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The International Joint Commission has submitted to the Governments of Canada and the United States its report and recommendations on remedial works designed to enhance and preserve the beauty of the Niagara Falls and River. The report and recommendations were submitted in response to a Reference to the Commission by the two governments on October 10, 1950, in fulfilment of Article II of the Niagara Treaty, signed and ratified in that year.

The Niagara Treaty of 1950 provides for the use of additional waters of the Niagara River by both countries for the development of electric power. It also provides for the construction by Canada and the United States of remedial works necessary to enhance the beauty of the Falls by distributing the water so as to produce an unbroken crestline on the Falls. Article II of the Treaty provided that "Canada and the United States of America shall request the International Joint Commission to make recommendations as to the nature and design of such remedial works and on the allocation of the task of construction as between Canada and the United States of America. Upon approval by Canada and the United States of America of such recommendations, the construction shall be undertaken pursuant thereto under the supervision of the International Joint Commission and shall be completed within four years after the date upon which Canada and the United States of America shall have approved the said recommendations. The total cost of the works shall be divided equally between Canada and the United States of America".

Upon receipt of the Reference of October 10, 1950, the International Joint Commission established the International Niagara Falls Engineering Board which, assisted by a Working Committee made up of groups in both countries interested in preserving the scenic beauty of Niagara Falls, officials of the Hydro-Electric Power Commission of Ontario, and the United States Army Corps of Engineers, has made extensive studies and model tests of plans intended to carry out the objectives of Article II of the Treaty of 1950. After a study of the Board's report, the International Joint Commission has recommended the building of a control structure with movable sluice gates extending 1,550 feet from the Canadian shore about a mile above the Horseshoe Falls. This structure, together with excavations and other improvements on both flanks of the Horseshoe Falls, is designed to produce an unbroken crestline over the falls on both sides of the international boundary.

The Government of Canada will now take the plans and recommendations of the IJC into consideration in consultation with the Government of Ontario which will be responsible for the construction of the Canadian portion of the works.

INTERNATIONAL JOINT COMMISSION

Report to the Governments of the United States of America and Canada on Remedial Works Necessary to Preserve and Enhance the Scenic Beauty of the Niagara Falls and River

This report to the Governments of the United States of America and Canada, with recommendations, is submitted pursuant to a Reference to this Commission embodied in identical letters dated October 10, 1950, and signed by the Under Secretary of State of the United States and the Acting Secretary of State for External Affairs for Canada. The full text of the Reference is quoted below:

> I have the honour to inform you that the Governments of Canada and the United States of America have agreed to request the International Joint Commission to investigate and make a report containing:
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> (1) Recommendations concerning the nature and design of the remedial works necessary to enhance the beauty of the Falls in the Niagara River by distributing the waters so as to produce an unbroken crestline on the Falls, in accordance with the objectives envisaged in the final report submitted to Canada and the United States of America on December 11, 1929, by the Special International Niagara Board and bearing in mind the provisions for the diversion of the waters of the Niagara River and the apportionment thereof, which have been agreed upon by the two Governments in the Treaty of February 27, 1950, respecting the uses of the waters of the Niagara River.
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> (2) Recommendations concerning the allocation of the task of construction of remedial works as between Canada and the United States of America, having regard to the recommendations made under paragraph (1).
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> (3) An estimate of the costs of such remedial works.
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> In the conduct of its investigations, and otherwise in the performance of its duties under this reference, the International Joint Commission may utilize the services of engineers and other specially qualified personnel of technical agencies of Canada and the United States, and will so far as possible, make use of information and technical data which has been acquired by such technical agencies or which may become available during the course of the investigation, thus avoiding duplication of effort and unnecessary expense.

The Treaty referred to in paragraph (1) of the Reference respecting the uses of the waters of the Niagara River was signed at Washington, D.C. on February 27, 1950, approved by the Canadian Parliament on June 14, 1950, consented to by the United States Senate on August 9, 1950, and put into force by an exchange of ratifications at Ottawa on October 10, 1950.

In the preparation of this report the Commission has been particularly concerned with Articles II to VI inclusive of the Treaty, which read:

ARTICLE II

The United States of America and Canada agree to complete in accordance with the objectives envisaged in the final report submitted to the United States of America and Canada on December 11, 1929, by the Special International Niagara Board, the remedial works which are necessary to enhance the beauty of the Falls by distributing the waters so as to produce an unbroken crestline on the Falls. The United States of America and Canada shall request the International Joint Commission to make recommendations as to the nature and design of such remedial works and the allocation of the task of construction as between the United States of America and Canada. Upon approval by the United States of America and Canada of such recommendations the construction shall be undertaken pursuant thereto under the supervision of the International Joint Commission and shall be completed within four years after the date upon which the United States of America and Canada shall have approved the said recommendations. The total cost of the works shall be divided equally between the United States of America and Canada.

ARTICLE III

The amount of water which shall be available for the purposes included in Articles IV and V of this Treaty shall be the total outflow from Lake Erie to the Welland Canal and the Niagara River (including the Black Rock Canal) less the amount of water used and necessary for domestic and sanitary purposes and for the service of canals for the purposes of navigation. Waters which are being diverted into the natural drainage of the Great Lakes System through the existing Long Lac-Ogoki works shall continue to be governed by the notes exchanged between the Government of the United States of America and the Government of Canada at Washington on October 14 and 31 and November 7, 1940, and shall not be included in the waters allocated under the provisions of this Treaty.

ARTICLE IV

In order to reserve sufficient amounts of water in the Niagara River for scenic purposes, no diversions of the water specified in Article III of this Treaty shall be made for power purposes which will reduce the flow over Niagara Falls to less than one hundred thousand cubic feet per second each day between the hours of eight a.m., E.S.T., and ten p.m., E.S.T., during the period of each year beginning April 1 and ending September 15, both dates inclusive, or to less than one hundred thousand cubic feet per second each day between the hours of eight a.m., E.S.T., and eight p.m., E.S.T. during the period of each year beginning September 16 and ending October 31, both dates inclusive, or to less than fifty thousand cubic feet per second at any other time; the minimum rate of fifty thousand cubic feet per second to be increased when additional

water is required for flushing ice above the Falls or through the rapids below the Falls. No diversion of the amounts of water, specified in this Article to flow over the Falls, shall be made for power purposes between the Falls and Lake Ontario.

ARTICLE V

All water specified in Article III of this Treaty in excess of water reserved for scenic purposes in Article IV may be diverted for power purposes.

ARTICLE VI

The waters made available for power purposes by the provisions of this Treaty shall be divided equally between the United States of America and Canada.

International Niagara Falls Engineering Board.

Upon receipt of the Reference the Commission created the International Niagara Falls Engineering Board, composed of Engineers drawn from the technical agencies of Canada and the United States, and directed it to make the necessary investigation of the Niagara Falls and River, and thereafter prepare a report setting forth the Board's findings and recommendations. The Board was directed to include in its report preliminary designs of the recommended remedial works, an estimate of the cost of such works and recommendations concerning the allocation of tasks of construction of the remedial works as between Canada and the United States. The Board's report, dated 1 March 1953, is attached hereto and constitutes a part of the Commission's report to the two Governments.

Description of the Niagara Falls Area

The Niagara River, about 36 miles in length, connects Lake Eric and Lake Ontario. The river carries the outflow from the four upper lakes of the Great Lakes system averaging about 200,000 cubic feet per second. The fall from lake to lake is 326 feet, about half of which is concentrated at Niagara Falls, 21.6 miles below the head of the River.

In the 1-mile reach immediately above the Falls, the river drops about 50 feet through cascades and rapids. Goat Island divides the river into two parts, the larger leading to the Horseshoe Falls on the Canadian side and the smaller to the American Falls.

The distance from shore to shore at Horseshoe Falls in 1200 feet but the total length of crest around the "horseshoe" is 2500 feet. The central portion of the crest has been receding faster than the flanks, with the result that in the last 100 years the crest length has increased about 100 feet. The depth of water flowing over the crest near each shore is less than one foot and this portion of the falling sheet of water usually appears white. Toward the center of the Horseshoe the crest depth increases to a maximum of 12 feet and the falling sheet of water has a darker, greenish appearance.

The American Falls has a relatively low flow distributed quite evenly along its 1100 feet of crest and has receded very slowly as compared with the Horseshoe Falls.

Nature and Extent of the Problem

The vast storage capacity of the upper Great Lakes results in an unusually uniform flow in the Niagara. This flow and the concentration of fall at Niagara have created a scenic spectacle of unusual beauty and a hydroelectric power resource of great value. Both Canada and the United States have given attention over the years to the preservation and use of these assets.

In the Boundary Waters Treaty of 11 January 1909, the two countries agreed to permit diversion of up to 56,000 cubic feet per second of the Niagara River flow for power purposes. To forestall possible adverse effects on the scenic beauty, a Special International Niagara Board was formed in 1926 to consider the problem. The Board recommended early construction of an initial phase of remedial works and outlined the further measures to be considered for preservation of the beauty of the falls under conditions which would permit more complete utilization of the hydroelectric potential.

With the growing need for power for defense activities the Governments of Canada and the United States concluded agreements in 1940 and 1941 to utilize on a temporary basis an additional 26,500 c.f.s. of Niagara Flow for power purposes. Pursuant to these agreements the initial phase of remedial works recommended by the Special International Niagara Board was accomplished by construction of a submerged weir in the Niagara River about one mile above the Horseshoe Falls during the period 1942 to 1947. The weir has substantially compensated for the lowering effect of the power diversions on the Chippawa-Grass Island Pool and has greatly increased the flow over the American Falls; but of course it has not improved the conditions on the flanks of the Horseshoe Falls.

In 1944 and 1948 the earlier agreements were modified to provide for small additional temporary diversions, and discussions which led to the Treaty of February 27, 1950 were commenced. By means of this Treaty the two Governments put into effect a revised permanent schedule of permissible power diversions under which the flow over the Falls may be reduced to not less than 100,000 cubic feet per second during the daylight hours of the tourist season and to not less than 50,000 cubic feet per second at any other time. Analyses and tests by the Board indicated that under these flow conditions the following objectionable conditions would result if remedial works were not provided:

(a) The Chippawa-Grass Island Pool level would drop as much as four feet below its present normal elevation, thereby exposing considerable areas of the river bed presently covered, particularly in the vicinity of the head of Goat Island. The general lowering of this pool would result in some lowering of levels of Lake Erie.

(b) The lowering of the Chippawa-Grass Island Pool level would reduce the flow over the American Falls well below that necessary for a satisfactory scenic spectacle.

(c) Under future maximum permissible diversions the flow over Horseshoe Falls during tourist season days would be concentrated towards the center leaving unsatisfactory conditions at the flanks; and during the non-tourist season and the night hours of the tourist season, the flow over the Horseshoe Falls would be so concentrated near the center of the crest

as to leave the flanks dry.

(d) The necessary change in the Chippawa-Grass Island Pool level to increase the flow over the Falls from 50,000 to 100,000 cubic feet per second and vice versa, would require so much time that only a small part of the extra diversion authorized at night during the tourist season could be used. Moreover, the lowering of the pool would slightly reduce the output of existing power plants.

Objectives

In conducting the studies for this report it was considered imperative that the remedial works be designed to improve the distribution of flow along the crest of the Horseshoe Falls, maintain the present satisfactory conditions at the American Falls, and control the levels of the Chippawa-Grass Island Pool. The maintenance of the present relationship between river flow and pool level is considered essential. Such regulation would preserve the existing conditions and appearance of the Niagara River upstream from the Pool and would insure that Lake Erie levels and corresponding outflows would remain inaffected, thus protecting interests upstream which otherwise might be affected adversely by a general lowering or rapid variation in the pool level. In addition, adequate flow down the American Rapids and over the Falls would be assured. Full advantage could be taken of the additional water available for power diversions in the night hours of the tourist season as well as at all other times. Therefore, it is considered that the remedial works should insure:

(a) A dependable flow of water over the American Falls and in the vicinity of Three Sisters Islands, approximating the satisfactory flow under existing conditions;

(b) A dependable adequate flow over both flanks of the Horseshoe Falls sufficient to provide an unbroken crestline;

(c) Maintenance of the present relationship between the total river flow and the level of the Chippawa-Grass Island Pool; and,

(d) Ability to meet promptly the changes in permissible power diversions while assuring flows of either 50,000 or 100,000 cubic feet per second over the Falls.

Investigation and Study Procedure

As contemplated in the Reference the detailed surveys and studies necessary for the design of remedial works to meet the objectives outlined above were accomplished by calling on the appropriate agencies in both countries. The International Niagara Falls Engineering Board appointed a working committee consisting of representatives of the agencies having regularly assigned responsibilities for the types of work involved. The regular field organizations of the appropriate agencies were asked to perform the various types of surveys and studies needed, thus insuring that the services of specialists available in both countries were utilized on various aspects of the problem as required.

The unusual river conditions at and in the vicinity of Niagara Falls, including high velocities of flow, great turbulence, and the risk that workmen might be swept downstream and over the Falls, made determination of water-surface

elevations, configuration of the riverbed, and hydraulic measurements extremely difficult. Nevertheless, by ingenious methods including use of helicopters, balloons, echo sounders, and search-lights, together with extra precautions with normal surveying equipment, thorough field surveys were made and adequate physical data for the design of the remedial works were obtained as described in the accompanying report of the Board.

The major phase of the engineering studies necessary for design of the remedial works was accomplished by means of hydraulic model studies. In order to cover all aspects of the problem and to utilize fully the available technical forces in both countries, two models were built. One model was constructed by the Corps of Engineers at its Waterways Experiment Station at Vicksburg, Mississippi. This model covered the entire upper Niagara River from Lake Erie to and including the Falls. The other model was constructed by the Hydro-Electric Power Commission of Ontario at Islington, near Toronto. This model was built to cover at the largest practicable scale the Falls proper and the cascades and pool area immediately above the Falls.

By use of the two models, complementary in coverage and providing a means of checking various tests, the full range of river conditions and numerous possible variations of remedial works were analysed and tested. The Commission is convinced that use of this important engineering tool made possible the design of the remedial works in a minimum of time and with maximum assurance of their adequacy.

As the model tests and design of remedial works neared completion, the Commission invited representatives of parks commissions and other interested agencies in both Canada and the United States to witness tests at the Islington model under typical conditions to be expected with and without the proposed remedial works. As a result of these demonstrations, representatives of these interests in general expressed their concurrence in the proposals for remedial works to preserve and enhance the scenic beauty of the Falls.

Recommended Plan of Remedial Works

The recommended plan of remedial works was developed as described in Section V of the Board's report. The complete plan consists of three separate works which, in the opinion of the Board, are necessary to ensure that the terms and intent of the 1950 Treaty will be fully met:

(a) A Chippawa-Grass Island Pool control structure.

(b) An excavation in the Horseshoe Cascades lying immediately upstream from the Canadian flank, and a crest fill 100 feet long on the Canadian flank extending out from the shore.

(c) An excavation in the Horseshoe Cascades lying immediately upstream from the Goat Island flank, and a crest fill 300 feet long on that flank extending out from the shore.

The location of the Chippawa-Grass Island Pool structure is shown in general on Plate 3 and in detail on Plate 6 of the Board's report. The structure would extend out from the Canadian shore some 1,500 feet into the river on

a line parellel with the present submerged weir and 200 to 250 feet downstream therefrom. With the exception of an approach fill adjacent to the Canadian shore, the structure would consist entirely of piers and movable control gates.

The excavation in the Horseshoe Cascades in the area upstream from the Canadian flank will tap the deep stream that flows down the Canadian side of the Cascades and divert flow to the Canadian flank in quantities adequate to cover the flank and preserve the spectacle under all future conditions. The extent and grade of the excavation are shown in detail on Plate 7, the estimated quantity involved being some 64,000 cubic yards of rock. As shown on Plate 7, the crest fill of 100 feet on the Canadian flank adjacent to the Canadian shore would extend upstream about 100 feet where it would merge with the present shore line. It is contemplated that a concrete retaining wall, faced with stone to blend into the surroundings, would enclose this fill. Inside the wall, fill would be placed to the grade of the adjacent improved park area, and the whole landscaped to provide an attractive area for viewing the Cascades and Falls at close range.

The excavation in the Horseshoe Cascades on the Goat Island flank will divert an adequate volume of flow over that flank under all future conditions in a manner similar to that on the Canadian side. The extent and grade of this excavation is shown in detail on Plate 7, the estimated quantity involved being 24,000 cubic yards of rock. The 300 foot crest fill adjoining Goat Island would merge with the existing shore line about 300 feet upstream. The extent of this fill is shown in detail on Plate 7. A concrete retaining wall suitably faced with rock would surround the fill which would be so graded as to be accessible from Goat Island. This area, suitably landscaped, would provide a much needed vantage point from which to view the Cascades and Falls. This fill is very similar to an improvement which it is understood has been under consideration by the Niagara Frontier State Park Commission.

Results to be Expected from Remedial Works

From the exhaustive and comprehensive series of engineering studies and model tests carried out on the proposed plan of remedial works at both Vicksburg and Islington, the Commission is confident that the proposed plan would fulfill the terms and intent of the 1950 Treaty. By operation of the gates in the proposed Chippawa-Grass Island Pool control structure, the same pool level would be maintained in the future, under power diversions permitted by the 1950 Treaty, as would result from conditions above Niagara Falls since the completion in 1947 of the existing submerged weir, and under present power diversions. Such regulation would preserve the regimen of the River in the Chippawa-Grass Island Pool and upstream thereof and would insure that Lake Erie levels and outflows would remain unaffected. Such regulation also would maintain sufficient flow over the American Falls to preserve the present satisfactory appearance which has prevailed since completion of the existing submerged weir in 1947. Adequate and scenically satisfactory flow conditions would exist at the head of Goat Island and in the vicinity of the Three Sisters Islands.

The design of the control structure is such that a total flow over the Falls of either 50,000 or 100,000 cubic feet per second as specified in the 1950 Treaty may be produced expeditiously at any time through the full range of Chippawa-Grass Island Pool levels without affecting the level of the

Pool, thereby making available for power purposes the maximum amount of water. The control structure sluices equipped with gates which lower to open can be expected to pass low and normal runs of ice while maintaining proposed pool levels, but in the event of an unusually heavy ice run, it is envisaged that all sluices would remain fully open during the run to minimize any obstruction to the floes. During such periods, which are usually of short duration, the normal regulation of the Pool would be suspended as the safe passage of ice is the more important consideration.

The proposed plan of excavations and crest fills in the Horseshoe Falls Cascades would ensure that in the daytime of the tourist season, when a minimum of 100,000 cubic feet per second is to be discharged over the Falls, an unbroken crestline on the Horseshoe Falls would extend from shore to shore and the intensity of flows on the flanks would always be sufficient to produce a very satisfactory scenic spectacle. In the other periods of the year, when a flow over the Falls as low as 50,000 cubic feet per second is permitted by the 1950 Treaty, these works would ensure that an unbroken crestline would always exist, and that the intensity of flow would be such that an impressive spectacle would result. The increasing of the flow over the flanks of the Horseshoe Falls by the diversion of water from the deep channels leading into the central portion of the Horseshoe will reduce the rate of recession in the central portion.

Conclusions

(a) Engineering studies and model tests show conclusively that remedial works are required to prevent impairment of the scenic beauty of Niagara Falls and River under flow conditions to be expected when withdrawals are made for power purposes to the extent permissible under the Treaty of February 27, 1950.

(b) Hydroelectric power works already under construction and scheduled for completion and operation within the next few years could not be fully utilized without detrimental effects on the beauty of the Falls unless remedial works are provided.

(c) In view of the urgent need for the power to be produced by generating facilities already under construction and other facilities to be constructed, initiation as soon as possible this year and completion within four years, of the remedial works authorized by the 1950 Treaty is a matter of urgency in the national interest of both countries.

The objectives for preservation and enhancement of Niagara Falls as contemplated by the 1950 Treaty can best be accomplished by construction of the remedial works described in this report and hereinafter recommended.

Recommendations

In response to specific requests of the two Governments as set forth in the Reference, the Commission submits the following recommendations:

1. Recommendations concerning the nature and design of the remedial works necessary to preserve and enhance the scenic beauty of the Niagara Falls and River.

The Commission recommends the construction of the remedial works described in this report and in the Board's report which is attached hereto and made a part hereof, with such minor modifications as the Commission may deem advisable at the time of construction, the works to include:

(a) A Chippawa-Grass Island Pool control structure, extending out from the Canadian shore approximately 1550 feet into the Niagara River, parallel to the existing submerged weir and about 225 feet downstream therefrom;

(b) An excavation in the Horseshoe Cascades lying immediately upstream from the Canadian flank of the Horseshoe Falls and a crest fill on that flank about 100 feet long; and,

(c) An excavation in the Horseshoe Cascades lying immediately upstream from the Goat Island flank of the Horseshoe Falls and a crest fill on that flank about 300 feet long.

2. Recommendations concerning the allocation of the task of construction of the remedial works as between Canada and the United States of America.

The Commission recommends that the task of construction be divided between the two countries in such manner that each country would construct, generally, those portions of the works which lie within its national boundaries. On this basis, Canada would construct the Chippawa-Grass Island Pool control structure and the excavation and crest fill on the Canadian flank of the Horseshoe Falls; and, the United States would construct the excavation and crest fill on the Goat Island flank of the Horseshoe Falls, including the small amount of excavation on the Canadian side of the Boundary.

3. The Commission further recommends that the construction of the proposed remedial works be initiated at the earliest possible moment and be pressed to completion as rapidly as possible. It is especially important that construction of the Chippawa-Grass Island Pool control structure be commenced immediately and that it be constructed to its ultimate length of approximately 1550 feet unless during the course of construction the status of prospective additional power diversion should permit consideration of a shorter structure initially. The excavation and fill on either flank of the Horseshoe Falls should be started as soon as possible and substantially completed before work is begun on the excavation and fill on the other flank in order to minimize temporary adverse effects on the scenic spectacle during the construction period.

4. The Commission also recommends that the two Governments authorize it to establish a Control Board to supervise the operation of the proposed control structure to insure accomplishment of its intended purposes and to insure that the levels of the Niagara River and Lake Erie will not be adversely affected. These functions, deemed properly within the purview of the Commission, are closely related to the function of determining the amount of water available for the purposes of the Treaty of February 27, 1950. Accordingly, it would seem desirable and in the public interest that the representatives of the United States and Canada to be designated pursuant to Article VII of the Treaty be appointed by the Commission to serve also as members of the Control Board which the Commission desires to establish and hold responsible for the operation of the Chippawa-Grass Island Pool control structure.

Cost Estimates

The construction cost of the remedial works (not including the comparatively small amount of pre-construction costs) is estimated to total $17,536,000 at July 1952 construction cost levels. A breakdown of this estimate is shown below:

Chippawa-Grass Island Pool Control Structure, 1550 Feet Long	$14,594,000
Excavation and Fill in the Cascades on the Canadian Flank of the Horseshoe Falls	1,582,000
Excavation and Fill in the Cascades on the Goat Island Flank of the Horseshoe Falls	1,360,000
Total	$17,536,000
Estimated Annual Cost of Operation and Maintenance of the Remedial Works	$100,000

Certain preliminary costs have been incurred under the terms of the Reference for surveys of the Niagara River between Lake Erie and the Falls and for other field investigations; also for two hydraulic models simulating the Niagara River above the Falls, one at Islington, Ontario, and the other at Vicksburg, Mississippi, and for much experimental work accomplished by the use of these models in connection with the design of the remedial works hereinbefore recommended; and for office studies and other activities incidental to determination of the most suitable types of remedial works. Inasmuch, however, as a part of this preliminary cost, particularly the costs incurred in connection with the hydraulic models, is chargeable to power development in both Canada and the United States, the duty of segregating the part thereof properly chargeable to remedial works, and determining the Canadian and United States costs properly chargeable thereto, is a duty which now devolves upon the Commission.

As soon as cost data and other essential information are available in sufficient detail, a supplemental report on costs incurred through March 31, 1953, for remedial works will be submitted to the two Governments. On the basis of incomplete information now available, it appears that such costs might aggregate about 2½ per cent of the estimated construction cost.

Division of Costs

Under the provisions of Article II of the Treaty the cost of the remedial works and the expense of operating and maintaining them are to be borne by the United States and Canada in equal moieties.

Signed this fifth day of May, 1953.