REPORT ON

SUBSIDENCE PREDICTION AND MANAGEMENT FOR DHAU NORTH BLOCK

WESTERN COALFIELDS LIMITED

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Report on subsidence prediction and management for Dhau North Block, WCL.

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1.0 INTRODUCTION :

A scheme for extension of Nandan -II UG mine in Dhau North Block, WCL is being prepared by CMPDI, Regional Institute-IV. In the proposed mining area Seam-III/III (Top) is the only potential coal seam which is proposed to be extracted. Considering the extractable reserve of 2 MT of coal, the estimated life of mine may be 7 to 12 years depending upon the technology to be implemented (Continuous Miner or LHD). The coal seam will be extracted by bord and pillar method with caving. The seam is proposed to be worked either by CM or LHD. Out of total 112.64 hector Land of the extension area 55.03 hector is forest land, rest 57.61 hector land is tenancy and government land.

As required by Regional Director, RI-IV, CMPDI vide letter no. RI-IV/Dhau North/2014/389 dated 24.03.2014, Underground Mining Division of CMPDI(HQ) has carried out subsidence prediction study due to extraction of Seam III /III (Top) and likely impact of subsidence on surface topography, surface features and forest. The subsidence prediction study is intended to constitute a part of an EMP report. The results of the study and subsidence management are presented in the following sections.

2.0 DETAILS OF THE MINE:

2.1	Mine	:	Dhau North Block
2.2	Area	:	Kanhan Area
2.3	Company	:	Weatern Coalfields Limited
2.4	Mining area	:	112.64 ha
2.5	Extractable reserves	:	2 MT
2.6	Geological reserve	:	7.045 MT

2.7 Details of the coal seams to be worked (in descending order):

Name	: Seam III / III (Top)
Depth	: 240.85m to 387.36m
Thickness	: 3.10 to 6.46 m (Average thickness 4.5m)

2.8	Proposed method of: extraction	Bord and pillar method with caving, using LHDs or continuous miner.

2.9	Anticipated percentage of extraction .	80% within the panel
2.10	Overlying rock mass:	motur, sandstone etc..
2.11	*Size of the panels:*	*sub- critical.*
2.12	Balance life of the mine:	7 to 12 years depending on the technology implemented (CM or LHD)
2.13	Topography:	The altitude of the area of mining block varies from 785 m to 865 m i.e. a difference of elevation is of 80m.
2.14	Surface properties and their protection:	Kanhan River and its tributaries. Kanhan river is proposed to be protected by leaving coal pillars unextracted vertically below and upto a distance of half of the depth on both sides of it as suggested in the scheme prepared by RI-IV.

3.0 TOPOGRAPHY, DRAINAGE AND LAND USE:

The proposed extension area in south side of Dhau North Block (South of Fault F2-F2 & F3-F3) is more or less flat. The altitude of the area of mining block varies from 785 m to 865 m i.e. a difference of elevation is of 80m. The drainage of the area is controlled by the Kanhan river flowing in the middle of the proposed extension area from N-W to S-E. A few seasonal nalas meet the Kanhan river in proposed area.

Out of total 112.64 ha. Land of the extension area, 55.03 ha.is forest land, rest 57.61 ha. Land is tenancy and government land.

4.0 GEOLOGY:

The entire block is covered by monotonous formation. Besides sandstones of motur some dolerite dykes are also found. Three coal seams designated from top to bottom as Seam-III, Seam-II and Seam-I occur in Dhau

designated from top to bottom as Seam-III, Seam-II and Seam-I occur in Dhau North Block. Seam-II is rather thin and it is not being considered for exploitation Seam-I has a thickness of more than 0.90m in localised patches. It is proposed in this scheme to work Seam-III (Comb.) where Seam-III does not split. However, where Seam-III has splitted into Seam-III (Top) and Seam-III (Bottom), only Seam-III (Top) will be worked. Thus, the workable seam considered in this scheme is Seam-III (Comb.)/Seam-III (Top). Seam-III (Comb)/III (Top) occurs at a depth range of 240.85m to 387.36 m in the mineable block. Its thickness varies 3.10 to 6.46 m and average thickness is 4.5m. Maximum extraction height is considered 4.5m.

5.0 METHOD OF MINING:

In the mining area Seam – III/III (Top) will be extracted by bord and pillar with caving. This seam is proposed to be worked by making drifts from Nandan-2 UG mine. It is suggested in the scheme prepared by RI-IV that, Kanhan river flowing through the mid of the property will be protected by leaving coal pillars unextracted vertically below and upto a distance of half of the depth of the panel. Thus subsidence prediction is done accordingly. The layout of the Seam-III/III (Top) is shown in Plate 1. The proposed layout of panels to be extracted is shown in Plate 2. The layout of the panels is taken from mine projection plan given by RI-IV.

6.0 SUBSIDENCE PREDICTION:

The subsidence prediction numerical model based on Influence Function method, developed in CMPDI, has been used for estimation of likely subsidence over the mining area. Subsidence prediction has been done for the panels as proposed to be extracted by caving method in mine projection plan leaving barriers against Kanhan river. As per the scheme maximum thickness of extraction have been considered 4.5m. Input data used for subsidence estimation, such as mining parameters, geology, panel dimensions and surface features have been collected from the scheme for extension of Nandan-2 UG mine in Dhau North Block and plans sent by RI-IV.

Details of panel's layout, surface contours, surface features and other relevant features have been digitised from mine projection plan, surface contour plan and revenue plan. The digitised data have been used as input parameters for subsidence prediction model.

To calibrate model for Dhau North Block, we required actual field data, and in its absence, data of an adjacent or nearby mine is considered. We had subsidence records of panel B of Nandan UG mine which was analysed, maximum subsidence value of only 7 cm was found, for extraction of 4.2m coal by caving, which is abnormal. In view of above its value has not been found acceptable and suitable to be used. Thus the parameters for calibration has been derived from the report of surface subsidence investigation of Sukri Mine collected by CMRI under S&T project in 1985. The parameters taken for subsidence prediction are as follows:

i) Subsidence factor : 0.36
ii) Angle of draw : 33 °
iii) Anticipated percentage of extraction in panels. : 80%
iv) Depth : Average depth for each panel.
v) Thickness of extraction : Average thickness of the seam for each panel maximum upto 4.5m

Before subsidence prediction, the prediction model has been calibrated according to the above mentioned subsidence parameters. For subsidence calculation, underground extraction area has been divided into 20m x 20m grid blocks as individual elements. The numerical procedure followed for prediction involves estimation of subsidence at the grid points of each element and subsequent integration to arrive at resultant values and the final area influenced by ground movement. Subsidence has been calculated over 8000 grid points.

7.0 SUBSIDENCE PREDICTION RESULTS:

7.1 Maximum Subsidence, Subsidence contours and Subsidence profiles:

The anticipated maximum possible subsidence likely to occur over mining area due to extraction of Seam III /III (Top) is 1.130m over panel PA. In

the forest area the estimated maximum possible subsidence likely to take place is 0.823m over the panel PA. From the estimated subsidence at each grid point, subsidence contours are drawn due to extraction of Seam III /III (Top) which is shown in Plate 4. In the plate, subsidence contours are shown alternately in violet and red colours at 0.2m intervals. Final subsidence profiles along line AA' and BB' have been drawn and shown in Plate 8 and 9 respectively. Both lines are intersecting at the maximum subsidence point over the mining area.

7.2 Effect of subsidence on surface topography and surface features along with mitigative measures :

Topography before mining and after extraction of Seam III/III (Top) are shown in Plates 3 and 5 respectively. Change in topography due to subsidence can be seen by comparing the above mentioned plates. For a comparative assessment of ground condition before and after mining, 3D views of surface before and after extraction of Seam III /III (Top) are shown in Plates 6 and 7 respectively. By comparing the above two views, it is observed that there is negligible change in surface topography. Surface profiles before mining and after final subsidence have also been drawn along line AA' and BB" and shown in Plates 8 and 9 respectively.

The topography of the mining area is more or less flat with elevation on north-eastern side of the area. The ground elevation of the area ranges from 785 m to 865m i.e. a difference of elevation of 80m. For such terrain the maximum anticipated subsidence of 1.130 m is unlikely to affect the drainage pattern in the area. However, subsidence may result in the formation of depressions over the centre of the panels and cracks at the zones of high tensile strain such as along the boundary and barriers. Pools of water are likely to be formed in these depressions during rains, which may be retained wherever possible for the benefit of vegetation in the forest land or filled up/drained out by cutting drains depending on safety of underground workings. The surface cracks, developed due to subsidence, need to be filled up properly and regularly with clay and stone chips to achieve the original drainage pattern of the area and to prevent

ingress of air and water into the goaf. This will minimise the chances of underground inundation and spontaneous heating.

For estimating the effects of subsidence on surface features, panel-wise anticipated maximum possible subsidence, slope and tensile strain have been calculated due to extraction of Seam III /III (Top), which are shown in Table 1. Strain developed due to subsidence is the prime cause of damage to surface features. Thus, values of strain likely to occur near important surface features have been estimated to envisage the extent of damages to the surface features. The impact of subsidence on different surface features are outlined below:

Impact of subsidence on Kanhan River:

Kanhan River is not likely to be affected by subsidence as barrier equal to half of the depth of coal seam is to be left unextracted on both sides of Kanhan river as proposed in the scheme prepared by RI-IV.

Impact of subsidence on Tributary of Kanhan River:

Tributary over the panel PD is likely to be affected by 0.03m of subsidence and 0.78mm/m of tensile strain. Therefore, there will not be any effect on this tributary of Kanhan river. However, to protect it completely from subsidence a barrier equal to half of the depth as proposed in the report prepared by RI-IV may be left unextracted from this tributary.

Impact of subsidence on Road:

Road over panel PC is not likely to be affected by subsidence as barrier left for Kanhan river is enough to protect the road.

Impact of subsidence on tenancy land:

Tenancy land is likely to be affected by a maximum subsidence of 1.13 m and tensile strain of 7.86 mm/m. A large number of fine cracks or a few 100 mm wide cracks with marked depression will take place. Single storied hutments in the area will suffer severe impact over Panel PA only.

Therefore any settlement over this panel should be settled elsewhere before commencement of depillaring operation. Over rest of the panels tenancy land is not likely to be affected by enough subsidence to suggest any mitigative measure.

Impact of subsidence on Government Land:

Government land is likely to be affected by a maximum of 0.026 m subsidence and 0.78 mm/m tensile strain. Therefore there will not be any damaging effect on Government land.

7.3 Effect of subsidence on forest with mitigative measures :

Due to extraction of Seam III /III (Top) in this mine the maximum anticipated subsidence in the forest area is estimated to be 0.823 m and maximum tensile strain of 7.86 mm/m which is less than the permissible limit of 10 mm/m strain in the forest area. Therefore, forest is not likely to be damaged by subsidence.

Thus, the area experiences a maximum strain of 7.86mm/m. Such amount of tensile strain is likely to develop surface cracks less than 50mm wide. The anticipated maximum possible slope likely to occur in the forest area is 15.91mm/m i.e. a tilt of 0.9^{o}, which unlikely to cause falling of trees in the forest area.

Thus, it is anticipated that the forest may not be affected by subsidence. Surface cracks likely to develop in the forest area should be filled up with clay and stone chips and thereafter with about 0.3m high clay heap over the cracks.

As per recommendation of MOEF, the area in the forest having more than 10 mm/m strain would be considered as subsidence affected area due to underground mining and accordingly NPV is to be paid.

8.0 SUBSIDENCE MANAGEMENT:

Considering the impact of subsidence on surface topography, forest and surface features, as explained in earlier chapters, the following

subsidence management aspects are required to be undertaken to overcome or to minimise adverse effects.

i) Due to subsidence, surface cracks likely to develop over the mining area need to be filled up properly and regularly by clay and stone chips and thereafter with about 0.3m high clay heap over the cracks. It will help in achieving the original drainage pattern over the mining area, improving the water retention capacity of the soil, minimising the top soil erosion and avoiding chances of underground inundation and spontaneous heating.

ii) It is suggested that a team is formed by the mine management which will be responsible for the proper and regular filling of surface cracks developed due to subsidence. The team will also maintain record of the development and filling of surface cracks. Adequate supply of filling materials should be arranged by mine management at the site.

iii) Subsidence may result in depressions on the surface with accumulation of water during the rains. Such accumulation of water may be beneficial for vegetation in the forest. These water bodies may be retained wherever possible or filled up/drained out by cutting drains depending on safety of the underground workings.

iv) Surface drains should be made outside of the subsidence influence area to prevent the surface water of adjoining area from coming into active subsidence area.

v) Coal pillars are to be left un-extracted vertically below and upto a distance equal to half of the depth on both sides of surface features which needs to be protected from subsidence damages, if any.

vi) Considering the make of water in small seasonal streamlets existing over the mining area, due care has to be undertaken while extraction is made below these streamlets such as avoiding extraction during monsoon and filling up cracks developed in the bed of the streamlets, when dry. However, if it is required to keep these streamlets totally out of

subsidence influence area, coal pillars should be left un-extracted vertically below and within angle of draw from the streamlet, i.e. within 33^0 angle of draw for multiple seam extraction.

The impact of subsidence on different surface features and forest land along with the degree of damage are provided in Annexure I for reference, i.e. the "Subsidence Impact Matrix". The Subsidence Impact Matrix (SIM) shown therein was developed under a Ministry of Coal funded S&T project.

9.0 CONCLUSION:

i) Due to extraction of Seam III/III (Top), the anticipated maximum possible subsidence likely to occur over mining area is 1.13 m, which is likely to take place over panel PA. The estimated maximum possible slope and tensile strain likely to occur are 15.91 mm/m and 7.86 mm/.m over the panel PA.

ii) The anticipated maximum possible subsidence likely to occur over forest area is 0.823, which is likely to take place over panel PA. The estimated maximum possible slope and tensile strain likely to occur are 15.91 mm/m and 7.86 mm/m over the panel PA. As strain value is less than 10 mm/m, there will not be any damaging effect on forest

iii) Due to extraction of Seam III/III (Top) in this mine the maximum anticipated subsidence in the forest area is estimated to be 0.823 m and maximum tensile strain of 7.86 mm/m which is less than the permissible limit of 10 mm/m strain in the forest area. Therefore, forest is not likely to be damaged by subsidence.

Thus, the area experiences a maximum strain of 7.86mm/m. Such amount of tensile strain is likely to develop surface cracks less than 50mm wide. The anticipated maximum possible slope likely to occur in the forest area is 15.91mm/m, i.e. a tilt of 0.9^o, which unlikely to cause falling of trees in the forest area.

iv) Provision has to be made for compensatory afforestation and strengthening of forest cover to take care of losses, if any.

v) For the purpose of Net Present Value (NPV), Central Government has made a recommendation for subsidence affected area in the forest due to underground mining, which depicts that the area in the forest having more than 10 mm/m strain would be considered as affected area and accordingly NPV is to be paid. Considering the above, the surface over the mining area likely to be affected by less than10 mm/m.

vi) Kanhan River is not likely to be affected by subsidence as a barrier equal to half of the depth of coal seam is to be left unextracted on both sides of Kanhan river as proposed in the scheme prepared by RI-IV.

vii) Tributary over the panel PD is likely to be affected by 0.03m of subsidence and 0.78mm/m of tensile strain. Therefore, there will not be any effect on this tributary of Kanhan river. However, to protect it completely from subsidence a barrier equal to half of the depth as proposed in the report prepared by RI-IV may be left unextracted from this tributary.

viii) Road over panel PC is not likely to be affected by subsidence as barrier left for Kanhan river is enough to protect the road.

ix) Though the small seasonal streamlets have not been shown on surface plan but if such streamlets exist over the mining area to control the surface drainage are likely to be affected by subsidence. Considering the make of water in these streamlets, due care has to be taken while extraction is made below it, such as avoiding extraction during monsoon and filling up cracks developed in the bed of streamlets, when dry to avoid inrush of water belowground in the rainy season. However, if it is necessary to bring the streamlets out of subsidence influence area, coal

pillars should be left un-extracted vertically below and within subsidence influence area from it.

x) Tenancy land is likely to be affected by a maximum subsidence of 1.13 m and tensile strain of 7.86 mm/m. A large number of fine cracks or a few 100 mm wide cracks with marked depression will take place. Single strong hutments in the area will suffer severe impact panel PA only. Therefore any settlement over this panel should be settled elsewhere before commencement of depillaring operation. Over rest of the panels tenancy land is not likely to be affected by subsidence to suggest any mitigative measure.

xi) Government land is likely to be affected by a maximum of 0.026 m subsidence and 0.78 mm/m tensile strain. Therefore there will not be any damaging effect on Government land.

xii) The proposed extension area in south side of Dhau North Block (South of Fault F2-F2 & F3-F3) is more or less flat. The altitude of the area of mining block varies from 785 m to 865 m i.e. a difference of elevation is of 80m. The drainage of the area is controlled by the Kanhan river flowing in the middle of the proposed extension area from N-W to S-E. A few seasonal nalas meet the Kanhan river in proposed area.

However, subsidence may result in the formation of depressions over the centre of the panels where water may accumulate during rains. The accumulation of water may be beneficial for vegetation in the forest. Thus, the desirable water bodies may be retained after extraction of both the workable seams. In case the safety of underground workings is impinged by it, the depressions should be filled up or water from them should be drained out by cutting drains.

xiii) Surface cracks formed due to subsidence will need to be filled up with clay and stone chips and thereafter with about 0.3m high clay heap over the cracks. It will help in achieving the original drainage pattern in the mining area, improving water retention capacity of the soil, minimising the

top soil erosion and avoiding chances of underground inundation and spontaneous heating.

xiv) It is suggested that the mine management forms a team that will be responsible for the proper and regular filling of surface cracks developed due to subsidence. The team will also maintain a record of the development and filling of surface cracks. Adequate supply of filling materials should be arranged by the mine management at the site.

xv) Surface drains should be made outside of the subsidence influence area to prevent the surface water of adjoining area from coming into active subsidence area.

xvi) It is recommended that while carrying out extraction in initial panel, close subsidence monitoring is required to be done. On the basis of observed data, necessary correction in subsidence estimation may be done.

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Table 1: Anticipated maximum subsidence, slope and tensile strain at surface after extraction of panels of seam- III/IIIT.

Panel No.	Av. Width	Av. Depth	Extraction Thickness	Max. Subsidence	Max. Slope	Max. Tensile Strain	Likely Width of Cracks
	(m)	(m)	(m)	(mm)	(mm/m)	(mm/m)	(mm)
PA	272	255	4.5	1130	15.91	7.86	<50
PB	184	290	4.5	450	13.47	6.58	<50
PC	188	320	4.5	80	2.47	1.21	No Cracks
PD	135	314	4.0	30	1.61	0.78	No Cracks
PE	140	380	3.8	0.00	0.00	0.00	No Cracks

ANNEXURE-1

SUBSIDENCE IMPACTS

The Subsidence Impact Matrix given below shows the degrees of damage for various surface features, including forest land, vis-a-vis subsidence, slope and strain values was developed as part of a Ministry of Coal funded S&T project and is extracted from the S&T Report titled "Subsidence in Mining Areas" by CMRI.

Sl. No.	Impact	Subsidence	Slope	Strain
		mm	mm/m	mm/m
1	2	3	4	5
	SURFACE TOPOGRAPHY			
1.	Practically no impact	<500	<3	<3
2.	Some fine cracks or one or two 50mm wide cracks with visible depression	<500 500-1000	3-5 5-10	3-5 3-5
3.	A large number of fine cracks or a few 100mm wide cracks with marked depression	500-2000	10-20	5-10
4.	A large number of 50-100mm wide cracks or a few 200mm wide cracks with stepping. Marked distortion in surface topography	500-2000	>20	10-20
5.	500mm wide cracks with stepping and prominent distortion in surface topography	>1000	>50	20-50
6.	Many 500mm wide cracks some upto 1000mm width, large stepping. Severe distortion in surface topography	>2000	>100	50-100
7.	Very severe distortion in surface topography. Stepped subsidence with very wide cracks.	>2000	>100	>100

1	2	3	4	5
		mm	mm/m	mm/m
	SURFACE WATER BODIES (Ponds, Rivers, Nallahs, Jores, HFL)			
1.	Practically no impact. No loss of water	<500	<3	<3
2.	Marginal impact in some cases only. Some loss of water and water logging	<1000	<5	<5
3.	Severe impacts. Major loss of water. Severe water logging	>1000	>5	>5
	SUB-SURFACE WATER TABLE			
1.	Marginal depletion in water retaining capacity	<500	<3	<3
2.	Severe depletion in water retaining capacity	-	-	>5
	AQUIFERS			
1.	Depletion in water retaining capacity	-	-	>3
	WATERLOGGING ON SURFACE			
1.	Very little waterlogging	<500	-	-
2.	Some (300-500mm deep depending on surface topography)	500-1000	-	-
3.	Marked waterlogging	>1000	-	-
	ROADS			
1.	Practically no impact	<500	<5	-
2.	Depressions with gentle slope	-	5-10	-
3.	Steeper slopes (speed restriction may be necessary)	-	20-50	-
4.	Marginal repairs necessary	-	20-50	>10
5.	Major repairs necessary	-	>50	>10

1	2	3	4	5
		mm	mm/m	mm/m
	RAILWAY LINES - JOINTED CONSTRUCTION			
1.	Practically no impact	-	<10	<3
2.	Minor to severe impacts, repairs necessary due to bending twisting and breaking of rails and steeper gradients	-	>10	>3
	RAILWAY LINES - WELDED CONSTRUCTION			
1.	No subsidence permitted. Even very small strain can cause twisting and breaking of rails,			
	RAILWAY SIDINGS (Jointed Construction)			
1.	Practically no impacts	-	<10	<3
2.	Minor to severe impacts, repairs necessary	-	>10	>3
	SINGLE STORY HUTMENTS (Kuccha)			
1.	Practically no impact. A few fine cracks in plastered walls	-	<5	<3
2.	Minor repairable impacts. Fine cracks. A few 10mm wide cracks.	-	<10	3-5
3.	Major/severe impacts. Wide cracks, stepping, tilting	-	>10	>5
	SINGLE STORY BUILDINGS			
1.	Very little impact. A few fine cracks or one/two 5-10mm wide crack in plaster	-	<5	<3
2.	Minor impacts, repairable. 5-10mm wide cracks, doors and windows getting slight jamming, slight tilting.	-	5-10	3-5
3.	Severe impacts, major repairs necessary. Wider cracks, stepping, crushing and marked tilting.	-	>10	>5

1	2	3	4	5
		mm	mm/m	mm/m
	RAILWAY LINES - JOINTED CONSTRUCTION			
1.	Practically no impact	-	<10	<3
2.	Minor to severe impacts, repairs necessary due to bending twisting and breaking of rails and steeper gradients	-	>10	>3
	RAILWAY LINES - WELDED CONSTRUCTION			
1.	No subsidence permitted. Even very small strain can cause twisting and breaking of rails,			
	RAILWAY SIDINGS (Jointed Construction)			
1.	Practically no impacts	-	<10	<3
2.	Minor to severe impacts, repairs necessary	-	>10	>3
	SINGLE STORY HUTMENTS (Kuccha)			
1.	Practically no impact. A few fine cracks in plastered walls	-	<5	<3
2.	Minor repairable impacts. Fine cracks. A few 10mm wide cracks.	-	<10	3-5
3.	Major/severe impacts. Wide cracks, stepping, tilting	-	>10	>5
	SINGLE STORY BUILDINGS			
1.	Very little impact. A few fine cracks or one/two 5-10mm wide crack in plaster	-	<5	<3
2.	Minor impacts, repairable. 5-10mm wide cracks, doors and windows getting slight jamming, slight tilting.	-	5-10	3-5
3.	Severe impacts, major repairs necessary. Wider cracks, stepping, crushing and marked tilting.	-	>10	>5

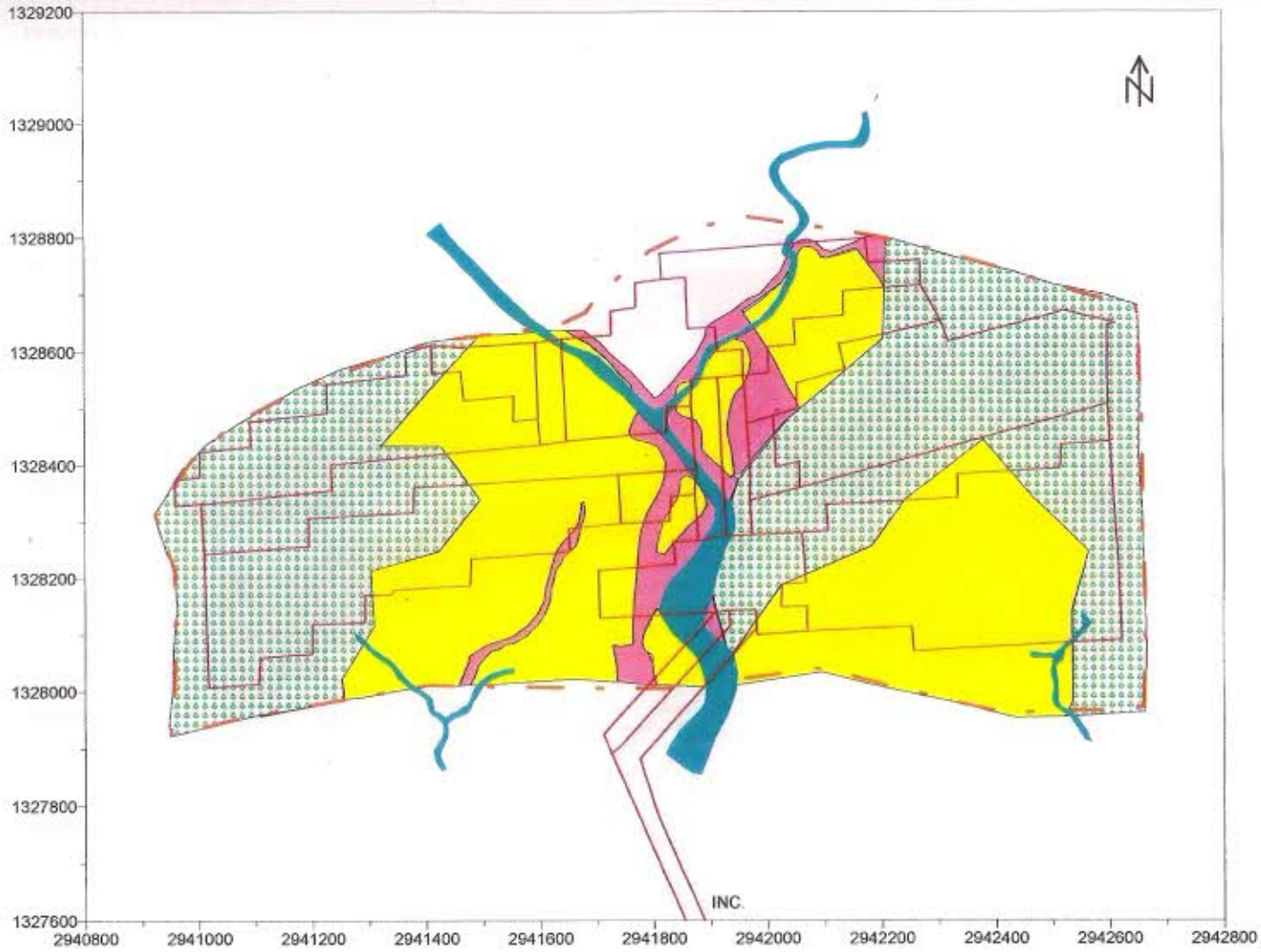
1	2	3	4	5
		mm	mm/m	mm/m
	DOUBLE STORY BUILDINGS			
1.	Very little impact. A few fine cracks or one/two 5-10mm wide cracks	-	<5	<3
2.	Little repairable impact, 5-10mm wide cracks, slight displacement of walls against roof, doors and windows getting slightly jammed.	-	5-10	3-5
3.	Severe impacts, major repair necessary. Wider cracks, stepping, crushing and tilting. Gaps between walls and roof.	-	>10	>5
	MULTI-STORY BUILDINGS			
1.	Little impacts, repairable 5-10mm wide cracks, doors and windows getting slight jamming, displacement of walls against roof.	-	<5	<3
2.	Severe impacts. Winder cracks, crushing, tilting, and stepping.	-	>5	>3
	LARGE BUILDINGS, MONUMENTS, HISTORICAL BUILDINGS, ETC.			
1.	Very little impact. A few fine cracks or one/two 5-10mm wide cracks	-	<3	<1.5
2.	Little impact, 5-10mm wide cracks, Damage to decorations; slight displacements; doors and windows getting jammed.	-	3-5	1.5-3
3.	Severe impacts. Wider cracks, tilting, crushing, etc. Major repairs necessary.	-	>5	>3
	AERIAL ROPEWAYS			
1.	Practically no impact	-	<5	<3
2.	Little repairable impacts	-	5-10	3-5
3.	Severe impacts. Ropes may leave pullies due to change in alignment. Tilting of pylons. Buckling of structure.	-	>10	>5
	HIGH TENSION PYLONS			
1.	Practically no impact	-	<5	<3
2.	Severe impacts. Tilting, buckling and may be collapse of pylons	-	>5	>3

1	2	3	4	5
		mm	mm/m	mm/m
	UNDERGROUND CABLES			
1.	Practically no impact	-	-	<3
2.	Severe impacts (cables may break due to tension).	-	-	>3
	UNDERGROUND PIPELINES			
1.	Practically no impact	-	-	<1.5
2.	Severe impacts. Breaking of pipes	-	-	>1.5
	OVERLYING VIRGIN SEAMS			
1.	Practically no impact. No visible signs of subsidence when the seams are developed.	-	<5	<3
2.	A little impact. A little crushing of coal, roof and floor rock. Fire risk when development is done in upper seam.	-	5-10	3-5
3.	Severe impacts. Crushing of coal, roof and floor rock. Stepping in tensile strain zone. Fire risk. Heaving, supports necessary during development.	-	10-20	5-10
4.	Very severe impacts. Severe crushing, large stepping, entry into subsided area rather difficult. High fire risk. Arching necessary.	-	>20	>10
	OVERLYING WORKINGS (Standing on developed pillars)			
1.	Practically no impact on galleries and pillars. Some spalling.	-	<5	<3
2.	Visible floor lifting, side spalling and roof falls. Supports required. Fire risk.	-	-	3-5
3.	Marked floor lifting, side spalling and roof falls. High fire risks. Workings unsafe.	-	-	5-10
4.	Severe floor lifting, large roof falls, wide spread side spalling, stepping, very high fire risk, workings unsafe.	-	-	>10
	OVERLYING WORKINGS (Standing on reduced pillars)			
1.	Practically no impact.	-	<3	<1.5

1	2	3	4	5
		mm	mm/m	mm/m
2.	Marginal impact on stability of stooks. The stooks with marginal factor of safety may collapse increasing loading on adjoining stooks.	-	<5	<5
3.	Failure of a few stooks may lead to chain of failures causing partial or total collapse of area. Thus causing additional subsidence on overlying horizons.	-	>5	>3
	OVERLYING WORKINGS (Packed or stowed)			
1.	Practically no impact on stowed workings. Some loss of water.	-	-	<5
2.	Complete loss of water from stowed areas and also from adjoining rise side areas.	-	-	>5
	WATERLOGGED OVERLYING WORKINGS (Standing on developed pillars)			
1.	Practically no impact on pillars, galleries and water retaining capacity of the workings.	-	-	<3
2.	Marginal loss of water through fine cracks in strata around. Dewatered areas may have risk of fires, roof falls, side spalling, floor lifting.	-	-	<5
3.	Major loss of water. High fire risk in dewatered areas with roof falls, side spalling, floor lifting, etc.	-	-	5-10
4.	Total loss of water. Very high fire risk with severe floor lifting, roof falls and spalling.	-	-	>10
	WATERLOGGED OVERLYING WORKINGS (Standing on reduced pillars/stooks)			
1.	Stooks may collapse causing additional subsidence on surface.	-	-	<3
2.	Partial loss of water. Collapse of stooks. Additional surface subsidence. Fire risk.	-	-	3-5
3.	Total loss of water. Collapse of workings. Additional surface subsidence; fire risk.	-	-	>5

1	2	3	4	5
		mm	mm/m	mm/m
IN CURRENT WORKINGS FROM SUBSIDENCE AT THE LEVEL OF SURFACE				
1.	Practically no impact.	-	-	<5
2.	Leakage of air. Fire in goaves at shallow depth.	-	-	>5
IN CURRENET WORKINGS FROM SUBSIDENCE AT THE LEVEL OF OVERLYING TATER BODIES				
1.	Practically no impact	-	-	<3
2.	Marginal increase in make of water.	-	-	3-5
3.	Appreciable increase in make of water.	-	-	5-10
4.	Heavy increase in make of water, which may lead to inundation.	-	-	>10
SURFACE ATMOSPHERE				
1.	Practically no impact.	-	-	<5
2.	Some air from underground workings at shallow depth may leak to surface.	-	-	5-10
3.	Air leakage from shallow depth workings. If the workings have fire, surface atmosphere is likely to be polluted by gases coming from the fire.	-	-	>10
SUB-SOIL				
1.	Practically no impact.	-	-	<3
2.	Very little impact in the form of reduction of water retaining capacity.	-	-	3-5
3.	Temporary loss in water retaining capacity. Cracks filling may improve water retaining capacity.	-	-	5-10
4.	Long term loss of water retaining capacity. Suitable protective measures necessary.	-	-	>10
AGRICULTURE				
1.	Practically no impact.	-	-	<5
2.	Marginal impact, i.e. reduction in yield due to loss in water retaining capacity of sub-soil.	-	-	5-10
3.	Major impact, i.e. sizeable reduction in yield.	-	-	>10

1	2	3	4	5
		mm	mm/m	mm/m
FOREST AND PLANTATION				
1.	Practically no impact.	-	<10	<5
2.	Temporary loss in water retaining capacity of top-soil may affect undergrowth slightly. Slight tilting of plants/trees.	-	10-20	5-10
3.	Short term impact on trees in zones having cracks. The cracks may get filled in due course. Tilting of trees.	-	20-50	10-20
4.	Wide cracks may severely affect undergrowth but may not have much impact on large trees except those in the tensile strain zone where wide cracks develop; high tilting may cause some trees to fall in the high slope zone.	-	>50	>20



INDEX

- PROPOSED WORKINGS OF SEAM III/IIIT
- GOVT. LAND
- FOREST LAND
- TENANCY LAND
- MINE BOUNDARY
- RIVER / NALA

NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER: WESTERN COALFIELDS LIMITED						
JOB TITLE: SUBSUDENCE PREDICTION FOR DHAU NORTH BLOCK					JOB NO. 4101730	
SUBJECT : Proposed Layout of u/g working of Seam III/IIIT(T).	ACTIVITY	NAME	DESIG.	SIGN	DATE	
	PREPARED	B.RIBA	AS.MGR.			
	PROCESSED	V.SINGH	SR.MGR.			
	CHECKED	M.SAHAY	CH.MGR.			
	APPROVED	A.K.RANA	GM			
CMPDI (ISO 9001 COMPANY)	SCALE : 1:12000			SHEET 1 OF 9		
	DRG. NO. PLATE-1			REV. NO. 0		

NOTE: ALL DIMENSIONS ARE IN METER

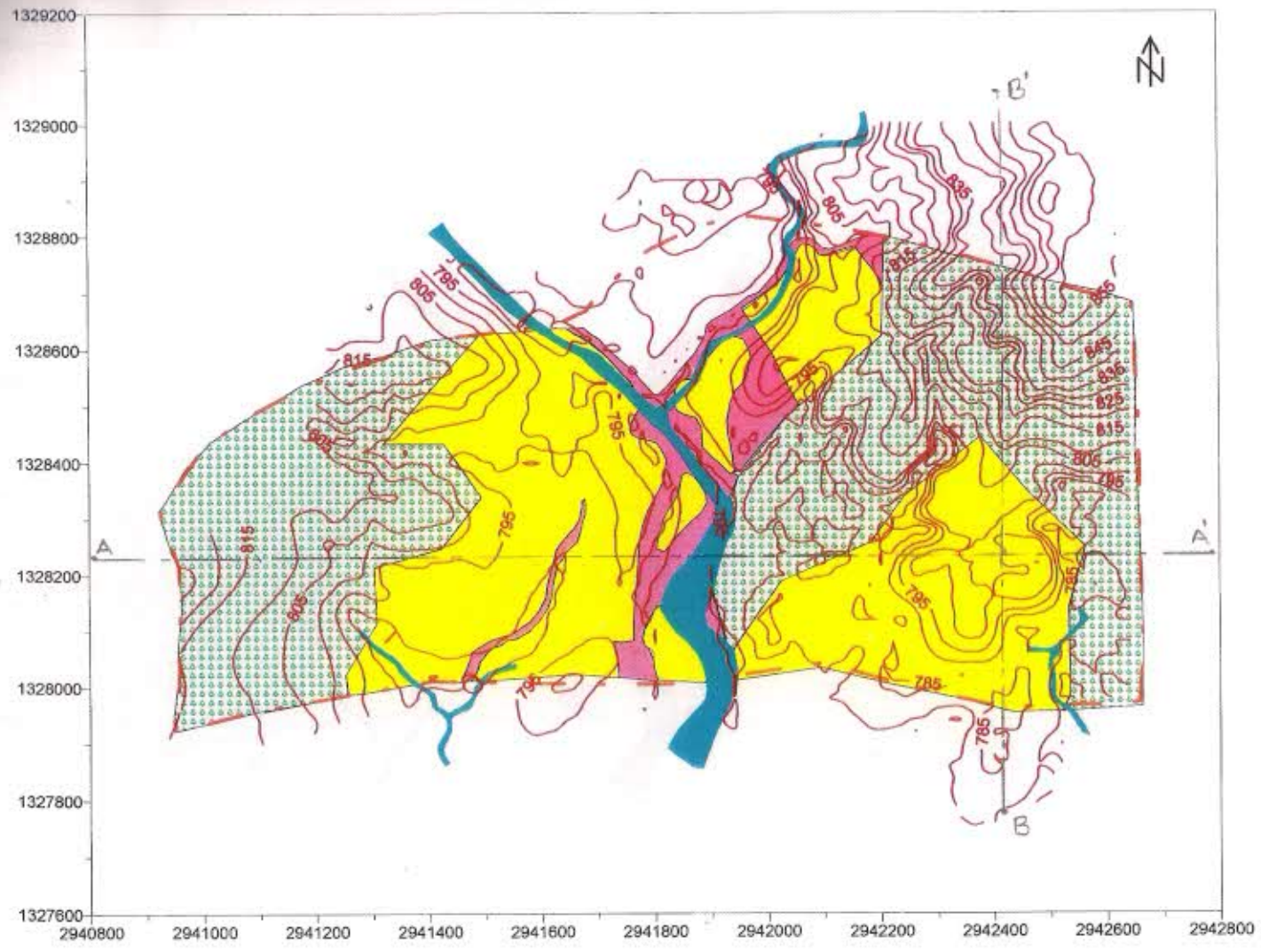
INDEX

PROPOSED WORKINGS OF SEAM III/IIIT

MINE BOUNDARY

FAULT

CUSTOMER : WESTERN COALFIELDS LIMITED					
JOB TITLE: SUBSUDENCE PREDICTION FOR DHAU NORTH BLOCK				JOB NO. 4101730	
SUBJECT : Panels of Seam III/IIII(T) proposed to be depillared.	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	B.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RANA	GM		
CMPDI ISO 9001 COMPANY	SCALE : 1:12000			SHEET 2 OF 9	
	DRG. NO. PLATE-2			REV. NO. 0	

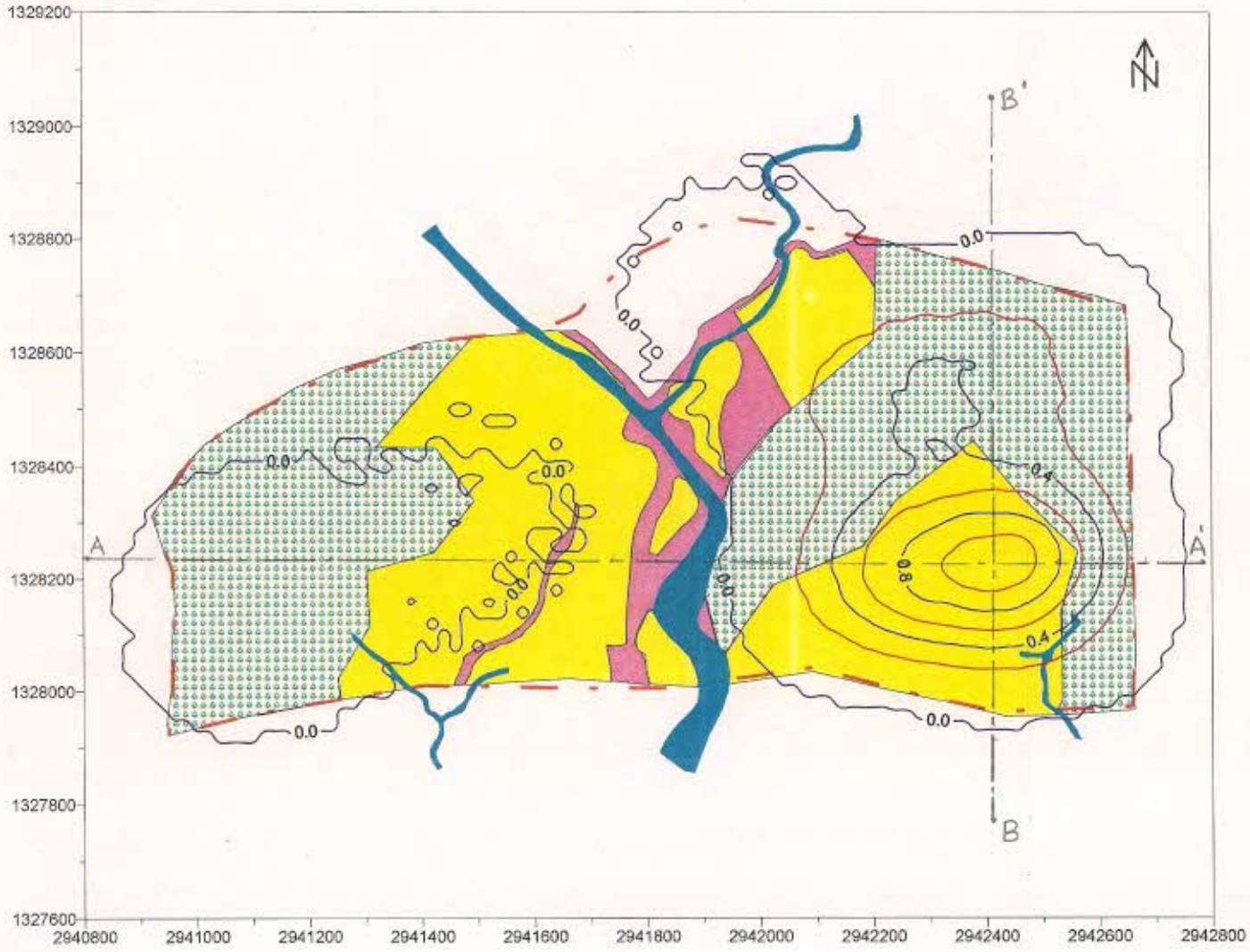


INDEX

- GOVT. LAND
- FOREST LAND
- TENANCY LAND
- MINE BOUNDARY
- RIVER / NALA

NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER : WESTERN COALFIELDS LIMITED				JOB NO. 4161738	
JOB TITLE: SUBSUDENCE PREDICTION FOR DHAU NORTH BLOCK					
SUBJECT : Topography before mining.	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	S.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RANA	GM		
CMPDI ISO 9001 COMPANY	SCALE : 1:12000			SHEET 3 OF 9	
	DRG. NO. PLATE-3			REV. NO. 0	

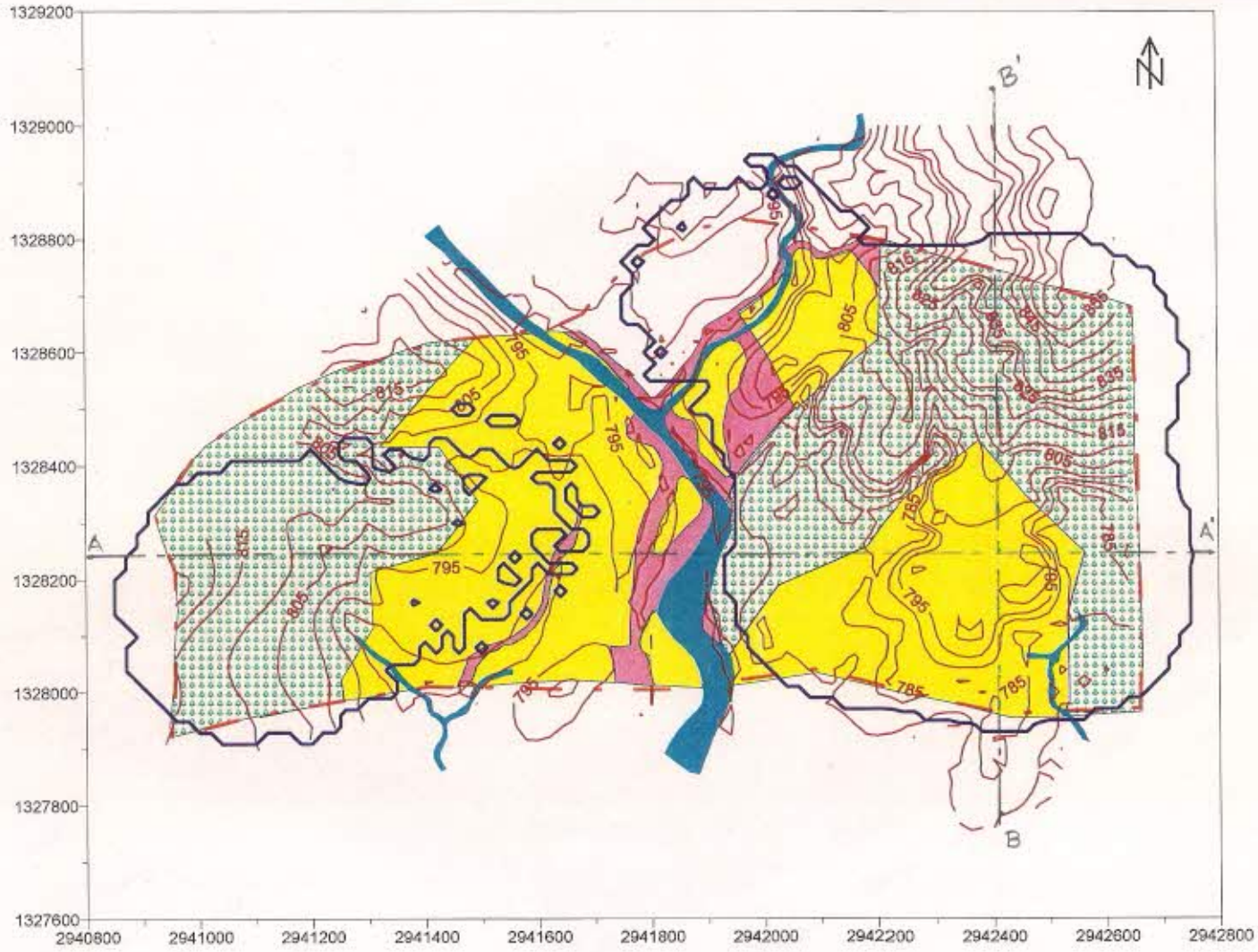


INDEX

- GOVT. LAND
- FOREST LAND
- TENANCY LAND
- MINE BOUNDARY
- RIVER / NALA

NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER : WESTERN COALFIELDS LIMITED					
JOB TITLE: SUBSUDENCE PREDICTION FOR DHAU NORTH BLOCK				JOB NO. 4101738	
SUBJECT :Subsidence contours after mining.	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	B.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RANA	GM		
CMPDI ISO 9001 COMPANY	SCALE : 1:12000			SHEET 4 OF 5	
	DRG. NO. PLATE-4			REV. NO. 0	

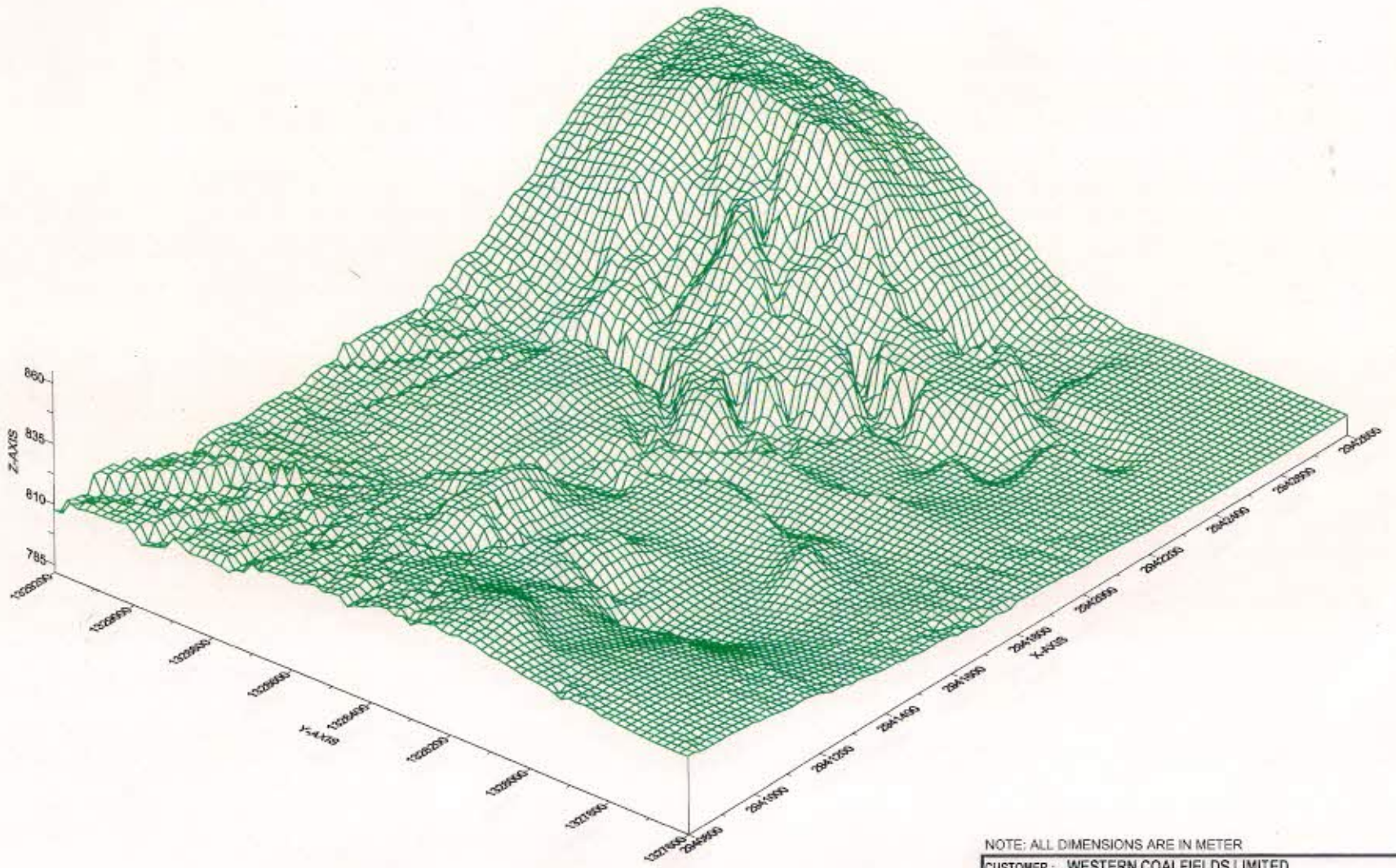


INDEX

- GOVT. LAND
- FOREST LAND
- TENANCY LAND
- MINE BOUNDARY
- RIVER / NALA
- SUBSIDENCE INFLUENCE AREA

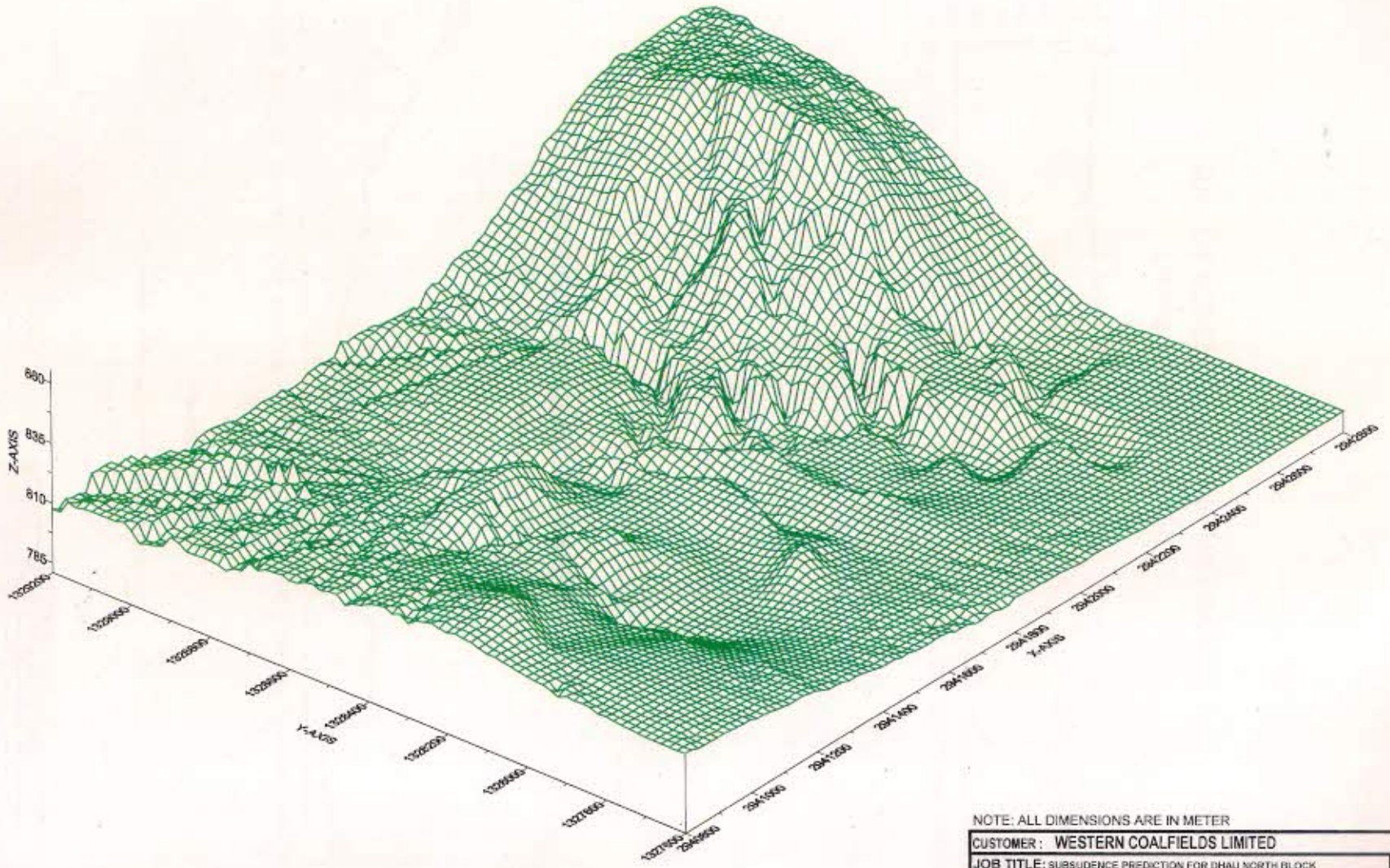
NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER : WESTERN COALFIELDS LIMITED						
JOB TITLE: SUBSIDENCE PREDICTION FOR DHAU NORTH BLOCK					JOB NO. 4101730	
SUBJECT :Topography after mining(At the end of mine life.)	ACTIVITY	NAME	DESIG.	SIGN	DATE	
	PREPARED	B.RIBA	AS.MGR.			
	PROCESSED	V.SINGH	SR.MGR.			
	CHECKED	M.SAHAY	CH.MGR.			
	APPROVED	A.K.RANA	GM			
CMPDI ISO 9001 COMPANY	SCALE : 1:12000				SHEET 5 OF 5	
	DRG. NO. PLATE-5				REV. NO. 0	



NOTE: ALL DIMENSIONS ARE IN METER

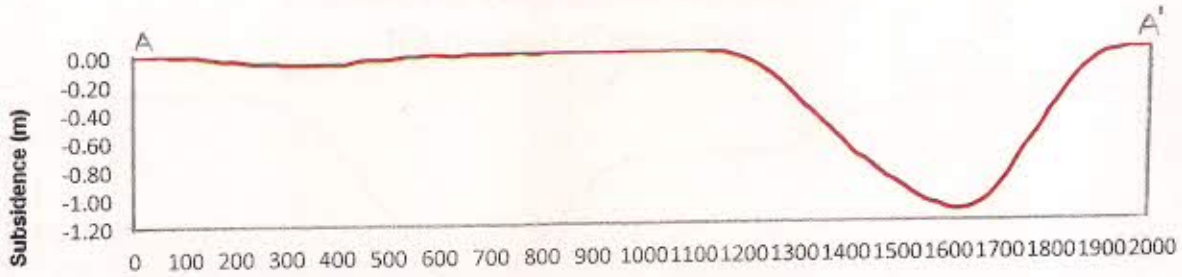
CUSTOMER : WESTERN COALFIELDS LIMITED					
JOB TITLE : SUBSIDENCE PREDICTION FOR DHAU NORTH BLOCK				JOB NO. 4101730	
SUBJECT :3D view of surface before mining.	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	B.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RANA	GM		
CMPDI ISO 9001 COMPANY	SCALE : 1:12000			SHEET 6 OF 9	
	DRG. NO. PLATE-6			REV. NO. 0	



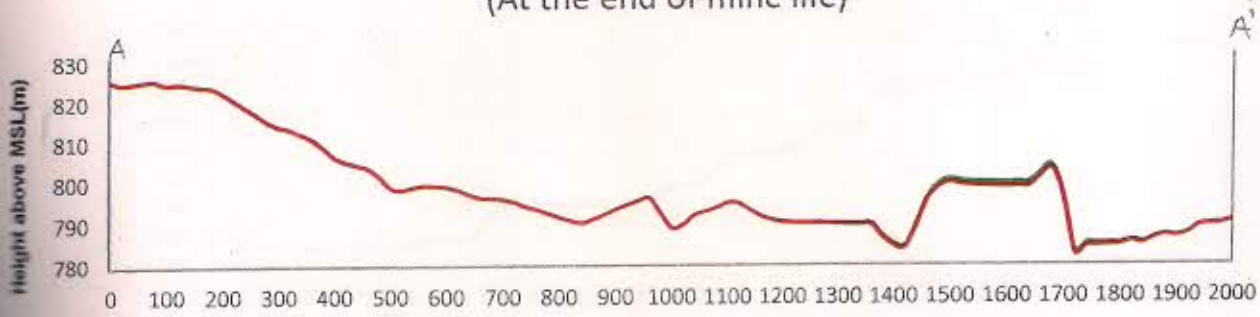
NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER : WESTERN COALFIELDS LIMITED					
JOB TITLE: SUBSIDENCE PREDICTION FOR DHAU NORTH BLOCK				JOB NO. 4101730	
SUBJECT :3D view of surface after mining.	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	B.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RANA	GM		
CMPDI ISO 9001 COMPANY	SCALE : 1:12000			SHEET 7 OF 8	
	DRG. NO. PLATE-7			REV. NO. 0	

SUBSIDENCE PROFILE ALONG LINE AA'
(At the end of mine life)



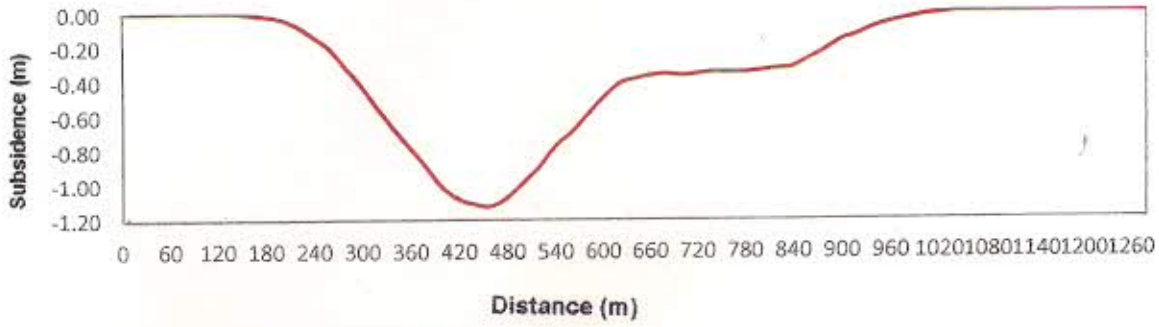
SURFACE PROFILE ALONG LINE AA'
(At the end of mine life)



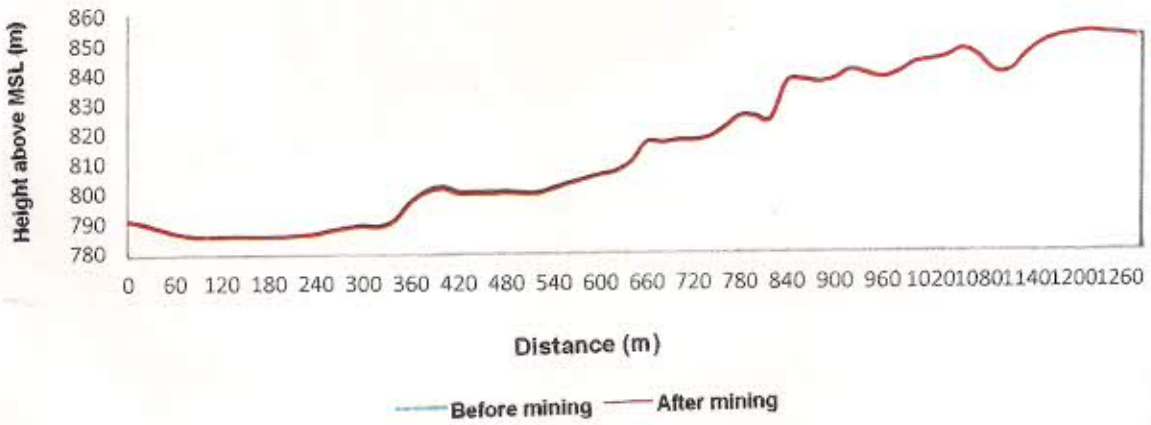
NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER : WESTERN COALFIELDS LIMITED					
JOB TITLE: SUBSIDENCE PREDICTION FOR DHAU NORTH BLOCK				JOB NO. 4101730	
SUBJECT :Subsidence and surface profiles along line AA'(As shown in plates 3,4 &5).	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	B.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RANA	GM		
CMPDI ISO 9001 COMPANY	SCALE :			SHEET 8 OF 9	
	DRG. NO. PLATE-8			REV. NO. 0	

SUBSIDENCE PROFILE ALONG LINE BB'
(At the end of mine life)



SURFACE PROFILE ALONG LINE BB'
(At the end of mine life)



NOTE: ALL DIMENSIONS ARE IN METER

CUSTOMER : WESTERN COALFIELDS LIMITED					
JOB TITLE: SUBSIDENCE PREDICTION FOR DHAU NORTH BLOCK				JOB NO. [illegible]	
SUBJECT :Subsidence and surface profiles along line BB'(As shown in plates 3, 4 & 5).	ACTIVITY	NAME	DESIG.	SIGN	DATE
	PREPARED	B.RIBA	AS.MGR.		
	PROCESSED	V.SINGH	SR.MGR.		
	CHECKED	M.SAHAY	CH.MGR.		
	APPROVED	A.K.RAMA	GM		
CMPDI ISO 9001 COMPANY	SCALE :			SHEET 9 OF 9	
	DRG. NO. PLATE-9			REV. NO. 0	

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REPORT ON

SUBSIDENCE PREDICTION AND MANAGEMENT FOR DHAU NORTH BLOCK

WESTERN COALFIELDS LIMITED

(Job No.4101730)

JUNE 2014

REGISTERED OFFICE

Gondwana Place, Kanke Road
Ranchi -834 031
(Jharkhand)

REGIONAL INSTITUTES

क्षेत्रीय संस्थान-I
वेस्ट एंड, जी.टी.रोड
आसनसोल-713 301
(पश्चिम बंगाल)

क्षेत्रीय संस्थान-II
कोयला भवन, कोयला नगर
धनबाद- 826 005
(झारखंड)

क्षेत्रीय संस्थान-III
गोंदवाना प्लेस,कांके रोड
राँची- 834 031
(झारखंड)

क्षेत्रीय संस्थान-IV
जरीपटका, कस्तूरबा नगर
नागपुर-440 014
(महाराष्ट्र)

क्षेत्रीय संस्थान-V
सीपत रोड
बिलासपुर-495 001
(छत्तीसगढ़)

क्षेत्रीय संस्थान-VI
पोस्ट :जयंत कॉलरी,
जिला : सिंगरौली
पिन नं0- 486 890
(मध्य प्रदेश)

क्षेत्रीय संस्थान-VII
गृह निर्माण भवन
सचिवालय मार्ग
भुवनेश्वर-751001
(उड़ीसा)

Regional Institute - I
West End, G.T Road
Asansol - 713 301
(West Bengal)

Regional Institute - II
Koyla Bhawan, Koyla Nagar
Dhanbad - 826 005
(Jharkhand)

Regional Institute - III
Gondwana Place, Kanke Road
Ranchi- 834 031
(Jharkhand)

Regional Institute - IV
Jaripathka, Kasturba Nagar
Nagpur - 440 014
(Maharashtra)

Regional Institute - V
Seepat Road
Bilaspur - 495 001
(Chattisgarh)

Regional Institute - VI
P.O Jayant Colliery
Dist. - Singrauli
PIN - 486 890
Madhya Pradesh

Regional Institute - VII
Grih Nirman Bhawan
Sachivalaya Marg
Bhubneswar - 751 001
(Orissa)

सेन्ट्रल माईन प्लानिंग एंड डिजाइन इन्स्टीच्यूट लिमिटेड

(कोल इंडिया की अनुषंगी कम्पनी)
एक मिनी रत्न कम्पनी

Central Mine Planning & Design Institute Limited

(A Subsidiary of Coal India Limited)
A Mini Ratna Company

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