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TRANSLATION

Number 27 1 Oct 1946

A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA

VOLUME II
(Parts 6 - 10)

ISSUED UNDER THE JOINT AUSPICES
OF
THE INTELLIGENCE DIVISION, W D G S
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SUMMARY OF CONTENTS

This is a translation of four documents prepared by the Japanese Far Eastern Research Section in 1941. They constitute a broad survey of the possibilities of hydroelectric development of the Yellow River in China, indicating eleven sites where power generating stations might be advantageously constructed.

The translations are published in three volumes. The basic document, WDC No 252519, containing ten parts, has been divided. Parts 1 - 5 are in Volume I, and Parts 6 - 10 are in Volume II. Two documents, WDC 252533 and 252536 include revisions and corrections of material contained in the basic report, 252519. The material from them has been incorporated in the main body of the report, wherever applicable, rather than being presented as separate translations. Volume III contains the complete translation of WDC 252528, which constitutes an addendum to the basic report and gives a detailed study, in graphs and tables, of the flow of the Yellow River at Shan.

The basic document deals with such topics as a basic survey, plans for the generation of electricity, economic factors, relation of the hydroelectric development plan to flood control and water conservation, industrial potentialities of the Yellow River, geology and subsurface resources of the Yellow River basin, the trend of supply and demand for electric power, plans for extensive industrial development, and plans for the hydroelectric site at the San-Men Gorge. These are supplemented with numerous tables, graphs and maps, including a large map of the entire area under study and detailed maps of the eleven projected hydroelectric development sites.

These are from a series of documents on economic and industrial subjects which were acquired by a US government mission to Japan and China in the Fall of 1945, and which are being translated by WDC.

Pages 1 through 178

COMPLETE TRANSLATION

A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA

Far Eastern Research Section
Survey Committee No 2
North China Committee
Subcommittee No 4
May 1941

Note: This report comprises translations of four documents as follows:

1. Document 252519 is the basic report containing the plan for the hydroelectric development of the Yellow River. It was issued by the Far Eastern Research Section in May 1941 and is made up of 10 parts.

2. Document 252533 is a revision of Part 1 of the basic report issued by the North China Electric Works in August 1941. The corrections, amendments and revisions contained in this document have been incorporated in Part 1 of this report wherever applicable.

3. Document 252536 is a further revision of other parts of the basic report issued by the Far Eastern Research Section in August 1941. The corrections, amendments and revisions contained in this document have been incorporated in the report wherever applicable.

4. Document 252528 is an addendum to the basic report issued by the Far Eastern Research Section in May 1941. It contains four sets of tables and graphs giving a detailed analysis of the flow of the Yellow River at Shan.

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A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA

Far Eastern Research Section
Survey Committee No 2
North China Committee
Subcommittee No 4
May 1941

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A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA
(Continued)

Far Eastern Research Section
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Subcommittee No 4
May 1941

PART 6. ADAPTABILITY OF THE YELLOW RIVER FOR INDUSTRIAL USES

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I Introduction

The first problem in connection with plans for heavy chemical industry in the development of North China is to find a supply of water suitable for industrial use. Because of the scanty rainfall, the difficulty of water conservation and the lack of forestation, North China has only one or two river systems which can furnish water in sufficient quantity for industrial use. One of these is the Yellow River, which by reason of its volume of water and extensive drainage basin would, after the equalization of its flow, go far toward solving the problem.

A complete study of the 4,000-kilometer Yellow River is of course impossible, and even an investigation of the localities suitable for future industrial development is unlikely at present. Since the Chinese army broke the dikes west of K'ai-feng in 1938, the main stream has not returned to its old course, and at present seems unlikely to do so. Hence the industrial areas near Hsin-hsiang and Chi-nan are deprived of water from this river, and are not objects for study. The region from K'ai-feng to T'ung-kuan and that north of Ho-ch'u were in the war zone and could not be surveyed. The only region along the upper river which was investigated was that around Pao-t'ou, which was under Japanese control. The suitability of Yellow River water for industrial use was determined from recent analyses of water specimens and from knowledge of the quantity of flow derived from other sources.

II Qualitative Study of Yellow River Water

There are many studies of the flow and silt-content of the Yellow River, but no study has covered the quality of the water. In this study the only specimens taken from the upper Yellow River itself were from the ferry landing 2 kilometers above Nan-hai-tzu, near Pao-t'ou. Observations made near Pao-t'ou partially compensate for this limitation, for there is no great difference in the quality of the water in the upper Yellow River and that at T'ung-kuan, where the Fen, Lo, and Wei Rivers have joined it. The conclusions are therefore based on those Pao-t'ou specimens.

The analysis by the Experimental Corps of the North China Economics Research Station, North Manchuria Railroad, of a specimen taken by a member of Subcommittee No 4 on July 1940, is shown below.

Analysis of Yellow River Water at Nan-hai-tzu

Sediment: 5.51%

Analysis of Sediment:

Silicon dioxide	49.10%	Titanium Oxide	0.43%
Ferric Oxide	13.37	Sulphur	0.14
Alumina	11.75	Soda	3.47
Manganese Oxide	0.01	Potassium	1.32
Magnesium Oxide	1.25	Phosphoric Acid	0.78
Calcium Oxide	7.12	Volatiles	10.98

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Analysis of Filtrate:

Appearance	Transparent	Total Solids	294.00 mg/L
Smell and Taste	None	Silica	1.40 "
Reaction	Slightly Alkaline	Ferric Oxide	3.19 "
		Alumina	2.69 "
Free Carbonic Acid	None	Calcium Ion	39.48 "
Carbonate Ion	22.20 mg/L	Magnesium Ion	26.74 "
Bicarbonate Ion	111.73 "	Total Hardness	11.74 degrees
Chloride Ion	31.95 "	Temporary "	5.25 degrees
Sulfate Ion	61.61 "	Potassium Permanganate Decoloration	6.95 mg/L
Nitrate Ion	454.50 "		

The two following tables show the results of a study of the turbidity of the water of the Yellow River made at the Pao-t'ou branch of the North China Traffic Co (KAHOKU KOTSU KAISHA) for a year and a half beginning Jan 1939. (Specimens were taken at the same place as those for the preceding table, and analyzed at the laboratory of the Canal Division, North China Traffic Co.)

(See Tables on following pages)

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ANALYSIS OF YELLOW RIVER WATER AT PAO-T'OU (taken 2 meters below surface)

Date	Sep 1939	Nov 1939	Dec 1939	Jan 1940	Feb 1940	Mar 1940	May 1940	Jun 1940	Jul 1940
Weather			Clear	Clear	Clear	Clear	Clear	Clear	Clear
Atmospheric Temperature (C)			-2°	-7°	-3°	-3°	22°	28°	24°
Water Temperature (C)			0°	0°	1°	0.8°	16°	21°	21°
Reaction			Slightly alkaline	Same	Same	Same	Same	Same	Same
Alkalinity (mg/L)			190	220	185	145	150	145	130
Chloride #			43.31	50.41	58.93	51.42	28.46	32.66	28.40
Sulfate #			None	None	None	None	25	None	25
Nitrate #			20	Traces	Traces	Traces	30	20	30
Nitrite #			Faint traces	Faint traces	None	None	None	None	None
Ammonia #			None	Non.	None	None	None	None	None
$KMnO_4$ Consumption #			8.21	8.21	6.32	6.63	7.86	6.95	6.63
Iron #			Traces	Faint traces	Faint traces	Faint traces	Faint traces	Faint traces	Faint traces
Evaporation Sediment #			284	366	288	284	294	288	308
Total Hardness Degrees			6.28	6.80	6.28	6.00	5.64	6.06	6.80

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(Contd)

ANALYSIS OF YELLOW RIVER WATER AT PAO-T'OU (taken 2 meters below surface)

Date	Sep 1939	Nov 1939	Dec 1939	Jan 1940	Feb 1940	Mar 1940	May 1940	Jun 1940	Jul 1940
Permanent Hardness Degrees			2.20	2.20	2.16	2.06	2.46	2.40	2.20
Temporary Hardness "			4.08	4.60	4.12	3.94	3.48	3.66	4.60
Turbidity "	2400	980	270	170	53	78	2400	950	18800
Silt Content (%)	0.50	0.25	0.07	0.02	0.01	0.02	0.33	0.20	3.54

Notes:

The specimens were taken at noon on the 20th of each month.

Specimens taken in September, October and November 1939 and in April, August and September 1940, were destroyed in transit.

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Analysis of Yellow River Water at Pao-t'ou (Taken from Surface)

Date		Sep 1939	Nov 1939	Dec 1939	Jan 1940	Feb 1940	Mar 1940	May 1940	Jun 1940	Jul 1940	Aug 1940	Sep 1940
Weather			Cloudy	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Atmospheric Temperature	(C)		-1°	-2°	-7°	-3°	-3°	22°	28°	24°	29°	16°
Water Temperature	(C)		1°	0°	0°	1°	1°	16°	21°	23°	21°	16°
Reaction				Slightly alkaline	Same	Same	Same	Same	Same	Same	Same	Same
Alkalinity	(mg/L)	170	190	190	220	190	145	150	145	130	130	150
Chloride	(")		34.08	44.73	51.83	60.35	51.12	28.40	32.66	28.40	42.60	28.40
Sulphate	(")			None detected	None detected	None detected	None detected	<25	None detected	<25	<25	Traces
Nitrate	(")			<20	Traces	Traces	Traces	<30	<20	<30	Traces	Traces
Nitrite	(")			None detected	Faint traces	Faint traces	None detected	None detected	None detected	None detected	None detected	None detected
Ammonia	(")			None detected	None detected	None detected	None detected	None detected	None detected	None detected	None detected	None detected
$KMnO_4$ Consumption	(")			7.70	6.63	6.47	6.95	6.95	6.63	6.95	6.63	11.37
Iron	(")			Traces	Traces	Faint traces	Faint traces	Faint traces	Faint traces	Faint traces	Faint traces	Faint traces
Evaporation Sediment	(")			294	318	294	288	268	284	320	392	248
Total Hardness	(Degrees)	6.60	5.90	6.28	6.80	6.38 [sic]	6.00	5.38	5.84	6.80	9.22	7.58
Permanent Hardness	(")			2.06	2.20	2.20	2.06	2.46	2.32	2.20	2.46	2.06
Temporary Hardness	(")			4.22	4.60	4.08	3.94	2.92	3.52	4.60	4.76	5.52
Turbidity	(")	2,700	1,000	240	135	55	78	1,600	900	22,400	8,320	5,400
Silt Content (%)		0.524	0.273	0.064	0.025	0.013	0.019	0.289	0.189	4.368	1.764	1.083

Notes:

Specimens were taken at noon on the 20th of each month.

Specimens taken in Oct 1939 and Apr 1940 were destroyed in transit.

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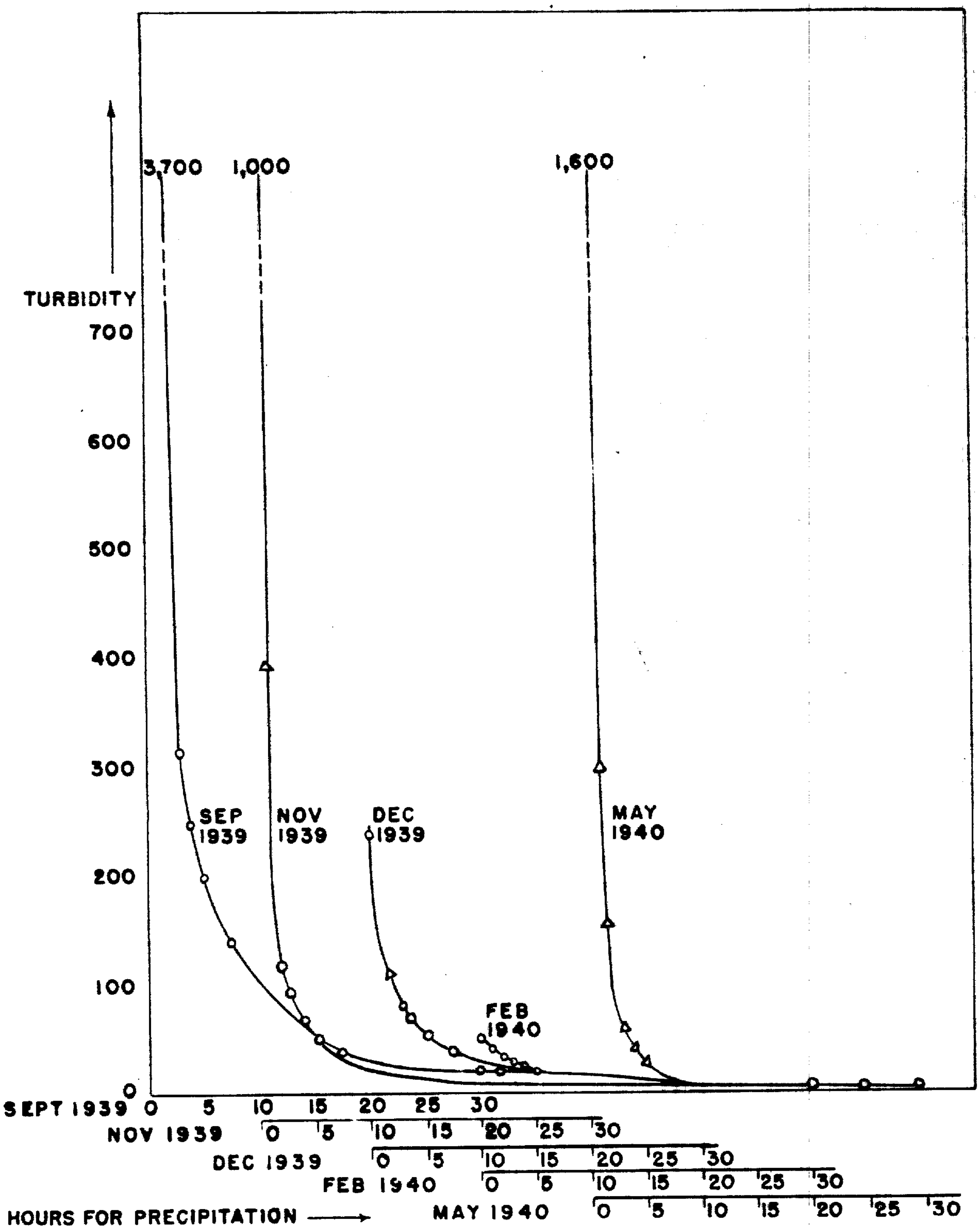
YELLOW RIVER WATER PRECIPITATION TEST



A. Turbidity

The first aspect of the quality of Yellow River water which requires consideration is its turbidity. Can it be utilized, and if so, how? The results of tests for this are given in the two preceding tables. The preceding graph is based on representative figures from these analyses.

The graph shows that, however turbid the water, after standing 20 hours turbidity decreases to 10 to 30 degrees; at 30 hours, to 5 to 20 degrees. After 30 hours, precipitation is very slow. The demand for water of less than 20 degrees turbidity, can be met by letting the water stand 20 to 30 hours and then purifying with some suitable filtration apparatus.

A well-known illustration of this method is the treatment given the turbid waters of the Pai River since 1903 to supply water to T'ien-ching. This supply now totals 36,000 metric tons per day.

Other examples are water used in boilers by the T'ien-ching Electrical Industry Co, Ltd (T'IEN-CHING TIEN-YEN KU-FE YU-HSIEN KUNG-SSU), and that used by the T'ien-ching Plant of the Oriental Paper Co (TOYO SEISHI KOGYO KAISHA), established after the outbreak of the China Incident.

The details are as follows:

1. T'ien-ching-Pai River Water Supply Co (T'IEN-CHING CHI-AN PAI-LAI-SHUI KUNG-SSU) (Investigated February 1941)

This company was founded in 1902 as an English company registered in Hong Kong. In 1937, it became a Chinese company. It takes water from two branches of the Pai River, the Yu and Hsi Rivers. The maximum intake per day is 21,360,000 English gallons, or 97,000 metric tons. The average amount of water supplied in one day is 8 million English gallons, or 36,000 metric tons. (It also has two wells capable of furnishing one million gallons per day.) The purification equipment is as follows:

a. Quick filtration pool

(1) Seven purifying and settling tanks with a total capacity of 141,000 English gallons or 64,000 metric /sic/ tons. Alum and chloride of lime are used for purification. Ideally, the water should be allowed to stand for eight hours to allow settling, but because of the demand, the contents are usually passed on to the filtration tanks after one to two hours. The capacity of these tanks is, therefore, 1,700,000 to 3,400,000 English gallons per day.

(2) Mechanical filters -- 14 tanks of 144-square feet filtration surface each. The capacity is 2,390 gallons per square foot per day. These tanks are cleaned daily.

b. Slow filtration pool

(1) Two settling pools -- total capacity four million gallons. Here germs are killed with liquid chlorine, and solid matter is allowed to settle for about 16 hours. In one day six million gallons can be treated. These pools are cleaned once a year, the process requiring about ten days.

(2) Thirty-nine sand filters, totalling 118,000 square feet. Filtering capacity is 50 gallons per square foot per day.

c. Other equipment

(1) Four storage reservoirs -- total capacity two million gallons.

(2) Water Purifiers: To purify one million gallons of water requires the following: alum, 400 pounds; chloride of lime, 21 pounds; liquid chlorine, seven pounds. Employees of the company state that the current price of chloride of lime and of liquid chlorine is about 2.50 and 0.55 yen per pound, respectively; alum made in Japan costs about 0.50 yen a pound. Hence the cost of chemicals to purify one million gallons is about 229 yen, or 0.05 yen per ton.

Water analysis:

The following table gives an analysis of water from the Pai River before and after purification.

/Table follows on next page/

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Analysis of Water of the T'ien-ching - Pai River Water Supply Co
(Before and After Purification)

		Oct 1939 Before	Oct 1939 After	Nov 1939 Before	Nov 1939 After	Dec 1939 Before	Dec 1939 After	Jan 1940 Before	Jan 1940 After	Feb 1940 Before	Feb 1940 After	Mar 1940 Before	Mar 1940 After
Physical Analysis	Turbidity	300	0	450	0	125	0	90	0	100	0	280	0
	Color	0	0	0	0	0	0	0	0	0	0	0	0
	Odor*	FF	0	FF, FE	0	FF, FE	0	FF, FE	0	FE	0	FE	0
	Temperature (C)	15°	11°	8°	12°	0°	7°	0.5°	4°	0.5°	3.5°	6.5°	7°
Chemical Analysis	Reaction (pH)	8.1	7.7	8.1	7.7	8.1	7.7	8.1	7.9	8.1	7.9	8.1	7.9
	Alkalinity (Pt/per M)	158	148	162	156	160	150	172	162	180	178	182	174
	Total Solids (")	390	270	580	240	380	320	280	260	330	260	370	260
	Total Hardness (")	150	140	220	210	250	230	220	210	220	210	230	220
	Chloride (")	22	22	39	37	49	49	33	32	36	35	25	25
	Nitrate (")	3.5	3.8	3.0	3.0	5.2	5.4	4.0	4.5	4.2	4.2	4.0	4.0
	Nitrite (")		0.001+		0.001+		0.001+		0.001+		0.001+		0.001+
	$KMnO_4$ Consumption (")	1.8	0.8	2.2	0.8	2.0	0.6	0.8	0.5	0.8	0.5	1.2	0.8
	Free Ammonia (")	0.05	0.02	0.07	0.02	0.08	0.01	0.05	0.01	0.06	0.01	0.10	0.02
	Albumin Ammonia (")	0.30	0.06	0.30	0.08	0.20	0.08	0.10	0.05	0.10	0.05	0.18	0.06
Bacteriological Analysis	Bacteria (Per/cc)	5,100	56	3,200	58	550	56	430	59	540	45	1,900	40
	Intestinal Bacteria (")	±	-	±	-	±	-	±	-	±	-	±	-

		Apr 1940 Before	Apr 1940 After	May 1940 Before	May 1940 After	Jun 1940 Before	Jun 1940 After	Jul 1940 Before	Jul 1940 After	Aug 1940 Before	Aug 1940 After	Sep 1940 Before	Sep 1940 After
Physical Analysis	Turbidity	620	0	320	0	330	0	8200	0	12000	0	5500	0
	Color	0	0	0	0	0	0	0	0	0	0	0	0
	Odor*	FF, FE	0	FG, FF, FE	0	DF, DE	0	FF, FE, FG	0	DA, DF, FF	0	DG, DF, DE	0
	Temperature (C)	12°	11°	18°	16°	24°	22°	29°	26°	26°	26°	24°	24°
Chemical Analysis	Reaction (pH)	8.1	7.9	8.1	7.9	8.1	7.9	8.1	7.7	8.1	7.6	8.1	7.7
	Alkalinity (Pt/per M)	196	176	190	182	164	152	142	140	132	130	170	136
	Total Solids (")	520	290	410	290	450	260	4750	280	6800	380	3500	290
	Total Hardness (")	200	190	190	170	190	180	210	190	210	190	220	180
	Chloride (")	17	17	19	20	19	20	52	52	23	23	22	22
	Nitrate (")	4.0	4.2	3.8	3.8	3.5	3.0	4.0	3.6	5.0	5.0	4.5	4.5
	Nitrite (")		0.002		0.002		0.002		0.001		0.001+		0.001+
	$KMnO_4$ Consumption (")	0.7	0.5	0.8	0.5	1.6	0.6	1.2	0.5	1.5	0.8	1.4	0.8
	Free Ammonia (")	0.10	0.02	0.10	0.01	0.06	0.01	0.06	0.01	0.05	0.01	0.06	0.01
	Albumin Ammonia (")	0.20	0.04	0.18	0.02	0.30	0.03	0.30	0.02	0.20	0.04	0.20	0.02
Bacteriological Analysis	Bacteria (Per/cc)	2,200	37	3,700	48	3,800	59	11,900	85	4,000	52	3,500	41
	Intestinal Bacteria (")	±	-	±	-	±	-	±	-	±	-	±	-

*FF-Faintly Fishy; FE-Faintly Earthy; FG-Faintly Grassy;
DA-Distinctly Agreeable; DF-Distinctly Foul

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2. T'ien-ching Electrical Industry Co., Ltd. (Investigated October 1940)

This company uses water both from the waterworks and from the Pai River. The former is used as drinking water, while the river water, after purification, is used in boilers and for other purposes.

The daily water consumption is as follows:

From the waterworks - 230 metric tons
From the Pai River - 50 metric tons

This is a very small amount, but furnishes a good example of the use of muddy water in North China in boilers for generating electricity.

Equipment for purifying the Pai River water:

a. Two settling tanks -- capacity 60 cubic meters each. Used alternately for one month each. River water is pumped into the tank, alum and soda ash are mixed in, and the matter in suspension is allowed to settle. Members of the company state that the monthly consumption of alum is 250 catties; of soda ash, 250 catties. (TN: one catty equals 1.32 pounds) The current price of alum is 13.5 sen per catty; of soda ash, 14.6 sen per catty. This totals about 4.6 sen per ton of water treated.

b. Two filtration tanks -- diameter 1.83 meters, height 2.36 meters, with a layer of sand 1.525 meters thick for quick filtration.

c. Water-softening apparatus

Only water for the boilers is treated by the permutite softening method. The dimensions of the permutite filtering tank are: diameter, 1.37 meters; height, 3.05 meters. By using 2 cubic meters of permutite, 240 cubic feet of water per day can be filtered. The reduction process is performed once in three days. The current price of the 1,000 catties of sodium chloride required each month is 13 sen per catty, or 10 sen per ton of water treated.

d. Quality of the water

Water softened by the above process has a hardness of 0.1 degrees (German). We have no detailed analysis of this water, but that of Pai River water is as follows:

Color	- Muddy	Alkali	- 87.1 mg/L
Floating Matter	- 15,950.4 mg/L	Sulfate	- 62.0 "
Silicon dioxide	- 4.2 "	Nitrate	- Slight
Calcium oxide	- 36.3 "	Carbonate	- 195.2 mg/L
Chloride	- 103.9 "	Total Solids	- 476.2 "
Free Carbonic Acid	- None	Total Hardness	- 11.4 degrees
Magnesium	- 27.7 "	Permanent Hardness	- 2.4 "
		Temporary Hardness	- 9.0 "

(Note: The above analysis was made in October 1936. The hardness of specimens of water taken from surface, middle and lower strata was found to be 12.2 degrees, 8.6 degrees and 7.5 degrees respectively. The specimen used in the above analysis was a mixture of all three.)

3. Oriental Paper Co, Tientsin Plant (TOYO SEISHI KOGYO KAISHA) (Investigated October 1940)

This plant uses 14,000 tons of purified water daily from the Pai River for its workers' homes and for the plant. Its purification equipment is as follows:

a. One storage tank -- 600 meters by 120 meters by 5 meters in depth, capacity 360,000 metric tons.

b. Twelve filtration pools -- each 6 meters by 4.5 meters by 5 meters in depth. Rate of filtration -- 5 meters per hour in 600 millimeters of sand.

c. NGK Filter -- capacity, about 2400 gallons per hour. Used for drinking water for homes and plant.

d. An analysis 30 May 1939 of the water purified for industrial use in the plant is as follows:

Appearance	-	Transparent
Reaction (pH)	-	7.0
Free Carbonic Acid	-	13.2 mg
Chloride	-	38.0 "
Silicon Dioxide	-	2.0 "
Sulfate	-	20.0 "
Carbonate	-	92.40 "
Total Solids	-	310.00 "
Total Hardness	-	6.62 degrees
Temporary Hardness	-	0.82 "
Permanent Hardness	-	5.44 "

e. Water-softening apparatus

Water is softened, for boiler use only, by the permutite method. Capacity of the main tank -- 9 cubic meters per hour per 2 cubic meters of permutite. Reduction is made twice daily.

Judging from the precipitation tests and the foregoing three examples, the water of the Yellow River should offer no difficulty in industrial use. The above tables show that the Pai and Yellow Rivers exhibit the same degree of turbidity at the same seasons. Moreover, the first graph of time required for precipitation of sediment from Yellow River water on preceding page roughly corresponds to Pai River water. The equipment required for precipitation and the process are simple. In short, the water of the Yellow River, like that of the almost identical Pai River, may be used easily and economically for industrial uses and for drinking purposes.

B. Quality of the Water

The next problem is chemical investigation of the water. A study of the character of the water is required primarily by the brewing, the bleaching and dyeing, the tanning and glue making, the paper, rayon and photographic film industries. The high degree of hardness of Yellow River water renders it unsuitable for making high-grade paper, though it can be used for such low-grade paper as newsprint and pasteboard. The water is not suited to bleaching and dyeing, chiefly because it contains too much iron (should be less than 0.1 milligrams per liter). The high bicarbonate ion content makes the production of high-grade leather impossible, and presents difficulties in rayon manufacture, especially in its bleaching process.

Since the quality may be improved by either physical or chemical purification processes, the only problem is to secure purified water in sufficiently large quantities. It is a question of cost. In rayon production, spinning requires only a small amount of purified water and would justify its production even at a high unit cost. But making photographic film requires large amounts of soft water that contains no heavy metal salts, and Yellow River water could not be used economically. The production cost of a product will vary directly with the amount of such water used. Other local conditions affecting each industry would be difficult to evaluate.

To summarize, Yellow River water cannot be used for high-grade production in the paper, bleaching, dyeing and tanning industries and it is not well suited for brewing. Its use would depend on the particular product and how it is processed. The water could not be used for manufacturing photographic film. Other industries would be able to use this water. Where there is no question of the chemical effect on a product, such as the use of water in boilers or for cooling purposes, experience with Pai River water shows that it can be used satisfactorily.

III Quantitative Study of Yellow River Water

The Yellow River can easily furnish more than enough water for industrial use, but the extent to which it will facilitate the development of coal and other deposits requires consideration.

A. Quantity

There is considerable material on the quantity of flow of the Yellow River. The following tables were compiled from existing sources by Subcommittee No 4. They show the average flow of the lower river at Shan and of the upper river at Pao-t'ou.

/Tables follow on next page/

Average Flow of Yellow River at Shan (cu m/sec)

	1919	1920	1921	1929	1934	1935	Average
Jan		358	464	310	288	626	407
Feb		467	568	327	488	593	481
Mar		675	630	636	671	1026	728
Apr	440	737	665	430	767	1027	678
May	434	1302	616	374	742	1258	788
Jun	944	1744	1025	753	953	1280	1116
Jul	2650	1466	3066	1588	1174	2903	2144
Aug	2525	2025	2933	2515	3548	4929	3079
Sep	1241	2185	2068	1488	2633	3547	2194
Oct	1320	2572	1431	1465	3839	2935	2260
Nov	728	1268	860	1028	1620	1893	1233
Dec	343	569	500	322	744	710	536
Yearly Average	1381	1280	1212	973	1454	1892	1365

Average Flow of the Yellow River at Pao-t'ou (cu m/sec)

	Pao-t'ou (Estimated)	Shan (Actual)
Jan	250	407
Feb	300	481
Mar	400	728
Apr	350	678
May	450	788
Jun	600	1,116
Jul	900	2,144
Aug	1,300	3,079
Sep	900	2,194
Oct	800	2,260
Nov	600	1,233
Dec	300	530
Yearly Average	600	1,365

A dam built at Ch'ing-shui-ho would receive an average annual flow of 600 metric tons per second, or 5,200,000 metric tons per day (TN: See figures on page 50.). One near Shan would receive 1,365 metric tons per second, or 11,800,000 per day (TN: 1 cubic meter of water equals 1 metric ton). If the emphasis is placed on flood control or hydroelectric development, it is doubtful how much water can be diverted to industrial use. Diversion of the volume needed for hydroelectric power, irrigation and downstream water transportation would leave barely 10 to 20 percent of the total. One can safely count on only 500,000 to 1,000,000 metric tons of water at Pao-t'ou for industrial use and 1,000,000 to 2,000,000 metric tons at Shan.

B. Temperature of the Water

Heavy chemical industry requires large amounts of water for cooling purposes. The temperature of the water is all-important for this use. There is very little data on the water temperature of the Yellow River. Data from the table on page is as follows:

Atmospheric and Water Temperatures at Pao-t'ou (Centigrade)

	At Surface			2 Meters Below Surface		
	Air	Water	Difference	Air	Water	Difference
Nov 1939	-1°	1°	2°	-	-	-
Dec 1939	-2°	0°	2°	-2°	0°	2°
Jan 1940	-7°	0°	7°	-7°	0°	7°
Feb 1940	-3°	1°	4°	-3°	1°	4°
Mar 1940	-3°	0.8°	3.8°	-3°	0.8°	3.8°
May 1940	22°	16°	-6°	22°	16°	-6°
Jun 1940	28°	21°	-7°	28°	21°	-7°
Jul 1940	24°	23°	-1°	24°	21°	-3°
Aug 1940	29°	21°	-8°	-	-	-
Sep 1940	16°	16°	0°	-	-	-

The above observations were made on the 20th day of each month, and therefore, give only one monthly recording. It is to be noted that the water temperature varies between 0° and 22.3°, and that in summer it is 3° to 8° lower than that of the air.

The isothermal maps of the Yellow River Basin show that in January, when the temperature is lowest, the line linking Wu-yuan and Pao-t'ou reads -14°, and that linking T'ung-kuan and Chi-nan reads -1°. In July, when the temperature is highest, the former line is 22° and the latter 29°. If the relation between atmospheric and water temperature conforms to the above table, the water temperature at Pao-t'ou and T'ung-kuan should reach 22.3° in summer, and fall to about 0° in winter.

Detailed records for the frozen season for the Yellow River, and for thickness of ice are lacking. According to statistics gathered in 24 places in Suiyuan (the northernmost and probably coldest region in the basin) from 1914 to 1923, the Yellow River surface becomes entirely frozen over between 25 November and 5 December and remains frozen until 18 to 24 March, an average of 3½ months.

Moreover, the Yellow River Basin in Honan differs little in latitude or atmospheric temperature from Lin-ch'ing, Shantung.

Recordings from 1924 to 1931 indicate that the grand canal at Lin-ch'ing is frozen an average of 52 days a year, the ice reaching 18 centimeters in thickness. The freezing and the thickness of the ice are influenced by the amount and rapidity of flow and by the topography, as well as by the atmospheric temperature, so that comparison of two rivers is difficult.

In any case, all rivers in this area remain frozen from $1\frac{1}{2}$ to $3\frac{1}{2}$ months a year, with ice at least 20 to 30 centimeters thick. This, however, presents no obstacle to use of the water in winter.

C. Limitations on Industrial Development

As stated above, allowing 20 percent of the flow for industrial use would give the Pao-t'ou region 500,000 to 1,000,000 metric tons per day, and the region below T'ung-kuan 1,000,000 to 2,000,000 metric tons. To allot this to industries requires consideration of those industries which use large volumes of water: iron, coal liquefaction, ammonium sulfate and pulp. Some idea of the needs may be gained from the following table of the requirements of these industries in Japan and Manchuria.

Water Required by Various Industries (metric tons)

Industry	Yearly Output (M Tons)	Material Used (M Tons)	Water Required per Day (M Tons)	Water per Metric Ton of Output (M Tons)	Water per Metric Ton of Raw Material (M Tons)
Iron Pig iron Steel	1,000,000 600,000	Coal 2,500,000	60,000	13.6	8.8
Coal Liquefaction	100,000	Coal 700,000	15,000	55	7.9
Ammonium Sulfate	100,000	Coal 150,000	30,000	110	73
Pulp	(Bleached sulphite pulp) 44,000	Lumber 700,000 (shih)	60,000	500	31 (shih)

(TN: shih = 133 1/3 lbs)

The various industries require different amounts of water according to their production methods, so no general statement can be made. Moreover, with modern cooling apparatus, the requirements in the foregoing table would be reduced somewhat, in which case the unit price of the water would be raised.

Iron and steel and synthetic gasoline industries which use coal as a raw material require 8 to 9 metric tons of water per metric ton of coal, while the ammonium sulfate industry needs about ten times that amount. In other words, if 1 million metric tons of water are available per day, the maximum possible development would be industries using 110,000 to 120,000 metric tons of coal a day or 40,000,000 metric tons a year (TN: This seems to give the correct version of the figures which were given on page 13.).

D. Conclusion

Yellow River water is entirely suitable in quality for industrial use except by a few industries. Its quantity is sufficient in the Pao-t'ou - Ch'ing-shui-ho area to serve industries using 20 to 40 million metric tons of coal per year; below T'ung-kuan it could serve industries using 40,000,000 to 80,000,000 metric tons of coal per year. The method of use should be based on the experience of existing plants at T'ien-ching. Industrial sites should be selected which will have the lowest unit cost of water, after survey by proper agencies.

Reference Material:

"Thoughts on the Yellow River": Part I - Climate; Part 3 - Hydrometry

"Preliminary Considerations on Development of Yellow River Water Power," and Preliminary Report No 1 by Subcommittee No 4, North China Committee, Survey Committee No 2, Far Eastern Research Section; August 1940

"Precipitation Tests in Turbid Water in North China," Preliminary Report No 1 by Subcommittee No 4, April 1940

"Climatic Maps of North China," Preliminary Report by Subcommittee No 6; March 1940

A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA
(Continued)

Far Eastern Research Section
Survey Committee No 2
North China Committee
Subcommittee No 4
May 1941

PART 7. GEOLOGY AND SUBSURFACE RESOURCES OF THE YELLOW RIVER BASIN

HORIUCHI Kazuo

TABLE OF CONTENTS

I Introduction

Studies of the geology and subsurface resources of China are long overdue. This is especially true of the Yellow River Basin, for which there is almost no reliable source material concerning its undeveloped middle and upstream sections. Nevertheless, an attempt has been made to describe the geology and subsurface resources of the Yellow River Basin by utilizing all available material, and with certain conclusions offered by the writer.

The only geological discussion of the region bordering the main river was taken from geological maps plus a detailed discussion based on the writer's observations around Ch'ing-shui-ho. Hence many of the statements made herein are based on conjecture rather than on factual knowledge.

Secondary source materials on the subsurface resources have also been relied upon and to these have been added some facts not hitherto published. Not only are studies of subsurface resources painfully lacking, but there is need for a fresh investigation in the light of recent social and economic changes. This report is confined to facts which will be of value to future development or investigation of subsurface resources. Although existing information may have exaggerated the value of some of the resources, it is certain that further investigation will lead to the discovery of new resources and new fields of production.

Detailed observations were made in Honan between Shan and Cheng-chou, and first-hand studies of the subsurface resources of the region about Ch'ing-shui-ho were added.

For convenience, a table giving a general bibliography of source material on subsurface resources has been added at this point. This is copied practically intact from previous works on the subject and must be revised according to the results of recent observations.

"Geology and Mines of Shantung Province," Civilian Administration Group, Army of Occupation in Tsingtao

"Survey of Foreign Minerals (Chinese section)," Geological Survey Laboratory, Ministry of Agriculture and Commerce

"Abstracts of Literature on Mining in North China," Geological Investigation Laboratory, South Manchurian Railway Co

"Mining in Shantung Province - Report No 1," Shantung Governmental Office

"Mining in Shantung Province - Report No 5," Shantung Governmental Office

"Geological Reports - Class A and C," Industrial Division, Peiping Geological Survey Laboratory

"Geological Reports," Industrial Division, Peiping Geological Survey Laboratory

"Survey of the Geology of Honan Province," Honan Geological Survey Laboratory

"Mining Report No 1, Honan Province," Honan Geological Survey Laboratory

"Mining Records for Shansi Province," Industrial Office Shansi Province

"Metallurgy," Central China Metallurgical Society

"Mining in Central China"

"Survey of Shensi and Kansu Provinces"

"Survey of Important Minerals in North China," Sugiyama Unit, North China Expeditionary Force

"Survey of Mines in North China," Headquarters, China Occupational Force

"Survey of Mines in North China," Industrial Bureau, South Manchurian Railway Co

"Iron Pyrite Resources in North China," by KADOKURA Sabuno

"Geological Maps of East Asia," Japanese Geographical Society

"Geology of the Yellow River (a translation)," East Asia Research Laboratory

II Geology

As stated above, in view of the scarcity of reliable data, brief statements of geological conditions have been extracted from the hitherto published geological maps covering the Yellow River Basin. These statements may not always be correct.

A. Between Ho-k'ou and Chi-nan

Here are broad alluvial plains and both banks of the Yellow River are of clay (loess) or fine sand.

B. Between Chi-nan and Tung-p'ing

Near Chi-nan small isolated Ordovician limestone ridges appear. Towards Tung-p'ing there are small hills on the banks, especially on the right bank. These are of Cambro-Ordovician limestone. For the most part however, the river flows through alluvial plains.

C. Between Tung-p'ing and Cheng-chou

Here too, are alluvial plains. Both banks are of clay (loess) and fine sand.

D. Between Cheng-chou and T'ung-kuan

From the upper reaches of Cheng-chou to Hsin-an, both banks are of loess. Near Hsin-an strata of alternate sandstone and shale (Permian and Triassic), Permocarboniferous sandstone and shale and Cambro-Ordovician Limestone are exposed along the river-banks. Near Yuan-ch'u and Mien-ch'ih Chinistan quartzite and argillite are exposed. Between Mien-ch'ih and Shan the same layers appear as those near Hsin-an. These beds in certain places are covered with a younger stratum; in particular, tertiary sediments may be seen between Yuan-ch'u and P'ing-lu.

The above-mentioned Permotriassic sediments,consist largely of a fine hard siliceous sandstone and the Permocarboniferous beds are made up of soft sandstone and shale, sometimes containing thin layers of limestone or even coal. The Chinistan quartzite and argillite is mostly of a hard variety.

Between Shan and T'ung-kuan the rock formations are covered with loess deposits but on the river bank, cliffs of Cambro-Ordovician limestone are exposed. Gneiss is found near T'ung-kuan.

E. From T'ung-kuan to Yu-men-k'ou

Here the river flows between cliffs of loess deposits, but below the loess ancient gneiss is exposed. (TN: Gneiss is not a sediment and so does not appear in layers) In the upper reaches of Yu-men-k'ou, gneiss, and above this region, Cambro-Ordovician and Permocarboniferous strata have been exposed by river erosion.

F. From Yu-men-k'ou to Pao-te

Judging from the geological maps, this region is entirely Permotriassic sandstone and shale cut by the Yellow River. This section consists of siliceous sandstone and shale, dipping steeply to the west.

G. From Pao-te to Ch'ing-shui-ho

Here the river cuts through strata of Cambro-Ordovician limestone, forming gorges. In places, Permocarboniferous coal seams appear above the limestone. The strata dip gently towards the west or northwest.

H. From Ch'ing-shui-ho to Tong-k'ou

The river again flows through alluvial soil which extends a short distance upstream from Ch'ing-shui River. Up to Tong-k'ou, loess or Aeolian deposits appear along the banks, and in places, rock beds are exposed.

I. From Tong-k'ou to Chin-chi

Here, for the most part, is loess, but near Shih-tsui-tzu the river cuts through Permocarboniferous and Cambro-Ordovician rock formations.

J. From Chin-chi to Chung-wei

Upstream a little way from Chin-chi, Permocarboniferous and Permotriassic strata are exposed in the banks, but for the most part the river flows through loessial deposits.

K. From Chung-wei to Kao-lan

Upstream from Chung-wei, Permocarboniferous and Permotriassic sandstone and shale strata are exposed along the river bank; from I-t'iao-ch'ong to Kao-lan, gneiss formations are exposed. In some places only loess deposits appear.

III Subsurface Resources

A. General

As previously pointed out, there are many obscure points concerning China's subsurface resources, especially in the upstream areas of the Yellow River. With scanty information at our disposal it is almost impossible to discuss the future development of these resources. Using the sources we have, however, it is possible to point out what should be especially noted in future studies.

1. Gold In Kansu and Tsinghai Provinces alluvial gold is found and deposits are believed to be large.
Alumina Shale This shale is to be found in all the coal fields of Honan, Shansi, Shantung and Hopeh Provinces. (Deposits are probably very extensive.)

2. Coal Found in all the provinces, particularly in Honan, Shansi, Shantung and Hopeh. (Deposits are probably very extensive.)
Petroleum Oil-bearing shales in Shensi, Kansu, Ningsia and Shansi Provinces. (Details not clear, but an important resource.)

3. Gypsum Found in Shansi. (Recently large beds have been discovered.)

4. Borax Found in Tsinghai and Ningsia. (Details not clear but a valuable resource.)

Besides the above, limestone is widely found; so there is no lack of this as a raw material for industry.

The following is a summary of the subsurface resources of North China, with especial reference to those along the Yellow River.

B. Resources

1. Metallic Subsurface Resources

a. Gold In Chi-tung /ancient name for Hopei Province/ and at Chao-yuan in Shantung, gold has been found and already developed to some extent by the Japanese. Because of geographical conditions and of the extent of the deposits this will warrant future development. In Shantung Province there are extensive alluvial gold and gold-ore deposits south of the Chiao-chou - Chi-nan Railroad, viz in the mountains extending from T'ai-an towards I-chou. There is also alluvial gold at Tai-hsien in Shansi and at Ch'ung-hsien in Honan, but these deposits are not extensive and little may be expected of them in the future. The most promising alluvial gold deposits are at Mount Ch'i-lien in Kansu Province, and in the Ch'ai-ta-mu River Basin, the Ta-t'ung River Basin, the T'ung-t'ien River Basin and the Huang-shui River Basin in Tsinghai Province. The alluvial gold deposits in Tsinghai extend over half the province and are said to contain 4,683,616 Chinese ounces. From a geographic point of view the above areas are not particularly advantageous, but should be noted as potential sources.

b. Lead, Silver (Zinc) These are known to exist in North China in various places, but not on a very large scale. Deposits are known in the Yellow River Basin, but it is doubtful if they are of any economic value. When peace is restored and communications are open, it may be possible to work these, even though on a small scale.

c. Copper This metal also occurs very rarely in North China. It is said to occur in Shantung at T'ao-k'o in Li-cheng-hsien, at Mao-tz'u in T'ai-an-hsien and at T'ao-hua-chien in I-shui-hsien; and in Hopeh at Wan-hsien and Chi-tung. These deposits, however, are relatively unimportant and the only deposit which bears much hope of development is that at T'ao-k'o where nickel is found along with the copper. Copper also occurs in Honan at Pen-shan and Ch'in-ling in Chi-yuan-hsien near the Yellow River and in Shansi at Wen-hsi-hsien, Yuan-ch'u-hsien, Hsia and Wei-ko-hsien. These deposits are rather widely separated but deserve further investigation.

d. Iron The most famous iron reserve is that at Lung-yen. It is said to contain over 100,000,000 tons. Next to this is the deposit at Pai-yun-opo, west of Pei-ling-miao, where the deposits are said to amount to 60,000,000 tons. In addition, there are deposits of about 10,000,000 tons in the Meng-chiang area at Cho-lu; in Shantung at Chin-ling-chen; in Kiangsu at Li-kuo; in Hopeh at

Luan-hsien and Tsun-hua-hsien. All are poor deposits.

Again, at Wu-an in Honan; southeast of Chi-nan and at Lai-wu-hsien in Shantung; at Lai-yuan-hsien there is iron ore occurring between limestone and igneous rock. Hitherto these deposits have been considered small but further investigation is expected. Also at Wu-t'ai-hsien and Ting-hsiang in Shansi there is the so-called "striped" iron ore which has possibilities for future development.

Besides the above, iron ore is found in North China appearing in the form of nodular lumps or nuggets at the base of coal seams in the Permocarboniferous strata. This type of ore is plentiful in Shansi where some of it is used in the iron industry, hence it is called Shansi iron. As said before, this iron is found in almost all the coal fields of North China. In the aggregate it amounts to a large quantity, but no great amount can be mined at any one place. Therefore large scale utilization is difficult. The iron ore near the Yellow River is almost all of this Shansi variety, suited only to small-scale demands.

e. Manganese Near Hai-chou in Kiangsu there are rather extensive deposits of manganese. It is found however, in phosphorite rock (apatite) and the percentage of phosphorus is very high, making it unsuitable for use in the iron industry. Also at Chi-tung and Ch'ang-p'ing-hsien and in Shansi at Ching-lo-hsien manganese beds are known to exist. Those at Ch'ang-p'ing-hsien are being worked at present, but the ore is not very rich. New beds, however, have recently been discovered in that vicinity. From this area to the hills west of Peiping, and to the northern end of the Ta-hang Range there may be manganese deposits but none of any great importance are to be expected. Those in Ching-lo are at the base of coal seams in the Permocarboniferous strata and at present are not worth considering, although future investigation may prove them to be of some value. In the Yellow River region at Hsin-t'ai-hsien in Shantung there are said to be placer deposit manganese beds of over 10 million tons. This is not very certain and calls for investigation, but is worth noting. The figures given are very doubtful.

f. Alumina Shale This source of aluminum is found at the base and above the coal seams in Permocarboniferous strata. These are being worked at present in North China, at the Ch'ang-ch'eng and the K'ai-luan coal fields in Hopeh and at the Tzu-ch'uan, Po-shan and the Chang-ch'ui coal fields in Shantung. The shale at the above-named coal fields, with the exception of Ch'ang-ch'eng may be said to be the world's finest, both for quality and quantity. Also, a large amount of good quality shale is known to exist at the I-hsien coal fields in Shantung.

Other coal fields known to contain alumina shale include the Hsin-t'ai and Ta-wen-k'ou fields in Shantung; the Ching-hsing field in Hopeh; the Liu-ho-kou, Chiao-tso, Hsin-mian and Yu-mi fields in Honan; and the T'ai-yuan (East and West mountains) field in Shansi. All these fields, with the exception of Ching-hsing, have an alumina content of less than 55%. Whether this is due to insufficient investigation or to regional conditions is a question that will have to be determined later. From an over-all point of view, it is assumed that all the coal fields in Hopeh (except in the hills west of Peiping), all in Shantung, those in Honan north of the central region and those in Shansi south of the central region contain this alumina shale in large quantities. Since the aluminum industry which makes use of this shale is only getting under way, it will be difficult to utilize these sources at present.

g. Tungston This is found at Mi-yun-hsien and Chi-hsien in Chi-tung. The beds at the latter place are widely distributed, and offer great promise, but because of the lack of sufficient study, we are unable to give an estimate of their value. Besides the above, no other tungsten fields are known, but future investigations may reveal more.

h. Others

(1). Platinum Discovery of platinum is reported at a farm 3 LI (TN: one LI equals approximately 1/3 mile) west of Chi-nan, but it is not clear whether or not this is true. Also it is said that platinum is found along with alluvial gold in Tsinghai along the Ta-t'ung River and the Wo-ni River. This fact is worthy of future attention.

(2) Nickel At the Chi-nan and T'ao-k'o copper mines in Shantung nickel is being developed along with copper, but in very small amounts. In future this region should be investigated for other deposits, but not much is to be expected from it.

(3) Molybdenum According to unconfirmed sources, molybdenum occurs at Lai-yang hsien and T'ai-an hsien in Shantung. It is also said to be found in Chi-tung, but this too is doubtful.

(4) Chromium This is said to exist on certain islands off Tsingtao in Chiao-chan Bay but the quantity is negligible,

(5) Vanadium and Titanium-bearing iron ores Unconfirmed sources report the occurrence of these ores in Chi-tung and since they have been found in Jehol, Manchuria, there is some probability of these reports being true. Further study, however, is required.

(6) Tin The occurrence of tin has been reported in Kansu and Tsinghai, but there is practically none in North China.

2. Non-metallic Subsurface Resources

a. Coal Coal is, of course, the greatest of North China's subsurface resources. It occurs all over the country, in Hopeh, Shantung, in parts of Honan and in parts of Meng-chiang. The largest deposits, however, are found in Shansi. Not much is known about its occurrence in Shensi, Kansu, Ningsia, Tsinghai and the Meng-Chiang area, but from a geographic standpoint, little can be expected from the development of these areas at present.

In the Yellow River region, except for one part of Ordos and the area downstream from K'ai-feng, coal is found almost everywhere so the amount must be tremendous. It must be noted, however, that as the study of those fields is still in its infancy and the amount and the quality not yet determined, any rationalized development of them at present is impossible. Moreover, the fields in northern Shensi, while widely distributed, are wanting in depth, so not much is to be expected of them.

b. Petroleum There is said to be petroleum in Shensi, Ningsia, and Kansu, but the authenticity of such reports is open to question and further investigation will be necessary to show whether or not there are any large fields to be exploited. The importance of petroleum makes this study most necessary.

Concerning oil in Shensi, the Standard Oil Company of the USA made an investigation, according to which there are traces of oil in 62 places and two oil wells at Yen-ch'ang. We thus may be assured that there is oil in Shensi. From their investigation, the Standard Oil Company has arrived at the following conclusions: (A) The wells at Yen-ch'ang are some 200 feet deep and the oil comes from an isolated trap. In spite of this, the output is 60 barrels per day which leads them to believe that they have discovered a field of considerable capacity. (B) Since there are many signs of oil, the distribution is probably rather wide. (C) The disadvantages are that the area is very sandy, the dips are low and the structure is extremely flat.

From the above we see that there is oil in Shensi, but its actual value must be determined by future investigation. Moreover there is said to be oil at Meng-hsien on the north bank of the Yellow River in Honan, and the presence of oil-bearing coal (TN: oil shale?) is mentioned in Chinese literature.

c. Oil-bearing Shale This is found in Shensi. The thickness of the strata is reported to be four feet and the distillate 19.5% by weight, i.e., 53 gallons per ton. This shale extends for at least 100 km in the vicinity of Yen-ch'ang and merits future investigation. Besides the above, there is no definite information on oil-bearing shale, but there are Mesozoic coal seams widely distributed in the eastern part of Shantung which call for further investigation.

d. Gypsum This occurs at P'ing-lu-hsien, where it has been extracted, and along the southern bank of the Yellow River in Shansi and at Shan-hsien and Kung-hsien in Honan. Besides the above, it occurs at Ta-t'ung and at Chieh-hsu and near T'ai-yuan in Shansi where it has been extracted recently. None of these, however, can be called large fields. Recently at Ling-shih in Shansi, extensive gypsum beds have been discovered in which the deposits amount to at least several hundred million tons, and it is quite possible that the same sort of beds occur in the mountains east of T'ai-yuan. It may be seen from this that gypsum has become one of the great resources of North China. It may also be supposed that hereafter other such fields of gypsum will be discovered in other regions.

e. Fluor-spar This occurs at P'eng-lai-hsien, Chiao-chou, Yeh-hsien and Po-shan-hsien in Shantung and is apparently limited to this region. It is shipped from Tsingtao to Japan. Reports of the discovery of two large deposits in the northwest section of Meng-chiang and near the Outer Mongolian border have been made but the details are not clear. There is said to be some along the Yellow River at Hsin-an-hsien in Honan but to what extent is not clear, It is also reported to occur at Chiao-ch'eng-hsien in Shansi.

f. Asbestos This is found chiefly at Ta-ch'ing-shan and Lai-yuan-hsien in the Mongolia - Sinkiang Area (the latter was formerly in Hopeh) and the deposits at both places are of good quality. In particular the mines at Lai-yuan-hsien have been worked extensively for some time. Besides these, asbestos deposits are found at Ch'ang-p'ing-hsien, Hu-lu and Ching-hsing in Hopeh. These deposits are on a small scale, although Ch'ang-p'ing is in a location favorably situated for exploitation. No potential source of asbestos is known in the Yellow River region.

g. Mica This occurs chiefly at P'ing-ti-ch'uan in the Mongolia - Sinkiang Area. At present this deposit is being developed and the mica shipped to Japan. Next in importance to this are deposits near Tsingtao and Chu-ch'eng in Shantung where produce is also shipped to Japan but their capacity is small. Other than these, no reserves have been discovered up to the present, although it is possible that in time mica may become one of the leading natural resources of North China. For this reason further investigation is important.

h. Graphite There are promising graphite veins in both the Meng-chiang Area and Shantung, the former being developed already. Besides these, however, no further deposits are expected.

i. Iron Pyrite This is found in all the coal fields of North China and is mined along with the coal. The quantity is small and not much attention has been paid to it hitherto, although the natives of the region have used it in their small-scale industry. Like the "Shansi iron ore," it is also found at the base of Permocarboniferous coal seams at T'ai-yuan, Fen-ch'eng and Fen-hsi in Shansi and at Hsin-an and Po-ai in Honan. The latter deposits are said to contain a million tons each. In ancient times, a great deal of sulphur was extracted from iron pyrite.

As stated above, this mineral is widely distributed, like the "Shansi iron ore," but there is no great amount in any one place, hence it is not well suited to large scale production at present. If it is mined with coal, as a by-product, it can be processed at small expense, and many uses will be found for it. In this regard, it will be necessary to study the occurrence of iron pyrite at the base of the coal seams.

j. Clays Hard clay, China clay, Kaolin, Refractory clay - almost all are found in the various coal fields, but the distinctions are not clearly marked. They differ in names and uses according to where they are found -- below the coal strata, between the seams, or above or below the Permocarboniferous strata. The latter condition is similar to the occurrence of the alumina shale previously described. The classification of the different types of clay is based primarily on the use to which they are put rather than on physical or chemical composition. The distribution and properties of these clays are about the same as those of the alumina shale previously described. They are found at the Ch'ang-ch'eng and K'ai-luan coalfields in Hopeh and at the Tzu-ch'uan, Po-shan, Chang-ch'u, and I-hsien coal fields in Shantung. They produce an excellent type of fire-brick. Other than the above, no deposits of high-grade alumina clay have been discovered up to the present.

k. Limestone This is widely distributed in North China and is found in the vicinity of every coal field. Little study, however, has been made concerning the quality and size of the deposits. Because of the wide distribution, it should be easy to find limestone in suitably large quantities for the manufacture of cement, for use in the iron industry and for other industrial purposes. In the Yellow River region, as stated above, Permo-carboniferous strata are widely distributed, and a large supply of limestone should be easy to obtain, although further study is necessary before it can be put to practical use. The fact that there is almost no limestone to be found along the coast of North China is a source of great inconvenience when industries are developed near the great harbors. There is a great possibility that Zechstein rock may be discovered in the limestone of North China.

l. Barite A number of deposits of barite are located around Chi-mo-hsien in Shantung, and it is also found in conjunction with gold veins at Chi-tung. There is no record of its occurrence elsewhere. Unconfirmed reports state that the deposits at Chi-mo-hsien are of considerable size.

m. Borax Borax is said to exist in the lakes of Tsinghai and Ningsia, but this report awaits verification. Its importance is such that an investigation of the above lakes as well as those of Kansu and the Mongolia - Sinkiang Area should be carried out.

n. Salt, natural soda In Shensi, Kansu, Ningsia, Tsinghai and Meng-chiang there are salt lakes (possibly Playa lakes) which contain salt and natural soda in great quantities. These minerals are taken out by native laborers. The so-called dirt-salt found south of Ta-t'ung in the Mongolia - Sinkiang Area and in the Ho-tung salt beds near Yun-ch'eng in southern Shansi yields salt and soda. Wells or ponds are dug in the Ho-t'ung salt beds and the salt and natural soda are extracted from these. The clay in Ta-t'ung contains a proportion of salt which is extracted. Downstream from K'ai-feng, along the Yellow River there are extensive salt and soda fields and the natives extract the salt and soda as side-work in the off-farming season.

There are other fields widely distributed throughout North China in which salt and natural soda deposits are exposed at the surface of the earth. The natives extract the salt and soda as side-work, but it is of little value for large-scale industry.

The provinces to the west, i.e., the Mongolia - Sinkiang Area, Shensi, Kansu, Ningsia, Tsinghai and Shansi, should be investigated, since it is possible that rock salt may be found there.

o. Others

(1) Talc Yeh-hsien in Shantung is noted as a source of talc but few details are known about its occurrence. There are other deposits in Shantung, but none of them seem large.

(2) Feldspar Shih-p'eng in Shantung is a promising source of feldspar. It is also mined at T'ai-yuan but little study has been made of this mineral and the details are not known.

(3) Quartz Little study has been made of this mineral but red-white quartzite is known to occur at Wu-t'ai-hsien in Shansi, and at T'ai-yuan silica has been used for making tiles. Near the Po-shan coal field and the K'ai-luan coal field, Permo-Triassic quartz-sandstone found above the coal seams has been used in making glass. These strata deserve further study as it is possible that deposits of minerals suitable for the manufacture of tile or glass may be discovered.

(4) Rock Crystal Unconfirmed reports claim the existence of rock crystal in the Ta-ch'ing mountains of the Mongolia - Sinkiang Area and the northern part of the Ta-hang Range between Hopeh and Shansi. Large crystals are found at Tzu-ching-kuan in eastern Lai-yuan-hsien but whether they are colorless, transparent, and of good quality is not known.

IV Geology and Mineral Deposits in the Vicinity of Ch'ing-shui-ho in the Mongolia - Sinkiang Area

A. Introduction

As a member of the committee surveying the Yellow River in the vicinity of Ch'ing-shui-ho in the Mongolia - Sinkiang Area, the writer left the railway at Hou-ho and spent four days, Nov 24-28, 1940, in the region between that point and Ch'ing-shui-ho. The following are the results of his observations, especially of the region around Ch'ing-shui-ho and the east bank of the Yellow River as far as Hsia-Ch'eng-wan.

This survey was very brief, and much time was consumed in travel, most of the observations having been made from the seat of a truck. Hence, there will be considerable conjecture mingled with the facts. There may be many errors, but the report is given for what it is worth, as a reference.

B. Topography

The areas of relief are in the form of a plateau. The surface of the plateau is cut up into little valleys, but the top of the plain near the mountains, is almost level. This slopes very gently from Ch'ing-shui-ho to the banks of the Yellow River. Bluffs of some 100 meters face the Yellow River valley. On the west side of the river, the topography is about the same.

The chief rivers are the Yellow River and its tributaries, the Ch'ing-shui River and Hung River. Here the Yellow River flows in an almost north-south course, the southern banks consisting of cliffs some 50 to 100 meters high, forming a gorge, so that the development of the alluvial plain can not be seen.

The Ch'ing-shui River flows westward south of Ch'ing-shui-ho till it joins the Yellow River upstream from Hsia-ch'eng-wan. Near Ch'ing-shui-ho the valley is wide and its flood plain is comparatively extensive, but downstream from that point the valley narrows. The Hung River rises near Liang-ch'eng, and flows west and southwest. West of Ch'ing-shui-ho it joins the Ch'ing-shui River as one of its tributaries. At T'u-kou-tzu and upstream it runs through a broad and shallow valley. These two small rivers have a scanty flow of water and are hardly suitable for water traffic.

Above and on the plateau are countless little valleys, and because of the loess, there are many gullies which make transportation very difficult. Also in places, sand hills are in evidence. The area west of the Yellow River is not as rugged as that east of the River.

C. Geology

Opportunity for observation being limited, the report on the geology of this region is largely conjectural. The nature of the geology of the region is as follows:

1. Reddish-brown sandy shale stratum (Cambrian? in its lower part)

2. Limestone stratum (Cambro-Ordovician)

3. Alternate strata, sandstone and shale (Permocarboniferous)

4. Reddish-brown siliceous sandstone stratum (Period unknown)

5. Laterite (Tertiary)

6. Loess (Quarternary)

7. Aeolian sand stratum (Quarternary)

8. Sand and pebbles stratum (Quarternary)

9. Diorite (Period unknown)

1. Reddish-brown sandy shale stratum

This is exposed at T'u-kou-tzu northwest of Ch'ing-shui-ho, also west of Ch'ing-shui-ho on the banks of the Ch'ing-shui River. Judging from the thickness of the limestone stratum covering it, and from the nature and position of the stratum, the lower part is probably Cambrian, and might be correlated with the so-called Manju shale.

2. Limestone stratum

This is in evidence from Ch'ing-shui-ho to Hsia-ch'eng-wan, and seems to form the basal stratum of the plateaux in this region. It probably consists of alternate layers of limestone and Zechstein and is over 300 meters thick.

On the bank of the Yellow River near Hsia-ch'eng-wan there are found spiral, vermiform, and oolitic limestone strata within the above limestone stratum. In the oolitic limestone are trilobite fossils. Hence this stratum clearly belongs to the Cambro-Ordovician period. This formation is also widely distributed on the west bank of the Yellow River.

3. Alternate sandstone and shale stratum

This stratum runs north from Hsia-ch'eng-wan and follows the Yellow River along its bank, appearing above the limestone stratum just described. It does not run parallel to the limestone stratum but below it there is a stratum of vari-colored shale, and several meters above is a limestone stratum some 10 meters in thickness. Since coal is obtained in this region, it is clear that this belongs to the Permocarboniferous period. The distribution of this stratum on the east bank of the Yellow River is not very wide and the upper part is eroded. It is probable that it extends more widely on the west bank.

4. Reddish-brown siliceous sandstone stratum

This is composed of a hard, fine-grained, reddish-brown quartzite, and extends northward from Ch'ing-shui-ho. Since it was impossible to observe its relation to the other strata, there is no data for determining the period to which it belongs. Judging from the character of the rock, it probably belongs to the Permo-triassic periods.

5. Laterite

This extends upstream from T'u-kou-tzu, which is north-west of Ch'ing-shui-ho, to the plateau on the left bank of the Hung River. It is of a reddish-brown color and covers the limestone and is in turn covered by loess. It does not appear on the plateau near Ch'ing-shui River and Hsia-ch'eng-wan. Since it seems to correspond to what is called laterite in Shansi, it is doubtless of the late tertiary period. Its thickness is not known.

6. Loess

As noted above, this covers laterite in the region north of T'u-kou-tzu. It also appears covering the limestone and the Permocarboniferous strata on the plateau and on the sides of the valley. On the table land the thickness of this material is about ten meters or less; on the sides and at the bottom of the valleys it is somewhat thicker.

7. Aeolian sand stratum

This appears on the alluvial plain of the Hung River, on the eastern slopes of the valleys, and occasionally on the plateau. This stratum is for the most part matter blown over from the Ordos region, and not much is in evidence on the east bank of the Yellow River, but is rather widely distributed on the plateau of the west bank.

8. Sand and pebbles

The bottom of the valleys of the Hung River and Ch'ing-shui River is a stratum of fluvially deposited gravel.

9. Diorite

It is exposed north of Ch'ing-shui-ho below the reddish-brown siliceous sandstone, and its relation to the sediments and its occurrence are not clear.

D. <u>Geological Structure</u>

The strata of this section, in part, showed a slight dip, but generally speaking they were almost level and the land was a level plateau. The structure seen at Ch'ing-shui-ho appeared almost exactly the same as that at the bank of the Yellow River. Judging from a fault in the vicinity of Ch'ing-shui-ho, there is some disturbance of the strata, but no other notable fault was observed.

A more detailed discussion of the region near Hsia-ch'eng-wan on the banks of the Yellow River follows. As mentioned above, Cambrian, Ordovician and Permocarboniferous strata are exposed. Here too, the dip is almost flat, but a more careful observation shows a gentle dip to the west or northwest. Downstream at Ta-yu-yao-tzu the strike is north 10° east; the dip is 10° to the west. The walls of the Yellow River valley are mostly Ordovician limestone; but downstream, Cambrian limestone is found beneath the previously mentioned limestone, hence we may conclude that in general the strata dips slightly to the west or northwest. Moreover, at Hsia-ch'eng wan and vicinity, where one observes the contact between the Ordovician limestone and the Permocarboniferous Period; the strike of the former is north 45° east, the dip is 30° to the northwest. In places the strata are folded. Near Ta-yu-yao-tzu there is a normal fault running east-west in the Yellow River valley. This fault has a small downthrust on the north side forming a 10-50 /several tens/ centimeter embankment. Similar faults may exist elsewhere, but none were observed on this occasion.

E. Mineral Deposits

Investigation concerning these was not made. Judging from observations made enroute, and from samples at the town office of Ch'ing-shui-ho, the following conjectures were made.

1. Coal

a. Location. This is to be found north of Hsia-ch'eng-wan, along the Yellow River, at Hei-chi-kou, Ta-sha-wan, Hsi-sha-wan, Tung-mu-kou and Yand-lu-t'an.

b. Coal beds and the geology. North of Hsia-ch'eng-wan coal seams are distributed in Permocarboniferous strata. The exact location of these strata is not clear, but they are found only along the Yellow River and probably end to the north at Yang-lu-t'an. Hence on the east bank of the river the distribution of the seams is not extensive, and as the dip is almost flat, the seams are found only at the bottom. There is no information concerning the number and size of the seams, but it is assumed that on the east bank, only the lower part of the seams is left, and that the main coal fields are to be found on the west side of the river towards Ordos.

c. Quality and quantity. The coal of this region is of a dull color for the most part, although here and there a line of glassy coal several millimeters in width is found. The inhabitants of Ch'ing-shui-ho and Hsia-ch'eng-wan use it for fuel in their homes. Analysis of this coal follows:

Laboratory - North China Economic Survey Office, South Manchurian Railway

Date analysis requested - 13 Dec 1940
Date analysis finished - 7 Mar 1941

	Dull Coal I	Glossy Coal II
Water	6.57 %	7.35 %
Ashes	8.50 %	6.31 %
Volatile Matter /Gasoline/	30.33 %	30.97 %
Fixed Carbon	54.60 %	55.37 %
Total Sulphur	0.34 %	0.51 %
Heating Value	6540 calories	6670 calories
Coking Property	Coagulation	Coagulation
Ash color-tone	Ashy white	Ashy white
Phosphorus (in ash)	Traces	Traces
Ash fire resisting degree (SK)	37	36-37

Note Analysis I is taken from the dark coal

Analysis II is taken from thin seams of glossy coal in the dark coal

The extent of the deposits is not known, but as stated above, the seams on the east bank are narrow and appear only at the bottom

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of the strata. Hence we should not expect the deposits to be very large. The natives mine it for home consumption.

If a dam should be built in this region and the district industrialized, the problem of the amount and the quality of the coal would become very vital. Therefore a careful investigation should be made as to the extent of the deposits on the eastern bank as well as the state of occurrence of coal on the west bank of the Yellow River.

2. Limestone

There is no information on this subject and the following is only a description of the observations.

a. Distribution. From Ch'ing-shui-ho to Hsia-ch'eng-wan along the Yellow River the entire region is Cambro-Ordovician limestone. Judging from previous observations in other regions, Ordovician limestone frequently contains Zochstein rock /dolomite/ and depending on its horizon /position of stratum/, it is ordinarily suitable for making cement or for use in iron melting or casting. We may conclude from the wide distribution of this limestone that this region has facilities suitable for making cement or for making iron castings. Since the whole area is a plateau and there is no level ground except that on the plateau, and since practically all of the strata are horizontal, it will be difficult to dig out any large quantity of limestone. This will be a serious problem in case it is necessary to build a cement factory for the construction of dams.

3. Hard quality clay

A specimen shown at the town office is white in color, and seems to be suitable for fire-resistant material or for pottery. Its origin and quantity are not known but it is obvious that it is found in Permocarboniferous coal seams.

4. Kaolin

Kaolin was also seen at the town office. Its color is ashy-purple. The site from which it was taken is unknown, but it is found in coal seams.

5. Loess

This is widely distributed in the region. In case this region should be industrialized in the future, an analysis of the loess is given in the following.

Laboratory - North China Economic Survey Office, South Manchurian Railway

Date analysis requested - 20 Dec 1940
Date analysis completed - 7 Mar 1941

Anhydrous silicic acid (SiO_2) (quartz)	59.94 %
Alumina (Al_2O_3) /Written Ao2o3/	10.02 %
Ferric Oxide (Fe_2O_3)	4.36 %

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Lime (CaO)	7.90 %
Magnesia (MgO)	4.43 %
Alkali (K_2O - Na_2O)	4.78 %
Material loss from heating	8.44 %

6. Iron Ore

Found at the base of coal seams. This is the so-called Shansi iron ore - brown and red iron ore. Amount of deposits is unknown. In ancient times it was used for making iron by primitive methods.

V Subsurface Resources along the Banks of the Yellow River Between Shan and Cheng-chou

A. Introduction

The material herein has all been published previously, most of it written before 1934; hence there will be much which does not fit the present situation. The expressions "now" or "at present" hereinafter used, are quoted from the sources, and refer to the time of their compilation. There are many instances where these differ widely from the situation after the [China] Incident.

There are many statements in these Chinese sources which are hard to believe, but they are published as they stand. This is especially true of the amount of the coal deposits. Further investigation is certainly called for. The amounts still to be mined are probably less than stated. (Material taken from source No 4 is excluded.)

B. Summary

The most important underground resource is coal; hitherto only small amounts have been mined, but much is to be mined in the future.

Next to coal comes limestone, and then fire-resistant clay (including alumina shale and kaolin). These are widely distributed, but their location and the amount of deposits are uncertain. The limestone seems to be suited for all sorts of industrial uses. The clay could be used in various ways, depending on the quality. Further investigation is required, but it seems suited for ordinary fire-resistant purposes. There are no very large deposits of iron sulphide and gypsum in this region, but it is said to be famous for these, so it would be well to investigate. The iron ore is the so-called Shansi ore; it is not to be hoped that much of it will be discovered. The copper ore of Chi-yuan-hsien is not described in detail, but because it is an important resource, its presence should be investigated further.

The following is a summary of the underground resources of this region:

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Resource	District (Hsien)	Source	Locale	Quality	Deposit
Coal	Hsin-an, Mien-ch'ih	Hsin-mien coal fields	Hsin-an-hsien, Chi-yuan-hsien, Shan-hsien, Mien-ch'ih-hsien	Anthracite and bituminous	1300 million metric tons
Coal	I-yang, Lo-yang	I-lo coal fields	Lo-yang-hsien, I-yang-hsien, Yen-shih-hsien, Kung-yang-hsien, Teng-feng-hsien	Bituminous and semi-anthracite	500 million metric tons
Coal	Yu, Mi-hsien	Yu-mi coal field	Yu-hsien, Mi-hsien	Bituminous and anthracite	1500 million metric tons
Coal	Hsiu-wu, Po-ai	Hsiu-po coal fields	Hsiu-wu-hsien, Po-ai-hsien	Anthracite and semi-anthracite	100 million metric tons
Iron Sulphide	Hsin-an	K'uang-k'ou	70 li (Chinese mile) NE of gov't seat	45% sulphur	1 million metric tons
Iron Sulphide	Po-ai	Hsiao-ling, Seu-hou, Li-feng	North of govt seat	35% sulphur	1 million metric tons
Fluor-Spar	Hsin-an	--	Details of place unknown	--	--
Gypsum	Kung	--	--	--	--
Gypsum	Shan	Ta-an-ts'un	--	Unknown	Unknown
Gypsum	P'ing-lu	San-men-ling, Hsu-yu-fen, P'o-ti-ts'un, P'an-nan-kou	50-80 li east of Hsien-ch'eng	Good	Unknown
Ink Stone	Chi-yuan		Northeastern Chi-yuan	--	--

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(Contd)

Resource	District (Hsien)	Source	Locale	Quality	Deposit
Iron	Hsiu-wu, Po-ai	Feng-huang-ling, Li-chuang	Within Hsiu-po coal fields	37.7 - 48.6% iron	150,000 metric tons possible
Iron	Hsin-an	Ho-t'ao-yuan, Chang-yuan	40 li NW of govt seat	55% iron	Unknown
Iron	Kung	Shih-liu-yuan	20 li SE of govt seat	--	--
Iron	Kung	Feng-men-k'ou	10 li east of Shih-liu-yuan		
Copper	Chi-yuan	Mang-shan, Ch'in-ling	40-80 li NW of govt seat	Highest grade copper, 6%	
Lead and Silver	Hsin-an	Hsi-ch'ien-ling	Details unknown		
Lead and Silver	Chi-yuan	Shuang-feng-shan	Details unknown		
Lead and Silver	Kung	Cheng-chia-ling	Details unknown		
Lead and Silver	Mi	T'ien-chung-wan	Details unknown		
Lead and Silver	P'ing-lu	San-feng-ssu	80 li east of govt seat		

Remarks

1. Deposit value given for Hsiu-po coal fields is the amount which still may be mined as determined by YAMANE, an engineer.
2. Limestone and fire-resistant clay exist in considerable quantities, but since exact place names cannot be given, they are omitted from this list.

1. Non-metallic Resources

a. Coal. In this region are the following coal fields:

(1) Hsin-mien Coal Field. North of and between the Lung-hai Railroad and the Yellow River between Shan and Hsin-an stations

(2) I-lo Coal Field. South of the Lung-hai Railroad extending from southeast of I-yang-hsien, through southern Lo-yang-hsien, Yen-shih-hsien, Kung and Ssu-shui-hsien as far as southeast of Jung-yang.

(3) Yu-mi Coal Field. Area includes the northern portions of Yu-hsien, Mi-hsien and Chia-hsien

(4) Hsiu-po Coal Field. Extends through Hsiu-wu-hsien, Po-ai-hsien and Ch'in-yang-hsien

Following is a detailed description of the above named coal fields:

1. Hsin-mien Coal Field

a. Location and Communication Facilities. North of and between the Lung-hai Railroad and the Yellow River between Shan and Hsin-an stations. On the east it runs from the western boundary of Chi-yuan-hsien through Hsin-an; on the west it extends through Mien-ch'ih-hsien and Shan-hsien. This coal field may be divided into three districts.

Hsin-Chi District. This area extends from Ch'u-kou, which is in the northwestern part of Hsin-an via Ku-teng-ts'un, Shih-ssu, northern Yen-chen, Han-hsin-kou, P'an-chia-p'o, eastern and western Yao-ts'un and Yen-ts'ang to areas Shih-ks'ao-ts'un and Tung-an-hsiao in Chi-yuan-hsien which is on the northern bank of the Yellow River.

Hsin-mien district. From Yu-shan in Hsin-an-hsien to P'ing-ch'uan in Mien-ch'ih-hsien.

Shan-mien district. Near Mien-ch'ih-hsien (south bank of Yellow River) and Shan-hsien border. The area extends from the lowlands of Pei-lang (on northwestern border of Mien-ch'ih-hsien) to Kuan-yun-tang in Shan-hsien.

This coal field is bounded by the Wang-wu-shan range on the north and by the Yao-shan Range on the south and is situated in a mountainous country; but east of Kuan-yin-t'ang the mountains are low. The Hsin-chi district is on both sides of the Yellow River, and water transportation can be utilized. The Hsin-mien and Shan-mien districts are intersected by the Lung-hai railroad line and in the coal fields there are light railroads and spur lines, so traffic is facilitated.

b. Geology. Distribution of the Coal Seams. The underlying rock is Cambro-Ordovician and the coal seams are in

Permocarboniferous strata. The coal is in seven (some say ten) strata, the upper two of which are about one foot thick or less and are not worth mining. Below third stratum, they are both deep and shallow; but the seventh is the deepest. For the most part it is from 20 to 30 feet in depth though in places it is only a few feet thick.

The third stratum is about one meter deep at Kuan-yin-t'ang and is mined by native methods. The fourth, at Ch'u-kou in Hsin-an-hsien is from 0.5 to 1 meter thick, and around Shih-ssu in the same area it is one meter thick and may be mined. The fifth at Ch'u-kou in Hsin-an-hsien is from 0.5 to 1 meter; at the boundary of Chi-yuan-hsien it becomes 1 to 2 meters. The sixth, at Ch'u-li and San-men near the boundary between Mien-ch'ih-hsien and Shan-hsien is 0.5 to 3 meters; at Huai-pe'i and Hsiao-wa it is 4.5 meters; at Chih-k'u it is 3 meters, at Yang-t'un it runs from 3 to 7 meters in depth; near Ch'u-kou in Hsin-an-hsien it becomes about 13 meters. At the border of Chi-yuan-hsien it is again 3 meters. The seventh stratum is the most important. At Kuan-yin-t'ang it is from 1 to 13 meters; at the triangular area in Shan-hsien it is about 10 meters, then it falls away to a mere 2 meters below the Huai-pei Cliff, and at Yu-shan in Hsin-an-hsien a seam of 3 meters is being mined.

c. Quality of the Coal

The coal of the northeast portion, i.e. the Hsin-chi and Hsin-mien districts, is semi-anthracite or anthracite; that in the west portion, i.e. at Kuan-yin-t'ang and at the triangular area in Shan-hsien, is mostly bituminous. This is also of the variety. The analysis of the coal in the various districts is as follows:

District (hsien)	Shan					Hsin-an-shang			
Place name or mine	Kuan-yin-t'ang	Min-sheng Mine				Ch'u-kou	Ma-hsin-kou		Ku-teng-ts'un
Per Cent Water	2.25	0.70	0.20	0.60	0.40	1.92	0.70	0.75	0.80
Per Cent Volatile Matter /Gasoline/	15.75	17.20	14.90	15.50	16.20	17.90	22.65	18.57	15.58
Per Cent Fixed Carbon	67.60	61.33	76.45	53.70	61.50	59.10	60.95	57.23	71.87
Per Cent Ash	14.50	20.77	8.45	30.20	21.90	18.60	15.70	23.45	11.75
Per Cent Sulphur	2.32	1.20	1.42	2.65	1.02	1.87	1.60	1.49	1.67
Coking Property	good	good	bad	good	good	bad	bad	good	bad
Heating Value Calories		6869	7967	6046	6792	6789	7284	6606	7636

(Note) The Min-sheng Mine is near Kuan-yin-t'ang.

d. Quantity of the Deposits

District (Hsien)	Hsin-an	Mien-ch'ih	Shan	Chi-yuan	
Location	N, NE, S	N, S	Kuan-yin-t'ang	Shih-ts'ao	
Depth of seam (m)	0.6-0.8	2.5-7.0	7.0	3.0	Total
Area (sq km)	236	29	15	159	459
Amount of Deposit (million MT) Anthracite	132	30	---	---	162
Bituminous	279	192	115	540	1126
Total Deposit	411	222	115	540	1288

e. Amount of Coal Mined 1931-1933 (Unit, metric ton)

District (Hsien)	Shan			Chi-yuan	Mien-Ch'ih	Hsin-an
	Large Mines	Small Mines	Total	Small Mines	Small Mines	Small Mines
1931	74,280	6,000	80,280	30,000	25,000	63,500
1932	65,000	5,000	70,000	56,000	30,000	29,090
1933	75,240	7,000	82,240	63,950	25,015	74,960

f. Various Mines. There are many mines in the Hsin-mien coal fields. The most important are the following:

(1) Min-sheng Mining Co

(a) Location and Communication facilities. Situated northwest of Kuan-yin-t'ang in Shan-hsien (along the Lung-hai Railroad), midway between Mu-wo and Yang-lou-wo, about 7 li from the Kuan-yin-t'ang Station. There is a light, 24-pound, railroad from the mine to the neighborhood of the Lung-hai railroad line, connecting with the latter by a cableway.

(b) History. This mine was opened in 1920 and at first only approximately 30 metric tons were mined daily by primitive methods; but in 1925 new mechanical equipment was installed. In 1929 work was stopped on

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account of the war, but it was resumed in 1930. The capital of the company is said to be two million yuan.

(c) Area. 30327.5 mou (市 亩) (TN: mou = 733.5 square yards)

(d) Seams. According to "authority" No 2, there are ten seams. Records made at the time of excavation of the shaft show thickness of the seams to be as follows. Seams 4 and 5 are 2 feet apart.

Seam No	Thickness	Seam No	Thickness	
1	0.2 Chinese feet	6	4.6 Chinese feet	Seams 6, 7 and 8 are being mined by the company.
2	0.4	7	6.6	
3	0.2	8	16.0	
4	1.2	9	1.0	
5	1.2	10	0.6	

(TN: According to Source Document No 2 there are seven seams.)

(See Chart on following page.)

(e) Quality of the Coal. This is bituminous, coking coal. An analysis of coal from Pit No 1 is as follows:

Water, 0.7 per cent; ash, 20.77 per cent; volatile matter, 17.20 per cent; heating value, 6889 calories; fixed carbon, 61.33 per cent.

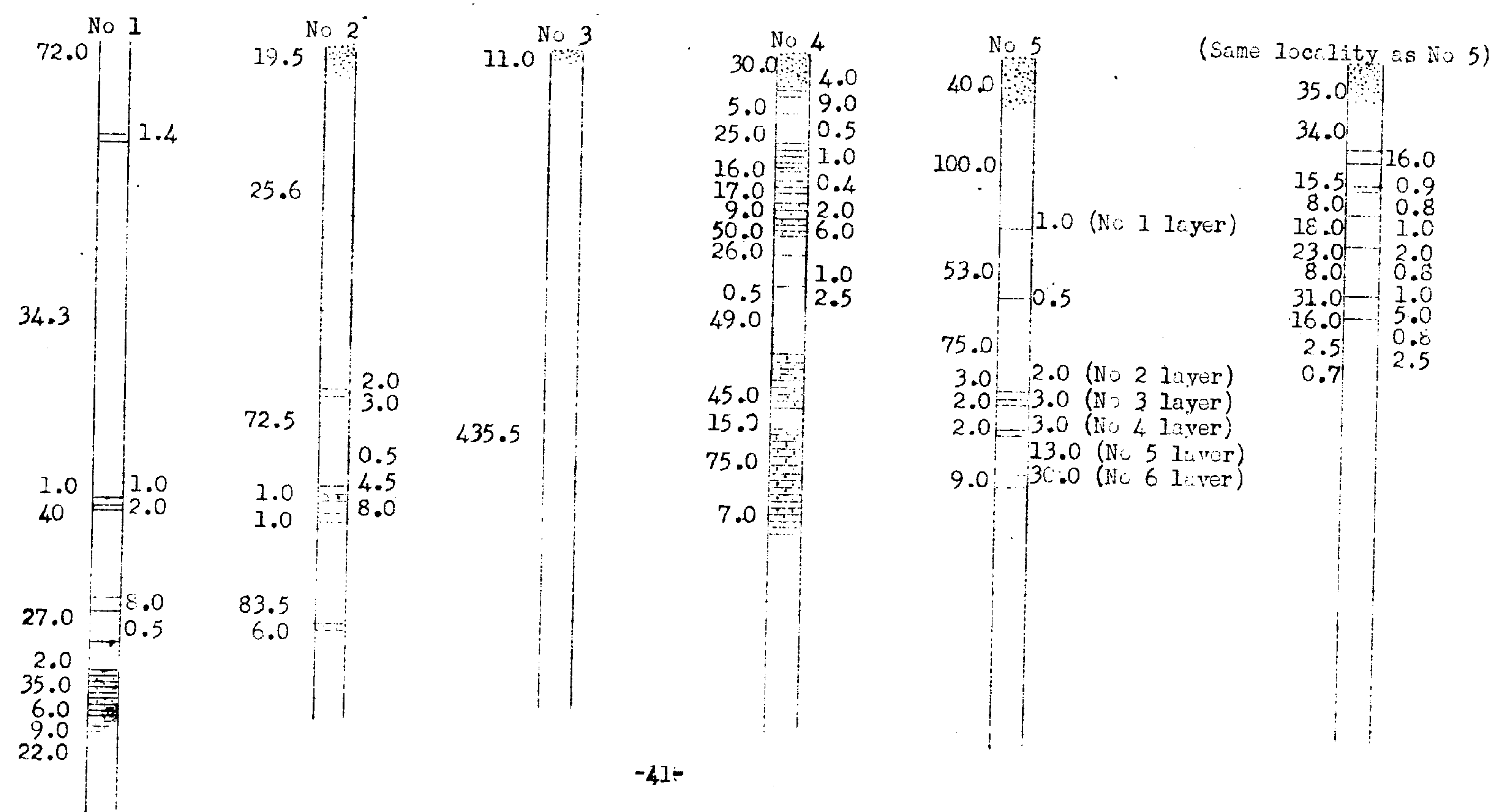
(f) Transportation. By light railway to the Lung-hai Railroad, then by cable-way to connect with same.

(g) Amount of coal mined. (Unit metric tons)

1926	25,700	1929	26,802.61	1932	75,000
1927	32,917.10	1930	31,905.05	1933	72,500
1928	60,582	1931	47,764.28	1934	63,000

(h) Conclusion. This mine, with good equipment, has a capacity of 1,000 metric tons per day, but because of the occurrence of igneous rocks and the uncertainty of the thickness of the seams, mining here is not profitable.

Record of the Menshing Mining Co's Test Shafts



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(2) Chun-hsing Mining Co

(a) Location and communication facilities. Area east of Ching-ts'un in Chi-yuan-hsien and about 2 li northwest of the government seat of Chi-yuan-hsien. Large wheeled vehicles can be used; thus transportation will be comparatively easy.

(b) History. Opened in the spring of 1933, but closed down during the summer monsoon season. Mining was by primitive methods; and the capital said to be 80,000 yuan.

(c) Area. 9136.64 mou.

(d) Coal seams. The one being worked is anthracite, 20 to 25 feet thick.

(3) Hsin-an Mining Co

(a) Location and communication facilities. In the northwest corner of Hsin-an-hsien above Ch'u-kou at Shang-ku-teng-ts'un. Thirty li from the government seat and 12 li from Hua-an-ssu area along the Lung-hai Railroad. Since the mine is situated on the northern slope of Chih Mt, a spur of the Lung-hai Railroad is laid for 600 meters to the southern side of the mountain. The distance between the terminal of the spur and the mine is covered by horse wagons, but in the monsoon season roads are often closed.

(b) History. The mine was opened in Oct 1919 and began producing in Sep 1920. Coal was extensively mined in 1922 and 1923, but in 1924 with the outbreak of fighting the work gradually fell off. Since 1925 it has been practically at a standstill. Capital of the company is one million yuan; liabilities, more than 200,000 yuan.

(c) Area. 16491.16 mou.

(d) Coal seams. The one being worked averages about 15 feet; it is 40 feet at its thickest. The coal is the so-called "big-coal."

(e) Quality. The coal is non-coking, semi-bituminous, 20 per cent ash, and has a heating value of 8700 calories. Recently two seams of coking coal have been discovered below the "big-coal." These are 3 to 5 feet in thickness.

(f) Output. When opened (1921), the yearly output was 150 metric tons; in 1923 it became 106,000 metric tons; it declined thereafter to 50,000 /sic/ in 1925, 12,000 in 1930, and 5,000 in 1931. Since 1932 it has been abandoned. Following is the yearly output from 1921 to 1931:

1921	150 MT
1922	72,000
1923	106,000
1924	81,000
1925	5,000
1926	18,000
1927	10,000
1928	21,600
1929	18,000
1930	12,000
1931	5,000

(4) Other small mines in Hsin-an-hsien. These are at (1) Hsiao-ts'un; mine area, 87.2 mou; output, small; and mined by primitive methods. (2) Li-yuan; mine area, 1068.91 mou; mined by primitive methods; output, six metric tons daily.

(5) Yu-Ch'ing Mining Co

(a) Location and communication facilities. In the eastern part of Mien-ch'ih near I-ma. There is a spur line of about 2 li from I-ma station.

(b) History. Opened 1918 with a capital of 100,000 yuan; since 1922 abandoned because of the state of affairs.

(c) Area. 28201 mou.

(d) Strike of beds is east and west with a dip of 10 degrees. Three seams were worked: 1st seam, 1 meter; 2d seam, 2 meters, 3d seam, 2 to 5 meters in thickness.

(e) Quality and quantity. Bituminous with much coal-dust; deposit said to be 5,400,000 metric tons.

(f) Output. 160 to 200 metric tons daily; 40,000 metric tons per year when in operation; it is closed down at present.

2. I-lo Coal Field

a. Location and Communication Facilities. Runs southeast of I-yang-hsien south of Lung-hai Railroad along the southern part of Lo-yang-hsien, Yen-shih-hsien, Kung-hsien, Ssu-shui-hsien to southeast of Jung-yang-hsien. It is about 130 kilometers in extent, and touches the Yu-mi coal field on the east. It is divided into the following districts:

(1) I-yang district. Runs from Ling-shan-ssu in I-yang-hsien eastward to Wan-chia-tien.

(2) Lo-yen district. Located on the border between Lo-yang-hsien and Yen-shih-hsien. Runs from Ch'ing-lung-k'ou in Lo-yang-hsien via Chi-chia-t'un, Lung-men-shan, Wu-chia-chai as far as Kao-lung, Ssu-t'un, Chan-fu-tien in Yen-shih-hsien. It is 50 kilometers long, east to west, and is one kilometer wide.

(3) Kung-Jung district. Extends across Kung-hsien, Ssu-shui-hsien and Jung-yang-hsien. To the west, from Pei River to Ch'uan-shui-t'ou for about 20 kilometers, then from there via the southern part of Ssu-shui-hsien as far as Chien-seng-tien and T'sui-miao in Jung-yang-hsien.

(4) The I-yang district is about 50 li from the Hsin-an station on the Lung-hai Railroad. The mountainous country between makes transportation difficult, but between the mines and the Lo-yang station on the railroad, the road is level, and the distance is 70 li.

b. Geology and Distribution of the Seams. The seams are located above Ordovician limestone. They belong to Permocarboniferous strata, but their development seems disconnected. There are nine seams in the I-yang district and their thicknesses are as follows:

Seam No	Thickness	Seam No	Thickness
1	5 feet	6	4 to 6 feet
2	1 to 3 feet	7	2 feet
3	3 feet	8	1 foot
4	2 to 6 feet	9	very thin
5	10 to 200 feet /sic/ (TN: Given as 200 feet but probably an error. The author tries to explain as due to a fault, but the fault was probably in the original.)		

Seams number 5 and 6 are being worked. They are only about 4 feet apart. The character of the Kung-Jung district is about the same as the above. In Lo-yen district, primitive methods are used; the No 1 seam which is similar to the No 5 seam of the I-yang district, is 20 to 30 feet thick and is being worked.

c. Quality. This is mostly bituminous or semi-anthracite. An analysis of the coal at I-yang is as follows:

	Nan-hsiang-ku-k'ou Sha-kuo-t'an	North District	San-li ho-kou
Per Cent Water	0.44	0.42	0.41
Volatiles	13.56	18.09	20.85
Per Cent Fixed Carbon	61.43	73.32	60.53
Per Cent Ash	24.55	5.70	17.92
Per Cent Sulphur	--	2.47	1.29
Coking Properties	non-coking	coking	non-coking
Heating value	7150	7700	6250

d. Deposits

	I-yang	Lo-yang	Ssu-shui Jung-yang	Kung	Teng-feng	Total
Thickness	8.0	4.8	0.3	4.4	1.5	
Area (sq km)	8	25	15	58	28	109
Deposits (Million MT) Anthracite			5	264		269
Bituminous (Million MT)	96	134			7	237
Total Deposit	96	134	5	264	7	506

e. Amount Mined (metric ton) from 1931 to 1933.

	I-yang	Ssu-shui Lo-yang	Teng-feng	Total
1931	50,000	63,500	53,000	128,000
1932	35,000	93,500	59,000	127,000
1933	39,050	93,000	58,255	125,930

f. Various Mines

(1) Hsieh-shen Mining Co

(a) Location and communication facilities. At Pei-po, Chu-yuan on the southern slope of Chin-p'ing-shan, about 3 li southeast of I-yang. The mine is 60 li from the Lo-yang Railroad station, to which it is connected by a wagon road.

(b) History. Opened in April 1932. Capital of the company is 6,000 yuan.

(c) Area and seams. The area is 600.73 mou. Seams dip 25° to 30°; the one being worked is 20 to 30 feet thick and is bituminous coal.

(d) Amount mined. 90 metric tons daily for seven months only, because it is closed during summer. Its capacity is 250 metric tons per day.

(2) Chung-hua Mining Co

(a) Location and communication facilities. At Hsing-shu-p'ing on the southern slope of Chin-p'ing-shan, 7 li southeast of I-yang; 70 li from Lo-yang Railroad Station, and 60 li from Lo-ning Railroad Station. It is only 8 li to the Lo River so transportation is convenient.

(b) History. Founded 1927; work begun 1933.

(c) Area and seams. The area is 1053.74 mou. The seam being worked is 25 feet thick and the coal is bituminous.

(d) Amount mined in one year averages 14,700 metric tons. In summer the mine is usually closed down.

(3) Ta-tung Mining Co

(a) Location and communication facilities. Near Lao-yao, Hou-kou, and Ma-kou, 1 li west of Shui-t'ou and 50 li southeast of government seat of Kung-hsien. The road from the mine to the government seat is mountainous and inconvenient.

(b) History. Opened in 1931; capital of the company is 50,000 yuan.

(c) Area. The area is 1496.48 mou. The seam being worked is 10 to 30 feet thick; the coal is anthracite.

(d) Amount mined is 160 metric tons daily, approximately 48,000 metric tons per year.

(4) Fu-chu Mining Co

(a) Location and communication facilities. One li east of Sheng-shui-ts'un in Kung-hsien; 45 li southwest of the government seat; 35 li southeast of the Hei-shih-kuan Railroad Station. The road is impassible for wagons, so pack horses are used.

(b) History. Opened in 1924; closed from 1926 to 1930 because of fighting; reopened in 1932.

(c) Area is 1665.27 mou; the seam being worked is 1 to 15 feet thick; the coal is anthracite.

(d) Amount mined is 60 metric tons daily and approximately 18,800 metric tons per year.

(5) Ts'ui-miao-chen Mining Co

(a) Location and communication facilities. Near Nan-shan, Ts'ui-miao-chen and Ti-kou in Jung-yang-hsien. The Jung-yang Railroad Station on the Lung-hai Railroad is 35 li to the north; and the Cheng Station is 70 li to the south. Except for about 20 li in the neighborhood of the mine, there are roads passable for wagons.

(b) History. Opened in 1932; mined by primitive methods.

(c) Area is 4762.35 mou; the seam being worked is over 10 feet thick; the coal is semi-anthracite with much coal-dust.

(d) Amount mined is approximately 1,500 metric tons per year.

(6) T'ung-hsing Mining Co

(a) Location and communication facilities. At Ch'en-lou-t'sun in Teng-feng-hsien. Mountains make traffic difficult.

(b) History. Opened Jan 1932, now closed down.

(c) Area is 831.6 mou; seam being worked, over ten feet thick; coal is semi-anthracite.

(7) T'ung-ch'ing Mining Co

(a) Location and communication facilities. At Pei-li-p'ing in Teng-feng-hsien; mountains makes traffic difficult.

(b) History. Opened Aug 1932.

(c) Area. 2379.18 mou; seam being worked, over ten feet thick; coal is semi-anthracite.

(d) Amount mined. 180 metric tons per day during three winter months only.

(8) Ho-kou Mining Co

At Ho-kou in Teng-feng-hsien; opened in 1933; area - 104.62 mou; 50 metric tons daily mined in winter.

(9) San-yuan-ts'un Mining Co

A small mine in Teng-feng-hsien; opened in 1933; output only few tons per day.

3. Yu-mi Coal Field

a. Location and communication facilities. Comprises the whole northern portion of Yu-hsien, Mi-hsien and Chia-yu-hsien and is known as Yu-mi coal fields. It extends from San-feng-shan over in the south to Wang-chai River in the north; a distance of over 100 li. It is divided into the following 12 districts.

San-feng-shan district. 15 to 30 li southwest of /the government seat/ of Yu-hsien; area 75 sq km

Yun-kai-shan district. 40 li west of Yu-hsien; area 45 sq km

Kuan-shan-chai district. 50 li WNW of Yu-hsien; area 15 sq km

Ti-shui-t'ai district. 6 li west of Hua-shih t'ou-chen in northwestern Yu-hsien; area 45 sq km

K'an-hua-t'ai district. 20 to 45 li northwest of /the government seat of/ Yu-hsien; area 20 sq km

Ch'ao-hua-chen district. 15 li south of /the government seat of/ Mi-hsien; area 19.5 sq km

Yo-miao district. 7 to 8 li southeast of /the government seat of/ Mi-hsien; area 6.5 sq km

Hsiao-li-chai district. 5 li southeast of /the government seat of/ Mi-hsien; area 4 sq km

Wu-li-tien district. 5 li north of /the government seat of/ Mi-hsien; area 5 sq km

Yu-ts'un district. 30 li northeast of /the government seat of/ Mi-hsien; area 3.5 sq km

Wang-chai River district. 40 li northeast of /the government seat of/ Mi-hsien; area 3 sq km

Chia North district. North border of Chia-hsien; area 5 sq km

This Yu-Mi coal field is surrounded on three sides by mountains, but connects on the east with an open plain. In the middle of the field is a cross ridge called Shang-miao-ling; south of this it is called the Yu-hsien coal field, north of it, the Mi-hsien coal field. These in turn are cut into the above 12 districts by faults. The distance from Shen-hou-chen, Lou-tzu-chao and San-feng-shan in the San-feng-shan district, via Yu-hsien, to the Hsu-ch'ang Railway Station on the Pei-ping - Han-k'ou /Ching-han Railroad/ Line, is 110 to 130 li, a level road, passable for wagons. In the future it would be easy to build a railroad here. Also, from Shen-hou-chen to the southern part of Chia-hsien for about 40 to 60 li, it is passable for horse-drawn vehicles. From Tsu-shen-miao, Ho-miao and Chu-yuan-kou mines in the Yun-kai-shan district to Yu-hsien there is a large road suitable for transportation. The Kan-hua-t'ai district is near the mountains, but there is a large road to Yu-hsien. Kuan-shan-chai and Ti-shui-t'ai districts are mountainous, and the roads are rather bad.

The Mi-hsien coal fields are on level terrain, and in general transportation is easy. The Ch'ao-hua-chen, Yo-miao, Hsiao-li-chai, Wu-tu-tien districts are 70 li from the Hsin-cheng Railway Station on the Peiping - Han-kou /Ching-Han R R./ Line. With slight repair, the road would be serviceable. Also there is a large road from Wang-chai River and Yo-ts'un to Cheng-chou, a distance of 60 li, making transportation easy.

b. Geology. The underlying rock is Ordovician limestone; the seams belong to the Permocarboniferous strata.

c. Distribution of the seams.

(1) The San-feng-shan district has 17 seams. these are 7 to 8 feet apart at their nearest, 207 feet at their farthest separation. The thickness of the seams is as follows:

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Seam Number	Thickness	Seam Number	Thickness
1	1 Chinese foot	10	3 Chinese feet
2	1-2 Chinese feet	11	2 Chinese feet
3	3 Chinese feet	12	3-4 Chinese feet
4	1 Chinese foot	13	3 Chinese feet
5	4 Chinese feet	14	3 Chinese feet
6	1.5 Chinese feet	15	15-20 Chinese feet
7	0.8 Chinese foot	16	0.6 Chinese foot
8	1.5-2 Chinese feet	17	1.5 Chinese feet
9	4 Chinese feet		

Of the above, only No 6, 9, 12, 15, 17 are being worked; the others are either too thin, or else of poor quality and are not worthwhile. (TN: Coal in the above seams is given fanciful Chinese names like Dragon Star, Willow Leaf, etc. which have been omitted.)

(2) Yun-kai-shan district. The seams being worked are the same as those in the San-feng-shan district. Near Tsu-shih they are working a seam of over 20 Chinese feet in thickness. Seam No 17 is 1.5 Chinese feet in thickness. Three seams, No 5, 9, and 12 are being worked near Szu-kou.

(3) Kuan-shan-chai District. At present they are working on two seams. The upper, bituminous, is 3 to 4 Chinese feet thick; the lower, anthracite, is about 20 Chinese feet thick.

(4) Ti-shui-t'ai District. Here they are working three seams. The upper two are 3 to 4 Chinese feet thick; the lower is 15 to 20 Chinese feet.

(5) K'an-hua-t'ai District. Four seams are being worked. The thickness of these seams, from top to bottom, is 3 to 4 Chinese feet, 25 Chinese feet, 4 Chinese feet, and 1 Chinese foot, respectively.

(6) Ch'ao-hua-chen District. Three seams are being worked. Seam No 5, 4 Chinese feet; Seam No 15, 25 Chinese feet; and seam No 17, 1 to 2 Chinese feet.

(7) Yo-miao District. Three seams are being worked. 3 to 4 Chinese feet where shallow, over 10 Chinese feet where thick.

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(8) Hsiao-li-chai District. Here seam No 15 is prominent and is from 10 to 30 Chinese feet thick. Above that the seams have been partially removed by erosion.

(9) Wu-li-tien District. Same as the previous district, the seam being 15 to 25 Chinese feet thick.

(10) Yo-ts'un District. Only one seam of 20 Chinese feet in thickness is known to exist.

(11) Wang-chai River. No precise information.

Besides the above, there are considerable seams in northern Chia-hsien District.

d. Quality of the coal. The following is an analysis of this coal:

District (Hsien) Yu

Place	Tung-feng-shan	(E) Samo	Hsi-feng-shan	Shen-hou-chen	Sha-t'un	Tsu-shih-miao
Seam No	5	6	9	12	15	17
Per Cent Water	1.04	0.65	1.95	1.20	1.42	0.60
Per Cent Volatile Matter /Gasoline/	17.21	18.07	15.27	14.45	13.58	14.05
Per Cent Fixed Carbon	65.45	62.08	46.63	59.20	74.65	74.10
Per Cent Ash	16.30	19.20	36.15	35.15	10.35	11.25
Per Cent Sulphur	0.46	0.88	1.51	1.11	2.37	1.35
Coking Property	good	slight	non-coking	non-coking	non-coking	non-coking
Heating value /Calories/	7226	7005	5401	6437	7701	7700

(The above analysis made at the Peking Geological Laboratory)

District (Hsien) Yu

Place	Shen-hou-chen	Tung Feng-Shan	Samo	Tsu-shih-miao
Seam No		5	6	
Per Cent Water	2.40	0.75	0.75	2.40
Per Cent Volatile Matter /Gasoline/	9.85	19.25	19.30	13.76
Per Cent Fixed Carbon	63.50	59.20	50.75	65.04
Per Cent Ash	24.25	20.80	19.20	18.80
Per Cent Sulphur	--	0.72	0.68	5.81
Coking Property	non-coking	coking	non-coking	non-coking
Heating Value /Calories/	7384	6837	6989	6888

(The above analysis made by the Honan Province Geological Laboratory)

District (Hsien) Mi

Place	Hsiao-li chai	Ch'ao-hua-chen	Han-t'ang-kou	Ku-chia-chuang	Wu-li-tien	Poi-chai
Seam No		15				
Per Cent Water	0.81	0.10	0.67	1.20	1.20	2.29
Per Cent Volatile Matter /Gasoline/	13.34	13.25	15.77	11.25	11.20	6.69
Per Cent Fixed Carbon	72.63	71.15	52.54	76.45	76.10	62.91
Per Cent Ash	13.22	14.50	31.02	11.10	11.50	6.13
Per Cent Sulphur	---	1.16	---	0.39	0.43	0.59
Coking Property	non-coking	non-coking	non-coking	non-coking	non-coking	non-coking
Heating Value /Calories/	7509	7371	5970	7641	7607	6030

(Analysis by the Poiping Geological Laboratory) (Analysis by the Honan Geological Laboratory)

e. Quality and Deposits. The following is a description of the quality of the coal and the amount of the deposits in the various districts. (For analysis, consult the foregoing table for reference.)

(1) San-feng-shan District. The lower middle part of the seam is anthracite. One variety is black and lustrous, holds heat and burns well but produces a bad smell. (Called smelly coal.) Another, yellow coal, has much coal dust, yellow on the surface, no lustre, burns well and is suited for home use. Four others, (Seams No 5, 6, 9, 12) give little smoke, burn well, are non-coking and are suitable for boiler or home use. The deposits cover 75,000,000 square meters. /sic/ The total thickness of the seams being worked is six meters. At a specific gravity of 1.3 the deposits amount to 585,000,000 metric tons. Since only 800,000 metric tons have been excavated so far, the amount remaining is 584,200,000 metric tons.

(2) Yun-kai-shan District. The "smelly" coal /Seam No 17/ in the neighborhood of Tsu-shih-miao gives a good heat and is suitable for pottery work. The "yellow" coal /Seam No 15/ of Szu-kou is of good quality, semi-bituminous, holds the heat and burns well and is suited to household use. The "big" coal /Seam No 5/ near Chu-yuan K'ou is bituminous and brittle.

The deposits cover 45 million square meters with an average thickness of five meters. At a specific gravity of 1.3 the deposits amount to 292,500,000 metric tons.

(3) Kuan-shan-chai District. The coal is bituminous and semi-anthracite. Length, five kilometers; depth 600 meters; seams, six meters thick. This works out to a deposit of approximately 58,500,000 metric tons.

(4) Ti-shui-t'ai District. Semi-anthracite and bituminous coal. Length, 10 kilometers; width, 4,500 meters; average thickness, five meters. This gives the deposit as 292,500,000 metric tons.

(5) K'an-hua-t'ai District. Bituminous and semi-anthracite coal; fairly good quality. Length, 17 kilometers, depth 600 meters, four meters thick. This gives an estimated deposit of 106,080,000 metric tons.

(6) Ch'ao-hua-chen District. Semi-anthracite and bituminous. Length, 15 kilometers; width, 1,300 meters; total depth of seam, five meters; deposit of 126,750,000 metric tons. Since 750,000 metric tons have been taken out already, the remaining amount is 126 million metric tons.

(7) Yo-miao District. Semi-anthracite and bituminous. Seams average three meters thick; deposit of about 25,350,000 metric tons.

(8) Hsiao-li-chai District. One seam, semi-anthracite; 10 to 20 Chinese feet thick; deposit, 15,600,000 metric tons.

(9) Wu-li-tien District. Semi-anthracite; area, five square kilometers; seams, 5 to 15 Chinese feet thick; average thickness, three meters; deposit of 19,500,000 metric tons.

(10) Yo-ts'un District. Seams average three meters thick; calculated to the depth of 600 meters, deposit of 13,650,000 metric tons.

(11) Wang-chai-ho District. Seams average three meters thick. Deposit of 11,700,000 metric tons.

The following table is a summary of the above:

Deposits in the Yu-Hi Coal Fields

District	Area (sq km)	Number of Seams	Kind of Coal	Deposit (MT)
San-feng-shan	75	6	Bituminous or Semi-bituminous	584,200,000
Yun-kai-shan	45	5	Bituminous or Semi-bituminous	292,500,000
Kuan-shan-chai	15	2	Bituminous or Semi-bituminous	58,500,000
Ti-shui-t'ai	45	4	Bituminous or Semi-bituminous	292,500,000
K'an-hua-t'ai	20	4	Bituminous or Semi-bituminous	106,000,000
Ch'ao-hua-chen	19.5	5	Bituminous or Semi-bituminous	126,000,000
Yo-miao	6.5	5	Bituminous or Semi-bituminous	25,350,000
Hsiao-li-chai	4	1	Semi-bituminous	15,600,000
Wu-li-tien	5	1	Semi-bituminous	19,500,000
Yo-ts'un	3.5	1	Semi-bituminous	13,650,000
Wang-chai-ho	3	3	Bituminous or Semi-bituminous	11,700,000
Total Deposits				1,545,580,000

f. Various Mines

(1) San-feng Mining Co. This company owns three mines viz Tung-feng, Chung-feng, Hsi-feng.

(a) Tung-feng mine

1. Location and communication facilities. On the north slope of the east peak of San-feng-shan, 15 li southwest of the government seat of Yu-hsien. The road from the mine to the government seat, and to the Hsu-ch'ang Railway Station on the Pei-p'ing - Han-kou Line (110 li) are passable for large wagons.

2. History. Opened in 1903 under the Ch'ing Dynasty; mined by primitive methods; work progressed well till fighting began; in 1927 new equipment was installed and the work was resumed.

3. Area and deposits. Three seams are being worked: Seam No 5, four Chinese feet; Seam No 6, three Chinese feet; and Seam No 9, four Chinese feet. The seams dip 10 to 20 degrees.

4. Quality. Bituminous, of more or less coking quality. The following is an analysis of the seams:

Seam No	5	6	9	5
	(Lumps) "Big" coal	"Dragon Star"	"Willow Leaf"	(Dust) "Big" coal
Per Cent Water	1.02	0.70	0.65	0.73
Per Cent Volatile Matter [Gasoline]	17.00	19.00	17.41	19.05
Per Cent Fixed Carbon	65.20	60.24	62.08	59.00
Per Cent Ash	16.30	19.20	19.20	20.50
Per Cent Sulphur	0.48	0.68	0.66	0.72
Heating Value [Calories]	7226	6989	7005	6837

5. Amount Mined. Mining is done mostly in winter and spring. In winter, 220 metric tons per day, maximum, are taken out; average for the year, 40,000 metric tons.

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(b) Yu-sheng Mine of Chung-feng

1. Location and communication facilities. On the north slope of the middle peak of San-feng-shan, 6 li from Tung-feng mine.

2. History. Opened in 1929.

3. Area, 6672.78 mou. One seam, No 9 seam, being worked, four Chinese feet thick.

4. Amount mined. None mined in summer and fall; yearly output 20,000 metric tons.

(c) Hsi-feng Mine

This is on the west peak, about 20 li from the government seat of Yu-hsien. The road between is serviceable for big wagons. Area, 6480.98 mou; at present, no longer worked; five workable seams.

(d) Chi-chung Mining Co

1. Location and communication facilities. At the northern foot of the east end of Wang-huang-shan, 25 li west of the government seat of Yu-hsien. The road to the government seat and to the Hsu-ch'ang Railroad Station on the Pei-p'ing - Han-k'ou Line is passable for big wagons.

2. History. Opened in 1924, but mining not begun till 1926. For a time 300 metric tons taken out per day, but from 1927 to 1933, because of fighting, the work practically stopped. In Sep 1933 they began to take out a little coal again.

3. Area, 32815.10 mou; two seams, No 5 and No 9, each four Chinese feet thick.

4. Amount mined. From 1926 to 1932 the yearly output was as follows:

1926	65,000 metric tons
1927	50,000 metric tons
1928	50,000 metric tons
1929	10,800 metric tons
1930	17,000 metric tons
1931	6,480 metric tons
1932	closed. Daily output 30 metric tons.

(e) Tsu-shih-miao Mine. In Yu-hsien; seam No 13, one Chinese foot or so of "Smelly" coal, semi-anthracite; daily output 10 to 15 metric

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tons. 2,700 metric tons per year for a six month period.

(f) Szu-kou, Sha-t'an Mine. In Yu-hsien, seam No 15, 15 Chinese feet of "Yellow" coal, bituminous; daily output 25 metric tons; 4,500 metric tons per year for a six month period.

(g) Shen-hou-chen Mine. In Yu-hsien; seam No 12 is now being prepared for working.

(h) Meng-ta-kou Mine in Mt Feng-ch'ih. In Yu-hsien; seam No 9, 3 to 4 Chinese feet of "Willow Leaf" coal, bituminous; daily output 20 metric tons; yearly, 3,600 metric tons for a six month period.

(i) Ch'en-kou Mine in Mt Ta-lin. In Yu-hsien; seam No 5, three Chinese feet of "Big" coal; daily output, 20 metric tons; worked six months only

(j) Huai-shu-wa Mine in Mt Ta-lin. In Yu-hsien; seam No 5, 3 to 4 Chinese feet of "Big" coal; daily output, 10 metric tons; yearly output, 1,800 metric tons.

(k) Hsin-chuang-i-hsun Mine SW of Yang-ling-chai. In Yu-hsien; seam No 12, three Chinese feet of bituminous coking coal; daily output, 14 metric tons; yearly, 2400 metric tons.

(l) Shih-t'u-shan Mine. In Yu-hsien; opened in 1933; area, 38593.5 mou. No mining done yet.

(m) Szu-hsiao-chuang Mine. Area, 8079 mou; not yet mined.

(n) Ch'ao-hua-chen - Fan-chia-chuang Mine. Located 15 li south of Mi-hsien; flat country; fairly good transportation. Area, 1378.4 mou. Mine was worked for 30 or more years before application was made to dig in 1928. Permission to dig granted Nov 1932. Seam No 15, 20 Chinese feet of "yellow" coal, semi-anthracite. Output, 200 metric tons daily; 5,400 metric tons yearly.

(o) Yu-feng Mining Co. At Li-shu-wo, three li south of Ch'ao-hua-chen in Mi-hsien, or 18 li southeast of the government seat of Mi-hsien. Level road, good for transportation purposes. Founded, 1932; capital, 2,300 yuan. Area, 1461.6 mou; seam, 18 Chinese feet thick; semi-anthracite. Daily output, 300 metric tons; yearly, 28,800 metric tons. No work done in summer.

(p) T'ung-hsin Mine. Located five li southeast of the government seat of Mi-hsien, in the west sector of Hsiao-li-chai. Opened, 1932; area, 1475.76 mou; seam No 15, 22 Chinese feet of "Yellow" coal; semi-anthracite; daily output, 200 metric tons; yearly output, 36,000 metric tons.

(q) Min-sheng Mine. At Li-shih-ya-kou, two li northeast of the government seat of Mi-hsien; the Jung-Yang Railroad Station on the Lung-Hai Line is 70 li to the north; the Hsin-Cheng Railroad Station on the Peiping - Han-k'ou Line is 90 li to the east; mountainous; difficult for transportation. Opened, 1932; capital, 1,000 yuan; area, 1470.38 mou. Seam, 7½ Chinese feet thick, semi-bituminous with much coal dust. Daily output, 100 metric tons; yearly output, 15,000 metric tons.

(r) Te-mao Mine. At Ta-yang-wa, 1.5 li outside the west border of the government seat of Mi-hsien. Transportation good to the government seat. Opened, 1932; capital, 1,000 yuan; area, 544.7 mou; seam, 21 Chinese feet thick; semi-anthracite. Daily output, 240 metric tons; yearly output, 14,400 metric tons.

(s) P'ing-mo-chieh-kou Mine. Two li south of P'ing-hsien in Mi-hsien. At present daily output, 2 to 3 metric tons.

(t) P'ing-hsien-t'ang-kou Mine. At T'ang-kou, five li southeast of P'ing-hsien in Mi-hsien. Seam, 4 to 10 Chinese feet; roads bad and at present mine is not being worked.

(u) Li-yuan and Wan-tzu-ho Mines. In Mi-hsien; opened in 1932; both mine "yellow" coal from seam No 15; yearly output, 12,600 metric tons each.

(v) Hei-yu-kou Mine. In the northeast part of Mi-hsien; "Yellow" coal from seam No 15; yearly output, 2,700 metric tons.

(w) Hsiao-li-chai Mine. In Mi-hsien; area, 996.44 mou; not being worked at present.

(x) Sung-chia-kang Mine. In Mi-hsien; area, 1482.20 mou; daily output, very small.

(y) Yen-chia-chai Mine. In Mi-hsien; area, 771 mou; not worked.

4. Hsiu-Po Coal Field

a. Location and communication facilities. From northwestern Hsiu-wu-hsien westward via northwestern Po-ai-hsien to the northern Pi-yang-hsien. It extends from east to west about 100 li. In the central part of the field near Chiao-tso-wong-chien there is an anicline which cuts the field into two districts. The Tao-Chi Railroad Line runs parallel with and through the field so that the most important mines are only 7 to 12 li from it. The main railway stations in the field are Chiao-tso, Li-ho and Ch'ang-k'ou and light railroads or lead in lines run through the mines.

b. Geology and extent of the deposits. The underlying rock is Ordovician limestone, the seams belong to the Permocarboniferous strata. Only one seam is known so far. This doubtless may be correlated as the same seam as that in the southeastern part of Shansi Province. The thickness is not constant, running from 5 to 36 Chinese feet, the average being about 15 feet. In about the center of the seam there is a layer of shale or poor glossy coal and occasionally there is a foot of poor quality coal near the bottom.

c. Quality. The coal is of a high lustre and hardness; anthracite or semi-anthracite. The following is an analysis:

District (Hsien)	Hsiu-wu					Pi-yang
Mine	Ssu-ho	Tung-shu-kou	Chiao-tso	Li-feng	(same)	Ch'ang-k'ou
Water	3.75	3.31	3.10	2.25	2.30	2.90
Volatile Matter /Gasoline/	6.12	18.14	12.45	5.33	5.83	15.55
Fixed Carbon	82.41	66.73	76.46	80.83	80.41	73.40
Coking Property		(All non-coking)				
Ash	7.72	11.82	7.99	11.29	11.46	8.15
Color of Ash	light brown	grey	light yellow	white	greyish brown	light yellow
Sulphur	0.34	0.29	0.41	0.45	0.36	0.73
Heating value (Calories)	7184	6814	7282	6882	6877	7040
Specific Gravity	1.537	1.555	1.558	1.580	1.584	1.613

(The above analysis was made by the Geological Laboratory of the Department of Commerce and Industry)

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District (Hsien)

Mine	Hsiu-wu: Chiao-tso	Ssu-ho	P'an-ho	Chiao-tso	Po-ai: Hua-hsing	Ssu-hou	Hsin-chuang	Hou-chuang
Water	2.90	0.99	2.89	2.87	2.45	2.54	2.75	2.80
Volatile Matter /Gasoline7	9.36	6.03	5.66	5.66	7.29	15.55	6.25	4.45
Fixed Carbon	86.81	80.27	81.16	81.16	77.06	72.39	78.42	81.70
Coking Property	non-	non-	non-	coking	non-	non-	non-	non-
Ash	9.88	12.71	10.31	10.31	13.20	9.61	12.10	11.05
Color of Ash	--	--	--	--	--	--	--	--
Sulphur	0.41	--	--	--	--	--	0.48	0.35
Heating Value (Calories)	6048	--	6914	6615	7296	7679	7363	7198
Specific Gravity	--	--	--	--	--	--	--	--

(Analysis made at the Peking Geological Laboratory) (Analysis made at the Honan Geological Laboratory)

d. Amount of Deposits

If the amount of coal deposits is calculated for the area between the mountain stream flowing to the east of the Ssu-ho mine to the river west of the Ch'ang-kou mine and to a depth of 300 meters below sea level, or in short, a perpendicular depth of 438 meters from the floor of the Chia-tso basin, it would be as follows:

Area (sq m)		Thickness (m)		Specific gravity		Deposit MT
28,925,000	X	4.5	X	1.5	=	195,243,750

Of the above, some 100 million MT are left to be mined.

Another estimate:

The Li-ho, Ssu-ho district (eastern part) and the Li-f..., Wang-feng (western part) are as follows:

The former extends 12 kilometers; the average thickness of the seams is 6 meters; average dip, 14°; specific gravity, 1.4; to a depth of 1000 meters, the deposit is 1200 X 4134 X 6 X 1.4 = 416,707,200 metric tons. The latter extends 11 kilometers; average thickness of seams, 6 meters; average dip, 10°; specific gravity, 1.4; to a depth of 1000 meters; the deposit is 1200 X 5757 X 6 X 1.4 = 531,946,800 metric tons.

Thus the deposit in this coal field amounts to approximately 948,654,000 metric tons. If mined to a depth of 600 meters it would be 609,786,000 metric tons.

c. Various Mines

(1) Chung-Fu Amalgamated Co

(a) The field belonging to this company has a long history. It was first mined in a small way by primitive methods; in 1901 a Peiping syndicate, the Fu Co, acquired a field in the center, 15 li by 5 li and began mining on a large scale with foreign equipment. In 1915 a company called Chung-Yuan was formed which took over the rest of the field viz, 15 by 5 li in the east, 12 by 5 li in the west, and competed with the Fu Co which was half native, half foreign in its methods. It is said that the Fu Co, rather than go under, united with Chung-Yuan to form a new company, the Chung-Fu Co. Thus competition was eliminated and the development of the coal field assured. The capital of the Chung-Yuan company was three million dollars, and in March 1922 at the meeting of the directors it voted an additional million dollars. The Fu Co was backed by English investments, with its main office at Peiping and with a capital of 1,500,000 pounds. The Chung-Fu Company's capital was 3 million dollars and one Chinese and one Englishman was selected as directors. In 1933 this became known as the Chung-Fu Amalgamated Company.

The most important mines in the field are five in number, viz beginning at the east, Ssu-ho, T'ung-shu-kou, Chiao-tso, Li-feng and Ch'ang-k'ou. Chiao-tso and Li-feng were formerly the mines of the Fu Co, the other three were owned by the Chung-Yuan Co.

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(b) Amount of coal mined. This is shown in the following table:

Year	Amount Mined by	
	Chung-Yuan Co	Fu Co
1913		421,803 MT
1914		251,707
1915		425,942
1916	416,627 MT	449,242
1917	340,385	506,087
1918	431,635	627,927
1919	832,763	449,742
1920	734,895	561,834
1921	245,290	648,716
1922	400,000	505,109
1923	568,404	694,143
1924	943,339	670,835
1925	564,200	255,918
1926	54,000	116,673
1927	93,928	Ended
1928	313,123	
1929	286,511	
1930	935,198	
1931	840,104	
1932	630,741	
1933	347,305 (to May)	
	424,695 (June-December by the Chung Fu Amalgamated Co)	
1934	909,600	
1935	531,234 (to June)	

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(2) Min-Yu Mining Co

Its mine is located 40 li northeast of (the government seat of) Po-ai-hsien and six li north of the Ch'ang-k'ou Railroad Station at Hou-hsin-chuang. Traffic - good. Regular mining was begun in 1932; the mine area is 1011 mou. The seam being worked is 25 Chinese feet of anthracite coal. Daily output, 500 metric tons.

(3) Hsiao-hsu-chuang Mine. In Po-ai-hsien. Mining begun by native methods in 1918; area, 6831 mou. Now abandoned because of lack of capital.

b. Limestone

Since the underlying rock of the various coal fields is Ordovician limestone, it is evident that it is widely distributed throughout this region. Careful surveys have not been made, so, little is known of the quality or of the extent of the deposits. But it is safe to say that upon investigation, limestone suitable in quality and quantity for various industrial purposes will be found. At present lime is obtained by calcination of the limestone.

c. Fire-resistant clay. (Alumina shale and potters' clay)

It is reported that there is such clay near all the coal fields. Since the seams are found in Permocarboniferous strata, where these meet Permotriassic strata we may expect to find the so-called A and G strata of clay of an alumina shale variety; also there is clay within the seams of coal. Further investigation is necessary before the extent, amount and quality of these deposits can be known but I will mention what the sources already at hand say on the subject.

(1) Hsin-mien Coal Field

Potter's clay is found near Kuan-yin-t'ang, and porcelain and electrical appliances are manufactured by the mining company. The soft clay is probably used from above the G stratum.

(2) I-lo Coal Field

Probably G clay exists here too.

(3) Yu-mi Coal Field

Here not only A and G, but also B, C, E and F strata clay is found, both of soft and hard quality. The pottery at Shen-hou-chen (in Yu-hsien) is famous. Also, clay is reported at San-feng-shan.

(4) Hsiu-po Coal Field

It is certain that G stratum clay exists here; it is reported to be two meters thick. Near Li-ho and Pei-shan it is dug out and used as material for pottery and fire-resistant brick.

(5) Conclusion

It seems practically certain that fire-resistant clay (alumina shale and potter's clay) exists in all the above coal fields; but whether it is of good quality for making fire-resistant brick or for aluminum must await further study. The extent of the deposits may be inferred from that of the coal fields.

d. Iron Sulphide

Pyrite is often found in Permocarboniferous strata, but whether the amount in this region is small or non-existent cannot be said with certainty. In Hsin-an-hsien and Po-ai-hsien there is a considerable amount found in the argillaceous shale at the bottom of the coal seams, as may be seen from the following discussion.

(1) Hsin-an-hsien, Iron Sulphide

(a) This is found 70 li northeast of the government seat of Hsin-an-hsien at K'uang-lan-chen, formerly K'uang-k'ou, and nearby villages such as: Tung-wo-ts'un, Hsi-wo-ts'un, An-lin, San-kuan-miao, Chu-yuan and Tan-ch'ih. The 90 li distance from K'uang-k'ou to Lo-yang Railroad Station is a broad road passable for wagons; but from K'uang-k'ou to the mines is from 3 to 4 li at nearest, 20 li at most; and the roads are bad.

(b) Geology. The ore deposit is found in the argillaceous shale at the bottom of the Permocarboniferous strata. Pyrite in the shale is in the form of tubers, lumps, or crystals, at times accumulated into sack-like form, and at other times scattered through the shale. This stratum of shale which holds the pyrite is some eight meters thick, but where the pyrite is found it is three Chinese feet thick, sometimes only a few inches thick. The part containing the pyrite in this shale is about 25 per cent of the whole

(c) Quality. Sulphur content is [illegible] in the crystalized form, but less in the lump variety. In the former the pyrite content is about 70 per cent. From 150 Chinese pounds of ore 30 Chinese pounds of sulphur may be obtained. The natives, using a primitive method, are able to get only 13 Chinese pounds from 150 Chinese pounds of ore. An analysis of the ore is as follows:

Best grade ore (crystallized), sulphur 49.825%; iron 46.67%
Second grade ore (lumps), Sulphur 44.041%; iron 40.92%

It is difficult to estimate the amount of the ore deposit; but if it is distributed in an area 1,000 meters wide, 3,000 meters long, at an average thickness of 0.45 meters, the deposit would be 135,000 cubic meters. With specific gravity of 3.2, and assuming the ore to be 25 per cent of the shale, the weight of the ore would be 1,080,000 metric tons. Deducting the amount already extracted, would leave about 10,000 metric tons. The greatest remaining amount is probably at Tung-wo-ts'un

(d) Production. Mining by native methods is not done during the height of the farming season; seven months is the most possible time for mining. At present most of the mining is being done at the villages of East Chu-yuan, Tan-ch'ih-p'o, and Tso-chin. Tung-wo-ts'un is next in importance. At present there are about 150 furnaces in the region, handling the raw ore as follows: daily, 2,500 Chinese pound (kin) (kin is about 1 1/3 lbs); monthly, 75,000; yearly, 525,000 kin, or about 320 metric tons or more. The mining bureau of Hsin-an buys up the rough product and refines it. This it sells throughout the country. Most of it is consumed in Honan Province, but a large amount is sent to Shantung, and recently even to Shanghai. The output is so small that it cannot keep pace with the demand.

(2) Iron Sulphide of Po-ai-hsien. This is found in three districts:

(a) Villages near Hsiao-ling, 30 li northwest of the government seat

(b) Villages near Ssu-hou, 20 li northeast of the government seat

(c) Li-feng and neighborhood

The road from the mines to the government seat is mountainous and bad. From Po-ai, however, there is a railroad.

Geology. At the base of Permocarboniferous strata there is grey shale and clay containing pyrite. The stratum containing pyrite is at the bottom of the lowest seam which is about six meters down, its thickness is two meters. Pyrite is scattered unevenly through this stratum in the form of tubers or lumps. Its appearance is just like that at Hsin-an-hsien. The ore bed is from several centimeters to one meter thick. The highest grade ore has a sulphur content of 33.688%; iron, 34.73%; the next grade has a sulphur content of 32.04%; iron, 25.92%. The area of deposits is about five square kilometers, the ore deposit being 1,200,000 metric tons.

There are 80 furnaces in the district with a daily output of 1,200 Chinese pounds of sulphur; monthly, 40,000 Chinese pounds; yearly, 300,000 Chinese pounds or approximately 230 metric tons. The product is bought up by a mining bureau similar to that in Hsian-an and is refined and sold in the country.

e. Fluorspar

Said to be found in Hsin-an-hsien, but no detailed information is available.

f. Gypsum

This is known to exist in this region at Kung-hsien, Shan-hsien and P'ing-lu-hsien in Shansi.

(1) Kung-hsien. Gypsum is said to be found here but there are no details.

(2) Shan-hsien. Gypsum is said to exist at Tai-an-t'sun but details are not clear. The same strata are found here in the northern part as in P'ing-lu-hsien in Shansi, so in all probability the gypsum here is the same as that in P'ing-lu-hsien.

(3) P'ing-lu-hsien. From San-men-ling east of the government seat, following the northern bank of east Yellow River for about 30 li, there are four exposed areas: at San-men-ling, 5 li east of the government seat; SW of Hsu-yu-fen, 65 li east of the government seat; NE of P'an-nan-kou, 70 li east of the government seat; and east of P'o-ti-ho-ts'un, 80 li east of the government seat.

Of the four places, the last named has the best gypsum. Transportation here is by pack horses; and once the Yellow River is reached, boat transportation is utilized.

The gypsum of this region has, since 1884, aroused the attention of the natives, who have been excavating it to some extent.

Geology. Tertiary (?) laterite contains the gypsum. The thickness of the strata ranges from 4 to 5 Chinese inches to over a Chinese foot. The extent of the deposit is ten kilometers in length and 1 to 5 kilometers in width.

The output for 1932, 1933 and 1934 was 2900, 2000, and 2500 metric tons respectively.

g. Other minerals

There are no other important nonmetallic resources except those already named. There is some marble, inkstone, and stone for building material. There is also some dolomite, but as the amount of these materials is small, they will not be discussed.

2. Metallic Resources

a. Iron Ore. This is always in the form of Shansi iron ore which is found at the base of Permocarboniferous strata.

(1) Hsiu-Po iron ore. This is found between the Ordovician limestone and the coal seams in the form of tubers, of uneven thickness, from 0.5 to 2.5 meters. The extent of the deposit is 15 km from Yen-ho Feng-huang-ling on the west to all of Li-chuang on the east. With the exception of Feng-huang-ling and Li-chuang, the amount of ore is very small; and since it is not concentrated in any specific area, it does not pay to mine it. For this reason, too, it is hard to make any estimate of the amount of the deposits, but if the Feng-huang-ling and Li-chuang area is included, it would amount to approximately 50,000 metric tons. In 1926 Hsung-yu Co began to mine this ore and set up a furnace at Hsin-hsiang, but abandoned the work after a few months. An analysis of the ore is as follows:

	Iron (per cent)	Sulphur	Phosphorus	Silica	Manganese
Good	48.66	0.11	0.04	13.59	0.14
Inferior	37.77	0.45	0.40	19.36	--

(2) Hsin-an-hsien Iron Ore. This is found at Ho-t'ao-yuan and Chang-yao-yuan 40 li northwest of the government seat, 20 li from the T'ieh-men Railroad Station on the Lung-Hai Line, but the road is mountainous and bad. The ore is of the Shansi variety like that at Feng-huang-ling. The ore is kidney ore, (hematite), 55 per cent iron, high in manganese content, low in phosphorus and sulphur. Amount of deposit is not clear, but the extent of deposit is about 15 square li.

(3) Shih-liu-yuan and Feng-men-k'ou iron ore of Kung-hsien. This is found at Shih-liu-yuan and Feng-men-k'ou; the former is 20 li southeast of the government seat, the latter is 10 li east of the former. Communication is difficult. The ore is of the Shansi variety, hematite.

b. Copper Ore

(1) Mang-shan and Chen-ling Copper Ore of Chi-yuan-hsien. This is found in a district 40 to 80 li northwest of the government seat in such places as Sun-chen-jen-fen, Ting-yu-kou, Ma-t'ou-shan, Hsiao-kou, Huang-t'u-yao, Chih-ma-yao, In-t'ung-yao, Ch'ing-T'ung-kou, Chieh-p'an-kou, Ch'e-fu-kou, Shui-ke-chien, Tou-fu-kou, Huang-t'ung-kou, Ching-hsu-kung, An-p'ing-chih-fang and An-ling. Rocks in this region are gneiss, schist, crystalized limestone and quartzite. There are malathite, azurite, cuprite, chalcopyrite together with iron pyrite and gelena in the ore. Copper ore is imbedded in the veins of quartz which pierce these. The veins are 1 to 3 Chinese feet wide; the copper content is 28 per cent at best. There is a slight amount of gold, 5 momme (momme is 3.75 grams) per metric ton. The amount of the ore is not clear, and since the deposits are small and scattered, they have not yet been worked.

c. Lead and Silver

(1) Hsi-ch'ien-ling in Hsin-an-hsien. Used to be mined but details are not available.

(2) Shuang-feng-shan in Chi-yuan-hsien. No details available.

(3) Cheng-chia-ling in Kung-hsien and at T'ien-chung-wan in Mi-hsien. These two places are very near to each other. It is said that they were once mined, and considerable silver taken out, but details are not available.

(4) San-feng-ssu silver mine in P'ing-lu-hsien. At a place east of P'ing-lu-hsien, north of San-feng-ssu Temple, and south of Chui-tzu-shan. It is 50 li from the government seat and the roads are bad. The geological formation is paleozoic gneiss. In this, veins of from several Chinese inches to a Chinese foot in width are found, but details are not available.

TABLE SHOWING THE UNDERGROUND RESOURCES IN THE YELLOW RIVER BASIN

NOTE:

A. In the original document, information is listed in tabular form with the following headings

1. District names (Hsien)
2. Place name or mine within the district
3. Location
4. Mine bed
5. Quality
6. Quantity (deposit)
7. History
8. Remarks
9. Source of information (Chinese publication)

B. The above headings are omitted from the translation. Columns 1 and 2 were combined into one column. Many names are omitted in column 2 because district names are sufficient for location of resources.

Column 9 is omitted because it is all in Chinese, and the information from these sources is included in the chart.

Columns 5, 6, 7 and 8 have very little information. Where there is information, it is included in columns 3 or 4 depending on its pertinency.

GOLD

Shantung Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Li-cheng	Chin-hsiao-ho	Chin-hsiao-ho area	Many veins
Meng-yin	Lao-niu-yu	20 li NE of the govt seat	Alluvial
T'ai-an	Chin-ching	40 li NE of the govt seat	Alluvial 50 x50 km 8 m thick
Lai-wu	Mao-sheng-t'ang	30 li S of the govt seat	Alluvial 20 li long
Hsin-t'ai	Ta-liu-chuang	20 li SE of govt seat	Alluvial
	Yen-ling-kuan	60 li NW of govt seat	"
	Lung (?)-yen	30 li N of the govt seat	"
Wen-shang	T'an-shan	50 km N of Tzu-yang	300 X m Other veins
Honan Province			
Ch'ung	Kao-tu, Te-t'ing Chuang-yu	160 li NW of the govt seat	Alluvial 60 sq li Average width of seam, 1 m Deposit 5,486,745.6 Chinese ounces (tael Remarks, Important
Shensi Province			
Hua	Chin-t'ui Ch'eng-chieh	6-7 li SE of the govt seat	Alluvial
Pei-shui		120-140 li SE of the govt seat	Alluvial - 40 to 50 li
Kansu Province			
Yung-teng - ?		Ta River Basin	
Yu-chung	Huang-shih-p'ing		
Ching-yuan	Yu-feng-ssu, Wu-fu-ssw	South bank, Yellow River	
Kao-lan	Chin-sha-p'ing	40 li E of the govt seat	

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GOLD

Kansu Province (Cont'd)

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Ch'ing-shui		100 li N of the govt seat	

Tsinghai Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
T-t'ung	Liu-huang-kou		Alluvial
	Tung-kou		"
	?e-ni-ho		"
	O-po, Po-ling-yao		"
	T'ien-p'eng-ho		"
	Shang-ch'uang		"
	Yeh-niu-kou		"
	Ta-t'ung-ho Basin		Well known Good prospect Should be investigated
Le-tu			Oldest hopeful "Thread gold"
Hsi-ning	Shun-shan-t'ang Huang-shui Basin		Alluvial "Thread gold" Annual output, 10,000 English ounces Important

LEAD and SILVER

Shantung Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Tzu-ch'uan	Niu-chiao-shih ch'ang	16 km SSE of P'u-chi Station along the Chiao-chi RR	Lead in a quartz vein in limestone Small amount
Po-shan	Chu-chia-chuang Nan-shan in Ku-shan district		Lead in limestone Poor and scarce 5.6% Experimented but abandoned later Mine opened in late Ching Dynasty

Hopeh Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Tz'u	Ch'i-chi-ling	110 li NW of the govt seat	Lead
	Ta-kung-k'ou		"

RESTRICTED

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Honan Province			
Lu-shih	Pei-sha-tung		Silver
I-yang	?		"
Ch'ung	Chiao-kou Li-tsu-p'ing		Lead and Silver
	Shang-chuang-p'ing		Lead
Hsin-an	Hsi-ch'ien-ling		Lead
Lo-yang	Shuang-feng-shan		"
Hui	T'ou-tao-kou		Lead in limestone pockets
Hsin-hsiang	Chang-feng-t'ang		Lead in limestone pockets
Chi	Pei-hao-shan		Lead in limestone pockets (galena)
I-yang	Yang-p'ing-chen Cheng-chia-ling		Lead in argyllite and calcite. Silver 8 ounces per metric ton
Mi	T'ien-chung-wan		Galena and Silver Silver 8 ounces per metric ton
Shansi Province			
Li-shih	Ma-t'ou-shan	60 li NW of the govt seat	In sandstone, limestone and quartz schist
P'u	Hsia-ts'un	45 li NE of the govt seat	Sandstone, limestone
Wen-hsi	Hsi-shan-kou	45 li from the govt seat	Quartz schist
P'ing-lu	San-feng-ssu	80 li E of the govt seat	In paleozoic gneiss
Chieh	T'ao-hua-tung	8 li SE of the govt seat	In limestone
Ninghsia Province			
A-la-shan			

RESTRICTED

Kansu Province

DISTRICT	PLACE NAME OR MINE	LOCATION	DEPOSIT
P'ing-liang			Silver
Yung-teng	Niu-ma-t'ou-hsia		Lead and Silver 50 ounces of silver per metric ton
Yung-teng	Ch'a-mao-t'sang		Lead
Ning-ting	Li-shu-ssu		Silver
Lin-hsia			"
Ching-yuan	Hung-kow and Li-shu		Lead
COPPER			
Shantung Province			
Li-ch'eng	T'ao-k'e	32 km SE of Chi-nan	In gneiss. Chalcopyrite Nickel 2% Small amount About 3,000 metric tons It is being worked now Should be developed
T'ai-an	?	SE of the govt seat of T'ai-an	
Honan Province			
Chi-yuan	Mang-shan, T'ai-ling	40 to 80 li NW of the govt seat	High grade copper In gneiss and lime-stone Formed from malachite and cuprite Many veins 1 to 3 Chinese feet in width Should be investigated
I-yang	Erh-lang-chen		Country-rock consists of conglomerate and quartzite in form of pockets, diameter 2 Chinese feet Chalcopyrite
Shansi Province			
Wen-hsi-yuan			2% copper
Ch'u-hsia-wei			
Ninghsia Province			
Chung-wei			

RESTRICTED

COPPER

Kansu Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Ching-yuan			
Hung-shui			Mine open in 1911
Yung-teng	Shih-men-kou		
T'ao-sha	Man-p'ing-kou		
Kao-lan	T'ung-ch'ang-kou		Width 70 CO Length 30

Tsinghai Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Hsi-ning			
Le-tu			

IRON

Shantung Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
I-tu	Chin-ling-chen	approximately 6 km N of Chin-ling-chin railroad station on the Chia-chou - Chi-nan RR	History: Mine started in 1905 by the Germans. After the World War Japanese took it over and worked it from 1920 to 1922 producing about 420,000 metric tons, Now discontinued Limestone and Diorite Hematite and Magnetite iron, 47 to 60%. 10 million metric tons deposit. Also prospects in neighborhood
Li-ch'eng	Yen-ch'i-shan and others	E of Chi-nan, to Chin-ling-chen	Exposed in limestone and diorite Should be investigated
Lai-wu	Lu-tung-chih		Exposed in limestone and diorite Should be investigated
	K'uang-shan	20 miles NNW of the govt seat	Exposed in limestone and diorite Should be investigated; magnetite

IRON

Shantung Province (Cont'd)

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
	Ch'eng-tzu Po		Hematite; 300m x5 m
	Yin-shan		Deposit one million metric tons
	Tung-an-chia-ling		200 m x 30 m Deposit 6,200,000 metric tons
T'ai-an	Chiao-yu		No outcrop
Hsin-t'ai	Hsin-t'ai coal fields		Below permo-carboniferous stratum Red Good; iron 60%
Ning-yang	Lao-kou-shan	S of San-t'ai-shan, near southern station on the Chin-p'u RR	

Henan Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Hsiu-wu and Po-ai	Feng-huang-ling to Li-chuang	20 li N of RR	"Shansi" iron; 15 km seam 0.5 to 2.5 m 150,000 metric tons
Hsin-an	Ho-t'ao-yuan and Ch'ang-yuan	20 li NW of the govt seat	"Shansi" iron 55% Some manganese
Kung	Shih-liu-yuan and Feng-hsiang-k'ou	20 li SE 10 li E of govt seat	"Shansi" iron Hematite
An-yang	Hao-ching-kou and others		
Lin	T'ao-hua-chi		

Shansi Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Chao-ch'eng		40 li E of the govt seat	"Shansi" iron in sandstone Limestone Iron 40%
Hu-kuan	Shen-chia-kou		"Shansi" iron Iron 56 to 60%
Ch'ang-chih		70 li S of the govt seat	

RESTRICTED

IRON

Shansi Province (Cont'd)

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Ling-ch'uan	Northwestern Ling-chuan-hsien		"Shansi" iron Iron 50%
Kao-p'ing		Coal field	"Shansi" iron 40 to 51%
Pi-shui		Coal field	"Shansi" iron 50%
Chin-ch'eng			Iron over 50%
Yang-ch'eng			Iron 53%
Wen-hsi	Shi-t'ung (?)	25 li NW of the govt seat	
Chieh	T'ao-hua-tung	8 li SE of govt seat	In sandstone, limestone argyllite
Yu-hsiang	Wang-kuan-yu	15 li SE of the govt seat	In sandstone, limestone, argyllite
Hsi		NE of the govt seat	"Shansi" iron 50%
Hsiao-i	Shen-chia-kou	Near Tui-chiu-yu	"Shansi" iron 50%
Chung-yang	Shang-ch'iao-chen	E of the govt seat	In limestone
Lin	Chao-hsien-chen	100 li SE of the govt seat	In sandstone, limestone
Shensi Province			
Fu-ku	?	10 li NE of the govt seat	"Shansi" iron
Han-ch'eng	Chih-hu-ch'uan	60 to 70 li N of the govt seat	"Shansi" iron, deposit 2,909,000 metric tons Hematite
	Chu-yuan-ts'un	Bad road for 50 li	It was once worked
Lueh-yang	Pa-p'ai	170 li W of the govt seat	
Kan-ch'uan	Ch'uan-fu-ts'un-chen		
Feng	T'ieh-lu-ch'uan and others	150 to 160 li S of Feng-hsien	Mine opened 1932 Work begun 1933

RESTRICTED

IRON

Shensi Province (Cont'd)

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
	Ta-shih-yeh Kao-ch'iao An-ho-lao		Produced 400 kin (kin - 3.75 gram) per day
Lo-nan	Wu-ts'un-chen	60 to 70 li SE of the govt seat	Annual output 300,000 to 400,000 kin
Meng-chiang			
Ku-yang	[illegible]-i-ming	20 li SW of the govt seat	In gneiss Deposit 700,000 metric tons
Sa-la-ch'i	Lao wo-p'u	N of Sa-la-ch'i	Magnetic iron exists in vein granite
Ninghsia Province			
Ning-hsia			
Kansu Province			
Ku-lang	Ta-ch'ing-pao		
Yung-teng	Shang-lan-shih	NE section	Strike - N & S Veins - 5 Chinese feet wide
Kao-lan	T'ieh-shih-shan		150 x 6 Chinese feet
	Huo-yen-shan		Vein - 2 li x 30 to 50 Chinese feet
	Che-yao-shan Chin-ke-shan		Vein- 100 to 400 x 20 to 40 Chinese feet
	Pai-shih-kung		Vein - 100 x 20 feet Started 1934 but was discontinued 2 years later
Ch'ing-yang	Heng-ling		
Hei-ning	Pai-shui-erh	Northern section	Vein - 1000 x 100 Chinese feet Deposit 100 metric tons

Kansu Province (Cont'd)

DISTRICT	PLACE NAME OR MINE	LOCATION	DEPOSIT
Hung-shui	Chu-tsui-chuang-pa		Vein - 100 to 150 Chinese feet long Width 3 to 15 Chinese feet Contains a little copper
Tsing-hai Province			
Le-tu	Hsia-k'ou Ts'ai-ts'ao-t'ai		100 to 600 x 400 Chinese feet contains limestone
Le-tu-Pa-yen	Ching-sha	On the border of the two	3 Chinese feet wide Contains much silica, poor quality
MANGANESE			
Shantung Province			
Hsin-t'ai	Pei-tso	25km W of the govt seat and 36 km E of South Station on Tientsin-Pukow RR	6 km long Manganese in round lumps 25% Manganese sand Deposits - 19,000,000 metric tons
Kansu Province			
Ying-teng	Right side of Shang-lan-shih	Northeastern section	7 x 20 Chinese feet
Kao-lan	Pai-shih-kuan		10 x 20 Chinese feet
ALUMINA SHALE			
Shantung Province			
Tzu-ch'uan and Po-shan		Tzu-ch'uan- & Pishan Coal fields	History: Mined by natives and Japanese. Shipped to Japan Recently developed by the North China Aluminum Mining Co. Located above and below the coal seam. Known as G and A seams respectively. Outcrop of "G" unknown, outcrop of "A" 62 km long. Est Deposit - 1,000,000,000 tons Cal Deposit 200,000,000 Tons

Shantung Province (Cont'd)

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
			Cal High Grade Deposit 2,500,000 ons Actual Deposit 62,000,000 Tons Act High Grade " 2,000,000 Tons Deposits accessible for open pit mining 1,250,000 Tons Average grade of A seam 40% Al_2O_3 High Grade Deposits 55% to 80% Al_2O_3
Hsin-t'ai and Meng-yin	Hsin-t'ai & Meng-yin Coal fields		
Ning-yang	Tzu-yao	Ta-wen-k'ou Coal fields near Tzu-yao	G seam 2-5 m thick scant alumina
T'ai-an	Yu-ts'un	Ta-wen-k'ou coal field near Yu-ts'un	A seam, 2.5-3 m thick
Honan Province			
Chang-te	Ta-ho-kou	Ta-ho-kou coal field	G seam
Shan	Kuan-yin-t'ang	Hsin-Mien coal field	
Yu and Mi		Yu-Mi Coal field	Appears to be A and G seam
Hsiu-wu and Po-ai		Within Hsiu-Po, the Tsao-tso	G seam, 2 m thick
Kansu Province			
Kao-lan	Hao-yu-chen	40 li S of the govt seat	Potter's clay kaolin
Ying-ten	Yao-chieh	60 li S of the govt seat	Potter's clay kaolin

COAL

Shantung Province

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Tzu-chuan	Tzu-chuan coal field	E of Tzu-ch'uan Railroad Station Between Tsingtao and Chang-tien 295 km Between Chang-tien and Tzu-chuan 18 km	Permocarboniferous 3,4,5,9,10 seams are best. Semi-anthracite and anthracite. Coking type Heating value 7000-8000 calories 209,098,000 metric tons
Chang-ch'iu	Chang-ch'iu coal field	Coal field S of Ta-lin-ch'ih and Lung shan Sta on Shantung RR Greater portion is in Chang-ch'iu-hsien and partially in Tzu-ch'uan-hsien	
Lai-wu	Lai-wu coal field	Extends 1.33 li W from Sha-t'an (7 li S of govt seat)	
	Yen-chuang coal field	Centered around Yen-chuang 30 li SE of govt seat	
Hsin-t'ai	Hsin-t'ai coal field	Area between Wan-nan (25 li S of govt seat) and Wan-yao-t'ou (36 li WSW of govt seat) 30 miles E of Ta-wen-k'ou Sta	
	Ch'uan-kou coal field	23 li WNW of govt seat 9 miles N of Hsin-t'ai coal field	
Men-yin	Wen-nan coal field	Near Wen-nan W of govt seat	
Tai-an	Shen-yu coal field	Near Shen-yu in hsien	

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
	Yu-ts'un coal field	30 km ESE of Ta-wen-kou sta on Chin-p'u RR	
Ning-yang	Tzu-yao coal field	E of govt seat near Tzu-yao-ts'un	
Hopei Province			
Tz'u	Tz'-hsien coal field	W of the govt seat There is a coal hauling RR 42 li from Ma-t'ou-chen sta on Ching-han RR	
Honan Province			
An-yang	An-yang coal field	In An-yang-hsien and partly in Tz'u-hsien there is a spur line from Feng-le-chan sta on Ching-han RR 40 km directly NW of Chang-te-fu	
	Shui-chih-chen	45 li W of Chang-te Area is 4 km E to W, and 8 km N to S	
T'ang-yin	Hao-pi-chen	45 li WNW of T'ang-yin Sta on Ping-Han RR	
Hsian-an - Chi-yu'an - shan - Mien-ch'ih	Hsin-mien coal field	N of Shan and Hsin-an Sta on Lung-Hai RR from the western border of Tsi-yuan-hsien (in the E thru Hsin-an-hsien to the area between Hsin-an-hsien and Shan-hsien in the W)	

RESTRICTED

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Iyang-Lo-yang-Yen-shi-Kung-ssu-shui-Tung-yang	Iyang coal field	S of Lung-hai RR from the SE of I-yang-hsien thru the southern parts of Lo-yang, Yen-shih, Kung and Ssu-shui to the SE of Tung-yang-hsien	
Yu-mi	Yu-mi coal field	Northern sectors of Yu-hsien, Mi-hsien, and Chia-yu-hsien	
Hsin-wu Po-ai	Hsin-Po coal field	From northwestern Hsin-wu-hsien through the northern part of the western Po-ai-hsien to the northern part of Ch'ing-yang-hsien	
Shansi Province			
Tse-chou Yang-ch'eng	Tse-chou coal field	Near Tse-chou and northeastern Yang-ch'eng-hsien	
Kao-ping-Chin-ch'eng	Kao-p'ing coal field	Centering on Kao-p'ing Area 35 km E to W 40 km N to S	
Ch'in-shui	Yao-t'ou coal field	10 km W of govt seat	
	Chung-tsien coal field	17 km SW of govt seat	
I-ch'eng	Ti-chia-ch'iao coal fields	18 km E of govt seat Area 10 km E to W 5 km N to S	
Po-shan	Po-shan coal field	Area of 15 sq km in Poshan-hsien Tzu-chuan-hsien	Permocarb 11-16 seams best, oily coal 1.5 to 3 Chinese feet thick

RESTRICTED

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Po-shan (Cont'd)			Large and small coal 3.5 to 11 Chinese feet thick Semi-anthracite and anthracite non-coking Heating value - 6000-8000 calories 169,654,400 metric tons
Chang-ch'iu	Chang-ch'iu coal field	South of RR near Lung-shan Sta partly in Tzu-ch'uan	13 seams bituminous semi-anthracite Some coking 194,634,000 metric tons
Lai-wu	Lai-wu coal field Yen-chuang coal field	Extends 1.33 li W from Shu-t'an (7 li S of govt seat)	Semi-anthracite 50,000,000 metric ton One seam, 1.6 to 7.2 Chinese feet Three seams in E part Two seams in W part 1.6 to 6.4 Chinese feet thick Coking 30,000,000 metric feet
Hsin-t'ai	Hsin-t'ai coal field	25 li S of the main town to Wan-yao-t'ou 36 li southeast, 30 miles from Ta- en-kou RR Sta	Seven seams, 0.5 to 5 Chinese feet Coking 80,000,000 metric tons
	Ch'uan-kou coal field	23 li WNW of the main town 9 miles N of Hsin-t'ai field	Three seams 1.6 to 5 Chinese feet Anthracite "Rich" deposit
Meng-yin	Wen-nan coal field	Near Wen-nan	Seam 9 Chinese feet Coking 24,830,000 metric tons Underground 500 meters

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
T'ai-an	Shen-yu Coal field	Near Shen-yu	Output 6,500 metric tons per year. (5 seams)
	Yu-ts'un coal field	30 km SE of Ta-wen-k'ou RR Sta	0.6 to 4.1 m Good coking property 6600 to 7800 calories Deposit remaining- 31,500,000 metric tons
Ning-yang	Tzu-yao coal field	E part of the govt seat near Tzu-yao, (?)	8 seams 0.7 to 1.67 m. Good coking High sulphur content 6,500 to 7,500 calories 48,610,000 metric tons
Hopeh Province			
Tz'u	Tz'u-hsien coal field	W part of the govt seat 42 li from Ma-t'ou RR Sta	9 seams 5.5 m bituminous Coking 6500-8000 calories 285,800,000 metric tons
Honan Province			
An-yang	Ta-ho-kou coal field	From An-yang through Tz'u-hsien, NW of Chang-te 40 li A branch railroad	10 seams, 5 good 3 to 5 m Coking 7000-8000 calories, 258,800,000 metric tons
An-yang	Shui-chih-chen	45 li W of Chang-te area 4 x 8 km	Two seams, 2 to 3 and 8 to 10 Chinese feet anthracite, 6954 cal 40,240,000 metric tons
T'ang-yin	Hao-pi-chen	45 li NW of T'ang-yin sta	Non-coking, 7300 cal Two seams, 1 to 2 and 17 Chinese feet 21,840,000 metric tons
Hsin-an - Chi-yuan Shan-Mien-ch'ih	Hsin-Mien coal-field	North of Lung-hai Railroad between Hsin-an and Shan stations, E to Chi-yuan W to Shan and Mien-ch'ih	Seven seams 5 worked Anthracite and semi-anthracite in east Bituminous in W 6000 to 8000 cals Anthracite - 162,000,000 metric tons Bituminous - 126,000,000 metric tons Total - 1,288,000,000 metric tons

COAL

DISTRICT (Hsien)	PLACE NAME OF MINE	LOCATION	DEPOSIT
I-yang Lo-yang Yen-shih Kung, Ssu-shui and Jung-yang	I-yang coal field	S of Lung-Hai RR from SE I-yang via the S part of Lo-yang, Yen-shih, Kung, and Ssu-shui to SE of Jung-yang	Nine seams; bituminous Semi-anthracite 7150 to 8250 calories Bituminous 237,000,000 metric tons Anthracite 267,000,000 metric tons Total - 504,000,000 metric tons
Yu-Mi	Yu-Mi coal field	Both Yu and Mi hsien and north part of Chia-yu (?)	17 seams; bituminous and semi-bituminous 7000 calories 1,545,580,000 metric tons
Hsiu-wu Po-ai	Hsiu-Po coal field	From Northwest Hsiu-wu via North part of west Po-ai to North part of Ch'in-yang	1 seam; anthracite and semi anthracite 7000 calories 100,000,000 metric tons
Shansi Province			
Tse-chou Yang-ch'eng	Tse-chou coal field	Near Tse-chou and NE part of Yang-ch'eng	4 seams, 2,1 1,3-5, and 5 Chinese feet, Anthracite and semi-anthracite 4,856,000,000 metric feet
Kao-p'ng Chin-ch'eng	Kao-p'ing coal field	Centering on Kao-p'ng, area E to W 35 km N to S 40 km	Non- coking
Ch'in-shui	Yao-t'ou coal field	10 km W of the main town	Three seams, 10 Chinese feet (total anthracite 334,000,000 metric tons
	Chung-ts'un coal field	17 km W of the govt seat	Two seams, 8 feet (total semi-anthracite 119,000,000 metric tons

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
I-ch'eng	Ti-chia-ch'iao coal field	18 km E of the govt seat E to W 10 km N to S 5 km	Two seams, 7 Chinese feet total semi-anthracite 134,000,000 metric tons
Yang-ch'eng	Yang-ch'eng coal field	4 km NE of govt seat	Two seams, 12.5 Chinese feet Total semi-anthracite and anthracite 371,000,000 metric tons
	Tung-chih coal field	14 km S of the govt seat	Six seams, 8.6 Chinese feet Total semi-anthracite and anthracite 62,000,000 metric tons
	Ku-lung coal field	20 km W of govt seat	5 Chinese feet Semi-anthracite and anthracite 36,000,000 metric tons
Wen-hsi	Ch'iao-chia-kou coal-field	90 li SE of the govt seat	Two seams, 7-8 Chinese inches and 2 Chinese feet
Ling-ch'uan	Ling-ch'uan coal-field	Within the district 24 km X 4 to 8 km	Non-coking 116,166,400 metric tons
Hsiang-yuan--Lu-ch'eng--Ch'ang-chih--Hu-kuan--Ch'ang-tzu	San-lu-an coalfield		Coking and non-coking 6,789,053,500 metric tons
Lin-fen P'u	Shan-hsi coal-field	Including T'u-men-hsien, Mi-tien, Chien-kou-li, Ho-lung-kuan areas	Two seams, 2 meters Coking 2,275,735,150 metric tons
P'u	Tung-shan coal-field	An-chia-yu, Shan-t'ou ts'un, Kao-ko-ts'un areas	Seams 6 m total thick bituminous 5,315,050,000 metric tons
Hsiang-ning	Hsiang-ning coal-field	In the district	Seams total 6 meters thick 3,144,960,000 metric tons

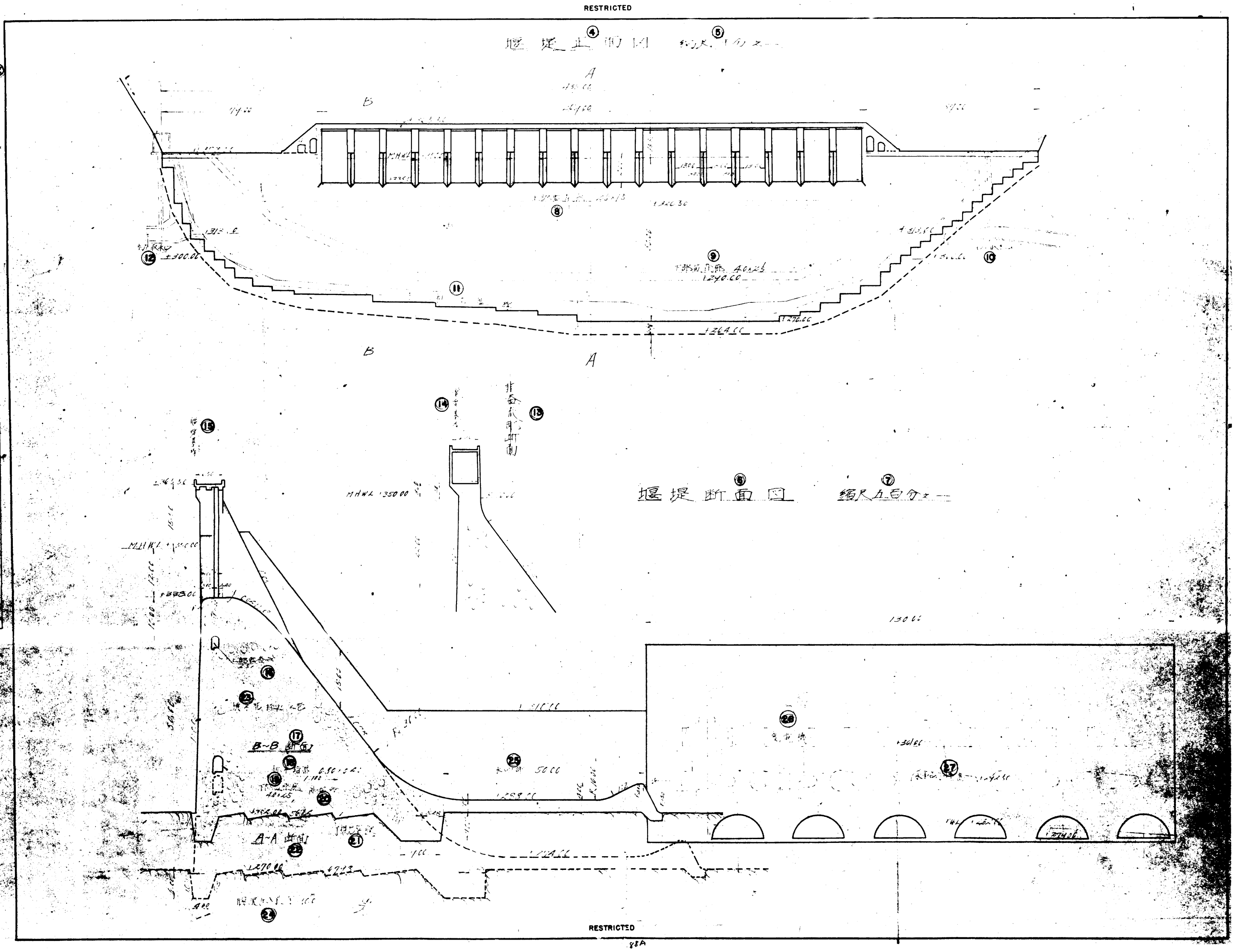
DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Hung-tung	Hsi-shan coal field	Nan-ling Kuo-chia-chuang, Tso-chia-kou, Nan-li-ts'un, Han-hou-ts'un and Lou-ts'un areas	Three seams total 22 Chinese feet thick 1,663,568,400 metric tons
Chao-ch'eng	Yuan-ch'uan coal field	NE of govt seat entire area of Mt Sung-chia	Seams total 7 m thick Bituminous 15,600,000 metric tons
	San-t'iao-ho coal-field	22 km W of govt seat 3.5 km N to S 4 km E to W	Seven seams total thickness 15 feet 181,000,000 metric tons
Ho	Fan-ch'uan coal-field	12 km W of the govt seat 6 km E to W 6 km N to S	Three seams total 9 feet 93,000,000 metric tons
	Tung-nan coal-field	SE of govt seat near Shang-ts'ao-ts'un and Sung-chuang	Seams 6 m thick Bituminous Coking 193,050,000 metric tons
Fen-hsi	Fen-hsi coal-field	Below the district	Seams total 4 to 7 m Coking 10,519,392,000 metric tons
Fen-yang--Hsiao-i --Ling-shih	Hsi-shan coal-field at Hsiao-i	Shih-chia-chuang Chang-chia-chuang of Fen-yang-hsien, Yao-chuang Hu-chia-yao, Tui-chiu-yu Ju-lai-ts'un of Hsiao-i-hsien Hua-wang, Chung-hsi, Tu-chen of Ling-shih-hsien	10 seams total 7 m Bituminous 7,601,048,000 metric tons
	Tui-chiu-yu coal-field	12 km W of Hsiao-i-hsien Area 11 km E to W 7 km N to S	Five seams total 15 Chinese feet 216,000,000 metric tons

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Li-shih -- Chung-yang-- Lin	Li-shih coal-field	Below all three districts	Total 7 m thick Coking 3,986,136,700 metric tons
Lin-- Shih	Chung-shih coal-field	Area between Lin-hsien and Shih-hsien	Total 6.5 m thick Coking 3,251,560,000 metric tons
Ho-ch'u -- P'ien-kuan,- and Pao-te, Hsing	Ho-Hsing coal-field	Below all districts	Total 15 m thick 10,807,664,400 metric tons
Shensi Province			
Fu-ku		10 li E of govt seat, near Liu-lin-chi and Ho-ts'un	Bituminous 160,000,000 metric tons
Shen-mu		20 to 80 li W of the govt seat Including Sha-kou-yang, Ta-pien-ts'un, T'an-yao-kou-ts'un, Ts'ao-lu-kou-ts'un, Shen-shu-kou-ts'un villages	Bituminous 480,000,000 metric tons
Yu-lin		10 to 50 li SE and S of the govt seat	Seam 1 ft Bituminous 250,000,000 metric tons
Mi-chih		60 li SE of the govt soat, several tens of li from Lung-erh-yai-kou	Bituminous 90,000,000 metric tons
Heng-shan		50 to 70 li E and S of the govt seat	Bituminous 12,000,000 metric tons
Sui-te		100 li W of the govt seat	Mesozoic and Paleozoic Bituminous 20,000,000 metric tons

黄河三門峡發電所設計図

第 號圖



昭和十六年五月

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
An-ting		3 villages located in the SE and N of the govt seat	Jurassic 19,000,000 metric tons
Ch'ing-chien	Lao-chuang-kou	70 li W of govt seat	Jurassic 16,000,000 metric tons
Yen-ch'uan	Ying-p'ing-chen	90 li NW of govt seat	Jurassic 7,000,000 metric tons
Han-ch'eng	Han-ch'eng coal field	Northern part of the district	Carboniferous 5 seams Bituminous and anthracite
Chung-pu	Ts'un-chen	50 li W of govt seat 2 to 3 li from Ts'un-chen	Carboniferous
I-chun	Yuan-tzu--p'ing	Western part of govt seat	In alternate sandstone and shale 1.5 to 2.5 Chinese feet
Ch'eng-ch'eng	Ch'ang-kuan-chen	20 li W of govt seat	380,000,000 metric feet
Pei-shui		15 to 20 li E of govt seat	Carboniferous 310,000,000 metric tons
P'u-ch'eng	Ts'ai-teng-chen	60 li NE of the govt seat	9,000,000 metric tons
T'ung-kuan			Seams 3.5 to 4 Chinese feet thick
Yao	Liu-lin-chen	NW of Liu-lin-chen, over 90 li NW of govt seat	Carboniferous
Ch'un-hua	Ch'un-hua coal field	50 li N of govt seat	Bituminous and semi-bituminous
Hsun-i	Yu-tzu-kou	30 li W of govt seat	

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Pin	Pei-tzu-kou	30 li E of govt seat	Carboniferous 303,030,000 or 370,000,000 metric tons
Inner Mongolia (Meng-chiang)			
Sa-la-chi	Chang-sheng-mao	13.7 km NW of Sa-la-chi	Three seams; bituminous area 10 sq km Seams 3 m thick 37,800,000 metric tons
	Yang-chi-ling	17 km NW of Sa-la-chi	Permocarboniferous area 2 sq km 1 to 2 m thick; Bituminous 6,100,000 metric tons Jurassic; area 3 sq km 1.5 m thick Bituminous 5,800,000 metric tons
	K'uan-tien-tzu coal field	8 km NW of Sa-la-chi RR Sta	Jurassic; 3 seams 2,1,3 feet thick respectively 24,000,000 metric tons
Hou-ho	Pa-k'ou-tzu coal field	20 li NW of Hou-he	Jurassic Weak coking
	Pei-shan coal field of Ch'a-su-chi	30 km W of Hou-ho	Jurassic anthracite 53,000,000 metric tons
	Liu-shu-wan coal field	20 li N of Ch'a-su-chi RR sta	Jurassic; 2 seams 1 ft and 2 to 4 feet anthracite 11,700,000 metric tons
	Hei-tou-kou coal field and the Northwestern coal field of Pi-k'o-chi	Over 10 li NW of Pi-k'o-chi RR sta	Jurassic seams 1 to 2 feet 500 m down 2,900,000 metric tons
	T'ai-ko-mu peat field	Area 12 km W from S of Tai-ko-mu RR sta	Peat Seams 1 to 3 feet 11,000,000 metric tons
Ku-yang	Wo-hsin-hao	10 li NW of govt seat	Four seams; total 2 m Bituminous 48,000,000 metric tons Area 20 sq km

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
	Shih-kuai	In Mt Ta-ching N W of Sa-li-chi	Jurassic 7 seams total 1.5 to 3 m Anthracite and bituminous 20,300,000 metric tons Area 39 sq km Teiseigan* 85,800,000 tons Total 106,100,000 tons
An-pei	Shuan-ma-chuang	S of Shuan-ma-chuang, NE of govt seat	Permocarb area 1.8 sq km 2 seams total 2 m Anthracite 3,250,000 metric tons
	Kuan-ching-kou	100 li E of the govt seat	Non-coking bituminous 5768 to 7520 calories 58,800,000 metric tons Area 7 sq km
Ninghsia Province			
Chung-wei	Chung-wei coal field		
Yu-wang	Yuwang coal field		
P'ing-lo	P'ing-lo coal field		
Ning-shuo	Ning-shuo coal field		
Ning-hsia	Eastern foot of Ho-lan-shan and Chieh-tzu coal field		Carboniferous anthracite
Kansu Province			
Wu-wei--Tan-sh n	Western coal field	From the east of Wu-wei, (along the northern mt of Ch'i-lien Shan) to the West of Yu-men	Permo-carboniferous

* (TN: Meaning of "teiseigan" cannot be ascertained, probably refers to lower grade coal of some kind.)

COAL

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Kao-lan -- Yung-teng	Central coal field	Centers about Kao-lan-hsien	Jurassic Clay in the seams
Ko-ting -- Ch'ung-hsin P'ing-yuan	Northeastern coal field	Extends through these three districts then to Ningsia	Permocarboniferous
Tsinghai Province			
Ta-t'ung	Ta-t'ung Coal field		
Le-tu	Le-tu coal field		
PETROLEUM			
Henan Province			
Meng	Chih-ch'eng-chen	40 li W of govt seat	In green sandstone, Permian Oil bearing coal seam 0.64 m thick 432,800 metric tons Rich in gasoline 100 parts coal to 10 parts gasoline
Shensi Province			
Yen-ch'ang Yen-ch'uan	Yen-ch'ang oil field		Important Two wells produce 60 barrels per day In mesozoic sandstone shale
Fu-shih		Near the govt seat	Small amount of oil
Kan-ch'uan	Sha-tzu-wan		Small amount of oil
Fu		2.5 km SW of the govt seat	Small amount of oil
I-chun		Everywhere below district	Small amount of oil
Hsun-i		2.5 km S of govt seat	Small amount of oil

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Heng-shan	Chi-lin-kou	80 km S of Yu-lin-hsien	Average percentage of oil extracted 2%. Oil bearing shale in Jurassic stratum, black, with ashy white clay alternate, 6 to 8 m Average percentage of oil estracted 5%. 1 meter thick Important 300 m down; rich seam (5%) 125,400,000 metric tons Oil, 2,006,400,000 gallons Poor seam (2%) 525,500,000 metric tons Oil 3,670,800,000 gallons
An-ting		From An-ting-hsien to the Northern border of Fu-shih-hsien	Oil bearing shale Rich seam (5%) 299,550,000 metric tons 5,386,500,000 gals Poor seam 3,933,000,000 metric tons 23,598,000,000 gallons Amount of oil extracted 6%
Chung-pu	San-ch'uan RR sta	12 km NW of Tien-t'ou-chen	Oil-bearing shale in Mesozoic stratum
<u>Ninghsia Province</u>			
P'ing-lo			Oil (sic)
<u>Kansu Province</u>			
Ying-teng	Ko-ssu-t'an		Oil-bearing shale 30 Chinese feet thick

GYPSUM

Shantung Province

DISTRICT (Hsien	PLACE NAME OR MINE	LOCATION	DEPOSIT
Lai-wu	Ta-chuang Ma-chia-miao		
T'ai-an	Hsu-chia-lou		
Kung		Near coal field	
Shan	Ta-an-ts'un		Important Like that in Shansi at P'ing-lu
Shensi Province			
P'ing-lu	P'o-chuang Ho-ts'ung and others	From San-men-ling E of the govt seat 30 li E along N bank of Yellow River. Yellow River to field several tens of li.	In tertiary red beds in small seams; several cm thick
Kansu Province			
Ting-hsi		5 li W of the govt seat	
FLOURSPAR			
Shantung Province			
Po-shan	Tung-shih-ma	17 km S of Hei-shan 3 km S of Tung-shih-ma	In limestone; in rope-like narrow veins 0.1 to 1 m thick Broken off at 2 km Rough calcium flouride 20 to 40% fine ore 69.57% Mined on a small scale from Ching Dynasty 22,500 metric tons
	Chu-chia-chuang Ch'ai-lo-shan	8 km from Hei-shan	As above 3 veins a. 2 m X 5 cm b. 3 m X 10 cm c. 5 m X 10 cm rough ore 20% fine ore 54 to 74% Mined by natives

FLOURSPAR

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
	Ta-chuang	7 km E of Hei-shan	In Limestone Slender vein Rough ore 28%. Very little left
Honan Province			
Hsin-an			
ASBESTOS			
Shensi Province			
Lueh-yang	Teng-yun-p'u	30 li E of the govt seat	In Mesozoic and Cretaceous strata It was once worked in Ching Dynasty
Lo-nan	Chi-shan Ho-liang-shan	100 li S of the govt seat	In triassic strata
Inner Mongolia			
Hou-ho	Shih-hui-yao-tzu	50 li NW of Ch'a-su-chi RR sta	In marble and in reddish gneiss, Long formation, white Formation 13,000 metric tons
Pao-t'ou	Sha-pa-tzu	100 li N of Pao-t'ou	Marble Granite contacts white 1 to 3 meters long Light-green Deposit 8,000 metric tons
	Chi-mao-vao-tzu	In marble	
Ku-yang		In marble	
Kansu Province			
Kao-lan	Ching-fan-kou	Northern part	Short formation
MICA			
Shantung Province			
Hsin-t'ai	Shih-p'eng	60 li NW of the govt seat	
Chang-ch'iu	Ch'ing-lung-shan	30 li S of the govt seat SE of P'u-i	

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
GRAPHITE			
Shensi Province			
Fu	T'i-tzu-kou		In Permocarboniferous coal
Suiyuan Province			
Lang-shan		S slope of Lang-shan	In Permocarboniferous coal
IRON SULPHITE			
Shantung Province			
Tzu-ch'uan Po-shan Chang-ch'iu		In the various coal fields	In coal seams Yearly output 1,500 metric tons
Honan Province			
Hsin-an	K'uang-k'ou	70 li NE of the govt seat 90 li of good road between Lo-yang RR sta & Kuang-k'ou	In clay and shale under Permocarb strata Shale 8 m Ore 3 Chinese feet to a few inches Ore-shale, 25% Best, 49% 1,080,000 metric tons Primitive mining method Produces sulphur
Po-ai	Hsiao-ling, Ssu-how, Hsiao-seng	Near Hsiu-wu-po-ai coal field	Best - 33% 1,000,000 metric tons At the base of Permocarboniferous stratum in the gray shale and kaolin deposit Seam 2 meters Important
Shansi Province			
Fen-hsi Ho	Hsin-chia-chuang "and others"	60 li W of the govt seat	With iron ore in sandstone Sulphur 40.8%

DISTRICT (hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
P'u[illegible]	[illegible]ei-lo-kou	NE of the govt seat	With iron ore in sandstone
Kansu Province			
Ying-teng	Yun ch'eng Fei-t'u-tung		Scanty
Tsinghai Province			
Le-tu	Le-ts'ao-t'ai	100 to 500 Chinese feet X 400 Chinese feet	
Hsi-ning	Wei-yuan-pao		
BARYTES			
Shantung Province			
Po-shan	Hsiao-ting-shan	Sung-ku-yu	Imbedded in limestone
Lai-wu			Imbedded in limestone
SALT and SODA			
Shantung, Hopeh, Honan Provinces			
Sector along the Yellow River bank from Kai-feng in Honan to the S of Yen-chou in Shantung also W and NE of Chi-nan-fu, to N of Chang-tien			Natural soda and saltpetre Mined by farmers as a side-line
Shansi Province			
An-i	Ho-tung Hsieh-ch'ih	S of Yun-ch'eng	Taken from wells Salt and saltpetre Chief products 1939 - 108,315 bikaru 1940 - 233,574 bikaru 1941 - 1,252,000 bikaru (Bikaru = 132 lbs)
Shensi Province			
Yu-lin	Upper and lower Yen-wen		

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
Sui-te	San-huang	80 li W of the govt seat 40 km N of Hsi-wei	In Jurassic stratum runs for 20 li Salt taken from wells
Ting-pien	3 lakes at Yen-ch'eng-pao	25 to 30 li NW of the govt seat	Salt
Chao-i	An-jen-chen and Ta-p'ing salt lakes	10 to 15 li NW of the govt seat	Upper stratum salt lower saltpetre
P'u-cheng	Nei-fu-t'an		
Ningsia Province			
Yen-ch'ih	6 salt lakes		
Ling-wu	Hui-an-ch'ih		1916 - year out-put 148,571 piculs Salt around lake for tens of li
A-la-shan	Chi-lan-t'ai-ch'ih		
Meng-wang-ch'ih			Salt in crystals 2 to 6 Chinese feet
Chung-wei	4 Salt lakes		
Kansu Province			
Hung-shui	Pei-t'un-tzu		1913 year out-put 20,272 piculs Salt from lake
Ching-yuan	Hsiao-jen-ching		Salt - annual output 1724 piculs
Yung-teng	Hung-wan-chih Ho-chia-ch'u		Salt annual output 3147 piculs
Tsinghai Province			
Huang-yuan			
Ta-t'ung	North and South parts		
Hsi-ning	Lu-sha-erh		
STEATITE			
Shantung Province			
Hsin-t'ai	Shih-p'eng	NE of Shih-p'eng 60 li NW of the govt seat	200,000 metric tons

RESTRICTED

DISTRICT (Hsien)	PLACE NAME OR MINE	LOCATION	DEPOSIT
T'ai-an	Hsiao-hsin-chuang	30 li NW of the govt seat	Soft Fire-resistant
	Chu-shan	45 li NE of the govt seat	400,000 metric tons
Shensi Province			
Lo-nan	Tung-wen-yu	80 li E of the govt seat	In mesozoic and cretaceous strata
QUARTZ			
Shantung Province			
T'ai-an	Ta-hsin-chuang	10 li from T'ai-an RR sta on Tientsin-Pukow RR	Paralles with the steatite vein 2 to 4.5 m wide runs 3 li
Po-shan			Quartzitic sandstone in upper seams
Tzu-ch'uan		30 li SW of the govt seat	Jurassic quartz seams 8 to 10 m
FELDSPAR			
Shantung Province			
Hsin-t'ai	Shih-p'eng	60 li NW of the govt seat	300 m down 45,000,000 metric tons
Meng-yin	Huang-tou	T'ai-shun on the western slope of Hsin-p'u-shan (60 li NW of govt seat	Poor, scanty

RESTRICTED

A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA
(Continued)

Far Eastern Research Section
Survey Committee No 2
North China Committee
Subcommittee No 4
May 1941

PART 8. TRENDS IN THE SUPPLY AND DEMAND FOR ELECTRIC POWER AND THE SIGNIFICANCE OF YELLOW RIVER WATER POWER

ORAI Saburo

TABLE OF CONTENTS

(NOTE: Throughout this Part only those portions pertaining to Russian and Manchurian hydroelectric power have been translated. A summary only is given of each chapter, followed by such translation as was considered necessary.)

I Introduction

A. Stresses in very general terms the importance of electric power to national life, including chemical industry, irrigation and transportation. The Yellow River will furnish electric power for the above uses.

(NOTE: No translation made of this chapter.)

II Trends in Supply and Demand for Electric Power in Various Nations

A. Table showing the world's total amount of electric power generated from 1929 to 1938 (excluding 1930 and 1931).

B. Table showing the increased use of electric power in 1919 and 1938 and its per capita use in 1938 in America, Germany, Russia, England, Canada, France, Italy, Norway, Sweden, Switzerland, China, and Japan Proper.

C. Table showing the amount of hydro- and thermo-electric power generated in some of the above nations in 1938.

D. Table showing the amount of water power developed in 1920 and 1938 in North America, South America, Europe, Asia, Africa and Oceania. (Table based on Power Plant Engineering, Dec 1940. This is presumably an English language publication.)

E. Table showing the potential water power for the above nations and Brazil.

(NOTE: No translation made of this chapter. The information here should be available in existing studies in English e.g. English publication cited in this document, Power Plant Engineering, Dec 1940.)

III Present Condition of Large Scale Water Power Development in the World

This chapter refers to the National Water Power Development Plan in the USA and the development plan for important rivers in Russia, including the Volga, Dnieper and Angara, and the development plan for the Upper Sungari and Yalu Rivers in Manchuria. This chapter has two charts: (1) Chart of the National Water Power Development Plan in the USA, (2) Plan for power generated by water in Russia, including the number of power stations, the estimated power generated per year and its uses.

(NOTE: Only those portions of this chapter pertaining to "The Plan for Water Generated Power in Russia" have been translated.)

A. General (TN: Complete translation)

With modern developments in the technique of constructing large dams, there has been marked development of hydroelectric power in the past ten years. Such development is based upon plans encompassing the damming of large rivers to form enormous artificial lakes which will equalize the annual flow, prevent floods and aid irrigation and water transportation.

The principal comprehensive hydroelectric development plans are the governmental plans in the United States, those for the Volga, Dnieper and Angara Rivers in Russia and those for the Upper Sungari and Yalu Rivers in Manchuria.

B. Hydroelectric Development Plans in the United States

(TN: This section has not been translated. It gives cursory details of the hydroelectric development plans in the United States.)

C. Plans for the Development of the Principle Rivers in Soviet Russia (TN: Complete translation)

1. The development of water power in the Soviet Union has a three-fold purpose: the generation of electric power, water transportation, and irrigation, plus the creation of large industrial areas centered around the water power stations.

2. The estimated amount of power that can be generated yearly by all the water power stations already constructed or under construction in 1937 is 12,500,000,000 kilowatt-hours. Of this total, 6,500,000,000 kilowatt-hours will be generated by dams built primarily for water transportation, 3,200,000,000 kilowatt-hours by those built primarily for irrigation purposes and only 2,800,000,000 kilowatt-hours by those built specifically for generating power.

3. The plan for the development of the water power of the major rivers in Soviet Russia is as follows:

Hydroelectric Power Plans of Soviet Russia

Name of Project	No of Power Stations	Total Capacity (in KW)	Total Amount of Power Generated Per Year (in KWH)	Use
Amu Darya	27	2,000,000	12,000,000,000	Irrigation
Amur	14	5,400,000	32,000,000,000	Water transport, Flood control
Angara	11	10,800,000	75,100,000,000	
Dnieper	68	1,700,000	8,900,000,000	
Kura (excluding Sanga River)	45	1,200,000	5,100,000,000	
Ob and Irtish	108	7,900,000	64,100,000,000	Water transport, Drinking water
Sevan - Sanga	10	600,000	2,400,000,000	Irrigation
Sulak	10	1,000,000	6,900,000,000	
Syr Darya	35	5,100,000	30,500,000,000	Irrigation
Volga	46	6,600,000	32,100,000,000	Water transport, Irrigation, Drinking water
Yenisei	20	12,000,000	63,300,000,000	Water transport
Total	394	54,300,000	332,400,000,000	

4. Plan for Developing the Volga River (given as an example)

The basins of both the Volga and Dnieper Rivers are densely populated and include important industrial and agricultural centers. Accordingly, their demand for electric power will be great. Much freight is handled in this area and the water transportation facilities are very important.

The down stream area of the 250 mm isohyet is well-developed agriculturally, but the slight amount of rainfall produces a great variation in the harvest from year to year, making irrigation the most important problem for this area. Accordingly, the economic development of the Volga River should be planned for three objectives: power generation, water transportation and irrigation. The construction of 46 power stations along the Volga River and its tributaries was planned, the capacity to be 6,600,000 kilowatts or a yearly output of 32,100,000,000 kilowatt-hours. This plan will give the Volga River sufficient depth to serve as an East-West artery for transportation to the main areas of Europe and Russia.

Furthermore, the total area to be irrigated will be about 10,000 acres. Since this is a high level area, 4,500,000,000 to 5,500,000,000 kilowatt-hours per year will be required to pump the water up from the Volga River. This irrigation plan will make for consistent yearly agricultural output and the harvest of wheat will probably reach 5,000,000 metric tons per year.

It is planned that 3,400,000 kilowatts out of the total 6,600,000 kilowatts will be furnished by the Kuibyshev Power Station, the biggest station in the world. During 1948, the first year of operation, 800,000 or 1,000,000 kilowatts can be generated and by 1950, 3,000,000 kilowatts can be generated. After the construction of the water power stations on the upper Volga River has been completed (1952 - 1954), the equalized flow will raise its generating power to 3,400,000 kilowatts.

Besides using the water power for the various industries along the Volga (oil drilling, synthetic oil, synthetic rubber, fertilizer, light metals, etc) and the electrification of farm villages and railroads, the power will be transmitted to the Moscow area by wire (900 kilometers). This wire will be connected with other transmission nets in the Gorki and Ivanov areas and the south-central part of the Ural region.

(NOTE: Chapter 3 ends with this section. There is no discussion of the hydroelectric development for the Upper Sungari and Yalu Rivers in Manchuria.)

IV National Defense and Electric Power

Stresses the importance of electric power for producing munitions, for national defense and for the mining and chemical industries. This chapter has five charts:

A. Chart 1 - shows the names of chemical products, the amount produced, and electric power required for various electro-chemical products. (Table based on "Electrical Engineering", Feb 1940. This presumably is an English publication.)

B. Chart 2 - shows the electric power consumed by electro-chemical industries in the USA.

C. Chart 3 - shows the various uses of electric power in Japan in 1926 and 1936, such as electric lights, electric cars and small and large concerns.

D. Chart 4 - shows the various uses of electric power by large concerns in Japan from 1936 to 1937 in such industries as fabrics, metals, machine tools, chemicals, ceramics, mining, food processing etc.

E. Chart 5 - a detailed breakdown of the amount of electric power used by chemical industries in Japan in the manufacture of various products.

(NOTE: No translation made of this chapter. The information found here should be available in existing studies in English e.g. English publication cited in this document, Electrical Engineering, published February, 1940.)

V Sources of Electric Power within the East Asia Co-prosperity Sphere and the Relative Importance of the Yellow River as a Source of Water Power

In this chapter, water power and coal are considered as the two most important sources of electric power.

The document shows the power potential of Japan using water power. This includes Japan Proper, Korea, Formosa, Manchuria (including Yalu River) and China. This chapter has two charts:

(1) shows the amount of coal deposits in East Asia, in such countries as China, Manchuria, Japan (including Korea) and Indo-China;

(2) shows the electric power generated and consumed in East Asia, in such countries as Japan (including Japan Proper, Korea, Formosa and Sakhalin), Manchuria, China, Philippines, French Indo-China and India.

(NOTE: Only those portions of this chapter pertaining to the hydroelectric power of Manchuria have been translated.)

A. Sources of Hydro-electric power that can be developed.

Japan

Japan Proper	20,000,000 kilowatts
Korea	2,370,000 kilowatts
Formosa	1,000,000 kilowatts
Manchuria (including the Yalu River)	7,500,000 kilowatts
China	21,000,000 kilowatts

B. The most economical sources of water power in Manchuria are the Yalu River and the Upper Sungari River. It is estimated, however, that about 15 years would be required to develop these sources. Therefore, the Yellow River as a source of water power would probably be considered as the next best possibility.

C. In Russia, initial steps have already been taken for the realization of a plan to transmit power 900 kilometers from the Kuibyshev Power Station on the Volga River to the Moscow area. This plan will probably materialize in the near future.

D. Extracts from Table No 12

Coal Deposits in East Asia
(in metric tons)

Manchuria	
Definitely known	409,000,000
Estimated additional amount	799,000,000
Total	1,208,000,000
Russia	
Estimated	60,037,000,000

E. Extracts from Table No 13

Electric Power Capacity and Consumption in East Asia

Manchuria (1938)	
Power generated by steam	501,000 KW
Output per year	1,624,000,000 KWH
Consumption per individual	54 KWH

A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA
(Continued)

Far Eastern Research Section
Survey Committee No 2
North China Committee
Subcommittee No 4
May 1941

PART 9. PLANS FOR EXTENSIVE INDUSTRIAL DEVELOPMENT

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TABLE OF CONTENTS

I. INTRODUCTION

The purpose of Part 9 is to explain where and how the enormous amount of electric power which will be produced by the development of the water-power resources of the Yellow River will be used. It is meaningless and impossible to suppose that today there are industries which can completely consume the entire electric power output of the Yellow River output, which is comparable to the power output of all Japan today. Since the progress of the industrial world, which will be the main consumer of electric power, will be exceedingly swift, it would be extremely difficult and dangerous to estimate either the new demands and objectives of tomorrow or the future of several decades. Nevertheless, since to conceive such a huge plan without any objective would be sheer folly, this general estimate is prepared in the light of available capital and vatural resources.

The question of what types of industries will be developed in North China cannot be decided in North China alone. It should be decided not only by research from the standpoint of collective development of the economic strength of the East Asia Co-Prosperity Sphere but also by paying attention to the demands of the development of the people and the point of view of national defense. As a practical way of thinking, looking at the conditions of industrial development caused by the division of industry in the Co-Prosperity Sphere, it has been said, "Japan would become the center of the high-grade finished products industry, Manchuria, the center for basic heavy industry, and China the center for raw materials and low-grade light industry. Such a division would avoid industrial friction between the three countries and would produce a mutual prosperity in which each country would supplement the other two." (From NIPPON JŪKŌGYŌ [Japan's Heavy Industries], Vol 2, Part 6, P 12) This view is reasonable enough if heavy emphasis is placed on present conditions, but the division of industry would be unsatisfactory after a few decades when viewed from the standpoint of a far-reaching national policy. The reorganization of industry in the East Asia Co-Prosperity Sphere must not be wasted through short-sighted planning.

It is natural to think that industry would expand, combining the capital and techniques of Japan and the abundant resources--coal, iron, alum shale, gypsum, salt, raw cotton, etc--imported to Japan from North China, but basic power production in Japan proper has almost reached its economic maximum. Hence, to plan rapid expansion of industry, which requires plentiful and cheap power, it is very difficult.

From this point of view the hydroelectric power production of the Yellow River will probably be the main element in producing revolutionary changes in the industrial system of the Co-Prosperity Sphere.

The following section deals with the consumption of hydroelectric power of the Yellow River.

II AREAS CONSUMING ELECTRICITY

The present production capacity of electric power in North China and Meng-chiang [Mongolia and Sinkiang] is 192,000 kilowatts for industrial use and 148,000 kilowatts for domestic use, a total of 340,000 kilowatts. The total consumption at 40 per cent load factor thus amounts to a per capita consumption of 12 kilowatt-hours a year (population of North China, Mongolia and Sinkiang was taken as 100,000,000 since it is estimated as 104,310,000 by the South Manchurian Railroad, North China Economic Survey) This is twice the six kilowatt-hour average per capita consumption for the whole of China, but is very far from the 457 Kilowatt-hour per capita consumption in Japan and the 1,130 kilowatt-hours per capita consumption in the United States.

If China consumed electricity at the same per capita rate as Japan, it would require 8,700,000 kilowatts at 60 percent load factor, and if her consumption were half the present per capita rate of the United States, she would require approximately twenty million kilowatts. Even such rough calculations as these show that this Yellow River hydroelectric development plan is not a useless theoretical discussion, and that eventually it will be realized.

The consumption of Yellow River hydroelectric power can be divided in four categories according to use: (1) general [domestic], (2) agriculture, (3) transportation, and (4) mining and industry. Each will be considered in turn. [Mining and industry will be considered seperately.]

A. General [Domestic] Uses

At present, the population of North China consumes very little electricity.

The consumption of electric power in the cities has shown a marked increase since the China incident because of the influx of the Japanese and of wealthy Chinese seeking peace in the cities. The farmers, who constitute more than 80 percent of the population, consume absolutely no electric power. Thus, the consumption of electric power by the general population is of no importance at the present time, but the rise in living standards which will accompany the industrial development of North China will increase considerably the consumption of electricity.

In Japan, industrial uses account for 60 to 70 percent of electric power, whereas all other uses take the remaining 40 percent to 30 percent.

The following chart shows the electricity required by cities of North China with an estimated population of over 300,000 [Population of North China as of 1941, South Manchurian Railway, North China Economic Survey], based on the Japanese 457 KWH per capita rate of consumption, assuming that half the nonindustrial electricity (20 percent) is domestic consumption.

City	Population	Electricity Required
T'ien Ching (including T'ang-Ku)*	3,000,000	270,000,000 KWH
Pei-p'ing*	2,500,000	225,000,000 KWH
Ch'ing-tao	1,000,000	90,000,000 KWH
Chi-nan*	1,000,000	90,000,000 KWH
Ta-t'ung*	1,000,000	90,000,000 KWH
T'ai-yuan*	500,000	45,000,000 KWH
Shih-men*	500,000	45,000,000 KWH
Hsin-hsiang*	500,000	45,000,000 KWH
Hsu-chou*	500,000	45,000,000 KWH
K'ai-feng*	300,000	27,000,000 KWH
T'ang-shan	300,000	27,000,000 KWH
Chih-fou	300,000	27,000,000 KWH
Wei-Hsien	300,000	27,000,000 KWH
Hai-chou	300,000	27,000,000 KWH
Total	12,000,000	1,080,000,000 KWH

* Can receive its supply of electricity from the Yellow River.

The domestic consumption of the above cities thus totals 1,080,000,000 kilowatt-hours. This would require 245,00 kilowatts at a load factor of 50 percent. The nine cities that could be supplied by the Yellow River would consume 882,000,000 kilowatt-hours and require 200,000 kilowatts.

B. Agricultural Uses

It is extremely difficult to estimate how much electricity the agriculture of North China will require in the future. Its requirements can be divided roughly into those for electrified agriculture and for irrigation.

Those of agricultural electrification will be considered first. HOKUSHI NOGYO YORAN [Important Aspects of the Agriculture of North China], compiled by the South Manchurian Railroad, North China Economic Survey, describes the small scale of North China agriculture as follows:

The average farm in North China has 27.4 se [0.671 acres] of arable land; 4.25 se [0.104 acres] per capita of total population or 5.35se[0.131 acres] per person engaged in agriculture. The average farming family consists of 5.1 persons. The calculation of average arable land per farm includes Meng-chiang [Mongolia and Sinkiang], where the estimates are too high. In the lowland, most farms have under 20 se[0.5 acres] of arable land while in the uplands most farms have from 20 to 50 se[0.5 acres to 1.225 acres] and colonized areas, such as Chiu Suiyuan Province, must have over 100 se[2.45 acres].

Professor Lossing Buck states that a minimum of 4.5 se [.104 acres] of land is necessary to maintain a single independent farmer. If 3.5 members of the five person household are independent, a minimum of 14.87 se[.364 acres] is required but actually the great majority of farmers eke out only the barest kind of starvation existence. This excessive dividing up of the land reduces its productivity and is really equivalent to a loss of land (from "New East Asia Economic Geography" /̲ SHIN TOA KEIZAI CHIRI /̲ by KAGAWA, Hideo, P 124).

Is it possible for the small scale agriculture of North China, operating under a starvation management, to achieve electrification? At first, it seems no problem at all. Let us observe the utilization of electric power in the agriculture of the Soviet Union.

"Electrification Developments in the Soviet Union", a study prepared by Krujivanovski /̲ TN: Phonetic /̲ of the Labor Studies Staff, Soviet Academy of Science, for presentation to the third World Labor Congress held in Washington in 1936, points out the importance of Dnieper power stations as a source of electricity for the agriculture in the Dniepropetrovsk region. According to the same study, the first important allocation of electric power in agriculture was for threshing, and in 1935 there were 754 places using electricity for threshing the grain crop from 350,000 hectares /̲ 865,00 acres /̲ of land. The great advantage of electricity in large-scale threshing over other methods is shown in the following chart:

Unit Cost for Threshing (Rubles charged to the public)

Year	Electric Motor Driven /̲ Power /̲	Tractor Driven /̲ Power /̲
1934	1.15	1.57
1935	0.88	1.26

The cost for electrical power in 1934, was 73 percent of that for tractor power, whereas in 1935 it was 69 percent. Grain loss in 1935 for tractor and electrical power threshing is shown in the following chart:

Type of Grain	Electric Power	Tractor Power
Wheat	1.72%	3.76%
Rye	3.70%	4.62%

These charts prove electrical power threshing far more efficient than other methods and it is known to be much quicker. Transformer substations which were constructed to supply this power are ordinarily in use only one and a half to two months (July and August) a year, and for this reason must be used for other purposes during the rest of the year. Electricity from Dnieper power stations is used on a large scale for cultivating, raising vegetables, irrigation, and stock raising. Cultivation by electricity is very efficient. A plan was carried out to equip the old farm machinery with crab type winches to cultivate 300 hectares /̲ 745 acres /̲ per season. Although imperfect, this electrical cultivation was far more efficient than tractor cultivation. Moreover, with electric motors there is less danger of fire and no need to supply fuel or water, which are extremely important considerations.

Thus, the electrification of Soviet agriculture has been extended year after year. The use of electric power in threshing and cultivation, in hot houses, stock raising, and collective farms and homes, may be expected to open vast areas for colonization. Electrification could thus be utilized in a country like Russia with its vast expanses of arable land and its peculiar state organization, but would be difficult to realize in small scale agricultural economy of North China where the farming population is suffering from overwork.

Another use of electricity in agriculture is irrigation, the lack of which is the weakest point of North China farming. Continued drought quickly ruins the harvest while excessive rainfall causes destructive floods everywhere. Irrigation is essential to the improvement of agriculture in North China, to the increase of crop yield per acre, and to the cultivation of higher grade crops such as cotton. Plans to dig wells in various places have been made and already have been carried out partially. The problem still is the need of electric power to use in these well irrigation projects. No sudden revision of the small scale farm economy of North China can be expected, and it would be difficult to increase the gains through securing the reliance on electric power of the small farms. The advantages and disadvantages between irrigation with electrically-pumped well-water and with water brought from rivers demand consideration. The former might be realized more easily and at less cost for a short period, but such matters as agriculture should be considered in terms of long-range national policy. Even though use of river water may cost much more at first, permanent installations built to handle it would eventually prove more desirable. Where it is technically impossible to use river water for irrigation it is assumed that all irrigation water would be pumped electrically from wells, since it would be difficult to estimate the degree of use of electricity which would be most profitable.

C. Transportation Uses (Electrification of Railways)

When considering the full economic development of North China, estimation of the extent to the extent to which railroads will be required is difficult. In view of the distribution of natural resources in the East Asia Co-Prosperity Sphere and China's role there, railroads should be built to connect important centers with seaports as a measure of national defense and to further the development of natural resources. The following lines should be built or improved as the most important for exploitation of natural resources:

1. T'ang-ku - Ta-T'ung (through Tsien-ching, Feng-tai, Men-t'ou-kou and Sha-cheng) about 500 kilometers
2. Ch'ing-tao - Lu-an (through Chi-nan and Chang-te) about 780 kilometers
3. Lien-yun - Tse-chou (through Hsu-chou, K'ai-feng, Hsin-hsiang) about 740 kilometers

According to the estimates of the North China Traffic Company the present 6,700 kilometers of railways in North China which transport 36,000,000 tons of freight, will total 21,000 kilometers and will transport 217,000,000 tons of freight, 30 years from now.

The carrying capacity of the railroads could be increased by electrification. The three railroad lines mentioned above as being especially useful for developing the natural resources are near the hydroelectric sites of the Yellow River and would be most effective. This railroad electrification would require about 100,000 KWH which is not a great demand on the electricity production, but is given as an illustration. Construction costs, transport capacity and transport expenditure should be studied carefully to determine the pulling power of electric engines and the desirability of electrification.

D. Mining Uses (Especially for the Development of the Coal Industry)

Coal is, without doubt, the most important factor for the economy of North China in the joint economic development of the East Asia Co-Prosperity Sphere. Source material indicates that coal is present in North China in overwhelming amounts, including large quantities of high quality bituminous, semi-anthracite and excellent anthracite coal. In order to supply the coal needs of Japan, Manchuria and China ten years from now, a total amount of 110 million tons of coal would have to be mined annually in North China. This large amount of mining would require about 450,000 kilowatts of electric power. It has been usual heretofore, to generate the electric power initially required in coal mining by steam at each mine, but the nearness of the Yellow River sites would call for use of their cheap electric power. The 450,000 kilowatts would be divided among the following districts as shown:

Ta-T'ung region	200,000 kilowatts
Along Shih-chia-chuan——T'ai-yuan and Pei-p'ing——Han-K'ou railway line	100,000 kilowatts
Southern Shansi area	150,000 kilowatts
Total	450,000 kilowatts

The plan is to transmit the power used in the Ta-T'ung region from Ching-shui River, Ho-ch'u and T'ien-ch'iao; that used along the Shih-chia-chuang——T'ai-yuan railroad line from Hei-yu-k'ou and Chi-k'ou-chen; that used along the Pei-p'ing——Han-k'ou line from San-men Gorge and Pa-li-hu-T'ung; and that used inthe Southern Shansi area from Yen-shui-kuan, Hu-k'ou, and Yu-men-k'ou.

E. Industrial Uses

A detailed description of North China's industrial progress and present day status cannot be given here. In general, it is organized as a semi-colonial area of the European and American imperialistic systems. The expansion of her modern industry with native capital has been greatly retarded. This capital consists largely of wholesale and manufacturing capital directed into such consumer-goods industries as cotton-spinning, knitting, pottery, carpet and embroidery, and foodstuffs, as well as the production of such implements as farm tools, simple spinning and knitting machines, jinrickshas, and wheel barrows.

Foreign capital has played an extremely important rôle in modern industrial expansion in China. It initiated China's advance by opening her seaports and building railways and stimulated the development of native industries. World War I marked the full industrial maturity of these industries and the post-warpanic consolidated the boom-industries. After the winning of customs autonomy in 1930, foreign industrial capital poured in, and industries based on home capital boomed. The investment of Japanese capital, especially in North China, increased rapidly after the "China Incident" and an extremely favorable position was obtained by the purchase of already established industries and through joint management.

Following is a comparison of the amount of capital of various nations invested in North China before and after the "China Incident".

Investment in North China Industry before and after the China Incident:

	Number of factories			Capital Funds		
	1936	1939	1939 Index No *	1936**	1939**	1939 Index No *
Japanese capital	121	225	185	146,675	179,683	122
Chinese capital	549	546	100	131,787	115,882	87
Foreign capital	29	27	93	71,655	71,055	99
Sino-Jap joint management	9	30	333	24,849	91,039	364
Chinese-foreign joint management	2	1	50	2,900	400	13
Totol	710	829	117	377,866	458,059	121

*1936 index number is 100
**No unit given. Probably in 1000 or 10,000 yen

The following chart shows the investment by industries before and after the China Incident.

Investment by Industries before and after the China Incident:

	1936		1939	
	Amount Invested*	Percentage	Amount Invested*	Percentage
Heavy Chemical Industries	50,226	13	64,503	14
Textile Industries	158,708	41	169,128	37
Foodstuffs	44,174	11	46,068	10
Others	23,137	8	28,789	6
Electrical Industries	101,621	27	149,571	33
Total	377,866	100	458,059	100

*No unit given. Probably in 1000 or 10,000 yen

As the above table shows, the North China industrial structure has an overwhelming preponderance of consumer-goods industries, which is based on agriculture. The percentage of this type of industries has shown a slight drop since the China Incident.

The greatest post-Incident development has been electrical industries which is based on motive power. Heavy chemical industries, which are basic industries, are weak buy show a slight increase over the pre-Incident period.

Thus, North China industry though still in a low state of development has shown a tendency toward steady, gradual improvement, with the stimulus of the China Incident. The relation of North China in its military and industrial role in the East Asia Co-Prosperity Sphere to the plan for utilizing Yellow River hydroelectric power should be considered.

It is needless to say that from the military standpoint since North China and Mongolia-Sinkiang geographically touch the northwestern border of Sinkiang, they comprise together with Manchuria the first line of defense against Soviet Russia. Their natural resources are the key to a closed economy of Japan and Manchuria in the East Asia Co-Prosperity Sphere, and tremendous expansion may be expected in industries using coal. Other important raw materials such as salt, alumina shale, iron ore, etc., should supplement the raw material deficiency in the Japanese economy. The basic objective, however, should be to promote heavy chemical industries in North China as quickly as possible and to supply Japan and Manchuria with finished or semi-finished products.

Materials needed for this industrial development can largely be supplied by Japan and Manchuria, but the plan is to supply them also from local sources, especially through the rapid development of such basic industries as iron, cement and machinery. Expansion of agriculture and light industries at the same time should also be planned so that North China can supply her own food and clothing to maintain her labor potential.

The industries discussed above should be scattered throughout the interior of the country for defense against air attack and access to raw materials rather than along the coast as the old laissez-faire economy would dictate. These industries would then benefit from Yellow River hydroelectric power.

The following is a consideration of various local factors influencing the industrial development of prospective electricity consumers in various areas in North China.

1. The T'ien-ching---T'ang-ku area. T'ang-shan, T'ien-ching, Pei-p'ing.

Even now this area is North China's chief industrial region, and in the future it will doubtless be a great industrial center. With the building of great new harbors, it will have the best communications of any area in North China. It is the main concentration point for raw materials. It is especially a great coal shipping port. It is only 90kilometers from the Kai-luan coal mine. It is near the alumina shale of Chi-tung and in the heart of the Ch'ang-lu salt fields, and it is 150 kilometers from the Luan River power station. /TN; At Luan. For location see Strategic Engineering Survey 144, Electric Power of China, Vol 1, PP 108 and 111 and map at front of this publication./ Although rather far from the Ho-ch'u power site, it could receive power from there. It is the best situated area in North China for securing water for industrial use. The Pai River alone could easily supply two million tons per day, and sea water could be used as well.

This region may be expected to develop pig iron and steel, cement, coal liquefaction, alumina, soda ash, fertilizers, cotton seed oil, linter, cotton spinning, flour milling and other industries.

2. The Ta-t'ung district

This district is located near the middle of the Ching-Pao/Pei-p'ing - Sui-yuan/ Railroad line, and will be the starting point for the trunk line to the new harbor at T'ang-Ku. It has 29 billion tons of jurassic and carboniferous bituminous coal deposits that are excellent for industrial use and 60 kilometers SSE of Ta-t'ung, near Hun-yuan, there is a vast amount of brown coal that is suitable for direct liquefaction. It is only 180 kilometers from the huge profected power sites at Ching-shui River and Ho-ch'u. The availability of water for industrial use must be investigated but a preliminary survey indicates that 300,000 to 400,000 tons per day can be obtained and hydroelectric power from the Yellow River could easily supply one million tons per day, pumping it 180 kilometers with no change in elevation.

Industries that will probably develop in this area are iron, using iron ore from Lung-yen/Chahar/ and local coal, cement, coal liquefaction, carbide, flour milling, etc.

3. The Hsin-hsiang--Chang-te Area

From the standpoint of communications this area plays an important role on the Ching-han/Pei-p'ing--Han-k'ou/ Railroad line, and will join the southern district of Shans, with direct connection with Chi-nan and with the harbor of Lien-yun. Within 100 kilometers there is good quality anthracite coal (Chiao-tso coal field), and abundant good coal between Lu-an and Tse-chou. Located inland, these important coal resources will develop an important local industrial area. This region is in the heart of the North Honan cotton growing area, and raw cotton from interior points, particularly the Shensi area, is also available. It is less than 150 kilometers from the San-men George site on the Yellow River and thus can easily use its electric power. Water is available from the Wei River for use in industry. After the establishment of flood control, on the the Yellow River, more than one million tons per day could be supplied to plants near the Yellow River.

The industries likely to arise in this area include cement, coal liquefaction, alumina, aluminum, carbide, fertilizer, cotton seed oil, linter, cotton-spinning, flour milling, etc.

4. T'ai-yuan area

This is in the center of Shansi Province at the junction of the Shih-chia-chuang—Tai-yuan Railroad line and the Ta-t'ung—Feng-lin-tu Railroad line. As for raw materials, coal and iron reserves are enormous, and in the south near Ling-shih, a deposit of nearly 300 million tons of gypsum was discovered recently. As they are far inland, these resources must be used locally. Water for industrial use can be supplied from the nearby Fen River at the rate of about 900,000 tons per day. Industries likely to develop in this area are iron, cement, fertilizer, carbide, coal liquefaction, etc.

The Chiao-chou—Chi-nan district, Ch'ing-tao and Hai-chou will also become industrialized and require electric power, but they are too far away to benefit from the Yellow River power development. Though at present outside the North China area, Cheng-chou, Hsi-an and Han-k'ou will become consumers of Yellow River power. Han-k'ou may well require 300,000 kilowatts.

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III Active Plans to Utilize Electric Power

A. Introduction

The eleven sites on the Yellow River will generate over eight million kilowatts, about as much as Japan's total generation of steam and water power at present. With the contrast in living standards and in industry between Japan and North China, it is evident that consumption of such a vast amount of electric power will require definite planning. This study was undertaken while plans for the unification of the economics of Japan, China and Manchuria were being formulated in Japan, but plans have not yet developed whereby they can be used as a guide to the consumption of Yellow River hydroelectric power in North China.

Since the Yellow River power study cannot await the completion of these plans, it considers the power consumption calculated from the North China economic development plan.

The plan provides for raw material industries where the main deposits are located, and in assigning industries to the best suited areas in Japan, Manchuria or China even provides for some heavy chemical industry. The following table shows the areas in which industries important in electricity consumption are likely to develop.

Industries by Location (Units in 1000 metric tons)

(Table on next page)

	T'ien-ching—Tang-ku	Ta-t'ung	Chang-te—Hsin-hsiang	Shih-chia-chuang—T'ai-yuan	Chiao-chou—Chinan	Ch'ing-tao	Hsu-chou—Hai-chou
Pig Iron	4,100	700		100	100		
Steel	3,400	450		50	100		
Synthetic Petroleum	500	600	700	200	300		
Aluminum			20				
Carbide		200	100	300			
Artificial fertilizer	500		500	300	300		200
Alumina	40		100		60		

Note:

(1) There are many other industries, such as cotton and cotton-seed processing, flour milling, machinery manufacture, cement, etc, but they were excluded from the plan because they are special cases or because they consume comparatively little electricity.

(2) Alumina will be produced by the dry electric hearth method in the Chiang-te—Hsin-hsiang area while in the T'ien-Ching—T'ang-ku and Chiao-chou—Chi-nan area it will be a by-product of the artificial fertilizer industry. The latter method to produce alumina will require very little electric power.

The water-power and coal resources of Japan, Manchuria and China are fairly rich for the present, but their self-sufficiency as sources of power several decades hence does not look optimistic. Since water power will constitute the main source of energy for North China, the Yellow River must be developed to meet this demand.

B. Active Consumption of Electricity

All the generating sites on the Yellow River are rather far inland. The following table shows the shortest direct-line distance from each dam site to the sea. The closest site is 550 kilometers inland, and Yellow River electric power will not be so cheap in coastal areas as nearer its source. These power sites are located in what is now considered a frontier area, but each dam would approximate in size the Suiho Dam power station on the Yalu River, making this the greatest electricity producing project in the world today. Most of the active consumption will be by industries which use a large amount of electricity, especially in areas near the hydro-electric power sites.

North China's economical development will naturally include large-scale industry near the coast. It is difficult to anticipate the electric power situation some 500 kilometers from the power sites, but if the Yellow River power is developed under sufficiently favorable conditions, it would still be cheaper than that from steam plants or small hydro-electric ones. Coastal industry was therefore included in the active consumption plan to be supplied from the Yellow River.

The maximum active consumption of electricity was calculated making allowances for each particular site. These figures are shown in the following table.

Maximum Active Electrical Consumption for Each Site

	Dam No	Average Electric Output (1000 KW)	Annual Power Output (1,000,000 KWH)	Active Electric Power Consumption (1,000,000 KWH)	Direct Distance to Sea Coast (km)
Ching-shui River	1	256	2,240	1,610	550
Ho-ch'u	2	283	2,480	1,790	560
T'ien-ch'iao	3	660	5,780	4,160	600
Hei-yu-k'ou	4	329	2,880	2,070	600
Chi-k'ou-chen	5	410	3,590	2,580	600
Yen-shui-kuan	6	418	3,660	2,640	660
Hu-k'ou	7	377	3,300	2,380	700
Yu-men-k'ou	8	398	3,500	2,520	700
San-men Gorge	9	590	5,170	3,720	730
Pa-li-hu-t'ung	10	1,122	9,830	7,080	640
Hsiao-hen-ti	11	162	1,420	1,020	600

The total electricity required for the active consumption demand is thus 31,570,000,000 kilowatt-hours annually. Some sites are more favored than others and the economical development plan provides for some variation in size and location of industries. This study will therefore consider in detail the electric consumption by industrial developments in each district, and the relation of each district to the power sites. The main districts are those mentioned above, the Ta-t'ung for the upper river, T'ai-yuan for the middle section, and Hsin-hsiang and Chang-te for the lower section, plus the coastal areas of Pei-p'ing---T'ien-ching (including Hopeh), Chinan (including Tzu-ch'uan and Po-shan regions), and Hsu-chou--Hai-chou.

C. Consumption Plans for Individual Districts

1. T'ien-ching--T'ang-ku

This district comprises a new port at T'ang-ku and its hinterland, including T'ien-ching, Pei-p'ing and Hopeh area. It is characterized by the large volume of exports and imports handled through the port and the assembly of coal there. It has great prospects as an exporter of coal for industrial use to Japan and Manchuria in exchange for manufactured goods.

To get most value from North China's coking coal, it will be combined with iron ore from Lung-yen and elsewhere to produce pig iron and stell at new mills in the hinterland of T'ang-ku and the Ch'in-huan-tao region. Half of this production will be for export. The anticipated annual production 4,100,000 metric tons of pig iron and 3,400,000 metric tons of steel. Profitable industries will develope at the Kai-lan, Pei-p'ing--Sui-yuan, Pei-p'ing--Han-k'ou, T'ien-ching--P'u-chou and other railroad lines. This district will supply about one fifth of the synthetic petroleum production planned for North China in the effort to gain self-sufficiency in liquid fuel for Japan, Manchuria, and China; 400,000 metric tons of synthetic petroleum by the Fischer method and 100,000 metric tons of synthetic iso-octane petroleum per year. The artificial fertilizer industry, in which coal is the chief ingredient, is similarly favored and may be expected to develop a capacity of 500,000 metric tons a year, to supply North, Central, and South China; Japan and Manchuria.

The large soda-ash industry which utilizes Ch'ang-lu salt, will also require electricity, but, because of its type, this industry normally uses electric power provided by steam generation since the escaping steam is used in the heating process, so it was omitted form consideration. The total electricity used in the above industries is shown in the following table.

Industries Planned		Yearly Production (metric tons)	Electric Power Required Per (KWH)	Electric Power required per year (KWH)
Iron	Pig iron	4,100,000		
	Steel	3,400,000	250 (most pig iron converted directly into steel)	1,025,000,000
Synthetic Petroleum	Fischer method	400,000	470	188,000,000
	Iso-octane method	100,000	2,000	200,000,000
Artificial fertilizer		500,000	1,000	500,000,000
Total				1,913,000,000

Geography does not favor the other industries that might be active consumers of Yellow River hydroelectric power and they were therefore omitted.

2. Chiao-chou - Chi-nan Area

This district is in the heart of the central coal mining region. It has iron ore at Chin-ling-chen and extensive arable land. These resources could be used to produce 300,000 metric tons of synthetic petroleum, 300,000 metric tons of artificial fertilizer, and 100,000 metric tons of steel (rotary hearth type). The required amount of electric power is shown in the following table.

Industries Planned		Annual Production (metric tons)	Electricity Required per MT (KWH)	Electricity Required per Year (KWH)
Synthetic petroleum	Fischer method	300,000	470	141,000,000
Artificial fertilizer		300,000	1,000	300,000,000
Iron	Rotary Hearth Type	100,000	100	10,000,000
Total				451,000,000

3. Ch'ing-tao and Hsu-chou--Hai-chou Areas

Apart from soda ash, the main industry of these areas is expected to be artificial fertilizer, with an annual production of 200,000 metric tons (in Hai-chou). Soda ash was excluded from the plan for the reason explained under the T'ien-ching--T'ang-ku area while the electricity required for the Hai-chou artificial fertilizer industry is expected to be 200,000,000 KWH.

4. The Ta-t'ung Area

This area has extensive coal and considerable iron deposits. There are 30 billion metric tons of coal at Ta-t'ung and other deposits at Hun-yuan, Fan-chih and Hsia-hua-yuan. In quality there are excellent fuel coals, coal usable in chemical industries, coking coal and coal for direct liquefaction. Iron ore is found near Lung-yen and there are probable deposits in Inner Mongolia. These factors should develop an iron industry producting 700,000 metric tons of pig iron and 450,000 metric tons of steel a year; a synthetic petroleum industry producing 300,000 metric tons by direct liquefaction, 100,000 metric tons by the Fischer method, and 200,000 metric tons a year of iso-octane gasoline; and a 200,000 metric ton carbide industry for synthetic rubber and organic-compounds industries. This section should require annually 3,513,000,000 kilowatt-hours of electric power, including 200,000 kilowatt-hours for the coal mines near Ta-t'ung and 100,000 kilowatts for the electrified railroad from Ta-t'ung to T'ang-ku. This demand for electric power is shown in the follow table.

Industries Planned		Annual Production (metric tons)	Electricity Required per MT (KWH)	Amount of Electricity Required per Year (KWH)
Iron	Pig Iron Steel	700,000 450,000	250 (assuming pig iron converted directly into steel)	175,000,000
Synthetic petroleum	Direct Liquefaction	300,000	2,000	600,000,000
	Fischer method	100,000	470	47,000,000
	Iso-octane	200,000	2,000	400,000,000
Carbide		200,000	4,000	800,000,000
Coal mining			(200,000 KW)	1,051,000,000
Ta-t'ung Coal Transport Railroad			(100,000 KW)	440,000,000
Total				3,513,000,000

As shown in the chart on page 119 the nearest power stations at Ching-shui River, Ho-ch'u and T'ien-ch'iao have a total maximum active consumption of 7,560,000,000 kilowatt-hours; which is 4,047,000,000 kilowatt-hours more than that required by the chart above. As explained above, however, these sites will also supply 1,913,000,000 Kilowatt-hours for industrial use to the Tien-ching--T'ang-ku area, leaving a surplus of 2,134,000,000 kilowatt-hours. This surplus will be considered below, along with plans for disposing of the surplus power of other areas.

5. Chang-te--Hsiang Area

Most of the Yellow River hydroelectric sites are in the hinterland of this area. The total yearly amount of electricity generated at San-men Gorge, Pa-li-hu-t'ung and Hsiao-hen-ti would be 16,420,000,000 kilowatt-hours, which is 37.5 percent of the total 43,850,000,000 kilowatt-hours from all the sites. In North China, water for industrial use is very scarce but this area has more than enough such water from the ei River and the canal to be constructed for irrigation along the new Yellow River (if it goes to Chi-nan). It will be a large active consumer of Yellow river electric power.

Probable industries are a synthetic petroleum industry using coal from the mines at Chiao-tso, Liu-ho-kou, Tz'u-hsien, Lu-an and Tse-chou to produce 500,000 metric tons a year by the Fischer method and 200,000 by the Iso-octane process; a 500,000 metric ton artificial fertilizer industry based on the coal; an alumina industry using the electric hearth method and using alumina shale found in the Chiao-tso and Chung-hsing coal fields and elsewhere with an annual production of 100,000 metric tons, 40 percent of which would be reduced by electrolysis, to produce 200,000 metric tons of aluminum by an aluminum smelting industry; a 100,000 metric ton carbide industry to supply raw material for sythetic rubber and organic compounds.

The electric power required by these industries is shown in the following table.

Industries Planned		Annual Production (metric tons	Electricity Required per MT (KWH)	Electricity Required per year (KWH)
Synthetic petroleum	Fischer method	500,000	470	235,000,000
	Iso-octane method	200,000	2,000	400,000,000
Artificial fertilizer		500,000	1,000	500,000,000
Alumina		100,000	17,000	1,700,000,000
Aluminum		20,000	22,000	440,000,000
Carbide		100,000	4,000	400,000,000
Total				3,675,000,000

The maximum active power consumption, is given in the chart on page 119 for San-men Gorge, Pa-li-hu-t'ung and Hsiao-hen-ti, is 11,820,000,000 kilowatt-hours, from which the above industries will take 3,675,000,000 kilowatt-hours and coal mining 150,000 kilowatts (788,000,000 kilowatt-hours per year), while 300,000 kilowatts (1,500,000,000 kilowatt-hours peryear) will be transmitted to the Han-k'ou area, 200,000,000 kilowatt-hours to the Hsu-chou--Hai-chou area, as mentioned above; and 451,000,000 kilowatt-hours to the Chiao-chou--Chi-nan area; leaving a balance of 5,206,000,000 kilowatt-hours. This surplus will be discussed below.

6. Shih-men - T'ai-yuan Area

This area actually includes both cities and the district between them but the economic development plan actually provides for active consumption of electricity only by the 100,000 metric ton pig iron and 50,000 metric ton steel industry at T'ai-yuan. T'ai-yuan, however, is located at the center of the Ta-t'ung--Feng-ling-tu Railroad line, which is parallel to the main part of the Yellow River power development, and it is close enough to utilize the power. There are various grades of coal at T'ai-yuan, Tung-shan, Hsi-shan, Hsien-kang-chen, Fu-chia-tan, Ning-wu and elsewhere, and a deposit of several hundred million tons of gypsum along the railroad line between T'ai-yuan and Ling-shih, both of great importance to East Asian self-sufficiency. Industry based on these can readily produce 200,000 metric tons of synthetic petroleum by the Fischer method, 300,000 metric tons of ammonium sulphate by the gypsum method and 300,000 metric tons of carbide per year, to be used in preparing organic compounds. The coal mines would require 100,000 kilowatts, making the total requirements as shown in the following table.

Planned Industries		Annual Production (metric tons)	Electricity Required per MT (KWH)*	Electricity Required per year (KWH)
Iron	Pig iron	100,000	250	25,000,000
	Steel	50,000		
Synthetic petroleum	Fischer method	200,000	470	94,000,000
Artificial fertilizer	Ammonium Sulphate by the gypsum method	300,000	1,000	300,000,000
Carbide		300,000	4,000	1,200,000,000
Coal mining			(100,000 KW)	526,000,000
Total				2,145,000,000

This demand nearly equals the 2,580,000,000 kilowatt-hours of electric power that would be generated at Chi-k'ou-chen.

7. Disposition of Surplus Power

The above economic plan calls for the utilization of 14,185,000,000 kilowatt-hours of electric power. The supply of this power is shown in the following table (active consumption figures from chart on page 119).

	Site	Active Electric Power Consumption (1,000,000 KWH per year)	Total	Consuming Area	Total Electric Power Required (1,000,000 KWH)	Total	Surplus Power 1,000,000 KWH
1.	Ch'ing-shui River	1,610	7,560	Ta-t'ung	3,513	5,426	1,714 /sic/
2.	Ho-chu	1,790		T'ien-ching-T'ang-ku	1,913		
3.	T'ien-ch'iao	4,160					
5.	Chi-k'ou-chen	2,580	2,580	Shih-men T'ai-hsiang	2,145	2,145	295 /sic/
9.	San-men Gorge	3,720	11,820	Chang-te-Hein-hsiang	5,963	6,614	4,546 /sic/
10.	Pa-li-hu-t'ung	7,080		Chiao-chou-Chi-nan	451		
11.	Hsiao-hen-ti	1,020		Hsu-chou-Hai-chou	200		
	Total	21,960	21,960		14,185	14,185	7,775 /sic/

In addition to the above, a total of 9,610,000,000 kilowatt-hours will be generated for active consumption at the following sites Hei-yu-kou (2,070,000,000), Yen-shui-kuan (2,640,000,000), Hu-kou (2,380,000,000), and Yu-men-k'ou (2,520,000,000).

This surplus electric power should be included in the East Asia economic development plan and requires further consideration.

The extent of future industrial development in North China is shown from the following figures, derived from the table on page 118.

Iron	pig iron	5,000,000 metric tons
	steel	4,000,000 metric tons
Synthetic petroleum		2,300,000 metric tons
Alumina (smelting method)		100,000 [sic] metric tons
Aluminum		20,000 metric tons
Carbide		600,000 metric tons
Artificial fertilizer		1,800,000 metric tons

These figures are calculated from the present situation in the Japan, Manchuria, and China Sphere. It would be extremely difficult to estimate the production level to which the requirements of national defense and development in East Asia will bring this region in 20 to 30 years, but for example, if the iron industry should reach the level it now has in the US and Germany, approximately one-third of this production would be in North China.

In other industries likewise, North China will play a very important economic role in the Japan, Manchuria and China Sphere. Considerable importance is given to the local conditions of each industry, and they should be reconsidered from the point of view of national defense. This reconsideration would take the following lines:

a. Iron production: In North China, there is little iron deposited except at Ta-t'ung, T'ai-yuan and in the Chiao-chou-Chi-nan area. Mills along the coast probably could use imported ore.

b. Synthetic petroleum: The chief role of synthetic petroleum is to insure fuel in wartime. It requires knowledge 20 or 30 years in advance of the type of warfare. The present trend makes high octane aviation gasoline essential.

Of the above 2,300,000 metric tons of synthetic petroleum, the 500,000 metric tons of iso-octane is the basis for 100-octane standard aviation gasoline. If required, this can be converted into higher grade neo-hexane, etc.

The planned development is sufficiently extensive, for the North China production would exceed the present world total production of 100-octane gasoline.

c. Alumina and aluminum: To maintain a production in the Japan, Manchuria and China Sphere of 200,000 metric tons of Aluminum, 400,000 metric of alumina for electrolysis will be required. North China and Manchuria alumina shale is sufficient to meet this demand.

The best method of producing alumina from this shale would be that advocated by Professor YAMAZAKI Jingoro in which alumina is a by-product in the production of ammonium sulfate.

Facilities producing 2,000,000 metric tons of ammonium sulfate would be sufficient to produce 400,000 metric tons of alumina. The present plan calls for 100,000 metric tons of alumina by the ammonium sulfate method and 100,000 metric tons by the electric furnace method. This quantity is sufficient considering the production capacity of ammonium sulfate in Japan and Manchuria.

Aluminum electrolysis facilities should be as dispersed as possible for national defense. Excluding the facilities in Japan, facilities in Korea, Manchuria and Formosa dispersed according to the water power, can supply 40,000 metric tons yearly. This production would permit an increase of 20,000 metric tons to the previously mentioned plan.

d. Artificial fertilizer: These are principally such ammonium nitrogenous fertilizers as ammonium sulfate, ammonium nitrate and ammonium chloride. This industry presents a complicated problem in North China. In regard to ammonium sulfate, the production of iron sulfide is small and does not exceed 100,000 metric tons annually; the gypsum deposit of several hundred million metric tons recently discovered in Shansi is too far from the sea coast, and other fertilizer material for agricultural use can be expected only in very small quantities.

The production of ammonium chloride as a by-product of soda ash manufacture is a new industry which could easily be developed in North China, but if one metric ton of soda ash, ium chloride is to be produced from each metric ton of soda ash, the present production of soda ash would limit the by-product to 1,000,000 metric tons a year.

e. Carbide: Carbide is probably one of the best producers of electrical energy at the present time. The above plan provides for a total production of 600,000 metric tons but these figures do not represent the exact quantity of the finished product. Many synthetic products can be derived from carbide, including synthetic rubber, synthetic resins, synthetic liquid fuel, synthetic fibre, acetic acid, etc. These synthetic commodities are not purely war-time substitutes but high quality pure synthetic raw materials. The minimum requirements as war-time substitutes must be considered.

(1) Japan's present demand for crude rubber is approximately 50,000 to 60,000 metric tons per year, excluding reclaimed rubber, but is is expected to reach 500,000 metric tons. (The present U.S. demand). If all of this amount is to be produced from carbide, approximately 2,000,000 metric tons will be required.

Maximum production of synthetic rubber from carbide is achieved by rubber of the chloroprene group, including the US Neoprene and the Russian Sov-prene. If 80 percent pure carbide is converted into acetylene from which chloroprene polymerised matter (synthetic rubber) is derived at 50 percent efficiency, one metric ton of synthetic rubber can be produced from approximately four metric tons of carbide.

(2) "Staple fibre," which is now used extensively as a substitute for wool and cotton, was originally another form of cellulose. Like rayon, it is not a synthetic fibre in a complete sense of the word. With the bottleneck in the supply of wood pulp and raw wood used for "Staple fibre" and rayon, these products cannot be a complete substitute. Nylon, which has recently appeared in the US, Germany's "PC" fibre and Japan's synthetic No 1 KANEBIAN* are pure synthetic fibres, and not derived from wood or cotton cellulose. Their properties make them satisfactory substitutes for wool, silk, rayon, and cotton thread. No doubt there will be a great development in the quality and value of new fibres and in East Asia's self-sufficiency in them.

The above products may be derived from various raw materials. Although considerable change in synthetic fibre production methods is expected, carbide is the most promising raw material in quantity in the Japan, Manchuria and China Sphere.

The following gives Japan's production of rayon and "staple fibre" for 1939 (taken from Chemical Industry Year Book/KAGAKU KOGYO NENKAN/, 1941):

JAPAN'S RAYON AND STABLE FIBRE PRODUCTION (metric tons)

	For Domestic Use	For Export	total
Rayon	43,200	58,700	101,900
Staple Fibre	112,100	16,200	133,500/sic/
Total	155,300	74,900	235,400/sic/

The exports were divided as follows (same source):

	Rayon Thread (lbs)	Rayon Cloth(sq yds)	"Staple fibre"(lbs)
To Manchuria, Kwantung Peninsula and China	4,580,000	72,447,000	24,428,000
To 3 first rate powers	32,162,000	237,482,000	8,415,000

The above two charts show that 23.5 percent or 13,800 metric tons of exported rayon and approximately 74.2 percent or 12,000 metric tons of exported "staple fibre" went to Manchuria, the Kwantung Peninsula and China. Added to the 155,300 metric tons produced for domestic use, this gives a total of 181,100 metric tons, the total 1939 consumption of synthetic fibre in the Japan, Manchuria and China sphere.

This cannot, however, be considered the amount of such fibre required there during wartime. The demand of this sphere will increase sharply as a result of the political situation restricting trade whereas the demand for substitute fibre will be met partly by measures to increase agricultural and live stock production. Taking the annual demand for substitute fibre as 200,000 metric tons, it would require approximately 1,240,000 metric tons of carbide if carbide is to supply this entire demand.

If the synthetic fibre includes vinyl alcohol or vinyl chloride, at 50 percent yield from acetylene one metric ton of 80 percent pure carbide would yield 0.162 metric tons of synthetic fibre. A production of 200,000 metric tons of synthetic fibre would require approximately 1,240,000 metric tons of carbide, while that of 300,000 metric tons of synthetic fibre would require 1,850,000 metric tons of carbide.

(3) The rayon industry, which uses synthetic acetic acid cellulose; the synthetic butanol industry, which has drawn considerable attention recently as a supplier of solvents and raw materials for high grade fuels (iso-octane); the synthetic resin industry; and the synthetic benzpl, toluol and alcohol industries (dyes, explosives, solvents and fuels--already active industries which are vital for peace and war) all use carbide as a raw material.

The production of these synthetic industries in the principal countries of the world is as follows (high grade fuels, synthetic rubber and rayon were discussed previously and are therefore omitted here): The total annual production of industrial chemicals of the acetylene group in 1938 in the US was 500,000,000 pounds, or approximately 230,000 metric tons. If all of this is produced from carbide (technically feasible, though unsound economically), it would require approximately one million metric tons of carbide per year.

The estimated annual German production of synthetic resin for 1939 was about 10,000 metric tons. Germany's 1938 benzol production, which was not synthetic, amounted to approximately

440,000 metric tons, while the US total production in the same year, totalled 118,000 metric tons. If the Japan, Manchuria, China Sphere is to achieve self-sufficiency 20 or 30 years from now in these products with a production comparable to that of the US or Germany, it will require a minimum of 3,000,000 metric tons of carbide per year.

The above general discussion of carbide shows that the above conditions are very favorable for future developments, but the problem of quantity requires some study in order to attain self-sufficiency in wartime. The Yellow River hydroelectric area is the most favorable section for this production in the Japan, Manchuria and China Sphere; and if it were to produce one half of the sphere's output, it would amount to about three million metric tons of carbide per year. This is 2,400,000 metric tons more than the total of 600,000 metric tons for all the districts listed above.

f. The following relatively basic industries also consume a considerable volume of electricity and therefore warrant consideration.

(1) The manufacture of special steels and iron alloys in electric furnaces

(2) The manufacture of abrasives and cast bricks

(3) The manufacture of artificial graphite

The following chart gives the total world production of these products (From Chemical Industry Year Book for 1941, p 227):

	Production (1,000 metric tons)		Electric Energy Used (1,000,000 KWH)	
	1929	1939	1929	1939
Electrically manufactured steel	2,200	2,500	1,100	1,200
Iron alloys	500	600	3,000	3,300
Abrasives	150	180	750	900

The total 1937 electricity production in Japan was 30,200,000,000 kilowatt-hours, 7 percent of the world's total of 430,000,000,000 kilowatt-hours. Japan's production of the above three products was about three times this percentage.

Japan's future production will be much larger than it is at present and the Yellow River area probably will equal approximately the present production in Japan. The following electric power demand should therefore be added to these discussed above:

	Annual Production (metric tons)	Electric Power Required annually (KWH)
Electrically manufactured steel	500,000	240,000,000
Iron Alloys	100,000	550,000,000
Abrasives	20,000	100,000,000
Artificial graphite	20,000	200,000,000

The above figures on electric power consumption will skyrocket whenever there is a drive for greater national defense.

Since Yellow River power is exceptionally favored in quantity and cost, the industries discussed above in this section should be added to those given in the chart on page 118 in planning the active reorganization of the industries of Japan, Manchuria and China. These additional industries would have the following electric power consumption:

Additional Industries	Annual Production (metric tons)	Electric Power Required (KWH)
Aluminum	20,000	440,000,000
Carbide	2,400,000	9,600,000,000
Electrically manufactured steel	500,000	240,000,000
Iron Alloys	100,000	550,000,000
Abrasives	20,000	100,000,000
Artificial Graphite	20,000	200,000,000
Total		11,130,000,000

This 11,130,000,000 kilowatt-hour of electric power is 3,355,000,000 kilowatt-hours more than the Yellow River surplus given in the chart on page . Therefore to equalize production and consumption of electric power, besides the sites listed in this chart, Hei-yu-k'ou (2,070,000,000 kilowatt-hours), and Yen-shui-kuan (2,640,000,000 kilowatt-hours) will have to supply most of the demands of the Shih-men--T'ai-yuan area, while these additional industries are distributed to the various production areas as follows:

(1) The aluminum industry should be in the Ta-t'ung area, which can produce at least 70,000 to 80,000 metric tons of lime tar annually for the ashless carbon electrodes.

(2) The carbide industry as mentioned above, should be situated near electric furnaces and at least the first stage in its conversion into semi-finished products should take place near the

furnaces. Water for industrial use should be abundant. The Ta-t'ung area is not well suited for this, and its electricity surplus would allow the production of 100,000 metric tons there. The Shih-men--T'ai-yuan and Chang-te--Hsin-hsiang areas have ample water, and each area could provide 1,150,000 metric tons.

(3) Electric Steel manufacture requires approximately 500 kilowatt-hours of electric power to produce one metric ton of steel. Consequently, proximity to the source of electric power is not important and of the 500,000 metric tons, 300,000 metric tons can be allotted to the T'ien-ching--T'ang-ku area and 200,000 metric tons to the Chang-te--Hsin-hsiang area.

(4) Iron alloy production involves only treatment in electric furnaces, so that this industry should be located where electric power is readily available. Accordingly, 50,000 metric tons were allocated to the Ta-t'ung and Chang-te--Hsin-shiang area, respectively.

(5) Abrasives and artificial graphite were assigned to the Chang-te--Hsin-hsiang area, where electric power is cheap, the raw materials are readily available and the finished products can easily be transported away.

D. Summary

The utilization of electric power by districts was covered above. The following chart shows the relation between the hydroelectric sites and the consuming industries.*

*(TN: According to later revision: "The electric power which would be required by the artificial fertilizer industry near Hai-chou is so small that it was omitted.

Site	Active Consumption of Electric Power (Million KWH per year)	Total(A)	Consuming District	Planned Industries	Annual Production (1000 metric tons)	Electric Power Required (million KWH per year)	Total(P)	Surplus Electric Power (million KWH per year) (A-P)
Ching-shui River	1,610			Iron: Pig Iron	700			
				Steel	450	175		
Ho-ch'u	1,790		Ta-t'ung	Synthetic petroleum	600	1,047		
				Carbide	300	1,200	4,628	
				Aluminum	20	440		
				Iron Alloys	50	275		
				Coal mining(200,000 KW)		1,051		
		7,560		Ta-t'ung coal railroad (100,000 KW)		440		875
T'ien-chiao	4,160		T'ien-ching T'ang-ku	Iron: Pig iron	4,100			
				Steel	3,400	1,025		
				Synthetic petroleum	500	388	2,057	
				Artificial fertilizer	500	500		
				Electrically manufactured steel	300	144		
Hei-yu-k'ou	2,070		Shih-men T'ai-yuan	Iron: Pig Iron	100			
				Steel	50	25		
Chi-k'ou-chen	2,580	7,290		Synthetic petroleum	200	94	6,745	
				Artificial fertilizer	300	300		545
				Carbide	1,450	5,800		
Yen-shui-kuan	2,640			Coal mining (100,000 KW)		526		

(Contd)

Site	Active Consumption of Electric power (million KWH per year)	Total (A)	Consuming District	Planned Industries	Annual Production (1000 metric tons)	Electric Power Required (million KWH per year)	Total (B)	Surplus Electric power (million KWH per year) (A-B)
Hu-k'ou	2,380	2,380						2,380
Yu-men-k'ou	2,520	2,520						2,520
				Synthetic petroleum	700	635		
				Artificial fertilizer	500	500		
			Chang-te	Alumina	100	1,700		
				Aluminum	20	440		
San-men Gorge	3,720		Hsin-hsiang	Carbide	1,250	5,000		
				Electrically Manufactured steel	200	96	9,734	
		11,820		Iron Alloy	50	275		135
				Abrasives	20	100		
				Synthetic graphite	20	200		
Pa-li-hu-t'ung	7,080			Coal mining (150,000 KW)		788		
			Han-k'ou Area	(300,000 KW)		1,500	1,500	
				Synthetic petroleum	300	141		
Hsiao-hen-ti	1,020		Chiao-chou	Artificial fertilizer	300	300	451	
			Chi-nan	Iron	100	10		
Total	31,570	31,570				25,115	25,115	6,455

Thus there will be a surplus of 6,455,000,000 kilowatt-hours for active consumption, but it is difficult to estimate future progress and demands for electric power and there will be great variations because of the scale of the above industries and location of development.

This study dealt mainly with electric consumption in North China, anticipation large scale transmission outside this section only to the Han-k'ou area. Several decades hence, the Yellow River project will have to supply the needs of regions to the west and northwest. Therefore, the surplus electric power is needed in the plan to supply necessary flexibility in the calculations.

In concluding this discussion on active consumption of Yellow River hydroelectric power, the main point to be remembered is that this development must be postulated upon the establishment of the Japan, Manchuria and China economy.

It would be absolutely impossible to develop even one-half of the total water power resources if Japan and Manchuria are excluded from the economic unit. This reduced economic base would raise the cost of producing electricity through the lowered average annual output and might even affect flood control which is the basic problem. Another prerequisite is that the economic expolitation of Yellow River hydroelectric power must take place under sufficiently good conditions.

Rapid conversion of industries to production for wartime is impossible and these industries are therefore no insurance against wartime demands. Synthetics industries which will consume more than half of the electric power consequently must be maintained on an economic basis during peacetime. This requires that the synthetic products resemble the natural ones as closely as possible. The Yellow River project thereby will show its complete value to the Japan, Manchuria and China Sphere as a natural resource.

IV. Plan for Transmission of Electric Power

A. Introduction

This chapter discusses the power transmission network planned for North China on the basis of the plan for active consumption of electric power treated in III, and gives the basic cost of Yellow River hydroelectric power in the principal consuming districts. This plan is one of the world's foremost for the distance and volume of electric power to be transmitted. It will require study by many technical experts and considerable time to develop. The transmission at 440,000 volts adopted in this plan, is higher than that used anywhere else in the world today. This high voltage transmission will require considerable technical study. There are now plans being formulated for the use of higher transmission voltages and longer transmission distances than those called for in the Yellow River plan. At the present time, countries are carefully studying electric transmillion by ultra high-voltage methods and in the near future the present plan will be realizeable.

The basic cost of electric power provided in the Yellow River Project seems high compared to completed projects and those under construction on the Yalu and Sungari River, but construction costs for the Yellow River project are based on current commodity prices. If the construction of these other projects had been done during the same period, technically there would be no question that the Yellow River project would be much more economical than any other project. Furthermore, the construction of the Yellow River dams is really more important for flood control and irrigation than for hydroelectric power, and these other benefits should bear a portion of the dam construction costs. If this apportionment were made, it would reduce even more the cost of electric power.

3. Electrical Demands

The demand for electrical power of the principal districts of North China was estimated from the above estimates of active consumption of electric power, while the average and maximum demand for electric power was determined from the estimated load factor for the industries in each district. These figures are shown in the following table:

Electrical Demands based on Active Consumption

District	Electric Power Required yearly (1,000 KWH)	Average Consumption (Kilowatts)	Maximum Consumption (KW)
Ta-t'ung	4,627,000	528,000	818,000
Pei-p'ing	516,000	59,000	117,000
T'ien-ching-T'ang-ku	2,017,000	235,000	335,000
Shih-men-T'ai-yuan	6,745,000	771,000	1,064,000
Chang-te-Hsin-hsieng	9,734,000	1,107,000	1,556,000
Chiao-chou-Chi-nan	451,000	51,000	70,000
Han-k'ou	1,500,000	170,000	300,000
Total	25,590,000	2,921,000	4,260,000

The electrical consumption of industries such as flour milling, machine manufacture, cement, etc and that for illumination and heating must be estimated also. The following estimates took into consideration the development of the new industrial districts resulting from the plan for active consumption and conditions in each district.

General Demand for Electric Power

District	Electric Power Required Yearly (1,000 KWH)	Average Consumption (KW)	Maximum Consumption (KW)
Ta-tung	780,000	89,000	198,000
Pei-p'ing	750,000	86,000	190,000
Ti'en-ching T'ang-ku	750,000	86,000	190,000
Shih-men-T'ai-yuan	1,150,000	130,000	290,000
Chang-te-Hsin-shieng	1,947,000	222,000	494,000
Chiao-chou Chi-nan	420,000	48,000	120,000
Total	5,797,000	661,000	1,482,000

The following chart consolidates the two previous charts to give the total demand for electricity in each district.

Total Demand for Electricity

District	Electric Power Required yearly (1,000 KW)	Average Consumption (KW)	Maximum Consumption (KW)
Ta-tung	5,407,000	617,000	1,016,000
Pei-p'ing	1,266,000	145,000	307,000
T'ien-ching-T-ang-ku	2,767,000	321,000	525,000
Shih-men-T'ai-yuan	7,895,000	901,000	1,354,000
Cheng-te-Hsin-hsiang	11,681,000	1,329,000	2,050,000
Chiao-chou-Chi-nan	871,000	99,000	190,000
Han-k'ou	1,500,000	170,000	300,000
Total	31,387,000	3,582,000	5,742,000

The above estimation of the total demand for electricity equals approximately 70 percent of the total capacity of 43,800,000,000 kilowatt-hours of Ching-shui River and ten hydroelectric sites and 70 percent of the maximum capacity of 80,000,000,000 kilowatt-hours of the same sites but if the loss through transformation and transmission is included it would be about 80 percent.

C. Transmission Network

In their supplying of electric power to the consuming districts, as stated in III above, the Yellow River plan calls for supply by only nine of the eleven hydroelectric plants. The following study assumes that the transmission network will lead from these nine stations.

T'ien-ch'iao, Ho-ch'u and Ching-shui River can supply the Ta-tung, Pei-p'ing and T'ien-ching-T'ang-ku districts and therefore are considered as a segment, temporarily called the Northern Network. Yei-yu-k'ou, Chi-k'ou-chen and Yen-shui-kuan supply the

Shih-men—T'ai-yuan district and will be called the Central Network, while San-men Gorge Pa-li-hu-t'ung and Hsiao-hen-ti supply the Chang-te-Hsin-hsiang, Chiao-chou-Chi-nan and Han-k'ou areas and will be called the Southern Network.

The distance of power lines was determined to the following centers for each district:

Ta-tung District (Ta-tung); Pei-p'ing District (Pei-p'ing); T'ien-ching-T'ang-ku District (T'ien-ching); Shih-men--T'ai-yuan District (T'ai-yuan): Chang-te-Hsin-hsiang District (Hsin-hsiang); Chiao-chou-Chi-nan District (Chi-nan): and Han-k'ou District (Han-k'ou).

Each of the three systems will transmit electricity as an independent unit. A rough outline of the power lines is given in the following chart.

Power Transmission Lines

NORTHERN NETWORK		T'ien-ch'iao	Ho-ch'u to Ching-shui River	Ching-shui River to Ta-tung	Ta-tung to Pei-p'ing	Pei-p'ing to T'ien-ching
	Distance	60 Km	40 Km	200 Km	270 Km	115 Km
	Voltage	440,000 volts	440,000	440,000	440,000	440,000
	No of Systems	2	2	4	4	2
CENTRAL SYSTEM		Mei-yu-k'ou to Chi-k'ou-chen	Yen-shi-kaun to Chi-k'ou-chen	Chi-k'ou to T'ai-yuan		
	Distance	80 Km	110 Km	180 Km		
	Voltage	440,000 volts	440,000	440,000		
	No of Systems	2	2	2		
SOUTHERN NETWORK		San-men-Gorge to Pa-li-hu-t'ung	Pa-li-hu-t'ung to Hsiao-hen-ti	Hsiao-hen-ti to Hsin-hsiang	Hsin-hsiang to Han-k'ou	Hsin-Hsiang to Chi-nan*
	Distance	70 Km	50 Km	130 Km	530 Km	350 Km
	Voltage	440,000 volts	440,000	440,000	440,000	220,000
	No of Systems	3	5	5	2	2

* The Hsin-hsiang--Chi-nan line will pass through Chang-te

The volume of electricity transmitted over the principal transmission network in this plan, if present industrial voltages are used, will require extremely large transmission lines or a considerable number of systems. The operation of Japan's 154,000 volt network from the central mountain region to the Kanto and Kansai districts is affected by the ground and produces considerable induction of electricity in communication lines. Increasing these facilities above their present capacity would present considerable problems.

Several communication systems will have to be constructed side by side with the power lines to the various consuming districts.

These will be affected only slightly in flat regions where they can be kept away easily from the power lines, but each system passes through some mountainous terrain that will force the lines closer together. Because of the number of systems, some inductive interference must be expected whenever there is line trouble. Use of higher voltages would reduce the construction costs. Opinion varies as to what voltage will be in use in the near future but R. W. E. Company [Reichs-Wirtschaft Elektrizitaet-Gesellschaft?] in Germany completed a plan several years ago using 380,000 volt lines, and so it is reasonable that the present plan can provide for at least 440,000 volt lines (terminal voltage of 400,000 volts). Although some problems still remain to be solved, this voltage has been adopted.

The decision of whether to use steel towers for each system or to have several systems on each tower must depend on the local topography, weather, methods of construction, etc; but for simplification, the plan provides for single system steel towers. Which type of cable will prove to be the best--steel-core aluminum cable, hollow copper cable, aldrey cable, or some other special cable--is a problem requiring research, but in this plan, the steel-core aluminum cable [ACSR] has been adopted.

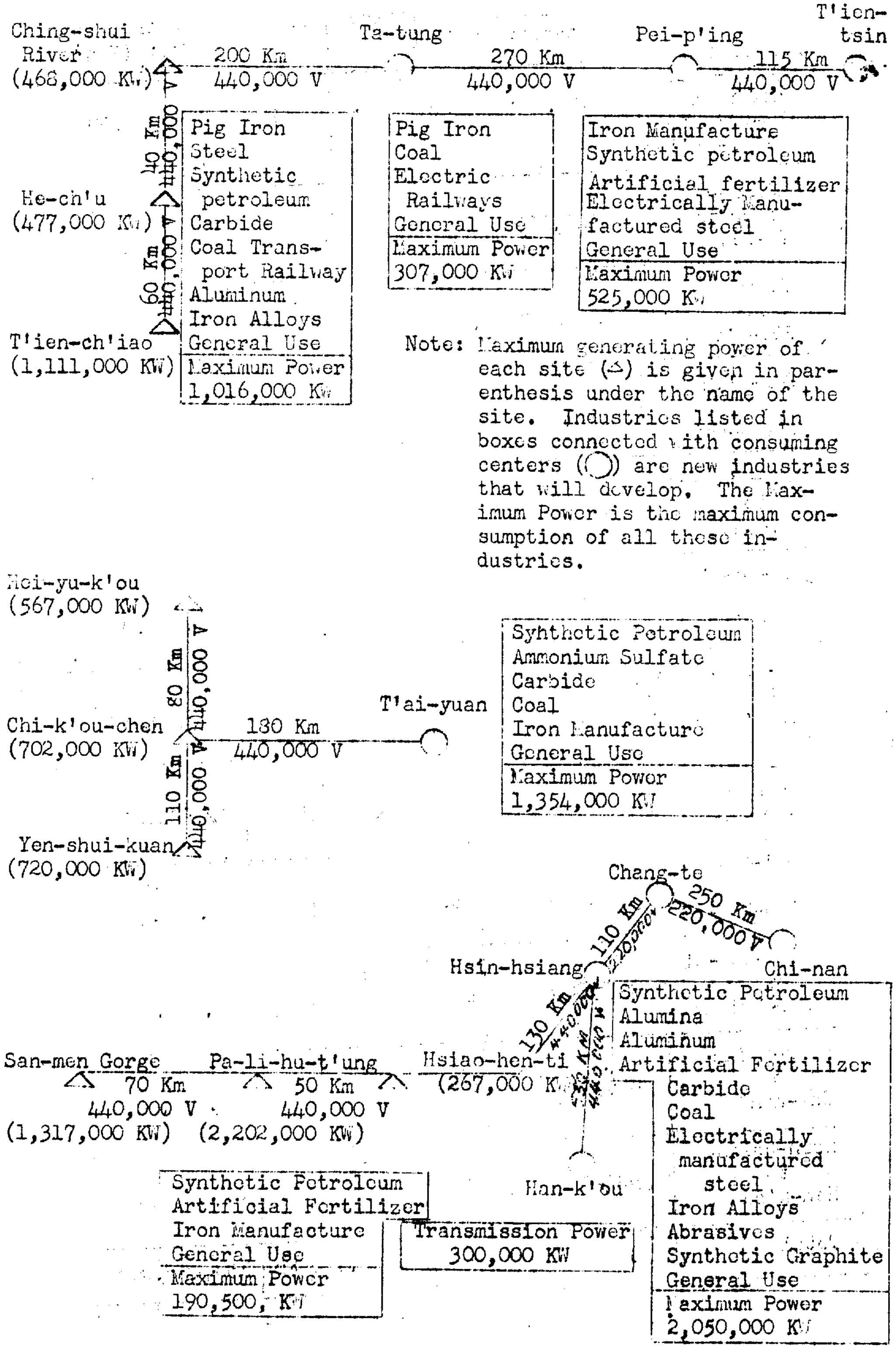
D. Construction Cost

It would be very difficult at present to estimate the construction cost of transmission lines and transformer facilities. from the estimated commodity prices current when the construction will take place, so the estimates are based on present commodity prices for the necessary material. This makes the costs of power lines and transformer facilities rather high, and when this plan materializes, the construction costs probably will be somewhat lower.

(1) Transmission Line Construction Cost

A rough estimate of the total construction cost of the approximate total transmission length of 6,100 Km is 353,400,000 Yen. Details are as follows:

TRANSMISSION PLAN



Construction Cost of Transmission Lines

	Transmission Voltage(volts)	Distance (Km)	Systems	Construction Cost (Yen)
Ching-shui River to Ho-ch'u to T'ien-ch'iao	440,000	100	2	12,000,000
Ching-shui River to Ta-tung	440,000	200	4	48,000,000
Ta-tung to Pei-p'ing	440,000	270	4	64,800,000
Pei-p'ing to T'ien-ching	440,000	115	2	13,800,000
Chi-k'ou-chen to Tai-yuan	440,000	180	3	32,400,000
Hei-yu-k'ou to Chi-k'ou-chen	440,000	80	2	9,600,000
Yen-shui-kuan to Chi-k'ou-chen	440,000	110	2	13,200,000
San-men Gorge to Pa-li-hu-t'ung	440,000	70	3	12,600,000
Pa-li-hu-t'ung to Hsiao-hen-ti	440,000	50	5	15,000,000
Hsiao-hen-ti to Hsin-hsiang	440,000	130	5	39,000,000
Hsin-hsiang to Chi-nan	220,000	350	2	29,400,000
Hsin-hsiang to Han-k'ou	440,000	530	2	63,600,000
Total			6,100 Km	353,400,000

2. Construction Costs for Transformer Facilities

A rough estimate of the total construction costs of transformer facilities to handle a total of 19,660,000 kilovolt-ampere is 494,350,000 yen.

Details are as follows:

Construction Cost for Transformer Station

Transformer Station	Capacity (KVA)	Construction Cost (Yen)
Pei-p'ing	700,000	17,500,000
T'ien-ching	875,000	21,900,000
Ta-t'ung	1,500,000	37,500,000
Ching-shui River	700,000	17,500,000
Ho-ch'u	700,000	17,500,000
T'ien-chiao	1,500,000	37,500,000
T'ai-yuan	2,000,000	50,000,000
Chi-k'ou-chen	900,000	22,500,000
Hei-yu-k'ou	600,000	15,000,000
Yen-shui-kuan	900,000	22,500,000
Hsin-hsiang #1	2,975,000	74,400,000
Hsin-hsiang #2	280,000	8,400,000
Han-k'ou	600,000	15,000,000
Chi-nan	280,000	8,400,000
Pa-li-hu-t'ung	3,000,000	75,000,000
San-men Gorge	1,750,000	43,750,000
Hsiao-hen-ti	400,000	10,000,000
Total	19,660,000	495,350,000

E. Materials Required

Following is a rough estimate of the principal materials needed for this plan:

1. Transmission lines

Steel	275,000 metric tons
Aluminum	106,000 metric tons
Cement	138,000 metric tons

b. Transformer stations

Cast Iron	295,000 metric tons
Steel	1,670,000 metric tons
Copper	30,000 metric tons
Cement	256,000 metric tons

F. Basic Cost of Electricity in Consuming Districts

The cost of electricity in each consuming district obtained from this project was determined from the total cost of generating the needed electricity at each hydroelectric site, as estimated in the chapter above, plus the cost of transmission and transforming.

1. Basic cost of generating electricity

The following is a tabulation of the cost of generating electricity in each producing district, calculated on a basis of 7 percent interest on construction cost, a depreciation factor of 40 years at 4.5 percent on engineering facilities and 30 years at 4.5 percent on generating plant facilities, plus an annual overhead including maintenance and operation costs and various taxes.

	Sites	Annual Electric Generation Overhead (Yen)	Annual Output (1,000 KWH)	Basic Cost of Electric Generation (Sen per KWH).
NORTHERN DISTRICT	Ching-shui River Ho-ch'u T'ien-chiao	126,400,000	10,485,000	1.206
CENTRAL DISTRICT	Hei-yu-k'ou Chi-k'ou-chen Yen-shui-kuan	120,600,000	8,780,000	1.368
SOUTHERN DISTRICT	San-men-hsia Pa-li-hu-t'ung Hsiao-hen-ti	134,100,000	15,610,000	0.859

2. Cost of Electricity to the Consumer

The following is a tabulation of the cost of electricity to the consuming centers calculated on a basis of 7 percent interest on construction costs; a depreciation factor of 40 years at 4.5 percent on transmission lines and 25 years at 4.5 percent on the transformer facilities; plus operation maintenance and other costs depending on the size of the installations and taking into account transmission and transformation losses.

Basic Cost of Electricity in Consuming Centers

Consuming Center	Basic Cost of Electric Generation (Sen per KWH)	Annual Cost for Transmitting and Transforming (Yen)	Power Delivered (KWH)	Delivered Cost (Sen per KWH)
Ta-t'ung	1.206	18,195,000	5,552,000	1.532
Pei-ping	1.206	7,203,000	1,266,000	1.775
T'ien-ching	1.206	14,930,000	2,767,000	1.746
T'ai-yuan	1.368	25,053,000	6,880,000	1.555
Hsin-hsiang	0.859	34,238,000	11,681,000	1.152
Chi-nan	0.859	6,371,000	871,000	1.591
Han-k'ou	0.859	10,584,000	1,500,000	1.565

The transmission distance makes it seem strange that the cost at T'ien-ching is cheaper that that at Pei-ping, i.e. from a point of transmission distance. This apparent discrepancy is caused by the more favorable load factor at T'ien-ching.

G. Comparisons to the large transmission networks of other countries.

Electricity can be generated from steam near its consuming center, but this is normally not true of hydroelectric power because the generating site is limited in location by natural factors and the consuming centers are limited by geographical and man-made factors, necessitating transmission of electric power from the generating site to the consuming center.

Electric power is the product of voltage and current, so that the same power can be transmitted by raising the voltage and reducing the current, and a smaller wire could be used than for low voltages. Accordingly, power line economy has been achieved in recent years by raising voltages for major power transmissions and the trend is toward even higher voltages.

The highest transmission voltage in Japan is 154,000 volts, but Manchuria and Korea are using 220,000 volt systems, and recently the Japan Transmission Company /Nihon Hasso Den Kaisha/ has completed a 250,000 volt system to operate over several tens of kilometers.

During the infancy of the electrical industry, no nation had more than distribution lines and short transmission lines, but the demand for power increased with technical developments, and the age of hydroelectric power arterial transmission lines were constructed to overcome the immobility imposed by geographical and natural conditions. All nations are developing the water power near to the consuming centers, and they are beginning to send hydroelectric power from the remaining distant sites over special high-tension long-distance transmission lines to the consuming centers.

The Southern California Edison Company of America was a forerunner in this field when it began transmitting at 220,000 volts in 1923, and the method has become widely adopted in several countries, including Germany, France, Italy, Switzerland, Sweden and Russia. The chart below gives those transmission lines in the world which now equals or exceed 220,000 volts. The 287,000 volts of the United States Boulder Dam is the highest voltage in actual operation; but Germany's R.W.E. Company has constructed a system to use 380,000 volts.

Principal High Voltage Transmission Systems

Name	Operating Concern	Country	Date of Construction	Voltage (KV)	Frequency (Cycle)	Systems	Span (Km)	Transmission Wire Type	Area (mm 2)	Composition	Weight (kg/m)	Remarks (Present Trans 110 KV) (Present Trans 154 KV)
Hsu-ch'uan River (Korea) No 1-No 3	Ch'ang-ching River Water Power Co	Japan	1940	220	60	2	34	ACSR	340	61/2.82	1.28	
Kurobe-Sasaru	Japan Transmission Co	"	1941	250	60	1	40	Type "H" Hollow Copper Cable	250	8 segments	2.22	
Big Creek-Eagle Rock	Southern California Edison Co	US	1923	220	50	2	388	ACSR	310	61/2.67	1.16	
Pit River Vaca Dixon	Pacific Gas and Elec Co	"	1923	220	60	2 2	288 45	Copper Stranded Cable ACSR	254 265	7x7x2.57 42/19/2.84	2.30	
Wallenpaupack-Siegfried	Electric Bond and Share Co	"	1923	220	50	1	105	ACSR	403	61/3.08	1.52	
Bucks Creek-Wilson	Great Western Power Co	"	1926-27	220	60	1-2	298	ACSR	403	61/3.08	1.52	
Big Creek No 3-Gould	Southern California Edison Co	"	1926	220	50	1	360	ACSR	524	61/3.52 30/4.14 ƒ	1.98	
Conowingo-Plymouth Meeting	Philadelphia Elec Co	"	1928	220	60	2	93	ACSR	403	19/2.48 26/4.44 ƒ	1.84	
Plymouth Meeting-Siegfried	Pennsylvania Power and Light Co	"	1928	220	60	1	79	ACSR	403	7/3.45	1.63	
Lighthipe-Long Beach	Southern California Edison Co	"	1928-29	220	50	2	16	Bronze Core Copper Stranded Cable	446	42 ƒ 19/3.16 30/4.14 ƒ	4.35	
Bushkill-Plymouth Meeting	Public Service Gas and Elec Co	"	1929-32	220	60	1	188	ACSR	403	19/2.48	1.84	
15-Mile Falls-Tewksbury	New England Power Association	"	1930	220	60	2	204	ACSR	403	61/3.08	1.52	
Wilson-Ashland	San Joaquin Light and Power Co	"	1930	220	60	1	70	Type "I" Hollow Copper Cable	260	28 ƒ 22/2.46	2.40	
Tiger Creek-Newark	Pacific Gas and Elec Co	"	1930	220	60	2	183	"	260	28 ƒ 22/2.46	2.40	
Brighton-Merced	Great Western Power Co	"	1931	220	60	1	165	"	260	28 ƒ 22/2.46 30/4.14 ƒ	2.40	
Safe Harbor-Westport	Pennsylvania Water and Power Co	"	1931	220	60	1	112	ASCR	403	19/2.48	1.84	
Boulder Dam-Los Angeles	City of Los Angeles	"	1936-40	287	60	3	438	Type "H" Hollow Copper Cable	260	10 strands 26/4.44 ƒ	2.34	
Boulder Dam-Hayfield	MWD of Southern California	"	1938	220	60	1	381	ACSR	403	7/3.45	1.63	
Boulder Dam-Barre	Southern California Edison Co	"	1939	220	50	1	418	ACSR	305	30/3.6 ƒ 19/2.17		
Powerlon-Crawford Ace	Commonwealth Edison Co	"	1940	220	60	1	236	ACSR	456	61/3.28	1.72	
Ottawa River-Leaside	Hydroelec Power Communications of Ontario	Canada	1928-31	220	25	3	327	ACSR	403	61/3.08	1.52	
Grand Mere-Rapids Blanc	Shawinigan Water and Power Co	"	1929	220	60	1	99	ACSR	403	61/3.08	1.52	
Beauharnois-Baudet	Beauharnois Light Heat and Power Co	"	1932	220	25	1	40	ACSR	403	61/3.08	1.52	
Paugan-Chats Falls	Gatineau Power Co	"	1928-30	220	25	2	41	ACSR	403	61/3.08	1.52	
Vorarlberg-Brauweiler	Rheinisch-Westfalisches Elek AG	Germany	1926	380 (220)	50	2	539	Type "H" Hollow Copper Cable Type "I" " " " Spiral Type Cable	400 400 400	12 strands SSW Type AEG Type	3.57 4.06 4.10	
Goldenberg-Herdecke	Rheinisch-Westfalisches Elek AG	"	1929	220	50	1	330	Type "H" Hollow Copper Cable	185	7 strands	1.69	
Borken-Lehrte	Preussiche Elek AG	"		220	50	2	176	Type "H" Hollow Copper Cable	210	7 strands	1.91	
Cardano-Cislago	Societe Idroelettrica Piemonte	Italy	1929	220	42 & 50	1	169 73	ACSR Aldrey	322 388	61/2.76 61/2.82	1.20 1.06	
Brommat-Chevilly	Paris-Orleans RR Co and other companies	France	1931-33	220	50	2	507	ACSR	295	37/3.54	1.33	
Saint Cothard	Officine Electriche Ticinesi	Switzerland	1934	220	50	1	58	Hard-drawn Copper and Bronze	230	42/2.28-353		
Lehrte-Magdeburg	Preussiche Elek AG	Germany	1935	220	50			ACSR	340			
Krangede-Stockholm	Stockholm City	Sweden	1936	220	50		340	Type "I" Hollow Copper Cable	255	28 ƒ 22/2.43 30/3.72 ƒ		
Swir No 2-Leningrad	USSR Government	Russia	1933	220	50	1	240	ACSR	363	19/2.35		
Kembs-Creney	Societe Transelectrique	France	1934	220	50	1	278	ACSR	295	37/3.54	1.33	

* Since the Yalu River — An-shan 220,000 volt line is under construction, it has been omitted.

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Operation of transmission systems with higher voltages than those now in use would require extreme application from technicians and experts in all fields after exhaustive study of the weather, construction material and methods, and even the economic situation. A great deal of work was involved in planning the above recently completed 250,000 volt transmission system.

As stated above, the 8,000,000 kilowatt output of the Yellow River projects (equivalent to the present total output of Japan) would be transmitted in three separate systems: The northern from T'ien-chiao, Ho-ch'u and Ching-shui-ho to Ta-t'ung, Pei-ping, and T'ien-ching; the central from Hei-yu-k'ou, Chi-k'ou-chen and Yen-shui-kuan to Tai-yuan; and the southern from San-men Gorge, Pa-li-hu-t'ung and Hsiao-hen-ti to Hsin-hsiang, Chi-nan and Han-k'ou. The distance and power transmitted would require a voltage of 440,000 volts, which is higher than any listed in the above chart, making this the world's greatest project in amount of electric power, distance and voltage used.

A plan of Mr. Chernishev is under consideration to transmit 1,500,000 kilowatts over a distance of 1,650 kilometers from Norway through Germany to France. This plan will use special bus bars capable of handling 2 x 500 KV DC (ground voltage).

These bus bars could economically transmit 2,000,000 to 3,000,000 kilowatts for 4,000 kilometers. These developments lend possibility to the Yellow River transmission plan, but technical study must be given to the problem of whether to use direct or alternating current. The characteristics of direct and alternating current are quite different. Using the same facilities and at the same voltage, more power can be transmitted by direct current because of the voltage-drop, skin effect, line-stability, etc. With intermediate direct ground points, insulators capable of carrying a line voltage of 440,000 volts direct current could carry only 156,000 volts alternating current. The corona voltage would be 1.6 to 1.7 times that of alternating current and hence the corona loss would be less.

Research now in progress on the transformation of alternating current to direct current and vice versa should solve this problem of transmission in alternating current versus direct current. All large transmission systems planned in Europe today propose to use direct current. Future study must decide whether the Yellow River plan should use direct or alternating current.

A JAPANESE PLAN FOR HYDROELECTRIC DEVELOPMENT OF THE YELLOW RIVER IN CHINA
(Continued)

Far Eastern Research Section
Survey Committee No 2
North China Committee
Subcommittee No 4
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PART 10. PLAN FOR SAN-MEN GORGE HYDRO-ELECTRIC DEVELOPMENT

OCHIAI Kushiro
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I. INTRODUCTION

Among the water power development sites along the Yellow River, San-men Gorge is one of the most densely populated areas and is therefore especially in need of river improvement, irrigation and flood control. This site also has better communication and transportation facilities than any other site. Since it is believed that this should be the first site developed, its plan will be described in detail. It is difficult, however, to approach the dam site because of a large body of stagnant water, which makes it impossible to make definite plans.

These theoretical plans are based on existing surveys and on the reports of persons who visited the site for other purposes.

All downstream water power sites on the Yellow River are somewhat similar, but at San-men Gorge the area covered by reservoir water would become especially large with the increase in the height of the dam. This area is heavily populated and may also contain some natural resources. A thorough investigation is impossible at present.

The Yellow River carries an exceptionally heavy silt load and would fill any reservoir within a few decades, unless the silting is prevented somehow. Since the reservoir would thereby lose all value, measures should be adopted to extend its life as much as possible. Reforestation and soil conservation in the headwater area should normally be accomplished before constructing any reservoirs, but the construction of dams to control the Yellow River floods should not be delayed even a single day. Furthermore, electric power development is urgently needed in the Orient.

A second plan was therefore considered to construct low dams which would have relatively small reservoirs that would not flood large areas, meanwhile making preparations so that they could later be developed into the requisite large dams.

The following discusses principally the first plan for a reservoir with maximum water level of 350 meters (from Tang-ku) and then treats the second plan to construct the dam in two stages. As there is inadequate time to describe each plan in detail, the second plan will be summarized only. San-men Gorge has for some time attracted attention in Yellow River conservation plans as a dam site. The best material dealing with this site is as follows:

1. "Rough Draft of Water-Utilization Plans for Shansi Province"

2. Eliassen: "Research on the Control of the Yellow River Floods by Retention Basins" (1936)

3. Topographical Map (1/5000) Survey by the Committee on North China Water Utilization (1936)

All these works considered dams for flood control and paid no attention to hydroelectric power.

No existing survey reports specifically suit the purposes of Yellow River hydroelectric plan, but investigation of the site has progressed considerably and there is more accurate information about this site than for any other. Although this information is incomplete, actual investigations and detailed surveys should check the accuracy of the conclusions.

II. THE SAN-MEN GORGE DAM SITE

As mentioned before, in 1936 the S. Eliassen treatise called: "Research on the Control of the Yellow River Floods by Retention Basins" was published. Notes were taken on this survey by him and consequently we are now able to estimate the conditions of the San-men Gorge site. The essential translated portions of his treatise are mentioned below for reference.

Since San-men Gorge is 25 kilometers downstream from Shan and only 10 kilometers from the nearest railroad station on the Lung Hai line it is the most accessible of the Yellow River water power sites. The road from the railroad to the engineering work shop is very poor, but an evenly sloped road from the nearest station (Fz'u-chung) to San-men Gorge could be constructed quite cheaply. At the rapids of San-men Gorge, because of two islands composed of bedrock which jut out into the Yellow River, three streams 30 to 40 meters wide have been formed. The stream on the south side is called Kuei-men, the central stream Shen-men and the stream on the north side is called Jen-men or Hiang-men. A small boat can cross the central stream, and when the stream is low, one can wade across the stream on the north side to the north island. Only the stream on the south side is crooked and the small awkward boats of this district are barely able to cross. When Eliassen inspected the San-men Gorge rapids, the volume of flow of the river was about 5000 cubic meters per second and the river formed three streams of rapids. The estimated difference in the water level below and above the islands was at least 4 to 5 meters. The total width of the three streams was not greater than 100 meters, and because the difference in water level was about 4 meters, the depth was estimated to be from 7 to 8 meters. Assuming that during the low water period there is no water in the Jen-men stream, then the other two must be slightly deeper than the above estimate but not deeper than 10 to 12 meters. It was estimated that during the low water period they may be no deeper than 6 to 8 meters. Owing to the speed of the current, of course, gravel and sediment are not deposited on the bedrock of the river bed. If the two streams, the Kuei-men and the Shen-men were very deep, their currents would be calm during low-water period. On the other hand, if the water flows fast enough to cause whirlpools, this indicates that the water is deep. The bedrock of the Kuei-men is very hard gneiss and granite. For this reason, the water flow has not much of an abrasive effect and as a result, it has remained the same since time immemorial. The bedrock of San-men Gorge is very hard and can therefore endure the erosive action of the sediments; it has preserved the same slope of the riverbed of the upper reaches for ages. However, it changes to quite soft metamorphic and sedimentary strata wherever the bedrock of the banks projects out into the river, and it is feared that in some places the main bedrock is composed of shale and sandstone. The line between the granite and sedimentary rock crosses the river obliquely from the dam site on the north bank to the south bank above San-men Gorge. The bedrock upstream from this line is metamorphic and sedimentary rock. The south bank consists entirely of hard, complex rock structure but on the north bank, only the lower strata is hard rock; the upper strata being soft metamorphic and sedimentary rock. To what extent those facts will affect the dam construction is hard to predict; this will have to wait for the results of future survey and research.

The above is according to Eliassen's report. He further states that the north and south banks are hardly high enough for the construction of a dam 60 meters in height but just which site he referred to is not clear. From inspecting the 1/50000 map which is based on aerial photographs or Map No 2 drafted by the Yellow River Water Utilization Committee, or if possible, actual photographs of the dam site, one would conclude that there are mountains there that should permit the construction of a dam about 100 meters high. He may have been referring to the plain in the upper reaches of the river but this is not necessarily true.

III. THE DAM, RESERVOIR AND AMOUNT OF USABLE WATER

Since Eliassen has already drawn up plans for the construction of a flood control dam at the site, and the Chinese Committee on the Survey of the Yellow River has charted a map based on actual survey, this place has been selected as the site for the dam. Furthermore, because there is a considerable gradient downstream from San-men Gorge, (although the difference depends on the volume of water the fall is about three meters) and if the geological conditions are the same, the question of whether the dam should be constructed above or below San-men Gorge should be carefully considered. It may be necessary to install a waterway of considerable size to produce a suitable head. This will be investigated carefully and decided upon later. For the present, we will arbitrarily choose the site above San-men Gorge. If river transportation by boat were to begin in this section of the river, it would be advantageous to raise the water level to the water level upstream at the drainage point of Yu-men-k'ou.

Because of the filling-in action of the silt and the great variation in the amount of water flow, it would be advisable to even the flow with a large capacity reservoir. This capacity can be calculated from past records of waterflow. We have records of the flow at Shan-hsien compiled by the Committee on the Water Utilization of the Yellow River and a summary of them will be found in the annexed Map Chart No 1. Its origin is unknown, but this blueprint of a graph representing the volume of water and water level over a period of 17 years (1919 to 1935), was found and it appears in this document in adjusted form. These records contain information noted in the document "Huang-ho-chih" and others; and although it is a record of the same year, there is a slight discrepancy and is difficult to determine which is correct. The figure for the greatest flow is the one given in these records, but in any case, there is only a difference of less than 100 cubic meters per second. As is shown in the annexed map, the volume of flow of the Yellow River differs greatly from year to year. The ratio between the volume of flow during the year of least flow (1928: 20,500,000,000 cubic meters) and the volume of water flow during the year of greatest flow (1921: 66,500,000,000 cubic meters) is 3.25. Therefore, in order to make the San-men Gorge hydroelectric power plant most efficient, the volume of water flow will have to be regulated year after year so that even during dry years auxiliary power plants will not be necessary. (Tables 1 and 2) In order to do this, not only seasonal regulation for one year, but regulation of the water flow year after year will be necessary. To determine the amount of water to be used according to the above mentioned graph, we will have to estimate the amount of reservoir water from the graph showing the amount of water flow in Chart No 3. Because of the settling of the silt in the reservoir, the number of years we should set as our objective will pose a considerable problem.

If we take the first plan, in view of the fact that the area of the reservoir's slack water will be very great, the area being a livelihood for natives in this area, and because it is thought that the reservoir area may contain natural resources, the height of the dam cannot be determined by simply referring to the graph of the volume of water flow. At present, the only known natural resources is the salt of the lake near Yun-ch'eng in Shansi. For the present, we plan to set the height of the dam to save this lake. The elevation of this salt lake is not accurately known, and has only been estimated from the elevation of the Ta-t'ung-Feng-ling-tu railroad. The Su River, which flows past the Yun-ch'eng area, forms gorges in its lower reaches. By cutting it off here, if it will be possible to pump the water of the Su River into the reservoir at San-men Gorge, the full water level of the reservoir can be raised. Since an investigation of this at the present is impossible, we will tentatively assume that the maximum elevation at which the water will not cover the salt lake is 350 meters above sea level. The discharge level at the Yu-men-k'ou hydroelectric plant is 366 meters, so the remaining usable head is 16 meters. In this case, if the dam is sunk to a depth of 15 meters below the river's median water level and the height above water at full water level is two meters, the overall height of the dam will be 86 meters and will contain about 1,400,000 cubic meters of concrete. If the water were permitted to rise up to 350 meters above sea level, as shown in Chart No 4, at first, the amount of reservoir water would be more than 40 billion cubic meters. In the event of cutting off the Su River, with 15 meters of effective reservoir water for power generation, the volume for river control would be more than 35 billion cubic meters. This volume is sufficient for regulating the amount of water flow of the Yellow River. This regulation will be even better when the reservoirs are constructed throughout the length of the Yellow River so that the burden at the San-men Gorge reservoir is lessened.

From 1919 to 35 the average volume of water flow was 1365 cubic meters per second. The water to be utilized for electric power is the amount which remains after subtracting evaporation and the amount of water used for irrigation, etc. The amount of water evaporated per year according to records of various places is 1,000 meters. Supposing that the average area of the reservoir water were 2,000 square kilometers, the total amount of water evaporated would be two billion cubic meters. This would be about 63 cubic meters per second. The average amount of utilizable water after subtracting water for irrigation, etc, is 1250 cubic meters per second. The maximum amount of utilizable water should be decided by considering the amount required for production of electric power. If this load factor is taken at 60 percent, the maximum amount of water used becomes 2100 cubic meters per second.

Table No 1

Table of the Yearly Volume of Water Flow at Shan-hsien

Year	Total Volume of Water-flow (cubic meters)	Average Volume of Flow (cubic meters per sec)	Maximum Volume of Flow (cubic meters per sec)	Minimum Volume of Flow(cubic meter per sec)
1919	44,430,000,000	1,408	14,720	115
1920	57,210,000,000	1,809	8,690	190
1921	66,540,000,000	2,110	11,110	300
1922	44,470,000,000	1,410	7,800	280
1923	52,170,000,000	1,654	10,200	340
1924	27,960,000,000	884	4,400	250
1925	52,690,000,000	1,671	14,880	220
1926	20,950,000,000	938	9,100	150
1927	40,070,000,000	1,271	6,700	120
1928	20,490,000,000	648	4,750	130
1929	35,600,000,000	1,129	12,380	220
1930	33,960,000,000	1,077	8,180	150
1931	31,730,000,000	1,006	4,850	250
1932	31,120,000,000	984	10,900	180
1933	53,360,000,000	1,692	21,150	185
1934	45,840,000,000	1,454	9,800	200
1935	64,360,000,000	2,041	18,200	410
Average	43,030,000,000	1,365	10,459	217

Table No 2

Table of the Average Volume of Water Flow each Month at Shan-hsien (1919 to 1934)

Month	Total Flow (cubic meters)	Average Rate of Flow (cubic meters per sec)
January	1,120,000,000	382
February	1,130,000,000	468
March	1,780,000,000	663
April	1,870,000,000	721
May	1,980,000,000	739
June	2,800,000,000	1,082
July	6,870,000,000	2,567
August	10,140,000,000	3,787
September	6,330,000,000	2,442
October	5,370,000,000	2,005
November	2,600,000,000	1,002
December	1,130,000,000	423

IV. EFFECTIVE HEAD AND ELECTRICAL GENERATIVE POWER

As mentioned in the previous section, the maximum water level is to be 350 meters above Tang-ku, the datum point. If building a high dam is considered impossible; as a second plan, the highest water level during the first phase will have to be 325 meters as at T'ung-kuan and during the second phase, the water level will be raised to that of the first plan. The discharge level will be decided by the site chosen for the construction of the dam. Tentatively, we shall choose a site upstream from San-men Gorge. It is decided that the generating plant should be constructed directly downstream from the dam and that the discharge level calculated be 282 meters above sea level. Since this reservior is to be used to control flood water, the necessary capacity for this must always be left in the reservoir. If the depth of water used for this purpose is three meters, then at first, the volume of the reservoir water will be seven billion cubic meters. For the time being it may be possible to reduce the amount of flood water. Even though the reservoir were filled, if the silt were let downstream by means of the surplus water discharge gates installed in the upper part, a certain reservoir capacity would permanently remain. If it proves possible to reduce the flow of flood water from the maximum of 25,000 cubic meters per second to 15,000 cubic meters per second, there will be no danger to the dam constructions downstream.

Next we shall calculate the generating power, assuming that the loss of head in conducting water to the turbine is one meter of water.

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Table No 3

Max water level	350 m above sea level
Min water level	330 m above sea level
Depth of utilizable water	17 m above sea level
Mean water level	342 m above sea level
Mean total head	60 m
Mean effective head	59 m
Depth of water used for flood control	3 m
Max effective head	64 m
Discharge level	282 m above sea level

Despite the head, the calculations of the generating power show the efficiency of the turbine to be 89 percent, the efficiency of the generator 96 percent and the combined efficiency to be 85.3 percent.

Assuming the maximum amount of utilizable water to be 2,100 cubic meters per second, the generative power and the amount of electrical power produced is as shown in Table No 4.

Table No 4

Max output	1,123,000 KW
Power generated	5,160,000,000 KWH

V. SILTING OF RESERVOIRS

According to the investigations to date, the average annual flow of silt at Shan-hsien is estimated to be about 1,050,000,000 cubic meters. If all this silt were to settle in the reservoir and even if the capacity of the reservoir were 40,000,000,000 cubic meters, it is calculated that within about 38 years it would be completely filled. Actually only at first would all the silt settle in the reservoir. It is difficult to predict how it will settle later since this will depend on the terrain, the design of the dam, the way the dam is operated, and many other factors. After is has been filled to a certain extent, however, the flood water will flow through the flood gates and the silt will not settle as at first. Besides, the fact that the flood water containing the most silt will be discharged through the flood gates, a change in the slope of the river upstream is expected so that a considerably greater number of years will be required for the reservoir to fill. After the construction of the dam, the development of the site at Ching-shui-ho and other sites will even the flow of the upper reaches of the river. Since this will serve to regulate the flood water, it will reduce the amount of water for San-men Gorge to handle and will also serve as a silt-stop. As a result, the life of the San-men Gorge reservoir will be extended. Within 40 years it will have paid for itself completely and it would be best to leave subsequent plans till then. As far as river conservation is concerned, by these means we will probably be able to control the flood waters satisfactorily.

It would be very difficult to make an accurate estimate of the storage capacity. Judging from the width and depth of the overflow and the fineness of the sediment, however, it can conclusively be said that the slope of the river's bed will remain fairly moderate. Therefore, it is thought that a capacity of at least one billion cubic meters can be permanently maintained. Such a capacity will definitely diminish the flood waters considerably. Meanwhile the two sites downstream will have been developed. It would be very effective to leave the excess flood waters to them. Consequently, it is thought that this filling-in action will present not too difficult a problem so far as flood water control is concerned. It is only with regard to the even regulating of the water flow that a certain amount of inconvenience will be encountered over a period of a few decades. As soon as the Ch'ing-shui-ho reservoir is filled in, regulation of the water flow will become almost impossible. This will probably take well over a hundred years. By this time the reforestation of the headwater area will have been expanded to include the tributaries and a thorough national soil conservation program will have been effected. With the advance in engineering technique, our present anxieties will be relieved. (Taking the gigantic dams of the world and USA in particular, there is a small difference in the number of years required to fill in a reservoir as compared to a similar reservoir in the Yellow River.)

VI A BRIEF OUTLINE OF THE CONSTRUCTION PLANS

In calculating the construction cost and in investigating the methods of construction, we must consider the formulation of a plan in its outline. It would be best to develop this type of site into a dam-type hydroelectric plant. At San-men Gorge there is a waterfall which has a head of three to four meters. Because of the fact that the rapids are quite swift, we are planning either to construct a considerably long waterway and to use its head as mentioned before or to increase the head by placing the dam below the waterfalls. The river in this section is very narrow compared to the amount of flow and the slope is very marked. The question as to whether or not it would be advantageous to place the dam above San-men Gorge, construct a waterway and make use of the head, must be decided after careful investigation. Now suppose we tentatively choose a dam site upstream from San-men Gorge. We will adopt a plan, which will call for an overflow type gravity dam made of concrete. The hydroelectric plants are to be placed as near to the dam as possible so as not to obstruct the flow of water from the flood gates. Hydroelectric plants of equal size will be installed on either bank of the river. In view of the fact that the river is narrow, much rock on either bank will probably have to be cut away before the hydroelectric plant is installed. (Refer to Map No 5)

The maximum flow of flood water as recorded in 1933 was 23,000 cubic meters per second. Initially, we will be able to concentrate this total amount of flow in the reservoir. Later, should the maximum rate of flow be as high as 25,000 cubic meters per second, this can be lowered to 15,000 cubic meters per second through flood control measures. Therefore, the flood gates must be able to handle 15,000 cubic meters per second. In actual construction the gates will be designed to handle 30,000 cubic meters per second and provisions for emergencies may have to be made. In order to control the flood waters the upper portion of the reservoir will always be open. Therefore, if the flood waters do not exceed the normal amount (25,000 cubic meters per second), it can be easily reduced to 15,000 cubic meters per second.

In order to eliminate silt most efficiently, the flood gates should be placed as deep as possible. Let us assume that the silt outlet is constructed to 12 meters water depth.

The conduit will run from the water intake which will be attached to the mountainside, through the water pressure tunnel, directly into the turbines. Pressure-controlling water tanks will not be used. One tunnel will be connected with each turbine. Their average length will be 250 meters and penstocks will be installed in the tunnels and will be connected with the turbine.

VII METHOD OF CONSTRUCTION

A. Facilities for the Transportation of Construction Materials

This site is about ten kilometers from the Tzu-chung station on the Lung-hai line. A line which will cross the Chung-tiao mountain range and connect the dam site with the Yun-ch'eng station on the Ta-t'ung--Feng-ling-tu line is also under consideration. This would be a direct line of 40 kilometers. Depending upon the terrain, the connection of the Ta-t'ung--Feng-ling-tu line with the Lung-hai line at the dam site will contribute to the construction of the dam, and as a future industrial transportation line, it will assist greatly in the development of north and south communications.

Although considerable difficulties would arise if construction work is to be begun before peace is restored along the Lung-hai line, it would probably be best to lay a track from Yun-ch'eng or An-i. (A road is now open between An-i and P'ing-lu). Whichever track is laid, a large type locomotive should be used on a standard track (4 feet $8\frac{1}{2}$ inches in width) so that the construction will proceed at a normal pace. Because of the problem of maintaining the peace, it is difficult to decide whether to use the Lung-hai line or the Ta-t'ung--Feng-ling-tu line. This problem will require careful study. For the time being we will decide to lay a track from both the Hui-hsing-chen station on the Lung-hai line and the Yon-ch'eng station on the Ta-t'ung--Feng-ling-tu line.

B. Cement Factories and Sources of Power for Construction

For the installation of the San-men Gorge Dam more than 400,000 metric tons of cement will be necessary. At present, there are no factories capable of producing this amount in this neighborhood. Therefore, we shall have to install factories to supply this amount. For the dam itself, a yearly output of 150, 000 metric tons will be sufficient, but because it will probably be necessary to supply nearby engineering projects, it would be better to install factories capable of producing 200,000 metric tons.

Just where to install this factory will be a problem. From the standpoint of natural resources, probably the Lin-ti--Kuan-yin-tung area along the Lung-hai line would be best. It seems that limestone, coal, clay, and gypsum, which are all necessary for the production of cement, are produced in great quantity in this area. According to records, this area is called the Hsin-shing coal field. Both bituminous and anthracite are mined here, from a deposit of 1,300,000,000 metric tons. It seems that limestone is produced everywhere in this area, but its quality is not known. Although the existence of clay has not been ascertained, generally the loess of North China contains amounts of silicon dioxide, alumina, iron, etc, suitable for use in the manufacture of cement with the possible addition of small amounts of certain materials. Gypsum of excellent quality produced in P'ing-lu-hsien, in the southern part of Shansi, is suitable for the manufacture of cement. The steam-electric plant which will supply power necessary for the cement factory and for use in construction is begun. If the Min-chih area along the Lung-hai line proves to be unsuitable because of local disturbances or for other reasons, a plan is considered to place the cement factory in Ho-nan or Cheng-hsien with a view to using the Lung-hai line in the future. If the factory were placed a little farther away in Hsin-hsiang, we could gradually make our preparations. Since it is impossible to install steam-electric plant equipment at Hsin-hsiang which is so far away, it would be wise to install it at Yun-ch'eng and transmit the power from there (distance of 40 kilometers). It would be a good idea also to use electric power generated from the surplus heat given off during the process of manufacturing cement. The amount of electrical power necessary for construction can be decided only after a careful investigation of the construction methods to be used, but it will probably be necessary to install equipment capable of producing 6,000 kilowatts (taking the period of construction as five years). Assuming that the Lung-hai line may not come under the control of the Japanese Army within the near future, the cement factory will have to be built at Lin-fen on the Ta-t'ung--Feng-ling-tu line in view of the fact that coal and limestone are produced here. Even in this case Yun-ch'eng would be more suitable for the electric power plant.

C. Cutting the River off and Changing its Course

The volume of flow at low water at this site, as shown in Table No 5, is 276 cubic meters per second. In view of the fact the width of the river at median water level is about 200 and several tens of meters, it will probably be possible to construct the dam by cutting the river off half way from each bank as was done at the Yalu River Dam and the Sungari River Dam. If this proves impossible, we must use the elaborate method used to construct Boulder Dam. If this method is used, the construction costs will increase tremendously. We shall assume, however, that the former method will be possible and make out calculations of the construction costs on this basis.

Table No 5

Volume of Flow at Low Water

Year	Volume of flow at low water (cubic meters per second)
1919	170
1920	250
1921	250
1922	330
1923	360
1924	310
1925	275
1926	260
1927	265
1928	195
1929	275
1930	200
1931	300
1932	230
1933	240
1934	220
1935	470
Total	4,700
Average	276

VIII. MATERIALS NECESSARY FOR THE DEVELOPMENT OF THE SITE

It may be foolish to try to calculate the amount of the various materials necessary for the development of such a large hydroelectric plant, but when describing this sort of site, the first things to mention should be construction costs and the necessary materials. For this reason, a rough calculation of the materials necessary for the development of this site, based on the calculations of the materials required in the construction of the large capacity hydroelectric plants on the Yalu and the Sungari Rivers and other places, is shown on Table No 6.

(See Table 6 on following page)

Table No 6

Outline of Materials Required for the San-men Gorge Power Development

Iron Materials		100,380 metric tons
Items		
Equipment for temporary use in construction		
Railway for transporting materials (15 kilometers)		
Rails and accessories		1,650 metric tons
Bridges, stations, etc.		750 metric tons
Locomotives (10/150-tonners)		1,500 metric tons
Freight-cars (100/15-tonners)		1,500 metric tons
Total		5,400 metric tons
Notes		
Track to connect Yün-ch'eng and the dam site - about 60 km in length		
Rails and accessories	6,600 metric tons	
Bridges, stations, etc. (estimate)	3,000 metric tons	
i.e. the approximate increase is	9,600 metric tons	
Power generating equipment		
Steel required to set up a steam-electric power station producing a maximum of 7,000 kilowatts		700 metric tons
Essential machinery (including repair materials)		19,700 metric tons
Total		25,800 metric tons
Permanent equipment for use in civil engineering works		
Reinforcing rods for use in the dam		2,000 metric tons
Reinforcing rods for temporary installations		1,460 metric tons
Penstocks		16,800 metric tons
Wire		1,000 metric tons
Iron for power stations		7,200 metric tons
Outdoor installations		500 metric tons
Flood-gates		3,800 metric tons
Overflow-gates		1,700 metric tons
Other		1,720 metric tons
Total		36,180 metric tons
Water turbines and dynamos		
Calls for the installation of 12 turbines with a unit capacity of 100,000 kilowatts (including primary transformers)		38,400 metric tons
Cement	approx	440,000 metric tons
Timber	raw lumber approx	100,000 cubic meters
Copper	approx	3,000 metric tons

IX. OUTLINE OF THE CONSTRUCTION COSTS

This theoretical plan has been drawn up without careful investigation, therefore it is extremely hard to make estimations of the construction costs. We have made our calculations taking into consideration the present prices, wages, and labor force necessary and using the Sungari and Yalu Rivers and others as references. These calculations appear in Table No 7. Next we will describe the fundamental suppositions used.

A. Cost of Railroad Construction

When the water level is raised to the maximum of the first plan, 350 meters above sea level, the Lung-hai line and the Ta-t'ung-- Feng-ling-tu line will be submerged by water for about 100 kilometers. A track to supply the construction materials should be laid from Yun-ch'eng station on the Ta-t'ung-- Feng-ling-tu line to the P'ing-lu area in order to connect San-men Gorge. If an extension of this line were built to connect the Lung-hai line, it would not be necessary to lay a track through the flooded area. For the time being, however, the calculations are made on the basis that the entire line will have to be laid. The cost of laying the track will be 200,000 yen per kilometer and the entire length of the extension will be 100 kilometers. This estimate includes all costs such as bridges, stations, etc. The costs entailed in the laying of the track to connect the Lung-hai line and the Ta-t'ung-- Feng-ling-tu line which will pass the dam site, should not be assigned wholly to San-men Gorge. This line will also be used to transport materials for the construction of other dams upstream and therefore they will share the cost of laying this track.

B. Cost of Land Compensation

If the surface level of the reservoir water is raised to 350 meters above sea level, it will result in a still water area of about 2,000 square kilometers. This area is known as the heart of China and as will be described later this area is densely populated and under heavy cultivation. Just how to pay for the land to be used may be a problem. The calculations of the amount to be paid will be made on the basis of the present land prices in Northern China. Well-cultivated land should cost about 50 yen per mou and land in former river beds should cost about 20 yen per mou. At this rate we should be able to purchase enough land. If this area comes under new political control, however, it will not be necessary to pay for land at the rate mentioned above. If the old Yellow River which runs towards Hopeh and Shantung is used as the course of the river hereafter, the greater part of the new Yellow River which flows south from west of K'ei-feng will be unnecessary. We will move the settlers here and thus the problem of settlers in the area required will be solved. When levee works and irrigation projects have been completed, the population per unit area will increase gradually. At present, we can expect the price of land to 30,000 yen per square kilometer.

C. The Cost of Temporarily Cutting the River off and Changing its Course

We shall assume that the construction methods used on the Yalu River will be suitable, and we shall tentatively assume these expenditures to be eight million yen.

D. The Cost of Temporary Equipment

The cost of temporary equipment should not necessarily be included in the cost of construction. As a considerable amount will remain, it would be a good idea to calculate the costs which must be born by San-men Gorge expenditures. Not counting the steam-electric plant, cement factory or railway, etc., the cost of 50 percent of the new construction machinery will be included in the San-men Gorge construction costs. The cement manufacturing equipment will be repaid at about three million yen on the yearly output of 150,000 metric tons (for 5 years). The cost of constructing the railroad for transporting the materials will of course not come under the construction cost. If the railroad running from Yun-ch'eng via San-men Gorge, to the Lung-hai line is used in place of the rebuilt railroad the cost of railroad reconstruction will not be required. It is not necessary to include the total cost of the steam-electric plant equipment in the cost of construction. Here, the repayment will be at the rate of 500 yen per kilowatt including the cost of operation during the construction of the dam.

E. Cost of Electrical Construction

With the exception of the construction of the foundation of the power plant, the primary transformer equipment, the turbine generator, the construction of the superstructure, the machinery etc., will be included in the costs. It is calculated that the cost of the equipment will be 100 yen per kilowatt produced. This may be a slight underestimate, but with the improvement in engineering technique, by the time the San-men Gorge hydro-electric plant is built, the cost will probably be reduced to this amount.

F. Basic Cost of Electricity

What we should take as the interest rate in the calculation of the cost of the hydroelectric plant is difficult to decide. Generally, in North China, the interest rate is fairly high, however, in the present case we will take the interest rate as 7 percent per year. We will assume depreciation in 40 years for the engineering construction and 30 years for the electrical installations, the rate of depreciation being 4.5 percent. As there are no examples of hydroelectric plants of such large capacity in North China, accurate figures for the maintenance and operational costs cannot be cited. The cost price will differ greatly according to whether or not all the electric power mentioned before is consumed. Taking the interest rate, payments on the original investment, maintenance and operational and other costs as 12.5 percent of the construction costs, the cost price of generating electric power will be 1 sen per kilowatt hour.

Table No 7

Outline of the rough estimates of the cost of construction (Plan 1) of the San-men Gorge Power Development

Items	Cost (Unit ¥ 1,000)	Remarks
Expenditure for entire work	442,130	
Use of land and indemnities	89,340	
Railway reconstruction	22,000	¥ 200,000 per km
Indemnities for still-water area	67,340	¥ 30,000 per sq km
Engineering works	96,700	
Cost of dam	49,670	
Excavation	2,400	¥ 4 per cubic meter
Concrete	28,000	¥ 20 per cubic meter
Water diversion	8,000	
Overflow-gates	2,550	
Intake-gates	4,200	
Misc equipment	4,520	
Waterways	47,030	
Intake-equipment	5,040	
Tunnel excavation	4,140	¥ 30 per cubic meter
Concrete for tunnels	2,840	¥ 45 per cubic meter
Penstocks	25,200	5 m in dia, ¥ 1,500 per MT
Excavation at Power station	1,250	¥ 8 per cubic meter
Reinforced concrete, etc., for power sta	1,800	
Discharge-gates	2,100	
Miscellaneous equip	4,660	
Electrical construction	120,000	¥ 100 per kilowatt
Temporary installations	60,980	
Building railway for transport	4,500	15 km ¥ 300,000 per km
Locomotives and freight cars	10,000	
Steam-electric power stations	3,500	to produce a maximum of 7,000 kilowatts
Cement manufacturing plants	2,930	cost of redeeming the initial investment in cement plants producing 150,000 MT per year
Various other machinery	21,670	
Temporary buildings	10,840	5% of the cost of both engineering and electrical works
Motive power	2,000	
Other	5,540	
Other items	66,440	
Survey and superintendence	16,400	17% of the cost of the engineering works
Interest on the loan	44,000	assuming 6% yearly for 4 years
Other	6,040	
Emergency funds	8,670	
Construction cost per kilowatt		¥ 394
Construction cost per kilowatt-hour		¥ 00.082
Basic generating cost per kilowatt-hour		¥ 00.01 (i.e., 12.5% of the construction cost)

X. METHOD OF PAYING FOR THE CONSTRUCTION COSTS

This site, in comparison with all the other sites on the Yellow River suitable for development as hydroelectric power plants, will be particularly valuable for purposes other than the generation of electrical power. Since it will be especially effective for river conservation and water utilization, the construction cost should not be met by the hydroelectric power alone. The cost of the equipment directly used to generate electrical power will be paid by electric power, but the other expenditures will be met by the profits from the river conservation and other water utilization projects (canals, irrigation). There is not time to calculate the proportions of the costs to be met by these various enterprises, but later, these costs will be decided upon after a careful investigation. In our present calculations all the transportation and construction costs are to be met by the returns from the sale of hydroelectric power only. If for some reason these estimated costs increase, (cost of land, etc.) this will be paid for from the profits on river conservation, water utilization, etc., and therefore, the cost of the hydroelectric power will not be affected.

XI. THE SECOND PROPOSED PLAN FOR THE DEVELOPMENT OF SAN-MEN GORGE

As described before, if the height of the dam were increased, the volume of slack water would increase tremendously; Consequently, the area which will be flooded and the population which will have to be evacuated will be great. If the Chinese Incident were completely settled, the situation might not present any serious problems. If considered from the standpoint of river conservation, water utilization and the development of hydroelectric power, the dam should be as high as possible so that the capacity of the reservoir will be great and so that it will be able to stand the great amount of silt. In view of the large area which will be flooded, the dam should be made as low as possible. The lower the dam, the less effective it will be for river conservation, water utilization and hydroelectric development. Consequently, we must consider how low the dam can be built. The flood water level at T'ung-kuan is 325 meters above sea level and if we made this the full water level, the area of still water would be much less than in the case of the first proposed plan. Consequently, we will choose this as the maximum water level for the first phase of the second plan. If we make it this level, it should be quite easy to dam up the river. After this construction is completed, we shall have to build homes to which the inhabitants living upstream in the still water area may move and then we shall carry out the second phase --increasing the height of the dam to the level proposed in the first plan. In the construction plans, the only difference between the first plan and the second is the height of the dam; the installations will be the same. All parts must be so constructed that they will meet all specifications even after the completion of the second phase of construction. The greatest problems will probably be the turbines and generators. These problems will have to be given careful study. At present, we cannot reach an immediate conclusion, but it would be best to install turbines which will be capable of handling the final output. If this proves impossible, we could probably remove the turbines of the first phase, install them at some other site and then install new large capacity turbines during the second phase. For the time being, we shall assume the turbines and generators suitable for the second phase will be installed from the beginning. They will operate at a low rate of efficiency at first, but after ten years, when the second phase has been completed, they will be able to operate at a high rate of efficiency. Thus, in the first phase of construction, all the electrical equipment installed will be the same as that to be used during the second phase. Of course there will be equipment such as transformers, etc., that are unnecessary in the first phase but for the sake of convenience, we shall install them as mentioned above.

Dividing the construction into two phases would be more expensive than constructing the dam to its ultimate height without interruption. (As will be mentioned later, it will mean an increase of 50 million yen in the total construction costs.) Furthermore, the higher the dam, the greater will be the reservoir capacity, and the more effective it will be in controlling flood water. If a low dam were built, not all the water flow could be controlled. During the flood water period, nearly all of the floodwater would have to be discharged. Consequently, we could not expect an even yearly output of electrical power. Moreover, there would not be an even yearly flow of water for irrigation and canals. As long as the irrigation and canal facilities are not completed, however, there will probably not be any immediate need for the water. On the other hand, when preparations for these facilities have been made, it would probably be advantageous to increase the height of the dam in order to prolong the life of the reservoir. Since it is calculated that even this large reservoir will be filled in with silt within a few decades, the number of years required to fill in the reservoir must be extended as much as possible. The best method of doing this would be to reforest completely the headwater area, so as to minimize the amount of silt and then to build the reservoir. By doing this, the life of the reservoir would be prolonged. To this end, it would be best to construct first a low dam. Later, after other water utilization projects, countermeasures against silting, etc., are fairly well under way, the height of the dam should be increased.

Whichever plan is followed, unless the height of the dam is finally increased, there will be little value in harnessing the Yellow River. The essential problem is whether to construct the dam without interruption (first plan) or to construct it in two phases (second plan). For the time being, we cannot reach a conclusion regarding this problem, therefore, we shall leave it unsolved. Specific information of the second plan described above appears in Table No 8. These plans are the same as those of the first proposal except that the dam is lower.

XII. INHABITANTS AND NATURAL RESOURCES IN THE STILL WATER AREA OF THE SAN-MEN GORGE DAM

A. General Discussion

The area which is expected to be submerged by water as a result of the construction of the San-men Gorge Dam is the region in which early civilization arose. At the present time, however, there are only the traces of past glory. The population engaged in agriculture is dense in proportion to the area of arable land. The agricultural methods have remained unchanged since ancient times. Here, the farmers are very poor as in the rest of northern China. Cotton which is important as a commercial product is grown in relative abundance and is the only product worthy of special note. This area is rich in valuable mineral resources everywhere, and it is fortunate that these deposits are not in the depressed areas. In the T'o-k'o-t'o area, the Yellow River turns southward, flows south through a gorge in the border between Shansi and Shensi and then joins the Lo and Wei Rivers in the Chao-i-hs'ien region. It then makes a big turn eastward and flows through the northern part of Honan to the east. In view of the nature of the terrain, however, navigation, except for special types of boats, is not recognized as having any value. Because of an excessive amount of precipitation, the Fen River and the Wei River sometimes do tremendous damage to the river banks. As for railroads, the Lung-hai and the Tung-pu RR line can be counted upon. The Lung-hai RR line is the main east-west artery of China. In the expected still water area, it runs from the Shan-hsien area, along the southern bank of the Yellow River passing through Ling-Pao-hsien and Wen-hsiang-hsien to Tung-kuan. From here, it runs along the southern bank of the Wei River as far as the Lin-T'ung area. Consequently, because of the dam construction, some changes in the present course of the railroad will probably be necessary. We do not believe that any great change need be made in order to use this railway to its fullest advantage.

The Ta-t'ung-- Feng-ling-tu RR starts at north Ta-t'ung and and runs north and south through Shansi to Feng-ling-tu. Here it crosses the Yellow River and is, from the standpoint of the Shansi industries, a very important line which connects with T'ung-kuan. South of Yu-hsiang-hsien, especially at points connected by the Lung-hai line, some changes will have to be made. Next we shall try to set forth an explanation by looking at the inhabitants and natural resources, etc.,which are concerned with the influences of this still water area.

B. The Area and Population of the Still Water Area

The natural resources in the area, which will be submerged by water because of the dam which is to be constructed at San-men Gorge, will be permanently lost. Furthermore, the means of livelihood will be taken from the inhabitants. Therefore, we must consider carefully the advantages and disadvantages of constructing the dam here. In the final stage the height of the dam will be 350 meters above sea level. During the process of construction, however, the height will be raised by several steps.

Table No 8

Plan II for the San-men Gorge Power Development

		Unit	Phase I	Phase II (corresponds to Plan I)
Area of drainage basin		sq km	721,500	721,500
Height of intake point		meters	325	350
Height of discharge point		meters	282	282
Projected amount of floodwater		cu m per sec	25,000	25,000
Projected amount of overflow		cu m per sec	15,000	15,000
Dam	Projected height	metres	61	86
	Length of crest	metres	395	450
	Overflow-gates	no of gates	17	17
	Excavation	cu meters	400,000	600,000
	Concrete	cu meters	685,000	1,400,000
	Area of stillwater	sq km	180	2,244.5
Amount of utilizable water	Maximum	cu meters	2,100	2,100
	Average		993	1,260
Head	Total head	meters	43	68
	Maximum effective head		36	64
	Average effective head		33	59
Generating power	Maximum	1,000 kilowatts	632	1,123
	Average		274	590
Yearly output of electric power		1 million kwh	2,400	5,410

The presumptive cost of construction follows, and so far as the foregoing estimates permit, an hypothesis similar to Plan I has been laid down and the same standards have been used. The factors are shown in Table No 9.

Table No 9

The San-men Gorge power Development (Plan II) Outline of Roughly Estimated Construction Costs

Item	Estimated Cost (Unit: ¥ 1,000) Phase I	Phase II
Total construction	281,070	212,910
Use of land and indemnities	5,400	83,940
Railway reconstruction		22,000
Indemnities for still-water area	5,400	61,940
Engineering works	56,510	50,340
Cost of dam	33,060	23,210
Excavation	1,600	800
Concrete	13,700	15,000
Water diversion	8,000	2,000
Overflow gates	2,550	2,550
Intake gates	4,200	1,840
Miscellaneous equipment	3,010	2,020
Waterways	23,450	27,130
Intake equipment	5,040	1,010
Tunnel excavation	2,420	1,720
Concrete for tunnels	1,660	1,180
Penstocks	8,280	16,920
Excavation at power station	770	480
Reinforced concrete etc, for power station	1,050	750
Discharge canals	2,100	1,000
Miscellaneous equipment	2,130	2,470
Electrical construction	120,000	24,000
Temporary installations	52,160	17,730
Construction of transport railroad	4,500	
Locomotives and freight cars	10,000	2,000
Steam-electric power stations	3,500	
Cement manufacturing plants	1,440	1,490
Various other machinery	17,650	7,430
Temporary equipment	8,830	3,720
Motive power	1,500	1,490
Other	4,740	1,610
Other items	41,490	32,730
Survey and superintendence	9,620	8,550
Interest on the loan	28,100	21,200
Other	3,770	2,980
Emergency funds	5,510	4,170
Construction cost per kilowatt	¥ 445	¥ 439
Construction cost per KWH	11.7 yen	9.1 sen

##Total for construction in both Phases I and II ¥ 493,980,000
Increase over Plan I ¥ 44,310,000

If basic cost of electricity is calculated as 12.5 percent of the cost of construction, in the same way as was done in Plan I (at the dam), and the figures are:

Phase I	1.5 sen
Phase II	1.1 sen

The Number of Villages Inundated by the San-men Gorge Reservoir

PROVINCE	District (Hsien)	Number of Flooded villages					
	Altitude	300 M	320 M	330 M	340 M	350 M	Total
	Shan-hsien	1	2	12	10	6	31
Ho-nan	Ling-pao	-	x 1	4	3	9	17
	Wen-hsiang		3	x 4	8	12	27
Total	3 Districts(hsien)	1	6	20	21	27	75
	P'ing-lu	1	1	5	x 4	2	13
	Jui-ch'eng			5	2	7	14
Shansi	Yung-chi			x 32	33	26	91
	Lin-chin				1	1	2
	Jung-ho					1	1
Total	5 District(hsien)	1	1	42	40	37	121
	T'ung-kuan			x 3			3
	Hua-yin			39	35	x 25	99
	Chao-i			25	21	18	64
Shensi	Ho-yang					8	8
	Ta-li			1	7	3	11
	Hua-hsien			7	54	x 19	80
	Wei-nan				16	49	65
	Lin-t'ung					7	7
Total	8 Districts(hsien)			75	133	129	337
Grand Total	19 Districts(hsien)	2	7	137	194	193	533
Total number of villages		2	9	146	340	533	

Notes 1. Figures according to Arisaka, Udemasa of the Head Office of the Construction Staff of Bureau IV

2. "x" indicates the location of the government (hsien) seat

(TN: Table 11 gives the names of those 533 villages of Table 1 that would be inundated by the San-men Gorge Reservoir--at various water levels. Table 11 is omitted.)

Now we shall examine the effects of the still water at each step of construction. The number of villages which will be flooded at each step of construction is shown in Table No 10.

As is shown in the above two tables, the area which will be submerged because of the construction of the San-men Gorge Dam, will extend over three provinces and 19 districts, that is 533 villages (including eight government (hsien) seats. In the above tables, we have assumed that these villages will be flooded during the process of cutting the river off at a point about 3 kilometers east of the government seat of Yung-chi-Hsien in the southern part of Shansi and checking the flood water flowing towards the eastern part. If a cut-off at this point proves impossible, the number of villages which will be flooded will increase as will be shown. At 350 meters, there will be a total of 150 villages inundated: in Yung-chi-Hsien four villages, in Yu-hsiang-Hsien 63 villages, in Chich-Hsien 72 villages , in Lin-pu-Hsien 10 villages, and in An-i-Hsien one village. As this includes the government seat of Cheih-Hsien, cutting off the river in the Yung-chi-Hsien area would have great effect on the depressed area. In the discussion of the still water area in the following section, we shall proceed with the assumption that it will be possible to cut the river off at this point. A rough calculation of the area which will be flooded and the area of arable land is shown in Table No 12.

(See Table on following page.)

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Table No 12

Rough Estimate of the Extent of Arable Land Inundated by the Construction of the San-men Gorge Dam

District (Hsien)	Ratio of Arable Land to Total Area	Top of Dam—320 meters: Total inundated area (sq km)	Top of Dam—320 meters: Extent of arable land inundated (mou)	Top of Dam—330 Meters: Total inundated area (sq km)	Top of Dam—330 Meters: Extent of Arable land inundated (mou)	Top of Dam—340 Meters: Total inundated area (sq km)	Top of Dam—340 Meters: Extent of arable land inundated (mou)	Top of Dam—350 Meters: Total inundated area (sq km)	Top of Dam—350 Meters: Extent of arable land inundated (mou)
Shan-hsien	95%	6.20	9,875	13.70	21,183	26.70	41,284	39.70	61,385
P'ing-lu	95%	13.50	20,874	22.50	34,790	29.00	44,840	35.30	54,582
Ling-pao	95%	8.00	12,370	20.30	31,388	27.80	42,985	40.80	63,086
Jui-ch'eng	95%	52.00	80,403	58.30	90,145	65.80	101,741	73.60	113,802
Wen-hsien	95%	4.40	6,803	14.60	22,575	26.30	40,666	44.30	68,498
T'ung-kuan	95%			1.00	1,546	1.80	2,783	3.60	5,566
Hua-yin	90%			133.30	195,263	348.30	510,204	384.00	562,498
Hua-hsien	90%			10.00	4,648	170.00	249,023	211.30	309,520
	(90%			63.00	92,285 *	135.50	198,493	235.50	344,970
Chao-i	(								
	(100%			162.00	263,671	178.00	289,712*	178.00	289,712*
Ta-li	90%			29.80	44,553	95.80	148,028	132.80	194,531
	(95%			27.00	41,748 *	54.00	83,496	82.80	126,027
Yung-chi	(								
	(100%			62.20	100,911	114.70	186,686*	114.70	186,686*
Lin-chin	100%					20.40	33,203*	20.70	33,691*
Ho-yang	100%					7.60	12,370*	7.60	12,370*
Wei-nan	90%							143.70	210,497
Lin-t'ung	90%							36.50	53,466*

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(Cont'd)

Rough Estimate of the Extent of Arable Land Inundated by the Construction of the San-men Gorge Dam

District (Hsien)	Ratio of Arable Land to Total Area	Top of Dam–320 Meters		Top of Dam–330 Meters		Top of Dam–340 Meters		Top of Dam–350 Meters	
		Total inundated area (sq km)	Extent of arable land inundated (mou)	Total inundated area (sq km)	Extent of arable land inundated (mou)	Total inundated area (sq km)	Extent of arable land inundated (mou)	Total inundated area (sq km)	Extent of arable land inundated (mou)
Farm land		84.10	130,037	393.50	580,124	981.00	1,463,542	1,463.90	2,170,429
Old River Bed				224.20	364,582*	320.70	521,971*	321.00	522,459*
TOTAL	93%	84.10	130,037	617.70	944,706	1,301.70	1,985,514	1,784.90	2,692,888

* Cheap, precariously cultivated land in the so-called "30 years east and 30 years west [meandering]" country between Yü-men-k'ou and T'ung-kuan, where the Yellow River reaches its greatest width and constantly undercuts the banks.

Note Since the Su-Su River will be dammed off three kilometers east of Yung-chi, this region has been omitted.

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Table No 13

The Relationship of the Population to the Construction of the San-men Gorge Dam

District (Hsien)	Top of Dam: Number of Villages and Population — 300 Meters: Village	300 Meters: Population	320 Meters: Village	320 Meters: Population	330 Meters: Village	330 Meters: Population	340 Meters: Village	340 Meters: Population	350 Meters: Village	350 Meters: Population	Basis for Calculating the Population — Population of Hsien	Population of Govt (Hsien) Seat	Population of Agricultural District	Number of Villages	Population of Average Village	
Shan-hsien	1	296	3	888	15	4,440	24 Govt Seat	7,104 6,000	30 Govt Seat	8,880 6,000	175,000	6,000	169,000	684	247	120% 296
Ling-pao			Govt Seat	9,000	4 Govt Seat	1,152 9,000	7 Govt Seat	2,016 9,000	16 Govt Seat	4,608 9,000	162,000	9,000	153,000	640	240	120% 288
Min-yu [sic]			3	1,104	6 Govt Seat	2,208 4,500	14 Govt Seat	5,152 4,500	26 Govt Seat	9,568 4,500	68,000	4,500	63,500	207	307	120% 368
P'ing-lu	1	312	2	624	7	2,184	10 Govt Seat	3,120 3,000	12 Govt Seat	3,744 3,000	95,000	3,000	92,000	353	260	120% 312
Jui-ch'eng					5	1,400	7	1,960	14	3,920	63,000	3,000	60,000	257	233	120% 280
Yung-chi					31 Govt Seat	7,130 10,000	64 Govt Seat	14,720 10,000	90 Govt Seat	20,700 10,000	121,000	10,000	111,000	405	225 [sic]	120% 230 [sic]
Lin-chin							1	330	2	660	95,000	10,000	85,000	258	330	100% 330
Jung-ho									1	476	78,000	15,000	63,000	135	476	100% 476
T'ung-kuan					2 Govt Seat	720 50,000	2 Govt Seat	720 50,000	2 Govt Seat	720 50,000	60,000	50,000	10,000	28	360	100% 360
Hua-yin					39	32,400	74	66,600	98 Govt Seat	88,200 13,000	193,000	13,000	180,000	194	900	100% 900
Chao-i					25	8,625	46	15,870	64	22,080	120,000	12,000	108,000	171	345	100% 345
Ho-yang									8	2,832	149,000	6,000	143,000	405	354	100% 354
Ta-li					1	356	8	2,848	11	3,916	102,000	18,000	84,000	236	356	100% 356
Hua-hsien					7	3,269	61	28,487	79 Govt Seat	36,893 10,000	142,000	10,000	132,000	283	467	100% 467
Wei-nan							16	14,240	65	57,850	500,000	50,000	450,000	506	890	100% 890
Lin-t'ung									7	2,121	220,000	13,000	207,000	685	303	100% 303
Total	2	608	8 Govt Seat	11,616	142+ 4 Govt Seat	137,384	334+ 6 Govt Seat	245,667	525+ 8 Govt Seat	372,668						

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According to Table No 12 the area of inundated arable land will be 2,170,429 mou (under cultivation) and 522,459 mou (the old river bed) making a total of 2,692,888 mou. The following is an estimate (in yen) of the value of land which will be lost as a result of inundation, based on average land prices. The price of arable land is usually ten times the profits from the harvest of the land. With the exception of cotton, there are three crops over a two-year period. At the average price of land in ordinary times of about 50 yen per mou (the pre-China Incident price) the value of the cultivated land lost would be roughly 103,000,000 yen and at 20 yen per mou, the value of the Yellow River bed land lost would be 10,000,000 yen making a total loss of 118,000,000 yen. The population of the 525 villages and the eight government (Hsien) seats which will be in the inundated area, as shown in Table No 13 is expected to be about 370,000 people. Just how to make provision for this population is a considerable problem. With the completion of the San-men Gorge hydroelectric plant, industries of considerable size which will use both the local natural resources and the electric power will develop. Consequently, a demand for labor necessary for those industries will suddenly arise. Of course it is possible that some of the population will be absorbed by those enterprises, but the rest will have to be moved to other areas. The evacuation of the population to Manchuria, Mongolia, Sinkiang, northwestern frontier and other regions that are sparsely populated and have large tracts of arable land, should be carried out with the assistance of and under the direction of the government.

C. Resources of the Still Water Area

1. Agricultural resources

Cereals, beans, etc, are the chief products of the area which will be inundated. Cotton which is produced in the Ling Pao area, (the so-called Ling Pao cotton) is known for its superior quality. Cereals, beans and other food products are nearly all consumed in this area. Even though there was a certain amount of circulation of these products within the border, this would not greatly influence the economy of this area. Cotton is the only commodity which serves as a standard of value, and is important not only for its quality but also for its quantity. With regard to the cotton produced in Honan, according to the publication "Cotton Statistics of North China" compiled by the South Manchurian Railroad Investigation Department and published by the Nippon Hyoron Co, the area under cotton cultivation in Honan is 3,800,000 mou, which is 8.58 percent of the whole area in China. The cotton crops are estimated to be 840,000 piculs (TN: picul-133 1/3 lbs) which is about 8 percent of the total Chinese crop. The cotton producing area centers around Ling Pao, and if this area were flooded, the resulting loss would be considerable.

Next we shall discuss the agricultural products of each Hsien.

(a) Honan Province

(1) Shan-Hsien

Shan-Hsien lies in a basin bordering the Yellow River, flowing through the Honan Plateau and is surrounded by plateaus on three sides. The

northern side is separated from the Yellow River and faces Shansi Province. The Hsien is entirely plateau and it produces cotton, kaoling, sorghum, and millet, etc., (see note). According to the Shan-hsien Journal, this Hsien produces cotton and medicinal herbs as well as millet, barley, sesame and beans.
(Note: The Chinese Provincial Journals, published by the East Asia Tung Wen Association, Honan)

(2) Ling-pao-Hsien

The area from Ku-han-kuan west of the govt seat of Ling Pao-Hsien, which stretches to the west is the cotton growing belt, and 30 Chinese miles (li) to the east of the govt (Hsien) seat cotton cultivation is most intense. According to the statements of the inhabitants, the amount of cotton produced in this area is about 200,000 piculs per year. This place is famous as the gathering and distributing center for the cotton produced in the area between here and Tung-kuan to the west.
(Note: Aside from cotton, it is famous for the production of the jujube tree. According to the Hsien Journal, barley, buckwheat, millet, kaoling, beans and sesame etc, are also produced.)
(Note: According to the survey of the North China Economic Survey office of the South Manchurian Railroad, the cotton crop, not counting that along the Yu-pei Road of Honan, or not counting the crop produced north of the New Yellow River, taken over the five-year period prior to the China Incident, was 200,000 piculs.)

(3) Wen-hsiang-Hsien

As mentioned before, in the area stretching from Ling-pao-Hsien to the northern sector, cotton is cultivated intensively. As this area is in the low-lying Yellow River Basin, when continuous rain occurs, muddy streams suddenly seep into the whole area of arable land. According to the Hsien Journal, aside from cotton, small amounts of commodities such as hemp and tobacco are produced. The production of barley, millet, corn, beans, (soya and lentils), sesame and other foodstuffs is the same here as in other areas.

(b) Shensi Province

Looking at the general topography of this province, one sees that the Ch'in-ling mountain range runs between the Han River and the Wei River, parallel to the Wei River and separates the northern part of the province from the southern. The regions north of the range and south of the range differ greatly in climatic and natural characteristics. The northern region is very mountainous and has few plains and little arable land, but in the southern district, there are expansive plains along the Han River. The southern region is rich in agricultural resources and is referred to as the fertile plains of Shensi. In view of the fact that the construction of the dam at San-men Gorge would result in the damaging of the area where the Yellow and the Wei Rivers join and of the banks of the lower reaches of the Wei River, we shall now briefly describe the basin of the Wei River. The Wei River orginates 25 Chinese miles (li) west of Wei-yuan-Hsien in Kansu Province. Its flow is to the east and it passes north of the Hsien flowing north of Kung-ch'ang-fu in Kansu and north of Nan-tai-chou in T'ai-an-Hsien and enters Feng-hsiang-fu in Shensi. From here it joins the Ch'ien River south of Feng-chi-Hsien and enters the Hsieh River north of Mei-Hsien, then it flows to the east still further and enters Hsi-an-Fu. South of Hsien-yang-Hsien, the Li River and the Kad River flow into the Wei River from the south. North of the government seat of Hsi-an-Fu, the Pa and Ch'an Rivers flow into it from the south, and north of Lin-t'ung, it meets the Ching River. It flows farther to the east, passing through the northern part of Hua-chou in Wei-nan-Hsien and south of Chao-i-Hsien in Hua-chou, it is joined by the Chi and Chu Rivers from the north. The Wei River flows into the Yellow River north of Hua-yin-Hsien. The soil of the regions through which this river flows is generally loess, and as it flows eastward, it becomes wider and deeper. We shall briefly examine each Hsien with a view to the possibilities of agricultural development in this sort of terrain and soil.

(1) T'ung-kuan-Hsien

T'ung-kuan is the gateway between the provinces of Honan and Shansi and the province of Shensi. This Hsien is bounded by the Yellow River on the north and by mountains on the south and thus is very strategic, however, it is poor in resources. According to the Hsien Journal and the Chinese Provincial Journal, the agricultural products consist of wheat, barley, millet, beans, tobacco, etc., but generally the amount of these crops is small.

(2) Hua-yin-Hsien

This Hsien is 45 Chinese miles (li) to the west of T'ung-kuan. The Wei River flows through the northern part; and the southern part, except for the large Hua Mountains, is flat and full of fertile paddy fields. The principal products are cotton, hemp, and other articles of commerce, barley, buckwheat, rice, sesame, beans, etc., are also produced. The chief agricultural products of the area which is expected to be submerged are cotton and rice. Since most of the hemp is produced on the slopes of the Hua Mountains, its cultivation will not be affected much. Cotton is cultivated along the southern reaches of the

Wei River, east of Hua-yin-miao on every plain up to the Hua Mountains and especially in areas close to the Wei River.

(Note: South of the Hsien government seat, rice is also produced. Although the methods of cultivation are primitive, the soil is fertile and the rice is of comparatively high standard.)

(Note: According to the aforementioned "Cotton Statistics of North China," the average area under cotton cultivation in Shensi, taken over the last five years was 3,000,000 mou--6.81 percent of the entire area of the country--and the average crop, taken over the same five year period, was 689,000 piculs--6.48 percent of the total Chinese crop.)

(3) Hua-Hsien

The terrain of this Hsien is very similar to that of Hua-yin-Hsien. Agriculture flourishes in the fertile plain between the Wei River to the north and the Hua Mountains to the south. The agricultural products are also quite similar to those of Hua-yin-Hsien. The chief products are cotton, which is especially famous for its high quality, maize, and barley.

(4) Wei-nan-Hsien

Wei-nan-Hsien is 45 Chinese miles (li) to the west of Hua-Hsien. The southern part forms a plateau and stretches far as Ch'in-ling and the northern part stretches from the Wei River to the distant plains north of Shan. The land along the banks of the Wei is for the most part fertile, consequently, this area is rich in various agricultural products. Cotton especially is largely concentrated west of Shan. Together with the three plains to the north, this is one of the big gathering and distributing centers for this region. Cotton is cultivated all over the district but particularly in the area north of the Wei River. The fact that the cotton produced in Lin-tung, Wei-nan, Wei-pei and Hua-chou is called Wei-nan cotton gives an indication of the amount. Another commodity aside from cotton is hemp which is produced in the hilly region of the southern part. Corn, millet, grain, sesame, beans, etc., are grown everywhere as in the neighboring districts.

(5) Lin-tung-Hsien

This district is almost directly between Wei-nan and Hsi-an. In the southern part are the Li Mountains and the northern part stretches from the Wei River to the distant plains of Wei-pei. As the soil is fertile and irrigation facilities are accessible, agricultural flourishes. Aside from cotton and hemp, such foodstuffs as rice, millet, sorghum, kaoling, beans, sesame, etc., are grown. As in the case of Wei-nan, the chief growing area of cotton is north of the Wei River.

(6) Chao-i-Hsien

This district is situated at the point where the Lo River and the Yellow River flow together. Agricultural products such as cereals, fruit, rice, barley, wheat, millet, sorghum, beans, hemp, etc., are grown.

(7) Ta-li-Hsien

This district is adjacent to Chao-i-Hsien. According to the Hsien Journal, besides cotton, peanuts, etc., cereals are grown in this as in the other districts.

(8) Ho-yang-Hsien

This district lies north of Chao-i-Hsien near the Yellow River. Here, the mountainous region of Chin-pei ends and the Wei River basin begins to spread out. The Hsien Journal states that the same cereals as are produced in the neighboring districts are grown here, as well as lumber and herbs.

(c) Shansi Province

Shansi Province is very mountainous and has few plains and except for the region east of the river, it is not very fertile. Because irrigation is in general inconvenient, agricultural production is low. Because of differences in climate and water utilization (irrigation), the arable land of this province can be divided into three areas - the northern, central, and southern sections. Consequently, the products of these areas differ.

The northern section is comparatively sparsely populated, has poor irrigation facilities, and generally the soil is not very fertile. As the winters are bitterly cold, the cultivation of winter crops is absolutely impossible. The harvest per unit area is small, but because this area is vast and thinly populated, the total crop of food stuffs shows a yearly surplus of from about 30 to 35 percent which is exported to other districts.

The central section is rather densely populated in comparison with the northern part. Since irrigation is more convenient and the climate is milder, the cultivation of winter crops is possible. As a result, the harvest is greater than that of the northern section. Wheat, rice, cotton and other high quality crops are grown. The crops here too show a surplus.

The southern section lies in the richest region of the province. The climate of this region is very similar to that of Honan and Anwei provinces. Because of the irrigation by the Fen River the crops of the greater part of this region are very abundant provided there are no floods. This region is very suitable for growing cotton and its cultivation is encouraged by the local officials. Since the cultivation of cotton is more profitable than the cultivation of foodstuffs, the amount of cotton produced is increasing every year. According to the aforementioned "Cotton Statistics of North China" compiled by the South Manchurian Railroad Bureau of Investigation, the average area under cotton cultivation in this province during the last five years was 1,300,000 mou (2.95 percent of the total area under cultivation in China) and the crop was 380,000 piculs (3.58 percent of the total Chinese crop.) The greater part of this is produced in the southern region. The other important agricultural product, beside cotton, is wheat of which 5,000,000 piculs is produced annually. The cultivation of corn, kaoling, millet, beans, etc is like that in southern Honan Province. The southern region, because the population is increasing and the area under the cultivation of foodstuffs is decreasing because of the increase in area of the land under cotton cultivation and because of the frequent flooding of the Fen and Yellow Rivers, is never self-sufficient in foodstuffs. Next we shall discuss the districts which will be covered by water.

(1) P'ing-lu-Hsien

This district does not touch upon the Yellow River, but as it is adjacent to the Honan cotton raising areas of Shan-Hsien and Ling-pao-Hsien it is in the heart of the cotton producing region on the northern banks of the Yellow River. Cotton has become the chief crop in Shansi since the cultivation of poppies, which is the source of opium, was forbidden. Up to that time only a small amount of raw cotton was grown for domestic use. Because of its comparatively large returns as a commercial crop, however, its cultivation has increased year after year as previously noted. In Shansi the principal cotton growing areas are in the south in the basin of the Fen River, with scattered cultivation elsewhere, and at P'ing-lu in the central area on the northern banks of the Yellow River. Apart from raw cotton, cereals are an important farm crop as in the other districts.

(2) Ju-ch'eng-Hsien

Ju-ch'eng-Hsien is in Honan province, between Men-hsiang-Hsien and the Yellow River. Apart from the five cereals and the jujube tree there are no agricultural products of particular note.

(3) Yung-ch-Hsien

This area was formerly the seat of government of P'u-chou-fu and is located in the southwestern part of the province, 75 Chinese miles (li) north of T'ung-kuan and 120 miles southwest of I-shih. It is bounded by the Yellow River for a great distance on its western and southern edges and it includes the Chung-t'iao Range to the east, and to the south, on an old river canal of the Yellow River, it joins an open plain. To the north and west the country also opens out on a plain.

The principal commodities are raw cotton and hemp for commercial exchange, mixed grains, and persimmons.

(4) Lin-chin-Hsien

This district is located to the west of I-shih in northern Yung-chi-Hsien. The prefectural journal lists mixed grains, soya beans, sesame, etc as products.

(5) Jung-ho-Hsien

This district is on the east bank of the Yellow River and faces Han-ch'eng-Hsien in Shensi Province, north of Lin-chin-Hsien. The chief agricultural products listed in the prefectural journal are millet, sorghum, kaoling, wheat, buckwheat, beans, sesame, etc. Raw cotton, raw silk and oils are also produced.

(2) Mineral Resources

(a) Honan Province

According to various records and data which have become known recently, there is little of particular note regarding the resources existing in the area which will be submerged. As for coal resources existing in this area, first of all we shall cite the Hsin-men fields. These fields extend to the east from the western border of Chi-yüan-Hsien, through Hsin-an-Hsien and to the west across Mien-ch'ih and Shensi-Hsien. This coal field, even though it is adjacent to the Shan and Mien-chi'i-Hsien, namely, in the neighborhood of the Mien-Chi'i and Shan borders on the south bank of the Yellow River regions which are near the areas to be submerged, its western-most edge near Kuan-yin-t'ang, escapes water coverage by present estimates. (Note: Taken from "Mineral Resources along the Banks of the Yellow River between Shan and Cheng-shou," by HORIUCHI Kazuo of the Bureau of East Asiatic Studies.)

Apart from this coal field there is nothing worth mentioning. The Ling-pao-Hsien journal merely states that "For a long time between the Sung and Chin dynasties, Lien and Hua in the district of Hsien-shan were deserted and it is no longer known where copper, iron, lead, and tin were mined and produced." It is therefore difficult to say that new resources will not be discovered by the advance of scientific investigations. Judging from the comparative investigations carried out in the interior of China by the Honan Geological Survey Bureau, and also from the results of previous investigations, it is reasonable to assume that the resources in the area to be submerged are not great. In his book (see above) HORIUCHI simply reports that gypsum is produced in the Ta-an village zone, in Shan-Hsien, under unknown conditions. The gypsum deposits in P'ing-lu-Hsien in Shansi and the same strata in northern Shan-Hsien have been developed. Perhaps as these gypsum fields begin to produce they may be swamped in the area to be submerged.

(b) Shensi Province

This province is particularly rich in oil, coal, iron, salt, natural soda, alumina shale, sulphur, gypsum, asbestos, and various other minerals. The principal producing areas are in the mountainous belt of northern Shensi and in the Ch'in-ling mountains in southern Shensi. There are really no important mineral resources in the area to be flooded by the construction of the San-men Gorge dam.
(Note: The North China Mineral Industry Bulletin notes that gold is produced in Hua-Hsien. Further the Hua-Hsien Hsien Journal state that "According to Travels over Mountain and Sea (Shan-hai) there is a great deal of copper to the south, and iron to the north of the western Fu-yu mountains in Lesser Hua. Moreover there are quantities of iron to the north and deep colored gold to the south of the oak clad crests of the Hsi-jih-ying mountains!! ")

Even apart from gold, it is quite probable that there are deposits of copper and iron, although details are lacking. Furthermore, judging from spots in the southern mountain zone, it may be concluded that they are outside the area which will be submerged.
(Note: South Manchurian Railroad's Tien-tsin Office: "North China Mineral Industry Bulletin" page 189.)

Further, page 538 of the Shensi edition of the above-mentioned records of the various Chinese provinces, contains a statement that coal is produced in Wei-nan-Hsien. The same source related that coal is produced south of the district, namely in the east-west Ch'in-ling range. Its quality as a black coal and its strong lustre and combustibility will more than fill local needs. This area of production is also outside the flood zone.

(c) Shansi Province

This province is abundantly rich in deposits of coal, iron, gypsum and various other mineral resources ready for exploitation, according to Richtofen /Rihitohofuen/ and numerous later scholars. That being the case it is a question just how extensive the underground resources are in the proposed area of submergence.

First of all, there are the gypsum deposits in Ping-lu-Hsien which run for about 30 Chinese miles (li) along the north bank of the East Yellow River from San-men-ling, which is east of the gov't(Hsien)seat. In this interval, outcrops occur in four places. The first is at San-men-ling (which is 5 Chinese miles (li) to the east of the government seat; another is to the south-west of Hsii-yu-fen/sic/ which is about 65 Chinese miles (li) east

of the government seat; a third is northeast of the village of P'an-nan-kou which is 70 Chinese miles (li) east of the government seat and the fourth is east of the village of P'o-ti-ho which is 80 Chinese miles (li) east of the prefectural capital. Of the four, the gypsum at Po-ti-ho village is superior by far. This gypsum deposit occurs in strata of tertiary laterite. Its thickness varies from four or five inches to more than a foot. The zone of occurrence is ten kilometers long and one to five kilometers wide. This gypsum deposit attracted the attention of the inhabitants around 1884. Mining operations gradually increased until, just before the China Incident they were taking out an estimated two to three thousand tons per year. Part of this gypsum range also appears as a well-defined outcrop near the San-men temple near San-men Gorge which is the construction site for the dam; therefore the considerable effect of the still water should be taken into account.
(Note: To the north of San-feng-ssu temple which is east of P'ing-lu-Hsien and to the south of Chui-tzu-shan there are silver ores. Communications (by letter) with the government seat more than 50 Chinese miles (li) away are poor. This silver ore body forms a vein in the archaean gneiss era and its width in many places varies from some inches to several feet. Further details are lacking.)
(Note: The gypsum deposits of P'ing-lu-Hsien are written up in greater detail by Ts'ao Shih-lu in Vol VIII, Sect IV, pp 327 ff of the Chinese Geological Society Magazine, published by the Chinese Geological Society, December 1929. A Japanese translation of these proceedings was made by OCHIAI Kushiro.)

Apart from P'ing-lu, fortunately no valuable resources are to be found in the stillwater area. The Shansi provincial records, in the "Complete Records of the Various Chinese Province," merely state (on page 629) that there are two iron mines in the vicinity of Yung-chi-Hsien. They are about 400 mou in extent, and iron is mined and manufactured in accordance with the agrarian laws. They supply the hardware stores in P'u-chou with finished articles. The small amount of coal produced in the neighborhood supplies the government seat but is almost of no consequence otherwise.

[End of Vol II]

Annexed maps and charts are appended.

[Addendum and Bibliography follow in Vol III]

ANNEXED MAPS AND CHARTS

KEY TO MAP X-A

1. No X-A
2. Map showing dam sites
3. Scale: 1/500,000
4. May 1941
5. Shensi Province
6. Huang-ho (Yellow River)
7. Yu-men-k'ou
8. San-yang
9. Han-ch'eng
10. Chih-ch'uan-chen
11. Ho-yang
12. T'ung-chou
13. Chao-i
14. Kuan-shan
15. T'ien-t'un-chen
16. Wei-ho (Wei River)
17. Shansi Province
18. Hsiang-yuan
19. Fen-chieng
20. Fen-ho (Fen River)
21. Ho-ching
22. Chi-shan
23. Hsin-chiang
24. Jung-ho
25. Wan-ch'uan Hsien
26. I-shih
27. Wen-hsi
28. T'ung-p'u
29. Ch'u-wu
30. I-ch'eng
31. Kuei-ho (Kuei River)
32. Chiang Hsien
33. Ch'in-shui
34. P'ing-min
35. P'u-chou
36. Canal
37. Yu-hsiang
38. Jui-ch'ang
39. Chieh Hsien
40. Salt Lake
41. Yun-chieng
42. An-I
43. Hsia-Hsien
44. P'ing-lu
45. Yuan-ch'u
46. Yang-ch'eng
47. Ch'ing-yuan
48. Pai-hsiao
49. Chin-ho (Ch'in River)
50. Kao-p'ing
51. San-chia-tien
52. Ch'i-ling-tien
53. Tse-chou
54. Hsi-fang-chuang
55. Huai-ch'ing
56. Meng-Hsien
57. Wen Hsien
58. Wu-chih
59. Po-ai
60. Yang-i-miao
61. Hsiu-wu
62. Shih-li-p'u
63. T'eng-ts'un
64. Ta-ch'ing-ying
65. K'ang-ts'un-i
66. Yuan-wu
67. (Hu)Hou-chia
68. Tai-chia-t'ien
69. Hsin-hsiang

70-A. Yang-wu
70-B. Hui-Hsien

71. Nan-ts'un
72. Lin-ch'i
73. Ling-ch'uan
74. Li-i-chen
75. Mi-shan-chen
76. In-ch'eng-chen
77. Hsiao-hen-ti Dam Site
78. Pa-li-hu-t'ung Dam Site
79. Ho-non Province
80. Ling-tung
81. Wei-nan
82. Hsin-shih-chen
83. Hou-tzu-chen
84. Lan-t'ien
85. Chih-shui-chen
86. Hua Hsien
87. Lung-hai Railroad
88. Hua-yin
89. Lo-nan
90. Tung-kuan
91. Wen-hsiang
92. Lu-shih
93. Ling-pao
94. Ta-ying
95. Shan Hsien
96. Chang-mao-chen
97. Hsia-shih-chen
98. Kuan-yin-t'ang
99. Mien-chih
100. Lung-hai Railroad
101. Hsin-an
102. Lo-ning
103. Lo-ho (Lo River)
104. Sung Hsien
105. I-ho (I River)
106. P'ing-teng
107. Ho-nan
108. K'uang-k'ou
109. T'ieh-hsieh

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KEY TO MAP X-A (Contd)

110. Meng-ching
111. Ti-cheng
112. Yen-shih
113. Lo-ho (Lo River)
114. Kung Hsien
115. Ssu-shui
116. Ying-yang-chen
117. I-yang
118. Chang-chai
119. Lin-ju
120. Hu-t'ou-chieh
121. Teng-chun-p'o
122. Ta-chin-tien
123. Teng-feng
124. Shun-tien
125. Hua-shih-chen
126. Yu-chou
127. Mi Hsien
128. Jung-yang
129. Ho-in
130. Ying-tse
131. Cheng-chou
132. Ching-hau Railroad
133. Kuo-tien-i
134. Hsin-cheng
135. Ch'ang-ko
136. Scale: 1/500,000
137. Kilometers
138. Japanese Ri
139. Chinese Ri
140. San-men-hsia Dam Site

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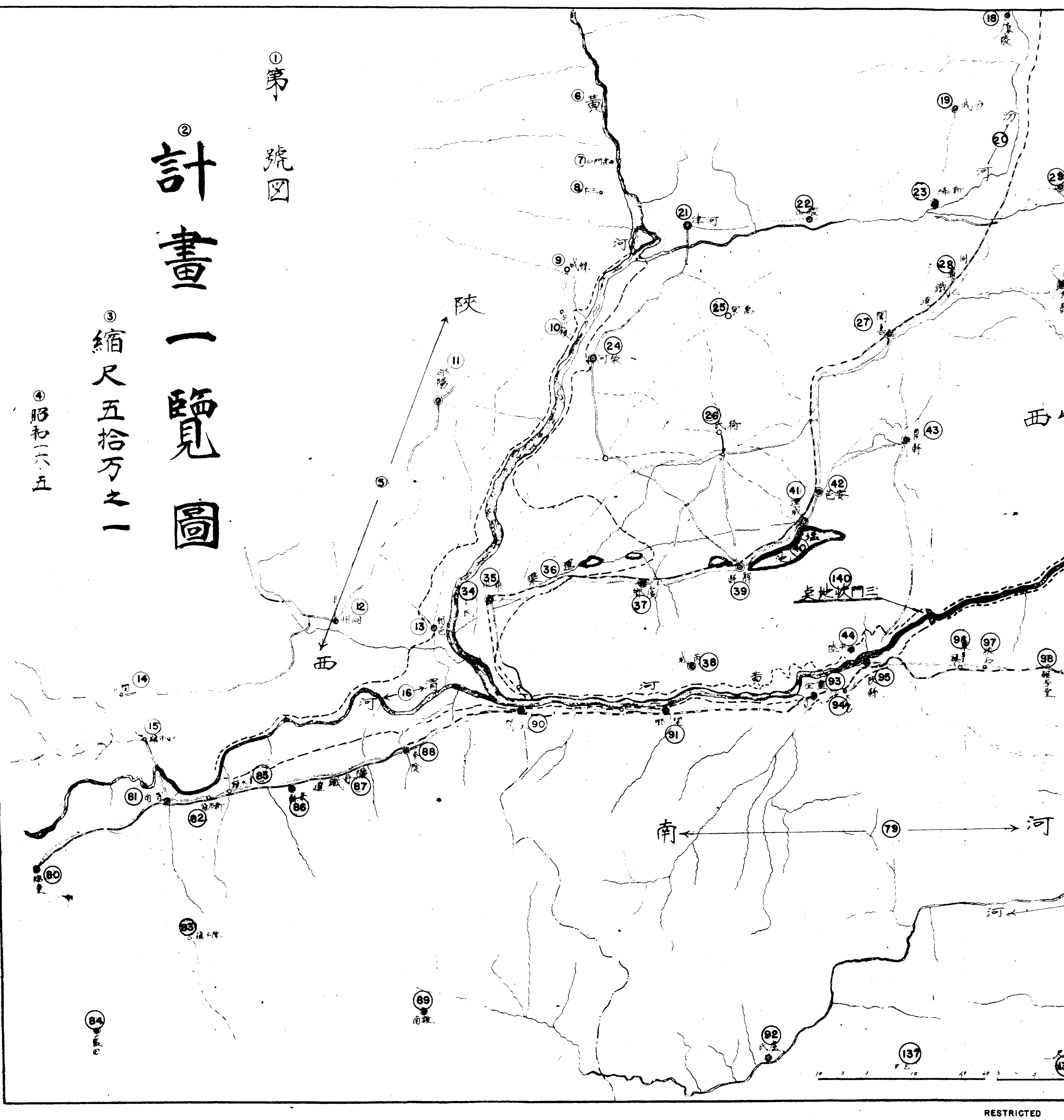

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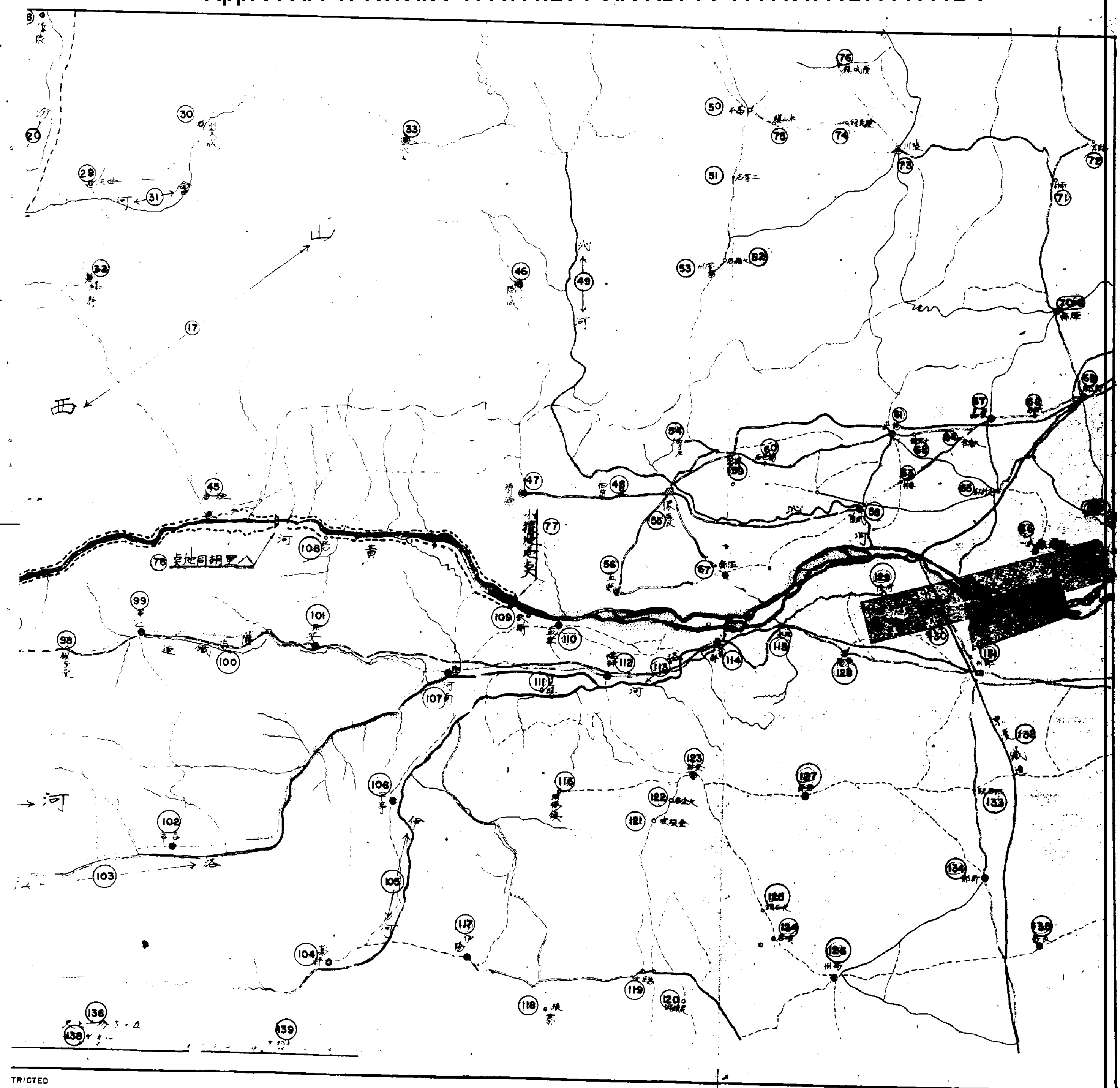

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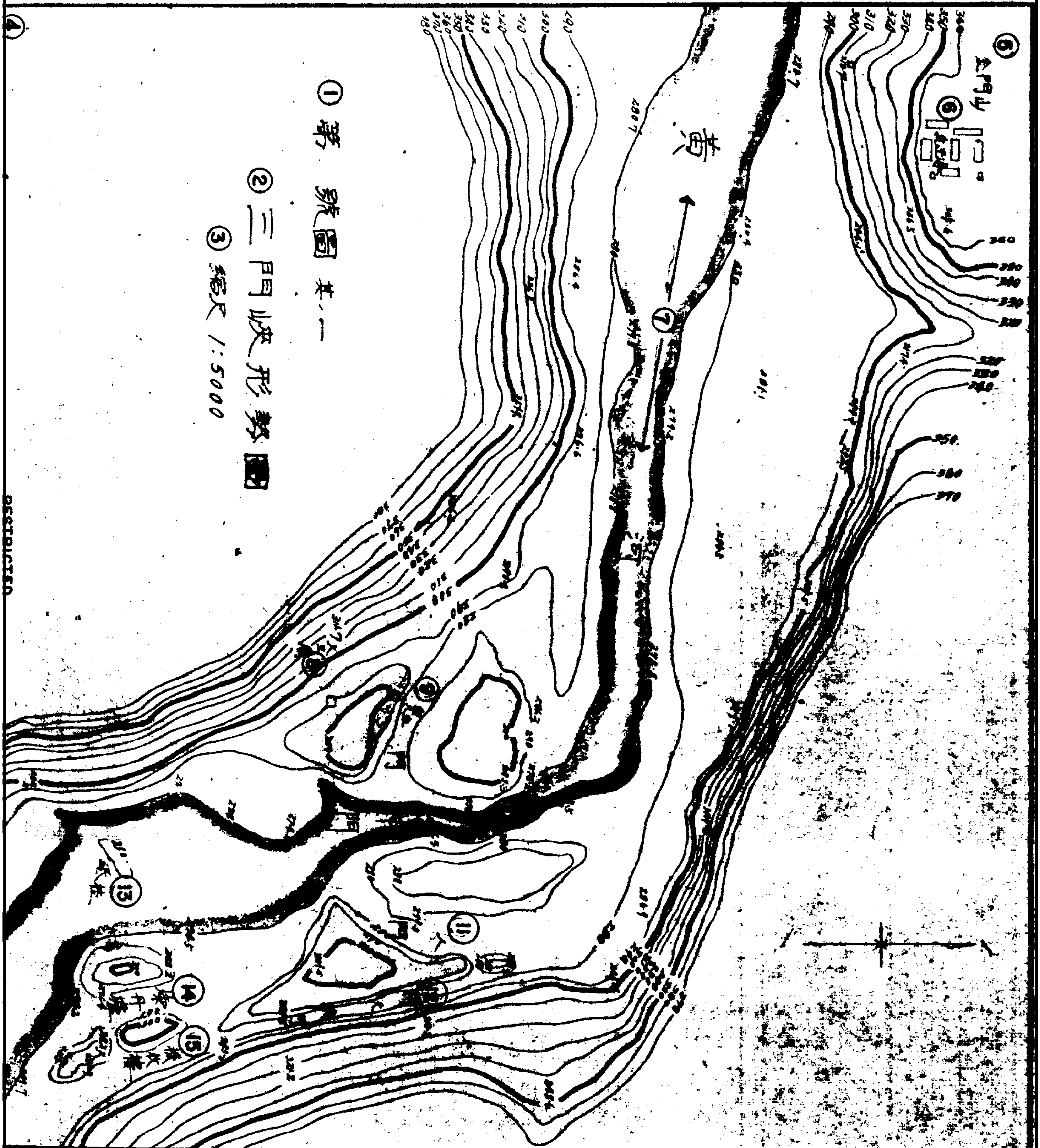
KEY TO MAP X-B

1. Map No X-B
2. Contour Map of San-men-hsia
3. Scale: 1 : 5000
4. May, 1941
5. Chin-men-shan
6. Hai wan yu
7. Hwang-ho (Yellow River)
8. Ta-wang-miao
9. Kuei-men
10. Shen-men
11. Jen-men
12. K'ai-yuan-hsin Ho
13. Chin-K'uang (A rock)
14. Lien-tan-lu
15. Shu-shou-lou

KEY TO MAP X-C

1. Part two of Map No X-C
2. Topographical sketch showing the area from P'ing-lu Hsien to Lung-yen Ts'un, shan-hsi Province
3. Scale 1:50,000
4. Surveyed Dec 1936 by the Chinese Government's Yellow River Water Conservation Committee
5. P'ing-lu Hsien
6. Kuan-ti Miao
7. Fan-jun Ts'un
8. Shan Hsien
9. Shan-hai Road and Shan Hsien Station
10. A-tien
11. Hui-hsing Chen
12. Mao-chin Tu
13. Sha-chien
14. Shih-chia T'an
15. Lung-yen Ts'un
16. Chai-chia (TN: illegible)



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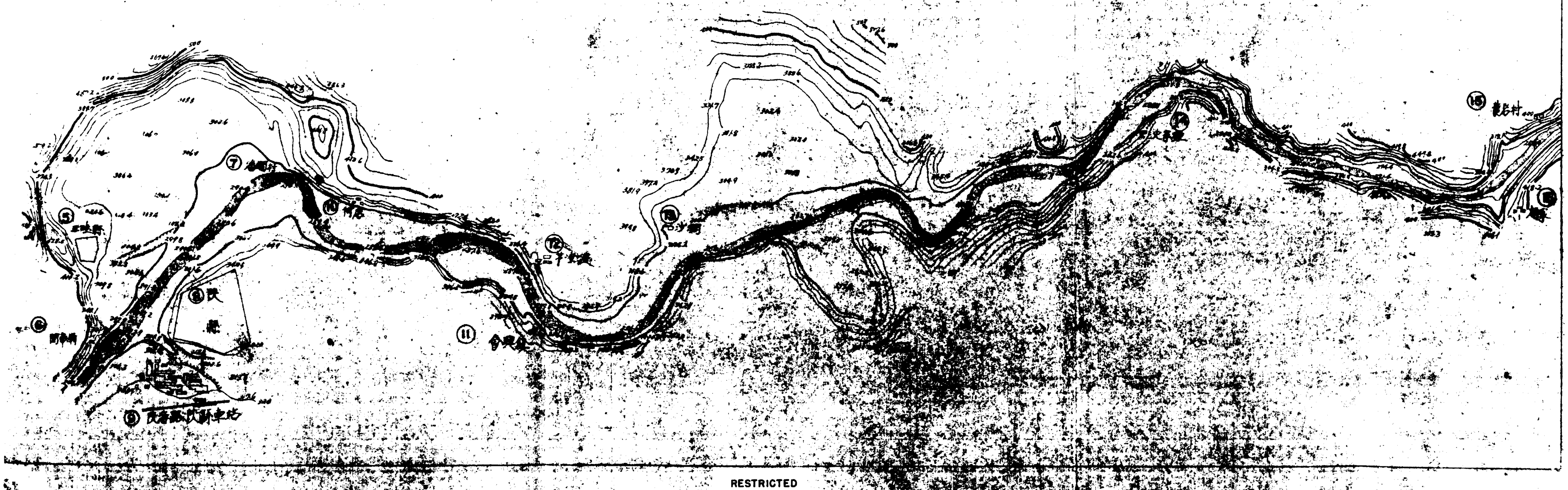
① 第　號圖其之二

② 山西平陸縣至龍岩村之地形簡圖

③ 縮尺 1/50000

④ 民國二十五年十二月實測
黃河水利委員會設計測量隊繪製



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KEY TO MAP-X-D

1. Graph showing variation in the flow of water at Shan
2. May 1941
3. Cubic meters
4. 1 January 1919
5. Years
6. 31 December 1935
7. Note: For months for which the flow was not measured and data was not available, the values were substituted from the curve of a year having a similar flow curve.

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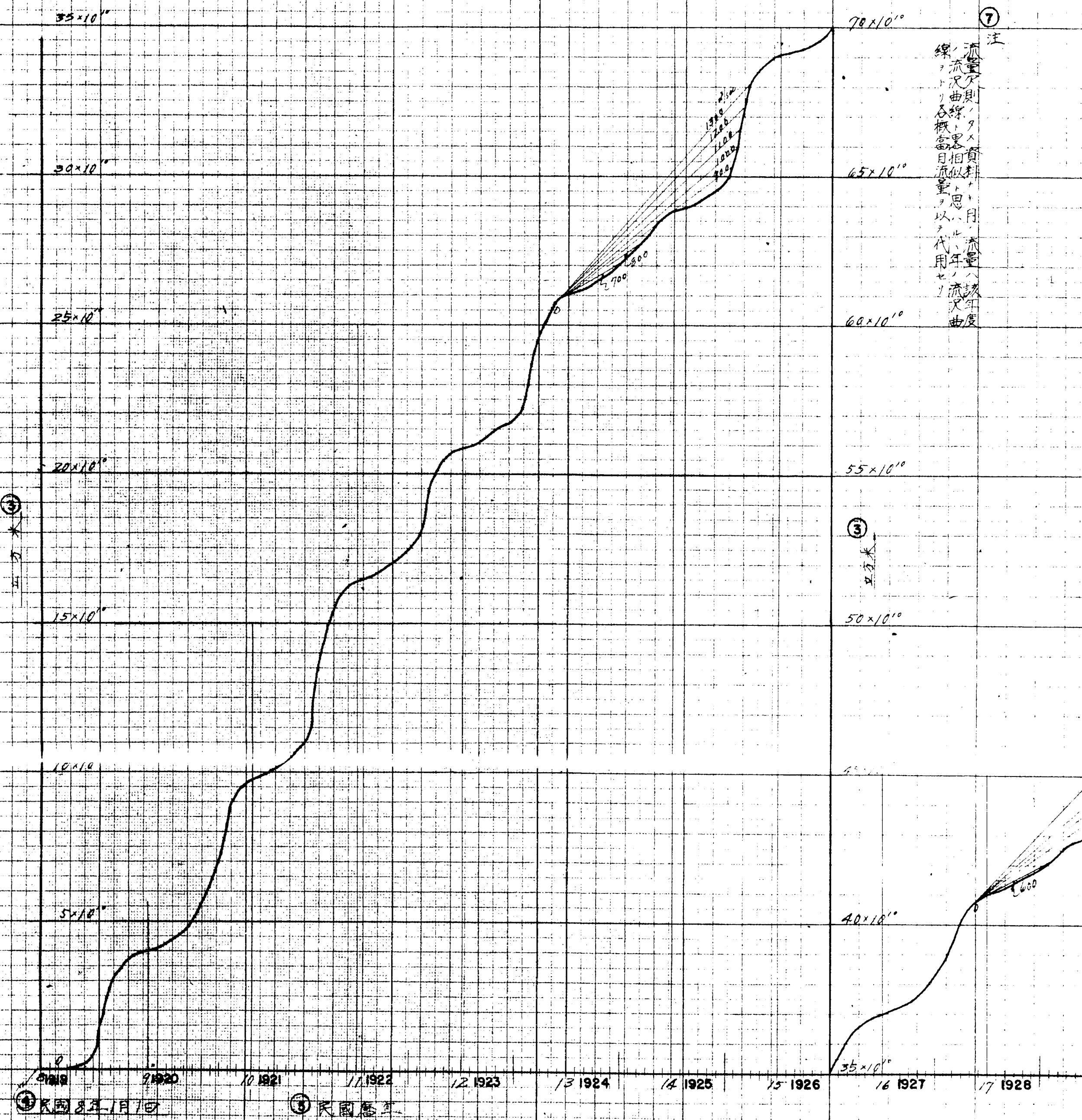
① 第　號図

陝州流量遞加曲線図　全

② 昭和十六年五月



⑦ 注
流量欠測ノタメ資料ナキ月ノ流量ハ該年度ノ流況曲線ト略相似ト思ハルヽ年ノ流況曲線ヨトリ各概當月流量ヲ以テ代用セリ

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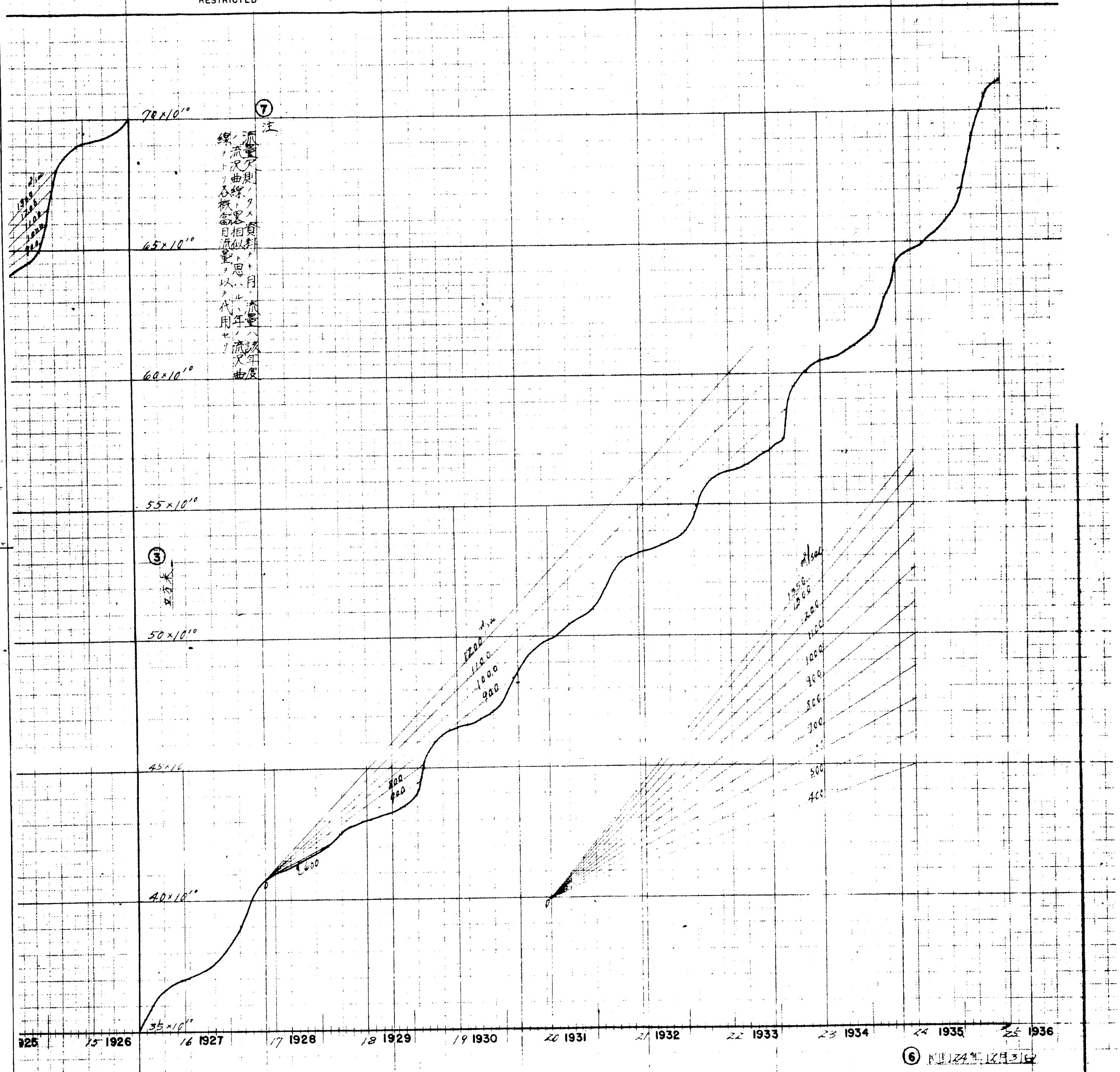

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Key to Map X-E

1. No X - E. The San-men-hsia Reservoir
2. Graph of Water level, water surface area, and amount of reservoir water
3. May, 1941
4. (If Chieh Hsien area is blocked off)
5. Amount of Reservoir Water
6. Water Surface Area
7. Depth of Water
8. Elevation of the top of the dam (above Tang-ku Datum)
9. Amount of Reservoir Water - 100,000,000 m^2
10. Water Surface Area - KM^2
11. Data used for calculating the amount of reservoir water
12. Elevation (Top of Dam)
13. Depth of Water
14. Difference in Depths of Water
15. Water Surface Area
16. Average Water Surface Area
17. Amount of Reservoir Water
18. Total Amount of Reservoir Water
19. Note: T. D = Tang-ku Datum

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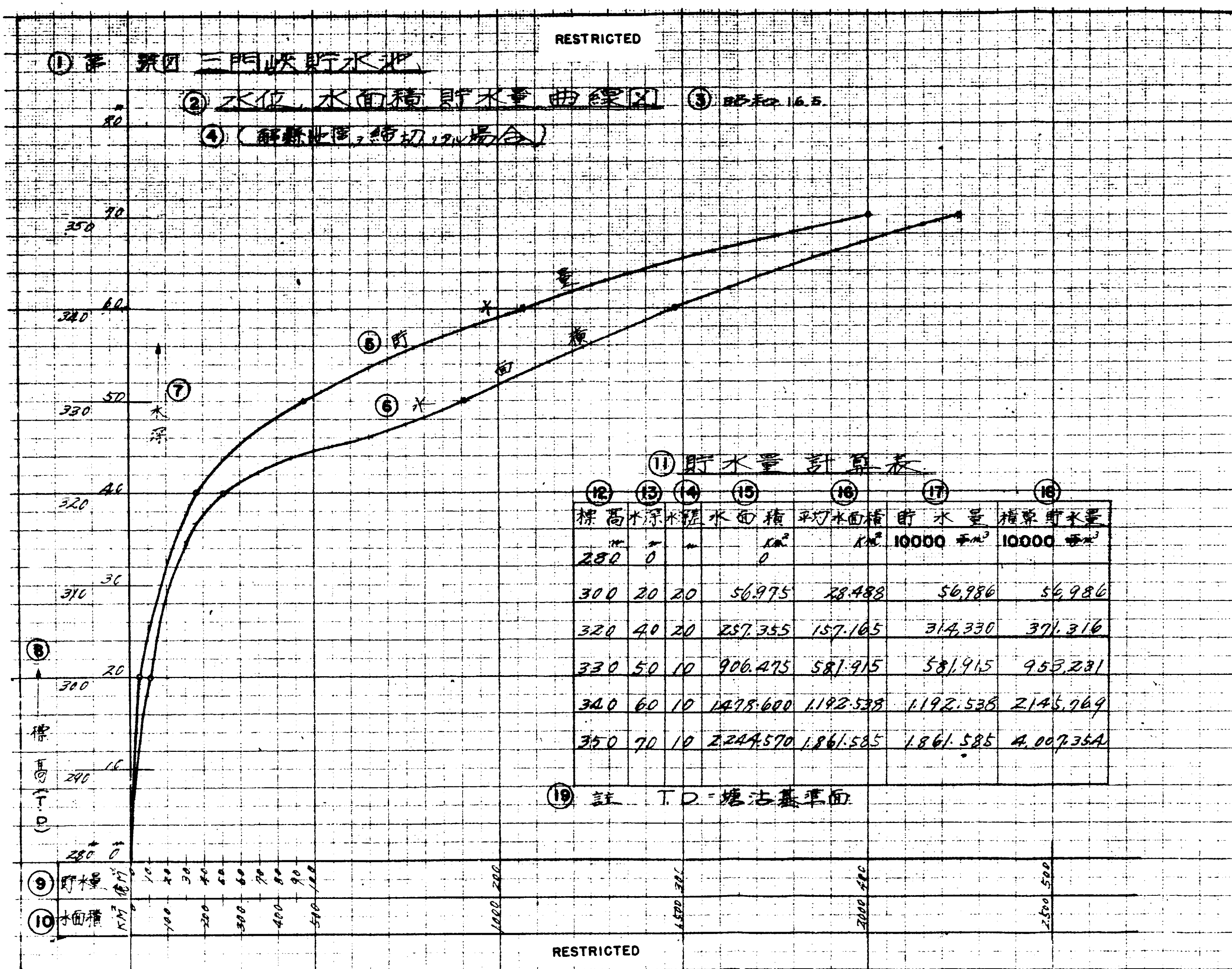
① 第　図 三門峡貯水池

② 水位，水面積 貯水量 曲線図　③ 昭和16.5.

④（解断此層ヲ締切リタル場合）



⑪ 貯水量計算表

⑫ 標高 m	⑬ 水深 m	⑭ 水距 m	⑮ 水面積 km²	⑯ 平均水面積 km²	⑰ 貯水量 10000 m³	⑱ 積累貯水量 10000 m³
280	0		0			
300	20	20	56.975	28.488	56.986	56.986
320	40	20	257.355	157.165	314.330	371.316
330	50	10	906.475	581.915	581.915	953.231
340	60	10	1478.600	1.192.538	1.192.538	2145.769
350	70	10	2244.570	1.861.585	1.861.585	4.007.354

⑲ 註 T.D＝塘沽基準面

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Key to Map X - F

1. No X - F
2. Graph of Water level, water surface area, and amount of reservoir water
3. May, 1941
4. (If Chieh Hsien area is not blocked off)
5. Amount of Reservoir Water
6. Water Surface Area
7. Depth of Water
8. Elevation of the top of the dam (above Tang-ku Datum)
9. Amount of Reservoir Water - 100,000,000 m2
10. Water Surface Area - KM2
11. Data used for calculating the amount of reservoir water
12. Elevation (Top of Dam)
13. Depth of Water
14. Difference in Depths of Water
15. Water Surface Area
16. Average Water Surface Area
17. Amount of Reservoir Water
18. Total Amount of Reservoir Water
19. Note: T. D. = Tang-ku Datum

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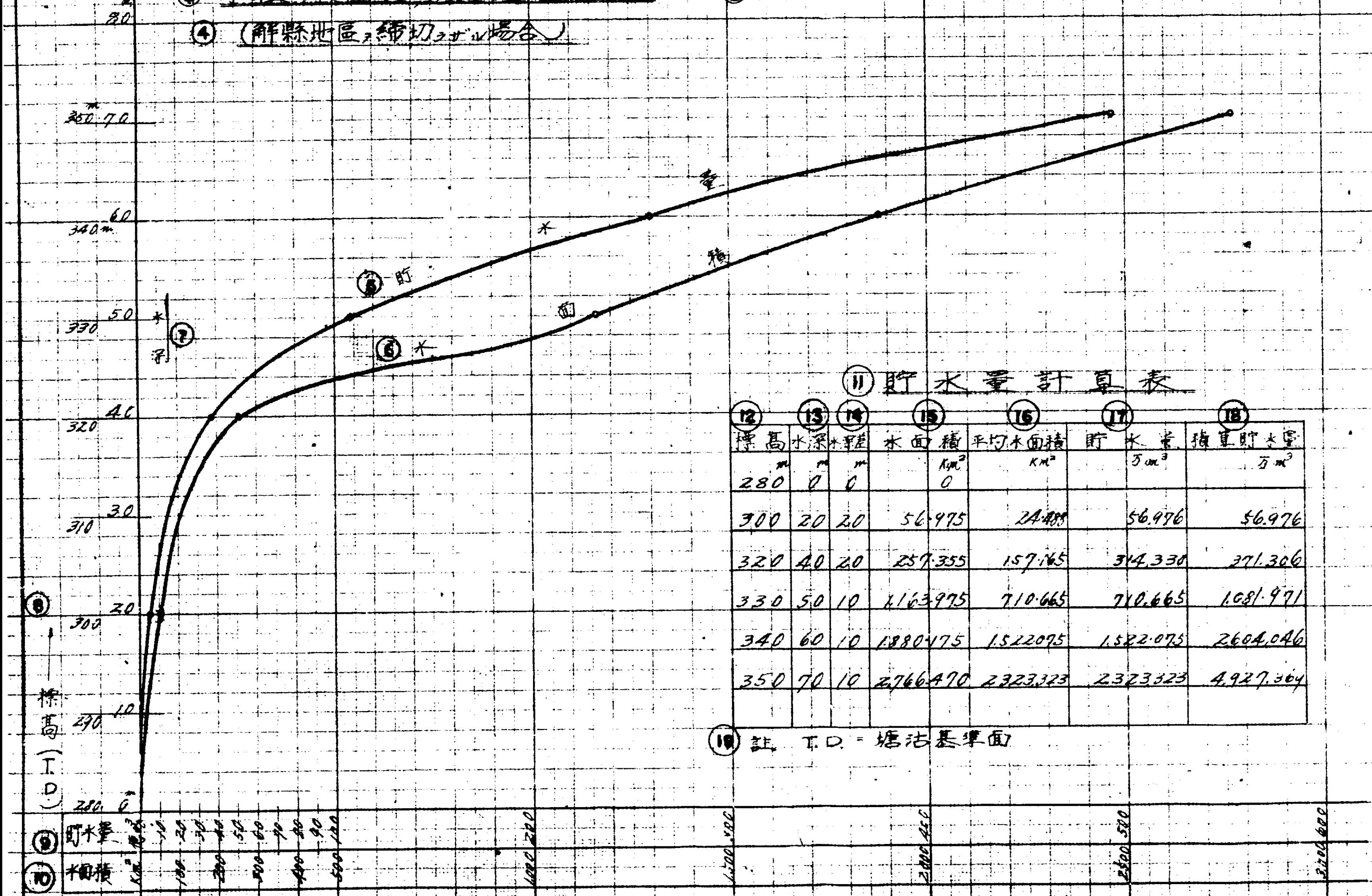
① 第 図

三門峡貯水池

② 水位 水面積 貯水量 曲線図

③ 昭和16.5.

④ (解県地區ヲ締切ラザル場合)



⑪ 貯水量計算表

⑫ 標高 m	⑬ 水深 m	⑭ 水深差 m	⑮ 水面積 Km²	⑯ 平均水面積 Km²	⑰ 貯水量 万m³	⑱ 積算貯水量 万m³
280	0	0	0			
300	20	20	56.975	24.488	56.976	56.976
320	40	20	257.355	157.165	314.330	371.306
330	50	10	1163.975	710.665	710.665	1081.971
340	60	10	1880.175	1522.075	1522.075	2604.046
350	70	10	2766.470	2323.323	2323.323	4927.364

⑲ 註. T.D. = 塘沽基準面

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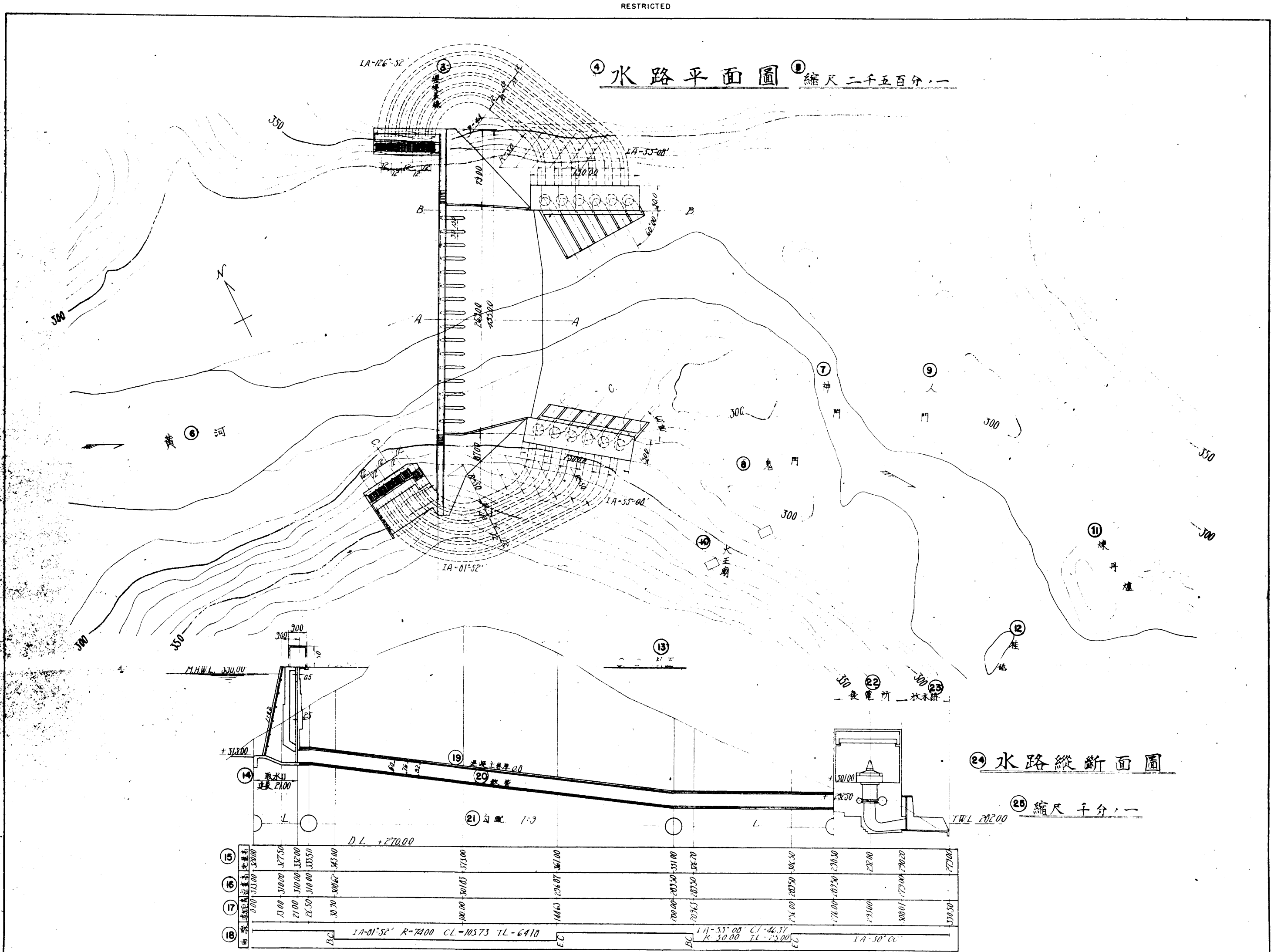
KEY TO MAP X-G

1. No X-G drawing showing Design of the San-men-hsia Power Development
2. May 1941
3. Base lines of the dam
4. Plan view of waterways
5. Scale: 1/2500
6. Hwang Ho (Yellow River)
7. Shen-men
8. Kuei-men
9. Jen-men
10. Ta-wang-miao
11. Lien-tan-lu
12. Chih-k'wang (a rock)
13. Cross section
14. Length of the Water Intake
15. Height of Base
16. Planned height
17. Increase
18. Graph
19. Thickness of concrete
20. Iron pipe
21. Slope 1:9
22. Power Plant
23. Discharge Pipes
24. Cross section showing Waterways
25. Scale: 1/1000

第 號圖

黃河三門峽發電所設計圖

昭和十六年 五月



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KEY TO MAP X-H

1. Drawing Showing Design of the San-men-hsia Power Development
2. No. X-H
3. May 1941
4. Front Elevation of Dam
5. Scale: 1/1000
6. Cross Section of Dam
7. Scale: 1.500
8. Upper Inspection Passage
9. Lower Inspection Passage
10. Right Water Intake
11. Proposed Rock Base Line
12. Left Water Intake
13. Cross Section of Emergency Overflow Part
14. Dam Base Line
15. Dam Base Line
16. Upper Inspection Passage
17. Cross Section
18. Drainage Conduit
19. Lower Inspection Passage
20. Ground Base Line
21. Proposed Rock Base Line
22. Cross Section
23. Drainage Pipe - Diameter-15
24. Holes used to Pressure Feed Cement Mortar
25. Lower portion of spillway
26. Generators
27. Elevation of turbine shafts

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