IDO-10073

PREPARED FOR THE

CITY OF IDAHO FALLS
IDAHO FALL, IDAHO

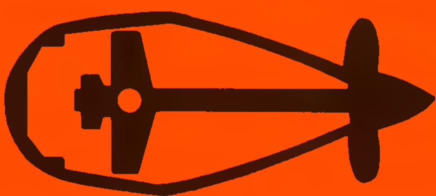
AND THE

DEPARTMENT OF ENERGY

MASTER

# PRELIMINARY REPORT

FEBRUARY 1978



# IDAHO FALLS

## CITY HYDROELECTRIC POWER PLANT

INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161
Price: Printed Copy $7.25; Microfiche $3.00

IDO-10073

Distributed Under Category:
UC-97e
Hydroelectric Power Generation
TID-4500, R66

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FEBRUARY 1978



# IDAHO FALLS
## CITY HYDROELECTRIC POWER PLANT



**INTERNATIONAL ENGINEERING COMPANY, INC.**
**A MORRISON-KNUDSEN COMPANY**

CONSULTING
ENGINEERS

950 4658

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R.B. CHRISTENSEN, P.E.
VICE PRESIDENT

August 31, 1977

Mr. S. Eddie Pedersen, Mayor
and City Council Members
City of Idaho Falls
P. O. Box 220
Idaho Falls, Idaho 83401

Gentlemen:

We are pleased to present this report on feasibility studies for the City Hydroelectric Power Plant. Presented in the report are the results of studies of four alternatives, an environmental evaluation of the site, and a recommended plan for redevelopment of the site. We conclude that installation of one 7200-kW bulb turbine-generator is technically and economically feasible and the most attractive of the alternatives investigated. Furthermore, since the City Power Plant is part of an overall three-plant project, we recommend installing three identical units of 7200 kW, one at each site.

We wish to express our appreciation for the excellent cooperation and assistance extended during the studies to our Project Manager, Pablo Chavez, by Electric Division Director Steve Harrison and Chief Engineer J. S. Paine.

We appreciate the opportunity we have had to assist you in bringing the project to this stage of completion. We are ready to assist you in detailed design, if you so desire.

Very truly yours,

R. B. Christensen

RBC:cc

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# EXECUTIVE SUMMARY

This report presents the results of a feasibility study to determine the most suitable plan for redeveloping the hydroelectric potential of the Snake River streamflows at the Idaho Falls City Power Plant site. This study is part of an overall feasibility investigation to upgrade all three of the City's hydroelectric plants. Under a contract signed in 1976, IECO performed feasibility studies for the City's other two power plants (the Upper and Lower Power Plants) and in January 1977 submitted a report to the City recommending the installation of one new 7200-kW bulb turbine-generator at each of those plant sites. Turbines of this type are the optimum units for the low-head, run-of-river conditions that prevail at all three Idaho Falls power plant sites.

Replacement of the City Power Plant's four existing generating units, which were installed between 1913 and 1922, has long been necessary because the useful life of these machines is, for all practical purposes, expended. Recently, the replacement of these units with efficient new units capable of utilizing the full streamflows has become a priority item because of the rapidly increasing load growth in the City's service area. In addition, the deterioration of the physical condition of the facilities, especially the concrete structures, makes it necessary to replace them with safe new structures.

The present studies included investigation and comparative evaluation of four alternatives for redeveloping the hydroelectric potential of the streamflows at the City Plant; selection of the most suitable redevelopment alternative; and evaluation of the existing environment and the environmental aspects of the recommended development.

The most viable generating scheme was selected on the basis of studies of installations having one and two bulb turbine-generators and one conventional Kaplan unit. Four alternative powerhouse layouts, to suit these generating schemes, were investigated and are described briefly below:

- Alternative 1 entails demolishing and removing the existing facilities, salvaging any equipment that has salvage value; providing a new diversion weir, trashrack structure, spillway at trashrack structure, powerhouse, spillway at powerhouse, control building, and maintenance shop; installing one new 7200-kW bulb turbine-generator in the new powerhouse; and improving flow conditions in the forebay channel.
- Alternative 2 is the same as Alternative 1, except that two 4000-kW bulb turbine-generators are installed instead of the single 7200-kW unit.
- Alternative 3 is the same as Alternative 1, except that the powerhouse is submerged, and an intake structure is provided instead of the trashrack structure.
- Alternative 4 is the same as Alternative 1, except that a 7200-kW Kaplan turbine is installed instead of the 7200-kW bulb turbine-generator.

Because of the desire to maintain the falls for their scenic value, the average annual energy that can be generated at the site was determined for two different plans of plant operation:

- Under Plan A, the power plant utilizes the full run-of-river flows of the Snake River throughout the year. Flows over the falls occur only when river flows exceed 5200 CFS.
- Under Plan B, the power plant utilizes the run-of-river flows, except during the dry season, when flows through the power plant are reduced to maintain a minimum flow of 850 CFS over the falls. This reduction is not applied during December, January, and February, when the falls are normally frozen and the entire flow is assumed to be available for power generation.

Table S-1 shows pertinent data, including average annual energy, costs, and benefits, for the four alternatives investigated. In selecting the most suitable alternative for redeveloping the City Plant site, Alternative 4 was found to be the least attractive development because its capital, annual, and energy costs are higher and its energy generation, benefits minus costs, and benefit-to-cost ratio are lower than those for any of the other alternatives. Moreover, the relatively high powerhouse profile makes this alternative the least acceptable environmentally.

Alternative 3 is desirable from an environmental standpoint because the submerged powerhouse gives the impression of being an integral part of the falls upstream. However, this advantage is outweighed by the fact that its capital, annual, and energy costs are higher and its energy generation, benefits minus costs, and benefit-to-cost ratio are lower than those for Alternatives 1 and 2.

Alternative 2 provides about 4% more energy and benefits than Alternative 1 (due to its higher installed capacity), and its two units offer greater flexibility of operation than is possible with any of the other alternatives. However, these advantages are outweighed by the fact that its capital, annual, and energy costs are higher and its benefits minus costs and benefit-to-cost ratio are lower than those for Alternative 1.

Alternative 1 is the most attractive alternative investigated, and based on the results of all of the comparative evaluations, it was selected as the recommended development. This development is technically and economically feasible. It will develop about 96% of the power generating potential of the City Plant site, and in comparison with the other three alternatives, it offers the following advantages:

- Lowest initial capital investment.
- Lowest total equivalent annual cost.
- Lowest energy cost (per kilowatt-hour).

TABLE S-1

COMPARISON OF REDEVELOPMENT ALTERNATIVES

| Item | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|---|
| NUMBER AND TYPE OF UNITS | one 7200-kW bulb unit | two 4000-kW bulb units | one 7200-kW bulb unit* | one 7200-kW Kaplan unit |
| AVERAGE ANNUAL ENERGY (kWh)** | | | | |
| Plan A | 53,600,000 | 55,500,000 | 53,600,000 | 53,000,000 |
| Plan B | 48,800,000 | 50,500,000 | 48,800,000 | 48,200,000 |
| COSTS | | | | |
| Capital Cost ($) | | | | |
| Total Construction Cost (including contingencies)*** | 10,625,000 | 11,415,000 | 11,606,000 | 12,648,000 |
| Engineering and Administration | 1,594,000 | 1,712,200 | 1,741,000 | 1,897,000 |
| Interest during Construction | 855,000 | 919,800 | 934,000 | 1,018,000 |
| Total Capital Cost | 13,074,000 | 14,046,000 | 14,281,000 | 15,563,000 |
| Equivalent Annual Cost ($/yr) | | | | |
| Capital Recovery (assuming 50-yr repayment period at 7% interest) | 947,340 | 1,017,770 | 1,034,800 | 1,127,700 |
| Operation and Maintenance | 63,500 | 70,560 | 65,230 | 62,370 |
| Total Equivalent Annual Cost | 1,010,840 | 1,088,330 | 1,100,030 | 1,190,070 |
| Energy Cost ($/kWh) | | | | |
| Plan A | 0.01886 | 0.01961 | 0.02052 | 0.02245 |
| Plan B | 0.02071 | 0.02155 | 0.02254 | 0.02469 |
| BENEFITS**** | | | | |
| Total Annual Benefits ($/yr) | 1,608,000 | 1,665,000 | 1,608,000 | 1,590,000 |
| Total Annual Benefits Minus Total Equivalent Annual Cost ($/yr) | 597,160 | 576,670 | 507,970 | 399,930 |
| Benefit-to-Cost Ratio | 1.591 | 1.530 | 1.462 | 1.336 |

* Submerged powerhouse.
** Under present flow conditions.
*** Includes salvage allowance for existing units.
**** Power benefits are based on plant operation under Plan A and on a value of $0.030/kWh, which was furnished by the Idaho Falls Electric Division.

- Highest benefits minus costs.
- Highest benefit-to-cost ratio.

In addition, the low profile of the powerhouse makes this development very acceptable environmentally, and the layout will strengthen the impression of a continuing green belt and open area along the river. Moreover, Alternative 1 provides a unit of the same size (7200 kW) and type (bulb turbine-generator) as previously recommended for installation at the Idaho Falls Upper and Lower Power Plants. This is an important consideration, since the City Power Plant is part of a three-plant hydroelectric project. The similarity of the three plants will result in: lower engineering costs (because of the similarity of the mechanical and electrical design aspects); lower procurement costs (because the three identical bulb turbine-generators can be obtained from a single supplier under a single contract); simpler installation (because construction personnel will be able to apply experience gained in installing the first unit to expedite installation of the other two units); and lower operation and maintenance costs (because personnel will become familiar with the operation and maintenance of the one plant type).

Therefore, IECO recommends that the Idaho Falls Electric Division proceed immediately with the following steps, which are necessary for implementation of the recommended developments at all three sites:

- Arrange for project financing (issue revenue bonds).
- Proceed with preparation of the bulb turbine-generator contract drawings and specifications.
- Proceed with preparation of final design contract drawings and specifications for construction of the recommended developments.
- Obtain the necessary permits and licenses from the appropriate local, State and Federal agencies (including the Idaho Department of Water Resources, the U.S. Army Corps of Engineers, and the Federal Power Commission) for construction of the project.[1]

---

(1) Preparation of the Federal Power Commission licensing application is underway.

# CHAPTER 1

# INTRODUCTION

# CHAPTER 1
# INTRODUCTION

## 1.1 PURPOSE

The City of Idaho Falls is currently experiencing rapid load growth in its power service area, as a result of significant population increases and increasing commercial development in the area. Most of the energy required by the City is purchased from Bonneville Power Administration. Energy deficits are anticipated, starting in 1983, because of Bonneville Power Administration's forecasted inability to provide energy for load growth beyond that date.

The City operates three hydroelectric stations and until about 1950 was self-sufficient in energy. At the present time, these three stations generate only about 5% of the City's energy needs. Upgrading of the three stations is overdue, since the useful life of the machines is almost expended and because the physical condition of the plants has deteriorated.

This study concerns one of the City's three hydroelectric stations: the City Power Plant, located on the Snake River at Idaho Falls. The City Plant has four units, installed between 1913 and 1920, with a total rated capacity of 2000 kW. At present, three machines are operational, and one machine is down. Deterioration of the physical condition of the plant has been evident for several years, and replacement of the facilities is now necessary for reasons of safety, efficiency, and the need to supply additional energy to meet forecasted load growth.

This report has been prepared to assist the City of Idaho Falls in redeveloping the hydroelectric potential of the City Plant. It appraises the condition of the existing facilities, analyzes the power potential of the site, evaluates the main redevelopment alternatives, recommends a plan for redevelopment of the site, and presents the results of an environmental evaluation of the site.

## 1.2 AUTHORITY

The engineering services were authorized under an agreement, dated February 2, 1977, between International Engineering Company, Inc. (IECO), San Francisco, California, and the City of Idaho Falls, Idaho.

## 1.3 SCOPE

The specific scope of engineering services is outlined in Appendix A of the above-mentioned agreement, a copy of which is included in Appendix E of this report. In general, the services comprise feasibility studies to determine the best plan for redeveloping the hydroelectric potential of the City Power Plant site, taking into account salvage of existing equipment and the environment of the site.

## 1.4 PRIOR STUDIES

In January 1977 IECO submitted a preliminary report to the Electric Division recommending a plan for redevelopment of the City's Upper and Lower Power Plants. Data contained in that report have been used in the present study.

## 1.5 ACKNOWLEDGMENTS

Grateful acknowledgment is made of the excellent cooperation and assistance provided by personnel of the Idaho Falls Electric Division.

# CHAPTER 2

# EXISTING FACILITIES

# CHAPTER 2
# EXISTING FACILITIES

This chapter describes briefly the existing hydroelectric facilities at Idaho Falls City Power Plant and appraises their present condition, with particular attention to the condition of the concrete structures. The descriptions and evaluations are based on information obtained in discussions with Idaho Falls Electric Division personnel and on observations made during two separate visits to Idaho Falls in March and April 1977.

## 2.1 DESCRIPTION OF FACILITIES

The City Power Plant is located on the east bank of the Snake River, about 550 feet south of Broadway Bridge, Idaho Falls' main east-west thoroughfare. Existing facilities at the site include a diversion weir, powerhouse, dispatch center, switchhouse, maintenance shop, switchyard, and a new Electric Division building. These facilities are located as shown on Exhibit A-4. The diversion weir and powerhouse are described below, and photographs of these structures are included at the end of this chapter.

### A. Diversion Weir, Intake Structure, and Forebay

The diversion weir, a concrete overflow structure that diverts river flows to the power plant for power generation, consists of two sections, connected by a pier of Broadway Bridge. One section extends from the upstream face of the bridge pier to the west bank of the river, about 1800 feet upstream. This section is located along the natural cataract that forms the scenic Idaho Falls. A gated intake structure on the upstream side of the bridge controls flows to the power plant. The other section of the weir extends from the downstream face of the bridge pier to a small island (the site of Pedersen's Sportsman's Park), about 100 feet downstream. Between the bridge and the powerhouse, the forebay channel is irregular in shape and ranges from 70 to 100 feet in width. The invert elevation ranges from El. 4689 under the bridge to El. 4674 halfway between there and the powerhouse.

B. Powerhouse

The powerhouse contains four open-flume, vertical-shaft, fixed-blade propeller-type turbines. Pertinent data for these four units are tabulated below:

| Unit No. | Nameplate Rating kVA | kW | rpm | Generator Volts | Year Installed | Present Condition |
|---|---|---|---|---|---|---|
| 1 | 400 | 400 | 120 | 2300 | 1913 | Operating |
| 2 | 625 | 500 | 150 | 2300 | 1922 | Operating |
| 3 | 625 | 500 | 150 | 2300 | 1922 | Inoperable |
| 4 | 750 | 600 | 150 | 2300 | 1919 | Operating |

The combined discharge capacity of the turbines is about 1750 CFS.

According to information provided by the Electric Division, normal operations are as follows:

| | |
|---|---|
| Normal headwater elevation | 4694.18 feet |
| Normal tailwater elevation | 4675.68 feet |
| Static head | 18.50 feet |

Access to the powerhouse is provided by a 300-foot-long, paved service road from Capital Avenue. This road parallels a railroad spur, which divides the area and, in effect, separates the powerhouse from the forebay and the diversion weir upstream.

## 2.2 APPRAISAL OF CONDITION

A. Concrete Structures

Most of the exposed concrete in the powerhouse, the overflow weir, and the gated intake structure has deteriorated, and the structures are in need of replacement. The deterioration is the result of the combined effects of freezing and thawing and alkali-aggregate reactivity.[1] Unexposed concrete (inside the powerhouse) appears to be in much better condition. The condition of the inside floor and the concrete around the turbines looks satisfactory. Typical conditions at different places are noted below, and selected photos are presented on pages 2-7 through 2-10.

- The concrete in the overflow weir is in an advanced stage of deterioration. Longitudinal cracking along the crest and the downstream unrestrained surface is undoubtedly due to alkali-aggregate reactivity. The action of freezing and thawing has accelerated the disintegration.

- Water seepage through the weir occurs in numerous places. Large fissures of erosion are evident along the length of the weir. These fissures are probably due to reactivity, poor construction joints, poor concrete originally, and other causes.

- On the downstream side of the weir, at the upstream end, there is a large leak, in the form of a boil. This leak should be monitored regularly because it could develop into an unsafe condition.

- The concrete in the intake structure is spalled, and the concrete in the piers that form the gate guides has deteriorated. Considerable leakage occurs around the sides of the gates when they are down.

- A portion of the weir section downstream from Broadway Bridge was partially blasted away, for safety reasons, during the June 1976 flood.

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[1] Alkali-aggregate reactivity refers to a chemical reaction that may occur in concrete between alkalies (sodium and potassium) in the portland cement and certain constituents of the aggregates. Deleterious expansion of the concrete may occur under certain conditions.

- The exposed concrete in the powerhouse has deteriorated to different degrees in different places, similar to the deterioration that has occurred in the exposed concrete in the Upper and Lower Power Plants.

- Major repairs to the concrete of the powerhouse were undertaken about 1969-70. Extensive gunite repairs were performed on large interior and exterior areas of the south and east walls. At present, these surfaces look satisfactory, but it is impossible to tell whether all questionable concrete was removed. Since then, additional deterioration has occurred on the south wall at the waterline, from freezing and thawing.

- The superstructure of the powerhouse is generally satisfactory, but the usual shrinkage cracks are visible.

The concrete in these structures is not salvageable. Rehabilitation would be a major costly procedure and could not be justified economically. When these structures were built, the causes of, and remedies for, concrete deterioration were not known. However, measures to prevent deterioration from freezing and thawing and to minimize alkali-aggregate reactivity are now available and should be used in future concrete structures. These measures include air entrainment, maintaining a low water-cement ratio, and using low-alkali portland cement and pozzolans. Competent inspection to ensure that specification requirements are followed is essential.

B. <u>Forebay Channel</u>

Bedrock is exposed along the east bank, and silt and sand partially cover the west bank of the forebay channel below Broadway Bridge. The flow conditions under Broadway Bridge and in the channel will have to be improved to satisfy the diversion requirements for a new bulb turbine installation. Thus, consideration should be given to removing the high bedrock under the bridge and to shotcreting the rock surfaces in the channel.

## C. Tailrace Channel

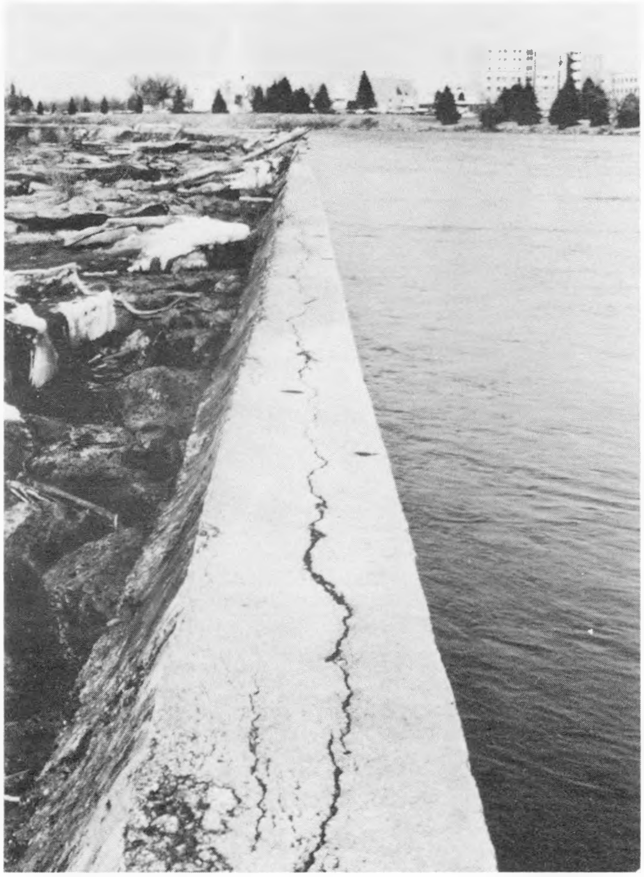
Conditions in the tailrace channel, which extends about 350 feet downstream from the powerhouse to the river, appear to be satisfactory. Excavation for a deeper channel for the bulb turbine installation is not expected to pose any problems. The June 1976 flood apparently undercut the retaining wall on the east bank of the tailrace channel, where it had been placed partially on alluvial fill. The undercut area, which is about 15 feet long and 2 to 15 inches high, extends under the wall about 18 inches. At present there is no sign of instability of this structure, but remedial work should be undertaken to ensure its continued stability.

## D. Operation and Maintenance

The turbines are obsolete. The generators and governors are well maintained, but their useful life is nearly expended. If they continue in service, they will need increasing maintenance.

Operational problems and possible mitigation measures were discussed with Electric Division personnel. During periods of high runoff, the handling of driftwood and other trash reaching the intake structure or the power plant requires considerable attention. Occasionally, a large water-logged tree jams under Broadway Bridge. When this happens, the forebay must be dewatered to allow use of chainsaws to cut the tree up so that it can be removed. In addition, maintenance vehicles frequently occupy one lane of Broadway Bridge, creating a traffic problem, while crews attend to ice and driftwood upstream from the bridge. Consideration should be given to design of a proper trashrack structure and log boom to prevent trees and other large objects from entering the forebay, as well as to mitigation of the traffic problem. Moreover, a suitable trashrack should be provided at the powerhouse to prevent small objects from reaching the unit.

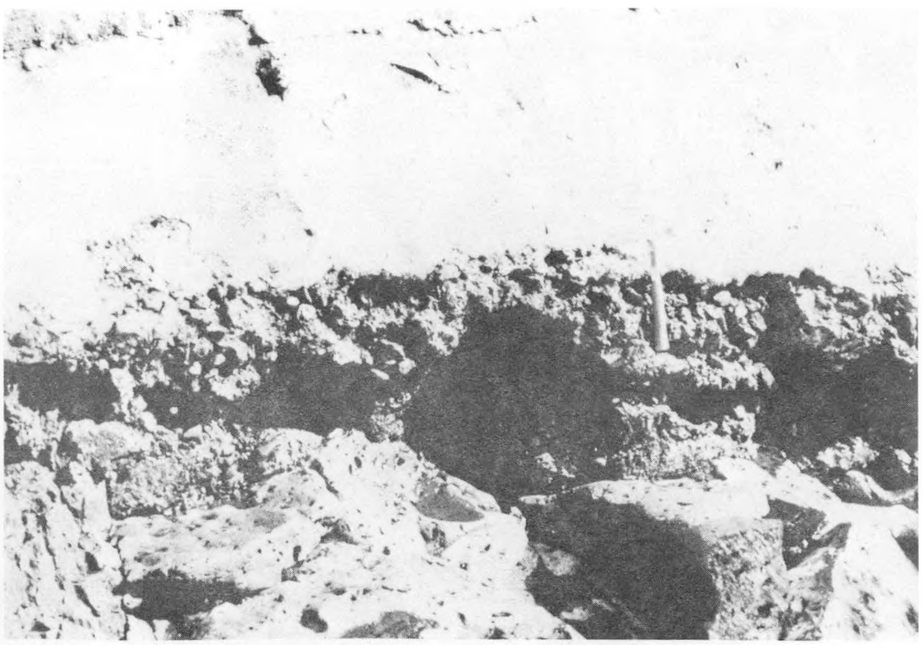
In winter, ice formations frequently adhere to the powerhouse trashracks and gates, hampering flow. Devices for preventing ice formation on the face of the powerhouse trashracks and keeping an area of open water upstream from the trashracks should be installed at the powerhouse. Also needed are means of passing ice floes downstream in the spring, when the ice breaks up. Consideration should be given to the design of suitable gates for sluicing ice floes, driftwood, and other objects.



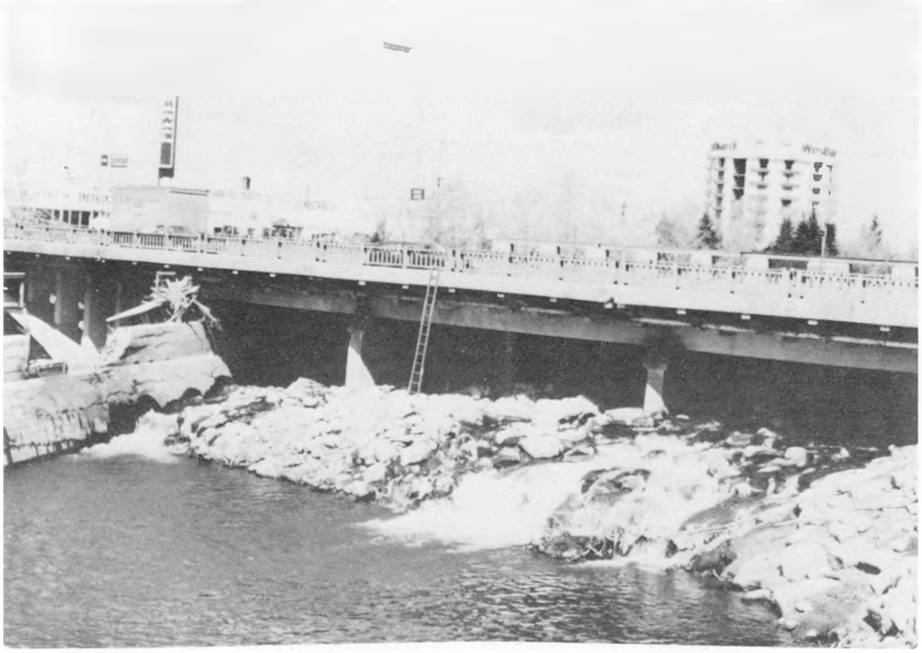
*Overflow weir - Note Longitudinal cracking along crest.*

*Overflow weir - Note longitudinal cracking on downstream unrestrained surface.*

*Seepage through weir - Note boil on downstream side (lower left of photo).*



*Large erosion pockets along length of weir.*



*South side of Broadway Bridge - Note high basalt bedrock under bridge and portion of wall blasted away.*

*Erosion along weir.*

*South side of powerhouse.*

*West side of powerhouse. Water tower and switchyard in background.*

# CHAPTER 3

# PROJECT POWER

CHAPTER 3

PROJECT POWER

This chapter deals with the power and energy that can be generated at the City Power Plant under four redevelopment alternatives, which are described and evaluated in Chapter 4. The following paragraphs summarize the basic data available, the criteria used in sizing the project power facilities, and the results of the power studies.

## 3.1 BASIC DATA

The following basic data were used in evaluating the power potential at the City Power Plant Site:

- Normal operating pool levels for the plant.
- Average monthly flow data for 45 years of record, representing two different flow conditions--present (1975) flow conditions[1] and the flow conditions that will prevail if the Recommended State Water Plan is implemented.
- Cross sections for the river reach between the Lower Plant and the City Plant (for derivation of tailwater curves).
- Cross sections for the forebay and the river upstream from the City Plant (for determination of crest elevations of the diversion dam to ensure that adequate flows will be diverted to the plant for power generation).

River cross sections are presented in Appendix A. Other basic data are presented in Appendix C, and backwater, tailwater, and power studies are discussed in Appendix C.

---

(1) In the power studies, present flow conditions were assumed to be the same as 1975 flow conditions, for which data were available.

## 3.2 CRITERIA FOR POWER STUDIES

To compare the amount of energy that can be generated by operating the plant to use the full run-of-river flows with the amount of energy that can be generated if flows through the plant are reduced during the dry season to maintain a minimum flow over the falls, power studies were performed for two plans of plant operation, as follows:

- Plan A - The power plant utilizes the run-of-river flows of the Snake River. Flows over the falls occur only when river flows exceed 5200 CFS.

- Plan B - The power plant utilizes the run-of-river flows, except during the dry season, when flows through the power plant are reduced to maintain a minimum flow of 850 CFS over the falls. This reduction is not applied during December, January, and February, when the river surface and the falls are normally frozen and the entire flow is assumed to be available for power generation.

The following assumptions were made in estimating average annual energy generation:

- The plant will operate as a run-of-river plant and will utilize water only as it comes to it from upstream lakes and reservoirs.
- The plant will operate continuously to carry a portion of the baseload.
- Discharge above the turbine design discharge will not increase the output above the unit rating.
- The overall efficiency is 89% for the bulb units and 88% for the Kaplan unit.

Energy calculations are based on average net head (determined from tailwater-duration curves) and on average flows utilized by the unit (determined from flow-duration curves). The results of the energy calculations with the two sets of river flows for various possible installed capacities under Plan A and Plan B operation are summarized on Figures C-6, C-7, C-10, and C-11. Separate studies were not made for each alternative because the flow conditions and average head are the same for all four alternatives.

## 3.3 INSTALLED CAPACITY

Studies to determine the installed capacity are presented in Appendix C. Preliminary results of these studies indicated that for maximum benefits the installed capacity should be in the range of 6500 to 8300 kW. To determine the most viable generating scheme, bulb turbine-generator installations of one and two units were selected for comparison. Based on a preliminary analysis of energy and cost, one 7200-kW unit was selected for further study. Two 4000-kW units were investigated to evaluate the greater flexibility offered by smaller machines. On the basis of maintenance considerations, 4000-kW units are the smallest practical size units recommended, and 8000 kW for the two units is within the range selected for study. For comparison with the bulb units, a 7200-kW conventional Kaplan turbine scheme was also studied.

Four alternative powerhouse layouts, to suit these generating schemes, were prepared and are presented in Appendix A. Estimated costs for the four alternatives are presented in Appendix B, and the alternatives are evaluated in Chapter 4. The installed capacities and the number of units in each alternative investigated are shown in Table 3-1. In the present study, 7200 kW, corresponding to a turbine design flow of 5200 CFS, is recommended as the bulb turbine installed capacity, on the basis of cost and greater benefits.

TABLE 3-1

INSTALLED CAPACITY

| Alter-native* | No. of Bulb Units | No. of Kaplan Units | Installed Capacity per Unit (kW) | Total Installed Capacity (kW) | Turbine Design Flow (CFS) |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 7200 | 7200 | 5200 |
| 2 | 2 | 0 | 4000 | 8000 | 5800 |
| 3 | 1 | 0 | 7200 | 7200 | 5200 |
| 4 | 0 | 1 | 7200 | 7200 | 5200 |

* See Chapter 4 for description of alternatives.

## 3.4 RESULTS OF POWER STUDIES

The average annual energy that can be generated at the City Plant for the two plans of operation and each redevelopment alternative, under both present flow conditions and flow conditions expected with the Recommended State Water Plan, are given in Table 3-2. These results are based on:

- Monthly streamflow data for water years 1938 through 1972.
- Flow-duration curves showing the percent of time flows would be equaled or exceeded.
- Tailwater-duration curves computed for each of the two flow conditions.
- Average tailwater elevations developed from flow-duration and tailwater-duration curves.
- Average operating pool elevations.

TABLE 3-2

AVERAGE ANNUAL ENERGY (in Million kWh)

| Alternative* | Plan A: Under Present Flow Conditions | Plan A: Under Flow Conditions of the Recommended State Water Plan | Plan B: Under Present Flow Conditions | Plan B: Under Flow Conditions of the Recommended State Water Plan |
|---|---|---|---|---|
| 1 | 53.6 | 56.5 | 48.8 | 54.3 |
| 2 | 55.5 | 60.7 | 50.5 | 57.4 |
| 3 | 53.6 | 56.5 | 48.8 | 54.3 |
| 4 | 53.0 | 55.9 | 48.2 | 53.7 |

* See Chapter 4 for description of alternatives.

# CHAPTER 4
# REDEVELOPMENT ALTERNATIVES

# CHAPTER 4
# REDEVELOPMENT ALTERNATIVES

This chapter describes and evaluates the main alternatives considered for redevelopment of the hydroelectric potential of the Snake River streamflows at the City Power Plant site. The main features of each alternative are outlined below:

- Alternative 1 entails demolishing the existing facilities, salvaging any equipment that has salvage value; providing a new diversion weir, trashrack structure, spillway at trashrack structure, powerhouse, spillway at powerhouse, control building, and maintenance shop; installing one new 7200-kW bulb turbine-generator; and improving flow conditions in the forebay channel.
- Alternative 2 is the same as Alternative 1, except that two 4000-kW bulb turbine-generators are installed instead of the single 7200-kW unit.
- Alternative 3 is the same as Alternative 1, except that the powerhouse is submerged, and an intake structure is provided instead of the trashrack structure.
- Alternative 4 is the same as Alternative 1, except that a 7200-kW Kaplan turbine is installed instead of the 7200-kW bulb turbine-generator.

## 4.1 BASIC INPUT DATA AND CRITERIA

### A. Hydrologic Data and Power Studies

Streamflow data (obtained from the Idaho Department of Water Resources) and flood data (obtained from the U.S. Geological Survey) are presented and discussed in Appendix C, along with other pertinent data, including the design flood, tailwater rating curve, flow-duration curves, and tailwater-duration curves. Power studies are also discussed in Appendix C, and the results are summarized in Chapter 3.

B. Geotechnical Data

Geotechnical data for the City Power Plant site, obtained by field reconnaissance of the site, are presented in Appendix D and on Exhibits A-2 and A-3.

C. Condition of Existing Facilities

The condition of the existing facilities, (particularly the concrete structures), as determined by field inspection of the facilities, is described in Chapter 2.

D. Cross Sections

River cross sections, provided by the Idaho Falls Electric Division for use in the backwater and tailwater studies, are shown on Exhibits A-14 through A-25.

## 4.2 OVERALL ENGINEERING CONSIDERATIONS

The main considerations, except environmental considerations, that formed the basis for the four alternatives investigated are discussed briefly below. The environmental considerations are presented in Chapter 6, Section 6.2.

A. Condition of Existing Facilities

Because of the severe deterioration of the physical condition of the structures and the obsolescence of the equipment of the City Power Plant, complete redevelopment of the City Plant facilities is considered necessary. Such redevelopment will maximize the power generation at the site and provide new safe structures.

B. Generating Units and Powerhouses

The main factors considered in selecting the type of units and powerhouses are:

- Provision of turbine-generator units that are best suited to the low-head, run-of-river conditions at the site, consistent with economy.
- Alignment of the powerhouse to result in minimum excavation quantities, consistent with operating requirements and foundation conditions.
- Utilization of existing space and prevention of interference with existing facilities, if practical and economical.
- Provision of adequate freeboard to prevent overtopping of the structures.

The optimum turbine-generator type for the low-head, high-flow-rate, run-of-river conditions that exist at all three Idaho Falls power plant sites is a unit known as a bulb turbine, which has a generator as an integral part of the unit. Under such conditions, bulb turbine-generators are more efficient than vertical-shaft, propeller turbines, both fixed-blade and adjustable-blade (Kaplan) types, for the following reasons: 1) they eliminate the need to turn the water through more than two $90^0$ angles; 2) they can achieve the same capacity with a smaller size because of both the deeper setting possible (which allows higher rotative speed) and the better straight-through flow characteristics. The greatest advantage of bulb turbine-generators, however, stems from the substantial reduction in the amount of excavation that is required and the amount of concrete supporting structure that must be provided. Although the manufacturer's price for bulb turbine-generators may exceed the manufacturer's price for vertical-shaft turbines, the overall power plant cost is substantially less. Bulb turbine-generators are somewhat more sophisticated than vertical-shaft turbines, and a higher degree of skill and care is required, particularly during installation. Recently, because of growing energy demands and the spiraling costs of thermal power production, many utilities have been considering additions to existing hydro installations. Bulb turbine-generators are particularly well suited to this type of application--for either replacing or supplementing existing low-head units.

C. Concrete Materials

Aggregate material in the Idaho Falls area is known to be susceptible to chemical reaction with alkalies in portland cement (alkali-aggregate reaction). The main consideration in providing new concrete structures is to use all known measures to prevent deterioration from freezing and thawing and to minimize deterioration from alkali-aggregate reactivity. These measures include air entrainment, maintaining a low water-cement ratio, and using low-alkali portland cement and pozzolans.

D. Spillway Gates and Hoists

The following factors were considered in selecting the type of spillway gates and hoists:

- Flood requirements.
- Ice problems (in the winter).
- Means of discharging ice floes and driftwood.
- Devices to prevent the formation of ice or to thaw ice adhering to the gates and seals.

E. Design Flood

The peak discharge selected for design of the structures is 75,000 CFS. Such a flood has an estimated frequency of once in 650 years, which exceeds the requirement of the Idaho Safety of Dams Regulations. The selected design flood represents a conservative estimate of the flood potential, considering the enormous flood control storage capability available upstream, especially at Palisades Reservoir. The design flood exceeds the estimated peak of the June 1976 flood and has an estimated probability of occurrence of 0.154%. Flood data and a more detailed discussion of the design flood are presented in Appendix C.

### F. Geotechnical Considerations

Bedrock of the powerhouse and diversion structure is a dark basalt, which is fine grained to microcrystalline, slightly vesicular, hard, layered, and blocky. Joints are tight and clean. No geologic features were observed that would preclude the construction of the diversion weir or powerhouse.

Available information on seismicity indicates that the structures are within a potential seismic zone. However, the size, standard design criteria, and construction of the structures will be such that no special seismic considerations will be required.

### G. Plant Operation

As discussed in Chapter 3 and Appendix C, two plans of operation (A and B) were investigated. With both plans, the power plant operates as a run-of-river plant. Under Plan A, the plant uses the full run-of-river flows throughout the year, and flows over the falls occur only when river flows exceed 5200 CFS. Under Plan B, flows through the power plant are reduced during the dry season to maintain a minimum flow of 850 CFS over the falls. This reduction does not apply during December, January, and February, when the falls are normally frozen.

## 4.3 REDEVELOPMENT ALTERNATIVES

The four alternatives investigated are described briefly below. The following project data are common to all four alternatives:

| | |
|---|---|
| Weir crest elevation (ft) | 4694.7 |
| Average headwater elevation at powerhouse (ft) | 4694.0 |
| Average tailwater elevation (ft) | 4674.7 |
| Assumed head losses through power plant (ft) | 1.0 |
| Net head (ft) | 18.3 |

## A. Alternative 1

The plan for Alternative 1 consists of replacing the four existing units (2000 kW total installed capacity) with a new bulb turbine-generator having an installed capacity of 7200 kW. The existing concrete structures, estimated at 6100 cubic yards of concrete, will be demolished and removed. They will be replaced with the following new safe structures.

- Diversion Weir - The new diversion weir, a mass concrete structure located at the same site as the existing weir (as shown on Exhibit A-4), will divert river flows to the power plant for power generation. Like the existing weir, the new weir will consist of two sections--one extending about 1870 feet upstream from the upstream side of Broadway Bridge to the west bank of the river and the other extending about 100 feet downstream from the downstream side of the bridge. The new weir will be designed to pass the major portion of the Snake River flood flows, thus minimizing the flood flows reaching the powerhouse.

- Trashrack Structure - A concrete trashrack structure will be located upstream from Broadway Bridge, as shown on Exhibit A-5.

- Spillway at Trashrack Structure - For sluicing out floating debris and ice from in front of the trashrack structure, an adjoining spillway will be provided. This spillway will be a continuation of the diversion weir on the upstream side, except that a 40-foot-wide by 5-foot-high Bascule gate will be provided on top of an ogee weir.

- Powerhouse - The new powerhouse will be a concrete structure, located immediately downstream from the existing powerhouse, as shown on Exhibit A-6. It will be flanked by mass concrete wing walls connecting to the banks. An earthfill between the powerhouse and the east bank will provide access to the powerhouse, which will contain a single 7200-kW bulb turbine-generator.

- Spillway at Powerhouse - At the end of the right wing wall, a 20-foot-wide spillway with a 20-foot by 5-foot Bascule gate will be provided to sluice out floating debris and ice floes from in front of the powerhouse.

- Control Building - A new control building, replacing the existing dispatch building, will be constructed on the east bank to house the electrical control facilities.

- Maintenance Shop - A new maintenance building, replacing the existing maintenance building, will be constructed adjacent to the control building.

Other features in Alternative 1 include excavating (deepening) the existing forebay channel, guniting the rock surfaces in selected areas, and removing all silt deposits.

For Alternative 1, the turbine design flow is 5200 CFS, and the average annual energy that can be generated under present flow conditions is as follows:

| Plan | Average Annual Energy (kWh) |
|---|---|
| A | 53,600,000 |
| B | 48,800,000 |

Alternative 2 is the same as Alternative 1, except that two smaller, identical bulb turbine units, each of 4000 kW capacity, will be installed instead of a single 7200-kW unit. The project features are the same as those in Alternative 1, with the following exceptions:

- The powerhouse will be wider in plan, but shallower in vertical profile because of the smaller size of the units, resulting overall in lesser quantities of excavation and concrete than in Alternative 1.

- The intake and the tailrace channel will be wider, but shallower than in Alternative 1.

The design discharge for the two units is 5800 CFS. The average annual energy that can be generated with Alternative 2, under present flow conditions, is as follows:

| Plan | Average Annual Energy (kWh) |
|---|---|
| A | 55,500,000 |
| B | 50,500,000 |

C. Alternative 3

Alternative 3 is the same as Alternative 1, except that the powerhouse will be submerged (as shown on Exhibit A-8) and a gated concrete intake structure will be provided upstream from Broadway Bridge (as shown on Exhibit A-5A), instead of the trashrack structure.

Because the powerhouse is submerged, only an overflow weir across the east channel will be evident. The general plan of the powerhouse will be the same as for the powerhouse in Alternative 1, except that the bulb turbine unit will be set deeper. A mass concrete overflow weir will be provided on the downstream wall of the powerhouse. This weir will extend on both sides of the powerhouse building, connecting to the east bank and to the spillway on the island to the west. Beyond the spillway on the island, this weir will continue north to higher ground on the island, near the existing ice chute. Access to the powerhouse will be from a room on the right bank through a gallery within the concrete overflow section at the downstream side. The spillway operator chamber will be accessible from a gallery within the concrete overflow weir to the west side. The deck of the powerhouse will be at El. 4689, five feet below the normal water surface (El. 4694.0). The deck of the drafttube structure (El. 4673) will be set about 1 foot below the tailwater (El. 4674). An access ramp to the drafttube structure will be provided on the east bank.

The gated intake structure will allow dewatering of the forebay, a necessity during maintenance at the power plant. Flows will be controlled by 14 rectangular submerged Butterfly valves, each 6 feet wide by 8 feet high. The forebay will be dewatered to an elevation below the top deck of the powerhouse, permitting access through hatches on the deck. A mobile crane parked on the east bank will be used during maintenance and servicing.

The average annual energy that can be generated under Alternative 3 is the same as under Alternative 1.

D. Alternative 4

Alternative 4 is the same as Alternative 1, except that a new 7200-kW Kaplan turbine will be installed instead of the bulb turbine-generator. The Kaplan unit layout is intended for comparison with bulb turbine units. As shown on Exhibit A-9, the Kaplan powerhouse deck will be at El. 4705.0, fixed by the turbine runner centerline at El. 4675 (1 foot above tailwater). This powerhouse will be an outdoor type with a removable cover over the generator. Freeboard above normal water surface will be 11 feet.

The access ramp required in the other alternatives can be eliminated in this alternative because the drafttube gate slots can be reached from the deck of the powerhouse. A parking area, flush with the top of the powerhouse deck, will be provided.

The design flow for the turbine is 5200 CFS. The average annual energy that can be generated with Alternative 4, under present flow conditions, is as follows:

| Plan | Average Annual Energy (kWh)* |
|---|---|
| A | 53,000,000 |
| B | 48,200,000 |

* Assuming an overall turbine/generator efficiency of 88%.

## 4.4 COMPARISON OF ALTERNATIVES

The costs, benefits, and average annual energy for the four redevelopment alternatives investigated are shown in Table 4-1. Basic quantity and cost estimates for each alternative are shown in Appendix B (Tables B-1 through B-4). Criteria for estimating quantities and costs are presented in Chapter 5 (Section 5.2) and summarized below:

- Estimated quantities for civil works are based, in general, on quantity takeoffs from the drawings.
- Costs of turbines, governors, and generators were obtained from information provided by manufacturers.
- Unit costs are based on costs for similar types of construction, adjusted to Idaho Falls and are considered current for the second quarter of 1977. No price escalation has been added.
- Operation and maintenance costs reflect Federal Power Commission experience records for hydroelectric projects.

TABLE 4-1

COMPARISON OF REDEVELOPMENT ALTERNATIVES

| Item | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|---|
| NUMBER AND TYPE OF UNITS | one 7.2-MW bulb unit | two 4.0-MW bulb units | one 7.2-MW bulb unit* | one 7.2-MW Kaplan unit |
| AVERAGE ANNUAL ENERGY (kWh)** | | | | |
| Plan A | 53,600,000 | 55,500,000 | 53,600,000 | 53,000,000 |
| Plan B | 48,800,000 | 50,500,000 | 48,800,000 | 48,200,000 |
| COSTS | | | | |
| Capital Cost ($) | | | | |
| Total Construction Cost (including contingencies)*** | 10,625,000 | 11,415,000 | 11,606,000 | 12,648,000 |
| Engineering and Administration | 1,594,000 | 1,712,200 | 1,741,000 | 1,897,000 |
| Interest during Construction | 855,000 | 919,800 | 934,000 | 1,018,000 |
| Total Capital Cost | 13,074,000 | 14,046,000 | 14,281,000 | 15,563,000 |
| Equivalent Annual Cost ($/yr) | | | | |
| Capital Recovery (assuming 50-yr repayment period at 7% interest) | 947,340 | 1,017,770 | 1,034,800 | 1,127,700 |
| Operation and Maintenance | 63,500 | 70,560 | 65,230 | 62,370 |
| Total Equivalent Annual Cost | 1,010,840 | 1,088,330 | 1,100,030 | 1,190,070 |
| Energy Cost ($/kWh) | | | | |
| Plan A | 0.01886 | 0.01961 | 0.02052 | 0.02245 |
| Plan B | 0.02071 | 0.02155 | 0.02254 | 0.02469 |

* Submerged powerhouse.
** Under present flow conditions.
*** Includes salvage allowance for existing units.

Benefits are used to determine economic justification, priorities, and scale of development and to select the most economical alternative. The economic analysis, shown in Table 4-2, compares the economic benefits with the project costs. The results of the analysis are expressed numerically as benefit-to-cost (B/C) ratios. A project is considered economically justified when the benefits to be derived from it, over the period of analysis, exceed the costs. Secondary benefits, such as the environmental improvement of the project area, and the recreational and tourism values, are not considered in the economic analysis.

Table 4-2 summarizes the benefits, costs, B/C ratio, and benefits minus costs for each alternative. As indicated, the B/C ratio is greater than 1.0 in each case; therefore, all four redevelopment alternatives are eonomically justified.

The main advantages and disadvantages of each alternative are presented below. (The alternatives are shown in the order of increasing capital costs.)

A. Alternative 1

Alternative 1 has the following advantages:

- It will require the least initial investment of capital.
- It will have the lowest total annual cost.
- It will provide a unit of the same size (7200 kW) as at the Upper and Lower Power Plants; consequently, installation will be simpler.
- Operation and maintenance will be relatively economical because personnel will become familiar with the same type of plant as the Upper and Lower Power Plants.
- The powerhouse layout is environmentally acceptable and will strengthen the impression of a continuing green belt and open area along the river.

TABLE 4-2

ECONOMIC ANALYSIS OF REDEVELOPMENT ALTERNATIVES

(ANALYSIS BASED ON TOTAL ANNUAL BENEFITS AND TOTAL ANNUAL COST)

PLAN A

| Alternative | Total Annual Benefits ($) | Total Annual Cost ($) | Total Benefits Minus Total Cost ($) | Benefit-to-Cost Ratio |
|---|---|---|---|---|
| 1 | 1,608,000 | 1,010,840 | 597,160 | 1.591 |
| 2 | 1,665,000 | 1,088,330 | 576,670 | 1.530 |
| 3 | 1,608,000 | 1,100,030 | 507,970 | 1.462 |
| 4 | 1,590,000 | 1,190,070 | 399,930 | 1.336 |

PLAN B

| Alternative | Total Annual Benefits ($) | Total Annual Cost ($) | Total Benefits Minus Total Cost ($) | Benefit-to-Cost Ratio |
|---|---|---|---|---|
| 1 | 1,464,000 | 1,010,840 | 453,160 | 1.448 |
| 2 | 1,515,000 | 1,088,330 | 426,670 | 1.342 |
| 3 | 1,464,000 | 1,100,030 | 363,970 | 1.331 |
| 4 | 1,446,000 | 1,190,070 | 255,930 | 1.215 |

* Power benefits are based on a value of $0.030/kWh, which was furnished by the Idaho Falls Electric Division.

The disadvantages of Alternative 1 are:

- The construction cost for the powerhouse civil works is higher than for Alternative 2.
- One 7200-kW unit offers less flexibility of operation than two 4000-kW units.
- Compared with Alternative 2, Alternative 1 will develop about 96% of the power potential of the site.

B. Alternative 2

The advantages of Alternative 2 are:

- Installation of two 4000-kW bulb turbine-generators will develop about 1.1 times more energy and benefits than Alternative 1.
- The construction cost for the powerhouse civil works will be lower than for Alternative 1.
- Greater flexibility of operation is possible than with one 7200-kW unit.
- The powerhouse layout is environmentally acceptable and, as in the case of Alternative 1, will strengthen the impression of a continuing green belt and open area along the river.

The disadvantages of Alternative 2 are:

- The initial investment of capital will be about 1.1 times higher than for Alternative 1.
- The operation and maintenance cost will be higher than for Alternative 1, because of the two units compared to the single unit for Alternative 1.
- The cost of the units and the mechanical auxiliary equipment will be higher than for Alternative 1; consequently, the overall powerhouse cost will be higher.

C. <u>Alternative 3</u>

Alternative 3 has the following advantages:

- It will provide a unit of the same size (7200 kW) as at the Uppper and Lower Power Plants (the same as Alternative 1).
- The powerhouse will be completely submerged, providing a more environmentally acceptable layout and giving the impression of being an integral part of the falls upstream.

The disadvantages of Alternative 3 are:

- The initial investment of capital will be about 1.1 times that for Alternative 1.
- The operation and maintenance costs will be higher than for Alternative 1 due to more difficult access.
- A gated intake structure will be required to lower the forebay water level for major maintenance; consequently, overall costs will be higher.

D. <u>Alternative 4</u>

Alternative 4 has the following advantages:

- Operation and maintenance will be more economical than for Alternative 1 (about 98% of the Alternative 1 operation and maintenance cost).
- U.S. firms are more experienced in the manufacture of Kaplan turbines.
- Permanent access to the tailrace structure will not be required.

The disadvantages of Alternative 4 are:

- The initial investment of capital will be about 1.2 times higher than for Alternative 1.

- The overall powerhouse construction cost will be about 1.2 times higher than for Alternative 1, due to higher civil works costs (about 1.5 times higher) and higher turbine and auxiliary equipment costs (about 1.1 times higher).
- The powerhouse layout will be less acceptable environmentally because the top deck of the powerhouse will be at a higher elevation and consequently more exposed.
- The benefits minus costs are only about 67% of that for Alternative 1.

## 4.5 SELECTION OF RECOMMENDED DEVELOPMENT

As shown in Section 4.4, all four alternatives investigated are economically justified. Alternatives 1 and 2 are more attractive than Alternatives 3 and 4 for the following reasons:

- Higher benefits minus costs.
- Higher benefit-to-cost ratios.
- Lower energy cost ($/kWh).

Although Alternative 2 has higher average annual energy and higher installed capacity than Alternative 1, Alternative 1 is preferable to Alternative 2 for the following reasons:

- Lower initial investment of capital.
- Higher benefit-to-cost ratio.
- Lower operation and maintenance cost.

If the previously recommended developments at the Upper and Lower Power Plants are undertaken, then the following additional factors become advantages for Alternative 1.

- Lower engineering costs because of similarity of mechanical and electrical design aspects to those of the Upper and Lower Power Plants (three identical 7200-kW units).

- Lower procurement costs because only one contract and one supplier will be involved for the three plants (three identical 7200-kW units).
- Installation will be simpler because of the similarity of the plants.

Therefore, for these reasons and based on all of the comparative evaluations, Alternative 1 is selected as the recommended development. This development is technically and economically feasible and will be economically beneficial to the City. It is described in detail in Chapter 5.

# CHAPTER 5

# RECOMMENDED DEVELOPMENT

# CHAPTER 5
# RECOMMENDED DEVELOPMENT

This chapter sets forth the recommended project works to redevelop the streamflows of the Snake River at the Idaho Falls City Power Plant site for power generation. The recommended development evolved from studies to determine the most viable generating scheme to suit the low-head, run-of-river conditions at the site. As discussed in Chapter 4, Alternative 1 was selected as the best plan for redeveloping the hydroelectric potential at the City Plant site. Briefly, Alternative 1 comprises the following:

- Demolishing and removing the existing facilities, salvaging any equipment that has salvage value.
- Providing a new diversion weir, trashrack structure, spillway at trashrack structure, powerhouse, spillway at powerhouse, control building, and maintenance shop.
- Installing one new 7200-kW bulb turbine-generator unit in the new powerhouse.
- Improving flow conditions in the forebay channel.

This chapter describes the recommended development in detail and presents project costs and a construction schedule. Environmental aspects of the recommended development are presented in Chapter 6, Section 6.3.

## 5.1 PROJECT FEATURES

The main features of the recommended development are shown on Exhibits A-4 through A-6 and described below. The layout and arrangement were selected from studies made to determine the most suitable combination of the project features, consistent with the site conditions. Pertinent project data are given in Table 5-1.

TABLE 5-1

RECOMMENDED DEVELOPMENT

PROJECT DATA

**General Data**

| | |
|---|---|
| Normal water surface elevation (ft) | 4,694.7 |
| Maximum water surface elevation (ft) | 4,700.0 |
| Design flood peak discharge (CFS) | 75,000 |
| Design flood frequency (yr) | 650 |

**Diversion Weir**

| | |
|---|---|
| Elevation of weir crest (ft) | 4,694.7 |
| Total weir length (ft) | 1,970 |
| Flood discharge (CFS) | 75,000 |
| Concrete volume (cu yd) | 7,200 |
| Removal of existing weir (cu yd) | 1,800 |

**Trashrack Structure**

| | |
|---|---|
| Minimum freeboard (ft) | 1.0 |
| Elevation of top of structure (ft) | 4,701.0 |
| Normal discharge (CFS) | 5,200 |
| Concrete volume (cu yd) | 1,000 |

**Spillway at Trashrack Structure**

| | |
|---|---|
| Crest elevation (ft) | 4,689.7 |
| Top of gate elevation (ft) | 4,694.7 |
| Bascule gate size (ft) | 40 x 5 |
| Maximum discharge (CFS) | 5,000 |
| Concrete volume (cu yd) | 290 |

**Powerhouse**

| | | |
|---|---|---|
| Installed capacity (kW) | | 7,200 |
| Average headwater elevation (ft) | | 4,694.0 |
| Average tailwater elevation (ft) | | 4,674.7 |
| Minimum tailwater elevation (ft) | | 4,674.0 |
| Maximum headwater elevation (ft) | | 4,699.7 |
| Assumed head losses (ft) | | 1.0 |
| Net head (ft) | | 18.3 |
| Average annual energy (kWh)* | | |
| Plan A | | 53,600,000 |
| Plan B | | 48,800,000 |
| Design capacity (CFS) | | 5,200 |
| Freeboard above average headwater (ft) | | 7.0 |
| Freeboard above maximum headwater (ft) | | 1.3 |
| Deck elevation (ft) | | 4,701.0 |
| Concrete volume (cu yd) | | |
| Powerhouse | 4,450 | |
| Wing walls | 3,600 | |
| Miscellaneous | 820 | |
| Total | | 8,870 |
| Rock excavation (cu yd) | | 9,760 |

**Spillway at Powerhouse (ice chute)**

| | |
|---|---|
| Normal water surface elevation (ft) | 4,694.0 |
| Maximum water surface elevation (ft) | 4,699.7 |
| Crest elevation (ft) | 4,689.7 |
| Top of gate elevation (ft) | 4,694.5 |
| Bascule gate size (ft) | 20 x 5 |
| Maximum discharge (CFS) | 2,500 |
| Concrete volume (cu yd) | 200.0 |

A. Diversion Weir

The new diversion weir, a concrete overflow structure, will be located at the same site as the existing weir (see Exhibit A-4). Like the existing weir, it will consist of two sections--one section, about 1870 feet long, will extend upstream from Broadway Bridge along the natural cataract that forms the falls, and the other section, about 100 feet long, will extend downstream from the bridge. It will create a pool in the east channel, divert flows to the powerhouse, and provide a differential head of about 18 feet for the new powerhouse.

The crest level and the new crest shape will be such that major floods will be able to pass over the weir with the upstream water levels no higher than those that result with the existing weir. The uncontrolled ogee weir crest will be at El. 4694.7, and the weir will be capable of passing 75,000 CFS with a surcharge of 5.3 feet, which will give an upstream water surface elevation of 4700.0 feet. The ogee shape will be more efficient hydraulically than the existing square-topped weir.

The weir will be founded on the same competent basalt rock as the existing weir. The average height will be about 7 feet. The height of the upstream section of the weir, where it crosses the main Snake River channel, will be about 20 to 30 feet. The maximum height of the short section downstream from Broadway Bridge will be about 18 feet.

B. Trashrack Structure

The new trashrack structure, located immediately upstream of Broadway Bridge (as shown on Exhibit A-5), will be designed to pass a normal flow of 5200 CFS. A truck-mounted mobile unit will be used for cleaning the trashracks.

C. Spillway at Trashrack Structure

Immediately adjoining the trashrack structure, a gated spillway with a 40-foot-wide by 5-foot-high Bascule type of gate will be provided, as shown on Exhibit A-5. The main function of this spillway will be to sluice trash and ice from in front of the trashrack structure. A log boom will be provided to catch driftwood and ice floes and to divert them through the spillway. The top of the gate, when the gate is upright, will be at El. 4695.2, providing 6 inches of freeboard above the crest of the diversion weir. The gate will be operated by two hydraulic operators, housed one each at a chamber within the end piers. With the gate lowered (at El. 4689.7 feet), the spillway will be capable of discharging about 1600 CFS with normal water surface elevation of 4694.7 feet and about 5000 CFS for maximum flood water surface elevation of 4700.0 feet.

D. Powerhouse

The existing powerhouse, including the adjoining dispatch building and the existing ice chute, will be removed and replaced by a new powerhouse, which will house a new 7200-kW bulb turbine-generator.

The new powerhouse will be located immediately downstream from the existing powerhouse in the east channel. Mass concrete wing walls will connect the powerhouse to the banks. A gallery within the right wing wall will provide direct access from the powerhouse to the new spillway on the right bank. The powerhouse will have a freeboard of 7 feet above the normal water surface elevation of 4694.0 feet, and the deck of the powerhouse will be at El. 4701.

Trashracks will be provided at the powerhouse intake. They will be cleaned periodically by the same truck-mounted raking unit that will be used to clean the trashracks at the trashrack structure.

The powerhouse will contain a single bulb turbine-generator with horizontal shaft, as shown on Exhibit A-6. The unit will have a rated capacity of 7200 kW and an overall efficiency of 89% under a net head of 18.3 feet at a design discharge of 5200 CFS. It will have a speed of 94.7 rpm with a runner diameter of about 15.5 feet. The governor will control the wicket gates and the runner blades for normal operations, and a trip weight will activate emergency closure of the wicket gates, when required. Two shafts will provide access from above to the unit bearings, the packing box, the generator cooling system, and the turbine blade control system. The unit will be supported by a single pier, and the turbine stay vanes will help to carry the thrust load.

Drainage pumps, sump, and valves will be provided below the unit. Fire protection, ventilation, and oil systems will be provided. A mobile crane will be required to operate the headgates and tailgates, as when the unit is to be dewatered or serviced. Remote control of the plant is planned, with periodic visits by operating personnel for startup of units, maintenance, and inspections.

The tailrace extends about 350 feet downstream from the powerhouse to the river. The existing channel is excavated in basalt rock. As shown on Exhibit A-6, additional excavation will be required due to the deeper setting of the new bulb turbine-generator, but should not pose any special problems.

A 15-foot-wide ramp along the east side of the tailrace channel will provide access to the top of the powerhouse drafttube deck (see Exhibit A-6).

E. Spillway at Powerhouse

A 20-foot-wide spillway will be provided at the end of the right wing wall of the powerhouse, as shown on Exhibit A-6. The spillway will be operated to discharge water and to sluice out floating debris and ice from the vicinity of the powerhouse intake and into the main channel of the river. A log boom across the forebay channel will direct the debris and ice toward the spillway.

The spillway will be a mass concrete ogee weir with a 20-foot-wide by 5-foot-high Bascule gate. The top of the gate, in the upright position, will be set at El. 4694.0 feet; with the gate in the lowered position, the spillway will form a smooth ogee section with crest at El. 4689.7. The gate will be operated by a single hydraulic operator, which will be housed in a chamber in the left pier. The operator chamber will be connected to the powerhouse by an access gallery within the right wing wall. With the gate lowered, the spillway will be capable of discharging 800 CFS with water surface elevation of 4694.0 feet, and 2500 CFS with estimated maximum water surface elevation of 4699.0 feet.

### F. Control Building

The existing dispatch building will be removed, and a new 50-foot by 90-foot control building will be provided on the east bank, as shown on Exhibit A-4. This building will house electric equipment and facilities for remote control and monitoring of the Upper, City, and Lower Power Plants. It will also house control equipment for the City's substations, including necessary equipment for the transition from the existing distribution system to the new indoor substation, located inside the new control building.

### G. Maintenance Shop

The existing maintenance shop will be removed, and a new 50-foot by 25-foot maintenance shop will be provided adjacent to the control building, as shown on Exhibit A-4. Routine maintenance for the turbines can be performed in this shop. Large turbine components will require little maintenance. What maintenance is required will be done in place during scheduled shutdowns.

## H. Forebay Channel Improvements

The forebay extends downstream from the upstream end of the weir to the powerhouse, a distance of about 2000 feet, passing under Broadway Bridge (see Exhibit A-4). The water passage section under the bridge is restricted due to high bedrock. This results in unacceptably high hydraulic head losses with flows of 5200 CFS.

The channel modifications to improve the flow conditions will consist of excavating and enlarging the existing channel, guniting the rock surfaces in selected areas, and removing all silt deposits in the channel. The excavation under Broadway Bridge will require controlled blasting. The rock between the piers will be excavated at a sufficient distance from the piers to prevent them from being damaged. At the powerhouse, the setting of the new bulb turbine-generator will require excavation of a deeper intake channel. The powerhouse layout takes into account the location of the existing railroad bridge piers so as not to disturb them.

## 5.2 PROJECT COSTS

The estimated capital, annual, and energy costs for the recommended development are summarized in Table 5-2, and the estimated annual costs and energy costs for different repayment periods and interest rates are shown in Table 5-3. The criteria used in estimating the project costs (for all four alternatives) are discussed below.

### A. Capital Costs

Detailed quantity and construction cost estimates for the recommended development are presented in Appendix B (Table B-1).

TABLE 5-2

RECOMMENDED DEVELOPMENT

SUMMARY OF CAPITAL, ANNUAL AND ENERGY COSTS

| | | |
|---|---|---|
| CAPITAL COST ($) | | |
| Construction Cost (including contingencies) | | |
| Diversion weir, trashrack structure, spillway, and channel improvements | | 2,122,000 |
| Powerhouse | | |
| Civil works | 2,936,000 | |
| Mechanical works | 5,074,000 | |
| Electrical works | 508,000 | |
| Subtotal - Powerhouse Cost | | 8,518,000 |
| Subtotal | | 10,640,000 |
| Less salvage allowance for existing units | | 15,000 |
| Total | | 10,625,000 |
| Engineering and administration | | 1,594,000 |
| Interest during construction | | 855,000 |
| Total capital cost | | 13,074,000 |
| EQUIVALENT ANNUAL COST ($/yr) | | |
| Capital recovery (assuming 50-yr repayment period at 7% interest) | | 947,340 |
| Operation and maintenance | | 63,500 |
| Total equivalent annual cost | | 1,010,840 |
| ENERGY COST (kWh)* | | |
| Plan A | | 0.01886 |
| Plan B | | 0.02071 |

* Based on average annual energy generation (under present conditions) as follows:

| | |
|---|---|
| Plan A | 53,600,000 kWh |
| Plan B | 48,800,000 kWh |

TABLE 5-3

RECOMMENDED DEVELOPMENT

ESTIMATED ANNUAL COSTS AND ENERGY COSTS
FOR DIFFERENT REPAYMENT PERIODS AND INTEREST RATES

| Repayment Period and Interest Rate | Capital Recovery Factor | Capital Recovery ($)* | Annual O&M Cost ($) | Total Annual Cost ($) | Cost Per Kilowatt-Hour ($)* Plan A | Plan B |
|---|---|---|---|---|---|---|
| 50 Years | | | | | | |
| 6% | 0.06344 | 829,415 | 63,500 | 892,915 | 0.01666 | 0.01830 |
| 7% | 0.07246 | 947,342 | 63,500 | 1,010,842 | 0.01886 | 0.02071 |
| 8% | 0.08174 | 1,068,669 | 63,500 | 1,132,169 | 0.02112 | 0.02320 |
| 9% | 0.09123 | 1,192,741 | 63,500 | 1,256,241 | 0.02344 | 0.02574 |
| 40 Years | | | | | | |
| 6% | 0.06646 | 868,898 | 63,500 | 932,398 | 0.01740 | 0.01911 |
| 7% | 0.07501 | 980,681 | 63,500 | 1,044,181 | 0.01948 | 0.02140 |
| 8% | 0.08386 | 1,096,386 | 63,500 | 1,159,886 | 0.02164 | 0.02377 |
| 9% | 0.09296 | 1,215,359 | 63,500 | 1,278,859 | 0.02386 | 0.02621 |
| 30 Years | | | | | | |
| 6% | 0.07265 | 949,826 | 63,500 | 1,013,326 | 0.01891 | 0.02076 |
| 7% | 0.08059 | 1,053,634 | 63,500 | 1,117,134 | 0.02084 | 0.02289 |
| 8% | 0.08883 | 1,161,363 | 63,500 | 1,224,863 | 0.02285 | 0.02510 |
| 9% | 0.09734 | 1,272,623 | 63,500 | 1,336,123 | 0.02493 | 0.02738 |
| 25 Years | | | | | | |
| 6% | 0.07823 | 1,022,779 | 63,500 | 1,086,279 | 0.02027 | 0.02226 |
| 7% | 0.08581 | 1,121,880 | 63,500 | 1,185,380 | 0.02212 | 0.02429 |
| 8% | 0.90368 | 1,224,772 | 63,500 | 1,288,272 | 0.02403 | 0.02640 |
| 9% | 0.10181 | 1,331,064 | 63,500 | 1,394,564 | 0.02602 | 0.02858 |

* Based on capital cost of $13,074,000 and average annual energy generation of 53,600,000 kWh under Plan A and 48,800,000 kWh under Plan B.

1. Quantity and Cost Estimates - Quantity estimates are based, in general, on takeoffs from the drawings, to an accuracy consistent with the purposes of the present studies. Costs of turbines, governors, and generators were obtained from information provided by manufacturers. The costs of the other mechanical and electrical items were estimated on the basis of experience.

2. Unit Costs - The unit costs applied in the estimates are based on information gathered for similar construction projects, adjusted to the Idaho Falls area. They are considered current (for the second quarter of 1977), complete, and adequate for the studies. No price escalation was added.

3. Contingencies - A contingency factor of 15% was added to the estimated construction costs to ensure that sufficient financing and credit are obtained.

4. Engineering and Administration - Costs for engineering and administration, including construction surveillance, were estimated by applying a factor of 15% to the estimated construction costs.

5. Interest during Construction - Interest during construction was estimated by assuming an annual interest rate of 7% and a 24-month construction period.

## B. Equivalent Annual Costs

Annual costs comprise capital recovery and operation and maintenance costs.

1. Capital Recovery - Capital recovery is based on a 50-year period of analysis, assuming an annual interest rate of 7%.

2. Operation and Maintenance Costs - Operation and maintenance costs include costs for manpower, services, offices, repair shops, equipment,

and parts incurred in project operation and maintenance. They reflect Federal Power Commission experience records for hydroelectric power plants.

C. Unit Cost of Energy

The unit cost of energy was estimated based on the estimated average annual energy generation for plant operation under Plans A and B (see Chapter 4, Section 4.2 G).

## 5.3 ENGINEERING AND CONSTRUCTION SCHEDULE

Although the City Plant is a part of an overall three-plant redevelopment project, it is not known at this time whether all three plants will be constructed under one contract. Therefore, the engineering and construction schedule presented herein is for the City Plant only.

The engineering and construction schedule for the project, presented on Figure 5-1, extends over a period of 42 months for design, construction, and testing and startup of the power plant. This schedule allows sufficient time for final design and investigations, preparation of bid documents, and contractor's mobilization. Engineering and preparation of specifications for the bulb turbine-generator will be performed at the beginning of the design studies. Delivery time for the bulb turbine-generator is approximately 24 months after receipt of a firm order; the work of detailed design for construction and the award of the construction contract are scheduled during this time. All the planned construction can be accomplished by present-day equipment. The construction, including final testing and startup, is scheduled over a 21-month period.

River flows will have to be handled over a minimum period of 12 months. Initial diversion for construction can be accomplished immmediately following the annual spring runoff. River diversion will be accomplished in two stages. Initially, cofferdams No. 1 and 2 will be constructed at proposed locations (shown on Exhibit A-4), permitting the construction of a major part of the diversion weir, the trashrack structure, the spillways, and the powerhouse. After this work has been completed, cofferdams No. 1 and 2 will be removed, and cofferdams No. 3 and 4 (located as shown on Exhibit A-4) will be constructed, permitting completion of the upstream portion of the diversion weir.

LEGEND:

Activities on Critical Path

Partial Time Activities

Other Activities

IDAHO FALLS HYDROELECTRIC PROJECT

CITY POWER PLANT

ENGINEERING AND CONSTRUCTION SCHEDULE

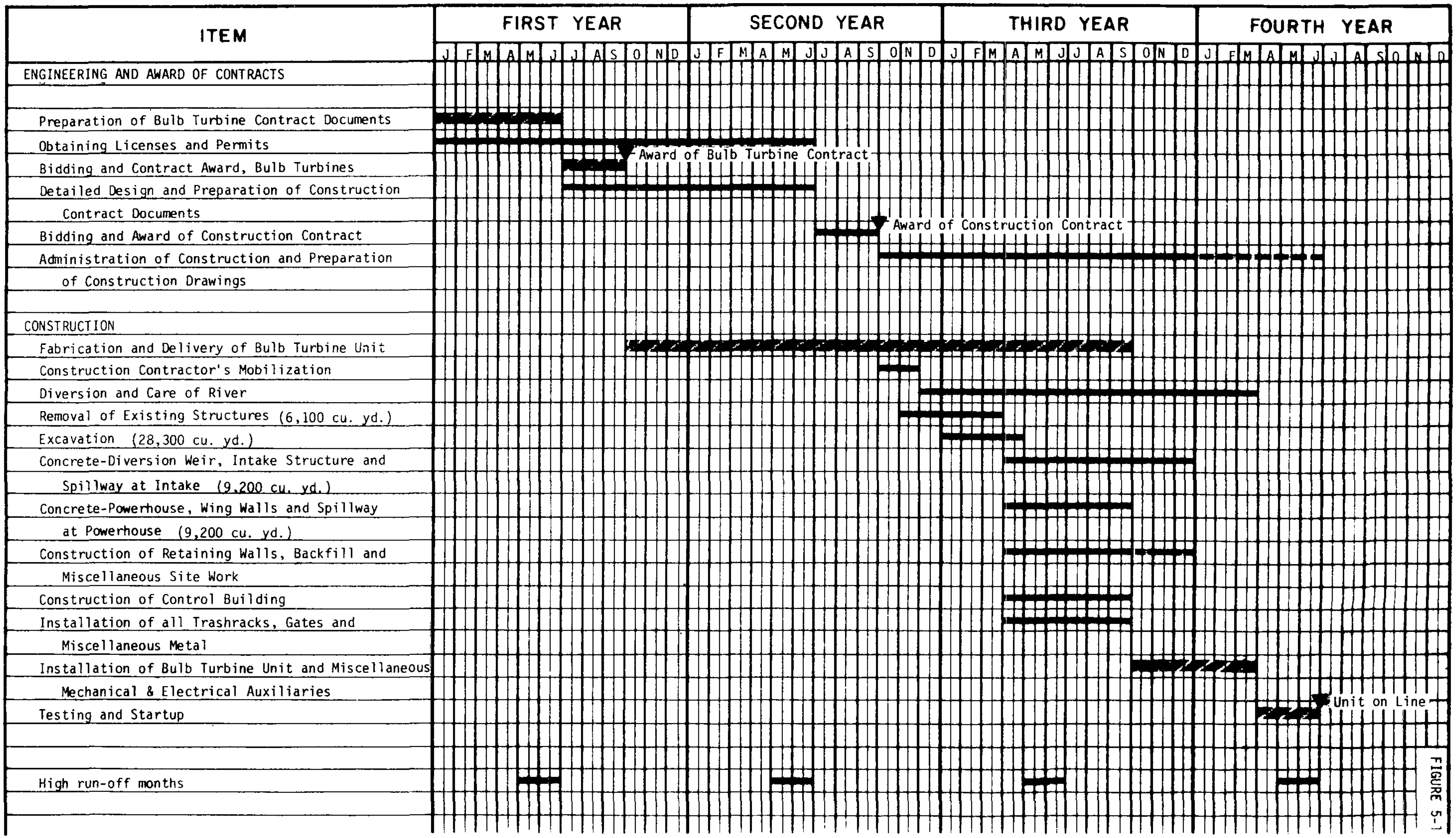



FIGURE 5-1

# CHAPTER 6

# ENVIRONMENTAL ASPECTS

# CHAPTER 6
# ENVIRONMENTAL ASPECTS

During the studies, IECO's architect performed an environmental evaluation of the three Idaho Falls power plant sites. The results of that evaluation are presented in a report, which was submitted to the Idaho Falls Electric Division in April 1977.

The environmental study area for the City Plant included the sites of the powerhouse, switchyard, forebay, intake structure, diversion weir, Electric Division maintenance yard, and the new Electric Division building, as well as Pedersen's Sportman's Park, Eagle Rock Park, the water tower near the powerhouse, the unimproved parking lot between Broadway and the Electric Division building, and the new library. The results of the environmental evaluation of this area formed the basis for studies made to preserve or enhance the scenic value of the City Plant site.

This chapter describes the present environment of the City Plant, presents the main factors that were considered in selecting an environmental development concept for the City Plant area, discusses the environmental aspects of the recommended development, and suggests other desirable environmental improvements.

## 6.1 CITY POWER PLANT ENVIRONMENT

The City Plant is located in the central section of the city, at the edge of an industrial area. From the north, it is partially screened from view from Broadway Bridge by Pedersen's Sportsman's Park. However, because it is so close to the center of the city and to heavily traveled Broadway, it is viewed by many people every day.

A developing greenbelt and park south of the plant and a proposed greenbelt on the west bank, opposite the plant, will strengthen the impression of a continuing open area along the river. New landscaping and a forebay overlook in Eagle Rock Park on the east bank just north of the plant (facing Pedersen's Sportsman's Park) are popular attractions. The falls upstream are an attractive, integral part of the power-generating complex.

Because of their high profiles, the switchyard and water tower are highly visible from both the north and the south. The switchyard contrasts sharply with the nearby greenbelt, parks, and urban-renewal areas, and the water tower is an incongruous landscape element. Moreover, the strong vertical lines of the water tower work against the generally horizontal lines and lower profile of its surroundings.

The new library, under construction 300 feet northeast of the plant site, is part of an urban-renewal program. Its modern brick architecture complements the recently lancscaped area in Eagle Rock Park. The new Electric Division building is also an aesthetically pleasing addition to the area. However, the existing powerhouse lends nothing to its surroundings. Its architectural style most closely resembles that of nearby buildings that have been razed for urban-renewal and greenbelt purposes. It is incompatible with the variety of structures that comprise the city, even the water tower and switchyard.

The railroad spur that bisects the area interrupts the visual concept of an integral power-generating system. It separates the falls and forebay from the powerhouse, in effect segregating integral parts of the generating complex. However, it does reinforce the historic value of the adjacent old bridge site and the area's historical significance as a main crossing point on the Snake River.

Power lines along the streets, rather than in alleys, interrupt views toward and away from the plant site. The parking lot between Broadway and the Electric Division building, adjacent to Eagle Rock Park, detracts from the scenic value of the entire area.

## 6.2 ENVIRONMENTAL CONSIDERATIONS

The main factors considered in selecting an environmental development concept for the City Plant area are:

- The historical significance of the site should be conserved and enhanced.
- The falls should be maintained, if possible, for their scenic value.
- All structures should be made as attractive as possible and they should be designed to be visually compatible with nearby physical features of the city.
- Open area with suitable landscaping should be provided to extend the greenbelt that is developing along the river.

## 6.3 RECOMMENDED DEVELOPMENT

The recommended development reflects the environmental considerations outlined above. A conceptual site plan and a powerhouse design resulting from the environmental studies are illustrated on Exhibits A-10 and A-11, respectively.

The scenic value of the falls can be preserved by reducing flows through the power plant during the dry season to maintain a minimum flow of 850 CFS over the falls. This reduction will not be necessary during December, January, and February, when the river surface and the falls are normally frozen.

### A. Power Plant

In contrast to the relatively high profile of the existing powerhouse, the new powerhouse will present a low profile (see Exhibit A-11). The top of the building will be practically level with the east bank of the river, and the architecture will blend with the open area and greenbelt developing along the river.

B. Forebay

The forebay will remain essentially unchanged. Construction activities required to improve flow conditions in the forebay will have only temporary effects.

C. Trashrack Structure

The top of the operating deck of the new trashrack structure will be essentially level with the river bank. To help solve the traffic problems that now arise when maintenance crews are removing ice and debris, the operating deck will be designed to support a maintenance vehicle.

D. Diversion Weir

The new diversion weir will be located at the same site as the existing weir. Construction activities required to replace the existing weir with the new weir will have only temporary effects.

E. Control Building

The new control building, which will replace the existing dispatch building, will have a low profile and be compatible with its surroundings.

F. Switchyard

Although hidden to some extent by the Electric Division building, the switchyard, because of its high profile, is still highly visible. Landscaping and screening will be provided to further hide it from view, for safety as well as aesthetic reasons.

## 6.4 OTHER ENVIRONMENTAL IMPROVEMENTS

Other possible environmental improvements (not included in the costs of the recommended development) are outlined below:

- Landscaping - Providing an open area and suitable landscaping around the power plant to visually connect Eagle Rock Park and Pedersen's Sportsman's Park with the greenbelt south of the plant.

- Circulation - Providing the following circulation features: a pedestrian overpass connecting Eagle Rock Park with the power plant area; access along the wingwall from the powerhouse to the south end of Pedersen's Sportsman's Park; and a pedestrian bridge passing under the main railroad bridge for circulation from the north end of Pedersen's Sportsman's Park to the powerhouse.

- Water Tower - Making the water tower the visual focal point of the City, remodeling it to incorporate a viewing platform and stairway, and providing landscape elements that have strong vertical components (such as Lombardy poplars) to complement the water tower's vertical line. (The water tower might be considered symbolic of the importance of the water supply, as well as the power supply, to the vitality of the City.)

- Visitors' Center - Incorporating a visitors' center in the new control building, putting parts of one of the old turbines on permanent display, and providing information on power generation before the advent of bulb turbine technology, in comparison with power generation using bulb turbine technology.

- Switchyard - Relocating the switchyard across the river from the power plant, giving it a lower profile to blend it into its surroundings, and providing landscaping and screening.

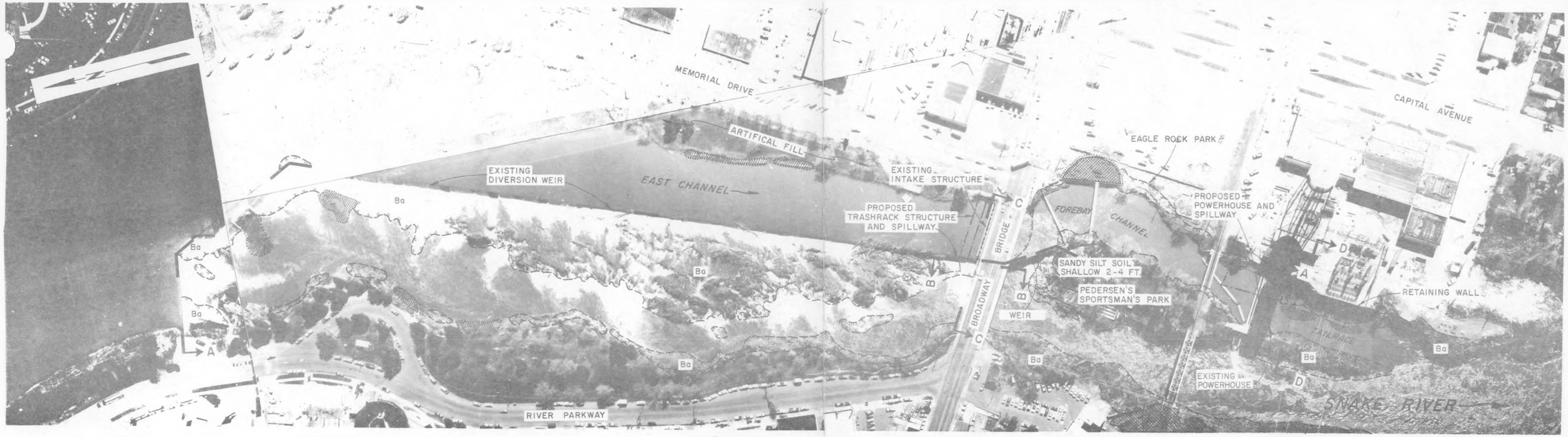
- Power Lines - Removing power lines from streets and restricting them to alleys or rear portions of lots.

- Parking Lot - Paving the parking lot, landscaping it to integrate it visually with adjacent areas, and creating a plaza at its south end for commercial and cultural activities.

# APPENDIX A
# PROJECT DRAWINGS

## PROJECT DRAWINGS

| Drawing Number | | |
|---|---|---|
| KV-03-001 | Exhibit A-1 | Location Map |
| -002 | Exhibit A-2 | City Power Plant, Project Area and Site Geology |
| -003 | Exhibit A-3 | City Power Plant, Geological Cross Sections |
| -004 | Exhibit A-4 | City Power Plant - General Plan |
| -005 | Exhibit A-5 | City Power Plant - Trashrack Structure, Spillway and Diversion Weir |
| -026 | Exhibit A-5A | City Power Plant - Intake Structure |
| -006 | Exhibit A-6 | City Power Plant - One 7.2 MW Bulb Turbine Unit |
| -007 | Exhibit A-7 | City Power Plant - Two 4.0 MV Bulb Turbine Units |
| -008 | Exhibit A-8 | City Power Plant - One 7.2 MW Bulb Turbine Unit - Overflow Layout |
| -009 | Exhibit A-9 | City Power Plant - One 7.2 MW Kaplan Unit |
| -010 | Exhibit A-10 | Conceptual Site Plan |
| -011 | Exhibit A-11 | Powerhouse Area Perspective |
| -012 | Exhibit A-12 | Key Map, Cross Section Location |
| -013 | Exhibit A-13 | Key Map - Reach No. 1 |
| -014 | Exhibit A-14 | Cross Sections North of Power Plant - Reach No. 1, Sheet 1 of 3 |
| -015 | Exhibit A-15 | Cross Sections North of Power Plant - Reach No. 1, Sheet 2 of 3 |
| -016 | Exhibit A-16 | Cross Sections North of Power Plant - Reach No. 1, Sheet 3 of 3 |
| -017 | Exhibit A-17 | Key Map - Reach No. 2 |
| -018 | Exhibit A-18 | Cross Sections South of Power Plant - Reach No. 2, Sheet 1 of 3 |
| -019 | Exhibit A-19 | Cross Sections South of Power Plant - Reach No. 2, Sheet 2 of 3 |
| -020 | Exhibit A-20 | Cross Sections South of Power Plant - Reach No. 2, Sheet 3 of 3 |
| -021 | Exhibit A-21 | Key Map - Reach No. 3 |
| -022 | Exhibit A-22 | Cross Sections South of Power Plant - Reach No. 3, Sheet 1 of 1 |
| -023 | Exhibit A-23 | Key Map - Reach No. 4 |
| -024 | Exhibit A-24 | Cross Sections South of Power Plant - Reach No. 4, Sheet 1 of 2 |
| -025 | Exhibit A-25 | Cross Sections South of Power Plant - Reach No. 4, Sheet 2 of 2 |




PLAN

LEGEND:

Loose rock blocks, gravel and sand-usually river deposits

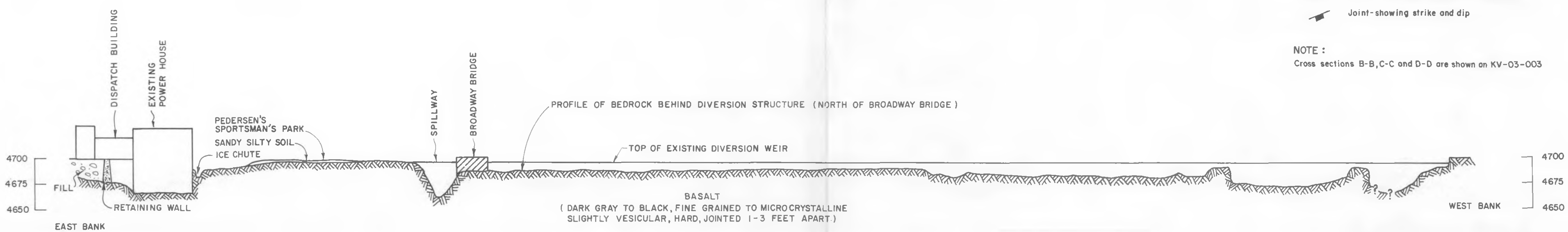
Artifical fill and slope wash deposits

Ba — Basalt-bedrock. Dark gray to black, slightly vesicular, fine grained to microcrystalline, hard, jointed, blocky to tabular structure. Contains riverworn potholes.

Vertical joint - showing direction (strike)

Joint-showing strike and dip

NOTE :
Cross sections B-B, C-C and D-D are shown on KV-03-003




Horiz. Scale 0 50 100 200 Feet

Vert. Scale 0 25 50 100 Feet

DEVELOPED GEOLOGIC CROSS SECTION A-A
( FROM POWER PLANT TO END OF DIVERSION WEIR)

CITY OF IDAHO FALLS

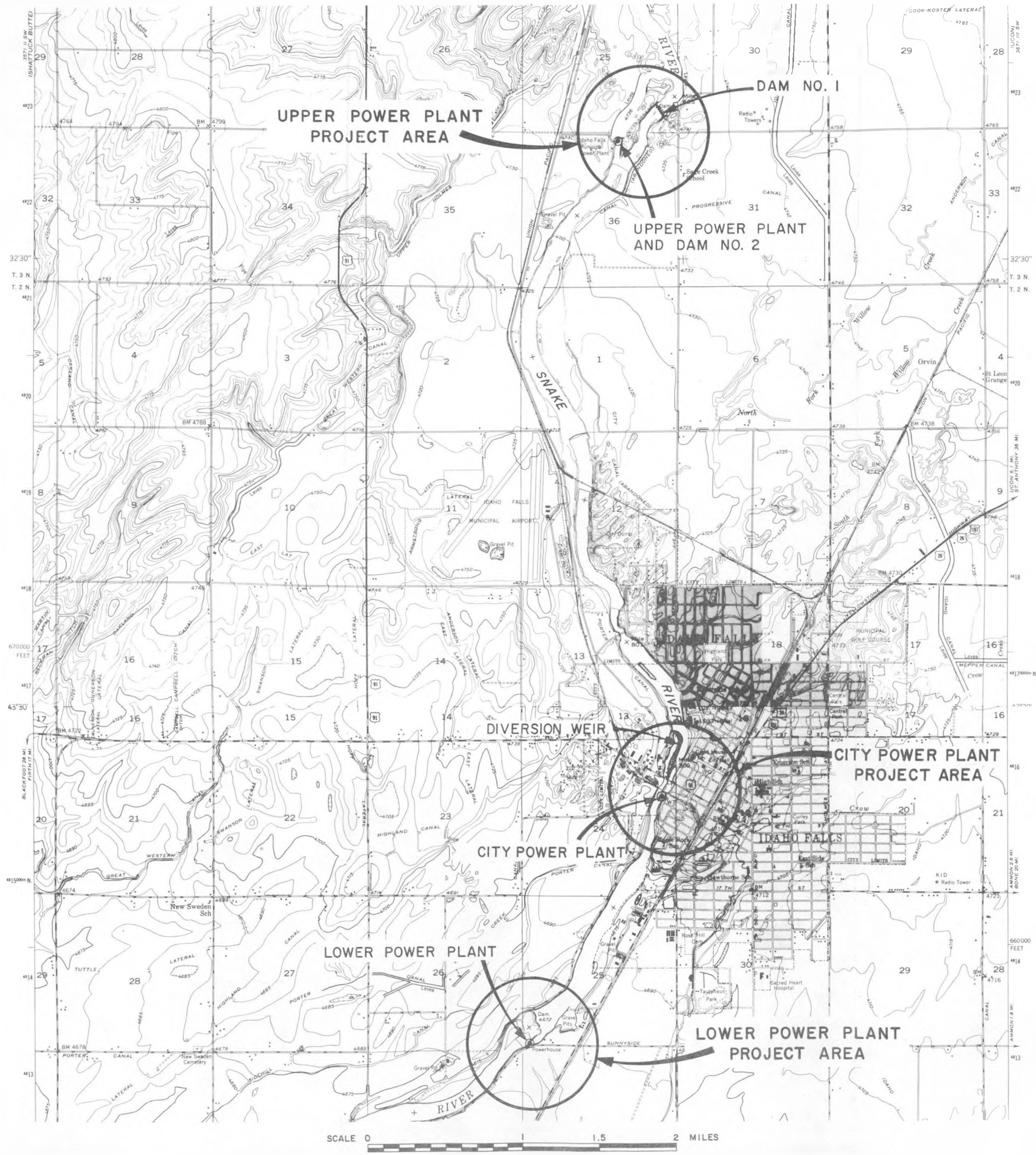
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

# PROJECT AREA AND SITE GEOLOGY

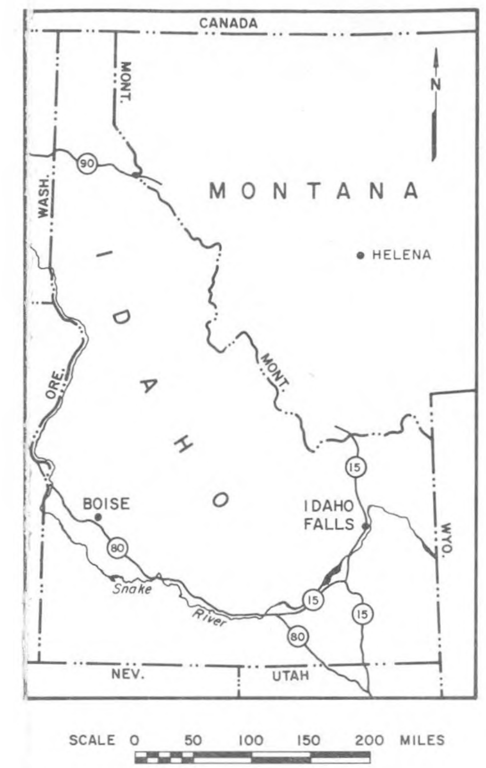
INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED J.A.C. | CHECKED J. A. C. | APPROVED [signature] |
| DRAWN [illegible] | INSPECT [illegible] | RECOMMENDED [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-002 |

REGISTERED PROFESSIONAL ENGINEER 3200 STATE OF IDAHO JAMES F. LACKEY, JR.




LOCATION MAP




KEY MAP

PROPOSED PROJECT WORKS

POWER PLANT ◉

DIVERSION DAM

CITY OF IDAHO FALLS

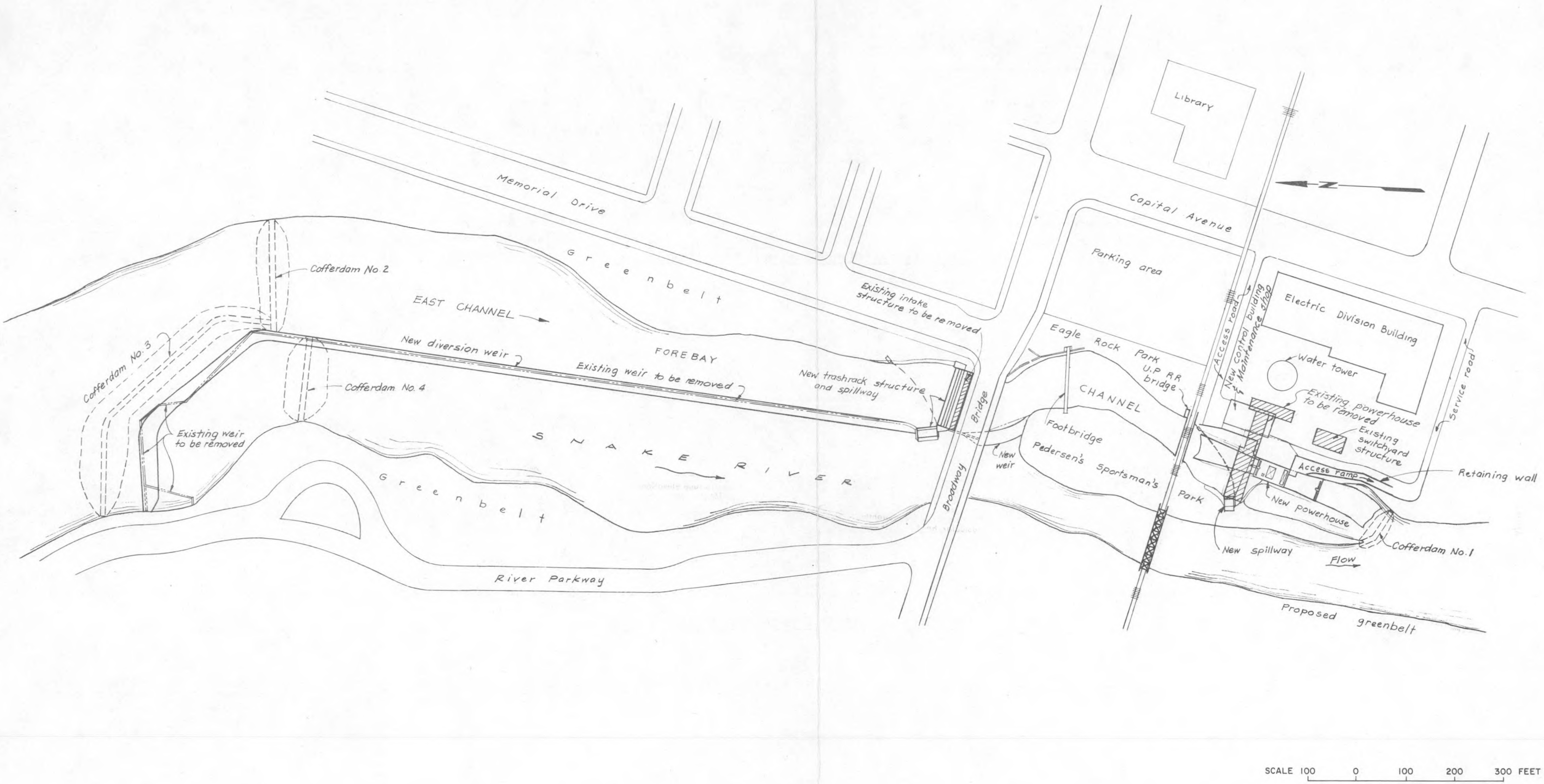
IDAHO FALLS HYDROELECTRIC PROJECT

LOCATION MAP

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED IECO | CHECKED JAC | APPROVED |
| DRAWN D.L.G. | INSPECT | RECOMMENDED |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-001 |

REGISTERED PROFESSIONAL ENGINEER 3200 STATE OF IDAHO JAMES F. LECKEY, JR.




CITY OF IDAHO FALLS

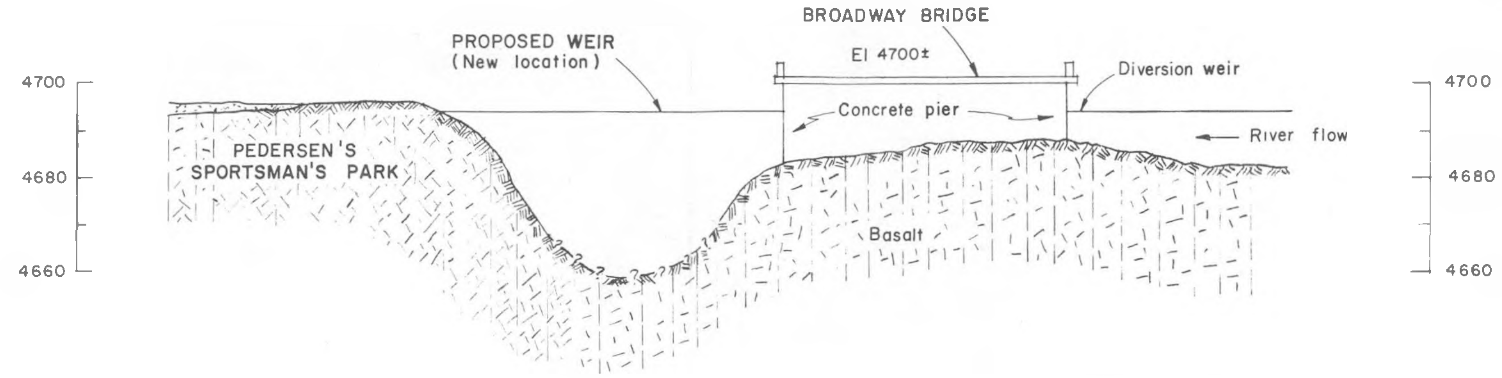
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

## GENERAL PLAN

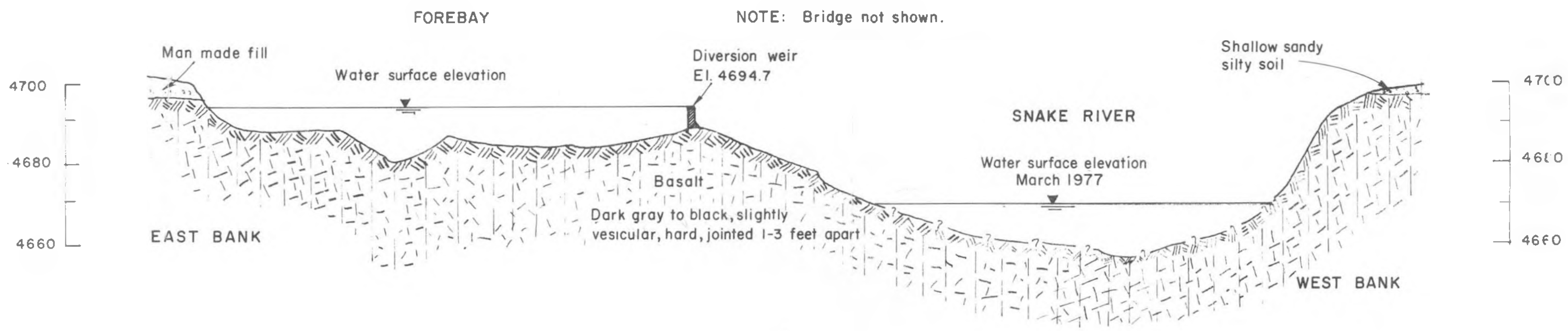
INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED P.K.M. | CHECKED SBB | APPROVED |
| DRAWN A.M.W. | INSPECT SPC | RECOMMENDED |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-004 |

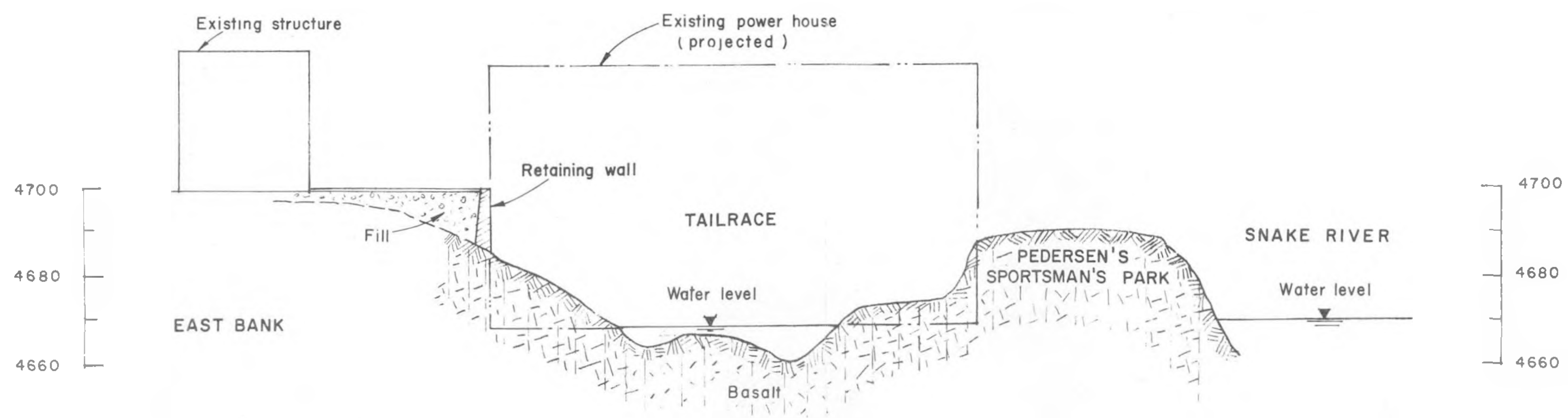
REGISTERED PROFESSIONAL ENGINEER 3200 STATE OF IDAHO JAMES F. LACKEY, JR.




SECTION B - B (PROPOSED WEIR NEW LOCATION)




SECTION C - C (NORTH OF BROADWAY BRIDGE)




SECTION D - D (DOWNSTREAM OF EXISTING POWER PLANT)

NOTE:

ALL SECTIONS TAKEN FROM RIVER CROSS SECTIONS PROVIDED BY ELECTRIC DIVISION, EXCEPT FOR SECTION B-B WHICH WAS ESTIMATED FROM COMBINED TOPOGRAPHIC INFORMATION AND AERIAL PHOTOGRAPHS.

SCALE 20 0 20 40 FEET

CITY OF IDAHO FALLS

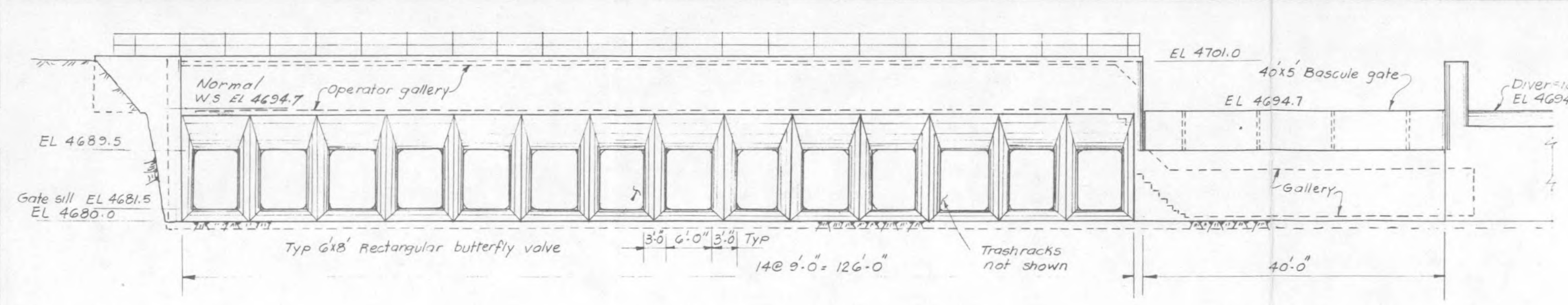
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

# GEOLOGICAL CROSS SECTIONS

INTERNATIONAL ENGINEERING COMPANY, INC.

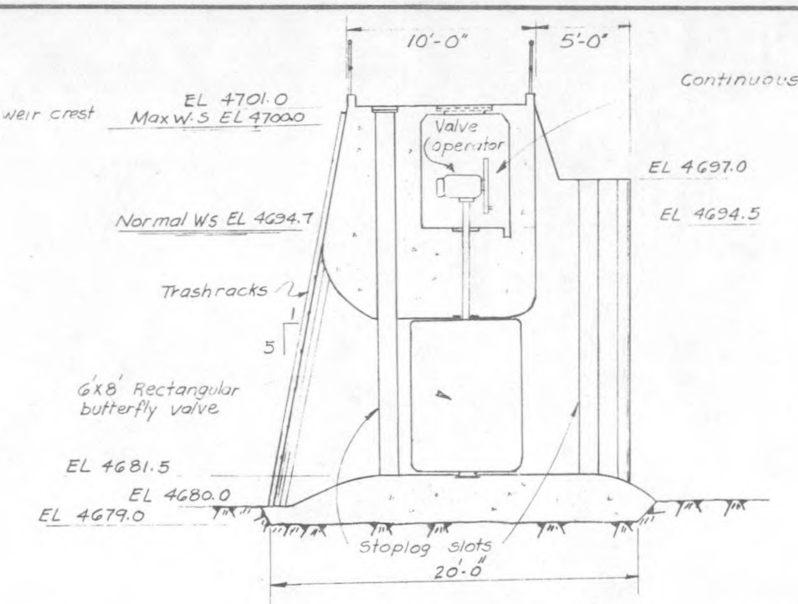
| | | |
|---|---|---|
| DESIGNED J.B.C. | CHECKED J. A. C. | APPROVED [signature] |
| DRAWN B.B. | INSPECT P.G. | RECOMMENDED Pablo [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-003 |

REGISTERED PROFESSIONAL ENGINEER 3200 6/22/77 STATE OF IDAHO JAMES F. LACKEY, JR.



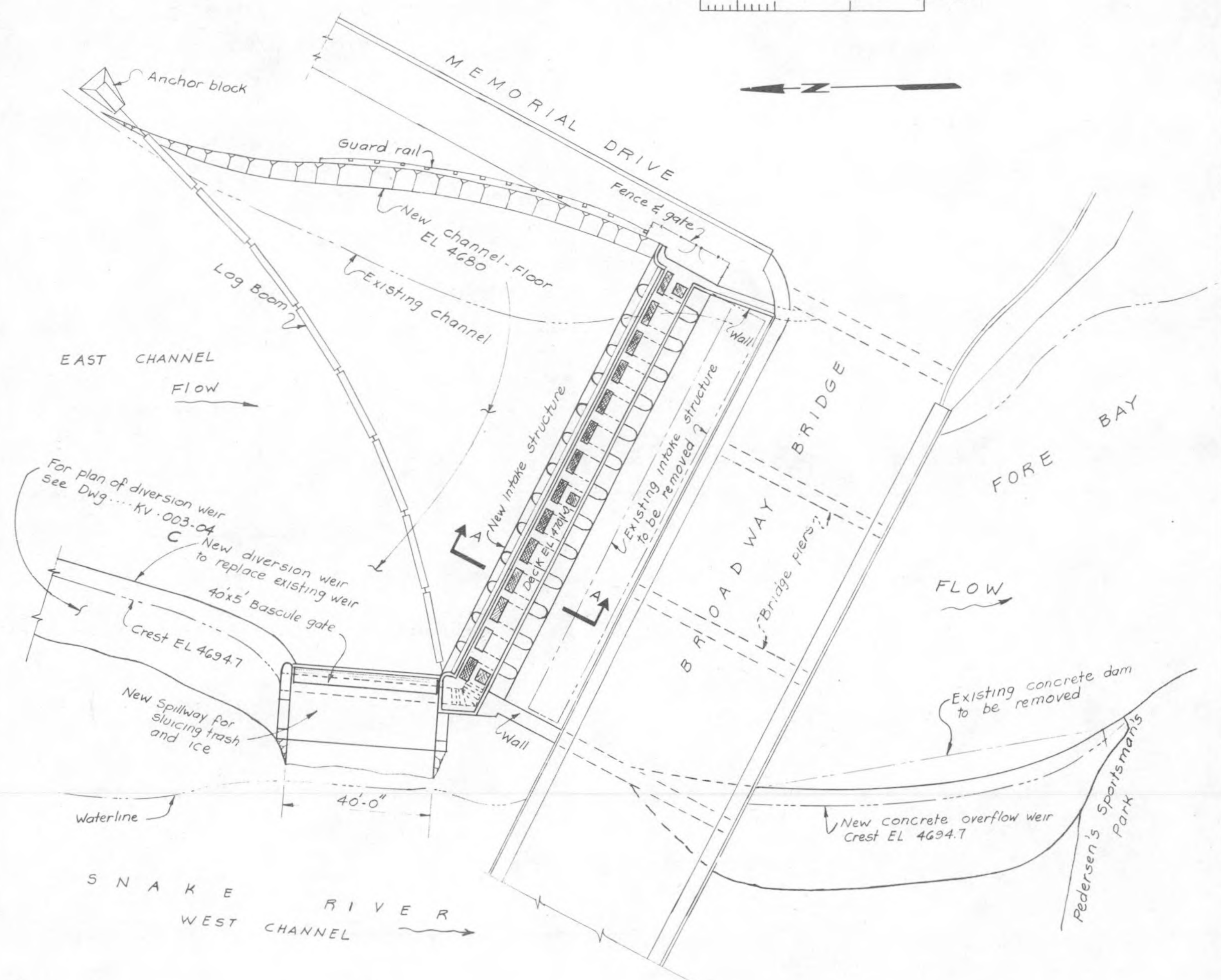

ELEVATION
INTAKE STRUCTURE AND SPILLWAY

Scale 10 0 10 20 Feet




SECTION A-A

Scale 5 0 5 Feet




PLAN
GATED INTAKE STRUCTURE, SPILLWAY AND DIVERSION WEIR

Scale 20 0 20 40 Feet

NOTES:

The gated intake structure shown on this drawing applies to Powerhouse alternative 3 only. For spillway and diversion weir details see Exhibit A-5

REFERENCE DRAWING

General Plan -------- KV-03-004

Scale as noted

CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

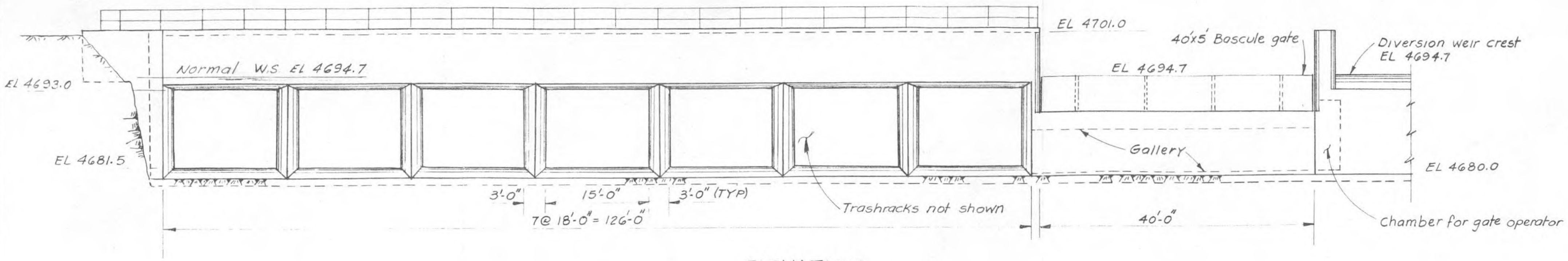
INTAKE STRUCTURE

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED P.K.M. | CHECKED SBS | APPROVED [signature] |
| DRAWN S.B.Z | INSPECT GE | RECOMMENDED [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-026 |

REGISTERED PROFESSIONAL ENGINEER 3200 STATE OF IDAHO JAMES F. LACKEY, JR.

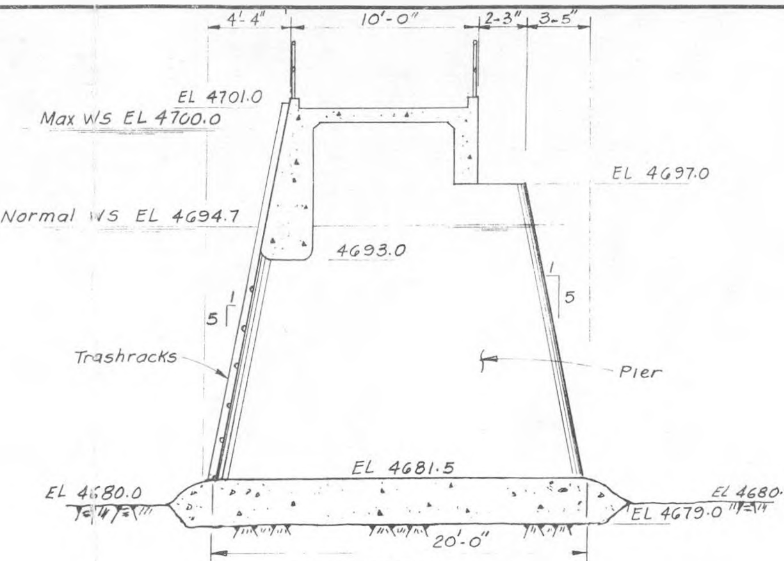
EXHIBIT A-5




ELEVATION

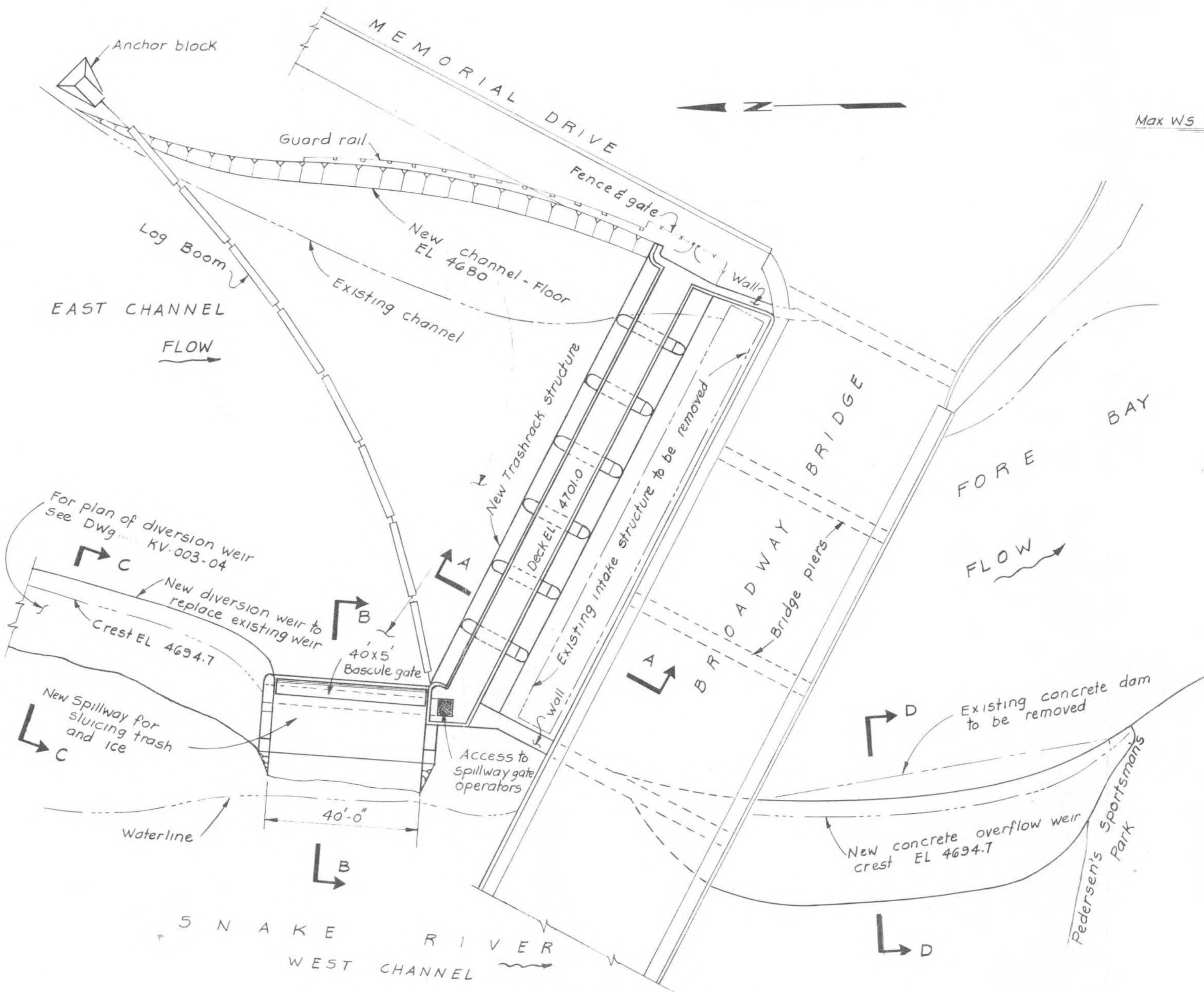
TRASHRACK STRUCTURE AND SPILLWAY

Scale 10 0 10 20 Feet




SECTION A-A

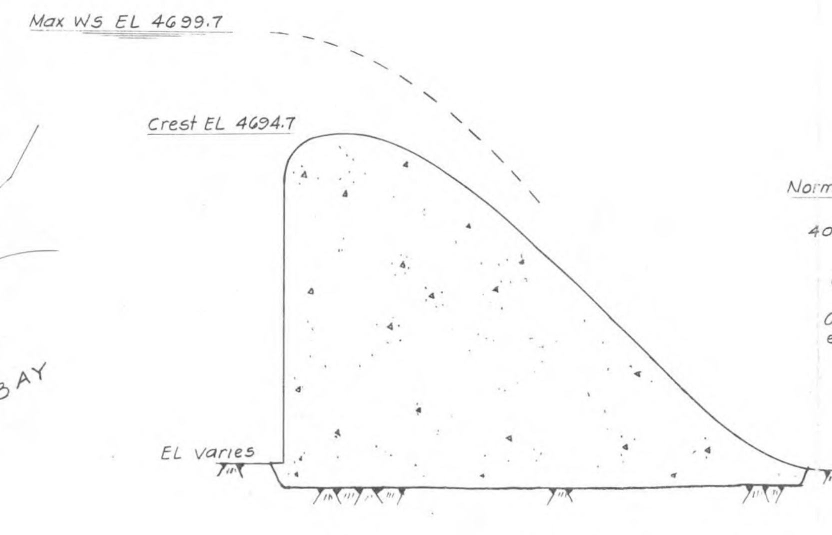
Scale 5 0 5 Feet




PLAN

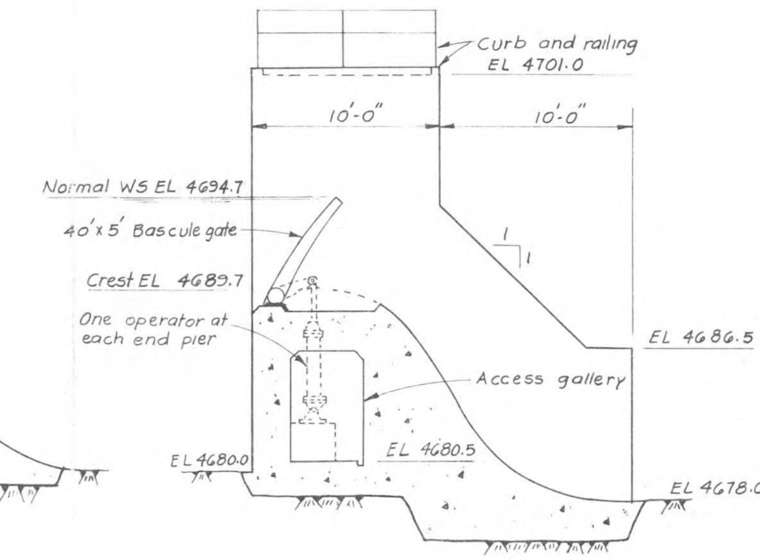
TRASHRACK STRUCTURE, SPILLWAY AND DIVERSION WEIR

Scale 20 0 20 40 Feet




SECTION D-D

Scale 5 0 5 Feet




SECTION B-B

Scale 5 0 5 Feet

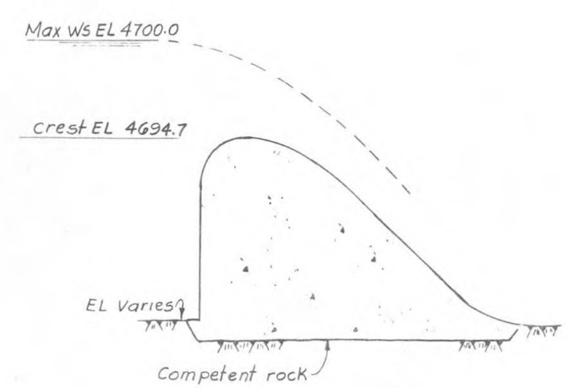
NOTE

The trashrack structure shown on this drawing applies to Powerhouse Alternatives 1, 2 and 4

REFERENCE DRAWING

General Plan ------- KV-03-004

Scale as noted




SECTION C-C

Scale 5 0 5 Feet

CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

TRASHRACK STRUCTURE, SPILLWAY AND DIVERSION WEIR

INTERNATIONAL ENGINEERING COMPANY, INC.

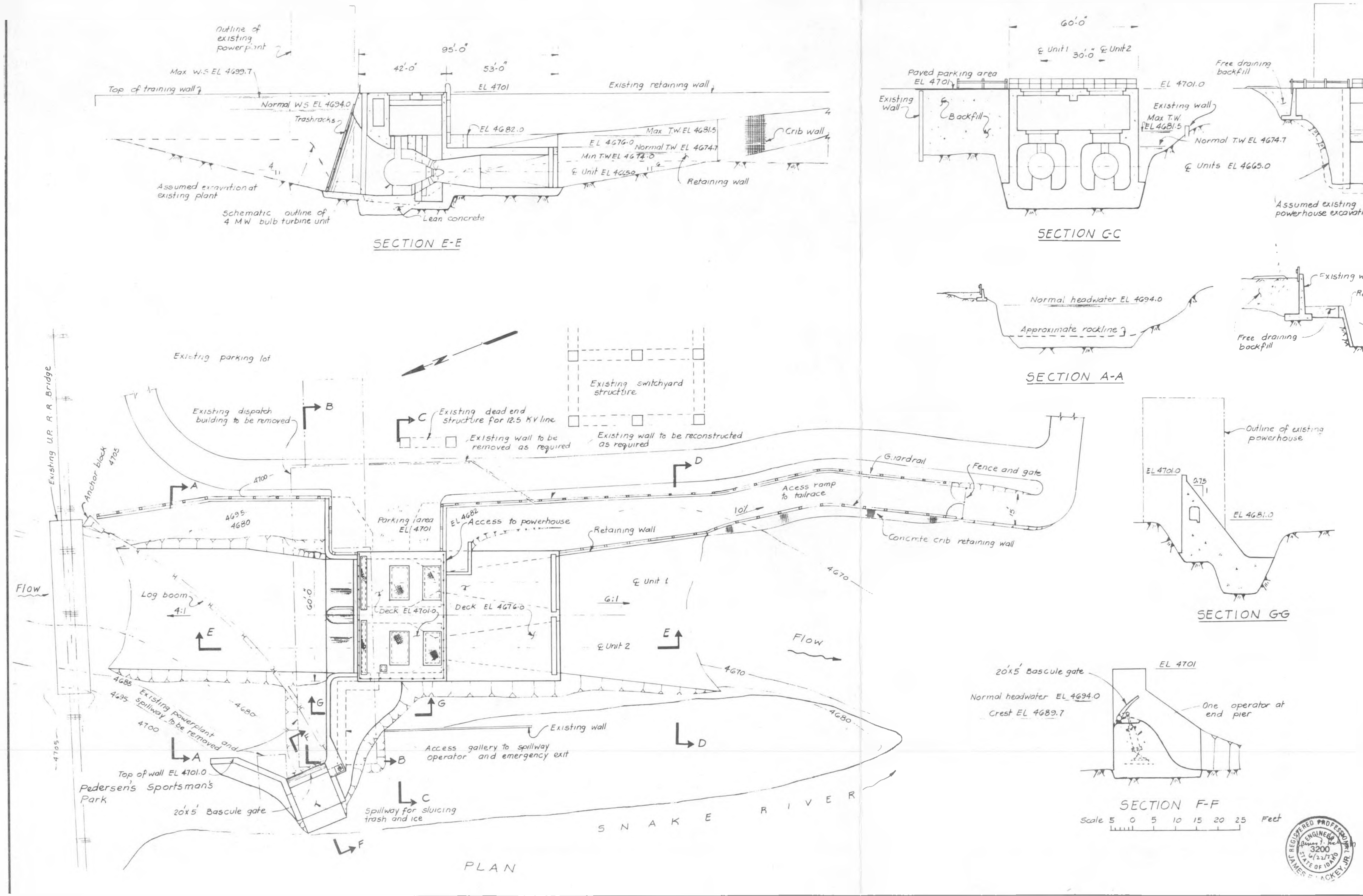
DESIGNED P.K.M. CHECKED SBZ APPROVED
DRAWN SBZ INSPECT
RECOMMENDED

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DATE JUNE 1977

DRAWING NO. KV-03-005

REGISTERED PROFESSIONAL ENGINEER 3200 STATE OF IDAHO JAMES F. LACKEY, JR.




**CITY OF IDAHO FALLS**

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

**TWO 4 MW BULB TURBINE UNITS**

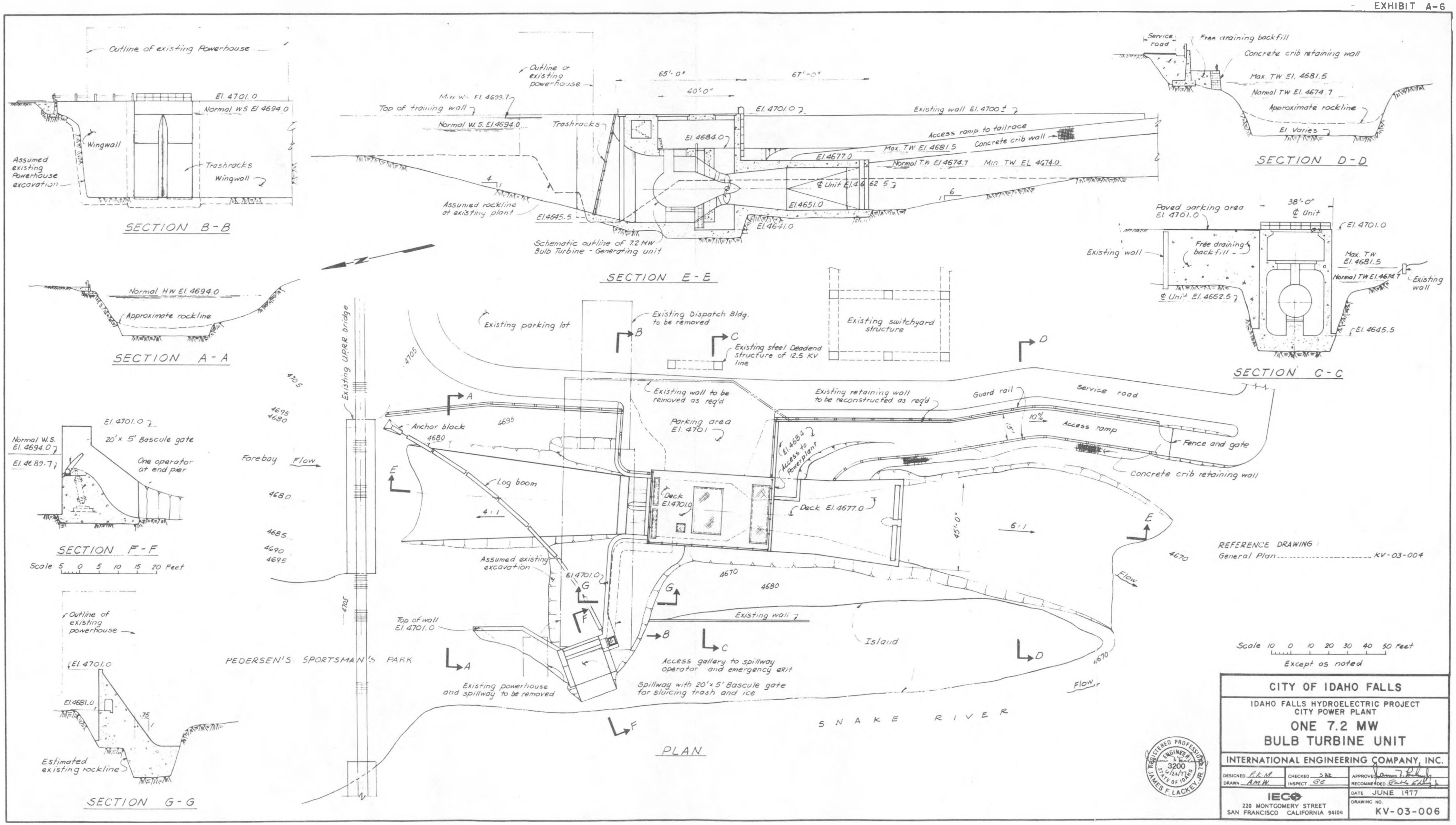
INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED R.L.M. CHECKED SBB APPROVED
DRAWN DBB INSPECT RE RECOMMENDED

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DATE JUNE 1977
DRAWING NO KV-03-007

EXHIBIT A-6


Outline of existing Powerhouse
El. 4701.0
Normal WS El 4694.0
Wingwall
Assumed existing Powerhouse excavation
Trashracks
Wingwall
SECTION B-B
Outline of existing powerhouse
Max W.S. El. 4699.7
Top of training wall
Normal W.S. El 4694.0
Trashracks
65'-0"
67'-0"
40'-0"
El. 4701.0
Existing wall El. 4700±
El. 4684.0
Access ramp to tailrace
Concrete crib wall
Max. TW El. 4681.5
El. 4677.0
Normal T.W. El 4674.7
Min TW EL 4674.0
℄ Unit El. 4662.5
El. 4651.0
El. 4641.0
El. 4645.5
Assumed rockline at existing plant
Schematic outline of 7.2 MW Bulb Turbine - Generating unit
SECTION E-E
Service road
Free draining backfill
Concrete crib retaining wall
Max TW El. 4681.5
Normal TW El. 4674.7
Approximate rockline
El Varies
SECTION D-D
Paved parking area El. 4701.0
38'-0"
℄ Unit
El. 4701.0
Existing wall
Free draining backfill
Max T.W El. 4681.5
Normal TW El. 4674.7
Existing wall
℄ Unit El. 4662.5
El. 4645.5
SECTION C-C
Normal HW El. 4694.0
Approximate rockline
SECTION A-A
El. 4701.0
Normal W.S. El. 4694.0
20' x 5' Bascule gate
El. 4689.7
One operator at end pier
SECTION F-F
Scale 5 0 5 10 15 20 Feet
Outline of existing powerhouse
El. 4701.0
El. 4681.0
.75
Estimated existing rockline
SECTION G-G
Existing UPRR bridge
Existing parking lot
Existing Dispatch Bldg. to be removed
Existing steel Deadend structure of 12.5 KV line
Existing switchyard structure
Existing wall to be removed as req'd
Parking area El. 4701
Existing retaining wall to be reconstructed as req'd
Guard rail
Service road
Access ramp
10%
Fence and gate
Concrete crib retaining wall
Anchor block
Forebay
Flow
Log boom
El. 4684 Access to Powerplant
Deck El. 4701.0
Deck El. 4677.0
45'-0"
6:1
4:1
Assumed existing excavation
El. 4701.0
Existing wall
Island
Top of wall El. 4701.0
PEDERSEN'S SPORTSMAN'S PARK
Existing powerhouse and spillway to be removed
Access gallery to spillway operator and emergency exit
Spillway with 20' x 5' Bascule gate for sluicing trash and ice
SNAKE RIVER
PLAN
REFERENCE DRAWING:
General Plan ........ KV-03-004
Scale 10 0 10 20 30 40 50 Feet
Except as noted
CITY OF IDAHO FALLS
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT
ONE 7.2 MW
BULB TURBINE UNIT
INTERNATIONAL ENGINEERING COMPANY, INC.
DESIGNED
DRAWN
CHECKED
INSPECT
APPROVED
RECOMMENDED
DATE JUNE 1977
DRAWING NO.
KV-03-006
IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104
REGISTERED PROFESSIONAL ENGINEER
3200
STATE OF IDAHO
JAMES F. LACKEY, JR.

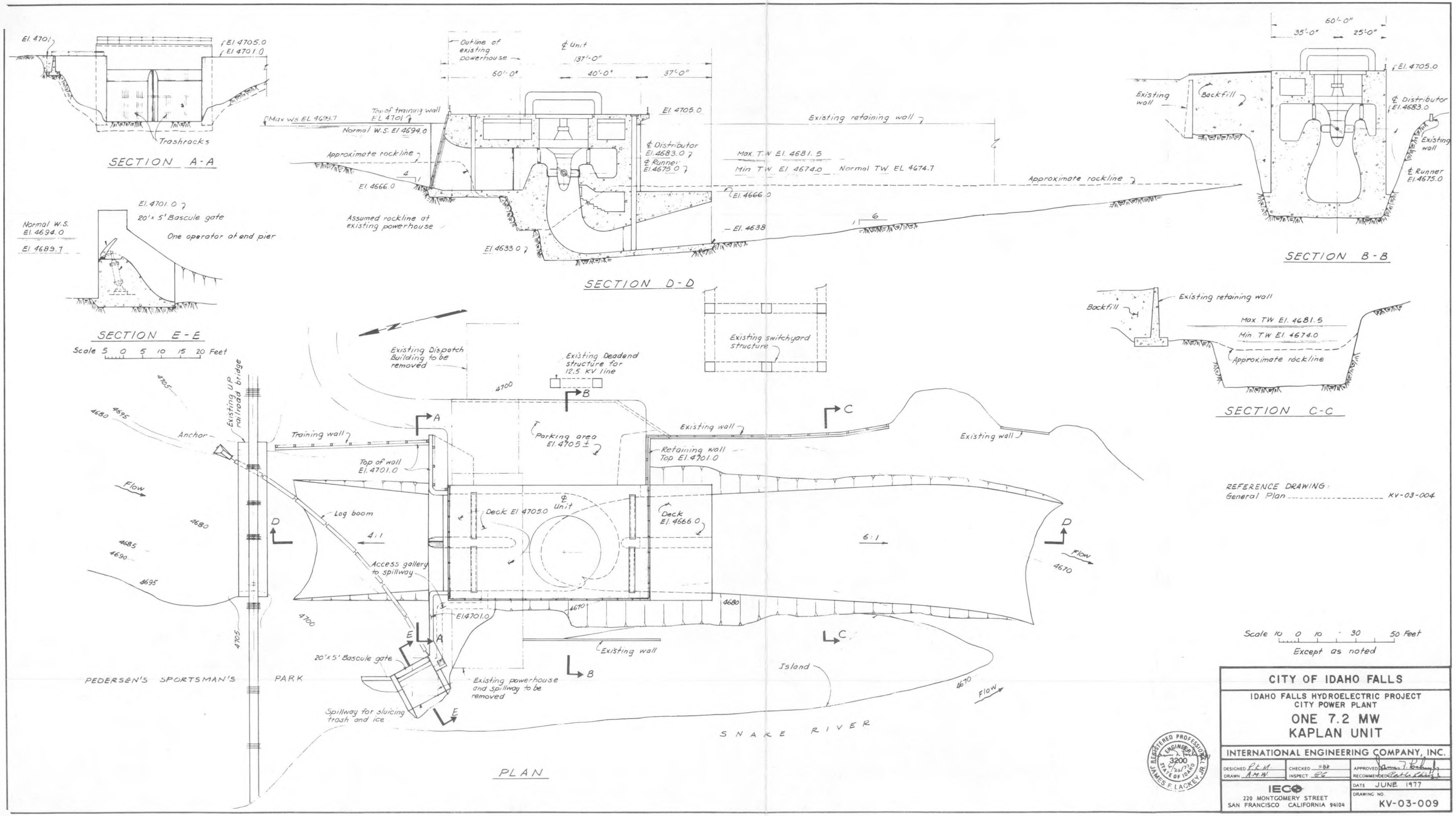
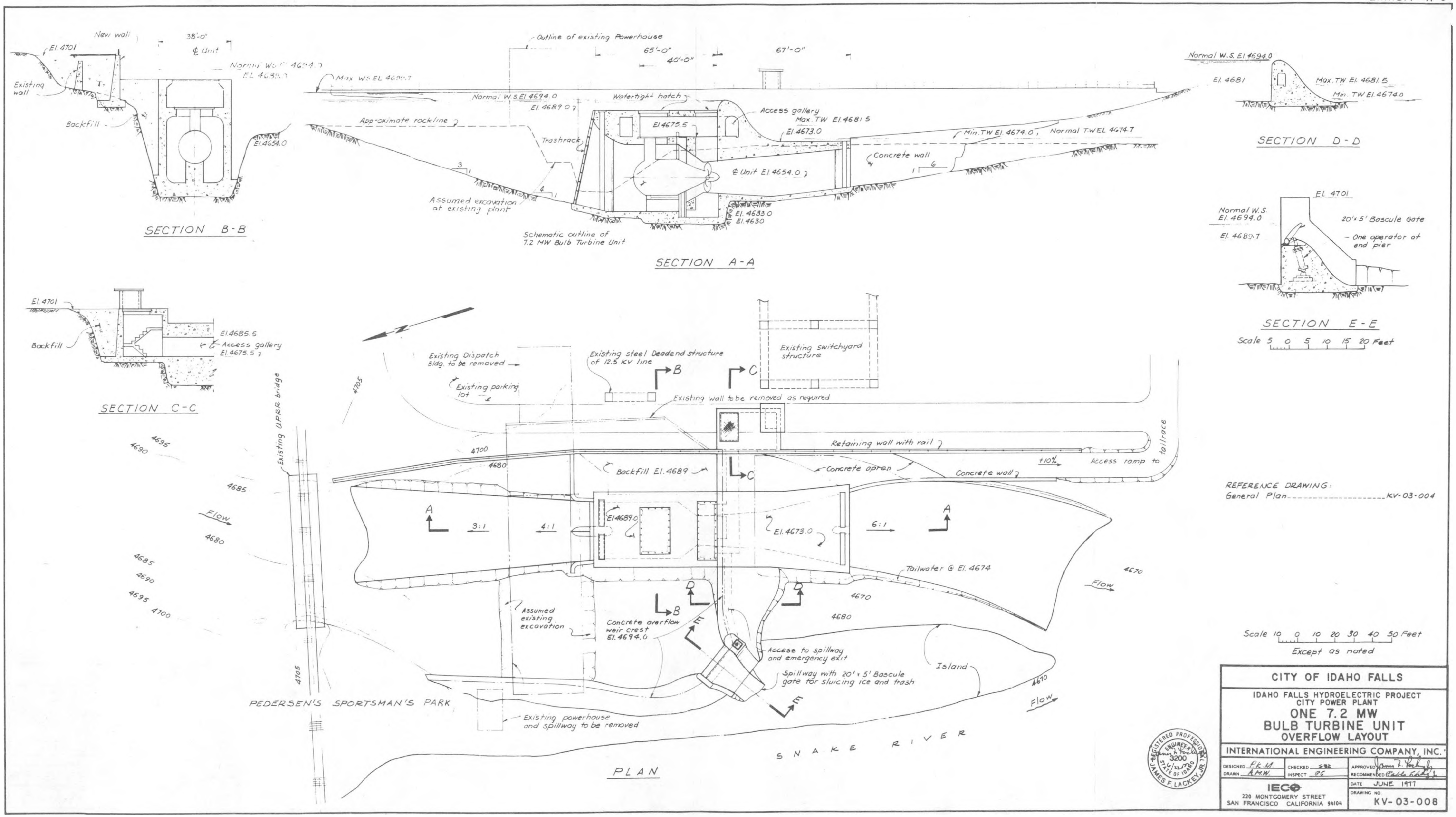
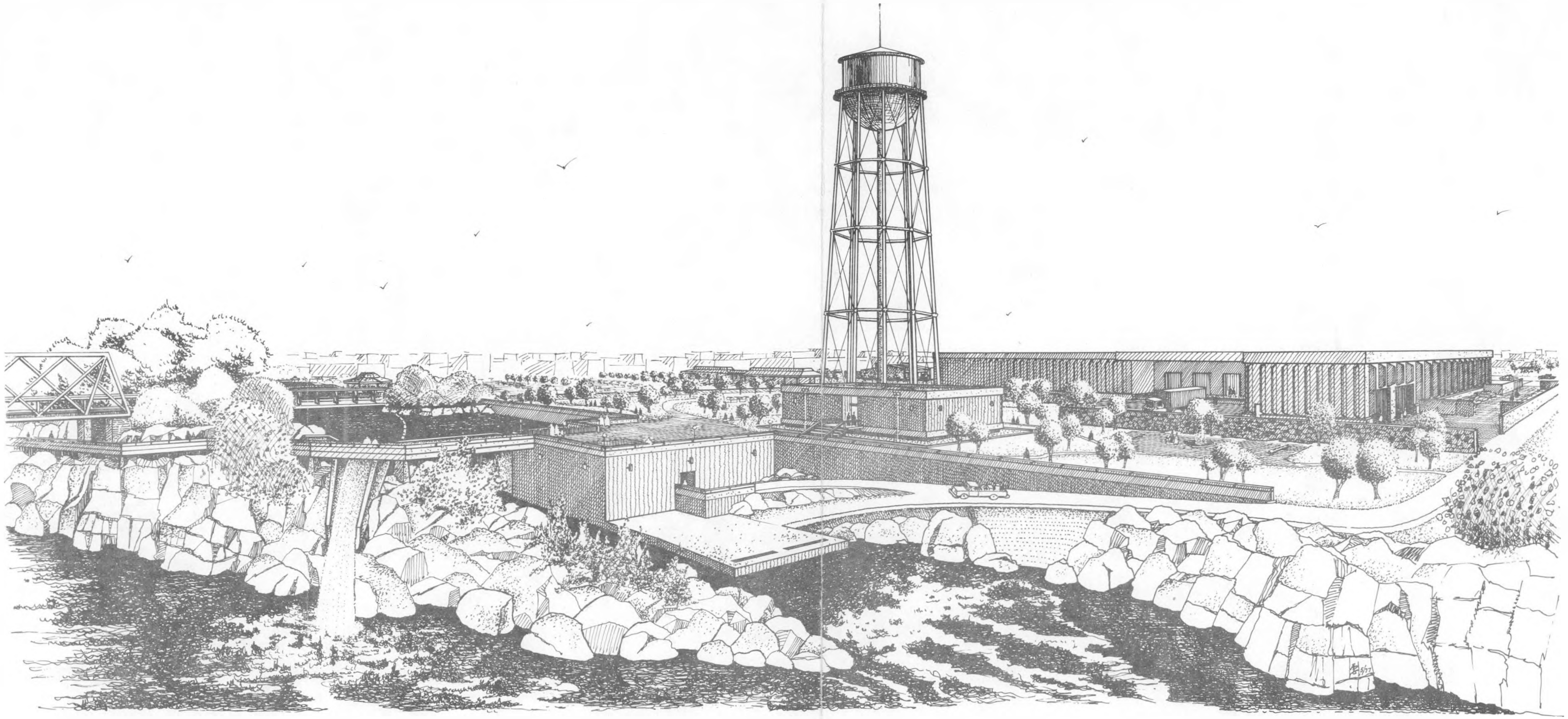

El. 4701
El. 4705.0
El. 4701.0
Trashracks
SECTION A-A
Normal W.S.
El. 4694.0
El. 4689.7
El. 4701.0
20' x 5' Bascule gate
One operator at end pier
SECTION E-E
Scale 5 0 5 10 15 20 Feet
Outline of existing powerhouse
℄ Unit
137'-0"
60'-0"
40'-0"
37'-0"
Max WS EL 4699.7
Top of training wall EL 4701
Normal W.S. El 4694.0
El. 4705.0
Approximate rockline
El. 4666.0
Assumed rockline at existing powerhouse
El 4633.0
℄ Distributor El. 4683.0
℄ Runner El. 4675.0
Existing retaining wall
Max. T.W El. 4681.5
Min T.W El. 4674.0
Normal TW EL 4674.7
El. 4666.0
El. 4638
Approximate rockline
SECTION D-D
60'-0"
35'-0"
25'-0"
El. 4705.0
Existing wall
Backfill
℄ Distributor El. 4683.0
Existing wall
℄ Runner El. 4675.0
SECTION B-B
Existing retaining wall
Backfill
Max TW El. 4681.5
Min TW El. 4674.0
Approximate rockline
SECTION C-C
Existing Dispatch Building to be removed
Existing Deadend structure for 12.5 KV line
Existing switchyard structure
Existing UP railroad bridge
Anchor
Training wall
Top of wall El. 4701.0
Parking area El. 4705 ±
Existing wall
Retaining wall Top El. 4701.0
Existing wall
Flow
Log boom
4:1
Deck El 4705.0
℄ Unit
Deck El. 4666.0
6:1
Access gallery to spillway
El 4701.0
Existing wall
20' x 5' Bascule gate
Existing powerhouse and spillway to be removed
Spillway for sluicing trash and ice
Island
PEDERSEN'S SPORTSMAN'S PARK
SNAKE RIVER
PLAN
REFERENCE DRAWING: General Plan KV-03-004
Scale 10 0 10 30 50 Feet
Except as noted
CITY OF IDAHO FALLS
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT
ONE 7.2 MW
KAPLAN UNIT
INTERNATIONAL ENGINEERING COMPANY, INC.
IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104
DATE JUNE 1977
DRAWING NO. KV-03-009

EXHIBIT A-8




| CITY OF IDAHO FALLS | |
|---|---|
| IDAHO FALLS HYDROELECTRIC PROJECT<br>CITY POWER PLANT<br>ONE 7.2 MW<br>BULB TURBINE UNIT<br>OVERFLOW LAYOUT | |
| INTERNATIONAL ENGINEERING COMPANY, INC. | |
| DESIGNED P.K.M. DRAWN A.M.W. CHECKED INSPECT | APPROVED RECOMMENDED |
| IECO<br>220 MONTGOMERY STREET<br>SAN FRANCISCO CALIFORNIA 94104 | DATE JUNE 1977<br>DRAWING NO. KV-03-008 |



CITY OF IDAHO FALLS

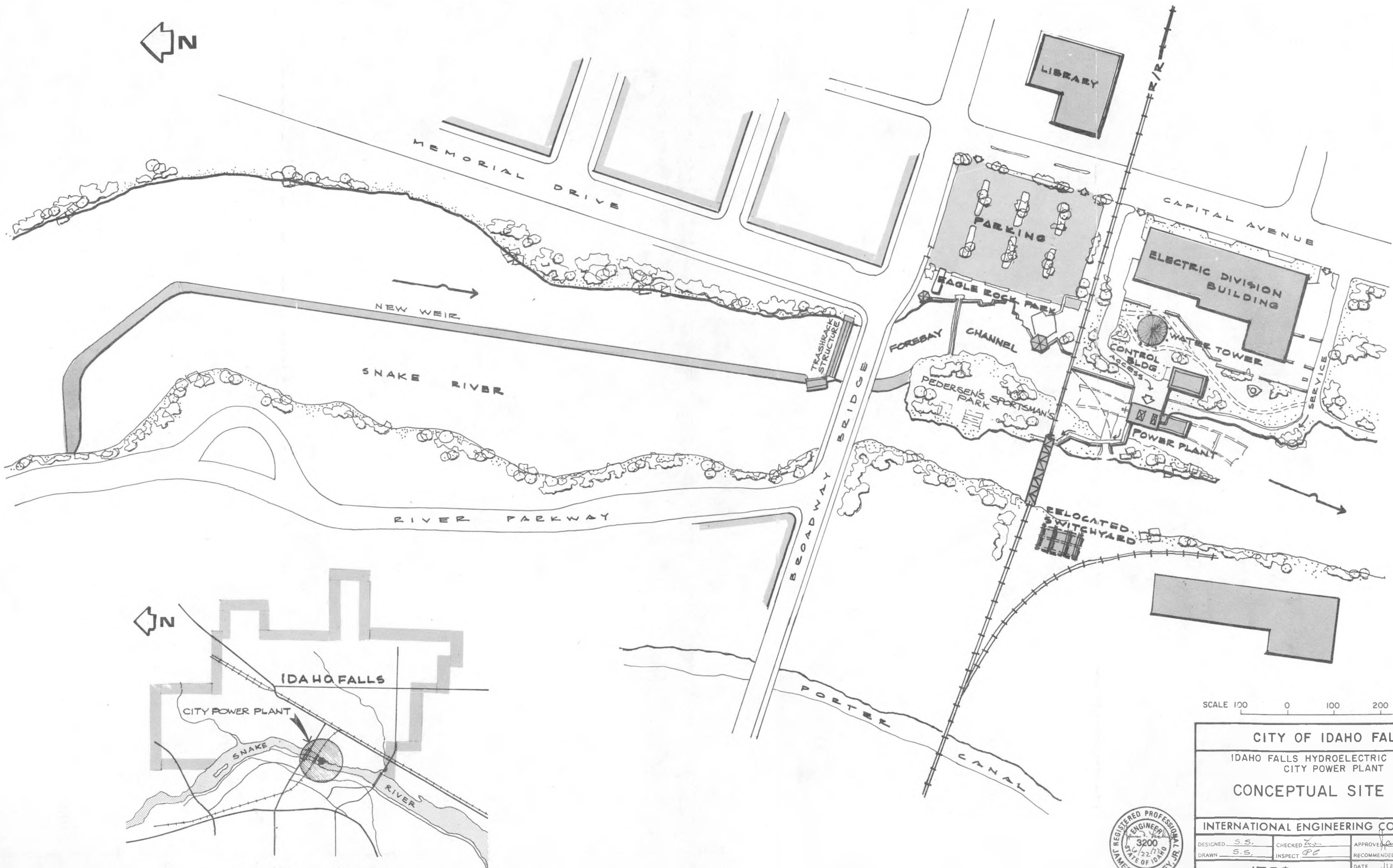
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

POWERHOUSE AREA
PERSPECTIVE

REGISTERED PROFESSIONAL ENGINEER 3200 STATE OF IDAHO JAMES F. LACKEY, JR. 6/22/77

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED K.F.N. | CHECKED | APPROVED |
| DRAWN K.F.N | INSPECT | RECOMMENDED |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-011 |

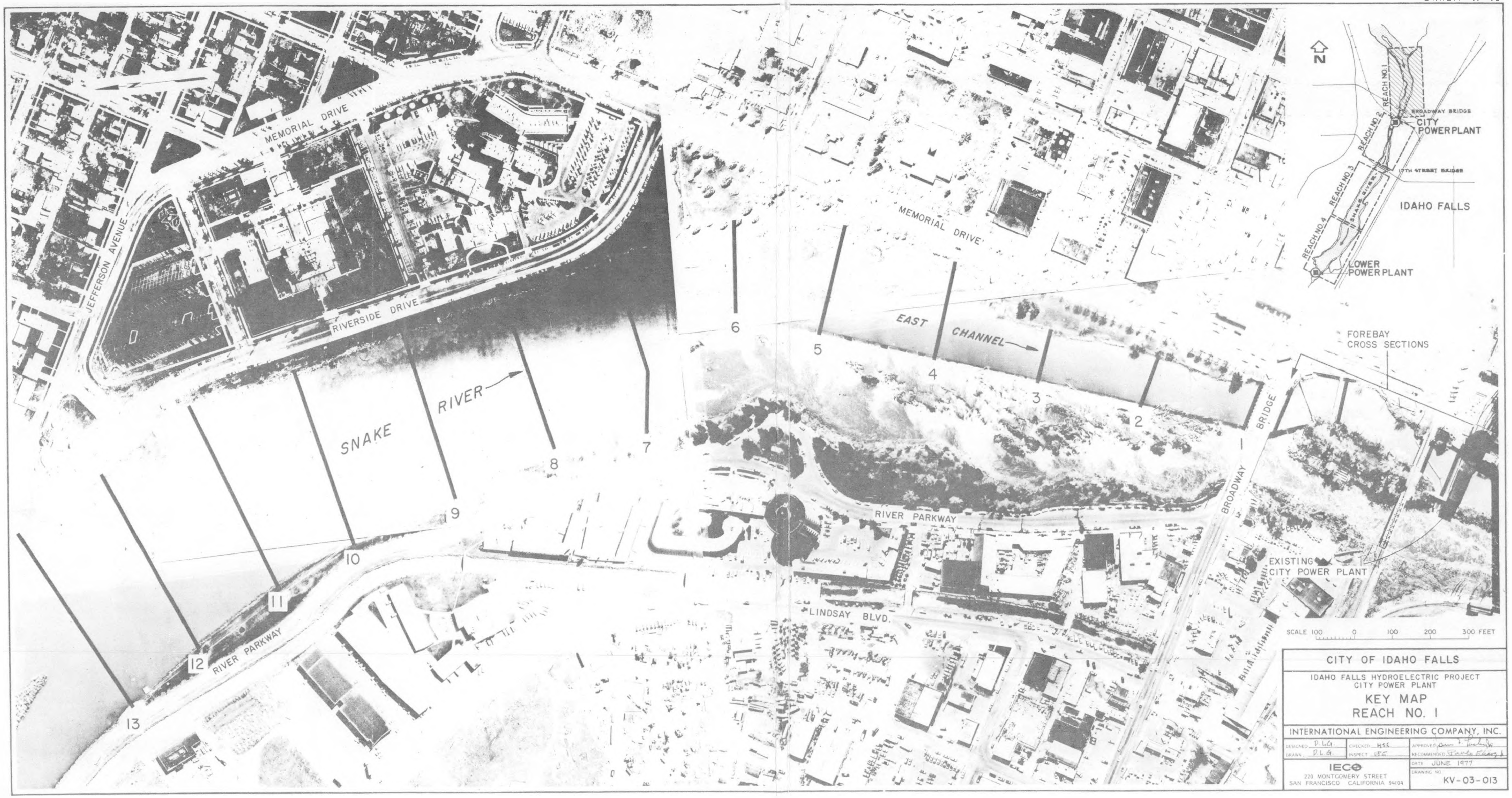


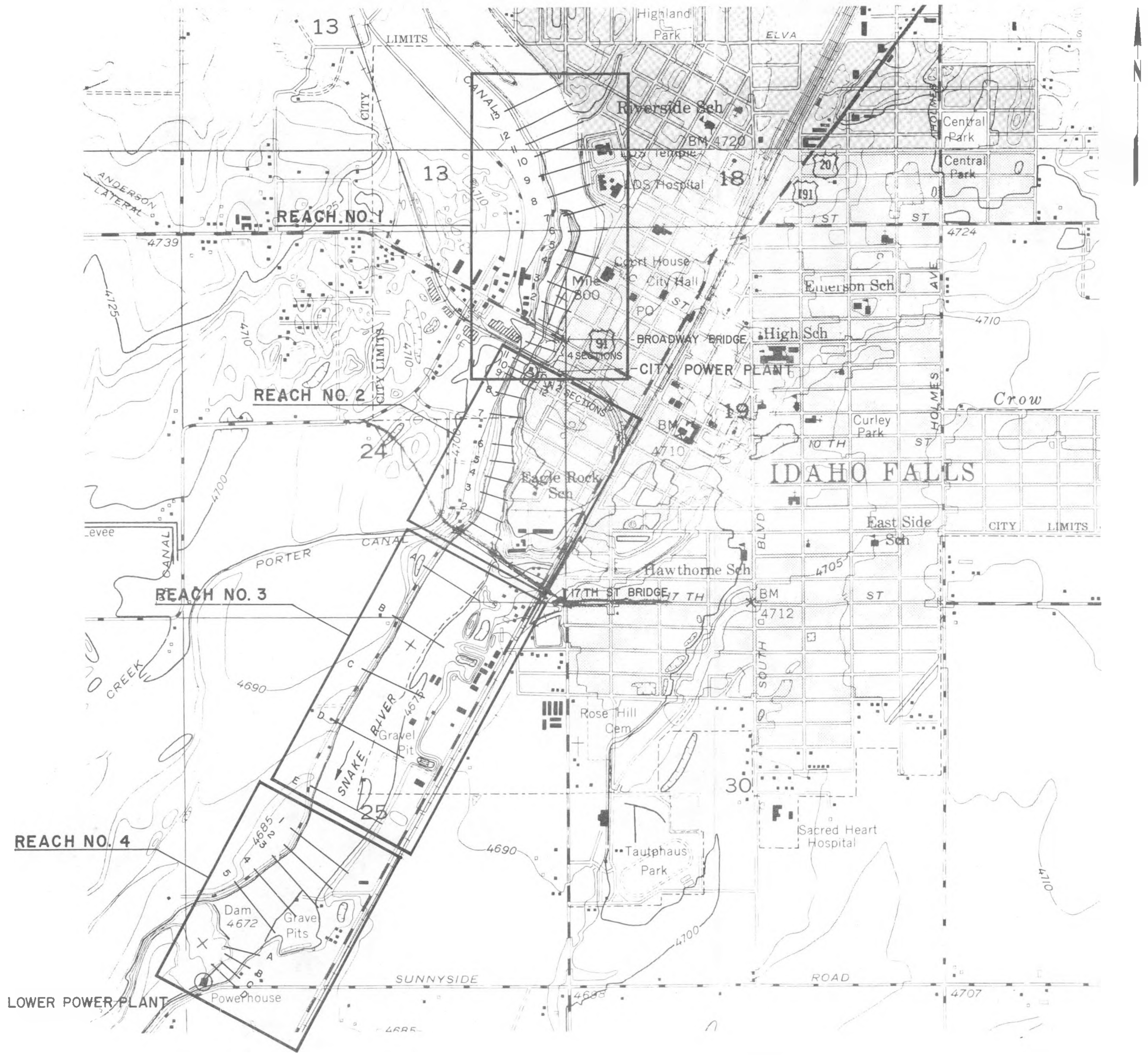

LOCATION MAP

| | | |
|---|---|---|
| CITY OF IDAHO FALLS | | |
| IDAHO FALLS HYDROELECTRIC PROJECT<br>CITY POWER PLANT | | |
| CONCEPTUAL SITE PLAN | | |
| INTERNATIONAL ENGINEERING COMPANY, INC. | | |
| DESIGNED S.S.<br>DRAWN S.S. | CHECKED<br>INSPECT PC | APPROVED<br>RECOMMENDED |
| IECO<br>220 MONTGOMERY STREET<br>SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977<br>DRAWING NO KV-03-010 |

REGISTERED PROFESSIONAL ENGINEER 3200 6/22/77 STATE OF IDAHO JAMES F. LACKEY, JR.

EXHIBIT A-13


N
REACH NO. 1
REACH NO. 2
REACH NO. 3
REACH NO. 4
BROADWAY BRIDGE
CITY POWER PLANT
17TH STREET BRIDGE
SNAKE RIVER
IDAHO FALLS
LOWER POWER PLANT
MEMORIAL DRIVE
JEFFERSON AVENUE
RIVERSIDE DRIVE
SNAKE RIVER
EAST CHANNEL
FOREBAY CROSS SECTIONS
BROADWAY BRIDGE
RIVER PARKWAY
LINDSAY BLVD.
RIVER PARKWAY
EXISTING CITY POWER PLANT
1
2
3
4
5
6
7
8
9
10
11
12
13
SCALE 100 0 100 200 300 FEET
CITY OF IDAHO FALLS
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT
KEY MAP
REACH NO. 1
INTERNATIONAL ENGINEERING COMPANY, INC.
DESIGNED D.L.G.
DRAWN D.L.G.
CHECKED HSE
APPROVED
RECOMMENDED
DATE JUNE 1977
IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104
DRAWING NO. KV-03-013




NOTE:

RIVER CROSS SECTIONS PROVIDED BY THE ELECTRIC DIVISION HAVE BEEN REDRAWN AND ARRANGED AS FOLLOWS:

NORTH OF THE POWER PLANT

REACH NO. 1:

CROSS SECTIONS 1-13 NORTH OF BROADWAY AND 4 CROSS SECTIONS OF THE CITY POWER PLANT FOREBAY.

SOUTH OF THE POWER PLANT

REACH NO. 2:

CROSS SECTIONS 1-12 NORTH OF 17TH STREET BRIDGE AND CROSS SECTIONS 0+30 AND 1+30 DOWNSTREAM FROM THE CITY POWER PLANT.

REACH NO. 3:

CROSS SECTIONS A-E SOUTH OF 17TH STREET BRIDGE.

REACH NO. 4:

CROSS SECTIONS A-D AND 1-5 NORTH OF THE LOWER POWER PLANT.

SCALE 1000 0 1000 2000 FEET

CITY OF IDAHO FALLS

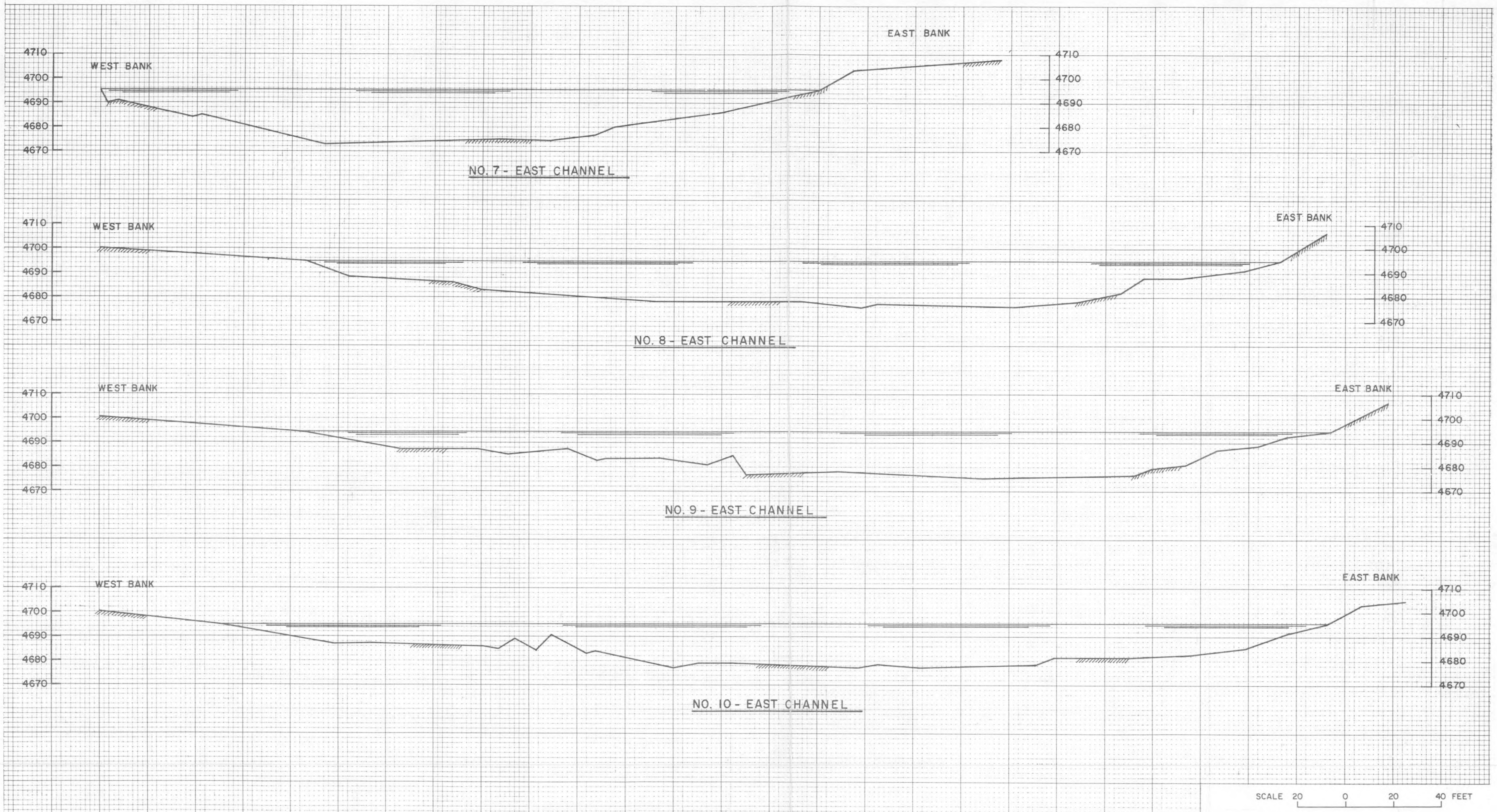
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

KEY MAP
CROSS SECTION LOCATIONS

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED D.L.G. / DRAWN D.L.G. | CHECKED MSE / INSPECT PE | APPROVED [signature] / RECOMMENDED [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 / DRAWING NO KV-03-012 |

EXHIBIT A-15



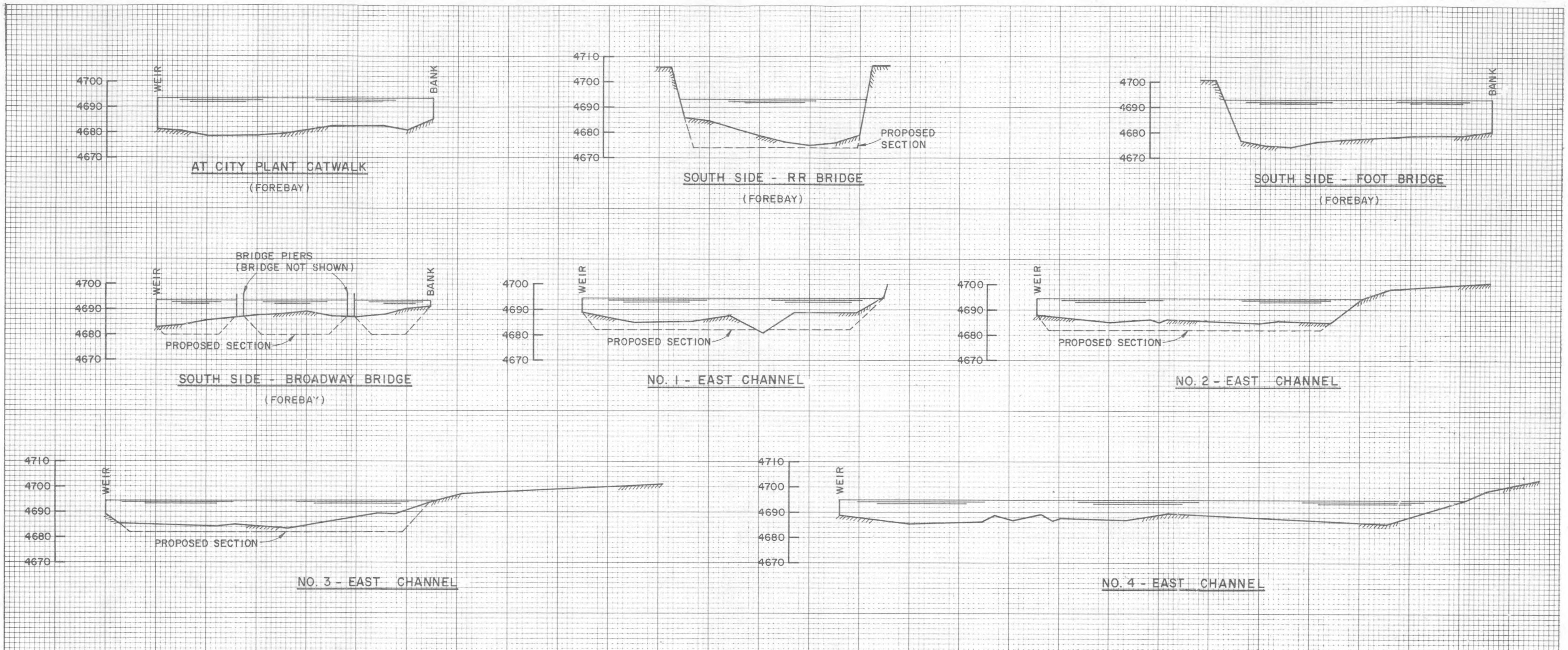

CITY OF IDAHO FALLS

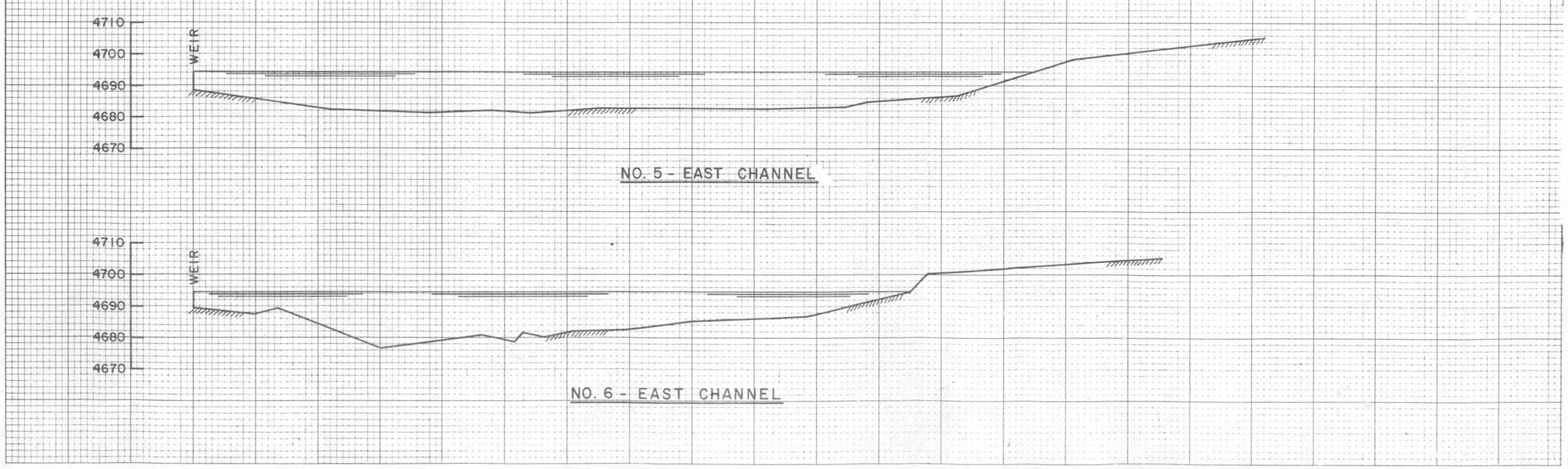
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

CROSS SECTIONS
NORTH OF POWER PLANT
REACH I SHEET 2 OF 3

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED D.L.G. | CHECKED HSE | APPROVED [signature] |
| DRAWN D.L.G. | INSPECT [illegible] | RECOMMENDED [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-015 |




NOTES:

1. ALL CROSS SECTIONS ARE SHOWN LOOKING UPSTREAM AT LOCATIONS INDICATED ON THE KEY MAP.

2. CROSS SECTIONS WERE REDRAWN FROM ORIGINAL CROSS SECTIONS FURNISHED BY THE ELECTRIC DIVISION.

SCALE 20 0 20 40 FEET

CITY OF IDAHO FALLS

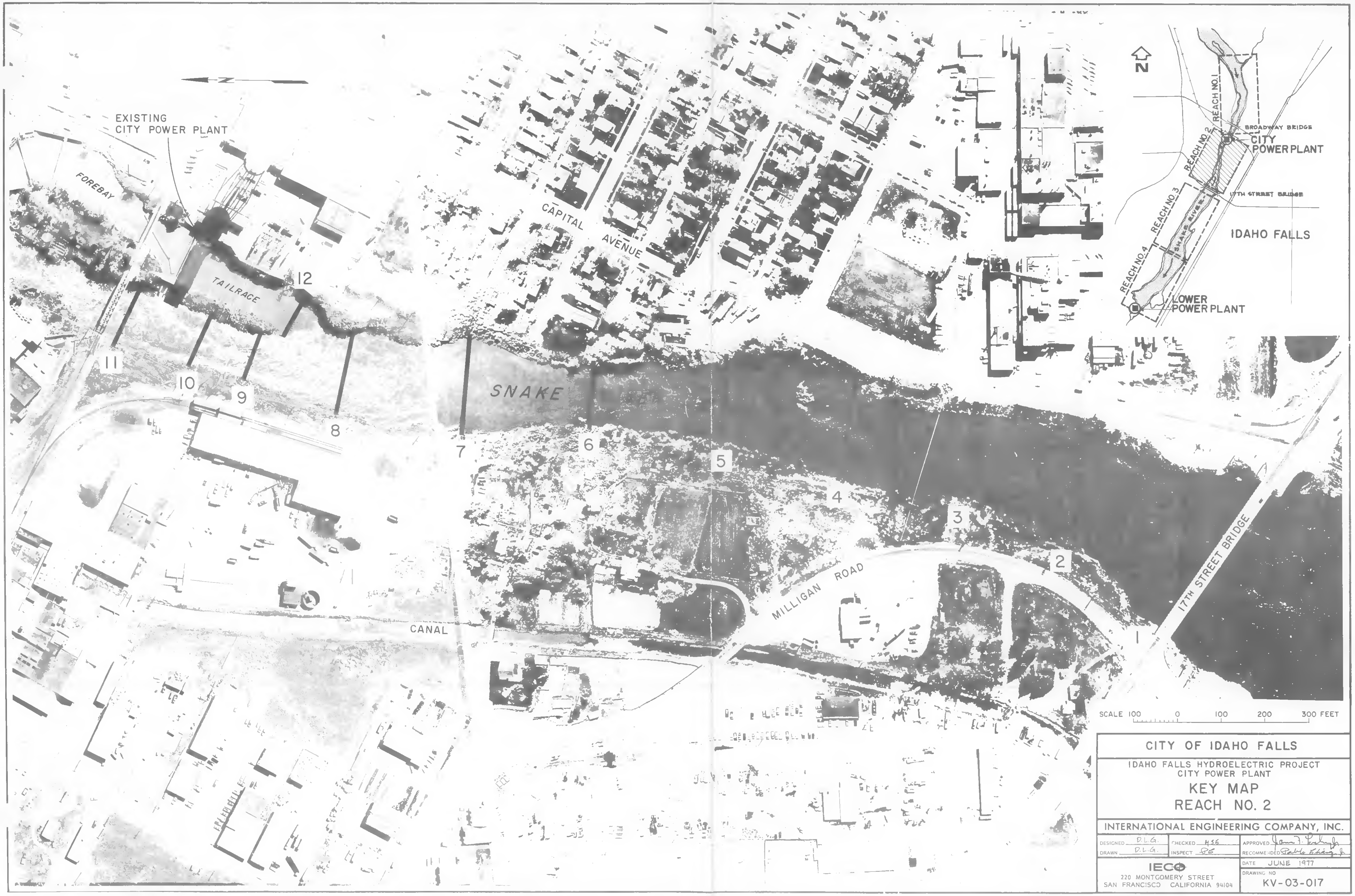
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

CROSS SECTIONS
NORTH OF POWER PLANT
REACH I SHEET I OF 3

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED D.L.G. | CHECKED HSE | APPROVED [signature] |
| DRAWN D.L.G. | INSPECT PG | RECOMMENDED [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO. KV-03-014 |

EXHIBIT A-17



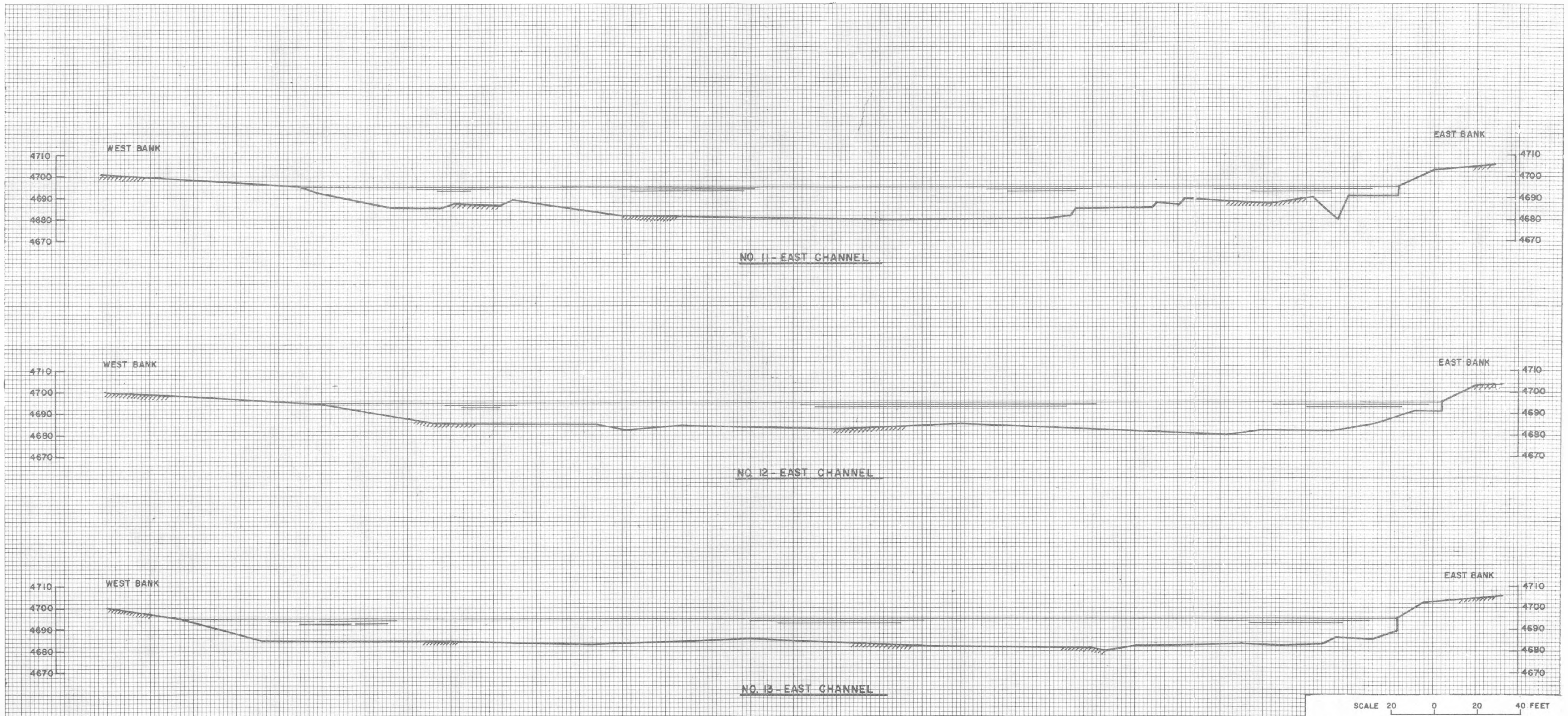

CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

KEY MAP
REACH NO. 2

INTERNATIONAL ENGINEERING COMPANY, INC.

| | | |
|---|---|---|
| DESIGNED D.L.G. | CHECKED HSS | APPROVED [signature] |
| DRAWN D.L.G. | INSPECT SG | RECOMMENDED [signature] |
| IECO 220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977 |
| | | DRAWING NO KV-03-017 |




CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

# CROSS SECTIONS
## NORTH OF POWER PLANT
REACH I SHEET 3 OF 3

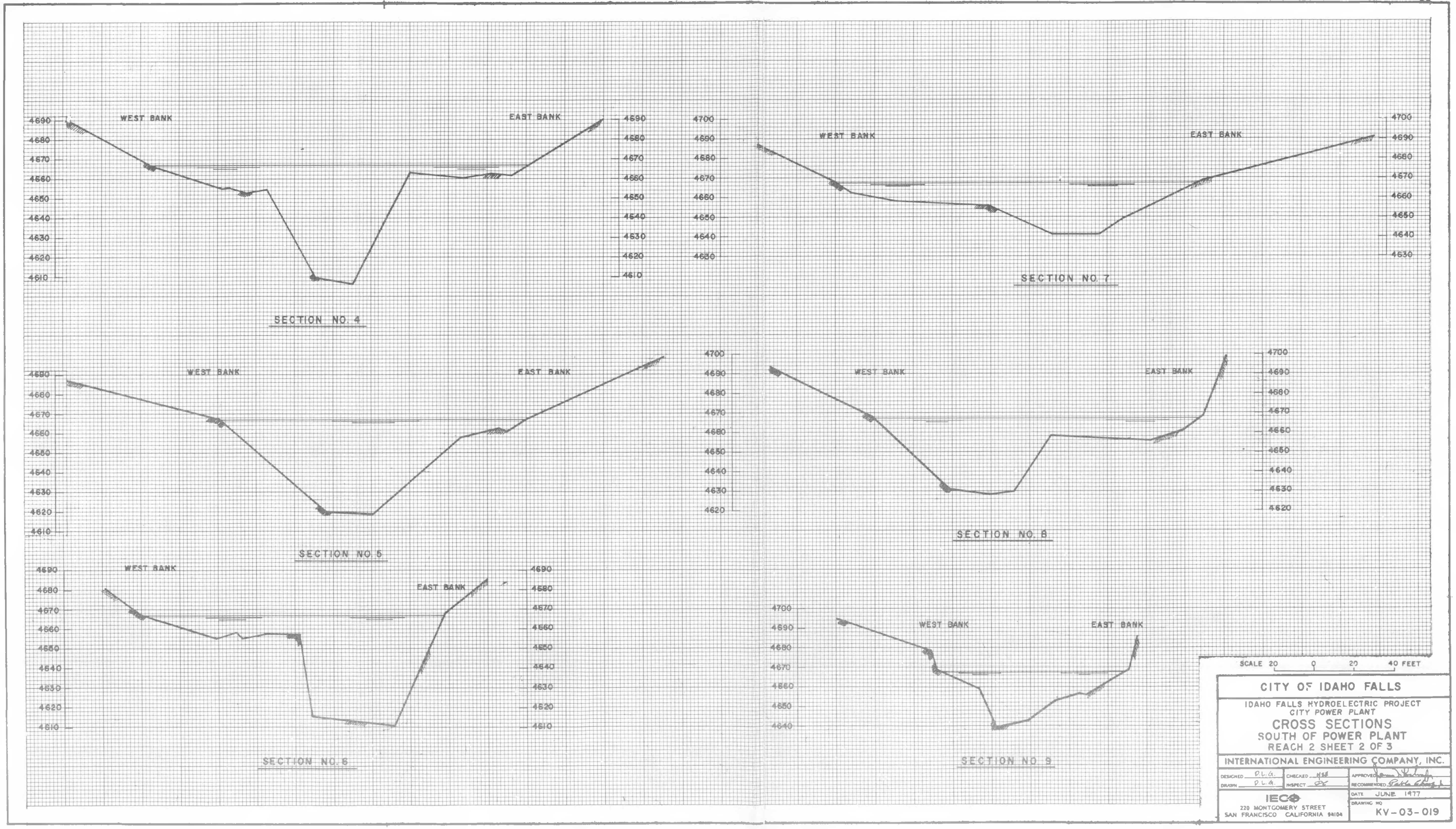
INTERNATIONAL ENGINEERING COMPANY, INC.

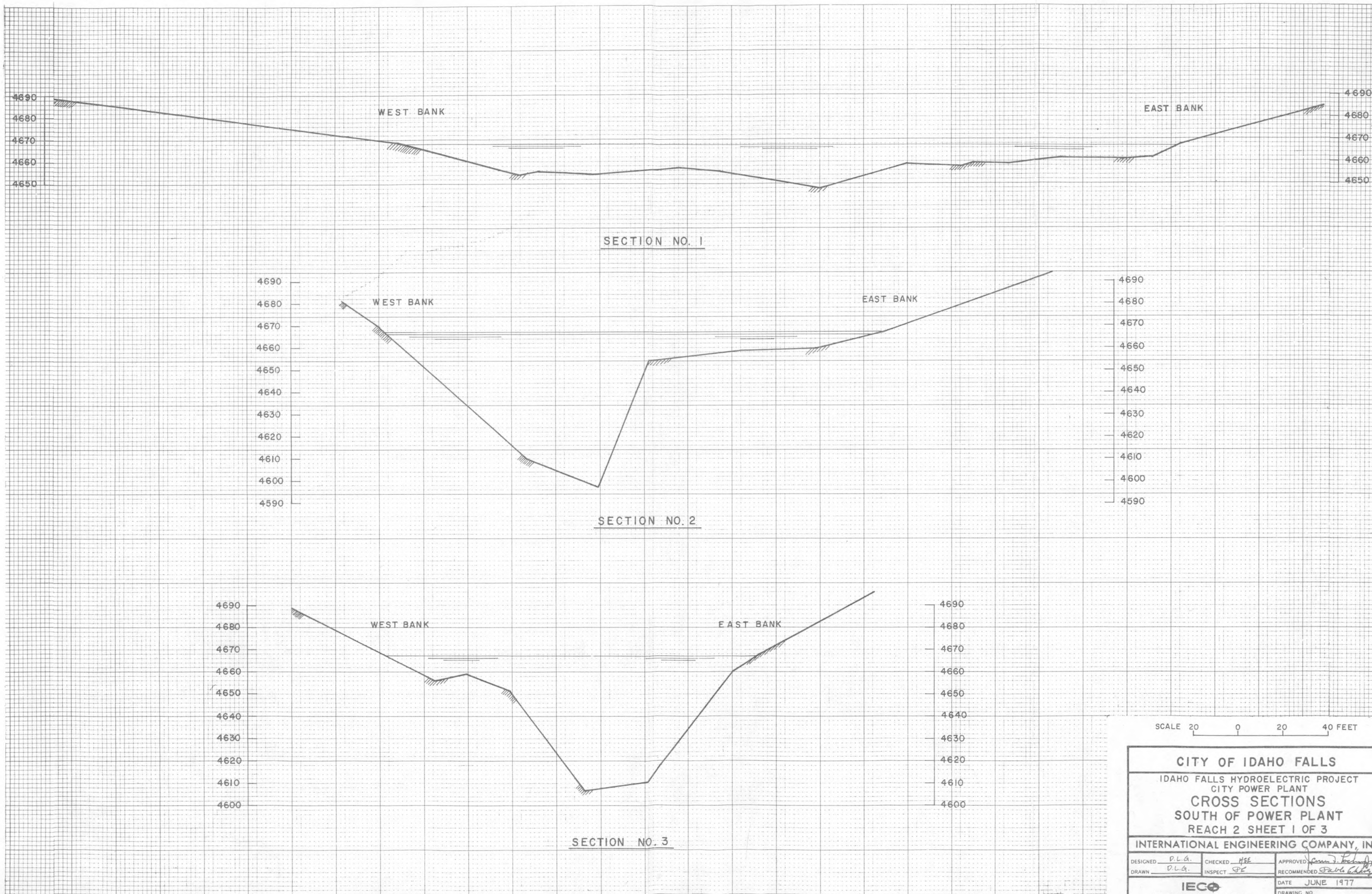
DESIGNED D.L.G. CHECKED HSE APPROVED [signature]
DRAWN D.L.G. INSPECT [initials] RECOMMENDED [signature]
DATE JUNE 1977

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DRAWING NO. KV-03-016

EXHIBIT A-19


WEST BANK
EAST BANK
SECTION NO. 4
SECTION NO. 5
SECTION NO. 6
SECTION NO. 7
SECTION NO. 8
SECTION NO. 9
SCALE 20 0 20 40 FEET
CITY OF IDAHO FALLS
IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT
CROSS SECTIONS
SOUTH OF POWER PLANT
REACH 2 SHEET 2 OF 3
INTERNATIONAL ENGINEERING COMPANY, INC.
DESIGNED D.L.G.
DRAWN D.L.G.
CHECKED
INSPECT
APPROVED
RECOMMENDED
IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104
DATE JUNE 1977
DRAWING NO
KV-03-019




CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

CROSS SECTIONS
SOUTH OF POWER PLANT
REACH 2 SHEET 1 OF 3

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED D.L.G. CHECKED HSE APPROVED [signature]
DRAWN D.L.G. INSPECT [initials] RECOMMENDED [signature]

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DATE JUNE 1977
DRAWING NO. KV-03-018

EXHIBIT A-21


CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

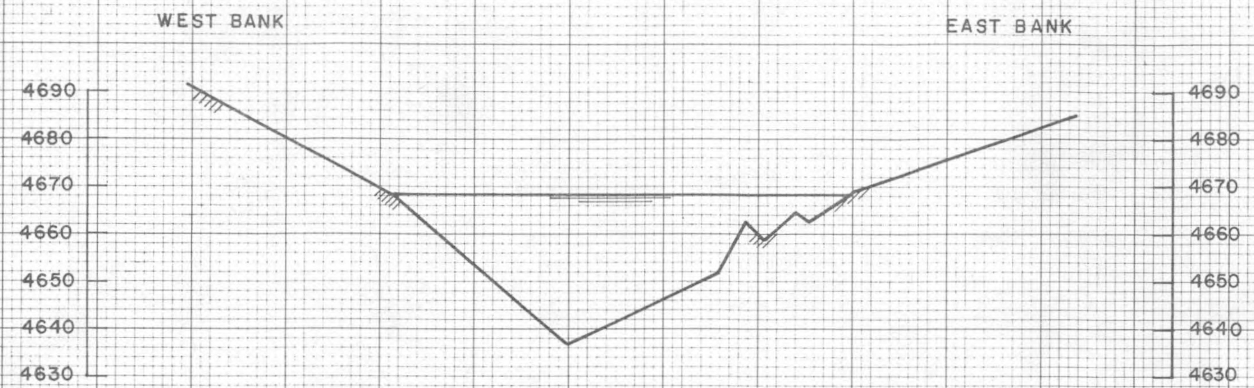
KEY MAP
REACH NO. 3

INTERNATIONAL ENGINEERING COMPANY, INC.

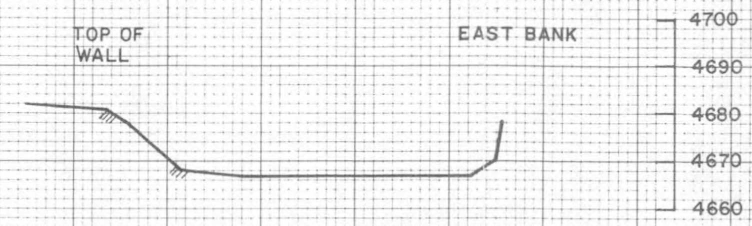
DESIGNED D.L.G. CHECKED MSE APPROVED
DRAWN D.L.G. INSPECTED RECOMMENDED

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

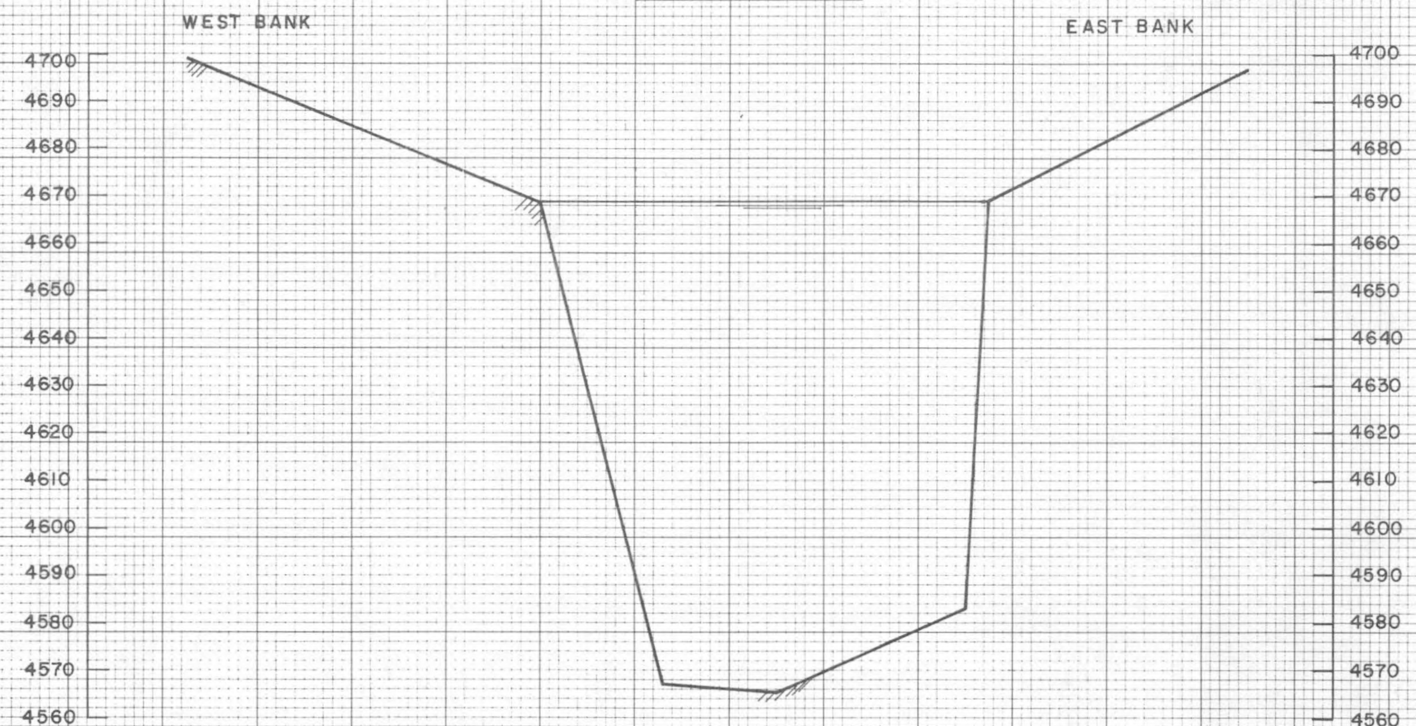
DATE JUNE 1977
DRAWING NO. KV-03-021



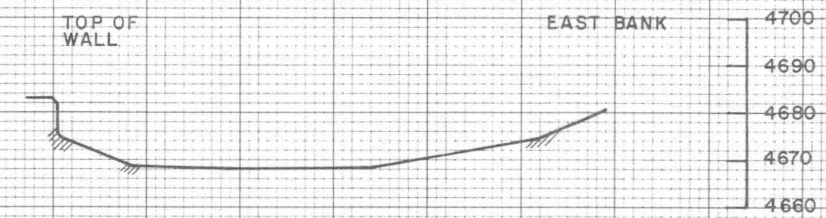

SECTION NO. 10




SECTION NO. 1+30

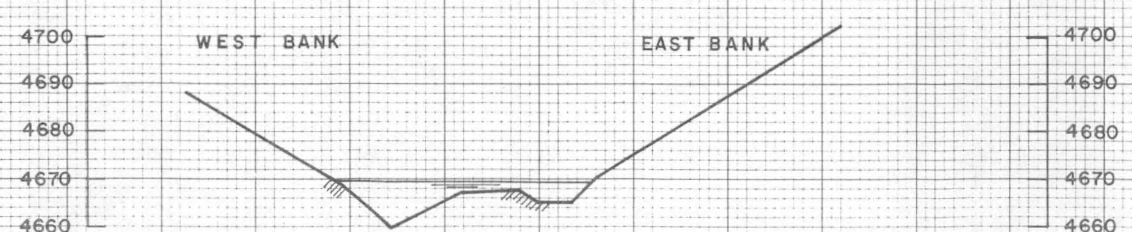



SECTION NO. 11




SECTION NO 0+30

STATION 0+00 IS AT THE DOWNSTREAM FACE OF THE CITY PLANT.




SECTION NO. 12

SCALE 20 0 20 40 FEET

CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

CROSS SECTIONS
SOUTH OF POWER PLANT
REACH 2 SHEET 3 OF 3

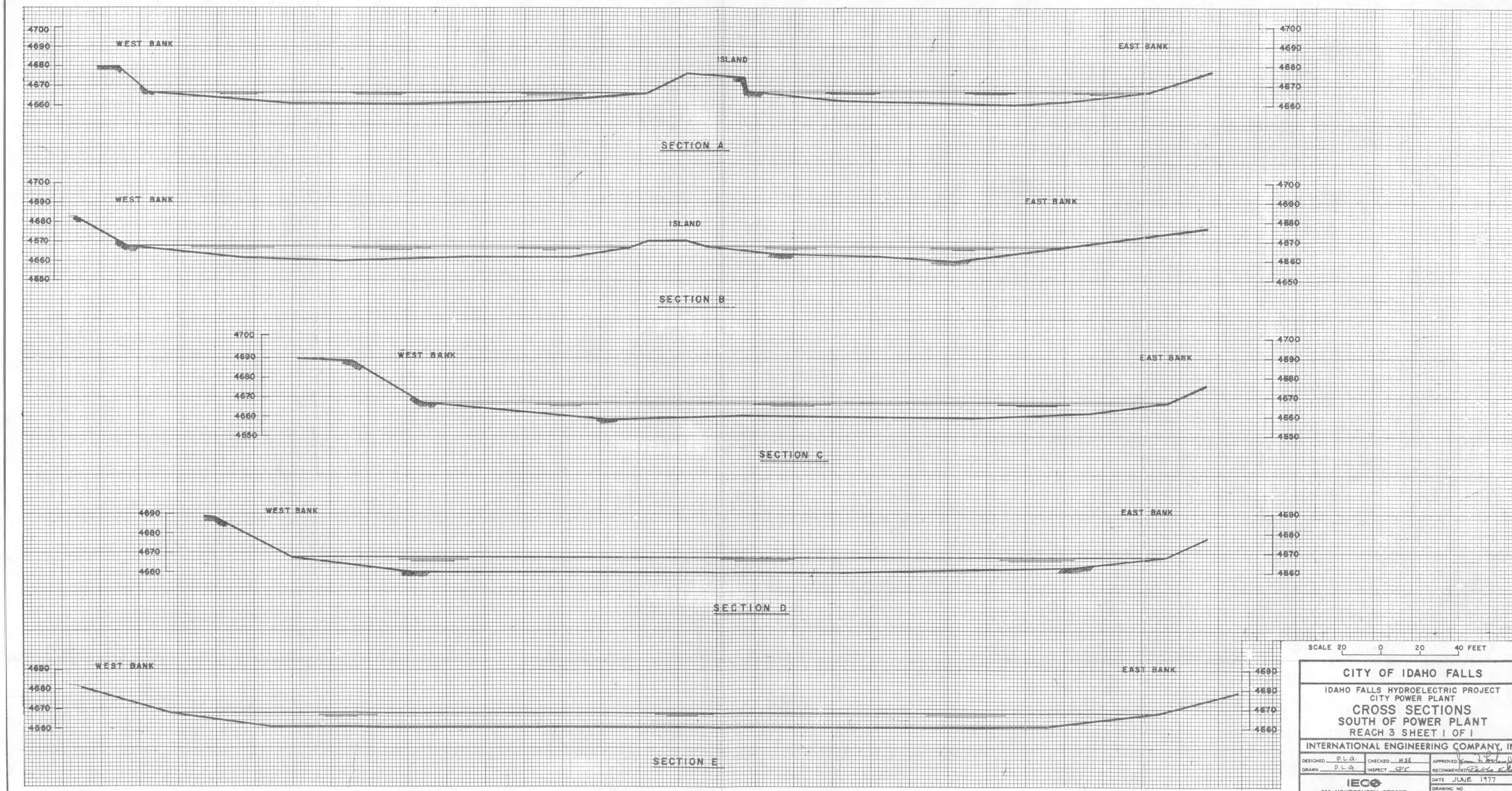
INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED D.L.G. CHECKED HSE APPROVED [signature]
DRAWN D.L.G. INSPECT SPF RECOMMENDED [signature]
DATE JUNE 1977

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DRAWING NO. KV-03-020

EXHIBIT A-22




**CITY OF IDAHO FALLS**

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

**CROSS SECTIONS**
**SOUTH OF POWER PLANT**
REACH 3 SHEET 1 OF 1

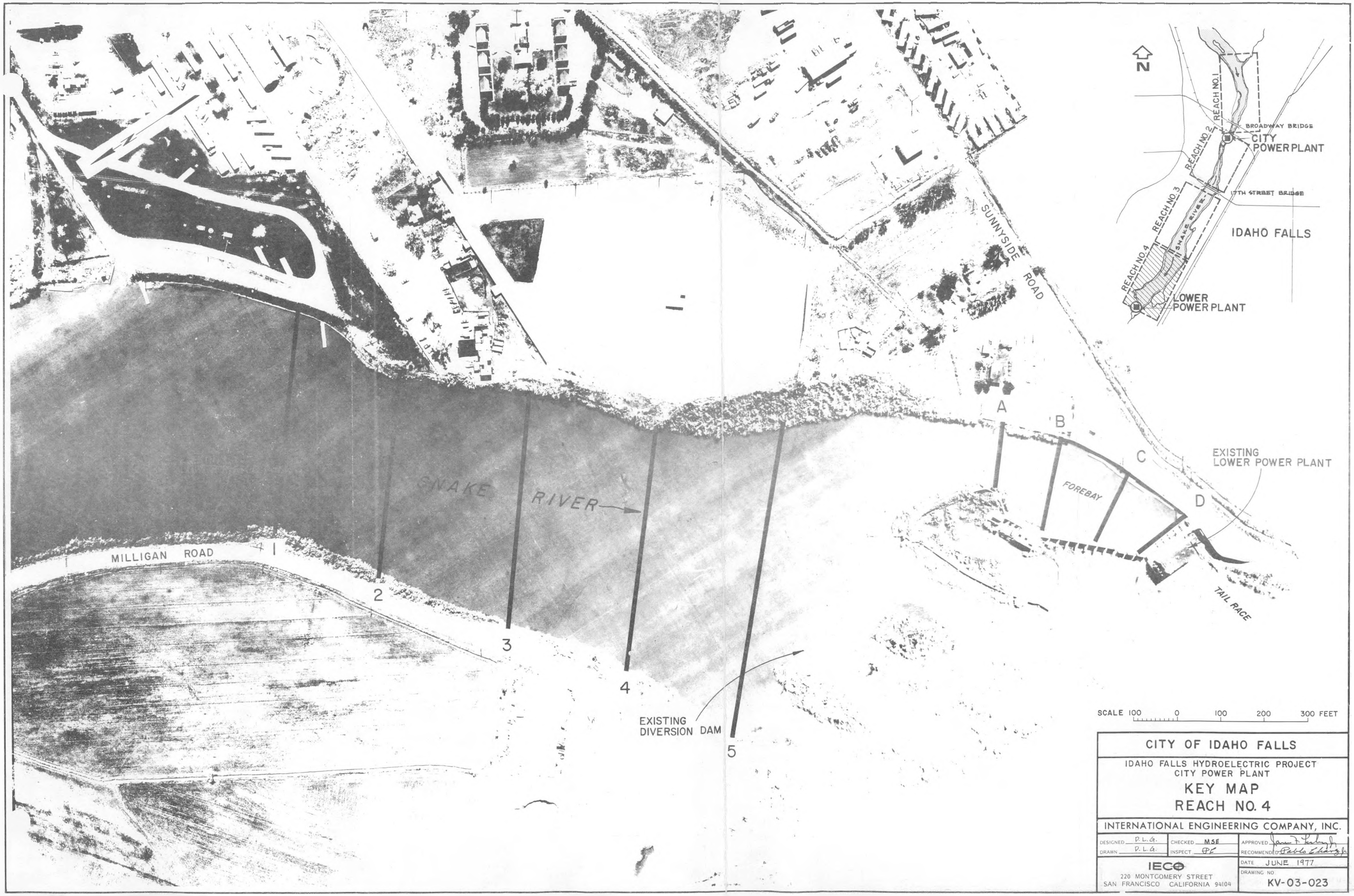
**INTERNATIONAL ENGINEERING COMPANY, INC.**

DESIGNED D.L.G. | CHECKED H.S.E. | APPROVED
DRAWN D.L.G. | INSPECT SPC | RECOMMENDED

DATE JUNE 1977

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DRAWING NO. KV-03-022




CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

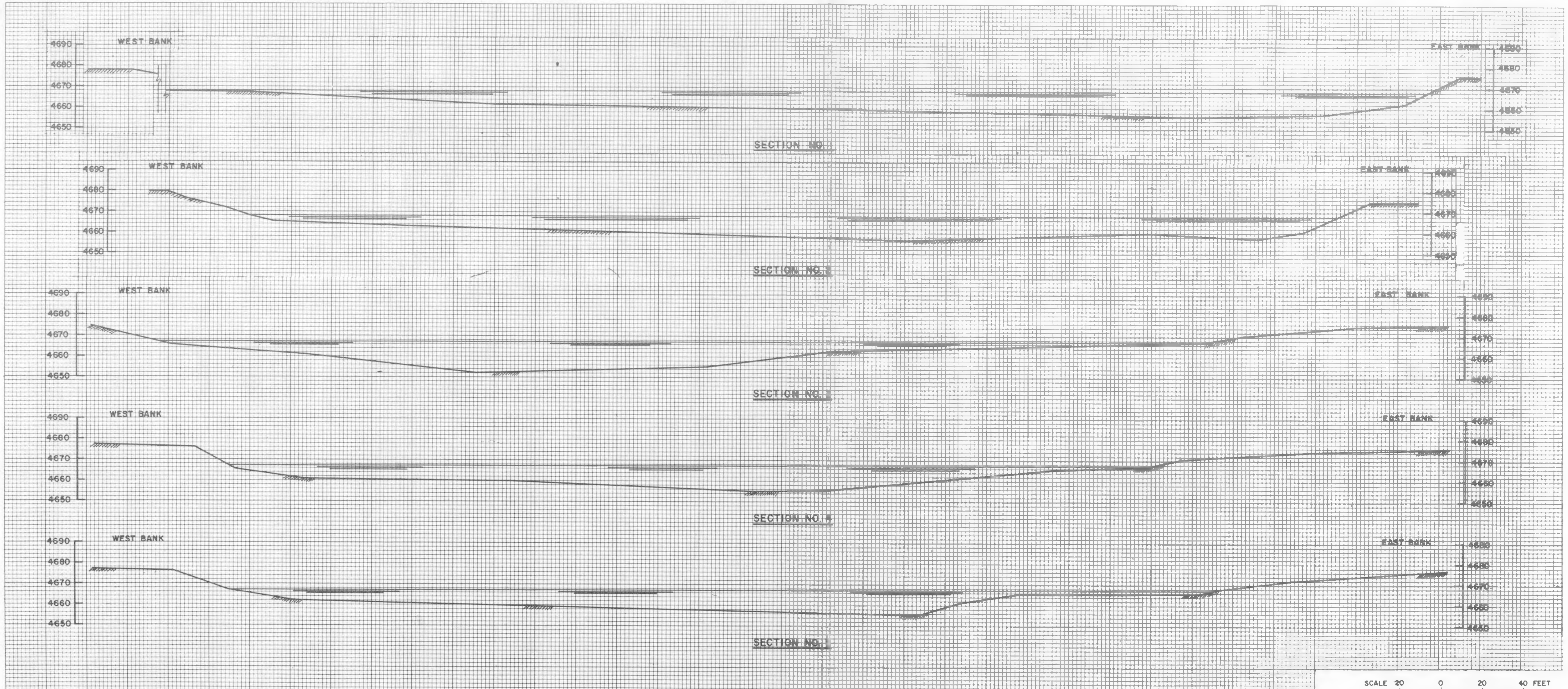
KEY MAP
REACH NO. 4

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED D.L.G. CHECKED MSE APPROVED [signature]
DRAWN D.L.G. INSPECT [initials] RECOMMENDED [signature]

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DATE JUNE 1977
DRAWING NO KV-03-023




## CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

# CROSS SECTIONS

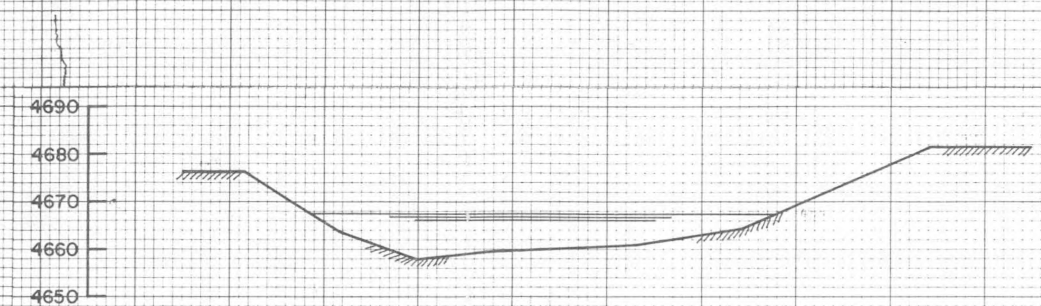
## SOUTH OF POWER PLANT

REACH 4 SHEET 2 OF 2

INTERNATIONAL ENGINEERING COMPANY, INC.

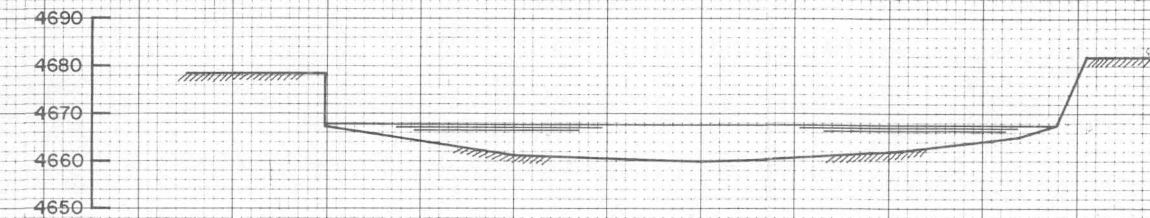
| | | |
|---|---|---|
| DESIGNED D.L.G. | CHECKED MSE | APPROVED [signature] |
| DRAWN D.L.G. | INSPECT [initials] | RECOMMENDED [signature] |
| IECO<br>220 MONTGOMERY STREET<br>SAN FRANCISCO CALIFORNIA 94104 | | DATE JUNE 1977<br>DRAWING NO KV-03-025 |

EXHIBIT A-24



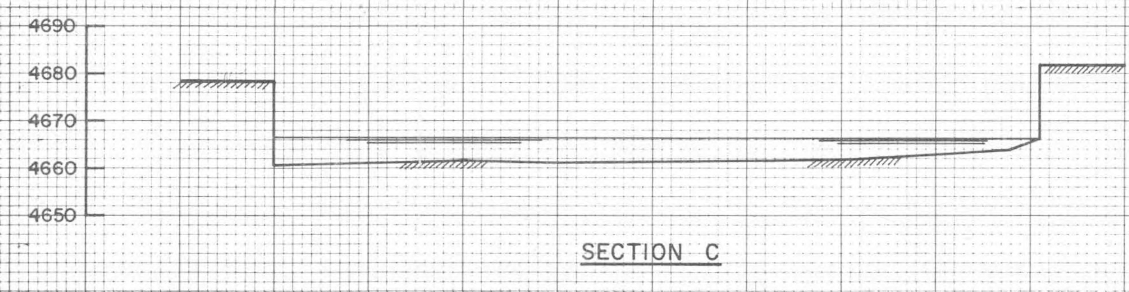

SECTION A

(NARROWS)

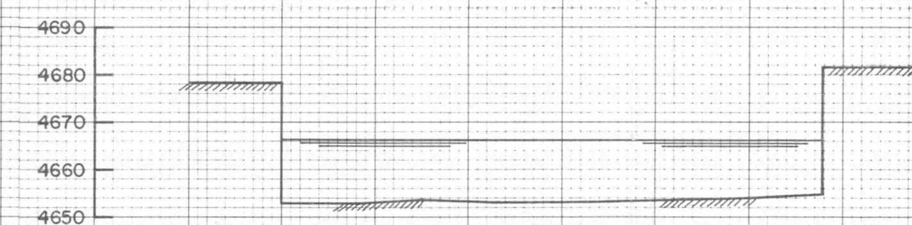



SECTION B

(OLD SPILLWAY)




SECTION C




SECTION D

(AT POWER PLANT)

SCALE 20 0 20 40 FEET

CITY OF IDAHO FALLS

IDAHO FALLS HYDROELECTRIC PROJECT
CITY POWER PLANT

CROSS SECTIONS
SOUTH OF POWER PLANT
REACH 4 SHEET 1 OF 2

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED D.L.G. | CHECKED MSE | APPROVED
DRAWN P.L.G. | INSPECT | RECOMMENDED

IECO
220 MONTGOMERY STREET
SAN FRANCISCO CALIFORNIA 94104

DATE JUNE 1977

DRAWING NO. KV-03-024

PRINTED ON DIETRICH POST CLEARPRINT

# APPENDIX B

# QUANTITY AND COST ESTIMATES

TABLE B-1
Sheet 1 of 4

ALTERNATIVE 1 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW DIVERSION WEIR, TRASHRACK STRUCTURE, SPILLWAY, AND CHANNEL IMPROVEMENTS | | | | |
| Mobilization | | | LS | 50,000 |
| Care of the river | | | LS | 100,000 |
| Concrete demolition and removal | | | LS | 34,000 |
| Foundation preparation | | | LS | 15,000 |
| Rock excavation | cu yd | 800 | 12.00 | 9,600 |
| Unclassified excavation, channel | cu yd | 17,000 | 4.50 | 76,500 |
| Reinforcement | ton | 63 | 1,000 | 63,000 |
| Ready-mix concrete | cu yd | 8,200 | 40.00 | 328,000 |
| Placing concrete, including forming, consolidating and curing | | | | |
| Trashrack structure | | | | |
| Mass concrete | cu yd | 200 | 80.00 | 16,000 |
| Slab decks and piers | cu yd | 800 | 150.00 | 120,000 |
| Diversion weir | cu yd | 7,200 | 80.00 | 576,000 |
| Waterstops | lin ft | 2,000 | 8.00 | 16,000 |
| Channel lining (3-inch shotcrete) | sq yd | 8,500 | 20.00 | 170,000 |
| Bascule gate, 4-ft x 5-ft | each | 1 | LS | 114,000 |
| Embedded metal | tons | 2 | 2,400 | 4,800 |
| Trashracks | tons | 22 | 2,000 | 44,000 |
| Miscellaneous metal | ton | 2 | 5,000 | 10,000 |
| Raking equipment | | | LS | 80,000 |
| Log boom | | | LS | 16,000 |
| Fencing and gates | | | LS | 2,000 |
| Subtotal | | | | 1,844,900 |
| Contingency | | | | 276,700 |
| Construction Cost | | | | 2,121,600 |
| | | | Say | 2,122,000 |

TABLE B-1
Sheet 2 of 4

ALTERNATIVE 1 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE | | | | |
| Civil Works | | | | |
| Mobilization | | | LS | 50,000 |
| Care of the river | | | LS | 100,000 |
| Concrete demolition and removal | cu yd | | LS | 100,000 |
| Rock excavation - powerhouse, and tailrace channel | cu yd | 9,900 | 12.00 | 118,000 |
| Common excavation | cu yd | 600 | 4.00 | 2,400 |
| Backfill | cu yd | 4,300 | 4.50 | 19,400 |
| Reinforcement (installed) | ton | 400 | 1,000 | 400,000 |
| Ready-mix concrete | cu yd | 9,200 | 40.00 | 368,000 |
| Placing concrete, including forming, consolidating and curing | | | | |
| Power plant | cu yd | 4,450 | 80.00 | 356,000 |
| Non-overflow section, spillway | cu yd | 3,800 | 80.00 | 304,000 |
| Structural | cu yd | 820 | 150.00 | 123,000 |
| Pre-cast concrete crib walls | cu yd | 70 | 250.00 | 17,500 |
| Water stops, joint filler, etc. (installed) | lin ft | 500 | 8.00 | 4,000 |
| Embedded metal for trashracks, intake gates and draft tube bulkheads (installed) | tons | 6 | 2,400 | 14,400 |
| Trashracks and accessories (installed) | tons | 17 | 2,600 | 44,200 |
| Intake gates (installed) | tons | 26 | 2,600 | 67,600 |
| Draft tube bulkheads (installed) | tons | 23 | 2,600 | 59,800 |

TABLE B-1
Sheet 3 of 4

ALTERNATIVE 1 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Civil Works | | | | |
| Miscellaneous metal (installed) | tons | 16 | 5,000 | 80,000 |
| Bascule gate, 20-ft x 5-ft | each | 1 | LS | 57,000 |
| Log boom | | | LS | 16,000 |
| Control building | | | LS | 180,000 |
| Maintenance shop | | | LS | 50,000 |
| Fencing and gates | | | LS | 2,000 |
| Guardrail | lin ft | 650 | 20.00 | 13,000 |
| Service road | | | LS | 6,000 |
| Subtotal | | | | 2,553,100 |
| Contingency | | | | 383,000 |
| Construction Cost (Civil Works) | | | | 2,936,100 |
| | | | Say | 2,936,000 |
| Mechanical Works | | | | |
| City Power Plant generating unit, complete including turbine, governor, etc. (installed) | | 1 | LS | 4,202,000 |
| Mechanical auxiliaries, complete (installed), including: | | | | |
| Dewatering drain piping and pumps<br>Cooling water and oil-change piping<br>Fans and heaters<br>Service and heaters<br>Wastewater<br>10-Ton mobile crane | | | LS | 210,000 |
| Subtotal | | | | 4,412,000 |
| Contingency | | | | 662,000 |
| Construction Cost (Mechanical Works) | | | | 5,074,000 |

TABLE B-1
Sheet 4 of 4

ALTERNATIVE 1 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Electrical Works | | | | |
| Control building equipment | | | LS | 208,000 |
| Grounding system | | | LS | 7,500 |
| Lighting system | | | LS | 8,000 |
| Conduit system and accessories | | | LS | 12,000 |
| Control switchboard and breaker | | | LS | 85,000 |
| Control panel (dc) and batteries | | | LS | 12,000 |
| Transportation for control switchboard, breaker, panel and batteries | | | LS | 11,000 |
| Switchgear (ac) (installed) | | | LS | 29,500 |
| Testing and inspection | | | LS | 18,000 |
| 15 kV Cable bus and surge protection equipment | | | LS | 30,000 |
| Disconnect and ground switch | | | LS | 2,500 |
| Subtotal | | | | 423,500 |
| Contingency | | | | 84,500 |
| Construction Cost (Electrical Works) | | | | 508,000 |
| Construction Cost (New Powerhouse) | | | | 8,518,000 |
| TOTAL CONSTRUCTION COST | | | | |
| New diversion weir, trashrack structure, spillway, and channel improvements | | | | 2,122,000 |
| New powerhouse | | | | 8,518,000 |
| Subtotal | | | | 10,640,000 |
| Less salvage allowance for existing units | | | | 15,000 |
| TOTAL | | | | 10,625,000 |

TABLE B-2
Sheet 1 of 3

ALTERNATIVE 2 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE | | | | |
| Civil Works | | | | |
| Mobilization | | | LS | 50,000 |
| Care of the river | | | LS | 100,000 |
| Concrete demolition and removal | cu yd | | LS | 100,000 |
| Rock excavation - powerhouse, and tailrace channel | cu yd | 5,700 | 12.00 | 68,400 |
| Common excavation | cu yd | 600 | 4.00 | 2,400 |
| Backfill | cu yd | 4,300 | 4.50 | 19,400 |
| Reinforcement (installed) | ton | 370 | 1,000 | 370,000 |
| Ready-mix concrete | cu yd | 8,300 | 40.00 | 332,000 |
| Placing concrete, including forming, consolidating and curing | | | | |
| Power plant | cu yd | 4,500 | 80.00 | 360,000 |
| Non-Overflow section and spillway | cu yd | 2,600 | 80.00 | 208,000 |
| Structural concrete | cu yd | 1,000 | 150.00 | 150,000 |
| Precast concrete crib walls | cu yd | 70 | 250.00 | 17,000 |
| Water stops, joint filler, etc. (installed) | lin ft | 625 | 8.00 | 5,000 |
| Embedded metal for trashracks, intake gates and draft tube bulkheads (installed) | tons | 7 | 2,400 | 16,800 |
| Trashracks and accessories (installed) | tons | 16 | 2,600 | 41,600 |
| Intake gates (installed) | tons | 24 | 2,600 | 62,400 |
| Draft tube bulkheads (installed) | tons | 16 | 2,600 | 41,600 |

ALTERNATIVE 2 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Civil Works (Cont'd.) | | | | |
| Miscellaneous metal (installed) | tons | 15 | 5,000 | 75,000 |
| Bascule gate, 20-ft X 5-ft | | 1 | LS | 57,000 |
| Log boom | | | LS | 16,000 |
| Control building | | | LS | 180,000 |
| Maintenance shop | | | LS | 50,000 |
| Fencing and gates | | | LS | 2,000 |
| Guardrail | lin ft | 700 | 20 | 14,000 |
| Service Road | | | LS | 6,000 |
| Subtotal | | | | 2,344,600 |
| Contingency | | | | 351,700 |
| Construction Cost (Civil Works) | | | | 2,696,300 |
| | | | Say | 2,696,000 |
| Mechanical Works | | | | |
| City Power Plant generating units complete, including turbines governors, etc. (installed) | | 2 | LS | 5,101,000 |
| Mechanical auxiliaries, complete (installed), including: | | | LS | 212,000 |
| Dewatering drain piping and pumps<br>Cooling water and oil-change piping<br>Fans and heaters<br>Service and potable water<br>Wastewater<br>10-Ton mobile crane | | | | |
| Subtotal | | | | 5,313,000 |
| Contingency | | | | 797,000 |
| Construction Cost (Mechanical Works) | | | | 6,110,000 |

TABLE B-2
Sheet 3 of 3

ALTERNATIVE 2 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Electrical Works | | | | |
| Control building equipment | | | LS | 209,000 |
| Grounding system | | | LS | 9,000 |
| Lighting system | | | LS | 9,500 |
| Conduit system and accessories | | | LS | 12,750 |
| Control switchboard and breaker | | | LS | 98,000 |
| Control panel (dc) and batteries | | | LS | 15,000 |
| Transportation for control switchboard, breaker, panel and batteries | | | LS | 10,000 |
| Switchgear (ac) (installed) | | | LS | 23,500 |
| Testing and inspection | | | LS | 29,000 |
| Disconnect and ground switch | | | LS | 2,500 |
| Subtotal | | | | 418,250 |
| Contingency | | | | 83,750 |
| Construction Cost (Electrical Works) | | | | 502,000 |
| Construction Cost (Powerhouse) | | | | 9,308,000 |
| TOTAL CONSTRUCTION COST | | | | |
| New diversion weir, trashrack structure, spillway, and channel improvements (see Table B-1, Sheet 1) | | | | 2,122,000 |
| New powerhouse | | | | 9,308,000 |
| Subtotal | | | | 11,430,000 |
| Less salvage allowance for existing units | | | | 15,000 |
| TOTAL | | | | 11,415,000 |

TABLE B-3
Sheet 1 of 4

ALTERNATIVE 3 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW DIVERSION WEIR, SPILLWAY, AND CHANNEL IMPROVEMENTS | | | | |
| Mobilization | | | LS | 50,000 |
| Care of the river | | | LS | 100,000 |
| Concrete demolition and removal | | | LS | 34,000 |
| Foundation preparation | | | LS | 15,000 |
| Rock excavation | cu yd | 800 | 12.00 | 9,600 |
| Unclassified excavation, channel | cu yd | 17,000 | 4.50 | 76,500 |
| Reinforcement | ton | 87 | 1,000 | 87,000 |
| Ready-mix concrete | cu yd | 8,500 | 40.00 | 340,000 |
| Placing concrete, including forming, consolidating and curing | | | | |
| Intake structure, mass concrete | cu yd | 200 | 80.00 | 16,000 |
| Decks and piers | cu yd | 1,100 | 150.00 | 165,000 |
| Diversion weir | cu yd | 7,200 | 80.00 | 576,000 |
| Stoplogs | | | LS | 5,000 |
| Waterstops | lin ft | 2,000 | 8.00 | 16,000 |
| Channel lining (3-inch shotcrete) | sq yd | 8,500 | 20.00 | 170,000 |
| Bascule gate, 4-ft x 5-ft | each | 1 | LS | 114,000 |
| Embedded metal | tons | 8 | 2,400 | 19,200 |
| Trashracks | tons | 22 | 2,000 | 44,000 |
| Miscellaneous metal | ton | 3 | 5,000 | 15,000 |
| Butterfly valves, 3-ft x 6-ft | each | 14 | 18,000 | 252,000 |
| Raking equipment | | | LS | 80,000 |
| Log boom | | | LS | 16,000 |
| Fencing and gates | | | LS | 2,000 |
| Subtotal | | | | 2,202,300 |
| Contingency | | | | 330,000 |
| Construction Cost | | | | 2,532,000 |

TABLE B-3
Sheet 2 of 4

ALTERNATIVE 3 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE | | | | |
| Civil Works | | | | |
| Mobilization | | | LS | 50,000 |
| Care of the river | | | LS | 100,000 |
| Concrete demolition and removal | cu yd | | LS | 100,000 |
| Rock excavation - powerhouse, and tailrace channel | cu yd | 20,700 | 12.00 | 248,400 |
| Common excavation | cu yd | 1,000 | 4.00 | 4,000 |
| Backfill | cu yd | 4,500 | 4.50 | 20,200 |
| Reinforcement (installed) | ton | 540 | 1,000 | 540,000 |
| Ready-mix concrete | cu yd | 10,100 | 40.00 | 404,000 |
| Placing concrete, including forming, consolidating and curing | | | | |
| Power plant | cu yd | 4,600 | 80.00 | 368,000 |
| Overflow weir and gate spillway | cu yd | 3,000 | 80.00 | 240,000 |
| Structural concrete | cu yd | 2,500 | 150.00 | 375,000 |
| Water stops, joint filler, etc. (installed) | lin ft | 600 | 8.00 | 4,800 |
| Embedded metal for trashracks, intake gates and draft tube bulkheads and hatch covers (installed) | tons | 6 | 2,400 | 14,400 |
| Trashracks and accessories (installed) | tons | 17 | 2,600 | 44,200 |
| Intake gates (installed) | tons | 26 | 2,600 | 67,600 |
| Draft tube bulkheads (installed) | tons | 23 | 2,600 | 59,800 |

TABLE B-3
Sheet 3 of 4

ALTERNATIVE 3 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Civil Works (Cont'd.) | | | | |
| Miscellaneous metal (installed) | tons | 18 | 5,000 | 90,000 |
| Bascule gate | | 1 | LS | 57,000 |
| Log boom | | | LS | 16,000 |
| Control building | | | LS | 180,000 |
| Maintenance shop | | | LS | 50,000 |
| Fencing and gates | | | LS | 2,000 |
| Guardrail | lin ft | 400 | 20 | 8,000 |
| Service road | | | LS | 6,000 |
| Subtotal | | | | 3,049,400 |
| Contingency | | | | 457,400 |
| Construction Cost (Civil Works) | | | | 3,506,800 |
| | | | Say | 3,507,000 |
| Mechanical Works | | | | |
| City Power Plant generating unit, complete, including turbine, governor, etc. (installed) | | 1 | LS | 4,202,000 |
| Mechanical auxiliaries, complete (installed), including: | | | LS | 210,000 |
| Dewatering drain piping and pumps<br>Cooling water and oil-change piping<br>Fans and heaters<br>Service and potable water<br>Wastewater<br>10-Ton mobile crane | | | | |
| Subtotal | | | | 4,412,000 |
| Contingency | | | | 662,000 |
| Construction Cost (Mechanical Works) | | | | 5,074,000 |

TABLE B-3
Sheet 4 of 4

ALTERNATIVE 3 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Electrical Works | | | | |
| Control building equipment | | | LS | 208,000 |
| Grounding system | | | LS | 7,500 |
| Lighting system | | | LS | 8,000 |
| Conduit system and accessories | | | LS | 12,000 |
| Control switchboard and breaker | | | LS | 85,000 |
| Control panel (dc) and batteries) | | | LS | 12,000 |
| Transportation for control switch-board, breaker, panel and batteries | | | LS | 11,000 |
| Switchgear (ac) (installed) | | | LS | 29,500 |
| Testing and inspection | | | LS | 18,000 |
| 15 kV Cable bus and surge protection equipment | | | | 30,000 |
| Disconnect and ground switch | | | | 2,500 |
| Subtotal | | | | 423,500 |
| Contingency | | | | 84,500 |
| Construction Cost (Electrical Works) | | | | 508,000 |
| Construction Cost (Powerhouse) | | | | 9,089,000 |
| TOTAL CONSTRUCTION COST | | | | |
| New diversion weir, intake, channel improvements | | | | 2,532,000 |
| New powerhouse | | | | 9,089,000 |
| Subtotal | | | | 11,621,000 |
| Less salvage allowance for existing units | | | | 15,000 |
| TOTAL | | | | 11,606,000 |

TABLE B-4
Sheet 1 of 3

ALTERNATIVE 4 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE | | | | |
| Civil Works | | | | |
| Mobilization | | | LS | 50,000 |
| Care of the river | | | LS | 100,000 |
| Concrete demolition and removal | cu yd | | LS | 100,000 |
| Rock excavation - powerhouse, and tailrace channel | cu yd | 21,000 | 12.00 | 252,000 |
| Common excavation | cu yd | 1,000 | 4.00 | 4,000 |
| Backfill | cu yd | 4,300 | 4.50 | 19,400 |
| Reinforcement (installed) | ton | 891 | 1,000 | 891,000 |
| Ready-mix concrete | cu yd | 13,400 | 40.00 | 536,000 |
| Placing concrete, including forming, consolidating and curing | | | | |
| Power plant | cu yd | 10,500 | 80.00 | 840,000 |
| Overflow weir and gate spillway | cu yd | 700 | 80.00 | 56,000 |
| Structural concrete | cu yd | 2,200 | 150.00 | 330,000 |
| Water stops, joint filler, etc. (installed) | lin ft | 600 | 8.00 | 4,800 |
| Embedded metal for trashracks, intake gates and draft tube bulkheads (installed) | tons | 7 | 2,400 | 16,800 |
| Trashracks and accessories (installed) | tons | 19 | 2,600 | 49,400 |
| Intake gates (installed) | tons | 42 | 2,600 | 109,200 |
| Draft tube bulkheads (installed) | tons | 25 | 2,600 | 65,000 |

TABLE B-4
Sheet 2 of 3

ALTERNATIVE 4 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Civil Works (Cont'd.) | | | | |
| Miscellaneous metal (installed) | tons | 18 | 5,000 | 90,000 |
| Bascule gate, 20-ft x 5-ft | | 1 | LS | 57,000 |
| Log boom | | | LS | 16,000 |
| Control building | | | LS | 180,000 |
| Maintenance shop | | | LS | 50,000 |
| Fencing and gates | | | LS | 2,000 |
| Guardrail | lin ft | 400 | 20 | 8,000 |
| Service road | | | LS | 6,000 |
| Subtotal | | | | 3,832,600 |
| Contingency | | | | 574,900 |
| Construction Cost (Civil Works) | | | | 4,407,500 |
| | | | Say | 4,408,000 |
| Mechanical Works | | | | |
| City Power Plant generating unit, (vertical plan) complete, including turbine, governor, etc. (installed) | | 1 | LS | 4,622,000 |
| Mechanical auxiliaries, complete (installed), including: | | | LS | 265,000 |
| Dewatering drain piping and pumps<br>Cooling water and oil-change piping<br>Fans and heaters<br>Service and potable water<br>Wastewater<br>15-Ton mobile crane | | | | |
| Subtotal | | | | 4,887,000 |
| Contingency | | | | 733,000 |
| Construction Cost (Mechanical Works) | | | | 5,620,000 |

TABLE B-4
Sheet 3 of 3

ALTERNATIVE 4 - CITY PLANT
QUANTITY AND COST ESTIMATE

| Item | Unit | Quantity | Unit Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| NEW POWERHOUSE (Cont'd.) | | | | |
| Electrical Works | | | | |
| Control building equipment | | | LS | 208,000 |
| Grounding system | | | LS | 9,000 |
| Lighting system | | | LS | 9,500 |
| Conduit system and accessories | | | LS | 13,000 |
| Control switchboard and breaker | | | LS | 85,000 |
| Control panel (dc) and batteries) | | | LS | 12,000 |
| Transportation for control switchboard, breaker, panel and batteries | | | LS | 11,000 |
| Switchgear (ac) (installed) | | | LS | 29,500 |
| Testing and inspection | | | LS | 18,000 |
| 15 kV Cable bus and surge protection equipment | | | | 30,000 |
| Disconnect and ground switch | | | | 2,500 |
| Subtotal | | | | 427,500 |
| Contingency | | | | 85,500 |
| Construction Cost (Electrical Works) | | | | 513,000 |
| Construction Cost (Powerhouse) | | | | 10,541,000 |
| TOTAL CONSTRUCTION COST | | | | |
| New diversion weir, trashrack structure, spillway, and channel improvements (see Table B-1, Sheet 1) | | | | 2,122,000 |
| New powerhouse | | | | 10,541,000 |
| Subtotal | | | | 12,663,000 |
| Less salvage allowance for existing units | | | | 15,000 |
| TOTAL | | | | 12,648,000 |

# APPENDIX C
# HYDROLOGY AND POWER STUDIES

# APPENDIX C
# HYDROLOGY AND POWER STUDIES

This appendix covers the hydrologic investigations and power studies made for the Idaho Falls City Power Plant. It briefly discusses the drainage basin of the Upper Snake River, above the City of Idaho Falls; the streamflow data obtained for use in this study; flood flows and flood frequencies; tailwater and backwater studies; and the power studies made to size the hydroelectric facilities for the City Power Plant. The streamflow data, flood flows, and flood frequencies presented in this report are the same as those presented in an earlier IECO report, Idaho Falls Hydroelectric Project, January 1977, but are repeated herein for convenience.

## C.1 UPPER SNAKE RIVER BASIN

The drainage area of the Upper Snake River at the City of Idaho Falls is about 9800 square miles. The headwaters of the Snake River originate in Yellowstone National Park, Wyoming, where the elevation of peaks of the Teton Range and the Continental Divide exceeds 9500 feet. From its source, the Snake River flows southward through the Jackson Hole area of western Wyoming and then turns northwestward into Idaho. Upon entering Idaho, it travels through the wide Snake River Valley and turns southwestward toward Idaho Falls. Near Idaho Falls it is joined by Henry's Fork, Falls River, and Teton River from the north and Willow Creek from the south.

The principal source of streamflow in this drainage basin is snowmelt from deep snow accumulations in the mountainous headwater region. Most of the snowmelt occurs during April, May, and June. Other sources of streamflow include light snowfall at lower elevations in the winter and light rainfall (including occasional thundershowers) at all elevations in the summer.

The normal annual precipitation ranges from 60 inches over the Teton Mountains and the Continental Divide to less than 10 inches at the valley floor of the Snake River plain.

The largest use of water is for irrigation and hydroelecrtic power generation. Irrigation of valley land started about 100 years ago, and the valley is presently extensively cultivated. Major lakes and reservoirs upstream from Idaho Falls are: Shoshone Lake, Lewis Lake, Jackson Lake, and Palisades Reservoir on the Snake River; Henry's Lake and Island Park Reservoir on Henry's Fork; and Gray's Lake on Willow Creek.

## C.2 BASIC DATA

Streamflow records are available for the numerous stream-gaging stations in the large drainage basin above Idaho Falls. Records of irrigation diversions, reservoir storage volumes, streamflows, and flood peaks are all published in U.S. Geological Survey (USGS) " Water Supply Papers". In recent years such data have also been published in yearly books on "Water Resources Data for Idaho" by the USGS, in cooperation with the State of Idaho and other State and local agencies. The following hydrologic data were obtained and used in the studies described herein:

- Monthly streamflow data for the Snake River near Idaho Falls for water years 1928 through 1972, adjusted to both present flow conditions and flow conditions of the Recommended State Water Plan. These two sets of 45-year flow records, which were obtained from the Idaho Department of Water Resources, reflect two levels of irrigation usage and upstream reservoir regulation. The present flow conditions represent the 1975 level of upstream development, whereas the Recommended State Water Plan flow conditions represent the projected level of upstream development and water usage for the year 2020 (see Tables C-1 and C-2).

- Flood data for the Snake River near the Shelley stream-gaging station (drainage area = 9790 square miles) were obtained from the USGS. These data include annual flood peaks and recorded gage heights for each year from water year 1915 through water year 1975. They also include annual peaks (among the highest on record) for water years 1890, 1892, 1893, and 1894. The Shelley gage is located a short distance downstream from Idaho Falls. The flood data recorded at the Shelley gage are considered representative of flood flows at all three Idaho Falls power plant sites, since flood flow contributions on the Snake River between Idaho Falls and the Shelley recording gage are small. The annual flood peaks, corresponding gage heights, and dates, as compiled by the USGS, are shown on Table C-3.

## C.3 DESIGN FLOOD

Using the flood peaks recorded at the Shelley gage, the USGS made flood frequency analyses, using a Log-Pearson Type III Distribution analysis. The USGS computer calculations are summarized in Table C-4. IECO then used the data in Table C-4 to prepare a flood frequency curve (see Figure C-1).

Discussions with personnel of the Idaho Falls ELectric Division led to the selection of a peak discharge of 75,000 CFS for the spillway design flood. Although assigning a flood frequency beyond 100 years is at best an estimate, this frequency corresponds to a flood recurrence interval of approximately once in 650 years, or a probability of occurrence of 0.154% according to the USGS calculations using the Log-Pearson Type III Distribution analysis to extend the frequency curve at extremely low recurrence intervals. The selected peak discharge of 75,000 CFS was used as the basis for design of the spillway gates and selection of weir crest elevations for the City Plant. This peak discharge represents a conservative estimate of the flood potential, considering the type of structures to be installed, the run-of-river type of power plant, and the enormous flood control storage capability available at upstream lakes, and especially at Palisades Reservoir.

## C.4 BACKWATER AND TAILWATER STUDIES

Representative river cross sections were made available to IECO by the Idaho Falls Electric Division for use in backwater and tailwater computations. The U.S. Army Corps of Engineers' Hydrologic Engineering Center Computer Program 22-J2-L121, "Backwater - Any Cross Section," was used in making these computations. The river cross sections are presented in Appendix A (Exhibits A-14 through A-25).

### A. Backwater Studies

Backwater studies were performed for the reach of the Snake River upstream of the City Power Plant to set the crest elevations of the diversion weir and the Bascule gate and to determine the channel depths necessary to ensure that adequate flows will be diverted into the forebay channel for power generation at the City Plant.

The weir and Bascule gate crest elevations and the depth of the forebay channel were determined so that, when total river flows are less than 5200 CFS, the entire amount will be diverted into the forebay channel for power generation. During high or flood flow stages, the weir will discharge the major portion of the flows to prevent damage to the power facilities. The results of these studies indicate that the crest of the diversion weir should be at El. 4694.7 and the operating level of the Bascule gate should be at the same elevation.

### B. Tailwater Rating Curve

A tailwater rating curve was derived for the City Plant for use in determining tailrace elevations, drafttube settings, and the hydraulic head available for power generation. This curve, shown on Figure C-2, was derived from backwater computations using a range of flows between 1000 CFS and 75,000 CFS (design flood discharge). Representative river cross sections for the entire river reach between the City Power Plant and the Lower Power Plant were used in the study. The operating headwater levels at the Lower Power Plant cause backwater effects at the tailrace section of the City Plant during low and average river flow conditions.

## C.5 POWER STUDIES

Power studies were performed using both sets of flow records (presented in Tables C-1 and C-2) under two plans of operation, described below. For each set of flow records, flow-duration curves, tailwater-duration curves, and energy curves showing the output for a range of possible installed capacities were prepared for study. The purpose of the studies was to select the preliminary installed capacity and to estimate the corresponding average annual energy over the 45-year period of streamflow records available.

### A. Plant Operation

The two plans of operation were developed to compare the amount of energy that can be generated by operating the plant to use the full run-of-river flows with the amount of energy that can be generated if flows through the plant are reduced during the dry season to maintain a minimum flow over the falls. These plans of operation are outlined below:

- Plan A - The power plant utilizes the run-of-river flows of the Snake River. Flows over the falls occur only when river flows exceed 5200 CFS.

- Plan B - The power plant utilizes the run-of-river flows, except during the dry season, when flows through the power plant are reduced to maintain a minimum flow of 850 CFS over the falls. This reduction is not applied during December, January, and February, when the river surface and the falls are normally frozen and the entire flow is assumed to be available for power generation.

B. Flow-Duration Curves

Flow-duration curves (Figures C-3 and C-4) were computed for the City Power Plant site for both sets of flow records for use in power studies under Plan A operation. These curves show the percent of time different discharges were equaled or exceeded over the 45-year period of streamflow records available. Similar flow-duration curves (Figures C-8 and C-9) were prepared from the monthly flow data to determine the inflow at the City Power Plant for power studies under Plan B operation.

C. Tailwater-Duration Curves

Tailwater-duration curves (Figure C-5) were computed for the City Power Plant site for both sets of flow records. For each flow condition the curve was developed by equating the appropriate flow-duration curve (Figure C-3 or C-4) with the tailwater rating curve (Figure C-2). From the tailwater-duration curves the average tailwater elevations were obtained. The average head was then determined using the computed average tailwater elevation and the normal operating pool elevation.

D. Average Annual Energy

The following assumptions were made in estimating average annual energy generation:

- The plant will operate as a run-of-river plant and will utilize water only as it comes to it from upstream lakes and reservoirs.
- The plant will operate continuously to carry a portion of the baseload.

- Discharge above the turbine design discharge will not increase the output over the unit rating.
- The overall efficiency is 89% for the bulb unit and 88% for the Kaplan unit.

The energy calculations are based on average net head (determined from the tailwater-duration curves) and on average flows utilized by the unit (determined from flow-duration curves). Figures C-6 and C-7 summarize the results of the energy calculations using the two sets of river flows under Plan A operation for various possible installed capacities. Figures C-10 and C-11 summarize the results of the energy calculations under Plan B operation for various possible installed capacities.

## E. Installed Capacity

Preliminary estimates of energy generation for the various possible installed capacities indicate that for maximum benefits the installed capacity should be in the range of 6500 to 8300 kW. Bulb turbine-generator installations of one 7200-kW unit and two 4000-kW units were investigated and evaluated on the basis of both cost and average annual energy generated. For comparison with the bulb units, a 7200-kW conventional Kaplan turbine scheme was also studied. Four alternative powerhouse layouts to suit these generating schemes were prepared and are presented in Appendix A. These alternatives are described and evaluated in Chapter 4. The results show that the 7200-kW bulb turbine-generator installation is the appropriate selection, based on greater benefits.

A bulb unit with a rated capacity of 7200 kW will have an overall efficiency of 89% under a net head of 18.3 feet at a design discharge of 5200 CFS. This size of unit will utilize flows between 5400 CFS and 1500 CFS. At flows above 5400 CFS, the unit output will not increase above the full rating, and at flows below about 1500 CFS, the unit will not be able to generate energy. From the flow-duration curves presented on Figures C-3, C-4, C-7, and C-8, the percent of time the turbine design flow and the minimum flow utilized by the unit would be equaled or exceeded was determined, as tabulated below. The average flow utilized by the unit (equivalent to 100% of the time) is 4440 CFS for Plan A and 4040 CFS for Plan B under present flow conditions, and 4680 CFS for Plan A and 4515 CFS for Plan B under flow conditions of the Recommended State Water Plan.

| | Percent of Time Flow Would Be Equaled or Exceeded | | | |
|---|---|---|---|---|
| | Plan A | | Plan B | |
| Flow (CFS) | Under Present Flow Conditions | Under Flow Conditions of the Recommended State Water Plan | Under Present Flow Conditions | Under Flow Conditions of the Recommended State Water Plan |
| 5200 | 41 | 61 | 32 | 51 |
| 1500 | 99.5 | 100 | 98 | 100 |

F. Results of Power Studies

The following tables summarize the results of the power studies under the two plans of operation investigated.

INSTALLED CAPACITY

| Alternative* | No. of Bulb Units | No. of Kaplan Units | Installed Capacity per Unit (kW) | Total Installed Capacity (kW) | Turbine Design Flow (CFS) |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 7200 | 7200 | 5200 |
| 2 | 2 | 0 | 4000 | 8000 | 5800 |
| 3 | 1 | 0 | 7200 | 7200 | 5200 |
| 4 | 0 | 1 | 7200 | 7200 | 5200 |

* See Chapter 4 for description of alternatives.

AVERAGE ANNUAL ENERGY (in Million kWh)

| Alter-native* | Plan A: Under Present Flow Conditions | Plan A: Under Flow Conditions of the Recommended State Water Plan | Plan B: Under Present Flow Conditions | Plan B: Under Flow Conditions of the Recommended State Water Plan |
|---|---|---|---|---|
| 1 | 56.6 | 56.5 | 48.8 | 54.3 |
| 2 | 55.5 | 60.7 | 50.5 | 57.4 |
| 3 | 53.6 | 56.5 | 48.8 | 54.3 |
| 4 | 53.0 | 55.9 | 48.2 | 53.7 |

* See Chapter 4 for description of alternatives.

TABLE C-1

DISCHARGE - SNAKE RIVER NEAR IDAHO FALLS (in CFS)

PRESENT (1975) FLOW CONDITIONS

| Water-Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 3,943 | 3,882 | 4,545 | 6,733 | 6,302 | 5,329 | 17,794 | 18,638 | 12,006 | 6,303 | 6,888 | 3,753 | 96,116 |
| 1929 | 3,234 | 3,533 | 4,729 | 5,001 | 4,256 | 3,342 | 4,096 | 7,456 | 12,537 | 5,291 | 4,969 | 3,728 | 62,171 |
| 1930 | 3,047 | 3,462 | 4,578 | 3,927 | 3,119 | 3,531 | 4,533 | 7,003 | 7,933 | 5,699 | 4,722 | 3,784 | 55,337 |
| 1931 | 2,524 | 4,463 | 4,356 | 3,424 | 3,109 | 3,306 | 3,462 | 5,649 | 5,722 | 6,069 | 4,555 | 3,470 | 50,109 |
| 1932 | 2,423 | 2,984 | 3,385 | 3,602 | 3,851 | 3,536 | 3,120 | 6,133 | 5,196 | 5,929 | 7,086 | 5,916 | 53,160 |
| 1933 | 4,103 | 4,285 | 3,926 | 3,317 | 3,973 | 3,501 | 4,004 | 8,843 | 6,228 | 5,674 | 5,579 | 5,955 | 59,387 |
| 1934 | 4,429 | 4,322 | 3,330 | 3,008 | 3,377 | 3,571 | 3,369 | 5,618 | 5,321 | 5,371 | 1,945 | 1,403 | 43,064 |
| 1935 | 1,329 | 1,652 | 2,907 | 3,297 | 3,121 | 3,207 | 3,403 | 5,597 | 6,199 | 8,112 | 9,996 | 2,609 | 51,428 |
| 1936 | 2,031 | 1,932 | 3,466 | 3,412 | 3,761 | 3,173 | 3,785 | 12,031 | 5,303 | 5,458 | 7,616 | 4,408 | 56,376 |
| 1937 | 4,351 | 4,174 | 3,238 | 3,704 | 3,543 | 3,292 | 3,456 | 7,115 | 5,704 | 5,435 | 5,480 | 3,913 | 53,406 |
| 1938 | 3,707 | 4,233 | 3,303 | 3,421 | 3,379 | 3,705 | 3,878 | 9,018 | 8,133 | 7,044 | 4,945 | 3,507 | 58,273 |
| 1939 | 3,116 | 3,554 | 4,498 | 4,832 | 4,178 | 3,952 | 6,912 | 9,810 | 7,178 | 6,119 | 4,784 | 3,075 | 62,008 |
| 1940 | 3,027 | 4,531 | 3,807 | 3,466 | 3,533 | 3,557 | 4,618 | 6,233 | 5,948 | 5,634 | 5,522 | 3,630 | 53,507 |
| 1941 | 2,413 | 4,010 | 3,498 | 3,470 | 3,532 | 3,505 | 3,174 | 6,194 | 5,916 | 5,732 | 4,426 | 3,539 | 49,408 |
| 1942 | 2,718 | 3,036 | 3,283 | 3,659 | 3,873 | 3,360 | 3,333 | 8,037 | 5,745 | 5,738 | 4,413 | 3,005 | 50,201 |
| 1943 | 3,376 | 3,883 | 3,374 | 3,267 | 3,774 | 3,833 | 20,297 | 12,951 | 8,548 | 11,443 | 4,941 | 4,322 | 84,008 |
| 1944 | 3,595 | 4,631 | 5,965 | 5,318 | 5,251 | 3,420 | 4,236 | 7,504 | 10,001 | 5,602 | 4,569 | 3,356 | 63,447 |
| 1945 | 3,302 | 3,136 | 4,185 | 4,579 | 3,191 | 3,573 | 4,158 | 9,867 | 11,522 | 8,204 | 6,043 | 3,551 | 65,311 |
| 1946 | 3,610 | 4,452 | 5,927 | 5,207 | 6,068 | 5,957 | 13,216 | 11,737 | 13,275 | 5,744 | 4,676 | 3,385 | 83,254 |
| 1947 | 3,496 | 3,551 | 4,643 | 5,055 | 3,892 | 4,889 | 8,667 | 15,807 | 8,279 | 5,898 | 6,351 | 3,675 | 74,203 |
| 1948 | 3,419 | 3,590 | 4,670 | 5,033 | 4,944 | 3,755 | 5,339 | 16,472 | 15,789 | 5,255 | 4,088 | 3,479 | 76,553 |
| 1949 | 2,752 | 3,484 | 4,513 | 4,493 | 3,788 | 7,643 | 5,837 | 17,408 | 8,309 | 5,590 | 4,727 | 3,373 | 71,917 |
| 1950 | 2,679 | 3,493 | 4,461 | 4,614 | 3,608 | 4,683 | 18,165 | 10,786 | 13,187 | 12,168 | 4,923 | 3,621 | 86,390 |
| 1951 | 5,023 | 6,223 | 6,422 | 5,485 | 8,770 | 11,307 | 14,618 | 17,626 | 5,654 | 8,601 | 9,454 | 3,918 | 103,102 |
| 1952 | 3,661 | 4,497 | 6,110 | 6,236 | 6,633 | 5,750 | 14,010 | 19,698 | 13,978 | 5,262 | 4,848 | 3,502 | 94,185 |
| 1953 | 3,350 | 3,543 | 4,914 | 5,360 | 4,303 | 4,695 | 4,520 | 6,811 | 15,940 | 5,567 | 5,032 | 3,532 | 67,566 |
| 1954 | 3,024 | 3,401 | 4,592 | 4,277 | 3,915 | 4,011 | 13,348 | 15,247 | 5,514 | 6,976 | 4,978 | 3,454 | 72,738 |
| 1955 | 2,856 | 3,324 | 4,523 | 3,778 | 3,880 | 3,569 | 4,363 | 7,950 | 8,423 | 6,495 | 4,691 | 3,699 | 57,551 |
| 1956 | 2,885 | 3,748 | 4,763 | 4,595 | 7,644 | 10,038 | 17,178 | 17,040 | 13,542 | 5,807 | 7,662 | 4,154 | 99,057 |
| 1957 | 3,322 | 3,673 | 4,910 | 5,147 | 4,913 | 5,286 | 11,989 | 19,858 | 12,613 | 7,305 | 6,617 | 3,885 | 89,517 |
| 1958 | 3,339 | 3,433 | 4,753 | 5,179 | 4,650 | 4,092 | 4,188 | 15,524 | 8,625 | 5,419 | 4,892 | 3,494 | 67,588 |
| 1959 | 3,442 | 3,275 | 3,583 | 3,449 | 3,599 | 3,572 | 3,752 | 5,613 | 10,280 | 6,667 | 5,621 | 3,409 | 56,263 |
| 1960 | 2,867 | 3,979 | 4,590 | 3,738 | 3,540 | 3,470 | 4,912 | 6,366 | 6,528 | 6,311 | 8,505 | 5,435 | 60,242 |
| 1961 | 2,469 | 3,773 | 3,462 | 3,800 | 3,378 | 3,379 | 3,404 | 6,499 | 6,594 | 6,486 | 5,054 | 3,693 | 51,991 |
| 1962 | 2,018 | 2,964 | 3,449 | 3,812 | 3,732 | 3,483 | 7,016 | 12,480 | 7,347 | 7,591 | 5,006 | 4,166 | 63,064 |
| 1963 | 3,219 | 4,342 | 4,526 | 4,094 | 3,732 | 3,326 | 3,750 | 9,356 | 17,566 | 6,620 | 4,796 | 3,234 | 68,561 |
| 1964 | 4,069 | 3,267 | 3,405 | 3,499 | 3,884 | 3,742 | 6,230 | 15,422 | 15,292 | 7,745 | 6,370 | 3,663 | 76,589 |
| 1965 | 3,352 | 3,479 | 5,163 | 7,783 | 7,033 | 9,175 | 17,201 | 12,949 | 11,536 | 11,478 | 5,860 | 5,268 | 100,276 |
| 1966 | 5,178 | 5,959 | 6,502 | 5,752 | 5,481 | 3,746 | 5,679 | 9,865 | 7,090 | 6,108 | 5,243 | 4,195 | 70,797 |
| 1967 | 3,368 | 3,006 | 3,640 | 3,437 | 3,622 | 3,716 | 3,415 | 11,101 | 16,257 | 9,562 | 5,407 | 3,954 | 70,484 |
| 1968 | 3,718 | 3,759 | 5,106 | 6,286 | 4,684 | 4,746 | 5,015 | 8,567 | 15,622 | 6,248 | 4,745 | 3,565 | 72,060 |
| 1969 | 4,138 | 5,488 | 6,106 | 6,887 | 11,006 | 8,587 | 7,113 | 14,363 | 6,961 | 5,830 | 4,932 | 3,346 | 84,757 |
| 1970 | 2,895 | 3,794 | 4,974 | 3,806 | 3,854 | 3,845 | 4,656 | 16,393 | 17,740 | 6,727 | 5,216 | 2,723 | 76,623 |
| 1971 | 3,442 | 4,965 | 6,208 | 9,233 | 9,292 | 10,314 | 15,641 | 20,255 | 19,954 | 14,368 | 5,990 | 6,020 | 125,681 |
| 1972 | 6,687 | 7,383 | 7,524 | 10,764 | 10,296 | 14,660 | 13,991 | 15,264 | 14,655 | 6,117 | 5,260 | 4,458 | 117,059 |
| Avg. | 3,354 | 3,901 | 4,529 | 4,716 | 4,739 | 4,892 | 7,530 | 11,337 | 10,038 | 6,818 | 5,559 | 3,805 | 71,217 |
| Max. | 6,687 | 7,383 | 7,524 | 10,764 | 11,006 | 14,660 | 20,297 | 20,255 | 19,954 | 14,368 | 9,996 | 6,020 | 125,681 |
| Min. | 1,329 | 1,652 | 2,907 | 3,008 | 3,109 | 3,173 | 3,120 | 5,597 | 5,196 | 3,371 | 1,945 | 1,403 | 43,064 |

Source: Idaho Department of Water Resources.

## TABLE C-2

## DISCHARGE - SNAKE RIVER NEAR IDAHO FALLS (in CFS)

## RECOMMENDED STATE WATER PLAN FLOW CONDITIONS

| Water-Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 6,202 | 5,121 | 4,684 | 6,820 | 6,392 | 5,447 | 18,476 | 21,902 | 15,721 | 10,498 | 7,251 | 6,149 | 114,663 |
| 1929 | 4,810 | 4,668 | 5,504 | 4,324 | 4,855 | 3,331 | 5,248 | 11,460 | 17,619 | 8,128 | 8,078 | 6,164 | 84,188 |
| 1930 | 4,624 | 4,153 | 4,402 | 4,112 | 3,232 | 3,658 | 6,408 | 10,431 | 13,026 | 8,542 | 6.977 | 6,360 | 75,927 |
| 1931 | 4,605 | 4,046 | 4,196 | 4,127 | 3,215 | 3,882 | 4,452 | 8,612 | 7,917 | 6,900 | 5,751 | 4,905 | 62,607 |
| 1932 | 3,465 | 3,359 | 3,578 | 3,572 | 3,795 | 3,531 | 4,553 | 10,850 | 7,538 | 12,870 | 9,917 | 5,941 | 72,969 |
| 1933 | 4,081 | 3,510 | 3,990 | 3,631 | 4,148 | 3,809 | 5,087 | 10,402 | 12,876 | 8,343 | 8,469 | 6,258 | 74,603 |
| 1934 | 3,924 | 3,566 | 3,385 | 3,361 | 3,547 | 4,229 | 5,099 | 7,677 | 7,235 | 8,688 | 7,766 | 4,267 | 62,744 |
| 1935 | 2,863 | 2,827 | 3,066 | 3,077 | 2,756 | 3,086 | 5,361 | 6,637 | 10,588 | 17,248 | 7,153 | 4,131 | 68,792 |
| 1936 | 3,613 | 2,751 | 3,512 | 3,537 | 3,743 | 3,209 | 5,633 | 13,984 | 11,035 | 8,883 | 9,347 | 5,833 | 75,081 |
| 1937 | 4,312 | 3,386 | 3,305 | 4,101 | 3,563 | 3,596 | 4,508 | 10,384 | 7,823 | 10,624 | 9,041 | 5,551 | 70,193 |
| 1938 | 4,068 | 3,502 | 3,383 | 3,658 | 3,468 | 3,652 | 5,284 | 14,021 | 17,241 | 9,499 | 8,712 | 5,106 | 82,594 |
| 1939 | 4,772 | 4,350 | 4,415 | 4,317 | 4,374 | 4,566 | 7,802 | 14,323 | 12,234 | 9,137 | 7,914 | 6,021 | 84,225 |
| 1940 | 3,743 | 3,579 | 3,785 | 3,659 | 3,718 | 3,963 | 5,564 | 10,321 | 8,013 | 7,990 | 7,122 | 5,200 | 66,657 |
| 1941 | 3,660 | 3,205 | 3,559 | 3,742 | 3,696 | 3,924 | 5,131 | 9,436 | 7,753 | 7,935 | 6,814 | 6,224 | 65,079 |
| 1942 | 3,698 | 3,425 | 3,458 | 4,179 | 3,708 | 3,551 | 5,327 | 9,100 | 11,465 | 8,164 | 7,009 | 5,811 | 68,894 |
| 1943 | 3,502 | 3,610 | 3,505 | 3,456 | 5,316 | 9,852 | 22,912 | 15,461 | 12,486 | 15,098 | 7,365 | 5,937 | 108,500 |
| 1944 | 5,920 | 6,743 | 5,962 | 5,222 | 5,158 | 3,504 | 5,201 | 9,558 | 12,577 | 8,113 | 7,412 | 5,806 | 81,175 |
| 1945 | 3,790 | 4,220 | 4,541 | 3,527 | 3,441 | 3,958 | 4,999 | 11,806 | 14,407 | 11,473 | 6,948 | 5,590 | 78,699 |
| 1946 | 5,925 | 6,219 | 5,826 | 5,028 | 6,057 | 5,961 | 13,829 | 15,743 | 17,646 | 8,434 | 7,512 | 5,396 | 103,576 |
| 1947 | 5,196 | 4,473 | 4,651 | 4,432 | 3,525 | 4,883 | 9,756 | 19,714 | 12,189 | 8,615 | 7,821 | 5,549 | 90,803 |
| 1948 | 5,143 | 4,718 | 5,729 | 4,564 | 5,129 | 4,289 | 6,041 | 17,691 | 20,347 | 7,609 | 7,363 | 5,746 | 94,369 |
| 1949 | 3,961 | 4,403 | 4,540 | 3,699 | 3,857 | 8,071 | 6,724 | 20,908 | 12,791 | 7,856 | 7,157 | 5,773 | 89,741 |
| 1950 | 4,985 | 4,291 | 4,433 | 3,960 | 3,649 | 5,013 | 18,975 | 14,065 | 16,601 | 15,216 | 6,810 | 6,635 | 104,633 |
| 1951 | 6,662 | 6,906 | 6,438 | 5,443 | 8,769 | 11,337 | 15,599 | 20,344 | 9,377 | 11,291 | 8,629 | 6,164 | 116,959 |
| 1952 | 6,539 | 6,575 | 6,207 | 6,135 | 6,945 | 5,760 | 14,627 | 23,190 | 18,539 | 6,955 | 6,606 | 5,285 | 113,363 |
| 1953 | 4,986 | 4,405 | 5,255 | 5,250 | 5,883 | 5,253 | 5,485 | 9,375 | 10,167 | 8,151 | 7,991 | 6,076 | 88,279 |
| 1954 | 4,722 | 4,185 | 4,597 | 4,515 | 3,686 | 4,643 | 14,430 | 19,691 | 7,553 | 8,582 | 9,239 | 5,707 | 91,551 |
| 1955 | 4,807 | 4,067 | 4,524 | 4,398 | 3,812 | 3,707 | 5,331 | 10,197 | 14,863 | 7,667 | 7,203 | 5,832 | 76,408 |
| 1956 | 4,608 | 4,232 | 4,829 | 6,493 | 8,099 | 9,914 | 18,515 | 20,634 | 18,298 | 9,412 | 6,869 | 5,843 | 117,745 |
| 1957 | 4,872 | 5,475 | 5,930 | 4,755 | 6,182 | 5,840 | 12,698 | 20,643 | 17,002 | 11,345 | 6,687 | 5,404 | 106,834 |
| 1958 | 5,118 | 5,218 | 5,782 | 5,065 | 5,678 | 4,565 | 4,813 | 19,024 | 13,413 | 7,880 | 7,191 | 5,602 | 89,348 |
| 1959 | 3,766 | 3,514 | 3,716 | 3,537 | 3,474 | 3,956 | 4,970 | 9,930 | 17,746 | 7,975 | 7,693 | 5,142 | 75,418 |
| 1960 | 5,397 | 4,444 | 4,612 | 4,477 | 3,965 | 3,950 | 6,202 | 10,013 | 13,114 | 9,160 | 7,847 | 5,280 | 79,460 |
| 1961 | 3,397 | 3,512 | 3,513 | 3,990 | 3,600 | 3,787 | 4,935 | 9,098 | 8,719 | 8,867 | 9,985 | 4,622 | 68,024 |
| 1962 | 3,746 | 3,311 | 3,510 | 3,961 | 3,397 | 3,637 | 14,894 | 16,257 | 11,983 | 8,922 | 7,348 | 5,410 | 87,376 |
| 1963 | 4,943 | 4,155 | 4,571 | 4,413 | 5,516 | 3,896 | 5,220 | 11,758 | 21,098 | 9,238 | 7,539 | 5,112 | 87,458 |
| 1964 | 4,488 | 4,211 | 4,310 | 3,568 | 3,956 | 3,810 | 9,225 | 16,891 | 18,255 | 12,158 | 6,974 | 5,797 | 93,645 |
| 1965 | 5,036 | 4,380 | 6,176 | 8,776 | 6,943 | 9,175 | 17,810 | 15,477 | 16,421 | 14,737 | 8,224 | 7,498 | 120,654 |
| 1966 | 6,850 | 6,756 | 6,314 | 5,584 | 5,383 | 3,741 | 6,488 | 14,647 | 12,354 | 8,779 | 7,593 | 5,459 | 89,948 |
| 1967 | 3,690 | 3,529 | 4,065 | 3,699 | 3,692 | 4,000 | 4,452 | 15,571 | 20,666 | 13,285 | 6,632 | 5,853 | 89,133 |
| 1968 | 5,264 | 5,514 | 5,924 | 5,496 | 5,422 | 5,275 | 5,619 | 12,024 | 20,150 | 8,624 | 6,971 | 5,975 | 92,258 |
| 1969 | 6,103 | 5,165 | 5,897 | 6,404 | 10,913 | 8,588 | 7,726 | 18,957 | 11,057 | 7,378 | 6,852 | 5,668 | 101,698 |
| 1970 | 5,441 | 4,577 | 4,786 | 4,537 | 3,816 | 4,170 | 6,454 | 17,655 | 23,403 | 10,776 | 6,810 | 4,492 | 96,918 |
| 1971 | 5,915 | 6,585 | 6,050 | 8,915 | 9,196 | 10,311 | 16,190 | 22,919 | 25,448 | 17,609 | 8,881 | 7,809 | 145,828 |
| 1972 | 8,084 | 8,074 | 7,328 | 10,594 | 10,194 | 14,651 | 14,578 | 20,733 | 19,524 | 10,107 | 7,110 | 6,999 | 137,976 |
| Avg. | 4,784 | 4,531 | 4,705 | 4,758 | 4,952 | 5,265 | 8,858 | 14,434 | 14,362 | 9,884 | 7,613 | 5,786 | 89,933 |
| Max. | 8,084 | 8,074 | 7,328 | 10,594 | 10,913 | 14,651 | 22,912 | 23,190 | 25,448 | 17,609 | 9,985 | 7,809 | 145,828 |
| Min. | 2,863 | 2,751 | 3,066 | 3,077 | 2,756 | 3,086 | 4,452 | 6,637 | 7,235 | 6,900 | 5,751 | 4,131 | 62,607 |

Source: Idaho Department of Water Resources.

TABLE C-3

SNAKE RIVER NEAR SHELLEY
ANNUAL FLOOD PEAKS AND GAGE HEIGHTS

| Date | Annual Peak (CFS) | Gage Height (feet) | Date | Annual Peak (CFS) | Gage Height (feet) |
|---|---|---|---|---|---|
| Jun. 4, 1890 | 51,000 | - | Jun. 12, 1944 | 21,900 | 11.05 |
| May 5, 1892 | 54,300 | - | Jun. 10, 1945 | 20,700 | 10.77 |
| Jun. 14, 1893 | 44,400 | - | Apr. 29, 1946 | 24,900 | 11.76 |
| Jun. 6, 1894 | 75,000 | - | Jun. 12, 1947 | 26,800 | 12.20 |
| Jun. 4, 1915 | 15,400 | 9.6 | Jun. 5, 1948 | 27,600 | 12.33 |
| Jun. 21, 1916 | 26,500 | 12.3 | May 20, 1949 | 25,700 | 12.00 |
| Jun. 22, 1917 | 36,800 | 14.68 | Jun. 9, 1950 | 28,000 | 12.55 |
| Jun. 17, 1918 | 47,200 | 16.97 | Mar. 31, 1951 | 26,600 | 12.27 |
| May 31, 1919 | 13,700 | 9.13 | May 6, 1952 | 29,600 | 12.82 |
| May 20, 1920 | 23,500 | 11.59 | Jun. 16, 1953 | 22,300 | 11.20 |
| Jun. 1, 1921 | 30,400 | 13.17 | Jun. 29, 1954 | 27,700 | 12.45 |
| May 27, 1922 | 26,700 | 12.33 | Jun. 18, 1955 | 14,100 | 9.16 |
| May 28, 1923 | 23,200 | 11.50 | May 29, 1956 | 30,100 | 12.90 |
| Jun. 2, 1924 | 11,000 | 8.40 | May 23, 1957 | 22,300 | 11.06 |
| May 23, 1925 | 27,600 | 12.54 | May 25, 1958 | 16,500 | 9.83 |
| Apr. 22, 1926 | 14,300 | 9.22 | Jun. 30, 1959 | 12,000 | 8.61 |
| Jun. 30, 1927 | 36,500 | 14.51 | Aug. 21, 1960 | 9,290 | 7.86 |
| May 29, 1928 | 36,600 | 14.36 | Jul. 7, 1961 | 6,900 | 7.18 |
| Jun. 19, 1929 | 24,600 | 11.70 | May 8, 1962 | 16,600 | 9.85 |
| Jun. 13, 1930 | 12,300 | 8.68 | Jun. 19, 1963 | 25,600 | 12.17 |
| May 18, 1931 | 6,830 | 7.18 | Jun. 21, 1964 | 24,300 | 11.94 |
| May 16, 1932 | 19,600 | 10.43 | Jun. 29, 1965 | 19,400 | 10.67 |
| Jun. 17, 1933 | 19,400 | 10.40 | Jun. 12, 1966 | 17,600 | 10.18 |
| May 10, 1934 | 6,550 | 7.05 | Jul. 2, 1967 | 19,800 | 10.63 |
| Jun. 16, 1935 | 15,100 | 9.32 | Jun. 15, 1968 | 21,500 | 11.29 |
| Jun. 3, 1936 | 28,600 | 12.60 | Apr. 26, 1969 | 18,900 | 10.39 |
| May 10, 1937 | 14,100 | 9.17 | Jul. 1, 1970 | 24,000 | 11.78 |
| Jul. 4, 1938 | 20,600 | 10.76 | May 15, 1971 | 25,600 | 12.16 |
| May 6, 1939 | 17,000 | 9.92 | Jun. 12, 1972 | 21,800 | 11.34 |
| Jun. 7, 1940 | 9,470 | 7.91 | May 28, 1973 | 16,800 | 10.02 |
| May 21, 1941 | 12,000 | 8.63 | Jun. 24, 1974 | 25,900 | 12.06 |
| May 2, 1942 | 16,300 | 9.72 | Jul. 9, 1975 | 19,500 | 10.66 |
| Jun. 2, 1943 | 30,400 | 12.94 | | | |

Notes: Drainage area = 9790 square miles
Gage datum = El. 4599.0 feet

Source: USGS, Idaho

TABLE C-4

SNAKE RIVER NEAR SHELLEY, IDAHO
FLOOD FREQUENCY COMPUTATIONS

## ANNUAL FLOOD STATISTICS

| | Logs | Discharge |
|---|---|---|
| Mean | 4.327 | 23,714.7 |
| Standard Deviation | 0.209 | 11,864.9 |
| Skewness | -0.230 | 1.757 |
| Standard Error of Skewness | 0.299 | - |

## LOG-PEARSON TYPE III CALCULATIONS

| Probability | Recurrence Interval (years) | Discharge (CFS) |
|---|---|---|
| 0.9900 | 1.01 | 6,396 |
| 0.9500 | 1.05 | 9,336 |
| 0.9000 | 1.11 | 11,338 |
| 0.8000 | 1.25 | 14,249 |
| 0.5000 | 2.00 | 21,617 |
| 0.2000 | 5.00 | 31,949 |
| 0.1000 | 10.00 | 38,790 |
| 0.0400 | 25.00 | 47,347 |
| 0.0200 | 50.00 | 53,634 |
| 0.0100 | 100.00 | 59,838 |
| 0.0050 | 200.00 | 65,995 |
| 0.0020 | 500.00 | 74,104 |

Source: USGS, Idaho

Notes: Drainage area = 9790 square miles
Length of data = water-years 1890-1975

# SNAKE RIVER NEAR SHELLEY, IDAHO
# FLOOD FREQUENCY CURVE

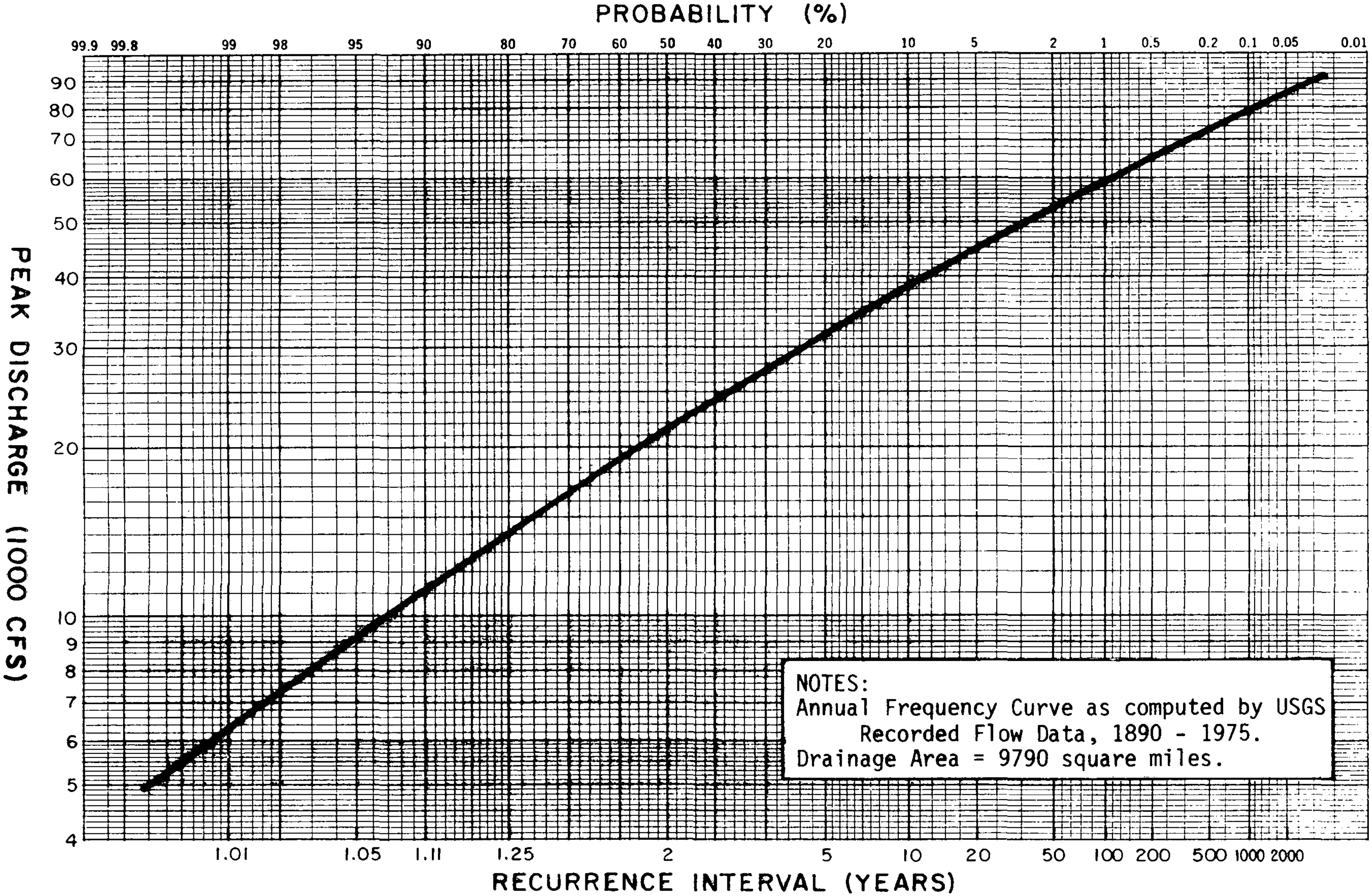
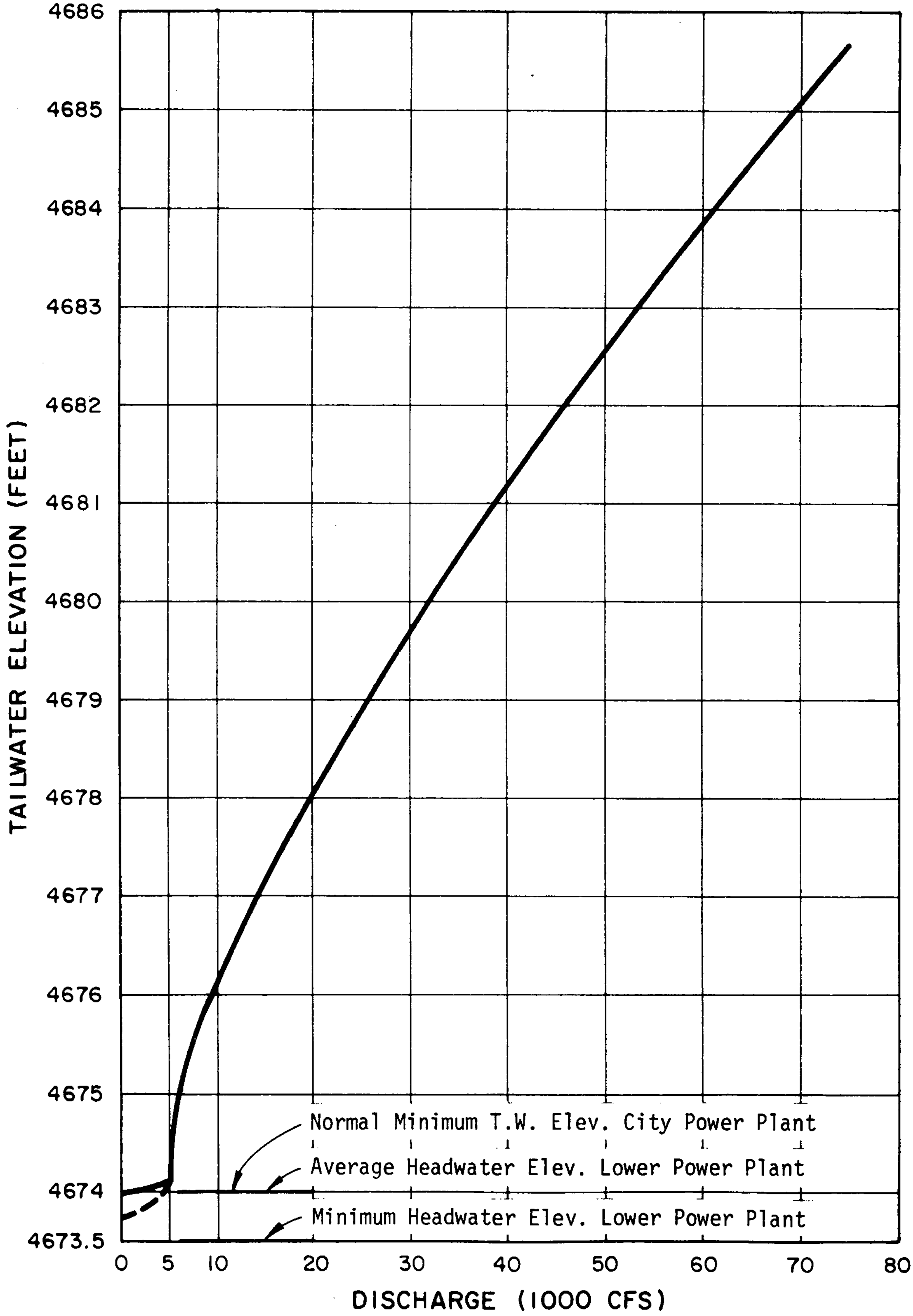



FIGURE C - 1

FIGURE C-2

# CITY POWER PLANT
# TAILWATER RATING CURVE



## SNAKE RIVER NEAR IDAHO FALLS
## FLOW-DURATION CURVE
### PRESENT (1975) FLOW CONDITIONS, MONTHLY DATA 1928-1972

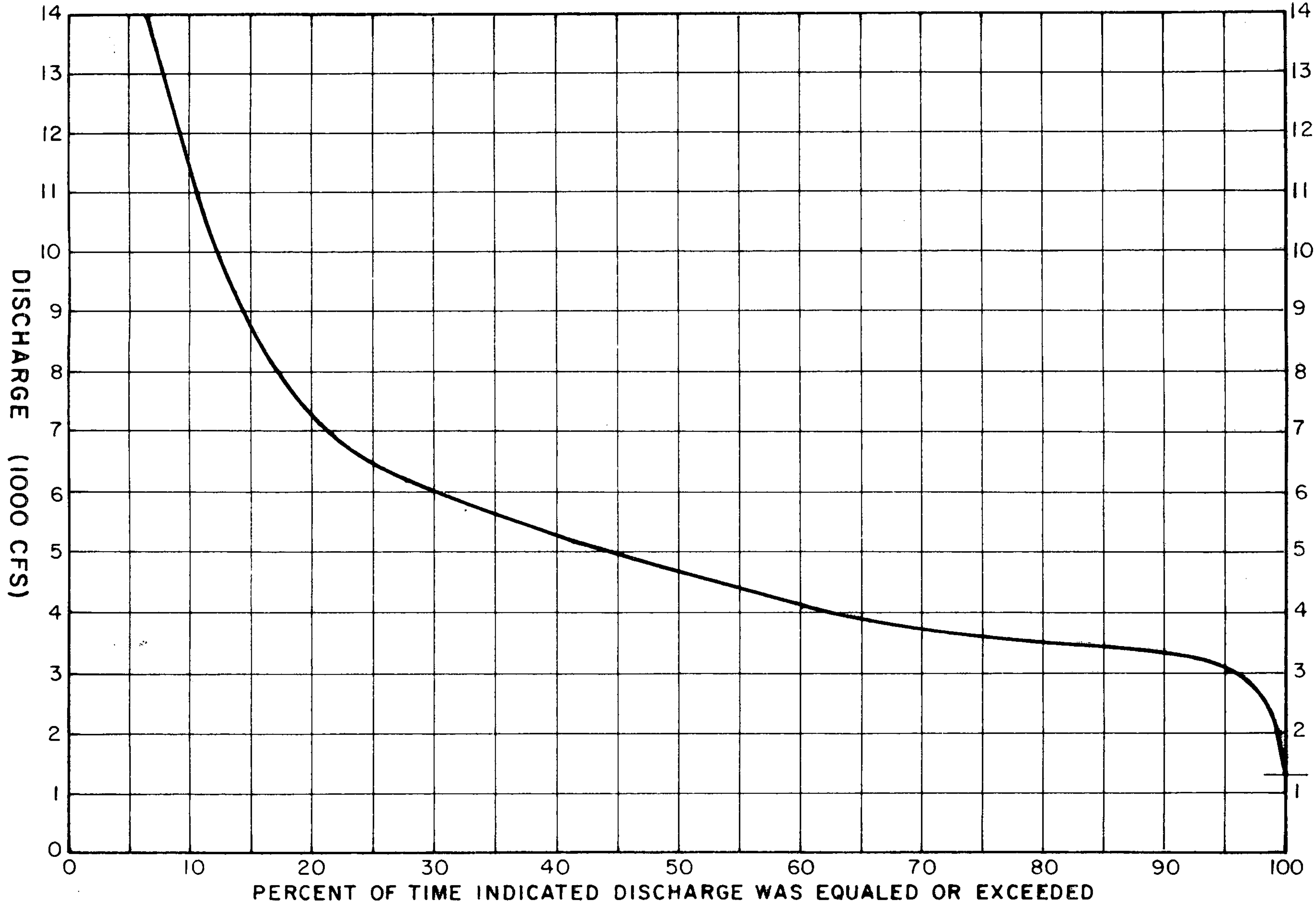



FIGURE C-3

SNAKE RIVER NEAR IDAHO FALLS
FLOW-DURATION CURVE
RECOMMENDED STATE WATER PLAN FLOW CONDITIONS, MONTHLY DATA 1928-1972

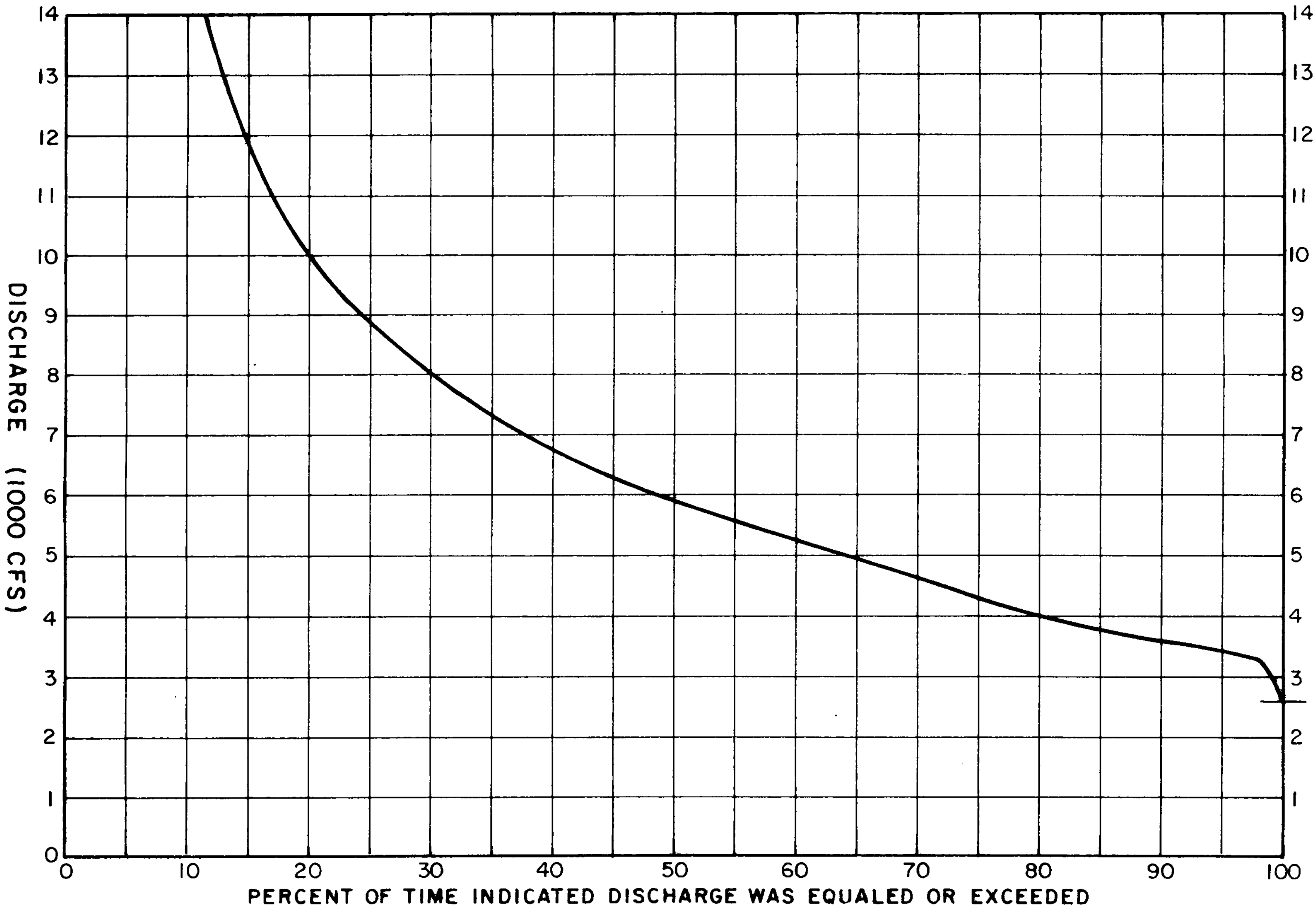
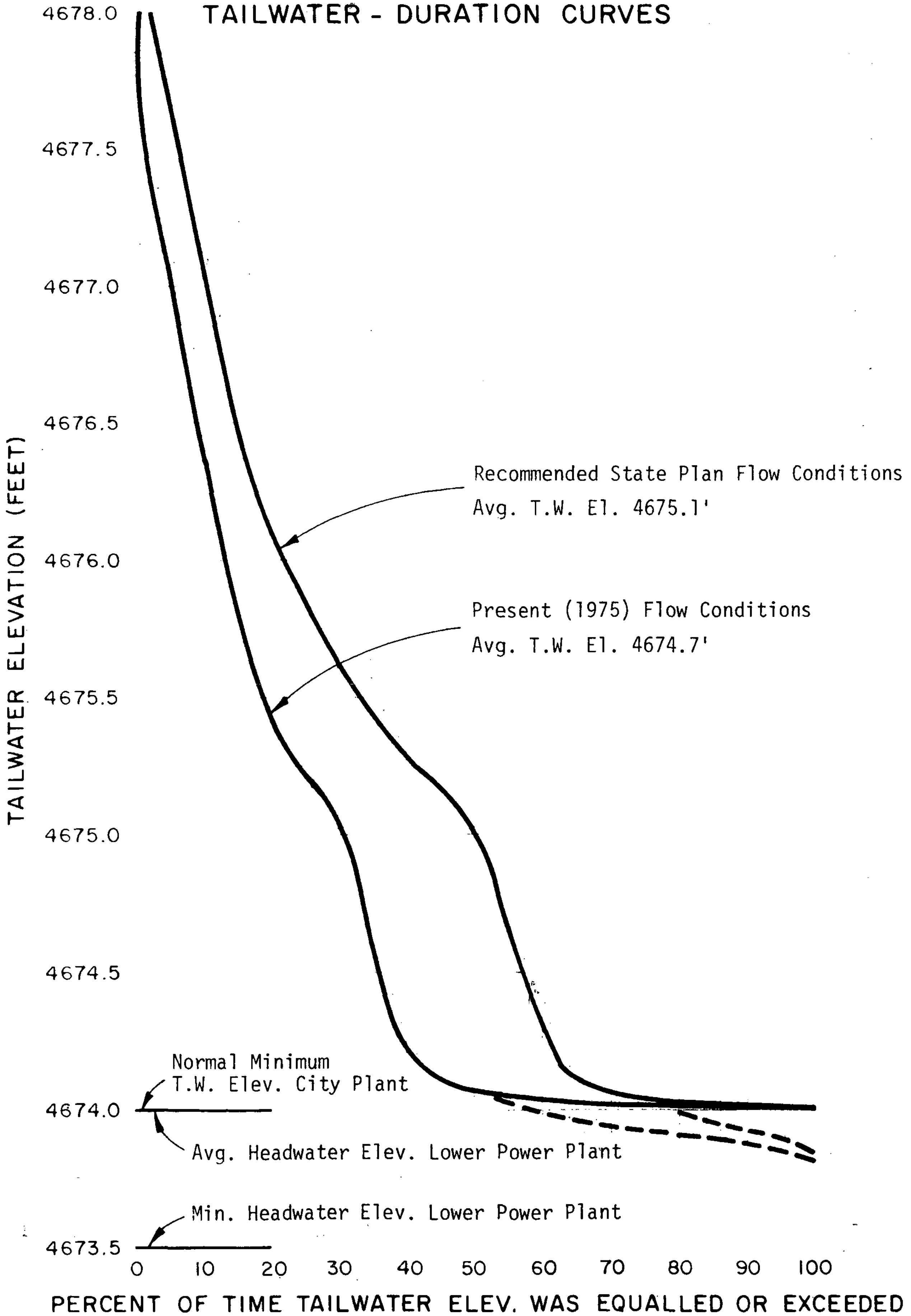



FIGURE C-4

# CITY POWER PLANT
# TAILWATER - DURATION CURVES



## CITY POWER PLANT - BULB TURBINE INSTALLATIONS

### INSTALLED CAPACITY VS. GENERATED ENERGY
### PRESENT (1975) FLOW CONDITIONS

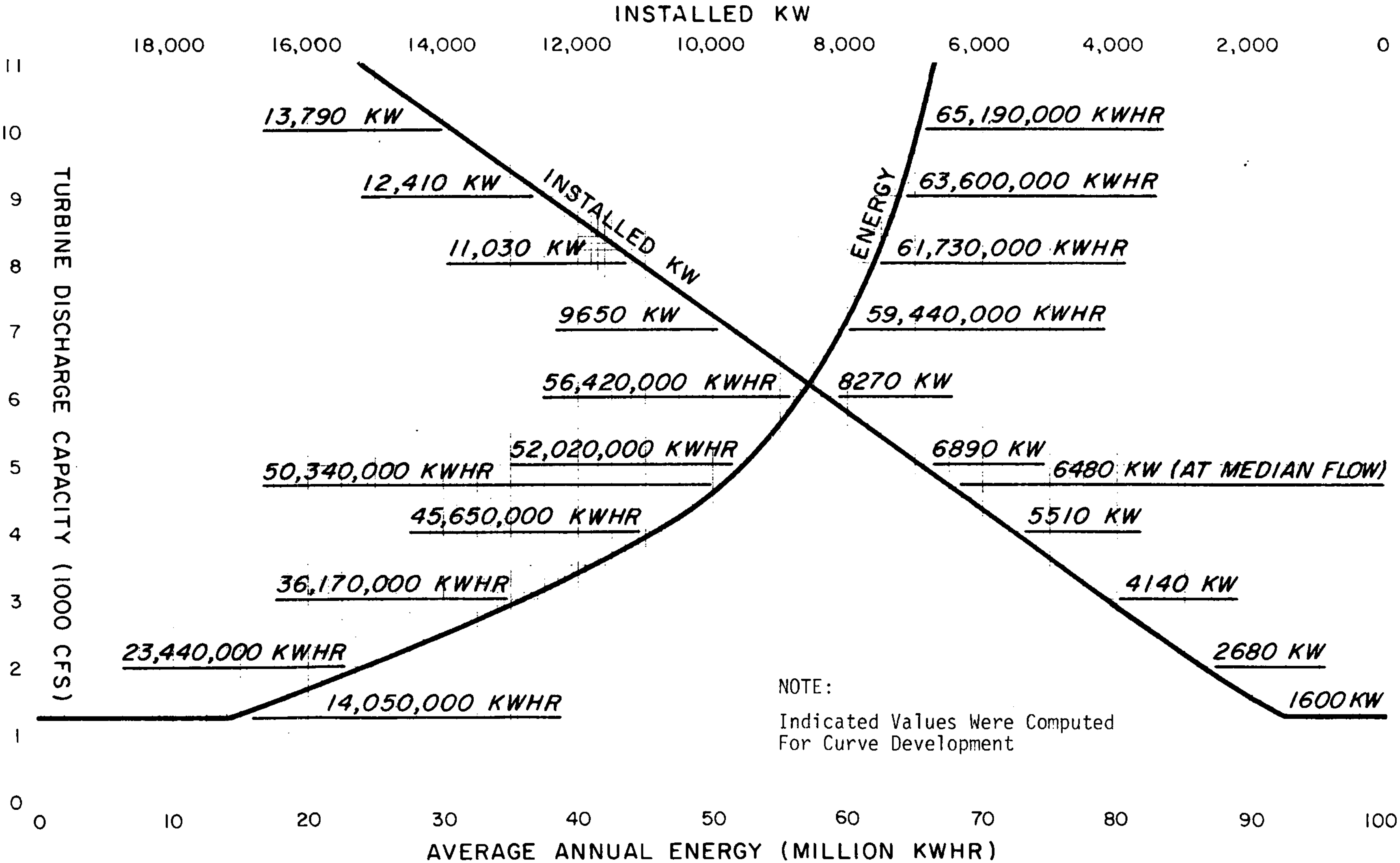



FIGURE C-6

## CITY POWER PLANT - BULB TURBINE INSTALLATIONS

## INSTALLED CAPACITY VS. GENERATED ENERGY
## RECOMMENDED STATE WATER PLAN FLOW CONDITIONS

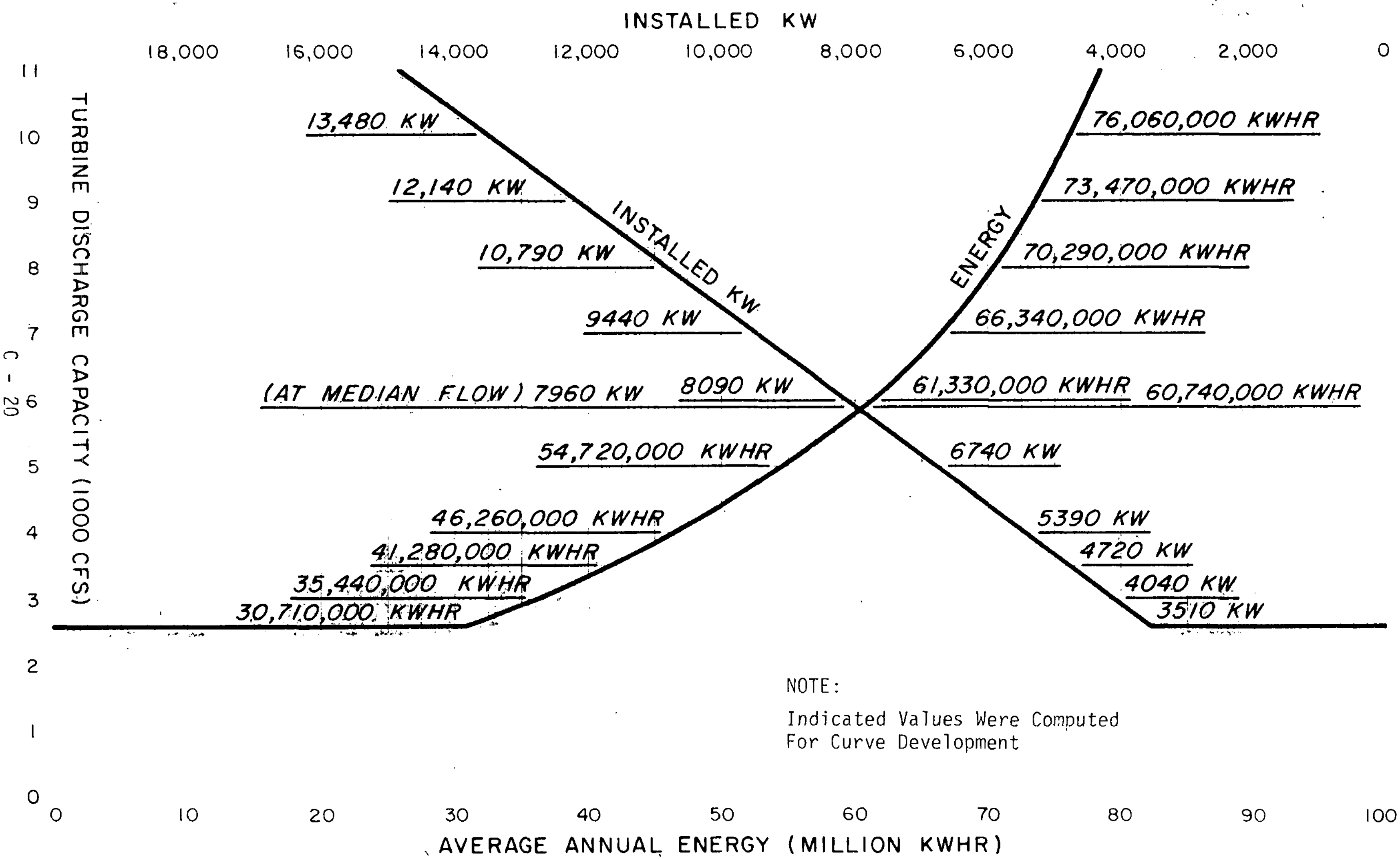



FIGURE C-7

CITY POWER PLANT - INFLOW-DURATION CURVE

PRESENT (1975) FLOW CONDITIONS,
ALLOWING 850 CFS FOR IDAHO FALLS

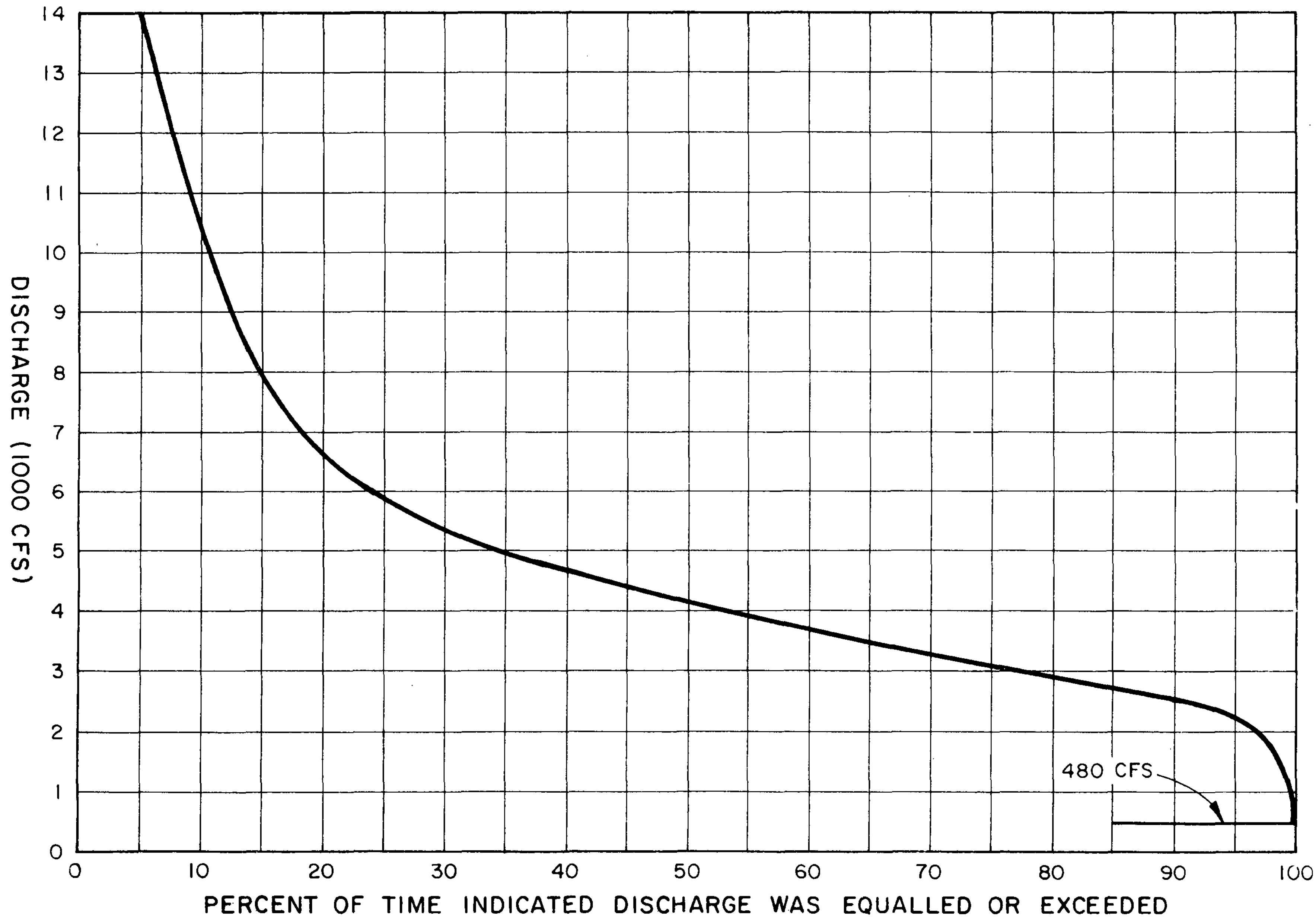



FIGURE C-8

# CITY POWER PLANT - INFLOW-DURATION CURVE

## RECOMMENDED STATE WATER PLAN FLOW CONDITIONS ALLOWING 850 CFS FOR IDAHO FALLS

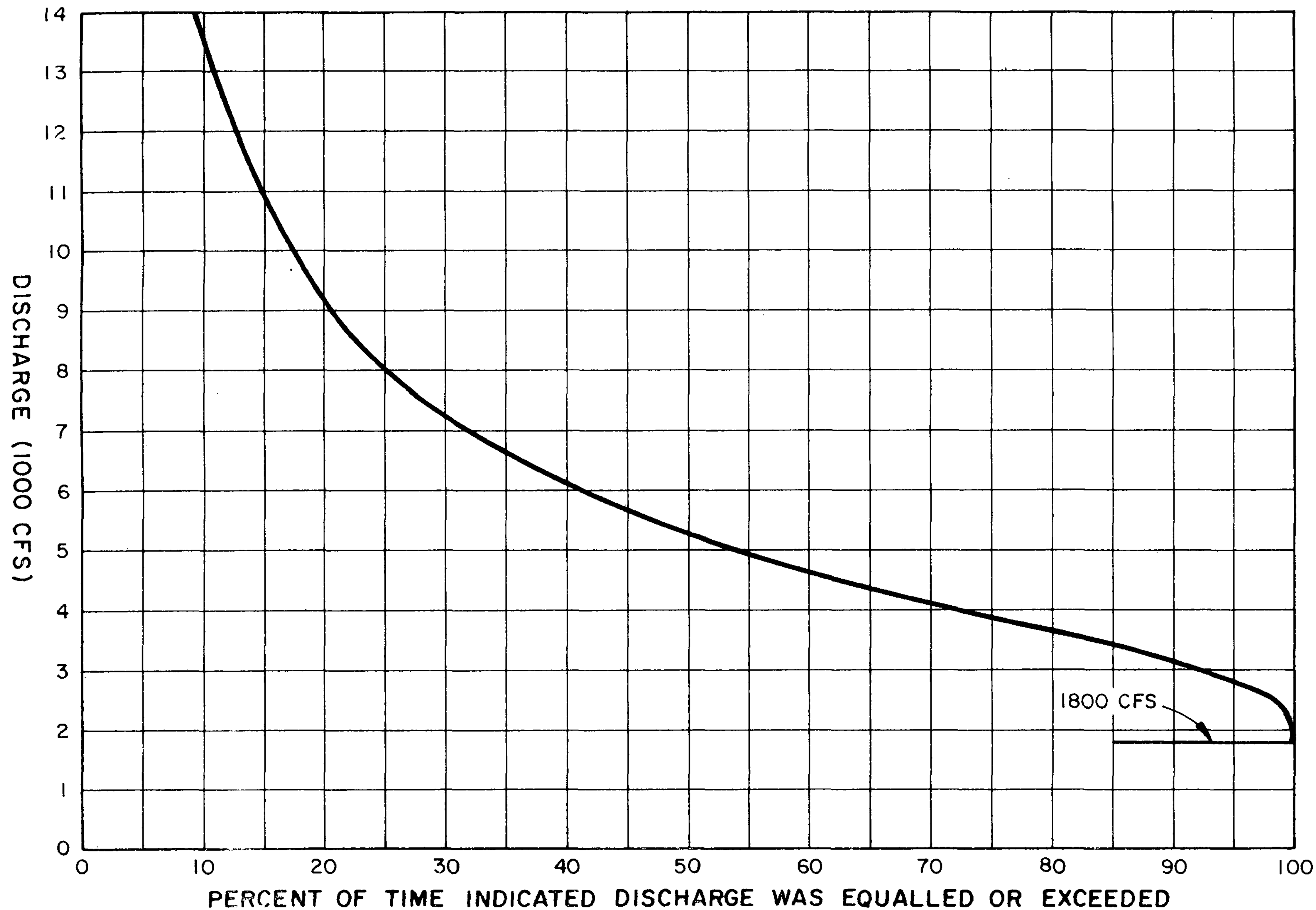
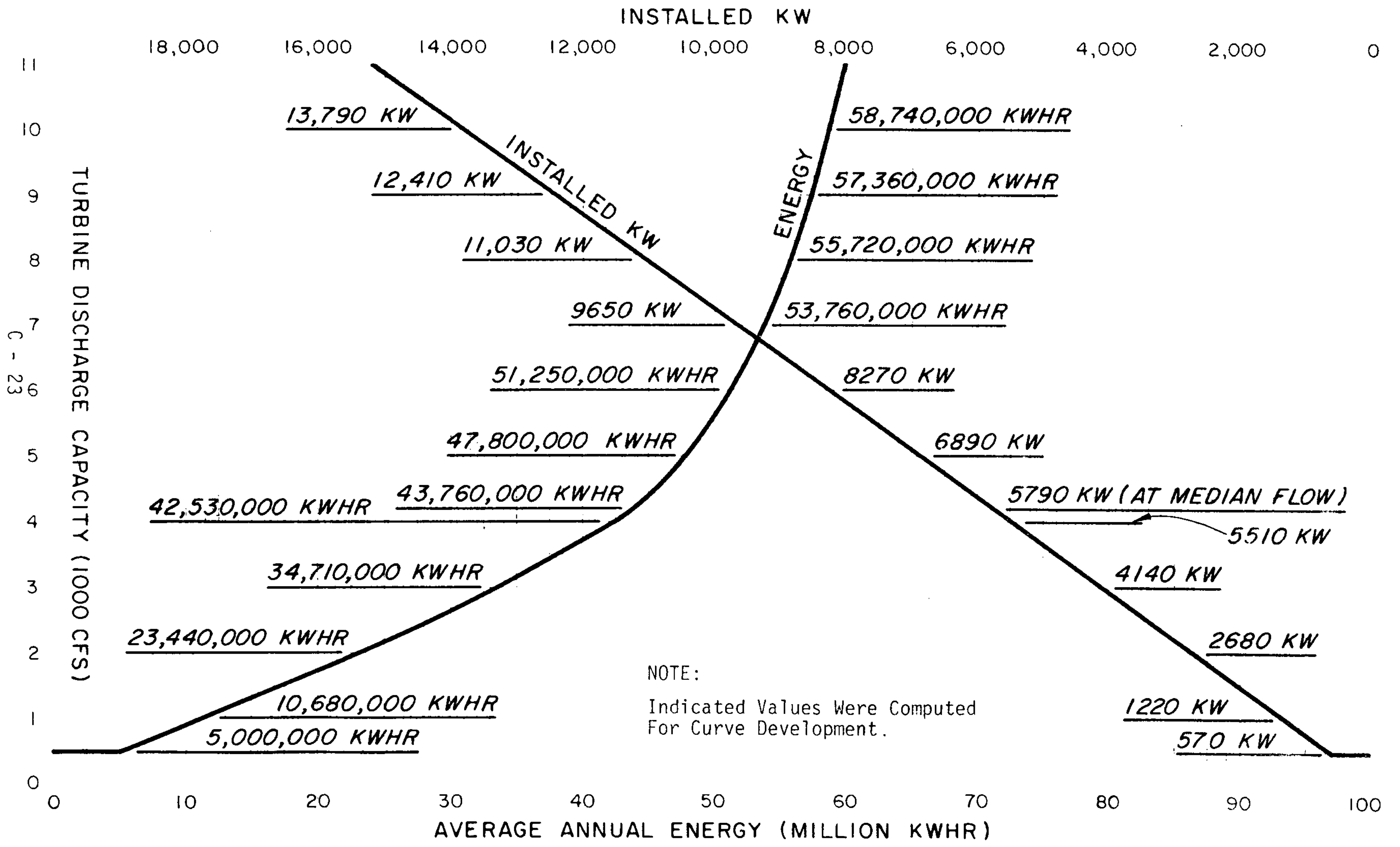



FIGURE C-9

CITY POWER PLANT - BULB TURBINE INSTALLATIONS

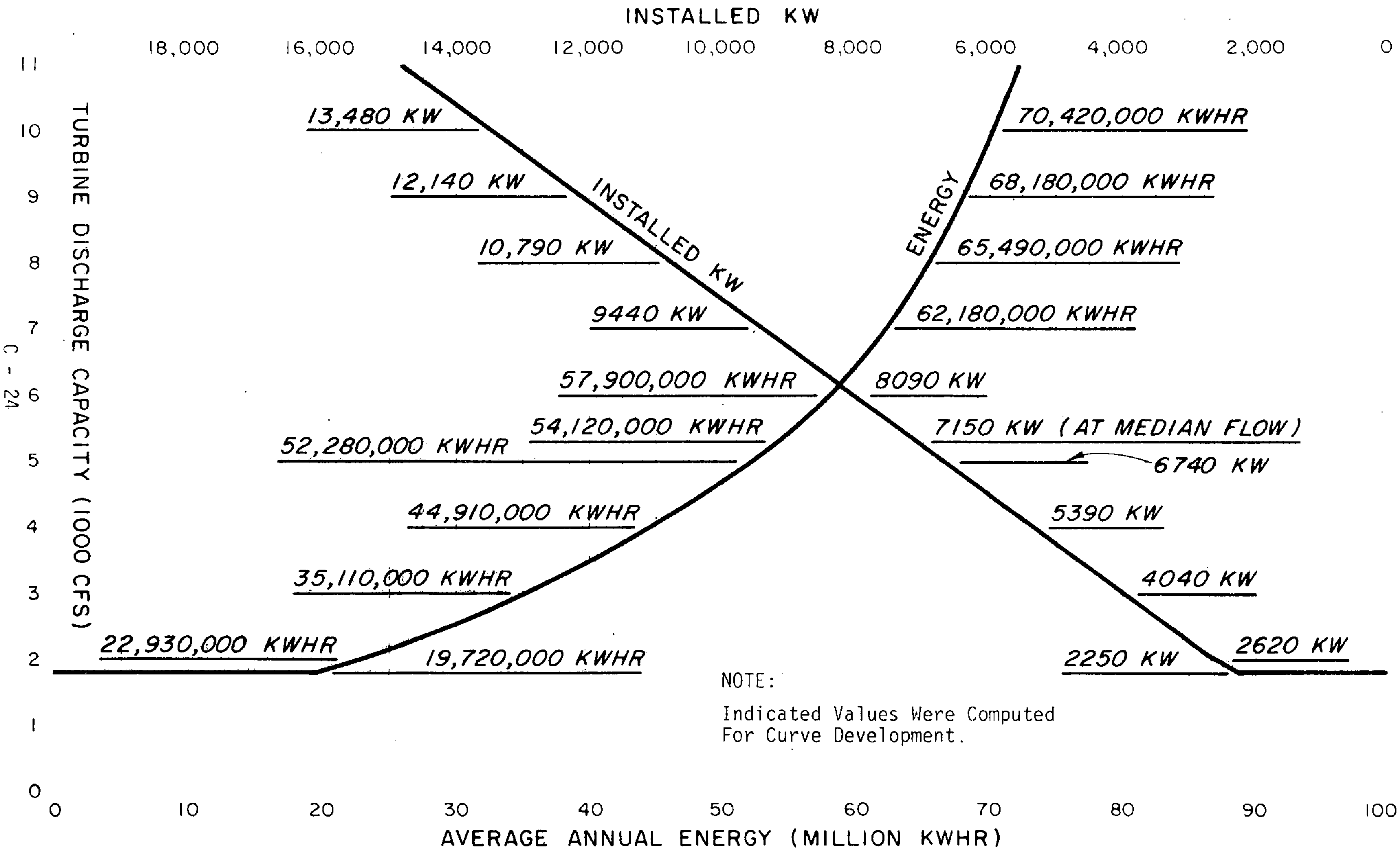
INSTALLED CAPACITY VS. GENERATED ENERGY

PRESENT (1975) FLOW CONDITIONS, ALLOWING 850 CFS FOR IDAHO FALLS



## CITY POWER PLANT - BULB TURBINE INSTALLATIONS

### INSTALLED CAPACITY VS. GENERATED ENERGY RECOMMENDED STATE WATER PLAN FLOW CONDITIONS, ALLOWING 850 CFS FOR IDAHO FALLS



# APPENDIX D
# GEOTECHNICAL INVESTIGATIONS

# APPENDIX D
# GEOTECHNICAL INVESTIGATIONS

This appendix presents the findings of the geotechnical investigations performed for the vicinity of the Idaho Falls City Power Plant. The field investigations were made between March 13 and March 16, 1977. The area in the vicinity of the power plant and related power generation features were investigated. The scope of the work consisted of:

- Review of available data describing the geologic and seismic conditions of the region.
- Geologic reconnaissance of the site.
- Geologic mapping to a scale of 1 inch = 100 feet on the available aerial photographs.
- Geotechnical consideration of the foundation rock.
- Seismic evaluation.

## D.1 REGIONAL GEOLOGY

The site of Idaho Falls City Power Plant is located within the Snake River plain, which is the eastern portion of the Columbia Plateau. The whole vast area has been formed by a series of basaltic lava flows of late Cenozoic Age (mainly Quaternary). These lava flows have determined the topography of the area, which is characterized by broad, flat landforms. The Snake River flows along the southern edge of the plain, on top of the lavas for most of its course. The course, or courses, of the ancient Snake River are concealed by numerous lava flows and alluvial flood deposits. Some meandering and river piracy have occurred because of the existence of shallow alluvial deposits.

The geologic history of the region can be summarized as follows. During pre-Tertiary time numerous lava flows and associated rocks poured out as floods of molten magma and accumulated in the basin. A mountain-building period followed, during which faulting, tilting, and fracturing of the rock occurred. Later, additional lava flows concealed some of the faulted and fractured rock.

Alluvial flood and stream deposits covered most of the lava flows. Extensive surficial alluvial floodplains and stream deposits around the project area have a maximum depth of about 25 feet. The deposits consist of sandy silty soils, gravel, boulders, and sand.

## D.2 AREA GEOLOGY

Bedrock in the vicinity of the City Power Plant site is basalt (see Exhibit A-2, "Project Area and Site Geology"). The rock is dark gray to almost black, very hard, fine grained to microcystalline, slightly vesicular and slightly weathered. Structure is limited to bedding of individual flows, which range in thickness from 2 to 10 feet, and nearly vertical joints 1 to 5 feet apart. The gross texture of the rock is blocky or tabular, but joints are generally clean and tight, and the overall strength and the suitability for foundations for the proposed structures are good.

Numerous potholes have been formed in the rock by river erosion, and in many areas the bedrock is covered by 2- to 5-foot-thick deposits of silty sand and gravel or deeper artificial fill along the river bank.

No faults or shear zones were found during the reconnaissance investigations.

## D.3 SITE GEOLOGY

Foundation conditions at particular structures or features are discussed below, along with an assessment of geotechnical factors pertinent to future construction.

### A. Diversion Weir

The rock underlying the upstream portion of the existing diversion weir (above Broadway Bridge) is somewhat less weathered and less jointed than average (see Exhibit A-2, cross section A-A). Joints, which are 2 to 5 feet apart, are tight and clean and show little evidence of weathering. The most predominant orientation is approximately east-west with a vertical dip. Other joint set orientations are N $50^{o}$ W, $80^{o}$ to $85^{o}$ E, and N $40^{o}$ E, $85^{o}$ W. Several river-worn potholes exist in the area.

Geological conditions are favorable for the construction of the new diversion weir. Foundation preparation should include removing all loose surface material, cleaning all potholes, and backfilling potholes with concrete.

The rock underlying the downstream portion of the existing diversion weir (below Broadway Bridge) is sound and hard and will provide a good foundation for the new structure (see Exhibit A-2 and Exhibit A-3, cross section B-B). It may be possible to reduce the length of this portion of the new weir by building it slightly west of the present location.

### B. Forebay

Bedrock exposed along the east channel between Broadway Bridge and the powerhouse is typical basalt, although silt and sand deposits approximately 1 to 3 feet thick partially cover the right bank of the channel. These deposits should be removed before any future improvement such as shotcreting is undertaken.

Some consideration has been given to removing part of the relatively high ridge of bedrock from beneath the east end of Broadway Bridge to improve flow conditions (see Exhibit A-3, cross section C-C). There should be no danger in excavating this rock with cut slopes of 0.5:1, assuming that carefully controlled blasting techniques are used to prevent damage to the existing structure.

C. Powerhouse and Tailrace

Bedrock in the vicinity of the powerhouse has slightly closer jointing than average and more conspicuous bedding structure than normal. Predominant joint set orientations are N $25^{o}$ to $30^{o}$ W, $78^{o}$ E, and N $75^{o}$ E, vertical. The resulting rock structure is blocky, but the joints are tight and clean, and no seepage was observed at or near the powerhouse. The rock will provide an acceptable foundation for the new structure, but strict control of blasting will be required to prevent damaging the foundation rock or the retaining wall east of the existing powerhouse (see Exhibit A-3, cross section D-D).

D. Retaining Wall

The retaining wall immediately east of the existing powerhouse supports an artificial fill, which is approximately 20 feet deep at its maximum depth. The switchyard, shops, and tranmission towers are among the structures built on the fill. During the June 1976 flood, the wall was undercut in an area where it had been placed partially on alluvial deposits. The undercut area is approximately 15 feet long and from 2 to 15 inches high; it extends under the wall approximately 1.5 feet. There is no sign of instability, such as cracking in the wall, but because of the importance of this structure consideration should be given to design of remedial work to ensure its continued stability.

## D.4 SEISMICITY

An evaluation of the sites for potential earthquakes was based on the combined study of the regional geology and seismic activity of the area and on a review of published literature, particularly proceedings of the World Conferences on Earthquake Engineering. Computer earthquake data listings for a 150-kilometer radius from the site were obtained from the National Oceanic and Atmospheric Administration.

The available information indicates that the structures are within a potential seismic zone. However, the size, standard design criteria, and construction of the structures will be such that no special seismic considerations will be required.

## D.5 CONCLUSIONS AND RECOMMENDATIONS

No geological features were observed that would preclude construction of the diversion weir or powerhouse. Some specific conclusions and recommendations are given below.

- Bedrock is good, and no foundation problems are foreseen for either the diversion weir or the powerhouse.
- Foundation preparation requires that all joints, fixtures, potholes, and exposed rock be cleaned well. If necessary, joints should be water-jetted, and potholes should be cleaned and backfilled. All loose blocks must be removed.
- All structures must be keyed to bedrock.

- The feasibility of realigning the weir section downstream from Broadway Bridge should be considered. A new location slightly west of the present structure would allow construction of a shorter structure and would improve debris control.

- Excavation under Broadway Bridge to improve flow conditions in the forebay is feasible. However, careful control of blasting will be required to prevent damage to the bridge and its foundation.

- Bedrock in the forebay section is good. However, some silt and sand deposits partially cover the right bank of the channel. These deposits should be removed if any improvement such as shotcrete is planned.

- The powerhouse excavation will require careful blasting control to avoid excessive rock breakage and to prevent damage to the retaining wall.

- Excavation along the tailrace poses no problems. The rock is good and almost vertical rock cuts will be stable.

# APPENDIX E

# NOTICE TO PROCEED AND SCOPE OF WORK

# CITY OF IDAHO FALLS

P.O. BOX 220

IDAHO FALLS, IDAHO 83401

OFFICE OF: Electric Division

February 2, 1977

International Engineering Company, Inc.
220 Montgomery Street
San Francisco, California 94104

Attention: Mr. R.B. Christensen, Vice President

Dear Bob: Re: Notice to Proceed

The City Council has authorized me to instruct you to proceed with the proposed City Power Plant feasibility study. The initial scope is:

1. Evaluate the City plant site for the possible installation of a bulb turbine taking into account salvage of existing equipment, aesthetics of the area, and other engineering aspects associated with a power plant of this type, and as outlined in your phase I proposal.

2. It is contemplated that total expenditures will not exceed $69,000 without prior written authorization.

3. This notice is not authorization to proceed with FPC licensing.

If you have any questions regarding this notice, please contact Jeff Paine or myself.

Sincerely,

G S Harrison

G. S. Harrison, Manager
Electric Light Division
City of Idaho Falls

lg

cc: Ralph Wood
Tom Campbell

APPENDIX A

TO

TECHNICAL SERVICES AGREEMENT

BETWEEN

INTERNATIONAL ENGINEERING COMPANY, INC.

AND

THE CITY OF IDAHO FALLS, IDAHO

FOR UPGRADING OF IDAHO FALLS CITY POWER PLANT

Engineering services and assistance for the upgrading of the City hydroelectric power plant of the City of Idaho Falls, Idaho will be accomplished in three phases as follows:

A. Phase I

- IECO will perform a preliminary review and evaluation of the existing facilities.
- IECO will prepare preliminary designs necessary to define the principal features of the project.
- IECO will investigate the following: salvage of the existing generating units, rehabilitation requirements of structures, material sources and location, potential generating capacity of the site, hydraulics, mechanical and electrical equipment required, geotechnical conditions, and environmental aspects.

The work will be based upon existing plans and other data provided by the City of Idaho Falls and supplemented by IECO as necessary. In performing this study, IECO will utilize to the maximum extent practical all results and recent data compiled for studies of the Upper and Lower Power Plants.

In accomplishing the above work, IECO will undertake the following activities:

1. Evaluation of Existing Facilities - The purpose of this evaluation will be to appraise the overall physical condition of the City hydroelectric power plant. The investigations will comprise the following:

a. Collection and review of existing hydrological, geotechnical, structural, mechanical and electrical data and reports, updating and supplementing the data as necessary.

b. Field reconnaissance of the site and existing facilities.

c. Geotechnical evaluations.

d. Appraisal of existing facilities including:

- Existing diversion dam, intake structure, forebay and powerhouse.
- Salvage value of existing generating units.
- Salvage value of existing accessory electrical and mechanical equipment.
- Site access.
- Environmental aspects.
- Aesthetics of the area.

The findings will be documented and reviewed with the City. Recommendations consistent with the findings will be outlined.

2. Geotechnical Considerations - The purpose of the Phase I geotechnical investigations program is to provide sufficient geotechnical data to determine:

- The stability of existing structures.
- The geotechnical feasibility of the alternate sites if new structures are determined necessary.
- The necessary geotechnical input data for preliminary design.
- Additional geotechnical investigations required in Phase II.

The results of the geological reconnaissance will be documented and reviewed with the City. Recommendations consistent with the results will be outlined.

The Phase II geotechnical investigations are dependent on the results of Phase I investigations. If new structures are found to be required then geotechnical investigations deferred to Phase II may include further site inspection, detailed mapping and subsurface exploration and testing.

3. Hydrology - The purpose of Phase I hydrologic investigations will be to determine the following:

- River flows to be used in the power studies.
- Flood frequency and inflow design floods at the site.

- Tailwater rating curves.
- Maximize the power potential of the site.
- Backwater studies of the forebay and immediate upstream river channel.

River Flows - Monthly streamflow data for the Snake River near Idaho Falls were obtained from the Idaho Department of Water Resources and used in studies of the Upper and Lower Power Plants. These two sets of 45-year flow records for water-years 1928 through 1972 are for present flow conditions and flow conditions for the Recommended State Water Plan. These river flows will be used for the power studies.

Design Floods - Flood data and flood frequency analyses for the Snake River near the Shelley stream-gaging station were obtained from the USGS and used in the studies of the Upper and Lower Power Plants. These flood analyses and the spillway design flood of 75,000 cfs selected for the studies of the Upper and Lower Power Plants will be used to check the upstream surcharge levels and adequacy of the weir of the existing diversion dam at the City Plant.

Tailwater Rating Curves - Tailwater rating curves sufficient to cover the range of turbine discharge and spillway discharge will be prepared for use in conjunction with power studies and designs of the power plant.

Power Studies - For the Phase I power studies, the two sets of flows for present flow conditions and flow conditions for the Recommended State Water Plan will be used to size the power potential of the City power plant. Power studies will be made for several installed capacities and the corresponding average annual energy computed.

Backwater Studies - Backwater studies for the forebay and the reach of the river immediately upstream from the Broadway Bridge will be performed to determine the hydraulic properties of the forebay and river channel. The results will be used to check the principal elevations of the diversion facilities, and the capacity of the existing intake structure and forebay, to ensure that adequate flows will be diverted for power generation at the City Plant.

4. Preliminary Designs and Estimates - Preliminary designs and cost estimates will be prepared for the upgrading of the existing facilities or for new replacement facilities if this is determined to be more economical. Alternatives to be evaluated include the following:

- New powerhouse at City Plant.
- New generating units at City Plant.
- Repairs to existing dam at City Plant.
- New intake structure at City Plant.
- New dam at City Plant.
- Gates and hoists.

Generating Units - To select the most viable alternative generating scheme, the installation of bulb, and conventional Kaplan turbines with governors and generators will be evaluated. Costs for installing either one or two generating units will be developed. Layouts of new modern powerhouses to suit the selected turbine generating scheme will be prepared.

Gates and Hoists - The selection of the gates will consider the existing ice problems in winter. Means of discharging ice floes and devices for preventing the formation of ice or to thaw ice adhering to the gates and seals will be investigated.

Alternatives to be evaluated include the installation of radial, drum, and vertical lift crest gates, and heating units and compressed air systems to select the most suitable type and size of gate.

Investigation of Powerhouse and Other Structures - Based on IECO's evaluation of the extent of upgrading and replacement necessary, preliminary design and cost estimates for safe structures will be developed. Alternative methods of construction and economy will be evaluated. Due consideration for the environmental aspects consistent with economy will be made.

To evaluate the alternatives, comparative cost estimates will be developed. These estimates will be based on accurate cost information available from M-K's estimating section, adjusted as required to reflect local conditions.

In addition to the construction costs, the comparative cost would include interest during construction, administrative and engineering costs. Separate estimates of annual costs of operation, maintenance and replacement will also be made for the alternatives considered.

5. Preliminary Report - The results of Phase I investigations will be presented in a preliminary report. This report will define the principal features of the projects for final design in Phase II. It will include preliminary designs and costs estimates. Preliminary descriptions of recommended mechanical and electrical equipment will be presented. Preliminary hydraulic, geotechnical, structural, electrical and mechanical details will be developed.

6. FPC License Application - If requested, IECO will assist the City in preparation of an application for licenses to the Federal Power Commission for the hydro station. IECO will assist the City in preparation of the necessary technical exhibits and other documents including the Exhibit W Environmental Report. However, the cost estimate included at the end of this section does not include any allowance for this work.

B. Phase II

Phase II activities will consist of final designs and estimates required for preparation of contract documents, drawings, and specifications.

C. Phase III

Phase III activities will consist of assistance of the City with advertising and bid evaluation; award of construction and procurement contracts by the City; preparation of detailed construction drawings; shop inspection and testing of equipment; and surveillance of construction. This phase will also include assistance with initial start-up operations.

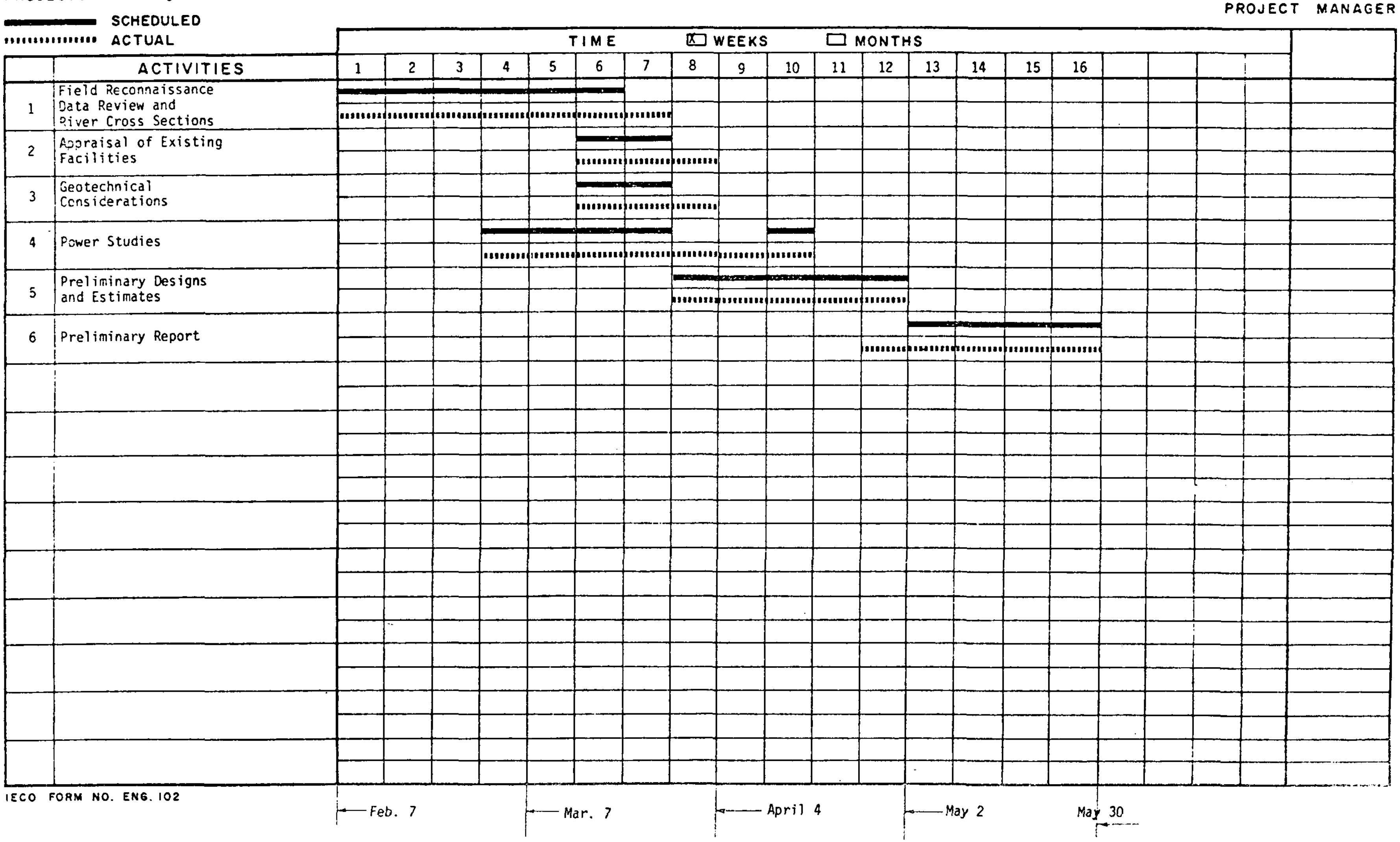
The cost estimate at the end of this section is for Phase I only and does not include any allowance for any work in Phase II and III.

INTERNATIONAL ENGINEERING COMPANY, INC.

# ENGINEERING DESIGN SCHEDULE

CONTRACT NO. 7007
CLIENT: City of Idaho Falls
PROJECT: Hydro Facilities (City Plant)

DATE February 1977
PAGE ____ OF ____
Pablo Chavez
PROJECT MANAGER




IECO FORM NO. ENG. 102