# Characterization of Former Coal Mining Ponds (voids) and Water Management System Planning 

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#### Abstract

This study aims to examine the characteristics and volume of ex-coal mining pools that have been filled with water in the form of voids using River Surveyor M9 technology. The results of the void profile study become important data in planning a water management system which includes draining the pond with a pumping planning system and planning a sludge pond. From the results of a void study in Pit E, it was found that the area of pit E is 27.25 Ha , a depth of 57 m , a length of 820 m , a width of 205 m , and a volume of $6,479,241.5 \mathrm{~m} 3$. The company plans to drain $71,991.57 \mathrm{~m}^{3}$ of voids per day, so it is estimated that it will take 90 days of working time. The required pump capacity is $3,850 \mathrm{~m} 3 /$ hour. From the results of a field study and the efficiency of the pump, it will be placed in the southern part of the ex-mining pond which has a total capacity of $3,913 \mathrm{~m} 3 / \mathrm{hour}$ and a total power of $1,181 \mathrm{HP}$. Sludge settling ponds are planned with a pond width of 18 m ; Pool length of 45 m ; pool depth of 4 m ; many compartments of 5 pieces; compartment length of 8 m ; settling capacity of 4000 m 3 ; compartment capacity of 800 m 3 . Water is channeled using an open canal in the form of a trapezoid, made of earth, dug normally without hardening of the seams with a slope of $0.044 \%$; channel bottom width 1.04 m ; water level 1.04 m ; top width of channel 4.12 m ; guard height 0.5 m , slope $43^{\circ}$.


## I. INTRODUCTION

PT. XYZ is a coal mining company that implements an open pit mining system, a mining system that is directly related to the outside weather and has 6 pits. Since 2000, namely pits A, B, C, $\mathrm{D}, \mathrm{E}$, and pit E, coal production has reached a cumulative production of $1,250,000$ metric tons. In 2014, the company stopped all of its production activities due to the drastic decline in coal prices.

In 2021 the company plans to reopen its pits, as a result of a technical study there are coal reserves that are still economical, namely pit E , all abandoned mine openings are now mine ponds (voids).
Under these conditions, the mine pond must be drained so that it can dig back the coal in the mining pit. The drying or dewatering process will be carried out with careful planning so that an effective dewatering system plan can be carried out.

This research was conducted to know the characteristics and profile of mine water ponds (voids), analyze pump point locations, and select pumps so that the target of dewatering void pit v is achieved and analyze settling pond system planning in pit E.

In drying mine ponds, it is necessary to study the characteristics of the mine ponds. The study of hydrology includes flow groundwater, hydrometeorology (water in the air and the form of a gas), limnology (surface water that is relatively calm such as lakes and reservoirs), cryptology (water in the form of solids such as ice and
snow) [1].
The characterization of the mine pond includes the profile of the mine pond.

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the local hydrological cycle as a basis for calculating the water discharge target [6].
This water discharge target is then used to analyze pump selection, starting from consideration of the available head for each location for pump placement, and pump efficiency at each location. [7].

All elements of open channel parameters must be known to prevent the water level from overflowing, so a guard height is needed in the channel. The guard is the vertical distance from the top of the canal to the water surface at the design discharge condition. The guard height is useful for raising the water level above the maximum water level and preventing damage to the canal embankment and is associated with the planned discharge of the canal [12].

## II. METHODOLOGY

Research conducted at PT. XYZ. Pengaron District, Banjar Regency, South Kalimantan. Location of all mining activities based on contract No. KW 98 AGB064. follow the coordinates between $03^{\circ} 15^{\prime} 59,6^{\prime \prime}$ South Latitude to $03^{\circ} 19^{\prime} 04^{\prime \prime}$ South Latitude and $115^{\circ} 05^{\prime} 21^{\prime \prime}$ East Longitude to $115006^{\prime} 27^{\prime \prime}$ East Longitude.


Figure 1. Map of Research Locations
The initial stage of this research is to conduct a literature study related to data and information related to previous coal mining such as identifying former coal mining pools and mapping former coal mining ponds.

The next step is to prepare field observations and measurements to find out the site's general condition, including the number and characteristics of the 6 ex-coal mining pools.

Then from these data determine the ex-mining pond (void) that will be studied, namely in the ex-mining pond in pit E. After that measurements are carried out by determining the zero point to obtain detailed data on the characteristics and profile of the pond including coordinates, depth, volume, and water discharge.

To obtain characteristic data and void E profiles, direct measurements were made using the river surveyor M9 tool.

Figure 2 shows the river surveyor M9 technology used to directly measure the characteristics of void E in the field.


Gambar 2. River Surveyor M9 Full set
The River Surveyor M9 is a tool for measuring subsurface conditions using the Acoustic Doppler Current Profiler (ADCP) approach specifically designed to work in rivers, lakes, and seas. River surveyor m9 can measure the speed of water currents, water discharge in 2 or 3 dimensions, the depth of the water surface, the state of the particles below the water surface, d bathymetry. Processing of research data obtained from the field as well as data from companies is processed using the River Surveyor Live application, Minescape 5.7, Global Mapper, and Microsoft Excel. The data processing steps are as follows:

1. Compile and process closure data and void pit E grids from the river surveyor live application to Microsoft Excel.
2. Input data from Microsoft Excel to calculate

The volume of water in the voids using the Minescape 5.7 application.
3. Processing rainfall data in Microsoft excel.
4. Calculating the catchment area using the Global

Mapper application.
Data analysis was carried out by evaluating the characteristics of the mine pond to determine the volume of water in the pit mine (voids) Pit E. Then analyzing the local hydrological cycle to calculate the target water discharge to be released (dewatering). This target water discharge is then used to analyze the selection of pumps that can meet the target, starting from consideration of the head for each location available for pump placement, and efficiency and ay at each location.

The next stage is to analyze the settling pond system. Settlement ponds (settling ponds) function as temporary water storage before flowing back into the river.

The sludge-settling pond is all a function as a place to control the quality of the water from the mixed mud or solid material which will be flowed out. In channeling water openly, planning the dimensions of the open channel needed to flow water to the nearest river body that meets environmental quality standards.

Calculation of the capacity of the drainage channel is done by using the Manning formula which is the basis for determining the channel. In designing channel dimensions, efforts must be made to obtain economical cross-sectional dimensions. Channel dimensions that are too large mean it is not economical, conversely channel dimensions that are too small the loss rate will be large. If the flow velocity and cross-section are known, then the flow rate can be calculated.

Figure 3 describes the research flowchart from the field survey stages, measurement and analysis of the characteristics study and dewatering and pumping planning as well as the dimensions of the sludge settling pond plan.


## III. RESULT AND DISCUSSION

The initial step in solving this case is through the following stages:

1. Evaluate the characteristics of the mine water pool (void) Pit E
a. Making a Mine Pool Profile

The first initial stage carried out in data processing in the Minescape 5.7 software is to enter closure data that has been taken with the river surveyor m 9 which is tied to a rubber boat by walking along the edge of the mine pond (void). This aims to determine the shape of the mining pond (void), making
this closure based on boundary coordinate data (Table 1) obtained from river surveyor live software.

Table 1. Void River Surveyor coordinates

| Step | Track | DMG | Depth | UTM X | UTM Y |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | m | m | m | m | m |
| Start Edge (1) | 0.36 | 0.36 | 12.94 | 296780.5 | 9648397 |
| Start Edge (2) | 0.74 | 0.74 | 12.9 | 296780.9 | 9648397 |
|  |  |  |  |  |  |
| Start Edge (3) | 1.09 | 1.08 | 12.77 | 296781.2 | 9648397 |
| Start Edge (4) | 1.44 | 1.43 | 12.86 | 296781.6 | 9648397 |
| Start Edge (5) | 1.74 | 1.73 | 12.66 | 296781.9 | 9648397 |

Source: Processed data, 2022

Profile data must be pre-processed in Microsoft excel software to change the depth to Z , by reducing the elevation with the depth obtained from the river surveyor $m 9$ tool.

The goal is that it can be loaded into the Minescape 5.7 software because the data that can be loaded in creating a mining pool profile (voids) must be in xyzfree form. After the X, Y, and Z coordinates (Table 2) are obtained, they are then loaded into the Minescape 5.7 software.

Tabel 2. Koordinat Void Pit E Dari Perhitungan River Surveyor Live

| No | UTM X | UTM Y | Depth | Permukaa <br> n air | Ketinggian |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | m | m | m | m | m |
| 1 | 296780.5 | 9648397 | 12.937 | 66 | 53.04 |
| 2 | 296780.9 | 9648397 | 12.932 | 66 | 53.08 |
| 3 | 296781.2 | 9648397 | 12.768 | 66 | 53.20 |
| 4 | 296781.6 | 9648397 | 12.859 | 66 | 53.12 |
|  | 296781.9 | 9648397 | 12.657 |  | 53.33 |

Figure 3. Research Flowchart


Figure 4. Pit E ex-mine pool (void).

## b. Making Grid or Cross Section

The next stage is gridding or the area division stage of the mining pool (void). The distance between each section is 25
meters. The distance of 25 meters was chosen not to have a certain standard but was chosen so that the results from the measurement of the mining pool (void) pit $E$ were more optimal. The smaller the distance between sections, the greater the level of accuracy, and vice versa the greater the distance between sections, the greater the level of accuracy.

## c. Making Contours with the Triangulation Method

The $\mathrm{X}, \mathrm{Y}$, and Z coordinate data that have been input into Minescape 5.7 are first processed into contour line data by clicking on the triangulation contour menu in Minescape so that the resulting contour lines are smoother, then processed into triangulation data. The figure shows the design of the triangulation model of the shape of the mining pool (Figure 4).
d. Calculation of the volume of mine pools (voids) Pit E

To calculate the volume, in addition to triangulation data from the mining pool, triangulation data from the water surface is also needed for additional data.

The volume calculation requires triangulation of water level data as the top layer and mining pool triangulation as the bottom layer (Figure 5).


Figure 5. Triangulated Void Layering at Pit E
From the calculation results, it is obtained that the volume of the pit E mine pond is $6,479,241.5 \mathrm{~m} 3$ with a surface area of 32.224 Ha and an average pool depth of 12.817 meters.
2. Analysis of Pump Selection and Location
a. Water discharge

The volume of the mine pond is $6,479,241.5 \mathrm{~m}^{3}$. The dewatering target is carried out in 90 days, so the water discharge issued per day is $71,991.57 \mathrm{~m}^{3} /$ day.

## b. Pump Installation

For pump location placement, 2 locations can be used as pump installation placements, namely in the north of the void and in the south of the void (figure 4).


Figure 5. Alternative locations for pump placement

Determination of the location where the pump is located is determined by comparing the size of the pump head, the number of alternative pumps to choose from, the amount of water discharge that can be pumped, and the power required for each pump installation.

The flow rate of each pump is obtained by plotting the head value on the head vs flowrate curve.


Figure 6. Pump installation plan in the northern part of the Mine Pond at Pit E

The pump installation plan in the coal mining pit as illustrated in Figure 6, shows that pump 03 cannot be used as an alternative because the topography in the north of the pond is too large and steep for the ability of the pump head or commonly referred to as the shut-off head, where at that head the pump cannot flow water which will result in inefficiency and the pump will be damaged.

The maximum pump capacity that can be
achieved is $1,450 \mathrm{~m}^{3} / \mathrm{h}$ with an efficiency of $77 \%$ and the lowest power is 309 HP . Thus, there are only 5 pump installations that can be used, namely pumps $01 \mathrm{~A}, 02 \mathrm{~B}, 02 \mathrm{C}, 03 \mathrm{~A}$, and 03 B as presented in table 3 below.

Table 3. Pump Installation North of the Mine Pond

| NORTH |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Tot |  |  |  |  |  |  |
| Numb er | He <br> ad <br> (m) | Se | L/s | $\mathrm{m}^{3} / \mathrm{h}$ | $\begin{aligned} & \text { cy } \\ & \% \end{aligned}$ |  | (HP) |
| 01 | 80,1512 | A | 200 | 720 | $\begin{aligned} & \hline 7 \\ & 0 \\ & \hline \end{aligned}$ | 1200 | 309 |
|  |  | B | 265 | 954 | $\begin{aligned} & 6 \\ & 7 \\ & \hline \end{aligned}$ | 1300 | 428 |
|  |  | C | 323 | 1.163 | $\begin{aligned} & 6 \\ & 0 \\ & \hline \end{aligned}$ | 1300 | 583 |
| 02 | 67,6253 |  | Shut off head |  |  |  |  |
| 03 | 73,3824 | A | 311 | 1.100 | $\begin{aligned} & 7 \\ & 5 \\ & \hline \end{aligned}$ | 1000 | 405 |
|  |  | B | 403 | 1.450 | $\begin{aligned} & 7 \\ & 7 \end{aligned}$ | 1000 | 520 |

The pump installation plan in the southern part of the ex mine pond is designed as shown in Figure 6, where th topographical field analysis results in the southern part of th mine pond can be handled by all available pumps and there ar 9 alternative pump installations.


Figure 7. Planned Pump Installation in the South of the Pit E Mine Pond

## c. Pump Selection

From the results of the analysis of the pump installation above, it aims to be able to meet the target of removing void pool water of $71,991.57 \mathrm{~m}^{3} /$ day, a pump capacity of 3,850 $\mathrm{m}^{3} /$ hour is needed with 20 working hours.

Table 5. Calculation of Pump Capacity and Power
$\left.\begin{array}{|c|c|c|c|c|c|c|c|}\hline \text { PUMP } & \begin{array}{c}\text { Setel } \\ \text { an }\end{array} & \begin{array}{c}\text { Daya } \\ \text { (HP) }\end{array} & \begin{array}{c}\text { Jumlah } \\ \text { Pompa }\end{array} & \begin{array}{c}\text { Kapasit } \\ \text { as total } \\ \left(\mathrm{m}^{3} / \mathrm{h}\right)\end{array} & \begin{array}{c}\text { Daya } \\ \text { Total } \\ \text { (HP) }\end{array} & \begin{array}{l}\text { Kapasitas } \\ \text { per 1 HP }\end{array} & \begin{array}{l}\text { HP } \\ \text { per } \\ 1 \\ \mathrm{~m} 3 /\end{array} \\ \mathrm{h}\end{array}\right]$

From the results of the study of alternative pump combinations in Table 5, all combinations meet the required minimum capacity. But from the results of the analysis of the effectiveness of the best alternative, combination 1 has the smallest power per $1 \mathrm{~m} 3 /$ hour and the largest capacity per 1 HP of power used compared to the other combinations. Thus, combination 1 is the most efficient choice.

Pump installation in the south of the mine pond shows.d. Settling pond system planning analysis greater pump capacity and lower power and more selection of alternative pumps compared to pump installation in the north of the mine pond (Table 4). From the results of field calculations and analysis, it is recommended that the pump installation be installed in the southern part of the Pit E ex-mine pond.

The largest pump capacity that can be achieved by the pump is $1,790 \mathrm{~m} 3 / \mathrm{h}$ with an efficiency of $70 \%$ and the lowest power is 107 HP .

Table 4. Pump installation South of mine pond

| South |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pump Number | Total <br> Head <br> Total <br> (m) | Setting | Capacity |  | Efisiency \% | RPM | Power <br> (HP) |
|  |  |  | L/s | $\mathrm{m}^{3} / \mathrm{h}$ |  |  |  |
|  |  |  |  |  | ${ }^{70}$ .04.202 | $\square$ | $\begin{array}{\|c\|} \hline 169 \\ \text { ibution } \\ 235 \\ \hline 23 \end{array}$ |
|  |  |  |  | 936 | 60 | 1100 | 317 |
| 4 |  | A | 185 | 665 | 75,5 | 900 | 107 |
|  | 32,6856 | B | 250 | 900 | 72 | 1000 | 152 |

Settling pond dimensions
The planning of the settling pond design aims to precipitate the sediments contained in the ex-mine pool water. Before planning a settling pond, the percentage of solids contained in the water must be calculated first. The total water discharge that enters the settling pond is $1.069 \mathrm{~m}^{3} /$ second. The particle size of the precipitate is $5 \times 10-3 \mathrm{~m}$, which means that the particles are fine powders with a solid density of $5,100 \mathrm{~kg} / \mathrm{m}^{3}$.

Suspended residue $=$ TSS $\times$ Pumping discharge (5)

$$
\begin{aligned}
& =180 \mathrm{gr} / \mathrm{m} 3 \times 1.069 \mathrm{~m}^{3} / \mathrm{s} \\
& =192.42 \mathrm{gr} / \mathrm{second}
\end{aligned}
$$

From the equation formula for the density of solids, it is known that the specific gravity of the solid is $5,100 \mathrm{~kg} / \mathrm{m}^{3}$, then the volume of solids entering is the amount of suspended solid $192.42 \mathrm{gr} / \mathrm{sec}$ divided by the specific gravity of $5,100 \mathrm{~kg} / \mathrm{m}^{3}$ so that the volume of solids entering is $0 ., 00003773$. For the
percentage of solids that enter the total water, the \% solids are obtained:

$$
\begin{gathered}
\text { \% Solids }=0.00003773 \mathrm{~m}^{3} / \mathrm{s} \times 100 \% 1.069 \mathrm{~m}^{3} / \mathrm{s} \\
=0.003529 \% \\
\left.\begin{array}{c}
\text { \% Water }= \\
\end{array}\right)=90.0 .99647 \%
\end{gathered}
$$

From the calculation results, the \% solid is less than $40 \%$
To calculate the settling velocity of the particles, Stokes' law is used. Calculations with Stokes' Law to find the speed of deposition of particles are as follows:


The width of the settling pond is made by 18
meters with the depth of the settling pond adjusted to the vertical reach of the available backhoe equipment minus 1 meter, which is 4 meters.

After the pond depth is determined, the time it takes for the particles to settle to the bottom of the pond is obtained from the pool depth (H) of 4 meters divided by the sludge settling velocity ( Vt ): $0.00697 \mathrm{~m} / \mathrm{s}$ in time per minute is 9.565 minutes.

The particles will settle to the bottom of the pool with a settling speed of $0.00697 \mathrm{~m} / \mathrm{s}$ within 10 minutes. These results indicate that to precipitate $90 \%$ of the particles contained in the water, the settling pond must be given several compartments.

$$
\begin{array}{r}
\% \% \text { Precipitation }=\frac{t \mathrm{~h}}{t_{\mathrm{th}+V t}} \quad x 100 \% \\
90 \%=\frac{t \mathrm{~h}}{t \mathrm{~h}+9,565} \\
0,9(\mathrm{th}+9,565)=1 \text { th }
\end{array}
$$

Flowing water time (years) $=86.085$ minutes
As a result, the particles settle by $90 \%$, the water takes 86.085 minutes to flow out of the pool. The length of the water flow that must be taken is;

Water flow $=$ th x v.h
$=86,085$ menit x $60 \operatorname{detik} /$ menit x $\frac{1,069 \mathrm{~m}^{3} / \text { detik }}{60 \mathrm{~m}^{2}}$
$=92,025 \mathrm{~m}$

Number of compartments $=92,025 \mathrm{~m} / 18 \mathrm{~m}$
$\begin{aligned} & =5 \text { compartments } \\ \text { Length of each compartment } & =\frac{4000 \mathrm{~m}^{3}}{(18 m \times 4 \mathrm{~m})}: 5\end{aligned}$

$$
=11 \mathrm{~m}
$$

From the calculation results above, the dimensions of the planned sludge settling pond to be made are described in Table 5 below
(a)

(b)


Figure 8. Concept and Dimensions of the Sludge Settlement Pond (a) Side view (b) Upper view

Table 5. Table of settling pond dimensions

| No | Dimension | Dimensions |
| :--- | :--- | :--- |
| 1 | Pool width | 18 m |
| 2 | The length of the pool | 55 m |
| 3 | The depth of the pool | 4 m |
| 4 | Number of compartments | 5 buah |
| 5 | Compartment length | 11 m |
| 6 | Pool capacity | 4.000 m 3 |
| 7 | Compartment capacity | 800 m 3 |

## e. Open Channel Dimensions

In planning the drainage, the trapezoidal shape was chosen, this is because it is easy to manufacture and maintain with soil material without talud pavement.

To calculate the wet cross-sectional area (A) obtained from the discharge value of the settling pond of $1.08 \mathrm{~m}^{3} /$ hour divided by the flow velocity of $0.5 \mathrm{~m} / \mathrm{s}$, the resulting wet cross-sectional area is 2.16 meters.

Because the design of the embankment/salad is made without pavement, the slope of the talus must be designed at $45^{\circ}$ and applies $\mathrm{b} / \mathrm{h}=1$, so that the width of the canal is 4.12 m . After the width of the channel bottom and water level is known, the length around the wet cross section $(\mathrm{P})$ can be calculated.

Circumference length $(\mathrm{P})$ :

$$
\begin{aligned}
\mathrm{P} & =0,82 \mathrm{~m}+2 \times 0,82 \mathrm{~m} \sqrt{1+1^{2}} \\
& =3,98 \mathrm{~m}
\end{aligned}
$$

The hydraulic radius can be calculated after the area and length, and the circumference of the wet cross sections are known. This hydraulic radius is useful for finding the slope of the channel so that the water discharge can flow as planned.

$$
\begin{aligned}
\operatorname{Hydraulic} \operatorname{radius}(\mathrm{R}) & =\frac{2,16 \mathrm{~m}^{2}}{3,98 \mathrm{~m}} \\
\mathrm{R} & =0,54 \mathrm{~m}
\end{aligned}
$$

The slope of the channel is very important because, without a slope, water will not move. The slope is affected by the manning roughness, which is equal to 0.028 .

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Because the channel will be made by regular and straight digging

$$
\begin{aligned}
\text { Channel slope (I) }= & \left(\frac{0,5 \mathrm{~m} / \mathrm{s} \times 0,028)^{2}}{0,542 / 3}\right) \times 100 \% \\
& =0,04425 \%
\end{aligned}
$$

To find out the parameters of the open channel that will be designed to prevent the water level from overflowing, it is necessary to have a guard height in the channel. Deflection height is the vertical distance from the top of the canal to the water surface at the design discharge condition. The guard height is used to raise the water level above the maximum water level and prevent damage to the canal embankment which is associated with the planned discharge of the canal. Because the design discharge made is $1.08 \mathrm{~m}^{3} /$ second and the design height is 0.5 meters.

An open channel is made with a wet cross-sectional area of 2.16 m and a wet cross-sectional area of 3.98 m (Table 6).

Table 6. Planned settling pond dimensions

| No | Dimensions | Dimensions |
| :---: | :--- | :---: |
| 1. | Wet cross-sectional area | $2,16 \mathrm{~m}$ |
| 2. | Circumferential wet section | $3,98 \mathrm{~m}$ |
| 3. | Water level | $1,04 \mathrm{~m}$ |
| 4 | Channel base width | $1,04 \mathrm{~m}$ |
| 5 | Top width of the channel | $4,12 \mathrm{~m}$ |
| 6. | Channel slope | $0,04425 \%$ |
| 7 | Flow rate | $0,5 \mathrm{~m} / \mathrm{s}$ |
| 8 | Flow discharge | $1,08 \mathrm{~m} 3 / \mathrm{s}$ |

The ideal cross-sectional dimensions of an open channel so that the target of water flow is achieved can be illustrated in Figure 8 below.


Figure 9. Sectional drainage plan

## IV. CONCLUSIONS

From the results of the characterization study of ex-mining ponds, it was found that the profile of the pond in Pit E with the deepest depth of the pond is 58 m ; the area of 26.72 Ha ; the Pool length is 800 m ; the pool width 200 m ; The water volume of the Pit E mine pond is estimated at $6,479,241.5 \mathrm{~m}^{3}$. The total planned water discharge volume with 20 hours working hours in 90 days is $3,850 \mathrm{~m}^{3}$ per hour.

The largest pump capacity in the south of the mine pond is $1,790 \mathrm{~m}^{3} / \mathrm{h}$; efficiency is $70 \%$; the smallest power is 107 HP . Pump installation is recommended to the South of the mine pond. The most pump combination efficient and meemeetse target, namely combination 1 with a capacity of $3,939 \mathrm{~m}^{3} / \mathrm{h}$ in total power $1,117 \mathrm{HP}$

Dimensions settling pond Appropriate plans are an 18 m wide pond; Pool length of 45 m ; Pool depth of 4 m ; many compartments of 5 pieces; Compartment length of 8 m ; pool capacity of $4000 \mathrm{~m}^{3}$; compartment capacity of $800 \mathrm{~m}^{3}$.

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## REFERENCES

[1]. Bambang, T. (2008). "Applied Hydrology". Yogyakarta: Beta offsets.
[2]. Cosgrove, WJ, \& Loucks, DP (2015). Water Management: Current Challenges and Future and Research Directions Water Resources Research. 51 (6) hh. 4823-4839
[3]. Dwivedi AK. (2017). Water Pollution Research: An Overview. International Research Journal of Applied Natural Sciences. 4 (1); dd. 118142. doi:10.13140/RG.2.2. 12094.08002.
[4]. Endra Setiawan et al. System Technical Review Distribution at the Coal Mine at PT Mall PT. Pipit Mutiara Jaya Rocky Site North Kalimantan Province. Journal Mining Technology, 12 (2016)
[5]. Gustari, I. (2019). "Rainfall Analysis West Coast of South Kalimantan period 20102019". Journal of Meteorology and Geophysics. 10(1):29-38
[6]. Gautama, RS., 2019. Drainage System Mining, Bandung Institute of Technology, Bandung.
[7]. Hartono. (2013). "Dictate of System Lectures Mine Distribution. Yogyakarta: University of National Development Yogyakarta "veterans".
[8]. Haryoko, L.O. (2017). "Evaluation and Plan Development of Drainage System in District Matan Tanjung Karang City Center Bandar Lampung. Thesis Department of Engineering University Faculty of Engineering Environment Malahayati.
[9]. Isnaeni et al. Technical Study of Settlement Pond Dimensions at Settling Pond 71 C PT. Perkasa Inakakerta, Bengalon District, East Kutai Regency, East Kalimantan Province. Mining Technology Journal 1, 2 (2016)
[10]. Kodoatie, R.J. (2008). "Source Management Integrated Water Power (2nd Edition)". Yogyakarta: Andi.
[11] Kushari, A. R., Kasim T. and Yunasril. 2017. Technical Study of the Mine Drainage The system at the Coal Open Mine of PT. Nusa Alam Lestari, Kenagarian Sinamar, Asam Jujuhan District, Dharmasraya Regency.

Mining Engineering Department, Faculty of Engineering, Padang State University. Journal of Mining Development, Vol. 3, No. 3. ISSN: 2302-3333.
[12] Siahan R et al. Technical Evaluation of Mine Drainage System Case Study: PT. Coal of Sustainable Energy, Nagan Raya Aceh District. Scientific Journal of Earth Engineering Students, 1, 1 (2017) Science Service. New York
[17]. SonTek. ( 2016). River Surveyors S5/M9 System Manual Firmware Version 1.0. Manual book, YSI incorporated, Californian.
[14]. Tahara H. 2018. "Pumps and Compressors".
Pradnya Paramita,

