

# MANAGING PIT LAKE WATER QUALITY

## PT ADARO INDONESIA



**DIDIK TRIWIBOWO, M.Env.Man**

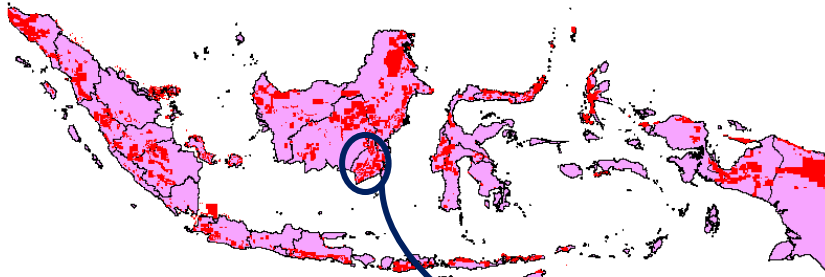
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# Content

- Introduction to PT Adaro Indonesia
- Paringin Pit Lake – Characteristics, final void shape, water quality, geochemical & geotechnical condition
- Factors controlling Good Pit Lake Condition
- Conclusion

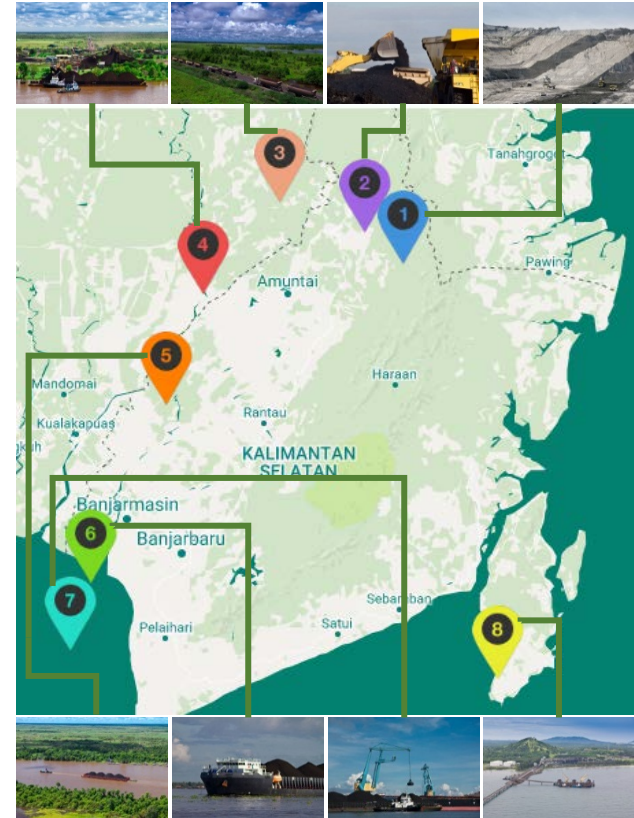
# Introduction to PT Adaro Indonesia

# Project Area

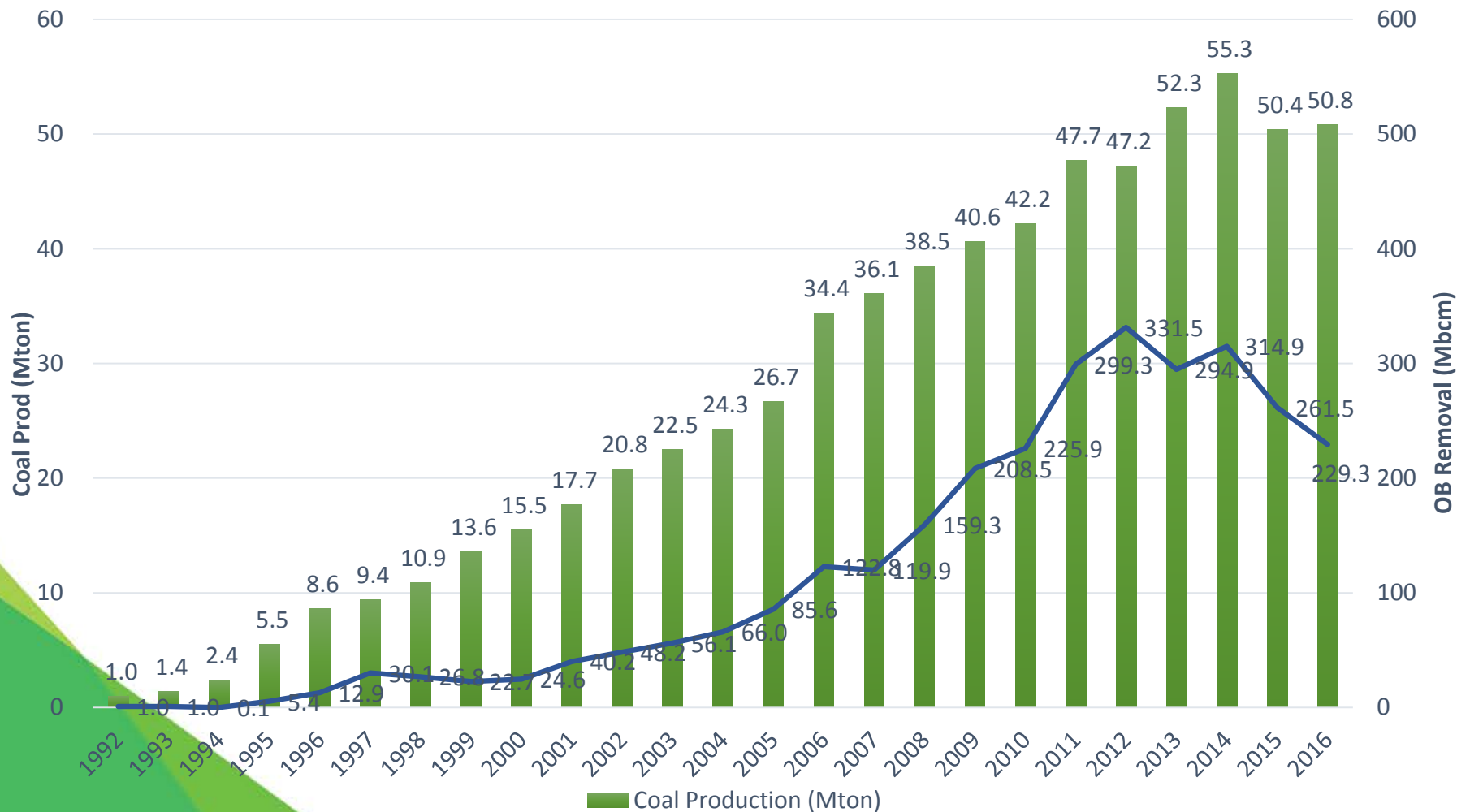


**PT Adaro Indonesia coal mine site located in the Island of Borneo, South Kalimantan Province, Indonesia.**

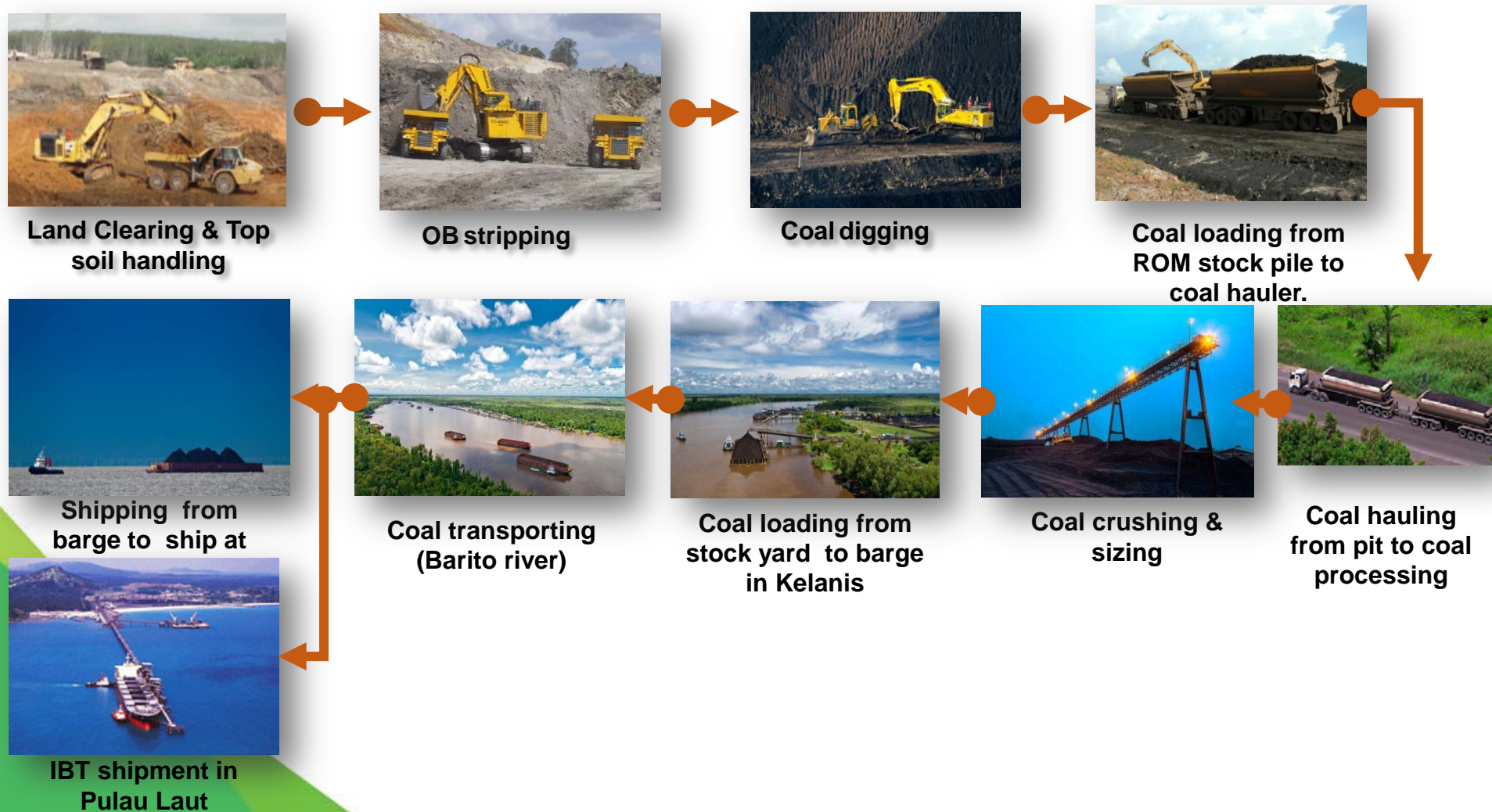
**It operates three open pits of Wara, Tutupan and Paringin pit within its concession area**



# Coal Production



# Mining Processes



# PT Adaro Indonesia Active Area vs Sydney Area

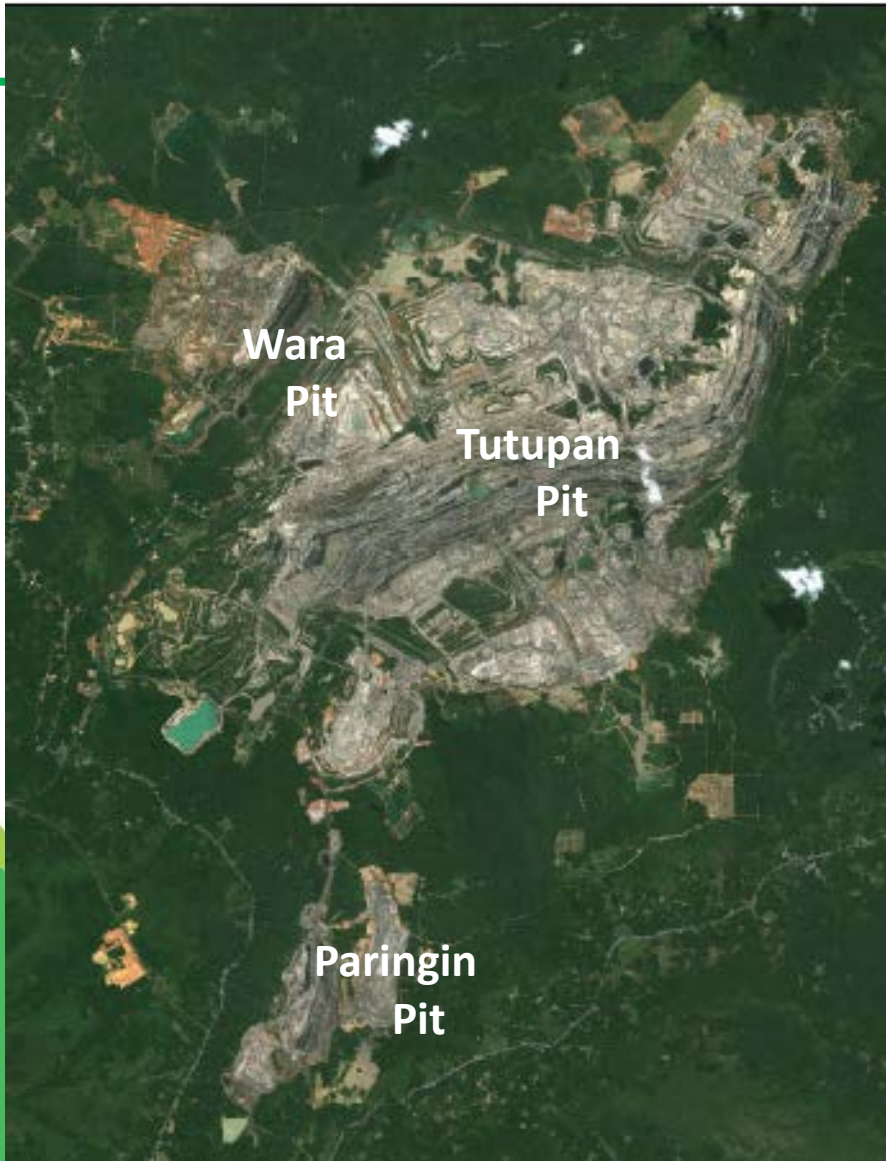


PT Adaro Indonesia Active area is 15,000 ha out of 35,000,000 ha concession area for mine pit and waste dump/overburden disposal area

This area equal to area from Macquarie University at North to Kingsgrove at the South with Sydney Olympic Park at the center

..and from Western Sydney University Parramatta at West to Hunters Hill at East

# PT Adaro Indonesia Physical - Meteorological characteristics



Huge active area of pits and disposal/waste dump area (15,000 ha)

Huge volume of waste dump (208 M BCM/year)

Acid Mine Drainage potency was found only at Wara Pit

High rainfall intensity during rainy season (3,000 – 4,000 mm/year)

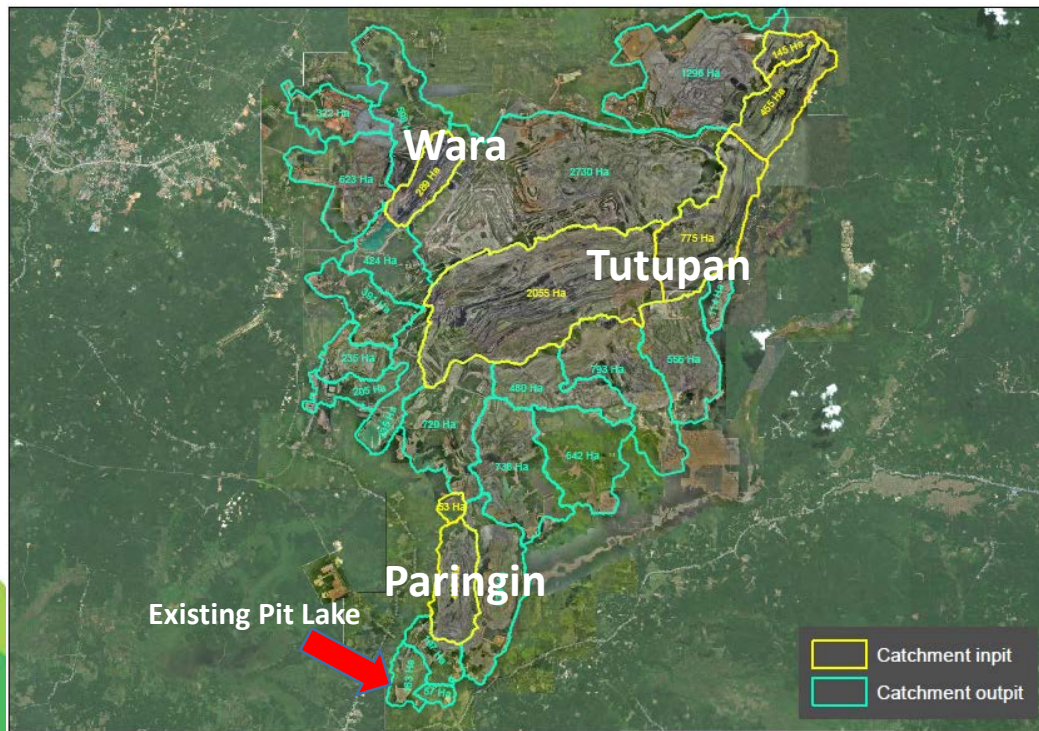
Huge volume of mine water to be treated (>350 M m<sup>3</sup>/year)

200 ha of annual revegetation during rainy season (6 months)

Final void will be created



# PT Adaro Indonesia Catchment Area & Mine Water



Total of 4,500 Ha of inpit catchment area and 11,500 Ha of output catchment area

6 major pit catchments with approximately 67 pump for dewatering activities

20 waste dump catchment areas with 18 active settling ponds for treating mine water

1 existing final pit lake in Paringin pit

# Paringin Pit Lake

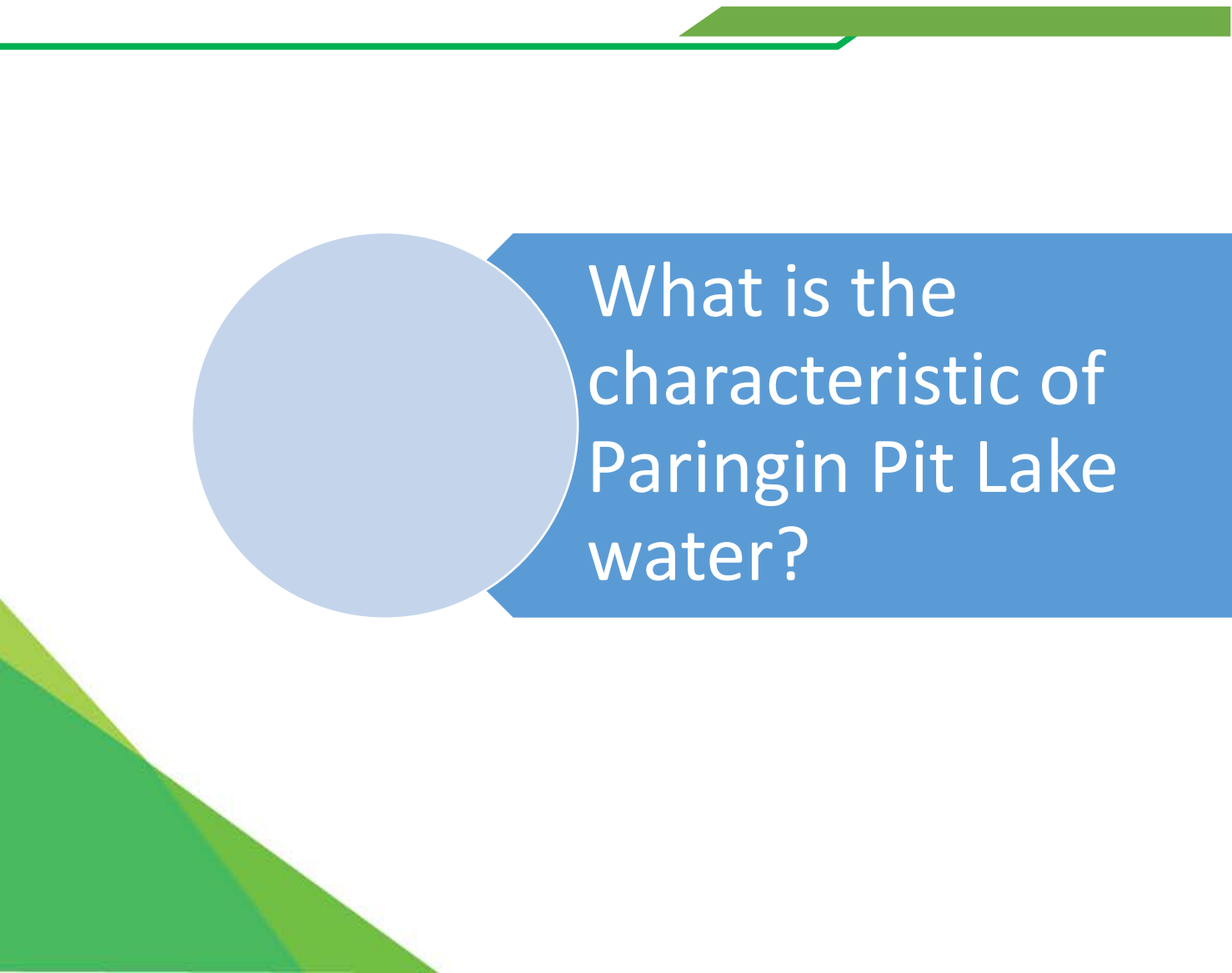
# Research Questions

What is the characteristic of Paringin Pit Lake water?

What factors contributing good water quality of Paringin Pit Lake since closure in 2005?

What current water used of Paringin Pit Lake?

What research needed for improvement for better future pit lake condition?



What is the  
characteristic of  
Paringin Pit Lake  
water?

# Resume of Characteristics of Paringin Pit Lake

- 20 ha of pit lake area; with 90m deep with good water quality.
- Active hydrologic processes (flow through process) inlet from surface water run off and outlet water flow to receiving river
- Near-Neutral pH of water with low TDS
- Concentrations of most trace metals are low.
- Stable DO (Dissolved Oxygen) concentration  $> 5$  mg/L above minimum standard for Aquaculture
- The water is currently used for fish farm of Bogor Enhanced Strain Tilapia (BEST), Nursery and Soil Laboratory.

# Existing Paringin Pit Lake

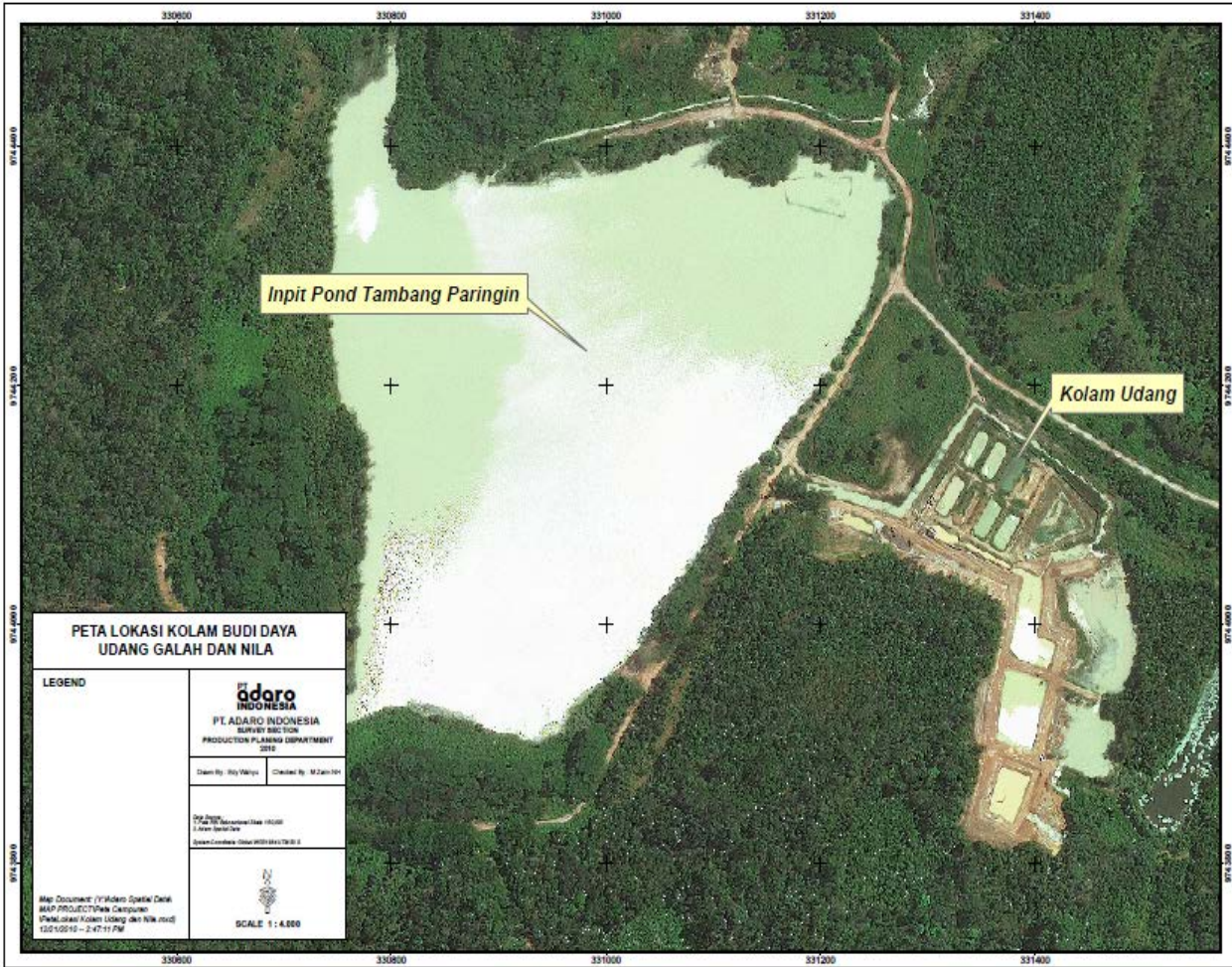
20 Ha of Pit lake area with 150 Ha of rehabilitated catchment area

Final void completed in 2005

Main source of water is from Run off of surrounding catchment

Water used for fish farm, nursery & Soil Lab

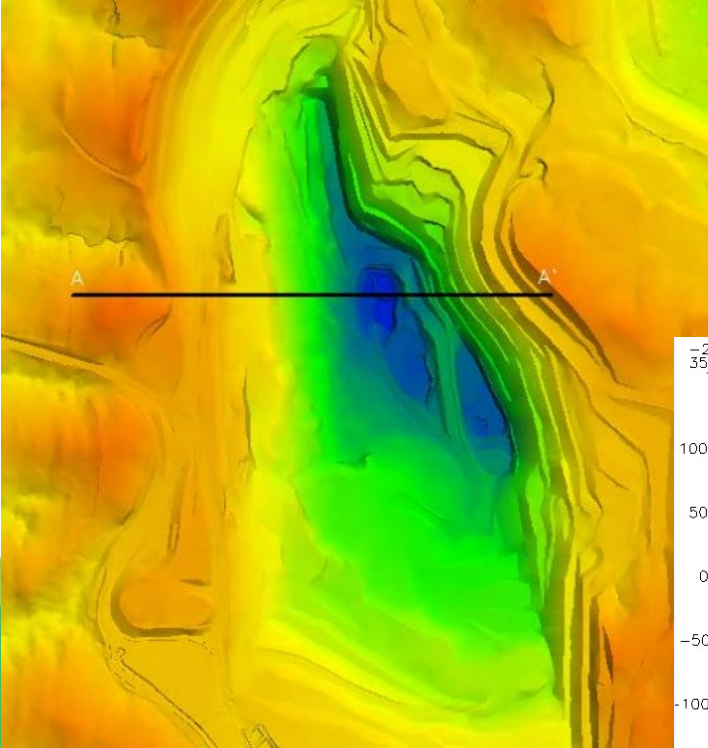
Outlet flow to receiving river



# Photos of Existing Paringin Pit Lake

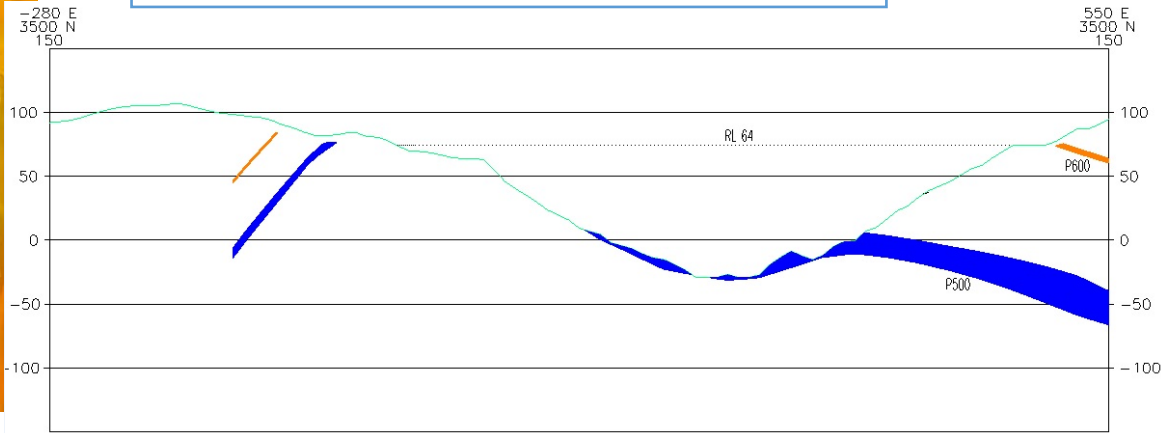


# Pit Lake Geometry



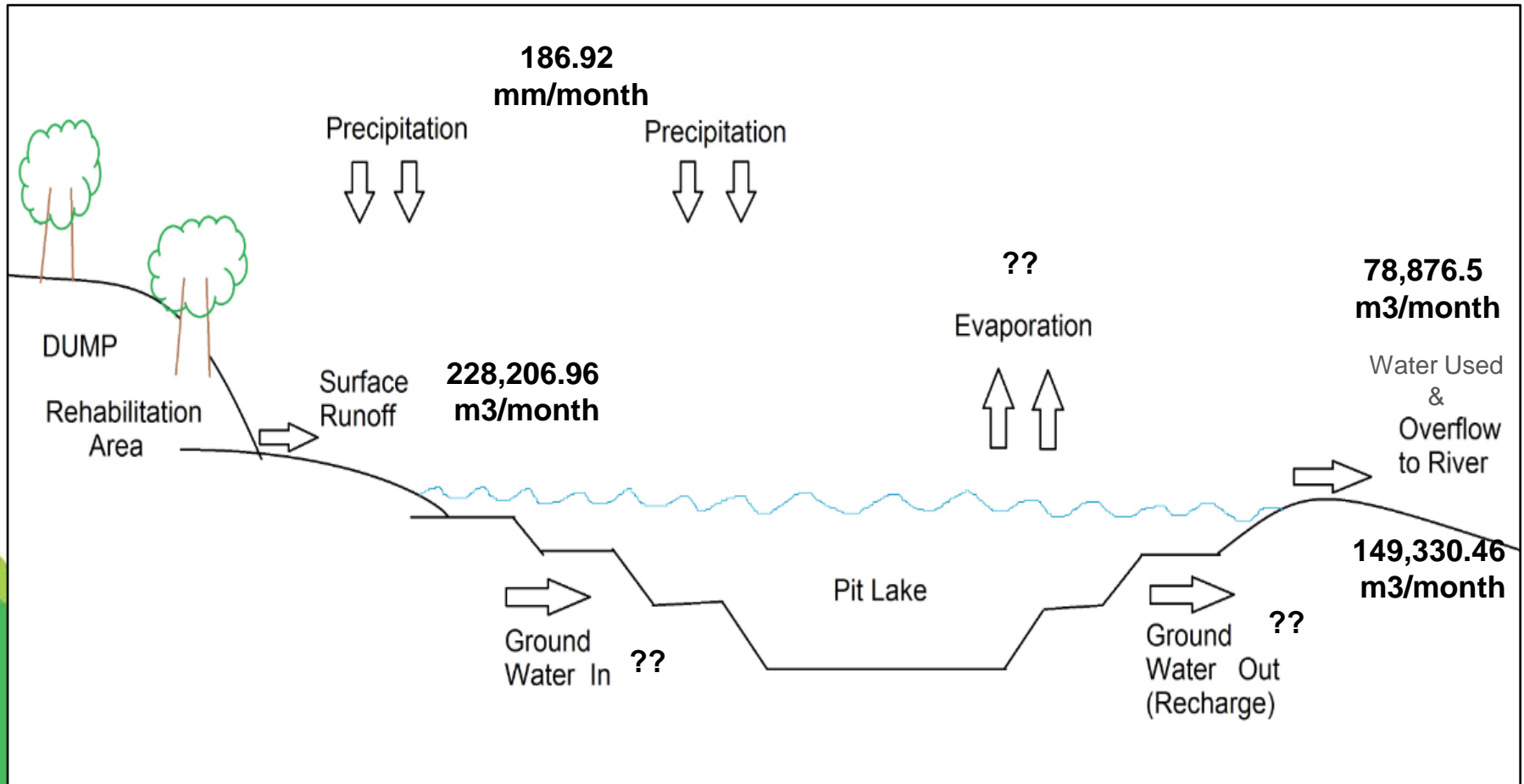
90 m of water depth

Surface water level at 64 m asl





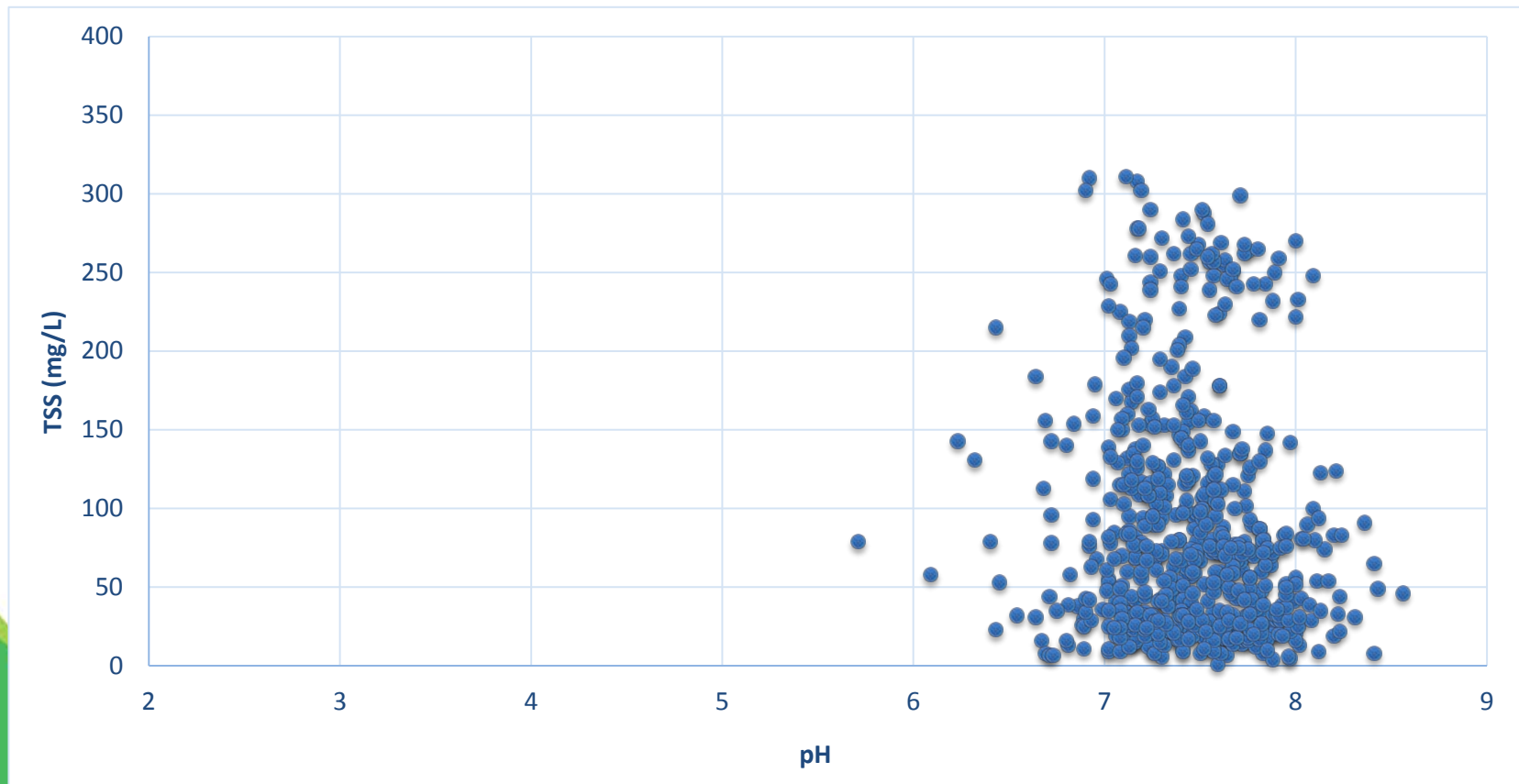
# Conceptual Process Paringin Pit Lake



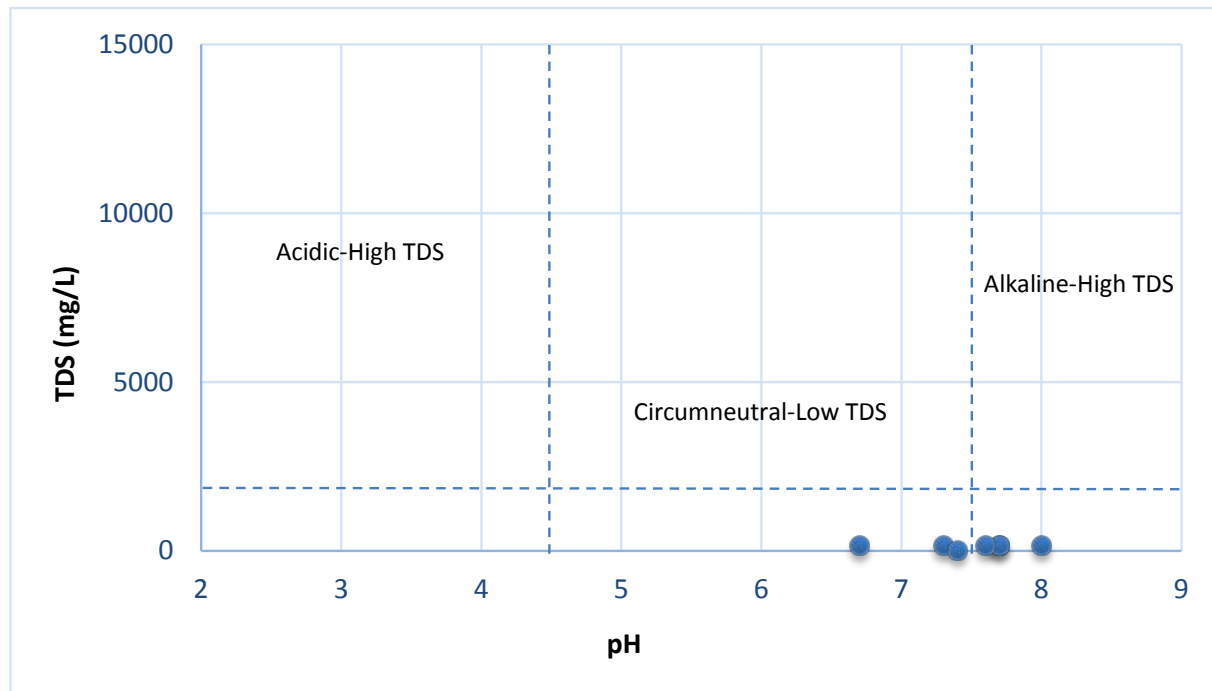
# Paringin Pit Lake Water Balance

No.	Month	Total Days	Median Rainfall	Inflow (I)	Water Used (O)	Inflow - Water Used	(Storage + (I-O))	Effective Pit lake vol capacity	Overflow to River	Water Elevation
			mm	m <sup>3</sup>	m <sup>3</sup>	m <sup>3</sup>	m <sup>3</sup>	m <sup>3</sup>	m <sup>3</sup>	m
								2,122,303.88		
1	Jan	31	240.73	293,889.12	80,389.20	213,499.92	2,335,803.80	2,122,303.88	213,499.92	64.80
2	Feb	28	263.00	321,083.55	72,609.60	248,473.95	2,370,777.83	2,122,303.88	248,473.95	64.80
3	Mar	31	253.43	309,393.91	80,389.20	229,004.71	2,351,308.59	2,122,303.88	229,004.71	64.80
4	Apr	30	203.61	248,580.32	77,796.00	170,784.32	2,293,088.20	2,122,303.88	170,784.32	64.80
5	May	31	117.38	143,307.44	80,389.20	62,918.24	2,185,222.12	2,122,303.88	62,918.24	64.80
6	Jun	30	147.80	180,441.63	77,796.00	102,645.63	2,224,949.51	2,122,303.88	102,645.63	64.80
7	Jul	31	118.00	144,060.30	80,389.20	63,671.10	2,185,974.98	2,122,303.88	63,671.10	64.80
8	Aug	31	101.00	123,305.85	80,389.20	42,916.65	2,165,220.53	2,122,303.88	42,916.65	64.80
9	Sep	30	101.00	123,305.85	77,796.00	45,509.85	2,167,813.73	2,122,303.88	45,509.85	64.80
10	Oct	31	136.50	166,646.03	80,389.20	86,256.83	2,208,560.71	2,122,303.88	86,256.82	64.80
11	Nov	30	256.50	313,148.03	77,796.00	235,352.03	2,357,655.91	2,122,303.88	235,352.03	64.80
12	Dec	31	304.15	371,321.53	80,389.20	290,932.33	2,413,236.21	2,122,303.88	290,932.33	64.80
<b>Total</b>				<b>2,738,483.55</b>	<b>946,518.00</b>	<b>1,791,965.55</b>			<b>1,791,965.55</b>	

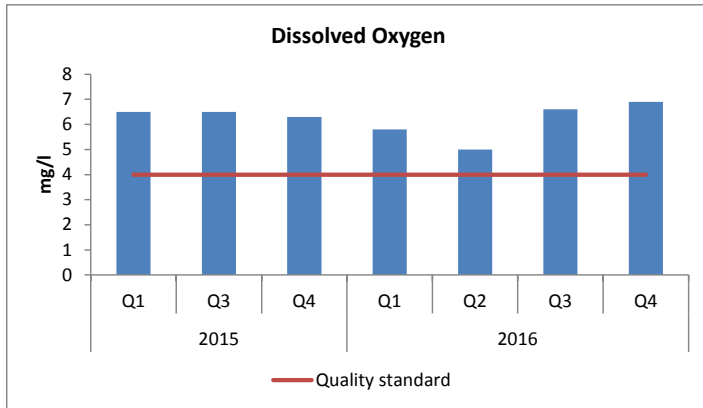
# Historical Daily pH vs TSS Data 2013 – Jan 2017



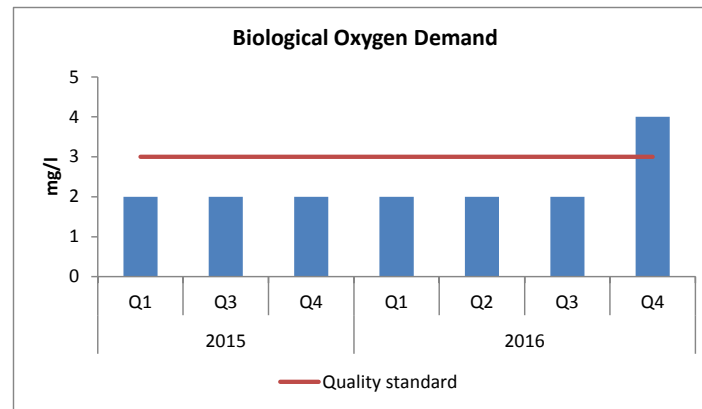
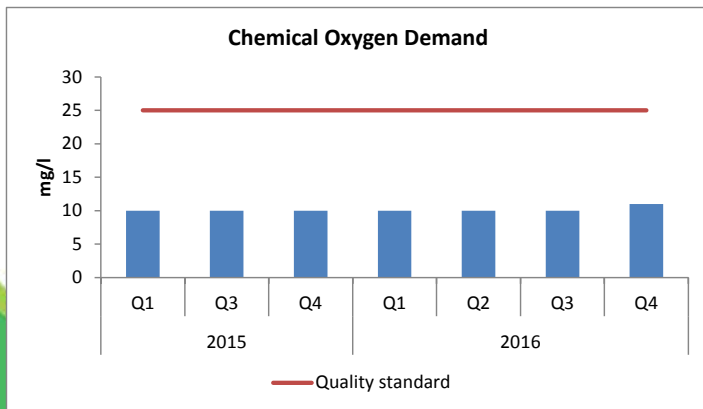
# 2015 - 2016 Quarterly TDS vs pH Data of Paringin Pit Lake



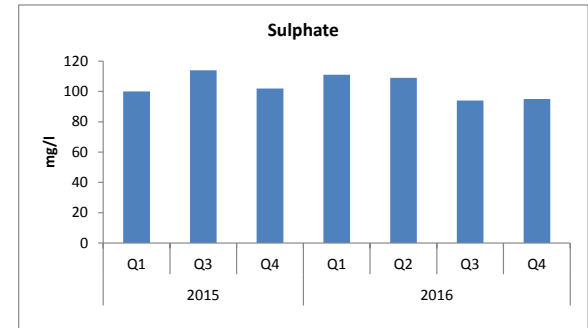
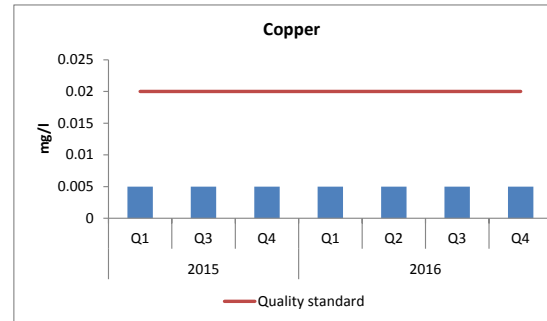
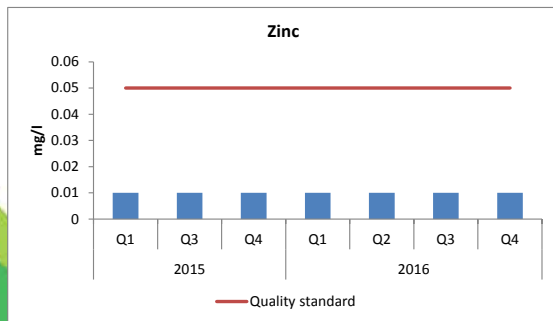
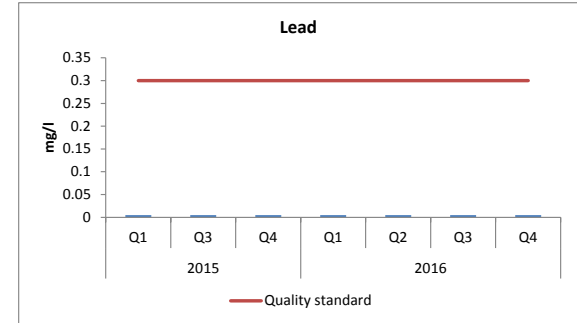
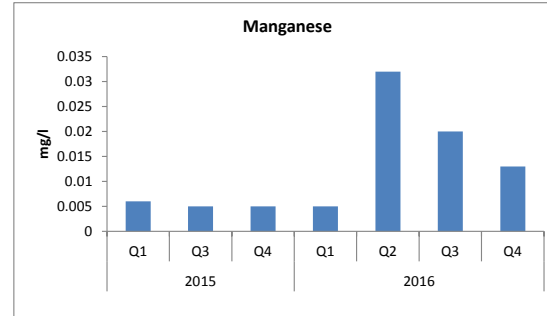
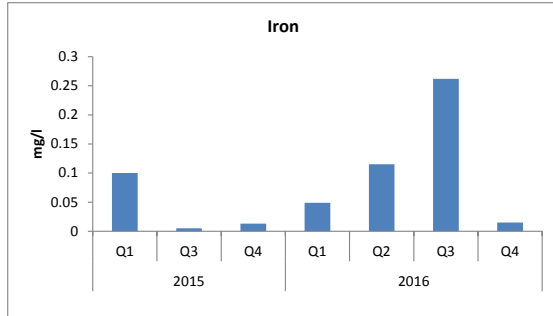
# 2015-2016 Quarterly DO, COD and BOD of Paringin Pit Lake

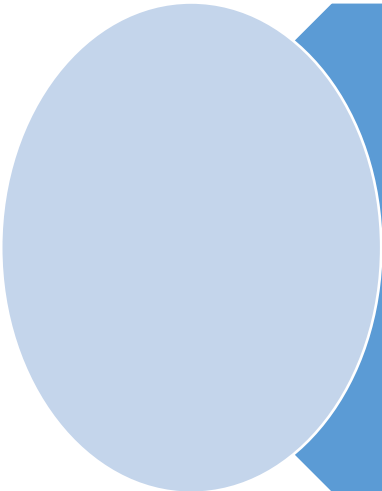



Good Dissolved Oxygen above 4mg/l  
COD below 25 mg/l  
BOD below 3 mg/l (except Q4)




# 2016 Quarterly Dissolved Metal of Paringin Pit Lake





What factors controlling  
Good water quality of  
Paringin Pit Lake since  
closure in 2005?



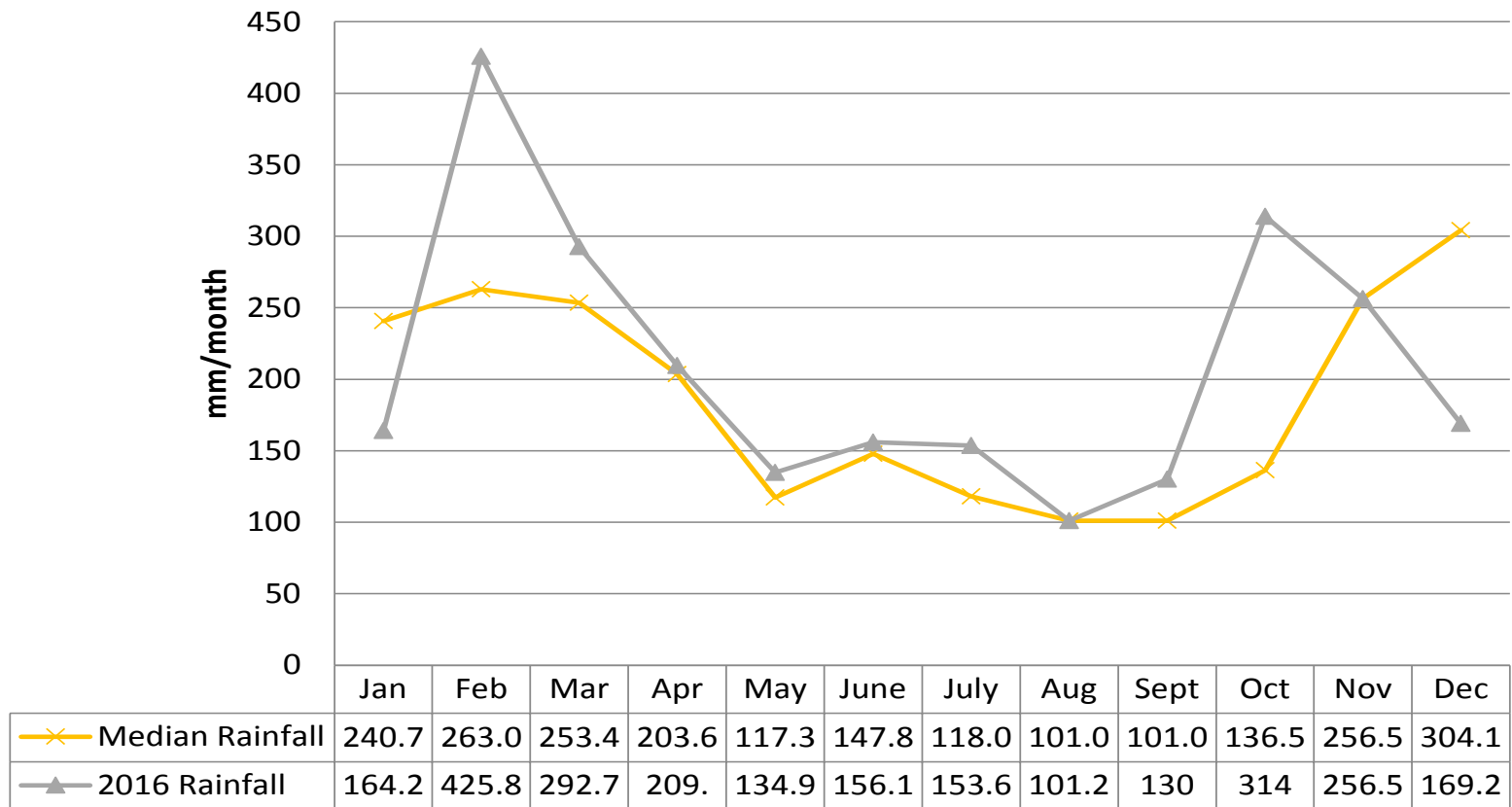
# Factors controlling Paringin Pit Lake water quality

- **Climatic Condition**
- **Stable Catchment Condition**
- **Low Erosion & Sedimentation Rate**
- **Stable Geochemical Condition**
- **Stable Geotechnical Condition**



# Climatic Condition

## Median Rainfall 2010-2016 vs 2016 Rainfall (mm/month)

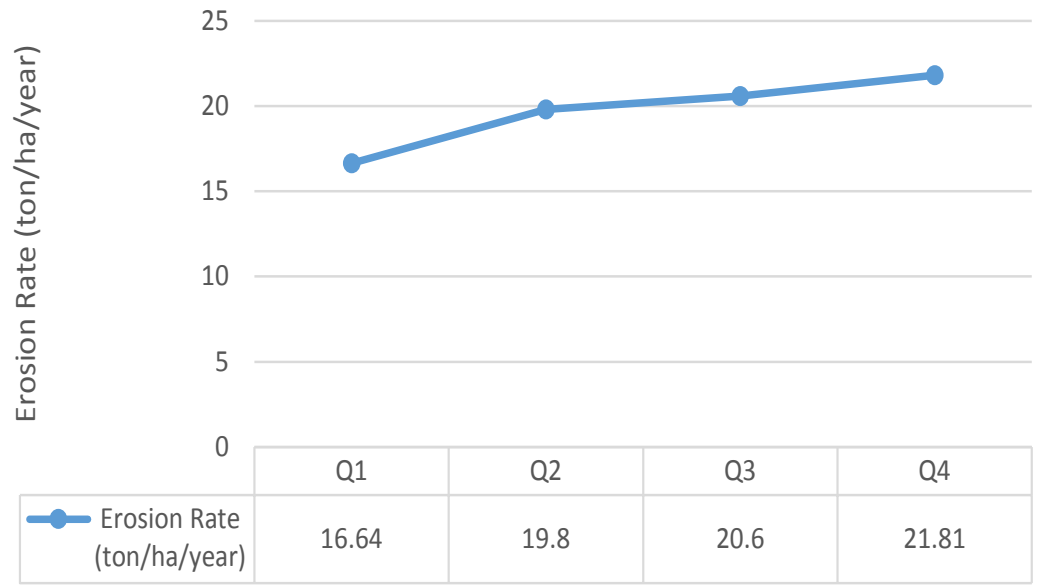


# Catchment Condition : Progressive Revegetation

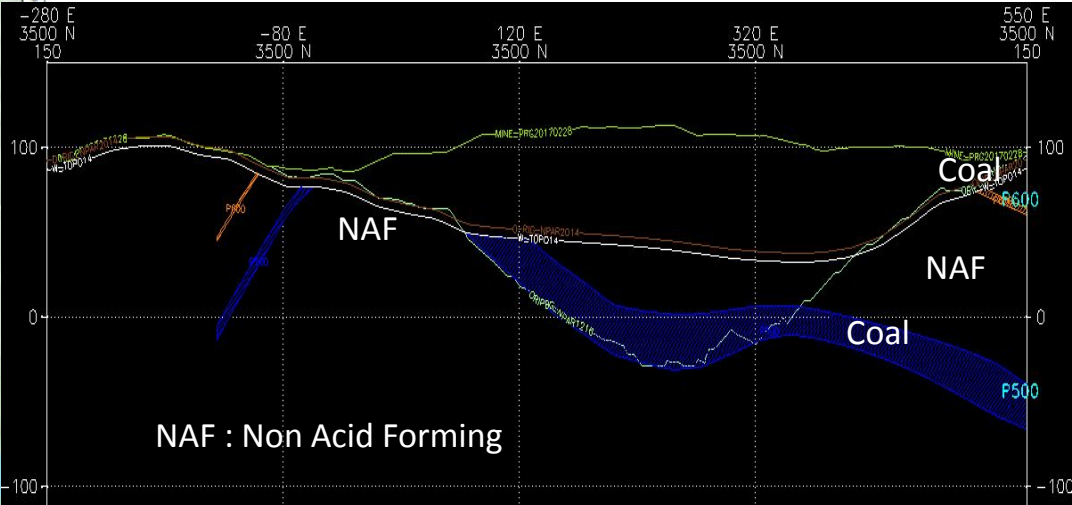
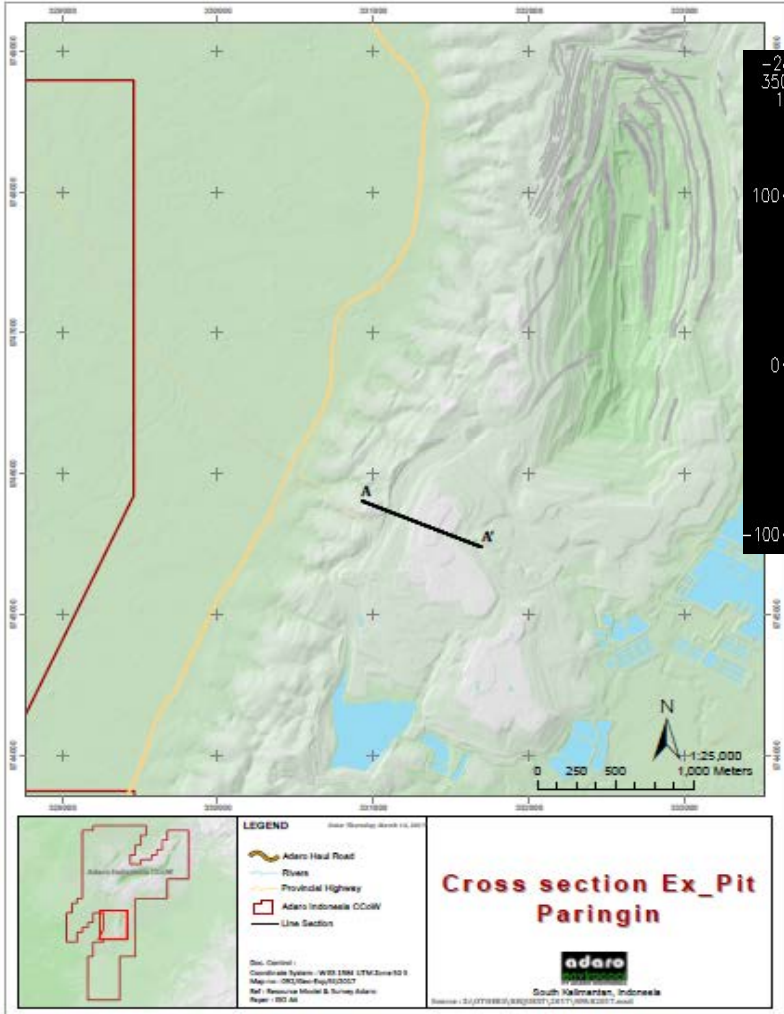


# Low Erosion Rate of Rehabilitated/ Revegetated Area

Erosion Rate Rehabilitated Area Paringin Pit Lake Catchment 2016 (ton/ha/year)



# Stable Geochemical Condition of Pit Lake Wall



# Stable Geochemical Condition of Pit Wall & Waste Dump



No	Hole name	Sample Number	Depth_from	Depth_To	Thickness	MPA	ANC	NAPP	Paste_pH	NAG	AMD Classification	Lithology
1	PN449C	PN449C S-07	27.4	32.4	5	1.84	0.00	1.84	6.9	7.8	NAF	Mudstone
2	PN449C	PN449C S-08	32.4	37.4	5	4.28	1.00	3.28	5.7	7.4	NAF	Mudstone
3	PN449C	PN449C S-09	37.4	42.4	5	3.98	2.00	1.98	6.7	7.5	NAF	Mudstone
4	PN449C	PN449C S-10	42.4	47.4	5	6.43	13.00	-6.57	6.6	7.6	NAF	Mudstone
5	PN449C	PN449C S-11	47.4	52.4	5	4.28	1.00	3.28	6.8	8	NAF	Mudstone
6	PN449C	PN449C S-12	52.4	57.4	5	3.98	0.00	3.98	6.5	7.1	NAF	Mudstone
7	PN449C	PN449C S-13	57.4	63.2	5.8	4.28	1.00	3.28	6.5	8	NAF	Mudstone
8	PN449C	PN449C S-14	63.2	67.8	4.6	4.28	44.00	-39.72	7.7	8.4	NAF	Mudstone
9	PN449C	PN449C S-15	67.8	72.8	5	8.57	0.00	8.57	5.9	5.2	NAF	Mudstone
10	PN449C	PN449C S-16	72.8	77.8	5	3.98	1.00	2.98	7	6.9	NAF	Mudstone
11	PN449C	PN449C S-17	77.8	82.8	5	3.37	0.00	3.37	7	7.4	NAF	Mudstone
12	PN449C	PN449C S-18	82.8	87.8	5	1.53	7.00	-5.47	7.3	7.5	NAF	Mudstone
13	PN449C	PN449C S-19	87.8	91	3.2	1.84	9.00	-7.16	7.3	7.5	NAF	Mudstone
14	PN449C	PN449C S-20	96	101	5	1.22	10.00	-8.78	8	7.9	NAF	Mudstone
15	PN449C	PN449C S-21	101	104.8	3.8	1.84	4.00	-2.16	7	7.6	NAF	Mudstone
16	PN503C	PN 503C_S-01	0	5	5	6.37	5.28	1.08	5.89	5.44	NAF	Mudstone
17	PN503C	PN 503C_S-02	5	10	5	1.47	36.53	-35.06	6.99	8.01	NAF	Mudstone
18	PN503C	PN 503C_S-03	10	14	4	3.92	13.90	-9.98	6.95	7.44	NAF	Mudstone
19	PN503C	PN 503C_S-04	14	19	5	2.45	12.95	-10.50	7.69	7.3	NAF	Sandstone
20	PN503C	PN 503C_S-05	19	24	5	2.94	15.57	-12.63	6.89	7.31	NAF	Sandstone
21	PN503C	PN 503C_S-06	24	29	5	6.37	37.26	-30.89	6.96	7.57	NAF	Mudstone
22	PN503C	PN 503C_S-07	29	34	5	4.41	17.48	-13.07	6.85	7.32	NAF	Mudstone
23	PN503C	PN 503C_S-08	34	39.9	5.9	4.91	10.56	-5.66	7.19	6.92	NAF	Mudstone
24	PN503C	PN 503C_S-09	40.5	45.5	5	2.94	12.95	-10.01	6.88	6.99	NAF	Mudstone
25	PN503C	PN 503C_S-10	45.5	50.5	5	4.42	12.95	-8.54	7.16	7.25	NAF	Mudstone
26	PN503C	PN 503C_S-11	50.5	55.5	5	5.39	17.95	-12.56	7.23	7.3	NAF	Mudstone
27	PN503C	PN 503C_S-12	55.5	60.5	5	2.45	32.49	-30.04	7.52	7.61	NAF	Mudstone
28	PN503C	PN 503C_S-13	60.5	64.4	3.9	4.90	11.52	-6.62	6.8	6.74	NAF	Mudstone
29	PN503C	PN 503C_S-14	64.4	72.1	7.7	1.96	23.44	-21.48	7.62	7.5	NAF	Sandstone
30	PN503C	PN 503C_S-15	72.1	78.5	6.4	3.43	10.33	-6.90	7.08	6.76	NAF	Mudstone
31	PN503C	PN 503C_S-16	80.4	82.5	2.1	1.96	10.33	-8.37	7.17	7.01	NAF	Mudstone
32	PN503C	PN 503C_S-17	83.8	88.8	5	2.94	14.38	-11.44	7.12	7.04	NAF	Mudstone
33	PN503C	PN 503C_S-18	88.8	93.8	5	2.45	13.43	-10.97	7.51	7.56	NAF	Mudstone
34	PN503C	PN 503C_S-19	93.8	98.8	5	3.43	15.33	-11.90	7.55	7.35	NAF	Mudstone
35	PN503C	PN 503C_S-20	98.8	103.8	5	0.98	13.66	-12.68	8.29	7.59	NAF	Mudstone
36	PN503C	PN 503C_S-21	103.8	109.6	5.8	2.94	16.76	-13.82	7.82	7.34	NAF	Mudstone
37	PN503C	PN 503C_S-22	110.1	115.1	5	2.45	12.71	-10.26	7.47	7.01	NAF	Mudstone
38	PN503C	PN 503C_S-23	115.1	120.1	5	5.39	10.81	-5.42	7.52	6.88	NAF	Mudstone
39	PN503C	PN 503C_S-24	120.1	125.1	5	2.94	16.04	-13.10	7.69	7.24	NAF	Mudstone
40	PN503C	PN 503C_S-25	125.1	130.1	5	3.43	27.24	-23.81	7.88	7.94	NAF	Mudstone
41	PN503C	PN 503C_S-26	130.1	135.1	5	2.45	20.57	-18.12	7.61	7.96	NAF	Mudstone
42	PN503C	PN 503C_S-27	135.1	140.1	5	5.39	15.09	-9.70	6.94	7.39	NAF	Mudstone
43	PN503C	PN 503C_S-28	140.1	145.1	5	4.41	13.91	-9.50	7.94	7.53	NAF	Mudstone
44	PN503C	PN 503C_S-29	145.1	150.1	5	3.43	17.24	-13.80	8.07	7.54	NAF	Mudstone
45	PN503C	PN 503C_S-30	147.8	151.6	3.8	4.41	17.72	-13.30	7.99	7.57	NAF	Mudstone
46	PN503C	PN 503C_S-31	151.6	153.5	1.9	2.94	22.24	-19.30	7.95	7.79	NAF	Sandstone
47	PN503C	PN 503C_S-32	153.5	156.7	3.2	2.94	16.53	-13.58	8.04	7.72	NAF	Mudstone
48	PN503C	PN 503C_S-33	156.7	157.8	1.1	4.41	18.91	-14.50	7.58	7.38	NAF	Sandstone
49	PN503C	PN 503C_S-34	157.8	162.4	4.6	2.45	26.29	-23.84	8.29	8	NAF	Mudstone

# Stable Geotechnical Condition of Pit & Waste Dump

**Stable Geotechnical Condition Based on geotechnical study and approved by Ministry of Energy & Mineral Resources**

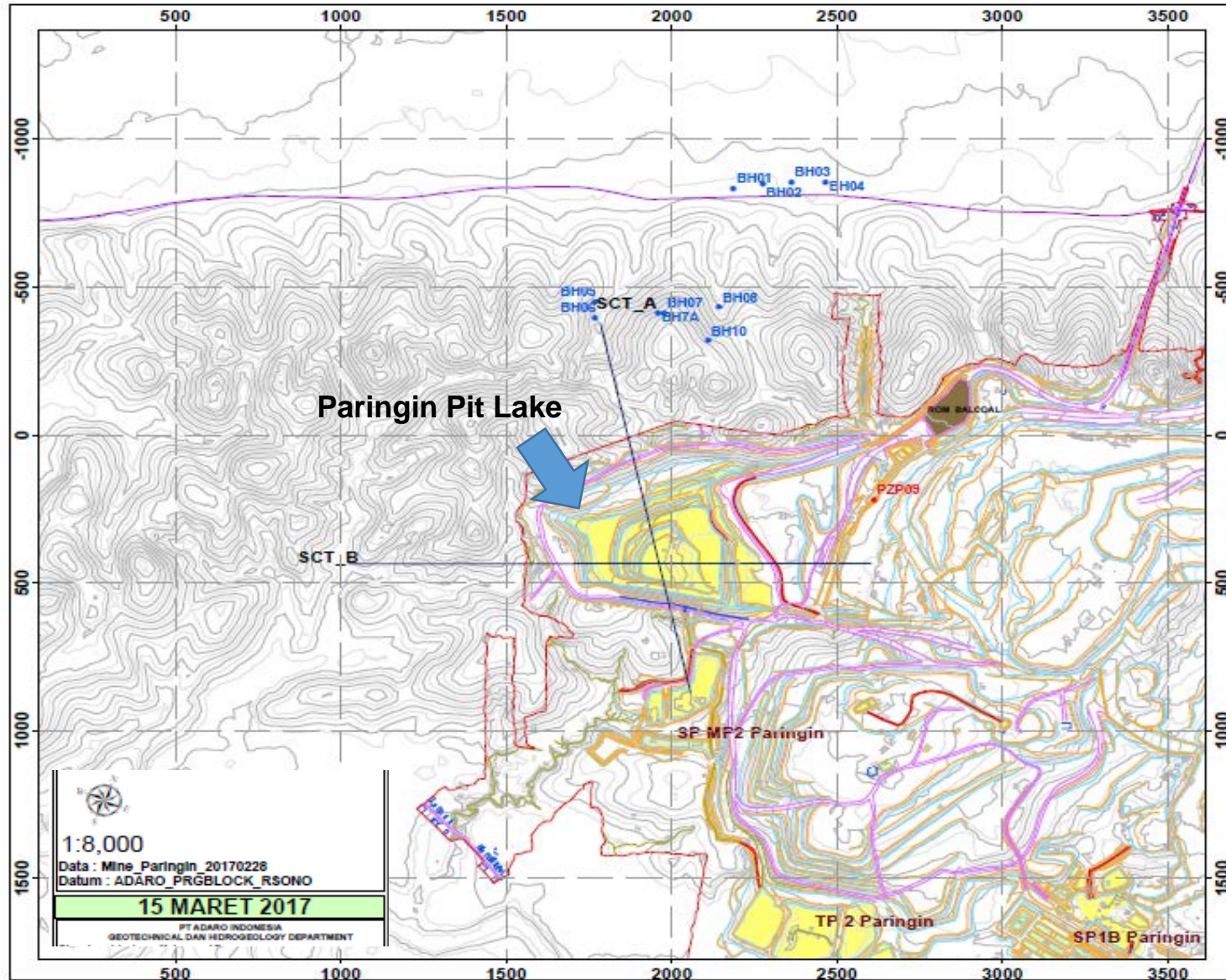
## A. Single Bench Geometry

Pit Wall	Material Type	Dimension	
		Height (m)	Angle (degree)
High Wall	Sandstone	16-36	45-70
	Mudstone	12	40
Low Wall	Sandstone	16-48	45-70
	Mudstone	16	40

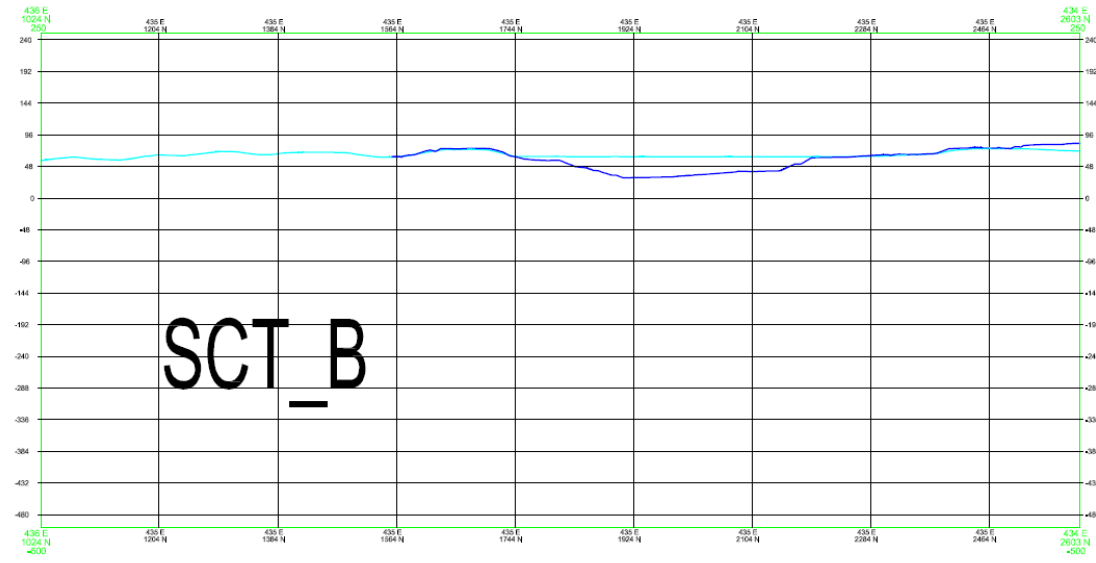
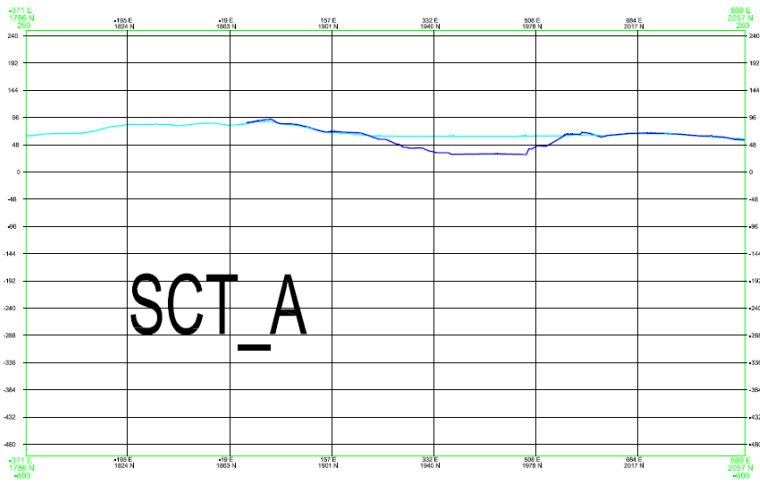
## B. Overall Pit Gemotery

High Wall		Low Wall	
Height (m)	Angle (degree)	Height (m)	Angle (degree)
29	21	62	17

# Geotechnical



# Geotechnical : Stable Slope Geometry







# water used of Paringin Pit Lake



# Paringin Pit Lake : Fresh water lake ecosystem services – Birds Habitat



Snakebird



Purple Heron



Little Egret



Oriental Dwarf-kingfisher



Stork-billed Kingfisher



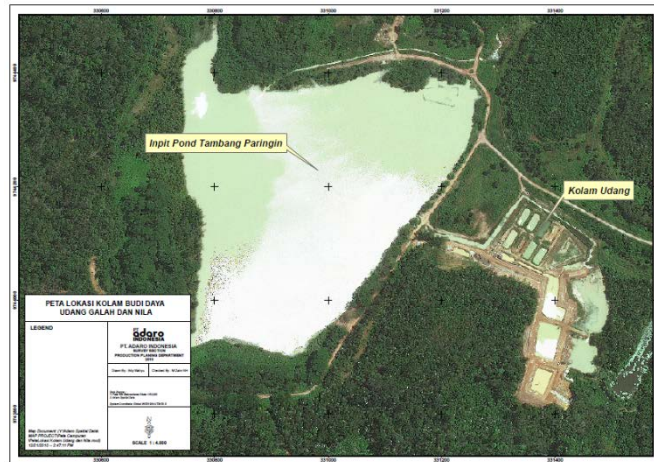
Collared Kingfisher



Blue-eared Kingfisher



# Paringin Pit Lake Water Used : Fish Farm




## Fish Farm:

- Total area of ponds : 1.5 Ha. Flow through water +/- 900,000 m<sup>3</sup>/month
- 8 fish ponds with dimension : 35 x 15 x 1,5 (depth) m
- 3 ponds for fish mating with 300 males and 900 females.
- 2 ponds for growing fish
- Juveniles are sent to locals for fish farming.

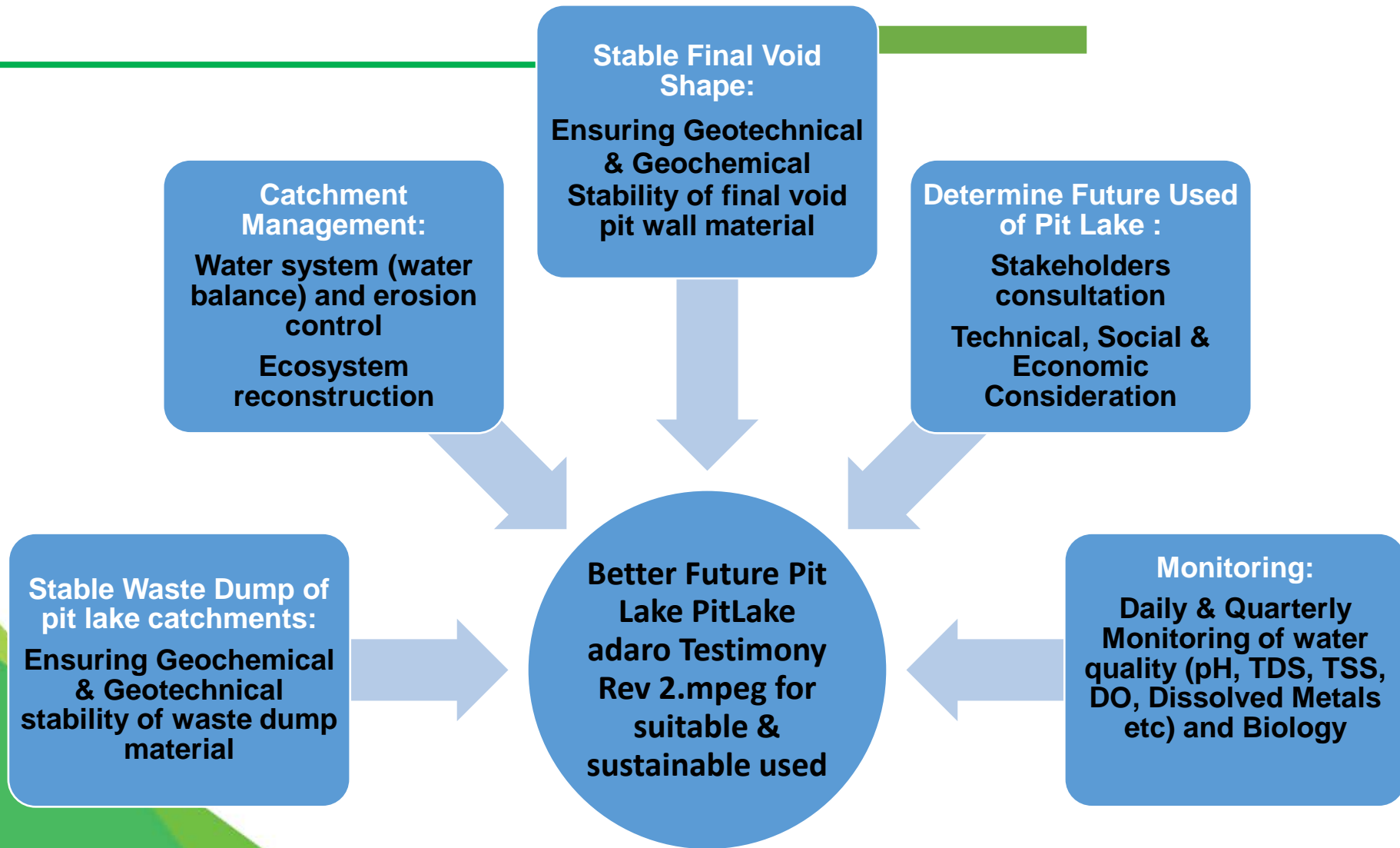


# Paringin Pit Lake Water Used : Nursery & Soil and Plants Lab

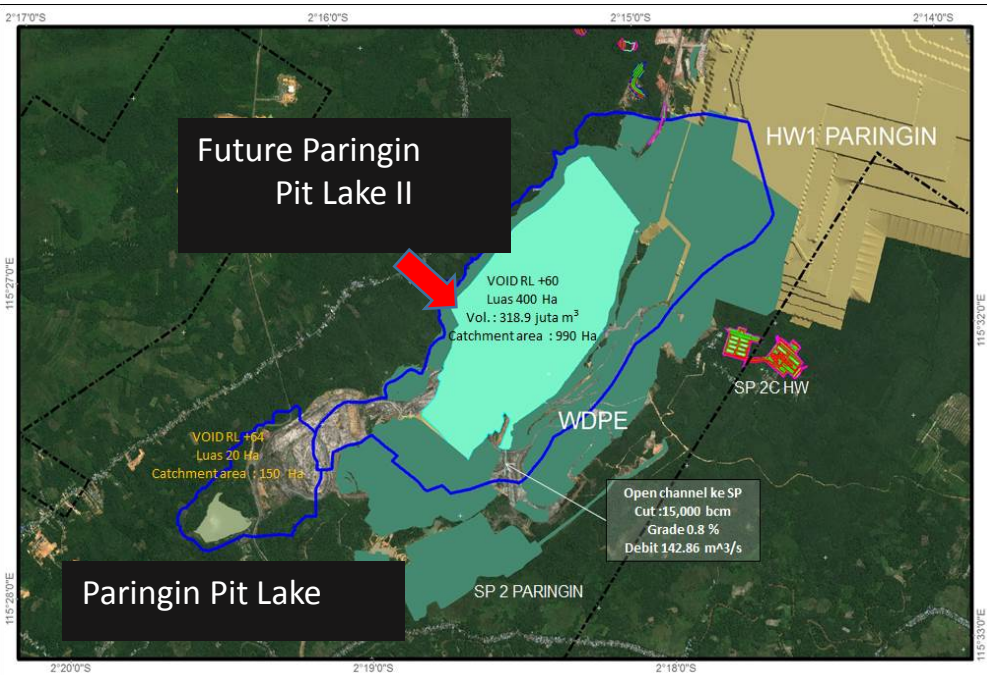




What lesson learnt  
& improvement for  
better future pit  
lake management?



# Future Paringin Pit Lake II



- Bigger future pit lake: final void shape 400 Ha, 990 Ha catchment area and 318.9 M m<sup>3</sup> of water volume
- Required careful management of geochemical, geotechnical & hydrological aspect.
- Potency of future pit lake used e.g. healthy lake ecosystem services, fresh water source, aquaculture & energy.

# Conclusion

- **Paringin pit lake is a good example of a coal pit lake that has excellent water quality e.g. near neutral pH, low TDS and TSS, low dissolved metal contents, good Dissolved Oxygen**
- **Paringin pit lake is also good example of flow through lake with stable hydrological process mainly sourced from surface water of surrounding rehabilitated catchment area and groundwater input with output flow to receiving river.**
- **Good water quality is resulted from successful management of key factors: geotechnical, geochemical condition of its catchment and hydrological aspect.**
- **Consistent water quality and biological monitoring should be conducted for continuous evaluation of pit lake.**
- **Future used of pit lake should consider environmental, technical, social & economic context and resulted from intensive stakeholders consultation.**



# Terima Kasih (Thank You)



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