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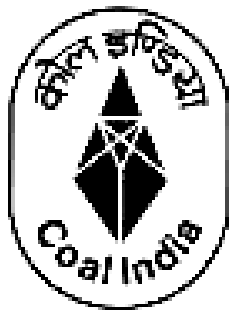
**GEOLOGICAL REPORT ON**  
COAL EXPLORATION (G3 STAGE)  
**ULIA- GAMHARDIH BLOCK**  
EAST OF BISRAMPUR COALFIELD  
DISTRICT- SURGUJA (CHHATTISGARH)

**VOLUME-I**

**NMET PROJECT**  
**TEXT**  
**JANUARY-2024**

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**EXPLORATION DEPARTMENT**



**CMPDI**

**A Mini Ratna Company**  
*(A Subsidiary of Coal India Ltd.)*

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**LIST OF ABBREVIATION**

|                 |   |
|-----------------|---|
| AFT             | - Ash Fusion Temperature Range                  |
| Ash%, A%        | - Ash percent                                   |
| BH No.          | - Borehole Number                               |
| Bh. Intersec.   | - Borehole Intersection                         |
| B               | - Bottom  |
| Cal             | - Calculated                                    |
| CIMFR           | - Central Institute of Mining and Fuel Research |
| CD              | - Closing Depth                                 |
| CVAR            | - Gross Calorific Value, as received basis      |
| CVDF            | - DMMF Gross CV or Unit Gross CV                |
| Det.            | - Determined                                    |
| Dist            | - District                                      |
| DMMF            | - Dry Mineral Matter Free                       |
| F/Faulted, FF   | - Floor Faulted                                 |
| F               | - Faulted                                       |
| FC%             | - Fixed Carbon percent                          |
| FRL / RRL       | - Floor / Roof Reduced Level                    |
| Gross CV        | - Gross Calorific Value                         |
| GSI             | - Geological Survey of India                    |
| H%              | - Hydrogen percent                              |
| HGI             | - Hard Grove Grindability Index                 |
| HQ              | - Head Quarters                                 |
| Kcal/kg         | - Kilocalories per kilogram                     |
| Km              | - Kilometre                                     |
| m               | - Metre   |
| M%              | - Moisture percent                              |
| MCM             | - Million Cubic Metres                          |
| Mt.             | - Million tonnes                                |
| SECL            | - South Eastern Coalfields Limited              |
| N.D.            | - Not Drilled                                   |
| N Dev/NDV       | - Not Developed                                 |
| M               | - Middle  |
| MTY             | - Million Tonnes per Year                       |
| NA              | - Not Available                                 |
| N%              | - Nitrogen percent                              |
| O%              | - Oxygen percent                                |
| OB              | - Overburden                                    |
| °C              | - Degree Celsius                                |
| OC              | - Opencast                                      |
| P/Faulted, PF   | - Parting Faulted                               |
| P <sub>60</sub> | - Proximate Analysis on 60% RH and 40°C         |
| R/Faulted, R/F  | - Roof Faulted                                  |
| RF              | - Representative Fraction                       |
| RH              | - Relative Humidity                             |
| RL              | - Reduced Level                                 |

**LIST OF ABBREVIATION**

|             |  |
|-------------|--|
| S%          | - Sulphur percent  |
| S/WM        | - Soil / Weathered mantle  |
| Sl.No.      | - Serial Number  |
| sq.km.      | - Square kilometre   |
| T           | - Top  |
| TD          | - Total Depth  |
| UA          | - Ultimate Analysis  |
| UG          | - Underground  |
| UHV         | - Useful Heat Value  |
| UG          | - Ungraded   |
| UVM%        | - Unit Volatile Matter percent   |
| VM%         | - Volatile Matter percent  |
| Waste       | - Non-coal which includes parting, overburden, Inseam band, < 1 m thick coal & ungraded coal |
| WM          | - Weathered Mantle   |
| Ash%        | Ash percentage   |
| AFTR:       | Ash Fusion Temp.Range  |
| BH No.      | Borehole number  |
| Bot.        | Bottom   |
| oC          | Degree Celcius   |
| CV          | Calorific Value  |
| C%          | Carbon Percent   |
| CMPDI       | Central Mine Planning & Design Institute Ltd.  |
| C.G.        | Madhya Pradesh   |
| CF:         | Coalfield  |
| Carb. shale | Carbonaceous shale Comp.          Composite  |
| Dist.       | District   |
| dmmf        | Dry mineral matter free  |
| FC%         | Fixed Carbon percentage  |
| Fig.        | Figure   |
| FRL         | Floor reduced level  |
| GCV         | Gross Calorific value  |
| GSI         | Geological Survey of India   |
| GR          | Geological Report  |
| Govt.       | Government   |
| H%          | Hydrogen percent   |
| HGI         | Hardgrove Grindability Index K.cal./kg<br>Kilocalories per kilogram                          |
| m.          | Metre  |
| M.T.        | Million tonnes   |
| M%          | Moisture percentage  |
| Mpa         | Mega Pascal  |
| N'Gamma     | Natural Gamma  |
| N%          | Nitrogen percentag   |

**LIST OF ABBREVIATION**

|      |                                 |
|------|---------------------------------|
| W/M  | Weathered Mantle                |
| Wt.  | Weight                          |
| SH   | Shale                           |
| SST  | Sand Stone                      |
| MGD  | Medium Grained                  |
| FGD  | Fine Grained                    |
| VCGD | Very Coarse Grained             |
| Carb | Carbonaceous                    |
| Vit  | Vitrinite                       |
| Lipt | Liptinite                       |
| Int  | Inertinite                      |
| VMM  | Visible Mineral Matter          |
| Rr   | Mean Random Reflectance of coal |

# **SALIENT FEATURES OF ULIA- GAMHARDIH BLOCK, EAST OF BISRAMPUR COALFIELD, CHHATTISGARH**

## **1. LOCATION OF THE BLOCK**

The Ulia-Gamhardih block is located in the east central part of Surguja district of Chhattisgarh. It is situated about 55 km north east of district headquarter Ambikapur. The Bistrampur coalfield lies south west of this area. Rajpur to the west and Shankargarh, Dipadih & Kusmi to the east are important places around this area. The area is bounded by latitudes 23°20'41.364" N and 23°25'29.111" N and longitudes 83°32'6.965" E and 83°36'47.053" E and falls in Survey of India Toposheet No. 64M/11.

## **2. ACCESSIBILITY / COMMUNICATION**

The Ulia-Gamhardih area is well connected by Ambikapur-Rajpur- Ramanujganj State Highway which passes through the western part of the area. This area is also approachable from southern side from Shankargarh, which falls on Rajpur- Shankargarh-Kusmi metalled road. Interior parts of the area are well connected through all-weather unmetalled road and forest tracks. Nearest railhead is the newly constructed railway station at Ambikapur. Earlier nearest railhead was at Bistrampur on Bilaspur- Annapur section of South Eastern Railway. Another railway station, 'Renukut' on Singrauli – Garhwa section of Eastern Railway is approximately 180 km away from this area. This area can also be approached from various important localities such as Wadrafnagar, Pratappur, Daltenganj, Garhwa and Kusmi.

## **3. OBJECTIVE**

The objective of the present investigation (**G3 stage of exploration**) is as follows,

1. To establish the existence and continuity of coal seams of Barakar Formation occurring in the block.
2. To establish the lay, disposition and potentiality of coal seams upto basement.
3. To appraise the resource potentiality of Barakar coal seams in the block.

This G3 stage of exploration drilling was done by M/s. MMPL under the supervision of CMPDI.

#### 4. PERIOD OF INVESTIGATION

##### Year-wise details of borehole meterage drilled in Ulia-Gamhardih Block, East of Bisrampur Coalfield

| Phase | Agency       | Period            | BH Drilled | Borehole series | Meterage (m)   |
|-------|--------------|-------------------|------------|-----------------|----------------|
| 1     | GSI          | Oct' 06 to Jul'07 | 6          | EBUG            | 948.30         |
| 2     | CMPDI        | Dec'22 to Jul'23  | 8          | CEBUG           | 894.30         |
|       | <b>TOTAL</b> |                   | <b>14</b>  |                 | <b>1842.60</b> |

#### 5. STATUS OF MINING

The block is entirely virgin.

#### 6. AREA & LIMIT

The block measures **39.14 sq.km.** and is bounded by:

North : The block is bounded on north side by Arjungarh pahar.

South : The south side bounded by metamorphics (Pre-Cambrian).

East : The block is bounded on East side by Dhaska Naugai block.

West : On the west by faulted boundary between Barakar Formation and metamorphics (Pre-Cambrian).

##### Cardinal Points of Block Boundary of Ulia-Gamhardih Block, East of Bisrampur Coalfield (WGS-84).

| Point ID | Longitude        | Latitude         | Point ID | Longitude        | Latitude         |
|----------|------------------|------------------|----------|------------------|------------------|
| 1        | 83°36' 15.123" E | 23°25' 28.914" N | 51       | 83°35' 1.830" E  | 23°21' 7.422" N  |
| 2        | 83°36' 15.617" E | 23°24' 7.148" N  | 52       | 83°34' 52.733" E | 23°21' 3.568" N  |
| 3        | 83°36' 16.129" E | 23°23' 48.760" N | 53       | 83°34' 45.640" E | 23°20' 59.867" N |
| 4        | 83°36' 16.887" E | 23°23' 48.836" N | 54       | 83°34' 36.851" E | 23°20' 54.727" N |
| 5        | 83°36' 17.594" E | 23°23' 49.071" N | 55       | 83°34' 24.362" E | 23°20' 48.354" N |
| 6        | 83°36' 17.958" E | 23°23' 49.178" N | 56       | 83°34' 16.858" E | 23°20' 44.859" N |
| 7        | 83°36' 18.729" E | 23°23' 49.136" N | 57       | 83°34' 10.485" E | 23°20' 41.364" N |
| 8        | 83°36' 19.778" E | 23°23' 49.136" N | 58       | 83°34' 8.275" E  | 23°20' 46.144" N |
| 9        | 83°36' 20.677" E | 23°23' 49.307" N | 59       | 83°34' 6.887" E  | 23°20' 49.177" N |
| 10       | 83°36' 21.770" E | 23°23' 49.435" N | 60       | 83°34' 5.448" E  | 23°20' 53.237" N |
| 11       | 83°36' 23.247" E | 23°23' 49.692" N | 61       | 83°34' 2.827" E  | 23°20' 58.531" N |
| 12       | 83°36' 24.703" E | 23°23' 49.692" N | 62       | 83°34' 1.336" E  | 23°21' 1.923" N  |
| 13       | 83°36' 25.881" E | 23°23' 49.671" N | 63       | 83°34' 0.205" E  | 23°21' 3.927" N  |
| 14       | 83°36' 26.909" E | 23°23' 49.585" N | 64       | 83°33' 59.383" E | 23°21' 6.035" N  |

| Point ID | Longitude        | Latitude         | Point ID | Longitude        | Latitude         |
|----------|------------------|------------------|----------|------------------|------------------|
| 15       | 83°36' 27.830" E | 23°23' 49.521" N | 65       | 83°33' 58.407" E | 23°21' 8.964" N  |
| 16       | 83°36' 28.323" E | 23°23' 49.607" N | 66       | 83°33' 57.173" E | 23°21' 12.099" N |
| 17       | 83°36' 29.072" E | 23°23' 49.607" N | 67       | 83°33' 56.145" E | 23°21' 15.183" N |
| 18       | 83°36' 29.586" E | 23°23' 49.564" N | 68       | 83°33' 55.683" E | 23°21' 17.496" N |
| 19       | 83°36' 30.507" E | 23°23' 49.243" N | 69       | 83°33' 54.963" E | 23°21' 19.449" N |
| 20       | 83°36' 31.770" E | 23°23' 48.986" N | 70       | 83°33' 53.010" E | 23°21' 25.411" N |
| 21       | 83°36' 32.648" E | 23°23' 48.900" N | 71       | 83°33' 50.954" E | 23°21' 31.681" N |
| 22       | 83°36' 33.462" E | 23°23' 48.986" N | 72       | 83°33' 47.870" E | 23°21' 39.545" N |
| 23       | 83°36' 34.040" E | 23°23' 49.200" N | 73       | 83°33' 45.146" E | 23°21' 47.100" N |
| 24       | 83°36' 34.747" E | 23°23' 49.371" N | 74       | 83°33' 49.721" E | 23°21' 47.254" N |
| 25       | 83°36' 35.432" E | 23°23' 49.264" N | 75       | 83°33' 52.342" E | 23°21' 47.357" N |
| 26       | 83°36' 36.353" E | 23°23' 48.921" N | 76       | 83°33' 55.683" E | 23°21' 47.254" N |
| 27       | 83°36' 37.231" E | 23°23' 48.386" N | 77       | 83°33' 58.458" E | 23°21' 47.254" N |
| 28       | 83°36' 40.315" E | 23°23' 48.022" N | 78       | 83°34' 1.233" E  | 23°21' 47.306" N |
| 29       | 83°36' 42.350" E | 23°23' 48.429" N | 79       | 83°33' 58.664" E | 23°21' 50.544" N |
| 30       | 83°36' 42.735" E | 23°23' 48.643" N | 80       | 83°33' 55.014" E | 23°21' 55.015" N |
| 31       | 83°36' 43.163" E | 23°23' 48.750" N | 81       | 83°33' 52.136" E | 23°21' 58.870" N |
| 32       | 83°36' 43.827" E | 23°23' 48.750" N | 82       | 83°33' 49.823" E | 23°22' 2.673" N  |
| 33       | 83°36' 44.384" E | 23°23' 48.514" N | 83       | 83°33' 46.277" E | 23°22' 7.093" N  |
| 34       | 83°36' 44.652" E | 23°23' 48.433" N | 84       | 83°33' 44.684" E | 23°22' 9.663" N  |
| 35       | 83°36' 46.748" E | 23°21' 55.236" N | 85       | 83°33' 42.114" E | 23°22' 13.107" N |
| 36       | 83°36' 47.053" E | 23°21' 44.148" N | 86       | 83°33' 40.778" E | 23°22' 14.803" N |
| 37       | 83°36' 41.744" E | 23°21' 41.087" N | 87       | 83°33' 38.876" E | 23°22' 17.630" N |
| 38       | 83°36' 35.525" E | 23°21' 38.466" N | 88       | 83°33' 35.638" E | 23°22' 22.512" N |
| 39       | 83°36' 28.124" E | 23°21' 35.125" N | 89       | 83°33' 32.554" E | 23°22' 26.727" N |
| 40       | 83°36' 21.031" E | 23°21' 31.527" N | 90       | 83°33' 30.961" E | 23°22' 27.909" N |
| 41       | 83°36' 15.789" E | 23°21' 29.677" N | 91       | 83°33' 16.107" E | 23°22' 30.582" N |
| 42       | 83°36' 9.724" E  | 23°21' 28.032" N | 92       | 83°32' 59.918" E | 23°22' 32.535" N |
| 43       | 83°36' 3.968" E  | 23°21' 26.079" N | 93       | 83°32' 48.559" E | 23°22' 34.128" N |
| 44       | 83°35' 56.978" E | 23°21' 24.280" N | 94       | 83°32' 31.187" E | 23°22' 36.749" N |
| 45       | 83°35' 53.277" E | 23°21' 23.201" N | 95       | 83°32' 18.029" E | 23°22' 37.828" N |
| 46       | 83°35' 49.525" E | 23°21' 22.070" N | 96       | 83°32' 9.600" E  | 23°22' 37.880" N |
| 47       | 83°35' 44.283" E | 23°21' 20.066" N | 97       | 83°32' 8.773" E  | 23°22' 37.899" N |
| 48       | 83°35' 32.308" E | 23°21' 15.697" N | 98       | 83°35' 6.965" E  | 23°25' 29.111" N |
| 49       | 83°35' 20.435" E | 23°21' 12.613" N | 99       | 83°36' 15.123" E | 23°25' 28.914" N |
| 50       | 83°35' 8.820" E  | 23°21' 9.838" N  |          |                  |                  |

## 7. BOREHOLE DENSITY

A total of 1842.60 m has been drilled within Uli-Gamhardih Block. A total of 14 boreholes have been drilled by CMPDI and GSI. The density of boreholes in the block is about 0.36 boreholes per sq. km.

## 8. CHEMICAL ANALYSIS

The details of chemical analysis of coal samples of the block are furnished in the following tables:

**Table S.F. 8A: Number and Type of Analysis in Ulia-Gamhardih Block, East of Bistrampur Coalfield during previous phases of investigation.**

| <b>BOREHOLE NAME</b> | <b>Number of band by band analysis samples</b> | <b>Number of Overall samples</b> | <b>Number of Special test samples</b> | <b>Number of Trace element test samples</b> | <b>Number of Petrographic test samples</b> |
|----------------------|--|----------------------------------|---------------------------------------|---|--|
| CEBUG-01             | 4  | NIL                              | NIL                                   | NIL   | NIL  |
| CEBUG-02             | NIL  | NIL                              | NIL                                   | NIL   | NIL  |
| CEBUG-03             | NIL  | NIL                              | NIL                                   | NIL   | NIL  |
| CEBUG-04             | 24   | 5                                | 5                                     | -   | 5  |
| CEBUG-05             | 32   | 2                                | 2                                     | -   | NIL  |
| CEBUG-06             | 23   | 7                                | -                                     | -   | NIL  |
| CEBUG-07             | 65   | 12                               | 5                                     | -   | NIL  |
| CEBUG-08             | 15   | 1                                | 1                                     | -   | NIL  |
| <b>Grand Total</b>   | <b>163</b>                                     | <b>27</b>                        | <b>-</b>                              | <b>-</b>                                    | <b>-</b>                                   |
| <b>Approved</b>      | <b>450</b>                                     | <b>120</b>                       | <b>13</b>                             | <b>-</b>                                    | <b>5</b>                                   |

**9. GEOLOGICAL FORMATION**

On the basis of Surface and Subsurface data of exploratory boreholes drilled by GSI/CMPDI) in and around Ulia-Gamhardih Block, the generalized sequence of the different Formations in the area under study is given below in Table S.F.9

**Table: S.F. 9 Stratigraphic sequence of Ulia-Gamhardih Block.**

| <b>Age</b>   | <b>Formation</b>  | <b>Lithology (Thickness in m)</b>  |
|--|-------------------|--|
| Recent/Sub Recent  | Alluvium          | Alluvium, Soil & Sandy Soil (upto 11.52m)  |
| Upper Tertiary to Pleistocene (?)  | Laterite          | Greyish brown to reddish brown, variegated and mottled coloured, hard, compact and ferruginous showing pisolitic and botroidal texture(upto 25.40m). |
| AAUnconformityAA |                   |  |
| Early Permian  | Barakar Formation | Fine to coarse grained feldspathic sandstone, grey and carbonaceous shales and coal seams.(upto 202.06+ m EBUG-04)                                   |
| Early Permian to Late Carboniferous  | Talchir Formation | Fine to medium grained moderately sorted greenish sandstone with shales and siltstone.(upto 52.28 m EBUG-02)   |
| ~~~~~Unconformity~~~~~   |                   |  |
| PreCambrian  | Metamorphics      | Granite and Gneiss   |

## 10. GEOLOGICAL STRUCTURE

The Geological structure of the block has been deciphered based on the sub surface data obtained from the boreholes as the block is entirely covered by soil / alluvium. This block is not much structurally complicated, a total three faults, F1, F2 and F3 have been deciphered on the basis of intersections in boreholes and floor contour plans coupled with geological cross section and field observation. In Ulia-Gamhardih block, the strike of the coal seam shows almost NNE-SSW trend. The overall dip of the coal seams varies between 3° to 4° towards ESE in the block.

**Table SF 10: Description of faults deciphered in Ulia-Gamhardih Block, East of Bisrampur Coalfield**

| Fault                          | Extension of fault in the block (km) | Trend (Strike of Fault)            | Throw Direction | Throw Amount (m) | Evidence  |
|--------------------------------|--------------------------------------|------------------------------------|-----------------|------------------|---|
| F <sub>1</sub> -F <sub>1</sub> | 7.4                                  | Trend of the fault is E-W          | North           | 110m             | Difference in FRL on either side of the fault (CEBUG-01,03, 05,7).  |
| F <sub>2</sub> -F <sub>2</sub> | 7.4                                  | Trend of the fault is almost N-S   | West            | 50m              | The trend of the fault is almost N-S. The fault has been delineated based on difference in FRL on either side of the fault (EBUG-04, 05,CEBUG-08,04).           |
| F <sub>3</sub> -F <sub>3</sub> | 6.0                                  | Trend of the fault is N-S to NW-SE | West            | 10m-180m         | The fault has been delineated based on the borehole number CEBUG-04, EBUG-04 and CEBUG-06, 07, EBUG-06, based on difference in FRL on either side of the fault. |

## 11. INTRUSIVE

No intrusion has been observed in this block.

## 12. SEQUENCE OF COAL SEAM IN ULIA-GAMHARDIH BLOCK

| Sequence of Seam / Parting | Depth Range of Seam (m) |         | Thickness (m) |         | No. of intersections |
|----------------------------|-------------------------|---------|---------------|---------|----------------------|
|                            | Minimum                 | Maximum | Minimum       | Maximum |                      |
| II                         | 9.55                    | 79.34   | 10.95         | 29.5    | 3                    |
| II TOP                     | 11.28                   | 98.23   | 1.47          | 4.37    | 4                    |
| II MIDDLE                  | 34.9                    | 102.84  | 2.05          | 2.92    | 2                    |
| II BOTTOM                  | 16.1                    | 115.1   | 0.64          | 20.81   | 4                    |
| I                          | 33.6                    | 173     | 0.6           | 5.3     | 8                    |

## 13. QUALITY/RESOURCES OF COAL SEAMS

In conformity with the occurrence of coal seams in Ulia-Gamhardih block of East of Bistrampur coalfield in general, G3 stage of exploration in the said block has revealed the existence of 5 coal horizons, viz. split seam sections of seam II i.e. Seam II Top, Seam II Middle and Seam II Bottom and Seam I in descending order.

A major fault (F1) is passing through the Southern and South-western part of the block, due to which no seams have been encountered in the boreholes (CEBUG01, CEBUG-02, CEBUG-03), drilled in the upthrown side of the fault(F1) to the Southern and South-western side of the block. There are two consistent seams namely seam II and it splits(Top, Middle and Bottom) I. Though Seam II is consistent seam the seam has been incropped within the block near the borehole CEBUG-05 and seam falls updip in the upthrown side of the faults F1-F1 and F2-F2. The seam II has been splitted in to top middle and bottom section, the combined section has been encountered near the boreholes CEBUG-06,04 and EBUG-06 having an area of around 7.8 sq.km, in the remaining area the seams has been splitted. The seam I has been developed in the block and the seam falls updip in the upthrown side of the fault F2-F2. All the seams have been considered for resource estimation and minimum workable thickness considered is 0.90m.

The area of influence considered as per ISP norms for the seam II and its splits & Seam I. However, in places it exceeds the area more than 800m up to 1000m maximum in limited places, for which the percentage is very low compared to the total block area. Hence all the resources have been put under the indicated category only.

## 14. GEOLOGICAL RESOURCES

A total Gross Indicated resource estimated is **587.70 million tonnes**.

The seam-wise grade-wise Gross Indicated Geological reserves are provided in Table–SF.14 a.

**Table–SF.14 a Seam-wise Grade-wise Gross Indicated Geological Resources, Ulia-Gamhardih block, East of Bisrampur Coalfield**

| Seam Name/Grade    | Grade Range  |             |             |              |               |              |              |               |             |              |             |             |             |             |             | Grand Total   |
|--------------------|--------------|-------------|-------------|--------------|---------------|--------------|--------------|---------------|-------------|--------------|-------------|-------------|-------------|-------------|-------------|---------------|
|                    | G3           | G4          | G5          | G6           | G7            | G8           | G9           | G10           | G11         | G12          | G13         | G14         | G15         | G16         | G17         |               |
| <b>II</b>          |              |             |             |              | 108.49        |              | 33.91        |               |             | 67.46        |             |             |             |             |             | <b>209.86</b> |
| <b>IIT</b>         | 3.83         | 3.85        | 1.17        | 0.04         | 1.06          | 4.54         | 3.90         | 0.85          | 1.43        | 2.37         | 2.65        | 0.07        |             |             |             | <b>25.76</b>  |
| <b>HM</b>          | 12.15        |             |             |              |               |              |              |               |             | 9.32         |             |             |             |             |             | <b>21.47</b>  |
| <b>IIB</b>         |              |             |             |              |               | 1.23         | 30.79        | 169.21        | 2.18        | 13.04        |             |             |             |             |             | <b>216.45</b> |
| <b>I</b>           |              | 0.32        | 4.18        | 15.01        | 28.02         | 33.67        | 12.59        | 7.38          | 5.50        | 3.64         | 1.69        | 1.00        | 0.61        | 0.37        | 0.18        | <b>114.16</b> |
| <b>Grand Total</b> | <b>15.98</b> | <b>4.17</b> | <b>5.35</b> | <b>15.05</b> | <b>137.57</b> | <b>39.44</b> | <b>81.19</b> | <b>177.44</b> | <b>9.11</b> | <b>95.83</b> | <b>4.34</b> | <b>1.07</b> | <b>0.61</b> | <b>0.37</b> | <b>0.18</b> | <b>587.70</b> |

## Chapter - 1

# INTRODUCTION

### 1.1 INTRODUCTION

The East of Bistrampur Coalfield lies in the eastern part of the Son- Mahanadi Valley Basin. This coalfield is separated from the Tatapani – Ramkola Coalfield to the north by large intervening tract covered by metamorphics (Pre-Cambrian). Consequent upon new find of coal around Ulia-Gamhardih area, published in the Geological Society of India, vol.- 66, Aug, 2005, exploration for coal by scout drilling in the aforesaid area to the east of the known confines of Bistrampur Coalfield was undertaken by GSI to examine the development of coal bearing Lower Gondwana sequence beside stratigraphy and structural set up of the area.

The investigation commenced in the area with large scale mapping on 1:25000 scale and surface geophysical investigation in January, 2006 followed by drilling and completed in July, 2007. A total of 1510.45 m were drilled in eight boreholes in Ulia-Gamhardih area and an area of about 80 sq km was geologically mapped on 1:25,000 scale during the period. Out of these eight boreholes only six boreholes falls within the present area of investigation, Ulia-Gamhardih block.

The Ulia- Gamhardih area, lying to the east of the confines of Bistrampur Coalfield is a small and detached sub-basin located east and north east of the Bistrampur Coalfield and to the south east of the Tatapani- Ramkola Coalfield. The vast tracts between these coalfields are occupied by Surguja crystalline complex. The Ulia-Gamhardih area, is actually a NW-SE trending sub- basin located in the east central part of Surguja district of Chhattisgarh.

The area is bounded by latitudes 23°20'41.364" N and 23°25'29.111" N and longitudes 83°32'6.965" E and 83°36'47.053" E and falls in Survey of India Toposheet No. 64M/11. It covers an area of about 39.14 sq. km. Forest area within the block is 29.01 sq. km (as per FSI map).

In the area, the Lower Gondwana Group of rocks belonging to Talchir and Barakar formation rest directly over the Precambrian metamorphics by E-W and NW-SE to NNW-SSE trending faults. The rocks of Talchir Formation are exposed in the north-western and western part of the area and are characterized by greenish to light bluish, thinly laminated shale/silty shale and siltstone with light greenish, fine grained, thin bands of sandstone.

The Ulia-Gamhardih Block has been identified for G-3 stage of exploration on the basis of findings of GSI reported in “Final Report On Exploration for Coal by Scout Drilling in and Around Ulia – Gamhardih Area to The East of the Confines of Bistrampur Coalfield, Surguja District, Chhattisgarh,2010”. CMPDI has drawn proposal for exploration for coal in the Block having area of about 39.14 sq.km and involving 1300 m in 8 no. of boreholes along with integrated geophysical survey. The boreholes have been proposed at about 1600 X 1600 m grid pattern. In the present Ulia-Gamhardih block, the drilling was undertaken, to prove the structure and existence of the coal Seams, during the period from 6-12-2022 to 9-08-2023. All the drilled boreholes are DGPS surveyed.

## **1.2 LOCATION**

The Ulia-Gamhardih block is located in the east central part of Surguja district of Chhattisgarh. It is situated about 55 km north east of district headquarter Ambikapur. The Bistrampur coalfield lies south west of this area. Rajpur to the west and Shankargarh, Dipadih & Kusmi to the east are important places around this area. The area is bounded by latitudes 23°20'41.364” N and 23°25'29.111” N and longitudes 83°32'6.965” E and 83°36'47.053” E and falls in Survey of India Toposheet No. 64M/11.

## **1.3 ACCESSIBILITY & COMMUNICATION**

The Ulia-Gamhardih area is well connected by Ambikapur-Rajpur- Ramanujganj state highway which passes through the western part of the area. This area is also approachable from southern side from Shankargarh, which falls on Rajpur-Shankargarh-Kusmi metalled road. Interior parts of the area are well connected through all-weather unmetalled road and forest tracks. Nearest railhead is the

newly constructed railway station at Ambikapur. Earlier nearest railhead was at Bistrampur on Bilaspur- Annupur section of South Eastern Railway. Another railway station, 'Renukut' on Singrauli – Garhwa section of Eastern Railway is approximately 180 km away from this area. This area can also be approached from various important localities such as Wadrafnagar, Pratappur, Daltenganj, Garhwa and Kusmi.

#### 1.4 AREA OF THE BLOCK

The block measures **39.14 sq.km.** and is bounded by:

- North : The block is bounded on north side by Arjungarh pahar.
- South : The south side bounded by metamorphics (Pre-Cambrian).
- East : The block is bounded on East side by Dhaska Naugai block.
- West : On the west by faulted boundary between Barakar Formation and metamorphics (Pre-Cambrian).

**Table 1.4A**

**Cardinal Points of Block Boundary of Ulia-Gamhardih Block, East of Bistrampur Coalfield (WGS-84).**

| Point ID | Longitude        | Latitude         | Point ID | Longitude        | Latitude         |
|----------|------------------|------------------|----------|------------------|------------------|
| 1        | 83°36' 15.123" E | 23°25' 28.914" N | 51       | 83°35' 1.830" E  | 23°21' 7.422" N  |
| 2        | 83°36' 15.617" E | 23°24' 7.148" N  | 52       | 83°34' 52.733" E | 23°21' 3.568" N  |
| 3        | 83°36' 16.129" E | 23°23' 48.760" N | 53       | 83°34' 45.640" E | 23°20' 59.867" N |
| 4        | 83°36' 16.887" E | 23°23' 48.836" N | 54       | 83°34' 36.851" E | 23°20' 54.727" N |
| 5        | 83°36' 17.594" E | 23°23' 49.071" N | 55       | 83°34' 24.362" E | 23°20' 48.354" N |
| 6        | 83°36' 17.958" E | 23°23' 49.178" N | 56       | 83°34' 16.858" E | 23°20' 44.859" N |
| 7        | 83°36' 18.729" E | 23°23' 49.136" N | 57       | 83°34' 10.485" E | 23°20' 41.364" N |
| 8        | 83°36' 19.778" E | 23°23' 49.136" N | 58       | 83°34' 8.275" E  | 23°20' 46.144" N |
| 9        | 83°36' 20.677" E | 23°23' 49.307" N | 59       | 83°34' 6.887" E  | 23°20' 49.177" N |
| 10       | 83°36' 21.770" E | 23°23' 49.435" N | 60       | 83°34' 5.448" E  | 23°20' 53.237" N |
| 11       | 83°36' 23.247" E | 23°23' 49.692" N | 61       | 83°34' 2.827" E  | 23°20' 58.531" N |
| 12       | 83°36' 24.703" E | 23°23' 49.692" N | 62       | 83°34' 1.336" E  | 23°21' 1.923" N  |
| 13       | 83°36' 25.881" E | 23°23' 49.671" N | 63       | 83°34' 0.205" E  | 23°21' 3.927" N  |
| 14       | 83°36' 26.909" E | 23°23' 49.585" N | 64       | 83°33' 59.383" E | 23°21' 6.035" N  |

| Point ID | Longitude        | Latitude         | Point ID | Longitude        | Latitude         |
|----------|------------------|------------------|----------|------------------|------------------|
| 15       | 83°36' 27.830" E | 23°23' 49.521" N | 65       | 83°33' 58.407" E | 23°21' 8.964" N  |
| 16       | 83°36' 28.323" E | 23°23' 49.607" N | 66       | 83°33' 57.173" E | 23°21' 12.099" N |
| 17       | 83°36' 29.072" E | 23°23' 49.607" N | 67       | 83°33' 56.145" E | 23°21' 15.183" N |
| 18       | 83°36' 29.586" E | 23°23' 49.564" N | 68       | 83°33' 55.683" E | 23°21' 17.496" N |
| 19       | 83°36' 30.507" E | 23°23' 49.243" N | 69       | 83°33' 54.963" E | 23°21' 19.449" N |
| 20       | 83°36' 31.770" E | 23°23' 48.986" N | 70       | 83°33' 53.010" E | 23°21' 25.411" N |
| 21       | 83°36' 32.648" E | 23°23' 48.900" N | 71       | 83°33' 50.954" E | 23°21' 31.681" N |
| 22       | 83°36' 33.462" E | 23°23' 48.986" N | 72       | 83°33' 47.870" E | 23°21' 39.545" N |
| 23       | 83°36' 34.040" E | 23°23' 49.200" N | 73       | 83°33' 45.146" E | 23°21' 47.100" N |
| 24       | 83°36' 34.747" E | 23°23' 49.371" N | 74       | 83°33' 49.721" E | 23°21' 47.254" N |
| 25       | 83°36' 35.432" E | 23°23' 49.264" N | 75       | 83°33' 52.342" E | 23°21' 47.357" N |
| 26       | 83°36' 36.353" E | 23°23' 48.921" N | 76       | 83°33' 55.683" E | 23°21' 47.254" N |
| 27       | 83°36' 37.231" E | 23°23' 48.386" N | 77       | 83°33' 58.458" E | 23°21' 47.254" N |
| 28       | 83°36' 40.315" E | 23°23' 48.022" N | 78       | 83°34' 1.233" E  | 23°21' 47.306" N |
| 29       | 83°36' 42.350" E | 23°23' 48.429" N | 79       | 83°33' 58.664" E | 23°21' 50.544" N |
| 30       | 83°36' 42.735" E | 23°23' 48.643" N | 80       | 83°33' 55.014" E | 23°21' 55.015" N |
| 31       | 83°36' 43.163" E | 23°23' 48.750" N | 81       | 83°33' 52.136" E | 23°21' 58.870" N |
| 32       | 83°36' 43.827" E | 23°23' 48.750" N | 82       | 83°33' 49.823" E | 23°22' 2.673" N  |
| 33       | 83°36' 44.384" E | 23°23' 48.514" N | 83       | 83°33' 46.277" E | 23°22' 7.093" N  |
| 34       | 83°36' 44.652" E | 23°23' 48.433" N | 84       | 83°33' 44.684" E | 23°22' 9.663" N  |
| 35       | 83°36' 46.748" E | 23°21' 55.236" N | 85       | 83°33' 42.114" E | 23°22' 13.107" N |
| 36       | 83°36' 47.053" E | 23°21' 44.148" N | 86       | 83°33' 40.778" E | 23°22' 14.803" N |
| 37       | 83°36' 41.744" E | 23°21' 41.087" N | 87       | 83°33' 38.876" E | 23°22' 17.630" N |
| 38       | 83°36' 35.525" E | 23°21' 38.466" N | 88       | 83°33' 35.638" E | 23°22' 22.512" N |
| 39       | 83°36' 28.124" E | 23°21' 35.125" N | 89       | 83°33' 32.554" E | 23°22' 26.727" N |
| 40       | 83°36' 21.031" E | 23°21' 31.527" N | 90       | 83°33' 30.961" E | 23°22' 27.909" N |
| 41       | 83°36' 15.789" E | 23°21' 29.677" N | 91       | 83°33' 16.107" E | 23°22' 30.582" N |
| 42       | 83°36' 9.724" E  | 23°21' 28.032" N | 92       | 83°32' 59.918" E | 23°22' 32.535" N |
| 43       | 83°36' 3.968" E  | 23°21' 26.079" N | 93       | 83°32' 48.559" E | 23°22' 34.128" N |
| 44       | 83°35' 56.978" E | 23°21' 24.280" N | 94       | 83°32' 31.187" E | 23°22' 36.749" N |
| 45       | 83°35' 53.277" E | 23°21' 23.201" N | 95       | 83°32' 18.029" E | 23°22' 37.828" N |
| 46       | 83°35' 49.525" E | 23°21' 22.070" N | 96       | 83°32' 9.600" E  | 23°22' 37.880" N |
| 47       | 83°35' 44.283" E | 23°21' 20.066" N | 97       | 83°32' 8.773" E  | 23°22' 37.899" N |
| 48       | 83°35' 32.308" E | 23°21' 15.697" N | 98       | 83°35' 6.965" E  | 23°25' 29.111" N |
| 49       | 83°35' 20.435" E | 23°21' 12.613" N | 99       | 83°36' 15.123" E | 23°25' 28.914" N |
| 50       | 83°35' 8.820" E  | 23°21' 9.838" N  |          |                  |                  |

## 1.5 PHYSIOGRAPHY & DRAINAGE

The southern part of the area is occupied by small hillocks and plain land as well. In this part, the ground elevation varies from about 600 m to 720 m. From south to north direction, gradual increase in ground elevation is observed. The north and northeastern edge of the coalfield is flanked by hills of Barakar Formation that are capped by laterite. Arjungarh Pahar in the north and Kandadara Pahar lying to the north east part are prominent topographical features. The peak

of the Arjungarh Pahar is 1094m high whereas peak of Kandadara Pahar is 1147 m above mean sea level.

Mahan River to the west is the principal drainage of this area. In western and central parts of the area numerous unnamed tributaries nala run either north to south or north- east to south- west feeding Mahan River that flows towards northwest. In the eastern part few tributaries flows in north direction.

## 1.6 CLIMATE, FLORA & FAUNA

The entire area falls under 'Protected Forest' which constitutes dense mixed jungle mainly of Sal, Bija, Saja, Dhaura, Mahua, Haldu, Bahera Kusum, Kendua, Palash, Amla etc. along with many medicinal plants. The area is infested with wild animals like bear, wild pig, anteater, fox, wolf etc. and many endangered species of birds and snakes as well.

The area experiences a tropical humid climate. Though winter is very cold with mercury dipping as low as 5° - 10° C, summer is oppressive with temperature often soaring up to 46° C. However, even day temperature is high, night is pleasant. Monsoon in the area enjoy a rather heavy rainfall.

## 1.7 PREVIOUS WORK

The credit of delineating the Bistrampur coalfield goes to the pioneer worker V. Ball (1873) who mapped the entire area around Bistrampur including the Bistrampur coalfield more than a century ago. Later, A.L.Coulson (1922-23) and C.S. Fox (1934) visited the area and have given a brief account of geology as well as an account of coal seams of the area. TISCO (1945-47) and Indian Bureau of Mines (1956-59) have prospected certain areas of the Bistrampur coalfield. T.S.Radhakrishna (1961-62) has also mapped certain areas around Bistrampur Coalfield. Geological Survey of India did detailed geological mapping of the area during 1961-64. The credit of preparing a large scale geological map (1:31,330) in and around Bistrampur Coalfield goes to P.K.Ghosh and M. Poonuswamy (1961-63) and P.K. Ghosh and P.K. Dutta (1964) who also started geological investigations for coal by drilling in the Bistrampur Coalfield. The investigations

were concentrated at Khargaon and Songara area where a total of 4120.85 m were drilled in 21 numbers of boreholes during 1963-66. Geological Survey of India explored the large, intervening tract around Songara, Latori and Khargaon during 1963-66 and 1969-80 by regional drilling. Jaiswal (DGM, MP; 1987) located a few exposures of Gondwana Group of rocks around Ulia and Gamhardih of the present area of investigation. Recently, Datta Manikar (DGM, Chhattisgarh; 2005) has given a brief account of rocks of coal bearing Barakar Formation in parts of Ulia-Patna-Jagima of the present area. Consequent upon new find of coal around Ulia-Gamhardih area, published in the Geological Society of India, Vol.- 66, Aug,2005, exploration for coal by scout drilling in and around Ulia- Gamhardih area to the east of the confines of Bistrampur Coalfield was undertaken mainly (i) to examine the development of coal bearing Lower Gondwana sequence and (ii) to decipher the stratigraphy and structural setup of area. As a part of exploration by scout drilling, eight boreholes viz. EBUG-1 to EBUG-7 and EBUG-7A were drilled involving 1510.45 m of drilling by deploying two drill machines. Of these boreholes, borehole EBUG-4 had to be closed prematurely in Barakar Formation due to drilling constraints. Rest of the boreholes were closed either within Talchir Formation or within basement metamorphics. Besides this, about 80 sq km area was geologically mapped on 1:25,000 scale and samples were collected for PET and CPS study. Prior to drilling, surface geophysical investigation by deploying Gravity, Magnetic and Deep Resistivity soundings along three profile lines were also carried out to study basement topography beneath the Gondwana sediments

## 1.8 MINING HISTORY OF THE BLOCK

The area in and around Ulia-Gamhardih Block is virgin with no mining activities.

## 1.9 EXPLORATION DESIGN

In 2022-23, CMPDI has drawn proposal for exploration for coal in the Ulia-Gamhardih Block having area of about 39.14 sq.km and involving 1300m of drilling in 8 boreholes. The G-3 stage of Exploration in the block is proposed to fulfill following objectives-

1. To establish the existence and continuity of coal seams of Barakar Formation occurring in the block.
2. To establish the lay, disposition and potentiality of coal seams upto basement.
3. To appraise the resource potentiality of Barakar coal seams in the block.

This G3 stage of exploration drilling was done by M/s. MMPL under the supervision of CMPDI.

| Phase | Agency       | Period            | BH Drilled | Borehole series | Meterage (m)   |
|-------|--------------|-------------------|------------|-----------------|----------------|
| 1     | GSI          | Oct' 06 to Jul'07 | 6          | EBUG            | 948.30         |
| 2     | CMPDI        | Dec'22 to Jul'23  | 8          | CEBUG           | 894.30         |
|       | <b>TOTAL</b> |                   | <b>14</b>  |                 | <b>1842.60</b> |

The run-wise lithology of boreholes drilled by GSI and CMPDI (through outsourcing) in the area is given in Annexure-IIA.

### 1.11 PRESENT INVESTIGATION

The quantum of schedule of exploration activities by CMPDI in Ulia-Gamhardih Block is given below:

**Table No.1.11.A.**

**The quantum & schedule of exploration activities by GSI and CMPDI in Ulia-Gamhardih Block, East of Bistrampur Coalfield.**

| S. No.   | Activity                                | Duration   |        | Quantum |
|----------|---|--|--------|---------|
|          |   | From   | To     |         |
| <b>1</b> | <b>Reconnaissance/Data Collection :</b> |  |        |         |
| a)       | GSI                                     | Oct'06   | Jul'07 | 6 BH'S  |
| b)       | CMPDI                                   | Dec'22   | Jul'23 | 8 BH'S  |
| <b>2</b> | <b>Mobilisation :</b>                   |  |        |         |
| a)       | GSI                                     | Oct'06   | Jul'07 | 6 BH'S  |
| b)       | CMPDI                                   | Dec'22   | Jul'23 | 8 BH'S  |
| <b>3</b> | a) Topographical Survey                 | Topographical as provided by Survey of India in 2m interval. |        |         |

|           |                             |                     |            |                         |
|-----------|-----------------------------|---------------------|------------|-------------------------|
|           | b) Borehole Survey          |                     |            |                         |
|           | i)                          | Oct'06              | Jul'07     | 6 BHs.<br>(EBUG Series) |
|           | ii)                         | Dec.2022            | Aug.2023   | 8 BH<br>(CEBUG Series)  |
| <b>4</b>  | <b>Drilling :</b>           |                     |            |                         |
| a)        |                             | 05.10.2006          | 20.07.2007 | 948.30m                 |
| b)        |                             | 11-12-2022          | 26-07-2023 | 894.30m                 |
| <b>5</b>  | <b>Geological Logging :</b> |                     |            |                         |
| a)        |                             | 05.10.2006          | 20.07.2007 | 948.30m                 |
| b)        |                             | 11-12-2022          | 26-07-2023 | 894.30m                 |
| <b>6</b>  | <b>Sampling/Packing</b>     |                     |            |                         |
| a)        |                             | Oct'06              | Jul'07     | 6 BHs.                  |
| b)        |                             | Dec.2022            | July.2023  | 06 Bhs.                 |
| <b>7</b>  | <b>Geophysical Logging</b>  |                     |            |                         |
|           |                             | 11-12-2022          | 26-07-2023 | 798.30m                 |
| <b>8</b>  | <b>Coal Core Analysis :</b> |                     |            |                         |
| a)        | GSI                         | 24 samples (6Bh's)  |            |                         |
| b)        | CMPDI                       | 163 samples (6Bh's) |            |                         |
| <b>10</b> | <b>Petrographic studies</b> |                     |            |                         |
|           |                             | 5 samples           |            |                         |
| <b>11</b> | <b>Trace Element Test</b>   |                     |            |                         |
|           |                             | NIL                 |            |                         |

Table 1.11.B. Number and Type of Analysis

| BOREHOLE NAME      | Number of b/b samples | Number of Overall samples | Number of Special test samples | Number of Trace element test samples | Number of Petrographic test samples |
|--------------------|-----------------------|---------------------------|--------------------------------|--------------------------------------|-------------------------------------|
| CEBUG-01           | 4                     | NIL                       | NIL                            | NIL                                  | NIL                                 |
| CEBUG-02           | NIL                   | NIL                       | NIL                            | NIL                                  | NIL                                 |
| CEBUG-03           | NIL                   | NIL                       | NIL                            | NIL                                  | NIL                                 |
| CEBUG-04           | 24                    | 5                         | 5                              | -                                    | 5                                   |
| CEBUG-05           | 32                    | 2                         | 2                              | -                                    | NIL                                 |
| CEBUG-06           | 23                    | 7                         | -                              | -                                    | NIL                                 |
| CEBUG-07           | 65                    | 13                        | 5                              | -                                    | NIL                                 |
| CEBUG-08           | 15                    | 1                         | 1                              | -                                    | NIL                                 |
| <b>Grand Total</b> | <b>163</b>            | <b>28</b>                 | <b>-</b>                       | <b>-</b>                             | <b>-</b>                            |
| <b>Approved</b>    | <b>450</b>            | <b>120</b>                | <b>13</b>                      | <b>-</b>                             | <b>5</b>                            |

## 1.12 SCOPE AND LIMITATION

The report deals with the potentiality of the coal seams in the block. Few patches occurrence of the thick mantle of soil is observed in the area. The geological information is largely based on sub surface data generated through drilling. The rocks present in the block are not compact in nature. This reflected at places by poor recovery obtained design drilling. In northern part of block the lateritic soil exposure. As the few area in Dhaska-Naugai block falls in either protected or Reserved Forest with rugged topography surveying and fixing of boreholes in the area was a very difficult task. The report is based on 14 boreholes which include 8 boreholes of CEBUG series and 6 boreholes of EBUG series. The seams in general are thin in nature therefore in most of the boreholes where the thickness of the seam is less than 0.50m the seams have not been subjected to band-by-band analysis.

Though all care has been taken to delineate precisely to delineate the incrop of the coal seams on the basis of boreholes data there is possibility of minor variation as the exact pattern of local weathering is difficult to ascertain.

## CHAPTER - 2

### EXPLORATION

#### 2.1 SCHEME

GSI has been involved in establishing existence of coal seams in East of Bisrampur Coalfield through mapping and regional drilling. Based on the GSI report, the entire area is crisscrossed by a number of transverse E-W faults and conjugate cross faults trending NW-SE and NE-SW. At places, the E-W faults vary ENE - WSW to ESE-WNW. The cross faults are mostly aligned along N50°W-S50°E and N40°E -S40°W directions. Majority of the faults are syn- sedimentary in nature which resulted in omission and offsetting of sedimentary strata as well as coal seams and coal bands over a short distance. In 2022-23, CMPDI has drawn proposal for exploration for coal in the Ulia-Gamhardih Block having area of about 39.14 sq.km and involving 1300m of drilling in 8 boreholes. The G-3 stage of Exploration in the block is proposed to fulfill following objectives- 1. To establish the existence and continuity of coal seams of Barakar Formation occurring in the block. 2. To establish the lay, disposition and potentiality of coal seams upto basement 3. To appraise the resource potentiality of Barakar coal seams in the block. This G3 stage of exploration drilling was done by M/s. MMPL under the supervision of CMPDI. The exploration was designed to examine the potentiality of split seam of seam II (II Top, II Middle and II Bot) & seam I in descending order over an area of 39.14 km<sup>2</sup>. A total of 8 boreholes were drilled in the block involving a total meterage of 894.30 m. The details of the boreholes drilled are furnished in Chapter-I. All these boreholes are coring boreholes. Geophysical logging has been done for the boreholes drilled during the current phase of exploration.

The core recoveries within coal and non-coal strata are generally above 90% and 75% respectively, barring exceptions. The depth ranges of boreholes drilled in Ulia-Gamhardih Block varies from a minimum of 60.10m in borehole CEBUG-02 (drilled during current phase of investigation) to a maximum of 242.75m in borehole EBUG-2 (drilled by GSI).

## 2.2 TOPOGRAPHIC SURVEY

### 2.2.1 General

In order to establish geographical (spherical) co-ordinates of the cardinal points of the block boundary, Differential Global Positioning System (DGPS) consisting of one Smart Link activated receiver is used in field survey.

Brief specifications of DGPS are provided in the table below.

| <b>Table Showing Details of Survey Instrument Used in DGPS Survey</b> |  |  |
|---|--|--|
| <b>A</b>  | <b>DGPS Instrument:</b>  |  |
|   | Make   | Leica  |
|   | Model  | GS16(Rover) and GS25(Base)   |
|   | Signal   | GPS (L1, L2, L2C, L5), Glonass (L1, L2, L2C, L32), BeiDou (B1, B2, B32), Galileo (E1, E5a, E5b, Alt-BOC, E62), QZSS (L1, L2C, L5, L62), NavIC L53, SBAS (WAAS, EGNOS, MSAS, GAGAN), L-band |
|   | Channels   | 555 (more signals, fast acquisition, high sensitivity)   |
|   | <b>Measurement Performance &amp; Accuracy:</b>   |  |
|   | Post Processed -<br>Static (phase) with long observations<br>Static and rapid static (phase) | Hz 3 mm + 0.1 ppm / V 3.5 mm + 0.4 ppm<br>Hz 3 mm + 0.5 ppm / V 5 mm + 0.5 ppm   |
|   | Real Time RTK- (Compliant to ISO17123-8 standard)<br>Single baseline-<br>Network RTK-        | Hz 8 mm + 1 ppm / V 15 mm + 1 ppm<br>Hz 8 mm + 0.5 ppm / V 15 mm + 0.5 ppm   |
|   | <b>Power:</b>  |  |
|   | Internal Battery   | Exchangeable Li-Ion battery (2.6 Ah / 7.4 V)   |
|   | <b>Communication:</b>  |  |
|   | USB and Bluetooth  | USB and RS232 serial Bluetooth® v2.00 + EDR, class 2   |
| <b>B</b>  | <b>Field Controller and Software</b>   |  |
|   | Leica Captivate software (Inbuilt Leica software for data recording)                         | Leica CS20 field controller.   |

For carrying out survey of surface features and determination of RL & Coordinate of boreholes from DGPS were used.

The cardinal points of the block are given below:

**Table 2.2.1A: Cardinal points of the block boundary of Ulia-Gamhardih block, East of Bisrampur Coalfield**

| Point ID | Longitude        | Latitude         | Point ID | Longitude        | Latitude         |
|----------|------------------|------------------|----------|------------------|------------------|
| 1        | 83°36' 15.123" E | 23°25' 28.914" N | 51       | 83°35' 1.830" E  | 23°21' 7.422" N  |
| 2        | 83°36' 15.617" E | 23°24' 7.148" N  | 52       | 83°34' 52.733" E | 23°21' 3.568" N  |
| 3        | 83°36' 16.129" E | 23°23' 48.760" N | 53       | 83°34' 45.640" E | 23°20' 59.867" N |
| 4        | 83°36' 16.887" E | 23°23' 48.836" N | 54       | 83°34' 36.851" E | 23°20' 54.727" N |
| 5        | 83°36' 17.594" E | 23°23' 49.071" N | 55       | 83°34' 24.362" E | 23°20' 48.354" N |
| 6        | 83°36' 17.958" E | 23°23' 49.178" N | 56       | 83°34' 16.858" E | 23°20' 44.859" N |
| 7        | 83°36' 18.729" E | 23°23' 49.136" N | 57       | 83°34' 10.485" E | 23°20' 41.364" N |
| 8        | 83°36' 19.778" E | 23°23' 49.136" N | 58       | 83°34' 8.275" E  | 23°20' 46.144" N |
| 9        | 83°36' 20.677" E | 23°23' 49.307" N | 59       | 83°34' 6.887" E  | 23°20' 49.177" N |
| 10       | 83°36' 21.770" E | 23°23' 49.435" N | 60       | 83°34' 5.448" E  | 23°20' 53.237" N |
| 11       | 83°36' 23.247" E | 23°23' 49.692" N | 61       | 83°34' 2.827" E  | 23°20' 58.531" N |
| 12       | 83°36' 24.703" E | 23°23' 49.692" N | 62       | 83°34' 1.336" E  | 23°21' 1.923" N  |
| 13       | 83°36' 25.881" E | 23°23' 49.671" N | 63       | 83°34' 0.205" E  | 23°21' 3.927" N  |
| 14       | 83°36' 26.909" E | 23°23' 49.585" N | 64       | 83°33' 59.383" E | 23°21' 6.035" N  |
| 15       | 83°36' 27.830" E | 23°23' 49.521" N | 65       | 83°33' 58.407" E | 23°21' 8.964" N  |
| 16       | 83°36' 28.323" E | 23°23' 49.607" N | 66       | 83°33' 57.173" E | 23°21' 12.099" N |
| 17       | 83°36' 29.072" E | 23°23' 49.607" N | 67       | 83°33' 56.145" E | 23°21' 15.183" N |
| 18       | 83°36' 29.586" E | 23°23' 49.564" N | 68       | 83°33' 55.683" E | 23°21' 17.496" N |
| 19       | 83°36' 30.507" E | 23°23' 49.243" N | 69       | 83°33' 54.963" E | 23°21' 19.449" N |
| 20       | 83°36' 31.770" E | 23°23' 48.986" N | 70       | 83°33' 53.010" E | 23°21' 25.411" N |
| 21       | 83°36' 32.648" E | 23°23' 48.900" N | 71       | 83°33' 50.954" E | 23°21' 31.681" N |
| 22       | 83°36' 33.462" E | 23°23' 48.986" N | 72       | 83°33' 47.870" E | 23°21' 39.545" N |
| 23       | 83°36' 34.040" E | 23°23' 49.200" N | 73       | 83°33' 45.146" E | 23°21' 47.100" N |
| 24       | 83°36' 34.747" E | 23°23' 49.371" N | 74       | 83°33' 49.721" E | 23°21' 47.254" N |
| 25       | 83°36' 35.432" E | 23°23' 49.264" N | 75       | 83°33' 52.342" E | 23°21' 47.357" N |
| 26       | 83°36' 36.353" E | 23°23' 48.921" N | 76       | 83°33' 55.683" E | 23°21' 47.254" N |
| 27       | 83°36' 37.231" E | 23°23' 48.386" N | 77       | 83°33' 58.458" E | 23°21' 47.254" N |
| 28       | 83°36' 40.315" E | 23°23' 48.022" N | 78       | 83°34' 1.233" E  | 23°21' 47.306" N |
| 29       | 83°36' 42.350" E | 23°23' 48.429" N | 79       | 83°33' 58.664" E | 23°21' 50.544" N |
| 30       | 83°36' 42.735" E | 23°23' 48.643" N | 80       | 83°33' 55.014" E | 23°21' 55.015" N |
| 31       | 83°36' 43.163" E | 23°23' 48.750" N | 81       | 83°33' 52.136" E | 23°21' 58.870" N |
| 32       | 83°36' 43.827" E | 23°23' 48.750" N | 82       | 83°33' 49.823" E | 23°22' 2.673" N  |
| 33       | 83°36' 44.384" E | 23°23' 48.514" N | 83       | 83°33' 46.277" E | 23°22' 7.093" N  |
| 34       | 83°36' 44.652" E | 23°23' 48.433" N | 84       | 83°33' 44.684" E | 23°22' 9.663" N  |
| 35       | 83°36' 46.748" E | 23°21' 55.236" N | 85       | 83°33' 42.114" E | 23°22' 13.107" N |
| 36       | 83°36' 47.053" E | 23°21' 44.148" N | 86       | 83°33' 40.778" E | 23°22' 14.803" N |
| 37       | 83°36' 41.744" E | 23°21' 41.087" N | 87       | 83°33' 38.876" E | 23°22' 17.630" N |
| 38       | 83°36' 35.525" E | 23°21' 38.466" N | 88       | 83°33' 35.638" E | 23°22' 22.512" N |
| 39       | 83°36' 28.124" E | 23°21' 35.125" N | 89       | 83°33' 32.554" E | 23°22' 26.727" N |
| 40       | 83°36' 21.031" E | 23°21' 31.527" N | 90       | 83°33' 30.961" E | 23°22' 27.909" N |
| 41       | 83°36' 15.789" E | 23°21' 29.677" N | 91       | 83°33' 16.107" E | 23°22' 30.582" N |
| 42       | 83°36' 9.724" E  | 23°21' 28.032" N | 92       | 83°32' 59.918" E | 23°22' 32.535" N |
| 43       | 83°36' 3.968" E  | 23°21' 26.079" N | 93       | 83°32' 48.559" E | 23°22' 34.128" N |
| 44       | 83°35' 56.978" E | 23°21' 24.280" N | 94       | 83°32' 31.187" E | 23°22' 36.749" N |
| 45       | 83°35' 53.277" E | 23°21' 23.201" N | 95       | 83°32' 18.029" E | 23°22' 37.828" N |
| 46       | 83°35' 49.525" E | 23°21' 22.070" N | 96       | 83°32' 9.600" E  | 23°22' 37.880" N |
| 47       | 83°35' 44.283" E | 23°21' 20.066" N | 97       | 83°32' 8.773" E  | 23°22' 37.899" N |
| 48       | 83°35' 32.308" E | 23°21' 15.697" N | 98       | 83°35' 6.965" E  | 23°25' 29.111" N |
| 49       | 83°35' 20.435" E | 23°21' 12.613" N | 99       | 83°36' 15.123" E | 23°25' 28.914" N |
| 50       | 83°35' 8.820" E  | 23°21' 9.838" N  |          |                  |                  |

## 2.3 GEOLOGICAL MAPPING

The block area is largely covered by soil and rock exposures are generally lacking. Though, a large inlier of metamorphic rock is exposed within the Gondwana Formation, about 2.5 km north west of Patna Village. It consists of gneiss, quartzite and pegmatite which have profuse porphyro blasts of pink coloured feldspars. The width of this inlier is about 50-70 m and extends for a length of about 200 m. Here, exposure of Pebbly white sandstone has been found. Lateritic soil exposure is found in the northern part of the block boundary No other significant surface exposure has been observed. The geological interpretation is mainly based on sub-surface data.

## 2.4 REMOTE SENSING

Remote sensing techniques have not been used for generation and interpretation of data.

## 2.5 SURFACE GEOPHYSICAL SURVEY

Surface geophysical survey have not been conducted.

## 2.6 DRILLING

### 2.6.1 Equipment

The details of the drilling rigs deployed in the block is tabulated below,

**Table 2.6.1A: List of drill rigs deployed in Ulia-Gamhardih block, East of Bistrampur Coalfield**

| Drill No.            | Make     | Drilling Capacity NQ Size (m) |
|----------------------|----------|-------------------------------|
| MMPL/XY-44H/RIG-134  | HENGYANG | 1200                          |
| MMPL/KDR-500/RIG-172 | KORES    | 500                           |
| MMPL/XY-4/ RIG-120   | HENGYANG | 400                           |
| MMPL/CSD-500/RIG-184 | CORTECH  | 500                           |

### 2.6.2 Drilling Conditions

The drilling conditions were generally favorable.

### 2.6.3 Core Recoveries

The core recoveries in coal and non-coal portions are generally above 90% and 75% respectively.

### 2.6.4 Boreholes Drilled

During current phase of investigation in Ulia-Gamhardih block 8 boreholes have been drilled. During the preparation of the geological report, boreholes from previous phases of exploration have been considered for proper understanding of seam correlation and spatial distribution of coal seams. A total of 14 numbers of boreholes have been considered for the preparation of geological report on Ulia-Gamhardih block. These 14 boreholes are falling inside the block boundary. Details of the different phases of exploration is tabulated in Table 2.6.4A

Financial year/period-wise details of borehole meterage drilled are given in the table below:

**Table 2.6.4A: Year-wise details of borehole meterage drilled in Ulia-Gamhardih block, East of Bistrampur Coalfield**

| Phase | Agency       | Period            | BH Drilled | Borehole series | Meterage (m)   |
|-------|--------------|-------------------|------------|-----------------|----------------|
| 1     | GSI          | Oct' 06 to Jul'07 | 6          | EBUG            | 948.30         |
| 2     | CMPDI        | Dec'22 to Jul'23  | 8          | CEBUG           | 894.30         |
|       | <b>TOTAL</b> |                   | <b>14</b>  |                 | <b>1842.60</b> |

## 2.7 CORE LOGGING, SAMPLING, PACKING AND DESPATCH

### 2.7.1 LOGGING

In Ulia-Gamhardih Block, a total of 1842.60 m of core was generated. The borehole core was megascopically examined and logged systematically. Physical characteristics (colour, grain size, etc.), mineralogical composition and structural data (core dip, fractures, slickensides, etc.) were recorded in detail. The extrapolation was done against loss of recovery, if any. The processing of the data was done through CEMPGEODOC package to obtain descriptive and graphic lithologs, on RF 1:500, which are presented in Annexure-IIA and Plate-IV respectively. The visually recorded roof and floor depths of seams were reconciled on the basis of band by band analysis.

### **2.7.2 SAMPLING**

After completion of each run, i.e 3.00 m, of drilling, the core is removed from inner tube of core barrel and systematically laid over the corrugated galvanized iron sheets. The core of each run is marked with wooden pieces mentioning the depth of the core. All the carbonaceous horizons viz, coal, shaly coal, carbonaceous shale and obvious dirt bands within seam, if any, are visually identified, logged and systematically sampled.

### **2.7.3 PACKING**

Carbonaceous horizons, viz, coal, shaly coal, carbonaceous shale and obvious dirt bands within seam (Total 4.22m coal core generation), after due correlation were picked up for dispatching for analysis. Out of the 14 drilled boreholes only 12 boreholes have developed coal horizon. Coal cores were properly placed in wooden core boxes after sampling and identification numbering, labeling depth, top and bottom, roof and floor of coal seams etc. and securely packed. Care has been taken while packing the core for analysis by using polythene sheets.

### **2.7.4 BOXING AND DISPATCH**

After proper packing, core boxes were serially numbered and suitably identified for each borehole. Care has been taken for properly nailing the boxes with lids, to avoid loss of core during transportation. The core boxes are then sent to Coal Characterization Laboratory, CMPDI Ranchi, for chemical analysis and different type of special tests.

## **2.8 GEOPHYSICAL LOGGING**

Geophysical logging was carried out by M/s Maheshwari Mining Private Limited. in 8 nos. of borehole in Uliia-Gamardih, Mand Raigarh Coal Field, during the period from December 2022 to July 2023 for delineation of depth and thickness of coal seams as a supplementary to drilling borehole data.

### **2.8.1 INSTRUMENTS USED**

The geophysical logs were recorded by Digital Geologging Micrologger-2 system, manufactured by M/s Robertson Geologging Ltd., Deganwy, U.K. It is a small and highly portable single unit logging equipment. It acts as an interface

between the host PC, winch, cable assembly and the probes also called the sonde. The computer interface of the micro-logger is provided through a Universal Serial Bus (USB). It includes an advanced sonde interface which is able to communicate with all the available sonde without the requirement of an additional module.

For data acquisition, a Windows based Operating System (OS) is provided. The software records different data and then displays the log responses.

## 2.8.2. DETAILS OF BOREHOLES

Eight nos. of borehole have been geophysically logged in the block by M/s Maheshwari Mining Private Limited. The logging was carried out by using density and electrical and sonic probes. The details of boreholes logged are given in Table 2.8.2.

**Table 2.8.2.: Details of Geophysically logged borehole**

| Sl. No. | B.H. No. | Type of borehole | Drilling depth of borehole (m) | Logging depth (m) | Parameters recorded                     |
|---------|----------|------------------|--------------------------------|-------------------|---|
| 1       | CEBUG-01 | Coring           | 142.40                         | 142.40            | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 2       | CEBUG-02 | Coring           | 60.10                          | 59.40             | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 3       | CEBUG-03 | Coring           | 96.50                          | 96.50             | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 4       | CEBUG-04 | Coring           | 155.80                         | 155               | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 5       | CEBUG-05 | Coring           | 170                            | 169               | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 6       | CEBUG-06 | Coring           | 90.80                          | 90.80             | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 7       | CEBUG-07 | Coring           | 93.40                          | 93.20             | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |
| 8       | CEBUG-08 | Coring           | 85.30                          | 85                | GAMMA, DEN,CAL, 16N,14N, SP, SPR, SONIC |

### 2.8.3 DATA INTERPRETATION

The geophysical logging of boreholes was carried out to identify the depth and thickness of coal seams encountered in the boreholes. The following parameters have been recorded.

- (i) Self-potential (SP)
- (ii) Single point resistance (SPR)
- (iii) Natural gamma (NGAM)
- (iv) Short normal resistivity (N 16")
- (v) Long normal resistivity (N 64")
- (vi) Density (DEN)
- (vii) Caliper (CALP)
- (viii) Sonic

The responses of various logs against coal seams are given in Table-2.8.3.

**Table-2.8.3.: Response of various logs against coal seams**

| <b>Geophysical logs</b> | <b>Response</b>     | <b>Not valid when</b>  |
|-------------------------|---------------------|--|
| Resistance/Resistivity  | High resistance     | (i) Highly resistive bed is adjacent to coal<br>(ii) Heavy cavity in coal bed<br>(iii) If the boreholes is cased |
| Natural gamma ray       | Low gamma Intensity | (i) Very clean sand is adjacent to coal bed<br>(ii) Coal bed is uranium accepted                                 |
| Density                 | Low Density         | (i) Seam is thinner than tool spacing  |

### 2.8.4. DISCUSSION OF RESULTS

The depth and thickness of various coal seams encountered in the borehole are interpreted by using Well-CAD software. The details of borehole wise coal seams are given in Table-2.8.4. Lithologs are shown in Plate I.

**Table-2.8.4: Summary of geophysical logs of borehole****(1)CEBUG-01**

| PBH-07 CEBUG-01 INTREPRETED LITHOLOGY |                   |                |                   |
|---------------------------------------|-------------------|----------------|-------------------|
| DRILL DEPTH : 142.40 M                |                   |                |                   |
| LOG DEPTH : 142.40 M                  |                   |                |                   |
| DATE OF LOGGING : 03.01.2023          |                   |                |                   |
| Top Depth<br>m                        | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY         |
| 0.00                                  | 6.30              | 6.30           | SOIL              |
| 6.30                                  | 17.90             | 11.60          | SHALY SANDSTONE   |
| 17.90                                 | 58.20             | 40.30          | SANDSTONE         |
| 58.20                                 | 58.90             | 0.70           | SHALE             |
| 58.90                                 | 60.70             | 1.80           | SHALY SANDSTONE   |
| 60.70                                 | 62.70             | 2.00           | SHALE             |
| 62.70                                 | 63.20             | 0.50           | SHALY COAL        |
| 63.20                                 | 71.80             | 8.60           | SANDSTONE         |
| 71.80                                 | 72.50             | 0.70           | SHALE             |
| 72.50                                 | 73.00             | 0.50           | CARBONCEOUS SHALE |
| 73.00                                 | 73.40             | 0.40           | SHALY COAL        |
| 73.40                                 | 74.10             | 0.70           | SHALE             |
| 74.10                                 | 82.50             | 8.40           | SANDSTONE         |
| 82.50                                 | 83.20             | 0.70           | SHALE             |
| 83.20                                 | 97.30             | 14.10          | SANDSTONE         |
| 97.30                                 | 103.30            | 6.00           | SANDY SHALE       |
| 103.30                                | 131.10            | 27.80          | SHALY SANDSTONE   |
| 131.10                                | 142.40            | 11.30          | SANDSTONE         |

**(2)CEBUG-02**

| PBH-08 CEBUG-02 INTREPRETED LITHOLOGY |                   |                |                 |
|---------------------------------------|-------------------|----------------|-----------------|
| DRILL DEPTH : 60.10 M                 |                   |                |                 |
| LOG DEPTH : 59.40 M                   |                   |                |                 |
| DATE OF LOGGING : 18.01.2023          |                   |                |                 |
| Top Depth<br>m                        | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY       |
| 0.00                                  | 4.20              | 4.20           | SOIL            |
| 4.20                                  | 11.30             | 7.10           | SANDSTONE       |
| 11.30                                 | 12.90             | 1.60           | SHALY SANDSTONE |
| 12.90                                 | 18.20             | 5.30           | SANDSTONE       |
| 18.20                                 | 20.70             | 2.50           | SANDY SHALE     |
| 20.70                                 | 21.70             | 1.00           | SHALE           |
| 21.70                                 | 24.60             | 2.90           | SHALY SANDSTONE |
| 24.60                                 | 34.50             | 9.90           | SANDSTONE       |
| 34.50                                 | 35.00             | 0.50           | SHALE           |

|       |       |      |                 |
|-------|-------|------|-----------------|
| 35.00 | 42.40 | 7.40 | SHALY SANDSTONE |
| 42.40 | 43.80 | 1.40 | SHALE           |
| 43.80 | 51.40 | 7.60 | SHALY SANDSTONE |
| 51.40 | 59.40 | 8.00 | SANDSTONE       |

### (3) CEBUG-03

| PBH-05A CEBUG-03 INTREPRETED LITHOLOGY |                   |                |                   |
|--|-------------------|----------------|-------------------|
| DRILL DEPTH : 96.50 M                  |                   |                |                   |
| LOG DEPTH : 96.50 M                    |                   |                |                   |
| DATE OF LOGGING : 28.02.2023           |                   |                |                   |
| Top Depth<br>m                         | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY         |
| 0.00                                   | 2.10              | 2.10           | SOIL              |
| 2.10                                   | 11.10             | 9.00           | SANDSTONE         |
| 11.10                                  | 13.90             | 2.80           | SHALY SANDSTONE   |
| 13.90                                  | 14.50             | 0.60           | SHALE             |
| 14.50                                  | 17.20             | 2.70           | SANDSTONE         |
| 17.20                                  | 21.10             | 3.90           | SANDY SHALE       |
| 21.10                                  | 22.30             | 1.20           | SHALE             |
| 22.30                                  | 22.70             | 0.40           | CARBONCEOUS SHALE |
| 22.70                                  | 33.50             | 10.80          | SANDSTONE         |
| 33.50                                  | 36.80             | 3.30           | SHALY SANDSTONE   |
| 36.80                                  | 49.10             | 12.30          | SANDSTONE         |
| 49.10                                  | 50.40             | 1.30           | SANDY SHALE       |
| 50.40                                  | 55.00             | 4.60           | SHALE             |
| 55.00                                  | 92.20             | 37.20          | SANDY SHALE       |
| 92.20                                  | 96.20             | 4.00           | SANDSTONE         |

### (4) CEBUG-04

| PBH-02 CEBUG-04 INTREPRETED LITHOLOGY |                   |                |                   |
|---------------------------------------|-------------------|----------------|-------------------|
| DRILL DEPTH : 155.80 M                |                   |                |                   |
| LOG DEPTH : 155.00 M                  |                   |                |                   |
| DATE OF LOGGING : 23.06.2023          |                   |                |                   |
| Top Depth<br>m                        | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY         |
| 0.00                                  | 6.60              | 6.60           | SOIL              |
| 6.60                                  | 62.30             | 55.70          | SANDSTONE         |
| 62.30                                 | 64.80             | 2.50           | SANDY SHALE       |
| 64.80                                 | 65.20             | 0.40           | SHALE             |
| 65.20                                 | 65.60             | 0.40           | CARBONCEOUS SHALE |
| 65.60                                 | 67.10             | 1.50           | SHALY SANDSTONE   |

|        |        |       |                   |
|--------|--------|-------|-------------------|
| 67.10  | 67.90  | 0.80  | SHALY COAL        |
| 67.90  | 68.50  | 0.60  | COAL              |
| 68.50  | 69.00  | 0.50  | SHALY COAL        |
| 69.00  | 69.70  | 0.70  | SHALY SANDSTONE   |
| 69.70  | 70.80  | 1.10  | SHALY COAL        |
| 70.80  | 71.20  | 0.40  | CARBONCEOUS SHALE |
| 71.20  | 72.00  | 0.80  | COAL              |
| 72.00  | 72.60  | 0.60  | SHALY COAL        |
| 72.60  | 73.80  | 1.20  | COAL              |
| 73.80  | 74.40  | 0.60  | SHALY COAL        |
| 74.40  | 75.00  | 0.60  | COAL              |
| 75.00  | 75.40  | 0.40  | SHALY COAL        |
| 75.40  | 75.70  | 0.30  | COAL              |
| 75.70  | 76.30  | 0.60  | SHALY COAL        |
| 76.30  | 77.70  | 1.40  | COAL              |
| 77.70  | 79.10  | 1.40  | SHALY COAL        |
| 79.10  | 79.60  | 0.50  | COAL              |
| 79.60  | 83.70  | 4.10  | SANDSTONE         |
| 83.70  | 84.30  | 0.60  | CARBONCEOUS SHALE |
| 84.30  | 84.80  | 0.50  | COAL              |
| 84.80  | 85.60  | 0.80  | CARBONCEOUS SHALE |
| 85.60  | 93.80  | 8.20  | SANDSTONE         |
| 93.80  | 94.20  | 0.40  | SHALY COAL        |
| 94.20  | 95.00  | 0.80  | CARBONCEOUS SHALE |
| 95.00  | 107.80 | 12.80 | SANDSTONE         |
| 107.80 | 108.20 | 0.40  | SHALE             |
| 108.20 | 113.30 | 5.10  | SANDSTONE         |
| 113.30 | 113.80 | 0.50  | SHALE             |
| 113.80 | 143.70 | 29.90 | SANDSTONE         |
| 143.70 | 144.00 | 0.30  | SHALY COAL        |
| 144.00 | 144.60 | 0.60  | SHALE             |
| 144.60 | 145.10 | 0.50  | CARBONCEOUS SHALE |
| 145.10 | 145.50 | 0.40  | COAL              |
| 145.50 | 146.50 | 1.00  | SANDY SHALE       |
| 146.50 | 149.80 | 3.30  | COAL              |
| 149.80 | 150.40 | 0.60  | SHALY COAL        |
| 150.40 | 154.70 | 4.30  | SANDSTONE         |

**(5) CEBUG-05**

| PBH-02 CEBUG-04 INTREPRETED LITHOLOGY |                   |                |                   |
|---------------------------------------|-------------------|----------------|-------------------|
| DRILL DEPTH : 170.00 M                |                   |                |                   |
| LOG DEPTH : 155.00 M                  |                   |                |                   |
| DATE OF LOGGING : 23.06.2023          |                   |                |                   |
| Top Depth<br>m                        | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY         |
| 0.00                                  | 6.60              | 6.60           | SOIL              |
| 6.60                                  | 62.30             | 55.70          | SANDSTONE         |
| 62.30                                 | 64.80             | 2.50           | SANDY SHALE       |
| 64.80                                 | 65.20             | 0.40           | SHALE             |
| 65.20                                 | 65.60             | 0.40           | CARBONCEOUS SHALE |
| 65.60                                 | 67.10             | 1.50           | SHALY SANDSTONE   |
| 67.10                                 | 67.90             | 0.80           | SHALY COAL        |
| 67.90                                 | 68.50             | 0.60           | COAL              |
| 68.50                                 | 69.00             | 0.50           | SHALY COAL        |
| 69.00                                 | 69.70             | 0.70           | SHALY SANDSTONE   |
| 69.70                                 | 70.80             | 1.10           | SHALY COAL        |
| 70.80                                 | 71.20             | 0.40           | CARBONCEOUS SHALE |
| 71.20                                 | 72.00             | 0.80           | COAL              |
| 72.00                                 | 72.60             | 0.60           | SHALY COAL        |
| 72.60                                 | 73.80             | 1.20           | COAL              |
| 73.80                                 | 74.40             | 0.60           | SHALY COAL        |
| 74.40                                 | 75.00             | 0.60           | COAL              |
| 75.00                                 | 75.40             | 0.40           | SHALY COAL        |
| 75.40                                 | 75.70             | 0.30           | COAL              |
| 75.70                                 | 76.30             | 0.60           | SHALY COAL        |
| 76.30                                 | 77.70             | 1.40           | COAL              |
| 77.70                                 | 79.10             | 1.40           | SHALY COAL        |
| 79.10                                 | 79.60             | 0.50           | COAL              |
| 79.60                                 | 83.70             | 4.10           | SANDSTONE         |
| 83.70                                 | 84.30             | 0.60           | CARBONCEOUS SHALE |
| 84.30                                 | 84.80             | 0.50           | COAL              |
| 84.80                                 | 85.60             | 0.80           | CARBONCEOUS SHALE |
| 85.60                                 | 93.80             | 8.20           | SANDSTONE         |
| 93.80                                 | 94.20             | 0.40           | SHALY COAL        |
| 94.20                                 | 95.00             | 0.80           | CARBONCEOUS SHALE |
| 95.00                                 | 107.80            | 12.80          | SANDSTONE         |
| 107.80                                | 108.20            | 0.40           | SHALE             |
| 108.20                                | 113.30            | 5.10           | SANDSTONE         |
| 113.30                                | 113.80            | 0.50           | SHALE             |
| 113.80                                | 143.70            | 29.90          | SANDSTONE         |
| 143.70                                | 144.00            | 0.30           | SHALY COAL        |
| 144.00                                | 144.60            | 0.60           | SHALE             |

|        |        |      |                   |
|--------|--------|------|-------------------|
| 144.60 | 145.10 | 0.50 | CARBONCEOUS SHALE |
| 145.10 | 145.50 | 0.40 | COAL              |
| 145.50 | 146.50 | 1.00 | SANDY SHALE       |
| 146.50 | 149.80 | 3.30 | COAL              |
| 149.80 | 150.40 | 0.60 | SHALY COAL        |
| 150.40 | 154.70 | 4.30 | SANDSTONE         |

### (6)CEBUG-06

| PBH-01 CEBUG-06 INTREPRETED LITHOLOGY |                   |                |                   |
|---------------------------------------|-------------------|----------------|-------------------|
| DRILL DEPTH : 90.80M                  |                   |                |                   |
| LOG DEPTH : 90.80 M                   |                   |                |                   |
| DATE OF LOGGING : 11.07.2023          |                   |                |                   |
| Top Depth<br>m                        | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY         |
| 0.00                                  | 7.20              | 7.20           | SOIL              |
| 7.20                                  | 8.20              | 1.00           | SANDSTONE         |
| 8.20                                  | 9.20              | 1.00           | COAL              |
| 9.20                                  | 10.50             | 1.30           | SHALE             |
| 10.50                                 | 11.80             | 1.30           | COAL              |
| 11.80                                 | 12.80             | 1.00           | SHALY COAL        |
| 12.80                                 | 13.90             | 1.10           | COAL              |
| 13.90                                 | 14.50             | 0.60           | CARBONCEOUS SHALE |
| 14.50                                 | 14.90             | 0.40           | COAL              |
| 14.90                                 | 15.80             | 0.90           | SHALY COAL        |
| 15.80                                 | 16.20             | 0.40           | SHALE             |
| 16.20                                 | 16.90             | 0.70           | COAL              |
| 16.90                                 | 17.30             | 0.40           | SHALY COAL        |
| 17.30                                 | 19.80             | 2.50           | COAL              |
| 19.80                                 | 20.20             | 0.40           | CARBONCEOUS SHALE |
| 20.20                                 | 20.60             | 0.40           | COAL              |
| 20.60                                 | 21.90             | 1.30           | CARBONCEOUS SHALE |
| 21.90                                 | 22.40             | 0.50           | SANDSTONE         |
| 22.40                                 | 22.70             | 0.30           | CARBONCEOUS SHALE |
| 22.70                                 | 23.40             | 0.70           | SANDSTONE         |
| 23.40                                 | 24.20             | 0.80           | COAL              |
| 24.20                                 | 25.00             | 0.80           | SANDSTONE         |
| 25.00                                 | 25.70             | 0.70           | SHALE             |
| 25.70                                 | 28.40             | 2.70           | SANDSTONE         |
| 28.40                                 | 34.90             | 6.50           | SHALY SANDSTONE   |
| 34.90                                 | 38.70             | 3.80           | SANDSTONE         |
| 38.70                                 | 39.20             | 0.50           | SHALY COAL        |
| 39.20                                 | 39.90             | 0.70           | SHALE             |
| 39.90                                 | 40.30             | 0.40           | SANDSTONE         |
| 40.30                                 | 41.10             | 0.80           | SHALE             |
| 41.10                                 | 84.10             | 43.00          | SANDSTONE         |

|       |       |      |                   |
|-------|-------|------|-------------------|
| 84.10 | 84.40 | 0.30 | COAL              |
| 84.40 | 84.80 | 0.40 | SHALE             |
| 84.80 | 85.20 | 0.40 | COAL              |
| 85.20 | 85.90 | 0.70 | SANDSTONE         |
| 85.90 | 86.20 | 0.30 | CARBONCEOUS SHALE |
| 86.20 | 86.50 | 0.30 | COAL              |
| 86.50 | 90.50 | 4.00 | SANDSTONE         |

**(7)CEBUG-07**

| PBH-06 CEBUG-07 INTREPRETED LITHOLOGY |              |           |                   |
|---------------------------------------|--------------|-----------|-------------------|
| DRILL DEPTH : 93.40 M                 |              |           |                   |
| LOG DEPTH : 93.00 M                   |              |           |                   |
| DATE OF LOGGING : 20.07.2023          |              |           |                   |
| Top Depth                             | Bottom Depth | Thickness | LITHOLOGY         |
| m                                     | m            | m         |                   |
| 0.00                                  | 8.60         | 8.60      | SOIL              |
| 8.60                                  | 11.80        | 3.20      | SANDSTONE         |
| 11.80                                 | 12.20        | 0.40      | COAL              |
| 12.20                                 | 13.00        | 0.80      | SHALE             |
| 13.00                                 | 14.00        | 1.00      | CARBONCEOUS SHALE |
| 14.00                                 | 14.50        | 0.50      | SHALY COAL        |
| 14.50                                 | 14.80        | 0.30      | SHALE             |
| 14.80                                 | 15.90        | 1.10      | SANDY SHALE       |
| 15.90                                 | 16.20        | 0.30      | CARBONCEOUS SHALE |
| 16.20                                 | 16.80        | 0.60      | SANDY SHALE       |
| 16.80                                 | 17.50        | 0.70      | SHALY COAL        |
| 17.50                                 | 17.90        | 0.40      | CARBONCEOUS SHALE |
| 17.90                                 | 21.40        | 3.50      | SHALY SANDSTONE   |
| 21.40                                 | 25.60        | 4.20      | SHALE             |
| 25.60                                 | 29.80        | 4.20      | SHALY SANDSTONE   |
| 29.80                                 | 30.60        | 0.80      | CARBONCEOUS SHALE |
| 30.60                                 | 31.10        | 0.50      | COAL              |
| 31.10                                 | 32.50        | 1.40      | SHALY SANDSTONE   |
| 32.50                                 | 32.90        | 0.40      | COAL              |
| 32.90                                 | 34.60        | 1.70      | SHALY SANDSTONE   |
| 34.60                                 | 34.90        | 0.30      | CARBONCEOUS SHALE |
| 34.90                                 | 35.30        | 0.40      | COAL              |
| 35.30                                 | 35.80        | 0.50      | CARBONCEOUS SHALE |
| 35.80                                 | 36.60        | 0.80      | COAL              |
| 36.60                                 | 36.90        | 0.30      | CARBONCEOUS SHALE |
| 36.90                                 | 37.80        | 0.90      | SHALE             |
| 37.80                                 | 38.30        | 0.50      | SANDY SHALE       |
| 38.30                                 | 38.50        | 0.20      | CARBONCEOUS SHALE |
| 38.50                                 | 40.70        | 2.20      | COAL              |

|       |       |      |                   |
|-------|-------|------|-------------------|
| 40.70 | 41.30 | 0.60 | SANDSTONE         |
| 41.30 | 41.60 | 0.30 | SHALY COAL        |
| 41.60 | 44.10 | 2.50 | COAL              |
| 44.10 | 44.70 | 0.60 | SHALY COAL        |
| 44.70 | 45.10 | 0.40 | CARBONCEOUS SHALE |
| 45.10 | 45.80 | 0.70 | SHALE             |
| 45.80 | 46.20 | 0.40 | COAL              |
| 46.20 | 46.70 | 0.50 | CARBONCEOUS SHALE |
| 46.70 | 48.90 | 2.20 | COAL              |
| 48.90 | 49.60 | 0.70 | SHALY COAL        |
| 49.60 | 50.60 | 1.00 | COAL              |
| 50.60 | 51.80 | 1.20 | CARBONCEOUS SHALE |
| 51.80 | 52.50 | 0.70 | COAL              |
| 52.50 | 53.00 | 0.50 | CARBONCEOUS SHALE |
| 53.00 | 53.80 | 0.80 | COAL              |
| 53.80 | 54.20 | 0.40 | SHALY COAL        |
| 54.20 | 54.50 | 0.30 | COAL              |
| 54.50 | 55.30 | 0.80 | SANDY SHALE       |
| 55.30 | 55.60 | 0.30 | SHALY COAL        |
| 55.60 | 56.70 | 1.10 | COAL              |
| 56.70 | 57.20 | 0.50 | CARBONCEOUS SHALE |
| 57.20 | 57.50 | 0.30 | SHALY COAL        |
| 57.50 | 58.30 | 0.80 | COAL              |
| 58.30 | 59.30 | 1.00 | SHALE             |
| 59.30 | 60.40 | 1.10 | SANDY SHALE       |
| 60.40 | 60.80 | 0.40 | CARBONCEOUS SHALE |
| 60.80 | 61.20 | 0.40 | COAL              |
| 61.20 | 61.90 | 0.70 | SANDY SHALE       |
| 61.90 | 62.40 | 0.50 | SHALY COAL        |
| 62.40 | 63.20 | 0.80 | SHALE             |
| 63.20 | 64.10 | 0.90 | SANDSTONE         |
| 64.10 | 65.20 | 1.10 | SHALE             |
| 65.20 | 65.60 | 0.40 | SANDSTONE         |
| 65.60 | 66.20 | 0.60 | COAL              |
| 66.20 | 66.50 | 0.30 | CARBONCEOUS SHALE |
| 66.50 | 66.80 | 0.30 | COAL              |
| 66.80 | 67.20 | 0.40 | CARBONCEOUS SHALE |
| 67.20 | 67.80 | 0.60 | SANDY SHALE       |
| 67.80 | 68.30 | 0.50 | SHALE             |
| 68.30 | 68.80 | 0.50 | SANDSTONE         |
| 68.80 | 69.10 | 0.30 | CARBONCEOUS SHALE |
| 69.10 | 69.70 | 0.60 | SANDSTONE         |
| 69.70 | 70.10 | 0.40 | CARBONCEOUS SHALE |
| 70.10 | 71.80 | 1.70 | SANDSTONE         |
| 71.80 | 72.20 | 0.40 | CARBONCEOUS SHALE |

|       |       |      |                   |
|-------|-------|------|-------------------|
| 72.20 | 72.40 | 0.20 | SHALY COAL        |
| 72.40 | 73.20 | 0.80 | COAL              |
| 73.20 | 73.50 | 0.30 | CARBONCEOUS SHALE |
| 73.50 | 75.10 | 1.60 | SANDY SHALE       |
| 75.10 | 78.30 | 3.20 | SANDSTONE         |
| 78.30 | 78.70 | 0.40 | COAL              |
| 78.70 | 79.60 | 0.90 | SHALE             |
| 79.60 | 81.90 | 2.30 | SANDSTONE         |
| 81.90 | 83.90 | 2.00 | SHALE             |
| 83.90 | 85.00 | 1.10 | SANDSTONE         |
| 85.00 | 87.10 | 2.10 | COAL              |
| 87.10 | 93.00 | 5.90 | SANDSTONE         |

### (8)CEBUG-08

| PBH-03 CEBUG-08 INTREPRETED LITHOLOGY |                   |                |                   |
|---------------------------------------|-------------------|----------------|-------------------|
| DRILL DEPTH : 85.30M                  |                   |                |                   |
| LOG DEPTH : 85.00 M                   |                   |                |                   |
| DATE OF LOGGING : 27.07.2023          |                   |                |                   |
| Top Depth<br>m                        | Bottom Depth<br>m | Thickness<br>m | LITHOLOGY         |
| 0.00                                  | 9.20              | 9.20           | SOIL              |
| 9.20                                  | 21.80             | 12.60          | SANDSTONE         |
| 21.80                                 | 22.40             | 0.60           | SHALE             |
| 22.40                                 | 25.10             | 2.70           | SANDSTONE         |
| 25.10                                 | 25.40             | 0.30           | CARBONCEOUS SHALE |
| 25.40                                 | 26.30             | 0.90           | SHALE             |
| 26.30                                 | 26.60             | 0.30           | CARBONCEOUS SHALE |
| 26.60                                 | 27.10             | 0.50           | SANDSTONE         |
| 27.10                                 | 27.80             | 0.70           | SHALE             |
| 27.80                                 | 29.60             | 1.80           | SANDSTONE         |
| 29.60                                 | 30.10             | 0.50           | SHALE             |
| 30.10                                 | 30.50             | 0.40           | CARBONCEOUS SHALE |
| 30.50                                 | 30.80             | 0.30           | SANDSTONE         |
| 30.80                                 | 31.10             | 0.30           | SHALE             |
| 31.10                                 | 31.60             | 0.50           | SANDSTONE         |
| 31.60                                 | 32.10             | 0.50           | SHALE             |
| 32.10                                 | 32.50             | 0.40           | CARBONCEOUS SHALE |
| 32.50                                 | 33.50             | 1.00           | SANDY SHALE       |
| 33.50                                 | 34.20             | 0.70           | COAL              |
| 34.20                                 | 34.80             | 0.60           | SHALE             |
| 34.80                                 | 35.30             | 0.50           | COAL              |
| 35.30                                 | 37.80             | 2.50           | SANDY SHALE       |
| 37.80                                 | 38.30             | 0.50           | COAL              |
| 38.30                                 | 61.10             | 22.80          | SANDSTONE         |

|       |       |       |                 |
|-------|-------|-------|-----------------|
| 61.10 | 61.80 | 0.70  | SHALE           |
| 61.80 | 62.20 | 0.40  | SANDSTONE       |
| 62.20 | 80.70 | 18.50 | SHALE           |
| 80.70 | 81.50 | 0.80  | SHALY SANDSTONE |
| 81.50 | 84.70 | 3.20  | SHALE           |

The geophysical logs along with interpreted results of all the 08 boreholes are given in Plate VI.

### 2.8.5. CONCLUSION

The report has been prepared on the basis of geophysical logging of boreholes with parameters Natural gamma, resistance, resistivity (including both Short normal & Long normal), SP, Density. & Sonic The resistivity values over a coal seam vary in very wide range due to quality of coal and moisture contact.

### 2.8.6 Vertical Electrical Sounding

The objective of Vertical Electrical Soundings (VES) was to assess the variation in resistivity of the formation with depth and also to select the inter-electrode spacing for conducting profiling survey in the area. In the resistivity sounding survey the point of observation is kept fixed, while the depth of penetration of current i.e. the depth of investigation was increased by increasing the electrode separation symmetrically on both sides of the point of observation from one reading to the next. The curve thus obtained was interpreted using standard master curves to obtain the depth, thickness and resistivity of various layers present below the point of observation. The results obtained from the VES curves were used for selecting the electrode separation for resistivity profiling survey to obtain the information from the desired depth.

80 Nos.of VES were conducted in the area. The locations of these VES are given below:

| Si. No. | VES No. | UTM-44      |              | WGS-84           |                  |
|---------|---------|-------------|--------------|------------------|------------------|
|         |         | Earthing    | Northing     | Latitude         | Longitude        |
| 1       | VES-01  | 760019.5570 | 2588373.5076 | 23°23' 4.0889"N  | 83°32' 38.1133"E |
| 2       | VES-02  | 760716.6735 | 2589092.7200 | 23°23' 27.0537"N | 83°33' 3.0952"E  |
| 3       | VES-03  | 761414.1140 | 2589810.8609 | 23°23' 49.9821"N | 83°33' 28.0901"E |
| 4       | VES-04  | 762111.2298 | 2590529.3700 | 23°24' 12.9213"N | 83°33' 53.0763"E |
| 5       | VES-05  | 762808.6708 | 2591248.2143 | 23°24' 35.8699"N | 83°34' 18.0765"E |

| Si. No. | VES No. | UTM-44      |              | WGS-84           |                  |
|---------|---------|-------------|--------------|------------------|------------------|
|         |         | Earthing    | Northing     | Latitude         | Longitude        |
| 6       | VES-06  | 763505.1289 | 2591966.0456 | 23°24' 58.7848"N | 83°34' 43.0439"E |
| 7       | VES-07  | 764202.4076 | 2592684.7225 | 23°25' 21.7254"N | 83°35' 8.0431"E  |
| 8       | VES-08  | 764563.1879 | 2592338.5358 | 23°25' 10.2689"N | 83°35' 20.5245"E |
| 9       | VES-09  | 763866.3983 | 2591620.3629 | 23°24' 47.345"N  | 83°34' 55.543"E  |
| 10      | VES-10  | 763168.9586 | 2590901.5200 | 23°24' 24.3983"N | 83°34' 30.5405"E |
| 11      | VES-11  | 762471.8412 | 2590183.0090 | 23°24' 1.4609"N  | 83°34' 5.552"E   |
| 12      | VES-12  | 761774.8899 | 2589464.6698 | 23°23' 38.5276"N | 83°33' 40.5719"E |
| 13      | VES-13  | 761077.6116 | 2588745.9932 | 23°23' 15.5823"N | 83°33' 15.5824"E |
| 14      | VES-14  | 760380.8249 | 2588027.8233 | 23°22' 52.6517"N | 83°32' 50.6129"E |
| 15      | VES-15  | 760741.9327 | 2587681.9742 | 23°22' 41.209"N  | 83°33' 3.1062"E  |
| 16      | VES-16  | 761438.8860 | 2588400.3157 | 23°23' 4.1445"N  | 83°33' 28.0815"E |
| 17      | VES-17  | 762135.6709 | 2589118.4838 | 23°23' 27.0731"N | 83°33' 53.0532"E |
| 18      | VES-18  | 762832.9452 | 2589837.1563 | 23°23' 50.0165"N | 83°34' 18.0448"E |
| 19      | VES-19  | 763529.8975 | 2590555.4968 | 23°24' 12.9479"N | 83°34' 43.0273"E |
| 20      | VES-20  | 764226.6862 | 2591273.6687 | 23°24' 35.8726"N | 83°35' 8.0063"E  |
| 21      | VES-21  | 764923.9636 | 2591992.3444 | 23°24' 58.812"N  | 83°35' 33.0052"E |
| 22      | VES-22  | 765626.8250 | 2592716.7754 | 23°25' 21.9338"N | 83°35' 58.2068"E |
| 23      | VES-23  | 765982.5979 | 2592363.9428 | 23°25' 10.2633"N | 83°36' 10.5064"E |
| 24      | VES-24  | 765285.6615 | 2591645.5948 | 23°24' 47.3362"N | 83°35' 45.5174"E |
| 25      | VES-25  | 764588.5617 | 2590927.0784 | 23°24' 24.4024"N | 83°35' 20.525"E  |
| 26      | VES-26  | 763891.7852 | 2590208.8952 | 23°24' 1.4779"N  | 83°34' 55.5465"E |
| 27      | VES-27  | 763194.5216 | 2589490.2100 | 23°23' 38.536"N  | 83°34' 30.553"E  |
| 28      | VES-28  | 762497.2522 | 2588771.5187 | 23°23' 15.5926"N | 83°34' 5.5616"E  |
| 29      | VES-29  | 761800.4756 | 2588053.3355 | 23°22' 52.664"N  | 83°33' 40.5904"E |
| 30      | VES-30  | 762161.0900 | 2587706.9779 | 23°22' 41.2041"N | 83°33' 53.0646"E |
| 31      | VES-31  | 762858.1908 | 2588425.4953 | 23°23' 4.1428"N  | 83°34' 18.0474"E |
| 32      | VES-32  | 763554.8029 | 2589143.5090 | 23°23' 27.064"N  | 83°34' 43.0151"E |
| 33      | VES-33  | 764252.7240 | 2589862.8720 | 23°23' 50.027"N  | 83°35' 8.0321"E  |
| 34      | VES-34  | 764949.5021 | 2590581.0568 | 23°24' 12.951"N  | 83°35' 33.0105"E |
| 35      | VES-35  | 765652.8426 | 2591306.0057 | 23°24' 36.0896"N | 83°35' 58.2266"E |
| 36      | VES-36  | 766007.0517 | 2590953.0459 | 23°24' 24.416"N  | 83°36' 10.47"E   |
| 37      | VES-37  | 765310.6023 | 2590235.2000 | 23°24' 1.5047"N  | 83°35' 45.5011"E |
| 38      | VES-38  | 764613.3404 | 2589516.5164 | 23°23' 38.5653"N | 83°35' 20.5055"E |
| 39      | VES-39  | 763916.0687 | 2588797.8228 | 23°23' 15.6242"N | 83°34' 55.5119"E |
| 40      | VES-40  | 763219.6259 | 2588079.9836 | 23°22' 52.7091"N | 83°34' 30.5504"E |
| 41      | VES-41  | 762522.3670 | 2587361.3032 | 23°22' 29.7658"N | 83°34' 5.5621"E  |
| 42      | VES-42  | 762882.8119 | 2587014.7708 | 23°22' 18.2998"N | 83°34' 18.0291"E |
| 43      | VES-43  | 763579.9177 | 2587733.2935 | 23°22' 41.2375"N | 83°34' 43.0119"E |
| 44      | VES-44  | 764277.3449 | 2588452.1473 | 23°23' 4.1845"N  | 83°35' 8.0085"E  |
| 45      | VES-45  | 764973.9536 | 2589170.1575 | 23°23' 27.1032"N | 83°35' 32.9782"E |
| 46      | VES-46  | 765671.5567 | 2589889.1927 | 23°23' 50.0533"N | 83°35' 57.986"E  |
| 47      | VES-47  | 766031.8338 | 2589542.4875 | 23°23' 38.5794"N | 83°36' 10.4459"E |
| 48      | VES-48  | 765334.7297 | 2588823.9666 | 23°23' 15.6463"N | 83°35' 45.4562"E |

| Si. No. | VES No. | UTM-44      |              | WGS-84           |                  |
|---------|---------|-------------|--------------|------------------|------------------|
|         |         | Earthing    | Northing     | Latitude         | Longitude        |
| 49      | VES-49  | 764638.1241 | 2588105.9596 | 23°22' 52.7282"N | 83°35' 20.4867"E |
| 50      | VES-50  | 763940.6796 | 2587387.0879 | 23°22' 29.7812"N | 83°34' 55.4895"E |
| 51      | VES-51  | 763243.9119 | 2586668.9138 | 23°22' 6.8552"N  | 83°34' 30.519"E  |
| 52      | VES-52  | 762547.1541 | 2585950.7499 | 23°21' 43.9281"N | 83°34' 5.5512"E  |
| 53      | VES-53  | 762907.4347 | 2585604.0482 | 23°21' 32.4568"N | 83°34' 18.0113"E |
| 54      | VES-54  | 763604.7048 | 2586322.7402 | 23°21'55.38"N    | 83°34'42.97"E    |
| 55      | VES-55  | 764301.9670 | 2587041.4240 | 23°22' 18.3432"N | 83°35' 7.987"E   |
| 56      | VES-56  | 764998.7357 | 2587759.5991 | 23°22' 41.2662"N | 83°35' 32.9583"E |
| 57      | VES-57  | 765696.3438 | 2588478.6394 | 23°23' 4.2167"N  | 83°35' 57.9636"E |
| 58      | VES-58  | 766392.9319 | 2589196.6284 | 23°23' 27.1323"N | 83°36' 22.9347"E |
| 59      | VES-59  | 766754.0450 | 2588850.7848 | 23°23' 15.6855"N | 83°36' 35.4234"E |
| 60      | VES-60  | 766056.9577 | 2588132.2813 | 23°22' 52.754"N  | 83°36' 10.4345"E |
| 61      | VES-61  | 765359.5118 | 2587413.4081 | 23°22' 29.8094"N | 83°35' 45.4351"E |
| 62      | VES-62  | 764662.4253 | 2586694.9055 | 23°22' 6.8753"N  | 83°35' 20.451"E  |
| 63      | VES-63  | 763964.9786 | 2585976.0314 | 23°21' 43.9279"N | 83°34' 55.4564"E |
| 64      | VES-64  | 763268.6924 | 2585258.3536 | 23°21' 21.0175"N | 83°34' 30.5058"E |
| 65      | VES-65  | 762571.2700 | 2584539.5047 | 23°20' 58.0683"N | 83°34' 5.5168"E  |
| 66      | VES-66  | 762932.0512 | 2584193.3190 | 23°20' 46.6136"N | 83°34' 17.9937"E |
| 67      | VES-67  | 763629.4920 | 2584912.1869 | 23°21' 9.5628"N  | 83°34' 42.9832"E |
| 68      | VES-68  | 764326.5842 | 2585630.6955 | 23°21' 32.4993"N | 83°35' 7.9626"E  |
| 69      | VES-69  | 765023.6838 | 2586349.2117 | 23°21' 55.4346"N | 83°35' 32.9447"E |
| 70      | VES-70  | 765720.6080 | 2587067.5471 | 23°22' 18.3628"N | 83°35' 57.9229"E |
| 71      | VES-71  | 766417.7106 | 2587786.0665 | 23°22' 41.2956"N | 83°36' 22.9098"E |
| 72      | VES-72  | 766778.8271 | 2587440.2264 | 23°22' 29.849"N  | 83°36' 35.3976"E |
| 73      | VES-73  | 766081.7465 | 2586721.7298 | 23°22' 6.9175"N  | 83°36' 10.4115"E |
| 74      | VES-74  | 765384.2939 | 2586002.8497 | 23°21' 43.9724"N | 83°35' 45.4146"E |
| 75      | VES-75  | 764687.5287 | 2585284.6781 | 23°21' 21.0486"N | 83°35' 20.4446"E |
| 76      | VES-76  | 765745.0700 | 2585656.6587 | 23°21' 32.5154"N | 83°35' 57.8897"E |
| 77      | VES-77  | 766442.5700 | 2586375.6300 | 23°21' 55.4629"N | 83°36' 22.8883"E |
| 78      | VES-78  | 766803.6092 | 2586029.6679 | 23°21' 44.0124"N | 83°36' 35.3722"E |
| 79      | VES-79  | 761921.9597 | 2586742.4498 | 23°22' 10.0083"N | 83°33' 44.0466"E |
| 80      | VES-80  | 759322.6054 | 2587655.1675 | 23°22' 41.1511"N | 83°32' 13.1402"E |

### 2.8.7 VES Interpretation

Total 80 no. of VES interpretation is done by inverse slope method. In this method plotting are made-electrode separation in X-axis and electrode separation divided by the apparent resistivity values are taken in Y-axis. After calculating the slope of each segment, the true resistivity of each layer can be obtained. The points are joined by the best fitting straight-line segments

similar to that being done in statistical analysis. The interpretation should reflect the layered sequences. The joining should not be done in the geometrical sense. It should be done to have the number of layers as visualized from the field curve. After completing the drawing of the segments, the inverse slopes of each segment are calculated. These give the resistivities in ohm /m of the various layers in the case of plotting by  $AB/2$  vs  $AB/2/Rho a$ . The points of intercepts give the depth to the various interfaces.

Curve of all 80 VES is shown in Plate II. On an average 15 to 20 number of layers have been identified by this interpretation method.

## 2.9 COAL ANALYSIS

The assessment of Seam Section II top, middle, bottom, II combined & Seam I has been done for assessing potentiality.

The analyses were obtained for BCS, I<sub>30</sub> & I<sub>100</sub> basis which are defined:

- BCS Sample: Coal + Shaly Coal+ Low Carbonaceous Shale
- I<sub>30</sub> Sample : BCS sample + High Carbonaceous Shale band up to 30 cm thickness.
- I<sub>100</sub> Sample : BCS sample + High Carbonaceous Shale band up to 100 cm thickness.

However, during this current phase of investigation, core samples of only 6 boreholes has been analyzed and the seams in that borehole are devoid of any dirt band and high ash carbonaceous shale. Hence, BCS, I<sub>30</sub> and I<sub>100</sub> sample is identical

Overall moisture content of the seam horizons encountered in the block is > 2%, thus for high moisture coal different lithological units on the basis of Ash % +Moisture % are defined as under (As per ISP 2022):

|                              |   |                            |
|------------------------------|---|----------------------------|
| Coal                         | : | Ash+Moisture up to 40%.    |
| Shaly Coal                   | : | Ash+Moisture 40.01 - 55%.  |
| Low Ash Carbonaceous Shale:  |   | Ash+Moisture 55.01 -65.0%. |
| High Ash Carbonaceous Shale: |   | Ash+Moisture 65.01 - 75%.  |
| Non-Combustible Dirt Band    | : | Ash+Moisture > 75%.        |

**Table 2.9: Details of Coal Analyses executed in Ulia-Gamhardih block, East of Bisrampur Coalfield, during current phase of investigation.**

| <b>BOREHOLE NAME</b> | <b>Number of b/b samples</b> | <b>Number of Overall samples</b> | <b>Number of Special test samples</b> | <b>Number of Trace element test samples</b> | <b>Number of Petrographic test samples</b> |
|----------------------|------------------------------|----------------------------------|---------------------------------------|---|--|
| CEBUG-01             | 4                            | NIL                              | NIL                                   | NIL   | NIL  |
| CEBUG-02             | NIL                          | NIL                              | NIL                                   | NIL   | NIL  |
| CEBUG-03             | NIL                          | NIL                              | NIL                                   | NIL   | NIL  |
| CEBUG-04             | 24                           | 5                                | 5                                     | -   | 5  |
| CEBUG-05             | 32                           | 2                                | 2                                     | -   | NIL  |
| CEBUG-06             | 23                           | 7                                | -                                     | -   | NIL  |
| CEBUG-07             | 65                           | 12                               | 5                                     | -   | NIL  |
| CEBUG-08             | 15                           | 1                                | 1                                     | -   | NIL  |
| <b>Grand Total</b>   | <b>163</b>                   | <b>27</b>                        | <b>-</b>                              | <b>-</b>                                    | <b>-</b>                                   |
| <b>Approved</b>      | <b>450</b>                   | <b>120</b>                       | <b>13</b>                             | <b>-</b>                                    | <b>5</b>                                   |

## **2.10 DATA SYNTHESIS**

The interpretation of geology and structure of Ulia-Gamhardih block has been done mainly on the basis of sub-surface data generated through boreholes. The study of physical characteristics, delineation and disposition of dirt bands in the seams etc. have been carried out on the basis of megascopic study of the borehole cores while the nature of combustible dirt bands, coal quality etc. have been established through different analysis of the cores.

The basic data utilized for documentation of the present report is based on borehole data obtained from the borehole core. The lithological logs, seam correlation and quality of the seam are prepared by the data processed in CEMPGEODOC software. The geological model is prepared in MINEX 6.5.5 software. The cross-section profiles, floor contour plans and reserve estimation are prepared from the geological model of the block. The basic data is synthesized in the following steps.

i) On the basis of data generated through geological logging of cores (coal and non-coal) obtained after drilling of boreholes, the seam thickness as well as the parting is extrapolated from the recovered thickness obtained in drilling. Accordingly, descriptive geological log of boreholes has been prepared and given in Annexure - II/A. Graphic lithological log prepared on RF 1:500 is given in Plates - IV.

ii) The roof and floor of seam is fixed by eliminating the High carbonaceous shale, shale and other non-combustible bands at the floor and roof of the seam.

iii) Correlation chart so prepared is given in Annexure-III.

iv) Geophysical Logging data has been provided in Plate No. VI

v) Geological cross sections are drawn across the strike of the seams at different locations in order to understand the geological structure of the block and is given in Plate – V.

## CHAPTER 3

### GEOLOGY AND STRUCTURE

#### 3.1 REGIONAL GEOLOGY

##### 3.1.1 General

The East of Bistrampur Coalfield lies in the eastern part of the Son-Mahanadi Valley Basin. This coalfield is separated from the Tatapani – Ramkola Coalfield to the north by large intervening tract covered by metamorphics. The Dhaska-Naugai area, lying to the east of the confines of East of Bistrampur Coalfield is a small and detached sub-basin located east and north east of the East of Bistrampur Coalfield and to the south east of the Tatapani- Ramkola Coalfield. The vast tracts between these coalfields are occupied by Surguja crystalline complex.

The Ulia- Gamhardih area, to the east of the confines of East of Bistrampur Coalfield is actually a NW-SE trending sub- basin bounded by the latitudes 23°18'00" N and 23°25'30" N and longitudes 83°30'00" E and 83°43'00" E. In this area the sediments of Lower Gondwana directly overlies the Surguja crystalline complex with a faulted contact.

##### 3.1.2 Stratigraphy

The generalized stratigraphic sequence of the eastern part of East of Bistrampur Coalfield is as follows: (after P.K. Ghosh and M. Poonuswamy, 1962; P.K. Ghosh and P.K. Dutta, 1963; C. S. Raja Rao, 1983):

**Table 3.1.2A: Stratigraphic succession of East of Bisrampur Coalfield**

| Age                             | Formation                   | Thickness        | Lithology   |
|---------------------------------|-----------------------------|------------------|---|
| Recent                          | Alluvium                    | --               | Soil, Sand, clay  |
| Cretaceous (?)                  | Dykes                       | --               | Dolerite  |
| Upper Permian to Lower Triassic | Kamthi (?)                  | 100 m            | Ferruginous conglomeratic sandstone.  |
|                                 | Barakar                     | 45 - 304 m       | Sandstone with pebbly bands, carbonaceous and grey shale and coal seams.                                  |
| Lower Permian                   | Karharbari                  | 5 - 105 m        | Coarse grained sandstone with reworked Talchir clasts and conglomerate lenses, shale and thin coal seams. |
| Upper Carboniferous(?)          | Talchir                     | 1.5 - 269 m      | Fine grained sandstone, siltstone, shale and Diamictite.  |
| -----                           | -----                       | --Unconformity-- | -----   |
| Pre-Cambrian                    | Surguja Crystalline Complex |                  | Granite, gneisses slate, quartzite, schist , Amphibolite, etc.  |

### 3.1.3 DESCRIPTION OF FORMATIONS

The Ulia – Gamhardih area to the east of the confines of East of Bisrampur Coalfield is NW-SE trending sub-basin bounded by Pondi, Bharatpur villages in the east and Mahan River in the north west & west and covers approximately 80 sq km area. The coal bearing Lower Gondwana sediments disposed in an arcuate pattern mostly in east-west direction from Uphia to Ghugri and then takes a southeasterly trend and finally terminates near Gamhardih against the east- west trending Boundary fault. This coalfield is bounded by a unique fault pattern. In the north - western part from Ulia to south- eastern part of Gamhardih, it has two conjugate sets of NW-SE and E-W trending faults. In the area, rocks of Talchir and Barakar formations directly overlie the Surguja crystalline complex with a faulted contact.

Based on the surface and sub-surface data, the general stratigraphic sequence of Ulia - Gamhardih area to the east of the confines of East of Bisrampur coalfield is as follows:

| Age                                 | Formation                   | Thickness | Lithology   |
|-------------------------------------|-----------------------------|-----------|---|
| Recent                              | Alluvium                    | 5-10m     | Soil, sand, clay, gritty materials.   |
| Upper Tertiary to Pleistocene (?)   | Laterite                    | 10-15m    | Greyish brown to reddish brown, variegated and mottled coloured, hard, compact and ferruginous showing pisolitic and botroidal texture.   |
| Early Permian                       | Barakar                     | 85-250m+  | Whitish grey to grey, medium to coarse grained, at places very coarse grained to gritty, micaceous, arkosic to sub-arkosic, massive, occasionally cross bedded, moderately sorted, sandstone associated with subordinate horizons of dark grey shale, silty shale, carbonaceous shale along with thin bands of conglomerate and coal seams/ bands, thick coal seams and coal bands. |
| Early Permian to Late Carboniferous | Talchir                     | 2-75m+    | Greenish to light bluish, thinly laminated shale /silty shale and siltstone, at places dark grey to black shale with grey to light greenish, fine grained, micaceous, massive, occasionally crudely bedded, thin bands of sandstone.  |
| ----- Faulted contact -----         |                             |           |   |
| Pre-Cambrian                        | Surguja Crystalline Complex |           | Gneiss, Granite, Biotite granite gneiss, Quartzite, Pegmatite etc.  |

Details of the formations are given below –

### **Surguja crystalline complex:**

The Surguja crystalline complex which forms the basement of Gondwana sediments is exposed all around the area except the north eastern part which forms of laterite. It is represented by whitish grey to grey, at places pinkish gneiss and granite, biotite granite- gneiss, quartzite and pegmatite. The gneiss often contains large porphyroblasts of feldspar. Towards down stream of Ubka nala section pink coloured mega porphyroblasts of feldspar, subhedral in shape, maximum size of 10" x 4" is recorded. Numerous quartz veins and pegmatite veins traverse these gneisses. The pegmatite veins contain large crystals of quartz and feldspar with mica flakes. In general, three prominent set of joints are observed within these gneiss viz NW-SE, NE -SW and NNE – SSW.

A large inlier of metamorphic rock is exposed within the Gondwana about 2.5 km north west of Patna Village. It consists of gneiss, quartzite and pegmatite which have profuse porphyroblasts of pink coloured feldspars. The width of this inlier is about 50-70 m and extends for a length of about 200 m.

### **Talchir Formation:**

Outcrops of Talchir are exposed in patches towards the northwestern margin of the area along Mahan River for a distance of about 2.5 km extending more or

less in a north – south direction between Uphia and south of Jarhadih village. Here, these consist of greenish/yellowish green to light bluish grey, micaceous, thinly laminated shale / silty shale and siltstone with grey to light greenish, fine grained, micaceous, massive, occasionally crudely bedded, thin bands of sandstone. The trend of beds is N50°E – S50°W with 3°-5° northwesterly dip and at places southwesterly dip as well. Another small outcrop of Talchir is exposed south west of Ulia village along the tributary nala section for about 0.5 km distance in east- west direction. In this section, it consists of light greenish grey to black shale intercalated with fine grained, micaceous, sandstone. Here, the strike of the bed is N35°E - S35°W with 3°-6° northwesterly dip. In the area, thinly laminated, greenish shale / silty shale of Talchir is succeeded by greyish, medium to coarse grained sandstone which is often gritty and pebbly. Besides, thin bands of conglomerate are also observed at places.

Seven, out of the eight scout boreholes (EBUG-1 to EBUG-7 and EBUG-7A) drilled in the area intersected the Talchir Formation except one (EBUG-4) that is prematurely closed due to drilling constraints. Talchir Formation has conformable contact with the basement and in the boreholes, a maximum of 75.54m thick Talchir sediment is intersected towards the far southeastern part of the coalfield near Naugai village in borehole EBUG-1. In the central part, about 2.5 km west of Patna village, a maximum of 61.34+ m is intersected in borehole EBUG-3. In the boreholes, the Talchir Formation is represented by typical olive green to light greenish grey shale / silty shale and siltstone and light grey to greenish, fine grained, micaceous sandstone. Basal part of Talchir Formation often contains thin bands of conglomerate. This part also shows minor faults, slumping, load and flame structures, parallel and convolute bedding which is often bioturbated.

#### **Barakar Formation:**

Most of the area under investigation is covered by rocks of Barakar Formation except the western part where patches of Talchir Formation are exposed. In the area, Barakar Formation abuts against the Surguja crystalline complex mostly along two sets of east-west and north west – south east trending step like faults. Such step like pattern of faults also corroborated with geophysical investigation.

In general, Barakar Formation is represented by whitish grey to greyish white, mainly medium to coarse grained, at places very coarse grained, micaceous, feldspathic, massive occasionally cross bedded, moderately sorted sandstone with subordinate horizons of dark grey shale, carbonaceous shale and a number of thick coal seams and coal bands. In most of the nala sections, particularly in central and western part, sandstones are greyish to milky white, coarse grained to very coarse grained, at places pebbly, micaceous, arkosic to sub-arkosic, massive, gritty, ill-sorted with small clasts of quartz and feldspar. These embedded clasts are mostly subhedral to anhedral in shape. These sandstones are multistoried in nature that very often shows cross bedding and cross lamination. At places, feldspars within the sandstones are mostly altered to clay. Barakar sandstone at and near the metamorphic contact contain large amount of pink/ reddish coloured feldspar, subhedral in shape. Such sandstones are characterized by reddish brown, arenaceous, very coarse grained, silicified, indurated and ferruginous nature that are also hard, compact and have high specific gravity. The subordinate shale / silty shale and siltstone of Barakar Formation are rich in plant impressions. At places, such shale / silty shale and siltstone are parallel and convolute laminated with alternate sequence of greyish white, fine grained, sandstone. At places, sedimentary structures like parallel and ripple laminations, load structure, pinch and swell structure etc are marked. Imbrications within these sandstones are also marked at places.

During large scale mapping (1:25,000) in and around Ulia- Gamhardih area, a number of coal outcrops (cumulative thickness varying from 1.00 m to 13.35 m) has been recorded in the area along nala sections as well as scarp faces of hills at different levels over a 3 km to 5 km stretch between Ulia and Patna. Similar coal outcrops, thickness varying from 1.00 m to 4.60m, have also been noted around northern and northeastern part of Ghugri areas. The overall thickness of coal in different exposures is between 1.00 m and 13.35 m (cumulative thickness) have been recorded in different horizons. A coal seam having cumulative thickness of 13.35 m was marked at up stream of Ubka nala section (Lat. 23°24'56" N: Long. 83°34'47" E), about 3 km north east of Patna village. This coal seam could be traced for about 500m along the strike.

The measured section is as follows: -

| <b>Litho- unit</b>  | <b>Thickness</b> |
|---|------------------|
| Milky white, fine to medium grained, micaceous, feldspathic sandstone | > 2.00 m         |
| Dark grey shale with carbonaceous shale and thin bands of shaly coal  | 1.25 m           |
| Coal  | 0.16 m           |
| Carbonaceous shale  | 0.70 m           |
| Burnt outcrop   | 2.90 m           |
| Coal  | 4.40 m           |
| Carbonaceous sandstone  | 0.45 m           |
| Coal  | 5.14 m           |
| Carbonaceous sandstone  | 1.60 m           |
| Coal  | 0.60 m           |
| Dark grey, micaceous shale  | 0.78 m           |
| Coal  | 2.00 m           |
| Carbonaceous sandstone  | 0.20 m           |
| Whitish grey, micaceous sandstone                                     | 1.00 m           |
| Shaly Coal  | 1.05 m           |
| Grey, micaceous Siltstone   | > 1.50 m         |

Sub-surface data reveals the occurrence of two distinct coal seam zone (I and II in ascending order) along with one local seam and few thin coal bands occur within the Barakar Formation. Seam Zone-I has been encountered in boreholes EBUG-4, EBUG-5 and EBUG-6 only in the depth range between 40.23m and 173.00m.

The cumulative clean coal varies from 1.27m to 3.48m belonging to 'B' to 'E' grade. The coal seam zone-II has been encountered in boreholes EBUG-1, EBUG-2, EBUG-3, EBUG-4, EBUG-6 and EBUG-7A. This seam zone occurs in multiple split sections with intervening parting of arenaceous / argillaceous component and carbonaceous shale. The cumulative clean coal varies from 1.11 to 23.74m and that belong to 'A' to 'F' grade. The local coal seam (L) is encountered in boreholes EBUG-1 & EBUG-2 only and its individual thickness of coal is 0.71m and 0.72m respectively.

At least one conglomeratic horizon is found all over the area within the Barakar Formation. This is matrix supported conglomerate with argillaceous matrix. Pebbles of quartz, feldspar, shale, granite and granite gneiss are embedded in the matrix. These pebbles are sub-rounded to sub-angular and

varying in size from 0.4 cm to 5.2 cm and show very poor sorting.

Burnt rocks are reported for the first time in this area. Burnt rocks are observed at several places in the mapped areas which are typical light brick red to whitish red coloured. These burnt rocks are prevalent in western, central and north central part of the area. Burnt rocks consist of sandstone and shale which are mostly altered and scattered in most of the nala sections as well as on top part of hills. All around on top part of hills, burnt rocks follow almost same contour. One such burnt rock section showing arcuate pattern is prominent in NNE of Patna village that traverse for about 3 km.

The entire area is crisscrossed by a number of transverse E-W faults and conjugate cross faults trending NW-SE and NE-SW. At places, the E-W faults vary ENE - WSW to ESE-WNW. The cross faults are mostly aligned along N50°W-S50°E and N40°E -S40°W directions. Majority of the faults are syn- sedimentary in nature which resulted in omission and offsetting of sedimentary strata as well as coal seams and coal bands over a short distance.

The sedimentary strata, in general, have a N35°E-S35°W strike with 2° to 4° northwesterly dip in the western and central parts of the area around Ulia and Patna village. However, rolling nature of dip characterize the area. Around Patna village and in adjacent Ubka nala the amount of dip is almost sub horizontal (1° to 2°). In the western part, in small nala east of Jarhadih the strike is N30°E-S30°W with 4° north westerly dip and towards eastward it swing almost to east- west with low ( 3° to 5° ) northerly dip. The strike, around 13.35 m cumulative thick exposure of coal seam NNE of Patna, is N60°W-S60°E with 3° southwesterly dip. In the eastern and southeastern parts of the area around Ghugri and Naugai villages, the beds generally strike N60°E-S60°W with low (3° to 4°) northwesterly dip. In general, strike direction varies between N30°E-S30°W to N70°E-S70°W and dip ranges from 2° to 5° which have rolling nature locally.

#### **Laterite:**

Laterite of this area is greyish brown to reddish brown, pitted, variegated and mottled coloured. It is often pisolitic and shows vesicular cavities that are irregular and filled with earthy materials. Generally, it is very hard, compact and ferruginous

and at places glazed with thin lining of iron oxide and often shows botroidal texture. It is believed to be of detrital origin, autochthonous and high level type and alteration product of sub-tropical decomposition of rocks with alternating wet and dry climatic conditions, as it is associated with fragmentary and impure sandstone and grit. In the satellite imagery, it is picked up as separate litho unit. At places, due to weathering its colour became grey to dark grey.

All along the northern part, particularly around Jampani to Joka village, rocks of Barakar Formation are capped by approximately 10-15 m thick laterite. Sandstone just beneath the laterite is kaolinised and is higher in ferruginous contents.

### **3.2 GEOLOGICAL STRUCTURE**

The Pre-Cambrian metamorphics which forms the basement for Gondwana sediments are exposed in the east, west, south, south east and north west with alternate set of E-W and NW-SE trending faults. The foliation within the Pre-Cambrian metamorphics is E-W. In the north west, west, south and south east parts of the area the Barakar Formation abut directly against the metamorphics along NW-SE and E-W trending boundary faults indicating entire Uliya-Patna-Jagima area as down thrown block. These two sets of fault constitute a unique step like fault pattern in the area. However, in the northern part, the rocks of Barakar Formation are covered by about 10-15 m thick laterite.

The sedimentary strata, in general, have a N35°E-S35°W strike with low 2° to 4° north westerly dip in the western and central parts of the area around Uphia and Patna villages whereas in the eastern part around Gamhardih and Ghugri, the beds generally strike N60°W-S60°E with low northerly dip. However, due to undulating topography, the dips have rolling nature locally. In most of the area Barakar Formation abut directly against the Pre-Cambrian metamorphics along step like faults. Current bedding and cross trough stratification are the most common primary sedimentary structures observed in the sandstone of Barakar Formation in the area. These sandstones are mostly massive and multistoried.

Apart from these, load and cast structure, flame structure, parallel & convolute laminations, slump structure are also observed in the borehole cores.

In addition to the major boundary faults, the coalfield is affected by numerous other faults which are aligned along two major direction viz.  $N40^{\circ}E-S40^{\circ}W$  and  $N50^{\circ}W-S50^{\circ}E$ . The NE-SW aligned faults are fairly extensive and vary from  $N35^{\circ}E-S35^{\circ}W$  to  $N55^{\circ}E-S55^{\circ}W$ . The central and western part of the coalfield is criss-crossed by a number of transverse faults mainly aligned along two major directions viz.  $N45^{\circ}E-S45^{\circ}W$  and  $N25^{\circ}E-S25^{\circ}W$  resulting in omission and offsetting of sedimentary strata as well as coal seams / bands.

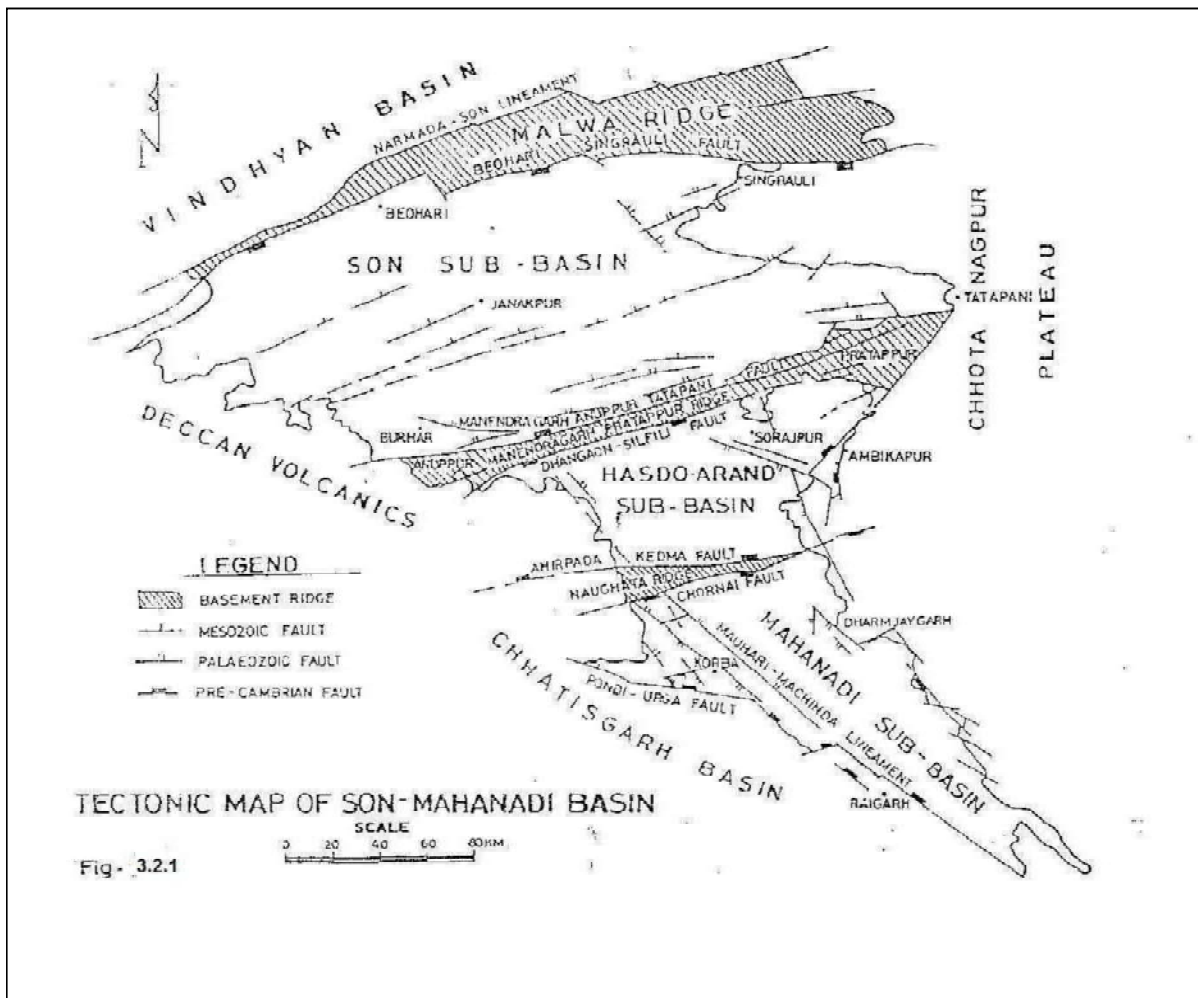


Fig: 3.2.1 Tectonic Setup of Rewa Gondwana Basin



### **3.3.3 DESCRIPTION OF FORMATIONS**

#### **Talchir**

Talchir formations has been encountered in all the boreholes drilled in the block, Considering all phases of exploration. The formation was identified in the core samples by the presence of greenish colored shale, medium to coarse grained sandstone with greenish tint and Diamictite (coarse pebbles in greenish shale). The formation in the core sample was identified by olive green colored shale, very fine grained sandstone with greenish tint.

#### **Barakar**

The Barakar Formation predominantly comprises sandstones with subordinate shales, carbonaceous shale and coal seams. The sandstones are generally light grey, varying from fine to medium grained to gritty sandstone. The average thickness of the Barakar Formation of Ulia-Gamhardih block is 38.10-202.06m. All the coal seams occurring within Ulia-Gamhardih block are confined to the Barakar Formation.

#### **Soil/Alluvium**

The soil/alluvium of the block is mostly of residual nature. The detailed lithology of the formations encountered in boreholes drilled in the block is furnished in Annexure No. IIA.

#### **3.3.4 Intrusive**

Ulia-Gamhardih block is devoid of any intrusive activities.

#### **3.3.5 Sequence of Coal Seams**

The sequence of coal seams/sections with their thickness ranges and parting ranges are furnished below.

**Table 3.3.5A: Sequence of coal seams with their thickness & parting range, Ulia-Gamhardih Block, East of Bistrampur Coalfield**

| Sequence of Seam / Parting | Depth Range of Seam (m) |         | Thickness (m) |         | No. of intersections |
|----------------------------|-------------------------|---------|---------------|---------|----------------------|
|                            | Minimum                 | Maximum | Minimum       | Maximum |                      |
| II                         | 9.55                    | 79.34   | 10.95         | 29.5    | 3                    |
| II TOP                     | 11.28                   | 98.23   | 1.47          | 4.37    | 4                    |
| II MIDDLE                  | 34.9                    | 102.84  | 2.05          | 2.92    | 2                    |
| II BOTTOM                  | 16.1                    | 115.1   | 0.64          | 20.81   | 4                    |
| I                          | 33.6                    | 173     | 0.6           | 5.3     | 8                    |

### 3.4 GEOLOGICAL STRUCTURE

#### 3.4.1 General

The Geological structure of the block has been deciphered based on the sub surface data obtained from the boreholes as the block is entirely covered by soil / alluvium. This block is not much structurally complicated, a total 3 faults, F1, F2 and F3 have been deciphered on the basis of intersections in boreholes and floor contour plans coupled with geological cross section and field observation.

#### 3.4.2 Strike and Dip

In Ulia-Gamhardih block, the strike of the coal seam shows almost NNE-SSW trend. The overall dip of the coal seams varies between 3° to 4° towards ESE in the block.

#### 3.4.3 Pattern of Faulting

A total two number of normal faults (F1 to F3) of Low to medium magnitude have been deciphered in the area. The faults are oriented almost N-S direction. The interpretation of the faults is done as per the borehole data; however, no surface evidence has been identified in the field. The throw of the faults varies from 0 to 180 meters. The details are as follows:

**Table 3.4.3A: Description of faults deciphered in Ulia-Gamhardih block, East of Bisrampur Coalfield**

| Fault                          | Extension of fault in the block (km) | Trend (Strike of Fault)            | Throw Direction | Throw Amount (m) | Evidence  |
|--------------------------------|--------------------------------------|------------------------------------|-----------------|------------------|---|
| F <sub>1</sub> -F <sub>1</sub> | 7.4                                  | Trend of the fault is E-W          | North           | 110m             | Difference in FRL on either side of the fault (CEBUG-01,03, 05,7).  |
| F <sub>2</sub> -F <sub>2</sub> | 7.4                                  | Trend of the fault is almost N-S   | West            | 50m              | The trend of the fault is almost N-S. The fault has been delineated based on difference in FRL on either side of the fault (EBUG-04, 05,CEBUG-08,04).           |
| F <sub>3</sub> -F <sub>3</sub> | 6.0                                  | Trend of the fault is N-S to NW-SE | West            | 10m-180m         | The fault has been delineated based on the borehole number CEBUG-04, EBUG-04 and CEBUG-06, 07, EBUG-06, based on difference in FRL on either side of the fault. |

## CHAPTER – 4

### DESCRIPTION OF COAL SEAMS

#### 4.1 GENERAL

In conformity with the occurrence of coal seams in Ulia-Gamhardih block of East of Bistrampur coalfield in general, G3 stage of exploration in the said block has revealed the existence of 5 coal horizons, viz. split seam sections of seam III i.e. **Seam II Top, Seam II Middle** and **Seam II Bottom** and **Seam I** in youngest to oldest order. A major fault (F1) is passing through the Southern and South-western part of the block, due to which no seams have been encountered in the upthrown side of the fault(F1) to the Southern and South-western side of the block. There are two consistent seams namely seam II and it splits (Top, Middle and Bottom) I. Though Seam II is consistent seam the seam has been incropped within the block near the borehole CEBUG-05 and seam falls up dip in the upthrown side of the faults F1-F1 and F2-F2. The seam II has been split into top middle and bottom section, the combined section has been encountered near the boreholes CEBUG-06,04 and EBUG-06 having an area of around 7.8 sq.km, in the remaining area the seams has been split. The seam I has been developed in the block and the seam falls updip in the upthrown side of the fault F2-F2.

#### 4.2 CORRELATION

The Coal seams/sections intersected in various boreholes in Ulia-Gamhardih block have been correlated on the basis of their thickness, physical makeup, quality, inter-seam partings and associated lithology. The graphic logs of the boreholes are given in Plate- III and the correlation of the coal seams is furnished in Annexure-III.

#### 4.3 QUALITY

##### PARAMETERS

##### COAL ANALYSIS

The analyses were obtained for BCS, I<sub>30</sub> & I<sub>100</sub> basis which are defined:

- BCS Sample : Coal + Shaly Coal+ Low Carbonaceous Shale
- I<sub>30</sub> Sample : BCS sample + High Carbonaceous Shale band up to 30 cm thickness.
- I<sub>100</sub> Sample : BCS sample + High Carbonaceous Shale band up to 100 cm thickness.

Overall moisture content of the seam horizons encountered in the block is > 2%, thus for high moisture coal different lithological units on the basis of Ash % +Moisture % are defined as under:

- |                               |                              |
|-------------------------------|------------------------------|
| ▪ Coal :                      | Ash+Moisture up to 40%.      |
| ▪ Shaly Coal:                 | Ash+Moisture 40.01 - 55%.    |
| ▪ Low Ash Carbonaceous Shale  | :Ash+Moisture 55.01 -65.0%.  |
| ▪ High Ash Carbonaceous Shale | :Ash+Moisture 65.01 – 75.0%. |
| ▪ Non-Combustible Dirt Band   | :Ash+Moisture > 75%.         |

Band-by-band analysis of the seams are given in Annexure-IV and details of dirt bands present in the seams are given in Annexure-V. The coal present in the blocks are of high moisture, moderate ash, low rank & non-coking coal.

The results of special tests i.e., Ash Fusion Temperature, Ultimate analysis, Ash analysis, HGI, etc. are tabulated in Annexure-VI. The determined GCV analysis on 60% RH & 40°C are available for 5 borehole, for the remaining boreholes the analysis on equilibrated basis has been calculated (by using M100 values) and the same is presented in Annexure-V. The seam wise average M100 values have been utilized for calculating analysis on equilibrated basis.

#### 4.3.1. M<sub>100</sub> CALCULATION

M<sub>100</sub> (moisture related to 100 parts of pure dry coal) value of a particular coal seam can be calculated from the data of boreholes, where determined seam overall proximate analysis on 60% RH & 40°C is available, by using following formula:

$$M_{100} = \frac{M \times 100}{100 - (1.1 A \% + M \%)}$$

Where, M = Moisture%, A = Ash%, determined on 60% RH & 40°C as per IS 1350, Part I, 1984.

#### 4.3.2 USEFUL HEAT VALUE CALCULATION

The heat values of coal are represented by Useful Heat Value (UHV) in kilocalories / kilogram. The computation of UHV was done from the formula:

$$\text{UHV in kcal/kg} = 8900 - 138 \times (A + M)$$

Where M and A are determined, moisture and ash percentage, on 60% RH and 40°C, as per IS 1350, Part I, 1984, for the seam is considered.

#### 4.3.3 CALORIFIC VALUE CALCULATION

Mazumder's formula for high moisture coal was used for calculation of Gross Calorific Value as described below:

$$\text{Gross CV in kcal/kg} = \frac{154 \times \{100 - (1.1 \times A + M)\} - 108 \times M}{1.80}$$

Where A = Ash% and M = Moisture % on equilibrated basis, determined as per IS 1350, Part I, 1984.

#### 4.3.4 ULTIMATE ANALYSIS ON DMMF BASIS

Percentages of carbon, hydrogen, etc. as determined by ultimate analysis have been converted to DMMF basis using the following formula, as shown below in case of carbon:

$$\text{Unit Carbon} = \frac{\text{Carbon} \times 100}{\text{Pure Coal}}$$

Where C was carbon percent of coal seam determined by ultimate analysis as per IS 1350, Part IV, 1974. Similar formula is used in case of other constituents except oxygen, which is obtained by subtracting carbon, hydrogen, nitrogen and sulphur on DMMF basis from 100. In all the above cases, pure coal is derived as follows: -

$$\text{Pure Coal} = 100 - (1.1 \times \text{Ash} + \text{Moisture})$$

Where Ash and Moisture were taken from determined seam overall on equilibrated basis.

#### 4.4 SEQUENCE OF COAL SEAMS

The sequence of coal seams and intervening partings found to occur within the block, as per borehole data, is given in Table 4.4 A below:

**Table 4.4A: Sequence of coal seams with their thickness & parting range, Ulia-Gamhardih block, East of Bistrampur Coalfield.**

| Sequence of Seam / Parting | Depth Range of Seam (m) |         | Thickness (m) |         | No. of intersections |
|----------------------------|-------------------------|---------|---------------|---------|----------------------|
|                            | Minimum                 | Maximum | Minimum       | Maximum |                      |
| II                         | 9.55                    | 79.34   | 10.95         | 29.5    | 3                    |
| II TOP                     | 11.28                   | 98.23   | 1.47          | 4.37    | 4                    |
| II MIDDLE                  | 34.9                    | 102.84  | 2.05          | 2.92    | 2                    |
| II BOTTOM                  | 16.1                    | 115.1   | 0.64          | 20.81   | 4                    |
| I                          | 33.6                    | 173     | 0.6           | 5.3     | 8                    |

### DESCRIPTION OF INDIVIDUAL COAL SEAMS

#### 4.5 SEAM II and its splits

##### 4.5.1 References

| Sl. No. | Particular               | Annexure No. | Plate No. |
|---------|--------------------------|--------------|-----------|
| 1       | Descriptive Lithologs    | IIA          |           |
| 2       | Correlation Chart        | III          |           |
| 3       | Overall Quality          | V            |           |
| 4       | Special Test             | VI           |           |
| 5       | Reserves                 | VII          |           |
| 6       | Graphic Lithologs        |              | IV        |
| 7       | Geological cross section |              | V         |

##### 4.5.2 Status of Mining

The seam section is virgin within the block.

### 4.5.3.1 Details of Borehole Intersections

| SEAM  |  | II Comb    | II Top    | II Middle | II Bottom |
|-------|--|------------|-----------|-----------|-----------|
| SI No | A. Intersections   | Nos.       | Nos.      | Nos.      | Nos.      |
| 1     | No. of full seam intersections in boreholes in the block                         | 03         | 04        | 02        | 04        |
| 2     | No. of boreholes where seam is not developed in the block                        | -          | -         | 02        | -         |
| 3     | No. of boreholes where seam is beyond incrop/ falling on updip side in the block | 07         |           |           |           |
| 4     | No. of boreholes where seam are split/ combined                                  | 04 (split) | 03 (comb) | 03 (comb) | 03 (comb) |
| 5     | No. of boreholes not considered  | -          | -         | -         | -         |
| 6     | Total number of boreholes  | 14         | 14        | 14        | 14        |

### 4.5.3.2 Details of depth of seam encountered in boreholes:

| Sl. No. | SEAM        |         | II Comb. |          | II top |         | II middle |          | II bottom |          |
|---------|-------------|---------|----------|----------|--------|---------|-----------|----------|-----------|----------|
| 1       | ROOF DEPTH  | MIN (M) | 9.55     | CEBUG-06 | 11.28  | EBUG-02 | 34.90     | CEBUG-07 | 16.18     | EBUG-02  |
| 2       |             | MAX (M) | 65.30    | CEBUG-04 | 96.02  | EBUG-04 | 99.92     | EBUG-04  | 111.08    | EBUG-04  |
| 3       | FLOOR DEPTH | MIN (M) | 20.50    | CEBUG-06 | 12.75  | EBUG-02 | 36.95     | CEBUG-07 | 21.48     | EBUG-02  |
| 4       |             | MAX (M) | 79.34    | CEBUG-04 | 98.23  | EBUG-04 | 102.84    | EBUG-04  | 115.10    | EBUG-04  |
| 5       | THICKNESS   | MIN (M) | 10.95    | CEBUG-06 | 1.47   | EBUG-02 | 2.05      | CEBUG-07 | 0.64      | EBUG-7A  |
| 6       |             | MAX (M) | 29.50    | EBUG-06  | 4.37   | EBUG-7A | 2.92      | EBUG-04  | 20.80     | CEBUG-07 |

Seam II is the topmost seam encountered in the block. The minimum depth of occurrence being 9.55m in borehole CEBUG-06(II combined) and maximum depth of occurrence being 111.08m in borehole EBUG-04(II bottom).

The depth of occurrence of the seam gradually increases towards the southern and eastern part of the block.

### 4.5.4 Stratigraphic Position

Seam II is the topmost seam to be encountered in the block lying above the seam I. This is the youngest seam.

#### 4.5.5 Parting

The details of the minimum and maximum parting thickness in the block is as follows,

| PARTICULARS  | THICKNESS OF PARTING |              |         |              | NATURE                        |
|--|----------------------|--------------|---------|--------------|-------------------------------|
|  | MIN (m)              | BOREHOLE NO. | MAX (m) | BOREHOLE NO. |                               |
| With underlying seam II combined/ bottom with seam I | 25.80                | CEBUG-07     | 66.71   | CEBUG-04     | Sandstone, sandy shale, shale |
| Between seam II top and middle                       | 1.69                 | EBUG-04      | 3.60    | CEBUG-07     | sandstone                     |
| Between seam II middle and bottom                    | 1.61                 | CEBUG-07     | 8.24    | EBUG-04      | Shale, sandstone              |

#### 4.5.6 Thickness

The details of the minimum and maximum thickness in the block is as follows,

| SEAM        | SEAM THICKNESS |          |       |          |
|-------------|----------------|----------|-------|----------|
|             | MIN            | BOREHOLE | MAX   | BOREHOLE |
|             | (m)            | NO.      | (m)   | NO.      |
| II Combined | 10.95          | CEBUG-06 | 29.50 | EBUG-06  |
| II top      | 1.47           | EBUG-02  | 4.37  | EBUG-7A  |
| II Middle   | 2.05           | CEBUG-07 | 2.92  | EBUG-04  |
| II Bottom   | 0.64           | EBUG-7A  | 20.80 | CEBUG-07 |

#### 4.5.7 Splitting

Seam II exhibits splitting behaviour and the seam has been split in to Top, Middle and Bottom section.

#### 4.5.8 Incrop

Seam II incrops in the Western part of the block and it is extended from Northern to Southern boundary of the block. The trend of the incrop is almost NNE-SSW and length is around 6.3km. Further the seam incrops in the southern and Eastern part of the block due to Fault F1-F1 and F2-F2.

#### 4.5.9 Roof and Floor of Seam II/ II Top/Middle/Bottom

| Predominant Roof/Floor | Nature of strata encountered                     |
|------------------------|--|
| Roof (up to 3.00 m)    | Comprises mainly of sandstone.                   |
| Floor (up to 1.00 m)   | Comprises mainly of sandstone, shale, sandyshale |

#### 4.5.10 Pyrolitisation

The seam section is not affected by Pyrolitisation to any extent.

#### 4.5.11 Dirt Bands

Dirt band has been included within seam II Combined in 01 borehole, with the total thickness of 0.36m (CEBUG-04). In Seam II Top, dirt band has been included in 01 borehole, with the total thickness of 0.44m (CEBUG-07). Seam II Middle is devoid of any dirt bands. Dirt band has been included within seam II BOT, with the total thickness of 1.05m (CEBUG-07).

#### 4.5.12 Proximate Analysis

The Proximate analysis and grade of Seam II/ II Top/Middle/Bottom are as follows:

**Table 4.5.12A: Proximate analysis & grade of Seam II/ II Top/Middle/Bottom, Ulia-Gamhardih block, East of Bistrampur Coalfield.**

| BH. NO.  | DEPTH  |        | SEAM NAME | TYPE OF SAMPLES | ANALYSED THICK (M) | BASIS          | PROXIMATE ANALYSIS AT 60% RH & 40°C |         |        |        | GCV<br>KCAL / KG | GRADE |
|----------|--------|--------|-----------|-----------------|--------------------|----------------|-------------------------------------|---------|--------|--------|------------------|-------|
|          | FROM   | TO     |           |                 |                    |                | M (%)                               | ASH (%) | VM (%) | FC (%) |                  |       |
|          | (M)    | (M)    |           |                 |                    |                |                                     |         |        |        |                  |       |
| CEBUG-04 | 65.3   | 79.34  | II        | BCS/I30/I100    | 13.68              | AR             | 7.2                                 | 36.5    | 32.1   | 24.2   | 3983             | G12   |
| CEBUG-04 | 65.3   | 79.34  | II        | BCS/I30/I100    | 13.68              | 60% RH<br>40°C | 7.7                                 | 36.3    | 31.9   | 24.1   | 3962             | G12   |
| CEBUG-06 | 9.55   | 20.5   | II        | BCS/I30/I100    | 10.95              | AR             | 9.7                                 | 26.7    | 22.2   | 41.4   | 4811             | G9    |
| CEBUG-06 | 9.55   | 20.5   | II        | BCS/I30/I100    | 10.95              | 60% RH<br>40°C | 9.2                                 | 26.8    | 22.3   | 41.6   | 4838             | G9    |
| CEBUG-07 | 29.45  | 31.3   | II TOP    | BCS/I30         | 1.41               | AR             | 9.5                                 | 38.0    | 23.2   | 29.3   | 3545             | G13   |
| CEBUG-07 | 29.45  | 31.3   | II TOP    | BCS/I30         | 1.41               | 60% RH<br>40°C | 8.5                                 | 38.4    | 23.5   | 29.6   | 3584             | G13   |
| CEBUG-07 | 29.45  | 31.3   | II TOP    | I100            | 1.85               | AR             | 8.3                                 | 45.9    | 20.8   | 25.0   | 3001             | G15   |
| CEBUG-07 | 29.45  | 31.3   | II TOP    | I100            | 1.85               | 60% RH<br>40°C | 8.1                                 | 46.0    | 20.8   | 25.1   | 3008             | G15   |
| CEBUG-07 | 34.9   | 36.95  | II MIDDLE | BCS/I30/I100    | 2.05               | AR             | 11.1                                | 32.8    | 24.7   | 31.4   | 3903             | G12   |
| CEBUG-07 | 34.9   | 36.95  | II MIDDLE | BCS/I30/I100    | 2.05               | 60% RH<br>40°C | 10.1                                | 33.2    | 25.0   | 31.8   | 3947             | G12   |
| CEBUG-07 | 38.56  | 59.37  | II BOTTOM | BCS/I30         | 19.39              | AR             | 9.5                                 | 29.7    | 25.2   | 35.6   | 4353             | G10   |
| CEBUG-07 | 38.56  | 59.37  | II BOTTOM | BCS/I30         | 19.39              | 60% RH<br>40°C | 8.4                                 | 30.1    | 25.5   | 36.0   | 4406             | G10   |
| CEBUG-07 | 38.56  | 59.37  | II BOTTOM | I100            | 19.79              | AR             | 9.5                                 | 30.2    | 25.2   | 35.1   | 4316             | G10   |
| CEBUG-07 | 38.56  | 59.37  | II BOTTOM | I100            | 19.79              | 60% RH<br>40°C | 9.3                                 | 30.3    | 25.3   | 35.2   | 4326             | G10   |
| EBUG-2   | 11.28  | 12.75  | II TOP    | I30/I100        | 1.47               | 60% RH<br>40°C | 8.0                                 | 22.4    |        |        | 5282             | G7    |
| EBUG-4   | 96.02  | 98.23  | II TOP    | BCS/I30/I100    | 2.21               | 60% RH<br>40°C | 8.6                                 | 9.3     |        |        | 6428             | G3    |
| EBUG-4   | 99.92  | 102.84 | II MIDDLE | BCS/I30/I100    | 2.92               | 60% RH<br>40°C | 8.9                                 | 8.9     |        |        | 6423             | G3    |
| EBUG-4   | 111.08 | 112.7  | II BOTTOM | I100            | 1.62               | 60% RH<br>40°C | 6.1                                 | 39.2    |        |        | 3982             | G12   |
| EBUG-7A  | 24.65  | 25.29  | II BOTTOM | BCS/I30/I100    | 0.64               | 60% RH<br>40°C | 5.7                                 | 36.3    |        |        | 4316             | G10   |

#### 4.5.13 Ultimate Analysis

Ultimate analysis results of the seam section encountered in the block is shown below: -

| BH. NO.  | DEPTH |       | SEAM THICK | SEAM NAME | TYPE OF SAMPLES | Basis | ULTIMATE ANALYSIS (dmmf) |      |      |      |       |
|----------|-------|-------|------------|-----------|-----------------|-------|--------------------------|------|------|------|-------|
|          | FROM  | TO    |            |           |                 |       | C                        | H    | N    | S    | O     |
|          | (M)   | (M)   |            |           |                 |       | (M)                      | %    | %    | %    | %     |
| CEBUG-04 | 65.30 | 79.34 | 14.04      | II        | BCS/I30/I100    | AR    | 45.20                    | 3.17 | 1.14 | 0.35 | 50.14 |
| CEBUG-04 | 65.30 | 79.34 | 14.04      | II        | BCS/I30/I100    | DRY   | 48.71                    | 2.55 | 1.23 | 0.38 | 47.14 |
| CEBUG-06 | 9.55  | 20.50 | 10.95      | II        | BCS/I30/I100    | AR    | 52.86                    | 3.76 | 1.22 | 1.33 | 40.83 |
| CEBUG-06 | 9.55  | 20.50 | 10.95      | II        | BCS/I30/I100    | DRY   | 58.54                    | 2.96 | 1.35 | 1.47 | 35.68 |

#### 4.5.14 Sulphur

Sulphur content of this seam section has been mentioned in Ultimate Analysis table.

#### 4.5.15 Ash Fusion Range

| BH. NO.  | DEPTH |       | SEAM THICK | SEAM NAME | TYPE OF SAMPLES | Basis | ASH FUSION TEMP RANGE |       |       |       |
|----------|-------|-------|------------|-----------|-----------------|-------|-----------------------|-------|-------|-------|
|          | FROM  | TO    |            |           |                 |       | IDT%                  | ST%   | HT%   | FT%   |
|          | (M)   | (M)   |            |           |                 |       | (M)                   |       |       |       |
| CEBUG-04 | 65.30 | 79.34 | 14.04      | II        | BCS/I30/I100    | AR    | >1400                 | >1400 | >1400 | >1400 |
| CEBUG-06 | 9.55  | 20.50 | 10.95      | II        | BCS/I30/I100    | AR    | 1376                  | >1400 | >1400 | >1400 |

#### 4.5.16 Ash Analysis

| BH. NO.  | DEPTH |       | SEAM THICK | SEAM NAME | TYPE OF SAMPLES | ASH (mass%)      |                                |                                |       |       |                 |                  |                  |                   |                               |       |
|----------|-------|-------|------------|-----------|-----------------|------------------|--------------------------------|--------------------------------|-------|-------|-----------------|------------------|------------------|-------------------|-------------------------------|-------|
|          | FROM  | TO    |            |           |                 | SiO <sub>2</sub> | Al <sub>2</sub> O <sub>3</sub> | Fe <sub>2</sub> O <sub>3</sub> | CaO   | MgO   | SO <sub>3</sub> | TiO <sub>2</sub> | K <sub>2</sub> O | Na <sub>2</sub> O | P <sub>2</sub> O <sub>5</sub> | MnO   |
|          | (M)   | (M)   |            |           |                 | (M)              |                                |                                |       |       |                 |                  |                  |                   |                               |       |
| CEBUG-04 | 65.3  | 79.34 | 14.04      | II        | BCS/I30/I100    | 64.746           | 26.354                         | 1.421                          | 1.701 | 0.881 | 0.754           | 1.872            | 0.491            | 0.003             | 0.013                         | 0.051 |
| CEBUG-06 | 9.55  | 20.5  | 10.95      | II        | BCS/I30/I100    | 56.822           | 25.634                         | 10.169                         | 1.597 | 1.180 | 0.287           | 1.912            | 0.780            | 0.000             | 0.003                         | 0.033 |

#### 4.5.17 Summary of Seam Parameters & Special Observations

The seam II TOP/ Combined is the topmost seam in the block. The minimum and maximum seam thickness of Seam II combined, II top, II middle and bottom is 10.95m to 29.50m, 1.47m to 4.37m, 2.05m to 2.92m and 0.64m to 20.80m The gross estimated Indicated reserve of seam II combined, II top, II middle and II bottom is about 209.87 MT, 46.97, 21.47 and 294.65 respectively and calculated General grade of seam II combined, II top, II middle and II bottom varies from G7-G12, G4-G13, G3-G12 and G9-G12 respectively.

## 4.6 SEAM I

### 4.6.1 References

| SI. No. | Particular               | Annexure No. | Plate No. |
|---------|--------------------------|--------------|-----------|
| 1       | Descriptive Lithologs    | IIA          |           |
| 2       | Correlation Chart        | III          |           |
| 3       | Overall Quality          | V            |           |
| 4       | Special Test             | VI           |           |
| 5       | Reserves                 | VII          |           |
| 6       | Graphic Lithologs        |              | IV        |
| 7       | Geological cross section |              | V         |

### 4.6.2 Status of Mining

The seam section is virgin within the block.

### 4.6.3 Details of Borehole Intersections

| SEAM  |  | I    |
|-------|--|------|
| SI No | A. Intersections   | Nos. |
| 1     | No. of full seam intersections in boreholes in the block                         | 08   |
| 2     | No. of boreholes where seam is not developed in the block                        | 03   |
| 3     | No. of boreholes where seam is beyond incrop/ falling on updip side in the block | 03   |
| 4     | No. of boreholes where seam is split/ combined                                   | -    |
| 5     | No. of boreholes not considered  | -    |
| 6     | Total number of boreholes  | 14   |

#### 4.6.3.1 Details of depth of seam encountered in boreholes:

| Sl. No. | SEAM        |         | I      |          |
|---------|-------------|---------|--------|----------|
| 1       | ROOF DEPTH  | MIN (M) | 33.60  | CEBUG-08 |
| 2       |             | MAX (M) | 168.30 | EBUG-04  |
| 3       | FLOOR DEPTH | MIN (M) | 38.90  | CEBUG-08 |
| 4       |             | MAX (M) | 173.00 | EBUG-04  |
| 5       | THICKNESS   | MIN (M) | 0.60   | CEBUG-05 |
| 6       |             | MAX (M) | 5.30   | CEBUG-08 |

Seam I is the bottom-most seam encountered in the block. The minimum depth of occurrence being 33.60m in borehole CEBUG-08 and maximum depth of occurrence being 111.08m in borehole EBUG-04( II bottom).In borehole CEBUG-05, seam I has been considered from depth 142.34m to 142.94m, though the sample is analyzed to be Shale. But for correlation purpose the sample has been considered as seam I (deteriorated seam) and not used for resource estimation.

The depth of occurrence of the seam gradually increases towards the southern and eastern part of the block.

#### 4.6.4 Stratigraphic Position

Seam I is the bottom most seam to be encountered in the block lying below the seam II/II bottom. This is the oldest seam.

#### 4.6.5 Parting

Seam I has a minimum parting of 25.80m with overlying seam II bottom/combined in borehole CEBUG-07 and a maximum parting of 66.71m in borehole CEBUG-04.

| PARTICULARS                         | THICKNESS OF PARTING |              |         |              | NATURE                 |
|-------------------------------------|----------------------|--------------|---------|--------------|------------------------|
|                                     | MIN (m)              | BOREHOLE NO. | MAX (m) | BOREHOLE NO. |                        |
| With overlying seam II Bottom/Comb. | 25.80                | CEBUG-07     | 66.71   | CEBUG-04     | Sandstone, sandy shale |

#### 4.6.6 Thickness

The thickness of the seam I varies within the block with general thickness varying from 1.30m to 4.15m. The seam section has a minimum thickness of 0.60m in borehole CEBUG-05 and a maximum thickness of 5.30m in borehole CEBUG-08.

| SEAM | SEAM THICKNESS |          |      |          |
|------|----------------|----------|------|----------|
|      | MIN            | BOREHOLE | MAX  | BOREHOLE |
|      | (m)            | NO.      | (m)  | NO.      |
| I    | 0.60           | CEBUG-05 | 5.30 | CEBUG-08 |

#### 4.6.7 Splitting

Seam I does not exhibit any splitting behaviour.

#### 4.6.8 Incrop

Seam I incrops in the block in the southern part due to fault F1-F1.

#### 4.6.9 Roof and Floor of Seam I

| Predominant Roof/Floor | Nature of strata encountered                     |
|------------------------|--|
| Roof (up to 3.00 m)    | Comprises mainly of sandstone.                   |
| Floor (up to 1.00 m)   | Comprises mainly of sandstone, shale, sandyshale |

#### 4.6.10 Pyrolitisation

The seam section is not affected by Pyrolitisation to any extent.

#### 4.6.11 Dirt Bands

Only in 02 boreholes, dirt band has been included within seam I, with total thickness ranging from 0.40m (CEBUG-06) to 1.27m (CEBUG-08).

#### 4.6.12 Proximate Analysis

The Proximate analysis and grade of Seam I are as follows:

**Table 4.6.12A: Proximate analysis & grade of Seam I, Ulia-Gamhardih block, East of Bisrampur Coalfield.**

| BH. NO.  | DEPTH  |       | SEAM NAME | TYPE OF SAMPLES | ANALYSED THICK (M) | BASIS          | PROXIMATE ANALYSIS AT 60% RH & 40°C |         |        |        | GCV<br>KCAL / KG | GRADE |
|----------|--------|-------|-----------|-----------------|--------------------|----------------|-------------------------------------|---------|--------|--------|------------------|-------|
|          | FROM   | TO    |           |                 |                    |                | M (%)                               | ASH (%) | VM (%) | FC (%) |                  |       |
|          | (M)    | (M)   |           |                 |                    |                |                                     |         |        |        |                  |       |
| CEBUG-04 | 146.05 | 150.2 | I         | BCS/I30/I100    | 4.15               | AR             | 8.6                                 | 26.1    | 21.9   | 43.4   | 4903             | G8    |
| CEBUG-04 | 146.05 | 150.2 | I         | BCS/I30/I100    | 4.15               | 60% RH<br>40°C | 8.3                                 | 26.2    | 22.0   | 43.5   | 4919             | G8    |
| CEBUG-06 | 82.63  | 83.93 | I         | BCS/I30         | 0.9                | AR             | 9.6                                 | 17.1    | 23.8   | 49.5   | 5838             | G5    |
| CEBUG-06 | 82.63  | 83.93 | I         | BCS/I30         | 0.9                | 60% RH<br>40°C | 9.3                                 | 17.2    | 23.9   | 49.7   | 5857             | G5    |
| CEBUG-07 | 85.17  | 87.45 | I         | BCS/I30/I100    | 2.28               | AR             | 12.7                                | 16.7    | 26.5   | 44.1   | 5311             | G7    |
| CEBUG-07 | 85.17  | 87.45 | I         | BCS/I30/I100    | 2.28               | 60% RH<br>40°C | 11.4                                | 16.9    | 26.9   | 44.8   | 5390             | G7    |
| CEBUG-08 | 33.6   | 38.9  | I         | BCS/I30/I100    | 4.03               | AR             | 6.9                                 | 25.0    | 26.0   | 42.1   | 5293             | G7    |
| CEBUG-08 | 33.6   | 38.9  | I         | BCS/I30/I100    | 4.03               | 60% RH<br>40°C | 6.1                                 | 25.2    | 26.2   | 42.5   | 5338             | G7    |
| EBUG-5   | 40.23  | 40.77 | I         | BCS/I30/I100    | 0.54               | 60% RH<br>40°C | 6.4                                 | 16.4    |        |        | 6083             | G5    |
| EBUG-5   | 41.18  | 41.91 | I         | BCS/I30/I100    | 0.73               | 60% RH<br>40°C | 5.1                                 | 25.0    |        |        | 5457             | G7    |
| EBUG-6   | 92.26  | 94.02 | I         | I30/I100        | 1.76               | 60% RH<br>40°C | 6.1                                 | 29.1    |        |        | 4932             | G8    |

#### 4.6.13 Ultimate Analysis

Ultimate analysis results of the seam section encountered in the block is shown below: -

| BH. NO.  | DEPTH  |        | SEAM THICK | SEAM NAME | TYPE OF SAMPLES | Basis | ULTIMATE ANALYSIS (dmmf) |      |      |      |       |
|----------|--------|--------|------------|-----------|-----------------|-------|--------------------------|------|------|------|-------|
|          | FROM   | TO     |            |           |                 |       | C                        | H    | N    | S    | O     |
|          | (M)    | (M)    |            |           |                 |       |                          |      |      |      |       |
| CEBUG-04 | 146.05 | 150.20 | 4.15       | I         | BCS/I30/I100    | AR    | 54.79                    | 3.62 | 1.40 | 0.87 | 39.32 |
| CEBUG-04 | 146.05 | 150.20 | 4.15       | I         | BCS/I30/I100    | DRY   | 59.95                    | 2.91 | 1.53 | 0.95 | 34.66 |
| CEBUG-06 | 82.63  | 83.93  | 1.30       | I         | BCS/I30         | AR    | 63.76                    | 4.14 | 1.57 | 1.37 | 29.16 |
| CEBUG-06 | 82.63  | 83.93  | 1.30       | I         | BCS/I30         | DRY   | 70.53                    | 3.39 | 1.74 | 1.52 | 22.83 |
| CEBUG-08 | 33.60  | 38.90  | 5.30       | I         | BCS/I30/I100    | AR    | 57.33                    | 4.00 | 1.38 | 0.48 | 36.81 |
| CEBUG-08 | 33.60  | 38.90  | 5.30       | I         | BCS/I30/I100    | DRY   | 61.58                    | 3.47 | 1.48 | 0.52 | 32.96 |

#### 4.6.14 Sulphur

Sulphur content of this seam section has been mentioned in Ultimate Analysis table.

#### 4.6.15 Ash Fusion Range

| BH. NO.  | DEPTH  |        | SEAM THICK | SEAM NAME | TYPE OF SAMPLES | ASH FUSION TEMP RANGE |       |       |       |
|----------|--------|--------|------------|-----------|-----------------|-----------------------|-------|-------|-------|
|          | FROM   | TO     |            |           |                 | IDT%                  | ST%   | HT%   | FT%   |
|          | (M)    | (M)    | (M)        |           |                 |                       |       |       |       |
| CEBUG-04 | 146.05 | 150.20 | 4.15       | I         | BCS/I30/I100    | >1400                 | >1400 | >1400 | >1400 |
| CEBUG-06 | 82.63  | 83.93  | 1.30       | I         | BCS/I30         | 1154                  | 1287  | 1358  | >1400 |
| CEBUG-08 | 33.60  | 38.90  | 5.30       | I         | BCS/I30/I100    | >1400                 | >1400 | >1400 | >1400 |

#### 4.6.16 Ash Analysis

| BH. NO.  | DEPTH  |       | SEAM THICK | SEAM NAME | TYPE OF SAMPLES | ASH (mass%)      |                                |                                |       |       |                 |                  |                  |                   |                               |       |
|----------|--------|-------|------------|-----------|-----------------|------------------|--------------------------------|--------------------------------|-------|-------|-----------------|------------------|------------------|-------------------|-------------------------------|-------|
|          | FROM   | TO    |            |           |                 | SiO <sub>2</sub> | Al <sub>2</sub> O <sub>3</sub> | Fe <sub>2</sub> O <sub>3</sub> | CaO   | MgO   | SO <sub>3</sub> | TiO <sub>2</sub> | K <sub>2</sub> O | Na <sub>2</sub> O | P <sub>2</sub> O <sub>5</sub> | MnO   |
|          | (M)    | (M)   | (M)        |           |                 |                  |                                |                                |       |       |                 |                  |                  |                   |                               |       |
| CEBUG-04 | 146.05 | 150.2 | 4.15       | I         | BCS/I30/I100    | 62.065           | 23.841                         | 6.928                          | 1.624 | 0.899 | 0.719           | 1.728            | 0.511            | 0.000             | 0.014                         | 0.045 |
| CEBUG-08 | 33.6   | 38.9  | 5.3        | I         | BCS/I30         | 57.776           | 30.688                         | 6.402                          | 1.338 | 0.687 | 0.107           | 1.374            | 1.488            | 0.004             | 0.024                         | 0.094 |

#### 4.6.17 Summary of Seam Parameters & Special Observations

The seam I underlies seam II has a minimum parting of 25.80m with overlying seam II bottom/combined in borehole CEBUG-07 and a maximum parting of 66.71m in borehole CEBUG-04. The thickness of the seam I varies within the block with general thickness varying from 1.30m to 4.15m. The seam section has a minimum thickness of 0.60m in borehole CEBUG-05 and a maximum thickness of 5.30m in borehole CEBUG-08. The gross estimated Indicated reserve of this seam is about 114.16 MT and calculated General grade varies from G6-G12.

## CHAPTER- 5

# RESOURCES

### 5.1 GENERAL

In conformity with the occurrence of coal seams in Ulia-Gamhardih block of East of Bistrampur Coalfield in general, G3 stage of exploration in the said block has revealed the existence of 5 coal horizons, viz split seam sections of seam II i.e. Seam II Top, Seam II Middle and Seam II Bottom and Seam I in youngest to oldest order. A major fault (F1) is passing through the Southern and South-western part of the block, due to which no seams have been encountered in the upthrown side of the fault(F1) to the Southern and South-western side of the block. There are two consistent seams namely seam II and it splits(Top, Middle and Bottom) I. Though Seam II is consistent seam the seam has been incropped within the block near the borehole CEBUG-05 and seam falls updip in the upthrown side of the faults F1-F1 and F2-F2. The seam II has been splitted in to top middle and bottom section, the combined section has been encountered near the boreholes CEBUG-06,04 and EBUG-06 having an area of around 7.8 sq.km, in the remaining area the seams has been splitted. The seam I has been developed in the block and the seam falls updip in the upthrown side of the fault F2-F2. The resource has been estimated for seam II Top, II Middle, II bottom, II and I. The coal seams/sections intersected in various boreholes in Ulia-Gamhardih block have been correlated on the basis of their thickness, physical makeup, quality, inter-seam partings and associated lithology. The graphic logs of the boreholes are given in Plate- III and the correlation of the coal seams is furnished in Annexure-III.

### 5.2 BASIC ASSUMPTION AND NORMS FOLLOWED

#### 5.2.1 DEFINITIONS

1. The coal and carbonaceous bands were defined on the basis of results of analysis, as applicable in high moisture (moisture >2%) non-coking coal. Coal, shaly coal, carb shale & non- combustible /obvious dirt bands are defined as per the ash+moisture% as given below:

- Coal : Ash+Moisture up to 40%.
- Shaly Coal : Ash+Moisture 40.01 - 55%.
- Low Ash Carbonaceous Shale: Ash+Moisture 55.01 -65.0%.
- High Ash Carbonaceous Shale: Ash+Moisture 65.01 - 75%.
- Non-Combustible Dirt Band :Ash+Moisture > 75%.

During current phase of investigation only 5 boreholes has been analyzed. The Minimum thickness of individual coal seams, considered for reserve estimation is taken as 0.90 m.

2. Reserves has been estimated for four coal seam viz. Seam II Top, Seam II Middle, Seam II bottom, Seam II and Seam I.

3. During the preparation of this report, Iso-chore and Iso-grade lines have been drawn using MINEX 6.5.3 software and resource have been computed depth-wise, grade-wise, thickness-wise.

4. Minimum workable thickness considered is 0.90m. For estimation of reserves, thickness ranges of 0.90m to 1.50m, 1.50m to 2.00m, 2.00m to 5.00m and 5.00m and above have been considered.

5. Reserves estimation for the areas within the heave zone of faults, have not been done.

6. Iso-grade lines have been considered utilizing the G.C.V values derived from Proximate Overall analysis on 60%RH & 40°C.

7. Resource in the block falls under the depth range of 0-200m, hence depth-wise has not been calculated separately.

### **5.2.2 SEAMS AFFECTED BY INTRUSIVES**

Any presence of igneous intrusion has not been observed in this Ulia-Gamhardih block.

### **5.2.3 CATEGORISATION OF RESOURCES**

The entire resource of the coal seams available within Ulia-Gamhardih block have been grouped under **Indicated Categories** as per ISP (Indian Standard Procedure).

After considering both the previous phases of boreholes and current G3 stage of exploration boreholes, it has been observed that boreholes are spaced within a range of 1000m radius from one another. As the resources are categorized under Indicated category, hence no deduction has been made for deriving “**Indicated Resources**”.

Qualitative analysis indicates the seams encountered in this block is high moisture (>2%) Non-coking coal. Determined GCV data is not available for the boreholes drilled in previous phases of exploration hence, out of 14 boreholes only 5 boreholes have determined GCV value. The grade of the seams for other boreholes have been calculated using  $M_{100}$  value.

The resources of coal in Ulia-Gamhardih block have been estimated by using standard formula as given below:

$$R = A \times Th. \times Sp.Gr.$$

Where

- R = Reserve in million tonnes, A = Area in Sq. Km.
- Th. = Thickness in metres
- Sp.Gr. = Specific Gravity of coal

#### 5.2.4 GRADE ESTIMATION

Coal quality of the non-coking coal of all the seams are categorized into various grades in accordance with Government of India, Ministry of Energy (Department of Coal) Gazette Notification dated 31.12.2011. The Gross Calorific Value (GCV) is calculated using the following formula:

$$GCV = 85.56 \times (100 - ((1.1A) + M)) - 60M$$

Where GCV is Gross Calorific Value in Kcal/kg.

A is Ash% at 60% RH & 40°C

M is Moisture % at 60% RH & 40°C.

The range of GCV (Kcal/ Kg) Value for the different grades is as follows:

| GRADE | FROM | TO   | GRADE    | FROM | TO   |
|-------|------|------|----------|------|------|
| G1    | >    | 7000 | G10      | 4301 | 4600 |
| G2    | 6701 | 7000 | G11      | 4001 | 4300 |
| G3    | 6401 | 6700 | G12      | 3701 | 4000 |
| G4    | 6101 | 6400 | G13      | 3401 | 3700 |
| G5    | 5801 | 6100 | G14      | 3101 | 3400 |
| G6    | 5501 | 5800 | G15      | 2801 | 3100 |
| G7    | 5201 | 5500 | G16      | 2501 | 2800 |
| G8    | 4901 | 5200 | G17      | 2201 | 2500 |
| G9    | 4601 | 4900 | Ungraded | 0    | 2200 |

### 5.3 PROCEDURES

#### 5.3.1 BLOCK BOUNDARY

North : The block is bounded on north side by Arjungarh pahar.

South : The south side bounded by metamorphics.

East : The block is bounded on East side by Dhaska Naugai block.

West : On the west by faulted boundary between barakar and metamorphics.

#### 5.3.2 BARRIER

No barrier is taken into consideration while estimating the reserves in Uli-Gamhardih block.

#### 5.3.3 SECTORS

Since, there are no barriers present in the block, no such sectors or sub-sectors has been introduced in the block and hence, the block as a whole is considered as one sector.

#### 5.3.4 MINE DATA CONSIDERED

This block is free from any Mining activity.

### 5.3.5 METHODOLOGY

Seam-wise, Depth-wise, thickness-wise, grade-wise reserved has been calculated after preparing grids using the MINEX software. Total area of each seam, total coal volume and Gross coal resource were calculated and output obtained on CSV format. The CSV data were further brought to EXCEL format and different tables were prepared as per requirement. As the reserves are categorized under “indicated reserve” hence no deduction has been made to account for unforeseen geological disturbances from Gross Resources.

### 5.3.6 AVERAGE SPECIFIC GRAVITY

For the purpose of converting volume of coal into tonnage, specific gravity of seam and sections as encountered in individual boreholes has been derived through by formula  $\{1.29 + (0.01 \times \text{ASH})\}$ . After taking into consideration of thus generated basic data of specific gravity necessary contours of equal values finally have been generated through MINEX software for calculation of reserve.

The specific gravity of each seam generated through CEMPGEODOC software is considered for estimation of reserves by MINEX software. The details of specific gravity are given in Annexure VI. The grade-wise specific gravity of the coal is tabulated below.

| SP. GRAVITY | GCV   |      |      |
|-------------|-------|------|------|
|             | GRADE | FROM | TO   |
| 1.36        | G1    | >    | 7000 |
| 1.40        | G2    | 6701 | 7000 |
| 1.43        | G3    | 6401 | 6700 |
| 1.44        | G4    | 6101 | 6400 |
| 1.47        | G5    | 5801 | 6100 |
| 1.50        | G6    | 5501 | 5800 |
| 1.53        | G7    | 5201 | 5500 |
| 1.56        | G8    | 4901 | 5200 |
| 1.58        | G9    | 4601 | 4900 |
| 1.61        | G10   | 4301 | 4600 |
| 1.65        | G11   | 4001 | 4300 |
| 1.69        | G12   | 3701 | 4000 |
| 1.73        | G13   | 3401 | 3700 |
| 1.78        | G14   | 3101 | 3400 |
| 1.81        | G15   | 2801 | 3100 |
| 1.84        | G16   | 2501 | 2800 |
| 1.87        | G17   | 2201 | 2500 |

### 5.3.7 COMPUTATION OF COAL RESOURCES

Seam-wise and Grade-wise gross geological coal reserves are computed through MINEX software taking into account the effective coal thickness, and specific gravity in MINEX. The volume of coal reserves is calculated by volumetric method by using the relevant module of CEMPGEODOC and MINEX software package.

For the purpose of converting the volume into tonnage, specific gravity as per the CEMPGEODOC package is considered.

The seam thickness and grade between various borehole points are extrapolated and depicted by drawing isochores and isogrades with the help of MINEX software.

The volume of coal reserves is calculated by volumetric method as follows:

$$\text{Volume (Mm}^3\text{)} = \text{Area (sq.km.)} \times \text{Thickness (m) considered}$$

Total Gross Indicated Reserves of **587.70** million tonnes is estimated for the whole block up to Seam I. The details of seam-wise, depth-wise and thickness-wise reserves for all the workable and persistent seams are given in Annexure-VII.

### 5.4 DESCRIPTION OF RESOURCES

Ulia-Gamhardih block covers an area of **39.14 sq. km.** Total Gross Indicated resource estimated is **587.70 million tonnes.**

The seam-wise grade-wise Gross Indicated Geological reserves are provided in Table-5.4 a.

**Table-5.4 a Seam-wise Grade-wise Gross Indicated Geological Resources, Ulia-Gamhardih block, East of Bisrampur Coalfield**

| Seam Name/Grade    | Grade Range  |             |             |              |               |              |              |               |             |              |             |             |             |             |             | Grand Total   |
|--------------------|--------------|-------------|-------------|--------------|---------------|--------------|--------------|---------------|-------------|--------------|-------------|-------------|-------------|-------------|-------------|---------------|
|                    | G3           | G4          | G5          | G6           | G7            | G8           | G9           | G10           | G11         | G12          | G13         | G14         | G15         | G16         | G17         |               |
| <b>II</b>          |              |             |             |              | 108.49        |              | 33.91        |               |             | 67.46        |             |             |             |             |             | <b>209.86</b> |
| <b>IIT</b>         | 3.83         | 3.85        | 1.17        | 0.04         | 1.06          | 4.54         | 3.90         | 0.85          | 1.43        | 2.37         | 2.65        | 0.07        |             |             |             | <b>25.76</b>  |
| <b>IIM</b>         | 12.15        |             |             |              |               |              |              |               |             | 9.32         |             |             |             |             |             | <b>21.47</b>  |
| <b>IIB</b>         |              |             |             |              |               | 1.23         | 30.79        | 169.21        | 2.18        | 13.04        |             |             |             |             |             | <b>216.45</b> |
| <b>I</b>           |              | 0.32        | 4.18        | 15.01        | 28.02         | 33.67        | 12.59        | 7.38          | 5.50        | 3.64         | 1.69        | 1.00        | 0.61        | 0.37        | 0.18        | <b>114.16</b> |
| <b>Grand Total</b> | <b>15.98</b> | <b>4.17</b> | <b>5.35</b> | <b>15.05</b> | <b>137.57</b> | <b>39.44</b> | <b>81.19</b> | <b>177.44</b> | <b>9.11</b> | <b>95.83</b> | <b>4.34</b> | <b>1.07</b> | <b>0.61</b> | <b>0.37</b> | <b>0.18</b> | <b>587.70</b> |

#### 5.4.1 Resource as Thin Seams:

Here resource has been estimated for seam II Top, II Bottom and I where the thickness range is between 0.50 meter to 0.90 meter.

| Seam Name                 | Reserve (MT) |
|---------------------------|--------------|
| <b>II Top</b>             | 0.88         |
| <b>II Bottom</b>          | 0.30         |
| <b>I</b>                  | 1.76         |
| <b>Total reserve (MT)</b> | <b>2.94</b>  |

#### 5.5 SUMMARY OF RESOURCES:

Resources have been estimated for 5 no. of seams/sections which have attained workable thickness and persistency in the block viz. Seam II Top, Seam II Middle, Seam II Bottom, Seam II & Seam I.

In Ulia-Gamhardih block, a total of 587.70 million tonnes (MT) Gross Indicated geological has been estimated (Considering workable seam thickness is more than 0.90 meter). Coal seams of Ulia-Gamhardih block belong to Non-coking coal category. Drilling of more boreholes are required to categorize the estimated resource to "Measured" category.

## 5.6 UNFC CLASSIFICATION

The UNFC consists of a three dimensional system with the axes: Geological Assessment, Feasibility Assessment and Economic viability. The process of geological assessment is generally conducted in stages of increasing details. The typical successive stages of geological investigation i.e. reconnaissance, prospecting, general exploration and detail exploration, generate resource data with a clearly defined degrees of geological assurance. These four stages are therefore used as geological assessment categories in the classification. Feasibility assessment studies form an essential part of the process of assessing a mining project. The typical successive stages of feasibility assessment i.e. geological study as initial stage followed by prefeasibility study and feasibility study/mining report are well defined. The degree of economic viability (economic or sub-economic) is assessed in the course of prefeasibility and feasibility studies. A prefeasibility study provides a preliminary assessment with a lower level of accuracy than that of a feasibility study, by which economic viability is assessed in detail.

In the 3-digit code based system, the economic viability axis representing the first digit, the feasibility axis the second digit and the geologic axis the third digit. The three categories of economic viability have sides 1,2 and 3 in decreasing order, similarly the three categories of feasibility study have also codes 1,2 and 3 while the four stages of geological assessment are represented by 4 codes i.e. 1 (detailed exploration),2 (general exploration),3(prospecting) and 4 (reconnaissance). Thus the highest category of resources under UNFC system will have the code 111 and lower category have the code 334.

According to the UNFC classification the total "Indicated" resource in the Uli-Gamhardih block may come under the category have the coded 332.

## CHAPTER – 6

# CONCLUSION

### 6.1 CONCLUSION

The Ulia-Gamhardih block of East of Bistrampur Coalfield is situated in the east central part of Surguja district of Chhattisgarh State. The Ulia- Gamhardih area, lying to the east of the confines of Bistrampur Coalfield is a small and detached sub-basin located east and north east of the Bistrampur Coalfield and to the south east of the Tatapani- Ramkola Coalfield. The vast tracts between these coalfields are occupied by Surguja crystalline complex. The block completely falls under the Survey of India Toposheet no. - **64 M/11** of R.F 1: 50,000. The peak of the Arjungarh Pahar is 1094m high whereas peak of Kandadara Pahar is 1147 m above mean sea level.

GSI involved in establishing existence of coal seams in East of Bistrampur Coalfield through mapping and regional drilling. The Ulia-Gamhardih block has been identified for G-3 stage of exploration on the basis of findings of GSI reported in “Final Report On Exploration for Coal by Scout Drilling in and Around Ulia – Gamhardih Area to The East of the Confines of Bistrampur Coalfield, Surguja District, Chhattisgarh,2010”.

In 2022-23, CMPDI has drawn proposal for exploration for coal in the Ulia-Gamhardih Block having area of about 39.14 sq.km and involving 1300m of drilling in 8 boreholes. The G-3 stage of Exploration in the block is proposed to fulfill following objectives-

1. To establish the existence and continuity of coal seams of Barakar Formation occurring in the block.
2. To establish the lay, disposition and potentiality of coal seams upto basement.
3. To appraise the resource potentiality of Barakar coal seams in the block.

This G3 stage of exploration drilling was done by M/s. MMPL under the supervision of CMPDI.

The Geological structure of the block has been deciphered based on the sub surface data obtained from the boreholes as the block is entirely covered by soil / alluvium.

In Ulia-Gamhardih block, the strike of the coal seam shows almost NNE-SSW trend. The overall dip of the coal seams varies between 3° to 4° towards ESE in the block. A total two number of normal faults (F1 to F3) of Low to medium magnitude have been deciphered in the area. The faults are oriented almost N-S direction. The interpretation of the faults is done as per the borehole data; however, no surface evidence has been identified in the field. The throw of the faults varies from 0 to 180 meters.

In conformity with the occurrence of coal seams in Ulia-Gamhardih block of East of Bistrampur coalfield in general, G3 stage of exploration in the said block has revealed the existence of 5 coal horizons, viz. split seam sections of seam II i.e. Seam II Top, Seam II Middle and Seam II Bottom and Seam I in youngest to oldest order. A major fault (F1) is passing through the Southern and South-western part of the block, due to which no seams have been encountered in the upthrown side of the fault(F1) to the Southern and South-western side of the block. There are two consistent seams namely seam II and it splits (Top, Middle and Bottom) I. Though Seam II is consistent seam the seam has been incropped within the block near the borehole CEBUG-05 and seam falls updip in the upthrown side of the faults F1-F1 and F2-F2. The seam II has been split in to top middle and bottom section, the combined section has been encountered near the boreholes CEBUG-06,04 and EBUG-06 having an area of around 7.8 sq.km, in the remaining area the seams has been splitted. The seam I has been developed in the block and the seam falls updip in the upthrown side of the fault F2-F2.

In Ulia-Gamhardih block, a total of **587.70 million tonnes (MT)** Gross Indicated geological has been estimated.

## 6.2 RECOMMENDATION

The objective of the present investigation (G3 stage of exploration) is primarily to assess the existence and continuity of coal seams of Barakar Formation occurring in this block as well as to decipher the lay, disposition & potentiality of coal seams upto basement. Therefore, further drilling of boreholes is required to establish the exact faulting pattern and the lay & disposition of coal seams & associated strata to make qualitative and quantitative assessment of the prospect with a view to possible future utilization. The resource estimated in the G3 stage of exploration would also get enhanced after drilling of more boreholes and the resource can be categorized under “Measured” category from “Indicated” category.

## **BIBLIOGRAPHY**

1. Final Report On Exploration For Coal By Scout Drilling In And Around Ulia – Gamhardih Area To The East Of The Confines Of Bistrampur Coalfield, Surguja District, Chhattisgarh, GSI, 2010.

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