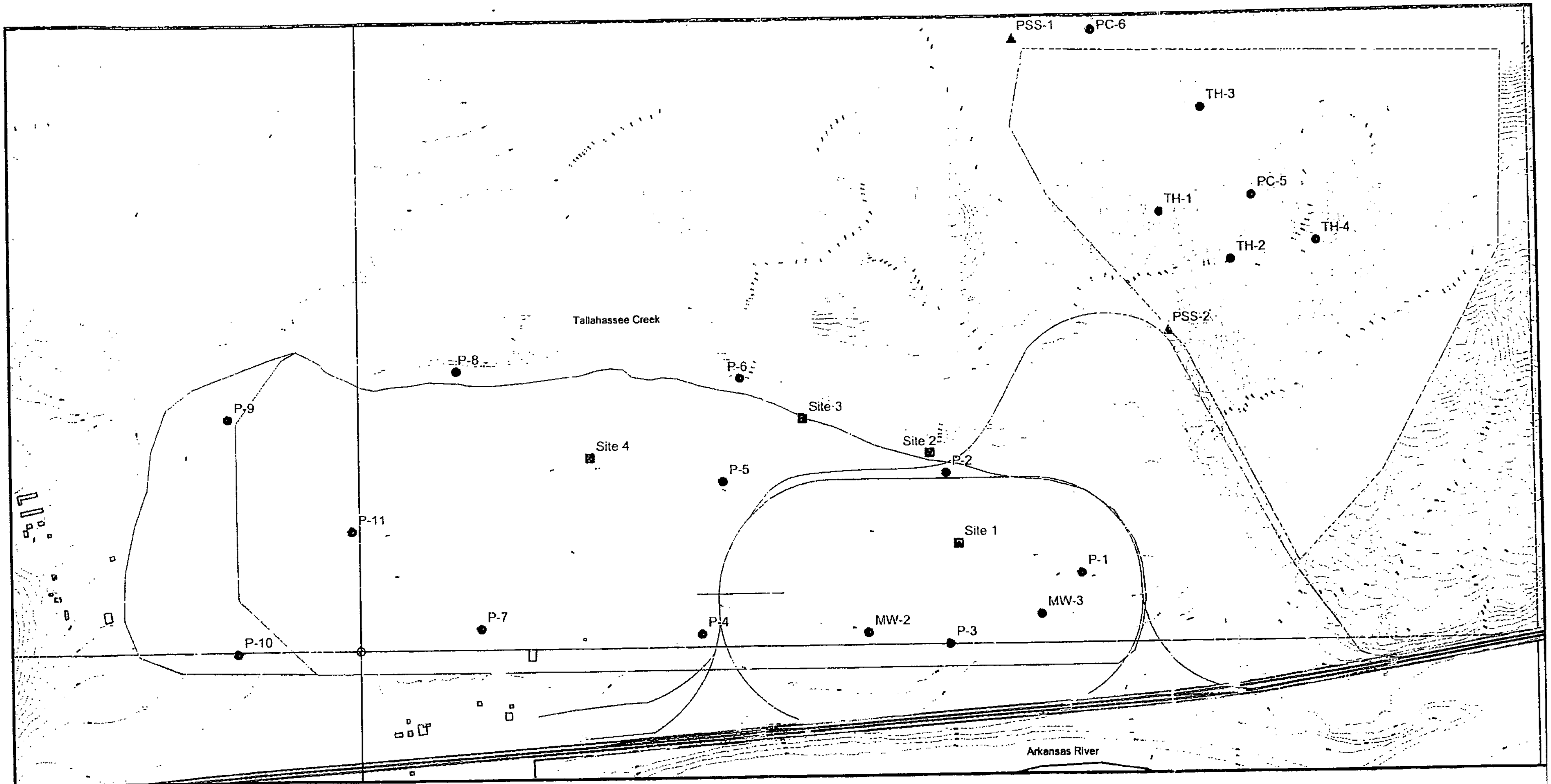
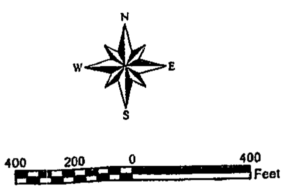
FIGURE 1- APPENDIX I
STEREOGRAPHIC PLOT OF JOINT DIP VECTORS FROM GRANITE QUARRY
PARKDALE PROJECT
PROJECT D04.033



Topographic base from AutoCad file received from Wiley Consulting, LLC, 2004
10-foot contour interval shown



EXPLANATION

- Drill Hole Location
- Stockpile Sample
- Surface Outcrop Sample
- Main Gravel Pit Outline
- West Gravel Pit Outline
- Quarry Outline

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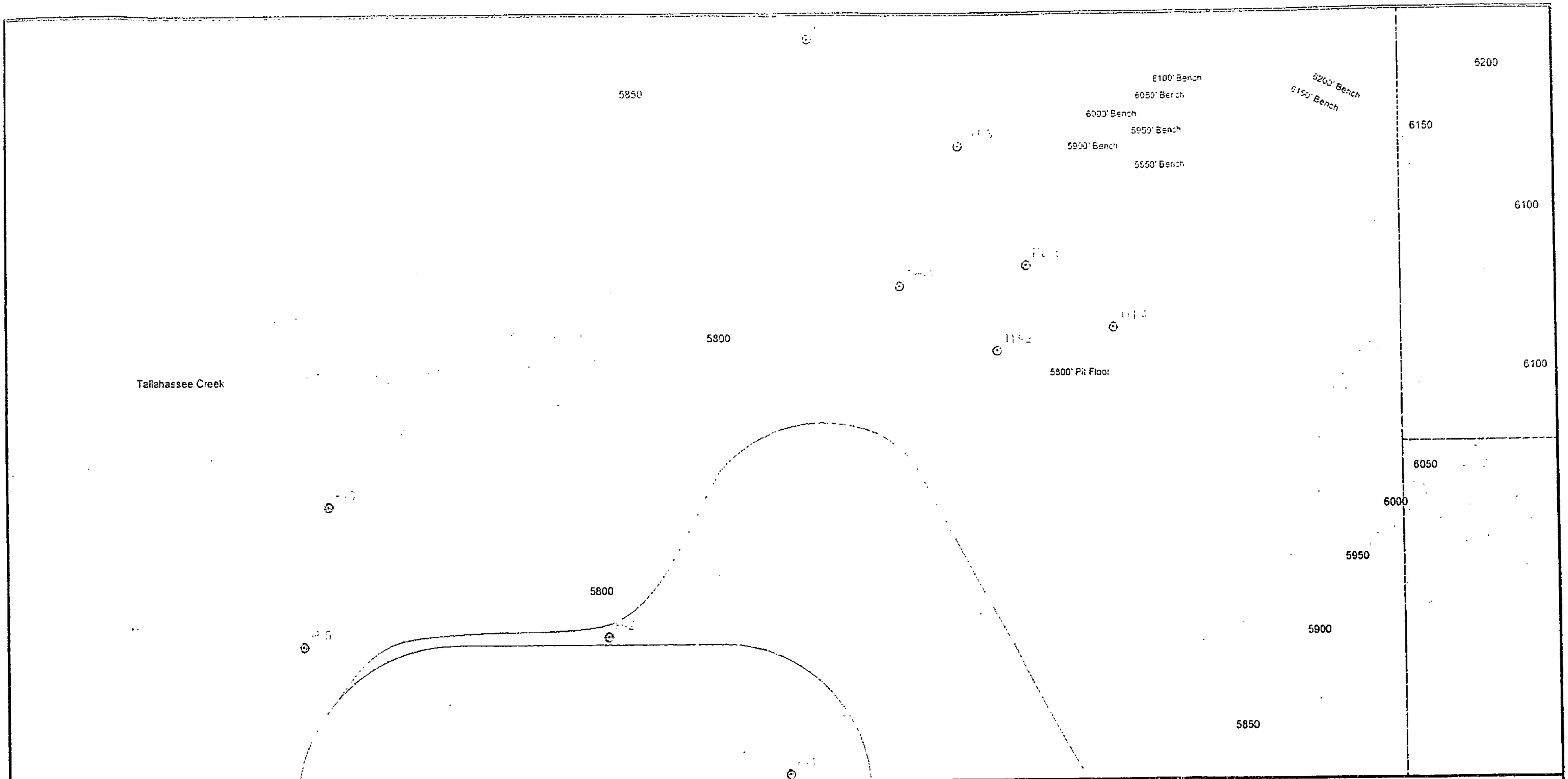
FIGURE A3
SITE PLAN
PARKDALE PROJECT
FREMONT COUNTY, COLORADO
PROJECT D04.033



Topographic base from AutoCad file received from Wiley Consulting, LLC, 2004
10-foot contour interval shown

EXPLANATION

Drill Hole Location

Quarry Outline

300 150 0 300 Feet

JA CESARE

FIGURE A7
5800-FT GRANITE QUARRY MODEL
PARKDALE PROJECT
FREMONT COUNTY, COLORADO
PROJECT D04.033

APPENDIX B
DRILL HOLE SUMMARY
PARKDALE PROJECT

Hole Number	North (ft)	East (ft)	Elevation (ft)	Total Depth (ft)	Depth to Bedrock (ft)	Bedrock Elev (ft)	Depth to Water (ft)	Water Elev (ft)
P-1	6,834.8	14,194.5	5,789.5	54	52	5,737.5	46	5,743.5
P-2	7,264.7	13,627.7	5,797.4	50	49	5,748.4	48	5,749.4
P-3	6,542.9	13,634.9	5,795.8	70	67	5,728.8	53	5,742.8
P-4	6,596.3	12,580.1	5,792.5	37	32	5,760.5	Dry	
P-5	7,238.2	12,677.4	5,805.7	64	63	5,742.7	56	5,749.7
P-6	7,676.0	12,756.5	5,809.7	67	66	5,743.7	56	5,753.7
P-7	6,629.3	11,649.8	5,791.2	37	35	5,756.2	Dry	
P-8	7,721.0	11,559.2	5,813.7	65	64	5,749.7	49	5,764.7
P-9	7,528.0	10,584.0	5,814.7	55	53	5,761.7	49	5,765.7
P-10	6,533.3	10,617.7	5,793.6	37	36	5,757.6	33	5,760.6
P-11	7,044.9	11,104.2	5,812.1	59	58	5,754.1	46	5,766.1
MW-2	6,593.0	13,290.9	5,799.3					
MW-3	6,663.9	14,023.6	5,780.5					
TH-1	8,355.8	14,552.0	5,911.5	150	10.0	5901.5		
TH-2	8,152.1	14,857.8	5,928.0	170	5.0	5923.0		
TH-3	8,791.4	14,740.0	5,999.4	210	10.0	5989.4		
TH-4	8,223.2	15,221.4	5,961.4	240	9.5	5951.9		
PC-5	8,418.4	14,950.4	5,962.4	199	7.0	5955.4	Dry	
PC-6	9,128.5	14,266.6	5,975.4	140.5	6.0	5969.4	Dry	

JAC drilled P-series and PC-series holes in February 2004
Water levels were measured during drilling
CTL/Thompson drilled TH-series holes in 2001, logs do not mention presence of groundwater
MW-series holes were apparently drilled by Azurite in 1997
All holes surveyed by Anthony Lutrey, PLS, in 2004

Putnam, 1981

Table 2.2 Base Friction Angles (Putnam, 1981, p. 95)

Material	ϕ residual (degrees)	Source*
Amphibolite (dry)	32	1
Attapulgite	30	2
Basalt (dry)	35-38	1
(wet)	31-36	1
Calcite (crushed)	30	2
Chalk (wet)	30	1
Conglomerate	35	3
Dolomite (dry)	31-37	1
(wet)	27-35	1
Feldspar (crushed)	35	2
Gneiss (schistose)	23-29	1
Granite	29-35	1
Kaolinite	15	2
Limestone	33-37	3
Melbourne Mudstone	25-35	4
Montmorillonite	4-10	2
Muscovite	17-24	2
Quartz (crushed)	35	2
Quartz Monzonite	32	3
Sandstone	25-34	3
Sandstone (clean diamond cut)	36	5
Sandstone (bentonite coated, diamond cut)	32	5
Shale (wet)	27	1
Siltstone (dry)	31-33	1
(wet)	27-31	1
Slate (dry)	25-30	1

* 1 - Reported by Barton (1973)
2 - Kenney (1967)
3 - Reported by Morgenstern (1968)
4 - Parkin and Donald (1975)
5 - Pells, Rowe, and Turner (1980)

Barton 1978

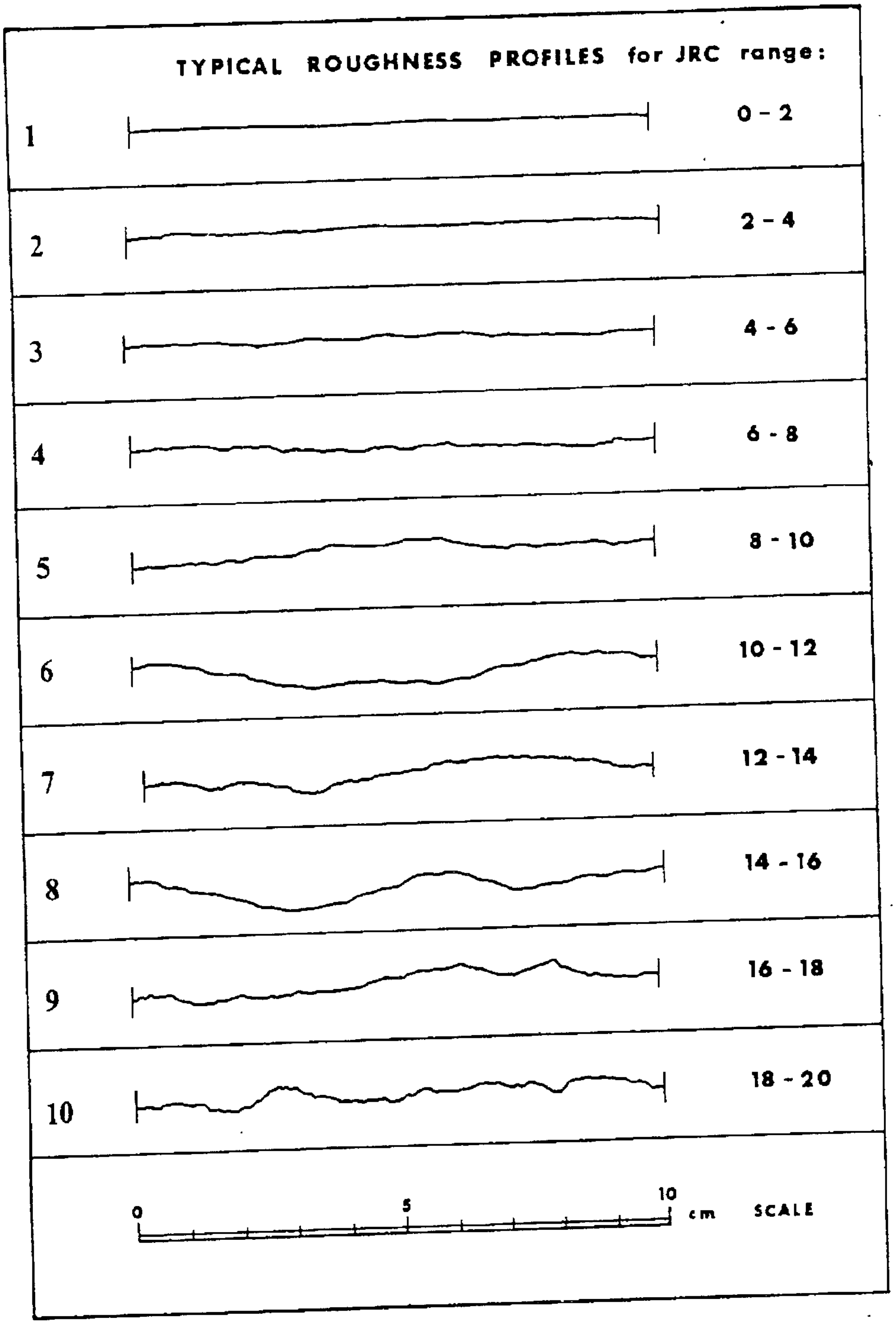


Figure 2.12 Joint Roughness Profiles

(Barton, 1978, p. 345)

Williams, 1980

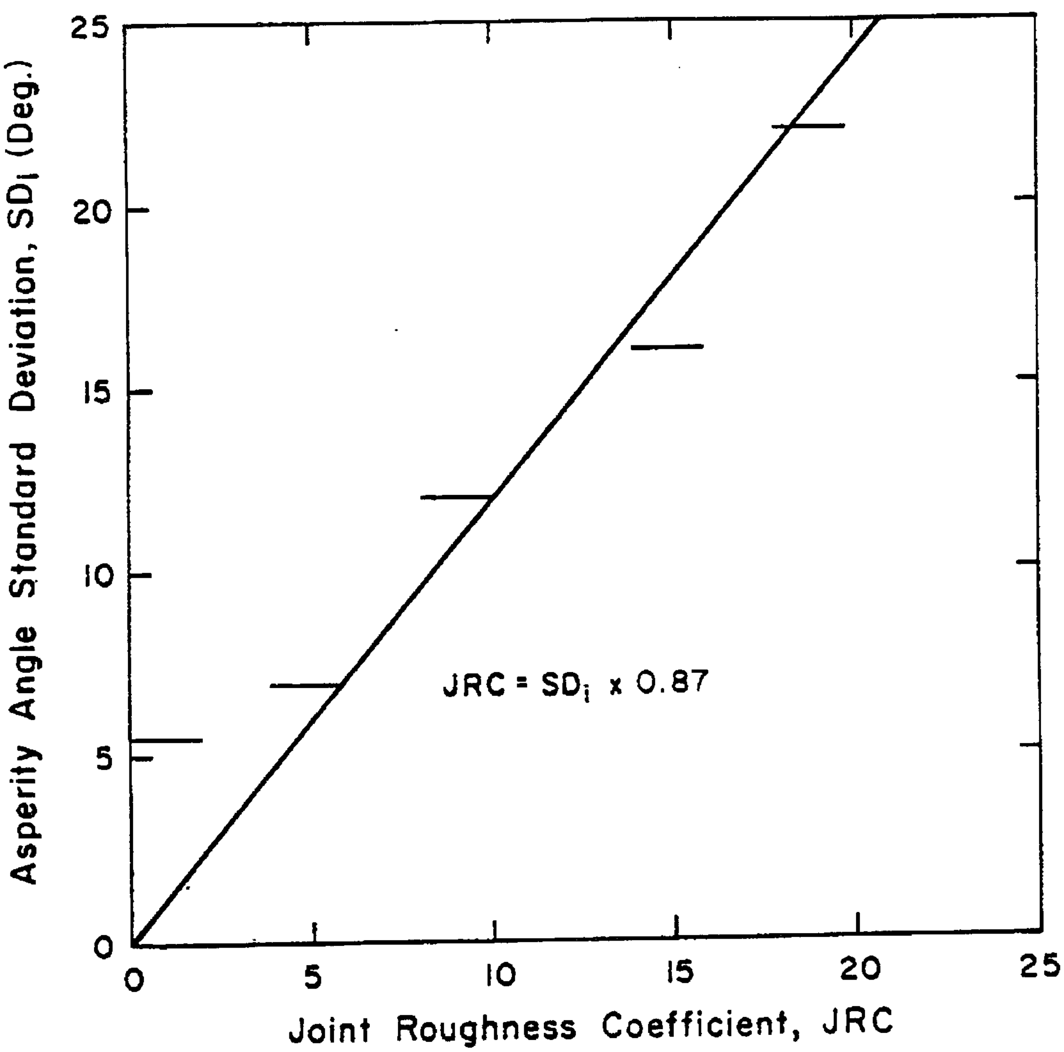


Figure 2.13 Correlation of Joint Roughness Coefficient with Dilation Angle

(Williams, 1980, p. 89)

an equilibrium condition is achieved.

Verification of these principles and equations, and an illustration of their practical application, is presented in Chapter 3.

2.8 REFERENCES

☆ Barton, N., Coordinator for ISRM, Commission on Standardization of Laboratory and Field Tests, "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses," International Journal of Rock Mechanics and Mining Sciences, Vol. 15, No. 6, Dec. 1978, pp. 319-368.

Barton, N. and Choubey, B., "The Shear Strength of Rock Joints in Theory and Practice," Rock Mechanics, Vol. 10, Nos. 1 & 2, Dec. 1977, pp. 1-54.

Byerlee, J. D., "Brittle-Ductile Transition in Rocks," Journal of Geophysical Research, Vol. 73, No. 14, July 1968, pp. 4741-4750.

Dight, P. M. and Chiu, H. K., "Prediction of Shear Behavior of Joints Using Profiles," International Journal of Rock Mechanics and Mining Sciences, Vol. 18, No. 5, Oct. 1981, pp. 369-386.

Goodman, R. E., "The Mechanical Properties of Joints," Proceedings, 3rd Congress of the International Society for Rock Mechanics, Vol. 1, Part A, Denver, 1974, pp. 127-140.

Goodman, R. E., Introduction to Rock Mechanics, John Wiley & Sons, New York, 1980, 478 p.

Goodman, R. E., Methods of Geological Engineering in Discontinuous Rocks, West Publishing Co., St. Paul, 1976, 472 p.

Horvath, R. G. and Kenney, T. C., "Shaft Resistance of Rock-Socketed Drilled Piers," Proceedings, Symposium on Deep Foundations, ASCE, Atlanta, 1979, pp. 182-214.

Horvath, R. G., Trow, W. A., and Kenney, T. C., "Results of Tests to Determine Shaft Resistance of Rock-Socketed Drilled Piers," Proceedings, International Conference on Structural Foundations on Rock, Vol. 1, Sydney, 1980, pp. 349-361.

Jaeger, J. C., "Friction of Rocks and the Stability of Rock Slopes," Geotechnique, Vol. 21, No. 2, June 1971, pp. 97-134.

Krahn, J. and Morgenstern, N. R., "The Ultimate Frictional Resistance of Rock Discontinuities," International Journal of Rock Mechanics and Mining Sciences, Vol. 16, No. 2, Apr. 1979, pp. 127-133.

Kulhawy, F. H. and Goodman, R. E., "Design of Foundations on Discontinuous Rock," Proceedings, International Conference on Structural Foundations on Rock, Vol. 1, Sydney, 1980, pp. 209-220.

Ladanyi, B. and Archambault, G., "Simulation of Shear Behavior of a Jointed Rock Mass," Proceedings, 11th U.S. Symposium on Rock Mechanics, Berkeley, 1969, pp. 105-125.

Mogi, K., "Pressure Dependence of Rock Strength and Transition from Brittle Fracture to Ductile Flow," Bulletin, Earthquake Research Institute, Vol. 44, Tokyo University, 1966, pp. 215-232, (as referenced by Dight and Chiu, 1981).

Nascimento, U. and Teixeira, H., "Mechanisms of Internal Friction in Soils and Rocks," Proceedings, ISRM Symposium on Rock Fracture, Nancy, 1971, Paper 2-3, (as referenced by Goodman, 1976).

Patton, F. D., "Multiple Modes of Shear Failure in Rock," Proceedings, 1st Congress of the International Society for Rock Mechanics, Vol. 1, Lisbon, 1966, pp. 509-513.

Pells, P. J. N., Rowe, R. K., and Turner, R. M., "An Experimental Investigation into Side Shear for Socketed Piles in Sandstone," Proceedings, International Conference on Structural Foundations on Rock, Vol. 1, Sydney, 1980, pp. 291-302.

Pells, P. J. N. and Turner, R. M., "Elastic Solutions for the Design and Analysis of Rock Socketed Piles," Canadian Geotechnical Journal, Vol. 16, No. 3, Aug. 1979, pp. 481-487.

Putnam, J. B., "Analysis and Design of Foundations on Discontinuous Rock," M. S. Thesis, Syracuse University, May 1981, 204 p.

Williams, A. F., "Principles of Side Resistance Development in Rock Socketed Piles," Proceedings, 3rd Australia-New Zealand Conference on Geomechanics, Vol. 1, Wellington, 1980, pp. 87-94.

CALCULATIONS	
File No.	106052
Sheet	1 of 4
Date	1/20/07
Computed By	K Pease
Checked By	[illegible]

Client: Front Range Agg

Project: Parkdale Quarry

Subject: Bench Fill Slope Stability

I **Purpose**: Calculate the slope stability of fill to be placed on benches in the quarry as part of reclamation.

II **Methods**: Comparison of the friction angle of the soils with the proposed slope angle.

III **References**:

1) Terzaghi & Peck; Soil Mech in Eng Practice; 1967

2) Sowers & Sowers; Introductory Soil Mechanics and Foundations; 1970

3) Peck, Hanson & Thornburn, Foundation Engineering; 1974

4) Carter & Bentley, Correlations of Soil Properties, 1991

5) EPRI (Elect Power Res Intl); Transmission Line Structure Foundations for Uplift-Compression Loading, 1983.

LYMAN HENN INC	CALCULATIONS	File No.	106052
		Sheet	2 of 4
Client	Front Range Agg	Date	1/20/07
Project	Parkdale Quarry	Computed By	K Pease
Subject	Bench Fill Slope Stability	Checked By	SW

IV Soil Types

1) Overburden: Granular soil primarily derived from decomposed granite. Expected to be primarily 6" minus gravel with sub angular particles and less than approx 25 percent fines. (GM)

2) Weathered Rock: Partially decomposed rock that is not suitable for processing and sale as aggregate. Expected to be rock chunks up to about 2' dia with a lot of gravel and sand sized particles also. Likeley less than 10 pecrent fines and angular particles. (GM)

3) Unsaleable crushed rock products and crusher fines. Expected to be 3/8 inch minus material left over from the processing stream. Likeley 10 parcent - 20 percent fines. (SM, SP-SM, SW-SM)

V Soil Properties

All these soil types are granular with a low percentage of fines. Soil strength is derived almost entirely from friction. Although there could be a small cohesive component, this will be neglected as a conservative assumption. Several correlations to follow based on page 91 of Ref 4.

CAL02AFH.FRP 20 November 1997

LYMAN HENN INC	CALCULATIONS	File No.	D6052
		Sheet	3 of 4
Client	Front Range Agg	Date	1/20/07
Project	Parkdale Quarry	Computed By	K Pease
Subject	Bench Fill Slope Stability	Checked By	SD

1) Overburden (GM) - Assumed med dense

Table 6.4

	Loose	Dense	Intermed.
Sandy gravel	35	50	(42°)
Silty Sand	27-33	30-34	(30°-33°)

table 6.5 for Compacted

GM $\phi > 34°$

But soil may not be fully compacted so this could be too high.

Use $\phi = 34° - 36°$

2) Weath Rock (GM)

Table 6.4

Sandy Gravel 35° - 50° (42°)

Use $\phi = 42°$

3) Unsaleable (SM, SP-SM, SW-SM)

Table 6.4

Well G Sand, ang 33° - 45° (39°)

Silty Sand 27° - 33° & 30° - 34° (30° - 33°)

Table 6.5

SW 38° } for compacted, but the
SP 37° } backfill may not be fully compacted

Use $\phi = 34° - 36°$

CAL02AFH.FRP 20 November 1997

LYMAN HENN INC	**CALCULATIONS**	File No.	106052
		Sheet	4 of 4
Client	Front Range Agg	Date	1/20/02
Project	Parkdale Quarry	Computed By	K. Pease
Subject	Bench Fill Slope Stability	Checked By	SD

VI Slope Stability.

Slope stability for purely frictional materials given by

$$FS = \frac{\tan \phi_{soil}}{\tan(\text{slope } \angle) = V/H}$$

Material		Safety Factors 1.5H:1V	Safety Factors 1.75H:1V
Overburden	34°-36°	1.01-1.09	1.18-1.27
Weathered Rock	38°	1.17	1.37
Unsaleable Material	34°-36°	1.01-1.09	1.18-1.27

A suitable safety factor used as the design criteria is 1.10.

In summary:

1) Weathered rock can be placed at slopes of 1.5H:1 or flatter

2) Overburden and unsaleable material should be placed on slopes at 1.75H:1V or slightly steeper with moderate compaction. With full compaction these soils could be placed on slopes at 1.5H:1V assuming testing and QA/QC.

Reference 4

Table 6.3 TYPICAL ANGLES OF EFFECTIVE SHEARING RESISTANCE FOR COMPACTED CLAYS

Soil description	*Class**	ϕ' (deg)
Silty clays, sand-silt mix	SM	34
Clayey sands, sand-clay mix	SC	31
Silts and clayey silts	ML	32
Clays of low plasticity	CL	28
Clayey silts, elastic silts	MH	25
Clays of high plasticity	CH	19

* Unified classification system.

plasticity index increases and shear strength decreases. As described previously, the strength of clays, in effective stress terms, is basically frictional so $c'=0$. This is certainly the case with remoulded saturated clays but partially saturated clays, where meniscus effects draw the particles together to produce inter-particle stresses, may appear to have a small cohesion value, though this itelf is a frictional phenomenon.

Typical values of the angle of shearing resistance, ϕ', for compacted clays are given in Table 6.3. Values are for soils compacted to the maximum dry density according to the standard compaction test (AASHTO T99, 5.5lb rammer method; or BS 1377:1975 test 12, 2.5kg rammer method).

6.4 SHEAR STRENGTH OF GRANULAR SOILS

Because of their high permeability, pore water pressures do not build up when granular soils are subjected to shearing forces, as they do with clays. The complication of total and effective stresses is therefore avoided and the phenomenon of apparent cohesion, or undrained shear strength, does not occur. Consequently, the shear strength of granular soils is defined exclusively in terms of the frictional resistance between the grains, as measured by the angle of shearing resistance.

Typical values of the angle of shearing resistance for sands and gravels are given in Table 6.4.

Typical values for compacted soils are given in Table 6.5. Values refer to soil compacted to maximum dry density at optimum moisture content as defined in the standard compaction test: AASHTO T99 (5.5lb rammer method) or BS 1377:1975 test 12 (2.5kg rammer method).

A relationship between dry density or relative density and the angle of shearing resistance is given by the US Navy (1982), as shown in

Table 6.4 TYPICAL VALUES OF THE ANGLE OF SHEARING RESISTANCE OF COHESIONLESS SOILS

Material	ϕ (deg) *Loose*	*Dense*
Uniform sand, round grains	27	34
Well-graded sand, angular grains	33	45
Sandy gravels	35	50
Silty sand	27–33	30–34
Inorganic silt	27–30	30–35

Table 6.5 TYPICAL VALUES OF THE ANGLE OF SHEARING RESISTANCE FOR COMPACTED SANDS AND GRAVELS

Soil description	*Class**	*Angle of shearing resistance*, ϕ (deg)
Well-graded sand-gravel mixtures	GW	>38
Poorly-graded sand gravel mixtures	GP	>37
Silty gravels, poorly graded sand-gravel-silt	GM	>34
Clayey gravels, poorly graded sand-gravel-clay	GC	>31
Well-graded clean sand, gravelly sands	SW	38
Poorly-graded clean sands, gravelly sands	SP	37

* Unified classification system.

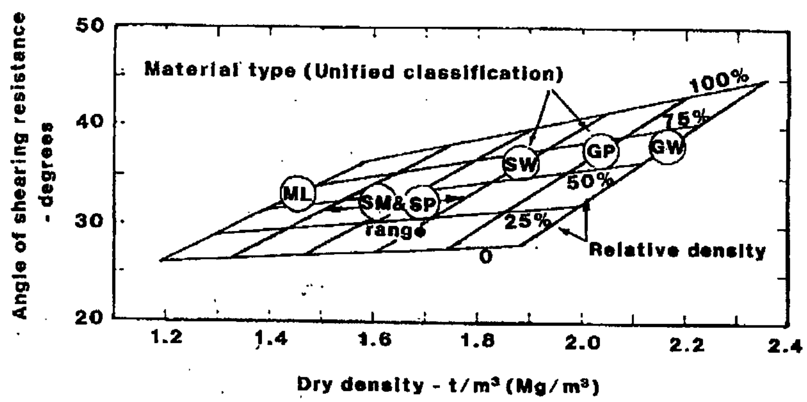


Figure 6.13 Typical values of density and angle of shearing resistance of cohesionless soils (modified after US Navy, 1982)