JOHN CAROLLO ENGINEERS
PHOENIX, AZ • WALNUT CREEK, CA
FOUNTAIN VALLEY, CA • VISALIA, CA
TUCSON, AZ • SAN DIEGO, CA
ANCHORAGE, AK

February 14, 1986
WO #2811.A0

City of Fort Bragg
416 North Franklin Street
Fort Bragg, CA 95437

Attention: Mr. Gary Milliman
City Administrator

Subject: Water System Study and Master Plan

Gentlemen:

We are providing the Water System Study and Master Plan for the City of Fort Bragg.

We have enclosed thirty (30) copies.

We appreciate the cooperation of your staff during the preparation of this study and plan, especially Mssrs. Frank Filice and Ted Steinhardt.

We are available to assist you in the presentation of this report to the City Council, if you so desire. If you need additional information please contact us at (415) 932-1710.

Very truly yours,

JOHN CAROLLO ENGINEERS

Howard M. Way

HMW:jmc

Enclosure

FORT BRAGG WATER STUDY

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CHAPTER I

PURPOSE AND SCOPE

AUTHORIZATION

John Carollo Engineers submitted a proposal on November 29, 1984 to the City of Fort Bragg to prepare a water system study and master plan. John Carollo Engineers was selected to do this work and entered into an agreement with the City on April 3, 1985 to provide engineering services to prepare the subject study and master plan.

PURPOSE

The purpose of the study and master plan is to evaluate several aspects of the water supply system. Some of the items evaluated include the following:

- present and future water supply sources
- water treatment plant components
- bypassing Simpson Reservoir
- physical improvement of existing sources
- existing and future distribution system by computer simulation

The recommendations made herein will be based on information contained in the General Plan existing pattern of development, historic, current, and projected population. The recommendations are estimated to include development through the year 2000.

SCOPE

The scope of this water system study and master plan report includes a review of the entire water system from water sources to distribution. A comprehensive evaluation of the water treatment equipment and process was made. Recommendations are made to improve capacity, quality, constructability and performance with a view based on cost effectiveness. Water source were inspected and recommendations made to improve quantity and quality. A dynamic computer model of the distribution system was made. The model was manipulated to give data that allowed recommendations to be made on needed improvements to the system to accommodate projected development. Priorities of these improvements were established after native sources of water were surveyed for quality and quantity.

A more detailed discussion of the Scope of Work is included in our proposal for the job.

CHAPTER II

WATER MASTER PLAN SUMMARY

GENERAL

The purpose of this Chapter is to summarize the proposed capital improvement projects described in Chapters VI, VII and IX and the costs associated with them presented in Chapter X. Recommended system improvements are divided among three categories - Immediate Improvements (by 1986), Recommended Improvements by 1990, and Recommended Improvements by 2000. These immediate improvements have been prioritized based on the system needs to meet the unrestricted water demands of the service area. Future needs are very dependent upon future development and growth patterns. Therefore, prioritization of the 1990, 2000 projects would not be accurate.

WATER SUPPLY IMPROVEMENTS

Immediate Improvements to the Raw Water Supply System. The potential for inadequate supply of raw water to the City of Fort Bragg Water Treatment Plant is established in this study based on dry year conditions. The deteriorated condition of portions of the raw water transmission system is also presented. Therefore most of the recommended improvements to secure raw water supplies for the Fort Bragg water system require immediate attention.

Due to the unmetered condition of all three raw water pipelines and the critical supply requirements of 1985, a leak detection survey (Item 1, Table II-1a) should be the first priority of the system. The survey would include direct and indirect location and quantification of the leaks and the condition and physical characteristics of the pipe. Quantifying the raw water diversion at the sources is critical for the establishment of the City's water rights and would help identify system losses downstream of the diversions. (Item 2, Table II-1a).

The Noyo pipeline has a present tested capacity of about 2.7 cfs (1,200 gpm). This capacity is less than current water rights on the Noyo River. The capacity limitation here is probably due to a silted condition of the 9.5 inch steel pipe segment (first 3,700 feet from Noyo Pump Station). Cleaning the inside of the steel portion of silt, rust, etc., and realigning the bends to be 90 degrees or less from the pump station to the access road up the hill, should increase the capacity of the line above the 3.0 cfs diversion right (Item 3, Table II-1a).

The Noyo collector has been functioning adequately in 1985. However, the impacts of seasonal siltation or low river flows could be minimized if a new collector was extended into the Madsen Hole immediately upstream of the old pump station (Item 4, Table II-1a),

The Noyo pump station was the key to adequate water supplies to Fort Bragg in 1985. The reliability and efficiency of this facility should therefore be maximized. To improve the efficiency and reliability of the Noyo pump station, two vertical turbine pumps of similar characteristics are recommended and estimated in Item 5, Table II-1a. To provide emergency power for a single turbine pump, a portable standby generator is recommended (Item 11, Table II-1a).

The Newman Reservoir seasonally has taste and odor problems or can have water levels too low to utilize. When any of these conditions occur, the Waterfall Gulch diversion should not be discharged into Newman but rather bypassed to the treatment plant site. Currently, there are no such controls to provide this option at Newman Reservoir. Item 6, Table II-1a is to install the necessary valving pipe for the bypass.

The Simpson pipeline is the only way to transport the raw water from Waterfall Gulch to Newman Reservoir. The gravity pipeline has provided excellent service at minimal cost. However, the pipeline is badly in need of repair to continue such service to the year 2000. Reconstruction of the pipe support system (Item 7, Table II-1a) proposes to accomplish this. To increase the capacity of the line and potential diversions from Waterfall Gulch for a relatively low cost, only about 20 percent of its length (6 inch pipe) needs to be replaced (with 10 inch pipe), (Item 8, Table II-1a).

The Waterfall Gulch diversion (Item 9, Table II-1a) into the Simpson pipeline should be improved to maximize diversion from the gulch. The proposed relocation of the diversion a short distance upstream accomplishes not only this, but also improves the head (hence capacity) of the Simpson pipeline.

The Newman pipeline transports water by gravity from the Newman-Simpson source to the water treatment plant. Sections of this line are in need of replacement Item 3, Table II-1a covers this replacement.

<u>Improvements to the Raw Water Supply System by 1990</u>. Future proposed improvements to meet dry year conditions relate to establishing new diversions on Covington Gulch (Item 1, Table II-2a) and on Hare Creek (Item 2, Table II-2a). These diversions, recommended by 1990, are in close proximity to the 10-inch Simpson pipeline but require pumping.

<u>Improvements to the Raw Water Supply System by 2000</u>. Replacement of the steel portion of the Noyo pipeline, built in 1959, is expected to occur by the year 2000. Table II-3a presents the two pipeline replacement alternatives.

WATER TREATMENT PLANT IMPROVEMENTS

The existing water treatment plant does not meet minimum operating standards in several aspects and some of the structures on the site also do not meet minimum standards for continued use. Recommended improvements in the facility are immediate needs and are rather extensive. They are intended to adequately treat raw water that may contain the typical taste, odor and bacteriological problems experienced in the Fort Bragg area and meet State Health Department standards.

The capital improvements recommended at the water treatment plant are summarized below in order of their priority. Because financing constraints may require staging the various improvements, the work has been grouped into projects that are compatible in terms of construction and operation.

1. New Filters.

   a. Purpose: Improve filtered water turbidity and reduce excessive water consumption during backwashing.

   b. Description: Construct two multicellar package filters, complete with controls, housed in steel tanks. Install backwash pumps and sumps for backwash water. Reroute influent and effluent pipes. Minor site work is required.

2. New Flocculation Basins.

   a. Purpose: Improve efficiency of flocculation process so that filters will more effectively remove turbidity colloidal materials and organisms such as Giardia.

   b. Description: Construct new modular concrete basins complete with vertical entry flocculators. Reroute piping and construct new manifold into basins. Relocate static mixer. Minor sitework required. Modify electrical controls as required.

3. Storage Ponds.

   a. Purpose: Enhance ability to settle water, buffer flow, provide maintenance access, recover waste washwater.

   b. Description: Remove existing growths, construct new center berms and roadways. Revise inlet and outlet piping to include junction boxes for isolation of individual compartments.

4. Sludge Handling.

   a. Purpose: Eliminate discharge of sludges to drainage ditch which eventually goes to Noyo River. Recover waste backwash water.

   b. Description: Convert existing reacter-clarifier into sludge thickener by removal of mechanism, add new mechanism and internal piping. Provide pipe to new sand drying beds.

5. Pump Station Improvements (Phase I).

   a. Purpose: Accommodate new chemical systems and improve space utilization. Increase safety by minimizing fire hazard.

   b. Description: Remove existing wooden superstructure and replace with non-flammable structure. Add laboratory and office space. Complete electrical revisions.

   Pump Station Improvements (Phase II).

   a. Purpose: Install new caustic soda and potassium permanganate chemical feed systems.

   b. Description: Reroute chemical solution lines, install bulk storage fiberglass tanks, and safety facilities.

   Pump Station Improvements (Phase III)

   a. Purpose: Complete the proposed improvements.

   b. Description: Complete instrumentation and alarm monitoring systems. Replace raw water pumps. Install plant security system.

   Costs for these improvements are identified in Table II-1b.

WATER DISTRIBUTION SYSTEM IMPROVEMENTS.

Immediate Improvements to the Water Distribution System. The College of the Redwoods and Todd Point Developments in the area south of the Noyo River are pending. To provide water to meet fire and consumptive demands, a storage tank, a pump to fill the storage tank on a timely basis and associated pipelines and controls should be constructed. These facilities will serve only the area south of the Noyo River. The projects recommended for immediate improvement are listed in Table II-1c.

The purpose for these recommended distribution system projects is to provide flow to meet fire demand to the College of the Redwoods and the higher areas in and adjacent to the Boatyard Shopping Center. These projects will also eliminate the low flow and pressure that now occur in the area when the fire hydrant or pump is activated.

Improvements to the Water Distribution System by 1990. It was assumed that development in the Study area south of the Noyo River will reach buildout by 1990 through development and annexation. To meet the fire and consumptive demands for this development, additional pipelines will be needed. Crossing Hare Creek in two places to provide better flow distribution is recommended. The projects recommended are those listed in Table II-2b.

Improvements to the Water Distribution System by 2000. It was assumed that development and annexation of the Study area north of Pudding Creek and infill of the existing City limits will occur between 1990 and 2000. To meet the fire and consumptive demands for this development and growth, additional pipelines will be needed. Crossing Pudding Creek with an additional pipeline is recommended to provide better flow distribution. The projects needed are listed in Table II-3b.

If development does not occur in the manner assumed, these facilities will still be needed. In this event, the facilities should be constructed in the manner and location growth is taking place to meet water needs.

Noyo River Crossing. A new pipe should be constructed across the Noyo River to provide reliability for the area served south of the Noyo River and to provide looped service of this area. Several alternatives should be studied before a decision is made as to how and where to make the River crossing. Three alternatives are presented below.

One alternative is to add another pipe to the existing Noyo River Bridge. This alternative requires Caltrans approval and appears to be the least costly of the three.

Another alternative is constructing the pipe crossing on a suspension bridge over the River. This alternative would be relatively expensive and will require environmental and aesthetic investigation.

Another alternative is constructing a pipe under the River in the vicinity of South Harbor and North Harbor Drives. This pipe should be buried deep enough to be below the level of the River bed that moves during high storm flows. Tunneling, boring and jacking, sheet piling with open trench excavation are some construction techniques that may be used to construct the pipe. However, the type of soil and its gradation may determine the construction technique used. In addition to soils information, restrictions by regulatory agencies such as the Corps of Engineers, California Fish and Game, etc., need to be determined in order to ultimately establish a cost for these project alternatives.

We recommend that a second pipe be constructed on the existing Noyo River Bridge. If Caltrans will not permit this construction, we recommend that a detailed study be made of other alternatives. Environmental sensitiveness, complexity of construction and regulatory constraints determined by additional study will permit the City to decide location, feasibility and desirability for constructing the second Noyo River pipe crossing.

NON-CAPITAL IMPROVEMENTS

Recognizing the limited capital resources of the City, there are several non-capital intensive areas of water system operations that can be pursued. City staff has already begun to clarify the water rights situation with the

State Division of Water Rights. This liaison should continue until the City's raw water sources are fully documented with respect to optimum utilization of the sources. The protection of the raw water sources from contamination, accidental as well as long-term potential from development, should become an active component of the City's programs. Along with this, an emergency operations program or plan should be developed for all aspects of the City's water system. This plan would address for example, accidental raw water contamination, power failure at various system locations, pipeline failures, chemical spill at plant, notification requirements/procedures, available resources for emergency responses (labor, materials, etc.) and response procedures for local well contamination.

Operationally, meters (although requiring capital), accurate meter records and periodic meter calibration are essential in sustaining and expanding the City's surface water rights. This includes the master metering at the raw water source and plant facilities as well as the metering of the places of uses within the treated water system. Leak detection surveys, meter exchange programs and review of meter sizes and customer use would also help to more accurately identify the water demands.

Procedures for maintaining the raw water sources should be developed to protect the yield and quality of the sources as well as the surrounding environment and wild life. These procedures should also satisfy outside agency requirements. A comprehensive operations manual should be developed for all routine aspects of the water system. System operations should be reviewed for energy conservation (i.e., excess pressure or pumping heads, pump efficiencies, scheduling of fire hydrant flushing with fire flow testing).

Currently, the City's water meters to Georgia Pacific (G-P) are large enough to permit G-P to draw as much as 3.4 MGD from City. This quantity of water would create significant problems for the City water system. To eliminate the potential for such a large draft on the water system, the City should replace some of their meters to G-P with smaller capacity ones.

Finally, the organizational structure of the City and the revenue program for the City water system should be reviewed to insure that they are able to properly support and fund the existing and future water customers.

TABLE II-1a

PROPOSED IMMEDIATE IMPROVEMENTS
CONSTRUCTION COSTS
FOR RAW WATER SOURCES

Priority	Proposed Construction Project	Escalated to June 1986 Mid Construction, $
1.	Leak Detection Survey Simpson, Newman, Noyo Pipelines	$ 7,000
2.	Install Flow Metering Devices/Structures at Simpson, Newman, Noyo Diversion (summer 98)	15,000
3.	Noyo Pipeline - Clean/flush entire pipeline to WTP. Realign bends greater than 90 degrees near pump station	19,000
4. (NEW DIVERSION)	Noyo Collector Extension - Install additional conduit on existing collector system extending upstream to Madsen Hole	17,000
5.	Noyo Pump Station New Pump - Install 100 Hp vertical turbine, existing 75 Hp submersible as standby, upgrade building	27,000
6.	Simpson Bypass of Newman Reservoir - Install valving pipe to allow direct piping of Simpson diversion into Newman Pipeline to WTP	19,000
7. (Rerouted Pipeline)	Simpson Pipeline Truss Reconditioning - Rework/replace existing Simpson Pipeline supports as required to secure pipeline integrity and properly support 10"Ø pipe throughout	116,000
8.	Simpson Pipeline - Replace 6" with 10" Ø	68,000
9.	Waterfall Gulch - New Diversion Relocate diversion upstream to improve water quality and quantity available to Simpson Pipeline (DETERMINED NOT NECESSARY - Reconstructed Reservoir)	41,000

TABLE II-1a (Continued)

PROPOSED IMMEDIATE IMPROVEMENTS
CONSTRUCTION COSTS
FOR RAW WATER SOURCES

Priority	Proposed Construction Project	Escalated to June 1986 Mid Construction, $
✓10.	Newman Pipeline - Replace Noyo River Crossing Dependent upon leak survey replace steel pipe crossing Noyo River wtih new pipe and casing	52,000
✓11.	Noyo Pump Station - Portable Standby Power Provide a quick electrical hookup at Noyo Pump Station and dedicated, portable generator to operate 100 Hp pump during electrical power outages	35,000
	SUBTOTAL PROPOSED PROJECT COSTS	$416,000

TABLE II-1b

SUMMARY OF PROPOSED IMPROVEMENTS
CONSTRUCTION COSTS
FOR WATER TREATMENT PLANT

Priority	Proposed Construction	Current 12/85 Costs, $	
1.	Storage Ponds		
	Remove growth	3,000	
	Scarify side slopes	4,500	
	Center earthen germ	16,000	
	Diversion boxes	30,000	
	Re-route existing piping	2,500	
	Gunite side slopes	64,000	
	Gravel bottom	8,000	
	Access roads	6,000	
			$144,000
2.	Pump Station		
	Remove superstructure	20,000	
	New superstructure	95,000	
	New laboratory area	35,000	
	Revise chemical systems	4,000	
	New potassium permanganate	12,000	
	Raw water pumps	46,000	
	Finished water pumps	51,000	
	Revise electrical panels	75,000	
	Revise alarm/monitoring system	25,000	
	New Caustic Soda System	16,000	
	Spare Polymer Feeder	3,000	
			$363,000
1.	Flash Mixing		
	Relocate	1,000	
			$1,000
1.	Flocculation		
	New flocculation basins	90,000	
	Vertical mixers	48,000	
	Internal baffles	3,000	
	Re-route piping	14,000	
	Sluice gates, baffles	23,000	
	Handrails	19,000	
			$197,000

TABLE II-1b (Continued)

SUMMARY OF PROPOSED IMPROVEMENTS
CONSTRUCTION COSTS
FOR WATER TREATMENT PLANT

Priority	Proposed Construction	Current 12/85 Costs, $	
1.	Filtration		
	Demolish existing filters	15,000	
	Re-route piping	8,000	
	Multicellular filters	300,000	
	Backwash sumps/pumps	11,000	
	Site work	21,000	
			$355,000
3.	Sludge Handling		
	Remove clarifier mechanism	8,000	
	Sludge collectors	60,000	
	Supernatant drawoff	6,000	
	Internal Piping	3,000	
	Pipe to storage ponds	11,000	
	Sand drying beds	65,000	
			$153,000
	Total Estimated Construction Cost		$1,232,000
	Engineering & Contingencies 30 percent		370,000
	Adjustment to mid 1986, ENR = 5200		68,000
	SUBTOTAL PROPOSED PROJECT COSTS		$1,670,000

TABLE II-1c

PROPOSED IMMEDIATE IMPROVEMENTS
CONSTRUCTION COSTS
FOR WATER DISTRIBUTION SYSTEM

	Proposed Construction Project	Escalated to Line Nos. from Figure IX-1	June 1986 Mid Construction, $
1.	2,400 LF 12-inch AC pipeline	35,36	98,000
2.	1,600 LF 12-inch AC pipeline Lines 34, 35, and 36 allow reservoir to fill/drain	34	64,000
3.	1,500 LF 12-inch AC pipeline Lines 29-31 provide fire demand and pressure to the Boatyard Shopping Center	29-31	60,000
4.	1,200 LF 12-inch AC pipeline Lines 32 and 33 supply the area adjacent to the Boatyard Shopping Center	32,33	49,000
5.	1,800 LF 8-inch AC pipeline	26,28	54,000
6.	600 LF 12-inch AC pipe Lines 26, 27, 28 provide fire demand to College	27	24,000
7.	Access road to storage tank		47,000
8.	Valves	54,000	
9.	6,000 LF telemetry cable		24,000
10.	300,000 gallon storage tank Storage tank in conjunction with its access road, valves, controls and pipelines provide fire demand to high areas south of the Noyo River		203,000
11.	Booster pump with standby power This pump fills the storage tank which could not otherwise be filled		149,000
	SUBTOTAL PROPOSED PROJECT COSTS		$826,000
	TOTAL PROJECT COSTS FOR PROPOSED IMMEDIATE IMPROVEMENTS - TABLES II-1a, II-1b, II-1c		$2,912,000

TABLE II-2a

PROPOSED IMPROVEMENTS BY 1990
CONSTRUCTION COSTS
FOR RAW WATER SOURCES

Proposed Construction Project	Escalated to June 1988 Mid Construction, $
1. Covington Gulch Diversion, Pipeline and Pump Station	106,000
2. Hare Creek Diversion and Pipeline to Covington Pump Station	46,000
SUBTOTAL PROPOSED PROJECT COSTS	$152,000

TABLE II-2b

PROPOSED IMPROVEMENTS BY 1990
CONSTRUCTION COSTS
FOR WATER DISTRIBUTION SYSTEM

	Proposed Construction Project	Line Nos. from Figure IX-1	Escalated to June 1988 Mid Construction, $
1.	3,300 LF 10-inch AC pipe	37-40	134,000
2.	3,500 LF 10-inch AC pipe	41-44	142,000
3.	2,300 LF 12-inch AC pipe	45,50,68	104,000
4.	150 LF 12-inch ductile iron pipe across Hare Creek	51,67	45,000
5.	50 LF 12-inch ductile iron pipe jacked under State Route 1	68	26,000
6.	2,500 LF 10-inch AC pipe	46-49	103,000
7.	2,300 LF 10-inch AC pipe	52-54	93,000
8.	3,600 LF 10-inch AC pipe	55-58	146,000
9.	4,600 LF 10-inch AC pipe	60-63	187,000
10.	3,500 LF 10-inch AC pipe	64-66	142,000
11.	7,600 LF 10-inch AC pipe	69-73	309,000
12.	Valves		151,000
	SUBTOTAL PROPOSED PROJECT COSTS		$1,582,000
	TOTAL PROJECT COSTS FOR PROPOSED IMPROVEMENTS BY 1990 - TABLES II-2a, II-2b		$1,734,000

TABLE II-3a

PROPOSED IMPROVEMENTS BY 2000
CONSTRUCTION COSTS
FOR RAW WATER SOURCES

Proposed Construction Project	Escalated to June 1995 Mid Construction, $
1. Noyo Pipeline	
a. Replace 3,700 feet of 9.5 inch steel with new 12 inch parallel line	$296,000
b. Replace 3,700 feet of 9.5 inch steel with new 12 inch along river alignment to GPRR tunnel and Ft. Bragg - Sherwood Rd.	301,000
2. Newman Pipeline	
Replace 5,700 feet of steel with new 12 inch	451,000
SUBTOTAL PROPOSED PROJECT COSTS	$752,000

TABLE II-3b

PROPOSED IMPROVEMENTS BY 2000
CONSTRUCTION COSTS
FOR WATER DISTRIBUTION SYSTEM

	Proposed Construction Project	Line Nos. from Figure IX-1	Escalated June 1995 Mid Construction, $
1.	8,500 LF 10-inch AC pipe	1-4	$ 520,000
2.	4,300 LF 10-inch AC pipe	5-12	262,000
3.	14,000 LF 10-inch AC pipe	13-17	855,000
4.	5,400 LF 10-inch AC pipe	18-22	330,000
5.	100 LF 12-inch ductile iron pipe jacked under railroad	23	79,000
6.	100 LF 12-inch ductile iron pipe across Pudding Creek	23	45,000
7.	1,600 LF 10-inch AC pipe	23	97,000
8.	600 LF 10-inch AC pipe (parallel)	24	36,000
9.	1,000 LF 10-inch AC pipe	25	61,000
10.	Valves		235,000
	SUBTOTAL PROPOSED PROJECT COSTS		$2,520,000

TOTAL PROJECT COSTS FOR PROPOSED IMPROVEMENTS BY 2000
- TABLE II-3a, II-3b $3,516,000

CHAPTER III

SERVICE AREA CHARACTERISTICS

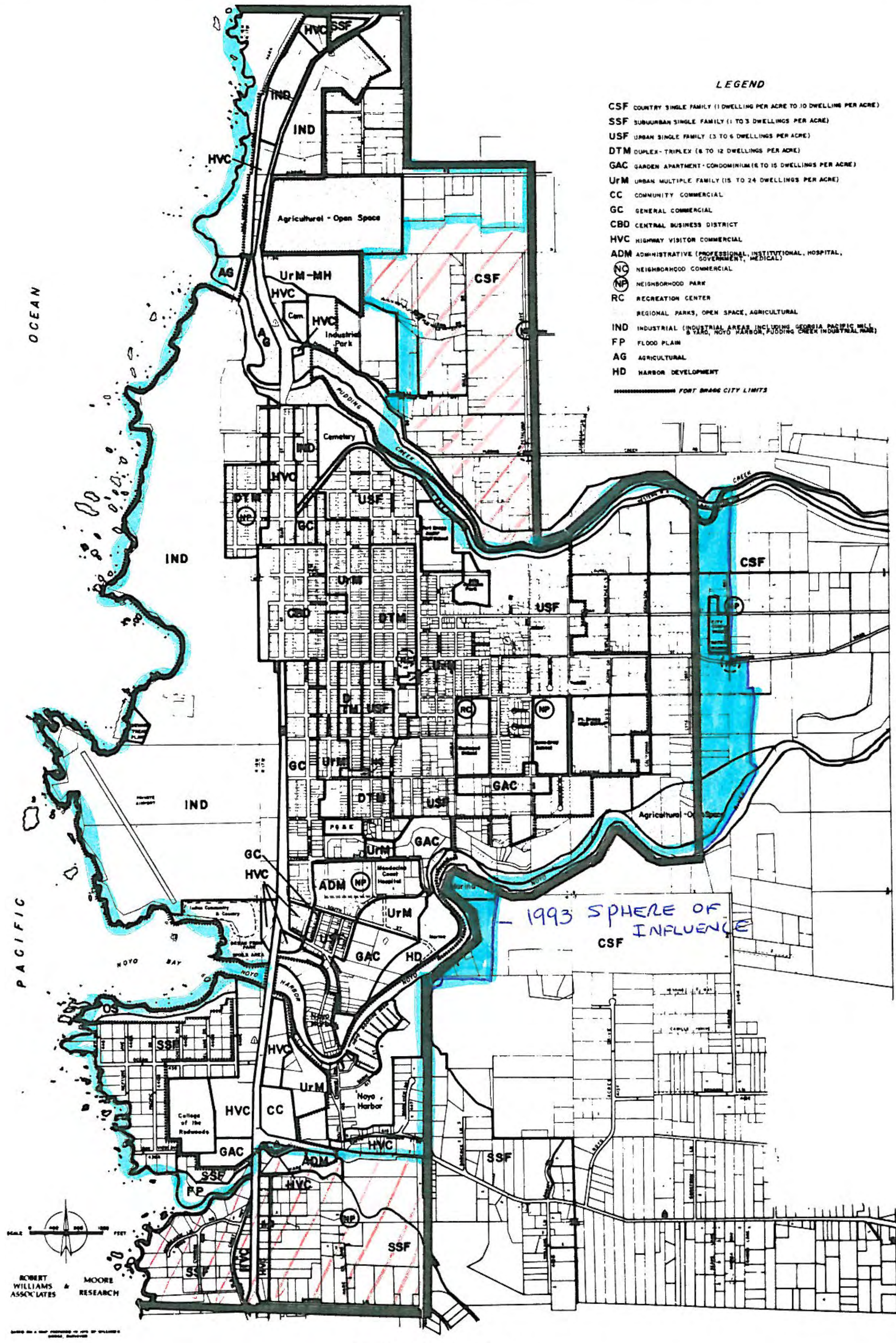
BOUNDARIES AND STUDY AREA

The future boundaries of the water service area were determined from the Fort Bragg General Plan, revised April 1, 1985. The boundary was established with advice from the Community Development Director and anticipates development to the year 2000. The study area coincides with the future water service area boundary and is shown in Figure III-1. The general plan is used for the basis of the study and master plan update. The zonings shown therein were used to estimate future population and distribution.

POPULATION

The 1985 population within the City limits is estimated by the City to be 5,600 people. Currently, an additional 2,500 people live in the Study area outside the City limits. However, water service is only provided to approximately 150 people and the Noyo River Harbor and Mooring Basin developments outside the City limit. The population within the City limit according to the 1980 census was 5,019. Historical and projected population data within the City limit is shown in Table III-1. Population estimates are discussed in Chapter IV of this study.

A critical assumption used in this Report is that the water service area will expand to the study area boundary by 2000. This means that there will be large annual increases in population served with water in the future compared to prior years. This growth can occur through the combination of development in the Study area and annexation of those areas that are currently outside the City limit. The service area is expected to develop primarily in the north,



STUDY AREA

CITY OF FORT BRAGG

JOHN CAROLLO ENGINEERS

Figure III-1

TABLE III-1

HISTORICAL AND PROJECTED POPULATION

FORT BRAGG & STUDY AREA

Year	Population within City limits	Population Study Area
1970	4,455	
1980	5,019	
1984	5,550	
1985	5,600	5,750
1990	5,825	6,000
2000 or beyond	9,400	9,400

south and east areas and through infill of existing areas. Development of the area west of State Route 1 is expected to be limited and to contain industrial activity only.

Land use density classifications listed on the 1985 Fort Bragg General Plan are shown in Table III-2.

Metered connections within the Study area in 1985 totaled 2,700.

LAND USE

Zoning for the City follows that of the General Plan. Most of the land available for residential development within the City has been developed (80 - 90 percent). Most of the undeveloped land lies in the east and southeast sections of the City in the vicinity of the higher elevations between Oak, Rasmussen, Dana and Chestnut Avenues.

For purposes of this report, the development that is predicted to occur will follow the zoning of the General Plan, revised April, 1985.

Most of the land in the Study area is zoned for residential use. The majority of zoning within the residential classification is single family. The next largest zoning classification in the area is industrial. The majority of the industrial land is owned or controlled primarily by Georgia Pacific Company and is located west of State Route 1.

Most of the land in the present (1985) City limits is zoned for residential use. The actual present use within the various residential zoning classifications, including multiple dwellings, is single family. However, it was assumed for this Report that the existing single family units that are in multiple zoning will remain single family and will not be replaced with higher density units.

TABLE III-2

LAND USE DENSITIES
1985 FORT BRAGG GENERAL PLAN

	Classification	Dwellings/acre (D/A) General Plan	Use
CSF	Country Single Family	0.10	0.5 D/A
SSF	Suburban Single Family	1 to 3	2 D/A
USF	Urban Single Family	3 to 6	4 D/A
DTM	Duplex-Triplex	6 to 12	9 D/A
GAC	Garden Apartment - Condominium	6 to 15	10 D/A
UrM	Urban Multiple Family	15 to 24	20 D/A
CC	Community Commercial		
GC	General Commercial		
CBD	Central Business District		
HVC	Highway Visitor Commercial		
ADM	Administrative (professional, institutional, hospital, government, medical)		
NC	Neighborhood Commercial		
NP	Neighborhood Park		
RC	Recreation Center regional parks, open space, agricultural		
IND	Industrial (industrial areas including Georgia Pacific Mill & Yard, Noyo Harbor, Pudding Creek Industrial Park)		
FP	Flood Plain		
AG	Agricultural		
HD	Harbor Development		

CHAPTER IV

WATER DEMANDS

POPULATION SERVED

The current population in the Study area is estimated to be 5,750 people. The 1980 census document showed a median household size of 2.3 persons/dwelling unit. This household size is used to estimate future water demand for this Report.

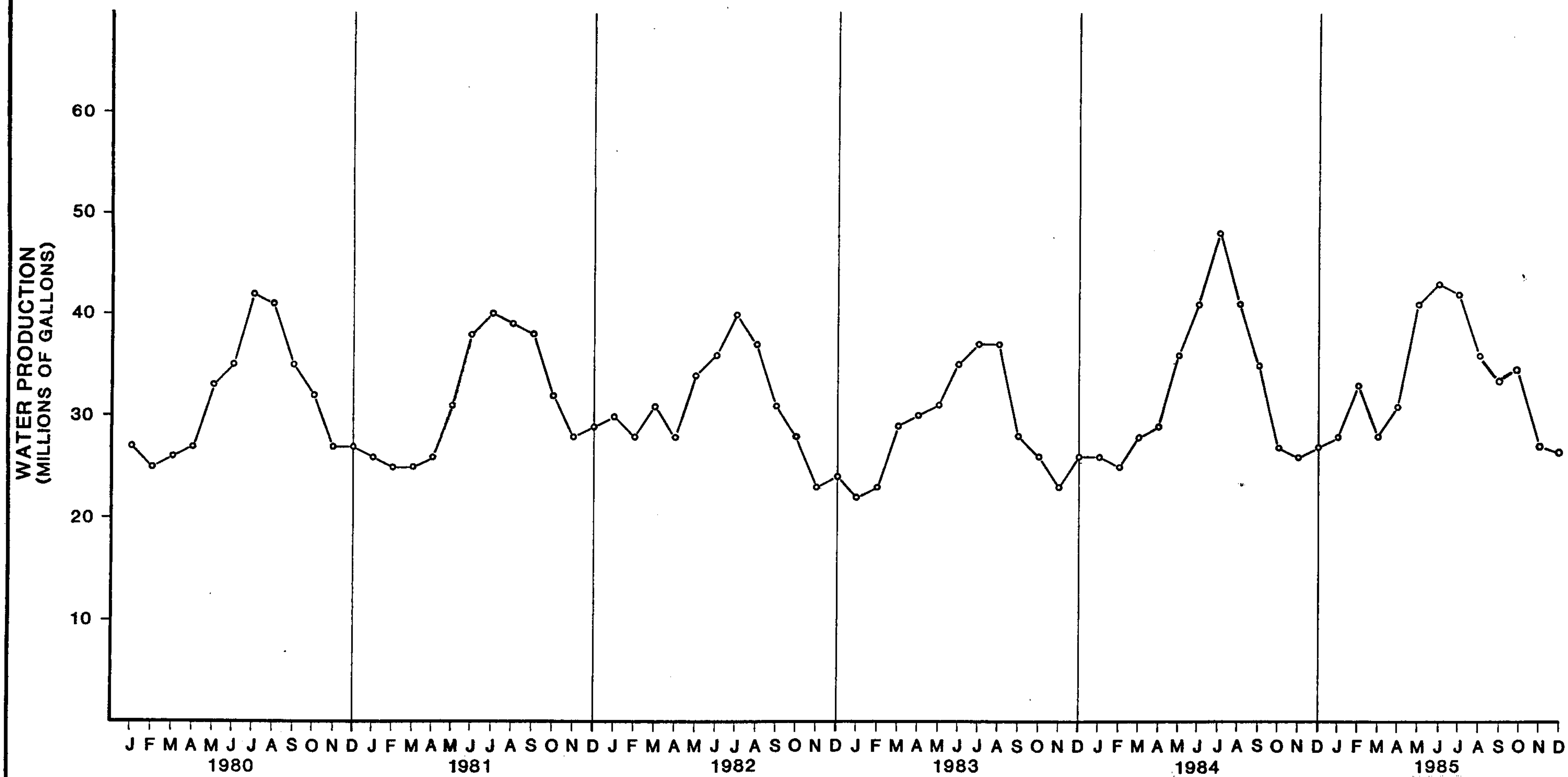
WATER USAGE

The average annual daily demand for 1985 for the Fort Bragg system is 1,123,123 gallons. This figure is based on the total annual volume of water supplied of 409,943,700 gallons for 1985. The volume of treated water produced at the treatment plant, distributed on a monthly basis for 1980 to 1985 is shown on Figure IV-1.

These figures represent water pumped into storage from the treatment plant. That is, residential, commercial, industrial backwash and unaccounted for water volumes are included in Figure IV-1.

The critical water demands for designing storage and distribution facilities are the maximum day and fire demand. Storage facilities and distribution pipes must be sized to provide flow at 20 psig residual pressure to any point in the distribution systems when both maximum day and fire demands occur simultaneously. The critical water demand for designing the water treatment plant is the average day of the maximum month demand (ADMM). The treatment plant must supply at least ADMM.

To establish a maximum day demand for use in this report, the City's water production records for the past 9 years were examined. A tabulation of



CITY OF FORT BRAGG
WATER PRODUCTION FOR COMBINED SOURCES
1980-1985

JOHN CAROLLO ENGINEERS

Figure IV-1

maximum day demand (MDD), maximum month demand, average day of the maximum month demand (ADMM) and the ratio of MDD to ADMM is presented in Table IV-1.

Table IV-1 shows that a maximum day demand of 1.76 MGD occurred in May, 1982, for a 24 hour period. The 24 hour period is important because some plant records show higher maximum day values. However, these higher values occurred for periods of pumping hours or flow meter readings in excess of a 24 hour period. For example, the plant records indicate that a maximum day occurred on July 29, 1982, of 2.07 MGD. However, closer examination of the records reveals that the 2.07 MGD occurred for a 30 hour period.

The 1.76 MGD maximum day demand (MDD) of 1982 has not been equaled or exceeded. This is due in part to a permanent water conservation program initiated by the City. Thus the 1.76 MGD maximum day demand will be used for 1985 conditions. The actual 1985 MDD of 1.57 MGD may be the result of temporary voluntary water use restrictions in effect in 1985.

To establish an average day of maximum month demand for use in this Report, the ratio of MDD to ADMM was used. Thus, the ADMM is determined from MDD instead of selecting a maximum month demand independent of MDD. The years of 1984 and 1985 were excluded from consideration because their MDD/ADMM is much lower than for other years. The MDD/ADMM ratio for 1977 to 1983 is 1.26. The future ADMM will be determined by reducing the MDD by 1.26.

The water treatment plant design is based on ADMM. If the trend to low (1.0 to 1.1) as in 1984 and 1985, it will be necessary to increase the treatment plant capacity significantly to produce enough water to meet the sustained demand of maximum month.

To project future water demand from the existing data, a unit basis for demands is needed. The approach used for this Report is to determine the

TABLE IV-1

WATER DEMANDS

MAXIMUM DAY AND AVERAGE DAY OF MAXIMUM MONTH
1977-1985

Year	Month	Max. Month MG	Max. Day MGD		ADMM MGD	Max. Day/ ADMM
1977	7	36.72	7/18	1.459	1.18	1.24
1978	7	35.02	8/28	1.386	1.13	1.23
1979	8	35.06	9/11	1.498	1.13	1.32
1980	7	42.12	7/25	1.557	1.36	1.14
1981	7	40.19	9/16	1.633	1.30	1.26
1982	7	40.15	5/27	1.762	1.30	1.36
1983	7	37.23	8/16	1.52	1.20	1.27
1984	7	48.21	7/17	1.57	1.56	1.06
1985	7	43.84	6/15	1.57	1.41	1.11

Average $\frac{\text{Max. Day}}{\text{ADMM}}$ 1977 to 1983 = 1.26

water demands for residential, commercial and industrial use from historical data. Further breakdown of these categories is accomplished by determining residential use on a per capita basis and commercial and industrial use on a per acre basis.

A period that covers high use was selected from existing records and used to distribute flows on a per capita and per acre basis. A computer printout from the City was used to show metered flow as demand for the three categories above. A summary of the computer results is shown in Table IV-2. The other uses shown in the Table IV-2 are put into the commercial use category. From Table IV-2, the following distribution of demand by use category is as follows:

Residential	56 percent
Commercial	32 percent
Industrial	12 percent
	100 percent

Based on the category percentages above, the 1.76 MGD maximum day demand assumed for 1985 is distributed as follows:

Residential (56%)	985,600 gpd
Commercial (32%)	563,200 gpd
Industrial (12%)	211,200 gpd
Total	1,760,000 gpd

The residential per capita consumption can now be estimated. The maximum day residential demand of 985,000 gpd for 5,750 people gives 171 gpcd. The commercial water demand is distributed on a unit gross area basis. The unit gross area means the total area without deductions for streets, parking lots, easements, etc. There are approximately 340 gross acres in commercial use in

TABLE IV-2

CITY OF FORT BRAGG METERED WATER CONSUMPTION
June 15, 1985 to August 15, 1985
(All Figures are in Gallons Per Day)

INDUSTRIAL USES	
Georgia Pacific	69,817
Harbor Related Ind.	70,345
Other	12,041
	152,203
COMMERCIAL USES	
Motels	91,774
Professional Offices	39,442
Restaurant	143,468
General Retail/Wholesale	13,540
Other Commercial Uses	25,262
Food Stores	13,945
Laundromats	17,055
	344,486
RESIDENTIAL	
Mobile Home Parks	34,490
Single Family	590,696
Duplex	28,420
3 or more Units	63,477
	717,083
OTHER USES (Commercial)	
Care Facilities/Hospitals	9,074
Recreation	1,805
Schools	50,316
Churches	8,601
	69,801
TOTAL	1,283,573

the study area served by City water. The Noyo Basin development and the Mooring Basin are served by City water but are outside the City limits. The commercial consumption per acre can now be estimated. The commercial demand of 563,200 gpd used over 340 acres gives 1,656 gpd per gross acre.

Industrial water usage is distributed on a unit gross acre basis. To estimate the gross industrial area actually served by City water, the total industrial area was reduced by deducting the industrial area north of Alder Street and west of State Route 1 from the total. The reason for reducing the industrial area is to allow for a portion of the Georgia Pacific area that is served by their private water system.

The industrial consumption per acre can now be estimated. The industrial demand of 211,200 gpd used over 159 acres gives 1,328 gpd per gross acre.

The estimated unit water demands for residential, commercial and industrial uses are summarized in Table IV-3.

FUTURE WATER DEMANDS

POPULATION TO BE SERVED. Using the zoning classifications from the General Plan, the Study area, and persons per dwelling unit of 2.3, population projections can be estimated. This estimate is presented in Table IV-4. As indicated in the table, approximately 9,500 people are expected to reside in the study area by the year 2000. By simple proportion, we anticipate that approximately 1,300 persons will be added by 1990. Thus, the population projection can be established as shown on Table IV-5 by the combination of annexation of existing developments outside the City limits and new developments.

FUTURE DEMANDS. We assume for purposes of this Report that commercial and industrial use will remain at the 1985 percentage of the total consumption

TABLE IV-3

ESTIMATED WATER DEMAND BY USE

1.76 MGD Maximum Day

Type of Use	Unit Demand
Residential	171 gpcd
Industrial	1,328 gpd/gross acre
Commercial	1,656 gpd/gross acre

TABLE IV-4

FUTURE POPULATION PROJECTIONS

Zoning Classification	Existing Service Area Acres	Future Area Added Gross Acres	Dwellings per Acre	Persons per Dwelling	Future Population Added
CSF	0	44	0.5	2.3	51
SSF	10	322	2	2.3	1,481
USF	300	247	4	2.3	2,272
DTM	123	0	9	2.3	0
GAC	65	0	10	2.3	0
UrM	126	0	20	2.3	0
Industrial	159*	309*			
Commercial	340	173			
Total Population Added					3,804
Existing Population Served					5,750
TOTAL FUTURE POPULATION					9,554
USE					9,500

1990 Census 2.4

* This number excludes the estimated 184 acres served by the Georgia Pacific private water system.

TABLE IV-5

POPULATION PROJECTION BY YEAR

Year	Service Area Population
1985	5,750
1990	6,900
2000	9,500

* Estimated for 5,750 people at 2.3 people per dwelling unit.

through the year 2000. We are assuming that the large CSF zoning areas presently outside the city and the large industrial area west of State Route 1 will remain/develop according to their respective zoning.

The information in Tables IV-1 through IV-3 can be combined to estimate future water demands. These future demands are shown in Table IV-6.

GEORGIA PACIFIC DEMAND

Georgia Pacific uses both City water and its own private water for its operations. Georgia Pacific can divert up to 1.51 MGD from the Noyo River and Pudding Creek combined. On the other hand, Georgia Pacific's treatment capacity according to staff is approximately 0.5 MGD. Georgia Pacific has seven water meters for its City water use. Since 1980, Georgia Pacific has used approximately 0.2 MGD of City water during its high demand season. However, Georgia Pacific has potential to draw 3.4 MGD at 80 percent design capacity according to AWWA meter tables. It is assumed that over the years Georgia Pacific has operated within its 0.5 MGD treatment capacity and the City water supplied. If Georgia Pacific decides not to use its private water and use City water instead, the City may have to provide an additional 0.5 MGD to Georgia Pacific. This 0.5 MGD is over and above the City water already used by Georgia Pacific. The use of all-City water by Georgia Pacific would have a significant impact on the City water system.

SELECTED AREAS DEMANDS

At the request of the City, the estimated demand for two sections in the Study area were estimated. These two sections are the area south of Hare Creek/State Route 20 to the study area boundary and the area north of Pudding Creek east of the extension of Brandon Way, Airport Road, Study area eastern

TABLE IV-6

FUTURE WATER DEMANDS
Maximum Day, MGD

Average Annual Day, MGD
Total Annual Flow Volume, Millions Gallons

Type of Use	Year 1985	1990	2000
Residential	0.99	1.34 (1)	2.03 (4)
Industrial	0.21	0.34 (2)	0.59 (5)
Commercial	0.56	0.64 (3)	0.81 (6)
TOTAL (Maximum Day)	1.76	2.32	3.43
Average Annual Day	1.1	1.47	2.2
ANNUAL TOTAL	401	536	805
	(1231 a-f)	(1645 a-f)	(2470 a-f)

(1) Based on 823 dwelling units developed and annexed since 1985.

(2) Based on 103 acres annexed since 1985.

(3) Based on 58 acres annexed and developed since 1985.

(4) Based on 2,470 dwelling units developed and annexed since 1985.

(5) Based on 309 acres annexed since 1985.

(6) Based on 173 acres developed and annexed since 1985.

Note: a-f = acre feet.

boundary and Pudding Creek. These two sections are primarily zoned residential. Based on assumptions in this Chapter the estimated maximum day demands are as follows:

North of Pudding Creek (122 DU) 0.5 MGD.

South of Hare Creek (421 DU; 16 acres commercial) 0.19 MGD.

DESIGN CRITERIA

The following design criteria is used in this Report to analyze/design existing and future components of the water system:

Component	Minimum Design Capacity
Water Treatment Plant	Average Day of Maximum Month (ADMM)
Minimum Storage	The sum of 1/2 maximum day demand (MDD) 1,000 gpm fire for 2 hours, maximum hour withdrawal estimated to be 20 percent of maximum day demand and the difference between MDD and ADMM on maximum day.
Distribution System	Maximum hour demand or the sum of fire and maximum day demands with at least 20 psig residual pressure.

CHAPTER V

WATER QUALITY

INTRODUCTION

The information presented in this chapter is highly technical and is not intended for the complete understanding of the general public. It is provided for the use of the regulatory agencies and engineering community that will deal with the water quality aspects required of the proposed water treatment facilities.

GENERAL

Today, the quality of drinking water that a community water system may provide is established by Federal and State water quality regulations. Federal regulations, as prescribed in the 1974 Safe Drinking Water Act (Public Law 93-523), are administered by the Environmental Protection Agency (EPA). State water quality standards are administered by the Department of Health Services. The State regulations are based on the Federal Primary and secondary standards. The EPA has granted the State of California primacy in enforcing the State regulations.

The EPA recognizes the California regulations as the standards governing public water systems in California.

SUMMARY OF WATER QUALITY CRITERIA

The Safe Drinking Water Act provided Primary and secondary water regulations for various parameters. The Federal regulations establish Maximum Contaminant Levels (MCLs) for parameters comprising the Primary standards. The current Primary MCLs are based on interim Primary regulations. The

Federal secondary MCLs are generally related to the esthetics of the water and are not enforceable by the EPA. The current secondary standards are the final secondary regulations promulgated in 1979.

Federal interim Primary regulations were amended in 1976 with regard to radionuclides and in 1977 and 1979 with regard to total trihalomethanes (TTHMs).

In 1977 the State of California adopted the Federal interim Primary and secondary regulations including the amendments for radionuclides promulgated in July, 1976. As noted above, the State adopted the Federal secondary standards as enforceable standards. The State regulations are covered in Title 22, Division 4, Chapter 15 of the California Administrative Code.

In addition to the regulatory standards discussed above, there is a set of more stringent goals for water quality adopted by the American Water Works Association's (AWWA) Committee on Water Quality Goals in 1968. These goals were identified as being attainable by correct application of known treatment processes and methods. The AWWA goals are not regulations; they are intended to serve as a guide for water systems producing high quality water.

Current Federal and State regulatory standards and AWWA goals are presented in Table V-1. We recommend adopting a combination of the State standards and AWWA as a reasonable goal for producing high quality water; our recommended goals are also indicated in Table V-1.

TRENDS IN WATER QUALITY REGULATIONS

Future changes in Federal and State standards are difficult to predict. However, an Advance Notice of Proposed Rule making (ANPRM) issued by the Environmental Protection Agency (EPA) recently provides in indication of the direction and nature of changes being considered by the Federal government.

TABLE V-1

CITY OF FORT BRAGG WATER TREATMENT PLANT
MODERNIZATION STUDY
WATER QUALITY CRITERIA

	Units	EPA	Calif. SDHS(f)	AWWA Goals	Recom-mended Goals
Inorganic					
Aluminum	mg/l	-	-	0.05 (c)	.05
Arsenic (P)	mg/l	0.05	0.05	-	0.05
Barium (P)	mg/l	1.00	1.00	-	1.0
Cadmium (P)	mg/l	0.01	0.01	-	0.01
Chloride (S)	mg/l	250	250 (j)	-	250
Chlorine	mg/l	-	-	-	≥0.5 (g)
Chromium (Total) (P)	mg/l	0.05	0.05	-	0.05
Copper (S)	mg/l	1.0	1.0	0.2	1.0
Dissolved Solids (Total) (S)	mg/l	500	500 (j)	200	500
Fluoride (P)	mg/l	1.4-2.4 (b)	1.4-2.4 (b)	-	1.4-2.4 (b)
Hardness	mg/l	-	-	80-100	-
Hydrogen Sulfide (S)	mg/l	0.05	-	-	0.05
Iron (S)	mg/l	0.3	0.3	0.05	0.3
Lead (P)	mg/l	0.05	0.05	-	0.05
Manganese(S)	mg/l	0.05	0.05	0.01	0.05
Mercury (P)	mg/l	0.002	0.002	-	0.002
Nitrate as N (P)	mg/l	10	10	-	10
pH (S)	No	6.5-8.5	-	-	6.5-8.5
Selenium (P)	mg/l	0.01	0.01	-	0.01
Silver (P)	mg/l	0.05	0.05	-	0.05
Sodium	mg/l	(a)	-	-	(a)
Sulfate (S)	mg/l	250	250 (j)	-	250
Zinc (S)	mg/l	5	5.0	1.0	5.0
Organic					
Carbon-Alcohol Extract	mg/l	-	-	0.10	0.10
Carbon-Chloroform Extract	mg/l	-	-	0.04	0.04
Foaming Agents (MBAS)	mg/l	0.5	0.5	0.20	0.5
Total Trihalomethanes (TTHMs) (P)	mg/l	0.100	-	-	0.100
Polychlorinated Biphenyls (PCB's)	mg/l	(d)	-	-	-
Phthalate Esters (TBCs)	mg/l	(d)	-	-	-

TABLE V-1 (Continued)

WATER QUALITY CRITERIA

	Units	EPA	Calif. SDHS(f)	AWWA Goals	Recommended Goals
Pesticides					
Aldrin	mg/l	.0074 (d,e)	-	-	-
Carbamates	mg/l	(d)	-	-	-
Chlorodane	mg/l	(d)	-	-	-
DDT	mg/l	(d)	-	-	-
Dieldrin	mg/l	0.0076 (d,e)	-	-	-
Endrin (P)	mg/l	0.0002	0.0002	-	0.0002
Heptachlor	mg/l	(d)	-	-	-
Heptachlor Epoxide	mg/l	(d)	-	-	-
Lindane (P)	mg/l	0.004	0.004	-	0.004
Methoxychlor (P)	mg/l	0.10	0.10	-	0.10
Organophosphates	mg/l	(d)	-	-	-
Toxaphene (P)	mg/l	0.005	0.005	-	0.005
Herbicides					
2, 4-D (P)	mg/l	0.10	0.10	-	0.10
2, 4, 5-TP (Silvex) (P)	mg/l	0.010	0.010	-	0.010
Physical Parameters					
Color Units (S)	Color Units	15	15	5	5
Odor Threshold (S)	T.O.N.	3	3	No odor	3
Specific Conductance (S)	(umho/cm)	-	900 (j)	-	900
Temperature °	°C	-	-	-	-
Turbidity (Source Water (P)	units	-	1.0 (h,k)	-	-
Turbidity (treated) (P)	units	1 (h)	5.0	0.1 (h)	0.1
Radiological Factors					
Gross Alpha (P)	pCi/L	15	15	-	15
Gross Beta (P)	pCi/L	50	50	-	50
Radium 226 & 228 (P)	pCi/L	5(i)	5 (i)	-	5 Total
Strontium 90 (P)	pCi/L	8	8	-	8
Strontium 89	-	(d)	-	-	-
Tritium (P)	pCi/L	20,000	20,000	-	20,000

TABLE V-1 (Continued)

WATER QUALITY CRITERIA

	Units	EPA	Calif. SDHS(f)	AWWA Goals	Recommended Goals
Microbiological					
Coliform Organisms (MPN) (P)	No./100 ml	1 (h)	1	None	None
Microorganisms	No./100 ml	-	-	None	None
Corrosion & Scaling					
Incrustation of St.Stl.	mg/cm^3	-	-	0.05	-
Corrosion of Galv. Iron	mg/cm^3	-	-	5	-
Langelier Index	No.	-	-	-	Positive Value
Corrosivity (S)	*	Noncorrosive	Relatively low	-	Relatively low

(a) No limit set - recommend maximum limit of 20 mg/l
(b) Limit is temperature dependent
(c) After floccing
(d) Still under investigation
(e) EPA water quality guidelines
(f) SDHS Secondary Standards are enforceable
(g) Only if chlorine is used as a disinfectant
(h) Monthly average or 5 based on 2 day average
(i) Sum of Radium 226 and 228
(j) Recommended standard
(k) For surface waters exposed to significant sewage hazards or recreational use, the standard is 0.5.
(l) For multiple tube fermentation method <2.2 MPN/100 ml is within standards.

(P) = Primary Standard
(S) = Secondary Standard

This ANPRM was published in the Federal Register on Wednesday, October 5, 1983. It covers the EPA's approach to developing the National Revised Primary Drinking Water Regulations and Recommended Maximum Contaminant Levels. Specific water quality parameters and the regulatory approach to them are discussed. Not surprisingly, over thirty synthetic organic chemicals are mentioned as being under consideration for new MCLs. A previous ANPRM dealt with Volatile Synthetic Organic Chemicals or VOCs, (March 4, 1982) which also listed a number of these chemicals being considered for regulation with MCLs. A proposal of RMCLs and MCLs for VOCs is expected to be published soon. Development of "final" regulations for disinfection by-products, including THMs, is the last phase of development of the National Revised Primary Drinking Water Regulations. The October 5, 1983 ANPRM does mention that because THM regulations have only recently been adopted. It is unlikely that there will be any changes in the standards for THMs in the near future.

Discussions on certain water quality parameters in the October, 1983 ANPRM are of interest here.

<u>LEAD</u>. The EPA is soliciting comments regarding health risks of lead and the feasibility of attaining levels of lead in finished water below the current 0.05 milligrams per liter (mg/l) standard. Corrosion control is mentioned as a means of attaining lower concentrations. There is some concern that the current standard does not offer sufficient protection for certain segments of the population. Lead is not a problem in the Fort Bragg water sources.

<u>ALUMINUM</u>. Limitations on residual aluminum were being considered when the ANPRM was published. Subsequently an AWWA periodical indicated that the EPA has decided against establishing an MCL for aluminum because drinking

water represents a small contribution to the total intake of aluminum. However, the ANPRM did encourage minimizing residual aluminum in treated water, referring to levels of 0.1 to 0.2 mg/l as being attainable in a "well-run" treatment plant. While regulation of aluminum may be a remote possibility it should not impact the Fort Bragg system because it is not a problem in the current raw water sources and proposed treatment will be accomplished by polymers alone.

ASBESTOS. The health effects of asbestos in drinking water are still uncertain, but to date, adverse effects have not been conclusively demonstrated. The ANPRM does mention that complete treatment including coagulation and filtration are required for asbestos removal. Corrosion control will also minimize leaching of asbestos from asbestos-cement pipe.

SODIUM. Because of the difficulty of removing sodium from water and the relatively minor role that water has in total sodium intake (compared to food), it appears that the EPA is not leaning towards an MCL for sodium. They are requesting comments of the health effects of sodium in drinking water and the need for an MCL. Sodium is not a problem in any of the present water sources.

ACRYLAMIDE. This is the monomer for constituent of polyacrylamide which is commonly used as a polyelectrolyte in water treatment. The monomer has an adverse health effect in humans. The ANPRM, requests comments on the need for a MCL for acrylamide. Fort Bragg is not using this polymer.

CORROSION

This section evaluates the natural aggressiveness of the three raw water supplies and defines the steps which will be taken to minimize corrosion related problems. Two commonly accepted measurements of corrosive tendencies were used, the Langelier Saturation Index and the Ryznar Stability Index.

This does not address the corrosion potential of the soils and stray current problems resulting from the close proximity of electrical power sources. These will be addressed in the detailed design phase.

BACKGROUND

WATER CHEMISTRY. The aggressiveness of water is dependent on the many complex interrelationships among its chemical constituents. The classical methods of evaluating corrosion indices rely on simplified procedures which take into account only 5 factors; temperature, calcium, alkalinity, total dissolved solids, and the actual pH.

The records of the three water sources were reviewed and a representative value for each of the five parameters were tabulated so an analysis could be performed. These values are listed below:

	Noyo	Newman	Simpson
Temperature, ^{o}F	55	55	55
Calcium, mg/l as $CaCO_3$	20	7	8
Alkalinity, mg/l as $CaCO_3$	50	14	16
Total Dissolved Solids, mg/l	75	45	35
Actual pH	8.3	7.3	7.3

LANGELIER SATURATION INDEX. The Langelier Index was first put forth in 1936 and has since been the most commonly used indicator of the aggressiveness of water. Note that it is called a "saturation" index and not a "corrosion" index. The Index only defines the tendency to form or dissolve calcium carbonate scale by comparing the actual pH observed in a given water to the pH calculated for that water if allowed to equilibrate with calcium carbonate. The equilibrium pH is commonly referred to as the "saturation pH."

A simplified version of the Langelier equation is given below.

Langelier Index = actual pH - saturation pH

A positive value of the Langelier Index indicates a scale-forming tendency whereas a negative value indicates a scale-dissolving tendency. It might be assumed, and correctly so, that a zero Index would be ideal. Traditionally, water treatment practice has, however, been directed towards a slightly positive Index value. A major shortcoming of the Langelier Index lies in its general interpretation. It is often not understood that the ability of the water to resist a change in the Index can be as important as the actual Index value. The ability to resist change, often called buffering capacity, is usually proportional to the water's alkalinity. The Fort Bragg source waters are particularly low in alkalinity. It is not uncommon for water with a slightly positive Index and a low alkalinity to be aggressive because, for example, the treatment process easily shifts the Index to a negative value. The common treatment chemicals (ferric chloride, aluminum sulfate, and chlorine) are acidic in nature and consume alkalinity, thereby inducing and aggravating the shift in Index values. The present use of polymers only at least reduces the pH depression.

All three raw water exhibits a range of Langelier Saturation Index that are strongly negative. Significantly, the waters are low in alkalinity, i.e., the Index is easily shifted toward negative values. It can be expected that the three sources are aggressive.

RYZNAR STABILITY INDEX. The Ryznar Index was introduced in 1944. It uses the same parameters as the Langelier Index, however, Ryznar developed the Index in an attempt to predict the mass of calcium carbonate that would be deposited more accurately than was previously possible. In actual case studies [1], Ryznar showed examples where the Langelier Index indicated all waters in a given set of samples would be scale-forming whereas the Ryznar Index properly identified that some were definitely scale-depositing.

The Ryznar Index is probably the second most common method used today to measure water's aggressiveness.

The equation for the Ryznar Index is given as:

Ryznar Index = 2 (saturation pH) - actual pH

When using this index, a value exceeding 6.0 is considered as an aggressive water while a value less than 6.0 is not.

The Ryznar Index also indicates the water will have consistently aggressive tendencies. It is up to the City staff to choose an index to use.

AGGRESSIVE INDEX. Perhaps one of the simplest methods to address the potential corrosiveness of water involves the "aggressive index." It can be mathematically stated as:

Aggressive Index = pH + log (AH)
where pH = standard pH values
A = total alkalinity in mg/l (as $CaCO_3$)
H = calcium hardness in mg/l (as $CaCO_3$)

If the index is equal to or greater than 12.0 the water is considered non-aggressive.

If the index is 10.0 to 11.9 it is moderately aggressive; and less than 10.0 is highly aggressive.

It should be noted that all the methods of calculating aggressivity have their short comings and should be monitored using coupons placed in the plant effluent. The coupons are weight checked periodically to see if they are experiencing a loss in weight.

1 Gardels, M.C., Schock, M.R. Corrosion Indices: Invalid or Invaluable? 9th Annual AWWA Water Quality Technology Conference, December, 1981.

CORROSION CONTROL PROGRAM

Evaluation of the three raw water supplies confirms that they all tend to be naturally aggressive A corrosion control program is warranted. The program should address the treatment process and the equipment used in the process.

TREATMENT PROCESS. Coagulants used in the water treatment process are acidic in nature. Alum depresses the pH when added to water. It also consumes alkalinity and reduces the natural buffering capacity of the water. Chlorination further reduces the pH of the water. The inherent reduction in pH by the addition of these chemicals and a corrosion control program are mutually exclusive. Although the use of polymers only is a mitigating factor, it is not enough, due to the very low alkalinity.

Attempts to reduce the aggressiveness by raising the pH of the influent water will adversely effect the coagulation efficiency of alum. Alum works over a specific pH range and its effectiveness drops off as the pH increases. The accepted operational pH range for alum is 6.5 to 8.2. The pH of the raw water is generally at the low end of the alum pH range. Attempts to decrease the aggressiveness by increasing the pH could be very detrimental to the effectiveness of alum unless sufficient lime were added to offer buffering capacity. These problems are non-existent in the present polymer only treatment method.

The germicidal efficiency of chlorine in solution is directly related to the pH of the water. It is less effective at higher pH's. For example, the same dosage of chlorine at a pH of 8.3 has one-third the germicidal efficiency at a pH of 7.5. Thus, it can be seen that raising the pH to reduce aggression in the water has a very significant impact on the effectiveness of chlorine.

The above discussion indicates that it may not be practical to routinely address the corrosion problem by increasing the pH of the plant influent. The alternative solution is to monitor corrosion after the treatment process (plant effluent) and utilize design concepts which minimize the exposure of submerged equipment to the aggressive waters.

CORROSION CONTROL ALTERNATIVES. Zinc orthophosphate can be added to the effluent to provide a protective coating for both ferrous and non-ferrous pipes. It can be purchased as a bulk liquid and must be protected from freezing. The free flowing granular solid form is also available and is fed the same as any other granular chemical. It must be handled with the same care as any other acidic material.

Sodium silicate has also been used extensively for corrosion control, especially in waters with a potential iron and manganese problem as would be expected if the local wells are used. Like phosphates, the real effectiveness can only be established by an in-situ coupon test program. The major chemical suppliers can supply the test equipment and coupons to evaluate the actual dosage costs involved.

Caustic soda is also commonly used for pH adjustment. Its application and use is explained in more detail in Chapter VII.

Although it is expected that caustic soda will be the method of choice for corrosion control, it may be wise to actually test the other chemicals and perform a specific cost comparison. The urgency of a corrosion control program will certainly allow time for such a study.

EQUIPMENT SELECTION. From previous discussions, it was concluded that the treatment process equipment selection should definitely consider corrosion as a problem. The following general guidelines will be applied to all equipment selection and design criteria:

- Submerged bearings should be eliminated
- Water lubricated equipment should not be used
- Submerged ferrous metals should be avoided
- Nonmetallic appurtenances should be used where possible
- Submerged fasteners should be stainless steel
- Anchor bolts should be insulated from rebar by nonmetallic sheathes
- Steel vessels should be coated and provided with cathodic protection

RECOMMENDATIONS

Based on the naturally aggressive corrosion characteristics of all three water sources, it is recommended that:

- A test program which compares the various chemicals available for corrosion control should be undertaken immediately, or;
- A pH adjustment system, utilizing caustic soda, should be part of the treatment process.
- pH adjustment should be accomplished in the plant effluent.

GIARDIA

BACKGROUND. Giardia lamblia, the agent which causes the intestinal disease known as giardiasis, recently has become a significant concern by regulatory agencies. The agent actually survives in its cyst stage which can be found in the raw water supplies. If not removed or deactivated by the treatment process, the cyst is ingested by the use of the water supply. Within the intestinal tract, Giardia is transformed into its reproductive stage (called a trophozoite) that causes the actual illness. It then transforms back into the cyst stage, is discharged from the intestines, and its life cycle is ready to start all over again.

Removal and/or deactivation of the cyst has proven difficult because of the very small size and resistance to chlorination. Studies have shown that effective pretreatment, i.e., coagulation and flocculation, is the key to removal by filtration. This concept is discussed further in Chapter VII in the filtration section.

The treatment scheme and chemicals proposed herein can effectively control giardia lamblia.

The effectiveness of chlorine is illustrated in Table V-2.

It should be emphasized that the watersheds of the Fort Bragg area are subject to contamination and the potential for Giardia does exist.

COMPARATIVE QUALITY. Table V-3 indicates a comparison of the existing raw water quality to the recommended finished water quality goals. These comparisons are based on limited data. It should be noted that aside from occasional bacteriological problems, the only real deviations from acceptable standards are for turbidity and color. The improvements proposed will bring both of these parameters into compliance with current requirements. It should be noted that an overall improvement in bacteriological results is inherent when these improvements are implemented.

GENERAL CHARACTERISTICS. When multiple sources of water are available, it is often beneficial if they can be characterized based on historical data and operating experiences. Seasonal trends are usually evident and can have a significant impact on the treatability. In the case of Fort Bragg, the characteristics stated herein are based heavily on comments from the staff and to a lesser degree on actual data.

1. The Noyo River is reportedly easier water to treat. Although the turbidity is often high, there is no real color problem. The Noyo water is higher in alkalinity and partially explains by it is easier to treat.

2. It is reported that, especially during the winter, the Simpson Newman waters experience high color which is not easily removed. Records of color do not exist but the problem is well documented by actual operating experiences.

TABLE V-2

EFFECT OF CHLORINE ON GIARDIA LAMBLIA CYST VIABILITY *

Temperature	MG/L	Minutes	pH 6	pH 7	pH8	Effectiveness
25° C (77°F)	1.5	10	x	x	x	100%
15°C (59°F)	2.5	10	x			100%
		30		x	x	Some cysts
		60		x	x	100%
5°C (41°F)	1.0	60				No Kill
	2.0	60	x	x		100%
	4.0	30				No Kill
		60	x	x	x	100%
	8.0	10	x	x		100%
		30			x	100%

* Source: California Health Department

TABLE V-3

COMPARISON OF WATER QUALITY CRITERIA
TO EXISTING RAW WATER SOURCES

	Units	Finished Water Recommended Goals	Raw Water		
			Noyo River	Simpson Lane	Newman Gulch
Inorganic					
Arsenic	mg/l	0.05	<0.01	<0.01	<0.01
Barium	mg/l	1.0	<0.05	<0.05	<0.05
Cadmium	mg/l	0.01	<0.01	<0.01	<0.01
Calcium	mg/l	--	20	7	8
Chloride	mg/l	250	5.3	12	12
Chromium (Total)	mg/l	0.05	<0.005	<0.005	<0.005
Copper	mg/l	1.0	<0.05	<0.05	<0.05
Dissolved Solids (Total)	mg/l	500	83	35	44
Fluoride	mg/l	1.4-2.4(a)	0.14	<0.10	<0.10
Hardness	mg/l	-	68	28	26
Iron	mg/l	0.3	0.14	0.15	0.19
Lead	mg/l	0.05	<0.05	<0.05	<0.05
Manganese	mg/l	0.05	<0.05	<0.05	<0.05
Mercury	mg/l	0.002	<0.002	<0.002	
Nitrate as N	mg/l	10	<0.01	<0.2	<0.01
pH	No	6.5-8.5	6.6	6.4	6.6
Selenium	mg/l	0.01	<0.01	<0.01	<0.01
Silver	mg/l	0.05	<0.02	<0.02	<0.02
Sodium	mg/l	(a)	9.8	11.0	11.0
Sulfate	mg/l	250	3.6	1.1	1.1
Zinc	mg/l	5.0	<0.05	0.15	<0.05
Organic					
Total Trihalomethanes (TTHMs)	mg/l	0.100	0.013*	0.040*	0.067*
Physical Parameters					
Color Units	Color	15	<15	>15	>15
Turbidity	Range of NTU's	<0.5	(<1-54)	(<1-3)	(<1-3)

Notes:

* Worst samples to date, taken February 7, 1984.

(a) Limit is temperature dependent.

(-) A dash indicates that the column in which the dash appears is not applicable to the given water quality parameter.

3. The increases in turbidity for all sources are more closely associated within rainfall rather than a seasonal occurrence. The worst month's data indicates turbidity values over 5 NTU occurred for only 6 consecutive days with a max value to 65 NTU.

4. Records indicate that the pH shift in the water is not as severe when alum was not being used. The only real source of acidity is the application of chlorine which can depress the pH because of the lack of natural alkalinity. When alum was used, its acidic nature caused a larger pH depression. This is also aggravated by the fact that alum must consume natural alkalinity in its chemical reaction.

CHAPTER VI

WATER SUPPLY

GENERAL

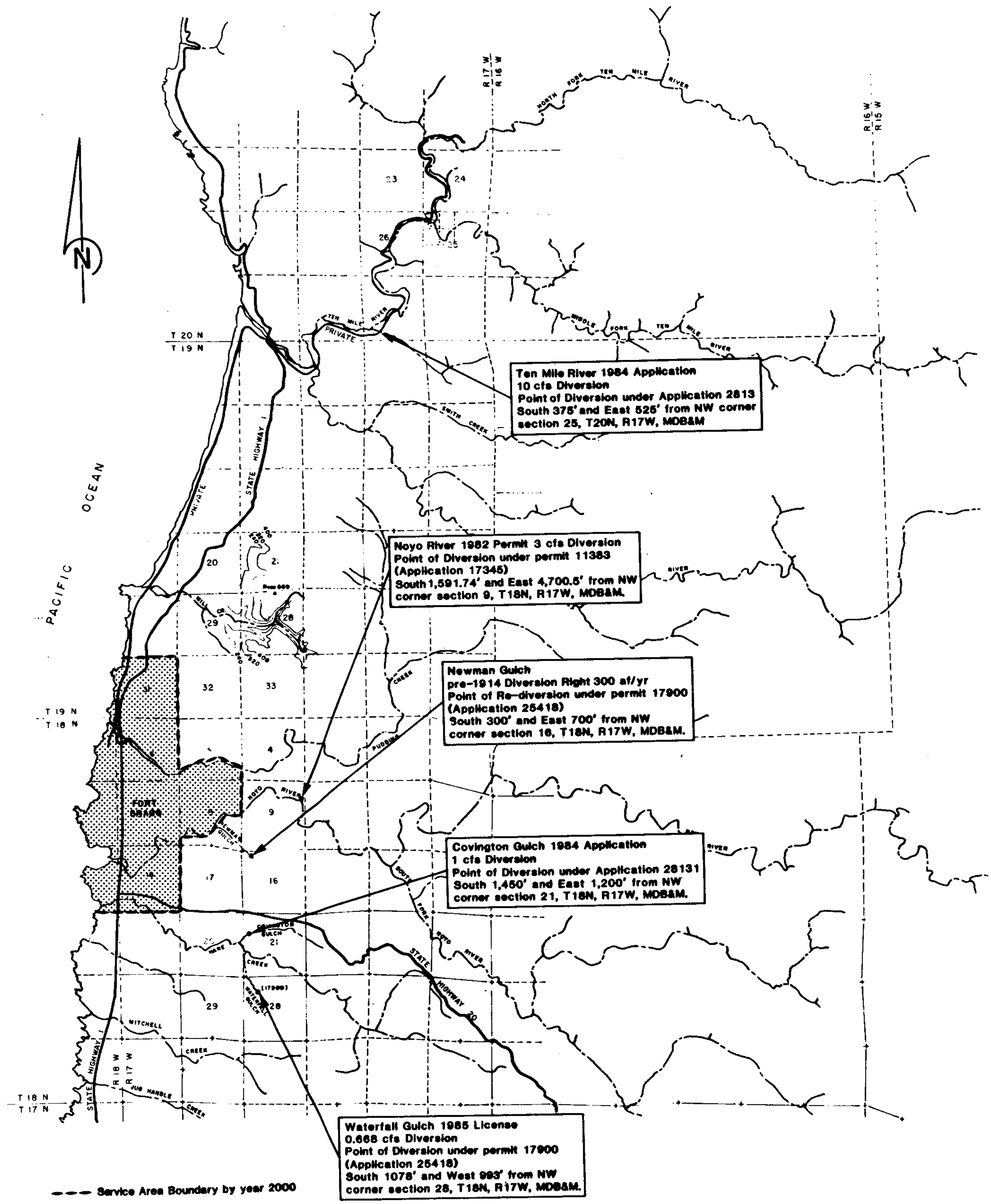
The water provided by the Fort Bragg water system has been traditionally derived from surface sources. These surface sources originate from precipitation, surface runoff and natural springs.

The Fort Bragg water service area includes the principal surface waters (from North to South) of Pudding Creek, Noyo River and Hare Creek (Figure VI-1). The sources for the Fort Bragg water system are diversions of surface water from the Noyo River; Newman Gulch, a tributary of the Noyo River; and an unnamed stream (locally called Waterfall Gulch), also a tributary of Hare Creek.

Sources of water used within the Fort Bragg water service area include the Fort Bragg water system, local springs, shallow wells, and direct diversion from the Noyo River, Hare Creek, Pudding Creek and their tributaries.

The Fort Bragg water system provides about 95 percent of the potable needs of the service area but only about 50 percent of the use within the service area (estimated for 1984).

It should be noted here that none of the three raw sources are metered individually at the water treatment plant (WTP). There is only one flow meter at the WTP on the downstream side of the raw water pumps. The raw water flows recorded daily in the plant logs are calculated from the log. The footnotes identify how many hours and how many pumps were operating at the Noyo Pump Station. There is a very indirect method for such critical data. The method does not consider actual diverted quantities at the points of diversion which



EXISTING OR REQUESTED WATER RIGHT SOURCES

CITY OF FORT BRAGG

JOHN CAROLLO ENGINEERS

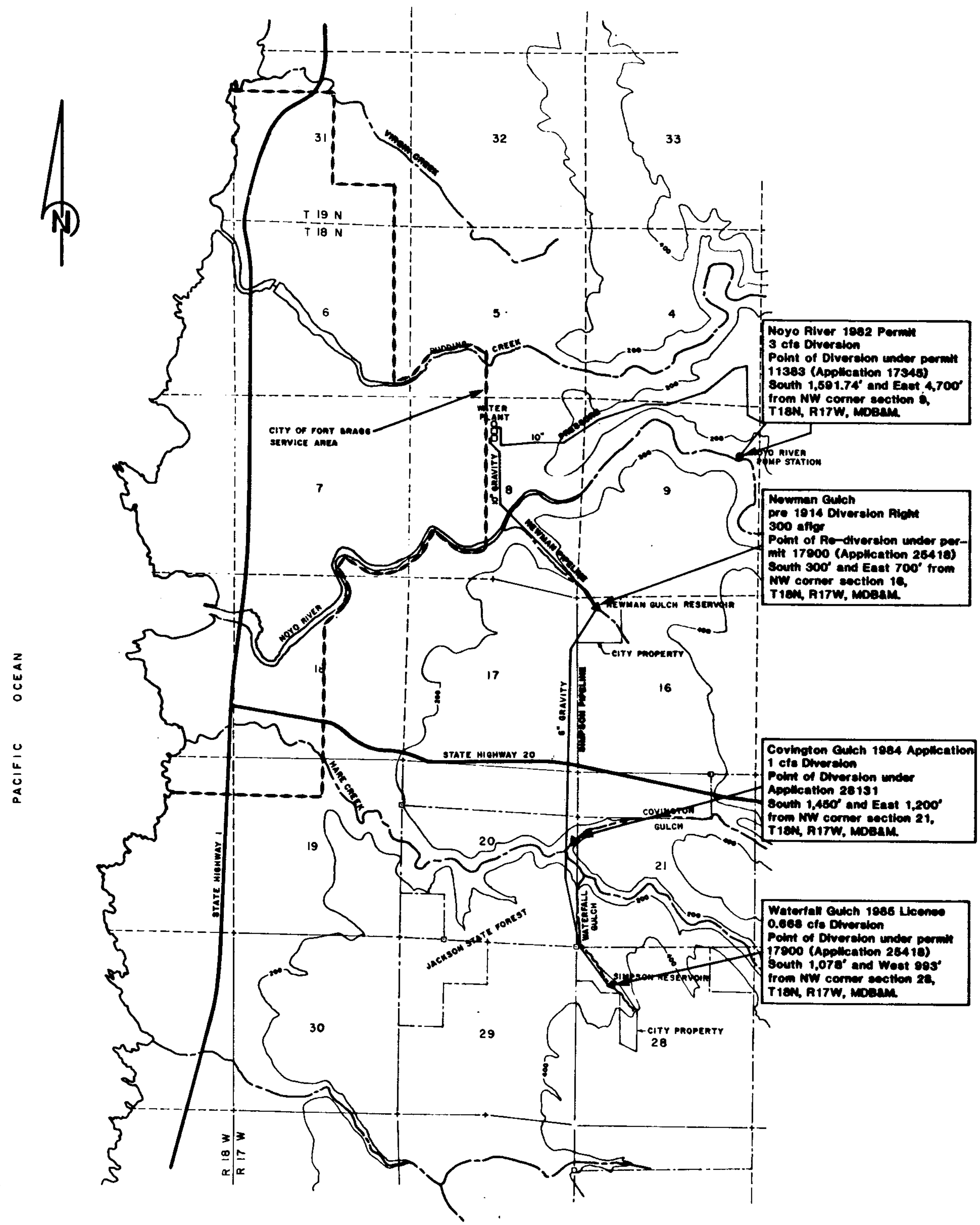
Figure VI-1

would include leakage losses in the raw water pipelines, evaporation/percolation losses in the raw water ponds, and/or plant meter error. However, it is upon this meter data, taken downstream of the raw water pumps, that the following raw water supply discussion is based.

PRESENT RAW WATER SOURCES

SOURCES FOR CITY WATER SYSTEM. Historically the major source of supply for the Fort Bragg water system has been the Newman Gulch Reservoir. The reservoir has about four acre feet of usable capacity with about 2 to 4 feet of humic and mud build-up on the bottom. The reservoir is supplied by runoff from a limited watershed and natural springs. There is no weir-box or metering capability to determine flows into and out of the reservoir. As a result of this, there are no flow records available for this water source from which future available water supplies can be reliably projected or accurate water rights established. Water from the reservoir is transported to the water treatment facility through a 10 inch gravity pipeline (See Figure VI-2). The pre-1914 water rights for this source, as documented by the City, and currently on file with the State Division of Water Rights, allow a maximum diversion of 300 acre-feet per year.

Traditionally, to augment the Newman source, diversion from a spring on an unnamed creek (locally called Waterfall Gulch) has been used. The Simpson Lane Reservoir is a small impoundment of about 5,000 gallons on Waterfall Gulch. The purpose of the impoundment is for direct diversion of spring water from the gulch into the Simpson pipeline. The Simpson pipeline (10,000 feet of 10 inch and 2,000 feet of 6 inch) transports the water from Waterfall Gulch by gravity and discharges freely into the Newman Gulch Reservoir. There are no regulating controls on the Simpson pipeline so the diversion from Waterfall



EXISTING OR REQUESTED WATER RIGHT SOURCES AND RAW WATER SUPPLY SYSTEM

CITY OF FORT BRAGG

JOHN CAROLLO ENGINEERS

Figure VI-2

Gulch is continuous. The City's currently permitted diversion right on the Waterfall Gulch is 0.668 cfs or 480 af per year. The diversion right is based on a 1985 assessment by the State Division of Water Rights. Since no metering structure exists at the Waterfall Gulch diversion and no historic records are available, future available water supplies cannot be reliably projected nor can accurate water rights be established. The co-mingled source of Newman Gulch and Waterfall Gulch waters is referred to locally and herein as the Newman-Simpson source.

During the drier seasons (1970, 1971, 1976, 1977, 1981), and more recently due to system operations (1984, 1985), diversions from the Noyo River, have exceeded the diversions provided by the combined Newman-Simpson sources. Table VI-1 shows the comparative annual diversions (1970-1985), and Table VI-2 shows the maximum month diversions on a total basis and for the Noyo Pump Station (1980-1985). The Noyo diversion currently consists of a series of perforated collector pipes buried approximately eight feet below the river bed. Water infiltrating these collector pipes is diverted by gravity into an 8 foot diameter wet well of the Noyo Pump Station on the north bank of the river. The raw water is then pumped out of the Noyo River basin and through a 10 inch transmission line to the WTP.

OTHER SOURCES WITHIN THE SERVICE AREA. In general, the Fort Bragg Service Area appears to have abundant amounts of water. Until recently the current City supplies have been adequate. However, this is because a significant portion of the water used within the Service Area has been, and will continue to be, supplied from sources other than the City's water system.

GEORGIA - PACIFIC CORPORATION. The largest water user of the City system is the Georgia Pacific Corporation (G-P) facilities on the west edge of the

TABLE VI-1

ANNUAL RAW WATER DIVERSIONS *
1970-1985

Year	Volume Units	Total Raw Water Diverted	Diversion from Newman-Simpson	Diversion from Noyo
1970	gal	313,037,000	146,130,000	166,907,000
	a-f	961	449	512
1971	gal	297,379,000	139,034,000	158,345,000
	a-f	913	427	486
1972	gal	296,790,000	205,395,000	91,395,000
	a-f	911	630	281
1973	gal	304,661,000	200,961,000	103,800,000
	a-f	935	616	319
1974	gal	287,784,000	191,207,000	96,577,000
	a-f	883	587	296
1975	gal	299,444,000	184,435,000	115,009,000
	a-f	919	566	353
1976	gal	349,879,000	160,327,000	139,552,000
	a-f	1,074	492	582
1977	gal	338,833,000	162,256,000	176,577,000
	a-f	1,039	498	541
1978	gal	323,242,000	201,727,000	121,515,000
	a-f	992	619	373
1979	gal	349,289,000	192,756,0000	156,533,000
	a-f	1,072	592	480
1980	gal	376,287,000	207,213,000	169,074,000
	a-f	1,155	636	519
1981	gal	375,567,000	180,036,000	195,531,000
	a-f	1,153	553	600
1982	gal	369,490,000	357,007,000	12,396,000
	a-f	1,134	1,096	38
1983	gal	348,033,600	299,446,000	48,587,000
	a-f	1,068	919	149
1984	gal	388,100,000	74,127,000	290,963,000
	a-f	1,191	228	893
1985	gal	408,342,000	27,800,000	380,542
	a-f	1,253	85	1,168

* According to City plant flow records

TABLE VI-2

RAW WATER DIVERSIONS
MAXIMUM MONTH
1980-1985

Date		MAXIMUM MONTH FOR YEAR		
Year	Month	Total Diversion Gallons	Newman-Simpson Diversion Gallons	Noyo Diversion Gallons
1980				
	January	27,334,000	27,334,000	-0-
	July	42,118,000	18,195,000	23,923,000
	August	40,683,000	15,027,000	25,656,000
1981				
	July	40,191,000	13,398,000	26,793,000
	December	28,852,000	28,852,000	-0-
1982				
	March	30,959,000	18,563,000	12,396,000
	July	40,149,000	40,149,000	-0-
1983				
	July	37,231,000	37,231,000	-0-
	December	25,675,000	-0-	25,675,000
1984				
	July	48,206,000	19,815,000	28,391,000
1985				
	June	43,020,000	4,000,000	39,020,000
	July	42,406,000	2,000,000	40,406,000
1980-1985 Monthly Maximums	gallons	48,206,000	40,149,000	40,406,000
	a-f	148	124	125
	cfs	2.42	2.01	2.01

NOTE: Total raw water diversion is determined from raw water meter at plant. Noyo diversion is estimated flow based on pump run-time at Noyo Pump Station. Newman-Simpson diversion is unmetered and is the difference between the Noyo and plant flows. No recent flow records are available for either of the Newman Gulch or Waterfall Gulch diversions.

Fort Bragg Service Area. According to Georgia Pacific (G-P), they have three water sources: potable water from the City system; two on-site wells; and two off-site stream diversions. The wells can provide a capacity of about 120 gpm to the G-P nurseries (see Appendix A for test data). However, seasonal fluctuation in the capacity can occur to significantly reduce this value. The G-P diversion entitlement on the Noyo River is 1.33 cfs, not to exceed 475 a-f per year. The Noyo diversion is about 200 feet downstream of the City's but on the south side of the river. G-P also has a license for diversion on Pudding Creek of 1.0 cfs, not to exceed 200 a-f per year (see Appendix B for Licenses). According to G-P, the stream diversions are used primarily for process water and mill pond makeup.

Fort Bragg School District. With grassed schoolgrounds and sports playing fields, the District has one of the largest irrigation requirements within City the system. According to staff, their well was drilled in 1970, has a 12 inch casing and is about 40 feet deep. In 1985, in response to the local efforts to minimize the nonpotable use of City water, the District returned to the use of their well to help satisfy their major irrigation needs. However, the well can only supply about half the irrigation needs of the fields (estimated at 120 gpm) during August and September.

Locally. Within the service area small private wells, small diversions of surface runoff and small impoundments are in use by private individuals to help satisfy their landscaping or other needs.

ADEQUACY OF PRESENT RAW WATER SOURCES

GENERAL. The present water system maximum annual diversion was 1191 a-f, (1.06 mgd or 1.6 cfs) in 1984. The maximum day demand was 1.6 MGD (or 2.4 cfs) in 1984 and 1985. These demands include water used in the treatment process and the treated water leaving the plant. The City's existing permitted water rights total 2950 a-f per year (Table VI-3) from the three sources. The projected water demand for the year 2000 is 2470 a-f. Based on this data it appears the City has adequate source entitlement on a daily and annual basis until the year 2000. However, two items can quickly change this.

From flows recorded by the United States Geological Survey (USGS) on the Noyo River from 1951-1977 (Appendix C) and recent City operating experiences indicate potentially severe seasonal shortages of water from two of these sources. Second, the 3.0 cfs average daily flow for the maximum 30 days of diversion (178 a-f) permitted diversion on the Noyo River is in the process of being reviewed by the State of California Division of Water Rights and could be reduced to 2.0 cfs. The City has recently received a five year extension to document the Noyo diversion.

SEASONAL FLUCTUATIONS IN NEWMAN GULCH. The Newman Gulch Reservoir has been the primary source of raw water for the City's system. Diversion from the reservoir (combined Newman Gulch and Waterfall Gulch diversion) reached a maximum of about 1100 a-f in 1982. However, since then, the yield from Newman Gulch has significantly fallen off. Even with the Waterfall Gulch diversion discharging continuously through the Simpson Pipeline into Newman Gulch Reservoir, no significant diversions could be made from the Newman from June to October, 1985.

City staff located a leak in the 10 inch steel pipe from Newman in October, 1985 in the Noyo riverbed. The area of the leak is in the tidal plain. Therefore, with the exception of low-minus tide events submerged conditions prevail at the site and make leak detection difficult.

TABLE VI-3

WATER RIGHTS/DEMANDS

EXISTING WATER RIGHTS

Source	Existing Water Rights
Newman Gulch	
MGD	0.27
cfs	0.42
a-f/yr	300
Waterfall Gulch	
MGD	0.38
cfs	0.67
a-f/yr	480
Noyo River	
MGD	1.9
cfs	3.0
a-f/yr	2,170
Annual Total	
MGD	2.6
cfs	4.09
a-f	2,950

ESTIMATED SYSTEM DEMANDS

	1985	1990	2000
Maximum Day (to date)			
MGD	1.8		2.6
cfs	2.7		4.0
Average Annual Day			
MGD	1.1	1.5	2.2
cfs	1.7	2.3	3.4
Annual Total			
MGD	401	536	805
a-f	1,230	1,645	2,470

The outlet valve on Newman Reservoir remained open from June to October to maintain on-line raw water users between the reservoir and the Noyo River. Then, due to the leak, no significant rise in the reservoir level above the reservoir outlet could be developed. Although this operating condition from June to October, 1985, could have been minimized if the leak had been detected earlier, the possibility of wastershed depletion during a dry season could occur. The watershed is only a couple of hundred acres and the springs therein appear, as a result of the 1985 conditions, limited to seasonal surface infiltration. The loss of the Newman Gulch source should therefore be considered an operational possibility.

SEASONAL FLUCTUATIONS ON THE NOYO RIVER. Streamflow records for the USGS Gaging Station 11-4685, about one mile upstream of the City's diversion on the Noyo indicate flows at that point seasonally drop below 6 cfs. Periods of interest are as follows:

1. For September, 1963 the average daily flow was 1.1 cfs, and less than 1 cfs for 12 consecutive days.

2. For about six weeks (August 1 through October 13, 1970) Noyo stream flows were less than 4 cfs.

3. Between September 8, 1970 and October 2, 1970 (25 consecutive days) Noyo flows were less than 2 cfs.

   NOTE: The 1976 "drought" conditions that existed in other areas in California were not, according to flow records, significantly "felt" in the raw water supplies or in significantly increased demands of the Fort Bragg water system.

Results of flow duration curves provided by the Georgia-Pacific Corporation for the Noyo River from 1951-1977 are shown in Table VI-4 (the curves are in Appendix D). The results illustrate recent potential of seasonally low flows (less than 4 cfs) from June through October. The significance of the 4 cfs (criteria in Table VI-4) is that the State Fish and Game Department has

TABLE VI-4

NOYO RIVER
STREAM FLOW RANGES

1951-1977

Month	95 Percent of the Time Flow Measured Was Greater Than (cfs)	Percent of Time Flows Measured Less Than 6 cfs *	Percent of Time Flow Less Than 4 cfs *
January	20	-0-	-0-
February	70	-0-	-0-
March	50	-0-	-0-
April	40	-0-	-0-
May	20	-0-	-0-
June	9	-0-	-0-
July	4	10%	4%
August	3	25%	7%
September	2	50%	17%
October	4	25%	5%
November	6	3%	-0-
December	9	-0-	-0-

Based on Duration Curve information from Georgia Pacific for USGS Gaging Station 11-4685. Extreme minimum daily flow is 0.2 cfs, recorded on September 28, 1964.

* 3 cfs requirement minimum fish release
+1 cfs Georgia-Pacific licensed water right
4 cfs
+2 cfs City of Fort Bragg relicensed water right
6 cfs

a minimum 3 cfs fish release requirement from June through September downstream of the state licensed G-P diversion and the G-P diversion is 1 cfs. The 6 cfs in Table VI-4 represents the 3 cfs fish release, 1 cfs for existing G-P rights and 2 cfs for the City's pending revised diversion right. These flows would be average daily values for a 30-day period.

It should be noted that no fish release requirement has yet been placed on the City's license. However, review for such a requirement should have occurred by the time the City's rights are relicensed within the next five years.

SEASONAL FLUCTUATIONS IN WATERFALL GULCH. No flow records have been maintained on the discharge from Waterfall Gulch at the diversion into the Simpson Pipeline. However, local observations indicate the springs in the gulch have been able to maintain a head of about 0.5 feet on the diversion intake during seasonally dry periods, including 1985. The current permitted water right of 0.668 cfs, estimated by the State, is based on this condition. Field inspections made during the rainy season indicate about one foot of head develops on the intake before the runoff starts to pass through the overflow pipes in the diversion dam. Loss of this diversion should be considered an operational possibility during a dry season.

POTENTIAL RAW WATER SUPPLY CONDITIONS. Although minimum flow conditions for both the Newman Gulch and Noyo River sources have yet to coincide, the potential exists. Recent experience (summer, 1985) demonstrated this with Newman Gulch and Waterfall Gulch sources unavailable and a 2 to 2.7 cfs pumping capacity limitation on diversions required from the Noyo River (Condition C, Table VI-5) to meet demands. As a result of the limited 1985 supply, a voluntary conservation effort was implemented by the City to cut maximum

TABLE VI-5

POTENTIAL SUPPLY/DEMAND CONDITIONS FOR EXISTING WATER SOURCES

	1985	1990	2000
Estimate Average Annual Daily Demand			
MGD	1.1	1.5	2.2
cfs	1.7	2.3	3.3
Estimated Average Day, Maximum Month Demand (to date)			
MGD	1.5	1.8	2.7
cfs	2.3	2.8	4.2
Estimated Maximum Day Demand (to date)			
MGD	1.8	2.3	3.4
cfs	2.7	3.5	5.2
City Water Rights*			
MGD	2.6	2.6	2.6
cfs	4.0	4.0	4.0
Source Availability			
A - cfs	4.2	4.2	4.2
B - cfs	3.4	3.4	3.4
C - cfs	2.0	2.0	2.0 Unable to meet average day of maximum month demand
D - cfs	1.7	1.7	1.7
E - cfs	0.7	0.7	0.7

* Pending or existing water rights 1984, no additional rights permitted.

Source Condition

A. Normal year 1 mgd (1.5 cfs) from Newman-Simpson, 1.8 MGD (2.7 cfs) pumping capability at Noyo source.

B. Newman Gulch unavailable, Noyo source at 2.7 cfs, Waterfall Gulch at 0.67 cfs.

C. Newman Gulch-Waterfall Gulch 1.0 cfs available, Noyo source at 1 cfs (1985).

D. Newman Gulch unavailable, Noyo source at 1 cfs.

E. Newman Gulch unavailable, Noyo source unavailable, Waterfall Gulch at 0.67 cfs.

demands. With continuous pumping from the Noyo River initially of 2 cfs and, after pump station modifications, 2.7 cfs, plus drafting from the 3.8 mg of raw water storage at the WTP site, the City's maximum demands were met. Fortunately no significant mechanical failure occurred at the Noyo Pump Station during this four month period of 22+ hours per day of operation.

The 3.8 mg of on-site pond storage at the water treatment plant is only sufficient to act as a raw water source on a daily basis as a maximum shaver, or for an emergency (power failure, pipeline failure, excessive demand). Wide fluctuations in the pond levels are not desirable however, as the ponds are construction of unlined earth.

The maximum month of water demand for the City system normally occurs between May and August. The monthly demand totals for May through August, 1985, were within 10 percent of each other. Therefore the demands for the estimated average day of the maximum month could be expected to be the average daily demand over a four month period. Table VI-5 illustrates the inability of the present water sources to provide average day of maximum month demand for 1990 if raw source availability drops below 2.8 cfs (conditions C, D, E).

Table VI-5 also projects that between 1990 and 2000, the system would have insufficient water rights to provide the system demand for the average day of the maximum month even if optimum dry weather flows were available from all three sources. This projection assumes no increase in diversion rights from the Noyo River (3.0 cfs).

IMPROVEMENTS TO RAW WATER AVAILABILITY

GENERAL. On the basis of potential dry season conditions, the current raw water supplies, either by established water rights or by delivery capacity, are incapable of providing the maximum system demands. Sufficient alternate water sources therefore must be developed to provide uninterrupted supplies to the Fort Bragg service area during these dry conditions.

WELLS. The groundwater conditions in the Fort Bragg service area are poor from the standpoint of a municipal supply. The Mendocino County Coastal Groundwater Study issued in June, 1982 by the State Department of Water Resources. The study evaluated data compiled from drillers logs for 71 wells drilled into the Franciscan bedrock, 136 wells drilled into marine terrace deposits and 48 wells drilled through both formations. The study considers the Coastal Belt Franciscan bedrock to be non-water bearing. However, fractured or weathered portions of the Franciscan formation can unpredictably yield wells of over 40 gpm. Typical yields in the Fort Bragg area would be in the 1 to 10 gpm range. The marine terrace deposits are considered the primary water producing zone in the Fort Bragg area.

Marine terrace deposit wells surveyed provided from 2 to 74 gpm with a mean yield of about 14 gpm. These wells are shallow (around 100 feet deep) and rely on the unconfined nature of the aquifer for seasonal recharge from surface runoff. As a result of the surface water dependency, seasonal variations or shifts in precipitation can cause significant fluctuations in the water table and yield of the wells. Also, this "unconfined" nature of the aquifer and relative quick response time to seasonal precipitation makes the wells highly susceptible to surface contamination from septic tank seepage, buried pipeline leakage, etc.

In some areas of the City, due to the landfill used to achieve current grades, old streambeds can be "tapped" for higher than typical water yields. The Georgia-Pacific and Fort Bragg High School wells discussed previously are near such "old" streambeds. However, the economic practicality of the City utilizing wells of similar quality and yield as G-P's currently is unfavorable. The water quality analysis of the G-P well (Appendix A) indicates iron and manganese concentrations about ten times the recommended goal in Chapter V and the aluminum concentration is over twenty times greater than the goal. Even if these metal concentrations can be discounted, the wells would be subject to surface contamination and would require on-site chlorination prior to introduction into the distribution system. The cost of well equipment automatic controls, pneumatic tank, chlorination facilities and maintenance for a seasonal 100-200 gpm well could readily exceed $70,000 (see Appendix E). Equipping a well does not include the land, design, or off-site piping costs. Equipping a well also assumes the first pilot hole drilled on the well site can be developed to the desired yield. The new well(s) could be located near the plant and used as a raw water source, or pumped directly into the distribution system after chlorination if there are no water quality problems. The potential risks and costs of developing 2 wells with a yield of 1/2 cfs (220 gpm) are far outweighed by the currently low costs of developing additional water rights and diversion capacity on the Noyo River, Newman Gulch and Waterfall Gulch. Therefore, City pursuit of well water as a permanent water source for the Fort Bragg system is not recommended at this time. Perhaps the best purpose for these 100-200 gpm wells is as they are now used by Georgia-Pacific and the Fort Bragg School District - for irrigation, used to displace the treated water from the City's plant.

SURFACE WATERS - EXISTING WATER RIGHTS. Adequate water rights, their acquisition and substantiation, is the critical task now facing the City for the continued, long term operation and expansion of the Fort Bragg water system.

As discussed previously, and illustrated in Table VI-5, only under optimum raw supply conditions can the current and 1990 demands be met. Based on projected demands, system demands will exceed all licensed or permitted water rights sometime between 1990 and 2000.

The City must apply for more water rights. Beneficial use and need must be established to permit such water rights. To illustrate:

1. At the present time, the permitted diversion on the Noyo River is 3 cfs annually (2,200 af-yr). However, recent contacts by State Division of Water Rights indicate that this "right" of diversion will be reduced to 2 cfs. The reason for the proposed reduction is that according to City records provided to the State, the maximum diversion rate from the Noyo River for a 30-day period through mid-1985 was about 2 cfs. Although pumping capacity is currently about 2.7 cfs, records indicate a maximum diversion of 2.1 cfs in July, 1985.

2. The 0.668 cfs (480 a-f/yr) diversion permitted on Waterfall Gulch is based upon the State's estimated capacity of the Simpson Pipeline. The permit is not based on actual flow measurements, as they do not exist.

3. Established as a pre-1914 right, the Newman Reservoir diversion is permitted for 300 af/yr. This limit is, according to the State is based on filings provided by the City. Although no flow records exist for Newman Reservoir, records of the co-mingled source for 1982 indicate a total of 1096 a-f/yr were diverted from the two sources. By current rights then if 300 a-f/yr was diverted from Newman Gulch, then 796 a-f/yr was diverted from Waterfall Gulch; or conversely, if 480 a-f/yr was diverted from Waterfall Gulch then 616 a-f had to come from Newman Gulch.

The purpose of these facts is to show how complete and proper documentation must be provided through direct measurement of flows at the points of diversion and submitted to the State Division of Water Rights for the City's sources to substantiate actual use.

SURFACE WATERS - FUTURE WATER RIGHTS

The City has diversion rights on Newman Gulch, Waterfall Gulch and the Noyo River (as shown in Figure VI-1). The City has also filed for water rights on Covington Gulch and Ten Mile River. Although Ten Mile River appears to be an under-utilized water source at this time, City use by the year 2000 is not foreseen in this report. The economics of the 50,600 feet of pipeline needed to reach the City service area cannot presently be justified. This is particularly true since Ten Mile River is a salmon spawning and nursery stream for the State Fish and Game Department and the City's water rights on their existing sources have yet to be maximized. There also appears to be other surface sources closer to existing City facilities.

The recent City application for diversion on Covington Creek is appropriate. We also recommend a filing for diversion rights on Hare Creek at a location only about 100 feet downstream of the requested Covington Gulch diversion. City staff observations through summer 1985 have shown Waterfall Gulch, Covington Gulch and Hare Creek to provide year-round flows. An estimated 1.5 cfs was flowing from the Waterfall and Covington sources at the proposed diversion points during the maximum of the 1985 dry season (early October). At the same time, flow in Hare Creek was estimated to be in excess of 6 cfs. It is recommended as immediate improvements that the Waterfall Gulch diversion be increased to 1.3 cfs and diversions of 1.2 cfs each be applied for on Covington Gulch and Hare Creek. Also, as an immediate improvement and with the proper approvals, weir structures or similar flow monitoring facilities should be installed in Covington Gulch and Hare Creek (if no records exist in the area of the proposed diversions). It is recommended that manpower allocated to establish the seasonal flows on these streams before permanent diversion improvements are made. The Covington Gulch and Hare Creek filings should be such to allow a single pumping facility along the existing Simpson pipeline to divert water from either source.

Pudding Creek runs in close proximity of the 10 inch raw water line in Sherwood Road (see Figure VI-2). However, Pudding Creek has recorded flows of less than 1 cfs for two months during the dry season. This low flow condition coupled with the existing 1 cfs G-P licensed diversion right (Appendix B) makes this potential source unattractive at this time (see Appendix F for the limited USGS flow records).

Mill Creek and Virgin Creek are developed from small watersheds north of the present water service area. These streams serve as residential sources of water and apparently have intermittent seasonal flows (no stream data available). These limiting conditions along with the extensive supply line needed to connect them to the treatment plant make these two sources unattractive at the present time.

Because of the unsettled or unclear conditions, it is recommended that as flow data becomes available, the status of the City's existing water rights, licenses, permits, applications and proposed diversions be closely reviewed and redefined with the State Division of Water Rights.

In the meantime positive efforts must be taken by the City to substantiate use and need for diversions from these five surface sources and their corresponding diversion points. (A summary listing of recommended water rights filings is shown in Table VI-6). The emphasis of these efforts should be to maximize the use of the existing sources that can reach the treatment plant by gravity (Newman Gulch and Waterfall Gulch). The reason for this emphasis is the cost to do otherwise. Table VI-7 shows the power costs at the Noyo Pump Station for 1984 and 1985. If the Newman-Simpson sources had been fully available between June and September, 1985, about $15,000 could have been saved on power bills by reducing Noyo pumping requirements. Figure VI-3

TABLE VI-6

PROPOSED WATER RIGHTS

Source	Water Rights Existing	Water Rights Proposed	Water Supply[1] Available (Dry Conditions)
Newman Gulch	300 af/yr	1.0 cfs or 600 af/yr	0.5 cfs
Waterfall Gulch	0.668 cfs or 480 af/yr	1.3 cfs or 935 af/yr	1.0 cfs
Noyo River	3.0 cfs	3.0 cfs	0.2 cfs
Covington Gulch	-0-	1.2 cfs	1.0 cfs
Hare Creek	-0-	1.2 cfs	1.0 cfs
TOTAL	4 cfs	7.7 cfs	3.7 cfs (2)

(1) Water rights are based on annual usage or on the 30 day period of maximum diversion. The water rights filings should be reviewed in 1988 and 1990 along with City developed stream flow and diversion records. Additional water rights should then be applied for where possible to provide at least 4.2 cfs based on minimum stream flows of record-to-date occurring simultaneously.

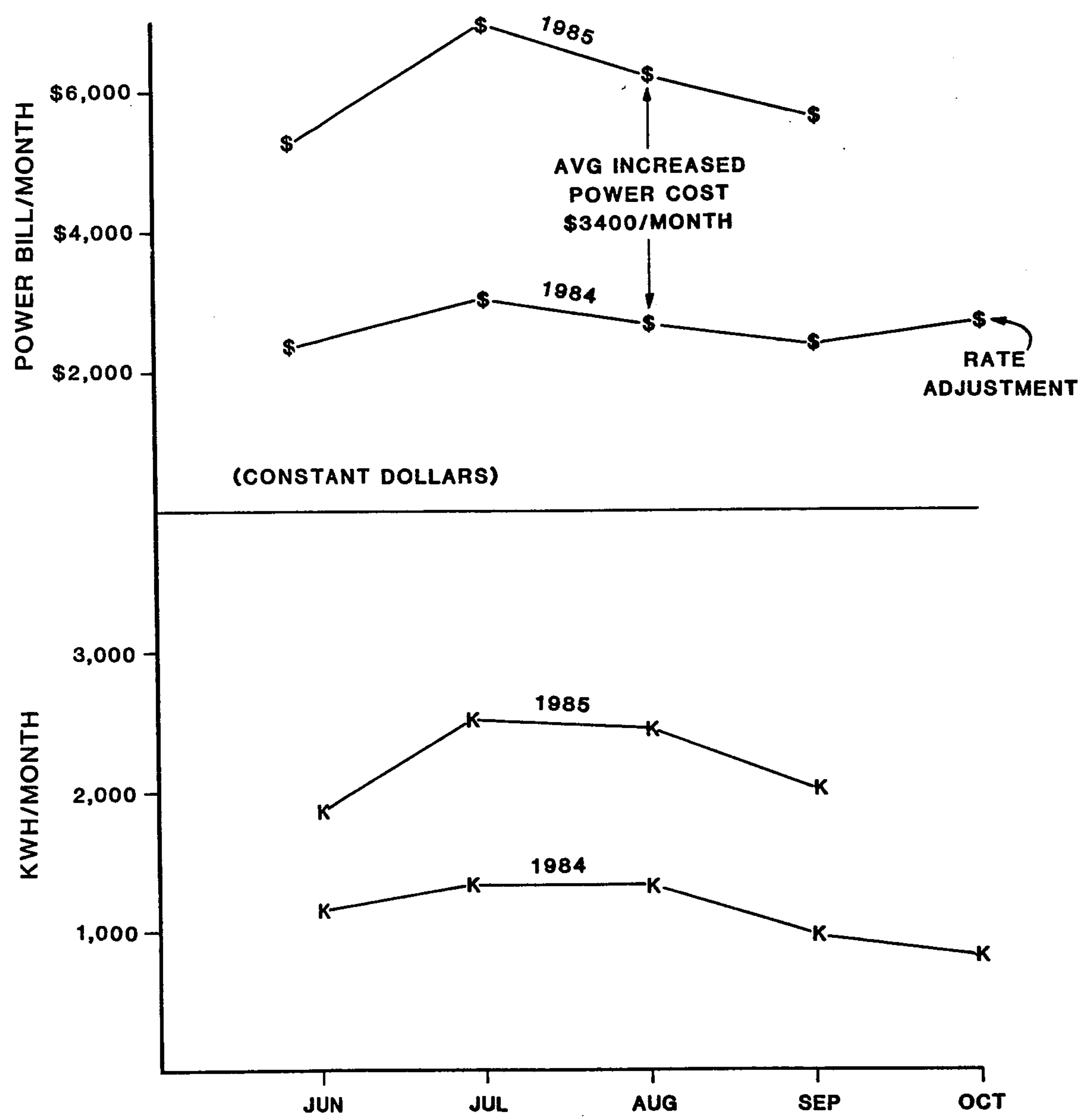
(2) Estimated Average Day, Maximum Month Demand for the year 2000 is 4.2 cfs

TABLE VI-7

NOYO PUMP STATION POWER COSTS[1]

		Month				
Year	Item	June	July	August	Sept.	Oct.
1984	KWH/day	1,164	1,335	1,345	980	819
	Cost/Mo	$2,344	$3,039	$2,663	$2,378	$2,670
1985	KWH/day	1,834	2,505	2,465	2,006	
	Cost/Mo	$,5234	$6,977	$6,221	$5,640	
Net change in KWH's		671	1,170	1,120	1,025	
					TOTAL 3,975 Ave. 997 KWH/day	
Net change in costs		$2890	$3938	$3558	$3062	
					TOTAL $13,448 Ave. $3400/Mo	

(1) Costs are in 1985 dollars



NOYO PUMP STATION
POWER COSTS
1984/1985

JOHN CAROLLO ENGINEERS

Figure VI-3

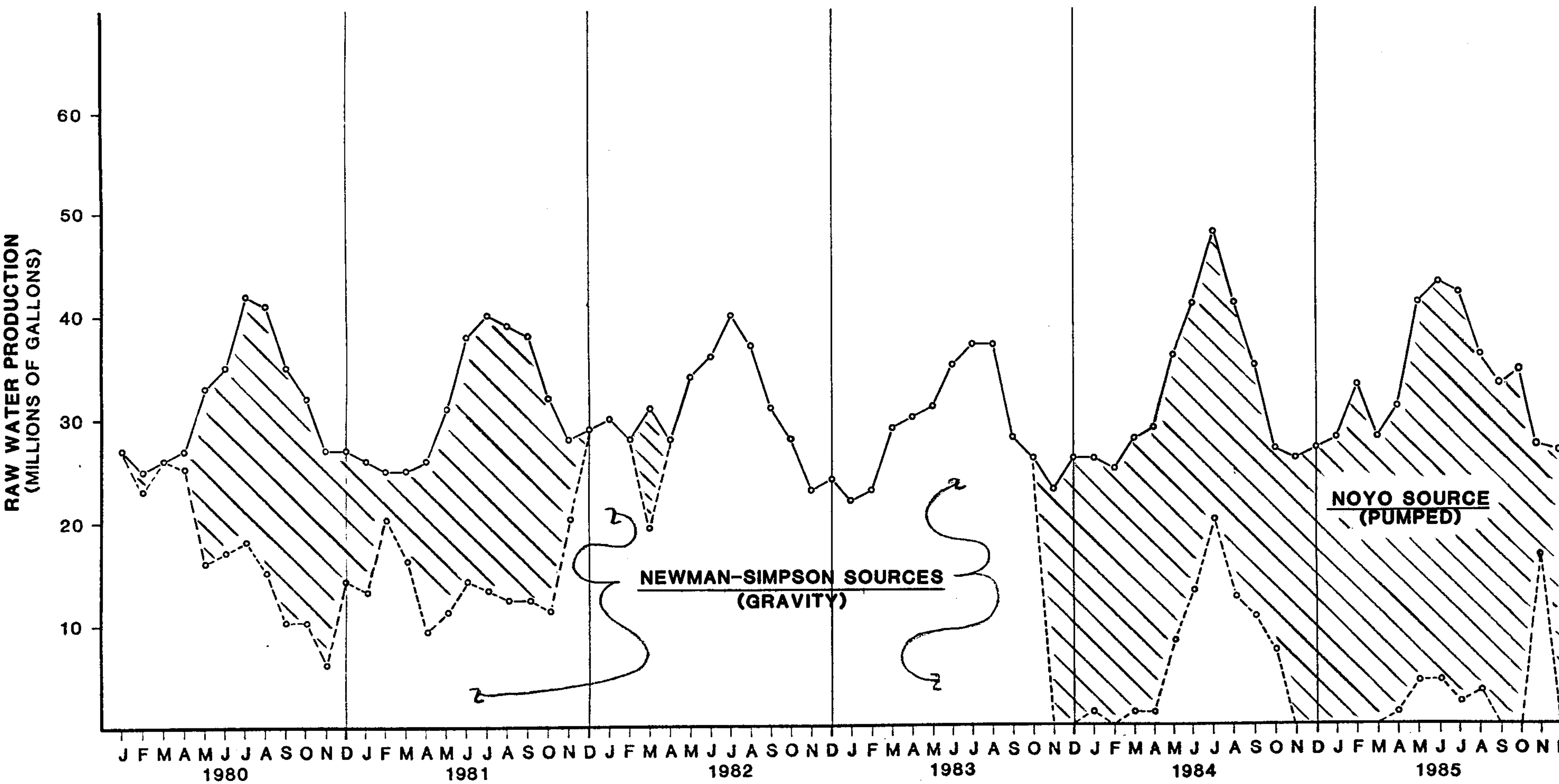
shows a comparative plot of these power costs. Figure VI-4 shows a comparative plot of the monthly flows from the Newman-Simpson and Noyo sources for 1980-1985.

EXISTING RAW WATER SUPPLY CONDITIONS AND RECOMMENDED IMPROVEMENTS

WATERFALL GULCH DIVERSION. The Waterfall Gulch diversion consists of an earthen dam about 18 feet high and 25 feet long impounding about 5,000 gallons of water (P1, P2, Appendix G). The diversion into the Simpson Pipeline consists of an upturned 10 inch section of pipe with a horizontal piece of heavy stainless steel mesh over it (P3, Appendix G). Even at maximum flows, only about 6 to 12 inches of head is on the diversion inlet. As a result, vortexing and air entrapment can occur in the pipe limiting its capacity. Influent silt and vegetation can also restrict the intake.

Just upstream of the diversion, the gulch is choked with vegetation (P4, P5, Appendix H). Brushing it would temporarily solve the problem, but the silt would continue to be a problem. The City owns 38.9 acres of property on both sides of the gulch as shown in Figure VI-5. Therefore, to avoid the worst vegetation in the gulch, minimize the silt problem, and increase head on the pipeline, it is recommended the Waterfall Gulch diversion be moved about 400 feet upstream of the present location. The new diversion would consist of a springbox with a weir plate, wing walls the width of the stream, and a gloryhole-type intake. The new diversion should be placed downstream of an existing private diversion structure in the gulch and include the springs on the west bank just downstream of the private diversion (Figure VI-5).

A new water rights filing might be necessary on Waterfall Gulch to define the new diversion location. Documentation should be included to substantiate a requested diversion rate of 1.3 cfs. The existing diversion pipe should be



CITY OF FORT BRAGG

RAW WATER PRODUCTION FOR NEWMAN-SIMPSON, NOYO SOURCES

1980-1985

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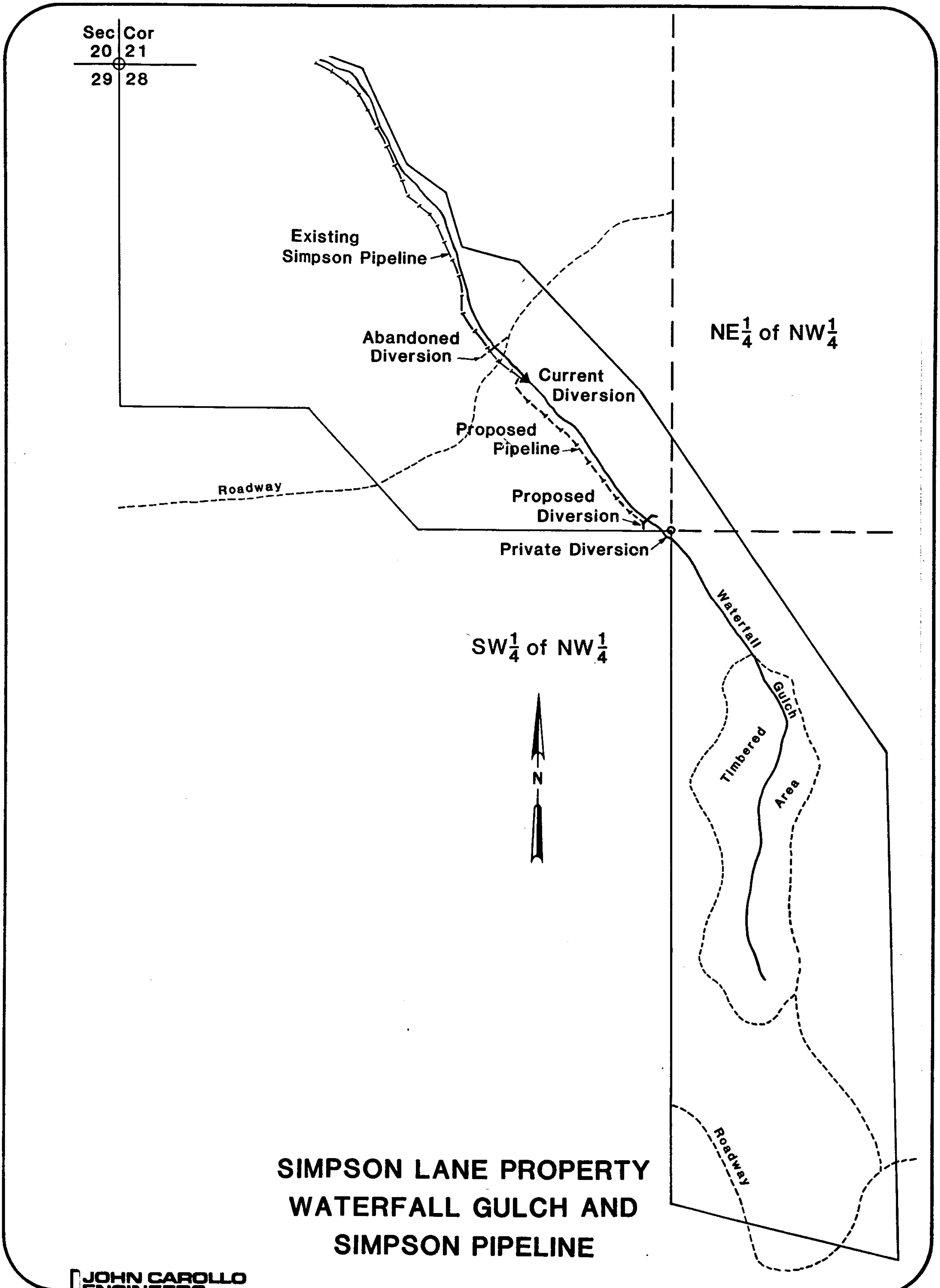
Figure VI-4



SIMPSON LANE PROPERTY
WATERFALL GULCH AND
SIMPSON PIPELINE

JOHN CAROLLO ENGINEERS

Figure VI-5

retained and valved appropriately. This valving would allow for intermittent use of the current diversion if the springs below the new location produce significant flows during the seasonal dry periods. Potential contamination to this small isolated watershed could come from humic buildup on the timbered floor or seepage from septic tanks serving the private development on the ridge on the east, south and west edges of the City's property. City removal of timber is not recommended, nor is ground disturbance by vehicular traffic, without detailed consideration as they might permanently diminish the yield of the springs in the gulch.

Measures for protection of the watershed could include: purchase of the land inside the drainage area; review of any new development in the compact area to insure compatible low density land use; minimizing road construction; minimizing drainage into the watershed from developed areas; and making the surrounding landowners aware of any potential contamination condition currently existing. With the proposed treatment plant improvements on line, contamination in the watershed from septic systems should be easily handled. Given these WTP improvements, the present financial resources of the City and the needed immediate system improvements, land purchase for protection of City watersheds or even fencing of current City boundaries are not considered realistic. The other measures discussed, however, are more of a public awareness approach and would not require capital expenditures.

SIMPSON PIPELINE. The Simpson Pipeline is about 12,000 feet long. It consists of about 10,000 feet of 10 inch and 2,000 feet of 6 inch asbestos-cement (A.C.) pipe. The A.C. pipe is exposed, either at grade (P6 Appendix G) in an open trench or supported on wooden trusses to maintain grade across low areas (P7 - P10, Appendix G). The general pipe condition is good and the pipe material can be expected to last to the year 2000. However, the eleven groups of wooden supports for this pipeline, used where the pipe is not in direct contact with the ground, are in immediate need of rebuilding or replacing. The horizontal and vertical alignments of the pipeline in these trussed sections are often beyond the allowable deflection limits for the pipe joints (P8, Appendix G). The exposed joints do not leak even though in some cases, the rubber gasket can be seen at the edge of the coupling (P11, Appendix G). Vegetation has encroached on the truss supports in many places (P12, P13, Appendix G). Partially fallen trees rest on the pipe (P14, Appendix G) and have bowed supporting truss members (P15, Appendix G) at one of the longer crossings. Surface runoff has undercut many of the supports, or caused footings to settle, and forced temporary means of support (P16, Appendix G).

It is recommended, in general, the following be considered as immediate improvements for the Simpson pipeline:

- The pipeline alignment be brushed a couple feet either side of the pipe or truss supports.
- The drainage under the trusses be rechannelled away from the supports where possible.
- The concrete footings for the trusses should be placed or reset as necessary.
- The design of trusses checked for proper sizing, adequate cross bracing, anchorage, etc., (P16 - P21, Appendix G).
- The cable tiebacks be removed and the truss systems reworked or replaced to be totally self supporting.
- The larger trusses, over 10 feet high, reworked with stainless steel, bolted connectors.
- Steeply sloped and exposed sections of the line should be re-engineered to secure the non-mechanical joints (or replacement of them) and replace the tiebacks to trees (P22, P23, Appendix G).

The 2,000 feet of 6 inch diameter A.C. pipe should be replaced with 10 inch to maximize capacity of the pipeline. The last section of 6 inch freely discharging into Newman Reservoir (P24, Appendix G) should be replaced with 10 inch, a flow meter installed, and appropriate valving to install a 10 inch bypass line from the Simpson (10") line around Newman Reservoir to the Newman (10") line downstream of the existing control valve. Both of these projects should be considered immediate improvements to maximize the water diversion and quality from Waterfall Gulch to the treatment plant.

NEWMAN GULCH AND RESERVOIR. Springs flowing in Newman Gulch have been used as a water supply since before 1914. The Newman Dam was constructed prior to 1914. Most of the small watershed of the gulch is owned by the City. An abandoned lumber mill is in the upstream area of the springs. With the exception of the old mill, the area is relatively undeveloped. The springs have run continuously as far back as City staff can remember, however, seasonal fluctuations have been observed to occur. No systematic flow measurements have been made of the flow into the reservoir. Visual observations indicate that the inflow has been seen to drop to a "trickle" in late summer (i.e., 1985).

The reservoir is heavily silted. Perhaps only about 40 percent of the original capacity remains. The estimated usable capacity is two to four acre-feet depending on the mud levels. The bottom mud is from four to six feet deep.

Seasonally, at lower water levels in the reservoir, the water quality can fluctuate quickly depending on the humic buildup in the mud (P24 - P25, Appendix G).

The condition of the dam and reservoir and the work necessary to improve reservoir yield, repair spillway damage and modify the outlet configuration are beyond the scope of this study. A separate report on these conditions should be pursued by the City.

Potential contamination in the Newman Gulch watershed is similar to Waterfall Gulch. However, the larger watershed means larger potential for contamination. Currently the watershed is all but undeveloped. The abandoned lumber mill has potential for redevelopment and the land surrounding the stream is level for residential development. Development should be expected by the year 2000. As with Waterfall Gulch, the City should establish the watershed drainage boundaries and closely review any development occurring within it. Development would include logging, improved accessibility into the watershed or permanent structures. This activity shall be controlled in such a manner as to minimize the potential for septic tank seepage, storm drainage, potential spillage from new roads, etc. from eventually entering the stream/reservoir.

As with Waterfall Gulch, current efforts for protection of the Newman Watershed should be made through non-capital channels in lieu of land purchases.

NEWMAN PIPELINE. The estimated 6,000 feet of 10 inch steel and transite pipe leaving the Newman Reservoir and terminating at the water treatment plant is buried its entire length. Records are inconclusive as to the pipeline's installed length, size, and type of material. It is recommended that the pipeline alignment be brushed for periodic access and inspection, especially near the river crossing. Recent City inspection of the pipeline river crossing showed significant leakage. The leaks found have been repaired. Assuming an overall deteriorated condition of the river crossing, about 300 feet of uncased steel pipe, should be scheduled for immediate replacement. Flow meters should be installed on the pipe at the dam and at the treatment plant site. (Modifications at the diversion in the Newman Reservoir for the intake and outlet through the dam to the control valve is considered to be part of the Newman Dam rehabilitation work and not covered in this study). Based on the condition of the Noyo line, the Newman Pipeline should be replaced by the year 2000.

NOYO COLLECTOR SYSTEM. The City's collector system has been installed in a meander of the river. As a result, the greater width of the river at the diversion causes the river flows to seasonally deposit silt and rocks over the infiltration pipes. This build-up must be removed at low flows to maintain the necessary infiltration into the culverts and flow to the pump wet well. Without a significant shift in the normal scour pattern of the river in the area of the collectors, the characteristically "sticky" silt of the river will continue to be a chronic plugging problem for the existing collector system.

The G-P diversion just downstream of the City's is a single, 3 foot diameter perforated pipe about 12 feet long. The pipe is located in the scour area of the river so seasonal flows tend to flush out the silt and gravel build-up. Consequently, G-P has had little maintenance on the system or few problems with maintaining the necessary infiltration into the pump wet well (P26-P29, Appendix G).

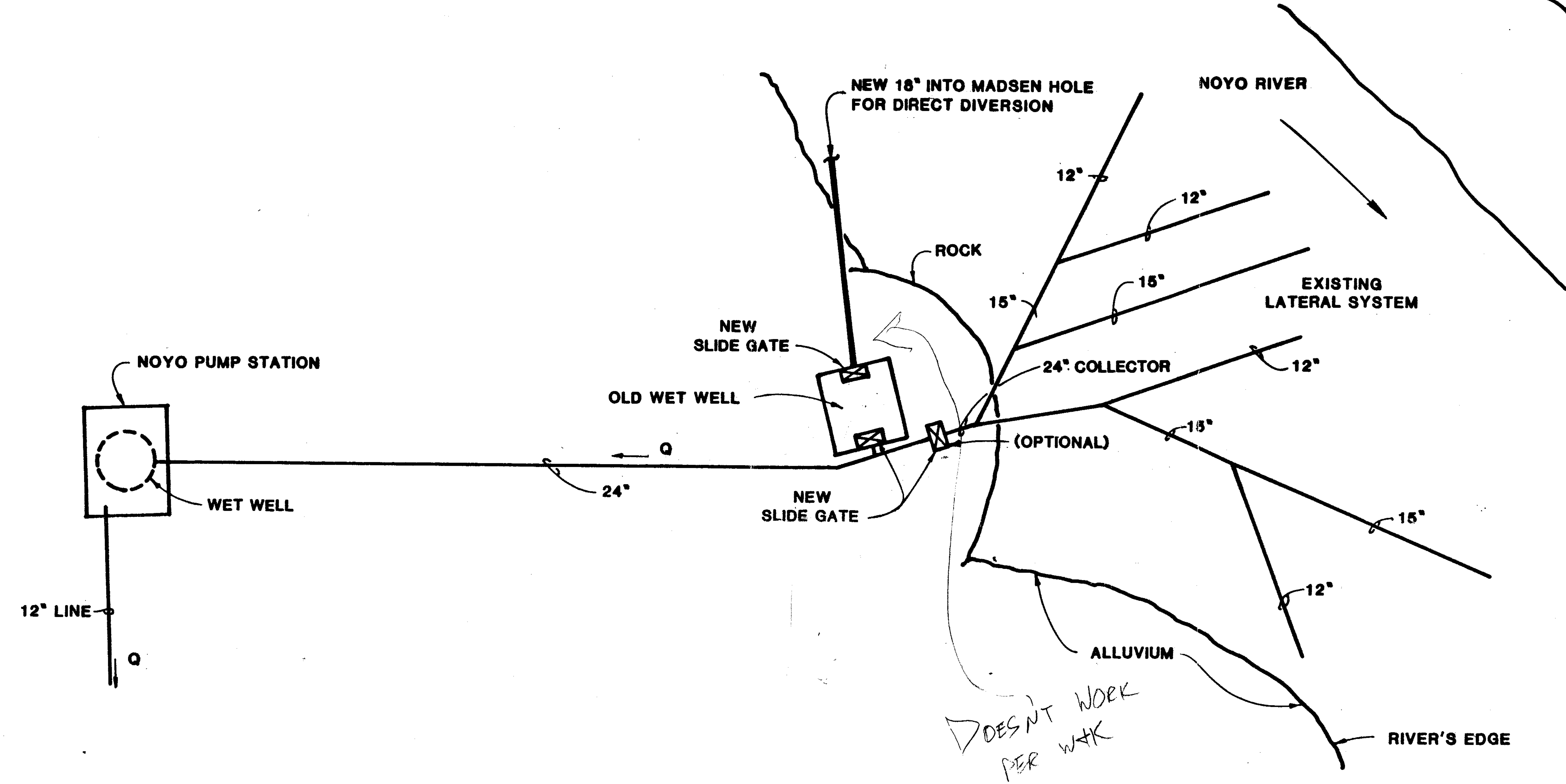
The City's collector system in the Noyo River presently consists of the following:

1. A 48 inch diameter hole, 8 feet deep filled with coarse rock.
2. A 24 inch diameter perforated culvert pipe buried 8 feet under the riverbed and emanating from 1. above. Coarse rock was used to

surround each culvert and to backfill the trenches. (Initially, fabric filter cloth surrounded the culverts to minimize intake of silt or clay. However, the cloth soon became clogged and had to be removed).

3. A 24 inch gravity line allows water to flow from 1 above, to the pump station wet well.

The collector system requires maintenance to prevent blending off by sediment buildup and to minimize air entrainment through vortexing in the river flow over the collectors. To minimize these maintenance requirements and to increase the water availability in the pump wet well of the Noyo Pump Station, it is recommended that an 18 inch or 24 inch conduit be installed permanently in the riverbed for direct diversion from the scour area of the "Madsen Hole" immediately upstream on the northerly bank (at the approximate 90 degree bend in the river). Preliminary contact with State Department of Health, Fish and Game Department and the State Water Resources Control Board (SWRCB) indicate that with the new plant facilities, complete direct diversion of the Noyo surface water should be possible. The conduit would be tied into the old concrete wet well. The old well would be teed into the new wet well, with diversion controlled by a slide gate in the old wet well (see Figure VI-6). The new conduit would have an open, screened end that would terminate in an approved area of the north bank or in the Madsen Hole. Actual location of the conduit will depend on property boundary location and final comments from the State Department of Health, Fish and Game Department, SWRCB and the Division of Water Rights. Both the Madsen Hole and the north bank just downstream maintain depth of four to six feet of water during low flow periods. Operation procedures required to periodically service the collector system should be cleared through these same agencies.



PROPOSED COLLECTOR EXTENSION INTO THE MADSEN HOLE AREA OF THE NOYO RIVER

The use of a temporary dam across the Noyo River immediately downstream of the collectors is not recommended. The silt load that now periodically plugs the river bottom and prevents vertical percolation of water would only be increased by the larger amounts silt being held behind the dam. Working in the river and disposal of the silt accumulation would be other considerations. Of more concern however, would be the various agency filings and environmental impact work required to obtain State approval for such a temporary structure. The Department of Fish and Game, Division of Dam Safety and Regional Water Quality Control Board are only a few of the entities that would become involved in reviewing and licensing the project.

Due to the large size of the watershed and the rivers, protection of the source by the City is limited to an awareness position. The City should establish a communications pipeline through State, County and local agencies involved in the management of the Noyo watershed to monitor/review development along the Noyo. The City should review the risk potential of hazardous chemical contamination by periodic use of pesticides, chemical growth inhibitors or defoliants along travelled rights-of-way. From this information, the City should develop an emergency action plan wherein various potential emergency conditions ranging from spillage contamination, highly turbid waters and power outages are discussed and inquiry/notification procedures are defined. This plan and approach could then be applied and modified as necessary for other other future diversions and their watershed.

NOYO PUMP STATION The system demands in June, 1985, forced improvements in the power availability at the Noyo Pump Station. At the present time, the 100 hp vertical turbine and the 75 hp submersible pumps can be operated concurrently, producing a flow of 2.7 cfs (1,200 gpm) at 185 psig as measured by

City staff. The addition of air/vacuum relief valves along the line and the replumbing of control valves at the pump station have eliminated the water hammer problems experienced in 1984.

The limitation in flow appears to be in the capacity of the 9.5 and 10 inch line from the pump station to the Sherwood-Fort Bragg Road.

The concurrent discharge from these two pumps should be such to maintain the Noyo River water diversion right of 3 cfs (1,350 gpm). Based on City staff data, calculations indicate the existing 3,700 ft of 9.5 inch steel pipe with a capacity of 2.7 cfs, has an estimated Hazen-Williams roughness factor of between 80 and 85. If cleaning the clay, sludge-like deposits from the line could improve the roughness factor to 110 to 120, and restore the full 9.5 inch inside diameter, the pipeline capacity should increase to about 3.2 to 3.4 cfs without any modifications to the existing pumping head.

Demands in 1985 demonstrated the immediate need for backup pumping facilities at the Noyo Pump Station. Both pumps in the station ran continuously for almost four months (June - October). This type of performance and commensurate City maintenance is commendable. However, it should not be expected on a recurrent basis, especially when the pumps are providing 90 - 100 percent of the City's demands.

For ease of maintenance, the pump equipment should be of a similar type. The existing pump station wet well does have sufficient space for an additional pump. It is recommended, as an immediate need, that the 75 hp submersible be relocated to act as a standby. A new vertical turbine comparable to the existing unit should be installed where the submersible is currently. (Two 100 hp vertical turbine pumps, with improved pipeline capacity, may be sufficient to provide 3.5 cfs at the treatment plant.

The motor controls, wiring, and building will need to be upgraded to code to accommodate the potential 200 hp load with two pumps running and a nominal 300 hp load in the future. Additional line capacity from PG&E to the pump station will probably also be necessary. It is also recommended as an immediate need, that the City acquire complete replacement assemblies for the different types of pumps, motors and other essential parts. These spares would then be on hand and available for the inevitable mechanical breakdowns.

Seasonally, electrical power can become a tenuous commodity in the Fort Bragg area. Although there it not a history of extended power supply problems during maximum water demands, the potential for power outages at the Noyo Pump Station exist. Therefore, it is recommended that the controls at the pump station be modified to include a portable generator hookup and a portable generator be available for service to at least one 100 hp pump.

<u>NOYO PIPELINE</u>. Installed in 1959, the Noyo Pipeline is 12,000 feet of 10 inch steel and asbestos-cement pipe that delivers raw water from the Noyo Pump Station to the water treatment plant. Recent tests by City staff show the line to have a 2.7 cfs (1,200 gpm) capacity with 185 psi discharge pressure at the Pump Station. The assumption is that the limited capacity problems are related to the 3,700 feet of 9.5 inch bell and spigot, 1/8 inch wall steel pipe from the pump station to Sherwood Road.

Since this 3,700 foot line is at the edge of the access road with minimal cover, leaks are readily visible. About 20 leaks have occurred in the steel portion last few years. Fourteen leaks occurred during the construction of the new pump station when heavy trucks used the road to the river. The leaks all occurred at pinhole failures (1/4 inch diameter or less) on the top or bottom outside curve of the pipe bell at the joints. All the leaks have been small (1/4 inch or less).

Contact with the Northwest Pipe and Casing of Portland, Oregon, indicates this type of 1/8 inch wall bell and spigot, electric resistance, spirally welded, steel pipe is still being manufactured. Current production does not include a white lining as found in the Noyo line. However, the pinhole leaks at the bells appear characteristically in the pipe when it is cyclically shock loaded. The 1/4 inch wall pipe is usually rated at 150 psi.

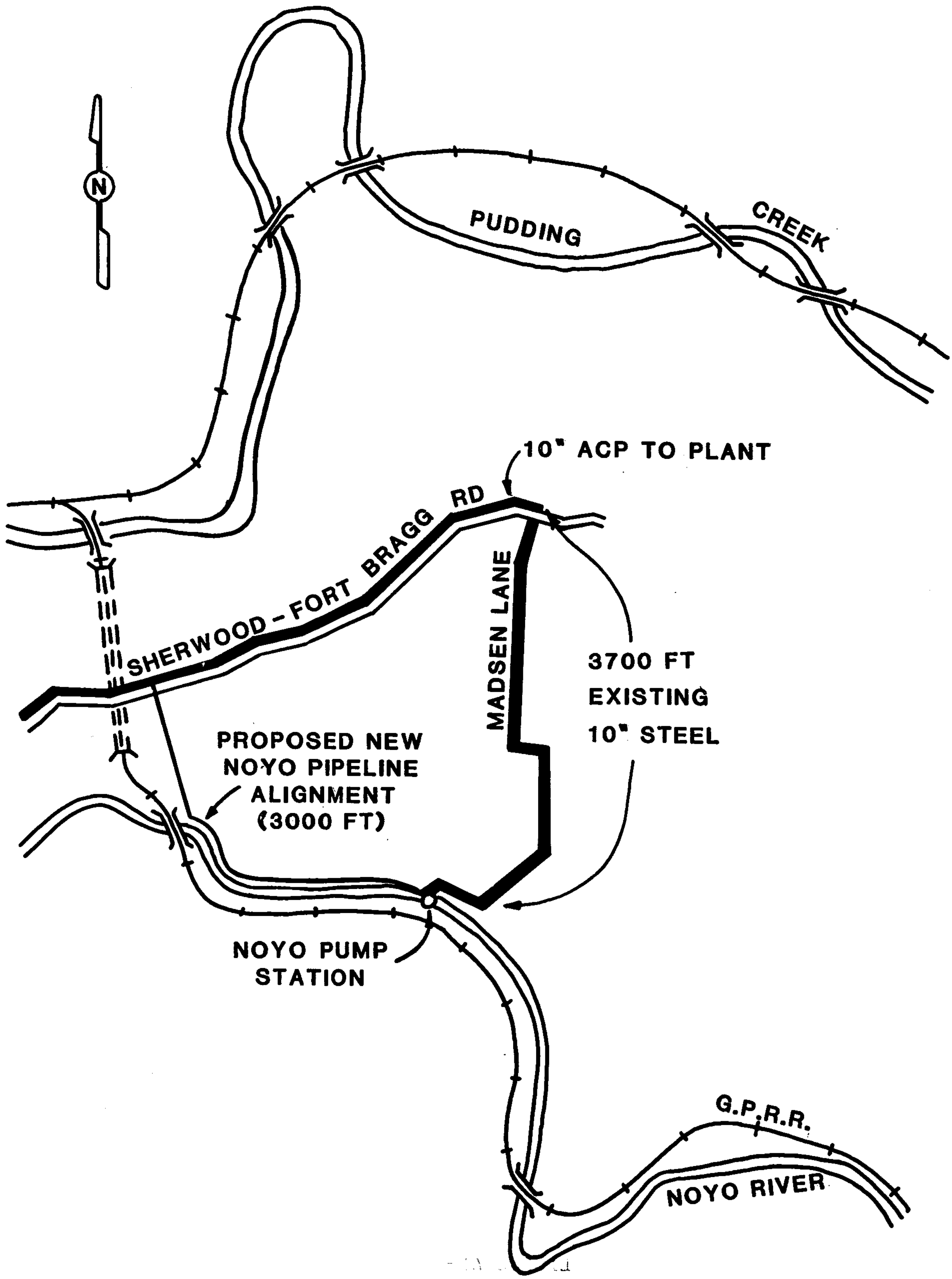
With normal operating pressures in the lower part of the Noyo line between 150 - 180 psi in the lower steel end, the water hammer or surges due to pump cycles would be expected to induce the pinhole leaks over a long time period. Proper surge control was installed in 1984/85. Recent operations have caused the pumps to cycle twice per day with the blow-off pressures on the relief valve set at about 190 - 195 psi. Leaks have again surfaced on the steel section. It is recommended that the relief valve at the pump station be set at about 185 psi and the relief valve at the top of the ridge (near Sherwood - Fort Bragg Rd) set at 5 psi or the minimum pressure required to provide gravity flow to the plant. It is also recommended that the pipe alignment for this pump station to the lower end of access road be reworked to minimize the bends in the pipe in this high pressure area. These changes would help minimize the hydraulic shock to the pipe joints and reduce head loss.

The interior of the 9.5 inch steel section was recently inspected by City staff. Inspection shows the steel line to be 9.5 inches inside diameter and in apparently sound condition. The exterior bitumastic coating is intact (P30, P31 Appendix G). The interior of the pipe however, is coated with two substances. The inside coating, about 1/32-inch thick, appears to be a factory applied, hard enamel or ceramic type material. The outer deposit, about 3/16-inch thick, is a soft, orange sticky clay material from the Noyo. The pipe should be "pigged" for removal of the soft deposits, retested for capacity and checked for leaks. If pipe conditions are such that excessive leaks develop along the pipe barrels in addition to the joints after "pigging," then the 3,700 foot steel segment of the Noyo pipeline should be replaced.

Replacement of this segment is otherwise scheduled between 1990 and the year 2000. Pipe sizing is based on a minimum of 3 cfs deliverable to the WTP at the existing available pumping head.

Replacement of the steel portion of the Noyo pipeline brings in two optional alignments - one is 3,700 feet of pipe along the existing alignment, in existing rights-of-way, and with 427 feet of pumping lift (estimated 1985 cost $170,000, Appendix H); the second is about 3,000 feet of pipe about 2,000 feet along the base of the northerly flood plain wall of the Noyo to the G-P railroad tunnel then up the flood plain wall to tie into the pipeline in Sherwood - Fort Bragg Rd (estimated 1985 cost, $173,000, Appendix H). This new alignment is proposed in rights-of-way yet to be acquired by the City but with only about 340 feet of pumping lift. Figure VI-7 shows the alignments.

An analysis of the energy servings relative to the 90 feet of head by changing the Noyo pipeline alignment from Madsen Lane to a "river route" shows an estimated savings of about $14,000/year. This appears to be an attractive alternative based on economics and the recent trend of increasing energy costs. However, the recommendation is to maximize the useful life of the existing line before pursuing replacement. Groundwork, however, by the City should begin immediately to better define costs related to the two pipeline routes. This would include details on rights-of-way, environmental

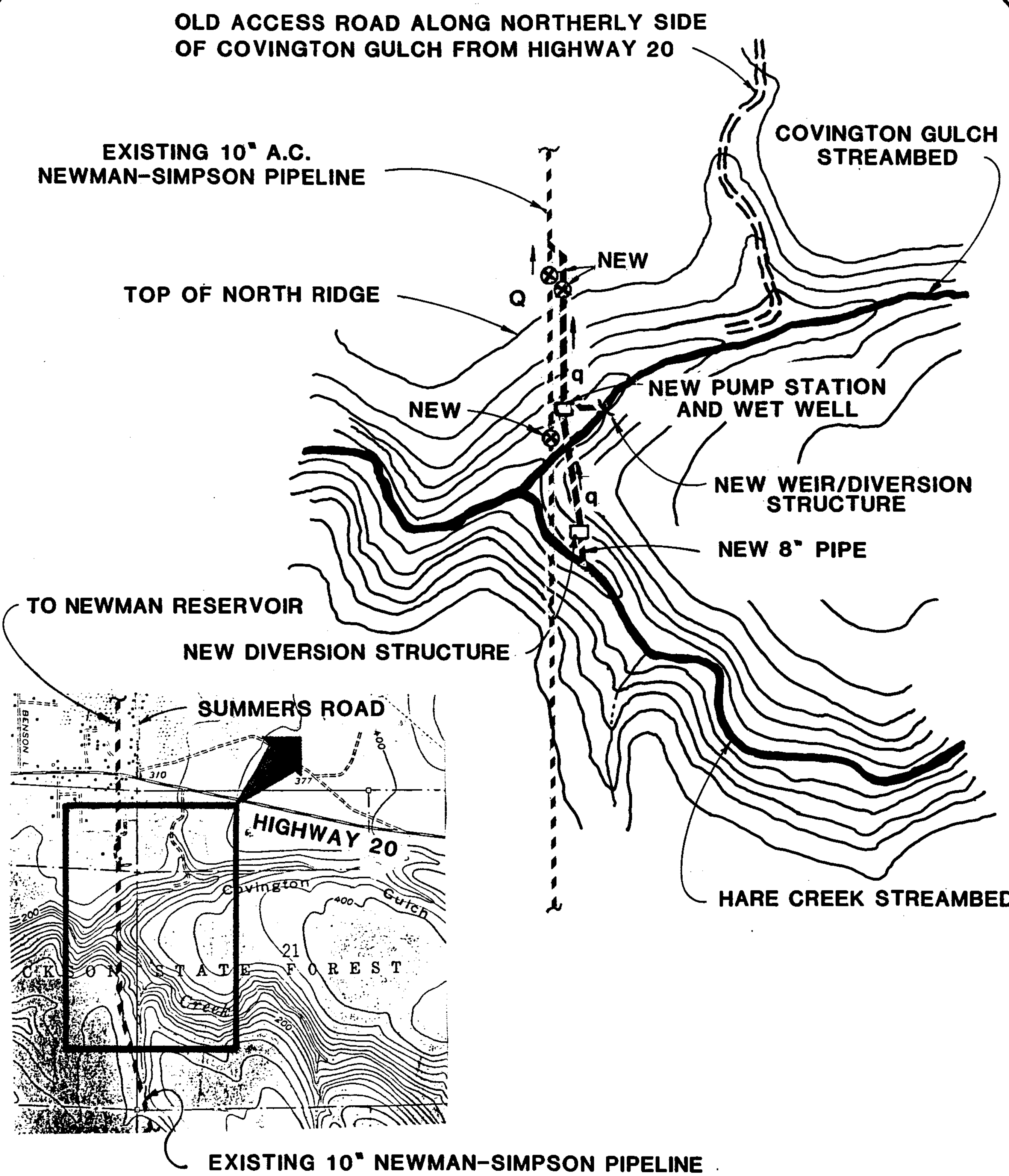


NOYO PIPELINE ALIGNMENTS

constraints, actual pipe distances, pipe material and proposed pipeline installation.

COVINGTON GULCH AND HARE CREEK DIVERSIONS. As discussed earlier, these two diversions would be served by a single pump station on Covington Gulch and discharge into the Simpson Pipeline at the top of the north ridge of Covington Gulch (el. 240 ±). To divert the proposed 1.2 cfs, initially, from each source, it is recommended that a spring box with a weir plate be used on Covington Gulch and a screened, open-ended conduit or an infiltration collector in the streambed (per Noyo diversion) be used on Hare Creek. The pump station would be on the north bank of Covington Gulch next to the spring box (el. 80 ±). The spring box and pump station would be located upstream of the Simpson Pipeline crossing of the gulch at the end of an old railroad access road. The diversion in Hare Creek would be upstream of the confluence of Covington Gulch and Hare Creek to allow diversion by gravity into the pump station wet well (see Figure VI-8).

The pumps would be submerged in a gravity fed wet well and discharge into a new 8 inch pipeline. The new pipeline would parallel the Simpson Pipeline to the top of the north ridge above Covington Gulch. The new line would be tied in at the top of the north bank. Power for the station would be extended from Pacific Gas and Electric facilities south from Highway 20.



PROPOSED COVINGTON GULCH/HARE CREEK DIVERSIONS

JOHN CAROLLO ENGINEERS

FIGURE VI-8

CHAPTER VII

WATER TREATMENT PLANT IMPROVEMENTS

EXISTING FACILITY DESCRIPTION

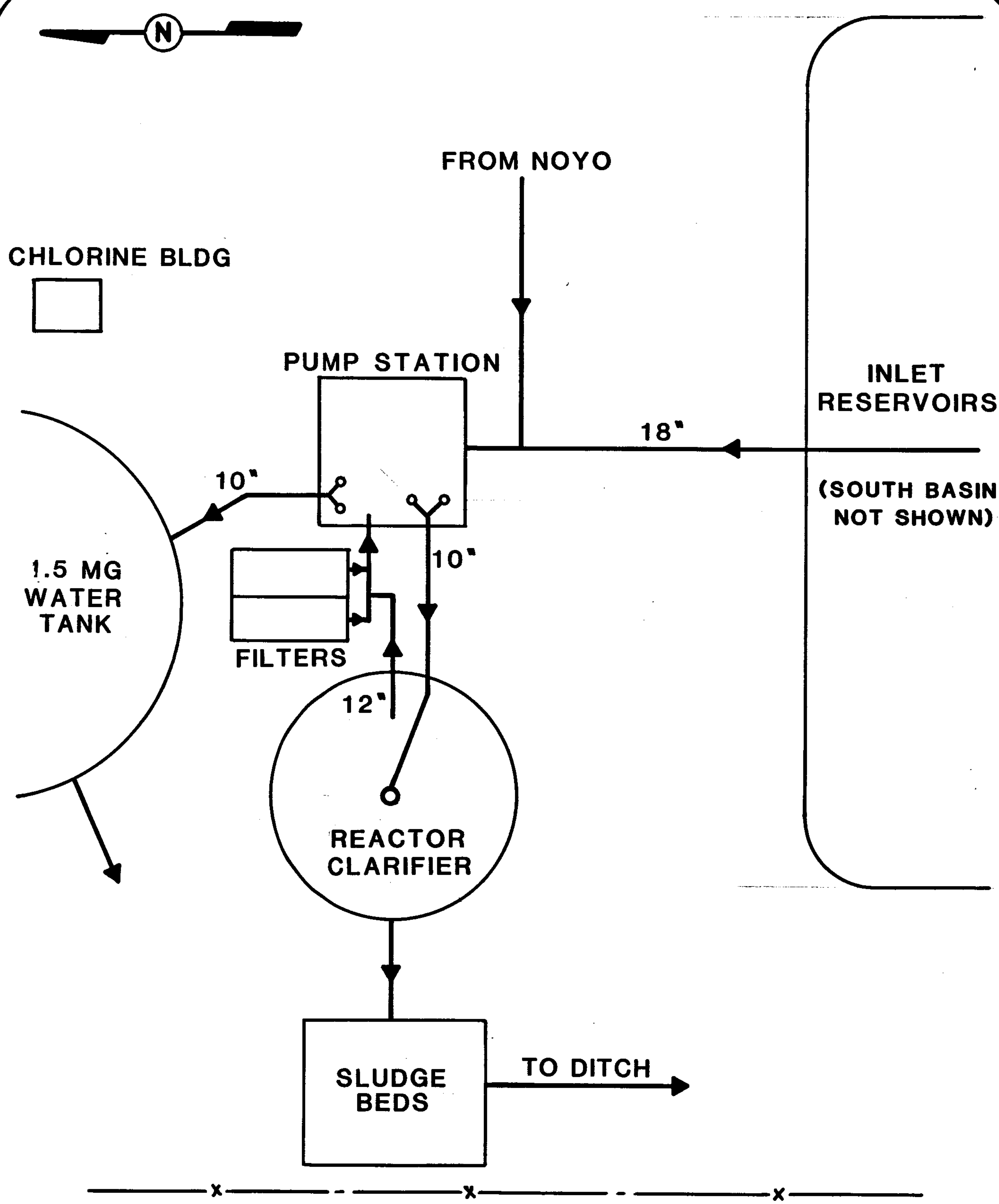
GENERAL. The existing facility was constructed in the late fifties and has subsequently had several improvements. The basic site plan and water flow schematic are indicated in Figure VII-1. The treatment scheme consists of chemical coagulation, flocculation, sedimentation, filtration, and chlorination. Water is pumped to the sedimentation basins and flows by gravity through the remainder of the process. The finished water must be pumped into the distribution system.

The original design concepts utilized lime and alum for the primary method of treatment. The City recently switched to an all polymer system and it operates with excellent results.

All systems are manually controlled and adjusted by a part-time operating staff. The staff relies on historical information and personal experience for adjustments to the process. The operators are also responsible for routine lab tests conducted at the water treatment plant (WTP).

Over the years, the finished water has exceeded both bacteriological and turbidity standards on many occasions. This is mainly a direct result of the operators not having the proper equipment to treat the water. It was the reason why numerous recent improvements were implemented and this study was undertaken.

A complete description of each unit process and an evaluation leading to a recommendation follows. They are described generally in the order that the water flows through the process.



CITY OF FORT BRAGG MASTER WATER PLAN

EXISTING PLANT SITE PLAN AND FLOW SCHEMATIC

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Figure VII-1

STORAGE PONDS

GENERAL. The raw water storage ponds (inlet reservoirs), are two series-flow earthen basins connected by a pipeline. Raw water from Newman Gulch continuously discharges into the ponds. The pond level fluctuates depending on the WTP production and the flow in the Noyo pipeline. The ponds serve two very beneficial purposes. They act as a flow buffer between the WTP and the water sources and they reduce the high turbidity in the raw water since they are actually large settling basins.

The pond level is monitored manually by visual observations. It is common for weeds and algae to encroach on and in the ponds. This is definitely conducive to a deterioration of the raw water quality.

The ponds are difficult to clean because of limited access and earthen construction.

It has been noted that equipment (specifically the street sweeper) is stored in close proximity to the ponds and can contribute to the dust and debris found in the ponds. The practice of burying dead animals and the use of herbicides on the berry bushes is also allowed within close proximity of the ponds.

EVALUATIONS. There are too many benefits of having these ponds at the head of the WTP to even consider not using them as part of future expansions. It would be more appropriate to enhance their efficiency and accessibility. The major emphasis should be placed on revising the piping and basin configuration so that access for maintenance can be assured. In addition, all the clarified waste backwash water should be diverted back to these ponds so it can be recovered. During the dry months, the backwash water can represent up to 10 percent of the plant production as it now exists.

Two methods of creating a multi-basin configuration were evaluated as indicated in Figure VII-2. These were:

1. Divide the existing basins into halves using an earthen berm. The earth would be removed from the side slopes and pushed towards the center. Reroute piping as required. The net change in basin volume would be minimal.

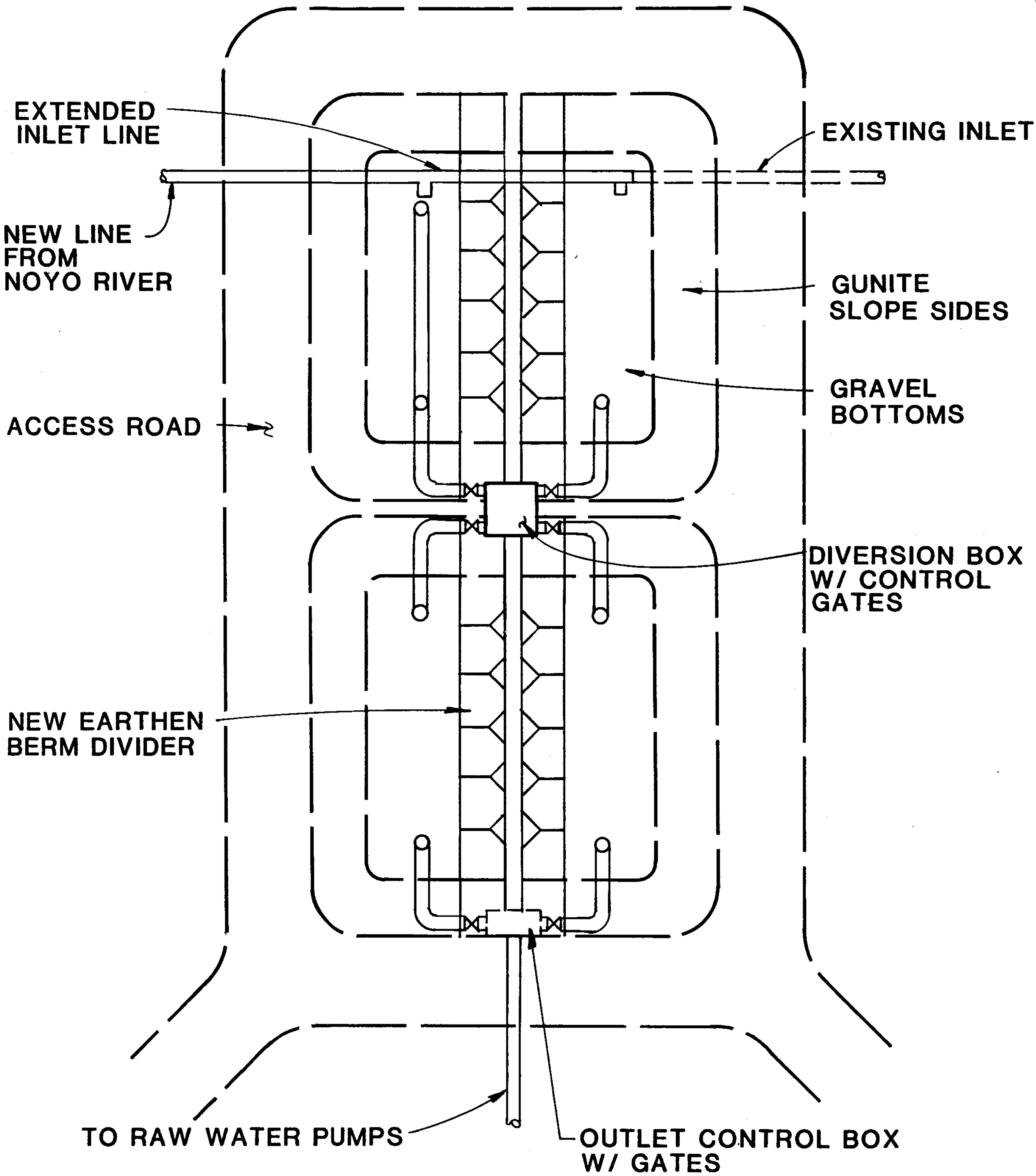
2. Divide the existing basins into halves by constructing a concrete dividing wall down the middle. Reroute piping as required.

Both of these configurations were further evaluated utilizing either concrete or gravel bottoms. Durable bottoms should be constructed for maintenance access and to reduce algae and/or weed growths. However, concrete bottoms are estimated to cost from eight to ten times more than gravel. Gunite side slopes will prevent weed growths and allow easy cleaning.

The operational aspects and the configurations are exactly the same so it is a matter of preference and cost as to the best choice. The costs for the earthen center berm would be from 10 to 20 percent of the cost of the concrete center wall.

The present 10 inch pipe from the Noyo River Pump Station goes directly into the WTP pump station. However, the line is also teed off into the plant inlet basins and thus effects the level in the basins. It will be beneficial if the Noyo pipeline is rerouted such that flow must go through both inlet basins and then to the WTP pump station. This flow scheme will improve circulation in the basins and increase the blending of the relatively easier to treat Noyo water with the more difficult Newman-Simpson water. Another major advantage is that rapid increases in Noyo water turbidity will be eliminated by blending.

RECOMMENDATIONS. Analysis of the inlet basins indicates that they are of great value and should be improved. The two existing basins should be split



CITY OF FORT BRAGG MASTER WATER PLAN

STORAGE POND MODIFICATIONS

JOHN CAROLLO ENGINEERS

Figure VII- 2

into four basins (Figure VII-1). The inlet pipe and backwash return lines should be rerouted to allow flow into each section. Permanent gunite side slopes are required to protect against weeds, algae, and erosion. Gravel bottoms will allow vehicular traffic for maintenance access. The Noyo pipeline should be diverted into the southerly basin with the operational option to discharge into either or both basins.

There should be a policy decision by the City which eliminates the use of the WTP grounds for any uses other than those directly related to the production of water. Equipment storage, animal burial, and herbicide spraying are not compatible uses.

PUMP STATION BUILDING

GENERAL. The existing pump station is actually a multiple use facility. It contains both the pumps for the raw water and finished water as well as all the administrative, lab, and maintenance areas. Except for chlorine, all chemicals are also contained within the structure. The uses within the building have changed over the years and the superstructure is in need of modernization so that the space can be better utilized. A structural field inspection of the clarifier, filter, water tanks and operations/pump building was made (Appendix I).

EVALUATIONS.

Water Storage. Both the raw water and finished water storage tanks are adequate and need not be replaced in the future. The pumps should be replaced as part of this modernization. Better level sensing should be incorporated for pump control and monitoring purposes. When new raw water pumps are purchased, they should be of the variable speed type equipped with a flow pacing signal transmitter for chemical systems and high efficiency motors. The finished water pumps need not be variable speed.

Chemical Systems. The location of the chemical systems is satisfactory and continued usage of the same equipment can be expected. Changes in piping would be appropriate when the new flocculators and filters are constructed. These changes are considered minor. A new potassium permanganate system should be installed. It will serve several purposes. It will reduce the chlorine demand thus allowing a reduction in applied chlorine and, more importantly, will reduce the potential for trihalomethane formation. It is also an excellent treatment method for taste and odor control in the raw water, especially for algae caused problems. A survey conducted by AWWA showed that 75 percent of taste and odor problems are algae related. The inlet reservoirs themselves can serve as an ideal place to grow algae. Application of the permanganate should be in the influent to these reservoirs to assist in algae control. It should be noted that permanganate turns the water purple and therefore care must be taken to insure that purple colored water does not leave the treatment plant. The operators must monitor the color so that purple water does not get past the first stage of the flocculation basins. This provides an ample margin of safety. The by-product manganese dioxide often acts as a flocculation aid and will be removed in the filters. Ideally, the filters should never have purple colored water applied to them. The possibility of manganese dioxide passing through the filters is directly proportional to the purple color that is allowed to be applied to the filters. A yellow brown color could be imparted to the finished water if manganese dioxide passes the filters.

The normal dosage of permanganate is from 0.5 to 2.5 mg/l. Specific characteristics are listed below:

Hazards:	Fire hazard associated with large quantities of potassium permanganate. Explosions are liable to occur

when it is brought into contact with organic or readily oxidizable materials either in solution or in dry state. May ignite combustibles (wood, paper, oil, etc.). Runoff to sewer may create fire or explosion. Contact may cause burns to skin and eyes. Vapors or dust may be irritating. Fire may produce irrigating or poisonous gases. It is spontaneously combustible with carbon. Self-contained breathing apparatus and full protective clothing should be provided. Overhead sprinkler system installed in the storage and feeder rooms is advised.

Bulk Storage: 330-pound drums.

Piping: Plastic, FRP or stainless steel.

Metering: Dry feeder with eductor from solution tank.

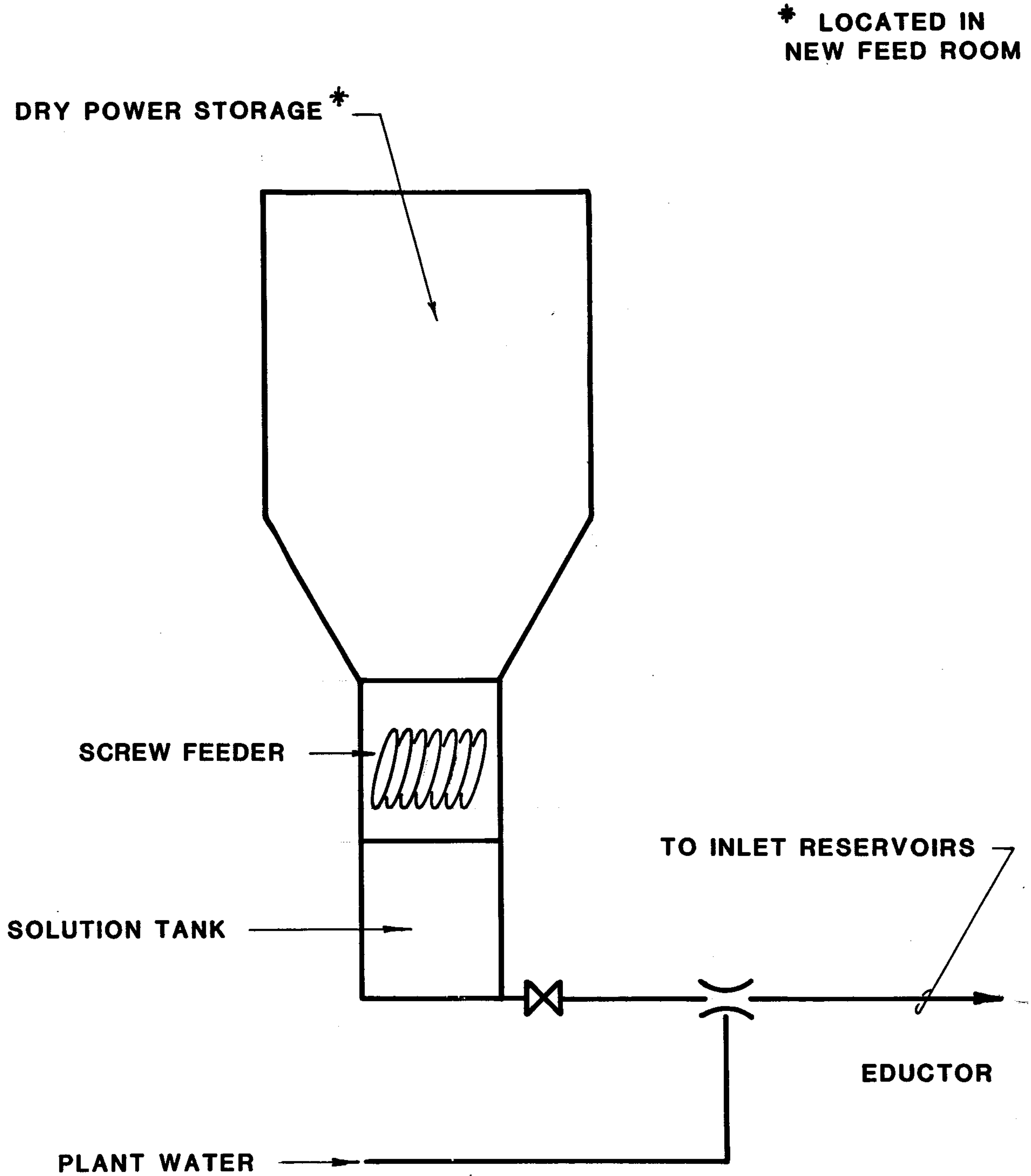
Freeze Protection: Not required because system will be indoors.

It is fed as a dry powder and then dissolved into a solution for application. A simple eductor system with a volumetric screw feeder is recommended as indicated in Figure VII-3.

If a trial corrosion control program is not implemented, a new caustic soda system should also be installed for pH control. This will allow pH adjustment prior to pumping into the distribution system so that Langier Index (corrosiveness) can be maintained within acceptable limits. The system is simple in that caustic soda is purchased in bulk liquid form, stored in fiberglass tanks, and pumped in a manner to apply precise amounts of the chemical.

When feeding caustic soda it is very important to design a system so that it is impossible to overfeed the chemical in the event of a mechanical malfunction of any component. The major safeguards should concern bulk storage. It should be designed such that it can not empty directly into the water system. Figure VII-4 indicates a typical installation. It´s characteristics are listed below:

Availability: Bulk or 55 gallon drums.



TYPICAL PERMANGANATE FEED SYSTEM SCHEMATIC

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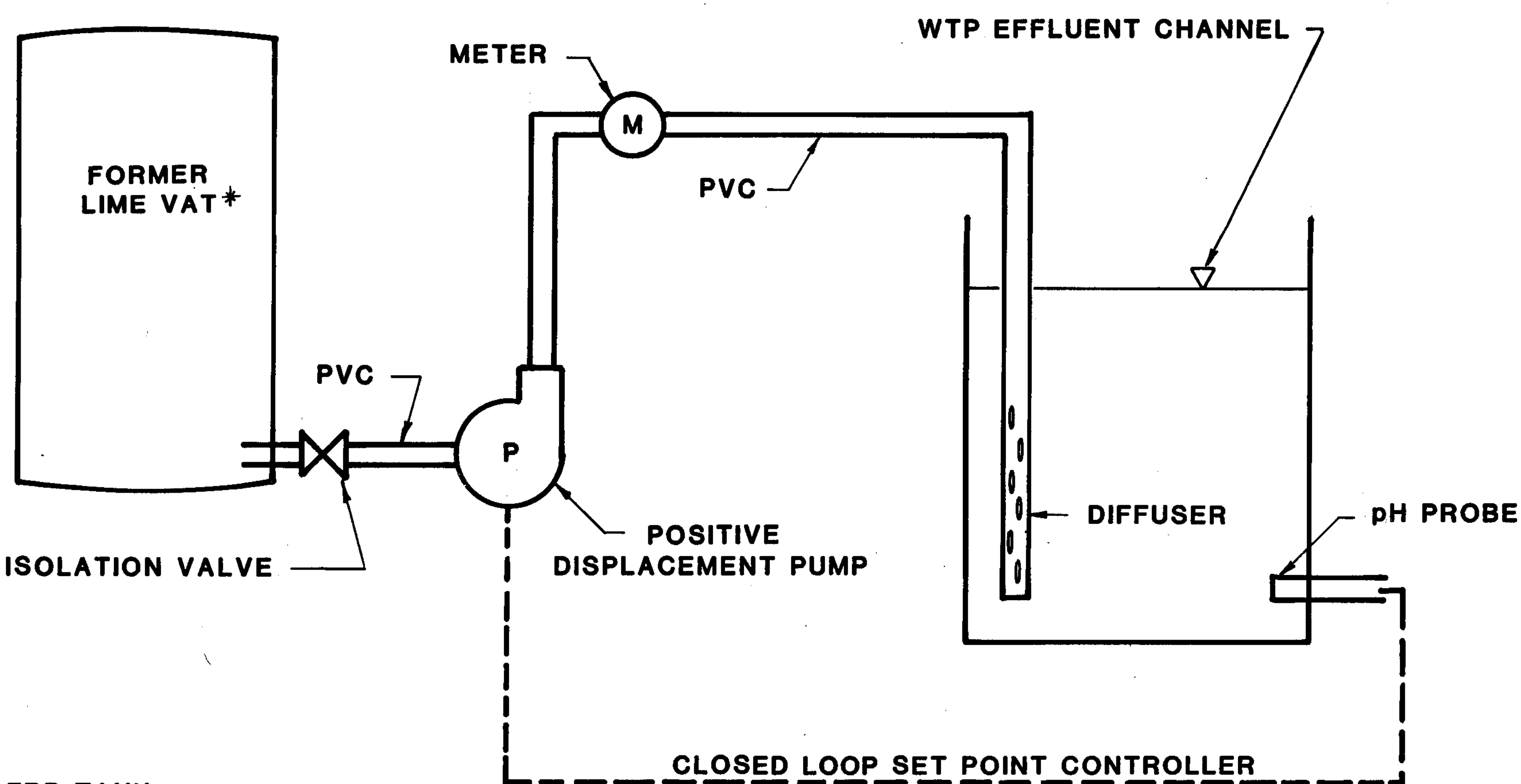
FIGURE VII - 3



* NEW FRP TANK
COULD BE USED

TYPICAL
CAUSTIC SODA FEED SYSTEM
SCHEMATIC

JOHN CAROLLO ENGINEERS

FIGURE VII - 4

Hazards: Caustic soda will cause severe burns to the skin and eyes, scarring of tissue and blindness. swallowing may cause severe burns of the mouth, throat and stomach. Death may result. Caustic soda is not combustible. Complete protective equipment is necessary, including head covering, respirator with goggles, cotton clothing, button collar, rubber apron, sleeves over rubber gloves, and trousers over rubber work shoes. Contact lenses should not be worn when working with this chemical.

Bulk Storage: FRP tank with dike around it for rupture protection or existing former lime vat in pump room.

Piping: Plastic, Alloy 20 or 316 stainless steel.

Metering: Positive displacement pump.

Freeze Protection: Gels below 60 degrees F. Heating provisions required unless housed indoors.

A back-up polymer pump is also recommended. The successful treatment of the water without alum places added significance on the need for reliability of the polymer system. The popularity of polymer treatment is increasing rapidly throughout the U.S. because of the ease of handling, feeding, and low sludge production. Several WTP's in the Bay area utilize this approach. JCE recently completed the design of a WTP in Utah that utilizes only polymers on a seasonal basis. It is interesting to note that during the pilot testing of the Utah WTP the particle counts (and turbidity) were significantly improved by the use of polymers.

Although polymers do not depress the pH as much as alum systems do, there is still a need for the proposed caustic soda system to control the final plant pH, i.e., corrosivity.

The City has had excellent experience in the treatment of the water using only polymers. The success of this practice is particularly significant in that the problem of low alkalinity is not a factor. Alum systems specifically must rely on adequate natural alkalinity for the reactions to occur. Waters, such as Ft. Bragg's, that do not have sufficient natural alkalinity must introduce a source of alkalinity in the treatment process. This normally requires a lime system to be installed. Lime systems are typically labor intensive due to high maintenance requirements and they cause the treatment process to generate significantly more sludge than a polymer system.

A powdered activated carbon (PAC) system was evaluated for taste and odor control but is not recommended. PAC offers none of the advantages of permanganate in that it will not reduce the chlorine demand, minimize THM formation potential, nor control algae in the inlet reservoirs. If the watersheds of Fort Bragg were subject to routine contamination by organic solvents or petroleum products, the PAC system would have a definite place in the overall treatment process.

From an operational viewpoint, the handling, storage, and application of PAC is extremely difficult and messy. The equipment is maintenance intensive and the capital costs are about 50 percent more than permanganate system. Specific characteristics are listed below:

Hazards:	Carbon is a flammable substance which burns with intense heat. Bags should be stored in fireproof room. Carbon is spontaneously combustible with gasoline, mineral or vegetable oils or chloride of lime, hypochlorites, sodium chlorite or potassium permanganate. Protective clothing, gloves, goggles and face shield should be provided for handling carbon. Dust collection equipment should be provided where carbon is being unloaded into bins or hoppers. Automatic fire protection system should be installed in case of fire.
Bulk Storage:	50-pound bags, slurry storage not recommended.

<u>Superstructure</u>. The superstructure was evaluated from two aspects; modifications to the existing building, and a completely new superstructure.

Two new chemical systems will be housed within the pump station building. These are the potassium permanganate and caustic soda facilities. Safety consideration dictates that the permanganate should not be housed in the wooden structure. A new fire proof feed room can easily be added in the front of the building near the unloading dock. The recently installed polymer tank will have to be relocated.

The caustic soda system could be located where the former lime vat and pump were. A pipe connection from the lime vat to the unloading dock area will allow bulk deliveries of caustic soda to be made conveniently.

The building itself is structurally sound, however, there is a shortage of office and laboratory space. Minimum laboratory size is approximately 250 sf including one office space. A new lab/office addition can be conveniently added to the south or east of the present lab area.

The major disadvantages of trying to modify the wooden structure are:

1. The structure is not adequately protected from fire hazards.

2. The electrical facilities do not meet current codes. Any changes to the system will require a complete modernization to current codes.

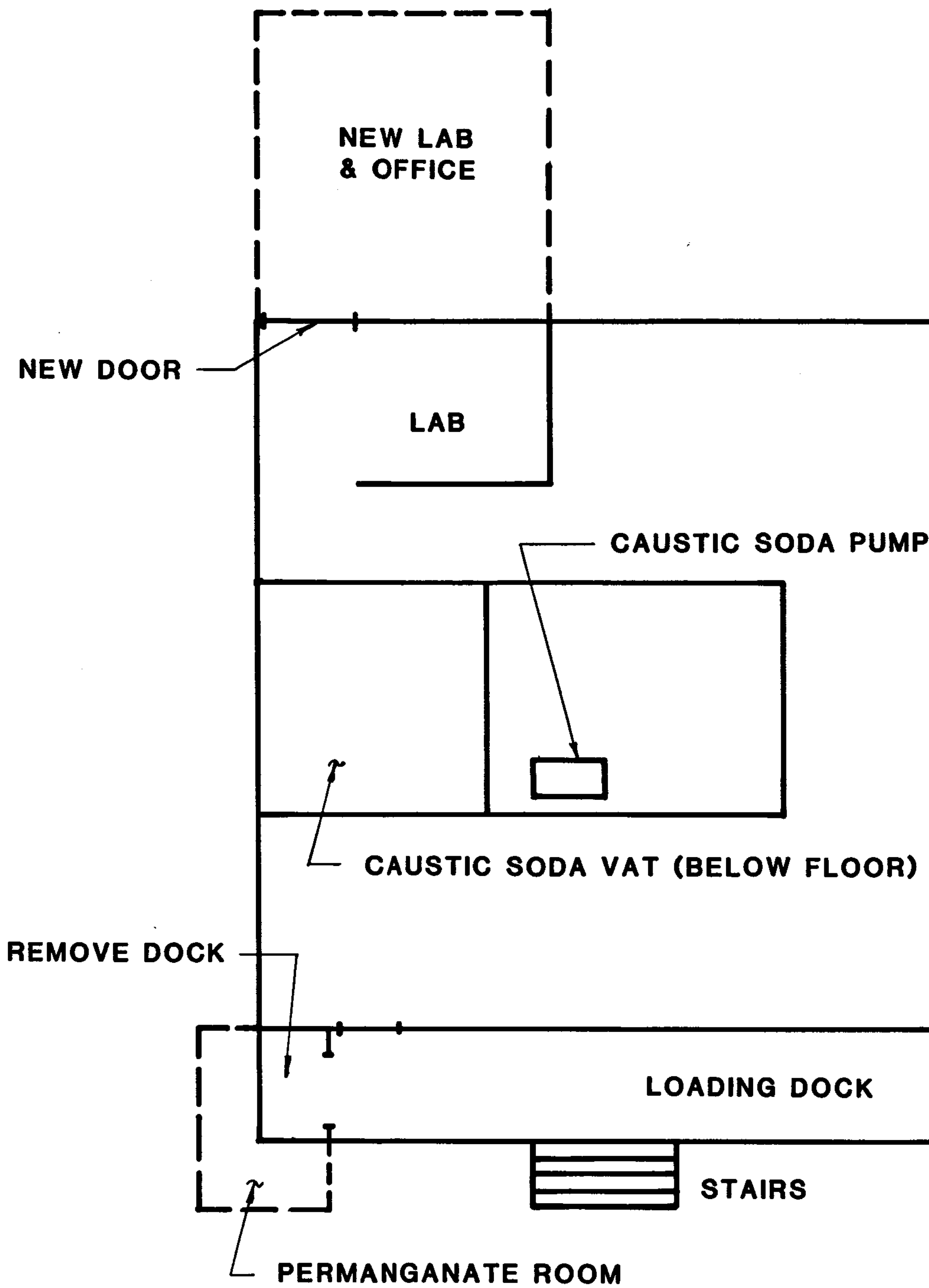
3. The heating and ventilation system was not designed for the environment that computer based equipment needs. Extensive insulation and mechanical equipment would be required.

4. Lighting does not comply with current OSHA criteria.

5. The useful life of the wood can not be expected to match the life of the new water treatment plant without an on-going program of maintenance even through the present condition is acceptable.

A suggested layout of the modified building is indicated on Figure VII-5. Refinements to this would be made during the detailed design phase.

The entire wooden superstructure can be systematically removed and replaced with new metal or block construction. To save money, the walls would



REVISED PUMP ROOM FLOOR PLAN

(ONLY NEW ADDITIONS SHOWN)

JOHN CAROLLO ENGINEERS

FIGURE VII - 5

be constructed on the roof of the present raw and finished water storage basins. The design would incorporate the necessary environmental features to allow human and computer comfort.

RECOMMENDATIONS. The location and condition of the concrete make it desirable to utilize this structure in future plant expansions. The following items are recommended:

1. Replace the present wooden superstructure with a new metal or block building.

2. Add a potassium permanganate system inside the new building.

3. Add a new caustic soda system inside the new building.

4. Purchase a spare polymer pump.

6. Add laboratory and office space.

FLASH MIXER

FLASH MIXING. The current method of flash mixing utilizes an in-line static mixer. It appears that this type of mixer works well and no changes, other than location, should be required.

FLOCCULATION/SEDIMENTATION

GENERAL. Flocculation is a process which converts the small coagulated particles formed during flash mixing into discrete, visible, suspended particles by promoting particle to particle contact. This is obtained operationally by gentle and prolonged mixing and results in particles large enough to settle by the influence of gravity and/or removal from suspension by filtration.

The primary purpose of the sedimentation basins is to reduce the solids load to the filters and remove bacteria entrapped during the flocculation process. To accomplish this, sedimentation basins must perform within certain design parameters, especially overflow rate, and have an efficient effluent collection system and proper detention time. Continuous sludge removal is also desirable and can significantly affect basic performance. These factors contribute to the overall removal efficiency and will reduce hydraulic short circuiting within the basin.

EXISTING REACTOR-CLARIFIER. The term "REACTOR-CLARIFIER" is a proprietary name for the EIMCO equipment that contains the flocculation and clarification steps within the same basin. The present unit is 50 feet in diameter and has a nominal surface area of 1,963 square feet. There is only one unit. The problems with this unit are well documented by the operational staff and observations by John Carollo Engineers (JCE). The following questions were addressed with regards to continued utilization of the structure in future expansions.

1. Is the concrete sound enough for continued use?

   Marginally, YES; from the limited design data available, and a visual inspection, it appears that the circular design would be adequate for many years to come.

2. Does the unit operate as it was originally intended?

   NO; these units are designed to operate with a sludge blanket to assist in floc entrapment before clarification. Operational experience verifies that the sludge blanket seldom, if ever, exists. The mechanisms cannot even be turned on without causing an immediate disruption in the process. Sludge seldom settles and is therefore passed immediately to the filters.

3. Is the unit large enough to be modified for future requirements?

   Marginally; experience with water that is difficult to treat indicates that the capacity will be limited by an overflow rate of 700 gal/day/sf. This corresponds to a production capacity of only 1.37 MGD which is not adequate. The addition of tube settlers could increase the capacity based on 2 gpm/sf, to meet the future maximum day demand of 3.4 MGD. The configuration of the flocculation zone is not conclusive to tapered energy flocculation and is thus considered deficient beyond modification.

4. Are the hydraulics of the existing unit compatible with future expansions?

   YES; the height of the unit makes it able to easily be compatible with future additions. It should, however, be noted that it is one of the goals of this evaluation to reduce overall energy consumption in the new process. In this light, the height of the unit is a definite negative characteristic.

5. Is a single unit adequate for reliability?

   NO; the flocculation process in particular, is very important to always have in service. If this particular unit is out of service, then both the flocculation and sedimentation processes are also out of service. The filters cannot be expected to perform adequately under these circumstances. There is sufficient room to construct a second duplicate unit.

6. Can this unit be utilized for any other purpose?

   YES; the existing tankage can be converted to a sludge thickening and storage tank for filter backwash water. The height of the structure will allow gravity flow of the settled backwash water to the storage basins at the head of the plant. The thickened sludge can be placed, by gravity, into new sludge drying beds.

CONCLUSIONS. Based on the answers to the above, questions and the jar testing data presented in Appendix J, it was concluded that:

1. Multiple flocculation units should be constructed as an independent unit process. They should incorporate tapered energy flocculation and have a 30 minute detention time.

2. Sedimentation basins should not be included in the future expansion. The floc exhibits very poor settling characteristics and basins would only be marginally effective. High turbidity in the raw water can be adequately handled by the storage ponds.

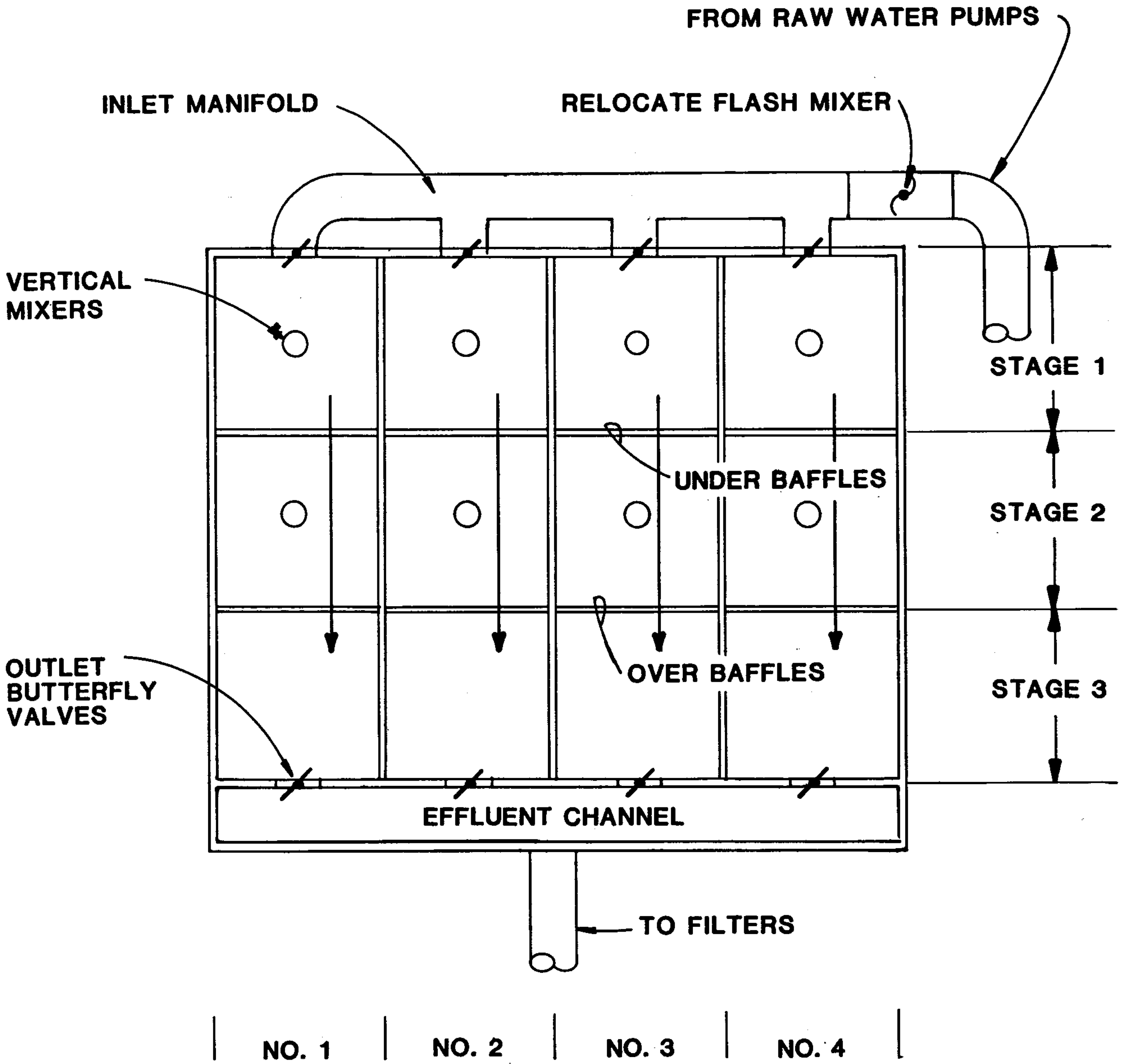
3. New units should be constructed at a lower hydraulic grade line as an energy conservation measure.

ALTERNATE CONFIGURATIONS. New flocculation basins should be constructed in a manner that allows operational flexibility for the staff. It is desirable to be able to take at least one unit down for maintenance without disrupting the process. Multiple units satisfy this need. Two units are not considered adequate because, depending on the time of year (flow), the detention time and treatment effectiveness would be severely impaired if one unit were out of service when it is really needed. Evaluations for three and four units were considered. The operating parameters are listed below. The numbers in parentheses represent one unit out of service.

Description	3 Units		4 Units	
Flow per unit, MGD				
@ average day of max. month	0.9	(1.06)	0.64	(0.71)
@ annual average day		(0.81)		(0.54)
Detention Times, minutes				
@ average day of max. month	30	(20)	30	(22.5)
@ annual average day	39	(26)	39	(29)

This data indicates that four units will allow the most flexibility and be able to keep within the 30 minute design criteria during the average day of the maximum month. The remainder of the year, one unit can be removed from service to save energy and operating expenses, while still keeping within the design criteria for detention time.

RECOMMENDED BASINS. It is recommended that four new concrete flocculation basins with three stages (compartments) be constructed. The basins would be concrete with non-metallic sluice gates and baffles. Mixers would be the vertical entry for ease of access and compactness of geometry. Jar testing indicates that very low energy gradients are required so the final stage will not be equipped with mechanical mixers. All mixers will have variable frequency drives for good process control. The new flocculator can be located between the existing raw water forebay and the earthen storage ponds. Their configuration is indicated in Figure VII-6. One foot of extra head will be designed into the basins so that sedimentation basins could be added in the future if necessary. The design criteria are listed below:



CITY OF FORT BRAGG MASTER WATER PLAN

PROPOSED FLOCCULATOR LAYOUT

Number basins, each	4
Number compartments	3, each basin
Volume, CF @ 30 min	
Total	5,900
each basin	1,476
Dimensions, ft. each basin	
length	7.9
width	7.9
depth	7.9
Type flocculator	vertical entry
Drive	variable frequency with planetary gears

Velocity Gradient, sec^{-1}		
1st stage	40	20
2nd stage	20	10
3rd stage	10	0

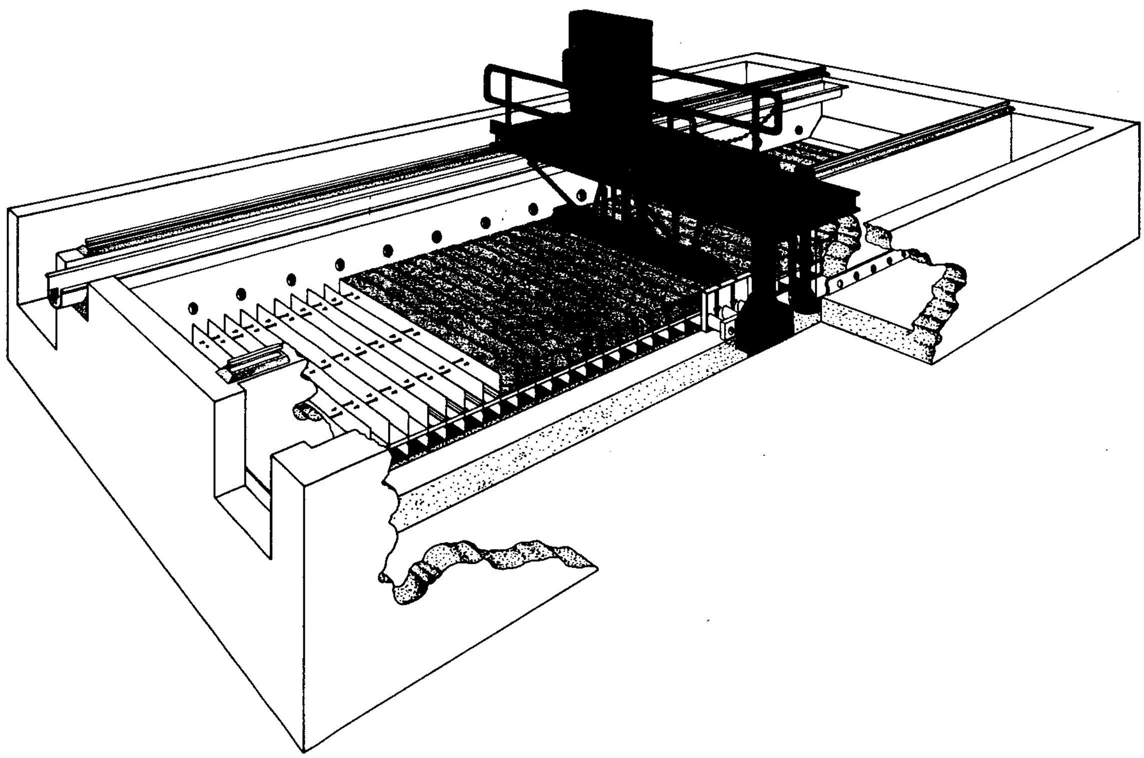
FILTRATION

GENERAL. With the possible exception of chlorination, filtration is the most important phase in the series of unit processes. It is the final process in the removal of suspended material from the water. Filtration is also effective in the removal of microorganisms, thus reducing the demand imposed upon chlorination and protecting the consumer against vital and bacterial contamination of water.

Filters are generally classified according to their operational characteristics. They can be hydraulically classified as slow or rapid, of which rapid is the most prevalent and economical. They can be classified by type of media such as sand, coal, coal-sand (dual media), mixed media, activated carbon, or diatomaceous earth of which dual and mixed media are the most predominant. The final classification is according to whether it operates by pressure or gravity, of which gravity is considered the more reliable. Pressure filtration will not be considered for this project based on poor reliability and less efficient turbidity removal. Implied is less efficient (or none) removal of Giardia or viral type organisms. Floc subjected to pressure is more likely to "break through" and cause a rapid deterioration in water quality. Since the early 1900's, most filtration plants have been constructed with rapid rate, granular media, gravity type filters. The early designs during this period were generally provided with a single sand type of media. In recent years, increasing use has been made of dual media, or multi-media filter beds, which are capable of increased efficiency at higher filtration rates than the conventional sand bed. Whether filtration is by single or dual media, effective filtration depends on media which is sized correctly and has appropriate physical characteristics. The sand and coal must also be compatible physically and hydraulically, especially for effective backwashing.

Before 1950, filters were designed to provide a reasonably constant flow rate, and the rate was controlled either manually or with an effluent rate-of-flow controller. This type of filter control is called constant rate effluent flow control (CREFC). During the past 30 years, two alternative methods of flow control have been developed, called constant rate influent flow splitting (CRIFS), and variable declining rate (VDR). These are both more appropriate to larger capacity water treatment plants than exists at Fort Bragg.

Multi-cellular automatic backwash filters have been manufactured and have been in continuous use for more than 40 years. These type are illustrated in Figure VII-7 and are particularly appropriate for the City of Fort Bragg. Recent improvements in the backwash methods now virtually eliminate the problems of turbidity breakthrough. A list of installations is included in Appendices K and L.



CITY OF FORT BRAGG MASTER WATER PLAN

MULTI CELLULAR AUTOMATIC BACKWASH FILTERS

JOHN CAROLLO ENGINEERS

DIRECT FILTRATION AT FORT BRAGG

GENERAL. The term "Direct Filtration" as used in this report is defined as a sequence of water treatment processes which include coagulation, flocculation and filtration, eliminating the sedimentation process. Direct filtration is not a new concept.

There are numerous reports in the literature regarding the successful application of direct filtration under favorable conditions. The favorable conditions most frequently mentioned are in reference to raw water quality and include a maximum turbidity of 15 to 25 for maximum turbidity units and maximum color of 25 to 40 units. Problems associated with higher values were reported to be alleviated by the use of polyelectrolytes. Coliform removals were satisfactory in direct filtration plants.

An AWWA Committee Report stated that in their evaluation of operating direct filtration plants, "bacteria and virus removal problems appear to be minimal as long as turbidity control and color removal are consistently attained and efficient chlorination is practiced." In recent years, there has been an intense concern over the occurrence of Giardia Lamblia in water system. Removal or destruction of Giardia can be extremely difficult in the water treatment process. There are two basic factors that must be addressed before adequate removal or deactivation can be assured. These are; resistance of the cysts to chlorination during the relatively short detention times normally encountered and; the small (10 um) size of the cyst. Cysts will pass directly through the pore spaces of all filters unless filtration is preceded by proper coagulation/flocculation.

The U.S. Environmental Protection Agency (EPA) recently completed (September, 1985) its final research project on the removal of Giardia cysts by rapid rate dual-media filters. It concluded that:

1. Effective coagulation flocculation is an absolute necessity for proper filtration of the cysts.

2. The filtration efficiency was not effected by the mode of filtration, i.e., direct filtration or in-line filtration.

3. The hydraulic loading rate over the range of 2-10 gpm/sf showed no discernible effect until that 10 gpm/sf rate was actually reached.

4. Turbidity reduction and coliform removal can be used as a surrogate measure of cyst removal.

It should be noted that this report specifically proposes flocculation basins that will allow proper pretreatment prior to filtration. The backwash water which would contain the cysts will be thickened in the modified reactor-clarifier. The encapsulated cysts will be removed in the sludge that is transferred to the drying beds. The supernatant that is returned to the inlet reservoirs will have been subjected to chlorination for an equivalent of 10 days. In the remote instance where a live cyst is reintroduced to the inlet reservoirs, it would go through the entire process again and the chances for its survival are essentially zero.

Some precautionary measures were suggested in some of the literature before direct filtration is recommended, including a careful evaluation of local conditions affecting the raw water quality and pilot plant testing to more accurately determine the suitability of direct filtration in providing satisfactory treatment.

The Committee report presented data accumulated from direct filtration plants across the country and listed some conditions which should be evaluated prior to recommending direct filtration. These included the following:

1. Can the supply source(s) be used selectively to control water quality to the filter plant?

2. Are turbidity-producing storms seasonal, and do they coincide with maximum water demands?

3. What is the likelihood of algae growths, especially those of the filter clogging species?

In addition to the above conditions, the Committee also presented the following criteria for direct filtration:

> "Experience cited in the literature provide some preliminary means of assessing the use of direct filtration. In general, waters with less than 40 units of color, turbidity consistently below five units, iron and manganese concentrations of less than 0.3 mg/l and 0.05 mg/l, respectively, and algae counts of up to 2,000 asu/ml appear to be perfect candidates for direct filtration. Bacteria and virus removal problems appear to be minimal as long as turbidity control and color removal are consistently attained and efficient chlorination is practiced."

With regard to the proposed plant modifications, the questions raised by the Direct Filtration Committee as presented herein can be evaluated as follows:

1. Can the supply sources be used selectively to control water quality to the filter plant?

   YES. The current sources appear to have raw water quality which can meet the requirements of the Federal and State Water Regulations. Direct filtration can be used because raw water quality meets these requirements and the sources can be selected by the operating staff.

2. Are turbidity-producing storms seasonal, and do they coincide with maximum water demands?

   The maximum turbidity occurs during the winter months which is also the period of reduced consumption. The existing earthen storage basins will serve to buffer the turbidity to acceptable standards. The rerouting of the Noyo pipeline directly into the inlet reservoirs is critical.

3. What is the likelihood of algae growths, especially those of the filter clogging species?

   Major algae growths can be avoided by controlled application of algaecides to the reservoirs located on the plant site.

Based on the above, the characteristics of the raw water supply are conducive to treatment by direct filtration.

RECOMMENDATIONS. We recommend that the Fort Bragg Water Treatment Plant be modified to provide operation in the direct filtration mode. The existing storage ponds should be modified to reduce the turbidity during the winter months.

EXISTING FILTERS. The existing filters suffer from a multitude of problems that are well known by the City staff. Rehabilitation or any other work on the filter is solely contingent on the structural integrity of the concrete. Based on this premise, a structural evaluation was immediately conducted. There were no detailed drawings of the structural steel reinforcement to check for compliance with current standards. A visual inspection revealed bowed walls and corner cracks that would be conducive to future failures, especially during an earthquake. The walls also contain areas of "rotten" concrete that could actually be picked away with a screw driver. Other areas show signs of long term "weeping" through the walls. Based on the above observations it is apparent that no money should be spent on rehabilitation of the existing filters and that they should be replaced with new filters.

ALTERNATIVE EVALUATIONS. A brief cost evaluation was conducted for replacement of the existing conventional filters with four new similar filters. The first two would be constructed opposite the existing filters. After they are put into service, the existing filters would be demolished and replaced with the remaining two new filters. The cost is based on the following filter criteria:

Number filters	4 each
Capacity,	0.68 MGD
Dimensions	
Length	14 feet
Width	16 feet
Depth	12 feet

Filtration rate	5 gpm/sf
Media	
Sand	10 inch
Coal	20 inch
Backwash rate	15 - 22.5 gpm/sf
Backwash volume per cycle	60,000 gallons
Backwash pump	none
Backwash recovery pumps	2 @ 5,500 GPM

The estimated total construction cost is $399,000 (ENR = 5200).

In addition to the cost, there are several reasons why these types of filters are not cost-effective for a small water treatment plant. These are:

1. When they are only two filters, and one has to be cleaned, a significant flow must be shifted to the other filter. This typically causes short term disruption in the filtration process unless each filter is over-sized to avoid the hydraulic surges. Using more filters, three or four, is costly in that substantially more structural and control costs are incurred for very little extra filtration capacity.

2. When backwashing the filters, the hydraulics of the wash water system must be designed for a sudden, short-duration, high flow rate. These filters typically require a large volume of water to adequately clean the media. The floc particles that are entrapped in the media have usually penetrated through the depth of the filter and remained there for several days making them difficult to remove.

3. These filters require 10-12 feet of available head to perform satisfactorily. All of the water is pumped to the filters and thus they would tend to be energy intensive if replaced in kind.

In summary, further consideration of conventional filters is not justified.

The use of pressure sand filters was not considered appropriate nor considered.

MULTI-CELLULAR FILTERS. The evaluation of the type of filters that would best replace the existing filters leads to one conclusion. That is, the use of automatic backwash filters or multi-cellular package filters as they also known by. These types of filters offer the following advantages.

1. They can be purchased in a steel tank that is factory assembled to engineered specifications and shipped as several large component pieces.

2. Steel structures can be easily designed to resist earthquake forces.

3. Two filters, each approximately 1.35 MGD capacity, can be utilized to give a tremendous increase in reliability over the present system.

4. The filters utilize approximately 25 individual media cells, one of which is always backwashing, so that there is never a surge of flow through the remainder of the filters.

5. Only small, continuous volumes of backwash water are required thus significantly reducing the size of yard piping, etc. No backwash tank is required.

6. Only one to two feet of head are required which will reduce energy costs significantly.

7. No filter effluent controls are required.

8. Can be adapted to include a future building to enclose them.

ALTERNATIVE LAYOUTS. The multi-cellular filters can be easily located next to each other. The size of the units can be custom tailored to fit the geography. The number of units is a matter of engineering judgement with two being the minimum. the only reason for more than two units would be increased reliability in the event of mechanical failures. The estimated construction costs for multiple units can be compared as follows, based on modular steel tanks. (ENR = 5200):

- two units, each 1.35 MGD, 9 feet x 26 feet — $210,000
- three units, each 0.86 MGD, 6 feet x 26 feet — $260,000

This type of filter has been manufactured for over forty years and has a proven record for reliability. It is not recommended that more than two units be purchased. The additional capital cost would not be cost-effective.

JCE was also asked to find out the estimated cost for two filters, each rated at 1.5 MGD, so that the City could evaluate installing a slightly larger filter capacity to handle unforeseen future circumstances. The estimated cost for the 1.5 MGD capacity filters is $242,000. (ENR = 5200).

RECOMMENDED FILTERS. It is recommended that the existing filters be demolished and replaced with two multi-cellular filters.

The following design criteria is recommended:

Capacity, each	1.35 MGD
Number units	2
Construction material	Steel, w/cathodic protection
Dimensions (overall)	
length	26 feet
width	9 feet
Filtration rate	3 gpm/sf
Media	
Sand	8 inch depth
Coal	8 inch depth
Backwash type	Continuous
Backwash rate	15 gpm/sf (200 gpm)
Backwash volume	Less than 2 percent
Backwash pump	6 horsepower

SLUDGE HANDLING

GENERAL. The present method of handling the sludges from both the clarifier and backwash water supply is inadequate. They overflow into a ditch on the site and eventually discharge to the Noyo River. The liquid portion of these wastewater discharges are not recovered and represent a loss of up to 10 percent of the daily production.

EVALUATION. The section on clarification recommended that future expansion do not include new basins for the chemical sludges generated as result of flocculation. Therefore, no provisions or evaluation need to be considered or conducted.

The backwash water, however, contains chemical sludge which must be handled. The type of filter recommended in the section on filtration will generate, volumetrically less backwash water then the present filters. There will also be no sudden, large volume of waste wash water during the backwash process.

It should also be noted that a direct filtration water treatment plant generates, overall, less sludge than the existing facilities. Water treatment plants which have sedimentation basins must feed sufficient alum and/or lime to produce a large settleable floc particle. These floc particles and the entrapped particulates are then removed by gravity prior to filtration. In water, such as at Fort Bragg, the particle entrapment could be accomplished with dosages of alum and/or polymers that are approximately one-half the alum dosage required for settling. The objective is to create a small, tough particle of floc that will filter, not settle.

When the backwash process occurs, the floc must either be returned to the head of the plant to settle in the storage ponds or be removed to drying beds. It is more appropriate to remove the floc and it´s impurities from the process instead of reintroducing it. This is normally accomplished by a "thickener." The thickened floc sludge can be disposed of to sand drying beds and the thickener supernatant (clear water) can be returned to the treatment process. This concept was considered for further evaluation using the existing reactor-clarifier as a sludge thickener. The elevation of the reactor-clarifier will allow gravity flow of the sludge to drying beds and the supernatant to the inlet storage ponds. Only minor piping changes are required to accomplish this. The internal flocculator mechanism must be removed and replaced with a new sludge collector mechanism.

The existing sand drying beds will need to be rehabilitated and enlarged in their present location. Two beds, each 60 feet x 30 feet, are required.

RECOMMENDATION. Handling of the sludge from the backwash water can be accomplished by converting the reactor-clarifier into a new thickener.

It is recommended that the existing reactor-clarifier be retrofitted with new mechanisms and that the thickened floc sludge be disposed of on a "batch" basis to new sand drying beds. The supernatant should be returned to the treatment process.

INSTRUMENTATION

GENERAL. Instrumentation systems are used to assist operators in making plant operational decisions as well as perform automatic control functions. The instrumentation system must accurately display, to the operator, real time plant conditions to allow continuous and efficient control of the water purification process.

All processes and component devices shall provide manual control at the location of each individual device. Automation of certain functions may be a normal mode, but manual override is always provided.

The sophistication of the instrumentation system is dependent on the process complexity and degree of automation required. Control and monitoring information requirements have a direct impact on the size of the control system. More importantly, the part-time staffing of the plant would increase the need for automatic functions and make alarm point notification more critical unless the present philosophy of completely manual control is continued.

The decision on how much to automate will have a significant impact on the overall cost. This section will outline in Table VII-1 some of the possible monitoring and control points. Normally, the decisions as to exactly what is to be done are made in the early design phases of the project.

In water treatment plants that desire security systems, it is typically provided as part of the overall monitoring and alarm system. Security related alarms can be connected to automatic dialing machines so that any designated

TABLE VII-1
IDENTIFICATION OF MONITORING & CONTROL POINTS

● From/at Control Room or Lab Only
* At Site Only
\+ Both at Control Room and at the Site

		FLOWRATE				TURBIDITY				RUNNING			CHLOR RESID		LEVEL		TEMP.		PRESS	pH	
		Controlled	Monitored	Recorded	Totalized	Monitored	Recorded	Alarm	Sample Line	Controlled	Monitored	Time Totalized	Monitored	Recorded	Monitored	Recorded	Monitored	Recorded	Monitored	Monitored	Recorded
PLANT INFLUENT																					
Noyo River	1	+	●	●	●	+	●		+								●	●	+		
Newman Gulch	1	+	●	●	●	+	●		+								●	●	+		
Simpson Lane	1	+	●	●	●	+	●		+								●	●	+		
Combined Flow	1	●	●	●	●	+		●	+											●	●
FLASH/RAPID MIXERS	1																				
FLOCCULATOR DRIVES	8									*	●	●									
FILTERS																					
Influent	1					●			+				●		+	●					
Effluent	1					+	●	●	*												
PLANT EFFLUENT																					
Reservoir Influent	1					+	●	●	+				●	●						●	●
RESERVOIR EFFLUENT	1												●	●	●	●					
FILTER BACKWASH SYSTEM																					
Storage Tank	1														●						
Backwash Pumps	2									●	●	●									
Backwash Flow	1	+	+		●																
BACKWASH RECOVERY SYSTEM																					
Settling Tanks	1								+						●						
Sludge Bed Decant Pumps	1									*	●	●									
PLANT WATER SYSTEM	2				*					*	●	●							*		
PLANT AIR SYSTEM	2									*	*	*							*		
CHLORINATION SYSTEM																					
Prechlorination	1	+	+	+									+								
Post Chlorination	1	+	+	+									+	+							
LIQUID CHEMICAL SYSTEMS																					
Alum	1	+	+							+	●				+						
Polymer, Floc-aid	1	+	+							+	●				●						
Polymer, Filter-aid	1	+	+							+	●				●						
Caustic Soda	1	+	+							+	●				●						
DRY CHEMICAL SYSTEM																					
Potassium Permanganate	1	+								+	●				●						

agency or person can be notified. This procedure is recommended because of the part time operation of the facility.

SITE PLAN. The location of the proposed facilities are depicted on Figure VII-8.

SUMMARY OF RECOMMENDED IMPROVEMENTS

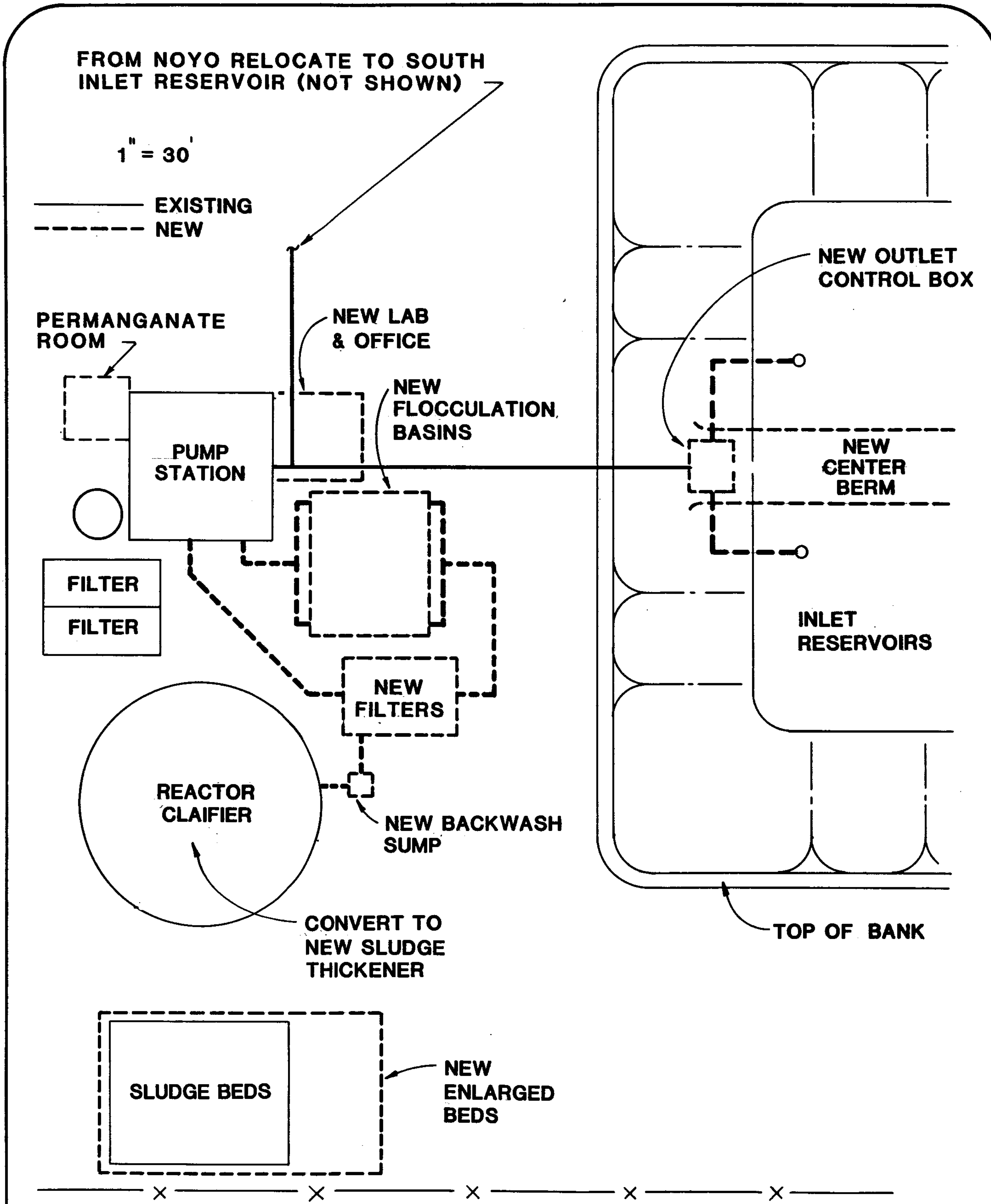
It should be noted that although the improvements are described herein as though they are a single project, it is not necessary that they all be accomplished simultaneously. The final choice rests with the City staff and their projected financial budgeting requirements. It is considered necessary that new flocculators and filters are constructed as soon as possible.

The storage ponds (inlet reservoirs) are to be retained and improved with internal baffles and a more operationally flexible piping configuration to include backwash water return. The side slopes and bottoms will be reworked for better maintenance access and a reduction in weed/algae growths.

The flash mixer can be utilized but will require relocation closer to the flocculation basins.

Four new concrete flocculation basins are required prior to filtration. No sedimentation basins are required. The water quality will allow a so called "direct-filtration" process. Water from the flocculator basins goes directly onto the filters. The existing reactor-clarifier is not worth retrofitting.

New multicellular filters that automatically backwash are proposed. They use significantly less operating head and backwash water, thus offering electrical energy savings and reductions in the size of all the backwash handling facilities. They will also eliminate the operational difficulties associated with backwashing the existing filters.



PROPOSED WATER TREATMENT PLANT SITE PLAN

JOHN CAROLLO ENGINEERS

Figure VII- 8

The existing reactor-clarifier will be converted to a backwash water solids thickening unit. The impurities entrapped in the filters can be separated from the backwash water and put on new sand drying beds. The clear water will be chlorinated and returned to the treatment process.

OPERATION DURING CONSTRUCTION PHASE

A detailed evaluation of the intricacies of continuing the daily operation of the WTP during the construction phase is normally done in a preliminary design meeting or report. As such, it is beyond the scope of this report to provide anything more the basic concepts of accomplishing the transition. It should be recognized that during this period, the treatment will be at least as good as is now accomplished. There will also be times when the facility must be taken out of service for up to a day, but this can be scheduled well in advance.

FILTERS. Installation of new filters is proposed in an area that will essentially not disturb any of the existing facilities. They can be completely constructed and prepared to be put into service very conveniently. When the new filters are ready to be serviceable, the old filters can simply be removed from service and abandoned or demolished. The level of treatment by the new filters will be better than with the existing filters. An immediate reduction in backwash water will be realized. The chlorinators will not be disturbed so all that is required is a minor piping change to allow pre and post-filtration chlorination.

FLOCCULATION BASINS. At this point the new flocculation basins should be constructed. All of the structural work can be completed without disruption of the treatment process. The new flocculator piping can be completed up to the point where it ties into the pump station and filters. This actual tie in can be accomplished in one day and can be scheduled well in advance. It is not required that the electrical work be completed prior to putting water through the basins. Without the electrical complete, the basins would merely be providing contact time which is all the reactor-clarifier really does now. Completion of the electrical work is dependent upon modification of the pump station superstructure unless weatherproof switchgear is desired for outside mounting near the new floc basin.

REACTOR-CLARIFIER. Removal of the old filters from service will automatically remove the reactor-clarifier from service so that it can be modified. During its rehabilitation, the backwash water can be pumped directly back to the inlet reservoirs. During this time, superchlorination of the backwash water may be advisable. The required internal work can be done to the reactor-clarifier without disrupting any other functions. Upon completion, the backwash water can be diverted into the modified structure and used. The sludge beds should be completed simultaneously to allow for easy operation of the solids system. Backwash water can continue to be wasted to the existing ditch (Noyo River eventually) until a new pipeline is installed to the inlet reservoirs.

INLET RESERVOIRS. During all the previously described improvements the inlet reservoirs can function essentially as they do now. Construction work in the earthen basins will require bypassing either one or both of the basins with temporary piping. A drying out period is also desirable to facilitate construction work and avoid excessive mud. It is recommended that efforts be made to do ths work during low water demand so that both basins can be worked on simultaneously.

This construction work will really not inconvenience plant operations to a great extent.

PUMP STATION SUPERSTRUCTURE. It is not suggested that any major work be accomplished on the interior of the existing superstructure until the floc basins, filters, and sludge handling is completed and in operation. The new lab and office space can be built simultaneously with the new building.

INSTRUMENTATION. The proposed instrumentation can be added at any time it is convenient without any disruption to plant operation.

CHAPTER VIII

EXISTING DISTRIBUTION SYSTEM

GENERAL

The existing water system is composed of the water treatment plant, two raw water sources (Noyo River and Simpson/Newman diversions), two 1.5 million gallon steel storage tanks, a booster pump station for the pressure zone and distribution piping. The water treatment plant was discussed in detail in Chapter VI. The storage tanks and distribution system will be covered in this Chapter. The tanks and distribution piping is shown in Figure VIII-1.

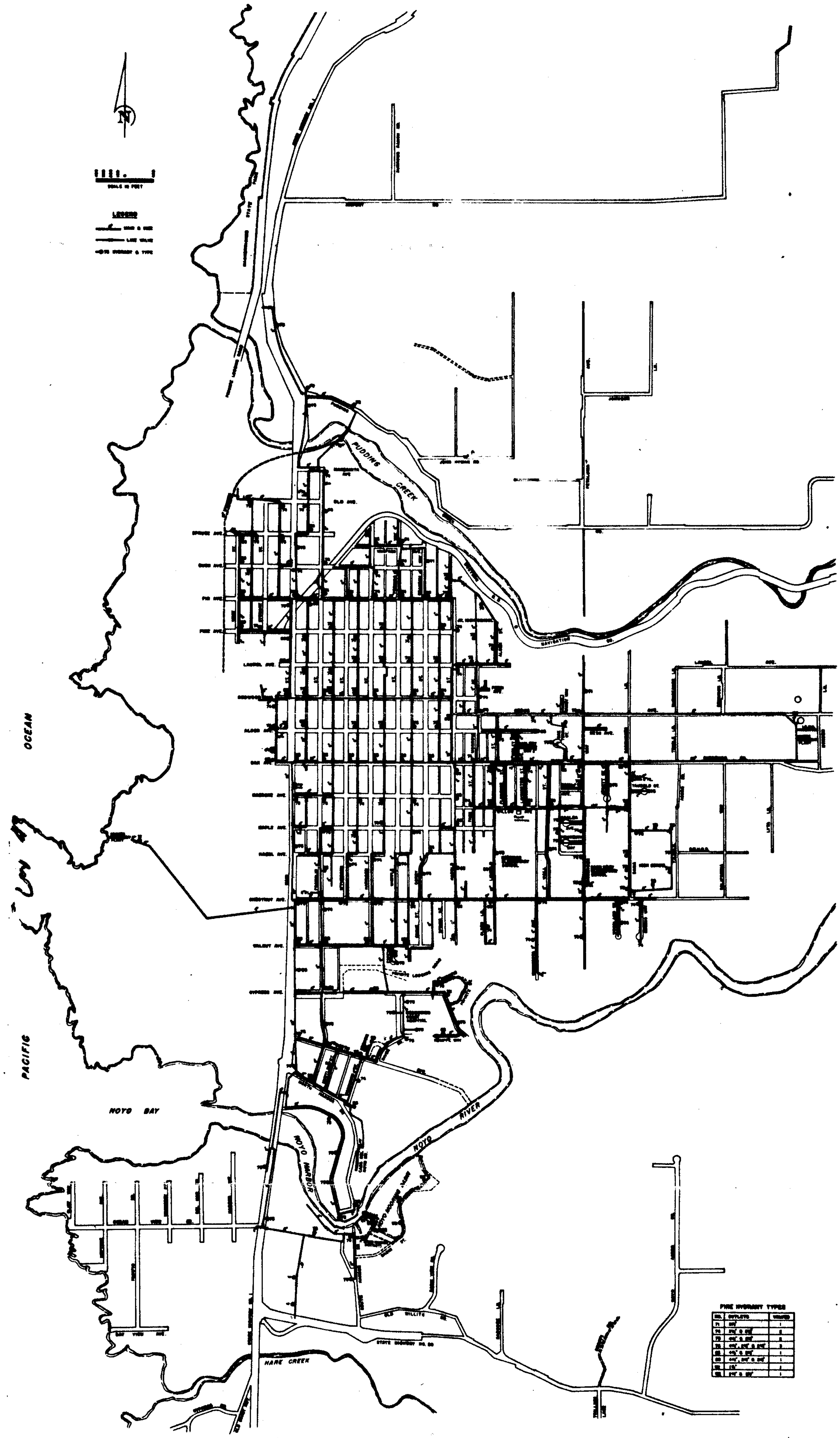
STORAGE VOLUME ANALYSIS

The maximum day demand (MDD) of 1.76 MGD is used to analyze the existing distribution system. Based on water plant records, the treatment plant capacity is estimated to be 1.76 MGD. Hence, on maximum day, no water from storage is needed to meet the MDD. Using the design criteria presented in Chapter IV, the minimum storage volume based on MDD is estimated as follows:

Emergency 12 hours	0.88 MG
1,000 gpm fire demand for 2 hours	0.23 MG
Maximum hour withdrawal @ 20% of MDD	0.35 MG
TOTAL	1.35MG

Thus, the MDD can be supplied solely from the existing 3.0 MG storage.

Plant records indicate a trend in 1984 and 1985 toward high demands for an entire maximum month, i.e., the ADMM is within 10 percent of maximum day for an entire month. If this occurs for the 1.76 MGD design flow, ADMM is 1.58 MGD. Then existing storage can supply less than two days at ADMM demand from storage alone. In the event of full or partial plant shutdown for more than two days, commensurate increases in existing storage volume would be needed.



CITY OF FORT BRAGG
EXISTING WATER SYSTEM

JOHN CAROLLO ENGINEERS

Figure VIII-1

The distribution piping from the existing storage to high points in the area south of the Noyo River is such that fire flow at 20 psig residual pressure cannot be provided. Hence, the Boatyard Shopping Center found it necessary to construct its own fire pump and reservoir. However, when the fire pump is in operation, other nearby high points experience low pressure and flows. More discussion of this problem is presented in Chapter IX.

COMPUTER MODEL OF EXISTING SYSTEM

The computer model (model) of the distribution system is the University of Kentucky's "Computer Analysis of Flow in Pipe Networks." The model was developed at the University of Kentucky by Professor Don Wood. The Fortran version of the program was used to model the system on an instantaneous basis. Extended time simulation was not used. The data base is created for the Fortran format. The program and data are stored on 5 1/4 inch diskettes.

The existing distribution system has pipe sizes ranging from 2 inches to 21 inches in diameter. Because we focused on complete loops or potentially complete loops for distribution only 6-inch diameter and larger pipes were used in the model. Tree or non-looped pipes was generally not used in the model. An example of a non-looped pipe demand is the line in Halsey Way east of McKinley St.

Demands were assigned to nodes used in the model on an area basis. Demands were input into the computer model (model) for the maximum day as original data. Demands for peak hour, average low 6 hours flow, etc., were generated by increasing or decreasing the maximum day demand by a constant factor.

Field testing of the model was done by comparing measured flow at specific hydrants and pressure at adjacent hydrants to the computer model pressure for the same flow rates. The results of the comparison is as follows:

Location	Flow, gpm	Measured Pressure, psi	Model Pressure, psi
South and Main	750	36	40
State Route 1 at 8"-6"-8" pipe split south of Noyo Bridge	750	32	31
Manzanita & Franklin	920	37	44
Fir near Franklin	1,060	46	55

These results are mixed in that the measured and computed pressure from the model in the north end of the City (Manzanita and Franklin and Fir near Franklin) are significantly different. However, the pressure comparison in the south area of the City shows an insignificant difference. The model data input was checked and is accurate. Measured pressure is lower than computed pressure for the north City test which indicates greater actual energy loss than is accounted for by the model. A different pipe material (e.g., ductile iron or steel pipe), a partially closed valve or other flow obstructions could cause the disparity. Additional investigation will be conducted with the cooperation of the Fire Department to determine the discrepancy.

COMPUTER MODEL RESULTS. The model shows that combined fire and maximum demands can be supplied at the minimum 20 psig pressure in most parts of the City. The high points in the area south of the Noyo River and higher areas in the east near the water treatment plant (WTP) are exceptions. There may be other areas in the City where minimum pressure cannot be maintained which are not included in the model. Hence, the model, as configured for this Report, did not show pressure deficiencies that may exist in some non-looped pipes.

The model results indicate that the existing pressure zone pumps (excluding fire pump) will provide 20 psig residual pressure at maximum day demand (excluding fire demand) as far east (uphill) as Dana Street.

The City requested that we include in our Report an investigation of a 1,000 gpm fire flow for 2 hours that would serve the College of the Redwoods on Ocean View and Del Mar Drives. The following conditions/improvements were analyzed on the model:

No improvements to the existing system.

Constructing an 8 inch pipe to existing 6 inch stub that parallels the existing 8 inch pipe in State Route 1 south of the Noyo Bridge, with no other improvements.

Constructing a 12 inch pipe under the Noyo River with no other improvements.

Constructing both the improvements to the existing system.

The model showed the results in Table VIII-1. These results indicate that the recommended 20 psig residual pressure at the hydrant may only be marginally obtained at high points in the area (Ocean View and Route 1, Boatyard Shopping Center), by either or both of the above improvements. The results of the model also show that the residual 20 psi pressure at the College site can be achieved because it is at a lower elevation than at Ocean View and Route 1 by approximately 25 feet. Thus, while the pressure at Del Mar and Ocean View exceeds 20 psi, the pressure at the higher locations, is 20 psig.

The model results also indicate that none of the improvements above will raise the pressure at the Boatyard Shopping Center to 20 psi. An additional improvement of adding 6 inch diameter pipe to make a loop in North Harbor Drive was considered. However, this loop did not significantly increase the pressure in the areas of concern.

TABLE VIII-1

FIRE FLOW RESIDUAL PRESSURE
AT THREE LOCATIONS

Fire Flow Location	Residual Pressure at Hydrant, psi			
	No Improvement	Pipe Under Noyo Only	Parallel Pipe to Route 1 Only	Combination Improvements
Ocean View & Route 1	0	13	19	20
Ocean View & Del Mar	0	25	30	31
Boatyard Shopping Center	-4	10	15	17

Because the model shows only marginally acceptable results, we do not believe that the City can supply fire demand to the College of the Redwoods with any of the proposed improvements. Our recommendation for a better solution to the low pressure problem is presented in Chapter IX.

A peak hour demand, estimated to be 1.5 times the maximum day demand, was used to check adequacy of the existing distribution system. Peak hour demand can be met by the existing system.

The majority of the existing distribution pipes are looped. An effort should be made to design loops for as many pipes as possible. In some cases, lack of development, terrain and other factors prevent constructing pipes to form loops with the existing pipes. Looping pipes provides better flow distribution, better pressure at any location in the loop, and minimizes taste and odor problems associated with non-looped or tree pipes.

On a larger scale, the areas served south of the Noyo River and north of Pudding Creek are each connected to the main water system by a single pipe crossing. For backup in the event the single pipes are disrupted, a second crossing of the Noyo River and Pudding Creek are needed. These crossings will be considered further in Chapter IX.

Although not in our scope of work for this Report, it was observed that pumps for the pressure zone discharge directly into the pressure zone distribution system. In order to prevent excessive cycling of the pumps and subsequent burn out of the motors, a hydropneumatic tank should be designed and constructed so that the pumps can discharge into it.

Georgia Pacific (GP) is served by City water through seven meters that range in size from 6 inch to 5/8-inch. These meters will permit up to 3.4 MGD to flow through them. To prevent this potential consumption by GP, some of these meters should be down-sized to reflect recent limit GP use.

CHAPTER IX

FUTURE DISTRIBUTION SYSTEM

IMMEDIATE IMPROVEMENTS TO THE SYSTEM

Immediate improvements are those needed for existing developments or developments expected in the near future. Several immediate improvements concern the following areas in the Study area:

- o Fire flow at the College of the Redwoods (Community College) and Todd Point Development.
- o Domestic and fire flow demands for developments at higher elevations near the eastern boundary of the Study area in the vicinity of the water treatment plant.

FIRE FLOW FOR THE COMMUNITY COLLEGE AND TODD POINT DEVELOPMENT. As indicated in Chapter VIII, the proposed improvements to the existing system (parallel line to the existing 8 inch line in State Route 1 and a new 12 inch pipe across the Noyo River) are not satisfactory.

The existing fire flow in the Boatyard Shopping Center is provided by a fire pump that draws its suction from both a surface storage tank in the Boatyard Shopping Center and the existing distribution system. However, when the pump operates, pressures much lower than 20 psi occur at Ocean View and State Route 1 and in the Todd Point Development. The small 6-inch line into and through the development takes too much energy from the flow to the fire pump to maintain a minimum pressure of 20 psi along the line. Customers complain of "low pressures" during operation of the fire pump.

Several alternative projects could be undertaken to provide fire flow for the Community College, Todd Point Development and all areas above elevation 90. These include the following:

1. Construct a fire pump station that will serve only the area above elevation 90. No new storage is involved.

2. Construct a storage tank which provides fire flow only for the areas above elevation 90. A booster pump to recharge the fire storage tank will be needed. This tank will be blocked off and not serve the area north of the Noyo River.

3. Construct a storage tank with sufficient volume to meet fire, maximum day, and maximum hour demands and an emergency for the entire Study area south of the Noyo River. A booster pump to recharge this storage tank will be required. This tank will be blocked off from and not serve the area north of the Noyo River.

4. Construct a storage tank with sufficient volume to meet maximum day, maximum hour and fire demands and an emergency for the entire Study area south of the Noyo River but "floats" on the entire system. This tank will serve the entire area both north and south of the Noyo River.

5. Construct a parallel pipe to deliver fire flow.

Fire Pump Station. For this alternative, a booster pump will pressurize the pipelines of the system above elevation 90. No storage is needed for this alternative. This booster pump will also supply a minimum of 1,000 gpm fire flow and the maximum hour demand to the system. The fire pump station should be located just north of the Noyo Bridge. The pump should produce a minimum of 1,250 gpm at 30 feet of head to supply the needed flows above. The pipelines serving areas lower than elevation 90 will need pressure reducing valves to prevent overpressurization in those areas. The booster fire pump will be actuated when the pressure in the line drops below a predetermined value at the pump. During normal operations (without a fire demand) the entire area south of the Noyo River will be served from the existing facilities. This alternative will allow the existing Todd Point fire pump to be eliminated.

Storage Reservoir for Fire Protection Only. For this alternative, a small surface storage tank of 120,000 gallons capacity will be constructed on a site east of Babcock Lane and south of State Route 20 at approximate elevation 185 (base of tank). This tank will supply fire flow to the areas south of the Noyo River above elevation 90 during a fire only. The storage tank will not "float" on any part of the system. Instead the tank will be blocked off from the entire system by a valve. The valve blocking the line to the reservoir will be activated and opened when the pressure drops below a predetermined pressure at a point such as the location where the existing fire pump is in the Todd Point development which indicates a fire demand. A booster pump capable of delivering the 120,000 gallons in a 6 hour period will be needed to recharge the storage tank for the next day in case of another emergency. This booster pump will fill the tank during the period between midnight and 6 a.m. when the system demands are minimum. The pump will come on when the water level in the tank drops below a predetermined level and will shut down when the tank is full. Standby power should be provided to permit filling the tank during power failure. The existing Todd Point fire pump may be eliminated by constructing a 12 inch or equivalent pipeline to the area where this existing fire pump is presently located. Since this storage is off line, (blocked off from the rest of system) the tank should be drained periodically to prevent odor and taste problems. A check valve will be needed in the line across the Noyo Bridge on the south side of the bridge to prevent flow from going into the area north of the Noyo River when the tank is draining.

Storage Reservoir for the Entire South Area. For this alternative, a storage tank of 300,000 gallon capacity will be constructed at the proposed site east of Babcock Lane and south of State Route 20. The base of the tank will be at approximate elevation 185. This tank will be capable of supplying fire maximum hour and maximum day demands to the entire area south of the Noyo during an emergency, such as interruption of the line in State Route 1 across Noyo River. Pressure regulating valves will be needed on lines leading from the areas above elevation 90 to lower areas. A check valve in the line across the Noyo south of the bridge in State Route 1 will be needed to prevent flow from going into the system north of the Noyo River. A booster pump capable of refilling the tank in the 6 hour period between midnight and 6 a.m. when demands are low will be needed. Such a pump will have to deliver 833 gpm to recharge a completely empty tank for the following day. The booster pump will come on when the storage tank level reaches the 120,000 gallon level and/or the empty level and will shut down when the tank is full. To prevent odor and taste problems, the storage tank should be drained or partially drained frequently. The tank could be drained frequently by allowing the volume over and above the 120,000 gallons dedicated to fire flow to be used to meet daily demands of the area south of the Noyo River. When the water level drops, due to these daily withdrawals, to the level needed to maintain 120,000 in the tank, the booster pump comes on and fills the tank. Thus, the water in the tank will be drained frequently enough to prevent odor and taste problems. Standby power should be provided to permit operation during power failure. The existing Todd Point fire pump may be eliminated by constructing a 12 inch or equivalent pipeline to the location of this fire pump from the proposed storage tank.

Storage Tank that "Floats" on the Entire System. Another alternative is to construct a reservoir that "floats" on the entire system or serves both areas north and south of the Noyo River. The computer model indicates that the storage tank will drain into the area south of the Noyo River and flow will cross into the system north of the Noyo River. The model shows that on maximum day the reservoir will drain at average rates up to 550 gpm without fire flow. At this rate, 792,000 gallons will drain from the reservoir during maximum day. Thus 912,000 gallons of storage will be needed including 120,000 gallons for fire flow.

Filling the proposed reservoir that "floats" must also be considered. Assuming that the storage tank drains for 18 hours and is filled, or recharged, for 6 hours for the following day, the 792,000 gallons must be replaced at a rate of 2,200 gpm. Since the storage tank will be at approximately the same elevation, filling by gravity will require considerably more than 6 hours. Thus, a pump will be needed for refilling. The computer model results indicate negative system pressures when pumping 2,200 gpm into the reservoir using the proposed improvements of a parallel line from the Noyo Bridge split to Ocean View Drive.

Construct a Parallel Pipe to Deliver Fire Flow. A parallel pipe could be constructed that will deliver fire demand to the area. A new 12-inch pipe constructed from Oak Street, under the Noyo River, then to the Ocean View - State Route 1 area will provide the required flows. It will be necessary to begin the new line at Oak Street where the pipe pressure is still high enough to deliver the fire demand. Approximately 10,000 feet of new 12 inch pipe will be needed. Approximately 200 of the 10,000 feet will be under the Noyo River. Dredging the river and burying the pipe deep enough to avoid washout by scour will be required.

Apparent Best Alternative. If a fire pump station is constructed, it will supply fire demand to the higher areas south of the Noyo River. However, in the event that the line across the bridge over the Noyo River fails, there would be no source of water to supply the area south of the Noyo. An obvious solution to provide better redundancy in case of failure is to construct a parallel pipeline under the Noyo River. The expense of such construction will not warrant the redundancy of this second supply pipeline to the area at this time.

A storage reservoir for fire protection only has some advantages over the fire pump. Fire protection is available even if the line across the Noyo River fails. For this tank however, while fire flow volume is available, this volume could not be reserved for fire flow in the event of the Noyo River Bridge line failure. Upon failure of the bridge pipeline, local demands would cause the proposed storage tank to drain and deplete the fire flow volume. This volume of the proposed storage tank is not sufficient to protect the area for fire flow and still provide the non-fire flow demands on failure of the bridge pipeline.

A storage tank that serves the area south of the Noyo River but is blocked off from flowing into the area north of the Noyo River has the advantage that all demands for the area south of the Noyo can be met even if the Noyo Bridge pipeline fails. Fire and other demands will be available up to 12 hours of emergency interruption from the main system. A storage tank that "floats" on, or serves, the entire system is not feasible when filling in a 6-hour period is considered. The draining of this proposed reservoir into the area north of the Noyo River means under utilizing the existing storage tank's capacity.

Selection of the Apparent Best Alternative. The recommended alternative is the construction of the 300,000 gallon storage tank that serves the development south of the Noyo River only.

A new 12 inch pipeline will be constructed to the northeast corner of the Todd Point development from the proposed storage tank. A minimum 10 inch pipeline should be constructed adjacent to State Route 20 from the proposed 12 inch pipeline to connect to the existing 6 inch pipeline in Todd Point. The existing pipelines and the proposed pipelines will then form a loop to serve the area. The recommended alternative and the proposed pipelines are shown in Figure IX-1 as immediate improvements.

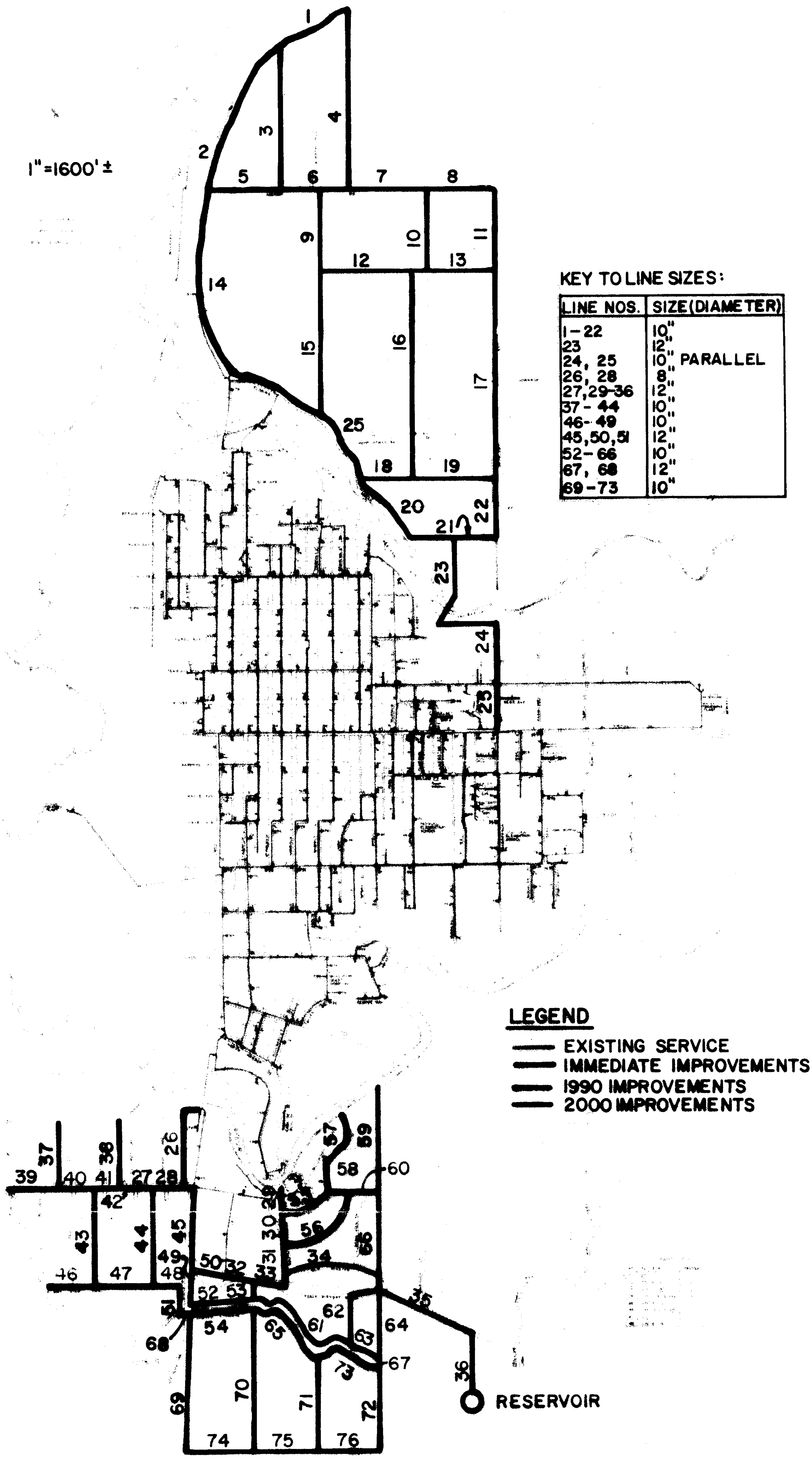
DEVELOPMENT BY 1990

As discussed in earlier chapters, the estimated maximum day demand is 2.3 MGD. Although uncertain at this time, it is assumed that this demand will be supplied from an upgraded treatment plant. The major part of this demand will be generated from development that is assumed to be constructed or annexed in the area south of the Noyo River. There are plans currently being prepared to develop the area in the vicinity of State Routes 1 and 20. We have assumed that additional development between 1985 and 1990 will be concentrated in the study area south of the Noyo River to Simpson Lane. The analysis for development by 1990 is based on this assumption.

Storage required for the entire service area, using the criteria listed in Chapter IV is 1.8 MG determined as follows:

12 hours, maximum day	1.15 MG
1,000 gpm fire, 2 hours	.23
Peak hour from storage 20 percent	.46
TOTAL	1.84 MG
USE	1.8

It is assumed that by 1990, the additional 0.3 MG storage will be completed. Thus the total storage volume by 1990 will be 3.3 MG. If the water treatment plant had to be operated at half capacity, 1.3 MGD, (power failure, shutdown of a filter, etc.) and high demands continued, without fire demand,



KEY TO LINE SIZES:

LINE NOS.	SIZE (DIAMETER)
1 – 22	10"
23	12"
24, 25	10" PARALLEL
26, 28	8"
27, 29-36	12"
37 - 44	10"
46 - 49	10"
45, 50, 51	12"
52 - 66	10"
67, 68	12"
69 - 73	10"

CITY OF FORT BRAGG
FUTURE IMPROVEMENTS.

Figure IX-1

approximately 3 days demand could be supplied from storage. That is, the water treatment plant would supply 1.3 MGD while 1.0 MGD could be supplied from storage.

The skeletal piping needed to accommodate development by 1990 is shown on Figure IX-1 as development by 1990. Two crossings of Hare Creek are proposed to provide a loop for the area south of Hare Creek.

DEVELOPMENT BY 2000

The remaining available land in the study area is assumed to be developed/annexed by the year 2000. New developments outside the current City limits north of Pudding Creek as well as in-fill developments will build out the Study area. The maximum day demand, as indicated earlier, is expected to be 3.4 MGD.

Storage required, using the criteria given in Chapter VIII, will be 3.3 MGD, determined as follows:

12 hours, maximum day	1.7 MG
1,000 gpm fire, 2 hours	0.23
Difference between plant capacity and maximum day demand (3.4 - 2.7)	0.7
Peak hour, 20 percent maximum day	.68
TOTAL	3.31 MG

Thus, the existing storage combined with the proposed 300,000 gallon tank is adequate. If the water treatment plant had to be operated at half capacity, 1.3 MGD, (power failure, shut down of a filter etc.) and high demands continued, without fire demand, approximately 1 1/2 days demand could be supplied from storage. That is, the water treatment plant could supply 1.3 MGD while 2.1 MGD could be supplied from storage.

Development will be primarily north of Pudding Creek and in-fill of the existing areas. The existing 10 inch line crossing Pudding Creek will not permit 1,000 gpm fire flow at 20 psig residual. Thus, the computer model indicates that another pipeline under Pudding Creek will be needed. A 12 inch or larger pipeline is recommended. The computer model results also indicate that a segment of the existing 6-inch pipeline in Sanderson Way should be increased to a minimum 12 inch equivalent pipeline between Sherwood Road and Pudding Creek. For this purpose a parallel 10 inch pipeline to the existing 6 inch pipeline should be constructed in Sanderson Way between the above limits. Improvements needed by 2000 are shown on Figure IX-1.

DEVELOPMENT AT HIGHER ELEVATIONS. Development near the eastern boundary of the study area near the Water Treatment Plant is subject to lower pressure because of its relatively high elevation compared to the elevation of existing storage tanks near the Water Plant. To ensure minimum 20 psi pressure, the subject developments should preferably be 100 vertical feet below the storage tank. A minimum of 80 vertical feet should be maintained if 100 feet cannot be achieved. The highest point at the eastern boundary of the Study area near the Water Treatment Plant is approximately elevation 160 feet. The closest site to locate a storage tank at 100 vertical feet, (elevation 260 feet) is approximately 1.5 miles east of the Study area boundary on Fort Bragg Road. A storage tank with a minimum volume designed to meet expected demand of these higher developments will be required. However, since only 1 1/2 days demand can be supplied from the existing/proposed 3.3 MG storage at buildout it is recommended that a 1 to 3 MG storage tank be constructed instead of a minimum storage tank. This 1 to 3 MG storage tank in conjunction with the treatment plant at 1/2 capacity would permit 2 to 3 days of high demand to be supplied from storage. A pump station connected to the existing system to fill the storage tank, telemetry to control the pump, and related equipment will also be needed.

Until the needed storage can be constructed, hydropneumatic tanks can serve new developments. A dedicated fire pump capable of delivering 1,000 gpm fire flow to the entire area will be needed. The hydropneumatic tanks and fire pump are only an interim solution. Developers should construct the interim hydropneumatic tanks and contribute toward the cost of constructing the proposed storage tank at the same time.

CHAPTER X

COST SUMMARY AND CAPITAL IMPROVEMENTS SCHEDULE

The immediate improvement projects needed to meet estimated immediate and future water system needs have been discussed in Chapters VI, VII and IX. A tabulation of these proposed capital construction projects is listed herein and scheduled according to estimated time of needed improvements. The estimated costs are based on the projected Engineering News Record (ENR) Index for San Francisco. The current ENR index of 5000, projected to June, 1986, at 6 percent annual increase is approximately 5200. Environmental assessments, regulatory considerations, rights-of-way and added costs for phasing over an extended period for the proposed projects are not included in the estimated costs. It is assumed that the permanent facilities will be constructed on City owned land or on land dedicated to the City by the developers.

The Immediate Improvements recommended are listed in Tables X-1a, X-1b, and X-1c. The immediate improvements recommended for the water treatment plant in Table X-1b are intended to be completed in 1986-1987 and of sufficient capacity to provide service to the year 2000 (or 4,000 people). The immediate improvements to the raw water sources and to the distribution system are intended to secure existing service commitments.

The ability to meet future service commitments projected in 1990 and 2000 is to be provided through proposed projects for those two intervals.

Improvements for the raw water sources and treated water distribution system by 1990 are based on buildout of the Study area south of the Noyo River. The proposed improvement projects for 1986 to 1990 are tabulated in Tables X-2a and X-2b. Costs are based on estimated prices for June, 1988. The San Francisco ENR, projected to June, 1988 at 6 percent annual increase, is estimated to be 5800.

TABLE X-1a

PROPOSED IMMEDIATE IMPROVEMENTS
CONSTRUCTION COSTS FOR
RAW WATER SOURCES

	Proposed Construction Project	Current (12/85) Costs, $	Including Engineering and Contingency, $	Escalated to June 1986 Mid Construction, $
1.	Leak Detection Survey	8,000	10,000	11,000
2.	Metering of Raw Water Source	10,000	13,000	14,000
3.	Waterfall Gulch New Diversion	30,000	39,000	41,000
4.	Simpson Pipeline Truss Reconditioning	85,000	111,000	116,000
5.	Simpson Pipeline Replace 6" with 10" Ø	50,000	65,000	68,000
6.	Simpson Bypass of Newman Reservoir	14,000	18,000	19,000
7.	Newman Pipeline Replace Noyo River Crossing	39,000	51,000	52,000
8.	Noyo Collector Extension	12,000	16,000	17,000
9.	Noyo Pump Station New Pump	20,000	26,000	27,000
10.	Noyo Pump Station ~~Portable~~ Standby Power	30,500	33,000	35,000
11.	Noyo Pipeline Recondition	13,000	18,000	19,000
	SUBTOTAL PROPOSED PROJECT COSTS			$419,000

TABLE X-1b (Continued)

PROPOSED SUMMARY OF IMPROVEMENTS
CONSTRUCTION COSTS
FOR WATER TREATMENT PLANT

Priority	Proposed Construction	Current 12/85 Costs, $	
5.	Filtration		
	Demolish existing filters	15,000	
	Re-route piping	8,000	
	Multicellular filters	300,000	
	Backwash sumps/pumps	11,000	
	Site work	21,000	
			$355,000
6.	Sludge Handling		
	Remove clarifier mechanism	8,000	
	Sludge collectors	60,000	
	Supernatant drawoff	6,000	
	Internal Piping	3,000	
	Pipe to storage ponds	11,000	
	Sand drying beds	65,000	
			$153,000
	Total Estimated Construction Cost		$1,232,000
	Engineering & Contingencies 30 percent		370,000
	Adjustment to mid-1986, ENR = 5200		68,000
	SUBTOTAL PROPOSED PROJECT COSTS		$1,670,000

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TABLE X-1c

PROPOSED IMMEDIATE IMPROVEMENTS
CONSTRUCTION COSTS
FOR WATER DISTRIBUTION SYSTEM

Proposed Construction Project	Line Nos. from Figure IX-1	Current (12/85) Costs, $	Including Engineering and Contingency, $	Escalated to June 1986 Mid Construction, $
1. 2,400 LF 12-inch AC pipeline	35,36	72,000	94,000	98,000
2. 1,600 LF 12-inch AC pipeline	34	48,000	62,000	64,000
3. 1,500 LF 12-inch AC pipeline	29-31	45,000	58,000	60,000
4. 1,200 LF 12-inch AC pipeline	32,33	36,000	47,000	49,000
5. 1,800 LF 8-inch AC pipeline	26,28	40,000	52,000	54,000
6. 600 LF 12-inch AC pipe	27	18,000	23,000	24,000
7. Hydropneumatic tank for pressure zone		20,000	26,000	27,000
8. Access road to storage tank		35,000	45,000	47,000
9. Valves		40,000	52,000	54,000
10. 6,000 LF telemetry cable		18,000	23,000	24,000
11. 300,000 gallon storage tank		150,000	195,000	203,000
12. Booster pump with standby power		110,000	143,000	149,000
SUBTOTAL PROPOSED PROJECT COSTS				$853,000

TOTAL PROJECT COSTS FOR PROPOSED IMMEDIATE IMPROVEMENTS – TABLES X-1a, X-1b, X-1c $2,858,000

TABLE X-2a

PROPOSED IMPROVEMENTS BY 1990
CONSTRUCTION COSTS
FOR RAW WATER SOURCES

Proposed Construction Project	Current (12/85) Costs, $	Including Engineering and Contingency, $	Escalated to June 1988 Mid Construction, $
1. Covington Gulch Diversion, Pipeline and Pump Station	70,000	91,000	106,000
2. Hare Creek Diversion and Pipeline to Covington Pump Station	30,000	39,000	46,000
SUBTOTAL PROPOSED PROJECT COSTS			$152,000

TABLE X-2b

PROPOSED IMPROVEMENTS BY 1990
CONSTRUCTION COSTS FOR
WATER DISTRIBUTION SYSTEM

Proposed Construction Project	Line Nos. from Figure IX-1	Current (12/85) Costs, $	Including Engineering and Contingency, $	Escalated to June 1988 Mid Construction, $
1. 3,300 LF 10-inch AC pipe	37-40	89,000	116,000	134,000
2. 3,500 LF 10-inch AC pipe	41-44	94,000	122,000	142,000
3. 2,300 LF 12-inch AC pipe	45,50,68	69,000	90,000	104,000
4. 150 LF 12-inch ductile iron pipe across Hare Creek	51,67	30,000	39,000	45,000
5. 50 LF 12-inch ductile iron pipe jacked under State Route 1	68	17,000	22,000	26,000
6. 2,500 LF 10-inch AC pipe	46-49	68,000	88,000	103,000
7. 2,300 LF 10-inch AC pipe	52-54	62,000	81,000	93,000
8. 3,600 LF 10-inch AC pipe	55-58	97,000	126,000	146,000
9. 4,600 LF 10-inch AC pipe	60-63	124,000	161,000	187,000
10. 3,500 LF 10-inch AC pipe	64-66	94,000	122,000	142,000
11. 7,600 LF 10-inch AC pipe	69-73	205,000	266,000	309,000
12. Valves		100,000	130,000	151,000
SUBTOTAL PROPOSED PROJECT COSTS				$1,582,000

TOTAL PROPOSED PROJECT COSTS FOR PROPOSED IMPROVEMENTS BY 1995 - TABLES X-2a, X-2b $1,734,000

Improvements for the raw water sources and treated water distribution system by 2000 are based on the development of the portion of the Study area north of Pudding Creek and infill of the existing City limits. The proposed improvement projects needed by 2000 are tabulated in Tables X-3a and X-3b. Costs are based on estimated prices for June, 1995. The San Francisco ENR projected to June, 1995 at 6 percent annual increase is estimated to be 8700.

TABLE X-3a

PROPOSED IMPROVEMENTS BY 2000
CONSTRUCTION COSTS FOR
RAW WATER SOURCES

Proposed Construction Project	Current (12/85) Costs, $	Including Engineering and Contingency, $	Escalated to June 1995 Mid Construction, $
1. Noyo Pipeline			
a. Replace with 12" parallel lines	131,000	170,000	296,000
b. Replace with 12" along river alignment	133,000	173,200	301,000
2. Newman Pipeline Replace 5700′ with 12"	200,000	259,000	451,000
SUBTOTAL PROPOSED PROJECT COSTS			$752,000

TABLE X-3b

PROPOSED IMPROVEMENTS BY 2000
CONSTRUCTION COSTS FOR
WATER DISTRIBUTION SYSTEM

Proposed Construction Project	Line Nos. from Figure IX-1	Current (12/85) Costs, $	Including Engineering and Contingency, $	Escalated June 1995 Mid Construction, $
1. 8,500 LF 10-inch AC pipe	1-4	230,000	299,000	520,000
2. 4,300 LF 10-inch AC pipe	5-12	116,000	151,000	262,000
3. 14,000 LF 10-inch AC pipe	13-17	378,000	491,000	855,000
4. 5,400 LF 10-inch AC pipe	18-22	146,000	190,000	330,000
5. 100 LF 12-inch ductile iron pipe jacked under railroad	23	35,000	46,000	79,000
6. 100 LF 12-inch ductile iron pipe across Pudding Creek	23	20,000	26,000	45,000
7. 1,600 LF 10-inch AC pipe	23	43,000	56,000	97,000
8. 600 LF 10-inch AC pipe (parallel)	24	16,000	21,000	36,000
9. 1,000 LF 10-inch AC pipe	25	27,000	35,000	61,000
10. Valves		104,000	135,000	235,000
SUBTOTAL PROPOSED PROJECT COSTS				$ 2,520,000

TOTAL PROPOSED PROJECT COSTS FOR PROPOSED IMPROVEMENTS BY 2000 - TABLE X-3a, X-3b $3,516,000

APPENDIX A

GEORGIA PACIFIC WELL TEST DATA

GEORGIA PACIFIC
WELL TEST
SUMMARY OF RESULTS

WELL A

The major portion of flow from this well appears to be entering the well between point B and the intake. Measurements shown between 67 and 97 gallons per minute coming into this section. The distance between point B and A contributes another 10-24 gallons per minute.

The other calculations show an averaging of the flow recovery rate over time.

WELL B

Unlike well A, which only took 32 minutes to pump down, well B took much longer. For the first test in which well B was pumped down to a depth of 12.7 feet it took it took 2 hours and 38 minutes. The second test required 7 hours and 38 minutes to reach 14.5 feet. The pumping rate was estimated to be 200 gallons per minute for both tests.

The major flow for well B appeared to enter below the 14 foot level. As it took a better part of a day to reach this level, flow recovery was only tested once in this region. The measurement is not believed to be very accurate because it is based only on one measurement.

CONCLUSIONS REGARDING FLOW

Both wells appear to be supplied with water in the 16-14 foot range, or towards the bottom of each well. Right now these walls probably could adequately supply the nursery. Later in the summer the flow will probably be reduced. Whether these wells could provide water all summer long is still questionable but I have been told that in the past these wells did provide water year round given the time to recover.

(Provided by Georgia-Pacific from their records)

CHEMICAL ANALYSIS: WELL WATER SUPPLY TO NURSERY, LOCATED SOUTH OF QUAD MILL PARKING LOT (WELL B) (SAMPLE DATE APRIL 8, 1979)

	Mg/1	Meg/1
Anions		
Sulfate (SO_4)	15	0.31
Chloride (Cl)	40.8	1.15
Biocarbonate (HCO_3)	80.7	1.32
Carbonate (Co_3)	0	0
Nitrate (No_3)	2.5	0.04
Cations		
Calcium	15	0.75
Magnesium	9	0.74
Sodium	39	1.7
Potassium	2.4	1.06
Manganese (total)	0.53	--
Iron (total)	44	--
Determinations		
Alkalinity	66.2	
Ca Hardness ($CaCo_3$)	37.5	
Mg Hardness ($CaCo_3$)	37.0	
Total Hardness ($CaCo_3$)	74.5	
pH	6.5	
Specific Cond. (micromhos)	320	
Other		
Phosphorus (total)	0.38	
Ammonia	0.3	
Nitrite	0.011	
Aluminum	1.2	

(Provided by Georgia-Pacific from their records)

11468500 NOYO RIVER NEAR FORT BRAGG, CA

LOCATION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mi (1.1 km) downstream from South Fork, and 3.5 mi (5.6 km) east of Fort Bragg.

DRAINAGE AREA.--106 mi² (275 km²).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--August 1951 to current year.

REVISED RECORDS.--WSP 1929: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft (3.575 m) above mean sea level.

REMARKS.--Records good. No regulation or diversion above station.

AVERAGE DISCHARGE.--26 years, 216 ft³/s (6.117 m³/s), 156,500 acre-ft/yr (193 hm³/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 26,600 ft³/s (753 m³/s) Mar. 29, 1974, gage height, 27.14 ft (8.272 m), from rating curve extended above 4,500 ft³/s (127 m³/s) on basis of slope-conveyance study; minimum daily, 0.79 ft³/s (0.022 m³/s) Sept. 8, 1977.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 153 ft³/s (4.33 m³/s) Mar. 15, gage height, 4.48 ft (1.366 m), no peak above base of 2,400 ft³/s (68 m³/s); minimum daily, 0.79 ft³/s (0.022 m³/s) Sept. 8.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	10	5.2	7.3	15	7.8	21	21	12	5.9	2.5	1.2	.91
2	8.5	5.0	7.3	34	7.8	18	19	16	5.9	2.4	1.2	1.9
3	6.8	5.0	7.3	70	7.5	17	18	16	5.5	2.6	1.1	.91
4	5.6	5.0	7.4	57	7.3	15	16	15	5.4	2.5	1.1	1.0
5	4.9	5.3	7.5	32	7.3	13	15	12	5.3	2.4	1.1	1.0
6	4.4	5.2	7.5	22	7.3	12	14	11	5.1	2.3	1.1	1.5
7	4.2	5.7	7.3	17	7.4	11	13	11	4.8	2.3	1.2	.99
8	4.1	5.1	7.5	14	26	11	17	11	4.7	2.2	1.1	.79
9	3.9	4.7	8.3	13	45	34	19	10	4.3	2.2	1.0	1.5
10	3.9	5.5	8.2	12	30	51	15	10	4.2	2.2	1.2	.84
11	3.8	15	8.0	12	22	37	13	9.8	4.2	2.2	1.1	1.3
12	3.8	18	7.8	17	18	33	13	9.9	4.3	2.0	1.1	.91
13	3.5	14	7.8	19	15	37	12	9.4	3.6	1.9	1.0	1.0
14	3.7	41	7.8	16	13	36	12	8.4	3.7	1.9	1.1	1.5
15	3.7	48	7.8	14	11	87	11	7.6	3.8	2.0	1.1	1.3
16	3.4	24	7.8	13	10	130	10	7.3	3.5	1.8	.96	2.0
17	3.4	16	7.8	12	9.3	86	9.8	6.7	3.3	1.7	1.0	2.8
18	3.4	13	8.2	11	8.5	59	9.3	8.1	3.3	1.7	1.0	4.5
19	3.4	11	7.9	11	7.7	44	8.8	10	3.8	1.6	1.1	19
20	3.4	9.5	8.1	10	8.6	35	8.8	10	3.5	1.5	1.2	17
21	3.4	8.9	8.3	9.9	27	29	8.8	8.3	3.2	1.4	1.0	9.3
22	3.7	8.4	9.0	9.4	44	25	8.4	7.3	3.4	1.3	.95	6.3
23	3.9	8.2	9.4	8.9	36	25	8.4	7.2	3.4	1.4	.96	4.5
24	4.1	7.8	9.4	8.9	33	40	6.7	6.8	2.9	1.5	1.0	4.2
25	5.0	7.8	9.4	8.9	27	62	4.8	6.7	2.7	1.7	2.0	13
26	5.1	7.8	9.4	8.7	23	54	6.7	9.1	2.5	1.8	2.3	3.7
27	5.4	7.7	9.4	8.3	19	43	7.5	9.3	2.8	1.7	3.1	2.9
28	5.0	7.3	9.7	8.3	21	35	7.5	8.3	2.5	1.6	2.2	18
29	5.0	7.3	11	7.8	---	29	7.6	7.5	2.4	1.6	2.7	24
30	5.0	7.3	25	7.8	---	26	8.7	6.7	2.5	1.6	2.1	15
31	5.0	---	22	7.8	---	23	---	6.2	---	1.4	1.5	---
TOTAL	142.4	339.7	286.6	515.7	506.5	1178	349.8	294.6	116.4	58.9	41.77	163.55
MEAN	4.59	11.3	9.25	16.6	18.1	38.0	11.7	9.50	3.88	1.90	1.35	5.45
MAX	10	48	25	70	45	130	21	16	5.9	2.6	3.1	24
MIN	3.4	4.7	7.3	7.8	7.3	11	4.8	6.2	2.4	1.3	.95	.79
AC-FT	282	674	568	1020	1000	2340	694	584	231	117	83	324

CAL YR 1976 TOTAL 26747.90 MEAN 73.1 MAX 2400 MIN 3.4 AC-FT 53050
WTR YR 1977 TOTAL 3993.92 MEAN 10.9 MAX 130 MIN .79 AC-FT 7920

11468500 NOYO RIVER NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mi (1.1 km) downstream from South Fork, and 3.5 mi (5.6 km) east of Fort Bragg.

DRAINAGE AREA.--106 mi² (275 km²).

PERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft (3.575 m) above mean sea level.

AVERAGE DISCHARGE.--24 years, 230 ft³/s (6.514 m³/s), 166,600 acre-ft/yr (205 hm³/yr).

EXTREMES.--Current year: Maximum discharge, 7,350 ft³/s (208 m³/s) Mar. 18 (gage height, 16.70 ft or 5.090 m); minimum daily, 5.5 ft³/s (0.16 m³/s) Sept. 6-10, 28-30.
Period of record: Maximum discharge, 26,600 ft³/s (753 m³/s) Mar. 29, 1974 (gage height, 27.14 ft or 8.272 m), from rating curve extended above 4,500 ft³/s (127 m³/s) on basis of slope-conveyance study; minimum daily, 0.80 ft³/s (0.023 m³/s) Sept. 12, 1968.

REMARKS.--Records fair. No regulation or diversion above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	10	12	16	45	650	194	292	126	35	20	11	6.5
2	11	10	27	37	1220	235	254	115	35	20	11	7.5
3	11	10	105	31	853	208	236	114	35	20	11	6.4
4	11	10	690	71	908	185	231	105	34	19	10	6.0
5	11	9.7	100	270	801	170	250	97	33	19	10	5.9
6	9.0	9.7	49	1800	674	159	234	92	32	18	10	5.5
7	6.9	16	34	1200	745	333	209	87	30	17	10	5.5
8	6.8	24	25	1600	750	1370	197	83	29	17	9.8	5.5
9	6.7	17	21	840	1260	1140	181	79	29	17	9.5	5.5
10	6.5	15	18	570	1740	838	167	76	28	16	9.2	5.5
11	6.6	13	23	420	1070	631	155	75	28	16	8.8	5.9
12	6.2	12	30	310	3420	480	143	71	27	15	8.6	6.0
13	6.2	11	54	250	5280	397	134	68	27	15	8.4	6.3
14	6.3	11	71	200	2000	332	128	64	26	15	8.1	6.5
15	6.2	10	81	160	1050	312	125	64	26	17	7.8	6.5
16	6.0	10	56	130	723	507	120	61	26	19	7.5	6.2
17	6.0	11	41	104	528	1390	115	56	25	17	8.1	6.9
18	6.0	19	30	83	427	5790	107	54	25	16	9.4	13
19	6.0	21	25	69	2180	3580	102	52	24	15	9.6	7.0
20	6.0	16	22	57	2290	1720	97	50	24	14	8.9	7.0
21	6.0	23	24	49	1100	2740	93	47	24	14	8.2	6.6
22	6.2	35	27	43	718	3400	90	46	24	13	7.5	6.5
23	7.0	27	20	37	521	1960	94	45	23	13	7.1	6.4
24	7.8	22	18	33	416	1770	178	44	23	12	6.9	6.4
25	7.9	31	16	31	348	4190	245	42	22	12	6.5	6.0
26	8.4	28	15	31	291	1850	203	41	22	12	6.5	6.1
27	12	23	1100	29	244	1040	181	39	21	12	6.6	6.0
28	54	20	1300	26	204	701	162	38	21	12	7.4	5.5
29	43	18	180	25	---	519	148	38	21	12	7.1	5.5
30	19	17	64	24	---	416	136	37	20	11	7.2	5.5
31	14	---	56	123	---	349	---	36	---	11	6.9	---
TOTAL	336.6	511.4	4338	8698	32411	38906	5007	2042	799	476	264.6	191.6
MEAN	10.9	17.0	140	281	1158	1255	167	65.9	26.6	15.4	8.54	6.39
MAX	54	35	1300	1800	5280	5790	292	126	35	20	11	13
MIN	6.0	9.7	15	24	204	159	90	36	20	11	6.5	5.5
AC-FT	668	1010	8600	17250	64290	77170	9930	4050	1580	944	525	380

CAL YR 1974 TOTAL 138253.3 MEAN 379 MAX 20100 MIN 3.7 AC-FT 274200
WTR YR 1975 TOTAL 93981.2 MEAN 257 MAX 5790 MIN 5.5 AC-FT 186400

Peak discharge (base, 2,400 ft³/s)

Date	Time	G.H.	Discharge	Date	Time	G.H.	Discharge
1-6	unknown	10.40	2,650	3-18	0530	16.70	7,350
2-1[illegible]	[illegible]215	16.27	6,900	3-21	2030	14.38	5,360
2-19	1915	13.28	4,350	3-25	0530	14.94	5,800

11468500 NOYO RIVER NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mi (1.1 km) downstream from South Fork, and 3.5 mi (5.6 km) east of Fort Bragg.

DRAINAGE AREA.--106 mi² (275 km²).

PERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft (3.575 m) above mean sea level.

AVERAGE DISCHARGE.--23 years, 229 ft³/s (6.485 m³/s), 165,900 acre-ft/yr (205 hm³/yr).

EXTREMES.--Current year: Maximum discharge, 26,600 ft³/s (753 m³/s) Mar. 29 (gage height, 27.14 ft or 8.272 m), from rating curve extended as explained below; minimum daily, 3.7 ft³/s (0.10 m³/s) Sept. 23.
Period of record: Maximum discharge, 26,600 ft³/s (753 m³/s) Mar. 29, 1974 (gage height, 27.14 ft or 8.272 m), from rating curve extended above 4,500 ft³/s (127 m³/s) on basis of slope-conveyance study; minimum daily, 0.80 ft³/s (0.023 m³/s) Sept. 12, 1968.

REMARKS.--Records fair. No regulation or diversion above station. Records of water temperatures for the current year are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7.6	20	1,880	590	438	2,330	7,480	156	48	24	15	9.6
2	7.2	18	1,240	450	398	1,990	3,460	149	47	23	15	9.5
3	7.2	17	803	406	363	1,770	1,800	142	46	23	15	9.5
4	6.8	16	617	393	327	1,140	1,230	127	44	22	14	10
5	6.8	205	503	376	291	759	969	125	43	22	14	7.8
6	17	285	419	363	228	595	766	120	42	22	16	7.2
7	60	347	378	349	166	647	643	115	41	22	15	7.1
8	33	661	353	333	143	558	587	108	40	51	14	6.7
9	21	1,320	320	307	120	469	670	102	39	53	13	6.3
10	16	1,610	293	278	104	410	627	97	38	34	13	6.0
11	13	2,630	355	256	91	730	566	93	36	28	12	5.7
12	12	1,750	380	258	110	821	519	91	35	25	12	5.4
13	11	1,290	632	267	100	732	476	87	35	24	12	5.4
14	10	1,050	710	820	79	601	436	84	35	23	12	4.9
15	9.9	740	638	5,540	68	480	399	82	34	22	12	4.7
16	9.4	1,680	542	20,100	110	394	365	78	33	21	12	4.5
17	8.9	1,330	506	4,820	99	330	330	80	33	21	12	4.4
18	8.5	1,150	443	2,510	328	282	323	80	34	21	12	4.3
19	8.9	812	395	2,590	3,070	245	295	74	35	21	11	4.3
20	9.4	667	358	1,770	1,290	213	270	70	37	20	11	4.1
21	19	616	770	1,120	813	184	251	68	34	19	11	4.1
22	242	565	761	796	587	164	235	66	32	19	10	4.0
23	248	481	605	601	452	148	225	64	31	18	10	3.7
24	133	426	500	488	376	131	215	61	30	18	9.8	4.0
25	73	366	428	425	318	146	212	59	28	17	9.3	6.6
26	50	324	401	363	290	128	229	58	28	17	9.3	7.6
27	45	287	575	320	258	279	204	56	27	16	9.2	8.1
28	32	262	788	287	1,420	839	186	54	26	15	9.1	9.4
29	26	355	1,170	249	------	11,000	174	52	26	15	9.0	9.6
30	23	1,210	1,120	225	------	11,600	163	50	25	15	9.0	9.8
31	21	------	799	324	------	3,210	------	49	------	15	9.3	------
TOTAL	1,195.6	22,490	19,682	47,974	12,437	43,325	24,305	2,697	1,062	706	367.0	194.3
MEAN	38.6	750	635	1,548	444	1,398	810	87.0	35.4	22.8	11.8	6.48
MAX	248	2,630	1,880	20,100	3,070	11,600	7,480	156	48	53	16	10
MIN	6.8	16	293	225	68	128	163	49	25	15	9.0	3.7
AC-FT	2,370	44,610	39,040	95,160	24,670	85,940	48,210	5,350	2,110	1,400	728	385

CAL YR 1973 TOTAL 111,556.4 MEAN 306 MAX 4,400 MIN 4.9 AC-FT 221,300
WTR YR 1974 TOTAL 176,434.9 MEAN 483 MAX 20,100 MIN 3.7 AC-FT 350,000

PEAK DISCHARGE (BASE, 2,400 FT³/S)

DATE	TIME	G.H.	DISCHARGE	DATE	TIME	G.H.	DISCHARGE
11-11	1130	12.68	3,610	2-28	2100	11.13	3,080
1-16	0915	27.10	26,400	3-29	2200	27.14	26,600
1-19	0445	10.70	2,820	4-1	1330	18.73	9,410
2-19	0600	13.40	4,610				

11468500 NOYO RIVER NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mile downstream from South Fork, and 3.5 miles east of Fort Bragg.

DRAINAGE AREA.--106 sq mi.

PERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft above mean sea level.

AVERAGE DISCHARGE.--22 years, 217 cfs (157,200 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 5,720 cfs Jan. 12 (gage height, 16.27 ft, from peak-stage indicator); minimum daily, 4.7 cfs Oct. 30, 31.
Period of record: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 0.80 cfs Sept. 12, 1968.

REMARKS.--Records good except those for periods of no gage-height record, which are fair. No regulation or diversion above station. Records of water temperatures for the current year are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	13	4.9	27	207	358	608	488	61	31	14	6.8	4.9
2	12	5.8	25	185	335	530	401	59	31	14	6.8	4.9
3	12	27	48	163	315	569	340	58	30	14	6.8	4.9
4	12	135	70	145	1,200	608	293	56	29	13	6.8	4.9
5	11	114	74	128	2,060	557	255	55	28	13	6.4	5.3
6	11	57	222	115	1,130	572	227	53	26	13	6.4	5.3
7	11	159	260	107	779	506	205	52	26	12	6.4	5.3
8	10	170	230	151	608	482	185	50	24	12	6.0	5.6
9	10	111	186	1,030	530	425	165	49	23	12	6.0	5.6
10	10	136	149	1,360	602	413	153	47	22	12	6.0	5.6
11	23	206	122	2,400	590	428	139	46	22	12	6.0	6.0
12	50	161	102	4,400	599	389	130	45	23	11	6.0	6.0
13	38	152	85	2,900	548	353	139	44	22	11	6.0	5.6
14	27	246	70	1,900	575	310	122	43	22	11	6.0	5.6
15	32	200	67	1,000	551	275	115	42	21	11	5.6	5.6
16	22	275	183	3,100	500	247	109	41	21	11	5.6	5.6
17	15	210	1,880	2,400	440	233	109	40	22	11	5.3	5.3
18	11	156	1,130	2,700	375	213	103	39	22	11	5.3	5.6
19	9.4	147	1,110	1,600	330	223	98	38	21	11	5.3	7.2
20	8.4	140	692	990	290	323	93	38	21	10	4.9	16
21	7.6	122	488	900	258	401	88	37	19	11	4.9	17
22	6.8	107	656	730	233	440	82	37	18	11	4.9	14
23	6.4	91	752	600	213	401	79	36	18	9.5	4.9	23
24	6.2	77	776	524	280	353	77	35	17	8.5	4.9	24
25	6.0	63	623	512	338	308	74	34	17	8.5	4.9	19
26	5.7	54	473	479	560	270	71	33	17	8.5	4.9	15
27	5.3	47	422	443	719	239	70	33	16	8.5	4.9	12
28	5.0	42	378	398	665	213	68	32	15	7.6	5.3	9.5
29	4.8	35	323	410	------	193	64	31	15	7.6	5.3	8.5
30	4.7	31	278	416	------	401	63	31	14	7.2	5.3	8.0
31	4.7	------	237	392	------	575	------	31	------	7.2	5.3	------
TOTAL	411.0	3,481.7	12,138	32,785	15,981	12,058	4,605	1,326	653	334.1	175.9	270.8
MEAN	13.3	116	392	1,058	571	389	154	42.8	21.8	10.8	5.67	9.03
MAX	50	275	1,880	4,400	2,060	608	488	61	31	14	6.8	24
MIN	4.7	4.9	25	107	213	193	63	31	14	7.2	4.9	4.9
AC-FT	815	6,910	24,080	65,030	31,700	23,920	9,130	2,630	1,300	663	349	537

CAL YR 1972 TOTAL 51,058.7 MEAN 140 MAX 2,700 MIN 3.9 AC-FT 101,300
WTR YR 1973 TOTAL 84,219.5 MEAN 231 MAX 4,400 MIN 4.7 AC-FT 167,000

PEAK DISCHARGE (BASE, 2,400 CFS)

DATE	TIME	G.H.	DISCHARGE	DATE	TIME	G.H.	DISCHARGE
12-17	1045	10.97	2,710	1-16	unknown	--	3,900
1-12	unknown	16.27	5,720	2-4	2200	11.65	3,060

NOTE.--No gage-height record Jan. 11-22, Apr. 27 to May 30.

11468500 NOYO RIVER NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mile downstream from South Fork, and 3.5 miles east of Fort Bragg.

DRAINAGE AREA.--106 sq mi.

PERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft above mean sea level.

AVERAGE DISCHARGE.--21 years, 216 cfs (156,500 acre-ft per year); median of yearly mean discharges, 210 cfs (152,000 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 3,770 cfs Jan. 23 (gage height, 12.95 ft, from peak-stage indicator); minimum daily, 3.9 cfs Sept. 11, 12, 14, 15, 22.

Period of record: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 0.80 cfs Sept. 12, 1968.

REMARKS.--Records good. No regulation or diversion above station. Records of water temperatures for the current year are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	14	8.5	53	79	230	650	126	62	25	15	7.1	4.5
2	10	8.5	112	70	210	800	117	59	25	15	7.0	4.5
3	8.5	8.0	156	63	192	1,350	109	56	24	15	6.7	4.5
4	8.0	7.5	130	57	189	880	102	54	24	15	6.4	4.6
5	7.5	7.5	95	52	186	610	113	51	24	15	6.2	4.7
6	7.0	7.5	263	48	176	539	131	49	22	14	5.8	4.9
7	6.5	7.5	158	45	167	398	121	50	22	14	5.6	4.5
8	6.1	7.5	96	43	159	306	109	51	22	14	5.4	4.3
9	7.0	8.0	112	40	148	259	102	46	29	13	5.2	4.1
10	11	9.0	163	38	137	233	96	44	31	13	5.0	4.0
11	5.7	16	170	36	127	215	119	42	24	13	4.9	3.9
12	5.7	27	482	35	115	191	241	40	23	12	4.8	3.9
13	5.7	84	365	34	108	177	332	37	22	12	4.8	4.2
14	6.1	57	209	33	100	162	277	36	21	12	5.5	3.9
15	5.7	31	142	31	93	150	228	34	20	11	5.9	3.9
16	6.1	21	104	30	89	139	190	34	20	11	6.4	4.0
17	6.1	15	82	29	82	129	164	39	20	11	7.8	4.1
18	6.5	13	70	28	82	120	146	36	19	11	7.2	4.3
19	7.5	11	61	39	97	112	131	35	19	11	6.9	4.2
20	10	10	54	56	84	105	118	37	19	11	6.5	4.1
21	11	9.5	52	920	110	100	107	37	18	9.9	6.0	4.0
22	10	9.5	183	2,100	170	152	93	35	18	9.6	5.7	3.9
23	12	9.0	284	2,700	240	144	96	33	18	9.4	5.5	4.0
24	11	11	362	840	600	182	118	32	18	9.0	5.4	4.3
25	11	12	428	630	750	240	101	31	18	8.6	5.2	4.7
26	9.0	26	314	540	1,300	234	90	29	17	8.4	5.0	26
27	8.5	65	236	450	850	215	82	29	16	8.0	5.0	92
28	8.0	84	165	370	840	192	76	28	16	7.8	4.9	35
29	7.5	95	132	320	930	171	69	27	16	7.6	4.8	22
30	7.5	78	108	290	------	152	65	26	15	7.5	4.7	15
31	6.5	------	91	250	------	138	------	26	------	7.3	4.6	------
TOTAL	254.7	763.5	5,432	10,296	8,561	9,527	3,969	1,225	625	351.1	177.9	296.0
MEAN	8.22	25.5	175	332	295	307	132	39.5	20.8	11.3	5.74	9.87
MAX	14	95	482	2,700	1,300	1,350	332	62	31	15	7.8	92
MIN	5.7	7.5	52	28	82	100	65	26	15	7.3	4.6	3.9
AC-FT	505	1,510	10,770	20,420	16,980	18,900	7,870	2,430	1,240	696	353	587

CAL YR 1971 TOTAL 68,887.3 MEAN 189 MAX 6,750 MIN 5.3 AC-FT 136,600
WTR YR 1972 TOTAL 41,478.2 MEAN 113 MAX 2,700 MIN 3.9 AC-FT 82,270

PEAK DISCHARGE (BASE, 2,400 CFS).--Jan. 23 (time unknown) 3,770 cfs (12.95 ft).

NOTE.--No gage-height record Jan. 21 to Feb. 2.

11468500 NOYO RIVER NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

DRAINAGE AREA.--106 sq mi.

PERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft above mean sea level.

AVERAGE DISCHARGE.--20 years, 221 cfs (160,100 acre-ft per year); median of yearly mean discharges, 210 cfs (152,000 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 9,080 cfs Dec. 4 (gage height, 19.98 ft); minimum daily, 1.9 cfs Oct. 1.

Period of record: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 0.80 cfs Sept. 12, 1968.

REMARKS.--Records good. No regulation or diversion above station. Record of water temperatures for the current year is published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.9	6.5	850	548	154	78	392	95	41	23	10	12
2	2.1	6.5	1,450	494	144	70	329	100	40	22	9.5	11
3	4.1	8.5	3,430	413	132	82	284	114	40	21	9.5	10
4	2.4	28	4,710	359	124	95	248	98	39	21	9.0	9.5
5	2.6	107	1,390	314	118	91	221	91	38	20	9.0	9.0
6	2.9	86	889	273	114	84	197	87	37	19	8.5	8.0
7	2.4	61	829	233	108	79	183	82	37	19	8.5	7.5
8	2.6	39	952	200	102	78	163	76	37	18	8.0	7.0
9	3.4	109	864	175	95	72	188	75	36	18	8.0	6.5
10	3.6	131	658	236	89	76	317	70	36	18	8.0	6.5
11	3.6	73	506	392	86	212	242	67	35	18	7.5	6.5
12	3.9	80	398	728	82	2,010	212	67	34	17	7.5	6.5
13	4.6	67	329	836	78	1,620	194	67	33	16	7.0	6.5
14	4.9	50	263	1,210	78	1,050	203	63	32	16	7.5	6.5
15	5.1	39	263	2,290	82	868	175	61	31	15	7.5	6.5
16	5.7	35	593	6,750	76	668	165	59	30	15	7.5	6.1
17	6.2	29	756	4,220	73	539	194	55	29	14	7.5	5.7
18	9.5	25	675	2,170	72	428	185	55	27	14	7.5	5.7
19	11	22	536	1,400	73	347	175	54	27	14	7.5	5.7
20	23	20	572	983	67	284	178	53	27	13	7.5	5.7
21	41	18	756	728	65	236	160	51	27	12	8.0	6.1
22	51	18	633	578	63	206	152	51	26	12	8.5	5.3
23	59	18	515	488	63	696	154	50	25	12	8.5	5.3
24	52	53	416	419	61	717	136	48	25	11	8.0	5.3
25	24	288	341	362	61	1,410	134	47	25	11	8.0	5.7
26	14	250	284	314	56	5,210	126	51	30	11	8.0	6.5
27	11	889	245	272	72	1,890	118	50	32	11	7.5	6.5
28	8.5	1,530	389	239	86	1,090	112	47	28	11	8.0	7.0
29	7.7	726	1,160	212	------	766	106	45	25	11	8.0	9.5
30	7.3	686	885	188	------	584	100	44	24	11	9.5	15
31	6.9	------	668	170	------	470	------	42	------	11	12	------
TOTAL	387.9	5,498.5	27,205	28,194	2,474	22,106	5,743	2,015	953	475	256.5	220.6
MEAN	12.5	183	878	909	88.4	713	191	65.0	31.8	15.3	8.27	7.35
MAX	59	1,530	4,710	6,750	154	5,210	392	114	41	23	12	15
MIN	1.9	6.5	245	170	56	70	100	42	24	11	7.0	5.3
AC-FT	769	10,910	53,960	55,920	4,910	43,850	11,390	4,000	1,890	942	509	438

CAL YR 1970 TOTAL 113,158.9 MEAN 310 MAX 7,250 MIN 1.4 AC-FT 224,500
WTR YR 1971 TOTAL 95,528.5 MEAN 262 MAX 6,750 MIN 1.9 AC-FT 189,500

PEAK DISCHARGE (BASE, 2,400 CFS)

DATE	TIME	G.H.	DISCHARGE	DATE	TIME	G.H.	DISCHARGE
12- 4	0130	19.98	9,080	3-12	1515	12.38	3,460
1-16	2000	18.80	7,900	3-26	0330	18.46	7,560

11468500 NOYO RIVER NEAR FORT BRAGG, CALIF.

TION.--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

DRAINAGE AREA.--106 sq mi.

ERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft above mean sea level.

AVERAGE DISCHARGE.--19 years, 219 cfs (158,700 acre-ft per year); median of yearly mean discharges, 210 cfs (152,000 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 13,300 cfs Jan. 23 (gage height, 22.28 ft); minimum daily, 1.4 cfs on many days in September.
Period of record: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 0.80 cfs Sept. 12, 1968.

REMARKS.--Records good. No regulation or diversion above station. Records of water temperatures for the water year 1970 are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.6	3.9	7.7	145	566	202	72	35	17	8.0	4.0	3.4
2	2.6	3.9	7.7	126	449	173	68	34	17	7.8	4.1	3.2
3	2.4	3.9	7.7	108	357	158	66	32	16	7.4	4.1	3.1
4	2.4	5.9	8.1	97	308	365	63	31	16	7.2	3.7	3.4
5	2.1	46	8.1	87	261	427	61	30	16	6.8	3.8	4.3
6	2.4	30	8.0	83	222	334	58	30	16	6.6	3.9	4.8
7	2.4	19	8.4	80	199	317	57	30	16	6.2	3.8	3.6
8	4.1	19	13	83	182	434	54	30	18	6.1	3.7	1.9
9	3.6	15	14	170	165	421	53	33	20	5.9	3.5	1.4
10	3.9	12	15	837	152	413	51	34	19	5.9	3.6	1.4
11	4.1	11	34	644	139	352	50	32	17	5.9	3.4	1.4
12	8.5	9.9	965	497	186	301	48	31	16	5.9	3.4	1.6
13	2.9	8.9	799	943	483	263	48	30	17	5.9	3.3	1.4
14	2.9	8.5	586	3,010	729	256	51	28	16	5.7	2.8	1.4
15	21	8.5	332	1,700	535	221	52	27	15	5.4	2.8	1.4
16	30	8.5	164	3,170	975	198	50	25	15	5.3	3.1	1.4
17	15	8.5	102	3,010	1,880	181	51	24	14	4.9	3.1	1.6
18	9.5	8.1	93	1,810	1,310	169	48	23	13	4.7	3.0	1.4
19	6.8	8.1	991	1,220	936	157	57	23	13	4.9	2.4	1.4
20	5.4	7.8	947	1,370	683	145	49	22	13	4.8	2.4	1.9
21	4.8	7.7	2,470	5,420	516	134	46	21	12	4.9	1.9	1.9
22	4.4	7.9	1,240	4,140	398	117	44	21	12	4.9	2.4	1.9
23	4.1	7.9	1,470	7,250	326	117	42	21	11	4.8	2.6	1.9
24	3.9	7.7	1,290	6,900	282	110	40	21	11	4.6	2.9	1.9
25	3.9	7.7	801	2,730	242	104	40	20	10	4.6	2.9	2.1
26	3.9	7.8	609	1,830	212	97	41	19	9.8	4.6	2.9	2.1
27	4.3	7.7	487	4,770	194	92	41	19	9.4	4.6	2.6	1.9
28	4.1	7.7	360	2,100	189	86	39	19	9.0	4.6	2.6	1.9
29	4.1	7.8	272	1,330	------	81	37	18	8.6	4.6	3.1	1.9
30	4.1	7.7	214	953	------	80	36	18	8.2	4.6	3.3	1.9
31	4.1	------	175	728	------	77	------	18	------	4.0	3.5	------
TOTAL	180.3	324.0	14,498.7	57,341	13,076	6,582	1,513	799	421.0	172.1	98.6	64.8
MEAN	5.82	10.8	468	1,850	467	212	50.4	25.8	14.0	5.55	3.18	2.16
MAX	30	46	2,470	7,250	1,880	434	72	35	20	8.0	4.1	4.8
MIN	2.1	3.9	7.7	80	139	77	36	18	8.2	4.0	1.9	1.4
AC-FT	358	643	28,760	113,700	25,940	13,060	3,000	1,580	835	341	196	129

CAL YR 1969 TOTAL 100,840.8 MEAN 276 MAX 7,760 MIN 2.1 AC-FT 200,000
WTR YR 1970 TOTAL 95,070.5 MEAN 260 MAX 7,250 MIN 1.4 AC-FT 188,600

PEAK DISCHARGE (BASE, 2,400 CFS)

DATE	TIME	G.H.	DISCHARGE	DATE	TIME	G.H.	DISCHARGE
12-21	1215	12.77	3,690	1-21	0745	17.14	6,410
1-14	1045	13.52	4,110	1-23	2345	22.28	13,300
1-16	1500	13.36	4,030	1-27	0515	17.85	6,980

NOTE.--No gage-height record May 27 to July 7.

11-4685. NOYO RIVER NEAR FORT BRAGG, CALIF.

ATION (revised).--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., Mendocino County, on right bank 0.7 mile downstream from South Fork, and 3.5 miles east of Fort Bragg.

DRAINAGE AREA.--106 sq mi.

ERIOD OF RECORD.--August 1951 to current year.

GAGE.--Water-stage recorder. Datum of gage is 11.73 ft above mean sea level.

AVERAGE DISCHARGE.--18 years, 217 cfs (157,200 acre-ft per year); median of yearly mean discharges, 190 cfs (138,000 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 9,300 cfs Jan. 12 (gage height, 20.13 ft); minimum daily, 2.7 cfs Oct. 1.
Period of record: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 0.80 cfs Sept. 12, 1968.

REMARKS.--Records fair. No regulation or diversion above station. Records of water temperatures for the water year 1969 are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.7	10	86	333	888	1,300	96	69	30	17	9.0	4.8
2	2.8	20	51	268	841	1,120	100	66	29	17	8.4	4.9
3	3.4	31	42	228	739	920	106	62	29	16	7.8	7.5
4	4.0	20	34	198	655	760	94	61	29	15	7.8	14
5	4.0	14	26	178	745	630	154	59	28	15	7.2	12
6	4.0	12	21	164	1,330	534	168	56	29	14	7.2	9.4
7	5.8	11	19	151	1,170	448	149	53	28	14	6.6	7.7
8	5.8	10	73	141	956	383	137	52	28	14	6.0	6.3
9	5.2	9.7	79	134	1,790	334	130	50	28	13	6.0	5.5
10	5.8	9.4	1,200	128	1,370	300	121	50	29	13	6.6	5.2
11	6.6	24	808	1,090	1,660	261	110	49	30	12	6.0	4.9
12	29	57	444	7,760	1,410	233	106	48	29	12	6.6	4.6
13	22	44	271	5,600	988	214	100	46	27	12	7.2	4.4
14	14	43	252	2,110	745	197	94	46	25	11	6.6	4.2
15	11	60	1,190	1,160	664	185	90	45	24	11	6.6	4.0
16	9.0	38	826	778	640	175	85	43	23	11	6.0	3.9
17	8.0	29	431	610	582	202	83	42	27	11	6.0	3.8
18	7.4	43	282	548	523	187	83	41	27	11	6.6	3.7
19	6.8	43	212	1,580	464	173	79	41	24	11	6.0	3.6
20	6.5	23	169	5,210	400	166	76	40	23	10	6.0	3.5
21	6.4	20	141	4,430	355	166	72	40	22	10	6.0	3.5
22	6.3	18	126	2,510	330	156	70	38	21	10	5.6	3.4
23	6.2	16	1,980	1,540	400	149	112	38	20	10	6.0	3.3
24	6.1	37	3,480	1,090	480	134	112	37	19	10	5.6	3.3
25	6.0	80	2,460	992	610	128	96	37	18	10	5.4	3.2
26	5.9	50	2,050	1,410	840	121	88	37	18	10	5.2	3.1
27	5.8	40	1,180	1,380	850	117	83	38	18	10	5.1	3.1
28	5.8	33	797	1,290	1,370	112	79	37	18	10	5.1	3.0
29	13	35	609	1,110	------	110	76	35	17	10	5.0	3.0
30	18	55	498	1,050	------	96	70	34	16	9.6	4.9	2.9
31	13	------	399	874	------	100	------	31	------	9.6	4.8	------
TOTAL	256.3	935.1	20,236	46,045	23,795	10,111	3,019	1,421	733	369.2	194.9	149.7
MEAN	8.27	31.2	653	1,485	850	326	101	45.8	24.4	11.9	6.29	4.99
MAX	29	80	3,480	7,760	1,790	1,300	168	69	30	17	9.0	14
MIN	2.7	9.4	19	128	330	96	70	31	16	9.6	4.8	2.9
AC-FT	508	1,850	40,140	91,330	47,200	20,050	5,990	2,820	1,450	732	387	297

CAL YR 1968 TOTAL 61,054.50 MEAN 167 MAX 3,480 MIN .80 AC-FT 121,100
WTR YR 1969 TOTAL 107,265.2 MEAN 294 MAX 7,760 MIN 2.7 AC-FT 212,800

PEAK DISCHARGE (BASE, 2,400 CFS)

DATE	TIME	G.H.	DISCHARGE	DATE	TIME	G.H.	DISCHARGE
12-23	2215	14.32	4,390	1-20	0530	17.04	6,130
1-12	0800	20.13	9,300				

11-4685. NOYO RIVER NEAR FORT BRAGG, CALIF.

…ON (revised).--Lat 39°25'42", long 123°44'12", in NE¼ sec.15, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork, and 3.5 miles east of Fort Bragg.

DRAINAGE AREA.--106 sq mi.

RECORDS AVAILABLE.--August 1951 to September 1968.

GAGE.--Digital water-stage recorder. Datum of gage is 11.73 ft above mean sea level, datum of 1929, supplementary adjustment of 1960. Prior to June 17, 1964, graphic water-stage recorder at same site and datum.

AVERAGE DISCHARGE.--17 years, 213 cfs (154,200 acre-ft per year); median of yearly mean discharges, 186 cfs (135,000 acre-ft per year).

EXTREMES.--Maximum discharge during year, 3,480 cfs Feb. 20 (gage height, 12.76 ft); minimum daily, 0.80 cfs Sept. 12.

1951-68: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 0.80 cfs Sept. 12, 1968.

REMARKS.--Records fair. No regulation or diversion above station. Records of water temperatures for the 1968 water year are published in Part 2 of this report.

REVISIONS (water year).--1965 report: 1964.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.0	15	106	46	513	270	128	37	17	5.8	3.0	7.3
2	11	15	118	49	530	235	120	37	15	5.8	3.1	6.3
3	13	14	480	41	647	205	107	36	18	5.8	3.2	5.6
4	6.4	14	285	39	550	185	99	34	19	5.8	3.5	5.2
5	16	15	485	37	433	170	95	33	18	5.8	3.8	4.9
6	13	16	263	35	333	155	89	32	21	5.2	4.1	4.6
7	12	15	448	32	253	145	85	30	20	4.6	4.3	4.5
8	11	17	293	38	206	135	82	30	19	4.6	4.3	4.4
9	10	24	176	99	179	128	78	30	15	4.0	4.3	2.2
10	9.5	21	130	1,190	161	120	74	30	16	4.0	4.3	2.2
11	9.0	20	105	553	145	112	71	28	16	4.0	4.2	1.0
12	8.8	20	89	318	132	305	69	28	16	3.9	4.2	.80
13	8.6	21	79	250	121	440	66	31	15	3.7	4.2	2.2
14	8.5	80	73	1,020	114	388	62	32	16	3.6	4.2	6.4
15	8.4	40	66	2,280	105	343	59	26	17	3.5	4.2	3.4
16	8.3	34	62	1,140	100	702	57	23	18	3.4	4.3	3.6
17	8.2	29	66	684	108	853	55	19	13	3.4	4.2	3.3
18	8.2	26	156	473	102	662	54	19	11	3.3	4.3	2.6
19	8.1	23	183	343	868	495	52	19	13	3.2	4.7	2.7
20	8.0	21	144	255	2,470	383	50	30	11	3.2	6.5	2.4
21	10	19	127	202	1,560	300	50	28	10	3.2	25	2.5
22	30	18	106	172	1,260	250	48	30	9.2	3.1	16	2.9
23	24	17	92	147	985	220	46	25	9.2	3.0	13	2.0
24	21	16	83	130	800	189	46	24	9.2	3.0	12	2.3
25	19	15	75	120	641	192	44	34	9.2	3.0	13	2.3
26	17	15	70	112	515	181	43	32	8.1	3.0	20	1.8
27	16	16	66	108	428	163	41	26	8.1	3.0	17	2.1
28	22	25	62	109	360	152	37	25	7.0	3.0	14	2.3
29	20	100	58	538	310	141	40	20	6.4	2.9	12	2.8
30	18	130	55	1,200	------	136	38	20	5.8	2.9	10	2.2
31	16	------	51	739	------	126	------	17	------	2.9	8.6	------
TOTAL	403.0	851	4,652	12,499	14,929	8,481	1,985	865	406.2	119.6	243.5	98.80
MEAN	13.0	28.4	150	403	515	274	66.2	27.9	13.5	3.86	7.85	3.29
MAX	30	130	485	2,280	2,470	853	128	37	21	5.8	25	7.3
MIN	4.0	14	51	32	100	112	37	17	5.8	2.9	3.0	.80
AC-FT	799	1,690	9,230	24,790	29,610	16,820	3,940	1,720	806	237	483	196

CAL YR 1967 TOTAL 66,788.8 MEAN 183 MAX 3,240 MIN 4.0 AC-FT 132,500
WTR YR 1968 TOTAL 45,533.10 MEAN 124 MAX 2,470 MIN .80 AC-FT 90,310

Peak discharge (base, 2,400 cfs).--Jan. 14 (2400 hrs) 2,770 cfs (11.33 ft); Feb. 20 (0215 hrs) 3,480 cfs (12.76 ft).

NOYO RIVER BASIN

11-4685. Noyo River near Fort Bragg, Calif.

...ation.--Lat 39°25'31", long 123°44'10", in SW¼ sec.10, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

...ainage area.--106 sq mi.

...ords available.--August 1951 to September 1966.

Gage.--Digital water-stage recorder. Datum of gage is 11.73 ft (revised) above mean sea level, datum of 1929, supplementary adjustment of 1960. Prior to June 17, 1964, graphic water-stage recorder at same site and datum.

Average discharge.--15 years, 219 cfs (158,500 acre-ft per year); median of yearly mean discharges, 180 cfs (130,000 acre-ft per year).

Extremes.--Maximum discharge during year, 19,200 cfs Jan. 5 (gage height, 24.67 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 3.1 cfs Sept. 15.
1951-66: Maximum discharge, 24,000 cfs Dec. 22, 1964 (gage height, 26.30 ft), from rating curve extended above 7,400 cfs on basis of slope-conveyance study; minimum daily, 2.4 cfs Aug. 25-28, Sept. 12, 1959.

Remarks.--Records good except those for period of no gage-height record, which are fair. No regulation or diversion above station. Records of chemical analyses and water temperatures for the water year 1966 are published in Part 2 of this report.

Revisions (water years).--1965 Report: 1964.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1965 TO SEPTEMBER 1966

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	5.4	4.3	42	324	840	315	115	66	24	15	6.8	4.2
2	5.4	4.5	37	246	960	285	108	63	23	17	7.4	5.1
3	5.1	5.1	34	405	800	250	104	61	22	17	7.5	5.1
4	5.1	5.7	32	4,940	1,600	225	99	59	22	18	5.8	4.6
5	6.1	5.4	30	12,200	1,220	205	94	57	21	18	6.8	4.3
6	5.9	5.7	29	3,620	1,000	195	90	56	21	18	6.5	3.9
7	5.9	10	28	1,480	720	180	89	53	21	18	6.5	3.8
8	6.7	23	28	960	500	175	85	52	19	18	6.2	3.8
9	7.2	11	28	680	405	350	85	51	19	18	6.3	3.4
10	7.2	7.2	27	530	318	760	101	50	17	5.8	6.3	3.3
11	7.1	7.2	26	440	246	670	214	49	17	4.6	6.3	3.3
12	7.8	11	26	340	206	540	482	47	15	4.4	6.2	3.3
13	8.0	30	25	270	181	460	361	45	15	4.6	6.2	3.4
14	8.5	40	24	220	160	382	276	43	13	5.8	5.9	3.5
15	8.6	28	24	195	145	388	218	41	13	6.1	5.8	3.1
16	10	16	24	172	133	380	181	40	12	5.7	5.4	3.2
17	6.0	15	24	155	125	344	162	38	11	5.3	5.6	3.5
18	4.2	57	24	142	119	324	147	37	11	6.4	5.4	4.7
19	4.4	75	24	125	216	344	131	35	9.6	5.7	5.3	4.8
20	4.8	35	24	111	195	307	118	34	9.0	5.9	4.7	4.7
21	4.8	19	24	107	170	302	108	32	9.0	5.8	4.4	4.9
22	4.5	13	24	110	170	272	101	31	9.5	5.6	4.2	4.6
23	4.2	13	24	106	210	244	96	30	9.9	5.0	4.3	4.4
24	4.2	91	41	97	270	216	90	30	10	4.6	4.1	4.5
25	4.2	222	125	93	400	195	86	28	10	4.1	4.0	4.5
26	4.1	182	118	90	600	172	82	27	11	4.4	3.9	6.6
27	3.8	124	90	86	430	160	79	26	11	4.8	3.8	7.1
28	3.8	90	186	83	355	151	75	26	12	6.0	4.0	7.2
29	3.8	65	695	350	------	139	73	22	13	7.4	3.9	6.8
30	4.0	51	376	1,180	------	130	69	25	15	8.3	4.3	6.8
31	4.1	------	318	980	------	122	------	25	------	7.7	4.4	------
TOTAL	174.9	1,266.1	2,581	30,837	12,694	9,182	4,119	1,279	445.0	281.0	168.2	136.4
MEAN	5.64	42.2	83.3	995	453	296	137	41.3	14.8	9.07	5.43	4.55
AC-FT	347	2,510	5,120	61,160	25,180	18,210	8,170	2,540	883	557	334	271

CALENDAR YEAR 1965 MAX 2,880 MIN 3.3 MEAN 137 AC-FT 99,470
WATER YEAR 1965-66 MAX 12,200 MIN 3.1 MEAN 173 AC-FT 125,300

Peak discharge (base, 2,400 cfs).--Jan. 5 (0630) 19,200 cfs (24.67 ft).

Note.--No gage-height record Jan. 8 to Feb. 9.

11-4685. Noyo River near Fort Bragg, Calif.

ation.--Lat 39°25'31", long 123°44'10", in SW¼ sec.10, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

area.--106 sq mi.

ords available.--August 1951 to September 1964.

e.--Water-stage recorder (digital). Datum of gage is 12.1 ft above mean sea level (planetable survey).

verage discharge.--13 years, 214 cfs (154,900 acre-ft per year); median of yearly mean discharges, 180 cfs (130,000 acre-ft per year).

remes.--Maximum discharge during year, 6,570 cfs Jan. 20 (gage height, 17.72 ft, from recorded range in stage); minimum, 0.2 cfs Sept. 28.
1951-64: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 0.2 cfs Sept. 28, 1964.

arks.--Records good except those for period of no gage-height record, which are fair. No regulation or diversion above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1963 TO SEPTEMBER 1964

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	5.4	13	122	83	238	67	*120	40	20	12	5.5	2.2
2	5.1	18	109	86	212	80	109	37	21	12	5.0	1.9
3	5.4	21	98	84	190	70	99	46	20	12	4.8	1.8
4	5.4	140	90	81	167	66	94	56	20	12	4.8	1.3
5	6.0	81	84	78	151	64	89	46	22	11	4.8	1.9
6	6.6	113	77	78	142	53	83	41	24	10	4.7	1.6
7	6.6	106	72	98	131	61	78	* 37	25	11	4.7	1.4
8	6.9	328	76	108	120	58	75	35	23	10	4.5	1.4
9	9.1	443	110	106	113	62	71	32	23	9.8	4.2	1.4
10	13	228	99	105	109	57	69	31	23	9.3	4.0	1.3
11	26	128	90	100	105	78	65	30	22	9.7	4.0	1.3
12	21	88	83	97	99	256	63	29	20	8.9	4.1	1.3
13	15	69	79	95	94	246	59	29	19	8.2	3.8	1.3
14	12	516	74	106	91	218	58	28	19	8.0	3.8	1.3
15	32	617	73	104	97	181	55	27	18	7.7	3.7	1.3
16	38	393	69	100	88	151	53	28	17	7.6	3.5	1.1
17	23	263	66	125	83	132	51	30	*16	8.1	3.5	1.1
18	18	186	65	330	78	119	51	29	16	7.9	3.5	1.2
19	15	283	*69	1,250	75	121	49	28	16	7.6	3.3	1.0
20	18	479	111	4,000	74	100	47	26	16	7.1	3.3	.8
21	16	*329	117	3,250	71	104	45	25	15	6.7	3.3	.6
22	15	244	111	*2,030	69	116	45	25	15	6.5	3.0	.6
23	26	1,430	100	1,560	67	137	44	24	14	*6.5	3.0	.6
24	*24	1,340	94	1,110	65	127	44	24	14	6.7	2.9	.5
25	20	708	98	845	65	117	42	23	13	6.5	2.9	.5
26	18	425	95	671	*62	110	41	24	13	5.9	*2.9	.4
27	16	296	92	513	59	106	38	24	12	5.7	2.7	.3
28	15	220	92	408	60	100	37	23	11	5.6	2.7	.2
29	13	170	90	352	62	95	36	22	12	5.6	2.4	.7
30	13	141	89	309	------	92	35	21	12	5.4	2.6	.6
31	12	------	87	263	------	94	------	21	------	5.4	2.2	------
TOTAL	475.5	9,816	2,781	18,530	3,037	3,448	1,845	941	531	256.9	114.1	33.4
MEAN	15.3	327	89.7	598	105	111	61.5	30.4	17.7	8.29	3.68	1.11
AC-FT	943	19,470	5,520	36,750	6,020	6,840	3,660	1,870	1,050	510	226	66
MAX	38	1,430	122	4,000	238	256	120	56	25	12	5.5	2.2
MIN	5.1	13	65	78	59	57	35	21	11	5.4	2.2	0.2

CALENDAR YEAR 1963 MAX 3,110 MIN 5.1 MEAN 190 AC-FT 137,300
WATER YEAR 1963-64 MAX 4,000 MIN 0.2 MEAN 114 AC-FT 82,920

discharge (base, 2,400 cfs).--Jan. 20 (time unknown) 6,570 cfs (17.72 ft).

Discharge measurement made on this day.
e.--No gage-height record Dec. 23 to Jan. 21.

11-4685. Noyo River near Fort Bragg, Calif.

Location.--Lat 39°25'41" (revised), long 123°44'10" (revised), in SW¼ sec.10, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1962.

Gage.--Water-stage recorder. Datum of gage is 12.1 ft above mean sea level (planetable survey).

Average discharge.--11 years, 223 cfs (161,400 acre-ft per year); median of yearly mean discharges, 190 cfs (138,000 acre-ft per year).

Extremes.--Maximum discharge during year, 7,460 cfs Feb. 13 (gage height, 18.60 ft); minimum, 2.8 cfs Sept. 20, 21.
1951-62: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 2.4 cfs several days in August and September 1959.

Remarks.--Records good. No regulation or diversion.

Discharge, in cubic feet per second, water year October 1961 to September 1962

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	4.0	*8.2	513	57	82	394	139	44	22	16	4.3	4.0
2	4.0	7.5	428	52	78	817	130	43	22	15	*4.3	4.0
3	4.2	6.8	213	51	73	868	116	42	21	13	4.5	5.5
4	3.8	6.8	132	47	70	760	106	39	20	13	5.8	5.8
5	3.5	6.8	95	43	68	748	95	38	20	12	6.2	4.3
6	4.0	6.5	74	40	79	*1.360	87	36	20	11	7.1	*4.0
7	3.5	6.5	60	38	124	1.260	82	36	20	10	16	4.3
8	3.5	6.2	51	37	468	868	77	36	20	10	41	4.3
9	3.0	6.5	46	35	782	634	76	38	19	10	44	4.0
10	4.0	6.8	41	34	872	490	71	39	18	10	29	3.8
11	27	7.8	36	32	589	415	67	36	18	10	16	3.8
12	27	9.2	33	34	455	332	64	34	18	9.6	11	3.5
13	14	9.6	*31	33	3.170	274	60	33	17	10	9.2	3.3
14	9.6	8.9	29	30	2.070	239	58	31	17	10	8.9	3.3
15	7.8	8.2	28	28	1.840	218	57	*31	17	9.2	7.8	3.3
16	6.8	8.5	26	*27	1.640	205	54	30	17	8.5	7.1	3.5
17	6.2	9.2	76	27	1.310	187	52	29	17	8.2	6.5	3.8
18	5.2	9.2	91	31	1.180	165	51	29	16	7.5	6.5	3.3
19	5.2	11	155	946	967	153	54	28	14	7.1	6.2	3.0
20	4.3	24	560	1.410	733	147	51	27	14	6.8	5.8	2.8
21	4.3	28	603	600	553	133	49	28	*13	6.8	5.8	2.8
22	4.8	36	390	346	418	430	47	27	14	5.8	5.2	3.0
23	5.2	52	260	247	332	565	46	27	16	5.5	4.5	3.3
24	5.2	149	189	200	274	503	45	27	16	5.2	5.2	3.3
25	5.5	377	147	166	230	418	44	27	17	5.2	5.2	3.3
26	10	228	117	142	195	342	42	26	17	4.8	5.2	3.0
27	13	144	99	124	170	284	58	26	16	4.8	4.5	4.3
28	21	96	84	112	178	*240	74	26	16	4.8	4.3	7.5
29	20	123	76	101	-	205	53	24	16	4.5	3.8	13
30	13	200	68	93	----------	176	47	24	15	4.3	3.8	19
31	9.6	----------	61	87	----------	154	----------	23	----------	4.3	4.0	----------
Total	262.2	1.607.2	4.812	5.250	19.000	13.984	2.052	984	523	262.9	298.7	140.1
Mean	8.46	53.6	155	169	679	451	68.4	31.7	17.4	8.48	9.64	4.67
Max	27	377	603	1.410	3.170	1.360	139	44	22	16	44	19
Min	3.0	6.2	26	27	68	133	42	23	13	4.3	3.8	2.8
Ac-ft	520	3.190	9.540	10.410	37.690	27.740	4.070	1.950	1.040	521	592	278

Calendar year 1961: Max 3.000 Min 3.0 Mean 153 Ac-ft 110.400
Water year 1961-62: Max 3.170 Min 2.8 Mean 135 Ac-ft 97.540

Peak discharge (base, 2,400 cfs).--Jan. 19 (2000) 2,540 cfs ([illegible] ft); Feb. 13 (2000) 7,460 cfs (18.60 ft).

* Discharge measurement made on this day.

TABLE X-1b

PROPOSED SUMMARY OF IMPROVEMENTS
CONSTRUCTION COSTS
FOR WATER TREATMENT PLANT

Priority	Proposed Construction	Current 12/85 Costs, $	
1.	Storage Ponds		
	Remove growth	3,000	
	Scarify side slopes	4,000	
	Center earthen germ	16,000	
	Diversion boxes	30,000	
	Re-route existing piping	3,000	
	Gunite side slopes	64,000	
	Gravel bottom	8,000	
	Access roads	6,000	
			$144,000
2.	Pump Station		
	Remove superstructure	20,000	
	New superstructure	95,000	
	New laboratory area	35,000	
	Revise chemical systems	4,000	
	New potassium permanganate	12,000	
	Raw water pumps	46,000	
	Finished water pumps	51,000	
	Revise electrical panels	75,000	
	Revise alarm/monitoring system	25,000	
	New Caustic Soda System	16,000	
	Spare Polymer Feeder	3,000	
			$363,000
~~1.~~	Flash Mixing		
	Relocate	1,000	
			$1,000
~~1.~~	Flocculation		
	New flocculation basins	90,000	
	Vertical mixers	48,000	
	Internal baffles	3,000	
	Re-route piping	14,000	
	Sluice gates, baffles	23,000	
	Handrails	19,000	
			$197,000

APPENDIX B

GEORGIA PACIFIC WATER RIGHTS

NOYO RIVER AND PUDDING CREEK

License for Diversion and Use of Water

Pudding Cr

APPLICATION 15082 PERMIT 9549 LICENSE 6449

THIS IS TO CERTIFY, *That* Union Lumber Company
620 Market Street
San Francisco, California

has made *proof as of* June 26, 1961, *(the date of inspection) to the satisfaction of the State Water Rights Board of a right to the use of the water of* Pudding Creek in Mendocino County

tributary to Pacific Ocean

for the purpose of industrial use
under Permit 9549 *of the State Water Rights Board and that said right to the use of said water has been perfected in accordance with the laws of California, the Rules and Regulations of the State Water Rights Board and the terms of the said permit; that the priority of the right herein confirmed dates from* November 14, 1952 *and that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to the amount actually beneficially used for said purposes and shall not exceed* one (1.0) cubic foot per second by direct diversion to be diverted from January 1 to December 31 of each year and two hundred (200) acre-feet per annum by storage to be collected from about October 1 of each year to about June 30 of the succeeding year.

The total amount of water diverted to storage under this license and under Application 15083, Permit 9550 shall not exceed 200 acre-feet per annum.

The point of diversion of such water is *located* :

North twenty degrees east (N20°E) three thousand three hundred eighty (3380) feet from SW corner of Section 6, T18N, R17W, MDB&M, being within SW¼ of NW¼ of said Section 6.

A description of the lands or the place where such water is put to beneficial use is as follows:

Within NE¼ of NE¼ of Section 12, T18N, R18W, MDB&M.

All rights and privileges under this license including method of diversion, method of use and quantity of water diverted are subject to the continuing authority of the State Water Rights Board in accordance with law and in the [illegible]

... license shall be in such form and contain such terms as may be prescribed by the board.

Section 1626. All licenses shall be under the terms and conditions of this division (of the Water Code).

Section 1627. A license shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code) but no longer.

Section 1628. Every license shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a license is issued takes the license subject to the conditions therein expressed.

Section 1629. Every licensee, if he accepts a license does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any license granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any licensee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any licensee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Section 1630. At any time after the expiration of twenty years after the granting of a license, the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State shall have the right to purchase the works and property occupied and used under the license and the works built or constructed for the enjoyment of the rights granted under the license.

Section 1631. In the event that the State, or any city, city and county, municipal water district, irrigation district, lighting district, or political subdivision of the State so desiring to purchase and the owner of the works and property cannot agree upon the purchase price, the price shall be determined in such manner as is now or may hereafter be provided by law for determining the value of property taken in eminent domain proceedings.

Dated: FEB 23 1962

L. K. Hill

L. K. HILL
Executive Officer

...SE 6449
...OF CALIFORNIA
...TER RIGHTS BOARD

...ICENSE
...PRIATE WATER

...lon Lumber Company

32289
...ater Rights Board
...589 ... 523

When Recorded Mail to:
STATE WATER RESOURCES CONTROL BOARD
Room 1140, Resources Building
Sacramento, California 95814

NOYO R.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS

License for Diversion and Use of Water

APPLICATION 15083 PERMIT 9550 LICENSE 9143

THIS IS TO CERTIFY, *That* BOISE CASCADE TIMBER PRODUCTS
90 WEST REDWOOD AVENUE, FORT BRAGG, CALIFORNIA 95437

HAS *made proof as of* AUGUST 5, 1969 *(the date of inspection) to the satisfaction of the State Water Resources Control Board of a right to the use of the water of* NOYO RIVER IN MENDOCINO COUNTY

tributary to PACIFIC OCEAN

for the purpose of INDUSTRIAL USE *under Permit* 9550 *of the Board and that the right to the use of this water has been perfected in accordance with the laws of California, the Regulations of the Board and the permit terms; that the priority of this right dates from* NOVEMBER 14, 1952 *and that the amount of water to which this right is entitled and hereby confirmed is limited to the amount actually beneficially used for the stated purposes and shall not exceed* ONE AND THIRTY-THREE HUNDREDTHS (1.33) CUBIC FEET PER SECOND TO BE DIVERTED FROM ABOUT MAY 15 TO ABOUT DECEMBER 1 OF EACH YEAR. THE MAXIMUM AMOUNT DIVERTED UNDER THIS LICENSE SHALL NOT EXCEED 475 ACRE-FEET PER YEAR.

THE POINT OF DIVERSION OF SUCH WATER IS LOCATED:

SOUTH 78° EAST 2,240 FEET FROM NW CORNER OF SECTION 9, T18N, R17W, MDB&M, BEING WITHIN NE1/4 OF NW1/4 OF SAID SECTION 9.

THE POINT OF REDIVERSION OF SUCH WATER IS LOCATED:

NORTH 20° EAST 3,380 FEET FROM SW CORNER OF SECTION 6, T18N, R17W, MDB&M, BEING WITHIN SW1/4 OF NW1/4 OF SAID SECTION 6.

A DESCRIPTION OF LANDS OR THE PLACE WHERE SUCH WATER IS PUT TO BENEFICIAL USE IS AS FOLLOWS:

WITHIN NE1/4 OF NE1/4 OF SECTION 12 T18N, R18W, MDB&M AT THE UNION LUMBER COMPANY SAWMILL PLANT.

Licensee shall allow representatives of the Board and other parties, as may be authorized from time to time by the Board, reasonable access to project works to determine compliance with the terms of this license.

All rights and privileges under this license including method of diversion, method of use and quantity of water diverted are subject to the continuing authority of the Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable method of use or unreasonable method of diversion of said water.

Reports shall be filed promptly by licensee on appropriate forms which will be provided for the purpose from time to time by the Board.

The right hereby confirmed to the diversion and use of water is restricted to the point or points of diversion herein specified and to the lands or place of use herein described.

This license is granted and licensee accepts all rights herein confirmed subject to the following provisions of the Water Code:

Section 1625. Each license shall be in such form and contain such terms as may be prescribed by the Board.

Section 1626. All licenses shall be under the terms and conditions of this division (of the Water Code).

Section 1627. A license shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code) but no longer.

Section 1628. Every license shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a license is issued takes the license subject to the conditions therein expressed.

Section 1629. Every licensee, if he accepts a license does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any license granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any licensee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any licensee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Section 1630. At any time after the expiration of twenty years after the granting of a license, the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State shall have the right to purchase the works and property occupied and used under the license and the works built or constructed for the enjoyment of the rights granted under the license.

Section 1631. In the event that the State, or any city, city and county, municipal water district, irrigation district, lighting district, or political subdivision of the State so desiring to purchase and the owner of the works and property cannot agree upon the purchase price, the price shall be determined in such manner as is now or may hereafter be provided by law for determining the value of property taken in eminent domain proceedings.

Dated:

STATE WATER RESOURCES CONTROL BOARD

Chief, Division of Water Rights

A copy of this document is being
recorded at your County Recorder.

Please retain this copy for your file.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS

ORDER

APPLICATION 15083 PERMIT 9550 LICENSE 9143

ORDER ALLOWING CHANGE IN POINT OF DIVERSION
AND AMENDING THE LICENSE

WHEREAS:

1. License 9143 was issued to Boise Cascade Timber Products and was recorded with the County Recorder of Mendocino County on March 5, 1970 in Book 811, Page 719.

2. License 9143 was subsequently assigned to Georgia-Pacific Corporation.

3. A petition for change in point of diversion has been filed with the State Water Resources Control Board and said Board has determined that good cause for such change has been shown.

4. The Board has determined that the petitioned change does not constitute the initiation of a new right nor operate to the injury of any other lawful user of water.

NOW, THEREFORE, IT IS ORDERED THAT:

1. The points of diversion under this license shall be as follows:

   1. South 78° East 2,240 feet from NW corner of Section 9, T18N, R17W, MDB&M, being within NE¼ of NW¼ of said Section 9.

   2. West 1,120 feet from NE corner of the SE¼ of NE¼ of Section 9, T18N, R17W, MDB&M being withn SE¼ of NE¼ of said Section 9.

2. A new paragraph is added to this license as follows:

   This license is subject to the agreement dated June 11, 1981 and June 15, 1981 between licensee and the California Department of Fish and Game to the extent such agreement covers matters within the Board's jurisdiction.

Dated: SEPTEMBER 25 1981

Raymond Walsh

Raymond Walsh, Chief
Division of Water Rights

State Water Resources Control Board
Division of Water Rights
77 Cadillac Drive
Sacramento, CA 95825

APPLICATION 15083 Georgia-Pacific Corporation on Noyo River in Mendocino County.

The undersigned applicant hereby acknowledges the Department of Fish and Game's protest of subject application on file with the Division of Water Rights and agrees to abide by the revised protest withdrawal conditions defined below. I understand that my violation of these terms may lead to a hearing before the Board and would result in revocation of any permit or license obtained under this application. Applicant agrees to provide the Board with copies of any supplemental agreements involving the project.

Georgia-Pacific Corp.
Applicant By [signature], Gen. Mgr.

Dated: June 15, 1981

1. Compliance with the Permit Term 60 Agreement dated June 8, 1981.

2. Georgia-Pacific agrees to review of the above by-pass amounts at such time as revised by-pass terms are placed on the City of Fort Bragg's diversion by the State Water Resources Control Board. By-pass flow values may be changed by agreement between Fish and Game and Georgia-Pacific. In the event of failure of both parties to reach agreement, the parties will agree to final resolution of the terms by the State Water Resources Control Board. Resolution of the disagreement will follow established Board procedures.

3. Installation of a staff gage at the point of diversion which shall be calibrated by gaging the river at point of diversion. This gaging will be checked against the water level recorder records at the USGS gaging station on the Noyo River if they are available.

In consideration of the foregoing and with the express understanding that any permit (license) issued under the above application, if and when issued, will contain a provision that it is issued subject to the above terms, the California Department of Fish and Game hereby withdraws its protest to approval of subject application. We understand that an invasion of those terms by the permittee (licensee) will give rise to a right of action on our part.

[signature]
California Department of Fish and Game

Dated: June 11, 1981

PERMIT TERM 60

TITLE: FISH PROTECTION

WHEN USED: After agreement between applicant and the Department of Fish and Game

TERM: For the protection of fish and wildlife, permittee shall during the period:

(a) From May 15 through May 31 by-pass a minimum of 20 cubic feet per second.*

(b) From June 1 through June 30 by-pass a minimum of 3 cubic feet per second.*

(c) From July 1 through July 31 by-pass a minimum of 3 cubic feet per second.*

(d) From August 1 through August 31 by-pass a minimum of 3 cubic feet per second.*

(e) From September 1 through September 30 by-pass a minimum of 3 cubic feet per second.*

(f) From October 1 through October 31 by-pass a minimum of 5 cubic feet per second.*

(g) From November 1 through November 30 by-pass a minimum of 10 cubic feet per second.*

1. During the month of November, if stream flow on the Noyo River falls below 25 cfs, Georgia-Pacific agrees to notify (by phone) the Department of Fish and Game. At that time, both Georgia-Pacific and Fish and Game will evaluate the current stream flow for fish passage. If the stream flow prevents the upstream passage of spawning fish, the following alternatives will be evaluated.

   a. Change the point of diversion to downstream station, recognizing the high tide salt water concentration problem.

   b. Aid fish, having problems, over critical riffles.

   c. Alter the streambed so as to allow fish to migrate upstream.

(h) The total streamflow shall be by-passed whenever it is less than the above designated amount for that period.*

*Except for the following drought conditions:

1. If by May 1 of any given year, the accumulated monthly rainfall beginning on October 1 of the previous year is less than 67 percent of the average rainfall for the period of record, a drought period will exist. Presently, 67 percent of the average precipitation for the period of October 1 to May 1 is 22.79 inches. Under drought conditions, Georgia-Pacific agrees to the following:

   A. Decrease the pumping rate to one-half the permitted rate of 1.33 cfs at the upstream point of diversion until such time as the minimum by-pass flow rate is exceeded. Pumping may then proceed at the permitted rate.

   B. Decrease the pumping rate to one-half the permitted rate if the flow should fall again below the permitted minimum by-pass value.

2. If under drought conditions, it is determined by the Department of Fish and Game or Georgia-Pacific that pumping at the present (or lower) point of diversion would be of more benefit to the fishery resource in the Noyo River, Georgia-Pacific agrees to the following:

   A. Decrease the pumping rate at the lower point of diversion to one-half the permitted rate of 1.33 cfs until such time as the minimum by-pass flow rate is exceeded. Pumping may then proceed at the permitted rate.

   B. Decrease the pumping rate to one-half the permitted rate if the flow should fall again below the permitted minimum by-pass value.

   C. Discontinue pumping at the lower point of diversion if salt water is being pumped from the Noyo River to Pudding Creek.

   D. Not pump water at both points of diversion simultaneously.

APPENDIX C

USGS FLOW DATA:

NOYO RIVER GAGING STATION RECORDS

1951-1977

…o River near Navarro, Calif.

…", in SE¼ sec.7, T.15 N., R.16 W., on left bank …4 miles upstream from mouth, and 6.6 miles west

…eptember 1960.

…ude of gage is 20 ft (from topographic map).

… (402,500 acre-ft per year).

…ar, 24,800 cfs Feb. 8 (gage height, 30.98 ft, from … 8, 23-26, 30. …,500 cfs Dec. 22, 1955 (gage height, 40.60 ft), from … cfs on basis of slope-area measurement of peak flow; …59. … stage of 38.2 ft, from floodmarks.

…r period of no gage-height record, which are poor. …s of chemical analyses for the water year 1960 are

1954(M).

…959-60 (gage height, in feet, and discharge, …ic feet per second) … method used Oct. 1 to Dec. 27)

Feb. 9 to Sept. 30

	4.15	5.0	7.0	830	
	4.2	7.8	9.0	1,820	
	4.3	18	13.0	4,500	
	4.5	50	17.0	8,200	
	5.0	158	20.0	11,400	
700	6.0	455			
800					

…ond, water year October 1959 to September 1960

	Mar.	Apr.	May	June	July	Aug.	Sept.
[illegible]	130	613	141	110	35	18	7.[illegible]
,030	125	515	139	99	35	18	7.[illegible]
,030	250	448	132	90	35	17	7.1
852	2,500	393	132	84	35	17	6.5
0	5,500	351	122	78	33	17	6.5
2	4,500	315	112	76	33	15	6.5
)	4,750	288	108	76	33	17	6.5
0	3,200	267	101	*72	33	15	6.[illegible]
,000	2,150	243	99	68	33	15	6.5
,200	1,400	225	92	66	32	14	7.1
	100	216	90	63	32	14	6.5
	,600	202	88	61	30	14	6.5
	2,050	189	84	57	29	14	6.5
)	1,450	184	82	54	27	14	6.5
640	*938	168	80	50	24	14	6.5
530	794	158	78	48	23	15	6.5
	662	151	76	47	23	14	7.1
	560	144	72	45	21	13	6.5
	483	139	68	42	*20	12	6.5
	417	129	68	40	18	11	7.1
270	372	124	70	40	17	10	6.5
235	336	120	70	43	15	9.3	6.5
215	309	132	92	38	15	9.3	6.[illegible]
	282	156	246	35	14	8.5	6.0
	261	134	336	33	15	7.8	6.0
	243	132	246	33	15	8.5	6.[illegible]
160	258	*243	205	35	17	8.5	6.5
150	399	243	174	33	17	8.5	6.5
140	306	181	153	35	17	12	5.5
	634	156	136	35	17	*10	6.[illegible]
	778	-------	120	-------	18	7.8	-------
	38,737	6,959	3,812	1,686	761	398.2	195.[illegible]
	1,250	232	123	56.2	24.5	12.8	6.5[illegible]
200	76,830	13,800	7,560	3,340	1,510	790	[illegible]

Mean 313 Ac-ft 226,800
Mean 331 Ac-ft 240,100

…ime unknown) 24,800 cfs (30.98 ft).

…ar. 14; discharge estimated on basis of 2 discharge meas-

4685. Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec.10, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1960.

Gage.--Water-stage recorder. Datum of gage is 12.1 ft above mean sea level (planetable survey).

Average discharge.--9 years, 239 cfs (173,000 acre-ft per year).

Extremes.--Maximum discharge during year, 12,000 cfs Feb. 8 (gage height, 21.75 ft); minimum, 4.0 cfs Oct. 6, 7, Aug. 21.
1951-60: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 2.4 cfs several days in August and September 1959.

Remarks.--Records good. No regulation or diversion. Records of chemical analyses for the water year 1960 are given in WSP 1744.

Rating tables, water year 1959-60 (gage height, in feet, and discharge, in cubic feet per second)
(Shifting-control method used Aug. 28-31)

Oct. 1 to Feb. 8				Feb. 8 to Sept. 30			
1.1	2.0	3.0	145	1.3	2.0	3.0	145
1.2	4.2	4.0	342	1.4	4.5	4.0	320
1.4	11	7.0	1,240	1.6	11	6.0	850
1.7	26	10.0	2,350	2.0	37	9.0	1,900
2.0	45	15.0	4,550	2.5	81	13.0	3,600
2.5	88	19.0	7,900				

Discharge, in cubic feet per second, water year October 1959 to September 1960

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	4.5	4.5	6.0	9.5	625	64	435	58	74	18	8.9	4.3
2	*4.5	4.5	6.0	8.7	773	60	356	58	66	18	9.2	4.3
3	4.2	4.5	6.3	8.7	464	121	306	56	58	17	8.5	4.3
4	9.2	4.8	6.3	8.3	380	1,730	258	58	51	15	8.2	4.5
5	5.1	4.8	6.3	*8.7	482	2,780	225	54	48	15	8.2	4.5
6	4.0	4.8	6.3	8.7	398	2,140	195	50	47	15	7.8	4.5
7	4.0	5.1	6.3	9.9	1,940	2,440	171	48	44	14	7.5	4.8
8	5.1	5.4	6.3	47	7,720	1,730	151	47	*41	14	7.5	4.8
9	9.1	5.1	6.3	49	3,240	982	135	45	39	13	7.1	4.8
10	9.1	5.1	6.9	33	2,410	646	122	43	36	13	7.1	4.8
11	8.0	5.1	7.6	61	*1,420	525	117	40	34	13	7.1	4.8
12	6.6	5.1	9.5	101	823	793	103	41	33	13	6.5	4.8
13	6.0	5.4	15	54	553	1,050	95	38	31	12	6.5	5.2
14	5.7	5.4	13	88	395	791	97	37	29	12	6.5	5.2
15	5.4	5.4	9.5	107	308	*570	85	36	28	12	6.5	5.2
16	5.1	5.4	8.0	66	253	443	79	35	27	12	6.2	5.2
17	5.1	5.4	7.2	45	215	350	74	34	26	12	6.2	5.5
18	4.8	5.4	7.2	35	203	288	72	33	25	11	6.2	5.5
19	4.8	5.1	7.6	30	178	244	72	32	24	*11	6.2	5.5
20	4.8	5.1	6.9	26	153	211	67	33	22	11	5.8	5.8
21	4.8	5.4	7.2	30	132	187	64	34	22	11	5.8	5.8
22	5.4	5.4	7.6	58	117	166	62	27	22	10	5.8	5.5
23	5.4	5.4	14	49	106	151	63	50	21	9.6	5.5	5.8
24	5.7	*6.0	32	50	95	135	62	126	19	9.2	5.2	5.8
25	5.7	6.0	52	194	88	123	60	150	20	9.2	5.2	5.8
26	5.7	6.0	30	267	83	116	63	197	20	9.2	4.8	11
27	5.7	5.7	19	248	77	126	*75	178	19	8.9	4.8	8.9
28	5.4	5.7	14	320	71	181	79	145	18	8.5	4.5	8.5
29	4.8	5.7	12	275	67	148	67	119	18	8.5	4.5	8.9
30	4.8	6.0	11	560	-------	446	61	99	18	8.5	*4.5	8.5
31	4.5	-------	10	325	-------	518	-------	86	-------	8.5	4.0	-------
Total	173.0	158.7	363.3	3,180.5	23,769	20,245	3,871	2,088	980	372.1	198.3	172.9
Mean	5.58	5.29	11.7	103	820	653	129	67.4	32.7	12.0	6.40	5.76
Ac-ft	343	315	721	6,310	47,150	40,160	7,680	4,140	1,940	738	393	343

Calendar year 1959: Max 3,100 Min 2.4 Mean 124 Ac-ft 89,610
Water year 1959-60: Max 7,720 Min 4.0 Mean 152 Ac-ft 110,200

Peak discharge (base, 2,400 cfs).--Feb. 8 (8 a.m.) 12,000 cfs (21.75 ft); Mar. 5 (4 p.m.) 3,780 cfs (13.40 ft).

* Discharge measurement made on this day.

4685. Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec.10, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1959.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Average discharge.--8 years, 250 cfs (181,000 acre-ft per year).

Extremes.--Maximum discharge during year, 4,280 cfs Jan. 12 (gage height, 14.45 ft); minimum, 2.4 cfs several days in August and September.
1951-59: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, that of August and September 1959.

Remarks.--Records good. No regulation or diversion. Records of chemical analyses for the water year 1959 are given in WSP 1644.

Rating tables, water year 1958-59 (gage height, in feet, and discharge, in cubic feet per second)

Oct. 1 to Feb. 16				Feb. 17 to Sept. 30			
1.3	5.0	3.0	158	1.1	2.0	2.5	88
1.4	8.2	4.0	344	1.2	4.2	3.0	145
1.5	13	7.0	1,240	1.4	11	4.0	342
2.0	48	10.0	2,350	1.7	26	7.0	1,240
2.5	93	12.0	3,150	2.0	45	10.0	2,350

Discharge, in cubic feet per second, water year October 1958 to September 1959

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	5.0	11	11	27	262	177	295	37	18	9.5	4.0	2.9
2	5.0	12	11	24	211	157	235	35	18	9.1	4.0	2.7
3	5.0	11	11	21	171	141	195	33	18	9.1	4.0	2.7
4	5.0	9.7	11	21	143	128	163	32	18	8.7	4.0	2.7
5	5.0	9.2	11	351	122	*117	142	31	18	8.3	3.8	2.9
6	5.0	8.7	11	331	105	109	126	30	17	8.0	3.8	2.9
7	5.0	8.7	11	313	94	101	111	30	16	8.0	3.6	2.9
8	5.0	8.2	10	2,300	85	94	93	28	16	*8.0	3.3	2.9
9	*5.0	12	10	3,100	90	87	89	27	16	7.6	3.1	2.7
10	5.3	22	10	1,300	252	81	*81	27	15	7.2	3.1	2.7
11	5.6	19	10	475	418	77	74	26	12	7.2	3.1	2.7
12	5.6	13	11	2,830	329	74	71	26	13	6.9	2.9	2.4
13	5.6	12	11	1,110	266	71	65	24	13	6.6	3.1	2.9
14	5.6	42	11	578	828	66	62	26	14	6.3	3.1	2.9
15	5.6	35	10	340	1,810	62	58	24	13	6.3	2.9	2.9
16	5.6	22	10	245	2,800	58	55	24	13	6.3	2.9	2.9
17	6.0	17	*10	188	1,970	56	53	24	13	6.3	2.7	3.1
18	6.0	18	10	147	1,410	54	51	24	13	6.3	2.7	30
19	6.3	52	11	117	1,270	53	48	23	13	6.0	2.7	24
20	6.3	39	13	96	1,150	51	46	22	12	6.0	*2.9	14
21	6.3	27	38	*84	1,030	54	45	*22	12	5.7	2.7	10
22	6.6	21	32	73	776	56	44	22	11	5.7	2.7	8.0
23	6.6	18	23	65	548	105	42	22	11	5.7	2.7	6.9
24	6.3	16	20	152	410	111	40	22	10	5.7	2.7	6.0
25	6.3	14	23	571	333	102	44	22	10	5.7	2.4	5.7
26	6.0	14	41	683	276	212	52	21	11	6.0	2.4	5.1
27	6.0	13	121	771	234	174	44	20	12	5.4	2.4	5.1
28	6.0	12	70	1,130	203	145	39	20	11	4.9	2.4	4.9
29	6.0	11	49	770	-	131	37	20	11	4.5	2.7	4.8
30	6.3	11	38	491	-------	351	37	19	9.9	4.2	2.7	4.8
31	7.2	-------	32	335	-------	376	-------	15	-------	4.0	2.7	-------
Total	178.1	538.5	701	19,039	17,596	3,283	2,549	781	407.9	205.1	94.4	177.0
Mean	5.75	18.0	22.6	614	628	117	85.0	25.2	13.6	6.62	3.05	5.90
Ac-ft	353	1,070	1,390	37,760	34,900	7,210	5,060	1,550	809	407	187	351

Calendar year 1958: Max 5,760 Min 5.0 Mean 341 Ac-ft 246,600
Water year 1958-59: Max 3,100 Min 2.4 Mean 126 Ac-ft 91,050

Peak discharge (base, 2,400 cfs).--Jan. 9 (time and discharge unknown); Jan. 12 (9 a.m.) 4,280 cfs (14.45 ft); Feb. 16 (2 p.m.) 3,870 cfs (13.59 ft).

* Discharge measurement made on this day.

4685. Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec.10, T.18 N., R.17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1958.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Average discharge.--7 years, 268 cfs (194,000 acre-ft per year).

Extremes.--Maximum discharge during year, 8,230 cfs Feb. 12 (gage height, 19.17 ft); minimum, 4.8 cfs Sept. 30.
1951-58: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 3.5 cfs Sept. 14, 22-24, 1951.

Remarks.--Records good except those for periods of no gage-height record, which are fair. No regulation or diversion.

Rating tables, water year 1957-58 (gage height, in feet, and discharge, in cubic feet per second)

Oct. 1 to Mar. 31				Apr. 1 to Sept. 30			
1.6	13	4.0	342	1.3	5.0	3.0	158
1.7	18	5.0	620	1.4	8.2	4.0	344
2.0	37	8.0	1,590	1.5	13	7.0	1,240
2.5	81	12.0	3,150	2.0	48	10.0	2,350
3.0	145	17.0	5,900	2.5	93	14.0	4,050

Discharge, in cubic feet per second, water year October 1957 to September 1958

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	25	44	57	414	1,010	783	a2,700	88	42	25	12	6.6
2	19	41	54	433	*1,190	585	a4,000	85	52	25	12	6.6
3	16	38	51	372	1,910	470	3,180	83	*53	25	11	*6.6
4	15	35	49	331	1,770	393	2,220	79	45	25	11	6.6
5	20	33	49	284	1,590	338	1,670	77	42	23	11	6.6
6	25	32	46	240	1,290	298	1,630	75	42	23	11	6.6
7	22	32	43	205	1,590	263	1,180	73	44	22	10	6.6
8	22	36	43	191	1,610	238	844	72	42	22	9.7	6.6
9	148	35	42	188	2,970	207	643	68	46	21	9.7	6.6
10	151	37	41	470	2,940	191	496	67	44	21	9.7	6.6
11	95	47	40	524	1,670	*181	411	68	42	19	9.2	6.6
12	86	48	39	1,030	5,760	168	359	67	40	19	9.2	6.9
13	1,070	465	39	1,200	2,960	159	316	63	38	19	8.7	6.9
14	352	1,500	38	792	1,880	165	279	60	36	18	8.7	6.9
15	181	631	44	576	2,270	181	247	59	33	*13	7.9	6.9
16	*113	368	100	437	1,820	160	219	57	33	14	7.9	6.9
17	85	247	172	359	1,400	143	203	54	32	19	7.9	7.2
18	65	204	746	300	*2,340	128	193	46	33	20	7.9	6.9
19	53	181	721	259	3,660	117	176	51	40	19	7.9	6.6
20	47	164	954	229	2,130	198	160	51	38	17	7.9	6.3
21	42	146	1,730	199	1,350	657	148	50	35	16	7.6	7.6
22	37	124	1,540	*180	1,010	a1,200	139	53	35	16	7.2	9.2
23	43	109	873	212	818	a1,000	130	68	33	16	7.2	6.3
24	65	99	624	*426	3,660	1,010	*123	58	32	16	7.2	6.0
25	70	93	489	511	3,880	1,080	114	53	31	15	6.9	6.3
26	80	*87	461	1,280	2,190	977	108	51	29	14	6.9	6.3
27	74	80	*412	1,140	1,460	779	103	47	28	13	6.9	6.0
28	65	72	1,060	812	1,050	579	100	46	27	13	6.6	6.0
29	57	66	1,370	2,790	-	a1,000	96	44	26	13	6.6	5.6
30	50	61	851	2,600	-------	a2,000	93	44	25	13	6.6	5.0
31	47	-------	556	1,450	-------	a1,400	-------	43	-------	13	6.6	-------
Total	3,240	5,155	13,334	20,434	59,178	17,048	22,280	1,900	1,118	567	266.6	193.4
Mean	105	172	430	659	2,114	550	743	61.3	37.3	18.3	8.60	6.61
Ac-ft	6,430	10,220	26,450	40,530	117,400	33,810	44,190	3,770	2,220	1,120	529	384

Calendar year 1957: Max 3,150 Min 5.8 Mean 198 Ac-ft 143,600
Water year 1957-58: Max 5,760 Min 5.0 Mean 396 Ac-ft 287,100

Peak discharge (base, 2,400 cfs).--Dec. 21 (6 p.m.) 2,620 cfs (10.65 ft); Jan. 29 (6 p.m.) 4,450 cfs (14.95 ft); Feb. 9 (7 p.m.) 5,470 cfs (16.33 ft); Feb. 12 (11 a.m.) 8,230 cfs (19.17 ft); Feb. 19 (9 a.m.) 4,160 cfs (14.27 ft); Feb. 24 (8 p.m.) 7,040 cfs (18.25 ft); Apr. 2 (time unknown) about 5,500 cfs.

* Discharge measurement made on this day.
a No gage-height record; discharge estimated on basis of records for Navarro River near Navarro and South Fork Gualala River near Annapolis.

Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec. 10, T. 18 N., R. 17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1957.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Average discharge.--6 years, 247 cfs (178,800 acre-ft per year).

Extremes.--Maximum discharge during year, 3,710 cfs Mar. 5 (gage height, 13.24 ft); minimum, 3.8 cfs Oct. 3.

1951-57: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 3.5 cfs Sept. 14, 22-24, 1951.

Remarks.--Records good. No regulation or diversion.

Rating tables, water year 1956-57 (gage height, in feet, and discharge, in cubic feet per second)

Oct. 1 to Mar. 5				Mar. 5 to Sept. 30			
1.6	3.4	3.0	122	1.4	4.3	3.0	145
1.8	11	4.0	284	1.5	8.0	4.0	342
2.0	23	6.0	760	1.7	18	5.0	620
2.5	63	10.0	2,010	2.0	37	8.0	1,590
				2.5	81	12.0	3,150

Discharge, in cubic feet per second, water year October 1956 to September 1957

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	4.8	85	12	12	48	479	150	78	107	27	13	7.3
2	4.5	62	12	12	61	331	138	*119	97	27	12	7.3
3	[4.1	48	12	12	57	324	129	96	90	27	12	6.9
4	4.5	38	14	*12	54	600	117	83	85	25	12	*6.5
5	[4.1	32	17	12	50	3,150	108	75	79	24	12	6.5
6	4.8	28	23	12	48	2,600	101	69	76	24	12	6.5
7	4.5	25	24	12	47	1,660	95	66	72	23	11	6.5
8	4.5	23	20	15	57	1,050	87	70	69	22	11	6.9
9	4.8	22	17	19	65	911	80	70	65	22	11	6.9
10	5.9	20	17	17	64	767	75	78	62	21	11	6.9
11	8.3	19	24	26	62	695	72	92	58	21	11	6.9
12	8.3	16	35	124	58	1,510	76	85	56	21	11	6.9
13	7.9	18	36	176	55	1,360	80	82	53	20	10	7.3
14	7.4	16	31	185	*51	944	291	80	*51	21	9.4	7.3
15	6.6	*14	28	320	48	806	232	72	49	21	9.4	7.6
16	6.3	14	24	188	43	698	220	66	47	20	9.4	7.6
17	6.3	14	22	126	40	596	289	80	45	19	9.4	7.6
18	6.3	14	20	92	39	476	400	1,450	43	18	8.9	7.6
19	6.6	14	18	90	37	*400	344	1,430	41	17	9.4	7.3
20	8.3	14	17	770	36	338	296	1,100	40	17	8.9	6.9
21	11	14	16	460	51	283	240	779	38	17	8.9	6.9
22	11	13	16	260	72	238	199	545	37	17	8.5	6.5
23	15	13	14	176	717	203	168	405	36	16	8.5	6.2
24	17	13	14	132	1,890	179	145	313	34	16	8.5	6.2
25	16	13	13	106	1,680	160	126	254	33	*15	8.0	5.8
26	22	13	13	91	1,490	150	113	212	31	15	7.6	12
27	37	13	13	76	1,290	133	102	184	30	15	7.3	53
28	28	13	13	67	739	122	93	162	30	14	7.3	43
29	28	12	12	59	-	136	86	144	29	14	7.3	25
30	188	12	12	52	-------	162	80	130	28	13	7.3	29
31	137	-------	12	47	-------	156	-------	116	-------	13	7.3	-------
Total	628.8	667	571	3,759	8,949	21,817	4,734	8,585	1,611	602	300.3	334.8
Mean	20.3	22.2	18.4	121	320	704	158	277	53.7	19.4	9.69	11.2
Ac-ft	1,250	1,320	1,130	7,460	17,750	43,270	9,390	17,030	3,200	1,190	596	664

Calendar year 1956: Max 7,270 Min 3.8 Mean 217 Ac-ft 157,700
Water year 1956-57: Max 3,150 Min 4.1 Mean 144 Ac-ft 104,200

Peak discharge (base, 2,400 cfs).--Mar. 5 (5 a.m.) 3,710 cfs (13.24 ft).

* Discharge measurement made on this day.

Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec. 10, T. 18 N., R. 17 W., on right bank 0.[illegible] mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1956.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Average discharge.--5 years, 267 cfs (193,300 acre-ft per year).

Extremes.--Maximum discharge during year, 22,000 cfs Dec. 22 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 3.8 cfs Sept. 24-28.
1951-56: Maximum discharge, that of Dec. 22, 1955; minimum, 3.5 cfs Sept. 14, 22-24, 1951.

Remarks.--Records good. No regulation or diversion.

Rating tables, water year 1955-56 (gage height, in feet, and discharge, in cubic feet per second)

Oct. 1 to Dec. 22

1.9	3.7	5.0	540
2.0	6.8	8.0	1,600
2.1	11	10.0	2,420
2.2	17	13.0	4,200
2.5	43	16.0	6,950
3.0	106	19.0	10,900
3.5	183	23.0	17,200
4.0	284		

Dec. 22 to Sept. 30

1.6	3.4	6.0	760
1.7	7.0	9.0	1,660
1.8	11	13.0	3,300
2.0	23	17.0	5,900
2.4	54	20.0	9,100
2.8	96	22.0	12,500
3.5	196	24.0	17,300
4.5	390		

Discharge, in cubic feet per second, water year October 1955 to September 1956

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	4.4	6.8	81	433	445	752	90	42	27	13	7.4	4.[illegible]
2	4.4	6.8	148	381	*370	620	64	40	27	13	7.0	4.[illegible]
3	4.4	6.8	123	339	318	532	78	42	26	12	7.0	4.[illegible]
4	4.4	7.2	96	462	258	476	75	56	26	12	7.0	4.[illegible]
5	4.4	8.8	248	747	262	488	73	58	25	12	7.0	4.[illegible]
6	4.4	9.2	2,800	760	239	505	70	57	24	12	7.0	4.[illegible]
7	4.4	9.2	843	1,730	218	474	70	53	*24	12	7.0	4.[illegible]
8	4.7	8.8	396	2,000	202	428	68	48	24	12	7.0	4.[illegible]
9	11	8.4	404	1,190	186	379	65	44	23	12	7.0	4.[illegible]
10	12	8.4	316	1,000	174	326	65	44	23	12	7.0	4.[illegible]
11	15	8.0	240	977	165	288	69	47	22	*12	6.6	4.[illegible]
12	12	8.0	185	815	159	253	67	43	22	11	6.6	4.[illegible]
13	8.4	12	148	731	150	230	65	39	22	11	6.3	4.[illegible]
14	7.2	25	126	4,630	143	210	64	37	22	12	6.3	4.[illegible]
15	6.8	20	107	7,270	137	191	62	36	23	12	6.3	4.[illegible]
16	6.4	15	107	3,350	130	174	59	35	22	11	6.3	4.[illegible]
17	6.4	15	186	*1,530	129	162	57	33	20	11	*6.3	4.[illegible]
18	6.4	24	1,210	1,030	126	152	54	32	20	10	6.6	4.[illegible]
19	*6.6	77	4,820	820	250	144	52	32	24	10	6.6	4.[illegible]
20	8.0	342	3,200	907	1,780	136	51	32	24	10	6.3	4.[illegible]
21	6.4	*278	3,090	1,040	4,410	130	49	32	20	9.6	6.3	4.[illegible]
22	8.8	117	*15,600	1,030	3,610	*125	48	31	18	9.2	5.9	4.[illegible]
23	8.0	205	*4,750	1,310	2,140	119	48	30	18	9.2	5.9	4.[illegible]
24	7.6	219	1,940	1,100	1,350	112	*48	30	16	8.7	5.9	[illegible]
25	7.6	117	1,220	1,210	1,340	109	50	30	16	8.3	5.9	*3.[illegible]
26	9.2	75	1,250	1,320	1,250	107	50	29	15	7.9	5.9	3.[illegible]
27	8.8	56	1,170	1,350	974	100	51	28	15	7.4	5.6	3.[illegible]
28	8.8	47	929	1,090	864	96	48	27	14	7.4	5.6	3.[illegible]
29	8.4	40	737	838	874	94	44	27	14	7.4	5.6	4.[illegible]
30	7.6	36	*577	664	------	91	43	27	13	7.4	5.2	4.[illegible]
31	6.8	------	457	541	------	96	------	27	------	7.4	5.2	------
Total	231.9	1,816.4	47,504	42,595	22,683	8,099	1,817	1,168	629	321.6	197.6	12[illegible]
Mean	7.48	60.5	1,532	1,374	782	261	60.6	37.7	21.0	10.4	6.37	4.[illegible]
Ac-ft	460	3,600	94,220	84,490	44,990	16,060	3,600	2,320	1,250	638	392	[illegible]

Calendar year 1955: Max 15,600 Min 4.1 Mean 205 Ac-ft 148,200
Water year 1955-56: Max 15,600 Min 3.8 Mean 348 Ac-ft 252,300

Peak discharge (base, 2,400 cfs).--Dec. 6 (9:30 a.m.) 4,600 cfs (13.50 ft); Dec. 19 (6:30 p.m.) 8,450 cfs (17.23 ft); Dec 22 (7 a.m.) 22,000 cfs (25.64 ft); Jan. 7 (11 p.m.) 2,540 cfs (11.40 ft); Jan. 15 (4:30 p.m.) 9,700 cfs (20.43 ft); Feb. 21 (6 p.m.) 5,920 cfs (17.02 ft).

* Discharge measurement made on this day.

Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec. 10, T. 18 N., R. 17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1955.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Extremes.--Maximum discharge during year, 3,680 cfs Dec. 31 (gage height, 12.26 ft); minimum, 4.1 cfs Sept. 6, 8-13.
1951-55: Maximum discharge, 16,000 cfs Dec. 27, 1951 (gage height, 24.56 ft), from rating curve extended above 3,600 cfs by logarithmic plotting; minimum, 3.5 cfs Sept. 14, 22-24, 1951.

Remarks.--Records good. No regulation or diversion.

Rating table, water year 1954-55 (gage height in feet, and discharge, in cubic feet per second)

1.9	3.7	3.5	183
2.0	6.8	4.0	284
2.1	11	5.0	540
2.2	17	8.0	1,600
2.5	43	10.0	2,420
3.0	106		

Discharge, in cubic feet per second, water year October 1954 to September 1955

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	8.0	9.7	60	1,460	134	152	50	220	34	18	8.0	4.[illegible]
2	8.0	9.7	*315	1,020	124	136	48	183	33	17	7.6	4.[illegible]
3	8.0	9.7	230	594	116	124	43	153	32	17	7.2	4.[illegible]
4	8.4	9.7	180	376	109	112	42	136	32	17	7.2	4.4
5	8.4	10	269	266	103	100	40	123	31	17	7.2	4.4
6	11	10	728	210	98	89	39	112	29	15	6.8	4.1
7	26	11	520	176	93	83	37	103	28	15	6.8	4.4
8	22	66	332	152	88	76	36	96	27	15	6.4	4.1
9	15	67	530	161	86	*84	35	87	26	15	6.4	4.1
10	13	37	492	155	82	91	34	80	26	15	6.4	4.1
11	12	52	311	134	79	82	33	75	27	14	6.4	4.1
12	11	93	214	120	76	74	*32	70	20	14	6.0	4.1
13	11	55	192	*112	71	71	33	66	24	13	6.4	4.1
14	*10	320	163	105	69	69	33	64	25	13	5.6	5.[illegible]
15	10	552	144	113	65	64	33	61	24	12	6.0	6.[illegible]
16	9.7	368	129	181	66	60	32	59	23	12	6.0	*6.8
17	9.7	187	116	226	66	56	35	56	23	11	*6.0	6.[illegible]
18	9.7	122	103	459	61	54	40	53	23	11	5.6	6.4
19	15	91	93	1,260	58	52	72	51	22	*11	5.6	6.0
20	17	72	87	1,180	56	50	575	50	22	10	5.6	5.[illegible]
21	15	59	80	704	54	47	784	47	20	9.7	5.3	5.[illegible]
22	13	51	75	470	52	46	540	46	20	9.7	5.3	5.[illegible]
23	12	45	71	347	52	44	342	43	20	9.2	5.3	4.7
24	11	40	70	275	51	43	244	*42	20	9.2	5.0	4.7
25	10	36	64	226	51	42	218	41	20	8.8	5.0	4.7
26	10	33	62	192	79	41	484	40	20	8.8	5.0	4.4
27	9.7	32	58	166	163	41	498	39	20	8.8	5.0	4.4
28	9.7	31	54	150	166	42	404	37	20	8.8	5.0	4.4
29	9.7	29	52	136	-	60	337	36	19	8.4	5.0	4.4
30	9.7	28	87	129	----	60	277	35	19	8.4	5.0	4.7
31	9.7	----	2,360	123	----	52	------	35	------	8.0	5.0	---
Total	362.4	2,535.8	8,241	11,378	2,368	2,197	5,450	2,340	729	379.8	185.1	146.4
Mean	11.7	84.5	266	367	84.6	70.9	182	75.5	24.3	12.3	5.97	4.88
Ac-ft	719	5,030	16,350	22,570	4,700	4,360	10,810	4,640	1,450	753	367	29[illegible]

Calendar year 1954: Max 8,100 Min 8.0 Mean 243 Ac-ft 176,200
Water year 1954-55: Max 2,360 Min 4.1 Mean 99.5 Ac-ft 72,040

Peak discharge (base, 2,400 cfs).--Dec. 31 (9:30 a.m.) 3,680 cfs (12.26 ft).
* Discharge measurement made on this day.

Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long. 123°44', in SW¼ sec. 10, T. 18 N., R. 17 W., on right bank 0.7 mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1954.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Extremes.--Maximum discharge during year, 11,700 cfs Jan. 17 (gage height, 20.87 ft), from rating curve extended above 3,600 cfs by logarithmic plotting; minimum, 8.2 cfs Oct. 7-9.

1951-54: Maximum discharge, 16,000 cfs Dec. 27, 1951 (gage height, 24.56 ft), from rating curve extended above 3,600 cfs by logarithmic plotting; minimum, 3.5 cfs Sept. 14, 22-24, 1951.

Remarks.--Records good. No regulation or diversion.

Rating tables, water year 1953-54 (gage height, in feet, and discharge, in cubic feet per second)

Oct. 1 to Jan. 17				Jan. 17 to Sept. 30			
2.09	8.2	4.0	284	2.0	6.8	4.0	284
2.2	16	5.0	540	2.1	11	5.0	540
2.5	43	8.0	1,650	2.2	17	8.0	1,600
3.0	106	11.0	3,140	2.5	43	11.0	2,900
3.5	183	14.0	5,250	3.0	106	14.0	4,900
				3.5	183	18.0	8,600

Discharge, in cubic feet per second, water year October 1953 to September 1954

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	*10	9.9	93	70	837	160	141	93	36	24	11	12
2	9.9	9.9	80	66	615	147	135	87	35	23	12	12
3	9.9	9.9	191	103	467	136	374	83	36	22	11	12
4	9.3	9.9	854	96	373	126	1,330	80	42	22	11	11
5	8.7	12	433	87	313	119	1,900	76	55	21	11	11
6	8.7	25	352	88	269	114	1,380	74	42	21	11	11
7	8.2	25	532	161	234	110	991	70	38	20	11	11
8	8.2	16	422	234	205	170	753	67	39	20	11	10
9	8.2	13	323	216	187	*1,040	585	66	55	20	11	10
10	14	17	255	196	171	1,300	467	64	47	20	*10	10
11	12	30	205	190	161	933	386	61	39	20	10	11
12	12	50	169	176	*616	675	325	59	38	20	9.7	11
13	12	51	147	156	1,040	512	275	58	32	*20	9.7	11
14	19	151	130	140	1,220	401	244	56	35	19	10	11
15	23	87	117	204	991	337	212	55	37	18	10	*12
16	19	*58	107	4,540	718	316	187	53	37	18	10	12
17	16	56	98	8,100	822	266	168	51	34	18	10	11
18	30	48	*95	2,190	1,060	226	155	50	32	18	9.7	11
19	37	46	98	1,190	858	421	144	47	31	16	9.7	10
20	25	82	181	807	651	537	*134	46	30	16	10	10
21	17	69	187	585	504	564	124	45	29	15	10	10
22	15	269	171	828	396	504	117	43	28	15	10	10
23	13	766	153	2,930	328	433	112	42	*28	15	9.7	9.7
24	12	942	134	1,790	280	371	110	41	26	15	9.2	9.7
25	20	467	122	1,060	244	308	105	41	26	14	9.7	9.7
26	10	277	109	950	212	253	98	*40	27	14	12	16
27	10	187	100	1,230	190	216	126	40	29	13	15	8.8
28	10	141	93	*2,970	171	201	126	39	26	12	37	8.4
29	12	114	87	2,420	-	188	110	39	24	12	26	8.4
30	10	106	79	1,790	------	174	99	38	24	11	17	8.4
31	9.9	------	74	1,170	------	155	------	37	------	11	15	------
Total	439.0	4,144.6	6,196	36,733	14,133	11,413	11,413	1,741	1,037	543	379.4	319.1
Mean	14.2	138	200	1,185	505	368	380	56.2	34.6	17.5	12.2	10.6
Ac-ft	871	8,220	12,290	72,860	28,030	22,640	22,640	3,450	2,000	1,080	753	633

Calendar year 1953: Max 8,740 Min 8.2 Mean 278 Ac-ft 201,100
Water year 1953-54: Max 8,100 Min 8.2 Mean 242 Ac-ft 175,500

Peak discharge (base, 2,400 cfs).--Jan. 17 (7 a.m.) 11,700 cfs (20.87 ft); Jan. 23 (11:30 p.m.) 4,190 cfs (12.98 ft); Jan. 28 (2:30 p.m.) 3,670 cfs (12.24 ft).

* Discharge measurement made on this day.

Noyo River near Fort Bragg, Calif.

[illegible]tion.--Lat 39°26', long. 123°44', in SW¼ sec. 10, T. 18 N., R. 17 W., on right bank [illegible] mile downstream from South Fork and 3.5 miles east of Fort Bragg.

[illegible]age area.--105 sq mi.

[illegible]rds available.--August 1951 to September 1953.

[illegible]e.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

[illegible]emes.--Maximum discharge during year, 13,000 cfs Jan. 18 (gage height, 22.05 ft), from [illegible]ting curve extended above 3,600 cfs by logarithmic plotting; minimum, 3.7 cfs [illegible]ct. 4-8.

1951-53: Maximum discharge, 16,000 cfs Dec. 27, 1951 (gage height, 24.96 ft), from [illegible]ating curve extended above 3,600 cfs by logarithmic plotting; minimum, 3.5 cfs Sept. 14, 22-24, 1951.

[illegible]arks.--Records good. No storage or diversion.

Rating tables, water year 1952-53 (gage height, in feet, and discharge, in cubic feet per second)
(Shifting-control method used Dec. 8-10, Jan. 7, 8, 10-17, Feb. 21 to Mar. 9)

Oct. 1 to May 21

1.99	3.7	5.0	540
2.1	8.4	6.0	965
2.3	21	9.0	2,100
2.6	46	12.0	3,800
3.0	100	19.0	9,700
4.0	284		

May 22 to Sept. 30

2.1	8.7
2.3	24
2.6	54
3.0	106
3.5	183

Discharge, in cubic feet per second, water year October 1952 to September 1953

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	4.5	6.1	125	1,570	244	70	164	316	123	50	20	17
	4.5	5.1	282	1,810	223	68	152	271	112	48	20	16
	4.1	6.1	214	1,150	208	66	139	230	100	47	20	13
	4.1	6.1	129	781	195	61	129	200	96	45	21	13
	4.1	6.1	1,010	567	210	59	121	177	95	42	22	13
	5.7	6.1	2,630	956	220	57	114	163	161	40	21	13
	3.7	6.1	5,200	1,990	210	56	108	179	171	39	20	13
	4.1	6.1	1,230	*2,280	212	53	106	165	164	39	19	13
	4.1	6.1	*714	6,070	197	54	102	147	161	37	19	12
	4.5	6.1	1,100	2,840	188	114	103	134	171	36	17	12
	4.9	6.5	1,850	1,540	173	140	92	130	153	35	17	12
	4.9	7.4	970	1,340	163	288	86	114	141	34	16	11
	4.9	29	603	1,650	154	277	81	*108	129	34	16	10
	5.3	111	417	2,020	144	222	79	100	119	33	16	10
	5.3	154	318	1,740	135	191	*75	94	112	32	16	10
	5.7	78	254	1,160	127	184	82	88	105	32	17	9.9
	6.1	37	220	3,530	121	189	100	82	*96	30	17	9.9
	6.9	27	180	8,740	118	282	82	79	88	29	16	9.9
	7.9	22	179	5,150	110	1,760	75	111	83	28	16	9.9
	8.4	19	224	*3,190	105	2,430	71	110	76	28	16	10
	8.4	17	206	2,420	100	*2,060	67	171	72	28	16	10
	7.4	15	202	1,490	96	1,190	62	161	69	26	15	10
	7.4	14	189	1,040	91	764	58	156	64	25	15	11
	7.4	13	184	784	88	561	56	150	61	24	15	10
	6.9	13	186	621	84	430	53	168	58	24	13	10
	6.9	13	472	504	*78	344	68	183	56	23	*14	10
	6.1	12	1,340	420	75	293	1,000	181	54	23	15	10
	6.1	12	823	366	72	260	728	171	53	21	16	10
	*6.1	12	594	328	-	228	506	156	52	20	20	10
	6.1	12	1,490	293	-	202	396	142	51	*20	26	9.9
	6.1	-	1,390	266	-	180	-	132	-	20	21	-
	176.6	664.9	24,925	58,596	4,146	13,133	5,055	4,767	3,046	991	548	338.5
	5.70	22.8	804	1,890	148	424	169	154	102	32.0	17.7	11.3
	350	1,360	49,440	116,200	8,220	26,050	10,030	9,460	6,040	1,970	1,090	671

[illegible]endar year 1952: Max 5,200 Min 3.7 Mean 278 Ac-ft 200,900
[illegible]er year 1952-53: Max 8,740 Min 3.7 Mean 313 Ac-ft 230,900

[illegible]ak discharge (base, 2,400 cfs).--Dec. 7 (3:30 a.m.) 8,260 cfs (17.56 ft); Jan. 9 (11 a.m.) 6,510 (15.95 ft); Jan. 18 (2 a.m.) 13,000 cfs (22.05 ft); Jan. 20 (3 p.m.) 3,480 cfs (11.55 ft); Mar. [illegible] (9 a.m.) 2,790 cfs (10.42 ft).

* Discharge measurement made on this day.

Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long. 123°44', in SW¼ sec. 10, T. 18 N., R. 17 W., on right bank [illegible] mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1952.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map).

Extremes.--1951: Maximum daily discharge for the period August to September, 7.7 cfs Sept. 28; minimum, 3.5 cfs, Sept. 14, 22-24.
1951-52: Maximum discharge during water year, 16,000 cfs Dec. 27 (gage height, 24.[illegible] ft), from rating curve extended above 2,500 cfs by logarithmic plotting; minimum, 3.7 cfs Sept. 16.

Remarks.--Records good. No regulation or diversion.

Discharge, in cubic feet per second, 1951-52
1951

Day	Aug.	Sept.	Day	Aug.	Sept.	Day	Aug.	Sept.	Day	Aug.	Sept.
1	-	4.6	9	-	5.5	17	(*)	4.2	25	5.5	4.6
2	-	4.6	10	-	5.0	18	5.0	4.2	26	6.0	4.6
3	-	4.6	11	-	6.5	19	5.0	4.2	27	5.0	6.0
4	-	5.0	12	-	3.8	20	5.0	3.8	28	5.0	7.7
5	-	5.0	13	-	3.8	21	5.0	3.8	29	5.0	5.5
6	-	5.0	14	-	3.5	22	5.0	3.5	30	5.0	7.1
7	-	5.5	15	-	3.6	23	5.5	3.5	31	4.6	-
8	-	5.5	16	-	4.2	24	5.5	*3.5			
Total										-	142.1
Mean										-	4.74
Ac-ft										-	282

* Discharge measurement made on this day.

Discharge, in cubic feet per second, water year October 1951 to September 1952

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	13	13	3,070	1,040	3,500	266	*163	119	31	32	11	6.1
2	28	12	1,940	*742	3,820	240	154	85	30	28	12	5.7
3	30	13	*1,920	*558	1,830	234	146	74	30	25	11	5.3
4	23	12	*1,790	443	1,170	218	137	67	30	22	10	5.3
5	17	12	1,700	371	854	202	129	63	29	21	9.4	6.1
6	12	12	1,050	481	669	284	122	59	28	20	9.4	6.5
7	11	12	642	470	540	394	122	*72	29	20	9.4	6.5
8	9.1	12	433	550	446	386	116	84	27	19	8.9	6.9
9	8.4	13	316	509	368	359	108	75	27	18	8.9	7.4
10	9.1	23	247	864	320	354	103	67	32	18	8.9	7.9
11	9.9	50	201	1,400	378	325	100	62	33	18	9.4	7.9
12	11	217	171	1,610	404	320	94	58	30	18	9.4	6.5
13	12	98	148	1,220	376	320	105	56	*30	18	10	8.8
14	11	69	130	2,870	356	416	111	52	30	18	10	13
15	11	58	114	2,910	335	795	91	50	29	17	9.4	5.7
16	9.9	47	103	2,120	688	736	85	48	27	16	8.9	*4.9
17	9.9	37	95	1,740	924	603	81	45	27	15	8.4	4.9
18	9.9	33	116	1,220	788	832	78	44	27	14	8.4	4.9
19	9.9	42	135	868	756	978	75	42	26	14	7.9	4.9
20	9.9	*99	120	1,120	918	886	72	40	26	14	7.4	4.9
21	9.1	140	109	1,180	879	718	71	39	25	13	7.4	4.9
22	9.1	92	107	1,010	739	564	68	39	24	13	7.4	4.9
23	13	67	110	851	645	448	66	38	27	13	7.4	4.9
24	45	53	144	904	*543	364	67	36	27	*12	7.4	5.3
25	59	48	163	862	478	316	66	34	27	12	6.9	4.9
26	*35	131	1,140	879	427	288	64	34	25	12	6.9	4.9
27	25	156	13,000	809	379	258	61	34	26	11	6.9	4.9
28	20	286	5,530	690	328	232	59	34	37	11	*6.5	4.5
29	17	280	2,650	582	293	210	57	32	59	10	6.5	4.5
30	14	692	2,270	*520	-	193	119	32	42	10	6.5	4.5
31	13	-	1,570	672	-	175	-	32	-	10	6.5	-
Total	524.2	2,829	41,234	32,065	24,150	12,914	2,890	1,646	897	512	264.4	178.3
Mean	16.9	94.3	1,330	1,034	833	417	96.3	53.1	29.9	16.5	8.53	5.94
Ac-ft	1,040	5,610	81,790	63,600	47,900	25,610	5,730	3,260	1,780	1,020	524	354

Calendar year 1951: Max - Min - Mean - Ac-ft -
Water year 1951-52: Max 13,000 Min 4.5 Mean 328 Ac-ft 238,200

Peak discharge (base, 2,400 cfs).--Dec. 1 (9:30 a.m.) 4,180 cfs (12.55 ft); Dec. 3 (3 p.m.) 2,480 cfs (9.53 ft); Dec. 27 (11 a.m.) 16,000 cfs (24.56 ft); Jan. 14 (10 p.m.) 3,480 cfs (11.55 ft); Feb. 1 (7 p.m.) 5,790 cfs (14.68 ft).
* Discharge measurement made on this day.

Mattole River near [illegible]

[illegible]tion (revised).--Lat 40°18'35", long. [illegible] [illegible] right bank 0.4 mile upstream from [illegible] and 0.1 miles upstream from North Fork.

[illegible]inage area.--240 sq mi (revised).

[illegible] available.--November 1911 to December [illegible]

[illegible].--Water-stage recorder. Altitude of [illegible] October 1950, staff or chain gages at sever[illegible] ent site at various datums.

[illegible]tremes.--1950-51: Maximum discharge during water [illegible] on records for Van Duzen River near [illegible] may have been less in October, prior to [illegible]
1951-52: Maximum discharge during water [illegible] ft); minimum daily, 26 cfs Sept. [illegible]
1911-13, 1950-52: Maximum discharge [illegible] 27.1 ft, datum then in use); minimum [illegible] 1913.

[illegible]marks.--Records good except those for period [illegible] No regulation or diversion.

Discharge, in cubic feet per second, water year [illegible]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1			-	616	87[illegible]	[illegible]
2			-	7[illegible]	*2,41[illegible]	[illegible]
3			-	1,540	5,5[illegible]	[illegible]
4			-	1,500	[illegible]	[illegible]
5			-	1,610	[illegible]	*1,7[illegible]
6			-	1,560	7,760	[illegible]
7			-	1,320	5,0[illegible]	[illegible]
8			-	*1,230	4,230	[illegible]
9			-	1,280	3,000	[illegible]
10			-	4,000	3,300	[illegible]
11			-	6,180	5,340	[illegible]
12			*5,030	6,140	4,940	[illegible]
13			3,800	4,030	3,720	[illegible]
14			8,930	2,910	2,[illegible]	[illegible]
15			8,760	4,230	2,360	[illegible]
16			5,810	4,370	2,0[illegible]	[illegible]
17			3,890	13,100	1,8[illegible]	[illegible]
18			2,870	13,200	1,6[illegible]	[illegible]
19			2,500	7,910	*1,3[illegible]	[illegible]
20			2,150	4,990	1,300	[illegible]
21			1,840	15,400	1,280	[illegible]
22			1,610	13,600	1,160	[illegible]
23			1,400	7,640	1,020	[illegible]
24			1,240	4,510	991	[illegible]
25			1,100	3,090	928	[illegible]
26			988	2,530	874	[illegible]
27			871	2,130	8[illegible]	[illegible]
28			790	1,760	7[illegible]	*4[illegible]
29			728	1,460	-	4[illegible]
30			760	1,230	-	4[illegible]
31			734	1,030	-	4[illegible]
Total	-	-	-	137,354	109,020	44[illegible]
Mean	e1,900	e1,900	e4,400	4,431	3,910	1,4[illegible]
Ac-ft	116,800	113,100	270,500	272,400	217,400	[illegible]

Calendar year 1950: Max - Min - [illegible]
Water year 1950-51: Max - Min - [illegible]

Peak discharge (base, 9,000 cfs).--Oct. 28, at [illegible] about 15,000 cfs; Dec. 15 (3:30 a.m.) 9,970 cfs ([illegible] Jan. 21 (5 p.m.) 22,900 cfs (15.03 ft); Feb. 4 ([illegible]
* Discharge measurement made on this day.
e Monthly discharge estimated on basis of records [illegible] Duzen River near Bridgeville.
[illegible] Computed from once-daily gage readings.
Note.--No gage-height record May 19 to July [illegible] of 5 discharge measurements, 3 observations of [illegible] Fork Mattole River at Petrolia.

4685. Noyo River near Fort Bragg, Calif.

Location.--Lat 39°26', long 123°44', in SW¼ sec.10, T.18 N., R.17 W., on right bank [illegible] mile downstream from South Fork and 3.5 miles east of Fort Bragg.

Drainage area.--105 sq mi.

Records available.--August 1951 to September 1960.

Gage.--Water-stage recorder. Datum of gage is 12.1 ft above mean sea level.

Average discharge.--9 years (1951-60), 239 cfs (173,000 acre-ft per year).

Extremes.--1951-60: Maximum discharge, 22,000 cfs Dec. 22, 1955 (gage height, 25.64 ft), from rating curve extended above 3,600 cfs on basis of slope-conveyance study; minimum, 0.4 cfs for several days in August and September 1959.

Remarks.--No regulation or diversion. Records of chemical analyses for the period January 1959 to September 1960 are published in reports of Geological Survey.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951	-	-	-	-	-	-	-	-	-	-	-	4.74	-
1952	16.9	94.3	1,330	1,034	833	417	96.3	53.1	29.9	16.5	8.53	5.94	328
1953	5.70	22.8	804	1,890	148	424	168	154	102	32.0	17.7	11.3	319
1954	14.2	138	200	1,185	505	368	330	56.2	34.6	17.5	12.2	10.6	242
1955	11.7	84.5	266	367	84.6	70.9	182	75.5	24.3	12.3	5.97	4.88	99.5
1956	7.48	60.5	1,532	1,374	782	261	60.6	37.7	21.0	10.4	6.37	4.28	348
1957	20.3	22.2	18.4	121	320	704	158	277	53.7	19.4	9.69	11.2	144
1958	105	172	430	659	2,114	550	743	61.3	37.3	18.3	8.60	6.61	396
1959	5.75	18.0	22.6	614	628	117	85.0	25.2	13.6	6.62	3.06	5.90	126
1960	5.58	5.29	11.7	103	820	653	129	67.4	32.7	12.0	6.40	5.76	152

Monthly and yearly discharge, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951	-	-	-	-	-	-	-	-	-	-	-	282	-
1952	1,040	5,610	81,790	63,600	47,900	25,610	5,730	3,260	1,780	1,020	524	354	238,200
1953	350	1,360	49,440	116,200	8,220	26,050	10,030	9,460	6,040	1,970	1,090	671	230,900
1954	871	8,220	12,290	72,860	28,030	22,640	22,640	3,450	2,060	1,080	753	633	175,500
1955	719	5,030	16,350	22,570	4,700	4,360	10,810	4,640	1,450	753	367	290	72,040
1956	460	3,600	94,220	84,490	44,990	16,060	3,600	2,320	1,250	638	392	254	252,300
1957	1,250	1,320	1,130	7,460	17,750	43,270	9,390	17,030	3,200	1,190	596	664	104,200
1958	6,430	10,220	26,450	40,530	117,400	33,810	44,190	3,770	2,220	1,120	529	394	287,100
1959	353	1,070	1,390	37,760	34,900	7,210	5,060	1,550	809	407	187	351	91,050
1960	343	315	721	6,310	47,150	40,160	7,680	4,140	1,940	738	393	343	110,200

Yearly discharge, in cubic feet per second

Year	WSP	Water year ending Sept. 30						Calendar year	
		Momentary maximum		Minimum day	Mean	Acre-feet		Mean	Acre-feet
		Discharge	Date						
1950									
1951	1245	-	-	-	-	-		-	-
1952	1245	16,000	Dec. 27, 1951	4.5	328	238,200		278	200,900
1953	1285	13,000	Jan. 18, 1953	3.7	319	230,900		278	201,100
1954	1345	11,700	Jan. 17, 1954	8.2	242	175,500		243	176,200
1955	1395	3,680	Dec. 31, 1954	4.1	99.5	72,040		205	148,200
1956	1445	22,000	Dec. 22, 1955	3.8	348	252,300		217	157,700
1957	1515	3,710	Mar. 5, 1957	4.1	144	104,200		198	143,600
1958	1565	8,230	Feb. 12, 1958	5.0	396	287,100		341	246,800
1959	1635	4,280	Jan. 12, 1959	2.4	126	91,050		124	89,610
1960	1715	12,000	Feb. 8, 1960	4.0	152	110,200		-	-

APPENDIX D

NOYO RIVER

FLOW DURATION CURVES BY MONTH

1951-1977

Duration curves constructed by ordering the daily flows of the Noyo River from water years 1951-1977. Records used are from USGS gaging station 11-4685.

Method used was to assign flow category divisions (see attached sheet) for the data available.

Daily flows recorded by flow category divisions.

Flows ordered with the largest event assigned the number one.

The assigned order number divided by the number of records ordered (the order number of the smallest flow in the group) multiplied by 100, yields percent of time that a particular flow category division has been equaled or exceeded.

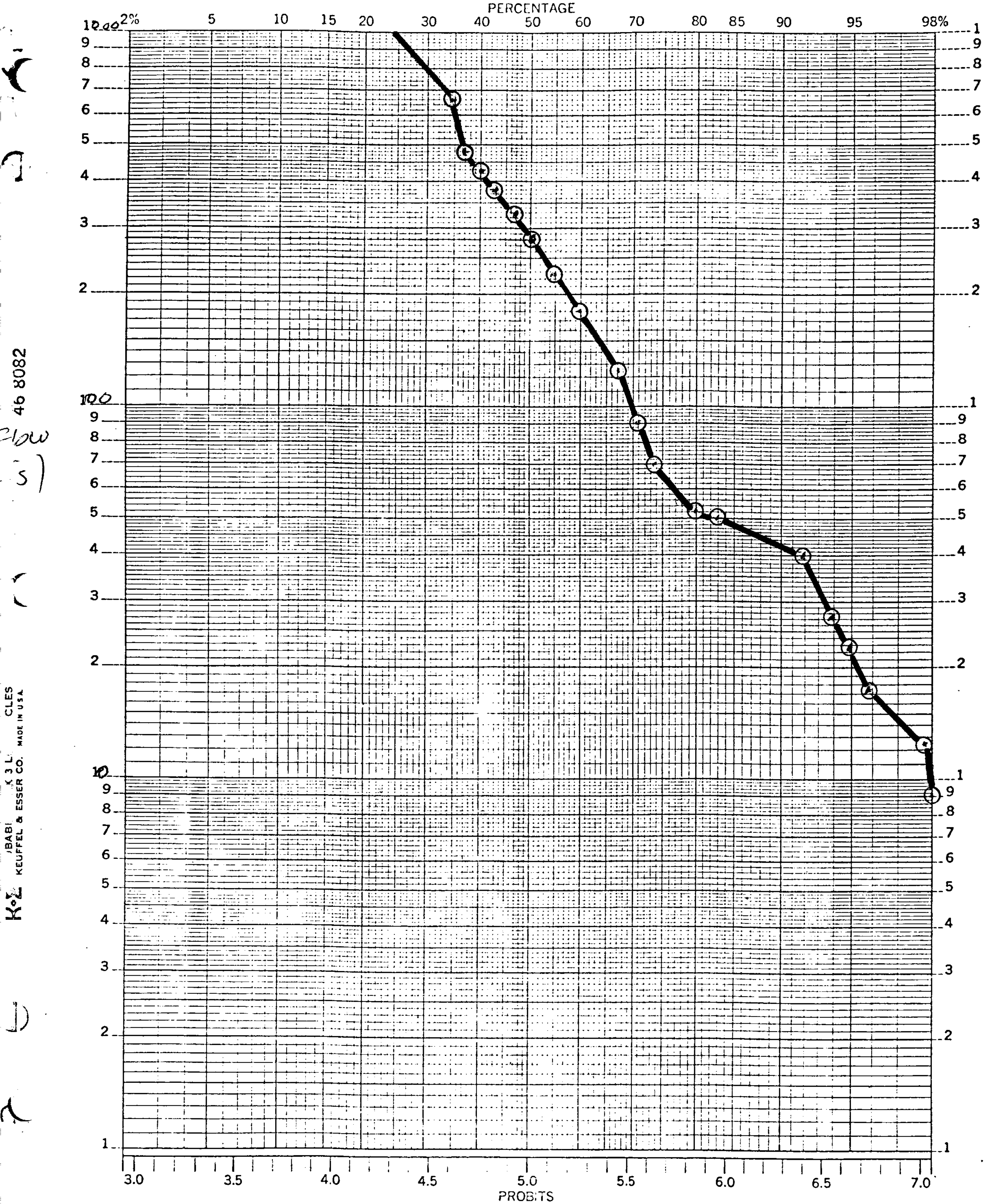
Percent exceedance has been plotted. Point on graph paper equals approximate middle of flow category division.

FLOW CATEGORY DIVISION

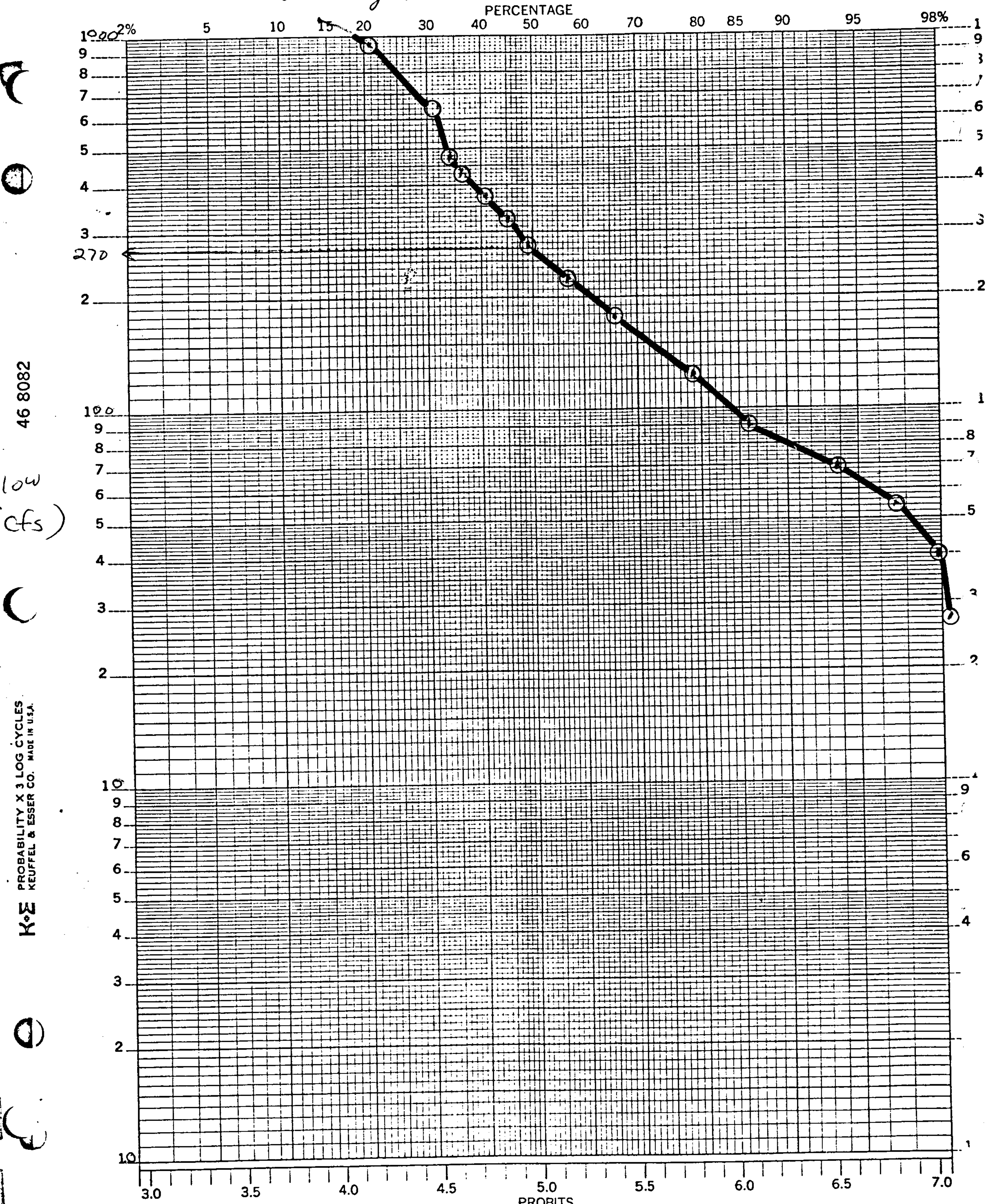
cfs		
<1		
1	-	2
2.1	-	4.0
4.1	-	6.0
6.1	-	8.0
8.1	-	10.0
10.1	-	15.0
15.1	-	20.0
20.1	-	25.0
25.1	-	30.0
30.1	-	50.0
50.1	-	60.0
60.1	-	80.0
80.1	-	100.0
100.1	-	150.0
151	-	200
201	-	250
251	-	300
301	-	350
351	-	400
401	-	450
451	-	500
501	-	800
801	-	1100
1101	-	1400
1401	-	1600
1601	-	1800
1801	-	2000
2001	-	2200
2201	-	2400
2401	-	2600
2601	-	2800
2801	-	3000
3001	-	3200
3201	-	3400
3401	-	4000
4001	-	4200

Flows above 1100 not plotted on flow duration curves for each month.

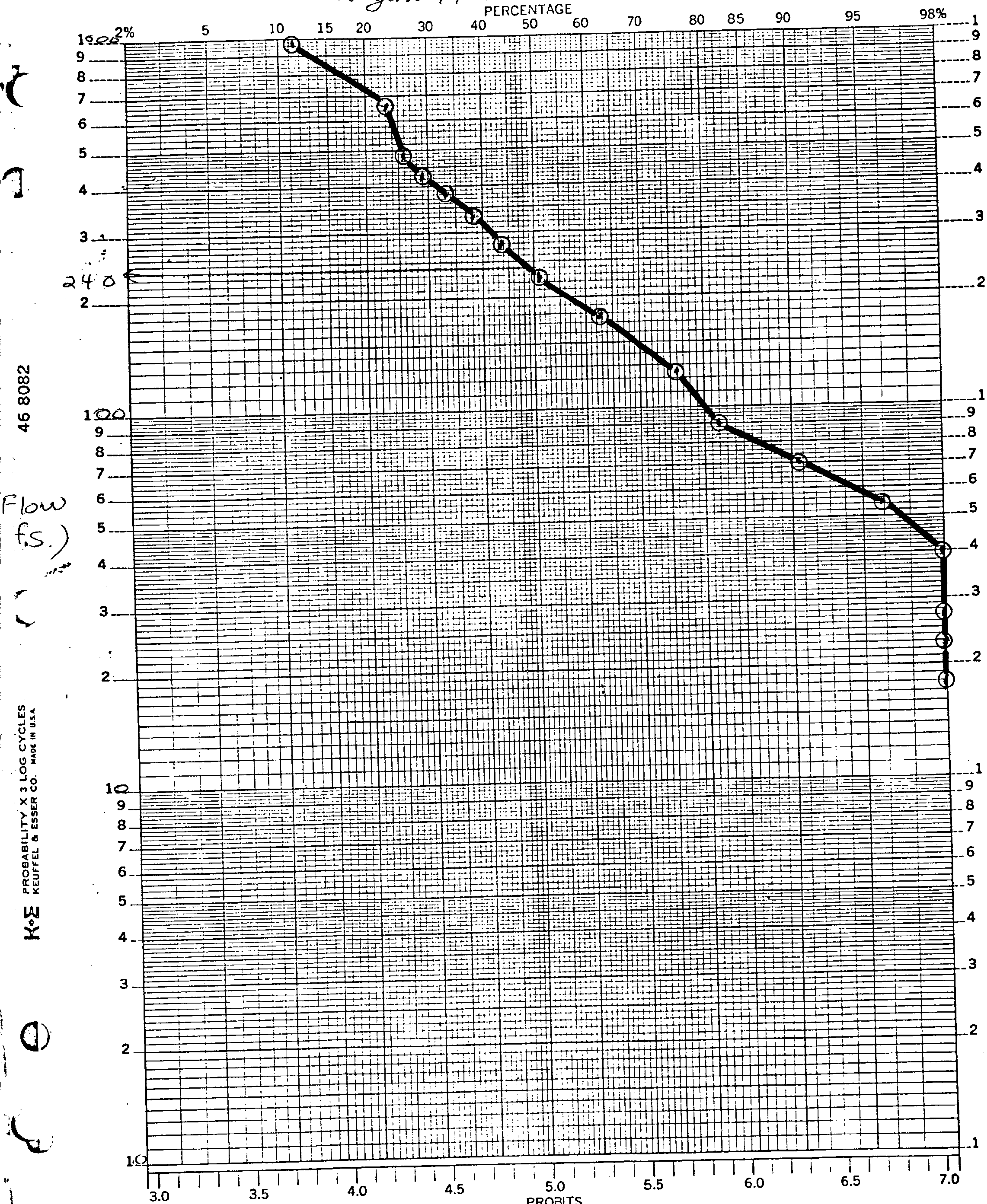
Noyo River – JAN
Water years 1951 - 1978



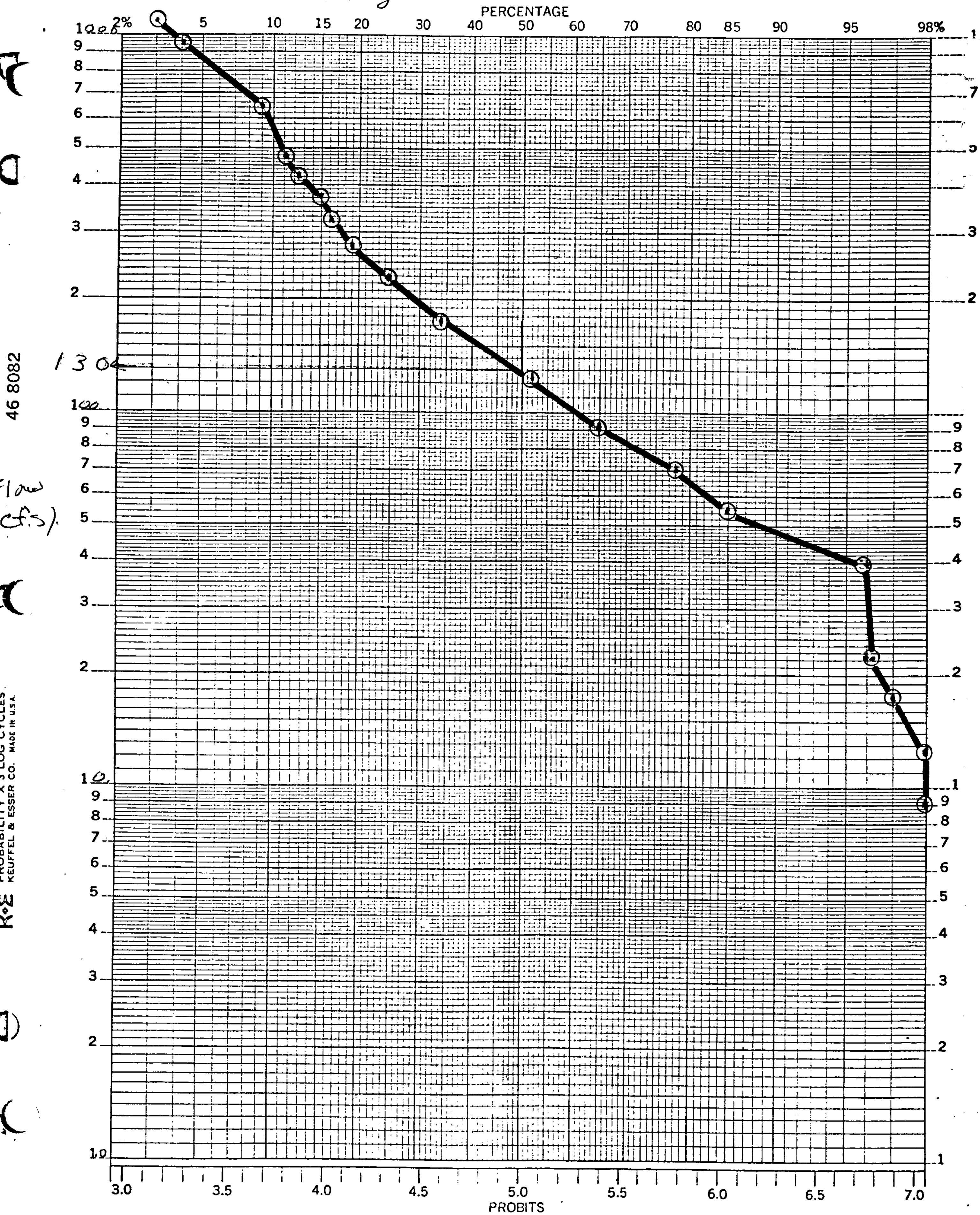
Noyo River - February
Water years 1951 - 1978



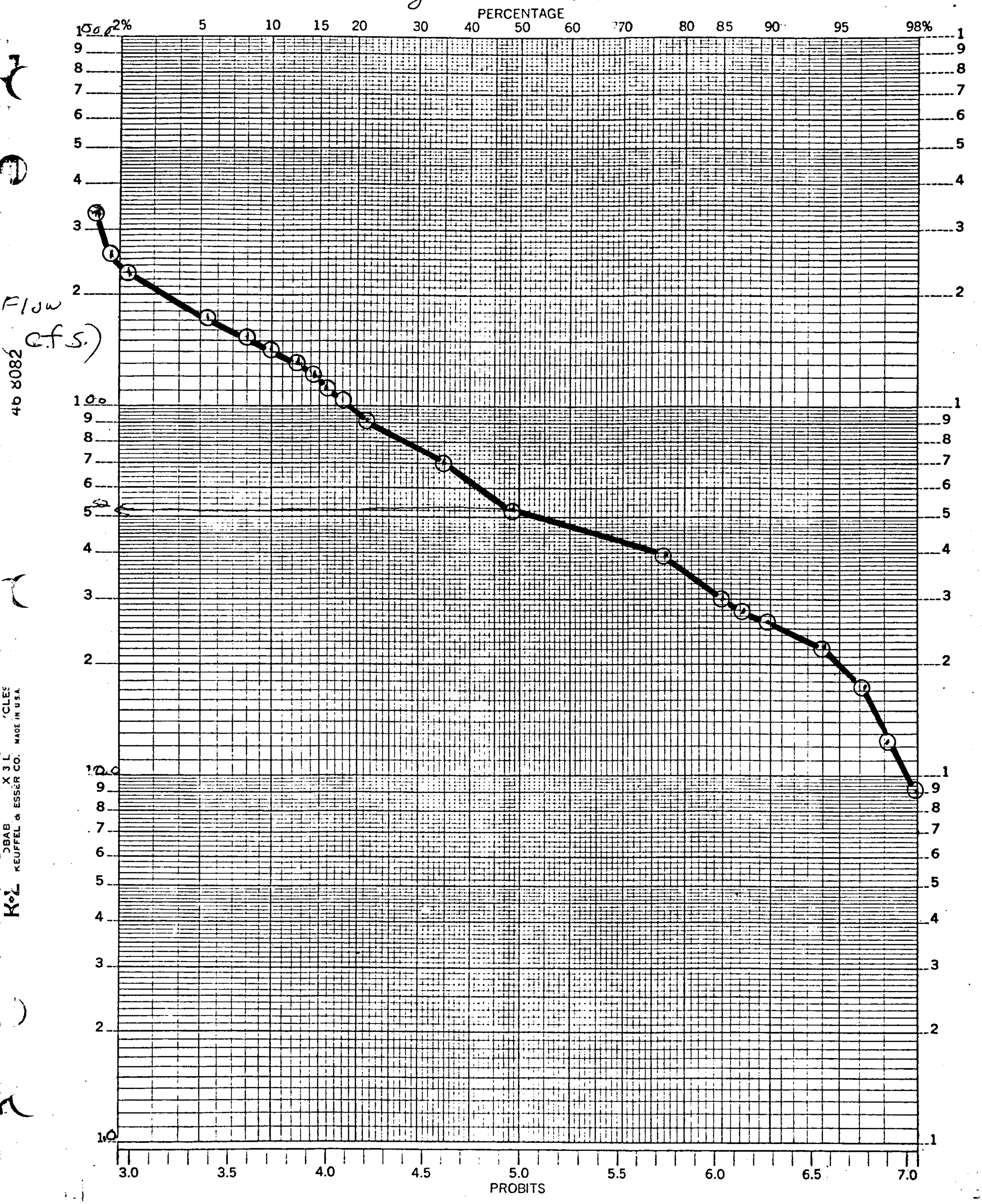
Noyo River - March
Water years 1957 - 1978



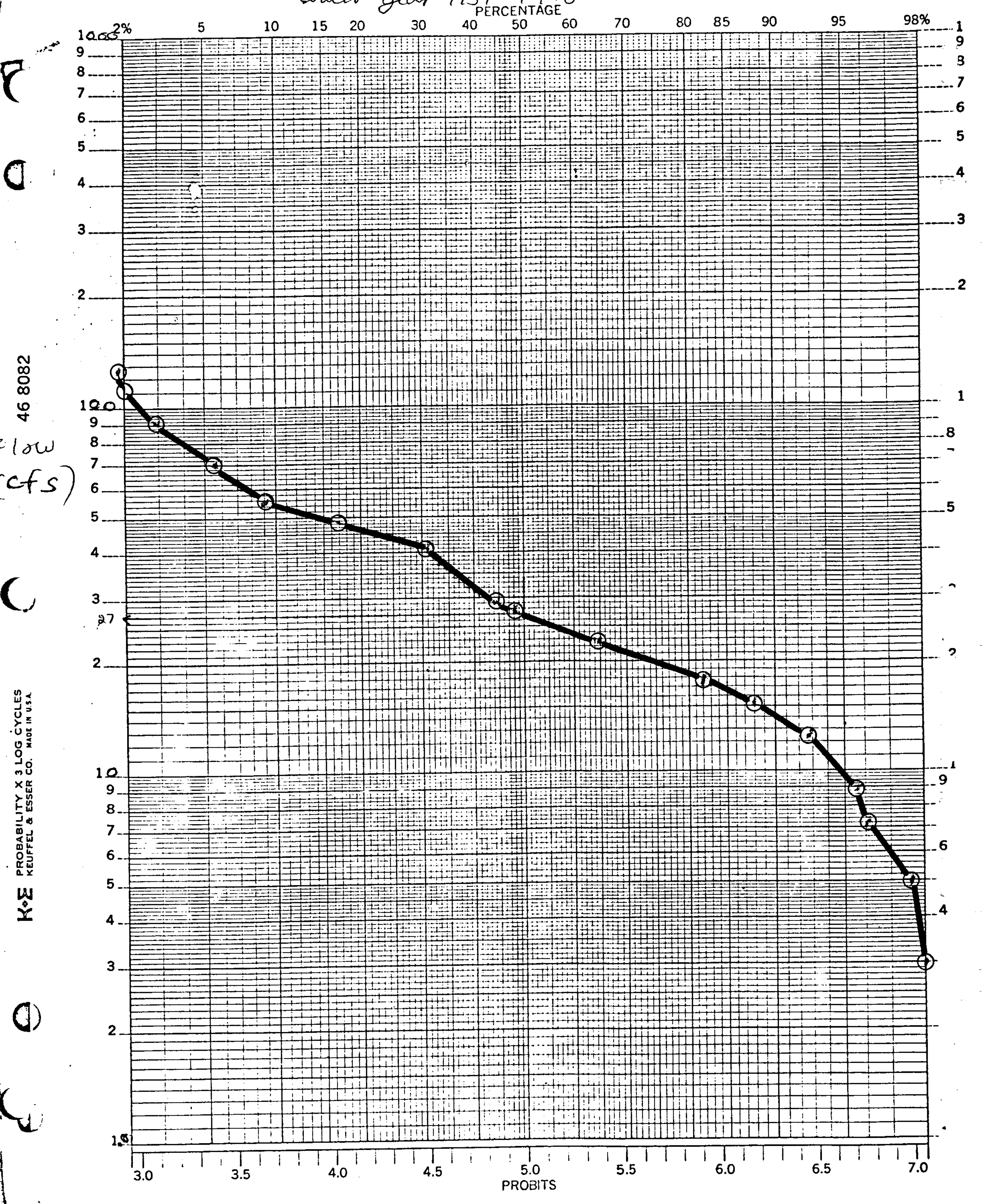
Noyo River - April
Lower years 1951-1978



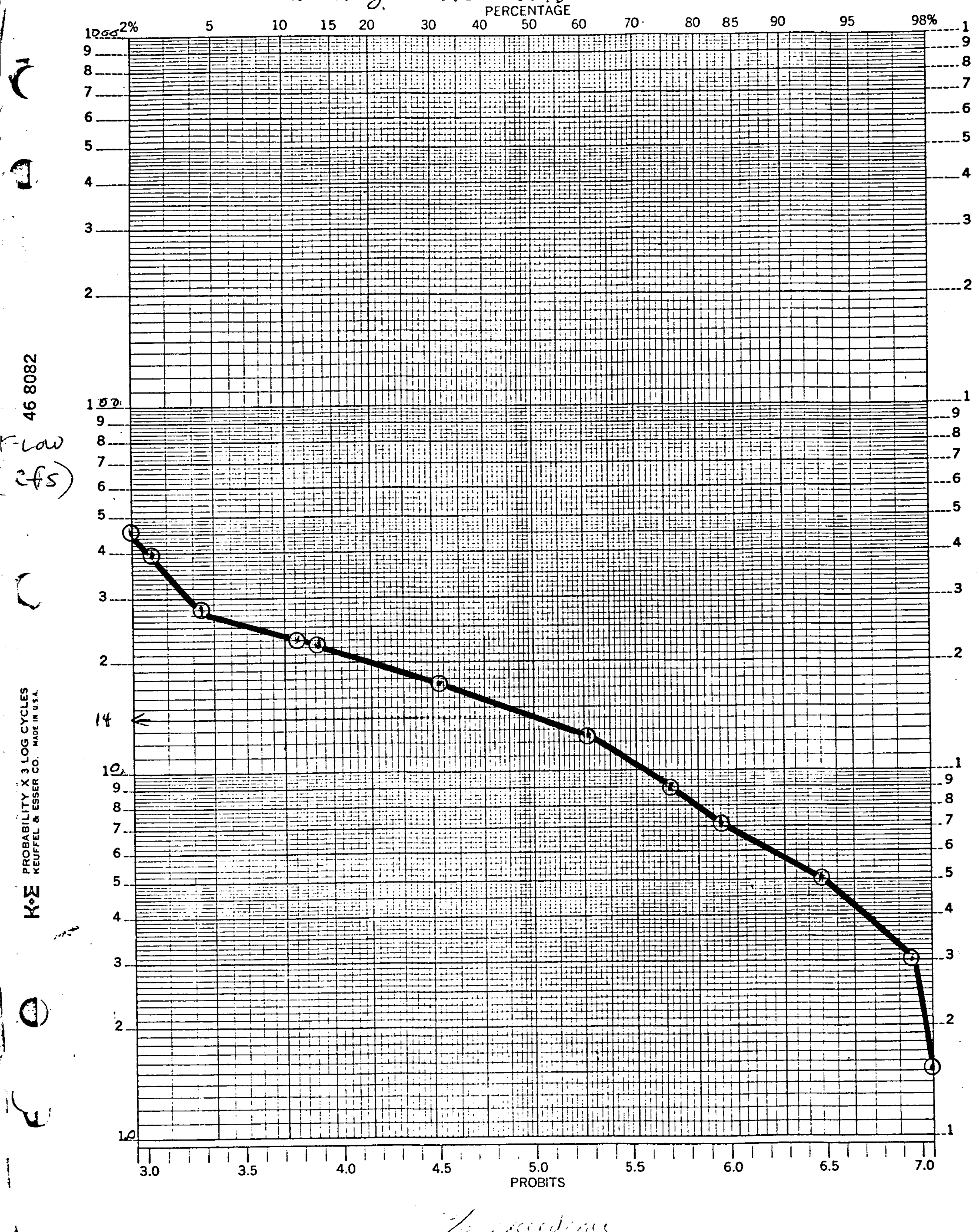
Noyo River - May
Water year 1951 - 1978

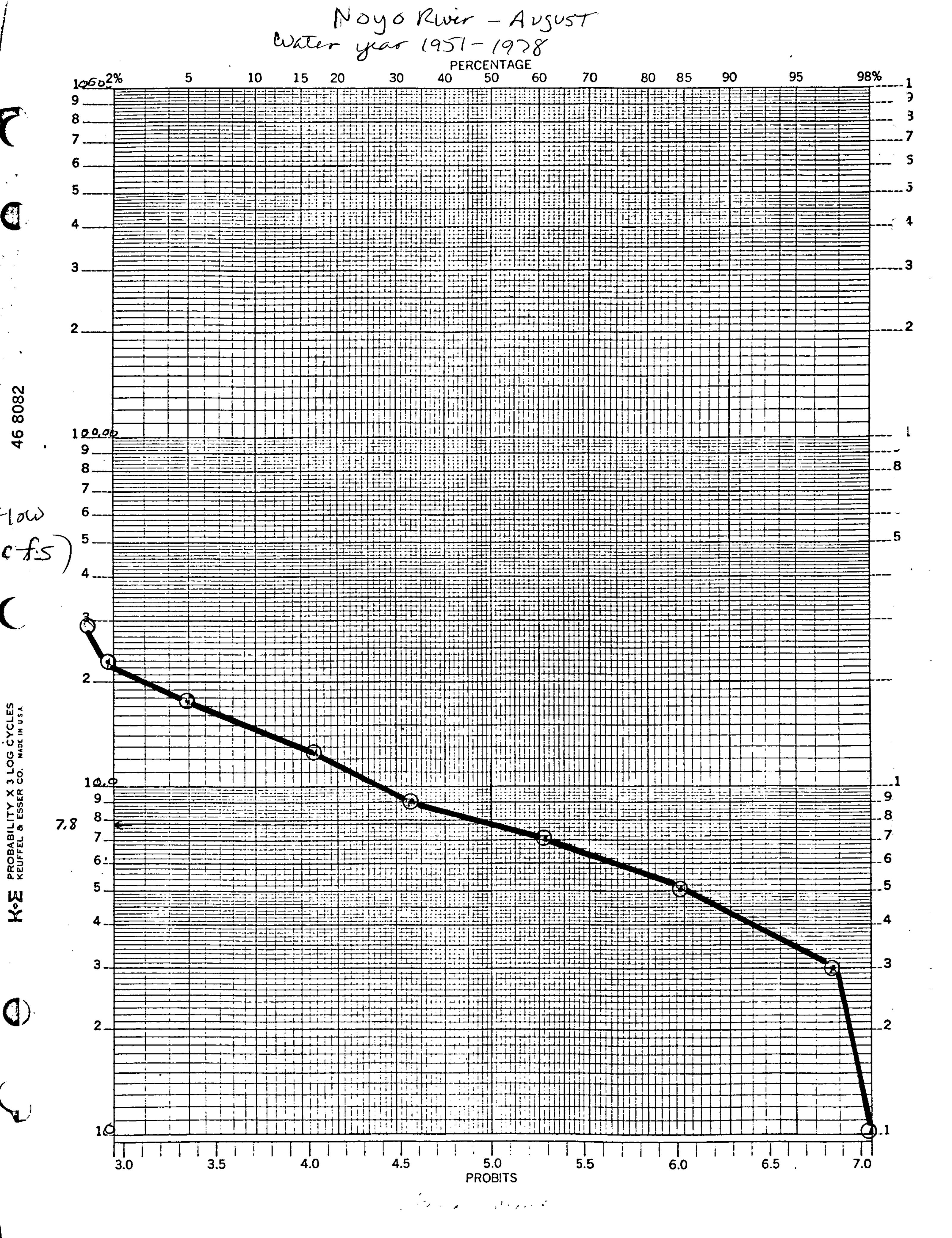


Noyo River - June
Water year 1951 - 1978

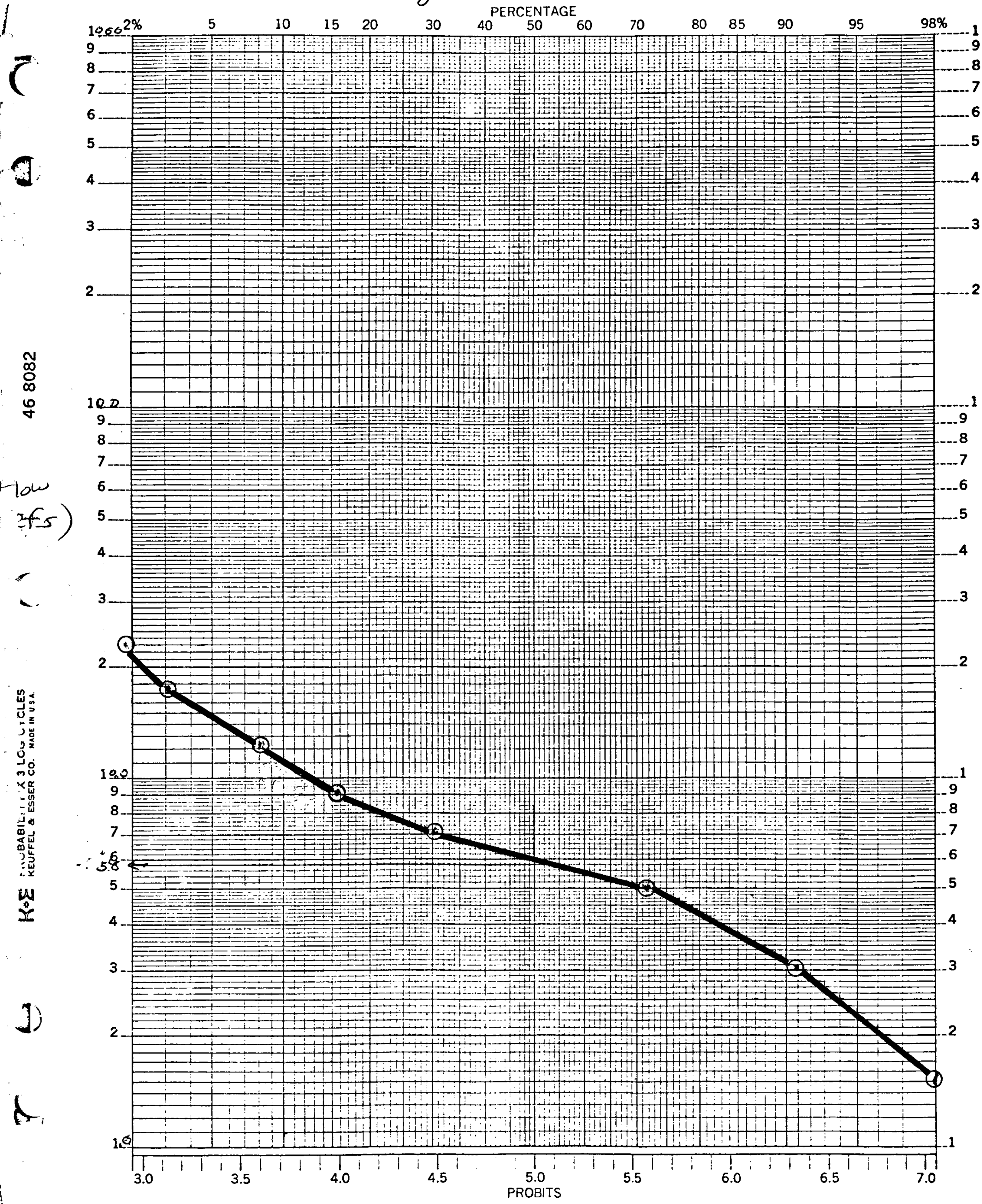


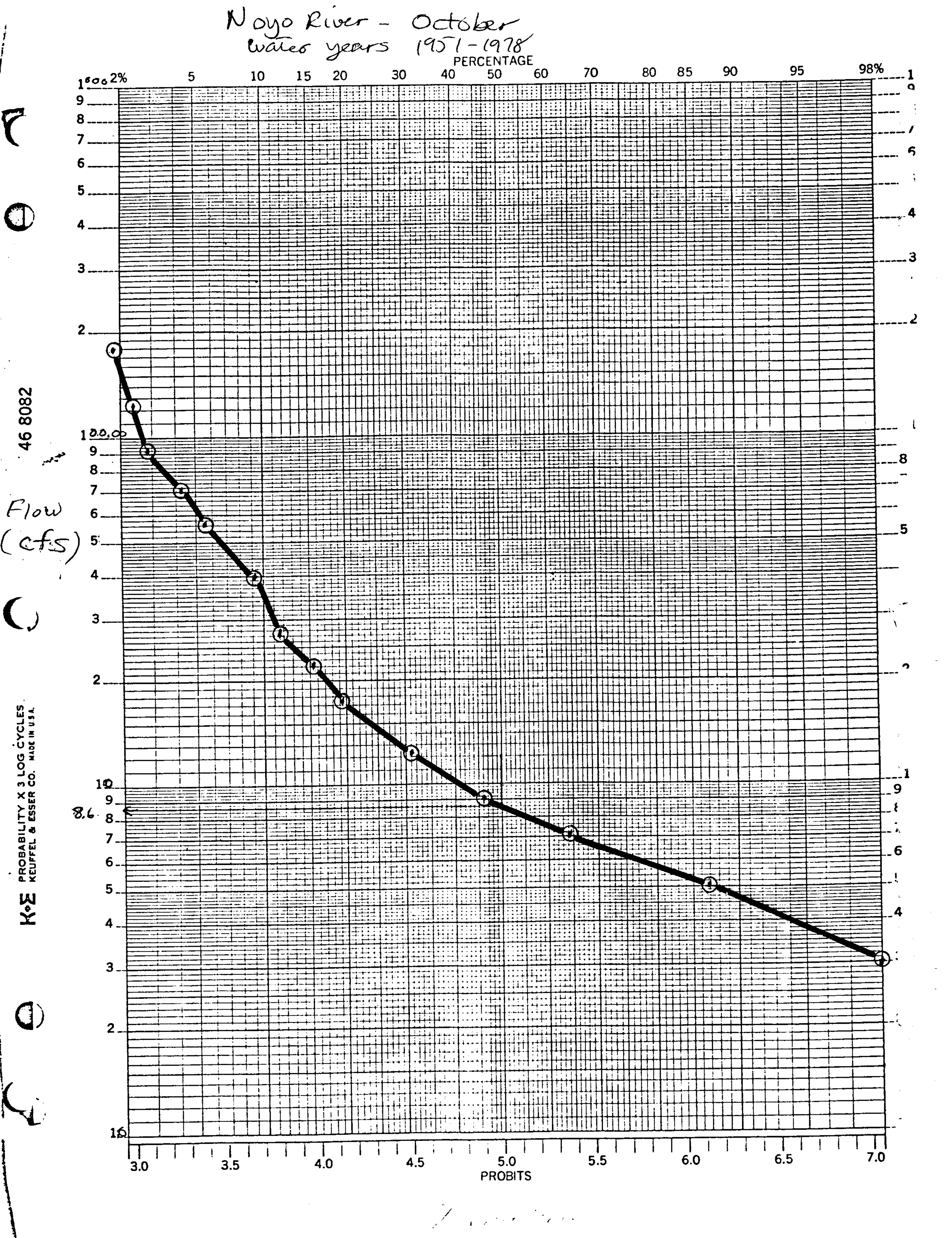
Noyo River - July
Water Year 1951-1978




Noyo River - August
Water year 1951-1978
PERCENTAGE
PROBITS
Flow (cfs)
7.8
46 8082
K+E PROBABILITY X 3 LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

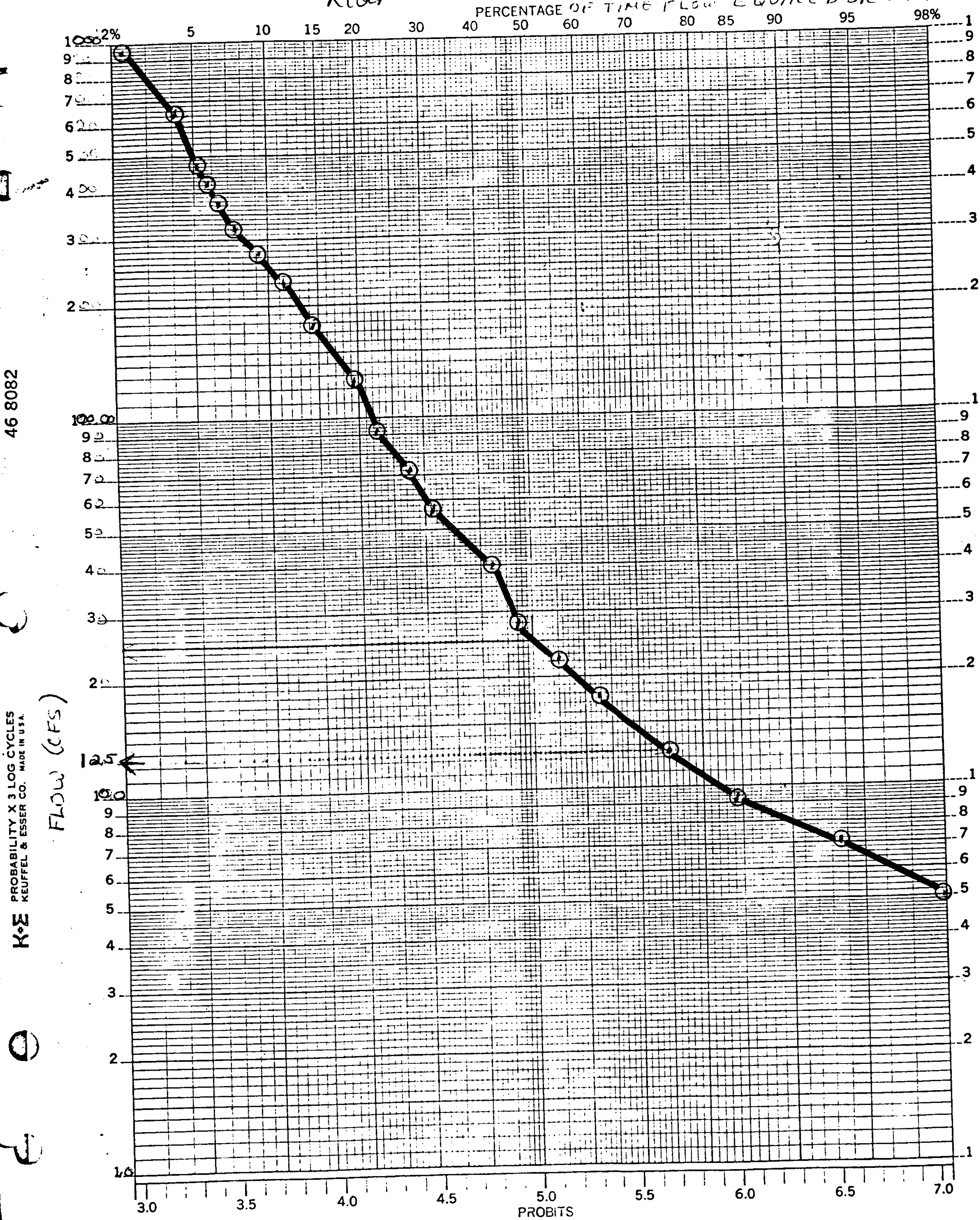
Noyo River - September
Water years 1951-1978



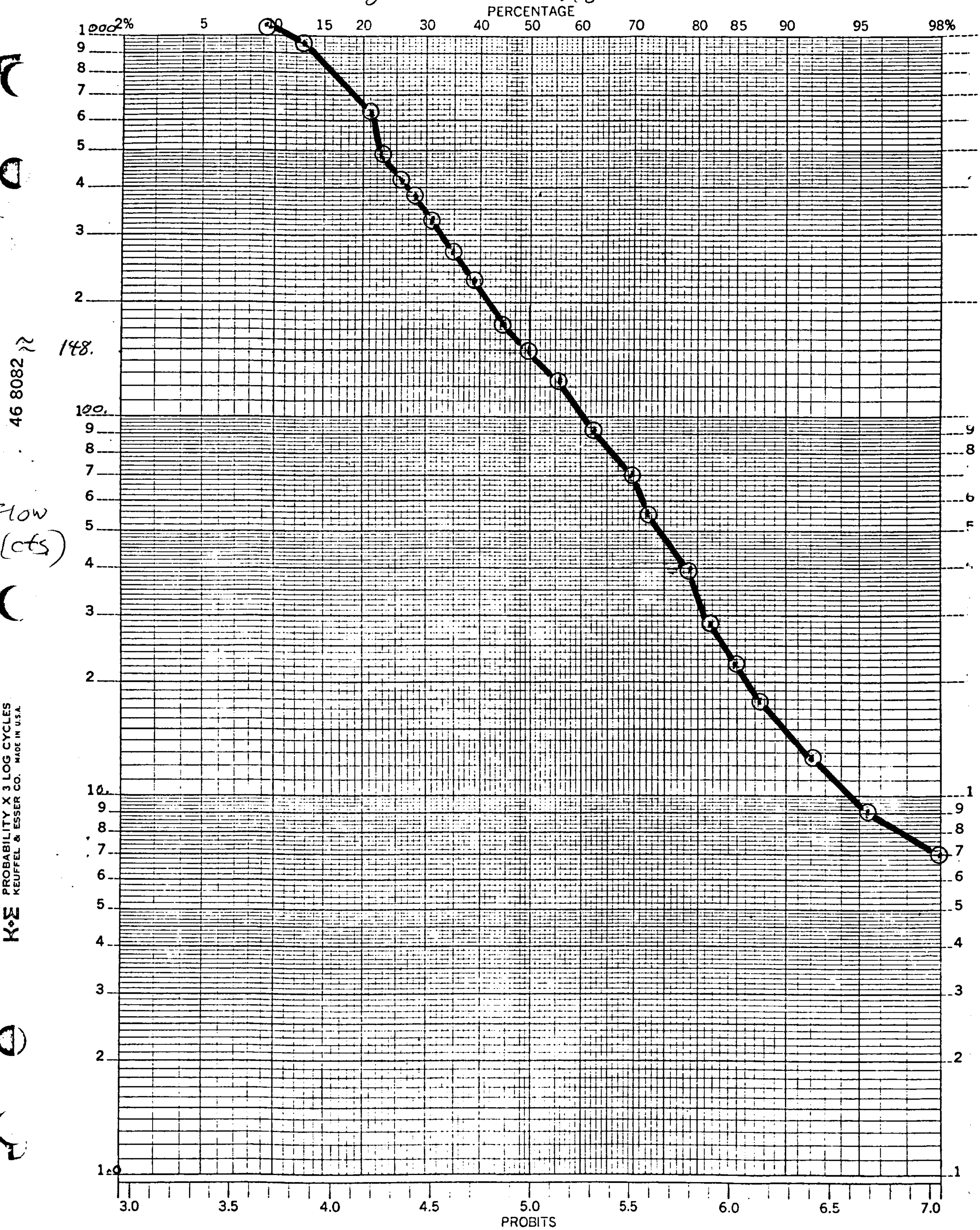


Noyo River - October
Water years 1951-1978
PERCENTAGE
2%
5
10
15
20
30
40
50
60
70
80
85
90
95
98%
1000
100.00
10
8.6
1
Flow (cfs)
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
PROBITS
46 8082
K+E PROBABILITY X 3 LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Noyo River – November   water years 1951 – 1970



Noyo River - December
water years 1951 - 1978



APPENDIX E

ESTIMTED WELL COSTS

AND

ADDITIONAL PUMPING

AT NOYO PUMP STATION

ESTIMATED COSTS FOR TWO 110 GPM WELLS
IN FORT BRAGG AREA
COMPARED TO ADDITIONAL PUMPING OF 0.5 CFS
FROM THE NOYO RIVER

Mobilization/Demobilization	$ 4,000
Drill Set-up	1,000
Drill 2 Pilot Holes (150 ft. deep - 2 each)	3,000
Geophysical logs (2 each)	1,000
Reaming Pilot Hole to 36-inch diameter (50 feet - 2 each)	500
Furnish and Install Conductor Casing (51 - 2 each)	2,000
Furnish and Install Grout Seal (2 each)	500
Ream Pilot Hole to 24-inch diameter (100 feet - 2 each)	2,000
Furnish and Install 12-inch Non-perforated Casing (70 feet - 2 each)	3,000
Furnish and Install 12-inch Well Screen (30 feet - 2 each)	5,000
Furnish and Install Gravel Pack (2 each)	1,000
Develop Well (2 each)	2,000
Furnish Pump Test for 40 Hours and Remove Equipment Equipment (2 each)	8,000
SUBTOTAL to Develop 2 Wells	$33,000
Water Quality Testing (2 each)	$2,000
Well Equipment	
100 gpm Submersible Pump and Controls (2 each)	8,000
1500 gal. pneumatics tank (2 each)	10,000
Building (2 each)	6,000
Concrete Slab, Miscellaneous (2 each)	3,000
Chlorination System (2 each)	2,000
Fencing (2 sites)	3,000
Electrical	3,000
Subtotal to Equip 2 Wells	$35,000

Estimated TOTAL to Develop and Equip 2 - 100 feet deep, 110 gpm Potable Wells for Direct Discharge into the Fort Bragg Water System	$70,000

Note: Cost does not include land design. A piping to system costs.

APPENDIX E
ESTIMATE COSTS
FOR ADDITIONAL PUMPING
FROM NOYO RIVER FOR 1/2 CFS (or 220 gpm±)

To provide additional 1/2-cfs would require a 100 Hp Vertical Turbine Pump to replace the existing 75 Hp Submersible Unit.

Pump	$ 8,000
Pump Fittings and Installation	7,000
Building Modification	5,000
Electrical to Code	5,000
	$25,000

Power Cost Consideration

Noyo Pump Station: Vertical Turbine Pump - 100 Hp, 430 feet TDH @ 700 gpm about 70 Hp per cfs delivered to WTP plus about 20 Hp/cfs at WTP.

Wells equipped with submissible 20 Hp 250 TDH @ 110 gpm or 100 Hp per cfs delivered into system.

Therefore, there would be no significant power cost differences based on nameplate horsepower.

Even if the Noyo pumps required more energy, the difference would not develop a significant cost savings. This is especially true when considering the in-place costs and risks associated with developing two wells in the Fort Bragg area capable of meeting water quality standards and 110 gpm output on a daily basis.

(10 Hp x 24 hrs/day operation divided by 90 percent pump efficiency x 0.746 kwh/Hp x $0.089/kwh or $17.70/day or $530/month).

APPENDIX F

USGS STREAM FLOW DATA

PUDDING CREEK 1963-1970

PUDDING CREEK BASIN
STATION 114685.40

NOTE: Station was operated on a temporary basis 1964-1970 and is only avaiable USGS data on stream.

11468540 PUDDING CREEK NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°27'25", long 123°43'20", in NE¼NW¼ sec.2, T.18 N., R.17 W., Mendocino County, on right bank at old town site of Glenblair, 0.7 mile downstream from Little Valley Creek, and 4.5 miles east of Fort Bragg.

DRAINAGE AREA.--12.5 sq mi.

PERIOD OF RECORD.--October 1963 to current year.

GAGE.--Water-stage recorder. Datum of gage is 88.92 ft above mean sea level.

AVERAGE DISCHARGE.--7 years, 20.3 cfs (14,710 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 1,130 cfs Jan. 23 (gage height, 6.74 ft); minimum daily, 0.04 cfs Aug. 29 to Sept. 2.
Period of record: Maximum discharge, 2,000 cfs Dec. 21, 1964 (gage height, 8.55 ft); no flow at times.

REMARKS.--Records good. No regulation or diversion above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.56	.30	.56	13	32	13	4.0	1.7	.65	.27	.11	[illegible]
2	.56	.30	.57	12	75	9.5	3.8	1.7	.55	.27	.07	[illegible]
3	.56	.3?	.5?	8.8	21	8.8	3.6	1.6	.55	.27	.05	[illegible]
4	.56	.92	.5?	7.?	19	57	3.6	1.6	.65	.31	.05	[illegible]
5	.45	6.7	.55	5.7	15	39	3.4	1.5	.65	.31	.05	[illegible]
6	.45	3.1	.5?	6.?	15	26	3.4	1.6	.65	.31	.05	[illegible]
7	.45	2.?	.5?	[illegible]	13	43	3.?	1.5	.55	.35	.05	[illegible]
8	.56	[illegible]	1.?	[illegible]	11	57	4.?	1.6	.75	.27	.05	[illegible]
9	.65	2.3	1.4	[illegible]	11	45	[illegible]	[illegible]	1.4	.27	.05	[illegible]
10	[illegible]	1.5	1.9	141	?.5	41	[illegible]	[illegible]	1.1	.27	.05	[illegible]
11	[illegible]	1.?	?.4	[illegible]	?.5	[illegible]	[illegible]	[illegible]	.65	.31	[illegible]	[illegible]
12	1.?	[illegible]	12?	61	2?	2?	2.8	[illegible]	.55	.31	[illegible]	[illegible]
13	1.1	.72	1??	13?	3?	19	[illegible]	2.1	.65	.31	[illegible]	[illegible]
14	1.?	.72	[illegible]	[illegible]	37	22	[illegible]	1.7	.65	.27	[illegible]	[illegible]
15	1.1	.72	4?	12?	[illegible]	16	?.8	1.5	.55	.27	[illegible]	[illegible]
16	2?4	.64	1?	312?	141	14	2.3	1.5	.55	.2?	[illegible]	[illegible]
17	1.4	.56	14	181	199	12	2.6	1.4	.5?	.2?	.05	[illegible]
18	.92?	.56	17	1??	33	13	2.6	1.4	.47	.23	[illegible]	[illegible]
19	.52	.56	149	176	65?	8.8	3.6	1.4	.40	.23	.05	[illegible]
20	.44	.56	107	131	41	7.9	3.?	[illegible]	.4?	[illegible]	.04	[illegible]
21	.47	.56	523	622	33	7.3	2.6	1.3	.43	.23	.05	.1?
22	.31	.56	144	347	23	6.7	2.5	1.3	.39	.19	.05	.1?
23	.35	.56	262	773	19	6.5	2.3	1.2	.31	.19	[illegible]	.1?
24	.3?	.56	163	433	16	6.0	2.1	1.1	.41	.19	.05	.1?
25	.25	.56	87	156	11	5.6	2.1	.95	.39	.19	.05	.1?
26	.26	.56	67	144	11	5.4	2.1	.95	.43	.15	.05	.15
27	.42	.56	56	188	10	5.0	2.3	1.1	.43	.15	.05	.1?
28	.41	.56	39	125	11	4.6	2.0	1.1?	.43	.15	.05	[illegible]
29	.3?	.56	28	69	------	4.4	1.8	.95	.35	.11	.04	[illegible]
30	.33	.56	25	53	------	4.4	1.8	.75	.27	.11	.04	.1?
31	.30	------	16	38	------	4.2	------	.65	------	.11	.04	------
TOTAL	21.77	33.14	2,087.55?	4,783.6	979.5?	559.1	85.0	47.05	16.90	7.29	1.6?	[illegible]
MEAN	.70?	1.1?	67.3	154	35.0	18.0	2.83	1.52	.56	.24	.05?	[illegible]
MAX	1.1	6.7	528?	773	197	57	4.?	2.8	1.4?	.3?	.11	[illegible]
MIN	.25	.30	.5?	6.?	9.5	4.2	1.8	.65	.27	.11	.04	[illegible]
AC-FT	43	66	4,14?	9,48?	1,94?	1,11?	169	93	34	14	3.?	[illegible]

CAL YR 1969 TOTAL [illegible] MEAN 26.1 MAX 762 MIN .02 AC-FT 18,900
WTR YR 1970 TOTAL [illegible] MEAN 23.6 MAX 773 MIN .04 AC-FT 17,110

PEAK DISCHARGE (BASE, 500 CFS)

DATE	TIME	G.H.	DISCHARGE	DATE	TIME	G.H.	DISCHARGE
12-21	1100	6.37	978	1-23	2100	6.74	1,130
1-21	0400	5.81	759	1-27	0900	5.53	661

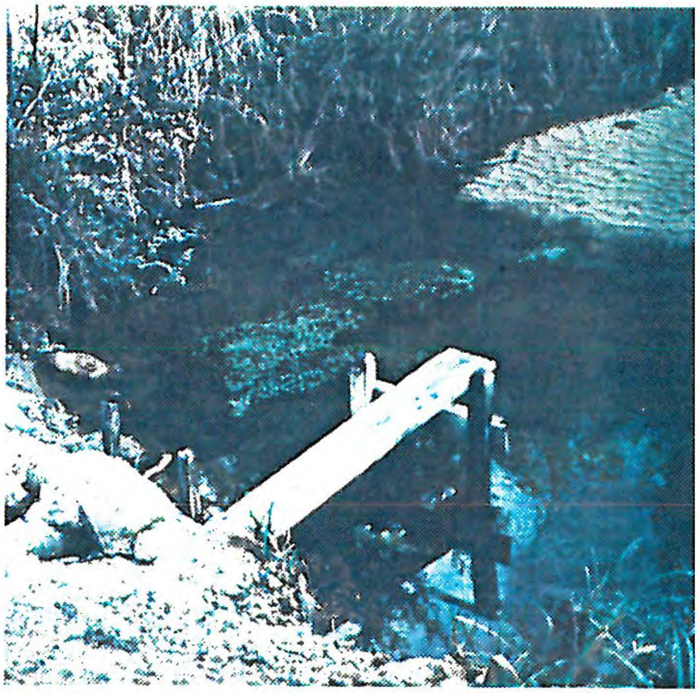
APPENDIX G

FIELD PHOTOS

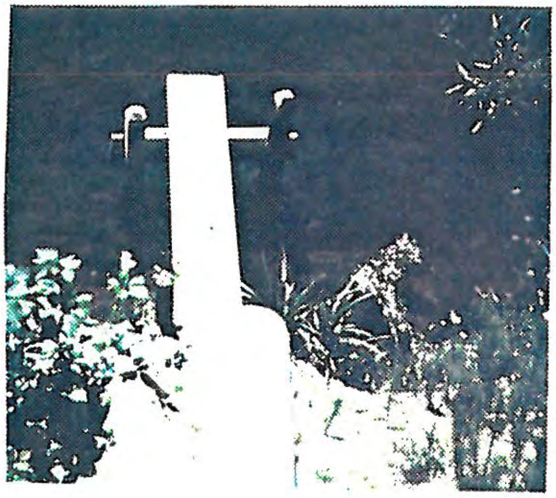
OF

RAW WATER FACILITIES

P-1 WATERFALL GULCH DIVERSIC
LOOKING UPSTREAM



P-2 WATERFALL GULCH DIVERSION
LOOKING UPSTREAM



P-3 STEEL MESH OVER INTAKE
TO SIMPSON PIPELINE

P-4 WATERFALL GULCH INFLOW
JANUARY 1985

P-5 WATERFALL GULCH INFLOW
OCTOBER 1985

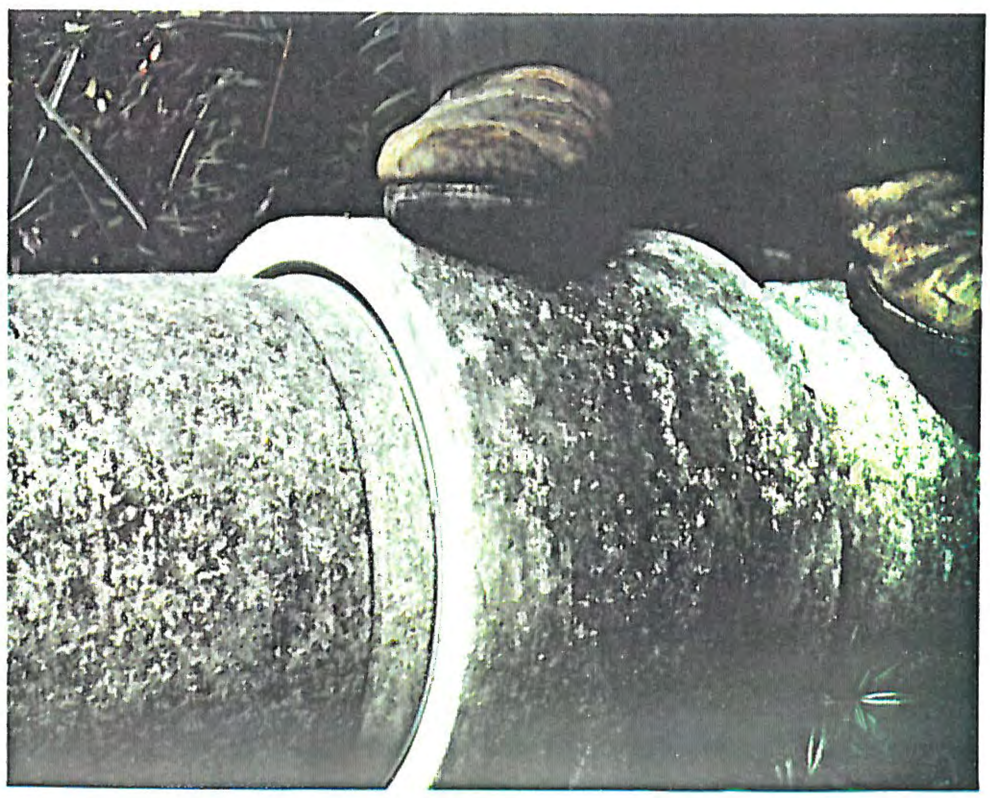
P-6 TYPICAL EXPOSED SECTION AT GRADE

P-7 TRESTLE # 1 – DOWNSTREAM OF SIMPSON PIPELINE

P-8 TRESTLE # 4

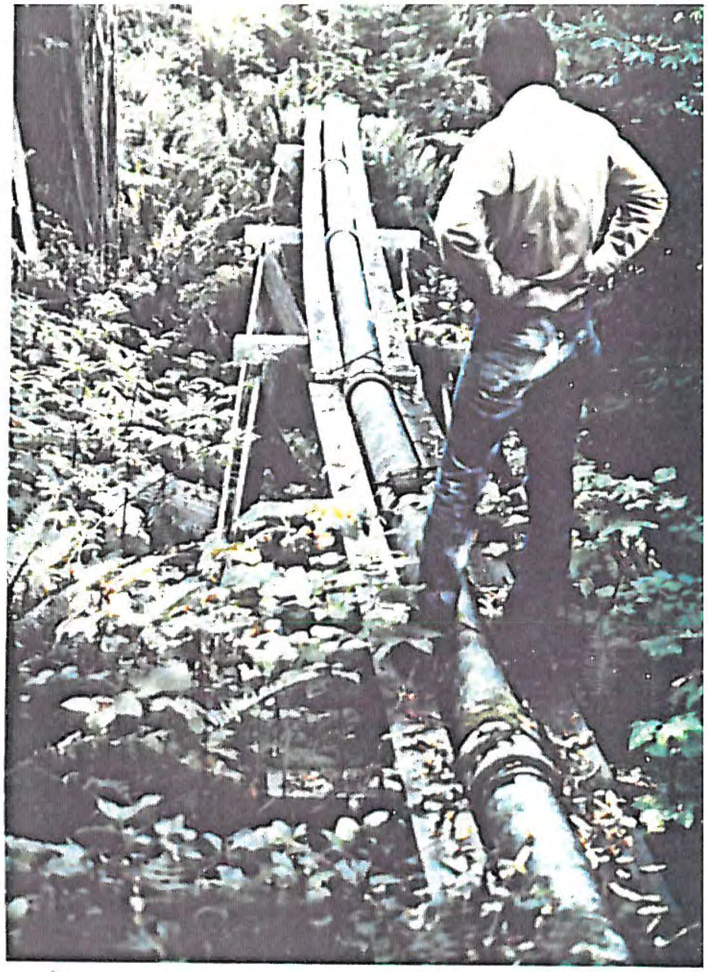
P-9 TRESTLE #8
LOOKING NORTH

P-10 TRESTLE #8
LOOKING SOUTH



P-11 TRESTLE #13
EXPOSED GASKET
ON 10" LINE

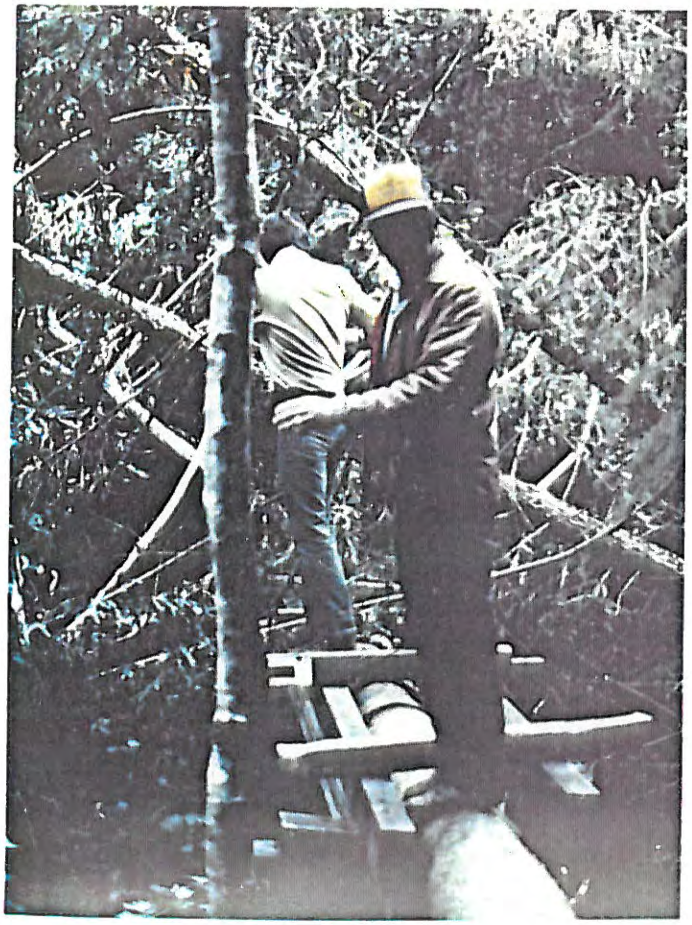
P-12 TRESTLE #13



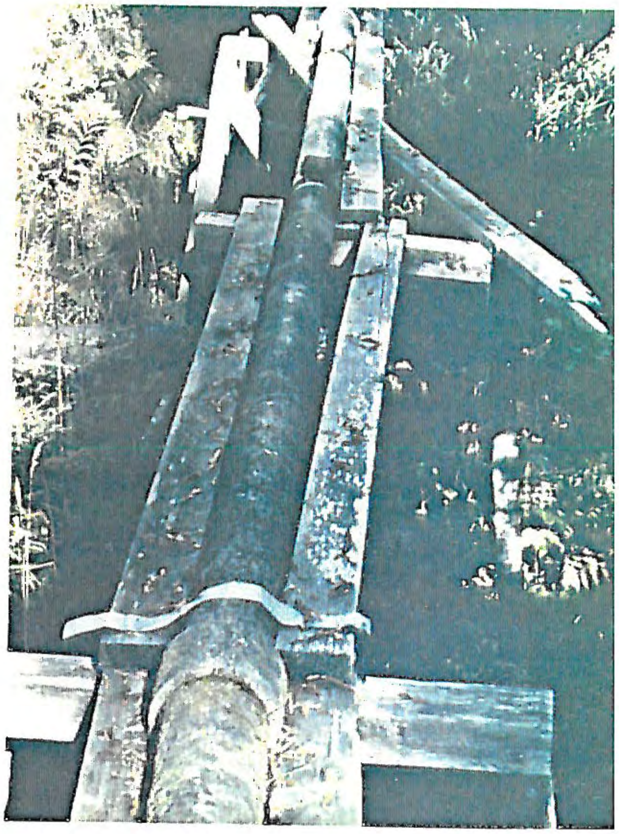
P-13 TRESTLE #9

P-15 TRESTLE #2

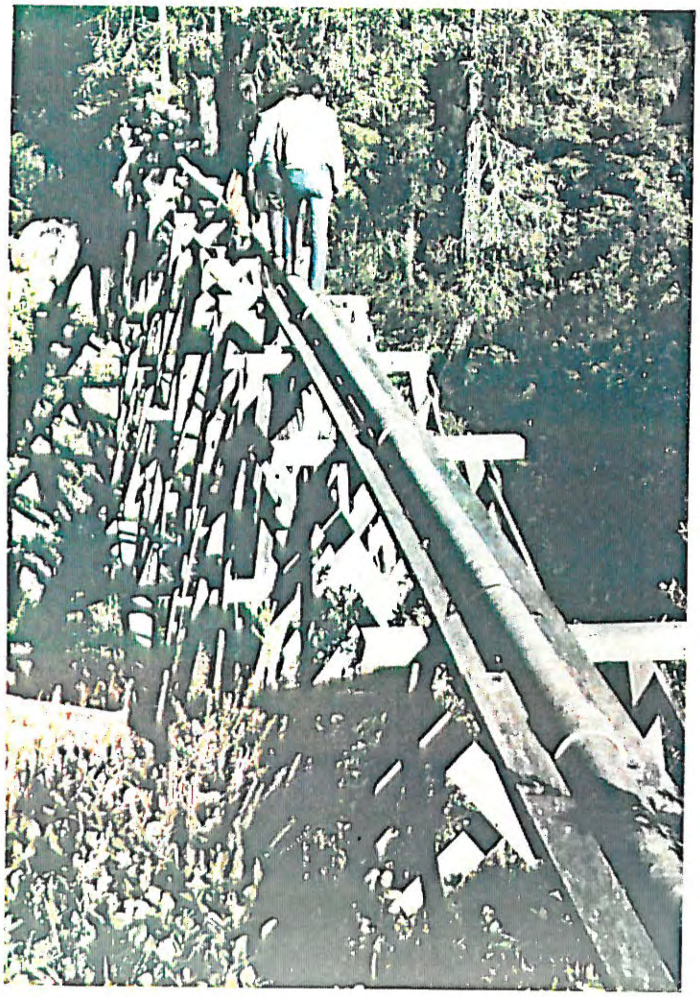
P-14 TRESTLE #2



P-16 TRESTLE #9



P-17 TRESTLE #12



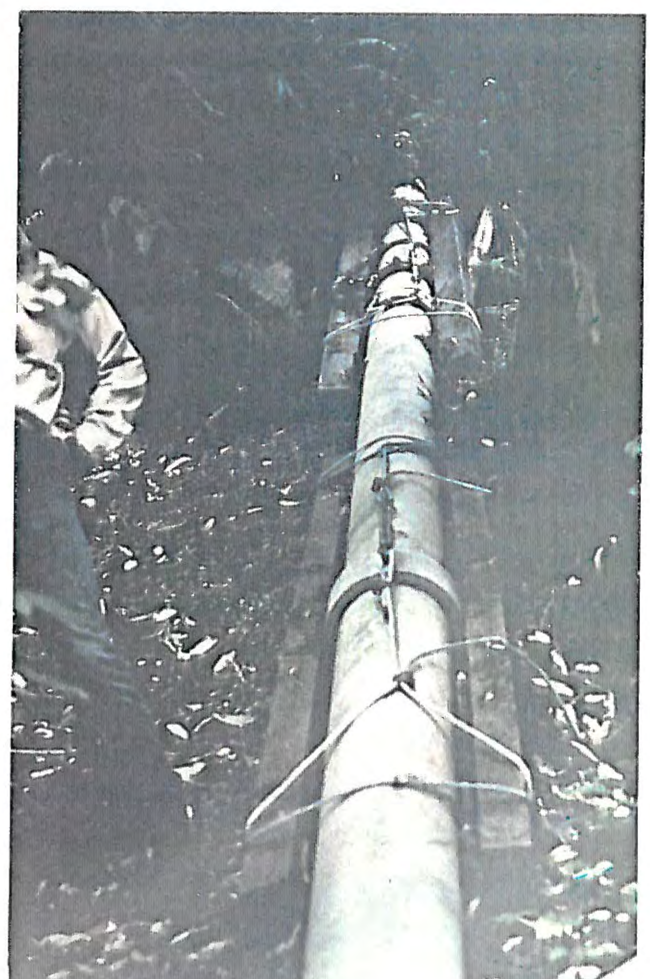
P-18 TRESTLE #11

P-19 TRESTLE #11

P-20 TRESTLE # 12

P-21 TRESTLE # 11

P-22 6" PIPELINE NEAR HARE CREEK



P-23 10" PIPELINE - ALIGNMENT UP NORTH BANK OF COVINGTON GULCH

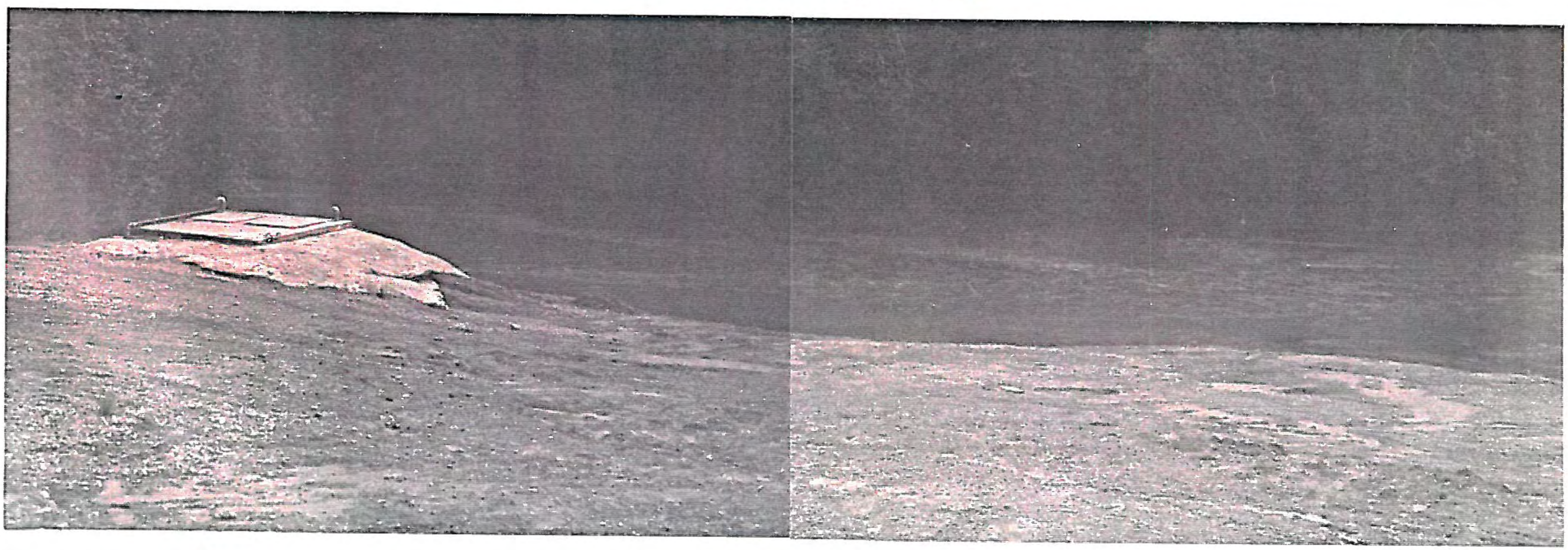
P-24 SIMPSON PIPELINE 6" DISCHARGE INTO NEWMAN RESERVOIR – JANUARY 1985

P-25 NEWMAN RESERVOIR – JUNE 1985

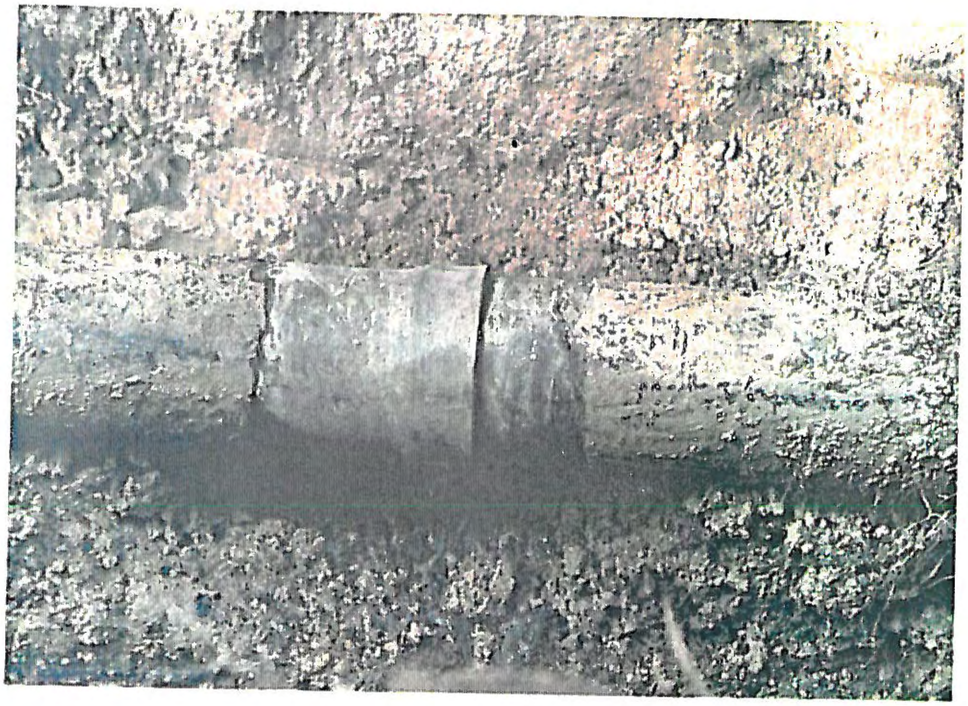
P-26 NOYO RIVER – LOOKING DOWNSTREAM
OLD PUMP STATION CENTER RIGHT
GEORGIA–PACIFIC PUMP STATION UPPER LEFT

P-27 NOYO RIVER – LOOKING UPSTREAM MADSEN
HOLE AT CENTER RIGHT AT BASE OF HILL
ON NORTH BANK

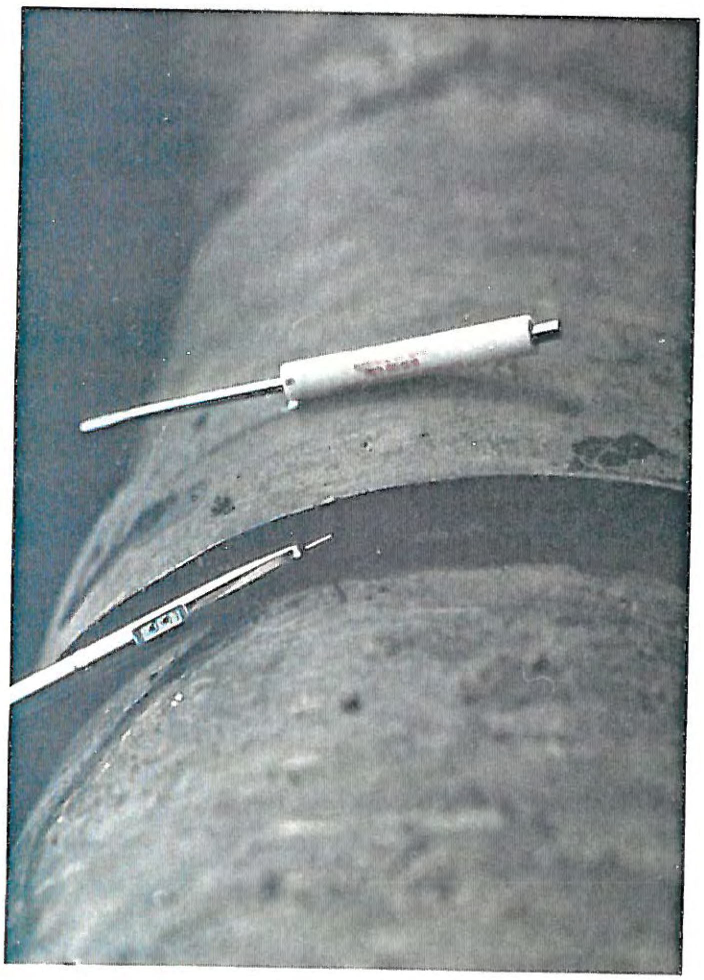
P-28 GEORGIA-PACIFIC DIVERSION



P-29 OLD PUMP STATION LEFT CENTER NOYO COLLECTORS IN RIVER CENTER



P-30



NOYO PIPELINE – 9 1/2" I.D. BELL AND SPIGOT, SPIRALLY WELDED STEEL PIPE ON LOWER 3700' OF PIPELINE.

P-31

APPENDIX H

ESTIMATED COSTS FOR ALTERNATE NOYO PIPELINE ALIGNMENTS

APPENDIX H
NOYO PIPELINE COST ESTIMATE

Alternate 1	Rework bends on the lower end of the pipeline near the pump station -	$ 5,000.
	Clean the 3700 feet of 9-1/2 inch steel line of clay sediment buildup -	8,000.
	Contingencies and Engineering -	5,000
		$18,000
Alternate 2	Bottom 500 feet of line to be 12-inch ductile iron pipe @ $57/foot	$28,500
	Use 12-inch Class 200 PVC Pipe for next 1,200 feet @ $35/foot	4,200
	Use 12-inch Class 150 PVC Pipe for next 2,000 feet @ $30/foot	60,000
		$131,000
	Emergency + Contingencies (30%)	39,000
	ENR = 5,000:	$170,000
	For 1990-2000, ENR = 8,700:	$296,000
Alternate 3:	Bottom 2,000 feet 12-inch Class 200 PVCP @ $35/feet	$70,000
	Use Class 150 or PVCP for next 1,000 feet @$30/feet	$30,000
	Add $15/feet for 1,500 steep slope work (or MJDIP above ground)	22,000
	R/W, land acquisition	16,000
		132,000
	Engineering and Contingency (30%)	40,000
	ENR = 5,000	
	For 1990-2000, ENR - 8,700	$301,000

Alternate 1 is the most economical approach for the pipeline until the costs of leak repair become sufficient to identify seriously deteriorated pipe conditions and justify the estimated cost of either Alternate 2 or 3.

With regard to Alternates 2 and 3, currently PVC is the least expensive pipe material available with a Class 200 rating and safe according to EPA.

Energy Consideration

Alternate 2 -	427 feet of lift
Alternate 3 -	340 feet of lift
Lift difference	90 feet of lift

Based on existing vertical turbine characteristics at the station, a savings of about 25 Hp per pump will be realized by Alternative 3.

Since 1 KWH = 0.746 Hp
25 Hp = 33.5 KWH consumed per hour of pump operation

From June 1985, PG&E billing was $5,234 for 58,680 KWH for 32 days or 1,834 KWH/day, average.

1834/(100 Hp divided by 90% x 0.746 Hp/Hour) = 22 hours/day

So for a 25 Hp savings

22 hours x 25 Hp divided by 0.90 x 0.746 = 370 KWH/day would be saved which converts to ($5,234/Month divided by 1,834 KWH/day for June, 1985) x 370 KWH/day = $1,100/month

Therefore for one 100 Hp pump running 22 hours/day, the 90 feet of lower required pumping head of Alternate 3 would result in an $1,100/month savings.

APPENDIX I

STRUCTURAL INSPECTION

APPENDIX I

STRUCTURAL INSPECTION

As part of a Water System Study and Master Plan, the condition of structures at the water plant were evaluated. The plant site was visited by Carl Gentry from the Walnut Creek office on June 12 and 13, 1985. The filters, clarifier, operations and pump building, and two water tanks were inspected.

CLARIFIER

1. The concrete appeared to be in generally good condition. There was no significant cracks that would indicate corrosion of the reinforcing bars.

2. There was only limited soil cover over the bottom of the clarifier foundation. This made the foundation subject to undermining due to erosion.

3. The exposed portions of the bridge truss for the clarifier mechanism was in generally good condition. The bridge should be painted to prevent further corrosion. The end diagonal on the bridge truss has been partially cut with a torch and should be repaired or replaced.

4. The center feed well is only nominally attached to its supports. Sloshing during an earthquake is likely to tear it away from the supports.

5. There was minor leakage in the concrete wall. There was no apparent corrosion of the wall reinforcing bars.

6. The submerged parts of the clarifier mechanism could not be inspected.

7. The ladder is corroding and needs to be painted.

FILTERS

1. Each outside wall corner of the filter has cracked over the full height of the wall. The main crack goes diagonally across the corner with a smaller crack going from the inside of the corner joint toward the diagonal crack. The cracking appears to be due to overload of the wall joint. After the corner joints failed, the load was transferred to the center portion of the East and West walls. The East and West walls have a very distinct bow due to the

overload condition. The walls bow out approximately 1-inch to 2-inches. Plans showing the original reinforcing bar layout are not available, so a check on the stress in the steel and concrete could not be made. Several of these cracks are leaking.

2. The concrete near the crack on the Northeast corner has deteriorated. The concrete is so weak that a sizeable hole was readily dug out using a claw hammer. The large aggregate was very soft. The "paste" between the large aggregate was so weak that it had the consistency similar to stiff clay. The concrete in this area was dark gray to almost black in color. Some other areas in the wall were also somewhat soft. The concrete deterioration may be due to chemicals used in the filter, reacting with the concrete.

3. There is some leakage through the walls at the pipes. There are small cracks running between the openings for the pipes.

4. The overhead piping located to the South of the filters have no lateral support. Also, none of the Dresser couplings have ties across the coupling. During a moderate to large earthquake, it is likely that the pipes would separate at the Dresser coupling and the whole overhead piping system might collapse. Also, the piping on grade does not have ties to the supports.

5. The stairs to the top of the filters are very steep and potentially dangerous.

6. The foundation for the filters has little or no embedment and could be easily undermined by erosion.

7. The inside face of the walls of the filters have been etched. This is probably due to a reaction between the low alkalinity of the water, and/or the chemicals used in the filters and the concrete.

OLD STEEL WATER STORAGE TANK

1. The tank sets on a gravel foundation. The tank is not tied to a foundation to increase its resistance to earthquakes.

2. The pipes connected to the tanks wall are rigidly connected. During an earthquake, the wall of the tank will most likely be lifted up which probably will break the pipes.

3. The tank appeared to be in generally good condition.

NEW WATER TANK

1. The tank appeared to be in generally good condition.

2. The tank had a concrete foundation and the tank walls were fastened to the foundations.

OPERATIONS AND PUMP BUILDING:

1. There was no significant spalling or cracking in the foundation or other concrete.

2. There was no evidence of dry rot in the wood.

3. The roof trusses showed no signs of distress or corrosion.

APPENDIX J

JAR TEST RESULTS

11-4685.4. PUDDING CREEK NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°27'25", long 123°43'20", in NE¼NW¼ sec.2, T.18 N., R.17 W., Mendocino County, on right bank at old town site of Glenblair, 0.7 mile downstream from Little Valley Creek, and 4.5 miles east of Fort Bragg.

DRAINAGE AREA.--12.5 sq mi.

PERIOD OF RECORD.--October 1963 to current year.

GAGE.--Water-stage recorder. Datum of gage is 88.92 ft above mean sea level.

AVERAGE DISCHARGE.--6 years, 19.8 cfs (14,350 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 902 cfs Jan. 12 (gage height, 6.18 ft); minimum daily, 0.02 cfs Sept. 3-10.
Period of record: Maximum discharge, 2,000 cfs Dec. 21, 1964 (gage height, 8.55 ft); no flow at times.

REMARKS.--Records good. No regulation or diversion above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.03	.41	8.7	19	97	136	4.2	4.2	1.1	.66	.16	.03
2	.03	.81	6.7	16	77	99	7.7	3.7	1.2	.64	.16	.03
3	.03	1.0	3.8	13	60	102	8.0	3.2	1.3	.61	.12	.02
4	.03	.81	2.3	11	52	72	5.9	3.0	1.1	.48	.12	.02
5	.03	.72	2.3	9.8	71	51	23	3.0	1.1	.15	.12	.02
6	.05	.56	2.7	8.7	203	36	22	3.2	1.1	.48	.12	.02
7	.09	.56	2.6	7.7	117	27	16	3.2	1.0	.41	.09	.02
8	.09	.64	5.1	6.7	88	22	13	3.2	1.0	.40	.09	.02
9	.12	.56	4.9	6.1	176	18	14	3.2	1.0	.40	.09	.02
10	.12	.56	154	6.4	114	16	12	3.2	1.2	.34	.09	.02
11	.35	1.3	104	176	287	13	9.4	3.0	1.3	.33	.09	.03
12	1.0	3.8	52	762	156	12	8.4	3.0	1.3	.32	.09	.03
13	.64	1.8	30	454	83	11	7.3	3.0	1.2	.30	.09	.03
14	.50	1.7	33	147	58	9.1	6.7	2.4	1.2	.30	.09	.03
15	.40	2.9	277	73	52	8.4	5.9	1.8	1.4	.25	.09	.03
16	.35	2.3	106	48	38	8.7	5.4	1.8	1.5	.25	.09	.03
17	.30	1.6	45	33	34	16	4.9	1.7	1.2	.25	.09	.03
18	.25	1.7	27	35	31	12	5.1	1.6	1.7	.25	.09	.09
19	.25	1.8	20	102	25	9.4	4.4	1.6	2.3	.20	.09	.12
20	.20	1.4	14	338	20	10	4.2	1.4	2.0	.20	.07	.16
21	.25	1.2	11	338	18	11	3.8	1.4	1.8	.20	.07	.16
22	.25	1.0	11	187	17	8.7	3.8	1.4	1.5	.20	.07	.16
23	.25	.81	267	110	49	7.3	21	1.6	1.3	.16	.07	.16
24	.25	4.2	310	75	78	6.4	18	1.7	1.2	.16	.03	.30
25	.25	8.7	341	109	96	5.9	12	1.7	1.1	.16	.03	.35
26	.25	4.9	218	141	88	5.4	9.4	1.6	1.0	.20	.03	.40
27	.25	3.0	104	122	72	4.9	7.7	1.6	.92	.20	.03	.45
28	.25	2.1	65	123	178	4.6	6.2	1.4	.83	.20	.03	.50
29	.45	2.4	43	109	------	4.4	5.4	1.2	.74	.16	.03	.50
30	.56	7.0	31	117	------	4.2	4.8	1.1	.69	.16	.03	.50
31	.45	------	24	89	------	4.4	------	1.1	------	.15	.03	------
TOTAL	8.32	62.24	2,326.1	3,792.4	2,435	755.6	279.6	70.2	37.28	9.18	2.49	4.28
MEAN	.27	2.07	75.0	122	87.0	24.4	9.32	2.26	1.24	.30	.080	.14
MAX	1.0	8.7	341	762	287	136	23	4.2	2.3	.66	.16	.50
MIN	.03	.41	2.3	6.1	17	4.2	3.8	1.1	.69	.15	.03	.02
AC-FT	17	123	4,610	7,520	4,830	1,500	555	139	74	18	4.9	8.5

CAL YR 1968 TOTAL 6,090.31 MEAN 16.6 MAX 341 MIN .03 AC-FT 12,080
WTR YR 1969 TOTAL 9,782.89 MEAN 26.8 MAX 762 MIN .02 AC-FT 19,400

PEAK DISCHARGE (BASE, 500 CFS).--Dec. 15 (1015) 591 cfs (5.33 ft); Jan. 12 (1230) 902 cfs (6.18 ft).

11-4685.4. PUDDING CREEK NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°27'25", long 123°43'20", in NE¼NW¼ sec.2, T.18 N., R.17 W., on right bank at old town site of Glenblair, 0.7 mile downstream from Little Valley Creek, and 4.5 miles east of Fort Bragg.

DRAINAGE AREA.--12.5 sq mi.

RECORDS AVAILABLE.--October 1963 to September 1968.

GAGE.--Digital water-stage recorder. Datum of gage is 88.92 ft above mean sea level, datum of 1929, supplementary adjustment of 1960. Prior to Oct. 1, 1964, graphic water-stage recorder at same site and datum.

AVERAGE DISCHARGE.--5 years, 18.4 cfs (13,320 acre-ft per year).

EXTREMES.--Maximum discharge during year, 397 cfs Jan. 14 (gage height, 4.74 ft); minimum daily, 0.03 cfs for several days.
1963-68: Maximum discharge, 2,000 cfs Dec. 21, 1964 (gage height, 8.55 ft); no flow at times.

REMARKS.--Records good. No regulation or diversion above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.12	.46	13	2.9	48	15	9.4	1.6	.84	.20	.05	.09
2	2.0	.58	18	2.7	56	14	8.4	1.4	.72	.16	.05	.09
3	1.7	.55	135	2.4	46	12	7.0	1.2	.81	.20	.03	.09
4	1.1	.50	72	2.3	38	9.8	6.1	1.7	.90	.20	.03	.09
5	3.2	.56	128	2.3	30	9.8	5.6	1.4	.90	.20	.03	.07
6	1.3	.52	46	2.3	23	9.1	4.9	1.3	1.0	.16	.05	.04
7	.72	.64	81	2.3	16	9.1	4.4	1.3	.81	.16	.05	.12
8	.50	.73	42	3.2	15	9.8	4.6	1.2	.64	.16	.05	.16
9	.40	.95	21	27	14	7.7	4.0	1.2	.56	.12	.05	.16
10	.35	.84	14	232	12	6.4	3.8	1.3	.56	.16	.05	.16
11	.35	.80	11	71	10	5.6	3.6	1.3	.56	.16	.03	.12
12	.30	.87	8.0	34	9.1	19	3.4	1.3	.56	.12	.03	.09
13	.30	.96	6.1	33	8.0	72	3.2	1.7	.50	.12	.03	.12
14	.30	10	5.1	169	7.3	40	2.9	1.6	.45	.12	.03	.20
15	.30	4.1	4.4	257	6.4	30	2.7	1.3	.45	.12	.03	.25
16	.30	2.4	4.0	110	6.7	78	2.7	1.1	.45	.09	.05	.16
17	.25	1.6	4.0	56	8.0	113	2.6	1.1	.40	.09	.05	.12
18	.25	1.2	13	36	6.7	69	2.4	1.0	.35	.09	.07	.09
19	.25	1.0	12	24	103	44	2.4	1.2	.35	.09	.09	.07
20	.26	.81	9.8	18	212	29	2.3	2.0	.30	.09	.12	.07
21	.30	.72	8.4	15	154	21	2.1	1.7	.30	.09	.25	.09
22	1.0	.64	7.0	12	122	17	2.1	1.6	.30	.07	.25	.09
23	.79	.56	6.1	10	88	18	2.0	1.2	.30	.07	.20	.05
24	.67	.50	5.4	8.7	63	14	2.1	1.2	.30	.07	.16	.03
25	.58	.50	4.9	8.0	45	22	2.0	2.4	.25	.07	.16	.03
26	.53	.50	4.4	7.7	32	17	1.8	2.1	.25	.05	.40	.03
27	.47	.56	4.0	12	24	14	1.8	1.6	.30	.05	.35	.03
28	.71	1.0	3.8	20	20	12	1.7	1.2	.25	.05	.25	.03
29	.62	12	3.4	120	17	11	1.6	1.1	.20	.03	.20	.03
30	.55	14	3.0	139	------	9.4	1.6	.90	.20	.05	.16	.03
31	.50	------	2.9	73	------	8.4	------	.81	------	.05	.12	------
TOTAL	20.97	61.02	700.7	1,512.8	1,242.2	766.1	105.2	43.01	14.56	3.46	3.47	2.85
MEAN	.68	2.03	22.6	48.8	42.8	24.7	3.51	1.39	.49	.11	.11	.095
MAX	3.2	14	135	257	212	113	9.4	2.4	1.0	.20	.40	.25
MIN	.12	.46	2.9	2.3	6.4	5.6	1.6	.81	.20	.03	.03	.03
AC-FT	42	121	1,390	3,000	2,460	1,520	209	85	29	6.9	6.9	5.7

CAL YR 1967 TOTAL 7,098.72 MEAN 19.4 MAX 429 MIN .06 AC-FT 14,080
WTR YR 1968 TOTAL 4,476.34 MEAN 12.2 MAX 257 MIN .03 AC-FT 8,880

Peak discharge (base, 500 cfs).--No peak above base.

11-4685.4. PUDDING CREEK NEAR FORT BRAGG, CALIF.

LOCATION.--Lat 39°27'25", long 123°43'20", in NE¼NW¼ sec.2, T.18 N., R.17 W., on right bank at old town site of Glenblair, 0.7 mile downstream from Little Valley Creek, and 4.5 miles east of Fort Bragg.

DRAINAGE AREA.--12.5 sq mi.

RECORDS AVAILABLE.--October 1963 to September 1967.

GAGE.--Digital water-stage recorder. Datum of gage is 88.92 ft above mean sea level, datum of 1929, supplementary adjustment of 1960. Prior to Oct. 1, 1964, graphic water-stage recorder at same site and datum.

EXTREMES.--Maximum discharge during year, 720 cfs Dec. 2 (gage height, 5.70 ft); no flow for several days.
1963-67: Maximum discharge, 2,000 cfs Dec. 21, 1964 (gage height, 8.55 ft); no flow at times in each year.

REMARKS.--Records good. No regulation or diversion above station.

DISCHARGE, IN CFS, WATER YEAR OCTOBER 1966 TO SEPTEMBER 1967

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	0	0	32	3.8	100	2.9	154	17	4.2	.90	.33	.16
2	0	0	333	3.7	64	2.7	75	16	5.0	.87	.31	.15
3	.01	0	171	3.5	42	2.6	49	15	3.6	.83	.30	.12
4	.01	0	158	3.7	30	2.5	31	13	3.1	.82	.30	.12
5	.01	0	235	4.9	24	2.3	28	12	3.1	.80	.29	.12
6	.01	0	100	3.9	19	2.2	121	11	2.9	.79	.28	.12
7	.01	.03	75	3.7	16	2.1	113	9.6	2.5	.78	.29	.10
8	.02	0	51	3.5	14	2.0	71	9.0	2.2	.76	.30	.08
9	.02	0	33	3.3	12	1.9	42	12	2.2	.75	.28	.09
10	.02	0	30	3.1	11	72	51	17	2.1	.74	.28	.09
11	.02	.01	23	2.9	9.6	160	65	13	2.1	.72	.29	.09
12	.02	3.9	22	2.9	8.6	118	42	10	2.0	.70	.30	.09
13	.02	3.3	26	2.9	8.0	82	33	8.7	1.8	.69	.28	.09
14	.02	16	25	2.7	8.6	67	35	7.3	1.7	.66	.27	.09
15	.02	20	22	2.7	12	60	29	6.5	1.7	.65	.23	.09
16	.01	36	18	2.7	11	110	23	5.8	1.7	.63	.20	.10
17	.01	11	15	2.5	8.9	87	120	5.3	1.6	.59	.20	.12
18	.02	3.9	13	2.5	7.6	65	149	5.1	1.5	.58	.20	.14
19	.01	8.2	11	2.9	6.7	41	88	5.0	1.5	.51	.20	.23
20	.02	46	9.8	167	5.6	97	68	4.8	1.6	.47	.20	.21
21	.02	109	8.5	429	5.1	69	51	4.5	1.6	.47	.20	.16
22	.02	103	7.6	170	4.6	55	51	4.0	1.5	.51	.20	.12
23	.03	30	8.2	82	3.8	54	46	3.9	1.4	.51	.20	[illegible]
24	.03	15	7.3	68	4.0	33	41	3.7	1.4	.50	.19	.09
25	.04	9.6	6.4	83	4.7	27	32	3.5	1.3	.47	.16	.06
26	.04	6.7	5.7	142	3.8	22	28	3.4	1.2	.46	.19	.09
27	.04	5.3	5.0	188	3.5	18	39	3.4	1.1	.45	.18	[illegible]
28	.06	7.3	4.6	224	3.1	20	28	3.9	1.0	.42	.20	.09
29	.06	13	4.4	279	------	17	24	3.5	.95	.41	.20	.09
30	.02	8.6	4.4	171	------	79	20	3.1	.93	.39	.23	.09
31	0	------	4.0	141	------	204	------	2.9	------	.37	.17	------
TOTAL	0.64	455.84	1,468.9	2,205.8	451.2	1,578.2	1,747	242.9	60.88	19.20	7.42	3.43
MEAN	.021	15.2	47.4	71.2	16.1	50.9	58.2	7.84	2.03	.62	.24	.11
MAX	.06	109	333	429	100	204	154	17	5.0	.90	.33	.23
MIN	0	0	4.0	2.5	3.1	1.9	20	2.9	.93	.37	.16	.06
AC-FT	1.3	904	2,910	4,380	895	3,130	3,470	482	121	38	15	6.8

CAL YR 1966: TOTAL 7,306.88 MEAN 20.0 MAX 1,330 MIN 0 AC-FT 14,490
WAT YR 1967: TOTAL 8,241.41 MEAN 22.6 MAX 429 MIN 0 AC-FT 16,350

Peak discharge (base, 500 cfs).--Dec. 2 (1430) 720 cfs (5.70 ft); Jan. 21 (1015) 556 cfs (5.23 ft).

Note.--No gage-height record Feb. 21 to Mar. 20.

11-4685.4. Pudding Creek near Fort Bragg, Calif.

Location.--Lat 39°27'25", long 123°[illegible], in NE¼NW¼ sec.2, T.18 N., R.17 W., on [illegible] [illegible] downstream from Little Valley Creek, and 4.5 miles east northeast of Fort Bragg.

Drainage area.--12.5 sq mi.

Records available.--October 1963 to September 1966.

Gage.--Digital water-stage recorder. Datum of gage is 85.92 ft above mean sea level, datum of 1929, supplementary [illegible]. Prior to Oct. 1, 1964, graphic water-stage recorder at same site and datum.

Extremes.--Maximum discharge during year, 1,960 cfs Jan. 4 (gage height, 8.49 ft); no flow July 31 to Sept. 30.
1963-66: Maximum discharge, 2,000 cfs Dec. 21, 1964 (gage height, 8.55 ft); no flow at times in each year.

Remarks.--Records good. No regulation or diversion above station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1965 TO SEPTEMBER 1966

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	0.10	0.20	5.6	53	45	25	6.9	3.1	1.1	[illegible]		
2	.10	.20	4.6	47	34	27	6.3	2.6	1.0	.30		
3	.10	.20	4.3	186	30	20	5.7	2.8	1.0	.30		
4	.10	.40	4.0	1,330	71	17	5.3	2.7	1.0	.20		
5	.10	.50	3.5	636	63	18	5.3	2.6	.90	.20		
6	.20	.50	3.0	224	65	18	5.1	2.6	1.0	.20		
7	.20	2.0	2.5	107	42	22	5.0	2.3	1.0	.20		
8	.20	3.3	2.0	84	24	23	4.8	2.4	.90	.20		
9	.20	1.3	2.0	53	22	70	4.6	2.5	.80	.20		
10	.20	1.0	1.8	37	22	133	13	2.5	.80	.20		
11	.30	1.3	1.7	27	17	79	42	2.3	.80	.20		
12	.20	2.3	1.9	21	14	49	46	2.1	.70	.20		
13	.30	6.7	1.7	17	12	53	35	2.0	.60	.30		
14	.40	8.9	1.6	14	10	35	24	1.9	.50	.20		
15	.40	4.6	1.5	12	9.2	47	18	1.8	.50	.20		
16	.30	2.9	1.4	11	8.1	47	15	1.7	.50	.20		
17	.30	3.7	1.3	9.4	7.5	35	12	1.6	.50	.20		
18	.30	20	1.3	8.4	7.3	30	10	1.6	.40	.20		
19	.40	18	1.2	7.7	29	47	8.6	1.5	.40	.20		
20	.40	8.6	1.2	7.3	18	31	7.2	1.4	.40	.10		
21	.40	5.1	1.2	7.3	15	28	6.4	1.4	.40	.10		
22	.30	3.5	1.2	10	19	24	5.7	1.4	.40	.10		
23	.30	3.4	1.1	10	27	20	5.1	1.3	.40	.10		
24	.20	44	16	10	60	17	4.6	1.3	.40	.10		
25	.20	87	20	10	74	14	4.3	1.2	.40	.10		
26	.10	50	14	10	77	12	4.0	1.3	.50	.10		
27	.10	26	11	10	49	11	3.8	1.3	.50	.10		
28	.10	16	127	10	33	10	3.6	1.2	.50	.10		
29	.10	11	138	36	------	9.1	3.4	1.2	.40	.10		
30	.20	7.7	94	34	------	8.3	3.1	1.4	.30	.10		
31	.20	------	82	25	------	7.5	------	1.3	------	0		
TOTAL	7.00	340.30	553.6	3,064.1	904.1	986.9	343.6	58.5	19.00	5.30	0	
MEAN	.23	11.3	17.9	98.5	32.3	31.8	11.5	1.89	.63	.17	0	
AC-FT	14	675	1,100	6,080	1,790	1,960	682	116	38	11	0	

CALENDAR YEAR	1965	MAX	260	MIN	0	MEAN	12.5	AC-FT	9,000
WATER YEAR	1965-66	MAX	1,330	MIN	0	MEAN	17.2	AC-FT	12,470

Peak discharge (base, 500 cfs).--Jan. 4 (1930) 1,960 cfs (8.49 ft).

11-4685.4 Pudding Creek near Fort Bragg, Calif.

Location.--Lat 39°27'25", long 123°43'20", in NE¼NW¼, sec.2, T.18 N., R.17 W., on right bank at old town site of Glenblair, 0.7 mile downstream from Little Valley Creek, and 4.5 miles east north-east of Fort Bragg.

Drainage area.--12.5 sq mi.

Records available.--October 1963 to September 1964.

Gage.--Water-stage recorder. Altitude of gage is 105 feet (from topographic map).

Extremes.--Maximum discharge during year, 830 cfs Jan. 20 (gage height, 5.90 ft), from rating curve extended above 200 cfs on basis of slope-area measurement of maximum flow; no flow Aug. 27.

Remarks.--Records good. No regulation or diversion above station.

Rating table (gage height, in feet, and discharge, in cubic feet per second)

1.5	0	2.2	11
1.6	.1	2.6	30
1.7	.5	2.9	53
1.8	1.3	3.4	113
1.9	2.7	4.2	267
2.0	4.8	5.1	530

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1963 TO SEPTEMBER 1964

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	0.1	0.9	11	8.2	21	7.3	*21	2.7	1.0	0.4	0.2	0.2
2	.1	2.0	10	17	18	9.6	14	2.5	1.0	.4	.2	.2
3	.1	2.2	6.9	12	15	6.1	11	6.4	1.0	.4	.2	.2
4	.1	26	7.9	10	14	5.3	9.6	4.8	1.0	.4	.2	.2
5	.2	12	7.5	9.3	13	5.1	8.7	3.5	1.1	.4	.2	.2
6	.2	*29	6.7	19	12	5.6	7.0	2.9	1.4	.3	.2	.2
7	.3	19	6.1	40	10	5.1	6.1	*2.3	1.6	.3	.2	.2
8	.3	66	8.6	27	9.6	4.4	5.6	2.2	1.4	.3	.2	.2
9	.4	71	21	23	8.9	4.1	5.1	2.0	1.3	.3	.1	.2
10	1.6	29	13	20	8.6	3.9	4.8	1.9	1.2	.3	.1	.2
11	3.3	16	10	16	7.9	33	4.4	1.7	1.1	.3	.1	.2
12	1.4	15	8.9	13	7.0	61	3.9	1.6	.9	.2	.1	.2
13	.8	8.2	7.9	16	6.4	41	3.7	1.6	.8	.2	.1	.3
14	.7	133	7.5	18	6.4	26	3.5	1.5	.7	.2	.2	.3
15	7.7	130	7.0	14	11	19	3.3	1.5	.7	.2	.2	.3
16	4.6	66	6.4	15	7.9	14	3.1	1.6	.7	.2	.2	.3
17	1.7	32	5.8	35	6.7	12	2.9	2.0	*.7	.2	.2	.3
18	1.3	21	5.8	104	6.1	9.6	2.9	1.7	.7	.2	.2	.3
19	1.0	61	7.5	326	5.9	8.2	2.7	1.6	.6	.2	.2	.3
20	.7	66	*17	*502	5.3	7.0	2.7	1.5	.6	.2	[illegible]	.2
21	.7	35	12	293	4.8	9.3	2.5	1.4	.5	.2	[illegible]	[illegible]
22	1.0	25	10	*206	4.4	14	2.5	1.3	.5	[illegible]	[illegible]	[illegible]
23	4.3	14[illegible]	9.3	147	4.4	14	2.5	1.[illegible]	.5	*.2	[illegible]	[illegible]
24	*2.5	150	8.6	98	4.1	11	2.3	1.2	.4	.2	[illegible]	.2
25	[illegible]	76	7.3	67	3.9	8.6	2.3	1.1	.4	.1	[illegible]	.2
26	1.5	4[illegible]	8.7	47	*3.7	7.6	2.2	1.3	.4	.1	.1	.2
27	1.2	28	13	35	3.5	7.[illegible]	2.2	1.3	.4	.1	0	.2
28	1.[illegible]	21	17	*27	3.7	6.7	2.0	1.1	.4	.1	[illegible]	.2
29	.9	16	[illegible]	30	3.9	6.1	2.0	1.0	.4	.1	.1	.2
30	[illegible]	15	7.5	26	------	5.9	2.0	1.0	.4	.1	[illegible]	.2
31	.7	------	9.2	22	------	7.3	------	1.0	------	.1	[illegible]	------
TOTAL	43.7	1,363.3	294.4	2,2[illegible]4.5	238.0	384.7	146.0	60.5	23.8	7.1	5.0	6.7
MEAN	1.41	45.6	9.50	72.1	8.21	12.4	4.9[illegible]	1.95	0.79	0.23	0.1[illegible]	0.22
MAX	7.7	150	21	502	21	61	21	6.4	1.6	0.4	0.2	0.3
MIN	0.1	0.9	5.8	8.2	3.5	3.9	2.0	1.0	0.4	0.1	0	0.2
AC-FT	87	2,720	584	4,43[illegible]	[illegible]72	763	294	120	47	14	9.9	13

CALENDAR YEAR 1963 MAX - MIN - MEAN - AC-FT -
WATER YEAR 1963-64 MAX 5[illegible]2 MIN [illegible] MEAN 13.2 AC-FT 9,55[illegible]

Peak discharge (base, 500 cfs).--Jan. 20 (1600) 8[illegible] cfs (5.90 ft).

* Discharge measurement made on this day.

11-4685.4. Pudding Creek near Fort Bragg, Calif.

Location.--Lat 39°27'25", long 123°43'20", in NE¼NW¼ sec.2, T.18 N., R.17 W., on right bank at old town site of Glenblair, 0.[illegible] mile downstream from Little Valley Creek, and 4.5 miles east north-east of Fort Bragg.

Drainage area.--12.5 sq mi.

Records available.--October 1963 4 to September 1965.

Gage.--Water-stage recorder (digital). Altitude of gage is 105 ft (from topographic map).

Extremes.--Maximum discharge during year, 2,000 cfs Dec. 21 (gage height, 8.55 ft); no flow Sept. 20, 21, 23.
1963-65: Maximum discharge, that of Dec. 21, 1964; no flow at times in each year.

Remarks.--Records good except those for periods of no gage-height record, which are fair.

Rating table (gage height, in feet, and discharge, in cubic feet per second)

1.5	0	2.6	30
1.6	.1	2.9	52
1.7	.5	3.4	[illegible]
1.8	1.3	4.0	222
1.9	2.7	5.0	[illegible]
2.0	4.8	7.0	1,240
2.2	11		

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1964 TO SEPTEMBER 1965

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
1	0.2	[illegible]	113	90	15	7.7	10	6.5	1.5	0.5	[illegible]	[illegible]
2	.2	2.7	96	74	13	7.9	8.5	5.7	1.5	.7	[illegible]	.1
3	.2	1.7	67	195	12	7.0	7.0	5.3	1.7	.6	[illegible]	.1
4	.2	1.1	37	144	12	6.1	6.0	5.0	1.6	.6	[illegible]	.1
5	.2	.7	23	174	39	[illegible]	5.4	4.6	1.6	.5	[illegible]	.1
6	.1	.5	15	260	25	5.6	[illegible]	4.1	1.7	.5	[illegible]	.1
7	.1	.5	17	179	20	5.6	4.7	3.9	1.8	.5	.1	[illegible]
8	.1	1.0	19	102	16	5.0	5.7	3.7	[illegible]	.4	.1	.1
9	.1	5.6	11	66	14	4.8	22	3.6	1.6	.4	.1	.1
10	.1	42	38	52	12	5.0	42	3.4	1.5	.4	.1	.1
11	.1	16	106	52	11	4.8	30	3.1	1.4	.5	[illegible]	.1
12	.2	14	53	39	10	4.8	20	3.2	1.2	.5	.1	.1
13	.2	16	27	31	9.6	4.4	15	3.1	1.1	.4	.1	.1
14	.2	10	22	26	10	4.1	12	3.1	1.2	.4	.1	.1
15	.2	6.4	17	22	8.6	3.9	99	2.8	1.3	.4	.1	.1
16	.2	4.6	13	19	7.9	3.7	118	2.6	1.2	.3	.1	[illegible]
17	.2	3.5	11	16	7.3	3.7	64	2.6	1.1	.3	.1	[illegible]
18	.2	2.6	10	14	6.7	3.5	80	2.4	1.1	.3	.1	.1
19	.2	2.1	45	15	6.7	3.5	79	2.7	1.0	.3	.1	.1
20	.2	1.8	225	15	6.4	[illegible]	70	3.1	.8	.3	.1	[illegible]
21	.3	1.8	889	13	6.1	3.2	57	2.7	.8	.3	[illegible]	[illegible]
22	.3	2.3	985	11	6.1	3.1	42	2.4	1.0	.3	.1	.1
23	.4	2.0	512	57	5.9	3.1	31	2.3	1.1	.3	.1	[illegible]
24	.3	2.5	405	124	5.6	3.1	22	2.1	1.0	.3	.1	.1
25	.3	16	300	78	5.0	2.9	18	2.0	.9	.3	[illegible]	[illegible]
26	.3	16	376	47	5.6	7.0	15	1.9	.8	.3	.1	[illegible]
27	.3	16	223	31	26	43	[illegible]	1.8	.7	.2	.1	[illegible]
28	1.3	301	164	26	11	17	10	1.7	.7	.2	.1	[illegible]
29	1.3	146	202	22	------	12	8.0	1.6	.7	.2	[illegible]	[illegible]
30	1.4	61	180	17	------	12	7.6	1.6	.7	.2	[illegible]	[illegible]
31	.7	------	142	16	------	11	------	1.5	------	[illegible]	.1	------
TOTAL	12.2	625.7	5,304	2,049	332.4	218.9	926.5	96.1	36.1	[illegible]	3.6	[illegible]
MEAN	0.39	23.3	171	66.1	11.9	7.06	30.9	3.10	1.20	[illegible]	0.12	[illegible]
AC-FT	24	1,390	10,520	4,060	659	434	1,840	191	72	[illegible]	[illegible]	[illegible]

Calendar year 1964 Max 985 Min 0 Mean 24.9 Ac-ft 18,100
Water year 1964-65 Max 985 Min 0 Mean 26.6 Ac-ft 19,230

Peak discharge (base, 500 cfs).--Nov. 28 (1600) 514 cfs (5.11 ft); Dec. 21 (2130) [illegible] cfs (8.55 ft).

Note.--No gage-height record Oct. 3-7, July 21 to Aug. 19.

APPENDIX J

JAR TEST RESULTS

Jar testing was included as part of the existing plant evaluation. The main points that were evaluated were velocity gradient, effect of different chemical dosages, effect of polymers, and the effect of adding bentonite.

The water used for testing was a mixture from two sources. Approximately 90 percent was from the Noyo River and 10 percent from Newman. Turbidity of the raw water varied between 1.2 NTU and 2.5 NTU. Temperature of the water varied between 60 and 65 degrees F.

VELOCITY GRADIENT

Velocity gradient is a measure of the energy input into the water. This level of energy input can affect settling and filtering characteristics. Jar tests were run at a velocity gradient of 10, 20, 40 and ;60 sec^{-1}. All tests used a flocculation time of thirty minutes. Settling characteristics of the floc were evaluated based on settled water turbidity samples from each jar taken after 2, 4, and 6 minutes of settling. These settling times correspond to sedimentation tank overflow rates of 1,750 gpd/sf, 875 gpd/sf and 580 gpd/sf, respectively. The results of these tests are shown in Figures 1, 2, and 3. Review of these graphs shows that the velocity gradient has little effect on the settling characteristics over the range tested. The poor settling characteristics are due to the small chemical floc that formed and is typically light and very difficult to settle.

The graph for the four minute and six minute settling time indicates that a velocity gradient of 20 sec^{-1} produces slightly better settling characteristics than the other levels of velocity gradient for some of the chemical dosages. Flocculation at a velocity gradient of 40 and ;60 sec^{-1} resulted in the settled water turbidities to be about the same regardless of chemical dosage.

CHEMICALS AND CHEMICAL DOSAGES

A chemical dosage of 5 to 15 mg/1 of alum was used ;with and without a flocculant aid. The results of these tests are shown in Figure 4. Comparison of the settling characteristics of the dosages of 5, 10, and 15 mg/1 of alum shows that 10 mg/1 had the lowest settled water turbidity. Comparison of settling characteristics of 10 mg/1 of alum to 10 mg/1 of alum with 4 mg/1 cationic polymer (nalco 8109) shows that the cationic polymer improved the settling characteristics.

The raw water turbidity ranged from 1.2 to 2.2 NTU. Treatment of such low turbidity water produces a floc with normally poor settling characteristics. Other treatment studies of low turbidity water have shown that the addition of bentonite clay improves settling characteristics.

The effect of additional turbidity (clay was added) was evaluated by comparing settled water turbidity with and without bentonite clay. The results are presented below:

Alum mg/1	4	6	10	5	10	15
Bentonite clay mg/1	6	6	6	0	0	0
Settled water Turbidities, NTU						
2 minutes	3.6	3.2	3.1	1.4	1.1	1.6
4 minutes	3.6	3.0	2.7	1.4	0.9	1.1
6 minutes	2.7	1.6	1.7	1.4	0.7	0.7

Results above show that the bentonite clay greatly increases the turbidity, however, settling characteristics are not enhanced sufficiently to justify the expense of a clay system. The addition of clay would also mean that sedimentation basins would be required and larger sand drying beds.

Jar testing also compared a cationic polymer (nalco 8109) with bentonite to alum with bentonite. The polymer and bentonite combination produced a floc that would not settle. The alum and bentonite dosage resulted in a lower settled water turbidity.

Jar testing using only polymers was not conducted because it has been demonstrated on a full scale at the water treatment plant that it works successfully. The practice of using polymers without a prime coagulant (alum) is increasing in popularity and is relatively common today. Polymers are easier to handle and feed than alum. They are often times more effective in turbidity removal while at the same time causing less total headloss in the filters. This can be significant from a process viewpoint in that fragile alum floc is more easily sheared off (causing turbidity breakthrough) at higher headlosses. In this respect, Giardia removal may be enhanced. JCE has recently designed a 15 MGD direct filtration water treatment plant in Utah which relies on polymers only during parts of the year when alum and/or ferric chloride is simply not effective.

JAR TESTING CONCLUSIONS

1. A velocity gradient of 20 sec^{-1} produced a floc with the best settling characteristics.

2. A cationic polymer with alum produced a floc with better settling characteristics.

3. Bentonite with alum resulted in a higher settled water turbidity than alum by itself but the use of clay is not justifiable.

APPENDIX K

INSTALLATION LIST OF MULTI-CELLULAR FILTERS EVALUATED BY JCE

The following cities were contacted and the wastewater treatment plant performance discussed and evaluated by JCE (specifically by Skip Griffin).

Name	Year Constructed	Company, MGD	Person Contacted
Anaheim, CA	1965	10	Dr. Moore
Pomona, CA	1959	4	Mol Gardner
Riverside, CA	1967	6.4	Norm Thomas
Ontario, CA	1958	7.2	Phil Crocker
Azusa, CA	1963	5	Ed Heck
Covina, CA	1967	15	Mr. Temple
Pasadena, CA	1971	5	Hank Stinebiser
Las Vegas, N.M.	1976	4.6	Chuck Standford
Brawley, CA	1963	5.5	Charlie Brown
El Toro, CA	1963	14.8	Pete Cooper
Fall River, MA	1976	24	Omer Jean
Norwich, CT	1972	10	Mr. Parsons
Poway, CA	1971	12	Glen Peterson
Elsinore, CA	1958	8	George Erickson

Reidsville, North Carolina

Filter Size: Two 12'6" wide X 70' long
Treatment Process: Tertiary wastewater treatment
Plant Operator: Boyd Wheeler - (919) 349-9251
Contractor: Wrenn-Wilson Cons. Co.-Durham, NC
Engineer: W.M. Piatt & Co. Engrs.-Durham, NC
Startup Date: 9/78

South Cobb, Georgia

Filter Size: Two 9' wide X 27' long
Treatment Process: Tertiary wastewater treatment
Plant Operator: Jerry Brown - (404) 429-8900
Contractor: So. Cons. & Engrg. Co.-Birmingham, AL
Engineer: Hensley-Schmidt, Inc.-Atlanta, GA
Startup Date: 9/78

North Attleboro, Massachusetts

Filter Size: Two 16' wide X 64' long (dual media)
Treatment Process: Tertiary wastewater treatment
Plant Operator: Emil Cherette - (617) 695-7872
Contractor: Wescott Construction-N. Attleboro, MA
Engineer: Whittman & Howard-Wellesley, MA
Startup Date: 12/78

West Plains, Missouri

Filter Size: Two 12'6" wide X 34' long
Treatment Process: Tertiary wastewater treatment
Plant Operator: Jed Forrester - (417) 256-7088
Contractor: Goodwin Bros. Cons.-Crystal City, MO
Engineer: Crame & Fleming-Hanibal, MO
Startup Date: 12/79

Springfield Township, Summit County, Akron, Ohio

Filter Size: Two 16' wide X 64' long
Treatment Process: Wastewater treatment
Plant Operator: John Hall - (216) 645-0003
Contractor: Gibbons Grable-Canton, OH
Engineer: John David Jones-Cuyahoga Falls, OH
Startup Date: 10/80

Lake Zurich, Illinois

Filter Size: Two 9' wide X 28' long
Treatment Process:
Plant Operator: Pat Boyle - (312) 438-5143 ext. 58
Contractor: Keno & Sons-Highland Park, IL
Engineer: Wight consulting Engineers
Startup Date: 10/80

Beaunit Corporation - Elizabethtown, Tennessee

Filter Size: Two 16' wide X 74' long
Treatment Process: Wastewater treatment
Contractor: Pendley Constructors-Bristol, TN
Engineers: Hulcher & Henderson-Richmond, VA
Startup Date: 2/79

Delco Air Conditioning - Moraine, Ohio

Filter Size: Two 16' wide X 52' long
Treatment Process: Wastewater treatment
Contractor: Foreman Industries-Dayton, OH
Engineers: Hubbel Roch Clark-Bloomfield Hills, MI
Startup Date: 5/81

Corporate West - Lisle, Illinois

Filter Size: 6' wide X 18' long
Treatment Process: Wastewater treatment
Plant Operator: Dan Chlebanowski - (312) 969-3140
Contractor: Driessen Cons. Co.-St. Charles, IL
Engineer: Triad Assoc., Inc.-Indianapolis, IN
Startup Date: 11/81

Milliken Chemical - Inman, South Carolina

Filter Size: 6' wide X 10' long package
Treatment Process: Wastewater treatment
Plant Operator:
Contractor:
Engineer:
Startup Date: 11/81

Stamford, Connecticut

Filter Size: Eight 16' wide x 92' long (4 carbon + 4 sand media)
Treatment Process: Water Treatment
Plant Operator:
Contractor: Atlas Construction Co.-Stamford, CT
Engineer: Whitman & Howard-Wellesley, MA
Startup Date: N/A

Alden, New York

Filter Size: Two 9' wide x 28' long
Treatment Process: Wastewater Treatment
Plant Operator:
Contractor: John W. Danforth Co.-Buffalo, NY
Engineer: O'Brien & Gere-Syracuse, NY
Startup Date: N/A

Drakesboro, Kentucky

Filter Size: One 6' wide x 8' long
Treatment Process: Wastewater Treatment
Plant Operator:
Contractor: Peters Construction Co.-Owensboro, KY
Engineer: Mayes, Sudderth & Etheredge, Inc.-Lexington, KY
Startup Date: 7/83

Georgetown, Kentucky

Filter Size: One 12.5' wide x 48' long
Treatment Process: Wastewater Treatment
Plant Operator:
Contractor: E. H. Hughes Company, Inc.-Georgetown, KY
Engineer: Proctor-Davis-Ray Engineers-Lexington, KY
Startup Date: 7/83

Standard Chlorine - Delaware City, Delaware

Filter Size: One 6' wide x 18' long
Treatment Process: Wastewater Treatment-Iron Removal
Plant Operator: Ivo Ceccarelli - (302) 834-4536
Contractor: Standard Chlorine-Delaware City, DE
Engineer: Ivo A. Ceccarelli
Startup Date: 9/82

Glenwood, Arkansas

Filter Size: One 6' wide x 24' long
Treatment Process: Wastewater Treatment
Plant Operator:
Contractor: Kraus Construction Co.-Fort Smith, AR
Engineer: Blaylock, Threet & Assoc.-Little Rock, AR
Startup Date: N/A

Tidewater Quarries - Richmond, VA

Filter Size: One 8½' wide x 14' long
Treatment Process:
Plant Operator: John Glazebrook
Contractor: Owner
Engineer: John Reid Engrg. Co.-Fredericksburg, VA
Startup Date: 7/83

Witco Chemical Co. - Houston, TX

Filter Size:	One 6' wide x 12' long
Treatment Process:	Wastewater-Deep Well Injection
Plant Operator	
Contractor:	N/A
Engineer:	N/A
Startup Date:	1/82

San Lando Utilities - San Lando, Florida

Filter Size:	One 12½' wide x 40' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	Bay Con General Contractors-Longwood, FL
Engineer:	Conklin, Porter & Holmes-Sanford, FL
Startup Date:	4/84

League City, Texas

Filter Size:	One 16' wide x 30' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	Poindexter Construction Co.-Katy, TX
Engineer:	CRN Associates-Houston, TX
Startup Date:	3/84

Cross Gate Utilities-Slidell, Louisiana

Filter Size:	One 9' wide x 22' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	N/A
Engineer:	J. V. Burkes
Startup Date:	N/A

Brookfield, Wisconsin

Filter Size:	Four 16' wide x 76' long
Treatment Process:	Tertiary wastewater Treatment
Plant Operator:	
Contractor:	Luterbach Construction Co.-New Berlin, WI
Subcontractor:	Tillmon Engrg. & Cons. Co.-Rockford, IL
Engineer:	Camp, Dresser & McKee
Startup Date:	N/A

Winona, Missouri

Filter Size:	One 6' wide x 18' long
Treatment Process:	Tertiary Wastewater Treatment
Plant Operator:	
Contractor:	Baumgartner Construction Inc.-Springfield, MO
Engineer:	C. B. Simmons-Republic, MO
Startup Date:	N/A

Rio Rancho Estates - Albuquerque, New Mexico

Filter Size:	One 14' x 47' long
Treatment Process:	
Plant Operator:	
Contractor:	Garnet Construction Co.
Engineer:	Trico International-Rio Rancho, NM
Startup Date:	1/81

Nevada City, California

Filter Size:	One 9' wide x 50' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	F & M Engineering Contractors, Inc.-Santa Cruz, CA
Engineer:	Cranmer Engr.-Grass Valley, CA
Startup Date:	N/A

Warren Township, New Jersey

Filter Size:	Two 6' wide x 18' long
Treatment Process:	
Plant Operator:	
Contractor:	PKF - Mark III, Inc.-Newton, PA
Engineer:	Elson T. Killam Assoc., Inc.-Milburn, NJ
Startup Date:	12/82

Millsborough, Delaware

Filter Size:	One 6' wide x 30' long
Treatment Process:	Wastewater Treatment
Plant Operator:	Harry Veasey - (302) 934-6043
Contractor:	McElwee-Scarborough Construction, Cherry Hill, NJ
Engineer:	Edward H. Richardson Assoc.-Dover, DE
Startup Date:	11/82

Fort Ritchie, Pennsylvania

Filter Size:	Two 6' wide x 12' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	Waynesboro Cons. Co.-Waynesboro, PA
Engineer:	Greenhorne & O'Mara, Inc.
Startup Date:	9/82

Fairfield Bay Community - Fairfield Bay, Arkansas

Filter Size:	One 6' wide x 12' long
Treatment Process:	Water Treatment
Plant Operator:	Charles N.
Contractor:	Fairfield Bay Community-Fairfield Bay, AR
Engineer:	Garver & Garver, Inc.-Little Rock, AR
Startup Date:	10/80

Curtis Creek Fish Hatchery - Mongo, Indiana

Filter Size:	One 9' wide x 32' long
Treatment Process:	
Plant Operator:	Steve Huffaker - (317) 342-5527
Contractor:	Wright Construction Co.-Elkhart, IN
Engineer:	Clyde Williams Engrg.-South Bend, IN
Startup Date:	10/80

Leitchfield, Kentucky

Filter Size:	One 16' wide x 40' long
Treatment Process:	Tertiary wastewater Treatment
Plant Operator:	
Contractor:	Hall Contractors-Louisville, KY
Engineer:	Watkins & Associates
Startup Date:	9/80

Brecknock Township W.P.C.P. - Lancaster, Pennsylvania

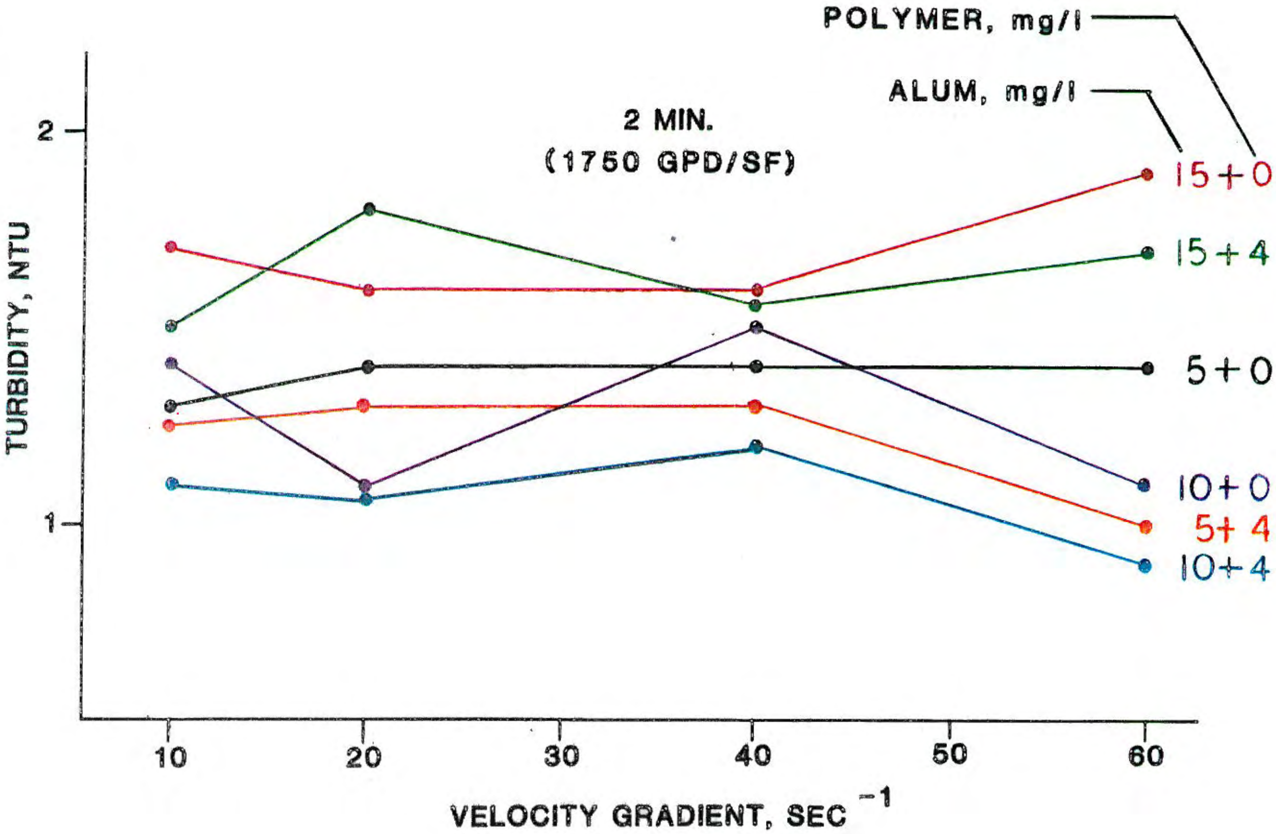
Filter Size:	Two 9' wide x 10' long
Treatment Process:	Tertiary wastewater Treatment
Plant Operator:	Frank Carlson - (215) 445-7553
Contractor:	McElwee Scarborough-Cherry Hill, NJ
Engineer:	Huth Engineers-Lancaster, PA
Startup Date:	4/81

Callawassie Island, South Carolina

Filter Size:	One 6' wide x 12' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	B-W-B, Inc.-Florence, SC
Engineer:	B. P. Barker Engrg.-Columbia, SC
Startup Date:	N/A

Hillsboro, Illinois

Filter Size:	Three 9' wide x 14' long
Treatment Process:	Wastewater Treatment
Plant Operator:	
Contractor:	J. A. Mutchler Excavating Co.-Hillsboro, IL
Engineer:	Hurst-Rosche Engineers-Hillsboro, IL
Startup Date:	3/84

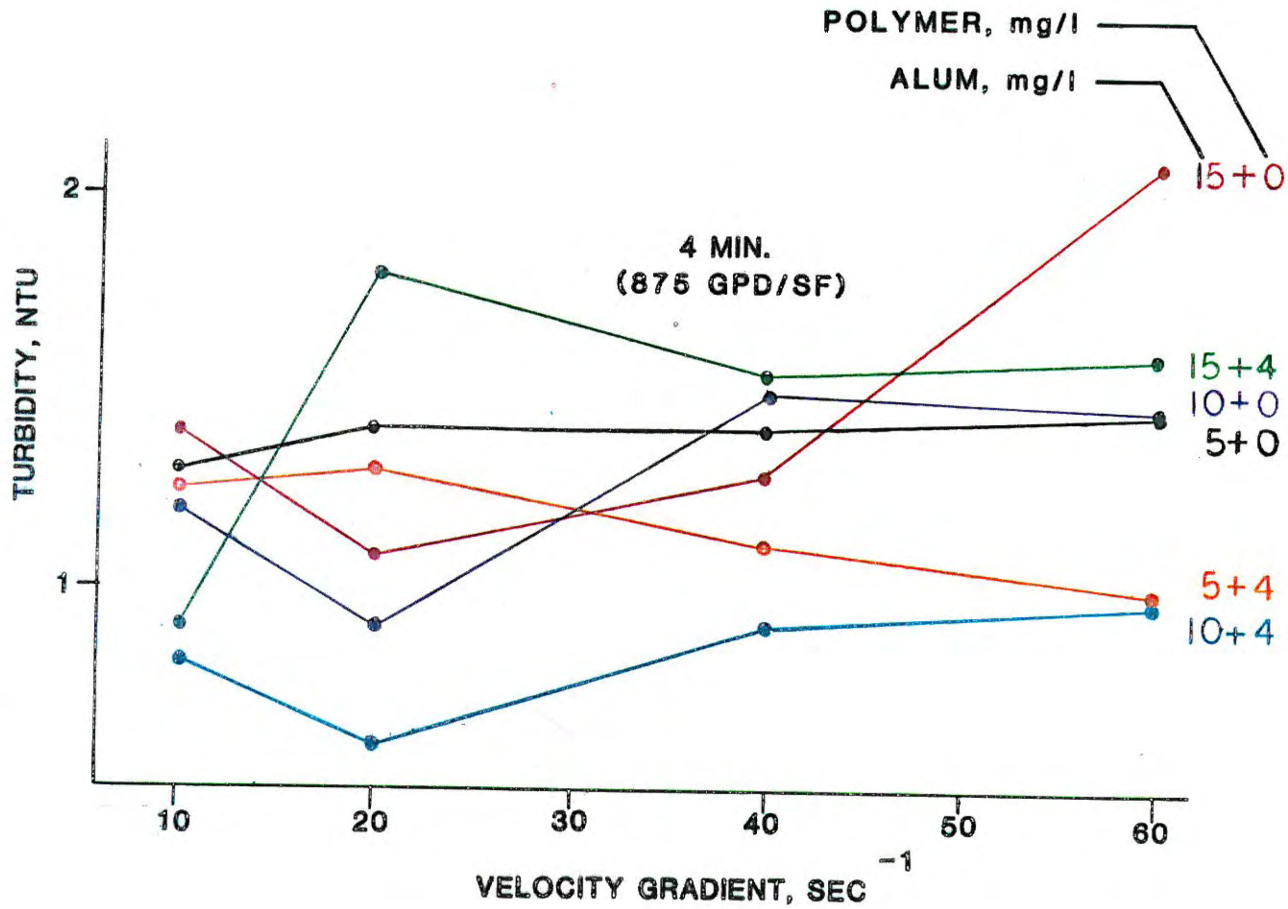


CITY OF FORT BRAGG MASTER WATER PLAN

EFFECTS OF VELOCITY GRADIENT

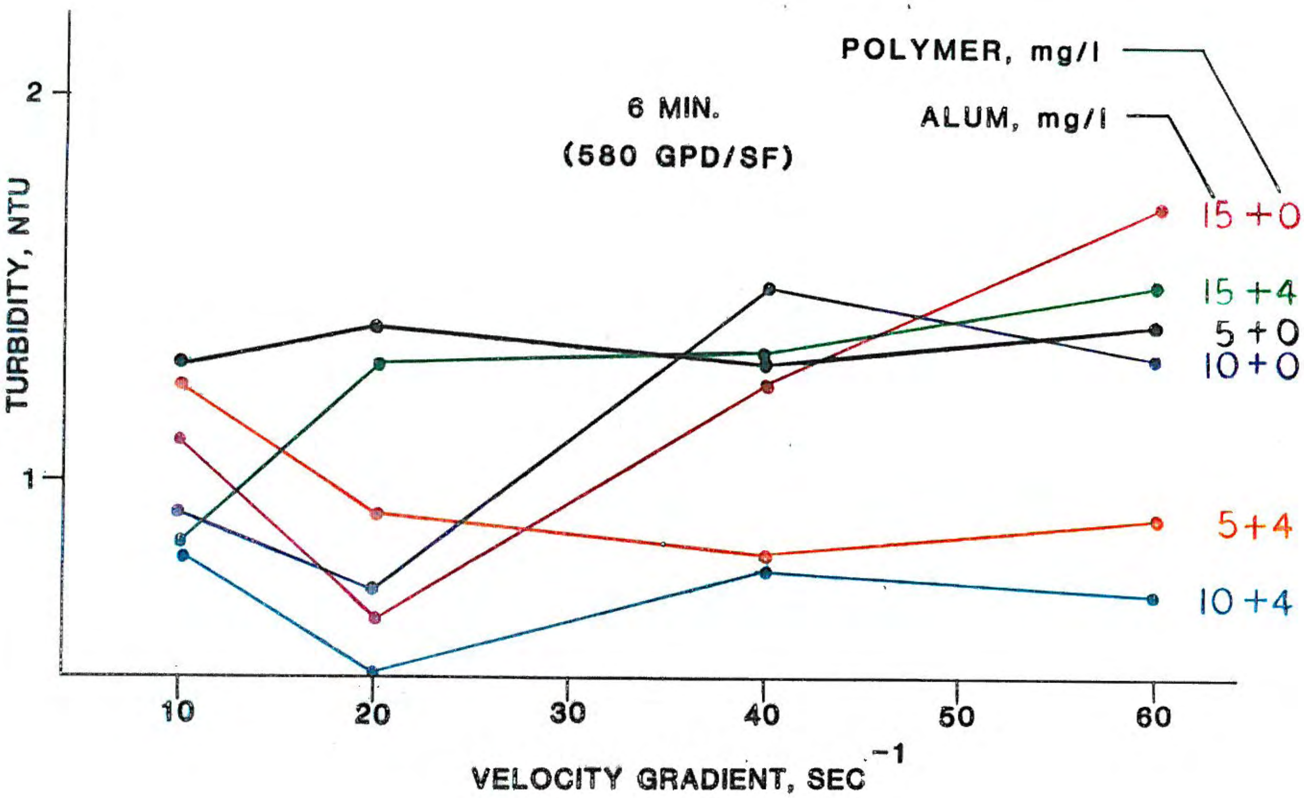
JOHN CAROLLO ENGINEERS

FIGURE 1



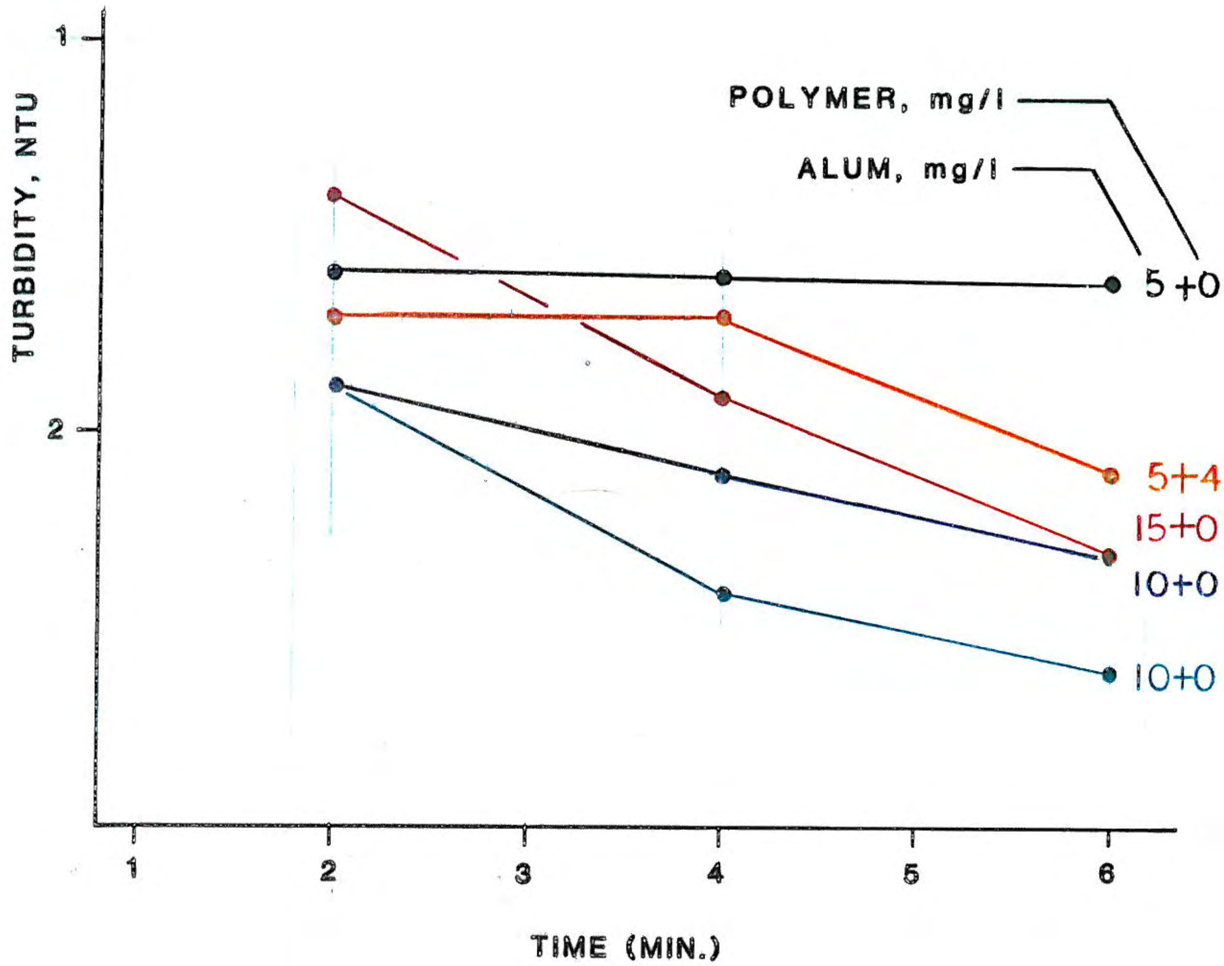
CITY OF FORT BRAGG MASTER WATER PLAN

EFFECTS OF VELOCITY GRADIENT



CITY OF FORT BRAGG MASTER WATER PLAN

EFFECTS OF VELOCITY GRADIENT



CITY OF FORT BRAGG MASTER WATER PLAN

COMPARISON OF CHEMICAL DOSAGES

JOHN CAROLLO ENGINEERS

FIGURE 4

APPENDIX L

INSTALLATION LIST OF FILTERS

MANUFACTURED BY AQUA AEROBIC

(INFORMATION SUPPLIED BY MANUFACTUER)

Partial List
AQUA-AEROBIC SYSTEMS, INC.

ıary

Village of Athens, New York

Filter Size:	One 9' wide X 36' long (dual media)
Treatment Process:	Potable water treatment
Plant Operator:	Jack Nichols - (518) 945-2682
Contractor:	Thomspon Cons. Corp.-Albany, NY
Engineer:	Robert J. Ganley-Delmar, NY
Startup Date:	10/78

Hampsire, Illinois

Size:	One 9' wide X 36' long
Treatment Process:	Tertiary wastewater treatment
Plant Operator:	Richard Sharp - (312) 683-2064
Contractor:	Keno & Sons Cons.Co.-Highland Park, IL
Engineer:	Baxter & Woodman-Crystal Lake, IL
Startup Date:	12/78

Mt. Carroll, Illinois

Filter Size:	One 9' wide X 20' long
Treatment Process:	Wastewater
Plant Operator:	Ronald Morgan - (815) 244-5921
Contractor:	Civil Constructors-Freeport, IL
Engineer:	Baxter & Woodman-Crystal Lake, IL
Startup Date:	3/81

Brooklyn, Wisconsin

Filter Size:	Two 6' wide X 14' long
Treatment Process:	Wastewater
Plant Operator:	Darell Thompson - (608) 455-1842
Contractor:	Mechanical Systems, Inc.-Madison, WI
Engineer:	Carl C. Crane, Inc.-Madison, WI
Startup Date:	6/81

Kittery, Maine

Filter Size:	Two 16' wide X 98' long
Treatment Process:	Water supply
Plant Operator:	Ed Junkins - (207) 363-4252
Contractor:	Winn Conn Construction-Laconia, NH
Engineer:	Whittman & Howard, Inc.-Westbrook, ME
Startup Date:	5/81

APPENDIX M

GEORGIA PACIFIC MATERIAL USE

OF CITY WATER 1980-1985

(HUNDREDS OF CUBIC FEET)

Month	Meter No.	1980	1981	1982	1983	1984	1985
February	1012	-0-	6,173	3,177	1,030	2,181	1,303
	1015-3"	82	423	792	577	560	14
	1018-3"	1	5	60	4	4	6
	1027-4"	636	1,437	1,657	1,824	4,925	1,570
	1042-1"	23	12	80	92	108	133
	1051-3"	828	2,524	4,702	1,709	1,002	770
	1090-5/8"	-0-	1	-0-	-0-	-0-	1
	TOTAL	1,570	10,575	10,528	5,236	8,780	3,801
April	1012	6,069	2,134	1,702	1,199	1,539	1,902
	1015	326	651	10	451	534	-0-
	1018	4	261	682	83	3	3
	1027	2,008	1,318	1,609	1,767	1,844	1,231
	1042	13	14	80	112	50	197
	1051	789	4,574	4,124	1,205	953	679
	1090	1	-0-	1	-0-	-0-	-0-
	TOTAL	9,210	8,954	8,208	10,053	4,923	4,012
June	1012	11,374	2,609	2,079	1.340	1,747	2,333
	1015	124	643	454	506	599	16
	1018	4	23	99	15	7	2
	1027	1,406	1,258	1,192	1,821	5,889	1,417
	1042	20	13	72	108	29	11
	1051	723	4,627	3,480	965	886	665
	1090	-0-	-0-	-0-	-0-	-0-	-0-
	TOTAL	13,651	9,173	7,376	4,755	9,157	4,444
August	1012	13,164	2,755	1,941	812	2,209	2,615
	1015	474	515	496	450	701	466
	1018	22	41	682	6	10	121
	1027	1361	1,442	1,520	1,916	10,295	1,591
	1042	16	98	66	108	28	182
	1051	546	4,763	2,188	1,035	875	716
	1090	-0-	-0-	-0-	-0-	2	-0-
	TOTAL	15,583	9,614	6,893	11,220	14,120	5,691
October	1012	17,169	1,865	1,672	12,840	2,510	2,393
	1015	468	186	569	345	759	476
	1018	16	31	-0-	4	12	68
	1027	1,571	1,687	1,684	1,558	5,077	1,625
	1042	12	107	108	95	35	-0-
	1051	8	4,815	2,180	1,034	807	660
	1090	-0-	-0-	-0-	1	2	1
	TOTAL	24,935	8,691	6,213	15,876	9,202	5,223

Month	Meter No.	1980	1981	1982	1983	1984	1985
December	1012	17,430	1,945	1,072	1,461	1,442	2,797
	1015	474	446	470	658	375	547
	1018	8	199	11	14	4	40
	1027	1,414	1,633	1,023	2,723	1,273	1,822
	1042	11	87	80	98	28	3
	1051	-0-	4,575	1,579	1,098	633	144
	1090	-0-	1	1	-0-	-0-	1
	TOTAL	19,310	8,886	4,235	6,052	9,812	4,754
ANNUAL TOTALS		98,824	55,893	43,453	53,192	55,994	27,925

Note: 19,000 hundred cubic feet of water for December, 1985, equal 14,212,000 gallons/month or 470,000 gallons per day or 330 gallons per minute or 0.7 cfs.