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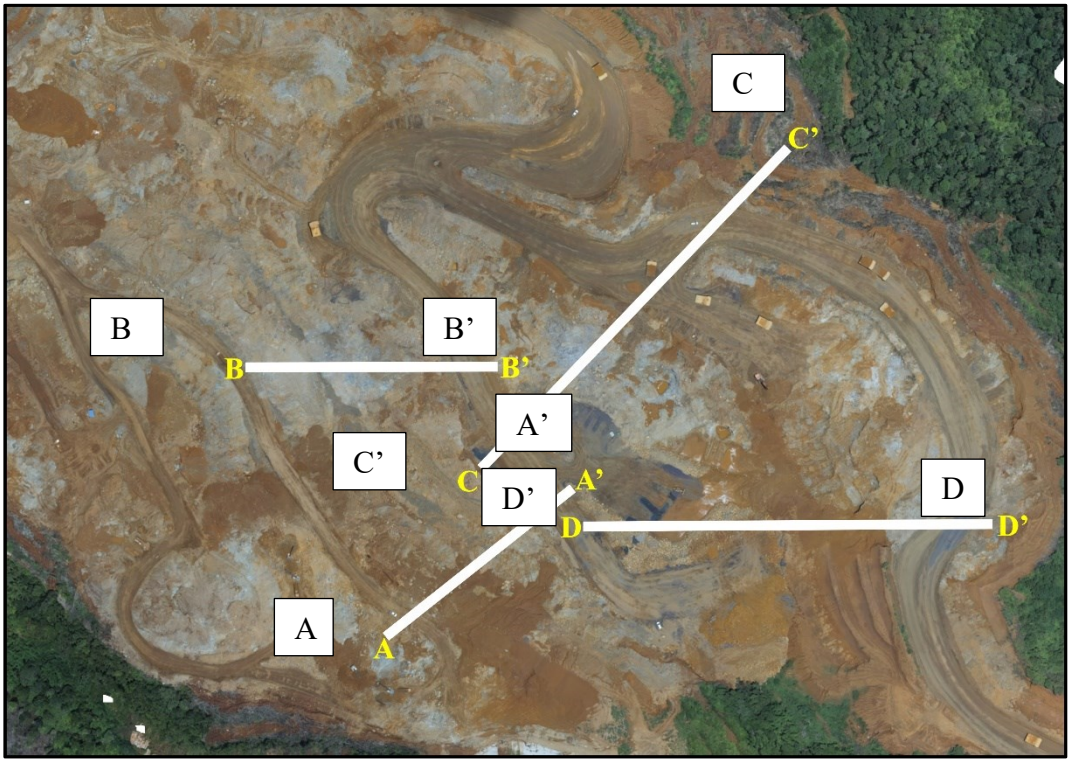
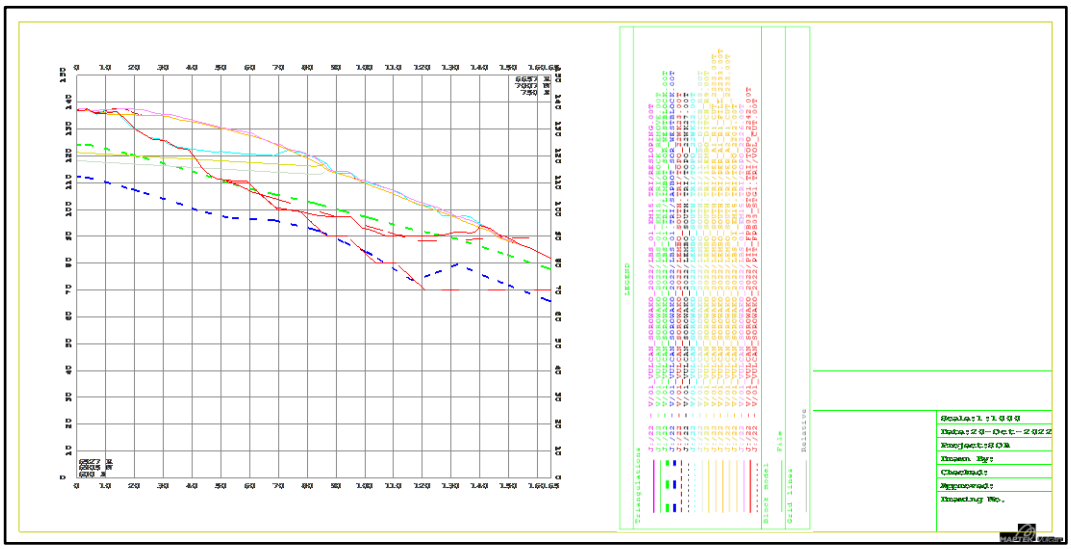
Lampiran 1 Lokasi *Section* Pit FPB-03



Lampiran 2 Penampang 2 Dimensi *Pit* FPB-03



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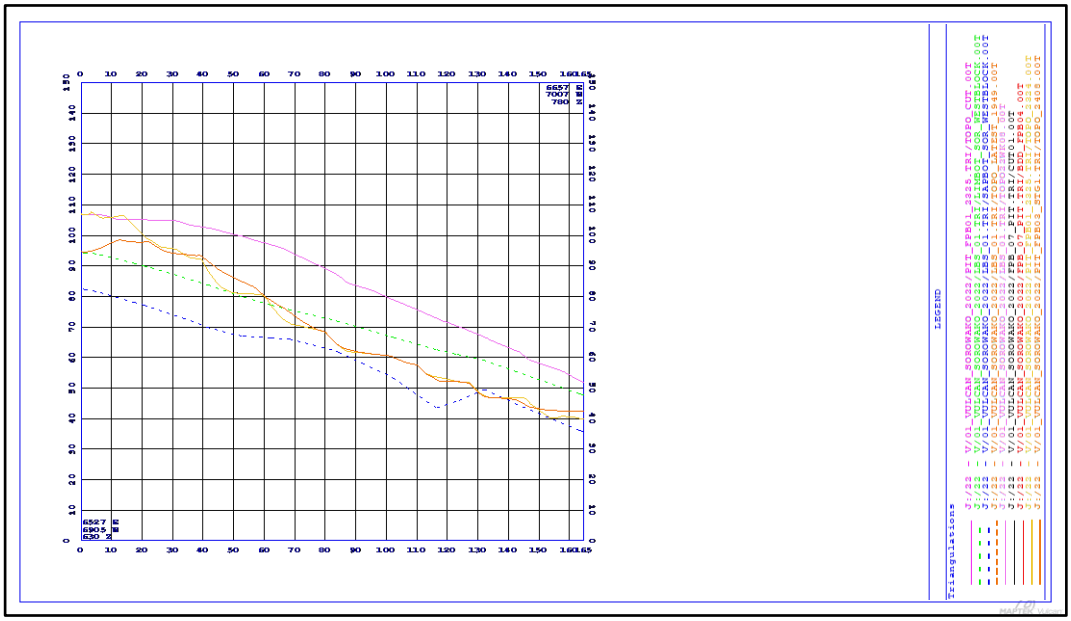

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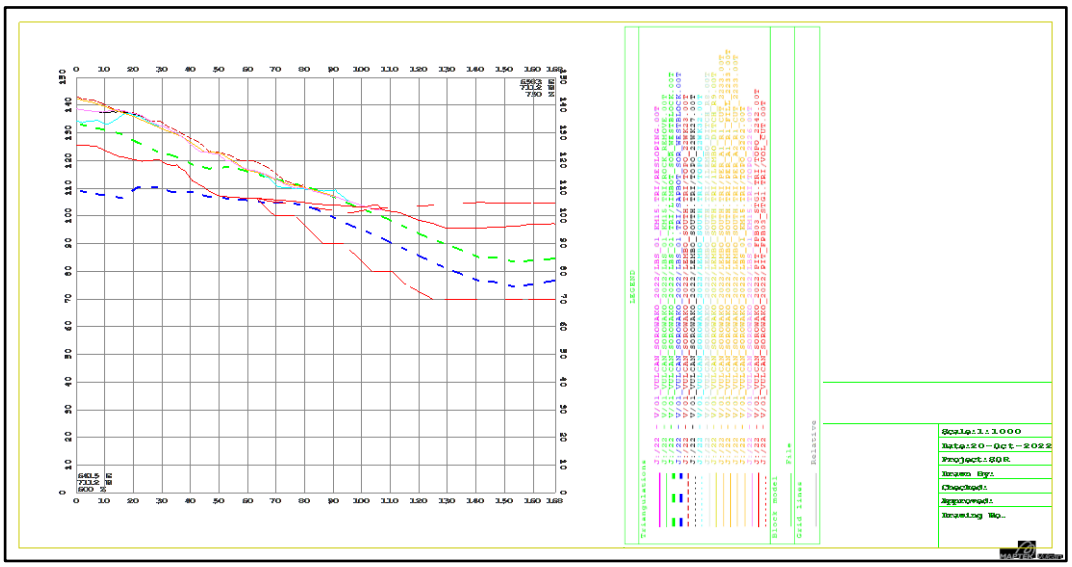

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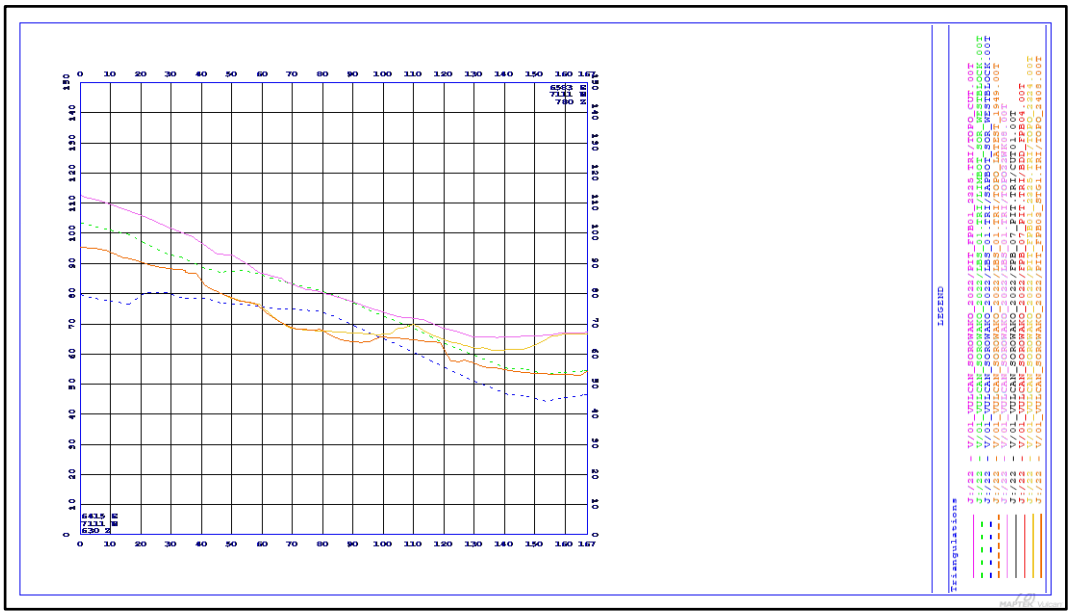

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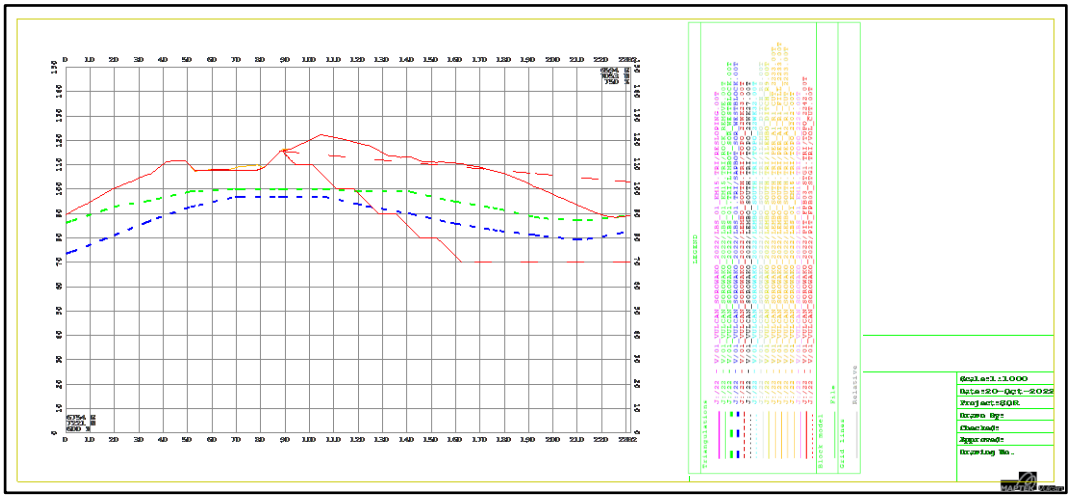

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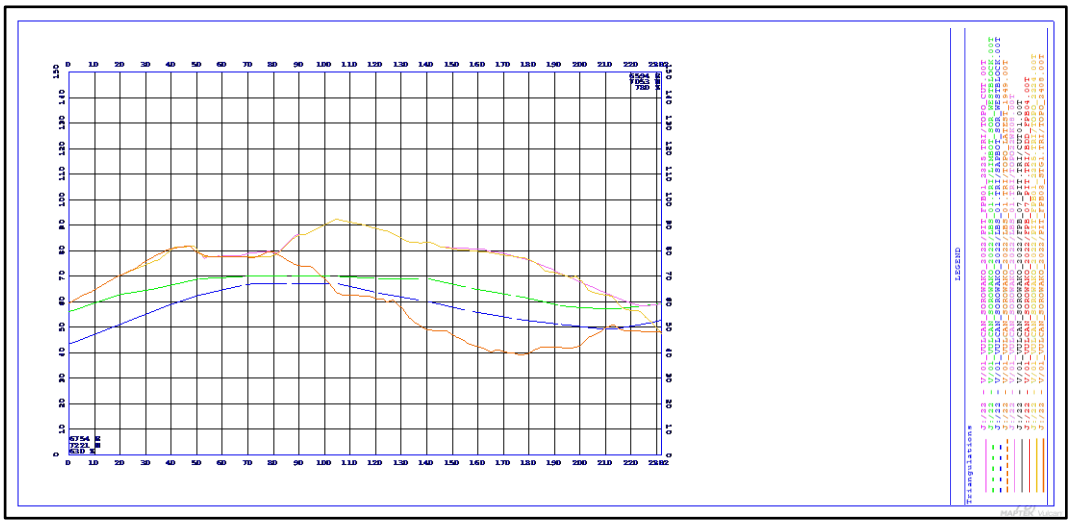

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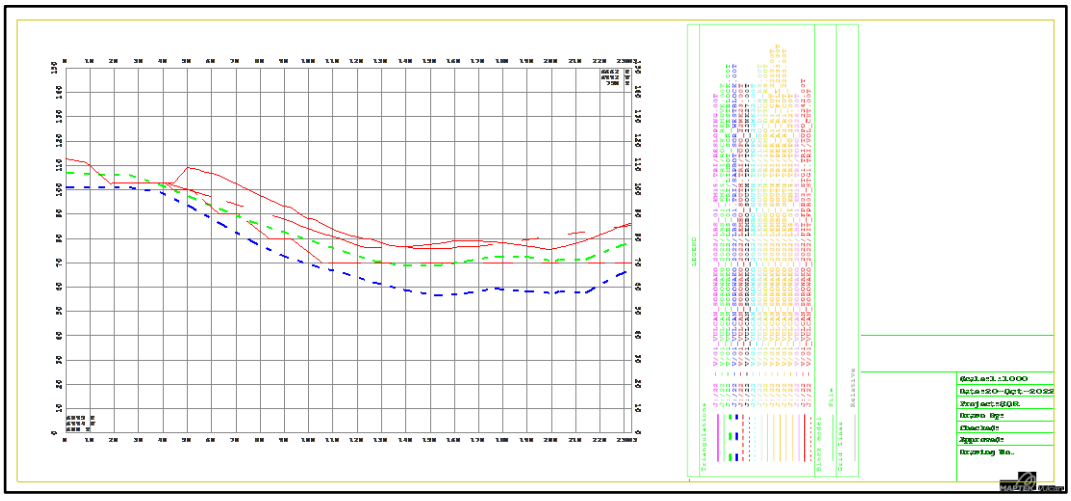

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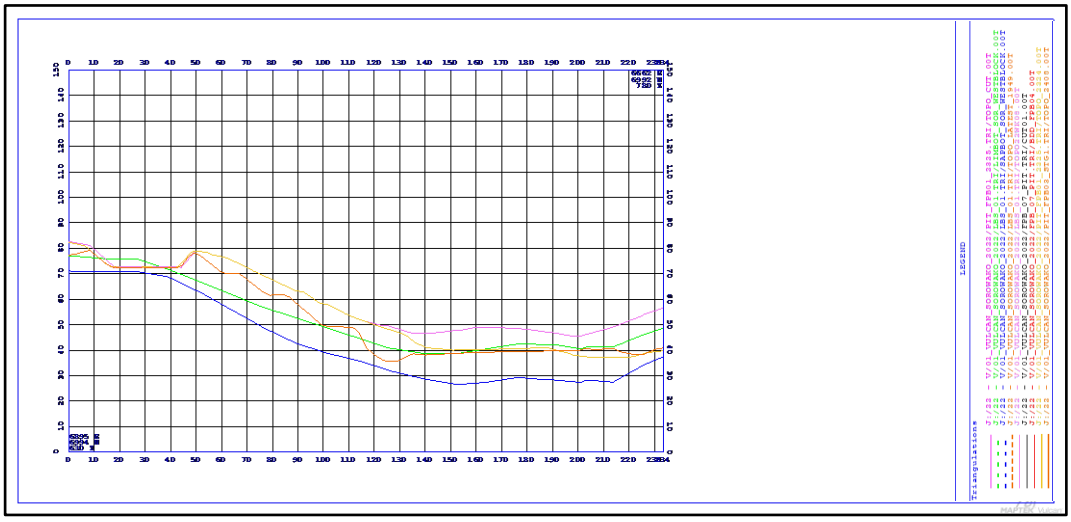


***Section* D-D' Aktual**

Lampiran 3 Perhitungan Kadar Air

Kadar air tanah asli dapat dihitung dengan persamaan sebagai berikut (Hawanto *et al*., 2021):

$$W = \frac{W2-W3}{W3-W1} x\ 100$$

Dimana,

W = Kadar air tanah asli (%)

W1 = Berat cawan kosong (gr)

W2 = Berat cawan + tanah basah (gr)

W3 = Berat cawan + tanah kering (gr)

1. Kedalaman 01.55 – 02.00 Meter

$$W_A = \frac{71.73 - 43.55}{43.55 - 8.43} x\ 100$$
$$= 80.21\%$$

$$W_B = \frac{61.63 - 37.29}{37.29 - 8.43} x\ 100$$
$$= 84.34\%$$

$$W_C = \frac{64.53 - 38.47}{38.47 - 8.46} x\ 100$$
$$= 86.84\%$$

$$W_D = \frac{74.99 - 46.80}{46.80 - 8.40} x\ 100$$
$$= 73.41\%$$

$$W_E = \frac{70.99 - 42.73}{42.73 - 8.35} x\ 100$$
$$= 82.22\%$$

$$W = \frac{80.21+84.34+86.84+73.41+82.22}{5} = 81.40\%$$

2. Kedalaman 03.50 – 04.00 Meter

$$W_A = \frac{44.70 - 28.98}{28.98 - 8.43} x\ 100$$
$$= 76.50\%$$

$$W_B = \frac{35.61 - 25.70}{25.70 - 8.42} x\ 100$$
$$= 57.35\%$$

$$W_C = \frac{47.44 - 31.45}{31.45 - 8.33} x\ 100$$
$$= 69.16\%$$

$$W_D = \frac{43.70 - 30.02}{30.02 - 8.33} x\ 100$$
$$= 63.07\%$$

$$W_E = \frac{56.59 - 34.93}{34.93 - 8.28} x\ 100$$
$$= 81.28\%$$

$$W = \frac{76.50+57.35+69.16+63.07+81.28}{5} = 69.47\%$$

3. Kedalaman 06.00 – 06.45 Meter

$$W_A = \frac{31.48 - 24.75}{24.75 - 9.34} x\ 100$$
$$= 43.65\%$$

$$W_B = \frac{31.73 - 24.55}{24.55 - 9.28} x\ 100$$
$$= 47.07\%$$

$$W_C = \frac{31.02 - 24.31}{24.31 - 9.33} x\ 100$$
$$= 44.78\%$$

$$W_D = \frac{30.95 - 24.43}{24.43 - 9.22} x\ 100$$
$$= 42.89\%$$

$$W_E = \frac{31.59 - 24.76}{24.76 - 9.28} x\ 100$$
$$= 44.07\%$$

$$W = \frac{43.65+47.07+44.78+42.89+44.07}{5} = 44.49\%$$

4. Kedalaman 08.00 – 08.45 Meter

$$W_A = \frac{62.30 - 38.12}{38.12 - 8.38} x\ 100$$
$$= 81.31\%$$

$$W_B = \frac{52.55 - 35.05}{35.05 - 8.35} x\ 100$$
$$= 65.54\%$$

$$W_C = \frac{53.76 - 35.41}{35.41 - 8.40} x\ 100$$
$$= 67.94\%$$

$$W_D = \frac{51.97 - 32.87}{32.87 - 8.85} x\ 100$$
$$= 79.52\%$$

$$W_E = \frac{62.71 - 38.60}{38.60 - 8.39} x\ 100$$
$$= 79.81\%$$

$$W = \frac{81.31+65.54+67.94+79.52+79.81}{5} = 74.83\%$$

5. Kedalaman 11.00 – 11.45 Meter

$$W_A = \frac{42.77 - 26.74}{26.74 - 8.34} x\ 100$$
$$= 87.12\%$$

$$W_B = \frac{34.45 - 23.31}{23.31 - 8.32} x\ 100$$
$$= 74.32\%$$

$W_C = \frac{25.01 - 19.09}{19.09 - 8.39} x\ 100$

$= 55.33\%$

$W_D = \frac{50.24 - 31.59}{31.59 - 8.51} x\ 100$

$= 80.81\%$

$W_E = \frac{39.10 - 25.59}{25.59 - 8.33} x\ 100$

$= 78.27\%$

$W = \frac{87.12+74.32+55.33+80.81+78.27}{5} = 75.17\%$

6. Kedalaman 13.00 – 13.45 Meter

$W_A = \frac{54.23 - 31.92}{31.92 - 8.41} x\ 100$

$= 94.90\%$

$W_B = \frac{56.42 - 32.84}{32.84 - 8.37} x\ 100$

$= 96.38\%$

$W_C = \frac{61.18 - 35.23}{35.23 - 8.47} x\ 100$

$= 97.03\%$

$W_D = \frac{55.93 - 32.38}{32.38 - 8.38} x\ 100$

$= 98.17\%$

$W_E = \frac{52.09 - 31.55}{31.55 - 8.36} x\ 100$

$= 88.56\%$

$W = \frac{94.90+96.38+97.03+98.17+88.56}{5} = 95.01\%$

7. Kedalaman 15.00 – 15.45 Meter

$W_A = \frac{37.71 - 23.35}{23.35 - 8.33} x\ 100$

$= 95.57\%$

$W_B = \frac{42.13 - 27.04}{27.04 - 8.39} x\ 100$

$= 80.95\%$

$W_C = \frac{39.72 - 25.41}{25.41 - 8.34} x\ 100$

$= 83.85\%$

$W_D = \frac{37.26 - 24.79}{24.79 - 8.32} x\ 100$

$= 75.76\%$

$W_E = \frac{44.81 - 27.90}{27.90 - 8.51} x\ 100$

$= 87.26\%$

$$W = \frac{95.57+80.95+83.85+75.76+87.26}{5} = 84.68\%$$

8. Kedalaman 17.00 – 17.45 Meter

$$W_A = \frac{40.25 - 26.06}{26.06 - 9.34} x\ 100$$
$$= 84.84\%$$

$$W_B = \frac{37.71 - 24.92}{24.92 - 9.28} x\ 100$$
$$= 81.74\%$$

$$W_C = \frac{36.11 - 24.39}{24.39 - 9.33} x\ 100$$
$$= 77.76\%$$

$$W_D = \frac{37.51 - 25.03}{25.03 - 9.22} x\ 100$$
$$= 78.93\%$$

$$W_E = \frac{40.80 - 26.66}{26.66 - 9.28} x\ 100$$
$$= 81.32\%$$

$$W = \frac{84.84+81.74+77.76+78.93+81.32}{5} = 80.92\%$$

9. Kedalaman 19.00 – 19.45 Meter

$$W_A = \frac{48.69 - 31.06}{31.06 - 8.38} x\ 100$$
$$= 77.74\%$$

$$W_B = \frac{49.99 - 32.42}{32.42 - 8.44} x\ 100$$
$$= 73.23\%$$

$$W_C = \frac{47.88 - 30.52}{30.52 - 8.36} x\ 100$$
$$= 78.35\%$$

$$W_D = \frac{59.24 - 35.70}{35.70 - 8.46} x\ 100$$
$$= 86.39\%$$

$$W_E = \frac{49.64 - 32.08}{32.08 - 8.41} x\ 100$$
$$= 74.22\%$$

$$W = \frac{77.74+73.23+78.35+86.39+74.22}{5} = 77.99\%$$

10. Kedalaman 21.00 – 21.45 Meter

$$W_A = \frac{33.32 - 21.21}{21.21 - 8.42} x\ 100$$
$$= 94.71\%$$

$$W_B = \frac{33.03 - 21.15}{21.15 - 8.28} x\ 100$$
$$= 92.25\%$$

$$W_C = \frac{25.53 - 17.99}{17.99 - 8.43} x\ 100$$

$$= 78.89\%$$

$$W_D = \frac{32.45 - 21.88}{21.88 - 8.33} x\ 100$$

$$= 77.97\%$$

$$W_E = \frac{32.84 - 20.72}{20.72 - 8.33} x\ 100$$

$$= 97.77\%$$

$$W = \frac{94.71+92.25+78.89+77.97+97.77}{5} = 88.32\%$$

11. Kedalaman 23.00 – 23.45 Meter

$$W_A = \frac{46.47 - 29.62}{29.62 - 8.40} x\ 100$$

$$= 79.42\%$$

$$W_B = \frac{59.13 - 34.40}{34.40 - 8.46} x\ 100$$

$$= 95.32\%$$

$$W_C = \frac{61.82 - 41.62}{41.62 - 8.43} x\ 100$$

$$= 60.85\%$$

$$W_D = \frac{60.13 - 34.97}{34.97 - 8.40} x\ 100$$

$$= 94.72\%$$

$$W_E = \frac{51.19 - 30.23}{30.23 - 8.39} x\ 100$$

$$= 96.01\%$$

$$W = \frac{79.42+95.32+60.85+94.71+96.01}{5} = 85.26\%$$

12. Kedalaman 27.00 – 27.45 Meter

$$W_A = \frac{49.79 - 34.97}{34.97 - 8.34} x\ 100$$

$$= 55.65\%$$

$$W_B = \frac{49.00 - 34.16}{34.16 - 8.32} x\ 100$$

$$= 57.43\%$$

$$W_C = \frac{49.82 - 33.25}{33.25 - 8.39} x\ 100$$

$$= 66.65\%$$

$$W_D = \frac{43.88 - 30.89}{30.81 - 8.51} x\ 100$$

$$= 58.04\%$$

$$W_E = \frac{56.82 - 45.63}{45.63 - 8.33} x\ 100$$

$$= 30\%$$

$$W = \frac{55.65+57.43+66.65+58.04+30}{5} = 53.56\%$$

Lampiran 4 Perhitungan *Specific Gravity*

Berat jenis tanah pada suhu t˚c dapat dihitung dengan persamaan dengan rumus (Hawanto *et al.,* 2021):

$$G = \frac{W2-W1}{(W4-W1)-(W3-W2)}$$

Dimana,

G = Berat jenis tanah

W1 = Berat piknometer kosong (gr)

W2 = Berat piknometer kosong + tanah kering (gr)

W3 = Berat piknometer kosong + tanah + air (gr)

W4 = Berat piknometer kosong + air (gr)

1. Kedalaman 01.55 – 02.00 Meter

$$G_A = \frac{131.36 - 106.35}{(355.27-106.35)-(373.10-131.36)}$$

$$= 3.48 \text{ Mg/m}^3$$

$$G_B = \frac{133.37 - 108.41}{(357.21-108.41)-(372.12 - 133.37)}$$

$$= 3.54 \text{ Mg/m}^3$$

$$G_C = \frac{131.42 - 106.42}{(355.24-106.42)-(373.10 - 131.42)}$$

$$= 3.50 \text{ Mg/m}^3$$

$$G = \frac{3.48+3.54+3.50}{3} = 3.51 \text{ Mg/m}^3$$

2. Kedalaman 03.50 – 04.00 Meter

$$G_A = \frac{131.24 - 106.32}{(355.13-106.32)-(371.29-131.24)}$$

$$= 2.85 \text{ Mg/m}^3$$

$$G_B = \frac{133.29 - 108.31}{(354.81-108.31)-(370.80 - 133.29)}$$

$$= 2.78 \text{ Mg/m}^3$$

$$G_C = \frac{129.75 - 104.74}{(352.96 - 104.74)-(368.98 - 129.75)}$$

$$= 2.78 \text{ Mg/m}^3$$

$$G = \frac{2.85+2.78+2.78}{3} = 2.8 \text{ Mg/m}^3$$

3. Kedalaman 06.00 – 06.45 Meter

$$G_A = \frac{131.16 - 106.20}{(353.70-106.20)-(371.01-131.16)}$$

$$= 3.26 \text{ Mg/m}^3$$

$$G_B = \frac{133.18 - 108.22}{(355.98 - 108.22)-(373.31 - 133.18)}$$

$$= 3.27 \text{ Mg/m}^3$$

$$G_C = \frac{130.23 - 104.66}{(352.15 - 104.66)-(370.05 - 130.23)}$$

$= 3.34 \text{ Mg/m}^3$

$G = \frac{3.26+3.27+3.34}{3} = 3.29 \text{ Mg/m}^3$

4. Kedalaman 08.00 – 08.45 Meter

$G_A = \frac{133.18 - 108.22}{(356.73 - 108.22) - (374.16 - 133.18)}$

$= 3.31 \text{ Mg/m}^3$

$G_B = \frac{122.45 - 97.44}{(345.93 - 97.44) - (363.62 - 122.45)}$

$= 3.42 \text{ Mg/m}^3$

$G_C = \frac{133.20 - 108.19}{(356.71 - 108.19) - (374.25 - 132.20)}$

$= 3.35 \text{ Mg/m}^3$

$G = \frac{3.31+3.42+3.35}{3} = 3.36 \text{ Mg/m}^3$

5. Kedalaman 11.00 – 11.45 Meter

$G_A = \frac{131.24 - 106.32}{(355.13 - 106.32) - (370.59 - 131.24)}$

$= 2.63 \text{ Mg/m}^3$

$G_B = \frac{133.29 - 108.31}{(354.81 - 108.31) - (370.10 - 133.29)}$

$= 2.58 \text{ Mg/m}^3$

$G_C = \frac{129.75 - 104.74}{(352.96 - 104.74) - (368.48 - 129.75)}$

$= 2.64 \text{ Mg/m}^3$

$G = \frac{2.63+2.58+2.64}{3} = 2.62 \text{ Mg/m}^3$

6. Kedalaman 13.00 – 13.45 Meter

$G_A = \frac{129.96 - 104.96}{(353.61 - 104.96) - (371.19 - 129.96)}$

$= 3.37 \text{ Mg/m}^3$

$G_B = \frac{130.50 - 105.53}{(354.27 - 105.53) - (371.29 - 130.50)}$

$= 3.15 \text{ Mg/m}^3$

$G_C = \frac{131.42 - 106.42}{(355.24 - 106.42) - (372.44 - 131.42)}$

$= 3.21 \text{ Mg/m}^3$

$G = \frac{3.37+3.14+3.21}{3} = 3.24 \text{ Mg/m}^3$

7. Kedalaman 15.00 – 15.45 Meter

$G_A = \frac{131.24 - 106.32}{(355.13 - 106.32) - (372.49 - 131.24)}$

$= 3.30 \text{ Mg/m}^3$

$G_B = \frac{133.29 - 108.31}{(354.81 - 108.31) - (372 - 133.29)}$

$= 3.21 \text{ Mg/m}^3$

$$G_C = \frac{129.75 - 104.74}{(352.96 - 104.74) - (370.18 - 129.75)}$$

$= 3.21$ Mg/m^3

$$G = \frac{3.30 + 3.21 + 3.21}{3} = 3.24 \text{ Mg/m}^3$$

8. Kedalaman 17.00 – 17.45 Meter

$$G_A = \frac{131.17 - 106.04}{(353.71 - 106.04) - (371.08 - 131.17)}$$

$= 3.24$ Mg/m^3

$$G_B = \frac{133.11 - 108.11}{(355.71 - 108.11) - (372.97 - 133.11)}$$

$= 3.23$ Mg/m^3

$$G_C = \frac{129.71 - 104.56}{(352.08 - 104.56) - (369.38 - 129.71)}$$

$= 3.21$ Mg/m^3

$$G = \frac{3.24 + 3.23 + 3.21}{3} = 3.22 \text{ Mg/m}^3$$

9. Kedalaman 19.00 – 19.45 Meter

$$G_A = \frac{133.52 - 108.51}{(354.85 - 108.51) - (372.21 - 133.52)}$$

$= 3.27$ Mg/m^3

$$G_B = \frac{130.09 - 105.10}{(353.55 - 105.10) - (370.37 - 130.09)}$$

$= 3.06$ Mg/m^3

$$G_C = \frac{133.43 - 108.44}{(354.83 - 108.44) - (372.14 - 133.43)}$$

$= 3.25$ Mg/m^3

$$G = \frac{3.27 + 3.06 + 3.25}{3} = 3.19 \text{ Mg/m}^3$$

10. Kedalaman 21.00 – 21.45 Meter

$$G_A = \frac{131.24 - 106.32}{(355.13 - 106.32) - (370.30 - 131.24)}$$

$= 2.56$ Mg/m^3

$$G_B = \frac{133.29 - 108.31}{(354.81 - 108.31) - (370.10 - 133.29)}$$

$= 2.58$ Mg/m^3

$$G_C = \frac{129.75 - 104.74}{(352.96 - 104.74) - (368.08 - 129.75)}$$

$= 2.53$ Mg/m^3

$$G = \frac{2.56 + 2.58 + 2.53}{3} = 2.55 \text{ Mg/m}^3$$

11. Kedalaman 23.00 – 23.45 Meter

$$G_A = \frac{131.78 - 106.76}{(355.25 - 106.76) - (372.40 - 131.78)}$$

$= 3.18$ Mg/m^3

$$G_B = \frac{133.70 - 108.71}{(357.12 - 108.71) - (373.90 - 133.70)}$$

$= 3.04$ Mg/m^3

$$G_C = \frac{131.42 - 106.42}{(355.25 - 106.42) - (372.31 - 131.42)}$$

$= 3.14$ Mg/m^3

$G = \frac{3.18 + 3.04 + 3.14}{3} = 3.12$ Mg/m^3

12. Kedalaman 27.00 – 27.45 Meter

$$G_A = \frac{131.24 - 106.32}{(355.13 - 106.32) - (372.21 - 131.24)}$$

$= 3.40$ Mg/m^3

$$G_B = \frac{133.29 - 108.31}{(354.81 - 108.31) - (372.60 - 133.29)}$$

$= 3.47$ Mg/m^3

$$G_C = \frac{129.75 - 104.74}{(352.96 - 104.74) - (370.48 - 129.75)}$$

$= 3.34$ Mg/m^3

$G = \frac{3.40 + 3.47 + 3.34}{3} = 3.40$ Mg/m^3

Lampiran 5 Perhitungan Analisis Saringan dan Hidrometer

Analisis saringan dipergunakan untuk mengetahui distribusi ukuran butiran tanah yang berbutir kasar (*granuler*), yang dilakukan terhadap sampel tanah yang kering. Analisis hidrometer dilakukan untuk mengetahui distribusi ukuran butir tanah yang berbutir halus atau bagian halus dari tanah berbutir campuran. Persentase distribusi butir dapat dihitung dengan perhitungan berikut:

Gravel = % Retained Cumulative Weight sieve No.4

Sand = % Retained Cumulative Weight sieve No.200 - %Gravel

Clay = % Finer Time 1440 Minute

Silt = % Finer analysis sieve No.200 - %Clay

Keterangan:

Gravel = 0%

1. Kedalaman 01.55 – 02.00 Meter

   Sand = 1 – 0

   = 1%

   Clay = 11.03%

   Silt = 99 - 11

   = 88%

2. Kedalaman 03.50 – 04.00 Meter

   Sand = 5.9 – 0

   = 5.9%

   Clay = 17.1 %

   Silt = 94.1 – 17.1

   = 77%

3. Kedalaman 06.00 – 06.45 Meter

   Sand = 2.1 – 0

   = 2.1%

   Clay = 16.5 %

   Silt = 97.9 – 16.5

   = 81.4%

4. Kedalaman 08.00 – 08.45 Meter

   Sand = 1.3 – 0

   = 1.3%

   Clay = 11.2 %

   Silt = 98.7 – 11.2

   = 87.5%

5. Kedalaman 11.00 – 11.45 Meter

Sand = 6.3 – 0
= 6.3%

Clay = 15.8%

Silt = 93.6 – 15.8
= 77.8%

6. Kedalaman 13.00 – 13.45 Meter

Sand = 1.5 – 0
= 1.5%

Clay = 2.5%

Silt = 98.5 – 2.5
= 96%

7. Kedalaman 15.00 – 15.45 Meter

Sand = 2.4 – 0
= 2.4%

Clay = 11.3%

Silt = 97.6 – 11.3
= 86.3%

8. Kedalaman 17.00 – 17.45 Meter

Sand = 4.2 – 0
= 4.2%

Clay = 7.6%

Silt = 95.8 – 7.6
= 88.2%

9. Kedalaman 19.00 – 19.45 Meter

Sand = 1.3– 0
= 1.3%

Clay = 2.5%

Silt = 98.7 – 2.5
= 96.2%

10. Kedalaman 21.00 – 21.45 Meter

Sand = 3.3 – 0
= 3.3%

Clay = 10.7%

Silt = 96.7 – 10.7
= 86%

11. Kedalaman 23.00 – 23.45 Meter

Sand = 2.8 – 0

= 2.8%

Clay = 0.7%

Silt = 97.2 – 0.7

= 96.5%

12. Kedalaman 27.00 – 27.45 Meter

Sand = 6.1 – 0

= 6.1%

Clay = 8.9%

Silt = 93.9 – 8.9

= 85%

Lampiran 6 Perhitungan Analisis Batas *Atterberg*

Perhitungan batas *Atterberg* diantaranya (PT. Vale Indonesia Tbk., 2022):

$$W\ (\%) = \frac{M2-M3}{M3-M1} x\ 100$$

$$LL = a \ln(25) + b$$

$$PL\ (\%) = \frac{M2-M3}{M3-M1} x\ 100$$

$$IP\ (\%) = LL\text{-}PL$$

Dimana,

W = Kadar air tanah asli (%)

M1 = Berat cawan kosong (gr)

M2 = Berat cawan + tanah basah (gr)

M3 = Berat cawan + tanah kering (gr)

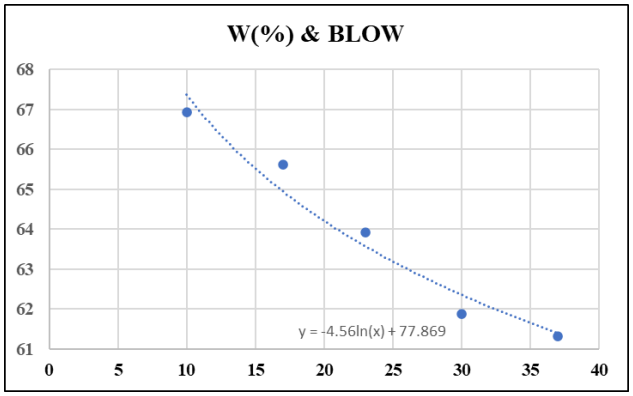
LL = Batas cair tanah

PL = Batas Plastis

IP = Indeks Plastis

1. Kedalaman 01.55 – 02.00 Meter

   a. Batas cair



$$W_A = \frac{21.39 - 15.46}{15.46 - 6.61} x\ 100$$

$$= 66.92\%$$

$$W_B = \frac{19.43 - 14.33}{14.33 - 6.56} x\ 100$$

$$= 65.62\%$$

$$W_C = \frac{17.24 - 13.09}{13.09 - 6.60} x\ 100$$

$$= 63.91\%$$

$$W_D = \frac{15.19 - 11.84}{11.84 - 6.44} x\ 100$$

$$= 61.87\%$$

$$W_E = \frac{13.59 - 10.97}{10.97 - 6.70} x\ 100$$

$$= 61.32\%$$

LL = -4.56 ln (25) + 77.869

= 63.19%

   b. Batas plastis

$$W_A = \frac{3.38 - 3.09}{3.09 - 2.46} x\ 100$$

$$= 46.21\%$$

$$W_B = \frac{3.43 - 3.16}{3.16 - 2.52} x\ 100$$

$$= 43.60\%$$

$W_C = \frac{4.79 - 4.47}{4.47 - 3.77} x\ 100$

$= 45.17\%$

$W_D = \frac{3.34 - 3.07}{3.07 - 2.49} x\ 100$

$= 46.19\%$

$W_E = \frac{3.42 - 3.13}{3.13 - 2.54} x\ 100$

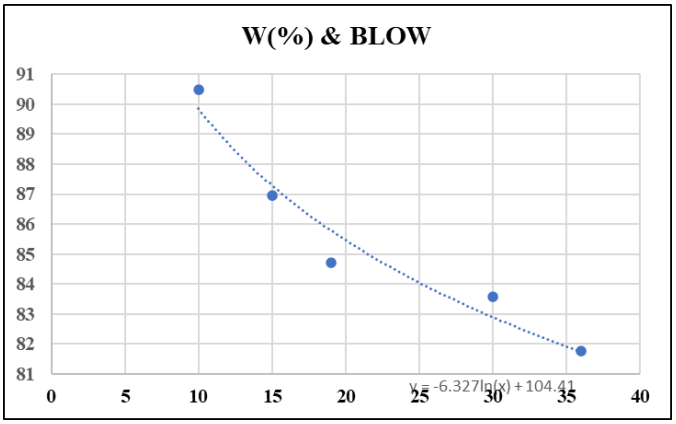
$= 48.90\%$

$PL = \frac{46.21+43.60+45.17+46.19+48.90}{5} = 46.02\%$

IP = 63.19 – 46.02 = 17.17%

2. Kedalaman 03.50 – 04.00 Meter

1. Batas cair



$W_A = \frac{20.82 - 14.90}{14.90 - 8.35} x\ 100$

$= 90.49\%$

$W_B = \frac{18.69 - 13.92}{13.92 - 8.42} x\ 100$

$= 86.96\%$

$W_C = \frac{16.76 - 12.89}{12.89 - 8.33} x\ 100$

$= 84.72\%$

$W_D = \frac{14.75 - 11.84}{11.84 - 8.37} x\ 100$

$= 83.59\%$

$W_E = \frac{12.49 - 10.65}{10.65 - 8.39} x\ 100$

$= 81.77\%$

LL = -6.327 ln (25) + 104.41

$= 84.04\%$

2. Batas plastis

$W_A = \frac{2.77 - 2.65}{2.65 - 2.45} x\ 100$

$= 62.56\%$

$W_B = \frac{2.71 - 2.61}{2.61 - 2.47} x\ 100$

$= 65.52\%$

$W_C = \frac{2.74 - 2.63}{2.63 - 2.46} x\ 100$

$= 66.47\%$

$W_D = \frac{2.76 - 2.63}{2.63 - 2.43} x\ 100$

$= 65.13\%$

$W_E = \frac{2.77 - 2.66}{2.66 - 2.48} x\ 100$

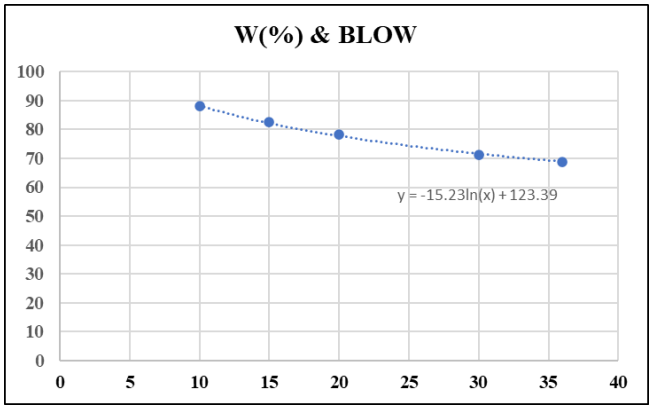
$= 66.10\%$

$PL = \frac{62.56+65.52+66.46+65.13+66.10}{5} = 65.15\%$

IP = 84.04 – 65.15 = 18.89%

3. Kedalaman 06.00 – 06.45 Meter

1. Batas cair



$W_A = \frac{22.13 - 16.12}{16.12 - 9.29} x\ 100$

$= 88.00\%$

$W_B = \frac{20.05 - 15.27}{15.27 - 9.47} x\ 100$

$= 82.42\%$

$W_C = \frac{18.62 - 14.56}{14.56 - 9.37} x\ 100$

$= 78.25\%$

$W_D = \frac{16.28 - 13.40}{13.40 - 9.34} x\ 100$

$= 71.10\%$

$W_E = \frac{14.39 - 12.31}{12.31 - 9.29} x\ 100$

$= 68.91\%$

LL = -15.23 ln (25) + 123.39

$= 74.37\%$

2. Batas plastis

$W_A = \frac{6.45 - 6.13}{6.13 - 5.55} x\ 100$

$= 52.89\%$

$W_B = \frac{6.29 - 6.02}{6.02 - 5.50} x\ 100$

$= 51.35\%$

$W_C = \frac{6.27 - 6.01}{6.01 - 5.48} x\ 100$

$= 50\%$

$W_D = \frac{6.21 - 5.97}{5.97 - 5.49} x\ 100$

$= 49.79\%$

$W_E = \frac{6.19 - 5.93}{5.93 - 5.45} x\ 100$

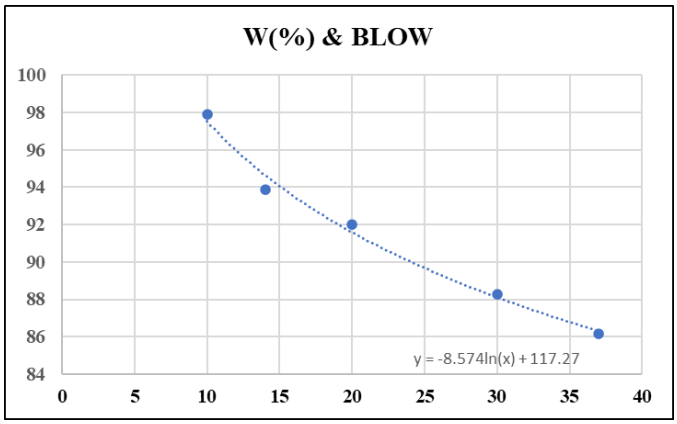
$= 52.69\%$

$PL = \frac{52.89+51.35+50+49.79+52.69}{5} = 61.34\%$

IP = 74.37 – 51.34 = 23.02%

4. Kedalaman 08.00 – 08.45 Meter

1. Batas cair



$W_A = \frac{21.69 - 15.50}{15.50 - 9.18} x\ 100$

$= 97.90\%$

$W_B = \frac{19.73 - 14.74}{14.74 - 9.41} x\ 100$

$= 93.85\%$

$W_C = \frac{17.81 - 13.92}{13.92 - 9.61} x\ 100$

$= 91.99\%$

$W_D = \frac{15.76 - 12.90}{12.90 - 9.66} x\ 100$

$= 88.28\%$

$W_E = \frac{13.72 - 11.77}{11.77 - 9.50} x\ 100$

$= 86.15\%$

LL = -8.574 ln (25) + 117.27

= 89.67%

2. Batas plastis

$W_A = \frac{3.18 - 2.90}{2.90 - 2.47} x\ 100$

$= 64.66\%$

$W_B = \frac{4.35 - 4.07}{4.07 - 3.65} x\ 100$

$= 66.35\%$

$W_C = \frac{3.23 - 2.95}{2.95 - 2.50} x\ 100$

$= 62.56\%$

$W_D = \frac{3.22 - 2.95}{2.95 - 2.56} x\ 100$

$= 68.62\%$

$W_E = \frac{3.27 - 2.97}{2.97 - 2.47} x\ 100$

$= 60.20\%$

$PL = \frac{64.66 + 66.35 + 62.56 + 68.62 + 60.20}{5} = 64.48\%$

IP = 89.67 – 64.48 = 25.19%

5. Kedalaman 11.00 – 11.45 Meter

1. Batas cair

$W_A = \frac{20.31 - 14.69}{14.69 - 8.39} x\ 100$

$= 89.22\%$

$W_B = \frac{18.69 - 13.94}{13.94 - 8.33} x\ 100$

$= 84.85\%$

$W_C = \frac{16.37 - 12.89}{12.89 - 8.37} x\ 100$

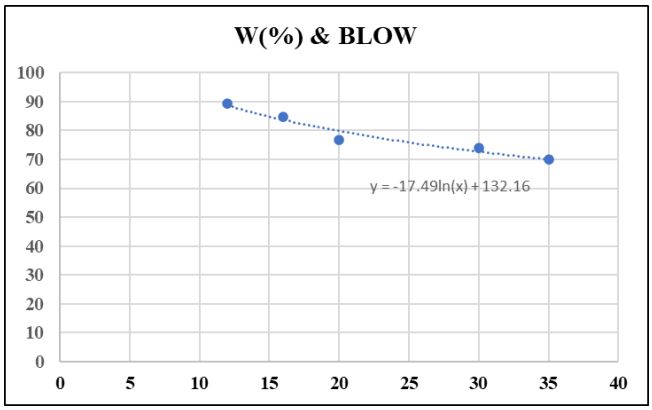
$= 76.76\%$

$W_D = \frac{14.66 - 11.97}{11.97 - 8.35} x\ 100$

$= 74.09\%$

$W_E = \frac{12.44 - 10.75}{10.75 - 8.33} x\ 100$

$= 69.90\%$



LL = -17.49 ln (25) + 132.16

= 75.86%

2. Batas plastis

$W_A = \frac{2.74 - 2.64}{2.64 - 2.48} x\ 100$

$= 62.66\%$

$W_B = \frac{2.73 - 2.64}{2.64 - 2.50} x\ 100$

$= 59.15\%$

$W_C = \frac{2.89 - 2.72}{2.72 - 2.48} x\ 100$

$= 66.80\%$

$W_D = \frac{2.80 - 2.69}{2.69 - 2.51} x\ 100$

$= 64.57\%$

$W_E = \frac{2.70 - 2.62}{2.62 - 2.49} x\ 100$

$= 63.64\%$

$PL = \frac{62.66+59.15+66.80+64.57+63.64}{5} = 63.36\%$

IP = 75.86 – 63.36 = 12.50%

6. Kedalaman 13.00 – 13.45 Meter

1. Batas cair

$W_A = \frac{24.82 - 17.44}{17.44 - 9.42} x\ 100$

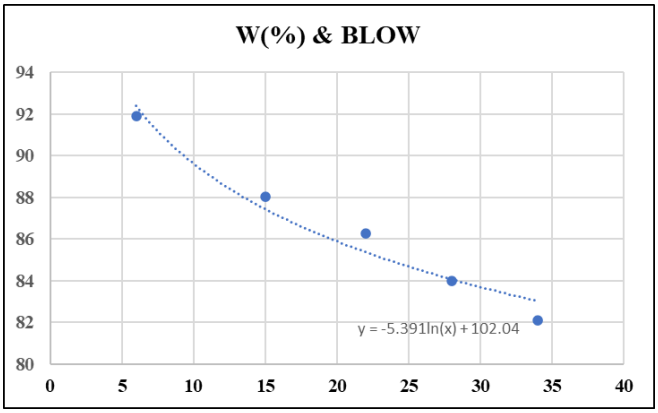
$= 91.89\%$

$W_B = \frac{22.86 - 16.62}{16.62 - 9.53} x\ 100$

$= 88.02\%$

$W_C = \frac{20.62 - 15.52}{15.52 - 9.74} x\ 100$

$= 86.27\%$



$W_D = \frac{18.59 - 14.55}{14.55 - 9.74} x\ 100$

= 84.02%

$W_E = \frac{16.64 - 13.47}{13.47 - 9.62} x\ 100$

= 82.10%

LL = -5.391 ln (25) + 102.04

= 84.69%

2. Batas plastis

$W_A = \frac{3.23 - 2.97}{2.97 - 2.53} x\ 100$

= 58.65%

$W_B = \frac{4.17 - 4.04}{4.04 - 3.80} x\ 100$

= 58.12%

$W_C = \frac{3.14 - 2.92}{2.92 - 2.52} x\ 100$

= 56.96%

$W_D = \frac{4.46 - 4.20}{4.46 - 3.74} x\ 100$

= 57.42%

$W_E = \frac{4.42 - 4.15}{4.15 - 3.69} x\ 100$

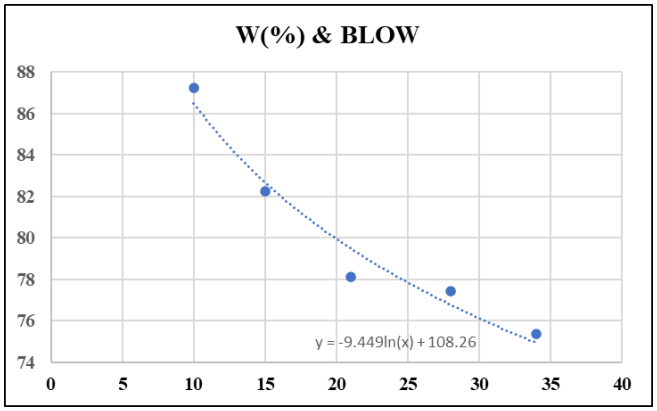
= 58.40%

$PL = \frac{58.65+58.12+56.96+57.42+58.40}{5} = 57.91\%$

IP = 84.69 – 57.91 = 26.78%

7. Kedalaman 15.00 – 15.45 Meter

1. Batas cair



$W_A = \frac{20.36 - 14.78}{14.78 - 8.39} x\ 100$

= 87.22%

$W_B = \frac{18.76 - 14.05}{14.05 - 8.33} x\ 100$

= 82.25%

$W_C = \frac{16.38 - 12.83}{12.83 - 8.28} x\ 100$

= 78.14%

$W_D = \frac{14.98 - 12.07}{12.07 - 8.31} x\ 100$

= 77.42%

$W_E = \frac{12.53 - 10.73}{10.73 - 8.35} x\ 100$

= 75.36%

LL = -9.449 ln (25) + 108.26

= 77.84%

2. Batas plastis

$W_A = \frac{2.69 - 2.60}{2.60 - 2.48} x\ 100$

= 68.75%

$W_B = \frac{2.78 - 2.67}{2.67 - 2.50} x\ 100$

= 70.37%

$W_C = \frac{2.80 - 2.69}{2.69 - 2.53} x\ 100$

= 70.57%

$W_D = \frac{2.73 - 2.62}{2.62 - 2.47} x\ 100$

= 70.59%

$W_E = \frac{2.82 - 2.68}{2.68 - 2.48} x\ 100$

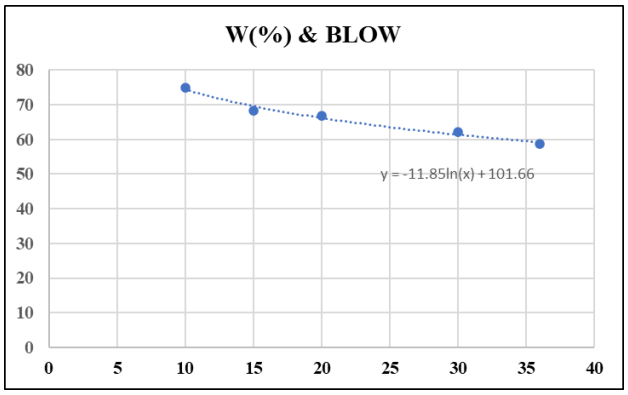
= 68.96%

$PL = \frac{68.75+70.37+74.19+70.58+68.96}{5} = 70.57\%$

IP = 77.84 – 70.57 = 7.27%

8. Kedalaman 17.00 – 17.45 Meter

1. Batas cair



$W_A = \frac{22.89 - 17.07}{17.07 - 9.29} x\ 100$

= 74.84%

$W_B = \frac{20.22 - 15.86}{15.86 - 9.47} x\ 100$

= 68.23%

$W_C = \frac{18.39 - 14.78}{14.78 - 9.37} x\ 100$

= 66.88%

$W_D = \frac{16.52 - 13.77}{13.77 - 9.34} x\ 100$

= 62.05%

$W_E = \frac{14.71 - 12.71}{12.71 - 9.29} x\ 100$

= 58.60%

LL = -11.85 ln (25) + 101.66

= 63.52%

2. Batas plastis

$W_A = \frac{6.00 - 5.87}{5.87 - 5.55} x\ 100$

= 42.32%

$W_B = \frac{5.91 - 5.78}{5.78 - 5.50} x\ 100$

$= 46.04\%$

$W_C = \frac{6.03 - 5.86}{5.86 - 5.49} x\ 100$

$= 45.48\%$

$W_D = \frac{6.04 - 5.86}{5.86 - 5.49} x\ 100$

$= 47.47\%$

$W_E = \frac{6.02 - 5.82}{5.82 - 5.45} x\ 100$

$= 55.86\%$

$PL = \frac{42.32+46.04+45.48+47.47+55.86}{5} = 47.43\%$

IP = 63.52 – 47.43 = 16.09%

9. Kedalaman 19.00 – 19.45 Meter

1. Batas cair

$W_A = \frac{20.84 - 13.92}{13.92 - 6.52} x\ 100$

$= 93.46\%$

$W_B = \frac{18.25 - 12.78}{12.78 - 6.58} x\ 100$

$= 88.21\%$

$W_C = \frac{16.85 - 12.17}{12.17 - 6.61} x\ 100$

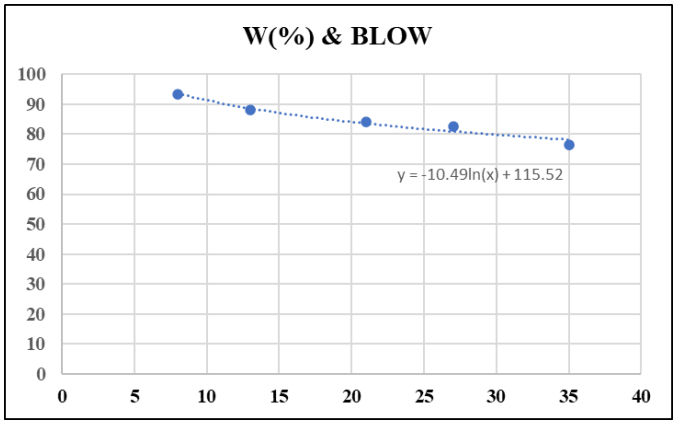
$= 84.16\%$

$W_D = \frac{14.18 - 10.75}{10.75 - 6.59} x\ 100$

$= 82.59\%$

$W_E = \frac{12.39 - 9.87}{9.87 - 6.58} x\ 100$

$= 76.58\%$



LL = -10.49 ln (25) + 115.52

$= 81.75\%$

2. Batas plastis

$W_A = \frac{4.56 - 4.24}{4.24 - 3.73} x\ 100$

$= 61.76\%$

$W_B = \frac{4.46 - 4.16}{4.16 - 3.62} x\ 100$

$= 56.42\%$

$W_C = \frac{3.10 - 2.85}{2.85 - 2.44} x\ 100$

$= 61.03\%$

$W_D = \frac{3.19 - 2.91}{2.91 - 2.45} x\ 100$

$= 60.91\%$

$W_E = \frac{3.17 - 2.93}{2.93 - 2.53} x\ 100$

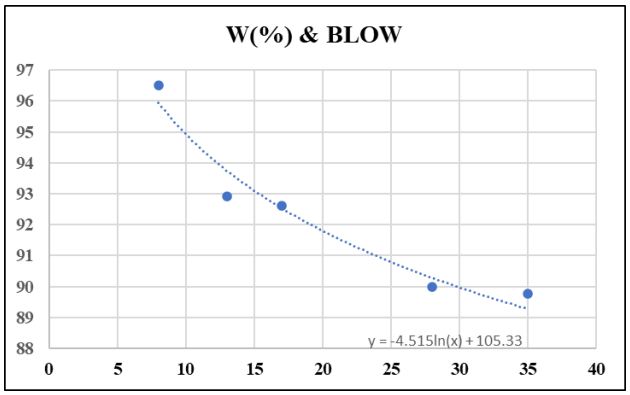
$= 59.15\%$

$PL = \frac{61.76+56.42+61.02+60.91+59.15}{5} = 59.85\%$

IP = 81.75 – 59.85 = 21.90%

10. Kedalaman 21.00 – 21.45 Meter

1. Batas cair



$W_A = \frac{20.88 - 14.73}{14.73 - 8.36} x\ 100$

$= 96.50\%$

$W_B = \frac{18.74 - 13.73}{13.73 - 8.33} x\ 100$

$= 92.91\%$

$W_C = \frac{16.25 - 12.46}{12.46 - 8.37} x\ 100$

$= 92.61\%$

$W_D = \frac{14.03 - 11.32}{11.32 - 8.32} x\ 100$

$= 89.98\%$

$W_E = \frac{13.00 - 10.82}{10.82 - 8.39} x\ 100$

$= 89.76\%$

LL = -4.515 ln (25) + 105.33

$= 90.80\%$

2. Batas plastis

$W_A = \frac{2.82 - 2.70}{2.70 - 2.54} x\ 100$

$= 73.29\%$

$W_B = \frac{2.63 - 2.56}{2.56 - 2.48} x\ 100$

$= 82.14\%$

$W_C = \frac{2.63 - 2.57}{2.57 - 2.48} x\ 100$

$= 74.70\%$

$W_D = \frac{2.58 - 2.52}{2.52 - 2.43} x\ 100$

$= 71.26\%$

$W_E = \frac{2.72 - 2.63}{2.63 - 2.51} x\ 100$

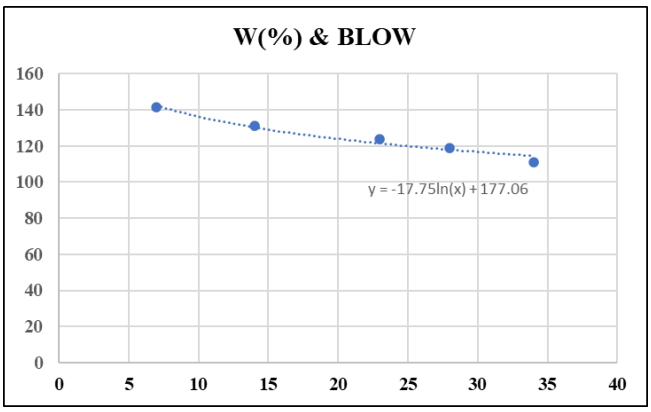
$= 73.55\%$

$PL = \frac{73.29+82.14+74.70+71.26+73.55}{5} = 74.99\%$

IP = 90.80 – 74.99 = 21.90%

11. Kedalaman 23.00 – 23.45 Meter

1. Batas cair



$W_A = \frac{21.77 - 14.54}{14.54 - 9.42} x\ 100$

= 141.27%

$W_B = \frac{19.69 - 14.00}{14.00 - 9.66} x\ 100$

= 131.06%

$W_C = \frac{17.25 - 12.78}{12.78 - 9.18} x\ 100$

= 123.96%

$W_D = \frac{15.68 - 12.32}{12.32 - 9.49} x\ 100$

= 119.09%

$W_E = \frac{13.74 - 11.60}{11.60 - 9.68} x\ 100$

= 111.14%

LL = -17.75 ln (25) + 177.06

= 119.92%

2. Batas plastis

$W_A = \frac{3.15 - 2.86}{2.86 - 2.47} x\ 100$

= 76.23%

$W_B = \frac{4.12 - 3.92}{3.92 - 3.65} x\ 100$

= 75.09%

$W_C = \frac{3.19 - 2.89}{2.89 - 2.49} x\ 100$

= 74.62%

$W_D = \frac{3.10 - 2.82}{2.82 - 2.47} x\ 100$

= 78.93%

$W_E = \frac{3.24 - 2.94}{2.94 - 2.52} x\ 100$

= 71.70%

$PL = \frac{76.23+75.09+74.62+78.93+71.90}{5} = 75.31\%$

IP = 119.92 – 75.31 = 44.61%

12. Kedalaman 27.00 – 27.45 Meter

1. Batas cair

$W_A = \frac{20.66 - 15.20}{15.20 - 8.32} x\ 100$

$= 79.44\%$

$W_B = \frac{18.04 - 13.86}{13.86 - 8.39} x\ 100$

$= 79.43\%$

$W_C = \frac{16.28 - 12.87}{12.87 - 8.31} x\ 100$

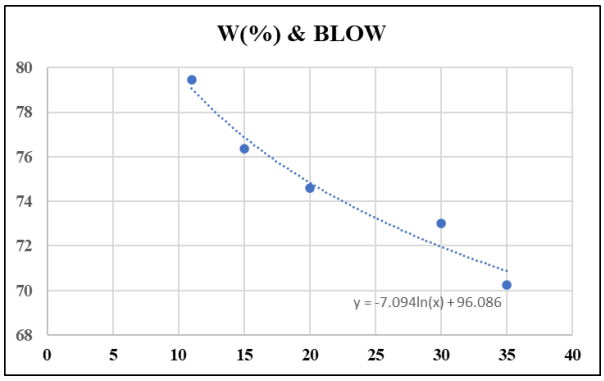
$= 74.59\%$

$W_D = \frac{14.88 - 12.15}{12.15 - 8.41} x\ 100$

$= 73.00\%$

$W_E = \frac{12.78 - 10.94}{10.94 - 8.33} x\ 100$

$= 70.23\%$



LL = -7.094 ln (25) + 96.086

= 73.25%

2. Batas plastis

$W_A = \frac{2.86 - 2.76}{2.76 - 2.50} x\ 100$

$= 40.54\%$

$W_B = \frac{2.84 - 2.74}{2.74 - 2.51} x\ 100$

$= 41.81\%$

$W_C = \frac{2.93 - 2.80}{2.80 - 2.49} x\ 100$

$= 42.12\%$

$W_D = \frac{3.01 - 2.85}{2.85 - 2.48} x\ 100$

$= 43.05\%$

$W_E = \frac{3.05 - 2.88}{2.88 - 2.48} x\ 100$

$= 43.11\%$

$PL = \frac{40.54+41.81+42.12+43.05+11}{5} = 42.13\%$

IP = 73.25 – 42.13 = 31.12%

Lampiran 7 Pemantauan Lereng Secara Aktual

VALE

MEMO - MINING TOUR

FPB-03

CHECK LIST PEMANTAUAN LERENG

Hari/Tanggal Selasa, 20 Februari 2024
Lokasi FPB 01
Nomor Alat HE-5010

Patok Penggalian	Ya	Tidak	Foto
Ada patok pit limit/ stake out	√		
Ada patok arah penggalian	√		
Ada patok kontrol level	√		
Tanda-Tanda Bahaya	Ya	Tidak	
Sudut kemiringan lereng terjal/menggantung		√	
Tinggi lereng melebihi rekomendasi		√	
Ada retakan tarik pada permukaan lereng		√	
Ditemukan bidang lemah/bidang gelincir		√	
Ada air yang keluar dari lereng		√	
Ada genangan air pada berm lereng		√	
Ada jatuhan material atau longsoran		√	
Tindakan Perbaikan	Ya	Tidak	
Harus dilakukan resloping		√	
Tinggi lereng harus diturunkan (continue)		√	

Catatan : - Pada saat inspeksi dilakukan, aktifitas shovel terpantau gali maju relatif ke Utara saat ini. Kondisi lereng penggalian aktif masih terpantau standard dilapangan, tidak ditemukan issue geoteknik secara keseluruhan.

Disiapkan Oleh
Didiet Prayudha M.
B/N. c35693

Disetujui Oleh
Andi Burhanuddin
11519

VALE

MEMO - MINING TOUR

FB-03

CHECK LIST PEMANTAUAN LERENG

Hari/Tanggal Rabu, 28 Februari 2024
Lokasi FPB 01
Nomor Alat HE-4030

Patok Penggalian	Ya	Tidak	Foto
Ada patok pit limit/ stake out	√		
Ada patok arah penggalian	√		
Ada patok kontrol level	√		
Tanda-Tanda Bahaya	Ya	Tidak	
Sudut kemiringan lereng terjal/menggantung		√	
Tinggi lereng melebihi rekomendasi		√	
Ada retakan tarik pada permukaan lereng		√	
Ditemukan bidang lemah/bidang gelincir		√	
Ada air yang keluar dari lereng		√	
Ada genangan air pada berm lereng		√	
Ada jatuhan material atau longsoran		√	
Tindakan Perbaikan	Ya	Tidak	
Harus dilakukan resloping		√	
Tinggi lereng harus diturunkan		√	

Catatan : - Pada saat inspeksi dilakukan, terpantau aktifitas digger masih continue gali maju ramp down ke sisi Tenggara. Terdapat unit support clean up paralel menurunkan ketinggian dilapangan.
- By visual terdapat buangan material side casting ke arah aktifitas minedev, dipastikan larian material ini tidak menggangu aktifitas konstruksi dyke.

Disiapkan Oleh
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Disetujui Oleh
Andi Burhanuddin
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VALE

MEMO - MINING TOUR

FPB-03

CHECK LIST PEMANTAUAN LERENG

Hari/Tanggal Selasa, 05 Maret 2024
Lokasi FPB 01
Nomor Alat HE-4030

Patok Penggalian	Ya	Tidak	Foto
Ada patok pit limit/ stake out	√		
Ada patok arah penggalian	√		
Ada patok kontrol level	√		
Tanda-Tanda Bahaya	Ya	Tidak	
Sudut kemiringan lereng terjal/menggantung		√	
Tinggi lereng melebihi rekomendasi		√	
Ada retakan tarik pada permukaan lereng		√	
Ditemukan bidang lemah/bidang gelincir		√	
Ada air yang keluar dari lereng		√	
Ada genangan air pada berm lereng		√	
Ada jatuhan material atau longsoran		√	
Tindakan Perbaikan	Ya	Tidak	
Harus dilakukan resloping		√	
Tinggi lereng harus diturunkan (continue)		√	

Catatan : - Pada saat inspeksi dilakukan, digger dalam kondisi gali mundur continue ke sisi Barat. Tidak ditemukan issue geoteknik secara keseluruhan.

Disiapkan Oleh
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B/N. c35693

Disetujui Oleh
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11519

VALE

MEMO - MINING TOUR

FPB-03

CHECK LIST PEMANTAUAN LERENG

Hari/Tanggal Selasa, 12 Maret 2024
Lokasi FPB 01
Nomor Alat HE-4029

Patok Penggalian	Ya	Tidak	Foto
Ada patok pit limit/ stake out	√		
Ada patok arah penggalian	√		
Ada patok kontrol level	√		
Tanda-Tanda Bahaya	Ya	Tidak	
Sudut kemiringan lereng terjal/menggantung		√	
Tinggi lereng melebihi rekomendasi		√	
Ada retakan tarik pada permukaan lereng		√	
Ditemukan bidang lemah/bidang gelincir		√	
Ada air yang keluar dari lereng		√	
Ada genangan air pada berm lereng		√	
Ada jatuhan material atau longsoran		√	
Tindakan Perbaikan	Ya	Tidak	
Harus dilakukan resloping		√	
Tinggi lereng harus diturunkan (continue)		√	

Catatan : - Pada saat inspeksi dilakukan, digger dalam kondisi gali maju (BL) flat ke sisi Timur. Mohon diperhatikan jika semakin maju ke Timur ada potensi ketinggian dilapangan.

Disiapkan Oleh
Didiet Prayudha M.
B/N. c35693

Disetujui Oleh
Andi Burhanuddin
11519

VALE

MEMO - MINING TOUR

FPB-03

CHECK LIST PEMANTAUAN LERENG

Hari/Tanggal Kamis, 21 Maret 2024
Lokasi FPB 01
Nomor Alat HE-5014

Patok Penggalian	Ya	Tidak	Foto
Ada patok pit limit/ stake out	√		
Ada patok arah penggalian	√		
Ada patok kontrol level	√		
Tanda-Tanda Bahaya	Ya	Tidak	
Sudut kemiringan lereng terjal/menggantung		√	
Tinggi lereng melebihi rekomendasi		√	
Ada retakan tarik pada permukaan lereng		√	
Ditemukan bidang lemah/bidang gelincir		√	
Ada air yang keluar dari lereng		√	
Ada genangan air pada berm lereng		√	
Ada jatuhan material atau longsoran		√	
Tindakan Perbaikan	Ya	Tidak	
Harus dilakukan resloping		√	
Tinggi lereng harus diturunkan (continue)		√	

Catatan :
- Pada saat inspeksi dilakukan, digger dalam kondisi gali mundur. Tidak ditemukan issue geoteknik dilapangan secara keseluruhan.

Disiapkan Oleh

Indra A Kabalmay
B/N. C024074

Disetujui Oleh

Andi Burnanuddin
11519

Lampiran 8 Kartu Konsultasi Tugas Akhir

Kartu Konsultasi Tugas Akhir

JUDUL: ANALISIS KESTABILAN LERENG PIT FBB-03 PT. VALE INDONESIA TBK BERDASARKAN HASIL KOMPARASI KONDISI DESAIN DAN AKTUAL PENAMBANGAN

(Konsultasi minimal 8 kali)

TANGGAL	MATERI KONSULTASI	PARAF DOSEN
18/04/2024	- Judul - Latar Belakang - Tujuan Penelitian - Rumusan Masalah - Format Penulisan.	
24/04/2024	- Tinjauan Pustaka - Penambahan analisis BAB IV - Kesimpulan	
30/04/2024	- Penambahan Latar Belakang - Format Penulisan judul dan Abstrak - Pembahasan - Perhitungan	
03/05/2024	- Analisis kondisi Statik, Pseudostatik, POF, Jenuh. - Format Penulisan METODOLOGI PENELITIAN - Bagan Alir Penelitian	
08/05/2024	- Pembahasan Pengaruh hasil uji sifat fisik, ke analisis software	

TANGGAL	MATERI KONSULTASI	PARAF DOSEN
15/05/2024	- Pembahasan Bab IV terkait Kondisi Analisis - Penambahan Tinjauan Pustaka - Penulisan daftar Pustaka	
22/05/2024	- Bab I Pengecekan Ulang latar Belakang - Bab II Penulisan Kerucs - Daftar Isi - Abstrak di persingkat - Kesimpulan - Perbaikan Saran	
05/06/2024	- Penulisan judul piramida terbalik - Halaman pengesahan - Format penulisan catatan kaki - Penggunaan kata kerja pada Langkah 2 kegiatan penelitian. dan pengolahan data - kesimpulan disingkat - Format artikel, dan Poster	
06/06/2024		
30/07/2024	- Analisis dinamis dan genuh PoF - Penambahan input Material	