Table 6.15 Soil Contamination

(mg/kg)

Location	Pb	Ni	Cu	Mo	Mn	Sn	V	Cr
Baganuur	2.1	3.5	3.6	1.2	135	7.9	7.6	6.1
Darhan	1.9	1.9	2.2	2.1	178	2.5	1.4	2.5
Ulaanbaatar	4.0	1.2	14.0	2.0	171	7.2	4.0	2.1
In. Ave. *1	40	10	20	2	850	10	50	200

source:Baganuur symposium, 1989

*1 : International average.

(4) Noise/Vibration

Noise and vibration pollution cannot be recognized in the survey area.

6.4.2 Natural environment

(1) Land

1) Topography

The survey area consists of flat valley plain and low hills. The valley plain is assumed to be a tectonic basin. Baga Gun Lake is located in the southwestern edge of valley plain. Low hills are situated in the western part of the area and they have several tens meter of relative height of relief.

Large scaled alteration of land shape is done by mining activities including stripping of overburden, piling of spoils and stacking waste dump areas. Total volume of wastes from the mine site, mainly consisting of overburden and side dump, is tentatively estimated at some 6,500,000 m^3. Waste dump is approximately 30 to 35 m height.

Wastes and spoils are planned to be used for later reclamation purposes of mined out areas and to reuse as raw material of construction, etc. Rest of wastes is planned to be reformed its land shape and be covered by topsoil and vegetation.

2) Geology

Cretaceous rocks, mainly consisting of sandstone, mudstone and coal seams, are wide-spread in the survey area as shown in Figure 6.5. The rocks are estimated approximately 500 m thick and show synclinal structure, trending northeast to southwest.

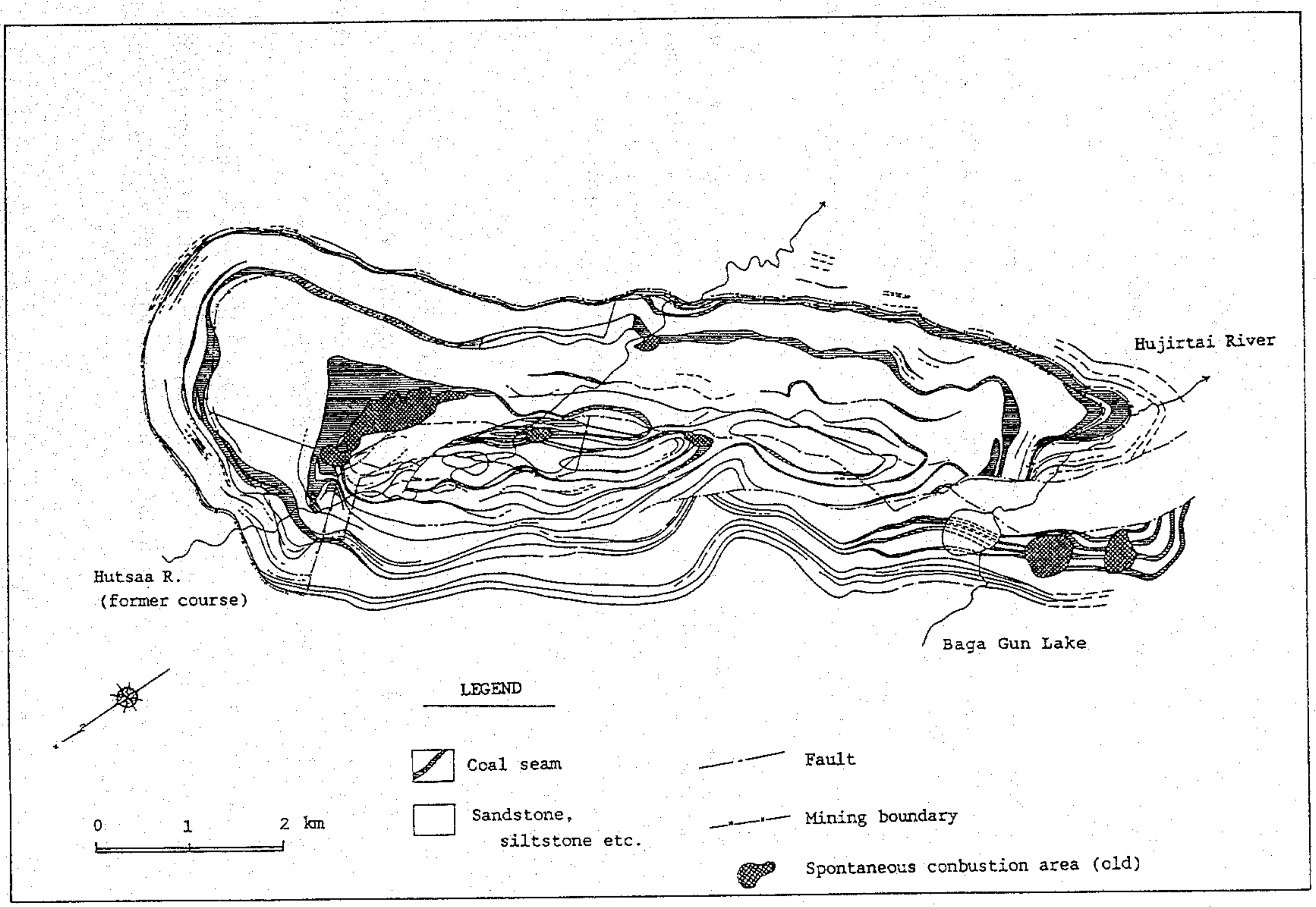

Figure 6.5 Geologic Map of the Survey Area

Twenty four coal seams (lignite quality) are confirmed in the rocks and minable coal seams are Seam No.3, Seam No.2a and Seam No.2 in ascending order. The deepest level of coal seam (Seam No.3) is approximately -400 meters deep. At present, total geological reserves of three minable coal seams except Baga Gun Lake area in the southwestern part of the mine area is estimated 567 million tons.

Sandstones, coal seams and alluvial deposits are confirmed as an aquifer. Pumpage ranging in volume from 20,000 to 36,000 m^3 per day has been done before and during stripping of overburden and mining of coal. The permeability efficient of upper sandstone, coal seams and lower sandstone are 2.6×10^{-4}, $1.4 \sim 1.8 \times 10^{-4}$ and 1.5×10^{-5} m/sec respectively (average 8.65×10^{-5} m/sec), based on the results of previous exploration during feasibility study of the Baganuur Coal Mine area.

Spoils dumped at mining site and waste dump areas are intensively eroded by rain-fall and wind. Surface of slope is incised by innumerable gully (so-called gully erosion) because of steep slope and non vegetation. And, wastes are flowed out and scattered to the surrounding dump areas. The slope of waste dump ranges in gradient from 32 to 36 degrees.

(2) Water

1) Surface water

Three tributaries of Kherlen River, namely Hutsaa River, Hujirtai River and Talbulag River flow across the survey area as shown Figures 6.2 and 6.4. Hujirtai River, passed the center of mining area, has been altered its water course to the north of mining area. Talbulag River flows into Baga Gun Lake, adjoining to the southwest of mining area.

Lowlands consisting of marshy ground and three lakes, namely Baga Gun Lake, Gungaluutai Lake and Ayagiin Lake are located in the southern and southwestern parts of the survey area. All of surface water in the lowlands flows out to Talbulag River as shown in Figure 6.2.

2) Groundwater

Groundwater in the survey area is very rich. Groundwater level is confirmed to range from -1.4 to -14.2 m deep. Although groundwater level in the northern part of the mining area is said to be -14 m deep, that of lowlands in the southern parts of the mining area is relatively shallow and might be formed perched groundwater because of the existence of aquiclude such as mud, silt and permafrost layers.

Present groundwater level in the mining area is stabilized ranging from -60 to -70 m deep by pumpage for stripping of overburden and coal mining. Pumping volume is 20,000 to 36,000 m^3 per day. Groundwater level in the future is planned to reduce down to -230 m deep.

Permafrost layer occupies approximately 25 % of the mining area, and is especially dominant in the southern part, the thickness varies between 20 m in average and 38 m in maximum, with depth from surface unknown.

3) Baga Gun Lake

Baga Gun Lake adjoining coal mine is thought to be received hydrological influence, that is drawdown of water level of the lake, by the development of coal mining as well as pumpage around the mining pit. Present water level of the lake is inferred to have been reduced approximately 4 meters compared with the primary water level.

The size and area of the lake at early stage were 510 m x 650 m and 27.1 ha respectively. Present size and area of the lake are 370 m x 520 m and 15.4 ha respectively, so that the rate of decreasing between the primary and present area of lake is 57 % decrease. It is feared that Baga Gun Lake will dry out with further mining development.

(3) Soil

Soil in the survey area mainly consists of brown soil and alluvium soil as shown in Figure 6.6. Brown soil, ranging in thickness from 35 to 130 cm, occupies low hilly ground in the southern part of the survey area. Especially, brown soil at the slope of hills tends to be thick because of resedimentation.

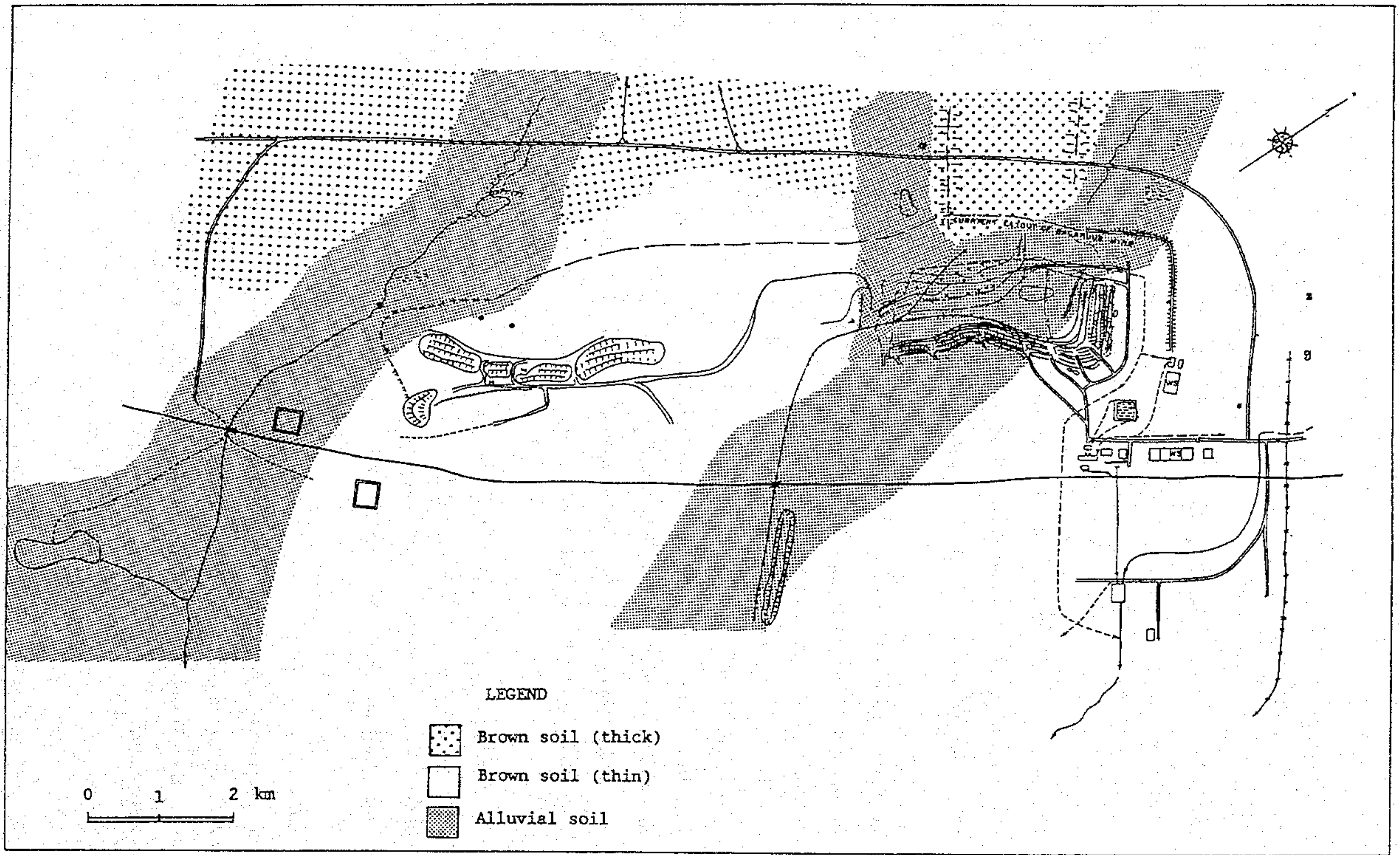

Figure 6.6 Soil Map of the Survey Area

Alluvial soil, ranging in thickness from 12 to 35 cm, is widely distributed along the water-courses in the survey area. The soil is relatively thinner vegetation than brown soil.

Soil erosion is recognized in the distant parts of the survey area.

At present, surface soil, approximately 30,000 m^3, has been piled at the outside of mining site in advance for covering up with soil to the waste (spoils) dump areas and mined out area after land reclamation.

(4) Fauna/flora

Mining and survey areas are covered with relatively thick grass.

Mongolia is known to be rich in wildlife resources, and 134 species of mammals, 415 species of birds, 70 species of fish, 9 species of reptiles, 15,000 species of insects and several thousand species of plants are present.

Endangered and threatened species of fauna and flora in Mongolia are listed in Table 6.16. Biological investigation in and around the area had not been carried out. Therefore, it is necessary to carry out the biological and ecological investigations in the survey area.

Mining activities including extraction of overburden, spoil dumping, waste dump areas, water pumping, water drainage, generation of dust and soot, etc., are thought to influence eco-system in and around the coal mine area.

(5) Landscape

Main landscape in the survey area consists of Baga Gun Lake, Gungaluutai Lake, Ayagiin Lake, grass field, Baganuur townsite, etc. Alteration of land shape by opencut mining is extensively done at mining sites and waste dump areas. Spoils at mining sites and waste dumps, which is approximately 30 to 35 m high, are planned to be used for land reclamation of mined out areas and to be reused as a material for construction. Mined out areas and waste dump areas are planned to reform their land shape and covered by soil and vegetation.

Table 6.16 Endangered and Threatened Species of Fauna and Flora

(1) Endangered species

Fauna/Flora :	Name	:	Scientific name
Mammals :			
	1. Red dogs	:	Cuon alpinus Dallas, 1811
	2. North otter	:	Lutra lutra lutra Linnaeus, 1758
	3. Gobi bear	:	Ursus pruinosus Blyth, 1854
	4. Przewalskii horse	:	Equus przewalskii Doliakov, 1881
	5. Mongolian saiga	:	Saiga tatarica mongolia Bannikov, 1946
	6. Saiga	:	Saiga tatarica Linnaeus, 1766
	7. Wild camel	:	Camelus farus Brzewalskii, 1883
Birds :			
	1. Siberian white crane	:	Grus Leucogerranus Pallas, 1773
	2. White haped crane	:	Grus vipio Pallas, 1811
	3. Hooded crane	:	Grus monacha Temminck, 1870
	4. Houbara Bustard	:	Chlamydotis undulata Jacquin, 1784
	5. Relic mew gull	:	Larus relictus Lonnberg, 1931
	6. Reed's parrotbill	:	Parodoxornis heudei David, 1872
Amphibians :	(Registered in National Red Book)		
and	1. Siberian salamander	:	Salamandralla keyserlingii Dybowski
reptiles	2. Asiatic graa frog	:	Rana chonsinesis David
	3. Gobi rock gecko	:	Cyrtapodion elongatur Blanferd
	4. Racerunner	:	Bremias arguta
	5. Tatary sand boa	:	Pryx tataricus
	6. Slender racer	:	Coluber spinalis
Plants :			
	1. Lance-shaped	:	Lancea tibetica Hook
	2. Smiss centaurt	:	Rhapontium carthamoides illjin
	3. Alpine saw-wort	:	Saussurea involucrate
	4. Sweet flag	:	C Acorus calamus L.
	5. Juniper	:	Juniperus dahurica Pall.
	6. (Dorogostai) alpine saw-wort	:	Saussurea Dorogostaiskii Palib.
	7. Oleaster	:	Plaeagnus Hoorcroftii wall. ex Schlecht.
	8. Siverian fir	:	Abies siberica Ledeb.
	9. Onion species	:	Allium macrostemon Bunge
	10. Plant species of Mongolian Gobi	:	Brachanthemum mongolicum Krasol
	11. Pheasant's eye	:	Adonis mongolia Sim.
	12. Spoar-grass	:	Stipa pennata L.
	13. Poplar	:	Populus diversifolia Schrenk
	14. Przewalski's gymnocarpous	:	Gymnocarpos Przewalskii Maxim
	15. Rock-jasmine	:	Androsace longifolia Turcz.
	16. Bilberry	:	Vaccinium myrtillus L.
	17. Pagoda-tree	:	Sophora flavescens soland

(2) Threatened species

Fauna / Flora :	Name	
Mammels :	1. Piver beaver	2. Jorboas
	3. Thick-tailed pigmy	4. Kozlov's pigmy jerboa
	5. Long-eared jerboa	6. Forest dormice
	7. Karbled polecat	8. Snow leopard
	9. Chinese desert cat	10. Wild ass
	11. Wild boar	12. East Siberian elk
	15. Goitred gazelle	16. Altai mountain wild sheep
Birds :	1. Dalmation pelican	2. Spoon bill
	3. Black stork	4. Whooper swan
	5. Mute swan	6. Swan goose
	7. Bar-headed goose	8. Osprey
	9. White-tailed eagle	10. Himalayan griffon
	11. English pheasant	12. Great bustard
	13. Little whimbrel	
Plants :	1. Plant species of Mongolian Altai	2. Tulip
	3. Turk's caplily	4. Saxaul-Rhodiola
	5. Saxaul	6. Allium allacium Rall.
	7. Allium obliguum L.	8. Tamarisk
	9. Pea-tree	10. Cynomorium soongaricum Rupr.
	11. Pagoda-tree	12. Salt ree
	13. Reed	14. Gentian
	15. Allium galanthum Kar.	16. Sea-buckthorn
	17. Lily-lily	18. Allium condensatum Turez.
	19. Valerian	20. Saxifrage
	21. Peony	

Source : UNCED, 1991

6.4.3 Social environment

(1) Wastes

Spoils caused by mining activities from mining sites mainly consist of overburden and interburden of coal seams without topsoil. The spoils are continuously stacked backward as a spoil ridge. The rest of the spoils are piled at waste dump areas adjacent to the mining sites, as shown in Figure 6.4. Waste dump areas are planned to reform their land shape and covered by soil and vegetation.

Topsoil is stacked separately for later reclamation and replantation purposes in advance.

(2) Natural monuments

Baga Gun Lake and small hills in the survey area are said to be respected as a natural monument of the district by the people who live around Baga Gun Lake. There are two religionous mounds (Ovoo) on the top of small hills near Baga Gun Lake, where hill tops are covered by impressive red soil and talus deposits due to old spontaneous combustion.

6.5 Environmental examination

Environmental present conditions in the survey area are integrated in Table 6.17 as well as extraction of several environmental issues. The environmental issues are examined based on the expansion plan of coal mine.

6.5.1 Living environment

(1) Air quality

Dust from mining sites, especially mine roads, is possible to be prevented by sprinkling with water on the roads. Therefore, it is necessary to provide several watering trucks based on the extension plan of mining and transportation.

Concerning smoke and soot from a thermal water plant, it is necessary to carry out continuous monitoring of air quality in Baganuur District.

(2) Water quality

Groundwater pumped at mining sites contains much soluble iron (Fe^{2+}), so that it is necessary to continue a treatment of extraction of soluble iron before reused as an industrial water and drainage to the existing watercourse.

Sewage water, seeped water at mining sites and infiltration water at waste dump areas are not clear concerning their quality and quantity because of a lack of data. Therefore, it is necessary to carry out detailed investigations and monitoring of water quality.

(3) Others

Soil contamination and noise/vibration pollution are not recognized.

Table 6.17 Environmental Checklist

Environmental items	Check items	Influence *1 1	2	3	Environmental issues	Moni.*2
I. Living environment						
1. Air quality	- Smoke from plantsite			?		+
	- Dust from mine site	○			Dust	
	- Smoke by s. combustion		△			
2. Water quality	- Drainage of ground-water	○			Fe	+
	- Drainage of sewage	○			Sewage water	+
	- Seepage water at pit		△			+
	- Infiltration water at			?		
	waste dump areas			?		+
3. Soil contamination	- Soil contamination		△			+
	- Dust from stacks			?		
4. Noise & vibration	- Machinery		△			+
	- Blasting		△			
II. Natural environment						
1. Land	- Open pit mining	○			Reclamation	
	- Waste dump areas	○				
	- Slope failure, etc.	○				+
2. Water	- Reducing of groundwater	◎				+
	- Extinction of lake			?	Water level	+
3. Soil	- Extraction of top soil	○			Reuse of soil	
	- Soil erosion		△			
4. Fauna/flora	- Influence to fauna		△		Investigation	
	- Influence to flora	○			Investigation	+
	- Decertification		△			+
5. Landscape	- Open pit mining	○			Reclamation	
	- Spoil and waste dump areas	◎			Reclamation	
	- Extinction of lake	◎				+
III. Social environment						
1. Waste	- Spoil of overburden	○			Reclamation, reuse	
	- Domestic waste		△			
2. Natural monument	- Baga Gun Lake	◎			Communication	
	- Monument	○				

*1 Influence : 1. ◎ : Major influence, ○ : Minor influence
2. △ : Very small to non influence
3. ? : Not clear

*2 Moni. : Monitoring

6.5.2 Natural environment

(1) Land

Total stripping volume as spoils is tentatively calculated approximately 6,500,000 m^3. The spoils are used for reclamation of mined out areas (open pits) and rest of spoils are piled at the waste dump areas.

The spoil ridges and waste dump areas at the present time are continuously eroded by rain-fall and dispersed by the wind, because the slope of ridges and waste dumps is too steep and there is no vegetation. Moreover, slope erosion is thought to affect the water quality and flora. Therefore, it is necessary that the slope of reclaimed land and waste dump areas should be reformed and replanted against the surface erosion and slope failure.

Standard gradient of stable slope is shown in Table 6.18. Wastes and spoils generally consist of loose sand and sandy earth, so that the slope of waste dump and reclaimed areas is desirable to set up 1:2.0 in slope gradient, 15 m in maximum height of embankment and 1 m wide berms at each 5 m high.

Table 6.18 Standard Slope Gradient for Embankment

Materials	: Height	: Gradient
Block (rock)	: 10 - 20 m	: 1:1.8 ~ 1:2.0
Sand	: < 10 m	: 1:1.8 ~ 1:2.0
Sandy earth	: < 5 m	: 1:1.5 ~ 1:1.8
	5 ~ 10 m	: 1:1.8 ~ 1:2.0
Sandy earth with gravel	: < 5 m	: 1:1.5 ~ 1:1.8
	5 ~ 15 m	: 1:1.8 ~ 1:2.0
Clay	: < 5 m	: 1:1.8 ~ 1:2.0

Source: Japan Road Association

(2) Water

1) Pumping of groundwater

Drawdown of groundwater is planned up to -230 m deep in maximum from surface for the mining of -150 m level. Pumping volume is presumably calculated as below.

$Q = n \times K \times 2\pi \times H \times L / (\ln L/r)$: Formula of pumpage

Q : Pumping volume (m^3)

K : Permeability coefficient (m/sec)

: Average 8.50×10^{-5} m/sec

n : Number of pumping well

H : Difference of head (m)

L : Length of aquifer (m)

r : Radius of well (m)

(Calculation of maximum pumping volume at present)

K = 8.50×10^{-5} m/sec (average)

H = 56 m

L = 30 m

r = 0.10 m

n = 23 wells

Q = 3.618 m^3/sec = 312,598 m^3/day

(0.157 m^3/sec/well)

(Calculation of forecasting pumping volume)

K = 8.50×10^{-5} m/sec (average)

Ka= 8.65×10^{-6} m/sec (apparent)

H = 146 m

L = 50 m

r = 0.10 m

n = 33 wells

Q = 20.561 m^3/sec = 1,776,440 m^3/day

(0.623 m^3/sec/well)

Qa= 2.092 m^3/sec = 180,749 m^3/day

(0.063 m^3/sec/well)

Qa : Apparent pumping volume

As results of the calculation of pumpage, maximum pumping volume at present of each well and total pumping volume are 0.157 m^3/sec and 3.618 m^3/sec respectively. Although actual pumping capacity of each well ranging from 6 to 10 l/sec is relatively lower than the maximum pumping volume of well, present groundwater level is kept an balance ranging in depth -60 to -70 m from surface and continuous pumpage ranging in volume from 20,000 to 32,000 m^3 per day. Because it is thought that supplement of groundwater to the mining areas lacks. The present actual pumping volume of each well and apparent permeability coefficient are recalculated to be 1,391 m^3/day (0.016 m^3/sec) and 8.65×10^{-6} m/sec.

On the other hand, forecasting pumping volume and maximum pumping volume of each well using apparent permeability coefficient are calculated 0.063 m^3/sec and 0.627 m^3/sec respectively. The pumpage required for drawdown of groundwater for mining in future is presumably 180,749 m^3/day, which is approximately six times of the present pumping volume of groundwater. The pumped water will be used approximately 10,000 m^3/day as industrial water, and the rest of water, approximately 170,000 m^3/day, will be drained to Kherlen River after treatment of Fe.

Increased drainage of water is presumably affected the water quality and bank erosion of Kerlen River and its tributary.

In addition, radius of influence of groundwater at the mine area is calculated as below.

$R = 3{,}000 \times Sw \times \sqrt{K}$ (Formula of Siechardt)

R : Radius of influence of groundwater (m)
Sw : Drawdown of groundwater (m) : 140 m, 300 m
K : Permeability coefficient (m/sec)
: Apparent 8.65×10^{-6} m/sec

Rp = 1,235.2 m (at present)

R = 2,647.0 m

The present and forecasting radius of influence are calculated approximately 1,200 m and 2,600 m respectively, so that the most of survey area including Baga Gun Lake will be affected by pumpage at mining sites. Therefore, it is necessary to examine the influences of Baga Gun Lake such as surrounding the mining sites.

2) Hydrological influence for Baga Gun Lake

The geological and hydrological conditions of Baga Gun Lake and its surroundings are shown in Figures 6.7 and 6.8. Baga Gun Lake is located at the southwestern wing of syncline and overlies several coal seams. Steep fault trending north to south is found 400 m east of the lake. Present mining boundary is along the fault as shown Figures 6.5 and 6.7. Baga Gun Lake is certainly influenced by pumpage at the mining site. Lowering of water level of the lake is approximately 4 m and area of the lake is reduced to 57 % without any alteration of land shape except mining activities at Pit No.5 and construction of road and bridge passed at the upper stream.

The geology around the lake consists of Cretaceous rocks and alluvial deposits as shown in Figures 6.8 and 6.9. Cretaceous rocks consisting of sandstone, siltstone and coal seams, are relatively loose consolidation and estimated 8.56×10^{-5} m/sec as an apparent permeability coefficient. Sandstone and coal seams are good aquifer. Alluvial deposits consist of gravel, sand, silt and clay. It is presumed that the bottom deposit of the lake or same horizon of alluvial deposits are composed of clay, silt and/or parmofrost as an aquiclude (or semi-pervious layer) for preserving lake. The groundwater is thought to be the condition of the perched groundwater, although there is not a detailed hydrogeological data in the area.

Outflow of the lake at present is presumed to be slightly less than inflow of the lake, that is losing water of stream. Difference of water balance mainly consists of infiltration into underground with subordinate evaporation from water surface, evapotranspiration and drinking by domestic animals.

Primary groundwater level around mining sites before development of coal mine is inferred to exist two levels, namely upper level and lower level (Figure 6.8). The upper groundwater level, is thought to be locally and temporarily situated in the alluvial deposits and it is controlled by the condition of alluvial aquiclude. The upper groundwater level, ranging in

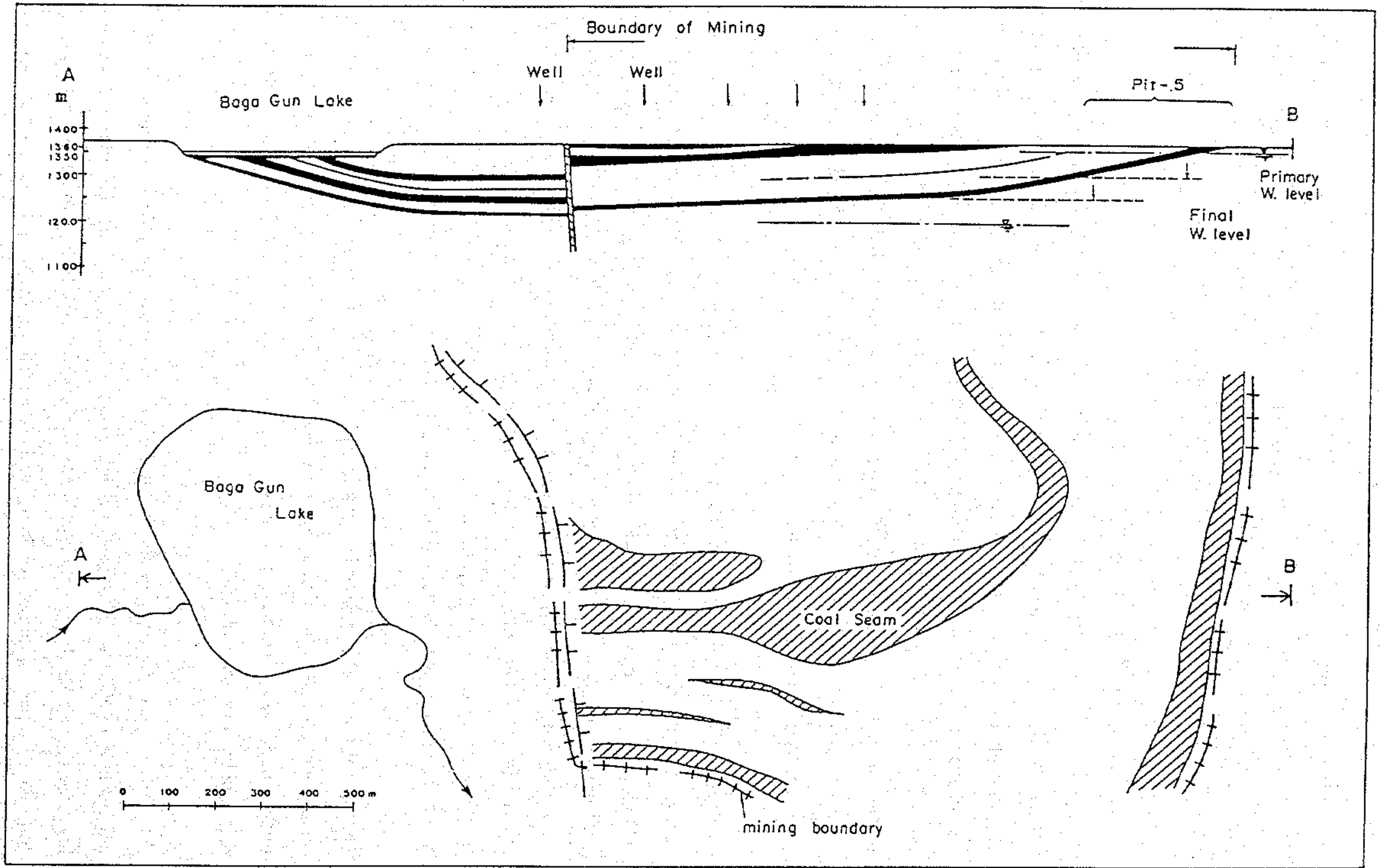

Figure 6.7 Geological Condition of Baga Gun Lake

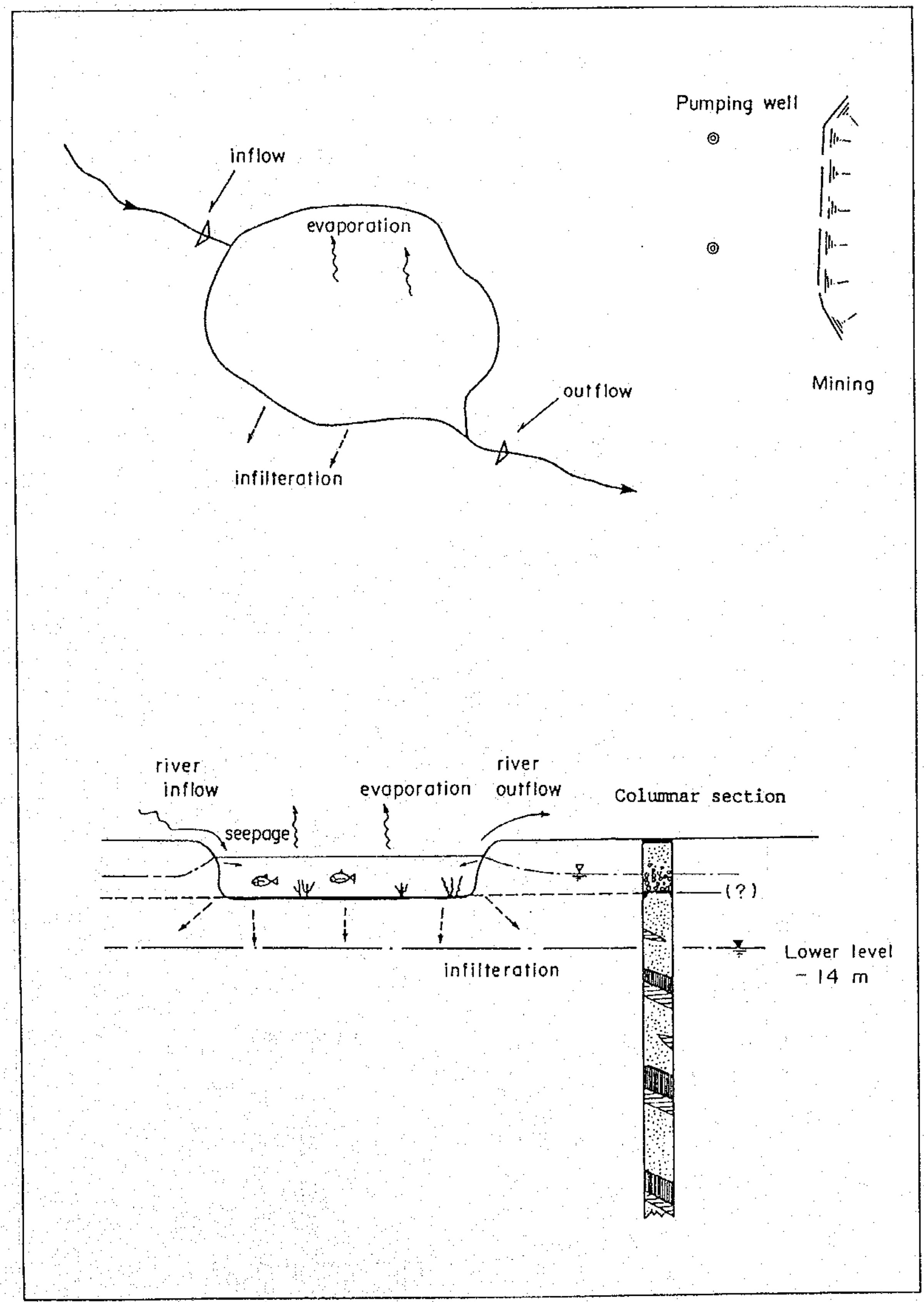

Figure 6.8 Hydrological Condition of Baga Gun Lake

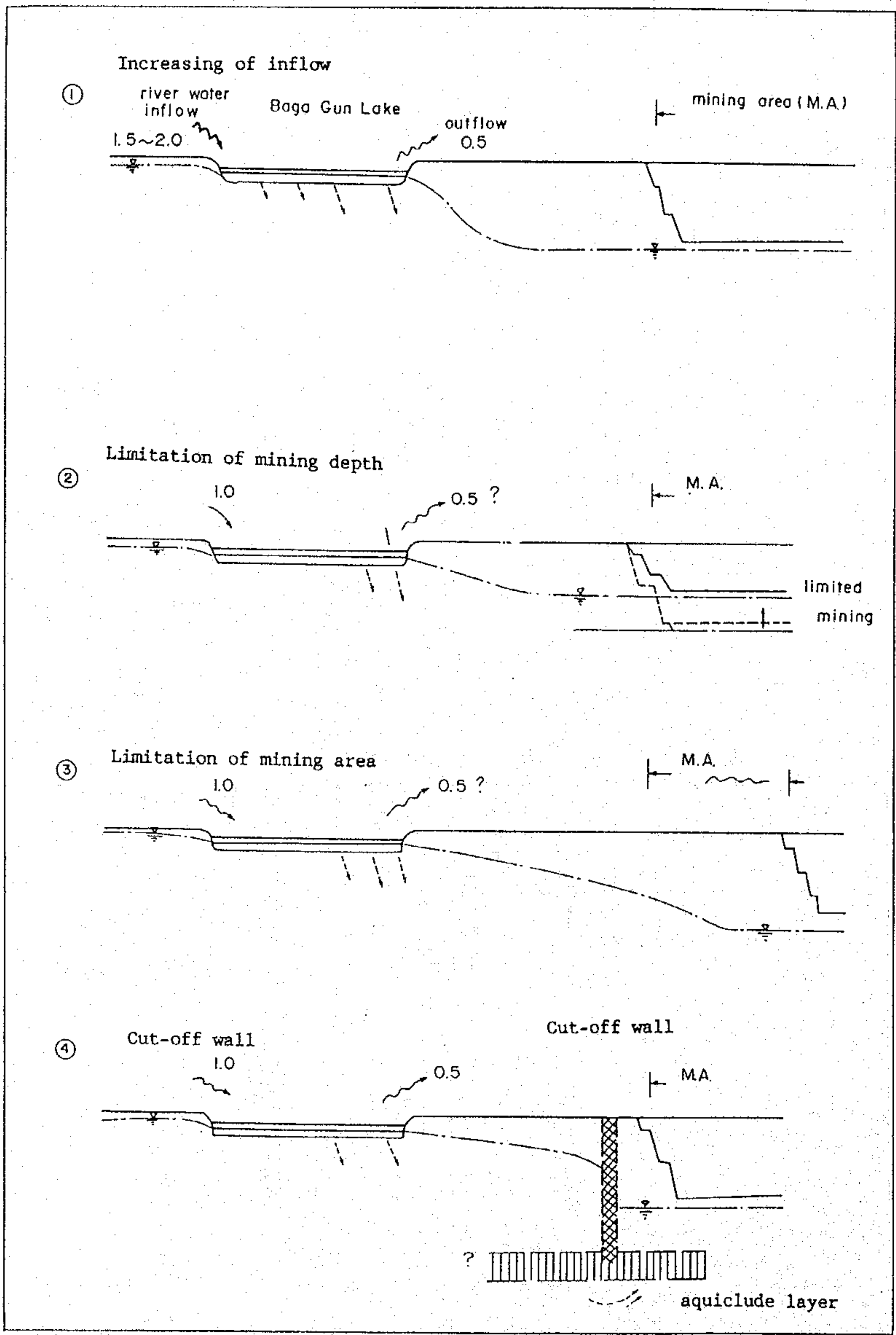

Figure 6.9 Forecasting Hydrological Condition of Baga Gun Lake

depth from -1 to -6 m, vary in dependence on the hydrological condition of the recharge area of the lake as shown in Figure 6.8.

The lower groundwater level is confirmed by drilling survey to be in the cretaceous rocks and it is approximately -14 m deep from surface.

The zone between bottom level of the lake and lower groundwater level must be an unsaturating condition. Therefore, the primary stage is thought to have been kept by the infiltration from the bottom of the lake as well as river, but the volume of infiltration water is relatively small because of existence of thin semi-pervious layer in the bottom of lake.
Influence of Baga Gun Lake by pumpage at mining site was forecasted based on the limited existing geological and hydrological data as below.

① Primary condition

Infiltration water from lake to underground under the primary condition is thought to be very small in comparison with the condition after pumpage at mine site. Therefore, the rate of inflow and outflow of lake is presumably 1.0 and 1.0 respectively as shown in Figure 6.9. Lower groundwater level was -14 m deep.

② Coal mining (present condition)

Since the coal mining was developed and the groundwater level has been a drawdown, down to -70 m deep, by the pumpage of the groundwater around the mining site and the water level of Baga Gun Lake has been lowered approximately 4 meters. Because Baga Gun Lake, located approximately 800 m west to the pumping wells, is involved in the influence area of groundwater by pumpage, which is approximately 1,200 m in radius. Drawdown of lower groundwater under the lake is thought to be approximately 0 to -5 meters deep from primary lower groundwater level, -14 m below from ground surface.

The infiltration from the lake to underground is promoted by pumpage. The rate of infiltration to the inflow of lake is presumed to be 0.1 to 0.3 based on the present condition of apparent water balance of the lake. Therefore, the rate of outflow to the inflow of lake ranges from 0.7 to 0.9.

③ Expansion of mining production

Groundwater level at the final stage of mining is planned to be lowered approximately -230 m deep at mining site. Mining boundary and most closed pumping wells will be located approximately 400 m and 200 m west from Baga Gun Lake respectively. Drawdown of lower groundwater under the lake is forecasted to be approximately -80 to -150 meters deep from surface.

Infiltration from lake to underground must be promoted more and more by pumpage. The rate of infiltration depends on the condition of semi-pervious of alluvial deposits. The alluvial semi-pervious layer indicates the conditions of the prevention against the drawdown of groundwater, because the zone between bottom of the lake and lower groundwater level is kept unsaturating condition. However, the rate of infiltration to inflow of the lake is presumed to be gradually changed from 0.2 to 0.6 in accordance of pumpage program.The rate of outflow to the inflow of lake is presumed ranging from 0.4 to 0.8. Therefore, the water of Baga Gun Lake may be preserved in the condition of the rate of 0.6 in case that the semi-pervious layer fulfills its function, massive leakage by damage of semi-pervious layer and pumpage of upper (perched) groundwater do not occur artificially, and inflow of lake does not change.

If the hydrological conditions as mentioned above are prevented, Baga Gun Lake will meet fatal condition such as extinction of the lake and destruction of ecological system related to the lake.

④ After termination of coal mining

Reclamation of the mined out areas will be done during mining and after termination of mining as well as pumpage work. Groundwater will be rapidly recovered to the primary groundwater level. If the reclamation is not enforced, large artificial lake will be appeared in the mined out areas. And then, the water of Baga Gun Lake also will be rapidly recovered.

(3) Soil

Total surface area of approximately 21 km^2 (2,100 ha) is topographically altered by mining activities. The thickness of surface soil is approximately 25 cm in average.

Present altered (mined out) areas are reached 7.5 km^2. Present total volume of topsoil for replanting is piled only 30,000 m^3 and rate of soil piles to the total volume of spoils is 1.6 %. Although necessary volume of the topsoil for replanting in whole mining area is arithmetically calculated 1,750,000 tons except alluvial soil, it may be possible to obtain topsoil of some 350,000 m^3 (20 %) in volume by careful stripping, two times of the rate to the volume of present topsoil piled. However, necessary volume of topsoil for replanting is thought to be at least 378,000 m^3.

Shortage of topsoil for replanting is possible to obtain from hills located southwest to the mining area. Massive soil is accumulated at the slope of hills. In this case, it is necessary to carry out a detailed investigation prior to the soil cutting and to care the slope protection and replantation after cutting of soil.

(4) Fauna/flora

Destruction of vegetation in association with alteration of land shape by mining activities extends to approximately 2,100 ha. After termination of coal mining, land reclamation of the mined out areas and replantation should be enforced for conservation of natural environment.

Replantation of grass should be used topsoil and additional soil taken from hills, which contain much seed of grass. It is, therefore, very important to reserve topsoil prior to stripping of overburden.

Expansion of mining production involves a risk of extinction of Baga Gun Lake by massive pumpage near the lake or mining at the lake. The extinction of Baga Gun Lake or loss of lake water corresponds with the extinction of ecological system including fauna and flora in and around the lake, even if the shape of lake will be recovered after termination of coal mining.

(5) Landscape

The mined out areas should be reclaimed to the previous shape. And waste dump areas are necessary to reform for not only preservation of erosion of slope, slope failure, treatment of waste water but also landscape.

Baga Gun Lake is also important as a landscape and natural monument as well as regional mounds in the district.

6.6 Environmental management plan

The environmental management plan based on the results of examination concerning each environmental item is briefly shown in Table 6.19.

Table 6.19 Environmental Management Plan

Items	: Causes and Influences	: Countermeasures
1. Air quality	: - Dust by transportation of coal and topsoil	: Sprinkling water by watering trucks
2. Water quality	: - Precipitation of Fe by drainage of groundwater	: Water treatment by extraction of Fe
3. Land	: - Alteration of land shape by open pit mining and	: Reclamation by reusing of spoils and reform of slope of embankment
4. Water	: - Bank erosion by increased drainage of groundwaer water pumped	: Bank protection of rivers
	: - Drawdown of water level of Baga Gun Lake	: Drawing water to Baga Gun Lake from Hutsaa River
5. Soil	:- Stripping of topsoil by open pit mining	: Piling of topsoil and reuse of topsoil for replantation
6. Fauna/flora	:- Stripping of vegetation by open pit mining and waste dumping	: Replantation at reclaimed and waste dump areas using piled topsoil
7. Landscape	: - Alteration of land shape by open pit mining and waste dumping	: Reclamation and replantation
8. Wastes	: - Occurrence of wastes and waste dump areas	: Reusing for reclamation at mined out areas, reform of slop of embankment and replantation of surface of wastes
9. Natural monument	: - Extinction of Baga Gun Lake by pumping groundwater	: Drawing water to Baga Gun Lake from from Hutsaa River

6.6.1 Living environment

(1) Air quality (Dust)

Dust mainly occurs from mine roads for transportation of coal, topsoil and/or waste. It is necessary to provide four watering trucks (40 tons capacity) for sprinkling water in accordance with expansion program of mining.

(2) Water quality (Drainage of groundwater)

Groundwater in the mine site contains much soluble iron (Fe^{2+}), so that water treatment, extraction of Fe^{2+}, needs before drainage to Kherlen River. The pumpage volume as well as treatment volume of water will be increased to approximately 17,000 m^3 per day, six times to the present drainage volume.

6.6.2 Natural environment

(1) Land

1) Mined out areas

Total stripping and piling volume as a waste is calculated approximately 6,500,000 m^3. The wastes are used for land reclamation of the mined out areas and reused as a material for construction, etc. Slope of reclaimed areas is desirable to set up 1:2.0 in slope gradient, 15 m in maximum height of embankment, 1 m wide berms at each 5 m high and slope protection.

2) Waste dump areas

The slope of waste dump areas should keep stable and prevent from erosion. Slope of waste dumps is desirable to set up 1:2.0 in slope gradient, 15 m in maximum height of embankment, 1 m wide berms at each 5 m high, drainage system and slope protection as shown in Figure 6.10. Size of reformed waste dump is tentatively estimated 300 m x 1,650 m wide and 15 m high, in case of 6,500,000 m^3 as final volume of wastes.

(2) Water

1) Drainage of groundwater

Massive drainage of groundwater, approximately 180,000 m^3/day, to the tributary and main stream of Kherlen River is possible to cause bank erosion of water course, so that it may be

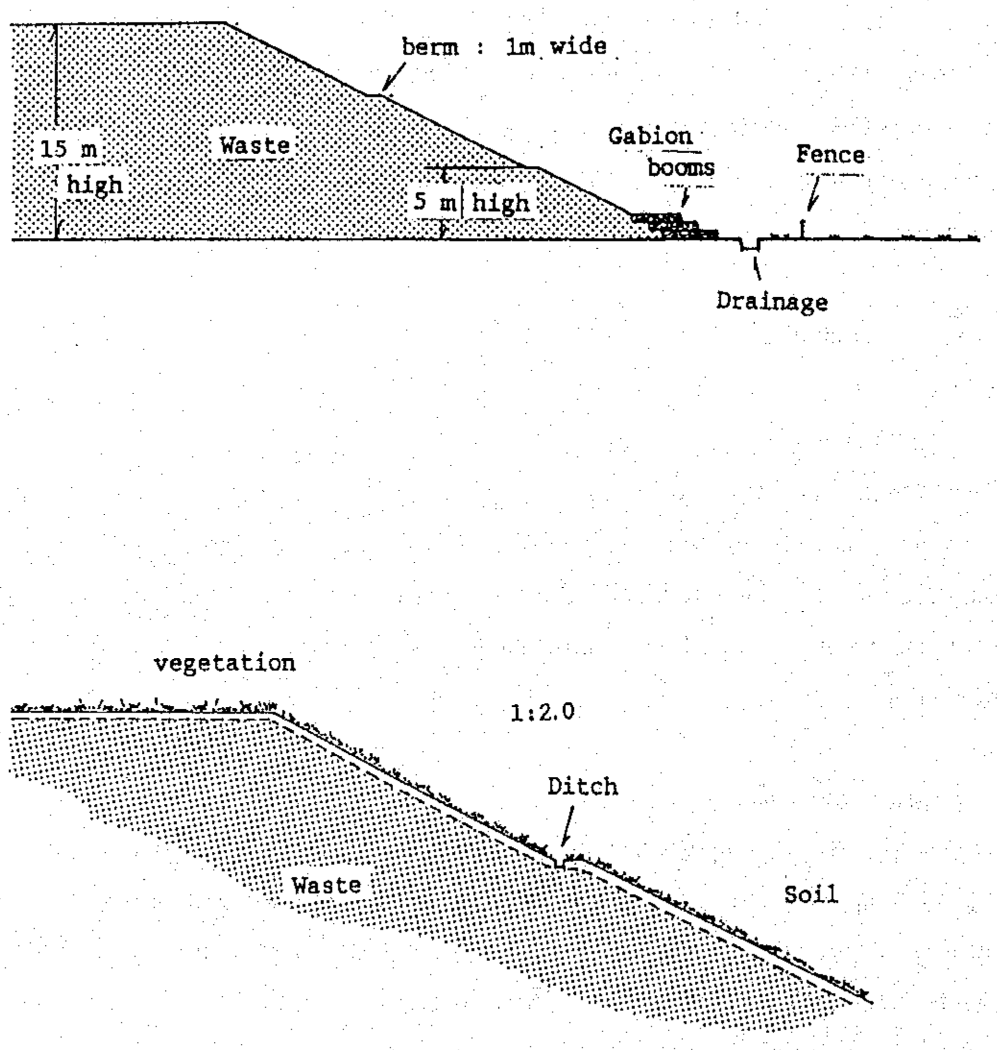

Figure 6.10 Slope of Waste Dump

necessary to consider countermeasures including bank protection and reconstruction of a bridge in accordance of the pumpage program and result of monitoring.

2) Drawdown of Baga Gun Lake

Massive pumpage of groundwater is induced to drawdown of groundwater and surface water level including Baga Gun Lake. Four methods of countermeasures for the drawdown of Baga Gun Lake are examined as below (see Figure 6.11). The method of increasing of water inflow to the lake is thought to be the most realistic countermeasure.

① Increase of inflow

Outflow of the lake will be decreased in rate of 0.4 to 0.8 to the inflow. Decreasing outflow can be recovered by pouring additional water supplied from Hutsaa River into Baga Gun Lake as shown in Figure 6.10. Water volume supplied corresponds with the volume of infiltration into the underground.

The water quality of Hutsaa River is presumably almost similar to that of Hujirtai River and Baga Gun Lake. Therefore, ecological system including Baga Gun Lake may be conserved.

② Limitation of mining depth

Decreasing of pumpage volume is effective for prevention of drawdown of groundwater and lake. In case that the mining depth is limited up to 70 m deep as shown in Figure 6.11.②, the present hydrological condition of surface will be preserved without extinction of the lake.

③ Limitation of mining area

In case that mining area is limited up to 1,000 m distance away from the lake as shown in Figure 6.11.③, decreasing rate of outflow may be possible to become small such as 0.2 to 0.4.

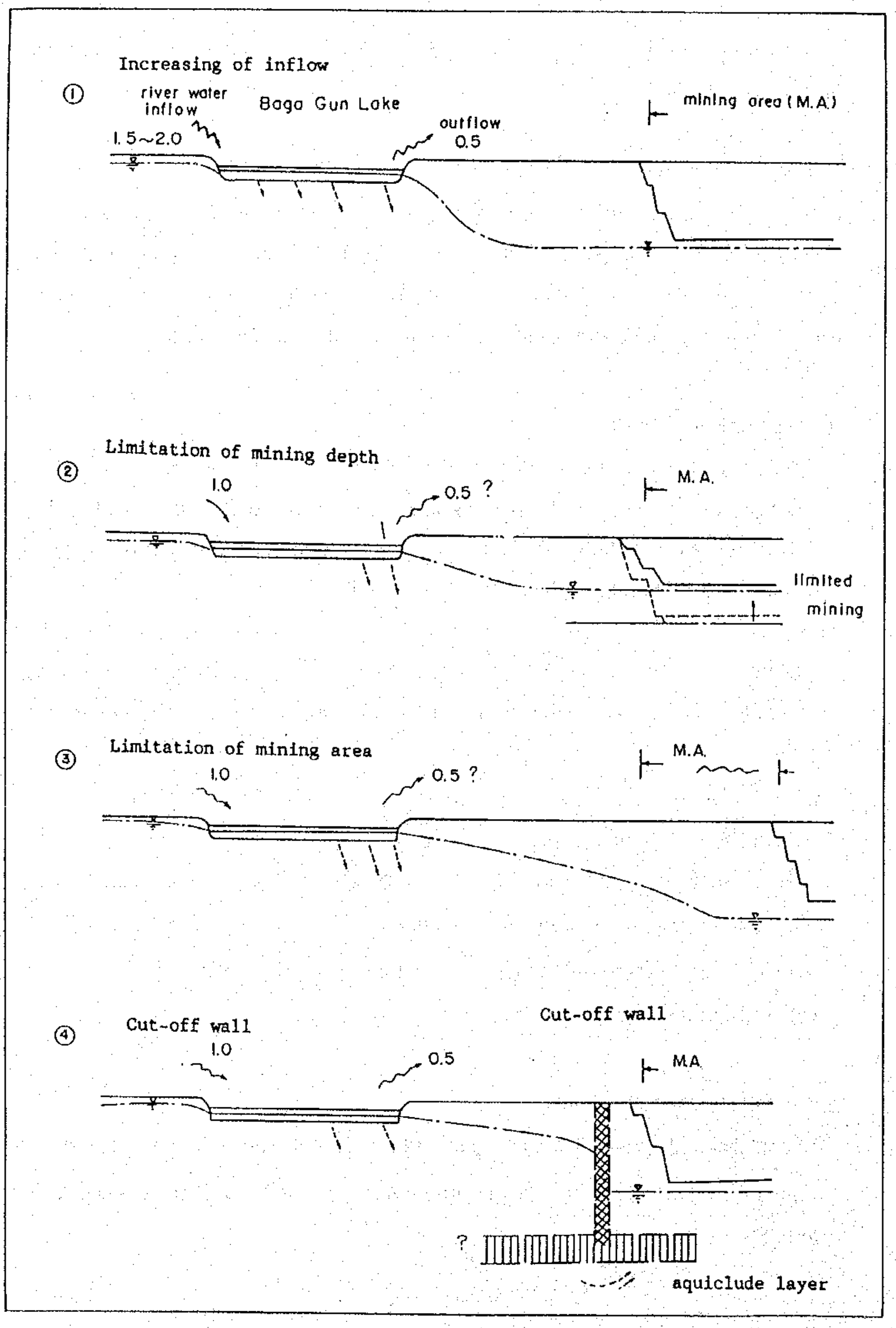

Figure 6.11 Countermeasures of Baga Gun Lake

④ Cut-off wall

Cut-off wall method under a condition that the aquiclude layer exists at a suitable depth in the underground as shown in Figure 6.11.④ is extremely effective for prevention of drawdown by massive pumpage. However, there is not appropriate aquiclude layer in the area, and thus it is impossible to cut off the groundwater.

(3) Soil

Surface soil (topsoil) is important for slope protection and replantation of grass as shown in Figure 6.10, so that it is necessary to pile up topsoil prior to the stripping of overburden.

(4) Fauna and flora

After land reclamation at the mined out areas and reform of waste dump areas, it is necessary to recover vegetation for ecological condition as well as protection of slope, dust dispersion, landscape, etc. Topsoil piled is suitable for replantation of grass by seeding as shown in Figure 6.10.

(5) Landscape

After land reclamation at the mined out areas and reform of waste dump areas, it is necessary to be replanted by seeding of grass for landscape.

6.6.3 Social environment

(1) Wastes

Waste dump areas should be reformed their shape for keeping stable condition, slope protection, drainage system as well as replantation of grass.

(2) Natural monument

As mentioned above, Baga Gun Lake will be considerably affected by massive pumpage in the mining area. The extinction of Baga Gun Lake is said to be important for the people who live in and around Baganuur District.

As the proprietary of the lake is not clear, it is necessary to have communication among the people, community, company, etc. who may concern.

6.7 Monitoring plan

It is necessary for monitoring to understand the environmental conditions and examine the preservation of environment. The components of monitoring are shown in Table 6.20.

6.7.1 Living environment

(1) Air quality

Monitoring of air quality consists of smoke and dust. Components of analysis are suspended particulate matter (SPM) and dust fall. Monitoring points are located around plantsite, mine site and Baganuur townsite.

(2) Water quality

Components of water quality of drainage of groundwater, sewage and seepage from pits and waste dump areas consists of pH, electric conductivity, chemical oxygen demand (COD), suspended solid (SS), total N, Fe, Mn, Cl, Na, K, Ca, Mg, HCO_3 and SO_4. Monitoring points are designated at the drainage point of groundwater and sewage, Kherlen River, mining site and waste dump areas.

Table 6.20 Monitoring Plan

Items	Influences	Monitoring	
1. Air quality	- Smoke and dust	: SPM, dust-fall	: Plantsite, mine site, townsite
2. Water quality	- Drainage of sewage and groundwater	: Main components *1	: Drainage point. Kherlen R., etc.
	- Seepage at pits and dump areas	: Main components *1	: Around mine site
3. Water	- Drainage of ground-water pumped	: Outflow, etc.	: Observation
	- Drawdown of water of Baga Gun Lake	: Inflow, outflow	: Observation

*1 : Component of analysis : pH, electric conductivity, chemical oxygen demand, suspended solid, total N, Fe, Mn, Cl, Na, K, Ca, Mg, HCO_3, SO_4

6.7.2 Natural environment

(1) Water

Concerning drainage of groundwater to the existing watercourse, it is necessary to observe condition of the river. Concerning drawdown of Baga Gun Lake, it is necessary to carry out geological and hydrological investigations and to observe the environment as a monitoring around the lake.

6.8 Environmental investigation

It is necessary to conduct a detailed environmental investigation in order to understand the environmental conditions in and around the mining area and for planning of concrete measurements for environmental conservation. The components of environmental investigation are listed in Table 6.21.

Table 6.21 Environmental Investigation

Items	Components	Location
1. Air quality	: SOx, NOx, SPM, dust-fall	: Plantsite, townsite, mining area and its circumstance
2. Water quality	: Chemical & physical analyses; components *1	: Rivers, lake, mining area and its circumstance, Baga Gun Lake
3. Water	: Hydrological investigation (Water balance, pumping teat, drilling survey	: Baga Gun Lake, rivers
4. Soil	: Soil investigation (Soil section, chemical analysis; components *2	: Mining area and its circumstance, plantsite, townsite
5. Fauna/flora	: Fauna & flora investigation	: Mining area and its circumstance, Baga Gun Lake

*1 : Components : pH, electric conductivity, chemical oxygen demand, suspended solid, total N, Fe, Mn, Cl, Na, K, Ca, Mg, HCO_3, SO_4

*2 : Components : Pb, Ni, Cu, Mo, Mn, Sn, V, Cr, Cd, Cyanide, Organic P, As, Hg

6.9 Cost estimation

Costs for environmental aspects consist of environmental investigation, environmental countermeasures and monitoring works as shown in Table 6.22. The total cost of environmental conservation, excluding the environmental investigation, is estimated to be additional 10 tg. per BCM of total excavation. After mined out of coal, the costs for additional environmental conservation, including reclamation, planting and monitoring works should be required.

Table 6.22 Costs of Environmental Conservation

(10-6 tg.)

Environmental Items	Components	Rate (%)	Year -1 1995	1 1996	2 1997	3 1998	4 1999	5 2000	6 2001	7 2002	8 2003	9 2004	10 2005
1. Air quality	Dust	5	-	8.7	8.7	12.1	14.9	14.9	14.9	14.9	14.9	14.9	14.9
2. Water quality	Water treatment	20	-	34.6	34.6	48.4	59.8	59.8	59.8	59.8	59.8	59.8	59.8
3. Land	Reclamation	41-49	-	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8
4. Water	Drainage	10	-	17.3	17.3	24.2	29.9	29.9	29.9	29.9	29.9	29.9	29.9
5. Soil	Stockpile	10	-	17.3	17.3	24.2	29.9	29.9	29.9	29.9	29.9	29.9	29.9
6. Flora	Planting	3	-	5.2	5.2	7.3	9.0	9.0	9.0	9.0	9.0	9.0	9.0
7. Baga Gen Lake	Conservation	0-0	-	-	13.8	19.3	23.9	-	-	-	-	23.9	-
8. Monitoring	-	3	-	5.2	5.2	7.3	9.0	9.0	9.0	9.0	9.0	9.0	9.0
9. Environmental investigation	-	-	80.0	-	-	-	-	-	-	-	-	-	-
1. A *4				173.0	173.0	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8
2. B *5				0.0	0.0	57.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1
Total		100	80.0	173.0	173.0	241.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9

Environmental Items	11 2006	12 2007	13 2008	14 2009	15 2010	16 2011	17 2012	18 2013	19 2014	20 2015	21 2016	22 2017	23 2018	24-33 2019-2028	Total
1. Air quality	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	-	328.3
2. Water quality	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	-	1.373.5
3. Land	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8 *1	3.502.5
4. Water	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	-	686.9
5. Soil	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	-	686.9
6. Flora	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	45.0 *2	206.0
7. Baga Gen Lake	-	-	-	-	23.9	-	-	-	23.9	-	-	-	-	-	128.8
8. Monitoring	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	90.0 *3	206.2
9. Environmental investigation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80.0
1. A *4	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8	139.7	4.366.5
2. B *5	114.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1	114.1	80.1	2.419.2
Total	298.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9	298.9	219.8	6.887.7

*1 : For one year after mined out.
*2 : For five years after mined out.
*3 : For ten years after mined out.
*4 : 10 tg. per BCM of total excavation in cace of A.
*5 : 10 tg. per BCM of total excavation in cace of B.

6.10 Conclusions and recommendations

6.10.1 Conclusions

The environmental investigation in Baganuur Coal Mine area was carried out for nine environmental items, air quality, water quality, soil contamination, noise/vibration, land, water, soil, fauna/flora and landscape.

① Any limitation on renovation for 6 million t/y was not recognized in all environmental aspects. The major influences consist of water quality of drainage of groundwater and possibility of water drawdown of Baga Gun Lake. The minor influences consist of air quality, land, fauna/flora and landscape.

② Expansion of an existing water treatment system of groundwater drainage and a change of the water flow route of Hutsaa River into Baga Gun Lake, if necessary, are proposed to resolve above-mentioned issues.

6.10.2 Recommendations

The environmental management plan and monitoring plan in order to preserve the environment in the district during and after mining of coal are recommended.

In addition, more detailed investigations of water quality, land, water, soil and fauna/flora as well as environmental impact assessment are recommended to carry out in the coal mine area.

7 Study of Capital and Operating Costs

7.1 Replacement schedule

As described in Section 4, a shovel and truck method was selected for mine expansion. Comparison study of the cost index shows that the present railway system is not an economical system compared with a shovel and truck system. In order to select the most economical renovation plan, three cases of replacement schedules for the existing equipment are prepared.

Case 1 is to maintain the existing railway system for 23 years of the project period. Table 7.1 shows the replacement schedule of Case 1.

Case 2 is to replace the railway system with a shovel and truck system from 1998. In this case, the existing railway system will be abandoned althrough their equipment life is still remained. Two units of diesel locomotives will be utilized for freight car hauling at the temporal loading site. Some electric shovels will be utilized at another working site. A modification and replacement schedule of Case 2 is shown in Table 7.2.

Case 3 is to abandon the railway system from 2002 when the life time of the major equipment of the existing railway system will be finished. In this case, three units of FEL will be required for the improvement of the railway system for the duration from 1998 to 2001. From 2002 to 2005, FEL will be used for the truck loading. Two units of electric rope shovels will be introduced in 2004 to replace three units of FEL. A modification and replacement schedule of this case is shown in Table 7.3.

Regarding the supporting equipment and facilities, the replacement schedule for these equipment and facilities will be commenced at the year shown in Table 4.7. Replacement of the equipment and facilities is planned to be conducted periodically in conformity with the life time of each equipment.

Table 7.1 Replacement Schedule of Major Equipment

-Case1:With-Railway system-

			1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Coal production	(million ton)		3.3	3.5	4.0	4.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Overburden removal	(million BCM)		9.0	13.1	14.2	14.2	19.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Existing equipment	Unit	Life	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dragline 20/90	1	15							1															1			
Dragline 15/90	1	15				1															1						
Dragline 10/70	2	15				1							1								1						
Dragline 13/50	3	15									1		1		1											1	
Shovel EKG-8u	4	15									1	1	1	1												1	1
Shovel EKG-5A	5	15						1		1		1			1		1						1		1		1
Shovel EKG-4y	2	15									1	1														1	1
Shovel EKG-4.6b	4	15	1			2			1									1			2			1			
E.Locomotive	10	15									2	2	4	2												2	2
D.Locomotive	5	15	1								2	1	1					1								2	1
Wagon	106	8		28	25	39	12		2			28	25	39	12		2			28	25	39	12		2		
Drill CbR 160	8	8	1		2	1	1	1	1	1	1		2	1	1	1	1	1	1		2	1	1	1	1	1	1
Drill CbR 2M	2	8			1	1							1	1							1	1					
Bulldozer DET-250	6	6			2	1	1	1	1		2	1	1	1	1		2	1	1	1	1		2	1	1	1	1
Bulldozer DE-110	4	6					4						4						4						4		
Bulldozer D-155	6	8					3	3							3	3							3	3			
D/T Belaz 548	19	6	5	6	2	3	3		5	6	2	3	3		5	6	2	3	3		5	6	2	3	3		5
D/T HD-325	20	8					20								20								20				
Scraper	2	8				1			1					1			1					1			1		
Grader	2	8				1			1					1			1					1			1		
Reinforce Railway system	unit	life	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
FEL 10 m3	3	8					3								3								3				

Table 7.2 Replacement Schedule of Major Equipment -Case2:Non-Railway System from 1998-

				1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Coal production	(million ton)			3.3	3.5	4.0	4.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Overburden removal	(million BCM)			9.0	13.1	14.2	14.2	19.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
	Unit		Life																									
Existing equipment	-1997	1998-		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dragline 20/90	1	1	15							1															1			
Dragline 15/90	1	1	15				1															1						
Dragline 10/70	2	2	15				1							1								1						
Dragline 13/50	3	1	15													1												
Shovel EKG-8u	4	3	15										1	1	1													1
Shovel EKG-5A	5	5	15						1		1		1			1		1						1		1		1
Shovel EKG-4y	2	0	15																									
Shovel EKG-4.6b	4	3	15	1			2															2			1			
E.Locomotive	10	0	15																									
D.Locomotive	5	2	15	1										1					1									
Wagon	106	0	8		28	25																						
Drill CbR 160	8	8	8	1		2	1	1	1	1	1	1		2	1	1	1	1	1	1		2	1	1	1	1	1	1
Drill CbR 2M	2	2	8			1	1							1	1							1	1					
Bulldozer DET-250	6	6	6			2	1	1	1	1		2	1	1	1	1		2	1	1	1	1		2	1	1	1	1
Bulldozer DE-110	4	4	6					4						4						4						4		
Bulldozer D-155	6	6	8					3	3							3	3							3	3			
D/T Belaz 548	19	19	6	5	6	2	3	3		5	6	2	3	3		5	6	2	3	3		5	6	2	3	3		5
D/T HD-325	20	20	8					20								20								20				
Scraper	2	2	8				1			1					1			1					1			1		
Grader	2	2	8				1			1					1			1					1			1		
Instead of Railway system																												
	Unit		life																									
	-1997	1998-		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
FEL 10 m3	0	0	8																									
12 m3 shovel	0	2	21					2																				
Dump truck 80 ton	0	18	8					18								18								18				

Table 7.3 Replacement Schedule of Major Equipment -Case3:Non-Railway system from 2002-

					1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Coal production	(million ton)				3.3	3.5	4.0	4.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Overburden removal	(million BCM)				9.0	13.1	14.2	14.2	19.0	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
	Unit			Life																									
Existing equipment	-2001	2002-			1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dragline 20/90	1	1		15							1															1			
Dragline 15/90	1	1		15				1															1						
Dragline 10/70	2	2		15				1							1								1						
Dragline 13/50	3	1		15													1												
Shovel EKG-8u	4	3		15										1	1	1													1
Shovel EKG-5A	5	5		15						1		1		1			1		1						1		1		1
Shovel EKG-4y	2	0		15																									
Shovel EKG-4.6b	4	3		15	1			2			1												2			1			
E.Locomotive	10	0		15																									
D.Locomotive	5	2		15	1										1					1									
Wagon	106	0		8		28	25	39	12		2																		
Drill CbR 160	8	8		8	1		2	1	1	1	1	1	1		2	1	1	1	1	1	1		2	1	1	1	1	1	1
Drill CbR 2M	2	2		8			1	1							1	1							1	1					
Bulldozer DET-250	6	6		6			2	1	1	1	1		2	1	1	1	1		2	1	1	1	1		2	1	1	1	1
Bulldozer DE-110	4	4		6					4						4						4						4		
Bulldozer D-155	6	6		8					3	3							3	3							3	3			
D/T Belaz 548	19	19		6	5	6	2	3	3		5	6	2	3	3		5	6	2	3	3		5	6	2	3	3		5
D/T HD-325	20	20		8					20								20								20				
Scraper	2	2		8				1			1					1			1					1			1		
Grader	2	2		8				1			1					1			1					1			1		

Instead of Railway system	Unit -2001	2002-	life	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
FEL 10 m3	3	0	8					3																				
12 m3 shovel	0	2	21													2												
Dump truck 80 ton	0	18	8									18								18								18

7.2 Equipment price and parts cost

For the purpose of estimating and evaluating the capital and operating cost for renovation, future cost data are projected from the current cost data and conversion factors. Table 7.4 shows the concept of recent price and cost structure in Mongolia to be used in this study. The CIF site total on Table 7.4 are all financial prices and costs expressed as 1.0000 except royalties and charges, in which border price, taxes, domestic transportation and other costs are included. The CIF site prices or costs without taxes illustrate conversion factors; financial costs can be reduced to economic costs at the mine site by multiplying a financial cost by its own conversion factor.

Initial investment cost and replace investment cost are included in the capital cost. Parts cost, diesel oil, gas and lubricants, electricity, explosives, labour cost, etc. are included in the operating cost.

Regarding the capital and operating costs for existing equipment, the current price level of the existing equipment is still low, but it is estimated that the prices will become closer to those of the modern type equipment. Based on the estimation of future equipment prices, future parts cost for "Railway system" and "Non-Railway system" are estimated.

Equipment price and parts cost for Case 1, (with existing railway system) at the current price level is shown in Table 3.15. Table 7.5 shows the estimation result of equipment price and parts cost as of 1998.

Equipment price and parts cost for Case 2 and 3 (non-railway system) at the current price level is shown in Tabel 7.6. Table 7.7 shows the estimation result of equipment price and parts cost as of 1998.

Tabel 7. 4 Price and Cost Structures

Items	Foreign Currency	Local Currency		CIF Site	
	Border Price	Taxes	Other Costs	Without Taxes	Total
Imported Equipment	0.8333 (1.0000)	0.1521 (0.1825)	0.0146 (0.0175)	0.8479 (1.0175)	1.0000 (1.2000)
Imported Parts including explosives	0.7407 (1.00000)	0.1963 (0.2650)	0.0630 (0.0850)	0.8037 (1.0850)	1.0000 (1.3500)
Diesel Oil	0.4726 (1.0000)	0.2578 (0.5455)	0.2696 (0.5703)	0.7422 (1.5703)	1.0000 (2.1158)
Gasoline & Lubricant	0.4611 (1.0000)	0.1653 (0.3585)	0.3736 (0.8102)	0.8347 (1.8102)	1.0000 (2.1687)
Electricity	———	0.0909	0.9091	0.9091	1.0000
M & E Others	———	0.0909	0.9091	0.9091	1.0000
Labor Costs (Salary)	———	0.0700	0.9300	0.9300	1.0000
Royalties & Charges	———	T & R	EC	EC	FC
* After Tax Expenses	———	———	1.0000	1.0000	1.0000

Where,

FC = Royalties and charges for financial cost
Baganuur ——— Revenue×0.03+**(S&W) ×0.048 + Coal(t) ×32.5+TBCM×1.01 Tg
Shivee Ovoo —— Revenue ×0.06+**(S&W) ×0.048 + Coal(t) ×27.0+TBCM×1.01 Tg

EC = Royalties and charges for economic cost
Health insurance, rail car standstill charges, fire fighter & guard, business trip, etc.
Baganuur ——— **(S&W) ×0.048 + Coal(t) ×32.5 Tg
Shivee Ovoo —— **(S&W) ×0.048 + Coal(t) ×27.0 Tg

T&R = Taxes and royalties
Baganuur ——— Revenue ×0.03 +TBCM×1.01 Tg
Shivee Ovoo —— Revenue ×0.06 +TBCM×1.01 Tg

Note: * "After tax expenses" mean the profit distribution procedure in the Mongolian accounting system; however, those are made up of "before tax expenses" and "after tax profits" in the western accounting system. In the analyses, the portion of "before tax expenses" such as bonus, food aid and pension supplement is included in the operating cost.

** (S&W) is short for salary and wage costs.

Table 7.5 Estimated Equipment Price and Parts Cost for the Existing Equipment -Case1:With-Railway System-

as of 1998

Name of the Item	unit	Estimated unit price (1000US$)	Required Parts (%)	Parts cost (1000 US$/y)	Current capital (1000US$)	Life (year)	Replace Capital (1000US$/y)
Electric locomotive	10	4,368	1.8	786	43,680	15	2,912
Diesel locomotive	5	1,073	12.0	644	5,365	15	358
Wagon	106	81	6.4	547	8,548	8	1,068
D/L 20/90	1	13,440	10.0	1,344	13,440	15	896
D/L 15/90	1	12,320	10.0	1,232	12,320	15	821
D/L 10/70	2	10,080	10.0	2,016	20,160	15	1,344
D/L 13/50	3	7,840	10.0	2,352	23,520	15	1,568
Shovel 8u	4	3,248	10.0	1,299	12,992	15	866
Shovel 4y	2	2,912	10.0	582	5,824	15	388
Shovel 5A	5	1,514	10.0	757	7,571	15	505
Shovel 4.6b	4	1,344	10.0	538	5,376	15	358
Drill 160	8	448	14.0	502	3,584	8	448
Crushing plant	1	4,480	10.0	448	4,480	15	299
Bulldozer DET250, 110	10	320	14.0	448	3,200	6	533
Bulldozer Komatsu	6	400	14.0	336	2,400	8	300
D/T Belaz	19	304	14.0	809	5,776	6	963
D/T Komatsu	20	380	14.0	1,064	7,600	8	950
Grand total (US$)				15,704	185,836		14,577
Local cost (35%)				5,496			
Local cost (20%)					37,167		2,915
Grand total				21,200	223,003		17,492

Note:
Parts for overhaul and daily maintenance are included.
Percents of required parts for Russian equipment are the same as those of the typical western equipment.

Table 7.6 Estimated Equipment Price and Parts Cost for the Existing Equipment as of 1994 -Non-Railway System-

as of 1994

Name of the Item	unit	Estimated unit price (1000US$)	Required Parts (%)	Parts cost (1000 US$/y)	Current capital (1000US$)	Life (year)	Replace Capital (1000US$/y)
Electric locomotive	0	1,950	1.4	0	0	15	0
Diesel locomotive	2	479	9.4	90	958	15	64
Wagon	0	36	5.0	0	0	8	0
D/L 20/90	1	6,000	7.8	468	6,000	15	400
D/L 15/90	1	5,500	7.8	429	5,500	15	367
D/L 10/70	2	4,500	7.8	702	9,000	15	600
D/L 13/50	1	3,500	7.8	273	3,500	15	233
Shovel 8u	3	1,450	7.8	339	4,350	15	290
Shovel 4y	0	1,300	7.8	0	0	15	0
Shovel 5A	5	676	7.8	264	3,380	15	225
Shovel 4.6b	3	600	7.8	140	1,800	15	120
Drill 160	8	200	3.0	48	1,600	8	200
Crushing plant	1	2,000	2.5	50	2,000	15	133
Bulldozer DET250, 110	10	90	11.0	99	900	6	150
Bulldozer Komatsu	6	400	14.0	336	2,400	8	300
D/T Belaz	19	80	11.0	167	1,520	6	253
D/T Komatsu	20	380	14.0	1,064	7,600	8	950
Grand total (US$)				4,469	50,508		4,285
Local cost (35%)				1,564			
Local cost (20%)					10,102		857
Grand total				6,033	60,610		5,142

Table 7.7 Estimated Equipment Price and Parts Cost for the Existing Equipment as of 1998 -Non-Railway System-

as of 1998

Name of the Item	unit	Estimated unit price (1000US$)	Required Parts (%)	Parts cost (1000 US$/y)	Current capital (1000US$)	Life (year)	Replace Capital (1000US$/y)
Electric locomotive	0	4,368	1.8	0	0	15	0
Diesel locomotive	2	1,073	12.0	258	2,146	15	143
Wagon	0	81	6.4	0	0	8	0
D/L 20/90	1	13,440	10.0	1,344	13,440	15	896
D/L 15/90	1	12,320	10.0	1,232	12,320	15	821
D/L 10/70	2	10,080	10.0	2,016	20,160	15	1,344
D/L 13/50	1	7,840	10.0	784	7,840	15	523
Shovel 8u	3	3,248	10.0	974	9,744	15	650
Shovel 4y	0	2,912	10.0	0	0	15	0
Shovel 5A	5	1,514	10.0	757	7,571	15	505
Shovel 4.6b	3	1,344	10.0	403	4,032	15	269
Drill 160	8	448	14.0	502	3,584	8	448
Crushing plant	1	4,480	10.0	448	4,480	15	299
Bulldozer DET250, 110	10	320	14.0	448	3,200	6	533
Bulldozer Komatsu	6	400	14.0	336	2,400	8	300
D/T Belaz	19	304	14.0	809	5,776	6	963
D/T Komatsu	20	380	14.0	1,064	7,600	8	950
Grand total (US$)				11,375	104,293		8,644
Local cost (35%)				3,981			
Local cost (20%)					20,859		1,729
Grand total				15,356	125,152		10,373

Note:
Parts for overhaul and daily maintenance are included.
Percents of required parts for Russian equipment are the same as those of the typical western equipment.

7.3 Capital and operating cost

7.3.1 Capital cost

Replacement capital cost of three cases are prepared from the replacement schedule described in Section 7.1 and the equipment price in Section 7.2. Investment schedule for Case1, during 23 years of the project period is shown in Table 7.8. Investment schedule for Case 2 and Case 3 are shown in Table 7.9 and Table 7.10. Investment schedule for additional equipment for expansion is shown in Table 7.11.

7.3.2 Operating cost

Table 7.12 shows the current unit operating costs such as explosives, consumables, diesel oil and electricity, (Base Data). Regarding the salary and wages, various data are analyzed and are shown in Appendix 7. Parts costs for the existing railway system and non-railway system are shown in Tables 7.7, 7.8 and 7.9.

Base data for additional equipment such as manpower, parts cost, fuel consumption and electric consumption are estimated. Table 7.13 shows the base data of the major equipment for railway system. In case of the with-railway system, base data for three units of FEL, three units of electric shovel and 27 units of 80 ton dump truck are listed in Table 7.13. Table 7.14 shows the base data for major equipment in case of without-railway system. In this case, five units of electric shovel and 45 units of 80 ton dump truck are listed in Table 7.14, while FEL is not listed due to unnecessary.

The future unit operating cost such as fuel, electricity and labour cost are also estimated as shown in Table 7.15. The estimations are mainly based on the production plan of 1995 provided by the mine, which are shown in Table 7.12. As for M&E others on the table, 10 Tg/TBCM is added to the estimation as environment conservation costs and 10 Tg/TBCM of sleeper & others is eliminated from those in the expansion scenario. Since an efficiency wage system has been employed in the mine, salary and wage variance factors are applied to the calculation program for sensitivity analysis as shown in Appendix 7, in which variance in the numbers of workers for all the scenarios is included. In the scenarios of non-railway system, the whole number of workers of 411 in the current overburden haulage and railway development in the mine are laid off and 115 workers for the newly introduced truck and shovel fleets and indirect jobs such as mining engineers, administrative clerks and unskilled workers are employed.

In order to estimate the operating cost for supporting equipment and facilities, basic data such as manpower, parts consumption, fuel consumption and electric consumption are estimated. Table 7.16 shows the base data for operating cost estimation for the improved existing system. Table 7.17 shows the base data of the additional system for operating cost estimation of the additional system for mine expansion.

Based on these data, differences in operation costs among scenarios are summarized in Table 7.18.

Table 7.8 Investment Schedule for Existing Equipment
-Case1 :With-Railway system-

EXISTING EQUIPMENT REPLACEMENT

UNIT:US$ 10^3 (Borderorder Price Basis)

EQUIPMENT	PRICE	LIFE yrs	UNIT	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
DRG. 20/90	13,440	15	1	0	0	0	0	0	0	1 13,440	0	0	0	0	0	0
DRG. 15/90	12,320	15	1	0	0	0	1 12,320	0	0	0	0	0	0	0	0	0
DRG. 10/70	10,080	15	3	0	0	0	1 10,080	0	0	0	0	0	0	1 10,080	0	0
DRG. 13/50	7,840	15	3	0	0	0	0	0	0	0	0	1 7,840	0	1 7,840	0	1 7,840
SHOVEL EXG-8Y	3,248	15	4	0	0	0	0	0	0	0	0	1 3,248	1 3,248	1 3,248	1 3,248	0
SHOVEL EXG-5A	1,514	15	5	0	0	0	0	0	1 1,514	0	1 1,514	0	1 1,514	0	0	1 1,514
SHOVEL EXG-4Y	2,912	15	2	0	0	0	0	0	0	0	0	1 2,912	1 2,912	0	0	0
SHOVEL EXG-4.8B	1,344	15	4	1 1,344	0	0	2 2,688	0	0	1 1,344	0	0	0	0	0	0
E.LOCO.	4,368	15	10	0	0	0	0	0	0	0	0	2 8,736	2 8,736	4 17,472	2 8,736	0
D.LOCO.	1,073	15	5	1 1,073	0	0	0	0	0	0	0	2 2,146	1 1,073	1 1,073	0	0
WAGON	81	8	106	0	28 2,268	25 2,025	39 3,159	12 972	0	2 162	0	0	28 2,268	25 2,025	39 3,159	12 972
DRILL CRR 180	448	8	4	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	0	2 896	1 448	1 448
DRILL CRR 2H	230	8	2	0	0	1 230	1 230	0	0	0	0	0	0	1 230	1 230	0
BULL. DET-250	320	6	6	0	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320
BULL. DH-130	229	6	4	0	0	0	0	4 916	0	0	0	0	0	4 916	0	0
BULL. D-155	400	8	6	0	0	0	0	3 1,200	3 1,200	0	0	0	0	0	0	3 1,200
D/T BERAZ 548	304	6	19	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520
D/T HD-325	380	8	20	0	0	0	0	20 7,600	0	0	0	0	0	0	0	20 7,600
SCRAPER	120	8	2	0	0	0	1 120	0	0	1 120	0	0	0	0	1 120	0
GRADER	130	8	2	0	0	0	1 130	0	0	1 130	0	0	0	0	1 130	0
		LIFE 15 yrs		2,417	0	0	25,088	0	1,514	14,784	1,514	24,882	17,483	39,713	11,984	9,354
		LIFE 8 yrs		448	2,268	3,151	4,087	10,220	1,648	880	448	448	2,268	3,151	4,087	10,220
		LIFE 6 yrs		1,520	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840
		TOTAL		4,385	4,092	4,399	30,407	12,368	3,482	17,464	3,786	26,573	20,983	45,012	16,391	21,414

EQUIPMENT	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
DRG. 20/90	0	0	0	0	0	0	0	0	1 13,440	0	0	0	2 26,880
DRG. 15/90	0	0	0	0	0	1 12,320	0	0	0	0	0	0	2 24,640
DRG. 10/70	0	0	0	0	0	1 10,080	0	0	0	0	0	0	3 30,240
DRG. 13/50	0	0	0	0	0	0	0	0	0	0	1 7,840	0	4 31,360
SHOVEL EXG-8Y	0	0	0	0	0	0	0	0	0	0	1 3,248	1 3,248	6 19,488
SHOVEL EXG-5A	0	1 1,514	0	0	0	0	0	1 1,514	0	1 1,514	0	1 1,514	8 12,112
SHOVEL EXG-4Y	0	0	0	0	0	0	0	0	0	0	1 2,912	1 2,912	4 11,648
SHOVEL EXG-4.8B	0	0	1 1,344	0	0	2 2,688	0	0	1 1,344	0	0	0	7 9,408
E.LOCO.	0	0	0	0	0	0	0	0	0	0	2 8,736	2 8,736	14 61,152
D.LOCO.	0	0	1 1,073	0	0	0	0	0	0	0	2 2,146	1 1,073	8 8,584
WAGON	0	2 162	0	0	28 2,268	25 2,025	39 3,159	12 972	0	2 162	0	0	290 23,490
DRILL CRR 180	1 448	1 448	1 448	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	24 10,752
DRILL CRR 2H	0	0	0	0	0	1 230	1 230	0	0	0	0	0	6 1,380
BULL. DET-250	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320	24 7,680
BULL. DH-130	0	0	0	4 916	0	0	0	0	0	4 916	0	0	16 3,664
BULL. D-155	3 1,200	0	0	0	0	0	0	3 1,200	3 1,200	0	0	0	18 7,200
D/T BERAZ 548	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	70 21,280
D/T HD-325	0	0	0	0	0	0	0	20 7,600	0	0	0	0	60 22,800
SCRAPER	0	1 120	0	0	0	0	1 120	0	0	1 120	0	0	6 720
GRADER	0	1 130	0	0	0	0	1 130	0	0	1 130	0	0	6 780
LIFE 15 yrs	0	1,514	2,417	0	0	25,088	0	1,514	14,784	1,514	24,882	12,483	235,512
LIFE 8 yrs	1,648	880	448	448	2,268	3,151	4,087	10,220	1,648	880	448	448	67,122
LIFE 6 yrs	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840	32,824
TOTAL	3,472	3,622	4,097	2,596	2,588	30,079	5,911	12,982	17,664	4,522	25,650	19,771	335,258

EXISTING EQUIPMENT

Initial Investment & Replacement

UNIT:US$ 10^3 (Borderorder Price Basis)

LIFE yrs	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1,258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,258	0	0	0	0	0	0	0	2,516
10	845	0	0	0	0	0	0	0	0	0	845	0	0	0	0	0	0	0	0	0	845	0	0	2,535
8	4,677	0	0	0	0	0	0	0	4,677	0	0	0	0	0	0	0	4,677	0	0	0	0	0	0	14,031
6	315	0	2,601	0	0	0	315	0	2,601	0	0	0	315	0	2,601	0	0	0	315	0	2,601	0	0	11,664
5	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	20,000
TOTAL	11,096	0	2,601	0	0	4,000	315	0	7,278	0	4,845	0	315	0	2,601	5,258	4,677	0	315	0	7,446	0	0	50,748

Note : 1) This table shows initial investment & replacement for additional supporting equipment and FEL (10m3) for reinfore railway system.
2) Equipment of each life is shown in Table 3.14.

Table 7.9 Investment Schedule for Existing Equipment
-Case 2:Non-Railway system from 1998-

EXISTING EQUIPMENT REPLACEMENT

UNIT:US$ 10*3 (Border Price Basis)

EQUIPMENT	PRICE	LIFE (yrs)	UNIT	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
DRG. 20/90	13,440	15	1	0	0	0	0	0	0	1 13,440	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 13,440	0	0	0	2 26,880
DRG. 15/90	12,320	15	1	0	0	0	1 12,320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 12,320	0	0	0	0	0	0	2 24,640
DRG. 10/70	10,080	15	2	0	0	0	1 10,080	0	0	0	0	0	0	1 10,080	0	0	0	0	0	0	0	1 10,080	0	0	0	0	0	0	3 30,240
DRG. 13/50	7,840	15	1	0	0	0	0	0	0	0	0	0	0	0	0	1 7,840	0	0	0	0	0	0	0	0	0	0	0	0	1 7,840
SHOVEL EXG-8	3,248	15	3	0	0	0	0	0	0	0	0	0	1 3,248	1 3,248	1 3,248	0	0	0	0	0	0	0	0	0	0	0	0	1 3,248	4 12,992
SHOVEL EXG-5A	1,514	15	5	0	0	0	0	0	1 1,514	0	1 1,514	0	1 1,514	0	0	1 1,514	0	1 1,514	0	0	0	0	0	1 1,514	0	1 1,514	0	1 1,514	8 12,112
SHOVEL EXG-4	2,912	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0
SHOVEL EXCA. 6	1,344	15	3	1 1,344	0	0	2 2,688	0	0	1 1,344	0	0	0	0	0	0	0	0	0	0	0	2 2,688	0	0	1 1,344	0	0	0	6 8,064
E. LOCO.	4,368	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0
D. LOCO.	1,073	15	2	1 1,073	0	0	0	0	0	0	0	0	0	1 1,073	0	0	0	0	1 1,073	0	0	0	0	0	0	0	0	0	2 2,146
WAGON	81	8	0	0	28 2,268	25 2,025	39 3,159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64 5,184
DRILL CBR 160	448	8	8	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	24 10,752
DRILL CBR 2X	230	8	2	0	0	1 230	1 230	0	0	0	0	0	0	1 230	1 230	0	0	0	0	0	0	1 230	1 230	0	0	0	0	0	6 1,380
BULL. DET-250	320	6	6	0	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320	24 7,680
BULL. DE-110	229	6	4	0	0	0	0	4 916	0	0	0	0	0	4 916	0	0	0	0	0	4 916	0	0	0	0	0	4 916	0	0	16 3,664
BULL. D-155	400	8	6	0	0	0	0	3 1,200	3 1,200	0	0	0	0	0	0	3 1,200	3 1,200	0	0	0	0	0	0	3 1,200	3 1,200	0	0	0	18 7,200
D/T BERAZ 548	304	6	19	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	70 21,280
D/T HD-325	380	8	20	0	0	0	0	20 7,600	0	0	0	0	0	0	0	20 7,600	0	0	0	0	0	0	0	20 7,600	0	0	0	0	60 22,800
SCRAPER	120	8	2	0	0	0	1 120	0	0	1 120	0	0	0	0	1 120	0	0	1 120	0	0	0	0	1 120	0	0	1 120	0	0	6 720
GRADER	130	8	2	0	0	0	1 130	0	0	1 130	0	0	0	0	1 130	0	0	1 130	0	0	0	0	1 130	0	0	1 130	0	0	6 780
		LIFE 15 yrs		2,417	0	0	25,088	0	1,514	14,784	1,514	0	4,762	14,401	3,248	9,354	0	1,514	1,073	0	0	25,088	0	1,514	14,784	1,514	0	4,762	124,914
		LIFE 8 yrs		448	2,268	3,151	4,087	9,248	1,648	698	448	448	0	1,126	928	9,248	1,648	698	448	448	0	1,126	928	9,248	1,648	698	448	448	48,816
		LIFE 6 yrs		1,520	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840	32,624
		TOTAL		4,385	4,092	4,399	30,407	11,396	3,482	17,322	3,786	1,696	5,994	17,675	4,496	20,442	3,472	3,460	2,753	2,596	320	28,054	2,752	12,010	17,664	4,360	768	7,050	296,354

EXISTING EQUIPMENT IMPROVEMENT

Initial Investment & Replacement

UNIT:US$ 10*3 (Border Price Basis)

LIFE (yrs)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
21	0	0	[8,018]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,018
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1,258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,258	0	0	0	0	0	0	0	2,516
10	845	0	0	0	0	0	0	0	0	0	845	0	0	0	0	0	0	0	0	0	845	0	0	2,535
8	4,677	0	0	0	0	0	0	0	4,677	0	0	0	0	0	0	0	4,677	0	0	0	0	0	0	14,031
6	315	0	[14,220]	0	0	0	315	0	14,220	0	0	0	315	0	14,220	0	0	0	315	0	14,220	0	0	58,140
5	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	20,000
TOTAL	11,095	0	22,238	0	0	4,000	315	0	18,897	0	4,845	0	315	0	14,220	5,258	4,677	0	315	0	19,065	0	0	105,240

Note : 1) This Table shows initial investment & replacement for additional supporting equipment and truck (80 ton) and shovel (12m3) which are introduced for railway system.
2) Figures in the box mean initial investment for truck (80 ton) and shovel (12m3).
3) Equipment of each life is shown in Table 3.14.

Table 7.10 Investment Schedule for Existing Equipment -Case 3:Non-Railway System from 2002-

EXISTING EQUIPMENT REPLACEMENT

UNIT:US$ 10*3 (Border Price Basis)

EQUIPMENT	PRICE	LIFE yrs	UNIT	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
DRG. 20/30	13,440	15	1	0	0	0	0	0	0	1 13,440	0	0	0	0	0	0
DRG. 15/30	12,320	15	1	0	0	0	1 12,320	0	0	0	0	0	0	0	0	0
DRG. 10/70	10,080	15	2	0	0	0	1 10,080	0	0	0	0	0	0	1 10,080	0	0
DRG. 13/50	7,840	15	1	0	0	0	0	0	0	0	0	0	0	0	0	1 7,840
SHOVEL EKG-8U	3,248	15	3	0	0	0	0	0	0	0	0	0	1 3,248	1 3,248	1 3,248	0
SHOVEL EKG-5A	1,514	15	5	0	0	0	0	0	1 1,514	0	1 1,514	0	1 1,514	0	0	1 1,514
SHOVEL EKG-4Y	2,912	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHOVEL EKG-4.6	1,344	15	3	1 1,344	0	0	2 2,688	0	0	1 1,344	0	0	0	0	0	0
E. LOCO.	4,368	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. LOCO.	1,073	15	2	1 1,073	0	0	0	0	0	0	0	0	0	1 1,073	0	0
WAGON	81	8	0	0	28 2,268	25 2,025	39 3,159	12 972	0	2 162	0	0	0	0	0	0
DRILL CBR 160	448	8	8	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	0	2 896	1 448	1 448
DRILL CBR 2X	230	8	2	0	0	1 230	1 230	0	0	0	0	0	0	1 230	1 230	0
BULL. DET-250	320	6	6	0	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320
BULL. DE-110	229	6	4	0	0	0	0	4 916	0	0	0	0	0	4 916	0	0
BULL. D-155	400	8	6	0	0	0	0	3 1,200	3 1,200	0	0	0	0	0	0	3 1,200
D/T BERAZ 548	304	6	19	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520
D/T HD-325	380	8	20	0	0	0	0	20 7,600	0	0	0	0	0	0	0	20 7,600
SCRAPER	120	8	2	0	0	0	1 120	0	0	1 120	0	0	0	0	1 120	0
GRADER	130	8	2	0	0	0	1 130	0	0	1 130	0	0	0	0	1 130	0
		LIFE 15 yrs		2,417	0	0	25,088	0	1,514	14,784	1,514	0	4,762	14,401	3,248	9,354
		LIFE 8 yrs		448	2,268	3,151	4,087	10,220	1,648	860	448	448	0	1,126	928	9,248
		LIFE 6 yrs		1,520	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840
		TOTAL		4,385	4,092	4,399	30,407	12,368	3,482	17,484	3,786	1,696	5,994	17,675	4,496	20,442

EQUIPMENT	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
DRG. 20/30	0	0	0	0	0	0	0	0	1 13,440	0	0	0	2 26,880
DRG. 15/30	0	0	0	0	0	1 12,320	0	0	0	0	0	0	2 24,640
DRG. 10/70	0	0	0	0	0	1 10,080	0	0	0	0	0	0	3 30,240
DRG. 13/50	0	0	0	0	0	0	0	0	0	0	0	0	1 7,840
SHOVEL EKG-8U	0	0	0	0	0	0	0	0	0	0	0	1 3,248	4 12,992
SHOVEL EKG-5A	0	1 1,514	0	0	0	0	0	1 1,514	0	1 1,514	0	1 1,514	8 12,112
SHOVEL EKG-4Y	0	0	0	0	0	0	0	0	0	0	0	0	0 0
SHOVEL EKG-4.6	0	0	0	0	0	2 2,688	0	0	1 1,344	0	0	0	6 8,064
E. LOCO.	0	0	0	0	0	0	0	0	0	0	0	0	0 0
D. LOCO.	0	0	1 1,073	0	0	0	0	0	0	0	0	0	2 2,146
WAGON	0	0	0	0	0	0	0	0	0	0	0	0	78 6,318
DRILL CBR 160	1 448	1 448	1 448	1 448	0	2 896	1 448	1 448	1 448	1 448	1 448	1 448	24 10,752
DRILL CBR 2X	0	0	0	0	0	1 230	1 230	0	0	0	0	0	6 1,380
BULL. DET-250	0	2 640	1 320	1 320	1 320	1 320	0	2 640	1 320	1 320	1 320	1 320	24 7,680
BULL. DE-110	0	0	0	4 916	0	0	0	0	0	4 916	0	0	16 3,664
BULL. D-155	3 1,200	0	0	0	0	0	0	3 1,200	3 1,200	0	0	0	18 7,200
D/T BERAZ 548	6 1,824	2 608	3 912	3 912	0	5 1,520	6 1,824	2 608	3 912	3 912	0	5 1,520	70 21,280
D/T HD-325	0	0	0	0	0	0	0	20 7,600	0	0	0	0	60 22,800
SCRAPER	0	1 120	0	0	0	0	1 120	0	0	1 120	0	0	6 720
GRADER	0	1 130	0	0	0	0	1 130	0	0	1 130	0	0	6 780
LIFE 15 yrs	0	1,514	1,073	0	0	25,088	0	1,514	14,784	1,514	0	4,762	124,914
LIFE 8 yrs	1,648	638	448	448	0	1,126	928	9,248	1,648	698	448	448	49,950
LIFE 6 yrs	1,824	1,248	1,232	2,148	320	1,840	1,824	1,248	1,232	2,148	320	1,840	32,624
TOTAL	3,472	3,460	2,753	2,596	320	28,054	2,752	12,010	17,664	4,360	768	7,050	207,488

EXISTING EQUIPMENT IMPROVEMEN

Initial Investment & Replacement

UNIT:US$ 10*3 (Border Price Basis)

LIFE yrs	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
21	0	0	0	0	0	0	0	0	[8,018]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,018
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1,258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,258	0	0	0	0	0	0	0	2,516
10	845	0	0	0	0	0	0	0	0	0	845	0	0	0	0	0	0	0	0	0	845	0	0	2,535
8	4,677	0	[2,601]	0	0	0	[14,220]	0	4,677	0	2,601	0	0	0	14,220	0	4,677	0	2,601	0	0	0	14,220	64,434
6	4,992	0	0	0	0	0	4,992	0	0	0	0	0	4,992	0	0	0	0	0	4,992	0	0	0	0	19,968
5	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	0	0	4,000	0	0	20,000
TOTAL	15,772	0	2,601	0	0	4,000	19,212	0	12,695	0	7,446	0	4,992	0	14,220	5,258	4,677	0	7,593	0	4,845	0	14,220	117,531

Note : 1) This Table shows initial investment & replacement for additional supporting equipment, truck (80 ton) and shovel (12 m3) which are introduced for railway system and FEL (10 m3) for reinforce railway system.
2) Figures in the box mean intial investment for truck (80 ton), shovel (12 m3) and FEL (10 m3).
3) Equipment of each life is shown in Table 3.14.

Table 7.11 Investment Schedule for Mine Expansion Mining Equipment and Supporting Facilities

EXPANSION

Initial Investment & Replacement

Major Equipment

UNIT:US$ 10^3 (Border Price Basis)

EQUIPMENT	PRICE	LIFE (yrs)	UNIT	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
SHOVEL 12 M3	4,009	21	3	3																					3
				12,027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,027
BULL 400 HP	524	8	11	11								11								11					33
				5,764	0	0	0	0	0	0	0	5,764	0	0	0	0	0	0	0	5,764	0	0	0	0	17,292
GRADER 254 HP	366	8	3	2				1				2				1				2				1	9
				732	0	0	0	366	0	0	0	732	0	0	0	366	0	0	0	732	0	0	0	366	3,294
D/T 80 T	790	8	27	27								27								27					81
				21,330	0	0	0	0	0	0	0	21,330	0	0	0	0	0	0	0	21,330	0	0	0	0	63,990
C/TRUCK 40 T	440	8	14	14								14								14					42
				6,160	0	0	0	0	0	0	0	6,160	0	0	0	0	0	0	0	6,160	0	0	0	0	18,480
	SUB TOTAL of LIFE 21 yrs			12,027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,027
	LIFE 8 yrs			33,986	0	0	0	366	0	0	0	33,986	0	0	0	366	0	0	0	33,986	0	0	0	366	103,056
	TOTAL			46,013	0	0	0	366	0	0	0	33,986	0	0	0	366	0	0	0	33,986	0	0	0	366	115,083

Support Equipment

UNIT:US$ 10^3 (Border Price Basis)

LIFE (yrs)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
20	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	800	1,600
15	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	255	0	0	0	0	0	510
10	1,333	0	0	0	0	0	0	0	0	0	1,333	0	0	0	0	0	0	0	0	0	1,333	3,999
8	1,977	0	0	0	0	0	0	0	1,977	0	0	0	0	0	0	0	1,977	0	0	0	0	5,931
6	298	0	0	0	0	0	298	0	0	0	0	0	298	0	0	0	0	0	298	0	0	1,192
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4,663	0	0	0	0	0	298	0	1,977	0	1,333	0	298	0	0	255	1,977	0	298	0	2,133	13,232

Note : 1) Equipment of each life is shown in Table 4.6.
2) This investment and replacement cost are estimated as the following formula : Table 4.6 - Table 3.14

Total

UNIT:US$ 10^3 (Border Price Basis)

LIFE (yrs)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
21	12,027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,027
20	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	800	1,600
15	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	255	0	0	0	0	0	510
10	1,333	0	0	0	0	0	0	0	0	0	1,333	0	0	0	0	0	0	0	0	0	1,333	3,999
8	35,963	0	0	0	366	0	0	0	35,963	0	0	0	366	0	0	0	35,963	0	0	0	366	108,987
6	298	0	0	0	0	0	298	0	0	0	0	0	298	0	0	0	0	0	298	0	0	1,192
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	50,676	0	0	0	366	0	298	0	35,963	0	1,333	0	664	0	0	255	35,963	0	298	0	2,499	128,315

Table 7.12 Current Unit Operating Cost

	1994 (Budget)	1994 (Expected)	1995 (Planed)	Used in Study
Coal Production (10^3t)	3,700	3,260	3,500	
Coal(1.29t/m³) (10^3BCM)	2,868	2,527	2,713	
Overburden (10^3BCM)	13,400	9,000	13,100	
TBCM (10^3BCM)	16,268	11,527	15,813	
Sub-meterials				
explosives	3,040t		(estimated)	
(kg/TBCM)	0.187		(0.19)	0.19
(Tg/kg)	207		(210)	210
consumable parts (10^3Tg)	254,153.7		(484,926)	
(Tg/TBCM)	15.62		* (30.67)	—
sleeper & others (10^3Tg)	136,123.7		(171,682)	
(Tg/TBCM)	8.37		(10.86)	M&E Others
Parts (10^3Tg)	721,012	748,458.8	998,356	Not uesd
(Tg/TBCM)	44.32	64.93	* 63.14	* (108)
Tires (10^3Tg)	207,329.6	190,568.4	221,041.4	—
(Tg/TBCM)	12.74	16.53	* 13.98	—
Diesel Oil (t)	5,868.5	4,069.4	5,781.3	
(Tg/kg)	144	144	144	144
(kg/TBCM)	0.3607	0.3530	0.3656	0.3656
Gas & Lub (% of Diesel)	27.1	23.4	23.6	24
Electricity (MWh)	46,161.3	42,991.8	40,000	
(Tg/KWh)	13.2	13.2	13.2	13.2
(KWh/TBCM)	2.838	3.730	2.530	2.530
M&E Others				
heat			459,836	
water			26,942.9	
sleeper & others			171,683.0	
cheap consumables			6,400	
their depreciation			6,800	
imporvement in environment and safety for workers			81,382.8	
printing, paper and communication			6,500	
Total (10^3Tg)			759,544.7	
(Tg/TBCM)			48.0	48.0
environment conservation costs(Tg/TBCM)			0	10.0
Rayalties and Charges				
natural resources			Revenue×0.03	Revenue×0.03
health insurance			S & W×0.048	S & W×0.048
land & auto			15,940.5×10^3Tg	1.01Tg×TBCM
rail car standstill charges (10^3Tg)			109,470	
fire fighter & gaurd (10^3Tg)			456	32.5Tg/Coal(t)
business trip, etc. (10^3Tg)			2,800	

Table 7.12 Cont.(1) Current Unit Operating Cost

	1994 (Budget)	1994 (Expected)	1995 (Planed)	Used in Study
After tax expenses				
1) Cost portion to be treated as "operating cost"(hereafter : Adjusted Operating Costs)				
・renovation in technological and working conditions			53,778	
・employees training			20,800	
・social development fund			235,564	
— food aid			(34,320)	
— fuel aid			(11,100)	
— compensationary salary for disabled miners			(6,552)	
— pension supplement			(7,552)	
— bonus			(164,040)	
— compensation for red ink subsidiary			(24,000)×1/2	
Total			310,142	
			0.05×T * ⟶	T×0.05
2) Profit portion not to be treated as "operating cost"				
・dividend			120,000	
・debt repayment			299,473	
・social development fund			163,000	
— compensation for red ink subsidiaries			(24,000)×1/2	
— construction costs of miner's apartment houses			(150,000)	
Total			581,473	
			0.094 ×T * ⟶	0

* Note: Plan for 1995 provided by the mine

T = Total Operating Costs without depreciation and payable interest = 6,186,663.6×10^3Tg

Table 7.13 Base Data for Operating Cost Estimation -Railway System-

Manpower

	Man/unit person	unit	Crew	Total person	Absence Rate	Required person
FEL 10 m3	1	3	4	12	0.83	14
12 m3 shovel	2	3	4	24	0.83	29
Bulldozer 400HP	1	11	4	44	0.83	53
Grader 254HP	1	3	4	12	0.83	14
Dump truck 80 ton	1	27	4	108	0.83	130
Coal truck 40 ton	1	14	4	56	0.83	67
Maintenance				60	0.83	72
Total				316		379

Spare parts

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor	Parts cost /unit 1000 US$	Unit	Parts cost total 1000 US$/y
FEL 10 m3	867	941	0.05	47	3	141
12 m3 shovel	4,009	4,350	0.05	218	3	654
Bulldozer 400HP	524	569	0.05	28	11	308
Grader 254HP	366	397	0.05	20	3	60
Dump truck 80 ton	790	857	0.05	43	27	1,161
Coal truck 40 ton	440	477	0.05	24	14	336
Total						2,660

Consumables

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Consume factor /hour	Operation hour h/year	Parts cost 1000 US$	Unit	Parts cost total 1000 US$/y
FEL 10 m3	867	941	0.00001	4,236	40	3	120
12 m3 shovel	4,009	4,350	0.00001	4,236	184	3	552
Bulldozer 400HP	524	569	0.00001	4,236	24	11	264
Grader 254HP	366	397	0.00001	4,236	17	3	51
Dump truck 80 ton	790	857	0.00001	4,236	36	27	972
Coal truck 40 ton	440	477	0.00001	4,236	20	14	280
Total							2,239

Overhaul

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor /time	Overhaul Interval year	Life time year	Overhaul time /life	Overhaul cost/life 1000 US$	Overhaul Cost/year 1000 US$/y	Unit	Overhaul cost/year 1000 US$/y
FEL 10 m3	867	941	0.1	2	8	3	282	35.30	3	106
12 m3 shovel	4,009	4,350	0.1	8	21	2	870	41.40	3	124
Bulldozer 400HP	524	569	0.1	2	8	3	171	21.40	11	235
Grader 254HP	366	397	0.1	2	8	3	119	14.90	3	45
Dump truck 80 ton	790	857	0.1	2	8	3	257	32.10	27	867
Coal truck 40 ton	440	477	0.1	2	8	3	143	17.90	14	251
Total								163.00		1,628

Tyre

	Tyre unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Number of tyre pcs	Life hour	Operation hour h/year	Consume /year pcs	Unit	Tyre cost 1000 US$/y
FEL 10 m3	10.8	11.7	4	4,000	4,236	4.2	3	147
Grader 254HP	1.4	1.5	6	4,000	4,236	6.4	3	29
Dump truck 80 ton	6.3	6.8	6	4,000	4,236	6.4	27	1,175
Coal truck 40 ton	6.8	7.4	6	4,000	4,236	6.4	14	663
Total								2,014

Fuel and Lubricant

	Diesel HP	Load factor	Operation hour h/year	consum 1000 l/y	unit	Total Fuel 1000 l/y
FEL 10 m3	930	0.11	4,236	433	3	1,299
Bulldozer 400HP	400	0.15	4,236	254	11	2,794
Grader 254HP	254	0.11	4,236	118	3	354
Dump truck 80 ton	690	0.06	4,236	175	27	4,725
Coal truck 40 ton	385	0.06	4,236	98	14	1,372
Total						10,544

Electricity

	Power kW	Load factor	Operation hour h/year	kWh/unit 1000 kWh	unit	kWh/year 1000 kWh/y
12 m3 shovel	1900	0.6	4,236	4,829	3	14,487

Table 7.14 Base Data for Operating Cost Estimation -Non-Railway System-

Manpower

	Man/unit person	uni	Crew	Total person	Absence Rate	Required person
FEL 10 m3	1	0	4	0	0.83	0
12 m3 shovel	2	5	4	40	0.83	48
Bulldozer 400HP	1	11	4	44	0.83	53
Grader 254HP	1	3	4	12	0.83	14
Dump truck 80 ton	1	45	4	180	0.83	217
Coal truck 40 ton	1	14	4	56	0.83	67
Maintenance				60	0.83	72
Total				392		471

Spare parts

	Equipment unit price					
	Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor	Parts cost /unit 1000 US$	Unit	Parts cost total 1000 US$/y
FEL 10 m3	867	941	0.05	47	0	0
12 m3 shovel	4,009	4,350	0.05	218	5	1,090
Bulldozer 400HP	524	569	0.05	28	11	308
Grader 254HP	366	397	0.05	20	3	60
Dump truck 80 ton	790	857	0.05	43	45	1,935
Coal truck 40 ton	440	477	0.05	24	14	336
Total						3,729

Consumables

	Equipment unit price						
	Border price 1000 US$	CIF Site w/o tax 1000 US$	Consume factor /hour	Operation hour h/year	Parts cost 1000 US$	Unit	Parts cost total 1000 US$/y
FEL 10 m3	867	941	0.00001	4,236	40	0	0
12 m3 shovel	4,009	4,350	0.00001	4,236	184	5	920
Bulldozer 400HP	524	569	0.00001	4,236	24	11	264
Grader 254HP	366	397	0.00001	4,236	17	3	51
Dump truck 80 ton	790	857	0.00001	4,236	36	45	1,620
Coal truck 40 ton	440	477	0.00001	4,236	20	14	280
Total							3,135

Overhaul

	Equipment unit price									
	Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor /time	Overhaul Interval year	Life time year	Overhaul time /life	Overhaul cost/life 1000 US$	Overhaul Cost 1000 US$/y	Unit	Overhaul cost 1000 US$/y
FEL 10 m3	867	941	0.1	2	8	3	282	35.3	0	0
12 m3 shovel	4,009	4,350	0.1	8	21	2	870	41.4	5	207
Bulldozer 400HP	524	569	0.1	2	8	3	171	21.4	11	235
Grader 254HP	366	397	0.1	2	8	3	119	14.9	3	45
Dump truck 80 ton	790	857	0.1	2	8	3	257	32.1	45	1,445
Coal truck 40 ton	440	477	0.1	2	8	3	143	17.9	14	251
Total										2,182

Tyre

	Tyre unit price							
	Border price 1000 US$	CIF Site w/o tax 1000 US$	No. of tyre pcs	Life hour	Operation hour h/year	Consume /year	Unit	Tyre cost 1000 US$/y
FEL 10 m3	10.80	11.70	4	4,000	4,236	4.20	0	0
Grader 254HP	1.40	1.50	6	4,000	4,236	6.40	3	29
Dump truck 80 ton	6.30	6.80	6	4,000	4,236	6.40	45	1,958
Coal truck 40 ton	6.80	7.40	6	4,000	4,236	6.40	14	663
Total								2,650

Fuel and Lubricant

	Diesel HP	Load factor	Operation hour h/year	consum 1000 l/y	unit	Total Fuel 1000 l/y
FEL 10 m3	930	0.1	4,236	433	0	0
Bulldozer 400HP	400	0.2	4,236	254	11	2,794
Grader 254HP	254	0.1	4,236	118	3	354
Dump truck 80 ton	690	0.1	4,236	175	45	7,875
Coal truck 40 ton	385	0.1	4,236	98	14	1,372
Total						12,395

Electricity

	Power kW	Load factor	Operation hour h/year	kWh/unit 1000 kWh	unit	kWh/year 1000 kWh/y
12 m3 shovel	1,900	0.6	4,236	4,829	5	24,145

Table 7.15 Other Future Unit Operating Costs for Renovation Project

Coal density	1.29
TBCM	Total Excavation (BCM) = Overburden removal + Coal ÷ Coal density (BCM)
Diesel oil	@144 Tg/kg
Gas & Lub	Diesel oil×0.24 (Gas:Lub = 20:80)
Electricity	@13.2 Tg/kWh (1994) @24.53Tg/kWh (1999) Escalation from 1994 to 1999: ER = 0.1319434
Explosives	0.19 kg/TBCM @210 Tg/kg
M & E Others	Part of Sub-material, heat, water, printing & paper, cheap consumables and their depreciation, costs for improvement in working environment and workers' safety, communication, etc. Existing 48.0 Tg/TBCM Expansion 38.0 Tg/TBCM Plus Environment 10.0 Tg/TBCM 10.0 Tg/TBCM Total 58.0 Tg/TBCM Total 48.0 Tg/TBCM
Salaries & Wages(S&W) Engineers Adm. Clerks Skilled Unskilled	 (Standard Number of Workers)× 860×10³ Tg/y×(Variance Factor) (〃)× 385×10³ Tg/y×(〃) (〃)× 585×10³ Tg/y×(〃) (〃)× 267×10³ Tg/y×(〃)
Social insurance	(S&W)×0.16
Royalties & Charges	Natural resources, land, health insurance, automobile property taxes, rail car standstill charges, fire fighter & guard, business trip, etc. Revenue×0.03 + (S&W)×0.048 + Coal(t)×32.5 Tg + TBCM×1.01 Tg
Adjusted Operating Costs	Operating cost included in "After Tax Expenses". A × 0.05 A = Total operating costs − payable interest − depreciation

Table 7.16 Base Data for Operating Cost Estimation
Supporting Equipment for Improvement

Manpower: to be supplied from the existing manpower

Spare parts

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor	Parts cost /unit 1000 US$/y	Unit	Parts cost total 1000 US$/y
Dozer shovel 250 HP	306	332	0.05	17	4	68
Bulldozer 400 HP	524	569	0.05	28	1	28
Bulldozer 200 HP	306	332	0.05	17	1	17
FEL 5 m3	408	443	0.05	22	2	44
Drill rig	459	498	0.05	25	2	50
Water truck	102	111	0.05	6	2	12
Service truck	51	55	0.05	3	5	15
Power distribution	167	181	0.05	9	2	18
Crushing plant	595	646	0.05	32	2	64
Subtotal						316
Others (15%)						47
Total						363

Consumables

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Consume factor /hour	Operation hour h/year	Parts cost 1000 US$/y	Unit	Parts cost total 1000 US$/y
Dozer shovel 250 HP	306	332	0.00001	4236	14	4	56
Bulldozer 400 HP	524	569	0.00001	4236	24	1	24
Bulldozer 200 HP	306	332	0.00001	4236	14	1	14
FEL 5 m3	408	443	0.00001	4236	19	2	38
Drill rig	459	498	0.00001	2824	14	2	28
Water truck	102	111	0.00001	4236	5	2	10
Service truck	51	55	0.00001	4236	2	5	10
Power distribution	167	181	0.00001	4236	8	2	16
Crushing plant	595	646	0.00001	4236	27	2	54
Subtotal							250
Others (15%)							38
Total							288

Overhaul

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor /time	Overhaul Interval year	Life time year	Overhaul time /life	Overhaul cost/life 1000 US$	Overhaul Cost/year 1000 US$	Unit	Overhaul cost/year 1000 US$
Dozer shovel 250 HP	306	332	0.1	2	8	3	100	12.5	4	50
Bulldozer 400 HP	524	569	0.1	2	8	3	171	21.4	1	21.4
Bulldozer 200 HP	306	332	0.1	2	8	3	100	12.5	1	12.5
FEL 5 m3	408	443	0.1	2	8	3	133	16.6	2	33.2
Drill rig	459	498	0.1	2	8	3	149	18.6	2	37.2
Water truck	102	111	0.1	2	8	3	33	4.1	2	8.2
Service truck	51	55	0.1	2	8	3	17	2.1	5	10.5
Power distribution	167	181	0.1	8	15	1	18	1.2	2	2.4
Crushing plant	595	646	0.1	5	20	3	194	9.7	2	19.4
Subtotal										194.8
Others (15%)										29
Total										223.8

Tyre

	Tyre unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	No. of tyre pcs	Life hour	Operation hour h/year	Consume /year pcs	Unit	Tyre cost /year 1000 US$/y
FEL 5 m3	4.3	4.7	4	4000	4236	4.2	2	39
Water truck	1.4	1.5	6	4000	4236	6.4	2	19
Service truck	0.9	1	6	4000	4236	6.4	5	32
Total								90

Fuel and Lubricant

	Power HP	Load factor	Operation hour h/year	Fuel consum 1000 ltr/y	unit	Total Fuel 1000 ltr/y
Dozer shovel 250 HP	250	0.11	4,236	116	4	464
Bulldozer 400 HP	400	0.15	4,236	254	1	254
Bulldozer 200 HP	200	0.15	4,236	127	1	127
FEL 5 m3	380	0.11	4,236	177	2	354
Water truck	400	0.06	4,236	102	2	204
Service truck	100	0.06	4,236	25	5	125
Total						1,528

Electricity

	Power kW	Load factor	Operation hour h/year	consum 1000 kWh/y	unit	consum 1000 kWh/y
Drill rig	75	0.60	2,824	127	2	254
Crushing Plant	500	0.60	4,236	1,271	2	2,542
Total						2,796

Table 7.17 Base Data for Operation Cost Estimation Supporting Equipment for Expansion

Manpower: to be supplied from the existing manpower

Spare parts

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor	Parts cost /unit 1000 US$/y	Unit	Parts cost total 1000 US$/y
Dozer shovel 250 HP	306	332	0.05	17	7	119
Bulldozer 400 HP	524	569	0.05	28	2	56
Bulldozer 200 HP	306	332	0.05	17	2	34
FEL 5 m3	408	443	0.05	22	2	44
Drill rig	459	498	0.05	25	2	50
Water truck	102	111	0.05	6	3	18
Service truck	51	55	0.05	3	10	30
Power distribution	167	181	0.05	9	4	36
Crushing plant	1,190	1,291	0.05	65	2	130
Subtotal						517
Others (15%)						78
Total						595

Consumables

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Consume factor /hour	Operation hour h/year	Parts cost 1000 US$/y	Unit	Parts cost total 1000 US$/y
Dozer shovel 250 HP	306	332	0.00001	4,236	14	7	98
Bulldozer 400 HP	524	569	0.00001	4,236	24	2	48
Bulldozer 200 HP	306	332	0.00001	4,236	14	2	28
FEL 5 m3	408	443	0.00001	4,236	19	2	38
Drill rig	459	498	0.00001	2,824	14	2	28
Water truck	102	111	0.00001	4,236	5	3	15
Service truck	51	55	0.00001	4,236	2	10	20
Power distribution	167	181	0.00001	4,236	8	4	32
Crushing plant	1,190	1,291	0.00001	4,236	55	2	110
Subtotal							417
Others (15%)							63
Total							480

Overhaul

	Equipment unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	Parts factor /time	Overhaul Interval year	Life time year	Overhaul time /life	Overhaul cost/life 1000 US$	Overhaul cost 1000 US$/y	Unit	Overhaul cost 1000 US$/y
Dozer shovel 250 HP	306	332	0.1	2	8	3	100	13	7	88
Bulldozer 400 HP	524	569	0.1	2	8	3	171	21	2	43
Bulldozer 200 HP	306	332	0.1	2	8	3	100	13	2	25
FEL 5 m3	408	443	0.1	2	8	3	133	17	2	33
Drill rig	459	498	0.1	2	8	3	149	19	2	37
Water truck	102	111	0.1	2	8	3	33	4	3	12
Service truck	51	55	0.1	2	8	3	17	2	10	21
Power distribution	167	181	0.1	8	15	1	18	1	4	5
Crushing plant	1,190	1,291	0.1	5	20	3	387	19	2	39
Subtotal										303
Others (15%)										45
Total										348

Tyre

	Tyre unit price Border price 1000 US$	CIF Site w/o tax 1000 US$	No. of tyre pcs	Life hour	Operation hour h/year	Consume /year pcs	Unit	Tyre cost /year 1000 US$/Y
FEL 5 m3	4.3	4.7	4	4,000	4,236	4.2	2	39
Water truck	1.4	1.5	6	4,000	4,236	6.4	3	29
Service truck	0.9	1.0	6	4,000	4,236	6.4	10	64
Total								132

Fuel and Lubricant

	Power HP	Load factor	Operation hour h/year	Fuel consum 1000 ltr/y	unit	Total Fuel 1000 ltr/y
Dozer shovel 250 HP	250	0.11	4,236	116	4	464
Bulldozer 400 HP	400	0.15	4,236	254	2	508
Bulldozer 200 HP	200	0.15	4,236	127	2	254
FEL 5 m3	380	0.11	4,236	177	2	354
Water truck	400	0.06	4,236	102	3	306
Service truck	100	0.06	4,236	25	10	250
Total						2,136

Electricity

	Power kW	Load factor	Operation hour h/year	consum 1000 kWh/y	unit	consum 1000 kWh/y
Drill rig	75	0.6	2,824	127	2	254
Crushing Plant	500	0.6	4,236	1,271	2	2,542
Total						2,796

Table 7.18 Differences in Operating Costs Among Scenarios

	Status Quo	Improvement in 1996	Additional in 1998	Non Railway System in 1998 or in 2002		
		(Existing)	(Additional)	(Existing)−(Railway)	(Truck & Shovel Substituted)	(Non Railway)
Total Extraction Capacity(10^3BCM) Skilled workers Total employees	11.900 1.262 1.592	17.300 1.262 1.592	18.489 1.279 1.613	14.489 923 1.181	4.000 92 115	18.489 1.015 1.296
Parts 10^3 US$ Tg/TBCM C: Conversion Factor	108.0	A: 1994 $ 5.977 (Table 3.15) 186.6 $15.704 (Table 7.5) 490.2 C: 400×1.35÷17.300 4.0 Mt. Support Eq. (Table 7.16) $(363+288+224+90)= $965 C: 400×1.35÷1.085 ÷17.300 Total ($15.704) + $965 490.2 + 27.7 = 517.9	Additional: 3FELs (10m³) (Table 7.13) $(141+120+105+147)= $513 C: 400×1.35÷1.085 ÷18.489 Total ($15.704)+($965+$513) = 458.6 + 39.8 = 498.4	B: 1994 $ 4.469.6 (Table 7.6) 130.5 $11.375.0 (Table 7.7) 332.2 C: 400×1.35÷18.489 4.0 Mt. Support Eq. $965 C = 400×1.35÷1.085 ÷18.489	Table 7.14—Expansion $(3.729+3.135+2.182+2.650)-$8.028 = $3.768 C:400×1.35÷1.085 ÷18.485	Total ($11.375)+$(965+3.768) = 332.2 + 127.4 = 459.6
Diesel kg/TBCM C: Conversion Factor	5.781.3 kg C: 1÷15.813 0.3656	Status Quo 0.3656 4.0 Mt. Support Eq. 1.528kl C: 0.83kg/l ÷17.300 Total 0.3656 + 0.0733 = 0.4389	Improvement 0.4389×17.300÷18.489 3 FELs 1.299kl C: 0.83kg/l÷18.489 Total 0.4107+0.0583= 0.4690	0.4389×17.300÷18.489 = 0.4107	Table 7.14—Expansion 12.395kl-(10.544-1.299)kl = 3.150 kl = 0.1414 C: 0.83kg/l÷18.489	Total 0.4107+0.1414 = 0.5521
Electricity kWh/TBCM C: Conversion Factor	40.000 MWh C: 1÷15.813 2.530	Status Quo 2.530 4.0 Mt. Support Eq. 2.796MWh C: 1÷17.300 Total 2.530 + 0.1616 = 2.6916	Increase in Loco comsp. 2.5% of Total 2.6916×17.300÷18.489×1.025 = 2.5815	31.286 MWh+2.796MWh	Table 7.14—Expansion (24.145−11.487) MWh = 9.658 MWh	Total 2.3657
Total Extraction Capacity(10^3BCM) Skilled workers Total employees			Expansion in 1998		11.411 362 457	
Parts 10^3US$ Tg/TBCM C: Conversion Factor			Major Eq. (Table 7.13)−3 FELs (10m³) $(2.660+2.239+1.628+2.014) − $513 = $8.028 Support Eq. (Table 7.17)−(Table 7.16) $(595+480+348+132) − $965 = $590 C: 400×1.35÷1.085 ÷11.411			Total $(8.028 + 590) Total 375.9
Diesel kg/TBCM			Major Eq. (10.544−1.299)kl+Support Eq. (2.136−1.528)kl = 9.853kl			C: 0.83kg/l ÷11.411 0.7167
Electricity kWh/TBCM			Major Eq. 14.487MWh+Support Eq. (2.796−2.796)MWh = 14.487MWh			C: 1÷11.411 1.2606

7.4 Foreign currency and local currency

7.4.1 Foreign currency

Foreign currency portion of capital and operating costs required 23 years for three cases are shown in three tables. These costs are prepared for both existing equipment and additional equipment.

Table 7.19 shows the foreign currency portion for with-railway system. Table 7.20 shows the foreign currency portion for non-railway system from 1998. Table 7.21 shows the foreign currency portion for non-railway system from 2002.

Foreign currency required for capital cost during the first three years is about US$ 130 million. Foreign currency required for operation cost during the first three years is about US$ 65 million.

7.4.2 Local currency

Local currency is required mainly for labour cost and electricity cost. Local cost for three cases are shown separately. Table 7.22 shows the local currency portion for with-railway system. Table 7.23 shows the local currency for non-railway system from 1998. Table 7.24 shows the local currency portion for non-railway system from 2002.

Table 7.19 Foreign Currency Portion for 23 years

- Case 1: With Railway System -

Million US$

Year	Capital cost *1			Operating cost *2			Yearly Total
	Existing	Addition	Total	Existing	Addition	Total	
1996	15.5	0.0	15.5	19.5	0.0	19.5	35.0
1997	30.4	0.0	30.4	19.5	0.0	19.5	49.9
1998	15.0	50.6	65.6	19.6	5.3	24.9	90.5
1999	3.4	0.0	3.4	20.3	10.5	30.8	34.2
2000	17.5	0.0	17.5	20.3	10.5	30.8	48.3
2001	7.8	0.0	7.8	20.2	10.5	30.7	38.5
2002	26.9	0.3	27.2	20.2	10.5	30.8	58.0
2003	21.0	0.0	21.0	20.2	10.5	30.7	51.7
2004	49.7	0.3	50.0	20.3	10.5	30.8	80.8
2005	16.4	0.0	16.4	20.3	10.5	30.8	47.2
2006	28.8	36.0	64.8	20.3	10.5	30.8	95.6
2007	3.5	0.0	3.5	20.2	10.5	30.7	34.2
2008	4.0	1.3	5.3	20.2	10.5	30.7	36.0
2009	4.1	0.0	4.1	20.3	10.5	30.8	34.9
2010	2.6	0.7	3.3	20.2	10.5	30.7	34.0
2011	7.8	0.0	7.8	20.3	10.5	30.8	38.6
2012	34.7	0.0	34.7	20.3	10.5	30.8	65.5
2013	5.9	0.3	6.2	20.2	10.5	30.7	36.9
2014	15.9	36.0	51.9	20.2	10.5	30.7	82.6
2015	17.7	0.0	17.7	20.2	10.5	30.7	48.4
2016	9.4	0.3	9.7	20.2	10.5	30.7	40.4
2017	25.6	0.0	25.6	20.3	10.5	30.8	56.4
2018	19.8	2.5	22.3	20.2	10.5	30.7	53.0
Total	383.4	128.3	511.7	463.5	215.3	578.9	1,190.6

Note *1 : Necessary capital costs of "existing" are the replacement cost of the existing equipment.

Taxes in Mongolia are not included.

: Necessary capital costs of "addition" include both initial and replacement costs for additional equipment and facilities.

*2 : Operation costs include yearly spare parts cost, periodic overhaul cost and imported consumable such as explosives,diesel oil, gasoline and lubricants.

Table 7.20 Foreign Currency Portion for 23 years

- Case 2: Non-Railway System from 1998-

Million US$

Year	Capital cost *1			Operating cost *2			Yearly Total
	Existing	Addition	Total	Existing	Addition	Total	
1996	15.5	0.0	15.5	19.5	0.0	19.5	35.0
1997	30.4	0.0	30.4	19.5	0.0	19.5	49.9
1998	33.7	50.6	84.3	18.6	5.3	23.9	108.2
1999	3.5	0.0	3.5	19.2	10.5	29.7	33.2
2000	17.3	0.0	17.3	19.2	10.5	29.7	47.0
2001	7.8	0.0	7.8	19.2	10.5	29.7	37.5
2002	2.0	0.4	2.4	19.2	10.5	29.7	32.1
2003	6.0	0.0	6.0	19.3	10.5	29.8	35.8
2004	36.6	0.3	36.9	19.2	10.5	29.7	66.6
2005	4.5	0.0	4.5	19.3	10.5	29.8	34.3
2006	25.3	35.9	61.2	19.3	10.5	29.8	91.0
2007	3.5	0.0	3.5	19.2	10.5	29.7	33.2
2008	3.8	1.3	5.1	19.3	10.5	29.8	34.9
2009	2.7	0.0	2.7	19.3	10.5	29.8	32.5
2010	16.8	0.7	17.5	19.2	10.5	29.7	47.2
2011	5.6	0.0	5.6	19.2	10.5	29.7	35.3
2012	32.7	0.0	32.7	19.3	10.5	29.8	62.5
2013	2.7	0.3	3.0	19.3	10.5	29.8	32.8
2014	12.3	36.0	48.3	19.2	10.5	29.7	78.0
2015	17.7	0.0	17.7	19.2	10.5	29.7	47.4
2016	23.4	0.3	23.7	19.3	10.5	29.8	53.5
2017	0.8	0.0	0.8	19.2	10.5	29.7	30.5
2018	7.0	2.5	9.5	19.3	10.5	29.8	39.3
Total	311.6	128.3	439.9	442.5	215.3	657.8	1,097.7

Note : See the note of Table 7.19.

Table 7.21 Foreign Currency Portion for 23 years

- Case 3: Non-Railway System from 2002-

Million US$

Year	Capital cost *1			Operating cost *2			Yearly Total
	Existing	Addition	Total	Existing	Addition	Total	
1996	20.2	0.0	20.2	19.5	0.0	19.4	39.6
1997	30.4	0.0	30.4	19.5	0.0	19.5	49.9
1998	15.0	50.6	65.6	19.6	5.3	24.9	90.5
1999	3.5	0.0	3.5	20.2	10.5	30.7	34.2
2000	17.5	0.0	17.5	20.2	10.5	30.7	48.2
2001	7.8	0.0	7.8	20.3	10.5	30.8	38.6
2002	20.9	0.4	21.3	19.2	10.5	29.7	51.0
2003	6.0	0.0	6.0	19.3	10.5	29.8	35.8
2004	30.3	0.3	30.6	19.3	10.5	29.8	60.4
2005	4.5	0.0	4.5	19.3	10.5	29.8	34.3
2006	27.9	35.9	63.8	19.3	10.5	29.8	93.6
2007	3.5	0.0	3.5	19.2	10.5	29.7	33.2
2008	8.5	1.3	9.8	19.2	10.5	29.7	39.5
2009	2.7	0.0	2.7	19.3	10.5	29.8	32.5
2010	16.8	0.7	17.5	19.2	10.5	29.7	47.2
2011	5.6	0.0	5.6	19.2	10.5	29.7	35.3
2012	32.7	0.0	32.7	19.3	10.5	29.8	62.5
2013	2.7	0.3	3.0	19.3	10.5	29.8	32.8
2014	19.5	36.0	55.5	19.3	10.5	29.8	85.3
2015	17.7	0.0	17.7	19.2	10.5	29.7	47.4
2016	9.2	0.3	9.5	19.3	10.5	29.8	39.3
2017	0.8	0.0	0.8	19.2	10.5	29.7	30.5
2018	21.3	2.5	23.8	19.2	10.5	29.7	53.5
Total	325.0	128.3	453.3	446.4	215.3	661.8	1,115.1

Note : See the note of Table 7.19.

Table 7.22 Local Currency Portion for 23 years

- Case 1: Railway System-

Million US$ as of 1994

Year	Labor cost	Electricity cost	Others*1	Total
1996	2.6	1.8	16.3	20.7
1996	2.6	2.0	7.7	12.3
1998	3.1	2.6	13.2	18.9
1999	3.3	3.5	14.6	21.4
2000	3.3	3.5	12.0	18.8
2001	3.3	3.5	11.9	18.7
2002	3.3	3.5	12.2	19.0
2003	3.3	3.5	12.1	18.9
2004	3.3	3.5	12.6	19.4
2005	3.3	3.5	12.0	18.8
2006	3.3	3.5	12.9	19.7
2007	3.3	3.5	11.8	18.6
2008	3.3	3.5	11.8	18.6
2009	3.3	3.5	11.8	18.6
2010	3.3	3.5	11.8	18.6
2011	3.3	3.5	11.8	18.7
2012	3.3	3.5	12.6	19.2
2013	3.3	3.5	11.8	18.6
2014	3.3	3.5	12.6	19.4
2015	3.3	3.5	12.1	18.9
2016	3.3	3.5	11.9	18.7
2017	3.3	3.5	12.2	19.0
2018	3.3	3.5	12.1	18.9
Total	74.3	76.4	281.7	432.4

Note*1; Others include domestic producted consumables (M & E others: see Tables 7.12 and 7.15), profit distribution (after tax expenses: see Tables 7.12 and 7.15), inland cost for imported material (see Table 7.4) and royalties & charges (scc Tables 7.12 and 7.15).

Table 7.23 Local Currency Portion for 23 years

- Case 2: Non-Railway System from 1998-

Million US$ as of 1994

Year	Labor cost	Electricity cost	Others*1	Total
1996	2.6	1.8	16.3	20.7
1996	2.6	2.0	7.7	12.3
1998	2.6	2.4	13.0	18.0
1999	2.8	3.2	14.6	20.6
2000	2.8	3.2	12.1	18.1
2001	2.8	3.2	11.9	17.9
2002	2.8	3.2	11.8	17.8
2003	2.8	3.2	11.9	17.9
2004	2.8	3.2	12.4	18.4
2005	2.8	3.2	11.8	17.8
2006	2.8	3.2	12.8	18.8
2007	2.8	3.2	12.8	17.8
2008	2.8	3.2	11.8	17.8
2009	2.8	3.2	11.8	17.8
2010	2.8	3.2	11.8	18.1
2011	2.8	3.2	11.8	17.8
2012	2.8	3.2	12.3	18.3
2013	2.8	3.2	11.8	17.8
2014	2.8	3.2	12.6	18.6
2015	2.8	3.2	12.1	18.1
2016	2.8	3.2	12.2	18.2
2017	2.8	3.2	11.8	17.8
2018	2.8	3.2	11.9	17.9
Total	63.8	70.2	280.3	414.3

Note: see Table 7.22.

Table 7.24 Local Currency Portion for 23 years

- Case 3: Non-Railway System from 2002-

Million US$ as of 1994

Year	Labor cost	Electricity cost	Others*1	Total
1996	2.6	1.8	16.4	20.8
1996	2.6	2.0	7.6	12.2
1998	3.1	2.6	13.2	18.9
1999	3.3	3.5	14.6	21.4
2000	3.3	3.5	12.1	18.9
2001	3.3	3.5	11.9	18.7
2002	2.8	3.2	11.6	17.6
2003	2.8	3.2	11.8	17.8
2004	2.8	3.2	12.3	18.3
2005	2.8	3.2	11.8	17.8
2006	2.8	3.2	12.9	18.9
2007	2.8	3.2	11.8	17.8
2008	2.8	3.2	12.0	18.0
2009	2.8	3.2	11.8	17.8
2010	2.8	3.2	12.1	18.1
2011	2.8	3.2	11.8	17.8
2012	2.8	3.2	12.3	18.3
2013	2.8	3.2	11.8	17.8
2014	2.8	3.2	12.7	18.7
2015	2.8	3.2	12.1	18.1
2016	2.8	3.2	11.9	17.9
2017	2.8	3.2	11.8	17.8
2018	2.8	3.2	12.2	18.2
Total	65.8	71.3	280.5	417.6

Note: see Table 7.22.

8 Economic and Financial Evaluation

8.1 Concept for evaluation

Economic and financial evaluations conducted in this section is based on the concepts of the time value of money with a compound interest rate, which are referred to as "discounted cash flow (DCF) analysis." Methodology and terminology are briefly illustrated in Appendix 8.

The objective of analysis here is to evaluate, from economic and financial standpoints, the conclusions and/or recommendations on various aspects deduced in the foregoing sections such as on mining and environment. The general approach to the analysis conducted here is as follows:

1) Project life studied

1996 to 2018 (23 years)

2) Time value of money

Constant 1994 Togrogs with an exchange rate of 400 Tg/US$

3) Renovation plans prepared for cash flow study

The cash flows prepared here are basically made up of three systems for renovation: firstly, rehabilitation of the existing mine; secondly, expansion of the production scale; and, finally, a combination of the two. The effect of introducing new truck and shovel fleets for the expansion is repercussive to the productivity of existing dragline operation as decreases in overburden rehandle. However, the ripple effect of this type has been treated as an improvement of existing operation and the capacity of expansion equipment is assumed to be 11.4 million BCM out of total 29.9 million BCM. Operating and capital costs are, then, treated accordingly.

Case 1: Rehabilitation of existing system

The existing equipment and mining system are, in principle, based on those from the ex-COMECON countries. This scenario is to continue the existing mining system with replacement of the existing equipment by the original sources, and also to supplement supporting equipment of modern models established in the free market countries to achieve the target "total excavation" (overburden removal plus coal production) of 18.5 million BCM.

Case 2: Case 1 - [railway system] + [truck & shovel system] in 1998

Case 3: Case 1 - [railway system] + [truck & shovel system] in 2002

These two scenarios, Case 2 and Case 3, are prepared for judging whether and when to abandon the railway system used in the existing system, since the current main equipment for the railway system is scheduled to be replaced in and after 2002. The railway system which is made up of equipment supplied from the ex-COMECON countries is superseded by a truck & shovel system which is fully based on the most modern equipment in the free market countries.

Case 4: Expansion of production

This scenario is to achieve a target additional "total excavation" of 11.4 million BCM. Additional equipment and facilities for expansion are based on modern models established in the free market countries.

Case 5: Case 1 + Case 4 29.9 million BCM using railway system

Case 6: Case 2 + Case 4 29.9 million BCM abandoning railway system in 1998

Case 7: Case 3 + Case 4 29.9 million BCM abandoning railway system in 2002

These three scenarios from Case 5 to Case 7 are prepared for examining a combination effect.

Note: For financial analysis, revaluation of the fixed assets currently existing in the mine is an option for all the scenarios.

4) Economic evaluation

Economic analyses by using a DCF method are conducted to select the most economical scenario and to evaluate the scenario selected here from a standpoint of the Mongolian economy as a whole. The value of a project itself is evaluated by Economical Internal Rate of Return (EIRR) on the total project, which means the cash investment basis.

Economic sensitivity analyses are conducted on the most economical scenario selected above to examine the impact of changes in the base case assumptions.

5) Financial analyses

Financial analyses by using a DCF method are conducted on the most economical scenario selected in the economic evaluation from a standpoint of an independent coal mine or investors. The value of a project itself is evaluated by Financial Internal Rate of Return (FIRR) on the total project, which is on a cash investment basis. And effects deriving from difference in capital structure (debt/equity) are examined by FIRR on equity, which is on a leverage investment basis. Then, the financial base case is to be prepared for sensitivity analyses.

Financial sensitivity analyses are conducted to examine the impact of changes in the base case assumptions by FIRR on the total project and FIRR on equity.

Although coal marketing analyses which involve coal supply/demand forecast have to be done prior to conducting these analyses, the coal supply/demand forecast in Mongolia is implemented in Part II of the study. Therefore a 100% product of coal from the mine is assumed to be sold to coal-fired power stations and other consumers in the analyses here.

8.2 Economic evaluation

The renovation project including improvement of the existing system and expansion of production scale for Baganuur coal mine is analyzed from a standpoint of the Monglian economy as a whole. Taxes and royalties liable to the mine are all evaluated as "transfer"; then, they are eliminated from economic costs. A trade tax of 10% of sale prices liable to consumers, however, is evaluated as an economic benefit.

The status quo of the current mining activity in Baganuur coal mine is that, without new injections of capital, the existing equipment would continue to be cannibalized until no equipment is left and mining activity disappears. This renovation project is to prevent the mine from such destruction; therefore, the status quo is not relevant to the without-project status. The total costs and benefits, then, are compared with one another by using a coal price of each scenario at a 10% EIRR. Sensitivity analyses are conducted on the most economical scenario in the above analysis.

8.2.1 Analytical criteria

The approach illustrated here is based on the following criteria:

- project financing of 100% debt for foreign currency;
- debt financing costs of 0; and
- no inflation but escalation of electricity from 1994 to 1999,
  escalation rate for electricity is to be 13.2% per annum.

The project financing of 100% debt for foreign currency reflects lack of fund, specially in hard currency, to be injected into the renovation project for the mine. The foreign debt financing is assumed to be a project-untied loan in the analysis here.

The financing sources are assumed to be: firstly, internal financing from retained profits; secondly, loans from international lending agencies for a foreign currency portion of capital investment; and finally, loans from domestic banks which are the sky limit. In the analysis here, the further restrictions are added: all the foreign currency portion of replacement of the existing equipment and additional investment for the years of 1996, 1997 and 1998 is allowed to use foreign loans up to the limitations if none of retained profits; after 1998, only additional investment for railway replacement with trucks is allowed to use foreign loans for a shortage after using retained profits. Replacement of the existing and additional equipment is allowed to use only domestic loans after 1998.

A domestic debt financing cost is 10% per month with a repayment period of 6 months; however, it is not an economic cost on the Mongolian economy as a whole but only "transfer" from the mine to domestic banks. Then, a domestic debt financing cost is eliminated from economic costs.

A foreign debt financing cost is 8% per annum with a repayment period of 10 years and repayment beginning the next year after borrowing, however, due to the assumption of a project-untied loan, the opportunity cost of financing is evaluated as zero.

Inflation, which is defined as persistent rise in the prices of a consumer price index type basket of commodities, goods and services, has not been applied to economic costs and benefits in the analysis here, since inflation equally affects them over the project period. It makes no difference in analytical results between with and without inflation. On the other hand, escalation is defined here as persistent rise in the price of specific commodities, goods or services due to a combination of supply/demand and other effects such as environmental and engineering changes, which should, if any, be considered in the analysis.

Under the current economic situation in Mongolia, which can be characterized by being in transition from planed economy to free market economy, adjustment escalations have to be required. To the prices of equipment and spare parts which are and will be supplied from the ex-COMECON countries, a rapid adjustment escalation has been applied by using 80% of the current international prices as detailed in 8.2.2 Economic costs. For electricity, however, a smooth changing in five years is assumed. Escalation rate used in the analysis does not include the effect of general inflation.

The current electricity tariff is administrated in the same manner as the pricing of coal by the Mongolian government and the current price level seems insufficient to sustain a normal operation in the power stations, of which equipment and facilities are all imported then, the situation is the same as in the coal mine. Moreover, the electricity supply agency, the Central Energy System (CES), currently delays its payment for coal to the coal mine, which causes the coal mine to borrow a huge amount of working capital to maintain its mine operation and consequently delay the mine's payment for new equipment and spare parts to the state owned trading company (NUURS Company), which takes responsibility for coal distribution and purchase of imports for the mine.

Since accurate estimation of a power price based on a renovation plan like this study for power plants is beyond the scope of work of the study, it is assumed that a power price levels off at 24.53 Tg/kWh(financial basis), which is 90% of the average 1993 price in the OECD countries, from the current price of 13.2 Tg/kWh (financial basis) within 5 years.

Prices of diesel oil, gasoline, lubricant and explosives are judged to reflect the current international prices. Any escalation is not applied to those prices in the analysis.

8.2.2 Economic costs

Economic costs are defined as the input of Mongolian national resources for the renovation project and are evaluated in detail hereunder.

(1) Capital costs

The capital costs estimated for all the scenarios are presented in Section 7. Taking into consideration the today's issue of a great amount of trading debts, working capital, required to finance operating costs which are incurred prior to receipt of revenues for the coal produced, is assumed to be equal to three months (25%) of the current year's operating costs in which depreciation and interest payments are not included. The amount of working capital will increase or decrease in any given year.

In the foregoing cost estimation, duplicate prices for the mining and supporting equipment are used: one for those supplied from the free market western countries which indicates a solid economic price; the other for those from the ex-COMECON countries which is estimated at 80% of the former price. Due to economic confusion by the aftermath of the collapse of the ex-COMECON economic block, the current prices of their products are judged to be uncertain and not to reflect their real market prices at the moment. Specific models of equipment such as trucks and bulldozers supplied from the ex-COMECON countries are also estimated to have a six-year working life period and, for the counterpart, to have a eight-year working life period.

80% of the international price represents, in average, 2.25 times the current price level for equipment from the ex-COMECON countries, which also involves estimate for spare parts costs. The effect of that estimation stated above is assessed as sensitivity analyses for base case selection.

No contingency has been applied to operating and capital costs since all the estimations are based on the current actual operation and popular mining equipment in addition to the consistent and stable geological setting in the field for the project. The effects of variances in operating and capital costs are assessed as sensitivity analyses.

(2) Conversion factors

Economic costs here are not including primarily visible taxes, royalties and domestic debt interest to be paid and are calculated from financial costs by using conversion factors as presented in the foregoing Table 7.4. The CIF site total on Table 7.4 except royalties and charges is all financial prices and costs expressed as 1.000, in which border price, taxes, domestic transportation and other costs are included. The CIF site prices or costs without taxes denote conversion factors; financial costs can be reduced to economic costs at the mine site by multiplying a financial cost by its own conversion factor.

Fig.8.1 shows the current tax system and the coal price structure in Mongolia.

As for the conversion factor of labor costs, only personal income tax (average 7% used) is eliminated from financial labor costs and any opportunity cost of the unskilled labors has not been reflected in the analysis. In Mongolian coal mines, the unskilled are much limited to a small portion of the entire workforce and most of them are regarded as the skilled labors. The renovation project here would not create a large amount of new jobs for the unskilled; therefore, the effect of differences in the number of the unskilled among the scenarios is assumed to be negligible.

A standard conversion factor and a shadow exchange rate have not been applied to the analysis.

(3) Operating costs

The operating costs as illustrated in the foregoing section include all mine operating and terminal costs including a railway load out operation as well as the head office administration costs at the mine site. Those operating costs, however, contain a different concept as shown on Table 7.12. Several of tax deductible cost items as recognized in the western accounting conventions are not included in the operating cost.

Those for renovation in technological and working conditions including coal exploration costs, employees training and social development funds including food aid, fuel aid, worker's compensations, pension supplements and bonus payments are not treated as operating costs and are not allowable for tax purposes in Mongolia. These expenses equivalent to operating costs in the western accounting, therefore, have been treated as costs in the analysis here.

Other expenditures in profit distributions such as dividend, debt repayment and construction costs for miners' apartment houses are treated as benefits in the same manner as in the West.

8.2.3 Benefits

Economic benefits are defined as an output from the renovation project and assumed to be only a function of the production of saleable coal from the mine and a sale price including 10% of trade tax at the mine site load out. Any other invisible benefits such as those derived from a ripple effect on other industries caused by coal production activity have not been included, due to, effectively, non existence of such chain relations in the Mongolian economy.

As for the economic price of Baganuur coal, there is no market price of coal reflecting "willingness to pay" in the country. Individual power plants have a certain degree of freedom in negotiating purchase contracts with the mining organizations after the economic restructuring program started in 1989 by the Mongolian government. The pricing of coal is, however, still under the government control.

Baganuur coal is classified as lignite by the Russian classification standards; however, it may be classified as sub-bituminous by the American Society for Testing and Materials (ASTM) standards. Either way, this type of coal is not traded internationally except between neighboring countries during barter trading of the COMECON era. On the other hand, looking at the function of coal, the essence is its own heating value or a source of electricity which can be seen as tradable.

Now internationally recognized most economical heating source traded today worldwide is coal. An economic value of coal produced by the Mongolian mines, therefore, is considered to be a calorific parity price of hypothetically imported coal from neighboring countries, which are China and Russia.

China (Datong) and Russia (Neryungri and Kuznetsky) have exported their coal to Japan and their statistics are shown in Tables 8.1 and 8.2 respectively. The average FOB prices of their coal are also presented on Table 8.3 and an overall average FOB price at the Far East port is 0.44 US¢ /kcal/kg. A railway distance from Neryungri to Nakhodka is 2,580km and from Kuznetsky to Nakhodka, 6,180km. On the other hand in China, a railway distance from Datong to Qinhuangdao is only 630km. Although the transport distance is shorter with China, Chinese coal is higher in average price than Russian one.

The distances from Neryungri, Kuznetsky and Datong to the Mongolian border and (Ulaanbaatar) are 2,414(2,770)km, 2,684(3,040)km and 366(1,180)km respectively. Regarding a border price, Datong coal seems most economical; however, it has difficulty in mass transportation due to a difference in railway gauge between Mongolia and China. Neryungri coal would be sold at almost the same price as at Nakhodka due to nearly equal distance to be transported. A sole beneficiary in terms of transport cost is Kuznetsky coal, which would not be sold at a price less than the current FOB price due to taking advantage of its situation.

As such, the economic price of Mongolian coal is assumed to be a Russian coal average of 0.425 US¢/kcal/kg. For the Baganuur coal with 3,563kcal/kg in long term average, it is assumed to be 6,057.1 Tg/t (gross calorific value basis)*. In the analysis, a Mongolian railway freight cost has been neglected.

* Note: Internationally used is a gross calorific value; however, a net calorific value is usually used for as received coal quality in Mongolia as well as in Russia.

To simplify the analysis, the variability in the heating value (HV) of the coal produced each year and the consequent impact on the pricing relationship are eliminated by assuming a constant as received HV over the life of the project which corresponds to the long term 23 year average HV.

8.2.4 Discounted cash flow analysis

The objective of the DCF analysis is to determine the positive cash flow that accrues to the project and the return on the total project. Procedures several added to the analysis are as follows:

1) The balances of investment/depreciation, remaining net working capital and also mine close reclamation costs are all included in the cash flow at the end of the final year of the project life;

2) In the cases with non-railway system, the balance between investment and depreciation on equipment for the railway system before superseded by a truck & shovel system is added to the

after tax profits in following the manner of fixed assets scrapping in 1998 for Case 2 and in 2002 for Case 3; and

3) The simplifying assumption is made that all benefits are received and costs are incurred at the end of the year.

A formula for cash flow used in the economic analyses is as follows:

Economic Benefits
− Total operating costs (payable interest = 0, depreciation =0)
− After tax expenses (adjustment of operating costs)
− Total capital costs
− Increase in working capital
+ *Project liquidation (at the end of the project life)

Cash flow for EIRR on total project

* Project liquidation
= Retained working capital + Equipment salvage - Reclamation costs

(1) Base case selection for economic evaluation

All the scenarios have been analyzed and the coal price of each scenario at a 10% EIRR has been calculated as shown on Table 8.4. Three combined scenarios are:

	Price	Index
Case 5: 29.9 million BCM using railway system	4,976.8 Tg/t	(1.0492)
Case 6: 29.9 million BCM non railway in 1998	4,743.5 Tg/t	(1.0000)
Case 7: 29.9 million BCM non railway in 2002	4,781.0 Tg/t	(1.0079)

The economic value of Baganuur coal is 6,057.1 Tg/t; then, all of three cases are favorable in view of the Mongolian economy due to their economical prices. Differences in price among these cases are quite small, specially between Case 6 and Case 7, implying that a bit changes in condition would affect economic priority.

DCF cash flow and foreign and local currency requirements of Case 6 at 6,086 Tg/t are shown on Table 8.5. These of Case 5 and Case 7 are attached in Appendix 8.

Among others, decisive one is the price of equipment and spare parts to be supplied from the ex-COMECON countries, since they are estimated at 80% of the current international price level against 36% in reality at the moment. The current prices and estimates are shown in the foregoing Table 3.15 and Table 7.6 respectively. DCF cash flows and foreign & local currency requirements are presented in Appendix 8.

Since Case 4 is for expansion in which none of equipment from the ex-COMECON countries are used, differences only come from Case 1, Case 2 and Case 3, to which a comparison has been made as shown on Table 8.6. In the analysis, comparison indexes reduced from international price levels, instead of using individual prices, are applied to the existing equipment replacement and spare parts in each scenario.

From the results, the threshold equipment price relevant to economic priority is approximately 50% of the current international price level or 1.4 times the current Mongolian import price, at which differences among three cases are almost nil in terms of the coal price at a 10% EIRR. In the case of the current price level, the existing railway system is most economical so that the current system should be continued by replacing wearing equipment supplied from the ex-COMECON countries with their original sources.

Taking into consideration, however, the current strong demand for price rise from the ex-COMECON countries and the fact that some of machines have reached to that level in their first offer before negotiation, it is reasonable to assume that the price level exceeds the threshold toward further price rise.

At every equipment price level, a difference in coal price between Case 2 and Case 3 is almost nil, ranging from 0.2% to 1.1%. In this comparison, a threshold is also approximately 50% of the current international price level and beyond this threshold, Case 2 is favorable, however.

Selecting either of these two cases probably does not make big difference and the result is maybe within an allowable error. The key to right selection lies not in EIRR but in social impact. When the railway system is superseded by a truck & shovel system, 296 employees are expected to be laid off. The most favorable timing is that both of expansion of the mine scale and abandonment of the railway system are accomplished all at once, since the expansion creates new jobs for 457 workers and the would-be laid off can be shifted to the expansion project. In that sense, Case 2 has been selected for a base case.

(2) Economic evaluation of base case

The base case, Case 6, is the combination of Case 2 and Case 4, in which improvement of the existing operation (Case 2) with superseding the current railway system by a truck & shovel system and expansion of mine scale (Case 4) are started at once in 1998. The results of the DCF analyses applying the economic coal value of 6,057.1 Tg/t to the base case are summarized below; however, due to high EIRR, the EIRR of Case 2 cannot be available.

		EIRR (%)
Case 2:	Rehabilitation abandoning railway in 1998	∞
Case 4:	Expansion in 1998	36.6
Case 6:	Renovation combined (Case 2 + Case 4)	97.0

8.2.5 Sensitivity analyses

The impact of changes in the base case assumptions has been evaluated and the results of the sensitivity analyses are presented on Table 8.7 in terms of EIRR. The changes evaluated against the base data at the economic value of 6,057.1 Tg/t are as follows:

- Coal value;
- Foreign exchange rate;
- Capital costs;
- Operating costs; and
- Total excavation with no changes in coal production.

The range of changes is±20% at every 5% step for all the items. The impact of changes in coal value is most significant; however, significant changes may be caused only by the change of the international energy price. Operating costs, total excavation and capital costs in a descending order are showing relatively big impacts on the project. The change of foreign exchange rates has little impact on the project.

Since the project is highly favorable in economic terms, serious impacts on the project from these changes will not be anticipated even if those changes should happen.

8.3 Financial evaluation

The renovation project (Case 6) including improvement of the existing system (Case 2) and expansion of production scale (Case 4) for Baganuur coal mine is analyzed from a standpoint of an independent coal mine or investors. Taxes and royalties liable to the mine are all evaluated as financial costs; a trade tax of 10% of sale prices liable to consumers is eliminated from the mine's revenues.

8.3.1 Analytical criteria

Since the financial analysis is to be conducted on the most economical scenario selected in the foregoing economic evaluation, only differences in assumption and criteria from those in the economic evaluation are illustrated in detail hereunder.

- project financing of 100% debt, 100% equity and mixed cases;
- a domestic debt financing cost of 10% per month with a repayment period of 6 months;
- a foreign debt financing cost of 8% with a repayment period of 10 years and repayment beginning the next year after borrowing; and
- no inflation but escalation of electricity and coal sale price from 1994 to 1999,

escalation rate for electricity	13.2% per annum,
escalation rates for coal sale price	(Price in $1999/2,750)^{1/5}$-1.

A domestic debt financing cost is 10% per month with a repayment period of 6 months; however, due to the simplifying assumption that all revenues are received and costs are incurred at the end of the year, interest payment and debt repayment are made altogether the next year after borrowing.

In order to eliminate the effect of general inflation, which is running 8% per month as shown on Table 8.8, the domestic debt financing costs of 10% per month is discounted to 24.6% per annum [$(1.10/1.08)^{12}$-1]. This interest rate discounted here is still too high to last for 23 years of the project life. Then, it is assumed that an interest rate comes to the same rate of 8% as the foreign interest rate assumed, including repayment terms after 2000.

Coal sale price should be adjusted to the catch up escalation of the prices of equipment, spare parts and electricity in order to compensate for their escalations. For a smooth transition from the current sale price of 2,750 Tg/t in 1994 to the constant price in real terms in and after 1999, an escalation rate has been given to the computer calculation program as a formula i.e. $(\text{Price in 1999} \div 2{,}750)^{1/5}$.

In order to assess the effect of variances in foreign debt interest rates and capital structure (debt/equity), in spite of an assumption that project financing is 100% debt, the Financial Internal Rate of Return (FIRR) on equity is also evaluated.

8.3.2 Financial costs

All the financial costs including operating and capital costs have been calculated by applying the conversion factors to the economic costs. The profit distributions in the Mongolian accounting are treated in the same manner as described in the foregoing economic evaluation. Tax calculation however, is in accordance with the Mongolian taxation regimes.

Currently Mongolia is under a rampant inflation environment, as shown in Tables 8.9 and 8.10, which has severely affected the mine management in financial terms, specially on their fixed assets devalued by the inflation. Depreciation of the fixed assets, then, seems to be almost non functional at all. To measure the effect of this situation, revaluation of the fixed assets has been carried out. As a revaluation index, foreign exchange rates are used for the imported fixed assets and general inflation rates are used for the domestic made buildings and structures. Depreciation used in the analysis is based on the fixed assets as of December 1993, investment in 1994 and some planed in 1995.

8.3.3 Revenues

The annual total revenues received by the mine is a function of the production of saleable coal from the mine and a sale price excluding trade tax. To simplify the analysis, the variability in the heating value (HV) of the coal produced each year and the consequent impact on the pricing relationship are eliminated by assuming a constant as received HV over the life of the project which corresponds to the long term 23 year average HV.