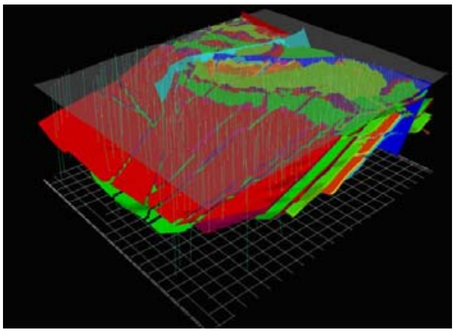
IMC GROUP CONSULTING LIMITED

# Government of the People's Republic of Bangladesh
# Energy and Mineral Resources Division
# Hydrocarbon Unit

## Review of "Techno-Economic Feasibility Study"

## Khalashpir Coal Mine



**Final Report**

**Prepared**

**By**

**IMC Group Consulting Limited**

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# 1.0 EXECUTIVE SUMMARY

## 1.1. Introduction

Government of the People's Republic of Bangladesh Energy and Mineral Resources Division, Hydrocarbon Unit ("the Client" or "HCU") has commissioned IMC Group Consulting Ltd ("IMC") to review "The Techno-Economic Feasibility Study of Khalashpir Coal Mine" ("FS") prepared and submitted to HCU by the Hosaf International Ltd, Shandong-Ludi, Xinwen Mining Group Consortium ("the Consortium") and prepare a Review Report ("the Report") in accordance with an agreed scope of works.

### 1.1.1. Scope of Works

In view of development of Khalashpir Coal Mine, a consultant will be engaged to review the Techno-Economic Feasibility Study report for the preparation of a complete "Review Report" consisting of the comments, suggestions and recommendations.

### 1.1.2. Project Description

The Khalashpir coal deposit is located in NW Bangladesh, some 50 km south of Rangpur and approximately 300 km north of the capital, Dhaka. The area is flat-lying and the land use is primarily agricultural with rice as the principal crop. Small villages are distributed across the deposit.

The Consortium has prepared the FS Report which addresses the extraction of a number of target coal seams forming a coal basin which lies at depths from 239 m to 485 m below the surface and averages a composite thickness of 45 metres.

The intended use for the extracted medium volatile coal is for electricity generation in local power station(s) yet to be built.

## 1.2. Geology

The existence of coal at Khalashpir was confirmed in 1989 following the completion of four boreholes by the Geological Survey of Bangladesh (GSB). Three of the four holes encountered coal seams, some of which are of potentially mineable thickness.

In 2004, Hosaf International Ltd was awarded the exploration licence undertook additional cored drilling to further evaluate the deposit. To date a total of fifteen boreholes have been completed.

### 1.2.1. Comment on Geological Findings

#### 1.2.1.1. Exploration Boreholes

The data submitted in the FS is limited and constrained for the following reasons:

- No geophysical logging has been undertaken in the boreholes and therefore no validation of coal seam thickness and depth can be made; and
- Analytical coal quality data is extremely limited and cannot be used to assist in detailed seam correlation.

For the purpose of this review, and to expedite the process, IMC has used the plan borehole locations as shown on the conceptual layout for Seam I in order to establish a database from which to generate preliminary computer models of total seam thickness, coal thickness, floor of seam levels and inter-burden variation.

#### 1.2.1.2. Tectonic Structure of the Deposit

The Khalashpir coal deposit is formed in an asymmetric synclinal basin with an axial NW-SE strike. 2D and 3D surface seismic surveys were undertaken over the prospect in 2005, and their results have determined the major tectonic structure of the basin. Generally, a good quality of data has been acquired, but the sequence of the coal seam stratigraphy is likely to be variable.

The western limit of the deposit is formed by the successive sub-crop of the seams beneath the uncomfortably overlying Miocene / Pliocene Surma Formation.

Seven normal faults have been identified by the seismic surveying, trending generally sub-parallel to the NW-SE synclinal axis. The three largest faults in the FS are interpreted with maximum vertical displacements in excess of 50 m.

These major fault discontinuities effectively subdivide the prospect into four discrete blocks for the purpose of resource estimation and the preparation of a conceptual mine plan.

#### 1.2.1.3. Stratigraphy and Coal Seam Correlation

Detailed correlation of the coal seams remains problematic. The original GSB exploration proposed a succession of coal seam horizons within the Permian Gondwana sequence in descending order and designated Seam I to Seam VIII. This correlation nomenclature has been continued for the latest GTB generation of exploration, although the graphic logs presented in the FS clearly demonstrate that the correlation is not as straightforward as a simple sequence of eight seams, but that rapid seam splits and unions occur within all groups of seams across the entire prospect, resulting in rapid coal and interburden thickness variation.

A very important consideration is that the paucity of analytical data does not allow a more detailed attempt at seam correlation from the chemical and physical coal properties.

#### 1.2.1.4. Coal Quality

Coal seam core samples from the initial GSB boreholes were analysed. The horizons of the each sample are identified in the FS report, although they have been averaged over the whole seam. No detailed sub-section analyses have been provided that could be a major aid to seam correlation.

These results also indicate that some of the coal sampled could have metallurgical coking properties. IMC recommends that this possibility is explored further with a number of isolated samples taken from new cores or re-sampling the existing cores, if the origin of the samples can be unquestionably verified.

### 1.2.2. Resource Estimation

Based on the coal thickness data supplied in the FS Report, and subdividing the prospect area into the four blocks as delineated by the interpreted structure, IMC has conducted a preliminary estimate of the potential resource in Seams I, II and IV, as shown in Table 1-1 below. Plans of the resource areas in each seam are contained in Appendix 2.

**Table 1-1 Preliminary Resource Estimate, Seams I, II & IV**

| Resource Block | Seam I | | | Seam II | | | Seam IV | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (hectares) | Average Coal Thickness (m) | In-situ Resource (Mt) | Area (hectares) | Average Coal Thickness (m) | In-situ Resource (Mt) | Area (hectares) | Average Coal Thickness (m) | In-situ Resource (Mt) |
| 1 | 335.99 | 4.00 | 17.74 | 410.77 | 12.00 | 65.07 | 449.15 | 6.00 | 35.57 |
| 2 | 247.85 | 14.00 | 45.80 | 248.13 | 18.00 | 58.96 | 247.89 | 18.00 | 58.90 |
| 3 | 63.25 | 5.00 | 4.17 | 56.63 | 6.00 | 4.49 | 63.53 | 12.00 | 10.06 |
| 4 | 112.99 | 6.00 | 8.95 | 117.99 | 8.00 | 12.46 | 114.62 | 10.00 | 15.13 |
| **Seam Totals** | | | **76.67** | | | **140.97** | | | **119.66** |
| | | | | | | | | **Total Seams I, II & IV** | **337.30** |

### 1.2.3. Recommendations for Further Geological Investigation

There are fundamental geological issues regarding the Khalashpir deposit that must be addressed before progress can be made towards establishing realistic and financially viable mining and business plans.

#### Exploration

- Additional exploration by surface drilling should be continued. This should be carried out by a reputable and proven drilling contractor with modern and well-maintained equipment who are qualified to operate to JORC standards.
- Previous boreholes that yielded unacceptable levels of core recovery (GTB-2) should be re-drilled.
- A focus should be applied to areas of particular concern where correlation issues have become apparent from the preliminary modelling of the coal seams.
- There are surface constraints to locating boreholes in the area, due mainly to access and the distribution of villages.

Any additional exploration must be carried out to internationally accepted standards such as JORC, utilising downhole geophysical logging in every hole.

#### Analysis

Samples should taken, logged and prepared in accordance with the JORC principles and supervised by a JORC accredited senior geologists.

Analysis should be undertaken by at least two accredited international laboratories observing the standard rules of analysis.

#### Interpretation

A full sedimentological study and seam mapping exercise must be undertaken of all available exploration data in order to increase mining confidence in the seam correlation and continuity.

## 1.3. Mining

### 1.3.1. Mining Approach

If the Khalashpir coal deposit was extracted by opencast methods it would rank amongst the deepest open pits in the world for all commodities and probably become the deepest operational open pit coal mine. It should also be noted to extract the deepest target seam a void approximately 4 km in diameter occupying a surface area of 12.5 $km^2$ would have to be created.

IMC agrees with the FS comments about the environmental and social unacceptability of opencast operations which would be a major hurdle to the Project as already demonstrated with the recent Phulbari coal mine project.

Underground mining would be, in general terms, the preferred method of coal extraction for a deposit of the Khalashpir specification, particularly with respect to the surface environmental and social considerations.

### 1.3.2. Mine Design

A mine design has to be established around a number of complementary criteria:

- Deposit geology;
- Deposit structure, faulting and coal seam specifications;
- Expected production;
- Projected underground environment; and
- Surface curtilage location options and accessibility.

IMC consider that the interpretation of the deposit geology is currently uncertain without further work. Consequently, the appraisal and comments in the following sub-sections must be taken as generic unless otherwise stated.

#### 1.3.2.1. Mine Access

Whereas the FS dismisses the use of drifts on the grounds of the length of freeze required to drive through the Dupi Tila aquifer IMC considers that the production capacity of the mine, especially at the enhanced 4 Mtpa may be better served with continuous drift conveying. It is likely that once the seam correlation is addressed that the Run of Mine (ROM) production to achieve a saleable production of 4 Mtpa may be significantly higher.

IMC recommends that once the ROM production is defined the Consortium should evaluate the life of mine costs of the following options from a production capacity, ventilation (mine temperature) and spontaneous combustion management view point:

- Two shafts at least 8.5 m diameter
- One 8.5 m diameter shaft and one 25 $m^2$ drift
- Two shafts at least 7.5 m diameter and one 20 $m^2$ drift

**Pit Bottom Depth and Location**

The FS indicates that the pit bottom is located at -370 m and outside the coal basin area based on a number of specified surface and underground factors and the use of horizon mining. Whereas IMC agree with these factors consideration should be given to the experiences of

Barapukuria where strata water control and extensive inclined track and dip roadways have been critical.

Currently the faulting and general basin structure are the known quantities and IMC would recommend that life of mine costs be developed for the option of locating the pit bottom, either shaft or drifts, at the lowest part of the basin close to where the major faults converge and in the FS proposed vicinity of the deep water sump.

### 1.3.2.2. Underground Mining Method

**Pillar and Stall**

IMC agrees that where the gradients are appropriate, near level, pillar and stall workings could be appropriate for Khalashpir.

**Longwall**

By far the majority of coal produced from large mines world wide is by longwall operations. Modern mechanised longwalls are highly productive but the system is expensive in the initial capital outlay. Typical cutting rates may be up to 10 m per minute loading at over 2,000 tph.

The FS details a longwall variant with multiple slices of the thicker seam sections taking 3 m cuts successively descending through the seam. The use of hydraulic fill has also been proposed to limit the subsidence effect on the base of the Dupi Tila aquifer and the surface. IMC would be sceptical about the effectiveness of hydraulic fill to control convergence which is likely to be expensive from a capital and operational cost view point.

The FS describes the use of longwall faces combined with sub-level or top coal caving as an efficient means of extracting the thicker and variable thickness target seams. IMC considers that this could be a valid approach.

**Development**

Longwalls are accessed by two systems world wide. Almost everywhere the retreat system is utilised where the panel of coal to be worked is blocked out by roads in the seam called gate roads. The face is then retreated back along these roadways.

### 1.3.2.3. Khalashpir Design Parameters

The critical design parameters as seen by IMC are:

- Geological specification and continuity of the target seams, which is currently uncertain;
- In-situ coal qualities, which are currently uncertain;
- Overall and longwall unit ROM production targets;
- Number of production units;
- Development ratio; and
- Aquifer bed strain control.

**Production and Development**

The FS indicates that the saleable production is projected to be initially 2 Mtpa increasing to 3 Mtpa in year 7 and 4 Mtpa by year 13 but does not provide any.

- Project implementation schedule
- Production or roadway development schedules

- Phased production and development plans

These omissions make it virtually impossible to evaluate the operational and economic feasibility of the Project and characteristics of the developing subsidence effect on the base of the Dupi Tila aquifer.

However, IMC are able to make some generalised observations on some of the proposed FS operational parameters.

**Project Implementation Programme**

In the absence of a FS project implementation programme IMC has prepared a generic example of a similar mine using shaft access, which forms Appendix 3.

**Longwall Faces**

The key proposed design specification from FS shows the longwall configuration in Table 1-2 below. IMC consider these parameters to be out of date with respect to current longwall technology or inappropriate to meet the overall production targets and have made alternative suggestions based on the limited FS information currently available.

**Table 1-2 FS and IMC Generalised Longwall Unit Specification**

| Parameter | FS | IMC (Suggestion) |
|---|---|---|
| Extracted Height | 3 m | Initially 3 to 4 m then up to seam height as determined by the developing subsidence profile of the aquifer base. |
| Panel Width | 120 m | 300 to 350 m as determined by the developing subsidence profile of the aquifer base. |
| Advance per Shear (web) | 0.6 m | 0.8 to 1.0 m as per current high capacity longwall specifications |
| Cutting and Loading Capacity | 700 tph | 2,000 tph as per current high capacity longwall specifications |
| Daily Production | 2,800 tpd | 13,300 tpd saleable, or 16,700 tpd ROM (assuming a 25% in-situ dirt content) as per current high capacity longwall specifications for thick seam extraction. |
| Annual Retreat per Unit | 1,600 m | 1,550 m based on a top coal caving unit |
| Number of Units | 4 | 1 to 2 faces or 1 face and a continuous miner section to achieve 4 Mtpa |

IMC would recommend the use of top coal caving longwall faces extracting a controlled coal thickness commensurate with a maximum aquifer base strain of 10 mm per metre. This approach could address the issues of numbers of operational longwall units, overall production rate and continuity, as a single face mine, but needs to be part of a detailed integrated Life of Mine (LOM) plan.

**Continuous Miners**

FS indicates that continuous miners working pillar and stall may be appropriate for the low seam gradients in the southern area of the deposit. IMC would agree with this approach as this method provides flexibility and roof support where the pillars are left in tact.

### 1.3.3. Underground Mining Services

#### 1.3.3.1. Coal Handling

IMC agrees with the FS that the coal clearance systems within the mine should be via conveyor from the working faces and developments to the coal shaft or main drift conveyor, depending on the option to be adopted.

#### 1.3.3.2. Transportation

IMC agrees with the FS general description but it should be noted that everything has to be transported to and from the working points which comes at a time and financial cost. The efficiency of the transport process has the most significant effect on the mine operations and profitability. Each facet of the transport should be developed into an integrated plan to determine the system capacities.

### 1.3.4. Human Resources

FS Section 10.6 provides a general description of the overall manpower envisaged at various stages of the Project without any build up or detail of categories.

Bangladesh does not have a history of coal mining and only one operational colliery. It is therefore important that the Consortium develops a strategy for the education and training of all levels of mining expertise.

### 1.3.5. Coal Preparation

There is no direct reference in the FS to the coal processing proposed for the project except some in-situ quality data indicating that some of the coal may have coking properties and a comment that washery discard may be used for hydraulic fill.

IMC considers that almost certainly some form of coal preparation will be required, which will be dependent on the saleable production products and their specifications.

### 1.3.6. Underground Environment

#### 1.3.6.1. Methane Gas

FS explains the basic effects and potential hazards of methane gas associated with underground coal mining. IMC considers these comments to be very rudimentary but agrees that the mine should be classed as a “Gassy” or “Flameproof (FLP)” mine from the outset. It is know that the initial methane emissions prediction for Barapukuria indicated that only minimal amounts of methane would be liberated during longwall production. However, the practice has show more methane than originally anticipated, probably from neighbouring seams distressed during operations.

IMC recommends that the Consortium undertakes a similar analysis for the seams of the Khalashpir Project which includes all seams not just the target seams. This may require gas desorption data from newly drill borehole cores to be reliable.

#### 1.3.6.2. Spontaneous Combustion

FS provides some generalised comments about the occurrence of spontaneous combustion. IMC do not agree with some of these statements but are pleased to see that the concept of self ignition temperature has been explained and that a test has been undertaken on one of the Khalashpir seams, although it is not clear which one.

It is therefore recommended that further controlled tests are undertaken with freshly extracted and identified samples from each seam to internationally accepted test and storage procedures. In the mean time any mine planning should assume that all seams are a high spontaneous combustion risk.

#### 1.3.6.3. Air Temperatures

The FS does not discuss the underground temperatures likely to be encountered but, as experiences at Barapukuria have already shown, this will be a significant factor which could affect the mine operations.

#### 1.3.6.4. Ventilation System

FS describes the perceived ventilation requirements for the mine at various stages of its development and production. This analysis has adopted a prescriptive approach using Chinese regulatory norms.

IMC considers that this approach does not adequately address the main ventilation aspects of the developing mine. All these issues interact and IMC would recommend the application of computer network analysis to assist the design process.

## 1.4. Surface Facilities and Infrastructure

Surface facilities and infrastructure are not specifically dealt with within the FS. This is surprising because surface facilities and infrastructure costs associated with a mine will often approach 20% of the total capital investment.

### 1.4.1. Surface Site Location

The FS proposes access to the mine to the NW of the deposit. However, due to overriding underground considerations as described in the mining section of this report IMC recommends access on the eastern boundary of the reserve as shown in Figure 5-1.

### 1.4.2. Site Layout

The IEA submission includes a surface layout based on the Barapukuria Surface facilitates are listed in the environmental and financial sections of the FS but not quantified in scope or provision.

The FS study is based on the Barapukuria Project which caters for all eventualities. Many of these facilities have proven to be unnecessary. IMC recommend that a minimalistic approach be adopted for Khalashpir and limited to only those facilities necessary for production and development activities.

IMC has prepared a conceptual sketch layout is provided in Figure 5-2 to illustrate the principle design consideration to be addressed at the next stage of project development.

### 1.4.3. Shaft Location

Shaft locations will be substantially be determined by underground considerations. There would appear to be no constraints to preclude the alternative site location postulated by IMC.

### 1.4.4. Surface Structures

Various options are available for the main structures which are not addressed in the FS but IMC has included the following on its conceptual layout.

- Shaft Winding Systems
- Fan House and Drift
- Coal Clearance
- ROM Coal Handling and Process Plant
- Materials Supply
- Workshops
- Surface Transportation
- Electrical Substation and Standby Generator Plant
- Mine Main Access Road

### 1.4.5. Land Development and Drainage

FS proposes that the existing site will be lifted by 1.5 m above maximum flood level. However, no analytical data is provided to justify this choice. In practice land development height may depend on ensuring adequate drainage falls from the mine to the tributary outfall SW of the site.

## 1.5. Environment

### 1.5.1. Regulatory Framework

#### 1.5.1.1. Environmental Management Plan

The FS includes a number of very important commitments referring to EMP, monitoring, reclamation and rehabilitation. Details are left to an Environmental Impact Assessment (EIA), which the Consortium is required to submit to obtain the final Environmental Clearance Certificate (ECC). The proposed ToR are generally compliant with international standards e.g. the “Equator Principles”.

It is common international practice to consider the environmental and social impacts of any project in three separate stages:

- Construction
- Operation
- Closure

Impacts, monitoring and mitigation measures to be incorporated into the EMP vary to during these stages. It is recommended to separately identify the impacts and EMP for the three different Project stages.

#### 1.5.1.2. Land Register and Inventory

IMC recommends the establishment, as a separate Project document, of an official land register which is kept in the locality. This register and inventory data base shall be acknowledged as baseline for future assessment of damage and fair compensation.

#### 1.5.1.3. Surface Fire Fighting Plan

The Consortium is required to describe emergency plans for fighting fires at the planned coal stocking yards as part of the EMP or Health & Safety plans.

#### 1.5.1.4. Cumulative Impacts

IMC recommends that the Consortium should consider in its EIA and risk analysis any likely impact of a mine mouth power plant should it be built. Special attention should be given to cumulative impact of:

- Air
- Noise
- Water
- Traffic
- Socio-economic conditions

### 1.5.2. Observations and Comment on Environmental Submission

#### 1.5.2.1. Site Selection

IMC site visit did not indicate any obstacles which would render Option 1 a less or more suitable alternative from an environmental perspective. IMC views on the preferred criteria for site selection are substantially governed by mining considerations.

#### 1.5.2.2. Responsibilities and Public Participation

The FS is fairly specific on this subject and states:

*"The mine will have a separate environmental department to look after all these issues and also to liaise with the local population to consider problems threatening the environment in and around the mine"* IMC recommends that this Consortium proposal is made a condition of any permit approval.

#### 1.5.2.3. Land Surface Monitoring

The Consortium shall propose a detailed topographic survey and regular monitoring program, initially based on area and magnitude of subsidence forecasted and risks involved. The preliminary topographic monitoring program shall be adapted in accordance with reasonable requirements once Project specific experience becomes available.

IMC recommends that this baseline plan should form the basis for subsidence prediction, compensation and or re-settlement requirements.

### 1.5.3. Hydro-Geological Observations

#### 1.5.3.1. Baseline Data

IMC suggests that the Consortium is requested to obtain the necessary baseline data during the EIA process which could be considered in the EIA scoping agreement between DoE and the Consortium.

#### 1.5.3.2. General Hydrogeology Description

The FS contains a number of fundamental statements on the general hydrogeological situation, without providing back-up evidence.

The text widely quotes Dupi Tila above the target coal seams as a major aquifer and the Gondwana formation below as a significant second aquifer without providing any hydraulic data on the latter. The groundwater hydraulics of the formations below the target seams need to be clearly understood for mine safety and drainage.

IMC considers that the Dupi Tila Formation is the only regional aquifer in the area. The lower formations have apparently significantly lower hydraulic conductivities and should not be addressed as aquifers.

#### 1.5.3.3. Hydrogeology Report – FS Annexure C

A summary of this report is included in FS. Additionally, hydrogeological investigations and regular monitoring need to be undertaken in all geological formations including the Gondwana formation below the target coal seams.

IMC recommends that if well installations and present conditions allow, pump tests in the wells GTB-1 and GTB-10 should be repeated for the Surma and Gondwana Groups.

#### 1.5.3.4. Groundwater Quality

The FS does not contain any groundwater analysis and states that there is no need for any quality testing but IMC considers this to be incorrect. It is a standard requirement for any mining project to provide some baseline groundwater quality data.

#### 1.5.3.5. Acid Mine Drainage

Internationally, AMD is an important topic in FS and EIA reports on mining projects. The Supplementary Information gives some general description on AMD and potential mitigation measures. There is no specific evidence provided on AMD from the Khalashpir Project.

#### 1.5.3.6. Groundwater and Aquifer Handling

The FS does not provide adequate information on the methods and quantities of groundwater handled by the Project and should be rectified.

**Effects of Subsidence on Groundwater**

The FS gives some general descriptions, possible effects and some general but important commitments on monitoring and compensation are made. Any FS and EIA of international standard needs to be specific about the impacts expected by subsidence and the mitigation measures applied in case the impact is found unacceptable.

IMC recommends that maps should be produced by the Consortium showing the baseline and expected contour lines of subsidence for characteristic time intervals and that this baseline plan should also form the basis for subsidence compensation and or re-settlement requirements.

**Aquifer Recharge**

The aspect of aquifer recharge is not considered in the FS. The natural recharge by rainfall, surface waters and by irrigation is understood to be in an acceptable balance under present conditions.

**Treatment Procedure**

The FS is very general, there is some description that *"mine drainage water collected in the shaft bottom pump lodge will be continuously pumped to the mine surface to be settled and subsequently used either for local irrigation or to supplement the mine water supply."*

### 1.5.4. Mining Subsidence Impacts

The preferred mining option is underground longwall mining subsidence will be a major impact on the use of land within the extractable areas of the mine which is presently primarily dedicated to rice cultivation producing surplus yields.

The Consortium should address this issue very carefully during the EIA assessment and engage the local population and all stakeholders in open discussion to ensure that land owners and workers are fully informed at all stages of project development and implementation.

#### 1.5.4.1. Subsidence Mitigation

Subsidence mitigation by hydraulic stowing as suggested in the FS is impractical and has proven ineffective when used in conjunction with high production longwall operations.

IMC suggest that various measures may be investigated based on firm data obtained in the next phase of Project development to extend the period land can be used productively.

The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre.

#### 1.5.4.2. Re-settlement Plans

The FS acknowledges that some re-settlement would be required due to the mining activities.

IMC recommend that re-settlement plans are fully integrated with socio-economic mitigation measures.

### 1.5.5. Socio Economic Impact

A statement on expected impacts is not available from the FS documents. The new EIA Guidelines are very detailed on key socio-economic issues and impacts and require that census data should not be older than 5 years or adequate primary surveys need to be undertaken.

IMC recommend that the Consortium purchase all land likely to be affected by mining and supplementary land requirement for mitigation measures at project inception to ensure the Consortium's capability to manage and implement committed mitigation measures for which it is responsible and to prevent land speculation by persons from outside the area, a potential source of major dispute with local peoples.

### 1.5.6. Reclamation

There are no details about reclamation and compensation issues in the Project documents. Broad intent statements included in the FS indicate the willingness of the Consortium to *"to obtain best results through consensus decision wherever possible"* This is certainly a good basis but details need to be developed. Such solutions should be considered at Project inception stage and financial provision made for implementing the closure plan.

## 1.6. Financial Evaluation

This FS evaluation has followed the Project Proforma (PP) approach to project evaluation but IMC considers that there are two basis issues which cause concern:

- Phased costs and cashflows are not referenced to an implementation or phased mining plan; and
- There is very little detail or justification of the costs used.

### 1.6.1. Capital Investment Programme

The FS capital investment has been built up from a limited number of cost categories with little supporting detail. IMC has prepared a series of capital expenditure template tables, in Appendix 4, showing the approach that would be expected at feasibility study level for a capital expenditure build up.

IMC would recommend that the capital investment and sustaining capital schedule be reviewed and updated adopting this approach. Once the absolute values have been established within the acceptable error margins for a feasibility study they should be phased in accordance with a:

- Project implementation programme; and
- Phased mining plan with a LOM production / development schedule.

### 1.6.2. Operating Costs

The FS operating costs used in the financial evaluation have the same deficiencies as the capital expenditure, basically there are:

- No explained calculations or a justified basis for the operational cost values used, which are only summary values without any build up detail
- No phased mining plan with a LOM production / development schedule to justify the operational cost phasing.

### 1.6.3. Financing

IMC would have expected the Project financing to be either outside the scope of a project feasibility study or if included the financing structure should be explained in detail.

### 1.6.4. Financial Evaluation

It is difficult to comment on the efficacy of the financial evaluation until all the recommendations described throughout this Report are implemented and a reliable LOM Project cashflow is available. However, IMC has made comments about some individual key values used in the FS financial evaluation.

## 1.7. Conclusions

IMC has come to the following conclusions from its FS review:

- There are fundamental geological data issues that must be addressed before progress can be made towards establishing realistic and financially viable mining and business plans;
- Additional exploration by surface drilling is required which must be undertaken to JORC standards;
- Analysis indicates that some of the coal sampled could have metallurgical coking properties and should be re-tested from fresh samples;
- The Khalashpir coal deposit could not be extracted by opencast methods;
- Underground mining would be the preferred method of coal extraction for a deposit of the Khalashpir specification, particularly with respect to the surface environmental and social considerations;
- Once the ROM production is defined the Consortium should evaluate the life of mine costs from a production capacity, ventilation (mine temperature) and spontaneous combustion management view point;
- Life of mine costs should be developed for the option of locating the pit bottom, either shaft or drifts, at the lowest part of the basin close to where the major faults converge on eastern boundary of the resource;
- FS production design parameters are out of date with respect to current longwall technology or inappropriate to meet the overall production targets and IMC has made more realistic alternative suggestions;
- The use of top coal caving longwall faces extracting a controlled coal thickness commensurate with a maximum aquifer base strain of 10 mm per metre could address the issues of numbers of operational longwall units, overall production rate and continuity, as a single face mine, but needs to be part of a detailed integrated LOM plan;
- Almost certainly some form of coal preparation will be required, which will be dependent on the saleable production products and their specifications;
- Spontaneous combustion and air temperatures are likely to be the dominant underground environmental issues, which interact and IMC would recommend the application of computer network analysis to assist the design process;
- Surface facilities and infrastructure costs associated with a mine will often approach 20% of the total capital investment;
- It is common international practice to consider the environmental and social impacts of any project in three separate stages:
    - Construction
    - Operation
    - Closure;
- Consortium should have a separate environmental department to look after all relevant issues and also to liaise with the local population to consider problems threatening the

environment in and around the mine, which should be a condition of any permit approval;

- The Dupi Tila Formation is the only regional aquifer in the area. The lower formations have apparently significantly lower hydraulic conductivities and should not be addressed as aquifers;
- The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre;
- Mining subsidence impacts should be addressed during the EIA assessment and engage the local population and all stakeholders in open discussion to ensure that land owners and workers are fully informed at all stages of project development and implementation;
- The Consortium should purchase all land likely to be affected by mining and supplementary land requirement for mitigation measures at project inception to ensure its capability to manage and implement committed mitigation measures for which it is responsible;
- An east Asian based marketing study is required to establish the optimal proceeds prices and mix for the various saleable products likely to be produced once the qualities are understood; and
- It is difficult to comment on the efficacy of the financial evaluation until all the recommendations described throughout this Report are implemented and a reliable LOM Project cashflow is available.

### 1.8. Draft Report Presentation, Discussion and Resulting Documentation

A draft of this report was presented to HCU by IMC. Additional documents generated as a follow on to that presentation and the subsequent discussions are reproduced as Appendices of this Report as follows:

| | |
|---|---|
| Appendix 5 | Questions and Observations of HCU on IMC Presentation with Summary Responses from IMC |
| Appendix 6 | Recommendation Matrix |
| Appendix 7 | Standards Appendix including comments on DoE's EIA Guidelines |

# 2.0 INTRODUCTION

Government of the People's Republic of Bangladesh Energy and Mineral Resources Division, Hydrocarbon Unit ("the Client" or "HCU") has commissioned IMC Group Consulting Ltd ("IMC") to review "The Techno-Economic Feasibility Study of Khalashpir Coal Mine" ("FS") prepared and submitted to HCU by the Hosaf International Ltd, Shandong-Ludi, Xinwen Mining Group Consortium ("the Consortium") and prepare a Review Report ("the Report") in accordance with an agreed scope of works.

## 2.1. Scope of Works

In view of development of Khalashpir Coal Mine, a consultant will be engaged to review the Techno-Economic Feasibility Study report for the preparation of a complete "Review Report" consisting of the comments, suggestions, recommendation, etc. The Scope of Work includes the following elements but not limited to:

i. Mine design as proposed in the study considering the geological structure of the mine;

ii. Technical & commercial viability of mining proposal;

iii. Reasons for selecting underground mining method;

iv. Underground mining services (transportation, coal handling system etc.), mine ventilation system (ventilation, dust control etc.) and related issues (methane gas handling, spontaneous combustion aspects, fire fighting arrangements, mine rescue plan etc;

v. Surface effect of underground mining;

vi. Environmental Management Plan (EMP) including re-settlement plans (if arises land subsidence issue);

vii. Groundwater handling procedure/ aquifer handling method and also recharge the aquifer, if necessary

viii. Treatment procedure of discharged mine water;

ix. Socio-economic impact on the entire area due to mining;

x. Reclamation procedure and compensation issues; and

xi. Cost, Investment Plan and financial analysis of the project as proposed in the study.

The review has consisted of a country and site visit $14^{th}$ to $18^{th}$ June for meetings with HCU officials and various stake holders, to familiarise IMC with the Project and its location, together with a desk study of the following documents provided by the Client.

- Techno-Economic Feasibility Study of Khalashpir Coal Mine Project, July 2006, Vol. 1 – 3;
- Initial Environmental Examination (IEE) of Khalashpir Coal Mine Development Project, 16 May 2006 (Photocopy);
- Supplementary Information on Techno-Economic Feasibility Study of Khalashpir Coal Mine Project, 23 August 2006 (Photocopy);
- Further Information on Techno-Economic Feasibility Study of Khalashpir Coal Mine Project, undated (Photocopy);

- The Mines and Minerals Rules, 1968 incl. Amendment, November 1989 and Amendment, December 1995 (Photocopy);
- Approval of Exploration license by the BMD (Photocopy) 03 June 2004;
- Land handed over certificate to HOSAF by the BMD, 17 March 2004;
- Contract between Government of Bangladesh and Consortium of HOSAF International for exploration of coal in Khalashpir, 22 January 2004;
- Grant of exploration licence to HOSAF, for the area comprising 2,500 hectares of land, Khalashpir by the BMD, 11 October 2003;
- Approval of exploration license by the ministry of Energy & Power to HOSAF International, 11 October 2003;
- Acceptance of Exploration license for Khalashpir by the HOSAF International, 15 October 2003;
- Submission of application for Granting of Exploration and Mining Lease by HOSAF International, 08 September 2003;
- Application form for Exploration Licence submitted by HOSAF International,
- 07 September 2003;
- Geological Drill Hole Log GTB-7; and
- Geological Drill Hole Log GTB-17.

Following the country and site visits a brief inception report was submitted to the Client on 18th June 2009.

## 2.2. Project Description

The Khalashpir coal deposit is located in NW Bangladesh, some 50 km south of Rangpur and approximately 300 km north of the capital, Dhaka. The area is flat-lying and the land use is primarily agricultural with rice as the principal crop. Small villages are distributed across the deposit.

GOB has granted exploration license to the Consortium, in early 2004, who has undertaken a topographical survey, two dimensional (2D) and three dimensional (3D) seismic surveys, exploratory drilling and hydrogeological tests utilising Indian, Chinese and North Korean expertise. Various laboratory tests have been executed on the core samples both in Bangladesh and abroad.

The Consortium has prepared the FS Report which addresses the extraction of a number of target coal seams forming a coal basin which lies at depths from 239 m to 485 m below the surface and averages a composite thickness of 45 metres.

The intended use for the extracted medium volatile coal is for electricity generation in local power station(s) yet to be built.

# 3.0 GEOLOGY

This geological review of the FS of the Khalashpir Coal Mine Project is based primarily on a UK-based desk-top study of documents submitted by the Consortium.

## 3.1. Exploration History

The existence of coal at Khalashpir was confirmed in 1989 following the completion of four boreholes by the Geological Survey of Bangladesh (GSB). Three of the four holes encountered coal seams, some of which are of potentially mineable thickness.

In 2004, Hosaf International Ltd was awarded the exploration licence for the prospect and contracted Geotech-India to undertake additional cored drilling to further evaluate the deposit. To date a total of fifteen (15) boreholes have been completed by Geotech giving a total of nineteen for the whole prospect.

IMC understands that no geophysical logging has been undertaken in any of the boreholes drilled to date.

In 2005, a contract was awarded to Geo-Mineral Engineering Co. Ltd (Shandong, China) to undertake 2D and 3D surface seismic surveys of the Project area.

Coal quality data on drill core sample analysis was obtained by GSB from the initial three boreholes. Subsequent to this, it appears from the FS that quality data is restricted to one sample of Seam II from GTB-1 borehole.

## 3.2. Comment on Geological Findings

### 3.2.1. Exploration Boreholes

The data submitted in the FS is limited and constrained for the following reasons:

- No geophysical logging has been undertaken in the boreholes completed thus far, and therefore no validation of coal seam thickness and depth can be made; and
- Analytical coal quality data is extremely limited, and cannot be used to assist in detailed seam correlation.

IMC has received AutoCad files of the conceptual mine plans for Seams I, II and IV as well as lithological and graphic logs of all boreholes completed to date. However, the surface locations of the boreholes as given in FS (Volume 3) report do not correspond to those shown on the conceptual mine plans for the three target seams as provided in AutoCad format. IMC considers that the locations of the boreholes as shown in the borehole logs are probably reliable, but at this time cannot reconcile them with the Autocad mine plans, which use a different local grid system. Further work will be required to achieve a standard grid, whether it is a local grid system (as at Barapukuria), or more appropriately a grid based on the national system.

For the purpose of this review, and to expedite the process, IMC has used the plan borehole locations as shown on the conceptual layout for Seam I in order to establish a database from which to generate preliminary computer models of total seam thickness, coal thickness, floor of seam levels and inter-burden variation.

### 3.2.2. Tectonic Structure of the Deposit

The Khalashpir coal deposit is formed in an asymmetric synclinal basin with an axial NW-SE strike. 2D and 3D surface seismic surveys were undertaken over the prospect in 2005, and their results have determined the major tectonic structure of the basin. Examination of the seismic profiles shows that generally, a good quality of data has been acquired, but that sequence of the coal seam stratigraphy is likely to be variable across the project area (Section 3.2.3).

The western limit of the deposit is formed by the successive subcrop of the seams beneath the uncomfortably overlying Miocene / Pliocene Surma Formation.

Seven normal faults have been identified by the seismic surveying, trending generally sub-parallel to the NW-SE synclinal axis. The three largest faults, designated F1, F3 and F6 in the FS are interpreted with maximum vertical displacements in excess of 50 m, although it is reported that the major F1 fault at the centre of the prospect area has a displacement of approximately 90 m over part of its strike length.

These major fault discontinuities effectively subdivide the prospect into four discrete blocks for the purpose of resource estimation and the preparation of a conceptual mine plan (Section 3.3).

Other subordinate faults have been interpreted with varying displacements up to 50 m, although the resolution of the 2D seismic surveying, given the uncertainty of the stratigraphy and the unreliable drill hole records cannot be assured.

For the purpose of formulating a conceptual mine plan of the prospect, with the exception of the major structures (F1, F3 & F6), it must be assumed that vertical displacements are interpreted. Experience at the Barapukuria Coal Mine within a similar tectonic and sedimentary environment has shown that certain faults indicated by surface seismic have not been encountered underground, and conversely, faults that have remained undetected by the seismic surveys have seriously disrupted mining operations.

As a "rule-of-thumb", experience in Bangladesh and indeed worldwide has shown that with optimum quality data and using dynamite sources, the vertical resolution of 2D seismic is of the order of 10 m. 3D seismic surveying in optimum conditions increases the resolution such that structures as small as 5 m displacement may be identified.

However, the surface stratigraphic formation is integral to the resultant resolution of any surface seismic survey. Poorly consolidated sands and gravels invariably reduce data quality, whereas the presence of tight clay or mudstone at the surface enhances it. The presence of the poorly consolidated Dupi Tila formation very close to the surface over the entire prospect area is, however, likely to have adversely affected the data quality and resolution obtained.

### 3.2.3. Stratigraphy and Coal Seam Correlation

Detailed correlation of the coal seams remains problematic. The original GSB exploration proposed a succession of coal seam horizons within the Permian Gondwana sequence in descending order and designated Seam I to Seam VIII. This correlation nomenclature has been continued for the latest GTB generation of exploration, although the graphic logs presented in the FS clearly demonstrate that the correlation is not as straightforward as a simple sequence of eight seams, but that rapid seam splits and unions occur within all groups of seams across the entire prospect, resulting in rapid coal and interburden thickness variation.

It would appear, therefore, that the sedimentary environment of coal deposition at Khalashpir was complex, and occurred in a fluviatile or deltaic system with rapidly migrating water courses, in a variable climatic regime. The petrographic descriptions of the coal horizons contained within the borehole logs are not particularly detailed, but it would appear that two distinct coal types predominate:

- Banded bright vitrainous and dull durain with subordinate thin fusainous horizons; and
- Mostly homogenous, unbanded dull, generally dirty or inferior coal with common eroded inclusions of sandstone, siltstone or mudstone.

It seems probable that the banded, apparently undisturbed coal type represents in-situ (as deposited) coal seam(s). In contrast, the homogenous dull coal with inclusions of detrital material of sandstone etc has been eroded or “washed out” from its original depositional location and re-deposited elsewhere.

Borehole records as examined generally do not specifically differentiate between these coal characteristics. Frequently the coal descriptions simply refer to the previous description of the overlying seam.

In-seam dirt horizons are listed within the logs in terms of their top and bottom depths, although this does not generally provide sufficient data upon which to correlate the seam splits.

A very important consideration is that the paucity of analytical data does not allow a more detailed attempt at seam correlation from the chemical and physical coal properties.

In other coalfields worldwide, the geophysical and chemical profiles of a coal seam are essential tools to establish a confident correlation of the seams and their component leaves in a splitting and reuniting depositional environment. These tools cannot be applied at Khalashpir with the current level of data.

Should the premise that the dull, homogenous coal horizons are concluded to be derived, their stratigraphic correlation with the in-situ coals would be almost impossible. Erosion and subsequent deposition of the in-situ coal seams could have occurred at any time or location throughout the Gondwana era. The eroded coal will most probably have been deposited over laterally limited areas in shallow lacustrine environments and therefore be lenticular and discontinuous in disposition within the Gondwana succession.

### 3.2.4. Coal Quality

Coal seam core samples from the initial GSB boreholes, GDH-45, GDH-46 and GDH-47 were analysed for the chemical and physical parameters normally investigated. These results are given in the FS Report in Table 15 (pages 132 to 133), and summarised in Table 11 (page 128). The horizons of the each sample are identified in the report, although they have been averaged over the whole seam. No detailed sub-section analyses have been provided that could be a major aid to seam correlation.

Coal quality data from the GTB (Geotech) generation of exploration is limited to Seam II in borehole GTB-1 (FS Section 5.8.3p). The results of the analysis are presented as Tables 12, 13 and 14 (pages 129 to131). The information supplied does not specify the horizon of origin of the samples, and therefore cannot be used to assist seam correlation.

These results also indicate that some of the coal sampled could have metallurgical coking properties. IMC recommends that this possibility is explored further with a number of isolated samples taken from new cores or re-sampling the existing cores, if the origin of the samples can be unquestionably verified. This could have a significant affect on the classification of the market products available and needs to be established at an early stage of the detailed feasibility analysis.

### 3.3. Resource Estimation

The existence of a substantial coal deposit at Khalashpir has been established beyond doubt. However, the methods of its exploration and subsequent evaluation are subjects of concern. In particular, the lack of geophysical downhole logging to verify field records, and the lack of reliable coal quality data from the GTB generation of exploration leads IMC to conclude that at this stage, a realistic conceptual mine plan would be difficult to formulate.

IMC has utilised seam thickness and depth data as included in the FS to establish simple preliminary computer models of the three principal and target coal seam horizons (Seams I, II & IV), together with models of the interburden thickness. No attempt has been made to manipulate the data as supplied, but the object was to establish any obvious miscorrelation of the coal seams. These would be identified by closely-spaced concentric contours (“bulls-eyes”) around one or more borehole(s). These models are in Appendix 2 as Figures 1 to 12.

The preliminary models confirm that correlation problems remain within the project area, and that these should be further investigated.

The FS Report (pages 134 to 137) describes the estimation of “Reserves”. In consideration of the remaining uncertainty of the seam correlation, the reliability of the borehole data and un-demonstrated economic extractability, at this time the Khalashpir deposit should be regarded as a “Resource”. Until such time as confident mining and business plans are established, reference to “Mineable Reserves” should be avoided.

Based on the coal thickness data supplied in the FS Report, and subdividing the prospect area into the four blocks as delineated by the interpreted structure, IMC has conducted a preliminary estimate of the potential resource in Seams I, II and IV, as shown in Table 3-1 below. Plans of the resource areas in each seam are contained in Appendix 2 as Figures 13 to 15.

**Table 3-1 Preliminary Resource Estimate, Seams I, II & IV**

| Resource Block | Seam I | | | Seam II | | | Seam IV | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (hectares) | Average Coal Thickness (m) | In-situ Resource (Mt) | Area (hectares) | Average Coal Thickness (m) | In-situ Resource (Mt) | Area (hectares) | Average Coal Thickness (m) | In-situ Resource (Mt) |
| 1 | 335.99 | 4.00 | 17.74 | 410.77 | 12.00 | 65.07 | 449.15 | 6.00 | 35.57 |
| 2 | 247.85 | 14.00 | 45.80 | 248.13 | 18.00 | 58.96 | 247.89 | 18.00 | 58.90 |
| 3 | 63.25 | 5.00 | 4.17 | 56.63 | 6.00 | 4.49 | 63.53 | 12.00 | 10.06 |
| 4 | 112.99 | 6.00 | 8.95 | 117.99 | 8.00 | 12.46 | 114.62 | 10.00 | 15.13 |
| **Seam Totals** | | | **76.67** | | | **140.97** | | | **119.66** |
| | | | | | | | | **Total Seams I, II & IV** | **337.30** |

The FS Report (Table 17, page136) estimates the total in-situ “reserves” in Seams I, II and IV as some 277 Mt. The IMC preliminary assessment has utilised total coal thickness as indicated in the FS Report in the tonnage quantification. As stated above, the three principal target seams are all subject to rapid splitting, and therefore there will be a high proportionate loss in the potential mineable fraction of the in-situ resource.

## 3.4. Recommendations for Further Geological Investigation

Based on the above, there are fundamental geological issues regarding the Khalashpir deposit that must be addressed before progress can be made towards establishing realistic and financially viable mining and business plans.

**Exploration**

- Additional exploration by surface drilling should be continued. This should be carried out by a reputable and proven drilling contractor with modern and well-maintained equipment who are qualified to operate to JORC standards.
- Previous boreholes that yielded unacceptable levels of core recovery (GTB-2) should be re-drilled.
- A focus should be applied to areas of particular concern where correlation issues have become apparent from the preliminary modelling of the coal seams.
- There are surface constraints to locating boreholes in the area, due mainly to access and the distribution of villages. A formal exploration program can only be finalised taking account of these factors.
- Any additional exploration must be carried out to internationally accepted standards such as JORC, utilising downhole geophysical logging in every hole. The suite of geophysical logs should include:
    - Natural Gamma Ray
    - Gamma-Gamma
    - Density
    - Calliper
    - Temperature

**Analysis**

Samples should taken, logged and prepared in accordance with the JORC principles and supervised by a JORC accredited senior geologists.

Analysis should be undertaken by at least two accredited international laboratories observing the standard rules of analysis by including:

- Standard samples;
- Repeats; and
- Dummies.

Suitable samples should be tested to establish seam by seam:

- Geological identification;
- Quality, proximate and ultimate analysis;
- Coking properties;
- Washability;
- Self ignition temperatures; and
- In-situ methane contents.

**Interpretation**

A full sedimentological study and seam mapping exercise must be undertaken of all available exploration data in order to increase mining confidence in the seam correlation and continuity.

This would initially involve the construction of detailed seam profiles including all in-seam dirt partings and their lithologies. The progressive subcropping of the seams beneath the Surma Formation to the west of the project area as identified by the seismic survey must be taken into account in this correlation exercise.

Only after a confident correlation has been established, can a meaningful computer model be generated.

The completed surface seismic surveying does confirm the basic structure of the deposit, although vertical resolution below 10 m cannot be assured. The variable nature of the reflective horizons indicates rapid lateral sedimentary changes within the Gondwana formation.

Coal quality proximate analyses must be undertaken as standard on all exploratory drill hole coal core samples to establish computer models of the following quality parameters:

- Ash content
- Calorific value
- Sulphur content
- Moisture content
- Volatile matter
- Fixed Carbon

## 3.5. Geological Criteria for Generic Mine Design Considerations

Full cognisance must be given to the experience gained to date at Barapukuria, the first underground coal mine in Bangladesh. Whilst the sedimentology and structure of Barapukuria is different to that of Khalashpir, a common factor is the presence close to the surface of a major aquifer in the Dupi Tila Formation. This will be a major factor in the design of a new mine at Khalashpir. A serious inflow of water at Barapukuria halted development works for many months during its early construction period and every effort should be made to avoid a repetition of such an occurrence at Khalashpir.

# 4.0 MINING

## 4.1. Mining Approach

Section 6 of the FS initially has a generalised comparison of the two basic approaches to mining a deposit like Khalashpir, through advantage and disadvantage tables.

- Opencast
- Underground

Unfortunately, some of the assumptions used in these evaluation tables and the basic method description are flawed but still come, in IMC's opinion, to the correct conclusion that the underground mining approach should be adopted.

### 4.1.1. Opencast Mining

Not all deposits can be opencast mined, especially a low value bulk product like coal. Examples of some of the world's largest opencast mines are shown in Table 4-1 below.

**Table 4-1 World's Large Opencast Mines**

| Mine | Country | Commodity | Depth (m) | Diameter (km) | Area ($km^2$) |
|---|---|---|---|---|---|
| Cerrejón | Columbia | Coal | 300 | 4 | 12.6 |
| Korkinsk | Russia | Coal | 700 | 2.9 | 6.6 |
| Hambach | Germany | Lignite | 400 | 7.3 | 42 |
| Nchanga | Zambia | Copper | 400 | 2.6 | 5.7 |
| Phalabora | South Africa | Copper | 450 | 2 | 3.1 |
| Jagersfontein | South Africa | Diamonds | 213 | 0.54 | 0.2 |
| Khalashpir | Bangladesh | Coal | 455 | 3.99 | 12.5 |

If the Khalashpir coal deposit was extracted by opencast methods it would rank amongst the deepest open pits in the world for all commodities and probably become the deepest operational open pit coal mine. It should also be noted to extract the deepest target seam a void approximately 4 km in diameter occupying a surface area of 12.5 $km^2$ would have to be created.

IMC agrees with the FS comments about the environmental and social unacceptability of opencast operations which, would be a major hurdle to the Project as already demonstrated with the recent Phulbari coal mine project.

### 4.1.2. Underground Mining

Underground mining would be, in general terms, the preferred method of coal extraction for a deposit of the Khalashpir specification, particularly with respect to the surface environmental and social considerations.

The technical considerations of seam depth and the overlaying Dupi Tila aquifer would also lead to the underground mining approach.

#### 4.1.3. Mining System Selection

IMC does not agree with the generalised statement in the FS "Opencast mining….involves high investment and operational costs. Underground mining on the other hand….its investment costs are relatively low compared to open cast mines". In general terms IMC would consider the investment and operating cost to be the opposite way round when comparing the two mining methods.

It is likely that the FS draws this conclusion from Table 20 where the Phulbari capital and operating costs are not typical for this type of operation.

The critical factors for rejecting the opencast approach centres on the:

- Stripping ratio associated with 455 m depth of seam IV;
- Excessive void dimensions; and
- Excessive volumes of water to be continually pumped from an exposed Dupi Tila aquifer.

IMC agrees with the selection criteria and the conclusion to select an underground mining approach as stated in Section 6.2 of the FS. However, the logic is stated with very little backup detail and without reference the respective economics of the two systems.

### 4.2. Mine Design

A mine design has to be established around a number of complementary criteria:

- Deposit geology;
- Deposit structure, faulting and coal seam specifications;
- Expected production;
- Projected underground environment; and
- Surface curtilage location options and accessibility.

As explained in the Section 3.0 (geology) of this report IMC consider that the interpretation of the deposit geology is currently uncertain without further work. Consequently, the appraisal and comments in the following sub-sections must be taken as generic unless otherwise stated.

#### 4.2.1. Mine Access

##### 4.2.1.1. Methods

The two methods of entry described in Section 7 of the FS which relate to underground mining are drifts and shafts. Each of these methods have their advantages and the FS does not provide an evaluation and logical conclusion.

**Shaft Features**

- Skip winding is a batch process and can impose a production capacity constraint;
- Depending on diameter, ventilation quantities and pressures can be compatible with underground temperature and spontaneous combustion management.

**Drift Features**

- Conveying is a continuous process and may be more compatible with the projected production capacity;
- The cross sectional area of even a large drift may impose a constraint ventilation quantities and pressures which may not be compatible with underground temperature and spontaneous combustion management.

Table 4-2 below shows the indicative production capacities for a shaft with twin 20 t skips and a 2,000 tph steel cored drift belt, where the drift belt has a significantly higher capacity in excess to the 4 Mtpa saleable production target.

**Table 4-2 Indicative Production Capacities**

| | Availability (%) | Tonnes per Skip/Hour | Winds per hour | Hours per day | Daily (t) | Annual (t) |
|---|---|---|---|---|---|---|
| **Skip Shaft** | 90 | 20 | 31 | 18.6 | 10,363 | 3,782,443 |
| **Drift Conveyor** | 90 | 1,500 | | 19 | 25,650 | 6,669,000 |

Whereas the FS dismisses the use of drifts on the grounds of the length of freeze required to drive through the Dupi Tila aquifer IMC considers that the production capacity of the mine, especially at the enhanced 4 Mtpa may be better served with continuous drift conveying. It is likely that once the seam correlation is addressed that the Run of Mine (ROM) production to achieve a saleable production of 4 Mtpa may be significantly higher.

IMC recommends that once the ROM production is defined the Consortium should evaluate the life of mine costs of the following options from a production capacity, ventilation (mine temperature) and spontaneous combustion management view point:

- Two shafts at least 8.5 m diameter
- One 8.5 m diameter shaft and one 25 $m^2$ drift
- Two shafts at least 7.5 m diameter and one 20 $m^2$ drift

### 4.2.1.2. Pit Bottom Depth and Location

The FS indicates that the pit bottom is located at -370 m and outside the coal basin area based on a number of specified surface and underground factors and the use of horizon mining. Whereas IMC agree with these factors consideration should be given to the experiences of Barapukuria where strata water control and extensive inclined track and dip roadways have been critical.

Currently the faulting and general basin structure are the known quantities and IMC would recommend that life of mine costs be developed for the option of locating the pit bottom, either shaft or drifts, at the lowest part of the basin close to where the major faults converge and in the FS proposed vicinity of the deep water sump, as shown in Figure 5-1.

This could have the following advantages but the economics must decide:

- Access to both sides of faults;
- Minimal pillar sterilisation;
- Gravity water drainage from the outset;

- True horizon mining with level access.

### 4.2.2. Underground Mining Method

The FS identifies a number of variations three mining methods:

- Pillar and Stall
- Longwall
- Hydraulic

#### 4.2.2.1. Pillar and Stall

Pillar and stall mining was used in the UK in many shallow deposits but gradually died out in most places in favour of longwall operations in the nineteenth and early twentieth century. It became the predominant method in the United States where conditions are much more appropriate. The method has also become highly mechanised and is used in many places in the world both in its mechanised and non mechanised form.

Pillar and stall operations in coal have certain limiting criteria.

- Depth.
- Seam gradient
- Gas emissions.
- Roof Conditions

Limiting depth is usually taken as about 450 m as a maximum, within the Khalashpir scope. In the US it is considered that the cheapest coal is produced not in primary operations but when depillaring is taking place.

Seam gradients are important particularly when mechanised operations are taking place. The best conditions are when the seam is flat or nearly flat. In more steeply inclined seams the practical mining limit can be increased by using such devices as lozenge shaped pillars. However, once again, stability can be a problem. Manoeuvring continuous miners on angles is also difficult.

The ventilation of pillar and stall operations is also difficult as there are numerous short circuit possibilities for the air. In high methane gas content coal it is not recommended.

IMC agrees that where the gradients are appropriate, near level, pillar and stall workings could be appropriate for Khalashpir.

#### 4.2.2.2. Longwall

By far the majority of coal produced from large mines in the UK and other major coal producing countries has been by longwall operations in recent years. The system has undergone continuous development for well over a hundred years and continues to do so. Modern mechanised longwalls are highly productive but the system is expensive in the initial capital outlay.

It has been used at depths of up to 1,300 metres, seam gradients of 1 in 1 (45°) and in extremely gassy conditions. It could be ideally suited to the conditions at Khalashpir in combination with pillar and stall operations.

Modern longwall systems have developed considerably since the proposals of the 1970's and 1980's. Improvements have seen outputs from faces increase so that single faces in the seam sections being proposed can produce over three million tonnes per year. Improvements include:

- Higher powered face conveyors thus allowing the coal winning machine to cut and load greater tonnages.
- Wider face conveyors allowing greater tonnages to be loaded.
- Larger chains are employed thus allowing for longer faces to be used. Faces of 350 m are common while in the 1970's face lengths of 200 m were considered to be the maximum.
- Coal shearers have higher powers and are much more reliable with less breakdowns and greater machine availability. All installations are now chainless for safety.
- Modern conveying systems away from the face also allow for higher loading rates.
- Face support design has been considerably improved with the shield type support offering much better face support so that seams considered unworkable in the past having been worked very successfully. Also the supports can advance automatically as the face coal getting machine passes through.
- Almost universally retreat longwall systems are employed thus allowing the face and coal winning machines to reach their true potential. Typically longwall faces that were being proposed in the 1970's were to advance at one metre per shift because of keeping up with roadway development. Current faces can be planned at four to five times this rate on retreat and with a longer face.
- The introduction of roofbolting for roadway support has allowed much increased development rates. In the 1970's advance rates of roadways for retreat faces was no better than about 30 m per week while today rates should be in the order of twice to four times that figure depending on the conditions and the equipment in use.
- This will be a new mine and flexible working should be proposed and agreed with the men at the very start. Because of capital costs the mine should work seven days per week.

The shearer has become almost the universal coal getting machine in medium to thick seams. It is usually all electric machines with the cutting heads driven electrically. They are robust and will cut stone such as when cutting in faulted ground. Typical cutting rates may be up to 10 m per minute in the coal sections being proposed so that whilst cutting these machines may be loading at over 2,000 tonnes per hour.

The FS details a longwall variant with multiple slices of the thicker seam sections taking 3 m cuts successively descending through the seam. The use of hydraulic fill has also been proposed to limit the subsidence effect on the base of the Dupi Tila aquifer and the surface. IMC would be sceptical about the effectiveness of hydraulic fill to control convergence which is likely to be expensive from a capital and operational cost view point. No detailed costs are provided in the FS to justify this approach. If the Consortium consider this method to be the preferred option IMC would recommend a more detailed evaluation including a phased mining and subsidence predication plan which is reflected in the Project cashflow.

The FS describes and Supplementary Document expands into more detail the use of longwall faces combined with sub-level or top coal caving as an efficient means of extracting the thicker and variable thickness target seams. IMC considers that this could be a valid approach which is referred to in more detail below.

#### 4.2.2.3. Hydraulic Mining

Hydraulic refers to the high pressure water monitors used to liberate coal from the seam. It has only limited application world wide and IMC agrees it is not appropriate for Khalashpir.

#### 4.2.2.4. Development

Longwalls are accessed by two systems world wide. Almost everywhere the retreat system is utilised where the panel of coal to be worked is blocked out by roads in the seam called gate roads. The face is then retreated back along these roadways. In the US instead of using single roadways there is a need, because of legislation, to use multi entry systems. This is because of a requirement of having second means of egress at all times. The US has much shallower mining than is common elsewhere and therefore this is a feasible mining system. Another variation is that used in Germany and in Russia where roadways are reused. This was used occasionally in the UK in shallower mines. It was used in Russia where there was a legal requirement until recently to utilise in theory 100% of the resource. This is no longer the case and the most profitable mines now utilise the system of inter-panel pillars. Roadways that are reused frequently cost more than twice those of single use roadways. Once they have been used for the first time they usually need extras support and repairs are usually necessary. It is also against regulations to reuse a roofbolted roadway in the UK.

IMC consider that the inseam gate roads should be supported using an active support system using roofbolting and the bolting of the sides. One complication is that in parts of the mine the strata will have a significant dip. To accommodate this it may be necessary to have trapezoidal shaped roadways with a horizontal floor but the roof cut to the dip of the seam to avoid “feather edges” which are difficult to secure.

When arched roadways were the norm development rates were considered good when straight line advances of 30 m per week were achieved. Straight line development rates in excess of 70 m are now regularly achieved in even the most arduous bolting conditions. Development machines have also been improved with downtimes much reduced and on board bolting machines employed. Continuous Miners originally developed for the room and pillar systems are frequently used. Where used they are used development rates in excess of 120 m can be achieved in straight drivage.

Roof bolting as a sole means of support was introduced in the UK with a high degree of monitoring and control that is open and available to be observed by every man at the mine it is now a safe and accepted system world-wide. The use of roofbolts also reduces the load on the mine transportation system as there is less weight and bulk of materials transported round the mine. At the face of the heading the materials are light and well within the capability of men to carry. Injuries such a back strains are very much reduced.

Roof bolting systems have reduced mining costs and allowed the industry to remain profitable in difficult times. IMC would support their use in gate roads at Khalashpir.

### 4.2.3. Khalashpir Design Parameters

The critical design parameters as seen by IMC are:

- Geological specification and continuity of the target seams, which is currently uncertain;

- In-situ coal qualities, which are currently uncertain;
- Overall and longwall unit ROM production targets;
- Number of production units;
- Development ratio; and
- Aquifer bed strain control.

#### 4.2.3.1. Production and Development

The FS indicates that the saleable production is projected to be initially 2 Mtpa increasing to 3 Mtpa in year 7 and 4 Mtpa by year 13, which is to be achieved from the production units shown in Table 4-3 below.

**Table 4-3 FS Production Schedule**

| | Annual Unit Production (Mt) | No of Units | Annual Production (Mt) |
|---|---|---|---|
| Longwall Faces | 0.840 | 4 | 3.36 |
| Continuous Miners | 0.414 | 1 | 0.414 |
| Developments | | | 0.264 |
| Total | | | 4.038 |

It should be noted that if the quality of the saleable Khalashpir coal proves to be similar that from Barapukuria then 4 Mtpa would be capable of sustaining 1.5 GW of power generation capacity or approximately 50% of the Bangladesh current demand. Unfortunately, the mine and presumably the power station(s) are in the north whereas the main demand is around the centres of population in the central and southern areas. IMC understands that the electrical distribution grid is currently being strengthened to respond to the new Barapukuria 250 MW power plant but significant further work would be required to support the Khalashpir project.

At 4 Mtpa Khalashpir mine would be a large mine by world standards and IMC recommends that the Project should be developed and evaluated as an integrated mine, power generation and distribution project capable of increasing the countries power capacity by 50%.

Section 9 (Mine Design) of the FS does not provide any:

- Project implementation schedule
- Production or roadway development schedules
- Phased production and development plans

These omissions make it virtually impossible to evaluate the operational and economic feasibility of the Project and characteristics of the developing subsidence effect on the base of the Dupi Tila aquifer.

However, IMC are able to make some generalised observations on some of the proposed FS operational parameters.

**Project Implementation Programme**

In the absence of a FS project implementation programme IMC has prepared a generic example of a similar mine using shaft access, which forms Appendix 3. It should be stressed that this is only an example and should not be used for detailed planning or financial evaluation purposes.

The programme demonstrates the various items IMC would expect to see in an implementation programme together with estimated task durations.

IMC has used their experience in the preparation of the programme which does not include any time contingencies. The programme shows the first face commissioning after five and a half years with a second face after six years. However, if any item on the critical path were to be delayed it would have a commensurate effect on these timings.

**Longwall Faces**

The key proposed design specification from FS shows the longwall configuration in Table 4-4 below. IMC consider these parameters to be out of date with respect to current longwall technology or inappropriate to meet the overall production targets and have made alternative suggestions based on the limited FS information currently available. These suggestions would need refining as more Project information detail is to hand.

**Table 4-4 FS and IMC Generalised Longwall Unit Specification**

| Parameter | FS | IMC (Suggestion) |
|---|---|---|
| Extracted Height | 3 m | Initially 3 to 4 m then up to seam height as determined by the developing subsidence profile of the aquifer base. |
| Panel Width | 120 m | 300 to 350 m as determined by the developing subsidence profile of the aquifer base. |
| Advance per Shear (web) | 0.6 m | 0.8 to 1.0 m as per current high capacity longwall specifications |
| Cutting and Loading Capacity | 700 tph | 2,000 tph as per current high capacity longwall specifications |
| Daily Production | 2,800 tpd | 13,300 tpd saleable, or 16,700 tpd ROM (assuming a 25% in-situ dirt content) as per current high capacity longwall specifications for thick seam extraction. |
| Annual Retreat per Unit | 1,600 m | 1,550 m based on a top coal caving unit |
| Number of Units | 4 | 1 to 2 faces or 1 face and a continuous miner section to achieve 4 Mtpa |

FS Section 9.5 describes the use of multi slicing the thicker seams at 2 to 3 m per slice supplemented by hydraulic stowing of waste areas to support the roof and alleviate convergence and the stain in the aquifer base. IMC agrees that the controlling factor for total extraction should be a maximum aquifer base strain of 10 mm per metre, it would question the:

- Support effectiveness of hydraulic fill;
- Ability to sustain a stowing system to service four longwall faces;
- Cost of stowing operations; and

- Ability to replace the longwall faces to achieve the required production rate and continuity.

IMC does not know of any longwall stowing operations at anywhere in the world that have been effective or sustained. There are many instances of stowing being included in mine designs but were quickly discontinued in the operational phase.

The FS postulates the re-use of gateroads, presumably to reduce the development drivage requirements. IMC considers that this is not practical, achievable or safe and is not compatible with the use of rock bolts for roadway support. A 4 Mtpa mine would be unsustainable without the use of rock bolts and the re-use of rock bolted gateroads is illegal under UK legislation, which also forms the basis of the impending Bangladesh regulations.

The re-use of gateroads also has ventilation and spontaneous combustion connotations as commented below in the relevant sections.

IMC would recommend the use of top coal caving longwall faces extracting a controlled coal thickness commensurate with a maximum aquifer base strain of 10 mm per metre, as shown in Figure 4-1 below. This approach could address the issues of numbers of operational longwall units, overall production rate and continuity, as a single face mine, but needs to be part of a detailed integrated Life of Mine (LOM) plan.

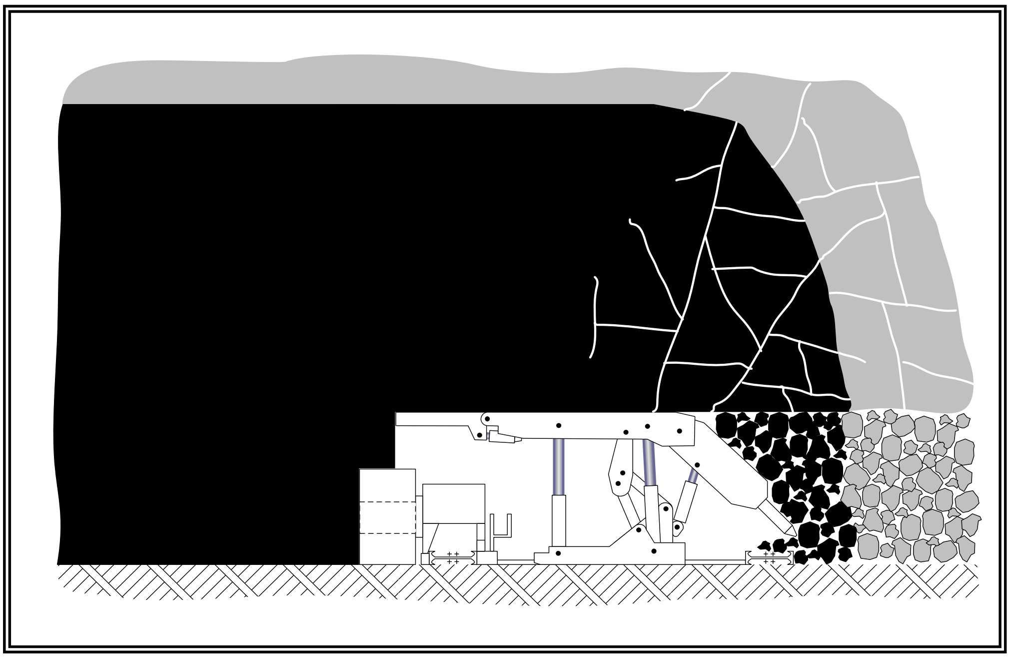

**Figure 4-1 Configuration of a Top Coal Caving Longwall**

Figure 4-2 below shows an example of a 5 m extraction longwall where all the coal is cut. This requires large and heavy powered supports and shearers which have to be moved around the mine during interface transfer.

**Figure 4-2 Example of a 5 m Extraction Longwall**

**Continuous Miners**

FS Section 9.6 indicates that continuous miners working pillar and stall may be appropriate for the low seam gradients in the southern area of the deposit. IMC would agree with this approach as this method provides flexibility and roof support where the pillars are left in tact.

However, extraction ratios are traditionally lower than longwall layouts with 25 to 30% without de-pillaring and 50 to 55% with de-pillaring.

The equipment specified for pillar and stall units in the FS has omitted rock bolting machines and feeder breakers which are essential parts of the operations and should be included in any evaluation update.

Figure 4-3 below shows an example of a continuous miner in a pillar and stall section. It should be noted that the machine is operated by remote control by a driver in a position of safety and that the cutting and support functions are separated by place changing ie cut and move with the bolter following behind.

**Figure 4-3 Continuous Miner in Pillar and Stall**

**Development**

The FS has orientated the longwall faces with the face lines on full dip and the gateroads close to strike which puts the main access roads on full dip as well. IMC agrees with this approach as it is the most common orientation for inclined seam extraction. The key proposed design specification from the FS shows the development heading in Table 4-5 below, which also includes IMC's suggested parameters for comparison.

**Table 4-5 FS and IMC Generalised Development Heading Specification**

| Parameter | FS | IMC (Suggestion) |
|---|---|---|
| Annual Face Retreat per Unit | 1,600 m | 1,550 m based on a top coal caving unit |
| Annual Face Retreat | 6,400 m | 1,550 m |
| Annual Development Rate per Heading | 2,116 m calculated giving 42.3 m per week average* | 1000 m based on 20 m per week average for planning |
| Annual Development | 19,050 m | 5,400 m |
| Development Ratio | 3 : 1 | 3.5 : 1 |
| Number of Headings | 9 | 6 |
| Number of Headings based on 20 m per week | 19 | 6 |

* IMC considers the average development rate of 42.3 m per week for planning is totally unsupportable bearing in mind that this includes junctions, machine moves and turning and work place unavailability. The FS expects these rates, which have been calculated from the FS information, to be achieved with roadheaders. From IMC experience using good management and planning with motivated teams, operating a combined roadheader and bolter miner machine fleet, a more realistic planning average is 20 m per week. This gives a more accurate requirement of 19 headings to sustain the FS mine layout. IMC consider that 25 working points, including 6 production machines, to be unsustainable and recommend that the phased planning of the mine be reconsidered using the IMC approach once the geology and seam characteristics are understood in more detail.

**Figure 4-4 Example of a Bolter Miner**

Figure 4-4 above shows an example of a bolter miner where the roadway is bolted by the same machine that cuts using onboard bolters. The bolted roadway can clearly be seen behind the machine.

Figure 4-5 below shows and example of a bolted gate roadway which is stable and has a good cross sectional area. High production longwalls need to be serviced by gate roads of this type if they are to consistently produce to budget.

**Figure 4-5 Example of a Bolted Gate Roadway**

### 4.2.4. Mine Layout

In the absence of a phased development and production plan and schedule showing the proposed working of each seam and each block it is difficult to opine of the efficacy of the underground layout.

The 2D and 3D seismic surveys provide a reasonable understanding of the major faulting, which define and locate the mining blocks. The FS shows the main access roadways for each of these blocks aligned to this major faulting pattern, presumably to minimise the coal sterilisation when laying out the faces and inter seam access. IMC would support this approach for production block main access layout which could be used to develop a more detailed phased mine plan.

In order to maximise resource extraction the FS indicates mining will be undertaken using “pillar less mining” extracting alternate panels. IMC would not recommend this approach from a strata control, production optimisation, methane and spontaneous combustion management point of view. The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre.

## 4.3. Underground Mining Services

### 4.3.1. Coal Handling

FS Section 10.4 indicates that the main means of underground coal handling will be by belt conveyor. IMC agrees that the coal clearance systems within the mine should be via conveyor from the working faces and developments along the gate roads, transferring to the main access or spine road conveyor and then to the coal shaft or main drift conveyor, depending on the option to be adopted.

Underground bunkerage should only be included in the mine design to interface between the continuous conveyors and a batch process like a skip shaft. All the main coal clearance conveying systems should be designed for the full production rate from the face together with development material.

IMC envisages that this will require a conveying capacity throughout the main coal clearance system of around 2,000 tph and the major conveyors would be sized on this basis.

However, a consideration could be the introduction of underground bunkerage to allow non coal drivage development dirt to be isolated from the coal production and removed from the mine during periods of non-coaling. It is considered better to run all mineral out on a common belt for separation in the Coal Preparation Plant.

A typical main conveyor for inclined spine roads or a surface drift would have the following specification:

- 2,000 tonne per hour of ROM Coal;
- 1,400 mm wide belt running at 4.7 m per sec;
- 159 mm diameter rollers with 30 mm 6306 bearings, 3-roll carrying idler sets and 2-roll vee returns;
- 3 x 1,500 kW Drive with an ST5000 steel cord belt.

A typical gate road production conveyor would be similar but be fabric rather than steel cored. The belt tensions would be considerably less due to little vertical lift, consequently the belt specification will be reduced.

### 4.3.2. Transportation

FS Section10.3 focuses on a general description of materials transport using the controlling factor as the auxiliary shaft capacity. Whereas IMC agrees with this general description it should be noted that everything has to be transported to and from the working points which comes at a time and financial cost. The efficiency of the transport process has the most significant effect on the mine operations and profitability. Each facet of the transport should be developed into an integrated plan to determine the system capacities.

It should noted that most time is lost changing systems and the number of changes should be minimised in the planning.

#### 4.3.2.1. Men

When men are travelling they are non-productive. The following man transport systems are used internationally in mines of a similar size to that proposed at Khalashpir.

- Locomotive or mono rail manriding trains.
- Rope hauled manriding trains for inclines.
- Free steered man transporters, usually for a single production or development teams.
- Manriding conveyor belts, with or without coal depending on speed and gradient.

#### 4.3.2.2. Materials

IMC agrees that the use of material batching particularly for developments is more efficient. With this in mind the main options for the mine transportation system are considered to be:

- Conventional rail system locomotives either battery or diesel but could be limited on the grounds of gradients.
- Conventional rail systems using rope haulages, including direct haulage for gradients or endless rope for level or shallow gradients.
- Monorail systems but they need height so that if there was floor lift it may roadway require repairs.
- Floor mounted trapped rail systems offer the possibility of fast transport and where gradients allow can go around corners.
- Free steered vehicles (FSV) which can provide flexibility in load type and overall weights.

#### 4.3.2.3. Interface Transfers

If face equipment is being transferred between longwall faces it is clearly non-productive but involves many large loads like whole powered supports. If not considered at design stage the interface transfer may be protracted and absorb resources to the detriment of the pit's performance.

- Dedicated rail systems with locomotives, monorails or rope haulage.
- Dedicated FSVs with the capacity to carry whole units.

It is particularly important to keep system transfers to a minimum with the large abnormal loads that would be involved.

## 4.4. Human Resources

FS Section 10.6 provides a general description of the overall manpower envisaged at various stages of the Project without any build up or detail of categories.

Bangladesh does not have a history of coal mining and only one operational colliery. It is therefore important that the Consortium develops a strategy for the education and training of all levels of mining expertise.

### 4.4.1. Colliery Staff

Table 4-6 below shows a typical mine staff complement for the management of mines is covered by UK Management and Administration of Safety and Health at Mines Regulations 1993 and Approved Code of Practice (ACOP). There are just two appointments that the mine owner must make. These are the mine manager and the surveyor. Their education, training and experience are prescribed.

However the ACOP goes on to prescribe other appointments. Thus an experienced supervisor from the Consortium could not be appointed an underground supervisor without considerable retraining.

**Table 4-6 Typical Mine Management Staff**

| **Activity** | **Number** |
|---|---|
| | |
| **Mine Manager** | 1 |
| Operations Manager | 1 |
| **Financial Controller** | 0 |
| Assistant to Financial Controller | 1 |
| Time and Wages | 3 |
| **Manager's Secretary/Administrator** | 1 |
| Other Clerical | 1 |
| **Surveyor** | 1 |
| **Deputy Surveyor** | 1 |
| Linesmen | 2 |
| **Human Resources Manager** | 0 |
| Training Officer | 1 |
| **Planner** | 1 |
| **Strata Control Engineer** | 1 |
| Strata Control Technicians | 2 |
| **Safety Engineer** | 1 |
| **Underground Environment Manager** | 0 |
| Ventilation Officer | 1 |
| Assistant Ventilation Officer (Air Measurer) | 1 |
| Methane Drainage Officer | 1 |
| Dust (Roadway and Airborne) | 1 |
| **Mechanical Engineer and Surface Manager** | 1 |
| Deputy Mechanical | 1 |
| **Electrical Engineer** | 1 |
| Deputy Electrical | 1 |
| **Surface Manager** | 0 |
| **Coal Preparation Manager** | 1 |
| Deputy Coal Prep Manager | 0 |
| **Supplies and Contracts Manager** | 0 |
| **Stores and Surface Compound Manager** | 0 |
| Stores Clerical | 1 |
| | |
| **Total For Mine** | 28 |

IMC recommends that a detailed manpower plan is developed for the various stages of the Project development with an individual build up of direct and on costs for inclusion into the Project cash flow model.

## 4.5. Coal Preparation

There is no direct reference in the FS to the coal processing proposed for the project except some in-situ quality data indicating that some of the coal may have coking properties and a comment that washery discard may be used for hydraulic fill.

IMC considers that almost certainly some form of coal preparation will be required, which will be dependent on the saleable production products and their specifications.

Figure 4-6 below shows the basic coal process design steps that IMC recommends should be employed in the Project.

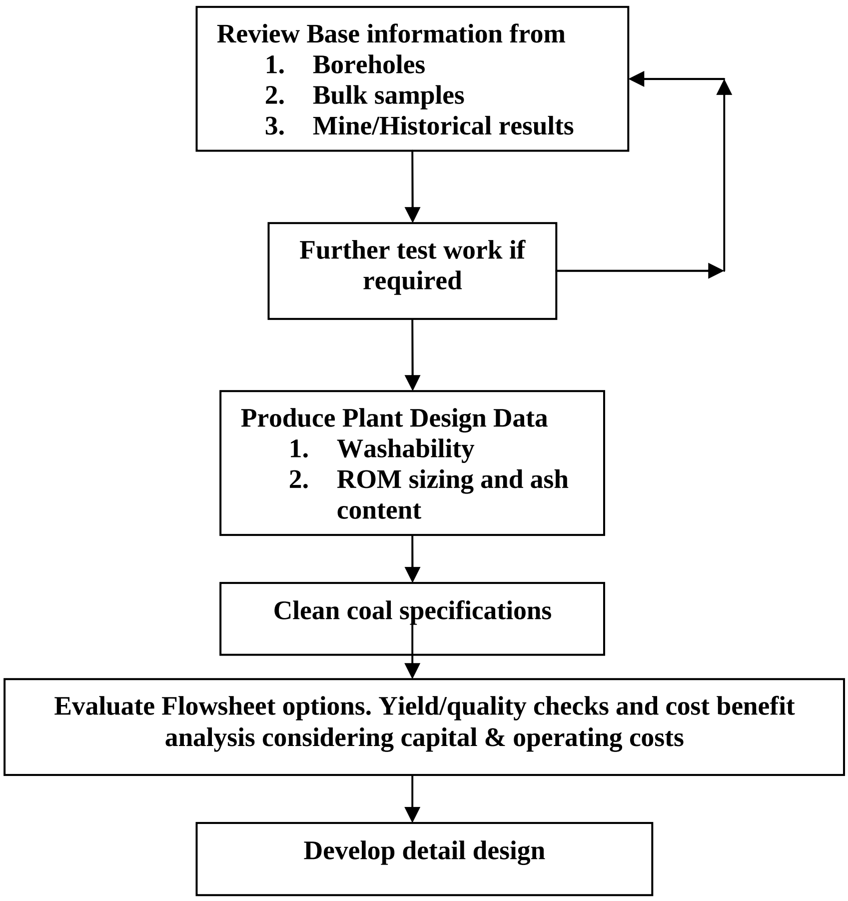


**Figure 4-6 Coal Process Design Steps**

It is likely but not guaranteed that the process design will have two product based methods:

- **Power Station Fuel** Bradford Breaker with barrel washers or Baum box jigs.
- **Metallurgical Coking Coal** Bradford Breaker with dense medium separation.

## 4.6. Underground Environment

In a naturally hot and humid country the environment likely to be encountered in a high production underground coal mine are likely to be more onerous that nearly anywhere else in the world. Not only is the baseline climatic conditions on the surface not very kind there are exacerbated by the following factors that will be encountered underground.

- Methane gas emissions;
- Spontaneous combustion;
- Geo Thermal gradient, air temperatures;
- Water make and relative humidity; and
- Dust.

### 4.6.1. Methane Gas

FS Section 11.3 explains the basic effects and potential hazards of methane gas associated with underground coal mining. IMC considers these comments to be very rudimentary but agrees that the mine should be classed as a "Gassy" or "Flameproof (FLP)" mine from the outset. It is know that the initial methane emissions prediction for Barapukuria indicated that only minimal amounts of methane would be liberated during longwall production. However, the practice has show more methane than originally anticipated, probably from neighbouring seams distressed during operations.

The total gas potentially released into the ventilating air during mining is made up of that from the seam being worked and from the seams in the surrounding strata. The latter is usually the larger source.

There are two methods of controlling methane emission in coal mines. These are dilution and capture. Both methods may be required in this mine.

As the intensity of working increased it became impossible to mine and still maintain the return air within statutory limits by using capture techniques usually called methane drainage. In the UK the statutory limits are:

- 1.25% where there is use of electricity (even live cables). Specific signalling type equipment can be kept live above this figure where the power supply and system is deemed to be intrinsically safe. By intrinsically safe it is meant that there is insufficient energy in any spark created to ignite methane.
- 2% where there are people present (Men is frequently used as an expression in mines)

A method of prediction was developed in the 1980's and has continued some development since that date for the prediction of specific emissions in UK coalfields. Specific emission is the amount of gas released from a longwall face per tonne of coal produced and not the gas content of the seam being worked. The specific emission is usually several times greater than the seam gas content. It depends on many factors but includes the density of coal seams and carbonaceous strata in the strata above and below the seam being worked, the strata type above and below the seam being worked, face length and many others. The prediction method is based on much research and has been calibrated against actual emissions in the UK. This is called FPPROG and runs on PC's.

IMC recommends that the Consortium undertakes a similar analysis for the seams of the Khalashpir Project which includes all seams not just the target seams. This may require gas desorption data from newly drill borehole cores to be reliable.

#### 4.6.1.1. FPPROG Predictions

FPPROG is used to predict methane emission levels during production. The typical input and output results are as follows.

**Input Date Used**

- Worked Seam — name or number
- Face Dimensions — m
- Face Advance — m/week
- Seam Gas Content — $m^3$pt
- Gradient — $m^3$pt per m

| | |
|---|---|
| • Adjacent Seams Gas Content | $m^3$pt |
| • Age of District | weeks |
| • Upper Limit Of Methane | 1.25 or 2% |
| • Coaling Weeks Per Year | number |
| • Assumed Density | t/$m^3$ |
| • Longwall Tonnes Per Year | Mt |

**Results**

| | |
|---|---|
| • Total Emission | litres per sec |
| • 50% Methane Drainage Capture | litres per sec |
| • 50% In Ventilating Air | litres per sec |

FPPROG is also able to predict from where the gas is originating as this helps determining the likely effectiveness of methane drainage and the possibilities of floor outbursts. Floor outbursts are not to be confused with coal and gas out bursts. Floor outbursts are caused by a build up of free gas under a cap rock such as hard sandstone. If this happens and there is some geological dislocation sudden emissions can occur.

Once run for each production face the results can be used to establish a phased methane emissions as part of a progressive mine ventilation network plan.

IMC would expect this analysis to show that methane drainage may not be required, but this is not certain, and with a smaller number of production faces, not five as per FS, the methane can be controlled through roadway ventilation.

This does not negate the use of methane gas explosion prevention and control using:

- Monitoring
- Air quantity and velocity
- FLP electrics
- Cutting drum water sprays
- Stone dust or water barriers

### 4.6.2. Spontaneous Combustion

FS Section 12 provides some generalised comments about the occurrence of spontaneous combustion. IMC do not agree with some of these statements but are pleased to see that the concept of self ignition temperature has been explained and that a test has been undertaken on one of the Khalashpir seams, although it is not clear which one.

IMC agrees that the coal sample tested would be classed as a medium to high risk but again it is not clear how the tested sample was recovered and stored prior to test as it may have been partially oxidised. It is therefore recommended that further controlled tests are undertaken with freshly extracted and identified samples from each seam to internationally accepted test and storage procedures. In the mean time any mine planning should assume that all seams are a high spontaneous combustion risk.

In seams prone to spontaneous combustion a heating will occur where very low velocity air currents pass through or over broken coal for example:

- Corners of broken coal pillars;
- In the waste area behind a longwall advance or retreat face;
- In sealed waste areas with air leakage paths; and
- Associated with sealed areas where there are rapid atmospheric pressure changes.

Spontaneous combustion prevention in high risk seams centres on the:

- Removal of leakage paths in or through exposed friable coal;
- Isolation of longwall panels and worked out wastes with pillars;
- Appropriate sealing of air paths as a face starts to retreat;
- Pressure balancing of sealed waste areas; and
- Monitoring for Carbon Monoxide (CO) and Products of Combustion (POC) in the mine roadways and behind stoppings with electronic or “Tube Bundle” sensors and samplers.

IMC recommends that when the Consortium develop their detailed phased mining plan and schedules if should incorporate all of the above comments. There should also be a plan and procedure to deal with local and major heatings should they occur with all the preparatory work to be undertaken in advance and the requisite equipment specified.

IMC considers that the use of hydraulic waste stowing will not only be ineffective as a roof support it will also be ineffective as a spontaneous combustion control and mitigation measure. Waste and roadway flooding should only be contemplated as part of an emergency procedure. However, the Consortium should consider the use of Nitrogen as an emergency or routine control measure which needs to be incorporated into the Project planning and financial analysis.

### 4.6.3. Air Temperatures

The FS does not discuss the underground temperatures likely to be encountered but, as experiences at Barapukuria have already shown, this will be a significant factor which could affect the mine operations. The main heat sources are considered in the following sub sections.

#### Surface Atmosphere

Bangladesh has a subtropical climate, with an annual average temperature of 24.8ºC and an annual average relative humidity of 74.8%. From April to September the average temperature is 28.1ºC and the average relative humidity is 79.25%. In summer, the temperature at night is nearly 35ºC and the relative humidity can be more than 95%. The highest annual temperature is 37.5ºC. So the mine inlet air temperature is high which provides a higher than average starting point.

#### Geothermal

The temperature of the isothermal zone of Barapukuria mine is about 25.5ºC, with a depth of about 30 m and an average geothermal gradient of 3.5ºC per 100 m. The original rock temperature of the main mining district at the lower part of the target seam VI is about 40ºC. Therefore, the heat interchange from rock or coal seam and working places is one of the main heat sources. There is every reason to believe that Khalashpir will be very similar, depending on the depth of the target seam.

**Heat Emitted from Electro-Mechanical Equipment**

The heat emitted from the underground electro-mechanical equipment, especially from high powered production or drivage equipment will remain in the air stream as rock is an extremely good insulator and thus is one of the main causes of temperature rise.

**Other Heat Sources**

This includes the heat primarily from the broken coal or rock being transported on conveyors. However, shot firing and human bodies are heat sources which contribute to the mine air temperature.

#### 4.6.3.1. Mine Heat Environment Index

The mine heat environment means the temperature, humidity, air velocity and heat radiation. It directly affects the heat equilibrium state of human bodies. If human beings work in a high temperature environment their heat equilibrium will be destroyed and a series of abnormal physiological symptoms will appear and seriously affect the health and working efficiency of the workers. Therefore, many countries in the world have established standards for mine heat environment.

Research shows that it is not satisfactory to calculate the index of heat environment by means of the dry bulb temperature. This can not really reflect the effect of the environment on human body. The effective temperature combines the 3 main parameters of temperature, humidity and air speed which affect the environment. Based on the effective temperature a standard can be established related to the effect that the heat environment has on the human body. It has been found that when the effective temperature reaches to 32ºC, equal to 33.5ºC of dry-bulb temperature, 100% relative humidity and 1 mps air velocity the human body feels slightly hot and the heart beats faster. There is little discomfort with the heat and little influence on the human body and the working efficiency. Therefore, many countries take this standard as the allowable upper working limit.

Although the effective temperature reflects to a certain extent the comprehensive functions of the heat environment, it is not related to the physiological metabolism and heat equilibrium of human bodies. In order to meet this deficiency the air cooling factor was developed by South African Scholars to evaluate the heat environment. The air cooling factor means the largest heat radiation and cooling capacity of the human skin surface of working people engaging in various tasks under certain heat environmental conditions. The data shows that the air cooling factors of 90, 190, and 270 $Wpm^2$ are the heat environment standards respectively for light, medium and hard physical labour. Overall, the temperature standard for Barapukuria mine can be considered to be an effective temperature of 32ºC and is likely to be similar at Khalashpir.

The capital and operational costs of reducing the air temperature are very high as demonstrated in the South Africa deep mines and can be prohibitive where the product is a bulk low value commodity such as coal.

The effects of temperature can be mitigated not only but temperature reduction but by a decrease in humidity and or and increase in air velocity. IMC would recommend that mine ventilation be used as the primary means of environmental temperature control which should be evaluated and integrated into the mine infrastructure from the outset.

### 4.6.4. Ventilation System

FS Section 11 describes the perceived ventilation requirements for the mine at various stages of its development and production. This analysis has adopted a prescriptive approach using Chinese regulatory norms for:

- Volumes of circulating air per person at various working points;
- Specified velocities a various mine locations; and
- Simple summation with allowances for leakage and chambers.

IMC considers that this approach does not adequately address the main ventilation aspects of the developing mine. The main parameters to evaluate in ventilation design are to optimise:

- Quantities to dilute methane and other noxious gases in the working locations;
- Quantities to adequately cool the working environment for both men and machines;
- Quantities to allow the use of diesel engines and FLP electrical power; and
- Pressures to minimise leakage paths and prevent spontaneous combustion.

These issues have to be considered in the mine layout and infrastructure design by specifying:

- Roadway locations, lengths, cross sectional areas and support hydraulic resistance;
- Developing roadway network;
- Phased production and development;
- Main accesses into the mine, shafts, drifts or a combination;
- Surface and underground mine fans; and
- Auxiliary fan usage.

All these issues interact and IMC would recommend the application of computer network analysis to assist the design process. The use of FPPROG has already been mentioned above but and can be used with internationally accepted network programmes such as SIM VEN or SIM CLIM.

The FS has predicted main ventilation quantities of 175 $m^3$ps up to 550 $m^3$ps to ventilate up to 5 working faces and 9 developments. IMC would consider the 550 $m^3$ps to be extremely high and unsustainable at pressures of 130 mm. However, adopting a production philosophy of 1 or 2 faces supported by 6 developments and suitable design criteria should be able to be ventilated at an acceptable cost whilst producing the proposed 4 Mtpa.

### 4.6.5. Water Make

It is not clear either from FS or the data whether or not any of the target coal seams could be considered as an aquifer. This needs to be established to supplement the hydrogeological analysis in Section 6.2.4. Nuisance water can affect the efficient operation of a mine especially one of the size planned at Khalashpir and will need to be understood in the detailed design stage in order to mitigate its effect.

#### 4.6.6. Dust Control

FS Section 11.2 has correctly identified the different types of hazard emanating from airborne and accumulations of dust likely to be present in a working coal mine and has described some operational responses to mitigate their effects. IMC would make two additional points:

1. Dust make should minimised at source through cutting element design and equipment configuration.
2. Respirable dust (PM10) will have to be monitored as part of the occupational heath regulations for work force protection against pneumoconiosis and silicosis.

### 4.7. Mine Safety

The mining health and safety regulations likely to be promulgated in Bangladesh include ACOPs for mine underground Fire Fighting and Emergency Rescue planning.

#### 4.7.1. Fire Fighting

The FS has essentially quoted some general aspects of the fire fighting requirements which IMC supports but these will have to be made mine specific as part of the detailed operational mine plan.

#### 4.7.2. Rescue Plan

Again the FS has quoted some general aspects of the Mine Rescue responsibilities imposed on the Manager, which again would have to be expanded and made mine specific. IMC would comment that once Khalashpir is being developed there will be two underground mines in close proximity to each other and it may be worth establishing a common dedicated mine rescue service.

# 5.0 SURFACE FACILITIES AND INFRASTRUCTURE

Surface facilities and infrastructure are not specifically dealt with within the FS. References are made and generalise descriptions are provided in the Mining, Environmental and Financial sections of the FS. This is surprising because surface facilities and infrastructure costs associated with a mine located in a remotely will often approach 20% of the total capital investment.

## 5.1. Surface Site Location

The FS proposes access to the mine to the NW of the deposit. From a surface design perspective this location only has the advantages of being closure to the main drainage outfall in the area. However, due to overriding underground considerations as described in the mining section of this report IMC recommends access on the eastern boundary of the resource as shown in Figure 5-1 below.

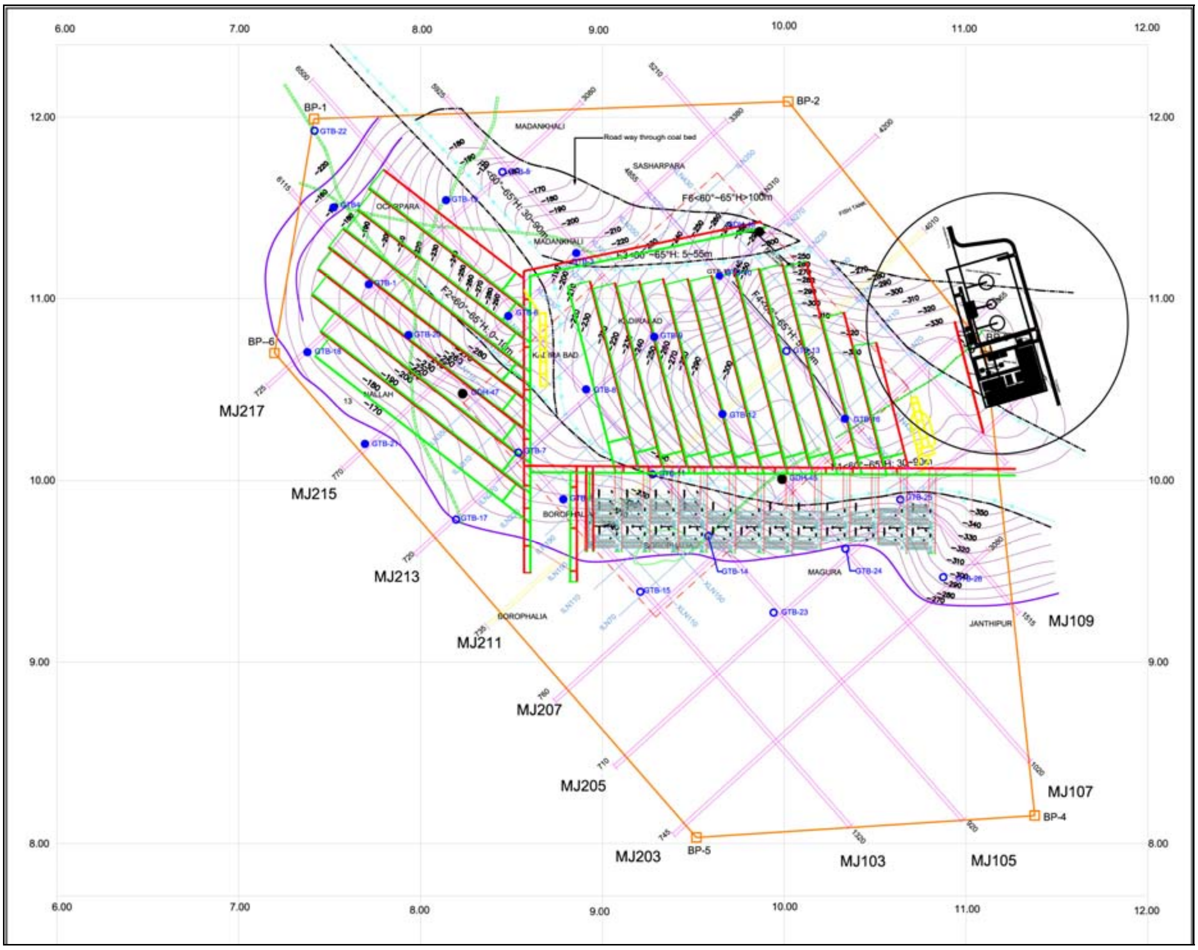


**Figure 5-1 Location of Surface Facilities**

The principle surface constraint on the surface location is mining subsidence and associated ground strains. The shafts and significant structures must be located outside the zone of influence of mining operations. In UK mining subsidence effects rarely extend beyond a distance equal to half depth of the nearest mining panel. However, realistic strata behaviour models will not be available for Khalashpir until after several years of mine operations. For contingency purposes, IMC recommend that the surface should be located so that it is at a minimum distance equal to full depth from the rib-side of the final panel in each of all three target seams. This approximates to 450 m subject to verification of final mining proposals.

In the presence of boundary faulting there is a risk of re-activation of the fault or may concentrate strain along the line of the fault whilst reducing subsidence effects closer to the mining. IMC recommend that significant structures or installations should not be located within 50 m of such boundary faults.

## 5.2. Site Layout

The IEA submission includes a surface layout based on the Barapukuria Surface facilitates are listed in the environmental and financial sections of the FS but not quantified in scope or provision.

The FS study submission is based on the Barapukuria Project assumes includes significant buildings, company office, staff accommodation and functional buildings to cater for all eventualities and constructed to high standard commensurate with a prestigious inter-Government project. Many of these facilities have proven to be unnecessary and do not contribute directly to support production and development activities.

IMC recommend that a minimalistic approach be adopted for Khalashpir and limited to only those facilities necessary for production and development activities and constructed and finished to good and serviceable industrial standard.

IMC has prepared a conceptual sketch layout is provided in Figure 5-2 below to solely illustrate the principle design consideration to be addressed at the next stage of project development. The final site layout will depend on additional geological and mining investigation during the next phase of project development.

IMC recommend that accommodation and social facilities for permanent staff and workers are not located at a site isolated from the mine to allow management to concentrate its effort on core tasks of constructing the mine and producing coal. Discussion may be held with the Khalashpir local authorise to develop suitable accommodation in the town constructed by independent developers on a commercial basis. This may be combined with re-settlement needs arising from mining subsidence and loss of land use as discussed in the socio-environmental section of this report.

The IEA suggests a total surface site area of approximately 36 ha including staff accommodation and social facilities. IMC preliminary assessment is 27 Ha for the main surface, which may be increased to 30 Ha for offsite road, drainage and lagoon facilities.

The Barapukuria Project is designed for a 1 Mtpa mine with clean coal feed directly to the power plant. The Khalashpir Project envisages a 4 Mtpa, probably requiring 5 Mtpa ROM necessitating coal washing facilities. The surface layout should therefore be specific to the Khalashpir mine. Design criteria for various site facilities are discussed below.

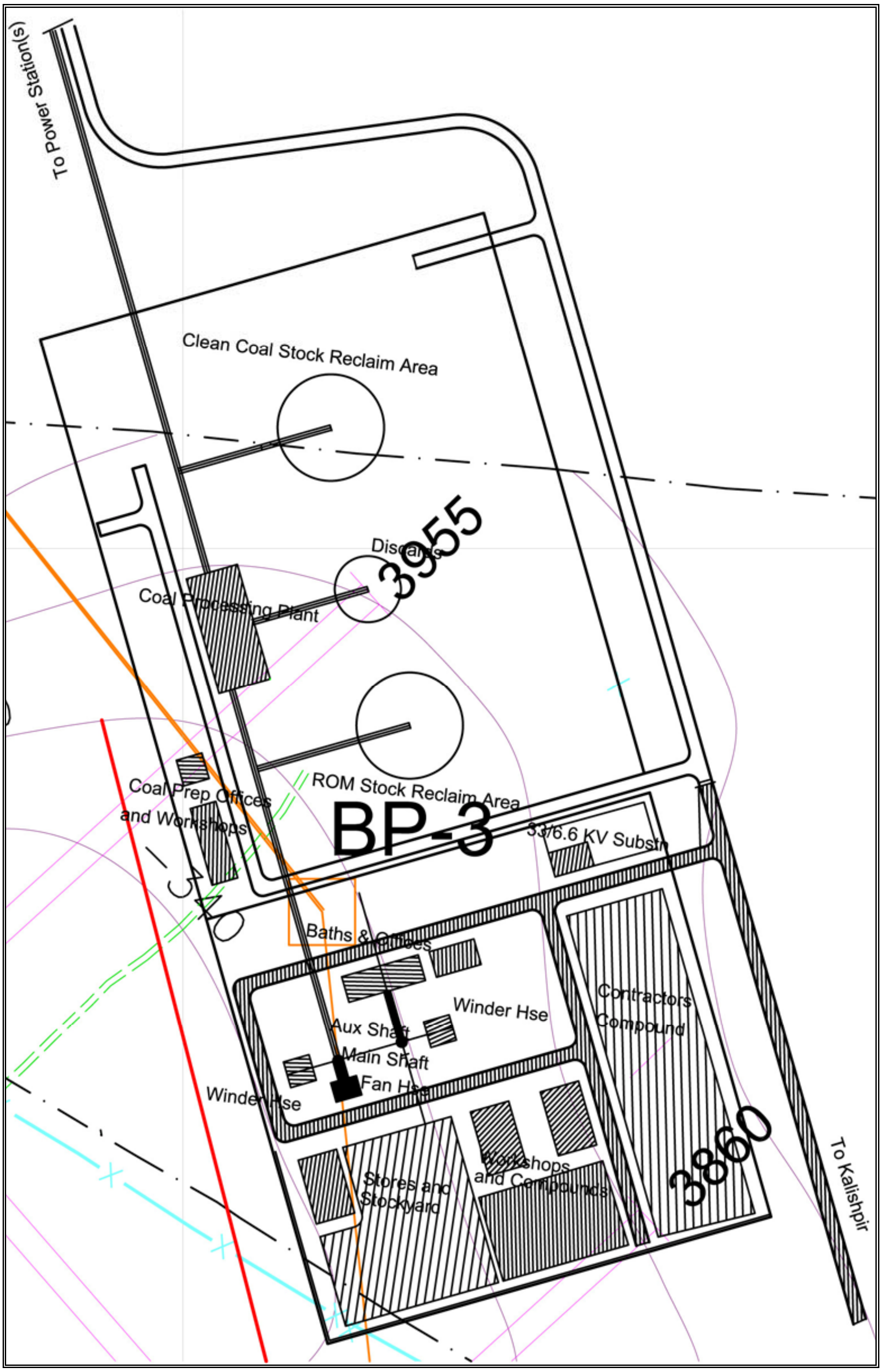


**Figure 5-2 Surface Layout**

### 5.2.1. Shaft Location

Shaft locations will be substantially be determined by underground considerations. There would appear to be no constraints to preclude the alternative site location postulated by IMC. Surface considerations will determine the distribution of support facilities necessary to ensure efficient men and material transport, coal conveyance and handling arrangements.

Volume 1 Section of the FS states that the two shafts shall have a minimum distance of 13.5 m between them. Consideration by IMC of other projects designs, IMC recommends a spacing of 50-75 m between shafts to ensure sufficient room for insets and access for transport and services at both the pit bottom and pit top.

### 5.2.2. Shaft Winding Systems

Various options are available for shaft winding arrangements requiring different surface configurations. These are not addressed in the FS. The above sketch layout allows for ground based winders symmetrically arranged on both shafts. Final selection may involve tower winders incorporated in the structure above the shaft reducing congestion in the shaft areas.

### 5.2.3. Fan House and Drift

The fan house and drift feeds directly into the main shaft, if homotropal ventilation of the mine is adopted, and should be located adjacent to the shaft to minimise air losses and drift construction costs.

### 5.2.4. Coal Clearance

IMC recommends that a corridor is required from the main (coal) shaft to ensure that coal can be conveyed directly to the coal processing and handling areas without the need for changes in direction requiring transfer stations.

### 5.2.5. ROM Coal Handling and Process Plant

Subject to further coal quality and geological investigation it is highly probable that coal washing/preparation will be required.

The area must be designed to accommodate coal processing plant, ROM and clean coal load-out and reclaim facilities in the event of coal preparation plant or power station breakdown respectively. Load-out and stockpile facilities will also be required for discards.

It is normal practice to stockpile clean coal at the point of use or sale in the case of mine mouth sales. Sufficient stockpile arrangements should be provided at the power station (3 months usage) to secure continued power supply so that during scheduled power station shutdowns and during periods of low output, the mine will not stop working due to restricted coal stocking capacity at the mine. (This is a repetitive problem at the Barapukuria Project).

The FS assumes that all coal will be used for power generation without reference to a market survey or addressing Bangladesh coal and power sector policy which IMC understand is the course of preparation.

Coal sales into other industrial sectors should not be ruled out at this stage. Coal is used in the brick making sector which is currently substantially met by Indian imports of low quality, high sulphur coal resulting in serious environmental and health hazards. IMC understands that there is a current market of 2 Mtpa. Bangladesh households were historically use to using coal for cooking and heating. Given a reliable local supply, the use of coal in the region for these purposes offers the possibility of reducing demand on ever diminishing gas and wood resources.

IMC recommends that the Consortium undertake a market survey, see Section 7.4, and if found necessary, contingency measures should be made for truck loading to service domestic and local brick burning industries. These will involve additional land requirements.

### 5.2.6. Materials Supply

Significant material storage areas and areas to prepare shift delivery to the underground will be required close to and with an uninterrupted access to the auxiliary shaft.

All major plant and equipment will be imported and will require a large store for the storage of spares and consumable many of which are long supply items in excess of 6 months. The store and stockyards will require sufficient capacity to store all imported consumables, component spares, and emergency and insurance equipment replacement items to keep the mine in production for a minimum of 12 months and 6 months for local supply items.

Security is a major issue and it would be prudent to allow for double security fencing for the stores area and restricted access and to ensure that all storage is within this secured area.

During the construction period the stores compound may be utilise to stockpile and handle waste rock arising from underground mine construction which may be used for permanent works construction and land development.

### 5.2.7. Workshops

Khalashpir is in a remote location requiring extensive workshop facilities to service, maintain and overhaul major underground equipment. Two workshops will be required; a workshop for large mining machinery repair and overhaul requiring heavy lifting capability, and a second workshop engineering workshop to do smaller scale electrical and mechanical component repairs.

The size and facilities to be provided should be based on an analysis of workshop tasks and throughput required to maintain commensurate with a planned preventative maintenance programme.

The workshops should be located close to the store area and have a direct corridor access to the auxiliary shaft to minimise double handling.

### 5.2.8. Surface Transportation

The FS proposes battery locomotive transport systems. Underground equipment for Khalashpir will be substantially larger and heavier than that utilised at the Barapukuria mine. Transport systems must be design in relation to track weight and gauge to satisfy safety requirements for the transportation of large loads.

### 5.2.9. Electrical Substation and Standby Generator Plant

A 33K V/6.6 KV Substation will be required within the site curtilage. This should be at the periphery of the site to avoid the need for high tension cables to cross the site and located to service both mine and coal processing plant areas.

The electrical supply system is determined to be weak in this region of Bangladesh, but is currently subject to upgrade. Unless a stable and strong power supply can be guaranteed, a standby generator facility will be required to service emergency mine loads including: pumping, winding and ventilation equipment in the event of a power outage. In the event that studies prove this necessary the generator plant will be located next to the main substation.

Ultimately, at least two incoming power lines will be required to service the mine from independent substations.

### 5.2.10. Land Development and Drainage

FS proposes that the existing site will be lifted by 1.5 m above maximum flood level. However, no analytical data is provided to justify this choice. If records not be available for this area investigations will need to be made based on local knowledge to which 600 mm should be added for freeboard wave action. In practice land development height may depend on ensuring adequate drainage falls from the mine to the tributary outfall SW of the site. A drainage ditch will be required from the mine site outfall to the river tributary to avoid risk of flooding or contaminating crop land.

The IEA describes the condition of the tributary feed south west of the main site which feeds into a river some 12 km, away as being heavily silted. Consideration should be given to dredging the tributary to provide a serviceable outfall for the mine, which will generate significant quantities of water. The dredged excavated ditch material may be used for land development purposes. These installations will require constructing prior to the commencement of major mine construction works.

Mine water and run off from the coal processing/handling site will require treatment. Provision should be made for water treatment plant should water quality tests, when available, indicate a need. Mine water quantities are anticipated to be high and will contain relatively high values of coal fines. This water will require the establishment of earth settlement lagoons prior to discharge into a water course. Sufficient settlement lagoons will be required to allow adequate settlement time and be provided with bypass arrangements to facilitate cleaning at regular intervals. Coal recovered from the lagoons will be saleable and proceeds generated will offset lagoon maintenance costs.

### 5.2.11. Mine Main Access Road

No mention is made in the FS for the construction of the main access road into the site from the main highway at Khalashpir. This will require construction prior to the commencement of major mine construction works. IMC recommends early discussion with the Road and Highways department to determine capital cost and implementation programme with due regard to land acquisition procedures.

### 5.2.12. Contractor Facilities

To avoid disruption to permanent mine construction a contractor compound will be required to provide space for temporary workshops and stores, fabrication areas, contractor's staff accommodation and the like. This area may later be utilised to house ancillary mine facilities such as: deep well pump station, water storage tower, sundry workshops and divisional substations.

# 6.0 ENVIRONMENT

## 6.1. Regulatory Framework

### 6.1.1. Environmental Management Plan

The FS includes, in Chapter 16, a number of very important commitments referring to EMP, monitoring, reclamation and rehabilitation. Details are left to an Environmental Impact Assessment (EIA), which the applicant is required to submit to obtain the final Environmental Clearance Certificate (ECC). Some revised Terms of Reference (ToR) for an EIA are proposed in the supplementary information submitted in the House of Consultants Limited letter dated 09/07/2006 (IEE 4, Annex 4). The proposed ToR are generally compliant with international standards e.g. the "Equator Principles" observed by International Financial Institutions, which are based on World Bank and IDA guidelines.

After issue of the FS documents the Department of the Environment (DoE) has published "EIA Guidelines for Coal Mining March 2009." These list (Chapter 4) detail requirements for the "Scoping" of any future EIA and EMP and a checklist and procedure (Chapter 10) under which an EIA will be reviewed for approval. Since the Guidelines are a public document there is no need to repeat here the DoE requirements.

The applicant has to submit a detailed EIA in accordance with the Bangladesh Regulations and to the satisfaction of the Director General of the DoE in order to receive the ECC. It is therefore mandatory that the Consortium obtains mutual agreement with the DoE on the EIA scoping, ToR and any special reports required. It is strongly recommended that mining experts from the EMRD cooperate very closely with the DoE during the scoping and ToR preparation.

In the following, comments and suggestions and recommendations are provided which are specific to the Khalashpir Project and may not have been that clearly identified in the generic Guidelines.

### 6.1.2. Project Specific Topics for the EIA and EMP

The EIA Guidelines are sometimes very specific. With reference to the area to be considered in an EIA the Guidelines define in Chapter 5.2.1 a "buffer zone" to include "areas within a radius of 10 km from the mine lease boundary". This definition is unusual and unnecessary. It is important in the scoping process to define ToR and the study limits. Each project study area should be defined on its own merits. Very often the physical impact of an underground coal mine is limited to its mine lease area. Only a few aspects like air, water, transport and socio-economics may need an extension of the study area in discrete directions.

As a fundamental aspect of the scoping task it is suggested to limit the EIA study area to the foreseeable Project impacts.

### 6.1.3. Project Phases

It is common international practice to consider the environmental and social impacts of any project in three separate stages:

- Construction
- Operation
- Closure

Impacts, monitoring and mitigation measures to be incorporated into the EMP vary to during these stages. The documents available so far focus on the operational activities.

It is recommended to separately identify the impacts and EMP for the three different Project stages.

### 6.1.4. Land Register and Inventory

It is generally accepted that land subsidence and associated impacts represent a major affects of the Khalashpir Project. Handling of fair compensation for impaired land use, damage to structures or complete loss of useful land needs to be well defined in the register of land titles which, may be already formally documented or are inherited in accordance with local culture. It can be expected that establishing a recognised land register of this kind will be very time consuming and arduous. It will probably need the collaboration of local representatives, governmental authorities and the Consortium.

IMC recommends the establishment, as a separate Project document, of an official land register which is kept in the locality. The Consortium shall provide assistance in building up such register by making available topographic survey, field posts, GIS-based documents and images of buildings and structures prior to mining. This register and inventory data base shall be acknowledged as baseline for future assessment of damage and fair compensation.

### 6.1.5. Surface Fire Fighting Plan

The EIA Guidelines list a series of emergency cases which need to be considered as part of the EMP. Taking experience from the Barapukuria mine into account the risk of spontaneous combustion is very likely when coal is exposed in a surface coal stocking yard for an extended period of time. Fire fighting facilities for surface coal stockpiles are fairly sophisticated so plans should be prepared and training undertaken to avoid environmental impacts and economic losses.

The Consortium is required to describe emergency plans for fighting fires at the planned coal stocking yards as part of the EMP or Health & Safety plans. Proper equipment, materials and training exercises need to be included in Project development plans.

### 6.1.6. Project Security

The Equator Principles acknowledge that in some countries personnel working for a major project and their valuables require special security measures.

This aspect should be addressed by the Consortium and should identify risks and impacts and management of the Project’s use of security personnel.

### 6.1.7. Cumulative Impacts

It is an international standard and also part of the Equator Principles to consider the cumulative impacts of projects. In case of the Khalashpir Project the impact includes an anticipated future coal fired power plant in the vicinity of the proposed mine site.

IMC recommends that the Consortium should consider in its EIA and risk analysis any likely impact of a mine mouth power plant should it be built. Special attention should be given to cumulative impact of:

- Air
- Noise

- Water
- Traffic
- Socio-economic conditions

## 6.2. Observations and Comment on Environmental Submission

### 6.2.1. Site Selection

The IEE Report (Doc 4, Chapter 5) includes analysis of suitability for alternative sites.

IMC's review of this analysis concludes that the FS analysis presents some general description of each site and hard data on ground suitability is lacking. The main arguments for Option 1 in preference of the other two options are the zero requirements for re-settlement and minimum loss of coal resources. The latter is subject to confirmation by additional drilling.

IMC site visit did not indicate any obstacles which would render Option 1 a less or more suitable alternative from an environmental perspective. IMC views on the preferred criteria for site selection are substantially governed by mining considerations as described in Section 4.2.1. It is recommended that additional shallow site investigations (soil, groundwater, geotechnical characteristics) are undertaken on the site ultimately selected and deep drill holes confirm the absence of commercial coal reserves.

### 6.2.2. Responsibilities and Public Participation

The FS is fairly specific on this subject and states:

"The mine will have a separate environmental department to look after all these issues and also to liaise with the local population to meet any situation which may result as a problem threatening the environment in and around the mine. A committee comprising the local elites and environmental officials shall be formed to have transparency and effective handling of the environmental issues. The land rehabilitation work in the selected areas will be carried out by a careful management of cultivation, manuring, cropping, control of grazing and installation of permanent under-drainage system. While Khalashpir mine will, as pledged, closely monitor such events it will also arrange participatory management through inducting local agricultural experts /officials to obtain best results through consensus decision wherever possible". (FS Vol. 2, pages 252 and 253).

IMC recommends that this Consortium proposal is made a condition of any permit approval.

### 6.2.3. Land Surface Monitoring

The EIA Guidelines (Post-monitoring, Annexure 2 of Guidelines) do not specifically include a continued topographic survey during mine operations and post closure. Number and frequency of such monitoring normally depend on risks involved. However, the topographic monitoring should be periodically updated to reflect the specific Project related changes.

The Consortium shall propose a detailed topographic survey and regular monitoring program, initially based on area and magnitude of subsidence forecasted and risks involved. The preliminary topographic monitoring program shall be adapted in accordance with reasonable requirements once Project specific experience becomes available.

IMC recommends that this baseline plan should form the basis for subsidence prediction, compensation and or re-settlement requirements.

### 6.2.4. Hydro-Geological Observations

#### 6.2.4.1. Baseline Data

The FS acknowledges that groundwater is vital for agriculture in the Project area. Nevertheless, only limited baseline data has been obtained for description and documentation of the present groundwater situation. With reference to international standards the FS and the IEE provide insufficient groundwater baseline data in their present form for a meaningful understanding of the regime. Some specifics on the deficiencies are given in the following.

The availability of groundwater baseline data and subsequent use as a reference to quantify the impact of mining activities are essential for a comprehensive FS and acceptable EIA.

IMC suggests that the Consortium is requested to obtain the necessary baseline data during the EIA process which could be considered in the EIA scoping agreement between DoE and the Consortium.

#### 6.2.4.2. General Hydrogeology Description

FS Vol. 1 (page 91) and IEE (pages 4-4 to 4-6 and 4-8) provide a short description of the Hydrogeology. It contains a number of fundamental statements on the general hydrogeological situation, without providing back-up evidence.

The text widely quotes Dupi Tila above the target coal seams as a major aquifer and the Gondwana formation below as significant second aquifer without providing any hydraulic data on the latter. The groundwater hydraulics of the formations below the target seams need to be clearly understood for mine safety and drainage. The IEE states (pages III and 8-2) that *"groundwater in different geological formation is hydraulically interconnected as is evident from same water level"*. This evidence is not provided.

FS Annexure C (page 2) states that the major rivers (Karatoya and Akhira) are hydraulically connected to the Dupi Tila aquifer but without providing proof. Additionally, evidence on the mutual inter-dependence of groundwater regimes and river water levels is not provided.

IMC considers, based on the data made available, that the Dupi Tila Formation is the only regional aquifer in the area. The lower formations have apparently significantly lower hydraulic conductivities and should not be addressed as aquifers. In general, the terminology should be made consistent with international standards.

Additionally, hydrogeological investigations and regular monitoring need to be undertaken in all geological formations including the Gondwana formation below the target coal seams. At suitable locations, and a minimum of 3 locations, multiple or a bundle of piezometers should be installed to allow groundwater head measurements in the different geological strata. This should serve to establish an understanding of vertical groundwater movement before, during and after mine drainage operations.

Any monitoring program should also include flow characteristics of the major rivers (water level, flow rate) and associated drainage channels within the Project area.

#### 6.2.4.3. Characteristics of the Dupi Tila Aquifer Formation

The IEE (pages 4-5) contains statements on the characteristics but do not present any original measurements, number and period of observations. The supplementary information submitted in House of Consultants Limited letter dated 09/07/2006 (Doc. 4, Annex 4) includes two groundwater contour maps of NW Bangladesh as well as the lowest and highest water levels from two water wells in 1977.

IMC consider this to be insufficient to adequately describe the pre-mining groundwater flow, water level fluctuations, recharge situation and aquifer characteristics.

The FS and future EIA will be required to include an adequate description of the hydrogeological characteristics of the Dupi Tila Formation. Assuming that there has been no regular groundwater observation done to date the Project will have to generate a reliable picture of the present regime.

IMC recommends that a permanent groundwater observation network be established including some 20 to 30 piezometers installed in the Dupi Tila Formation. The observations should cover the area of future mining at various depths as well as the upstream and downstream groundwater area which could reasonably expected to be impacted by sub-surface mining.

The piezometers should all be tested for hydraulic conductivity using simple tests, e.g. falling head or slug and bail tests. Groundwater level readings need to be taken from the piezometers well ahead of mine development either by regular manual readings or better by installation of data loggers within the piezometers. Water level fluctuations need to be evaluated and contour maps, using average, extreme min. and max. data for the groundwater flow in the Project area. Groundwater quality samples also need to be taken for the baseline documentation. Number, location and data recordings should be agreed in conjunction with the DoE.

#### 6.2.4.4. Characteristics of the Surma Group

As commented above the number of baseline groundwater measurements is currently insufficient. The two pump tests performed in the Surma Group formation are not enough to prove the reported generally low hydraulic conductivity. The IEE (pages 4-6) states correctly that hydraulic circuits are possible through faults extending from the mining levels into the Dupi Tila Formation. The investigations to date do not include this very important topic and only reference is made to some groundwater inflow at Barapukuria mine reportedly along faults. Investigations need to be Project specific as the Surma Group does not exist above Barapukuria coal seams.

IMC recommends that the potential mechanism of groundwater inflow into mine areas through faults needs to be investigated for the Khalashpir Project, where at least 3 to 5 locations should be investigated. It might be necessary to penetrate suspected fault zones by inclined or deflected drill holes. Hydraulic tests should be performed to get data on hydraulic conductivities of the Surma Group. These drill holes should be included in the regular groundwater monitoring program for water levels and quality.

#### 6.2.4.5. Characteristics of the Gondwana Group

The hydraulic conductivities quoted from the two boreholes pump tested are fairly low at an average of 0.064 mpd. The term aquifer here is not correct and confusing. The investigations stopped at the layer of conglomerate directly below the coal seams (Doc. 4, pages 4-5). There is no hydrogeological information available on the part of the Gondwana Formation underlying the coal seams to be exploited. The fault zones have not been investigated either. At Barapukuria groundwater inflow through coal seams yields water at an increased temperature (up to 51°C was reportedly measured) has been observed affecting significantly working conditions, coal face temperature and humidity. All three features are important for the mine safety and drainage and need to be investigated for the Khalashpir Project.

IMC recommends that additional investigations should be undertaken to define the hydrogeological characteristics of the Gondwana Formation below the coal seams (min. 2 holes) and within fault zones (min. 2 holes, if inclined or deviated drilling is used). When penetrating coal seams special attention should to be paid to temperature changes and possible water inflow. All holes should be tested for hydraulic conductivity, hydraulic conductivities of the coal seams and be integrated into a regular groundwater monitoring program.

Plans for the operational phase of the Project should include continuous observations of groundwater inflow through coal seams.

Before approaching suspected fault zones during mine operations geophysical investigations, e.g. in-seam seismic, and/or underground guided hole drilling could be applied to assess the risk situation.

### 6.2.4.6. Hydrogeology Report – FS Annexure C

A summary of this report is included in FS Vol. 1 (pages 92-96). The Annex C contains the data base for the hydrogeological characteristics mentioned in the FS and in the IEE. Annexure C sometimes is not very clear due to poor English. Considerable efforts were invested in performing pump tests but not all relevant data is documented and the pump test procedures applied are not all understandable.

In the case of the three Dupi Tila pumping tests performed, the data recorded appear logical and the evaluation of hydraulic conductivity can be verified.

For Surma and Gondwana Formations no static groundwater levels are recorded which leaves hydraulic evaluations uncertain. Data provided in Annexure C for these pump tests is conflicting and can not be verified. Altogether, the general conclusions appear to be correct in principle.

IMC recommends that if well installations and present conditions allow, pump tests in the wells GTB-1 and GTB-10 should be repeated for the Surma and Gondwana Groups. Controllable packer units should be applied to separate the various hydraulic units and pressure gauges recording continuously the water head should be used during periods of drawdown and recovery. Pump tests should be performed at constant pump rates for a minimum of 17 hours to allow for various log-cycles when using data for non-steady state evaluation methods. The measurements of water level recovery should be continued until the original static water level is reached.

In the event hydraulic tests could not be performed at GTB-1 and GTB-10, two additional locations should be selected for hydraulic testing of Surma and Gondwana Groups.

### 6.2.4.7. Groundwater Quality

The documents do not contain any groundwater analysis. Doc 4 (pages 4-8) states that there is no need for any quality testing but IMC considers this to be incorrect. It is a standard requirement for any mining project to provide some baseline groundwater quality data. In the case where there is nil to minor impact expected it is in the interest of mine operators to protect themselves from any unjustified future claims.

IMC considers that groundwater quality samples need to be taken from all geological formations, mainly the Dupi Tila aquifer. The highest risk for impact on groundwater quality is around the surface area of the future coal stocking yard and possibly the coal washing discard tip, thus analyses need to be performed there. For locations, quality parameters and frequency of sampling consent should be obtained from the DoE.

#### 6.2.4.8. Acid Mine Drainage

Internationally, Acid Mine Drainage (AMD) is an important topic in FS and EIA reports on mining projects. The Supplementary Information dated 23 August 2006 gives some general description on AMD and potential mitigation measures. There is no specific evidence provided on AMD from the Khalashpir Project.

AMD could only occur underground or at the coal stock pile on the surface. The coal quality data documented indicate a relatively low total sulphur content of <1% so presence of sulphidic sulphur which, is related to AMD appears to be very limited. Barapukuria mine reports slightly alkaline pH of the mine water. It is very likely that AMD is not a concern at Khalashpir but this needs to be demonstrated.

IMC considers tests should be undertaken to provide an indication of AMD potential as well as for leaching of constituents like heavy metals or arsenic.

Static Acid Base accounting tests are recommended on representative samples of all three coal seams which are planned to be exploited, say about 9 tests in total. The tests are short term (usually measured in hours or days) at relatively low cost and developed to provide an estimate of a rock's capacity to produce acid and its capacity to neutralise acid. These tests do not consider parameters such as the actual availability of acid-producing and acid-neutralising minerals and differences between the respective dissolution rates of acid-producing and acid-neutralising minerals. The tests are commonly used as a screening tool, and their implications are subject to further verification if required.

The most common methods involve:

determination of the Acid Potential (AP) based on the total sulphur and sulphide-Sulphur or bi-sulphide-Sulphur content

- determination of TIC (total inorganic carbon) as measure for the carbonate content
- determination of the Neutralisation Potential (NP) including the:
  - reaction of a sample with an inorganic acid of measured quantity
  - determination of the base equivalency of the acid consumed
  - conversion of measured quantities to a Neutralising Potential in g per kg or kg per tonne calcium carbonate ($CaCO_3$).

The result of the tests is the neutralisation potential ratio (NPR), which is the ratio of NP value to AP value. Based on the NPR values, the Acid-Base Accounting screening criteria recommended by the British Columbia Ministry of Employment and Investment of Canada can be applied.

More sophisticated kinetic tests should only be performed when according to the static test results, samples are characterised as potentially acid generating or fall in the zone of uncertainty.

The coal samples should also be subjected to standard leach tests, for example.

- US EPA Toxicity Characteristic Leaching Procedure (TCLP, Method 1311)
- German standard DIN 38414-S4

Analytical results will be required for assessment of potential environmental impact or surface water and groundwater.

#### 6.2.4.9. Groundwater and Aquifer Handling

The documents reviewed do not provide adequate information on the methods and quantities of groundwater handled by the Project and should be rectified.

**Potable Water Supply**

The IEE (e.g. pages 7-3) make a general commitment that potable water facilities will be provided according to regulations. It is assumed that groundwater from the Dupi Tila Formation will be used as a potable supply but no data was provided on the location of supply wells and planned extraction rates.

IMC recommends that the plans for potable water need to be detailed and in the case where groundwater is used specifications of well construction and groundwater pumping should be provided. Evidence should be provided that the interference with other groundwater users and impacts of groundwater extraction are acceptable.

**Mine Water Drainage Quantities**

A considerable quantity of groundwater will be discharged by a dedicated mine drainage system during development and operation of the mine. Vol. 2 of the FS (pages 216, 217) gives a general description of the methodology to be applied. The IEE (pages 4-6) contains a very simplified calculation of mine water to be pumped from the underground workings considering a certain length of “tunnel”. At its maximum size the mine water should total 32,500 $m^3$/day plus some unspecified inflow through faults.

There is no mention from which geological formation the mine water is ultimately coming and what impact, if any, there might be on groundwater levels or the Dupi Tila aquifer. The calculation made on mine water quantities is too simplistic and inconclusive, e.g. it does not consider inflow through the goaf area. With similar internationally projects, numerical groundwater models are generally used when groundwater flow systems are complex. Another reasonable approach is to base predictions on mine water discharge on rates experienced at neighbouring mines working under comparable conditions. As long as no better data are available, Barapukuria mine could be used as a reference case which is still at an early stage of development. There, mine water is pumped at present at a rate of about 1500 $m^3$/h or 36,000 $m^3$/day indicating that rates considered for the Khalashpir mine should be further investigated.

The design criteria for a sump capacity of 6 hours inflow at the pit bottom (Doc. 4, pages 4-6) is considered inadequate especially if the pit bottom is located at the bottom of the basin as suggested by IMC and should be re-evaluated on a single sump basis.

In essence, no major technical risk should exist that would render mine drainage un-manageable.

IMC considers the mine water drainage quantities to be expected should be calculated using more suitable methodologies, e.g. numerical models on groundwater flow. This is reasonable to do when more adequate baseline data as recommended above become available. As long as suitable calculations on mine drainage quantities are not available the rates experienced at Barapukuria mine could be considered for initial development plans. Engineering concepts should account for additional capacities in the event higher mine water drainage rates are experienced at Khalashpir.

It appears reasonable to expect that in the long term a significant proportion of the mine water discharged from underground will stem from the Dupi Tila aquifer. This portion and the detailed impact on Dupi Tila groundwater levels need to be assessed for an adequate prediction of the environmental impact, possible mitigation measures and associated costs.

IMC recommends that a 3D numerical groundwater flow model be prepared which simulates the mine drainage and quantifies the impact on the Dupi Tila aquifer during and after mine operations. The model to be used should be acceptable to EMRD and DoE.

**Mine Water Quality**

The documents do not give any information on the quality of the mine water expected. A commitment is included to treat the mine water prior to discharge. Equally, no consideration is given to mine water quality at and after the time of mine closure and mine water rebound. There is a theoretical risk that after closure mine water of inferior quality may mix with groundwater of the Dupi Tila aquifer because mining created enhanced hydraulic connections between the Gondwana Formation and the Dupi Tila aquifer.

Acceptable predictions on mine water quality should become available by the tests recommended above. For the period of mine operations, engineering plans should predict structures allowing settlement of suspended solids in the underground workings to the extent possible. This would reduce wear and tear on mine water pumps and pipes and also would benefit the subsequent mine water treatment.

IMC considers in the event the chemical quality of mine water might be a risk to the groundwater quality of the Dupi Tila aquifer, a separate study on water conditions after mine closure should be performed and concepts be developed to alleviate the risk. The mine closure concept should be further improved at later stages after gaining experience of the mine water quality and hydraulic conditions during the time of mine operations.

### 6.2.4.10. Effects of Subsidence on Groundwater

Doc 6 “Further Information” includes “Principal Interpretation of caving effect on aquifer” which is partially repeated in the FS Vol. 2 (pages 241, 242). Some general descriptions, possible effects and some general but important commitments on monitoring and compensation are made. Any FS and EIA of international standard needs to be specific about the impacts expected by subsidence and the mitigation measures applied in case the impact is found unacceptable.

Subsidence will influence the groundwater levels and flow directions in the Dupi Tila aquifer. Depending on the risks involved it might be necessary to predict the potential impact in advance in order to determine the necessity for mitigation. An adequate prognosis tool is generally a numerical groundwater flow model which, simulates the effects of subsidence developing with time at the surface.

IMC recommends that maps should be produced by the Consortium showing the baseline and expected contour lines of subsidence for characteristic time intervals and that this baseline plan should also form the basis for subsidence compensation and or re-settlement requirements. Based on this information a risk analysis should be made evaluating the needs for mitigation measures. In addition to a scenario with zero mitigation, effects of mitigation measures should be shown separately. In the event that the risk analysis indicates possibly unacceptable impacts on the groundwater situation, a suitable numerical groundwater flow model should be developed for alternative scenarios, with and without mitigation measures. The numerical model should simulate non-steady conditions during progressive mining stages and also long term steady state conditions characteristic for the post mining period. The model to be used should be acceptable to EMRD and DoE.

### 6.2.4.11. Aquifer Recharge

The aspect of aquifer recharge is not considered in the documents. The natural recharge by rainfall, surface waters and by irrigation is understood to be in an acceptable balance under present conditions. There is no prediction made as to whether the mining will deteriorate this existing balance. The possible hydraulic connections between the Dupi Tila aquifer and the Gondwana Formation as described in the FS Vol. 2 (page 241) underlines a potential risk that mine drainage might lower the groundwater levels within a certain area of the Dupi Tila aquifer. If this is found unacceptable one well should be established whether the mode of mitigation is artificial recharge of the aquifer. This could be done by injection wells, ditches or artificial wetlands from where surface water seeps into the groundwater.

IMC considers that the Consortium should undertake a risk analysis on the potential impact created by mining on the groundwater balance of the Dupi Tila aquifer. If a risk can not definitely be excluded a numerical groundwater model should be applied as recommended above in order to quantify the risk.

In the event the risk analysis demonstrates a need for mitigation measures, engineering concepts should be developed. These concepts should include artificial recharge of the Dupi Tila aquifer by either mine water of acceptable quality or surface water imported from rivers. The numerical groundwater model should be used to simulate the effects of the recharge scenarios.

### 6.2.4.12. Treatment Procedure

The FS is very general on this item. In Vol. 2 (pages 216, 217) there is some description that "mine drainage water collected in the shaft bottom pump lodge will be continuously pumped to the mine surface to be settled and subsequently used either for local irrigation or to supplement the mine water supply."

Vol. 2, page 252 contains a commitment that "due measures prior to discharge of water flow to the surface canal shall be taken so that the discharged water is within the parameters of allowable limit of safe water."

Doc. 4 (p. 4-6) describes the process as flow through a stilling basin and subsequent treatment in a treatment plant. There is no mentioning of incoming mine water quality and no conceptual design of a treatment process. This needs to be amended for the purpose of a FS and EIA of international standard.

There are conflicting statements as to which part of the treated mine water will be used for the requirements of the mine (FS Vol. 2, page 217) and whether the final discharge of treated mine water is directed into the Korotoya River (Doc. 4, pages 4-6) or used for irrigation (Doc. 4, pages 8-3). It is advisable to recycle as much water as possible for the mine requirements but for the approval process the Consortium has to clearly specify what quantity of final discharge of the treated mine water goes where.

IMC considers the mine water treatment process requires a comprehensible conceptual design including fundamental data of incoming mine water quality and quantity. Main quality data could be obtained from leach tests as suggested above. These tests would clarify if, in addition to physical treatment in form of settling of solids, more sophisticated physical or chemical treatment is required. The treatment process has to yield mine water discharge qualities at least in compliance with Schedule 10 of the Bangladesh Environment

Conservation Rules, 1977. It is likely the treatment process can be limited to removal of total suspended solids (TSS) as is the case at Barapukuria mine. The present regulations call for less than 150 mg/L TSS when discharging into Inland Surface Water or less than 200 mg/L when final discharge is on Irrigated Land. Both concentration limits appear high when compared with international standards, e.g. World Bank maximum value for "Liquid Effluents from Coal Mining", July 1998, which is 35 mg/L TSS for the monthly average. IMC recommend that the treatment process should follow the World Bank Standard. It is expected that a treatment process similar to the present Barapukuria process using thickeners, suitable flocculants and sludge drying, can comply with the treatment objectives. As a low cost addition some constructed wetlands could be suitable to achieve low TSS before discharge into the environment.

IMC also recommend that the surface water runoff from the coal stocking yard and other surface areas of coal handling is properly collected and directed into the mine water treatment process plant. The design of the runoff collection system and retention basins should take into account the extreme precipitation events for a 10 year period.

It is recommended that the Consortium provides an overall water balance for the Project showing average and maximum rates expected.

### 6.2.5. Mining Subsidence Impacts

#### 6.2.5.1. Overall Impact

The preferred mining option is underground longwall mine as proposed within the FS and substantially endorsed by IMC under Section 4.2.2 above. Mining subsidence will be a major impact on the use of land within the extractable areas of the mine which is presently primarily dedicated to rice cultivation producing surplus yields. This form of cultivation is sensitive to water level and regional drainage. Modest subsidence of ± 300-500 mm in an area that varies in level by less than 1.0 m will effectively preclude rice production and also preclude cultivation of other crops in the monsoon season due to water logging.

Subsidence impacts will not occur instantaneously but will progressively develop across the affected area concurrent with the mining of the first target seam. This may be envisaged as a subsidence wave crossing the area in front of the mining operation. Subsidence will commence immediately upon the extraction of the first longwall face assuming that a critical panel width is mined initially. For the first longwall face approximately 90% of subsidence can be anticipated as the face is being mined and thereafter would continue for a period of 12 months after completion of the face to reach a maximum.

Although detailed strata behaviour cannot be accurately predicted until such time as subsidence monitoring is implemented to calibrate a subsidence prediction model, as a general rule of thumb, maximum subsidence for a given face may be assessed as 0.7 times the extracted depth, that is 3.5 m for an extraction depth of 5.0 m consistent with mining height proposals for the first seam mined.

In order to maximise resource extraction the FS indicates mining will be undertaken using "pillar less mining" methods involving hit and miss panels within the seam. After alternate panels have been mined out, the surface will adopt a standard subsidence profile with maximum subsidence at the panel centre repeated at intervals of 2 times the panel width selected. However, IMC would not recommend this approach from a strata control, production optimisation, methane and spontaneous combustion management point of view as described in Section 1.3. The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre.

Upon completion of all longwall faces in the first seam it may be envisaged that the surface profile will be a depression of 3.5m over the whole mined out area reducing at the perimeter of the mined area to a zero subsidence line anticipated 200 to 400 m from the mined out boundary. Special consideration is required adjacent to faults which may reactive the fault or concentrate subsidence effect along the fault line.

Likewise mining successive seams will increase the subsidence depth over the area of the seam worked. The overall mining subsidence depression will be superimposed for successive seams worked to give a subsidence of approximately 0.7 times the total extraction depth.

The Consortium should address this issue very carefully during the EIA assessment and engage the local population and all stakeholders in open discussion and ensure that land owners and workers are fully informed at all stages of project development and implementation.

Agricultural production in the area is a valuable resource and, as such, the plans presented showing affected areas and phasing with an underlying objective of keeping land in productive use for as long as possible to effect a gradual and extended transition from agricultural activity to other forms of employment.

#### 6.2.5.2. Subsidence Mitigation

Subsidence mitigation by hydraulic stowing as suggested in the FS is impractical and has proven ineffective when used in conjunction with high production longwall operations for the reasons stated in Section 4.0 (Mining) of this report.

IMC suggest the following measures that may be investigated based on firm data obtained in the next phase of Project development to extend the period land can be used productively.

- The FS suggests that waste material arising during development (excavations in rock) may be disposed of commercially based on the experience of the Barapukuria mine. IMC concur, but note that this will not be the only waste from the mine and associated operations. Geological data obtained to date indicate that the seam section splits and contains dirt bands. The extent cannot be assessed accurately at this stage based on the available geological data, but it is highly probable that the mining section will contain both coal and significant dirt partings necessitating the need for coal washing. Preliminary indications would suggest that the washing of 5 Mtpa of ROM would be required to achieve a saleable product of 4 Mtpa. Over a mine life of 30 years (a minimum mine life taken for economic analysis) the mine this would generate in the region of 30 Mt of dirt requiring disposal. Ash generated at the associated power plants not suitable for other industrial uses will also go to waste.
- Normally, waste material would be tipped as high as possible to minimise the tip foot-print and land take. As an alternative, designated sections of land to be affected by mining subsidence can be pre-stripped, the waste material used to build up levels (+ 3.5 m) and top-soiled over in advance of subsidence to extend the period that designated areas of land can be used for agricultural use when mining the first seam.
- Subsidence will affect the hydrological regime of the area at the intermediate stage possibly isolating areas not yet affected by mining subsidence. Mitigation measures should be investigated which temporary restores the localised drainage regime to extend the period of land use. This may involve vertical re-alignment of existing

drainage, construction of a major outfall drain, localised pumping or a combination of both.

## 6.3. Re-settlement Plans

The FS acknowledges that some re-settlement would be required due to the mining activities (Vol. 1, page 139). The mine surface facilities as discussed in IEE, Chapter 5, aim to reduce re-settlement requirements to zero (preferred Option 1). A re-settlement plan is mentioned in the proposed ToR of the EIA (Doc. 4, Annex 4). This is also a requirement of international standard, mentioned in the "Equator Principles" as well as in the new DoE EIA Guidelines (Chapter 7.9). The Guidelines have requirements for "Resettlement and Rehabilitation" (R&R) plans to a great detail which are not repeated here.

Verbal information obtained from Barapukuria mine indicate that simple adherence to legal requirements, acquisition of immovable property Rules (No. S.R.O. 172-L/82), will not solve the social problems involved with re-settlements in an amicable way. The EIA Guidelines (Table 7.3) provide a very suitable "Recommended outline for an R&R plan" which the Consortium should follow. From experience in European countries IMC recommend that the Consortium start the re-settlement of affected persons as early as possible.

IMC recommend that the Consortium plan the re-settlement as early as possible but certainly well in advance of approaching of mining operations and consequential mining subsidence effects.

IMC recommend that re-settlement plans are fully integrated with socio-economic mitigation measures.

## 6.4. Socio Economic Impact

The IEE includes a Chapter 4.5 which is titled "Socio-economic Profile". It is based on existing census data issued in 2001 by the Bangladesh Bureau of Statistics. A quantitative statement on expected impacts is not available from the Project documents.

The new EIA Guidelines are very detailed on key socio-economic issues and impacts (Chapter 3.5 and Table 10.1, No. 3.g and 4.i). The Guidelines require that the census data should not be older than 5 years or alternatively, adequate primary surveys need to be performed.

The Consortium should perform a new socio-economic survey in conjunction with the DoE. A satisfactory description of expected socio-economic impacts plus adequate mitigation procedures should be made. The issues and impacts to be considered need to follow the DoE Guidelines.

In the context of the Khalashpir project, the primary impact to be addressed is the loss of livelihood by the majority of persons living in the area who depend wholly on agriculture for their income. This must be addressed by the Consortium at project inception and appropriate mitigation measures identified and committed as part of the project plan.

With the exception of temporary compensation payment to facilitate project development activity, IMC is not convinced that a compensation and financial incentive approach is effective in the longer term. Recent experience with the Barapukuria and Phulbari Projects highlights the over-riding aspiration of the local populace to ensure that there is a future not only for themselves, but also for the children and their children's children. Social mitigation measures should therefore be presented and committed to remove this concern at project inception.

IMC would suggest that the following measures be investigated by the Consortium to offset loss of livelihood for existing workers and their descendents and, where found feasible, made a condition of permitting:

- Preference given to affected persons for employment during mine construction and operational phases;
- Construction of a model village to house displaced persons and those destined to be employed at the mine. It is in the interest of the Consortium to develop a healthy and literate workforce justifying medical and schooling facility within the village;
- Zone areas (at the industrial site entrance) for retail development to service construction and operational personnel and give preference to those affected persons for first option on prime retail locations; and
- Zone areas for industrial development for the manufacture of local manufacture and supply of mine supplies to provide alternative source of employment.

The Consortium may also consider investment in upgrading surrounding agricultural areas (outside the zero subsidence line) that are low yield or presently unsuitable for productive use and thereby offset the loss of agricultural production from the mining affected area and thereby retain agricultural jobs in the area.

IMC recommend that the Consortium purchase all land likely to be affected by mining and supplementary land requirement for mitigation measures at project inception to ensure the Consortium's (or their successors) capability to manage and implement committed mitigation measures for which it is responsible and to prevent land speculation by persons from outside the area, a potential source of major dispute with local peoples. This land can be leased back for continued use until such time as commercial agricultural use is precluded by land drainage constraints arising from mining subsidence.

## 6.5. Reclamation

There are no details about reclamation and compensation issues in the Project documents. The statements included in the FS, Chapter 16, indicate the willingness of the Consortium to "to obtain best results through consensus decision wherever possible" (Vol. 2, page 253). This is certainly a good basis but details need to be developed. As an essential pre-requisite the land register described above is required.

IMC considers that the Consortium should describe in detail reclamation procedures and produce a closure plan. The cost of which to be reflected in the Project cost schedules.

The FS does not address in any detail potential outcomes following the completion of mining operations.

The form that the remediation plan takes depends on whether open pit or underground methods are adopted.

For open pit operations standard procedures allow for the restoration of levels and the land returned to its original use as mining progresses across the take. Under normal circumstances where the original terrain was undulating and not constrained by drainage factors, it would be possible to re-contour the land and return the land to its original use without the need to import significant quantities of material. However, to return land to its original use at Khalashpir, substantial volumes of material equivalent to the coal volume extracted over the life of the mine would have to be imported. Potentially, this could be achieved by importing material at distance from river dredging activities but would be at substantial costs rendering the project financially unviable. Ultimately, a significant area of the land may be reclaimed, but there would still remain a sizeable void and expanse of water over a large area.

Underground operations will result in a subsidence depression equal to approximately 0.7 times the extracted depth extending over the total mining area making restoration to original land use financially unviable as with the open pit option.

For both mining methods this residual state is not unmanageable from an engineering perspective involving draining the catchment area into the existing river course to maintain stable water levels. Remediation/mitigation would then concentrate on identifying viable alternative uses for the expanse of water. In the UK and closed mining operations in Europe, such areas have been successfully turned into amenity areas attracting large numbers of visitors and the development of a tourist and leisure resource incorporating holiday homes, hotels and service support industries. Other uses adopted include the development of large and small scale fish farming which is well within the traditional skill base of the local populace. As a benefit the water resource would be an economic source of irrigation for surrounding areas during the dry season, reducing present seasonal and energy inefficient pumping activities.

Such solutions should be considered at project inception stage and financial provision made for implementing the closure plan.

### 6.5.1. Financial Guarantees

The EIA Guidelines only ask “Is there a provision for financial surety for implementing the mine closure plan?”. This is a crucial point because in the past some mining companies ran out of financial resources when it came to production end leaving closure costs to Government and local authorities. In the EU this is now addressed under Directive 2006/21/EC of 15 March 2006 which calls for financial funds to be provided by the operator and to be available at any given time for rehabilitation of the land affected. Similar financial guarantees are also international standard in the event a conditional temporary or limited permit is granted to an applicant at earlier stages of a mine project. This tool allows for some flexibility in the approval process.

IMC recommends that the Consortium includes in any permit adequate financial guarantees (bank guarantees, bonds or cash deposits) so that reclamation and mine closure can be performed in the event of the Consortium becoming insolvent.

The cash cost of any such guarantees should be adequately provided in the FS financial model.

# 7.0 FINANCIAL EVALUATION

FS Section 17 shows the investment cost of the Project and resulting cashflow evaluation to obtain a "free cashflow" and "Internal Rate of Return" (IRR) and "Net Present Value" at an operational level without any depreciation.

This FS evaluation has followed the Project Proforma (PP) approach to project evaluation but IMC considers that there are two basis issues which cause concern:

- Phased costs and cashflows are not referenced to an implementation or phased mining plan; and
- There is very little detail or justification of the costs used.

## 7.1. Capital Investment Programme

The FS capital investment has been built up from a limited number of cost categories with little supporting detail. IMC has prepared a series of capital expenditure template tables, in Appendix 4, showing the approach that would be expected at feasibility study level for a capital expenditure build up. Appendix Table 1 shows the Summary with Appendix Tables 2 to 15 showing the build up under the following categories:

- Pre Project Costs;
- General Expenses;
- Preliminary Cost;
- Shaft Sinking;
- Surface Structures;
- Auxiliary Items;
- Coal Clearance and Ventilation;
- Power Supplies and Distribution;
- Coal Preparation Plant;
- Surface Mineral Handling;
- Underground Drivages;
- Underground Permanent Equipment;
- Longwall Face Equipment; and
- Monitoring and Control Systems

IMC would recommend that the capital investment and sustaining capital schedule be reviewed and updated adopting the above approach. Once the absolute values have been established within the acceptable error margins for a feasibility study they should be phased in accordance with a:

- Project implementation programme; and
- Phased mining plan with a LOM production / development schedule.

IMC would expect to see this build up supported by manufacturer's and contractor's indicative quotations for equipment and major construction items, eg shafts, access spine roads and pumping systems etc.

The FS supplementary report included a "List of Capital Equipment" omitted from the original FS. IMC consider the list to be far too generic and not sufficiently extensive to form a feasibility study evaluation. Quantities, site specific planning and outline design criteria should form the basis of the equipment list. For example the FS has no provision, apart from functional buildings, for surface facilities or infrastructure.

## 7.2. Operating Costs

The FS operating costs used in the financial evaluation have the same deficiencies discussed in the capital expenditure section above, basically there are:

- No explained calculations or a justified basis for the operational cost values used, which are only summary values without any build up detail. For example there is no costed manpower schedule for the various stages of the Project development as recommended in Section 4.4.
- No phased mining plan with a LOM production / development schedule to justify the operational cost phasing.

IMC would again recommend that the operational cost estimates be updated adopting the above approach, with phased costs established from operational plan schedules for each cost category.

## 7.3. Financing

The FS does explain the proposed mechanisms for financing the Project either in principle or detail. There is a proposed interest rate of 11% applied to the debt aspects of the financing which are geared at 25%.

IMC would have expected the Project financing to be either outside the scope of a project feasibility study or if included the financing structure should be explained in detail. This explanation should show what safeguards the Consortium are proposing to give the appropriate level of comfort to the Licensor, in this case the GOB and particularly the HCU.

## 7.4. Financial Evaluation

It is difficult to comment on the efficacy of the financial evaluation until all the recommendations described throughout this Report are implemented and a reliable LOM Project cashflow is available. However, IMC would make the following comments about some individual key values used in the FS financial evaluation.

- Project period 2006 to 2009 is clearly out of date and is likely to be too short;
- Exchange rate 69 Taka to1 US$ needs updating;
- The evaluation should be on a real not nominal cash basis stating the year of origin;
- A real discount rate of 15% is too high and IMC would recommend 12.5%, subject to financing body approval;
- Taxes on imported equipment and the Project as a whole are not adequately represented; and
- PSF proceeds prices of 50 US$ per tonne ex mine appear to be too low. IMC would have expected to see approximately 90 US$ per tonne for coking coal and 65 to 70 US$ per tonne for PSF for long term project evaluation, subject to an East Asian based market study.

## 8.0 CONCLUSIONS

IMC has come to the following conclusions from its FS review:

- There are fundamental geological data issues that must be addressed before progress can be made towards establishing realistic and financially viable mining and business plans;
- Additional exploration by surface drilling is required which must be undertaken to JORC standards;
- Analysis indicates that some of the coal sampled could have metallurgical coking properties and should be re-tested from fresh samples;
- The Khalashpir coal deposit could not be extracted by opencast methods;
- Underground mining would be the preferred method of coal extraction for a deposit of the Khalashpir specification, particularly with respect to the surface environmental and social considerations;
- Once the ROM production is defined the Consortium should evaluate the life of mine costs from a production capacity, ventilation (mine temperature) and spontaneous combustion management view point;
- Life of mine costs should be developed for the option of locating the pit bottom, either shaft or drifts, at the lowest part of the basin close to where the major faults converge on eastern boundary of the resource;
- FS production design parameters are out of date with respect to current longwall technology or inappropriate to meet the overall production targets and IMC has made more realistic alternative suggestions;
- The use of top coal caving longwall faces extracting a controlled coal thickness commensurate with a maximum aquifer base strain of 10 mm per metre could address the issues of numbers of operational longwall units, overall production rate and continuity, as a single face mine, but needs to be part of a detailed integrated LOM plan;
- Almost certainly some form of coal preparation will be required, which will be dependent on the saleable production products and their specifications;
- Spontaneous combustion and air temperatures are likely to be the dominant underground environmental issues, which interact and IMC would recommend the application of computer network analysis to assist the design process;
- Surface facilities and infrastructure costs associated with a mine will often approach 20% of the total capital investment;
- It is common international practice to consider the environmental and social impacts of any project in three separate stages:
  - Construction
  - Operation
  - Closure;
- Consortium should have a separate environmental department to look after all relevant issues and also to liaise with the local population to consider problems threatening the

environment in and around the mine, which should be a condition of any permit approval;

- The Dupi Tila Formation is the only regional aquifer in the area. The lower formations have apparently significantly lower hydraulic conductivities and should not be addressed as aquifers;
- The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre;
- Mining subsidence impacts should be addressed during the EIA assessment and engage the local population and all stakeholders in open discussion to ensure that land owners and workers are fully informed at all stages of project development and implementation;
- The Consortium should purchase all land likely to be affected by mining and supplementary land requirement for mitigation measures at project inception to ensure its capability to manage and implement committed mitigation measures for which it is responsible;
- An east Asian based marketing study is required to establish the optimal proceeds prices and mix for the various saleable products likely to be produced once the qualities are understood; and
- It is difficult to comment on the efficacy of the financial evaluation until all the recommendations described throughout this Report are implemented and a reliable LOM Project cashflow is available.

**DISTRIBUTION LIST**

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**Project Personnel** John Warwick (Project Director & Mining Engineer); Chris Thorne (Geologist); Peter Robinson (Financial Analyst); Werner Unland (Environmental).John Warwick (Project Director & Mining Engineer); Chris Thorne (Geologist); Peter Robinson (Financial Analyst); Werner Unland (Environmental).

**Key Words** Coal; Khalashpir; Barapukuria; Deep Mine; Longwall; Pillar and Stall; Rangpur.

| | Signature | Name / Designation |
|---|---|---|
| Production: | | John Warwick<br>Project Director |
| Verification: | | Chris Thorne<br>Geologist |
| Approval: | | John Warwick<br>IMC Managing Director |
| Date: | 9th December 2010 | |

# Appendix 1

# QUALIFICATIONS OF CONSULTANTS

Qualifications of Consultants

**J S Warwick Project Director**

B Sc Electrical Engineering (Hons), Newcastle University (1973); B Sc Mining Engineering (Hons), Nottingham University (1975); Mine Manager's 1st Class Certificate; Fellow Institute of Materials, Minerals and Mining; Chartered Engineer; European Engineer (Eur Ing).

34 years experience in the coal, base metals and industrial minerals mining industry and 7 years of directing Due Diligence Reports.

**Chris Thorne Geologist**

B Sc (Hons) Geology, Birmingham University

37 years experience gained in a number of UK and overseas coal mining areas, specialising in geological and geotechnical studies relating to both underground and surface mines.

P C Robinson Valuation Engineer

Associate, Chartered Institute of Management Accountants

33 years experience in the mining, minerals and consulting industry worldwide with specific experience of investment and mine purchases including the first successful listing outside China of a Chinese coal mining company.

***Dr Werner Unland Environmental Engineer**

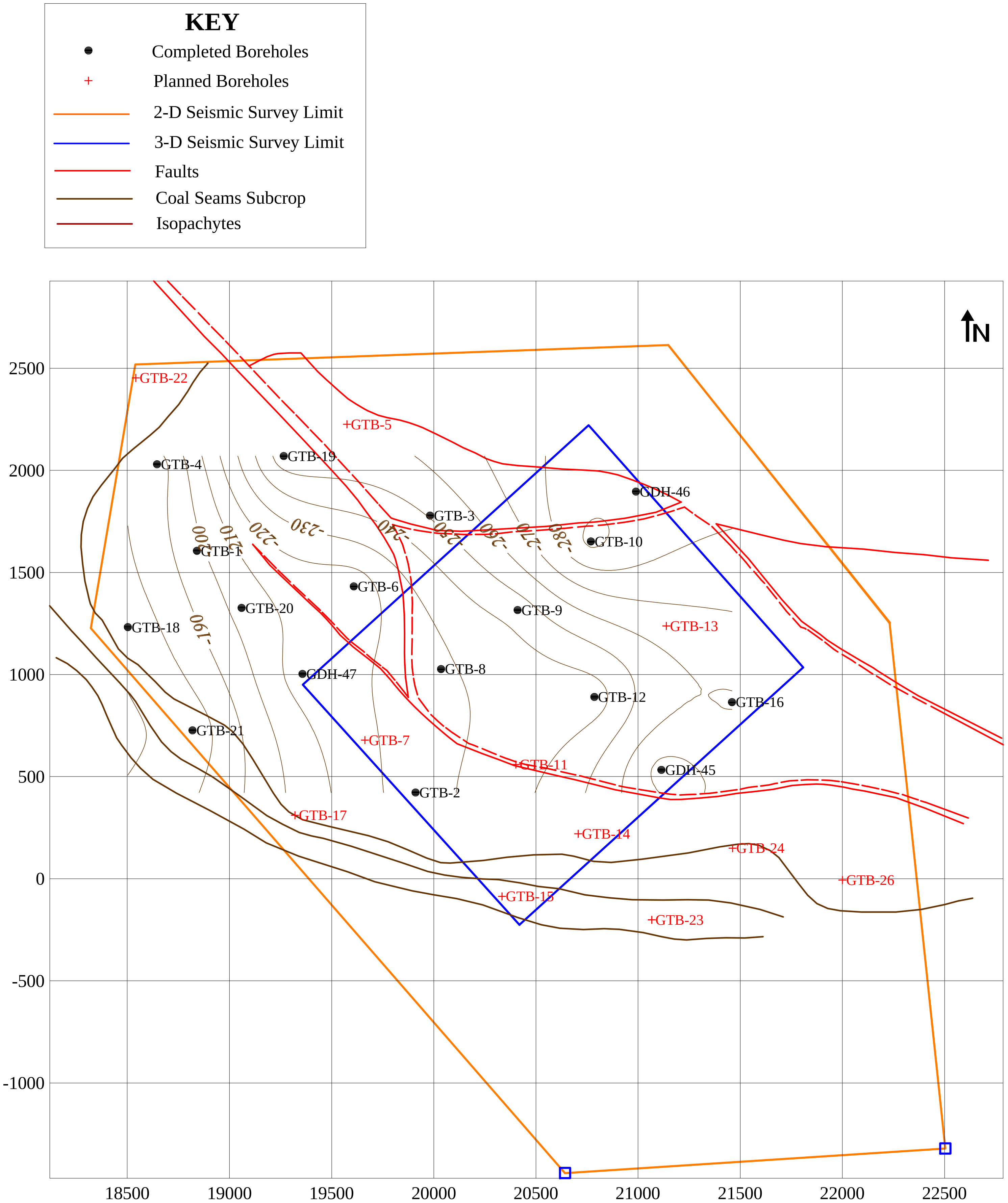
Intermediate Diploma in Geology, University of Freiburg, Germany (1970); University of Granada (1971); Diploma in Geology and PhD in Hydrogeology, University of Münster, Germany (1976); Member of the International Mine Water Association; Member of the Ingenieurtechnische Vereinigung Altlasten (German Association of Engineers dealing with contaminated sites)

34 years experience in international environmental consultancy including the assessment of environmental impacts and the performance of due diligence. Design engineer and project manager at coal mine dewatering/water management projects, waste dumps, municipal and industrial landfill sites.

* - denotes visited site

# Appendix 2

# PRELIMINARY GEOLOGICAL MODEL FIGURES



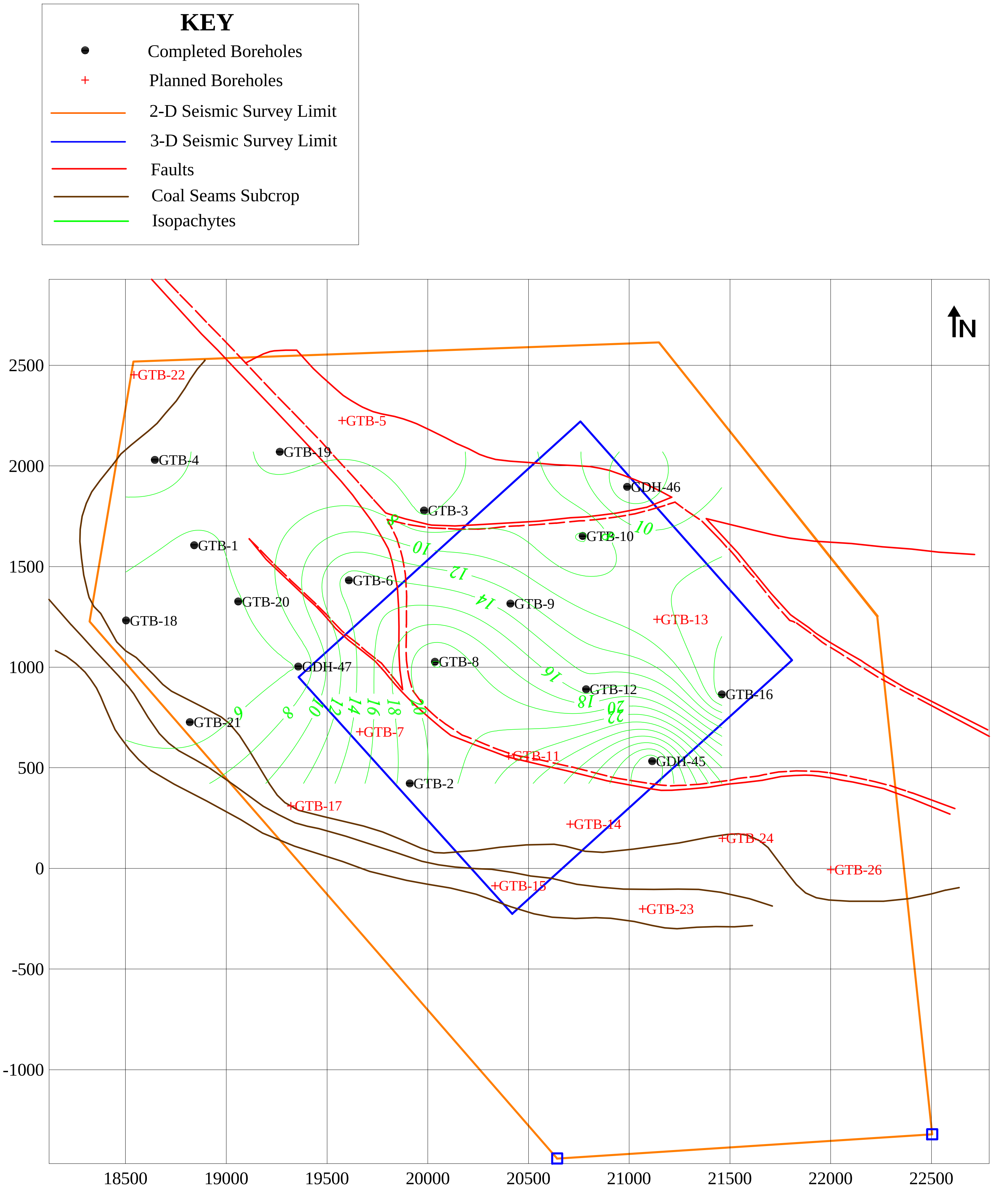

**Khalashpir Coal Mine Project**

**"SEAM I"**

**Preliminary Model of Seam Floor Contours**

**Scale 1:25,000**

**Figure 1**



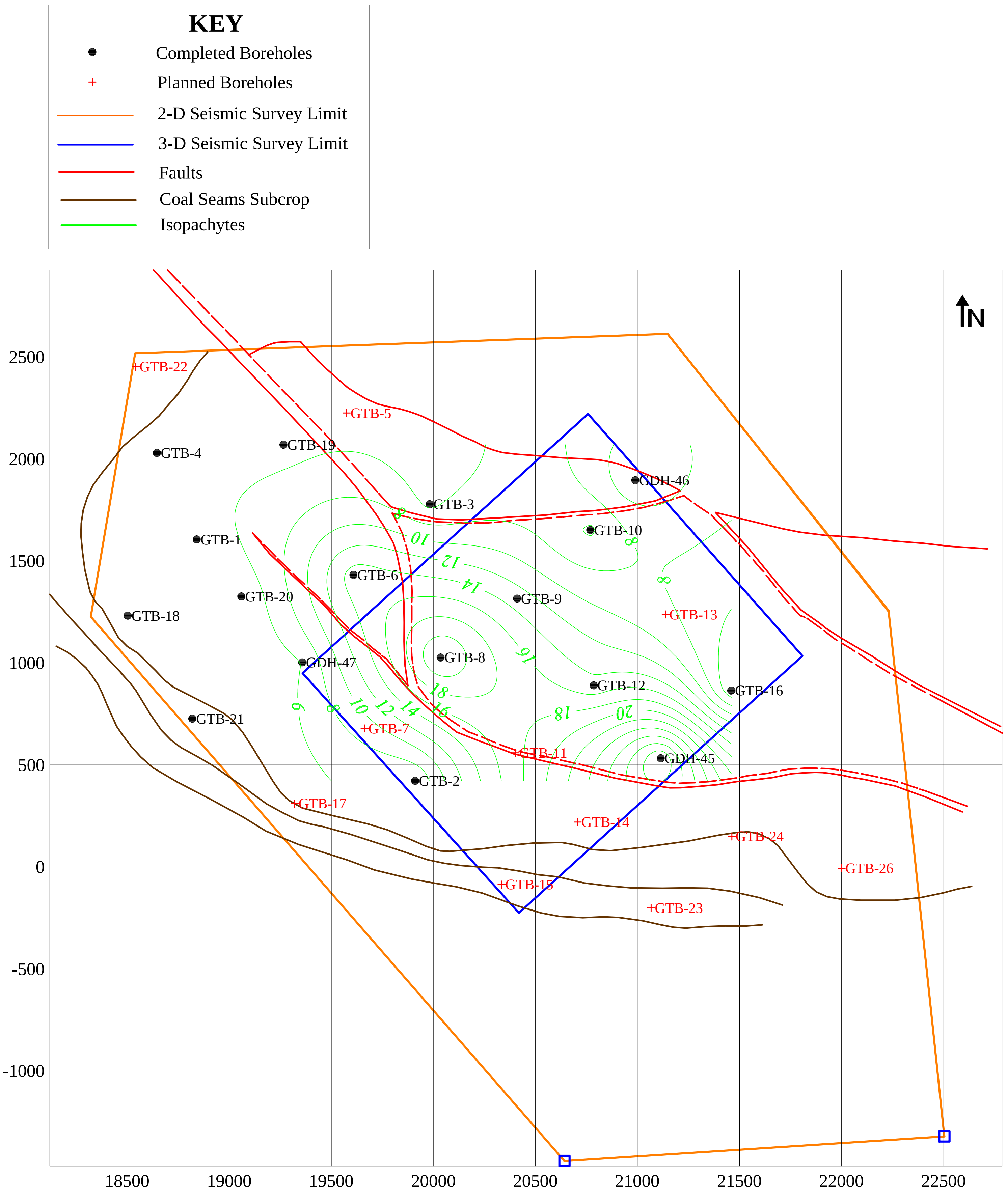

**Khalashpir Coal Mine Project**

**"SEAM I"**

**Preliminary Model of Seam Thickness Contours**

**Scale 1:25,000**

**Figure 2**



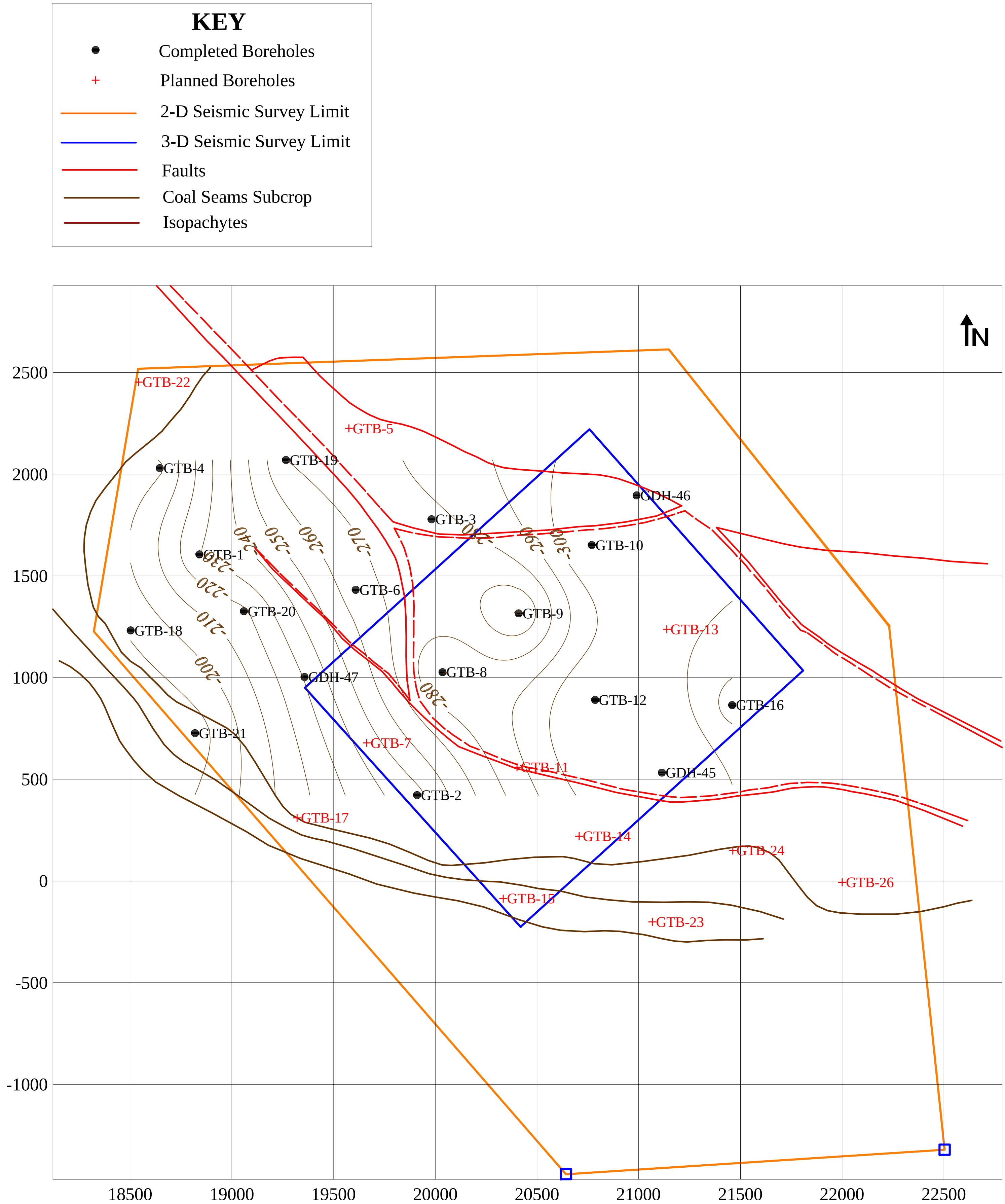

**Khalashpir Coal Mine Project**

**"SEAM I"**

**Preliminary Model of Coal Thickness Contours**

**Scale 1:25,000**

**Figure 3**



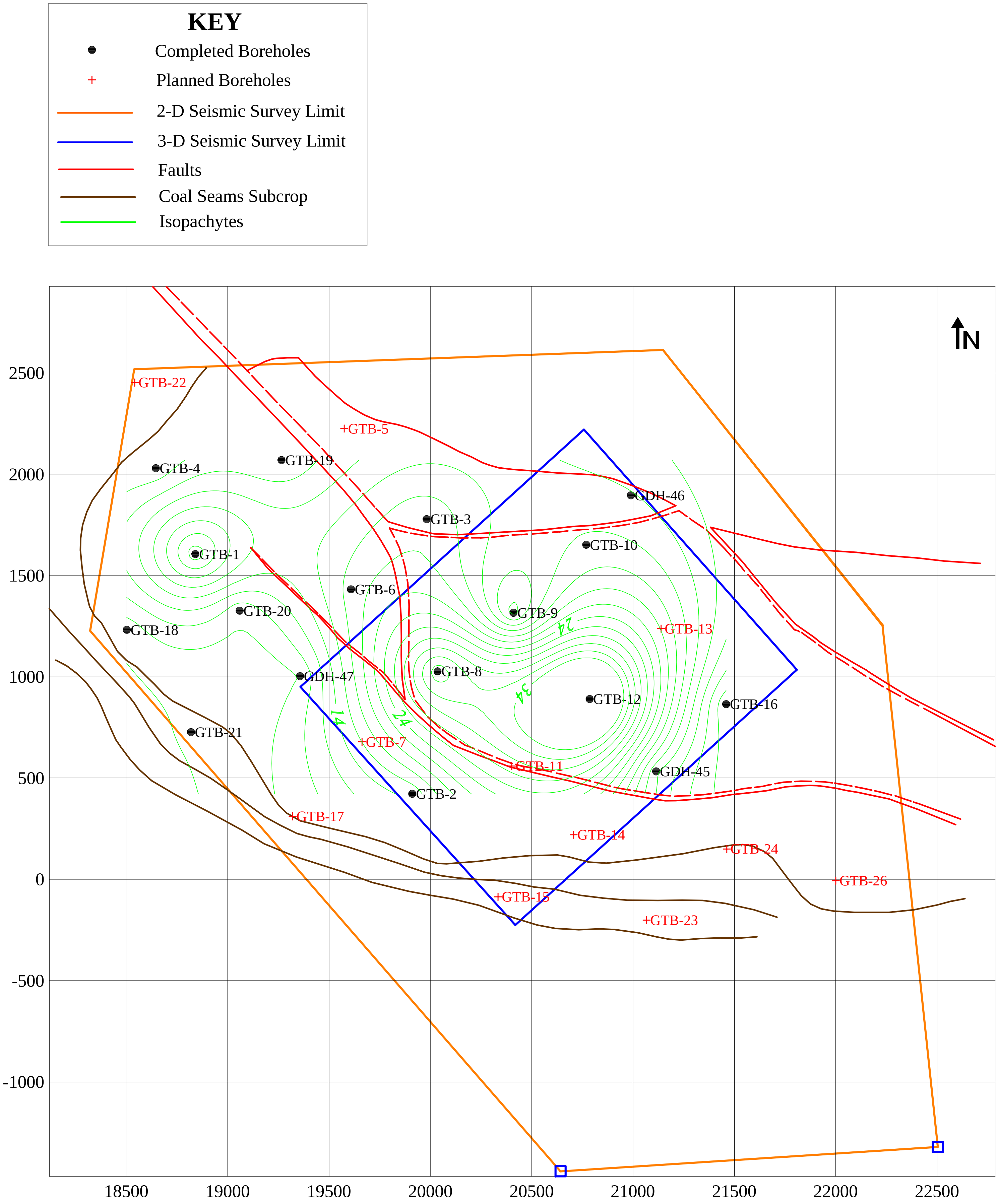

## Khalashpir Coal Mine Project

## "SEAM II"

**Preliminary Model of Seam Floor Contours**

**Scale 1:25,000**

**Figure 4**




**Khalashpir Coal Mine Project**

**"SEAM II"**

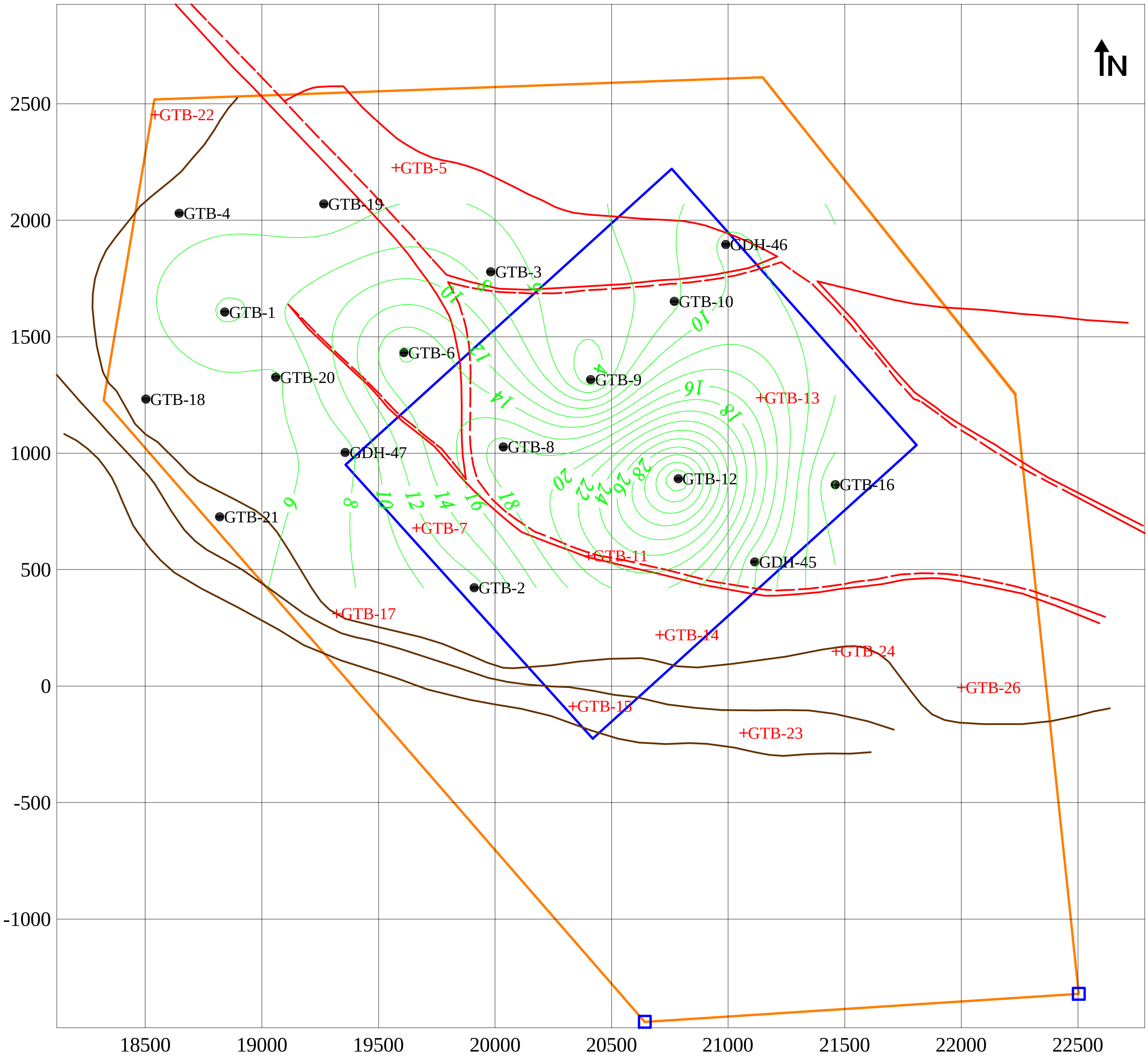
**Preliminary Model of Seam Thickness Contours**

**Scale 1:25,000**

**Figure 5**

**KEY**

- ● Completed Boreholes
- + Planned Boreholes
- 2-D Seismic Survey Limit
- 3-D Seismic Survey Limit
- Faults
- Coal Seams Subcrop
- Isopachytes



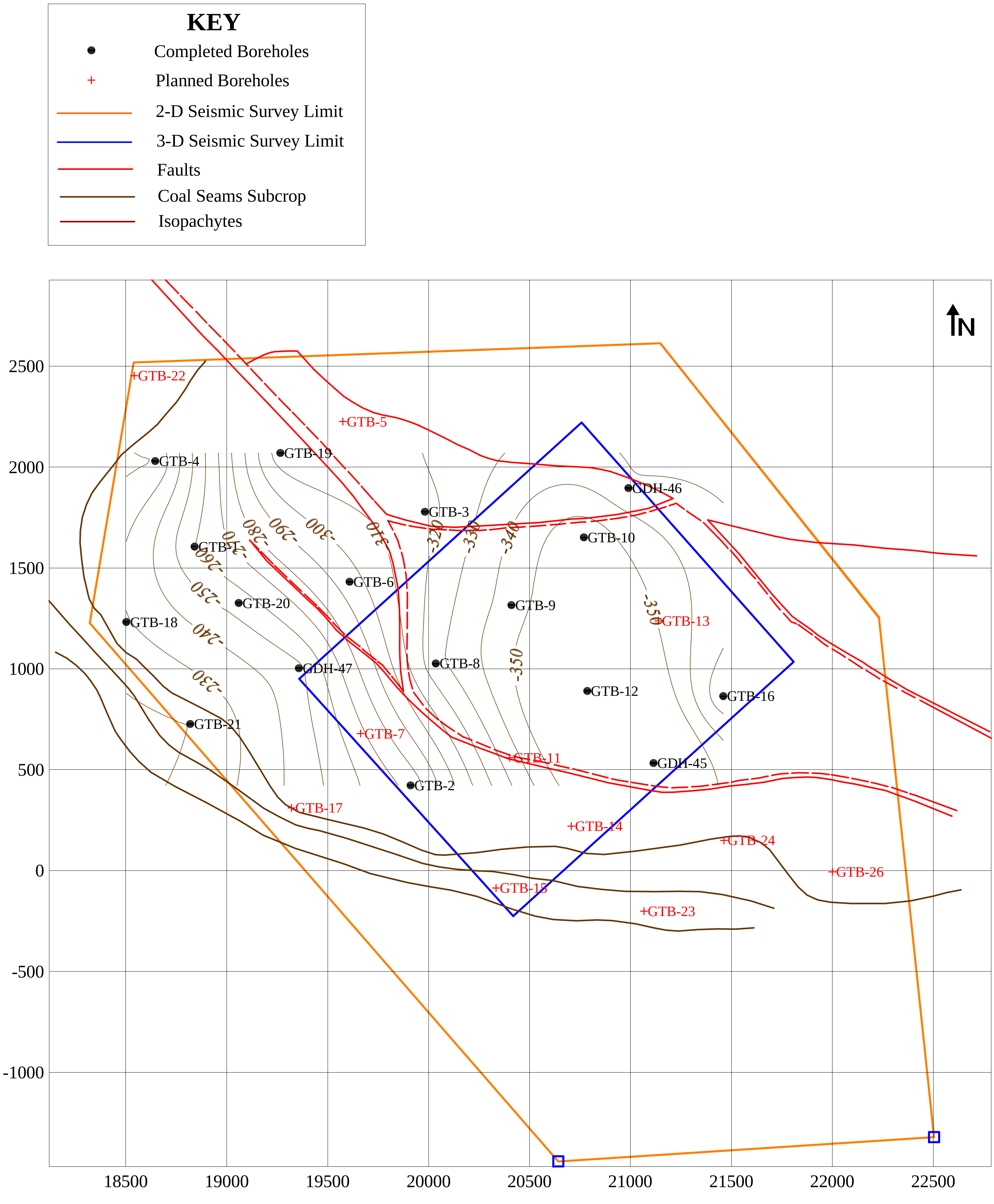

**Khalashpir Coal Mine Project**

**"SEAM II"**

**Preliminary Model of Coal Thickness Contours**

**Scale 1:25,000**

**Figure 6**



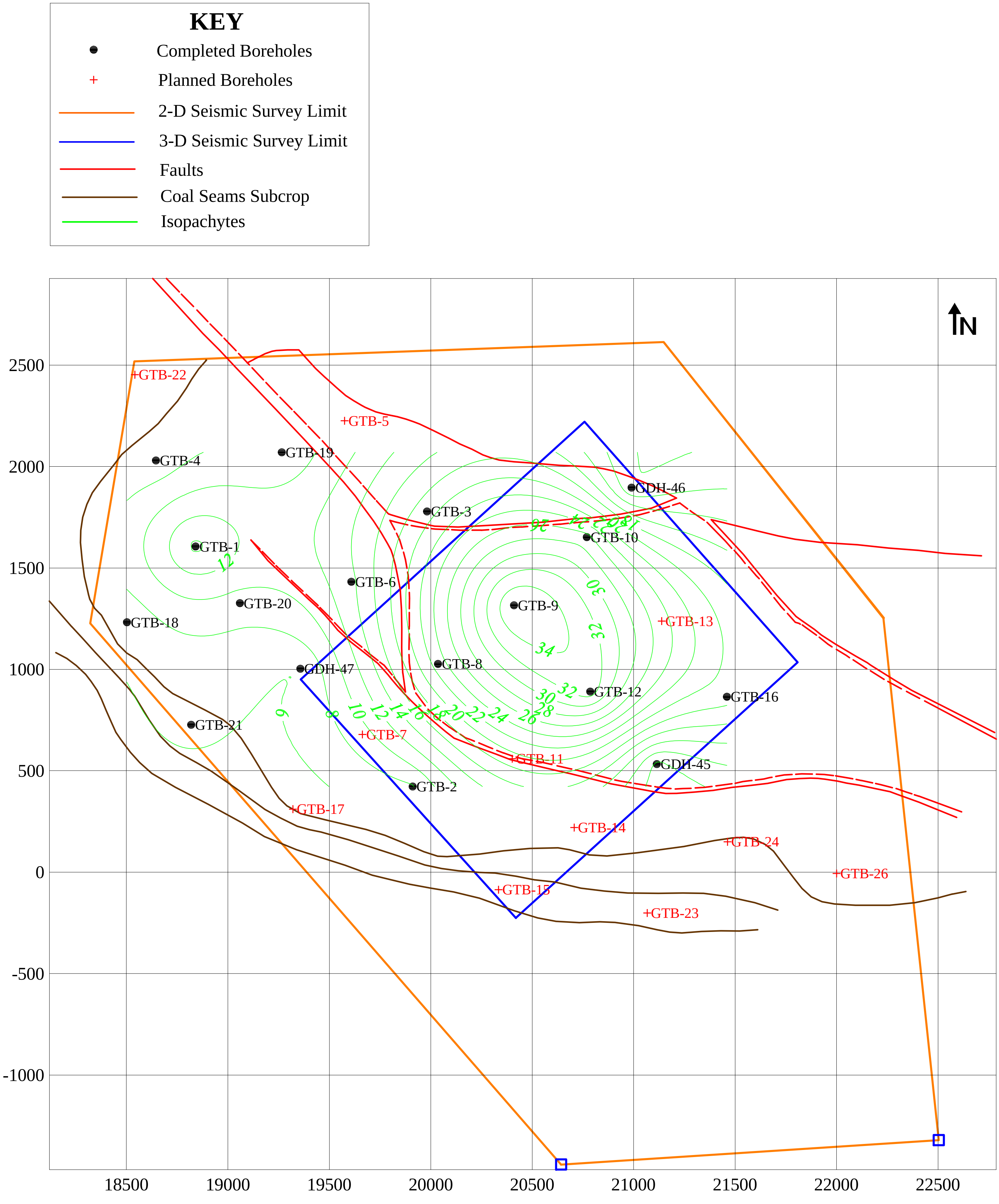

**Khalashpir Coal Mine Project**

**"SEAM IV"**

**Preliminary Model of Seam Floor Contours**

**Scale 1:25,000**

**Figure 7**




**Khalashpir Coal Mine Project**

**"SEAM IV"**

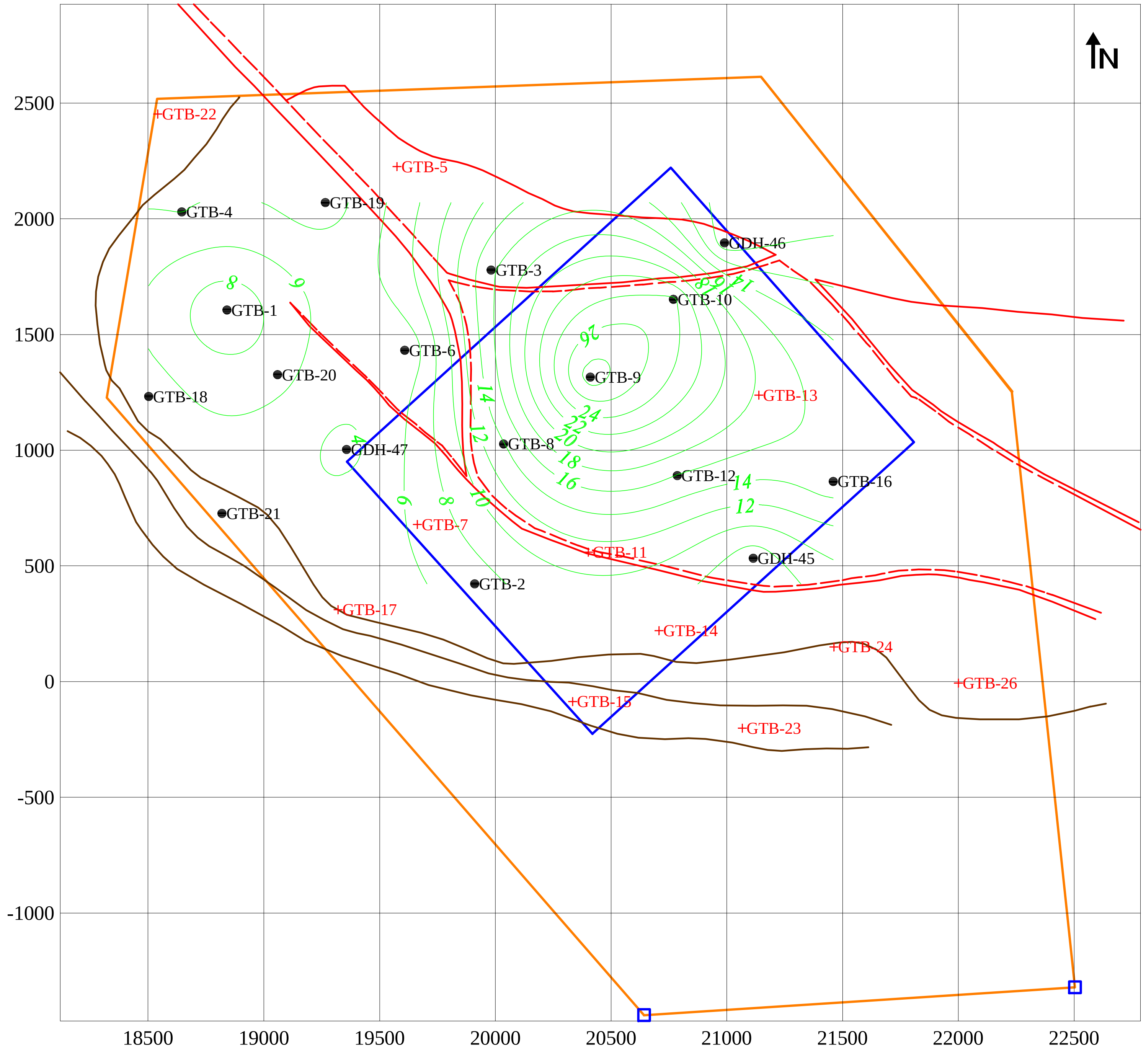
**Preliminary Model of Seam Thickness Contours**

**Scale 1:25,000**

**Figure 8**

**KEY**

- Completed Boreholes
- Planned Boreholes
- 2-D Seismic Survey Limit
- 3-D Seismic Survey Limit
- Faults
- Coal Seams Subcrop
- Isopachytes



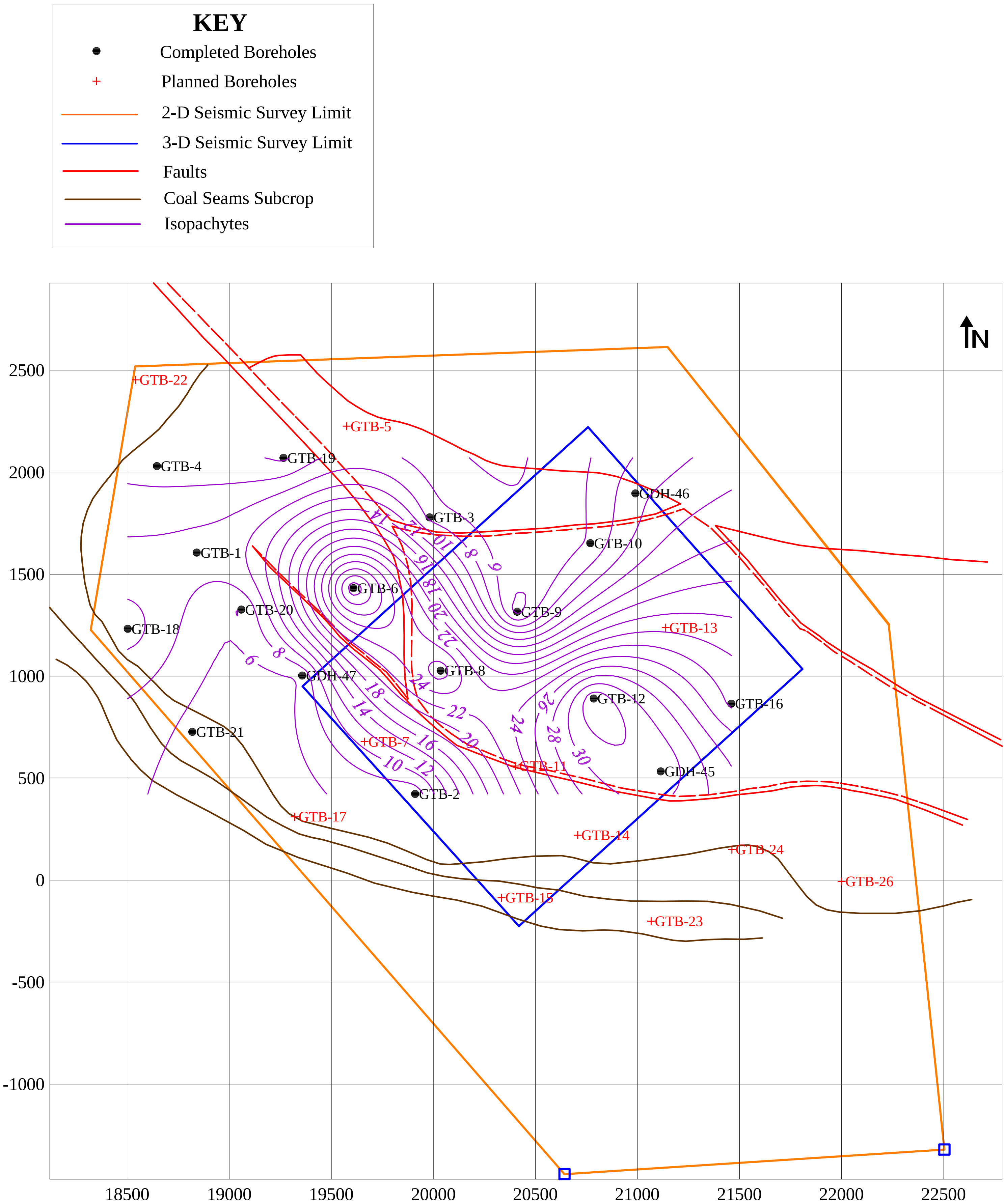

**Khalashpir Coal Mine Project**

**"SEAM IV"**

**Preliminary Model of Coal Thickness Contours**

**Scale 1:25,000**

**Figure 9**

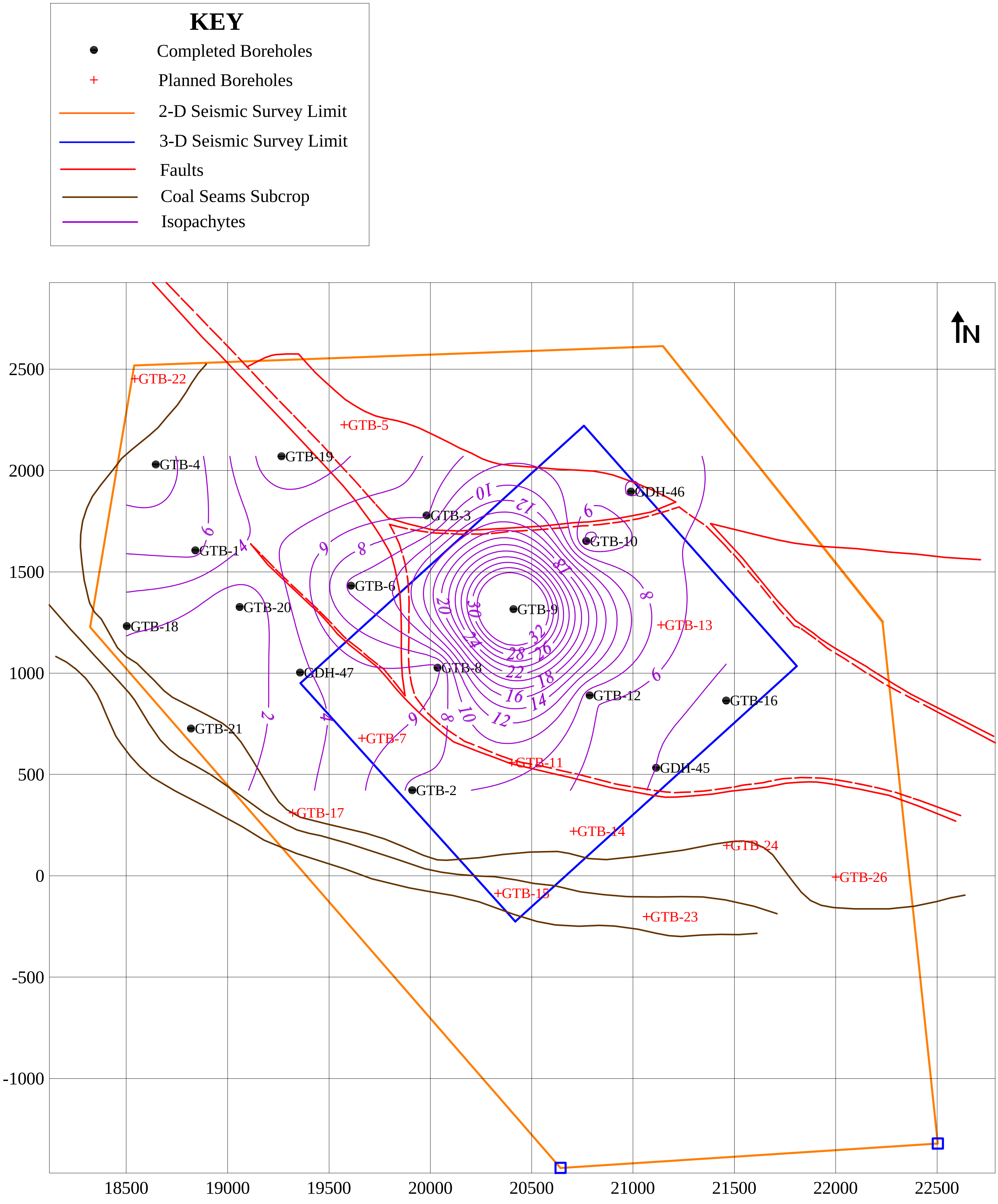



**Khalashpir Coal Mine Project**

**Preliminary Model of "Seam I" to "Seam II" Interburden**

**Scale 1:25,000**

**Figure 10**

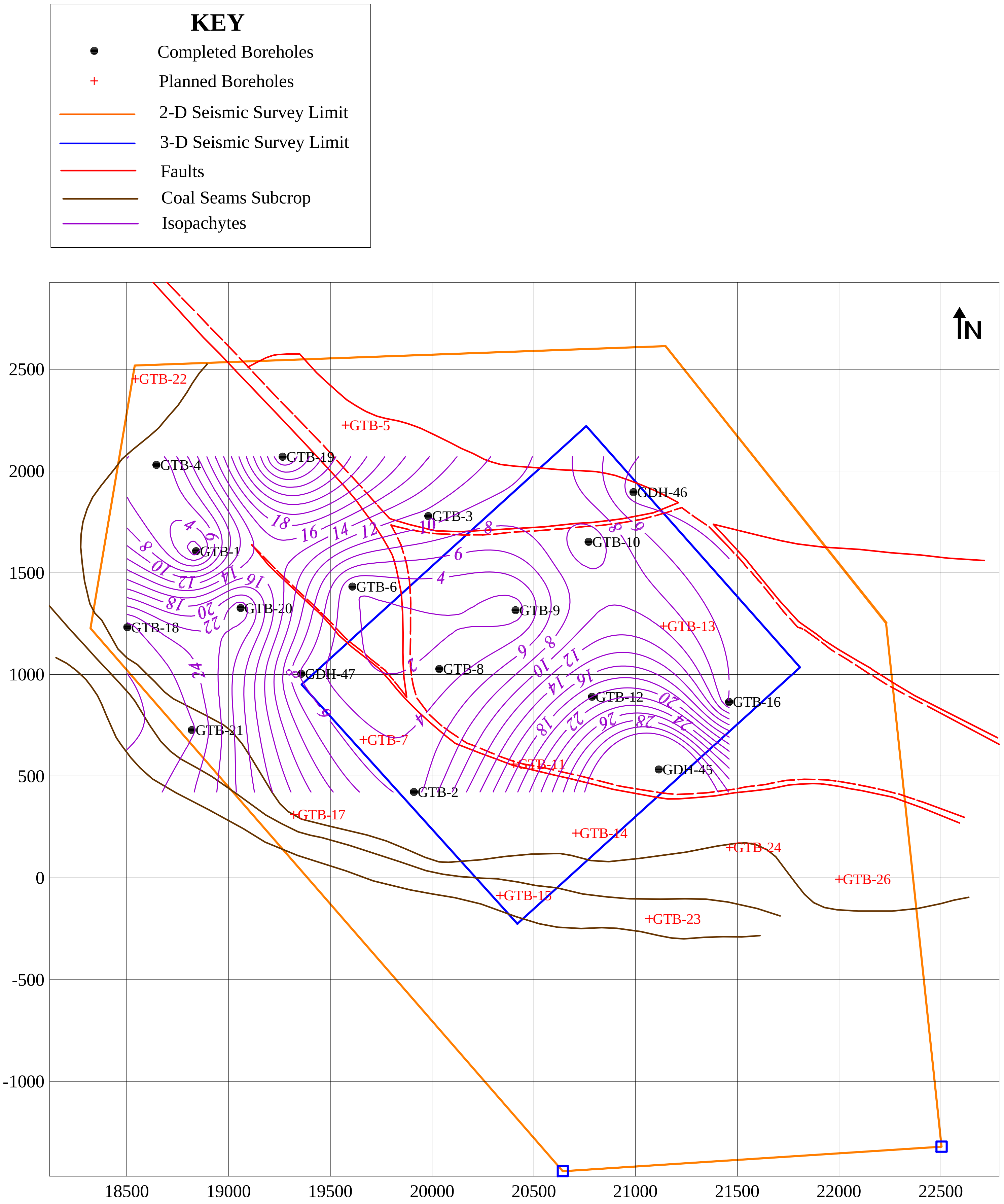



**Khalashpir Coal Mine Project**

**Preliminary Model of "Seam II" to "Seam III" Interburden**

**Scale 1:25,000**

**Figure 11**

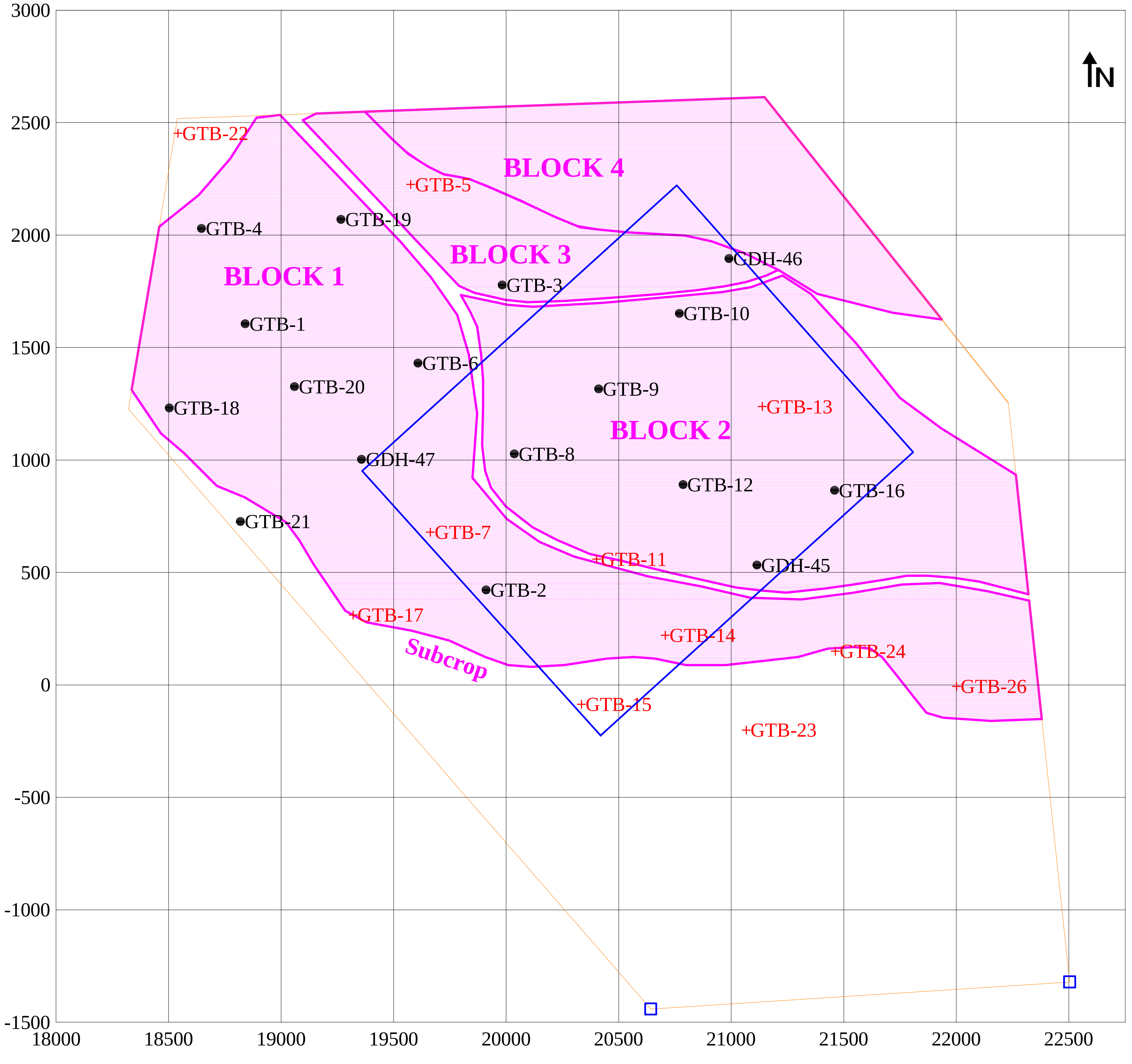



**Khalashpir Coal Mine Project**

# Preliminary Model of "Seam III" to "Seam IV" Interburden

**Scale 1:25,000**

**Figure 12**



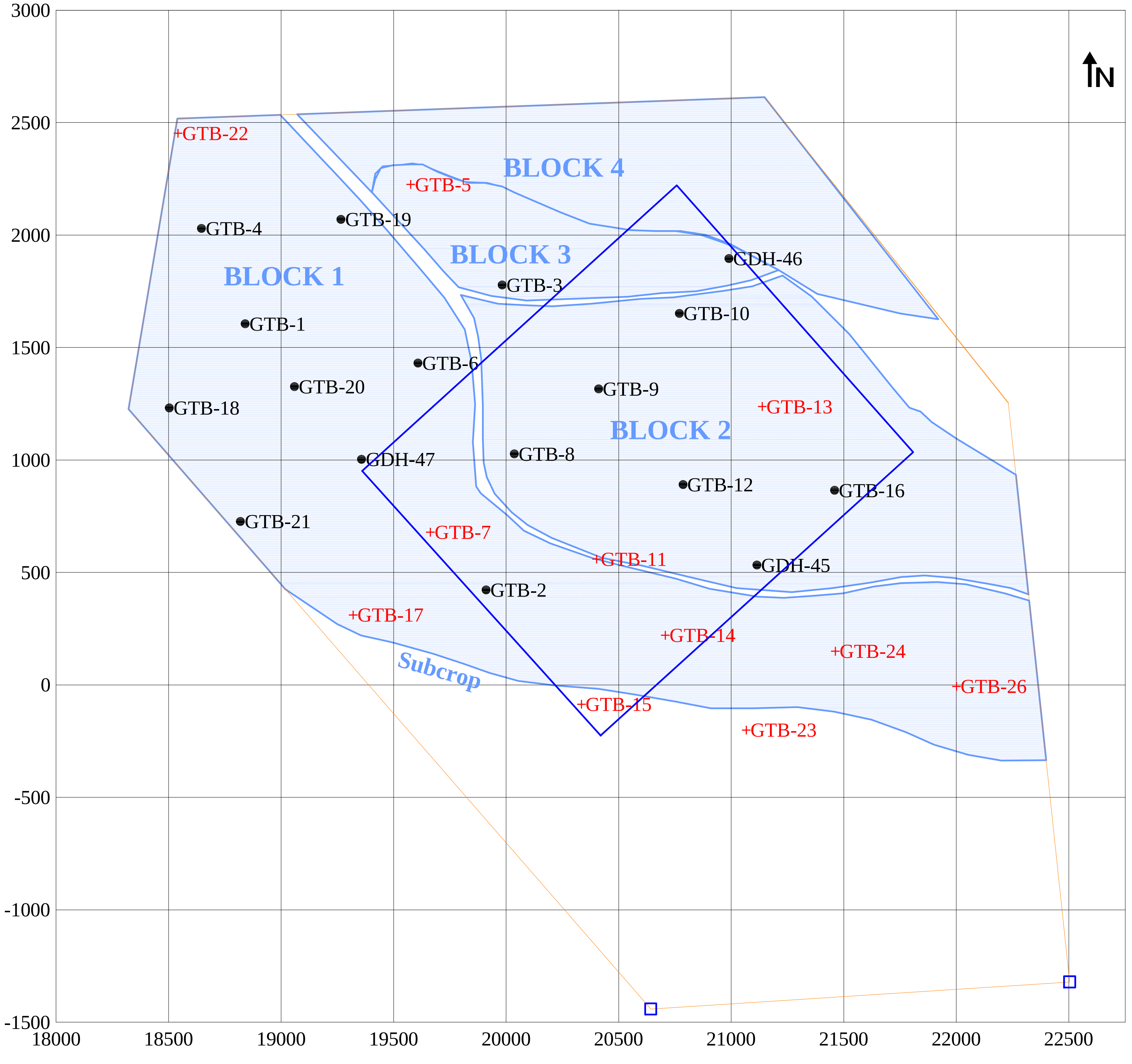

**Khalashpir Coal Mine Project**

**"SEAM I"**

**Resource Blocks**

**Scale 1:25,000**

**Figure 13**



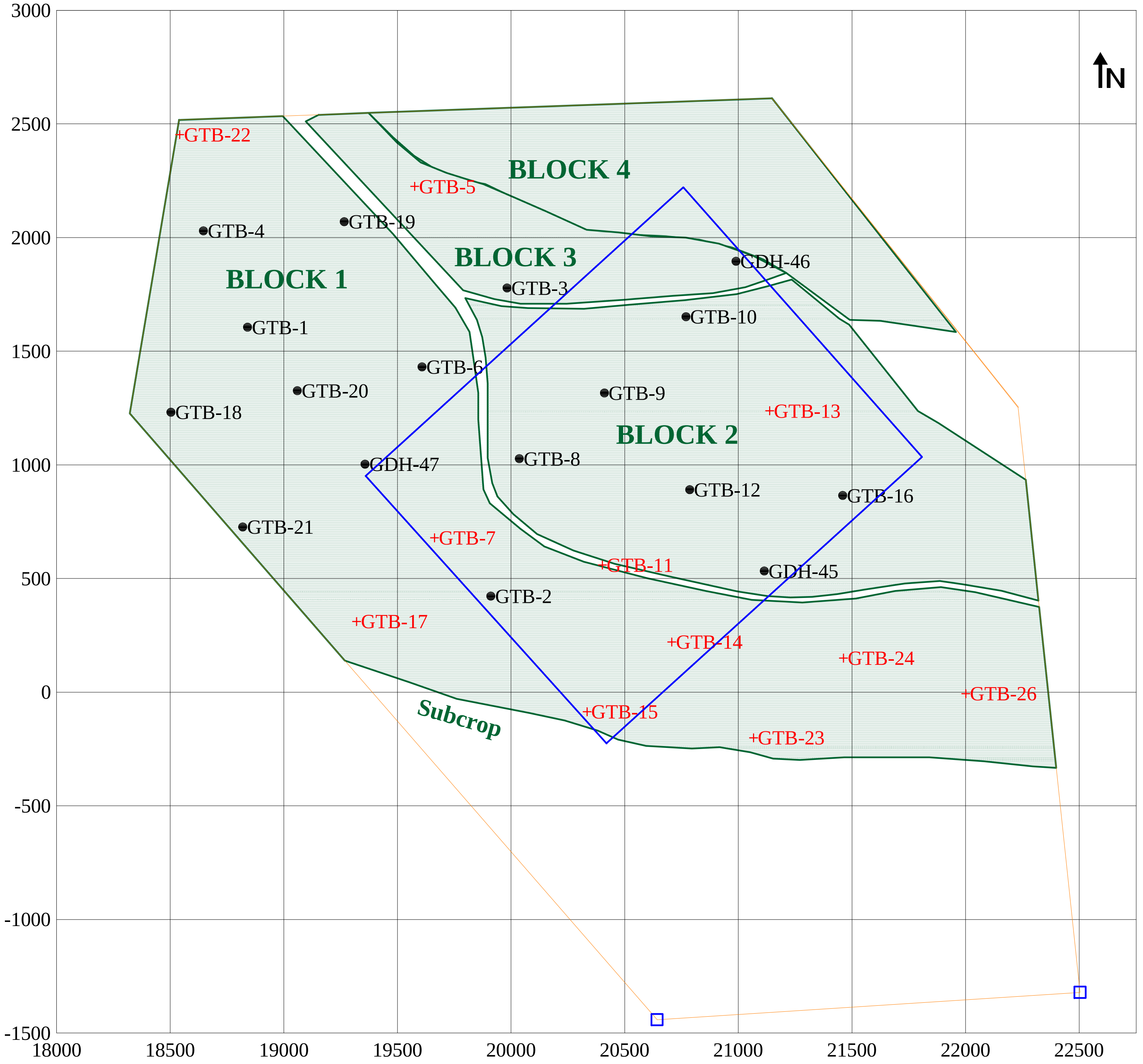

**Khalashpir Coal Mine Project**

**"SEAM II"**

**Resource Blocks**

**Scale 1:25,000**

**Figure 14**




**Khalashpir Coal Mine Project**

**"SEAM IV"**

**Resource Blocks**

**Scale 1:25,000**

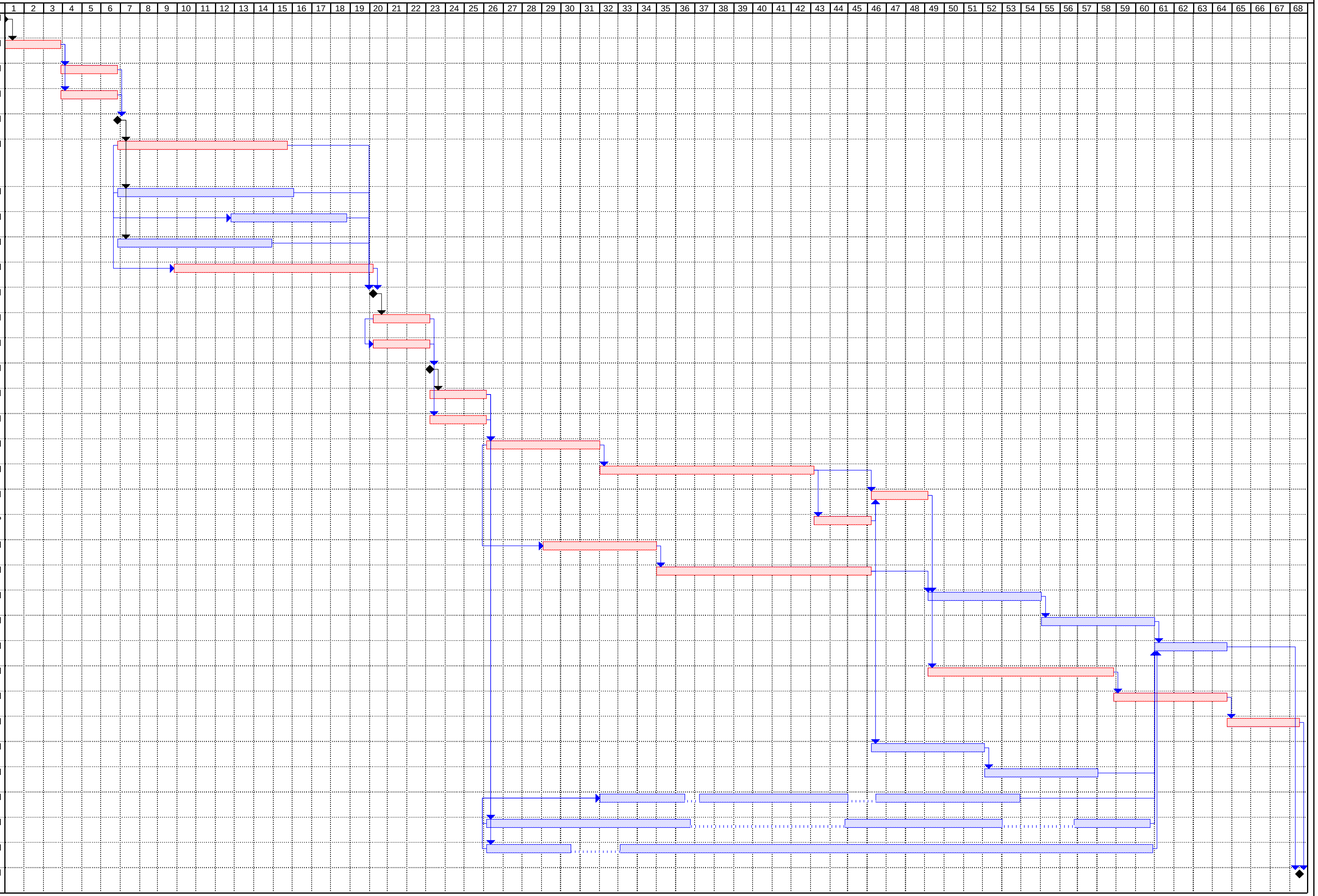
**Figure 15**

# Appendix 3

# GENERIC IMPLEMENTATION PROGRAMME

## KALASHPIR COAL MINE DEVELOPMENT PROJECT
### Example Implementation Programme
### (Based on Generic Deign)

| ID | Task Name | Duration |
|---|---|---|
| 1 | Start | 0 d |
| 2 | Evaluate Initial Study | 90 d |
| 3 | Negotiate Mining Lease | 90 d |
| 4 | Initial Environmental Clearance/Agree TOR for full EIA | 90 d |
| 5 | Issue Mining Lease (Conditional on implementation targets) | 0 d |
| 6 | Mobilise and Undertake supplementary Geological and Hydrogeological Investigation | 270 d |
| 7 | EIA baseline assessment | 280 d |
| 8 | EIA and EMP | 184 d |
| 9 | Supplementary Geological Investigation & Shaft Centre BH | 245 d |
| 10 | Update Feasibility Study to bankable Standards | 316 d |
| 11 | Submit Bankable FS | 0 d |
| 12 | GOB/Consortium Confirm Implementation | 90 d |
| 13 | Finalise Finance Package Arrangements | 90 d |
| 14 | Initiate Project Construction | 0 d |
| 15 | Detailed Design Shafts | 90 d |
| 16 | Mobilise Shaft Freezing and Sinking Contractor | 90 d |
| 17 | Shaft Drilling Freezing/Foreshaft Construction - Aux Shaft | 180 d |
| 18 | Shaft Sinking and Lining - Aux Shaft | 340 d |
| 19 | Pit Bottom Connection | 90 d |
| 20 | Instal Temp Pumps and Ventillation Plant | 91 d? |
| 21 | Shaft Drilling Freezing/Foreshaft Construction - Main Shaft | 180 d |
| 22 | Shaft Sinking and Lining - Main Shaft | 341 d |
| 23 | Development into Mining District 1 | 180 d |
| 24 | Gate and Return Drivages Face 1 | 180 d |
| 25 | Install Commission Face 1 | 115 d |
| 26 | Development into Mining District 2 | 295 d |
| 27 | Gate and Return Drivages Face 2 | 180 d |
| 28 | Install Commission Face 2 | 115 d |
| 29 | Winding System and Shaft Furnishings Main Shaft | 180 d |
| 30 | Winding System and Shaft Furnishings Aux Shaft | 180 d |
| 31 | Equipment Procurement/Manufacture | 600 d |
| 32 | Detailed Design & Construction Underground | 695 d |
| 33 | Detailed Design & Construction Surface | 980 d |
| 34 | Finish | 0 d |



# Appendix 4

# GENERIC CAPITAL EXPENDITURE TABLE TEMPLATES

## Appendix Table 1 Project Summary

| Section | Sub Section | Item | Description | Estimated Cost before Contingencies | Allowance for | | Fees | | Total Estimated | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | | £ | | | | | | | | |
| | | | **Summary** | | | | | | | | | |
| | | | | | | | | | | | | |
| 0 | | | Pre Project Costs | | | | | | | | | |
| | | | | | | | | | | | | |
| 1 | | | General Expenses | | | | | | | | | |
| | | | | | | | | | | | | |
| 2 | | | Preliminary site access and preparation | | | | | | | | | |
| | | | | | | | | | | | | |
| 3 | | | Surface Drifts | | | | | | | | | |
| | | | | | | | | | | | | |
| 4 | | | Surface Structures etc | | | | | | | | | |
| | | | | | | | | | | | | |
| 5 | | | Conveyors and Ventilation | | | | | | | | | |
| | | | | | | | | | | | | |
| 6 | | | Power Supplies and Distribution | | | | | | | | | |
| | | | | | | | | | | | | |
| 7 | | | Coal Preparation Plant | | | | | | | | | |
| | | | | | | | | | | | | |
| 8 | | | Surface Mineral handling | | | | | | | | | |
| | | | | | | | | | | | | |
| 9 | | | Underground Drivages | | | | | | | | | |
| | | | | | | | | | | | | |
| 10 | | | Underground Permanent Equipment | | | | | | | | | |
| | | | | | | | | | | | | |
| 11 | | | Face Equipment | | | | | | | | | |
| | | | | | | | | | | | | |
| 12 | | | Monitoring and Control Systems | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | Total | | | | | | | | | |

## Appendix Table 2 Pre Project Costs

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % |
| | | | **Pre Project Costs** | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | Technical and Financial Appraisal to April 2009 IMC Costs | Sunk Cost | | | | | | | | | | |
| | | | Technical and Financial Appraisal to April 2009 Company Costs | Sunk Cost | | | | | | | | | | |
| | | | Technical and Financial Appraisal to April 2009 HQ Costs | Sunk Cost | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | Feasibility Study to September 2010 | | | | | | | | | | | |
| | | | Feasibility Study to September 2010 Company Costs | | | | | | | | | | | |
| | | | Feasibility Study to September 2010 HQ Costs | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | **Geology** | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | Additional Exploration - Boreholes Faulting | | | | | | | | | | | |
| | | | Additional Exploration - Boreholes Resource Extension | | | | | | | | | | | |
| | | | Additional Exploration - 2D Seismic | | | | | | | | | | | |
| | | | Additional Exploration - 3D Seismic | | | | | | | | | | | |
| | | | Feasibility Study | | | | | | | | | | | |
| | | | EIA | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | Public Inquiry | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | Site Investigation (Boreholes, Environmental Investigations) | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

## Appendix Table 3 General Expenses

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **General expenses** | | | | | | | | | | | | |
| | | | Corus salaries & expenses year 1 | | | | | | | | | | | | |
| | | | Corus salaries & expenses year 2 | | | | | | | | | | | | |
| | | | Corus salaries & expenses year 3 | | | | | | | | | | | | |
| | | | Corus salaries & expenses year 4 | | | | | | | | | | | | |
| | | | General materials & plant hire | In Cost estimates | | | | | | | | | | | |
| | | | Salaries,Materials, Power & General Expenses Costs Year 1 | | | | | | | | | | | | |
| | | | Salaries,Materials, Power & General Expenses Costs Year 2 | | | | | | | | | | | | |
| | | | Salaries,Materials, Power & General Expenses Costs Year 3 | | | | | | | | | | | | |
| | | | Salaries,Materials, Power & General Expenses Costs Year 4 | | | | | | | | | | | | |
| | | | Salaries,Materials, Power & General Expenses Costs Year 5 | | | | | | | | | | | | |
| | | | Salaries,Materials, Power & General Expenses Costs Year 6 | | | | | | | | | | | | |
| | | | General consumables | | | | | | | | | | | | |
| | | | Consultancy fees year 1 | Lump Sum | | | | | | | | | | | |
| | | | Consultancy fees year 2 | Lump Sum | | | | | | | | | | | |
| | | | Consultancy fees year 3 | Lump Sum | | | | | | | | | | | |
| | | | Consultancy fees year 4 | Lump Sum | | | | | | | | | | | |
| | | | QS fees year 0 | In Consultancy | | | | | | | | | | | |
| | | | QS fees year 1 | In Consultancy | | | | | | | | | | | |
| | | | QS fees year 2 | In Consultancy | | | | | | | | | | | |
| | | | QS fees year 3 | In Consultancy | | | | | | | | | | | |
| | | | QS fees year 4 | In Consultancy | | | | | | | | | | | |
| | | | Planning Inquiry Costs | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |

## Appendix Table 4 Preliminary Cost

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Preliminary site access and preparation** | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Preliminary civils works | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Temporary buildings & equipment | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Temporary heating lighting, electrics | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Diversion of existing services | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | New Electrical Supply | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | New Water Supply | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Conection to Telephone System | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Wheel Wash | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Fencing to delineate the Mine Site | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Surface Roads | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

## Appendix Table 5 Shaft Sinking

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Surface Shafts** | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Site Investigation | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Intake and return foreshaft construction to 270 m | | | | | | | | | | | | |
| | | | Return foreshaft construction & airlock | In Above | | | | | | | | | | | |
| | | | Fan drift & evasse | Else Where | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Intake shaft sink (Salaries and Materials only) | | | | | | | | | | | | |
| | | | Temporary haulage | Not required | | | | | | | | | | | |
| | | | Conveyor drive, loop, electrics (Not required) | Done Elsewhere | | | | | | | | | | | |
| | | | Temporary gantries | | | | | | | | | | | | |
| | | | Temporary pumping arrangements | | | | | | | | | | | | |
| | | | Electrics for auxilary fans | Else where | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Return shaft sink (Salaries and Materials only) | | | | | | | | | | | | |
| | | | Temporary haulage | Not required | | | | | | | | | | | |
| | | | Conveyor drive, loop, electrics (Not Required) | Else where | | | | | | | | | | | |
| | | | Temporary gantries | In the Intake Figure | | | | | | | | | | | |
| | | | Temporary pumping arrangements | | | | | | | | | | | | |
| | | | Electrics for auxilary fans | Else where | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

# Appendix Table 6 Surface Structures

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Surface layout, Structures, Buildings and Equipment** | | | | | | | | | | | | |
| | | | Site investigation | | | | | | | | | | | | |
| | | | Site remediation | | | | | | | | | | | | |
| | | | Site preparation | | | | | | | | | | | | |
| | | A | Admin, Baths, Lamproom, Offices - Civils | Tech Est WYG | | 2,250 $M^2$ | | | | | | | | | |
| | | | Admin, Baths, Lamproom, Offices Equipment | | | | | | | | | | | | |
| | | H | Workshops - Civils | Tech Est WYG | | 525 $M^2$ | | | | | | | | | |
| | | | Workshops equipment mech'l & elec'l | | | | | | | | | | | | |
| | | I | Stores - Civils | Tech Est WYG | | 360 $M^2$ | | | | | | | | | |
| | | B | Methane Plant - Civils | Tech Est WYG | | 400 $M^2$ | | | | | | | | | |
| | | C | Power Generation Plant - Civils | Tech Est WYG | | 300 $M^2$ | | | | | | | | | |
| | | E | Fan House & Drift - Civils | Tech Est WYG | | 300 $M^2$ | | | | | | | | | |
| | | J | Belt drive house - Civils | Tech Est WYG | | 200 $M^2$ | | | | | | | | | |
| | | P | Main substation and MCC - Civils | | | | | | | | | | | | |
| | | | Elsewhere | | | | | | | | | | | | |
| | | G | Stores Compound & travelling o/head crane - Civils | Tech Est WYG | | 3,600 $M^2$ | | | | | | | | | |
| | | F | Car park & permanent roads - Civils | Tech Est WYG | | 3,000 $M^2$ | | | | | | | | | |
| | | M | Settling bays - Civils | Tech Est WYG | | 100 $M^2$ | | | | | | | | | |
| | | N | Pump house - Civils | Tech Est WYG | | 25 $M^2$ | | | | | | | | | |
| | | | Explosive magazine - Civils | Tech Est WYG | | 100 $M^2$ | | | | | | | | | |
| | | | Telephone & communications system - Civils | Part of accom Block | | | | | | | | | | | |
| | | | Electrics & distribution - Civils | Tech Est WYG | | 150 $M^2$ | | | | | | | | | |
| | | | Water mains distribution/ fire fighting - Civils | Tech Est WYG | | 150 $M^2$ | | | | | | | | | |
| | | | Long term/Large equipment storage area - Civils | Tech Est WYG | | 100 $M^2$ | | | | | | | | | |
| | | | Clean Coal Store - Civils | Tech Est WYG | | 500 $M^2$ | | | | | | | | | |
| | | | Compressors + Civils | Tech Est WYG | | | | | | | | | | | |
| | | | Lighting | Tech Est WYG | | | | | | | | | | | |
| | | | Surface Water Drainage | Tech Est WYG | | | | | | | | | | | |
| | | | Foul water Drainage | Tech Est WYG | | | | | | | | | | | |
| | | | Racking for Cables Etc | Tech Est WYG | | | | | | | | | | | |
| | | | Auxilliary Safety Equipment etc | Separate list | | | | | | | | | | | |
| | | | Total | | | | 0 | | | | | | | | |

## Appendix Table 7 Auxiliary Items

| Description | Number | Unit price | Total price |
|---|---|---|---|
| | | £ | |
| **Lamps** | | | |
| Electric Cap Lamps | 700 | | |
| Battery Charging Racks | 7 | | |
| Charging Equipment | 7 | | |
| Photometer Test Unit | 2 | | |
| Lamp Room Test Unit | 2 | | |
| Maintenance Equipment | 3 | | |
| | | | |
| **Self Rescuers** | | | |
| Self Rescue Units | 700 | | |
| Storage Racks | 7 | | |
| Maintenance Equipment | 4 | | |
| | | | |
| **Breathing Apparatus** | | | |
| SCBA Units | 30 | | |
| Flow Meter Test Equipment | 3 | | |
| Oxygen Charging System | 3 | | |
| Spare Parts | 3 | | |
| | | | |
| **Reviving Apparatus** | | | |
| Reviving Apparatus | 10 | | |
| Spare parts | 1 | | |
| | | | |
| **Dust Masks** | 700 | | |
| | | | |
| **Hand Held Multi Gas Detectors** | | | |
| Multi Gas detectors | 60 | | |
| Chargers | 10 | | |
| Calibration Kits | 3 | | |
| | | | |
| **Ventilation Dept Sep up** | 1 | | |
| | | | |
| **Suvey Dept set up** | 1 | | |
| | | | |
| **Computers Servers** | 50 | | |
| | | | |
| **Software** | 1 | | |
| | | | |
| **Office Equipment** | 30 | | |
| | | | |
| **Flame Safety Lamps!!!!** | 100 | | |
| | | | |
| **Boot, Gloves, Helemet, Respirators, Shin Guards, Goggles etc** | 700 | | |
| | | | |
| **TOTAL** | | | |

## Appendix Table 8 Coal Clearance and Ventilation

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Coal Clearance Transport and ventilation systems** | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Surface Shaft | budget estimate | | | | | | | | | | | |
| | | | | (Continental) | | | | | | | | | | | |
| | | | Pit Bottom | budget estimate | | | | | | | | | | | |
| | | | | (Continental) | | | | | | | | | | | |
| | | | West spine road 1st leg | budget estimate | | | | | | | | | | | |
| | | | | (Continental) | | | | | | | | | | | |
| | | | West spine road 2nd leg | budget estimate | | | | | | | | | | | |
| | | | | (Continental) | | | | | | | | | | | |
| | | | East spine road 1st leg | budget estimate | | | | | | | | | | | |
| | | | | (Continental) | | | | | | | | | | | |
| | | | East spine road 2nd leg | budget estimate | | | | | | | | | | | |
| | | | | (Continental) | | | | | | | | | | | |
| | | | Gate belts | budget estimate | 4 | | | | | | | | | | |
| | | | | (Sandvik) | | | | | | | | | | | |
| | | | Development belts | budget estimate | 4 | | | | | | | | | | |
| | | | | (Sandvik) | | | | | | | | | | | |
| | | | Intake Integrated trapped rail loco haulage system | | Else where | | | | | | | | | | |
| | | | Locos only. Track in Devs £700 per metre | | | | | | | | | | | | |
| | | | Return haulage system | | Total | | | | | | | | | | |
| | | | Total System Above Including 3 loco sets | | | | | | | | | | | | |
| | | | Main surface fans, switchgear, installation | | 9 x 450kW | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Fan cables, power supply, services | Else where | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Auxilliary Fans | 90 kW Howden | 8 | 90 kW | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Dust Control fans and Filter | 37 kW | 8 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

## Appendix Table 9 Power Supplies and Distribution

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Power Supplies and Distribution** | | | | | | | | | | | | |
| | | | Incoming main power feed lines | | | | | | | | | | | | |
| | | | Main sub station | | | | | | | | | | | | |
| | | | Surface electrical power distribution | In Above | | | | | | | | | | | |
| | | | Methane extraction plant | | | | | | | | | | | | |
| | | | Gas engines and generation system 3.5 MW | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |

## Appendix Table 10 Coal Preparation Plant

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Coal Preparation** | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Coal Prep Plant buildings | ) | | | | | | | | | | | |
| | | | Coal Prep Plant Equipment | ) | | | | | | | | | | | |
| | | | Coal Prep Plant erection | ) | | | | | | | | | | | |
| | | | Coal Prep Electrics/Controls ) | | | | | | | | | | | | |
| | | | Total for above | Budget Estimate | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Civils works for above | TE | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

## Appendix Table 11 Surface Mineral Handling

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Surface Mineral Handling** | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | T | Overspill bunker & House | TE | 1 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | ROM stockpile tripper C/V | TE | 1 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | V | ROM stockpile inc civils | TE | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Return conveyor from ROM stock + feeders | TE | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Reject conveyors | TE | 2 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Clean coal conveyors | | 3 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Washed coal emergency pad | TE | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | W | Rejects stock pad and rail loading point | TE | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Offsite wagon discharge system for rejects | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

## Appendix Table 12 Underground Drivages

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Underground Drivages and Electrical** | | | | | | | | | | | | |
| | | | Drivage machines | | | | | | | | | | | | |
| | | | Heavy duty inc Bolters | | 2 | Mk4 Dosco | | | | | | | | | |
| | | | Spares for above 15% | | | | | | | | | | | | |
| | | | Medium duty inc bolters | | 3+1 | Dosco LH 1400 | | | | | | | | | |
| | | | Spares for above 15% | | | | | | | | | | | | |
| | | | Drift bottom substation | | 2 | | | | | | | | | | |
| | | | Drift bottom pumphouse | | 1 | | | | | | | | | | |
| | | | Inbye substations | | 6 | | | | | | | | | | |
| | | | Drivages | | | | | | | | | | | | |
| | | | Stone & Coal Drivages (Salaries and Materials only) | Team 1 | | | | | | | | | | | |
| | | | | Team 2 | | | | | | | | | | | |
| | | | | Team 3 | | | | | | | | | | | |
| | | | | Team 4 | | | | | | | | | | | |
| | | | | Team 5 | | | | | | | | | | | |
| | | | | Team 6 | | | | | | | | | | | |
| | | | | Coal Credits | | | | | | | | | | | |
| | | | Loco garage | | 2 | | | | | | | | | | |
| | | | Track work | In drivage costs | | | | | | | | | | | |
| | | | Conveyor drive houses | In junction Costs | | | | | | | | | | | |
| | | | Switch gear + Section switch | | | | | | | | | | | | |
| | | | Section Switch | | 7 | | | | | | | | | | |
| | | | Fan Starter and Lighting | | 7 | | | | | | | | | | |
| | | | Load centres 7 switch | | 7 | | | | | | | | | | |
| | | | Conveyor Switch | | 7 | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |

## Appendix Table 13 Underground Permanent Equipment

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Underground permanent equipment** | | | | | | | | | | | | |
| | | | U/G Power distribution systems | See separate calculations | | | | | | | | | | | |
| | | | Pump lodge & pump house | | | | | | | | | | | | |
| | | | Mine water main pump sets | | 2 | | | | | | | | | | |
| | | | Electrics &switchgear for above | | | | | | | | | | | | |
| | | | Spine road pump sets | | 2 | | | | | | | | | | |
| | | | Ancillary pump sets | | | | | | | | | | | | |
| | | | Electrics for above | | | | | | | | | | | | |
| | | | Pumping range main drift | In Cost per metre | 6500m | 150mm | | | | | | | | | |
| | | | Pump ranges spine roads | In Cost per metre | 6000m | 150mm | | | | | | | | | |
| | | | Methane ranges | | 8500m | 400mm | | | | | | | | | |
| | | | HP water supply / firefighting pipe range | In Cost per metre | | | | | | | | | | | |
| | | | Compressed Air Range | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |

## Appendix Table 14 Longwall Face Equipment

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Face Equipment** | | | | | | | | | | | | |
| | | | AFC panline, 2 drives and tail ends ) | | | | | | | | | | | | |
| | | | Stage loader, crusher, electrics ) | Budget estimate | 2 sets | | | | | | | | | | |
| | | | Roof Supports 350 metres, 8 end chocks +RS 205 controls | Budget estimate | 2 sets | | | | | | | | | | |
| | | | Shearers | Budget estimate | 2 | | | | | | | | | | |
| | | | Pump Station | Budget estimate | 2 | | | | | | | | | | |
| | | | Load centres | Budget estimate | 2 | | | | | | | | | | |
| | | | Methane drainage Rigs | | 6 | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |

## Appendix Table 15 Monitoring and Control Systems

| Section | Sub Section | Item | Description | Basis of Estimate (estimate by technical persons, Current Prices, Tender etc.) | No of Items Required, Length of Roadway or Shaft etc | Size or Capacity | Estimated Cost before Contingencies | Allowance for Contingencies | | Fees | | Total Estimated Expenditure | | Depreciation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % | Amount | % | Amount | Capital | Revenue | % | Estimated Annual Charge |
| | | | **Monitoring & Control Systems** | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Remote control,scada,mine monitoring and communication | Davis Derby | | | | | | | | | | | |
| | | | systems including installation | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Conveyor Control System | Davis Derby | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | General Broadcast System | Davis Derby | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Telephone System inc cabling | Davis derby | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | Total | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

# Appendix 5

## Questions and Observations of HCU on IMC Presentation with Summary Responses from IMC

# Review of "Techno-Economic Feasibility Study" of Khalashpir Coal Mine Project

## Questions asked at the end of IMC Presentation with Summary Responses

**1. How do you fill the voids with underground mining?**

If pillar and stall mining is used there will be negligible subsidence therefore no need to fill the voids.

If longwall is used the roof will be caved behind the face with a subsidence effect on the surface and there is no economic way of effectively filling the goaf voids.

**2. Is 2D and 3D data enough for a geological model?**

Not alone borehole data is required. IMC has produced a very basic model based on the level of data available and demonstrated that the results are currently inadequate.

**3. Is correlation by 2D and 3D seismic not enough?**

The primary approach to correlation is from borehole data verified by geophysical logging. Seismic surveying is also a verification tool mainly used for structure delineation.

**4. Is there any potential for coking coal?**

As stated is in the presentation:

Tested samples indicate that some of the coal could have metallurgical coking properties although it is not sure which seams or leaves they are.

IMC recommend the testing of a number of isolated samples taken from new cores or re-sampling the existing cores, if the origin of the samples can be unquestionably verified.

**5. What is the transmisivity of the over laying aquifer?**

The FS includes a hydrogeological report which is not conclusive enough for mine planning. Additionally, hydrogeological investigations and regular monitoring needs to be undertaken in all geological formations including the Gondwana formation below the target coal seams.

IMC recommends that if well installations and present conditions allow, pump tests in the wells GTB-1 and GTB-10 should be repeated for the Surma and Gondwana Groups.

**6. Will Khalashpir mine be developed with underground mining methods considering the transmisivity?**

The only way to develop Khalashpir mine economically will be as an underground mine. A detailed understanding of the hydrogeology is vital to initial mine planning.

The transmissivity will change during mining operations.

Thus IMC recommend that:

The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre.

**7. Is pillar-less or pillared mining suitable?**

This is resumed to mean pillar and stall or longwall mining. Both methods are likely to included in the mine plan but it must be recognised that the extraction ratios when leaving pillars is significantly lower than de-pillaring or longwall operations.

**8. How many cored boreholes have been drilled?**

4 by GSB and 11 by the Consortium making a total of 15.

**9. What is the resolution of the seismic data?**

It is to a satisfactory level to identify major structures and fault displacements greater that seam thickness, therefore adequate for mine planning.

**10. What is the period of the seismic data**

The FS states during 2005.

# Appendix 6

# Recommendation Matrix

## Review of "Techno-Economic Feasibility Study" of Khalashpir Coal Mine Project

## Recommendations Matrix

| Report Section | Issue | Recommendation |
|---|---|---|
| **Mine design as proposed in the study considering the geological structure of the mine** | | |
| Coal Seam Correlation | Coal seam correlation is very difficult because of the poor analytical data. Mainly, there has been no geophysical borehole logging and there is a lack of chemical and physical property data. | Exploration<br>• Surface drilling should be continued to JORC<br>• Geophysical logging of each new borehole<br>Analysis<br>• Samples taken, prepared and analysed to JORC supervised by accredited senior geologists<br>Interpretation<br>• A full sedimentological study and seam mapping undertaken. |
| Coal Quality | Tested samples indicate that some of the coal could have metallurgical coking properties although it is not sure which seams or leaves they are. | Test a number of isolated samples taken from new cores or re-sampling the existing cores, if the origin of the samples can be unquestionably verified. |
| **Technical & commercial viability of mining proposal** | | |
| Project | The FS indicates that the saleable production is projected to be initially 2 Mtpa increasing to 3 Mtpa in year 7 and 4 Mtpa | Prepare the following: |

| Report Section | Issue | Recommendation |
|---|---|---|
| Scheduling | by year 13 but does not provide any phased planning detail. These omissions make it virtually impossible to evaluate the operational and economic feasibility of the Project. | • Project implementation schedule<br>• Production or roadway development schedules<br>• Phased production and development plans |
| Production Capacities | The FS production design parameters are out of date with respect to current longwall technology or inappropriate to meet the overall production targets | Consider the following:<br>• Current longwall production capacities<br>• Number of production units<br>• Development ratio<br>• Application of top coal caving<br>• Aquifer bed strain control |
| **Reasons for selecting underground mining method** | | |
| | Opencast would rank amongst the deepest open pits in the world with 4 km in diameter and a surface area of 12.5 $km^2$<br>Reasons to avoid an opencast:<br>• High stripping ratio for seam IV<br>• Excessive aquifer water to continually pump<br>• Social unacceptable | Underground mining because:<br>• International approach for this type of deposit<br>• Surface environmental and social considerations are better<br>• Potentially economic |
| **Underground mining services (transportation, coal handling system etc.), mine ventilation system (ventilation, dust control etc.) and related issues (methane gas handling, spontaneous combustion aspects, fire fighting arrangements, mine rescue plan etc** | | |

| Report Section | Issue | Recommendation |
|---|---|---|
| Underground Mine Environment | The FS discusses but does not address the Project specific approach to manage the following issues:<br>• Methane Gas<br>• Spontaneous Combustion<br>• Air Temperature<br>• Ventilation System<br>All of these issues will interact but spontaneous combustion and air temperatures are likely to be the dominant of these underground environmental issues. | Consider the application of computer network analysis to assist the design process for:<br>• Methane specific emissions<br>• Air temperature modelling<br>• Ventilation network modelling |
| Mine Access | FS dismisses the use of drifts on the grounds of the length of freeze required to drive through the Dupi Tila aquifer but drifts have coal clearance capacity advantages whilst shafts have ventilation advantages. | Once the ROM production is defined the Consortium should evaluate the life of mine costs of the following options from a production capacity, ventilation (mine temperature) and spontaneous combustion management view point:<br>• Two shafts at least 8.5 m diameter<br>• One 8.5 m diameter shaft and one 25 $m^2$ drift<br>• Two shafts at least 7.5 m diameter and one 20 $m^2$ drift |
| Pit Bottom Location | The FS indicates that the pit bottom is located at -370 m and outside the coal basin area but consideration should be given to the experiences of Barapukuria where strata water control and extensive inclined track and dip roadways have been | Life of mine costs be developed for the option of locating the pit bottom, either shaft or drifts, at the lowest part of the basin close to where the major faults converge and in the FS proposed vicinity of the deep water sump. |

| Report Section | Issue | Recommendation |
|---|---|---|
| | critical. | |
| Coal Preparation | This is not considered on the FS | Consider the following depending on tested coal qualities:<br>• Jig or Baum box washing for power station fuel<br>• Dense medium separation for coking coal |
| Surface Structures | Various options are available for the main structures which are not addressed in the FS | The following should be included in a conceptual layout plan:<br>• Shaft Winding Systems<br>• Fan House and Drift<br>• Coal Clearance<br>• ROM Coal Handling and Process Plant<br>• Materials Supply<br>• Workshops<br>• Surface Transportation<br>• Electrical Substation and Standby Generator Plant<br>• Mine Main Access Road |
| **Surface effect of underground mining** | | |
| Mining Subsidence | The preferred mining option is underground longwall mining subsidence will be a major impact on the use of land within the extractable areas of the mine which is presently primarily | Address during the EIA assessment and engage the local population and all stakeholders in open discussion to ensure that land owners and workers are fully informed at all stages |

| Report Section | Issue | Recommendation |
|---|---|---|
| Impacts | dedicated to rice cultivation. | of project development and implementation. |
| Subsidence Mitigation | Subsidence mitigation by hydraulic stowing as suggested in the FS is impractical and has proven ineffective when used in conjunction with high production longwall operations. | 1. The sequence of extraction and longwall dimensions should be determined from progressive strata control modelling and be constrained by limiting the strain on the base of the Dupi Tila to a maximum of 10 mm per metre.<br>2. Various measures be investigated based on firm data to extend the period land can be used productively. |
| Effects of Subsidence on Groundwater | Any FS and EIA of international standard needs to be specific about the impacts expected by subsidence and the mitigation measures applied in case the impact is found unacceptable. | Maps should be produced showing the baseline and expected contour lines of subsidence for characteristic time intervals and that this baseline plan should also form the basis for subsidence compensation and or re-settlement requirements. |
| **Environmental Management Plan (EMP) including re-settlement plans (if arises land subsidence issue)** | | |
| Environmental Management Plan | The FS includes a number of very important commitments referring to EMP, monitoring, reclamation and rehabilitation. Details are left to an Environmental Impact Assessment (EIA). The proposed ToR are generally compliant with international standards e.g. the “Equator Principles” | 1. Agree the EIA terms of reference with the Dept of Environment prior to commencement to ensure compliant to the March 2009 guidelines.<br>2. Consider the environmental and social impacts in three separate stages:<br>• Construction<br>• Operation<br>• Closure |

| Report Section | Issue | Recommendation |
|---|---|---|
| | | 3. Establish a separate Project document as a baseline for future assessment of damage and fair compensation. |
| Public Participation | The FS states that *“The mine will have a separate environmental department to look after all these issues and also to liaise with the local population to consider problems threatening the environment in and around the mine”* | Consortium proposal is made a condition of any permit approval. |
| Land Surface Monitoring | The FS states that *“The Consortium shall propose a detailed topographic survey and regular monitoring program, initially based on area and magnitude of subsidence forecasted and risks involved.”* | This baseline plan should form the basis for subsidence prediction, compensation and or re-settlement requirements. |
| **Groundwater handling procedure/ aquifer handling method and also recharge the aquifer, if necessary** | | |
| Baseline Data | To ensure all base line data is considered in the EIA. | Obtain the necessary baseline data during the EIA process which could be considered in the EIA scoping agreement between DoE and the Consortium. |
| Hydrogeology Report | Additionally, hydrogeological investigations and regular monitoring need to be undertaken in all geological formations including the Gondwana formation below the target coal seams. | If well installations and present conditions allow, pump tests in the wells GTB-1 and GTB-10 should be repeated for the Surma and Gondwana Groups. |
| Groundwater Quality | The FS does not contain any groundwater analysis and states that there is no need for any quality testing. | It is a standard requirement for any mining project to provide some baseline groundwater quality data and appropriate should be undertaken. |

| Report Section | Issue | Recommendation |
| --- | --- | --- |
| Groundwater and Aquifer Handling | The FS does not provide adequate information on the methods and quantities of groundwater handled by the Project. | This should be rectified and a handling plan developed. |
| **Treatment procedure of discharged mine water** | | |
| Treatment Procedure | The FS states that *"mine drainage water collected in the shaft bottom pump lodge will be continuously pumped to the mine surface to be settled and subsequently used either for local irrigation or to supplement the mine water supply"* | Assess if this approach is adequate from quality analysis and estimated suspended solids. |
| **Socio-economic impact on the entire area due to mining** | | |
| Socio Economic Impact | The new EIA Guidelines are very detailed on key socio-economic issues and impacts and require that census data should not be older than 5 years. | Purchase all land likely to be affected by mining and supplementary land requirement at project inception to ensure the capability to manage and implement committed mitigation measures and to prevent land speculation by persons from outside the area. |
| **Reclamation procedure and compensation issues** | | |
| Reclamation | The FS states that *"to obtain best results through consensus decision wherever possible"* The new guidelines and the equator principles as clear that closure and reclamation should be considered at project inception. | A costed closure plan should be developed and financial provision made for implementation. |
| **Cost, Investment Plan and financial analysis of the project as proposed in the study** | | |

| Report Section | Issue | Recommendation |
|---|---|---|
| Capital Investment and Operating Costs | In the FS there is:<br>• No calculations only summary values without build up detail<br>• No phased mining plan to justify operating cost phasing | An investment, sustaining capital and operating cost schedule be developed based on:<br>• Project implementation programme<br>• Phased mining plan with a LOM production / development schedule. |
| Project Financing | The FS addresses the issue in a basic way. | Either financing should be outside the scope of a project feasibility study or if included the financing structure should be explained in detail. |
| Financial Evaluation | The FS makes it difficult to comment on the efficacy of the financial evaluation until all the recommendations described above are implemented. | Implement the above recommendations and develop a reliable Life of Mine Project cashflow. |

# Appendix 7

# Standards Appendix Including Comments on DoE's EIA Guidelines

# Standards Appendix

In preparing the Report IMC has referred to and benchmarked against a number of international standards in the following disciplines:

- Geological exploration and Reserves and Resources classification
- Mining operational Health and Safety
- Environmental and social Impact Management

IMC would naturally expect the Consortium to adopt these standards at all stages of the Project development from exploration to mine closure.

These standards are explained in terms of purpose and application in the following subsections.

## 1.0 GEOLOGICAL EXPLORATION AND RESERVES AND RESOURCES CLASSIFICATION

### 1.1. The JORC Code

The JORC code is used as a reporting system in international exploration campaigns. The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore reserves was established in 1971 by the Joint Ore Reserves Committee (JORC) and is the fundamental reporting system in Australia, Canada, South Africa, USA, UK and Ireland. It is also accepted in many states in Europe following the agreement to incorporate the CMMI (Council of Mining and Metallurgical Institutions) definitions into the International Framework Classification for Reserves and Resources – Solid Fuels and Mineral Commodities, developed by the United Nations Economic Commission for Europe (UN-ECE).

One of the main factors in the JORC code reporting is that a 'competent person' executes the reporting. A competent person must have a minimum of five years experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which that person is undertaking. If the Competent Person is estimating or supervising the estimation of mineral resources, the relevant experience must be in the estimation, assessment and evaluation of mineral resources.

The JORC code uses the following terms and definitions.

A **Mineral Resource** is a concentration or occurrence of material of intrinsic economic interest in or on the earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are sub-divided, in order of increasing geological confidence, into three categories.

- **Inferred Mineral Resource** - is part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered from locations such as outcrops, trenches, pits, workings and drill holes which may be limited or of uncertain quality and reliability.
- **Indicated Mineral Resource** - is part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.
- **Measured Mineral Resource** - is part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.

A **Mineral Reserve** is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowance for losses, which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time reporting that extraction could reasonably be justified. Mineral reserves are sub-divided in order of increasing confidence into two categories.

- **Probable Ore Reserve** - is the economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. It includes diluting materials and allowance for losses, which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time reporting that extraction could reasonably be justified.
- **Proved Ore Reserve** - is the economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowance for losses, which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time reporting that extraction could reasonably be justified.

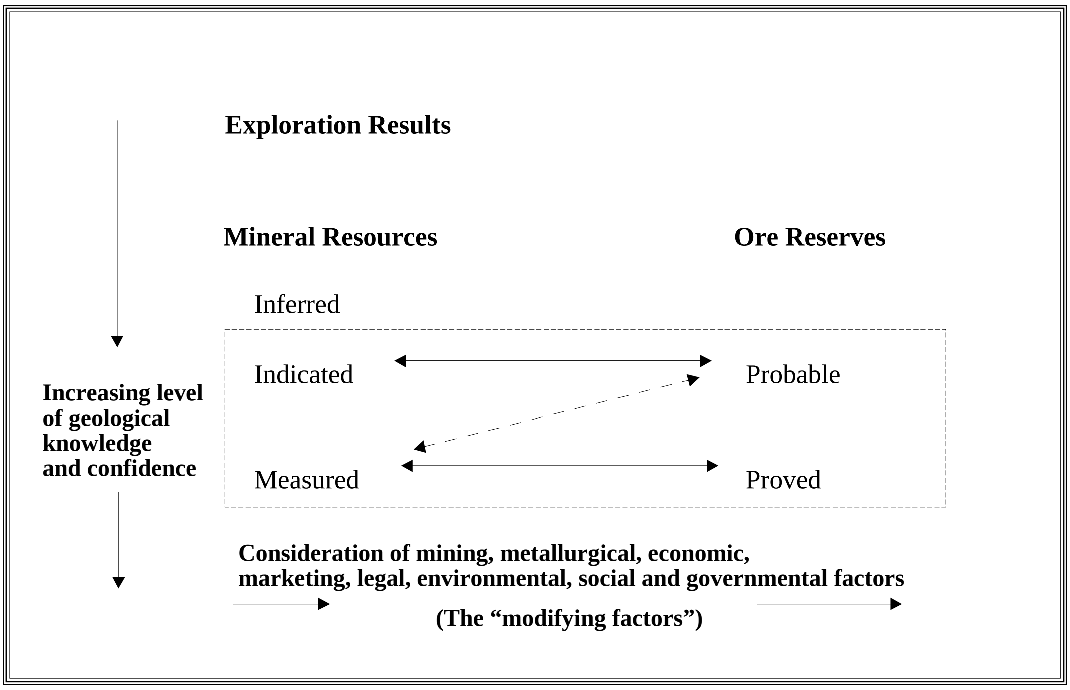



**Figure 1-1 JORC Relationship between Exploration Results, Mineral Resources and Ore Reserves**

In the assessment of coal deposits the terms Probable Ore Reserve and Proved Ore Reserve can be substituted by Probable Reserve and Proved Reserve, or by Probable Coal Reserve and Proved Coal Reserve.

### 1.1.1. Criteria for an Internationally Compliant (JORC) Reserves and Resources

Under the JORC system of reporting the competent person is responsible for the assessment of reserves and resources based upon the level of geological knowledge of the coal area and on the economics of extraction of that coal area.

The geological knowledge is based primarily on the level of proving, whether this be by drilling or working of the seam and/or the under and overworking in other seams to give confidence to the assessment of the tectonic structure. Any other exploration such as 2D or 3D seismic surveys all add to the geological base knowledge of the block or area in question.

A second vital component is then applied under JORC and that is whether the block of coal being assessed can be mined economically. This assessment is usually made within the business plan or within some such document as a feasibility study that determines the costs of mining along with the proceeds from the sale of the coal. If this is profitable then the area of mineral under examination falls into the reserve categories providing it meets all other modifying factors such as mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors that are in force at the time of assessment.

## 2.0 MINING OPERATIONAL HEALTH AND SAFETY

The current mining legislation of Bangladesh is based on the Mines Act 1923. This Act is the statutory instrument under which Regulations are to be made to operate any type of mine in Bangladesh. At the present time there have been no regulations made under the Mines Act despite the construction of two underground mines, which commenced in the 1990's. Draft Regulations have been prepared for the GOB but await promulgation.

### 2.1. Mines Act 1923

Like all mining legislation enacted in different countries around the world, the main purpose of the Act is to create the legal framework to ensure that mines are worked safely under the control of a systematic management structure and overseen by a suitable body to enforce the law.

The 1923 Act provides for:

- A mines inspectorate headed by a Chief Inspector. As yet neither has a Chief Inspector been appointed nor an inspectorate established.

- The appointment of a Manger to each mine. Again no such appointments have been made at either of the mines under construction.
- The reporting of serious accidents or dangerous occurrences to the Chief Inspector of Mines. This system is in place but the reports are made to the Ministry of Energy.
- Regulations to be made to operate all types of mines.

### 2.1.1. Applicable Regulations and Codes

As there were no Regulations and Codes in force in Bangladesh at the time the two mine projects were designed or tendered and the Petrobangla did not provide any interim regulations or codes. Each design and construction contractor has used the Regulations and Codes that apply in their native countries. Thus Barapukuria is designed and constructed to Chinese Regulations and design codes and Maddhapara is designed and constructed to Korean Regulations and design codes.

### 2.1.2. Draft Regulations

The draft Regulations are based on the recently revised Regulations from the UK mining industry.

The UK mining industry is considered to be one of the oldest and safest industries in the world. Legislation has been enacted continuously over the last 150 years to improve health and safety standards, usually as the result of accidents or incidents. The industry has operated under private and public ownership during those 150 years as the legislation has developed.

In the early stages and up to the mid 1980’s the legislation was “Prescriptive”. This is where the rules and regulations are specific, detailed and rigid instructions to be applied in all cases. However, the specific instructions cannot cover all the circumstances and could not always be applied. This lead to three situations:

- The mines inspectors had to be expert mining, mechanical or electrical engineers with the knowledge to apply the sprit of the law practically.
- Close professional relationships were established between colliery managers and inspectors so that both parties could develop a practical approach.
- A large number of exemptions had to be granted from various Regulations in order to allow the mines to operate within the law.

During the mid 1980's it was realised by both the Health and Safety Executive and the Mine operators that the Prescriptive approach was no longer workable, especially as the mining industry was about to go back into the private sector. The legislation was progressively changed to "Enabling" legislation.  This where the regulations create a framework for the Mine Manager and Owner to prepare his own codes of practice and rules, which are specific and relevant to his own mine. These codes of practice and rules have all the force of the law the same as Regulations. They have to be drawn up with reference to "Approved Codes of Practice" (ACOP) and be approved by the mines inspector.  The effect of using enabling legislation is to:

- Allow the operating rules to be directly applicable to the mine concerned.
- Reduces the need for large numbers of exemptions.
- Allows for the law to be applied more specifically when operating the mine without reverting to the "Spirit of the Law" all the time.

In preparing the Regulations for Bangladesh the drafting consultant has very closely referred to the UK Regulations and ACOPs, which had recently been revised into the Enabling format.

The health and safety topics covered in the Bangladesh Regulations and ACOPS are as follows:

**Table 2-1 Regulations**

| Regulations | Subject |
|---|---|
| Preamble | Preamble To The Mines and Quarries Regulations |
| REG-001 | Management and Control |
| REG-002 | Shaft Sinking |
| REG-003 | Fire Prevention and Control |
| REG-004 | Precautions in Vertical Bunkers |
| REG-005 | Protection Against Accidents |
| REG-006 | Strata Control |
| REG-007 | Protection Against Outbursts |
| REG-008 | Protection Against Explosions |
| REG-009 | Respirable Dust Control |
| REG-010 | Protection Against Inrushes |

| Regulations | Subject |
|---|---|
| REG-011 | Protection Against Noise |
| REG-012 | Protection Against Spontaneous Combustion |
| REG-013 | Protection Against High Temperatures |
| REG-014 | Medical Examinations |
| REG-015 | Safety of Exits |
| REG-016 | Safety of Persons in Transport Roads |
| REG-017 | Safety Provisions in Shafts and Winding |
| REG-018 | Safety Lamps and Lighting |
| REG-019 | Safety of Tips |
| REG-020 | Ionising Radiation |
| REG-021 | Electrical Regulations and Approved Electrical Procedures |
| REG-022 | Quarries (Special Regulations) |

**Table 2-2 Approved Codes of Practice**

| ACOP | Subject |
|---|---|
| ACOP-001 | Surveying Practice |
| ACOP-002 | Prevention and Control of Fire |
| ACOP-003 | Training Practice |
| ACOP-004 | Support of Mine Workings |
| ACOP-005 | Outburst Precautions |
| ACOP-006 | Prevention of Explosions |
| ACOP-007 | Transport Rules |
| ACOP-008 | Blasting Operations |
| ACOP-009 | Ventilation Rules |
| ACOP-010 | Operation of Machinery |
| ACOP-011 | Electrical Procedures |
| ACOP-012 | Mechanical Procedures |

| ACOP | Subject |
|---|---|
| ACOP-013 | First Aid and Accident Procedures |
| ACOP-014 | Mine Emergency Scheme |
| ACOP-015 | Mine Rescue Facilities |
| ACOP-016 | Respirable Dust Precautions |
| ACOP-017 | Noise Control Scheme |
| ACOP-018 | Tips Rules |
| ACOP-019 | Precautions Against Inrushes |
| ACOP-020 | Precautions Against Spontaneous Combustion |
| ACOP-021 | Precautions Against High Temperatures |
| ACOP-022 | Vertical Bunkers |
| ACOP-023 | Shafts and Winding |

## 3.0 ENVIRONMENTAL AND SOCIAL IMPACT MANAGEMENT

### 3.1. Environmental Impact Assessment

If the Consortium is seeking external finance for the Project it is essential that the EIA is compatible with the international banks' policy for investment in non-OECD countries. In addition, the EIA should be developed to conform to the Equator Principles, which uses the benchmark standards of:

- The International Finance Corporation (IFC) Performance Standards on Social and Environmental Sustainability.
- The World Bank Group Environmental Health and Safety Guidelines.

The IFC Performance Standards are:

- Performance Standard 1: Social and Environmental Assessment and Management System.
- Performance Standard 2: Labour and Working Conditions.
- Performance Standard 3: Pollution Prevention and Abatement.
- Performance Standard 4: Community Health, Safety and Security.
- Performance Standard 5: Land Acquisition and Involuntary Resettlement.
- Performance Standard 6: Bio-diversity Conservation and Sustainable Natural Resource Management.
- Performance Standard 7: Indigenous Peoples.

- Performance Standard 8: Cultural Heritage.

In order to comply with these principles IMC would consider the EIA scope to include:

- The EIA should consider all phases of the project - exploration, construction, operating, post operating.
- The project policy and standards with reference to the legal and administrative framework in Bangladesh and international standards and industry good practice.
- Baseline study of the present situation concerning:
    - climate;
    - geology and soil;
    - land use and capability;
    - flora and fauna, assessment of sensitive areas and endangered species, biodiversity;
    - surface and underground water resources – quality, use and sustainability;
    - air quality;
    - noise; and
    - cultural and heritage sites
- Assessment of project alternatives:
    - either the project proceeds; or
    - the existing status continues.

Other issues to be considered include traffic impact and management, waste management, operational health and safety including emergency response, social and economic components.

The project design should be based on best available techniques (process and abatement) for preventing or minimising emissions.

Internationally accepted standards are included in the World Bank Pollution Prevention and Abatement Handbook which is regularly updated. Applicable for the industry sector two papers of the World Bank Handbook were issued in July 1998:

General Environmental Guidelines and

Coal Mining and Production.

Another valuable reference for assessing mining impacts, including coal mining, is the European Commission Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities, dated July 2004.

### 3.2. Bangladesh EIA Draft Regulations, March 2009

In contrast to mining legislation the environmental legislation in Bangladesh is based on relatively new legal provisions:

- The Environmental Conservation Act, 1995
- The Environmental Conservation Rules, 1997.

The requirement for undertaking environmental impact assessments is already well specified in general terms. The Director General of the Department of Environment (DoE) is the authority in charge to issue finally an Environmental Clearance Certificate allowing major projects to proceed. Addressing specifically environmental and social aspects of coal mining the DoE issued EIA Guidelines for Coal Mining, dated March 2009. These Guidelines were prepared by Centre for Science and Environment (CSE), New Dehli, India, in consultation with DoE and the Bangladesh Environmental Institutional strengthening Project funded by the Canadian International Development Agency.

The objective of the Guidelines have been defined as follows:

- Assisting regulatory agencies and EIA practitioners to understand the main areas of concern, and using that understanding to enhance the quality of the EIA study and its report
- Keeping regulatory agencies and EIA practitioners informed about the best environmental and social management practices in the coal mining sector
- Assisting regulatory agencies to better assess EIA reports and arrive at sound judgements.

Also directing to the regulatory agencies the Guidelines are a very valuable tool to make all stakeholders familiar with coal mining technology, environmental considerations and the approval process. It should be self understood that any EIA submitted by the Consortium will need to follow these Guidelines.

IMC considers the Guidelines well up to international standards. There might be some risk that by inexperienced regulatory staff the guidelines are applied to rigidly. As an example, the Guidelines suggest the study zone to include areas within a radius of 10 km from the mine lease boundary or specific software packages to forecast the impact. As the term “guideline” implies the application should allow for some flexibility and in conformance with international best practice, each project should be dealt with on its own merits but within the frame of applicable legislation.

IMC has viewed the Guidelines and found, as for any first issue of guidelines, there is some room for improvement. Nevertheless, the new Bangladesh EIA Guidelines for Coal Mining are an adequate basis for further environmental and social assessments for the Khalashpir Project. Increasing experience with applying the EIA Guidelines will help to make future revisions of the Guidelines more perfect.