NLC WELCOMES TO THE

PRESENTATION ON
OB DUMP STABILITY
INDO-US WORKING GROUP MEETING AT NEW DELHI
APRIL-2006

A BRIEF ON NLC LTD

- Neyveli Lignite Corporation Ltd., a Mini Ratna of GOI under Ministry of Coal.
- NLC was incorporated in November 1956.
- **<u>Existing Projects of NLC:</u>**

Units	Capacity
Mine – I	10.5 MTPA
TPS – I	600 MW
Mine – II	10.5 MTPA
TPS – II	1470 MW
Mine – IA	3.0 MTPA
TPS – I Expn.	420 MW

A BRIEF ON NLC LTD

New Projects:

- **Projects under implementation:**

  a. Mine – II capacity to 15.0 MTPA & TPS –II Expansion (2*250 MW) at Neyveli.

  b. 2.1 MTPA Lignite Mine with Thermal Power Plant of 2*125 MW capacity at Barsingsar, Bikaner, Rajasthan

- **Projects under proposal:**

  a. Lignite Mine (9 MTPA) and Thermal Power Plants (1000 MW) at Jayamkondam, Tamilnadu.

  b. RIRI Mine Cum Thermal Power Project, Rajasthan.

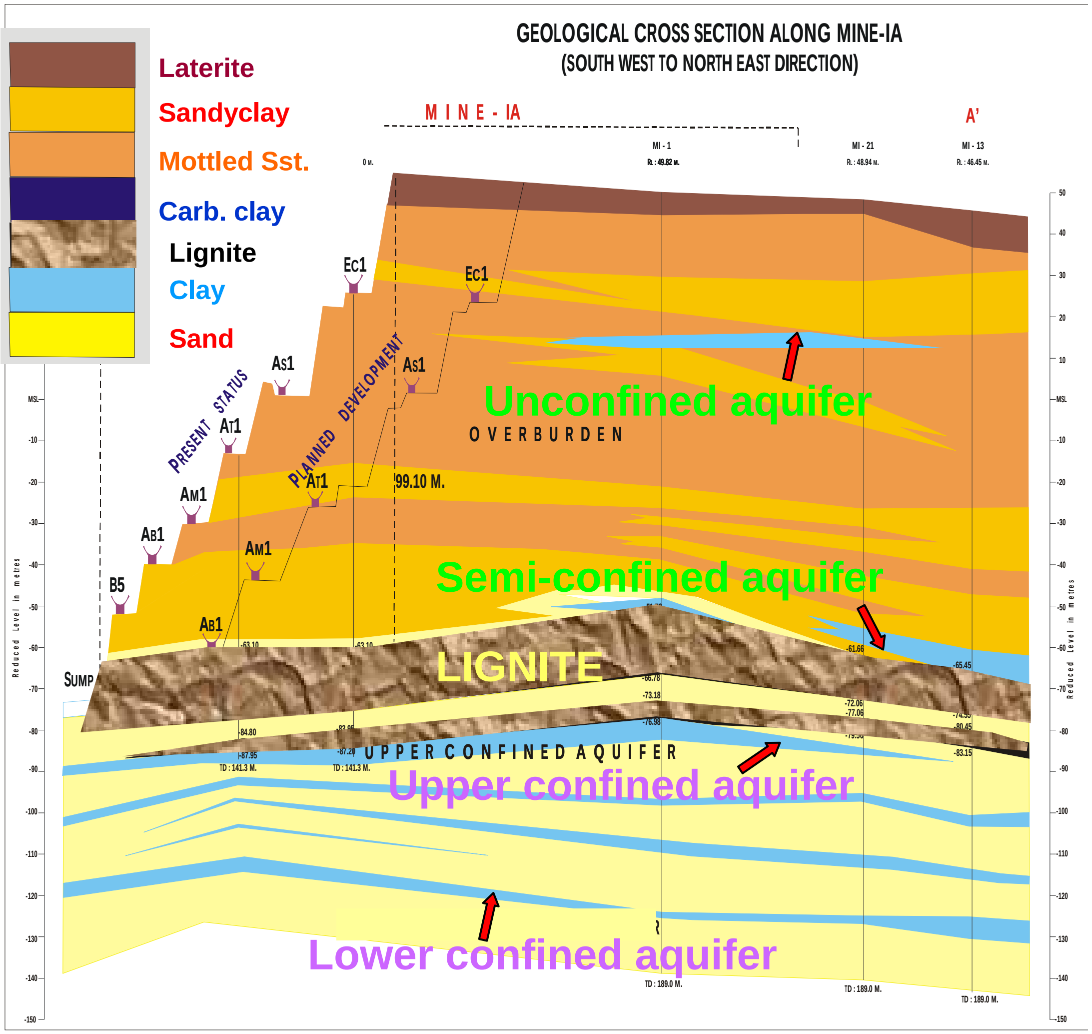
  c. Expansion of the Barsingsar Project.

  d. Thermal Power Station at Tuticorin as Joint Venture with TNEB.

GEOLOGY AND GEO- HYDROLOGY OF NLC MINES

- **The main Overburden formations consists of argillaceous and Ferruginous sandstone and clays with aquifer sands .**
- **The sandstones constitute a major portion of the overburden and they are fine to coarse grained.**
- **The annual rainfall varies between 860 mm and 2070 mm with an average of 1200 mm.**
- **A huge reservoir of ground water exists below the entire lignite bed, exerting an upward pressure of 6 to 8 kg/cm^2, which is tackled by an effective ground water management system.**
- **The pressure of the artesian aquifer is being controlled by pumping (around 28,000 gallons per minute).**
- **Drawdown requirement depends upon the disposition of the bottom of lignite.**

CROSS SECTION SHOWING HYDROLOGY & GEOLOGY



Unconfined Aquifer:

- Just below ground level up to a maximum depth of 50 mts comprising of lateritic sand stones/alluvium.
- Water level fluctuates between ground level and 15 mts

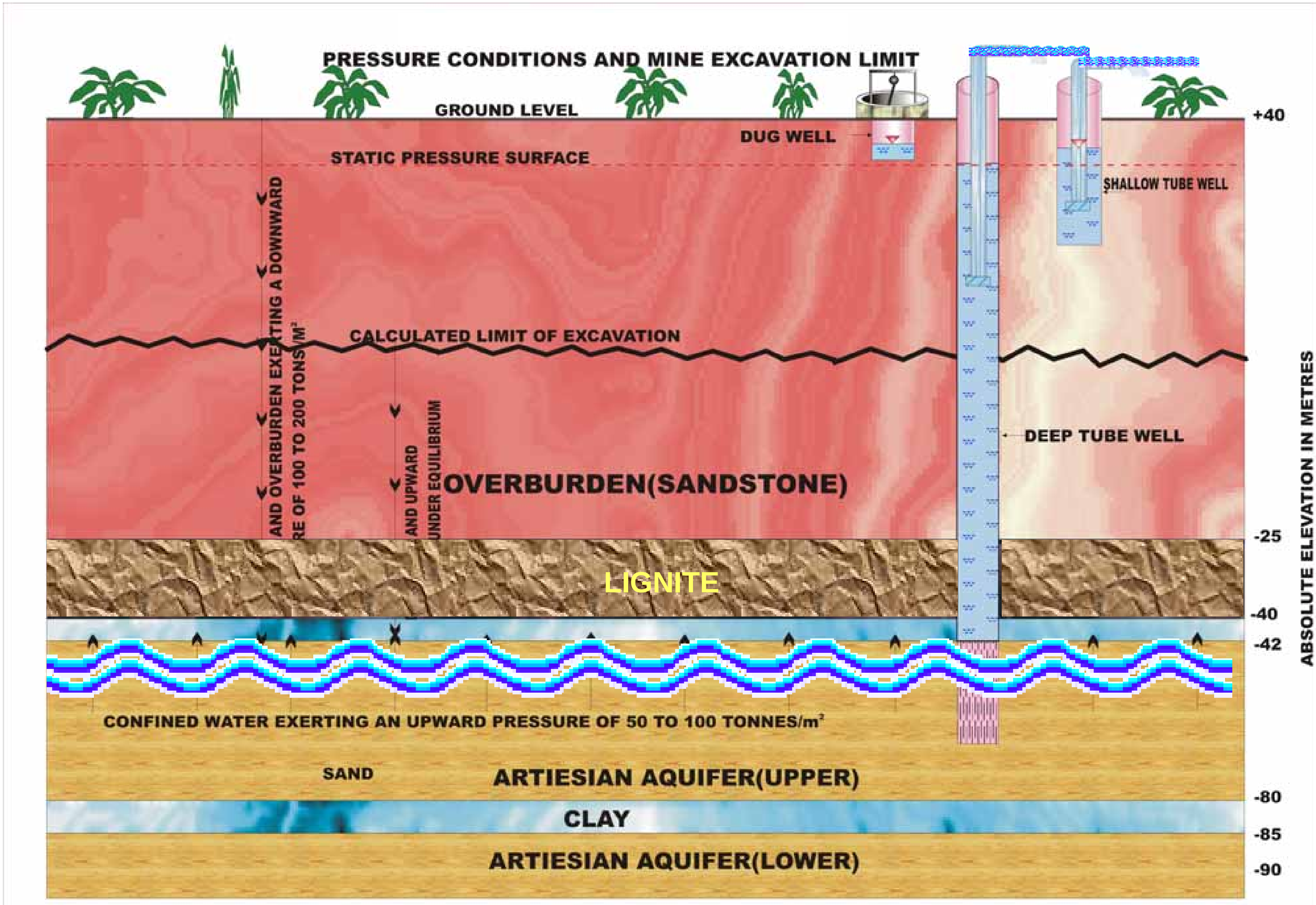
Semi-confined Aquifer:

- Occurs just above lignite seam in the southern parts of Mine-I and is predominant in Mine-II and further south.
- Its thickness varies between 5 and 10 mts.

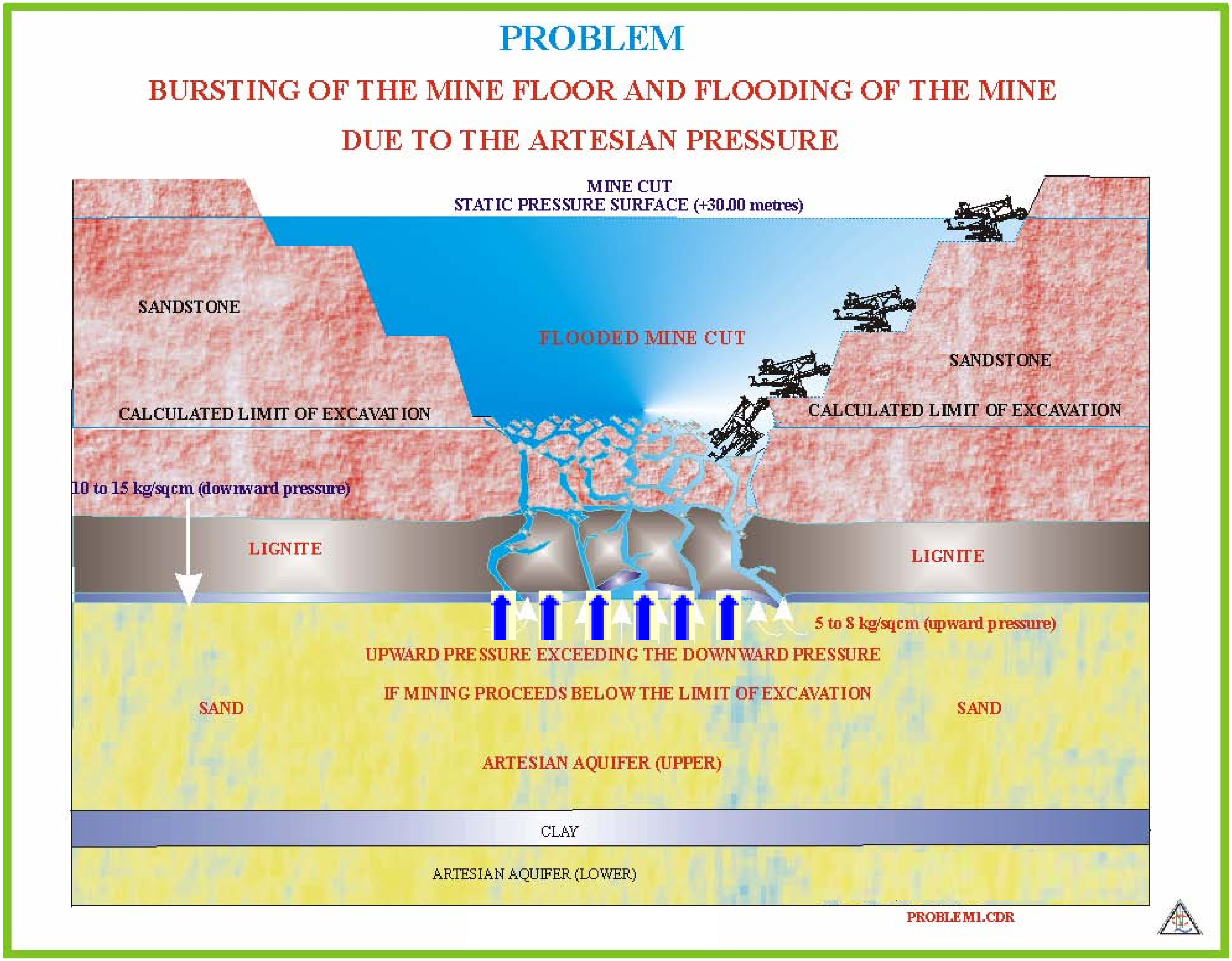
Confined Aquifer:

- Its occurrence is predominant, thickness is around 400 mts in the core lignite region and pinches in the west
- Within the lignite bearing area there is continuous thick barrier of clay at a depth of around 40 to 50 mts which divides the aquifer into two parts viz. Upper and Lower confined aquifer
- This aquifer is mainly recharged due to rainfall in the demarcated recharge area of 420 sq.kms lying west of the lignite field.

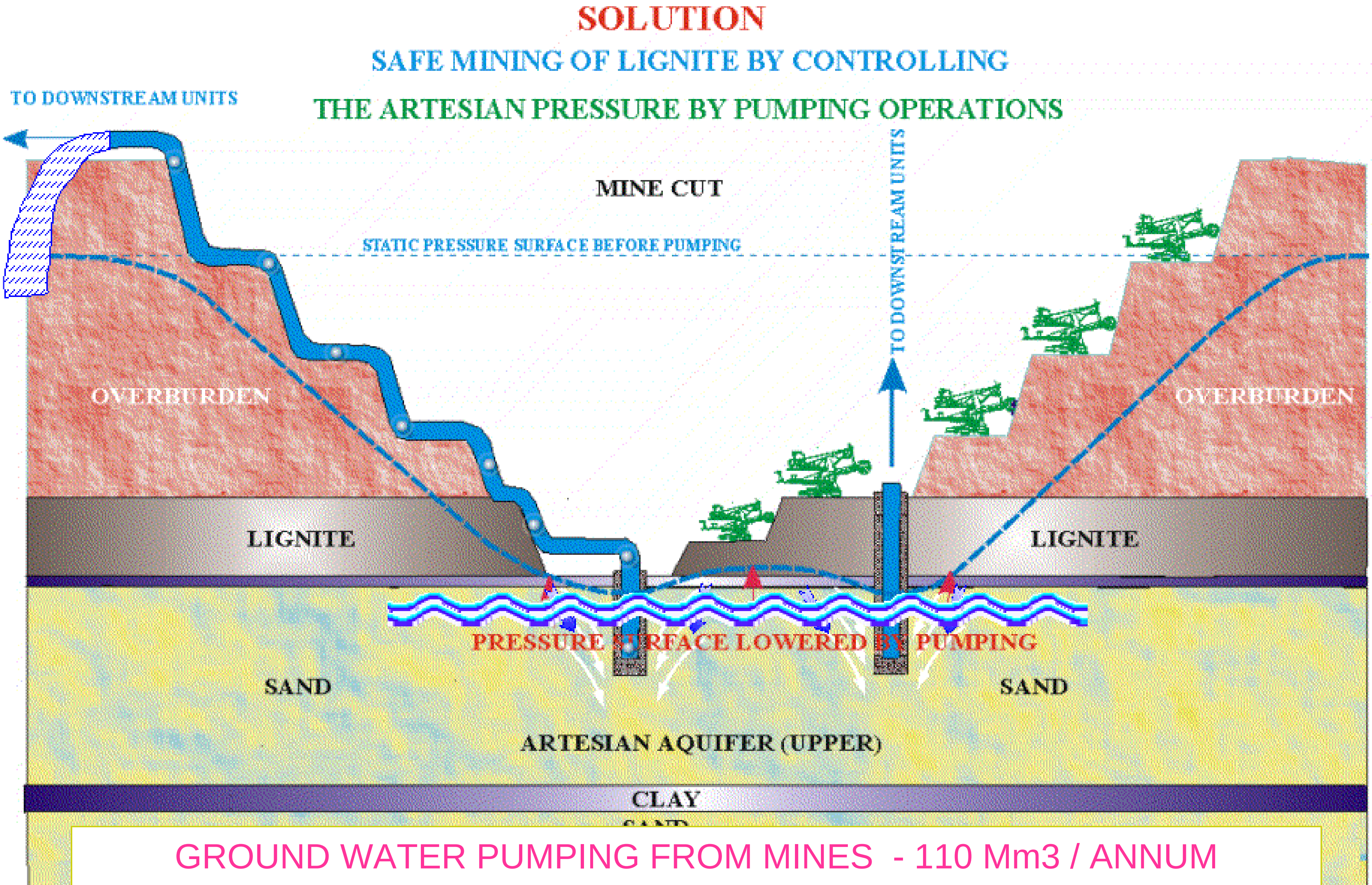
PRE-MINING HYDROLOGICAL CONDITION



PROBLEM WHEN NOT DEPRESSURISED



EXCAVATION WITH LOCAL DEPRESSURISATION



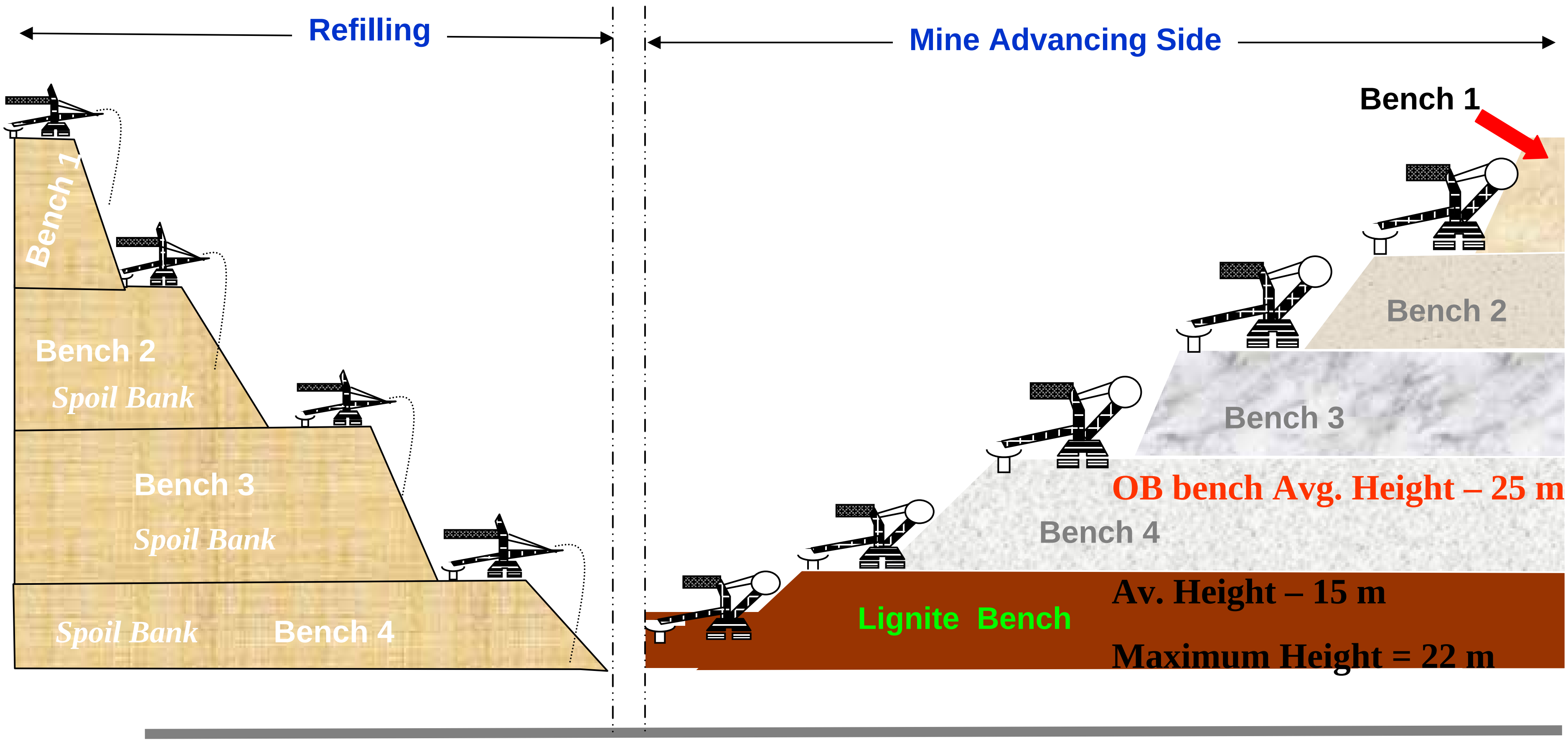
GROUND WATER PUMPING FROM MINES - 110 Mm3 / ANNUM

45 NUMBERS OF 1000 GPM PUMPS (20" DIA) ARE IN OPERATION

METHOD OF MINING

Opencast continuous mining system using

- Bucket Wheel Excavators
- Spreaders
- Conveyor Systems



SALIENT FEATURES OF MINE WORKING

- **Overburden thickness : 72 to 110 m,**
- **Lignite thickness : 10 to 23 m.**
- **Number of Excavation Benches : 5**
- **Height of Excavation Bench : 20 – 25 m**
- **METHOD OF WORKING : Opencast Mining utilising Specialized Mining Equipment like Bucket Wheel Excavators, (1400 lit & 700 lit capacity) for Excavation, Belt Conveyor for transportation and Spreaders (20000 &11000T / hr) for dumping.**

ANNUAL OB DUMPING QUANTITY (Million m^3)

DUMPING	MINE-I	MINE-IA	MINE-II
INTERNAL	24.9	22.0	33.0
EXTERNAL	22.1	NIL	18.0
TOTAL	47.0	22.0	51.0

AVERAGE GEO-TECHNICAL PROPERTIES OF THE OVERBURDEN SOIL

Geotechnical properties	Lateritic soil	Variegated sandy clay	Clay	Sandstone
Water content %	10 - 13	5 - 13	9 - 24	3 - 12
Liquid limit %	36 - 44	36 - 50	55 - 90	-
Plastic limit %	16 - 20	16 - 22	22 -32	-
Consistency index	1.0 - 1.3	1.2 - 1.6	0.9 - 1.6	-
Degree of saturation %	50 - 85	30 - 90	25 - 85	20 - 90
Average density (t/m^3)	2.0	1.9 -2.3	2.0 - 2.3	2.0 - 2.4

AVERAGE GEO-TECHNICAL PROPERTIES OF THE OVERBURDEN SOIL

Geotechnical properties	Lateritic soil	Variegated sandy clay	Clay	Sandstone
Grain size distribution				
SL & CL %	15 - 45	45 - 70	-	15 - 30
SN %	85 - 55	55 - 30	-	85 - 70
Cohesion (kg/Sq.cm)	6 - 9	2.5 - 10	2.0 - 9.0	3.0 - 1.6
Compressive strength (kg/cm2)	12 - 18	5 - 20	4 - 20	6 - 32
Angle of internal friction (degrees)	18 - 30	15 - 35	-	25 - 40
Coefficient of permeability (cm/sec)	1.0×10^{-4} - 10^{-5}	10^{-5} - 10^{-7}	-	10^{-4} - 10^{-6}
Swell factor				
Dry condition	1.5	1.4 - 1.6	1.5 - 1.6	1.3 - 1.5
Wet condition	2.0	2.0 - 2.2	2.2 - 2.4	1.7 - 2.1

SL = SILT CL = CLAY SN = SAND

PROCESSES LEADING TO SOIL SLIDE

Name of Agent	Event or Process which brings agent into action	Mode of action of agent		Slope materials most sensitive to action	Physical nature of significant actions of agent	Effects on equilibrium conditions of slope
WATER	Seepage from artificial source of water	1	Seepage toward slope.	Sandy loam soil	Increases pore-water pressure	Decrease of frictional resistance.
		2.	Displaces air in the voids.	Moisture, fine sand	Eliminates surface tension	Decrease of Cohesion
		3.	Removes soluble binder.	Sandy clay	Destroys intergranular bond	

Recent Dump Failures at NLC Mines

1. In Mine-II, way back in 1985 at the southern side of T-6 conveyor area a heavy subsidence at the top of the dump occurred. Simultaneously with the subsidence activities, the southern slope as well as the adjacent ground surface were " Pushed up" gradually with small trees and plants were lifted up "en-masse" without being topped down or disturbed . The height of the upheaval was about 10m .
2. In Mine-II, during March 2005 area near S6 drive head / toe of present dump heaving was noticed.
3. During March 2006 circular cracks developed along S6 shifting side and followed subsidence the dump toe is also moved gradually.
4. Around 4 lakh m3 of dumped soil slided during October – 2002 in the dump yard of New Surface bench, Mine-I. Toe of the dump moved to a distance of around 530 m along the sloping ground.

5. The second dump slope failure had occurred at the bottom bench of Mine-I, just by the side of the inner track of spreader -320. The Spreader 320 was working on soil dump containing ad mixture of sand, clay, carbonaceous clay with patch of local seam lignite, it was slightly wet. It happened, while dumping was being performed through spreader 320 with a combination of B6 Conveyor and tripper car, at 26m from B6 Conveyor along the direction of the conveyor.

6. Dump slide occurred during May – 2005 in the dump yard of bottom bench, Mine-IA. An area of about 70m x 80m was moved about 25m.

CAUSES OF DUMPED SOIL MASS SLIDING

1. **Stagnation of storm water in between the old dumped heaps of soil mass.**
2. **Inadequate drainage in wet, saturated old dumps.**
3. **The surface of old dumps had little compaction control due to presence of water.**
4. **Due to dumping the soil mass over the water stagnated area, pore water pressure was built up in the old and new dumped soil mass.**

CAUSES OF DUMPED SOIL MASS SLIDING

5. Pore water pressure had reduced the bearing strength of soil mass as well as weakens the base stratum.
6. Shear failure is followed by liquefaction (complete loss of strength at the bottom of new dump) with catastrophic consequences.
7. The dynamic load of dumping, increasing engineering activities and the movement of the spoil bank could have helped the soil mass sliding.

PREVENTION OF SPOIL HEAP SLIDING

1. **Stagnant water bodies in between the old spoil heaps shall be drained and allowed the surface to get dried, before dumping takes place.**

2. Preventing any further storm water to approach the soil mass susceptible to sliding.

3. Proper drainage arrangements shall be made to facilitate surface water run off and reduce the percolation of meteoric water along the slopes.

4. Maintaining the slope angle up to 35^0, above this slope angle gravitative forces get an upper hand

PREVENTION OF SPOIL HEAP SLIDING

5. The height of the dump should be maintained at an optimum level.

6. The slope of soil mass shall have adequate stabilization in either by flattening the slope (to ensure stable limit) or decreasing the load or increasing the shearing resistance of the soil by decreasing its water content with the help of drains.

7. Special care is required when dumping overburden soil on sloping grounds (such locations are sometimes unavoidable).

8. Stability of soil heaps must be carefully evaluated for dynamic loading conditions.

GUIDANCE / TECHNICQUES REQUIRED

1. **Due to confined aquifer, water seepage on lignite floor is unavoidable and waste is dumped in watery floor. Hence *suitable technology and management*, alternate to SME technology to suit this condition.**
2. ***Stabilization of dumps* considering SME technology.**
3. ***Slope monitoring techniques/ measures* for Variations in Soil Condition, Excessive Seepage due to Higher Permeability, Seismic Instability etc.**
4. **Active Mining Zone and Residential Area – *System of monitoring* for any *instability of dumps of total height of 60m* or more.**
5. **Other effective *methodology of managing high dumps.***

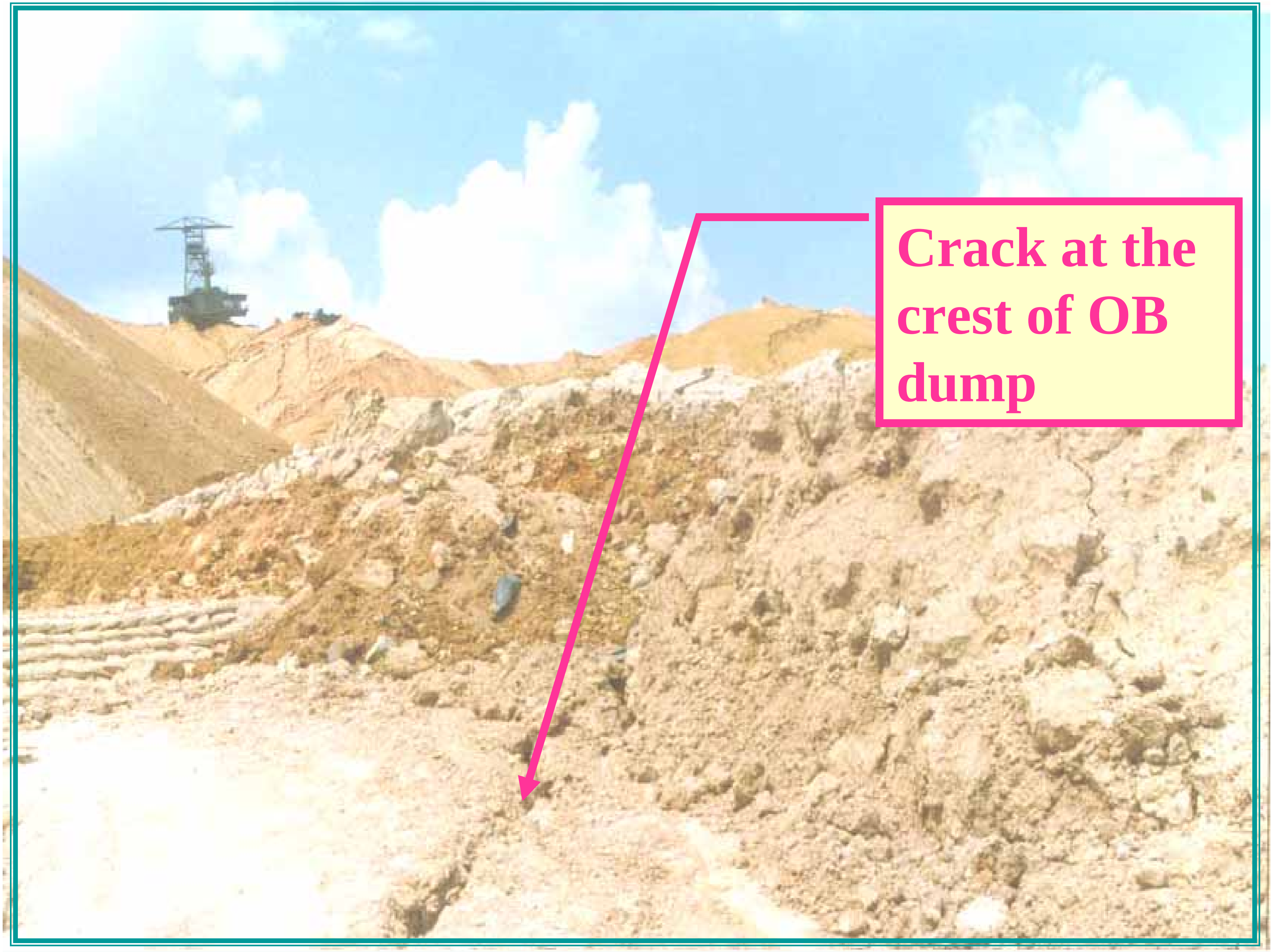
VIEWS

OF

SOIL

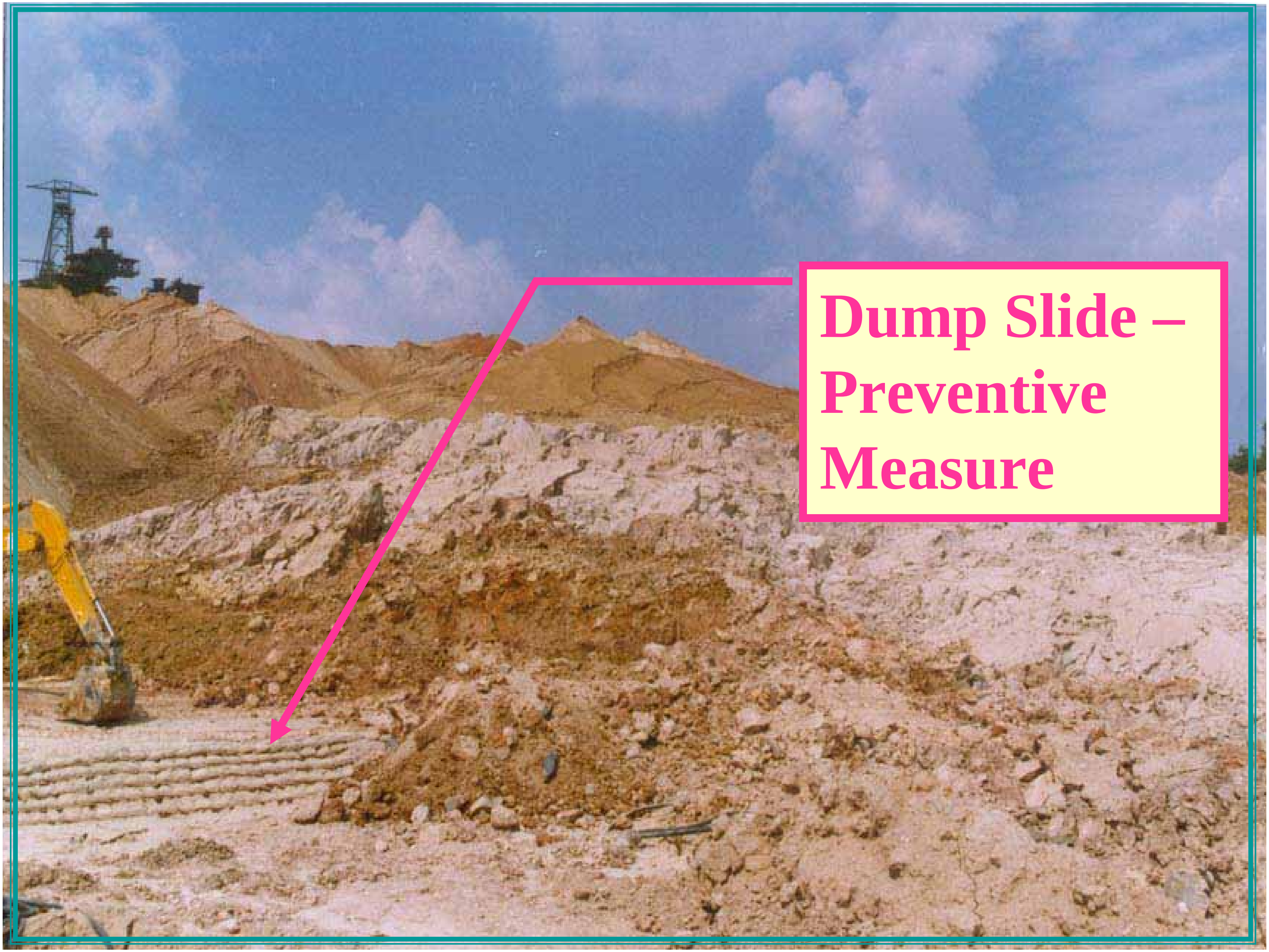
SLIDED

AREA


Crack at the crest of OB dump


Dump Slide


Dump Slide


Dump Slide –
Preventive
Measure


Massive
Dump Slide
at the Toe


Cavity formation due to dump Slide


Dump Slide – Preventive Measure


Dump Slide


Dump Slide


Dump Slide