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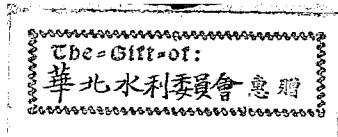
內政部華北水利委員會  
永定河治本計畫提要

THE ABRIDGED REPORT  
on  
THE RADICAL IMPROVEMENT SCHEME  
for  
THE YUNG TING HO

Prepared and Published  
by  
The North China River Commission  
Ministry of Interior

Tientsin  
1934

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## THE NORTH CHINA RIVER COMMISSION

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## PREFACE

This Abridged Report on the Radical Improvement Scheme for the Yung Ting Ho is prepared, especially for the English speaking engineers. It sets forth, in a concise and yet clear manner, the evolution of the Yung Ting Ho Improvement Problem and the status of this problem under the present light of information. It enunciates the elements of the scheme and reflects on the balanced consideration given to flood prevention, navigation, agricultural and other interests. While estimates of cost complete the scheme quantitatively, the section on "benefits to be derived" concretely proves the project to be one very sound economically. Finally a Nine-year Plan and another Five-year Plan are appended to show different working programs so as to suit different schedules for financing the project.

Those who desire to read the Full Report on the Radical Improvement Scheme for the Yung Ting Ho are advised to consult the Commission's Report therefor in Chinese which consists of two volumes of descriptions and discussions and two volumes of plans and drawings. This Full Report is composed of 7 Chapters, 3 Appendices, 4 related Documents, 78 Tables, and 123 Plans and Drawings. The body of this Full Report begins with Chapter I on the Characteristics of the Yung Ting Ho and its Catchment Basin, then Chapter II on the Floods of the Yung Ting Ho and the Evolution of its Regulation, Chapter III on the Hydrologic Basis for the Radical Improvement Scheme, Chapter IV on Detention Basins, Chapter V on Regulation of its Lower Course, Chapter VI on Disposal of Silt, and finally ends with Chapter VII on Conclusions.

The North China River Commission is indebted to the members and engineers of the former Chihli River Commission for the data they collected from 1918 to 1928 and for its Grand Scheme issued in 1925. Credit is due to those engineers of the Commission who conducted the extensive reconnaissance into the upper course of the Yung Ting Ho and its tributaries, who surveyed the mountainous regions of the river, and especially to those who have painstakingly worked on the preparation of the present radical improvement scheme during the past few years. In the course of preparation of this scheme, the Commission's engineers freely drew information from all possible sources to which the Commission is much obliged. The Commission desires to express here its deep appreciation to those Hydraulic Experts in China who were present at the Conference to discuss the scheme and who freely expressed constructive criticisms.

To the League of Nations' Hydraulic Engineering Mission to China the Commission owes much for their valuable suggestions. The approval of the scheme by the Conference of Hydraulic Experts in China and again by the League of Nations' Hydraulic Engineering Mission to China has established the fact that the scheme is not only an exceedingly sound engineering project but also a most economic undertaking of the present day in China.

The preparation of this scheme was started when Mr. Li Yi-tze was Chairman and Chief Engineer and Mr. Hsu Kai was Deputy Chief Engineer of the Commission, however the entire revised scheme was worked out by the Commission's engineers under the able direction of its Chief Engineer, Mr. Hsu Shih-ta.

The Commission will heartily welcome criticisms and suggestions on the Radical Improvement Scheme for the Yung Ting Ho from all expert hydraulic engineers before its execution. And any helpful effort toward the financing of this project will be greatly appreciated by the Commission on behalf of all interests of the Yung Ting Ho valley and the Port of Tientsin.

LI SHU-T'EN

Executive Member

and Chief Secretary of the Commission.

Tientsin, China, March, 1934.

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**THE ABRIDGED REPORT**  
on  
**THE RADICAL IMPROVEMENT SCHEME**  
for  
**THE YUNG-TING HO.**

**I. Introduction**

The Yung Ting Ho which is the largest river in North China has been the cause of greatest catastrophe for centuries. Its catchment basin above Kuan Ting which is some 266 kilometers from its mouth embraces 47,000 sq. kms. Its main tributaries are the Yang Ho draining the Inner Mongolian Plateau along the Peiping Suiyuan Railway, and the Sang Kan Ho, deriving its source from the Wu Tai Shan Mountain Range. These two tributaries join at Chu Kuan Tun. Thence the main river flows southeastwardly to Sze Chia Tsai where another confluent, the Wei Sui Ho, enters it. Shortly after this junction the river cuts through a rocky gorge for about 100 kms. until it reaches San Chia Tien where the flood plain widens. About 10 kms. below San Chia Tien dyke work commences down to the river mouth. Thus the river flows between two dykes until east of Shuang Ying where the dykes diverge to form a wide food basin, called San Chiao Tien (Yung Ting Ho Delta). The east boundary of this flood basin is the west dyke of the Pei Yun Ho which takes the Yung Ting Ho and finally discharges into the Hai Ho.

All the tributaries of the Yung Ting Ho drain bare mountainous regions richly covered with Huang-tu (loess), Hung-tu, and other alluvial deposits. The bed slope of the river is rarely flatter than 1 in 500. Thus a tremendous amount of silt is carried down annually by the river to its lower reaches. Because of the sudden flattening of the bed slope, the silt deposited in the river bed between the dykes, in the Delta, and in the Hai Ho is enormous, unless flood water breaks the dyke. Because of its treacherous nature, this river was formerly called the Wu Ting Ho, (that is, "Never Settling River").

In the old times though it was unavoidable that the river breached its banks quite frequently yet its effect was not felt so much as it is at present, for a great flood in one year might be compensated by a good crop in another and what was lost in this year



might be made up in the next. But since the seat of government was located at Peking from the time of the Ch'in dynasty, about a thousand years ago, as the metropolitan districts were often visited by floods it was necessary to devise preventive means, resulting in the construction of dykes. Again for transportation of grain from the southern provinces to the capital the Grand Canal must always be kept navigable by all means and the fact that other rivers including the Yung Ting Ho could not flow into the sea in regulated channels was entirely disregarded. The five large rivers in North China, namely, the Yung Ting, the Pei Yun, the Tse Ya, the Ta Ching and the Nan Yun, have only one outlet, the Hai Ho, into which they all discharge their waters, causing great floods in the autumn, while during that time of the year there are high tides. History shows that floods had occurred during the Ming and Ching dynasties (1368-1911) much more frequently than those before that period of time. In the Kang Hsi and Chien Lung regimes (1662-1796) when the treasury was in possession of enormous wealth, dykes were built along the banks in the lower course of the Yung Ting Ho. From that time on, the cultivatable land ceased to take advantage of the silt deposits while the river bed has become much elevated. Since the middle of last century the government has always been so fully engaged in affairs more important than river conservancy and the price of commodities so rapidly raised that the old dykes were left to themselves causing great damages to the people and property on account of frequent breaches which happened almost every few years.

## II. Report by the Former Chihli River Commission

In the year 1917 Tientsin was inundated. As a measure to prevent further occurrence, both Chinese and foreigners petitioned the government with the request that a Chihli River Commission be organized, whose duty was to study ways and means to effect a radical improvement. As a result of this institution topographic and hydrometric surveys of the rivers in North China were made and taken as a basis of the projected scheme. Another disastrous flood occurred in 1924, and the people were greatly alarmed. The former Chihli River Commission then in 1925 made a general report on the radical improvement scheme for the Chihli rivers. With regard to the improvement work for the Yung Ting Ho this report contains two alternative plans, one for the river to take the northern course via the old Delta to the sea and the other to take the southern course via a new delta. In either of these plans the identical points are (a) the construction of detention basin at Kuan Ting and (b) the regulation of the main channel between Lu Kou Chiao and Chin Men Cha.



In the first plan it is also proposed that the channel between Chin Men Cha and Shuang Ying shall be regulated, that a new channel shall be cut through the Delta and that a new leading channel to the sea shall be excavated north of Tientsin, at a total estimated cost of \$45,760,000.00. The second plan involves expenses concerning the regulation of the channel below Chin Men Cha, the purchase of land for a new delta and the construction of a new leading channel to the sea, at a total estimated cost of \$32,790,000.00.

It is evident that the second plan which the former Chihli River Commission finally decided to adopt is cheaper by \$13,000,000.00. "This plan", the report says, "may result in the distribution of flood waters in a more natural manner and in the diversion of the silt-laden water of the Yung Ting Ho to a course south of the Hai Ho, which course is far better than the one north of the latter river". Although the new delta would require an area of 580 square kilometers, the elevation of not an insignificant part of it amounting to 240 square kilometers is less than 7 meters above the sea level at Taku. This region is, therefore, always under water in times of flood, as was the case in 1920 when the inundated area embraced 400 square kilometers. The Commission was of the opinion that since the upper part of the existing Delta was now from 6 to 8 meters higher than the adjacent lands and was rendered almost useless as a settling basin, a new course must be found for the Yung Ting Ho to flow into the sea. This is another reason for the choice of the second plan.

Regarding the channel leading the Yung Ting Ho to the sea the Commission's Report says, "After flowing over the new delta the river should join its two affluents, the Ta Ching Ho and the Tse Ya Ho. Part of the water from these three rivers should go to the Hai Ho and thence to the sea while the remaining part should flow in a new channel to be excavated from Ti Liu Pu (near Tu Liu Chen) to the sea. At Ti Liu Pu diversion works are to be built so as to regulate the flow and maintain the navigability of the Nan Yun Ho and the Hai Ho". This new channel shall be located at some distance to the north of Hsiao Chan ricefield.

Owing to the unsettled political conditions the plan announced officially in 1925 as referred to above has not been carried out. Expert critics all agree that it is necessary to build a detention basin at Kuan Ting though they are of different opinion as to the advantages and disadvantages of a new or old delta as well as of a southern or northern channel to the sea.

### III. Proposal Made by The North China River Commission

While the plans of the former Chihli River Commission concerning the regulation of the Yung Ting Ho were held in abeyance, its only outlet, the Hai Ho, had, since 1926, become shallower and shallower as time went on, because of the deposition of tremendous amount of silt. In the year 1928 Tientsin was not accessible to steamers of over 10 feet draught and almost became a dead port. Chinese and foreigners alike, who had formerly been anxious to have the Yung Ting Ho improvement plans carried out to prevent further great floods, now turned their attention to the same question with a view to removing the silt. However as the regulation of the whole Yung Ting Ho requires both time and money, the palliative scheme for the improvement of the Hai Ho could temporarily solve the problem.

In the autumn of 1928 the North China River Commission which was entrusted with the conservancy work of all rivers in North China took up the problems left unsolved by the former Chihli River Commission and spared no efforts in carrying out wherever possible the schemes for the improvement of both the Hai Ho and the Yung Ting Ho. On the 14th day of December of the same year at the 2nd plenary meeting of the members of the Commission the following was proposed and approved:

(1) To construct a detention basin at Kuan Ting for regulating the flood flow and the storage capacity for irrigation purposes. A further comparison of all available plans should decide whether the overflow dam with six culverts underneath as proposed by the former Chihli River Commission or the high dam with side tunnels and regulator gates should be adopted.

(2) To discard the project of a southern channel with a new delta as proposed by the former Chihli River Commission. As to the Tu Liu to sea flood escape channel which is necessary to accommodate the flood waters of the Ta Ching Ho, the Tze Ya Ho, and the overflow of the Yung Ting Ho, it was decided that this channel should be included in the new plan.

(3) As an emergency measure of reducing the silt deposit in the Hai Ho, to build a new channel starting from San Chiao Tien (The Yung Ting Ho Delta), across the Pei Yun Ho to the Ta Ho Tien, via the Chin Chung Ho and thence to the sea. The silt depositing districts may, in the future, be made larger in area than originally planned, extending to the alkaline land to the east of the Chin Chung Ho.

(4) To utilize the Yung Ting Ho by diverting part of the water upon the lands on both south and north sides of the river, for irrigation as well as silt-deposition purposes.

(5) To apply to the National Construction Commission at Nanking for approval of the scheme as proposed and adopted at this meeting. The construction work in this connection should be undertaken jointly by the North China River Commission and the Hopei Provincial Government.

(6) To petition the National Construction Commission with the request that the National Government be persuaded for the issuance of a loan of \$3,600,000.00 with customs surtax as security. In the meantime the China International Famine Relief Commission should be asked to contribute \$1,000,000.00 as a famine relief fund for the Hopei Province. With these funds the work for the Kuan Ting detention basin and the Ta Ho Tien settling basin might be commenced. Necessary funds should also be raised elsewhere for the construction of a flood escape channel from Tu Liu to the sea.

Based on the above resolutions the whole scheme together with an estimate of the expenses involved as well as a suggestion on methods to raise the required funds was submitted to the National Construction Commission on the 19th of December, 1928, with the request to transmit the same to the National Government for consideration and approval so that work might be started at once, thus making it possible to prevent the Yung Ting Ho plain from further floods, to utilize the Yung Ting Ho water for irrigation and to maintain the navigability of the Hai Ho. At about the same time the Hopei Provincial Government and the Tientsin Municipal Government jointly organized the Hai Ho Improvement Commission with a view to starting work for the diversion of silt-laden water from the Yung Ting Ho to a new settling basin. In April, 1929, the National Construction Commission appointed additional members to the Hai Ho Improvement Commission, while the Legislative Yuan approved the regulations governing the issuance of the "Hai Ho Short Term Bond". However, the Hai Ho Improvement Commission had not been formally organized until September, 1929. For various reasons the Bonds mentioned above had not been issued until the early summer of 1931. On account of these delays the work could not be carried out as originally planned.

#### IV. A Revised Scheme

In July, 1929, heavy rain fell in and near Peiping. In the afternoon of the 18th a dyke breach of over 700 feet occurred a short distance above Chin Men Cha along the Yung Ting Ho, in-

undating a score of villages nearby. Subsequently this breach was extended to a length of about 1800 feet. The North China River Commission was ordered by the National Construction Commission to send engineers to the spot and investigate how to draw up a plan for closing the breach. As a result of the joint investigation conducted by engineers of this Commission and of the Hopei Provincial Construction Department and the Yung Ting Ho Bureau a breach-closure scheme together with an estimate of the expenses concerning this work was submitted to the National Construction Commission for transmission to the Executive Yuan which in turn should, after due consideration, order the Ministry of Finance to provide funds for relief purposes. In the meantime observations were made as to the maximum and total discharge at several important stations along the river, to be compared with those of the 1924 flood. The records are as follow:—

Drainage Area	Maximum Discharge Cubic Meters per Second	Total Discharge Million Cubic Meters
	1924 Flood (July 11-13)	
Above Kuan Ting	4,300	360
Between Kuan Ting and San Chia Tien	2,600	180
Above San Chia Tien	5,200	540
At Lu Kou Chiao	4,900	425
	1929 Flood (July 16-18)	
Above Kuan Ting	2,100	150
Between Kuan Ting and San Chia Tien	2,000	30
Above San Chia Tien	2,000	30
At Lu Kou Chiao	2,650	205
	1929 Flood (August 1-3)	
Above Kuan Ting	1,200	207
Between Kuan Ting and San Chia Tien	3,700	183
Above San Chia Tien	4,200	390
At Lu Kou Chiao	4,000	400

The foregoing maximum discharge between Kuan Ting and San Chia Tien is the maximum difference between the hydrographs of these two places allowing time for the Kuan Ting flood to reach San Chia Tien. From the above data it may be asserted that the reducing of flood peak above Kuan Ting can only partially relieve the Yung Ting Ho flood.

The flood records of the Yung Ting Ho are available for such a short period that they can hardly serve the purpose for determining

the maximum flood discharge. Water depth records at Lu Kou Chiao have been kept by the Yung Ting Ho Bureau for a period of over 100 year, yet those data are uncertain and discharges are unknown, therefore, any estimate can only be based upon maximum rainfall records compared with those rainfalls which caused the recorded floods. The Lin Min Kwan storm is taken as a basis, with the center of storm transferred to the region between Kuan Ting and San Chia Tien. From this storm and the maximum percentage of run off, the estimates of maximum flood discharges are as follow:

Drainage Area	Estimated Maximum Flood Discharge Cubic Meters per Second	Estimated Maximum Flood Discharge, Million Cubic Meters
Above Kuan Ting	8,000	670
Between Kuan Ting and San Chia Tien	4,900	350
Above San Chia Tien	10,200	1,020
At Lu Kou Chiao	9,800	1,070

With the above investigations and estimates and all other available data on hand the following principles were adopted at the 6th plenary meeting of the members of the North China River Commission, held on the 6th of October, 1929:

- (a) To construct two detention basins, one at Kuan Ting and another at Shih Hsia Li.
- (b) To build several artificial lakes at proper places between Kuan Ting and San Chia Tien.
- (c) To regulate the main channel.
- (d) To excavate leading channels.
- (e) To repair and strengthen the dykes.

After this scheme was approved, the Chief Engineer of the Commission was at once instructed to make further studies at the spot and draw up a definite working plan for carrying out the project. In the spring of 1930 field work was commenced and engineers were sent out to make a river survey from Kuan Ting to San Chia Tien and to make foundation borings at Kuan Ting and other dam sites between Kuan Ting and San Chia Tien. At the same time, in the office, studies were made of the various types of dams, to ascertain which would serve the best purpose at least expense; also the ways and means for regulating the channel in the lower course were discussed. But a little time afterwards on account of political unrest this Commission was unable to carry out its work as planned, for its

financial supply was practically exhausted. However, as a result of the efforts exerted by the members of this Commission surveying work was completed in a comparatively shorter period of time and three borings into the dam site were made at Kuan Ting where it was found that the bed rock was much farther than was first explored by the former Chihli River Commission.

It may be said in passing that in connection with the improvement scheme for the Yung Ting Ho most people maintained that all the calamity caused by this river was due to the treacherous nature of its lower course while the upper course had nothing to do with it, hence no observations whatsoever were recorded of its upper valley. But this Commission was of firm opinion that all the trouble in the lower course was simply caused by the flood flow from the upper valley, and that it was absolutely necessary to make a careful study of the conditions therein. As early as November, 1928, when this Commission was first organized technical experts were dispatched to the upper regions, to conduct actual investigations. After traveling over a distance of 600 kilometers within three months' time they returned to Tientsin with a comprehensive report on the conditions of the upper tributaries, of the regions drained by them, of the sites for detention basins and on the possibilities for irrigation and water power development, etc. Besides, a careful observation was made of the sources of silt carried down by the Yung Ting Ho. All these data furnish this Commission the basis of the present scheme.

Furthermore, in the early days those to whom the work of improving the Yung Ting Ho was entrusted counted on the dykes as the sole means to check flood, being entirely ignorant of the fact that flood water could be utilized for improving adjacent lands. If there were no dykes along the lower course there might be alternate years of flood and crop and it would be much easier for us to harness the river to-day. To construct a new channel of a considerable length would also involve heavy expenditure and great difficulties. Therefore, this Commission would rather have the silt settled in lands adjacent to the river than carry it all to the sea. In this way the lands along the banks are raised higher, thus preventing the flood from inundating the neighboring villages. A scheme to that effect was submitted to the National Construction Commission early in July, 1929.

#### V. The Yung Ting Ho Silt

The amount of silt carried down by the Yung Ting Ho was determined in conjunction with the discharge, but the data are more

or less scattered. The maximum silt record is 38% by weight. The total amount of silt carried down to the Delta has been estimated to be 175 million cubic meters during a period of 7 years, according to record from two topographic surveys made in the Delta, one in 1921 and another in 1927. Including the silt deposit in the river bed and on the flood plain of the Ta Ching Ho, the amount of silt carried annually by the Yung Ting Ho is estimated to be from 27 to 30 million cubic meters. The Hai Ho Conservancy Commission estimated that an average of 1 million cubic meters of silt is carried down annually by the Hai Ho, of which four-sevenths is from the Yung Ting Ho, and that in 1927 about 6 to 8 million cubic meters of silt was carried to the Hai Ho from the Yung Ting Ho.

#### VI. The Twofold Problem.

The problem, then, to be solved is twofold: first how to regulate the flood flow in order to relieve the suffering of the farmers of the Yung Ting Ho valley and secondly how to dispose of the silt in order to ameliorate the silting of the Hai Ho and to increase the prosperity of Tientsin.

There are three methods to regulate the flood flow and to prevent dyke breaches; viz. to reduce the flood peak, to divert the flood flow into other channels and to increase the flood channel capacity. So far as the Yung Ting Ho is concerned, the first method will be the most satisfactory, because there are suitable places upstream for detention basins. Moreover, the Lu Kou Chiao weir and the Chin Men Cha weir shall also be utilized to divert a part of the flood flow of the river into the Hsiao Ching Ho. The flood channel capacity of the Yung Ting Ho below Lu Kou Chiao is only from 1,000 to 2,700 cubic meters per second. If the river is divided into three sections, the capacity of each section will be as follows:

Between Lu Kou Chiao and Chin Men Cha	2,700 cubic meters per second,
Between Chin Men Cha and Shuang Ying	2,000 " " " " "
Below Shuang Ying	1,000 " " " " "

At Lu Kou Chiao and Chin Men Cha there are diversion weirs, each discharging part of the flood, thus:

Lu Kou Chiao Weir	1,000 to 1,400 cubic meters per second,
Chin Men Cha	200 to 600 " " " " "

Obviously a flood discharge of over 3,000 cubic meters per second is dangerous and a discharge of 4,000 cubic meters per second

will certainly cause dyke-breaches. The solution is therefore to reduce the flood peak in such a way that during floods similar to those of 1924 and 1929 no overflow would result in the Delta below Shuang Ying and during maximum flood the channel capacity above Shuang Ying would not be exceeded. Of course it is out of question to increase the height of the dykes, which are already high enough, to any considerable extent or to form a new course for the river below Lu Kou Chiao on account of local opposition.

In order to ameliorate the silting of the Hai Ho, the best solution would be to divert the Yung Ting Ho away from the Hai Ho. Limited by topography, the only alternate outlet for the Yung Ting Ho beside the Hai Ho is the Chi Yun Ho which discharges into the sea at Pei Tang not very far north of Ta Ku. It would be transferring an evil from one place to another, should the Yung Ting Ho be allowed to silt up the Chi Yun Ho. Furthermore, the Yung Ting Ho is a complement of the Pei Yun Ho, the comparatively clear water of which is beneficial to the Hai Ho. To provide a satisfactory outlet for the Yung Ting Ho, it is proposed to drain the river into the sea through a settling basin wherein its silt load will be discharged. A part of the clear water in the settling basin may be returned to the Hai Ho.

An evident result of the Yung Ting Ho silt beside the shoaling of the Hai Ho is the raising of the river bed and Delta, which are now from three to six meters higher than the adjacent lands. This causes frequent overtopping and breaching of dykes. The capacities of the detention basins and the settling basins are limited and can not possibly last forever. The fundamental solution of the silt problem would therefore be the prevention of its being carried down the river. This can be partially accomplished by building check dams to flatten the slope upstreams and by afforestation. The residual portion that will still be carried down the river can be disposed of on the lowlands adjacent to the river, as this silt may be utilized as fertilizer.

#### VII. The Radical Improvement Scheme

The Radical Improvement Scheme consists of the following works:

(1) Flood detention which requires the building of detention basins (a) at Kuan Ting to reduce the flood peak coming from the drainage basin above Kuan Ting, and (b) at Tai Tze Mu for the drainage basin between Kuan Ting and Tai Tze Mu.

(2) Flood diversion which includes (a) reconstruction of the Lu Kou Chiao weir into a regulator, and (b) repair of the Chin Men Cha weir.



(3) River regulation which consists of repairing the dykes, smoothing the low water course to prevent undermining, protecting the banks by revetment and spur dykes, and regulating the channel to prevent further raising of the bed.

(4) Improvement of the outlet which includes the dredging of the Pei Yun Ho below its confluence with the Yung Ting Ho, the dredging of the Chin Chung Ho and the repairing and raising of dykes.

(5) Reduction of the silt-load of its upper tributaries by building check dams at proper places along the Yang Ho and Sang Kan Ho and their confluents.

(6) Disposal of silt on the alkaline lands along its northern and southern banks, together with the construction of a regulator on the Lung Feng Ho and the dredging of the Pei Yun Ho above its confluence with the Yung Ting Ho.

**Kuan Ting Detention Basin.**—The Kuan Ting detention basin is situated just above the Kuan Ting Gorge in the Huai Lai District of Charhar Province. There is a comparatively wide valley where the Yung Ting Ho and the Wei Shui Ho join together. An overflow dam of 27 meters high (measured from the river bed) and 90 meters crest length (the total length of the dam being 111 meters) is to be built at the upper mouth of the gorge and will have a storage capacity of 330 million cubic meters up to the crest of spillway, which will reduce the flood peak such as that of 1924 from 5,700 (inflow) to 1,200 (outflow) cubic meters per second. The outlet consists of three open culverts, each 6 meters wide and  $4\frac{1}{2}$  meters high, the upper portion of which being semi-circular. Gate seats will be provided for the full use of the basin as a storage reservoir, if the silting condition in the basin is found to be favorable. Floods higher than the 1924 flood will flow over the top of the dam and the overflow would be 3 meters above the dam crest (then the storage capacity of the dam would be 460 million cubic meters), should the estimated maximum flood occur.

The estimated cost for this work together with the acquisition of land will be \$2,440,000 approximately.

**Tai Tze Mu Detention Basin.**—This basin is located in the neighborhood of a village of the same name in the Wan Ping district of Hopei province, and 60 kilometers below Kuan Ting. An overflow dam of similar design as that at Kuan Ting will be built. It will be 48 meters high with a spillway of 150 meters (total length of the dam being about 189 meters). The culverts will also be of same design as those at Kuan Ting, but no gate seats will be provided for.

The regulated flood flow from Tai Tze Mu, due to the overflow dams at this point and at Kuan Ting, combined with the runoff from the drainage area between Tai Tze Mu and Lu Kou Chiao will result in flood discharges at Lu Kou Chiao as follows:—

Flood	Unregulated Max. Discharge (Cubic Meters per second)	Regulated Max. Discharge (Cubic Meters per second)
1924	4,900	3,040
1929	4,000	2,230
Estimated Maximum	9,800	3,700

With one dam built at Kuan Ting but none at Tai Tze Mu the effect would be that the maximum discharge of the 1929 flood would still remain at about 4,000 cubic meters per second at Lu Kou Chiao.

This dam is estimated at a cost of \$4,440,000.00.

**Reconstruction of Lu Kou Chiao Weir.**—The existing weir at Lu Kou Chiao can discharge from 1,000 to 1,400 cubic meters per second. It is an open weir and will overflow whenever the water level above Lu Kou Chiao is higher than the crest of the weir. It reduces the low water flow in the main channel, yet its maximum capacity is restricted only in one direction, that is, the head over the weir. To make the weir a more effective structure for flood diversion, it shall be reconstructed as a regulator with gates to regulate the flow. Fourteen openings of 8.2 meters each will be provided, the sills lowered about 3 meters below the present weir crest. This regulator will be operated by electric power. When the flood flow reaches 1,150 cubic meters per second, ten gates shall be raised until the flow is over 2,200 cubic meters per second, then the remaining gates shall be opened. The maximum regulated flood flow above Lu Kou Chiao is estimated to be 3,700 cubic meters per second, of which 2,200 cubic meters per second will go to the main channel and 1,500 cubic meters per second will be diverted through the regulator to the Hsiao Ching Ho and thence to the Ta Ching Ho. The damages thus possibly to be done to the lands along the last named two rivers will be comparatively lighter than they are under the present circumstances (i.e. without a regulator), because the amount of water discharged through the regulator will consist of only the peak in times of flood.

The cost of this work is estimated at \$450,000.00.

**Repairs to the Chin Men Cha.**—The Chin Men Cha or Golden Gate Weir is comparatively in good condition except that its apron was partly destroyed. It was provided with gate openings, but no

sign of gates can now be seen. The repair work will be limited to the provision of new gates and the repairing of the apron.

This work will cost about \$50,000.00.

**Regulation of Main Channel.**—The present channel of the Yung Ting Ho is in such a poor condition that during high water many sections of the dykes are subjected to overtopping, and during low water the flow is divided and crooked. This divided and crooked flow is constantly attacking the foot of the dykes, resulting in caving and breaching during floods. To improve the river the dykes shall be repaired and wherever necessary raised 1 meter above the highest flood level estimated and the crooked channel shall be changed to straight stretches and gentle curves, the radius of which shall not be less than 2,000 meters. This will be accomplished by cut-offs (leading channels only) and building low water spur dykes. Concave banks shall be protected either by low water spurs or by revetment of concrete and riprap. The channel in the San Chiao Tien (Delta) shall be regulated by building new dykes with suitable provision of culverts for discharge of water and disposal of silt.

This channel regulation work will cost about \$3,200,000.00.

**Contraction of Main Channel.**—Some portions of the channel are too wide. Shallow water hastens the deposition of silt and results in frequent shift and division of low water course. Considerable area of cultivable land has been rendered useless. The river channel shall therefore be contracted to such a width that further raising of bed shall be prevented. The contraction shall be done by building permeable spur dykes, or earth spur dykes protected with riprap, or closing dykes, or willow banks as circumstances may justify.

The estimated cost of this channel contraction work is \$3,300,000.00 approximately.

**Improvement of Outlet.**—The work for the improvement of the Yung Ting Ho outlet which was undertaken by the Hai Ho Improvement Commission consisted mainly of the construction of a regulator and a boat lock across the Pei Yun Ho, a sluice to the leading channel, a leading channel to the settling basin, an outlet sluice and an outlet channel. The flood water finally goes to the Chin Chung Ho and thence to the Chi Yun Ho. A part of this water, being clear and siltless, will be led back to the Hai Ho for scouring the existing bed, thus making it deeper and navigable by larger boats. The scheme is, in general, satisfactory, except that it was based on the flood condition of 1922, with the consideration that floods similar to those of 1924 and 1929 would cause breaches in the dykes above

Shuang Ying, and would not affect the scheme. To conform the resulted flow with this radical scheme the new channel dyke shall be partly raised and the section of the Pei Yun Ho above the regulator shall be dredged so as to provide capacities of 800 and 1,200 cubic meters per second respectively. The section of the Chin Chung Ho above and below the Ching Lung Wan Ho mouth shall also be dredged to a capacity of 300 and 500 cubic meters per second respectively. A regulator shall be built at the junction of the Lung Feng Ho and the Pei Yun Ho in order to prevent the back water from overflowing the lowlands of the Lung Feng Ho valley.

The settling basin provided at present would be silted up in 10 or 15 years, should the amount of silt carried downstreams not be checked otherwise. But the life of the settling basin would be limited even if the silt in the river could be reduced to its minimum. Further extension of the settling basin is, however, practicable along the Chin Chung Ho and an estimated life of about 100 years may be attained.

The areas and capacities provided for settling of silt are listed below:—

District	Area up to El. 5 m. T.D. Square Kilometers	Capacity Million Cubic Meters
North of Tah Ho Tien	182	365
(present basin)	96	243
Tah Ho Tien	196	421
Kuang Erh Kang	40	560
South of Chin Chung Ho	(up to El. 4.5 m. T.D.)	

The estimated cost of this work for the improvement of outlet is about \$2,220,000.00.

**Check Dams.**—Check dams of from 3 meters to 15 meters high shall be built on the upper tributaries of the Yung Ting Ho in order to reduce the bed slope and hence the velocity, thereby also diminishing the amount of silt to be carried downstream. Under these circumstances the deposition of silt in the lower course will be much reduced, while the dry regions in the upper valley may be irrigated by the excessive water thus stored due to the existence of the dams. These dams shall be built of loose rocks quarried from nearby mountains. It is planned at present that five dams shall be built on the Yang Ho and its confluents and six on the Sang Kan Ho and its confluents. In case these dams prove satisfactory more dams will be constructed later on.

The cost of the eleven check dams is estimated to be \$1,090,000.00 approximately.

**Silt Depositing Districts.**—Along each dyke of the Yung Ting Ho there is a strip of land about two to three kilometers wide, mostly alkaline, sandy, or swampy in character. Except in a few places, only willows and weeds are the prominent plants that grow. The said land is two to three meters lower than the river bed. In order to dispose of the silt of the Yung Ting Ho and at the same time to improve the adjacent land it is proposed that diversion sluices shall be built along the dykes to divert flood waters thereto. The depth of water on the land shall be limited to one meter and the velocity of water to flow down the land to not more than one centimeter per second. Finally the water diverted from the left dyke will drain to the Feng Ho and thence to the Pei Yun Ho, and that from the right bank to the Chung Ting Ho and thence to the Ta Ching Ho. In course of settling, almost all the silt contained in the diverted water can be deposited and the land gradually raised. The land will dry up before the end of September, enabling the planting of winter wheat, which will increase considerably the value of land. The following list shows the areas and number of sections into which these silt-depositing districts are to be divided:

District	No. of Sections to be divided	Length Kilometers	Av. Width Kilometers	Area Square Kilometers
Left Bank (from Li Fa to Hsiao Chin Fa)	12	65	2.9	189
Right Bank (from Chin Men Chao to Shuang Ying)	8	55	3.2	176

The works for the disposal of silt consist mainly of the construction of diversion sluices, diversion canals and openings, dykes and outlet sluices.

The estimated cost for silt-depositing works will be \$2,240,000.00.

In addition to the figures given above the sum of \$720,000 should be included in the estimate for a construction plant, making a grand total of \$20,668,000.00 approximately (see the Nine-year Plan and the Five-year Plan appended hereto).

The above figures already include 10% for engineering and 20% for contingencies.

### VIII. Benefits to be derived.

The Radical Improvement Scheme for the Yung Ting Ho involves an expenditure of over \$20,000,000.00. According to the present day rate of interest in China the investment should yield an annual profit of \$2,000,000.00. Let us proceed to find out the direct and indirect benefits to be derived from carrying out the above stated scheme, in order to ascertain whether or not this project conforms with economic principles.

(1) The amount of flood water discharged from the Yung Ting Ho to the Ta Ching Ho valley (that is, the right bank of the Yung Ting Ho) was 1,300,000,000 cubic meters in 1924 and 1,000,000,000 cubic meters in 1929. Had this scheme been carried out, 673 square kilometers (or 1,100,000 mou) would have been saved from the flood of 1924, and 387 square kilometers (or 630,000 mou) from that of 1929. As such kind of flood may occur once every seven years the average area of land to be saved will, after the completion of this scheme, amount to above 123,000 mou annually. Calculated on a basis of minimum damage, say, 7 dollars per mou, this annual saving of land from inundation will recover \$860,000.00.

(2) Another large area subject to flood is the fertile land within the Yung Ting Ho Delta on account of the small capacity of the channel. This Delta has an area of 600 square kilometers, of which a small part is overflowed yearly, and 90% is flooded once every three years. This scheme will protect the land from being overflowed except by flood much greater than those of 1924 and 1929. Such protection will recover nearly \$1,000,000.00 annually.

(3) As dyke-breach occurs once every six or seven years, the expenditure required for its closure is enormous. It was recorded that \$3,400,000.00 had been spent between 1912 and 1932 or \$170,000.00 per year for the aforesaid purpose. This expenditure might be entirely eliminated after the completion of this scheme.

It will be seen that the direct benefits to be derived from protecting the vast area of land along the river from periodic floods, as stated in the above three items alone, will amount to something over \$2,000,000.00 a year, disregarding such amounts of money as may be involved in famine relief work and in the loss of life and property due to occasional floods.

Other benefits to be obtained after this radical improvement scheme is carried out may be enumerated as follows:—

(1) The present swampy and sandy land within the dykes of the Yung Ting Ho, amounting to 127,000 mou, may be reclaimed for agriculture with a suitable amount of silt deposited therein after

the river channel is regulated according to this scheme. Taking a minimum increment of land value of \$10.00 per mou, a sum of \$1,270,000.00 will be added to the wealth of the country.

(2) The silt depositing districts along both banks of the Yung Ting Ho occupy strips of land to the extent of 590,000 mou, which are alkaline and sandy and of very little value. After the land is improved by the deposition of silt autumn wheat may be planted with good prospect of a plentiful harvest. Assuming a minimum increase of land value of \$10.00 per mou as in the previous case, we may have an additional direct benefit of \$5,900,000.00.

(3) The Lung Feng Ho valley, which is flooded almost nine out of ten years, will also be benefited by reducing the flood in volume as well as in duration. After completing this scheme the land will, except during times of maximum flood, become dry before the end of September. This covers an area of 130 square kilometers (210,000 mou), if the land elevation is taken at 7.5 meters or lower. Considering an increase in value of \$5.00 per mou a sum of \$1,050,000.00 will be effected.

The total amount of the benefits from the above three items will be \$8,220,000.00 approximately.

Most of the adjacent lands of the outlet channel which have been allotted to future settling basins are at present alkaline and sandy. An area of 180 square kilometers (300,000 mou) in the first section and of 670 square kilometers (1,100,000 mou) in the other four sections will finally become fertile farm-land for raising crops. The profit thus derived will amount to \$14,000,000.00 if the increment of land value is taken at \$10.00 per mou. This part of the scheme, however, is not included in the estimate, as a part of the work has been done by the Hai Ho Improvement Commission while the extension work will not be started until ten or fifteen years later,

The first evident indirect benefit to be derived from this Radical Improvement Scheme is the improvement of the navigability of the Hai Ho. After the navigable channel becomes deeper, freight transportation will be greatly increased. This indirect benefit can hardly be expressed in figures. According to the 1929 Report of the Hai Ho Conservancy Commission, the number of vessels with draught of over 13 feet passing over the Taku Bar and arriving at the Tientsin Bund during the two years, 1925 and 1926, averaged about 1,000 and that of vessels with draught of below 13 feet was about 630, giving the highest record for the port of Tientsin. From 1927 on the Hai Ho has gradually become silted, resulting in only 688 vessels of below 13 feet draught coming to Tientsin in 1928 and only

544 vessels of below 13 feet draught coming to Tientsin in 1929 (including 6 vessels with a maximum draught of 13 feet). The silting condition of the Hai Ho certainly has a tremendous effect upon the prosperity of Tientsin. It is, then, evident that the problem of ameliorating the silting of the Hai Ho and its further improvement depends much upon the completion of the proposed scheme. The prosperity of Tientsin as in 1925 and 1926 may, at least, be restored. It is beyond our imagination what a great benefit this scheme will confer.

Again, the solution of the problem of the silting of the Hai Ho, thereby increasing the discharge capacity, will enable its tributaries, viz, the Ta Ching Ho, the Tze Ya Ho and the Nan Yun Ho, to discharge their flood water at a more rapid rate. Although there are no available data to estimate the exact amount of benefit from this source yet it cannot be denied that such benefit can only be derived after the carrying out of this scheme.

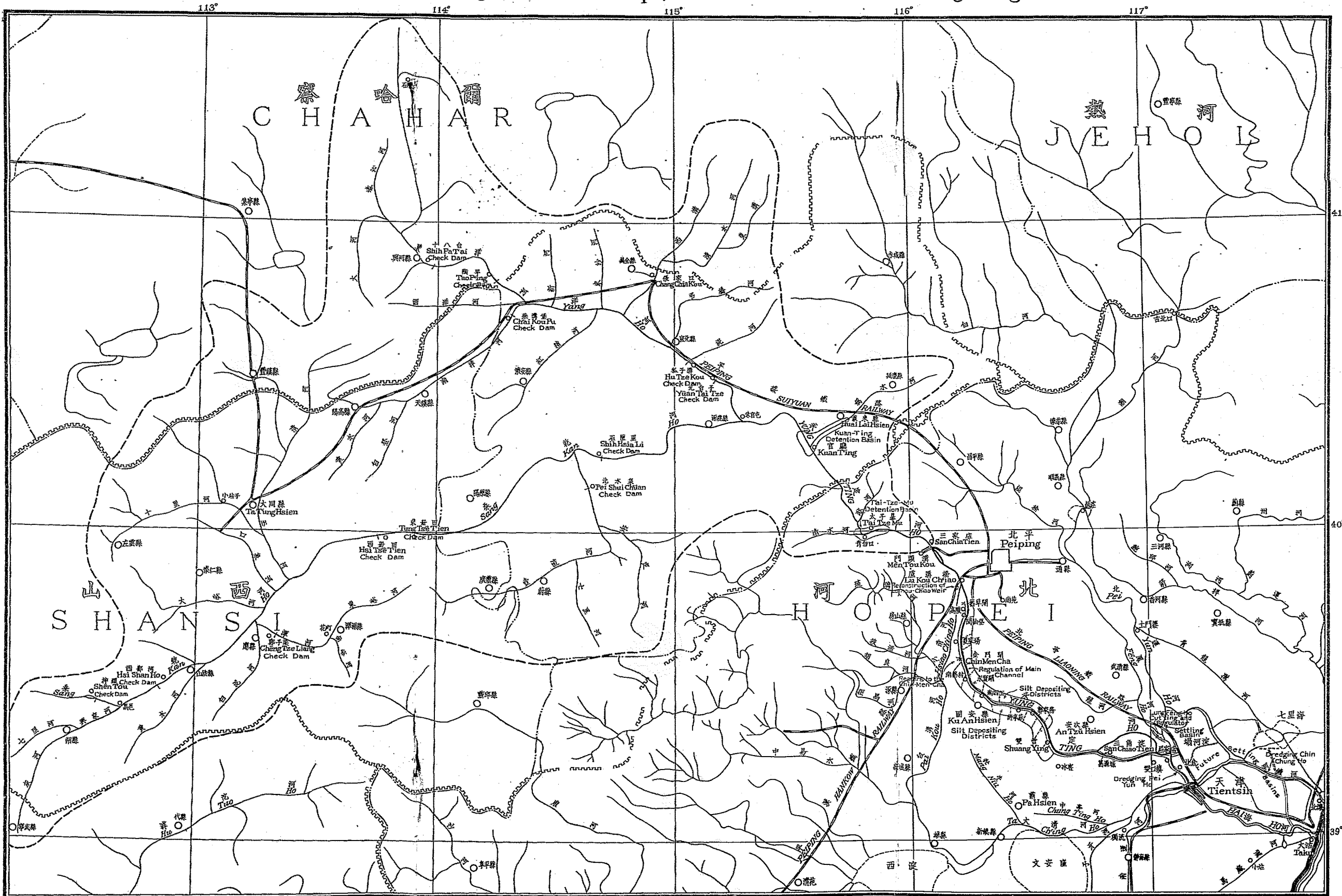
Finally, let us consider the check dams to be built upstream. The main object is, as aforesaid, to reduce the bed slope and hence the velocity, thus preventing the silt from being carried down. But the greatest facilities that such constructions will accord at the same time consist in the draining of the sandy, alkaline, and dry lands of the upper regions through which the Yung Ting Ho and its tributaries flow. These lands which are now laid waste will ultimately become fertile and cultivable. The benefit out of reclaiming these lands may be expressed in terms of dollars and cents when surveying work is completed.

To sum up, although it seems that the Radical Improvement Scheme for the Yung Ting Ho involves large expenditure the direct and indirect benefits to be derived therefrom are too enormous and will far exceed the amount invested. During the present time when public construction program in China is just in its beginning, such an undertaking as the Yung Ting Ho Improvement Scheme should be the first to be considered, even if foreign capitalists are to be invited to invest their monies therein.



# 永定河治本計畫總圖

## General Plan showing the Radical Improvement Scheme for the Yung Ting Ho

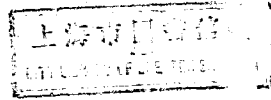


比例尺 百萬分之一 SCALE 1 : 1,000,000  
0 20 40 60 80 100 Kilometers

## APPENDICES

## A. — A Nine-Year Plan

Year	Work to be done	Estimated Amount of cost	Total
First	Acquisition of land and materials for Kuan Ting Detention Basin .....	\$1,000,000	
	Purchase of Construction Plant .....	720,000	
	Dredging the Chin Chung Ho .....	600,000	\$2,320,000
Second	Construction of Kuan Ting Detention Basin .....	900,000	
	Dredging the Chin Chung Ho .....	1,283,000	
	Acquisition of land for Tai Tze Mu Detention Basin .....	196,500	\$2,329,500
Third	Completing the Kuan Ting Detention Basin .....	542,100	
	Construction of Tai Tze Mu Detention Basin .....	1,900,000	\$2,442,100
Fourth	Construction of Tai Tze Mu Detention Basin .....	1,800,000	
	Improvement of Dykes .....	600,000	\$2,400,000
Fifth	Completing the Tai Tze Mu Detention Basin .....	544,700	
	Reconstruction of Lu Kou Chiao Weir and Repairs to Chin Men Cha .....	505,000	
	Improvement of Dykes .....	1,300,000	\$2,349,700
Sixth	Improvement of Dykes .....	1,254,300	
	Dredging the lower part of the Pei Yun Ho and Raising the dykes of the New Channel .....	390,000	
	Construction of Spur Dykes and Permeable Spur Dykes .....	700,000	\$2,344,300
Seventh	Construction of Spur Dykes and Permeable Spur Dykes .....	1,500,000	
	Silt Disposal along the left bank .....	810,000	\$2,310,000
Eighth	Construction of Spur Dykes and Permeable Spur Dykes .....	880,000	
	Construction of Lung Feng Ho Regulator and dredging the Pei Yun Ho .....	619,500	
	Construction of Check Dams Upstream ..	620,600	\$2,120,100
Ninth	Construction of Spur Dykes and Permeable Spur Dykes .....	766,300	
	Construction of Check Dams Upstream ..	472,000	
	Silt Disposal along the right bank .....	814,600	\$2,052,900
Grand Total			\$20,668,600



## B. — A Five-Year Plan

Year	Work to be done	Estimated Amount of cost	Total
First	Construction of Kuan Ting Detention Basin including acquisition of land .....	\$1,600,000	\$4,153,600
	Improvement of Outlet .....	1,833,000	
	Purchase of Construction Plant .....	720,000	
Second	Completing the Kuan Ting Detention Basin.	842,100	\$4,132,100
	Construction of Tai Tze Mu Detention Basin .....	2,400,000	
	Completing Outlet Improvement Work ....	390,000	
	Regulation of River Channel .....	500,000	
Third	Completing the Tai Tze Mu Detention Basin.	2,041,200	\$4,146,200
	Reconstruction of Lu Kou Chiao Weir and Repairs to Chin Men Cha .....	505,000	
	Regulation of River Channel .....	1,600,000	
Fourth	Silt Disposal .....	1,434,100	\$4,144,100
	Regulation of River Channel .....	2,710,000	
Fifth	Check Dams .....	1,092,600	\$4,093,200
	Regulation of River Channel .....	2,190,600	
	Silt Disposal .....	810,000	
Grand Total			\$20,668,600

**THE ABRIDGED REPORT**  
on  
**THE RADICAL IMPROVEMENT SCHEME**  
for  
**THE YUNG TING HO**

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