E-161

PRESELECTED ITEM FOR WORLD BANK LOAN

ENVIRONMENTAL IMPACT ASSESSMENT

of the Proposed

Tuoketuo Power Plant (Plant A) Project

NORTH CHINA ELECTRIC POWER DESIGN INSTITUTE
THE MINISTRY OF ELECTRIC POWER INDUSTRY

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North China Electric Power Design Institute
January, 1996

CHINA

Inner Mongolia Autonomous Region

Tuoketuo Power Plant

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Introduction:

1. The proposed Tuoketuo Power plant is located in the Tuoketuo County, Inner-Mongolia Autonomous Region, about 80 km southwest of Huhhot City. The planned capacity of the power plant is 6 x 600 MW, with 2 x 600 MW sub-critical, intermediate reheat, condensing type turbine-generators to be installed for Phase I of the project. Auxiliary facilities include: water intake and delivery structures; ash disposal area; railway siding and transmission line. The environmental impacts of the power station and each of the auxiliary components has been assessed. The project is designed to meet national and World Bank effluent and emission standards. High efficiency electrostatic precipitators (not less than 99.76 %), and low NOx burners will be used, and space will be provided in the plant layout for flue gas desulfurization. The two generating sets will share one 240 m high reinforced concrete chimney. Continuous stack gas and ambient air monitoring equipment will be installed. A closed cycle condenser cooling system would be used, as well as ash slurry water recycling, and recycling of other process waters where possible, due to the scarcity of local water resources. A geotextile leachate liner system will be installed at the ash disposal area to prevent groundwater contamination. An environmental management unit would be established in the power company. This environmental unit would cooperate will local authorities and other institutional experts in desertification control, and would undertake an ongoing soil conservation and desertification control project to be funded by Tuoketuo Power Company.

Project Description :

2. Coal Source: On the basis of the coal supply agreement signed between the Zhungeer Coal Industry Corporation and the Tuoketuo Power Plant, the plant will burn the bituminous coal from the Zhungeer Coal Mine. The first phase of the coal mine project has began construction. The state-run mines will have a total annual output of 12 million tons and local mines 3 million tons. The coal mine project is scheduled to reach the design output in 1996. The feasibility study report for the second phase of the project has been pre-reviewed. The completion of the second phase will bring the total annual output of the coal mine up to 30-40 million tons. The annual coal consumption required by the first phase of the Tuoketuo Power Project will be about 4 million tons, which can be fully ensured by the Zhungeer Coal Mine.

3. Coal properties: Zhungeer mine coal will be washed at the mine, and four qualities of coal will be produced. The check coal sulfur content is 0.47 %, and the ash content is 30 %. This is the lowest grade of Zhungeer coal after washing.

4. Coal consumption: the first phase (2x 600 MW) will consume 14,520 tons/day (check coal); the capacity power station (6 x 600 MW) will consume 43,560 tons/day (check coal).

5. Coal transportation: The coal will be transported to the site through the Zhungeer-Fengzhen railway line which is under the unified control of the Zhungeer Coal Industry Corporation, and then along a dedicated (43.75 km) railway line owned by the power plant.

6. Power evacuation: The power plant will evacuate electricity via a 500 KV transmission line running northward, then turning eastward and finally entering Beijing District.

7. Water supplies: Cooling, potable, fire fighting and process water supplies will be drawn from the Yellow River. The water supply project includes 3 components: intake from the Yellow River; water treatment (clarification), and delivery to the power plant. The water intake will be placed at Putanguai, on the north bank of the Yellow River, about 12 km southwest of the plant site. Cooling water treatment will include elongated sedimentation ponds, acid dosing, and precipitation. Cooling water will be chlorinated to prevent biofouling in an installation located near the cooling towers.

Baseline data:

8. Site characteristics: The site is located within the boundary of Yanshanying, in the south of the county, about 0.3 km east of the Huhhot-Zhungeer Highway, 7 km north of the Yellow River, and about 20 km southeast of the county town. The ash yard is located on a dune sloping-field of Gaobaoshiying Village about 2 km south of the plant site. The area is rural; there are no neighboring large-scale industrial facilities. There are no power stations existing or planned within 80km of the site.

9. Location and geography: Tuoketuo County is located in the southeastern part of the Inner Mongolia Front Bend Plain, at the juncture of the Yellow River-Daheihe River alluvial plain and the Helingeer Hill pediment alluvial slant plain. The whole county is an open plain except a very small area in the southeastern part belonging to Helingeer Hill Zone. The elevation of the plain area ranges from 1070 m in the northeastern part to 992 m in the southwestern part. There are many large and small dunes scattered over the southern part of the plain area where the power station site is located. The dune heights range from 5 to 10 m, covered with sparse vegetation. The northern part of the plain area is vast, flat, uncultivated land. Land use in the county is divided into a third each of: i) cultivated land; ii) "shelter forest" and grassland (for desertification control); and, iii) wasteland.

10. Climate: The climate is semi-arid with average annual rainfall of 395.2 mm, and annual evaporation of 1825.6 mm. The climate is classified as continental semi-dry monsoon, with prevailing westerly.

11. Hydrology and floods: The Yellow River passes Tuoketuo County to the south. No definite flood river courses or channels exist within the boundary of the county. The few low-lying lands do not form complete flood channels because of the interrupted terrain. Floods that have occurred during rainy seasons have mainly seeped into the ground or evaporated from the low-lying lands where the floods accumulated. The site is 3 km west of the Shagou flood discharge canal. Since the 1.0 % flow rate of floods in Shagou makes some threat to the site, the top level of Shagou dike would be raised. In addition, there is a hill zone covering a 30.8 km^2 area to the south of the site; storm floods from this zone will threaten the site to a certain degree. Therefore, the bed for the dedicated railway line shall be raised and reinforced as a flood control measure. The power station itself will be constructed above the elevation of the 100 - year flood.

12. Siesmicity: The area is rated 7th degree for earthquake damage, with a probability of 10 % in 50 years. The damage potential rating is a national standard with a range of 1 to 12. An earthquake of 7th degree is a strong earthquake, with potential to cause structural damage; therefor the power station will be engineered to withstand this level of quake. There have been no major earthquakes in the area of the site in recorded history.

13. Ambient air quality: The background values of SO_2 and NOx are very low in this region, with the monitoring results far below the permitted values specified by the national standard. Ambient air quality has not been affected by industrial pollution. Random and average daily concentration of SO_2 are lower than national standard class II in both heating and non-heating seasons. The random and average daily concentration are also lower than national standard class I in two seasons at all monitoring points except the point at the Tuoketuo county town.

14. During the heating and non-heating seasons, the random sample concentration and average daily concentration of NOx are lower than national standard class II at each monitoring point. The average daily concentration of NOx is lower than national standard class I at most monitoring points.

15. Both random and average daily concentration of particulate (TSP) meet national class II standards at each monitoring point in the non-heating season. The daily TSP average concentration was 14.3-57.1% above standards at all monitoring points during 6 of 7 days in the heating season. TSP concentration in the town residential district is not higher than that of the countryside. This observation indicates that it is wind erosion and desertification, rather than pollution, that is the main cause of high ambient TSP in Tuoketuo county.

16. Socio-economiocs: Tuoketuo County has a population of about 0.16 million, among which 12 thousand are county town residents. Agriculture is Tuoketuo County's economic mainstay. The county is well-known throughout the country for its indigence. Highways connect all villages of the county and neighboring banners and counties. The county has a program of encouraging development to help move subsistence agricultural workers into more lucrative forms of employment. The power station and related economic spin-off are viewed as a positive impact on the local economy.

Impacts and mitigation:

17. Impact on flora and fauna: There are 248 species of plants in assessment zone including 194 species of wild plants. They are all common species and occur in uniform distribution. Consequently, construction of the power plant will not result in local loss of rare indigenous species, change the composition of local plant species, or result in extinction of species. Animals in the assessment zone are low in species diversity and common in agricultural areas. Even fewer species are found around plant site and ash disposal yard. Construction will cause emigration of some animal species without resulting in large changes of species diversity or number. More botanical species will exist after completion of the power plant due to greening and beautification of the plant area, as well as the desertification control program, providing more habitat for avifauna.

18. Changes of vegetation around ash yard and plant area: The two alternative ash disposal yard locations are characterized by sparse vegetation, low species diversity, and fixed or semi-fixed sandy soil. Gaobaoshi ash yard is the poorest with respect of structure and stability of vegetation. All original vegetation within the ash disposal and plant areas will be destroyed completely during the construction. Such factors as construction and transportation will also affect the growth of vegetation outside ash disposal and plant areas. Water and wind erosion will be intensified because the final elevation of ash disposal area will be 19~30m higher than the original ground surface. Growth of vegetation on ash disposal areas through natural evolution is impossible. This will result in desertification of soil. Therefore, the ash disposal areas will be reclaimed using principles of arid land vegetation establishment developed by local experts.

19. Air emission controls: A high-efficiency ESP will be used in the phase I project, with efficiency ≥99.76 %, calculated to meet Bank emission standards of 100 mg/Nm^3. Use of coal with low sulfur content, and a 240 m high chimney will satisfy emission standards for SO_2. Low NOx burners will be used with emission concentration below 400 ppm.

20. Dispersion modeling of air emission impacts: The North China Electric Power Design Institute used the U. S. EPA CRSTER point source dispersion model to analyze emission impacts of the proposed power station, with controls as detailed above. The worst case scenario was used in the impact modeling: "C" class stability, because it gave the high value of GLC max. Wind speed was chosen according to data from a local weather monitoring station; the wind speed chosen was an average value, since at chimney height lower wind velocities seldom occur. The maximum height of inversion layer, during the diurnal cycle when it is maximum (after sunrise), was used. The height of the inversion layer in the area never exceeds 139 m, and the chimney height is 240 m; therefor the chimney design allows for favorable dispersion. Conditions are similar from summer to winter.

21. Sulfur dioxide (SO_2): Ambient air quality monitoring has shown low background values of SO_2, with concentrations <50 $\mu g/m^3$. The Tuoketuo area can be classified according to Bank criteria for SO_2 as a "unpolluted" area; therefor the Bank standards of 500 t/day

emissions of SO_2 and an ambient air concentration of no more than 50 $\mu g/m^3$ apply. The daily SO_2 emission of Phase I of Tuoketuo Power plant (Plant A) is estimated at 100.54 t/day with design coal and 113.70 t/day with check coal. According to the model, the maximum annual average concentration of SO_2 in the plume of the plant is 14.5$\mu g/m^3$ and 16.4$\mu g/m^3$ for check coal and design coal respectively, which are 29% and 33% of World Bank standard. In the case of planned capacity (6 × 600 MW) of Tuoketuo Power plant, the daily SO_2 emission is 301.62 t/day for design coal and 341.10 t/day for check coal; the maximum annual average concentration of SO_2 for design coal and check coal would be 43.5$\mu g/m^3$ and 49.2 $\mu g/m^3$ respectively.

22. Noise control measures: An analysis of equipment noise has been performed. Accordingly the boiler exhaust pipes will be equipped with silencers, and the allowable noise levels of relevant standards will be stipulated in bid documents.

23. Wastewater treatment: Process wastewater will be treated at the point of generation to meet national and World Bank effluent standards, then drained southward to the Yellow River via a discharge pipeline (5.5 km) into the Gengqinggou Canal. Separate drainage systems will be used in the power station for sanitary sewage, industrial waste water and rain water.

24. Water recycling and conservation measures: Various water conservation measures will be used including: a demister inside the cooling tower; decreasing the water-ash ratio for hydraulic ash removal; ash slurry water recycling; closed-loop circulation for industrial and condenser cooling water; and, recovery of water from ventilation and blowdown of cooling towers. The make-up water requirement in summer will be 3895 m^3/h for 2×600 MW, and 10980 m^3/h for 6×600 MW capacity.

25. Ash disposal area: The ash disposal area will be located on a gentle slope with a hill forming one of the sides, about 2 km south of the power station site. The ash disposal area will be constructed in stages and utilized in sections. Each section will be reclaimed when full to prevent erosion. A shielding forest belt will be planted around the ash disposal area. The area occupied for Phase I will be 3.36 km^2, with an average dam height of 15 m, and storage capacity for 17.3 years for 2 × 600 MW. The final total occupied area of ash yard will be 6.36 km^2, with a height 30 m and a total ash storage capacity (6 × 600 MW) for 24 years.

26. Leachate liner: There is sufficient clay within most of the ash disposal area to provide a 300 mm minimum base layer for a geotextile/plastic liner. The liner material is in use internationally (Japan, England, France, U.S., and others), and is 3-4 mm thick. In areas where a sand or clay base is not available, a minimum of 300 mm clay will be spread as base material for the liner. In order to prevent liner damage from construction and weathering a protective 300-500 mm thick layer of clay will be installed above the liner as well. International experience with these liner systems has shown that they are serviceable for 20-30 years; sufficient for the life of this project.

27. Soil Conservation and Desertification Control Project: The project would contribute to the effort already planned in the "San Bei" (Northeast, North and Northwest

China) area, to arrest progressive desertification through soil conservation techniques; establishment of vegetative cover to combat wind erosion, and improvement of soil microclimate, water retention and fertility properties. The Tuoketuo County overall target for revegetation is to establish a forest cover for 40 % of the land area, (Long-Term Plan in 2000 of Tuoketuo County). The forest cover in an area within 30 km of the power station site is 15 % of the land area at this time (1995). Local people will be employed in the revegetation effort, with preference given to land oustees.

Analysis of alternatives:

28. Plant site: Three plant sites were considered for TuoKeTuo Power Plant A: Yanshanying; Majiaqi; and, Namujia. All are located on the south side of TuoKeTuo County and north side of the Yellow River and would have level ash disposal areas (except for Gaobaoshi ash yard). One common problem of the three plant sites considered was the proximity of a water source and FenZhun railway.

29. On comparison of site conditions, Yanshanying had advantages over the other two plant sites. Though there are some disadvantages, e.g. movement of two villages (Daduiying and Gaobaoshiying) and adoptation of flood prevention measures, its advantages were still obvious. The Yanshanying location is close to the ash disposal area, has convenient sewage drainage, transportation and is mostly wasteland. The most obvious advantage is that natural foundations can be used for the main buildings saving considerable investment and shortening 1~1.5 years of the construction period for the first phase. The significance of a more immediate power supply is inestimable.

30. Conditions at the Majiaqi site are similar to those at Yanshanying except that the foundations would have to be constructed artificially.

31. The Namujia site had less favorable conditions than the other two, but would also have been suitable for construction of a power plant

32. Schemes of cooling water treatment: The circulating cooling water discharge will meet national discharge standards without treatment. Scale prevention will be carried out for the turbine circulating cooling system by addition of acid or lime to circulating water. The concentration ratio and discharge quantity of circulating cooling water will vary with the different treatment processes. Two schemes were considered:

Scheme 1: Adding acid and stabilizing agent

Scheme 2: Lime pretreatment and adding stabilizing agent

The evaluation showed that from an economic comparison, the advantage of scheme 1 would be low investment, fast results and convenience for operating management and maintenance. The disadvantage of this scheme is that the concentration ratio is small, requiring a larger amount of make up water. From an economic comparison, the primary investment for scheme 2 is high and the operating management and maintenance are complicated. The concentration ratio is high, so scheme 2 would require less make up water. For this project, scheme 1 was selected.

33. Selection of an ash disposal alternative: The EIA discusses alternatives of dry or hydraulic ash disposal systems. The hydraulic method was chosen for the following reasons:

> i) the climate of the project area is arid, with low annual rainfall, and a high evaporation rate; therefore the water requirement to keep down fugitive dust on the dry ash disposal pile would be high;
>
> ii) there are many days each year with high winds ("gale">17m/sec) in Inner Mongolia, (7 gale days, 11 sandstorm days), another problem for fugitive dust emission;
>
> iii) the dry ash disposal scheme requires a more complicated process; and,
>
> iv) only one plant in Inner Mongolia is currently using the dry ash disposal technique, there is not much experience with this process.

The overriding advantage of hydraulic ash disposal is the available water cover to hold down fugitive dust. With the use of a liner, ground water contamination can be prevented.

Public consultation:

34. In order to ensure the improvement of the living standards of PAP's and fulfill the resettlement plan successfully, the Electric Power Corporation of Inner Mongolia has undertaken the following activities in order to enlist community participation.

35. Symposium for social survey: In October of 1993, 15 persons from villages, the town, and the county affected by the project attended a symposium for social survey organized by the Electric Power Corporation of Inner Mongolia. Land acquisition, the scope of resettlement and requirements of residents and local government were discussed in this meeting.

36. Forum for drafts of resettlement plan: In April of 1994, 20 persons from villages affected by this project, the local environment department and the local government were invited by TuoKeTuo Power Plant Preparatory Department (TPPPD) to participate in a forum for drafts of the resettlement plan. The drafts for the resettlement plan drawn up by TPPPD and approved by Electric Power Corporation of Inner Mongolia were announced, and the contents of the draft, compensation standard for PAP's and arrangement for the immplementation of the resettlement plan were discussed in this meeting.

37. Report of investigation of opinions of PAP's in occupied land, TuoKeTuo Power Plant and ash yard: From June 20 to June 22, 1994, a meeting of cadres from villages and the town was held at Xikoukou village of Yanshanying county. The opinions on land occupation of the power plant and relocation of PAP's were sought.

38. Symposium attended by representatives of residents: In July of 1993, 16 representatives from Yanshanying township government and 6 villages affected by the project participated in a symposium of representatives of residents organized by TPPPD. In this meeting, methods of labor arrangement and construction of new residences were discussed.

Resettlement and Rehabilitation:

39. A total of 26 families would be resettled in this project, including all auxiliary facilities. In addition, cultivated lands will be occupied by the power station, ash pond, water intake and delivery system, railway and transmission line. A total of 772 residents will be affected by this project.

40. The following policies relate to the resettlement components of the Touketuo project: (i) Laws and stipulations concerning resettlement; (ii) "Law for land of People's Republic of China;" (iii) "Regulation for Implement of Law for Land of Inner Mongolia Autonomous Region;" and, (iv) "Provisional Regulation for Compensated utilization of Land of Huhhot City."

41. Resettlement villages: Daduiying and Gaobaoshi Village with inhabitants from 26 families shall be moved to the north side of Shulinzi to new villages. In order to improve the residential conditions, brick and wooden structure will be used in the new one-story houses. Each family has its own independent courtyard. Residential conditions would be improved. Each family would be provided with toilet, electricity, sewer and tap water. There is also infrastructure such as roads, communication, cultural and educational facilities, scientific and technical activities room, clinic, shops, etc

42. Community development plan: Sewer, tap water and electric lighting will be provided in the new residences, and communication facilities, clinic, shops and primary school will be set up in the new residential village. The living conditions of resettlers after relocation will be better than before resettlement and public environmental conditions will be greatly improved.

43. Rehabilitation plan: Residents affected by construction of power plant with working ability (287) shall be employed as agreed with the local government. Among them, 87 people will be employed in brick and tile factory, 30 people in the sand and stone material factory, 40 people in the steel window factory, 30 people in a canned food factory and 40 people in commercial departments. The remaining 60 people will be employed by

the power plant. Residents not having working ability (80) will be paid with a one-time old-age compensation of 7000 Yuan RMB.

44. In order to successfully implement the resettlement plan, a sepecial settlement organization for PAP's will be set up in TuoKeTuo Power Plant Preparatory Department (TPPPD) to bear the responsibilities for the following resettlement work: 1) survey of social economics at site; 2) preparation of resettlement plan; 3) estimation of settlement cost of emigrants; 4) pooling funds of emigrants; 5) application for permits of land acquisition and relocation of emigrants; 6) arrangement of community participation; 7) arrangement for construction of new residences; 8) negotiation with local government concerning resettlement problems; 9) seeking opinions of settlers in resettlement work.

45. Supervision: The North China Electric Power Design Institute (NEPDI) entrusted by the Electric Power Corporation of Inner Mongolia will be responsible for supervision and assessment for resettlement. NEPDI will set up one supervision team composed of 4-5 persons (some of them are specialized in enviromental protection) for the resettlement work. In each stage of resettlement, this team will supervise the execution of resettlement work, and prepare the assessment report of this work after completion of resettlement. These reports would be submitted to the World Bank for review.

Environmental monitoring:

46. The financial requirements for sampling and analysis equipment have been included in the power station design budget. Tuoketuo Power Plant A will be equipped with an automatic continuous monitoring system for flue gas and ambient air quality. Monitoring parameters for this system include: emission concentrations of SO_2, NO_x, PM_{10} and CO and such meteorological parameters as flue gas temperature and volume, wind speed, wind direction and atmospheric temperature, etc. Two continuous weather and ambient air quality monitoring stations have been in operation for one year.

47. In the course of the commercial operation of the power plant A, monitoring work will be carried out in accordance with the national "Environmental Supervision Regulation for Thermal Power Plants." The following parameters will be monitored: flue gas emitted from the gas duct after boiler; efficiency of the precipitators; and, water quality of each waste water stream.. The following environmental parameters will be monitored: atmospheric quality in both the production area and in the living quarters; quality of the receiving water; quality of ground water around the ash yard; noise pollution in the production area and in the living quarters.

Institutional strengthening:

48. A technical assistance component would help the Electric Power Corporation of Inner Mongolia to establish technical and social environmental capabilities. The technical assistance would include: 1) assistance in reorganization for environmental functions under a

Head of the Environmental Department; 2) development of policies and regulations; 3) establishment of corporate standards in operations, development and engineering, safety, monitoring, auditing and EIA's, infrastructure for rehabilitation colonies, and R&R budgeting and norms; 4) organization of laboratories; 5) human resources development; and 6) data management improvement.

49. An environmental management unit (EMU) and monitoring station will be set up under the Tuoketuo Power Plant A; the station will be staffed with 5 to 6 specialized persons and equipped for sampling and analysis. The EMU will have responsibility for management, monitoring, supervision, propaganda, education in connection with environmental protection, as well as follow-up investigation of the social and economical effect derived from the plant construction.

Chapter 1 Preface

1.1 Project developer and purpose of environmental assessment

1.1.1 Name of project

The new construction Project is TuoKeTuo power plant (plant A), located in Inner Mongolia.

1.1.2 Project developer

Preparatory Department of TuoKeTuo Power Plant

1.1.3 Source of the project

(1) REPLY OF THE PROJECT PROPOSAL FOR NEW CONSTRUCTION OF TUOKETUO POWER PLANT, INNER MONGOLIA, GJN [1994] No.1076 issued by the State Planning Commission

(2) ENTRUST OF COMPILING ENVIRONMENT IMPACT ASSESSMENT OF TUOKETUO POWER PLANT AS THE PROJECT LOANED BY WORLD BANK TDGJZ [1994] No.2 issued by the Preparatory Department of TuoKeTuo Power Plant.

1.1.4 Importance of the project

TuoKeTuo Power Plant A (herein after referred to as Touketuo Plant A), is one of the important projects in the national development plan for the Zhungeer energy base. Tuoketuo Plant A is a mine mouth power plant that would supply power to the cities of Beijing, Tianjin, and southern of Hebei province. The project will make use of the rich coal resource of Zhungeer coal field and take water from the nearby Yellow River. The Touketuo Plant A has been listed in the preselected projects to receive loans from the world bank according to the REPLY OF THE PROJECT PROPOSAL FOR NEW CONSTRUCTION OF TUOKETUO POWER PLANT, INNER MONGOLIA, GJN [1994] No.1076 issued by the State Planning Commission.

The western Inner Mongolia and the northern Shanxi province are some of the richest coal resource areas in our country. In the coming decades, the increase of coal production of our country will mainly depend on these areas. The cost/benefits of coal transportation versus electric power favors electric power transmission. The quality of Zhungeer coal is suitable for electric power generation. TuoKeTuo prefecture lies to the south of Zhungeer coal mine in a setting favorable for industrial development, with the additional plus of the Yellow River as a nearby water supply.

TuoKeTuo prefecture has the correct conditions for development of a large scale power plant. Touketuo Plant A will supply electricity to Beijing, Tianjin, Tangshan and the south of Hebei province, play an important role in the economic development of the above mentioned areas, and help to alleviate the electricity demand problem.

1.1.5 Purpose of the environmental assessment and a brief description of the project

The appraisal system of environmental impact reports is to be used for any construction project which will impact the environment, in accordance with the specification of Environmental Protection Law of PRC and Environmental Protection Management Measure on Construction Project issued by the state. The environmental impact report of the construction project will include the assessment for pollution arising from the construction project and the impact on the environment as well as prevention and control measures. After pre-examination by the project department-in-charge, a report is made to the environmental protection administrative institution for ratification in accordance with a specified schedule. As one of the preselected projects to receive loans from the World Bank, the composition of the Environmental Impact Report for Touketuo Plant A will meet the national requirements as well as the World Bank's. The work has been carried out in accordance with the NOTICE OF STRENGTHENING THE WORK OF ENVIRONMENTAL IMPACT ASSESSMENT MANAGEMENT OF THE PROJECT LOANED BY INTERNATIONAL FINANCE ORGANIZATION issued by the State and stipulations of the annex and the relevant requirements on environmental assessment issued by the World Bank.

North China Electric Power Design Institute (NCEPDI) was entrusted by Touketuo Plant A Preparatory Department to assess environmental impact for the Inner Mongolia Touketuo Plant A, a preselected project to receive a loan by the World Bank. The Environmental Impact Assessment (EIA) outline for this report was reviewed by the National Environmental Protection Agency and accepted.

Standards to be implemented for the project have been specified in the documents issued by the Environmental Protection Division of Environmental Protection Urban & Rural Construction Environmental Protection Department of Inner Mongolia Autonomous Region (see section 1.3.2).

In accordance with the proposals by the officials from the World Bank during their visiting to Huhehot in November, 1994, and the requirements of the environmental assessment operational directive, additional investigations and analysis were carried out on current ambient air monitoring data, public participation, migration settlement, impact from designated railway and power distribution and transmission lines, etc. This is the World Bank edition of the Environmental Impact Report for New Construction Project of Inner Mongolia, Touketuo Plant A.

1.2 Environmental protection laws and regulations

1.2 .1 Regulatory framework and government approvals

(1) ENVIRONMENT PROTECTION LAW OF PEOPLE'S REPUBLIC OF CHINA. According to this law, an Environmental Impact Assessment must be prepared and approved by NEPA. NEPA has given approval of the EIA in their letter of August 30,1995 (see Annex 2). The Inner Mongolia Environmental Protection Agency (IMEPA) has also approved the EIA in their letter of August 30,1995.

(2) Other laws related to this Assessment include: ENVIRONMENT PROTECTION MANAGEMENT MEASURE OF CONSTRUCTION PROJECT GHZ(1986) No.003 issued by Environmental Protection Commission of State Council, State Planning Commission, State Economy and Trade Commission.

(3) NOTICE OF STRENGTHENING THE WORK OF ENVIRONMENT IMPACT ASSESSMENT MANAGEMENT OF THE PROJECT LOANED BY INTERNATIONAL FINANCE ORGANIZATION HJZ [1993] No.324 issued by National Environment Protection Agency, State Planning Commission, Ministry of Finance, People's Bank of China.

1.2.2 Documents of technical nature

(1) ENVIRONMENTAL IMPACT ASSESSMENT OUTLINE OF NEW CONSTRUCTION OF TUOKETUO POWER PLANT (PLANT A) PROJECT issued by North China Electric Power Design Institute

(2) REFERRING FORM AND SUMMARY FOR THE REPORT OF ENVIRONMENTAL IMPACT ASSESSMENT OF CONSTRUCTION PROJECT LOANED BY INTERNATIONAL FINANCE ORGANIZATION

(3) ENVIRONMENT ASSESSMENT(Operational Directive No.4, Annex A issued by the World Bank)

1.2.3. Project environmental documentmentation

(1) AGREEMENT FOR THE PROPOSAL OF THE SITE PLANNING AND RELEVANT CORRESPONDENCES FOR T. PLANT [1991] CJZ No.18 issued by the Environmental Protection Bureau for the Rural and Urban Construction of TuoKeTuo County;

(2) AGREEMENT FOR THE CONSTRUCTION OF POWER PLANT IN TUOKETUO COUNTY [1994] HCJGZ No.64 issued by the Rural and Urban Construction Bureau of Huhehot Municipality;

(3) REPLY FOR THE RELEVANT ENVIRONMENT STANDARDS TO BE IMPLEMENTED IN THE PROJECT OF TUOKETUO POWER PLANT (PLANT A) NJHZ [94]No.29 issued by Environment Protection Bureau for Rural and Urban Construction of Inner Mongolia Autonomous Region;

(4) REPLY OF THE AGREEMENT ON CARRYING OUT ENVIRONMENT IMPACT ASSESSMENT FOR TUOKETUO POWER PLANT HJZ [1994] No. 076 issued by National Environment Protection Bureau.

(5) Agreement of the coal supply and delivery to Tuoketuo "A" Power Plant for the electric power generation.

1.3 Scope and standards applied to this assessment

1.3.1 Scope of assessment

1.3.1.1 Scope of assessment for air contamination impacts

According to the features of dividing functional zones, wind direction and the areas affected by the power plant, eight (8) air quality monitoring points were set up respectively at Chengguan of TuoKeTuo county, Xinyingliao, Namujia, Shilawushuhao, Zhanggaiying, Hetongying, Wushijia and Yanshanying for the assessment of air quality conditions.

The area of impact assessment for air contamination is a 30km X 30km square area including all the monitoring points mentioned above. The plant site is located at the center of the area and a 30x30 bilinear mesh is employed.

1.3.1.2 Scope of assessment for impacts on surface water

Scope of assessment for surface water status is from the Daheihe River mouth to Jianci on the Yellow River.

The pre-assessing scope is from Putanguai of the Yellow River to Dashiyao.

Scope of assessment for groundwater is 3 km from the ash yard.

1.3.1.3 Scope of assessment for water supply project

The investigation and assessment scope is the nearby area around the water supply project of the power plant, mainly in Zhongtang village.

The assessment study area for surface water included:

Yellow River, from Toudaoguai to intake (Putanguai); and,

Chapter 1 Preface

1.1 Project developer and purpose of environmental assessment

1.1.1 Name of project

The new construction Project is TuoKeTuo power plant (plant A), located in Inner Mongolia.

1.1.2 Project developer

Preparatory Department of TuoKeTuo Power Plant

1.1.3 Source of the project

(1) REPLY OF THE PROJECT PROPOSAL FOR NEW CONSTRUCTION OF TUOKETUO POWER PLANT, INNER MONGOLIA, GJN [1994] No.1076 issued by the State Planning Commission

(2) ENTRUST OF COMPILING ENVIRONMENT IMPACT ASSESSMENT OF TUOKETUO POWER PLANT AS THE PROJECT LOANED BY WORLD BANK TDGJZ [1994] No.2 issued by the Preparatory Department of TuoKeTuo Power Plant.

1.1.4 Importance of the project

TuoKeTuo Power Plant A (herein after referred to as Touketuo Plant A), is one of the important projects in the national development plan for the Zhungeer energy base. Tuoketuo Plant A is a mine mouth power plant that would supply power to the cities of Beijing, Tianjin, and southern of Hebei province. The project will make use of the rich coal resource of Zhungeer coal field and take water from the nearby Yellow River. The Touketuo Plant A has been listed in the preselected projects to receive loans from the world bank according to the REPLY OF THE PROJECT PROPOSAL FOR NEW CONSTRUCTION OF TUOKETUO POWER PLANT, INNER MONGOLIA, GJN [1994] No.1076 issued by the State Planning Commission.

The western Inner Mongolia and the northern Shanxi province are some of the richest coal resource areas in our country. In the coming decades, the increase of coal production of our country will mainly depend on these areas. The cost/benefits of coal transportation versus electric power favors electric power transmission. The quality of Zhungeer coal is suitable for electric power generation. TuoKeTuo prefecture lies to the south of Zhungeer coal mine in a setting favorable for industrial development, with the additional plus of the Yellow River as a nearby water supply.

TuoKeTuo prefecture has the correct conditions for development of a large scale power plant. Touketuo Plant A will supply electricity to Beijing, Tianjin, Tangshan and the south of Hebei province, play an important role in the economic development of the above mentioned areas, and help to alleviate the electricity demand problem.

1.1.5 Purpose of the environmental assessment and a brief description of the project

The appraisal system of environmental impact reports is to be used for any construction project which will impact the environment, in accordance with the specification of Environmental Protection Law of PRC and Environmental Protection Management Measure on Construction Project issued by the state. The environmental impact report of the construction project will include the assessment for pollution arising from the construction project and the impact on the environment as well as prevention and control measures. After pre-examination by the project department-in-charge, a report is made to the environmental protection administrative institution for ratification in accordance with a specified schedule. As one of the preselected projects to receive loans from the World Bank, the composition of the Environmental Impact Report for Touketuo Plant A will meet the national requirements as well as the World Bank's. The work has been carried out in accordance with the NOTICE OF STRENGTHENING THE WORK OF ENVIRONMENTAL IMPACT ASSESSMENT MANAGEMENT OF THE PROJECT LOANED BY INTERNATIONAL FINANCE ORGANIZATION issued by the State and stipulations of the annex and the relevant requirements on environmental assessment issued by the World Bank.

North China Electric Power Design Institute (NCEPDI) was entrusted by Touketuo Plant A Preparatory Department to assess environmental impact for the Inner Mongolia Touketuo Plant A, a preselected project to receive a loan by the World Bank. The Environmental Impact Assessment (EIA) outline for this report was reviewed by the National Environmental Protection Agency and accepted.

Standards to be implemented for the project have been specified in the documents issued by the Environmental Protection Division of Environmental Protection Urban & Rural Construction Environmental Protection Department of Inner Mongolia Autonomous Region (see section 1.3.2).

In accordance with the proposals by the officials from the World Bank during their visiting to Huhehot in November, 1994, and the requirements of the environmental assessment operational directive, additional investigations and analysis were carried out on current ambient air monitoring data, public participation, migration settlement, impact from designated railway and power distribution and transmission lines, etc. This is the World Bank edition of the Environmental Impact Report for New Construction Project of Inner Mongolia, Touketuo Plant A.

1.2 Environmental protection laws and regulations

1.2 .1 Regulatory framework and government approvals

(1) ENVIRONMENT PROTECTION LAW OF PEOPLE'S REPUBLIC OF CHINA. According to this law, an Environmental Impact Assessment must be prepared and approved by NEPA. NEPA has given approval of the EIA in their letter of August 30,1995 (see Annex 2). The Inner Mongolia Environmental Protection Agency (IMEPA) has also approved the EIA in their letter of August 30,1995.

(2) Other laws related to this Assessment include: ENVIRONMENT PROTECTION MANAGEMENT MEASURE OF CONSTRUCTION PROJECT GHZ(1986) No.003 issued by Environmental Protection Commission of State Council, State Planning Commission, State Economy and Trade Commission.

(3) NOTICE OF STRENGTHENING THE WORK OF ENVIRONMENT IMPACT ASSESSMENT MANAGEMENT OF THE PROJECT LOANED BY INTERNATIONAL FINANCE ORGANIZATION HJZ [1993] No.324 issued by National Environment Protection Agency, State Planning Commission, Ministry of Finance, People's Bank of China.

1.2.2 Documents of technical nature

(1) ENVIRONMENTAL IMPACT ASSESSMENT OUTLINE OF NEW CONSTRUCTION OF TUOKETUO POWER PLANT (PLANT A) PROJECT issued by North China Electric Power Design Institute

(2) REFERRING FORM AND SUMMARY FOR THE REPORT OF ENVIRONMENTAL IMPACT ASSESSMENT OF CONSTRUCTION PROJECT LOANED BY INTERNATIONAL FINANCE ORGANIZATION

(3) ENVIRONMENT ASSESSMENT(Operational Directive No.4, Annex A issued by the World Bank)

1.2.3. Project environmental documentmentation

(1) AGREEMENT FOR THE PROPOSAL OF THE SITE PLANNING AND RELEVANT CORRESPONDENCES FOR T. PLANT [1991] CJZ No.18 issued by the Environmental Protection Bureau for the Rural and Urban Construction of TuoKeTuo County;

(2) AGREEMENT FOR THE CONSTRUCTION OF POWER PLANT IN TUOKETUO COUNTY [1994] HCJGZ No.64 issued by the Rural and Urban Construction Bureau of Huhehot Municipality;

(3) REPLY FOR THE RELEVANT ENVIRONMENT STANDARDS TO BE IMPLEMENTED IN THE PROJECT OF TUOKETUO POWER PLANT (PLANT A) NJHZ [94]No.29 issued by Environment Protection Bureau for Rural and Urban Construction of Inner Mongolia Autonomous Region;

(4) REPLY OF THE AGREEMENT ON CARRYING OUT ENVIRONMENT IMPACT ASSESSMENT FOR TUOKETUO POWER PLANT HJZ [1994] No. 076 issued by National Environment Protection Bureau.

(5) Agreement of the coal supply and delivery to Tuoketuo "A" Power Plant for the electric power generation.

1.3 Scope and standards applied to this assessment

1.3.1 Scope of assessment

1.3.1.1 Scope of assessment for air contamination impacts

According to the features of dividing functional zones, wind direction and the areas affected by the power plant, eight (8) air quality monitoring points were set up respectively at Chengguan of TuoKeTuo county, Xinyingliao, Namujia, Shilawushuhao, Zhanggaiying, Hetongying, Wushijia and Yanshanying for the assessment of air quality conditions.

The area of impact assessment for air contamination is a 30km X 30km square area including all the monitoring points mentioned above. The plant site is located at the center of the area and a 30x30 bilinear mesh is employed.

1.3.1.2 Scope of assessment for impacts on surface water

Scope of assessment for surface water status is from the Daheihe River mouth to Jianci on the Yellow River.

The pre-assessing scope is from Putanguai of the Yellow River to Dashiyao.

Scope of assessment for surface and groundwater is 3 km from the ash yard.

1.3.1.3 Scope of assessment for water supply project

The investigation and assessment scope is the nearby area around the water supply project of the power plant, mainly in Zhongtang village.

The assessment study area for surface water included:

Yellow River, from Toudaoguai to intake (Putanguai); and, Daheihe River, mainly in the downstream of the Xiaoheihe River mouth.

The scope of assessment for other project components lies mainly in the south of Hekou town, the north of Putanguai and the beach of the Yellow River in the Zhongtang village in western Yiliuwantaidi.

1.3.1.4 Scope of ecological assessment

The scope of ecological asessments is equivalent to the scope of atmospheric impact assessment, that is, a square area of 30 km x 30 km with the plant site at the center.

1.3.2 Assessment standards

1.3.2.1 Environmental quality standards

According to the requirement of Document No.29 NJHZ [94] "The Reply for the relevant environment standards to be implemented in the project of TuoKeTuo Power Plant (Plant A)" issued by the Environment Protection Bureau for Rural and Urban Construction of Inner Mongolia Autonomous Region, the relevant environmental quality standards implemented in this assessment are as follows:

(1) Class II standard of GB3095-82 "AMBIENT AIR QUALITY STANDARD" will be employed for the assessment of air contamination (see Table 1.3.1 below).

(2) Category III standard of GB 3833-88 "ENVIRONMENT QUALITY STANDARD FOR SURFACE WATER" will be employed for the surface water both upstream and downstream of Putanguai on the Yellow River (see Table 1.3.2 below).

(3) Standard of GB5749-85 "SANITARY STANDARD FOR POTABLE WATER" will be employed for ground water (see Table 1.3.3 below)

Table 1.3.1
GB3095-82 Standard of Atmospheric Environment Quality

Pollutant Designation	Concentration Limits mg/m^3			
	Sampling Time	Class I Standard	Class II Standard	Class III Standard
Total Suspended Solids	Daily Average	0.15	0.30	0.50
	Any Random Time	0.30	1.00	1.50
Sulphur Dioxide	Daily Average	0.05	0.15	0.25
	Any Random Time	0.15	0.50	0.70
NOx	Daily Average	0.05	0.10	0.15
	Any Random Time	0.10	0.15	0.30

Table 1.3.2
GB3838-88 Environmental Quality Standard for Surface Water (Class III)

PH value	Dissolved oxygen (DO)	CODcr	BOD5
6.5-8.5	5	15	4
petroleum	Hexavalent chrome	Lead	Cadmium
0.05	0.05	0.05	0.005

Table 1.3.3
GB5749-85 Sanitary Standard for Drinking Water

pH value	Chloride compound	Sulphate	Arsenic	Hexavalent chrome	Cadmium
6.5-8.5	250	250	0.05	0.05	0.01
Lead	Zinc	Fluorine compound	Colon bacterial colonies (piece/l)	total number of bacteria (piece/l)	
0.05	1.0	1.0	3	100	

1.3.2.2 Emission standards

The project as designed will meet World Bank as well as the following national standards:

(1) Atmospheric emissions from the power plant will be in accordance with the newly modified standard in countryside area, "ATMOSPHERIC POLLUTANT EMISSION STANDARD FOR COAL-FIRED POWER PLANT" (GB13223-91);

(2) The standard Class I of GB8978-88 "SEWAGE WATER COMPREHENSIVE DISCHARGE STANDARD" will be used for the waste water discharge of the power plant; and,

(3) Category III standard of GB12348-90 "PLANT BOUNDARY NOISE STANDARD WITHIN INDUSTRIAL ENTERPRISES" is to be used for noise assessment.

1.3.2.3 Regulations

The project bid documents will require compliance with (1) Regulation "Design technological regulation for fire fighting" electric power scheduling and design institute of the Electric Power Ministry, 1991, and (2) all relevant Labor Protection regulations.

1.4 Emphasis of assessment

Project analysis is the emphasis of this assessment. Ambient air quality, surface water, and ash disposal area impacts are also included in this assessment, stemming from the project characteristics of TouKeTuo Power Plant A, and the environmental features of the plant area. Also taken into consideration are the water supply project, ecology, migration (resettlement), noise, revegetation, wind breaks, environmental monitoring plans and analysis of environmental economic loss and benefit.

TuoKeTuo Power Plant is located in plain countryside area There are no places of historic interest, scenic spots, airports, or other major landmarks of environmental protection concerns in the plant area. The main issues of environmental protection with respect to contamination of the atmosphere will be the town of Tuoketuo county and relatively densely populated villages and towns near the power plant. The main issues of environmental impact with respect to the aquatic environment will be the water quality of the Yellow River and groundwater at the ash yard.

Environmental Quality Standards and Emission Standards must be satisfied during the construction and operation of the power plant.

1.5 Methodology

According to Appendix II HJ No.324 [1993] issued by the National Environmental Protection Bureau, Environmental Impact Assessment Outline and approval documents, the techniques and methods to be used in the environmental assessment of Touketuo Plant. Are shown in Table 1.5.1 below.

Table 1.5.1.

Techniques and methods adopted in the environmental assessment

Environment status condition of the project area	Natural environment	Collect relevant reports and local general information; survey, investigate on site, compile analysis
	Ecological environment	Information collection, comparing, investigation and research, survey and test on site
	Social environment	Local chronicles and relevant reports collection, obtaining information from local government
	Living quality	Analysis and sum up relevant information; obtain information from local government; survey on site and have interview
	Environmental quality	Monitor and analysis on site
Environment impact	Atmosphere	Carry out meteorological gauging on pollution and diffusion test, determine model parameter and carry out predicting calculation with the Gaussian plume model
	Surface water	Carry out comparing information collection;determine model parameter; predict the influence of the Yellow River with two-dimension water quality model
	Underground water	Carry out comparing information collection;determine model index; predict the influence of the underground water around the ash yard with two-dimension water quality mobile model
	Dry ash and dust raising	Determine the source strength of dust raising with Bygeno formula and calculate dust raising influence adopting American ISC short term surface source model
	Noise	Using the comparing investigation to determine the sources of noise and acoustic parameter; using the prediction model to predict noise distribution and carry out assessment
	Water supply project	Carry out assessment according to "TRIAL CODE ON ENVIRONMENT IMPACT OF HYDRAULIC AND HYDROELECTRIC ENGINEERING" ,mainly carry out collection of existing survey, design, environmental information and carry out necessary investigation work on site and make a influence assessment on impact of on the mud and sand submerge land use and voyage of the water supply project
	Ecological impact	With the help of assessing data of atmosphere water body to SO_2 measure the fluorine content in coal and the influence of TSP Fluorine on plants and on soil race group of plants and animals on structure of scenery; ecological influence of accidence;
Migration and public participation		Investigate and interview;have a meeting on land occupation and migrate arrangement; full consideration of the opinions from affected public groups and non governmental organization, put these opinions into the design
Environmental influence during construction period		Analysis of short term influence of construction

1.6 Established topics

(1) Investigation for pollutant sources and regional planning in the area

(2) Monitoring and assessment of ambient air quality

(3) Prediction of impact on ambient air quality

(4) Assessment of impacts on surface and groundwater resources

(5) Analysis and assessment of ash disposal area impacts

(6) Engineering analysis

(7) Noise impact analysis

(8) Revegetation and wind erosion prevention

(9) Environmental economic loss and benefit analysis

(10) Management plan of environmental protection and environmental monitoring plan

(11) Resettlement

(12) Public participation

(13) Environmental impact assessment of water supply project

(14) Ecological environmental impact assessment

(15) Power transmission line impact analysis

(16) Designated railway line impact analysis

1.7 Principal personnel

This assessment has been prepared by the North China Electric Power Design Institute, Ministry of Electric Power Industry. The institute has 27 full-time technical personnel in environmental protection and assessment, who are assigned full time in the fields of environmental engineering, hydrology, meteorology, geography, chemistry, and thermodynamics. Most have more than ten years of experience. The NCEPDI holds a Class A Environmental Impact Certificate issued by the State Environmental Protection Agency. Most of these professionals have completed environmental impact assessment work for the Shijingshan Power Plant, Jixian Power Plant, Qinhuangdao Power Plant, Sanhe Power Plant, Huaneng Beijing Power Plant, Shalingzi Power Plant, Shenzhen Mawan Power Plant, Beijing NO.3 Coal Fired Power Plant, Douhe Power Plant, Pinggu Power Plant, Luanhe Power Plant, Datong Power Plant and Shentou Power Plant.

The principal personnel who participated in this project are listed in Table 1.7-1

Table 1.7-1

Principal personnel, Touketuo Plant A EIA Preparation

Name	Title	Specialty	Experience in environmental assessment work	Topic	Working Unit
Chen Jin	Engineer	Thermotechnic engineering	11 years	General report and engineering analysis	NCEPDI*
Gu Ming	Senior engineer	Environment engineering	11 years	General report and engineering analysis	NCEPDI
Liu Haiyan	Engineer	Meteorology	10 years	Atmosphere environment impact assessment	NCEPDI
Shen Qing	Engineer	Hydrogeology environment engineering	11 years	Slag and ash environment impact assessment	NCEPDI
Zhao Hongyan	Engineer	Environment engineering	5 years	Water environment noise impact assessment	IMEPDI*
liu Lan feng	Senior engineer	Environment hydraulics	10 years	Surface water environment impact assessment	CNWCSRI*
Gao Qing	Engineer	Environment hydraulics	5 years	Underground water environment impact assessment	CNWCSRI
Hu Dahai	Engineer	Environment hydraulics	10 years	Water supply environment impact assessment	IMWCDI
Yang Yingfeng	Engineer	Chemicals	25 years	Atmosphere status assessment	HEPSRI*
Sun Jingping	Engineer	Ecology	10 years	Ecological environment impact assessment	IMEPSRI*
Xue Zenrong	Engineer	Technical economy	30 years	Technical economic analysis	NCEPDI
Feng Dongfang	Engineer	Environment economy	8 years	Environment economic brief analysis	CEENEPA*

Notes:

NCEPDI-- North China Electric Power Design Institute

IMEPDI--Inner Mongolia Electric Power Design Institute

CNWCSRI-- China National Water Conservancy Scientific Research Institute

IMWCDI-- Inner Mongolia Water Conservancy Scientific Research Institute

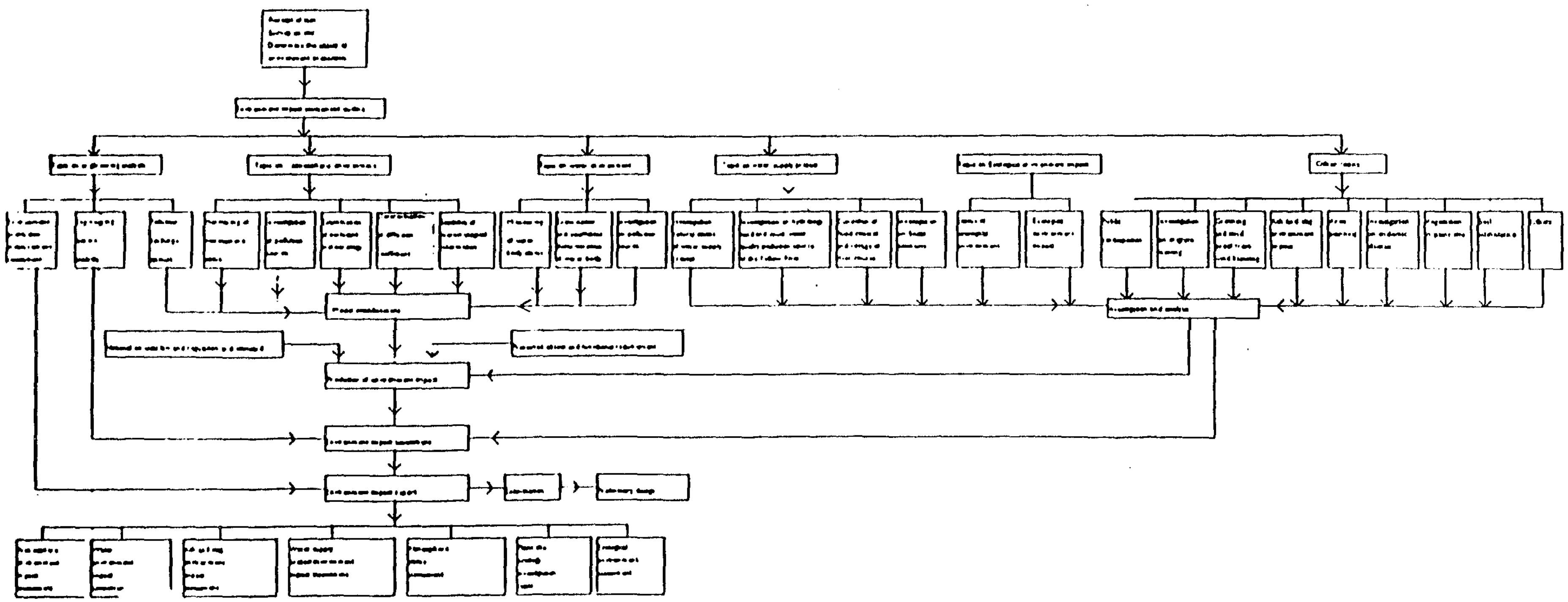
HEPSRI-- Huhehot Environment Protection Scientific Research Institute

IMEPSRI-- Inner Mongolia Environment Protection Scientific Research Institute

CEENEPA-- Center of Environment and Economic Policy, National Environmental Protection Agency

1.8 Overall plan of assessment

See Table 1.8-1 for the overall plan of assessment



Chapter 2 General project information

2.1 General

2.1.1 Nature of the project

Touketuo Plant A will be a new and large scale coal fired power plant.

2.1.2 Geographic location of plant site

Touketuo Plant A is located in TuoKeTuo county, Huhehot, Inner Mongolia. It is about 20 km from TuoKeTuo town in the northwest, 70 km away from Huhehot City in the east, and 7 km from the Yellow River to the south.

The geographic location of TuoKeTuo is: East longitude 111°00' - 111°32', north latitude 40°05' - 40°35', adjacent to Helingeer county in east and to Qingshuihe county in the south. To the southwest is Tumoteyouqi, to the north is Tumotezuoqi. It faces Zhungeerqi to the south across the Yellow River.

See Figure 2.1-1 for the geographic location of the plant site.

2.1.3 Site plan

The feasibility report for Touketuo Plant A recommended Yanshanying as the plant site.

The plant site in Yanshanying is located in Yanshanying village in the south of TuoKeTuo County, 0.3 km from Huzhun Highway to the west, 7 km from the Yellow River to the south and 20 km from TuoKeTuo Town.

The area is mainly small sand dunes with some non-irrigated farmland in the site location, where there is a small village, Daduisuiying, with 22 households and 86 persons. This village will be resettled when the power plant is built.

See oversize Figure 2.1-2 for site plan of Touketuo Plant A.

2.1.4 Construction scale

Two sets of 600MW condensing units will be installed in the first phase of Touketuo Plant A Project. Planned capacity is 3600 MW in accordance with the reply by the State Planning Commission to the project proposal.

2.1.5 Total amount of investment

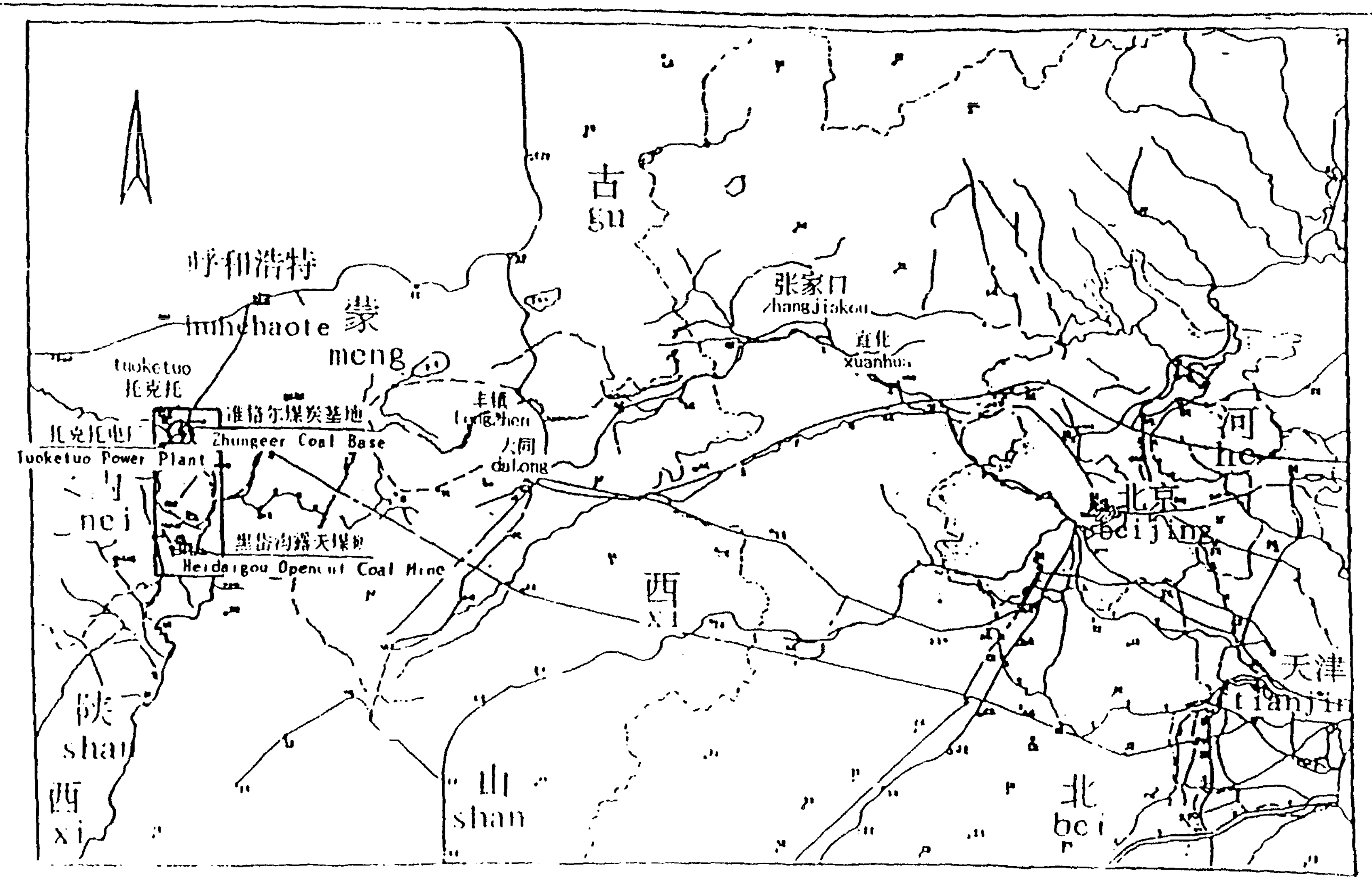
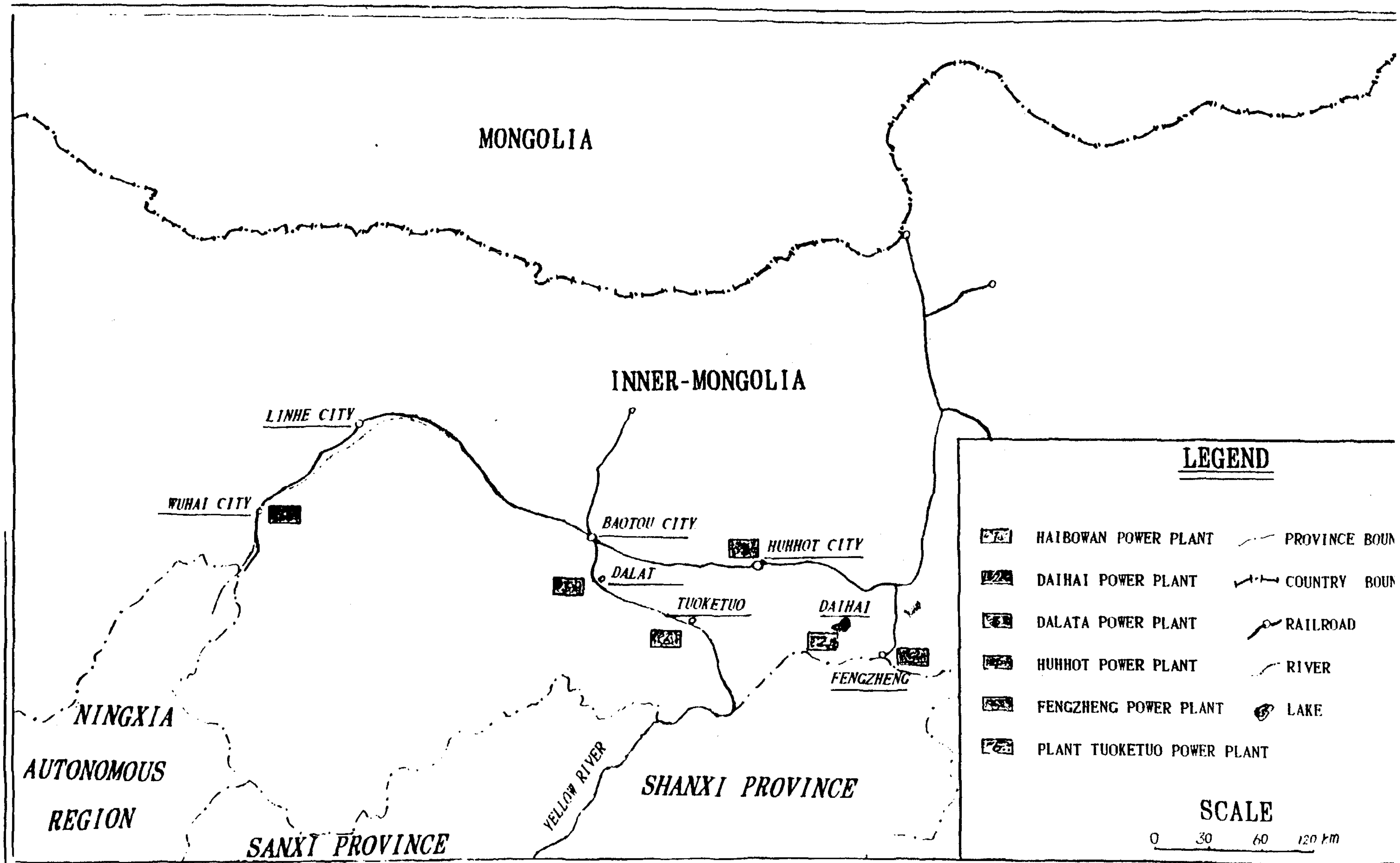


图2.1-1　　厂址地理位置图

Fig.2.1-1Geographic location drawing of the power plant.



DISTRIBUTION OF POWER PLANT IN WEST INNER-MONGOLIA

For this phase of Touketuo Plant A, 2 x 600 MW, the preliminary amount of investment, estimated on 1993 prices, is 8226.84 million Yuan RMB (including the investment on support projects, 1455 million Yuan RMB). The static investment of the first phase of power plant project is: 6771.84 million Yuan RMB, in which the loan of World Bank is 400 million US dollars mainly used for international bid purchase of boilers, steam turbine generators and their auxiliaries, construction machinery and I & C devices.

2.1.6 Milestone construction schedule

See Table 2.5-1 for the Milestone Construction Schedule.

2.1.7 Contents of major project items

Major projects include: power generation, transmission lines, water supply (water intake), and designated railway lines.

2.1.8 Land area

The 361 Ha will be occupied by the plant site and 145 Ha for the ash yard.

2.1.9 Number of staff members

The Standard number of staff members for operation of the first phase project Touketuo Plant A 2 x 600 MW is 1600 persons. About 5,000-6,000 construction workers will be employed.

2.1.10 General layout of plant site

See oversize Figure 2.1-3 for the general layout of the plant site.

2.2 Major equipment of the power plant and production process flow

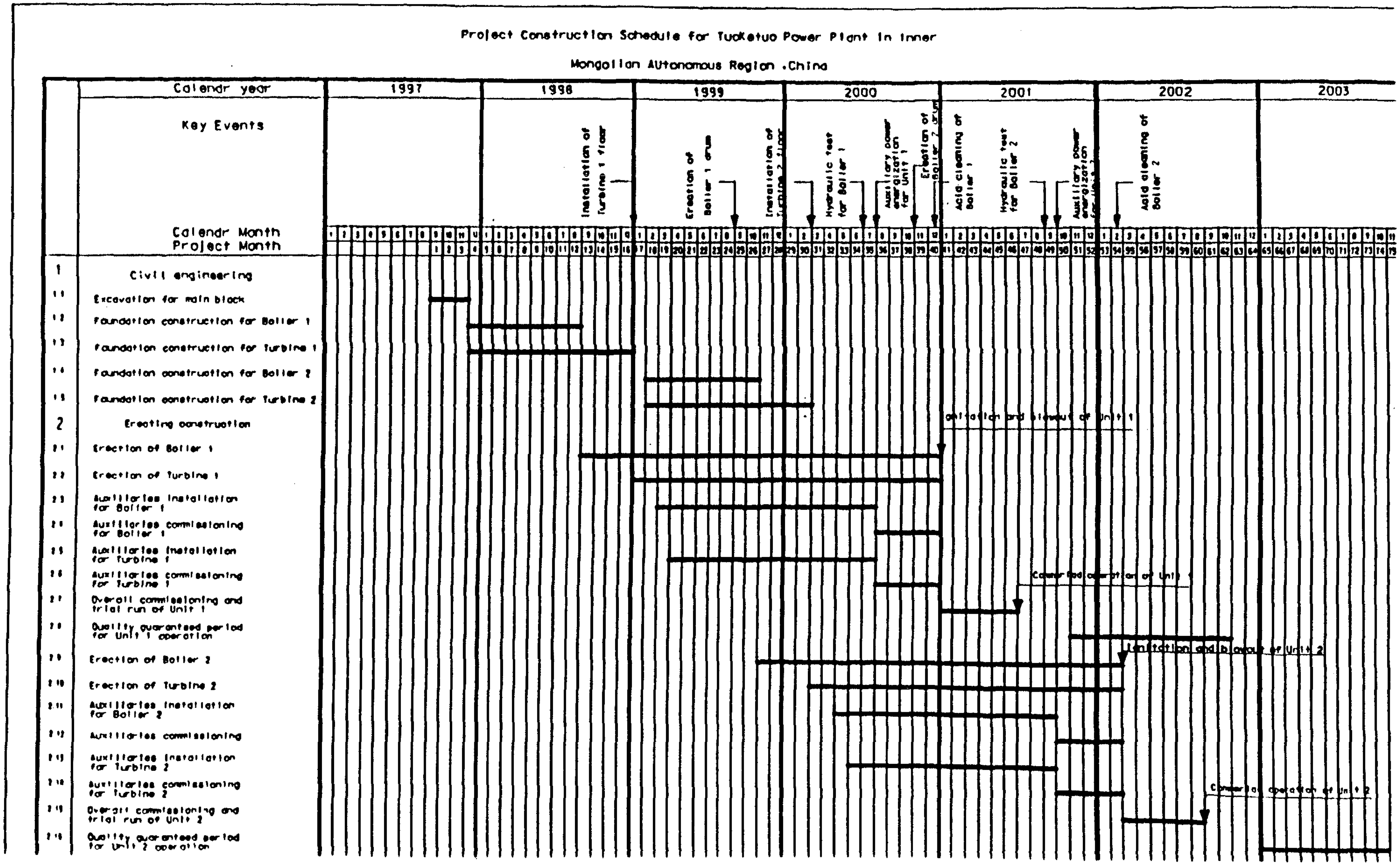
2.2.1 Major equipment of the power plant

In accordance with the design feasibility study, major equipment of the power plant shall include:

Boiler: Two (2) sets of subcritical, once intermediate reheat, balance draft, drum-type, pulverized coal fired and slag discharge in solid state with rated output 2008 t/h. (Steam Evaporation per set).

Steam Turbine: Two (2) sets of subcritical, intermediate reheat, single shaft four cylinders with four air exhaust, double back pressure condensing type with rated output 600 MW.

Table 2.5-1: for the Milestone Construction Schedule



Generator: Two(2) sets of Stator coil water cooled, stator core and rotor hydrogen cooled, incorporated with excitation device of high start response with the rated output 600 MW.

2.2.2. Production process flow

See the Figure 2.2-1 for Production Process Flow Chart of the Power Plant.

2.2.3 Fuel content and consumption

2.2.3.1 Coal source

In accordance with the reply by the State Planning Commission to the Project Proposal of TOUKETUO PLANT A , Inner Mongolia, the coal for the power plant shall be supplied from Zhungeer open-cut coal mine. The Coal Supply Agreement (CSA) has already been obtained. (see Annex 3).

2.2.3.2 Coal quality

Zhungeer mine coal will be washed at the mine. Four qualities of coal will be produced. The analyses below represent the lowest quality of coal after washing.

Table 2.2-1

Coal quality analysis

ZHUNGEER COAL AFTER WASHING (LOWEST QUALITY)

	Item	Symbol	Unit	Design value
Industrial analysis	Low heat value	$Q_{net.v}$	kJ/kg	17991.2
	Total moisture	M_{Inh}	%	13.25
	Inherent moisture	M_t	%	3.84
	Ash content	A_{ar}	%	26±4
	Volatile matter	V_{adf}	%	38~41
Elemental analysis	Carbon	C_{ar}	%	47.62
	Hydrogen	H_{ar}	%	3.01
	Oxygen	O_{ar}	%	8.77
	Nitrogen	N_{ar}	%	0.88
	Sulpher	S_{ar}	%	0.47

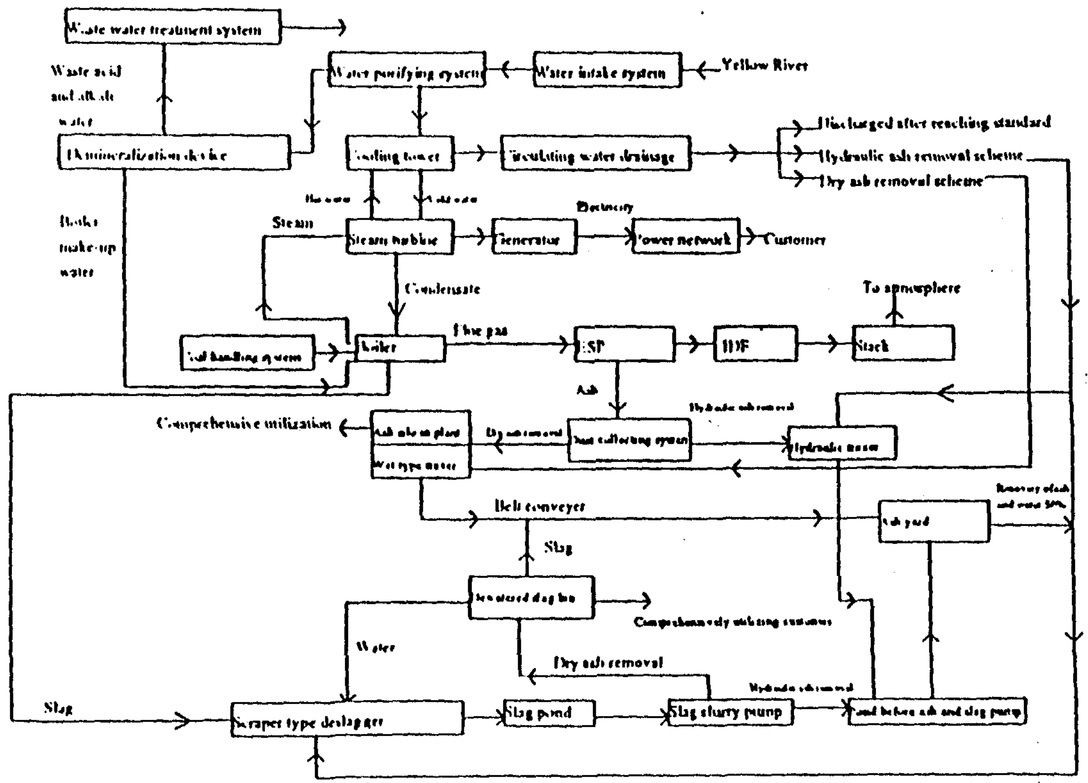


Fig. 2.2-1 Process flow chart of the power plant

The check coal sulfur content is 0.47 %, ash content is 30 %. Since the power plant is located near the mine mouth, it is unlikely that another source of coal would be used, because of transportation costs. Therefor ash and sulfur content are not likely to increase, since this is the lowest of the coal quality grades after washing.

2.2.3.3 Fuel consumption

Daily coal consumption is calculated on 20 hours' utilization and annual coal consumption is calculated on 6000 hours' utilization.

Table 2.2-2.

Fuel consumption

Capacity (MW)		Coal consumption per hour (t/h)	Daily coal consumption (t/d)	Annual coal consumption (10^4t/a)
Design coal	2x600	642	12840	385.2
	6x600	1926	38520	1155.6
Check coal	2x600	726	14520	435.6
	6x600	2178	43560	1306.8

2.2.4 Water sources and consumption of the power plant

2.2.4.1 Water source

The water for the power plant is taken from the Yellow River Water intake project is located on the Putanguai section of the Yellow River, 12 km from the town of TuoKeTuo County to the southeast. The water taken from Yellow River is treated, and flows into conservation pond for utilization by the power plant (see Table 3 1-2 for flow of theYellow River). See Annex 7 for the official letter concerning approval of water usage.

2.2.4.2 Water consumption of the power plant

Water consumption for the first phase of 2 x 600 MW of the power plant will be 0.99 m^3/s.

2.2.5 Water quantity balance chart

See Figure 2.2-1 for the water quantity balance chart for the dry ash removal alternative, and Figure 2.2-2 for the water quantity balance chart for the hydraulic ash removal alternative.

2.3 Main pollution sources and discharges

2.3.1 Main pollution sources

TOUKETUO PLANT A is a coal-fired electrical power generation plant that will use coal and water as raw materials. Flue gases, waste water, ash and slag, and noise are the main potential environmental pollutants. Flue gas has an impact on ambient air quality, production waste water and domestic sewage have impacts on surface water, the dry ash disposal alternative could impact ambient air and ground water. Power generation noise and coal dust fugitive emissions canalso have negative impacts on the environment.

2.3.1.1 Flue gas

The main constituents of flue gases discharged from an electrostatic precipitator and the stacks after fuel coal firing in the boiler are SO_2, suspended particulates (SPM), and NO_x.

2.3.1.2 Ash and slag

Ash will be collected by the electrostatic precipitator and air preheater and slag discharged from the bottom of boilers.

2.3.1.3 Effluent

(1) Drainage of circulating cooling water:

Natural draft circulating cooling water towers will be used for turbine condenser cooling in the project. Cooling water temperatures are elevated from heat exchange in the condenser and tail section of the turbine. The heated water is pumped to the cooling water tower, cools through evaporation, and is then pumped back to the condenser for next heat exchange cycle.

The evaporative loss in the cooling tower can reduce water quantity and increase mineral concentration. In order to maintain normal operation of the system, a large volume of water must be made up. Waste cooling water must be concentrated and drained; this wastestream is called circulating cooling water blowdown.

(2) Chemical acid and alkali waste water:

The raw water is to be deionized with an ion exchange resin in the demineralization plant to become boiler feed water. Acid and alkali waste water rom the DM plant is produced

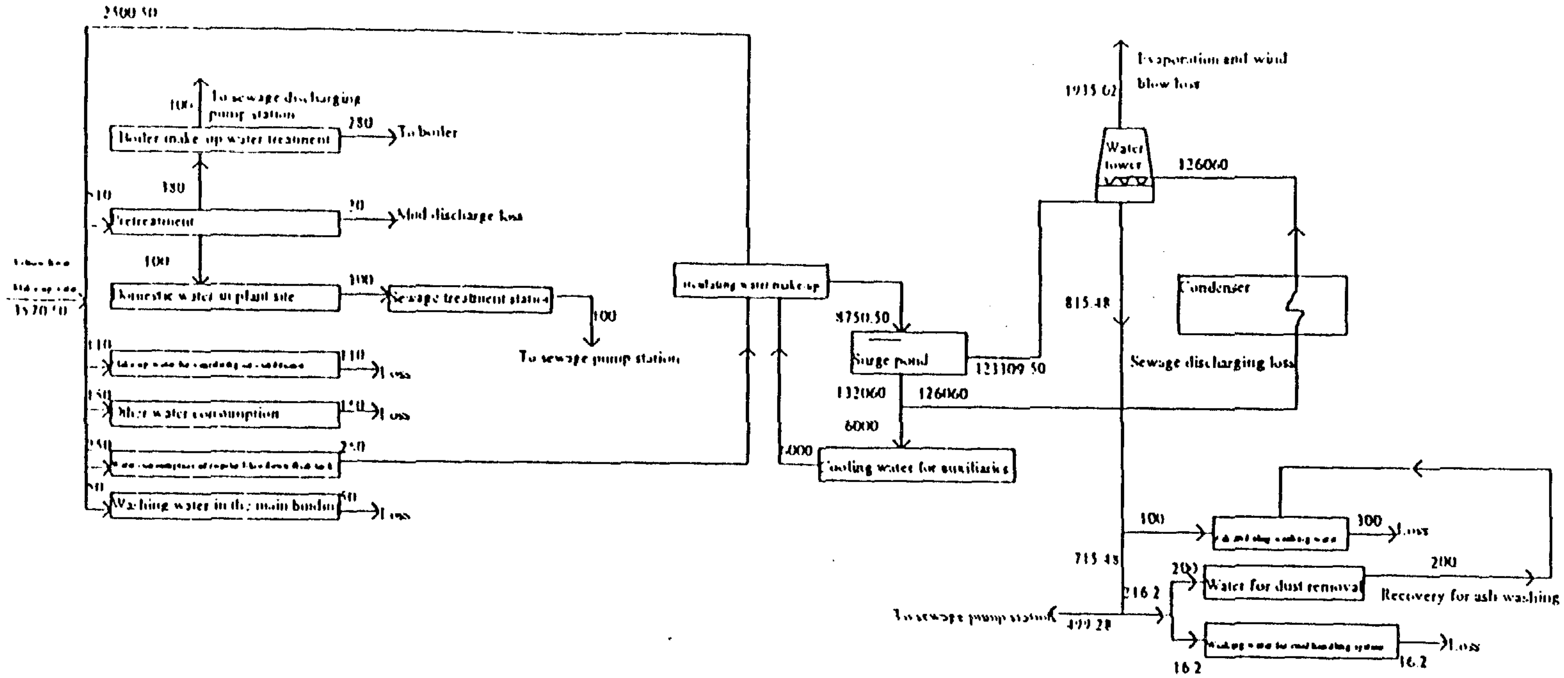


Fig.2.2-2 Water balance chart(dry ash removal scheme)
Unit: m^3/h

when renewing ion exchange resin with acid and alkali. The major pollutant is acid and alkali.

(3) Oil contaminated wastewater:

Oil contaminated wastewater comes mainly from the heavy oil unloading area and rainfall runoff from the oil storage area. The major pollutant is oil.

(4) Sanitary sewage:

Sanitary sewage is generated from the residential areas and officer's facilities in the power station: production office building, shift operator building, building for singles, guest house, canteen, and bath room. The major pollutant is BOD_5.

(5) Runoff from the coal handling system:

Contaminated runoff waters are generated dust suppression sprays and wash water from the coal handling system. The major pollutant is total suspended solids (TSS).

(6) Ash slurry water:

The volume of waste water from ash disposal depends mainly on the mode of ash transportation to the disposal area.

In the hydraulic ash removal system, slag or bottom ash is slurried at the bottom of the boiler. Fly ash from the electrostatic precipitator is slurried at the ESP with industrial waste water in a set ratio and pumped to the ash disposal area along with the bottom ash using ash and slag pumps. A certain volume of ash slurry water is kept as cover for the ash disposal area to suppress fugitive dust. In order to save water, the ash slurry water is to be recycled.

In the dry ash removal system, ash and slag are handled separately. After being collected in the slag removal system, slag is pumped to a dewatering hopper and then transported to the ash disposal area by conveyer belt. Ash is conveyed to an ash silo by a collecting system, wet mixed and conveyed to the ash disposal area. This method of ash disposal has no waste water discharge.

Rainfall runoff can become contaminated in the ash disposal area. The major pollutants of rainwater collected in the ash disposal area in the rainy season are pH and total suspended solids(TSS).

(7) Waste from acid cleaning boilers:

Acid cleaning of the inside wall tubing of the boilers is done to get rid of metal scraps and impurities before the boiler is put into use. The effluent is contaminated with acid.

2.3.1.4 Noise

Equipment noise originates from the turbine generator set and coal mill, etc. in the turbine hall; the cooling tower outside the main building, and electromagnetic noise from the main transformer station.

2.3.1.5 Fugitive dust

Fugitive dust is generated from the dry ash disposal area and the coal yard of the power plant.

2.3.2 Project environmental impact factors

The environmental impacts of a coal fired power plant are not complicated and potential environmental impacts are easily identified. According to the characteristics of TuoKeTuo Power Plant A, the environmental setting and the identified wastestreams, a matrix sensitivity analysis for the environment around the power plant was performed to identify and compare the potential environmental impacts.

Table 2.3-1

Environmental Impact Matrix for TuoKeTuo Power Plant (A)

		Natural environment							
Timeframe	Impact	Ambient air quality			Surface water			Groundwater	
		Dust	TSP	SO_2	Water resources	Water quality	Function	Water quality	Level
Operation period	Boiler flue gas		S	L					
	Fly dust in coal yard	S							
	Fly dust in ash yard	M							
	All kinds of waste water					S	S		
	Ash water from hydraulic ash sluicing yard					M	S		
	Rain water in dry ash yard					S	S		
	Influent water in hydraulic ash disposal yard							M	S

* S - small; L - large; M - middle; W - without, F - favorable

Table 2.3-1(continued)

Environment Impact Matrix for TuoKeTuo Power Plant (A)

		Natural environment							
Timeframe	Impact factor	Ambient air quality			Surface water			Groundwater	
		Dust	TSP	SO_2	Water resources	Water quality	Function	Water quality	Level
	Lasting noise								
	Water supply and sand sediment	S			S				
Construction period	Removal of dwelling houses								
	Resettlement								
	Land use								
	Excavation and filling								
	Transport								
	Noise								

* S - small; L - large; M - middle; W - without; F - favorable

Table 2.3-1 (continued)

Environmental Impact Matrix for TuoKeTuo Power Plant (A)

		Ecological and social environment											
Timeframe	Impact factor	Soil, animals and plants			Noise		Traffic		Landscape		Living quality		
		Land resources	Rare animals and plants	Vegetation	Production area	Outside the plant boundary	Railway	Highway	Historical spots	Scenic spots	Living conditions	Income	Community service
Operation period	Boiler flue gas												
	Fly dust in coal yard												
	Fly dust in ash yard												
	All kinds of waste water												
	Ash water from hydraulic ash sluicing yard												
	Rain water in dry ash yard												
	Influent water in hydraulic ash disposal yard												

* S - small; L - large; M - middle; W - without; F - favorable

Table 2.3-1(continued)

Environmental Impact Matrix for TuoKeTuo Power Plant (A)

		Ecological and social environment											
Timeframe	Impact factor	Soil, animals and plants			Noise		Traffic		Landscape		Living quality		
		Land resources	Rare animals and plants	Vegetation	Production area	Outside the plant boundary	Railway	Highway	Historical spots	Scenic spots	Living conditions	Income	Community service
	Lasting noise				M	S							
	Water supply and sand sediment												
Construction period	Removal of dwelling houses	S					S	S	W				
	Resettlement										F	F	F
	Land use	S							W				
	Excavation and filling								W				
	Transport						S	M					
	Noise				M								

* S - small, L - large; M - middle; W - without; F - favorable

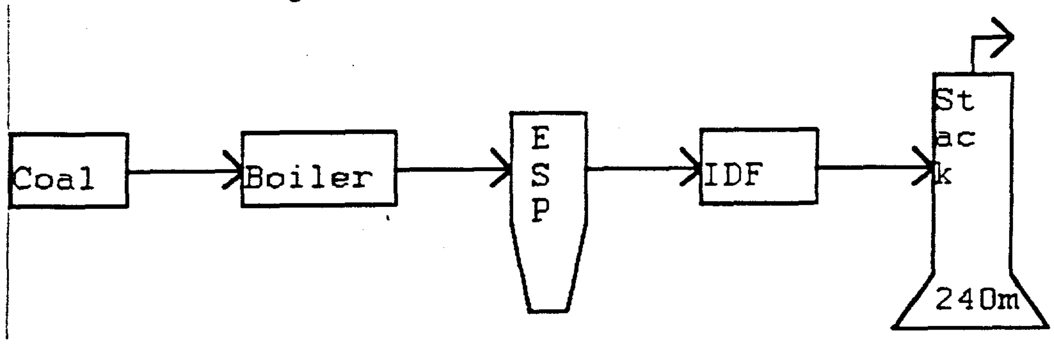
2.3.3 Wastestreams

2.3.3.1 Stack gas

(1) Flue gas system

Air emissions from the power plant are mainly stack gases released when coal is burned in the boiler during power generation. The stack gases are exhausted to the atmosphere after dust is collected in a high efficiency electrostatic precipitator.

Figure 2.3-1 Process flow of flue gas system



(2) Atmospheric pollutant emission characteristics

See Table 2.3-2 for atmospheric pollutant emission characteristics

Table 2.3-2

Emission characteristics

Coal	Parameter	SO2	Flue gas	Dust
	Construction scale	Emission quantity(t/h)	Emission quantity(t/h)	Emission concentration(mg/Nm^3)
Design coal	2 x 600 MW	5.027	0.563	77
Check coal	2 x 600 MW	5.685	0.728	100

2.3.3.2 Effluent discharge characteristics

See Table 2.3-3 for waste water discharge of the power plant.

Table 2.3-3

Waste water discharges of the power plant (2 x 600 MW)

Effluent	Discharge Quantity(t/h)	Major pollutant	Nature of discharge	Treatment measures
Discharge of circulating cooling water	199(H), 499 (D)	Mineral content	Continuous discharge	No treatment
Boiler make-up water treatment system	100	Acid, alkali	Frequent	Centralized treatment
Waste water recovery of condensed treatment system	300t/time	Acid, alkali	Regular discharge	Centralized treatment
Discharge of lab	10t/month	Acid	Frequent intermittent discharge	Centralized treatment
Sewage containing oil	10t/time	Petroleum	Regular discharge	Centralized treatment
boiler pickling liquid	Not determined	Acid	Regular discharge	Centralized treatment
Drainage of coal yard	60	Suspended substance	Regular discharge	Not determine
Domestic sewage	100	BOD5	Frequent	Grade II biochemical treatment
Ash washing water	600	pH	Continuous discharge	50% recovery

A Portion of the discharged waste water from the circulating cooling water system is used as ash slurry water, the other portion is discharged directly without any treatment (see figure 4.12-6).

Acid and alkali waste water from recovery of chemical water treatment equipment is to be discharged after reaching standards (see section 4.12.2.2).

Domestic sewage goes to a drainage pump station after II class treatment.

When the scheme of pickling is decided, waste liquid of boiler pickling is to be discharged after reaching standards.

Details of the wastewater recycling and treatment systems are given in Section 4.12.2.

2.3.3.3 Ash and slag discharge characteristics

See Table 2.3 - 4 for characterization of ash and slag discharges.

Table 2.3-4

Ash and slag discharge characteristics

Construction scale	Item			
	Coal type	Ash and slag quantity per hour(t)	Daily ash and slag quantity(t)	Annual ash and slag quantity (10^4t)
2 x 600 MW	Design coal	175.4	3508	105.24
	Check coal	226.4	4528	135.84

Note: Daily coal consumption is calculated on 20 hours of operation; and annual coal consumption is calculated on 6000 hours of operation.

(3) Ash analysis

Table 2.3-5
Ash analysis

S/N	Item	Symbol	Unit	Value
1	Silica	SiO_2	%	40.75
2	Aluminum	Al_2O_3	%	47.26
3	Ferric oxide	Fe_2O_3	%	4.73
4	Calcium oxide	CaO	%	0.89
5	Magnesium oxide	MgO	%	0.20
6	Titanium dioxide	TiO_2	%	1.84
7	Sulfur trioxide	SO_3	%	1.06

2.3.3.4 Noise

See table 2.3-6 for an estimation of Grade A noise from the Touketuo Plant A Project.

Table 2.3-6

Noise Grade A estimation of Touketuo Plant A Project

Location	Name of equipment	Noise Grade A dB(A)	Mechanism of noise generation
Turbine shop	Turbine	97	Operation
	Exciter	91	Operation
	Generator	87	Operation
	Water pump	100	Operation and water flow turbulence
Boiler House	Coal mill	90	Operation
	Coal feeder	89	Operation
	Primary air fan	92	Operation air turbulence
	FD fan	94	Operation air turbulence
	Water pump	83	Operation water flow turbulence
I.D fan room	I.D.fan	87	Operation
Ash slurry pump station	Ash slurry pump	94	Operation
Air compressor room	Air compressor	90	Operation
Outdoor noise source	Boiler steam exhaust	135	air turbulence
	Air exhaust of air storing container of air compressor	110	Air turbulence
	Main transformer	80	Electromagnetic oscillation
	Cooling tower	82	sprinkling water

2.4 Ash disposal area

There are two alternative schemes, namely Fengyan ash disposal area for dry ash disposal and Gaobaoshi ash disposal area for hydraulic ash disposal. Both alternatives have been analyzed, and the Gaobashi Site with hydraulic ash removal has been chosen as the preferred alternative.

2.4.1 Gaobaoshi ash disposal area

Gaobaoshi ash disposal area is located on sloping land belonging to Yangshanying Village, which lies 2 km from the Yanshanying plant site to the south, between Mahuangtan and XihaoLai Village. The elevation is high in the northeast and low in the southwest. The natural slope of the ground is between 10 and 15%. The elevation of the ground is between 1080-1110 msl. Gaobaoshi Village with 2 households and 4 persons is located in the ash disposal area. When the plant is built, they will be resettled.

2.5 Construction activity arrangements

2.5.1 General layout of construction

The construction area is composed of a building construction area, equipment installation area, utility area, and construction worker residential quarters.

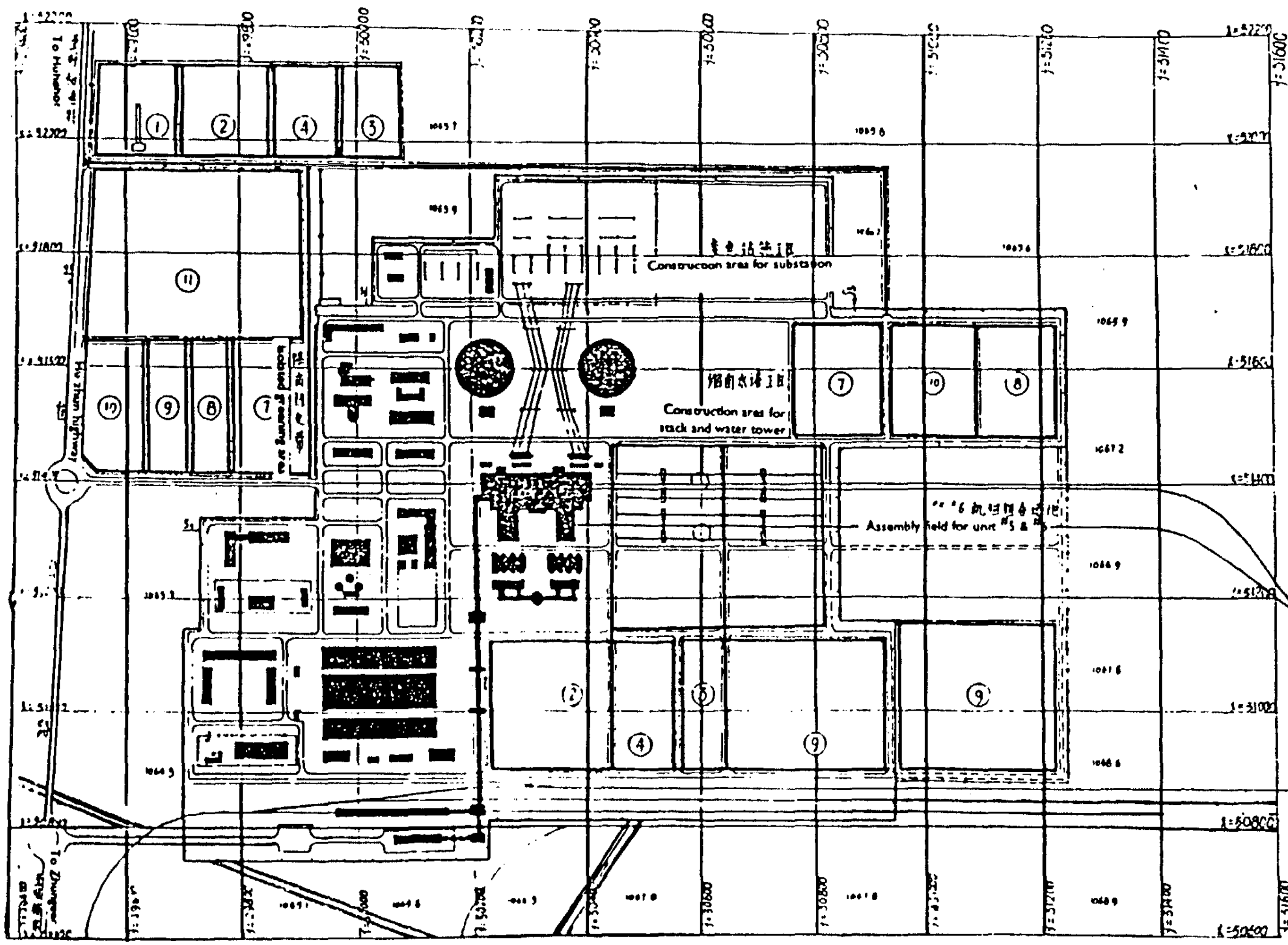
See Figure 2.5-1 for construction general layout.

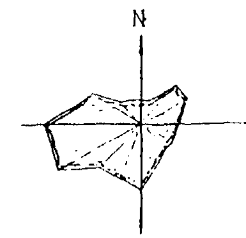
2.5.2 Construction Cycle

See Table 2.5-1 for Milestone Construction Schedule.

2.5.3 Land occupied during construction

See Table 2.5-2 for land occupied in construction area.





S/N	Description
1	Concrete mixing station
2	Medium and small sized prefabricated matters yard
3	Reinforced steel processing area
4	Carpentry and mold area
5	Boiler assembly yard
6	Turbine assembly yard
7	Preparing reviting and welding yard
8	Equipment transporting station area
9	Warehouse area
10	Construction managing area
11	Construction living area
12	Road for construction outside the plant site
13	Construction of ash storing yard
	Total

图2 6-1 施工 面布置图

Fig 2 5-1 Const on general layout.

Table 2.5-2

Land occupied for construction and temporary buildings

S/N	Description	Occupied area(m2)		Temporary building area (m^2)	Remarks
		Plant site occupied	Land rent		
1	Concrete mixing station	—	25840	2920	Must be rent in this term
2	Medium and small sized prefabrication	46000	27200	300	Rent can be postponed in this phase
3	Reinforced steel processing	16100	18700	1180	Rent can be postponed in this phase
4	Carpentry and mold area	23000	19500	1860	Rent can be postponed
5	Boiler assembly yard	75600	—	—	Make use of the land in the plant site in this phase
6	Turbine assembly yard	40700	—	—	Make use of the land in the plant site in this phase
7	Riveting and welding prep. yard	32000	24440	1090	Rent can be postponed in this phase
8	Equipment transporting	26000	17390	2140	Rent can be postponed in this phase
9	Warehouse area	74400	105900	4740	Must be rent in this phase
10	Construction managing area	30000	27380	12330	Must be rent in this phase
11	Construction housing	—	110000	70100	Must be rent in this phase
	Subtotal	363800	376400	97560	269120 must be rent
12	Road for construction outside the plant site	—	51400	—	
13	Construction of ash disposal area	—	12200	360	
	Total	—	440000	97920	332720 must be rent

2.5.4 Principal construction machinery and construction methods

2.5.4.1 Land leveling and earthwork

Because the elevation differences of the project grounds are not large, bulldozers and scrapers will be used for land leveling. Excavation for the construction of main buildings (main building, cooling water tower, stacks) will use large excavation techniques with backhoes and manual bottom cleaning. The excavated earth is to be piled in the transformer station area temporarily. Extra earth can be used as fill for leveling in the plant area.

2.5.4.2 Concrete construction of main buildings (foundations) ± 0 m elevation

Large area construction methods will be used in the main building area of the two units. Pump trucks for concrete handling will be used. In some areas in which pump trucks can not get in, trestle or pipe construction methods would be used.

2.5.4.3 Lifting of steel structure above ±0 m of main building

Lifting for coal bunker and deaerator is to be completed with the method of primer comprehensive lifting combined with the method of backwards lifting with moving type caterpillar crane. Large sized equipment of various floors is to be lifted on at the same time as civil engineering construction.

2.5.4.4 Stacks

The stacks (240m) will be reinforced concrete structures built with reverse molds.

2.5.4.5 Cooling water tower

The body of the cooling water tower is to be built with reverse mold Vertical conveyance will use a folded arm crane, provided with curved construction man lift.

2.5.6 Social activities during construction

With respect to social arrangements during construction, a worker's union organization will be established for each contractor. Worker programs would be formulated by the unions to organize construction staff member participation in entertainment activities and sports during holidays or after work. These would include library, sport activities, TV or video, cinema and recreational performances.

Chapter 3 Environmental baseline of plant area

3.1 Natural environment

3.1.1 Geological land form

Plant area is located in the southeast part of Qiantao Plain, Inner Mongolia. It lies in the intersection of the alluvial plain of Yellow River, Daheihe River and flood alluvial plain at the base of the Zhungeer Hills.

The elevation of the plant site is from 1063 to 1067 msl. It is highest in the southeast and lowest in northwest. The slope is 0.5%. The terrain of the plant site is broad and flat and belongs to the Motechuan plain land form.

The plant site and ash disposal area lie on the Arduous mass and TuoKeTuo Lake deposit platform of Huhe over fault depression slope. The basic earthquake intensity is 7th degree.

3.1.2 Climate

The plant area is in the continental semidry monsoon climate area, with prevailing westerlies. South winds prevails in summer, west winds prevail in the other seasons. Owing to the control exerted by the Mongolian high pressure, winters are severely cold and long. Under the control of subtropical high pressure of the Pacific, the summer is hot and short. The climate is arid, with average annual rainfall of 395.2 mm. Evaporation rate is 154.4 mm. The average temperature ranges from -12.4 °C in January to 22.9 °C in July, (see Table 3.1-1).

A meteorological station was established in the end of the 1950's and is 18 km from the power plant site. Its geographic coordinates are east longitude 111° 11', north latitude 40° 16'. The ground elevation is 1016 msl.

Meteorological information used here is from historical statistics from 1959 to 1990 compiled by the meteorological station of TuoKeTuo County.

See Figure 3.1-1 for a wind rose map of TuoKeTuo meteorological station.

See Table 3.1-1 for month by month meteorological data from TuoKeTuo meteorological station.

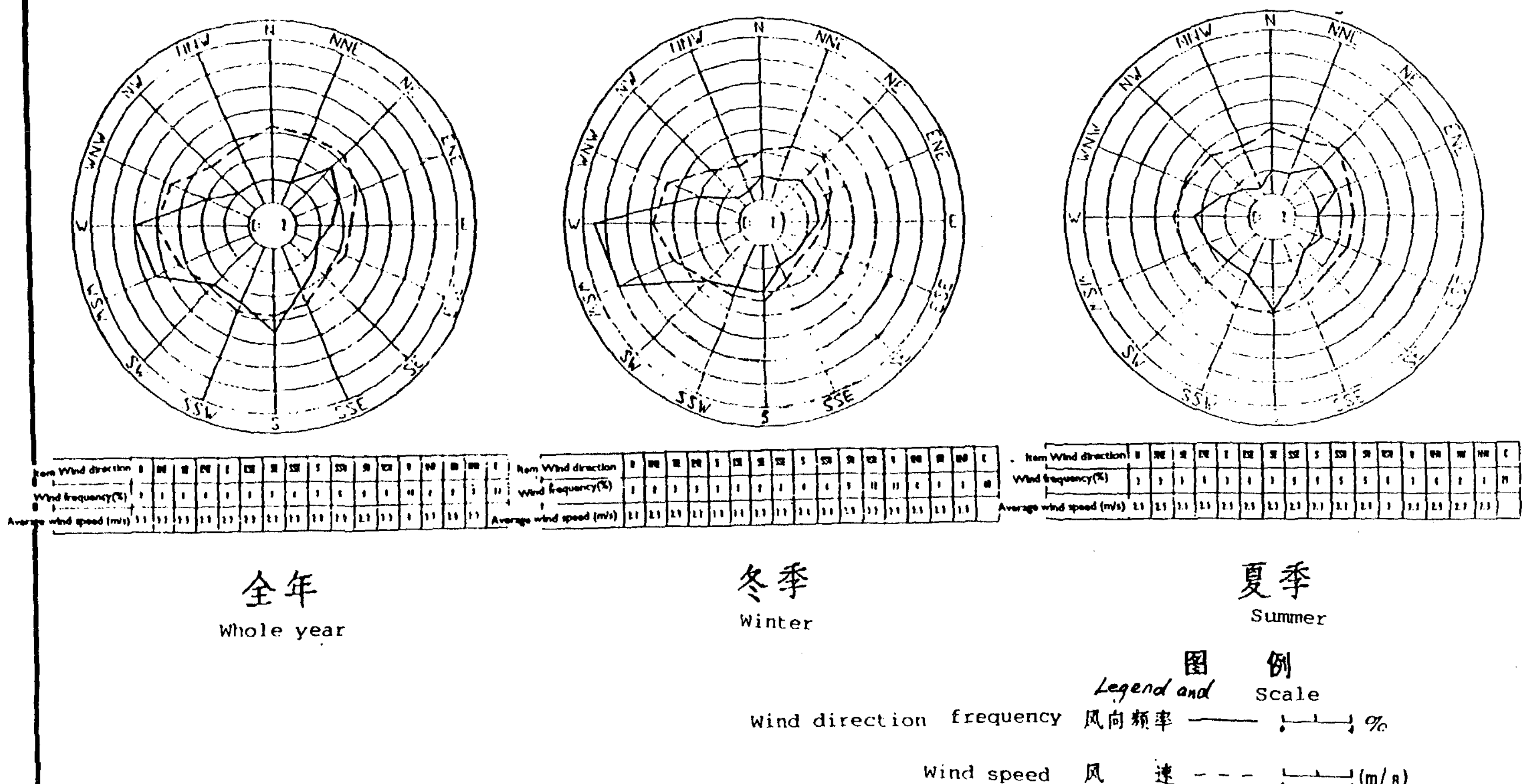


Fig.3.1-1 Rose map of over year average wind direction of Tuoketuo meteorological station.

图 3.1-1 托县气象站累年平均风象玫瑰图

Table 3.1-1

Monthly Meteorological data from TuoKeTuo Meteorological Station

S/N	Item	Unit	Duration	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug. /	Sep.	Oct.	Nov.	Dec.	Annual average
1	Average temperature over years M by M	jæ	1960~1990	-12.4	-8.1	0.3	9.2	16.5	21.1	22.9	20.9	15.0	7.8	-1.7	-10.2	6.8
2	Average pressure over years M by M	Hpa	"	906.3	904.4	901.7	898.5	895.9	893.4	892.0	895.3	900.3	904.6	906.7	906.9	900.5
3	Average relative humidity over years M by M	59 %			55	47	41	40	47	60	67	62	59	58	60	54.6
4	Average wind speed over years M by M	m/s	"	2.0	2.2	2.7	3.3	3.2	2.8	2.2	1.9	1.9	2.0	2.3	2.1	2.4
5	Average precipitation over years M by M	mm	"	2.6	50.1	8.8	18	23.8	37.7	84.6	83.9	46.8	21.4	5.6	1.9	395.2
6	Daily max. precipitation over years M by M	mm	"	6.0	21.8	13.8	25.2	27.7	54.5	75.2	146.4	79.8	30.1	16.3	5.2	-
7	Average evaporation over years M by M	mm	1966~1990	27.7	44	112.1	225.9	317.6	308.1	260.7	201.8	156.8	116.9	54	27.6	154.4

3.1.3 Hydrological characteristics

3.1.3.1 Surface water

TuoKeTuo County is located in the Yellow River Basin. Except for the Yellow river, the other rivers are seasonal. Flow volume of the river is relatively high in the rainy season.

(1) Yellow River: flows into TuoKeTuo County at Shisifen Village, coming out at Dashiyao to Qingshuihe County. The total length in the county is 37.5 km. Annual average flow is $1500m^3/s$.

(2) Dahehe river: converged into being by the rivers in the northeast of Huhehot City, coming into TuoKeTuo County at Dongwan Village and flows into the Yellow River at Xialahu beach. The total length within the county is 42 km. Annual runoff volume is about $5000m^3$.

(3) Shilawushuhe River: originated from Bijia Mountain in the northeast of Huhehot City, coming into TuoKeTuo County at Nanzhe and flows into the Heihe River at Dakoko Village. The total length within the county is 27 km. Annual average flow is about 30 m^3/s.

(4) Yinhaohe River: originated from the territory of Hilingeer county, coming into TuoKeTuo County at Youfanying village, and flows into Shilalwushuhe River at Dongdageda. The total length in the county is 30 km.

(5) Sahe River: originated in Qingshuihe County, gets into TuoKeTuo County at Sagozi village, coming into Shilawushuhe River at Dongdageda. The total length in the county is 25 km. Annual average flow is $0.5m^3/s$.

(6) Baobeihe River: jointed into being by the rivers in the Helingeer County, gets into TuoKeTuo County at Heishatu and flows into Shilawushuhe River at Xidageda. The total length in the county is 10 km.

See Figure 3.1-2 River distribution map in TuoKeTuo County, for the routes of various rivers in the county.

3.1.3.2. Hydrological characteristics of the Yellow River

Water supplies for this project will be taken from the Yellow River. The Yellow River flows into TuoKeTuo County at Shisifen Village and flows out at Dashiyao into Qingshuihe County. Its total length in the county is 37.5 km. According to the data provided by Toudaoguai Hydrological Station (17 km upstream of Putangguai Water

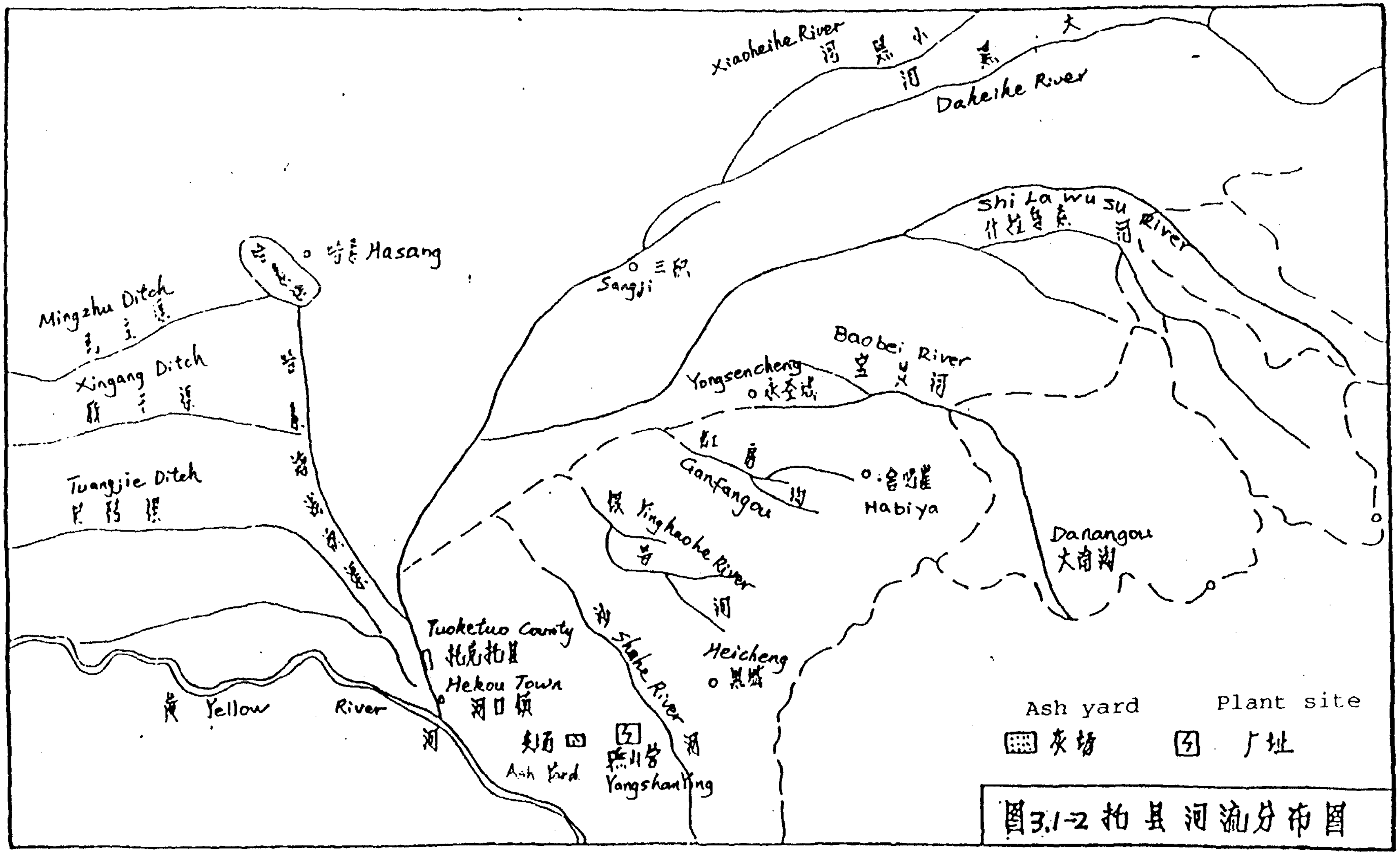


Fig.3.1-2 River distribution map in Tuoketuo County

Intake), the average annual flow rate of the Yellow River is 221.8 x $10^8 m^3$, maximum flow rate is 345.9 x 10^8 m^3 (measured in 1976), minimum flow rate is 117.6 x 10^8 m^3 (measured in 1987), based on actual multiyear measurements.

See Table 3.1-2 for monthly, annual average flow rates measured at Toudaoguai Hydrological Station.

Table 3.1-2.

Monthly, annually average flow rate measured at Toudaoguai Hydrological Station

Average monthly flow rate (m^3/s)												Annual flow rate($10^8 m^3$)
Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	
481	547	720	669	305	401	844	1180	1250	1010	576	436	221.8

3.1.3.3 Silt loading in the Yellow River

The Yellow River carries a heavy silt load. Silt data for the Yellow River has been obtained from the Yellow River Toudaoguai Hydrological Station.

(1) Silt loading: annual average suspended silt load discharge is 9.963 x 10^7 tons at the Yellow River Toudaoguai from 1969 to 1990, and the multiyear average silt content is 4.35 kg/m^3. The calculated silt bed load discharge volume is 3.2 x 10^5 tons based on the formula established according to bed load data measured at the Yellow River Toudaoguai Hydrological Station from 1962 to 1966, total silt discharge volume is 1 x 10^8 tons, in which the flood season accounts for 77.5%.

During the past 22 years (1969 to 1990), the day of maximum silt content was on July, 30 1978 with 5.4 kg/m^3; the day with minimum measured silt content was on July 25, 1970 with 0.054 kg/m^3 (minimum silt content measurements occurred during freezing conditions most years).

(2) Silt particles: the diameter of average calculated suspension load silt particles is 0.0389 mm according to measured data from 1971 to 1985, d_{50} is 0.025 mm. Silt deposits are powder fine silt.

3.1.3.4 Ground water

According to the report on ground water resources issued by the Hydraulics Bureau of TuoKeTuo County, east of the plant site Yangshangying and Majiagedu village are located in an agricultural irrigation area with well depths of 100--150 m and good quality water. Ground water meets specified national potable water standards. The production volume for one well has been measured at 50 m^3/h.

According to plant geological survey data, ground water within the plant area is phreatic water at 1.50--6.50 m depth with fairly high mineralization.

3.2 Ecological environment

3.2.1 Current residential districts

Township residents live mainly in TuoKeTuo countytown and Chengguuan town (just outside the countytown). Agricultural workers reside in 11 townships within the county area.

3.2.2 Endangered Species

There are no endangered species in assessed area (see letter from Inner Mongolia Environmental Protection Agency, Annex 3).

3.2.3 Bio-diversity

3.2.3.1 Flora

The assessed area belongs to Europe-Asia Prairie Plant Area, Loess Plateau Prairie Plant Province, Yinnan Loess Hilly Prefecture. Owing to the geographic location and ecological conditions as well as long term farming and other effects, the botanical species diversity in this area is poor. According to the preliminary investigation and statistics, there are 248 species of seed plants in which the bean family enjoys a dominance.

3.2.3.2 Wildlife

Wildlife found in the assessed area belong to the Loess Plateau subarea of North China. According to the EIA investigation, there are more than 50 kinds of wildlife of 16 orders and 24 families, in which mammals represent 4 orders, 7 families and 13 species; birds 9 orders, 15 families and 25 species; reptiles have one order, 2 families and 5 species; amphibians have one order, 2 families and 4 species; fish have 1 orders, 1 family and 4 species. Species listings can be found in Annex 4.

Fish form the majority of aquatic animals within the boundary of TuoKeTuo County.

Curcian carp and Carp are the major economic fish species in the Yellow River according to the Fishery Division of TuoKeTuo County; but with low production. The largest fishery is of curcian carp, carp and silver carp farmed in pits and pools in the villages in Zhongtan Township, Chengguan Town, and Yanshanying Township.

3.2.4 Soil

3.2.4.1 Soil distribution

Soils in the southeast to northwest and western hilly areas are greyish brown and dark brown. Soils in the pluvial platform are meadow categories, and windblown sandy soil category. The soil in the assessed area is classified in six categories, eleven subcategories, twenty-seven genera, and seventy-nine species.

See Table 3.2-1 for statistics on the number of categories of soil in the assessed area.

Table 3.2-1

Classification of soil types in the assessed area

Category	Subcategory	Genera	Species
Greyish brown soil	1	2	2
Dark brown soil	1	3	10
Meadow soil	3	14	52
Saline soil	2	4	11
Marsh soil	1	1	1
Wind sandy soil	3	3	3
Total	11	27	79

3.2.4.2 Soil status

(1) Soil at the site of Touketuo Plant A and surround the planned ash disposal area is poor with low fertility. Total nitrogen (N) content of the soil in all sampled areas is of the poorest level (level VI) according to specified standards of the national soil survey, which shows N content in the soil in the area of fairly poor status. Average organic matter, and quick-acting potassium (K) content in the soil of 80% of the sampled area belongs to the poorest level (level VI) and the remaining 20% belongs to the inferior poor level (level V), which has fairly poor organic matter and quick-acting potassium (K) content. Quick-acting phosphorous (P) content in the soil is relatively rich: P content in 40% of the soil samples belongs to the inferior poor level (level V); while the remaining 60% belongs to a bit poorer than average (level IV). The above data show that due to low levels of organic matter, nitrogen and potassium, the soil is of fairly poor quality for agricultural and livestock production.

(2) A large portion of the area surrounding Touketuo Plant A is irrigated land and floodplain land irrigated by taking water from the Yellow River. As a result of high ground water levels in the area and long-term irrigation, the soil hardens with a high salt content, poor physical and chemical characteristics, and widespread salinization. This is a disadvantage for development of agricultural production.

(3) More than 60% of the farmland surrounding Touketuo Plant A is sandy, dry, hilly land except for the irrigated areas. Low annual rainfall, high evaporation and heavy seepage in the sandy soils results in dry farmland poor in both fertility and moisture. The fragile ecological environment for agricultural and livestock production depends on natural meteorological conditions, resulting in unstable and low unit production. For instance, in early June, 1994, the group undertaking this field sampling operation visited the North China site during the season of high temperatures and little rainfall. Several successive months of drought and high evaporation rates in the sandy soils prevented sowing seed in almost all dry farmland in the area, especially in the hilly areas, resulting in the risk of laying waste to the plowed farmland.

(4) Sand soils or sandy soils cover more than 90% of the Touketuo Plant A site. Heavy winds and excessive sand result in wind erosion and desertification. More than 60% of the area is subject to heavy and extremely heavy wind erosion and desertification according to calculations made of the sampled areas. Wind erosion and desertification affects farmland and forest, degrading the ecological environment impacting development of agricultural and livestock production critically. For example, one sample spot, Mahuantan, was originally sand sandwiched light soil with relatively good soil structure, suitable for agricultural production. The higher terrain in the southeast of the village slowed wind speed and power, causing sand to build up in this area. This resulted in loss of the original forest, grass land and formed fixed or semi-fixed dunes critically eroded by wind and sand.

3.2.4.3 Forest land in assessed area

The greater portion of forest is scattered with poor growth. The area is difficult to afforest. Drought stunts young growth.

The greater part of forest in the assessed area is growth under 20 years old and of a single species. The main vegetation on the sandy land is scattered forest of willow green in summer. Natural grasslands no longer have the natural vegetation community structure. The lowest productivity and highest exploitation is found on field borders, steep slopes and low land in various stages of salinization. Vegetation coverage is under 15%.

Agricultural by-products, grassland and forage from forest areas are the main feed sources in the area. Plant diseases and insect pests of livestock, crops, vegetables, fruit trees and forest have done no serious harm on a large scale in the area.

3.2.4.4 Land use

TuoKeTuo is an agricultural county. Refer to Table 3.2-2 for land use.

Table 3.2-2

Land Use

Designation		Area(km2)	Coverage in assessed area (%)
Cultivated area	Irrigated land	171.89	19.70
	Dry land	212.95	23.66
Garden plot	Orchard	1.00	0.11
Forest	Scattered forest	244.16	27.13
	Bush land	14.45	1.60
Grass land		108.82	12.08
Residential land		24.30	2.70
Traffic land	Road	6.40	0.72
Waters	River	11.17	1.24
	Pit & pool	1.61	0.18
Hard to use land	Bare sand	41.76	4.64
	Waste land	23.47	2.61
	Gully	38.04	4.23
Total		900	100

The above figures show that cultivated land for agricultural purposes accounts 42.76 % of the total area; but because of low fertility and poor meteorological conditions in the area, 60 % of the cultivated lands are impacted by drought, infertility, poor irrigation and excessive cultivation. Grain yield is well below the national average

3.2.5 Analysis of ecological environment

The assessed area is typical of an artificial ecological system with a long and history of cultivation and exploitation. The fragile artificial ecosystem resulted arid meteorological conditions and extensive cultivation by humans.

Wildlife species are not rich in the assessed area. There are 50 families, 164 categories, and 248 species of wild animals, in which 24 orders, 43 families and more than 90 species are common wild animals. There are no animal or plant species near extinction or in need special protection in the assessed area.

The Yellow River and groundwater resources are used for irrigation supply. Soil hardened or salinized in a large portion of the area results from high levels of ground water in the area. This is especially true in the eastern portion of the assessed area, due to long term irrigation and heavy evaporation. Dry land dominates in the hilly areas, but poor cultivation technique resulting in wastelands is common. Agricultural activity depending on natural meteorological conditions, drought and land infertility are the main causes of low agricultural productivity.

Land desertification prominently reflects the weakness of the ecological environment. Wind erosion of soils and desertification ratios in the assessed area reaches 100 % of the farmland. Sand accounts 31 % of the total area, in which fixed sand accounts 5.54 %, semi-fixed sand accounts 20.02 % and moving sand accounts 5.4 % (Kubuqi sand belt accounts 4.64%). Degleyed meadow, dark brown soil, and windblown sandy soil are the main soil categories in the assessed area. Soil are characterized by high sand content, infertility, and an average organic matter content of 0.26--1.15 %. The poor soil classifications of levels V and VI are predominant, and are short of potassium and nitrogen. The trace elements fluorine F, arsenic As, cadmium Cd, and lead Pb are within the common national and worldwide ranges.

In summary the area where Touketuo Plant A located is infertile, and has progressive salinization, heavy wind erosion and desertification and low productivity. Extensive agricultural cultivation, poor production means and monocropping result in low and unstable agricultural incomes. The area is impoverished and backward.

The Inner Mongolia Environmental Protection Agency (IMEPA) has stated that there are no protected areas within TuoKeTuo County (see letter from TuoKeTuo County City and Town construction and Environmental Protection Bureau, Annex 1).

3.3 Social environment

3.3.1 Zoning and population distribution

The proposed project site lies in a rural area. The total population of the county is 177,021 (according to the 1992's information of the Statistic Bureau of TuoKeTuo County), in which the agricultural population is 154,125. The agricultural population accounts for 87.1 % of the total population. The population is composed of 20 nationalities of Han, Mongolia, Man, Hui, Zhang, Miao, Korean, Tu, Dahaner, Zhuang, etc.

3.3.2 Industries, agriculture, husbandry and forestry

TuoKeTuo County is an agriculture county. There is no large scale industrial enterprise. There are only 12 local state-owned industrial enterprises. The main industrial products are water pumps for agricultural purposes, galvanized lead wire, alcoholic beverages, carpets for export, and raw salt.

The main grain crops are wheat, corn, millet, sorghum, oats, and fennel. Total grain production of the county in 1992 was 88.39 million Jin.

Husbandry is not well developed, the annual average increase rate is 3.9 % since 1949. In 1992, there were 141,433 head of large and small livestock. Forestry is a priority for development in TuoKeTuo County. Artificial foresting began in 1959, and 4774 mu of forests were established in that year. By 1990, 458 thousand mu had been developed. The area of artificial forests per person is 2.5 mu.

3.3.3 Infrastructure

TuoKeTuo County has 338 km of roads of which 45 km is the Huhehot-Zhungeer coal field grade II, 77 km is the Huhehot-Lamawan of grade III, 41 km is the Shalaqi-Liancheng road and 58 km is the TuoKeTuo-Cashuqi road. Various roads connect 120 administrational villages and towns of the county.

Until 1992, there were 24 automobiles for passenger transportation and 300 trucks for goods transportation in the whole county. There are 10 post offices and post Bureaus, 945 telephones, 404 km of pole lines for telephone, and 657 km urban and rural delivery routes. 5000 sets of program controlled telephone buildings have been built in a short time.

3.3.3.1. West Inner Mongolia regional power sector development plan

The table below lists the power generation projects planned for Inner Mongolia, from 1995 to 2002. The distances of each from the TuoKeTuo A project are shown in Table 3.3.3.1 below. The nearest power station to TuoKeTuo A is Hohehot, located 70 km to the north.

Table 3.3.3.1
Power Generation Development Plans, 1995 to 2002

	West Inner-Mongolia	780	660	530	400	530	630	1500	1200
1	Haibowan			200	200		300	300	
2	Daihai							600	600
3	Dalate	330	660	330		330	330		
4	Huhhot	50			200	200			
5	Fengzhen	400							
6	Tuoketuo A							600	600

3.3.4 District planning

3.3.4.1 Chengguan town is the seat of Touketuo county government. Touketuo county is divided into Dongcheng district and Xicheng district. Xicheng district is the main area of the town. Dongcheng district is a new area that has been developing in recent years. The buildings in Dongcheng district are few and scattered at present. Dongcheng district will be a priority for future development.

The functional zones of the planned Tuoketuo Town are an industrial zone lying in the east part of the town, separated from residential and cultural zones by roads and a greenbelt. The zone plan is a checkered layout of roads by longitude and latitude Drainage will be unified to change the current situation. Drainage will be delivered to the river in the north side of Doufuyaozi with unified piping.

TuoKeTuo Town has a population of approximately 30,000. The population development scale of the planned zone is 100 thousand, including staff of the TuoKeTuo Power Plant

3.3.4.2 Development plans for industry, agriculture, forestry and animal husbandry

The industrial development plan includes the following subjects. structural adjustment, potentialities tapping, financial concentration, guarantee key project, joint-venture and cooperation, accumulation inside and contacting outwards, speeding up development, increasing profit, basing on energy transforming industry, effectively developing in rural enterprises, processing business on the source from outside, industries of outwards business and supported projects of big industry.

The agricultural development plan includes the following: taking water conservancy construction as emphasis, supporting the construction of water pump stations and water intake project from the Yellow River to Huhehot City to improve the agricultural production condition and to change the situation of dependence on nature thoroughly; insisting on the program of "Combining agriculture, husbandry, forestry, and fishing, realizing agricultural comprehensive development"; to develop ecological agriculture; to realize the transformation of agriculture from traditional mixed agriculture to comprehensive, marketing and modernized agriculture.

The forestry development plan includes: wind erosion and prevention of desertification, water and soil erosion, construction of shelter forest for farm land, carrying out the second phase project of "San Bei" (North, Northeast and Northwest China) shelter forest overall construction plan and "Greening Project" of TuoKeTuo County, combined with overall plan of "shan bei" shelter forest system.

3.3.5 Mineral resources

There are no important mineral resources in the TuoKeTuo area. The common mineral products are only salt, alkali and mirabilite (Na_2SO_3 used in paper making). None of these are important, and export production volume is small.

3.3.6 Tourism resources

There are no important tourism resources in the TuoKeTuo area.

3.4 Quality of life

3.4.1 Public health

TuoKeTuo County has 24 places of hospitals, sanitation and clinic stations, health center for women and children, hospital of traditional Chinese medicine, commune hospital of various towns and villages and centralized hospitals, 435 medical staff and 215 beds.

3.4.2 Recreational facilities

There are 43 cinemas, art galleries, cultural stations, libraries, broadcasting stations, TV relay stations, satellite receiver stations in TuoKeTuo. The library has a collection of 41,000 books, and 56,000 visits are made per year. Library houses, and projectionist (film) teams have been popularized in countryside, helping to enrich people's cultural life in rural and urban areas.

3.4.3 Standard of living

Total salaries in 1992 of the employees of the enterprises owned by the state was 14.375 million yuan; the annual average salary per person was 1664 Yuan. The annual income per person in the countryside is 583 Yuan. The national average annual income in 1995 was 1820 yuan. Income per person in the countryside increased by 10.7 % per year since the reform and opening of our country.

In the countryside, calculated on population, grain allotment per person was 287 Jin (1 Jin = 0.5 kg) in 1949 and 548 in 1992, increasing by 1.5 % per year on average.

There are 116 primary schools, 32 high schools. There are about 10 thousand students and 837 teachers and staff in these schools. There have been about 4,000 students sent to professional schools, colleges and universities.

3.5 Cultural and historic landmarks

3.5.1 Cultural landmarks

TuoKeTuo Town is in the outskirts far away from Huhehot City. The Inner Mongolia Autonomous Region consists of any nationalities, with the Han nationality accounting for 97.4 % and the Mongolian nationality 2.1 %, the remaining nationalities only account for 0.5 %. Therefore, the culture of the Han nationality dominates cultural landmarks and folk customs.

There will be no impact on the historic heritage during construction of Tuoketuo Plant A.

3.5.2 Historic and archaeological sites

There are no archaeological, historic and religious relics and sites, architectures or ruins with aesthetic value recognized by the national or autonomous region as key for protection. The nearest cultural landmarks are Dazhao Temple & Wutasi Temple and the Tomb of Zhao Jun in Hohehot. A letter concerning cultural and historic landmarks from the TuoKeTuo Government can be found in Annex

3.6 Environmental quality status

3.6.1 Ambient air in assessed areas

3.6.1.1 Investigation of air pollution sources

(1) Coal resources of TuoKeTuo County

Most of the coal for industrial enterprises in the county town is supplied by the Fuel Company of TuoKeTuo County. Some enterprises transport the coal themselves. All of the coal comes from Zhungeer coal field.

(2) Fuel structure

See Table 3.6-1 and 3.6-2 for fuel structure and coal consumption and distribution conditions. From this list, we can see that coal is the major fuel consumed in the TuoKeTuo area. Annual total coal consumption is 152,229 tons (equal to 112,649 tons of standard coal). Coal consumption accounts for 98.4 % of all fuel consumption in a year. Rural enterprises enjoy the maximum proportion of the coal distribution with annual coal consumption rates of 65,130 tons, taking 42.18 % of the coal consumption of the whole county.

Table 3.6-1

Fuel structure of the county

Fuel name	Coal	Coke	Diesel	Gasoline
Annual consumption(t)	152229	318	331	750
Equivalent to standard coal(t)	112649	308	477	1095
Structural ratio(%)	98.4	0.27	0.42	0.97

Table 3.6-2

Coal consumption and distribution in the county

S/N	Classification	Coal consumption(t/a)	Coal distribution(%)
1	County town	49110	32.26
2	Rural enterprises	65130	42.78
3	Residents of countryside	37989	24.96
	Total	152229	100

(3) Coal usage in the assessed area is shown in Table 3.6-3.

Table 3.6-3

Table of coal usage

	County urban area				Countryside	
	Industry	Institution	Commercial network and places	Residents	Rural enterprises	Residents
Annual coal Consumption(t)	23539	8137	493	16936	57946	23145
Subtotal(t)	49110				81091	
Total(t)	130201					

(4) Air pollutant emissions

The principal big coal burning units in the assessed area are the five industrial enterprises and more than ten brick factories near the plant site. See Tables 3.6-4 and Table 3.6-5 for their coal consumption and pollutant emissions.

Table 3.6-4

Air pollutant emissions of large volume coal consumers in TuoKeTuo County town

Name of user	Place	Product and production capacity(t/a)	Nature of enterprise	Boiler conditions			Coal consumption (t/a)	ESP conditions			Pollutant emissions (t/a)		Height of stacks (m)
				Type	Qty.	Utilizing condition		Type	Qty.	Efficiency	Flue gas and dust	Sulfur dioxide	
TuoKeTuo Winery	Xinjian Road	Spirit and fruit wine 6050	Owned by state	KZL4-125AIII	2	All in use	6043	XZD-4	2	80%	317.86	43.51	20
TuoKeTuo Jinhe Forage Additive Factory	47km Tuoxin Road	Additive 1100	Rural enterprise	DZL4-125AIII SZL240-70/95	3 1	All in use	6000	XZD-4	4	80%	316.05	43.20	15
TuoKeTuo Alcohol Plant	Tuoxin Road	Alcohol 5000	Owned by state	DZL4-125AIII	3	2 in use and 1 spare	5228	XZD-4	3	80%	275.00	37.64	20
TuoKeTuo Paper MIll		Packing carton 4500	Owned by state		1	In use	4800	---	--		252.84	34.56	
TuoKeTuo Agricultural machinery Plant	Xinjian Road	Series G pump 30 thousand pieces/year	Owned by state	KZGII-2	3	2 in use 1 spare	790	XZD-2	3	80%	41.55	5.69	
Total	--	--	--	--	--	--	22861	--	--	--	1203.3	164.60	--

Table 3.6-5

Air pollutant emissions of large volume coal consumers in the assessed area

S/N	Name of user	Place	Product	Q'ty of brickline	Annual coal consumption(t)	Precipitation efficiency	Flue gas exhaust (t/a)	SO2 exhausted
(t/a)								
1	Zhongtan Brick Plant	Zhongtan	Machine made brick	13	33410	0	1759.70	240.55
2	Chenguan Brick Plant	County town	Machine made brick	1	1760	0	92.70	12.67
3	Wushijia Brick Plant	Wushijia	Machine made brick	2	5140	0	270.72	37.01
4	Yanshanyi ng Brick Plant	Yanshany -ing Village	Machine made brick	1	2570	0	135.36	18.50
5	Heicheng Village Brick Plant	Heicheng Village	Machine made brick	1	2570	0	135.36	1′
6	Wushen Village Brick Plant	Wushen Village	Machine made brick	1	2570	0	135.36	18.50
Total		--	--		48020	---	2529.20	345.73

(5) Result of pollution source investigation

Coal is the major fuel in TuoKeTuo administrative area. Annual coal consumption is 152,229 tons. Annual coal consumption of the assessed area is 130,201 tons, taking 85.5 % of the annual water consumption of the whole county.

There are more than 20 big coal users (including 5 users in town) in the assessed area. Their coal consumption rates are 70,881 tons, and annual flue gas and dust emissions are 3732.5 tons with 510.33 tons of annual sulfur dioxide.

Among the five big units in the county town, boilers of four enterprises are in good condition with precipitators in normal operation; the exception is TuoKeTuo Paper Plant.

Although more than ten prickline have no precipitation measures, they can not cause atmospheric environmental problems currently because their locations are widely distributed.

3.6.1.2 Ambient air quality

In 1992, the Inner Mongolia Environment Science & Research Institute and Huhehot Environment Protection Science & Research Institute carried out seven (7) days of monitoring quarterly for ambient air quality in two seasons (non heating season and heating season) respectively in March 28 - April 4 and in August 23 - 30. The monitoring parameters were total suspended particles (TSP), sulfur dioxide (SO_2), Nitrogen oxide (NOx) and Fluorine. Monitoring points included 8 points in the countryside, town, county town and around the plant site. See Figure 3.6-1 for the monitoring point locations. See Table 3.6-6--Table 3.6-9 for monitoring results.

The methods for atmospheric environmental quality for individual pollutant index were used for the assessment:

$$I_i = C_i / S_i$$

Where: Ci-- Actual measured concentration for pollutant i

Si--Assessment standard for pollutant i

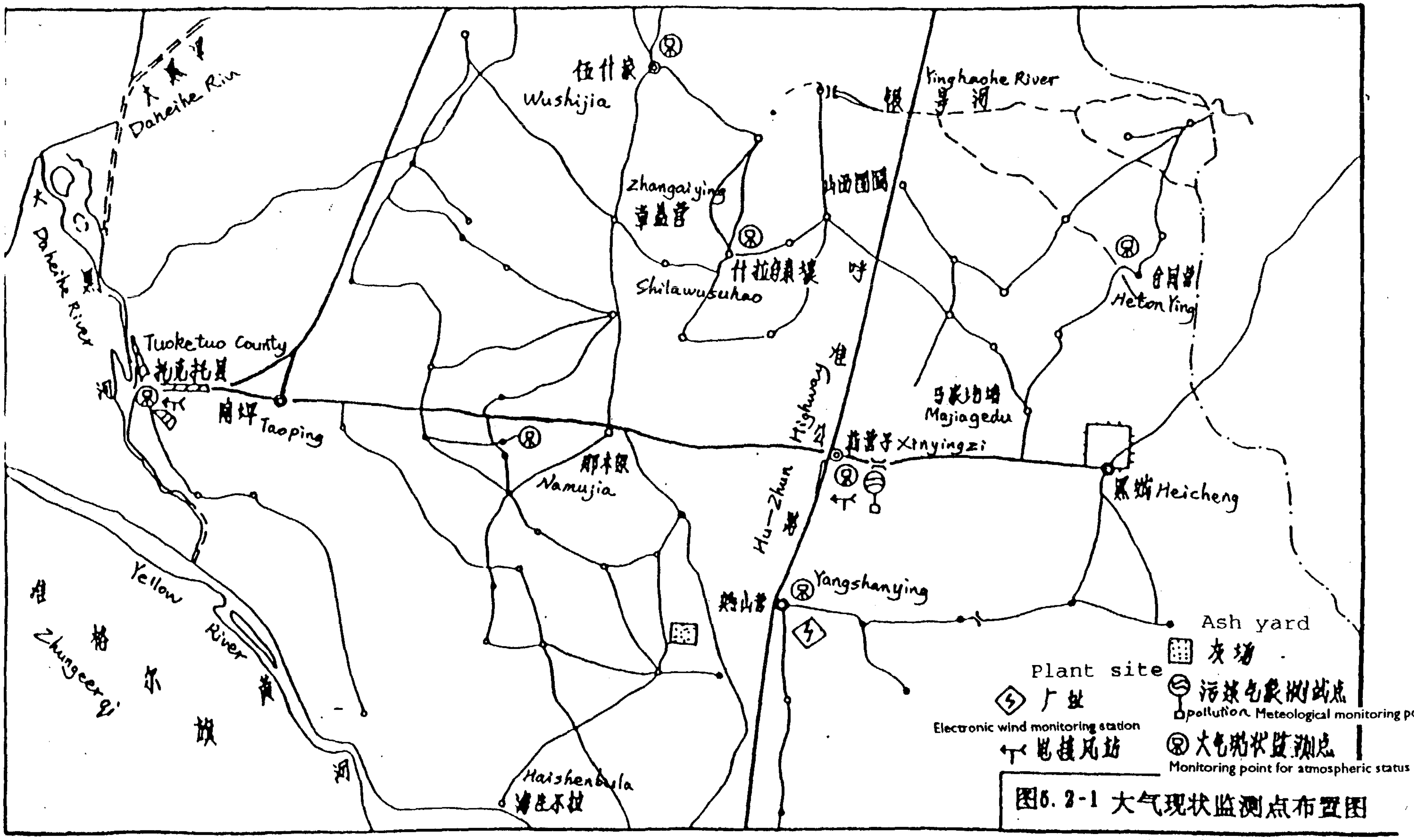


图5.2-1 大气现状监测点布置图

5.2-1 Monitoring points layout for atmospheric status

图 3.6-1 大气现状监测点布置图

Fig.3.6-1 Monitoring sites la for atmospheric status

Table 3.6-6

Monitoring results for sulfur dioxide (SO_2)

Units: mg/m^3

Time	Nonheating season (8.23-8.30.1992)			Heating season (3.28-4.4.1992)		
Monitoring points	Primary concentration range	Daily average concentration range	7-day average value	Primary concentration range	Daily average concentration range	7-day average value
TuoKeTuo county town	0.010-0.048	0.017-0.025	0.021	0.010-0.161	0.016-0.058	0.032
Xinyingzi	0.010-0.044	0.010-0.021	0.015	0.010-0.100	0.013-0.039	0.021
Namujia	0.010-0.051	0.010-0.020	0.012	0.010-0.115	0.010-0.041	0.013
Shilazhai	0.010-0.059	0.010-0.022	0.013	0.010-0.040	0.010-0.018	0.013
Zhanggaiying	0.010-0.063	0.010-0.023	0.015	0.010-0.025	0.010-0.016	0.012
Hetonying	0.010-0.020	0.010-0.017	0.012	---	---	---
Wushijia	0.010-0.089	0.010-0039	0.016	0.010-0.029	0.010-0.025	0.012
Yanshanying	0.010-0.020	0.010-0.012	0.010	0.010-0.050	0.0030-0.024	0.014
Grade II standard	0.50	0.15		0.50	0.15	

Table 3.6-7

Monitoring results for total suspended particulate (SPM)

Units: (mg/m^3)

Monitoring time	Nonheating period (8.23-8.30.92)			Heating period (3.23-4.4.92)				
	Primary concentration range	Daily average concentration range	7-day average value	Primary concentration		Daily average concentration		
Monitoring point				Concentration range	Standard exceeding rate	Concentration range	Standard exceeding rate	7-day average value
TuoKeTuo county town	0.002-0.046	0.016-0.019	0.018	0.030-0.843	0.0%	0.118-0.440	28.6%	0.275
Xinyingzi	0.003-0.041	0.006-0.027	0.017	0.117-0.580	0.0%	0.219-0.533	57.1%	0.337
Namujia	0.001-0.013	0.004-0.009	0.007	0.036-0.776	0.0%	0.123-0.467	28.6%	0.235
Shilahao	0.001-0.038	0.007-0.02	0.010	0.087-1.470	3.6%	0.116-0.751	57.1%	0.383
Zhanggaoying	0.001-0.097	0.004-0.054	0.020	0.028-0.301	0.0%	0.073-0.176	0.0%	0.108
Hetongying	0.001-0.030	0.003-0.016	0.008	—	—	—	—	—
Wushijia	0.002-0.036	0.006-0.018	0.010	0.029-1.035	3.6%	0.095-0.671	14.3%	0.320
Yanshanying	0.003-0.019	0.004-0.012	0.008	0.029-1.096	4.0%	0.037-0.484	14.3%	0.18
Grade II standard	1.00	0.30		1.00	—	0.30	—	0.3

Table 3.6-8

Monitoring results for Nitrogen oxides (NOx)

Units: mg/m^3

Time	Nonheating season(8.23.92-8.30.92)			Heating season (3.28-4.4.92)		
Monitoring point	Primary concentration range	Daily average concentration range	7-day average value	Primary concentration	Daily average concentration range	7-day average value
TuoKeTuo county town	0.018-0.078	0.032-0.053	0.037	0.006-0.073	0.016-0.073	0.025
Xinyingzi	0.013-0.095	0.022-0.066	0.033	0.006-0.032	0.016-0.027	0.019
Namujia	0.006-0.041	0.010-0.031	0.016	0.006-0.104	0.007-0.034	0.015
Shilahao	0.006-0.027	0.008-0.024	0.014	0.006-0.057	0.009-0.024	0.014
Zhanggaiying	0.006-0.032	0.006-0.021	0.010	0.006-0.021	0.007-0.016	0.011
Hetongying	0.006-0.030	0.009-0.017	0.012	---	---	---
Wushijia	0.006-0.033	0.009-0.018	0.012	0.006-0.028	0.010-0.019	0.014
Yanshanying	0.006-0.118	0.008-0.064	0.029	0.006-0.043	0.009-0.021	0.012
Grade II standard	0.15	0.10		0.15	0 10	

Table 3.6-9

Monitoring results for fluorine compounds

(Units: mg/100 cm^2/day)

Name	TuoKeTuo county town	Xinyingzi	Namujiazi	Shilahao	Zhanggaiying	Wushijia	Yanshanying
Winter	0.206	0.630	0.184	0.640	0.488	0.344	0.376
Summer	Not been tested out						
Standard	2.0						

Both primary concentration and daily average concentrations of SO_2 are lower than national standard class II in the area in heating and non-heating seasons based on atmospheric environmental quality monitoring results in 1992. The primary concentration and daily average concentrations of SO_2 are also lower than national standard class I at all monitoring points except the point at Chengguan Town in TuoKeTuo county in both heating and non-heating seasons.

The primary concentration and daily average concentration of NOx are lower than national standard class II at each monitoring point in heating and non-heating seasons, and even lower than national standard class I at the majority of points.

The background values of SO_2 and NOx are quite low in this area, where the monitored values are far lower than national standards. Fluoride concentration in the air is far lower than the limit of local specification as well. Ambient air that has not been impacted by industrial pollution has a large capacity. The atmospheric environmental quality in the assessed area is relatively good.

Primary concentration and daily average concentrations of SPM meet the national class II standards at each monitoring point in the non-heating season. The primary concentration exceeds the limit with a ratio of 3.6--4.0 % at three monitoring points in the heating season. In the heating season the pollution index is 1.47 at the monitoring point of the highest concentration. The limit exceeding ratio of SPM daily average concentration is 14.3--57.1% at all monitoring points during 7 days monitoring in the heating season except at the Zhanggaiying Monitoring Point. The average of 7 days exceeds the limit slightly at three points, among which the concentration at Lashihao is the highest with a pollution index 1.28. The measured SPM in the township residential district is not higher than that in rural areas. This indicates the main cause of high SPM in TuoKeTuo county is not industrial pollution emissions, but meteorological conditions and desertification of bare sandy land.

According to the requirements for environmental assessments of the World Bank, Touketuo Plant A is undertaking an ambient air quality monitoring program for one year. A "BF-7000 Atmospheric Pollution Monitoring System" is being used. This equipment is manufactured by the Beijing Analysis Instrument Works under arrangements to introduce manufacturing technology in environmental monitoring instruments and systems from USA Monitor Labs, instrument manufacture technology from USA Daxibi Co. and Germany Mehac AG. The system automatically monitors SO_2, NOx, SPM, flying dust, etc. atmospheric quality parameters successively in the atmospheric environment, as well as temperature (T), relative humidity (RH), wind direction (WD), wind speed (WS), atmospheric pressure (P), and other meteorological parameters. The system is equipped with a special data processing system to acquire and process the monitored data in the system and control the system. The special data processing system controls calibration and other functions related to time automatically, and calculates average value, vector, sum and report average.

Two sets of BF-7000 Atmospheric Pollution Monitoring Systems procured for Touketuo Plant A have been installed at two automatic monitoring stations, one at the plant site and the other at the TuoKeTuo countytown to monitor parameters including SO_2, NOx, SPM, and fugitive dust. The monitoring data is included as an Annex to this report.

3.6.2 Surface water quality

3.6.2.1 Surface water pollution investigation

(1) Water resources of the assessed area

All the areas use ground water, except for the 6500 t/d tap water available for the county town,. Water in the shallow aquifer is used for drinking in most areas. The depth of wells in Xinyingzi Village is about 180 m.

(2) Investigation of big water users (for sewage discharge purposes) in the assessed area.

See Table 3.6-10 for the investigation of big water users (for sewage discharge purposes) in the assessed area.

Table 3.6-10

Investigation of large volume water users (for sewage discharge purposes)

S/N	Name of enterprise	Place	Product production capacity(t/a)	Nature of enterprise	Water consumption 10^4t	Waste water discharge point	Location of waste water discharge	Quantity of waste water discharge	Main pollutant	Method treated	treating efficiency
1	TuoKeTuo Paper Plant	Nanping Village	Packing cartons 4500	Owned by collective	52.5	The south wall of the plant	Nanlianghao	42.0	Volatile phenol sulfur compound SS pH COD BOD5	No	No
2	TuoKeTuo Alcohol Plant	Tuoxin Road	Alcohol 500	Owned by state	30.7	The north wall of the plant	Shuerliang	24.56	SS COD BOD5 volatile phenol sulfur compounds	Precipitation	Bad
3	Jinhe Forage additive Plant	Tuoxin Road	Additive 1100	Rural enterprise	24.7	The north wall of the plant	Shuerliang	19.76	SS COD BOD5	No	No
4	TuoKeTuo Winery	Xinjian Road	Spirit etc. 600	Owned by state	20.6	The north wall of the plant	Town	16.48	Volatile phenol sulfur compounds SS COD BOD5	No	No

3.6.2.2 Surface and groundwater quality

(1) Location of sampling points

a. Surface water sampling stations

Daheihe River: From Liujiayao to the mouth on the Yellow River, two sections

Yellow River: From Xiashalahutan above the Daheihe River mouth to Jianchi, in three sections downstream, which are respectively the Xialahutan section, Putanguai section and Jianchi section.

According to the Feasibility Report, the waste water of the power plant will be discharged to the Yellow River after being treated to meet effluent standards. An assessment of the water quality of the Yellow River is given below.

b. Groundwater

Potable water supplies are drawn from groundwater wells in the countryside near the Fengyan ash yard and Gaobaoshi ash yard sites; the specific monitoring points are as follows:

Fengyan ash yard: Fenyan, Maobula, Xiao, Haishengbula
Gaobaoshi ash yard: Xihao, Hougapu, Huangmatan, Huwulanying

See Figure 3.6-2 for the locations of the monitored river reaches and monitoring points for groundwater.

(2) Sampling periods

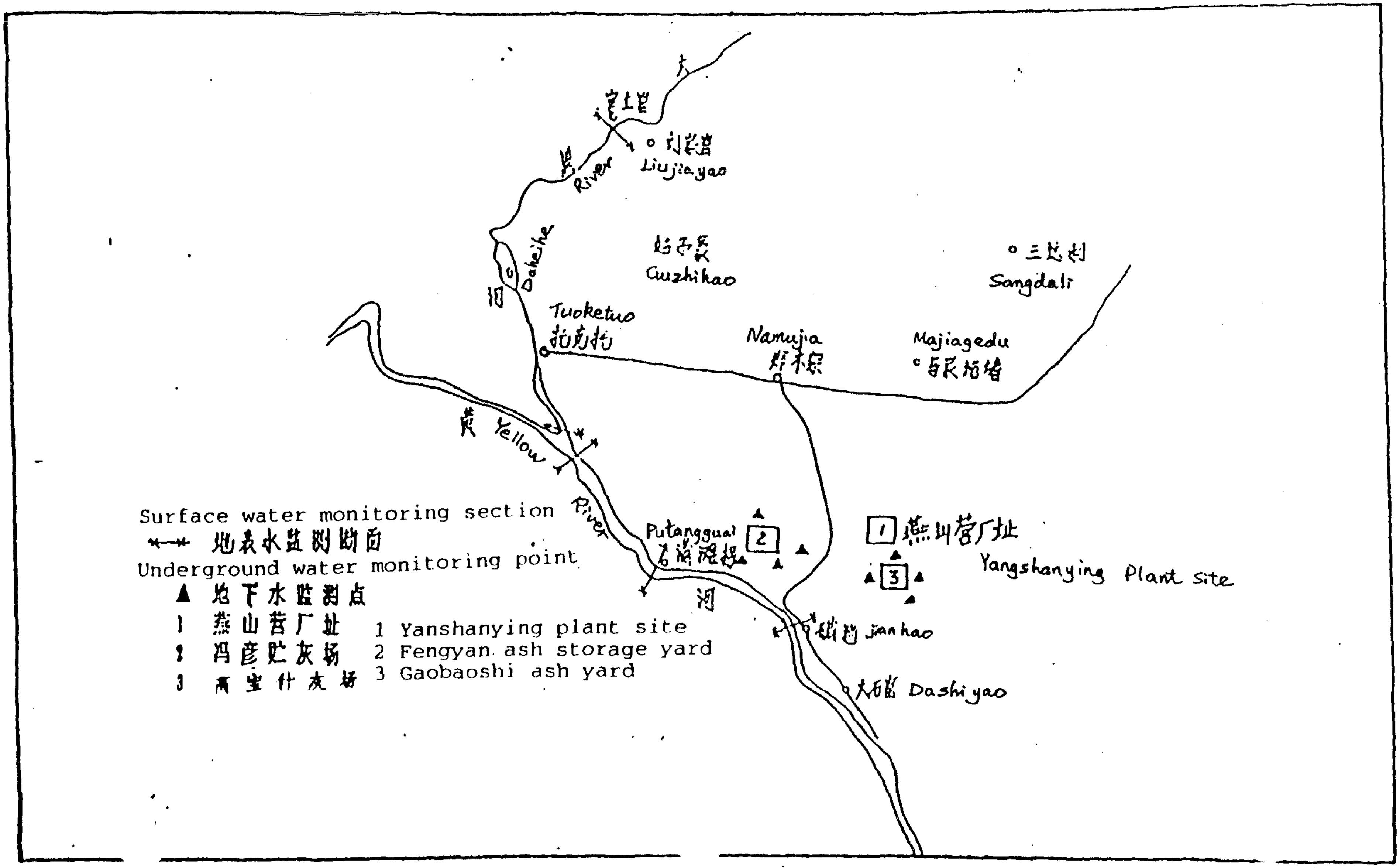
Sampling of surface water was undertaken in the rainy season in September, 1992, and in the dry season in May, 1992.

Sampling of groundwater at Fengyan ash yard was undertaken in the rainy season in September, 1993, and in the dry season in June 1993.

Sampling of groundwater at Gaobaoshi ash disposal area was undertaken in the rainy season in July 1994, and in the dry season of May 1994.

(3) Assessment method:

The data was analyzed using the following formula to assess compliance with surface water quality standards. The results are shown in Table 3.6-12.



Surface water monitoring section
地表水监测断面
Underground water monitoring point
地下水监测点
1 燕山营厂址
2 冯彦贮灰场
3 高宝什灰场
1 Yanshanying plant site
2 Fengyan ash storage yard
3 Gaobaoshi ash yard
River
Liujiayao
Dakeihe
Guzhihao
Sangdali
Tuoketuo
Namujia
Majiagedu
Yellow
River
Putangguai
1 燕山营厂址
Yangshanying Plant site
jian hao
Dashiyao

a. Standard index of single water quality parameter i on the j point

$S_{ij}= C_{ij}/C_{mi}$

b. Calculate standard index of dissolved oxygen with following formula:

$S_{DOj}=(DO_i-DO_j)/(DO_f-DO_s)$ (when $DO_j \geq DOs$)
$S_{DOj}=10-9xDO_j/DOs$ (when $DO_j<DOs$)

c.Calculate standard index of pH value with following formula:

$S_{PHj}=(7,0-PH_j)/(7.0-PH_{sd})$ (when $PH_j \leq 7.0$)
$S_{PHj}=(PH_j-7.0)/(PH_{su}-7.0)$ (when $PH_j>7.0$)

where:

Sij----Standard index of single item water quality parameter i on j point

Cij----Concentration of pollutant i on the monitoring point j, mg/l

Csi----Surface water quality standard of water quality parameter i, mg/l;

S_{Doj}---Standard index of single item water quality parameter DO on point j;

DO_j ---Concentration of water quality parameter DO on point j, mg/l

DO_f---Saturation concentration of dissolved oxygen ,mg/l

DO_s ---Standard index of single item water quality parameter, mg/l

S_{PHj} --- Standard index of single item water quality parameter pH value on the j point

PH_j ---PH value on j point;

PH_{sd} ---pH low limit specified in surface water quality standard;

PH_{su}--- PH high limit specified in surface water quality standard;

(4) Assessment of surface water environmental status

Surface water temperature, pH value, total suspended solids, dissolved oxygen, COD, BOD, petroleum, cadmium, hexavalent chrome and lead, etc. are shown below in Table 3.6-11.

Table 3.6-11

Surface water monitoring results

Sampling section	Sampling time	Water temperature (°C)	pH value	Total Suspended Solids (TSS)	Dissolved Oxygen (DO)	Chemical Oxygen Demand (COD)	Biochemical Oxygen Demand (BOD)	Petroleum	Hexavalent chrome	Lead	Cadmium
Xiashalahutan	May 92 (dry season)	15.8	8.22	68	11.28	10.63	2.64	0.04	0.0443	0.0332	0.0001
	Sep 92 (rainy season)	20	8.20	72	7.92	8.17	0.56	0.03	0.0120	0.0166	0.0036
Putanguai	May 92 (dry season)	15.8	8.44	14	8.49	9.19	2.08	0.01	0.0307	0.0166	0.0001
	Sep.92 (rainy season)	20	8.20	30	8.11	12.96	0.95	0.04	0.0033	0.0193	0.0031
Jianchi	May 92 (dry season)	15.8	8.44	32	10.18	11.67	2.94	0.02	0.0425	0.0400	0.0001
	Sep 92 (rainy season)	20	8.22	92	8.58	11.68	0.76	0.03	0.0017	0.0242	0.0045
Standard implemented			6.5-8.5	No standard.	5	15	4	0.05	0.05	0.05	0.005

Note: Except for pH value, all unmarked units are in mg/l.

Table 3.6-12

Water quality indexes of surface water (Yellow River)

Sampling section	Sampling time	pH value	Dissolved oxygen (DO)	Chemical oxygen demand (COD)	Biochemical oxygen demand (BOD)	Petroleum	Hexavalent chrome	Lead	Cadmium
Xiashalah utan	May 92 (dry season)	0.81	0.22	0.71	0.66	0.80	1.09	0.66	0.02
	Sep 92 (rainy season)	0.80	0.64	0.54	0.14	0.60	0.24	0.33	0.72
Putanguai	May 92 (dry season)	0.96	0.56	0.61	0.52	0.20	0.61	0.33	0.02
	Sep 92 (rainy season)	0.80	0.61	0.86	0.24	0.80	0.07	0.39	0.62
Jianchi	May 92 (dry season)	0.96	0.35	0.78	0.74	0.40	0.85	0.96	0.02
	Sep 92 (rainy season)	0.81	0.55	0.78	0.19	0.60	0.03	0.48	0.90

The monitored values for pH, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, petroleum, cadmium and hexavalent chromium on the three reaches of the Yellow River meet the national category III standard of "Surface Water Environmental Quality Standard" GB3838-88.

(5) Assessment of groundwater quality

See Table 3.6-13 for the monitored results of pH value, chloride compounds, sulfate, arsenic, hexavalent chrome, cadmium, lead, zinc, fluorine compounds, fecal coliform colonies, and total number of bacteria.

Table 3.6-13

Groundwater monitoring results

Sampling point	Sampling time	pH value	Chloride compound	Sulfate	Arsenic	Hexavalent chrome	Cadmium	Lead	Zinc	Fluorine compounds	Fecal coliform colonies (piece/l)	Total number of bacteria (piece/l)
Fengyan	Jun.93	6.80	29.78	91.07	0.0200	0.0500	0.0002	0.0002	0.170	0.350	5	20
	Sep.93	8.06	46.29	24.02	0.0400	0.0114	0.0003	0.0002	0.210	0.930	20	300
Maobula	Jun.93	6.85	13.90	38.90	0.0000	0.0043	0.0003	0.0003	0.020	0.799	20	18
	Sep.93	7.82	13.70	7.69	0.0000	0.0045	0.0002	0.0001	0.060	0.150	25	500
Xiaokoukou	Jun.93	6.87	158.05	23.05	0.0000	0.0120	0.0002	0.0002	0.020	0.921	20	72
	Sep.93	8.26	182.44	46.11	0.0000	0.0223	0.0002	0.0003	0.110	0.780	20	300
Haishengbula	Jun.93	6.82	9.10	8.17	0.0000	0.0045	0.0003	0.0003	0.020	1.077	20	14
	Sep.93	8.48	9.00	4.80	0.0200	0.0047	0.0003	0.0002	0.050	1.200	25	200
Xihaolai	May.94	7.20	32.99	88.95	0.0035	0.0043	0.0005	0.0110	0.003	1.030	17	40
	Jul.94	8.28	25.50	38.80	0.0050	0.0120	0.0010	0.0050	0.093	0.600	36	53
Gaobashi	May.94	7.60	40.19	45.15	0.0035	0.0043	0.0005	0.0050	0.040	1.120	20	80
	Jul.94	7.58	18.00	17.00	0.0050	0.0020	0.0010	0.0050	0.091	1.000	29	480
Mahuangtan	May.94	7.80	7.10	9.99	0.0035	0.0086	0.0005	0.0050	0.037	0.490	25	70
	Jul.94	8.32	42.00	48.40	0.0050	0.0000	0.0010	0.0050	0.085	0.700	24	140
Huwulangyin g	May.94	7.80	24.69	74.16	0.0035	0.0122	0.0005	0.0050	0.054	0.880	15	60
	Jul.94	8.46	21.00	23.60	0.0050	0.0080	0.0010	0.0050	0.065	0.400	25	30
Standards implemented		6.5-8.5	250	250	0 05	0.05	0.01	0.05	1.0	1.0	3	100

Note: Except for pH value and bacteria counts, all unmarked units are in "mg1.

The above water quality parameters were taken as factors for assessment of groundwater quality; the calculated water quality indexes are shown in Table 3.6-14.

Table 3.6-14

Water quality indexes for groundwater

Sampling points	Sampling time	pH value	Chloride compounds	Sulfate	Arsenic	Hexavalent chrome	Cadmium	Lead	Zinc	Fluorine compounds	Fecal coliform colonies	total number of bacteria
Fengyan	93.6	0.40	0.12	0.36	0.40	1.00	0.02	0.00	0.17	0.35	1.68	0.20
	93.9	0.71	0.19	0.10	0.80	0.23	0.03	0.00	0.21	0.93	6.67	3.00
Maobula	93.6	0.30	0.06	0.16	0.00	0.09	0.03	0.01	0.02	0.78	6.67	0.18
	93.9	0.53	0.05	0.03	0.00	0.09	0.02	0.00	0.06	0.15	8.33	5.00
Xiaokoukou	93.6	0.26	0.63	0.09	0.00	0.24	0.02	0.00	0.02	0.92	6.67	0.72
	93.9	0.84	0.32	0.18	0.00	0.45	0.02	0.01	0.11	0.78	6.67	3.00
Haishengbula	93.6	0.36	0.04	0.03	0.00	0.09	0.03	0.01	0.02	1.07	6.67	0.14
	93.9	0.99	0.04	0.02	0 40	0.15	0.03	0.00	0.05	1.20	8.33	2.00
Xihaolai	94.5	0.13	0.13	0.36	0.07	0.09	0.05	0.22	0.00	1.03	5.67	0.40
	94.7	0.85	0.10	0.16	0.10	0.24	0.10	0.10	0.09	0.60	12.0	0.53
Gaobashi	94.5	0.40	0.16	0.18	0 07	0.09	0.05	0.10	0.04	1.12	6.67	0.8
	94.7	0.39	0.07	0 07	0 10	0.04	0.10	0.10	0.09	1.00	9.67	4.80
Mahuangtan	94 5	0.53	0.03	0 22	0 07	0.17	0.05	0.10	0.04	0.49	8.33	0.70
	94.7	0.88	0.17	0.19	0.100	0.16	0.10	0.10	0.09	0.70	8.00	1.40
Huwulangying	94.5	0.53	0.10	0.30	0 07	0.24	0.05	0.10	0.05	0.88	5.00	0.60
	94.7	0.97	0.08	0.09	0 10	0.16	0.10	0.10	0.07	0.40	8.33	0.30

Most of the 11 groundwater parameters monitored at 8 sampling points meet the requirements of the national "Domestic Drinking Water Hygiene Standard;" however a few items exceed the standard, mainly fecal coliform colony counts and total number of bacteria at various sampling points.

Chapter 4 Predicted environment impacts and control strategies

4.1 Prediction and assessment of environmental impacts

Continuous ambient air quality monitoring at two stations (site and TuoKeTuo County seat) indicates air quality meets Class II standards. Class II standards have been set by the Inner Mongolia City and Town Construction and Environmental Protection Bureau for the project area.

(1) GB3095-82 "Standard of Atmospheric Environment Quality"

Pollutant Designation	Concentration Limits mg/m^3			
	Sampling Time	Class I Standard	Class II Standard	Class III Standard
Total Suspended Particulate	Daily Average	0.15	0.30	0.50
	Any Random Time	0.30	1.00	1.50
Sulfur Dioxide	Daily Average	0.05	0.15	0.25
	Any Random Time	0.15	0.50	0.70
NOx	Daily Average	0.05	0.10	0.15
	Any Random Time	0.10	0.15	0.30

Dispersion modeling has been performed to assess the impacts of the project, including impact on the largest village (Xinyingzi) near the plant site. The EPA CRSTER single point source model was used. The model yielded yearly average maximum 24 hour concentration, meteorological conditions for maximum ground level concentration; value and location of maximum ground level concentration (GLC max). Results are compared to World Bank standards on Table 4.1-17 (SO_2); Table 4.1-18 (SPM); and Table 4.1-19 (NOx). The project is designed to meet Bank standards.

Prevailing winds in the area are from the west, which would carry emissions from the project site away from TuoKeTuo County, the largest nearby population center. To the east of the project site there are no population centers within 30 km. TuoKeTuo County has a sparse population, and the area east of the project site is largely devoid of agricultural activity.

4.1.1 Analysis of meteorological conditions

4.1.1.1 Vertical wind profile

(1) Wind direction profile

Figures 4.1-1 and 4.1-2 show the wind frequency measured with a small balloon on various regulated height levels to 1200 m during a two season atmospheric test in March and August of 1992. From the drawings, we can see, the prevailing wind direction at increasing altitude in the plant area deflects to the right (clockwise).

In summer, below the height of the stacks (10-200 m), the prevailing wind direction is S-SSW; above the height of the stacks (250-400 m), the prevailing wind direction is SSW; at the height of 600-1000 m, the prevailing wind direction is SW; above 1000m, the prevailing wind direction is WSW.

In the heating season, below the height of the stacks (10-200 m), the prevailing wind is S-SSW; above the height of the stacks (250-600 m), the prevailing wind direction is W; above 800 m, the prevailing wind is direction WNW.

(2) Wind speed profile

Statistical analysis of the field measurement data show: the average wind speed in the plant area increases rapidly with height; the average wind speed is more than 5 m/s above the height of 100 m, and more than 6 m/s above stack height (250m). Frequency of stagnant conditions decreases with altitude. The frequency of stagnant conditions at the different levels above stack height (250m) is less than 4% in summer and less than 3% in winter. (See Table 4.1-1)

Table 4.1-1

Average wind speed and frequency of stagnant conditions at various altitudes

Height (m)		10	50	100	150	200	250	300	400	600	800	1000	1200
Summer	Average wind speed (m/s)	2.2	4.2	5.3	5.6	5.9	6.2	6.3	6.4	6.7	7.0	7.4	7.4
	Frequency of stagnant condition (%)	19.2	1.3	2.6	1.3	1.3	3.8	2.6	1.3	0.0	0.0	1.3	1.3
Winter	Average wind speed (m s)	3.3	4.9	5.6	5.9	6.2	6.1	6.2	6.3	6 7	6.5	6.6	6.6
	Frequency of stagnant condition (%)	1.2	0.0	0.0	0.0	1.2	1.2	1.2	2 4	1.2	1.2	1.2	2.6

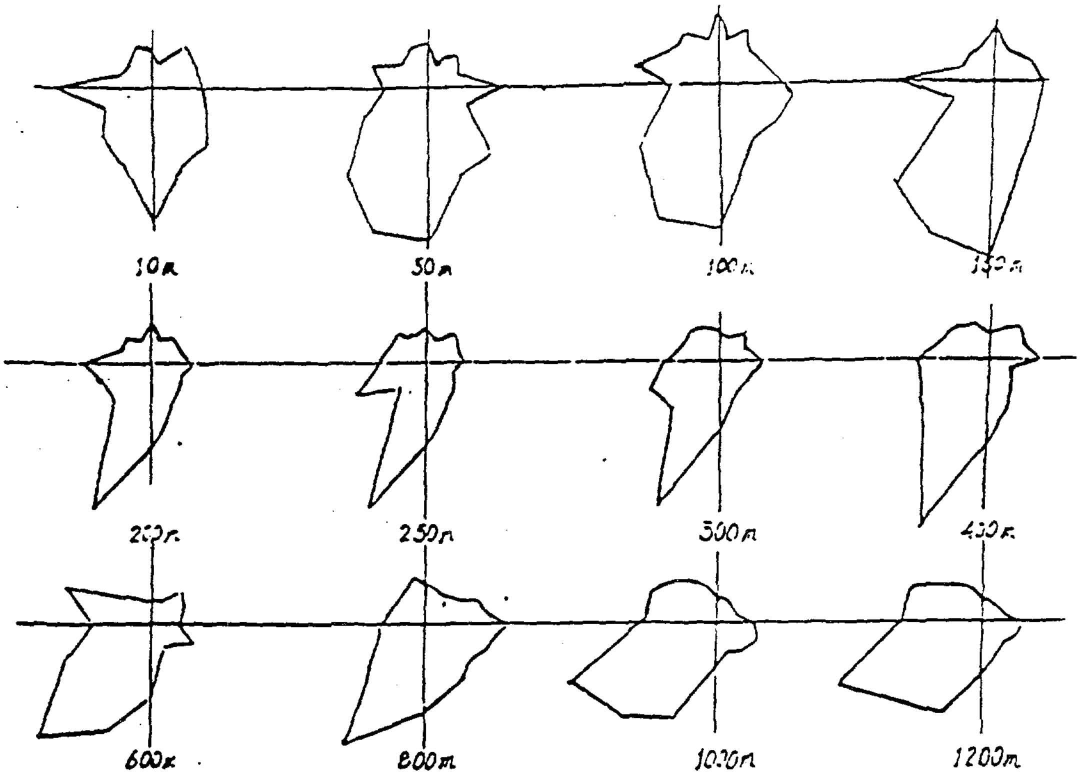


图4.1-1厂址地区夏季规定高度上风向玫瑰图
Fig.4.1-1 Wind rose on the regulated height in the plant area in summer.

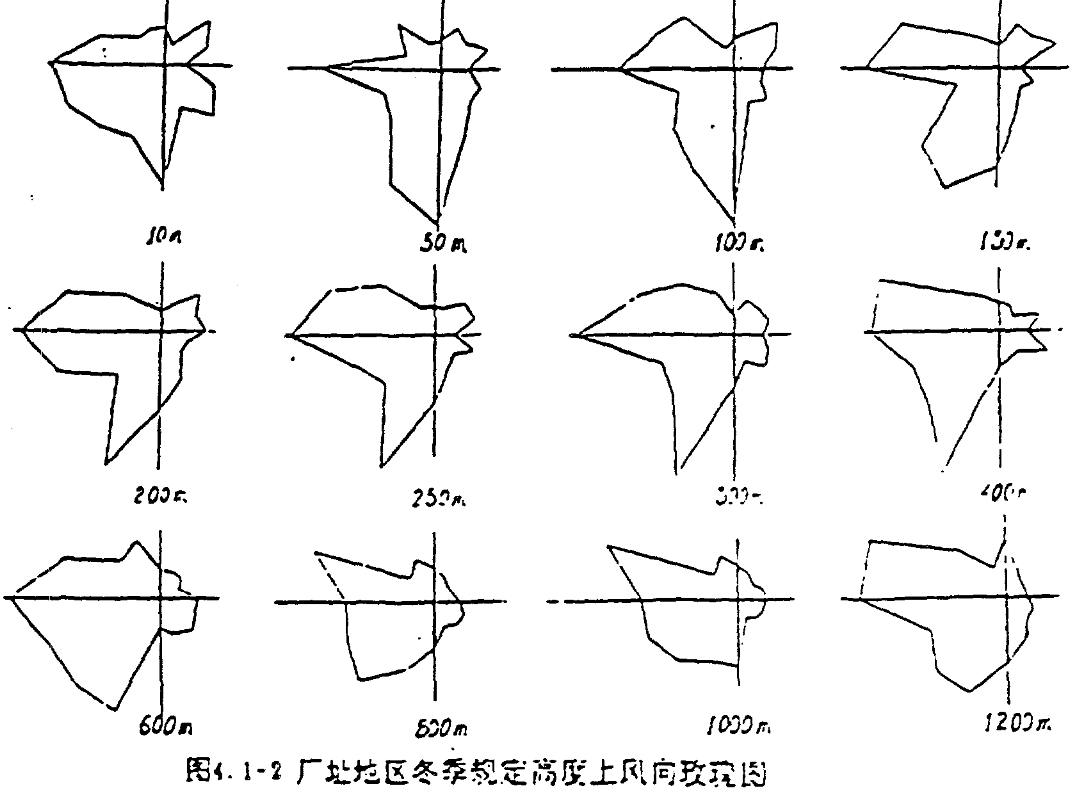


图4.1-2 厂址地区冬季规定高度上风向玫瑰图

Fig. 4.1-2 Wind rose on the regulated height in the plant area in winter.

(3) Wind speed power index

To describe the vertical variation of the wind speed, an exponential function is employed:

$$U(Z)=U_1\left(\frac{Z}{Z_1}\right)^P$$

where:

U(Z),U1 are the average wind speed at the height of Z, Z_1 respectively, P is the power index which is in relation to atmospheric stability and ground roughness coefficient.

Table 4.1-2 shows the wind speed power index under different atmospheric stability conditions in the plant area, the ground roughness coefficient of this area is Z_0= 0.24m.

Table 4.1-2

Power index of wind speed in the plant area

Stability	A	B	C	D	E-F
Touketuo A Z_0=0.24	----	0.15	0.21	0.25	0.30

4.1.1.2 Atmospheric temperature profile

(1) Common characteristics of temperature profile

Under the influence of the ground, the atmospheric temperature near the surface rises in the day time after absorbing radiation from the sun, and heat is sent upwards with the help of convection; the atmospheric temperature decreases with increasing altitude. At night, owing to the cooling radiation from the ground surface, the ground temperature decreases rapidly, leading to a temperature inversion structure. When the sun rises the next morning, and ground temperatures rise, the temperature inversion near the ground disappears, but the night temperature inversion structure can still exist, which leads to a lifting inversion of temperature.

Figures 4.1-3 and 4.1-4 show the variation curves of temperature vs. height of near ground layers during the field observation period in 1992. From the figures, we can see, in summer time in the plant area, from 0:0 o'clock to 4:0 o'clock, the max. inversion layer of temperature exists before sunrise. The temperature inversion near the ground can still last for one or two hours after sunrise, and it is broken up and a lifting temperature inversion begins at about 8 o'clock. At about 10 o'clock, the unstable structure of the lower levels becomes stronger, and the inversion structure disappears completely. At dusk, inversion begins again and becomes stronger and thicker.

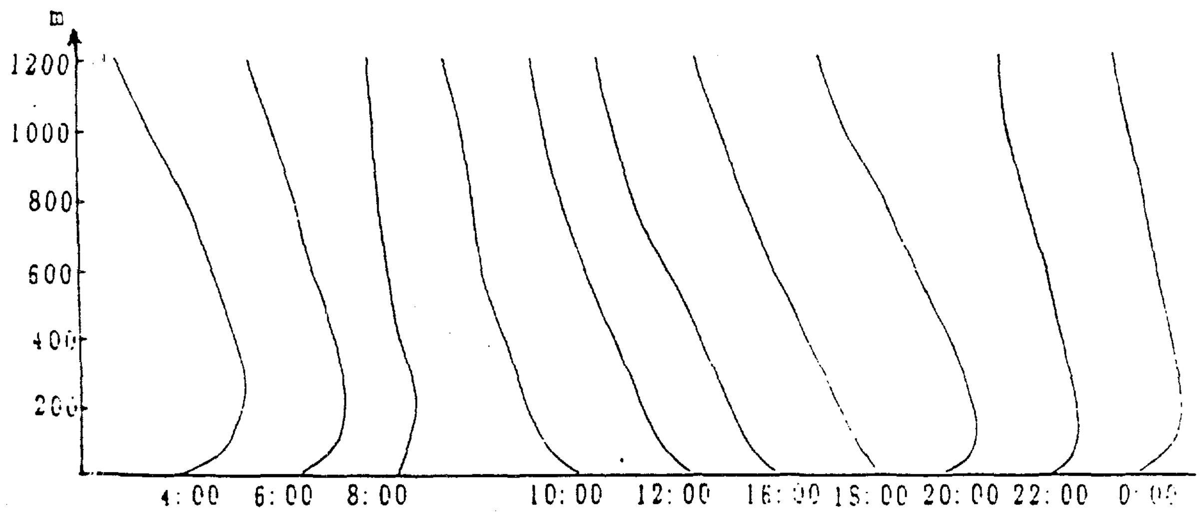


图4.1-4 厂址地区冬季温度廓线图

Fig.4.1-4. Temperature profile chart in winter time in the plant area.

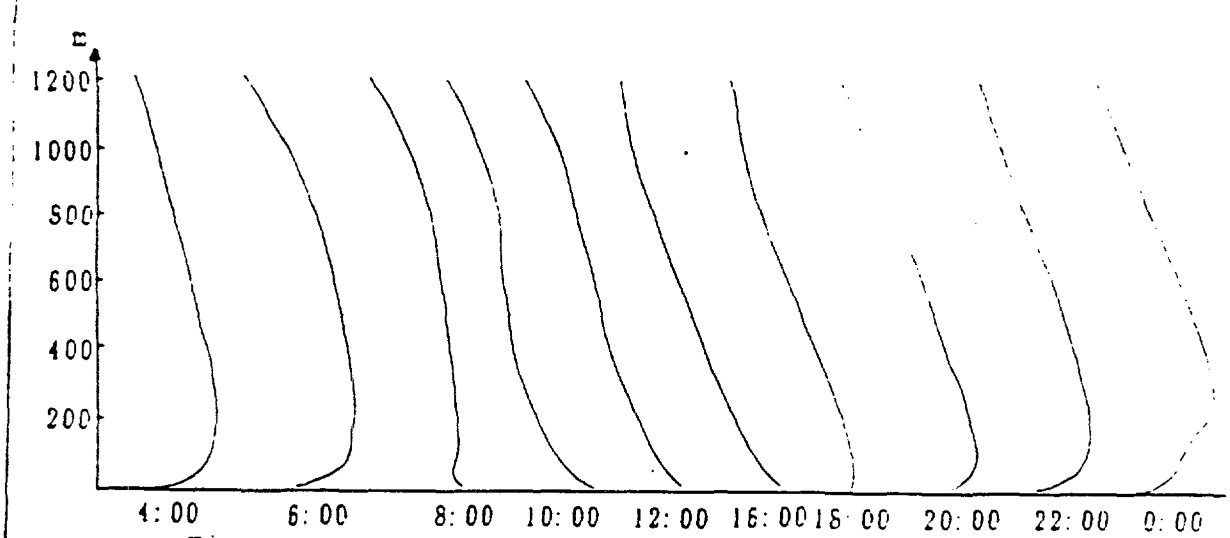


Fig.4.1-3 Temperature profile chart in summer time in the plant area

图4.1-3 厂址地区夏季温度廓线图

The daily change in temperature vs. height still follows the above mentioned trends in the winter.

(2) Characteristics of temperature inversions

a. Frequency of temperature inversions

The statistical results of atmospheric field observations shows that the frequency of inversions is 61.1% during the observation period, in which half was radiation inversion and half was inversion of the upper layers. The frequency of inversions in winter is 63.5%, of which most are radiation inversions (Refer to Table 4.1-3)

Table 4.1-3

Frequency of inversions in the plant area

Season	Prospecting times	Inversion times	Frequency (%)
Summer	95	58	61.1
Winter	85	54	63.5

Table 4.1-4 and 4.1-5 show the characteristics of inversions in summer and winter and daily changes in the plant area. From Table 4.1-5 we can see inversions near the ground are formed mainly at dusk, the strength and thickness increasing with time to the maximum value. The next morning, after sunrise, the ground surface temperature increases quickly, the base of the inversion near the ground rises and a lifting inversion begins with strength and thickness decreasing until it disappears at about 10 o'clock. Higher layer inversions can occur in summer or winter.

Table 4.1-4

Statistics on summer temperature inversions in the plant area

Type of inversion	Near ground inversion		Lifting inversion				High layer inversion			
Time	Top height(m)	Strength (°C/100m)	Bottom height (m)	Top height(m)	Thickness (m)	Strength (°C/100m)	Top height(m)	Strength (°C/100m)	Bottom height (m)	Strength (°C/100m)
04	116	3.8					289	361	72	0.8
06	96	3.7					327	398	71	1.5
08	70	2.3	92	164	72	1.6	432	482	50	0.9
10			168	193	25	1.6	513	623	110	1.2
12							753	809	56	1.1
14										
16										
18	58	2.9					116	166	50	1.6
20	62	2.7								
22	103	3.8					241	326	85	0.6
24	139	4.9					77	244	167	2.3
Average	83	3.2	130	179	39	1.6	343	426	83	1.3

Table 4.1-5

Statistics on winter temperature inversions in the plant area

Type of inversion	Near ground inversion		Lifting inversion				High layer inversion			
Time	Top height (m)	Strength (°C/100m)	Bottom height (m)	Top height (m)	Thickness (m)	Strength (° C/100m)	Top height (m)	Strength (° C/100m)	Bottom height (m)	Strength (°C/100m)
04	180	3.8								
06	118	2.9					292	430	138	0.8
08	105	2.8	35	143	108	2.5	310	432	122	1.0
10			43	77	34	1.2	516	603	87	1.4
12							752	859	107	1.7
14										
16							645	965	320	0.7
18							1451	1496	45	1.4
20	67	3.1					609	745	136	1.2
22	125	2.2					310	368	58	0.7
24	176	2.9					126	167	41	1.2
Average	129	3.0	39	110	71	1.9	557	674	117	1.1

4.1.1.3 Classification of atmospheric stability

The classification of atmospheric stability in the TuoKeTuo area has an obvious seasonal variability. With atmospheric stability classifications (Table 4.1-6) made from the statistic information of ground observations of the county meteorological station, we can see: i) in winter, the static layer structure is Class E and F with a high frequency, the frequency of unstable conditions is low; ii) in summer, the frequency of unstable conditions increases and the frequency of static conditions decreases; iii) in spring and fall, the frequency of frequency of unstable conditions is low; ii) in summer, the frequency of unstable conditions increases and the frequency of static conditions decreases; iii) in spring and fall, the frequency of various kinds of stability are between those of summer and winter. Throughout the year in this area, the frequency of stability of the neutral class D is 18.37 %, and the frequency of static conditions is more than that of unstable conditions.

Table 4.1-6

Frequency in percentage of atmospheric stability classifications TuoKeTuo area (p-c method) (%)

Stability	Atmospheric stability			
Season	A-B	C	D	E-F
Winter	11.73	5.58	12.00	70.90
Spring	17.37	13.84	26.03	42.60
Summer	30.36	6.23	20.84	42.31
Fall	18.59	7.39	14.19	59.40
Whole year	19.67	8.32	18.37	53.80

4.1.1.4 Mixing layer height

Determined by atmospheric dynamics and thermodynamics, there is a discontinuous interlayer at the plant boundary layer, under which atmospheric turbulence is generally stronger. This interlayer restrains the upward diffusion of pollutants from the lower layers and makes them reflect downwards and spread. The atmospheric layer under this interlayer is usually called the mixing layer, and it height is the mixing layer height.

See Table 4.1-7 for the recommended value of the mixing layer height under different stabilities in the plant area, which is calculated according to the measured curve of low atmosphere exploration and reference to the Nozaki experience formula:

$$h(m)=\frac{121}{6}(6-Ps)(T-Td)+\frac{0.169Ps}{12f\ln(z/z_0)}(U(z)+0.257)$$

Table 4.1-7

Recommended value of mixing layer height in the plant area (m)

Stability	A-B	C	D
Mixing layer height	1300	900	650

4.1.2 Atmospheric dispersion parameters

Atmospheric dispersion parameters of the power plant area are measured and obtained by using the balance balloon which is also called zero lifting force balloon. The balloon is filled with a mixture of air and brought to a certain height of release, where it is in a condition of random balance and is displaced with atmospheric movements. The balloon displacements reflect three dimensional atmospheric diffusion directly. The vertical and horizontal diffusion parameters of the plant area are shown as follows:

$$\sigma_y = \gamma_1 X^{\alpha 1}$$

$$\sigma_z = \gamma_2 X^{\alpha 2}$$

where: σy---Horizontal dispersion parameter
σz---Vertical dispersion parameter
X--- the down wind distance from the source
$\gamma 1, \alpha 1, \gamma 2, \alpha 2$---diffusion parameter related to stability

Table 4.1-8 shows the $\gamma 1, \alpha 1$, $\gamma 2$, $\alpha 2$ of the plant area according to the statistics of observation data. The analysis of statistic results shows that the atmospheric parameters of the power plant area are between the Briggs urban diffusion parameters and rural diffusion parameters.

Table 4.1-8

Dispersion parameters of the plant elevated point source

Diffusion parameter	σ_y		σ_z	
Stability	γ_1	α_1	γ_2	α_2
A-B	0.63	0.82	0.28	0.95
C	0.53	0.80	0.23	0.86
D	0.38	0.78	0.25	0.80
E-F	0.27	0.78	0.28	0.63

4.1.3 Dispersion model

According to the nature of the predicted atmospheric pollutant emissions and local meteorological conditions, the Gaussian plume model for an elevated point source with the boundary conditions of a mixed layer was used for prediction of the concentration of sulfur dioxide. From analysis of the pollution meteorological characteristics, in summer and winter, the low velocity wind frequency is less than 4 % at the altitude above stack height (300 m), so calculation for low velocity winds were not made in this assessment.

4.1.3.1 Gaussian plume model of elevated point source

Taking the ground position of the stacks as the point of origin and average wind direction as the X axis, the ground concentration at any point down wind of the pollution source is:

$$C(x.\ y.0)=\frac{Q}{2\pi U\sigma_y\sigma_z}EXP\left(\frac{-y^2}{2\sigma^2{}_y}\right)\ EXP\left[\frac{-He^2}{2\sigma^2{}_z}\right]$$

where: C(x. y.0)---ground concentration of pollutant (mg/Nm^3)
Q ---emission rate (mg/s)
U ---Average wind speed at stack height(m/s);
σ_y,σ_z --Horizontal and vertical diffusion parameter
He --Effective stack height(m);

4.1.3.2 Model of closed type inversion

When an upper inversion of temperature appears, the vertical diffusion of pollutants will be restrained between the inversion layer and the ground. The boundary should be considered and the calculation formula is:

$$C(x,y,0) = \frac{Q}{2\pi U\sigma_y\sigma_z} \exp\left(\frac{-y^2}{2\sigma_y^2}\right) \sum_{-n}^{n} \exp\left(\frac{-(H_e - 2nL)^2}{2\sigma_z^2}\right)$$

where: L - Height of mixing layer (m)

n---Times of boundary, N = 3 - 5 is used usually

Other symbols are the same as mentioned above.

4.1.3.3 Model of daily average concentration

Daily average concentration is the average of the addition of the ground concentrations over time. That is:

$$C_d(x,y,0) = \frac{1}{n} \sum_{i=1}^{n} C_i(x,y,0)$$

where: n = Daily observation times

4.1.4 Calculation of sulfur dioxide and fly ash emission rate

4.1.4.1 Formula of emission rate and concentration of SO_2 and fly ash in flue gas

(1) SO_2 emission rate

$$M_{SO_2} = 2B_g \left(1 - \frac{\eta_{SO_2}}{100}\right)\left(1 - \frac{q_4}{100}\right) \frac{S^y}{100} K$$

Where:

M_{SO_2} --- Emission rate of SO_2(t/h)

B_g --- Total coal consumption at boiler rated evaporation rate (t/h)

η_{SO_2} --- Desulfurization efficiency of precipitator (%)

S^y --- Sulfur content of coal (%)

q_4 --- Heat loss when boiler at incomplete combustion

K --- Percentage sulfur content of coal which will be oxidized to SO_2 after combustion, for a pulverized coal-fired boiler K = 0.85

(2) Emission rate of dust:

$$M_a = B_g \left(1 - \frac{\eta_C}{100}\right)\left(\frac{A^y}{100} + \frac{q_4}{100}\right)\left(\frac{Q_{DW}}{8100 \times 4.1868}\right)\alpha_{fh}$$

where:

M_a --- Quantity of fly ash emission rate (t/h)
ηc --- Efficiency of precipitator (%)
A^y --- Ash content of coal (%)
Q_{DW} ---Low level heat value of coal (kJ/kg)
α_{fh} ---Fly ash percentage brought by flue gas of boiler. For pulverized coal-fired boiler with solid slag discharging $\alpha_{fh} = 0.9$.

(3) Dust concentration of flue gas at outlet of precipitator of boiler:

$$c(mg/Nm^3)\text{dry flue} = \frac{\text{Actual flue ash exhaust}(mg/s)}{\text{Quantity of dry flue gas at outlet of precipitator}(Nm^3/s)}$$

4.1.4.2 Allowable stack SO_2 emission rate and allowable fly ash concentration in flue gas (GB13223-91)

(1) For emissions with single stack, allowable quantity of SO_2 emission rate of the whole plant is:

$$Q_{SO_2} = P \times U \times (H_e)^m \times 10^{-6}$$

$$U = U_{10} \left(\frac{H_s}{10}\right)^{0.15}$$

$$H_e = H_s + \Delta H$$

Where:

Q_{SO_2} --- Allowable emission rate of SO_2(t/h)
U --- Wind speed (m/s)
U_{10} --- Average wind speed 10 m above the ground (m/s)
H_s --- Geometric height of stack (m)
H_e--- Effective height of stack (m)
ΔH --- Lifting height of plume (m)
P --- For emissions control coefficient, referring to GB13223-91
m---Index of ground diffusion condition, referring to GB13223-91

(2) When multiple stacks are adopted in a newly rebuilt power plant, allowable emission quantity of SO_2 of the whole plant calculated based on equivalent single source:

$$Q_{SO_2} = P \times U \times (H_g)^m \times 10^{-6}$$

$$U = \frac{1}{N} \sum_{i=1}^{N} Ui,$$

$$Hg = \sqrt{\frac{1}{N} \Big/ \sum_{i=1}^{N} (Hei)2}$$

where:

Hg --- Equivalent height of multiple stacks (m)
N --- Number of stacks of the whole plant
i --- No. of the stacks(i=1,2...,N)
Hei--- Effective height of No.i stack(m)
U --- Average conveying wind speed(m/s)
Ui --- Wind speed of No.i stack(m/s).

(3) Max. allowable fly ash concentration of flue gas at outlet of precipitator of boiler:

$$C_2 = 1.7\,K \frac{C_2'}{a}$$

where:

C_2 --- Max. allowable fly ash concentration of flue gas at outlet of precipitator of boiler(mg/Nm^3 dry flue gas)
a -- Coefficient of air surplus at outlet of precipitator
C_2'-- Pulverized coal-fired boiler with solid slag discharge, when a=1.7, max. allowable fly ash concentration of flue gas implemented according to Table 3 of GB13223-91.
K --- Reducing coefficient of boiler type, referring to Table 4 of GB13223-91.

4.1.5 Prediction of air quality impacts

4.1.5.1 Input parameters

(1) Model of atmospheric pollution parameters

The atmospheric pollutant source of a power plant is an elevated continuous point source. The major pollutant of flue gas is sulfur dioxide and suspended particulate matter (SPM). See Table 4.1-9 for its mission parameters.

Table 4.1-9

Parameters of emissions from TuoKeTuo Power Plant A

Parameter	Symbol	Unit	Project first phase (2 x 600 MW)	Ultimate capacity (6 x 600 MW)
Coal type			Zhungeer coal	Zhungeer coal
Coal consumption of boiler	Bg	t/h	2x321	6x321
Flue emission rate	Vo	N m^3/s	2x710.8	6x710.8
Temperature of flue gas(inlet of stacks)	Ts	°C		
Type of stack			Single cylinder	Single cylinder
Height of stacks	Hs	m	240	240
Internal diameter of stack outlet	D	m	10	10
Efficiency of Electrostatic precipitator	η_c	%	99.76	99.76
Desulfurization efficiency of precipitator	η_{SO2}	%	0	0
Emission rate of fly gas	Ma	mg/s	156389	469167
Emission rate of SO_2	M_{SO2}	mg/s	1396111	4188333

(2) Grids of the assessed area

The assessed area was divided into grids of 1 km x 1 km, and encode them, the longitude direction from the right lower corner is J and latitude direction is I. The coordinates of the emission source are I=15-16, J=15-16, located at the center of the assessed area.

Owing to the smooth terrain in the assessed area, there is no topographic modification made in this assessment.

(3) Meteorological parameters

The short term prediction was carried out only for the concentration of pollutant in this assessment. The meteorological data for primary concentration predictions are from the statistical results of many years observation data from the meteorological station. The meteorological data for the calculation of daily average concentration is taken from the observation data of wind direction, wind speed and temperature, and stability in the upper air layers from the atmospheric field observations made in 1992.

4.1.5.2 Determination of effective stack height

The lifting height of the plume of the power plant is calculated by using the formula regulated in national standard GB13223-91. When QH > 21000 kJ/s, and T > 35k, unstable and neutral atmospheric condition:

$\Delta H=1.427\ Q^{1/3}{}_H\ H^{2/3}{}_s/Us$

under the condition of stable atmosphere, Briggs formula is adopted for calculation:

$\Delta H = 2.4[F/(UxS)]^{1/3}$

where:

$QH = Cp.Vo.\Delta T$

$\Delta T = Ts\text{-}Ta$

$F = 0.037\ QH$

$$S = \frac{g}{Ta}(\gamma\alpha-\gamma)$$

H---- lifting height of plume(m)
QH---- Heat release rate of flue gas(kJ/s)
Hs --- Geometric height of stack(m)
Us --- Average wind speed at stack height(m/s)
Cp --- Average constant pressure specific heat, 1.38kJ/Nm^3.K
Vo --- Rate of flue emissions of boiler (Nm^3/s)
Ts --- Temperature of flue gas at the outlet of stack(K)
Ta --- Average environmental temperature at outlet of stack(K)

4.1.5.3 Prediction of air quality impacts

(1) Primary maximum concentration

See Table 4.1-10 for plume rise parameters for Touketuo Plant A. According to the calculations using the GB formula, the maximum concentration value of pollutants discharged from Touketuo Plant A would occur under stability class C. When one boiler is in operation burning design coal and check coal, the primary maximum concentration of sulfur dioxide is 0.046 mg/m3 and 0.052 mg/m3 respectively, which is 9.2 % and 10.4 % of the national standard grade II. The primary maximum concentration of suspended particulate matter is 0.013 mg/m3 and 0.016 mg/m3 respectively, which is 2.6 % and 3.2 % of the national standard grade II; the maximum concentration point (GLC max) is 6876 m and 6930 m away from the point source respectively.

Table 4.1-10

Plume rise parameters for Touketuo Plant A

Parameter		Symbol	Unit	A-B	C	D	E-F
Ground wind speed		Uo	m/s	1.3	3.3	4.0	1.1
Power series of wind speed		P		0.15	0.21	0.25	0.30
Wind speed at height of source		U	m/s	2.1	6.4	8.9	2.9
Lifting height(design coal)	1 boiler	ΔH	m	1221	401	288	365
	2 boilers	ΔH	m	1538	505	363	461
Lifting height(check coal)	1 boiler	ΔH	m	1223	405	291	369
	2 boilers	ΔH	m	1553	510	367	465
Stability parameter		S		0.000363			
Temperature at height of source		ΔT	°C	5.4			
Parameter of flue flow				Design coal		Check coal	
Heat releasing rate	1 boiler	QH	KJ/S	100641		103699	
	2 boilers	QH	KJ/S	201282		207398	
Quantity of sulfur dioxide emission	1 boiler	QSO2	mg/s	698193		789545	
	2 boilers	QSO2	mg/s	1396386		1579090	
Emission quantity of flue gas	1 boiler	Qa	mg/s	78167		101111	
	2 boilers	Qa	mg/s	156389		202222	

When two boilers are in operation burning design coal and check coal, primary maximum concentration of sulfur dioxide is 0.068 mg/m3 and 0.076 mg/m3 respectively, which is 13.6 % and 15.2 % of the national standard grade II; maximum primary concentration of suspended particulate matter is 0.019 mg/m3 and 0.024 mg/m3 respectively, which is 3.8% and 4.8% of the national standard grade II; and the maximum concentration point is 8298 m and 8368 m from the source respectively (Refer to 4.1-11 and 4.1-12 for details).

Table 4.1-11

Primary maximum concentration of SO_2 and suspended particulate (design coal)

Item / Pollutant / Stability		1 boiler (1 x 600 MW)			2 boiler (2 x 600 MW)			6 boiler (6 x 600 MW)		
		Cm(mg m³)	Xm(m)	Percentage of national standard(%)	Cm(mg/m3)	Xm(m)	Percentage of national standard (%)	Cm(mg/m³)	Xm(m)	Percentage of national standard(%)
Sulfur dioxide	A-B	0.023	14748	4.6	0.030	18794	6.0	0.91	18794	18.2
	C	0.046	6876	9.2	0.068	8298	13.6	0.203	8298	40.6
	D	0.031	11141	6.2	0.047	13181	9.4	0.140	13181	28.0
	E-F	0.043	27414	8.6	0.061	33451	12.2	0.184	33451	36.8
Suspended dust	A-B	0.006	14748	1.2	0.009	18794	1.8	0.026	18794	5.2
	C	0.013	6876	2.6	0.019	8298	3.8	0.057	8298	11.4
	D	0.009	11141	1.8	0.013	12181	2.6	0.040	12181	8.0
	E-F	0.012	27414	2.4	0.017	33451	3.4	0.052	33451	10.4
Grade II standard		0.50 mg/Nm³			0.50 mg/Nm3			0.50 mg/Nm3		

Table 4.1-12

Primary maximum concentration of SO_2 and suspended particulate matter (check coal)

Item / Pollutant / Stability		1 boiler (1 x 600 MW)			2 boiler (2 x 600 MW)			6 boiler (6 x 600 MW)		
		Cm(mg/m3)	Xm(m)	Percentage of national standard(%)	Cm(mg/m3)	Xm(m)	Percentage of national standard(%)	Cm(mg/m3)	Xm(m)	Percentage of national standard(%)
Sulfur dioxide	A-B	0.025	14898	5.0	0.034	18990	6.8	0.101	18990	20.2
	C	0.052	6930	10.4	0.076	8368	15.2	0.227	8368	45.4
	D	0.035	11221	7.0	0.053	13291	10.6	0.159	13291	31.8
	E-F	0.048	27659	9.6	0.068	33709	13.6	0.205	33709	41.0
Suspended dust	A-B	0.008	14898	1.6	0.011	18990	2.2	0.032	18990	6.4
	C	0.016	6930	3.2	0.024	8368	4.8	0.072	8368	14.4
	D	0.011	11221	2.2	0.017	13291	3.4	0.051	13291	10.2
	E-F	0.015	27659	3.0	0.022	33709	4.4	0.066	33709	13.2
Grade II standard		0.50 mg/Nm3			0.5 mg/Nm3			0.50 mg/Nm3		

When the power plant is at planned capacity (6 x 600 MW), the primary maximum ground concentration of sulfur dioxide is estimated at 0.203 mg/m3 (design coal) and 0.227 mg/m3 (check coal), which is 40.5 % and 45.4 % of the national standard grade II.

(2)Daily average concentration

a. Selection of a typical day

Meteorological conditions observed during the field survey can be divided roughly into two types of atmospheric conditions, system circulation and local circulation. The characteristic of local circulation is that the direction of a low velocity breeze changes between west and south during the day. When under the control of system circulation, the wind is west (in winter) or south (in summer) with higher wind. Table 4.1-13 shows the average wind direction, speed, stability and frequency at the height of 250 m-600 m in ten typical days in winter and summer.

Table 4.1-13

Meteorological conditions on typical days

Date	Wind direction	Wind speed (m/s)	Stability	Frequency
3.28	WNW W	5-8	D E	4.35
3.29	W WSW SW	2-6.6	D E	15.22
3.30	SSW WSW W	3-4	D E	8.69
4.1	W WNW	4.6-9.4	D E	4.35
4.4	WSW WNW SW	2.6-5.3	D E	15.22
4.5	NNW ENE S NW	3.0-6.9	D E	15.22
8.20	SW W WSW SSW	3-4	D E	8.69
8.25	S SSW	5-9	D E	4.35
8.26	SSW WSW SE S	2.0-5.8	D E	15.22
8.30	ESE E NE SSE	2.0-5.0	D E	8.69

b. Prediction of daily average concentration of sulfur dioxide

The power plant will have a stack height of 240 m for flue gas emission. The temperature of flue gas having a certain initial speed is much higher than that of the ambient temperature, which produces the plume rise and increases the effective height of the stack. Therefore the direction and speed of wind in the air above the stack has much more direct influence on dispersion of atmospheric pollutants.

See Figures 4.1-5 - 4.1-7 for the predicted daily trends of ground concentration distribution of sulfur dioxide from the project phase I, based on the measured data of wind direction, wind speed and atmospheric temperature above the height of stack. From the figures we can see, the highest values of daily concentration of sulfur dioxide change

TABLE THE PREDICTING & MONITORING GROUNDLEVEL CONCENTRATION OF AIR POLLUTANT IN POWER AREA

Capacity	Parameter	Coal type	The max. predicting daily average concentration (mg/Nm^3)		The monitoring value range (mg/Nm^3)		National standard (mg/Nm^3)	
2×600MW	SO_2	Design coal	Heating period	0.0326	Design coal	0.012~0.032		
		Check coal	Non-heating period	0.0210	Check coal	0.010~0.021		
		Design coal	Heating period	0.0369	Design coal	0.012~0.032		
		Check coal	Non-heating period	0.0238	Check coal	0.010~0.021	SO_2	0.15
	PM_{10}	Design coal	Heating period	0.0091	Design coal	0.0322~0.0606		
		Check coal	Non-heating period	0.0059	Check coal	0.0252~0.0585		
		Design coal	Heating period	0.0118	Design coal	0.0322~0.0606		
		Check coal	Non-heating period	0.0076	Check coal	0.0252~0.0585		
6×600MW	SO_2	Design coal	Heating period	0.0978	Design coal	0.012~0.032		
		Check coal	Non-heating period	0.0630	Check coal	0.010~0.021		
		Design coal	Heating period	0.1107	Design coal	0.012~0.032		
		Check coal	Non-heating period	0.0714	Check coal	0.010~0.021	PM_{10}	0.15
	PM_{10}	Design coal	Heating period	0.0273	Design coal	0.0322~0.0606		
		Check coal	Non-heating period	0.0177	Check coal	0.0252~0.0585		
		Design coal	Heating period	0.0354	Design coal	0.0322~0.0606		
		Check coal	Non-heating period	0.0228	Check coal	0.0252~0.0585		

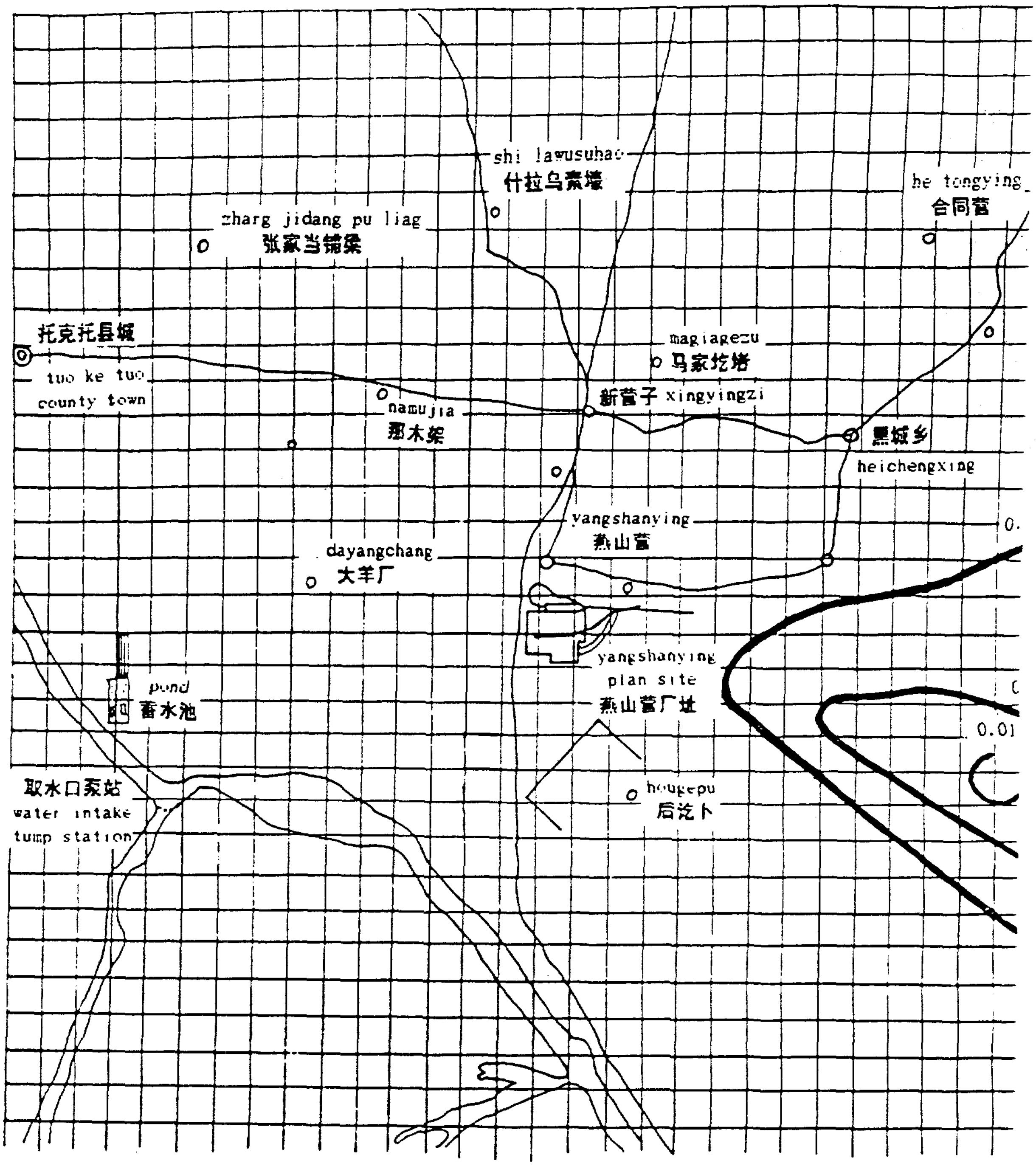


图4.1-5 SO_2日均浓度分布图(2×600MW)(3月28日)(mg/m^3)

Fig. 4.1-5 Distribution of daily average concentration of SO_2 2x600MW (28th,March)

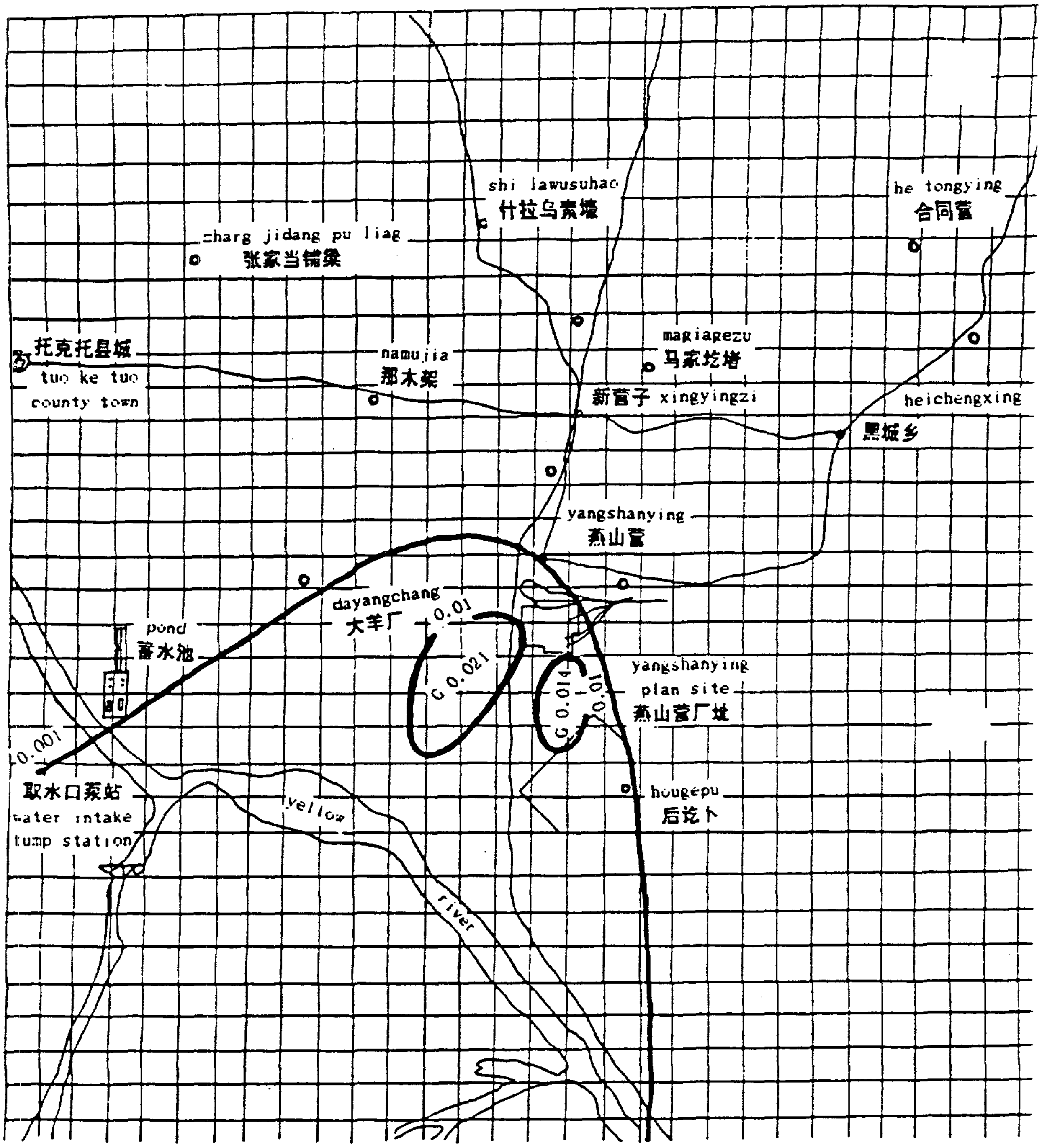


图4.1-6 SO_2日均浓度分布图(2×600MW)(8月30日)(mg/m³)

Fig 4.1-6 Distribution of daily average concentration of SO_2 (2×600MW) (30th, August)

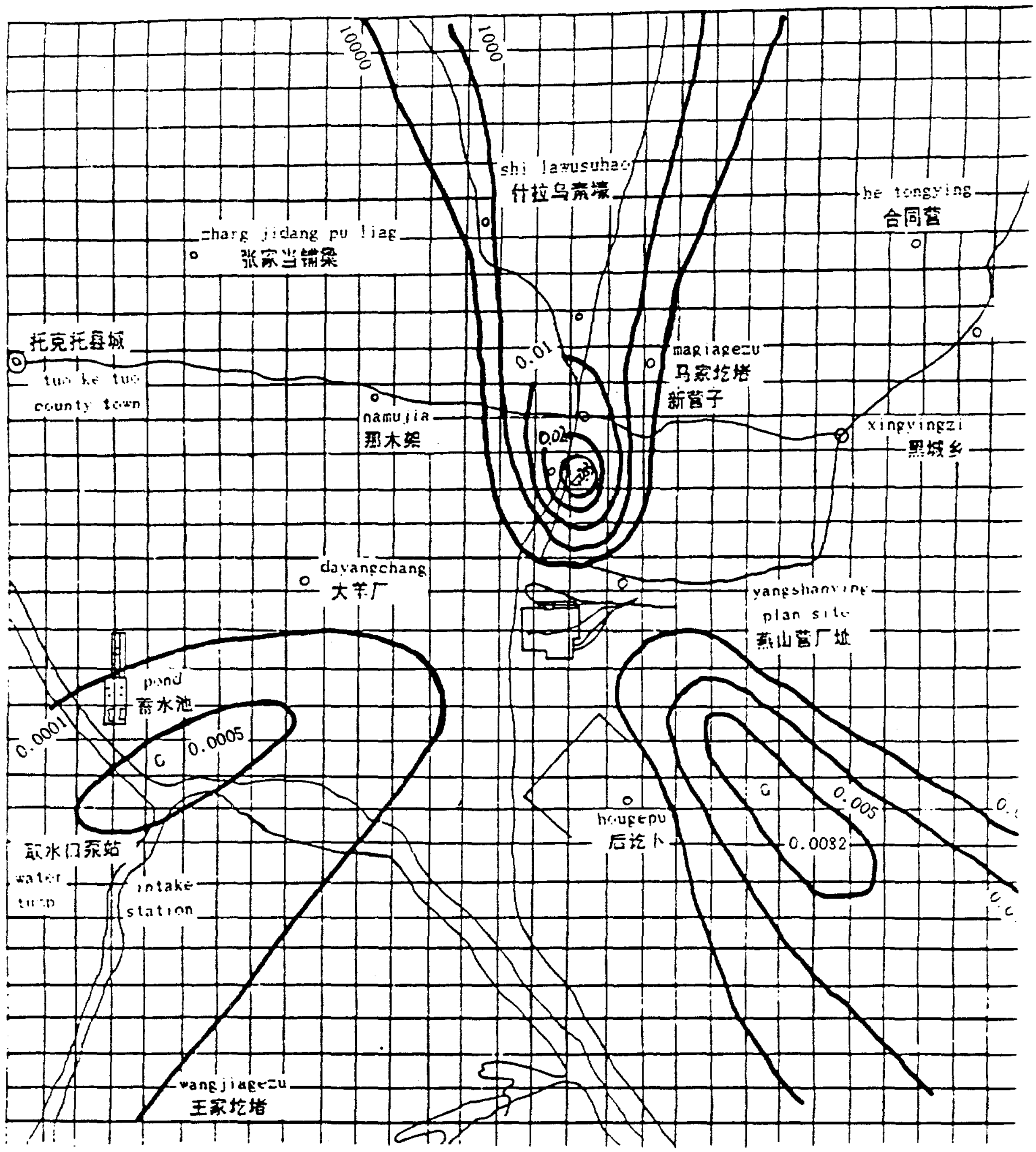


图4.1-7 SO_2日均浓度分布图(2×600MW)(4月5日)(mg/m^3)

Fig.4.1-7 Distribution of daily average concentration of SO_2(2x600MW) (5th, April) with wind direction. When a wind direction persists all day with a higher relative speed, the highest daily average concentration of sulfur dioxide is at the downwind distance of 9-10 km, with a center concentration of 0.0003-0.0101 mg/m^3. This concentration is 6.7 % of the national grade II standard (March 28th). When the wind speed is 2-5 m/s, most of the pollutants from the power plant are accumulated in the highest ground level concentration area about 2-3 km from the plant site (August 30th). When the wind direction changes, it is possible to have multiple high concentration areas distributed in the assessed area (April 5th). Maximum values of daily average concentration in this case are 0.0037-0.0326 mg/m^3 which are 2.5-21.7 % of the national grade II standard.

The distribution of daily ground SPM concentration of the power plant is similar to that of sulfur dioxide, the emission of the former is just 28 % of that of the latter. Therefor the impact on air quality of suspended particulate from the power plant is much less than that of sulfur dioxide.

At the planned capacity of 6 X 600 MW, the daily average concentration is 3 (three) times of that of Phase 1.

4.1.5.4 Allowable sulfur dioxide emission rate of the power plant and the analysis of allowable concentration in flue gas

Calculated according to "emission standard of atmospheric pollutant of coal firing power plant" (GB13223-91), the highest allowable concentration of flue gas at the outlet of the precipitator of the boiler of 2008 t/h from the power plant is 386 mg/m^3(dry flue gas), when burning design coal, the lowest precipitation efficiency of the precipitator for this requirement is 98.88 %, when burning check coal, the lowest precipitation efficiency is 99.08%. Efficiency of the precipitator of engineering design is 99.76 %, when burning design coal and check coal, the actual concentration of flue gas at the outlet of the precipitator is 100 mg/m^3 (dry flue gas), which will meet World Bank standard (See Table 4.1-14).

Allowable sulfur dioxide emission rate is 26.867 t/h (design coal) and 27.341 t/h (check coal). Actual sulfur dioxide emission rate of the first phase project of the power plant is 5.027 t/h (design coal) and 5.685 t/h (check coal), which is 18.7% and 20.8% of the allowable emission rate. Actual sulfur dioxide emission rate of the planned capacity is 15.081 t/h (design coal) and 17.055 t/h (check coal), which is 56.1% (design coal) and 62.4% (check coal) of the allowable emission rate.(See Table 4.1-15).

The actual concentration of the fly ash in flue gas and actual emission rate should be in conformity with the stipulations of "For emissions standard of atmospheric pollutant of coal firing power plant"(GB13223-91) issued by the state, and World Bank guidelines.

(1) GB3095-82 "Standard of Atmospheric Environment Quality"

Pollutant Designation	Concentration Limits mg/m^3			
	Sampling Time	Class I Standard	Class II Standard	Class III Standard
Total Suspended Solids	Daily Average	0.15	0.30	0.50
	Any Random Time	0.30	1.00	1.50
Sulfur Dioxide	Daily Average	0.05	0.15	0.25
	Any Random Time	0.15	0.50	0.70
NOx	Daily Average	0.05	0.10	0.15
	Any Random Time	0.10	0.15	0.30

Table 4.1-14

Calculation sheet for highest allowable emission concentration of flue gas at precipitator outlet of boiler

Item	Symbol	Unit	Design coal	Check coal
The highest allowable for emissions concentration of fly ash	C_2	mg/Nm^3	100	100
The lowest efficiency of precipitator	ηc	%	98.88	99.08
Design efficiency of precipitator	η_c	%	99.76	99.76
Coefficient of surplus air at precipitator outlet	α		1.54	1.54
Reducing coefficient of boiler type	K		1.0	1.0
Actual emission concentration of fly ash	Ca	mg/Nm^3	< 100	100

Table 4.1-15

Calculation sheet for allowable emission rate of sulfur dioxide

Parameter	Symbol	Unit	First term project (2 x 600 MW)		Planned capacity (6 x 600 MW)	
			Design coal	Check coal	Design coal	Check coal
Type of power plant	--	--	Newly reconstructed power plant		Newly reconstructed power plant	
Control coefficient of for emissions	P	--	3.608		3.608	
Index of local diffusion condition	m	--	2.075		2.075	
Sulfur allowable for emissions quantity of the whole plant	M_{SO2}	t/h			26.867	27.341
Sulfur actual for emissions quantity of the whole plant	M_{SO2}	t/h	5.027	5.685	15.081	17.055
Efficient height of stack	He	m	1064	1073	1064	1073
Equivalent single height of multiple stacks	Hg	m	--	--	1064	1073
Average conveying wind speed	U	m/s	3.9	3.9	3.9	3.9

(2) Analysis calculation concerning World Bank guideline for sulfur dioxide emission

Taking into account of the wide spread distribution of sulfur dioxide and potential possibility of acid rain and the regulation of "World Bank Guideline for emission", sulfur emissions must meet two independent standards (refer to Table 4.1-16 "Sulfur dioxide emission standard"). Standard I mainly concerns background conditions and sulfur content of fuel; Standard II concerns background conditions, local meteorological conditions, topographic conditions and stack height. A certain quantity of desulfurization is required to meet each standard. Calculation of the maximum requirement of desulfurization should be made when allowable emissions are being defined. A proper air quality model is required in Standard II to define the concentration increment.

Table 4.1-16

Sulfur dioxide emission standard

Background value of sulfur dioxide (μg/m^3)				Standard I	Standard II
Background air quality (SO_2)		Annual average value	Maximum 24 hour value	Max. emission of sulfur dioxide (t/d)	Max. allowable increment of ground concentration (μg/m^3 average value of a year)
Unpolluted		<50	<200	500	50
Medium pollution*	Low	50	200	500	50
	High	100	400	100	10
Serious pollution **		>100	>400	100	10

Note:* Linear interpolation method can be used for the middle value between 5 and 100 μg /m^3;

** Projects with any sulfur emission are not acceptable in this kind of area.

According to the measurement of air quality, the background concentration of sulfur dioxide in TuoKeTuo area is very low. The measured average concentration of SO_2 at the site is <50 μg/m^3; therefor TuoKeTuo is defined as an unpolluted area.

At Touketuo Plant A project phase I, daily emission of sulfur dioxide is 100.54 t with design coal and daily allowable emission of sulfur dioxide is 113.70 t with check coal. The maximum annual average ambient air concentration contribution of sulfur dioxide from design coal and check coal respectively is 14.5 μg/m^3 and 16.4 μg/m^3; just 29% and 33% of the World Bank standard respectively.

In the plan for (6 x 600 MW) capacity of Plant A, the daily sulfur dioxide emission of design coal is 301.62 t, and daily sulfur dioxide emission of check coal is 341.10 t, annual average maximum concentration contribution of design coal and check coal is 43.5 μg/m^3 and 42.9μg/m^3 respectively. Therefore, sulfur dioxide emissions and the increment of ground surface concentration caused in the assessed area are much lower than the limits of Standard I and Standard II of the World Bank under the condition of no controlling measurement adopted in the first phase project (2 x 600 MW) of Touketuo Plant A. So desulfurization equipment is not needed according to the World Bank guideline for sulfur dioxide emission. In the plan for 6 x 600 MW, the sulfur dioxide emission and the increment of ground level sulfur concentration in the assessed area can meet the criteria I and II of the World Bank sulfur dioxide emission standard as well.

SO_2 emission control strategy

To decrease the ground concentration, a high chimney is used. Two boilers in the first phase of the project shall share one 240 m high single-tube chimney. The inside diameter of the outlet is 10 m and the velocity at the chimney outlet is 26.62 m/s, which can satisfy the requirement that velocity of flue gas at the chimney outlet shall not be less than 1.5 times as much as the average wind speed at the chimney outlet (see section 4.12 for further details).

Table 4.1-17

Calculation of sulfur dioxide emission of Touketuo Plant A according to the World Bank standard

Capacity of power plant (MW)	Daily average of atmospheric background quality ($\mu g/m3$)	Uncontrolled sulfur dioxide emission (t/d)	Standard I (t/d)	Required desulfurization I (SSR)	Uncontrolled concentration increase in air ($\mu g/m^3$)	Standard II ($\mu g/m^3$)	Required desulfurization I (SSR)
2 x 600	<50	100.54 (113.70)	500	0.0%	14.5 (16.4)	50	0.0%
6 x 600	<50	301.62 (341.10)	500	0.0%	43.59 (49.2)	50	0.0%

Note:() The figures in () are for check coal.

(3) Fly ash collection efficiency calculated in accordance to the World Bank guidelines

The World Bank guideline for suspended particulate emission is 100 mg/m^3. With respect to this calculation, the ESP efficiency is $\eta_c \geq 99.76$ % when designed coal is to be adopted for Tuoketuo Power Plant. In that case, it can satisfy the requirement of the World Bank on dust emission. For check coal, ESP efficiency is $\eta_c \geq 99.64\%$ which may meet the World Bank requirement on dust emission.

The following will be the ESP efficiency calculated in accordance to the standard on dust emission made by World Bank.

Table 4.1-18

ESP efficiency calculated with respect to World Bank guidelines

Item	Symbol	Unit	Design coal	Check coal
Allowable plume concentration prescribed by the World Bank	C2	mg/Nm^3	100	100
Minimum ESP efficiency	η_c	%	99.55	99.64
Designed ESP efficiency	η_c	%		99.76
Actual plume concentration	C_3	mg/Nm^3		100
Recommended fly ash collection efficiency	η_c	%	99.76	

PM10 emission control strategy

A high-efficiency electrostatic precipitator will be used in the phase I of the project with efficiency of ≥99.76 % so as to satisfy the requirement stipulated by the state standard (GB13223-91) "Emission Standard for the Atmospheric Pollutant of Coal-Fired Power Plant" (see section 4.12 for further details) and World Bank guidelines.

4.1.5.5 Analysis of NOx emission

There is no regulation concerning NOx emissions in the existing national standards for coal fired power plants. The NOx emission of the Touketuo Plant A is estimated (no control) and compared with other power plants in China.

(1) Estimation of NOx production

According to the formula recommended by the Chinese Academy of Environmental Research Sciences, the NOx emission rate of the power plant is to be calculated with the following formula:

$$NOx = \frac{9\times10^{-3} \times W_{coal}}{Q_{flue}} \times \frac{\alpha_{actual}}{\alpha_{standard}}$$

where:

NOx----NOx concentration in flue gas($\mu g/m^3$)
9 ----NOx emission factor (9 kg/t coal) according to "Handbook of Environment Protection Practical Data"
W_{coal}--Coal consumption (mg/s)
Q_{fuel}--Flue gas quality(Nm^3/s)
α_{actual}-Actual air surplus coefficient
$\alpha_{standard}$--Standard air surplus coefficient taken as 1.4

See the following table for NOx emission

Table 4.1-19

NOx emission of Touketuo Plant A

Item	Project of the first phase (2 boilers)
Coal consumption(mg/s)	89166667
Quantity of flue gas(Nm^3/s)	655.7
NOx in flue gas concentration(mg/Nm^3)	1346

Note: The above calculation is based on the consideration of boiler without low NOx burners

(2) NOx emissions of domestic power plants

According to the general investigation of boiler NOx emission of 59 representative boilers of various power plants of our country carried out by the Xian Thermo-Engineering Institute under Ministry of Electric Power in 1986-1987:

Pulverized coal-fired boiler with slag discharge in solid state: NOx concentration in flue gas is 600-1200 mg/m^3.

Pulverized coal-fired boiler with slag discharge in liquid state: NOx concentration in flue gas is 850-1500 mg/Nm^3;

Oil-fired boiler: NOx concentration in flue gas is 720-1680 mg/Nm^3;

The conservative calculation data in the above table reveals that if no measures are taken for NOx control, the emission rate of TuoKeTuo Power Plant will exceed the upper limit of the current emission standards for the domestic power plants.

NO_X control strategy

Based on the calculation, the emission of NO_X in the first phase of TuoKeTuo A has exceeded the upper limit of emission standard for domestic large-scale power stations. As new emission standards for coal-fired power plants will be followed and concentration of NOx will be restricted, low NOx combustion technology will be used to control the flue gas concentration of NOx to within the allowable value (see section 4.12 for further details).

4.2 Impact on water quality

Impacts of effluent discharge on the environment are discussed below. Details of the wastewater recycling and treatment systems are given in section 4.12.

4.2.1 Effect of wastewater discharge on the Yellow River

In accordance with the power plant design, the industrial wastewater and sanitary sewage of the plant will be discharged to the Yellow River via drainage pipelines after being treated to meet national and World Bank standards.

4.2.1.1 Wastewater discharge (1200 MW)

Both dry ash removal and hydraulic ash removal approaches were proposed in the feasibility study. For the hydraulic ash removal alternative, the wastewater discharge volume is 400 t/h, including 100 t/h sanitary sewage, 200 t/h cooling water blowdown and 100 t/h acid & alkali wastewater.

For the dry ash removal alternative, the wastewater discharged is 700 t/h, including 100 t/h sanitary sewage, 500t/h cooling water blowdown and 100 t/h acid & alkali wastewater.

4.2.1.2 Discharge route

A wastewater pipeline will be laid from the wastewater pump house at the site to the Gengqinggou Canal on the bank of the Yellow River. Gengqinggou Canal will be dredged in order to channel the drainage into the Yellow River.

Refer to the Figure 4.2-1 for the location of the point of discharge and a general view of the receiving water course. The figure shows that the receiving course, or Lamawan section, has a low gradient and is straight, with an average width of 600 m

4.2.1.3 Characteristics of discharge

As water quality of Yellow River must conform with the Standard of Category III in "Standard for surface Water Environment Quality" (GB 3838-88), the discharge from the proposed Power Plant is required to follow the Grade I of "Comprehensive Discharging Standard for Industrial Wastewater (GB8978-88)" which applies to newly-built, extension and reconstruction projects.

(1) Industrial wastewater includes cooling water blowdown, effluent from the boiler acid treatment system and sewage from the laboratory, etc. The principal pollutants are acid and alkali, and will be discharged after being treated to meet the discharge standards for pH.

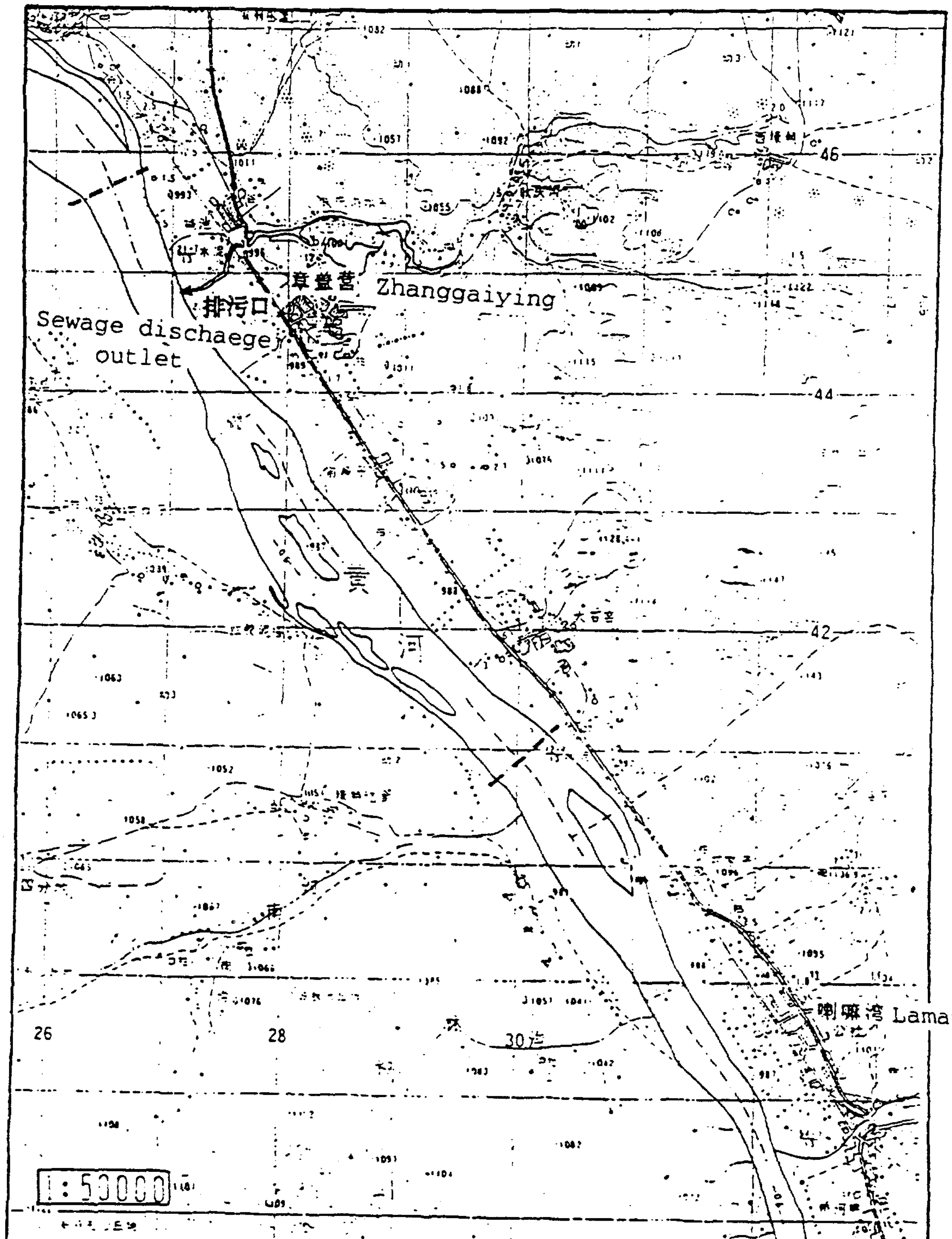


图 4.2-1 电厂排污口位置及排污河段示意图

Fig.4.2-1 General survey of discharging outlet position and river section discharging sewage.

(2) Sanitary sewage: the flow volume is 100 t/h; and the concentration of BOD_5 is approximately 30 mg/l, after treatment in the two-stage biochemical process.

(3) A volume of 10 tons of oil contaminated wastewater is discharged twice a month for a one hour period. A petroleum concentration of 10.0 mg/l can meet the requirements of the Grade I "Comprehensive Discharging Standard for Industrial Wastewater (GB8978-88)" which applies to newly-built, extensions and reconstruction projects.

(4) Water quality at the discharge outlet of the power plant will meet the requirement of the Grade I "Comprehensive Discharging Standard for Industrial Wastewater (GB8978-88)" which applies to newly-built, extensions and reconstruction projects.

See Table 4.2-1 for water quality at the discharge outlet of the power plant

Table 4.2-1

Water quality at discharge outlet of power plant

Item	Wastewater quantity	
	700t/h (dry ash removal)	400t/h(hydraulic ash removal)
	Concentration(mg/l)	
BOD_5	4.20	7.50
COD_{cr}	14.3	25.0
pH value	6-9	6-9
NH_3-N	2.14	3.75
Petroleum	≤10	≤10

Comparison with actual operational data of existing power plants shows that the quality of the various wastewater streams at the discharge outlet would satisfy the control index of the Grade I of "Comprehensive Discharge Standard for Industrial Wastewater (GB8978-88)" which applies to newly-built, extension and reconstruction projects. It can be estimated that no negative environmental impacts will result from wastewater discharged into the Yellow River. The environmental protection requirement for the Yellow River is thus satisfied.

4.2.2 The impact of ash leachate on groundwater

Both hydraulic ash removal and dry ash removal approaches are considered in two proposed ash disposal areas, Fenyan ash disposal area, and Gaobashi ash disposal area respectively. The preferred alternative is hydraulic removal. Dry ash removal system has been discussed. Water used in this system is used only for wetting and mixing dry ash. No ash water seepage would occur. Therefore, there will be no effect on quality of groundwater around the ash disposal area.

Gaobashi ash disposal area is located on mountainous terrain. The hydraulic ash removal alternative is proposed here. For the hydraulic ash removal alternative, the ash and water slurry would be pumped to the ash disposal area, and clear water recycled in the ash disposal system. The ash disposal area will be operated with a water cover on the ash to control fugitive dust. If the ash disposal area were located on permeable soils without a liner system, the phenomenon of phreatic water rising around the ash disposal area would take place because of ash water seepage through soils and the dikes. The ash disposal area can not be efficiently operated with losses from seepage and evaporation, in addition to the requirement to maintain a water cover.

Material for the earth dam will be borrowed from the interior of the ash disposal area if found suitable. If borrow from other areas is used, these borrow areas will be backfilled.

Groundwater modeling indicates that the ash disposal area would pollute groundwater (see Annex 7). There are potable water wells within 500-1000 m of the disposal area. Therefore, soil and groundwater pollution will be prevented by installation of a plastic leachate liner. There are 4 potable water wells within 500 m-1000 m of the proposed ash disposal area. These wells are monitored regularly and monitoring will continue throughout the life of the protect (see Table 3.6-13, wells Gaobashi, Mahuangtan, Huwulangying.

Geotextile liner system

There is sufficient clay within most of the disposal area to provide a 300 mm minimum base layer for the geotextile/ plastic liner. The liner material is in use internationally(Japan, England, France, U.S., and others), and is 3-4 mm thick. In areas where a sand or clay base is not available, a minimum of 300 mm clay will be spread as base material for the liner. In order to prevent liner damage from construction and weathering a protective layer of clay will be installed above the liner 300-500 mm thick. International experience with these liner systems has shown that they are serviceable for 20-30 years, sufficient for this project.

Runoff collection trench

A runoff collection trench will be installed around the perimeter of the ash disposal area, water collected will drain to a sump, and be pumped into the ash slurry system.

The groundwater impact analysis of Gaobashi ash disposal area follows.

4.2.2.1 Selection of pollution factors

In the proposed project, all the water used in ash disposal shall be recycled, except for that which evaporates or blown down from the system. The recycling rate is 50%. Make up water for ash removal will be replenished with cooling tower blowdown. Water from the rainfall collection trench is drained to a sump and put back into the ash slurry transport system. The amount of water used in ash removal is about 1200 m^3/h (2 x 600 MW). The ratio of ash and water is 1:4.5~1:5.5.

According to ash leachate test results (see Annex 8) on coal ash of the Zhungeer coal conducted by Inner Mongolia Electric Power Design Institute (IMEPDI), all parameters can meet Class III for surface water quality and sanitary standards for potable water, except for the pH value and concentration of fluorine in the ash leachate. Thus we chose pH value and fluorine as major pollution factors for water quality impact predictions.

4.2.2.2 Survey of hydrogeologic conditions of Gaobashi ash disposal area

(1) Survey of Gaobashi ash disposal area

Gaobashi ash disposal area is located on a hillside; dams would be built on three sides and the mountainside would form the fouth side. When hydraulic ash removal is used, the dams will be built on several phases. There are two methods for building the dams, i.e. making upper stages high or lower stages high. All the parameters of the ash disposal area for these two methods are shown in Table 4.2-6.

Table 4.2-6

Survey of ash disposal area

alternative		area of land occupied (km^2)	height of piled ash max. (m)	Volume of ash stored (10^6m^3)	Service years (year)	main engine-engineering		
						Dam (10^6m^3)	gravel (10^4m^3)	Geotextile (10^4m^2)
Making upper reaches high	Ash disposal area in first phase	2.41	10	12.40	10	1.28	4.80	1.19
	Planned capacity	5.49	30	74.32	20	4.10	9.81	3.60
Making lower reaches high	Ash disposal area in first phase	2.80	10	12.40	10	1.28	3.55	
	Planned capacity	6.79	30	74.32	20	10.72	8.01	

Notes: Installed capacity in the first phase is 2 x 600 MW;
Planned capacity is 6 x 600 MW.

(2)Hydrogeological conditions

According to "Engineering geologic survey report of ash and slag transfer station and ash disposal area engineering of Houqipu on the proposed project of TuoKeTuo Power Plant (plant A)", groundwater is stored in a loose subsidence layer of the Quaternary period near Gaobashi ash disposal area (Houqipu ash disposal areaThe water table is unconfined (phreatic). The depth to groundwater is between 1.70~6.10 m, and average depth is 4.0 m. The silt sand and silt soil are found on the surface with thicknesses of 3.0 m. The water bearing stata are the silt soils of the second layer and clay and middle coarse sand of the third layer. The thickness of the water bearing stata is 8.0~9.0 m.

Parameters for model calculation (parameters of media)

media	thickness (m)	permeable coefficient ($x10^{-4}$cm/s)	porosity	Vertical degree of diffusion (1)(cm)	Horizontal degree of diffusion (l)(cm)	ratio of storing water(2) (m^{-1})
silt sand	1.30	$4.79x10^{-1}$	0.846	10.00	0.01	0.19
Silt soil	1.00	$4.52x10^{-1}$	0.889	7.51	0.008	0.20
Clay	3.50	$1.04x10^{-8}$	0.627	6.18	0.001	0.22
Middle coarse sand	4.00	$5.64x10^{-5}$	0.578	15.32	0.07	0.23

Flow direction of ground water is affected by topography and the catchment water system. The hydraulic gradient is about 2~5 %, flowing from northeast to southwest. Groundwater in the area of the ash disposal area is recharged with seepage from upper reaches, and precipitation.

Groundwater modeling results

The results of groundwater modeling indicate the need for a liner in the ash disposal area. The groundwater modeling results are shown graphically and explained below. Leachate tests indicate that pH and flouride are the pollution parameters of concern, therefore, modeling was carried out on these two parameters.

Figure 4.2-2~Figure 4.2-21 show the concentration of pH and flouride. At the 5th year, 15th, 20th, 25th year in the lowest level of ash disposal area. Taking rise in pH value of 0.5 ppm and rise of flouride concentration of 0.1 ppm as the criteria, we can see:

(1) The concentration of pH and flouride will rise as groundwater is affected by ash water within the range of 500 m outside ash disposal area in 5th year.

(2) The dispersion zone of pollutants is approximately 0~1000 m from the 5th year to 10th year .

(3) The impact area of pH value and flouride is steady and limited within the range of 1000 m basically from 10th to 15th year.

(4) From the 15th year to 25th year, the affected zone is limited within 1500 m.

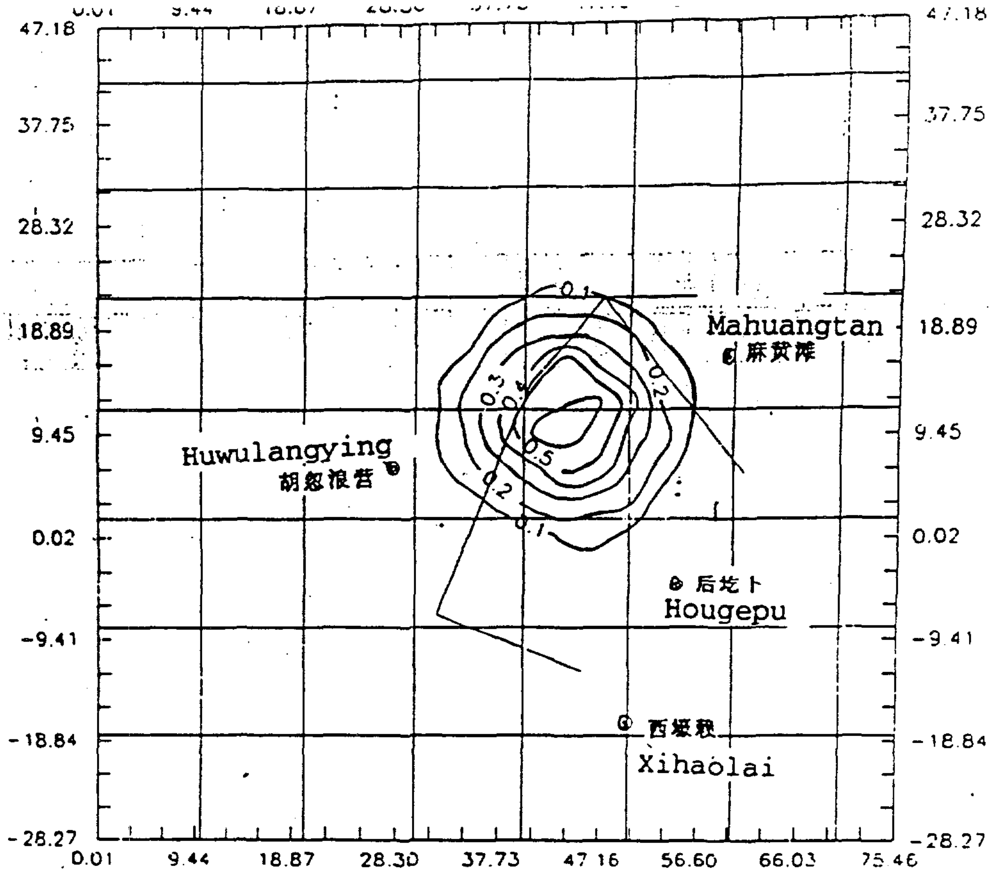


图 4.2-2 氟 (第 5 年) Fluorine (the 5th year)

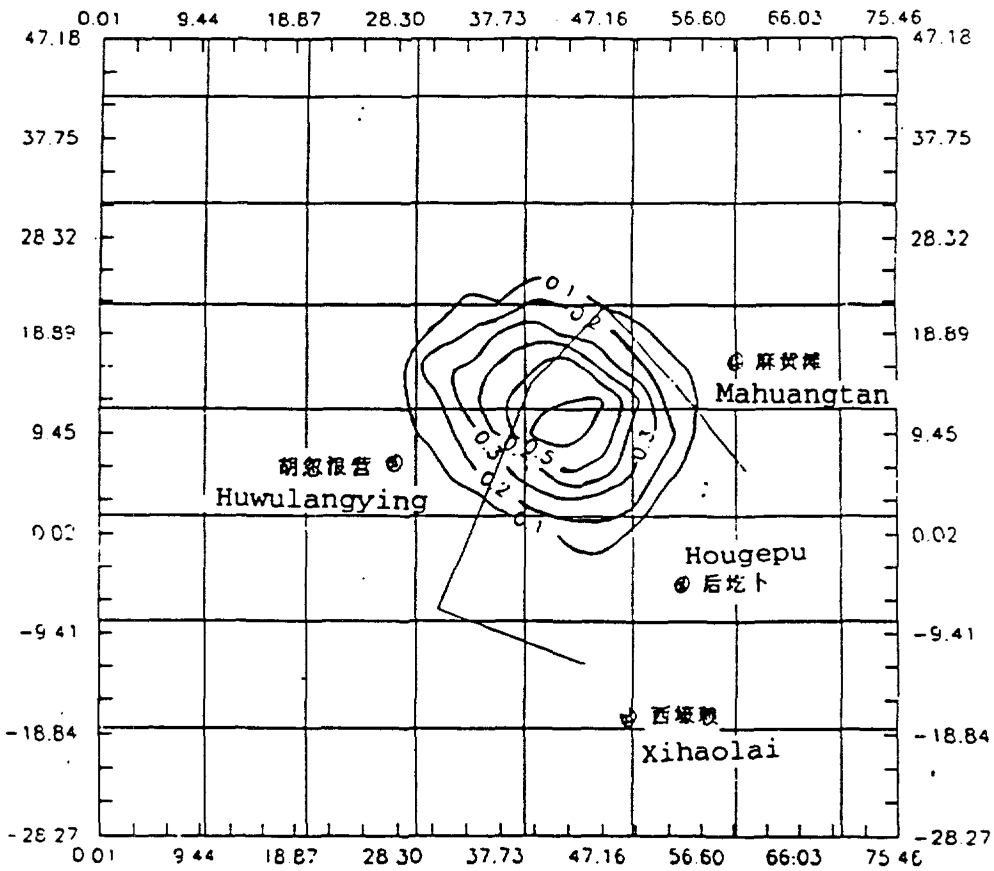


图 4.2-3 氟 (第 10 年)
Fluorine (the 10th year)

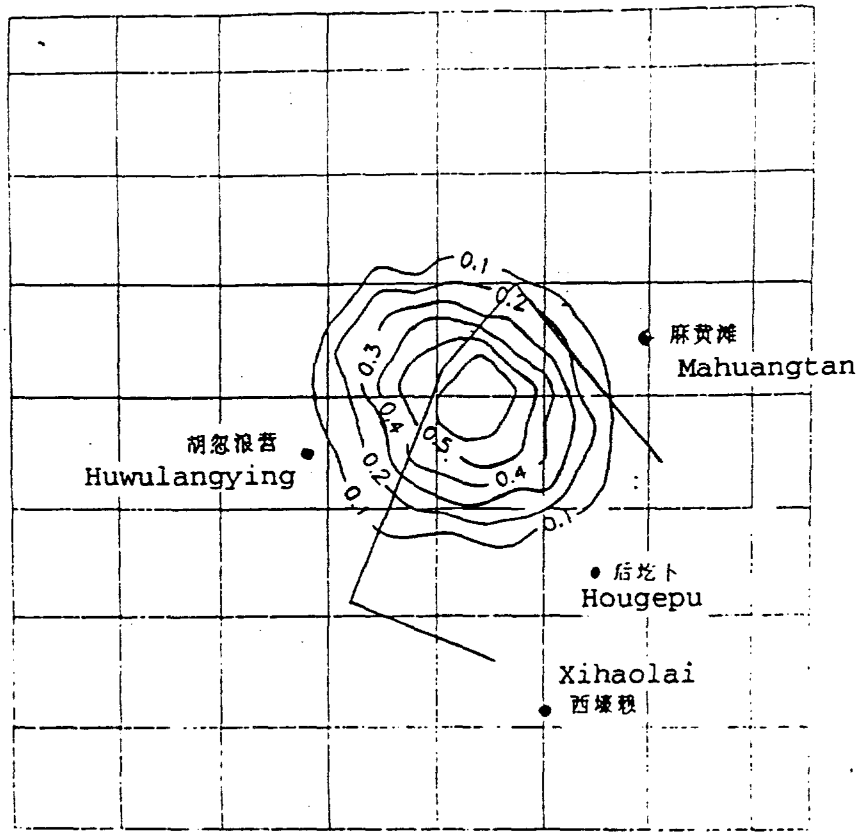


图 4.2-4 氟 (第 15 年) Fluorine (the 15th year)

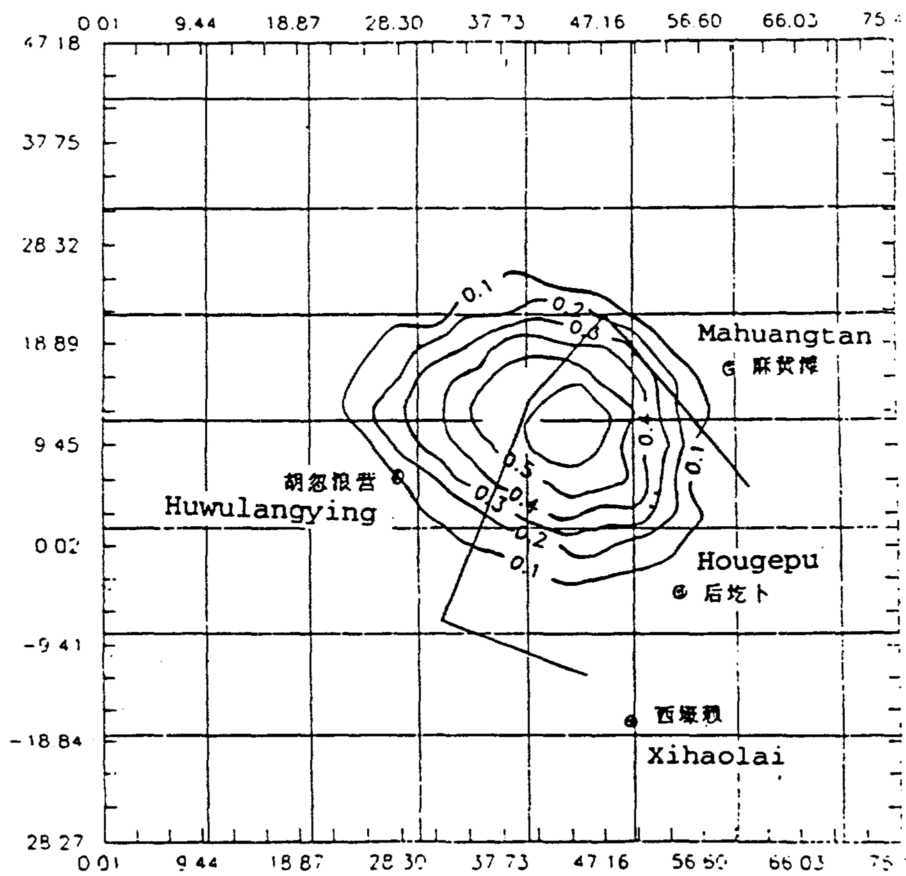


图 4.2-5 氟 (第 20 年)
Fluorine (the 20th year)

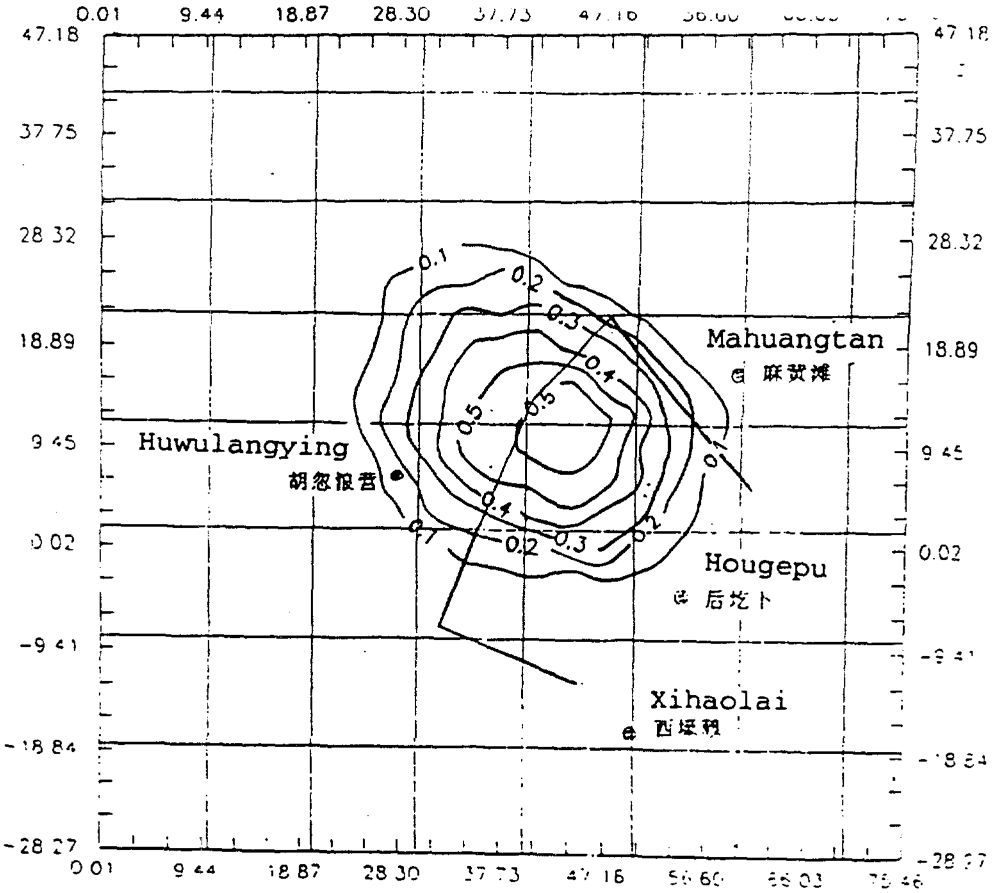


图 4.2-6 Fluorine (the 25th year)
氟 (第 25 年)

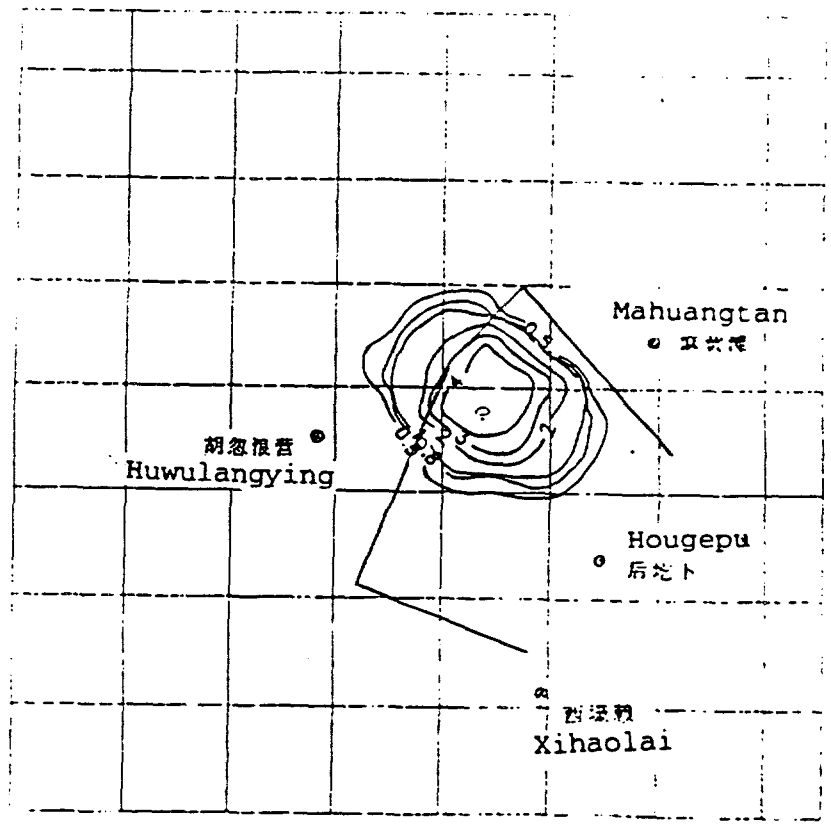


图 4.2-7 PH (第 5 年)
pH (the 5th year)

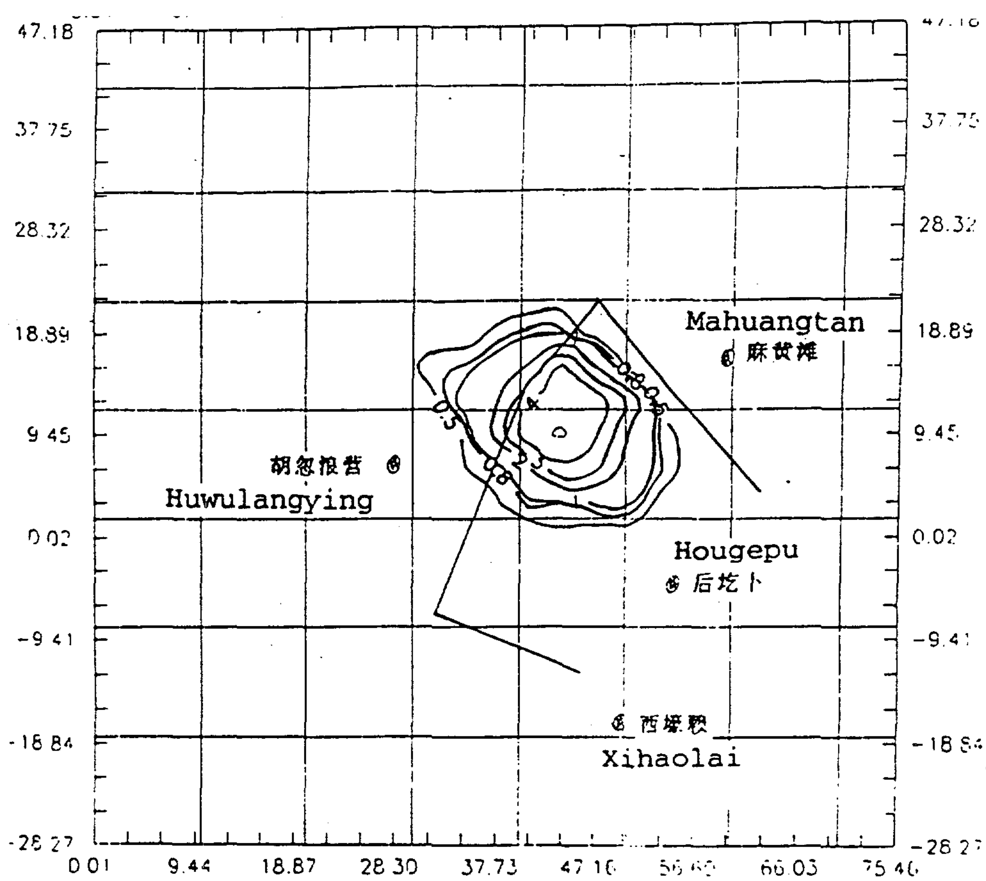


图 4.2-8 PH (第 10 年)

pH (the 10th year)

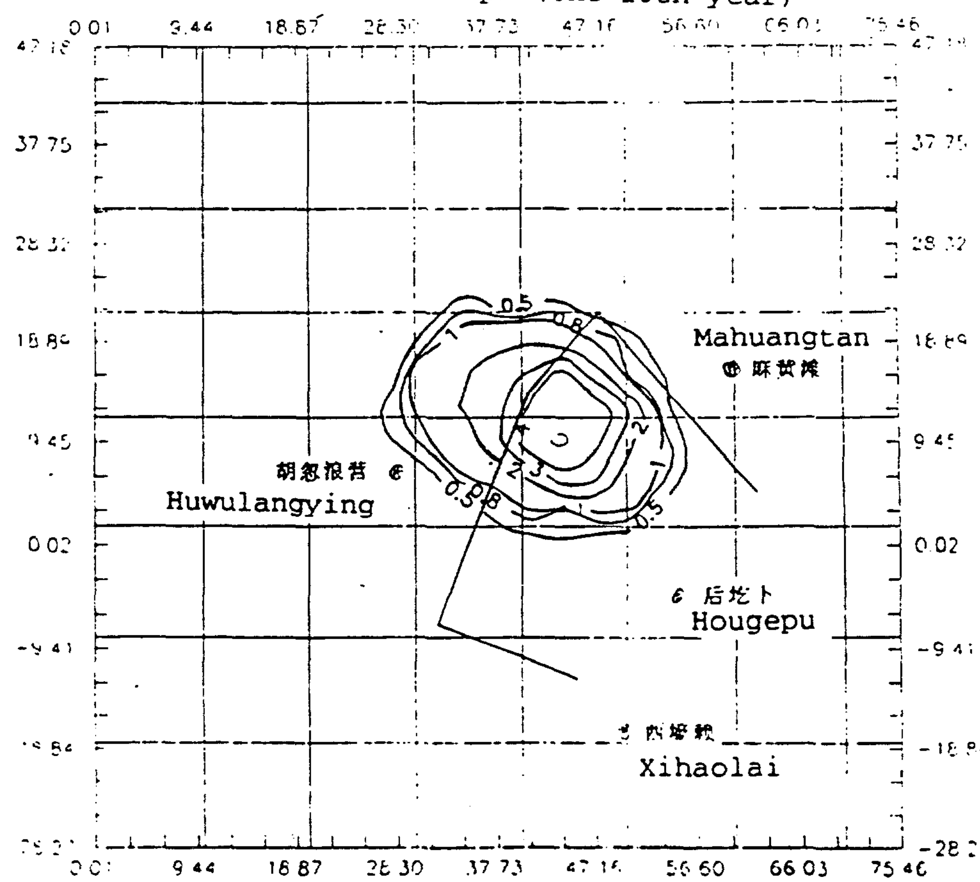
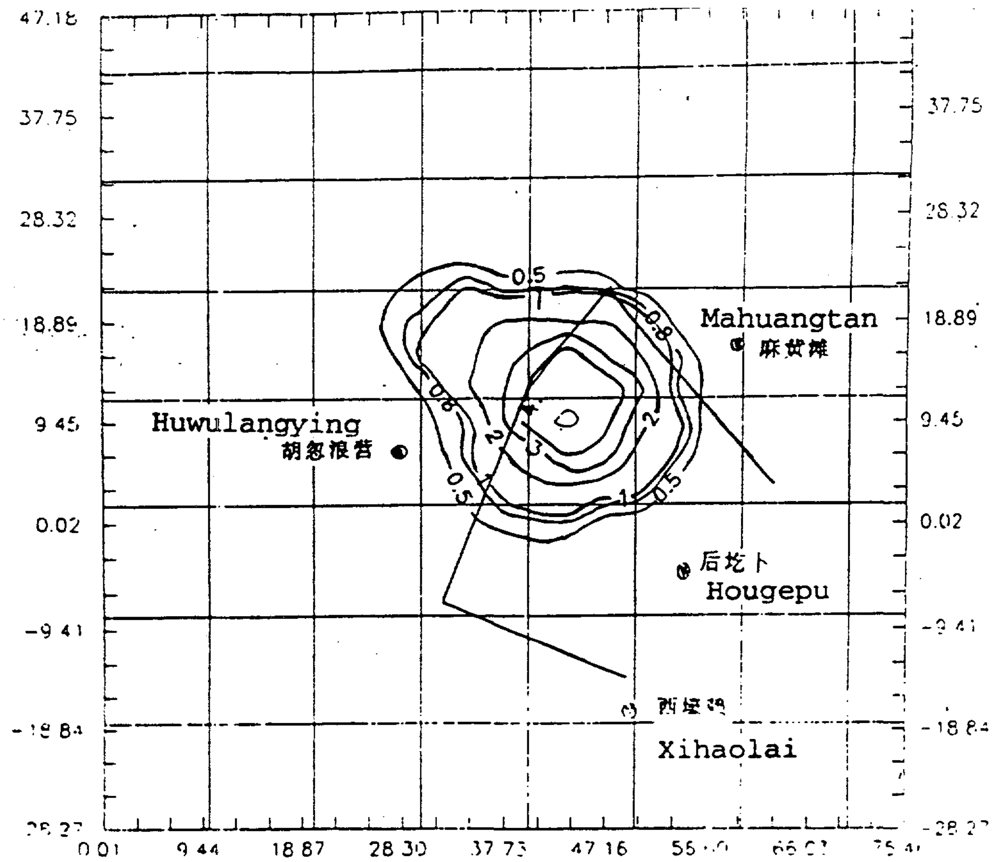


图 4.2-9 PH (第 15 年)

pH (the 15th year)



pH (the 20th year)

图 4.2-10 PH (第 20 年)

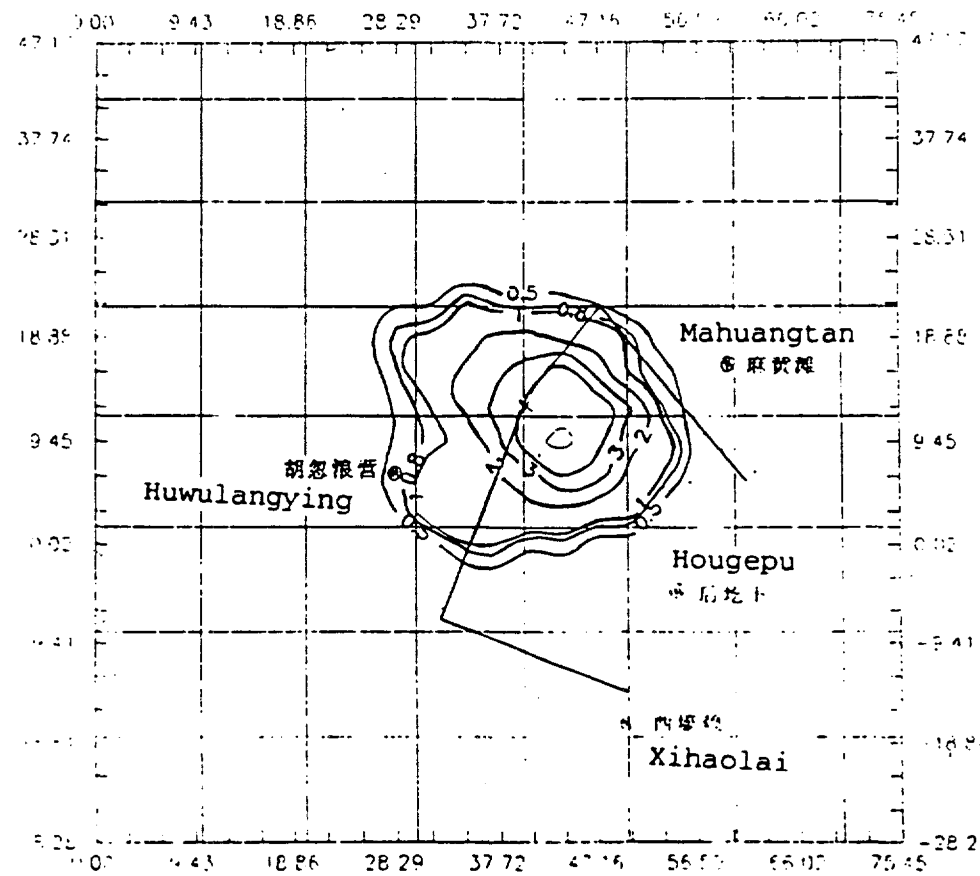
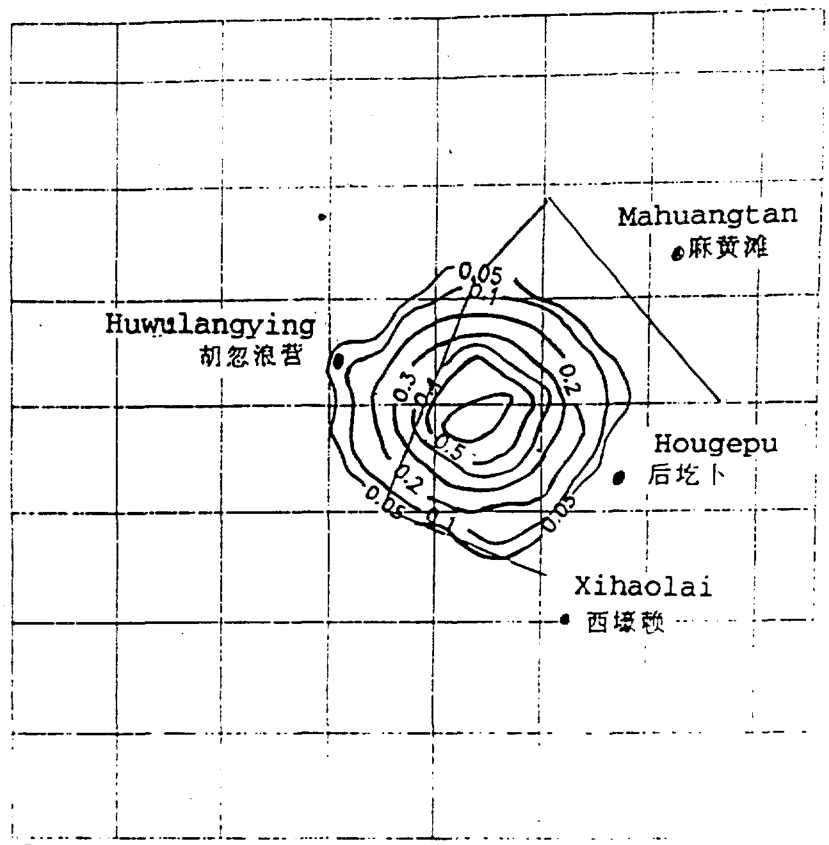


图 4.2-11 PH (第 26 年)

pH (the 25th year)



Fluoride isoline of ground water of ash yard (the 5 year) scale 1:50000 图 4.2-12 灰场地下水氟化物等值线图 (第5年) 比例尺1:50000

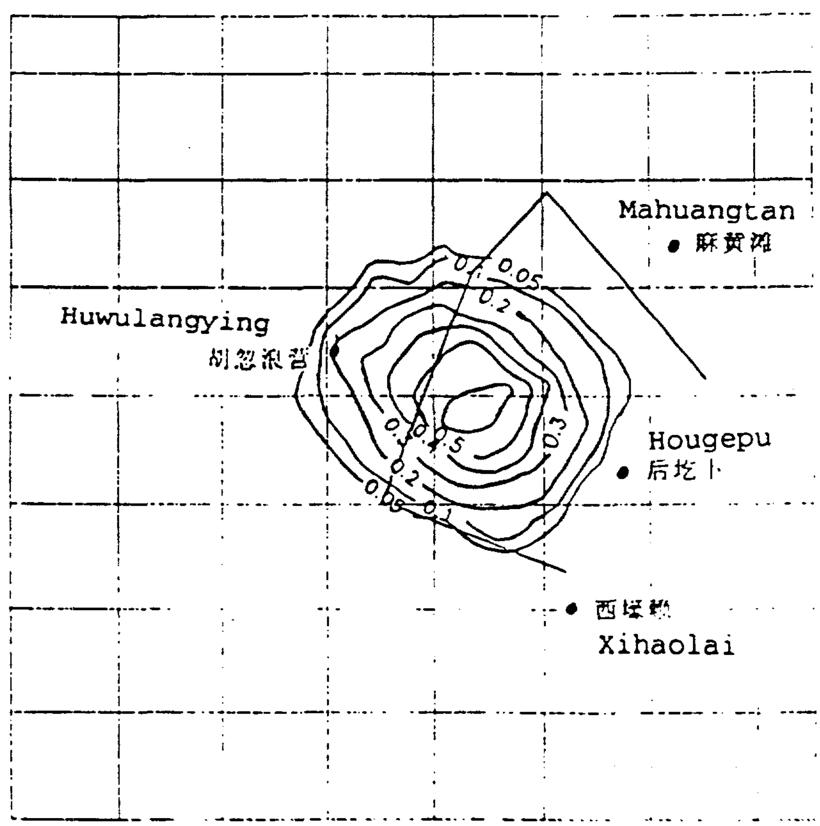
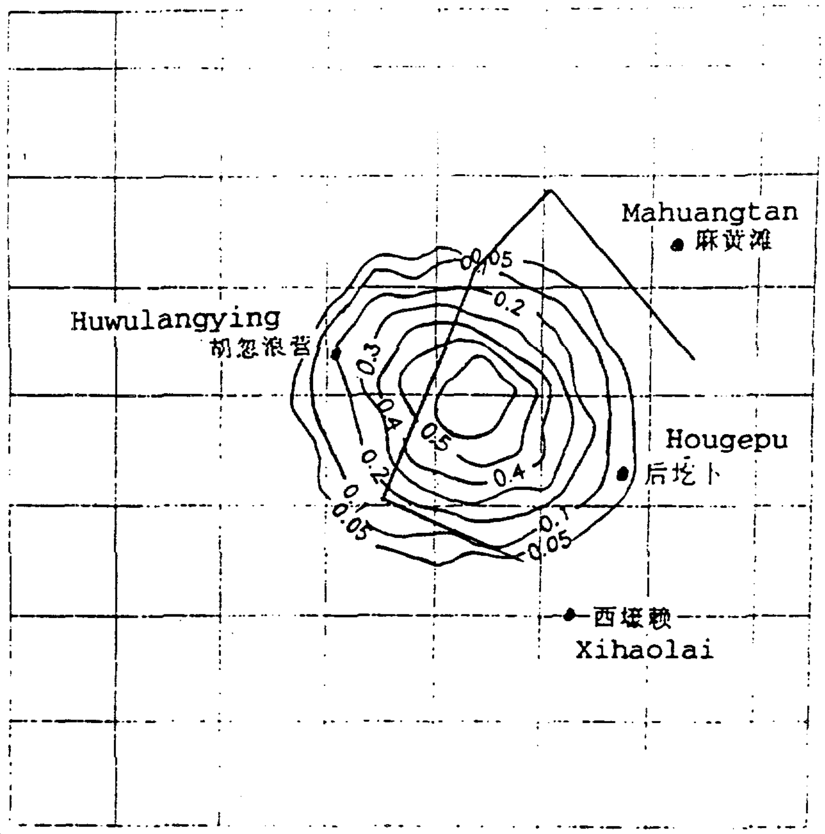


图 4.2-13 灰场地下水氟化物等值线图 (第10年) 比例尺1:50000
Fluoride isoline of ground water of ash yard (the 10 year) scale 1:50000



Fluoride isoline of ground water of ash yard (the 15 year) scale 1:50000

图 4.2-14 灰场地下水氟化物等值线图 （第15年） 比例尺1:50000

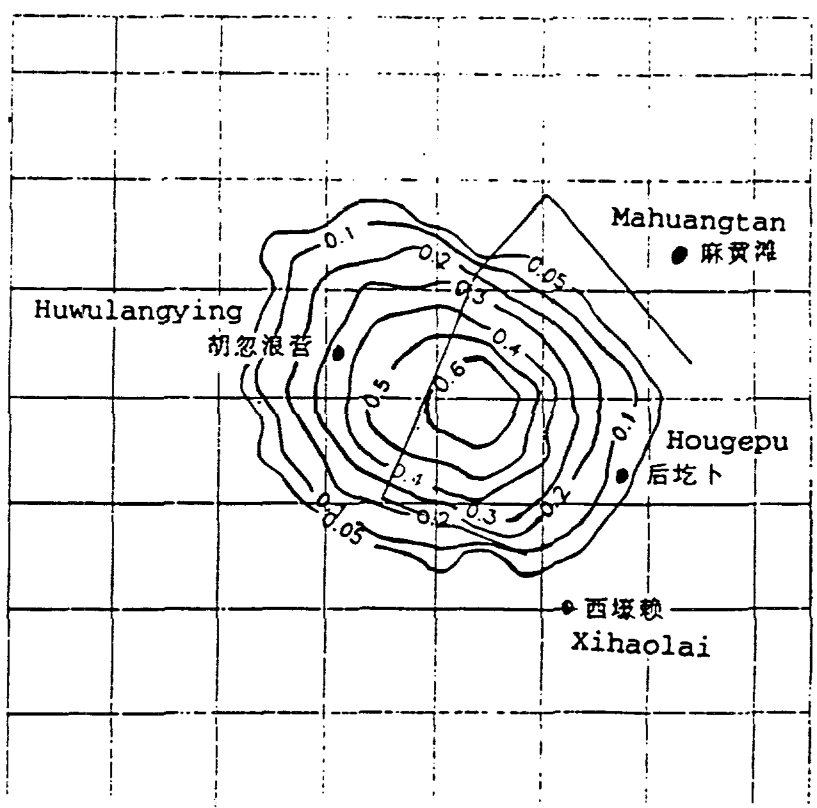
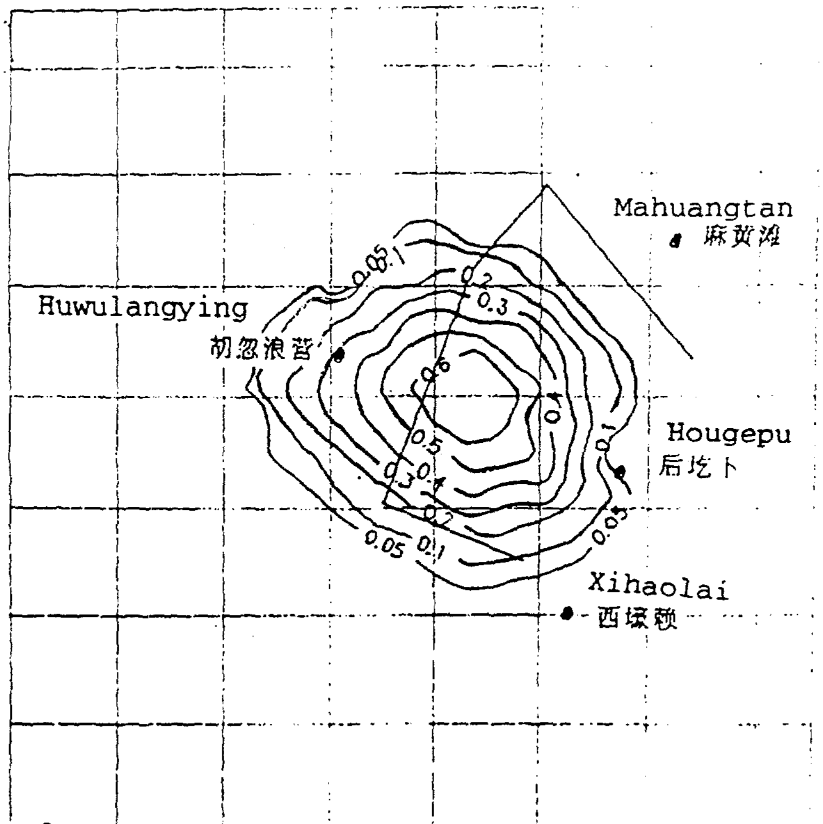


图 4.2-15 灰场地下水氟化物等值线图 （第20年） 比例尺1:50000

Fluoride isoline of ground water of ash yard (the 20 year) scale 1:50000



Fluoride isoline of ground water of ash yard (the 25 year) scale 1:50000

图 4.2-16 灰场地下水氟化物等值线图 （第25年） 比例尺 1:50000

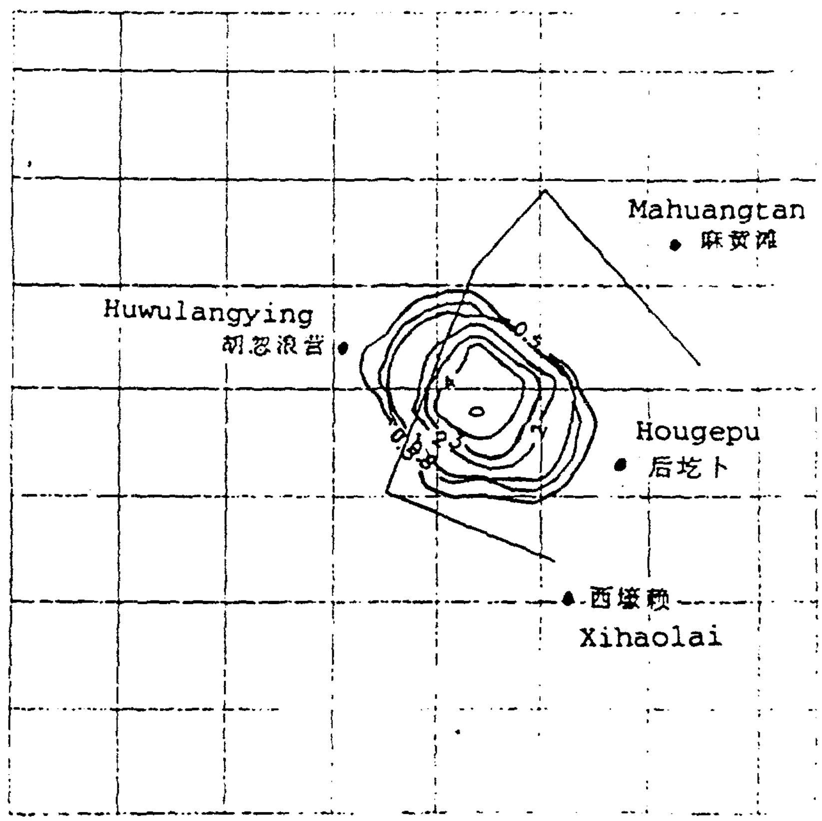
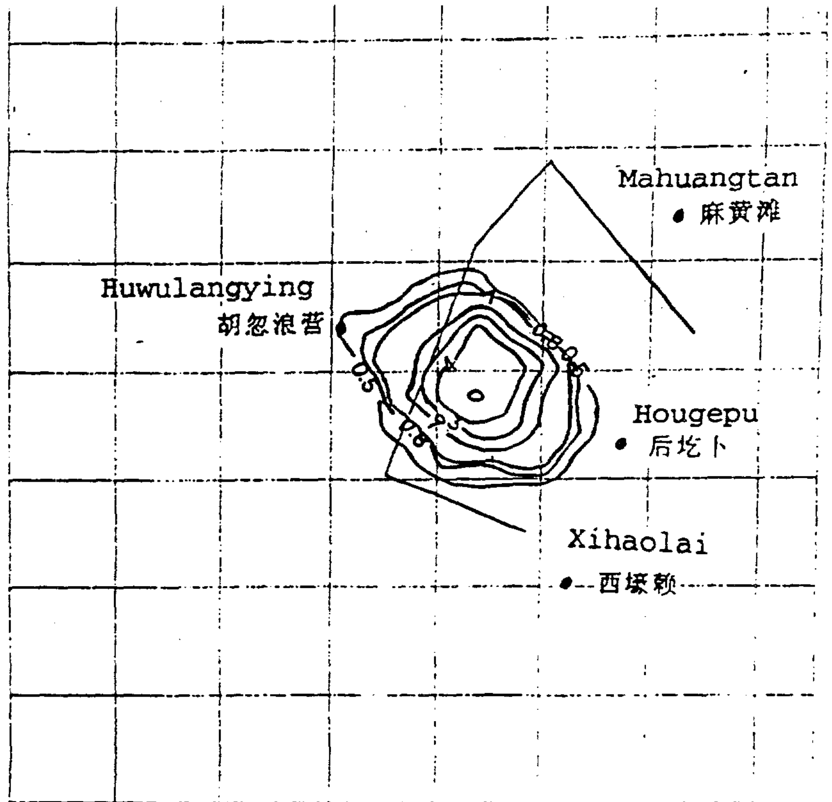


图 4.2-17 灰场地下水PH等值线图 （第5年） 比例尺 1:50000

PH isoline of ground water of ash yard (the 5 year) scale 1:50000



PH isoline of ground water of ash yard (the 10 year)
scale 1:50000
图 4.2-18 灰场地下水PH等值线图 （第10年） 比例尺1:50000

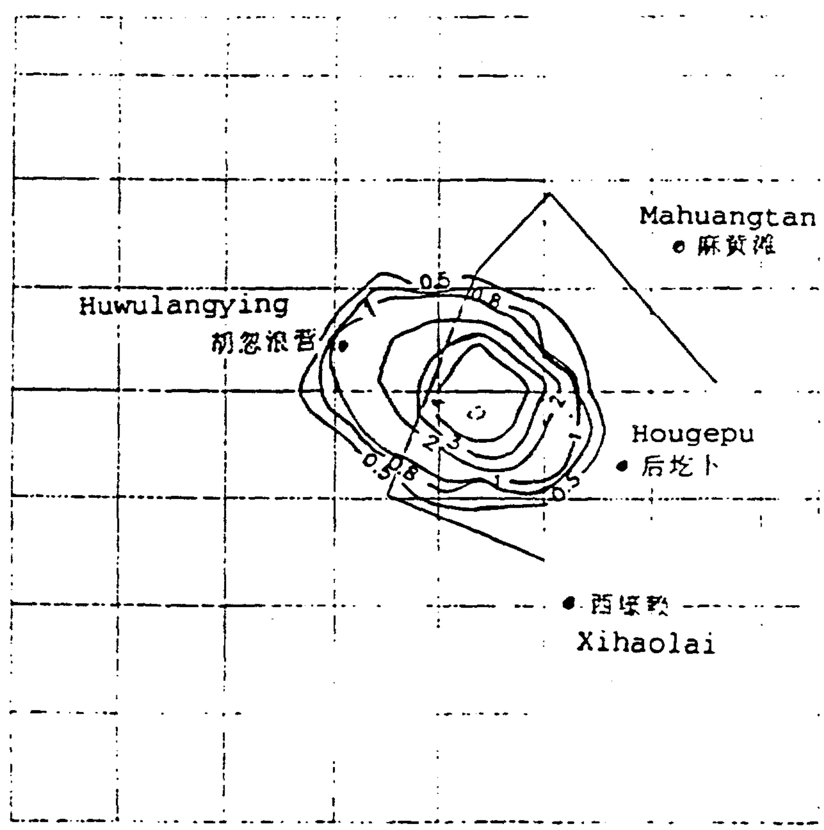
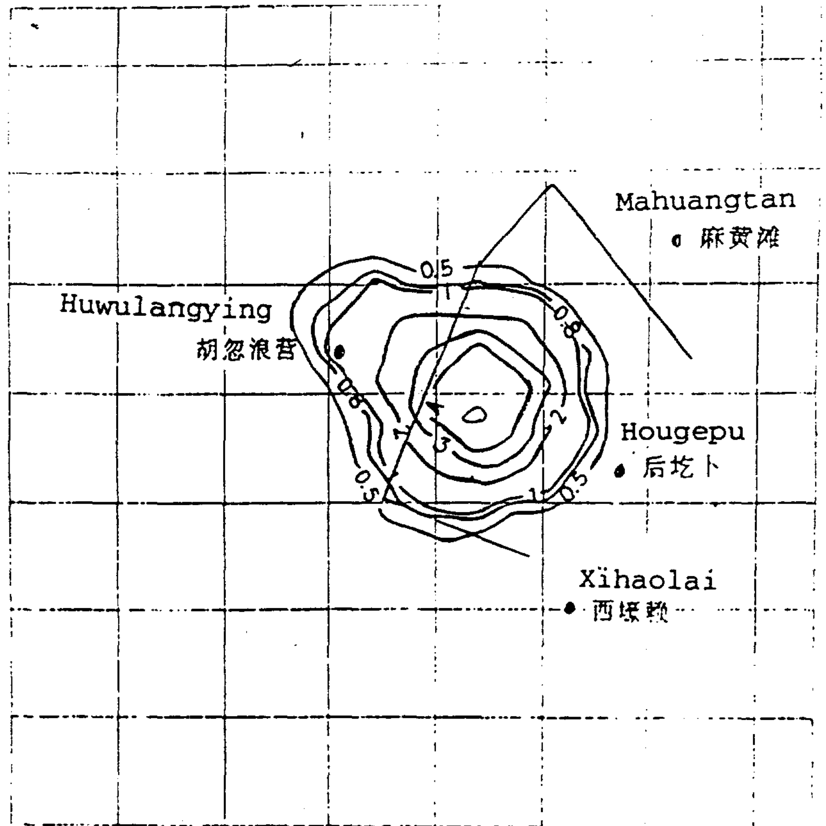


图 4.2-19 灰场地下水PH等值线图 （第15年） 比例尺1:50000
PH isoline of ground water of ash yard (the 15 year)
scale 1:50000



PH isoline of ground water of ash yard (the 20 year)
scale 1:50000
图 4.2-20 灰场地下水PH等值线图 （第20年） 比例尺1:50000

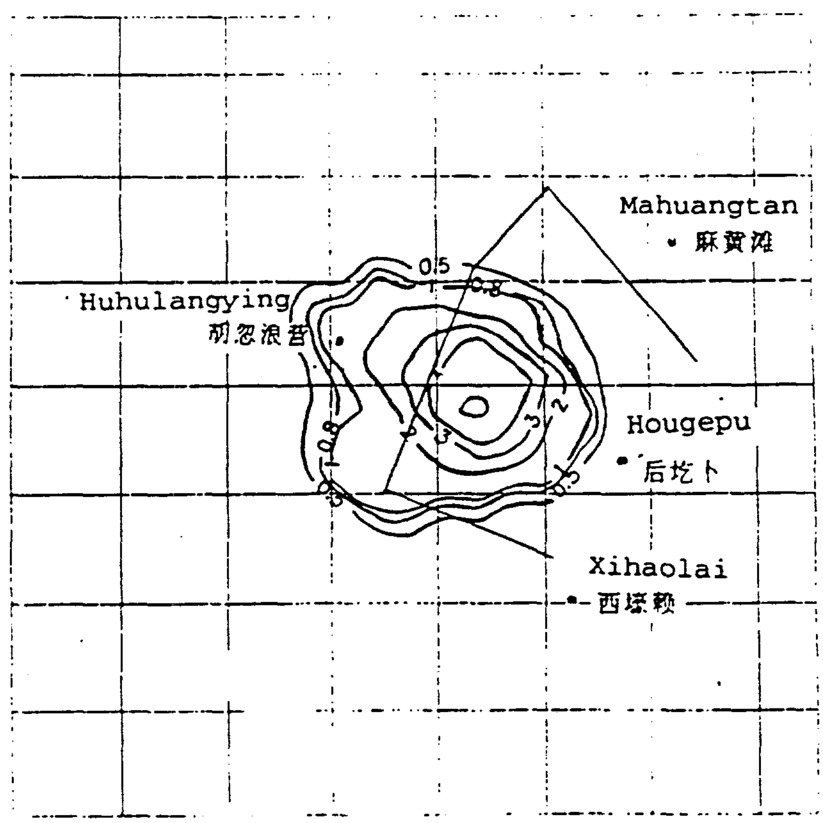


图 4.2-21 灰场地下水PH等值线图 （第25年） 比例尺1:50000
PH isoline of ground water of ash yard (the 25 year)
scale 1:50000

Figure 4.2-22~Figure 4.2-31 show the vertical and horizontal distributions of pH and flouride. At the 5th, 10th, 15th, 20th, 25th, years, under the worst case conditions.

(1) The concentration of pH and flouride will rise as groundwater is affected by ash water within the rang of 700 m outside ash disposal area.

(2) The impact zone of pollutants is approximately 0~1000 m from the 5th year to the 10th year .

(3) The impact area of pH value and flouride is limited within 1200 m from the 10th to the15th year.

(4) Pollution quantity tends steady basically from the 15th year to 25th year. The impact zone of pollutants is controlled with 1500 m.

(5) The dam is 500 m from Huhulangyeng at the closest point. So the leachate of the ash disposal area would affect Huhulangying during operation period of ash disposal area within 5 years.

4.2.2.3 through 4.2.2.6 (Void)

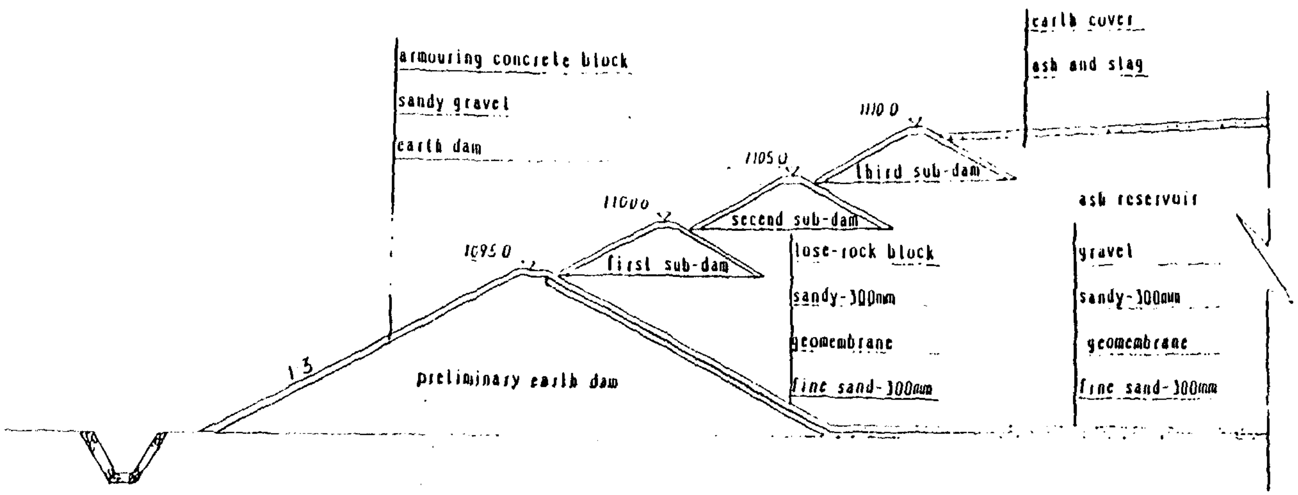
4.2.2.7 Engineering geology of Gaobashi ash disposal area (Section drawing for Gaobashi Ash Yard Dam: see Fig. 4.2 AAA)

In addition to groundwater modeling, an engineering study of Gaobashi disposal area was conducted to evaluate pollution potential. In feasibility study design of TuoKeTuo Power Plant A, the survey department of North China Electric Power Design Institute carried out a field survey during March to April, 1994 and completed "Engineering Geologic Survey Report of Ash and Slag Centralized Transportation Station and Ash Disposal Area Engineering of Houqipu (Gaobashi) on New Construction Project of TuoKeTuo Power Plant A (feasibility)" in May, 1994. The report is summarized below.

According to the report, six borings were made at Gaobashi, the total footage is 55.00 m The maximum depth of borings was 10.00 m. The following field activities were performed at ten deep wells: standard penetration experiments (11), undisturbed soil samples (10), and disturbed soil samples (11). In excavations ($160m^3$) with maximum depth of 4.0 m and total footage of 31.00 m, undisturbed soil samples (17), and disturbed soil samples (2) were taken. The locations of sampling wells are shown on Figure 4.2-32.

Engineering geology sections from boring data are shown in Figures 4.2-33~4.2-40.

From Engineering geology section diagrams we can see that ground water level in wells 6,7,8,8',T_4,K_4,K_1 is higher, depth is between 1.70 m~6.10 m.



SECTION DRAWING FOR GAO BA SHI ASH YARD DAM (FIG. 4.2-AAA)

ILLUSTRATION

THIS DIAGRAM SHOWS THE GEOMEMBRANE IN GAOBASHI ASH YARD

水利电力部华北电力设计院	托克托发电厂A厂 工程	设计
	高宝什贮灰场剖面示意图 （水力除灰灰场防渗方案）	
	图号	

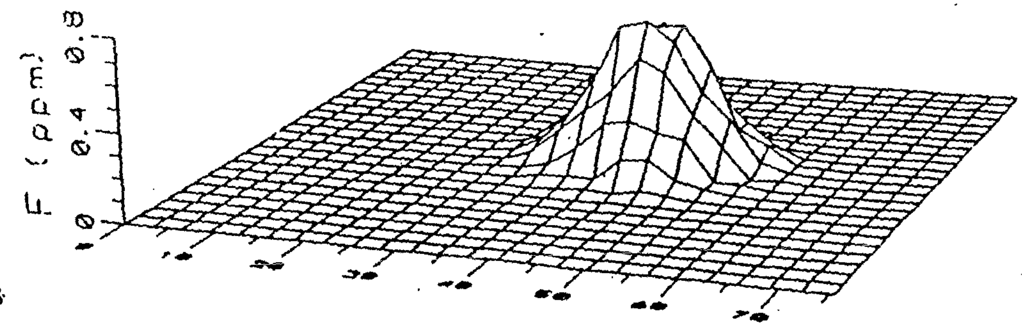


图 4.2-22 灰场地下水氟化物立体图 （第5年） 水平座标×100m

Fig.4.2-22 Fluoride three-dimensional diagram of ground water of ash yard (the 5 year) Horizontal coordinate x 100m

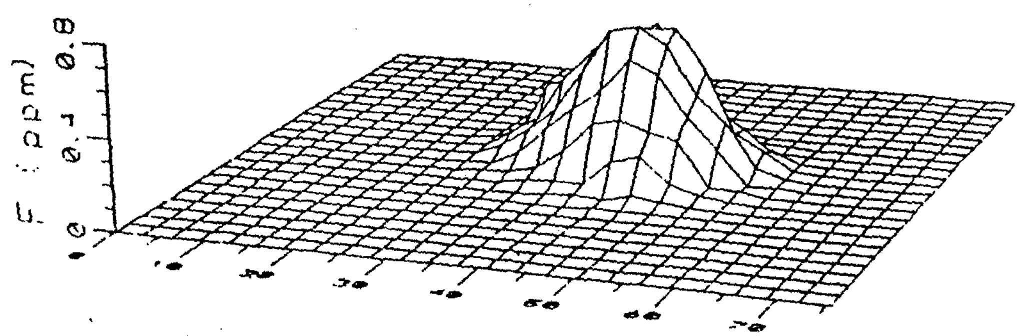


图 4.2-23 灰场地下水氟化物立体图 （第10年） 水平座标×100m

Fig.4.2-24 Fluoride three-dimensional diagram of ground water of ash yard (the 10 year) Horizontal coordinate x 100m

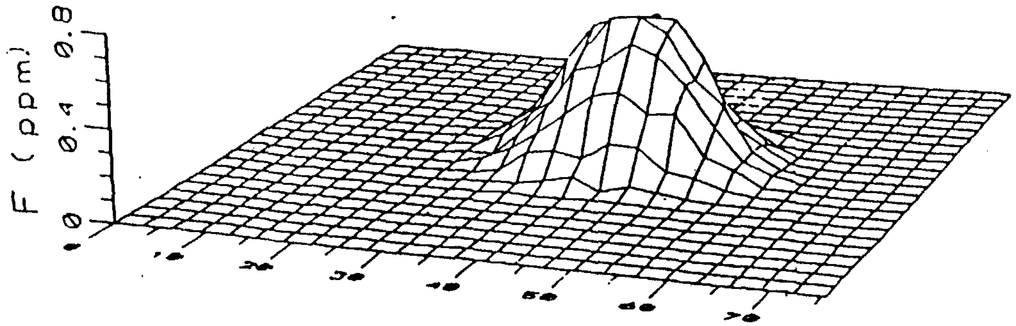


图 4.2-24 灰场地下水氟化物立体图 （第15年）水平座标×100m

Fig.4.2-24 Fluoride three-dimensional diagram of ground water of ash yard (the 15 year) Horizontal coordinate x 100m

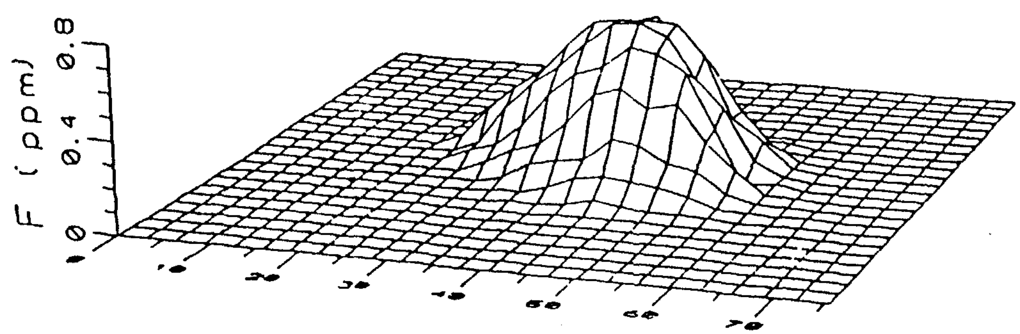


Fig.4.2-25 Fluoride three-dimensional diagram of ground water of ash yard (the 20 year) Horizontal coordinate x 100m

图 4.2-25 灰场地下水氟化物立体图 （第20年）水平座标×100m

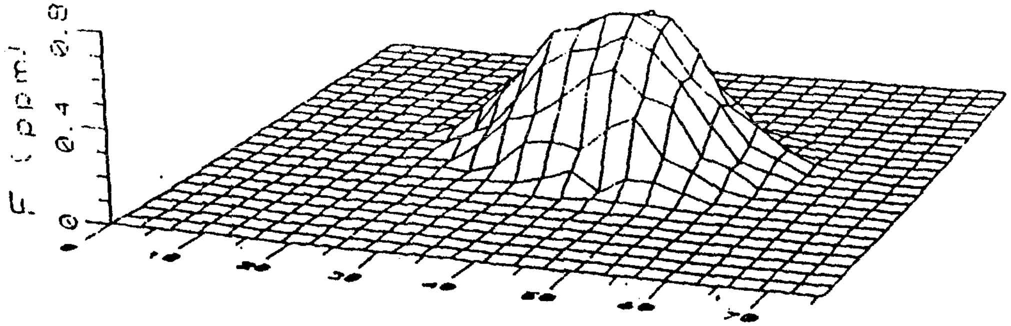


图 4.2-26 灰场地下水氟化物立体图 （第25年）水平座标×100m

Fig.4.4-26 Fluoride three-dimensional diagram of ground water of ash yard (the 25 year) Horizontal coordinate x 100m

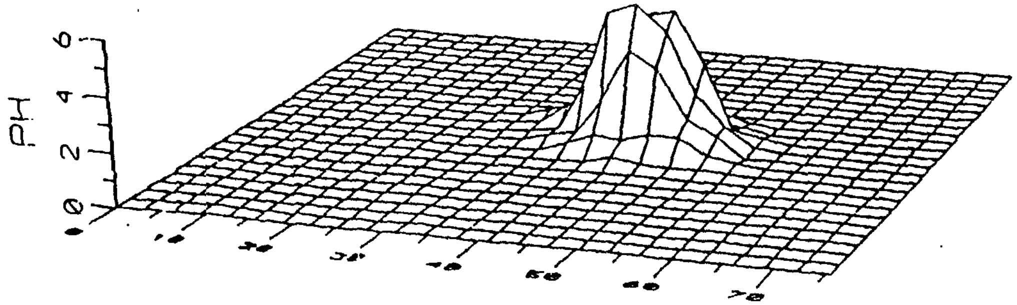


Fig.4.2-27 pH three-dimensional diagram of ground water of ash yard (the 5 year) Horizontal coordinate x 100m

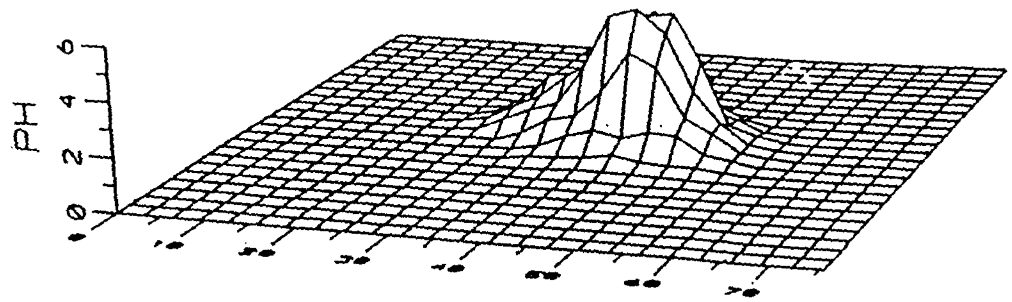


图 4.2-28 灰场地下水PH立体图 （第15年） 水平座标×100m

Fig.4.2-28 PH three-dimensional diagram of ground water of ash yard (the 15 year) Horizontal coordinate x 100m

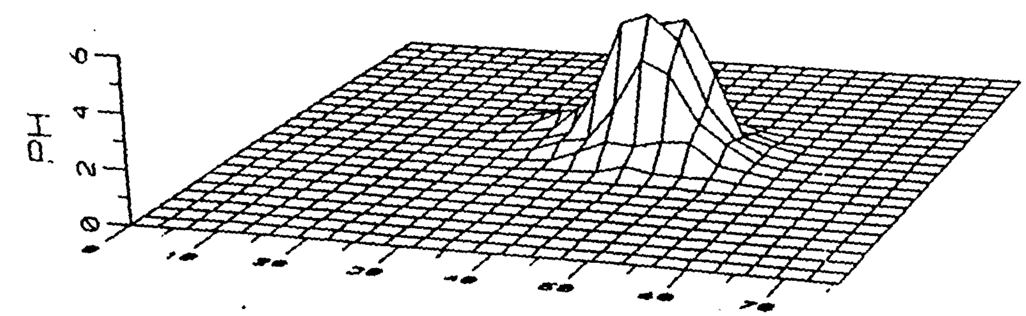


Fig.4.2-29 PH three-dimensional diagram of ground water of ash yard (the 10 year) Horizontal coordinate x 100m

图 4.2-28 灰场地下水PH立体图 （第10年） 水平座标×100m

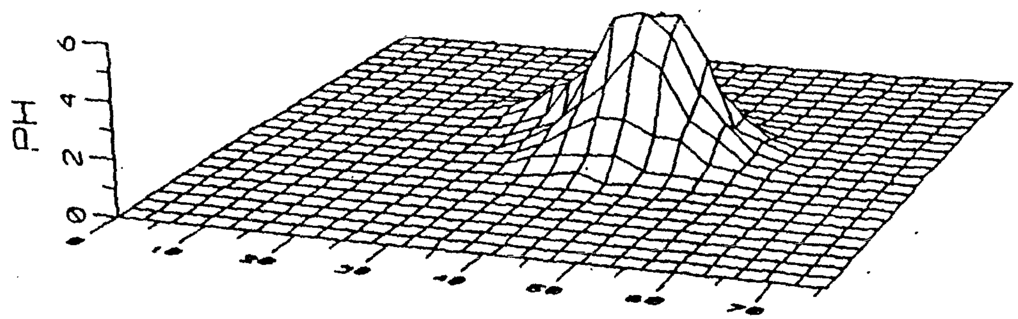


图 4.2-30 灰场地下水PH立体图 （第20年） 水平座标×100m

Fig.4.2-30 PH three-dimensional diagram of ground water of ash yard (the 20 year) Horizontal coordinate x 100m

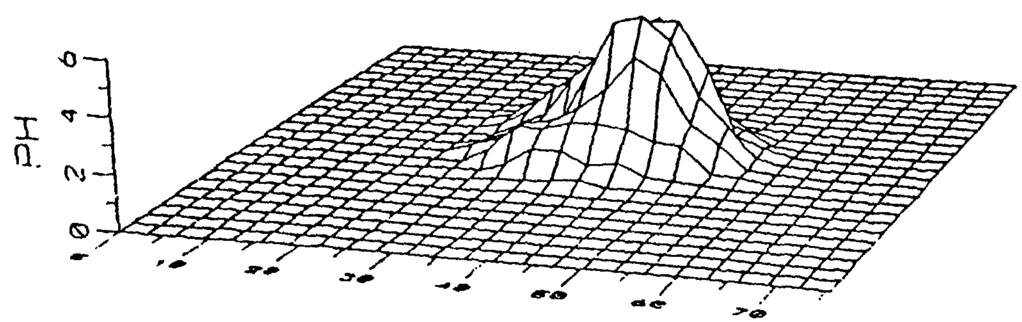
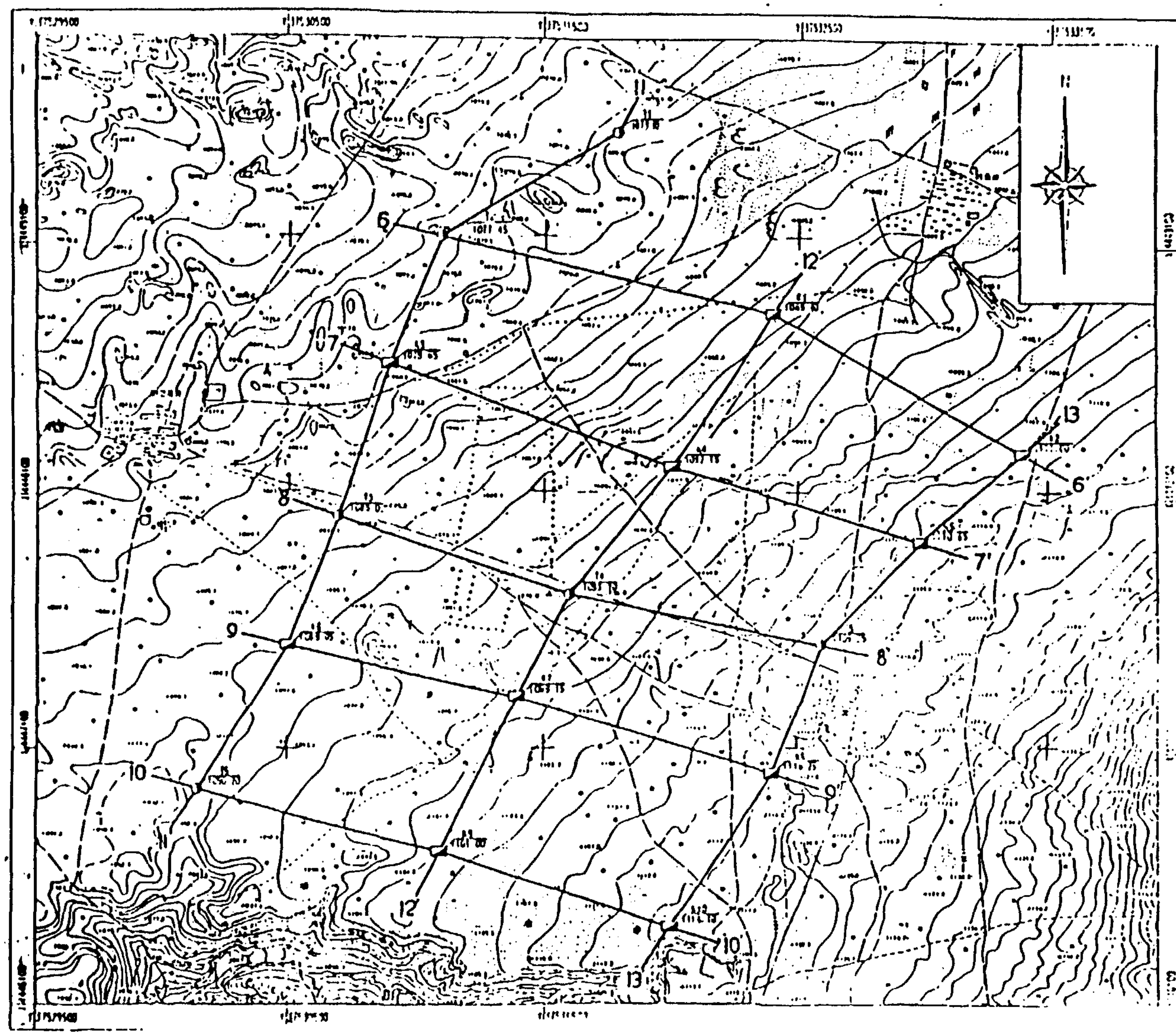


图 4.2-31 灰场地下水PH立体图 （第25年） 水平座标×100m

Fig.4.2-31 PH three-dimens' 'al diagram of ground water of ash yard (the 25 year) Horizontal coordinate x 100m



图例 Legend

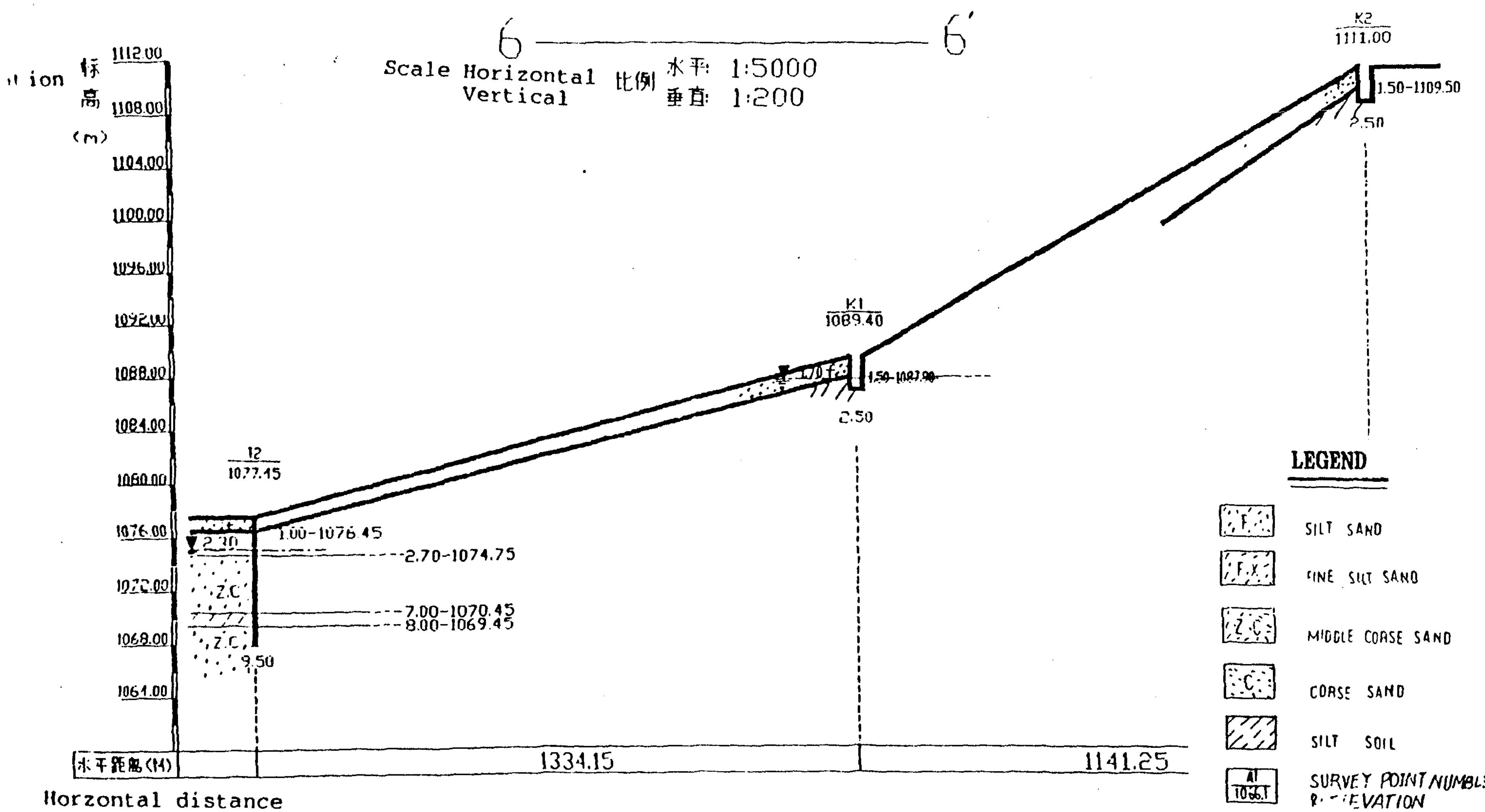
Surveying point and number
勘测模号及编号
Technically drilled hole
技术性钻孔
Technically exploired wel
技术性探井
勘测模剖面线及地面标高
Surveying point sectional line and ground elevation

Microstation CAD

图 4.2-32 勘探点平面布置图

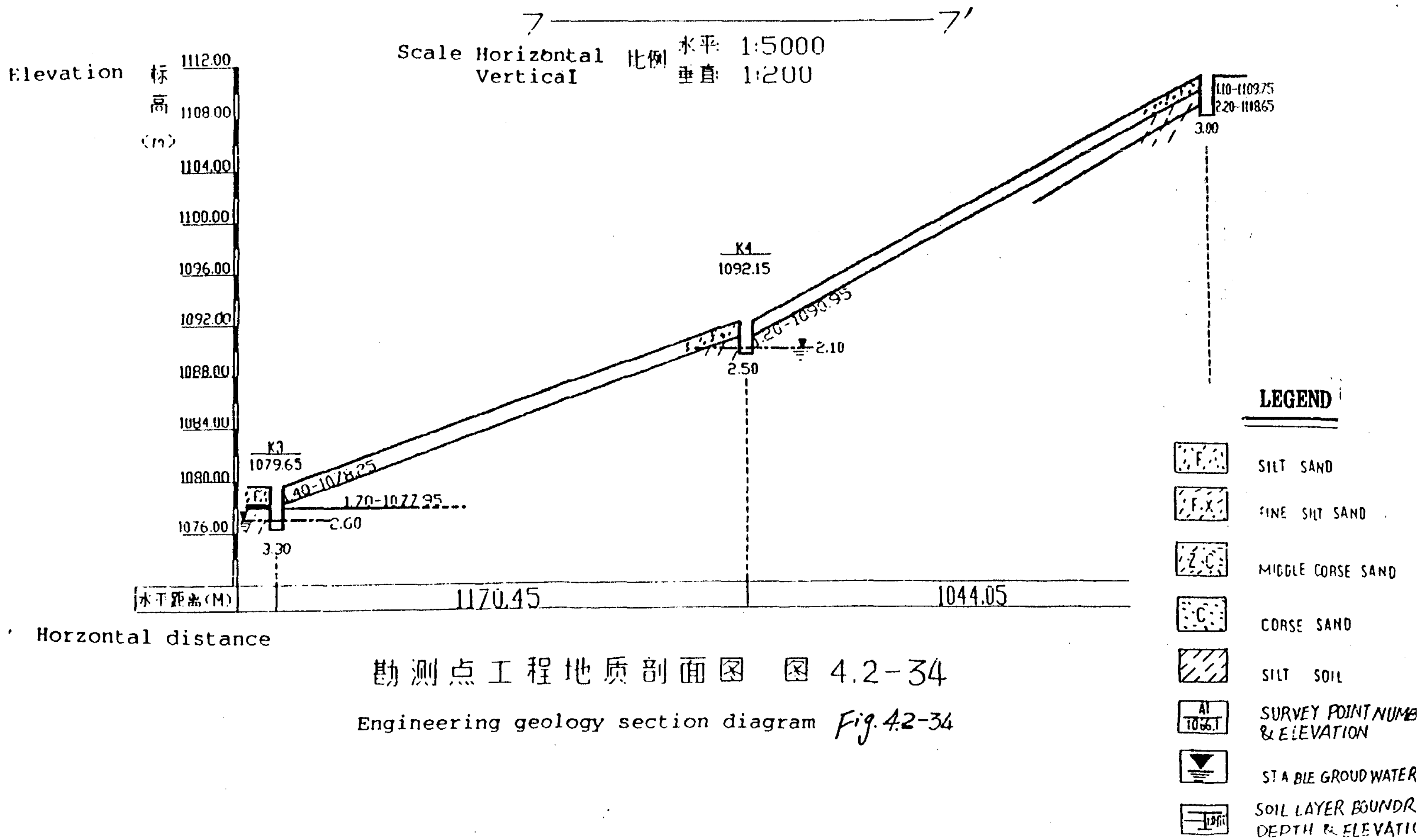
Fig.4.2-32

Engineering survey points layout



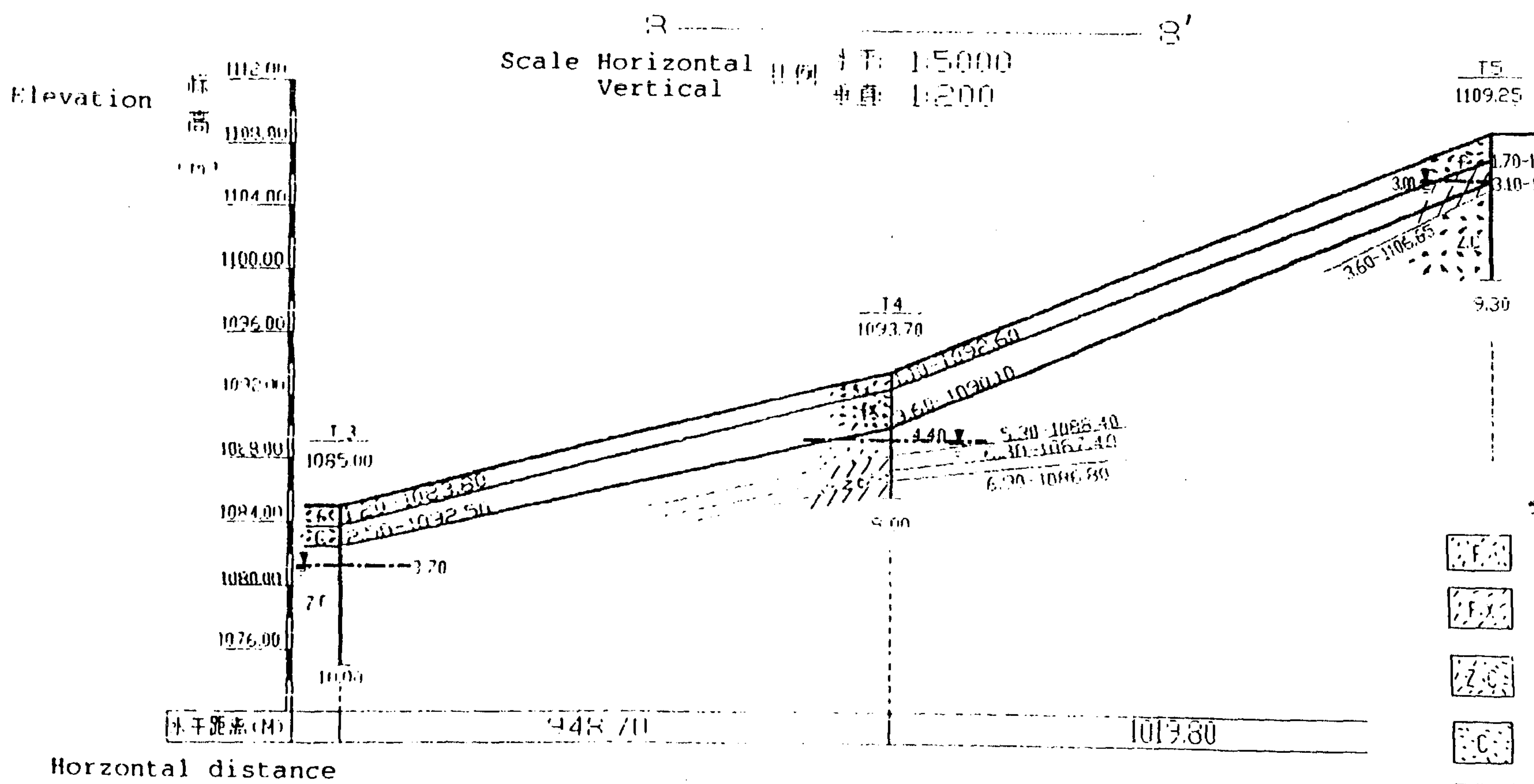
勘测点工程地质剖面图 图4.2-33

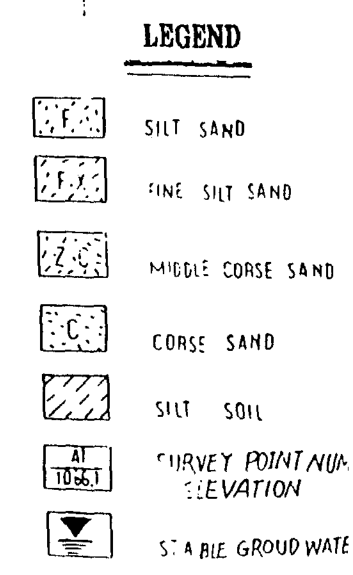
Engineering geology section diagram Fig4.2-33



勘测点工程地质剖面图 图 4.2-34

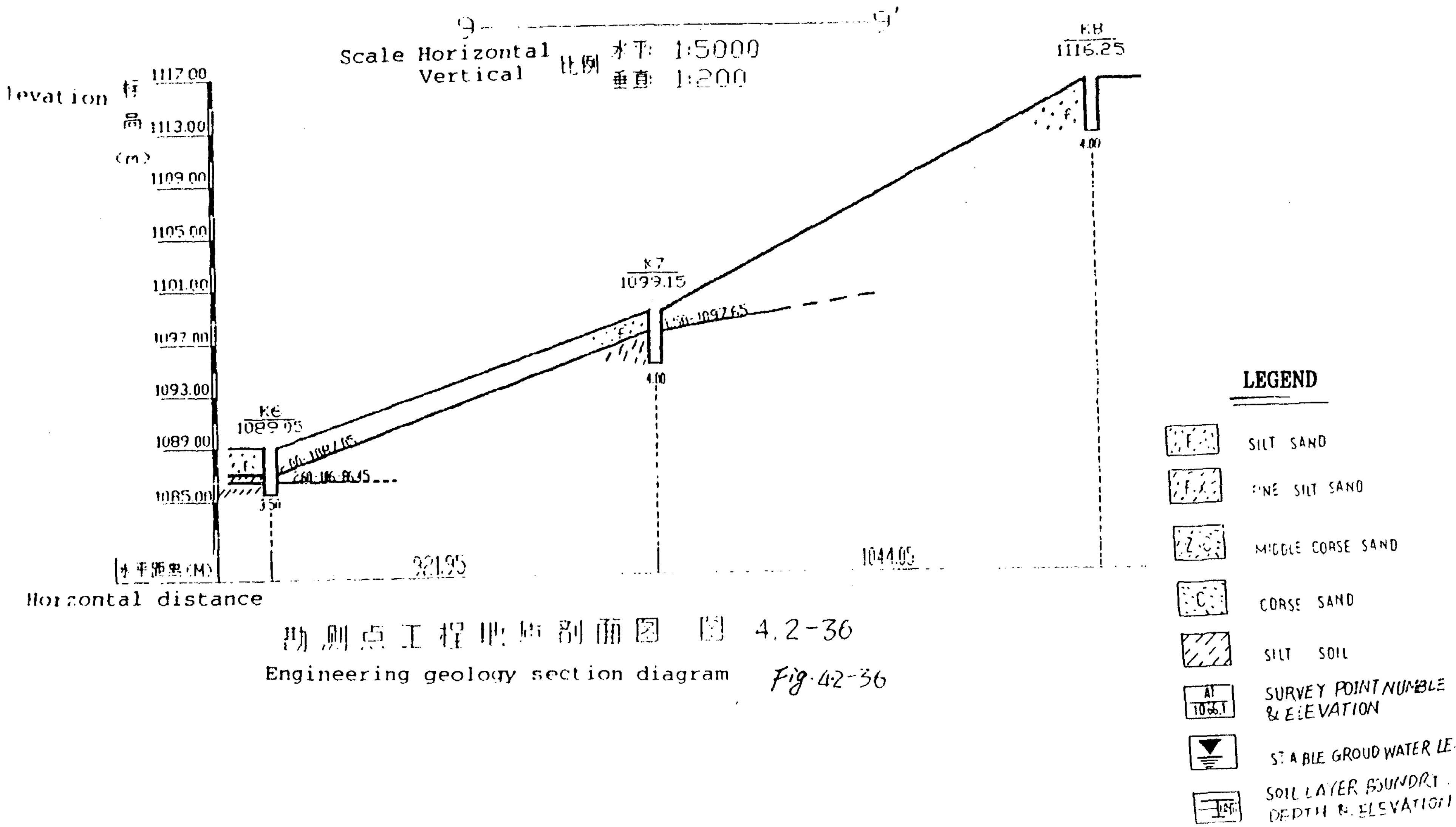
Engineering geology section diagram Fig. 4.2-34





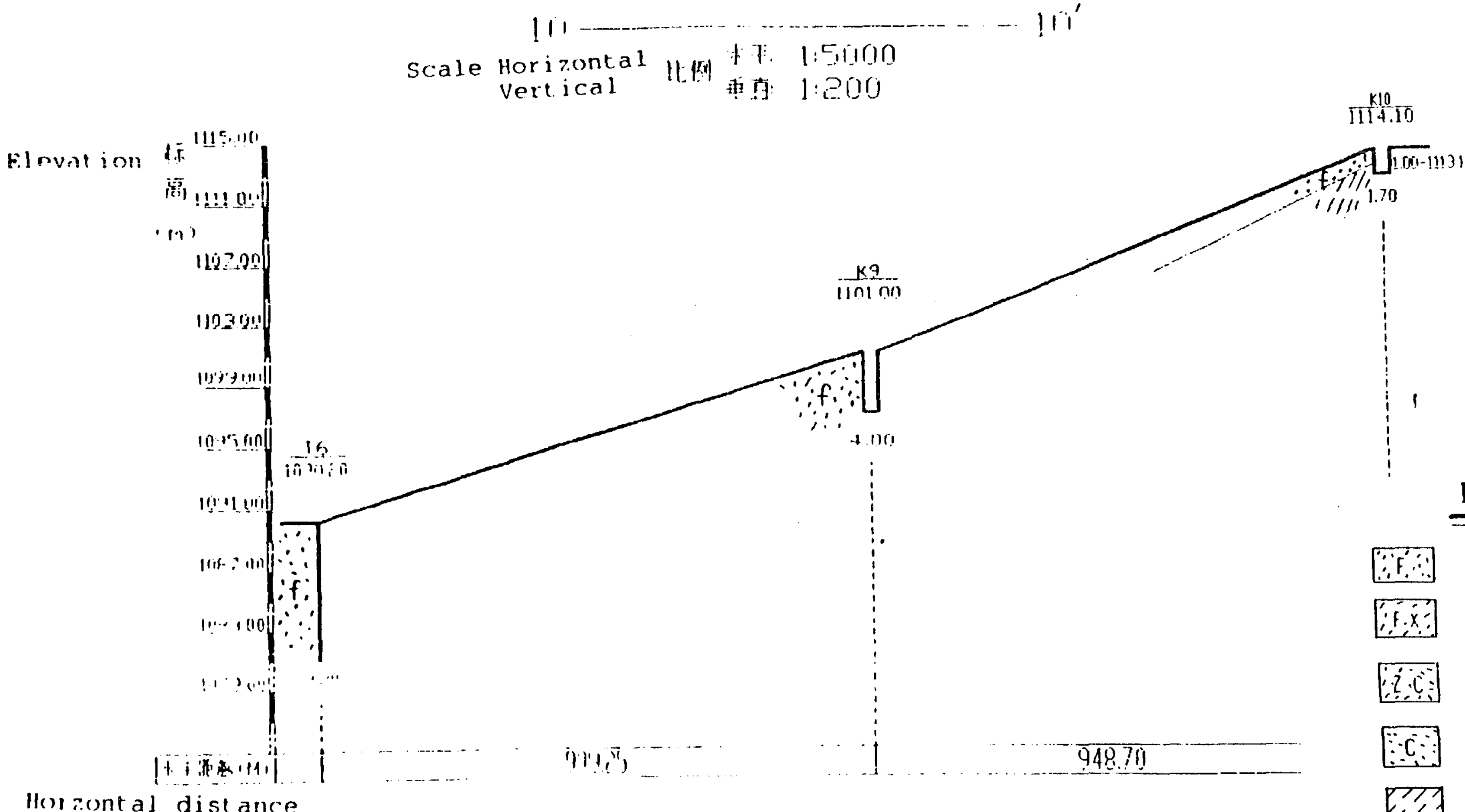
勘测点工程地质剖面图 图4.2-35

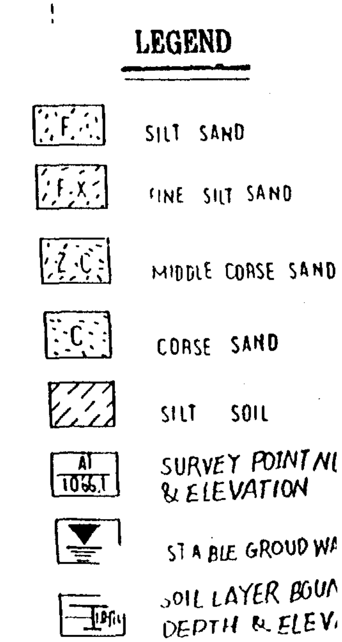
Engineering geology secti liagram Fig.4.2-35



勘测点工程地质剖面图 图 4.2-36

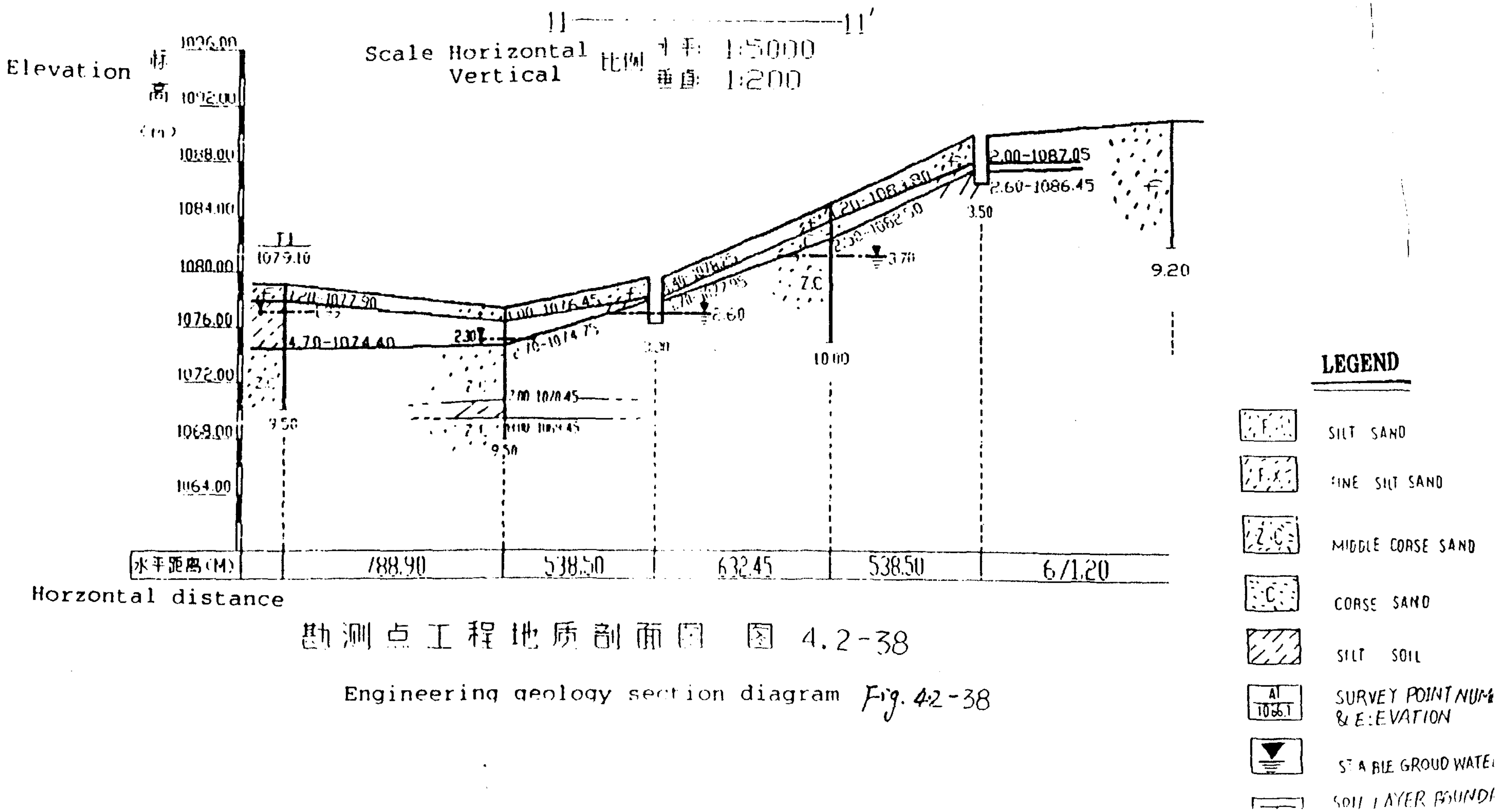
Engineering geology section diagram *Fig. 42-36*





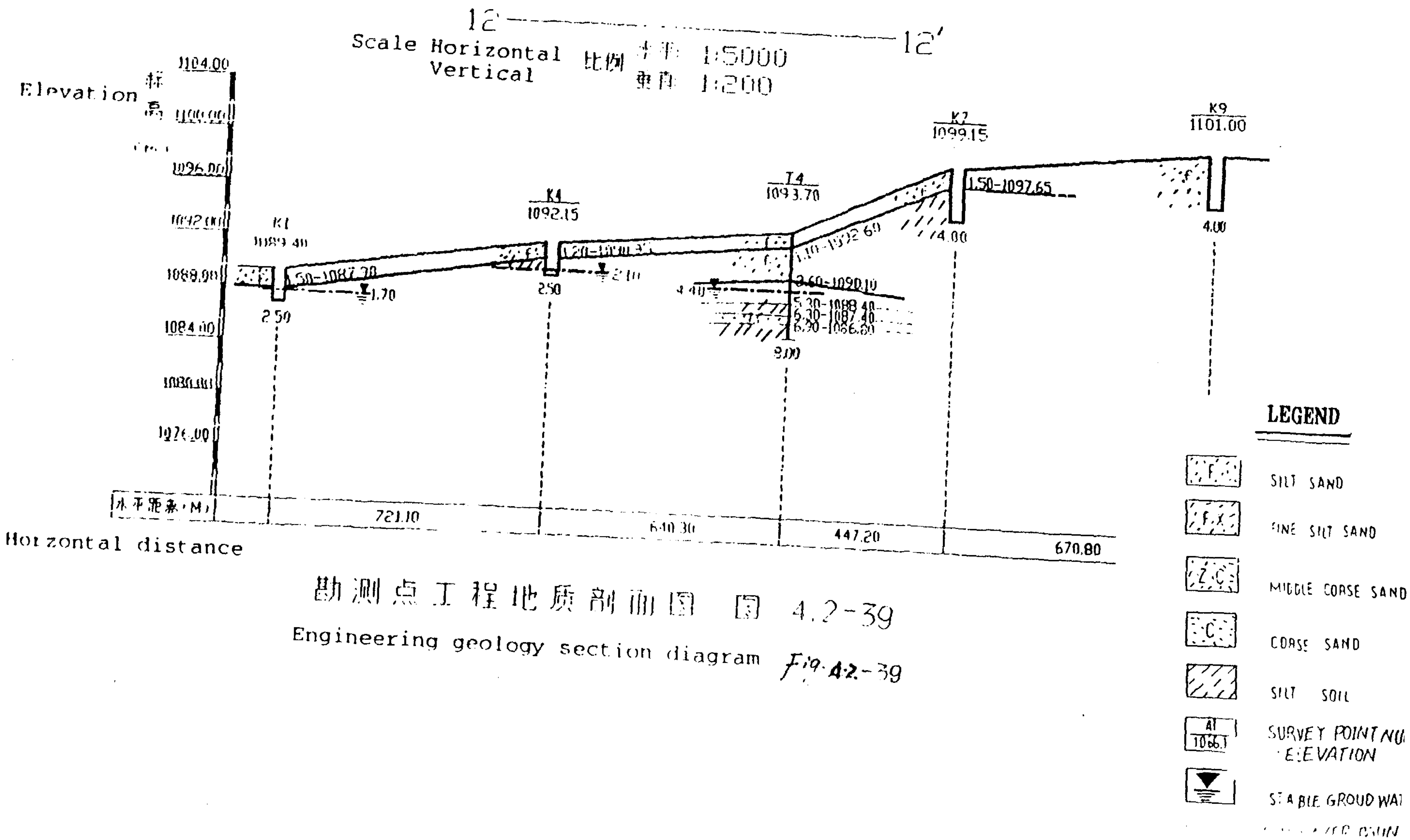
勘测点工程地质剖面图 图 4.2-37

Engineering geology section diagram *Fig.4.2-37*



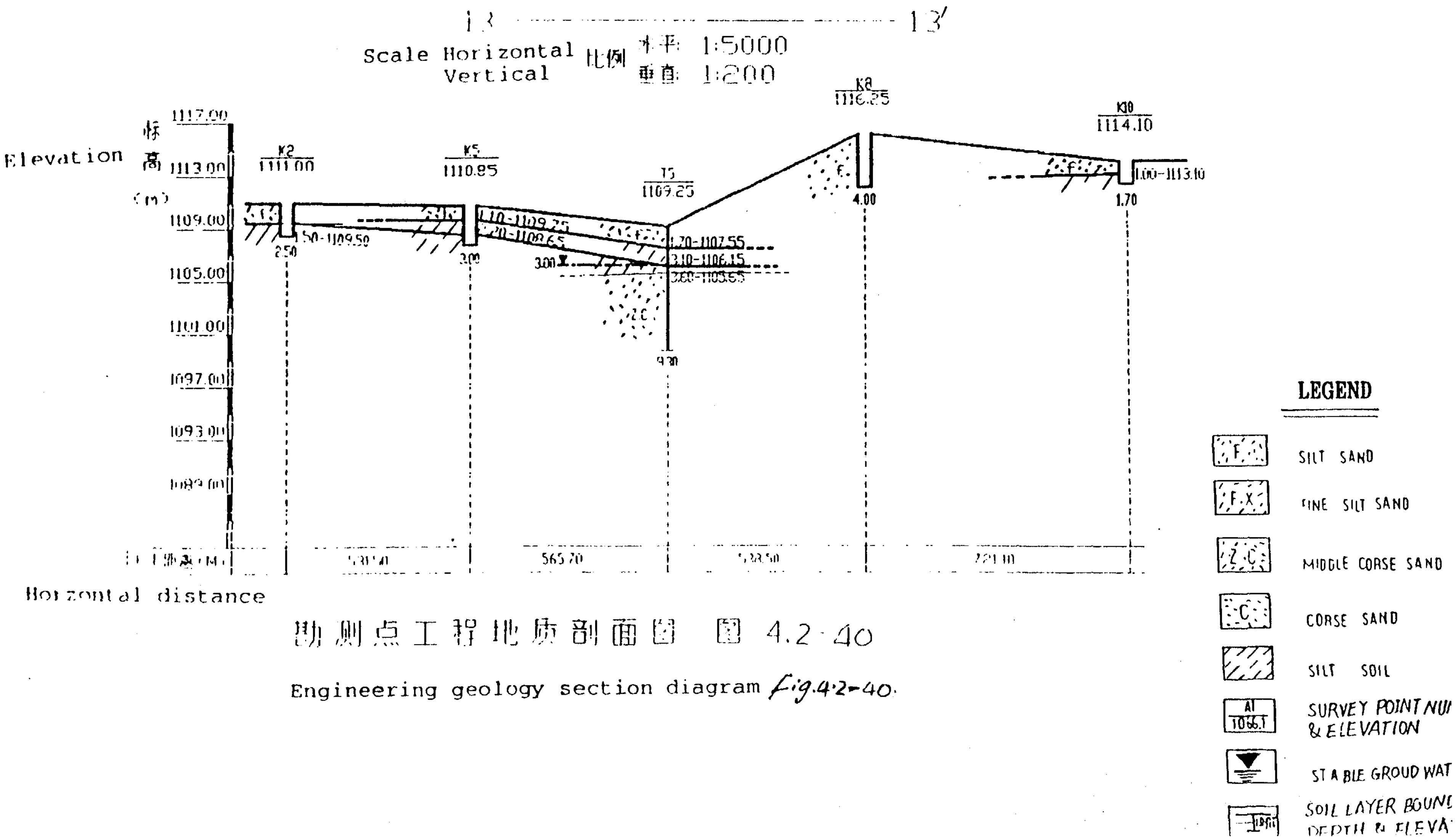
勘测点工程地质剖面图 图 4.2-38

Engineering geology section diagram Fig. 42-38



勘测点工程地质剖面图 图 4.2-39

Engineering geology section diagram Fig. 4.2-39



勘测点工程地质剖面图 图 4.2-40

Engineering geology section diagram Fig.4.2-40.

Conclusion:

For the option of hydraulic disposal at Gaobashi, based on the site geology as surveyed, if no measures are taken against seepage, the ash water would contaminate groundwater around the ash disposal area.

4.2.2.8 Groundwater contamination prevention measures in the ash disposal area

According to the engineering geology reports (feasibility stage) on Gaobashi ash disposal area and calculations of ash leachate impact on groundwater using a two dimensional model, the conclusion is that ground water around the ash disposal area will be affected after the ash disposal area is in operation for five years. In the design of Gaobashi ash disposal area, therefore, a geotextile liner system will be installed to prevent leachate contamination of groundwater.

Geotextile liner system

There is sufficient clay within most of the disposal area to provide a 300 mm minimum base layer for the geotextile/ plastic liner. The liner material is in use internationally (Japan, England, France, U.S., and others), and is 3-4 mm thick. In areas where a sand or clay base is not available, a minimum of 300 mm clay will be spread as base material for the liner. In order to prevent liner damage from construction and weathering a protective layer of clay will be installed above the liner 300-500 mm thick. International experience with these liner systems has shown that they are serviceable for 20-30 years, sufficient for this project.

The drinking water for the villagers will not be affected by the ash leachate with the seepage prevention measures installed.
In order to monitor the potential impact of seepage water on the drinking water. monitoring wells will be built around the ash disposal area.

4.2.3 Mitigation measures for wastewater

4.2.3.1 Wastewater treatment

Sewage and wastewater of the power plant will be treated as mentioned above. The discharged industrial wastewater, oil-contaminated water, and sanitary sewage will be treated and discharged only after meeting standards.

4.2.4 Water conservation measures of the power plant

(1) The cooling water of auxiliary equipment will be recycled. The cooling water of the auxiliary equipment within the main building will be collected in pipes and drained to the

cooling tower pond, and then mixed together with circulating water, finally to be boosted by circulating pumps for next cycle.

(2) When a demister is mounted on the cooling tower, the water loss caused by wind will be reduced from 252.04 t/h to 126.02 t/h; a water savings of 50 %.

(3) Maximize cooling water recycling and minimize make up water usage.

a. The cooling water blow down will be taken as the water supply for wash water in the coal handling system, water for dust removal, seepage of boiler wastewater, dry ash wetting, slag removal and spray water to control fugitive dust in the coal yard.

b. Reuse of water recovered from the slag dewatering bin system in the dry ash removal alternative.

c. Reuse of water from ventilation and air-conditioning in summer would be discharged into the circulating cooling water system.

With these various water saving measures adopted for TuoKeTuo A, the water saved can be used for plantation, spraying pond and beautification of the environment, etc. In this way, the original situation of simplified structure and unitary species has been changed to various species, high cover rate and better growth of plants. Thus the waste land will be changed to oasis.

4.2.5 Conclusion of impact analysis on water quality

4.2.5.1 Analysis of impact on the Yellow River

(1) The sewage discharged by the power plant can meet the requirements of the Grade I of "Comprehensive Discharging Standard for Industrial wastewater (GB8978-88)" which applies to newly-built, extension and reconstruction projects It can be estimated that no negative environmental impact will result from wastewater discharged into the Yellow River. The environmental protection requirement for Yellow River can thus be satisfied.

GB8978-88 "Comprehensive Discharge Standard for Wastewater" (Class I)

pH value	Suspended solids	BOD5	COD cr
6.5-9.0	70	30	100
Petroleum	Hexavalent chrome	Lead	Cadmium
10.0	0.50	1.00	0.10

(2) An analysis for <u>initial</u> start-up of the power station sanitary wastewater system is shown in section 4.11. During start up, process upsets can occur while the system is stabilized and the plant operators are learning to optimize the process. A conservative

analysis has been performed on the impact of releases of incompletely treated sewage during startup and stabilization (section 4.11).

4.2.5.2 Analysis of impact of ash disposal area on groundwater

(1) The water resource of TuoKeTuo county will not be affected by ash water during operation of Gaobashi ash disposal area.

(2) Without leachate control measures, when the ash water is stored at the lowest terrain in the ash disposal area, the groundwater at the area of 500 m surrounding the ash disposal area would be polluted by the ash water in 5 years. The area 1500 m surrounding the ash disposal area will be polluted in the period of 15 ~20 years. When the ash water is stored at most unfavorable position, the groundwater in the area about 500 m away from the ash disposal area and Huwulangying village would be polluted by the ash water in 5 years. The area about 1500 m away from the ash disposal area would be polluted in the period of 15 ~20 years. In accordance with these impact assessment results concerning groundwater contamination potential a geotextile leachate liner system will be used.

(3) Monitoring wells shall be set up at a certain distance around the lower reach of the ash disposal area in order to sample and analyze any impacts on groundwater on a regular basis.

4.3 Noise impact analysis

4.3.1 Purpose of assessment

According to actual information about domestic generator units of the same type, the noise impact regulation, after units (2 x 600 MW) are put into operation, can be predicted and prevention measures shall be adopted based on local specific conditions. Noise control requirements will be included in bid documents. Since noise is a localized phenomena, the impact of 6 x 600 MW cannot be calculated at this time, since the noise level of the units to be used is not known.

GB12348-90 "Standard for Noise within the Boundary of Industrial Enterprises" (Class III)

Applicable Area	Day	Night
Centralized Industry complex	65 dBA	55 dBA

4.3.2 Analysis of Noise Sources

4.3.2.1 Estimation of noise source

Estimation of noise level for the source has referred to actual data of noise level for operation of 600 MW units in related power plant of the country (Yuanbaosha Power Plant, Douer Power Plant). See Table 2.3-4 for the noise level of estimation for each noise source.

4.3.2.2 Characteristics of noise source

(1) Noise sources where the noise level are greater than 100 dB(A), e.g. steam exhausted outlet for boiler, exhaust outlet of air accumulator for air compressor, etc., are outdoor intermittent noise sources. Steam exhaust valves of boiler only opens in case of boiler start-up and overpressure in the boiler, while exhaust outlet of air accumulator for air compressor only starts exhausting in case of excess air and overpressure in air accumulator, so, neither of them has regulation.

(2) Other outdoor noise sources included cooling tower, main transformer, etc. have larger volume and lower level of noise. Their levels are 82.2 db(A) and 79.9 db(A) respectively.

(3) Level of noise for main turbogenerator, boiler and auxiliary equipment is higher and about 90 db(A), but all these are indoor noise sources. Indoor noise will be mixed in the shop and can be reduced by the shop structure. So, each separate shop can be considered as an independent noise source.

4.3.2.3 Simplification of indoor noise sources

Wall of shop consists of homogeneous walls, doors and windows which are of combined acoustical structure.

(1) Calculation of acoustical volume for combined wall

1) To calculate proportion of combined doors and windows area and homogeneous wall;

2) To calculate difference between acoustical volume of homogeneous wall and that of door and window;

3) To find out loss of acoustical volume in calculation table of acoustical volume for combined parts;

4) Total acoustical volume for combined walls can be got by acoustical volume of wall minus loss of acoustical volume.

(2) Refer to 4.3-1 for calculation results of acoustic volume.

Table 4.3-1:

Calculation results of acoustic volume for shop structure

Noise sources	Acoustical volume of walls L_{T11}(dbA)	Acoustical volume of door and walls L_{T12}(dbA)	Door & window area/Walls area	L_{T11}-L_{T12} (dbA)	Loss (dbA)	Actual acoustical volume(dbA)
Boiler house	51	20	1/10	31	19	32
Turbine house	51	20	1/10	31	19	32
Air compressor room	49	20	1/4	29	22	27
ID fan room	49	20	1/10	29	18	31
Slurry pump house	49	20	1/10	20	18	31

4.3.2.4 Summary of noise sources

Table 4.3-2 shows a summary of simplification for noise sources.

Table 4.3-2

Summary simplification for noise sources

Noise source	Quantity	Noise level(indoor)(dbA)	Noise level(outdoor)(dbA)
Boiler steam exhaust outlet (WITHOUT SILENCER)	2		135
Exhaust outlet of air accumulator for air compressor	1		110
Main transformer	2		80
Turbine house	1	97	65
Boiler house	1	94	62
ID fan room	2	87	56
Slurry pump house	1	95	63
Air compressor room	1	90	63
Cooling tower	2		82

Notes:

"Outdoor" means 1 meter away from noise source (first 3 items and cooling tower), all other "outdoor" figures are estimates for 1 meter from the noise source (whole building).
"Indoor" means 1 meter from the equipment.

4.3.3 Noise impact prediction

4.3.3.1 Noise reduction regulation

$$L_{p1} - L_{p2} = 20 \lg\left(\frac{r_2}{r_1}\right)$$

Where:

L_{p1}-- Acoustic pressure level at point of r1 from noise source

L_{p2}-- Acoustic pressure level at point of r2 from noise source

4.3.3.2 Impact of continuous noise sources

Continuous noise sources include turbine house, boiler house, ID fan room, slurry pump house, air compressor room, cooling tower and main transformer, etc.

We can see from Table 4.3-2 that outdoor noise level of turbine house, boiler house, ID fan room, slurry pump house and air compressor room is relatively small due to acoustic function of room structure, which does not exceed 65db(A). Therefore, it has little impact on plant area and surrounding environment. Therefor, the only noise impact of cooling tower and main transformer is discussed.

(1) Cooling tower

Two cooling towers, situated at the north of main building, are used for the first phase of project. The distance between them is 210 m. It is 220 m to the north of plant area and 290 m to the west of plant area. Refer to Table 4.3-3 for distribution of noise.

Table 4.3-3:

Noise distribution around cooling tower

Distance to cooling tower(m)	5	10	20	30	40	50	100
Noise level(dbA)	82	76	70	66	64	62	56

(2) Main transformer

Noise of main transformer is electromagnetic noise. Two transformers are built close to north side of main building, with distance of 120 m, during this phase of project. It is located at point of 380 m to the north of plant site and 330 m to the west of plant site. Refer to Table 4.3-4 for noise distribution.

Table 4.3-4:

Noise distribution around main transformer

Distance to main transformer(m)	1	5	10	40	60	80
Noise level(dbA)	80	66	60	48	44	42

4.3.3.3 Impact of intermittent noise sources

Intermittent noise sources mainly consist of steam exhaust outlet of boiler and steam exhaust outlet for air accumulator of air compressor.

(1) Steam exhaust outlet of boiler

There are two groups of outlets that are located on top of boiler house. Refer to Table 4.3-5 for noise impact range of steam exhaust.

Table 4.3-5:

Noise impact range of steam exhaust outlet for boiler

Distance to exhaust outlet(m)	1	10	100	200	500	1000	2000	3000	4000	6000
Noise level(dbA)	135	116	96	90	82	76	70	66	64	60

(2) Steam exhaust outlet for air accumulator of air compressor

There is one group of outlets that is close to the boiler house. Refer to Table 4.3-6 for noise impact range.

Table 4.3-6:

Noise impact range for steam exhaust of air accumulator in air compressor

Distance to exhaust outlet(m)	1	10	50	100	200	300	400
Noise level(dbA)	110	90	76	70	64	60.5	58

Noise and the 3600 MW installation: Since the estimates and measurements above refer to distances nearly adjacent to the noise sources, they will apply to the 3600 MW phase, should the same types of equipment be used. Equipment specifications will require compliance with noise standards.

4.3.4 Characteristics of Regional Noise Pollution

4.3.4.1 Key noise sources in plant area (See Table 4.3-7)

Table 4.3-7:

Impact range of key noise sources

Source	Level (dbA)	Distance to source (m)	Distance needed for reduction to 70 db(A) (m)	Distance needed for reduction to 65(dbA) (m)	Distance needed for reduction to 55(dbA) (m)
Steam exhaust outlet of boiler	135.0	1	1778	3162	10000
Steam exhaust outlet for air accumulator of air compressor	110	1	100	178	562

Two types of noise sources have higher noise level, longer dispersion distance and a wider range of influence. Noise of steam exhaust for boiler, in particular, shall be reduced respectively at distances of 1788 m, 3162 m and 10000 m to reach noise standard IV & III of day and night values in the plant, which would exceed the scope of the plant area. Noise at steam exhaust outlet for air accumulator can reach noise standard IV & III of day value but it must disperse for a distance of 562 m in order to reach the night noise standard, which would exceed the scope of the plant area. These noise sources will be treated with attenuators.

4.3.4.2 Influence range of continuous noise sources

Table 4.3-8:

Influence range of continuous noise sources

Noise source	Distance to reduce to 70(dbA) (m)	Distance to reduce to 65(dbA) (m)	Distance to reduce to 55(dbA) (m)
Cooling tower	20	36	115
Main transformer	3	6	18

The two kinds of noises mentioned above can reach noise standard IV & III at the plant boundary.

4.3.5 Noise Prevention Measures

4.3.5.1 Control of noise source at steam exhaust outlet of boiler

The main noise source of this project is the efflux noise caused by steam exhaust of the boiler. Control of the noise at this place can avoid exceeding the noise standard. Silencers based on the principle of "throttling and pressure dropping" and "spraying of small hole" can be used for this noise. After silencer is mounted, the noise level is 93~100(dbA). Due to factors such as air absorption and reduction by distance, etc., it would not have major impact on the surroundings. Furthermore, after normal operation of units, times and period to open and close for boiler steam exhaust and safety valve shall be reduced, having little impact on the noise environment.

Table 4.3-9:

Noise influence range at steam exhaust outlet of boiler after silencer is mounted

Distance from exhaust outlet	1	5	10	20	30	50	100
Noise level(dbA)	100	86	80	74	70	66	60

4.3.5.2 Simultaneous control of other noise sources

Other noise sources to be controlled include Turbine house, Boiler house, Air compressor room, etc.

With regard to prevention of these noise sources, selection of equipment shall be first considered to meet the requirement, and meanwhile double-layer lighting acoustical glass and door shall be adopted. Other measures will include vibration reduction of equipment foundation, amortization of piping, mounting of muffler at draining outlet, reduction of leakage for valve, provision of acoustical room in duty room, etc.

Noise control standards can be met by taking measures for other noise sources to minimize the noise in this project. In this way, it shall not pollute the environment.

4.4.1 Coal yard and equipment

Coal yard and related equipment are shown in Table 4.4-1.

Table 4.4-1

Coal yard and equipment

Items	Unit capacity	
	first phase	planned capacity
	2 x 600 MW	6 x 600 MW
Capacity of coal storage yard(10^4t)	16	48
Storage days in coal yard(d)	12	12
Capacity of frequently used coal piles(t)	89880	269640
Capacity of coal pile used for storage(t)	70120	210360
Type of layout of bucket extractor	polygonal return	polygonal return
Model and number of bucket extractor		
	2 sets	6 sets
Main technical specifications of bucket extractor	piling 1500t/h fetching 1500t/h	piling 1500t/h fetching 1500t/h
	arm length 30m	
Coal reclaimer		
	4 sets	

4.4.2 Analysis of the reasons for fugitive dust in coal yard

Fugitive dust is released in the process of coal unloading from trains, coal stacking in coal yard and coal piling and fetching activities in order to control fugitive dust, a spray system will be installed.

4.4.2.1 Unloading coal from trains

The coal is unloaded by bottom-dump, the flying dust is caused by the wind during coal unloading process when the coal falls due to the effect of gravity.

4.4.2.2 Coal stacking

Influenced by the surface wind of coal yard. Flying dust is caused by mechanical force of coal stacking and fetching extractors.

4.4.2.3 Stacking and reclaiming

The coal layer containing moisture is destroyed during coal handling processes. The dust on the surface of new coal layers will be subjected to wind and result in fugitive dust emissions.

Under normal working conditions, the fugitive dust caused by mechanical coal fetching and coal falling in the coal yard will take place continuously. The amount of fugitive dust depends upon the moisture contained in the coal and the wind speed, in addition to the grain diameter of coal & dust and working conditions (see Para. 4.4.3 for an analysis of fugitive dust emissions).

4.4 Comparative Investigation and Analysis of Flying Dust Impact of Coal Yard

4.4.3 Features of emission source for coal dust

4.4.3.1 Grain diameter of coal dust

The portion of coal dust sized under 200 to 250 μm is considered to be the source which affects coal yard and its surroundings. The coal dust of bigger size is not considered as source. Its spreading distance is near emitting source which is only tens of meters or less caused by turbulent flow and falling effect of gravity.

4.4.3.2 Moisture content contained in coal

According to American Standard of Testing Method for Dust (ASTMD 547-41), the test conducted for one kind of coal under range of conventional wind speed shows that the amount of flying dust appears in e exponential decay relation with the moisture content increases. When the moisture content increases from 1% to 7%, the amount of flying dust decreases 90% accordingly. In natural conditions, it is proper to set the 8% moisture content as dust-holding upper limit.The moisture content on the surface of coal layer will be secured by the spraying facilities of coal yard.

4.4.3.3 Wind speed causing dust flying

Starting wind speed is defined as critical one which does not result in dust flying of the coal pile. The minimum wind speed which makes the dust flying is defined as dust flying speed.

The impact on the surroundings by fugitive dust is mainly caused by the surface wind except of which caused by mechanical activities. The tests results are listed in Table 4.4-2 for the starting wind speed of coal pile surface with 50~30 μm grain diameter of coal dust by flume test. The Table shows that starting wind speed is in direct ratio relation with moisture content of coal pile and the grain diameter. The starting wind speed is above 3m/s for different sizes of coal dust. In general, the flying dust speed is 10 % higher than starting wind speed.

Table 4.4-2

Relation between starting wind speed on mimic coal pile surface and grain diameter

Average grain diameter(μm)		50	75	100	150	200	250
Starting wind speed(m/s)	Moisture content 6%	3.90	3.43	3.56	3.85	4.06	4.69
	Moisture content 4%	/	3.10	3.22	3.35	3.51	3.84
	Moisture content 2%	3.53	3.01	3.06	3.12	3.20	3.23

4.4.4 Analysis of flying dust impact on coal yard

Average wind speed is 2.6m/s in TuoKeTuo country.Table 4.4-3 is frequency table of different wind speed classes in various downwards direction in whole year.

Table 4.4-3

Frequency table of different wind speed classes in various downwards direction (%)

Wind direction	Wind speed class(m/s)					
	<1.0	1.0~2.0	2.0~3.0	3.0~6.0	>6.0	Total
N	0.63	0.35	0.48	0.35	0	1.81
NNE	0.70	1.23	1.17	0.76	0.14	4.00
NE	1.04	1.98	1.11	1.57	0.14	5.84
ENE	1.71	2.13	1.44	1.31	0	6.59
E	1.44	1.92	0.83	0.28	0	4.47
ESE	1.91	1.66	0.55	0.14	0	4.26
SE	1.24	1.10	0.07	0.07	0	2.48
SSE	1.64	1.92	0.21	0.28	0	4.05
S	1.44	1.44	0.97	0.14	0.07	4.06
SSW	1.57	2.87	1.65	0.41	0.07	6.57
SW	1.24	2.53	0.96	0.55	0	5.28
WSW	1.45	3.14	2.61	2.74	0.28	10.22
W	0.62	1.84	2.05	1.90	0.14	6.55
WNW	0.89	1.44	1.91	1.65	0.21	6.10
NW	0.55	0.90	0.21	0.35	0	2.01
NNW	0.56	1.24	0.28	0.35	0	2.43
C	23.50					23.50
Total	42.13	27.69	16.50	12.85	1.05	100

The statistics results of surface wind direction and wind speed materials in many years in Tuotetuo show that the annual frequency is 42.13% when wind speed is less than 1.0m/s(including static wind frequency 23.50%),the annual frequency is 27.69% when wind speed is 1.0~2.0m/s, the annual frequency is 16.50% when wind speed is 2.0~3.0m/s, the annual frequency is 12.85% when wind speed is 3.0~6.0m/s the annual frequency is 1.05% when wind speed is more than 6.0m/s. It is obvious that the annual frequency is the highest when wind speed is less than 2.0m/s in TuoKeTuo. According to the test results in Table 4.4-2 , relation between starting wind speed on mimic coal pile surface and grain diameter ,the starting wind speed is defined as 3.3m/s, the annual frequency of the flying dust caused by wind is 14% during operation of coal yard. In addition, according to meteorology statistics information of meteorological observatory station in TuoKeTuo county, the annual strong wind is 7 days (wind speed is more than 17m/s) in this district and the annual sandstorm is 11 days. In such specific meteorology conditions, the measures shall be taken in time during coal yard operation such as increase the time and number of spraying water, keeping moisture content in the surface of the coal pile in coal yard so as to minimize the dust flying.

4.5 Comprehensive utilization of ash and slag

The total amount of ash and slag produced by all national power plants is 7,982 x 10^4 tons, but the amount used in secondary applications (utilization) is 2,547 x 10^4 tons (rate of utilization is 32 %). It is predicted that the total amount of ash and slag in 1995 will reach 110 million tons, an increase of 37.8 % over 1992. The amount of ash and slag currently utilized is 3,400 x 10^4 tons (rate of utilization is 30.9 %). It is predicted that the total amount of ash and slag in 2000 will reach 153 million tons, an increase of 91.7 % over 1992, and the amount of ash and slag utlized is 4,500 x 10^4 tons, a utilization rate of 29.4 %.

With the rapid development of power plants, the amount of ash and slag will increase by a large margin, and the task of omprehensive utilization of coal ash will be extremely difficult.

According to document No. 89, otice regarding discussion of creating conditions for comprehensive utilization of coal ash of new, extending, rebuilding projects, issued by the Electric Design Institute in 1994, the comprehensive utilization of coal ash shall use suitable measures for local conditions and a variety of technologies. An alternatives investigation will be conducted by Touketuo Plant A according to the policies of combining storage with utilization.

Comprehensive utilization of ash and slag is not limited to building materials; it can be used to pave roads, and improve soil. TuoKeTuo Power Plant A will develop works according to the needs of construction work in the power plant area.

In the design of TuoKeTuo power plant A, the outlet for comprehensive utilization of ash and slag has been considered in the alternative for dry ash removal, but the outlet has not been considered in the alternative for hydraulic ash removal. The ash silos and dehydration ash bin will be provided with outlets for the comprehensive utilization of ash and slag in accordance with investigation and study results.

4.6 Impact analysis of special railway siding

4.6.1 Work scope

The special railway siding of TuoKeTuo Power Plant A is 43.75 Km from WangGuiYao station where the rails intersect the boundary wall of YanShanYing Plant on the FengZhun line.

4.6.2 Environmental survey of railway route

4.6.2.1 Railway alingment

The special railway is located in the west of the Inner Mongolia Autonomous Region, and runs from WangGuiYao station centre on the FengZhun line and passes through WangGuiYao, LanJiaYao, TaKe, and WangYuYing to the YanShanYing Plant site.

4.6.2.2 Environmental survey

(1) Topography and geomorphology

The region through which the line passes is mainly in the lower and medium mountain district with a height above sea level between 1000~1350 meters. The greater part is covered with loess. River erosion is relatively severe, and V-shaped gullies and box canyons have formed in large numbers with depths of 10~30 meters. Bed rock is exposed in some of them. Deep gullies and canyons are crossed along the railway line. Alluvial and lake plains surround the power plant site, where there is flat terrain.

(2) Geological structure

The railway line passes over red mudstone strata. New loess is distributed widely along the whole line. Some areas around power plant are salinized.

(3) Hydrology and hydrogeological characteristics

This railway is located on the eastern bank of the Yellow River in Inner Mongolia and belongs to the Yellow River system. The streams in all local gullies and channels are seasonal, with the exception of the main channel of the Yellow River The flood season is between July and September. In the rainy season, floods are charaterized by their short duration and sudden rise and fall of floodwaters. Groundwater in the southeast plain of TuoKeTuo county is found at depths of 3~10 meters. Confined aquifers are found below 50 meters. Groundwater in the foothills and mountain areas is found in bed rock fissures with little storage volume.

(4) Earthquake intensity

The area is classified 7 on a national standard scale for earthquake damage intensity. This standard is used in design of the railway.

4.6.2.3 Social environmental survey

This railway line is located south of Huhehot city which is in the west of Inner Mongolia. The regional economy relies mainly on agriculture. The major crops include wheat, naked oats, broom corn millet and potato all with high output. An industrial base which lacks in ability is composed of small village and township enterprises. Therefore large industrial pollution sources do not exist and environmental quality is farely ideal. Highway traffic is also convenient. The route passes through mountains, and passes beween two small villages as it nears the power station. The railway section will occupy 3,903mu (15mu=1hectare):

1,853mu non-irrigated
1mu fruit orchard
325mu forest of poplar trees
391mu barren land
1,311mu irrigated land
22mu sand drift prevention forest

There will be no resettlement required for construction of the railway.

4.6.3 Possible pollution from railway construction

4.6.3.1 Main pollution sources and main pollutants of railway construction

Four stations are set up for this railway project, WangYuYing station acts as operating mechanical service section, LanJiaYao station as a turnaround depot for locomotive auxiliaries. Railway type is determined as electric locomotive. The pollution on railroads mainly comes from the noise and whistle of running trains as well as "solid, liquid and gas waste " which are discharged by industrial and domestic facilities at all stations and depots along the line. The running train is defined as a moving pollution source. Industrial and domestic facilities of all stations and depots along the line as well as standstill trains are defined as continuous pollution sources. The pollutants include waste gas, waste water, waste slag and noise.

4.6.3.2 Continuous pollution sources

The amount of pollutants discharged at all stations is shown in Table 4.6-1.

Table 4.6-1

The amount of pollutants discharged at all stations

Units: t/a

Name of station	Fuel consumption		Main atmospheric pollutants				waste water discharge (m^3/d)		Waste slag discharge	Noise
	Coal consumption	Oil consumption	Flue dust	SO_2	CO	NOx	Industrial waste water	Sanitary sewage		
WangGuiYao	-	-	-	-	-	-	-	10	-	Boiler ID fan and air compressor are main noise sources and the level may reach up to 90dB(A).
LanJiaYao	-	-	-	-	-	-	-	10	-	
TaKe	234	-	4.68	4.45	10.53	0.35	-	10	38.5	
WangYuYing	7351.2	401.5	156.72	144.38	341.80	18.90	100	200	1882.8	

4.6.3.3 Mobile pollution sources

The noise of running trains is regarded as a moving source which propagates out in a columnar shape along two sides of the line, its intensity decay is comparatively slow and the affected distance is relatively long. The transient noise level at a point 30 m may reach 84~87dB when the train travels at a speed of 70~110 km/h.

The traveling of trains on tracks corresponds to the running of objects on the surface of elastic media. Thus vibration remains in the range of microvibration will be produced and will exert no bad effect on the safety of buildings nearby or human health.

This railway line is designed for electric-powered traction which will cause an electromagnetic interference at nearby wire and wireless communication facilities,as the train passes.

4.6.4 Pollution mitigation measures

4.6.4.1 Atmosphere

Due to the oil-firing of internal combustion locomotives and the coal-burning of boilers, the flue dust and waste gas will be exhausted and can pollute the ambient air. During selection of boilers, the equipment with flue elimination and dust collecting efficiency above 85% will be provided. All stations, depots and residential areas will be landscaped.

4.6.4.2 Surfacewater

The oil contaminated industrial wastewater at Lanjiayao station and Wangyuying station will be treated in a horizontal oil separation tank. The wastewater containing lead and acid will be treated by chemical methods. The sanitary sewage will be treated in septic tanks or anaerobic filter tanks.

4.6.4.3 Waste slag treatment

Waste slag on this line mainly relates to slag accumulated at TaKe station and WangYuYing station, discharged from coal-burning industrial and domestic boilers. Such slag will be used as building material after centralized treatment.

4.6.4.4 Noise vibration

It is recommended that elastic track structure should be adopted in order to reduce noise pollution. Long rails should be replaced and the whistling portion of the line will also be controlled after a start-up period.

Trees will be planted along two sides of the line and around the stations and depots so as to reduce the noise of running locomotives and trains.

4.6.5 Impact of railway construction on natural environment and measures to be taken.

4.6.5.1 Line

A major section of this line is characterized by deep excavations, from Lanjiayao to Qianzaigou, and will destroy the natural state of the mountain, which is mainly composed of loess and mudstone. Grouted slice stones will be used along the cuts in order to maintain slope stability. In the design of Honghekou Bridge, the arch should be as high as possible so as to keep water flow direction unchanged and to prevent the river water from eroding the mountain base.

The terrain along the line from TaKe station to power plant is flat. The special line should be kept away from economic crop zones. The irrigation canals for water conservancy should be passed through culverts. Those canals obstructed by the railway line should be compensated reasonably, and payment should be made for the reconstruction of irrigation canals.

4.6.5.2 Bridges and culverts

There are 11 different size bridges and 160 small culverts along this line. The majority of flood drainage bridges and culverts are located at natural river trenches. The trenches with low flows and specially difficult utilization should be re-built. The bridge arches with larger oblique angles should be enlarged properly. In this manner, floods should be maintained at natural levels so as to reduce the impact on upstream and downstream beaches.

4.6.5.3 Tunnels

The vegetation around tunnels at TaKe station is sparse and gullies form a criss-cross network. The windblown loess and sandy clay beneath are very easily eroded. Disturbance of should be restricted. Paving protection is conducted after dug slopes and gutters are built properly. Protective treatment should be made for those active gullies around the exits and entrances of tunnels.

Since slag from tunnels is generally dumped into trenches or onto the slope, slag walls should be biult along the side of trenches. Vegetation will be planted on the slag surface to improve the ecological environment and to prevent the water and soil erosion.

The ditches inside tunnels may be connected with dug trenches or existing ditches outside the tunnels, so that water from tunnels is drained into them in order to prevent water from overflowing to the farmland and polluting surface water.

A tunnel exit is close to TaKe Village, here the mechanical equipment only should be used, and blasting should be avoided construction so as not to disturb the inhabitants.

4.6.5.4 Machine service and trains

Wangyuying Station on this line will be provided with one operation and maintenance shop having service facilities for internal combustion locomotives and electric locomotives. In the shop there are oil depot, sand storage chamber, servicing rails and devices for diesel and electric locomotives. The oil contaminated sewage from oil tank, grease chamber, and locomotive inspection pit on servicing rail should be treated in a horizontal oil/water separation tank. Grinders should be equipped with dust collection devices. A check-up point will be also built at WangYuYing station. Wastewater containing lead and acid shall be treated by chemical methods. Trees and flowers will be planted on the open ground at those points to improve the environment.

4.6.5.5 Water supply and drainage

Impact of railway water usage on groundwater resources

The areas along the railway are sparsely populated, and the water volume required for industry, railway and mine is very small. So the overall impact on local groundwater is negligible.

Railway sewage discharge and treatment

Small amounts of oil contaminated industrial waste water will be discharged from WangYuYing station and LanJiaYao station (only when leakage occurs) and will be treated in a horizontal oil/water separation tank. Waste water containing lead and acid from check-up point at WangYuYing station will be treated by chemical methods. The treated waste water will be discharged into a seepage pit.

The septic tanks and anaerobic filter tanks will be arranged at all stations. Part of sanitary sewage will be treated through the septic tank and then discharged into a seepage pit. The remaining part will be treated by anaerobic filter tank and then discharged into local surface water.

4.6.5.6 Stations

The four stations, namely WangGuiYao, TaKe, LanJiaYao and WangYuYing, will be set up along this line, among which WangYuYing station serves as an industrial station, the rest are intermediate stations.

The following measures will be taken in the design of stations in order to reduce the impact of the railway on the surrounding environment.

(1) The roads in the areas of stations should be provided with overpasses or other suitable and safe means to guarantee convenient and safe travel for residents.

(2) Two sided drainage slopes will be set up at stations so as to make drainage unobstructed.

(3) This line is located in a very windy and dusty region. Trees and grasses should be planted at stations for the purpose of windbreak and sand fixation, reduction of noise and environmental beautification.

4.6.5.7 Power supply for electric train

One electric trailing substation will be built at TaKe station. Transformer oil will be discharged into an underground oil storage tank. The waste oil will be sent to a treatment facility. These will be new transformers, and no PCB transformer oils will be used. The transformer is installed in the power substation. The noise will not cause an impact on the surrounding environment.

4.6.6 Impact of railway construction on ecological environment and measures to be taken

(1) This railway, which is characterized by ditch and valley, has a varied topography and a steep-slope riverbed. So the excavated soil should be used for filling ditches during construction in order to avoid unnecessary excavation of the mountain side and maintain slope stability.

(2) A section of this line will pass through loess area where an economic zone and gullies are developing. In these sensitive areas the railway line will be routed so as to reduce occupying land and to protect farmland.

(3) Bridges and culverts on this line are laid out according to natural river channels. The span of arches, and culvert size should be greater than the width of main river channels. Diversion dykes and large diversion channels should not be built. Water flow in the river channels should be kept in natural the state as far as possible so as to reduce impacts on all existing irrigation facilities built along the river. Bridges and culverts should be designed so as to guarantee the original function of irrigation facilities.

(4) The sand ground and sand dunes should be delineated and excavation of earth prohibited in order to protect the original vegetation in these fragile areas.

(5) Those pits and waste piles remaining at the stations should be immediately leveled after construction. The trees shall be planted upon completion of construction.

(6) Landscaping should be carried out in areas such as the roadsides and around houses in the district of stations.

(7) Trees will be planted along two sides of the railway line within the right of way.

(see Chapter 9 for land use and compensation details).

4.7 Impact analysis of power transmission lines

4.7.1 Impact analysis of electromagnetic field intensity

When human beings or animals are exposed to high voltage electrical fields, a "steady-state" current flows through the body or a corona spark discharge is produced. In addition, hair irritation, tetinus and stabbing face pain may be experienced. What is called "field effect" means only those reactions which are in connection with field intensity where people are present but not in connection with current. The seriousness of the effect will be decided by field intensity.

Research on EMF effects has been done in many countries. According to Ultra High Frequency (UHF) Plan, sensory reaction tests on humans in the strong electric fields have been conducted under test lines. The results of tests showed that 10 % of persons begin to be sensitive in a field intensity of 10~15 KV/m (the field intensity indicated in this section means effective values). When the field intensity reaches 15~25 KV/m, reactions such as hair irritation and stabbing pain within the body (especially arms) and sensed by a small number of persons. If no spark discharge occurs when ground field intensity is up to 25 KV/m, a person has no harmful abnormal reaction. When repeated spark discharges occur, persons feel oversensitive and to weak to continue work. However, repeated spark discharge generally don't take place under normal working conditions or below power transmission lines. Even if it occurs accidentally, the human response will be of short duration, with recovery in the first day. US investigators have made systematic studies of persons who have worked for many years in strong EMF fields, such as live line inspectors and maintenance personnel for UHV power transmission lines. Negative health effects were not disovered. To date there is no evidence of negative health effects from exposure to electrostatic fields of power transmission lines and power substations.

The research conclusions of the Water and Electricity Bureau of Quebec and Water and Electricity Research Institute of Quebec in Canada, showing interference from the electrostatic field below power transmission lines and in power substations produces direct biological effects have been made without good basis. The only direct influence is that stabbing pain and sensitivity on a person's scalp is be perceived, and this sensation shouldn't be seen as an unfavorable bioeffect; though continuous inductive alternating current, especially inductive impulse current of very short duration, would have effect. Neither the continuous alternating current nor the discharging impulse current possess the strength to cause direct physiological injury; but these will cause painful sensations more or less. Under unfavorable conditions, continuous inductive current may reach drop-away current. The painful sensation caused by inductive alternating may lead to stress reactions.

The term "stress reaction" reflects the following fact that a series of reactions will be produced in the organism for any strong actions on human beings and animals (such as happy or unhappy). Among these reactions some will be immediately observed, for example adrenal gland increase, but maybe thymus gland and lymphatic gland decrease. According to the different type, strength of actions and different characteristics of objects, other kinds of reactions may also be observed, e.g. ulcer aggravation, nervous reaction, impotence etc. It may be acceptable if strong noise or electric shock occurs only accidentally. However if they repeatedly occur, a syndrome may develope.On the other hand, thwe effect may be felt to be unacceptable at the beginning of exposure; but upon aclimation, the syndrome will disappear gradually.

Researchers from West Germany tested personnel using field intensities up to 30 KV/m. This research did not concluded that any influence or harm was done to human health.

A proclamation was officially issued by CIGRE in 1980, which stated that "the assessment of the danger from electricomagnetic fields was given too far to much importance in the past," and declares that the field intensity of existing high voltage power transmission lines does no harm to human health, and there is a large margin of safety for allowable electric field intensity.

According to the domestic information, an electric field will be produced around the the conductors when they are energized. For 500 KV power transmission lines, maximum field intensity on the ground in the corridor is less than 9 KV/m . As compared with this, field intensity of household electrothermal blankets is between 0.24 KV/m and 10 KV/m. In addition, field intensity for power transmission lines will rapidly decrease as the distance from the power lines increases. So the influenced range is limited.

With 500 KV power transmission lines, the short-circuit current experienced by persons at ground potential is approximately 0.114 mA. For a woman of 55 Kg weight, the average biological current is approx. 0.67 mA; for a man of 80Kg weight, it is about 1 mA. The safe range of biological current for the human body is 5~30 mA. It is thus clear that inductive current produced by the power transmission lines on the human body is far less than average existing current. Therefore, an unfavourable influence on human health is unlikely.

Voltage can be induced on human beings as well as objects by electric fields. Therefore if large-sized objects nearby the HV power transmission lines (such as fences or other large metal objects) are insulated from earth, then painful electric shocks may result when a person touches these objects at ground potential. It is therefor stipulated in some countries (U.S.) that all iron fence, metal structures and other metal objects should be earthed within a fixed distance from 500 KV power transmission lines. The corresponding fixed distance is normally in the range of 50 m, according to the type of object.

The research results concerning influence on plant growth from alternating current shows that the leaftips of certain plants will be injured slightly under the action of field intensity 15~20 KV/m. This is because the field intensity nearby conductiive pointed objects will be enhanced greatly. When this field intensity reaches a certain level, corona effect may occur and lead to heat build up and a withered leaftip. However, the circular section of the plant will not be injured even under the action of field intensities of 50 mv/m. In all plants, including those with leaftips injured by corona effect, the growth speed and output is not influenced.

4.7.2 Power transmission lines impact on bird migration

Midway rest stops are necessary for long range bird migrations. Generally the choice is made for elevated positions free from human beings and other animal interference. Power transmission towers and lines are ideal resting places for birds. Frequent perching on towers and high voltage transmission lines will always result in deaths due to electric shock, affect the normal breeding of birds and impact the ecological system. There are no migratory bird flyways in the area of the transmission lines.

4.7.3 Impact analysis of transmission line corridors

The are no historical sites, scenic spots or tourist areas near the planned 500 kv transmission line. The right of way passes through farm land and wasteland. Transmission line construction will not have a negative influence on cultivation or an unfavorable impact on land utilization.

4.8 Impacts of the water intake project

The analysis of impacts of the water intake project was undertaken to solve two major problems: i) whether the natural environment allows location of the water intake mouth in this area; and, ii) the impact of hydraulic engineering buildings on the natural enviroment

4.8.1 Baseline conditions of the river at the water intake

4.8.1.1 Flow and sediment

Upon the completion of large hydraulic and hydroelectric projects in the upstream reaches of the Yellow River, including the Liujiaxia project, the sand content of upstream flows at Toudaoguai was changed, the flow was reduced and the sand content was obviously reduced. Water and sand flow, and sediment transport over the years have become comparatively stable since the completion of Liujiaxia reservoir according to surveys. This is favorable to stability of the river course.

4.8.1.2 Geologic conditions of river bed

Most of the river section from Toudaoguai to Lamawan is covered with loose deposits of the Quaternary Period and in some places stratum of the Tertiary Period are exposed. Within the river section from Haojiayao to Putanguai, mudstone, with erosion-proof capability, is exposed on the left bank of the proposed water intake mouth, while the right bank is eolian deposit layers of fine silt and active sand dunes. At the base of the sand dunes there is a sod layer which extends from the bank to river bottom with strong erosion-proof capability. This mudstone on the left bank and sod layer on the right bank of the river section forms a natural node. Therefore, it is an ideal water intake position.

4.8.1.3 River bed conditions

The river section from Toudaoguai to Shalahutan is located downstream of a bend in the river. The river reach in the section of the intake structure has few changes and the water course is comparatively stable and straight. The main flow is changed from right bank to left bank.

Flow direction of the mainstream of the river course from Haojiayao to Putanguai has large changes. The left bank of Putanguai is mudstone and the right bank is sod node. The main channel in the wet season and average periods is close to left bank. The river bed of this section forms a deep trough and becomes relatively ideal for a water intake mouth.

According to the analysis the above mentioned flow and sediment conditions, geologic conditions of the river bed course and river characteristics, the natural environment of the river course from Haojiayao to Putanguai is suited for location of a water intake structure. The immediate surroundings of this location are suitable for water intake structures and treatment facilities as well.

4.8.2 Impact of hydraulic engineering buildings on environment

4.8.2.1 Effect of dredging project on river course

Layout of dredging project refers to Diagram 4.8-1.

Based on the analysis for the purpose of dredging project of river course, the hydraulic engineering buildings of this project have an influence on the nature of the river course, by preventing erosion, and controling the main channel, as well as stabilizing the river course so that the left bank cannot be eroded, and ensuring the safety of people and properties in this area. These influences are advantageous.

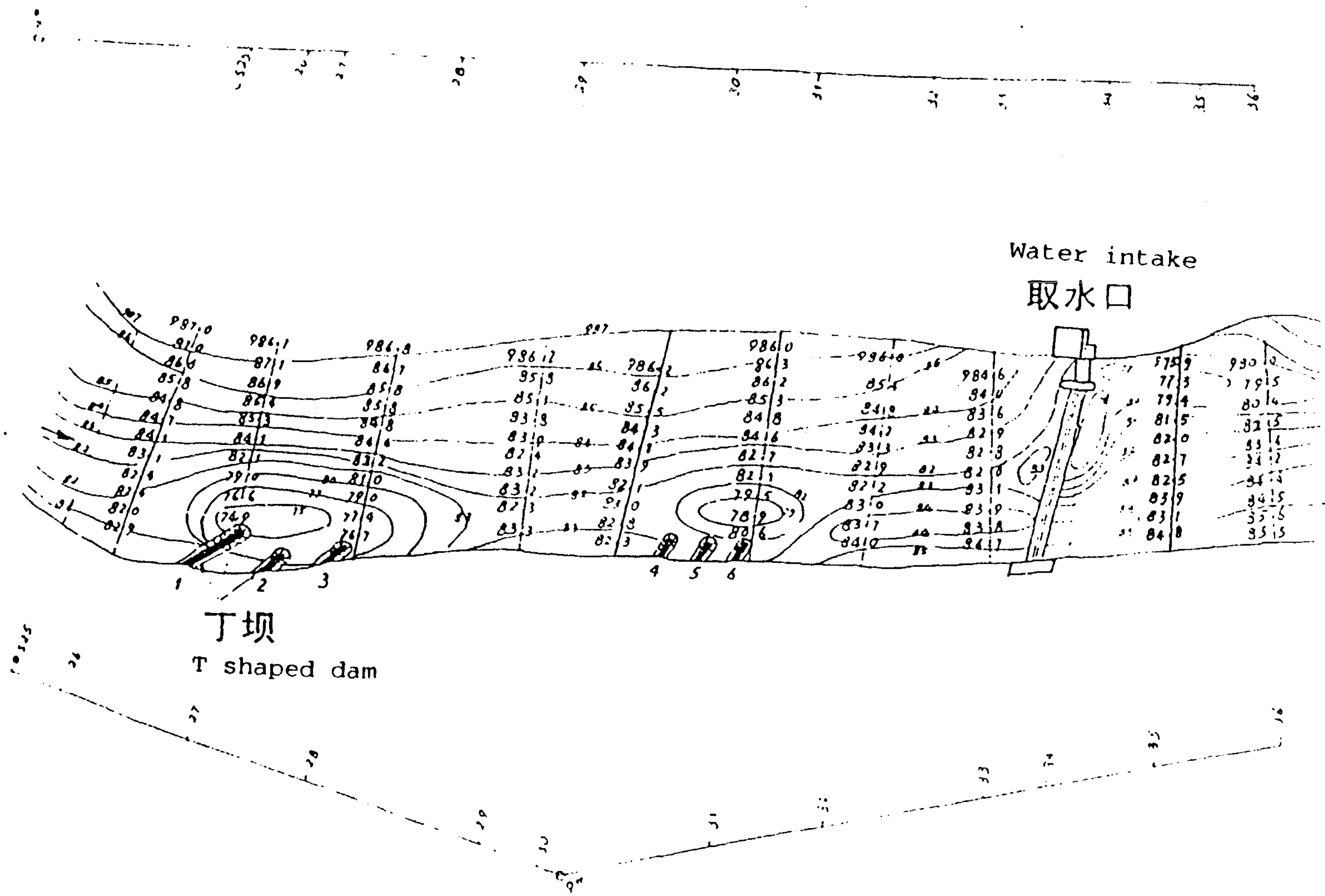


图 4.8-1　整治工程平面布置图（1：10000）

Fig.4.8-1 Dredging engineering plan layout (1:10000)

4.8.2.2 Impact on siltation

As inferred from the result of a backwater siltation analysis performed by Wuhan hydroelectric college, (physical model), the water intake buildings have little influence on both variation of water bed, flood control and drainage. Sedimentation and return water caused by construction of the water intake buildings is limited and cannot result in damage, i.e. having little influence on the environment. The design scheme is reasonable.

Refer to Diagram 4.8-2 for a sectional view of water intake buildings.

4.8.3 Impact of cooling water intake settling basins on groundwater

4.8.3.1 Geologic conditions

Three strata are found within the excavation area for the settling basins. The bottom layer is tertiary Pliocene lateritic mudstone (laterite) in half-rock status. The geologic condition is comparatively uniform, compact and hard plastic with good water-proof properties. The middle layer is quaternary intermediate-lower Pleistocene lacustrine deposit with horizontal layers. The main content is green clay with fine silt lens in some places. The clay is in plastic-hard plastic status. The upper layer is quaternary Holocene alluvial deposit, in which the top layers are brown clay with stable and continuous distribution of loose structure and in plastic-hard plastic status while the bottom layer is fine silt with loose structure and uniform particle classification and saturated.

4.8.3.2 Infiltration

The following formula is used to calculate infiltration of reservoir:

$$q = \frac{H}{\frac{2b}{K_2 T_2} + 2\sqrt{\frac{T_1}{K_1 K_2 T_2}}}$$

H--- difference of water level , H=5m (low flow period of the Yellow River);

2b--- Dam bottom width, 2b=30m;

T_1--- Weak permeable bed thickness, T_1=3m;

T_2--- Permeable bed thickness, T_2=7m;

K_1--- Infiltration coefficient of weak permeable bed, K_1=0.17m/d;

K_2--- Infiltration coefficient of permeable bed, K_2=4.3m/d;

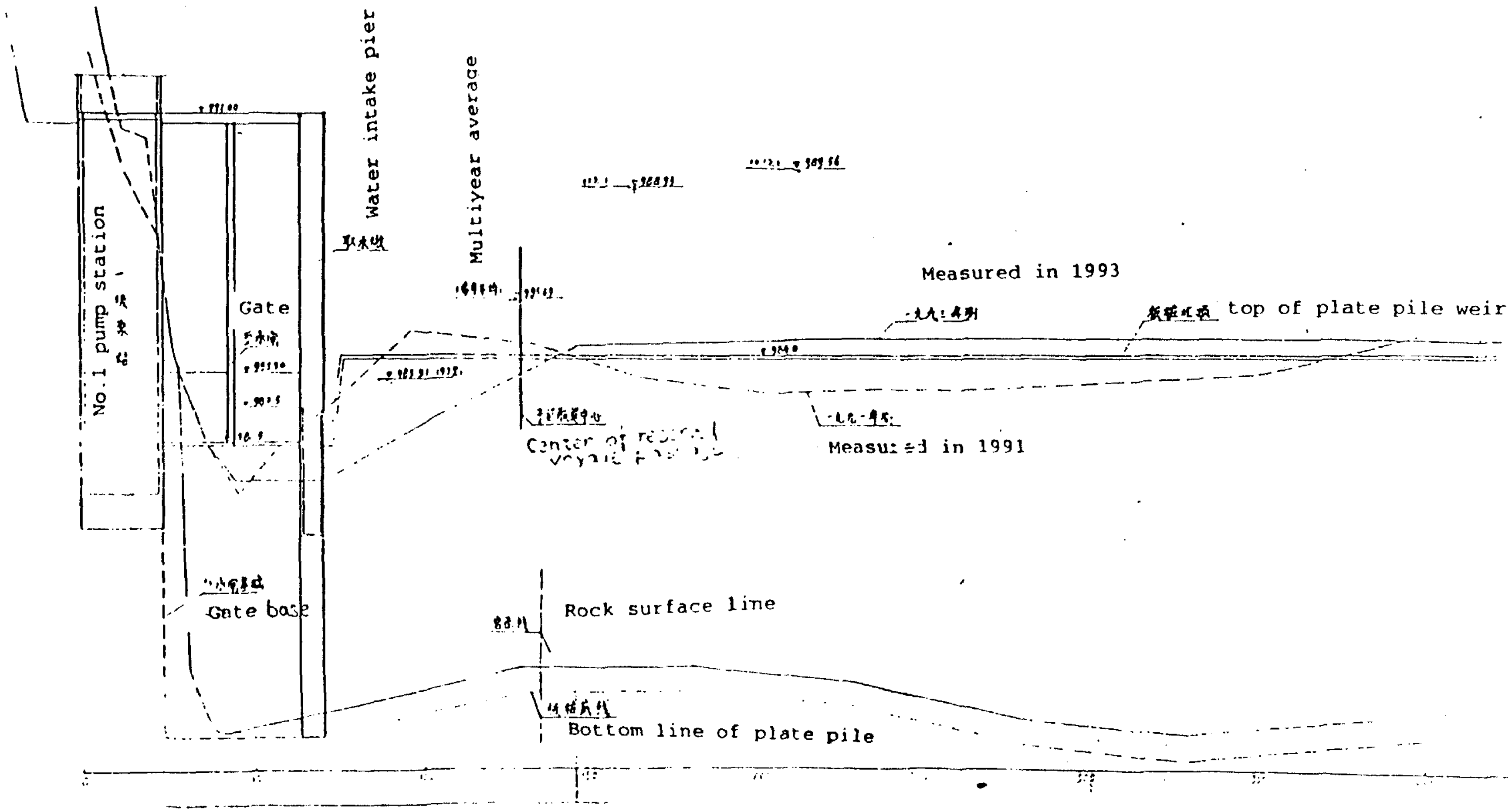


Fig.4.8-7 Water intake building cross section drawing

图 -7 取水建筑物剖面图

q--- Infiltration of unit width (m^3/d.m)

The calculation shows that the infiltration per width (q) is $q=1.8m^3/m.d$ which is similar to actual values of fish pond infiltration.

The surface clay on north side of water pond is relatively thick and can be used for preventing infiltration after being rolled. The same case lies on east side of water pond, the clay is thick and water-proof. Groundwater level at the east platform toe (with spring water elevation of 999~1003 m) is higher than the design level of the water pond. Therefore, no permanent infiltration would occur on the east and north sides. Only infiltration on the south and west sides shall be taken into account.

Length of infiltration section on west and south sides of water pond is 2280 m and 100 m respectively, and the total infiltration volume of the calculated section is 4284 m^3/d.

Total annual infiltration volume is

$$W = t \times q = 365 \times 4282 = 1.564 \times 10^6 m^3$$

4.8.3.3 Immersion

Problems of saline soils on the east of the water purification plant area have existed before construction of fishponds. As per existing survey information, after completion of fishponds for storing water, salinization problems occured within 300~500 m on the west side of the fishpond. Therefore, drainage works outside the dam of the water pond shall be properly handled after the completion of the water pond to prevent the area of salinization from enlarging.

Villages are distributed to the east of the water pond. Foundations of residential houses are 988 m away and far away from the water pond. Consequently, drainage measures will have little influence on residences.

4.8.4 Impact of water intake project on navigation

4.8.4.1 Conditions and plan for navigation of the Yellow River in TuoKeTuo County

Just like navigation on whole main stream of the Yellow River, navigation capacity in TuoKeTuo County is in decline. However, as a means of transportation, navigation of the Yellow River TuoKeTuo section has its own characteristics and beneficial values.

(1) Fifth-class navigation standard

Influence of water supply project on navigation will be analyzed and evaluated in this assessment on the basis of fifth-class navigation standards.

(2) National inland river fifth-class navigation standards and the requirements for middle-term navigation planning of Yellow River are shown in Tables 4.8-1 and 4.8-2.

Table 4.8.1
Main navigation size standard for national inland rivers

Class of passage-way	Tonnage of barge (t)	Size of ship (m), (overall length x width x design draft)	Size of flotilla, (length x width x draft)	Size of passage-way (m): natural and canalization river: water level of shallows	Size of passage-way (m): natural and canalization river: width of single line	Size of passage-way (m): natural and canalization river: width of double line	Size of passage-way (m): limit passage-way: depth of water	Size of passage-way (m): limit passage-way: width of bottom	Size of passage-way (m): bending radius	useful size of lock cabin(m): length	useful size of lock cabin(m): width	useful size of lock cabin(m): water deepth of threshold	clearance size of building across river(m): clearance width: natural and canalization	clearance size of building across river(m): clearance width: limit passage-way	clearance size of building across river(m): clearance height
Class five	300	35 x 9.2 x 1.3	125 x 18.4 x 1.3	1.3-1.6	40	75			380	140	23	2.0-2.5	50		85.5
			89 x 18.4 x 1.3		35	70	2.0	70	270	100	23	2.0-2.5	40	75	
			87 x 9.2 x 1.3		22	40	2.0	35	260	100	12(16)	2.0-2.5	30	40	

Table 4.8-2

Navigation planning of the Yellow River in 2010

River section	Length (km)	Passage-way planning goal			
		Class	Width (m)	Depth (m)	Bending radius (m)
Wuhai~Wanjiazhai	745	V	50	1.3	400

Note: This table is adapted from "Navigation Planning Report For Yellow River Drainage "

(2) Present navigation situation in the Yellow River of TuoKeTuo section

Refer to schematic diagram 4.8-3 for information on ferry and ship traffic in TuoKeTuo County and distribution of ferries of the Yellow River basin in TuoKeTuo County.

Shuerqeliang Ferry: one small boat

Madihao Ferry: one motor sailboat with 12 horsepower and load capacity of 10 tons; one tugboat with 300 horsepower and load capacity of 240 tons at Madihao pumping station.

Putanguai Ferry: one small boat.

Maobula Ferry: one motor sailboat with 12 horsepower and load capacity of 10 tons.

Above is the present situation in TuoKeTuo County. In 1956, there was a wooden sailing boat co-op in TuoKeTuo County which processed 27 boats and 233 workers. But navigation was in decline in the 1970s. Table 4.8-3 shows navigation situation of TuoKeTuo County in the 1970s.

Table 4.8-3

Shipping capacity statistics for TuoKeTuo County in 1971~1978

Year	Shipping capacity(t)	Turnover(tkm)
1971	276	96365
1972	2207	248189
1973	4435	392881
1974	5990	403829
1975	13400	161480
1976	13400	161480
1977	15537	539123
1978	5218	574097

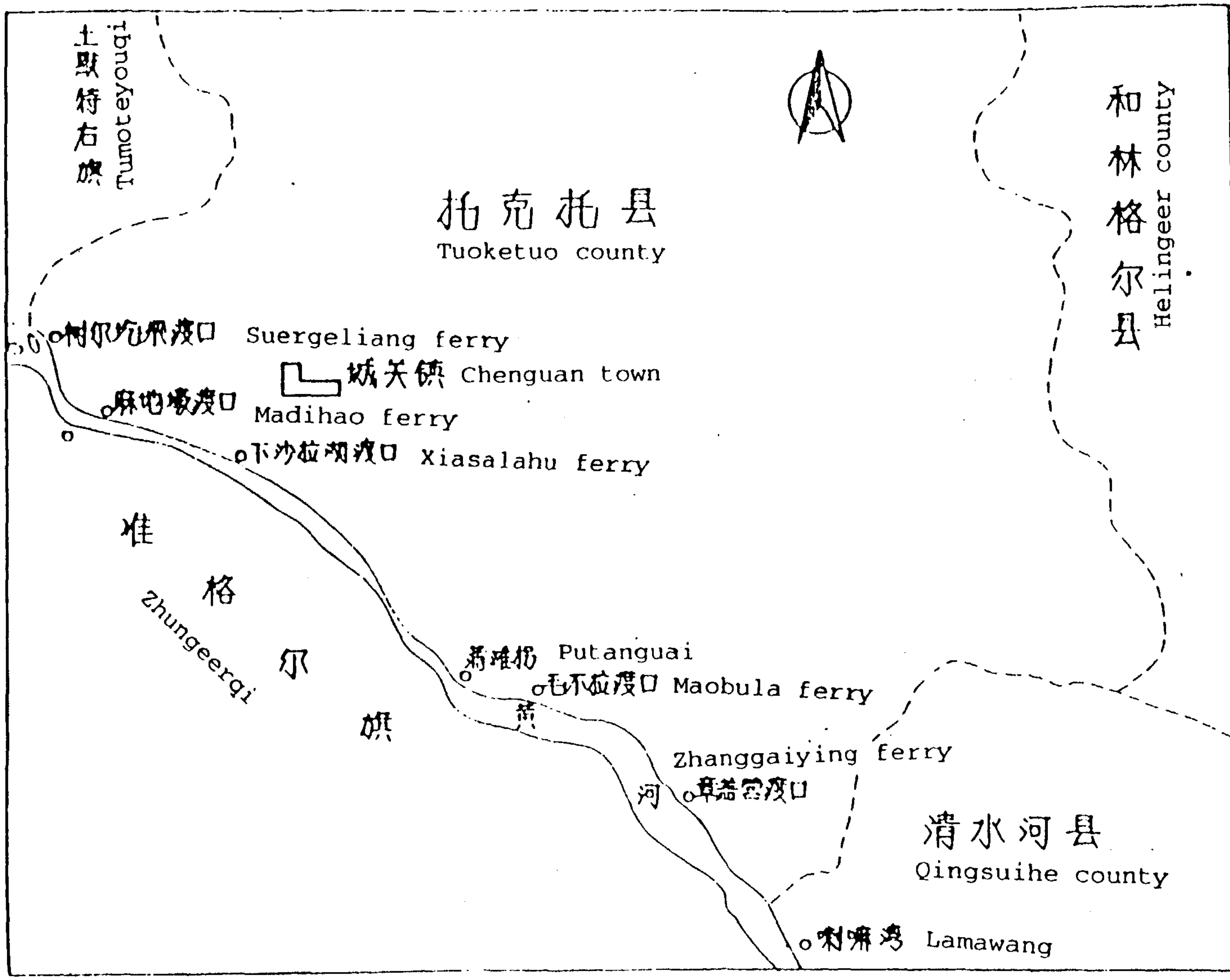


Fig.4.8-3 Distribution diagram of Yellow River ferry in Tuoketuo county

图 4.8-3　托县黄河流域渡口分布示意图

In the 1980s, long-distance freight transport was in gradual decline. Up to 1985, long-distance freight had almost stopped after the completion and use of Lamawan Bridge.

4.8.5 Impact of hydraulic engineering buildings on navigation

Buildings of the water supply project that may affect navigation include water intake buildings such as water intake piers, pile weir, backwater gate, etc. and water course dredging projects.

Water intake pier is the main building at the beginning of the water intake. It is located on the main channel (See Diagram 6.3-2) which is 50 m away from the left bank, the deck size is 9 x 28 meters.

We can see from Diagram 6.3-2 that the water intake pier is 6 m above water level. The water course for about 60 m, from the left bank to the main flow zone would be occupied by water intake facilities. In addition, it would occuppy the main channel of this river section. Therefore, it would be difficult for selection of passage ways for ships. However, design of water intake buildings has taken into account the navigation requirements in the feasibity study phase and reserved space for navigation on the right side of the water intake pier, so the adverse effects on navigation caused by the water intake buildings are insignificant.

4.8.6 Submergence and land acquired

Submergence and land acquired means land dredged for the water intake pond, and occupied by the water purification, delivery and discharge projects. The discharge will travel by pipeline to an existing water channel to the Yellow River downstream of the intake structures.

Water pond only occupies a used fishpond. It will neither occupy cultivated land nor cause moving of houses. The submerged land has no vegetation except some plants such as Achnatherum splendors (Trin.) Nevski. Therefore, it has little influence on local residents

Layout of water purification project, excluding sludge discharging yard, covers an area of 9.6 km^2. It will occupy as little cultivated land as possible and make full use of wastelands. There are few plants or trees on the occupied land and they will not be destroyed during the construction of the water purification project. Therefore, it has little influence on the natural ecology.

For the water delivery pipe, the depth buried will be under the frozen soil layer, so it is unnecessary to consider the influence of occupation. It will only occupy cultivated land temporarily during construction.

(see Chapter 9 for land use and compensation details).

4.8.7 Impact of water intake project on environment

4.8.7.1 Main beneficial impacts

The beneficial impacts of the water intake construction project on the natural environment can be regarded as: i) stabilization of the water course; ii) strengthening the bank slopes of the water courses near Dongying village from scouring by the Yellow River; iii) improving the safety and protection of properties and agricultural production of local residents from the flood damage of the Yellow River. The beneficial impact is significant with respect to both the natural and social environment.

The water supply project will benefit navigation due to stabilization of the water course and channel. Vertical and side infiltration of the water pond would have no effect on ground water and salinization of soil.

4.8.7.2 Main adverse effects

Environmental impact of silt treatment is the main adverse effect. Sediment disposal yard covers an area of 71.3 ha; dry silt will be stacked at this area 3.4 m high. If no mitigation measures are taken, in time it will surely become a pollution source. Therefore, great attention shall be paid to environmental impacts of silt treatment, and necessary mitigation measures shall be taken, such as planting windbreak forests, and improving the properties of the silt, to enable planting of grasses, trees and crops. In addition, silt can be developed into rich soil to minimize the adverse impact on navigation.

Hydraulic engineering buildings may adversely affect navigation. This mainly refers to the fact that the water intake pier and auxiliary buildings will narrow the navigable water course by 60 m, which will affect the selection of passage. Location of passage way has been reserved in the design. However, small boats are used for shipping in TuoKeTuo County that do not pass the water intake building site. Therefore, it has little adverse effect on the navigation.

4.9 Ecological environmental impact assessment

4.9.1 Main impact factors of construction of the power plant

TuoKeTuo A is coal-fired power plant, and its impact on the ecological environment during operation mainly involves flue gas emissions: the main pollutants include SO_2, NO_x, SPM & flourine. A large amount of ash and slag will be generated from the electrostatic precipitator and boiler bottoms. There is a potential for groundwater contamination from the ash disposal area. Regarding pollutants discharged from the power plant, control of the total amount of pollutants generated by the plant has already been considered in the design and construction plans for the power plant, which will keep pollutants released to the surrounding area at the lowest economically and technologically feasible level. The direct impacts caused by operations can be negligible.

4.9.2 Ecological impact

Civil works during construction of power plant such as the ash disposal area, living quarters, roads, and pipelines will require excavation, earthwork transport, and mechanical work. The construction project will result in an increase in local population. Construction activities will destroy or damage vegetation cover, thus affecting the habitat of some living beings. Basically the area in the plant site and ash disposal area is a loose type of soil, most of which is fixed or semi-fixed sandy land. There are even sand dunes in some places. Vegetation includes poplars, shrubs of C. microphylla Lam. and weeds. Canopy density of forests is relatively low and cover rate of grasses is less than 5 %. Since the climate in this area belongs to semidry grassland, the main ecological environmental problem caused by construction of the power plant is the drifting of sandy land due to damage to existing vegetation. These impacts will be mitigated by revegetation of all construction areas (see Chapter 5). In addition, a large capital soil conservation and desertification control program is planned to coincide with project development. Resettlement and compensation issues are detailed in Chapter 9.

4.9.3 Impact of pollution factors on ecological environment

(1) Flue gas

If concentration of flue gas from power plant exceeds certain limits, it will be potentially dangerous for the soil-crop ecological system. Gaseous fluoride will increase fluorine content in vegetation and have direct or indirect affect on human health. During blooming periods of crops, SO_2 will affect fertilization.

According to the predicted results for ground concentration of atmospheric pollutants and from the view of growth of vegetation, daily average ground concentration of SO_2 in all typical days is very low or relatively low, and meets the requirements of GB9137-88 'Maximum Allowable Emission Concentration of Atmospheric Pollutants for Protection of Crops.' This standard refers to flouride and SOx For the most sensitive types of crop grown in the assessment area, the (ambient air) standard for flouride is 5.0 μg per square decimeter per day; and 1.0 μg per square decimeter per day average over the growing season. The SO_2 standard for sensitive crops is 0.15 μg /m^3, 24 hour average; and 0.05 μ g /m^3 average over the growing season. This is the same as the Class II standard as well as the World Bank standard used in this assessment. SOx will not impact growth of vegetation, based on this, it can be inferred that concentration of other pollutants (e.g. fluoride, hydroxide, etc.) is also within the scope of corresponding concentration, therefore, no unfavorable impact will be imposed on the environment and ecological system. High efficiency electrostatic precipitator will be used in the power plant, so concentration of SPM will meet the requirement of allowable emission standards.

(2) Ash and slag

TuoKeTuo Power Plant A is a large-scale coal-fired power plant with high coal consumption and ash content, so the power plant will discharge a large volume of ash.

Ash disposal area of TuoKeTuo A will be a closed-cycle flow area with a leachate liner system to prevent groundwater contamination. But in some special cases, e.g. in case of heavy rain or thunderstorm, rain water will submerge the ash disposal area. Overflow ash water will possibly harm soil and vegetation with alkali matters or other pollutants. Therefore, a rainfall runoff drainage system is included in the design which will prevent overflow ash water form affecting soil and vegetation. The collected runoff will be pumped into the ash slurry water recycling system (for details see section 4.12).

(3) Industrial waste water

TuoKeTuo Power Plant A will discharge large volumes of waste water with complex water quality. Industrial waste water will be treated in the process area where it is generated without dilution to meet discharge standards before being released. In this way, pollution of the soil-vegetation system due to distributed discharge will be reduced or avoided (for details of wastewater treatment and recycling systems, see section 4.12).

4.9.4 Impact of construction of power plant on macroscopic ecological environment

4.9.4.1 Natural resources impacted by planned project

(1) Scenery and change of land utilization

Construction of the power plant will change present scenery composed of cultivated lands, sparse forests and villages into that composed of modern towns and factories. The main building, chimney, coal yard, ash disposal area and water tower will have influence on natural scenery, especially the flue gas from chimney and water/steam discharged by the natural draft cooling tower, which will be visible for several kilometers

Due to the land occuppied by the power plant (2 x 600 MW) to be constructed, cultivated land in the assessment zone will be reduced by 0.12 %, and forests by 0.99%, and the land occupied by factory or mine land will increase 1.18 %. Construction of the power plant will make full use of land which otherwise difficult to develop.

(2) Loss of land resources

Table 4.9-1 shows the area and type of the land occupied by the power plant at the project phase I. The assessment for loss of land can be seen in Table 4.9-2.

Table 4.9-1

Statistic for area and resources type of occupied land for first phase of TuoKeTuo Power Plant A

Unit: Mu

Villages	Item description					
	Irrigated land	Dry land	Forest land	Meadow	villages	Land area
Shulinzi	197	127	100	63	-	487
Daduiying	146	108	99	80	53	433
Jiahao	191	90	28	-	-	309
Mahuangtan	62	50	25	-	-	137
Yanshanying	-	71	-	102	-	173
Zhanggaiying	-	-	157	-	-	157
Forestry center	-	-	96	-	-	96
Total	596	446	505	245	53	1845

The equipment designs for the next phases of development have not been made; therefore exact space requirements have not been listed. They are likely to be similar.

(3) Impact on flora and fauna

There are 248 species in assessment zone which include 194 species of wild plants. These plants are of common and extensively distributed species. Consequently, construction of the power plant will neither result in local loss of native plant species, nor change composition of plant species, nor result in extinction of species. There are few different species of wild animals in the assessment area and those found use agricultural lanls for habitat. Even fewer species are distributed around the proposed power station site and ash disposal area. The construction will cause emigration of some animal species without resulting in a large change of their species composition or number of species. More plant species will exist after the completion of the power station due to landscaping and beautification of the power station area, and some birds use the new vegetation for habitat.

(4) Impact on evolution of vegetation

A. Changes of vegetation around ash disposal area and plant area

The common characteristics of the two ash disposal areas and plant site are sparse vegetation, low species diversity, and fixed or semi-fixed sandy soil. Gaobaoshi ash disposal area is the worst with respect to structure and stability of vegetation. All original vegetation within the ash disposal areas and plant site will be destroyed completely during construction. Such factors as construction and transportation will also affect the growth of vegetation outside ash disposal areas and the plant area. Water and wind erosion will be intensified because the final elevation of the ash disposal area will be 19~30 m higher than the original ground surface. Growth of vegetation on ash disposal areas by natural evolution is impossible. This will result in desertification of soil. Therefore, scientific and stable vegetation around ash disposal area and plant area shall be established by The Touketuo Plant environmental department on the basis of mastering the requirements of adaptable vegetation.

B. Vegetation pattern changes in the regional environment

Construction of the power plant will occupy land which will result in unfavorable influence in some places. However, if mitigation measures are taken during the construction, serious problems can be avoided. Meanwhile we can conclude that construction of the power plant will have a favorable influence locally: first, labor and capital investors will form a great construction force; second, improvement of education and technology enables peasants to improve the natural environment and enhance their own production capabilities.

The demand for food such as meat, eggs, milk, fruits and vegetables will be increased with growth in population for construction of the power plant. In this case, peasants will change their original planting pattern, which is cultivation of grains to establishment and protection of stable man-made summer green forests for development of forestry and fruit trees; and establishment of artificial grassland and forage for development of animal husbandry. Grain output can be increased by planting grass and crops alternately. In this way, wind erosion and desertification will be reduced by means of the combination of ecological environment improvement and economic development. Thus the expected ecological impact would be positive.

4.10 Environmental impact analysis of power plant construction

4.10.1 Impact on social economy under local administration

The construction of TuoKeTuo Power Plant A will bring greater changes to the features of social economy under local administration. It is always beneficial for this project to analyze the power plant construction from the economic viewpoint. TuoKeTuo county and nearby villages and township enterprises will benefit from this project. First of all, subordinate economic activities which result from the employment opportunity increases will be reinforced. With the development of the local economy, the corresponding cultural technology of peasants will be improved, which may improve the natural environment and increase productivity. With the growth of the population related to the power plant and the greater demand for non-staple foods such as meat, eggs, milk, fruit, and vegetables, the peasants will transform their former cropping structure, which gave priority to grain crops. The development of a diversified rural economy will be promoted.

Construction materials are in such great demanded for power plant construction, this should promote the development of a local construction material industry and engineering, and stimulate economic growth in the local area side by side.

4.10.2 Employment and labor forces

The large construction labor force (5,000 - 6,000 construction laborers, not including temporary workers) required for power plant during construction may be recruited locally. Hosts of idle manpower in rural areas around power plant may be utilized so that a great number of employment opportunities will be provided,(see section 7.1.2).

4.10.3 Housing

The casual laborers employed for all stages of construction may be recruited locally, and they have their own housing. Those regular staff and workers taking part in the power plant construction will reside in the dormitory buildings for staff and workers (adequate for 5,000-6,000 people) in the plant site. Power plant construction therefore will not exert pressure on the local housing.

4.10.4 Public facilities and services

The highway traffic load from Huhehot to the plant site will be somewhat increased due to weekend bus service, trucks for material transport and large pieces of electric equipment transported to the power plant. However the traffic load increase on the highway will be limited due to occassional usage. Most employees will commute between the power plant and dwelling places during power plant construction. Moreover, a special road will be built between the power plant and residential areas. There will be no need to use Huzhun highway for staff and workers living in the residential areas in the plant when they travel to work.

Cultural life and activities for construction personnel after workhours in the power plant will have little effect on public facilities and service in the locality during plant construction. The residential area of the plant is at a distance from county towns. The recreational activities of staff and workers focus mainly on residential areas where dance parties, ball room and chess games are often held in new self-built cultural palace, stadium, club and cinema. The staff and workers are satisfied and given recreational opportunities. A hospital and child-care centre for staff and workers will be established in the power plant for staff and their family members. Most single staff and workers will settle in Huhehot city and can get back home every week. So they will not feel lonely. There will be a labor union which will take an individual interest in the members.

4.10.5 Impact on land utilization and the landscape

The utilization of existing land and land forms will be influenced during construction period. The land will be excavated and piled, because necessary warehouses for storage of equipment and materials as well as walls are to be built. The activities for building will temporarily result in impact on the landscape. Therefore, protective measures have to be taken by the contractors in order to minimize the impact and side effects on the environment TuoKeTuo County Environmental Protection Bureau has juristiction for supervision of environmental impact control measures during construction. The following will be included in contractor bid specifications:

- Water and soil conservation measures shall include the preservation of vegetation covers in the construction area.
- Reduction of soil exposure measures shall include the development of temporary surface coverage to reduce the soil erosion.
- Management of construction garbage shall include the clean up of construction garbage and related matters.
- Compliance with the local and national regulations on security and health shall include the legal and administrative construction regulation.
- Maintanance of the landscape on the construction site shall include the greening and gardening work in accordance with design requirements.

4.10.6 Impact on sutface water quality

The following stipulations shall be included in contractor bid specifications for construction of water supply project structures:

- Minimization of developed areas of land and to carry out the greening on the completed areas as soon as possible.
- Taking necessary measures to prevent the oil and fuel pollution to the soil along river course.
- No garbage shall be allowed to be piled at the river bank.
- Minimization of the generation of filth to keep the water quality during various construction.
- Excavated earth will be backfilled and not dumped to the river.

4.10.7 Impact on ecological system

The impact of construction of the power plant on the ecosystem shall mainly include the damage and migration of vegetation groups, and separation, breakage and interference with natural vegetation. Only some ordinary vegetation will be influenced in the construction of Touketuo Plant A, such as salix Matsudana. Its loss shall have small impact on the vegetation and varieties of habitat species for wildlife.

4.10.8 Impact on soil

After the transformation from farming and communal land to impervious buildings and roads the infiltration of precipitation into soils will be minimized, and surface runoff will increase. The impact will be quite small in TuoKeTuo area owing to the level plant site and favorable infiltration properties of the soils. Moreover, the precipitation in this area is small (395.2 mm) and would result in little impact.

4.10.9 Impacts on ambient air quality

During construction the unfavorable impacts on ambient air quality should be minimized as much as possible; law and management requirements on atmospheric pollution control stipulated by the state and local authorities should be strictly carried out. During the construction period of the power plant, category II standard of BOILER ATMOSPHERE POLLUTANT DISCHARGE STANDARD GB3841-83 (300-400 $\mu g/Nm^3$ SPM; Ringleman Index Class I opacity) will be implemented for the flue gas emissions from heating and drinking water boilers. Water will be sprinkled to moisten the ground surface in dry and windy seasons in order to prevent fugitive dust pollution and flue gas emissions of construction machinery and vehicle exhaust will meet the relevant requirements for hydrocaron emissions and carbon monoxide. Hydrocarbon, CO, NO_X, and dust will increase near the Huhhot-Zhungeer Highway and roads in plant area during the power plant construction but with little impact.

4.11 Sanitary wastewater discharges during wastewater treatment plant start up

It is very important to prevent the water quality of the Yellow River from being polluted since the Yellow River is one of major rivers in China. The waste water discharged by the Touketou Power Plant A to the Yellow River can meet the requirements of the Grade I of "Comprehensive Discharging Standard for Industrial wastewater (GB8978-88)" which applies to newly-built, extension and reconstruction projects. Nevertheless, operations of the sanitary sewage treatment facility may be experience process upsets in the initial operation period, prior to system stabilization, resulting in discharges of wastewater that exceed the permited standards. Therefore, a risk assessment has been conducted concerning impacts on the Yellow River from discharge of untreated sanitary sewage.

The wastewater discharged to the Yellow River will affect the water quality in some sections of the river. A two dimensional mathematical model was employed to predict the polluted zone.

4.11.1 Model of water quality

In accordance with characteristics of the Lamawan section of the Yellow River, a two-dimensional mathematical model with vertical mean was adopted for calculation and prediction of velocity of flow and concentration of pollutants.

Condition of simplification for model:

(1) Uniform distribution of flow velocity and concentration along with the direction of water depth;

(2) Items of K force and wind stress in momentum equation are neglected;

(3) Diffusion coefficients in calculation area shall be of constants.

The control equations set:

Continuity equation:

$$\frac{\partial H}{\partial t} + u\frac{\partial (Hu)}{\partial x} + v\frac{\partial (Hv)}{\partial y} = 0$$

Momentum equation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -g\frac{\partial \xi}{\partial x} - \frac{gu(u^2 + v^2)^{1/2}}{C^2 H} + E(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2})$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -g\frac{\partial \xi}{\partial y} - \frac{gv(u^2 + v^2)^{1/2}}{C^2 H} + E(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2})$$

Concentration equation:

$$\frac{\partial c}{\partial t} + u\frac{\partial c}{\partial x} + v\frac{\partial c}{\partial y} = D(\frac{\partial^2 c}{\partial x^2} + \frac{\partial^2 c}{\partial y^2}) - Kc$$

Where:

H-- water depth, H=h+s , where h is average depth and s is variation of water depth over average depth.

u,v-- flow velocity in direction of X and Y
g -- gravity acceleration

C-- Cechz coefficient, $C=\frac{1}{n}H^{1/6}$, where n is
roughness coefficient

E-- Flow diffusion coefficient
c-- Concentration pollutant
D-- Diffusion coefficient
k-- Degradation coefficient of pollutant

For calculation, finite element analysis is used for the continuity equation; the characteristic line method is used for convection items in the momentum equation and the concentration equation, while mode of centralized quality finite element is used for diffusion items. This model is relatively stable and suitable for calculation of areas with irregular boundaries, and has been used for the prediction and calculation of several projects, and has given reasonable results.

4.11.2 Calculation conditions and parameters

(1) Analysis & determination of calculation conditions

a. Quantity of sewage and waste water discharged from the power plant:

The discharged wastewater volume is 400 t/h with hydraulic ash removal scheme and 700 t/h with dry ash removal scheme.

b. Main pollution factors and discharging concentration

Based on the characteristics of discharged wastewater, BOD_5 and CODcr are selected as a major index for assessment of sanitary sewage.

The concentration of BOD_5 in sanitary sewage is approximately 200 mg/l when two-stage treatment process is not adopted. After mixing with other waste water discharged BOD_5 is 50.0 mg/l (400t/h) and 28.6 mg/l (700t/h) respectively. The distribution diagram of polluted zone and its isoline enveloped area reveal that there exist two main factors controlling the distribution scope of the polluted zone, namely, discharge concentration and flow rate upstream in the river course.

c. Flow

The average annual run-off volume is approximtely 22,880,000,000 m^3 according to statistical results for 22 years measured at Toudaoguai hydrological station, average annual flow over the years is 725 m^3/s. The corresponding water level is 985.63 m. This flow rate represents typical values.

Monthly average flows over several years measured at Toudaoguai hydrological station are listed in Table 3.1-2.

Both average annual flow and average flow in dry season are selected in the calculation, i.e. average annual flow is 725 m^3/s and average flow in dry season over several years is 305 m^3/s.

d. Water depth

In the calculation, an average depth of 1.8 m is used corresponding to flow of 305 m^3/s and 2.5 m for flow of 725 m^3/s.

e. Boundary conditions

Flows at upstream and downstream boundaries in this calculation area are determined. Flow rate is assigned to each joint of the boundary limit on the water sections according to parabolic distribution, c/n = 0 at the bottom and side walls. Sliding boundary conditions are selected for flow on solid boundaries.

(2) Selection of calculation parameters

Selection of calculation parameters shall be calculated by referring to concerned materials and adjusted.

a. Selection of flow diffusion coefficient (E) and concentration diffusion coefficient (D) are selected referring to "Water Environment Capacity Manual" and adjusted based on experiences of calculation for other similar water courses. The selected values of E and D coefficients are 10.0 m^2/s and 5.0 m^2/s respectively.

b. Bottom roughness coefficient: n = 0.025

c. Degradation of the pollutants in Gengqinggou is neglected in calculation.

d. Degradation coefficient for pollutants are selected refering to "Water Environment Capacity Manual". See Table 4.2-2.

Table 4.11-1:

Degradation coefficient k

Flow of river course	Pollution index	
	COD_{cr}	BOD_5
	K values	
$Q=305m^3/s$	0.30	0.62
$Q=725m^3/s$		0.41

4.11.3 Analysis results

The selected calculation area is the Yellow River at Lamawan section, indicated in Figure 4.2-1. The calculation area is about 5.0km long and 600m in average width with total area of about $3.0km^2$. There are 858 irregular triangle units in the calculation network with total joints of 529, including 4 oasis. Refer to Figure 4.11-1 for details.

Both average annual flow and monthly average lowest flow conditions are considered for the prediction and calculation. Monthly average lowest flow is approximately 305 m^3/s with corresponding design water level of 984.93 m; average annual flow is approximately 725 m^3/s with corresponding design water level of 985.63 m. Discharged wastewater for dry ash removal and hydraulic ash removal are $0.194m^3/s$ (700 t/h) and $0.111m^3/s$ (400t/h) respectively. Initial wastewater discharge concentration will be Co(CODcr) = 100 mg/l and Co (BOD5) = 28.6 mg/l for dry ash removal, and Co (CODcr) = 100 mg/l and Co (BOD5) = 50.0 mg/l for hydraulic ash removal.

Based on the analysis for existing monitoring data collected upstream of the discharge piont during dry the season, the background concentrations of COD_{cr} and BOD_5 are 11.67 mg/l and 2.94 mg/l respectively.

Refer to Figure 4.11-2 for the prediction of flow velocity for average annual flow and monthly low flow conditions.

The distribution results of the pollutants in the water area are given in the form of concentration lines. The predicted results for the mixing zone with recieving a wastewater volume of 700 t/h are shown in Figures 4.11-3 and 4.11-4; whereas the predicted results for the mixing zone with recieving 400 t/h of wastewater are shown in Figures 4.11-5 and 4.11-6.

The corresponding isoline enveloped areas are shown in Figures 4.11-2 and 4.11-3.

Predicted concentration of CODcr and BOD5 have already taken the background values into consideration, such as the distribution over the river sections and enveloped areas.

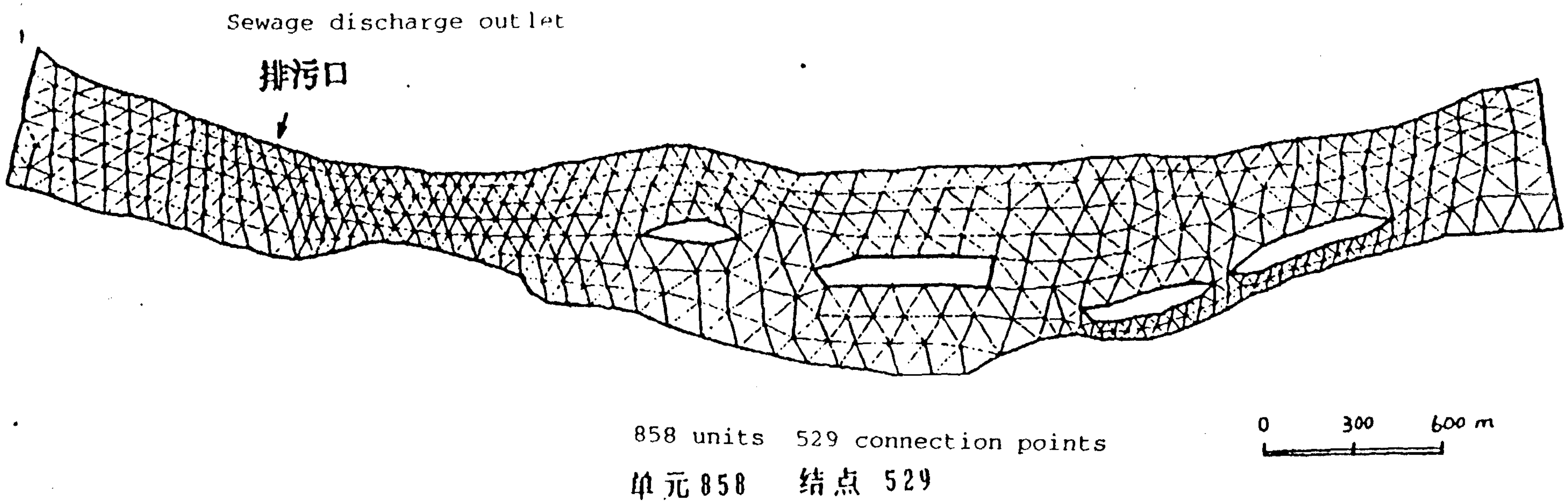


图4.11-1 计算网格图

Fig.4.11-1 Calculation grid diagram

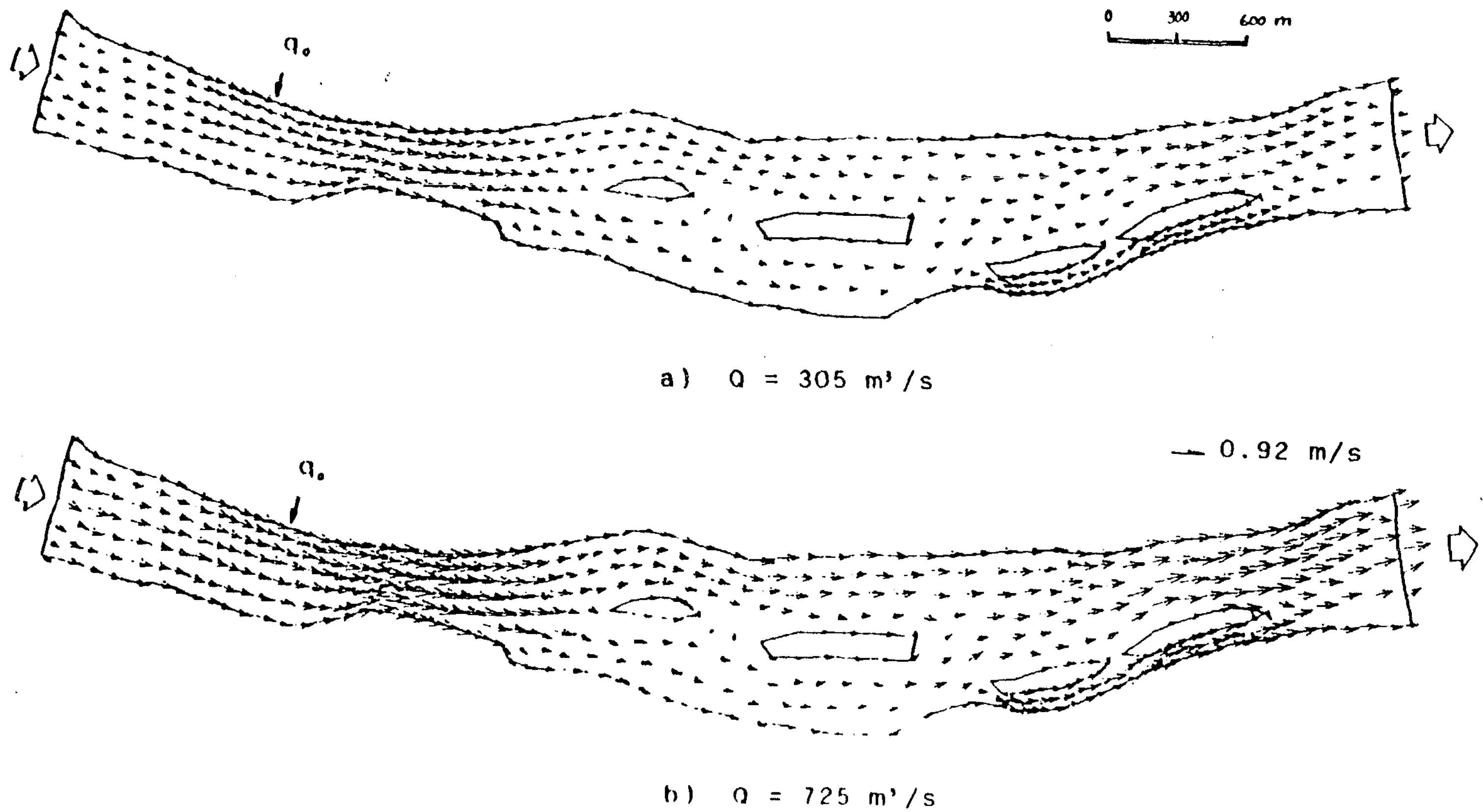


图4.11-2 电厂排污河段（喇嘛湾段）的流速分布图

Fig.4.11-2 Flow speed distribution diagram for sewage discharging river section (Lamawan section)

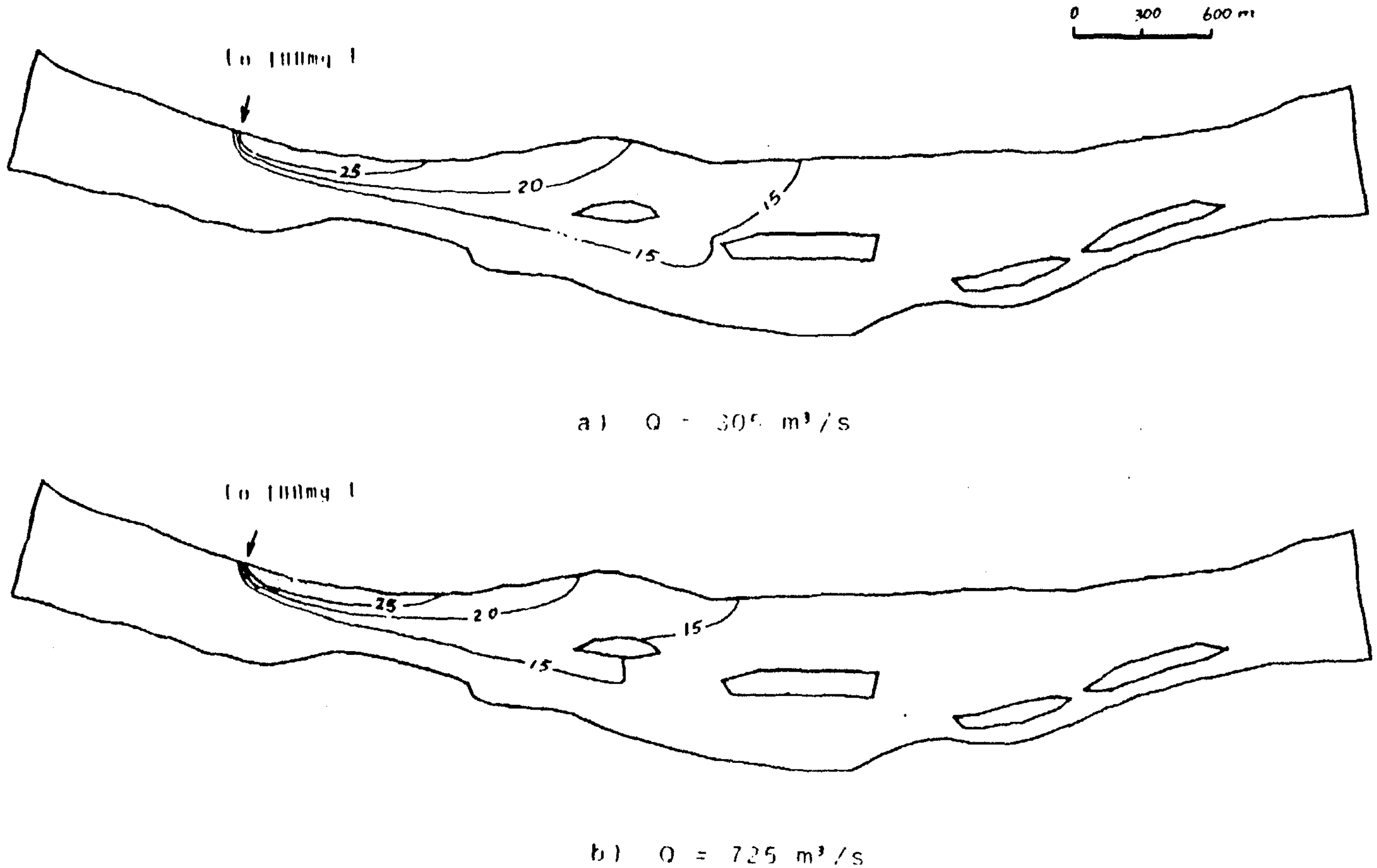


图 4.11-3电厂排污河段COD_{Cr}浓度分布图
排污量 700吨/小时

Fig. 4.11-3 COD_{Cr} concentration distribution diagram for sewage discharging outlet river section (discharging rate 700t/h)

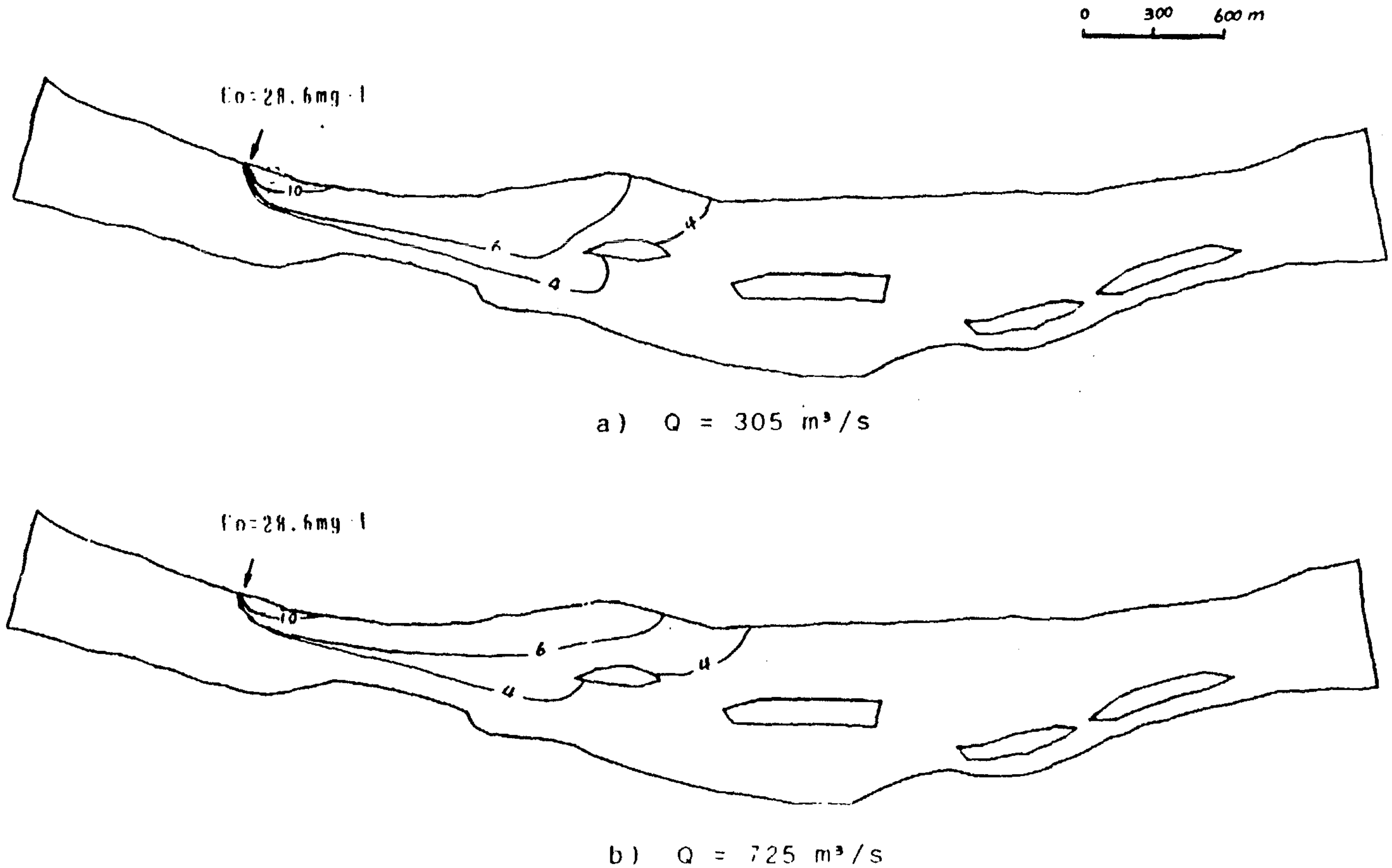
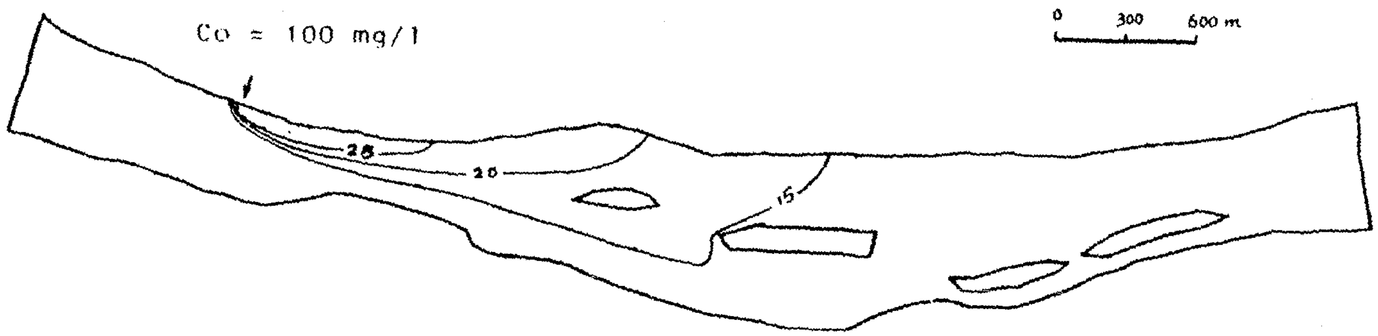


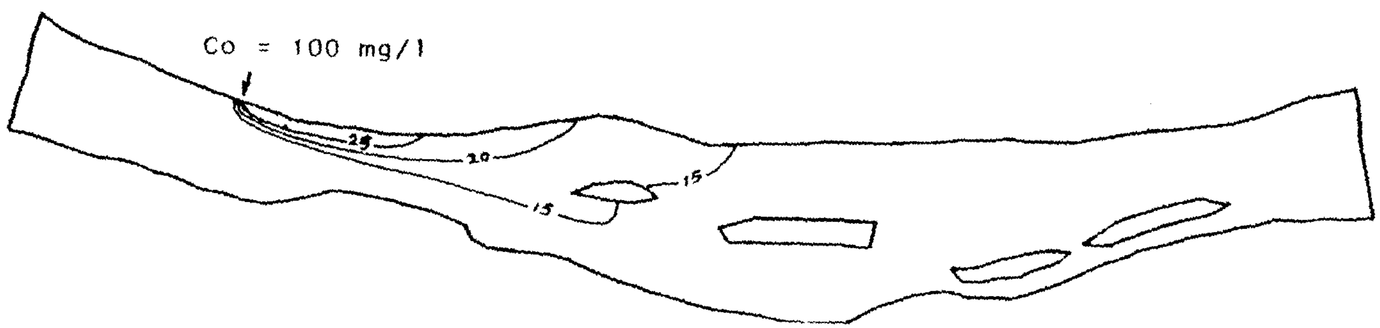
图4.11-4电厂排污口河段的BOD_5浓度分布图

排污量700吨/小时

Fig.4.11-4 BOD_5 concentration distribution diagram for sewage discharging outlet river section (discharging rate 700t/h)



a) $Q = 305\ m^3/s$

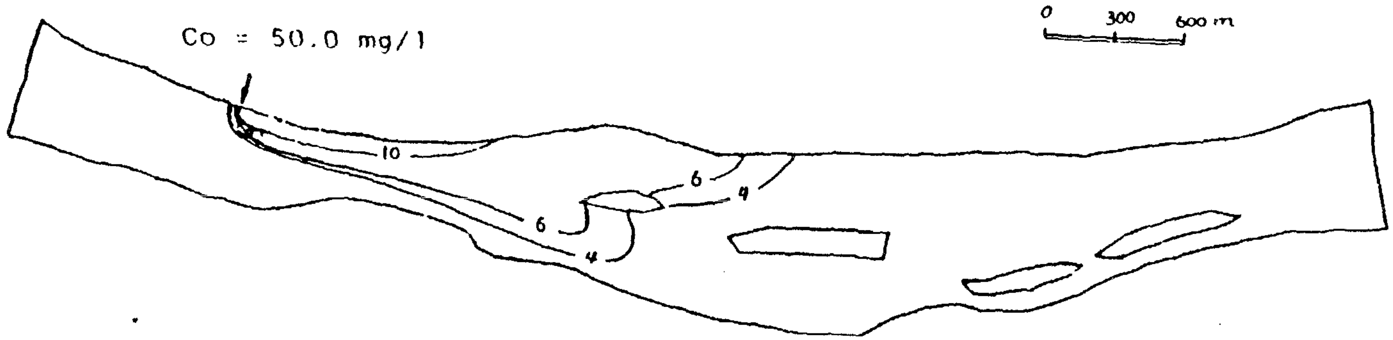


b) $Q = 725\ m^3/s$

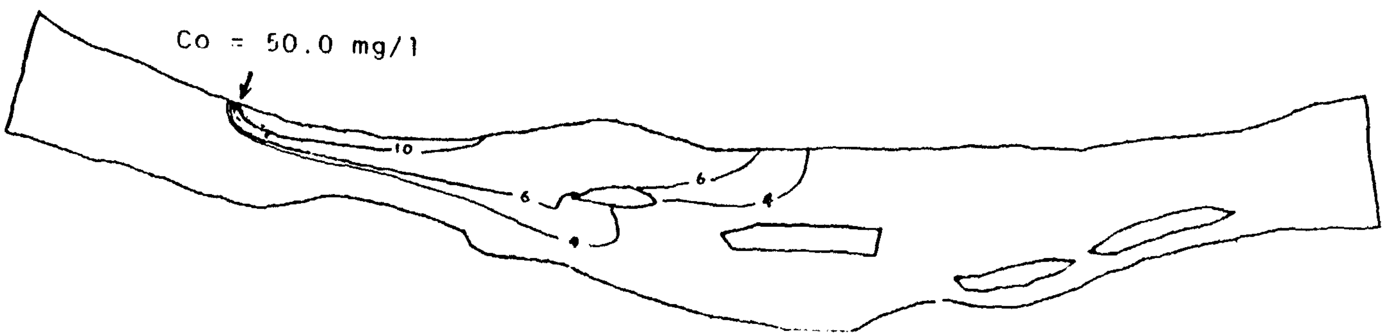
图4.11-5电厂排污河段COD_{cr}浓度分布图

排污量 400吨/小时

Fig.4.11 5 COD_{cr} concentration distribution diagram for sewage discharging outlet river section (discharging rate 400t/h)



a) $Q = 305\ m^3/s$



b) $Q = 725\ m^3/s$

图4.11-6电厂排污口河段的BOD_5浓度分布图

排污量 400吨/小时

Fig.4.11 6 BOD_5 concentration distribution diagram for sewage discharging outlet river section (discharging rate 400t/h)

The predicted pollution gradient diagram and enveloped area values of isolines shows: the two major factors deciding contamination plume size are the discharge concentration and flow rate of the river.

Discharge concentration, namely, the source intensity, will have direct influence on the distribution of concentration in contamination plume. With high source intensity, the area of the higher concentration isoline will be enlarged. The scope of lower concentration isoline will be enlarged too, but not so obviously. If the source intensity is constant and waste discharge is different, the distribution of contamination plume will basically be the same. Therefore, the impacts of wastewater discharge concentration is the controlling factor in the distribution of contamination plume size. For higher concentration distributions, the impact will be significant.

The flow rate of the river will affect the length and width of the contamination plume. With large flow rate, the river's self purification capacity will increase and the contamination plume size will be decrease, and vice versa. This phenomenon was proved by the comparison between the two predicted result for river flow rate listed in each diagram of concentration distribution.

Table 4.11-2

Enveloped area of COD_{cr} isoline

Operating condition	Enveloped area (km^2)	Concentration (mg/l)		
		Class V Water	Class IV Water	Class III Water
		≥25.0	≥20.0	≥15.0
Discharged sewage volume(700t/h)	Q=305m³/s	0.063	0.198	0.673
	Q=725m³/s	0.052	0.112	0.414
	Average	0.058	0.155	0.543
Discharged sewage volume(400t/h)	Q=305m³/s	0.065	0.216	0.682
	Q=725m³/s	0.046	0.103	0.431
	Average	0.056	0.159	0.556

Table 4.11-3:

Enveloped area of BOD_5 isoline

Operating condition	Enveloping area(km^2)	Concentration (mg/l)		
		Class V Water	Class IV Water	Class III Water
		≥10.0	≥6.0	≥4.0
Discharged sewage volume(700t/h)	$Q=305m^3/s$	0.013	0.298	0.535
	$Q=725m^3/s$	0.013	0.232	0.400
	Average	0.013	0.265	0.467
Discharged sewage volume(400t/h)	$Q=305m^3/s$	0.067	0.431	0.673
	$Q=725m^3/s$	0.052	0.362	0.535
	Average	0.059	0.396	0.604

Comprehensive analysis on the two flow rates and calculated enveloped area of each isoline indicate:

With 700 t/h of wastewater discharge, the CODcr index (plume area exceeding standards) will be in the range of 0.543 km^2 of water exceeding Class III, 0.155 km^2 of water exceeding Class IV and 0.058 km^2 of water exceeding Class V; the BOD_5 index will be in the range of 0.467 km^2 of water exceeding Class III, 0.265 km^2 of water exceeding Class IV and 0.013 km^2 of water exceeding Class V.

With 400 t/h of waste water discharge, the CODcr index will be in the range of 0.556 km^2 of water exceeding Class III, 0.159 km^2 of water exceeding Class IV and 0.056 km^2 to water exceeding Class V; and the BOD_5 index will be in the range of 0 604 km^2 of water exceeding Class III, 0.396 km^2 of water exceeding Class IV and 0.059 km^2 of water exceeding Class V.

Therefore, domestic sewage discharge will have an effect on the Yellow River when the sanitary wastewater treatment facility malfunctions, but the impact is insignificant.

4.12 Mitigation and control strategies

4.12.1 Control strategy for stack gas

Conclusion of Atmospheric Assessment

In general, construction of 2 x 600 MW units for first phase of the TuoKeTuo Power Plant A is feasible based on the analysis of ambient air quality, meteorological characteristics of pollution, emission rates of SO_2 & fugitive dust and their impact on ground level concentrations in the assessment and key conservation zones.

TuoKeTuo Power Plant A, as a new construction project, will employ the following control measures for stack gas:

(1) High chimney: The two boilers share one 240 m chimney with single cylinder in the first phase project. The dilution and diffusing ability of the atmosphere is used to reduce ground level concentration of pollutants. When one or two boilers are in operation, their stack gas velocity and plume rise can meet requirements of environment protection and technology.

(2) High efficiency electrostatic precipitator: In the first phase project, a four fields high efficiency electrostatic precipitator will be chosen. Its design dust collection efficiency is more than 99.76 %. It still can keep collection efficiency of 99.76 % when one power block is in failure. The actual amount of SO_2 emissions from the power plant and concentration of flue gas is less than permitted values stipulated in the international standard.

(3) Low sulfur content coal is to be burned: The design coal and check coal of TuoKeTuo Power Plant A are from Zhungeer, its applied sulfur content is 0.47 %. Use of low sulfur coal is an effective measure for long term reduction of SO_2 emissions. Desulfurization equipment would not be installed in this phase of the project according to the ambient air quality and impact analysis; however, space has been reserved in the plant layout for FGD equipment.

(4) Low nitrogen oxide burners: The power station will use low NOx combustion technologies in the design. The project will import low NOx burners made with advanced technology from abroad, to control NOx discharge concentration below 400 ppm.

The above advanced technology air pollution controls will be used in TuoKeTuo Power Plant A, with efficient ESP and selection of low NOx burner. Calculations have been made of SO_2 emissions according to guidelines of the World Bank, based on statistics of meteorology measurements of pollution and dispersion model results. Engineering investment and unit cost were considered as well, and the selection for type of chimney and installation without desulfurization are considered proper and the requirements of air emission standards and ambient air quality can be met.

4.12.2 Wastewater treatment measures

4.12.2.1 Drainage system

The distributed and concentrated treatment scheme for drainage system will be adopted in Power plant: continuous water drainage (mainly acid and alkaline waste water discharged from chemical demineralization and regeneration) will be treated at the DM plant; temporal water drainage (mainly flushing water of air preheater and waste water of acid cleaning for boiler) will be treated concentratedly.

Drainage manner of power plant: industrial waste water and rain in plant are concentrated to drain off; domestic sewage is treated with a two-stage treatment process prior to drainage to pump station.

4.12.2.2 Treatment measures of industrial waste water

(1) Technical process of waste water treatment facility (dry ash removal) is shown in Figure 4.12-1.

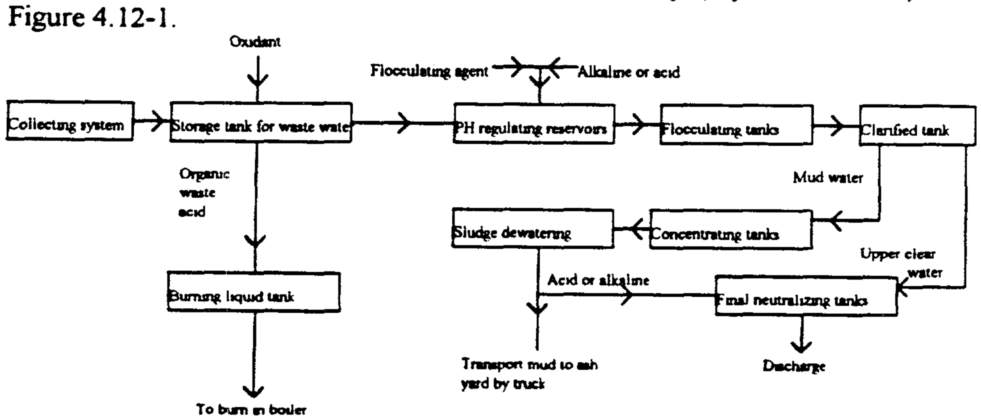


Figure 4.12-1 Technological process of waste water treatment

(2) Technological process of waste water treatment facility (hydraulic ash removal) is shown in Figure 4.12-2.

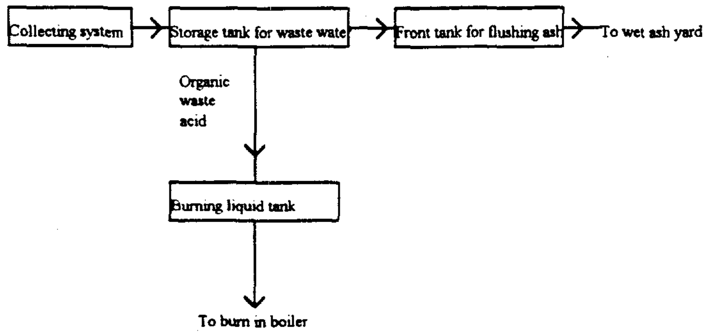


Figure 4.12-2 Technological process of waste water treatment

4.12.2.3 Treatment of oil contaminated wastewater

Oil contaminated wastewater is collected by sewers, and treated by concentrated treatment station prior to discharge. This includes physical separation and sparged air floatation.

Treatment process of oil contaminated waste water is shown in Figure 4.12-3.

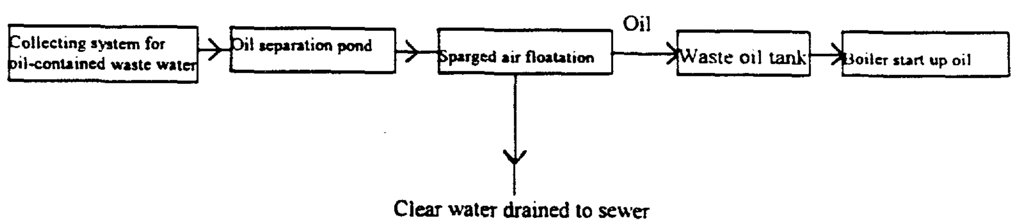


Figure 4.12-3 Treatment process of oil-contained waste water

Sparged air floatation is expected to achieve less than 10 ppm oil concentration.

4.12.2.4 Technical of waste water for dust removal in coal handling system

The wastewater drained from the coal yard and flushing water for coal handling will be clarified in a settling tank. The coal is returned to coal yard and clear water is reclaimed.

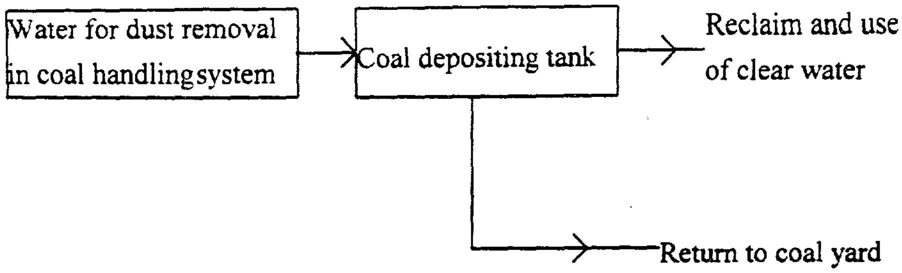


Figure 4.12-4 Technological process of waste water for dust removal in coal handling system

4.12.2.5 Drinking water

Drinking water for the power station will be drawn from the Yellow River, and disinfected by an electrolytic process.

4.12.2.6 Treatment measures of sanitary sewage

Sanitary sewage at the power station is treated in a biochemical process prior to discharge.

Technological process of domestic sewage treatment is shown in Figure 4.12-5

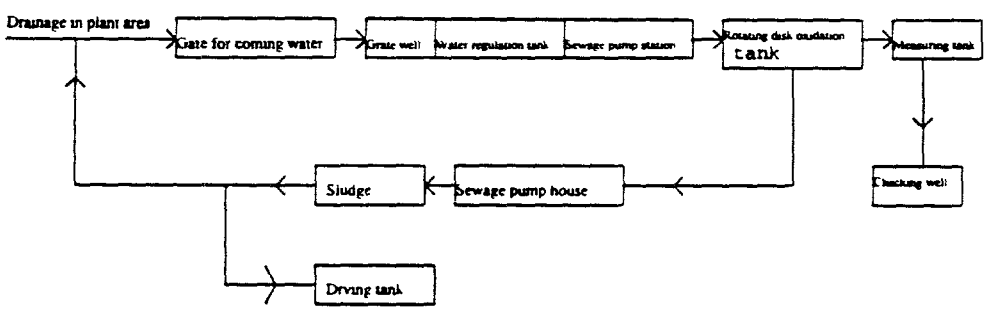


Figure 4.12-5 Technological process of domestic sewage treatment

The oxidation stage of the treatment process is a rotating disk oxidation tank, where a series of half submerged fiberglass disks are rotated in the supernatant to create a thin biofilm (on the disk) where maximum oxygen absorbtion allows for maximum microbial activity to take place.

4.12.2.7 Waste water treatment

(1) Result of wastewater treatment

The discharge of industrial waste water, oil contaminated wastewater and domestic sewage will be in compliance with the permited standards after treatment.

(2) Treatment scheme of cooling water and its drainage

Drainage of cooling water is unpolluted. So the quality can meet the permit drainage standard without treatment. But cooling system of steam turbine needs anti-scaling, the anti-scaling method is to pretreat the water by adding acid or lime. The concentration and drainage volume of circulating cooling water will be contaminated and require treatment.

Cooling water represents the largest volume of water consumption by the power plant, and the drainage volume covers a large percentage of the total drainage of wastewater from power plant. Two schemes for cooling water treatment are provided for comparation according to operating conditions of cooling water, make up water quantity and water quality.

Scheme 1: add acid and stabilizer.
Scheme 2: pretreat with lime and add stabilizer

The recommended scheme for cooling water is pretreatment with lime and addition of stabilizer.

A schematic for recycling of cooling water is shown in Figure 4.12-6

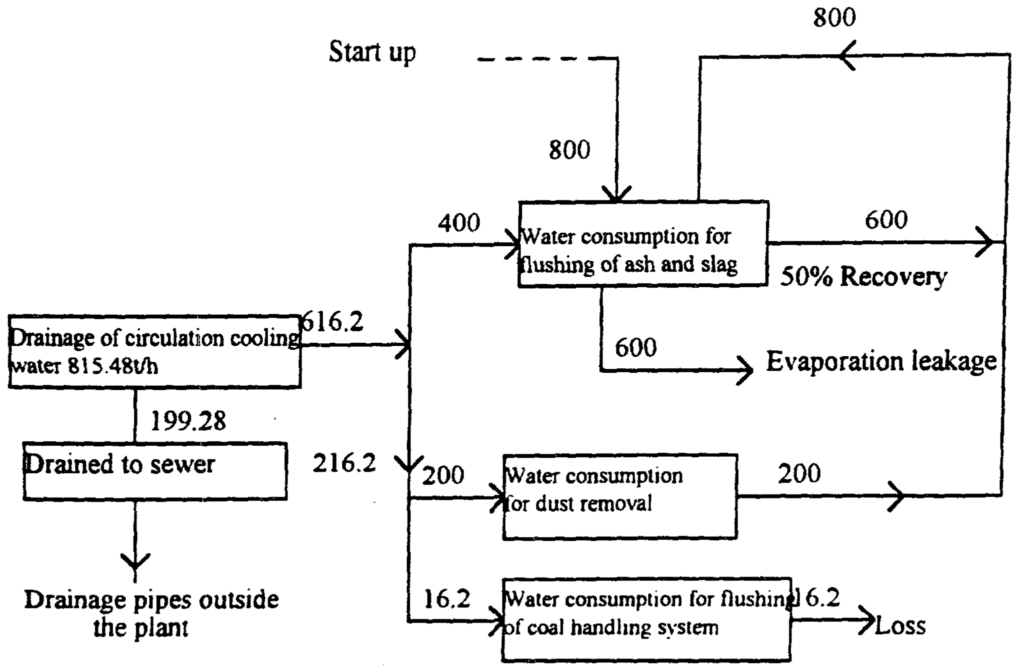


Figure 4.12-6 Condenser cooling water recycling

The quantity of fresh water for power plant is amount of vaporization loss and wind flowing loss and drainage loss of waste water. Evaporation loss and wind flying loss depends on local climate conditions and heat diffusion conditions of cooling tower, so they are difficult to change, because of this, the key for saving water and reducing drainage water is to increase the concentrated rate of cooling water. For increasing the concentrated rate of cooling water, some power plants tried to use water quality stabilizer phosphate free or with low phosphate and obtained some achievements. So it is recommended that some necessary experiments shall be carried out to determine type and dosage of stabilizer (either low phosphate or no phosphate) and suitable concentrated rate of cooling water . No zinc or chromium compounds will be used.

Another alternative for drainage cooling water is to fully utilize drainage cooling water. The draining cooling water can be main water source for flushing water of hydraulic ash removal and for humidifying of dry ash and flushing water of coal handling system etc.. By this way, the features of stable water quantity and good water quality of cooling water can be used fully to ensure safety operation of dust removal system and to improve quality of drainage by mining with other draining water so that a kind of water water can be utilized in many ways not only waste water, but reducing drainage amount of waste water and protecting environment.

4.12.3 Ash handling

4.12.3.1 Dry ash handling (not the alternative chosen)

(1) The ash removal scheme can be characterized by separate removal of ash and slag, separate discharge of coarse and fine ash, dry discharge of dry ash and mechanical centralization, and reserving conditions for comprehensive utilization.

(2) Dry ash shall be humidified and agitated with water in ash silos area to section humidity of 20%, and then send to ash disposal area with belt conveyor.

(3) Ash disposal area is used by periods and by blocks according to design requirements .

(4) After wetted ash is sent to ash disposal area, arm-type ash conveyor shall be used for stacking ash, then the ash will be rolled and leveled.

(5) Capstan-type automatic sprinkler or plumbing-arm sprinkler shall be equipped in the scope of ash disposal area. The water is sprinkled periodically for preventing the second fugitive dust .

(6) Drainage shaft shall be provided for dry ash disposal area for collecting rainwater. Rainwater collection ditch is built around ash disposal area so as to discharge rain water after it is treated in settling pond .

(7) Ash disposal area shall be used by blocks. Vegetation shall be planted with recovery soil with slop formation. When the stacking height sections the design height, soil shall be covered (500m thick) and trees and grasses shall be planted.

(8) Windbreak greening zone will be set up around ash disposal area (100m wide).

(9) Environmental monitoring of ash disposal area is required according to standards and codes issued by the ministry,(see Chapter 8, Table 8,5-2).

4.12.3.2 Hydraulic ash handling

(1) Infiltration interruption pipe is buried around ash dam to reclaim ash water and send it to reclaim pump house.

(2) Ash disposal area shall be used by blocks and store ash in an order. Ash disposal area which is not in urgent use will not be built in advance so as to avoid to expose the surface soil and speed up desertification of soil.

(3) Operation management shall be strengthened and operation of stored water shall be assured.

(4) To reduce proportion of ash and water, and reclaim ash water, thus not only saves water, but also reduce discharging of ash water.

(5) Windbreak greening zone (100 m wide) shall be built around ash disposal area.

(6) After ash disposal area are utilized by blocks, it shall be recovered by soil to become cultivated land.

4.12.3.3 Mitigation for exposed ash at ash disposal pond (prefered alternative)

Because of improper operating management and meteorological conditions of the area which the power plant locates, the ash disposal area with adoption of hydraulic ash removal scheme may form dry shoal operation, the surface of ash disposal area will dry up and expose ash, it is easy to cause the secondary time flying dust. Wind speed in winter and spring of TuoKeTuo is strong, so the necessary mitigation measures shall be taken for preventing flying of dry ash.

(1) Regulate the drainage spillway of ash disposal area, and ensure operation of water storage of ash disposal area and wet surface of ash to prevent dry ash from producing fugitive dust.

(2) The sprinkling system shall be provided around ash disposal area for sprinkling on ash surface to maintain moisture on the surface of ash in the case that water storage operation can not be guaranteed so that the rising of dry ash can be prevented.

Environmental monitoring plan for ash disposal operation is given in Chapter 8, Table 8.5-2.

4.12.4 Coal dust suppression systems

(1) Spraying and dust-proof system is provided for the whole coal storage yard

(2) Rotary sprinkler will be provided for dust prevention of loading, unloading and rotating parts of stacker/reclaimer, belt conveyor and coal feeder etc. in coal yard, and the sprinkler is used for dust suppression on.

(3) Cyclone separator shall be provided in each transfer station, coal bunker bay and coal crusher room. Vacuum cleaning and hydraulic cleaning will be adopted for coal dust on coal conveying gallery.

(4) Baghouses will be provided in coal storage silos.

4.12.5 Mitigation measures for regional ecological environment

4.12.5.1 Mitigation measures

(1) To strengthen administrative means and environmental protection functions, strengthen composition for professional personnel of ecological environmental protection, and enhance the knowledge concerning environmental monitoring work (Details are given in Chapter 8).

(2) Environmental protection organization of the plant is not only responsible for monitoring pollution source inside and outside of power plant, but also for construction, improvement and maintenance of shelter forest, and shall be responsible for assist local government to improve regional environment (Details are given below and in Chapter 5).

(3) It is suggested that shelter forest be constructed before the construction of power plant in order to guarantee growth of vegetation and achieve better effects of protection.

4.12.5.2 *Vegetation community construction techniques*

The plant area and surrounding it are an integrated ecosystem. Vegetation construction and improvement of the ecological environment around the plant has the function of promotion and protection for production of the power plant. With increasing population in the plant area, demands for various foods will increase, therefore, it is necessary for the plant to harmonize with improvement of the environment and development of production. Peasants will take measures to enhance grain output and productivity force for forestry, husbandry, by-products, under the influence of construction of the power plant. Production can be developed only when environmental conditions are improved.

4.12.5.3 Construction of forests

Stable and integrated vegetation with a combination of arbors, shrubs and grasses will be established in sandy areas. Planting of seedlings in trenches is proper for arbors and shrubs. Leguminous forage grass, e.g. Melilotus svaveolens Ledeb., A.adsurgens Pall. and Medicago sativa L. etc., will be planted between rows of arbors and shrubs. In this way, growing trees can have the function of protection with herbage. Seedling stage is the key period for planting herbage. The seeds shall be sowed in appropriate conditions of rainfall period, at first small area shall be protected and then extended year by year. In sparse forest, forage grasses shall be sowed based on local conditions so as to improve productivity of grassland in forest areas in the short term, while having the functions of protecting against wind erosion and fixation of shifting sands, and improving the fertility of the soil.

Loess hills shall be trenched and planted with arbors, such as Chinese pine, oriental arborvitae, etc., for the purpose of water and soil conservation and wind protection, while embellishing the landscape.

Plantations of fruit trees shall be developed on the lower rises of hills and slopes or shoals as well as the sides of houses of peasants. These places are appropriate due to sufficient sunshine and available water.

Construction work (e.g. dam construction) shall be performed at first for gully with intense water erosion, after which these areas will be developed for timber. Branch gullies shall be treated first.

Sparse vegetation grows on salinization grassland. This area can be used to plant Ta. chinensis Lour. and Elaeagnus angustifolia L.. Successful trials of these species have been demonstrated to the north of the assessment zone in Zhijihao.

4.12.5.4 Grassland construction

The area with steeper slopes and hills is not suitable for agriculture. If irrigation of the areas is deemed impossible, they shall be developed as pasturage and forest instead of cultivated land. Artificial and semiartificial grassland shall be set up in these areas to develop pasturage. Purple alfalfa was planted on loess slopes at Yinbei in Qingshuihe County; now communities of Stipa bungeana Trin., Medicago sativa L. and weeds have formed cover on these areas with heights of 55 cm and canopies of 40~60cm. Grass output can amount to 1000 Jin/mu.

According to the purposes of land utilization, artificial or semiartificial grassland or forage fields will be established. Single species seeding, mixed seeding or supplemented seeding can be adopted for sowing. Supplemented seeding or mixed seeding of species shall consider the combination of long-term, medium-term and short-term effects as well as competition or mutual supplementation between species. Selection of proper seeding time is the key technique for construction of grassland in this area. Seeding of grass in spring is improper because of spring drought in this area, so seeding of grass shall be performed in the later period of spring or in the rainy season so as to guarantee seedlings develop at almost the same time. Newly-built grassland cannot be used for livestock for one or two years, after which limited areas can be delineated for use by livestock. This is helpful for botanical community structure and soil conservancy.

Cultivated land with lower fertility can be used to grow grass and crops in rotation, that is, leguminous plants as forage grass or green manure to improve the fertility of land and produce grain in the following year to enhance grain output.

4.12.5.5 Preservation and utilization of topsoil (cultivated soil)

In disturbed areas the cultivation layer and surface soil become a viable topsoil after cultivation and the action of vegetation over the years. For establishment of vegetation, topsoil cannot be substituted by the uncultivated soils of deeper layers (subsoil), since the stopsoil plays key roles in the sprouting of seeds. Therefore, cultivated topsoils of 0~30 cm in the surface layer shall be protected and utilized during the construction of the power plant, and stockpiled to be utilized for construction of shelter forest.

4.13 Favorable and unfavorable impacts of power plant construction

4.13.1 Favorable impact

The power plant will be built to meet electricity shortage requirements, especially to solve various problems caused by lack of power, by transmitting electricity to the Capital City - Beijing.

Construction of the power plant will effectively serve the public in the district as well as industry, agriculture, commerce and other utility services.

Short-term benefit of the power plant construction will be gained even during the construction period. For example, a great number of employment opportunities will be provided, commerce in the district and the related secondary economic activities will quickly increase with the construction of the power plant, consequently, local tax revenue will grow a formerly backward economy will rapidly develop. People's living standard will be raised in varying degrees. Industry, economy, commerce and public in the Capital City will benefit from the power plant construction because the power will be transmitted to Beijing to relieve electricity shortages.

4.13.2 Unavoidable unfavorable impact

The environmental impacts, which may be caused by putting the Touketou Power Plant A into operation, have been discussed and analyzed above. These impacts are the conditions under which benefits will be exchanged with the impacts after the power plant is put into operation. However, in most cases, the impact will be reduced to a smaller extent after the control measures have been taken. These control measures address stack gases, wastewater, and atmospheric quality controls. This may alleviate the unfavorable impacts on the environment and meet each of the World Bank and state standards, and relevant stipulations of Inner Mongolia Autonomous Region.

4.13.2.1 Water quality

Industrial wastewater, produced by the power plant during operations, and domestic sewage will meet the state concentration requirement on wastewater discharge. Therefore, the wastewater will have almost no impact on water quality of the Yellow River, and ecological equilibrium of aquatic life.

4.13.2.2 Air quality

The TuoKeTuo Power Plant is a coal-fired power plant which will emit atmospheric pollutants during operation. In addition, pollutant emissions can not be thoroughly controlled by means of the flue gas control system. But the atmospheric pollutants emitted by the power plant during operation, and ground concentration can meet the requirement of the state atmospheric emission standard and environmental quality standard. It is possible to not only protect environment so as to prevent the known and estimated unfavorable impacts; but also control pollutant emissions within a reasonable, safe scope.

4.13.2.3 Land

With respect to land utilization, the Touketou Power Plant will occupy 361 ha land, in which farmland, woods and wasteland are included. Even though most land in the district is seriously desertified with poor agricultural output, the power plant construction will have an influence on local land utilization, such as landscape. The method to ease up impact is gardening and greening of the power plant.

4.13.2.4 Ecological system

The land occupied by the power plant is those difficult to use for any agricultural purpose, vegetation is sparse, species diversity is low with mainly fixed and semi-fixed aeolian soils. During the power plant construction vegetation within the occupied land will be completely damaged and the surrounding vegetation outside will be affected to a certain extent in development, so the way to solve the problem is to set up scientific and stable man-made vegetation in the ash disposal area, plant area and surroundings. This will gradually reduce deflation and desertification of the land occupied by the power plant and lead the ecological environment in a sound development direction.

Land occupation of the power plant will have some effects on the habitat of wild animals, as it changes into the industrial landform and green belt. However, there are no national or provincial protected animals or plants in the district, and the ecological system will be little affected.

4.13.3 Irredeamable and unrecoverable resources

The natural resources to be used for the power plant construction and operation will be unrecoverable after utilization.

4.13.4 Fuel

The coal with low sulphur content from the Zhungeer Coal Field will be used in the Touketou Power Plant A and the main solid wastes after combustion are slag and fly ash. Fossil fuels are non-renewable. Compared with the structure of original materials, that of remainder after combustion is greatly changed. Therefore, the coal used as the fuel of the power plant is unrecoverable; this is natural resources consumption.

4.13.5 Land utilization

After the power plant is put into operation, 361 ha land resources will be turned into industrial land. The land occupied by the power plant will certainly not be reused for agricultural production after the service life of the power plant elapses, because the service life of the power station will probably be extended. So the project is an unredeemable loss for agricultural production.

The project can increase electric power generation, boost the development of new commerce and private economy and improve land utilization, but the development is not easy toforecast due to increased land unrecoverability.

4.13.6 Water

Water consumption (mainly evaporation loss) of the Yellow River during the 30 year operation period of the project is unrecoverable. In addition, the present original condition of the Yellow River water quality will be changed as the wastewater of the power plant is discharged into the Yellow River.

4.13.7 Construction materials

The construction material wastes can be utilized and materials can be recycled for use. In addition, most man-made materials will be unconvertible and consumed, or their service life will be shortened. These materials will include steel, copper, nickel, lead and oil fuel as well as cement.

4.13.8 Labor

Unrecoverable labor resources, which are necessary for construction and operation of the power plant, will be consumed during the power plant construction

Chapter 5 Industrial Hazards

5.1 Plant layout

Fuel oil storage and the coal yard will be located in a corner opposite from the hydrogen plant. There will be no concentrations of workers in these areas during normal plant operations. These potential hazard/areas are also remote from the unit control room.

5.1.1 Firewater

The Yellow River water will be used for the firewater system, separate from the condenser cooling water system. Specifications to which the plant fire fighting system are designed are included in, Power Plant and Substation Firefighting Design Code, and Technical Regulations for Power Plant Domestic and Fire fighting Water Supply and Discharge Design.

5.2.1 Hazardous materials storage and handling

Hazardous materials and storage areas at the power station include: i) fuel oil storage tanks and railway loading racks; ii) acid and canotic tanks at the demineralyzed water plant, and, iii) hydrogen produced in an electrolytic cell process. Chlorination of drinking water will be carried out using an electrolytic process.

5.2.2 Condenser cooling water

Condenser cooling water will be chlorinated at dosing stations located near the cooling towers. A shock dosing system (1/2 hour every 2 hours) will be used to maximize effectiveness in bilfouling control and minimize chlorine usage. Dosage concentration will be 1-2 ppm, with a residual of 0.1-0.2 ppm at the outlet of the cooling towers. Usage is estimated at 100 kg/hour for each 600 MW. Chlorine will be dispersed from one ton cylinders. The dosing buildings will be equipped with a leak alarm with relay to the power station control room. The alarm will be available outside the dosing building, and a windsock will be installed in a spot visible in all directions. If the chlorine detecter senses leakage above a preset concentration, an air evacuation system is activated automatically to draw the spilled chlorine gas into a counter-current flow neutralization column. The fiberglass neutralization column is supplied from a reservoir of NaOH, and is packed with ceramic beads. Chlorine gas can be refluxed through the column.

5.2.3 Personnel protective equipment

Personnel protective equipment will be provided for chlorine handling personnel, including: SCUBA, protective clothing and bak stemming gear. Personnel will be trained in safe handling practices and emergency spill response. Emergency spill response and first aid procedures will be included in the Disaster Management Plan.

5.2.4 Oil storage and handling, spill control

The oil storage tanks will be contained within a diked area with a base impervious to sillage. The volume of the available containment will be at least equal to the volume of the largest tank. Rainfall runoff will be collected in a sump, with connection via pump over the dike crest to the wastewater oil /water separation system. There will be high and low level alarms on the tanks, with remote readout at the oil loading pump control station. All oil storage tanks will be grounded. Regular inspections for tank wall integrity will be carried out, with attention to the bottom edge of the tanks.

The railway oil loading racks will be equipped with impervious spill containment, with drainage to an oil/water separation system. The drainage sump will not be continous with the oil/water separation system(manually operated pump in between) in order to prevent a massive spill from draining directly to the oil/water separation system. The loading racks will be equipped with grounding provisions for the tank cars. Foam and water fire suppression systems will be installed.

Spillage in either the oil storage area or railway loading racks will be cleaned up immediately to prevent fire hazard, (see also " fire fighting -detection and suppression systems").

5.2.5 Acid and caustic storage and handling

Acid and caustic tanks will be contained within separate diked areas with impervious and corrosion resistant coating of base and dike wall. The tanks will be equipped with high and low level alarms, and redundant tanks for acid and for caustic will be included in the plan to be available as reservoirs in case of massive spills. The high and low level alarms will be relayed to the loading pump control station. The spill containment dike area will have a volume equal at least to the largest tank. There will be a closure device (gate or valve) between the containment dikes and the neutralization pit to revent accidental massive spills from draining in an uncontrolled manner directly into the neutralization pit. These closure devices will normally remain in the closed position in case of accidental spills. Acid tank vents will be equipped with vapor knock out drums. Truckloading connections and bases for acid and canotic tanks will be provided with (separated) spill containment berms and blend sumps, or closure devices to prevent direct uncontrolled drainage of an accidental spill to the meutralization pit. All loading connections to the tanks will be equipped with check valves. Hoses will be pressure tested on at least an annual basis.

Steel tanks will be equipped with corrosion resistant liner material. The integrity of the tanks will be cheked on an annual basis, and the tanks replaced or re-lined as required.

Eyewash fountains and emergency showers will be provided at the acid caustic storage tank areas as well as at the tank loading connections. Two sets of eyewash fountains an emergency showers will be installed at each area-one set immediately available in case of small accidental exposures, and one set at a safe distance from a potential massive spill (irritating vapor inhalation hazard).

Personnel protective gear will be maintained at the acid and caustic storage and loading areas, including: boots, gogeles, protective clothing and acid mist respirators. Personnel will be trained in the use of this equipment, and drills in spill control and first aid will be conducted on a regular basis.

5.2.6 Hydrogen generation plant

The hydrogen generation plant building will be provided with adequate ventilation to prevent enclosure of explosive atmosphere. Explosive gas sensors and automated alarm system will be provided, with relays to the control rooms of the hydrogen plant and the power station. All electrical equipment will be explosion proof, (see also "fire fighting - detection and suppression systems").

5.3 Earth dam safety monitoring

The ash disposal area will be equipped with a leachate liner system. However the possibility of liner breakage exists. Breakage of the liner could result in an increase of seepage through the earth dam with the possibility of compromising the structural integrity of the dams. The earth dams will initiallly be raised to a height of 15 m (2 x 600 MW) with an ultimate planned height of 30 m (6 x 600 MW). The dams will be equipped with a toe drain/runoff collection systems, with collection in a sump and discharge into the ash slurry water recycling system. This should minimize potential for damage to the dam structure from liner leachage. This and other potentially hazardous conditions will be the focus of a regular earth dam inspection and monitoring program. Weekly inspections(with written reports) will note for immediate remedial action:

i) erosion on either side of the dam

ii) growth of woody vegetation on the dam

iii) animal burrows into the dam

iv) seepage breakouts at the dam toe

As the power project progresses, the ash disposal area will be reclaimed in stages as sectons are filled. The weekly inspections can then be used to monitor progress of revegetation efforts, and institute remedial measures on a timely basis if probems are noted.

The structural integrity of the earth dams will also be monitored with the use of piezometers installed within the dam itself, to monitor seepage; and monuments installed and precisely surveyed onto the dam crest to monitor lateral movement and settling. The piezometers will be checked in the rainy and dry seasons to establish baseline conditons and thereafter as part of the monitoring program.

Survey monument on the dam crests will be checked (re-surveyed) annually.

Ash slurry pipelines between the power station and ash disposal area will be inspected for leakage on a daily basis. There will be alternate pipelines constructed to be used when maintenance operations call for down one of the liner. Leakage of ash slurry will be immediately attended with pipelind repaire.

5.4 Disaster management

5.4.1 Stability of the power plant site

TuoKeTuo Power Plant is located about 70km southwest of Huhehot City. The terrain of the plant site is level and belongs to Tumotechuan plain land form. The plant site lies on the arduous mass and TuoKeTuo Lake deposit platform of Huhe over fault depressive slope. There is no landslide, mud-rock flow or bad soil liquefaction in this area. So the soil stability in this area is acceptable for plant construction.

5.4.2 Earthquake

In the " China Earthquake Intensity Area Division Map " published by China Earthquake Publishing House in Feb.1991, the plant site is located in the area of 7 degrees earthquake area. The TuoKeTuo plant site does not have any historical record of big earthquake. Only the earthquake in the area between Huhehot and Datong had some effects on this area in the history.

5.4.3 Flood

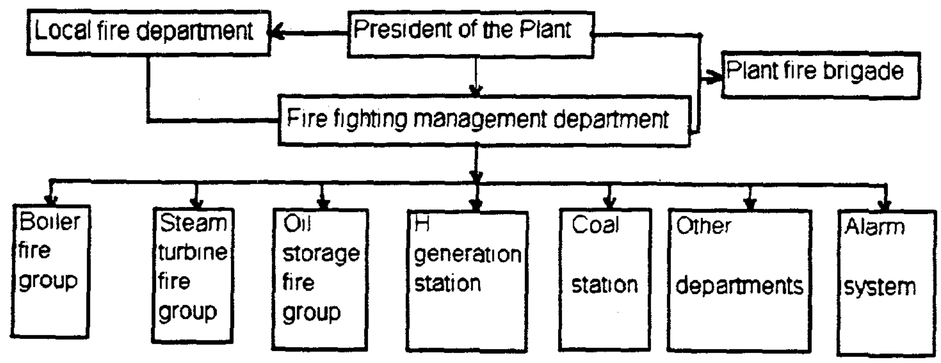
The design elevation of the plant site is higher than the 100 year flood water level. Therefore, the power plant won't be affected by flood during its operation.

5.4.4 Fire

Fire is one of the disasters which the plant will pay most attention to. Some facilities in the power plant are combustable and explosive, so the design standards for fire and explosion prevention and fighting for thermal power plant are high and strict in China.(refer to fire fighting section of Industrial hazards). There are also strict relevant production management regulations and operation codes for the above mentioned facilities. The plant fire fighting brigade often offer training courses to all the employees of the plant on how to use firefighting tools. There are also mock drills held for all the employees. The automatic fire alarm system can monitor and detect fire in the whole area of the plant. When there is fire, the alarm starts in the central control room, the relevant equipment is switched off, and appropriate control measures taken. The plant personnel will contact the local fire fighting department with information on the place and object of fire. The local fire department people can come to the fire site within shortest time to help.

Each and every employee of the plant has knowledge of fire fighting. When a person finds fire, he knows what to do to extinguish th efire and how to contact the plant and local fire departments for help. The telephone number of the special line for fire is "119", which is known to everybody and can never be used for another purpose.

The following is the organization chart of the fire fighting system.



5.4.5 Disaster management plan

The disaster management plan can be divided into two sections

i) Natural disasters--floods & earthquake
ii) Industrial accidents--oils spills, hydrogen explosion

A disaster management plan for firefighting has been developed for the facility. Additional for flood, hazardous material spills, explosions and other identified industrial hazards will be developed.

Chapter 6 Greening for preventing wind erosion

6.1 Construction of green vegetation

Green vegetation is the base of ecosystem and primary producer. Good green vegetation is the precondition for making artificial ecosystems.

6.1.1 Construction target

In the production period of power plant (in 2000), the forest cover rate target is 40 % in the assessment area, (quoted from Long-term Plan in 2000 in TuoKeTuo Country, "the covering rate of forest will be 40 % in south of TuoKeTuo county"). The green vegetation canopy of will be 40~50%. After meeting this target, the sand in this area will be fixed, wind erosion and desertization will be reduced, and the environment will be improved.

6.1.2 Greening principle

There is a topical northern climate in TuoKeTuo with little rainfall, relatively greater evaporation rate, and wind erosion and windblown sand, with some mobile sand dunes. The technical measures of combining revegetation with erosion prevention and sand fixation shall be adopted for greening in this project. Based on the present siuation of the ecological environment in this area and character of the power plant, the construction of green vegetation for the power plant shall follow the following principles:

(1) Before construction of power plant or at the same time.

(2) Combination of biologic and engineering measures

(3) Combination of short, middle,long-term efficiencies

(4) Suitable measures to local conditions, to chose advantageous environment resistant species.

(5) Identical with local long-term developing plan, combination of plantation and cultivation, and to develop diversified economy and establish good artificial ecosystem.

6.1.3 Prevention as priority to strengthen enclosed plantations

Vegetation would grow well with a large canopy, and sand dunes remain stable around the location of the power plant, if the vegetation can be protected, and wind erosion and sand drift can be checked. Prevention measures would be to protect ground vegetation and to prevent damage to existing vegetation, especially damages during construction. Besides this, measures shall be taken to establish an enclosed belt of a certain width to help plants grow naturally.

6.1.4 Prevention of enviornmental damage to power station

Prevention of enviornmental damage to the power station will include measures to prevent wind and sand damage to the power plant. The damage potential of wind and sand is closely connected to the direction windblown sand and the number of sand sources. The prevailing summer wind direction in this region is south, and in other seasons west. According to the harmful characteristics of windblown sand in this region, natural conditions and social factors, the prevention system should include a shelter belt for wind and fixation of sand and enclosure belt. The principle for establishing a wind prevention and sand fixation belt is to take measures artificially based on the physics of windblown sand, that is to isolate sand from the airstream, and restrict resuspension of the sand particles. The enclosure belt is set up for prevention of artificial damage to vegetation, which leads to the extension of desertification.

6.1.5 Enclosure for cultivation and protection of vegetation.

There are a few fixed dunes in the scope of the plant location. The vegetation canopy is relatively better. The dominant species is S.matsudana et skv., with better growth and species richness and good natural renewal, it has the correct properties for sand drift prevention and grass cultivation.

Natural vegetation protection and prohibition of woodcutting and grazing is requiresd to control sand drift and for cultivating grass belts. In addition it is necessary to sow and plant herbage as a supplement, such as A.adsurgens pall., Agriophyllum squarrosum (L.) Moq. The vegetation coverage of should be kept above 60%.

The sand fixing belt requires shrubs such as C. microphylla Lam., S. flavtda Chang et skv., as supplements in the original natural vegetation zone. The coverage of vegetation should be kept above 70 %, and protection and management strengthened.

Forest belts should not be too wide. Row spacing should be 3 x 4 m or 2 x 3 m. Tree species can include Populus simonii carr., Elaeagnus angustifolia L. Survival rate and conservancy rate of afforestation should be improved, along with strenghthening of management.

6.2 Botanical species suitable for growth in the assessment area

According to the local peasants' experiences, consultation with research documents and our own experiences, (planting tests in assessment area of Zhungeer Coal Mine in 1986), the following plants are suitable for this region.

Table 6.2-1

Plants suitable for growth in the zone of TuoKeTuo Power Plant.

Type	Plant name	Suitable living environment	Anti-pollution property
evergreen arbor	Pinus tabulaeformis Carr.	hills and hillside fiekls.resident area .etc.	
	north china larch	hills and hillside resident area .etc.	
	P.sylvestris L. var.mongolica Litvinov.	sand, valley	
	oriental arborvitae	sides of roads, surroundings of resident area, etc.	high prevention for SO2 and dust
deciduous arbor	S. matsudana koidz	hillside fields, valley and sand	
	Populus simonii Carr.	hillside fields.valley and sand, etc.	
	Hebei poplar	hillside fields, beaches, etc.	
	P.pseudo-simonii Kitagawa.	river valley, beaches, resident area, etc.	high prevention for SO2 and dust
	P.alba L.Var. Py	river valley, deaches, resident area, etc.	
	U.pumila L.	hillside fields, beaches, resident area, etc.	
	Ulmus macrocarpa Hance	hill fields, walley, beaches, etc	
	chinese scholar tree	valley, resident area, etc	weeping willow
	Malus Pumila Mill	valley, beaches, etc.	
	Prunus armeniaca	hillside fields, valley, beaches	
	P.persica(L.) Batsch	hillside fields, valley, beaches	
	P.salicina. Lind L	hillside fields, valley	
	Chinese flowering crabapple tree	valley, hillside fields, etc.	
	narrow-leaved oleaster tree	hillside fields, beaches, sand, etc.	high prevention for salt and alkali and HF

Type	Plant name	Suitable living environment	Anti-pollution property
deciduous shrub	Salix cheilophila schneid	hillside fields, valley, beaches, etc.	
	Hippophae rhamnoides L.	hillside fields, valley, sides of valley, sand, etc.	
	Lycium.chinense Mill.	sand, hillside fields, etc.	high prevention for dust
	false indigo	sand, hillside fields, etc.	high prevention for dust
	S.flavtda Chang et skv.	hillside fields, sand, etc.	
	C.microphylla Lam.	hillside fields etc.	prevention for wind and sand
	Caragana opulens Kom.	hillside fields, sand etc.	provention for wind and sand
	Ta.chinensis Lour.	beaches.etc	provention for salt alkali in soil
perennial herb	Medicago sativa L.	hillside fields, valley, sand, etc.	lower prevention for salt and alkali
	M.albus Desr.	hillside fields, beaches etc.	lower prevention for salt and alkali
	A.melilotoides Pall.	hillside fields, beaches etc.	
	A.adsurgens pall.	sand, hillside fields etc.	higher prevention for wind and fixation for sand
	E.dahuricus Turcz.	hillside fields, beaches etc.	
	Aneurolepidium chinense(Trin.)Kitagawa.	hillside fields, sand etc.	
lain plant	jielu grass	sides of resident area and roads	cleaning air
	yanghuzi grass	sides of resident area and roads	cleaning air
	dizaoshuhe grass	sides of resident area and roads	cleaning air
	wild ox grass	sides of resident area and roads	cleaning air

6.3 Greening in ash disposal and plant area

6.3.1 Greening in ash disposal area

At present, a large area of sand dunes exist near the two selected ash disposal area sites. In order to prevent the ash disposal area from submerging in sand accumulated by the wind and protect the surroundings against the influence of fugitive dust from the ash disposal area, a three-dimensional greenbelt with width of 100 m surrounding the ash disposal area shall be planted, the greening scheme is as follows:

(1) The big deciduous arbors shall be planted mainly within 30 m outside of ash dam. The main type of tree considered is Populus simonii Carr.

(2) Evergreen arbors are planted within 30 m around the above. The main type of tree considered is pines.

(3) Shrubs suitable for drought climate shall be planted at outermost scope with 40 m wide, the main plant considered shall be S.flavtda Chang et skv. and C.microphylla Lam., extensively grown in the locatity. Requirements of greening belt include row spacing of the arbors 3 x 4 m or 2 x 3 m. Survival rate of afforestation shall be improved, meanwhile management shall be strengthened. The shrub belt serves to protect vegetation and prohibit wood gathering and grazing. Supplementary plantings shall be done in original natural vegetation areas so as to form a large percentage coverage of vegetation, and the protection and management shall be strengthened.

(4) Vegetation activities will be undertaken while the ash is being deposited in the ash disposal area. In the final stages, the ash disposal area will be covered with perennial green vegetation.

Currently, there is sparse artificial vegetation that is green in the summer at the ash disposal area and power station site. The vegetation community structure should be improved further before the power station is put into operation. A combination of arbors, shrubs, grasses, and coniferous trees for pollution prevention should be increased around the area of the power station, plants adapted for saline and alkaline soil conditions should be planted in the ash disposal area, finally, a stable mixed forest of coniferous and broad-leaved species would form an outer zone so that the optimum effects for controlling dust, pollution and windblown sand can be deveoped.

As the final elevation of the ash disposal area is higher thannatural ground, a little plain shall be built at the top of ash disposal area for controlling water losses and soil erosion. Revegetation will be undertaken during ash disposal. In order to assure success in recovering soil and developing long-term economic benefits, a 50~200 cm thick soil layer shall be replaced after the useful life of the ash disposal area expires. Greening measures shall be taken on the two sides of newly built road during construction.

6.3.2 Greening in the power station area

(1) Green belt as flower bed is adopted in the center of the road to plant. Holly and hedge is planted around, one tree will be planted every 20 m in the center and the grasslands will be in the other area. Many layers greening is adopted on both sides of the road with pines in the inner, willows on the outside, and poplars in the outermost section.

(2) The front area of plant is big flower bed, large area of grassland, holly and hedge and a large quantity of ornamental coppices. A big fountain is located before production and administration building and there is large area grassland around it .

(3) Large area of grassland will be planted between water towers in the water tower area outside row A of main building to absorb dust and prevent the electrical equipment from pollution of water and steam with dust.

(4) The green belt 10 m wide is considered around coal yard behind boiler. Three rows of tall arbors 6 m wide are planted inside, 4 m shrubs such as C. microphylla Lam. and S.flavtda Chang et skv. are planted outside so that dust and noise are isolated and influence of coal yard on plant area is reduced.

(5) Road trees are planted on the both sides of all roads.

(6) Total greening area shall section to 15 km^2, greening coefficient in whole plant exceeds 12%.

(7) Water pipes for greening irrigation are laid in the scope of whole plant for convenience of watering. It is suggested to use domestic sewage after being treated as water source for irrigation.

Chapter 7 Analysis of alternatives

7.1 Comparison of external conditions for selection of plant site

Three alternative plant sites were selected for TuoKeTuo Power Plant A, i.e. Yanshanying, Majiaqi and Namujia, all of which are located on the south side of TuoKeTuo County and north side of the Yellow River. All have level ash disposal areas (except for Gaobaoshi ash disposal area). A perimeter earthdam would be constructed as the ash disposal area. Wastewater will be discharged to the Yellow River after being treated to meet emission standards. Water for the three sites would be taken at Putanguai water intake and delivered by two-stage pumps to the plant after solids settling.

Refer to Table 7.1-1 for comparison of external economical conditions for the three alternative plant sites.

Table 7.1-1

Economic comparison for three plant sites

Scheme Item	Yanshanying (hundred thousand RMB)	Majiaqidu (hundred thousand RMB)	Namujia (hundred thousand RMB)
Price difference for purchasing land	0	780	0
Immigration fee for village	0	-204	204
Movement of main irrigation channel	0	-15	-15
Railway price difference	0	-300	2100
Railway flyover	0	0	1000
Water supply pipeline	0	61	-3270
Ash removal piping	0	214	100
Ash water reclaim	0	4	24
Drainage piping	0	480	200
Foundation treatment	0	12000	12000
Power supply line	0	160	640
Movement of power supply line	0	250	0
Total	0	13660	12570

Note: The total number is not total investment, but only the difference of comparison for external conditions of three plant sites.

In accordance with above comparison of conditions, Yanshanying has the most advantages over the other two plant sites. Though there are some disadvantages, e.g. movement of two villages (Daduiying and Gaobaoshiying) and use of flood prevention measures, its advantage is still obvious. Concerning site conditions, the location of the plant is best in close proximity to the ash disposal area, with convenient sewage drainage and transportation. A site with the largest proportion of wasteland is also preferred. The most obvious advantage is that natural foundations can be adopted for main buildings so as to save an investment of 120 million yuan RMB and shorten 1~1.5 years of construction time for the first phase. The significance of earlier access to additional power supply is inestimable.

Conditions at the Majiaqi site are similar to those at the Yanshanying site; except that the foundations would have to be constructed artificially.

Namujia site has the least favorable conditions of the three; but is also suitable for construction of a power plant.

One common problem for all three plant sites is that the water source and the intersection of FenHuai railway and the special power station railway are located some distance apart. If plant the site selected is to be located at a place nearby a water source, it will be far from the railway intersection. On the contrary, if the plant is built near the railway intersection, it will be far from a water source.

7.1.2 Comparison of environmental impacts associated with the three plant sites

The three plant sites are located on the plain with similar construction conditions, and there are no scenic spots or historic sites, airports or important environmental protection items in any of the three sites. The main protection issue is downtown TuoKeTuo county and villages with dense population near the power plant sites

The three sites are in triangular distribution with a distance of 6~8 km. between each They have similar meteorological and atmospheric diffusion conditions, representative environmental monitoring data and the same wastewater drainage route. Domestic advanced equipment is to be used for environmental protection. Desulfurization facilities will not be considered in the first phase.

Regarding Yanshanying site, two villages would have to be resettled. However, the villages have very small populations. Construction of the power plant would improve living conditions of the resettled people.

Therefore, all of three sites are suitable for power plant construction based on analysis concerning environmental protection.

7.2 Condenser cooling water treatment alternatives

Cooling water represents the largest volume of water consumption by the power plant, and the effluent accounts for a large percentage of the total effluent of the power plant. Two alternatives for cooling water treatment were compared according to the operating conditions of cooling water, make up water quantity and water quality.

Scheme 1: add acid and stabilizer.
Scheme 2: pretreat with lime and add stabilizer

Table 7.2-1 is a comparison of the two alternatives.

Table 7.2-1

Comparison of treatment alternatives for circulating cooling water

No.	Item	System	
		Add acid and stabilizer (scheme 1)	Pretreat with lime and add stabilizer (scheme 2)
1	total investment (ten thousand yuan)	492	2685 + 900
2	operating cost per year(ten thousand yuan)	533.4	497.7
3	consumption of chemicals(ten thousand ton)	(H_2SO_4) 1680	(CaO) 6500
4	consuming water amount(ten thousand ton)	2	5
5	concentrated rate cooling water	3	5
6	drainage rate (%)	0.62	

Notes: 900 ten thousand yuan is investment for lime factory in scheme 2

From the above comparison we can see that:

Scheme 1 is advantageous in economic comparison. This scheme has features of less investment, quick effects, convenient operating management and maintenance; however, it requires more make up water due to the large volume of water consumption and low dissolved solids concentration.

Scheme 2 requires a large capital investment in economic comparison, and the operating management and maintenance are complicated, but demands of make up water are less because the higher dissolved solids concentration.

The recommended scheme of this project is pretreatment with lime and addition of stabilizer for cooling water.

7.3 Ash disposal area

There were two alternative schemes, namely Fengyan ash disposal area for dry ash disposal and Gaobaoshi ash disposal area for hydraulic ash disposal. Both alternatives have been analyzed, and the Gaobaoshi Site with hydraulic ash removal has been chosen as the preferred alternative.

7.3.1 Fengyan ash disposal area

Fengyan ash disposal area, belonging to Zhongtang Village of TuoKeTuo County, is 3.5 km from the Yanshanying plant site. The land and nearby area are level terrain to the north. There are a lot of windblown sand dunes fully covered with perennial sand break vegetation. Fengyan ash disposal area will be located on level ground. The ground elevation of the ash disposal area is between 1055-1063 msl. There is a village and TuoKeTuo water source well within 400 m from the ash disposal area to the north.

The annual rainfall in the area is 395.2 mm/yr, evaportranspiration rate is 154.4 (See Table 3.1-1). The geologic strata below the proposed ash disposal area site are shown in figures 4.2-32 through 4.2 - 40.

7.3.2 Gaobaoshi ash disposal area

Gaobaoshi ash disposal area is located on sloping land belonging to Yangshanying Village, which lies 2 km from the Yanshanying plant site to the south, between Mahuangtan and XihaoLai Village. The site elevations are higher in the northeast and lower in the southwest. The natural slope of the ground is between 10 and 15 %. The elevation of the ground is between 1080-1110 msl. Gaobaoshi Village with 2 households and 4 persons is located in the ash disposal area. When the plant is built, they will be resettled.

See Table 7.3-1 for ash disposal area characteristics. Figures 4.5-1 through 4.5-4 show diagrams for lifting dust concentration on dry ash yard of Gaobashi.

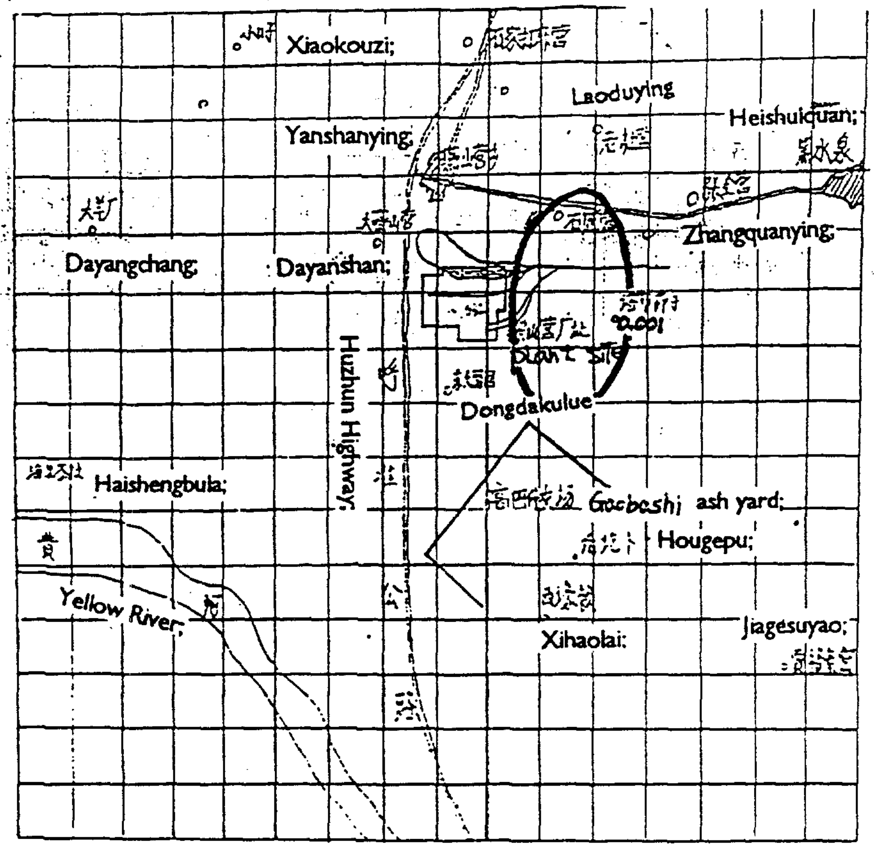


Fig.4.5-1 Diagram for lifting dust concentration on dry ash yard of Gaobashi ash yard (South wind: 5m/s) (mg/m^3)

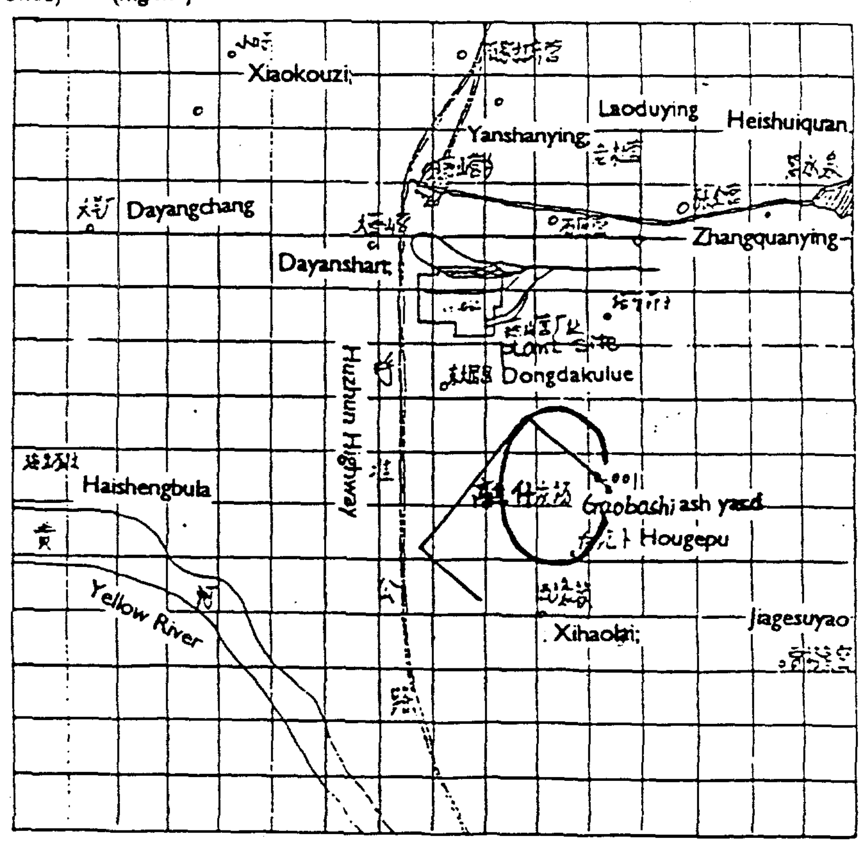


Fig.4.5-2 Diagram for lifting dust concentration on dry ash yard of Gaobashi ash yard (North wind: 5m/s) (mg/m^3)

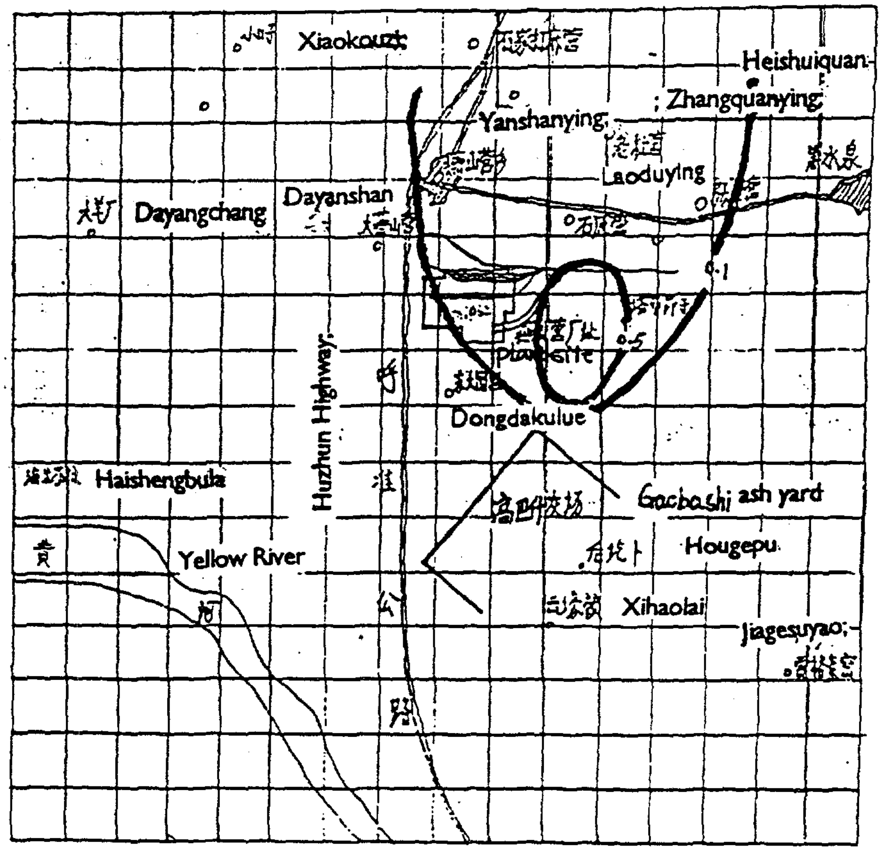


Fig.4.5-3 Diagram for lifting dust concentration on dry ash yard of Gaobashi ash yard (South wind: 7m/s) (mg/m^3)

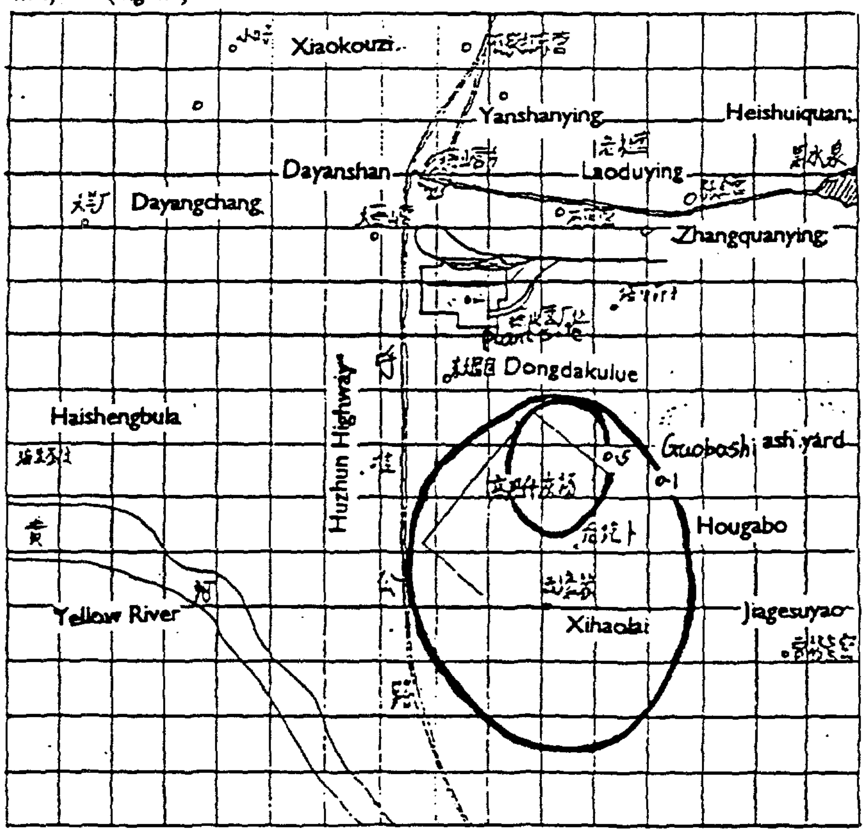


Fig.4.5 -4 Diagram for lifting dust concentration on dry ash yard of Gaobashi ash yard (North wind: 7m/s) (mg/m^3)

Table 7.3-1

Ash disposal area characteristics

Name of ash disposal area	Construction scale	Land occupied area (km^2)	Height of ash pile(m)	Ash storing capacity 10^6m^3	Ash storing years(a)	Method of ash storing	Remarks
Fengyan ash disposal area	2 x 600 MW	1.51	20	14.9	14.66	Dry ash removal	
Fengyan ash disposal area	2 x 600 MW	1.82	11	11.80	10.6	Hydraulic ash removal	
Gaobaoshi ash disposal area	2 x 600 MW	2.41	10	12.40	10	hydraulic ash removal	Upstream dam built
Gaobaoshi ash disposal area	2 x 600 MW	2.80	10	12.6	10	Hydraulic ash removal	Downstream dam built
Gaobaoshi ash disposal area	2 x 600 MW	2.2	10	11.69	11.1	Dry ash removal	

Chapter 8 Environmental Management and Environmental Monitoring

8.1 Plan for Environmental Management

The plan for environmental monitoring and environmental protection during operation of power plant shall be formulated by environmental engineers and management personnel. In order to reduce the potential negative environmental impacts during operation of the power plant, necessary regulations for operation, maintenance, safety and health shall be formulated, and enforced by management. Training will also be provided for operations personnel.

8.2 Environmental Monitoring Stations

According to "Environmental Monitoring Regulations for Coal-fired Power Plant" issued by the former Ministry of Hydroelectric Industry in 1987, environmental monitoring station for a coal-fired power plant is a component of environmental protection and supervision for production, and shall be placed in line with production management.

The task of the environmental monitoring station is to monitor and supervise pollutant discharged during production, control environmental quality and trends, and provide a scientific basis for prevention of pollution.

8.3 Monitoring organization

According to the stipulations of "Environmental Monitoring Regulations for Coal-fired Power Plant," environmental monitoring organizations for coal-fired power plants are divided into three parts, i.e. environmental monitoring stations affiliated respectively to the Ministry, Bureau and Plant.

An affiliated environmental monitoring station will be set up for TuoKeTuo Power Plant A, and 5-6 technical personnel specializing in analytic chemistry, environmental engineering, etc. will be allocated. Monitoring will include all discharge outlets of the power plant. The monitoring station will be equipped for monitoring ambient air quality, water and noise, and the provision of the apparatus shall follow the above mentioned regulation, "Collection of Construction Drawing for Environmental Monitoring Station of Coal-fired Power Plant." The area of the monitoring station is $300m^2$.

8.4 Environmental monitoring station equipment

Table 8.4-1

Environmental monitoring station equipment for TuoKeTuo Power Plant A

No.	Name of equipment	Qty.
1	Analytical balance with precision of 0.0001g	2
2	Spectrophotometer	1
3	pH value	2
4	Biochemical incubator	1
5	Electric heating drying tank	1
6	Tester for dust in flue gas	2
7	Speed meter	2
8	Anemoscope	2
9	Atmospheric sampler	6
10	Total suspended particle sampler	6
11	Precision acoustimeter	2
12	Refrigerator	1
13	Environment monitoring vehicle	1
14	Computer	2
15	Atmospheric environment monitoring system	2
16	Atomic absorption spectrometer	1
17	CO tester	1
18	Nitrogen oxide tester	1
19	SO2 impulse fluorescent analyzer	1
20	Gas chromatography	1
21	Others (where needed)	

8.5 Monitoring Items

Monitoring points and methods shall follow "Environmental Monitoring Regulations for Coal-fired Power Plant (1987) SDJZ No.299" and "Technical Specification for Environmental Monitoring of Coal-fired Power Plant (DL414-91)".

8.5.1 Normal monitoring items and monitoring frequency

8.5.1.1 Atmospheric monitoring

Table 8.5-1

Table for arrangement of atmospheric monitoring work of TuoKeTuo Power Plant A

No.	Monitoring place		Monitoring item	Monitoring method	Monitoring frequency	Scope and principle
1	Chimney		SO_2 NOx temperature of flue gas	Continuously	Continuous	In the middle of chimney, even section of flow of flue gas or flue gas duct
2	ESP		Dust removal efficiency	Dust tester	Continuous	In accordance with the part of atmosphere of "Unified Analysis method for pollution resource
3	Monitoring points	Yanshanying, Gaobaoshi	SO_2 NO_x TSP IP	Atmospheric automatic continuous monitoring system	Continuous	One station for each
4	Coal yard		TSP	Ditto	Continuous	One point
5	Plant area and working environment		SO_2 NO_x TSP	Ditto	Continuous	One point in plant

8.5.1.2 Effluent monitoring

Table 8.5-2

Table for monitoring water quality

Monitoring item, Monitoring time, Sampling place	pH Value	Suspended solids (TSS)	Chemical oxygen demand (chromium method) COD_2	Arsenic and inorganic compound	Fluorine and inorganic compound	Sulfide	Trinitride	Petroleum	Volatile phenol	Biological oxygen demand (5 days, 15 °C) (BOD_5)	Water temperature
1.Drainage outlet of industrial waste water	once/ten days	once/ten days	once/ten days	once/month	once/month	once/month	once/quarter				
2.Dainage outlet of chemical acid and alkline waster water	spot test once/mouth										
3 Drainage outlet of domestic sewage	once/month	once/month	once/month				once/quarter			monitoring when discharging	
4 Drainage outlet of water for open-air coal yard	monitored when water exist	monitoring when water exist	monitored when water exist								
5.Drainage outlet of oil-containing waster water								more than twice/month			
6 Discharging liquid of chemical cleaning shutdown and conservation	monitoring for poisonous and injurious matters before discharging	monitoring for poisonous and injurious matters before discharging	monitoring for poisonous and injurious matters before discharging	monitoring for poisonous and injurious matters before discharging						monitoring when discharging	
7.Gaobaoshi ash disposal area	once/ten days	once/ten days	once ten days	once/month	once/month	once/month					

Table 8.5-3

Recording table for monitoring results of effluent water quality

Sampling place	Standard value	Actual monitoring value							
Time of sampling									
pH									
COD									
BOD_5									
SS									

8.5.2 Continuous flue gas monitoring

TuoKeTuo Power Plant A is a large-scale coal-fired power plant. There exists the possibility to establish a power generation base in TuoKeTuo, therefore, it is necessary to monitor the pollutants from the power plant, especially to continuously monitor pollutants in the atmosphere. TuoKeTuo Power Plant A will be equipped with an automatic continuous monitoring system for flue gas and ambient air quality.

Monitoring items for this system include: discharging concentration of SO_2, NO_x, particulate and CO and such meteorological parameters as flue gas temperature and volume, wind speed, wind direction and atmospheric temperature, etc.

Table 8.5-4

Report for test of emission rate of flue gas

Name of Power Plant		TuoKeTuo Power Plant A				
Boiler		No.1 Boiler		No.2 Boiler		Remark
Time of test						
Place of test						
Concentration of flue gas	Sulfur dioxide (PPM)					
	Nitrogen oxide (PPM)					
	Flue dust (mg/m^3)					
Emission rate	Sulfur dioxide (m^3/h)					
	Nitrogen oxide (m^3/h)					
	Flue dust (kg/h)					
Flue gas rate						
Temperature of flue gas (°C)						
Emission Speed of flue gas (m/s)						
Fuel condition	Calorific value (kJ/kg)					
	Sulfur S_{ar} (%)					
	Nitrogen N_{ar} (%)					
	Consumption(t/h)					
Boiler condition	rate of load (%)					
	Evaporation upon monitoring (t/h)					
	Coefficient of surplus air (%)					

Table 8.5-5

Record of continuous monitoring for sulfur dioxide in flue gas

Name of Plant			TuoKeTuo Power Plant A		
Boiler			Boiler No.1	Boiler No.2	Remark
Record continuous monitoring of for concentration of sulfur oxide(PPM)	Max.	month			
		month			
		month			
	Average	month			
		month			
		month			
Fuel consumption at max. concentration $(t/h)(m_3/h)$ and the sulfur in flue gas $(S_{ar})(\%)$	*month*	fuel			
		consumption			
		Sulfur (S_{ar})			
	month	fuel			
		consumption			
		Sulfur (S_{ar})			
	month	fule			
		consumption			
		Sulfur (S_{ar})			
Testing time of for continuous monitoring system sulfur dioxide		month hour minute			
		month hour minute			
		month hour minute			

Table 8.5-6

Record of continuous monitoring for nitrogen oxide in flue gas

Name of Plant			TuoKeTuo Power Plant A		
Boiler			Boiler No.1	Boiler No.2	Remark
Record continuous monitoring of for concentration of nitrogen oxide (ppb)	Max.	month			
		month			
		month			
	Average	month			
		month			
		month			
Fuel consumption at max. concentration (t/h) (m_3/h) and the Nitrogen in flue gas (N_{ar}) (%)	month	fuel			
		consumption			
		nitrogen (N_{ar})			
	month	fuel			
		consumption			
		nitrogen (N_{ar})			
	month	fule			
		consumption			
		nitrogen (N_{ar})			
Testing time of for continuous monitoring system nitrogen oxide		month hour minute			
		month hour minute			
		month hour minute			

8.5.3 Continuous ambient air monitoring system

Upon completion of TuoKeTuo Power Plant A, the automatic continuous monitoring system BF-7000 will be adopted for monitoring ambient air quality perennially.

Chapter 9 Land Acquisition and Resettlement

9.1 Purpose of resettlement

The purpose of resettlement is mainly to assure those people who must move due to this project, through the compensation for occupied lands and loss of properties, to build new residences and arrange labor reasonably, and build public facilities in new living quarters so that the project affected persons can obtain improved living standard, income and productivity.

9.2 Policies and attitudes related with project affected people

(1) Laws and stipulations concerning resettlement;
(2) "Law for land of People's Republic of China"
(3) "Regulation for Implement of Law for Land of Inner Mongolia Autonomous Region"
(4) "Provisional Regulation for Compensated utilization of Land of Huhehot City"

9.3 Scope of resettlement and situation of population

TuoKeTuo Power Plant A is located in Yanshanying county. This county is located in the area of Daduiying and Shulinzi villages which are under the administration of Xidakulun Village. Shulinzi village is to the north of the plant site while Dongdakulun Village is located to the south of the site. Jianhao Village lies east of the site and west of the site is Huhhot-Zhungeer highway. Agriculture is predominant in this area. Grain is the main product and such cash crops as fennel and sunflower are planted in the area. The income and living standard of the people in this area is very low. Accordingly, it is one of the poorest counties in China.

The area of the occupied lands is 2,115 mu (145 ha), the lands occupied by the site are possessed by 6 villages, and 1 forest farm, 222 families, 893 inhabitants will be affected by this project, among them, 80 inhabitants of 22 families must be resettled.

Gaobaoshi ash disposal area lies about 2 km to the north of Yanshanying site. The project phase I will occupy 3,298 mu of land (220 ha). The ash disposal area will occupy 10,185 mu of land (679 ha) for the planned capacity. The requisitioned land is possessed by two villages of Yanshanying county, Tuoketuo County. There is a tree farm on the land to be occupied. Gaobaoshi village with 9 residents of 4 families is located at the ash disposal area; the village shall be moved during construction.

26 families must to move in this project, total area of house reaches to 3525 mu, because the cultivated lands will be occupied by plant, the families and residents influenced by this project are 131 and 515 respectively.

9.3.1 Investigation situation of population within occupied lands of power plant

The structure of population within scope of requisitioned land for power plant refer to Table 9.3-1 and Table 9.3-2.

Table 9.3-1

Investigation for population within the scope of requisitioned lands for power plant

Name of village	Total No. of families	Total population	Sex		Educational level				
			Male	Female	illiterate	Primary school	Junior middle school	Senior middle school	Child below 8 years old
Shulinzi	31	120	64	56	31	26	21	20	22
Daduiving	22	86	45	41	5	21	29	19	12
Jianhao	74	300	162	138	42	87	44	36	91
Mahuangtan	91	378	192	186	64	103	71	49	91
Total	218	884	463	421	142	237	165	124	216

Table 9.3-2

Investigation for population within the scope of requisitioned lands for power plant

Name of village	Structure of age													
	Below 16		16~25		26~35		36~45		46~50		51~60		Over 60	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Shulinzi	19	17	15	15	11	10	6	6	3	2	4	3	6	3
Daduiving	14	12	14	13	5	4	6	5	1	2	3	2	2	3
Jianhao	47	44	46	37	18	17	19	21	8	4	8	7	14	11
Mahuangtan	67	64	51	47	24	23	23	25	12	4	11	7	13	7
Total	147	138	126	112	58	54	54	57	24	12	26	19	35	24

Note: M.:Male F.:Female

9.3.2 Investigation for population within occupied lands of ash disposal area

Investigation for population within requisitioned lands of ash disposal area refer to Table 9.3-3 and 9.3-4.

Table 9.3-3

Investigation for population within requisitioned lands of ash disposal area

Name of village	Total No. of families	Total population	Sex		Education			
			M.	F.	Illiterate	Primary school	Junior middle school	Senior middle school
Gaobaoshi	4	9	5	4	3	4	2	-

Note:F.:Female M.:Male

Table 9.3-4

Investigation for population within requisitioned lands of ash disposal area (2)

Name of village	Structure of age													
	Below 16		18~25		26~45		36~45		46~50		51~60		Over 60	
	Male	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Gaobaoshi	-	-	2	1	1	-	1	1	-	-	-	-	1	2

9.4 Construction plan for new residence of project affected people and arrangement for labor

9.4.1 Construction plan for new residence of project affected people

Daduiying and Gaobaoshi Village with inhabitants from 26 families shall be moved to the north side of Shulinzi to set up new villages, total building area is 3,536 m^2, including residences of 1,872 m^2, storage rooms of 1,560 m^2, lavatories of 104 m^2. In order to improve the residential conditions, brick and wooden structures will be used in construction of the new one-story houses. Each family will have their own courtyard independent of each other. Residential conditions will be improved over those before the project. Each family will be provided with toilet, electricity, sewer and tap water. There are such utilities as roads, communication, cultural and educational facilities, scientific and technical activities room, clinic, shops, etc.

Table 9.4-1 shows estimation of cost for construction of new residences for project affected people.

Table 9.4-1

Estimation of cost for construction of new residence for project affected people

No.	Item	Area (m^2)	Unit price (yuan/m^2)	Cost (ten thousand RMB)
1	average area for each family ($72m^2$)	1872	500	93.6
2	area of storage room ($60m^2$)	1560	300	46.8
3	area of toilet ($4m^2$)	104	300	3.12
4	covered area of courtyard	18.2	5500	10.01
5	area of road	1560	8.28	1.29
6	wall of courtyard	1040	50	5.2
	Total			160.02

Note: It is expected that 26 families can move to new residences in the first quarter of 1996.

9.4.2 Construction of culture and education and sanitation, commercial networks at new residential village

Sewers, tap water and electric lighting will be provided in the new residences, and communication facilities, clinic, shops and primary school will be set up in the new residential village. The living conditions of resettlers after relocation will be better than before resettlement and the public environmental conditions will be improved greatly. The estimated costs are shown on Table 9.4-2.

Table 9.4-2

Estimation of the cost for cultural, educational facilities and sanitary facilities

No.	Item	Unit	Qty.	Unit price	Total cost (ten thousand Yuan RMB)	Remark
1	Cost for lands occupied by roads	mu	18	5500 yuan/mu	9.9	
2	Cost for construction of roads				16.00	macadam road
3	Sewer	km	1.5	13300 yuan/km	2.00	
4	Installation of tap water				20.00	
5	Building of primary school	m^2	360	583 yuan/m^2	21.00	
6	Cost of educational facilities				1.00	
7	Cost of land occupied by school		5	5500 yuan/mu	2.75	
8	Total				72.65	

Estimation of cost for others facilities and commercial networks refer to Table 9.4-3.

Table 9.4-3

Estimation of cost for other facilities and commercial networks

	Item	Area (m^2)	Unit price (yuan/m^2)	Cost (ten thousand Yuan RMB)	Remark
1	Scientific and technical station	160	550	9.0	including equipment cost
2	Land occupation	832	8.25	0.69	
3	Clinic	72	500	4.60	including equipment cost
4	Committee of village			5.13	
5	Commercial networks	140	500	7.00	
6	Others			1.55	
	Total			27.97	

Refer to the table 9.4-4 for the cost of broadcast, communication and electric power facilities.

Table 9.4-4.

Estimation cost for broadcast, communications and electric power facilities

	Item	Unit	Cost (ten thousand Yuan RMB)
1	Broadcast, communication and road lamp		10.0
2	400V power cable	2kV	2.00
3	10kV power cable	2kV	2.50
4	100kV transformer	1	2.00
5	Cost for enlarging capacity		4.00
6	Total		20.50

9.5 Labor of occupied land of power plant and ash disposal area and their arrangement

Residents affected by construction of power plant, (287 people with working ability) shall be rearranged for employment as agreed with local government. Among them, 87 people will be employed in a brick and tile factory, 30 people in sand and stone material factory, 40 people in steel window factory, 30 people in canned food factory and 40 people in commercial departments, i.e 227 in total. The remaining 60 people will be employed by the power plant. 80 residents not having working ability will be paid with a one-time old-age compensation of 7000 Yuan RMB. Arrangement cost for labors in occupied land is shown in Table 9.5-1.

Table 9.5-1

Table of arrangement for labors in occupied land of power plant

Units: 10,000 Yuan RMB

Item / Village	Number of families	Population			Average loss rate of land	Number of required settlement	People with work capability			People without work capability		
		Name of village Total	Male	Female			Number	Standard	Subtotal	Number	Standard	Subtotal
Shulinzi	31	120	66	54	57%	85	60	6000 Yuan	36.00	25	7000Yuan	17.50
Daduiying	22	86	45	41	66%	75	38	6000 Yuan	22.80	37	7000Yuan	25.90
Jianhao	74	300	162	138	67%	201	183	6000 Yuan	109.80	18	7000Yuan	12.60
Gao baoshen	4	9	5	4	100%	9	6	6000Yuan	3.60	3	7000Yuan	2.10
Total	127	515	278	237	58%	370	287	6000Yuan	172.00	83	7000Yuan	58.10

9.6 Brief classification and compensation standards for occupied land of power plant and ash disposal area

9.6.1 Brief classification for occupied land of power plant and ash disposal area

9.6.1.1 Brief classification for occupied land of power plant

Brief classification for occupied land of power plant s shown in Table 9.6-1.

Table 9.6-1

Brief classification of occupied land by the power plant

Village	Items					
	Irrigated land(mu)	Arid land (mu)	Forest (mu)	Grassland (mu)	Village(mu)	Land area (mu)
Shulinzi	197	127	100	63	--	487
Daduiying	146	108	99	80	53	433
Jianhao	191	90	28	--	--	309
Mahuangtan	62	50	25	--	--	137
Yanshanying	--	71	--	102	--	173
Zhanggaiying	--	--	157	--	--	157
Tree farm	--	--	96	--	--	96
Total	596	446	505	245	53	1845

9.6.1.2 Resettlement and land acquisition for railway and water intake project

Touketuo power plant railway project will occupy 260.1 ha, and there will be 151 project affected people. The water intake project will affect 106 people and occupy 186 ha The total number of people affected by the two auxiliary projects is 257, of which 46 do not have the ability to work, and 211 have working ability. the resettlement plan is as follows:

- People without working ability will be paid a one-time old-age compensation of 7,000 yuan;
- 50 people will be employed in railway construction with a monthly average income of 500 yuan;
- 90 people will be employed by the water supply construction unit, with a monthly average income of 500 yuan;

- 30 people will be employed by the power plant with a monthly average income of 300 yuan;

- 41 people will be employed by the local government in the following organizations: Touketuo County Engineering Company; Touketuo Count Catering Trade Company; Touketuo County Cement Plant; and, Touketuo County Sand and Stone Plant. the average monthly income is 250 yuan.

The average monthly salary of the above mentioned arrangements is 422 yuan, which is 8.7 times as much as in 1992, and 5.4 times as much as in 1994. Therefor the income of the resettled people will be increased.

9.6.1.3 Brief classification of land to be occupied by Gaobaoshi ash disposal area

A brief classification of the land occupied by Gaobaoshi ash disposal area is shown in Table 9.6-2. The length of the ash pipeline is 4,600 m x 2 m wide, and covering .92 ha. Compensation standard for land acquisition is the same as for Gaobaoshi ash disposal area.

Table 9.6-2

Brief classification of land occupied by Gaobaoshi ash disposal area

Village	Items					
	Irrigated land(mu)	Arid land (mu)	Forest (mu)	Grassland(mu)	Village(mu)	Area of lands (mu)
Huhulang	250	407.41	3378.4	614.13	10.20	4660.20
Tabumao	–	88.50	912.50	491.21	–	1491.91
Tree farm	–	79.60	3414.3	537.40	1.50	4032.89
Total	250	575.51	7705.2	1642.7	11.70	10185

9.6.2 Compensation standard for land acquisition

The standard shall be in accordance with "Law for Land of People's Republic of China" and the relevant stipulations issued by the local government.

9.6.2.1 Estimated cost of land acquisition for the power plant

Estimation of cost of land acquisition for the power plant is shown in Table 9.6-3.

Table 9.6-3

Estimated cost of land acquisition for the power plant

Items	Type											
	Irrigated land			Dry land			Wasteland			Forest land		
	mu	Yuan /mu	Amount (10000 yuan)	mu	Yuan /mu	Amount (10000 yuan)	mu	Yua n/mu	Amount (10000 yuan)	mu	Yuan/ mu	Amount (10000 yuan)
Reparation for land (3-5 times as much as yearly output)	596	2100	125.16	44 6	780	34.79	24 5	400	9.80	505	1600	80.80
Labor settlement cost(10 times as much as yearly output	596	3500	200.6	44 6	1300	57.90						
Tax for occupied land (3 yuan/m2	596	2001	119.26	44 6	2001	89.25						
Utilization fee for cultivated land (2 yuan/m2)	596	1334	79.51	44 6	1334	59.50						
Deposit-refund for recultivation (2 yuan/m2)	596	2001	119.26	44 6	2001	89.25						
Total cost for management (excluding taxes 8~4%)	596	268	15.97	44 6	201	8.97	24 5	12	0.29	505	45	2.27
Business income tax tax(5%)	596	290	17.20	44 6	104	4.64	24 5	20	0.49	505	80	4.04
Total	596	1148 4	685.04	44 6	7721	344.38		432	10.58			87.11

9.6.2.2 Cost for land acquisition of Gaobaoshi ash disposal area

Estimated cost of land acquisition for Gaobaoshi ash disposal area is shown in Table 9.6-4.

Table 9.6-4

Estimation of cost for land acquisition of Gaobaoshi ash disposal area

Items	Type											
	Irrigated land			Dry land			Grassland			Forest land		
	mu	Yuan /mu	Amount (10000 yuan)	mu	Yuan /mu	Amount (1000 yuan)	mu	Yuan/ mu	Amount (10000 yuan)	mu	Yuan/mu	Amount (10000 yuan)
Reparation for land	250	2100	52.50	575.51	780	44.9	1642.74	400	65.7	7705.2	1600	1232.8
Labor settlement cost	250	3500	87.50	575.51	1300	74.8	-	-	-	-	-	-
Tax for cultivated land	250	2001	50.00	575.51	2001	120.9	-	-	-	-	-	-
Utilization fee for land	250	1334	33.40	575.51	1334	76.8	-	-	-	-	-	-
Cash deposit for recultivation	250	2001	50.00	575.51	2001	120.9	-	-	-	-	-	-
Total cost for management	250	268	6.70	575.51	201	11.5	1642.74	12	1.98	7705.2	45	34.7
Business income tax	250	280	7.00	575.51	104	5.99	1642.74	20	3.3	7705.2	80	61.6
Total			287.1			455.79			70.98			1329.1

9.6.3 Compensation standard for project affected people

For people with capability to work: 6000 yuan/person. For people without work capability: 7000 yuan/person

9.6.4 Compensation standard for loss of properties of project affected people

For each family: 10,000 yuan

Estimated compensation cost for project affected people is shown in Table 9.6-5

Table 9.6-5

Estimated compensation cost for project affected people

	Item	Amount
1	Cost for land acquisition of site	11,271,100 yuan
2	Cost for land acquisition of ash disposal area	21,313,700 yuan
3	Compensation for loss of properties	260,000 yuan
3	Construction fee for new residence and public facilities	2,791,400 yuan
4	Relocation fee of project affected people	2,303,000 yuan
5	Subtotal	37,939,200 yuan
6	Expenses for urgent need	1,896,160 yuan
7	Total	39,836,160 yuan

9.7 Responsibilities of resettlement organization

In order to implement the resettlement the plan successfully, a special resettlement organization for project affected people will be set up in TuoKeTuo Power Plant Preparatory Department (TPPPD) to bear the responsibilities for the following resettlement work:

1. Survey of social economics at site;

2. Preparation of resettlement plan;

3. Estimation of resettlement cost of project affected people;

4. Pooling funds of project affected people;

5. Application for permits for land acquisition and relocation of project affected people;

6. Arrangement of community participation;

7. Arrangement for construction of new residences;

8. Negotiation with local government concerning resettlement problems;

9. Seeking opinions of project affected people in resettlement work;

Chapter 10 Community Participation

In order to ensure the improvement of living standards of project affected people and fulfill the resettlement plan successfully, the Electric Power Corporation of Inner Mongolia will undertake the following procedures for community participation.

10.1 Convening of symposium for social survey

In October of 1993, 15 persons from village, town, and county affected by the project attended the symposium for social survey organized by the Electric Power Corporation of Inner Mongolia, the land acquisition, scope of resettlement and requirements of residents and local government were been discussed in this meeting.

10.2 Forum for drafts of resettlement plan

In April of 1994, 20 persons from villages affected by this project, local environment departments and local government were invited by TuoKeTuo Power Plant Preparatory Department (TPPPD) to participate in a forum for drafts of the resettlement plan. The drafts of the resettlement plan drawn by TPPPD and approved by Electric Power Corporation of Inner Mongolia were declared, and the contents of the drafts, compensation standard for project affected people and arrangement for implementation of the resettlement plan were discussed in this meeting.

10.3 Report of investigation into the opinions of project affected people in lands to be occupied, TuoKeTuo Power Plant and ash disposal area

From June 20 to June 22, 1994, meetings of cadres from villages and towns were held at Xikoukou village of Yanshanying county. The opinions for land occupation of power plant and relocation of project affected people were sought. After the meeting, the opinions of 20 people in Dakuiying village were sought, it was unanimously agreed that:

- TuoKeTuo Power Plant is one of the state's key projects, and is beneficial for both country and people, active support and good cooperation for the construction of this project is needed.

- Construction of the Power Plant will not result in environmental pollution and other damages. On the contrary, it will improve the living standard and change the poor condition.

- We are satisfied with the location of project affected people. The living conditions can be improved and the entertainment, communication, transportation, etc. can be developed after relocation.

- Construction of the Power Plant will provide good opportunities for the development of economy. Therefore, we will not only support in respect of land occupation, resettlement etc., but also will create all advantageous conditions for construction of Power Plant.

10.4 Symposium attended by representatives of residents

In July of 1993, 16 representatives from Yanshanying township government and 6 villages affected by the project participated in a symposium of representatives of residents organized by TPPPD, in this meeting, methods of labor arrangement and construction of new residences were discussed.

10.5 Supervision and assessment of resettlement

North China Electric Power Design Institute (NEPDI) entrusted by Electric Power Corporation of Inner Mongolia will be responsible for supervision and assessment for resettlement. NEPDI will set up one supervision team composed of 4-5 persons (some of them are specialized in environmental protection) for the resettlement work. In each stage of resettlement, this team will supervise the implementation of resettlement work, and prepare an assessment report of this work after completion of resettlement. The report will be submitted to the World Bank for evaluation.

Signatures of attendants and representatives:

Wang Wenzhen	Yang Zhidong	Dong Jimei	Sun Weijun
Zhang Zhigong	Zhang Liuzhu	Zhang Runquan	Wang Zhuxiao
Zhang Yuliang	Zhang Fenhu	Zhang Banren	Zhang Ermian
Zhang Mianhuan	Zhang Gangbao	Zhang Liuwei	ZhangLiuming
Zhang Wunu	Wang Chunping	Wang Chunsha	Zhang Lanquan
Zhang Zhenfu	Zhang Zhiliang	Zhang Yuanbiao	Zhang You
Zhang Dangshou	Wei Suliang	Hui Sanxing	Wang Wende

Date of signature: June 22,1994

The members of investigation for land occupation of Power Plant and ash disposal area are shown in Table 10.6-6.

Table 10.6-6

Resettlement Investigation for the Land Occupation of Touketuo Power Plant and Ash disposal area

Name	Sex	Profession	Position
Yun Gaobei	M	Cadre	President of TuoKeTuo County People's Government
Li He	M	Cadre	Vice President of TuoKeTuo County People's Government
Wang Yu	M	Cadre	Director of Land Administration in TuoKeTuo County
Jiang Shouzhi	M	Cadre	Director of TuoKeTuo County People's Congress Standing Committee
Tian Shengzhi	M	Cadre	President of TuoKeTuo County Political Consultative Conference
Shun Weijun	M	Farmer	Director of Yanshanying Township Government in TuoKeTuo County
Wang Wende	M	Farmer	Vice Director of Yanshanying Township Government in TuoKeTuo County
Wang Zhen	M	Farmer	Head of Xida Village Committee in Yanshanying
Bai Shengcai	M	Farmer	Accountant Xida Village in Yanshanying
Zhang liuzhu	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Runquan	M	Farmer	Community member of Datuoying Village in Yanshanying
zhang Mianhuan	M	Farmer	Community member of Datuoying Village in Yanshanying
Wang Yunu	W	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Banren	M	Farmer	Community member of Datuoying Village in Yanshanying
Wang Cunshou	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang liuming	M	Farmer	Community member of Datuoying Village in Yanshanying
Wang zhuzi	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Yuliang	M	Farmer	Community member of Datuoying Village in Yanshanying
Wang Cunping	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang You	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Fengliang	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Dangshou	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Ermian	M	Farmer	Community member of Datuoying Village in Yanshanying
Zhang Wunu	M	Farmer	Community member of Datuoying Village in Yanshanying

Chapter 11 Conclusions

11.1 Construction of the power plant

TuoKeTuo Power Plant A (Phase 1) is one of most important thermal power generation projects that the State Planning Committee and the Ministry of Electric Power have planned for Inner Mongolia in China's Ninth Five-Year Plan. The power plant's purpose is to supply power to the Beijing-Tianjin-Tangshan Network, particularly to Beijing, in order to alleviate power shortages in the capital city. Implementation of the project will greatly contribute to improving the existing state of power utilization in Beijing, and contribute to a safe, reliable and stable operation of the BTT network. Consequently, it is vitally necessary to facilitate construction of the project.

The power plant is the largest project ever seen in TuoKeTuo County. Its operation will bring about development and prosperity in the county, leading to a fundamental change in the existing economic backwardness. The plant construction will offer great impetus for the development of industry, agriculture, trade, employment and other public services. Furthermore, it will also play an important role in promoting the economic development of Inner Mongolia as a whole.

The capacity of Power Plant A at phase I is 2 x 600 MW, of which a loan of some $400 million is expected from the World Bank. The annual coal consumption is 3.85 million tons, water consumption is 0.99 m^3/s.

The plant is located in the rural area of Yanshanying Township, TuoKeTuo County, Inner Mongolia, close to Huhehot-Zhungeer Highway. The plant construction will involve the resettlement altogether of 127 households and 370 residents from two small villages.

Yanshanying Site of the TuoKeTuo Power Plant has good geological conditions, with natural foundations available. The background of environmental contamination around the site is at a low level. The plant is located in a plain, favorable for the diffusion of fluegas emitted from the plant.

The People's Government of TuoKeTuo County has expressed its full approval of the construction of this large sized thermal power plant in the region, the Urban and Rural Construction Bureau under Huhehote Municipality has also voiced its support, the Urban and Rural Construction Division under Inner Mongolia Autonomous Region states that the construction project installed with 2 x 600 MW coal-fired generating sets is practical.

11.2 Control Measures for the Pollutants of the Power Plant

11.2.1 Control Measures for Fluegas

Two (2) boilers of the project phase I will share one 240-meter-high single-shaft chimney, so the atmospheric capacity for diffusion will be fully utilized in reducing the ground concentration of pollutants.

The project phase I will use a 4-field high efficiency electrostatic precipitator, with a designed efficiency $\geq$ 99.76 %. Both actual SO_2 emission and fluegas emitting concentration caused by the power plant will be lower than the permitted value of the state standard.

Zhungeer coal is to be used in the plant. Its as-received basis sulfur content is 0.47% (guaranteed by Agreement, see Annex 2) . Long-term use of low sulfur-content coal in China has proven to be an effective measure in reducing SO_2 emission. In light of the environmental assessment and the actual conditions of the plant site, there is no need for desulfurization measures in the present phase. Space will be reserved for an FGD in the power station layout.

In engineering design, low NO_X combustion technology will be recommended so as to keep the NO_X concentration to 400 ppm, which is lower than the World Bank Guideline value of 417 ppm.

11.2.2 Control Measures for Waste Water

A chemical waste water treatment system is to be installed for the centralized treatment of collected waste water, which will not be discharged until the water quality meets the standard concerned.

The drainage of circulating cooling water will be recycled as the washing water for dust-removing and coal-conveying system, the rest will be discharged.

Oil contaminated sewage will be collected through the piping system to the centralized treatment station. After being treated, the water with permitted quality is then discharged.

Water drained from the coal yard and water used to wash the coal-conveying system will be delivered to a coal setting pool. In slurry from it is to be pumped back to the coal yard, while the cleaned water is to be recovered for reuse.

Sanitary sewage is to go through a two-stage biochemical treatment system and then discharged when water quality is up to the environmental protection standard.

11.2.3 Control Measures for Ash and Slag

It is recommended in both the feasibility study design and environment assessment that a hydraulic ash removal system be introduced at Gaobaoshi ash yard with seepage proof measures.

The ash yard is to be segmented to enable reclamation of filled areas in series. The ash yard, after being utilized one part after another, is to be turned into farmland immediately.

The ash disposal area will be maintained with water cover to control fugitive dust.

Vertical wind-proof greening-belt 100 m wide will be set up around the ash yard.

All around the ash yard, the water spraying system is to be installed. In case the yard fails to maintain the water-retained operation, sprinkling will be executed to keep moisture on the surface ash so as to control fugitive dust.

11.2.4 Control measures for coal handling system

The coal storage yard and the operating machinery are equipped with water spraying system against fugitive dust.

Dust removal equipment is installed to various transfer stations, coal bunker bays and the coal crushing room; the coal dust over the coal conveying gallery will be removed by way of vacuum cleaning or hydraulic cleaning; there are flat-bag filters in the silos for removing dust.

11.2.5 Noise control measures

For noise control, priority shall be given to equipment selection so as to ensure the equipment meets relevant requirements. The equipment foundations will be treated to attenuate vibration; silencers will be attached to the safety valves of boilers, to exhaust pipes and drainage outlets; sound insulation cabinets will be set up for the shift room.

11.3 Environmental quality baseline

11.3.1 Ambient air quality

TuoKeTuo County is a region backward in industry, with no large sized enterprises at present that may cause industrial atmospheric pollution. There are 70,881 tons of coal burnt each year in the region, and annual amount of flue dust and SO_2 emitted is relatively small.

Local atmospheric monitoring indicates that in the heating season and non-heating season, both primary SO_2 concentration and its daily average concentration are lower than State Standard Grade II. The primary SO_2 concentration and its daily average concentration taken in both the heating and non-heating season at all monitoring points, except those at the county town, are found lower than State Standard Grade I.

The primary NOx concentration and its daily average concentration taken at all monitoring points in both the heating and non-heating seasons are found lower than State Standard Grade II. The daily average NOx concentration taken at most monitoring points is found lower than State Standard Grade I.

The primary TSP concentration and its daily average concentration taken at each monitoring point in the non-heating season, can meet the requirement of State Standard Grade II. In the heating season, the primary TSP concentrations taken at three monitoring points exceed the State Standard by a rate of 3.6% to 4.0%. At the monitoring point where the highest concentration was detected, the pollution index is 1.47. The daily average TSP concentration measured over a period of seven days in the heating season at all monitoring points, except that at Zhanggaiying, exceed the state standard by a rate of 14.3 to 57.1%. There are three monitoring points where the seven-day average TSP concentration exceeds the state standard. Of the concentration taken at the three points, that measured at Shilahao is the highest, the pollution index there being 1.28. The above-mentioned results show that the TSP concentration found in the urban community area is no higher than that in the deserted country side. Hence the conclusion can be derived that the main factors affecting TSP concentration in the county lie in climatic condition and its bare desertified soil, instead of industrial pollutants.

The local background SO_2 and NOx concentrations are significantly low, with the monitored results far below the values permitted by the state standard. The tolerant capacity of atmospheric environment appears fairly massive since it is basically not impacted by industrial air pollution. The local atmospheric environment is thus assessed as relatively good and graded as clean.

A one-year period of continuous ambient air monitoring around the plant site is under way. The data already available are close to those obtained in 1992, which shows that atmospheric environment around the plant site and the county site is fine (see Annex 9).

11.3.2 Water quality

Monitored values of 8 items obtained at three sections of the surface water (the Yellow River) met the requirements of GB 3838-88 "Surface Water Environment Quality Standard".

For monitored values of 11 items obtained at 8 sampling points, most can meet the requirement of GB 5749-85 "The Sanitation standard concerning Drinking Water". Only the result of such items as the total number of coliform bacillus and other bacteria exceed the standard concerned.

11.3.3 Existing state of ecological environment

The evaluated zone appears ecologically fragile, being favored with few species, poor natural vegetation, barren soil, heavy alkalization, wind erosion and desertification in some areas.

11.4 Prediction of environmental impact

11.4.1 Prediction of atmospheric environmental impact

(1) Impact on the concentration of evaluated zone by SO_2 and particulate matter emitted from the plant phase I

The maximum primary concentration of atmospheric pollutants (SO_2 and suspended particulate) emitted from the Power Plant A having 2 x 600 MW generating sets installed at the phase I will occur under the stability condition of Category C, with the peaking point 8 km away from the plant site to the east. This is an area of fixed dunes and infertile saline and alkaline land. There is sparse population and little agricultural activity in this area.

The maximum primary concentration of emitted SO_2 is 0.068 mg/m^3 for design coal, accounting for 13.6% of State Standard Grade II; and 0.076 mg/m^3 for check coal, accounting for 15.2% of the Grade II; the daily maximum average SO_2 concentration is 0.0326 mg/m^3, accounting for 27.6% of the Grade II.

The maximum primary concentration of suspended particulate is 0.019 mg/m^3 for design coal, accounting for 3.8% of the Standard Grade II; and 0.024 mg/m^3 for check coal, accounting for 4.8% of the Grade II.

The daily average concentration calculation upon 10 typical-day in the period of atmospheric measurement reveals that within the daily average SO_2 concentration high-value distributed area, the maximum is 0.0326 mg/m^3, accounting for 27.6% of the Standard Grade II. The SO_2 emitted from the project phase I contributing to the daily average concentration of the air in the evaluated zone is greatly lower than the Standard Grade II.

The amount of suspended particulate emitted accounts for only 28% of the SO_2 emission. Hence the daily average concentration of suspended particulate is greatly lower than that of SO_2. The distribution of suspended particulate concentration is about the same as that of SO_2. Under the same standard of assessment, it can be seen that the daily average suspended particulate concentration accounts for only a tiny percentage of Standard Grade II.

The power plant A is located in the plain countryside, without any sensitive receptors in the vicinity which would require particular atmospheric environmental protection. The site is 18 km away from the county town, the air flow is favorable for diffusion.

(2) Permitted emission rate of SO_2 and fluegas

As calculated according to GB13223-91 "Atmospheric Pollutants Emission Standard for Coal-fired Power Plants," in the case of two boilers sharing one 240 m high chimney at the planned capacity of the Power Plant A, the permitted SO_2 emission rate is 26.87 t/h for the design coal; and 27.34 t/h for the check coal. It is prescribed in the "World Bank Standard Concerning SO_2 Emission" that in a pollution-free zone the daily maximum SO_2 emission rate is 500 t/d, and the maximum annual average value contributed to the ground concentration is 50 $\mu g/m^3$.

The actual SO_2 emission rate from power plant A burning design coal amounts to 5.027 t/h, that from check coal is 5.685 t/h, accounting respectively for 18.7% and 20.8% of the permitted emission rate of whole power plant. The daily SO_2 emission rate from power plant A burning design coal is 100.54 t, that from check coal is 113.7 t, accounting respectively for 20.1% and 22.7% of the amount prescribed as a limitation in the above mentioned World Bank Standard.

The power plant A will use electrostatic precipitators with efficiency of $\geq$ 99.76 %; the actual gas concentration is less than 100 mg/Nm^3 for design coal, and 100 mg/Nm^3 for check coal, which can meet the World Band and State Standard as to the permitted maximum concentration of total suspended particulate (SPM) emitted at the outlet of precipitators.

As calculated according to State Standard "Atmospheric Pollutants Emission Standard for Coal-fired Power Plant" and the "World Bank's Guideline Concerning SO_2 Emission Standard," and taking into account the calculated result of the ground concentration of atmospheric pollutants emitted from the power plant, it is proper for the power plant A to use: burning low sulfur content coal, two boilers sharing one 240 m chimney, adopting ESP with efficiency $\geq$ 99.76 % etc. It can thus meet air pollutant emission standards and the local requirements for ambient air quality.

When the power plant expands to its planned capacity of 6 x 600 MW, the actual SO_2 emission rate will increase to around 15 to 17 t/h, three times as much as that of the project phase I, accounting for 56 to 62% of the permitted values of state standard, and accounting for 60 to 66% of that prescribed by the World Bank Standard. Consequently, the actual SO_2 emission rate is within the standard.

As a coal-fired power plant, it is unavoidable for Touketuo Power Plant A to emit pollutants into the atmosphere in the course of its operation. And it is impossible to completely avoid emissions by way of flue gas control measures; however, emissions of the power plant, as well as calculated ground level concentrations can meet environmental standards and can be controlled within reasonable, permissible and safe limits.

11.4.2 Prediction of water quality impacts

With the waste water treatment measures put into practice as proposed in the present environment assessment, the industrial waste water and domestic sewage generated in the operation of the power plant can meet requirements prescribed in GB8978-88 "Comprehensive Discharge Standard Concerning Waste Water" with reference to Grade I standards for newly built, extension and reconstruction projects.

The condenser cooling water will be recycled not only to save water, but also to reduce wastewater discharge.

Owing to the fact that Fengyan ash yard is found close to the water source of the country, it is inadvisable to adopt a hydraulic ash disposal system. This alternative has been rejected.

Environmental assessment calculation and analysis for the Gaobashi ash yard confirms that no impact will be brought about by the ash slurry water on groundwater with the ash disposal area leachate liner and runoff control measures as described herein.

11.4.3 Environmental impact of noise

The power plant is located in a sparsely populated region. There is no major community, cultural or commercial centers nearby which requires particular protection against noise pollution. The operational noise produced within the boundary of the power plant will meet the requirement stipulated by emission standard after noise control measures taken.

11.4.4 Environmental impact of the dedicated railway

The dedicated railway for Touketuo Power Plant A runs from Wangguiyao Station, where it joins with the Fengzhen-Zhungeer Railway, to the plant boundary at the Yanshanying Site, covering 43.75 km. Electric-driven locomotives will be employed. As to environmental impact mitigation measures concerning the railway, attention should be paid to the management of railway construction and control of emissions of fixed pollution sources during operations.

Impacts include pollutants produced in railway construction; the whistling noise and vibration caused by a moving locomotive; and, the waste gas, water and slag discharged by operating or living facilities at stations or sections along the railway line. The moving locomotive is a mobile source of pollution, while all other facilities and stopped locomotive represent fixed sources of pollution.

The dedicated railway will run through some sections where there is complicated terrain and steep slopes. In construction, excavated soil will be used as fill where possible so as to stabilize hills and sloping land.

The dedicated line will pass through loess area with well developed gullies. Those lines will be straightened or detoured as required so as to minimize earthwork and preserve farmland. Attention is to be paid to the conservation of the natural vegetation on sandy soil and dunes in order to prevent wind blown erosion. No earth shall be allowed to be taken from such places.

Running locomotives are mobile and linear sources of noise which spreads away from both sides of the railway in cylinder-shaped mode. When the train travels at a speed of 70 to 110 km/h, the noise level may reach 84 to 87 dBA as measured at a point 30 m distant. With a view to such noise pollution of the environment, it is recommended that elastic rail structure be adopted, after a period of operation the long-type rail be replaced, and that whistling be restricted to only certain specified sections. Along either sides of the railway a belt of trees is to be planted in order to reduce the noise produced by the trains.

The vibration caused by a train moving along the rails is negligible, without any harmful effect on buildings nearby or on human bodies. The running electric-driven locomotives may produce electromagnetic interference on wire and wireless communication facilities, which will be taken into consideration when the railway is designed.

Fixed boilers at stations along the railway are to be equipped with particulate emission control devices with an efficiency above 85 %. Trees are to be planned at various stations and residential areas along the railway.

The oily water discharged from production at the Lanjiayao and Wangyuying Station will be treated in slow-flow oil-separating tanks; lead and acid contaminated water and other wastewater will be treated by chemical processes; domestic sewage will be treated in septic tanks or by anaerobic digestion.

11.4.5 Environmental impact of substations and transmission lines

As indicated by many research results at home and abroad, and by practical experience, electric field intensity of 500 kV overhead transmission lines cause no harm to the human body, and is much lower than the permitted intensity for human safety.

As shown by research results concerning the effects of alternating current on the growth of plants, field intensity of 15 to 20 kV/m may slightly damage the leaf tip parts of certain plants, but the round parts of leaves remain intact even under field intensities up to 50 kV/m. Moreover, the growth and yield of all plants, including those whose leaf tips are damaged, will not suffer.

Nearby the planned 500 kV transmission line there are no historic sites, scenic spots, or tourist resorts. Running through mainly farmland or waste land, the transmission line to be erected will not interfere in people's farming, nor bring any harm to the land.

11.4.6 Environmental impacts of the water supply project

Construction of the water supply project will bring about favorable influences on the natural environment in the following ways: 1) contribute to the consolidation of the river course; 2) strengthen the dikes along the Yellow River, and prevent the river banks from being washed away. As a result, flood damage in this section of the river will be alleviated, and navigation will be facilitated.

Silt removal in the water supply project is an important issue. Because of the large volumes of dry silt to be disposed in the large-size slurry yard, failure to treat the silt properly will make it a man-made source of pollution. Therefor, great importance is attached to silt treatment. Effective mitigation measures must be taken, such as establishment of wind-break forest, soil property improvements for the disposal area silt, reclamation of the area with grasses and trees, and cropping to fully utilize the silt and to minimize harmful impacts.

The hydraulic structures of the water supply project will affect navigation. The main problem lies in the intake pier and auxiliary structures which will narrow the navigable river channel by approximate 60 m and thus limit the route selection. A channel for navigation will be reserved in the project design. Moreover, navigation within the boundary of Touketuo County involves only small boats used as ferries to cross the river, with no need to pass through the intake structures. Therefor the structures will not have much impact on navigation.

11.4.7 Ecological environmental impact

Most of the land to be occupied by Touketuo Power Plant A can hardly be cultivated, with poor vegetation, very few species of plants. Soils are sandy and stationary or semi-stationary. Construction of the power plant will destroy the vegetation on the occupied land and to some extent, will affect the vegetation evolution of the land nearby the site. The solution to the problem, therefore, is to cultivate a sustained artificial vegetation in a scientific way in the area around the ash yard, and in and around the plant compound, to gradually reduce wind erosion and desertification in the area and bring about a favorable development of ecological environment.

Construction will affect wildlife habitat, turning the area into a place of industry with shelter forests. There are, however, no species of animals or plants in the region that are assigned as the objects for conservation either at the provincial or national level. Hence there are no serious ecological or biodiversity problems.

The area where the power plant and the ash yard are to be built is covered with wind blown sandy soil, stationary or semi-stationary. Construction of the plant will destroy the vegetation in the region and that around the site, causing a "breach in vegetation." Therefore, tree-planting and vegetation cultivation should be carried out prior to the construction or simultaneously.

The area where the plant is to be set up is one of serious wind erosion and desertification, with poor productivity. It is sensible utilization of such a barren piece of land to set up a power plant.

When all the environmental protection measures are put into practice for the power plant, the unfavorable impact of pollutants produced by the plant, such as waste water, ash and slag, flue gas etc. on the soil and biological system in the evaluated zone will be limited within permitted standards.

Construction of the power plant will bring along with it local economical development and prosperity.

11.5 Resettlement arrangement and community participation

Construction of the Power Plant A and its expansion will facilitate the development of rural and township enterprises in the region, thus giving impetus to the optimal adjustment of local agricultural production and leading to greater local output values. It will create favorable conditions for the economic development in Touketuo County and raise the income of the local population.

The plant construction, land requisition and resettlement plan have received the full support from the local people and authorities. The county government has already approved land acquisition for construction within the boundary of the county.

11.6 Management and supervision plan for environmental protection

11.6.1 Environmental management and monitoring during construction period

Articles concerning environmental protection are to be included in the construction contracts and the implementation shall be put under supervision.

Environmental monitoring in the construction period shall include:

1) atmospheric quality monitoring will be carried out with the BF-7000 ambient air quality automatic monitoring system;

2) monitoring of fugitive dust or particulate matter, accumulated water, slurry and building rubbish; shall be cleared out if found;

3) monitoring of wastewater discharge and the noise produced in the course of construction, such as that caused by construction machinery.

11.6.2 Environmental protection management plan for operations

An environmental protection department and monitoring station will be set up under the plant; the station will be staffed with 5 to 6 specialized persons and equipped with specific environmental monitoring and analysis instruments. The Environmental Management Unit (EMU) will have responsibility for: management, monitoring, supervision, propaganda, education in connection with environmental protection, follow-up investigations of the social and economic impacts of the power plant construction.

The EMU, consisting of full-time staff members, will undertake the jobs of leadership and supervision of all activities in this field. It shall prepare the monthly, quarterly and annual reports concerning the environmental situation, and also set up various technical files and systematic diagrams relevant to the subject.

11.6.3 Environmental monitoring plan for operations

In the course of the commercial operation of Power Plant A, monitoring work will be carried out on pollution sources and environmental quality in accordance with the national standards for, "Environmental Supervision Regulation for Thermal Power Plant." As to the pollution sources, the following items will be monitored: the fluegas emitted from the gas duct after boiler; the efficiency of the precipitators; the water quality at each discharge point of wastewater. As to environmental monitoring, the following items will be measured: ambient air quality in the production area and living quarters; quality of the receiving waters; quality of groundwater around the ash yard; noise pollution in the production area and in the living quarters (see Chapter 8 for details). The fund for purchase of monitoring instruments has been itemized in the design budget. The monitoring station building will have a floor space of 300 m^2.

11.7 Comprehensive conclusions

The environmental quality and conditions in Touketuo County are generally good for the construction of a large-sized thermal power plant. It is an area of barren soil, backward in industry and agriculture, with a relatively poor standard of living. The plant construction will play a very important role in promoting economic development in the region. The project will bring about very significant and comprehensive benefits and advantages. So it has received the support from the local government and people. The resettled people can expect improvement in the quality of their lives.

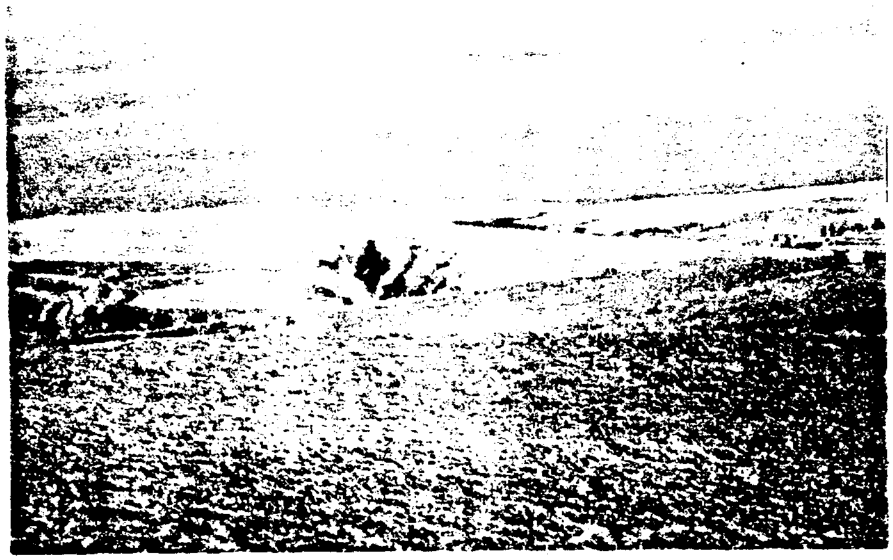
The location of the plant is reasonable, the measures of coping with the various environmental problems are advanced and feasible; the pollutants discharged from the plant are within the standards permitted, and the potential environmental impacts will not exceed the permitted values. From the viewpoint of environmental protection, consequently, the construction of the Phase I project of the Touketuo Power Plant A is feasible.

The planned capacity of the power plant is 6 x 600 MW. When planning and designing the power plant, full consideration has been given to its possible extension in the future and necessary conditions have been technically reserved. Seen from the angle of environmental protection, the planned capacity is also practical in general. Supplementary assessment of environmental impact involved in the extension stage will be made in due time.

Annexes

Annex 1 Site photographs

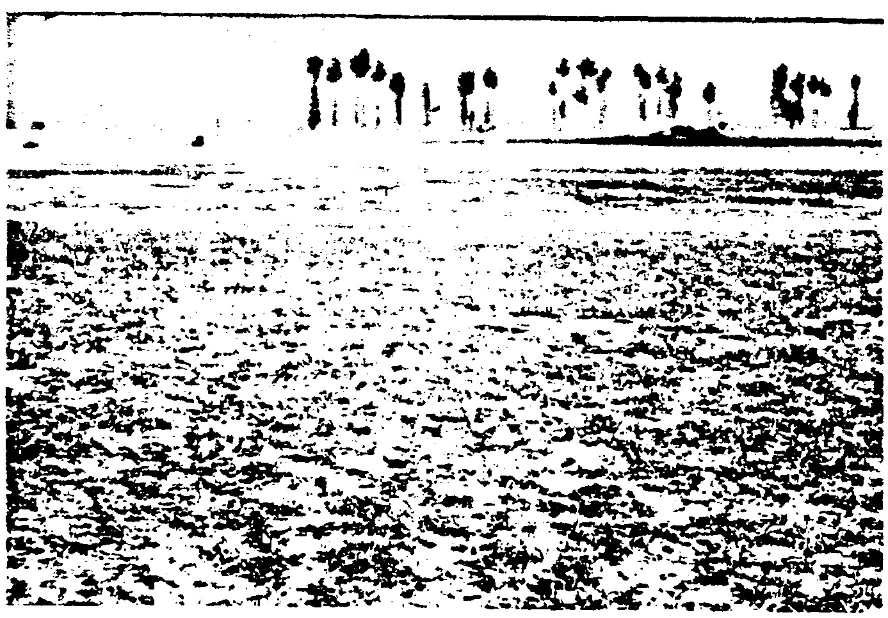
1. The "low hill" area to east of power station and ash disposal area sites. This area is downwind of prevailing westerlies in fall, winter and spring.



2. "Low Hill Area."

3. "Low Hill Area."

4. Saline and alkaline grassland - scattered throughout assessment area.



5. Fixed dune -- scattered throughout assessment area.

6. Stunted trees in area of sand stabilization project -- trees are about 20 years old.

Annex 2 Environmental Impact Assessment Approval Letter

NATIONAL ENVIRONMENT PROTECTION BUREAU DOCUMENT

EP (1995) NO.479

LETTER FOR THE REVIEW AND APPROVAL OF ENVIRONMENT IMPACT ASSESSMENT FOR THE INNER MONGOLIA TUOKETUO POWER PLANT A TO BE BUILT TO MINISTRY OF ELECTRIC POWER:

WE ARE IN RECEIPT OF YOUR EP(1994)NO.748 DOCUMENT. THROUGH REVIEW, THE FOLLOWING IS THE WRITTEN REPLY OF THE ENVIRONMENT IMPACT ASSESSMENT (HEREINAFTER CALLED THE REPORT) OF INNER MONGOLIA TUOKETUO POWER PLANT A TO BE BUILT:

1.WE AGREE WITH YOUR PRE-REVIEW OPINION. WE AGREE THAT THE TUOKETUO POWER PLANT A FIRST PHASE USES THE WORLD BANK LOAN TO BUILD 2-600MW COAL FIRED UNITS AT YANSHANYING. THE CONCLUSION AND THE POLLUTION CONTROL MEASURES CAN BE THE BASIS OF THE PRELIMINARY DESIGN OF THE PROJECT.

2. WE AGREE THAT TWO BOILERS SHARE ONE 240M CHIMNEY. ELECTROSTATIC PRECIPITATOR SHALL BE USED WITH THE EFFICIENCY OF 99.3%. LOW NO_X BURNING TECHNOLOGY AND MEATURES SHOULD BE ADOPTED.

3. ALL KINDS OF INDUSTRIAL AND DOMESTIC WASTE WATER SHOULD BE DISCHARGED AFTER IT IS TREATED UP TO THE CLASS I STANDARD FOR NEWLY BUILT, ENTENSION AND RETROFITTING PROJECTS IN "EFFLUENT DISCHARGE STANDARD" TO REDUCE THE IMPACT ON YELLOW RIVER.

4. WE AGREE WITH THE GAOBASHI ASH YARD AND HYDRAULIC ASH REMOVAL SCHEME. THE SEEPAGE PROOF MEASURES IN THE ASH YARD SHOULD BE FURTHER DEVELOPED IN THE PRELIMINARY DESIGN OF THE PROJECT TO PREVENT THE ASH WATER POLLUTION OF THE GROUND WATER.

5. IN ORDER TO REDUCE THE IMPACT ON THE ENVIRONMENT DURING THE CONSTRUCTION OF THE POWER PLANT, THE MANAGEMJENT SHOULD BE STRENGTHENED AND EFFECTIVE MEASURES SHOULD BE

TAKEN. THE PLAN FOR COMPREHENSIVE UTILIZATION OF COAL ASH SHOULD BE FURTHER DEVELOPED.

6. THE CONSTRUCTION UNITS MUST FOLLOW THE SYSTEM OF "THREE SIMULTANEITY" OF CONSTRUCTION AND ENVIORNMENT PROTECTION MANAGEMENT. INNER MONGOLIA ENVIRONMENT PROTECTION BUREAU WILL BE RESPONSIBLE FOR THE ENVIRONMENT PROTECTION MANAGEMENT DURING THE CONSTRUCTION OF THE POWER PLANT.

AUG. 31, 1995

KEY WORDS: ELECTRIC POWER ENVIRONMENT IMPACT REPORT REPLY LETTER

C.C.: NATIONAL PLANNING COMMITTEE, CHINA INTERNATIONAL ENGINEERING CONSULTANCE CO., ELECTRIC POWER PLANNING AND ENGINEERING DESIGN INSTITUTE OF ELECTRIC POWER MINISTRY, INNER MONGOLIA ENVIRONMENT PROTECTION BUREAU, INNER MONGOLIA ELECTRIC POWER BUREAU, HUHEHOT ENVIRONMENT PROTECTION BUREAU, NORTH CHINA ELECTRIC POWER DESIGN INSTITUTE.

环境影响评价证书

单位名称：能源部华北电力设计院

证书等级：甲级

证书编号：国环评证 甲字第0330号

发证单位：

一九八[illegible]十日

CERTIFICATE FOR ENVIRONMENTAL IMPACT ASSESSMENT

UNIT NAME: NORTH CHINA ELECTRIC POWER DESIGN INSTITUTE

CERTIFICATE CLASS: CLASS A

CERTIFICATE NUMBER: GHPZJZ No. 0330

ISSUED BY:

NATIONAL ENVIRONMENTAL PROTECTION BUREAU

Annex 3 Coal Supply Agreement

THE AGREEMENT ABOUT COAL SUPPLY FOR TUOKETUO POWER PLANT A

Zhungeer Coal Industry Company (the selling party) holds a negotiation with Tuoketuo Power Plant (the buying party) about coal in power plant and reaches an agreement.

- The selling party supplies 4 million ton coal to the buying party per year.
- The coal quality must accord with the requirements of the buying party, which are as follows.

Industry analysis

Lower heat value	$Q_{net.v}$=17991.2±2092KJ/Kg
Volatile matter	V_{adf}=38~41%
Inherent moisture	W^f=3.84%

Element analysis

Carbon	C^y=47.62%
Hydrogen	H^y=3.01%
Oxygen	O^y=8.77%
Nitrogen	N^y=0.88%
Sulphur	S^y=0.47%
Water	W^y=26±4%
Abrasion coefficient	K^{HGJ}=57
	t_1=1180°C
Melting point of ash	t_2>1400 °C
	t_3=——

Ash analysis

Silica	SiO_2=40.75%
Alumind	AL_2O_3=47.26%
Ferric oxide	Fe_2O_3=4.78%
calcium oxide	CaO=0.89%
Magnesium oxide	MgO=0.20%
Sulphur trioxide	SO_3=1.06%
Coke slag model	3~4

- Other details about coal supply will be discussed after the coal supply contract is signed.

April. 6th, 1995

关于向托克托电厂(A)厂供应发电用煤的协议

准格尔煤炭工业公司（以下简称甲方）同托克托电厂（以下简称乙方）就托克托电厂发电用煤有关事项进行了洽谈，经双方协商对涉及的问题达成如下协议：

一、甲方同意向乙方供应燃煤４００万吨/年。

二、甲方供应的煤质应满足乙方的要求，具体指标如下：

１、工业分析

低位发热量：Q_{dw}^{y}=17991.2±2092 KJ/kg

(4300±500 Kcal/kg)

可燃基挥发份：V^{r}=38～41%

分析基水份:W^{f}=3.84%

灰　　份：A^{y}=26±4%

２、元素分析：

应用基碳：C^{y}=47.62%

应用基氢：H^{y}=3.01%

应用基氧：O^{y}=8.77%

应用基氮：N^{y}=0.88%

应用基硫：S^{y}=0.47%

应用基水份：W^{y}=13.25%

应用基灰份：A^{y}=26±4%

3、可磨系数：K_{KM}^{HQI}=57

4、灰熔点：t_1=1180℃

t_2>1400℃

t_3=———

5、灰分析：

二氧化硅：SiO_2=40.75%

三氧化二铝：Al_2O_3=47.26%

三氧化二铁：Fe_2O_3=4.73%

氧化钙：CaO=0.89%

氧化镁：MgO=0.20%

二氧化钛：TiO_2=1.84%

三氧化硫：SO_3=1.06%

焦渣型号：3-4

三、对供应燃煤的其它细节问题，待双方签署供煤合

同时再作详洽。

甲方：准格尔煤炭工业公司

代表：吴俊明 （签字）

乙方：托克托发电厂筹备处

代表：赵正谦 （签字）

一九九五年四月六日

Annex 4 Endangered Species

TUOKETUO COUNTY GOVERNMENT DOCUMENT

TUOKETUO POLITICAL LETTER NO. (1995) 6

LETTER CONCERNING RELEVANT ISSUES OF TUOKETUO POWER PLANT ENVIRONMENT ASSESSMENT

TO TUOKETUO POWER PLANT PREPERATION DEPARTMENT:

IN THE ASSESSMENT AREA OF THE POWER PLANT, THERE IS LOW SPECIES DIVERSITY OF WILD ANIMALS AND PLANTS. THE WILD ANIMALS AND PLANTS ARE OF COMMON KINDS IN AGRICULTURAL AREA. THERE IS LOWER SPECIES DIVERSITY IN THE AREA OF THE POWER PLANT AND THE ASH DISPOSAL YARD. THERE ARE NO ENDANGERED WILD ANIMALS OR PLANTS. THE SPECIES IN THE ASSESSMENT AREA WILL NOT BE AFFECTED NEGATIVELY BY THE CONSTRUCTION OF THE POWER PLANT. ON THE CONTRARY, AFTER THE POWER PLANT IS BUILT, THE ENVIRONMENT OF THE PLANT WILL BE GREENED AND BEAUTIFIED. THERE WILL BE NORE SPECIES OF PLANTS AND PROBABLY MORE BIRDS WILL BE ATTRACTED TO STAY AND LIVE IN THE AREA.

NOV. 8TH, 1995

请转环评处　陈瑛

托克托县城乡建设环境保护局文件

托城建字(1995)12号

关于托克托电厂环境评价有关问题的

复　　函

托克托电厂筹备处：

对于电厂厂址的动、植物评价区内，野生动、植物种类非常单调，是农区常见种，在拟建厂区和贮灰场周围的分布则更少，而且没有濒临灭绝的动、植物，不会使评价区动物物种及其种群发生变化。电厂建成后厂区环境绿化、美化，将比现有植物物种丰富，并有可能招致一些鸟类的栖息与生存。

一九九五年[illegible]月八日

Annex 5 Historic Relics

TUOKETUO COUNTY GOVENMENT DOCUMENT

LETTER CONCERNING NO HISTORICAL RELICS AT THE TUOKETUO POWER PLANT SITE

TO TUOKETUO POWER PLANT PREPERATION DEPARTMENT:

THERE ARE NO PROTECTED CULTURE OR HISTORIC RELICS IN THE AREA OF TUOKETUO POWER PLANT SITE AND ASH DISPOSAL YARD, SO THE PLANT WILL NOT OCCUPY ANY LAND OF HISTORICAL RELICS.

NOV. 8TH, 1995

请转环保处　陈曙

托克托县文化教育委员会文件

托文教委文字（1995）7号

关于托克托电厂没有文物遗址的

复　　函

托克托电厂筹备处：

托克托电厂厂址及储灰场内，没有国家级、自治区级的重点保护文物，也没有古文物遗址，不存在占压文物遗址的问题。

一九九五年十一月八日

Annex 6 Species Listing

ANNEX

ITEMS OF WILD ANIMAL IN ASSESMENTAL AREA

MAMMAL CLASS		DISTRIBUTION PLACE[1]
INSETIVORA	CARNIVORES ORDER	
Mustelidae	Weasel Family	
m.sibirila	skunk	c e
meles meles	badger	e
LAGOMORPHA	RABBIT ORDER	
Leporidae	Rabbit Family	
lepus capensis	grass rabbit	d e
Ockotomidae	Mouse Rabbit Family	
ockotona daurica	dawuli mouse rabbit	d
KODENTIA	RODENT ORDER	
Sciuridae	Squirrel Family	
eutamias sibiria	anthophaein sqeuirrel	b d
citellus dauricus	yellow squirrel	e
Muridae	Mouse Family	
rat tus norvegious	vole	c e
mus musculus	rat	c e
rattus confucianus	shrew	d
Cricetidae	Hamster Family	
cricetulus bouabensis	black line hamster	e
cricetulus triton	big hamster	e
meriones unhuiculaius	long claw hamster	e
CHIROPTERA	WING ORDER	
Vespertilionidae	Bat Family	
vespertilio syperans	oriental bat	c
BIRD CLASS		
FALCONIFORMES	HAWK ORDER	
Accipitridae	Hawk Family	
accipiter	black hawk	b d e
accipiter nisus	bird hawk	b d e
GALLIFORMES	COCK ORDER	
Phasianidae	Pheasant Family	
alectoris graeca	rock cock	e
phasianus colckicus	wild cock	b e

1 a The depression near river. b Sparse tree place.
c Residential area. d Canals and gorges. e Farmland.

LARIFORMES	GULL ORDER	
Laridae	Gull Family	
laridae	sea gull	a
COLUMBIFOUMES	DOVE ORDER	
Pteroclidia	Sand Cock Family	
syrrkapies paradoxus	sand cock	e
Columbidae	Turtledove Family	
columba rupestris	rock turtledove	e d
streptopeliu orienialis	moutain turtledove	e d
CUCULIFORMES	CUCKOO ORDER	
cuculidae	big cuckoo	c
APODIFORMES	SWIFT ORDER	
Apodidae	Swift Family	
apus pacificus	white waist swift	d e
CURACIFORMES	BUDDHIST DOCTINE ORDER	
Alcedinidae	Kingfisher Family	
alcedo atthis	kingfisher	a
PICIFORMES	LIEXING Order	
Picidae	Woodpecker Family	
picus canus	green woodpecker	b
deudrocop major	stain woodpecker	b
PASSERIFOUMES	SPARROW ORDER	
Aloudidae	Lark Family	
galerida cristata	breeze lark	e
eremophila alpestris	angle lark	e
alauda arvensis	sprrow	e
Hirundinidae	Swallow Family	
riparia riparia	brown swallow	d
hirundo rusticas	swallow	a c e
Corvidae	Crow Family	
pica pica	magpie	c e
corous inounedula	cold crow	e
pyrrhocorax pyrrkocouax	red mouth crow	e
Paridae	Black Bird Family	
parus major	white face black bird	b
Fringillidage	Sparrow Family	
carduelis sinica	golden wing sparrow	b
carpodacus erhthinus	red sparrow	b
carpodacus roseus	north red sparrow	b e

REPTILE CLASS

SOUAMATA	LEPIS ORDER	
SERPENTES	SECOND SNAKE ORDER	
Colubribae	Snake Family	
coluber spinalis	yellow backbone snake	d
agkistrodon kalys	viper	d
elaphe rufodorsata	red stain snake	b d
SAURIA	SCECOND LIZARD ORDER	
Lacertidae	Lizard Family	
eremias argus	stain lizard	d e
pkuynocepklus przewalskii	sand lizard	d e

AMPHIBIANS CLASS

SALIENTIA	NO TAIL ORDER	
Rufonidae	Toad Family	
bufo bufo	big toad	a b e
bufo raddei	stain toad	a b e
Ranidae	Frog Family	
rana nigromaculaia	tree frog	a b
rana temporaria	black stain frog	a b e

FISH CLASS

CYPRINIFOUMES	CARP ORDER
Cyprinidae	Carp Family
cyprinus carpio	carp
carassius auraius	crucian carp
ctenopkaryngodon idellus	grass carp
sgualiobarbus curricalus	red eyes trout

Annex 7 Water Use Approval Letter

DOCUMENT OF THE YELLOW RIVER HYDRAULIC ADMINISTRATION COMMITTEE, MINISTRY OF THE HYDRAULIC AND THE WATER RESOURCE, PEOPLE'S REPUBLIC OF CHINA

Huang Shui Zheng (1993) No. 28

THE APPROVAL OF THE PRE-APPLICATION ON THE WATER INTAKE FROM THE YELLOW RIVER USED FOR THE TUOKETUO POWER PLANT

Inner Mongolia Hydraulic Administration Bureau:

We have received the Document [Shui Zheng Zi (1993) No.42], <<The Application for the Varification of the Quantity of the Water Intake From the Yellow River Used for the Tuoketuo Power Plant and Issuing of the Certificate for the Water Intake>>issued by your bureau. After the review now, the written reply are as follows:

1. We agree that the installed capacity for the first phase project of the Tuoketuo Power Plant will be 1200MW, and the quantity of the water intake annually from the Yellow River will be 40 million cubic meter(the designed capacity of the water intake should not exceed 1.67cubic meter per second), and the water quantity taken from the Yellow River will be distributed under the overall flanning within the target of the water supply distribution from the Yellow River in Inner Mongolia Autonomous Region set in the State plan.

2. In accordance with the institution and stipulation for the water intake from the Yellow River, the fees for the water resources should be paid. The sand and silt accumulated from the water should be treated and handled properly and appropriately, and should be prohibited again, to release to the Yellow River.

3. The water intake project from the yellow River by Tuoketuo Power Plant is just the project under the jurisdiction and administration of the main streams of the Yellow River. According to the requirements with the document[Shui Zheng(1992)No.7], <<The Relevant Institutions and Stipulations for the Project Construction within the Range of the River Administration and Management>>,jointly issued by the Ministry of Hydraulic and Water Resources, and the State Planning Commission, and with the document[Shui Zheng (1993) No.263, <<Notification on the Jrisdiction for the Project Construction Appraisal and Approval by the Yellow River Hydraulic Administration Committee within the Range of the Administrative Regions and Areas of the Yellow River>>, issued by

the Ministry of the Hydraulic and Water Resources, the Project for the water intake by Tuoketuo Power Plant should be reviewed and approved by the Committee prior to the approval of the project of the Tuoketuo power Plant in line with the procedures of the capital construction. Consequently, in accordance with the stipulations in Article 5 of the Document [Shui Zheng(1992) No.7], jointly issued by the Ministry of the Hydraulic and Water Resources, and the State Planning Commission, after the preliminary comments provided by the Inner Mongolia Electric Power Adminstration, the relevant documents on it should be submitted to the Committee for review and approval.

August 27, 1993.

The yellow River Hydraulic Administration Committee, Ministry of Hydraulic And Water Resources, P.R. of China. (Seal)

cc: Inner Mongolia Autonomous Region Planning Commission; Inner Mongolia Autonomous Region Electric Power Adminstration; The Yellow River Upper and Intermediate Stream Administration Bureau.

Annex 8 Fugitive Coal Dust Analysis

(void, See the main text para. 4.4.3.)

Annex 9 Dispersion Model

DISPERSION MODEL

Point source dispersion model when wind occurs (10m above ground, average wind speed $U_{10} \geq 1.5$m/s)

The concentration C(mg/m^3) of sampling time less than 24 hours with option point on low wind ground (x,y) can be calculated adopting the following formula when stack ground location is used as origin:

$$C = \frac{Q}{2\pi U \sigma_y \sigma_z} \times \exp(-\frac{y^2}{2\sigma_y^2}) \times F \quad ....(3)$$

where:

Q——emission rate, mg/s;
y——vertical distance on horizontal level between this point and average wind direction axis which past through stack,m;
σ_y——horizontal diffusion parameter, m;
σ_z——vertical diffusion parameter, m;
U——average wind speed at the outlet of stack, m/s.

$$F = \sum_{n=-k}^{+k} \left\{ \exp\left[-\frac{(2nh - He)^2}{2\sigma_z^2} \right] + \exp\left[-\frac{(2nh + He)^2}{2\sigma_z^2} \right] \right\} \quad ....(4)$$

where:

h—thickness of mixing layer, m;

H_e—effective stack height m.

H_e will be calculated with following formula:

$$H_e = H + \Delta H \quad ....(5)$$

where:

H—Geometric height of stack above ground, m;
ΔH—flue gas lift height, m. Calculation method see 7.6.

If no actual measure value, U may be calculated according to Formula (2). Annual average wind speed U_{10} with a 10m height above ground at the meteorological observatory in the neighbourhood will be adopted for U, in the formula. During survey, execution will be according to 6.1.3. For Class III assessment items; height index P of wind speed will be recommended to adopted according to Table 3.

Table 3 P value of all stability grades

Area	Stability grades				
	A	B	C	D	E-F
Urban	0.1	0.15	0.20	0.25	0.30
Rural	0.07	0.07	0.10	0.15	0.25

For Class I,II assessment items, k=4 in Formula(4) may be adopted; For Class III assessment items, k=0 may be adopted, at this time, **Error! Not a valid embedded object.** .

Dispersion parameters σ_y,σ_z may be showed in following fromula:

$\sigma_y = \gamma_1 X^{a1}$, $\sigma_z = \gamma_2 X^{a2}$ ....(6)

where:

a1—-regression index of transverse dispersion parameter;

a2—-regression index of vertical dispersion parameter;
γ_1— regression coefficient of transverse dispersion parameter;
γ_2— regression coefficient of vertical dispersion parameter;
X—-horizontal distance away from low wind of stack,m

Maximum ground level concentration Cm(mg/m^3) of single sampling time(30min) of stack with low wind, and its distance Xm(m) from stack will be recommended to calculate according to the Formula below:

Error! Not a valid embedded object. ....(7)

where:

where:

$$P_1 = \frac{2\gamma_1 \bullet \gamma_2^{-\frac{a_1}{a_2}}}{(1 + \frac{a_1}{a_2})^{\frac{1}{2}(1+\frac{a_1}{a_2})} \bullet He^{(1-\frac{a_1}{a_2})} \bullet e^{\frac{1}{2}(1-\frac{a_1}{a_2})}} \qquad \text{.........................(8)}$$

$$Xm = (\frac{He}{\gamma_2})^{1/a_2} (1 + \frac{a_1}{a_2})^{-1/2a_2} \qquad \text{..............................(9)}$$

Annex 10 Water Pollution Analysis

(Sub-paras. 4.2.2.3 through 4.2.2.6 is attached here.)

4.2.2.3 The selection of prediction model and basic mathematics theory

According to feature of ground water seepage flow field in the area of ash yard, we choose two-dimensional ground water quality mobile model --VS2DT developed by USGS which is most advanced to predict and study ground water pollution around ash yard. As ash water in ash yard spreads like radiation in water layer, therefore, it is planned after study that the plane of two dimensional analysis is to be carried out for the prediction and assessment of the impact of ash yard on residents nearby and water quality of the water source in TuoKeTuo county.

(1) Structure of model and calculating flow.

VS2DT water quality model is made up of twenty-six modules. Each one has different calculating functions, including data file operation ,grid automatic separation, automatic control of time length, identification of boundary condition and physical and chemical process such as diffusion ,adsorption, radioactivity decay, ion exchange for pollutants.

(2) Basic mathematics theory

The advective and migration of pollutants in ground water may be affected by many kinds of processes such as diffusion, advection, adsorption, radioactivity decay, ion exchange and chemical reaction. Three kinds of mechanism are concluded: (1) effect of diffusion ; (2) effect of advection;(3) sources and sinks. As a matter of fact, the water quality model is the super imposition of seepage flow model, pollutant convection and diffusion. The basic mathematics model for the advective and migration of pollutants is as follows:

Seepage flow model:

$$Ss \frac{\partial H}{\partial t} = \nabla (k \nabla H) + SS'$$

$$H(x,y,t) \big|_{\tau=0} = H_0(x,y)$$

$$M \cdot K \frac{\partial H}{\partial n} \mid \uparrow \gamma_2 = F_1(x,y,t)$$

where:

$$\nabla = \frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{\partial z}, (L^{-1})$$

Ss----Water storing rate (L^{-1})
H-----water head,(L)
k-----Seepage factor (LT^{-1})
SS'---Sources and sinks, such as water pumping,rain seeping etc.
γ_2---Boundary of category II (flux boundary)
n---Unit vertical vector on boundary
Ho(x,y)---Function of initial water head
$F_1(x,y.t)$---Flux function of water quality on boundary ,it is treated by model itself calculation
m----Thickness of water-contained layer

Water quality model:

$$\frac{\partial c}{\partial t} = \nabla (Dh\ \nabla c) - \nabla (u.c) + SS$$

$$C\ (x,y,t) \mid_{\tau=0} = C_0\ (x,y)$$

$$\frac{\partial}{\partial n} \left(D_h \frac{\partial}{\partial C} - u \cdot c \right) \mid \uparrow \gamma_2 = F_2\ (x,y,z)$$

Where:

D_h-----Hydraulic diffusion coefficient (L^2T^{-1})
u-----Flow speed of ground water (LT^{-1})
C-------Concentration of pollution (PPM)
SS-----Sources and sinks,including adsorption ,decay, water pumping, ion exchange ,etc.
Co(x,y)---Function of initial concentration
$F_2(x,y,t)$----Flux function of concentration on boundary,it is treated by model itself calculation

VS2DT model is a confined differential model.All classes of skew differtial items in time and space of the above mathmatics specific solution problem is replaced by the manner of conseal cenetr difference, the amount of calculation work is much great. But there is a main adventage which keeps stable no matter how large the step of time and space are.

4.2.2.4 Calculation parameter and selection of calculation approach

The main calculation parameter of VS2DT water quality model and method selection are as follows:

(1) Permeable coefficient K of water contained layer

There are three kinds of soil layers near this ash yard: layer No.1 is silt sand, two-number experiment results shows that permeable coefficient of silt sand on the surface is 0.25cm/min. According to materials on engineering geology survey, average thickness of silt soil layer No.2 is 1.00m, permeable coefficient is between 1.58×10^{-4} ~4.52×10^{-4}. Clay layer No.3 is in the same layer with middle coarse soil, permeable coefficient is 1.04×10^{-8}cm/s and 5.64×10^{-5}cm/s respectively. The permeable coefficient of non water contained media under the surface in the model is counted by weighted average of the thickness of soil layers:

$$k = \frac{\Sigma k_i \ m_i}{\Sigma m_i}$$

Where:

k_i and m_i are permeable coefficient and relevant thickness of various layers of rock nature respectively.

(2) Porosity and storing water rate are determined according to the report of engineering geology survey.

(3) Degree of diffusion of water contained layer use the data of similar rock nature.

See Table 4.2-7 for the values of various parameters

Table 4.2-7:

Parameters for model calculation (paramter of media)

media	thickness (m)	permeable coefficient ($\times10^{-4}$cm/s)	porosity	Vertical degree of diffusion (1)(cm)	Horizontal degree of diffusion (l)(cm)	ratio of storing water(2) (m^{-1})
silt sand	1.30	4.79×10^{-1}	0.846	10.00	0.01	0.19
Silt soil	1.00	4.52×10^{-1}	0.889	7.51	0.008	0.20
Clay	3.50	1.04×10^{-8}	0.627	6.18	0.001	0.22
Middle coarse sand	4.00	5.64×10^{-5}	0.578	15.32	0.07	0.23

Notes:

<1>Cited from <<Pollution of ground Water and ground water Quality modelling>> Compiled by Wangbingzhuang,Publishing House of Beijing teachers College,1987.

<2>Cited from <<Professional Hydrology>> ,Compiled by Fangpeixian mainly,Publishing House of Science,1990.

4.2.2.5 Treatment of boundary and initial value conditions

Monitoring of ground water quality was carried out at Gaobashi ash yard and nearby area in May and July, 1994. It is considered as initial state of the water quality calculation. The distribution of water head of area background flow was calculated according to the exiting topography and burial depth of ground water with internal insert method.

There is no river in research area. Surrounding boundary is undefined flux boundary. Stream current and solute flux are self-calculated by model according to concentration field and speed field.

In VS2DT model,sources or sinks on element(D is source, out is sink) is identified as a specific boundary. The most important source is ash water of ash yard. As regional ground water burial depth is about 4~6 m and ground water burial depth is 6m in the area of ash yard. The ground water level will not rise beyond surface of earth and the unsaturation belt exist during operation of ash yard at beginning. Now the area submerged by ash water is flux of the element .When ground water level rises to the surface of earth or bottom of ditch for seepage which is located at the dam edge of ash yard. The element changes to the element with specific water head and relevant node is specific water head node. As there is ditch for intercepting seepage with 5m depth designed in Gaobashi ash yard, the height from bottom of basement of ditch controls seepage flow field outside ash yard. We modified VS2DT model and add calculation function for identifying ground water level of area of ash yard and adjusting type of node.

Another source item is recharged water from precipitation .The seepage coefficient is 0.1. The solute motion process will be subjected to all kinds of physics chemical reaction such as adsorption of Fluorine,cushioning effect of PH value and CO_2-H_2O system each other,etc.

4.2.2.6 Results of groundwater modelling

(1) The conservation and safety are taken as directive ideas for the prediction , the specific technical treatment is as follows. The groundwater impacts were modeled in order to determine if a liner would be required.

<1> In fact, the soil has some absorbing effect for the movement of fluoride,especially the clay in the third soil layer, which has high absorbtion capacity. This effect was not considered in the prediction.

<2> The pH value of ash water and concentration of fluoride take the highest value in the result of water soluble analogue experiment on Zhungeer coal ash by IMEPDI are taken as the concentration value of ash water concentration (F=1.77ppm, pH=12.82). At the same time, the cushioning effect of CO2-H2O system upon pH value has been neglected, while the pHvalue will be buffered in ash yard and other ground water system.

<3> The lowest terrain in ash yard will be considered at first operation. Suppose percolation zone remains unchanged during operation of ash yard and area of percolation zone is 1 km. In fact, this supposition is conservative, the range is smaller. In the condition of equivalent quantity of ash water discharging, the area of ash water in north area is less than 0.5 km^2.

<4> Some quoted parameters of water quality model use conservative data according to existing research results. For instance, surface seepage coefficient of silt soil is employed. The dilution effect of atmospheric precipitation on the concentration of pollutants was not taken into consideration.

<5> Regardless of the factor that the seepage coefficient falls year by year along with the operation of ash yard.

<6> The measures are taken for ash water reuse by vertical pothole in ash yard and the quantity of ash water reused is not considered in the calculation.

<7> Regardless of the water resistance effect by dam, therefore, the calculation is conservative.

(2) Prediction results are as follows:

The predictive period of ground water quality in Gaobashi ash yard is 25 years. The initial step time is 0.25 years, each time step will increase two times later until the year of the maximum value. The calculation result of pH value and concentration of fluoride dispersed in 144 nodes in ash yard and nearby district in the 5th, 10th, 15th, 20th, 25th year are put out. The maxmium planned service time of Gaobashi ash yard is 20 years. Suppose that the service time will be 25 years, the analysis is given for the changing tendency of surrounding ground water quality after the final close of ash yard.

Annex 11 Ash Leachate Analysis

THE REGISTER TABLE OF ASH LEACHATE ANALYSIS TEST

Subject: Tuoketuo Power Plant
Sampling Date: September 10,1994 Analysis Date: September 15,1994

sample name	element name								
	F	Cu	Pb	Cd	Fe	Mn	Ni	pH	
	1.77	0.0032	0.0305	0.0057	0.0306	0.0055	0.0273	12.82	
remark	The unit is "mg/l" excepting pH.								

Operator: Cao Jianyong Ying Wengxiang Li Li Wang Jianwei Copyist: Cao Jianyong

Proofreader: Zhao Hongyan

传真号：010－8862533，请交环保处陈曦先生。

淋溶实验结果登记表

工程名称：托克托电厂A厂　采样日期：94年9月10日　分析日期：94年9月15日　负责人：

样品名称	测定元素 F	Cu	Pb	Cd	Fe	Mn	Ni	pH值	
	1.77	0.0032	0.0305	0.0057	0.0306	0.0055	0.0273	12.82	
备注	单位除pH值外均为"mg/L"								

分析者：曹建勇、殷文香、李莉、王剑伟　抄录：曹建勇　校核：

96.2.13

Annex 12 Ambient Air Quality Data

Table: The month of Air Pollutant Ground Level Concentration of Tuoketuo County Monitoring Station

Item	SO_2 (ppb)			NO_X (ppb)			TSP (mg/m^3)			PM_{10} (mg/m^3)		
Period	Min.	Max.	Ave.	Min.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
Jan.	18.6	49.9	36.6	11.2	28.2	16.1	0.1331	1.1138	0.3433	0.0178	0.1691	0.0322
Feb.	16.6	47.8	31.2	8.7	23.9	10.5	0.0832	1.1396	0.2967	0.0087	0.1256	0.0329
Mar.	8.5	31.7	26.0	7.7	15.5	9.2	0.1026	1.3392	0.3363	0.0137	0.1258	0.0486
Apr.	6.3	28.9	21.3	6.3	15.3	7.4	0.1165	1.0337	0.3524	0.0070	0.1444	0.0606
May.	4.2	24.2	13.0	3.4	14.3	8.0	0.0639	1.2016	0.3256	0.0201	0.1389	0.0489
Jun.	2.8	15.8	7.0	3.4	13.0	8.0	0.0876	1.0749	0.3075	0.0177	0.1046	0.0487
Jul.	3.4	15.8	9.0	4.4	12.7	8.8	0.0947	1.0921	0.2745	0.0244	0.2391	0.0585
Aug.	2.6	17.3	8.6	5.6	12.4	8.8	0.0165	0.8876	0.2764	0.0233	0.1214	0.0531
Sept.	2.4	10.0	5.3	7.3	16.3	11.4	0.0055	1.0146	0.2913	0.0273	0.1062	0.0566
Oct.	4.5	17.8	9.4	3.5	16.5	9.6	0.0937	1.0428	0.3004	0.0122	0.1496	0.0537
Nov.	9.8	38.1	23.6	7.3	25.3	16.7	0.1124	1.0627	0.2904	0.0168	0.1495	0.0585
Dec.	13.9	50.4	34.1	8.9	25.7	20.3	0.1090	1.0257	0.3138	0.0336	0.1486	0.0580

Table: The Month of Air Pollutant Ground Level Concentration of Power Plant Site Monitoring Station

Item	SO_2 (ppb)			NO_X (ppb)			TSP (mg/m^3)			PM_{10} (mg/m^3)		
Period	Min.	Max.	Ave.	Min.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
Jan.	11.6	24.3	13.4	11.1	22.7	11.8	0.1395	1.0042	0.3389	0.0134	0.1276	0.0427
Feb.	8.6	23.8	10.3	10.9	22.4	11.9	0.1209	1.0032	0.2926	0.0121	0.1546	0.0483
Mar.	7.8	19.3	9.7	9.6	22.6	10.7	0.1332	1.2772	0.2823	0.0187	0.1544	0.0600
Apr.	7.5	11.3	8.8	7.0	18.8	8.0	0.1631	1.1262	0.3772	0.0193	0.1507	0.0606
May.	0.8	6.8	2.1	4.3	22.6	7.6	0.1079	1.0394	0.3403	0.0123	0.0962	0.0339
Jun.	1.3	9.5	3.7	5.1	16.5	9.6	0.1041	1.0798	0.3215	0.0075	0.1030	0.0286
Jul.	0.8	3.8	2.3	4.6	21.9	8.4	0.0941	1.0293	0.2529	0.0091	0.0731	0.0285
Aug.	1.3	12.7	8.5	4.9	17.4	8.4	0.0611	1.0727	0.2972	0.0133	0.0472	0.0252
Sept.	1.2	8.9	4.9	3.1	19.6	9.0	0.1541	1.0717	0.2850	0.0129	0.0652	0.0356
Oct.	8.6	12.9	9.5	2.8	15.4	8.9	0.0936	1.0885	0.2987	0.0118	0.0595	0.0394
Nov.	11.6	15.6	14.4	2.9	20.7	10.6	0.1047	1.1121	0.2997	0.0104	0.1002	0.0375
Dec.	18.8	20.3	19.5	5.9	20.4	11.3	0.1014	1.0595	0.3048	0.0142	0.1029	0.0421

Annex 13 References

Annex 13 References

The following reference information was used in preparation of this assessment:

(1) The World Bank Operational Manual No.4

(2) World Bank Technical Paper No.139, “Environmental Assessment Sourcebook”.

(3) “Feasibility Study Report on the Dedicated Railway of Touketuo Power Plant” written by the Third Design Institute of the Railway Ministry.

(4) “Feasibility Study Report on the Water Supply Project of TuoKeTuo Power Plant” written by the Water Conservancy Survey and Design Institute of Inner Mongolia Autonomous Region.

(5) “Research on the Composition Concerning Environmental Assessment of Foreign Thermal Power Plant” compiled by Xu Aifen from the East China Electric Power Design Institute.

Annex 14 Environmental Standards

Annex 14 Environmental Standards

(1) GB3095-82 Standard of Atmospheric Environment Quality

Pollutant Designation	Concentration Limits mg/m^3			
	Sampling Time	Class I Standard	Class II Standard	Class III Standard
Total Suspended particulate	Daily Average	0.15	0.30	0.50
	Any Random Time	0.30	1.00	1.50
Sulfur Dioxide	Daily Average	0.05	0.15	0.25
	Any Random Time	0.15	0.50	0.70
NOx	Daily Average	0.05	0.10	0.15
	Any Random Time	0.10	0.15	0.30

(2) GB3838-88 "Environmental Quality Standard for Surface Water" (Class III)

pH value	DO	CODcr	BOD_5
6.5-8.5	5	15	4
petroleum	Hexavalent chrome	Lead	Cadmium
0.05	0.05	0.05	0.005

(3) GB5749-85 "Sanitary Standard for Drinking Water"

pH value	Chloride compound	Sulfate	Arsenic	Hexavalent chrome	Cadmium
6.5-8.5	250	250	0.05	0.05	0.01
Lead	Zinc	Fluorine compound	Colon bacterial crowd (piece/l)	total number of bacterium (Piece/l)	
0.05	1.0	1.0	3	100	

(4) GB8978-88 “Comprehensive Discharge Standard for Wastewater” (Class I)

pH value	Suspended particulate	BOD5	CODcr	TuoKeTuo A wastewater treatment design performance
6.5-9.0	70	30	100	
Petroleum	Hexavalent chrome	Lead	Cadmium	
10.0	0.50	1.00	0.10	
Fecal coliform 10,000/liter				

(5) GB12348-90 “Standard for Noise within the Boundary of Industrial Enterprises” (Class III)

Applicable Area	Day	Night
Centralized Industry complex	65 dBA	55 dBA

Annex 15 Associated Documents

Annex 15 Associated Documents

(1) "Reply to the Standard applied for the Environmental Impact Assessment" issued by the State Planning Commission.
No.1994-076

(2) "Reply to the Outline of Environmental Impact Assessment" issued by the National Environment Protection Bureau. No.1994-076

(3) "Reply to the Item Proposal" issued by the Urban and Rural Construction and Environment Protection Administration of Inner Mongolia Autonomous Region. No.1994-29