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Date:	Monday, 17 August 2015 3:31:42 PM
Attachments:	Hazelwood-Mine-Fire-Inquiry-17-August.docx Mine-recultivation-RWE-Germany.pdf Neyveli-Sustainability-M-Velan.pdf

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Organisation represented (if applicable): ALP: Combined Traralgon and Morwell Branch

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Hazelwood Mine Fire Inquiry – Mine Rehabilitation

Submission from the

Australian Labor Party Combined Morwell and Traralgon Branches.

13 August 2015

Introduction

We congratulate the Victorian Government and the Board of Inquiry in exploring the rehabilitation of the three Latrobe Valley Open Cuts according to "world best practice" instead of merely providing for future major fire prevention.

The Latrobe Valley Open Cuts are so vast that they cannot be wished away. Rather, they should be considered a unique resource to be developed rather than a liability.

We contend that with foresight and imaginative thinking, ideas can be developed which generate wealth and change the equation of rehabilitation being a cost. We provide a sample of ideas which could be further explored including examples from overseas which demonstrate our contention that these sorts of ideas can be successful.

Overseas Examples. Two industry leaders in mine rehabilitation - RWE Ag, a German energy company, operates several Brown Coal (Lignite) mines and the Neyveli Lignite Corporation Ltd, an Indian government body operates several mines in South India. Their philosophy, policy and procedures are posted on the Internet. (Pg 2 and Appendix)

Adapting the Overseas Examples. The examples could well be adapted for any or all of the three Latrobe Valley mines.

We appreciate that rehabilitation has hardly been touched in the past due to the size, depth and longevity of our open cuts. However starting soon will enable the recoupment of the cost to be spread over a diminishing number of years left in the life of each open cut. Progressive reclamation of the worked out section of the Morwell and Loy Yang Mines will reduce the coal dust hazard in Traralgon.

The wealth generated by the assets created should justify rehabilitation with foresight and imagination.

A sample of ideas for Latrobe

- **Commercial:** agricultural, horticultural, forestry cultivation with trees appropriate for paper manufacture, fisheries in lakes created in the open cuts.

- **Recreational:** mountain bike (Hazelwood batters), motor bike and motor car racing tracks, fisheries, and swimming centre in Traralgon featuring fresh water and artesian water baths which will be a major year-round tourist attraction similar to the artesian baths in Moree, NSW but distant enough not to compete with Moree.

- **Research Linkages: Federation University and Federation TAFE** could become centres of excellence to provide all the sustainable research including alternative uses of brown coal, agriculture, forestry, horticulture, soils and stability of soils and in fact everything relating to the resources of the Gippsland Region. Training will be required for the future workers and for retraining of existing workers in future redundant occupations.

- **Examples from the past: - Successful Adult Re-training**. Adult Returned servicemen whose education was interrupted by World War 2 retrained at Universities and Technical Colleges and successfully led our Nation for years.The former State Electricity Commission of Victoria successfully trained redundant adult employees to become operatives and leaders in Power Stations.

RWE Ag, Germany and Neyveli, India,

Provision is made for agricultural, horticultural, forestry cultivation, return of fauna and flora, re-establishment of lost regional species and recreation. (Seeds saved during the original clearing are regrown).

Top soil which has been saved when initially removed as overburden is returned to the mine but in a careful sequence to ensure adequate drainage and stability in the future.

Continuous research is undertaken in Universities and Institutes and implemented.

The company accepts responsibility for maintaining the productivity of the land for 25 years.

Additional procedures in RWE Ag, Germany provide for plans for the rehabilitation of an open cut to be prepared after consultation with all interested parties and enshrined in law before a new mine is opened.

RWE Ag established **a “**Corporate Responsibility Stakeholder Council**” (**in 2014)

of eight International experts representing a broad range of stakeholder backgrounds “literally opening the company’s doors and allowing the outside world in: making stakeholders part of discussions about the challenges RWE faces, entering into dialogue with them.”

Extracts from the RWE Ag, Germany and Neyveli, India web pages are attached as separate doenloads..

RWE Power

The post-mining landscape

Recultivation in the Rhineland

RWE Power – All the power

RWE Power is Germany's biggest power producer and a leading player in the extraction of energy raw materials. Our core business consists of the low-cost, environmentally sound, safe and reliable generation of electricity and heat as well as fossil fuel extraction.

In our business, we rely on a diversified primary energy mix of lignite and hard coal, nuclear power, gas and renewable sources to produce electricity in the base, intermediate and peak load ranges.

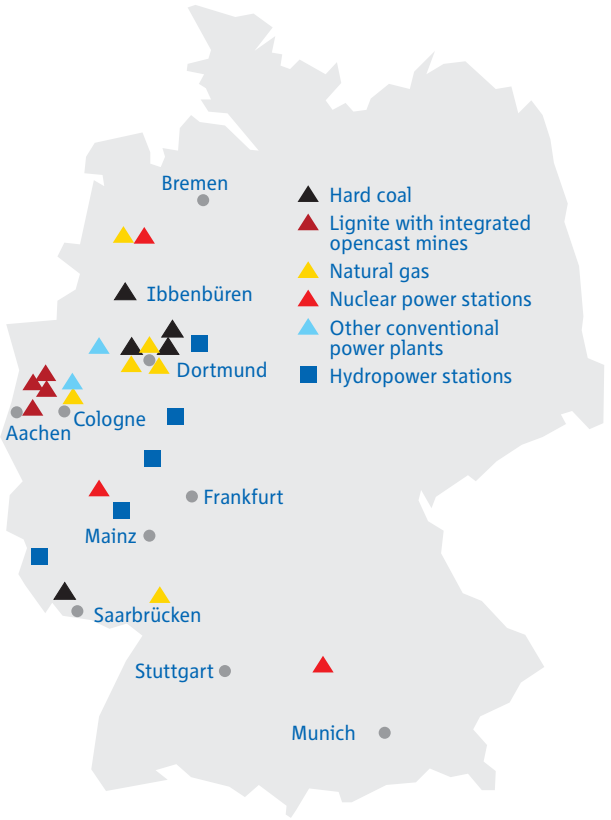
RWE Power operates in a market characterized by fierce competition. Our aim is to remain a leading national power producer and to expand our international position, making a crucial contribution toward shaping future energy supplies.

A strategy with this focus, underpinned by efficient cost management, is the basis of our success. All the same, we never lose sight of one important aspect of our corporate philosophy: environmental protection. At RWE Power, a responsible use of nature and its resources is more than mere lip service.

Our healthy financial base, plus the competent and committed support of some 18,000 employees working under the umbrella of RWE Power, enable us to systematically exploit the opportunities offered by a liberalized energy market.

In this respect, our business activities are embedded in a corporate culture that is marked by team spirit and by internal and external transparency.

The bundling of all generating activities at RWE Power has made us no. 1 in Germany, with a 30 per cent share in electricity generation, and no. 3 in Europe, with a 9 per cent share. That is what we are working for – with all our power.

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Opencast mining and cultivated landscapes

Lignite can only be extracted by opencast mining, so that interference in densely-populated cultivated landscapes is correspondingly deep.

The opencast lignite mines are located in a what has always been a heavily used cultivated landscape. It is the catchment area of the cities of Cologne, Aachen, Mönchengladbach and Düsseldorf and, hence, a region with a relatively dense population. Traffic development and urbanization have significantly moulded every aspect of the structure of this space that used to be a rural area. What is more, the soil is among the best found in Germany, so that the land is mostly used for farming purposes.

It is this cultivated landscape that the opencast mines invade: wherever overburden is removed and lignite mined, landscape is a thing of the past – for the time being. It is the loose layers of soil in the Rhineland that make impossible the underground mining that is pursued, say, in the mines of the near-by Ruhr region. Rhenish lignite must be extracted by opencast methods.

However, this interference is merely temporary, and the basic features of a post-mining landscape are defined already during the approval procedure for an opencast mine. This is when concrete planning for the new landscape commences. As soon as the first sections of a lignite seam have been stripped, restoration of farmland, forests and other surfaces starts: recultivation.

Taking stock

Worldwide, Rhenish recultivation is deemed exemplary not just among experts – and it is steadily further developed.

A lease covering the Roddergrube mine near Brühl dating from 1766 demonstrates that, even then, former mining areas had to be replanted. Since then, the recultivation of opencast mining surfaces has been inseparably linked with lignite extraction. The methods used in recultivation schemes have evolved steadily up a long learning curve. Down the decades, they have been adjusted to meet changing objectives and include new scientific findings. Today, the results obtained are deemed exemplary worldwide, not just among experts.

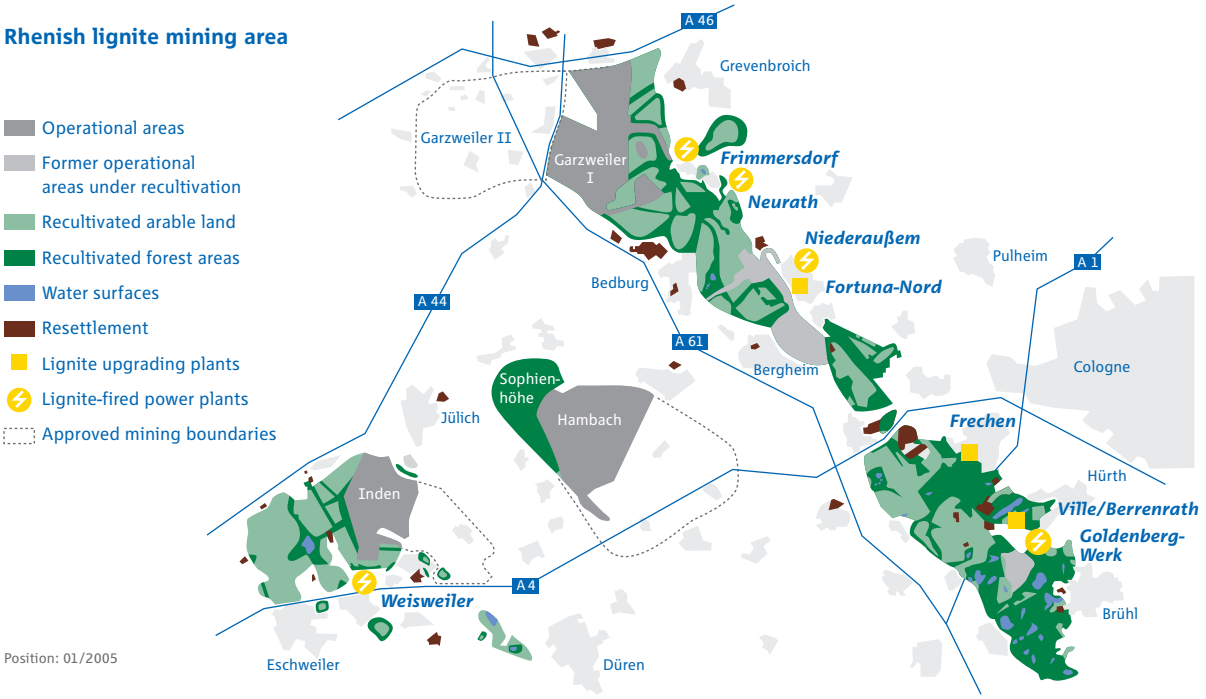
The learning is ongoing. Scientific studies by university institutes accompany the recultivation schemes to benefit the work on the new landscape. At Jüchen, RWE Power has set up a research unit for recultivation. It serves scientists as a port of call, offering a library and laboratory for their studies (www.forschungsstellerekultivierung.de).

International specialists have attended two recultivation congresses so far at the invitation of RWE Power to exchange news and views.

High-quality recultivation is important because the lignite industry depends on good neighbourly relations with the people in the region. But it is also indispensable because the new landscape must offer a substitute and an offset, not only temporarily, but on a sustainable long-term basis – as living and economic space for many generations to come.

Rhenish opencast mines have used about 290 square kilometres of land so far. Of this, some 200 square kilometres have been rehabilitated, including a good 103 square kilometres of arable land, 77 square kilometres of forests, and 20 square kilometres of water and other surfaces.

Rhenish lignite mining area



Position: 01/2005

Recultivation starts before opencast mining operations

Early on, public-law approval procedures create the framework for the later design of the landscape.

How RWE Power has to design the land after an opencast mine has gone is always decided by public-law procedures. With the first regional planning approval for an opencast mine, a decision is already made on the look and feel of the new landscape. This includes initial stipulations on the breakdown of the surfaces into agricultural, forestry, settlement or other uses.

In the course of further operational planning procedures, these stipulations are concretised, section by section and in near real-time, until the time of execution. In these procedures, farmers, foresters, environmentalists, traffic planners, business sponsors and many others express their interests. Here, conflicts are pre-programmed. All representatives of public concerns usually stand up for their justified interests and have their own ideas on later use options: new arable land is needed for farmers and their families and, hence, for their livelihoods; municipalities wish to have new industrial estates to provide an economic impetus, i.e. jobs and tax income. New forests, open fields and lakes are welcome recreation areas.

The experts from public authorities, associations, scholarship and mining sector are agreed on the basics: recultivation cannot be an attempt to copy nature. Humans can only provide start-up aid, creating the best possible preconditions for a landscape that can be used on a sustainable basis. And the compromises to be reached are no stop-gap solutions: it is not the separation of uses, but their networking that will reconcile the concerns of economy and ecology in the long term.

Operating bases

The loess soil so abundant in the Rhineland is one of the success factors for recultivation. It is treated with corresponding care.

The soil needed for recultivation purposes is provided by the opencast mine itself: stackers start by dumping clay, sand and gravel in the depleted extraction site and then top this with a drainage layer of permeable material. Embankments and hollows in the terrain are designed as close to nature as possible, meaning: as unevenly as provided by nature herself.

Where planning calls for reforestation, we spread a mixture of loess loam and gravel as topmost soil layer, so-called forest gravel. While this material is so loose that tree roots can penetrate the soil deep enough, it is also so loamy that it can store sufficient water for the drier seasons of the year. Land recultivated using forest gravel is no longer levelled today. This is to avoid compaction and, hence, stagnant moisture and erosion, and to exploit the micro-climatic advantages of rough surfaces and small hollows.

Where new farmland is envisaged, the stackers spread pure loess and loess loam. The same is true of surfaces that are to be reforested in plains. After a certain settling time, this layer must be at least two metres thick. In a next step, the loess is levelled, but in a soil-sparing fashion. Water surfaces and alternately humid locations, too, are included in the recultivation effort. The final voids of older opencast mines are lakes today and, due to the lack of material expected after lignite-mining has ceased, planning also calls for large bodies of water to be provided in the final voids of today's opencast mines.

Agricultural recultivation

After a seven-year preparation phase, the new agricultural land and fields pass into the hands of farmers.

Loess on its own does not make for fully arable soil. That takes humus, a valuable store of nutrients and micro-organisms that plants need to grow. Also, the soil's functions have to be reinstated first. For this purpose, the new fields are initially farmed by RWE Power itself. In the first few years, agriculturalists working for the Company grow pioneering plants like alfalfa that deeply root the soil and enrich it with nitrogen. The aim here is not good harvests, but biological activation of the soil. Later, grain and other field crops are grown, plants that can be cultivated and harvested in a soil-sparing manner. RWE Power experts deploy tractors and farming equipment with wide tyres and use special ploughing methods in order not to compact the sensitive young soil too much. Soil protection now plays a growing role in rehabilitation efforts.

In agricultural recultivation, ecological issues, too, matter. Local recreation and conservation have gained in importance. Field shoulders, hedges, groves and other special areas are designed to loosen up and enrich the new landscape. Weeds left to their own devices can sprout on partial areas, offering small animals on open fields food and shelter. In this way, nature returns to the new living space even during recultivation.

After a preparatory effort lasting at least seven years, the new agricultural land is passed on to the farmers who originally made their land available elsewhere for mining purposes. Often, they farm the land out of new hamlets located on the recultivated open fields.

Despite favourable conditions, the farmers have to add higher amounts of fertilizer to build up more humus, especially in the first few years of cultivation. For that, they receive a financial offset during intermediate cultivation.

To back the long-term security of the affected farmers, RWE Power assumes liability for the sold recultivated surfaces for a period of 10 years, i.e. going beyond the statutory minimum term, for defects like troughs, moist and compacted areas, or rocks. For another eight years, RWE Power is responsible for removing any troughs that occur at a later date. If we add the seven-year intermediate cultivation period, the Company warrants the good quality of the soil for a total of 25 years.

Forest recultivation

Less is more: RWE Power implements the principle of close-to-nature forest management. An opencast mine leaves more forest behind than was there before.

For many purposes, timber is a good construction material and, on top of that, a renewable raw material. So, in every respect, this is a product with interesting commercial prospects for which the foresters at RWE Power must create optimal starting conditions during reforestation already. But they work with more than the economic aspects in mind. In fact, their aim is to lay the foundations for forest communities that suit their location and are thus ecologically stable. Because less is often more when it comes to planning and caring for such new woods, the foresters follow the principle of close-to-nature forest management – as do their public colleagues.

Today's planting programme in forest recultivation comprises numerous tree and shrub species. Deciduous trees have priority over coniferous woods, because it is they that have dominated the natural vegetation in the Lower Rhine Basin since time immemorial. But there is no complete lack of conifers. In places, they liven up the landscape, and offer shelter in winter to the deer that soon immigrate here.

Every year, RWE's foresters and woodsmen plant several hundred thousand copses on the dump sites: mainly common oaks and red beech, but also small-leaf linden and wild fruit trees. They obtain the young plants from nurseries. At the same time, they harvest tree seeds from the old tree population in the area due to be mined in order to retain the genetic potential of the old native woods. In the young stock, enough gaps are left for naturally immigrating tree types like the birch.

For the opencast mines Garzweiler, Hambach and Inden, an extra 1,900 hectares and more of woodland have been defined in all. This means that, by the middle of the century, the opencast mines operating today will leave behind 19 square kilometres more woodland than was there before.

Even now, the record of the region's forest management is a balanced one: a good 7,300 hectares of wood had to make way for the opencast mines, and more than 7,300 hectares have been re-planted.

Ecology

Though man-made, several recultivated areas are nature reserves. Flora and fauna threatened by extinction have made them their home.

The creation of water surfaces is a must in recultivation. Over 700 hectares of lakes, ponds and wetlands have emerged by now in all sections of the mining area. They not only enhance the recreational value of the new landscape for people, but also offer a home to the animal kingdom. At many sites, the bird world boasts more biodiversity than in the period before mining operations intervened.

Protection of endangered species is the object of the programme: with expertise and much love of detail, RWE's specialists devote themselves to the nitty-gritty of ecology alongside their tasks in forestry: hanging up nesting boxes for cave breeders and bats, installing perches for birds of prey in the fledgling forest population, introducing toad and frog spawn from the pre-mining areas into the new biotopes. Even entire ant colonies are resettled to the recultivated landscape.

Still, the crucial work is done by nature herself. From the word go, flora and fauna develop a living community and evolve slowly, but steadily and naturally. In the course of time, locational factors will change, and the composition of the species will adapt accordingly. In many young and, hence, thin recultivated areas, for example, ornithologists observe the wheatear, a ground breeder that is on the list of endangered species. This species is then ousted as the forest grows. By contrast, the likewise endangered lesser spotted woodpecker and grey-headed woodpecker live in older forest stocks. A similar succession can be observed in the plant world. Both evolutions share one feature: they are natural processes. What matters is that recultivation provides the basis for a healthy, ecologically sustainable and stable process in such a succession. That it is capable of doing so is demonstrated by the many older recultivated areas in the mining region.

There, only those in the know will spot that these areas were created by man. Several sections measuring over 300 hectares in all are already nature reserves – although they were once man-made. Many endangered animal and plant species have settled on the recultivated land: among others, 13 native orchid species. Not least, the acclaim of people in the region proves how much they appreciate the new landscape: many recultivated areas are destinations for outings.

Examples

At many spots in the Rhenish mining area, recultivated land extends an invitation to seek recreation and experience nature. RWE Power provides hiking maps.

The age of a recultivated landscape and, hence, of the trees growing there, is not what matters either for humans or for flora and fauna. Early on, strollers and cyclists, ramblers and sportspeople use the recultivated land for leisure purposes. They visit even the youngest areas of the 200-metre-high Sophienhöhe hill on the edge of the Hambach opencast mine. A network of hiking trails nearly 100 kilometres in length extends an invitation to ramble in a peaceful setting; a hiking map is available from RWE Power by phoning +49/221/480-22010. From viewpoints like Jülicher Kopf and Steinstrasser Wall, it is possible, on a clear day, to see all the way to Cologne, the Rureifel hills and the German-Dutch border.

Near Eschweiler, right in the middle of the agriculturally recultivated former opencast mine Zukunft-West, lies Blausteinsee lake measuring some 100 hectares. Although it is not yet finally filled with well water, it has been used for all kinds of water sports for years now.

A few kilometres distant is the Inden opencast mine: in the summer of 2005, it will cut through today's bed of the Inde river along a 5-kilometre front. The river will then be diverted to a new 12-kilometre-long bed located in the recultivated land of the opencast mine. There, it can freely meander amidst a wide, largely wooded low-lying area before returning to its old, regulated bed near Kirchberg.

The medieval small town of Alt-Kaster, a district in Bedburg with many listed buildings, used to be surrounded on three sides by an opencast mine. Today, it is located in the middle of an extensive recultivated area which is marked by the Mühlenerft river and Kasterer See lake. A lake is also the highlight in the new, open landscape of the former Frechen opencast mine.

The recultivated land of the former Fortuna-Garsdorf opencast mine is situated along the "Energy Route", which was set up by Rhein-Erft county and RWE Power. The landscaped lake Peringsmaar and the Wiedenfelder Höhe heights are two stops on this stretch for cycling or motoring tourists, starting at RWE Power's information centre Schloss Paffendorf. Touring maps are available there: phone +49/221/480-22010.

Further to the south is the forest/lake district which, all the way into the 1970s, had still been one of the focuses of Rhenish lignite mining. This lake district forms part of the Kottenforst-Ville nature reserve and offers ample space for water sports, rambling and cycle tours – a local recreation area par excellence right on the doorstep of the major cities Cologne and Bonn. Hiking maps are obtainable from the book trade and from RWE Power.

Outlook

Even if much progress has demonstrably been made and success scored down the decades, recultivation remains, in every respect, a learning process.

The experts at RWE Power are open in all directions: findings, whether from our own work, from research carried out at universities or from experience exchanged at the specialized congresses staged by RWE Power, find their way into the daily work of the two technical departments in charge, and help to further develop our recultivation efforts. Nothing is so good that it cannot be improved.

Research in recultivation pursues three objectives: one aim is to document the evolution of new landscapes and show where help and support are called for. The second is to check ecological efficacy. For example, one study has found that today's customary practice of dumping without levelling in forestry areas encourages later biodiversity and promotes the growth of important tree types. The third object of research is to supply ideas for improving recultivation work, e.g., the settlement and propagation of native shrubs and trees: today, RWE Power grows plants from the seeds of old forests for the new land, thus maintaining genetic variety, one element in biodiversity.

Recultivation remains a learning process for all those involved. The greater the in-depth input from knowledgeable participants, the better the results will be. The goal remains ambitious: to reintegrate the landscape consumed by mining operations into the surrounding cultivated space in a way that ensures versatility of use and high ecological quality, while leaving open all options for generations to come.

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Environmental Sustainability and Cleaner Perspectives - A Challenging Experience from Lignite Mining Industry in India

M. Velan

Abstract: Mining of lignite causes pollution of Environment and ecological damage if unattended. Being conscious that environmental regeneration is the foundation on which Productivity has to be built, N.L.C. started investing on Eco Care long back and it continues. Early investment in Environment protection has resulted in steady growth. N.L.C.'s futuristic vision is to be in the vanguard among the contributors to the community, environment and the Nation by developing and utilizing industrial and human resources to the optimum. Untiring efforts are being put in Mines (NLC as a whole) to maintain and sustain the ecological balance arising due to the continuous mining activity. The Neyveli's Environmental Management System is becoming a symbolic role model for any of the opencast mines in the South-East Asia.

Keywords- Lignite, mining, Sustainability, Environmental, protection.

I. INTRODUCTION

Mining is an important industry for economic development but operation of the mines may harm surrounding environment as well as to the population. The lignite deposits in South India were found extensively in late 1930's while drilling for irrigation purposes. The estimated reserve of lignite as on 31.03.12 is about 42 billion tonnes, of which 80 % was in the southern State of Tamil Nadu. India is one of the top ten brown coal producers in the world. Geological Survey of India (GSI) proved the lignite resources in Neyveli in 1943. In 1956, Govt. of India formed Neyveli Lignite Corporation Limited for commercial exploitation of lignite. Now NLC is a 'Navratna' company functioning under the control of Ministry of Coal. . It has now become a major Energy source of supplying Power to the Southern States. Its core business is lignite mining and Thermal Power generation.

NLC operates three highly mechanised opencast Lignite Mines (28.5 Million Tonnes per Annum) at Neyveli and one Lignite Mine (2.1 Million Tonnes per Annum) at Barsingsar, Rajasthan with a total capacity of **30.6 MTPA**. Three Thermal Power Stations (2490 Mega Watt) at Neyveli and one Thermal Power plant in Barsingsar, Rajasthan (250 Mega Watt) with a total capacity of **2740 MW** which would shortly increase to 3240MW.with the addition of 500 MW in Thermal Power Station-II Expansion. The unique feature of NLC is steady growth with excellent track record of not only producing lignite mining and power generation but also protecting the environment and maintaining ecological balance. Keeping mining operations environmentally safe and clean from the start is more cost-effective.

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Instead of cleaning up and restoration of ecosystem destruction or human health effects, NLC investment into sustainable practices which saved money in the long role.

Lignite Mining Operations at Neyveli

The salient features of open cast lignite mines and linked power generation of NLC which are in operation is given below Table 1:

Table 1 - The salient features of open cast lignite mines

Particulars	TAMILNADU				RAJASTHAN
	Unit	Mine – I	Mine - IA	Mine II & Expn.	BARSINGSAR
Mining Area	Sq. Km.	27.0	12	41.22	3.89
Capacity / Annum	MT	10.5	3.0	15	2.1
Lignite Reserve	MT	429	120	595.69	53
OB Thickness	Mts.	45 to 110	55 to 110	45 to 103	44 to 118
Lignite Thickness	Mts.	8 to 26	6 to 24	8 to 22	15 to 25
Average Stripping Ratio	Tons: M^3	1: 5.5	1: 7.0	1: 5.5	1: 4.81
Mining Started on	Date	20.05.1957	30.07.2001	14.04.1981	07.08.2006
Lignite First Exposed	Date	24.08.1961	24.03.2003	30.09.1984	21.05.2007
Overburden Excavated*	MM^3	1631.53	210.57	1332.29	55.60
Lignite Mined *	MT	298.92	26.91	212.41	1.471
Linked Power Station	Name	TPS-I(600 MW) & TPS–I Expn. (2 X 210 MW)	ST-CMS (Pvt.) (250 MW)	TPS – II (7 X 210) TPS –II Expn. (2 x 250) MW	Barsingsar Thermal Power Station (2x125 MW)
Generation Capacity	MW	1020	250	1970	250

As on 1st April 2012
Total Lignite Production Capacity: 30.6 MT
Total Power Generation Capacity: 3240** MW

Age of Lignite – 25 Million years

** including TPS-II Expansion & excluding ST-CMS

II. ENVIRONMENT IMPACT OF MINING OPERATIONS

Lignite mining at Neyveli is carried out by open cast mining techniques with high mechanization for excavation, transportation and disposal. Lignite is covered by overburden consisting of different types of clay and hard abrasive Cuddalore sand stone. The thickness of the overburden is from 55 to 100 metres. The overburden is removed by specialized mining equipments such as bucket wheel excavators, conveyors, tripper cars & spreaders etc., Mining operation is a continuous process and the overburden soil removed is filled in the de-coaled area. The average thickness of the lignite is about 10 to 20 metres. Neyveli being an artesian area, the aquifer exerts an upward thrust of around 8 kgm/sq.cm. For successful mining of lignite, depressurization of aquifer is essential. Large scale pumping is continuously done to avert heaving of the mine floor and consequent flooding of mine pit. Strip mining eliminates existing vegetation destroys the genetic soil profile, displaces or destroys wildlife and habitant, alters current land uses, and to some extent permanently changes the general topography for the area mined.

The removal of vegetative cover, stockpiling overburden, hauling of soil and lignite increase the quantity of dust around mining operations. Dust, vibration and diesel exhaust odors are created (affecting sight, sound, and smell). Soil removal from the area to be surface-mined attesters or destroys many natural soil characteristic, and reduces its biodiversity and productivity for agricultural. Soil erosion and wash-off from the spoil heap formed from the soil excavated and dumped at dumping sites affects drainage and water bodies. Pumping of ground water may affect the water level in nearby wells and underground aquifer.

Surface mining of coal causes direct and indirect damage to wildlife. Pit and spoil areas are not capable of providing food and cover for most species of wildlife. Mobile wildlife species like game animals, birds, and predators leave these areas. Invertebrates, reptiles, and small mammals may be destroyed. The community of microorganisms and nutrient-cycling processes arre upset by movement, storage, and redistribution of soil. Many wildlife of species are dependent on vegetation growing in natural drainage areas. The vegetation provides essential food, nesting sites and cover from predators.

In the open cast mines like the one at Neyveli the presence of the above factors are considerable. The magnitude of environmental effect by mining could be imagined, if all the potential lignite in the area were to be tapped, then about 480 sq.kms. will have to be covered by excavation and nearly 25% of this area will be additionally required for spoil banks. Confronted with multi-various pollutants as indicated above the environment management demands much more greater efforts than while dealing with a single pollutant factor or two.

The problem in Neyveli mine is compounded with the factor that blasting is done for loosening the soil to relieve pressure, from the abrasive Cuddalore sand stone, off bucket Wheel Excavators. The overburden removal is carried out in 4 benches at different levels and each system has BWE, mobile transfer conveyor, conveyor system, tripper – spreader combination. The environmental management in mining at Neyveli is done in the following areas with great alacrity and result orientation. A view of operation of Lignite mine is given in Figure 1.

Figure 1 : view of lignite mine in operation

Environmental Management

To combat the above impacts, NLC has taken appropriate control measures. The details are given below :

Dust Suppression

The NLC has adopted continuous mining operation with SME such as BWE, conveyor, Tripper cars, spreaders etc. All are electrically operated equipments and hence during operation the dust emission in this system is comparatively low.

The major dust emanating sources are due to movement of crawler equipments like dozer, pipe layer, mobile cranes and transport vehicles plying through the haul roads.

Methods adopted for reducing generation and dispersal of dust are:

Minimizing dust at the critical generating points: excavation is done by using sharp teeth of BWE and timely changing of the teeth; a system of teeth changing is instituted as a part of maintenance schedule.

Using sharp drill bits for blast hole drilling.

Spraying water on roads and outside surfaces through mobile tankers or sprinklers for quenching dust.

To the extent possible, providing dust free roads within the mine area for movement of trucks and conventional mining equipments.

Providing protective respirators and masks to the operators, who are working in dusty areas.

Studies conducted hitherto reveal that the dust concentration is within threshold limit.

The lignite stacks in the bunker is being made wet with permanent sprinkler arrangements and water spraying, In addition to that special spraying systems are installed in the conveyors transporting the lignite.

The lignite handling systems in the Power Stations are having arrangements to contain the dust by effective sprinkling and spraying arrangements. Automatic Dust Suppression system have been installed in all the Thermal Power Stations covering the Dust emanating areas including Bunkers, Grinding Mills, etc.. Emission Control: Electrostatic Precipitators (ESPs) of more than 99% efficiency have been installed in all the three power stations of NLC to remove the ash particles from the outgoing flue gas. The stack heights are also as per the prescribed norms for effective disposal of other gases like SO_x and NO_x at wider range. To monitor the pollution in the stack emission, Online SPM and gas analyzers are installed. Apart from this, periodical survey by the State Pollution Control Board is also being carried out and so far, no abnormalities were reported. Dust suppression on haul roads by water spraying from water lorries is seen in Figure 2.

Figure 2 - Dust suppression on haul roads by water spraying from water lorries

Ground Vibration

Blasting operation creates disturbances in the terra-firma and is likely to transmit vibrations to the buildings closeby. However, as the soil is wet and the high overburden dumps is on the mine periphery, the effect of vibration in the township is not so keenly felt. Regular checks and monitoring are done to minimize the vibration by controlled blasting using the latest electronic detonators.

Noise and Vibration Control

The noise level is generally kept reduced below the permissible level by adopting certain remedial measures. Noise created by the machineries are muffed with silencers to modulate noise to tolerable level.Providing thick tree belt around the periphery of mine to screen the noise.

Reducing the exposure time of workmen in higher noise level working area.Checking of noise level in the machineries periodically i.e., once in the month to ensure that the noise level is in the threshold limit value of 85 db for a continuous period of 8 hrs. working. In the case of blasting, the effect of the shock / vibration is controlled at the mine surface level itself by adopting the use of milli second delay action detonators and milli second detonating relays. There is therefore, no danger of vibration being carried on to the nearer structures / Buildings.

Balancing of Water Table

NLC is pumping ground water from the deep confined aquifer for safe lignite mining. The pumping is regulated on the scientific pattern and the drawal of water is as per the restriction laid down by Ministry of Environment and Forests, Government of India. While NLC is restricting drawal of ground water, it has no control over the industrial and agricultural requirement of the surrounding mostly in the hands of private people.Even for the pumping from NLC mines and to safeguard the water balance in the region, it has taken many proactive steps so that with the growth of NLC's operation in Neyveli region, the balance in ground water is largely maintained.

Land Reclamation

Excavation of soil for the purpose of extracting lignite are a pre-requisite for mining operation. NLC is acquiring land for its mining activities in a phased manner from the adjacent villages by paying suitable compensation as per Government rules and norms. The Neyveli Lignite Mines at Neyveli is using Specialized Mining Equipments and in the process of mining lignite several hectares of land is disturbed every year. Even at the Project formulation stage, NLC has planned for refilling and reclamation of mined out area. The concept of reclamation is given due importance in NLC even at a time when the environmental awareness in Indian Mining sector was at a primitive stage. The soil excavated is backfilled in dumps and slope is stabilized by Conventional Mining Equipments.

The back filled areas with sterile soil are reclaimed by adopting different methods. The land is reclaimed for agricultural, horticulture crops and development of forestry, pasture land etc. N.L.C. has undertaken various collaborative projects with Ministry of Coal (S&T) in co-ordination with Annamalai University, Central Fuel Research Institute, Dhanbad, Tamil Nadu Agricultural University, Coimbatore and Madras University, Chennai, etc. So far, a total area of about 2104 ha. of land is reclaimed for agricultural, horticulture crops and a total area of 1926 ha. was afforested in all the three mines. An orchard has been developed in an area of 100 ha. by planting different varieties of fruit trees and also herbal cultivation is undertaken in the reclaimed area to cater to the needs of the Ayurvedic dispensary of NLC and also public. The yield from this land is as good as the produce from natural and normal agricultural lands. The reclamation statistics of mines is given in Table 2.

Table 2 - Reclamation statistics of mines

Unit	Mine-I	Mine-IA	Mine-II
Mine area	2700 ha.	1091 ha	4416.61 ha.
Mined out area	1864.6 ha.	321.4 ha	1878.45 ha.
Out side dump area	478.14 ha.	Over the existing Mine-I dump	1601.52 ha.
Area reclaimed	1420 ha.	171.1 ha.	460.5ha.
Area afforested	1342.0 ha.	126.17 ha.	402.0 ha.
No. of trees planted	70,28,336	72,472	10,18,000
Other activities			
(a) Water body	15.0 ha	4.04 ha	55 ha
(b) Crop cultivation	16.0 ha	8.0 ha	8.0 ha
(C) fruit bearing trees	5.0 ha	4.04 ha	50 ha

Integrated Farming Systems (IFS)

Integrated Farming System an innovative concept has been adopted in reclaiming the mine spoil areas. The sustainable integration of different agriculturally related enterprises such as grain crops, commercial crops, vegetables, flowers, medicinal plants, fodder crops, fruit trees, etc., with animal components such as cattle, birds, goats, aquaculture, etc., bio-gas generation, azolla and mushroom cultivation, provides ways to recycle products and by-products of onecomponent serves as input to another linked component and reduce the cost of production. Further this farming system approach helps to sustain crop productivity in mine spoil with increased profitability and employment generation. Cattle rearing through Integrated farming System

Slope Stabilisation

The external over dumps created during the initial opening of the Mines cuts are causing a lot of environmental problems. In order to fulfill social obligations, that the huge quantities of mines spoil dumped over a large area should be converted into vegetative one making it fit for habitation, a Project namely **SLOPE STABILISATION** of the Mines Over Burden dumps has been undertaken with the collaboration of Tamil Nadu Agricultural University, Coimbatore, South India. These dumps were terraced to different Benches with proper drainage facilities and irrigation facilities and suitable species are identified for plantations in the slopes in order to have soil compatibility and also for green belt. In order to have proper moisture on the slopes, drip irrigation system has been deployed and the slopes are being stabilized. N.L.C. on its own has taken up efforts to stabilize newly created slope in Mine-I A using, used coir mats and other local retaining materials (Figures 3 & 4).

Figure 3 - Slope Stabilisation

Figure 4 - Paddy Field in the Reclaimed Area

Water management

Ground Water

To depressurise the deep aquifer below Lignite field, a certain quantity of ground water is to be pumped out and is diverted to the Thermal Power Plant Lakes for Industrial use. For safe mining operation, ground water is pumped out continuously round the clock through bore wells located at predetermined points. Over the years, through continuous study and implementation of new methods, the quantity of water pumped out has been reduced considerably. The water level is continuously monitored through observation wells for proper ground water management.

Storm Water

Major portion of the storm water, collected in sumps is due to rain and seepage from the Mines. This storm water is collected in sedimentation sumps and the part of the clear water from Mine-I is pumped to a modern Water Treatment Plant and treated water is supplied for domestic purpose to the Township. Similar treatment plant of 15000 GPM is under construction to treat the storm water from Mine-II, for utilization in the Thermal Power Station-II Expansion (2 x 250 MW) and for Thermal Power Station-II. Ground water pumping is avoided and the ground water is conserved. Further, the clear storm water from Mines is supplied to surrounding villages for agricultural activities. This in a great way reduces the ground water pumping, avoids wastage of water into the ground and conserves the ground water.

Green Belt Development, Plantation and Nursery in Township and industrial Units

N.L.C. is maintaining thick and massive green belt in its Industrial Units and Township. Township is maintaining greenery by planting trees like Neem, Eucalyptus, etc. including fruit bearing trees like mango, jack fruit, etc. Besides this, the circumferential areas of Township have been developed with. Eucalyptus, acacia and cashew plantations, to maintain ecological balance. Green Belt development have been taken up and completed in the left out areas of Power Plants. Since the available areas within the Plants have been covered fully, additional plantations are being taken up in the vacant areas in Township.

Horticulture

There are four Nurseries maintained in the Township by N.L.C. Horticulture Department for raising saplings of fruit bearing trees, flowering trees and shrubs. Herbal gardens are developed in all the three Mines to an extent of one acre in each Mine. Nurseries to develop various plants and herbal plantation have been created in all the three Mines. Around 18.9 million trees have been planted in and around Neyveli Township and Production Units which helps in maintaining clean environment, dust suppression, noise control, lowering the atmospheric temperature and maintaining ecological balance

III. ENVIRONMENTAL MONITORING SYSTEM

Ambient Air Quality Monitoring

Adopting the Central Pollution Control Board (CPCB) guidelines, N.L.C. has installed 13 permanent Ambient Air Quality (AAQ) Stations in and around the Industrial Units, Residential Colony and peripheral areas of Neyveli, (Figure 7) and is continuously monitoring the pollutants like SPM, SO_x and NO_x for 24 hours on alternate days throughout the year. AAQ measured values are compared with CPCB standards and its found to be well within the limits. The monitored results of the Ambient Air Quality monitored at thirteen locations is given **in Annexure-1**. The location of the Ambient air Quality monitoring station is given below. The Ambient Air Quality in and around Neyveli for the period 2011-12 is given in Table 3..

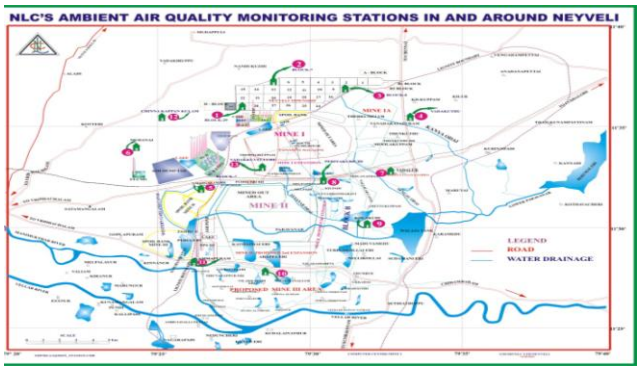

Figure 7 – NLC's Ambient air quality monitoring stations in and around Neyveli

Table 3 - Ambient Air Quality in and around Neyveli for the period 2011-12

Sl. No	Location	SO_2 µg/nm^3	NOx µg/nm^3	PM10 µg/nm^3
1	Block-29	0.86	13.96	40.39
2	Block-6	0.86	13.70	39.03
3	Block-8	0.83	13.58	40.90
4	Vadakkuthu	1.12	13.70	42.27
5	Umangalam	0.75	13.76	40.89
6	Mudhanai	0.58	13.64	43.19
7	Vadalur	0.74	13.98	44.08
8	Periyakurichi	0.68	13.98	48.86
9	Kulakkudi	2.74	17.45	37.69
10	Sathapadi	3.44	18.38	38.40
11	Kammapuram	4.24	19.11	48.49
12	Chinnakappankulam	4.11	19.88	47.22
13	Vaddakkuvellur	4.50	19.85	41.62
	Threshold limit in PPM	100	80	80
	Average	1.96	15.77	42.54

Tamil Nadu Pollution Control Board, the Statutory Authority is also monitoring regularly every year the AAQ and the measured values are well within the norms prescribed. In addition, work place air quality monitoring is also conducted at three locations inside the mines and the results are given in **Annexure-II** which are also within permissible limits. Repairable dust monitoring is made in occupational areas for periodical assessment. The results of the respirable dust monitoring are given in Annexure-III

which is also within the permissible limits. Keeping pace with the developments in air quality monitoring, On no on line Continuous Monitoring Ambient Air Quality Station with all modern facilities is introduced and results are displayed at 5 prominent locations in the Neyveli Township for the benefit of the Public (Table 4 & 5).

Table 4 - Workplace Air Quality in monitoring inside the mines for the year 2011-2012

YEAR	Location	PM_{10}	SO_2	NOx
2011-12	New Shift Office	72-92.5	0.1 – 1.5	11.9- 35
	Control Tower	63-92	0.1 - 13	11.1-37.2
	Administrative Office	63-73	0.2 - 15	14.8-35
Threshold limit in PPM		100	80	80

Table 5 - Respirable dust monitoring inside mines for the period 2011-12

Sl. No.	Location	Dust concentration (mg/nm^3)			
		Aug-06	Apr-09	Jan-10	Feb-11
1	Bunker Stacker	0.27	0.15	0.45	0.24
2	Lignite Bench _BWE 1571	0.21	0.10	0.27	0.21
3	Surface bench – BHD – IR 18	0.76	0.12	0.70	0.43
4	Surface Bench-New Spreader-1	0.47	0.23	0.33	0.36
5	Surface bench BWE 1421	0.35	0.12	0.23	0.42
6	Top bench – New BWE MAN 1	0.44	0.30	0.32	0.32
7	Top bench – New Spreader II	0.32	0.21	0.34	0.42
8	Road side – Opposite to SS	0.54	0.20	0.25	0.12
9	BHD yard road side	0.47	0.13	0.42	0.27

The threshold limit of Respirable dust concentration 3 mg/nm^3

Effluent Monitoring

Effluent discharges from the mines are periodically (monthly) collected and analysed to assess the effluent quality to meet the Standards prescribed by State Pollution Control Board.

Water Monitoring

The underground water is also monitored by taking samples from the dug wells in and around Neyveli and tested every quarter.A number of observatory wells are also drilled around Neyveli Region for monitoring purposes.A number of check dams at Mines spoil bank, Township and nearby villages have been constructed for effective harvesting and recharging of rainwater.

Meteorological Monitoring

Wind speed, direction, rainfall, humidity, temperature, etc. are monitored daily throughout the year. One number automatic weather station is installed by India Meteorological Department (MD) which is functioning continuously logging meteorological parameters.

Corporate Social Responsibility

NLC is one of the public sector undertakings that has begun to address CSR concerns since inception. However, Govt of India came out with guidelines on the CSR in the year 2010; As per the guidelines profit making companies have to allocate not less than 1% of Profit After Tax in the annual budget towards Corporate Social responsibility. The CSR umbrella in NLC covers the entire gamut of community development – rehabilitation (Figure 10 & 11), relief, women empowerment, philanthropy. The annual budget allocation and expenditure is given in Table 8.

Figure 10 - Tricycle given to physically disabled person

Figure 11 - CMD, NLC issuing

Vocational Training Certificate to PAP

Table 8 - CSR Funds Allocation and Expenditure

Year	Profit After tax (PAT) in the previous year (Rs. In Crores)	Budget allocation for CSR (Rs. In Crores)	Expenditure on CSR (Rs. In Crores)	
			Actual	%
2010-11	1247.46	12.48	13.23	106.01
2011-12	1298.33	13.00	14.09	108.38
2012-13	1411.33	16.00	2.81 upto Aug' 12	

The company which has set bench marks towards Social Sustainabilty has provided Reliable source of Power for over 5 decades to the southern States. Its Profits grown from Rs.566.78 to Rs.1247.46 crores in the last 4 yrs.(129%)

IV. CONCLUSION

Mining of lignite causes pollution of Environment and ecological damage if unattended. Being conscious that environmental regeneration is the foundation on which Productivity has to be built, N.L.C. started investing on Eco

Care long back and it continues. Early investment in Environment protection has resulted in steady growth. N.L.C.'s futuristic vision is to be in the vanguard among the contributors to the community, environment and the Nation by developing and utilizing industrial and human resources to the optimum. Untiring efforts are being put in Mines (NLC as a whole) to maintain and sustain the ecological balance arising due to the continuous mining activity. The Neyveli's Environmental Management System is becoming a symbolic role model for any of the opencast mines in the South-East Asia.