Bidang Penelitian: Rekayasa/Keteknikan

Laporan Akhir

PENELITIAN UNGGULAN KOMPETITIF

UNIVERSITAS SRIWIJAYA

MODEL EKONOMI PEMANFAATAN LAHAN BEKAS TAMBANG DAN AIR VOID: IMPLEMENTASI PERATURAN PEMERINTAH NOMOR 46 TAHUN 2017 TENTANG INSTRUMEN EKONOMI LINGKUNGAN HIDUP

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UNIVERSITAS SRIWIJAYA
JURUSAN TEKNIK PERTAMBANGAN
FAKULTAS TEKNIK

NOVEMBER 2018

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RINGKASAN

MODEL EKONOMI PEMANFAATAN LAHAN BEKAS TAMBANG DAN AIR VOID: IMPLEMENTASI PERATURAN PEMERINTAH NOMOR 46 TAHUN 2017 TENTANG INSTRUMEN EKONOMI LINGKUNGAN HIDUP

Ringkasan

Peraturan Pemerintah Nomor 46 Tahun 2017 Tentang Instrumen Ekonomi Lingkungan Hidup mengharuskan semua kegiatan yang menimbulkan dampak terhadap lingkungan hidup wajib menginternalisasikan instrumen lingkungan hidup terhadap dampak tersebut. Kajian kelayakan ekonomi pemanfaatan lahan bekas tambang menggunakan metode analisis manfaat dan biaya dilakukan guna mengimplementasikan Peraturan Pemerintah di atas. Kajian kelayakan diperlukan untuk mengetahui apakah lahan bekas tambang PT Semen Baturaja (Persero) Tbk layak dimanfaatkan untuk keberlanjutan sumberdaya air sebagai pembangkit listrik tenaga mikrohidro, dan perkebunan karet. Hasil penelitian ini diharapkan dapat memberikan manfaat bagi para pemangku kepentingan, praktisi dan asosiasi pertambangan dan lingkungan hidup, dan dapat dijadikan sebagai dasar bagi kebijakan kementerian ESDM dalam rangka pemanfaatan lahan pasca tambang dan internalisasi lingkungan hidup di sektor pertambangan. Luaran selain model ekonomi pemanfaatan air void tambang untuk mikrohidro juga dihasilkan publikasi pada jurnal internasional bereputasi dan hak kekayaan intelektual (hak cipta).

Keyword : Lahan bekas tambang batukapur, Air void tambang batukapur, PLTMH, Perkebunan karet, Analisis manfaat dan biaya.

PRAKATA

Puji syukur kami panjatkan kehadirat Allah SWT, atas limpahan rahmat dan hidayahnya sehingga kami dapat menyelesaikan laporan kemajuan kegiatan penelitian yang berjudul "Model Ekonomi Pemanfaatan Lahan Bekas Tambang Dan Air Void: Implementasi Peraturan Pemerintah Nomor 46 Tahun 2017 Tentang Instrumen Ekonomi Lingkungan Hidup".

Laporan kemajuan kegiatan ini dapat diselesaikan dengan baik, tidak lepas dari bantuan berbagai pihak. Oleh karena itu, dalam kesempatan ini perkenankanlah kami mengucapkan terima kasih kepada :

1. Dekan Fakultas Teknik Universitas Sriwijaya.
2. Ketua Lembaga Penelitian Universitas Sriwijaya.
3. PT Semen Baturaja (Persero) Tbk.
4. Pihak-pihak yang telah membantu dan mensukseskan pelaksanaan kegiatan ini.

Kami berharap kegiatan yang telah terlaksana ini dapat bermanfaat untuk pengembangan PT Semen Baturaja (Persero) Tbk serta masyarakat pada umumnya.

Palembang, November 2018
Ketua Tim Peneliti

Dr. Ir. Restu Juniah, MT., IPM.

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BAB 1
PENDAHULUAN

1.1. Latar Belakang

Tujuan dan alat penyeimbang pilar ekonomi, sosial dan lingkungan di sektor pertambangan adalah pertambangan berkelanjutan (Kokko et.al, 2015). Kebijakan manajemen sumberdaya alam dapat digunakan dan diperlukan sebagai dasar dan menjadi tantangan untuk keberlanjutan sumberdaya alam seperti air dan energi (Juniah & Sastradinata, 2017). Fungsi lingkungan sebagai penyedia sumber daya alam, asimilator karbon, dan nilai estetika. Mengintegrasikan lingkungan hidup dapat menjadikan lingkungan pertambangan tetap berkelanjutan secara ekonomi, sosial dan ekologi. Hutan yang beragam secara ekologis secara drastis dapat terganggu oleh kegiatan penambangan (Dallaire, 2015). Langkah pertama yang penting untuk dilakukan adalah pemulihan fungsi ekosistem. Hal ini dikarenakan pembangunan berwawasan lingkungan menjadi suatu kebutuhan penting bagi setiap bangsa dan negara yang menginginkan kelestarian sumberdaya alam dan pelestarian fungsi lingkungan hidup (Juniah, 2017).

Penilaian ekonomi diatur secara khusus dalam Peraturan Pemerintah Nomor 46 tahun 2017 Tentang Instrumen Ekonomi Lingkungan Hidup. Berdasarkan Peraturan ini, menjadi hal yang penting untuk memberikan penilaian ekonomi dalam rangka pelestarian fungsi lingkungan hidup. Kegiatan pertambangan batukapur meninggalkan lahan bekas tambang berupa *void* (kolam bekas tambang) dan *non void*. Lahan bekas tambang dan air *void* tambang dapat dimanfaatkan untuk berbagai keperuntukan. Valuasi ekonomi (penilaian ekonomi) adalah nilai barang dan jasa yang dapat diperjual belikan, sehingga memberikan pendapatan (Betani et.al, 2016).

Berdasarkan hal di atas menjadi hal yang sangat penting untuk dilakukan penelitian terkait model ekonomi terhadap pemanfaatan air *void* tambang batukapur PT Semen Baturaja (Persero) Tbk untuk pembangkit listrik tenaga mikrohidro (PLTMH) dan lahan bekas tambang untuk perkebunan karet yang menjadi kekuatan dalam penelitian ini.

1.2. Urgensi Penelitian

Hasil penelitian dan kajian sebelumnya menemukan jika lahan bekas tambang dapat direhabilitasi dan dipergunakan untuk berbagai keperuntukan (Dariah et.al, 2010; Juniah et.al. 2012; Juniah, 2013; Juniah 2017; Daru et.al, 2016; Syafrianto, 2016; Mashud & Engelbert, 2014; Yuniawatiningtyas, 2014. Hidayanto et.al, 2014; Margaretta, 2010; Tamin, 2016). Demikian juga dengan hasil penelitian dan kajian sebelumnya menemukan PLTMH sebagai salah satu jenis sumber energi terbarukan yang dapat menghasilkan energi listrik (Juniah & Sastradinata, 2017). Penelitian pemanfaatan lahan bekas tambang yang sebelumnya dilakukan lebih kepada kemanfaatannya untuk perkebunan, budidaya air tawar, kehutanan. Demikian juga halnya penelitian PLTMH yang memanfaatkan air *void* tambang untuk menghasilkan energi listrik masih sangat jarang dilakukan, khususnya di pertambangan batu kapur. Penelitian terkait lahan bekas tambang kapur lebih kepada revegetasi tambang batu kapur.

Kualitas air *void* tambang yang cenderung di bawah baku mutu menyebabkan air dalam *void* tambang kehilangan fungsinya sebagai penyedia sumberdaya air, yang diperlukan baik untuk keberlanjutan sumberdaya air itu sendiri maupun untuk dipergunakan oleh masyarakat yang bermukim sekitar pertambangan batukapur. *Void* tambang dapat menyebabkan ketidak berlanjutan sumberdaya air secara kuantititas dan kualitas. Pemanfaatan air *void* tambang batukapur PT Semen Baturaja (Persero) Tbk untuk PLTMH diharapkan, selain dapat mengembalikan sumberdaya air secara kuantitas dan kualitas, juga dapat menjaga keberlanjutan sumber daya air sehingga energi dan lingkungan tetap berkelanjutan dan lestari. Lahan bekas tambang PT Semen Baturaja (Persero) Tbk untuk perkebunan karet dapat memberi manfaat bagi masyarakat khususnya yang bermukim sekitar tambang, bagi keberlanjutan sumberdaya alam terbarukan sehingga dapat menggantikan sumberdaya alam tak terbarukan batukapur, dan keberlanjutan ekologi lingkungan pertambangan batukapur PT Semen Baturaja (Persero) Tbk. Model ekonomi yang dibangun dalam riset ini dalam rangka mengimplementasikan Peraturan Pemerintah Nomor 46 Tahun 2017 tentang Instrumen Ekonomi Lingkungan Hidup terhadap pemanfaatan lahan bekas tambang batukapur PT Semen Baturaja (Persero) Tbk untuk perkebunan karet,

dan PLTMH. Penelitian ini akan memberikan hasil optimum bagi pemanfaatan air *void* tambang untuk PLTMH dan pemanfatan lahan bekas tambang untuk perkebunan karet, bagi keberlanjutan sumberdaya air sektor pertambangan batukapur dan energi berkelanjutan. Keberlanjutan sumberdaya air untuk PLTMH dan keberlanjutan sumberdaya alam terbarukan secara ekonomi, sosial, dan lingkungan di sektor pertambangan batukapur melalui penelitian ini dapat dipahami. Keberhasilan penelitian ini akan memberikan sumbangan pemikiran untuk keberlanjutan sumberdaya air, dan sumberdaya alam terbarukan sebagai salah satu sumberdaya energi baru terbarukan menggantikan sumberdaya energi dan sumberdaya alam tak terbarukan, sehingga sumberdaya energi dan sumberdaya alam tak terbarukan pada lahan bekas tambang batukapur sektor pertambangan tetap berkelanjutan (*sustainable*). Model yang dihasilkan dan ditemukan dalam penelitian ini diharapkan dapat digunakan di sektor pertambangan batukapur, sehingga dengan penemuan baru ini dapat dihasilkan Hak Kekayaan Intelektual berupa hak cipta, 6 publikasi internasional (1 jurnal terindex scopus, 1 proseding teridex scopus dan 6 terindex DOAJ).

BAB 2
PETA JALAN PENELITIAN

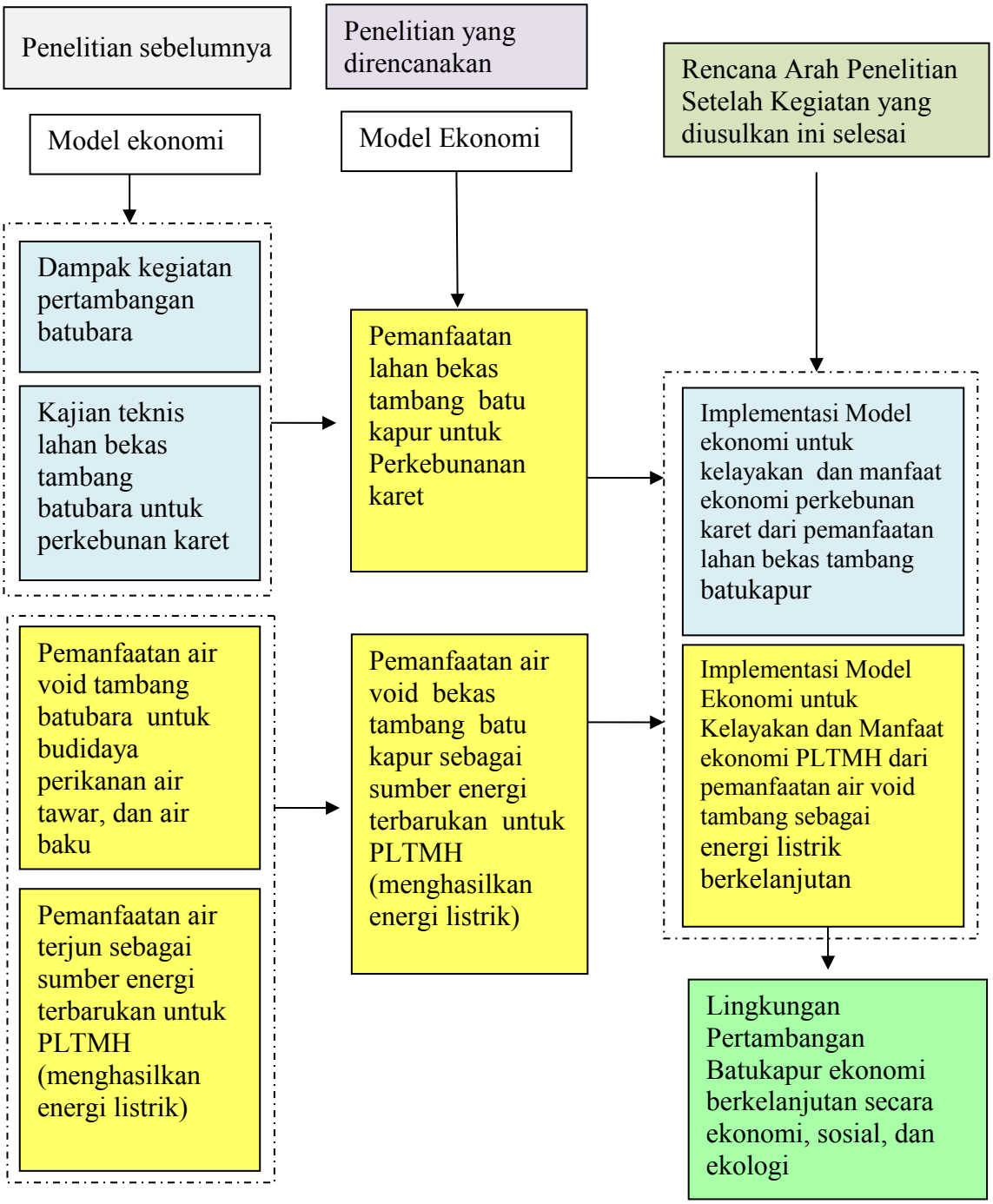
Peta jalan penelitian yang diusulkan mengacu pada peta jalan penelitian unsri yaitu peta jalan "pengendalian lahan bekas tambang", dan "Hydro-energy" pembangkit listrik tenaga mikrohidro (PLTMH).

Kegiatan pertambangan di akhir kegiatan akan meninggalkan lahan bekas tambang. Lahan bekas tambang dapat menjadi lahan yang tidak produktif apabila pemanfaatan lahan bekas tambang tidak sesuai dengan keperuntukannya. Demikian juga halnya dengan *void* tambang (kolam bekas tambang), yang menjadi momok khususnya bagi masyarakat yang bermukim sekitar tambang. Hal ini dikarenakan apabila air yang terdapat dalam *void* tidak dikelola dengan baik sehingga dapat mencemari dan merusak lingkungan. Oleh karena itu, dengan menyadari bahwa kegiatan pertambangan dapat mengakibatkan penurunan kualitas lingkungan seperti kualitas air, kualitas tanah, serta deplesi sumber daya alam, maka pada akhir kegiatan pertambangan perlu untuk mengendalikan dan memanfaatkan lahan bekas tambang sesuai keperuntukannya.

Berdasarkan hal di atas, maka dapat dirumuskan peta jalan penelitian sebagaimana tampak pada Gambar 2.1. Penelitian sebelumnya yang telah dilakukan adalah memberikan penilaian ekonomi terhadap dampak kegiatan pertambangan batubara PT Bukit Asam Tbk Provinsi Sumatera Selatan. Penelitian ini dilakukan untuk mengetahui nilai ekonomi yang timbul secara langsung dan tidak langsung pada aspek ekonomi, sosial, dan ekologi untuk keberlanjutan lingkungan pertambangan batukapur. Keberlanjutan lingkungan pertambangan batukapur dapat terwujud, apabila kegiatan pertambangan batukapur selama masa operasi produksi dan setelah pasca operasi produksi (pascatambang) dapat berkelanjutan secara ekonomi, sosial dan ekologi (sebagaimana dipersyaratkan dalam tiga pilar pembangunan berkelanjutan/ *sustainable development*).

Air *void* tambang batukapur dapat dimanfaatkan untuk sumber air baku, budidaya perikanan air tawar, pembangkit listrik tenaga mikrohidro, pariwisata dan lain-lain yang memberi kemanfaatan ekonomi baik secara langsung maupun

tidak langsung pada aspek ekonomi, sosial dan ekologi. Penelitian yang sudah dilakukan sebelumnya keberlanjutan lingkungan pertambangan batubara dengan memanfaatkan air *void* tambang sebagai air baku, dan budidaya perikanan air tawar yang dilakukan pada pertambangan PT Adaro Indonesia Provinsi Kalimantan Selatan. Lahan bekas tambang yang *non void* dapat dimanfaatkan untuk tanaman pertanian seperti sagu, tanaman hutan seperti jabon, dan tanaman perkebunan seperti karet. Pemanfaatan ini memberi manfaat bagi keberlanjutan ekonomi, sosial maupun ekologi. Penelitian sebelumnya terlait dengan keekonomian karbon keperuntukan lahan bekas tambang batubara untuk perkebunan karet di PT Samantaka Batubara Provinsi Riau.



Gambar 2.1. Peta Jalan Penelitian "Model Ekonomi Pemanfaatan Lahan Bekas Tambang: Implementasi Peraturan Pemerintah Nomor 46 Tahun 2017 Tentang Instrumen Ekonomi Lingkungan Hidup".

Pemanfaatan air *void* tambang untuk pembangkit listrik tenaga mikrohidro diperlukan selain untuk menjaga keberlanjutan sumber daya air, juga dalam rangka pemanfaatan sumberdaya air sebagai sumber energi terbarukan untuk menghasilkan listrik. Pemanfaatan lahan bekas tambang untuk perkebunan karet

memberi manfaat ekonomi, sosial dan ekologi pada pascatambang batukapur. Hal ini mengingat tanaman karet dapat berperan sebagai tanaman perkebunan sekaligus tanaman hutan.

Penelitian ini akan difokuskan pada pembangunan model ekonomi terhadap keperuntukan lahan bekas tambang batukapur untuk perkebunan karet dan void tambang untuk PLTMH. Pemilihan lahan bekas tambang kapur dikarenakan pembangunan model ekonomi pada penelitian sebelumnya dilakukan terhadap lahan tambang batubara. Pemilihan didasarkan pada pertimbangan karakteristik sifat kimia dan fisika batukapur yang berbeda dengan batubara, serta lapisan tanah penutup yang menutupi batukapur juga berbeda dengan lapisan tanah penutup yang menutupi batukapur. Demikian juga halnya dengan lapisan tanah pucuk yang terdapat pada lapisan paling atas dari masing-masing komoditas tambang tersebut juga berbeda. Perbedaan ini menimbulkan dampak yang juga berbeda terhadap penurunan kualitas air dan kualitas tanah yang terdapat di area pertambangan batukapur maupun batukapur. Perbedaan ini akan berpengaruh terhadap variabel-variabel yang diperlukan baik dalam pengelolaan terhadap air maupun tanah sehingga biaya yang diperlukan untuk pengelolaan tersebut juga berbeda. Hal ini pada akhirnya akan berpengaruh terhadap kelayakan ekonomi dan manfaat ekonomi yang ditimbulkan. Hal ini menjadi sesuatu yang menarik untuk dikaji dan yang akan ditemukan dalam penelitian ini.

Penelitian sebelumnya terhadap PLTMH berasal dari sumberdaya air terjun yang ada di Kabupaten OKUS, sedangkan pada penelitian ini difokuskan pada pemanfaatan air *void* tambang batukapur PT Semen Baturaja Persero Tbk. Pertimbangan untuk melakukan penelitian ini mengingat air yang terdapat dalam *void* tambang berbeda dengan air terjun.

Air terjun sudah memenuhi baku mutu sebagaimana yang dipersyaratkan dalam PP 82 Tahun 2001 Tentang Kriteria Mutu Air sehingga tidak diperlukan pengelolaan terhadap kualitasnya, sedangkan air void tambang harus dikelola terlebih dahulu untuk memenuhi baku mutu air sebagaimana yang dipersyaratkan dalam PP tersebut, sehingga diperlukan biaya untuk pengelolaannya. Hal ini menjadi sesuatu yang juga menarik untuk dibangun model ekonomi terhadap

pemanfaatan air void tambang untuk menghasilkan energi listrik melalui PLTMH. Arahan penelitian yang terdapat dalam renstra Unsri memfokuskan pada tiga hal, di antaranya lingkungan dan energi terbarukan, sedangkan peta jalan penelitian unsri untuk pengendalian lahan bekas tambang, pada peta jalan tiga mengarahkan pada agrowisata memiliki keterkaitan dengan penelitian yang akan diusulkan dan rencana arah penelitian setelah kegiatan yang diusulkan ini selesai. Pemanfaatan lahan bekas tambang batukapur PT Semen Baturaja (Persero) Tbk dapat dijadikan pengembangan bagi agrowisata yaitu perkebunan karet. Pengembangan ini di satu sisi, yaitu tanaman karet sebagai sumberdaya alam terbarukan dapat menggantikan batukapur sebagai sumberdaya alam tidak terbarukan. Peta jalan dua dan tiga, pada peta jalan penelitian Unsri untuk *hydro energy*, mengarahkan pada PLTMH di Sumsel juga memiliki keterkaitan dengan penelitian yang akan diusulkan dimana pemanfaatan air *void* tambang PT Semen Baturaja (Persero) Tbk untuk PLTMH dapat menghasilkan energi listrik dan menambah PLTMH yang ada di Sumsel. Hasil dan luaran dari riset ini sebagaimana ditunjukkan pada Tabel 2.1.

Tabel 2.1. Indikator Capaian Penelitian/Luaran Penelitian

No	Jenis Luaran		Indikator Capaian	Keterangan*)	Jumlah Paper
1	Luaran Wajib berupa Publikasi Ilmiah	Jurnal Internasional terindeks DOAJ	TS	Dipublikasikan IJOEMS (International Joernal Of Environtment Management and Susstainable **Accepted** Terbit Desember 2018	4
		Jurnal internasional terindeks Scopus Canadian Joernal (Q3)	TS	Naskah siap dikirimkan	1
		Proseding Terindex scopous	TS	IOP Proceding) Accepted Revition (Uder review).	1
2	Luaran Tambahan Berupa HKI	Hak Cipta	TS	Siap Dikirimkan	

BAB 3
TINJAUAN PUSTAKA

3.1.Kerangka Teori

Kegiatan pertambangan selalu mendapat sorotan, dikarenakan masyarakat sudah semakin sadar terhadap berbagai permasalahan lingkungan. Pembukaan tambang yang merubah bentang alam atau rona awal. Perubahan bentang alam berdampak pada ketidak berlanjutan sumberdaya alam termasuk sumberdaya air dan energi yang dibutuhkan untuk menyangga kehidupan dan menjadi hajat hidup orang banyak. Kegiatan pertambangan di akhir kegiatannya akan meninggalkan lahan bekas tambang dan *void* (kolam bekas tambang). Pemanfaatan lahan bekas tambang dan air *void* tambang untuk berbagai keperuntukan diperlukan untuk meminimalisir dampak yang timbul terhadap lingkungan. Hal ini diperlukan dalam rangka fungsi lingkungan hidup, keberlanjutan sumberdaya alam dan keberlanjutan fungsi lingkungan. Rencana pemanfaatan lahan pascatambang sektor pertambang diatur dalam Peraturan Menteri ESDM No. 7 tahun 2014 Tentang Rencana Reklamasi dan Rencana Pasca Tambang.

3.1.1. Keperuntukan Lahan Bekas Tambang Batukapur untuk Perkebunan Karet.

Batukapur diperlukan sebagai bahan baku untuk pembuatan semen. Kegiatan pertambangan dalam rangka pemanfaatan sumberdaya alam tak terbarukan batukapur dilakukan secara tambang terbuka dengan sistem *quarry mining* seperti di pertambangan England (Eugene, L.R & Singh, 2014). Tahapan kegiatan pertambangan batukapur di Indonesia sebagaimana halnya tahapan kegiatan pertambangan yang dilakukan di pertambangan batukapur di England. Rangkaian kegiatan tersebut sebagai berikut:

1. Pembersihan lahan (*land clearing*);
2. Pengelolaan tanah pucuk (*top soil management*);
3. Pemberaian batukapur (*limestone mining*) dengan peledakan dan *surface miner*;
4. Pengangkutan batukapur ke *stockpile* atau langsung ke *processing plant;*

5. Pengolahan batukapur (*limestone processing*) menjadi salah satu bahan baku utama pembuatan semen;
6. Reklamasi daerah bekas penambangan (*mine rehabilitation*).

Kegiatan pertambangan batukapur secara terbuka dengan sistem *quarry* menimbulkan dampak terhadap penurunan kualitas tanah. Reklamasi yang dilakukan terhadap lahan bekas tambang batukapur di England dapat meningkatkan kualitas lingkungan dari tanah yang terdegradasi akibat penggalian dengan sistem *quarry* tersebut (Legwaila et. al, 2015). Reklamasi lahan bekas tambang batukapur dalam rangka memanfaatkan lahan bekas tambang kapur membutuhkan penerapan teknik reklamasi yang baik dan benar (Adi et.al, 2017).

Perusahaan pertambangan batukapur di Indonesia seperti PT Semen Padang akan mereklamasi tambang batu kapur apabila ketinggian bukit kapur sudah mencapai level yang tidak bisa ditambang lagi atau sekitar 200 m dari permukaan laut (Harian Umum Singgalang, 2018). PT Semen Baturaja Persero Tbk saat ini sudah melakukan reklamasi pada lahan bekas tambang batukapur yang tidak di tambang lagi (PT Semen Baturaja Persero Tbk, 2018). Rehabilitasi lahan yang terganggu oleh kegiatan pertambangan diperlukan untuk mengembalikan kondisi lahan tersebut secara fisik, kimia dan biologi. Hal ini dikarenakan perubahan unsur-unsur bentang alam seperti topografi, vegetasi penutup, pola hidrologi, kerusakan struktur tanah, dan lain-lain akibat penggunaan metode tambang terbuka dapat menyulitkan proses reklamasinya. Kondisi ini dapat di atasi dengan pendekatan dan teknologi yang tepat. Menurut Dariah *et. al*, 2010, pendekatan dan teknologi yang digunakan akan berbeda tergantung sifat gangguan yang terjadi dan juga keperuntukannya yaitu penggunaan setelah proses reklamasi.

Dampak terhadap parameter fisika dan kimia air yang mengakibatkan menurunnya kualitas badan air permukaan merupakan dampak lain yang timbul dengan adanya pertambangan batukapur (Eugene, L.R & Singh, 2014).

Lahan bekas tambang terbuka dapat dimanfaatkan untuk berbagai keperuntukan seperti perkebunan, peternakan, kehutanan, pengembangan untuk arbetarium, dan lain-lain. Hasil penelitian yang dilakukan oleh peneliti

sebelumnya terhadap pemanfaatan lahan bekas tambang batukapur luar negeri maupun di Indonesia menemukan jika lahan bekas tambang batukapur dapat dimanfaatkan untuk berbagai keperuntukan.

Lahan bekas tambang terbuka di West Virginia dimanfaatkan untuk menghasilkan tanaman bioenergi seperti witchgrass (*Panicum virgatum*) *and Miscanthus* (*Miscanthus x giganteus*) yang merupakan rumput abadi musiman musim panas (Scagline *et.al*, 2015). Potensi produksi biomassa yang tinggi dimiliki oleh kedua spesies ini, memerlukan syarat tumbuh pada kesuburan tanah rendah. Lahan bekas tambang batubara memiliki kesesuaian untuk ditanami karet dan sawit Syafrianto (2016). Lahan bekas tambang batubara PT Samantaka untuk perkebunan karet di Kabupaten Indragiri hulu Provinsi Riau (Juniah, 2017)

Lahan bekas tambang batubara PT. Kaltim Prima Coal (KPC) di Propinsi Kalimantan Timur untuk lahan pertanian tanaman sagu (Mashud & Engelbert, 2014). Pengembangkan area bekas tambang untuk *arboretum* dengan mengkonservasi air, tanah, dan keragaman hayati terutama jenis tanaman lokal (Yuniawatiningtyas, 2014). Pemanfaatan lahan bekas tambang untuk tanaman perkebunan, budidaya tanaman semusim termasuk padi sawah, dan tanaman coklat (Dariah *et. al*, 2010). Lahan bekas penambangan batukapur di kabupaten Kutai Kartanegara Provinsi Kalimantan Timur dapat dikembangkan untuk tanaman padi Towuti dengan sistem pengelolaan khusus (Hidayanto *et.al*, 2014). Lahan bekas tambang juga dapat dimanfaatkan untuk tanaman jagung manis (Margaretta 2010), dan pohon jabon (Tamin, 2016). Lahan bekas tambang batubara PT Nan Riang di Kabupaten Batanghari Provinsi Jambi dimanfaatkan untuk tanaman jabon (Juniah *et.al*, 2012). Lahan pascatambang batubara PT. Kitadin di Provinsi Kalimantan Timur dimanfaatkan sebagai usaha peternakan sapi potong berkelanjutan (Daru et.al, 2016).

Sebagaimana halnya pemanfaatan lahan bekas tambang untuk berbagai keperuntukan dari hasil riset di atas, maka terhadap lahan bekas tambang batukapur juga dapat dimanfaatkan untuk berbagai keperuntukan. Pemanfaatan untuk kawasan wisata seperti yang terdapat di beberapa bekas tambang batu kapur yang ada di Jawa Timur.

PT Semen Gersik memperuntukan lahan bekas tambangnya untuk kawasan hutan dengan tanaman seperti jati,trembesi, mahoni serta albasia (sengon) (RPT PT Semen Gresik, 2013; Republika, 2018). Lahan bekas tambang batukapur PT Semen Baturaja (Persero) Tbk dimanfaatkan untuk tanaman cemara.

3.1.2. Keperuntukan Air *Void* Tambang Batukapur untuk PLTMH

Parameter kunci dalam daya dukung lingkungan adalah air. Semua bentuk kehidupan di bumi ini berasal dari air sehingga air sumber kehidupan utama yang menyangga kehidupan (Juniah, 2003).

Void yang terbentuk setelah pascatambang atau pada penutupan tambang *mine closure* menjadi isu penting bagi pemerintah dan industri pertambangan di Western Australia atas dampak yang ditimbulkannya (Johnson, 2003). Hal ini sebagai satu bentuk kekhawatiran terhadap *void* tambang. Apa yang dikemukakan oleh Jhonson tentunya tidak hanya di Western Australia. Hal ini dikarenakan, diseluruh negara termasuk di Indonesia yang terdapat kegiatan pertambangan secara terbuka pasti memiliki kekhawatiran yang sama. *Void* untuk jangka panjang berpotensi menimbulkan dampak lingkungan. Rembesan air *void* yang mengandung beberapa logam berat ke sistem air tanah dapat mencemari air tanah dan air permukaan.

Void tambang sebagaimana lahan bekas tambang, juga dapat dimanfaatkan untuk berbagai keperuntukan. *Void* tambang PT Adaro Indonesia dapat diperuntukkan untuk budidaya perikanan air tawar, wisata air, air minum; *void* tambang PT Bukit Asam untuk budidaya perikanan air tawar dan pariwisata; PT Kaltim Prima Coal untuk pariwisata, budidaya perikanan air tawar (Juniah, 2013). PT Semen Padang akan memanfaatkan void tambang untuk kolam air atau waduk (Harian Umum Singgalang, 2018). Penelitian mengenai pemanfaatan air *void* tambang untuk air baku telah dilakukan di pertambangan batubara bawah tanah di West Virginia, dan pertambangan di Kansas USA. Pemanfaatan dilakukan untuk memenuhi kebutuhan air baku di kota tersebut (Juniah, 2013). PT Adaro Indonesia di provinsi Kalimantan Selatan merupakan satu-satunya perusahaan pertambangan di Indonesia yang memanfaatkan air *void* tambang untuk air baku.

Sumberdaya air yang berasal dari air *void* tambang dibeberapa pertambangan batubara telah dimanfaatkan sebagai air baku, dan budidaya perikanan air tawar (PT Nanriang, 2012; Juniah 2013; Moersidik dkk, 2014), dan belum untuk mikrohidro.

Gambar 3.1. Pemanfaatan air *Void* Tambang Untuk Budidaya Perikanan di PT Adaro Indonesia; PT Bukit Asam Tbk, dan PT Nan Riang, serta Air Minum di PT Adaro Indonesia (Juniah, 2013; Moersidik dkk, 2014 , PT Nan Riang, 2012)

Energi berkelanjutan menjadi isu strategis dimana salah satunya adalah energi listrik yang diperlukan untuk hajat hidup orang banyak. Ketersediaan energi ini masih belum mampu memenuhi kebutuhan masyarakat akan energi tersebut. Penggunaan PLTMH untuk menghasilkan energi listrik memerlukan keberlanjutan sumberdaya air secara berkelanjutan. Krisis energi listrik di satu pihak dapat menyebabkan energi menjadi tidak berkelanjutan, sedangkan di pihak lain apabila air *void* tambang tidak dimanfaatkan dapat menyebabkan sumberdaya air menjadi tidak berkelanjutan. Hal ini dikarenakan deplesi sumberdaya air (secara kualitas dan kuantitas), sehingga dapat mencemari lingkungan.

Pembangkit listrik tenaga mikrohidro memanfaatkan sumberdaya air yang berasal dari irigasi, badan air permukaan, atau air terjun untuk menghasilkan energi listrik sebagai salah satu energi terbarukan (Juniah & Sastradinata, 2017). Pemanfaatan air *void* tambang sebagai sumber energi terbarukan untuk tenaga

mikrohidro, selain dapat menghasilkan tenaga listrik untuk energi berkelanjutan, juga dapat menjaga keberlanjutan sumberdaya air di sektor pertambangan, namun sayangnya masih banyak perusahaan pertambangan baik batubara maupun pertambangan batukapur yang belum memanfaatkannya.

3.1.3. Model Ekonomi Keperuntukan Lahan Bekas Tambang Batukapur Untuk Perkebunan karet dan Air *Void* Tambang untuk PLTMH.

Nilai manfaat produk dan jasa-jasa lingkungan yang dimiliki hutan bersifat *tangible* maupun *intangible* (tidak dapat dicerminkan oleh *harga pasar)*. Gangguan terhadap hutan masih terus berlangsung selama kurangnya pengetahuan dan pemahaman terhadap manfaat tersebut. Oleh karena itu diperlukan valuasi ekonomi (penilaian ekonomi) sehingga manfaat ekonomi dari hutan secara kuantitatif tidak dapat diketahui (Yusuf *et. al*, 2010). Valuasi ekonomi adalah nilai barang dan jasa dapat diperjualbelikan, sehingga memberikan pendapatan yang didasarkan pada konsep ekonomi kegunaan, kepuasan atau kesenangan yang diperoleh individu atau masyarakat (Betani et.al, 2016). Peraturan Pemerintah Nomor 46 Tahun 2017 Tentang Instrumen Ekonomi Lingkungan Hidup, secara mendasar dan prinsip memberi ruang untuk dilakukannya penilaian ekonomi atas nilai *intagible* tersebut. Perkebunan karet selain memberi manfaat ekologis juga memberi manfaat ekonomi untuk jangka waktu yang panjang. Dararath *et.al*, 2011, menemukan manfaat bersih dari perkebunan karet skala besar dan perkebunan karet rakyat di Cambodia pada periode lebih 25 tahun diperkirakan sebesar USD 15.690 dan USD 7.661. Demikian juga halnya perkebunan karet rakyat di wilayah West Garo Hills District of Meghalaya, India. *Cost benefit anaysis* dengan menemukan nilai ekonomi perhektar kebun karet rakyat sebesar Rs 55014,11(Goswami S,N.& Challa, O. 2007).

Pemanfaatan lahan bekas tambang memberikan manfaat ekonomi baik secara langsung maupun tidak langsung. Manfaat bersih yang ditemukan dari pemanfaatan ruang pasca tambang terpadu sampai penutupan tambang batubara PT Bukit Asam menggunakan analisis manfaat dan biaya sebesar tahun 2043 USD 91.295.530 (Kodir dkk, 2017). Manfaat ekonomi karbon terserap terhadap

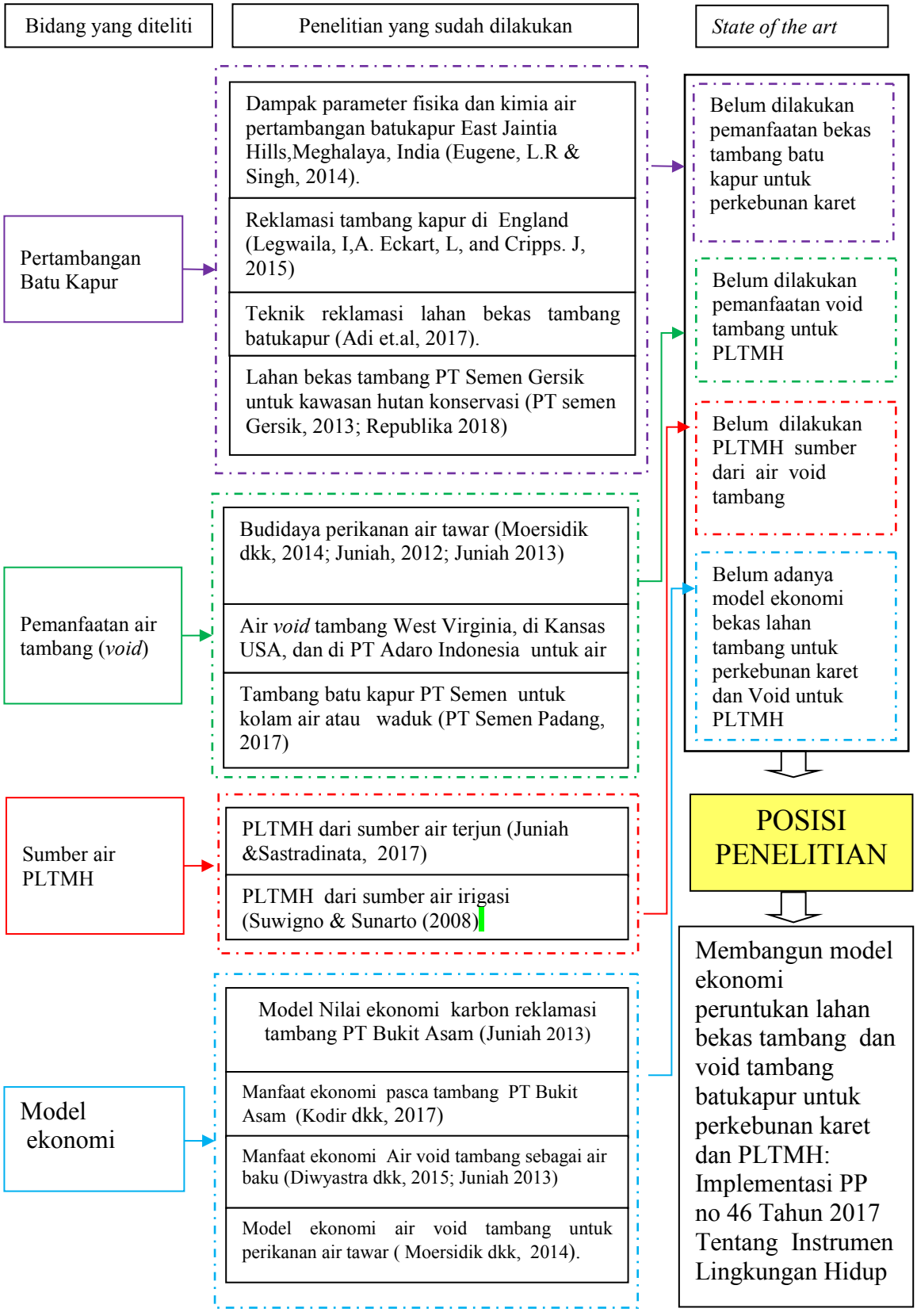
kegiatan reklamasi pada lahan bekas tambang PT Bukit Asam Provinsi Sumatera Selatan sebesar Rp 22.810.994.971 (Juniah dkk, 2016).

Berdasarkan hasil penelitian di atas menunjukkan jika manfaat ekonomi yang dilakukan selama ini oleh penelitian sebelumnya adalah terhadap lahan bekas tambang batubara, belum untuk tambang batukapur khususnya pemanfaatannya untuk perkebunan karet. Penelitian ini akan melakukan penilaian ekonomi peruntukan lahan bekas tambang batu kapur untuk perkebunan karet.

Pemanfatan air void tambang untuk air baku memberi manfaat ekonomi dan ekologis bagi keberlanjutan sumberdaya air dan lingkungan pertambangan. Pemanfaatan air void tambang di pertambangan PT Multi Harapan Utama memberi manfaat ekonomi langsung dan tak langsung (Diwyastra dkk, 2015). Pemanfaatan air void tambang batubara untuk budidaya perikanan air tawar di pertambangan PT Adaro memberi manfaat ekonomi langsung dan tidak langsung (Moersidik dkk, 2014). Manfaat ekonomi air *void* tambang PT Bukit Asam memberi keberlanjutan bagi lingkungan pertambangan batubara (Juniah, 2013). Hasil penelitian ini Moersidik dkk (2014), dan Juniah (2013) menemukan model keberlanjutan sumberdaya air pemanfaatan air *void* tambang untuk budidaya air tawar dan air baku, dan belum untuk keberlanjutan sumberdaya air untuk mikrohidro yang dapat menghasilkan energi listrik dan energi berkelanjutan. Penelitian ini akan membangun model ekonomi dengan mengembangkan model keberlanjutan sumberdaya air *void* tambang batukapur untuk mikrohidro guna energi berkelanjutan sektor pertambangan batukapur, dan model ekonomi pemanfaatan lahan bekas tambang batu kapur untuk perkebunan karet.

3.2.Kemutakhiran (*State of the art*) dan Posisi Penelitian

Berdasarkan hasil penelitian yang dilakukan sebelumnya dapat dirumuskan kemutakhiran (*State of the art*) dan posisi penelitian sebagaimana tampak pada Gambar 3.2.



Gambar 3.2. *State of the Art* "Kemutakhiran" dan Posisi Penelitian

BAB 4
MANFAAT PENELTIAN

4.1. Manfaat Teoritis

Penelitian ini diharapkan memberikan manfaat teoritis berupa:

1. Memberi kontribusi kepada pengembangan ilmu pertambangan terkait pemanfaatan lahan bekas tambang kapur untuk perkebunan sawit.
2. Memberi kontribusi kepada pengembangan ilmu pertambangan terkait dengan model ekonomi pemanfaatan air void tambang sebagai sumber energi terbarukan untuk mikrohidro.

4.2. Manfaat Praktis

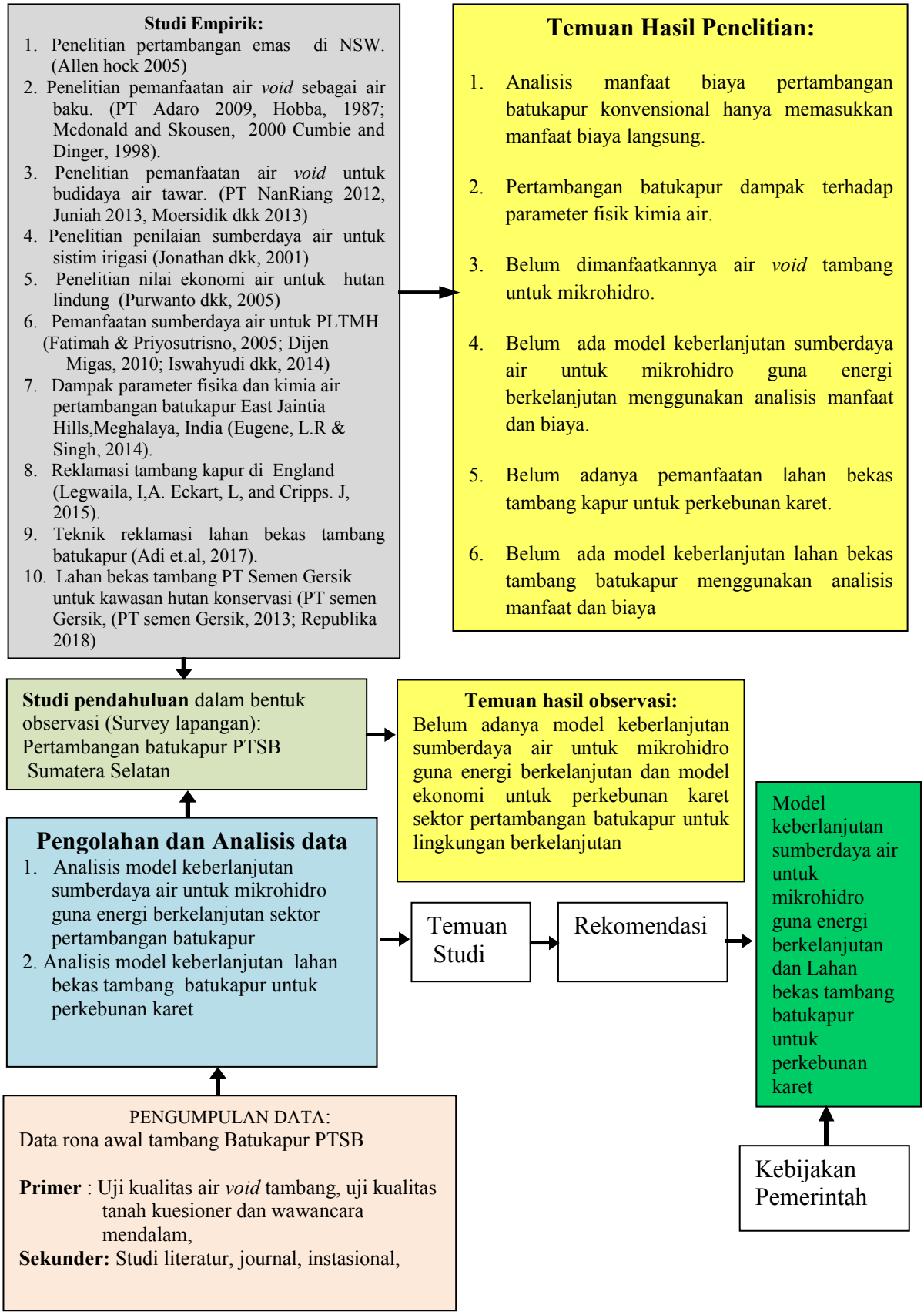
Penelitian ini diharapkan memberikan manfaat praktis berupa:

1. Model ekonomi keberlanjutan sumberdaya air yang dikembangkan untuk mikrohidro di sektor pertambangan batukapur dan pemanfaatan lahan bekas tambang untuk perkebunan karet diharapkan dapat dijadikan dasar penetapan untuk dan sebagai dasar pertimbangan kementerian ESDM dalam penyusunan rencana kegiatan usaha pertambangan untuk keberlanjutan sumberdaya air dan energi berkelanjutan energi di sektor pertambangan batukapur.
2. Memberikan masukan kepada perusahaan pertambangan batukapur tentang pemanfaatan air void tambang mikrohidro di sektor pertambangan batukapur dan peruntukan lahan bekas tambang untuk perkebunan karet.
3. Diimplementasikannya Peraturan Pemerintah Nomor 46 Tahun 2017 Tentang Instrumen Ekonomi Lingkungan Hidup.

BAB 5
METODE PENELITIAN

5.1. Desain Penelitian

Penelitian ini merupakan *exploratory research* dengan model pengembangan *extended net present value* berdasarkan pemanfaatan lahan bekas tambang batukapur untuk perkebunan karet dan nilai air *void* pada tambang batukapur untuk PLTMH. Metode penelitian adalah secara survey langsung ke lapangan blok Tambang Eksisting PT Semen Baturaja (Persero) Tbk. Metode eksperimental dengan melakukan pengukuran kualitas air di PT Semen Baturaja Persero Tbk dengan 4 titik pengambilan yang menjadi sampel penelitian yaitu *void* tambang *inlet sump, outlet quarry*, dan pengukuran kualitas tanah di dua titik pengambilan yang menjadi sampel penelitian di lokasi tambang eksisting. Tahapan pelaksanaan penelitian sebagaimana tampak pada bagan alir kegiatan riset pada Gambar 5.1.



Gambar 5.1. Bagan Alir Riset

5.2. Populasi dan Sampel Penelitian

Populasi penelitian adalah tambang batu kapur yang ada di PT Semen Baturaja Tbk yang terletak di Kabupaten OKU yaitu tambang Eksisting, dan tambang Pelawi. Sampel penelitian adalah blok Tambang Eksisting PT Semen Baturaja Tbk yang ditetapkan secara *purposive sampling.* Menurut Sukandar Rumidi, (2002), pada cara ini, siapa yang akan diambil sebagai anggota sampel diserahkan pada pertimbangan pengumpul data yang berdasarkan atas pertimbangannya sesuai dengan maksud dan tujuan penelitian. Penetapan sampel secara *purposive* didasarkan pada pertimbangan karena blok ini yang sekarang sedang berlangsung kegiatan pertambangan batukapur.

Populasi penelitian adalah semua lokasi sumber air yang ada di lokasi pertambangan batukapur PT Semen Baturaja (Persero) Tbk. Sampel penelitian adalah air yang berasal dari *void* tambang eksisting PT Semen Baturaja (Persero) Tbk. Penetapan sampel secara *purposive sampling*.

Populasi penelitian adalah semua tanah yang ada di lokasi tambang batukapur PT Semen Baturaja Tbk. Sampel Penelitian adalah tanah yang berasal dari tambang eksisting PT Semen Baturaja Tbk. Penetapan sampel secara secara *purposive sampling*.

Populasi penelitian adalah semua pegawai UPTD OKU Dinas Pertambangan Provinsi Sumatera Selatan, semua akademisi yang bekerja di Prodi Sarjana dan Magister Teknik Pertambangan Unsri, semua Manajemen PT Semen Baturaja Persero Tbk, semua pegawai BLH Kabupaten OKU, semua Konsultan pertambangan, semua Konsultan PLTMH.

Sampel penelitian adalah Pejabat eselon II dan III UPTD OKU ESDM Sumsel, akademisi yang mengajar di magister teknik Pertambangan Fakultas Teknik Universitas Sriwijaya (UNSRI), KTT PTSB, Konsultan penyusun dokumen Rencana Pasca Tambang kegiatan pertambangan, Konsultan penyusun dokumen Rancang bangun dan DED PLTMH. Jumlah responden terpilih yang digunakan dalam penelitian ini sebanyak 14 orang ditetapkan secara *purposive sampling*.

5.3. Jenis Data Dan Pengumpulan Data

Data yang diperlukan dalam penelitian ini bersumber pada data primer dan data sekunder. Data primer bersumber dari a) Pengukuran kualitas air *void* tambang di lokasi tambang eksisting PT Semen Baturaja Persero Tbk; b) Pengukuran kualitas tanah di lokasi tambang eksisting PT Semen Baturaja Tbk; c) Penyebaran kuesioner dengan masyarakat

yang bermukim disekitar PT Semen Baturaja Persero TBK; d) Wawancara dengan responden seperti Pejabat dari PT Semen Baturaja Persero Tbk, Pejabat DLH dan UPTD OKU, Akademisi, Praktisi pertambangan, Konsultan pertambangan,

Data sekunder yang diperoleh dari berbagai dokumen instasional, perusahaan pertambangan PT Semen Baturaja Persero Tbk, data penelitian sebelumnya, jurnal dan literatur terkait masalah yang diteliti.

5.4. Pengolahan data

Kegiatan pengolahan data dilakukan untuk mengolah data primer yang telah didapatkan melalui pengukuran/uji laboratorium, dan data sekunder yang didapatkan melalui studi pustaka dan instasional. Hal ini perlu dilakukan mengingat data yang didapatkan dari ke tiga kegiatan ini masih bersifat data mentah yang perlu diolah lebih lanjut guna mendapatkan data yang diperlukan untuk membangun model ekonomi pemanfatan lahan bekas tambang batukapur dan air void tambang untuk PLTMH menggunakan metode analisis manfaat dan biaya dengan model *extended* manfaat dan biaya (dikembangkan dari metode *NPV* Konvensional).

5.5. Metode Analisis Data

Metode analisis yang digunakan adalah secara dekriftif terhadap data yang dihasilkan dari pengujian, dan model ekonomi yang terbangun dari pemanfaatan lahan bekas tambang batu kapur untuk perkebunan karet dan air void untuk PLTMH. Analisis deskriftif juga digunakan untuk mendekripsikan dampak yang timbul dengan adanya pertambangan batukapur terhadap ketidakberlanjutan sumberdaya air secara ekonomi, sosial dan lingkungan di sektor pertambangan batukapur, dan mendiskripsikan pemanfaatan lahan bekas tambang batukapur untuk perkebunan karet.

Model *Extended NPV* untuk mikrohidro guna keberlanjutan sumberdaya air dan energi berkelanjutan di sektor pertambangan batukapur, serta keberlanjutan sumberdaya terbarukan tanaman karet secara ekonomi, sosial, ekologi secara langasung dan tidak langsung. Hal ini dikarenakan setiap kegiatan dapat menimbulkan manfaat eksternal maupun biaya eksternal yang timbul karena adanya aspek lingkungan yang harus diperhitungkan, maka analisis biaya dan manfaat berkembang menjadi analisis manfaata dan biaya yang diperluas dengan memasukkan dimensi biaya dan manfaat lingkungan di dalamnya atau *extended net present value*. Analisis manfaat dan biaya merupakan salah

satu dari intrumen ekonomi lingkungan hidup yang dapat digunakan untuk mengimplentasikan Peraturan Pemerintah nomor 46 tahun 2017.

5.6. Hipotesis

Hipotesis yang diajukan adalah dengan memasukkan nilai air *void* tambang batukapur untuk mikrohidro memberikan manfaat bgi sumberdaya air dan energi berkelanjutan, dan dengan memanfaatkan lahan bekas tambang batukapur untuk perkebunan karet memberikan manfaat secara ekonomi, sosial dan ekologis bagi lingkungan pertambangan batukapur.

Tujuan penelitian, Data yang digunakan, Cara mendapatkan Data (Sumber data), Analisis data, Luaran Pertahun dan Indikator pencapaian dari penelitian ini disajikan pada Tabel 5.1.

Tabel 5.1. Tujuan Penelitian, Data Yang Digunakan, Cara Mendapatkan Data (Sumber Data), Analisis Data, Luaran Pertahun Dan Indikator Pencapaian

No	Data Yang Digunakan	Pengumpulan Data	Analisis data	Hasil Dan Luaran Yang Ditargetkan	Indikator Pencapaian
1	Rona Awal Tambang Batukapur PTSB	Secara Primer (survey) Secara Instational (PTSB, Dinas ESDM Prov Sumsel)	Deskriptif	Dampak kegiatan pertambangan batukapur terhadap keberlanjutan sumberdaya alam tak terbarukan batukapur dapat diidentifikasi.	Teridentifikasinya (dapat ditemu kenali) ketidakberlanjutan sumberdaya tak terbarukan di sektor pertambangan batukapur.
2	Sumberdaya dan cadangan batukapur PTSB	Secara Instational (PTSB, Dinas ESDM Prov Sumsel)	Deskriptif	Deplesi sumberdaya alam tak terbarukan batukapur sektor pertambangan dapat diinventarisa-sikan.	Terinvetarisnya jumlah sumberdaya alam tak terbarukan batukapur akibat deplesi yang terjadi.
3	Kualitas tanah	Secara primer	Deskriptif	Pemanfaatan	Terinventarisirnya

No	Data Yang Digunakan	Pengumpulan Data	Analisis data	Hasil Dan Luaran Yang Ditargetkan	Indikator Pencapaian
		(uji kualitas tanah)		lahan bekas tambang batukapur untuk perkebunan karet dapat dinventarisir	lahan bekas tambang batukapur untuk perkebunan karet
4	Model ekonomi pemanfaatan lahan bekas tambang kapur untuk perkebunan karet	Secara Primer	Model Analisis manfaat dan biaya	Penilaian ekonomi pemanfaatan lahan bekas tambang kapur untuk perkebunan karet dapat dikembangkan	Ditemukannya Model ekonomi pemanfaatan lahan bekas tambang kapur untuk perkebunan karet
5	Pemanfaatan lahan bekas tambang batu kapur untuk tanaman sengon/cemara/perkebunan karet dan lingkungan berkelanjutan	Primer sekunder	Deskriptif Analisis manfaat dan biaya	Naskah tulisan ilmiah (tentang nilai Pemanfaatan lahan bekas tambang batu kapur untuk perkebunan karet untuk lingkungan berkelanjutan; tanaman sengon; dan cemara	Terpublikasinya naskah tulisan ilmiah di proseding internasional terindex scopus (IOP Proceding); Jurnal Internasional DOAJ IJOEMS (International Jornal Of Environment Managemen and Susitanable)
7	Kualitas air void tambang	Secara primer (Uji kualitas air)	Deskriptif	Dampak kegiatan pertambangan batukapur terhadap keberlanjutan sumberdaya air dapat diidentifikasi.	Teridentifikasi nya (dapat ditemu kenali) ketidakberlanjutan sumberdaya air di sektor pertambangan batukapur.
8	Model ekonomi	Secara primer Secara	Deskriftif Model	Naskah tulisan ilmiah (tentang	Terpublikasinya naskah tulisan

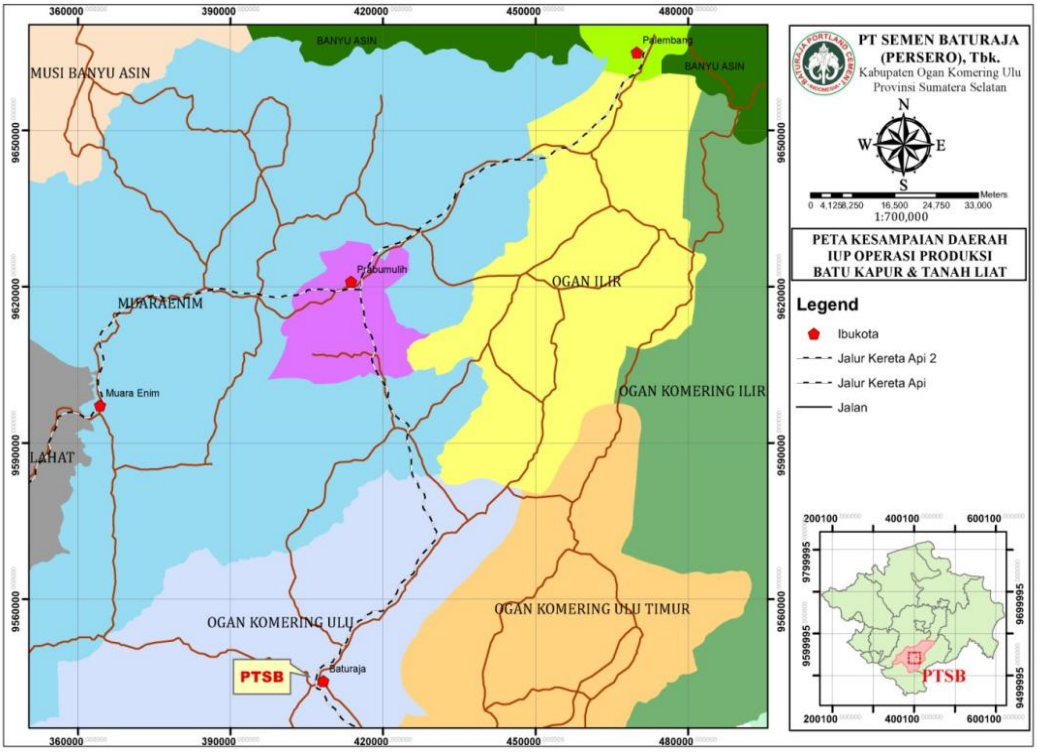
No	Data Yang Digunakan	Pengumpulan Data	Analisis data	Hasil Dan Luaran Yang Ditargetkan	Indikator Pencapaian
	pemanfaatan air *void* tambang batukapur untuk PLTMH	sekunder	Analisis manfaat dan biaya	model ekonomi pemanfaatan air *void* tambang untuk PLTMH; budidaya ikan nila siap dikirim ke jurnal internasional terindeks Scopus.	ilmiah di internasional Terindeks Scopus Canadian Joernal (Q3) Jurnal Internasional DOAJ IJOEMS (International Jornal Of Environment Managemen and Susitanable)
9	Model ekonomi pemanfaatan air void tambang untuk PLTMH	Secara primer Secara sekunder	Deskriftif Model Analisis manfaat dan biaya	Pengajuan Hak Kekayaan Intelektual (Hak Cipta) siap dikirim ke Menkumham RI	Didapatkannya Hak Kekayaan Intelektual (Hak Cipta) dari Menkumham RI

BAB 6
HASIL DAN PEMBAHASAN

6.1. Kesampaian Daerah

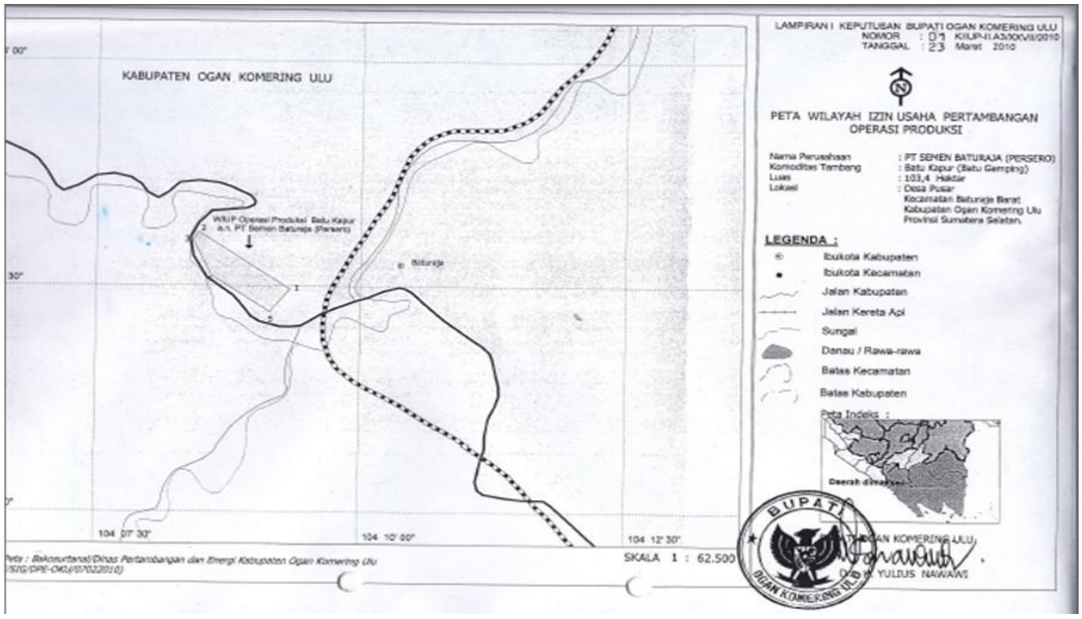
Areal IUP operasi produksi PT Semen Baturaja Persero Tbk secara geografis terletak di Desa Pusar Kecamatan Baturaja Barat, Kabupaten OKU, Sumatera Selatan. PT Semen Baturaja memiliki luas area IUP Operasi Produksi seluas 103,4 Ha. Daerah IUP memiliki geomorfologi perbukitan bergelombang hingga dataran tinggi. Kesampaian daerah pertambangan batukapur PT Semen Baturaja Persero Tbk dapatdilihat pada Gambar 6.1.

Lokasi penelitian berada berada di Kecamatan Baturaja Barat, Kabupaten Ogan Komering Ulu Sematera Selatan. Lokasi dapat ditempuh menggunakan kendaraan roda empat melalui jalan lintas propinsi dengan waktu tempuh sekitar ± 6 jam. Kemudian menuju desa Pusar melalui jalan desa dengan waktu tempuh sekitar ±15 menit.



Gambar 6.1. Peta Lokasi: (Dokumen Studi Kelayakan PT. Semen Baturaja, 2018)

PT Semen Baturaja (Persero) Tbk telah mendapatkan Ijin Usaha Pertambangan Operasi Produksi (IUP Operasi Produksi) untuk pertambangan batu kapur Nomor: 01/K/IUP-II.A3/XXVII/2010 dengan luas 103,4 Ha pada tanggal 23 Maret 2010 sebagaimana ditunjukkan pada Gambar 6.2.



Gambar 6.2. Lokasi IUP PT Semen Baturaja (Dokumen Studi Kelayakan PT. Semen Baturaja (Persero) Tbk., 2018)

6.2. Rona Awal Lingkungan Hidup Tambang Batukapur PT Semen Baturaja (Persero) Tbk.

Rona awal dalam penelitian ini berfokus pada kajian rona lingkungan geofisik yang terkait dengan tanah dan biologi dengan tanaman yang ada di lokasi tapak proyek. Hal ini didasarkan pada pendapat Cahyani (2017) yang menyatakan bahwa perubahan sifat fisik maupun kimia tanah yang terjadi akibat penambangan diantaranya berupa peningkatan bulk densitas dan kelembaban tanah serta penurunan permeabilitas dan kesuburan tanah. Aspek teknis berupa analisis tanah harus dilakukan sebelum kegiatan reklamasi dan revegetasi untuk menentukan perlakuan yang harus diberikan agar sifat fisik dan kimia tanah berada dalam kualitas baik (KLH HUT, 2013).

6.2.1. Kondisi Iklim

Lokasi kegiatan pengembangan tambang batukapur PT Semen Baturaja (Persero) Tbk di Kabupaten Ogan Komering Ulu secara administratif berada di Kabupaten OKU Provinsi Sumatera Selatan. Berdasarkan tipe iklim di Sumatera Selatan umumnya dan kabupaten khususnya, wilayah ini termasuk ke dalam daerah yang beriklim tropis. Pernyataan iklim tropis tersebut digambarkan oleh beberapa ahli dengan berbagai istilah sebagai berikut:

- Termasuk Iklim Afa (iklim hujan tropis), menurut *Koppen*.
- Termasuk Iklim A (daerah sangat basah), menurut *Schmidt – Ferguson* 1950.
- Termasuk Iklim B1 (daerah dengan 7 sampai 9 bulan basah dan dua bulan kering), menurut *Oldeman* 1979.

Data klimatologi berupa data curah hujan dan data meteorologi yang mewakili daerah studi diperoleh dari dokumen AMDAL (Analisis Mengenai Dampak Lingkungan) Tahun 2017. Data tersebut dikumpulkan untuk rentang waktu 10 tahun terakhir (2006-2015) dengan faktor-faktor iklim meliputi curah hujan dan hari hujan, suhu udara, kecepatan dan arah angin, serta unsur iklim di wilayah studi.

Berdasarkan data yang diperoleh diketahui bahwa curah hujan tertinggi terjadi pada tahun 2010 sebesar 2.807 mm dan curah hujan terendah terjadi pada tahun 2011 sebesar 1.168 mm. Curah hujan bulanan tertinggi adalah pada bulan Maret 2005 sebesar 715 mm dan terendah adalah pada bulan Agustus 2009 sebesar 4 mm. Jumlah hari hujan tahunan berkisar antara 87 sampai 201. Jumlah hari hujan terendah adalah 1 hari pada bulan Oktober 2009 sedangkan jumlah hari hujan tertinggi adalah sebanyak 25 hari pada bulan Desember 2007. Rata-rata curah hujan berkisar antara 23,9 mm^3 (Juni) sampai 634 mm^3 (November) selama tahun 2008. Data curah hujan terbanyak (350 mm) terjadi pada bulan Desember dan paling sedikit (61,3) mm terjadi pada bulan Agustus. Curah hujan berkisar antara 210 – 350 mm/bulan pada bulan basah yang terjadi selama 7 bulan yaitu bulan Oktober sampai dengan bulan April. Intensitas curah hujan antara 8,84 – 17,57 mm/hari pada bulan kering terjadi selama 5 (lima) bulan yaitu bulan Mei sampai dengan September dan mencapai titik terendah pada bulan Agustus yaitu

8,84 mm/hari. Rata-rata jumlah hari hujan pada bulan Oktober sampai dengan bulan April merupakan bulan-bulan hujan (basah) dengan frekuensi hari hujan berkisar antara 13 – 21 hari hujan/bulan. Jumlah hari hujan terbesar terjadi pada bulan Desember dan Januari yatu rata-rata selama 21 hari/bulan. Bulan-bulan kering memiliki jumlah hari hujan antara 9 – 15 hari/bulan yang terjadi pada bulan Mei sampai dengan bulan September. Berdasarkan dari uraian tersebut di atas dan dari data yang disajikan selama 10 (sepuluh) tahun (2006 - 2015), maka kawasan lokasi kegiatan termasuk ke dalam tipe iklim Afa menurut klasifikasi iklim Koppen dan termasuk zona agroklimat B2 menurut klasifikasi iklim Oldeman beriklim tropika basah dengan ciri-ciri khas yaitu: curah hujan yang cukup tinggi dengan penyebaran merata sepanjang tahun. Data rerata curah hujan, hari hujan, dan intensitas hujan serta kelembaban udara bulanan secara lengkap disajikan pada Tabel 6.1.

Tabel 6.1. Suhu Udara Minimum, Maksimum dan Rerata, Lama Penyinaran Matahari, Kelembaban Udara, Kecepatan Angin rata-rata, Arah Angin, Curah Hujan dan Hari di Daerah Studi Tahun 2006 – 2015.

Unsur Iklim		**Tahun 2006**											
		Jan	**Feb**	**Mar**	**Apr**	**Mei**	**Jun**	**Jul**	**Agt**	**Sep**	**Okt**	**Nov**	**Des**
Suhu Udara (°C)	Rata-rata	26,4	26,6	26,9	27,5	27,8	27,9	26,8	27,5	27,9	27,5	27,1	26,5
	Max	30,8	31,6	32,1	33,0	32,9	32,7	31,9	32,9	34,1	33,6	32,5	31,2
	Min	24,2	24,0	23,9	24,6	24,7	24,2	23,8	23,5	23,9	23,7	24,0	24,0
Lama Penyinaran Matahari (%)		47	51	51	71	67	62	58	83	74	61	67	40
Kelembaban Udara (%)		87	85	87	84	83	78	82	75	76	78	82	85
Kec. Angin Rata-rata (knot)		4	4	4	4	4	5	5	4	4	4	4	4
Arah Angin		NW	NW	NW	SE	SE	SE	SE	SE	SE	SE	NW	NW
Curah Hujan (mm)		257	192	414	199	243	64	264	37	32	155	210	259
Hari Hujan		23	21	24	19	15	7	17	2	10	15	21	25
Unsur Iklim		**Tahun 2007**											
		Jan	**Feb**	**Mar**	**Apr**	**Mei**	**Jun**	**Jul**	**Agt**	**Sep**	**Okt**	**Nov**	**Des**
Suhu Udara (°C)	Rata-rata	26,5	27,2	27,0	27,5	28,0	27,5	27,3	27,3	27,7	27,3	26,9	26,9
	Max	31,0	31,9	31,9	32,6	32,8	32,1	32,1	32,2	32,7	32,1	31,2	31,4
	Min	24,0	24,5	24,2	24,7	24,9	24,7	24,2	24,3	24,4	24,2	23,9	23,8
Lama Penyinaran Matahari (%)		49	59	58	56	71	59	70	71	62	61	39	30
Kelembaban Udara (%)		84	84	84	83	82	84	81	80	79	83	86	86
Kec. Angin Rata-rata (knot)		4	5	4	3	4	4	4	4	5	5	0	0
Arah Angin		NW	N	N	SE	SE	E	E	SE	S	SE	0	NW
Curah Hujan (mm)		248,9	224,2	412,6	224,7	249,1	182	170	67,3	151	157	211	223
Hari Hujan		16	18	22	18	17	20	15	14	10	14	20	21
Unsur Iklim		**Tahun 2008**											
		Jan	**Feb**	**Mar**	**Apr**	**Mei**	**Jun**	**Jul**	**Agt**	**Sep**	**Okt**	**Nov**	**Des**
Suhu Udara (°C)	Rata-rata	26,4	26,9	26,9	26,9	27,3	26,7	27,4	27,4	27,7	28,9	27,5	27,3
	Max	30,6	31,8	31,7	32,1	32	31,3	32,1	32,7	33,7	34,9	33,6	32,1
	Min	23,7	24,1	23,9	24,2	24,5	24	24,3	23,7	23,7	24,4	24	24,5
Lama Penyinaran Matahari (%)		40	60	44	52	50	56	70	86	81	45	53	51
Kelembaban Udara (%)		87	87	87	87	87	87	85	79	76	71	82	84
Kec. Angin Rata-rata (knot)		5	6	5	CALM	5	2,6	2,6	3	4	3	2	5
Arah Angin		NW	N	N	CALM	E	E	E	SE	E	SE	E	NW
Curah Hujan (mm)		360	253	420	285	92	191	120	10	1	0	135,2	220,6
Hari Hujan		26	17	23	22	19	16	12	2	2	2	23	28

Unsur Iklim		Tahun 2009											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara (°C)	Rata-rata	26,5	26,3	27,0	27,3	27,5	26,5	26,9	27,3	27,5	27,2	27,1	26,4
	Max	30,9	31,1	32,0	32,4	32,2	31,7	31,5	32,4	32,8	33,0	31,9	30,6
	Min	24,2	23,7	23,9	24,3	24,8	24,8	24,3	24,0	24,2	24	24,3	23,6
Lama Penyinaran Matahari (%)		31	50	48	65	57	57	57	72	67	63	51	40
Kelembaban Udara (%)		88	79	85	86	88	84	84	79	78	82	84	87
Kec. Angin Rata-rata (knot)		3	4	3	2	3	3	3	3	4	3	3	4
Arah Angin		NW	NW	NW	W	SE	SE	SE	SE	E	SE	NW	NW
Curah Hujan (mm)		503	179	208	379	187	130	98	3	58	114	123	381,9
Hari Hujan		28	18	22	22	18	13	13	8	8	18	18	24

Unsur Iklim		Tahun 2010											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara (°C)	Rata-rata	26,5	26,4	26,4	27,3	27,8	27,4	26,4	26,5	27,1	26,8	27	26,6
	Max	30,9	30,8	31,2	32,2	32,4	32,1	31,5	31,8	32	32,0	31,3	30,6
	Min	23,8	23,7	23,8	24	24,8	24,5	24	23,9	24,2	24,1	24,2	24,3
Lama Penyinaran Matahari (%)		46	44	40	63	67	64	64	68	58	54	40	30
Kelembaban Udara (%)		87	85	87	85	80	82	82	84	83	87	88	88
Kec. Angin Rata-rata (knot)		4	5	3	2	3	3	3	3	3	3	2	3
Arah Angin		NW	N/NW	NW	SW	S	S	S	SW	SW	E	NW	NW
Curah Hujan (mm)		203,6	143,1	371,9	323,4	48,4	23,9	150,4	175,3	61	318,6	634,4	231,7
Hari Hujan		23	20	23	22	9	11	12	16	17	23	22	26

Unsur Iklim		Tahun 2011											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara (°C)	Rata-rata	25,9	26,4	26,9	28,0	28,1	27,8	27,5	28,0	28,6	27,5	27,2	26,7
	Max	30,2	31,1	32,7	33,2	32,9	33,1	32,6	33,7	34,3	33,4	32,6	31,9
	Min	23,7	24,0	23,9	24,7	24,5	24,3	23,9	24,0	24,4	24	23,9	24
Lama Penyinaran Matahari (%)		40	35	57	68	67	67	70	74	61	58	48	44
Kelembaban Udara (%)		89	87	86	83	81	82	79	78	74	81	83	85
Kec. Angin Rata-rata (knot)		3	3	2	3	3	3	3	3	3	3	2	3
Arah Angin		NW	NW	NW	SE	SE	SE	SE	SE	SE	SE	NW	NW
Curah Hujan (mm)		275	134	564	339	112	140	36	97	33	212	184	284
Hari Hujan		27	25	24	20	16	10	10	7	6	22	24	23

Unsur Iklim		Tahun 2012											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara (°C)	Rata-rata	26,6	27,1	27,4	28,1	28,5	27,5	27,3	27,3	27	27,7	27,3	26,7
	Max	31,6	32,0	32,8	33,5	33,7	32,6	32,4	32,6	32,7	32,9	32,6	31,4
	Min	23,8	24,3	24,5	24,5	25,3	24,6	24,4	24,2	23,9	24	23,8	23,7
Lama Penyinaran Matahari (%)		40	47	45	52	55	54	54	57	54	53	56	38
Kelembaban Udara (%)		86	88	87	85	86	86	85	85	88	84	86	86
Kec. Angin Rata-rata (knot)		3	2	2	2	2	2	3	3	2	2	2	2
Arah Angin		NW	NW	W	W	SE	SE	SE	SE	SE	NW	NW	NW
Curah Hujan (mm)		251	325	542	420	243	171	91	194	371	336	520	249
Hari Hujan		27	26	26	22	21	21	23	21	22	23	23	19

Unsur Iklim		Tahun 2013											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara (°C)	Rata-rata	26,2	26,4	26,8	27,1	27,9	27,8	27,4	27,9	24,2	27,3	27,5	26,8
	Max	31,0	31,8	32,3	32,6	33,2	32,9	32,6	34	34,6	33,3	32,6	31,4
	Min	23,4	23,4	23,7	24,1	24,4	24,4	24,0	23,9	28,4	24,1	24,2	24,1
Lama Penyinaran Matahari (%)		36	48	47	47	62	62	64	78	65	58	46	33
Kelembaban Udara (%)		87	87	87	87	86	85	85	80	77	84	85	87
Kec. Angin Rata-rata (knot)		3	3	3	2	2	3	3	4	2	2	2	2
Arah Angin		NW	NW	NW	NW	SE	SE	SE	SE	SE	SE	NW	NW
Curah Hujan (mm)		210,2	338,8	392,4	378,4	292,4	65,4	33,8	33,6	14,6	264,9	219,4	348,9
Hari Hujan		22	19	28	25	17	14	10	6	6	23	22	25

Unsur Iklim		Tahun 2014											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara (°C)	Rata-rata	27,2	26,5	27,2	27,2	27,9	27,7	27,7	27,0	28,4	27,9	27,2	26,9
	Max	32,4	32,0	32,9	33,0	33,1	33,0	32,2	33,3	34,6	34,1	32,7	31,9
	Min	23,9	23,7	24,0	24,1	24,6	24,2	23,9	23,9	23,9	24,4	24	23,9
Lama Penyinaran Matahari (%)		51	47	55	67	63	70	63	66	65	57	44	42
Kelembaban Udara (%)		85	89	86	85	83	81	80	76	72	80	86	88
Kec. Angin Rata-rata (knot)		3	2	3	3	3	3	3	4	4	2	2	3
Arah Angin		NW	NW	NW	SE	SE	SE	SE	SE	E	NE	NW	NW
Curah Hujan (mm)		201	348	246	405	205	199	86	51	1	226	650	466
Hari Hujan		19	25	19	25	18	10	10	7	3	16	24	26

Unsur Iklim		Tahun 2015											
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Suhu Udara	Rata-rata	26,7	27,0	27,5	27,5	27,7	28,3	26,6	27,1	27,3	27,7	27,3	26,6

(ºC)	Max	31,5	32,1	32,9	33,2	33,7	31,8	31,8	32,4	32,5	33,1	32,7	31,3
	Min	23,9	24,1	24,3	23,8	23,7	23,9	24,0	23,7	23,9	23,9	24,0	24,0
Lama Penyinaran Matahari (%)		36	46	56	53	53	65	41	62	53	50	46	22
Kelembaban Udara (%)		88	86	85	87	86	81	85	82	82	81	84	87
Kec. Angin Rata-rata (knot)		4	4	3	3	3	3	3	4	4	4	3	5
Arah Angin		NW	NW	NW	SE	SE	SE	SE	SE	SE	SE	W	NW
Curah Hujan (mm)		309	333	613	368	119	150	86	154	282	191	312	496
Hari Hujan		29	21	23	25	20	14	10	13	17	17	25	25

Sumber: Dokumen Addendum AMDAL PTSB, 2017

Berdasarkan curah hujan dan hari hujan serta kategori iklim dengan ciri khas curah hujan yang cukup tinggi dengan penyebaran merata sepanjang tahun dengan bulan basah terjadi pada rentang oktober hingga april. Hal ini menunjukkan jika pada rentang ini maka jumlah curah hujan yang akan masuk ke dalam void tambang batu kapur PTSB juga semakin tinggi. Demikian juga jumlah air yang akan masuk dibulan-bulan kering rentang mei-september juga akan berkurang atau sedikit**.**

6.2.2. Kualitas Air dan Tanah

6.2.2.1. Kualitas Air Permukaan

Posisi geografi, curah hujan dan geologi merupakan aspek yang mempengaruhi kondisi hidrologi suatu daerah. Air permukaan atau sungai (*run off water*) dan air tanah (*groundwater*) merupakan cakupan kajian terhadap kondisi hidrologi daerah studi. Karakteristik sumberdaya air yang secara kualitas dapat memenuhi kebutuhan salah satunya ditentukan oleh kajian hidrologi.

Air dibutuhkan oleh setap makhluk hidup dan air yang bersih akan menjamin kesehatan. Air berdasarkan tempatnya apat dibedakan menjadi dua, yaitu air yang berada di permukaan tanah yang selanjutnya air ini disebut air permukaan dan yang berada di dalam tanah yang disebut sebagai air tanah. Air hujan dan air yang menggenang di permukaan tanah seperti waduk, sungai dan sumur menjadi sumber perolehan air yang diperlukan oleh manusia untuk minum, masak, mandi dan cuci.

Hasil analisis air permukaan pada kegiatan eksisting pada titik pengambilan sampel di *inlet sump* dan *outlet quarry* ditampilkan pada Tabel 6.2.

Tabel 6.2. Hasil Analisis Air Permukaan di Wilayah Studi

	Parameter	Satuan	Kadar maksimum yang diperbolehkan	Hasil		Metode Pemeriksaan
				Inlet	Outlet	
	A. FISIKA					
1	Temperatur	℃	38	25,4	26,8	SNI 06-6989.23-2005
2	ZatPadatTerlarut	mg/L	2000	31	20	Direct Reading
3	ZatPadatTersuspensi	mg/L	200	22,0	17	Direct Reading
	B. KIMIA Anorganik					
1	pH	#	6-9	6,07	6,07	SNI 06-6989.11-2004
2	Besi	mg/L	5	0,12	0,08	SNI 6989.4-2009
3	Mangan	mg/L	2	0,05	0,05	SNI 6989.5-2009
4	Barium	mg/L	2	0,001	0,001	SNI 06-6989.16-2004
5	Tembaga	mg/L	2	<0,003	<0,003	SNI 6989.6-2009
6	Seng	mg/L	5	0,03	0,001	SNI 6989.7-2009
7	Krom total		0,5	<0,018	<0,018	SNI 06-6989.17-2004
8	Kadmium	mg/L	0,05	<0,0015	<0,0015	SNI 6989.16-2009
9	Air Raksa	mg/L	0,002	<0,0001	<0,0001	AAS-MVU
10	Timbal	mg/L	0,1	<0,003	<0,003	SNI 6989.8-2009
11	Arsen	mg/L	0,1	<0,0009	<0,0009	AAS-HVG
12	Selenium	mg/L	0,05	<0,0012	<0,0012	AAS-HVG
13	Sianida	mg/L	0,02	0,004	0,002	Spektofotometri
14	Kobalt	mg/L	0,4	0,00	0,00	SNI 6989.68-2009
15	Flourida	mg/L	2	0,25	0,17	SNI 06-6989.29-2004
16	Amoniakbebas	mg/L	1	0,33	0,32	SNI 06-2479-1991
17	Nitrat, sebagai N	mg/L	20	2,92	2,90	SNI 06-2480.1991
18	Nitrit, sebagai N	mg/L	1	0,180	0,174	SNI 06-6989.9-2004
19	KebutuhanOksigenBiokimia	mg/L	50	2,62	2,51	SNI 06-2503-1991
20	KebutuhanOksigen Kimia	mg/L	100	19	15	SNI 6989.2-2009
21	Disolved Oxygen	mg/L	-	2,07	2,01	SNI 06-6989.14-2004
22	Sulfida	mg/L	0,05	<0,03	0,00	SNI 698970-2009
	C. KIMIA Orgnik					
1	Minyak dan Lemak	mg/L	5	0,19	0,13	SNI-06-6989.10-2004
2	Fenol	mg/L	0,05	0,00	0,00	SNI 06-6989.21-2004

Sumber: Data Primer (Tim Hibah Kompetitif Unsri, 2018)

*): Peraturan Gubernur Sumatera Selatan No. 16 Tahun 2005

Berdasarkan hasil uji kualitas air yang dikeluarkan laboratorium BKTL yang terkreditasi KAN menunjukkan bahwa pH air di wilayah studi sebesar 0,7 berada dalam baku Mutu yang dipersyaratkan dalam peraturan Peraturan Gubernur Sumatera Selatan No. 16 Tahun 2005 yaitu rentang 6-9. Zat padat terlarut dan zat padat tersuspensi juga berada dibawah baku mutu yang dipersyaratkan masing-masing 21-31 dan 17-21. Peraturan gubernur Sumsel masing 2000 mg/L dan 200 mg/L.

Zat padat terlarut merupakan padatan yang terdiri dari bahan padat organik maupun anorganik yang larut, mengendap maupun suspensi. Bahan ini akan mengendap pada dasar air yang lama kelamaan menimbulkan pendangkalan khususnya pada badan air permukaan penerima. Akibat lain dari padatan ini menimbulkan tumbuhnya tanaman air tertentu dan dapatmenjadi racun bagi makhluk lain. Banyak padatan menunjukkan banyak lumpur terkandung dalam air. Padatan terlarut adalah padatan-padatan yang mempunyai ukuran yang lebih kecil dari padatan tersuspensi. Padatan ini terdiri dari senyawa-senyawa anorganik dan senyawa-senyawa organik yang larut dalam air, mineral dan garam-garamnya. Dengan hasil uji kualitas yang ada menunjukkan bahwa zat pada terlarut ini aman untuk menimbulkan tumbuhnya tumbuhnya tanaman air tertentu yang dapat menjadi racun bagi makhluk lain. Hal ini menunjukka jika secara ekologi akan aman bagi makluk lain dan ekositem air permukaan akan berkelanjutan.

Zat padatan tersuspensi didalam perairan dipengaruhi oleh kecepatan arus, jika kecepatan arus lambat maka partikel-partikel dan koloidal yang larut dalam air mempunyai kesempatan mengendap. Padatan tersuspensi yang terdapat di dalam air dapat berupa partikel-partikel anorganik dan organik atau campuran keduanya. Partikel-partikel itu terutama berasal dari pengikisan dasar sungai, erosi tanah, buangan rumah tangga dan industri lainnya. Tingginya zat padatan tersuspensi dalam perairan maka nilai kekeruhan air juga akan tinggi. Hasil pengukuran kandungan zat padat tersuspensi di atas menunjukkan bahwa kandungan zat padat terlarut yang berada di bawah baku mutu lingkungan. Hasil ini juga menunjukkan keberadaan zat padat tersuspensi aman bagi ekosistem perairan dan secara ekologi lingkungan perairan dapat berkelanjutan.

6.2.2.2. Kualitas Tanah

Jenis tanah di daerah kegiatan merupakan jenis podsolik merah kekuningan jenis tanah alluvial, hidromorf serta jenis tanah podsolik. Memperhatikan hal tersebut, maka pada dasarnya di lokasi studi dan sekitarnya ditemui paling tidak tiga jenis tanah meliputi, podsolik, alluvial dan hidromorfik (AMDAL addendum PTSB, 2017).

a. Tanah *Podsolik*

Tanah ini mempunyai lapisan permukaan yang tercuci berat, berwarna kelabu cerah sampai kekuningan di atas horison akumulasi yang bertekstur relatif berat. Struktur tanah gumpal, agregat kurang stabil dengan permeabilitas rendah. Kandungan bahan organic, keterjuhan basa dan pH rendah. Karena itu tanah podsolik ini memiliki kesuburan alami yang rendah serta peka akan erosi.

b. Tanah *Alluvial*

Tanah ini terbentuk akibat banjir di musim hujan, karena itu sifat-sifatnya tergantung pada kekuatan banjir dan asal serta macam-macam bahan yang diangkut, sehingga menampakkan ciri morfologi berlapis-lapis atau berlembar-lembaran tetapi bukan horizon karena bukan hasil perkembangan tanah. Ciri pembentukan alluvial adalah bahwa bagian terbesar bahan kasar akan diendapkan tidak jauh dari sumbernya. Tekstur bahan yang diendapkan pada waktu dan tempat yang sama akan lebih seragam, makin jauh dari sumbernya makin halus butir yang diangkut. Karena itu terbentuk akibat banjir di musim hujan, maka sifat bahan-bahannya juga tergantung pada kekuatan banjir dan asal serta macam bahan yang diangkut, sehingga menampakkan ciri morfologi yang berlapis-lapis atau berlembaran-lembaran yang bukan horizon karena bukan hasil perkembangan tanah. Kebanyakan tanah alluvial sepanjang aliran besar merupakan campuran mangandung cukup banyak hara tanaman, sehingga umumnya dianggap tanah subur.

Masalah pada tanah adalah pengawasan tata air termasuk perlindungan terhadap banjir, drainase dan irigasi. Tekstur tanahnya sangat seragam, baik vertikal maupun horizontal, jika banyak mengandung liat tanahnya sukar diolah

dan menghambat drainase. Tanah alluvial studi umumnya memberi hasil produksi padi, palawija dan sayur-sayuran, bahkan di beberapa lokasi merupakan lahan perkebunan seperti perkebunan karet, kelapa, durian, cempedak dan rambutan.

c. Tanah *hidromorfik*

Jenis tanah ini umumnya bersolum lebih dalam, dengan warna kelabu atau kelabu kuning, terdiri atas horizon-horizon yang lebih lengkap. Meskipun mempunyai gejala glei pada horizon yang lebih dalam, seringkali mengandung konkresi Mn atau Fe sebagai lapisan atau berserakan pada profil tanah dan kadang-kadang juga terdapat plintit atau selaput liat (*clay skin*). Kondisi lahan di sekitar kegiatan hingga sekarang sudah dimanfaatkan untuk kegiatan perkebunan karet dan ladang penduduk.

Uji kualitas tanah berdasarkan pengambilan sampel tanah didaerah penelitian dilakukan di laboratorium. Pengambilan sampel tanah dilakukan di area yang belum dilakukan penambangan di sekitar area tambang atau area rona awal dan di area reklamasi atau area timbunan. Hasil Uji kualitas Tanah disajikan pada Tabel 6.3.

Tabel 6.3. Hasil Uji Kualitas Tanah Lahan Bekas Tambang Batu Kapur PT Semen Baturaja (Persero) Tbk

No.	Parameter		Method	Unit	Identification Number	
					Tanah Timbunan	Tanah Rona Awal
					1810.03981	1810.03982
1.	C-Organik		Walkley & Black / Gravimetri	%	0.72	9.29
2.	N-Total		Kjeldahl	%	0.14	0.45
3.	C/N Ratio		Penghitungan	-	5	21
4.	P_2O_5 Tersedia		Bray / Olsen	ppm	7	16
5.	P_2O_5 Potensial		HCl 25%	mg/100g	40	116
6.	K_2O Potensial		HCl 25%	mg/100g	30	51
7.	Kation Dapat Dipertukarkan	K^+	*N* NH_4OAc	cmol(+)/kg	0.56	0.62
		Na^+			0.15	0.18
		Ca^{++}			17.10	33.94
		Mg^{++}			0.82	1.86
8.	Kemasaman DapatTukar	Al-dd	*N* KCl	cmol(+)/kg	21.57	0.21
		H-dd			2.14	0.22
9.	Kapasitas Tukar Kation		*N* NH_4OAc	cmol(+)/kg	49.84	52.61

No.	Parameter		Method	Unit	Identification Number	
					Tanah Timbunan	Tanah Rona Awal
					1810.03981	1810.03982
10.	Kejenuhan Basa		Penghitungan	%	37.37	69.58
11.	Kadar Air		Gravimetri	%	10.7	8.9
12.	pH	H_2O	Potensiometri	-	6.2	5.2
		N KCl			4.5	3.6
13.	Tekstur 3 Fraksi	Pasir	Pipet	%	41	-*
		Debu			18	-*
		Klei			42	-*

*) Tekstur 3 tidak dilakukan analisis jika kadar C organik >5%

Sumber: Data Primer (Tim Hibah Kompetitif Unsri, 2018).

6.2.2.3. Vegetasi Daerah Studi

Aspek vegetasi (flora) yang diamati terdiri dari tipe vegetasi, keaneka-ragaman jenis, dan jenis vegetasi alami, serta vegetasi yang dibudidayakan. Lokasi pengamatan biota darat adalah pada tapak proyek dan daerah sekitarnya. Aspek vegetasi menunjukan bahwa tipe vegetasi yang terdapat di sekitar rencana kegiatan adalah vegetasi hutan sekunder yang antara lain terdiri dari jenis tanaman perkebunan dan semak belukar.

Vegetasi (flora) berdasarkan hasil survey lapangan tipe vegetasi yang terdapat pada daerah sekitar penelitian di penambangan batukapur PT. Semen Baturaja adalah tanaman semak belukar, tanaman cemara, bungur, kiara payung, jati, sawit, mahoni. Vegetasi daerah pertambangan batu kapur PT Semen Baturaja seperti terlihat pada Gambar 6.3

Gambar 6.3. Vegetasi Daerah Studi (Survey Tim Hibah Kompetitif Unsri, 2018)

Tanaman karet yang merupakan salah satu vegetasi yang terdapat di sekitar pertambangan batukapur PT Semen Baturaja (Persero) Tbk belum dimanfaatkan sebagai tanaman yang digunakan dalam kegiatan revegetasi di lahan bekas tambang batukapur PT Semen Baturaja (Persero) Tbk. Tanaman karet merupakan tanaman yang selain bernilai ekologis juga bernilai ekonomis (Juniah, 2018). Nilai yang terkandung dalam tanaman karet akan memberikan manfaat tidak hanya keberlanjutan ekoogis tapi lingkungan pertambangan batukapur PT Semen Baturaja (Persero) Tbk tapi juga memberi nilai manfaat ekonomis dengan memanfaatkan getah dari tanaman karet atau kayu dari tanaman karet tersebut. Pemanfaatan lahan bekas tambang sebagaimana yang diteliti oleh Dariah *et, al*, 2010 membutuhkan beberapa pendekatan salah satunya adalah teknologi. Hal ini dikarenakan teknologi yang tepat untuk restorasi lahan menjadi salah satu faktor penentu termanfaatkannya lahan bekas tambang untuk berbagai keperuntukan.

6.3. Keperuntukan Lahan Bekas Tambang Batukapur dan Void PT Semen Baturaja (Persero) Tbk.

Kegiatan pertambangan di akhir kegiatannya akan meninggalkan lahan bekas tambang. Lahan bekas tambang ini dapat berupa lobang bekas tambang (*void*) atau tidak berupa lobang bekas tambang (lahan kosong/*non void*). Lahan bekas tambang yang berupa lahan kosong ini, sebelumnya juga berbentuk lobang bekas galian komoditas tambang. Kegiatan penimbunan tanah penutup (*back filling*) ke dalam lobang bekas galian ini mengakibatkan seluruh lobang bekas galian tambang tertutupi sehingga tidak ada lagi bagian dari lobang yang tersisa, yang ada adalah lahan tanah kosong yang siap untuk dilakukan kegiatan revegetasi. Lahan bekas tambang batukapur PT Semen Baturaja (Persero) Tbk tampak pada Gambar 6.4

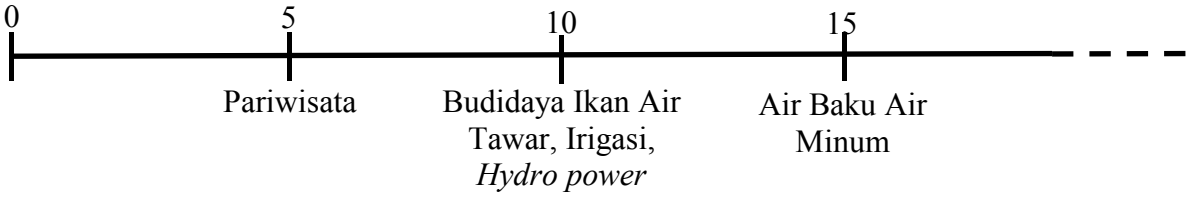
Gambar 6.4 Void dan Lahan Bekas Tambang Batukapur PT Semen Baturaja (Persero) Tbk (Survey Tim Hibah Riset Kompetitif Unsri, 2018)

Berdasarkan peraturan perundangan yang berlaku di wilayah Republik Indonesia, sudah menjadi kewajiban bagi perusahaan yang bergerak di sektor pertambangan mineral dan batukapur untuk merencanakan keperuntukan lahan bekas tambang setelah akhir sebagian atau seluruh kegiatan usaha pertambangan yang dilakukan. Perubahan unsur-unsur bentang alam seperti topografi, vegetasi

penutup, pola hidrologi, kerusakan struktur tanah, dan lain-lain akibat penggunaan metode tambang terbuka dapat menyulitkan proses reklamasinya. Kondisi ini dapat di atasi dengan pendekatan dan teknologi yang tepat. Pendekatan dan teknologi yang digunakan akan berbeda tergantung sifat gangguan yang terjadi dan juga keperuntukannya yaitu penggunaan setelah proses reklamasi (Dariah *et. al*, 2010).

Lahan bekas tambang yang berupa lahan kosong dapat diperuntukkan untuk perkebunan, peternakan, kehutanan, dan lain-lain. Hal ini ditunjukkan dari penelitian Dariah *et. al*, 2010 yang memanfaatkan lahan bekas tambang untuk tanaman perkebunan, budidaya tanaman semusim termasuk padi sawah, dan tanaman coklat. Berdasarkan hasil uji kualitas tanah dan jenis tanah yang terdapat di area studi dan pengamatan di lapangan, lahan bekas tambang PT Semen Baturaja (Persero) Tbk pada saat ini diperuntukan untuk tanaman sengon, cemara, tembresi, karet, kiara payung, mahoni.

Keberadaan air *void* sangat dibutuhkan oleh masyarakat lingkar tambang seperti petani, pekebun. Berdasarkan studi sosial terhadap masyarakat di Desa Ring 1 PT Semen Baturaja , pemanfaatan air *void* tambang dapat digunakan untuk berbagai kebutuhan seperti pariwisata sumber power dari mikrohidro, air baku. Gambaran penggunaan air void sesuai waktu kelayakan penggunaannya tampak pada Gambar 6.5.



Gambar 6.5. Potensi Pemanfaatan Air Void Sesuai Waktu Kelayakan Penggunaannya (Moersidik dkk, 2013).

Air memiliki sifat *self purification* yaitu dapat merecovery dirinya kmbali secara alamiah. Berdasarkan sifat tersebut dan gambar di atas menunjukkan jika air *void* tambang secara alami maka membutuhkan waktu 5 tahun untuk merecovery apabila dimanfaatkan untuk pariwisata. Pemanfaatan untuk budidaya

perikanan air tawar, irigasi, hydro power (PLTMH) membutuhkan waktu 10 tahun, sedangkan untuk air baku membutuhkan waktu 15 tahun. .

Pemanfaatan air void untuk masing-masing keperuntukan di atas harus memenuhi kriteria mutu air. Kriteria mutu air berdasarkan PP Nomor 82 tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air, ditetapkan menjadi 4 (empat) kelas, yaitu :

1. Kelas I : Air yang peruntukannya dapat digunakan untuk air minum, dan atau peruntukan lain yang mempersyaratkan mutu air yang sama dengan kegunaan tersebut
2. Kelas II : Air yang peruntukannya dapat digunakan untuk prasarana/sarana rekreasi air, pembudidayaan ikan air tawar, peternakan, air untuk mengairi pertanaman, dan atau peruntukan lain yang mempersyaratkan mutu air yang sama dengan kegunaan tersebut
3. Kelas III : Air yang peruntukannya dapat digunakan untuk pembudidayaan ikan air tawar, peternakan, air untuk mengairi pertanaman, dan atau peruntukan lain yang mempersyaratkan mutu air yang sama dengan kegunaan tersebut
4. Kelas IV : Air yang peruntukannya dapat digunakan untuk mengairi pertanaman, dan atau peruntukan lain yang mempersyaratkan mutu air yang sama dengan kegunaan tersebut

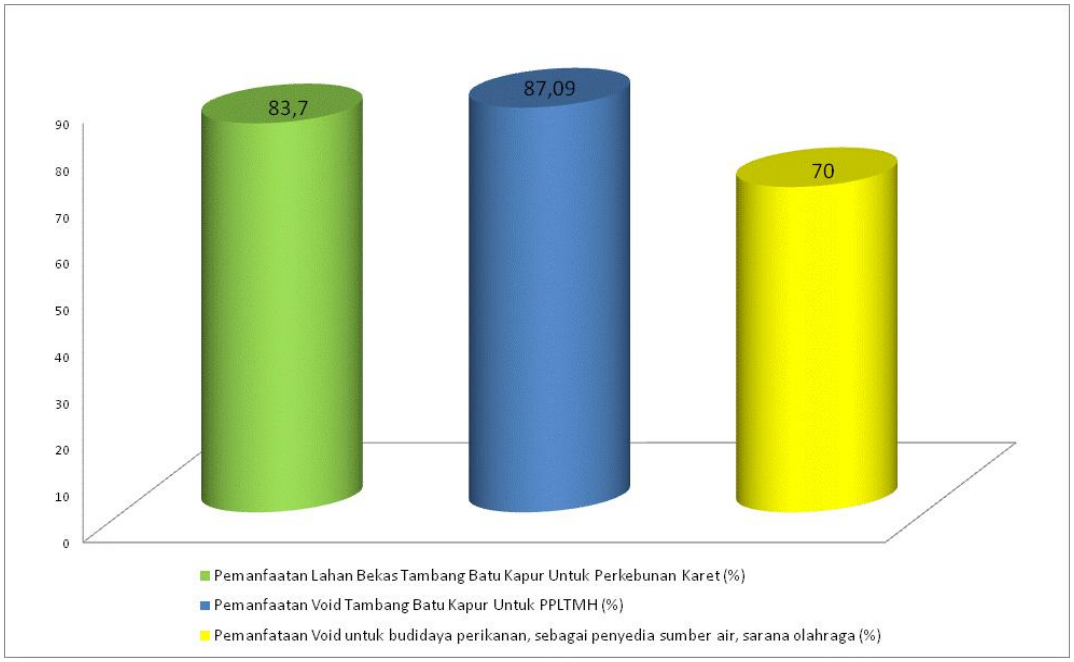
Pengelolaan air limbah tambang selama ini dilakukan melalui sederet kolam pengendap (*settling pond*) yang berfungsi untuk mengendapkan sedimen, dan kualitas air yang dikeluarkan memenuhi baku mutu yang dipersyaratkan, yaitu dalam Keputusan Menteri Lingkungan Hidup No. 113 Tahun 2003. Kualitas air bekas tambang dan kualitas air sungai pascatambang akan tetap memenuhi baku mutu air sesuai dengan PP No. 82 Tahun 2001.

Penambangan batukapur PT Semen Baturaja (Pesero) Tbk di akhir kegiatannya akan meninggalkan void seluas 53,94 Ha (RPT PTSB,2018).

Ketersediaan air yang sangat besar ini sangat potensial untuk dimanfaatkan sebagai seumber pembangkit listrik tenaga mikrohidro (PLTMH).

Pemanfaatan sumberdaya alam batukapur yang dilakukan oleh PT. Semen Baturaja dengan melakukan kegiatan pertambangan batukapur berdampak pada terbukanya tutupan bumi. Pascatambang pada kegiatan pertambangan batukapur menghasilkan *void* yang berisi air, akibat limpasan air hujan yang tertampung di dalamnya. Air yang tertampung didalamnya berjumlah ribuan kubik, yang tentunya dapat dimanfaatkan untuk berbagai peruntukan. Air void tambang yang terjadi pascatambang dapat dimanfaatkan lebih optimal oleh masyarakat sekitar tambang PT. Semen Baturaja.

Berdasarkan hal tersebut maka penelitian ini akan mendeskripsikan pernyataan para responden yang mewakili masyarakat yang berada di sekitar tambang PT. Semen Baturaja. Berdasarkan hasil kuesioner yang telah dilakukan didapatkan hasil bahwa sebagian besar responden (>80%) menyetujui untuk pemanfaatan lahan pascatambang batu kapur PT Semen Baturaja (Persero) Tbk untuk peruntukan perkebunan karet dan air *void* pascatambang batu kapur untuk peruntukan PTMH. Pemanfaatan lain dari air *void* tambang batu kapur menurut responden dapat dimanfaatkan juga sebagai penyedia sumber air, sarana wisata air, dan lain-lain. Hasil pendapat responden terhadap pemanfaatan lahn bekas tambang batu kapur dan air *void* PT Semen Baturaja (Persero) Tbk ditampilkan pada Gambar 6.6.

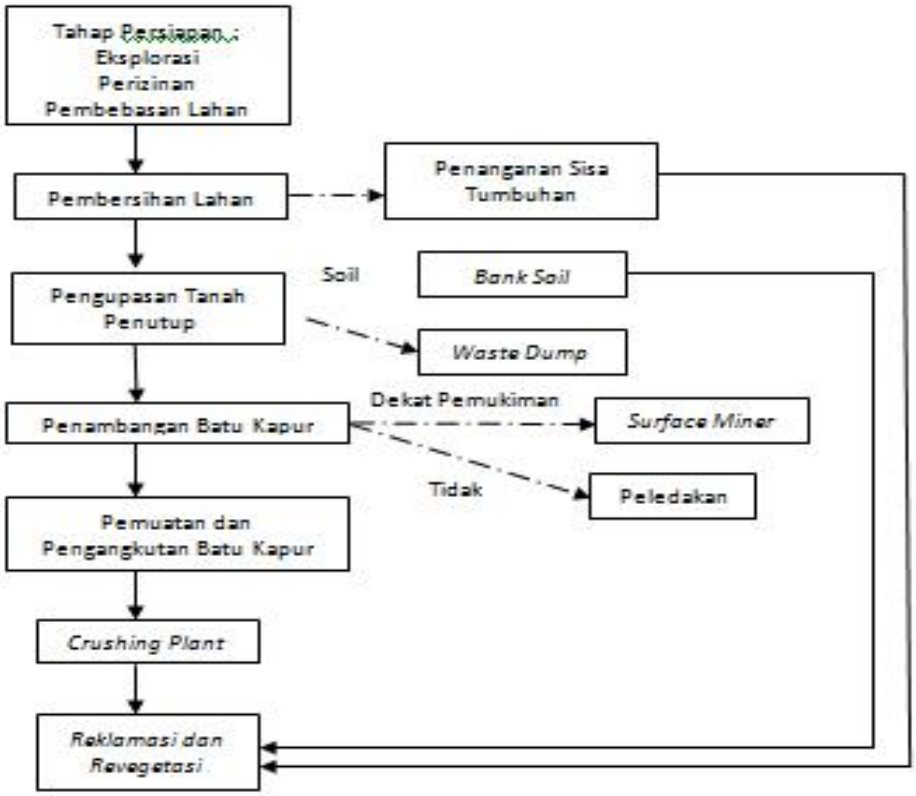


Sumber: Hasil Olahan Tim Riset Hibah Kompetitif Unsri, 2018

Gambar 6.6. Pendapat Responden Terhadap Pemanfaatan Lahan Bekas Tambang PT Semen Baturaja (Persero) Tbk

6.4. Kegiatan Penambangan PT Semen Baturaja Persero Tbk

Penambangan batukapur di PT Semen Baturaja (Persero) Tbk menggunakan metoda tambang terbuka dengan sistim *quarry*. Tahapan kegiatan operasi penambangan batukapur PT Semen Baturaja (Persero) Tbk sebagaimana tampak pada Gambar 6.7.



Gambar 6.7. Tahapan kegiatan operasi penambangan batukapur PT Semen Baturaja (Persero) Tbk

1. Pembersihan Lahan

Pembersihan semak belukar, membuat jalan perintis, dan membuat saluran air termasuk ke dalam kegiatan pembersihan lahan.

2. Pengupasan Lahan Penutup

Alat gali muat excavator digunakan dalam pengupasan lapisan lahan penutup. Lapisan penutup yang menutupi bahan galian berupa tanah pucuk, batu kapur, dan batu lunak.

3. Pembongkaran

Metode pembongkaran yang di rencanakan akan dilakukan PT Semen Baturaja (Persero) Tbk di lokasi tambang Desa Pusar terdiri dari dua metode, yaitu metode tanpa peledakan dengan alat gali mekanis surface miner dan peledakan dengan alat gali mekanis excavator class 30T.

4. Pemuatan

Alat gali muat yang digunakan berupa 1 unit excavatorclass 20 T untuk menggali dan memuat top soil, 1 unit excavatorclass 30 T untuk menggali dan

memuat overburden dan batu kapur, dan 1 unit wheel loader untuk mengumpulkan material hasil pemberaian oleh alat Surface Minerclass 500 T.

5. Pengangkutan

Alat angkut yang digunakan adalah dumptruck class 30 T. Hasil penambangan batu kapur diangkut menggunakan dumptruck menuju ke crusher. Jarak tambang dan crusher diperkirakan antara 0,5 km hingga 1.5 km.

Kegiatan operasi penambangan batukapur tampak pada Gambar 6.8.

Gambar 6.8. Kegiatan operasi penambangan batukapur (Survey Tim Hibah Riset Kompetitif Unsri, 2018).

6.5. Model Ekonomi Pemanfaatan Lahan Bekas Tambang Batukapur dan Void PT Semen Baturaja (Persero) Tbk.

Kata void tambang atau biasa dikenal oleh awam atau masyarakat sebagai kolam bekas tambang, selama ini terdengar sebagai sesuatu yang menyeramkan. Hal ini dikarenakan terbayang sebuah kolam dengan luasan dan kedalaman yang tidak kecil serta air dengan keasaman rendah. Masyarakat tidak bisa dipersalahkan atas pemahaman tersebut. Hal ini dikarenakan jauh sebelum adanya peraturan

perundangan yang mengatur tentang reklamasi dan rencana pascatambang yang diterbitkan oleh pemerintah, dalam hal ini kementerian sumberdaya energi dan mineral (KESDM) RI, perusahaan tambang terutama tambang-tambang peti selalu meninggalkan kolam bekas tambang tanpa memikirkan dampak pencemaran dan kerusakan lingkungan yang ditimbulkannya. Pertambangan timah di kepulauan Bangka Belitung adalah salah satu contohnya. Penutupan tambang meninggalkan kolong-kolong bekas penambangan timah (void) tambang. Selain kerusakan lingkungan yang timbul, tidak adanya pemanfaatan air sebagai sumberdaya air baku pada kolong-kolong tersebut selama kegiatan operasi produksi timah menyebabkan hilangnya keberlanjutan sumberdaya air baku dilokasi pertambangan timah dan masyarakat yang bermukim di sekitar pertambangan timah.

Sungai dan danau yang dijumpai di hampir semua tempat pada mulanya, sebelum ada gangguan manusia, mempunyai kualitas air yang bersifat alamiah (Asdak, 2004). Erosi dan sedimentasi menyebabkan penurunan kualitas dari air tersebut, demikian juga yang ada di dalam void tambang. Namun demikian dikarenakan ekosistem memiliki sistem keseimbangan, maka secara alamiah kualitas air yang terdapat di dalam void dapat pulih sesuai dengan fungsi waktu, sehingga seiring dengan bertambahnya usia void maka kualitas air di dalam void akan semakin membaik.

Void dengan kualitas air yang sudah aman untuk di konsumsi sebagai air minum tampak pada Gambar 6.8. Void yang terletak di blok Paringin ini sudah ditinggalkan dan tidak ditambang lagi oleh PT Adaro Indonesia sejak tahun 1992. Usia void ini 15 tahun. Hal yang sama ditemukan pada kolong-kolong bekas tambang timah di Kabupaten Belitung. Menurut Asdak (2004), kolong-kolong yang ditinggalkan tersebut, sampai batas di bawah 5 tahun setelah ditinggalkan maka air di kolong aman digunakan untuk keperluan mandi, selanjutnya < 15 tahun aman untuk keperluan budidaya, dan rentang 15-20 tahun aman untuk dikonsumsi sebagai air minum.

Gambar 6.9. *Void* dengan Kualitas Air yang Sudah Aman untuk di Konsumsi Sebagai Air Minum Blok Paringin PT Adaro Indonesia (Moersidik, dkk 2013).

Void sebagai sebuah kolam yang cenderung dengan kedalaman dan luasan yang besar sebetulnya cenderung akan memberi kesan atau identik dengan sebuah danau buatan. Sebuah danau alamiah sebagai sebuah ekosistem, memiliki fungsi dan peranan penting sebagai tempat untuk ketersediaan air secara kualitas dan kuantitas. Demikian juga halnya dengan *void* tambang sebagai danau buatan, *void* memiliki peran dan fungsi yang sama sebagai tempat untuk menyediakan air secara kuantitas dan kualitas. Hal ini dapat dicapai apabila pemanfaatan air didalam *void* tambang memenuhi baku mutu keperuntuk air sesuai dengan peraturan perundangan yang berlaku. Pemanfaaatan air *void* tambang untuk berbagai keperuntukan sesuai dengan kelas baku mutur air dapat menjamin keberlanjutan sumberdaya air di sektor pertambangan batukapur.

Jasa lingkungan sebagai sebuah produk dari ekosistem banyak sekali memiliki nilai manfaat melalui fungsi-fungsi yang dimilikinya seperti ekosistem DAS, sesuai fungsi utamanya memberi manfaat jasa lingkungan yang penting untuk produksi air (Alikodra, 2012). Demikian juga dengan keanekaragaman hayati memberikan manfaat penting jasa lingkungan, baik secara langsung (misalnya makanan, obat- obatan, kayu, serat, dan bio energi), pengaturan (misalnya dekomposisi bahan, filtrasi air, dan pengaturan iklim, penyerbukan tanaman, dan pengendalian berbagai penyakit manusia), supporting (misalnya proses fotosintesis, siklus bahan, dan pembentukan tanah), maupun budaya (misalnya aspek spiritual, keindahan, dan rekreasi) (Alikodra,

2012). Fungsi-fungsi ini memegang peranan penting untuk keberlanjutan lingkungan pertambangan batukapur.

Seyogyanya manfaat yang demikian banyak di atas dapat di integrasikan ke dalam model manfaat dan biaya untuk menentukan keberlanjutan lingkungan pertambangan batukapur, namun demikian dikarenakan keterbatasan yang ada maka dalam penelitian ini nilai jasa lingkungan yang dimasukkkan ke dalam model terbatas pada nilai komponen manfaat dan biaya yang diperlukan untuk membangun model umum extended manfaat dan biaya untuk pemanfaatan lahan bekas tambang batukapur sebagai perkebunan karet dan air void tambang untuk PLTMH.

Paradigma pembangunan berkelanjutan mensyaratkan pembangunan di atas 3 pilar keberlanjutan yaitu ekonomi, sosial, dan lingkungan. Prasyarat inilah yang menjadi dasar perluasan persamaan manfaat dan biaya konvensional atau Net Present Value konvensional (NPV_{kf}) menjadi *extended* manfaat dan biaya sebagaimana tampak pada Persamaan 6.1. Persamaan matematis manfaat dan biaya konvensional adalah persamaan yang sudah given dengan variabel manfaat dan variabel biaya di dalamnya, maka sebagaimana yang telah dilakukan Munasinghe sebelumnya, yang dapat dilakukan terhadap persamaan matematis manfaat dan biaya yang given ini hanya melakukan perluasan terhadap komponen dari manfaat dan biaya tersebut. Jadi, tidak menambah atau mengurangi dengan cara memasukkan variabel baru di luar variabel manfaat dan biaya yang ada.

$$\textit{MANFAAT BIAYA} = \text{NPV} = \sum_{t=0}^{T} \frac{(B_d - \mathbf{C_d})}{(1+r)^t} = \sum_{t=0}^{T} \frac{\mathbf{CF_t}}{(1+r)^t} \qquad (6.1)$$

(Sumber: Tim Hibah Riset Kompetitif Unsri, 2018)

Pembangunan model *extended* manfaat dan biaya keberlanjutan sumberdaya air di sektor pertambangan batukapur dilakukan dengan langkah-langkah sebagai berikut:

1. Mengidentifikasi eksternalitas positif dan negatif dampak pertambangan batukapur terhadap nilai jasa lingkungan, dan air void tambang untuk

PLTMH selama umur tambang dan pascatambang batukapur pada aspek ekonomi, sosial dan ekologi.

2. Penerapan analisa manfaat dan biaya pertambangan batukapur berkelanjutan berdasarkan hasil identifikasi eksternalitas positif dan negatif dampak pertambangan batukapur di atas
3. Melakukan internalisasi dampak eksternalitas ke dalam model analisa manfaat dan biaya dengan memasukkan manfaat dan biaya finansial, manfaat dan biaya lingkungan dan masyarakat, serta jasa lingkungan air void tambang untuk PLTMH selama umur tambang, serta manfaat dan biaya pemanfaatan air void pascatambang batukapur.

Mengikuti 4 langkah di atas dapat dirumuskan dan ditemukan "model umum persamaan matematis extended manfaat dan biaya" keberlanjutan sumberdaya air sektor pertambangan batukapur sebagai berikut (persamaan 6.2),

$$\textbf{Extended NPVav} = \sum_{t=0}^{n} \frac{(B_{av} + B_{emav})}{(1+r)^t} - \sum_{t=0}^{n} \frac{(C_{av} + C_{emav})}{(1+r)^t} = \sum_{t=0}^{n} \frac{(B_{avp} - C_{avp})}{(1+r)^t} \quad (6.2)$$

(Sumber: Tim Hibah Riset Kompetitif Unsri, 2018)

dimana,

Extended NPVav = nilai sekarang netto/net present value (nilai keberlanjutan sumberdaya PLTMH)

$\mathbf{B_{av}}$ = manfaat langsung air void untuk internal perusahaan PTSB

$\mathbf{C_{av}}$ = biaya langsung pemanfaatan air void sebagai air PLTMH

$\mathbf{B_{emav}}$ = Manfaat eksternal masyarakat (manfaat air void bagi masyarakat sekitar tambang PTSB)

$\mathbf{C_{emav}}$ = Biaya eksternal masyarakat

$\mathbf{B_{avp}}$ = Manfaat sumberdaya air berkelanjutan = $\mathbf{B_{av} + B_{em}}$)

$\mathbf{C_{avp}}$ = Biaya sumberdaya air berkelanjutan = ($\mathbf{C_{av} + C_{em}}$)

r = Tingkat bunga

t = Tahun dari 0 sampai T

$\sum$ = Jumlah

Model ekonomi pemanfaatan lahan bekas tambang batu kapur PT Semen Baturaja untuk perkebunan karet dengan cara yang sama dapat ditemukan sebagaimana tampak pada persamaan 6.3. Langkah pembangunan model ekonomi lahan bekas tambang batukapur untuk perkebunan karet sebagai berikut.

1. Mengidentifikasi eksternalitas positif dan negatif dampak pertambangan batukapur terhadap nilai jasa lingkungan, dan lahan bekas tambang untuk perkebunan karet selama umur tambang dan pascatambang batukapur pada aspek ekonomi, sosial dan ekologi.
2. Penerapan analisa manfaat dan biaya pertambangan batukapur berkelanjutan berdasarkan hasil identifikasi eksternalitas positif dan negatif dampak pertambangan batukapur di atas
3. Melakukan internalisasi dampak eksternalitas ke dalam model analisa manfaat dan biaya dengan memasukkan manfaat dan biaya finansial, manfaat dan biaya lingkungan dan masyarakat, serta jasa lingkungan lahan bekas tambang untuk perkebunan karet selama umur tambang.

$$\textbf{Extended NPV}_k = \sum_{t=0}^{n} \frac{(B_k + B_{ek})}{(1+r)^t} - \sum_{t=0}^{n} \frac{(C_k + C_{ek})}{(1+r)^t} \qquad (6.3)$$

(Sumber: Tim Hibah Riset Kompetitif Unsri, 2018)

dimana,
Extended NPVk = nilai sekarang netto/net present value (nilai keberlanjutan sumberdaya perkebunan karet)
$\mathbf{B_k}$ = manfaat langsung perkebunan karet
$\mathbf{C_k}$ = biaya langsung perkebunan karet
$\mathbf{B_{ek}}$ = Manfaat eksternal lahan bekas tambang untuk perkebunan karet
$\mathbf{C_{ek}}$ = Biaya eksternal lahan bekas tambang untuk perkebunan karet
r = Tingkat bunga
t = Tahun dari 0 sampai T
$\sum$ = Jumlah

Implementasi dari PP 46 tahun 2017 tentang instrumen ekonomi lingkungan hidup terkait internalisasi aspek lingkungan hidup di dalam persamaan di atas ditunjukkan dengan adanya nilai manfaat eksternal lingkungan hidup. Manfaat eksternal lingkungan hidup yang diimplementasikan pada pemanfaatan lahan bekas tambang batukapur berupa terserapnya karbon oleh tanaman karet, sedangkan biaya eksternal lingkungan hidup yang ditambahkan adalah terlepasnya karbon ke udara akibat hilangnya kemampuan serapan karbon pada kawasan hutan atau tanaman yang terdapat di lokasi tambang batukapur (akibat hilangnya vegetasi

karena kegiatan pembersihan lahan/ *land clearing*). Manfaat eksternal yang diimplementasikan pada pemanfaatan *void* tambang untuk PLTMH adalah energi listrik yang dihasilkan dari kegiatan pemanfaatan sumber daya air *void* tambang untuk PLTMH.

BAB 7
KESIMPULAN

Kesimpulan yang didapat dari hasil penelitian yang telah dilakukan adalah sebagai berikut:

1. Jumlah air dalam void pada bulan basah (Oktober-April) bertambah/banyak dan pada bulan kering (Mei-September) berkurang/sedikit.
2. Hasil uji kualitas air berada di bawah baku mutu lingkungan yang dipersyaratkan Pergub Sumsel.
3. Revegetasi di lahan bekas tambang batukapur saat ini sebagaian sudah memanfaatkan tanaman pada rona awal seperti Sengon, Tembesi, Mahoni.
4. Tanah di wilayah studi yang dapat dimanfaatkan untuk pertanian dan perkebunan adalah jenis Alluvia.
5. Temuan Studi ada dua:
   a. Model ekonomi pemanfaatan lahan bekas tambang batukapur untuk Perkebunan karet
   b. Model ekonomi void tambang batukapur untuk PLTMH

Rekomendasi terhadap penelitian selanjutnya adalah:

1. Karet merupakan tanaman selain bernilai ekologis juga bernilai ekonomis, dan sarankan agar perusahaan PTSB dapat memanfaatkan lahan bekas tambang batukapur PTSB untuk tanaman karet.
2. Penelitian lanjutan untuk menemukan nilai ekonomi pemanfaatan lahan bekas tambang batu kapur PTSB untuk perkebunan karet dan air void tambang untuk PLTMH menggunakan model yang ditemukan dalam penelitian ini.

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Technical Review of Land Usage of Former Limestone Mine for Rubber Plantation in PT Semen BaturajaTbk for Sustainable Mining Environment

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Abstract

Limestone mining activities at PT Semen Baturaja Tbk in Ogan Komering Ulu Regency of South Sumatera Province is conducted on an open quarry mining system. Limestone is the main raw material needed in the manufacture of cement in PT Semen BaturajaTbk. Through open mining activities at the end, will leave the former mining area, the former mining land should be utilized to keep the mining environment sustainable. Utilization this land can be done for various utilizations such as rubber plantations, palm oil plantations, teak forests, pine forests, orchards, and others. The former land of limestone mine of PT Semen Baturaja Tbk as stated in its Post Mine Plan document, one of them is for rubber plantation. The survey research aims to examine technically the utilization of ex-mining land of PT Semen Baturaja Tbk for rubber plantations to keep the mining environment sustainable. The results show that the utilization of former limestone mining land for rubber plantations at PT Semen Baturaja Tbk has met the technical aspects required in post mining planning for sustainable mining environment. The results are expected to benefit stakeholders, academics, researchers, practitioners and mining associations, and the environment.

Keywords: Utilization of former land mining, Sustainable Environmental of Limestone Mining, Technical Aspects, Rubber Plantation

1. Introduction

Indonesia as a country rich in natural resources such as limestone. Limestone is widely used as raw materials of cement, building materials, materials stability of roads, and so forth. PT Semen BaturajaTbk is one of cement producer in Indonesia in fulfilling limestone requirement as raw material of cement production doing its own mining activity. Limestone mining by PT Semen BaturajaTbk is located in Baturaja, OganKomeringUlu Regency. Mining activities undertaken by PT Semen BaturajaTbk are not denied to have an impact on the environment around the mining area. Positive impacts arise from economic improvement of communities around mining, employment, development, and so on. Mining activities conducted on the other hand also cause harm to the environment [1].

The former mining environment will undergo chemical, biological, and physical changes. The effort to handle the negative impacts of this mining activity is to carry out planned reclamation activities [2]. Reclamation aims to prevent erosion or decrease the speed of running water flow, keep the land unstable and more productive, and hopefully can generate added value for the environment and create a much better state than the previous environment so that the mining environment is sustainable for the welfare present and future generations [3,4].

Limestone mining activities are not always possible because the activities that take place depend on the availability of reserves. Based on the feasibility study document of PT. Semen Baturaja (Persero) Tbk in 2018, limestone mining activities will end in 2026. Mining activities that have ended will certainly have an impact on the community as well as the surrounding environment. Therefore it is necessary to plan activities that will be done after the mining activities end so that people stay prosperous and the environment remains sustainable. PT Semen Baturaja Tbk as a company conducting mining activities is obliged to carry out reclamation and post-mining activities as regulated in Government Regulation no. 78 of 2010 and Ministerial Regulation no. 7 of 2014. Post-mining is an activity undertaken to restore the function of the natural environment and social function according to local conditions throughout the mining area in a planned, systematic and sustainable way when some mining activities will end or all mining activities expire [5].

Post-mining activities of PT Semen Baturaja Tbk through post-mining land allotment are expected to restore the function of the forest as an ecosystem so that the

disturbed land due to mining activities (forest) as a natural resource remains sustainable and the mining environment of limestone remains sustainable. Based on this it becomes an important point and becomes a force in this research to study the technical aspects of PT Semen Baturaja Tbk's post-mining plan.

2. Data/Materials and Methods

The research method is survey, by observing directly the condition of location of mining business license of PT Semen Baturaja Tbk. Descriptive analysis is used to describe the initial hue conditions at the study sites. This becomes the basic foundation in designing / planning the former land of limestone mine in PT Semen Baturaja Tbk is technically to keep the mining environment sustainable. Data collection was done primarily to obtain primary data conducted by direct observation, and secondary to secondary data by studying literature and institutional.
Administratively, the research location is included in West Baturaja Sub-district, Ogan Komering Ulu Regency, South Sumatera Province. The territory can be reached by land travel from Palembang City to Ogan Komering Ulu Regency using four-wheeled vehicles through provincial road with a travel time of about 6 hours. Then go to Pusar village through village road with travel time about 15 minutes. The location of the study is shown in Figure 1.

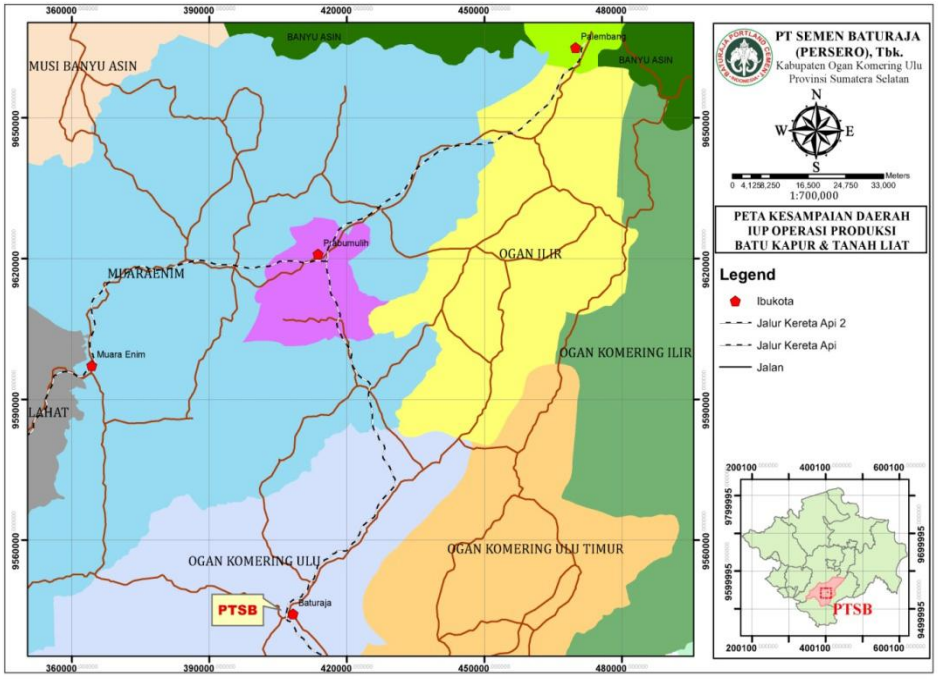

Figure1. Regional Accomplished Map [6]

3. Results and discussion.

Technical aspects and important economic aspects are taken into account in determining the post-mining land allocation. Technical aspects serve as the basis for determining the economic planning of post-mining costs. The technical aspects discussed are as follows:

3.1. Initial Condition

The initial environmental tile is a description of the environmental condition of the location of the mining cement mining activity of PT Semen Baturaja Tbk. This environmental tone is very important to examine to measure changes that will occur due to a series of activities that have been and will be done. The environmental tones studied include physics-chemical, biological, socio-economic, socio-cultural and public health hues.

The initial tone in this study focuses on the study of geophysical environmental ties associated with soil and biology with existing plants at the site of the project site. This is based on a journal article in [7] which states that changes in physical and chemical properties of the soil that occur due to mining include increased bulk density and soil moisture and decreased permeability and soil fertility. Technical aspects of soil analysis should be undertaken prior to reclamation and re-vegetation activities to determine the treatment to be provided for soil physical and chemical properties in good quality [8].

Reference [9] metions, the type of soil in the research area is a yellowish red podzolic type. In addition, also found alluvial and hydromorf soil type associations. Noting the case, basically at the study site and its surroundings encountered at least three types of soil covering, podzolic, alluvial and hydromorphic. According to field observations, the soil at the site of activity is classified as infertile soil for agriculture. The soil at the study site needs to be improved by the dominance of the sand and dust fraction which shows the composition of sand and dust present in the soil. The soils dominated by the sand fraction have a high composition so that the soils are very low in water retention. All soil types found in the study sites are in fact low in natural fertility. Generally the soil reaction is acid, the organic matter content and the total nitrogen content is moderate.

The soil quality at the study site is influenced by land cover vegetation. Based on a survey conducted showing some plants or vegetation cover in the location of limestone mining PT Semen Baturaja Tbk is the dominant rubber garden. The other plants are shrubs with levels of herbs, stakes, poles, and trees. Vegetation of land cover at PT Semen Baturaja Tbk limestone mine is shown in Figure 2.

Figure 2.Vegetation Plant Around Existing Mine Sites [6]

3.2. Mine Design and Mine Age

Post-mining land acquisition planning is based on technical design of mining activities in the form of mining method, mining system, mining design, and mine age. Based on the shape and characteristics of layers of limestone and its cover layer, the mining method to be applied by PT Semen Baturaja Tbk is open pit method [6].

The limestone mine design of PT. Semen Baturaja Tbk is designed with the following criteria:

1. Based on the calculation from the Geotechnical consultant, we get the angle of slope that is 50^0 with the Security Factor of 1.387
2. Dumping of cover soil using a overall slope angle of 34^0 with FK = 1.53
3. The first year of limestone production amounted to 1,620,100 tons, increased to 1,970,000 tons in the eighth year and 1,412,297 tons in the ninth year.

Based on the amount of mining reserves worth 16,560,647 tons, the first limestone production was 1,620,100 tons, increasing to 1,970,000 tons in the eighth year and 1,412,297 tons in the ninth year.

3.3. Reclamation and Allocation of Post-Mined Land

3.3.1. Mine Reclamation

Mine closure planning should be integrated into three aspects, namely economic, social, and environmental. It aims to keep the mine closed after making a positive contribution to sustainable development.

The characteristics of limestone resources in Indonesia are mostly deposited near the surface of the earth. This causes the mining method that many do is open pit method. Mining activities will cause landscape changes such as topography, vegetation cover, hydrological patterns, soil structure damage, and others. This can be difficult in the process of recovering and restoring former mining land in accordance with the designation or known as reclamation.

Reclamation phases include top soil conservation, cover crop planting, pioneer planting, heavy metal countermeasures [10]. Reference [11] argued that reclamation activities require different approaches and technologies because the landscape

changes that occur can be permanent (eg very deep soil, soil changes, and biodiversity loss) or temporary (eg residual pile excavation and tailings waste).

3.3.2. Land Allocation Post-Mine

Natural resource management policies in sustainable development can use natural resource and environmental sustainability challenge approaches [12]. Post-mining planning for a sustainable mining environment represents the form of its implementation in the mining sector. Post-mining stages for mineral, coal, nonmetallic and rock mining are carried out as shown in the figure below.

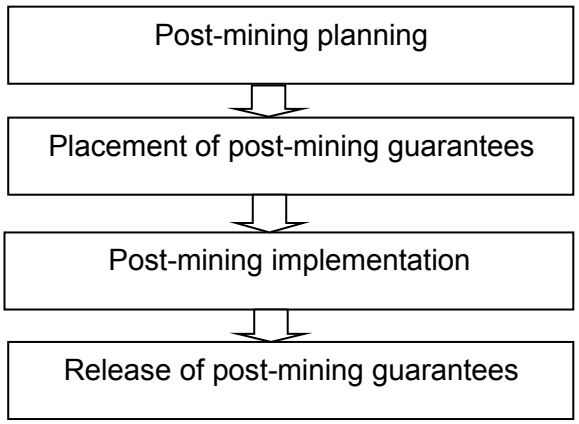

Figure 2.Post-mining Phase Diagram [10]

Based on figure 2, it appears that post-mining planning is in the first stage. This means that post-mining land use planning is done first or earlier before mining activities are conducted. The preparation of the post-mining plan is contained in the post-mining plan document which aims to maintain a sustainable and sustainable environment.

PT Semen Baturaja Tbk is committed to implementing post-mining plans that benefit communities living around the mine as well as the mining environment by maximizing the management of the mining environment for planned land forests. PT Semen Baturaja Tbk based on the post-mining plan that has been prepares, designate the land of limestone quarry for the revegetation zone with an area of 3.58 Ha.

The location of limestone mining PT Semen Baturaja Tbk is in a plantation area of the population and shrubs. PT Semen Baturaja Tbk's former limestone mine has to provide benefits for the surrounding community by maintaining environmental sustainability. Therefore, some of the former mining land of PT Semen Baturaja limestone will be used for revegetation zone. This zone will be use for rubber plantation. This is given that the initial environmental tone of the study site is a

community rubber plantation. Seeds to be planted can be imported from outside or seeds from the surrounding community. Land Allotment Plan (Mine Final Hue) Mining of limestone PT. Semen Baturaja Tbk is shown in Figure 3.

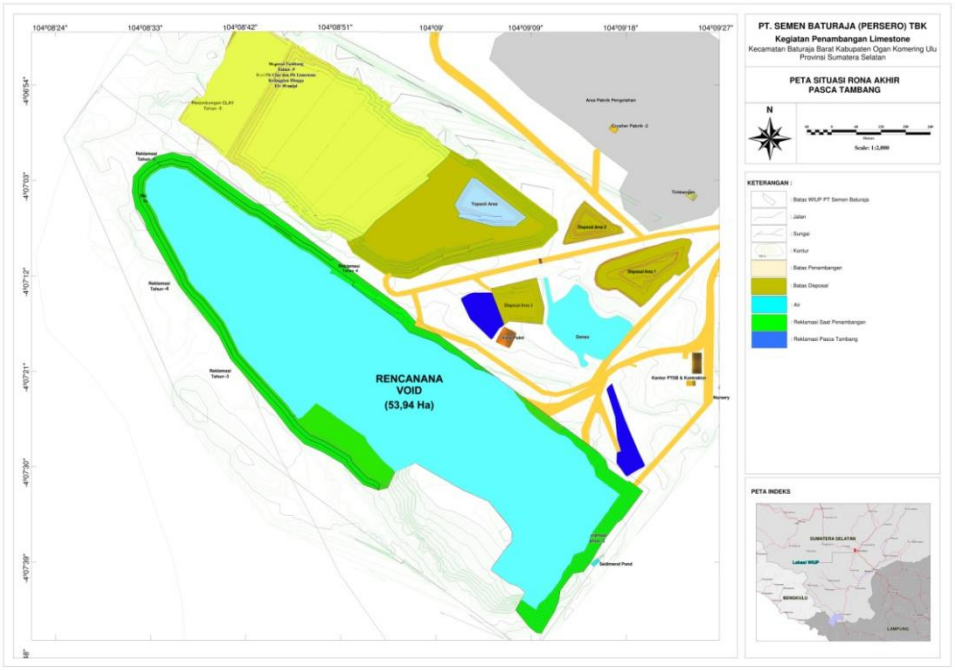

Figure 3.Land Use Plan (End Mine Condition) Limestone Mining PT. Semen Baturaja Tbk [13]

4. Conclusions

Postponement of post-mining land of PT Semen Baturaja Tbk at the end of production operations is planned in order to restore environmental function and sustainable limestone mining is for the revegetation zone for rubber plantation with an area of 3,58 ha. This is based on technical studies such as initial hue conditions, mine design and mine life.

Acknowledgment

Thank you to the management of PT Semen Baturaja Tbk for the opportunity given to the author to conduct a research survey on the location of mining business permit PT Semen Baturaja Tbk.

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Our decision is to: Accept Submission

Dr Muhammad Said
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Indonesian Journal of Environmental Management and Sustainability

THE STUDY OF THE TECHNICAL PLAN OF POST MINES LAND LIMESTONE QUARRY IN PT SEMEN BATURAJA (PERSERO) TBK

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ABSTRACT

Limestone mining activities of PT Semen Baturaja Ogan Komering Ulu Regency Tbk South Sumatra Province is done in the open mining quarry mining mining with the system. Limestone is the primary raw material required in the manufacture of cement in PT semen baturaja Tbk. Mining activities in the quarry is open at the end of its activities, will leave the land mines. Land mines must be utilized in order to make the environment mining can function returns appropriate allocation. Utilization of land mines can be done for a variety of Evergreen plants such as designation, orchards, and others. Designation ex limestone mines of PT Semen Baturaja Tbk as contained in document his rope Post Plans, one of which is for Evergreen plants. Research conducted in the survey aims to assess, technically land use limestone mines of PT Semen Baturaja for Evergreen plants so that land mines can be used again, so that the negative effects of mining activities can be reduced. The results showed, the utilization of land of a former limestone to plant pine PT Semen baturaja has met the required technical aspect in planning post-war mine . Research results are expected to be of benefit to the stakeholders, academics, researchers, practitioners and the Association of mining, and the environment.

Keywords: land use Plan, a former Post-war mines, technical aspects, Plant Evergreen

1. INTRODUCTION

PT Semen Baturaja (Persero) Tbk which operates in Baturaja Barat, Ogan Komering Ulu Regency, South Sumatra Province, has a strong commitment in running process of limestone quarries (limestone) which is environmentally. This is done to maintain the sustainability of the environment and the ecosystem functions, to the survival of present and future generations. Exploration activities conducted by PT Semen Baturaja (Persero) Tbk has successfully identified a number of reserves of limestone (chalk) which is an important backup. The results of an investigation into an exploration of limestone (lime) in the area of IUP production operation of PT Semen Baturaja (Persero) Tbk with total Reserves are 16,560,647 tonnes. Production plan with the target of 1,412,297 – 1,970,000 tons/year of its increase regularly every year.

Reclamation and post mine is part and parcel of mining activities, so that mining in this case not only the activities of the dig, load, loading, but must also return the land as an allotment. Act No. 4 of the year 2009 about Mineral and coal mining explained that reclamation is an activity that is conducted throughout the stages of the mining effort to organize, restore, and improve the quality of the environment and the ecosystem to function return appropriate allocation[1].

Limestone mining activities is not always can be done because the activity that takes place depends on the availability of a backup. Based on document mining feasibility study (business feasibility study) of PT Semen Baturaja. (Persero) Tbk year 2018, limestone mining activity plan will end in the year 2026. The mining activity has ended will certainly give impact on the community and also the environment around it. Therefore it takes a plan of activities to be

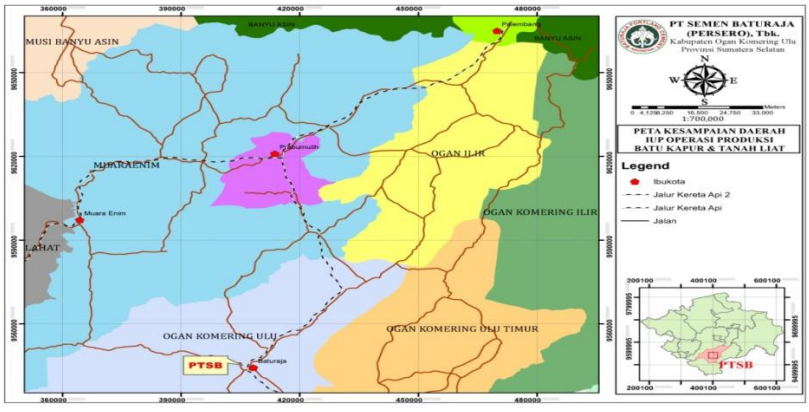
performed after the mining activity ended so that the community remains prosperous and environment remain sustainable. PT Semen Baturaja (Persero) Tbk as the companies doing mining activities are obliged to carry out reclamation and post mine as already provided for in Regulation No. 78 Years 2010 and Ministerial Regulation No. 7 the year 2014. Post-war mine is an activity that is performed to restore the function of the natural environment and social functions according to local conditions throughout the region mining programmatically, systematic, and sustained some mining activities will end or the entire mining activity ended[2].

Former mining environment will undergo changes in chemical, biological, and physical. Business handling the negative impact of mining activities this is a planned reclamation activities [3]. Reclamation aims to prevent erosion or to reduce the speed of the flow of water runoff, keeping land in order not to labile and more productive, and expected to be able to generate added value for the environment and creating conditions that are much more good compared with the State of the environment before the mining sustainable environment for the welfare of the current generation and future generations [4].

The reclamation plan activities refer to sustainable development (sustainable development). The definition of sustainable development is development that is carried out to improve the well-being of the present generation without compromising the well-being of future generations and continued [5]. Sustainable development in the mining activity has a sense that taking or exploit natural resources (though it pollutes the environment) and reinvest in other forms such as in the bentun natural resources that can be updated (SDA), man-made capital or resources (producted asset) (SDK), or the human resources (HR).

2. EXPERIMENTALSECTION

The location of the research carried out at the site of limestone mining of PT Semen Baturaja (Persero) Tbk in Baturaja Barat, Ogan Komering Ulu Regency, South Sumatra Province. Recall area can be reached by road from the city of Palembang, Ogan Komering Ulu Regency towards using four-wheeled vehicles through the cross-province with travel time approximately 6 hours. Then to the village of belly button through the streets of the village with journey time approximately 15 minutes. Research location as shown in Figure 1.



Source: Document the feasibility study of PT Semen Baturaja Tbk, 2018

Figure 1. Map Of The Regional Recall

2.1. Literature Study

This research study library first seek to aid in resolving the issues that are in the field of literature are used relate to the title of the research such as the books with the publication of technical Studies regarding the post-war plans the mine, a journal of research, handbook and PT Semen Baturaja from archives, Tbk.

2.2. The observation Field

Field observations performed with observation directly onto the field against the general condition of the field, the activities of mining and activities connected with mine reclamation and post plans on the location of PT Semen Baturaja, Tbk.

2.3. Data retrieval

This research combines theory and data – field data, so both are obtained from the approach to problem resolution. The sequence of research work, namely:

1. The primary Data

Primary data is data that is obtained from the results of observation and orientation in the field, namely: data test results soil samples.

2. Secondary Data

Secondary data is data obtained from the supporting documents of PT Semen Baturaja: Map of regional Recall PT. Semen Baturaja (Persero) Tbk., Data is Data, Initial Hue land area RPT.

2.4. Data processing

Data processing activities carried out in order to process data that has been obtained through the primary measurement/test lab, and secondary data obtained through the study of literature and instasional. This needs to be done because the data obtained are still raw data so that needs to be processed further in order to get the data you need to plan for the post-war mine.

2.5. The deliberations of the

Problem solving in the research thesis is done by analyzing the results of the processing of data, where the data analysis is based against the literature-literature-related research issues.

2.6. Conclusions and Suggestions

After doing a correlation analysis of the data by examining the problems that were in the field could get an outline or conclusion. The taking of the conclusion is a core issue in field so that at subsequent research can serve as a basic reference point reference. After that, the conclusion will be accompanied by a suggestion so that in advising carefully in order to provide solutions and consider the company party.

3. RESULTS and DISCUSSION

3.1. Initial Environmental Hue

Rona early in this research focuses on the study of the geophysical environment hue associated with soil and biology with the existing plant at the site of the project footprint. The changing nature of physical or chemical soil that occurs due to the mining of which in the form of an increase in bulk density and soil moisture as well as a decrease in permeability and the fertility of the soil [6]. Technical aspects in the form of soil analysis must be done before the reclamation activities and revegetasi to determine the treatment that must be given in order for chemical and physical properties of soils are in good quality [7].

The type of soil in the area of research is the kind of podsolik yellowish red. It also found the Association hidromorf and the alluvial soil types [8]. Pay attention to these things, then it's basically on site studies and its surroundings found at least three types of ground covers, podsolik, alluvial and hidromorfik. According to the results of field observations, ground on site activities belongs to the ground fertile for farming. Research on the location of land needs to be fixed sand fraction and domination of the ashes were where it shows the composition of the sand and dust of the ground. The lands dominated by sand fraction have a high composition so that the lands were very low in the water. All types of soil found at the site of the study in fact has a low natural fertility level.

3.1.1. Climatic

Location of limestone quarry development activities of PT Semen Baturaja (Persero) Tbk in OKU administratively in the Regency of South Sumatra Province OKU. Based on the type of climate in the South Sumatra District in particular, and generally this area belong to the tropical regions. The tropical climate described statements by some experts with a wide range of terms are as follows:

• Including Afa Climate (tropical rain climate), according to Koppen.

• Include A Climate (very wet), according to Schmidt – Ferguson 1950.

• Include Climate B1 (area with 7 to 9 months of wet and dry two months), according to a 1979 Oldeman.

The data in the form of climatology data for rainfall and meteorological data which represent the areas of study are obtained from a previous Report about the environment i.e. AMDAL (environmental impact analysis on Th 2017) and retrieved from the station Climatology Kenten Palembang. The data collected for the span of the last 10 years (2006-2015) and climate factors include precipitation and rainy day, air temperature, wind direction and speed, as well as elements of climate studies. With the presence of climate data is expected to provide a reflection of climatic conditions in the area of activity.

3.1.2. Conditions of space and Geology

3.1.2.1 Space Conditions

The village of Navel and beyond is largely a forest production that is not too dense, most other coffee plantations, rubber, pepper and the fields of the people. Area of inquiry is within the river basin area of Saka, Sangur, and Lungkuk. Average temperatures range between 21, 73o C to 32, 39o C, with a relatively high rainfall.

3.1.2.2. Fisiografi and geology

Based on Geological Sheet Map of Palembang from Centre for research and improvement of Geology (Gafoer et al., 1986), including part of Palembang sheet subbasin the North of Palembang, partly included in subbasin Jambi. The second sub basin is part of the South Sumatra basin that formed during the tertiary period.

Figure 3.2. Geologic Map Of The Location Of The Mining
PT Semen Baturaja (Persero) Tbk

The geological formation of Baturaja in General according to Van Bemmelen was included in the Group of Palembang who has the formation of Air Benakat (Tma), Kasai (Qtk), and Muara Enim (Tmpm). Formation of Batukapur is a collection of very bottom of fasies of 1,000 thick Telisa-1,200 m grown as the deposits of sand and was region oil (Talang Akar, Verandah, Benakat). Area of IUP limestone in the area of PT Semen Baturaja Navel (Persero) Tbk ± 103.5 Ha, located in the subdistrict of Baturaja Barat Regency of Ogan Komering Ulu South Sumatra Province. The topography of the region of Batukapur in mining area power Navel is characterized by Karst topography which has an average altitude of 45 meters above sea level. Navel land restricted by the mining population in the Southwest is located approximately 210 metres from the highway with Azimuth 2150 49 ', while from railway station of approximately 620 metres Northwest. Batukapur mining area is surrounded by the river Ogan, a distance of approximately 320 meters against the mining location. Ogan river water is 30 m from the sea. Map of the geology of the study area is shown in Figure 4.2. The location of areas of study including class 0-8% slope was Meosin old, at the area found more than 300 metres maximum.

3.1.3. The vegetation

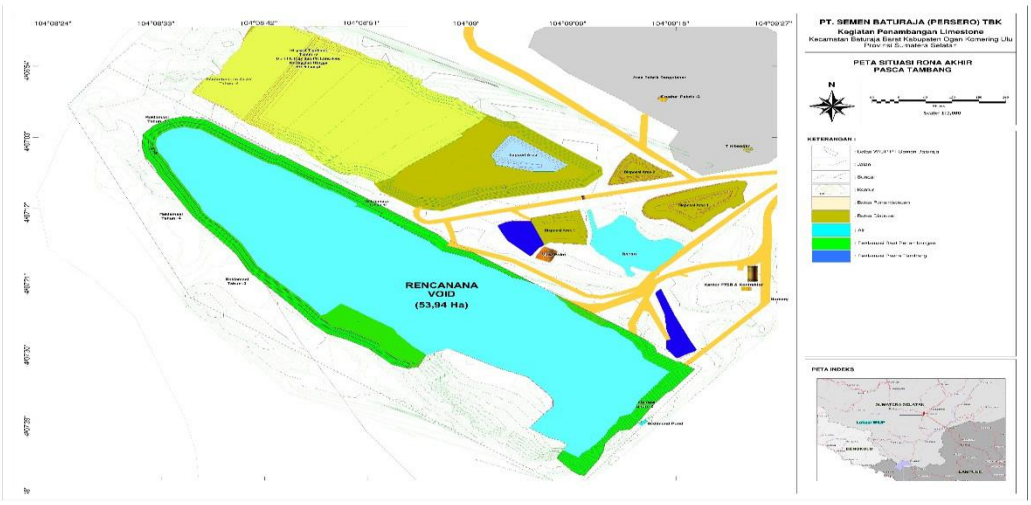
The type of vegetation found in the location of the activity plan an increase in cement production capacity of PT Semen Baturaja (Persero) Tbk in OKU are shrubs (Figure 3.3). Based on field survey to see that vast vegetation of shrubs is very small, in the form of open land due to the opening of land for access roads by PT Semen Baturaja (Persero) Tbk. from the quarry to the factory. It is also surrounded by small to medium diameter trees (Figure 3.4).

Figure 3.3 condition of vegetation in the area of research

Figure 3.4 the vegetation mix of shrubs and trees had the small-medium

3.2. Land use Post mine to Plant Evergreen

Stages of reclamation include the conservation of top soil, planting a cover crop, crop planting countermeasure of heavy metal pioneers, (Juniah, 2017). Structuring and allotment of land to plant spruce mine post has an area of 3.58 ha. Reclamation on the post mining plan of PT Semen Baturaja (Persero) Tbk is intended for the stocksoil location of former topsoil landfills in the form of reforestation or land rehabilitation activities after the closure of ex-mining areas and the return of surface land to restore and restore land quality, especially those related to prevention of land erosion quality of waters and rivers, pollution of heavy metals. Reclamation activities carried out by means of revegetation by planting a cover crop in the area that has been rehabilitated are interspersed with greening of grasses of elephant grass.



Source: Processed Data FROM PT Semen Baturaja RPT TEAM (Persero) Tbk, 2018

Figure 3.5. Land Allocation Plan (Rona End Mine) Mining of PT Semen Baturaja limestone (Persero) Tbk

3.2.1 types of plants

The choice of plant species based on considerations such as suitability of land use, suitability of possible growth and benefit principles. For that type of plant cover is selected i.e. Legumes Cover Croop (LCC) as well as with the staple crops that is Evergreen plants (Figure 3.6). Procurement of seeds is done by purchasing the seedlings ready for planting. Prior to sowing staple crops it is necessary in the planting of plant cover. Pine seedling needs as much as 625 stems per hectare

Figure 3.6 Evergreen Plants in zone revegetasi

3.2.2 Planting

The cropping pattern is set based on norms with attention to the aspects of soil and water conservation, as well as in accordance with the results of the study set a distance of planting 4 m x 4 m, so the number of plants is 625 Tree/Ha. Planting is carried out with a grid system on relatively flat land (0-15%), namely the placement of perpendicular lines and planting points spread evenly without taking into account contours. The direction of the planting path is as far as possible north-south. Planting paths are continued when cutting the road. Planting on undulating land (slopes of 15-25%) is carried out with a planting path in the direction of contour lines (according to the technical preparation of land / open lines on sloping land), so that it is not straight. Planting in one comparteman is done in monoculture which means that in one compartment there is only one type of staple plant. The planting process begins with the installation of a stake (45 cm long) which is inserted into the point and planting path as a sign of the position of the plant hole to be made. Stake is plugged into all planting points with the help of a rope (so that it is straight). If right at the planting point there is a disturbing rock or stem base, the position of the driver is shifted, but for the next point it still follows the initial path. Planting holes are made at each planting point that has been marked as a marker. Planting holes are made with a size of about 30x30x30 cm.

3.2.3 maintenance and Plant Care

1. Maintenance of the Crop year to-1

Plant maintenance year 1 started at the plant's age one month. Principal plant maintenance activities be weeding and trimming, stitching is as well as the eradication of pests and diseases of plants.

2. Plant Maintenance-2nd Year

Maintenance activities year 2 begins after the plants age over 1 year or second year of planting activities include weeding, fertilization, as well as pest and disease safely.

3. Maintenance of the Crop year to-3

Maintenance activities 3rd year begins after the plants age over 2 year or third year planting activities include weeding, fertilization, as well as pest and disease safely.

3.2.4 Success Criterion

Reclamation implementation success rates note by doing an assessment of all the activities of the reclamation with a success rate of reclaiming as follows.

3.2.4.1 the arrangement of land

a. Wide area (ha) furnished > 90% of the acreage that is supposed to be styled.

b. the scattering/placement of ground shoots with the criteria:

1. Extensive acreage set (ha) > 80% of the area that should be filled.

2. The amount of land sprinkled > Tops 80% of the total land shoots dug and stored.

3.2.4.2 Revegetasi

a. percentage of growing plants

Percentage grow plants every swath of calculated by way of comparing the number of plants that existed with the plan the number of plants that are supposed to exist within a swath of measure are assessed.

$$T = (\sum \sum hi/Ni) \times 100\%$$

$$= (h1 + h2 + ... + hn)/(N1 + N2 + ... + Nn) \times 100\%$$

Where:

T = percent (%) of growing plants

Hi = Amount of plant life found on the swath of measure to i Ni = number of plants that are supposed to be there on a swath of measure to the i

To determine the success rate of the plant used the criteria, as follows:

a) Successfully: percentage of 90% > growing plants

b) Were: percentage of 80% plant-growing 90%

c) less successful: percentage of 80% < growing plants

b. percentage of Healthy Plants

Observation of growth of plants classified in three (3) criteria that is healthy, less healthy, and languished with the following restriction:

1. healthy Plants are plants that grow fresh and relatively straight shaft and high minimum in accordance with the theme of the standard.

2. less healthy Plants are plants that have abnormal growth or stricken with pests and diseases.

3. Plants languish are plants that have abnormal growth or stricken with pests diseases so if kept small is likely to grow well.

c. the number of plants Per Hectare

The number of plants per hectare minimum of 625 trees/ha or tailored to his planting distance, and maximum distance of planting 4 m x 4 m.

d. Komposis types of plants

The diversity of types of plants adapted to the objectives and provisions of the reclamation of the already designed in the original planning.

3.2.4.3 Final Completion

This final settlement includes plant maintenance activities carried out, including covering planting, fertilizing, eradicating pests and diseases or weeding / irrigation and enrichment.

3.2.5 Soil Quality Test

The initial environmental tone for quantitative soil quality was determined by measuring and sampling directly in the field followed by laboratory analysis. The results of the measurement of soil quality analysis are then compared with the Land Quality Standards set out in the draft Decree of the State Minister of Environment in 1994. This Ministerial Decree states that land quality standards are set by each Governor by referring to National Quality Standards. Determination of quality standards is based on research and still accommodates the aspirations of the community, employers and interested parties.

The taking of soil samples at the study site includes soil on the pile soil can be seen in Figure 3.7 and also the initial hue soil can be seen in Figure 3.8 with the results of testing in the lab, can be seen in table 3.1. The results of organic C-test on pile soil samples are 0.72, in the criteria of soil chemistry including very low different from the results of organic testing in soil samples the initial hue is 9.29, in the criteria of soil chemistry including very high. The Ph content in the pile soil and initial hue soil samples is almost close together, in the soil sample the Ph content is 6.2 whereas in the soil sample the initial pH content is 5.2. In the texture of 3 fractions including sand, dust, clay on soil samples of texture deposits 3 sand fractions: 41, dust: 18, clay: 42 whereas in soil samples the initial hue of texture 3 fractions cannot be analyzed because the initial ronal soil sample content> 5% .

Figure 3.7 sampling soil pile on zone revegetasi

Figure 3.8 sampling the soil initial hue

Table 3.1 Soil Quality Test Result

No.	Parameter		Method	Unit	Identification Number	
					Pile Soil	Initial Hue Soil
					1810.03981	1810.03982
1.	C-Organik		Walkley & Black / Gravimetric	%	0.72	9.29
2.	N-Total		Kjeldahl	%	0.14	0.45
3.	C/N Ratio		Calculation	-	5	21
4.	P_2O_5Available		Bray / Olsen	ppm	7	16
5.	P_2O_5 Potential		HCl 25%	mg/100 g	40	116
6.	K_2O Potential		HCl 25%	mg/100 g	30	51
7.	Cations Can Be Exchanged	K^+	*N* NH_4OAc	cmol(+)/kg	0.56	0.62
		Na^+			0.15	0.18
		Ca^{++}			17.10	33.94
		Mg^{++}			0.82	1.86
8.	Acidity Can Excahange	Al-dd	*N* KCl	cmol(+)/kg	21.57	0.21
		H-dd			2.14	0.22
9.	Cation Exchange Capacity		*N* NH_4OAc	cmol(+)/kg	49.84	52.61
10.	Base Saturation		Calculation	%	37.37	69.58
11.	Water Content		Gravimetric	%	10.7	8.9
12.	pH	H_2O	Potensiometri	-	6.2	5.2
		N KCl			4.5	3.6
13.	Texture Of 3 Fractions	Sand	Pipette	%	41	-*
		Dust			18	-*
		Clay			42	-*

4. CONCLUSION

Based on the research that has been done, get the following conclusions:

1. The condition of the initial environmental tones at the study sites in Pusar Village, West Baturaja District, Ogan komering Ulu Regency, South Sumatra has a tropical climate.

2. The limestone mine post mining plan is intended for pine plant activities including:

   a. Plans for land allotment for revegation zones with an area of 3.58 ha.

   b. The geology of baturaja formation is included in the Palembang group which has Air Benakat (Tma), Kasai(Qtk), and Muara Enim (Tmpm) formations.

   c. The IUP area of limestone in the Pusar area of PT. Semen Baturaja (Persero) Tb covering an area of ± 103.5 Ha.

   d. The type of vegetation contained in the planned location of activities to increase cement production capacity of PT. Semen Baturaja (Persero) Tbk in OKU Regency is a bush.

   e. The types of plants to be planted are the basic types of plants such as evergreen plants. Besides that, it is also planted with a cover crop of Legum Cover Crop (LCC).

   f. The distance of plants to be planned is 4m x 4m so that the number of evergreen plants needed for an area of 3.58 hectares is 2,238 stems.

   g. The success criteria are assessed based on the set parameters, namely the percentage of land success calculated based on the total area of the arrangement compared to the area that should be structured, revegated and the final settlement which includes the activities of planting, fertilizing, eradicating pests and diseases or weeding / enriching.

ACKNOWLEDGMENT

Author want to say thank you to PT Semen Baturaja (Persero) Tbk

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Fahmi Ramadhan <mgsmfahmi@gmail.com> 23 November 2018 16.42
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We have reached a decision regarding your submission to Indonesian Journal of Environmental Management and Sustainability, "USED MINING PIT (VOID) LIMESTONE MINE IN PT. SEMEN BATURAJA (PERSERO) TBK FOR FRESHWATER AQUACULTURE PONDS.".

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Indonesian Journal of Environmental Management and Sustainability

USED MINING PIT (VOID) LIMESTONE MINE IN PT. SEMEN BATURAJA (PERSERO) TBK FOR FRESHWATER AQUACULTURE PONDS.

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ABSTRACT

In meeting the needs of cement raw materials of limestone, PT Semen Baturaja (Persero) Tbk do its own mining activities. Mining activities will have an impact on the surrounding environment. When mining activities are completed, there is a changes in the natural order that will be generated, which is a mine hole (void). This research are started by study of literature, field observation, data retrieval, data processing, discussion, and conclusion. The climate in South Sumatra, this region is generally included in tropical regions.Mining activities at the limestone quarry of PT. Semen Baturaja (Persero) Tbk. carried out in two ways, it was surface mining, and blasting activity. There are two parameters that did not meet the requirements on the inlet, it'snitrite (NO_2) and sulfide (H_2S) content. Industrial waste such as mining industrial waste is the cause of the exceeds nitrite limit. Decomposition of organic substances carried out by bacteria is the cause of exceeds the limit of sulfide, sulfide content is commonly found in industrial waste disposal sites, in this research, the mining industry. The results of the water test at the outlet showed one parameter of inorganic chemistry that did not meet the air requirements, namely the content of nitrite (NO_2).Based on the water test that have been adjusted with the government regulation, the water are safe for freshwater aquaculture, and the water are harmless for the fish.

Keywords: Postmining plan, reclamation, void, freshwater aquaculture

1. INTRODUCTION

Limestone is one of the raw materials for cement. PT Semen Baturaja (Persero) Tbk in meeting the needs of cement raw materials in the form of limestone do its own mining activities. The location of limestone mining by PT. Semen Baturaja (Persero) Tbk is located in Pusar Village, West Baturaja District, OganKomeringUlu Regency[1]. Mining activities cannot be denied will have an impact on the surrounding environment. These impacts can take the form of positive impacts and negative impacts. Positive impacts arise from mining activities such as increasing the income of the surrounding community, opening jobs, and so on. Meanwhile, the negative impacts caused are the change in the natural order and the color of the earth, noise, air pollution, water quality degradation, and others. Changes in the natural order that will be generated after mining activities are completed, one of which is a mine hole (void). Mining holes (void) that exist after mining activities are still too many that have not been managed properly. Pit holes (void) which are in lower topographic conditions make it a reservoir for running water and rainwater with a compacted soil structure. Good void management will contribute positively to mine reclamation management efforts, successful land revegetation and regional succession, and regional hydrology. Therefore, it is necessary to do an appropriate and accurate plan for reclamation and post-mining activities so that the objectives desired by all parties can be realized.

One of the problems that arise due to the increase in human activities is the pollution of water to water sources because they receive pollution loads that exceed their carrying capacity. Pollution that results in quality maintenance can come from centralized waste (point sources) such as: industrial waste, livestock, hotel, hospital and non-point sources such as agricultural, plantation and domestic waste [2].
Based on Government Regulation no. 78 of 2010, exploration IUP holders and exploration IUPK are required to carry out reclamation and post-mining. The reclamation in question is carried out on land disturbed by exploration activities [3]. Referring to some of these changes, reclamation activities become a very important need to be done. Besides aiming to prevent erosion or reduce the speed of runoff, reclamation is carried out to keep the land from being unstable and more productive. Reclamation is expected to be able to produce added value to the environment and create a situation that is far better than the previous environmental conditions [4].
This research uses the formulation of the problem, how the condition of the initial environmental of the limestone mining environment of PT. Semen Baturaja (Persero) Tbk, and how to utilize voids from limestone mines of PT. Semen Baturaja (Persero) Tbk for freshwater fish aquaculture. The mining method that will be applied to the existing mine of PT Semen Baturaja (Persero) Tbk is an open pit mine with an open pit method[5].
Reclamation activity is an activity to organize, restore, and improve the environment so that it can function according to its use. Meanwhile, post mining is an activity carried out to restore the function of the natural environment and social functions according to local conditions in all mining areas in a planned, systematic, and sustainable manner when part of mining activities will end or all mining activities end[6].
The final form that is usually caused by limestone mining is the form of ex-mining land and also mine pit (void). Juniah (2014) categorizes voids into three parts, namely: (a) existing voids, are voids found in mining areas during mining operations; (b) void residuals, are voids that occur during mine closure; and (c) the final void is a void formed after the end of all mining production operations or the end of the mine's operational life[7].
Fish farming in ex-mining ponds requires identification of local environmental conditions, by looking at factors that influence fish farming. Open mining will result in changes in soil physical, chemical and biological properties that can affect the water quality of post-mining ponds, so an analysis of the management of ex-coal mining land for sustainable fish farming is needed [8].

2. EXPERIMENT

This research was conducted on 27 August 2018 until 23 October 2018 at PT. Semen Baturaja, Tbk. This study took data at PT Semen Baturaja, Tbk. located in OganKomeringUlu Regency, South Sumatra, Indonesia. In conducting this research starting from field orientation activities, reference and data collection, data processing, consultation and guidance, as well as compilation and collection of reports. Then data processing and analysis are carried out, then conclusions and suggestions are taken.The equipment needed during the study is stationery, notebook, computer, cell phone, and calculator.

2.1. Study of literature

This research first sought literature as an assistant in solving problems in the field. The literature used relates to research titles such as books with publications on post-mining plans, research journals, handbooks and archives from PT Semen Baturaja, Tbk.

2.2. Field observation
Field observations are carried out by direct observation to the field on the general conditions of the field, mining activities and activities related to reclamation and post-mining plans at locations in PT Semen Baturaja, Tbk.

2.3. Data retrieval
Data collection is done to get value from various aspects that affect the economic value of the post-mining plan. The data needed in this study are primary data and secondary data.
1. Primary Data
Primary Data is data obtained from the orientation and observation results in the field, namely: data from the test results of water samples.
2. Secondary data
Secondary data is supporting data obtained from PT Semen Baturaja documents, namely: Regional Deliberation Map of PT. Semen Baturaja (Persero) Tbk., Initial Baseline Data, Post Mining Plan Land Area Data.

2.4. Data processing
Through primary data and secondary data that have been obtained, data processing will be carried out. Data processing is done to find out whether the postmining plan activities are beneficial for the company or the surrounding community.

2.5. Discussion
Problem solving in this research is done by analyzing the results of data processing, where the data analysis is guided by the literature related to the problem of this research.

2.6. Conclusions
After correlating the data analysis by examining the problems in the field, then get an outline or conclusion. Conclusion is the core problem in the field so that further research can be used as a reference reference. After that, the conclusion will be accompanied by a suggestion so that in giving the best possible advice so that it can provide solutions and consider the company.

3. RESULTS AND DISCUSSION
3.1. Regional Location
Location of limestone mining by PT. Semen Baturaja (Persero) Tbk is administratively located in West BaturajaSubdistrict, OganKomeringUlu District uses four-wheeled vehicles through provincial roads with a travel time of around ± 6 hours. Then go to Pusar village through the village road with a travel time of about ± 15 minutes. PT Semen Baturaja (Persero) Tbk has obtained a Production Operation Mining Permit (IUP Production Operation) for limestone mining Number: 01 / K / IUP-II.A3 / XXVII / 2010 with an area of 103.4 Ha on March 23, 2010. Location map can be seen in Figure 1.

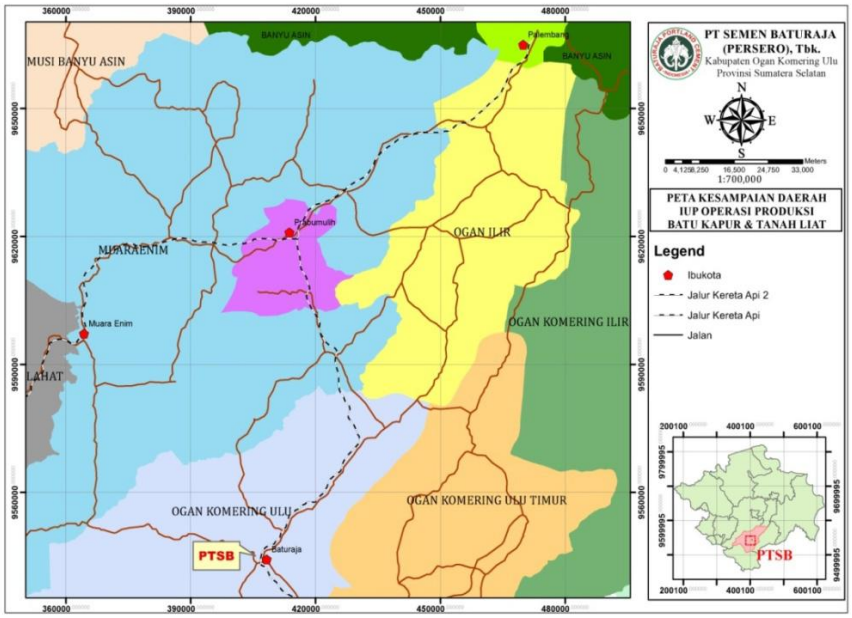

Figure 1. Location Map (Feasibility Study Document of PT. Semen Baturaja (Persero) Tbk., 2018)

3.2. Initial Environmental Conditions

Geographically, the research location is in Pusar Village, West Baturaja District, OganKomeringUlu District, South Sumatra Province. Area of exploration IUP of PT. Semen Baturaja (Persero) Tbk is an area of 96.84 Ha.

3.2.1. Climate

Based on the type of climate in South Sumatra in general, this region is included in tropical regions. Climatological data in the form of rainfall data and meteorological data representing the study area were obtained from previous environmental reports, namely AMDAL (Environmental Impact Analysis Th 2017) and obtained from the Kenten Climatology Station Palembang. The data was collected for the span of the last 10 years (2006-2015) with climate factors including rainfall and rainy days, air temperature, wind speed and direction, and climate elements in the study area.

Based on secondary data from Kenten Palembang Meteorology and Geophysics Agency, rainfall data and the number of rainy days in the activity area are presented in a span of 10 years. Based on the data obtained shows that the highest rainfall is 2,807 mm in 2010 and the lowest is 1,168 mm in 2011. The highest monthly rainfall is 715 mm in March 2005 and the lowest is 4 mm in August 2009. The number of rainy days the annual average ranges from 87 to 201 days, with a record of the lowest number of rainy days in October 2009 that is 1 day while the highest number of rainy days is December 2007 as many as 25 days. The average rainfall during 2008 ranged from 23.9 mm3 (June) to 634 mm3 (November). The most rainfall data in December is 350 mm and the lowest is in August, which is 61.3 mm. Wet months occur for 7 (seven) months, namely October to April with rainfall ranging from 210 - 350 mm / month. Conversely, dry months occur for 5 (five) months, namely May to September with rainfall intensity between 8.84 - 17.57 mm / day and reaching the lowest point in August, which is 8.84 mm / day. The average number of rainy days from October to April is the months of rain (wet) with the frequency of rainy days ranging from 13-21 rainy days / month. The largest number of rainy days occurred in December and January which averaged 21 days / month. Dry months have a number of days of rain between 9-15 days /

month that occur in May to September. Based on the description above and from the data presented for 10 (ten) years (2006 - 2015).

3.2.2. Vegetation Components

Vegetation components are divided into several types that are observed, including the flora and fauna found in the land area. The flora and fauna itself will be further divided into 2 different types, namely terrestrial flora and fauna, and aquatic biota.

The aspects of vegetation (flora) observed in the study location were several types of plants such as shrubs (forest), and several types of plantations. The aspects of terrestrial fauna found in the study location are several types of animals such as frogs, snakes and several species of birds. Field observations show several types of mammals such as wild boar, and monkeys are also found in these locations. Several types of wild animals are found on the site, some of which are included in protected animals such as porcupines, and pangolin.The fauna aspect of the perennial biota found in the Ogan River shows several kinds of fish that are quite diverse. Some fish that can be seen include cork fish, lais fish, river catfish, and others. Condition of forest vegetation can be seen in Figure 2.

Figure 2. Conditions of Forest Vegetation Components Around the Limestone Mine

3.2.3. Geological Conditions

The geology of the Baturaja formation is generally included in the Palembang group, which has Tma, Qtk and Tmpm formations. This stratigraphy from the Baturaja region is as follows: the lowest layer (base) of Baturaja limestone is the Basalt layer, and there are also quartz sand, quartz conglomerates and limestone. The Limestone Formation according to condition (1975) consists of two members, namely: Carolline Limestone, Sandy Limestone.

Formation Limestone is a facies from the lowest collection from the Telisa side with a thickness of 1,000-1,200 m developing as sandstone sediment and is an oily area (TalangAkar, Pendopo, Benakat). The Geological map of mining location can be seen in Figure 3.

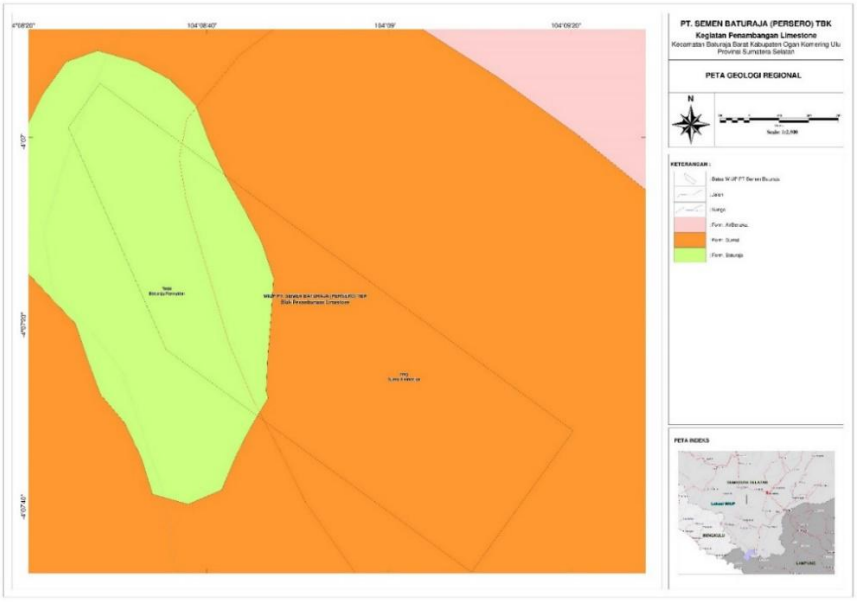

Figure 3. Geological Map of Mining Locations (Feasibility Study Document of PT. Semen Baturaja (Persero) Tbk., 2018)

3.3. Post-Mining Land Use

3.3.1. Mining Activities

Mining activities carried out at the limestone quarry of PT. Semen Baturaja (Persero) Tbk., Carried out in two ways, namely surface mining, and conducting blasting. This is done because of the distance of the community house adjacent to the limestone mining area. So as to reduce the vibration caused by blasting activities, the class 500 T surface miner tool is used in parts close to the residents' homes.

The surface miner tool works with a gear wheel that crushes the limestone that is passed. The results of the grinding carried out by the tool were immediately collected using a wheel loader, which was then loaded with a back hoe load-digging device into the dump truck. Surface miner tool can be seen in Figure 4

Figure 4. The limestone mining process using a surface miner tool

Blasting carried out on limestone mines at PT. Semen Baturaja (Persero) Tbk., Carried out in stages. It aims to reduce vibrations that occur due to blasting activities, because of the distance of residents' homes that are not far from the mining location. Blasting is carried out only once in one day, at 12.00 WIB. Blasting activity can be seen in Figure 5.

Figure 5. Blasting Activity PT. Semen Baturaja (Persero) Tbk.

Mining activities at PT. Semen Baturaja (Persero) begins with land clearing, and then continues with the construction of supporting infrastructure such as the construction of mining roads, construction of office buildings, etc. Overburden stripping activities are carried out after all facilities and infrastructure has been completed, then limestone mining activities are carried out. Activities of loading materials into dump trucks can be seen in Figure 6.

Figure6. Activities of Loading Materials into the Dump Trucks.

A dump truck that has been fully charged will send the excavated material to the Crushing Plant and then it will be directly flowed to the factory to be processed into cement. The dumping activities at the crushing plant and the stages of mining activities carried out by PT. Semen Baturaja (Persero) Tbk., can be seen in Figure 7 and Figure 8.

Figure 7. Dumping Activities at the Crushing Plant.

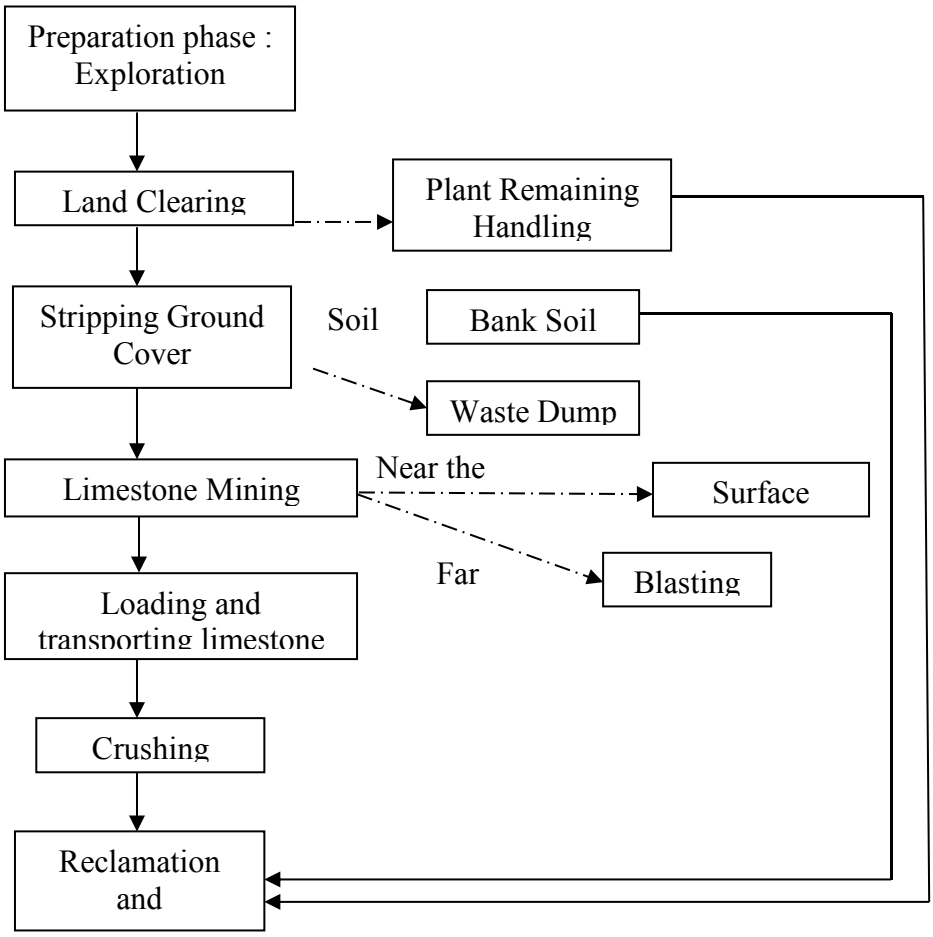

Figure 8. Mining Flow Chart PT. Semen Baturaja (Persero) Tbk.

3.3.2. Post-mining plan

Land that has been mined will leave a hole that destroys the natural ecosystem; therefore it is necessary to carry out reclamation activities with the aim of restoring land functions. The land that has been mined will leave a mine pit (void). One of the land function restoration plans carried out is to convert some of the voids into freshwater aquaculture ponds. The creation of

a freshwater aquaculture pond is intended to restore the function of land that has been mined, and provide economic value to the land. Plans for allotment of post-mining land can be seen in Figure 9.
Freshwater aquaculture will be carried out to provide economic value and can be used as an indicator that the water contained in voids is not dangerous, and is still in a standard regulated by the government.

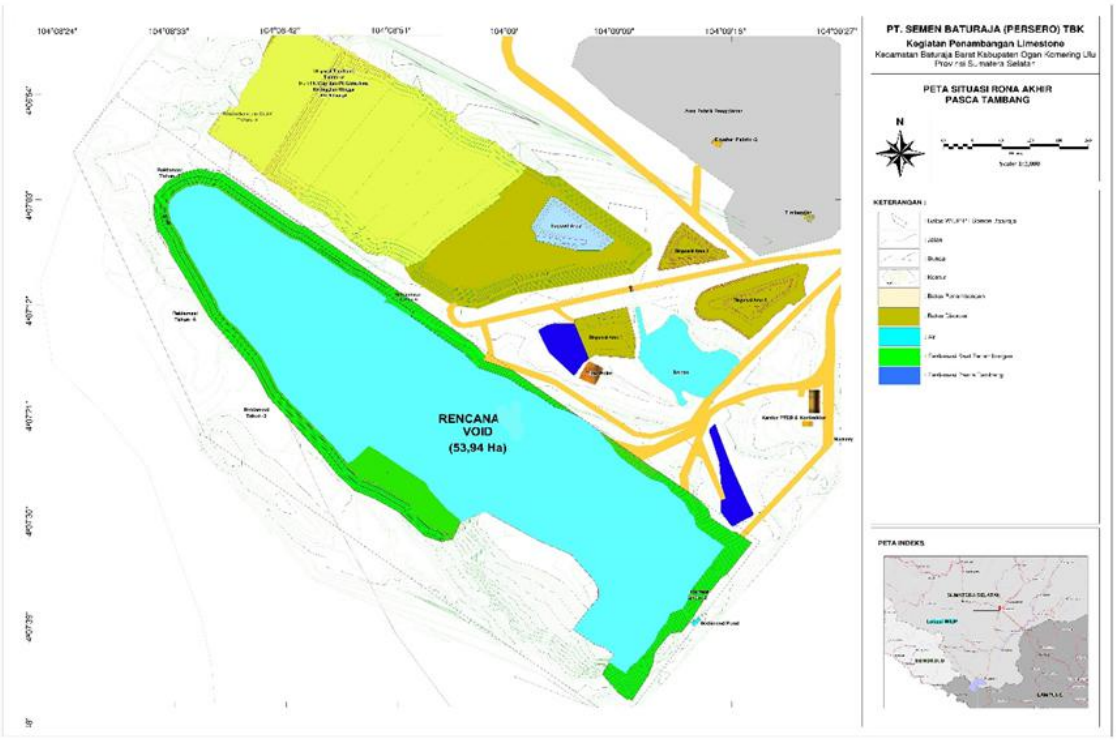

Figure 9. Land Allocation Plan (Mine Final Plan) PT. Semen Baturaja (Persero) Tbk.

3.3.3. Freshwater Fish Aquaculture
The type of fish that will be bred in this freshwater aquaculture pond is a type of tilapia. Test results of water samples indicate that the water is not dangerous, pH and water temperature are in accordance with the requirements for tilapia cultivation, so this makes it possible to cultivate freshwater fish with tilapia fish.
This tilapia aquaculture pond was made so that voids from limestone mines could provide positive benefits for the surrounding community and for PT. Semen Baturaja (Persero) Tbk. Sampling of water in the inlet and outlet are done for knowing the water quality. Sampling of water can be seen in Figure 10. The water test results can be seen in Table 1 and Table 2.

Figure 10. Sampling of Water in the Inlet (S: 04 ° 07'41 "; E: 104 ° 09'09") and Water Outlet (S: 04 ° 07'37,7 "; E: 104 ° 09'16,6")

Table1. Water Test Results in the Inlet (S: 04 ° 07'41 "; E: 104 ° 09'09")

Num.	Parameter	Unit	Maximum Level [9]	Yield	Inspection Method
	A. Physics				
1	Temperature (in the Laboratory)	◦C	38	25.4	SNI 06-6989.23-2005
2	Total Dissolved Solids (TDS)	mg/l	2000	31	Direct Reading
3	Total Suspended Solids (TSS)	mg/l	200	22.0	Direct Reading
	B. Inorganic Chemistry				
1	pH *(in the Laboratory)	#	(6-9)	6.07	SNI 06-6989.11-2004
2	Iron *(Fe)	mg/l	5	0.12	SNI 6989.4-2009
3	Manganese *(Mn)	mg/l	2	0.05	SNI 6989.5-2009
4	Barium (Ba)	mg/l	2	0.001	SNI 06-6989.16-2004
5	Copper *(Cu)	mg/l	2	<0.003	SNI 6989.6-2009
6	Zinc *(Zn)	mg/l	5	0.03	SNI 6989.7-2009
7	Total Chrome (Cr)		0.5	<0.018	SNI 06-6989.17-2004
8	Cadmium *(Cd)	mg/l	0.05	<0.0015	SNI 6989.16-2009
9	Mercury (Hg)	mg/l	0.002	<0.0001	AAS-MVU
10	Lead *(Pb)	mg/l	0.1	<0.003	SNI 6989.8-2009
11	Arsenic (As)	mg/l	0.1	<0.0009	AAS-HVG
12	Selenium (Se)	mg/l	0.05	<0.0012	AAS-HVG
13	Cyanide (CN)	mg/l	0.02	0.004	Spectrophotometry
14	Cobalt (Co)	mg/l	0.4	0.00	SNI 6989.68-2009
15	Flouride(F)	mg/l	2	0.25	SNI 06-6989.29-2004
16	Free Ammonia(NH3-N)	mg/l	1	0.33	SNI 06-2479-1991
17	Nitrate, as N (NO3)	mg/l	20	2.92	SNI 06-2480. 1991
18	Nitrite, as N *(NO2)	mg/l	1	0.180	SNI 06-6989.9-2004
19	Biochemical Oxygen Demand (BOD5)	mg/l	50	2.62	SNI 06-2503-1991
20	chemical oxygen Demand (COD)	mg/l	100	19	SNI 6989.2-2009
21	Dissolved Oxygen (DO)	mg/l	-	2.07	SNI 06-6989.14-2004
22	Sulfide (H2S)	mg/l	0.05	<0.03	SNI 6989.70-2009
	B. Organic Chemistry				
1	Oil and Fat	mg/l	5	0.19	SNI 06-6989.10-2004
2	Phenol	mg/l	0.5	0.00	SNI 06-6989.21-2004
	Information:				
	*) : Accredited			#) : No Units	

Table 2. Water Test Results in the Outlet (S: 04 ° 07'37,7 "; E: 104 ° 09'16,6")

Num.	Parameter	Unit	Maximum Level [9]	Yield	Inspection Method
	A. Physics				
1	Temperature (in the Laboratory)	◦C	38	26.8	SNI 06-6989.23-2005

2	Total Dissolved Solids (TDS)	mg/l	2000	20	Direct Reading
3	Total Suspended Solids (TSS)	mg/l	200	17.0	Direct Reading
	B. Inorganic Chemistry				
1	pH *(in the Laboratory)	#	(6-9)	6.07	SNI 06-6989.11-2004
2	Iron *(Fe)	mg/l	5	0.08	SNI 6989.4-2009
3	Manganese *(Mn)	mg/l	2	0.05	SNI 6989.5-2009
4	Barium (Ba)	mg/l	2	0.001	SNI 06-6989.16-2004
5	Copper *(Cu)	mg/l	2	<0.003	SNI 6989.6-2009
6	Zinc *(Zn)	mg/l	5	0.01	SNI 6989.7-2009
7	Total Chrome (Cr)		0.5	<0.018	SNI 06-6989.17-2004
8	Cadmium *(Cd)	mg/l	0.05	<0.0015	SNI 6989.16-2009
9	Mercury (Hg)	mg/l	0.002	<0.0001	AAS-MVU
10	Lead *(Pb)	mg/l	0.1	<0.003	SNI 6989.8-2009
11	Arsenic (As)	mg/l	0.1	<0.0009	AAS-HVG
12	Selenium (Se)	mg/l	0.05	<0.0012	AAS-HVG
13	Cyanide (CN)	mg/l	0.02	0.002	Spectrophotometry
14	Cobalt (Co)	mg/l	0.4	0.00	SNI 6989.68-2009
15	Flouride (F)	mg/l	2	0.17	SNI 06-6989.29-2004
16	Free Ammonia (NH3-N)	mg/l	1	0.32	SNI 06-2479-1991
17	Nitrate, as N (NO3)	mg/l	20	2.90	SNI 06-2480. 1991
18	Nitrite, as N *(NO2)	mg/l	1	0.174	SNI 06-6989.9-2004
19	Biochemical Oxygen Demand (BOD5)	mg/l	50	2.51	SNI 06-2503-1991
20	chemical oxygen Demand (COD)	mg/l	100	15	SNI 6989.2-2009
21	Dissolved Oxygen (DO)	mg/l	-	2.01	SNI 06-6989.14-2004
22	Sulfide (H2S)	mg/l	0.05	0.0	SNI 6989.70-2009
	B. Organic Chemistry				
1	Oil and Fat	mg/l	5	0.13	SNI 06-6989.10-2004
2	Phenol	mg/l	0.5	0.00	SNI 06-6989.21-2004

Information:

*) : Accredited #) : No Units

Based on the Regulation of the Governor of South Sumatra Number 8 of 2012 concerning Quality Standards Liquid waste for industrial, hotel, hospital, domestic and domestic activities shows that the water content has met the specified requirements. Republic of Indonesia Government Regulation number 82 of 2001 concerning air quality management and monitoring of water disbursement which states that activities for freshwater cultivation are included in class II[10]. The results of the water tests that have been carried out show that the inlet and outlet samples are qualified to regulate class II water quality. The results of the water test on the inlet show two inorganic chemical parameters that do not meet water requirements, namely nitrite (NO_2) and sulfide (H_2S) content. Nitrite content that exceeds the limit referred to by waste water from industrial waste is the mining industry. The sulfide content that exceeds the limit is caused by the decomposition of organic substances carried out by bacteria. The sulfide content is commonly found in industrial waste disposal sites, in this research, the mining industry.. The results of the water test at the outlet showed one parameter of inorganic chemistry that did not meet the air requirements, namely the content of nitrite (NO_2).

The results of water tests that have been adjusted with the Indonesian Government Regulation for freshwater cultivation activities, both tilapias, can be done because they have met water quality requirements, and have qualified for a place for tilapia.

4. CONCLUSION

Based on the research that has been done, the following conclusions are:

1. The condition of the environmental baseline at the research location located in Pusar Village, Baturaja Barat District, OganKomeringUlu District, South Sumatra has a tropical climate. The highest rainfall is 2,807 mm in 2010 and the lowest rainfall is 1,168 mm in 2011. Aspects of flora and fauna vegetation show the diversity of plants and animals that exist, ranging from trees, shrubs, to plantation crops, with the types of animals that quite diverse, ranging from amphibians, reptiles and mammals. The Ogan River which is located near the location also stores fish diversity.
2. Test results of water samples indicate that the water is clean and harmless. Positive test results indicate that making freshwater fishery cultivation can be done to provide economic value.

ACKNOWLEDGMENT

Author want to say thank you to the mentors in the field, as well as all employees of PT Semen Baturaja (Persero) Tbk.

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Our decision is to: Accept Submission

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Indonesian Journal of Environmental Management and Sustainability

Post-mining Land of Limestone Quarries for Sengon Plants in PT Semen Baturaja (Persero) Tbk

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ABSTRAK

Limestone mining in PT Semen Baturaja mine mining materials in the form of limestone. Limestone is the material needed to make cement. Open mining activities at the final stage will leave ex-mining land. Ex-mine land in the PT Semen Baturaja reclamation area has been planned for revegetation of sengon seedlings. The research was conducted to examine economically post-mining land of limestone mines for sengon plantations. The initial baseline studied in the study area includes climate, space and geological conditions, and vegetation. Some plants in the study area include sengon, cypress, and guava. The results showed that the use of limestone quarry land for sengon plants had met economically. The results of the study are expected to be utilized by stakeholders, academics, practitioners, researchers, mining associations and the environment.

Keywords: *Limestone, Limestone Mining, Ex-mining land, Sengon seedlings*

I. INTRODUCTION

Limestone mining at PT Semen Baturaja uses open-pit mining methods with Quarry mining systems. The limestone mine at PT Semen Baturaja produces limestone that is needed in the manufacture of cement. Lime or carbonate is a rock consisting of salt carbonate minerals formed chemically in the form of a solution, where the organism's water participates in the formation of carbonate rocks. Carbonate rocks are formed cretically (through deposition mechanization) or the process of chemical concentration of carbonate salts originating from marine animals including foraminifera plankton or mollusc which will form reefs through diagenesis (cementation, micritization (by organic)), compaction, neomorphism (the process of replacing minerals similar or polymorphic [1]. Cement is the material needed for buildings, especially in Indonesia. The final stage of limestone mining left the land of ex-mining and mine pit. Limestone mining has positive and negative impacts. The positive impact of limestone mining is an increase in the economy around the mining area. Negative impacts of limestone mining in the form of losses to the environment, both directly and indirectly [4].

An important requirement for countries that want natural resource conservation is environmentally friendly development. Natural resources need to be maintained and maintained for human survival in the present, and for the next generation. The value of forest benefits has been reduced due to forest damage [3]. Limestone is a sedimentary rock which has three main components, including carbonate grains, mud (lime mud / micrite), and cement (cement). Sedimentary rocks are generally characterized by stratification, specific minerals from sedimentary origin (for example, glauconite, chamosite), sedimentary structures on the bed surface and inside beds, fossils and grains or gravels that have been transported (ie clusters) [9]. Limestone is a mineral belonging to carbonate minerals which are formed from organic remains of living things [2].

Limestone mining has a mining period in accordance with available reserves. The limestone mining plan will end in 2026 based on the feasibility study document. After mining ends, efforts are needed in reclamation to restore land functions. Postmining is an activity to restore the function of nature and social conditions according to local conditions [7]. One of the activities in mining is stripping the cover layer. The cover can be in the form of topsoil, limestone or soft / weathered rock which covers the excavated material. Stripping is done by a mechanical excavator. The mechanical device planned

for stripping the cover is 1 unit of class 30 T excavator for overburden and class 20 T excavators for top soil and 1 unit of Bulldozer to push material and top soil. Cover layer in the form of top soil is dug up and piled separately to the bank's top soil location. The top soil deposits are maintained in such a way as to minimize erosion so that they can be redistributed to land that is ready to be rehabilitated and reclaimed. Likewise, the overburden in the form of weathered rock, the material will be excavated and piled in the location of the waste dump that has been determined with the geometry of the embankment slope does not pass the maximum geometry recommended based on geotechnical analysis [8].

Mining is a mineral and coal business activity which consists of stages of activities. The stages of limestone mining activities consist of activities of general investigation, exploration, feasibility study, preparation / construction, mining, processing and refining, sales, and post-mining [10]. One type of sengon plant is sea sengon. Sea Sengon has a specific gravity of 0.33 which is durable in its class. Sengon wood is widely used by the community as building materials, making veneers, pulp, and so on [5]. Quality seeds are needed to produce quality sengon. One of the things that affects the quality of seeded seedlings is growing media. Growing media has a function as a provider of nutrients, oxygen, and the place where roots grow [6].

II. EXPERIMENTAL SECTION

The method that will be carried out in retrieving the data needed for the purpose of completing this final report writing is:

1. Study of literature

Performed by studying literature materials in the form of books and various references to research reports related to this research.

2. Data Collection

The data collected by the author are:

a. Primary Field Data, namely data collected by observing directly in the field such as questionnaire data (direct field interviews), data on land area (length and width), soil quality test data (soil pH and metal content), and others.

b. Secondary Field Data, namely data collected based on references from companies such as baseline data, economic data, cost benefit analysis, mapping, literature and journal studies.

3. Data Processing

The data obtained, processed using a mathematical formula, are then presented in table form, drawings and completion calculations. Data processing includes calculating data on extended cost benefits or extended NPV and analyzing data on soil laboratory test results in accordance with soil composition.

4. Data Analysis

The processed data is then analyzed based on the literature related to the problem.

5. Research location

Administratively the study location is included in the West Baturaja District, Ogan Komering Ulu District, South Sumatra Province. The accomplishment of the area can be reached by road from the City of Palembang to the Ogan Komering Ulu District using four-wheeled vehicles through provincial roads with a travel time of around ± 5 hours. Then go to Pusar village through the village road with a travel time of about ± 15 minutes.Research location as shown in Figure 1.

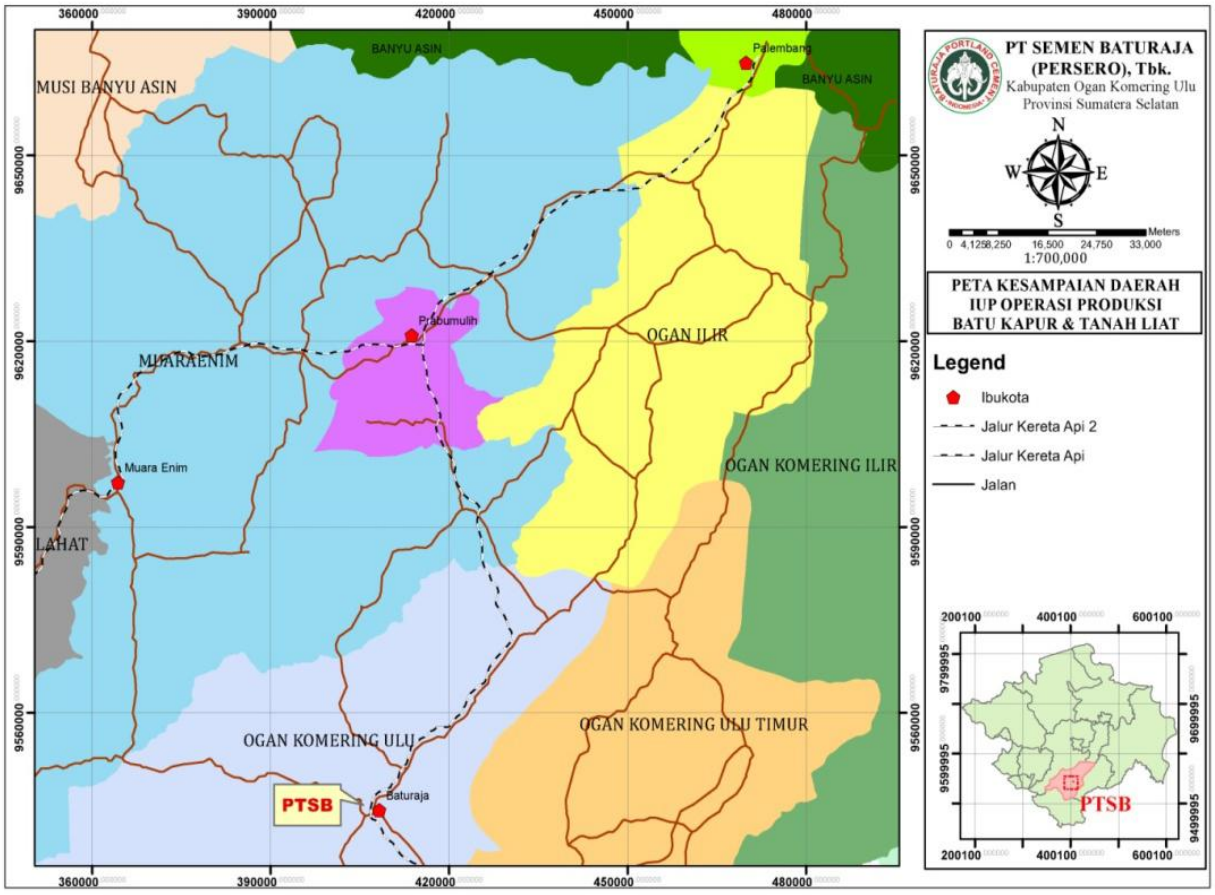

Figure 1. Map of Regional Accomplishments (PT. Semen Baturaja Tbk, 2018)

III. RESULTS AND DISCUSSION

Technical aspects and economic aspects are important to consider in determining the designation of post-mining land. Technical aspects are used as a basis in determining the economic planning of post-mining costs. The economic aspects discussed are as follows:

3.1 Regional Achievement

The area of the Mining Business License ("IUP") of PT Semen Baturaja (Persero) Tbk is geographically located in Pusar Village which is included in the administrative area of West Baturaja District, OKU Regency, South Sumatra Province. The area of Production Operation IUP PT Semen Baturaja (Persero) Tbk is 103.4 Ha.

3.2Initial Hue

Initial hue is an object that describes the conditions of an area. Some of the things discussed in the baseline are as follows.

3.2.1 Climate

The location of the limestone mine development activities of PT Semen Baturaja (Persero) Tbk in OKU Regency is administratively located in OKU Regency, South Sumatra Province. Based on the type of climate in South Sumatra in general and in particular districts, this region is included in tropical regions.

3.2.2. Space and geological conditions

3.2.2.1 Space Conditions

Pusar Village and its surroundings are mostly production forests that are not too dense, others are coffee, rubber, pepper and smallholder plantations. The area of investigation is in

the area of the Saka, Lungkuk, and Sangur River flows. The average air temperature ranges from 21.73ºC to 32.39ºC, with relatively high rainfall.

3.2.2.2. Geological Conditions

Geological conditions in the study area can be viewed from various things, one of which is lithology. Lithological interpretation is made from drilling data when conducting exploration activities. Drilling is carried out by PT Sucopindo in the area of the Exploration Mining Business Permit (IUPK) of limestone and clay PT Semen Baturaja (Persero), Tbk. Geology of the Baturaja formation in general according to Van Bemmelen belongs to the Palembang group which has the formation of Tma, Qtk, and Tmpm. The limestoneformation is a facies from the lowest collection from the Telisa side with a thickness of 1,000-1,200 m which develops as a pasiran sediment and is an oily area (TalangAkar, Pendopo, Benakat). The limestone IUP area in the Pusar area of PT Semen Baturaja (Persero) Tbk covering an area of ± 103.5 hectares, is located in the West Baturaja District of OganKomering Ulu District, South Sumatra Province. The topography of the limestone mining area in the Pusar area is marked by Karst topography which has an average height of 45 meters above sea level. Navel mining is limited by the land of the population in the Southwest located ± 210 meters from the highway with Azimut 2150 49 ', while from the train station ± 620 meters northwest. The Batukapur mining area is surrounded by the Ogan river, with a distance of ± 320 meters to the mining site. The water level of the Ogan river is 30 m from the sea level. The geological map of the study area is shown in Figure 4.2. The location of the study area included a slope of 0 - 8% in Old Meosin, with a maximum area of more than 300 meters in that area. Geological map of limestone mine in PT. Semen Baturaja (Persero) Tbk can be seen in the Figure2.

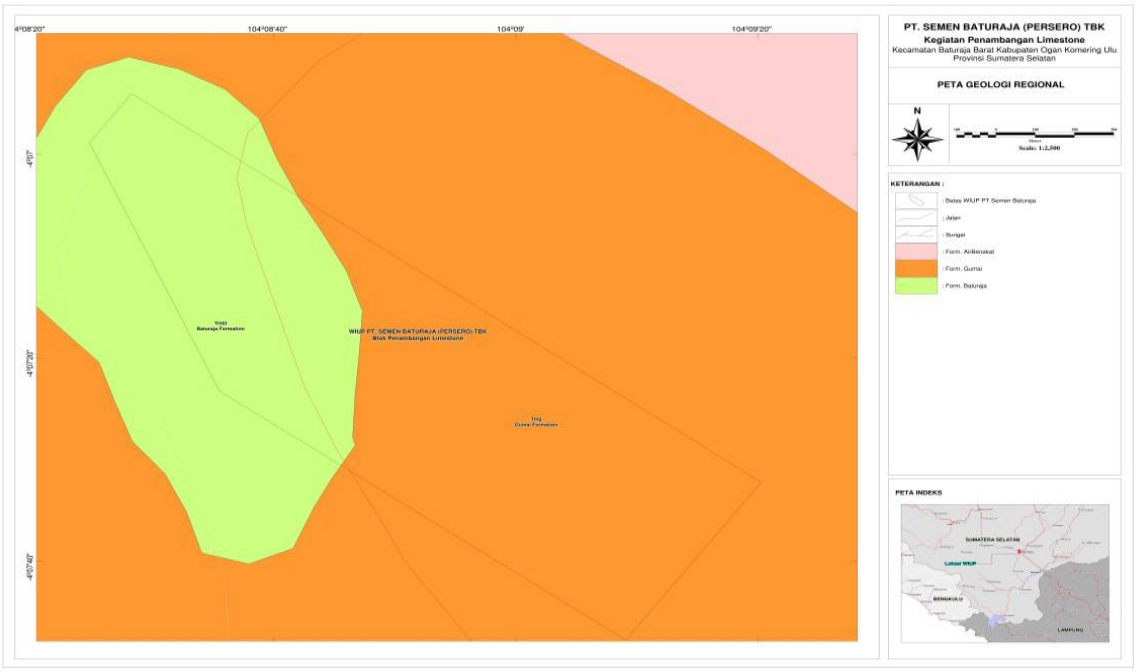

Figure 2. Geological Map of Limestone Mine in PT. Semen Baturaja (Persero) Tbk

3.2.2.3 Topographic conditions

Topographic conditions in the study area are medium wavy plains. Morphology in the study area consists of plain terrain and sloping area.

3.2.3 Vegetation

Vegetation around the study area has various types. Vegetation is divided into natural vegetation and cultivation vegetation. The area of the planned expansion area at the PT. Semen Baturaja (Persero) Tbk in Pusar Village, West Baturaja District, OKU Regency in the form of shrubs, rubber gardens, sengon and mixed gardens. Most of the area that will be used as the location for the development of the coking mine in PT Semen Baturaja (Persero) Tbk is community-owned land, both for rubber plantations and bushes. The vegetation structure of shrubs is also various levels, namely the level of herbs, saplings, poles, and trees. In general, the vegetation at the Navel location with an observation area of 103.4 Ha has the highest diversity value between the vegetation levels is the tree level with a diversity index value of 2.940, then followed by the stake level with a diversity index of 2.441, pole level of 1.930 and herbaceous levels of 1,721.Planting distance on sengon plants planted in the research area between one plant and another measuring 4 x 4 m. 2The natural vegetation found in the research area includes rubber trees. Rubber trees as natural vegetation can be seen in the Figure3.

Figure 3. Rubber Trees as Natural Vegetation

3.3 Post-mining Land Use for Sengon Plantation

Post-mining land in the research location is used to restore land functions as before. The aspects carried out in post-mining land use include mining techniques, post-mining plans, and soil quality testing. Post-mining land use can be done in several ways, one of which is tree planting. Trees planted in the reclamation research area are sengon trees.

3.3.1 Technical of mine

3.3.1.1 Mining Preparations

The first mining activity carried out is land clearing. Activities after clearing land are carrying out construction activities. Supporting facilities from construction that are constructed such as haul roads, limestone processing plants, 'stockpile', limestone loading ports, offices, explosives warehouse settlements, fuel warehouses, and others.

3.3.1.2 Mining Operations

Mining operations consist of land clearing, stripping overburden, followed by mining consisting of excavation, loading and hauling.

1. Land Clearing

Shrub cleaning, making pioneer roads, and making waterways included in land clearing activities.

2. Stripping Overburden

Excavator load digging tools are used in stripping the cover layer. The cover layer that covers the excavated material is topsoil, limestone and soft stone. Land clearing activities in the research area are carried out with bulldozer heavy equipment. The working principle of bulldozers is leveling the land covered with trees and shrubs, making roads, and making drains. Subsequent activities after land clearing activities are stripping activities. The overburden to be peeled can come from limestone or soft rock that covers the excavated material. Mechanical devices planned for stripping top soil are class 30 T excavators and bulldozers. Stripping the overburden used excavators. Stripping Cover Ground Layer Using 30 T Excavator can be seen in Figure 4.

Figure 4. Stripping Cover Ground Layer Using 30 T Excavator

3. Demolition

The demolition method planned by PT Semen Baturaja (Persero) Tbk at the Pusar Village mine site consists of two methods, namely a method without blasting with a surface miner mechanical digging tool and blasting with a mechanical excavator class 30T excavator.

4. Loading

The excavator used was a class 20 T excavator unit to dig and load top soil, 1 class 30 T excavator to dig and load overburden and limestone, and 1 wheel loader unit to collect the delivery material by Surface Miner class 500 Q.

5. Transportation

The transport equipment used is a class 30 T dumptruck. The results of the limestone mining are transported using dumptruck to the crusher. The distance of the mine and crusher is estimated to be between 0.5 km to 1.5 km.

3.3.3 Post-mining plan

Post-mining land use can be done by planting sengon. The sengon trees planted in the study area have a close distance, which is around 4m. Other plants planted in the post-mining reclamation area are fir and guava. The types of plants that are planted cannot be done with sceneries due to adjusting to soil conditions, climate, and so on. Sengon trees in the post-mining reclamation area can be seen in Figure5.

Figure 5. Sengon trees in the post-mining reclamation

3.3.4 Soil quality test

Soil quality tests based on soil sampling in the study area are carried out in the laboratory. The collection of soil samples is carried out in areas that have not been mined around the mine area or the initial hue area and in the reclamation area or embankment area. The collection of soil samples in the study area is carried out individually. The initial hue soil sampling can be seen atFigure6.

Figure 6. The initial hue soil sampling

Soil sampling is also carried out in the post-mining reclamation area. The principle of taking soil samples is also the same as taking initial soil samples. The collection of soil samples is to determine the differences in the content of soil embankments and initial hues. The collection of soil samples must use hand protectors that limit the touch between skin and soil so that contamination of the soil does not occur. Sampling of embankment soil can be seen in Figure7.

Figure 7. Sampling of embankment soil

Soil samples that have been taken in the study area will then be tested for the quality of the soil samples. Testing of soil samples is carried out in the Environmental Biotechnology laboratory of PT. Indonesian Biotechnology Biodiversity. Soil test results for embankment and initial hue soil indicate differences in soil quality. The results of the soil quality test are in accordance with procedures and have met the quality standards set by the government. Soil test results can be seen in the Table 1.

Table 1. Soil TestResults

No	Parameter		Method	Unit	Identification Number	
					Landfill	Early Soil Land
					1810.03981	1810.03982
1.	C-Organic		Walkley & Black / Gravimetri	%	0.72	9.29
2.	N-Total		Kjeldahl	%	0.14	0.45
3.	C/N Ratio		Calculation	-	5	21
4.	P_2O_5Available		Bray / Olsen	ppm	7	16
5.	P_2O_5 Potential		HCl 25%	mg/100g	40	116
6.	K_2O Potential		HCl 25%	mg/100g	30	51
	Cations can be	K^+	*N* NH_4OAc		0.56	0.62
		Na^+			0.15	0.18
		Ca^{++}			17.10	33.94

7.	exchanged	Mg^{++}		cmol(+)/kg	0.82	1.86
8.	Acidity Exchangeable	Al-dd	*N* KCl	cmol(+)/kg	21.57	0.21
		H-dd			2.14	0.22
9.	Cation Exchange Capacity		*N* NH_4OAc	cmol(+)/kg	49.84	52.61
10.	Base saturation		Calculation	%	37.37	69.58
11.	Water Content		Gravimetri	%	10.7	8.9
12.	pH	H_2O	Potensiometri	-	6.2	5.2
		N KCl			4.5	3.6
13.	Texture of 3 fractions	Sand	Pipette	%	41	-*
		Dust			18	-*
		Clay			42	-*

3.3.5 Technicalstudy on the use of the batukapur mine post-mining land for sengon plantation

Changes in soil quality physically and chemically can occur along with the development of limestone mining activities. The collection of soil samples in the study area includes taking samples of embankment and initial soil. The pH level on the sample results showed a difference, where the pH level of the embankment soil was 4.5-6.2, while the pH level of the soil in the baseline soil was 3.6-5.2. The content of soil elements such as C-Organic, N-Total and so on is still below the maximum permissible level. The test results of the soil samples show that the physical and chemical properties are still in accordance with the land quality standard set by the government.

The soil pH tested showed an increase in alkaline properties in the soil, where there was an increase from pH 3.6-5.2 to pH 4.5-6.2. The level of base saturation in embankment soil is 37.37, while in the baseline soil is 69.58. Some plants that have been tested on the previous landfill are sengon, cypress, and guava plants. Activities planned to be carried out on landfill are planting sengon seeds. Planting sengon seeds can provide benefits in the future.

IV. Conclussion

1. The initial hue includes geophysical and geochemical components consisting of climate, geological conditions, and vegetation that have met the requirements in relation to the use of sengon plants.Some of the things obtained from the research include:
   a. Planting distance on sengon plants planted in the research area between one plant andanother measuring 4 x 4 m.
   b. Most of the area that will be used as the location for the development of the coking mine in PT Semen Baturaja (Persero) Tbk is community-owned land, both for rubber plantations and bushes.
   c. In general, the vegetation at the Navel location with an observation area of 103.4 Ha has the highest diversity value between the vegetation levels is the tree level with a diversity index value of 2.940, then followed by the stake level with a diversity index of 2.441, pole level amounting to 1,930 and herbaceous levels of 1,721.
2. Soil quality in the study area is suitable for planting sengon plant seeds. The soil pH quality for initial soil is 5.2 for H_2O and 3.6 for NKCL. The pH quality of soil for landfill is 6.2 for H_2O and 4.5 for NKCL. This shows the change in soil pH becomes alkaline.

ACKNOWLEDGMENT

The author want say thank you to the management of PT Semen BaturajaTbk for the opportunity given to the author to conduct a research survey on the location of the Batukapur mining business permit PT Semen BaturajaTbk.

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Our decision is to: Accept Submission

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Indonesian Journal of Environmental Management and Sustainability

THE USAGE OF MINING VOID IN LIMESTONE MINING FOR MICRO HIDRO POWER PLAN IN PT. SEMEN BATURAJA (PERSERO) TBK

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ABSTRACT
Pt. Semen Baturaja TBK Persero is one of the state-owned companies engaged in the cement industry, since 1974 located in West Baturaja, OganKomering Ulu, South Sumatra Province. PT Semen Baturaja utilizes limestone as the main raw material in making cement by applying surface mining and blasting methods. every end of the mining activity must implement reclamation. one of the post mining activity plans by PT Semen BaturajaTbk is to utilize voids as a micro hydro power plant. One of the parameters that must be met is the quality of water. The results of water sample testing indicate that the water content in the limestone mining area has a suspended solid content of 17-22 mg / L, with the metal content contained in the water still below the water quality standard.With a void area of 53.94 Ha, it is capability to storing of water, void in the area of the former limestone mining at PT Semen Baturaja has the potential as a source of water for micro-hydro power plants
Keyword: reclamation, post mining, voids, micro hydro power plant.

1. PRELIMINARY

Rapid infrastructure development in Indonesia needs to be supported by the availability of adequate raw materials, one of them are cement. PT Semen Baturaja (Persero) Tbk is a cement producer that contributes in supplying national cement needs. The main raw material in making cement is limestone. PT Semen Baturaja (Persero) Tbk to meet the need for limestone to carry out limestone mining activities located in Pusar Village, West Baturaja, OganKomering Ulu. Production Operation Mining Permit (Production Operation IUP) of PT Semen Baturaja (Persero) Tbk for limestone mining is Number: 01 / K / IUP-II.A3 / XXVII / 2010 with an area of 103.4 Ha on March 23, 2010.

Mining commodities have non-renewable characteristics, so that the use of mining has a limited period of time, in accordance with its potential reserves. Another feature of mining activitieshas a relatively higher physical and social impact on the environment. Mining activities can lead to environmental degradation problems that originated from the loss of vegetation and topographic changes which are generally followed by the negative impact of decreasing the ability of water infiltration and erosion, will lead to degradation of soil fertility and hydro logical systems. Topographic changes caused by mining activities are the emergence of mine voids.problems that arise as a result of mining activities are the emergence of diseases caused by mining waste that are not handled properly, there is a decline in environmental quality. [1][2]

The final environmental that is usually caused by limestone mining is in the form of ex-mining land and also mine pit (void). Void can be grouped into three parts, there are (a) existing void, is a void found in the mining area during the mine's operation; (b) residuals void, are voids that occur during mine closure; and (c) the final void, is a void formed after the end of all mining production operations in the end of the mine's operational life. [3]

The mine excavation pit at the end of mining will become a reservoir area for runoff and rainwater because the topography tends to be lower with compacted soil structure. Stagnant land will gradually become a new artificial water reservoir. [4]

One of the important issues for the government and the mining industry in Western Australia is the void formed after the mine or at mine closure. voids in the long term have the potential to cause environmental impacts. Some of the previous studies on the use of post mining include the use of post coal mining land at PT Adaro Indonesia for freshwater aquaculture, water tourism, drinking water; PT Kaltim Prima Coal and PT Bukit Asam for tourism, aquaculture. Theseresearchhave studied the utilization of voids, but there has been no research on the use of limestone void as a micro-hydro power plant. [3][5]

Reclamation activity is an activity to organize, restore, and improve the environtment so that it can fuction according to its usage. [6]

2. EXPERIMENTAL SECTION

This research was carried out on 27 August to 23 October 2018 in the limestone mining at PT Semen Baturaja located in West Baturaja, OganKomering Ulu, South Sumatra. The methods used include: literature study, data collection, data processing, data analysis and conclusions

2.1. Study of Literature

At this stage researchers are looking for literature sources related to the subject matter of limestone mining and utilization of voids as microhydro power plants. The literature in question includes journals, books, and institutional documents.

2.2 Data Retrieval

Collecting data activities begin with field observations. Field observations were carried out to find out the actual conditions. Data retrieval activities consist of:

1. Primary Data: the primary data in this study is the samples of water and soil samples at the limestone mining. Water samples were obtained from the limestone mine inlet and the outlet of a mine drainage channel. The soil used as the sample test is top soil in the area of wild vegetation where there is no disturbance in mining activities. Questionnaires were also made to residents of the surrounding area.
2. Secondary Data: Secondary data obtained from observation at PT. Semen Baturaja (Persero) Tbk. are as follows: initial environmental condition, ultimate pit limit map, mining final condition map, rainfall data.

2.3 Prosessing Data

Primary data and secondary data that have been obtained in the form of water quality samples are tested to determine the content of mine water. Ultimate map, final environmental conditional map, rainfall data is processed to determine the volume of voids of the post limestone mining. The sample results of the questionnaire for residents around the mining area were processed as data that represented the overall population.

2.4 Data Analysis

Data analysis was carried out by analyzing the results of mine water quality testing on water quality standards set by the Governor of South Sumatra. Questionnaire data is used as a reference for public opinion on the plan to use voids as a micro-hydro power plant.

3. RESULT AND DISSCUSSION

3.1 Research Location

The area of Production Operation PT Semen Baturaja IUP is located in West Baturaja, OganKomering Ulu, South Sumatra. PT Semen Baturaja has an area of Production Operation IUP covering an area of 103.4 Ha. The IUP area has bumpy geomorphology to the highlands. Morphological conditions in the Batukapur Mining area of PT Semen Baturaja can be seen in (figure 1)

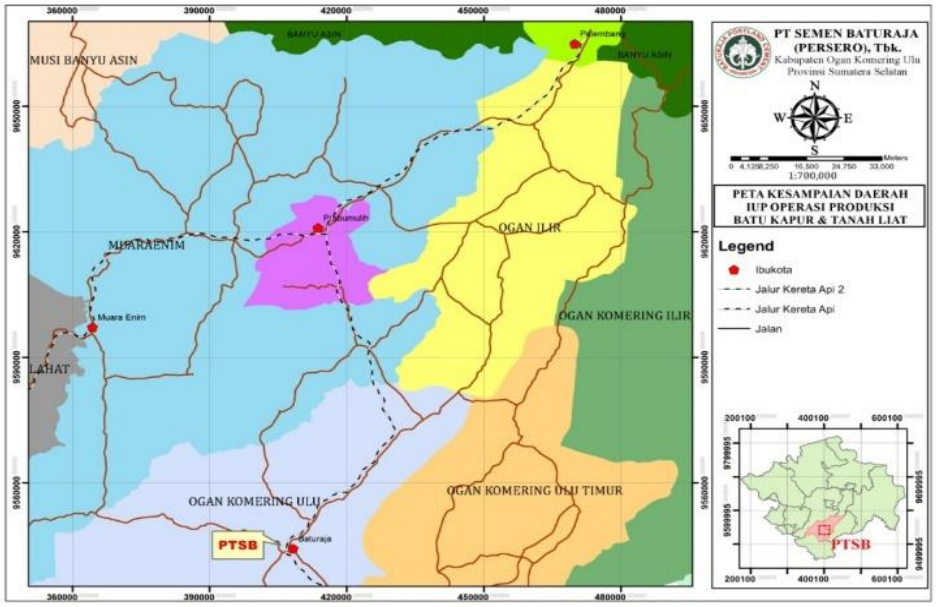

Figure 1 Research Location Map

The research location is in West BaturajaOganKomering Ulu, South Sumatera. The location can be reached by using roadtrough Palembang-Prabumulih-Baturaja Provincial Road with a distance of ± 200 km from Palembang City.

3.2 Initial Environment Condition

Limestone mining area at PT. Semen Baturaja (Persero), Tbk has a hilly topography with a height varying from 40 meters to 60 meters above sea level (masl). The topography of the mining area in the Pusar area is characterized by Karst topography with an average height of 45 meters above sea level. The PT Semen Baturaja Mining Business Area is limited by the population area to the west and east. North of the mining area, the Kemene River flows, the sub of Ogan River that has an elevation of 42 meters above sea level. The Ogan River flows to the south with an elevation of 37 meters above sea level.

Based on data from the Feasibility Study document, the research area is located on the Palembang sheet geological map. In Palembang sheet, there are stratigraphic units of Telisayang rock and Palembang group, both of which are formed in tertiary times. The Telisayang group is formed in the phase of sea inundation, while the Palembang group is formed in the phase of sea shrinkage.

Based on drilling data and surface geological observations, rock types in the study area are included in the Baturaja Formation which is a carbonate deposit composed of carbonate limestone and limestone and marl-coated calcarenite. The top of the formation is hanging out with the Gumai Formation. The geological structure that develops in the study area is a rising fault.

The research area based on descriptive morphology division has four morphological units, there are:

1. Low Corrugated Morphology Unit
2. 2. The Wavy Corrugated Morphology Unit

3. High Corrugated Morphology Unit
4. The Unit of Steep Hill Morphology

Research locations are generally inclu and meteorology in the study area were obtained ch is vulnerable to data collection over the past te 3.1. Based on the data obtained shows that the a The largest number of rainy days occurred in Dec The least rainfall data in August is 61.3 mm and nths occur from October to April, dry months occu hs.

Figure 2 Taking Water Sample in Inlet (S t S : 04°07’37,7” ; E : 104°09’16,6”)

In the study area tested the surface udes taking at the mine water inlet and outlet, sho ined become parameters of the feasibility of mine d the mining area. Feasibility is based on water quality standards that have been determined by the decision of Governor Ordinance od South Sumatera number 8 of 2012 concerning Liquid Waste Quality Standards for Industrial Activities, Hotel, Hospital, Domestic and Coal Mining.

The hilly topography conditions make the type of vegetation found in the form of dry land vegetation. Based on the results of the field survey, the type of vegetation found in the area around the research in Batukapur mining PT. Semen Baturaja is a shrub and plantation crop in the form of rubber plants. Vegetation of Batukapur mining area of PT Semen Baturaja as shown in Figure 3.

Figure 3 Vegetation condition in Mining area at PT Semen Baturaja

3.3 Mining Plan

3.3.1 Technical Mining

The number of mined reserves in limestone is 35 million tons, with estimated mined reserves in the first five years being 16,560,647 tons or 7,200,281 BCM, with overburden amounting to ± 3,999,695 BCM.

Based on the investigation, batukapur deposits are found in the Gumai Formation and Baturaja Formation with a depth of 25 meters. Based on the characteristics of the overburden and limestone layer, the mining applied is an open pit mine using the open pit method. PT Semen Baturaja Flow Chart activity can be seen in Figure 4.

Mining activities in an effort to utilize limestone non-renewable natural resources are carried out by open-pit mining with quarry mining systems such as in England mining. The activities planned for mining operations at PT Semen Baturaja include:[7]

1. Land Clearing

Land Cleansing Activities aim to open mining sites from vegetation that covers the land so that it is possible to carry out further activities. The work tool used is a bulldozer.

2. Stripping Overburden

The overburden stripping activity is carried out by taking the top soil, peeling rocks that cover the commodity material. Topsoil are dug and stockpiled into the bank top soil for further distribution to reclamation activities. The planned mechanical devices are

a. 1 unit of class 20 T excavator for top soil and 1 unit of class 30 T excavator for overburden
b. 1 bulldozer unit to push the topsoil material.

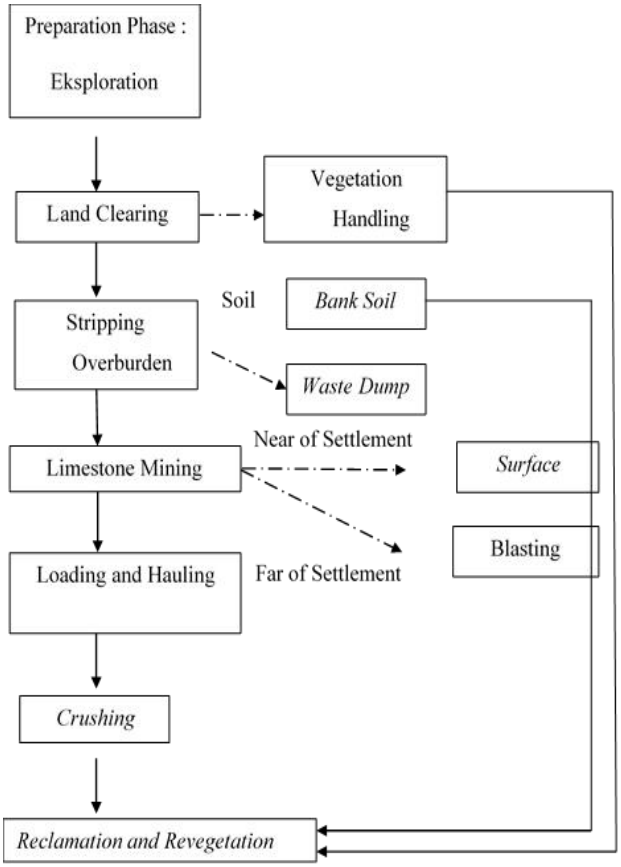

Figure 4 Flowchart of Mining Activity at PT Semen Baturaja

3. Disassembly

Mining activities at PT Semen Baturaja carried out two methods of dismantling, namely the method of unloading without blasting and the method of dismantling with blasting, shown in figure 5 and figure6.

The mechanical tools used in the unloading method are class 500 surface miners and 30 T excavators. The class miner T 500 has a cutting tool on the bottom of the machine that functions as a crockery which then fragments the material to be loaded by a 30 T excavator into the hauling machine.

Figure 5 Blasting Activity in Limestone Mining at PT Semen Baturaja

Figure 6 Surface Mining Activity

4. Loading and Hauling

Loading and transporting activities include loading of limestone into crushing plan and topsoil to be stored in bank soil to be used again in reclamation activities. The excavator and conveyor planned for limestone mining are:

a. 1 unit excavator class 20T for top soil materialb. 1 unit excavator class 30T to dig overburden and limestone

c. dump truck class 30T for transporting the limestone to the crusher or ROM

3.3.2 USAGE MINING VOID FOR MICRO HIDRO POWER PLAN

Surface water at the end of the limestone mining activities at PT Semen Baturaja will be arranged based on the water flow pattern and the final morphological conditions of the mine.

The quality of surface water will change both physically and chemically during the development of limestone quarrying.

Water sampling at the research location includes water at the inlet and outlet, with the results of testing in the lab, can be seen in table 1. The results of testing the samples in the inlet water samples showed results similar to the water outlet samples, both in physical properties, chemical content both inorganic and organic chemistry. The pH level of both samples is 6.07, where the allowed pH threshold is 6-9.

Metal content in samples such as iron, mercury, sulphide, copper and other metals is still below the maximum permissible level. Based on the results of the permit value, it can be noted that the quality of mine water in the limestone mining of PT Semen Baturaja has met the water quality standard, both in physical and chemical properties.

The water quality classification is divided into four classes, covering the first to fourth grades. The results of the comparison of water quality sample data inthe PT Limestone Baturaja limestone mine with water quality classification standards, it is known that water samples taken from the limestone mine inlet and outlet are second class water. Water with second class quality criteria has the use of water as a means of water recreation, freshwater fish cultivation, livestock, water to irrigate landscaping, and or other uses that require the same water quality as these uses. [8]

The results of testing water samples show that the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) exceed the threshold of the first class standard. High levels of biochemical oxygen (BOD) and chemical oxygen (COD) indirectly indicate water pollution caused by domestic waste, agricultural waste or mining waste. [9]

The test results of water samples sulphide in the inlet and outlet of the water quality standard second-class show different results. The sulphide content in the inlet water sample is less than 0.03 mg / L, far exceeding the second class sulphide threshold of 0.002 mg / L. Testing of water samples at the outlet was not found in sulphides.

Plans for inundation of mining void can be seen in (Figure 7). With a void area of 53.94 Ha, it is capable of storing water as much as m3, void in the area of the former coking stone at PT Semen Baturaja has the potential as a source of water for micro-hydro power plant

Table 1 Result of Water Analysis

	Parameter	**Unit**	**Maximum Allowed Rate[10]**	**Result**		**Examination Method**
				Inlet	**Outlet**	
	A. PHISIC					
1	Temperature	℃	38	25,4	26,8	SNI 06-6989.23-2005
2	Solid Dispension	mg/L	2000	31	20	Direct Reading
3	Solid Suspension	mg/L	200	22,0	17	Direct Reading
	B. Anorganic Chemical					
1	pH	#	6-9	6,07	6,07	SNI 06-6989.11-2004
2	Iron (Fe)	mg/L	5	0,12	0,08	SNI 6989.4-2009
3	Mangan (Mn)	mg/L	2	0,05	0,05	SNI 6989.5-

						2009
4	Barium (Ba)	mg/L	2		0,001	0,001	SNI 06-6989.16-2004
5	Copper (Cu)	mg/L	2		<0,003	<0,003	SNI 6989.6-2009
6	Zinc (Zn)	mg/L	5		0,03	0,001	SNI 6989.7-2009
7	Chrom total (Cr)		0,5		<0,018	<0,018	SNI 06-6989.17-2004
8	Cadmium (Cd)	mg/L	0,05		<0,0015	<0,0015	SNI 6989.16-2009
9	Mercury (Hg)	mg/L	0,002		<0,0001	<0,0001	AAS-MVU
10	Lead (Pb)	mg/L	0,1		<0,003	<0,003	SNI 6989.8-2009
11	Arsene (As)	mg/L	0,1		<0,0009	<0,0009	AAS-HVG
12	Selenium (Se)	mg/L	0,05		<0,0012	<0,0012	AAS-HVG
13	Sianida (CN)	mg/L	0,02		0,004	0,002	Spektofotometri
14	Cobalt (Co)	mg/L	0,4		0,00	0,00	SNI 6989.68-2009
15	Flourida (F)	mg/L	2		0,25	0,17	SNI 06-6989.29-2004
16	Ammonia (NH_3-N)	mg/L	1	0,33	0,32	SNI 06-2479-1991	
17	Nitrat, as N (NO_3)	mg/L	20	2,92	2,90	SNI 06-2480.1991	
18	Nitrit, as N (NO_2)	mg/L	1	0,180	0,174	SNI 06-6989.9-2004	
19	Needed Biochemical Oxigen (BOD_5)	mg/L	50	2,62	2,51	SNI 06-2503-1991	
20	Needed Chemical Oxigen (COD)	mg/L	100	19	15	SNI 6989.2-2009	
21	Disolved Oxygen (DO)	mg/L	-	2,07	2,01	SNI 06-6989.14-2004	
22	Sulfide (H_2S)	mg/L	0,05	<0,03	0,00	SNI 698970-2009	
	C. Organic Chemical						
1	Oil and Fat	mg/L	5	0,19	0,13	SNI-06-6989.10-2004	
2	Fenol	mg/L	0,05	0,00	0,00	SNI 06-6989.21-2004	

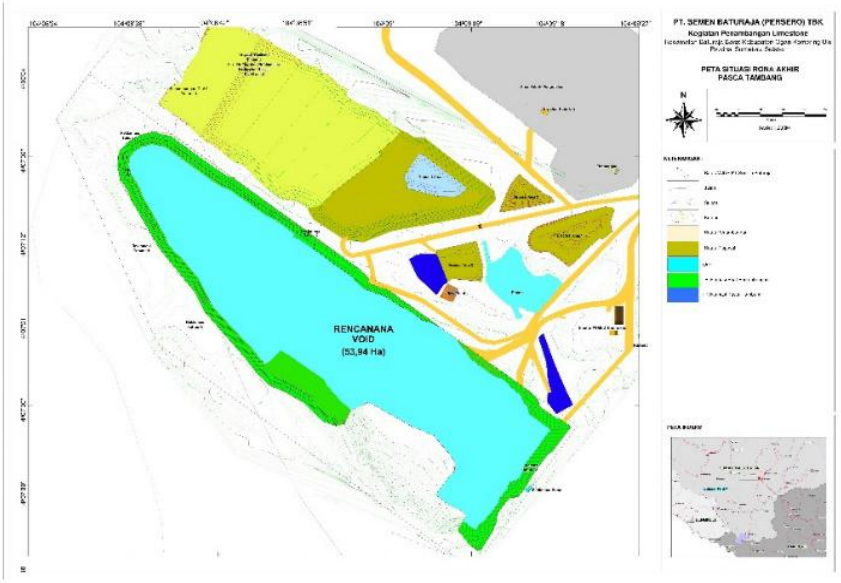

Figure 7. Final Condition Environmental Map of Limestone Mining in PT Semen Baturaja TBK

4. CONCLUTION

Conclusions that can be expressed from the explanation of previous chapters are as follows:

1. Characteristics of the initial hue in limestone mining in West Baturaja , OganKomering Ulu has a tropical climate, with susceptible monthly rainfall between 4 mm to 715 mm. The dominant vegetation encountered was scrub.
2. The results of testing water samples in the limestone mine of PT Semen Baturaja TBK taken from two locations, inlet and outlet, water samples are still in a safe zone from the maximum limit that has been determined, both from physical and chemical properties. Void that will be formed at the end of mining has an area of 53.94 hectares has the potential as a water reservoir. Based from these two variables, limestone mining voids at PT Semen Baturaja (Persero) have the potential as micro-hydro power plants.

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[9]Juniah, Restu, and Rahmi, Hisni. 2017. The Influence of Sand Mining toward the Sustainability of Power Support and Capacity of Lambidaro River. AIP Conference Proceedings 1903, 040015 (2017): American Institute of Physics
[10] South Sumatra Government. 2012. Governor Regulation no. 8 of 2012 Concern Liquid Waste Quality Standards For Industrial Activities, Hotels, Hospitals, Domestic and Coal Mining. Palembang

KEGIATAN PENELITIAN

Rapat Tim Riset Hibah Kompetitif Unsri 2018

Diskusi Tim Riset Hibah Kompetitif Unsri

Rapat Tim Riset Hibah Kompetitif Unsri 2018

Tim Riset Hibah Kompetitif Unsri 2018 di PT Semen Baturaja

Diskusi dengan pihak PT Semen Baturaja

Survey di PT Semen Baturaja

Tambang eksisting PT Semen Baturaja

Pabrik PT Semen Baturaja

Kegiatan penambangan batukapur *(surface mining)*

Kegiatan penambangan batukapur *(blasting/* peledakan*)*

Pengambilan sampel air (inlet)

Pengambilan sampel air (outlet)

Pengambilan sampel tanah (Topsoil yang belum diganggu)

Pengambilan sampel tanah (Disposal)

Kegitan kuesioner

kegiatan kuesioner

Menghadiri kegiatan seminar Internasional ICASMI 2018 Lampung sebagai Pemakalah

Seminar Internasional ICASMI 2018 Lampung

Menghadiri kegiatan seminar nasional Avoer X tahun 2018 di Palembang sebagai Peserta

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KEMENTERIAN KESEHATAN RI
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DAN PENGENDALIAN PENYAKIT KELAS I
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Laboratorium Penguji
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SERTIFIKAT HASIL UJI
IR.02.02/VIII.8/३५७ /18

FR. 5.10.1.1
Rev. 02

UMUM

No. Urut	:	786
Laboratorium	:	**KIMIA AIR**
Nama Konsumen	:	PT. Semen Baturaja
Lokasi Sampling	:	Palembang
Jenis Sampel/Baku Mutu	:	Air Limbah/Air Limbah
Kode Sampel	:	Inlet
Diambil/Diterima tanggal	:	*24 September 2018/24 September 2018*
Tgl Pengujian di Lab	:	24 September
Kode Lab	:	3691

HASIL UJI

No	Parameter	Satuan	Kadar maksimum yang di perbolehkan	Hasil	Metode Pemeriksaan
	A. FISIKA				
1	Temperatur* *(diLaboratorium)*	°C	38	25,4	SNI 06-6989.23-2005
2	Zat padat terlarut *(TDS)*	mg/L	2000	31	Direct Reading
3	Zat padat tersuspensi *(TSS)*	mg/L	200	22,0	Direct Reading
	B. KIMIA Anorganik				
1	pH *(diLaboratorium)**	#	6 – 9	6,07	SNI 06-6989.11-2004
2	Besi *(Fe)**	mg/L	5	0,12	SNI 6989.4-2009
3	Mangan *(Mn)**	mg/L	2	0,05	SNI 6989.5-2009
4	Barium *(Ba)*	mg/L	2	0,001	SNI 06-6989.16-2004
5	Tembaga *(Cu)**	mg/L	2	<0,003	SNI 6989.6-2009
6	Seng *(Zn)**	mg/L	5	0,03	SNI 6989.7-2009
7	Krom total *(Cr)*		0,5	<0,018	SNI 06-6989.17-2004
8	Kadmium *(Cd)**	mg/L	0,05	<0,0015	SNI 6989.16-2009
9	Air Raksa *(Hg)*	mg/L	0,002	<0,0001	AAS-MVU
10	Timbal *(Pb)**	mg/L	0,1	<0,003	SNI 6989.8-2009
11	Arsen *(As)*	mg/L	0,1	<0,0009	AAS-HVG
12	Selenium *(Se)*	mg/L	0,05	<0,0012	AAS-HVG
13	Sianida *(CN)*	mg/L	0,02	0,004	Spektrofotometri
14	Kobalt *(Co)*	mg/L	0,4	0,00	SNI 6989.68-2009
15	Flourida *(F)*	mg/L	2	0,25	SNI 06-6989.29-2004
16	Amoniak Bebas *(NH_3-N)*	mg/L	1	0,33	SNI 06-2479-1991
17	Nitrat, Sebagai N *(NO_3)*	mg/L	20	2,92	SNI 06-2480. 1991
18	Nitrit, Sebagai N *(NO_2)**	mg/L	1	0,180	SNI 06-6989.9-2004
19	Kebutuhan Oksigen Biokimia *(BOD_5)*	mg/L	50	2,62	SNI 06-2503-1991
20	Kebutuhan Oksigen Kimia *(COD)*	mg/L	100	19	SNI 6989.2-2009
21	Dissolved Oxygen *(DO)*	mg/L	-	2,07	SNI 06-6989.14-2004
22	Sulfida *(H2S)*	mg/L	0,05	<0,03	SNI 6989.70-2009
	C. KIMIA Organik				
1	Minyak dan Lemak	mg/L	5	0,19	SNI 06-6989.10-2004
2	Fenol	mg/L	0,5	0,00	SNI 06-6989.21-2004

*) : Terkareditasi #) : Tidak ada satuan

Catatan : Baku mutu sesuai yang telah ditetapkan oleh Peraturan Gubernur Sumsel No.8 tahun 2012 Golongan I Baku Mutu Limbah Cair.

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SERTIFIKAT HASIL UJI
IR.02.02/VIII.8/3243/18

FR. 5.10.1.1
Rev. 02

UMUM

No. Urut	:	786
Laboratorium	:	**KIMIA AIR**
Nama Konsumen	:	PT. Semen Baturaja
Lokasi Sampling	:	Palembang
Jenis Sampel/Baku Mutu	:	Air Limbah/Air Limbah
Kode Sampel	:	Outlet
Diambil/Diterima tanggal	:	*24 September 2018/24 September 2018*
Tgl Pengujian di Lab	:	24 September
Kode Lab	:	3692

HASIL UJI

No	Parameter	Satuan	Kadar maksimum yang di perbolehkan	Hasil	Metode Pemeriksaan
	D. FISIKA				
1	Temperatur* *(diLaboratorium)*	°C	38	26,8	SNI 06-6989.23-2005
2	Zat padat terlarut *(TDS)*	mg/L	2000	20	Direct Reading
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	E. KIMIA Anorganik				
1	pH *(diLaboratorium)**	#	6 – 9	6,07	SNI 06-6989.11-2004
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17	Nitrat, Sebagai N *(NO_3)*	mg/L	20	2,90	SNI 06-2480. 1991
18	Nitrit, Sebagai N *(NO_2)**	mg/L	1	0,174	SNI 06-6989.9-2004
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21	Dissolved Oxygen *(DO)*	mg/L	-	2,01	SNI 06-6989.14-2004
22	Sulfida *(H2S)*	mg/L	0,05	0,0	SNI 6989.70-2009
	F. KIMIA Organik				
1	Minyak dan Lemak	mg/L	5	0,13	SNI 06-6989.10-2004
2	Fenol	mg/L	0,5	0,00	SNI 06-6989.21-2004

*) : Terkareditasi #) : Tidak ada satuan

Catatan : Baku mutu sesuai yang telah ditetapkan oleh Peraturan Gubernur Sumsel No.8 tahun 2012 Golongan I Baku Mutu Limbah Cair.

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Ph. 62-251-8423 005 / 8423 003 Fax: 62-251-8423 004
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   1.2. No. Invoice / *Invoice No.* : Inv-445/ICBB/X/2018

2. Pelanggan / *Principal*
   2.1. Nama / *Name* : Dr. Ir. Restu Juniah, MT IPM
   2.2. Alamat / *Address* : Teknik Pertambangan Universitas Sriwijaya

3. Contoh Uji / *Sampel*
   3.1. No. Identifikasi / *Ident. No.* : 1810.03981 Tanah Timbunan
   1810.03982 Tanah Rona Awal

   3.2. Nama / *Sample Name* : Tanah
   3.3. Diterima / *Date of Received* : 01/10/2018
   3.4. Tanggal Uji / *Date of Analysis* : 05/10/2018 s/d 23/10/2018

LABORATORIUM BIOTEKNOLOGI LINGKUNGAN
PT. BIODIVERSITAS BIOTEKNOLOGI INDONESIA
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Kota Bogor 16115 - Jawa Barat - INDONESIA
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4. Hasil Uji / *Result* : No.: ICBB.LHP.X.2018.1383

No.	Parameter		Method	Unit	Identification Number	
					Tanah Timbunan	Tanah Rona Awal
					1810.03981	1810.03982
1.	C-Organik		Walkley & Black / Gravimetri	%	0.72	9.29
2.	N-Total		Kjeldahl	%	0.14	0.45
3.	C/N Ratio		Penghitungan	-	5	21
4.	P_2O_5 Tersedia		Bray / Olsen	ppm	7	16
5.	P_2O_5 Potensial		HCl 25%	mg/100g	40	116
6.	K_2O Potensial		HCl 25%	mg/100g	30	51
7.	Kation Dapat Dipertukarkan	K^+	*N* NH_4OAc	cmol(+)/kg	0.56	0.62
		Na^+			0.15	0.18
		Ca^{++}			17.10	33.94
		Mg^{++}			0.82	1.86
8.	Kemasaman Dapat Tukar	Al-dd	*N* KCl	cmol(+)/kg	21.57	0.21
		H-dd			2.14	0.22
9.	Kapasitas Tukar Kation		*N* NH_4OAc	cmol(+)/kg	49.84	52.61
10.	Kejenuhan Basa		Penghitungan	%	37.37	69.58
11.	Kadar Air		Gravimetri	%	10.7	8.9

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No.	Parameter		Method	Unit	Identification Number	
					Tanah Timbunan	Tanah Rona Awal
					1810.03981	1810.03982
12.	pH	H_2O	Potensiometri	-	6.2	5.2
		N KCl			4.5	3.6
13.	Tekstur 3 Fraksi	Pasir	Pipet	%	41	-*
		Debu			18	-*
		Klei			42	-*

*) Tekstur 3 fraksi tidak dilakukan analisis jika kadar C Organik > 5 %

Bogor, 24 Oktober 2018
Environmental Biotechnology Laboratory
PT Biodiversitas Bioteknologi Indonesia

Salmah Shahab, SP
(*Deputy Laboratory Manager*)