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LAMPIRAN

MAPPING FACE TUNNEL

ROCK MASS RATING (By Bieniawski, 1989)

SHEET NO.	: 1
DATE	: 16/07/2019
ROCK TYPE	: Sandstone, Sandstone - Shale
LOCATION	: HTA 2D
CHAINAGE	: 6+423,50 , CH : 1+141,50
TUNNEL AXIS	: N 235°E
JOINT SET ORIENTATION	:
#1	: N 180° E / 50
#2	: N 55° E / 50
#3	: N 315° E / 45 T
#4	: N ___° E / ___

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ULFHA	

KEMENTERIAN RISET TEKNOLOGI DAN PENDIDIKAN TINGGI
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DEPARTEMEN TEKNIK GEOLOGI

MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25
Rating	20	17	(13)	8	3

13

3. Spacing of Discontinuities (SJ)					
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06
Rating	(20)	15	10	(8)	5

9

4. Conition of Discontinuities (CJ)									
PARAMETER	Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	19
		Rating	(6)	4	(2)	1	0		
	Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
		Rating	(6)	5	4	(1)	0		
	Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	2	
		Rating	6	5	(3)	(1)	0		
	Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
		Rating	(6)	(4)	2	2	0		
	Weathering	Weathering	Fresh	Slighlty W.	Moderatly W.	Highly W.	Decomposed	6	
		Rating	(6)	5	3	1	0		

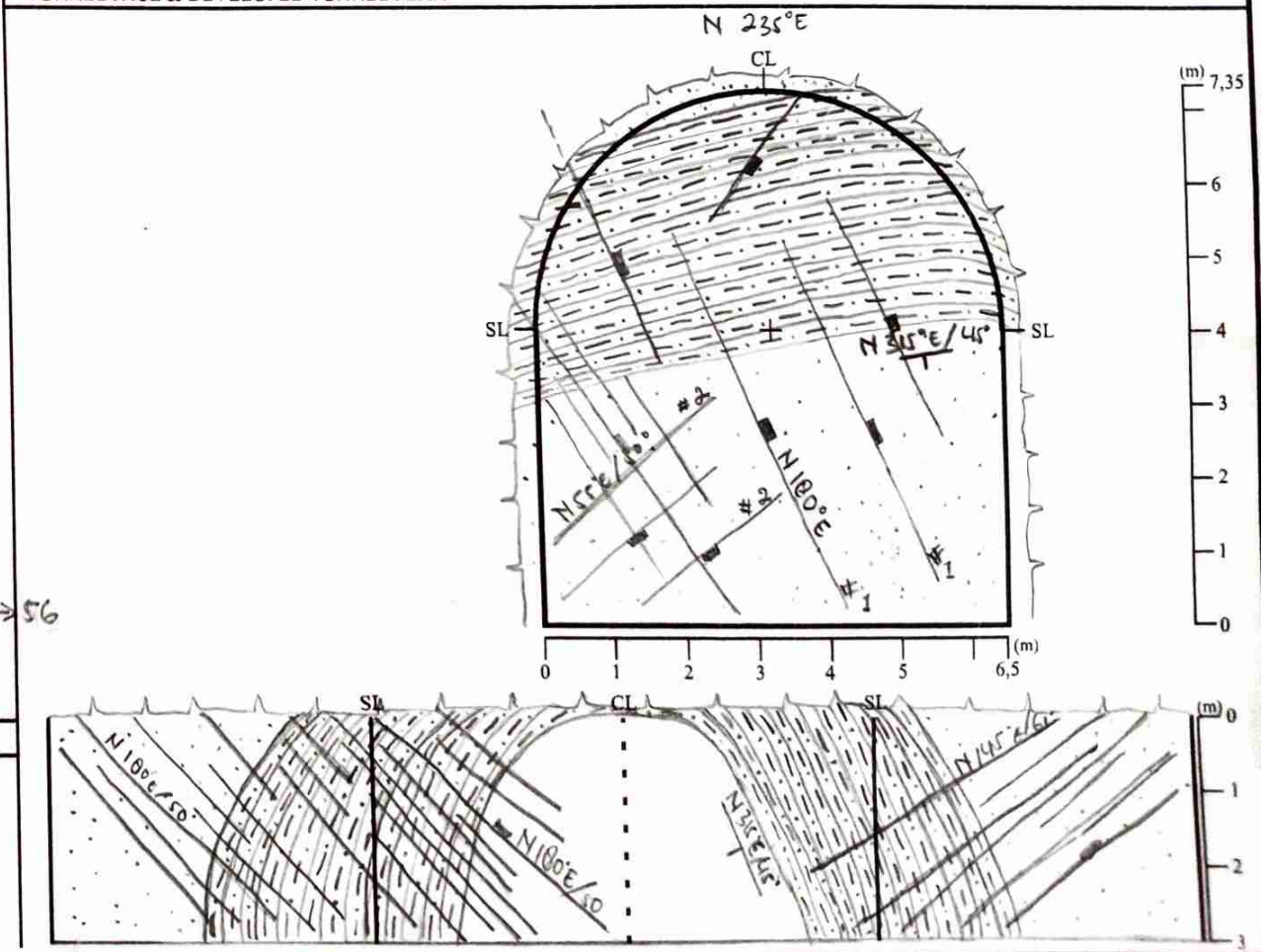
5. Groundwater (CW)						
Inflow/10m Tunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	13
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)	
Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)	-5
Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling Strike Perpendicular to Tunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable) Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable) Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable) Irrespectif of Strike : (Dip 0 - 20, Fair)	

RMR = SR + RQD + SJ + CJ + CW - AJ	Total Rating of RMR	61 - 5 → 56

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

TUNNEL FACE & DEVELOPED TUNNEL PLAN



NOTE

Sandstone : GREY, FRESH, MEDIUM STRONG, TIGHT JOINT, DAMP - DRY

Sandstone-shale : GREY - DARK GREY, FRESH, TIGHT - JOINT

ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25
Rating	20	17	(13)	8	3

13

3. Spacing of Discontinuities (SJ)					
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06
Rating	(20)	15	10	(8)	5

9

4. Condition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	21
	Rating	6	(4)	(2)	1	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slightly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
	Rating	(6)	4	(2)	2	0		
Weathering	Weathering	Fresh	Slightly W.	Moderately W.	Highly W.	Decomposed	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (CW)

Inflow/10m Tunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	13
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling

Strike Prependicular to Tunnel Axis	: Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable)	-5
	Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)	
Strike: Parallel to Tunnel Axis	: (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)	
Irrespectif of Strike	: (Dip 0 - 20, Fair)	

RMR = SR + RQD + SJ + CJ + CW - AJ **Total Rating of RMR** 63-5 → 58

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A: Sandstone : grey, fresh, medium strong, tight joint.
B: sandstone - shale : grey - clerk grey, fresh, calcite infilling

SHEET NO. : 2
DATE : 17/7/2019
ROCK TYPE : Sandstone, sandstone - shale
LOCATION : HTA2D
CHAINAGE : 6+427,00 CH: 1+1145,00
TUNNEL AXIS : N 235°E
JOINT SET ORIENTATION :
#1 : N 200° E / 16°
#2 : N 55° E / 50°
#3 : N 325° E / 40°
#4 : N ___ E / ___

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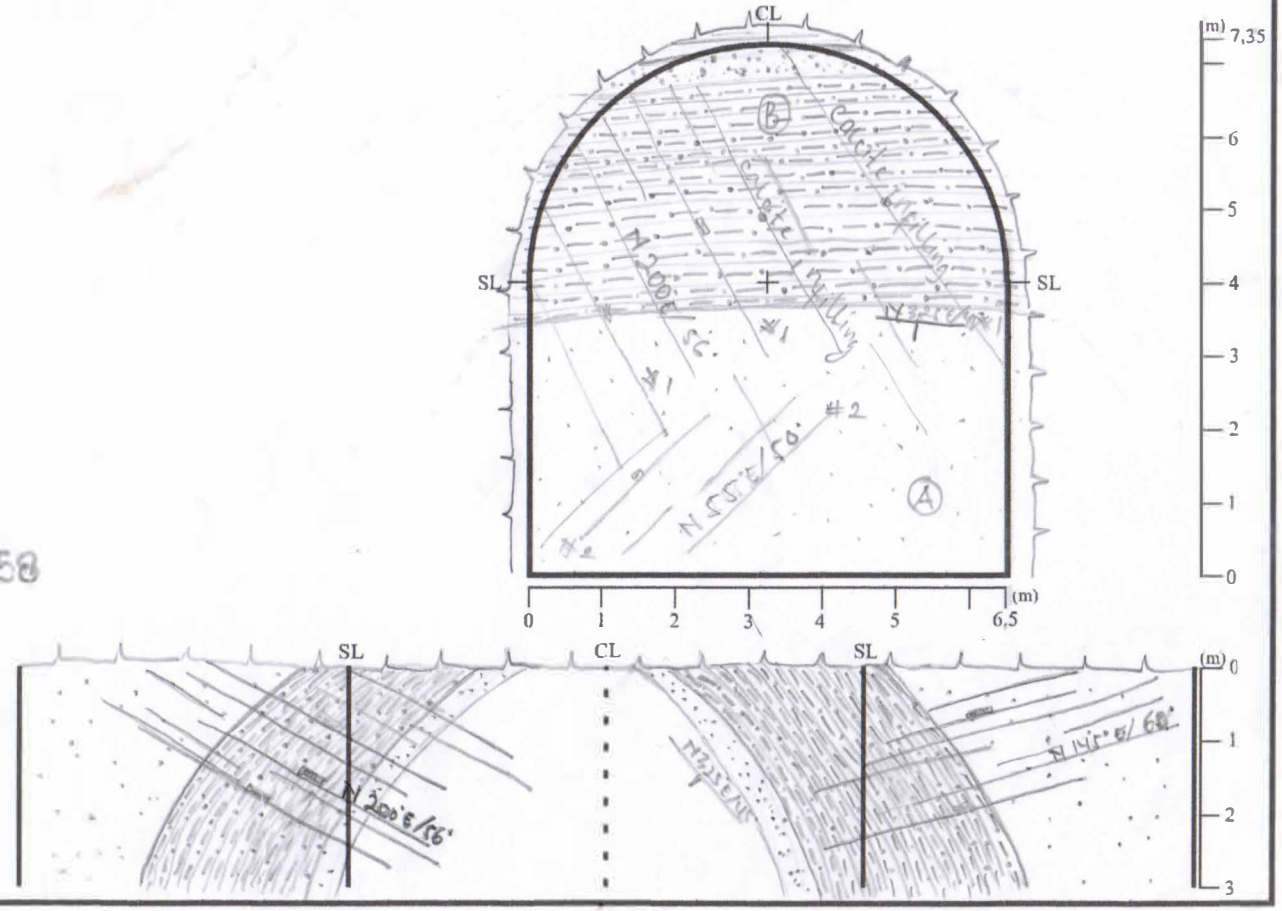
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25	13
Rating	20	17	(13)	8	3	

3. Spacing of Discontinuities (SJ)						
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06	9
Rating	(20)	15	10	(8)	5	

4. Conition of Discontinuities (CJ)

PARAMETER									
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	20
	Rating	(6)	4	(2)	1	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	4	
	Rating	(6)	4	(2)	2	0		
Weathering	Weathering	Fresh	Slightly W.	Moderatly W.	Highly W.	Decomposed	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (GW)						
Inflow/10mTunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontiniuties (AJ)

Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12) → -5

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling
Strike Prependicular toTunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable); Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
Irrespectif of Strike : (Dip 0 - 20, Fair)

RMR = SR + RQD + SJ + CJ + CW - AJ — **Total Rating of RMR** 63-5 → 58

MEANING OF ROCK MASS CLASS

81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A: Sandstone : grey, fresh, Medium strong, tight joint.
B: Sandstone-shale : grey - dark grey, fresh, tight joint

SHEET NO. : 3
DATE : 18/7/2019
ROCK TYPE : Sandstone, sandstone-shale
LOCATION : HTA2D
CHAINAGE : 6+429,10 CH: 1147,10
TUNNEL AXIS : N 235°E
JOINT SET ORIENTATION :
#1 : N 180° E/° 58
#2 : N 145° E/° 58
#3 : N 320° E/° 45
#4 : N ___° E/° ___

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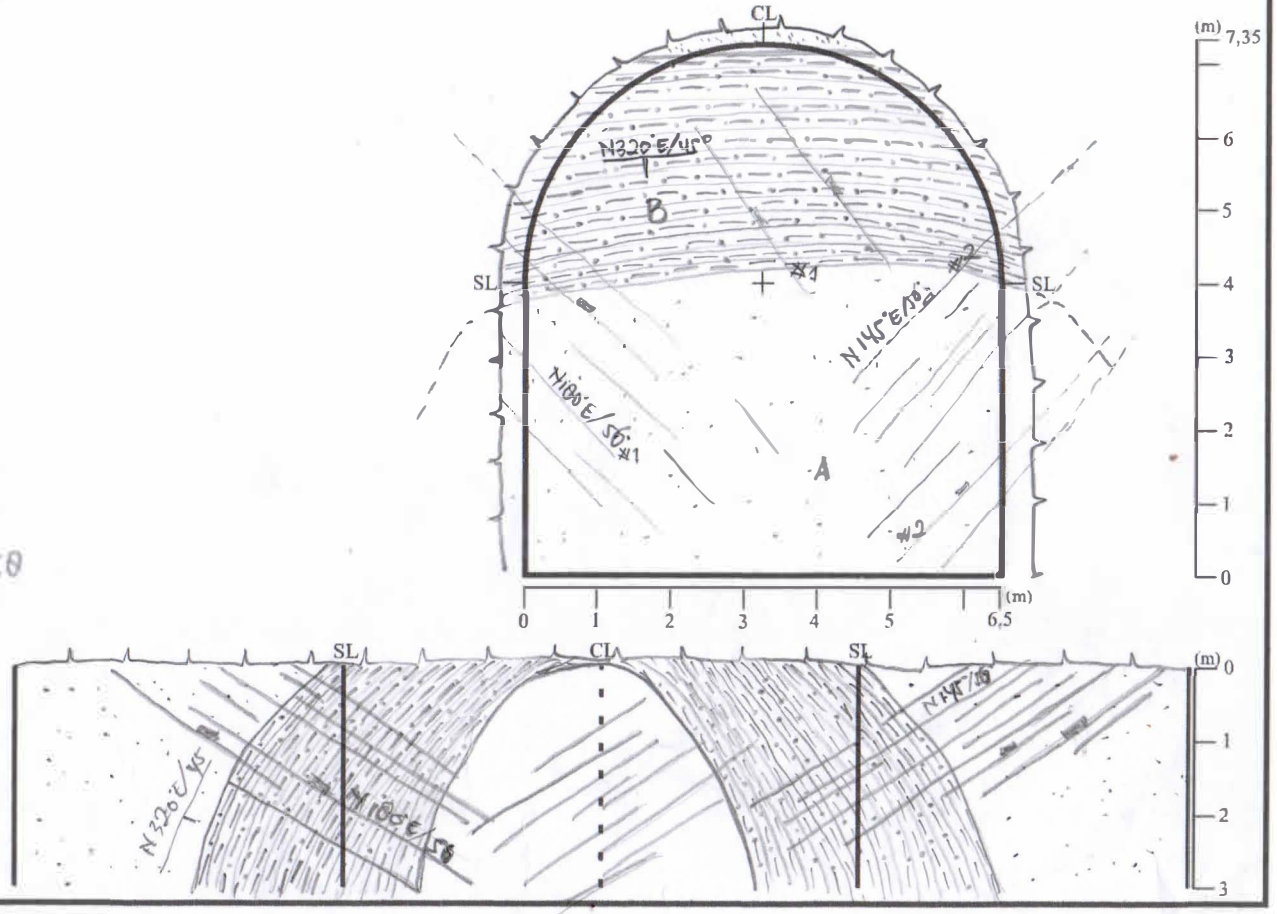
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS
: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)								Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25
Rating	20	17	(13)	8	3

13

3. Spacing of Discontinuities (SJ)					
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06
Rating	(20)	15	10	(8)	5

9

4. Conition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	21
	Rating	6	(4)	(2)	1	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
	Rating	(6)	(4)	2	2	0		
Weathering	Weathering	Fresh	Slightly W.	Moderatly W.	Highly W.	Decomposed	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (CW)

Inflow/10mTunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	13
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling
Strike Prependicular toTunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable)
Drive againts Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axie : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
Irrespectif of Strike : (Dip 0 - 20, Fair)

-5

RMR = SR + RQD + SJ + CJ + CW - AJ — **Total Rating of RMR** 63-5 → 58

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	(41 - 60 (III)) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A : Sandstone : grey, fresh, medium strong, Tight joint.
B : Sandstone - shale : grey - dark grey, fresh, tight joint.

SHEET NO. : 4
DATE : 19/7/2019
ROCK TYPE : Sandstone, sandstone - shale
LOCATION : HTA 2D
CHAINAGE : 6+433,90 CH 1+151,90
TUNNEL AXIS : N 235°E
JOINT SET ORIENTATION :
#1 : N 190°E/°56
#2 : N 320E/°45
#3 : N 130°E/°55
#4 : N ___°E/°___

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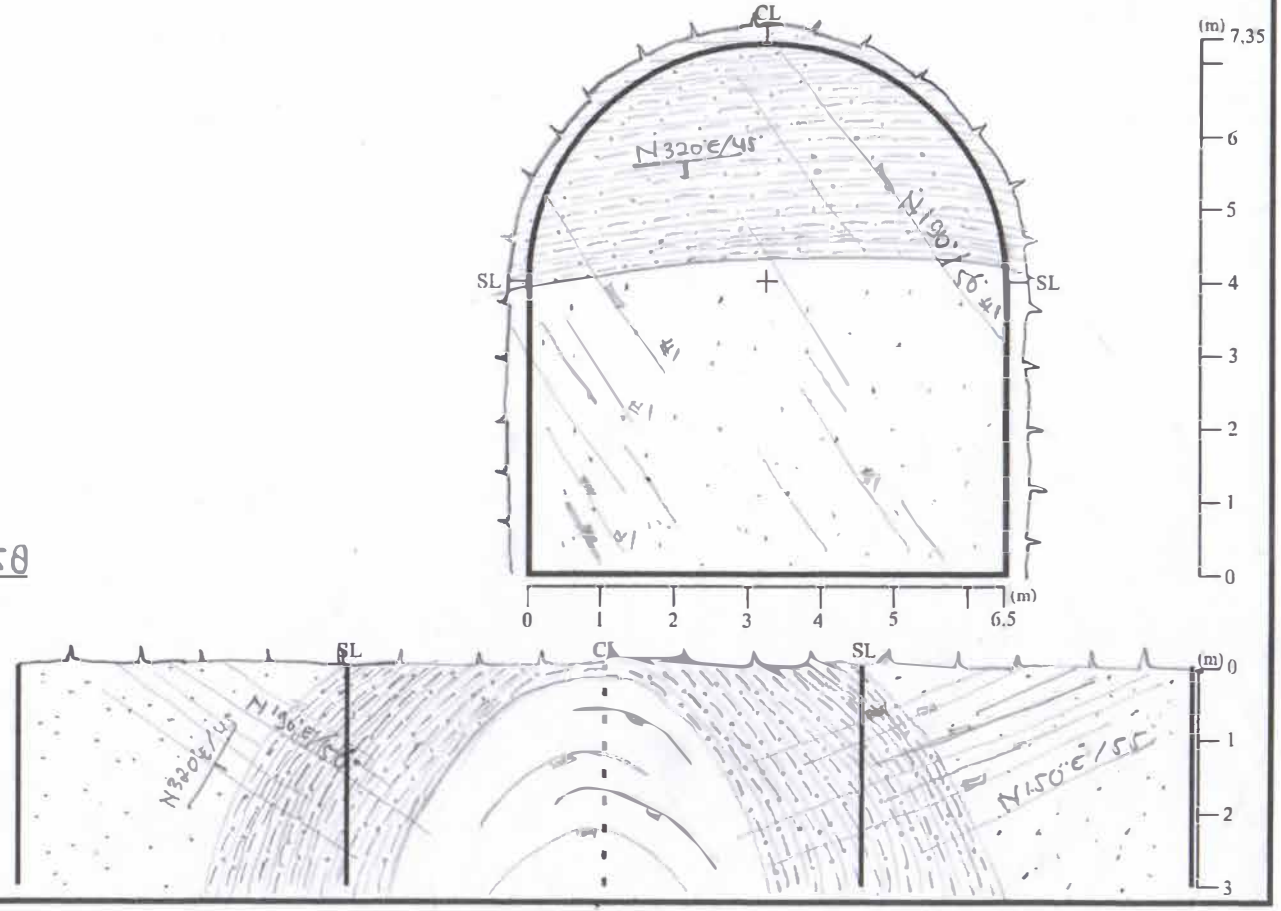
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS
: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)								Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25
Rating	20	17	(13)	8	3

13

3. Spacing of Discontinuities (SJ)					
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06
Rating	(20)	15	10	(8)	5

9

4. Conition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	21
	Rating	(6)	4	(2)	4	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
	Rating	(6)	(4)	2	2	0		
Weathering	Weathering	Fresh	Slighlty W.	Moderatly W.	Highly W.	Decomposed	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (CW)

Inflow/10m Tunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)	
Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling	
Strike Prependicular to Tunnel Axis	: Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable) Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axis	: (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
Irrespectif of Strike	: (Dip 0 - 20, Fair)

-5

RMR = SR + RQD + SJ + CJ + CW - AJ — **Total Rating of RMR** 64 - 5 → 59

MEANING OF ROCK MASS CLASS

81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A. Sandstone : grey, fresh, medium strong, tight joint

B. Sandstone - shale - grey - dark grey, fresh

SHEET NO. : 5

DATE : 20/7/2019

ROCK TYPE : Sandstone, sandstone-shale

LOCATION : HTA2D

CHAINAGE : 6+436.20 CH 1+154,20

TUNNEL AXIS :

JOINT SET ORIENTATION :

#1 : N 190 °E/ °56'
#2 : N 320 °E/ °45
#3 : N 145 °E/ °56
#4 : N ___ °E/ °___

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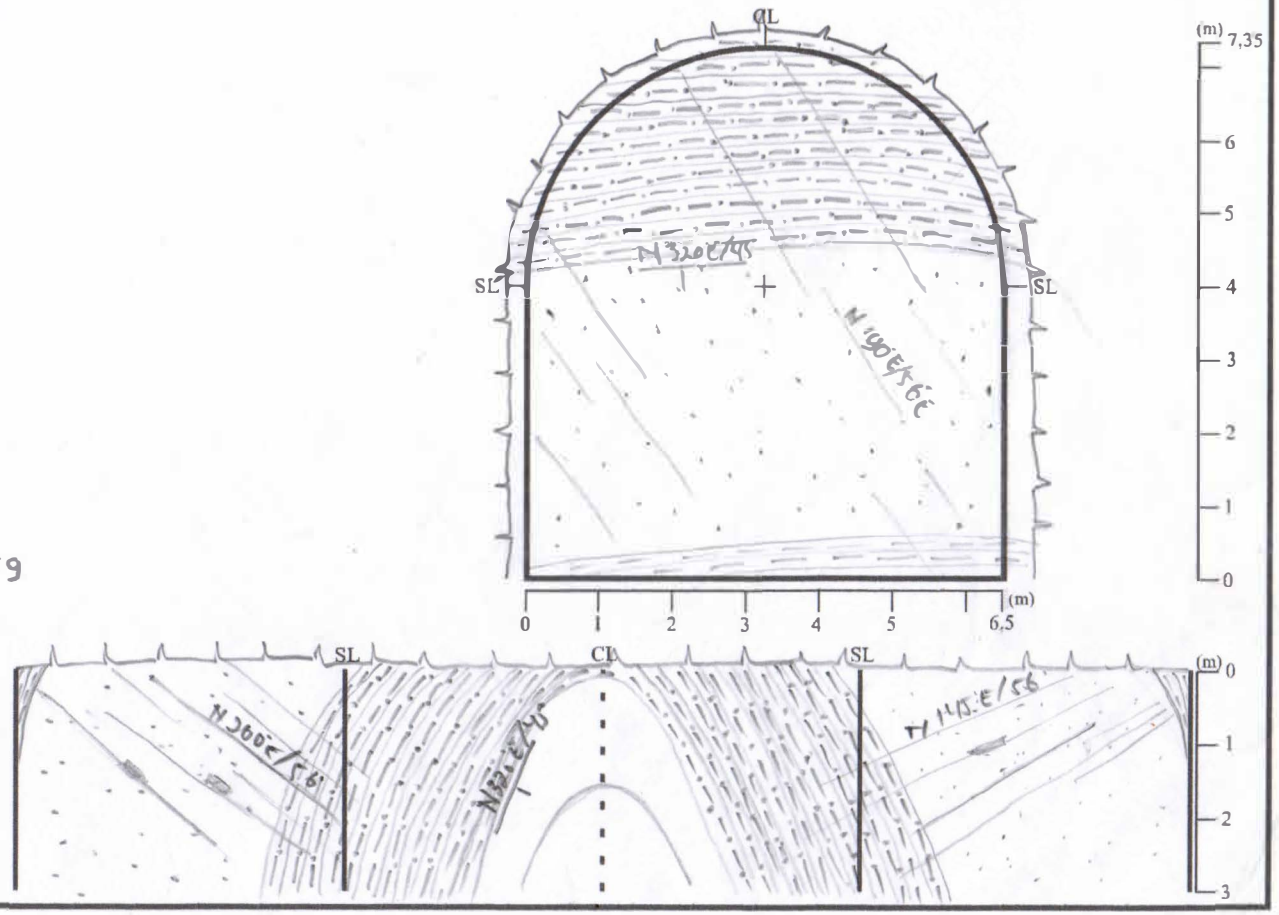
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) | >27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25	3
Rating	20	17	13	8	(3)	

3. Spacing of Discontinuities (SJ)						
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06	9
Rating	(20)	15	10	(8)	5	

4. Conition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	2	19
	Rating	(6)	4	(2)	1	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	2	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
	Rating	(6)	(4)	2	2	0		
Weathering	Weathering	Fresh	Slightly W.	Moderatly W.	Highly W.	Decompose d	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (CW)						
Inflow/ 10mTunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating :Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12) → -12

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling
Strike Prependicular to Tunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable)
Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
Irrespectif of Strike : (Dip 0 - 20, Fair)

RMR = SR + RQD + SJ + CJ + CW - AJ **Total Rating of RMR** 52 - 12 → 40

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A : Sandstone : grey, fresh, medium strong, tight joint

B : Sandstone - shale : grey, dark grey, fresh, tight joint.

SHEET NO. : 6
DATE : 22 / 7 / 2019
ROCK TYPE : Sandstone, sandstone-shale
LOCATION : TTA2D
CHAINAGE : 6+441,30 CH: 1159,30
TUNNEL AXIS : N 235°E
JOINT SET ORIENTATION :
#1 : N 200° E / 56°
#2 : N 325° E / 50°
#3 : N 142° E / 56°
#4 : N ___° E / ___°

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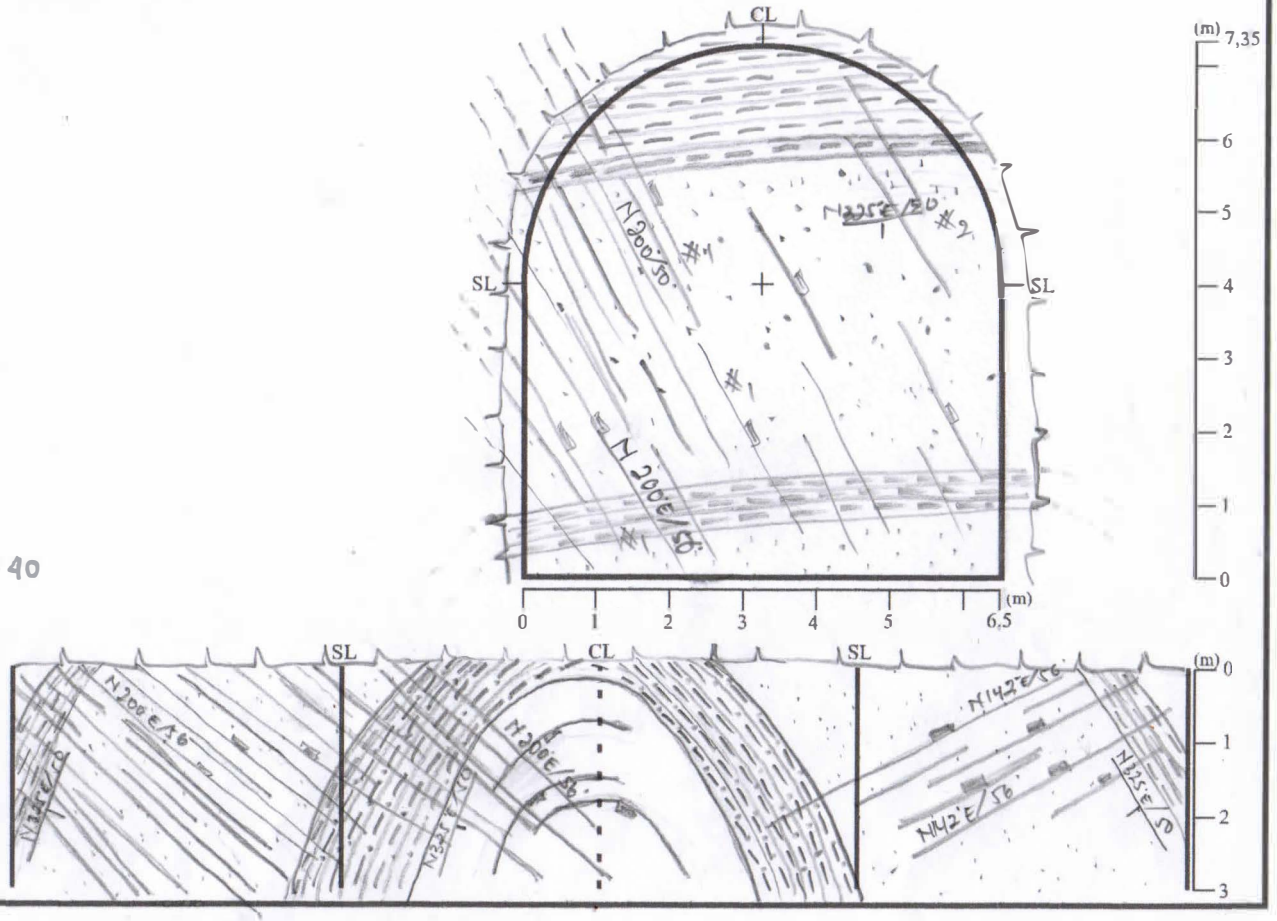
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)								Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25
Rating	20	17	(13)	8	3

13

3. Spacing of Discontinuities (SJ)					
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06
Rating	(20)	15	10	(8)	5

9

4. Conition of Discontinuities (CJ)								
PARAMETER	Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3
		Rating	(6)	4	(2)	1	0	
	Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3
		Rating	(6)	5	4	(1)	0	
	Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4
		Rating	6	(5)	3	(1)	0	
	Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5
		Rating	(6)	(4)	2	2	0	
	Weathering	Weathering	Fresh	Slightly W.	Moderatly W.	Highly W.	Decomposed	6
		Rating	(6)	5	3	1	0	

21

5. Groundwater (CW)						
Inflow/10m Tunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)	
Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)	-5
Note : Effect of Discontinuities Strike and Dip Orientation in Tunnelling Strike Prependicular to Tunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable) Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable) Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable) Irrespectif of Strike : (Dip 0 - 20, Fair)	

RMR = SR + RQD + SJ + CJ + CW - AJ — **Total Rating of RMR** = 64 - 5 → 59

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A: Sandstone : grey, Fresh, medium strong, tight joint

B: Sandstone - shale : grey - dark grey, Fresh, tight joint

SHEET NO. : 7

DATE : 23 / 7 / 2019

ROCK TYPE : Sandstone, sandstone - shale

LOCATION : HTA2D

CHAINAGE : 6+445,90 CH: 1+163.90

TUNNEL AXIS : N 235°E

JOINT SET ORIENTATION :

#1 : N 200 "E / "52
#2 : N 322 "E / "45
#3 : N 120 "E / "56
#4 : N ___ "E / "___

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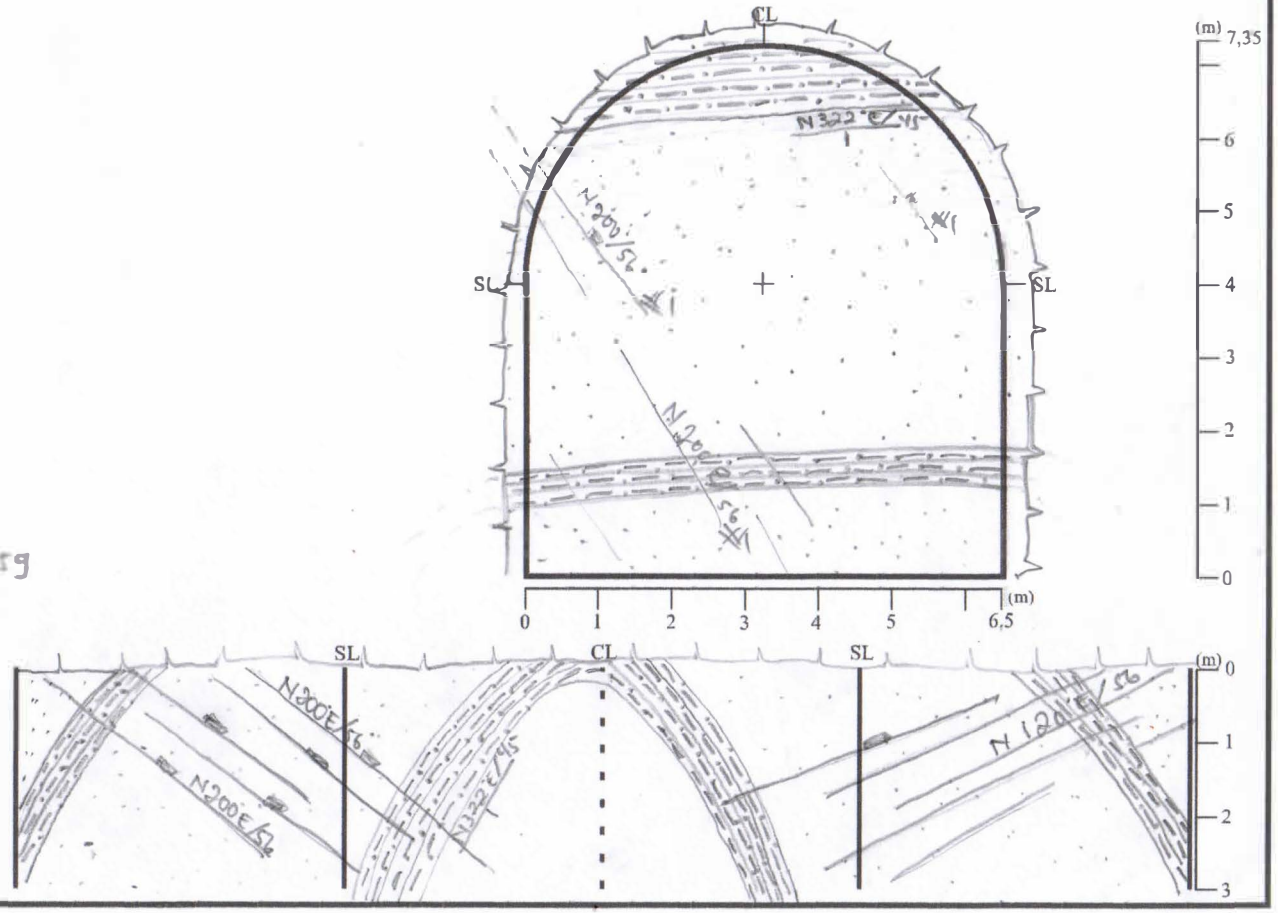
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25
Rating	20	17	(13)	8	3

13

3. Spacing of Discontinuities (SJ)					
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06
Rating	(20)	15	10	(8)	5

9

4. Conition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3
	Rating	(6)	4	(2)	1	0	
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3
	Rating	(6)	5	4	(1)	0	
Roughness	Roughness	Very Rough	Rough	Slightly R.	Smooth	Slickensided	4
	Rating	6	(5)	3	(1)	0	
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5
	Rating	(6)	(4)	2	2	0	
Weathering	Weathering	Fresh	Slightly W.	Moderatly W.	Highly W.	Decomposed	6
	Rating	(6)	5	3	1	0	

21

5. Groundwater (GW)						
Inflow/10m Tunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	13
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating :Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling
Strike Prependicular to Tunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable)
Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
Irrespectif of Strike : (Dip 0 - 20, Fair)

-5

RMR = SR + RQD + SJ + CJ + GW - AJ **Total Rating of RMR** 63 - 5 → 58

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A : grey, fresh, medium strong, tight joint

B : grey - dark grey, fresh tight joint

SHEET NO. : 8
DATE : 24/7/2019
ROCK TYPE : Sandstone, sandstone - shale
LOCATION : HTA2D
CHAINAGE : 6+449,90 CH 1+167,90
TUNNEL AXIS : N 235° E
JOINT SET ORIENTATION :
#1 : N ___ ° E / ° ___
#2 : N ___ ° E / ° ___
#3 : N ___ ° E / ° ___
#4 : N ___ ° E / ° ___

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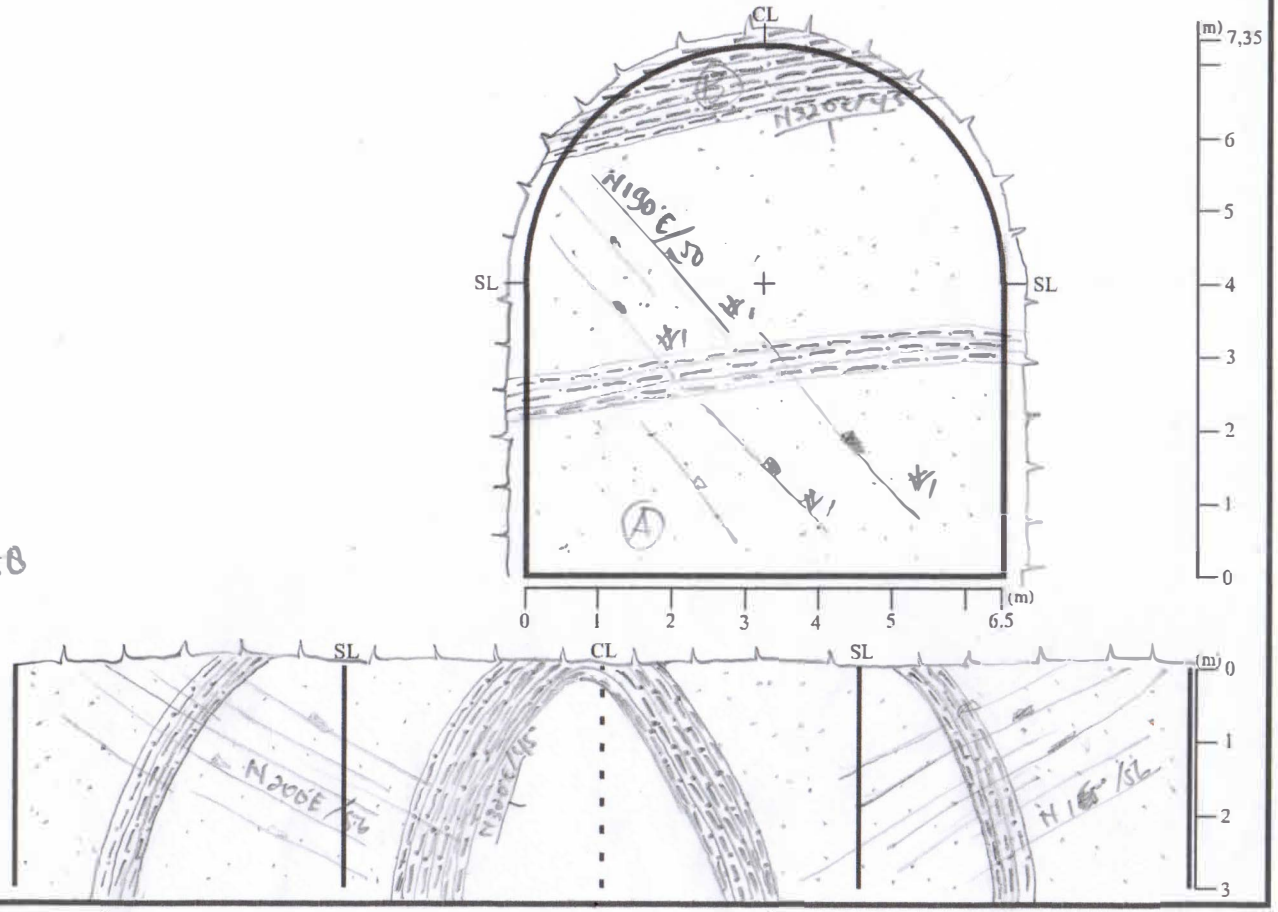
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS
: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

SHEET NO.	: 9
DATE	: 25
ROCK TYPE	: Sandstone, sandstone-shale
LOCATION	: TMAZD
CHAINAGE	: 6+452,30 CH: 1170,30
TUNNEL AXIS	: N235°E
JOINT SET ORIENTATION	:
#1	: N 210° E/° 60
#2	: N 325° E/° 50
#3	: N ____° E/° ____
#4	: N ____° E/° ____

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MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25	8
Rating	20	17	13	(8)	3	

3. Spacing of Discontinuities (SJ)						
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06	9
Rating	(20)	15	10	(8)	5	

4. Conition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	21
	Rating	(6)	4	(2)	1	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
	Rating	(6)	(4)	2	2	0		
Weathering	Weathering	Fresh	Slightly W.	Moderatly W.	Highly W.	Decomposed	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (CW)						
Inflow/10mTunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling
Strike Prependicular toTunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable)
Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
Irrespectif of Strike : (Dip 0 - 20, Fair)

-12

RMR = SR + RQD + SJ + CJ + CW - AJ **Total Rating of RMR** 59-12=47

MEANING OF ROCK MASS CLASS

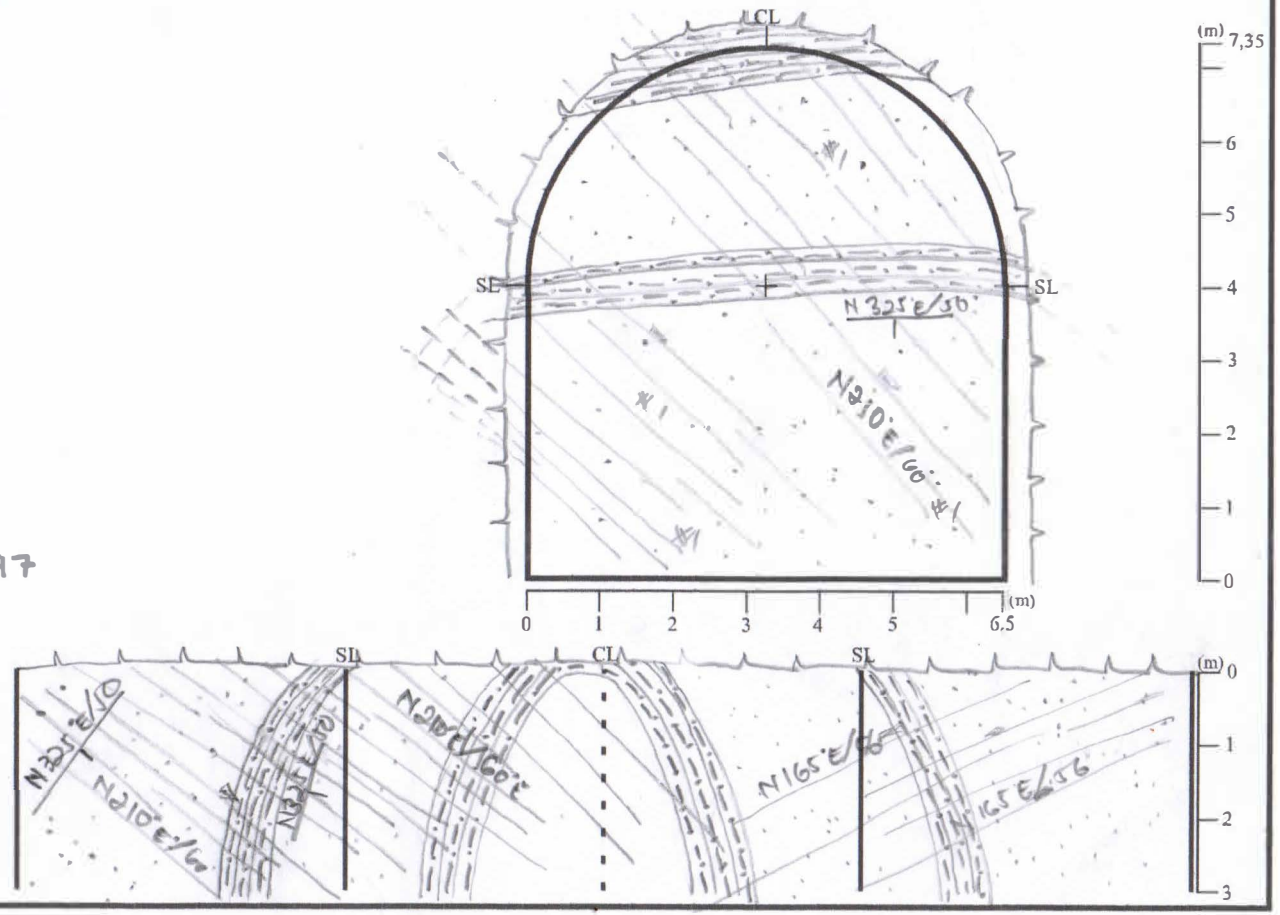
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	(41 - 60 (III) Fair Rock)	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A : sandstone : gray, fresh, medium strong, tight joint

B : Sandstone - shale : gray - dark gray, fresh tight joint

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)								Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	<25	13
Rating	20	17	(13)	8	3	

3. Spacing of Discontinuities (SJ)						
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06	9
Rating	(20)	15	10	8	(5)	

4. Conition of Discontinuities (CJ)									
PARAMETER	Discontiniuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	21
		Rating	(6)	4	(2)	1	0		
	Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
		Rating	(6)	5	4	(1)	0		
	Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
		Rating	6	(5)	3	(1)	0		
	Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	5	
		Rating	(6)	(4)	2	2	0		
	Weathering	Weathering	Fresh	Slighthly W.	Moderatly W.	Highly W.	Decomposed	6	
		Rating	(6)	5	3	1	0		

5. Groundwater (CW)						
Inflow/10m Tunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)	
Tunnel and Mines Rating :Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12)	-5
Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling Strike Perpendicular to Tunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable) Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable) Strike Parallel to Tunnel Axis : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable) Irrespeutif of Strike : (Dip 0 - 20, Fair)	
RMR = SR + RQD + SJ + CJ + CW - AJ	Total Rating of RMR: 64-5 ⇒ 59

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A : Sandstone : gray, fresh, medium strong, tight joint

B : Sandstone - shale : gray - dark gray, fresh, calcite infilling.

SHEET NO. : 10
DATE : 26/7/2019
ROCK TYPE : Sandstone, sandstone - shale
LOCATION : FTA 20
CHAINAGE : 6+454,60 CH : 1+172,60
TUNNEL AXIS : N 235
JOINT SET ORIENTATION :
#1 : N 210 °E/° 50
#2 : N 245 °E/° 45
#3 : N 235 °E/° 50 T
#4 : N ___ °E/° ___

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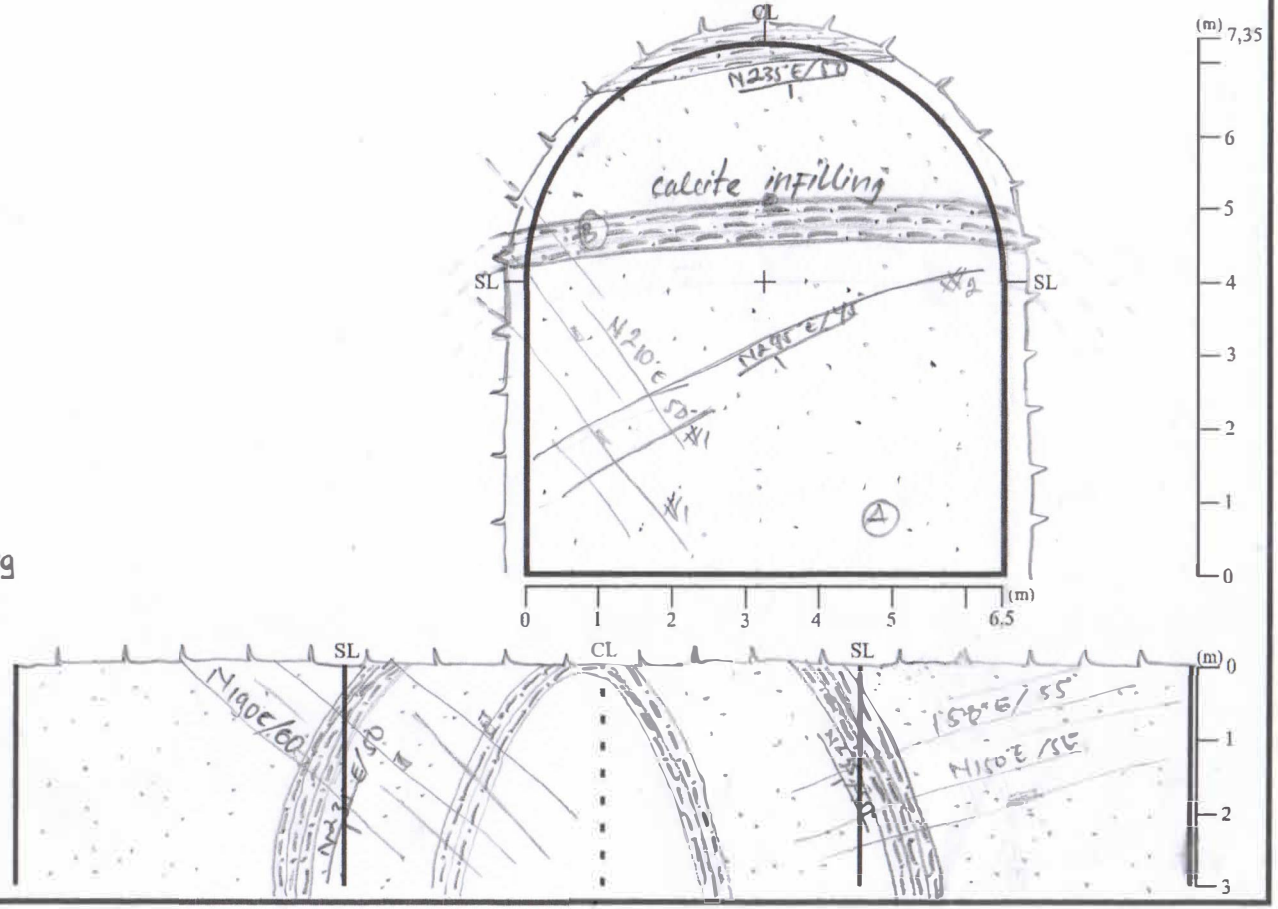
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS

: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

TUNNEL FACE & DEVELOPED TUNNEL PLAN



ROCK MASS RATING (By Bieniawski, 1989)

1. Strenghth of Intact Rock (SR)							Actual
UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	7
Rating	15	12	(7)	4	2	1	0	

2. Rock Quality Design (RQD) [>27Jn = <25 | 20 - 27Jn = 25 -50 | 13 - 19Jn = 50 - 75 | 8 - 12Jn = 75 - 90 | 0 - 7Jn = 75 - 100]					
RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	<25	13
Rating	20	17	(13)	8	3	

3. Spacing of Discontinuities (SJ)						
Spacing (m)	>2	0.6 - 2	0.2 - 0.6	0.06 - 0.2	< 0.06	9
Rating	(20)	15	10	(8)	5	

4. Conition of Discontinuities (CJ)

PARAMETER								
Discontinuities	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	21
	Rating	(6)	4	(2)	1	0		
Separation	Aperture (mm)	None	< 0.1	0.1 - 1	1 - 5	> 5	3	
	Rating	(6)	5	4	(1)	0		
Roughness	Roughness	Very Rough	Rough	Slighthly R.	Smooth	Slickensided	4	
	Rating	6	(5)	3	(1)	0		
Infilling	Gauge (mm)	None	< 5 (Hard)	> 5 (Hard)	< 5 (Soft)	> 5 (Soft)	3	
	Rating	(6)	4	(2)	2	0		
Weathering	Weathering	Fresh	Slighlty W.	Moderatly W.	Highly W.	Decomposed	6	
	Rating	(6)	5	3	1	0		

5. Groundwater (CW)						
Inflow/10mTunnel Length (L/min)	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	>125 Flowing	14
Rating	(15)	(10)	7	4	0	

6. Rating Adjustment for Discontinuities (AJ)

Tunnel and Mines Rating : Very Favorable (0), Favorable (-2), Fair (-5), Unfavorable (-10), Very Unfavorable (-12) → -5

Note : Effect of Discontinuities Strike and Dip Orientation in Tunneling
Strike Prependicular to Tunnel Axis : Drive with Dip (45 - 90, Very Favorable); (20 - 45, Favorable)
Drive against Dip (Dip 45 - 90, Fair) & (Dip 20 - 45, Unfavorable)
Strike Parallel to Tunnel Axis Irrespectif of Strike : (Dip 20 - 45, Fair) & (Dip 45 - 90, Very Unfavorable)
(Dip 0 - 20, Fair)

RMR = SR + RQD + SJ + CJ + CW - AJ — **Total Rating of RMR** 64 - 5 => 59

MEANING OF ROCK MASS CLASS				
81 - 100 (I) Very Good Rock	61 - 80 (II) Good Rock	(41 - 60 (III) Fair Rock	21 - 40 (IV) Poor Rock	< 20 (V) Very Poor Rock

NOTE

A : Sandstone : grey, fresh, Medium strong, clay infilling.
B : Sandstone - shale : grey - dark grey, fresh, tight joint.

SHEET NO. : 11
DATE : 27/7/2019
ROCK TYPE : Sandstone, Sandstone - shale
LOCATION : HTA2D
CHAINAGE : CH458.80 CH: 1+176.80
TUNNEL AXIS : N 235°E
JOINT SET ORIENTATION :
#1 : N 190 °E / 61
#2 : N 322 °E / 45
#3 : N ____ °E / ____
#4 : N ____ °E / ____

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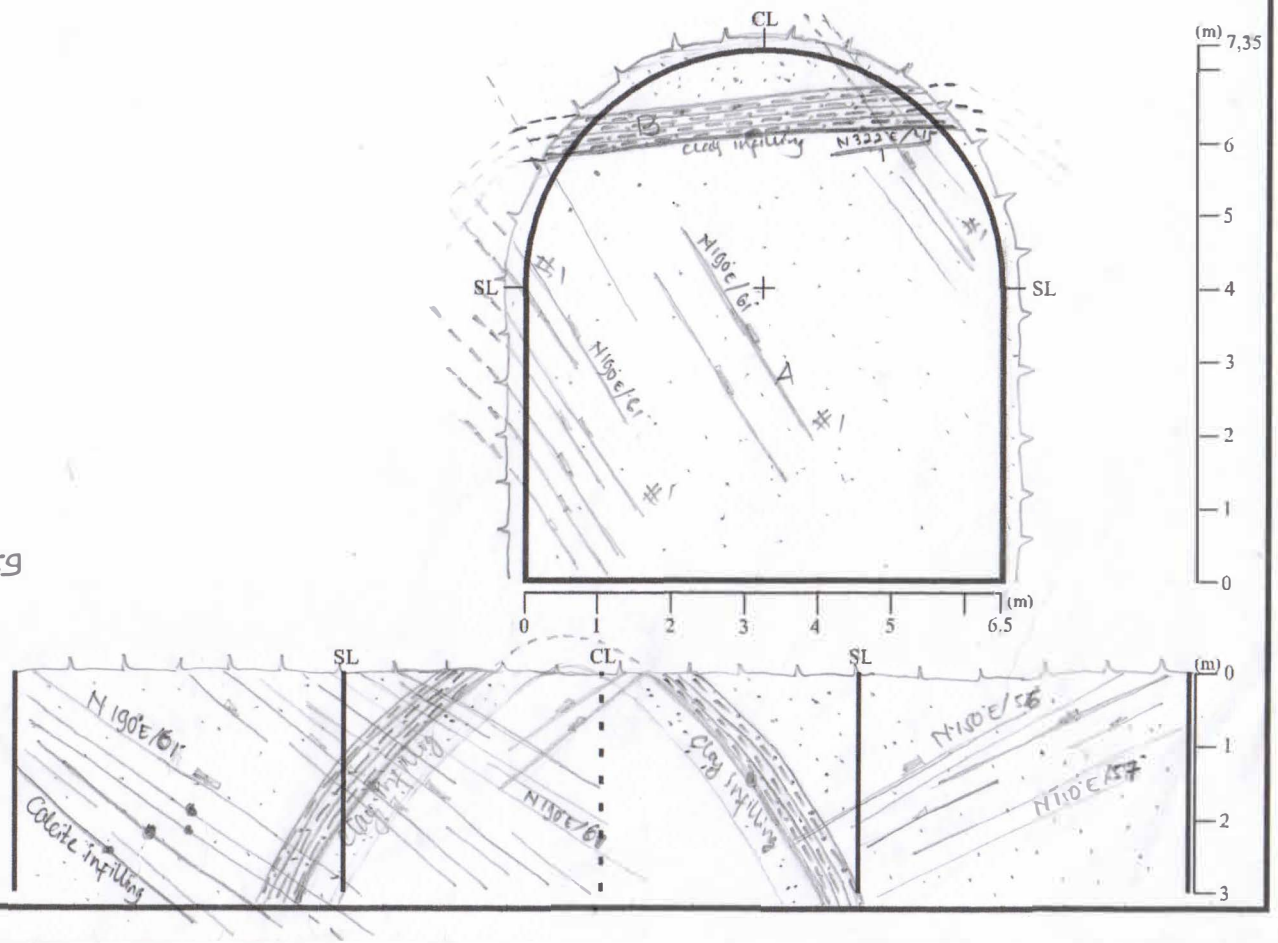
MAPPING FACE TUNNEL
SKALA
1 : 100
TANA TORAJA
2019

SYMBOLS
: OPEN JOINT
: COARSE IN FILL JOINT
: TIGHT JOINT
: CLAY/SILT/CALCITE IN FILL JOINT
: FAULT
: CRACK
: GROUND WATER
: SHALE
: SANDSTONE

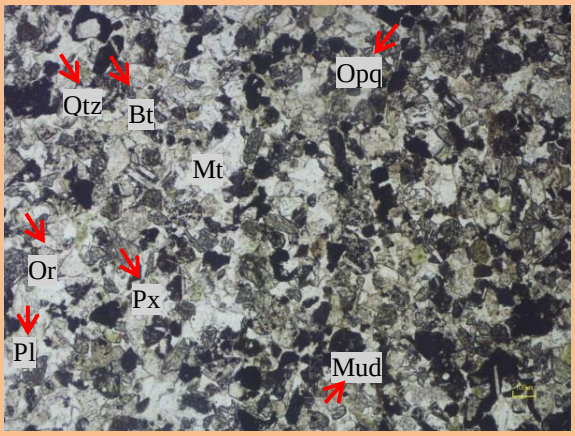
TUNNEL FACE & DEVELOPED TUNNEL PLAN



DESKRIPSI PETROGRAFI

No sayatan / No conto	**: UL/01/SST**	**Satuan**	**: Batupasir**
Lokasi	**: Ulfha**	**Nama Batuan**	**: *Arcosic arenite***

Foto



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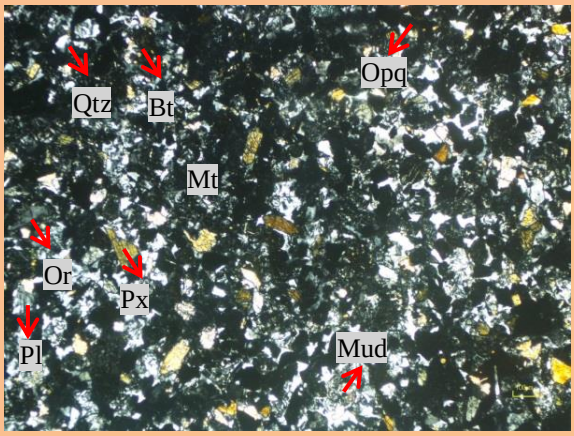


X – Nikol

Lensa Okuler : 10x *Lensa Obyektif : 5x* *Perbesaran Total : 50x*

Tipe Batuan **: Batuan Sedimen**

Tipe Stuktur **: Berlapis**

Mikroskopis **:**

Warna absorbsi kecoklatan, warna interferensi kuning kehitaman, tekstur klastik, bentuk *angular – rounded*. Komposisi material terdiri dari biotit, piroksin, kuarsa, plagioklas, ortoklas, mineral opak, matriks dan mud. Ukuran mineral ≤0,025 mm – 2,05 mm.

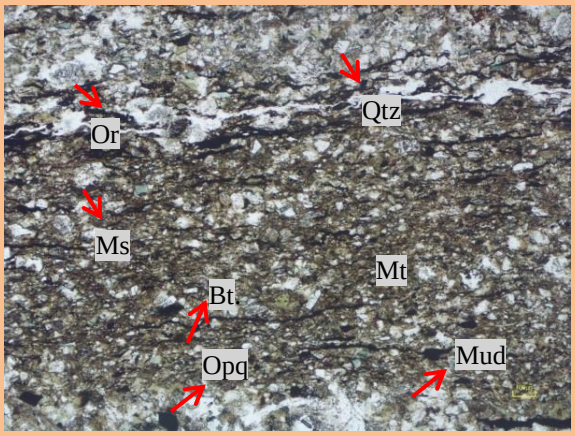
Deskripsi Material

Komposisi Material	Jumlah (%)	Keterangan Optik Material
Biotit (Bt.)	**5**	Warna absorbsi kuning kecokelatan, pleokroisme dwikroik kuat, relief sedang, belahan 1 arah, ukuran mineral 0,2 – 0,3 mm, warna interferensi cokelat, sudut pemadaman 0°, jenis gelapan paralel
Piroksin (Px.)	**20**	Warna absorbsi tidak berwarna – kuning kecokelatan, pleokroisme tidak ada, relief tinggi, belahan 1 arah, ukuran mineral 0,5 – 0,7 mm, warna interferensi kuning kecokelatan, sudut pemadaman 43°, jenis gelapan miring
Kuarsa (Qtz.)	**25**	Warna absorpsi tidak berwarna, pleokroisme tidak ada, relief rendah, bentuk subangular-angular, belahan tidak ada, ukuran mineral 0,225 – 0,625 mm, warna interferensi putih keabu-abuan, jenis pemadaman bergelombang.
Plagioklas (Pl.)	**10**	Warna absorbsi tidak berwarna, pleokroisme tidak ada, relief rendah, indeks bias $n_{min} < n_{cb}$, belahan tidak ada, ukuran mineral 0,15 – 0,5 mm, warna interferensi putih keabu-abuan, sudut pemadaman 15°, jenis pemadaman miring, kembaran Albit, jenis plagioklas albit.
Ortoklas (Or.)	**15**	Warna absorpsi tidak berwarna, pleokroisme tidak ada, relief rendah, belahan satu arah, ukuran mineral 0,375 – 0,75 mm, warna interferensi putih keabu-abuan, sudut pemadaman 6°, jenis pemadaman miring.
Mineral Opak (Opq.)	**10**	Warna absorbsi hitam, ukuran 0,25 – 0,55 mm, warna interferensi hitam .
Matriks (Mt.)	**10**	Matriks berupa massa dasar mikrokristalin memiliki warna absorbsi kuning kecoklatan, warna interferensi abu-agu kehitaman, ukuran ≤ 0,025 *mm*.
Mud	**5**	*Lime mud* dengan sifat optik warna absorbsi tidak berwarna, ukuran mineral < 0,02 mm, warna interferensi kuning keemasan

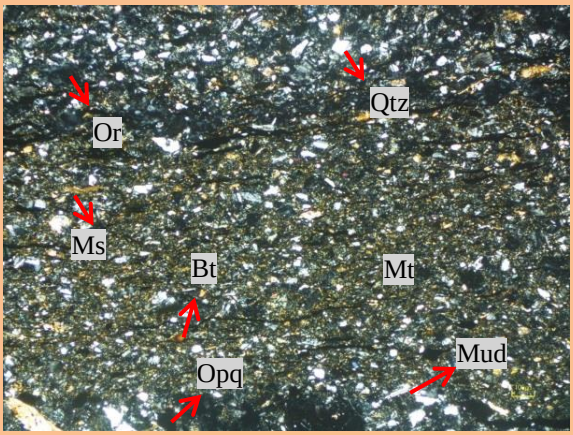
Nama Batuan **: *Arcosic arenite* (Pettijohn, 1975)**

No sayatan / No conto	**: UL/02/SH**	**Satuan**	**: Serpih**
Lokasi	**: Ulfha**	**Nama Batuan**	**: *Feldspatic wacke***

Foto



//– Nikol



X – Nikol

Lensa Okuler : 10x *Lensa Obyektif : 5x* *Perbesaran Total : 50x*

Tipe Batuan **: Batuan Sedimen**

Tipe Stuktur **: Berlapis, Menyerpih**

Mikroskopis **:**

Warna absorbsi kecoklatan, warna interferensi kuning kehitaman, tekstur klastik, bentuk *angular – rounded*. Komposisi material terdiri dari biotit, kuarsa, ortoklas, muskovit, mineral opaq, matriks dan *mud*. Ukuran mineral ≤0,025 mm – 0,25 mm.

Deskripsi Material

Komposisi Material	Jumlah (%)	Keterangan Optik Material
Biotit (Bt.)	**5**	Warna absorbsi kuning kecokelatan, pleokroisme dwikroik kuat, relief sedang, belahan 1 arah, ukuran mineral 0,2 – 0,3 mm, warna interferensi cokelat, sudut pemadaman 0°, jenis gelapan paralel
Kuarsa (Qtz.)	**5**	Warna absorpsi tidak berwarna, pleokroisme tidak ada, relief rendah, bentuk subangular-angular, belahan tidak ada, ukuran mineral 0,2 – 0,25 mm, warna interferensi putih keabu-abuan, jenis pemadaman bergelombang.
Ortoklas (Or.)	**25**	Warna absorpsi tidak berwarna, pleokroisme tidak ada, relief rendah, belahan satu arah, ukuran mineral 0,2– 0,25 mm, warna interferensi putih keabu-abuan, sudut pemadaman 6°, jenis pemadaman miring.
Muskovit (Ms.)	**10**	Muskovit memiliki warna absorbsi transparan/*colourless*, warna interferensi kuning kemerahan. Memiliki relief sedang, bentuk mineral anhedral – subhedral, intensitas tinggi, ukuran 0,3 – 0,4 mm, pecahan tidak rata, belahan satu arah, pleokrisme dwikroik, sudut gelapan 3^0, jenis gelapan bergelombang.
Mineral Opak (Opq.)	**5**	Warna absorbsi hitam, ukuran 0,1 – 0,2 mm, warna interferensi hitam .
Matriks (Mt.)	**45**	Matriks berupa massa dasar mikrokristalin memiliki warna absorbsi kuning kecoklatan, warna interferensi abu-agu kehitaman, ukuran ≤ 0,025 *mm*.
Mud	**5**	*Lime mud* dengan sifat optik warna absorbsi tidak berwarna, ukuran mineral < 0,02 mm, warna interferensi kuning keemasan

Nama Batuan **: *Feldspatic wacke* (Pettijohn, 1975)**

DATA
NILAI UCS

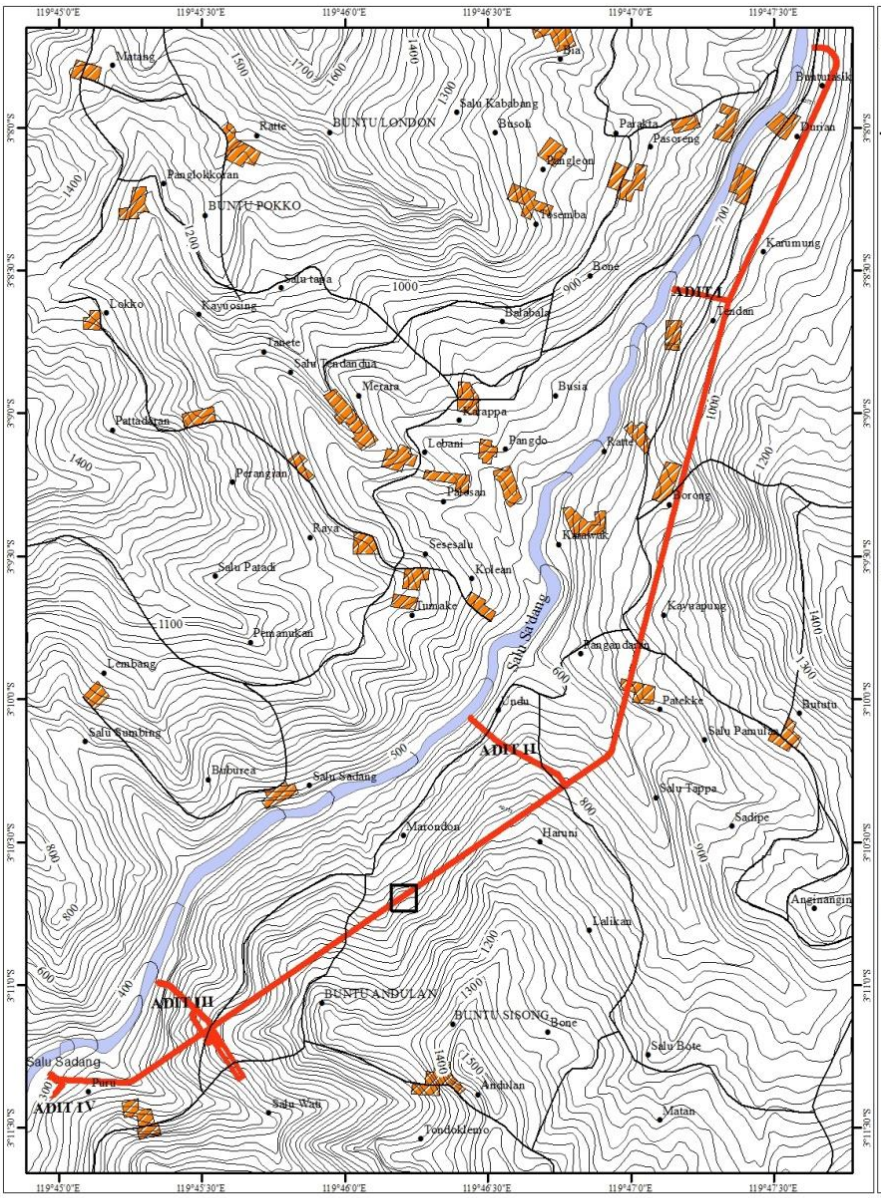
BALAI BANGUNAN HIDRAULIK DAN GEOTEKNIK KEAIRAN
LABORATORIUM MEKANIKA BAHAN DAN BATUAN
Jl. Ir. H. Juanda No. 193 Bandung 40135
Tel/Fax : 022-2510374 Email : lab.bahan_pusair@yahoo.com

Summary

PLTA Malea _ Makale,Toraja Sulawesi Selatan

No.	SAMPLE			PETROGRAFI	INDEX PROPERTIES										UNCONFINED COMPRESSIVE STRENGTH								ALKALI REACTIVITY		
															Natural				Saturated						
	ID	DEPTH (m) From	DEPTH (m) To	LITHOLOGY	Natural Density d	Natural Water Content	Saturat. Density s	Absorp/ ST. Water	Dry Density d	Deg. Of Saturated S	Porosity n	Ap. Spec. Gravity	TRUE Spec. Gravity	Void Ratio e	σc	E (Axial)	E (Diametral)	Poisson Ratio	σc	E (Axial)	E (Diametral)	Poisson Ratio	Disolve silica (SC)	Alkali reduce (RC)	Reactivity
					gr/cm³	%	gr/cm³	%	gr/cm³	%	%	-	-	-	kg/cm²	kg/cm²	kg/cm²	-	kg/cm²	kg/cm²	kg/cm²	-	mmol/l	mmol/l	-
1	H.01 (P)	8,30	9,25	TF - SD Left Dam	2,596	2,27	2,607	2,71	2,538	84,00	6,87	2,5385	2,7257	0,074	493,592	6,46E+04	2,16E+05	0,30	352,401	1,51E+04	4,52E+04	0,33			
2	H.02 (P)	11,10	12,00	TF - SD Right Dam	2,639	1,64	2,654	2,22	2,596	73,91	5,76	2,5965	2,7553	0,061	482,965	7,71E+04	2,66E+05	0,29	358,369	6,28E+04	2,05E+05	0,31			
3	H.03 (P)	23,00	24,00	TF - SD Right Dam	2,518	3,22	2,539	4,06	2,440	78,95	9,95	2,4396	2,7093	0,110	623,003	8,76E+04	3,15E+05	0,28	523,690	6,30E+04	2,01E+05	0,31			
4	H.03.1 (P)	2,00	2,70	TF-SD	2,498	3,31	2,519	4,18	2,418	79,31	10,10	2,4181	2,6899	0,112	781,677	9,86E+04	3,61E+05	0,27	658,988	6,16E+04	1,91E+05	0,32			
5	H.03.2 (P)	3,00	3,70	TF-SD	2,590	2,45	2,613	3,36	2,528	72,73	8,51	2,5264	2,7634	0,093	427,270	7,32E+04	2,27E+05	0,32	406,973	5,73E+04	1,67E+05	0,34			
6	H.03.3 (P)	14,25	15,00	TF-SD	2,547	2,36	2,578	3,62	2,488	65,36	9,00	2,4879	2,7330	0,099	874,956	8,67E+04	3,28E+05	0,26	824,415	7,97E+04	2,83E+05	0,28			
7	H.04.1 (P)	16,00	18,40	TF-SD	2,617	2,71	2,636	3,46	2,548	78,20	8,81	2,5479	2,7941	0,097	814,466	9,42E+04	3,71E+05	0,25	520,947	6,10E+04	2,01E+05	0,30			
8	H.06.1 (P)	7,00	8,00	TF-SD	2,413	3,37	2,445	4,72	2,335	71,43	11,02	2,3346	2,6239	0,124	591,681	7,38E+04	2,31E+05	0,32	531,705	5,63E+04	1,62E+05	0,35			
9	H.07.1 (P)	11,10	11,85	BR - R Dam	2,479	2,95	2,513	4,35	2,408	67,86	10,49	2,4082	2,6904	0,117	547,807	5,67E+04	1,65E+05	0,36	481,244	9,05E+04	2,36E+05	0,38			
10	H.07.2 (P)	17,00	17,90	BR - R Dam	2,396	2,88	2,460	5,62	2,329	51,28	13,09	2,3289	2,6795	0,151	644,802	7,44E+04	2,25E+05	0,33	520,273	7,06E+04	1,91E+05	0,37			
11	H.07.3 (P)	24,00	24,90	BR - R Dam	2,573	2.90	2,580	3,21	2,500	90,46	8,02	2,5000	2,7176	0,087	617,183	6,56E+04	2,12E+05	0,31	565,187	8,63E+04	2,48E+05	0,35			
12	H.07.4 (P)	5,25	6,15	SS - R Dam	2,480	3,95	2,500	4,81	2,385	82,14	11,48	2,3852	2,6944	0,130	654,640	5,74E+04	1,78E+05	0,32	419,050	6,08E+04	1,57E+05	0,39			
13	H.07.5 (P)	8,10	8,60	SS - R Dam	2,458	3,14	2,491	4,52	2,383	69,44	10,78	2,3832	2,6711	0,121	619,664	9,10E+04	3,27E+05	0,28	416,866	6,93E+04	2,03E+05	0,34			
14	H.10.1 (P)	11,20	13,30	SS - Inlet	2,565	2,11	2,574	2,44	2,513	86,36	6,13	2,5125	2,6766	0,065	884,478	8,44E+04	3,36E+05	0,25	484,103	7,59E+04	2,08E+05	0,36			
15	H.10.2 (P)	13,55	14,45	BR - Inlet	2,624	2,25	2,631	2,51	2,566	89,47	6,44	2,5661	2,7428	0,059	657,884	6,05E+04	2,66E+05	0,26	542,749	7,42E+04	2,45E+05	0,30			
16	H.10.3 (P)	15,30	16,80	BR - Inlet	2,619	2,08	2,631	2,55	2,566	81,48	6,55	2,5655	2,7455	0,070	578,027	7,94E+04	2,91E+05	0,27	566,268	5,14E+04	1,70E+05	0,30			
17	H.10.4 (P)	26,50	26.75	BR - HW - Inlet	2,681	0,90	2,689	1,20	2,657	75,00	3,10	2,6569	2,7445	0,033	864,345	6,60E+04	2,71E+05	0,24	787,080	8,69E+04	3,29E+05	0,26			
18	H.10.5 (P)	64,20	64,90	BR - HW - Inlet	2,577	1,12	2,597	1,91	2,549	58,82	4,86	2,5486	2,6797	0,051	949,758	9,10E+04	3,91E+05	0,23	797,570	7,08E+04	2,40E+05	0,29			
19	A-1 (3)	-	-	Pyroclastic breccia																			15,20	169,37	Not react
20	A-2 (1)	-	-	Pyroclastic breccia																			16,35	138,58	Not react
21	M-1 H0	18,80	19,00	Crystal tuff																					
22	M-1 H0	22,70	22,90	Crystal tuff																					
23	M-3 H3	8,10	8,25	Pyroclastic breccia																					
24	M-4 H3	25,50	25,72	Lithic tuff																					
Total Testing				6	18										36								2		

LAMPIRAN
PETA



KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS HASANUDDIN
FAKULTAS TEKNIK
DEPARTEMEN TEKNIK GEOLOGI

PETA TUNNEL PLTA
PT. MALEA ENERGY

N
W E
S

0 200 400 800 1.200 1.600
Meters

SKALA 1 : 30.000
IK 25

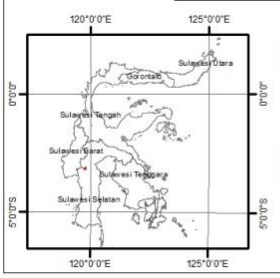
OLEH
ULFHA
D611 15 12

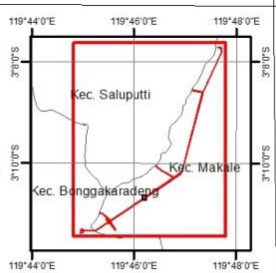
MAKASSAR
2021

KETERANGAN :

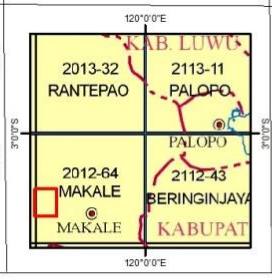
- : Terowongan
- : Lokasi Penelitian
- : Kontur Biasa
- : Kontur Indeks
- : Jalan
- : Sungai
- : Pemukiman
- Haruni : Nama Desa

PETA TUNJUK LOKASI





PETA INDEKS



SUDUT DEKLINASI

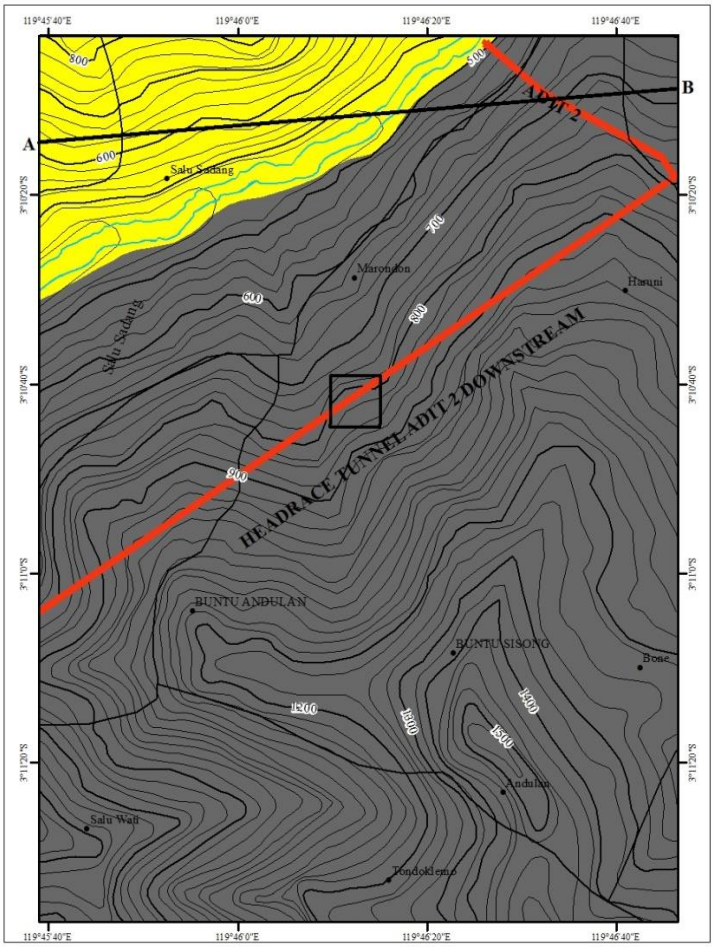
US : Utara Sebenarnya (Geografi)
UG : Utara Grid (UTM)
UM : Utara Magnetik

Hubungan antara Utara sebenarnya, Utara grid dan Utara magnetik ditunjukkan secara diagram untuk pusat peta ini.

Deklinasi magnetik rata-rata 1°17' tahun 1999 dipusat lembar peta.
Deklinasi tersebut tiap tahun berkurang dengan 03'

PETA RUPA BUMI 1 : 50.000
LEMBAR MAKALE 2012-64
DITERBITKAN OLEH BADAN KOORDINASI SURVEY DAN PEMETAAN NASIONAL (BAKOSURTANAL)

Cibinong, Bogor



KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS HASANUDDIN
FAKULTAS TEKNIK
DEPARTEMEN TEKNIK GEOLOGI

PETA GEOLOGI
DAERAH PENELITIAN

N
W E
S

0 150 300 600 900 1.200 Meters

SKALA 1 : 15.000
IK : 25

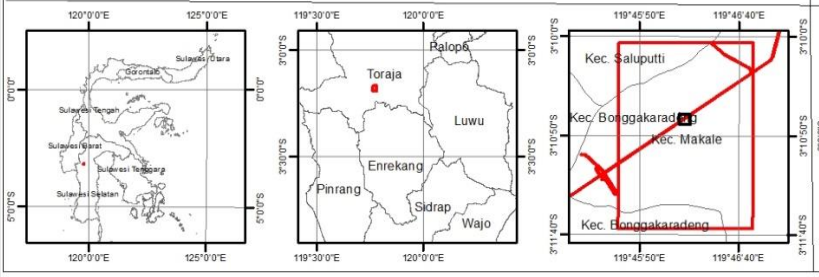
OLEH
ULFHA
D611 15 12

MAKASSAR
2021

KETERANGAN :

- : Satuan Serpih (Tmps)
- : Satuan Batupasir (Tmps)
- : Garis Sayatan Penamang Geologi
- : Terowongan
- : Sungai
- : Kontur Indeks
- : Kontur Biasa
- : Jalan
- Haruni : Nama Desa

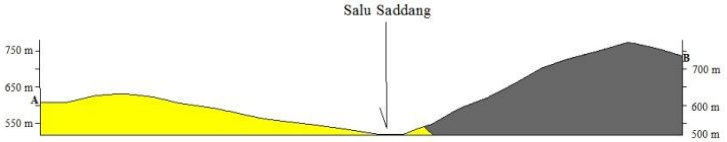
PETA TUNJUK LOKASI

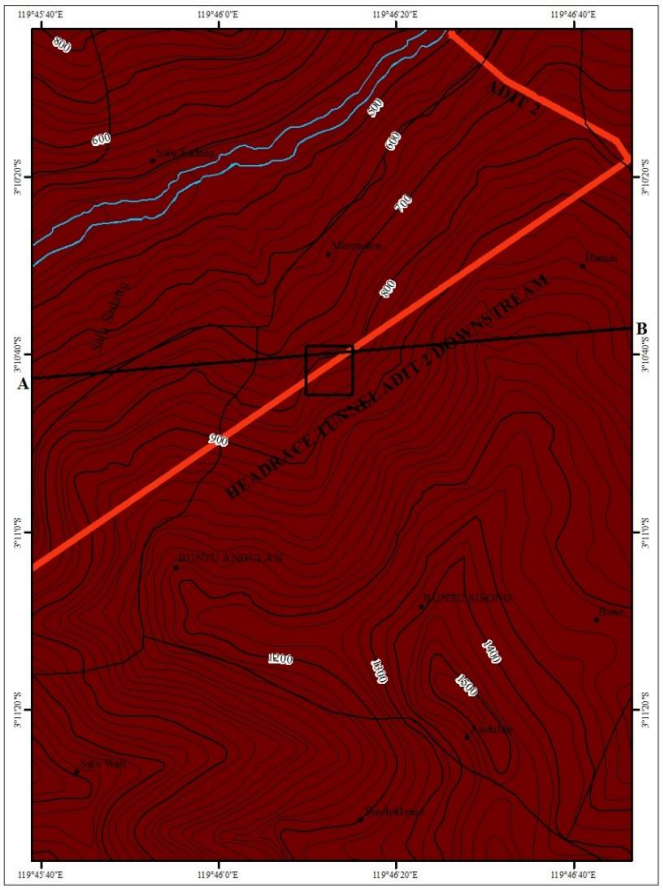


PETA INDEKS

SUDUT DEKLINASI

PENAMPANG GEOLOGI A - B
H : V
1 : 2





KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS HASANUDDIN
FAKULTAS TEKNIK
DEPARTEMEN TEKNIK GEOLOGI

PETA GEOMORFOLOGI
DAERAH PENELITIAN

N
W E
S

0 150 300 600 900 1.200 Meters

SKALA 1 : 15.000
IK : 25

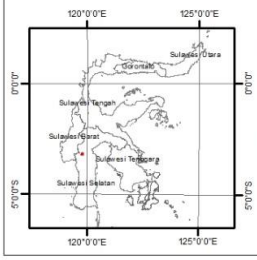
OLEH
ULFHA
D611 15 12

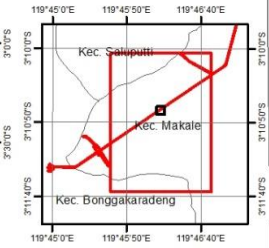
MAKASSAR
2021

KETERANGAN :

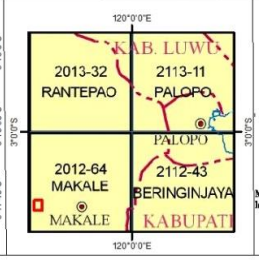
- : Satuan Morfologi Pegunungan Denudasional
- : Terowongan
- : Garis Sayatan Penampang
- : Kontur Biasa
- : Kontur Indeks
- : Jalan
- : Sungai
- : Pemukiman
- Haruni : Nama Desa

PETA TUNJUK LOKASI





PETA INDEKS



SUDUT DEKLINASI

US : Utara Sebenarnya (Geograf)
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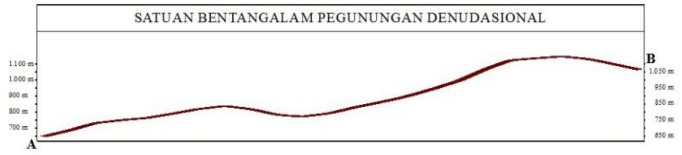
Hubungan antara Utara sebenarnya, Utara grid dan Utara magnetik ditunjukkan secara diagram untuk pusat peta ini

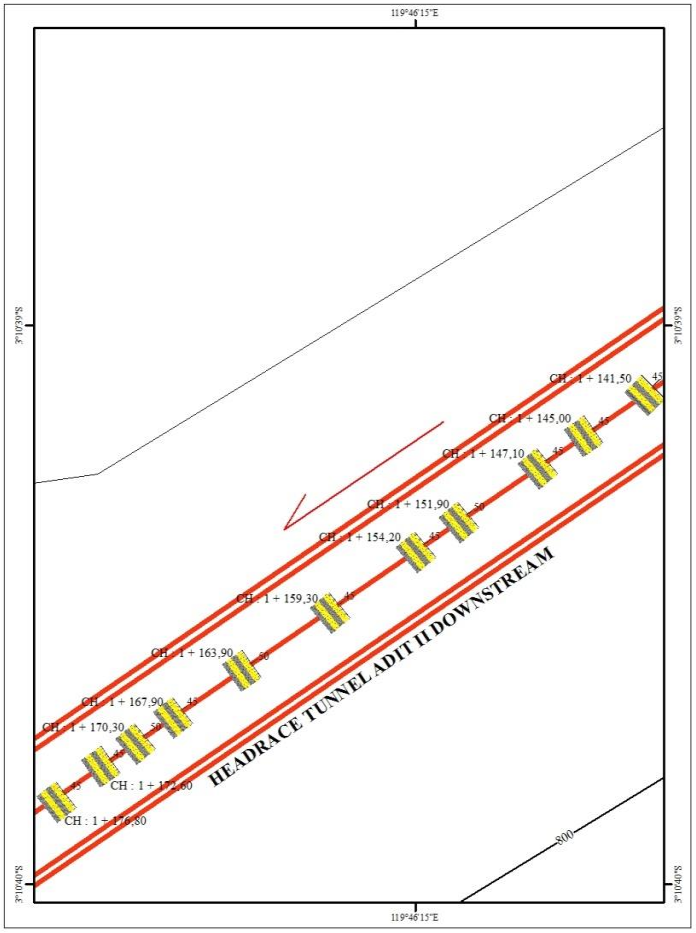
Deklinasi magnetik rata-rata 1°17' tahun 1999 dipusat lembar peta.
Deklinasi tersebut tiap tahun berserang dengan 03'

PETA RUPABUMI 1 : 50.000
LEMBAR MAKALE 2012-64
DITERBITKAN OLEH BADAN KOORDINASI SURVEY DAN PEMETAAN NASIONAL (BAKOSURTANAL)

Cibinong, Bogor

PENAMPANG GEOMORFOLOGI SAYATAN A - B
H : V
1 : 1





KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS HASANUDDIN
FAKULTAS TEKNIK
DEPARTEMEN TEKNIK GEOLOGI

PETA STASIUN HTA2D
CH : 1.141,50 M - 1.176,80 M

N
W E
S

0 2 4 8 12 16 Meters

SKALA 1 : 250
IK : 25

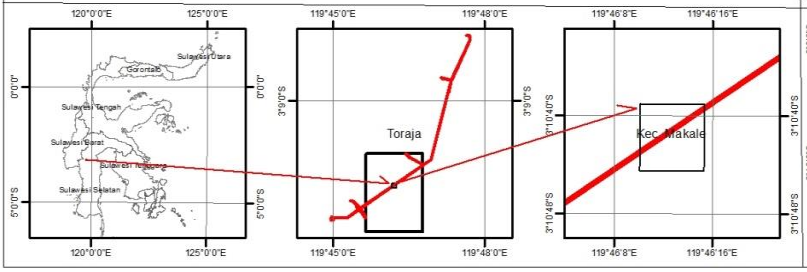
OLEH
ULFHA
D611 15 12

MAKASSAR
2021

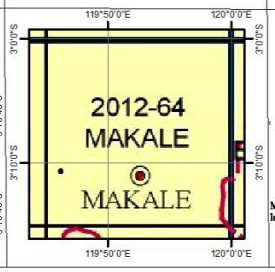
KETERANGAN :

- CH : 1 + 159,30 : Nomor Stasiun
- : Batupasir
- : Serpih
- : Kedudukan Batuan
- : Eskavasi Terowongan
- : Arah Eskavasi terowongan
- : Kontur

PETA TUNJUK LOKASI



PETA INDEKS



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Deklinasi magnetik rata-rata 1°17' tahun 1999 dipusat lembar peta.
Deklinasi tersebut tiap tahun bertambah sebesar 03'

MAKALE
lember 2012-64

PETA RUPABUMI 1 : 50.000
LEMBAR MAKALE 2012-64
DITERBITKAN OLEH BADAN KOORDINASI SURVEY DAN PEMETAAN NASIONAL (BAKOSURTANAL)

Cibinong, Bogor