GPS BASED TRUCK DISPATCH SYSTEM (TDS) IN HIGHLY MECHANIZED BAUXITE MINES A CASE STUDY.

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NALCO

❑ **Asia's largest integrated Aluminium Complex,**

Encompassing bauxite mining, alumina refining, aluminium smelting and casting, power generation, rail and port operations.

❑ **Formation of the Company in Jan,1981 and commissioning of**

❖ Port Facilities(Visakhapatnam, AP) in Sept,1985

❖ Bauxite Mines(Damanjodi, Orissa) in Nov,1985

❖ Alumina Refinery(Damanjodi,Orissa) in Sept ,1986

❖ Captive Power Plant(Anugul Orissa) in Sept,1986

❖ Smelter Plant(Anugul, Orissa)   in   March,1987

UNIT WISE CAPACITY

Unit	Product	Original Capacities	Expanded Capacities
Bauxite Mines	Bauxite	24,00,000 MT	63,00,000 MT
Alumina Refinery	Alumina	8,00,000 MT	21,00,000 MT
Aluminium Smelter	Aluminium	2,18,000 MT	4,60,000 MT
Power Plant	Thermal Power	600 MW	1200 MW

PANCHPATMALI BAUXITE MINES,NALCO

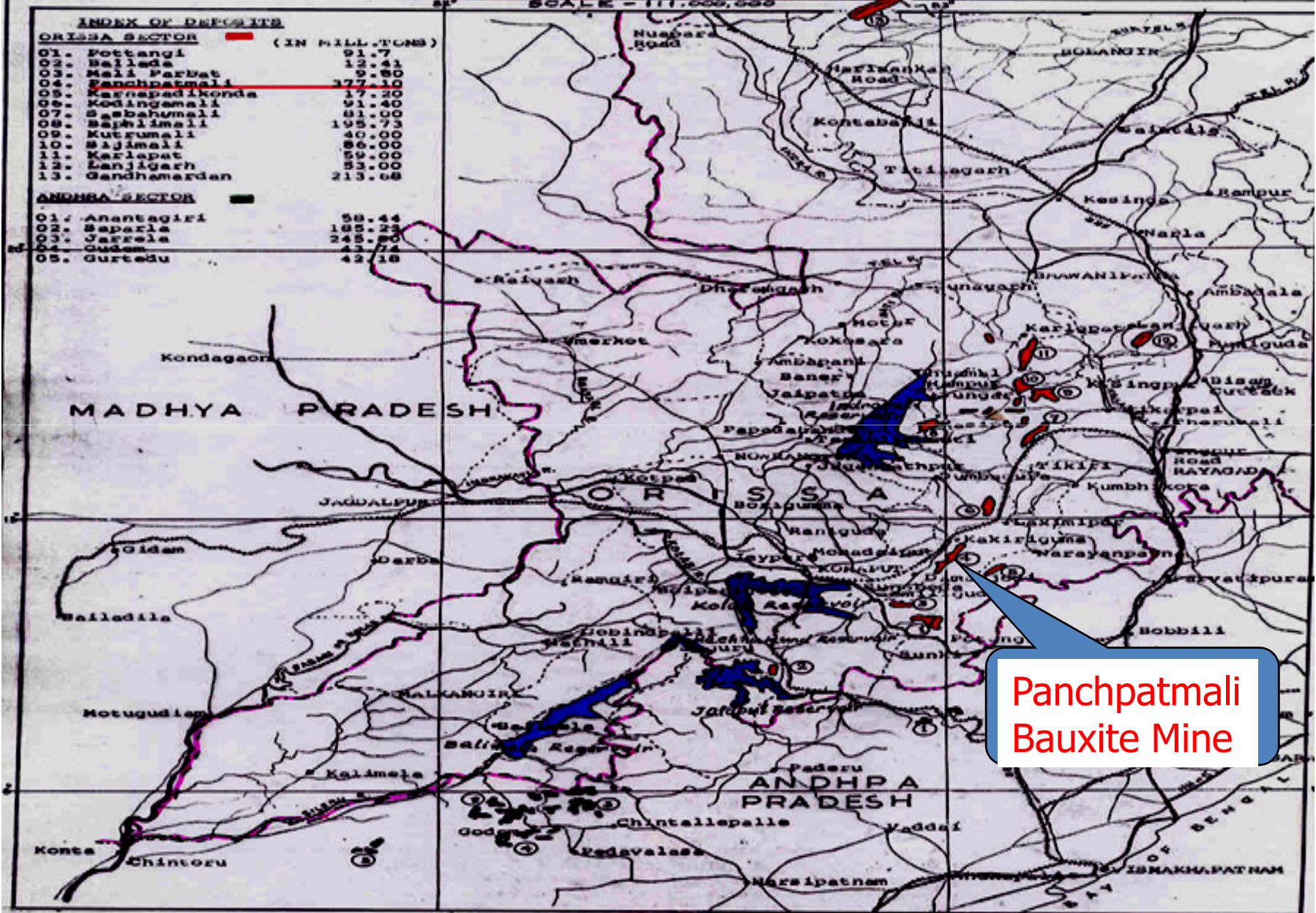# EAST COAST BAUXTE DEPOSITS
PANCHPATMALI BAUXITE MINES
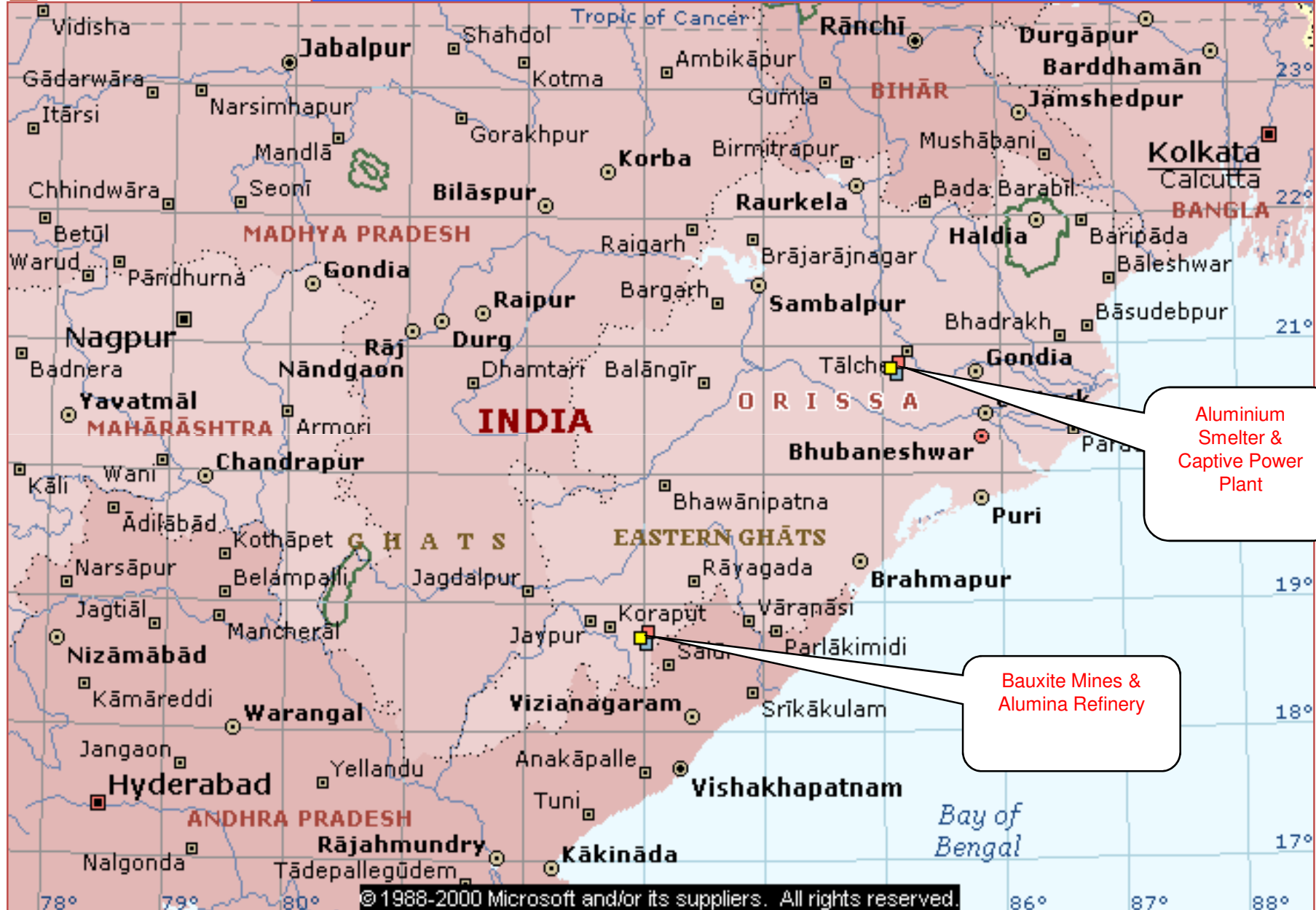### SCALE = 1:1,000,000

INDEX OF DEPOSITS

ORISSA SECTOR (IN MILL.TONS)

No.	Deposit	Value
01.	Pottangi	91.7
02.	Balleda	12.41
03.	Mali Parbat	9.80
04.	Panchpatmali	177.10
05.	Karnapadikonda	17.20
06.	Kodingamali	91.40
07.	Sasbahumali	81.00
08.	Saphlimali	195.73
09.	Kutrumali	40.00
10.	Sijimali	86.00
11.	Karlapat	59.00
12.	Lanjigarh	53.00
13.	Gandhamardan	213.68

ANDHRA SECTOR

No.	Deposit	Value
01.	Anantagiri	58.44
02.	Saparla	105.23
03.	Jarrela	245.80
04.	Gudem	41.74
05.	Gurtedu	42.18

Panchpatmali Bauxite Mine

LOCATION OF UNITS

Aluminium Smelter & Captive Power Plant

Bauxite Mines & Alumina Refinery

LARGEST BAUXITED EPOSIT IN(SINGLE) THE WORLD

Schematic Plan of Panchpatmali Bauxite Deposit and Mine.
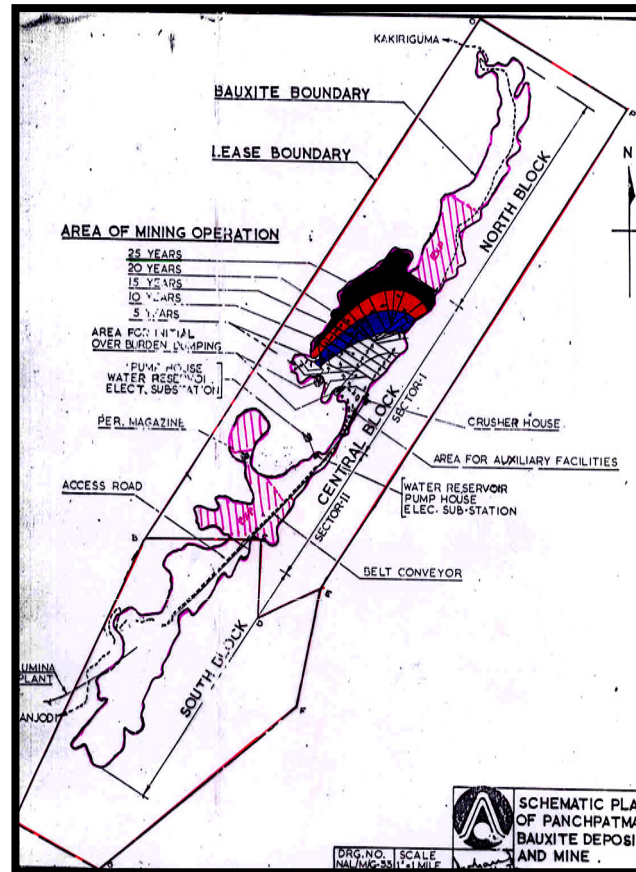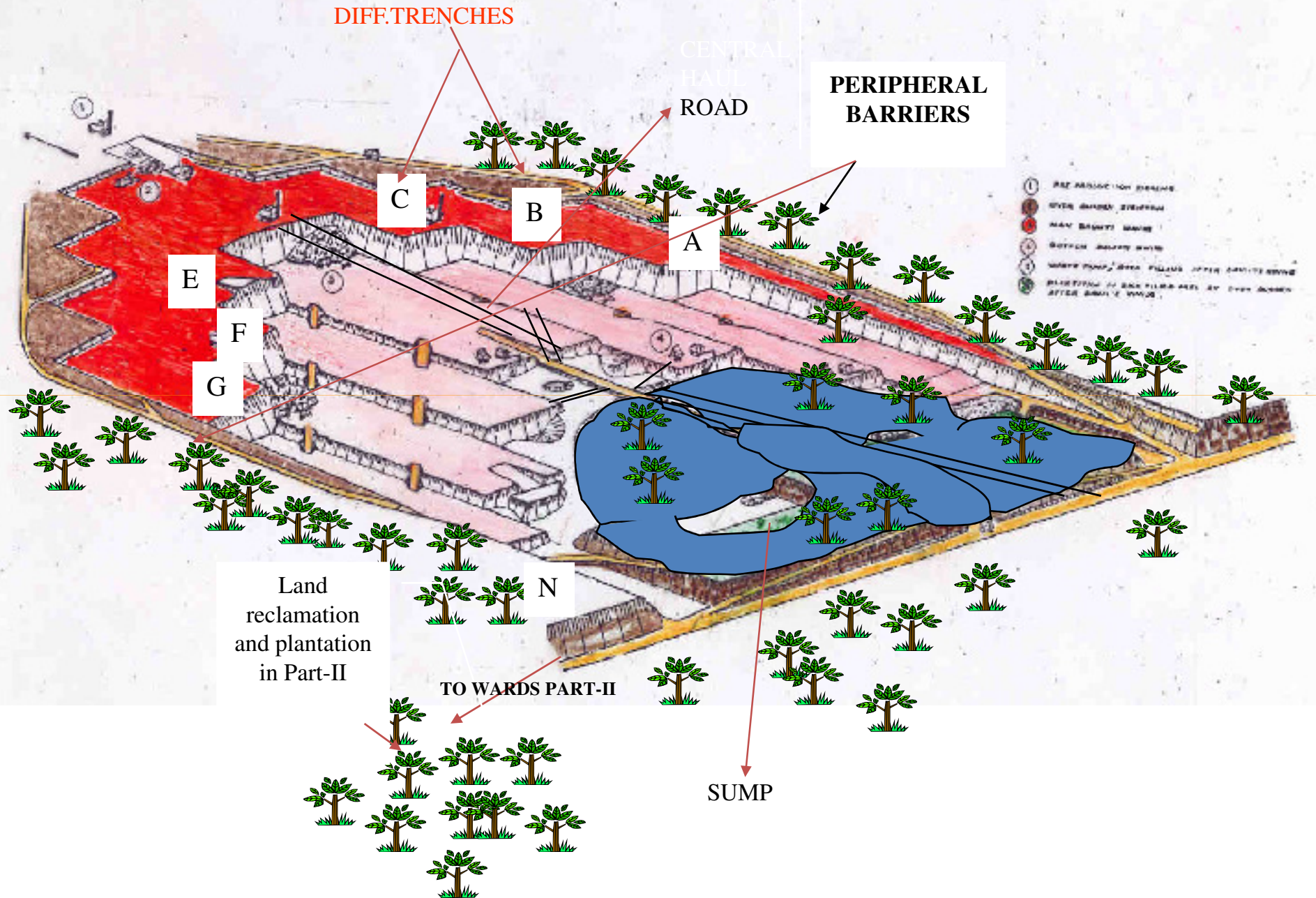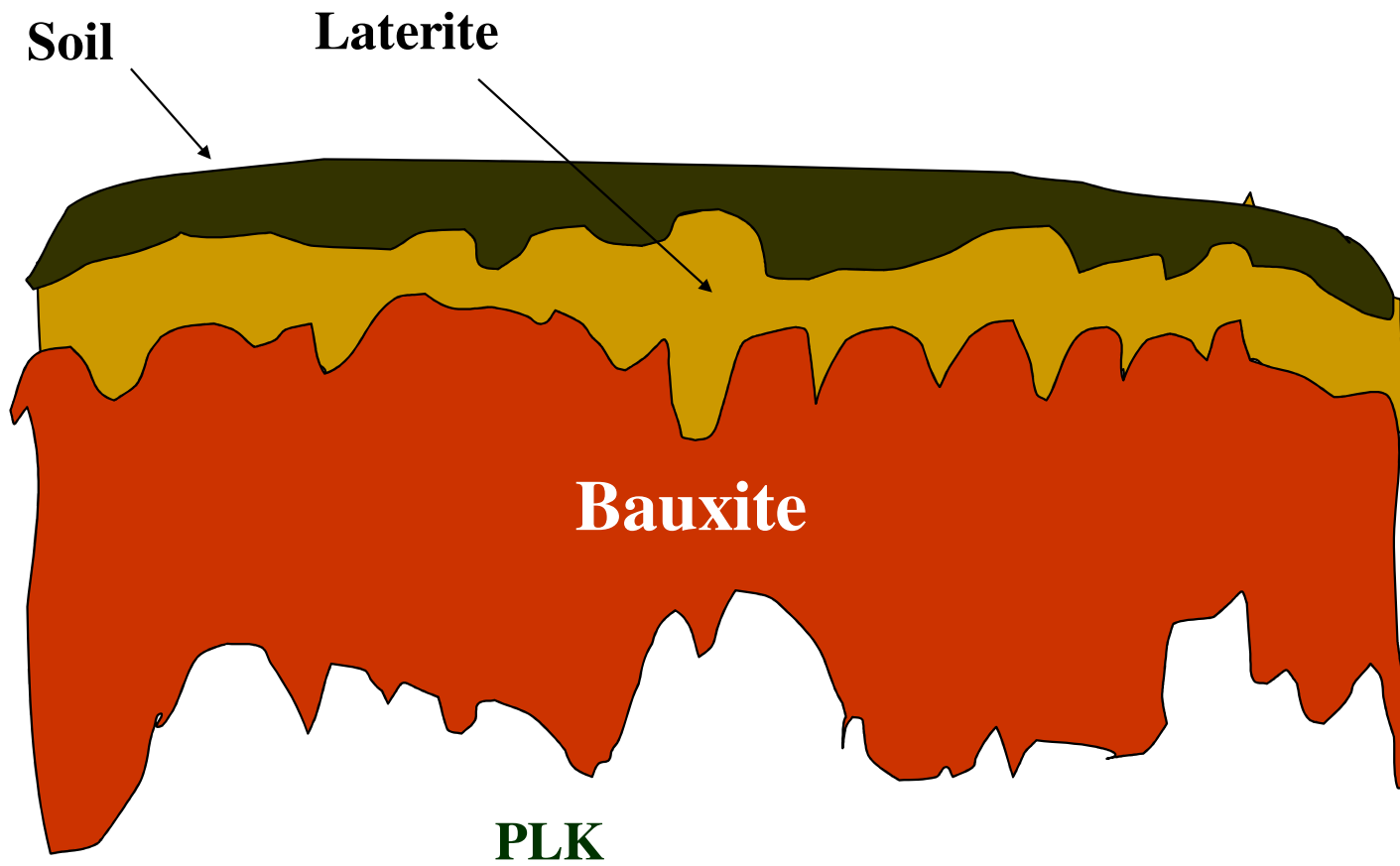
➢   310 MT of flat Bauxite deposit spread in 16 sq km area, on the top of the Panchpatmali hill in Koraput District of Orissa.

➢   Average thickness of about 14 mts lies below about 3 mts of overburden, best for opencast mining.

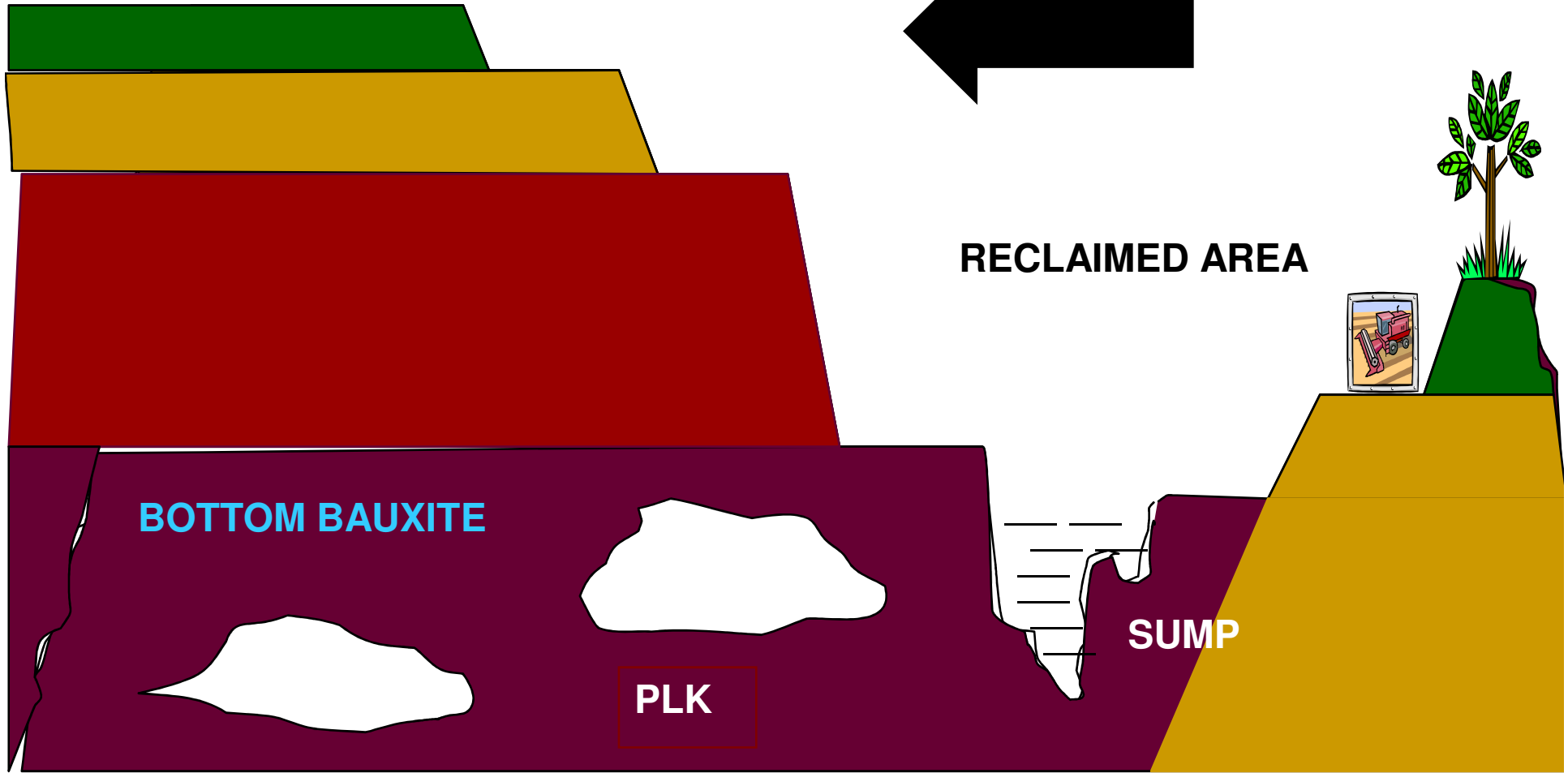# SCHEMATIC VIEW OF TRENCH MINING

DIFF.TRENCHES

CENTRAL HAUL ROAD

PERIPHERAL BARRIERS

C

B

A

E

F

G

N

Land reclamation and plantation in Part-II

TO WARDS PART-II

SUMP

CROSS SECTION OF BAUXITE DEPOSIT

Soil

Laterite

Bauxite

PLK

MINING

MINE FACE ADVANCEMENT
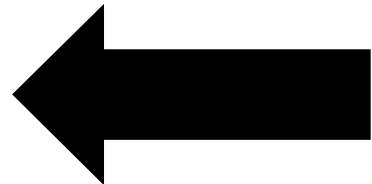
RECLAIMED AREA

BOTTOM BAUXITE

PLK

SUMP

IMPORTANT FEATURE OF THE PANCHPATMALI BAUXITE MINE

➢ Trench Mining Method is adopted as mining method.

➢ 14.6Kms single flight multi curve cable belt conveyor from Mines to Refinery for bauxite transportation.

➢ Deep hole Blasting with ANFO is used for both Overburden and Bauxite .

➢ Mechanised Mines with all the modern opencast machines are used.

➢ High capacity Ripper Dozers is also used for excavation and supporting jobs.

➢ Wheel Loaders and Hydraulic shovels for loading and Haulpac Dumpers for hauling of Overburden and Bauxite are used.

➢ Surface Miner operation is in the experimentation stage; if it becomes successful ,it will help in phase out Blasting and a major step towards clean and continuous mining in the mine.

➢ TDS system for Mine operation and pit optimization since may-2005.

➢ Surpac mine planning software is being used since 2007.

CONVENTIONAL MINING

- MANUAL ATTENDANCE

- LISTING OF AVAILABLE EQIPMENT.

- MANUAL ALLOCATION OF EQUIP.

- MANUAL INFORMATION OF EQIP. GETTING B/D.

- REALLOCATION OF EQUIP. BY INCHARGE.

- TRIP COUNTED BY TRIP MEN.

- MANUAL MAINTENANCE SCHEDULE.

- MANUAL REPORT PREPARATION.

GLOBAL POSITIONING SYSTEM (GPS) TECHNOLOGY

❑ GPS is a satellite based tracking system.

❑ 24 satellites orbiting the earth twice everyday, in 6 different orbital planes at an altitude of 20,200 kms.

❑ Each satellite is equipped with an atomic clock to let it broadcast signals coupled with a precise time message.

❑ A GPS receiver on the earth surface takes this signal , compares it with its own time and uses the difference to calculate its distance from the satellite.

❑ By checking its time with the time of three such satellites,

❑ A receiver could pinpoint its longitude, latitude and   altitude on the earth surface.

OBJECTIVE OF TDS

- REDUCTION OF IDLE TIME OF MACHINERY.

- OPTIMUM UTILISATION OF HEMMS.

- HEALTH MONITORING OF HEMMS.

- QUALITY CONTROL

- ONLINE B/D REPORTING OF MACHINES

- CRUSHER THROUGHPUT MANAGEMENT.

- IMPROVED MINE SAFETY.

- EXTENSIVE ONLINE REAL TIME REPORTING.

- FEEL OF MINE ACTIVITY THROUGH ELECTRONIC EYE.

USE OF GPS IN MINING

- ✓ Automatic and optimized haul truck assignment.
- ✓ Auxiliary equipment tracking.
- ✓ Equipment vital signs monitoring.
- ✓ R & D for different parts of a machine by 3D plotting of the GPS Traces.
- ✓ Quality control of ore /material blending.
- ✓ Subsidence Management.
- ✓ Dump/Slope management.
- ✓ Automation.

USE OF TDS IN THE MINE
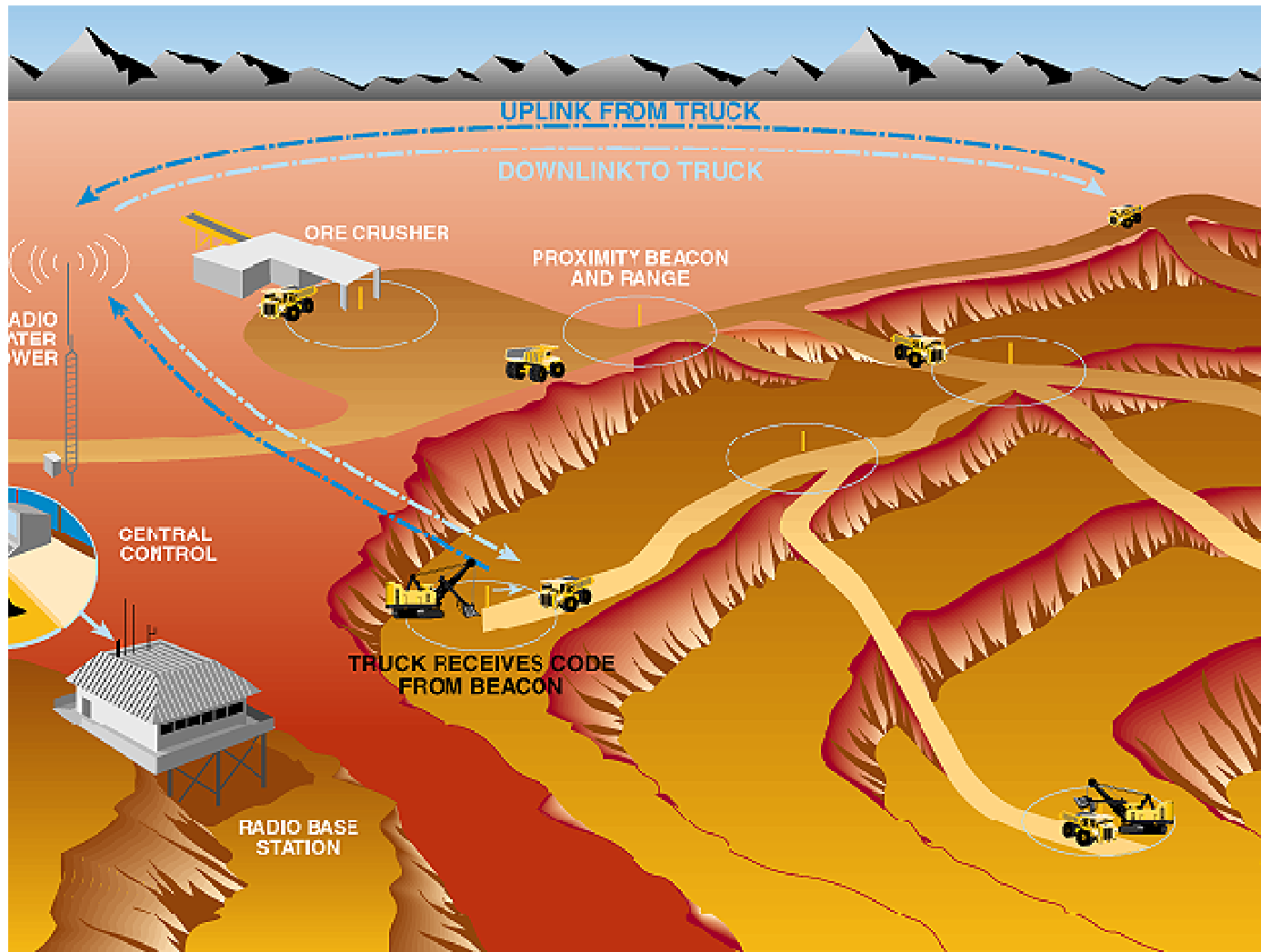
➢Since May-2005.

➢Provided by Modular mining System, US.

➢It is a GPS based Truck Dispatch System.

WHAT IS TDS
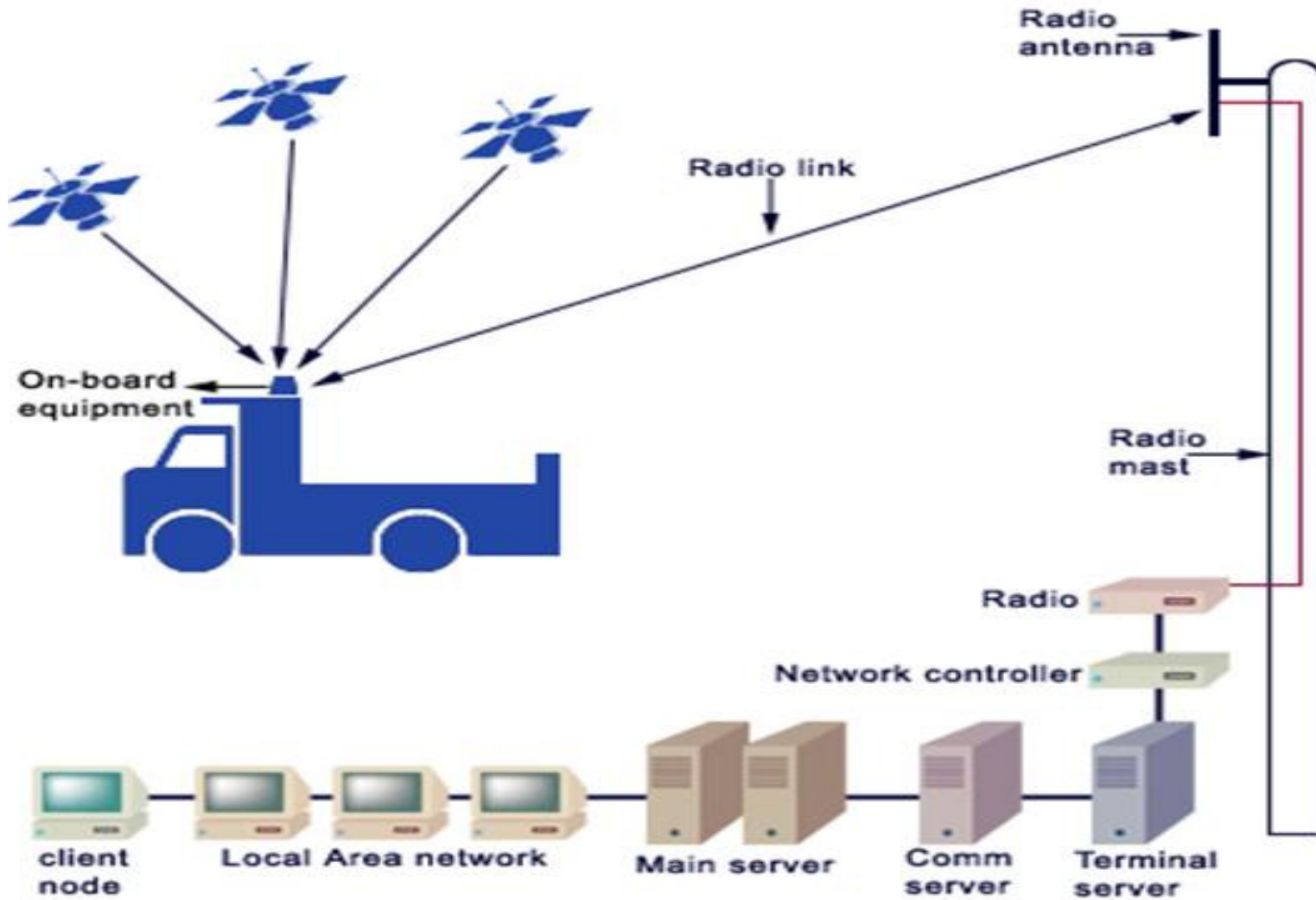
TYPICAL SYSTEM

- Field Computer Systems (FCS), including Hub and Color Graphical Console (CGC) for each truck and shovel

- Wireless radio network

- Central computer equipment

- GPS ground reference station

- The Field Computer Hub contains:

  - Global Positioning System (GPS) location system

  - Data radio

PANCHPATMALI BAUXITE MINES,NALCO

CALL POINT

PURPOSE OF TDS

OPTIMIZATION of the mine operation based on real-time data

HOW DOES IT DO IT?

By providing all of the following and more:

- ❑ · Automatic, optimised haul truck assignments
- ❑ · Auxiliary equipment tracking
- ❑ · Automatic fuel assignments
- ❑ · Equipment vital signs monitoring
- ❑ · Maintenance tracking

MINE OPERATION SCENARIO WITH

DISPATCH

❑   Optimal production circuits.
❑   Dynamic assignments.
❑   Real-time blending control.
❑   Dynamic adjustment of cycle times

DISPATCH AS A TOOL

DISPATCH as a tool has many functions

-       An integrated data collector
-       A massive database, and
-       A high-speed, real-time problem solver

DISPATCH AS A DATA COLLECTOR

❑ DISPATCH is constantly receiving data , referring to data and storing data. It uses the data, real-time and historical, to update records, make assignment decisions, and to generate reports.

INTERACTIVE DATA COLLECTION

• Operator responses (button presses)
• Dispatcher interaction
  - Changing operator names
  - Altering a truck assignment
  - Changing the status of equipment

DISPATCH requires a certain amount of interactivity from the operators and the dispatchers in order to update its records, keep its data free of error, and to make sound decisions.

DISPATCH AS A REAL-TIME PROBLEM SOLVER

✓   Constantly receiving data and updating its databases.

✓   It is always calculating travel times, load times, queue times, fuel levels, tire usages, load counts, and a host of other events that affect overall mine operations.

DISPATCH AS A REAL-TIME PROBLEM SOLVER

✓   The primary question being solved is

"what is the best assignment for each piece of equipment right now in order to achieve the mine's goal?"

HOW DOES IT SOLVE THESE PROBLEMS?

Equipped with the data in the pit database, DISPATCH uses three computer (OR) models to help it solve these questions and others like them:

- The best path (BP) model,
- The linear programming (LP) model, and
- The dynamic programming (DP) model

THE BEST PATH (BP) MODEL

- Used to determine the shortest path between two points in the mine.

- DISPATCH calculates the shortest path (by distance, not time) from each point in the mine to every other point in the mine whenever there is a change in the mine road network and whenever the LP model is recalculated. The results of the best path calculation are included in the LP model.

Haul Cycle Model
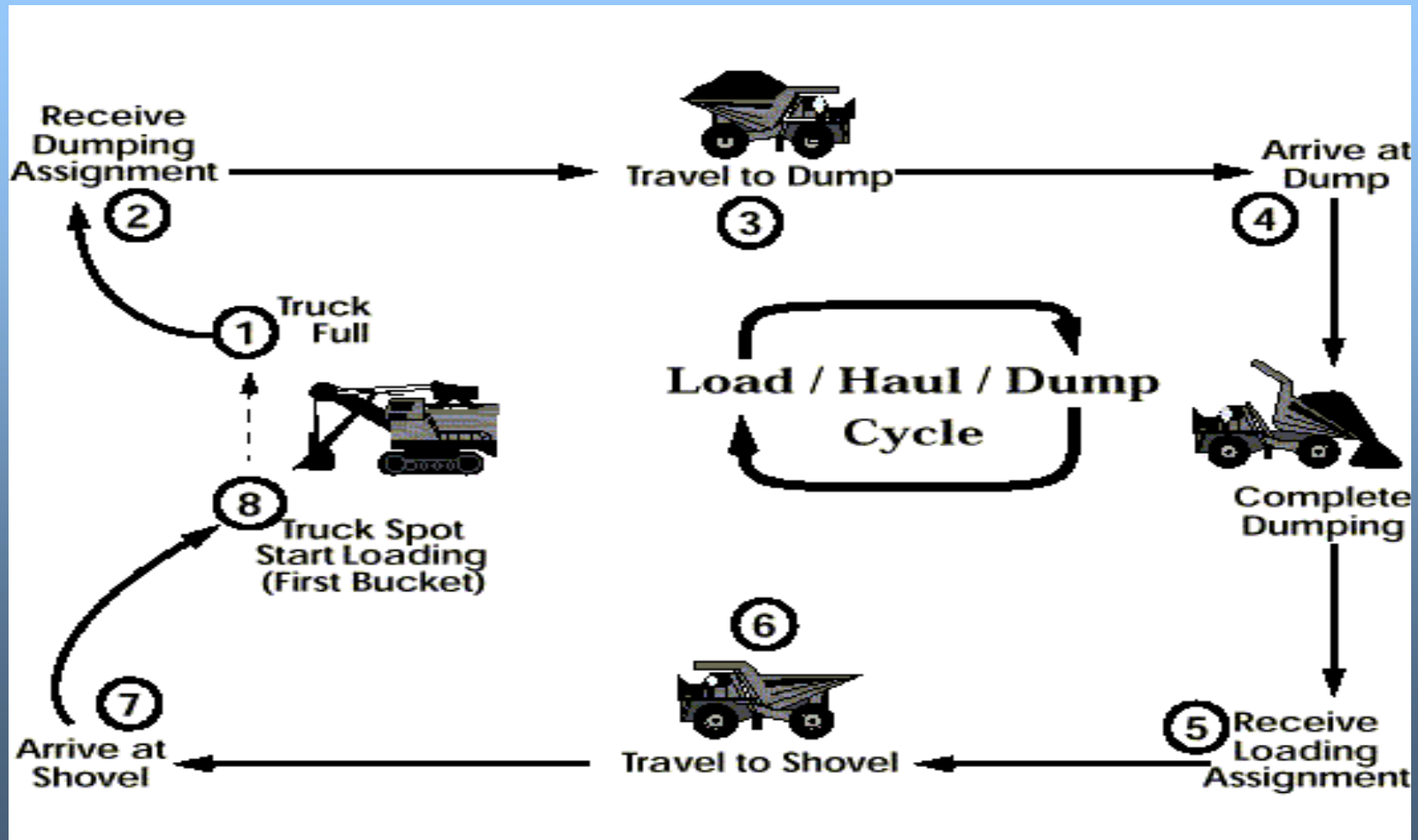
THE IMPORTANCE OF THE HAUL CYCLE MODEL

✓   DISPATCH bases many decisions on this operational model.

✓   DISPATCH always expects the next event in the haul cycle to occur for each shovel and each truck and anticipates its occurrence within a certain computed timeframe

✓   Based on that expectation of the next event or action for each truck and shovel (and other operational considerations), DISPATCH makes a decision that is necessary right now, such as an assignment request from the field

Path Options for Dispatching
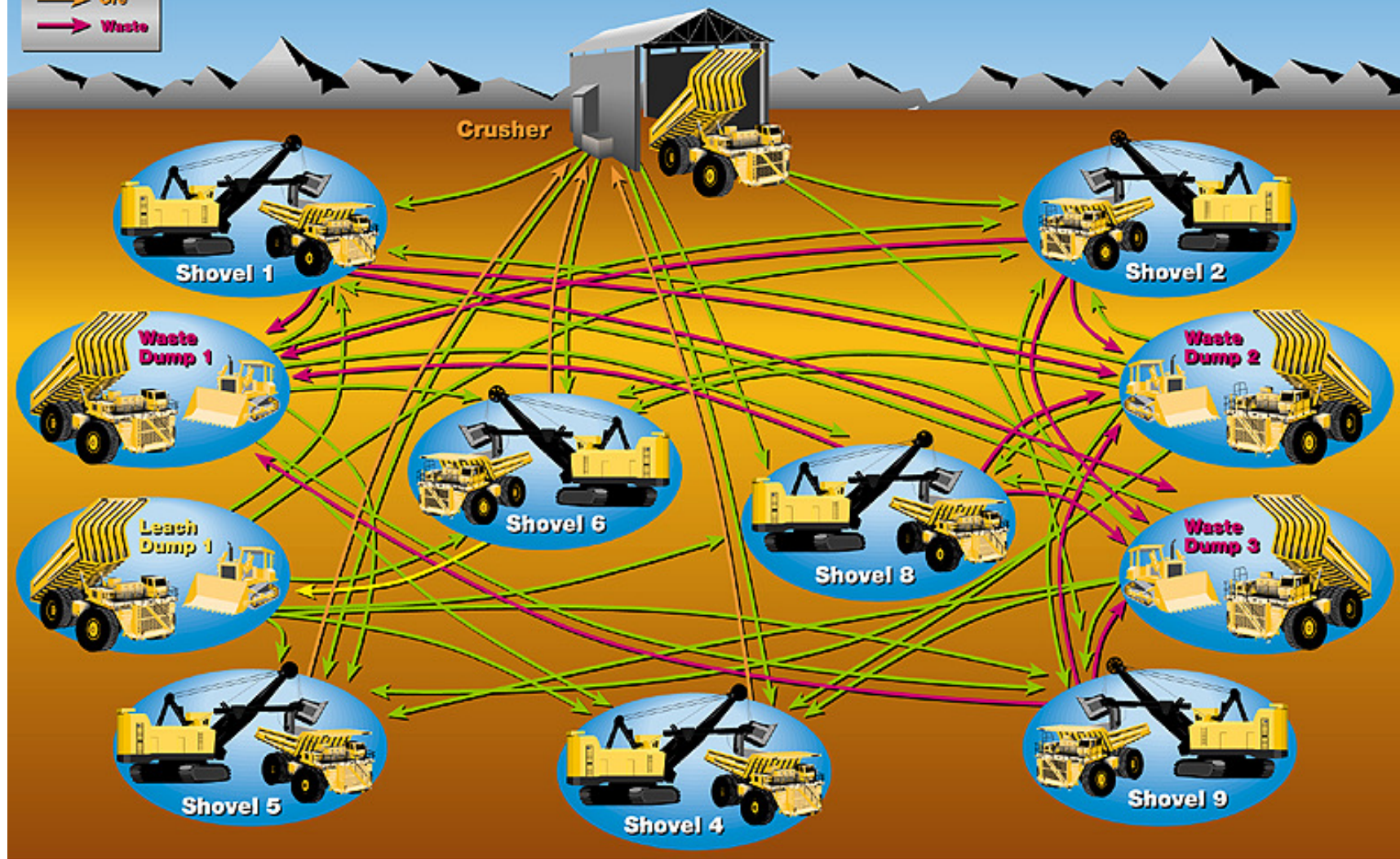
DISPATCH® Selected Paths
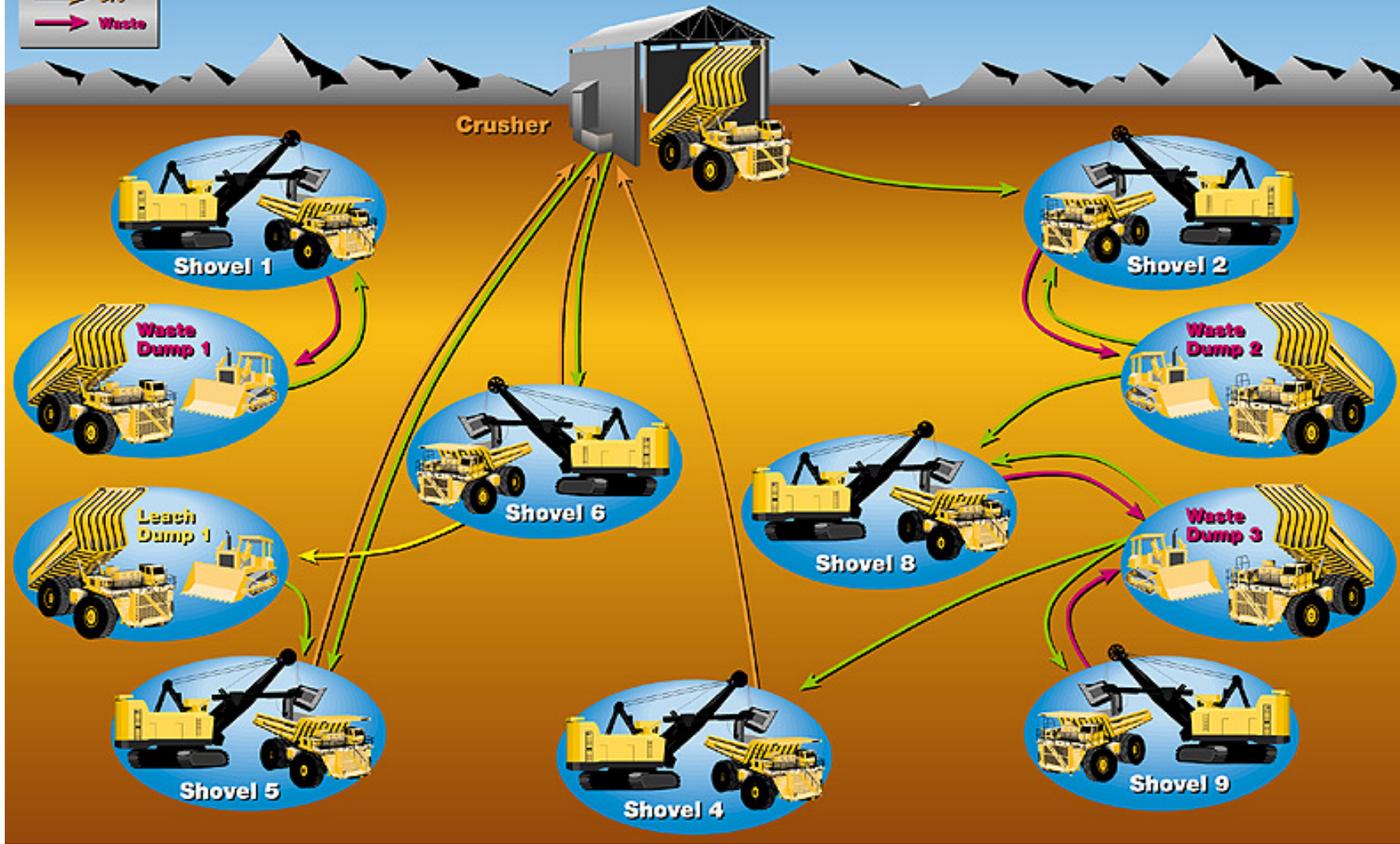
Configuration of DISPATCH

PIT OPTIMIZATION

It is a powerful mathematical algorithm when generating optimized haul truck assignments, including:

Best Path (BP)-Uses distance as the criteria as the shortest,

Linear Programming (LP)-
-uses production and operational constraints,

Dynamic Programming (DP)-
-It uses the LP's Master Plan as a reference, and builds "future" scenarios when generating assignments.

Pit graphics

HAUL ROUTE SHOWING THE LOADING AND DUMPING LOCATIONS

HaulRoute

fresh Display Utilities Search

Excav to Dump: 6.03 mins   Dump to Excav: 8.27 mins

RAL1: Have 10, Need 10 Avg Trucks   CENTRAL1: Actual trucks: 10, LP C

HD61 CRUSHER   CRUSHER
HD69 CRUSHER   CRUSHER
HD51 CRUSHER   CRUSHER
HD62 HD67 CRUSHER   CRUSHER

WL15   WL17   WL18   CRUSHER   Shiftchange   Fuel

HD66
HD63
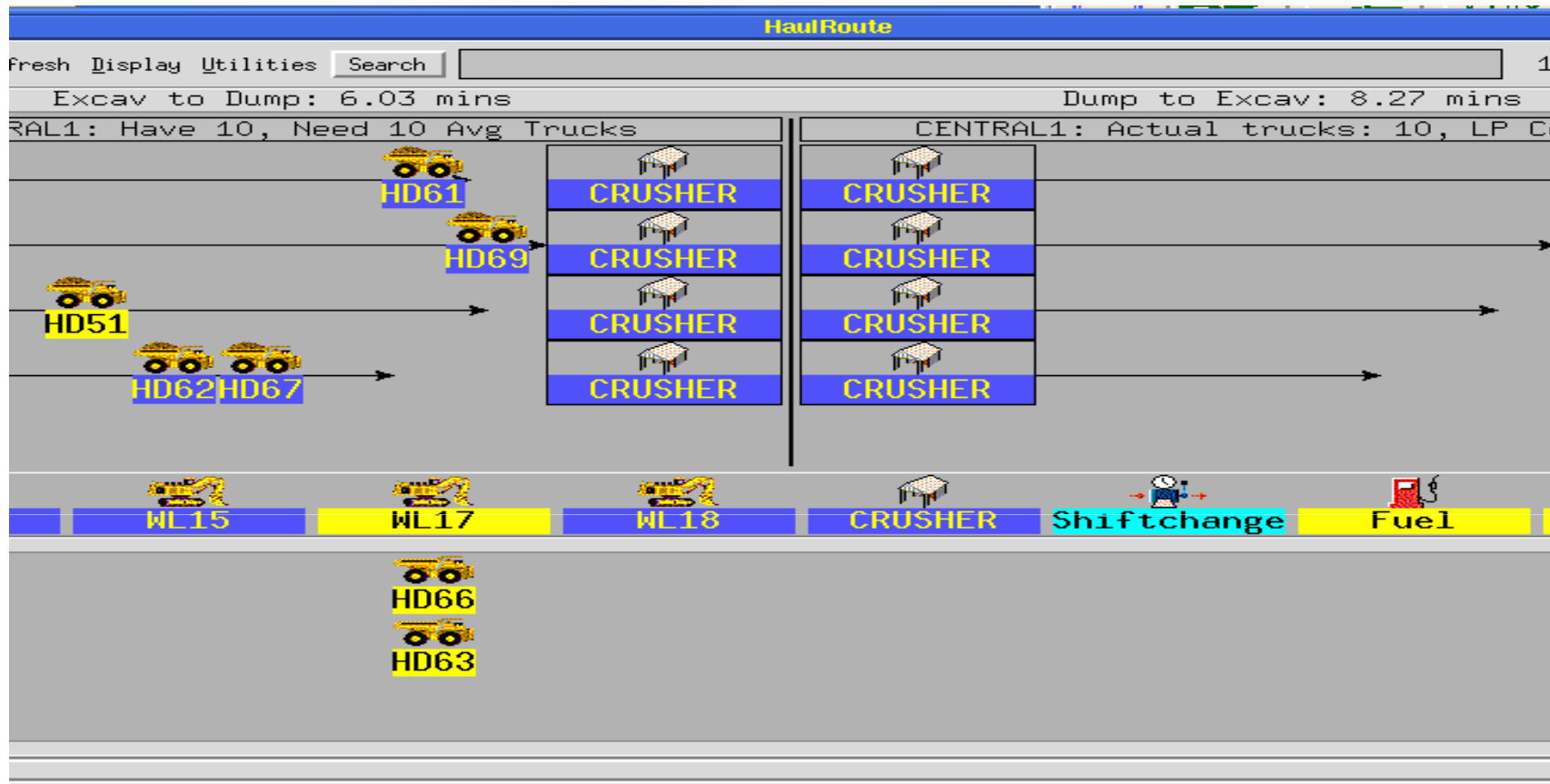
Four Loading machines and 10 dumpers running with TDS system in the mines.

BENEFITS
DUMPER PERFORMANCE REPORT

| Bottom | PageUp | PageDn | Print | Refresh | Remove | Help | Exit | Config | S |

TRUCK OPERATOR REPORT

19-JUL-06 A Shift at 12:10:32 with A

Operator	Idle Min/Load	Loads Bauxi	Waste	Rehan	Total	Used Hrs.	Lds/Used Hr.	tonnes	tonnes/Used
D Gouda	0.00	9	0	0	9	3.60	2.5	405.0	112.4
P.K.Behera	0.00	1	0	0	1	0.78	1.3	45.0	57.9
Md.Ansari	0.16	9	0	0	9	1.80	5.0	405.0	224.8
H K Yadab	0.00	8	0	0	8	3.20	2.5	360.0	112.5
H.N.Patnaik	0.17	13	0	0	13	3.72	3.5	585.0	157.4
P.K.Sahoo	0.00	14	0	0	14	3.67	3.8	630.0	171.5
C.Soren	0.00	3	0	0	3	1.02	2.9	135.0	131.9
A K Pradhan	0.67	5	0	0	5	0.98	5.1	225.0	228.7
D K Singh	0.50	10	0	0	10	2.93	3.4	450.0	153.4
G SIYA	0.45	14	0	0	14	4.03	3.5	630.0	156.2
Md.Ansari	0.00	4	0	0	4	0.85	4.7	180.0	211.5
C.S.Nayak	0.14	15	0	0	15	3.91	3.8	675.0	172.8
A K Pradhan	0.23	4	0	0	4	0.76	5.2	180.0	235.7
R K Behera	0.51	13	0	0	13	3.90	3.3	585.0	149.9
R.Mahanandia	1.03	13	0	0	13	3.30	3.9	585.0	177.1
G N Beshra	0.89	3	0	0	3	0.89	3.4	135.0	152.0
K Pradhan	0.00	5	0	0	5	3.41	1.5	225.0	65.9
A R Lal	2.44	3	0	0	3	0.75	4.0	135.0	179.3

➢ Automatic trip count.

➢ Idle time and used time recording.

➢ Performance of any machine or operator can be at any time seen at ay time during and after the shift.

➢ Performance for a period of time can also be analyzed instantly by multiple shift report.

LOADER PERFORMANCE REPORT

| Top | Bottom | PageUp | PageDn | Print | Refresh | Remove | Help | Exit | Config | Select |

SHOVEL OPERATOR REPORT

19-JUL-06 A Shift at 12:08:04 with A

Shovel	Operator	Avg Ld Time(mins)					Loads						
		Idle	Spot	Dig	Bauxi	Waste	Rehan	Total	Used Hrs.	Lds/Used H	tonnes	tonnes/Used
WL15	K C Sahu(Jr)	2.45	0.48	2.46	43	0	0	43	3.9	11.1	1935.0	500.8
WL17	L Hembram	3.48	0.65	1.46	7	0	0	7	0.7	10.7	315.0	483.0
WL17	B Gour	3.18	0.17	2.11	42	0	0	42	3.8	11.0	1890.0	494.4
	Subtotal	3.22	0.24	2.02	49	0	0	49	4.5	10.9	2205.0	492.7
WL18	P Sahoo	1.16	0.41	1.77	12	0	0	12	0.7	17.9	540.0	807.6
WL18	I P Gomango	3.39	0.72	1.73	39	0	0	39	3.8	10.3	1755.0	462.2
	Subtotal	2.86	0.65	1.74	51	0	0	51	4.5	11.4	2295.0	514.0
HE08	R K Sahoo	8.09	0.00	8.82	17	0	0	17	4.8	3.5	765.0	159.6

Press space bar to continue...

➢   Loader performance ,like the dumpers ,can also be seen at anytime and compared for further improvement.

➢   Low tonnes/used hrs of a loading machine means insufficient number of dumpers and it can be deployed in other jobs immediately which was not possible without the system.

PRIMARY BENEFITS

❖   Improved equipment utilization

❖   Absolute control over material origin and destination

❖   Changes the nature of technical and operational decision making

❖   Focuses employees on performance

❖   Provides feedback on the effect of variations in their own contribution

BENEFITS

Increase in utilization by:

- ✓ Real-time display and monitoring of the entire mining operations.

- ✓ Instantaneous generation of alarms for stationary dumpers.

- ✓ Equipment Tracking and automatic warning against movement into unsafe zone and breakdown dumper movement.

- ✓ Bauxite Grade control.

- ✓ This utility contains all the logic required to manage the flow of material movement in the mine. This utility uses the ore body quality data files .

BENEFITS

✓   Key performance Indicator (KPI) for various parameters of pit management.

✓   **Crusher System**.

        It manages the flow of traffic at the crusher. The system automatically or manually by the crusher supervisor directs arriving trucks to the appropriate bin or dumping bay.

✓   Online Reporting and report generation as desired.

THANK YOU!

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