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Ground Water Management in Neyveli Lignite Mines for Safe Mining Operations

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Abstract:
Opencast Mining of Sedimentary deposits involve removal of huge amount of Overburden for reaching the deposit. This may cause disturbance of the underlying confined aquifers resulting in release of stored water with high pressure in the working area. This makes mining difficult and unsafe due to inrush of water in the working pit. Similar type of problems are faced by mines at Neyveli area. Mining of lignite from NLCIL's mines in Neyveli area is faced with a unique hydrological problem due to the presence of confined aquifers below lignite seam exerting an upward pressure, if not controlled; it could jeopardize the entire mining operations. The hydro-geological investigation and pumping tests conducted in this field proved that most practical–cum-economic solution to this problem is depressurization of confined aquifer and maintaining the pressure head constantly below the lignite seam (initial technique) or just above lignite seam (positive head- improvised technique) by large scale continuous pumping operation from the series of large diameter pump well located /situated at hydrologically pre-planned /calculated distances from the active excavation zone. Therefore, the depressurization of this aquifer is being done to maintain the pressure head constantly at the lignite bottom through pumping operations from strategically located pumping wells in the lignite mines/ close to excavation zone. The pressure surface is controlled through adequate number of large diameter pumping wells (Drilling dia :36 inches/Casing dia 20inches) with capacity of 1000 & 500 gallon per minute. Effective control of Ground water pressure is achieved by shifting the location of drilling/pumping wells at lignite bund closer to lignite excavation area and overcoming earlier problems of high groundwater pressure resulting in available lignite not been extracted fully. Groundwater and Storm Water aspects have been improvised over a period of time to suit the lignite mining operations. The groundwater pumped out from the mines is being used in Thermal Power Stations for power generation and the surplus water is supplied for community use in after proper treatment. In order to pump out water from the aquifers, proper planning of pumping locations and proper methods are to be analysed in order to make the working area suitable for excavation. This article presents a detailed analysis of various methods adopted for ground water control and management in Mines for safe and optimum mining process and also to check the efficiency for ground water control in mines.

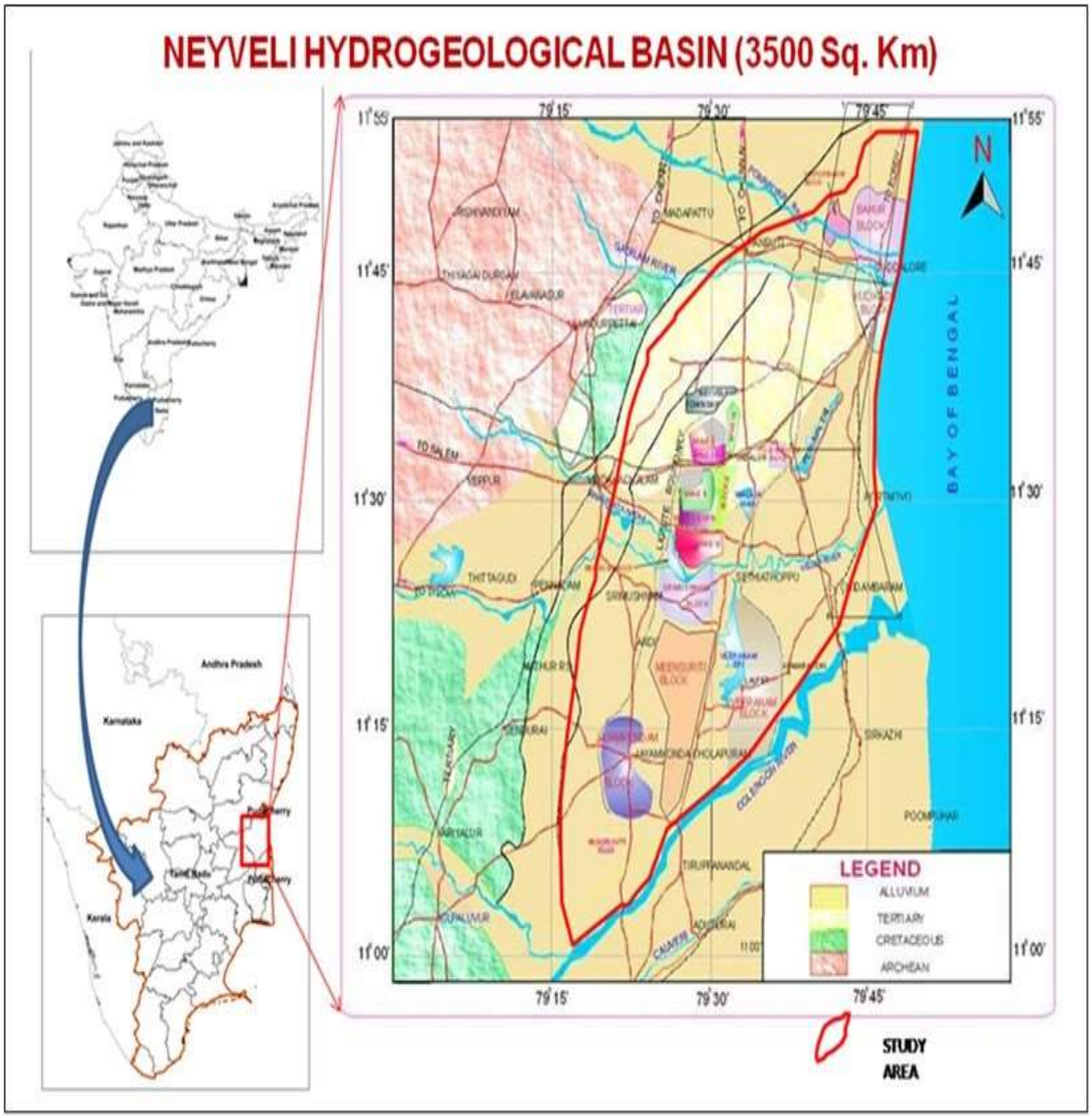
Introduction

Opencast Mining of Sedimentary deposits involve removal of huge amount of Overburden for reaching the deposit. This may cause disturbance of the underlying confined aquifers resulting in release of stored water with high pressure in the working area. This makes mining difficult and unsafe due to inrush of water in the working pit. Similar type of problems are faced by mines at Neyveli area. The hydrogeological basin of Neyveli (Fig. 1) is famous for its lignite deposits. Discovery and development of large lignite

deposits around Neyveli stands Asia's biggest lignite mining centre giving it place of pride on the energy map of India.[2]

NLCIL operates three opencast lignite mines, Viz., Mine-I, Mine-IA, and Mine-II in Neyveli area with a combined lignite production capacity of 28.0 million tons per annum (MTPA) and pit-head thermal power stations with an aggregate capacity of 3390 megawatts (MW) at Neyveli, Cuddalore District, TN. For better environmental care, the monitoring and management of Neyveli Hydro-geological basin is prime for sustainable lignite development in this region. The Neyveli hydro-geological basin, covering an area of 3500 sq km, is a multi-layered aquifer system comprising four aquifer systems. Out of four aquifer systems, two exist above and the remaining two exists below the lignite formation. The aquifer occurring above lignite is semi confined and unconfined whereas the aquifer lying below lignite is called upper and lower confined aquifers. The above said powerful aquifer system of the Neyveli hydro- geological basin is being managed by judicial pumping to achieve safe mining operation without exceeding the MoEF permissible limit of pumping, i.e., around 149.70 MCM. At present NLCIL is pumping of ground water around 12.85 MCM which is less than the MoEF prescribed limit. The entire amount of water pumped out from the mines is being used for Thermal Power Stations. Thus the NLCIL is judicially managing the ground water resources available in the Neyveli hydro geological basin for safe lignite mining and power generation in sustainable manner and maintaining the eco-fragile system in the coastal region of cuddalore district, Tamilnadu[8]. This outstanding achievement is possible for the NLCIL by means of integrated ground water management and development studies by involving remote sensing, land use and land cover, ground water modeling, artificial recharge studies.[3]

In absence of any perennial rivers in this region utilization of ground water has become important. The depressurization of the artesian aquifer occurring just below the lignite is a prerequisite for safe mining of lignite. The localized depressurization in the artesian aquifer is being done by pumping the water through large diameter wells, which is based on hydrological tests like pump tests and R&D studies. Hydrogeological basin of Neyveli is shown below (FIG-1).



Area of Study- Brief Description of Neyveli Lignite Mines

The Neyveli lignite deposit region is located in the northern sub-basin of the Cauvery Basin, specifically within the Ariyalur-Pondicherry sub-basin. It spans the coastal plains of Pondicherry and Tamil Nadu, approximately 200 kilometers south of Chennai. The area features a flat landscape that gently slopes from north to south and west to east, with the land primarily used for agriculture. Within the Neyveli sub-area, numerous water tanks are present, some of which are filled with water year-round, while others are seasonal.

The study region is well-connected to Chennai and other major towns in South India through an extensive rail and road network.[9]

Mine-II is the southernmost of the two active mines operated by NLC. It is situated to the south of Mine-I/Mine-IA, with both mines separated by a small pillar through which the road from Vridhachalam to Vadalur passes. To the south, Mine-II's mining area is bordered by a main road (Vridhachalam to

Setiatope) that experiences heavy traffic. Additionally, to the east of Mine-II, the mining area known as Block-B is connected.

Hydrogeological Set up of Neyveli Basin

The lignite Mines are located in the Neyveli hydro-geological basin covering an area of 3500sq km. Detailed Hydrological study has indicated the presence of three prominent multi-layered aquifers system in the area [8]

- Unconfined aquifer (shallow water table aquifer)
- Semi-confined aquifer above the lignite seam
- Confined aquifer below lignite seam

Shallow Water Table Aquifer (Phreatic)

This aquifer is extensive over large part of the area and varies in thickness from 2 meters to 30 meters. The aquifer consists of laterites, lateralized sandstones, clayey sandstones and mottled ferruginous sandstones. The sandstone are generally fine to medium grained and are well cemented by clayey or ferruginous matrix. Coarse grained, porous sandstones are not common. Recharge to this shallow water table aquifer is effectively carried out by direct precipitation.[7]

Semi-Confined Aquifer

It occurs just above lignite seam in the southern parts of Mine-I and is predominant in M- II and further south. Its thickness varies between 5 and 10mts. There is no considerable ground water pressure and the water from this aquifer is being tackled by constructing the pump wells in both semi-confined and confined aquifers as a combined well, in addition to the toe drains, provided for tackling the seepage of water from this aquifer. [6]

Confined Aquifer

This aquifer is present in the entire Neyveli region. The maximum thickness is around 400 mts in the core lignite region and pinches in the west. Within the lignite bearing area there is almost continuous thick barrier clay at a depth of around 30 to 40 mts which divides the aquifer into two parts viz. Upper and Lower confined aquifer in the lignite bearing area. The upper confined aquifer exerts an upward hydrostatic pressure of about 5 to 8 kg/sq.cm within the mining area. This aquifer is mainly recharged due to rainfall in the demarcated recharge area.

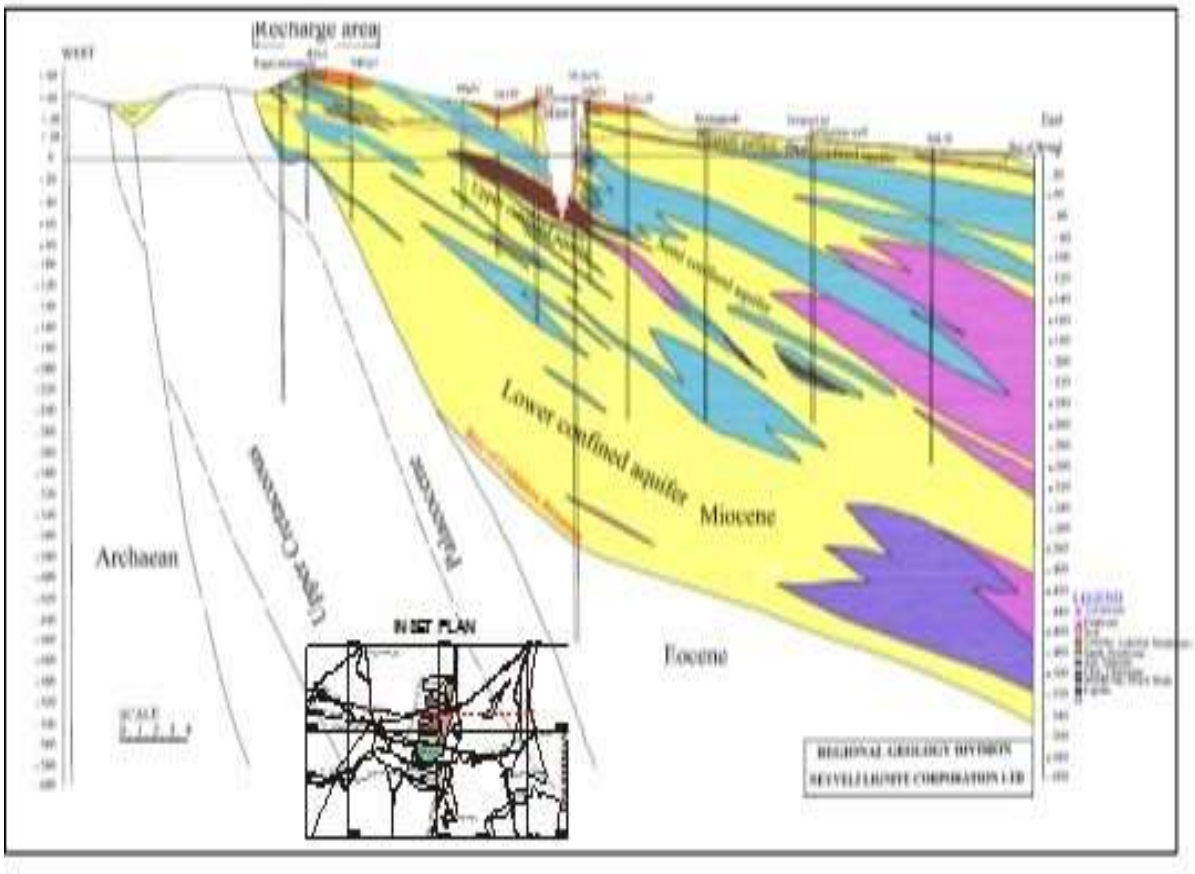


Fig-2- West to East Geological Cross Section in the center of Hydro geological basin

Method of Mining

In Neyveli Mines,

- Overburden which is soft clayey sandstone with sandy clay beds, is removed in bench levels deploying specialized mining equipment's & conveyor systems are operated to exclusively for overburden removal. The excavated OB is conveyed through conveyors and backfilled in the mined out area.[9]
- Neyveli mines of NLCIL adopts continuous mining technology which uses Bucket Wheel Excavator and Conveyors for the excavation of overburden and lignite.
- The lignite is being excavated by bucket wheel excavators which are the discharged to conveyors and transported to stackyard and then ultimately to pit head thermal plants of Neyveli for power generation.

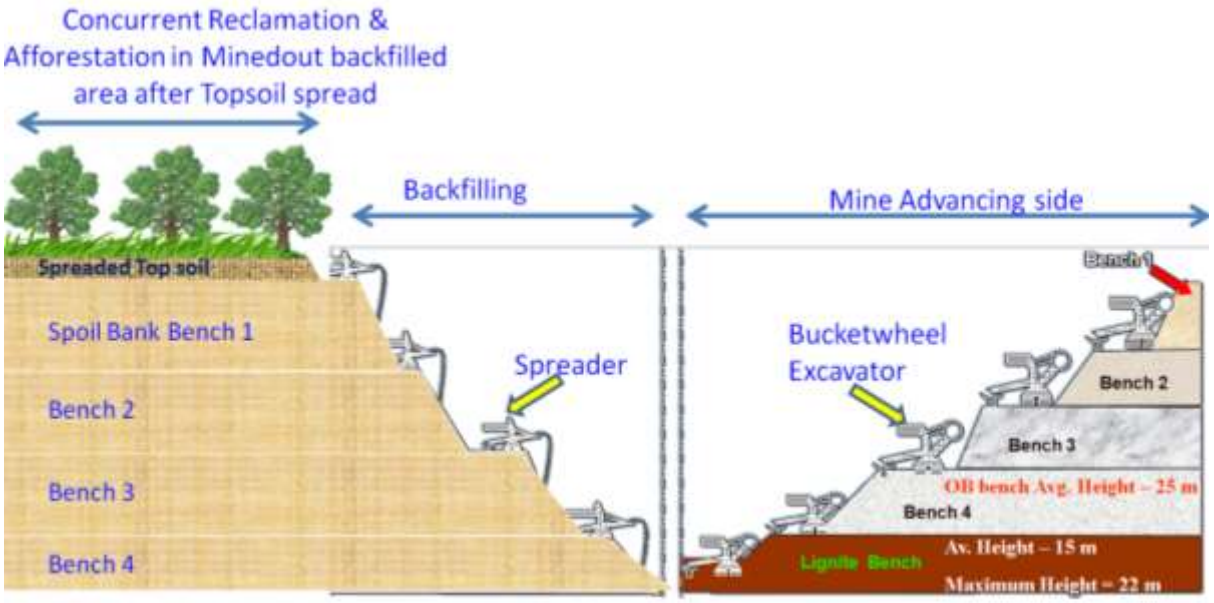


FIG-3-Method of Opencast Mining in Neyveli

Need for groundwater Depressurization-

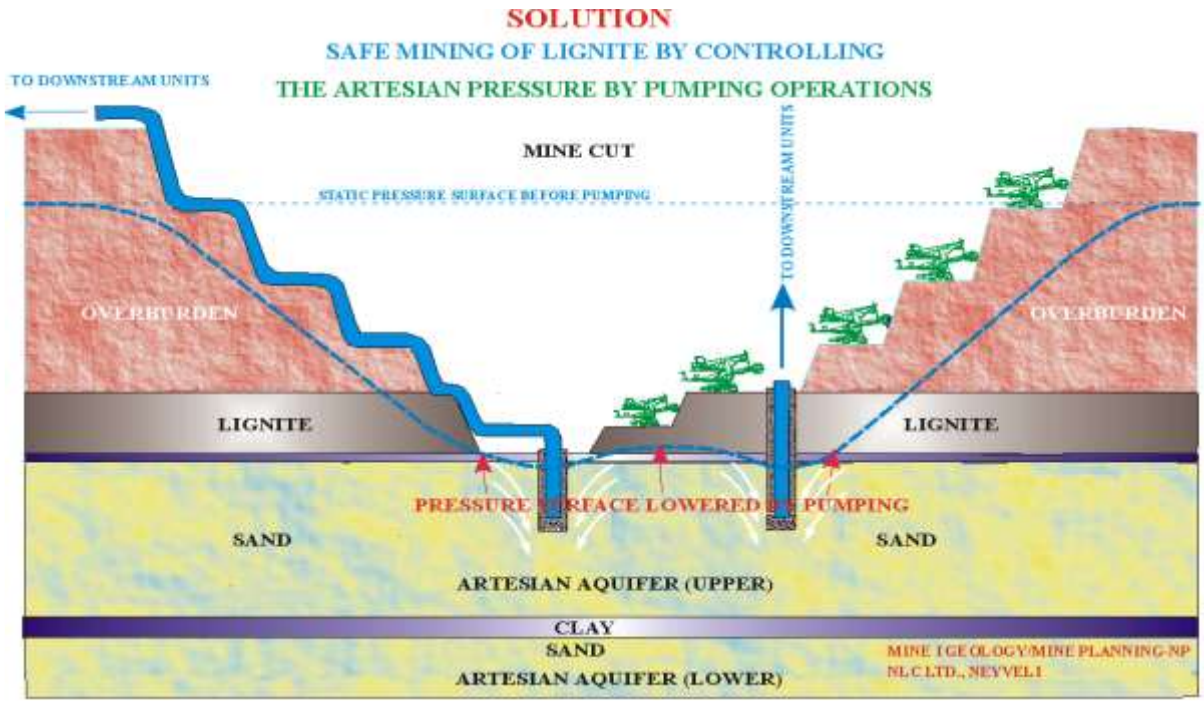
Mining of lignite from NLCIL mines in Neyveli is faced with a unique hydrological problem due to the presence of powerful aquifers below the lignite seam exerting an upward pressure, if not controlled, it could jeopardize the entire mining operations.

Therefore, the depressurization of the aquifer is essential during mining operation to maintain the pressure head constantly at the lignite bottom at the depth of 80 to 120 m, and to bring down the pressure surface locally very closer to mine cut region through pumping operations by strategically located pumping wells in the lignite mines/ close to excavation zone. [9]

In addition to the groundwater from confined aquifer, seepage water from semi-confined and unconfined aquifer zones are also causing problem while mining. All these water is managed by judicial pumping to achieve safe mining operation without exceeding the MoEF permissible limit of pumping.[8]

Method of existing groundwater control operation with optimum pumping w.r.t MoEF&CC stipulated conditions:

The hydro-geological investigation and pumping tests conducted in this field proved that most practical–cum-economic solution to this problem is depressurization of confined aquifer and maintaining the pressure head constantly below the lignite seam (initial technique) or just above lignite seam (positive head- improvised technique) by large scale continuous pumping operation from the series of large diameter pump well located /situated at hydrologically pre-planned /calculated distances from the active excavation zone. The ground water solution is exhibited in below (FIG-4)



(FIG-4)

Groundwater control (GWC) operations in NLCIL Neyveli mines:

The pressure surface is being controlled through pumping from large diameter wells (Drilling: 36 inches/Casing: 20inches) strategically located at pre-determined places and taken down to depths determined from hydrological tests.[2]

Huge submersible pumps initially of 175 HP and later upto 250 HP with heads of 150 m are now lowered and pumped at optimum discharge of around 1000 GPM &500 GPM /well.

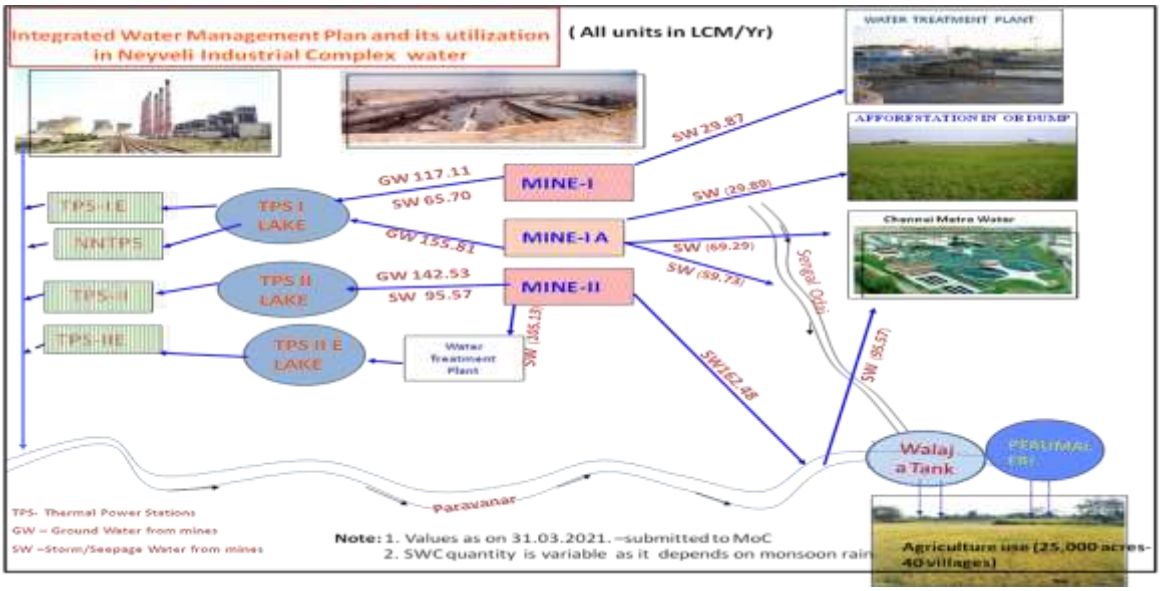
Reverse circulatory drill positioned for drilling large diameter well for depressurization

Location of GWC Wells for Ground water pumping operations)- FIG-5

Integrated Mine Water Management, Utilization and Augmentation in opencast lignite mines, Neyveli Hydrogeological Basin

The groundwater which is being pumped out from the mines is being used in Thermal Power Stations of Neyveli area for power generation and the surplus water is supplied for community use in after proper treatment.

- NLCIL is pumping about 42000 GPM of groundwater from its mines for safe mining operations, which is entirely consumed by Thermal Power Stations (4 Nos.).
- The storm water and seepage water accumulated in mines is pumped out on an average of 26500 GPM, of which 6800 GPM is consumed for drinking water use after treatment.
- The drinking water requirement of 6806GPM in Neyveli Township is met from treated storm water from Mine-I. [4]
- About 19700 GPM of storm water is being let out into Sengal odai, Kanya odai, and Paravanar feeding to walaja tank and Perumal eri by which 20000 acres of land is cultivated by local farmers.
- NLCIL has plans for treatment of entire quantity of storm water in future as a step towards conservation of groundwater.



The flow diagram and table showing the water distribution to various uses are given below (FIG-6)
Regional Groundwater Management In Neyveli Hydrogeological Basin

- NLC is involved in monitoring the ground water levels and quality through series of dug wells and tube wells established in the hydro-geological basin.
- NLC is taking up studies on sea water –fresh water interface in the coastal region from Pondicherry in the north to Chidambarm in the south.
- NLC is constantly involved in enhancing the ground water potential of the region through integrated studies viz: Rain Water Harvesting, Recharging deep seated aquifer through establishing of artificial recharge structures such as check dam, percolation wells, Infiltration wells and de-silting of reservoirs etc.[3]

Conclusion

NLCIL has developed an effective system for Ground water control and management system for sustainable development with integrated mining and industrial complexes at Neyveli after adopting the latest techniques. To enhance the recharge potential to basin, NLCIL has established many artificial recharge structures like Check dams, percolation wells, Infiltration wells in and around Neyveli and proposed to construct many new artificial structures in suitable places. NLCIL is judicially managing the Mine water (ground water & storm water) resources available in the Neyveli hydro-geological basin for safe lignite mining for power generation in sustainable manner and also to the community by maintaining the eco-fragile system in the coastal region of Cuddalore district of Tamilnadu.

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