Yuba County Water Agency

SLATE CREEK
Water Supply Alternative

July
1993

MORRISON
KNUDSEN
CORPORATION

Slate Creek Water Supply Alternative for Yuba County Water Agency

July 1993

Submitted by

MORRISON KNUDSEN CORPORATION

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HARRY L. BLOHM
VICE PRESIDENT - WATER RESOURCE OPERATIONS
TRANSPORTATION AND WATER RESOURCES GROUP

July 20, 1993

Mr. Donn Wilson
Manager/Engineer
Yuba County Water Agency
1402 D Street
Marysville, CA 905901-4226

Dear Mr. Wilson:

Morrison Knudsen is pleased to submit herewith our Report on Slate Creek Water Supply Alternatives performed by our firm on behalf of your Agency.

The report suggests adding a valuable water supply addition, Slate Creek Reservoir, to your Yuba River Water Development Program where the funds for payment of the project probably would be self-supporting from power revenues. Also, the report proposes that a portion of the yield from Slate Creek Reservoir be used to supply the future needs of Yuba County Water District. Lastly, the report recommends that polyethylene pipe be placed in the Forbestown Ditch to decrease the seepage losses and improve the District's delivery system.

We hope that you will find our report responsive to your needs. We will be pleased to discuss future actions at your convenience to expedite these interesting and challenging projects.

Sincerely,

H. L. Blohm

HLB/DCW/rc

Table of Contents

Executive Summary

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Yuba County Water Agency authorized this study to investigate on a reconnaissance-level the storage of water on Slate Creek for possible use by Yuba County Water District and use of a new reservoir at New York Creek or Costa Creek for terminal storage of water for the District. The study also compares the cost of terminal storage to another alternative, placing pipe in the existing Forbestown Ditch.

Three sizes of storage reservoirs on Slate Creek were investigated. The sizes and reservoir are 35,000, 65,000 and 95,000 acre-feet in capacity. The heights of corresponding dams were 290, 365 and 450 feet. The site was visited and it appears suitable for a concrete gravity dam constructed by the roller compacted concrete (RCC) method. Construction materials for the dam are abundantly available in the river bed upstream from the proposed dam site.

The total project cost of the three sizes of reservoirs are 22, 36 and 50 million dollars. Water from the proposed project would be supplied to Oroville Wyandotte's South Fork Hydroelectric Project and DWR's Feather River Projects for power generation. It appears from the preliminary cost and benefit studies that sufficient energy would be generated by the proposed project to provide a benefit-cost ratio of greater than one the first year of operation. If more conservative values of power are assumed, the benefit-cost ratio becomes greater than one for the third year of operation. Either scenario is thought to be financiable.

Three sites were investigated for terminal storage for the Yuba County Water District and an alternative to providing terminal storage, placing a polyethylene pipe in the existing Forbestown Ditch. The alternative appears to be more economical and has less environmental impacts than constructing a terminal reservoir. The report suggests that the next step is to prepare a feasibility study of replacing the ditch with a pipeline and for the District to seek funds from DWR for construction as it qualifies for grant funds because it conserves water. Even, if no grant funds can be obtained for construction of the pipeline, the cost of constructing a facility to carry an additional 10,000 acre-feet of water appears reasonable when considering the value of the water saved and the cost will be less than $30 per acre-feet.

Section I
Introduction

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This section provides authorization, background information, and the purpose of the study.

Authorization

Authorization for the study was provided by the Yuba County Water Agency (YCWA) at its board meeting on February 23, 1993. The work was performed in accordance with Morrison Knudsen Corporation's proposal letter dated February 17, 1993.

Background

YCWD/OWID Agreement

In the mid 1950's, Yuba County Water District (YCWD) and Oroville-Wyandotte Irrigation District (OWID) each were engaged in the planning of and had made applications for water rights for conflicting hydroelectric and water conservation projects on the South Fork of the Feather River and the North Fork of the Yuba River.

An agreement was reached between YCWD and OWID in December 1959 that permitted OWID to proceed with its hydroelectric and water conservation project on the South Fork Feather River. It's principal features included new dams at Little Grass Valley and Sly Creek and new power plants at Sly Creek, Woodleaf, Forbestown and Kelly Ridge. Several provisions of the YCWD/OWID Agreement are germane to this study and include:

- OWID may defer construction of a storage dam on Slate Creek.
- OWID will include an outlet valve in the South Fork Project or valves at the head of Woodleaf penstock for the discharge of 50 cfs to Forbestown Ditch with an additional flange to permit later installation of additional valve or valves.
- OWID will divert 3,700 AF per annum for YCWD use, with the water diverted into Forbestown Ditch at the head of Woodleaf penstock at a maximum flow of 12 cfs on an irrigation demand schedule between April 15 and October 15 until such time Canyon Creek water is made available.
- OWID agrees to give to YCWD the right to enlarge Forbestown Ditch and increase the capacity of the Woodleaf penstock outlet works up to a total capacity of 110 cfs.

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Slate Creek Reservoir

In the early 1960's, OWID received a Federal Power Commission License (FPC) now Federal Energy Regulatory Commission (FERC), to construct their South Fork Project. When construction bids received were higher than the funds made available, OWID made application to FPC to amend their license to defer construction of a reservoir on Slate Creek until it was economically feasible. This deferment was a provision of the YCWD/OWID December 1959 agreement, referred to previously. The license was amended and issued on June 3, 1960. OWID has not considered construction of a reservoir on Slate Creek since that time.

OWID did construct as a part of their South Fork Project, a small diversion dam that diverts a portion of the Slate Creek flow of water into Sly Creek Reservoir via the Slate Creek Tunnel. The diversion dam and entrance to the tunnel is approximately one mile downstream of the proposed Slate Creek storage damsite. Water that is not diverted at the diversion dam flows down the creek into New Bullards Bar Reservoir for power generation at YCWA's New Colgate and New Narrows Power Plants. New Bullards Bar Reservoir occasionally cannot contain all the runoff from the Yuba River including Slate Creek, and therefore, water spills into the Feather and Sacramento Rivers. Also, whenever the level of water in the reservoir exceeds the flood pool reservation, water is released through the outlet works in addition to generating power. In addition, OWID does not divert its entitlement of water from Slate Creek whenever their Sly Creek Reservoir may spill.

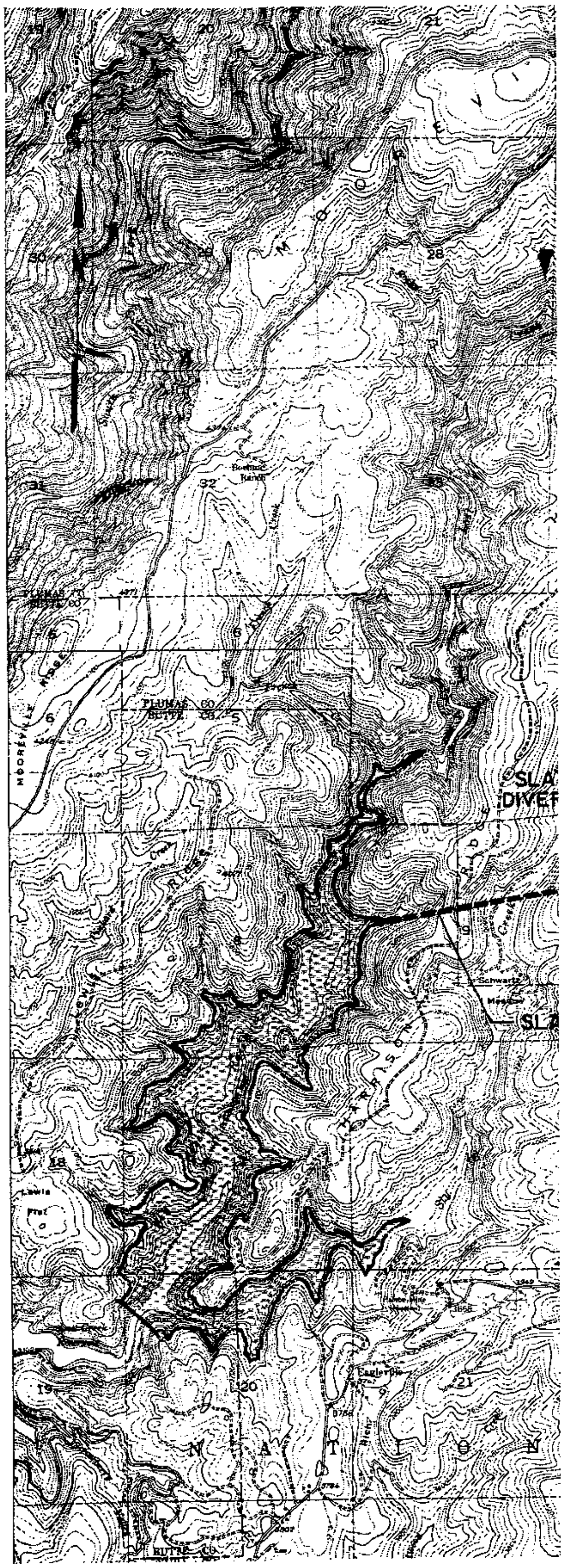
A storage reservoir on Slate Creek would be advantageous to YCWA to develop a new water supply for YCWD which now has a limited water supply from the Forbestown Ditch in accordance with the YCWD/OWID December 1959 Agreement. The ditch originally began at OWID's Lost Creek Diversion Dam. Since OWID completed its South Fork Project, the diversion was moved to OWID's Woodleaf penstock under the provisions of the December 1959 Agreement. It is a disadvantage to YCWA to store and divert water at Slate Creek to the South Fork Project, since this water would no longer be available for power generation at YCWA's New Bullards Bar Project.

Forbestown Ditch

The Forbestown Ditch is approximately 10.5 miles in length from the penstock at Woodleaf Power Plant to a drainage course which could serve as a turnout to supply supplemental water to New York or Costa Creeks. As indicated previously, OWID has an agreement to supply YCWD with approximately 3,700 AF of water annually via the Forbestown Ditch. The ditch originally was designed to carry about 40 cfs, but in recent years, due to a reduction in maintenance and demand for water, the ditch is maintained to carry only a maximum amount of about 24 cfs. Of this amount, one half is for OWID's use and the other half for YCWD. The water is used primarily for irrigation and flows at its capacity during the months of June through September. YCWD also uses the water for domestic purposes and receives a small portion of its entitlement all year round. YCWD estimates that they lose 30 percent of its annual flow in seepage. In order to reduce seepage losses, OWID provides water to YCWD for domestic purposes in the off-season by pulsing the flows to YCWD's small domestic reservoir. Pulsing the flows in the ditch causes taste and odor problems when the water is treated. To increase the water supply to YCWD, the District or OWID needs to enlarge the carrying capacity of the ditch to transport more water during the peak seasons or direct water "off-peak" to a new terminal storage reservoir in the New York Flat or Costa Creek areas. If new water were to be provided to YCWD, i.e. new Slate Creek Reservoir, it would appear that YCWD's current agreement with OWID would permit the enlargement of the ditch to increase its carrying capacity.

Purpose of Study

The purpose of this study is to evaluate on a reconnaissance-level the storage of water from Slate Creek for use by YCWD and use of a new reservoir at New York Creek or Costa Creek for terminal storage or the enlargement of Forbestown Ditch to carry water on demand to YCWD. Water not utilized by YCWD from Slate Creek Reservoir can be used for power generation, producing energy for sale to Pacific Gas and Electric Company (PG&E) at OWID's South Fork Project and DWR's Hyatt and Thermalito Afterbay's Power Plants. Under this arrangement, the power benefits would be used to pay for the new construction of Slate Creek Reservoir and possible enlargement of Forbestown Ditch. Figures 1 and 2 following were prepared to illustrate the location of the main project features studied.



YUBA COUNTY WATER AGENCY

MAP OF PROPOSED
SLATE CREEK RESERVOIR

FIGURE 2

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Section II
Basic Data

Section II Basic Data

This Section presents a discussion of water rights, hydrology, water use data and energy values that need to be established in order to evaluate the various alternatives presented.

Water Rights

The OWID has established a water right on Slate Creek (Permit 13956) to divert up to 600 cfs through their Slate Creek Tunnel. It is reported in the USGS publication that the peak flow carrying capacity of the tunnel is 863 cfs. The minimum instream flow at Slate Creek Diversion dam which must be bypassed is 10 cfs or natural flow if less than 10 cfs. Water stored at a new Slate Creek Reservoir would require the filing of a permit from the State Water Resource Control Board (SWRCB). Water stored in the New York Flat or Costa Creek areas may also require a permit for rediversion and storage from the SWRCB.

Hydrology

Operation studies were performed for the storing of water at Slate Creek Reservoir, the determination of power lost at New Colgate and New Narrows Power Plants, and power gained at the South Fork Project. Annual water storage and power generation studies were performed by MK and the data provided in Table III-1, next section. Monthly operation studies were performed by Bookman-Edmonston Engineering, Inc. of Sacramento, California under contract to YCWA. The period of record from WY 1922 to WY 1992 was used by Bookman-Edmonston in the simulation studies for the proposed Slate Creek Reservoir. These assumptions and studies are provided separately to YCWA. Several pages from their report are provided in Appendix A. They are, Page 2 illustrating the Schematic Diagram of Simulation Studies, Page 5 indicating "Preproject Diversions from Slate Creek to Sly Creek Reservoir"), Page 7 indicating "Flow Below Existing slate Creek Diversion" Page 9, "Inflow to Slate Creek Reservoir After Bypass of Fishery flows and Existing Slate Creek Diversions" and a Page 2A, New Bullards Bar Spills Above the Colgate Penstock capacity of 3700 cfs. Page 2A does not appear in their report.

Water Needs

Yuba County Water Agency directed Bookman-Edmonston to prepare a report in February 1990 to determine the present and projected water requirements of the various water districts in Yuba County comprising the YCWA. Table 7 of their report indicated that YCWD's estimated future irrigation crop patterns at full potential development are 3,960 acres of pasture and 820 acres of trees. The estimated farm headgate delivery including 30 percent distribution losses amounts to a total water demand for irrigation of 32,700 AF. Table 9 indicated that the estimated 1989 and future (2020) urban water requirements are 1,630 and 3,850 AF respectively. This would provide for an increase in population from about 5,000 to 11,000 persons within the YCWD's service area. Discussions with the Manager of YCWD indicated that the District's delivery system would need to be substantially increased and extended to utilize the estimated full water supply. With their present delivery system, the District has a possible foreseeable future need of only between 5,000 and 10,000 AF for their irrigation system. The YCWD Manager also said that the future urban requirements tabulated are realistic and delivery of urban water would be made at their present turnout from the Forbestown Ditch.

Power Plant Generation Factors

The value of an acre-foot of stored water flowing through a power development can be quantified by dividing the number of acre-feet passing through the project into the number of kilowatt-hours (Kwh) generated for a representative time period. Both quantities are continuously tabulated by utilities at each power plant. Factors computed in this manner account for changes in head on the plant due to reservoir fluctuations, friction loss in conduits, and efficiency of the rotating and static machinery in the powerhouse.

The factors for the various powerhouses in the OWID's South Fork Project Development were provided by OWID for this study. In descending elevation from the Sly Creek Reservoir, the factors are as follows:

Sly Creek	180 Kwh/AF
Woodleaf	1,236 Kwh/AF
Forbestown	689 Kwh/AF
Kelly Ridge	519 Kwh/AF
TOTAL	2,619 Kwh/AF

Water diverted from Slate Creek Reservoir into Sly Creek Reservoir will not be available from generation at New Colgate or New Narrows Power Plants. In descending elevation from Bullards Bar Reservoir, the factors are as follows:

New Colgate	1,130 Kwh/AF
New Narrows	192 Kwh/AF
TOTAL	1,322 Kwh/AF

Operation studies were performed by Bookman-Edmonston. These studies indicate that for the representative period WY 1927 through WY 1943, the average flow of the representative period equals the average long term flow of the Sacramento River at Verona. These studies indicated that approximately one-half of the water stored and diverted into Slate Creek tunnel could not have been used for power generation at New Colgate (Bullards Bar Dam) and New Narrows Power Plants because Bullards Bar Dam was spilling, or water was released due to the reservation for flood control. Included in Appendix A is Page 2A which lists by month the New Bullards Bar Spills above the Colgate Penstock Capacity of 3,700 cfs, assuming no Slate Creek Reservoir. To account the reduction in generation because of the spills, the Kwhr/AF factor for power benefit for New Colgate and New Narrows Power Plants of 1,322 KWh/AF was reduced by one-half to 660 KWh/AF for use in determining the benefits of water stored and released through the OWID system.

Water stored in Slate Creek Reservoir, diverted to Sly Creek Reservoir and then diverted into the Forbestown Ditch only passes through Sly Creek Power Plant and therefore has a value of 180 KWh/AF.

It should be noted that the water stored at Slate Creek may not be used for generation at Kelly Ridge Power Plant since its capacity is limited. While not considered in this study, the water, however, could be used at the State of California Department of Water Resources (DWR) Hyatt and Thermalito Afterbay Power Plants where it is assumed that the benefit would be similar, or possibly greater. An agreement could be reached to provide a similar monetary benefit from the increased generation.

Annual Cost Factor

The Annual Cost of a facility, such as a reservoir for storage of water, consists of fixed charges on the investment and the production cost. The production cost is the cost to operate, maintain and administer the facility. The fixed charges for the construction of a reservoir by the Agency or District would consist of the principal and interest payments on the bonds used to construct the facility. It is believed since the facilities primary use is for water supply that the interest payments to the bond holder may be exempt from State and Federal income tax.

Section 142 (a) (4) of the Internal Revenue Code of 1986, as amended, states that financing of any of the projects described in this report may proceed on a tax-exempt basis. The Code introduced the new concept of a "Private Activity Bond" which can be issued as tax-exempt if it is also a qualified bond. Now, Private Activity Bonds (formerly IDB's), may be issued as a tax-exempt obligation, only if they fit within one of the qualified bond exceptions found in Sections 142 through 145 of the Code.

Section 142 (a) (4) provides the exclusion of proceeds used to finance facilities for the furnishing of water. Such facilities may include those components of a system for the distribution of water to customers that are necessary for the collection, treatment and distribution of water to a service area. The furnishing of water may include a reservoir or dam that is used to furnish water; the fact that one of the uses of the water is to produce electricity will not fail to qualify the facility. The general public may include electric utility, industrial, agricultural and commercial users; but in order to qualify as serving the general public, it must make available (though they need not take it) at least 25% of its overall water supply to residential users or a municipal water district.

For use in this report, a tax-exempt rate of 6.5 percent was used. This is about 0.5 percent higher than the current (April 1993) rate for a 35 year bond. For the production cost, a cost of 0.5 percent of the constructed cost was used.

Basis for Cost Estimates

Cost estimates were provided for the alternative plans and are presented in Table III-2 through III-8. The estimates were prepared using construction costs prevailing for works and materials as of mid year 1993. The construction costs were increased by 15 percent to reflect the cost of engineering, construction management and owners costs. That sum was increased by 25 percent to allow for contingencies. An additional 12 percent was added for interest during construction (assume two year period) and other financial costs. No right-of-way cost was included since the land to be inundated by the proposed Slate Creek Reservoir is in federal ownership and YCWD owns the New York Creek Reservoir site.

The cost estimates reflect a project being completed and funded to store water for use in the 1996 water year. An allowance of 12 percent of the total capital cost was included for interest during construction, cost of issuance of bonds and other financial cost. Other minor financial costs were not included. For water storage projects dependent upon a variable water supply (on a variable income stream), provisions need to be made for low water yields. The owner has the option of self insuring, providing a year or more of debt service as part of the bond issue, obtaining low flow water insurance, or obtaining letter of credit from a financial institution. This report does not consider insurance costs for Slate Creek Reservoir. For increasing the capacity of the Forbestown Ditch or terminal reservoir, those costs would not be appropriate.

Value of Water

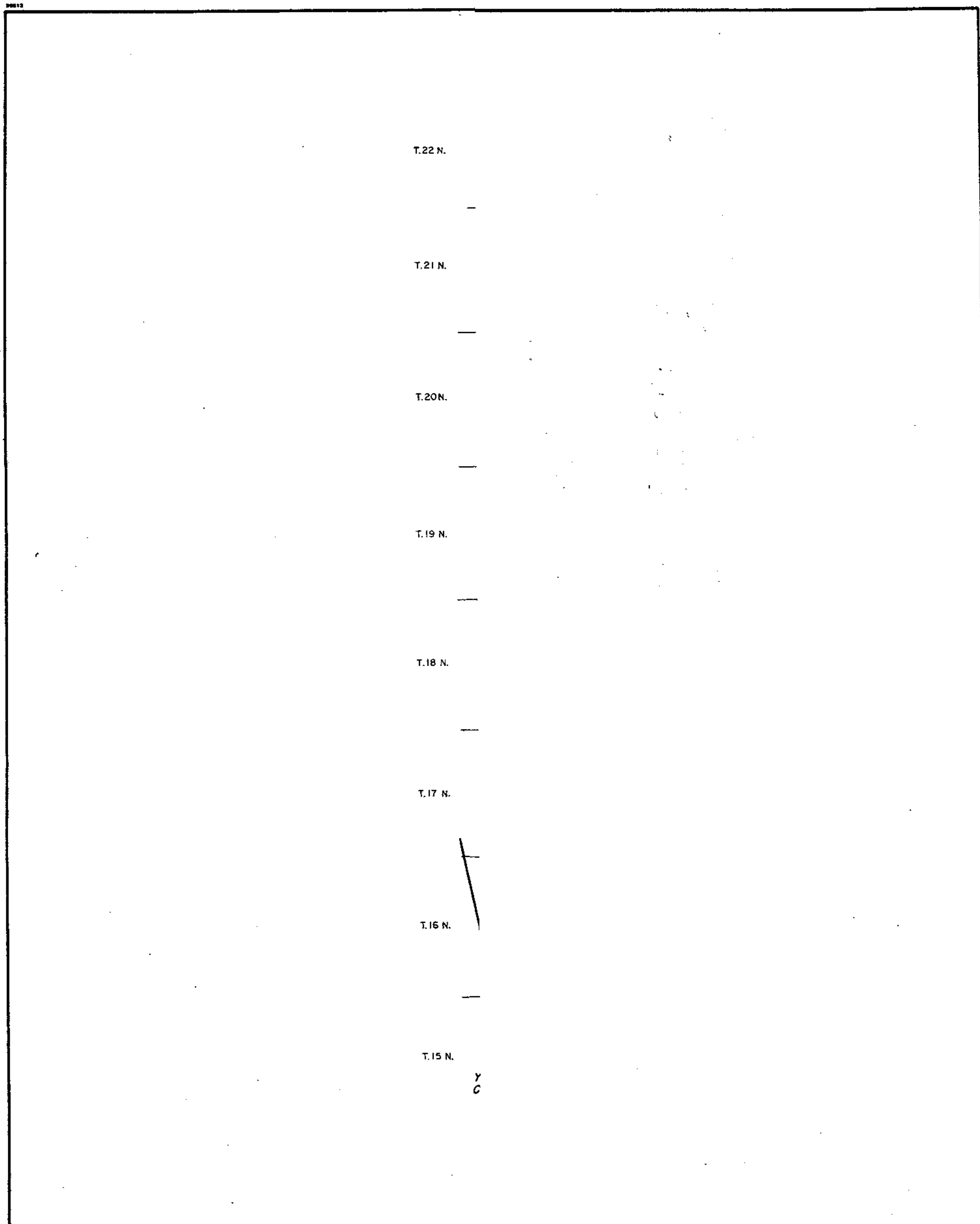
For this report, the value of energy used in computing the benefit of water for power generation is PG&E's Short-Run Avoided Cost energy forecast based on Electric Report 90 (ER-90) resource plan assumptions defined in the California Energy Commission's 1990 Electricity Report issued October 1990. The calculations are proposed to be prepared by PG&E every two years. The ER-92 resource plan Short-Run Avoided Costs have not yet been prepared. In discussions with representative of PG&E, it was indicated that the ER-90 forecast for energy is believed to be too high and the values should be reduced by ten percent to reflect current prices. Also, it should be noted that PG&E's projections are for a mix of fuels used with natural gas (lowest cost fuel) the most dominant.

Henwood Energy Services, Inc. prepared three projected energy values, a high, a base case and a low, based upon projections for natural gas and PG&E's system heat rate for the Association of California Water Agencies. The weighted average of the 20% high case, 50% base case and 30% low case was also computed. It should also be noted that these costs were based upon only use of natural gas as a fuel. The weighted average computed in this manner is lower than PG&E's ER-90 forecast.

For comparison purposes, Table II-1 provides both the ER-90 energy prices reduced by ten percent and the Henwood weighted average forecast by years beginning in 1996. The Henwood high case projected amounts for the value of energy are approximately the same as the modified ER-90 forecast.

In addition, the water stored in Slate Creek Reservoir used for generation of power through OWID's South Fork Project has a value for dispatchable energy since the water can be released to respond to the needs for power generation. The water that now flows into New Bullards Bar Reservoir and used for generation of power at New Colgate and New Narrows Power Plants has only an off-peak energy value since the power cannot be dispatched at peak periods of time. This is true since the South Yuba River, which is largely uncontrolled, peaks about the same time as water is spilled at Slate Creek diversion, and the New Narrows Power Plants is already producing its maximum capability on peak.

The value which can be placed on dispatchable energy is a subject for negotiations with PG&E. For the purpose of this report, the projected values of energy prices for qualifying facilities were increased by 15 percent to reflect the value of dispatchable energy. The amount of 15 percent is consistent with PG&E's Irrigation District Incentive Policy to provide an incentive to Districts to identify cost-effective improvements to their hydroelectric systems. However, the difference between on-peak and off-peak energy prices for qualified facilities is often greater than 15 percent. Table II-1 also includes a listing by years of the assumed value of dispatchable energy for both Henwood's projections and ER-90 projections.



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YUBA COUNTY WATER AGENCY

VICINITY MAP

FIGURE 1

Table II−1
Energy Prices and Dispatchable
Energy Prices − Mills/kWh

Year	Henwood Average Projections Avoided Cost (1)	PG&E's Short Run Avoided Cost ER−90 Less 10 % (2)	Henwood Dispatchable Energy (Col 1 * 1.15) (3)	PG&E's Short Run Dispatchable Energy (Col 2 * 1.15) (4)
1996	33.8	43.2	38.9	49.7
1997	36.2	47.3	41.6	54.4
1998	38.8	49.5	44.6	56.9
1999	41.6	56.6	47.8	65.1
2000	44.4	60.6	51.1	69.7
2001	47.2	64.1	54.3	73.7
2002	50.5	71.8	58.1	82.6
2003	53.9	77.0	62.0	88.6
2004	57.7	80.6	66.4	92.7
2005	62.2	87.3	71.5	100.4
2006	67.0	92.9	77.1	106.8
2007	72.2	97.5	83.0	112.2
2008	77.8	105.6	89.5	121.5
2009	83.7	115.2	96.3	132.5
2010	91.0	120.9	104.6	139.1
2011	98.7	127.0	113.5	146.0
2012	103.6	133.3	119.2	153.3
2013	108.8	140.0	125.1	161.0
2014	114.3	147.0	131.4	169.1
2015	120.0	154.4	138.0	177.5
2016	126.0	162.1	144.9	186.4
2017	132.3	170.2	152.1	195.7
2018	138.9	178.7	159.7	205.5
2019	145.8	187.6	167.7	215.8
2020	153.1	197.0	176.1	226.5
2021	160.8	206.8	184.9	237.9

Notes:
Col 1, Henwood Avoided Energy Cost projections for Assoc. of Calif. Water Agencies
Col 2. PG&E's Short−Run Avoided Cost (SRAC) energy price forcast reduced by 10 percent based on Electricity Report 90 (ER−90) resource plan assumptions defined in the California Energy Commission's 1990 Electricity Report issued October 1990.
Beyond 2009, energy price escalated at 5% per year (assumed GNP deflator)
Col 3, Henwood Energy Prices increased by 15 percent for Dispatchable Energy.
Col 4, PG&E's SRAC energy prices increased by 15 percent for Dispatchable Energy

dcw−tblell−1

Section III Alternative Project Formulations

This section describes the general concept for project development, sizing and costs of the various elements to be considered when formulating the projects.

Alternatives

The general concept for project development consists of storing water in a reservoir on Slate Creek above the existing Slate Creek Diversion Dam. The stored water would be released as required through the Slate Creek Tunnel into Sly Creek Reservoir. The water would be released to keep the level behind Sly Creek Dam at or near spillway crest elevation. The additional energy generated at Sly Creek Power Plant from keeping the level higher than present has not been taken into account in this report. The water would flow through Sly Creek Power Plant and then through the remaining OWID's South Fork Power Plants and DWR's Power Plants for the generation of power. As YCWD's needs for water increase over their present usage, the new water developed at Slate Creek Reservoir will be diverted out of the Woodleaf penstock into the Forbestown Ditch. The ditch will carry the water to New York or Costa Creeks for use by the District. The ditch is presently carrying full capacity of water during the summer months. Therefore, in order to increase the delivery of water to YCWD, the ditch must be improved to carry more water, or the water carried during off-peak months to a terminal reservoir in the New York or Costa Creek Flat areas.

This study investigates three sizes of reservoirs on Slate Creek. The study also investigates the cost of improving Forbestown Ditch to carry on-peak irrigation water of 5,000 and 10,000 AF of water to YCWD. The monthly flow of on-peak irrigation water was assumed at 20% of annual flow. This amounts to increasing the carrying capacity of the ditch by 16.7 and 33.4 cfs for an annual increase of 5,000 and 10,000AF. The study also investigates the cost of storing 5,000 AF and 10,000 AF water at two sites in the New York Flat area and one site on Costa Creek which is the adjacent drainage course.

From the standpoint of financial feasibility, this report assumes that the cost of storage of water in Slate Creek will be recovered from revenues received from the generation of power. If needed to pay debt service on the bonds, the cost of water diverted at Woodleaf Penstock would be priced as the cost of power foregone during the repayment period of the bonds. After the bonds sold to finance the project are retired or as energy increases in value, the water cost would be reduced substantially, or possibly be diverted at no cost.

It is proposed that the capital for either restoring the ditch capacity or providing terminal storage would come from other sources. However, funds from power generation not used annually to pay debt service on the bonds for the Slate Creek Reservoir could be used in-part for payment of increasing the capacity of the ditch or a new terminal reservoir.

The proposed storage dam on Slate Creek is about 4,000 feet upstream from the inlet to Slate Creek Tunnel. For the 95,000 acre-feet reservoir, there is a gross head difference between the proposed reservoir on Slate Creek and Sly Creek Reservoir of 440 feet. At a tunnel flow of 650 cfs, there is a potential to develop about 20,000 KW of power which, we believe, likely would be financially very attractive. However, a study of the benefits of such an arrangement is not included in the scope of this study but could be the subject of an additional study.

Slate Creek Reservoir

Description of Studies

Two sites were originally investigated for a storage dam on Slate Creek. The site selected for further study appears in Section 2, T2ON, R8E. As shown on Figure 2, the site is approximately 4,000 ft upstream from Slate Creek diversion dam. The three sizes selected for study were 35,000, 65,000 and 95,000 AF with 5,000 AF designated as dead storage in each size. Plate 1 provides an area-capacity curve for the Slate Creek site.

Operation Studies

Operation studies were prepared on an annual basis. The studies are provided in Table III-1 following. It was assumed that all the flow above the amount OWID can divert under its rights, up to the maximum reservoir amount, would be stored each year and all of the water used for power generation in later months of the same year when Sly Creek Reservoir can receive the water without spilling. Monthly operation studies for Sly Creek Reservoir were obtained from OWID to verify that the water stored at Slate Creek could be used later in the same year through OWID powerplants. Since the present requirement for stream flow maintenance is 10 cfs (7300 AF annually) or natural flow, if less than 10 cfs, the operation studies assumed that 7300 AF of water would continually pass the diversion dam annually. The OWID generation includes Kelly Ridge Power Plant, although, the generation may take place at DWR's Hyatt and Thermalito Afterbay Power Plant.

The result of the operation studies are summarized in the table following:

SUMMARY OF OPERATION STUDIES FROM WATER NOW SPILLED AT SLY CREEK DIVERSION

Live Storage of Slate Creek Reservoir (AF)	OWID S.F. Projected Increase in Average Annual Generation (M kWh)	YWCA Yuba River Development Average Annual Generation (M kWh)	Increase in Average Annual Generation (M kWh) (1)
30,000	52.8	13.3	39.5
60,000	97.9	24.6	73.3
90,000	132.4	33.3	99.1

(1) See Table III-1.

Site Visit and Construction Materials

The Slate Creek Damsite is located in a narrow canyon incised into granitic bedrock about 0.7 miles upstream of the existing Slate Creek Diversion Dam. Because of high water it was not possible to reach the proposed dam axis on foot from the diversion dam. The damsite is characterized by relatively steep slopes (1:2.5) of exposed bedrock on the right abutment which faces South and a somewhat flatter (1:1) slope on the densely forested northerly facing left abutment.

The present study considered three alternative sizes for Slate Creek Reservoir. The highest dam would be a concrete gravity structure about 450 ft. high with a crest length of 880 ft. at el. 3970, constructed by the roller compacted concrete (RCC) method. The upstream face of the dam is vertical and the downstream face slopes at 0.75:1. Total RCC volume would be 1,000,000 C.Y. The spillway will be built into the dam and will consist of an ungated ogee with steps and an energy dissipator located at the toe of the dam.

The dam will be founded on a granitic complex of hard, sound rock which outcrops on both abutments. The rockmass is moderately jointed. The principal joint system that might affect the engineering properties of the foundation occurs subparallel to the ground surface, as exposed on the right abutment, and is probably associated with stress relief. The left abutment is covered with trees and other vegetation and outcrops are difficult to observe from a distance.

Construction materials for an RCC gravity dam are abundantly available in the river bed. They consist of well-rounded to sub-rounded alluvial sand and gravel. A great deal of the material in the river is redeposited gravel from earlier hydraulic mining work at Poverty Hill, located about 2.0 miles upstream, during the 1870s. Waste gravel from this process accumulated behind timber crib dams built in the river just upstream of the dam axis. The volume of gravel available seems adequate to supply all the material necessary to construct the size of dam contemplated.

It is probable that fine gold is disseminated in these sand and gravel tailings and could be recovered as a byproduct of material processing. Sale of gold could partially offset the cost of the project. This potential revenue has not been considered in the benefits of the proposed project.

An RCC dam design is environmentally favorable because it requires less materials than an embankment dam, does not require construction of a separate spillway, and will utilize mining waste that is currently contributing to sediment load in the river. The concepts for the dams were selected based upon current experience at similar sites. In later stages of engineering, other concepts will be evaluated to select the optimum concept.

Cost Estimate

Cost estimates were prepared for a RCC dam for three heights. The cost estimates are presented on Tables III-2, III-3 and III-4 provided at the end of this section. The significant features and costs are summarized below:

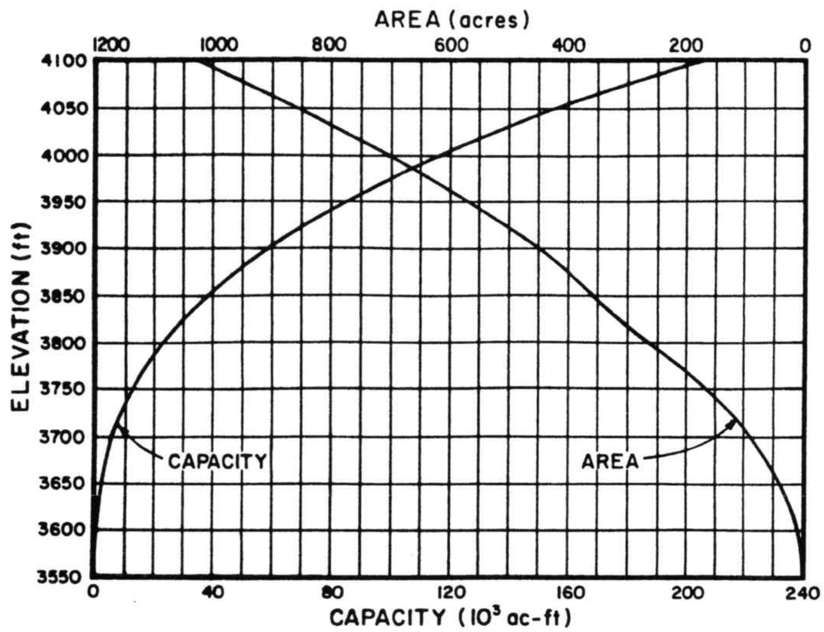
Summary of Costs of Slate Creek Dam

Size of Reservoir (AF)	Dam Height (ft.)	RCC Volume (CY)	Total Project Cost ($) (1)	Total Annual Cost ($) (2)
35,000	290	352,000	24,700,000	1,880,000
65,000	365	677,000	40,800,000	3,100,000
95,000	450	1,000,000	56,500,000	4,300,000

(1) Including 12% financial cost.

(2) Debt Service including financial cost @ 6½%, 35 years plus production cost at ½% of construction cost of dam (no contingency).

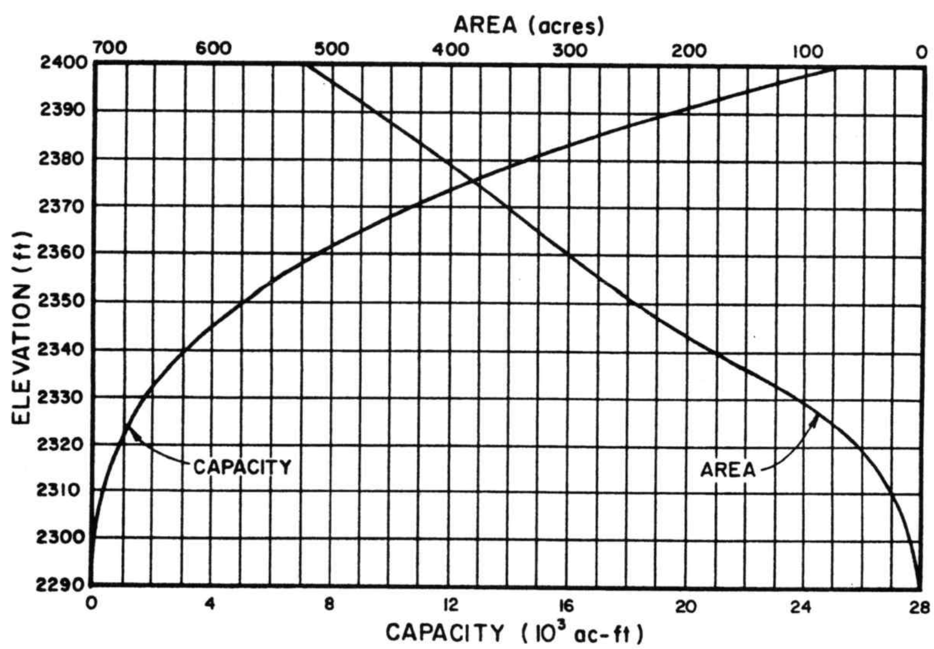
Section III
Alternative Project Formulations



RESERVOIR AREA AND CAPACITY CURVES
(SLATE CREEK RESERVOIR)

MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP

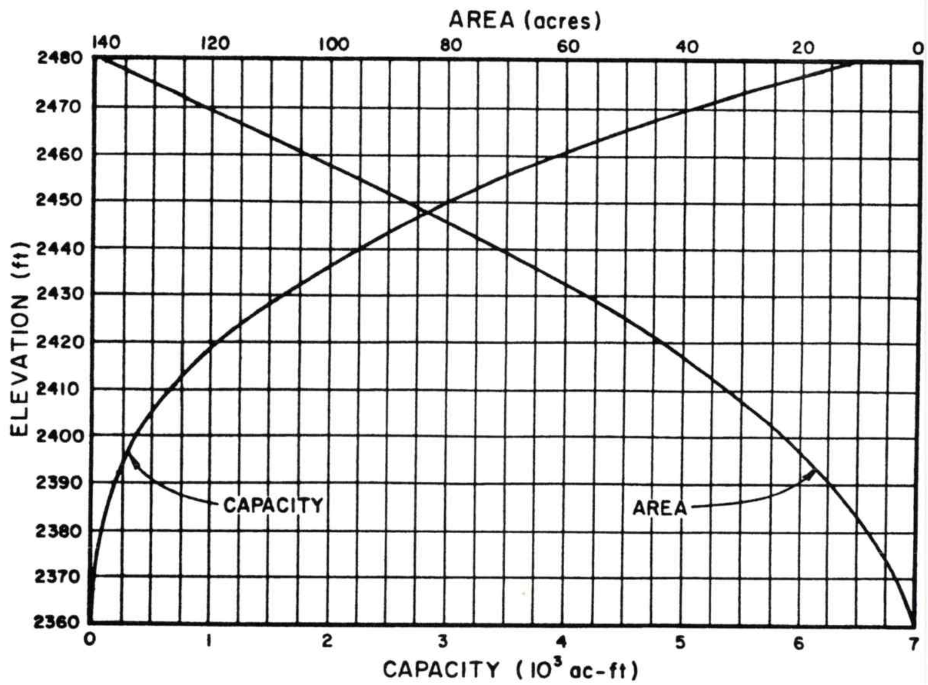
PLATE 1



RESERVOIR AREA AND CAPACITY CURVES
(LOWER NEW YORK FLAT RESERVOIR)

MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP

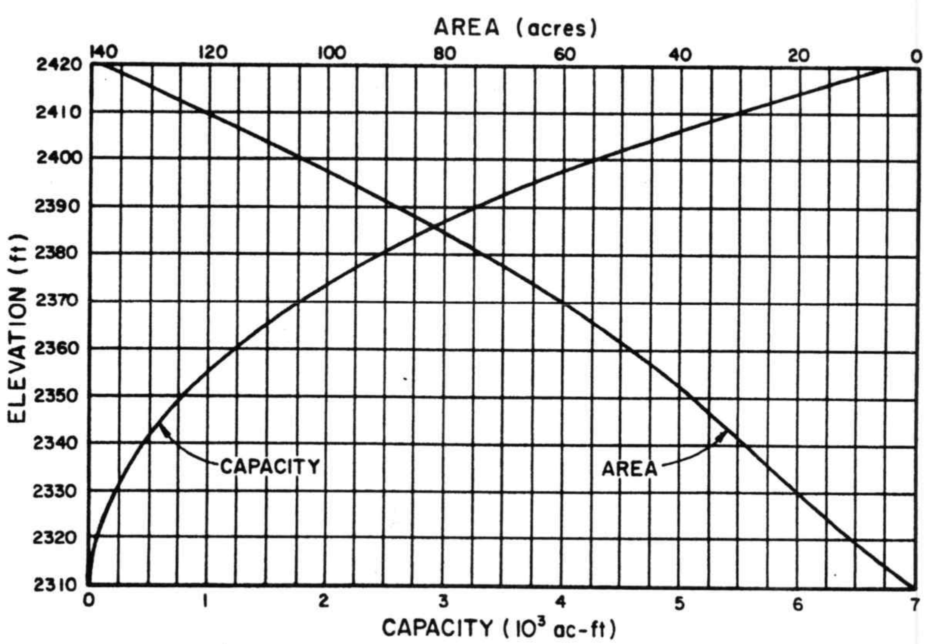
PLATE 2



RESERVOIR AREA AND CAPACITY CURVES
(UPPER NEW YORK FLAT RESERVOIR)

MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP

PLATE 3



RESERVOIR AREA AND CAPACITY CURVES
(COSTA CREEK RESERVOIR)

MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP

PLATE 4

is flexible and the sections can be joined in one location and pulled in lengths up to 1,500 feet into the ditch alignment. The polyethylene pipe comes in all sizes up to 36-in diameter required for the Forbestown installation. For a 40.7 cfs flow (24 cfs present capacity + 16.7 cfs), the velocity in the pipe would be 6.52 ft/s and the head loss about 1.7 ft per 1,000 ft (about the same grade as the ditch). For a 57.4 cfs flow (24 cfs present capacity plus 33.4 cfs), the velocity in the pipe increases to 9.2 ft/s and the head loss about 3.5 ft per 1,000 ft. This increase in head loss would required an entrance head on the pipeline to be about 65 ft. The working pressure of polyethylene pipe (SDR 32.5), minimum thickness, 1.1 inches, will withstand 50 psi.

An option for improvement of the ditch would be to apply gunite to the floor and walls. This would reduce the seepage and improve the flow conditions but the cost per foot would be about the same as for pipe and would have a much shorter life and higher annual maintenance cost. Therefore, gunite for improvement of the ditch flow is not recommended.

The cost of improvement to the ditch by placing the 36-inch polyethylene pipe is presented in Table III-9. The annual cost for the pipeline installation including debt service on the bonds and an allowance for operation and maintenance is about $350,000. Since the facility would be capable of carrying 10,000 acre-feet of water, the cost per acre-foot (assuming an increase of delivery of 10,000 AF) is $35.00. There will be a savings in water now lost to seepage which would further reduce the unit price.

Cost Estimates

Cost estimates were performed for the three reservoir sites. They are on Tables III-5, III-6, III-7 and III-8.

A summary of the results of the cost estimates is provided in the following table:

Location	Size (AF)	Total (1) Project Cost ($)	Total (2) Annual Cost ($)	Annual Cost $ per AF Storage
New York Flat (Lower)	10,000	7,100,000	554,000	55.40
New York Flat (Lower)	5,000	4,620,000	352,500	70.40
New York Flat (Upper)	5,000	20,800,000	1,585,000	317.00
Costa Creek	5,000	15,150,000	1,154,000	230.80

(1) Including 12% financial cost

(2) Debt service @ 6½%, 35 year repayment plus production cost at ½% of construction cost of the dam.

Forbestown Ditch

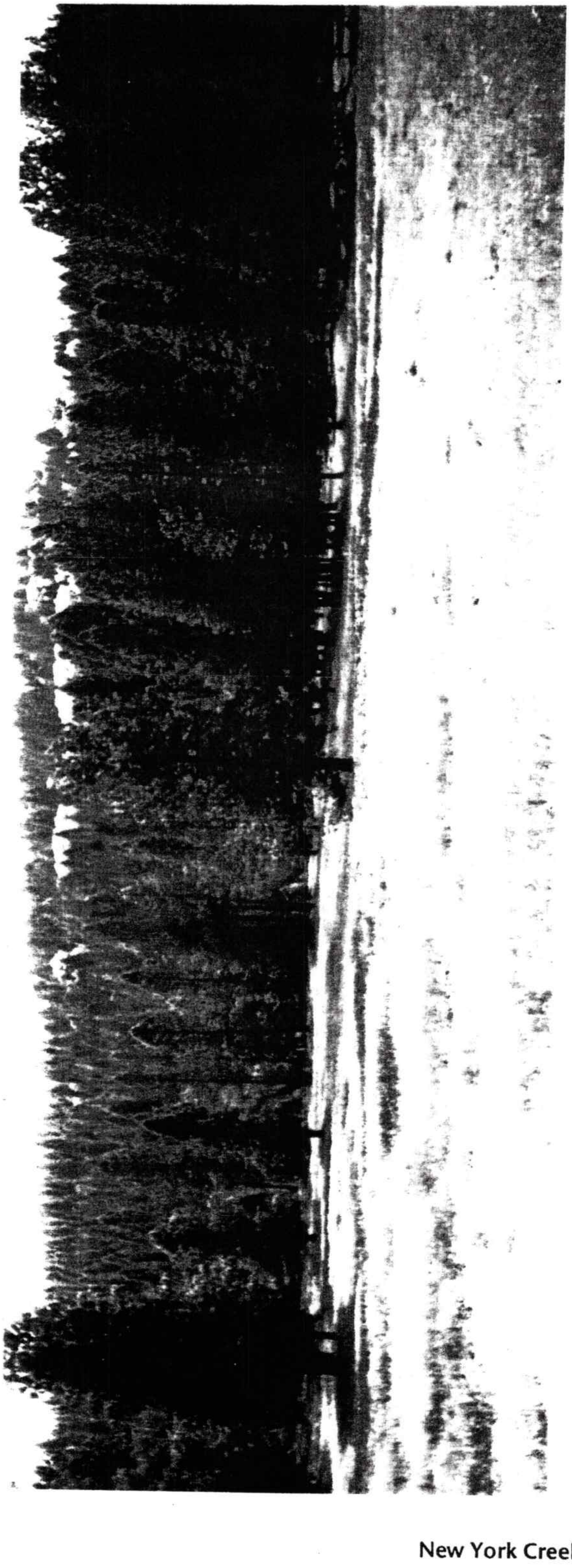
Existing Condition

The present alignment of the ditch begins at the Woodleaf penstock and water flows by gravity at an approximate slope of 2 ft per 1,000 ft for a distance of 7.2 miles. Then, the flow of water cascades down a water course from about elevation 3110 to elevation 2875. The flow in the ditch then continues at about the same slope. The YCWD's turnout is about 3.2 miles from the bottom of the cascade area. After YCWD's turnout, the ditch continues carrying water for OWID toward Oroville. Figure 3 shows the location of the ditch.

At the same level of maintenance, it is assumed that the ditch will be able to carry about the same amount of water as its present capacity. It is reported that about 30 percent of the flow to the YCWD's turnout is lost in seepage. The loss is shared equally by OWID and YCWD. The loss in similar ditches have been measured and a loss of 3% per mile is not unusual.

Enlargement and Project Cost

The plan for improvement of the flow capacity consists of placement of high density polyethylene pipe in the ditch. The pipe would be placed in two sections, 7.2 miles to the cascade area and 3.2 miles from the bottom of the cascade area to YCWD's turnout. The pipeline would be free flow to prevent build-up of pressure. Polyethylene pipe



New York Creek Reservoir

A reservoir at the lower site would flood a broad rolling meadow and wetland covered with grass and willows and could be environmentally objectionable. At this time, it is our judgement that, because of the extent of the existing wetlands, about 60 acres in size, a COE's section 404 Permit would be denied. Further, because of the rich habitat, it is possible that an endangered species could be present. Two photographs of the reservoir area are provided on the following page.

The upstream damsite at New York Flat is located about 2.0 miles upstream of the lower axis. The site is suitable for impounding a reservoir of 5,000 AF. The upstream site would not encroach upon the wetlands referred to previously. The creek bed is choked with willows and the abutments are covered with trees. The dam would have a height of 118 ft. and a crest length of 1,200 ft. at el. 2478 No rock outcrops were visible during the site visit, but abundant quantities of colluvial sand, gravel and clay occur on the abutments. Based on site topography and the nature of the construction materials available, it appears that the dam would be a homogeneous embankment with a spillway located on the left abutment.

Costa Creek

As an alternative to the New York Flat dam, a damsite was briefly examined on Costa Creek which is the next drainage to the northeast of New York Flat Creek and is currently part of the delivery system for the Yuba County Water District. It appears that there are no significant wetlands in the valley; however, there are several homesites. Topographically the most favorable dam and reservoir site appears to be located about 0.2 miles upstream of the confluence of Costa Creek with Dry Creek. The area is heavily vegetated and it was not possible to make any observations regarding foundation or construction materials. For the purpose of this study a 5,000 AF. reservoir has been laid out assuming a homogeneous earth embankment design with a height of 100 ft., and a crest length of 1,010 at el. 2414. The spillway would be located on the left abutment.

New York Flat and Costa Creek Terminal Reservoirs

Description of Studies

Two Sites were investigated for a terminal reservoir in the New York Flat area and one site in an adjacent water course, Costa Creek. The lower site on New York Flat Creek for both 5,000 AF and 10,000 AF size reservoir would inundate a wetlands area which might be environmentally unacceptable. However, the lower site was included for price comparison. The upper site, which is above the wetlands area, was investigated for only a 5,000 AF reservoir. A 5,000 AF reservoir at this site has a maximum water surface of elevation 2470. This site could support a maximum size reservoir of about a 7,500 AF. Likewise a 5,000 AF reservoir with a maximum water surface of elevation 2408 was evaluated on Costa Creek. Plates 2, 3 and 4 are area-capacity curves developed for the three sites, Lower New York Flat site, Upper New York Flat site and Costa Creek site. Figure 3 shows the location of the damsites and the extent of the reservoir areas.

Operation of Terminal Reservoir

The maximum carrying capacity of Forbestown ditch is 24 cfs. It will take about 3 months of full ditch flow to fill 5,000 AF of storage and 6 months to fill 10,000 AF of storage. Either case is possible since the ditch does not carry any significant flow for 6 months of each year.

Site Visit/ Construction Materials/Wetlands Issue

New York Flat

There are two potential damsites in the New York Flat area. The lower site, which was studied by DWR in the 1960s, is located in a flat (4:1 slopes), "v" shaped valley about 0.2 miles upstream of the confluence with Dry Creek. The site is suitable for either a 5,000 or 10,000 AF reservoir with dam heights and crest lengths and elevations of 68 ft, 650 ft, and 2358; and 86 ft, 820 ft, and 2376 respectively. The lower parts of the abutments are formed by exposed bedrock giving way to tree covered slopes with soil of unknown depth. The rock is highly jointed diabase. The foundation is suitable for either a zoned embankment-type dam or an RCC gravity dam depending on the availability of construction materials. Abundant volumes of material will be available from the alluvial deposits in the floor of the reservoir upstream of the dam. However, it was not possible to determine the nature of these deposits during the field reconnaissance.

It is recommended that YCWA consider the following:

1. Prepare a feasibility study for a dam on Slate Creek. Prior to the beginning of the study, the following steps should be accomplished to look for a fatal flaw.

    a. Monthly operation study should be performed of OWID South Fork Power Plants to demonstrate the gain in energy along with the Yuba River Development Project to define more accurately the water and power impacts.

    b. Discussion with PG&E on value of dispatchable energy from the OWID/Power Plants, loss of value under PG&E/YCWA contract, and value of increased generation at Sly Creek Power Plant from higher levels of water at Sly Creek Reservoir.

    c. Discussion with DWR over the value for the increase in energy generated and water to DWR at Hyatt and Thermalito Afterbay Power Plants.

    d. Discussions with OWID over sharing the increased cost of generating additional power, sharing the value of increased generation at Sly Creek Powerplant from higher levels of water at Sly Creek Reservoir and possible joint ownership of Slate Creek Reservoir.

    e. Discussion with YCWD covering the plan for supplying supplemental water from Slate Creek Reservoir and to obtain its concurrence that consideration should be given to Forbestown Ditch improvement rather than pursuing a terminal reservoir at New York Flat.

2. Prepare a feasibility level design for placing a polyethylene pipe in the Forbestown Ditch to provide for increasing carrying capacity of the ditch. Assuming that the results of a feasibility study will confirm the conclusions of the reconnaissance study, YCWD should abandon the plan for constructing a reservoir in New York Flat. The placing of the polyethylene pipe in the ditch will increase the water supply by about 30 percent by reducing the seepage losses without adding any new storage. The DWR has a program of making loans to water districts for such a project. It is suggested that the DWR loan program be investigated for preparation of the feasibility study.

If the feasibility study is favorable; develop an agreement with YCWA, OWID and YCWD over sharing payments for the construction of the improvements to Forbestown Ditch.

3. Prepare a reconnaissance-level study of the power potential of available head between the proposed reservoir at Slate Creek and Sly Creek Reservoir.

Table IV-1
Annual Benefits and Costs
Alternative Size Slate Creek Reservoirs

Year	PG&E's Short Run Dispatchable Energy Price Mills/kWhr	35,000 AF Reservoir (5,000 AF Dead Storage) Pwr Benefit $ (1)	35,000 AF Annual Cost $	35,000 AF Benefit-Cost $	35,000 AF B/C Ratio	65,000 AF Reservoir Pwr Benefit $ (1)	65,000 AF Annual Cost $	65,000 AF Benefit-Cost $	65,000 AF B/C Ratio	95,000 AF Reservoir Pwr Benefit $ (1)	95,000 AF Annual Cost $	95,000 AF Benefit-Cost $	95,000 AF B/C Ratio
1996	49.7	1,962,360	1,880,000	82,360	1.04	3,641,544	3,100,000	541,544	1.17	4,923,288	4,300,000	623,288	1.14
1997	54.4	2,148,603	1,880,000	268,602	1.14	3,987,154	3,100,000	887,153	1.29	5,390,545	4,300,000	1,090,544	1.25
1998	56.9	2,248,538	1,880,000	368,538	1.20	4,172,603	3,100,000	1,072,603	1.35	5,641,268	4,300,000	1,341,268	1.31
1999	65.1	2,571,055	1,880,000	691,055	1.37	4,771,097	3,100,000	1,671,097	1.54	6,450,419	4,300,000	2,150,419	1.50
2000	69.7	2,752,755	1,880,000	872,755	1.46	5,108,277	3,100,000	2,008,277	1.65	6,906,279	4,300,000	2,606,279	1.61
2001	73.7	2,911,743	1,880,000	1,031,742	1.55	5,403,310	3,100,000	2,303,309	1.74	7,305,157	4,300,000	3,005,156	1.70
2002	82.6	3,261,515	1,880,000	1,381,515	1.73	6,052,381	3,100,000	2,952,381	1.95	8,182,687	4,300,000	3,882,687	1.90
2003	88.6	3,497,725	1,880,000	1,617,725	1.86	6,490,715	3,100,000	3,390,715	2.09	8,775,305	4,300,000	4,475,305	2.04
2004	92.7	3,661,255	1,880,000	1,781,255	1.95	6,794,177	3,100,000	3,694,177	2.19	9,185,579	4,300,000	4,885,579	2.14
2005	100.7	3,979,230	1,880,000	2,099,230	2.12	7,384,242	3,100,000	4,284,242	2.38	9,983,334	4,300,000	5,683,334	2.32
2006	106.8	4,219,983	1,880,000	2,339,983	2.24	7,831,006	3,100,000	4,731,006	2.53	10,587,349	4,300,000	6,287,349	2.46
2007	112.1	4,428,938	1,880,000	2,548,938	2.36	8,218,763	3,100,000	5,118,763	2.65	11,111,588	4,300,000	6,811,588	2.58
2008	121.4	4,796,880	1,880,000	2,916,880	2.55	8,901,552	3,100,000	5,801,552	2.87	12,034,704	4,300,000	7,734,704	2.80
2009	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2010	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2011	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2012	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2013	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2014	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2015	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2016	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2017	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2018	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2019	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2020	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05
2021	132.5	5,232,960	1,880,000	3,352,960	2.78	9,710,784	3,100,000	6,610,784	3.13	13,128,768	4,300,000	8,828,768	3.05

Note: Short-Run Avoided Cost (SRAC) energy price forcast reduced by 10 percent based on PG&E's Electricity Report 90 (ER-90) resource plan. See Text.
SRAC Energy Price increased by 15% for Dispatchable Energy
Beyond 2009, energy price not escalated for this table.

dcw BCRACIO

Appendix A
Significant pages from Bookman-Edmonston Engineering, Inc. Report

Section IV
Discussion of Alternatives and Conclusion

Section IV Discussion of Alternatives and Conclusion

This section discusses the alternative sizes proposed for Slate Creek Dam and alternatives for conveying and storing of water to YCWD. The section also provides conclusions and recommendations.

Storage - Slate Creek

Three sizes of storage reservoirs on Slate Creek were investigated. Table IV-1 following provides the annual cost and annual benefit for each of the three reservoir sizes, from year 1996 to year 2021. Using PG&E's short run dispatchable energy price (ER-90 modified), each of the three projects have a positive benefit/cost ratio from the first year of operation, assuming average water supply. As the value of dispatchable energy increases in future years, the benefit/cost ratio increases substantially. The calculations were also performed in a similar manner using Henwood's projections of dispatchable energy. Both 65,000 Af and 95,000 AF reservoirs showed a benefit/cost ratio greater than one in the third year of operation. The 35,000 AF size reservoir required five years until a benefit/cost ratio greater than one was achieved. It should be pointed out, however, that the values used for dispatchable energy are projections made with the best known information. It is believed that both projections of energy, confirm that a viable project can be developed. Factors, such as, an oil embargo, gas embargo, an energy tax on imported carbon fuels could change the projected energy values significantly upward. There is also the possibility that the values will increase at a lesser rate than projected. However, it does not appear likely that the values will decrease with time.

From reviewing the data presented on the table, there appears to be little difference in benefits versus costs for a 65,000 AF versus 95,000 AF reservoir. Because there could be a market for the new water developed by the project, the 95,000 AF reservoir should be favored.

Water Supply - YCWD

In order to increase the water supply to YCWD, the carrying capacity of Forbestown Ditch needs to be increased or, as an alternative, terminal storage needs to be provided in New York Flat or Costa Creek area. There are several ways of increasing the carrying capacity of Forbestown Ditch. The placement of high density polyethylene pipe in the ditch for increasing the carrying capacity is believed to be the most cost effective solution. Another mountain county water district has successfully utilized polyethylene pipe to replace an open ditch.

Three terminal reservoir sites were investigated. Of the three sites, the lower New York Flat site for the 5,000 and 10,000 AF of storage reservoirs is the most economic, but would be the most difficult to obtain the necessary permits and approvals. In fact, it is highly probable that the owner would be denied a Corps of Engineers, Section 404 permit for the project became of the wetlands that exist in the reservoir area. Storage of water at the other two sites is limited to about 5,000 to 7,000 AF, less than the 10,000 AF amount desired by YCWD. The next lowest cost site would be Costa Creek where the annual cost of storing 5,000 AF of water amounts to about $230 per acre-feet per annum.

In comparing the cost of improving the carrying capacity of Forbestown ditch so that water may be delivered on demand to YCWD versus the cost of developing a terminal reservoir, the improvement of the ditch is more desirable from an economic view point as compared to any of the three dams studied. The annual cost of constructing a pipeline capable of carrying 10,000 AF of additional water supply amounts to about $35 per acre-feet. When water lost due to seepage in the canal is considered having a value, the cost of the additional water supply conveyance is even lower.

Conclusions and Recommendation

This reconnaissance study indicates that a storage dam on Slate Creek greater than 65,000 AF in size may be economical and financial feasible. This conclusion is based upon being able to reach an agreement with PG&E on the value of the water used for generation through the OWID system and DWR through their Feather River system as described this study.

This current study also reviewed several ways to improve the supply of water to YCWD. The study concludes that the increase in supply of water can be best provided by placing a polyethylene pipe in the Forbestown Ditch to increase its carrying capacity rather than a new terminal reservoir at New York Flat. This feature cannot stand alone as YCWD also needs a source of water, such as, Slate Creek Reservoir.

Table III – 9
Pipeline Replacement of Forbestown Ditch
Cost Estimate

Item:	Unit	Unit Price $	Quantity	Amount $
Mobilization	LS	–	–	150,000
Penstock Connection	LS	–	–	25,000
Furnish 36 in. Polyethylene Pipe	FT	26.60	55,000	1,463,000
Install 36 in. Pipe	FT	9.00	55,000	495,000
Prepare Pipe Bed	FT	3.00	55,000	165,000
Backfill Trench	FT	7.00	55,000	385,000
Concrete Anchors	CY	300.00	220.00	66,000
Misc. Work	LS	–	–	50,000
Total Construction Cost			$	2,799,000
Indirect Costs, Engineering, Administration (15%)				419,850
Subtotal			$	3,218,850
Contingency (25%)				804,713
Total			$	4,023,563
Financial Cost (12%) (1)				482,828
Total Bond Issue			$	4,506,390

ANNUAL COST:
Interest Rate (in decimal): 0.065
Bond Period (years): 35.00
Debt Service: $ 329,247

Note: (1) See Text for Exclusions

dcw POLYPIPE

Table III–8
Costa Creek Dam – 5,000 A–F
Cost Estimate
Spillway Crest: 2406 feet

Item	Unit	Unit Price ($)	Quantity	Amount ($)
Mobilization	LS	–	–	260,000
Care of River	LS	–	–	85,000
Reservoir Clearing	AC	500	118	59,000
Excavation & Foundation	CY	5	30,050	150,250
Grouting	CY	25	4,510	112,750
Impervious Fill	CY	6	618,200	3,709,200
Filter/Drain	CY	25	66,700	1,667,500
Rip Rap/Bedding	CY	45	40,900	1,840,500
D/S Slope Protection	CY	35	10,100	353,500
Spillway	LS	–	–	449,500
Outlet Works	LS	–	–	275,040
Unlisted Items (5%)	LS	–	–	450,000
Total Construction Cost			$	9,412,240
Indirect Costs, Engineering and Administration (15%)				1,411,836
Subtotal			$	10,824,076
Contingency (25%)				2,706,019
Total			$	13,530,095
Financial Cost (12%) (1)				1,623,611
Total Bond Issue			$	15,153,706

ANNUAL COST:

Interest Rate (in decin	0.065
Bond Period (years)	35

Debt Service: $ 1,107,164

Note: (1) See Text for Exclusions

dcw COSTACR5

Table III–7
New York Flat Dam – Upper Site – 5,000 A–F
Cost Estimate
Spillway Crest: 2368 feet

Item	Unit	Unit Price ($)	Quantity	Amount ($)
Mobilization	LS	–	–	340,000
Care of River	LS	–	–	115,000
Reservoir Clearing	AC	500	120	60,000
Excavation & Foundation	CY	5	42,625	213,125
Grouting	CY	25	5,857	146,425
Impervious Fill	CY	6	882,064	5,292,384
Filter/Drain	CY	25	81,672	2,041,800
Rip Rap/Bedding	CY	45	54,004	2,430,180
D/S Slope Protection	CY	35	13,030	456,050
Spillway	LS	–	–	449,500
Outlet Works	LS	–	–	275,040
Unlisted Items (5%)	LS	–	–	590,000
Total Construction Cost			$	12,409,504
Indirect Costs, Engineering and Administration (15%)				1,861,426
Subtotal			$	14,270,930
Contingency (25%)				3,567,732
Total			$	17,838,662
Financial Cost (12%) (1)				2,140,639
Total Bond Issue			$	19,979,301

ANNUAL COST:

Interest Rate (in dec	0.065			
Bond Period (years)	35			
		Debt Service:	$	1,459,733

Note: (1) See Text for Exclusions

dcw NYFLTU5

Table III–5
New York Flat Dam Lower Site – 10,000 AF
Cost Estimate
Spillway Crest: 2368 feet

Item	Unit	Unit Price ($)	Quantity	Amount ($)
Mobilization	LS	–	–	120,000
Care of River	LS	–	–	40,000
Reservoir Clearing	AC	500	320	160,000
Excavation & Foundation	CY	5	16,540	82,700
Grouting	CY	25	2,184	54,600
Impervious Fill	CY	6	256,760	1,540,560
Filter/Drain	CY	25	30,040	751,000
Rip Rap/Bedding	CY	45	11,720	527,400
D/S Slope Protection	CY	35	5,680	198,800
Spillway	LS	–	–	449,500
Outlet Works	LS	–	–	275,040
Unlisted Items (5%)	LS	–	–	210,000
Total Construction Cost			$	4,409,600
Indirect Costs, Engineering and Administration (15%)				661,440
Subtotal			$	5,071,040
Contingency (25%)				1,267,760
Total			$	6,338,800
Financial Cost (12%) (1)				760,656
Total Bond Issue			$	7,099,456

ANNUAL COST:
Interest Rate (in decimal): 0.065
Bond Period (years): 35
Debt Service: $ 518,702

Note: (1) See Text for Exclusions

dcw NYFLTL10

Table III–6
Cost Estimate
New York Flat Dam Lower Site – 5,000 AF
Spillway Crest: 2350 feet

Item	Unit	Unit Price ($)	Quantity	Amount ($)
Mobilization	LS	–	–	75,000
Care of River	LS	–	–	25,000
Reservoir Clearing	AC	500	240	120,000
Excavation & Foundation	CY	5	12,650	63,250
Grouting	CY	25	1,380	34,500
Impervious Fill	CY	6	129,880	779,280
Filter/Drain	CY	25	18,270	456,750
Rip Rap/Bedding	CY	45	7,840	352,800
D/S Slope Protection	CY	35	2,950	103,250
Spillway	LS	–	–	449,500
Outlet Works	LS	–	–	275,040
Unlisted Items (5%)	LS	–	–	135,000
Total Construction Cost			$	2,869,370
Indirect Costs, Engineering and Administration (15%)				430,406
Subtotal			$	3,299,776
Contingency (25%)				824,944
Total			$	4,124,719
Financial Cost (12%) (1)				494,966
Total Bond Issue			$	4,619,686

ANNUAL COST:
Interest Rate (in decimal): 0.065
Bond Period (years) 35
Debt Service: $ 337,525

Note: (1) See Text for Exclusions

dcw NYFLTL5

Table III–4
Slate Creek Dam – 95,000 AF
Spillway Crest: 3,970 feet

Item:	Unit	Unit Price $	Quantity		Amount $
Mobilization	LS	–	–		500,000
Care of River	LS	–	–		150,000
Reservoir Clearing	Acre	500.00	700		350,000
Foundation Excavation	CY	10.00	48,380		483,796
Grouting	LF	50.00	15,675		783,750
Drain Holes	LF	40.00	7,838		313,500
Drainage Gallery	LF	375.00	400		150,000
RCC dam	CY	26.00	999,738		25,993,196
Concrete Facing Spillway	CY	122.50	5,409		662,562
Precast Facing Panels	SF	15.50	310,500		4,812,750
Dam Crest, Parapet wall	CY	175.00	100		117,500
Instrumentation	LS	–	–		25,000
Site Protection	LS	–	–		100,000
Intake, Pipeline, HB Valve	LS	–	–		50,000
Road Relocation	Mile	1.00	100,000		100,000
Unlisted Items	LS	–	–		500,000
Total Construction Cost				$	35,092,054
Indirect Costs, Engineering & Adminstration. (15%)					5,263,808
Subtotal				$	40,355,862
Contingency (25%)					10,088,965
Total				$	50,444,827
Financial Cost (12%) (1)					6,053,379
Total Bond Issue				$	56,498,206

ANNUAL COST:
Interest Rate (in decimal): 0.065
Bond Period (years): 35.00
Debt Service $ 4,127,887

Note: (1) See Text for Exclusions

dcw slate95

Table III–3
Slate Creek Dam – 65,000 AF
Spillway Crest: 3,915 feet

Item:	Unit	Unit Price $	Quantity	Amount $
Mobilization	LS	–	–	500,000
Care of River	LS	–	–	150,000
Reservoir Clearing	Acre	500	500	250,000
Foundation Excavation	CY	10.00	37,130	371,296
Grouting	LF	50.00	12,030	601,500
Drain Holes	LF	40.00	6,015	240,600
Drainage Gallery	LF	375.00	400	150,000
RCC dam	CY	27.00	676,933	18,277,203
Concrete Facing Spillway	CY	122.50	5,266	645,126
Precast Facing Panels	SF	15.50	215,500	3,340,250
Dam Crest, Parapet wall	CY	175.00	78	113,611
Instrumentation	LS	–	–	25,000
Site Protection	LS	–	–	100,000
Intake, Pipeline, HB Valve	LS	–	–	70,000
Road Relocation	Mile	1.00	100,000	100,000
Unlisted Items	LS	–	–	400,000
Total Construction Cost			$	25,334,586
Indirect Costs, Engineering ,Administration (15%)				3,800,188
Subtotal			$	29,134,774
Contingency (25%)				7,283,694
Total			$	36,418,468
Financial Cost (12%) (1)				4,370,216
Total Bond Issue			$	40,788,684

ANNUAL COST:
Interest Rate (in decimal): 0.065
Bond Period (years): 35.00
Debt Service: $ 2,980,113

Note: (1) See Text for Exclusions

DCW slate65

Table III-2
Slate Creek Dam – 35,000 AF
Spillway Crest: 3,840 feet

Item:	Unit	Unit Price $	Quantity	Amount $
Mobilization	LS	–	–	500,000
Care of River	LS	–	–	150,000
Reservoir Clearing	Acre	500.00	325	162,500
Foundation Excavation	CY	10.00	23,889	238,889
Grouting	LF	50.00	7,740	387,000
Drain Holes	LF	40.00	3,870	154,800
Drainage Gallery	LF	375.00	400	150,000
RCC dam	CY	30.00	352,131	10,563,930
Concrete Facing Spillway	CY	122.50	3,345	409,742
Precast Facing Panels	SF	15.50	128,625	1,993,688
Dam Crest, Parapet wall	CY	175.00	50	108,750
Instrumentation	LS	–	–	25,000
Site Protection	LS	–	–	100,000
Intake, Pipeline, HB Valve	LS	–	–	50,000
Road Relocation	Mile	1.00	100,000	100,000
Unlisted Items	LS	–	–	240,000

Total Construction Cost	$	15,334,298
Indirect Costs, Engineering, Administration (15%)		2,300,145
Subtotal	$	17,634,443
Contingency (25%)		4,408,611
Total	$	22,043,054
Financial Cost (12%) (1)		2,645,166
Total Bond Issue	$	24,688,220

ANNUAL COST:
Interest Rate (in decimal): 0.065
Bond Period (years): 35.00
Debt Service: $ 1,803,777

Note: (1) See Text for Exclusions

dcw Slate35

Table III-1

Slate Creek Reservoir Operation Study

Water Year	Total Water Flow Below Diversion (1) 1,000 AF	30,000 AF Reservoir Water Stored 1,000 AF (2)	Power Gen. M kWhr (3)	60,000 AF Reservoir Water Stored 1,000 AF (2)	Power Gen. M kWhr (3)	90,000 AF Reservoir Water Stored 1,000 AF (2)	Power Gen. M kWhr (3)
1961	81.9	30.0	58.8	60.0	117.5	74.6	146.1
1962	106.8	30.0	58.8	60.0	117.5	90.0	176.3
1963	152.8	30.0	58.8	60.0	117.5	90.0	176.3
1964	11.7	4.4	8.6	4.4	8.6	4.4	8.6
1965	179.1	30.0	58.8	60.0	117.5	90.0	176.3
1966	16.8	9.5	18.6	9.5	18.6	9.5	18.6
1967	95.8	30.0	58.8	60.0	117.5	88.5	173.4
1968	20.3	13.0	25.5	13.0	25.5	13.0	25.5
1969	165.5	30.0	58.8	60.0	117.5	90.0	176.3
1970	125.4	30.0	58.8	60.0	117.5	90.0	176.3
1971	64.3	30.0	58.8	57.0	111.7	57.0	111.7
1972	12.6	5.3	10.4	5.3	10.4	5.3	10.4
1973	69.1	30.0	58.8	61.8	121.1	61.8	121.1
1974	219.9	30.0	58.8	60.0	117.5	90.0	176.3
1975	63.5	30.0	58.8	56.2	110.1	56.2	110.1
1976	7.6	0.3	0.6	0.3	0.6	0.3	0.6
1977	12.6	5.3	10.4	5.3	10.4	5.3	10.4
1978	152.6	30.0	58.8	60.0	117.5	90.0	176.3
1979	24.7	17.4	34.1	17.4	34.1	17.4	34.1
1980	153.6	30.0	58.8	60.0	117.5	90.0	176.3
1981	15.4	8.1	15.9	8.1	15.9	8.1	15.9
1982	254.4	30.0	58.8	60.0	117.5	90.0	176.3
1983	227.2	30.0	58.8	60.0	117.5	90.0	176.3
1984	95.4	30.0	58.8	60.0	117.5	88.1	172.6
1985	8.7	1.4	2.7	1.4	2.7	1.4	2.7
1986	129.2	30.0	58.8	60.0	117.5	90.0	176.3
1987	13.8	6.5	12.7	6.5	12.7	8.5	16.7
1988	8.6	1.3	2.5	1.3	2.5	1.3	2.5
1989	71.7	30.0	58.8	60.0	117.5	64.4	126.2
1990	10.7	3.4	6.7	3.4	6.7	3.4	6.7
1991	16.5	9.2	18.0	9.2	18.0	9.2	18.0
		Sum	1224.6	Sum	2272.6	Sum	3071.1
		Ave	39.5	Ave	73.3	Ave	99.1

Notes
(1) Flows available after OWID diversion of water.
(2) Minimum Stream Flow Releases 7,300 AF cannot be stored.
(3) Assumes OWID-YCWD Net generation - 1,959 kWhr/AF

dcw slateop

Inflow to Slate Creek Reservoir After Bypass of Fishery Flows and Existing Slate Creek Diversions

Constant for all reservoir models

		Average Monthly Flow (Cubic-Feet-per-Second)													
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL (cfs)	TOTAL (Ac-Ft)
WY	1922	2	2	11	16	39	96	482	1,024	538	3	0	0	2,213	133,815
WY	1923	0	5	21	13	15	11	229	473	119	2	0	0	888	53,812
WY	1924	2	0	0	0	0	0	0	1	0	0	0	0	3	184
WY	1925	1	4	8	8	83	12	199	384	3	1	0	0	703	42,324
WY	1926	0	3	3	3	19	14	34	5	3	0	0	0	84	4,973
WY	1927	0	28	22	24	368	442	713	478	205	3	0	0	2,283	136,312
WY	1928	0	14	8	20	15	377	513	276	1	0	0	0	1,224	74,125
WY	1929	0	0	0	0	0	0	0	1	2	2	0	0	5	303
WY	1930	1	2	22	9	19	26	14	173	4	1	1	0	272	16,572
WY	1931	0	0	0	0	0	3	0	0	0	0	0	0	3	184
WY	1932	1	7	57	38	48	16	7	312	265	2	0	0	753	45,462
WY	1933	0	1	0	0	0	18	0	3	0	1	0	0	23	1,412
WY	1934	0	0	0	0	10	0	2	4	4	0	0	0	20	1,158
WY	1935	1	7	5	22	19	14	242	468	221	1	0	0	1,000	60,443
WY	1936	0	4	9	27	47	62	446	491	122	1	1	0	1,210	72,987
WY	1937	0	2	2	0	0	0	95	237	117	2	0	0	455	27,553
WY	1938	0	0	29	21	0	439	792	933	358	5	3	0	2,580	156,359
WY	1939	3	8	7	0	0	11	17	0	1	0	0	0	47	2,838
WY	1940	1	1	5	20	111	437	575	361	3	1	0	0	1,515	91,346
WY	1941	2	3	22	27	88	174	479	694	174	6	1	3	1,673	101,039
WY	1942	0	4	24	66	216	299	657	566	368	5	1	0	2,206	132,317
WY	1943	0	29	47	89	221	696	603	340	14	2	1	0	2,042	122,963
WY	1944	0	0	0	22	1	4	31	18	5	1	1	0	83	5,026
WY	1945	1	0	3	10	35	2	17	429	59	1	0	0	557	33,890
WY	1946	1	15	39	31	17	21	403	475	2	1	2	0	1,007	60,985
WY	1947	0	0	0	5	12	10	9	0	0	0	1	0	37	2,186
WY	1948	5	7	0	20	1	0	64	254	289	3	1	0	644	38,879
WY	1949	0	10	0	0	0	0	89	127	4	0	1	0	231	14,000
WY	1950	1	1	1	0	0	40	170	516	185	1	1	2	918	55,736
WY	1951	3	296	636	432	464	244	371	252	7	3	0	0	2,708	162,413
WY	1952	3	8	42	0	71	14	771	1,314	613	71	3	3	2,913	175,927
WY	1953	3	3	0	37	26	107	536	475	402	5	2	1	1,597	96,174
WY	1954	5	3	0	0	8	52	462	307	3	2	1	0	843	50,859
WY	1955	0	0	0	0	0	14	37	0	0	1	3	0	55	3,308
WY	1956	0	0	611	526	379	299	407	597	237	3	3	2	3,064	184,864
WY	1957	3	0	5	0	8	61	39	465	119	3	3	2	708	43,169
WY	1958	1	11	13	19	229	57	570	1,002	364	4	2	1	2,273	136,524
WY	1959	0	0	0	8	0	26	2	0	0	1	0	2	39	2,390
WY	1960	0	0	0	4	26	73	18	5	5	5	3	0	139	8,347
WY	1961	0	7	16	3	33	24	33	16	0	2	2	0	136	8,087
WY	1962	1	2	13	2	60	21	237	317	294	0	0	0	947	56,815
WY	1963	18	10	50	29	537	133	645	642	37	0	1	2	2,104	124,800
WY	1964	2	7	5	0	15	12	40	16	0	0	0	0	97	5,782
WY	1965	0	12	1,224	473	300	224	661	403	52	0	0	0	3,349	202,702
WY	1966	0	4	0	0	6	63	226	133	0	0	0	0	432	26,071
WY	1967	0	6	36	32	53	208	195	889	486	1	3	1	1,910	115,763
WY	1968	3	0	5	0	83	36	53	143	1	0	1	0	325	19,383
WY	1969	2	10	14	527	15	81	773	961	259	0	0	0	2,642	160,297
WY	1970	3	2	74	1,034	283	281	131	112	0	0	0	0	1,920	116,110
WY	1971	3	27	9	23	53	76	405	710	375	0	0	1	1,682	101,506
WY	1972	2	5	0	28	22	97	170	242	0	0	0	0	566	34,324
WY	1973	6	14	43	76	44	45	382	754	3	2	0	2	1,371	83,244
WY	1974	6	196	75	530	147	855	524	527	179	1	0	0	3,040	184,267
WY	1975	1	2	0	6	33	107	62	481	425	0	0	0	1,117	67,516
WY	1976	0	0	10	0	2	22	10	0	0	0	0	0	44	2,674
WY	1977	0	0	0	0	0	0	0	2	0	0	0	0	2	123
WY	1978	0	12	90	467	280	785	573	283	2	0	0	2	2,494	150,518
WY	1979	0	0	0	21	6	12	23	266	0	0	0	0	328	20,087
WY	1980	12	3	17	1,093	780	262	320	21	2	2	3	3	2,518	149,536
WY	1981	3	5	35	24	71	11	15	3	0	0	0	0	167	9,806
WY	1982	26	520	987	208	768	361	760	618	1	0	0	10	4,259	254,749
WY	1983	50	102	242	97	658	945	484	821	444	0	0	3	3,846	230,520
WY	1984	0	195	660	221	150	217	9	0	0	0	0	2	1,454	88,103
WY	1985	0	7	3	8	0	0	9	3	2	0	0	0	32	1,932
WY	1986	0	4	16	111	1,531	579	47	3	0	0	0	3	2,294	131,837
WY	1987	0	0	2	7	64	15	0	0	0	0	0	0	88	5,030
WY	1988	0	0	14	0	29	0	2	0	0	0	0	0	45	2,590
WY	1989	0	64	0	2	16	660	348	0	0	0	0	0	1,090	66,110
WY	1990	11	0	0	0	0	5	0	93	0	0	3	0	112	6,887
WY	1991	0	5	0	4	8	130	48	21	0	0	0	0	216	13,129
WY	1992	0	5	0	4	8	130	48	21	0	0	0	0	216	13,129
Avg (cfs)		3	24	75	92	122	149	244	309	104	2	1	1	1,125	67,698
Avg (ac-ft)		164	1,428	4,583	5,670	6,766	9,152	14,523	19,019	6,183	131	42	38	67,698	

Flow Below Existing Slate Creek Diversion

Constant for all reservoir models

Average Monthly Flow (Cubic-Feet-per-Second)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL (cfs)	TOTAL (Ac-Ft)
WY 1922	12	12	21	26	49	106	492	1,034	548	13	10	7	2,330	140,876
WY 1923	10	15	31	23	25	21	239	483	129	12	10	10	1,008	61,052
WY 1924	12	8	7	7	6	10	6	11	10	5	3	5	90	5,441
WY 1925	11	14	18	18	93	22	209	394	13	11	10	8	821	49,445
WY 1926	10	13	13	13	29	24	44	15	13	8	7	7	196	11,726
WY 1927	10	38	32	34	378	452	723	488	215	13	10	8	2,401	143,433
WY 1928	10	24	18	30	25	387	523	286	11	10	10	10	1,344	81,365
WY 1929	10	10	10	8	5	9	10	11	12	12	7	7	111	6,718
WY 1930	11	12	32	19	29	36	24	183	14	11	11	10	392	23,812
WY 1931	5	10	7	10	10	13	0	8	10	5	5	5	88	5,302
WY 1932	11	17	67	48	58	26	17	322	275	12	9	7	869	52,462
WY 1933	8	11	7	5	9	28	8	13	8	11	7	7	122	7,381
WY 1934	10	8	6	3	20	0	12	14	14	7	5	7	106	6,317
WY 1935	11	17	15	32	29	24	252	478	231	11	10	7	1,117	67,504
WY 1936	10	14	19	37	57	72	456	501	132	11	11	10	1,330	80,227
WY 1937	10	12	12	5	0	8	105	247	127	12	10	7	555	33,628
WY 1938	10	10	39	31	0	449	802	943	368	15	13	10	2,690	163,044
WY 1939	13	18	17	7	4	21	27	10	11	8	3	3	142	8,591
WY 1940	11	11	15	30	121	447	585	371	13	11	10	10	1,635	98,586
WY 1941	12	13	32	37	98	184	489	704	184	16	11	13	1,793	108,279
WY 1942	8	14	34	76	226	309	667	576	378	15	11	10	2,324	139,434
WY 1943	9	39	57	99	231	706	613	350	24	12	11	8	2,159	130,022
WY 1944	9	0	2	32	11	14	41	28	15	11	11	8	182	10,999
WY 1945	11	10	13	20	45	12	27	439	69	11	8	8	673	40,888
WY 1946	11	25	49	41	27	31	413	485	12	11	12	10	1,127	68,224
WY 1947	10	10	6	15	22	20	19	9	10	10	11	7	149	8,940
WY 1948	15	17	9	30	11	0	74	264	299	13	11	8	751	45,323
WY 1949	9	20	0	7	2	7	99	137	14	9	11	10	325	19,688
WY 1950	11	11	11	4	10	50	180	526	195	11	11	12	1,032	62,607
WY 1951	13	306	646	442	474	254	381	262	17	13	10	10	2,828	169,653
WY 1952	13	18	52	0	81	24	781	1,324	623	81	13	13	3,023	182,551
WY 1953	13	13	0	47	36	117	546	485	412	15	12	11	1,707	102,799
WY 1954	15	13	10	1	18	62	472	317	13	12	11	10	954	57,545
WY 1955	3	8	3	2	7	24	47	8	9	11	13	8	143	8,608
WY 1956	10	10	621	536	389	309	417	607	247	13	13	12	3,184	192,104
WY 1957	13	10	15	8	18	71	49	475	129	13	13	12	826	50,286
WY 1958	11	21	23	29	239	67	580	1,012	374	14	12	11	2,393	143,764
WY 1959	10	8	6	18	0	36	12	9	8	11	9	12	139	8,468
WY 1960	8	10	9	14	36	83	28	15	15	15	13	8	254	15,283
WY 1961	5	17	26	13	43	34	43	26	10	12	12	8	249	14,900
WY 1962	11	12	23	12	70	31	247	327	304	9	10	10	1,066	63,994
WY 1963	28	20	60	39	547	143	655	652	47	9	11	12	2,223	131,978
WY 1964	12	17	15	3	25	22	50	26	10	8	10	10	208	12,468
WY 1965	8	22	1,234	483	310	234	671	413	62	9	9	10	3,465	209,696
WY 1966	9	14	3	8	16	73	236	143	8	10	10	10	540	32,577
WY 1967	7	16	46	42	63	218	205	899	496	11	13	11	2,027	122,818
WY 1968	13	10	15	10	93	46	63	153	11	8	11	5	438	26,202
WY 1969	12	20	24	537	25	91	783	971	269	8	10	10	2,760	167,413
WY 1970	13	12	84	1,044	293	291	141	122	9	9	10	5	2,033	122,931
WY 1971	13	37	19	33	63	86	415	720	385	10	10	11	1,802	108,745
WY 1972	12	15	0	38	32	107	180	252	8	9	9	10	672	40,707
WY 1973	16	24	53	86	54	55	392	764	13	12	10	12	1,491	90,483
WY 1974	16	206	85	540	157	865	534	537	189	11	10	8	3,158	191,388
WY 1975	11	12	9	16	43	117	72	491	435	10	8	9	1,233	74,512
WY 1976	9	3	20	8	12	32	20	10	5	6	6	7	138	8,345
WY 1977	7	7	8	8	7	9	8	12	6	3	3	5	83	5,010
WY 1978	7	22	100	477	290	795	583	293	12	6	8	12	2,605	157,204
WY 1979	10	10	10	31	16	22	33	276	8	5	7	7	435	26,537
WY 1980	22	13	27	1,103	790	272	330	31	12	12	13	13	2,638	156,776
WY 1981	13	15	45	34	81	21	25	13	10	9	7	10	283	16,800
WY 1982	36	530	997	218	778	371	770	628	11	7	8	20	4,374	261,681
WY 1983	60	112	252	107	668	955	494	831	454	6	10	13	3,962	237,514
WY 1984	8	205	670	231	160	227	19	6	7	7	10	12	1,562	94,611
WY 1985	8	17	13	18	8	8	19	13	12	10	10	10	146	8,815
WY 1986	7	14	26	121	1,541	589	57	13	10	10	8	13	2,409	138,770
WY 1987	5	10	12	17	74	25	10	10	8	8	5	5	189	11,116
WY 1988	7	8	24	6	39	0	12	10	7	9	7	5	134	7,944
WY 1989	5	74	6	12	26	670	358	10	8	7	9	10	1,195	72,431
WY 1990	21	2	10	8	6	15	10	103	10	5	13	8	211	12,879
WY 1991	3	15	5	14	18	140	58	31	10	7	8	7	316	19,145
WY 1992	3	15	5	14	18	140	58	31	10	7	8	7	316	19,145
Avg (cfs)	12	33	83	101	131	158	254	319	113	11	10	9	1,235	74,337
Avg (ac-ft)	715	1,991	5,118	6,214	7,270	9,733	15,103	19,625	6,753	679	590	546	74,337	

Preproject Diversions From Slate Creek

Constant for all reservoir models

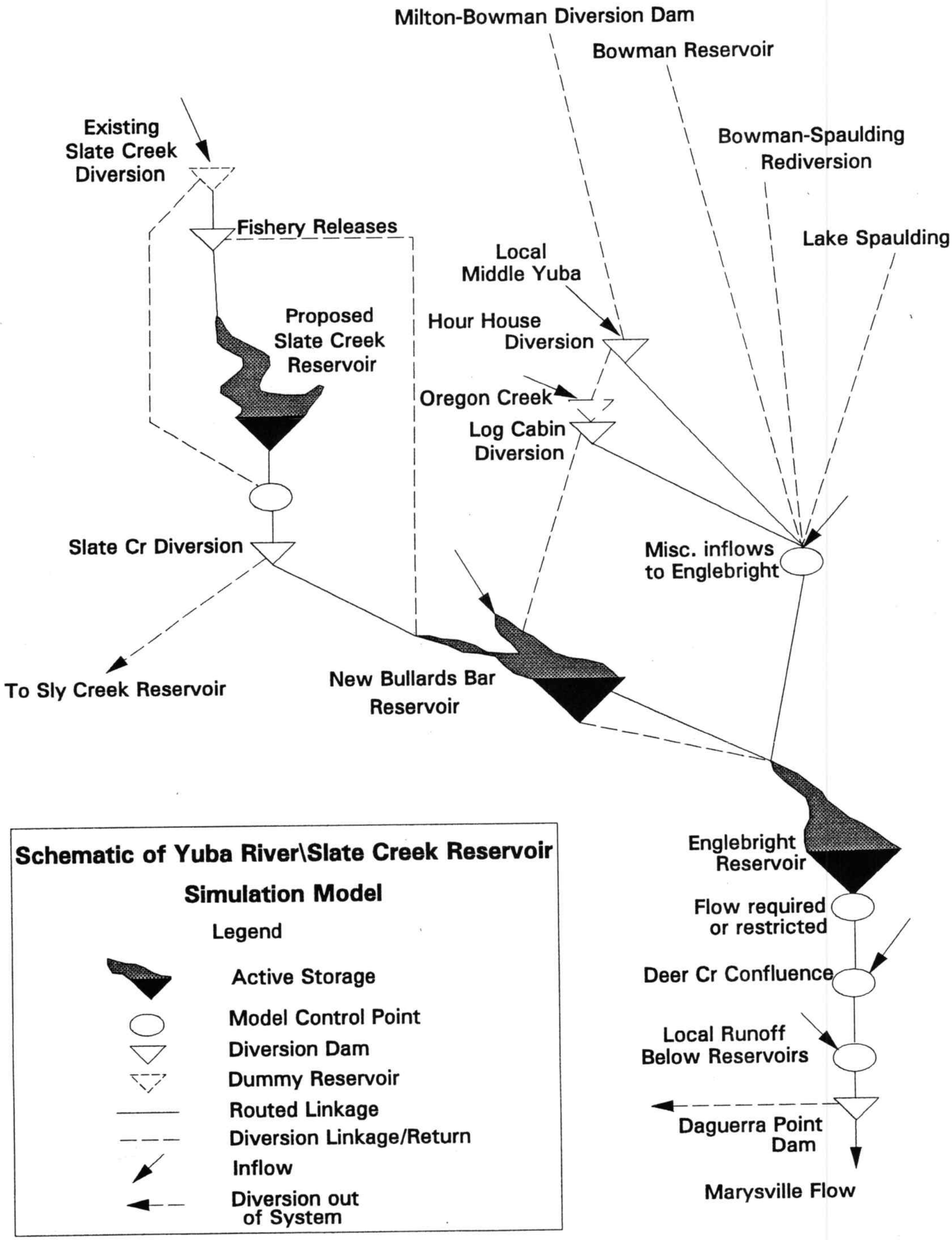
Average Monthly Diversion (Cubic-Feet-per-Second)

		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL (cfs)	TOTAL (Ac-Ft)
WY	1922	8	13	104	111	326	164	0	0	0	37	5	0	768	45,258
WY	1923	10	47	286	146	110	164	311	0	37	34	3	2	1,150	69,270
WY	1924	21	17	52	34	151	76	160	57	2	0	0	0	570	33,795
WY	1925	15	45	112	102	571	259	297	0	76	7	0	0	1,484	87,022
WY	1926	8	29	52	57	436	228	514	169	29	0	0	0	1,522	89,857
WY	1927	13	303	194	213	510	54	0	0	3	20	0	0	1,310	76,908
WY	1928	8	139	128	172	155	512	27	0	34	5	0	0	1,180	71,237
WY	1929	5	29	42	39	92	141	224	306	94	3	0	0	975	58,716
WY	1930	0	0	285	166	212	343	398	67	57	2	0	0	1,530	91,913
WY	1931	0	42	11	52	58	163	173	85	15	0	0	0	599	36,030
WY	1932	10	18	109	111	169	262	385	325	2	16	2	0	1,409	84,828
WY	1933	5	13	21	37	38	117	237	330	229	10	0	0	1,037	62,587
WY	1934	10	24	98	130	153	286	185	59	15	0	0	0	960	57,674
WY	1935	2	49	63	137	149	181	526	176	3	13	0	0	1,299	77,840
WY	1936	11	20	36	283	454	364	250	0	34	18	0	0	1,470	87,084
WY	1937	5	8	21	24	176	234	418	459	39	11	0	0	1,395	83,807
WY	1938	5	72	446	132	385	333	0	0	2	42	5	0	1,422	84,999
WY	1939	23	39	46	52	50	197	324	109	18	0	0	0	858	51,704
WY	1940	7	7	21	377	558	407	0	0	76	5	0	0	1,458	86,165
WY	1941	11	61	223	311	475	322	0	0	3	49	7	2	1,464	87,062
WY	1942	21	52	363	493	330	8	0	0	2	47	10	0	1,326	79,463
WY	1943	11	146	293	517	162	0	0	0	104	16	5	2	1,256	75,766
WY	1944	20	45	52	41	99	181	240	504	121	15	2	0	1,320	79,770
WY	1945	10	86	164	120	445	198	405	68	72	15	5	0	1,588	93,879
WY	1946	20	101	398	252	158	267	155	0	104	15	3	0	1,473	88,918
WY	1947	16	108	109	68	203	291	260	172	49	3	0	0	1,279	76,609
WY	1948	31	54	46	224	92	96	496	325	2	28	5	0	1,399	84,380
WY	1949	15	44	52	55	61	174	472	340	67	7	0	0	1,287	77,616
WY	1950	7	18	26	198	330	285	502	55	3	18	5	0	1,447	85,973
WY	1951	37	576	436	0	0	0	0	0	54	10	3	0	1,116	67,372
WY	1952	28	49	231	197	414	311	222	0	0	78	20	5	1,555	92,604
WY	1953	15	27	104	529	184	119	0	0	0	78	11	2	1,069	64,579
WY	1954	18	64	68	127	241	428	94	0	49	8	0	0	1,097	65,608
WY	1955	10	42	96	81	76	109	200	439	136	13	2	0	1,204	72,830
WY	1956	11	22	571	298	0	0	0	0	3	34	11	5	955	58,662
WY	1957	29	54	57	65	340	394	314	34	37	16	3	0	1,343	79,753
WY	1958	28	50	117	145	551	359	77	0	2	36	11	13	1,389	81,847
WY	1959	16	37	36	210	212	216	269	159	44	5	2	0	1,206	72,199
WY	1960	7	10	15	67	362	408	375	237	71	8	2	0	1,562	92,986
WY	1961	0	22	52	39	202	168	291	267	67	8	3	0	1,119	66,850
WY	1962	0	0	50	29	450	133	521	151	2	20	5	0	1,361	79,971
WY	1963	455	54	220	314	101	0	0	0	84	20	7	3	1,258	76,472
WY	1964	3	230	52	86	76	93	353	320	81	15	5	2	1,316	79,146
WY	1965	0	49	545	0	0	0	0	0	72	24	15	5	710	43,407
WY	1966	2	57	33	49	52	278	524	166	24	3	0	0	1,188	71,539
WY	1967	0	166	276	356	299	291	0	0	0	70	8	2	1,468	88,153
WY	1968	8	3	31	112	456	260	266	24	44	7	2	0	1,213	71,251
WY	1969	8	59	85	561	214	155	7	0	2	39	11	3	1,144	68,929
WY	1970	10	8	433	514	0	0	0	31	45	7	3	0	1,051	64,519
WY	1971	8	192	202	182	198	449	190	0	0	60	11	7	1,499	90,221
WY	1972	3	22	67	115	162	524	203	0	61	7	2	5	1,171	70,462
WY	1973	28	79	220	381	288	309	156	0	96	11	0	3	1,571	94,222
WY	1974	21	587	335	293	0	0	0	0	3	49	8	0	1,296	78,519
WY	1975	0	13	28	65	200	327	266	405	0	36	10	3	1,353	81,444
WY	1976	37	52	42	28	76	140	131	75	13	2	2	0	598	35,929
WY	1977	0	0	0	5	16	20	24	50	7	0	0	0	122	7,345
WY	1978	0	0	185	255	0	0	0	250	247	36	5	12	990	60,360
WY	1979	0	7	11	78	108	324	464	410	89	13	0	0	1,504	90,725
WY	1980	24	84	59	114	9	0	40	278	94	21	2	0	725	44,093
WY	1981	0	5	57	52	194	252	303	119	25	2	0	0	1,009	60,227
WY	1982	29	314	0	28	72	81	72	0	197	42	7	0	842	50,189
WY	1983	44	165	272	259	0	0	0	0	213	145	24	7	1,129	68,657
WY	1984	16	321	150	41	101	115	245	228	57	13	3	0	1,290	77,483
WY	1985	8	146	78	41	86	150	420	148	25	3	0	3	1,108	66,439
WY	1986	3	20	119	346	459	141	222	159	42	8	2	22	1,543	91,539
WY	1987	15	7	8	29	155	317	158	60	12	2	0	0	763	45,642
WY	1988	0	2	166	109	134	213	170	107	42	7	0	0	950	57,192
WY	1989	0	77	46	47	158	543	168	159	39	8	2	2	1,249	75,292
WY	1990	39	35	23	124	59	294	274	172	136	15	0	0	1,171	70,769
WY	1991	0	0	2	2	20	169	350	337	96	16	2	0	994	60,116
WY	1992	0	0	2	2	20	169	350	337	96	16	2	0	994	60,116
Avg (cfs)		18	75	133	155	195	205	207	123	52	20	4	2	1,189	71,293
Avg (ac-ft)		1,115	4,472	8,169	9,552	10,836	12,615	12,302	7,559	3,100	1,253	228	92	71,293	

NEW BULLARDS BAR SPILLS

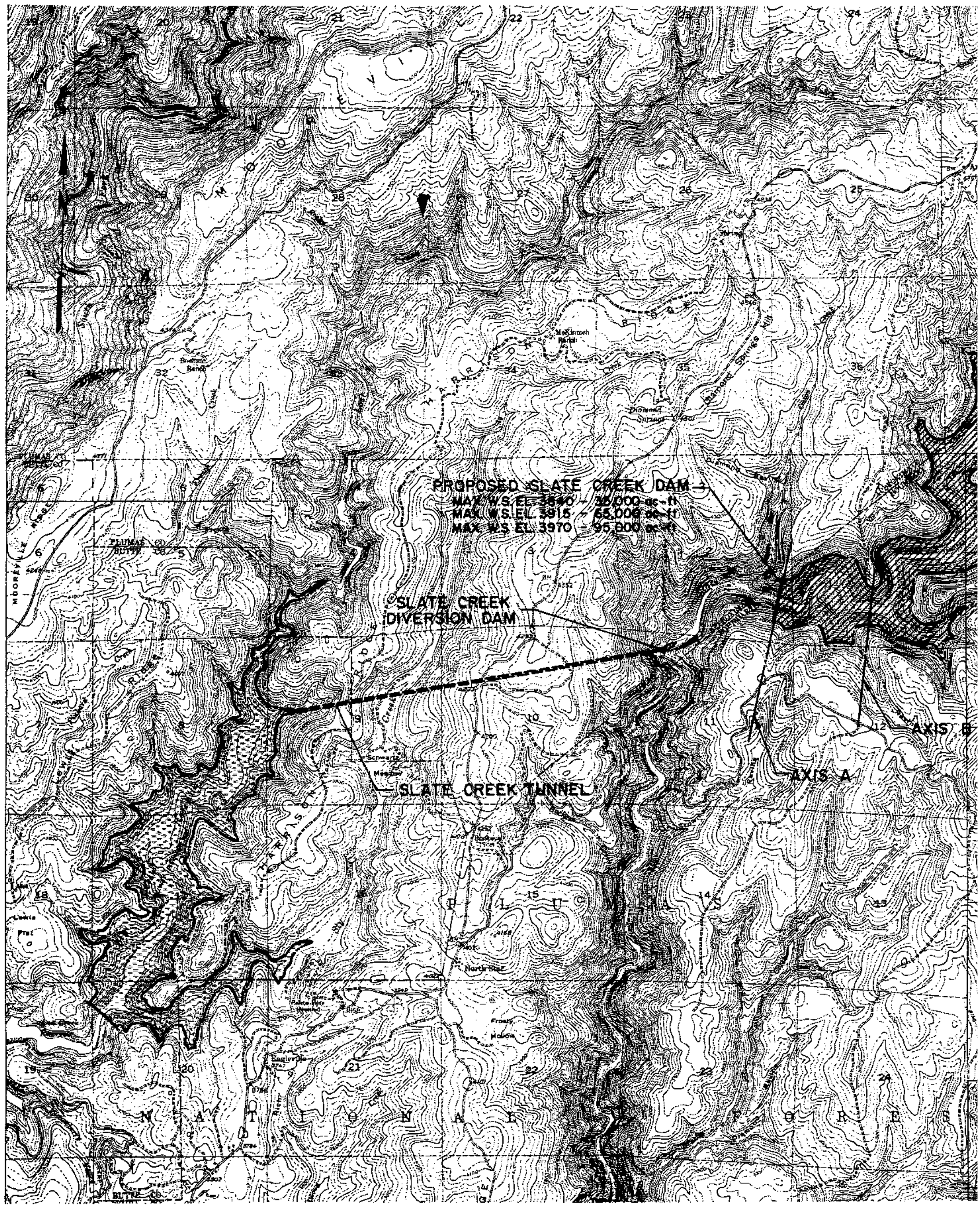
New Bullards Bar Spills Above the Colgate Penstock Capacity of 3700 cfs.
No Slate Creek Reservoir, Only Historical Slate Creek Diversion

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
						Acre-Feet							
WY 22	0	0	0	0	0	0	0	196,300	124,400	0	0	0	320,700
WY 23	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 24	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 25	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 26	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 27	0	0	0	0	64,000	0	70,100	0	0	0	0	0	134,100
WY 28	0	0	0	0	0	80,800	0	0	0	0	0	0	80,800
WY 29	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 30	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 31	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 32	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 33	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 34	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 35	0	0	0	0	0	0	35,400	0	0	0	0	0	35,400
WY 36	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 37	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 38	0	0	0	0	0	82,900	108,100	177,300	64,300	0	0	0	432,600
WY 39	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 40	0	0	0	0	0	121,900	4,000	0	0	0	0	0	125,900
WY 41	0	0	0	0	75,300	0	0	57,500	0	0	0	0	132,800
WY 42	0	0	0	0	73,000	0	8,500	10,500	3,000	0	0	0	95,000
WY 43	0	0	0	0	0	85,000	1,200	0	0	0	0	0	86,200
WY 44	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 45	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 46	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 47	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 48	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 49	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 50	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 51	0	0	198,300	0	13,200	0	0	0	0	0	0	0	211,500
WY 52	0	0	0	0	0	0	114,500	229,900	81,300	1,300	0	0	427,000
WY 53	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 54	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 55	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 56	0	0	236,000	202,300	0	0	0	0	0	0	0	0	438,300
WY 57	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 58	0	0	0	0	55,500	0	62,200	145,800	0	0	0	0	263,500
WY 59	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 60	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 61	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 62	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 63	0	0	0	0	5,700	0	8,100	25,000	0	0	0	0	38,800
WY 64	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 65	0	0	355,300	170,300	0	0	0	0	0	0	0	0	525,600
WY 66	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 67	0	0	0	0	0	0	0	44,100	89,400	0	0	0	133,500
WY 68	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 69	0	0	0	163,600	0	0	0	92,700	0	0	0	0	256,300
WY 70	0	0	0	378,600	0	0	0	0	0	0	0	0	378,600
WY 71	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 72	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 73	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 74	0	0	0	192,200	0	96,500	42,200	0	0	0	0	0	330,900
WY 75	0	0	0	0	0	0	0	0	15,200	0	0	0	15,200
WY 76	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 77	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 78	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 79	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 80	0	0	0	180,600	153,100	0	0	0	0	0	0	0	333,700
WY 81	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 82	0	0	258,100	0	191,800	0	259,700	63,900	0	0	0	0	773,500
WY 83	0	0	0	0	151,400	297,300	1,700	99,400	125,500	0	0	0	675,300
WY 84	0	0	252,900	0	0	0	0	0	0	0	0	0	252,900
WY 85	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 86	0	0	0	0	426,200	173,200	0	0	0	0	0	0	599,400
WY 87	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 88	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 89	0	0	0	0	0	12,700	0	0	0	0	0	0	12,700
WY 90	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 91	0	0	0	0	0	0	0	0	0	0	0	0	0
WY 92	0	0	0	0	0	0	0	0	0	0	0	0	0
Average:	0	0	18,318	18,135	17,031	13,385	10,080	16,090	7,086	18	0	0	100,144


Milton-Bowman Diversion Dam
Bowman Reservoir
Existing Slate Creek Diversion
Bowman-Spaulding Rediversion
Fishery Releases
Lake Spaulding
Local Middle Yuba
Proposed Slate Creek Reservoir
Hour House Diversion
Oregon Creek
Log Cabin Diversion
Slate Cr Diversion
Misc. inflows to Englebright
To Sly Creek Reservoir
New Bullards Bar Reservoir
Schematic of Yuba River\Slate Creek Reservoir
Simulation Model
Legend
Active Storage
Model Control Point
Diversion Dam
Dummy Reservoir
Routed Linkage
Diversion Linkage/Return
Inflow
Diversion out of System
Englebright Reservoir
Flow required or restricted
Deer Cr Confluence
Local Runoff Below Reservoirs
Daguerra Point Dam
Marysville Flow

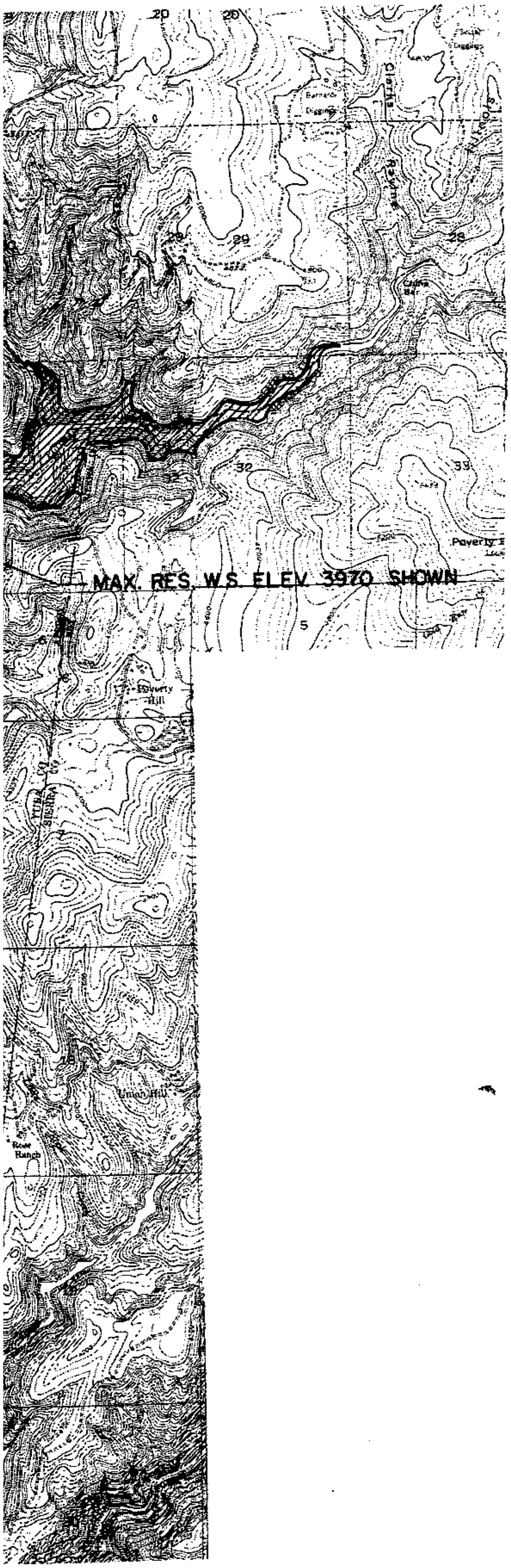
Appendix A

Appendix A contains significant pages from Bookman-Edmonston Engineering, Inc. Report.



2000 0 2000 4000
SCALE 1"=2000' FEET

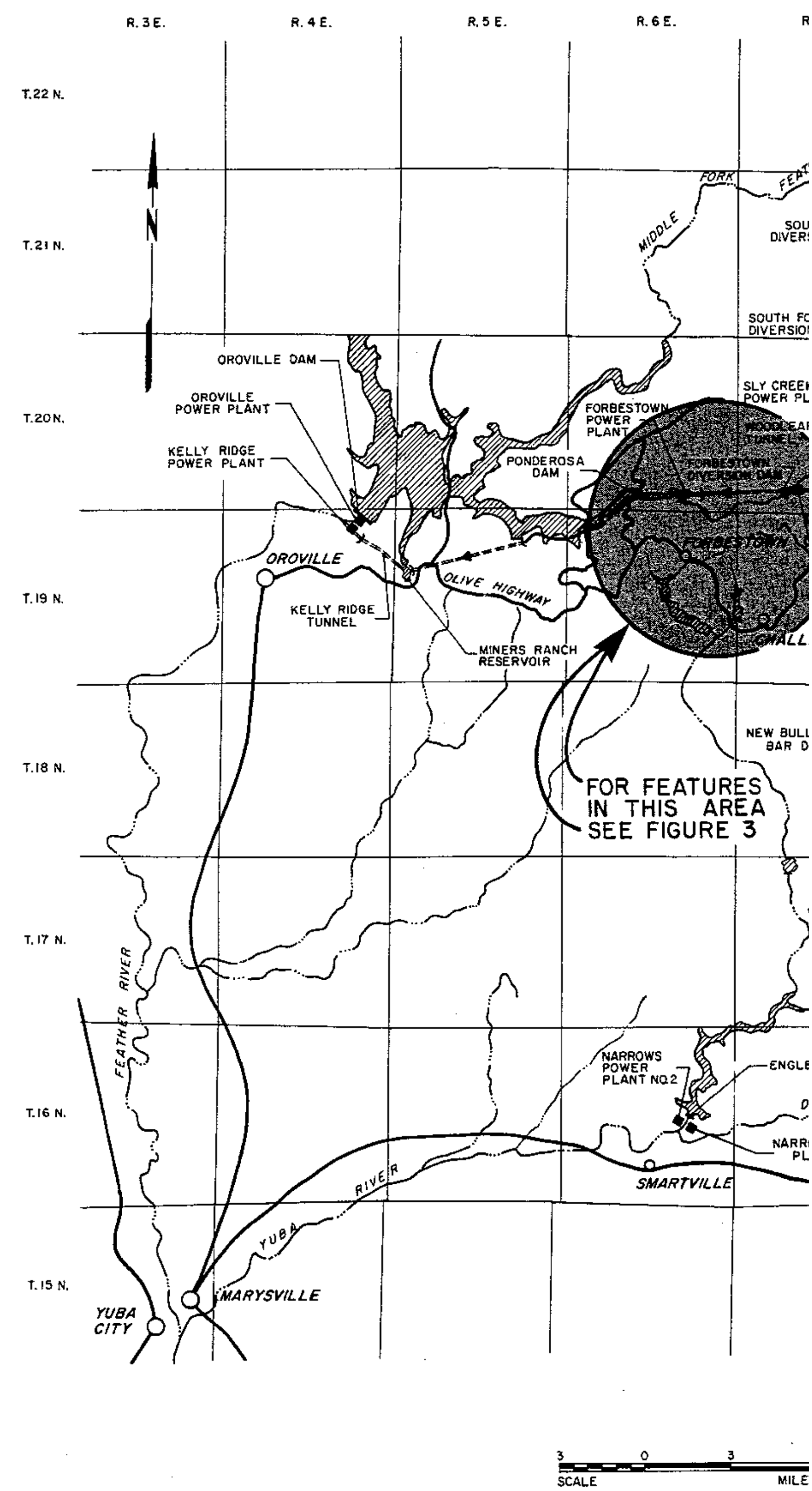
MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP



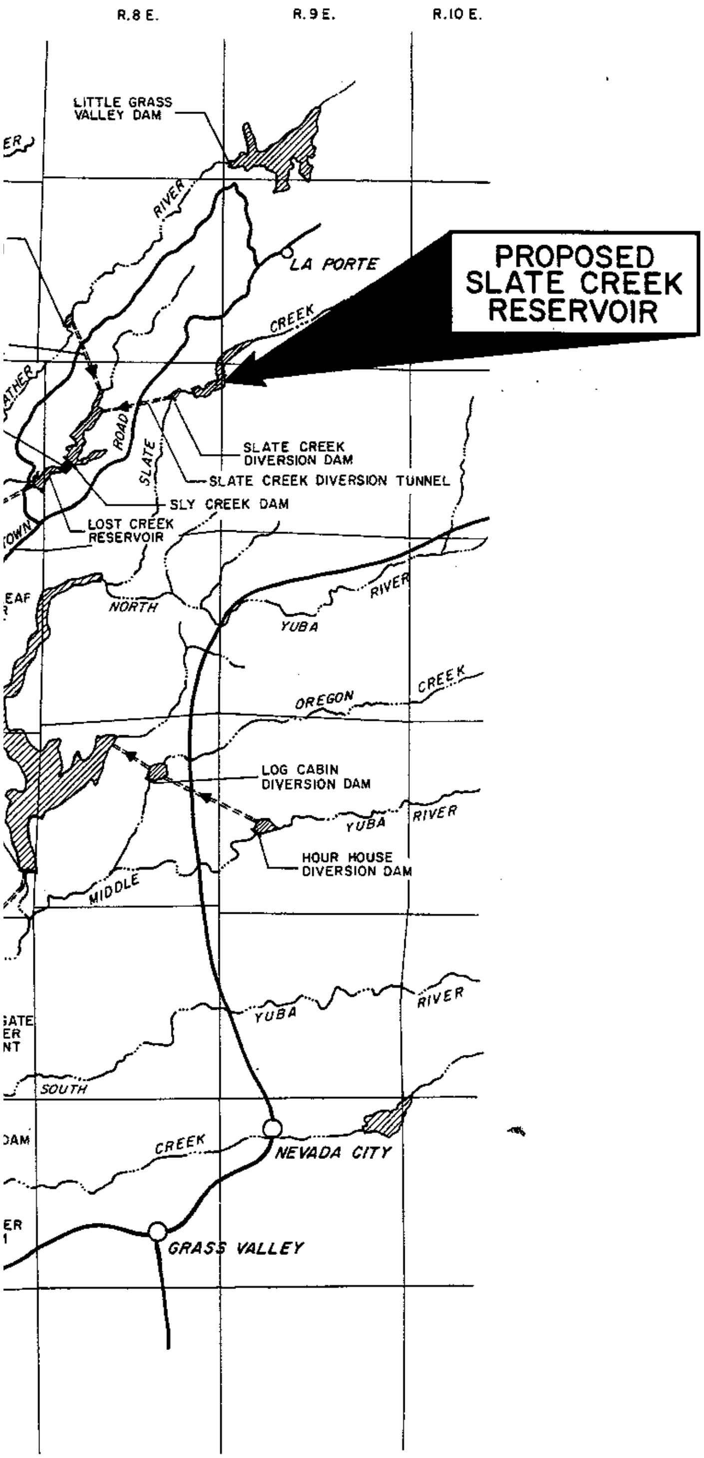
YUBA COUNTY WATER AGENCY

MAP OF PROPOSED
SLATE CREEK RESERVOIR

FIGURE 2



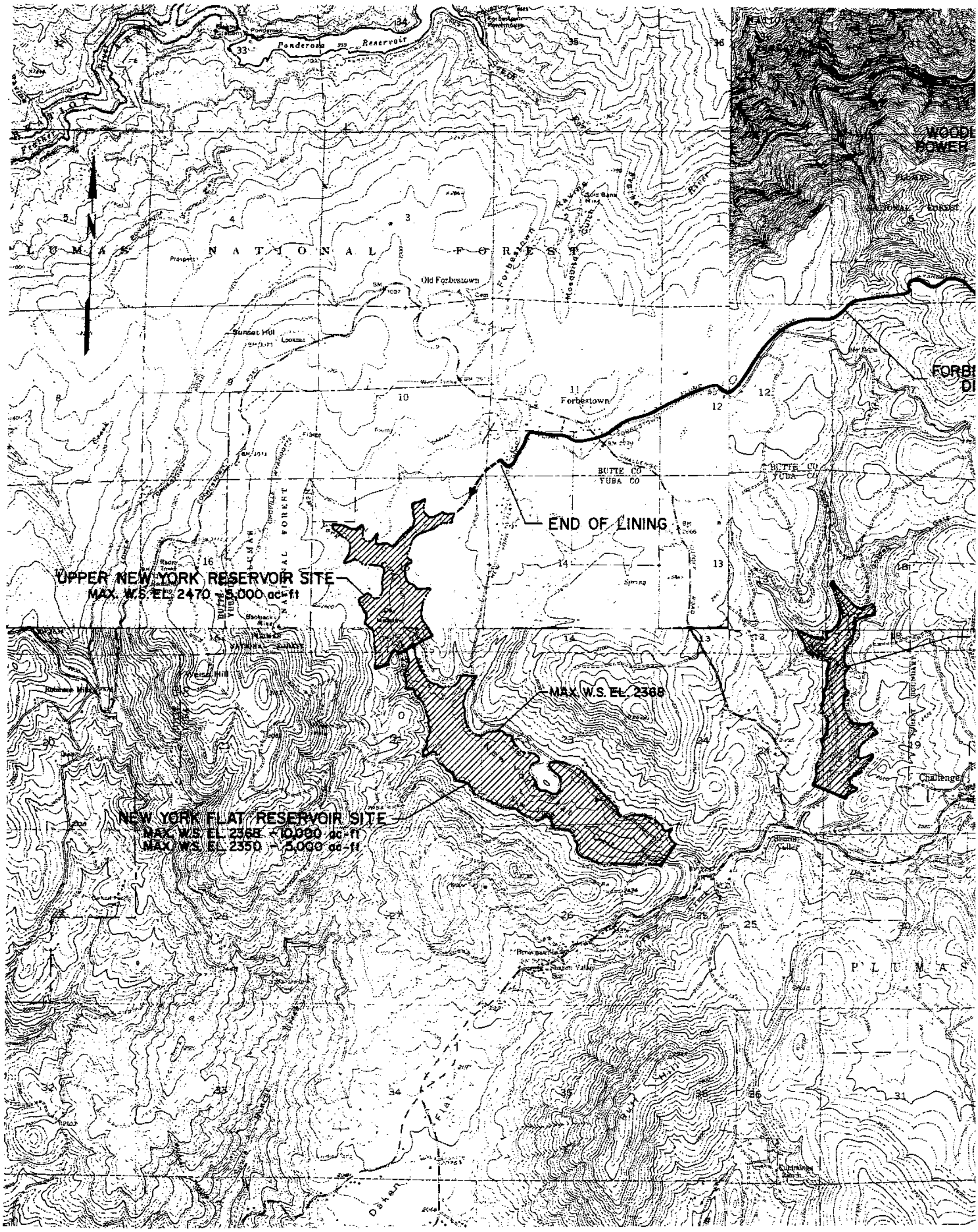
MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP



YUBA COUNTY WATER AGENCY

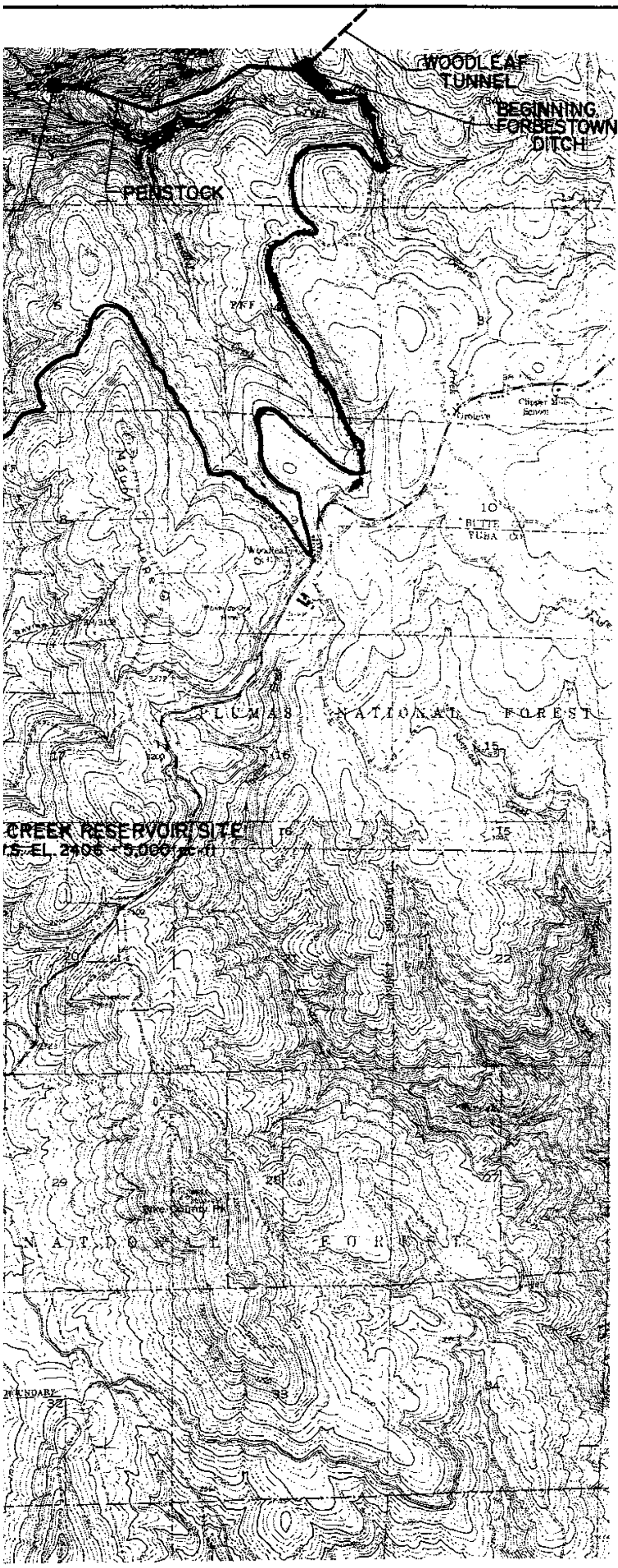
VICINITY MAP

FIGURE 1



2000 0 2000 4000
SCALE 1" = 2000' FEET

MORRISON KNUDSEN CORPORATION
TRANSPORTATION AND WATER RESOURCES GROUP



YUBA COUNTY WATER AGENCY

VICINITY MAP

NEW YORK AND COSTA CREEK
RESERVOIR SITES AND
FORBESTOWN DITCH IMPROVEMENT

FIGURE 3

MORRISON
KNUDSEN
CORPORATION