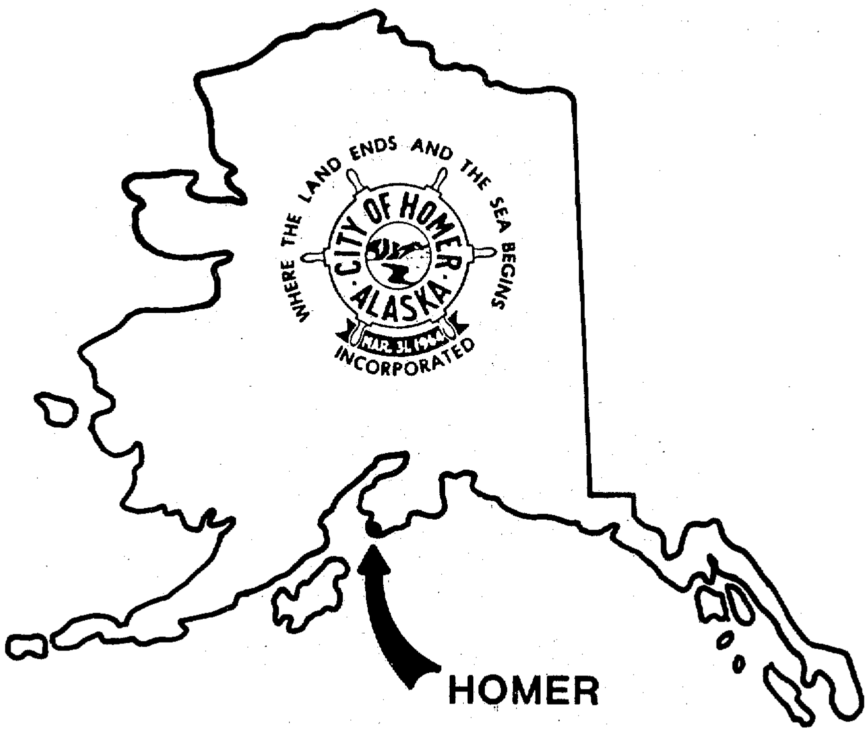
1983 WATER SUPPLY STUDY

CITY OF HOMER, AK



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FOR

CITY OF HOMER, ALASKA

Prepared by

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WATER IMPROVEMENTS STUDY
CITY OF HOMER, ALASKA

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SECTION I

FUTURE WATER REQUIREMENTS & SUPPLY ALTERNATIVES

1.0 INTRODUCTION

1.1 General

This Water Improvement Study for the City of Homer includes Preliminary Engineering and Cost Estimate of a Storage Reservoir and Dam; Preliminary Engineering and Cost of Storage, Treatment and Transmission Facilities; Environmental Assessment of the Preferred Alternative and the Land Acquisition Analysis.

In order to design facilities it is necessary to determine the projected water needs. This was done in the Draft 1982 Comprehensive Plan for the Distribution of Water by others. We reviewed the assumptions and projections for residential, commercial-industrial uses and system losses and found the figures to be reasonable. We therefore accepted the figures and incorporated them into this study.

1.2 Scope of Work

We have carried out the water supply study for the City of Homer by completing four major objectives. These objectives were developed and are timed to occur based upon our understanding of the needs of the City and the extent to which reliable technical data are available. The result has been an analysis of future needs and availability, as well as development of a preliminary engineering design for a new municipal water supply for the City. Finally, costs, project impacts, and alternative project financing has been evaluated and presented such that recommended improvements may be scheduled and budgeted by the City.

The four objectives are:

OBJECTIVE 1: EVALUATE FUTURE WATER REQUIREMENTS AND WATER SUPPLY ALTERNATIVES

OBJECTIVE 2: PREPARE PRELIMINARY DESIGN OF PREFERRED SUPPLY SOURCE AND ASSOCIATED SYSTEM IMPROVEMENTS

OBJECTIVE 3: PROJECT FINANCING AND IMPACT ASSESSMENT

OBJECTIVE 4: PUBLIC PARTICIPATION AND REPORT PREPARATION

The timing of these objectives has been developed in accordance with the schedule for completion of the City's 1982 Comprehensive Plan and other related projects to be undertaken by the City.

1.3 Results of Study

The results of the study include:

- Analyses of water demands, future needs and alternative sources of supply; recommendations for development of preferred alternative supply
- Analysis and development of design criteria for water reservoir, dam, water treatment, pumping, transmission and storage improvements to existing City water system
- Preliminary layout and design concepts for recommended system improvements
- Cost estimates for system improvement alternatives

- Environmental assessment of project development and mitigating measures

- Project feasibility and financing alternatives; evaluation of impact of project on City financial structure

1.4 Study Source Locations

Locations of potential sources for additional water are shown on Figure 1.1.

2.0 WATER DEMAND

2.1 General

An estimate of future water demand for Homer is necessary in analyzing the timing and need for development of additional water supplies. Several previous studies have been conducted (USDA, 1962; Hill and Associates, 1971; CH_2M-Hill, 1977; and CH_2M-Hill, 1980) in which projections were prepared and recommendations made regarding future water needs and possible supplies for the City. These studies primarily used growth in population as the basis on which water demands were projected because there was a lack of reliable long-term demand data to use for this purpose. With operation of the water treatment plant for the period 1976-82, however, more accurate demand data are available to utilize in projecting future water use within the City.

2.2 Exiting Demand

Table 2.1 is a summary of water demands during the period 1976 through the first nine months of 1982 based upon total supply to the distribution system. These records show total flow which has been supplied to the distribution system from the existing water treatment plant and 500,000 gallon storage tank at the plant. Since 1976, annual average demand has increased from 0.380 to 0.560 MGD, or at an average annual rate of growth of 6.7 percent per year. Over the same period, population has increased from approximately 1,600 to 2,873 or at an annual growth rate of 10.2 percent according to the latest Borough census figures. During this period the number of residences served has been reported to have increased from approximately 200 (CH_2M-Hill, 1977) to 700 (J. Hobbs, 1982).

TABLE 2.1

AVERAGE DAILY DEMAND (ADD) BY MONTH, MGD

Month	1976	1977	1978	1979	1980	1981	1982
Jan.	0.320	0.275	0.627	0.390	0.555	0.496	0.650
Feb.	.320	.233	.424	.420	.509	.436	.505
Mar.	.398	.221	.364	.418	.481	.404	.469
Apr.	.424	.256	.366	.401	.461	.498	.397
May	-	.253	.316	.464	.499	.405	.447
June	-	.318	.513	.528	.481	.514	.495
July	.413	.381	.548	.722	.804	.790	.879
Aug.	.546	.476	.444	.724	.714	.747	.779
Sept.	.447	.367	.403	.559	.463	.533	.418
Oct.	.337	.307	.371	.551	.593	.586	
Nov.	.265	.521	.515	.425	.516	.457	
Dec.	.325	.592	.479	.632	.555	.524	
Annual Average	0.380	0.350	0.448	0.520	0.550	0.533	0.560[1]

[1] Based upon first nine months of record

Source: Homer Water Treatment Plant Monthly Operating Reports, 1976-1982

Three factors tend to influence the proportion of total demand which is allocated to the various components such as residential, public, commercial, large commercial, and miscellaneous demand. First, the greater proportion of the City's population now being served can result in a greater proportion of total demand being attributable to the residential, public and commercial component. This is particularly true if the other components remain at nearly the same level of demand with time. Second, changes in production and process variations or closures by the major water users in the large commercial component can have a dramatic effect on water usage in that category. A good example of this is the closure of Campford Fisheries on Homer Spit and the prospects for a reduced crab catch requiring processing by Seward Fisheries on the Spit. Third, the City's recent efforts in a leak investigation program can result in the reduction of miscellaneous demand due to meter inaccuracies, leaks, etc.

In the 1977 Comprehensive Water Plan (CH_2M-Hill, 1977), residential, public and commercial demand was reported to constitute 20 percent of the average annual demand within the City, while the large commercial component made up over one-half the annual average daily water consumption. Of the large commercial component, over 90 percent was reported to be attributable to the two processors on the Spit. Miscellaneous demand was reported to constitute 24 percent of total demand, which was greater than that normally in distribution systems (10 percent). With rapid population growth and changes in production by the processors on the Spit, however, the proportion of total demand by each component is likely to be different now than in 1976. As the Comprehensive Water Plan is updated, the proportion of total demand currently attributable to the various components will be determined and estimates of usage prepared that can be used to verify estimates provided herein.

For purposes of this first report, it has been assumed that water use in the large commercial category currently averages approximately 0.2 MGD (J. Hobbs, 1982), about 35 percent of annual average demand, or at about the same level of demand as earlier reported (CH_2M-Hill, 1977).

Because the City has recently performed leak investigations, it is assumed that miscellaneous demand (leakage, firefighting, hydrant flushing, etc.) has remained at about the same level of demand, or about 0.1 MGD as earlier reported in the 1977 Comprehensive Water Plan, even though the distribution system has been expanded since then and now conveys larger flows. The remainder of the total demand, approximately 0.26 MGD, is therefore allocated to residential, public and commercial demand. Based upon 700 residential units being served with a population density of 3.2 persons per household unit, per capita water use in this category currently averages about 120 gallons per capita per day (gpcd). This compares well with per capita usage determined in the 1977 Comprehensive Water Plan. It should be noted that the figure is subject to variation, however, as more of the City's population acquires water services due to expansion of the existing distribution system. Nonetheless, per capita usage is a useful indicator in estimating future demands likely to occur in response to population growth.

2.2 Future Demand

In Table 2.2, projected population of the City (Pacific Rim Planners & Engineers, 1982) and surrounding area for low, intermediate and high rates of growth are given for the period 1985-2010. These population projections are described more fully in the Homer Comprehensive Plan update currently in preparation. Overall, the intermediate, or mid-range, projections anticipate declining rate of growth in percentage terms, but stable to increasing growth in absolute terms. The growth rate is projected to fall from the current 9 percent-plus rate to 7.5 percent through 1985, 6.5 percent through 1990 and 5.5 percent thereafter. Absolute population increases would rise from the recent rate of 175 additional persons per year to about 260 by the end of the 1980's, and nearly 300 per year during the 1990's. It is difficult to project with great confidence beyond more than a decade or so, since many developments which will affect total population cannot yet be identified; however, projections for 1995 to 2010 based on existing

Table 2.2
CURRENT AND PROJECTED POPULATION
HOMER AREA - 1978 to 2010

	City of Homer	Other Homer Areas*	Total Homer Area
Actual			
1978	2,054	1,577	3,631
1980	2,209	NA	NA
1981	2,588	NA	NA
1982	2,873	2,069	4,942
Low Projection			
1985	3,100	2,300	5,400
1990	3,900	3,000	6,900
1995	4,500	3,500	8,000
2000	5,200	4,200	9,400
2005	5,800	4,600	10,400
2010	6,400	5,100	11,500
Intermediate Projection			
1985	3,400	2,800	6,200
1990	4,700	4,000	8,700
1995	6,200	5,600	11,800
2000	8,100	7,500	15,600
2005	9,400	8,800	18,200
2010	10,900	10,400	21,300
2015	12,000	11,500	23,500
2020	13,200	12,700	25,900
2025	13,900	13,300	27,200
2030	14,600	14,000	28,600
High Projection			
1985	3,800	3,100	6,900
1900	6,500	5,600	12,100
1995	10,400	9,600	20,000
2000	13,300	12,600	25,900
2005	16,200	15,700	31,900
2010	19,700	19,600	39,300
2015	21,800	22,700	44,500
2020	24,100	25,100	49,200
2025	25,300	26,300	51,600
2030	26,600	27,600	54,200

*Diamond Ridge, Fritz Creek and Kachemak City voting precincts (1978 boundaries)

NA - Data not available

Source: Kenai Peninsula Borough 1979 and 1982, and Pacific Rim Planners & Engineers, Olympic Associates Company.

growth factors anticipate increasing numbers of new residents, but falling growth rates in percentage terms.

These projections were prepared primarily by extrapolating previous population trends, but also considering possible economic development scenarios described in the Homer Comprehensive Plan (Pacific Rim Planners & Engineers, 1982). In essence, potential population growth is limited only by the capacity of possible economic activities in Homer and nearby vicinities.

In considering the intermediate growth scenario, increases in residential, public and commercial demand are expected to constitute the major growth in demand for water within the City. Annual average day demand projections occurring under this scenario are shown in Tables 2.3 and 2.4. Table 2.3 represents estimated demands from population growth within City limits, while in Table 2.4, estimated annual average day demands also include that portion of the population living outside the City that might require water service in the event that a Fritz Creek reservoir is developed. Also shown in Tables 2.3 and 2.4 are estimated average daily demands that would be experienced under the higher rate of population growth in the City and surrounding area best served by a Fritz Creek reservoir. Figures 2.1 and 2.2 detail these projections and provide a comparison with other recent estimates of future demands (CH_2M-Hill, 1980).

In preparing these estimates, it is assumed that large commercial and miscellaneous demands remain at or near present levels, and that all population growth taking place within the City limits over the period is serviced. One-half of the population growth in the Kachemak City and Fritz Creek precincts are assumed to be serviced, and water requirements from these areas are envisioned to be only for residential, public and commercial purposes. Large commercial demands are difficult to predict, and hence estimates are provided both with and without an increase in demand in that category. Higher rates of per capita usage are assumed under the high growth rate scenario since

TABLE 2.3

ESTIMATED FUTURE AVERAGE DAILY DEMANDS (ADD), MGD (EXCLUSIVE OF DEMAND OUTSIDE CITY LIMITS)

Condition	1985	1990	1995	2000	2005	2010
Intermediate Population Growth[1]	0.67	0.85	0.96	1.19	1.34	1.52
High Population Growth[2]	0.74	1.13	1.61	2.02	2.42	2.91
High Population Growth w/large commercial increase	0.84	1.23	1.71	2.12	2.52	3.01

[1] assuming residental, public and commercial demand @ 120 gpcd, entire population served

[2] assuming same historical level of large commercial demand and misc. demand

[3] assuming residential, public & commercial demand @ 140 gpcd, entire population served

TABLE 2.4

ESTIMATED FUTURE AVERAGE DAILY DEMANDS (ADD), MGD (INCLUDING POPULATION OUTSIDE CITY LIMITS)

Condition	1985	1990	1995	2000	2005	2010
Intermediate Population Growth[1]	0.80	1.04	1.23	1.55	1.76	2.03
High Population Growth[2]	0.89	1.40	2.07	2.64	3.18	3.87
High Population Growth w/large commercial increase[2]	0.99	1.50	2.17	2.74	3.28	3.97

[1] assuming residental, public and commercial usage of 120 gpcd inside Homer, with entire population served, and demand of 150 gpcd outside City limits

[2] assuming 50% of projected population growth in Kachemak City and Fritz Creek precincts served

[3] assuming residential, public & commercial usage of 140 gpcd inside Homer, with entire population served, and demand of 150 gpcd outside City limits

economic projections (Pacific Rim Planners & Engineers, 1982) suggest that Homer's economy might rely increasingly more on tourism and visitor services, in which non-resident use would possibly result in an apparent greater per capita residential usage. However, the estimates serve to define the range in which future use is likely to occur.

Maximum day demands are also detailed in Tables 2.5and 2.6, and illustrated in Figures 2.3 and 2.4. Projections are developed which indicate a range of demands depending upon population growth and potential for increases in large commercial demands.

TABLE 2.5

ESTIMATED FUTURE MAXIMUM DAY DEMAND (MDD), MGD (EXCLUSIVE OF DEMAND OUTSIDE CITY LIMITS)

Condition	1985	1990	1995	2000	2005	2010
Intermediate Population Growth[1]	1.52	1.88	2.10	2.56	2.86	3.22
High Population Growth[1]	1.66	2.44	3.40	4.22	5.02	6.00
High Population Growth[1], w/large commercial increase	1.96	2.74	3.70	4.52	5.32	6.30

[1] assuming ratio of maximum day demand to average day = 2.0, entire population served

[2] assuming large commercial peak day demand of .3 MGD

TABLE 2.6

ESTIMATED FUTURE MAXIMUM DAY DEMAND (MDD), MGD
(INCLUDES POPULATION SERVED OUTSIDE CITY LIMITS)

Condition	1985	1990	1995	2000	2005	2010
Intermediate Population Growth[1]	1.79	2.26	2.64	3.28	3.70	4.24
High Population Growth[1]	1.96	2.98	4.32	5.46	6.54	7.92
High Population Growth[1], w/large commercial increase	2.26	3.28	4.62	5.76	6.84	8.22

[1] assuming ratio of maximum day demand to average day = 2.0, entire City population served, 50% of population in Kachemak City and Fritz Creek precincts served

[2] assuming large commercial peak day demand of 0.3 MGD

3.0 ASSESSMENT OF GROUNDWATER SUPPLIES

3.1 Background

As an alternative to surface water development, conjunctive use of groundwater in the Homer area with existing supplies is herein considered. Previous studies (Feulner, A.J., 1963; Waller, R.M., Feulner, A.J., and Morris, D.A., 1968) suggest that some form of conjunctive use might prove advantageous, although such studies were conducted when the area's population and water demands were significantly less than current totals. At one time, the City did practice this method of operation, when six wells were drilled in the Bridge Creek drainage near a small surface reservoir. This practice was discontinued, however, as several of the wells developed operating problems such as casing misalignment, declining production, etc., (Hill and Associates, 1971) and the existing reservoir was constructed. Currently, individual wells and springs supply water for primarily domestic purposes for a significant portion of the area's population, such wells being located in both the bench and upland portions of Homer and the surrounding area.

3.2 Occurrence of Groundwater

Fresh groundwater occurs in two zones within the study area: first, in the young, thin, unconsolidated Quaternary deposits located along the bench and lowland portions of Homer, as well as stream beds and valleys nearby; and second, in the escarpment region above and to the north of the City limits (See Figure 3.1). This second region, referred to as the Kenai Formation, consists of moderately indurated sand, silt, and clay of Tertiary age generally in thin beds and lenses, interbedded with a few thick lenses of fine conglomerate and many thin lenses of subbituminous coal (Waller, R.M., Feulner, A.J., and Morris, D.A., 1968). The thickness of the formation is not known, although test drilling near Homer has been conducted in which over 10,000 feet of the Formation has been discovered. Typical logs from wells drilled in the Formation are shown in Table 3.1.

Underlying the entire Homer area, the Kenai Formation contains many fine grained sandstone sequences containing ferruginous masses or ironstone concretions in bands or as scattered nodules throughout the formation (Waller, R.M., Feulner, A.J., and Morris, D.A., 1968). The formation dips shallowly to the north such that groundwater movement is thought (Hill and Associates, 1971) to flow to the north parallel to the dip and away from the City. Permeability is generally poor (Hill and Associates, 1971).

Groundwater in these two water-bearing strata is derived from rainfall and snowmelt, which, as previously mentioned, averages about 23 inches at the airport and 28 inches on the upland above the escarpment at altitudes in excess of 1,000 feet. Of this annual precipitation, total recharge to the area is only about 5 inches per year (238,000 gpd/mi^2) or about one-fifth of total annual precipitation (Hill and Associates, 1971). This compares favorably with recharge rates for aquifers of similar geologic and climatic conditions (Walton, W.C., 1970).

Groundwater in the Homer area is of the sodium bicarbonate or calcium bicarbonate type, and in some areas contains as much as 30 ppm iron and some combustible gas (Waller, R.M., Feulner, A.J., and Morris, D.A.; Fromer, 1982). Selected chemical analysis shows groundwater to contain moderate amounts of dissolved solids, and can range from extremely soft to very hard. The soft water is generally found in the Kenai Formation, the harder water from the Quaternary deposits in the lowland areas. The pH of the water is typically in the range of 6.7 to 8.5, suitable for most purposes. Sulfides have been reported to be present

TABLE 3.1

LOGS OF SELECTED WELLS IN HOMER AREA, ALASKA

WELL 2 @ OHLSON MOUNTAIN

Drilled in 1960 by Corps of Engineers, U. S. Army, Alaska District. Diameter 6-inch to 398 feet, 5-inch to 531 feet, cased 6-inch to 398, 5-inch liner set from 381 to 531 feet, perforations cut with a torch, approximately 1/16-inch wide and 6-inch long, perforated 423-470, 504-508, 513-521, and 529-531.

Material	Thickness (feet)	Depth (feet)
Backfill	2	2
Yellow clay	14	16
Blue clay	12	23
Coal seam	1	29
Sandy silt (fine)	24	53
Brown shale	15	68
Brown sand and silt (fine)	16	84
Brown shale with coal seams (water at about 2 gpm)	3	87
Brown shale	22	109
Brown shale and shell rock	3	112
Coal with rock lenses	5	117
Grey shale	27	144
Coal (dry)	2	146
Grey shale	30	176
Sandstone, fine	40	216
Brown shale with thin lenses of coal	4	220
Grey shale	19	239
Brown shale	55	294
Grey shale, sandy	12	306
Grey sandstone	21	327
Coal (water level in well dropped from 81 to 181 feet)	10	337
Brown shale	34	371
Coal	3	374
Brown shale	12	386
Brown shale, sandy	8	394
Coal	4	398
Blue shale	62	460
Brown shale with coal seams	10	470
Brown shale, sandy	10	480
Brown shale	7	487
Coal	1	488
Brown shale	4	492
Coal	7	499
Brown shale	4	503
Coal	3	506
Brown shale	2	508
Coal	3	511
Brown shale, sandy	3	514
Grey sandstone (hard)	17	531

Remarks: Static water level 220 feet.

TABLE 3.1 (CONT'D)

LOGS OF SELECTED WELLS
IN HOMER AREA, ALASKA

Material	Thickness (feet)	Depth (feet)
Well 90. U. S. Air Force (White Alice site). Log by Chapman		
Vegetation	2	2
Surface soil	23	25
Clay	7	32
Clay with rock	15	47
Clay changing to claystone	3	50
Claystone	2	52
Hardstone	23	75
Coal, soft (small amount of water	3	78
Sandstone, hard	5	83
Coal and stone, mixed	4	87
Sandstone	26	113
Clay, soft	8	121
Sandstone	9	130
Clay, very soft	7	137
Coal, soft	5	142
Sandstone	7	149
Clay, fairly hard	13	162
Sandstone	4	166
Clay	28	194
Coal and rock	3	197
Clay	27	224
Stone and coal, with clay, mixed	7	231
Clay	7	238
Siltstone, very hard	8	246
Clay	12	258
Clay, very soft and sticky	2	260
Clay, softer and squeezing	10	270
Clay	10	280
Clay, soft and blue silt	40	320
Coal, very hard and brittle	5	325
Claystone, hard and shale	53	378
Sandstone (water)	36	414
Claystone	1	415
Clay, soft and squeezing	35	450

Source: Feulner, A.J., 1963; Waller, R.M., 1963

(Fromer, 1982), as well as insignificant concentrations of fluoride. Table 3.2 details selected chemical characteristics of groundwater from wells located throughout the region.

3.3 Use of Groundwater

In general, the water from the Kenai Formation in the uplands above and to the north of the escarpment is of better quality than that from Quaternary deposits below. Iron concentrations average only 1-2 ppm (Waller, R.M., Feulner, A.J., and Morris, D.A.) as contrasted to about 4 ppm in the lowlands, stream valleys and bench areas. The water, also being lower in dissolved solids and being softer, would probably require less extensive treatment prior to use.

Of the two water-bearing strata, the Kenai Formation is also reported (Feulner, A.J., 1963; Waller, R.M., Feulner, A.J., and Morris, D.A., 1968; Hill and Associates, 1971) to constitute the most extensive and most productive aquifer system in the study area. Well logs and production records from several wells drilled in the area (Waller, R.M., 1963) suggest that water may be obtained at or near each of the coal seams penetrated by wells, although the yield from each of the seams penetrated is low (on the order of 2-5 gpm per seam). Lesser quantities of water are reported to be available from the unconsolidated alluvial and flood-plain deposits occurring along stream channels and in the lowlands.

The USGS has predicted yields from properly constructed and operated wells in the area based upon results of test drillings and review of operating records (Waller, R.M., Feulner, A.J., and Morris, D.A., 1968). Data suggest sustained annual yields in properly spaced and constructed wells in the Kenai Formation upland of Homer between 50 to 80 gpm (.072-.115 MGD), which compares favorably with reported yields (Hill and Associates, 1971) from wells previously pumped in the Bridge Creek area for municipal purposes. Lower yields of between 10-20 gpm might be obtainable in the bench area, while yields from shallow wells

TABLE 3.2

WATER ANALYSES FROM SELECTED SURFACE AND GROUND-WATER SOURCES

(Analyses by the U.S. Geological Survey - chemical concentrations in parts per million)

Township range, section, and ¼ section locations	Well no	Date of collection	Depth of well (feet)	Silica (SiO_2)	Total iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180° C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25° C)	pH	Color
																	Calcium, Magnesium	Noncarbonate			
6S 13W 16 NWSESE	4	9-14-62	112	26	0.12[1]	0.01	8.0	1.0	292	4.4	772	4.0	6.0	0.0	0.6	735	24		1130	8.5	
16 NWSESE	4	12-20-62	195	50	0.9	.00	6.4	1.0	117	6.3	310	2.0	6.5	.2	.2	346	20		497	8.3	20
1 SENWNE	4S	4-24-63	Spring	37	.02	.00	14	2.9	9.6	3.1	72	1.0	6.5	.2	.2	112	46		160	7.0	5
19 NWNESE	56	6-16-55	107	31	4.6	.64	39	4.9	40	2.9	226	.7	14	.0	.4	246	117		290	7.6	
10 SESESW	11	8-28-63	72	40	6.8		13	3.6	127	8.4	354	4.0	14	.2	.8	353	46		545	7.5	
16 NESWSW	13	4-24-63	80	21	1.9	.00	2.4	1.0	40	1.0	85	3.0	16	.1	.7	136	10		177	6.9	80
12 SENWNE	14	12-14-62	187	17	.72[1]	.00	4.0	.0	306	4.0	800	1.0	16	.2	.3	744	9		1150	7.2	
20 SENWNW	30	5-31-53	119	34	.59	.00	1.6	.0	164	2.4	466	.0	16	.1	.1	467	4		732	7.7	
6S 14W 15 NESWNW	49a	4-4-60	73	40	11	.69	25	4.2	8.0	1.2	90	1.0	19	.2	.0	154	82		201	6.7	0
15 NESWNW	49a	5-31-63	247	37	8.5	.30	42	17	20	4.3	235	15	12	.0	.1	263	174		430	6.6	
6S 14W 2 SWSWSW	90	3-25-65	550	48	3.1	.30	15	13	7.0	6.4	112	1.0	6.0	.3	6.0	170	103		247	7.0	25
6S 13W 1 SWSWSW	102	4-24-65	115	41	6.6	.89	49	21	12	6.2	270	6.0	11	.3	.2	265	208		446	6.6	40
21 SWNWSE	110	10-25-62	41	35	10	1.2	25	11	13	1.7	68	7.0	41	.1	.0	175	108		296	6.2	5
6 NWNWNW	132	6-1-64	224	47	2.0[2]	-	14	10	5.1	5.0	110	1.4	6.4	0.1	0.3	144	95		190	7.0	10
	Fritz Creek	8-25-62	Creek	39	.10[2]	.00	11	7.2	7.6	2.8	60	5.0	6.0	.0	.2	118	23		143	7.1	

[1] In solution at time of analysis
[2] Field determination

Source: Waller, R. M., Feulner, A. J., and Morris, D. A., 1968 in alluvial-fan deposits near Beluga Lake are estimated to yield up to 25 gpm. Wells on the Spit are reported to yield only saline or brackish water. Local well drillers report that yields in excess of 80 gpm are possible from deep wells drilled in the Kenai formation, but that casing, screening and development of such wells are necessary and depths may be excessive.

The above data suggests that groundwater would probably not provide an economic source of supply to augment the Bridge Creek reservoir. Low yields from individual wells in the Kenai Formation would necessitate installation of many wells to supply sufficient quantities of water to the municipal system to match demand in excess of 1.7 MGD, the reported capacity of the existing reservoir. Alternatively, fewer but deeper wells might be drilled and developed, but with associated pipeline, power and treatment costs required of such extensive groundwater development, it is likely that such development would be uneconomic.

4.0 ASSESSMENT OF DISTANT SURFACE WATER SUPPLIES

4.1 Sources of Supply

USGS maps of the area across Kachemak Bay from Homer show several lakes and streams that might be suitable for use. In evaluating the possible sources, attempts were made to locate earlier studies which were reported (L. Farnen, 1982) to have been prepared addressing the use of Hazel Lake such that this source could be studied further. Efforts to locate such studies were unsuccessful, however, as interviews with City staff and other consultants familiar with Homer's water system could not produce an identifiable project in which use of Hazel Lake was addressed. As a result, attention has been focused on evaluating several possible sources located on the south side of the Bay and identifying factors associated with their use.

Inspection of the area immediately across from the Spit shows that many of the surface streams draining into Kachemak Bay are glacial in origin, and likely would not be of suitable water quality for municipal purposes. The area located across from the end of the Spit, the closest point to which connection to the existing distribution system is possible, is primarily land within Kachemak Bay State Park. Within the Park boundaries, land and water use is reported to be for public recreation and enhancement only (R. Crenshaw, 1982), which suggests that use of surface waters for municipal water supply would require negotiation with the State Department of Natural Resources to secure their use.

Surface sources not within the boundaries of the Park are several miles distant from any point within Homer's water distribution system, however, and would require very long transmission lines, both underwater and overland. The one body of water in this category that was considered was Bradley Lake lying southeast of the head of Kachemak Bay. Attention was focused on Bradley Lake because of recent speculation of the lake being a potential hydroelectric site. It was felt that if a dam and power-generating facility were constructed, that incorporation of a water intake structure could be included. The hydroelectric potential has since been shelved. The cost of a remote intake structure, access road, four miles of underwater, and 20+ miles of overland transmission main would be prohibitive in cost; therefore this consideration was dropped.

Attention has been directed towards China Poot Lake (Leisure Lake), a relatively large and accessible source of water which appears to be the minimum distance from a connection with the existing distribution system on the Spit, although its watershed lies within the State Park boundaries.

4.2 Utilization of China Poot Lake

China Poot Lake is located about 0.7 miles upstream of the head end of China Poot Bay, or about 8 miles from the end of Homer Spit. Data collected by the Alaska Department of Fish & Game concerning characteristics of the lake include the following (Alaska Department of Fish & Game, 1982):

Parameter	Value
Altitude	190 ft.
Surface Area	0.42 mi^2
Volume	8.5 x 10^8 ft^3 (6.3 x 10^9 gal)
Average Depth	72 ft.
Maximum Depth	482 ft.
Mean Discharge (from lake outlet)	87 cfs

Selected water quality characteristics obtained from the Department of Fish & Game are also shown in Table 4.1. The lake is oligotrophic and water quality is reported to be good and only slightly variable with time. From a water supply standpoint, the data in Table 4.1 suggest that the water would be a good source for municipal purposes, although additional data are necessary to predict specific treatment measures needed to be employed. Nonetheless, comparison of these data to that collected for surface sources near Homer suggest a higher quality water that would require less treatment than Twitter or Fritz Creeks.

China Poot Lake lies within the boundaries of the Kachemak Bay State Park. The Departments of Natural Resources and Fish & Game were contacted to ascertain mechanisms by which water could be utilized for municipal purposes. Although the Master Park Plan has yet to be drafted, statutes which were developed when the State Park was created appear to limit use of lands and waters within the Park for public recreation and enhancement purposes, as mentioned earlier. Because of this, use of waters and land other than for recreation would require a special use be designated for the City and likely impose particular requirements on such a project to protect Park lands. Also, the Lake is currently used by the Department of Fish & Game for a juvenile sockeye salmon stocking program, which supports the commercial sockeye fishery within Kachemak Bay. In order to protect the stocking program in the Lake, effects on lake water levels and/or streamflow would need to be minimized.

Because of these factors, it is assumed that utilization of water from this lake would involve construction of a lake "tap" or intake and regulating structure, transmission line both underwater and overland, and upgrading to the existing distribution system on the Spit. In addition, such a project would likely require a treatment facility to be constructed, preferably on the end of the Spit to provide at the minimum disinfection of supplies. (Based upon the data presented in Table 3.1, it would also be necessary to provide filtration as well.) A transmission line from the end of the Spit to convey the flow to the

TABLE 4.1

SELECTED WATER QUALITY CHARACTERISTICS CHINA POOT LAKE (LEISURE LAKE)

Parameter	Value (mg/l unless noted)
Alkalinity	29-34 mg/l as $CaCO_3$
pH	6.9-7.7 (avg. 7.2)
Ca^{2+}	10-12
Mg^{2+}	2
Fe	12-25 g/l
Suspended Solids	5 mg/l
Conductivity	75-85 mhos/cm
Color	negligible

Source: Alaska Department of Fish & Game,
J. Koenings, 1982.

remainder of the City would require a larger capacity than the existing Spit pipeline.

In considering this scenario, major costs would involve the construction of a transmission line from the lake to the Spit, a distance of approximately 8 miles. Of the 8 miles, a maximum of 3 miles might be overland, depending upon alignment of the transmission line and location of the intake. The remainder would be a submerged pipeline crossing of Kachemak Bay and a portion of China Poot Bay. Pipe material used would need to be pre-tensioned concrete cylinder pipe with a steel outer shell, and mortar lined inside and out to provide negative buoyancy. Since detailed information on bottom conditions and topography in the Bay is not available at this time, the type of excavation and quantities can only be estimated. Since cost of such a transmission line is particularly sensitive to the bottom profile and sizing is not complete, only order-of-magnitude costs can be developed at this time.

Based upon similar projects, it is anticipated that installed costs for the submerged portion of the transmission line would be on the order of $425 per foot, or approximately $11,220,000 (1982 dollars) for a 5-mile line. In addition, a three-mile overland portion of the transmission line could add as much as $4,118,000. The cost of 20,000 feet of main installed the length of the Spit has already been estimated at $5,206,000. An intake structure designed to preclude entry of fish would cost an estimated $500,000. Finally, a water treatment facility would cost approximately $1,500,000. Thus the total estimated cost without any land acquisition, easements or Department of Natural Resources leases would conservatively be $22,544,000. Should capital cost estimates of the other alternatives be projected to be significantly greater as more detailed analysis is completed, however, further analysis of this alternative may be warranted.

5.0 ASSESSMENT OF REVERSE OSMOSIS FEASIBILITY

5.1 Background

Seawater reverse osmosis (RO) is moving into the large-production class in only about a decade following its commercial introduction. Already, RO technology has been developed to the point where major metropolitan areas, such as Riyadh, Saudi Arabia, employ the technology to provide municipal supplies of potable water (DuPont Corp., 1981). With increasing energy costs and greater demands for fresh water, RO has replaced multi-stage flash distillation as the preferred method of seawater conversion as RO represents the most energy-efficient technology developed to date. For brackish water also, RO is becoming more widely employed as an alternative to more conventional treatment methods or development of distant surface and/or groundwater supplies.

In Homer, the apparent lack of adequate groundwater supplies and relatively long distances to suitable surface sources suggests the need to investigate seawater utilization potential. With the City bordering on Kachemak Bay, abundant supplies of seawater could be used as a source to supply industrial, commercial and even residential demands in the area. In addition, having a large proportion of the City's water demand related to activities on the Homer Spit, use of RO technology on the Spit would allow demand to be met with a nearby water source.

For these reasons, the feasibility of employing RO technology in Homer is briefly reviewed herein. The type of technology to be employed and order-of-magnitude costs for installation of an RO system to meet anticipated demands is included, and conclusions drawn as to its applicability. This review is intended to allow comparison between this and other alternatives available to the City.

5.2 RO Technology

Reverse osmosis is nothing more than sophisticated filtration. Water is passed through a membrane under a pressure which is greater than the osmotic pressure of the dissolved salts in the water (Am. City & County, 1978). The membrane separates the solution into two parts--one dilute (permeate) and the other a concentrate (reject). In water treatment, the permeate is the desired product. RO membranes are essentially non-porous and permit separation of solutes from water by differential solubilities and diffusion rates through the membrane. In the main there are two cost-effective membrane materials: one based on cellulose acetate, the other on aromatic polyamide material (World Water, 1979). The geometry in which the membrane is packaged to form the permeator is important to successful conversion of seawater. The membranes are either referred to as spiral wound or hollow fiber.

In an RO plant, seawater is typically collected via seawells or in the case of brackish groundwater, from wells experiencing salt-water intrusion. From the well, the water is pretreated by a combination of physical and chemical means to protect the membranes which separate dissolved salts from the water. Usually, this pretreatment involves acid addition, sequestrant addition (chemical addition to stabilize scale-forming constituents in the water) and filtration through either sand or carbon filters. Following pretreatment, the water is pressurized by means of high-pressure pumps and fed to a bank of RO membranes which provide two effluent streams, the first being a concentrated reject stream of dissolved salts, and the second a product stream of high quality (low dissolved salts). The reject stream is wasted, and the product passes to a storage tank for final processing. From this point, the water is degassified to remove carbon dioxide and hydrogen sulfide, and the pH adjusted to approximately 7 prior to storage and distribution. A simplified flow diagram (Figure 6.1) of a typical seawater RO installation illustrates the process.

5.3 Application of RO Technology to Homer

The process shown in Figure 5.1 is the type of system which would most likely be employed in Homer to augment fresh-water supplies from the existing reservoir. An advantage of this kind of process is that it is modular and can be constructed in phases to match demand for the product. In this manner, modules of a specific capacity can be constructed sequentially in a plant designed for an ultimate capacity of up to several million gallons per day and construction phases staged over a long period of time. The particular installation schematically represented by Figure 5.1 currently supplies approximately 3 MGD of potable water to residents of Key West, Florida, where alternative fresh-water supplies must be piped more than 120 miles to augment the desalinated water. In a likewise fashion, an RO unit designed to convert seawater from Kachemak Bay to a potable supply could be located such that an alternative consisting of construction of a pipeline of several miles length, a surface water impoundment and associated treatment facilities would not be necessary. Because RO treatment of saline waters is energy intensive, however, and also less efficient at low water temperatures, cost comparisons need to be made with other alternatives at this stage.

For an RO plant of the type illustrated in Figure 5.1, recent capital cost projections (DuPont Corp., 1981; World Water, 1979; Quinn, R.M., 1982) suggest an installed equipment cost of between $4.00-$7.00 per gallon per day of plant product capacity for plants up to 1 MGD production. Above 1 MGD, plant costs (DuPont Corp., 1981) decrease somewhat due to economies of scale in plant construction. In Alaska, such plants would experience higher capital costs due to provisions to construct and operate a facility in sub-arctic conditions. For a plant constructed in phases in accordance with demands at Homer, such as with an initial capacity of 1.5 MGD to be increased later to 3 MGD, estimated initial capital costs (in 1982 dollars) would be on the order of $13,000,000-$18,000,000. This assumes that the initial treatment plant cost includes additional treatment capacity provided to offset reduced operating efficiency of permeators with low seawater feed temperatures. Further plant expansion to meet additional demands would likely cost an additional $2.00-$4.00/gpd of capacity. Comparison of these capital cost estimates with those suggested for a Fritz Creek alternative (CH_2M-Hill, 1980) providing for fish flows suggests that RO would be more than double the cost of developing the Fritz Creek site.

Because of its energy intensive nature, the operating costs of an RO plant would be much higher than that of a surface water plant of equal capacity. Typical operating costs for an RO plant producing approximately 1 MGD are reported (DuPont Corp., 1981; Quinn, R.M., 1982) to be on the order of $4.00/1000 gallons of product, or approximately $1,400,000 per year for Homer. At a greater plant capacity, unit costs will decline only slightly, so an assumption of $4.00/1000 gal of product appears reasonable. Compared to costs for operation and maintenance of a Fritz Creek alternative assumed to be roughly equal to that incurred in operation of the Bridge Creek facility, RO appears to be much more expensive to operate and maintain.

5.4 Conclusions

The utilization of RO technology to provide a municipal water supply for Homer, while technically feasible, appears to be economically unjustifiable in comparison with projected costs for alternative surface water development. Both capital and operating costs for an RO plant capable of supplying Homer with water to supplement Bridge Creek supplies are much in excess of those likely to be incurred in development and operation of a Fritz Creek supply. Further investigation of this source of supply is not warranted at this time unless all other sources of supply are found to be unfeasible.

6.0 HYDROLOGY

6.1 General

Hydrological studies were performed on the existing Bridge Creek site and the proposed sites on Fritz and Twitter Creeks. This investigation was based on existing and in-house computer generated data.

6.2 Methodology

No long-term streamflow records suitable for reservoir design are available at the existing or potential dam sites. However, relatively good meteorological data are available in the vicinity of the study areas, and continuous streamflow data are available for approximately ten years from the nearby Anchor River.

The approach adopted for the hydrologic aspects of the study was to reconstruct the historic streamflow record at the dam sites for a period of about twenty years. This data was then used to determine the yield at the sites under investigation.

The historic streamflow record was reconstructed using computer based mathematical models of the land surface hydrology. The models used were the National Weather Service's (NWS) Snow Accumulation and Ablation Model and the NWS Soil Moisture Accounting Model. Together these models transform historic precipitation and temperature data. The process of snow accumulation and melt is modeled, as is movement of moisture either from rainfall or snowmelt, through the soil horizon into the stream channel system.

Having reconstructed the historic streamflow record, conventional mass curve analyses were used to estimate the reservoir capacities and yields.

6.3 Precipitation and Temperature Data

Daily precipitation data and daily maximum and minimum temperature data have been collected by the National Weather Service at four sites in the vicinity of Homer. The locations of these sites are shown in Figure 1.1 and information pertaining to the records is given in Table 2.1.

The record available from Homer 8NW is too short to be of interest for this study. The record from Homer Research Center is also of limited value because of the short length of record and the large amount of missing or estimated data.

However, because of the proximity of Homer Research Center to the Fritz Creek catchment, monthly precipitation data from this site were obtained for analysis.

The records from Homer WSO and Homer 5NW are both of good quality with very little missing or estimated data, and are the most useful data series for this study. The daily data from Homer WSO and Homer 5NW were obtained on magnetic tape from the National Climatic Center for the period January 1948 through December 1976.

The mean annual precipitation at Homer 5NW (elevation 1000 ft.) is 27.7 inches and the mean annual precipitation at Homer WSO (elevation 63 ft.) is 23.2 inches. The mean monthly precipitation and mean monthly temperature at Homer WSO and Homer 5 NW are shown in Figures 2-1 and 2-3 for the common period of record October 1952 through September 1972. It is noted that this period represents water years 1953 through 1972, i.e., twenty water years of data.

Table 6.1

PRECIPITATION AND TEMPERATURE DATA

Station Name	Station Index No.	Station Elevation (ft)	Period of Record	Mean Water-Year Precipitation (in.)*	Mean Water-Year Temperature (°F)*
Homer WSO AP	503665	63	Jan. 1943 - present	23.2	36.3
Homer 5NW	503670	1000	Mar. 1952 - Aug. 1973	27.7	36.0
Homer 8NW	503672	1000	Oct. 1977 - present	--	
Homer Research Center	503680	280	Oct. 1973 - Dec. 1978	--	

*Based on common period of record 1953-1972

The records indicate that the higher elevation land immediately north of Homer receives about 20% more precipitation than is recorded at the Homer WSO gage at Homer Airport. Close inspection of temperature data at Homer WSO also shows that this low elevation station experiences occasional periods with appreciably lower temperatures than are encountered at Homer 5NW. These low temperatures are caused by cold air draining from glaciers on the north slopes of the Kenai Mountains and settling over Kachemak Bay. The temperature and precipitation record at Homer 5NW is thus more representative of conditions over the catchments of interest in this study than is the data from Homer WSO.

As mentioned earlier, monthly precipitation data were obtained from Homer Research Center for the period October 1973 through December 1978. During this period, National Weather Service records show that 8 months of data were missing, and data for parts of at least 4 months were estimated. The methods by which these data were estimated have not been determined. Complete data for two years, 1974 and 1976 are available. The mean annual precipitation for this period is 17.48 inches at Homer Research Center and 22.61 inches at Homer WSO. Analysis of concurrent monthly data from Homer WSO and Homer Research Center shows that the monthly data have a correlation coefficient of about 0.86. There is no obvious seasonal variation in the relationship between monthly precipitation data at the two stations.

The short record available from Homer Research Center suggets that precipitation decreases as one moves along the coast in a northeasterly direction from Homer. The long-term mean annual precipitation at Homer Research Center is estimated as about 18.6 inches, i.e., 80% of the amount at Homer WSO. Similar reductions in precipitation may be expected at the higher elevation as one moves in an easterly direction from Homer 5NW.

6.4 Streamflow Data

Streamflow data in various forms have been collected by the U.S. Geological Survey from a number of sites of interest to this study. The locations of streamflow gaging sites are shown in Figure 1-1 and information pertaining to the records available is given in Table 6.2.

The continuous discharge record for the Anchor River near Anchor Point was obtained on magnetic tape from the U.S.G.S. Data from other sites have been obtained from the series of annual U.S.G.S. publications entitled, "Water Resources Data for Alaska." At the partial record stations a number of discharge measurements are made each year, often during base flow conditions. The crest-stage data from Fritz Creek gives the instantaneous peak flow observed in each water year.

The quality of the continuous discharge record on Anchor River and Twitter Creek is described by the U.S.G.S. as being either fair or good except during the winter months. Because of freeze-up, gage height data is usually unavailable during the winter months November through April, and a continuous record is estimated by interpolating between occasional instantaneous discharge measurements. These data are thus often of poor quality during the winter months. The partial record and crest-stage data probably provide accurate estimates of instantaneous flow rates at all times.

The mean annual flow at the Anchor River gage for the period of record is 208 cfs (1.56 cfs/sq. mi.). The drainage areas is 133 sq. mi. The distribution of flows within the year is shown in Figure 6.1. The plot of mean monthly flows exhibits two peaks, one in May associated with snowmelt and a secondary peak in October associated with early fall storms. Precipitation from November through March is generally in the form of snow. Freeze-up in the winter months results in low streamflows from December through March.

Table 6.2

STREAMFLOW DATA

Station Name	Station Index No.	Drainage Area (mi^2)	Period of Record	Type of Record	Mean Annual Runoff (cfs/mi^2)
Anchor River	15239900	133	June 1965 - Sept. 1973	Continuous Record	1.56 (water years 1966-73 & 1978-81)
			Sept. 1978 - present		1.33 (water years 1972-73)
Twitter Creek nr. Lookout Mountain	15239845	1.63	1978 - present	Continuous Record	----
Twitter Creek nr. Homer	15239880	16.1	Aug. 1971 - Sept. 1973	Continuous Record	1.32 (water years 1972-73)
Fritz Creek	15239500	10.4	1963 - present	Partial Record and Crest Stage Record	----

6.5 Evaporation Data

Evaporation data is necessary for mathematical modeling of the rainfall/runoff transformation using a soil moisture accounting method. Estimates of potential evapotranspiration are usually based on either pan evaporation data or an analysis of available meteorological data. The nearest evaporation pan to the study area is located at Matanuska, some 150 miles northwest of Homer. Because of the differences in climate at Matanuska and Homer, this data was not used for this study. Rather, mean monthly evaporation data were estimated using the nomograph presented by Kohler et al. (1955). Calculations were based on mean monthly air temperature, relative humidity, wind speed and cloud cover recorded at Homer WSO. The estimated mean monthly evaporation over the study area is given in Table 6.3.

6.6 Calibration of Anchor River Catchment

The NWS Snow Accumulation and Ablation and Soil Moisture Accounting Models are generalized hydrologic models which may be used in a wide variety of climatic regimes. Application of these models to a particular catchment or area requires that model parameters be set to represent conditions in the catchment of interest. The process by which the parameter values are obtained is known as calibration.

These models were calibrated to accurately reconstruct the flows on the Anchor River at the Anchor River stream gage for the period of record 1966-1970. Input to the models was provided by the time series of precipitation and temperature data from Homer 5NW, and the estimated mean monthly lake evaporation data given in Table 6.3. Output from the models include simulated snowpack conditions and simulated flows at the Anchor River gage. The model parameters were chosen and adjusted in an iterative manner until the simulated flows from the model conformed as closely as possible to the observed Anchor River flows.

Table 6.3

ESTIMATED MEAN MONTHLY POTENTIAL EVAPORATION

Month	Evaporation (inches)
October	0.8
November	0.3
December	0.3
January	0.3
February	0.3
March	0.3
April	1.4
May	1.9
June	2.9
July	2.8
August	2.2
September	1.2
Annual	14.7

Good calibrations were achieved of the critical winter low flow conditions, and the timing of spring snowmelt was simulated satisfactorily. Peak flows during snowmelt were, however, overestimated, and the duration of simulated snowmelt periods were somewhat shorter than recorded. The latter difficulties do not, however, affect the sizing of storage reservoirs required in this study. The adequacy of calibration is illustrated in Figure 6.2, which shows a comparison of flow duration curves for the simulated and recorded flows.

7.0 ASSESSMENT OF SURFACE WATER SUPPLIES

7.1 General

The initial phase of surfce water investigations has focused upon development of estimates of water yields from surface supplies identified for possible use in earlier studies. These include, but are not limited to, the following:

a. Anchor River/Beaver Creek.
b. Increasing the capacity of the existing reservoir on Bridge Creek.
c. Construction of a new reservoir on Twitter Creek.
d. Construction of a new reservoir on Fritz Creek.

The locations of these sites are shown on Figure 1.1.

7.2 Anchor River/Beaver Creek

These two potential sources of water supply were considered both individually and in conjunction with each other. Beaver Creek, being a tributary to Anchor River, is therefore part of the Anchor River watershed.

a. Beaver Creek is located about 7 miles northeasterly of Homer. The creek flows in a westerly direction, draining approximately a 10 square mile basin. It enters the Anchor River about 16 miles east of the mouth of the Anchor River. The only measured flow on Beaver Creek near its mouth was July 1970. The flow indicated a mean discharge of 8.93 cubic feet per second (cfs) as measured by the U.S. Geological Survey. In order to maximize available water it would be necessary to construct a dam approximately two miles upstream from the mouth of Beaver Creek. Such a structure has been deemed unsatisfactory by the Alaska Department of Fish and Game (ADF&G) for two reasons. The first is that Beaver Creek is a spawning creek for anadromous fish which would have to be guaranteed one-half the total flow and with provision to transverse the dam. The other major factor in rejecting Beaver Creek is that a major portion of the lower half of the creek goes through a wide, marshy basin which is a haven and feeding ground for moose. This area is several times the size of the winter feeding grounds in the Fritz Creek basin. The area would be inundated were a dam to be built on Beaver Creek, and lost permanently as a feeding ground.

b. The Anchor River discharges into Cook Inlet at Anchor Point at the Town of Anchor Point. The Anchor River flows westerly across the tip of the Kenai Peninsula, draining a basin of approximately 226 square miles. Moving upstream approximately 3 miles to where the Sterling Highway bridge crosses the Anchor River, the drainage area is reduced to 133 square miles. U.S. Geological Survey records indicate a minimum/maximum flow range from 20 cfs to 2240 cfs. The mean low monthly (Jan.-Feb.) range being 69 cfs.

Statements have been repeatedly made by ADF&G personnel that any diversion of water from (much less damming of) the Anchor River could be expected to be blocked by a very powerful lobby of sports and commercial fishing interests through the State Legislature.

There is a potential means of collecting water from the water-bearing strata beneath a body of water. This is called the Ranney Method and consists of a sunken caisson on shore which serves as a stilling well or pump sump. Well point screens are driven out into the sandy-gravelly layer beneath the stream bed and collect ground water. This water goes into the caisson and is subsequently pumped out into the transmission main. Using this method there is no construction in the river and no intake withdrawing directly from the river.

To utilize the Ranney Method of radial collector wells would involve sinking the caisson on land near the river, incorporating the pumphouse in the upper chamber of the caisson (but basically underground), installing 37,000 feet of transmission main along the Sterling Highway to about West Hill Road and construction of a water treatment plant. The treatment plant is a common cost to any of the alternative sources studied. This may be one of the more cost-effective alternatives as it could also have provisions to supply Anchor Point.

In order to give this alternative serious consideration, however, two things must be done. The concept must be submitted for consideration to ADF&G and the Department of Natural Resources (since it is a ground water extraction well). If a favorable response is received, then a small well should be drilled and a water sampling program initiated in order to determine the water quality obtained, which in turn influences the water treatment plant design.

7.3 Bridge, Fritz and Twitter Creeks

These three creeks have, to one degree or another, been considered and studied in reports going back over 20 years. Reports dated 1962 (Soil Conservation Corps), 1971, 1977, 1980 and on have been re-reviewed. Ultimately, Bridge Creek was developed as a new surface water source in 1975, which led to the abandoning of the unreliable ground water wells located in the vicinity of the new Bridge Creek dam.

The next step in this report was to expand on the generalized nature of the previous reports. There were no long-term flow records available at Bridge Creek, Twitter Creek and Fritz Creek. In order to determine the adequacy of available water supply where no records exist, the next step in the study was to simulate flows for each of the three creeks, based on the Anchor River flow simulation discussed in the previous chapter.

7.3.1 Simulation of Daily Flows: Twitter Creek and Bridge Creek

The NWS models calibrated for the Anchor River catchment were used to simulate average daily flows at the Twitter Creek and Bridge Creek damsites for water years 1949 through 1972. As has been noted earlier, the continuous discharge record on Twitter Creek shows that this catchment has a lower base runoff (cfs/mi^2) than the Anchor River as a whole. The parameters obtained from the Anchor River calibration were therefore adjusted to produce lower primary baseflow and steeper initial recession rates. The effects of the parameter changes were checked by comparing simulated and recorded flows at the Twitter Creek continuous record gage for the period of record, water years 1972-1973. A plot of simulated and recorded runoff for water year 1972 shows relatively good agreement between recorded and simulated streamflow.

Input data for simulating Twitter Creek and Bridge Creek flows were again precipitation and temperature data for the period 1952-1973 from Homer 5NW. The Homer 5NW record started immediately after a two-year period of very dry conditions. As this period (1951-1952) was thought to be important for determining the required reservoir storages, the Homer 5NW record was extended back to October 1949 using the longer term record from Homer WSO.

Precipitation data for 1949-52 was obtained simply by multiplying Homer WSO data by the ratio of mean annual precipitation at Homer 5NW and Homer WSO for the period of common record 1953-72.

Temperature data for the period 1949-52 was taken without adjustment from the Homer WSO record. The simulated monthly flows at the dam site and the calculated drainage areas are given in Sections 9.2 and 10.2.

7.3.2 Estimation of Daily Flows: Fritz Creek

Because of uncertainty about the precipitation regime in the area of Fritz Creek, mean daily flows at the Fritz Creek dam site were estimated by prorating the simulated flows on Twitter Creek for water years 1949 through 1972.

Analysis of simulated data indicated that the runoff rate (cfs/mi^2) from Fritz Creek was about 76% of that on the Anchor River. It was also shown that the runoff per square mile at Anchor River and Twitter Creek is about the same. It was thus assumed that mean daily runoff (cfs/mi^2) from Fritz Creek was 76% of that simulated for Twitter Creek.

The estimated flows for Fritz Creek were compared with the data from the partial record at the Fritz Creek gage. In most instances, agreement between simulated and recorded flows was satisfactory, although some large differences in peak flow did occur which could not be explained with the available data. However, such differences are not critical in the development of water yield from the reservoir. The simulated monthly flows at the dam site and the calculated drainage area are given in Table 11.2.

7.3.3 Conclusions

Historical flows were estimated by means of a simulation model. The estimated mean annual runoff from the watersheds of Bridge Creek, Twitter Creek and Fritz Creek sites are 4.9 cfs, 6.2 cfs and 9.9 cfs, respectively (3.2 MGD, 4.0 MGD and 6.4 MGD). The annual runoff in the critical dry year during the period for which flows were synthesized were 1.8 cfs, 2.25 cfs and 3.6 cfs, respectively (1.16 MGD, 1.45 MGD and 2.32 MGD).

8.0 REGIONAL GEOLOGY

8.1 General

Geological descriptions of a general nature presented herein are based on the review of previous reports. Numbers in parentheses refer to the reports listed under References.

It is the purpose of this section to present the relevant geological information and to point out its significance to the design and construction of dams.

The main geomorphic elements consist of an escarpment of moderately indurated sedimentary bedrock immediately north of Homer and beyond this to the north an upland area of the same bedrock almost entirely covered by glacial deposits. Dam sites described are on creeks incised in the upland and range from about 2.5 to 8 miles from the City. The Homer Spit, which extends about 4 miles southward from Homer into Kachemak Bay, is a narrow bar consisting of coarse beach gravel and boulders. Apart from the Spit, the only known sizeable source of alluvial sand and gravel is a pit at Anchor Point, located about 16 miles by paved highway west of Homer.

8.2 Bedrock

The entire area is underlain at shallow depth by the Kenai Formation which consists of moderately indurated sandstone, siltstone and claystone, mainly in thin beds and lenses, interbedded with a few thin lenses of fine conglomerate and many thin beds of subbituminous or lignitic coal. Ferruginous masses and ironstone concretions are common (Waller, R. M., et al., 1968). The Kenai Formation is of Tertiary age and is believed to be up to 20,000 feet in thickness. Where observed in the study area the beds dip northerly about 4 degrees below horizontal.

Excavated rock of the Kenai Formation, observed in quarries during a reconnaissance of the area, is broken down to sand and gravel sizes. Confirmation of the softness of the material is given by descriptions of the bedrock at the Bridge Creek dam site where it is described as "generally semiconsolidated into a moderately soft rock . . . cut easily with a knife and sometimes scratched with a fingernail" (Hill-Harned & Assoc., 1974). It is therefore expected that for dam construction purposes quarries in the bedrock would not represent a source of rock fill but could well serve as a source of sand.

The Kenai Formation is described as probably constituting the most extensive and the most productive aquifer system in the area. However, objectionable amounts of iron occur in the ground water throughout much of the area and some of the ground water contains methane gas probably derived from the coal formations (Waller, R. M., et al., 1968).

Highly permeable zones, of course, represent unfavorable features in a dam foundation. At the Bridge Creek dam site, coal beds were described as highly fractured and it was anticipated that water losses during pressure tests would occur through these fractures. While water losses at that site were also expected to occur through joints and bedding planes of the siltstone and silty sandstone and not through the rock itself, some of the non-silty sandstones appeared to be porous, and water losses were expected to occur through the sandstone itself as well as along joints and bedding planes (Hill-Harned & Assoc., 1974). This raises the possibility of piping occurring in sandstone beds in dam foundations should the piezometric gradients result in water flowing at velocities high enough to move the sand grains.

8.3 Overburden

As a relatively short time has elapsed since the ice sheet that formerly covered the area receded, the Kenai Formation is mantled by nearly continuous deposits of glacial draft. The deposits of this material observed during the reconnaissance appear to be unsorted mixtures apparently deposited directly by glaciers and consisting of clay, silt, sand, gravel and boulders. These deposits are referred to herein as glacial till. The largest boulders observed in this material are in the order of 2-ft. diameter. While it is reported by others that some of the glacial drift deposits consist of stratified gravely outwash material, and a few boulders greater than 2-ft. in diameter were observed during the reconnaissance, for general planning purposes it is taken that the overburden at the dam sites discussed herein consists essentially of the unstratified glacial till described.

This material is believed to have extremely low permeability and, while not well consolidated near the surface, appears to be suitable to serve as a dam foundation and as impervious core material for an earth-fill dam.

Regarding the depth of overburden, it is noted that during a soil survey of the area reported in 1971 (U.S.D.A., 1971), to expose soil profiles many holes were dug through the topsoil into the parent material. Although in the great majority of the holes the parent material was found to be glacial drift, some of the holes encountered bedrock. As the soil directly overlying bedrock at shallow depth was given a special designation, Kachemak silt loam, occurrences of this soil mapping are of interest in estimating the depth of overburden in the study area. Widely distributed occurrences of the Kachemak silt loam indicate the possibility of bedrock occurring at shallow to moderate depth at all of the dam sites. At the Bridge Creek dam site, however, by exploratory drilling the depth of overburden was found to be as great as 34 feet on the right (north) abutment (Hill-Harned & Assoc., 1974).

Topsoils in the study area are mainly silty loams 2 or 3 feet thick but include in muskegs peat soils comprising mats of moss and peat many feet thick (U.S.D.A., 1971). The majority of the soils are rated from moderate to high in corrosive acidity potential (Hill & Assoc., 1972).

8.4 Seismicity

The results of seismic hazard analyses are presented in previous reports, (Hill-Harned & Assoc., 1974; CTA, 1974). It has been found that:

a. Every year in the Homer area there are numerous earthquakes of Richter magnitude 4 to 5 and there has been in historical time an earthquake of magnitude 6.5 located approximately 20 miles southwest of the Bridge Creek dam site and an earthquake of magnitude 6.25 seven miles northeast of that site.

b. No surface ruptures or displacements of significance appear on any geologic maps of the Homer area.

c. Past events in historical time have probably caused, at the Bridge Creek site, bedrock accelerations up to 0.35g with a predominant period of 0.35 seconds and it is reasonable to treat this as the maximum acceleration to be expected in the future.

d. Although the area is within an Earthquake III zone, it appears that it is within one of the quieter or less active areas of Zone III.

Regarding the response of dams to earthquakes, it should be pointed out that safety of an earthfill dam depends to a great extent on the pore pressure build-up and deformation characteristics to be expected under earthquake conditions. Dams of clay fills on clay or rock foundations have withstood extremely strong shaking, producing horizontal forces of

0.35 to 0.8g caused by an earthquake of magnitude 8.2 with no apparent damage (Seed, H. B., Geotechnique, Vol. 29, No. 3, 1979).

Improvements in design and construction methods have tended to counteract the effects of inertia forces related to dam height. Slippage is not generally due to the inertia forces under the shaking action but to reduction of shear strength caused by high pore pressures induced (especially where silty material subject to liquefaction is present).

9.0 BRIDGE CREEK ALTERNATIVE

9.1 General

This alternative involves increasing the storage capability of Bridge Creek by raising the existing dam.

9.2 Streamflow Synthesis

The drainage area at the Bridge Creek damsite is 3.6 square miles. Input data for simulating Bridge Creek flows were precipitation and temperature data for the period 1952-1973 from Homer 5NW. The Homer 5NW record started immediately after a two-year period of very dry conditions. As this period (1951-1952) was thought to be important for determining the required reservoir storages, the Homer 5NW record was extended back to October 1949 using the longer term record from Homer WSO.

Precipitation data for 1949-1952 was obtained simply by multiplying Homer data by the ratio of mean annual precipitation at Homer 5NW and Homer WSO record. The NWS models calibrated for the Anchor River catchment were used to simulate average daily flows for water year 1949 through 1972. The simulated monthly flows at the damsite are given in Table 9.1. Since no streamflow measurements have been recorded at Bridge Creek, the simulated flows represent the best available data upon which to make estimates of reservoir yield and the mean monthly flows for 24 years are shown in Figure 9.1. It is noted that the flows have double peak, one occurring in spring and another occurring in fall. Low flows occur in winter and summer.

TABLE 9.1

SIMULATED STREAMFLOW, BRIDGE CREEK, cfs

```
OPTION =MONTH

ENTER SUBROUTINE MONST

DSN=     2
BYR=    49
EYR=    72
SIMULATED FLOWS BRIDGE CREEK  3.6 sq. mi.

STATION   WYR     OCT     NOV     DEC     JAN     FEB     MAR     APR     MAY     JUN     JUL     AUG     SEP   ANNUAL
15239851   49    6.53    5.19    1.83    1.20    1.03    1.30    6.02   17.27    5.44    2.11    1.41    3.04    4.40
15239851   50    6.09   10.65    3.43    1.56    1.21    2.93    9.52    7.57    2.06    1.31    1.10    1.54    4.09
15239851   51    2.40    2.03    1.09    1.42    1.03     .93    7.48    5.34    1.82    1.15    1.02    2.49    2.35
15239851   52    2.23    3.22    1.59    1.01     .86     .77    1.71    4.35    1.79    1.19     .98    1.46    1.76
15239851   53    7.08   21.64    7.23    6.00    2.34    1.74   13.57   17.61    4.20    1.77    1.96    4.67    7.58
15239851   54    6.49    4.02    3.02    1.70    1.17    1.01    4.50   20.52    3.10    1.50    3.07    3.17    4.45
15239851   55    7.13    7.39    2.60    1.56    1.49    1.20    2.28   20.97    5.41    1.99    1.40    2.35    4.87
15239851   56    5.76    2.91    1.39    1.07     .95     .86    4.29   21.37    5.25    1.90    1.80    2.57    4.19
15239851   57    5.21    5.04    3.28    1.42    2.15    1.66    7.73    6.13    1.40    1.22    1.38    6.69    3.63
15239851   58    8.87   15.29    5.51    1.88    1.34    1.27   14.83   14.73    3.17    3.45    4.36    6.55    6.74
15239851   59    6.17    5.30    2.61    1.57    1.30    1.04    4.81   31.11    4.61    2.56    1.55    1.49    5.34
15239851   60    3.38    5.21    3.10    1.69    1.15     .97    2.79   31.68    4.66    2.73    5.10    6.72    5.75
15239851   61    6.96    5.88   11.61   15.33    4.01    1.76    4.54   11.21    2.48    1.74    1.73   11.12    6.54
15239851   62    7.46    5.93    5.36    2.05    1.32    1.48    6.60   24.37    3.13    2.36    1.45    1.38    5.57
15239851   63    2.78    5.14    3.83   10.26    4.03    3.67    4.44    4.09    1.55    1.14    1.47    2.56    3.75
15239851   64    6.03    2.58    7.89    3.33    2.09    1.53    2.44   15.21    6.23    2.05    1.73    2.33    4.61
15239851   65    6.58    3.57    1.78    1.18    1.02    4.20   13.60   18.19    6.26    2.55    2.17    5.56    5.55
15239851   66    5.84    2.08    1.35    1.10     .99     .90    5.05   21.12    6.59    2.26    5.54   11.51    5.36
15239851   67    9.49    3.28    1.85    1.29    1.12    1.02    2.95   19.75    3.07    1.51    3.77   10.16    4.94
15239851   68    4.50    9.26    4.39    3.13    3.21    2.97    3.93   13.92    2.93    1.45    1.16    1.11    4.33
15239851   69    1.38    1.44    1.10     .83     .74     .67    4.91   14.86    3.46    1.53    1.20    1.09    2.77
15239851   70    9.76    4.95    8.75    4.01    3.48    4.34    5.71   23.78    3.65    1.67    1.81    3.44    6.22
15239851   71    4.78    7.34    1.95    1.24    2.00    1.20     .94   10.63   40.50    3.72    1.97    2.05    6.53
15239851   72    9.76    3.59    1.73    1.23    1.07     .96     .86   23.76   11.75    2.45    2.14    7.81    5.59

***WARN*** EOF IN FILE      2 AFTER WYR   72

SAMPLE SIZE        24      24      24      24      24      24      24      24      24      24      24      24      24

MEAN             5.94    5.96    3.68    2.51    1.71    1.68    5.54   16.65    5.98    1.98    2.14    4.27    4.37
STD. DEV         2.28    4.45    2.70    3.30     .98    1.07    3.78    7.63    7.60     .69    1.26    3.16    1.39

FINISH MONST
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9.3 Water Yield

The design of a reliable water supply is based on the firm yield concept in which the supply is designed to meet demands during the most critical low-flow periods, which in this case would be represented by the period July 1950 through September 1951.

The mass curve approach was used in determining firm yield. A mass curve such as that shown in Figure 9.2 is a plot of cumulative flows with time. A mass curve of inflow represents the total amount of water passing through a given point in a river with time. The mass curve of inflow shown is for the dry period 1950-1951 and was adjusted for downstream use for the required release of 700 gpm (1.0 MGD) or the actual flow in the river, whichever is less (L. Farnen, 1982). A mass curve of outflow can also be drawn on the same plot and this represents the total amount of water that could be withdrawn or utilized. The slope of the mass curve of outflow would be the rate at which water could be withdrawn. The difference in volume between the mass curve of outflow and inflow is the amount of water that is withdrawn from reservoir storage and the maximum ordinate between these two curves is the size of the reservoir that is required to accommodate the stored water. The existing storage capacity at Bridge Creek is 470 acre-feet. It is seen in Figure 9.2 that this storage capacity would allow a withdrawal rate of 0.66 MGD which is defined as the firm yield. Since the dry period occurred once in 24 years, it can be concluded that the data predict a water yield of 0.66 MGD or greater in 23 out of 24 years of record or a confidence level of 96%. A similar analysis could be performed on the next driest period and the confidence level that would be obtained would be 22 out of 24 or 92%. A plot of water yield versus confidence levels is shown in Figure 9.3. The graph shows that, at 90% confidence level the data predict a firm yield of 0.69 MGD, and that at 95% confidence level would predict 0.58 MGD. In other words, the data suggest that Bridge Creek reservoir will supply 0.69 MGD nine times out of ten and 0.58 MGD 95 out of 100. Larger yields than 0.69 MGD could be predicted but with a lesser degree of confidence than 90%.

Comparison of these results to the actual and projected water demands (Figure 9.4) shows that the Bridge Creek reservoir firm yield is likely to be reached in the near future.

As demand increases with time, or if demand grows at a faster rate than expected, the odds against the City being able to meet all demands increases. Hence, the City may wish to consider the risks and consequences of insufficient supplies in planning for water system developments, or wish to consider means by which to prevent rapid increases in water consumption.

9.4 Evaluation of Bridge Creek Reservoir Expansion

A technique by which the City could increase the safe yield from the existing reservoir would be to increase the effective storage capacity by raising the height of the dam. The effect of increasing the height of the dam would be to permit more water to be stored during wet periods for subsequent use during dry periods. The topographic and geotechnical considerations for developing this alternative are discussed in the following sections.

9.5 Topography and Geology

This section is from reports previously reviewed (Hill-Harned & Assoc., 1974; C. A. Hill & Assoc., 1972).

The valley floor at the Bridge Creek Dam site is about elevation 900 feet and the creek has incised a channel about 30 feet deep with a floodplain about 50 feet wide in the valley bottom. The slopes of the valley rise on 7 to 8 percent grades to ridge tops at about 1100 to 1200 feet elevation. Outcrops of sandstone and siltstone occur at scattered locations along the south bank of the creek. Elsewhere the bedrock is mantled by glacial drift.

Before construction of the dam, the site was investigated with seven boreholes in the vicinity of the proposed axis and with numerous test pits. Gray siltstone and sandy siltstone were found to constitute over 60 percent of the geologic section tested, with sandstone comprising less than 30 percent and coal comprising about 10 percent. The surface of the Kenai sandstone and siltstone was found to be weathered and decomposed with relatively fresh rock occurring below about 2 feet; however, the bedrock throughout appeared to be fractured. Coal beds encountered were highly fractured and it was anticipated that water losses would occur through the fractures.

The mantle of overburden was deepest on the right abutment where it consisted of one foot of organic soil over 4 feet of soft silty clay overlying 34 feet of compact to dense glacial drift overlying the Kenai Formation. The drift was generally compact to very dense and was described as consisting of stratified silt, sand and gravel (CH_2M-Hill). However, water losses during the drilling and packet tests performed indicated the glacial drift to be low in permeability. Penetration resistance tests showed that the glacial drift has a high strength and is relatively incompressible.

Because of the gentle slopes, no landslides or areas of potential landslides were noted in the reservoir system.

9.6 Raising Bridge Creek Dam

The dam section at Bridge Creek is shown in Figure 9.5. It is believed that raising Bridge Creek Dam would be very expensive and quite impractical. The design problems described below arise from the fact that Bridge Creek Dam has never been intended to be raised by its designers.

a. The internal zoning of the existing dam narrows toward the crest. The central core, Zone 1, would have to be continued upward in a narrow upstream-inclined zone, and Zone 3 would have to be turned section of the existing dam. Thus, the dam would not only have to be raised, but widened at least toward downstream.

b. The hydraulic gradient, H/L, governing the underseepage and uplift conditions within the dam foundations, already unusually steep for a dam sitting on a highly erodible foundation, should certainly not be steepened. Thus, if the head, H, is increased the internal impervious blanket under the upstream shell of the dam would have to be continued farther upstream. This cannot be done without dewatering the reservoir.

c. The outlet structures would have to be relocated and/or reinforced to accommodate the widened plan area of the dam.

9.7 New Downstream Dam

An alternate to raising the existing Bridge Creek Dam would be to move downstream and construct a new high dam. Ignoring ADF&G's release rate requirement to sustain fish population and that because of this release, that no more useable storage would be obtained beyond that presently available from the existing dam, other factors negated this alternative. The present worth in today's dollars of the existing dam and appurtenances would be discarded with no salvage value. The cost of the new dam, spillway structure and intake structure would be incurred at today's dollars. In addition, raising the lake surface significantly would flood the pumping station, which would have to be rebuilt at a higher elevation. When considering the effects of building a totally new dam downstream, it was concluded that it would not be cost-effective for the amount of water obtained.

10.0 TWITTER CREEK ALTERNATIVE

10.1 General

This alternative includes providing a storage reservoir by constructing a dam at Twitter Creek. The proposed dam will be located in Section 32 opposite Ohlson Mountain (Figure 1-1).

10.2 Streamflow Synthesis

Analysis of the continuous discharge record from Anchor River and Twitter Creek shows that runoff was nearly the same at these two sites for water years 1972 and 1973. This suggests that the long-term mean annual runoff on Twitter Creek is similar to that for the Anchor River as a whole (i.e., approximately 1.5 cfs/sq. mi.).

The concurrent monthly flows for Anchor River and Twitter Creek are plotted in Figure 10.1 for the period of record available on Twitter Creek. This plot indicates that Twitter Creek has consistently lower winter base flows and somewhat higher peak flows than the Anchor River. The higher base flows on the Anchor River probably arise from storage of water in marshland bordering the river channel. Comparatively few marsh areas are found in the Twitter Creek catchments.

Data from the partial record station on Twitter Creek near Lookout Mountain are given in Table 10.1, along with the concurrent mean daily flow at the Anchor River gage where available. The runoff measurements (cfs/sq. mi.) at the partial record gages are plotted against the mean daily runoff (cfs/sq. mi.) at the Anchor River gage in Figure 10.2.

TABLE 10.1

PARTIAL RECORD DATA, TWITTER CREEK

Date	Twitter Creek Near Lookout Mountain	Anchor River Near Anchor Point
07/13/78	1.7	
08/18/78	1.2	
09/15/78	1.1	136.0
10/10/78	1.4	202.0
11/09/78	2.1	148.0
01/12/79	1.2	125.0
03/19/79	0.49	80.0
04/17/79	1.0	190.0
05/03/79	14.0	933.0
05/15/79	12.0	521.0
05/30/79	4.2	246.0
06/15/79	1.5	111.0
07/19/79	0.88	104.0
08/16/79	0.97	95.0
03/05/80	1.1	150.0
07/23/80	2.4	154.0
09/04/80	1.4	111.0

Also shown on these figures are 45 degree lines through the original indicating the line the data would fall on if the runoff per unit area were equal at both the partial record gage and the Anchor River gage.

The data from Twitter Creek near Lookout Mountain (Figure 10.2) are inadequate for determining the relationship between flows on Twitter Creek and the Anchor River. The data available do, however, indicate somewhat lower base runoff and higher peak runoff than is found on the Anchor River. This agrees with the comparison of continuous records from Twitter Creek near Homer and concurrent records from the Anchor River discussed earlier.

The drainage area at the proposed damsite is 4.6 square miles. Input data for simulating Twitter Creek were again precipitaiton and temperature data for the period 1952-1973 from Homer 5NW. The Homer 5NW record started immediately after a two-year period of very dry conditions. As this period (1951-1952) was thought to be important for determining the required reservoir storages, the Homer 5NW record was extended back to October 1949 using the longer term record from Homer WSO.

Precipitation data for 1949-1952 was obtained simply by multiplying Homer WSO data by the ratio of mean annual precipitation at Homer 5NW and Homer WSO for the period of common record.

Temperature data for the period 1949-1952 was taken without adjustment from the Homer WSO record. The simulated monthly flows at the damsite and the calculated drainage areas are given in Table 10.2.

The NWS models calibrated for the Anchor River catchment were again used to simulate average daily flows for water years 1949 through 1972. As had been noted earlier, the continuous discharge record on Twitter Creek shows that this catchment has a lower base runoff (cfs/sq. mi.) than the Anchor River as a whole. The parameters obtained form the Anchor River calibration were therefore adjusted to produce lower

TABLE 10.2

SIMULATED STREAMFLOWS, TWITTER CREEK, cfs

```
OPTION =MONTH

ENTER SUBROUTINE MONST

DSN=    2
BYR=   49
EYR=   72
SIMULATED FLOWS TWITTER CK DAM 4.6 sq. mi.

STATION   WYR   OCT    NOV    DEC    JAN    FEB    MAR    APR    MAY    JUN    JUL    AUG    SEP    ANNUAL
15239846  49    8.34   6.63   2.34   1.54   1.32   1.66   7.69  22.06   7.47   2.59   1.80   3.95   5.63
15239846  50    7.78  13.61   4.39   2.00   1.54   3.74  12.30   9.66   2.63   1.07   1.41   1.47   5.23
15239846  51    3.07   2.60   1.39   1.82   1.31   1.18   9.56   6.62   2.33   1.48   1.31   3.18   3.30
15239846  52    2.85   4.12   2.03   1.27   1.09    .99   2.18   5.56   2.29   1.52   1.25   1.86   2.25
15239846  53    9.04  27.65   9.23   7.67   2.99   2.22  17.47  22.50   6.65   2.26   2.51   5.96   9.58
15239846  54    8.29   5.14   3.86   2.17   1.50   1.29   5.75  20.22   3.96   2.04   3.92   4.05   5.58
15239846  55    9.11   9.45   3.32   2.00   1.91   1.54   2.92  26.80   7.17   2.54   1.79   3.01   5.76
15239846  56    7.36   3.72   1.77   1.37   1.21   1.10   5.49  27.30   6.72   2.43   2.30   3.41   5.35
15239846  57    6.66   6.44   4.19   2.32   2.75   2.12   9.23   7.84   2.30   1.55   1.76   8.55   4.54
15239846  58   11.33  19.53   7.04   2.40   1.72   1.62  18.94  18.83   4.06   4.41   5.70   7.73   8.51
15239846  59    7.89   6.78   3.33   2.01   1.64   1.33   6.14  37.75   5.89   3.27   1.99   1.90   6.83
15239846  60    4.31   6.66   3.96   2.15   1.47   1.25   3.56  40.48   5.95   3.49   6.52   8.58   7.37
15239846  61    8.89   7.52  14.83  19.57   5.13   2.25   5.93  14.33   3.16   2.22   2.21  14.20   8.36
15239846  62    9.53   7.58   6.85   2.62   1.69   1.89   8.43  31.14  10.38   3.15   1.86   1.76   7.24
15239846  63    3.55   6.57   5.90  13.11   5.15   4.59   5.67   5.22   1.99   1.45   1.88   3.28   4.79
15239846  64    7.70   3.30  10.09   4.25   2.67   1.83   3.12  19.43  10.52   2.62   2.21   2.98   5.99
15239846  65    8.41   4.56   2.28   1.51   1.30   5.37  17.38  23.24   7.99   3.26   2.78   7.02   7.39
15239846  66    7.46   2.66   1.73   1.41   1.27   1.15   6.46  26.99   8.41   2.89   7.09  14.70   6.85
15239846  67   12.12   4.19   2.37   1.65   1.43   1.30   3.77  25.24   3.92   1.93   4.82  12.98   6.31
15239846  68    5.75  11.84   5.61   3.99   4.10   3.90   5.03  17.78   3.74   1.85   1.49   1.41   5.53
15239846  69    1.70   1.84   1.41   1.06    .94    .95   6.28  18.99   5.45   2.02   1.53   1.40   3.55
15239846  70   12.47   6.33  11.18   5.13   4.44   5.54   7.29  30.39   4.67   2.14   2.31   4.39   8.02
15239846  71    6.10   9.38   2.50   1.58   2.56   1.54   1.20  13.59  21.76   4.75   2.52   2.62   8.34
15239846  72   12.47   4.59   2.22   1.56   1.36   1.73   1.10  30.36  15.01   3.17   2.73   9.98   7.15

***WARN*** EOF IN FILE     2 AFTER WYR   72

SAMPLE SIZE     24     24     24     24     24     24     24     24     24     24     24     24     24

MEAN            7.59   7.61   4.70   3.59   2.19   2.15   7.20  21.27   7.64   2.53   2.74   5.45   6.22
STD. DEV        2.92   5.69   3.44   4.22   1.26   1.37   4.83   9.75   9.71    .87   1.62   4.03   1.77

FINISH MONST
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primary baseflow and steeper initial recession rates. The effect of the parameter changes was checked by comparing simulated and recorded flows at the Twitter Creek continuous record gage for the period of record, water years 1972-1973.

10.3 Water Yield

Water yield for Twitter Creek was evaluated in the same manner as for Fritz Creek. Streamflow estimates from the simulation model were used to determine firm yield from a reservoir on the creek assuming 60% of the actual flows or 60% of the long-term mean annual flow as the instream flow requirement. Analysis conducted predict that the firm yield from the site would be 1.98 cfs (1.28 MGD) if 60% of the actual flow were maintained as instream flow and the reservoir size required would be 1500 acre-feet. Using the same size of reservoir and applying the other criterion, i.e., 60% of the long-term mean annual flow or the actual flow, whichever is less, as instream flow would result in a firm yield of 1.36 cfs (0.88 MGD). These flows represent the yield obtainable during a critical dry period such as that experienced in 1950-1952.

10.4 Topography and Geology

The topographic and geologic conditions are similar to the ones existing at Bridge Creek and at Upper Fritz Creek site. Any dam design, therefore, would be similar to any design developed for Fritz Creek. Topographic maps and the soil mapping units given in the soil survey report (1), were reviewed.

The topographic map illustrates that the Twitter Creek confluences with the Anchor River and Bridge Creek occur at approximately elevations of 400 and 500, respectively, while the headwaters of Twitter Creek are found at approximately elevation 1400 feet. Along the lower reaches of the creek the valley slopes rise to ridges along both banks at elevations ranging from 700 to well over 1000 feet. The slopes are indicated to vary in gradient from maximums of about 30 percent at locations immediately above the narrow floodplain of the creek. Numerous gullies occurring in the slopes appear to have been eroded in the glacial till.

Although no outcrops are known to occur in this vicinity and the creek appears to have been incised essentially in glacial till or other glacial drift deposits, numerous occurrences of the Kachemak soils on both banks indicate the possibility of bedrock occurring at shallow depths along Twitter Creek upstream from its confluence with Bridge Creek.

10.5 Preliminary Project Arrangement

The project will consist of a dam approximately 100 ft. high, a morning-glory shaft spillway, an emergency auxiliary spillway to pass unusual floods, a low-level outlet works and a pump house (Figure 10.3). Water will be conveyed from Twitter Creek to Bridge Creek reservoir through a buried steel pipeline about 2.5 miles long. The pipeline will have to cross Crossman Ridge which is at Elevation 1200. Pumping will be necessary to deliver water to Bridge Creek. There will be three pumps, each rated at 75 HP at 300 ft. total dynamic head. One of the pumps will be for standby use. Normal pool level will be at El. 1085. Minimum pool will be at El. 1010.

The dam will be an earthfill structure with slopes of 1 on 3 and would be constructed using:

a. A massive impervious core and some impervious blanket constructed of compacted clay-silt-sand-gravel and cobble mixtures, i.e., of compacted glacial till;

b. A minimum amount of compacted clean sand in the upstream shell zone subject to drawdown, and further such sand for filters (which may be replaced, alternatively, by filter cloth);

c. Processed clean, coarse sand, or coarse sand and gravel, for an internal drain layer, frost-proof crest and "rock" toe;

d. Random organics-free sand or gracial till fill for the downstream shell; and

e. Riprap on filter cloth protecting the upstream reservoir slope as well as the dam toe at tailwater.

11.0 FRITZ CREEK ALTERNATIVE

11.1 General

This alternative involves providing a storage reservoir by constructing a dam. Water would be piped to the Homer distribution system, which is 6.5 miles away.

11.2 Streamflow Synthesis

Because of uncertainty about the precipitation regime in the area of Fritz Creek, mean daily flows at the Fritz Creek dam site were estimated by prorating the simulated flows on Twitter Creek for water years 1949 through 1972.

Data from the partial record at Fritz Creek with the concurrent mean daily flow at Anchor River are shown in Table 11.1 and plotted Figure 11.1. Also shown in this figure is a 45 degree line through the original indicating the line the data would fall on if the runoff per unit area were equal at the Fritz gage and the Anchor River gage. A linear regression analysis indicated that the mean annual runoff per square mile on Fritz is about 76% of that on the Anchor River or about 1.1 cfs/sq. mi. It is also shown in Section 6 that the runoff per square mile at Anchor River and Twitter Creek is about the same.

It was thus assumed that mean daily runoff (cfs/sq. mi.) from Fritz Creek was 76% of that simulated for Twitter Creek. The drainage area at Fritz Creek is 9.6 square miles.

TABLE 11.1

PARTIAL RECORD DATA, FRITZ CREEK

Date	Fritz Creek	Anchor River Near Anchor Point
07/13/63	12.3	
10/02/63	9.56	
06/05/64	31.5	
06/19/64	17.5	
07/22/65	9.42	
06/01/66	26.3	639.0
07/12/66	24.1	377.0
08/16/66	6.97	116.0
09/19/66	45.5	1170.0
03/27/67	3.34	55.0
05/23/67	12.0	240.0
06/13/67	14.1	203.0
07/26/67	3.99	82.0
09/03/67	7.56	152.0
10/21/67	8.44	135.0
04/14/68	2.15	92.0
08/01/68	2.50	72.0
08/20/68	4.57	75.0
10/22/68	3.34	58.0
01/13/69	0.85	28.0
03/19/69	9.41	60.0
05/07/69	28.0	350.0
06/23/69	7.17	111.0

TABLE 11.1 (continued)

Date	Fritz Creek	Anchor River Near Anchor Point
07/31/69	4.84	78.0
09/08/69	2.70	58.0
10/12/69	47.2	747.0
03/04/70	6.81	160.0
03/19/70	28.2	200.0
06/25/70	6.76	161.0
07/24/70	4.86	124.0
08/08/70	6.21	109.0
09/29/70	4.68	113.0
11/12/70	19.0	272.0
03/22/71	3.16	74.0
07/16/71	12.8	224.0
08/28/71	7.85	112.0
04/01/72	1.78	80.0
05/10/72	61.0	1000.0
05/26/72	25.3	570.0
07/07/72	6.23	107.0
08/15/72	10.1	166.0
10/07/72	23.0	269.0
05/10/73	29.0	510.0
06/20/73	12.0	197.0
10/10/73	22.0	
06/21/74	6.8	
10/09/74	12.0	
05/14/75	76.0	

TABLE 11.1 (continued)

Date	Fritz Creek	Anchor River Near Anchor Point
06/11/75	31.0	
09/11/75	32.0	
05/20/76	26.0	
05/04/77	39.0	
08/08/77	3.6	
07/11/78	6.1	
08/16/78	3.2	
09/15/78	8.8	136.0
10/10/78	12.0	202.0
11/09/78	8.9	148.0
01/05/79	6.7	125.0
03/14/79	4.8	76.0
04/17/79	14.0	190.0
05/01/79	53.0	947.0
05/15/79	27.0	521.0
05/30/79	11.0	246.0
06/15/79	5.0	111.0
07/20/79	4.9	100.0
08/16/79	3.6	95.0
11/29/79	91.0	1250.0
03/05/80	7.7	150.0
05/01/80	68.0	844.0
07/23/80	8.9	154.0
09/05/80	5.5	106.0

The estimated flows for Fritz Creek were compared with the data from the partial record at the Fritz Creek gage. In most instances, agreement between simulated and recorded flows was satisfactory, although some large differences did occur which could not be explained with the available data. However, these differences are not critical in the development of water yield from the reservoir.

The simulated monthly flows at the dam site have been shown in Table 11.2.

11.3 Water Yield

Stream flow estimates applied to Fritz Creek were used to determine estimates of firm yields. As with the case of Bridge Creek, provision for maintaining instream flows has a great effect on the firm yield available for municipal uses. Criteria for providing instream flows was provided by the Alaska Department of Fish and Game (D. McKay, 1982). The instream flow criteria are:

a. 60% of the instantaneous flow

b. 60% of long-term mean annual flow or the actual flow, whichever is less

In both cases, the criteria developed by ADF&G was intended to be conservative (D. McKay, 1982) subject to further analysis and revision in light of additional stream data. Thus, for purposes of evaluation these criteria have been used to determine the effect on reservoir sizing. A mass curve analysis using Criterion 1 and the driest period of record (May 1950 - March 1953) with a reservoir storage capacity of 2300 acre-feet would provide a firm yield of 1.87 MGD. A similar mass curve analysis using Criterion 2, provided a yield of 2.30 MGD with a correspondingly larger size reservoir of 4900 acre-feet. These results are given in Table 11.3.

TABLE 11.2

SIMULATED STREAMFLOWS, FRITZ CREEK, cfs

```
OPTION =MONTH

ENTER SUBROUTINE MONST

DSN=    3
BYR=   49
EYR=   72
SIMULATED FLOWS FRITZ CK DAM  9.6 sq. mi.

STATION   WYR    OCT     NOV     DEC     JAN     FEB     MAR     APR     MAY     JUN     JUL     AUG     SEP    ANNUAL
15239501   49   13.24   10.53    3.72    2.44    2.12    3.55   12.21   35.01   11.35    4.27    2.85    5.25    8.93
15239501   50   12.34   21.60    6.97    3.17    2.45    5.93   19.51   15.36    4.18    2.56    2.24    3.12    6.29
15239501   51    4.87    4.12    2.21    2.89    2.08    1.88   15.18   10.83    3.09    2.35    2.07    5.35    4.77
15239501   52    4.52    6.53    3.22    2.04    1.73    1.56    3.46    8.82    3.63    2.40    1.99    2.95    3.57
15239501   53   14.35   43.88   14.65   12.17    4.74    3.53   27.72   35.71   10.55    3.59    3.98    9.45   15.36
15239501   54   13.16    8.15    6.12    3.43    2.37    2.35    9.13   41.62    6.29    3.24    6.22    6.42    9.02
15239501   55   14.46   14.99    5.28    3.17    3.03    2.44    4.63   42.52   11.38    4.03    2.85    4.77    9.46
15239501   56   11.67    5.91    2.81    2.17    1.92    1.74    8.71   43.33   10.66    3.86    3.64    5.41    8.49
15239501   57   10.56   10.22    6.66    3.63    4.37    3.30   14.65   12.44    3.66    2.47    2.80   13.57    7.37
15239501   58   17.98   30.99   11.17    3.81    2.72    2.57   30.06   29.88    6.44    7.01    9.04   12.26   13.56
15239501   59   12.52   10.76    5.29    3.13    2.63    2.11    9.75   63.38    9.44    5.19    3.15    4.02   13.85
15239501   60    6.85   10.57    6.29    3.42    2.33    1.98    5.65   64.24    9.45    5.55   10.34   13.62   11.57
15239501   61   14.11   11.93   23.54   31.03    8.15    3.56    9.40   22.73    5.02    3.53    3.51   22.54   13.26
15239501   62   15.13   12.03   10.88    4.15    2.68    3.00   13.38   49.42   16.48    4.97    2.94    2.83   11.49
15239501   63    5.63   10.42    7.77   20.81    8.18    7.44    9.00    8.29    3.15    2.30    2.99    5.20    7.50
15239501   64   12.22    5.24   16.01    6.76    4.24    2.90    4.95   30.84   16.09    4.16    3.51    4.73    9.35
15239501   65   13.35    7.24    3.61    2.39    2.06    9.52   27.58   36.88   12.09    5.17    4.41   11.15   11.26
15239501   66   11.85    4.22    2.74    2.24    2.01    1.83   10.25   42.83   13.35    4.59   11.24   23.33   10.87
15239501   67   19.24    6.65    3.75    2.61    2.27    2.06    5.98   40.06    6.23    3.06    7.65   23.60   10.91
15239501   68    9.13   18.78    8.90    6.34    5.50    5.33    7.96   28.22    5.94    2.94    2.36    2.24    8.78
15239501   69    2.79    2.93    2.24    1.63    1.49    1.36    9.96   30.14    7.06    3.21    2.43    2.22    5.63
15239501   70   19.79   10.05   17.74    8.14    7.05    3.50   11.58   48.22    7.41    3.39    3.67    6.97   12.73
15239501   71    9.68   14.88    3.96    2.51    4.06    2.44    1.90   21.56   82.13    7.54    4.00    4.15   13.24
15239501   72   19.78    7.28    3.52    2.43    2.16    1.95    1.75   48.18   23.82    5.03    4.33   15.84   11.35

***WARN*** EOF IN FILE      3 AFTER WYR    72

SAMPLE SIZE          24      24      24      24      24      24      24      24      24      24      24      24      24

MEAN              12.05   12.08    7.46    5.73    3.47    3.40   11.43   33.76   12.13    4.02    4.34    8.65    9.88
STD. DEV           4.63    9.02    5.47    6.69    1.99    2.17    7.66   15.47   15.51    1.38    2.56    6.50    2.82

FINISH MONST
```

TABLE 11.3

EFFECT OF INSTREAM FLOW REQUIREMENT, Fritz Creek

	Criterion 1 60% of Actual	Criterion 2 60% of Mean Annual	Criterion 1A 28% of Actual	Criterion 2A 28% of Mean Annual
Yield,	2.9 cfs (1.87 MGD)	3.56 cfs (2.30 MGD)	5.3 cfs (3.42 MGD)	5.3 cfs (3.42 MGD)
Reservoir size, acre-feet	2300	4900	4000	5800
Add: Bridge Creek Yield	0.90 cfs (.58 MGD)	0.90 cfs (.58 MGD)	0.90 cfs (.58 MGD)	0.90 cfs (.58 MGD)
Total Yield	3.8 cfs (2.45 MGD)	4.46 cfs (2.88 MGD)	6.2 cfs (4.0 MGD)	6.2 cfs (4.0 MGD)
Year 2030 Demand	6.2 cfs (4.0 MGD)	6.2 cfs (4.0 MGD)	6.2 cfs (4.0 MGD)	6.2 cfs (4.0 MGD)

In comparing these results to average daily demands (ADD) projected to occur 40 to 50 years hence, it is observed that the combined firm yields of Fritz Creek and the existing Bridge Creek reservoir (0.58 MGD) under either criterion, would be significantly less than those future demands (2030 ADD = 4.0 MGD).

To meet the year 2030 demands (4.0 MGD), it will be necessary to modify Criterion 1 or Criterion 2 to 28%. The corresponding reservoir volumes required would be 4000 acre-feet under a criterion similar to Criterion 1 (Criterion 1A) and 5800 acre-feet under a criterion similar to Criterion 2 (Criterion 2A).

These data point to the need for the City to clarify with ADF&G instream requirements for Fritz Creek. The position of ADF&G has shown that for planning purposes the 60% requirement should be met (Criterion 1 or 2), after which more detailed studies of stream morphology might be required to re-evaluate and adjust the criteria. Analyses presented herein may provide the additional information upon which refined estimates of instream requirements can be made by ADF&G. Based on these studies, it can be concluded that the reservoir size would range between 2300 acre-feet which is that required to meet Criterion 1 (Table 11.3), and 5800 acre-feet which is that required if Criterion 2 can be modified to 28% to meet 2030 demands.

11.4 Topography and Geology

From the reconnaissance carried out along the valley of Fritz Creek, it appears that the creek bed and the slopes adjacent to the creek are underlain by deposits of glacial till. In the downstream reaches examined, the creek has cut deeply into the soil mantle, resulting in relatively steep continuous valley slopes with gradients commonly in the order of 40 to 60 percent rising from the floodplain which is limited to widths on the order of 50 feet. Numerous indications of soil instability, such as slumped zones extending 100 feet or so along the base of the slopes and extensive tilting of trees indicate that at least the upper 10 or 20 feet of the soil is loosely consolidated and subject to failure on the steep slopes.

Proceeding upstream the valley gradually changes in form with the floodplain widening and the slopes becoming far more gentle with no significant evidence of slope instability.

Depth to bedrock is a matter for conjecture. The presence of a quarry in bedrock high on the right bank in the general vicinity of the dam axis considered farthest downstream (Site 1, Figure 1.1) indicates that the bedrock surface occurs within the right wall of the valley. There is no evidence, however, to indicate how deep it is at creek level.

Similarly, occurrences of Kachemak soils high on the left bank, as indicated by the soil survey (1), suggest that the bedrock surface lies within the left wall along the lower reaches of the valley where the creek is deeply incised in the upland surface.

11.5 Preliminary Project Arrangement

For comparison purposes with Twitter Creek, a reservoir size of 2300 acre-feet has been selected. The project will consist of an approximately 90 ft. high dam, a morning-glory shaft spillway, an emergency auxiliary spillway and a low-level outlet works (Figure 10.3). Normal pool level would be at El. 530. Minimum pool level would be at El. 480. The dam would be an earthfill dam with slopes 1 on 3. It will have an impervious core constructed of compacted clay-silt-sand and gravel. The upstream shell would be clean sand while the downstream shell would be random organic free sand or glacial till. Processed clean sand will be used for filters.

Because of the erodible foundation, a sheet pile cut-off will be driven with lengths generally about two-thirds of the head. The shallow dyke part on the left abutment will be protected by an impervious blanket. A pressure relief curtain consisting of 80-foot deep wells spaced at 20 feet will be provided at the dam toe.

The morning glory spillway will have a weir crest diameter of 14.5 feet. The vertical shaft will be 5.3 ft. in diameter and will join to a horizontal 7.0-ft. diameter conduit.

12.0 COMPARISON OF FRITZ AND TWITTER CREEKS

12.1 General

Preliminary cost estimates for comparison purposes were prepared for Twitter and Fritz Creek alternatives. These estimates, though not complete, were developed to an equivalent level sufficient for the determination of the most economically attractive alternative.

The cost estimate and available water at each site were then compared. This comparison is shown in Table 12.1.

12.2 Twitter Creek Cost

Based on the information presented in Section 10, (TWITTER CREEK ALTERNATIVE), a cost estimate was prepared.

The estimated cost of construction for Twitter Creek is $18,644,000 (1983 dollars) which will include the cost of the facilities required to deliver the water to Bridge Creek. This will result in a capital investment of almost $13,000 per acre-foot of water yield.

12.3 Fritz Creek Cost

Based on the information presented in Section 11, (FRITZ CREEK ALTERNATIVE), a cost estimate was prepared.

The estimated cost of construction will be $17,533,000. The 6.5-mile transmission line to Homer will cost approximately $3,089,000. Thus, the total cost will be $20,622,000 excluding treatment facilities.

TABLE 12.1

TWITTER & FRITZ CREEKS RESERVOIR DATA

	Twitter Creek	Fritz Creek
Firm Yield[1]	1.98 cfs (1.28 MGD)	2.9 cfs (1.87 MGD)
Storage Volume	1,500 ac-ft	2,300 ac-ft
Capital cost, 1983 dollars	$18,644,000	$20,622,000
Yield, ac-ft per year	1433	2100
Capital cost per ac-ft of yield	$12,950	$9,820

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[1] 60% of monthly flow reserved for instream requirements; yield based upon critical dry period 1950-1952.

This will result in a capital investment of $9,820 per acre-foot of water yield.

12.4 Alternative Selection

The capital cost for Twitter Creek includes the cost of delivering the water to Bridge Creek reservoir but does not include the treatment plant expansion that might eventually be required. The cost of Fritz Creek includes the cost of delivering the water to Homer but does not include the cost of a new treatment facility.

The data above suggests that Fritz Creek would be a more attractive alternative than Twitter to augment the Bridge Creek supply. To reiterate, Fritz Creek has 50% more yield and thus would meet future demands over a longer period of time. Secondly, water can be obtained from Fritz Creek at 76% of the cost per acre-foot of that from Twitter Creek.

Based on the results of the preceding sections, Fritz Creek was selected as the Alternative to pursue.

13.0 FRITZ CREEK SITE ALTERNATIVES

13.1 General

This section discusses the selection of various alternative sites on Fritz Creek. Field reconnaissance has indicated that storage dams could be built nearly everywhere on this creek below Beaver Creek Flats and upstream of a point in the creek where the cross-section narrows down. By rejecting wider cross-sections and slide-suspect slopes, the selection was narrowed down to three sites which are shown in Figure 1-1. These sites are identified as Sites 1, 2 and 3. All sites are downstream of Beaver Creek Flats, a habitat for wildlife. Selection of the final plan should consider the environmental undesirability of reservoir intrusion on this area.

13.2 Topography and Geology

A discussion of the regional geology is found in Section 8. The items of geologic interest to the Fritz Creek Sites, resulting from the geological study performed, are found in Section 11.4

13.3 Alternative Site 3

At the farthest upstream location identified as Site 3, there appears to be a greater feasibility for both abutments and the river bed to be underlain with glacial till to considerable depths than on the other sites. This site appears to have distinct geologic advantages for a dam as compared to the other two sites. These advantages are:

a. Wider valley section with less steep slopes, allowing a lower dam and smaller reservoir depth for a given storage capacity, more stable slopes both at the dam and in the reservoir area, greater space for a spillway and its chute and easier access for construction;

b. Lesser creek bed gradient which is favorable to dam design, reservoir storage capacity and access;

c. Greater elevation of the dam foundation and therefore a greater possibility of founding the dam on glacial till rather than on the more permeable bedrock in the area; and

d. Higher elevation, thus providing greater available head.

13.4 Alternative Site 1

This site which is located farthest downstream is considered to be the least suitable damsite. Because of steep, marginally stable slopes, reservoir shore failure could occur under fast drawdown conditions. Also, the emergency spillway will require deep excavations and extensive and expensive use of gabions with stepped chutes.

13.5 Alternative Site 2

Site 2 is ranked midway in quality between Sites 1 and 3. This alternative mostly avoids possible shore failure of steep, marginally stable slopes under rapid drawdown conditions. The emergency spillway will require deep excavation. This site will also require a higher dam than at Site 1 for a given size of reservoir.

SECTION II

PRELIMINARY DESIGN AND COST ESTIMATES

14.0 PRELIMINARY COST COMPARISON OF ALL SOURCES

14.1 General

In order to generate a cost comparison of the various sources considered, it was necessary to make some general assumptions. It was assumed that rock excavation would be minimal; that each source would require approximately the same degree of treatment, hence approximately the same cost for treatment plant new construction or existing expansion; that contingencies would all be at the same ratio, thus not included in the estimated costs; and that land and easements, if required, would be obtained at a nominal fee. Until a firm design has been undertaken, to try to cost out these types of items tends to be speculative.

14.2 Ground Water Sources

The average well in the Homer area produces <25 gpm. It would take approximately 60 wells to produce the required water. This number of wells required is in reality academic since their withdrawal rate far exceeds the published recharge rate (300 gpm per U.S. Geological Survey) for the area. If the number of wells developed were close to the number required, a very substantial operating and maintenance (O&M) cost would be incurred due to the number of pumps, electrical controllers, etc. Without knowing the motor sizes, well depths, well locations with reference to a treatment plant, the O&M costs cannot be reasonably estimated; therefore only the cost of developing wells and treatment plant costs have been estimated. Again, without firm locations of wells, the quantity of transmission main to tie into the existing system cannot be reasonably estimated.

Well Development	$3,560,000
Treatment Plant(s)	4,000,000
Estimated Basic Cost	$7,560,000

Alternative dropped because of insufficient water production.

14.3 Distant Surface Sources

Bradley Lake consideration was estimated but not further pursued once the hydroelectric development was shelved. Minimum basic costs without consideration of constructing access roads and furnishing electrical power was estimated as:

Transmission Main - on land	$22,000,000
- marine	7,390,000
Treatment Plant	2,000,000
Estimated Basic Cost	$31,390,000

China Poot Lake was the only distant surface source near enough to realistically qualify for consideration. As previously stated, there remains the problem of actually withdrawing water because of the lake's location within the State Park. Construction problems are significant due to the depth of the crossing off the end of the Homer Spit. There will be substantial currents to deal with with each change of tide. Construction on the far shore will be expensive if on land, as much of the excavation will be in solid rock. If the on-shore line is installed in the tidal flats, there can be expected to be considerable opposition to construction in the marshlands.

Transmission Main - overland	$ 4,118,000
- marine	11,220,000
- Homer Spit	5,206,000
Head work at China Poot Lake	500,000
Water treatment	1,500,000
Estimated Basic Cost	$22,544,000

14.4 Reverse Osmosis (Desalination)

A desalination plant utilizing the reverse osmosis process has been previously estimated. To this cost must be added the replacement of the line along the Spit. The one very significant cost associated with this alternative is the high annual O&M cost. This process is very energy (power) intensive.

R.O. Plant (2 MGD)	$14,000,000
Future Expansion (to 3.6 MGD)	8,000,000
Plant Cost	22,000,000
Spit Transmission Main	5,206,000
Estimated Basic Cost	$27,206,000
Annual O&M Estimated Cost	$ 1,400,000

14.5 Bridge Creek

Two options were considered for Bridge Creek as a source of supply: either raising the existing dam or constructing a new dam downstream of the existing dam.

The main problem is that the existing dam was never intended to be raised. In order to do so, one of the tasks would be to raise the inner core. This is an impervious barrier which inhibits seepage through the structure. As a tapering barrier, it would be necessary to add to the core along the front (downstream) face sufficiently to extend the core to a new height. In order to do this, it would be necessary to strip the material off the face of the dam. This renders the dam structurally unsound, unless the reservoir level is lower. This in turn jeopardizes the existing water supply. Therefore, this option was eliminated as being impractical. No cost estimate was made.

As was previously discussed in Section 9.7, constructing a new dam downstream meant abandoning the existing dam and appurtenances, abandoning the existing pump station, constructing the new dam and appurtenances and constructing a new pump station. Implementing this option would not significantly increase the available water due to instream release rates required by ADF&G. This option was also deemed to be not cost-effective; therefore no estimate was made.

14.6 Twitter Creek

The development of Twitter Creek involved construction of a dam, an intake structure and a pump station. The existing treatment plant at the Bridge Creek site would have to be expanded to process the additional flow. The pumps would have to develop over 300 feet of head to pump over Crossman Ridge and on to Bridge Creek. The ADF&G have indicated (May 1983 meeting) that any request to dam Twitter Creek would meet with considerable opposition since this creek supports anadromous fish runs. The cost to develop Twitter Creek as a source of supply is:

Dam and Pump Station	$18,644,000
Expand Water Treatment Plant	1,900,000
Increase Transmittion Main from Existing W.T.P. to Homer	1,300,000
Basic Estimated Cost	$21,844,000

14.7 Fritz Creek

Fritz Creek was realized to be the most favorable near surface water source based on the ability to supply sufficient water for the 30-year projection. This having been determined, three sites were selected. Analysis of these sites determined that while any of the individual sites would fulfill the requirement, the northerly (most upstream) site would be the most economical. That is, provide the greatest reservoir volume for the least earthwork (dam) volume. Further consideration was given to selected reservoir volume sizes which would be dependent upon the final instream release rate imposed by ADF&G. Regardless of the site selected and the reservoir size, a transmission main from the dam to the treatment plant would be required. The treatment plant would be planned to be located just north of East Road near where Fritz Creek intercepts the road. Another transmission main would follow East Road to the end of the existing main near Palmer Creek, west of Kachemak City.

Dam (site 3, 2300 Ac.Ft.)	$14,767,000
Treatment Plant	1,629,000
Transmission Main	2,935,000
Basic Cost	$19,331,000
Dam (4000 Ac.Ft.)	$19,255,000
Treatment Plant	1,629,000
Transmission Main	2,935,000
Basic Cost	$23,819,000
Dam (5800 Ac.Ft.)	$23,611,000
Treatment Plant	1,629,000
Transmission Main	2,935,000
Basic Cost	$28,175,000

15.0 SITE SELECTION

15.1 Basis of Selection

In order to evaluate the three sites under consideration, a reservoir size of 2300 acre-ffet has been selected as a basis for comparison. Project layouts were made for each of the three sites. The Direct Construction costs of each arrangement were estimated and are shown in Table 9.1.

Table 15.1
PROJECT COSTS AT DIFFERENT SITES
(1983 Dollars)

	Site 1	Site 2	Site 3
Total Cost of Dam and Other Facilities	$23,035,000	$16,568,000	$14,767,000

It is evident that the least project cost will be obtained at Site 3. Similar investigations for other reservoir sizes showed that Site 3 yields the least project cost. In addition to the economic advantages, other geologic advantages have been discussed previously. Unless there are environmental problems not evident at this time, Site 3 is considered to be the most feasible site at Fritz Creek.

15.2 Optimum Reservoir Size

Experience has shown that for any given site, there is a reservoir volume for which the cost, per acre-foot of storage, of constructing a dam is least.

At Fritz Creek, environmental considerations limit the incursion of the reservoir towards Beaver Flats. It was shown in Table 11.2 that the maximum reservoir size to meet year 2030 demands is 5800 acre-feet.

The lower limit of reservoir size will be 2300 acre-feet, which is the minimum required to store the creek's firm yield. This has been calculated in previous submittals. Thus the reservoir size should be between 5800 and 2300 acre-feet. For optimization analysis, an intermediate size of 4000 acre-feet was also analyzed. The results of the analysis are shown in Figure 15.1, where it is shown that the optimum size (least cost in $/acre-ft vs. storage in acre-feet) is beyond the range of sizes being investigated.

15.3 Reservoir Site Selection

In practice, the selection of reservoir size may be governed by considerations other than economics. Normally, the instream flow requirements are first determined. Then either one of two factors control the selection. If the yield of the basin is adequate, the reservoir can be sized to meet the demands at a future date, say 40 to 50 years, the design life of the project. If the yield is not adequate, then the reservoir will be sized to match the firm yield of the basin. Since the instream flows are not known at this time, curves (Figure 15.2) have been developed which will show the reservoir storage requirement to develop the firm yield of the basin for a specified instream flow. The upper end of the curve shows the size required to meet year 2030 demands. The first figure is based on Criterion 1, i.e., instream flow which is a percentage of actual flow, while the second figure is based on Criterion 2, i.e., instream flow which is a percentage of mean

mean annual flow. On the same graphs, firm yield corresponding to any given reservoir size are also shown. With these curves and the criterion to be used and the instream flow requirements known, the reservoir size can be selected.

16.0 DESIGN FLOODS

16.1 Spillway Design Flood

An estimate of the spillway design flood was made using 18 years of crest-stage data from Fritz Creek collected by the U.S.G.S.

Floods on Fritz Creek are generally caused either by snowmelt in May or June or by heavy rainfall associated with an intense frontal system in late summer or early fall. Floods from fall storms may be augmented by melt from an early season snowpack. The simulation of daily flows described in previous submittals showed that the flood of record, which occurred on November 1, 1970, was caused by heavy rainfall on an early and shallow snowpack.

A flood frequency chart is shown in Figure 16.1. The estimated 500-year flood from this analysis is about 570 cfs. A 10,000-year flood is 740 cfs.

In this geographic area, estimates of probable maximum precipitation (PMP) are considered to be unreliable and no data exist for transforming storm rainfall to flood hydrographs for the small catchments of interest in this study. The most appropriate approach for estimating design floods was thus deemed to be based on extrapolation of frequency curves of recorded events.

For design purposes, a service spillway will be provided to pass a 500-year flood and an auxiliary emergency spillway will be added so that the combined capacities will pass a 10,000-year flood.

16.2 Construction Design Flood

The construction period flood was estimated using the curve in Figure 16.1. Because overtopping of the cofferdams will cause a delay in construction, a recurrence interval of 1 in 10 years was adopted for the construction period flood.

17.0 PROJECT FEATURES

17.1 Basic Preliminary Design

The design presented herein is preliminary. Extensive geotechnical investigations will have to be made prior to final design. A proposed geotechnical program for the next phase is described in Section 22. The plan, section and details of the project features are shown in Figures 17.1 and 17.2.

The height of dam will depend on the reservoir volume required which in turn can only be determined after instream flows are firmed up. The reservoir size will be determined from Figure 15.2 as discussed in Section 15.

17.2 Dam

It is assumed that no more than 10 feet depth of stripping will be required. The dam embankment shall be constructed using:

a. A massive impervious core and some impervious blanket constructed of compacted clay-silt-sand-gravel and cobble mixtures, i.e., of compacted glacial till;

b. A minimum amount of compacted clean sand in the upstream shell zone which is subject to drawdown;

c. Processed clean, coarse sand, or coarse sand and gravel for an internal drain layer, frost-proof crest and "rock" toe;

d. Random organics-free sand or glacial till fill for the downstream shell; and

e. Riprap on filter cloth protecting the upstream reservoir slope as well as the dam toe at tailwater.

Except for a shallow, dyke-like part of the dam up on the left abutment which will be protected by an impervious blanket, the main dam will feature a sheet pile cutoff wall to varying depth. This depth might be 2/3 of the dam head measured vertically down, or 5 times the dam head measured horizontally into the slopes, whichever measure yields the deeper sheet piling. Both the blanket as well as the sheet piling will protect the very erodible foundation (in some places) against internal erosion ("piping"). The dam will tentatively have 1 vertical over 3 horizontal slopes.

17.3 Service Spillway

The service spillway will be a morning glory spillway designed to pass 570 cfs, a 500-year flood. The weir will be 14 feet in diameter set at normal pool level. The spillway shaft will join to an inclined buried 7-foot diameter conduit. The conduit will be steel-lined where it will pass under the impervious core and downstream shell of the dam. Flows will be dissipated before being diverted back to the creek.

17.4 Auxiliary Spillway

The service spillway will be augmented by an open-chute auxiliary spillway on the right bank of the dam. The combined capacity will be 740 cfs, which is equivalent to a 10,000-year flood.

17.5 Low Level Outlet Works

The low level outlet works conduit will serve as a diversion conduit during construction and for releasing flows during operation into the river or to the treatment plant. During construction, the lower conduit will be open. When the dam is completed, a low gate at the portal will be closed and the conduit will be plugged. Because some parts of the foundation may be flexible, the outlet works pipe will be placed within a gallery to avoid possible flexing of the pipe as the dam is constructed.

17.6 Construction Materials

The materials required for dam construction are:

a. Glacial till - numerous deposits near the dam sites at elevations suitable for downhill hauling;

b. Clean sand - beds of moderately indurated sandstone which may be extracted selectively from quarries such as that on the right bank of Fritz Creek and one observed on the left bank of Bridge Creek;

c. Clean coarse sand or coarse sand and gravel - alluvial deposits at Anchor Point and beach deposits on Homer Spit;

d. Random fill - beds of moderately indurated sandstone, siltstone and claystone in quarries such as those described in (b), or glacial till as described in (a); and

e. Riprap and coarse rock for gabion construction - present in scattered deposits along creekbeds in sizes commonly up to 2 ft. in diameter, in beach deposits of Kachemak Bay and available in sizes to about 2 ft. through the processing of glacial drift deposits near the dam sites.

18.0 IN-STREAM ANALYSIS AND RESERVOIR SIZING

18.1 Discussion

At the outset of this study, the Alaska Department of Fish and Game (ADF&G) stated a general policy of 60% of a stream flow be reserved for the fisheries habitat. This in turn created a condition where a considerable volume (up to one-half if measured against mean annual flow) of the reservoir was in essence not available for the City's use. In order to satisfy the City's ultimate needs plus the in-stream requirement, a reservoir of substantial size was realized.

If the in-stream flow was a percentage of the mean annual flow, the minimum reservoir was 4900 acre-feet (1.6 billion gallons) of which 2300 acre-feet (750 million gallons) was available to the City. When the in-stream flow was measured as a percentage of actual flow, the minimum reservoir size dropped to 2300 acre-feet (750 million gallons) with 1900 acre-feet (600 million gallons) available to the City.

In either instance, using a 60% in-stream flow would not yield the 3400 acre-feet required to satisfy the City's 2030 peak day demand (over the life of the dam). A meeting was held May 5, 1983, with the City, the City's engineering consultant and ADF&G to discuss the in-stream flow requirement and the effects of the reservoir on moose wintering grounds (see Appendix A). At this meeting ADF&G brought out that there were no returning anadromous fish runs in Fritz Creek due to a blockage to the fish near the stream's mouth. The only fisheries use of Fritz Creek was an annual (May) release of salmon smolt at the point where Fritz Creek goes under East Road.

The much greater concern was the size and location of the reservoir and its effect in the partial elimination of wintering grounds of moose during periodic extremely severe winters.

In order to address these concerns, the reservoir-dam site requirements were reexamined. The maximum day demand is peak domestic demand (during a hot spell) plus the canneries' usage during processing from June to September. At other times the water required is significantly less with the peak day to average day ratio in the range of 1.70-1.96. Thus the daily average usage could be expected to be in the range of 2.0-2.4 MGD.

The projected mean annual flow is 9.88 cubic feet per second (cfs). The year 2010 maximum day is 6.2 cfs and the 2010 average day is 3.7 cfs. The lowest recorded mean daily flow, which occurred on January 13, 1969, was 0.85 cfs or 8.5% of the mean annual flow. The second-most low was 1.78 cfs or 18% occurring on April 1, 1972. As can be seen, both low flows occurred during the period of low demand, i.e., cold weather and fish processors not operating.

18.2 Conclusions

The reservoir capacity is based on the maximum day demand for a projected population in the year 2010. The average day demand is 60% of the maximum day demand, including processors.

The 60% in-stream flow appears to be an arbitrary guideline to serve until additional information is available. This guideline assumes a certain volume of water being available for fish, if no other study is undertaken.

A third factor not discussed is that some volume of water needs to be released at all times for aesthetic reasons.

Once the reservoir is filled, at most times of the year, the stream flow will exceed the City's demand and water will be spilled anyway. It is very easy to concentrate on one time period such as the maximum day and forget about the other 364 days.

18.3 Recommendations

The dam should be built under a phased construction program. The first phase would be to a pool elevation of 515 feet. This would provide a storage of 1050 acre-feet. The average daily demand of 2.4 MG equals 662 acre-feet. If the processors' demand of 0.43 MG is included, the total becomes 1050 acre-feet. This also gives a 90-day supply of water which should be sufficient to go through the summer months including processing. The dam can be raised to the design pool elevation of 530 feet at some time in the future if the need materializes.

It is further recommended that the in-stream flow be no less than 20%. This will maintain the lower recorded flows while in most instances will be considerably above this percentage. In addition, the City should work out a program with ADF&G to release an increased volume of water into Fritz Creek during the period in which salmon smolt are being released.

19.0 WATER QUALITY

19.1 Objectives of Water Treatment

The three basic objectives of water treatment are:

a. Production of water safe for human consumption.
b. Production of water appealing to the customer.
c. Production of water using facilities reasonable with respect to capital and operating costs.

In other words, safe and healthy, esthically acceptable, and economical water. A properly designed plant is not a guarantee of safety, however. Skillful and alert plant operation and attention to the sanitary rquirements of the source of supply and the distribution system are equally important.

19.2 Quality of Source of Supply

The type of treatment depends on the quality of the source of supply and the quality desired in the finished product. Adequate information on the source is thus a prerequisite for design. This includes analysis of the water and the ranges of the various characteristics. Surface waters tend to be variable in quality, contain lower concentrations of minerals, to be more highly colored, to be turbid at times, and to contain taste- and odor-producing substances.

In order to produce data required on the potential quality of source waters, an ongoing water sampling and analysis program was established. The program has been in effect in excess of one year, having started in

July 1982. The results to date are shown in Tables 19.1, 19.2 and 19.3 for the six major parameters measured. In addition, for Bridge Creek, some of the major parameters are analyzed on a daily basis for both influent (raw) water and for effluent (treated) water.

a. Color

Color indicates the presence of dissolved foreign substances. Color is pH sensitive with color more intense at high pH values. Color can absorb chlorine and reduce chlorine effectiveness as a disinfectant. Colored water is objectionable in appearance and causes difficulties in washing clothes, manufacturing foodstuffs, etc.

b. Odor

Odors generally originate from biological sources such as algae, decaying organic matter, and bacterial reactions. Most odors are objectionable in nature, unpleasant in certain levels and may, at the extreme, harbor lethal gases.

c. Turbidity

Turbidity in water is caused by minute suspended particles of clay, silt, organic and inorganic matter, plankton and other microscopic organisms. Turbidity scatters and absorbs light. Water-borne diseases may be hosted by the particulates causing the turbidity. Chlorination may not be fully effective as a disinfectant in the presense of particulate matter, therefore creates the need for very low turbidity for a first-class drinking water source.

d. Alkalinity

Alkalinity is a measure of hydroxide, carbonate or bicarbonates

Table 19.1

SOURCE WATER QUALITY

	COLOR Color Units			TURBIDITY (JTU)		
Date	Bridge	Fritz	Twitter	Bridge	Fritz	Twitter
(State Standard)		(15)			(5 JTU)	
07-19-82	30	25	15	3.4	6.5	1.0
08-26-82	16	27.5	40.8	2.4	3.7	5.1
10-24-82	25	25	20	2.0	1.4	1.1
11-18-82	15	20	-	0.8	1.3	-
12-17-82	25	30	30	0.34	0.95	0.73
02-17-83	30	15		1.6	1.4	
04-06-83	100	100		42	38	
05-10-83	-	75		-	15	
08-25-83	60	35		2.8	1.2	
09-15-83	50	40		3.9	4.1	

Table 19.2

SOURCE WATER QUALITY

Date	IRON (mg/L) Bridge	IRON (mg/L) Fritz	IRON (mg/L) Twitter	TOTAL DISSOLVED SOLIDS (TDS) (mg/L) Bridge	TOTAL DISSOLVED SOLIDS (TDS) (mg/L) Fritz	TOTAL DISSOLVED SOLIDS (TDS) (mg/L) Twitter
(State Standard)		(0.3 mg/L)			(500 mg/L)	
07-19-82	0.59	0.34	<0.05	65	92	63
08-26-82	0.47	0.18	1.12	99.7	69.4	95.4
10-24-82	0.1	0.3	0.5	32.5	5.5	5.4
11-18 82	0.17	1.40		68.5	81.5	
12-17-82	0.15	0.24	0.72	69	98	89
02-17-83	0.66	0.38		61	94	
04-06-83	2.17	2.08		56	74	
05-10-83	-	1.00		-	63	
08-17-83	1.06	0.69		64	82	
09-15-83	0.74	1.09		63	83	

Table 19.3

SOURCE WATER QUALITY

	pH			ALKALINITY (as $CaCO_3$)		
Date	Bridge	Fritz	Twitter	Bridge	Fritz	Twitter
07-19-82	6.9	6.6	6.7	30	40	26
08-26-82	6.9	6.4	6.6	50	27	37
10-24-82	6.1	6.5	6.4	29	35	26
11-18 82	6.8	7.1		21	32	-
12-17-82	6.7	7.5	6.9	23	43	30
02-17-83	6.2	6.6		23	66	
04-06-83	6.4	6.3		17	32	
05-10-83	-	7.2		-	24	
08-17-83	7.0	6.9		29	49	
09-15-83	6.6	6.4		27	43	

present in solution. This presence relates to the hardness of water. Although "hardness" or "softness" of water is subjective by individual, in general soft water lathers easily and leaves no "ring" in the bathtub. Hard water does not lather well, leaves hands rough and a "ring" in the tub. Also, hard water leaves deposits in boilers and can be corrosive to certain materials.

e. Total Dissolved Solids (TDS)

Total dissolved solids are those solids remaining in solution after all the suspended solids have been removed by a filter. TDS can be measured by conductivity or the solution's ability to conduct an electrical current. This in turn is related to the concentration of ionized substances in the water.

f. Iron

Iron is generally present in all normal waters to some extent, but is not normally a public health problem, merely a nuisance. Iron hydroxide stains clothing and porcelains. Iron is also a food source for so-called iron bacteria and its associated slime growths, taste and odor problems.

20.0 WATER TREATMENT PLANT

20.1 General

The characteristics of the Fritz Creek water closely resemble that of Bridge Creek. This has been verified by approximately one year of monthly sampling of both raw water sources. Based on this similarity the decision was made to design a plant similar to the existing plant on Bridge Creek. This decision serves two purposes. First, we are using a proven treatment process and secondly, it will not be necessary to retrain or maintain operators for two different processes. In addition, annual O&M costs should be less as there will be duplicated equipment and chemicals.

20.2 Design Criteria

	5 Units		6 Units (Future)	
Net Flow Rates	Average	Maximum	Average	Maximum
	2 MGD	2.8 MGD	3 MGD	4 MGD
	1400 GPM	1960 GPM	2211 GPM	2800 GPM

Filter Data

Diameter	10'-0"
Overall Height	10'-7"
Filter Area	78.5 sq.ft.
Filter Rates	5 Units - 3.68 GPM/ft^2 avg. - 5.1 GPM/ft^2 max. 6 Units - 4.7 GPM/ft^2 avg. - 6.2 GPM/ft^2 max.
Media Design	Graded gravel - 16 in. High density support gravel - 3 in MF 32 Mixed media - 30" MF 186

Filter Wash

Backwash Rate	1413 GPM @ 45' TDH (18 GPM/ft^2)
Surface Wash Rate	50 GPM @ 60 psi
Cycle	10-15 min. (each unit)
Washwater Useage	11,775 gal/cycle/unit

Chemical Treatment

Chemical	Dose Rate mg/L	Avg. Dose Rate mg/L	Solution	Max. Soln. Feed Rate (GPH)	Consumption lb/day Average (2 MGD)	Consumption lb/day Maximum (2.8 MGD)
Alum	3-30	20	15%	20	332	464.8
Soda Ash	1.5-15	10	10%	20	166	232.4
Polymer	0.1-2	0.5	0.25%	3	8.3	11.62
SHMP	1-10	5	20%	3	83	116.2

Chlorination

Prechlorination dosage	0.3 to 3.0 mg/L
Average dose	2 mg/L
Consumption average	33.6 lb/day max. @ 2.0 MGD
Injector water	8 GPM @ 30 psi
Postchlorination dosage	0.5 to 4 mg/L
Average dose	2 mg/L
Consumption average	33.6 lb/day, max 93.3 lb/day
Injector water	20 GPM @ 10 psi
Chlorine Withdrawal	
Average	67.2 lb/day
Maximum	100.8 lb/day
Cylinders	4 - 150 lb in service (4 max days) 15 - 150 lb in reserve and transit (31 avg. days)

Sludge Production

Average plant rate	2.0 MGD
Suspended solids in raw water	10 mg/L

Average Sludge Production	Daily	Annual	
Weight	498	181,770	lb
Vol. @ 1% (settling ponds)	800	292,000	cu.ft.
Vol. @ 5% (drained sludge)		16,000	cu.ft.
Vol. @ 17% (frozen sludge)		4,705	cu.ft.

Backwash Settling Ponds

Backwash storage volumes to be determined at a later date based on soil analysis at the project site.

20.3 Description of Operation

The proposed water treatment plant for Homer, Alaska, is a direct filtration plant with pressure filters, chemical feed, pumps, valves, instrumentation and controls as described on the attached flow diagram, Figure 20.1

Raw water will be delivered to the plant by gravity. Provision is made to chlorinate the raw water pipeline if algae is present. Raw water pumps are provided to boost the incoming pressure during periods of high flow. It is estimated that 50 feet of head is required to push water through the plant under maximum conditions. An additional 16-18 feet of head is required to fill the storage tank. When the reservoir is full and the demand is low, the raw water pumps will not be used.

An influent flow meter will be provided to monitor the plant flow and establish a set point for the chemical feeders.

The chemical feed equipment consists of gaseous chlorine (Cl_2) for disinfection, aluminum sulphate (alum) for coagulation, soda ash for pH adjustment, polyelectrolyte for filter conditioning and sodium hexametaphosphate (SHMP) for corrosion control. Chemical feed rates are set manually as determined by the flow rate, jar tests, and effluent water quality. A static mixer insures the complete distribution of chemicals in the raw water.

Filtration is provided by five 10-foot-diameter pressure tanks (plus one future tank) designed to deliver an average flow of 2 MGD with peaks to 2.8 MGD (4 MGD future). Each filter will be complete with filter media, underdrains, surface wash arms, mainways, insulation, automatic control valves, and a turbidimeter.

The filtration system will be operated in declining rate with a common differential pressure switch/indicator and effluent rate control valve.

A 500,000-gallon tank will be installed to provide water for backwash and surface wash purposes as well as storage for peak flow conditions. Level controls in this tank will start and stop the plant.

Backwash and surface wash pumps will be provided to clean the filters as they become dirty. The resulting backwash waste will be directed outside the building to two lagoons. The lagoons will be operated alternately to allow dewatering and sludge disposal of the offline unit.

The amount of treated water actually delivered to the distribution system is monitored by a final effluent flow meter. A recorder in the plant control panel will provide a permanent record.

A programmable controller will provide the logic hardware required to operate the plant. The controls will provide for automatic operation with manual override. Recorders will provide a permanent record of the amount of water treated and its turbidity.

20.4 Estimated Power Requirements

Equipment	Quantity	Voltage	Amps	KVA
Heater	2*	115	6	1.38
Dehumidifiers	2	230	30	13.8
Wall Heaters	6	230	10	13.8
B/W Pump		460	26	12
S/W Pump		460	10	4.6
Cl_2 Booster		230	8**	1.84
Controls	10	115	10	11.5
Lighting		230	25**	5.75
Chemical Pumps	4	230	5	4.60
Compressor		230	10	2.3
Raw Pumps	2	460	32.8	15.09
				86.66 KVA

* Assumes gas heaters
** Estimated

21.0 TRANSMISSION MAIN

The transmission main can be divided up into two distinct packages: the section from the dam to the water treatment plant and that section from the treatment plant to the end of the existing line at Kachemak.

21.1 Design

The optimum transmission main size to deliver the maximum day flow of 4.0 MGD (2770 gpm) with acceptable line friction losses is 18 inches in diameter. However, with the addition of storage at the treatment plant and a second 0.5 MG storage tank in the vicinity of the termination of this line near Kachemak City, the line size can be reduced to a 16-inch diameter. In this preliminary study we have assumed the latter line size.

21.2 Location and Siting

The proposed site of the Fritz Creek reservoir requires that the water main to the treatment plant be laid next to the existing creek, preferably on the west side. This will make it necessary to construct a road next to the existing creek for construction, and future access to the water main. The length of this road will be approximately 7600 feet. All of this section will be required to be on easements.

The location of the proposed water treatment plant is critical. It must be at an elevation of 425 to 450 feet to provide by gravity the required design flow for the year 2010. The final siting cannot be completed until a parcel of land is obtained.

Wherever the water treatment plant is located, a 500,000-gallon storage tank must be provided to handle peak water demand as well as to provide storage for backwashing the filters. The tank should contain a level control for shutting the plant off when the storage tank is full and for turning the plant on at some pre-determined low water level.

The run of transmission main from the treatment plant to Kachemak will be entirely within public right-of-way. The line would preferably be located on the northerly (uphill) side of East Road.

In the vicinity of where the new water transmission main will connect with the existing 12-inch diameter main, a water storage tank must be provided to equalize the incoming pressure from the transmission main with the elev. 340 pressure zone to which it will connect.

This connection will require a backflow check valve chamber on the downstream side of the storage tank to prevent the possibility of water in the distribution system from backing up into the tank.

Future consideration should be given to construction of a 12-inch main from the terminus of this 16-inch line, parallel to the existing 12-inch main through Kachemak to Miller's Landing, then along Kachemak Bay Drive to the end of the existing 12-inch line at the airport. This would provide a looped system and a more direct feed to the Spit.

21.3 Material

Transmission main piping should be ductile iron with consideration given to use of mechanical joints on the steeper runs from the dam site to the treatment plant.

21.4 Depth of Bury

All piping shall have a minimum depth of bury of seven feet. Native material should be acceptable for backfill with the use of ductile iron pipe.

21.5 Hydrants

Hydrants have been spotted on the transmission main from the treatment plant to Kachemak City. The hydrants were located in the vicinity of existing structures. Provision for additional future hydrants has been made through the installation of capped tees at intervals of approximately 500 feet.

22.0 CONSTRUCTION COST ESTIMATES

22.1 General

The construction cost estimates are based on the arrangement described in Section 11. These cost estimates are based on 1983 price levels. Since the reservoir size cannot be established until instream flows are firmed up, three cost estimates were made for reservoir sizes 2300, 4000 and 5800 acre-feet. A cost curve is also developed in Figure 22.1 to allow interpolation of costs for intermediate reservoir volumes.

Quantities were established for major construction features to which unit prices were applied. Unit prices were derived using labor and equipment rental rates in Alaska. An overhead factor of 0.40 was applied to direct costs to obtain bid unit prices. The following assumptions were made in deriving unit prices:

a. Till material is available within one mile of the dam site;

b. Pit run sand can be obtained on the right bank of Fritz Creek;

c. Filters will be trucked from Anchor Point, about 16 miles away;

d. Random fill can be obtained from excavation in the vicinity;

e. Riprap and coarse rock for gabion construction will be available from observed beach deposits at Kachemak Bay; and,

f. Redi-mix can be purchased locally.

It was also assumed that no campsite will be constructed and the labor force will be located at Homer. Mobilization and demobilization are included in the unit prices.

The estimated construction cost was prepared with the assistance of Diversified Engineers and Constructions, Inc., a professional cost estimating firm with considerable Alaskan experience.

22.2 Basis of Costs

a. Direct Construction Costs

This cost includes the total of all costs directly chargeable to the construction of the project and in essence represents a contractor's bid.

b. Contingencies

To allow for unforeseen difficulties during construction, uncertainties due to lack of sub-surface information and items not reflected in the estimate, an allowance of 20% for contingencies was applied to the Direct Construction Cost.

c. Engineering and Owner Administration

The Engineering and Owner Administration costs are based on actual experience with costs for similar work. The item includes all preliminary engineering work; project feasibility and environmental studies; field investigation; processing of required permits and licenses; final design and preparation of construction contract documents; inspection of construction; and Owner Administration. An allowance of 13% of the sum of the Direct Construction Cost plus Contingencies is considered a reasonable estimate for this item.

d. Total Construction Cost

The total construction cost is the sum of the Direct Construction Costs, Contingnecies, and Engineering and Owner Administration.

e. Interest During Construction

No allowance for interest during construction is included in the estimates but should be included in calculating the total capital requirements.

f. Escalation

As discussed above, the Direct Construction Costs are based on a 1983 price level. The cost should be escalated to the date at which bids are to be called.

22.3 Construction Cost Estimates

A cost estimate summary is shown in Table 22.1 and the detailed Direct Construction Cost estimates are included in Appendix A.

Table 22.1
COST ESTIMATE

A. SUMMARY - SECTION 1		
Transmission Main	$2,935,400	
Site Improvements	185,850	
Water Treatment Plant	1,443,234	
Subtotal		$ 4,564,484
B. SUMMARY - SECTION 2, Page 12.5		
Dam and Appurtenances for:		
2300 Ac-ft Reservoir		$14,767,000
4000 Ac-ft Reservoir		19,255,000
5800 Ac-ft Reservoir		23,611,000
C. ENGINEERING DESIGN		$ 172,200
D. GEOTECHNICAL SURVEY AT DAM		$ 73,000
E. CONSTRUCTION MANAGEMENT & INSPECTION (PART-TIME)		$ 79,200

23.0 PROJECT IMPLEMENTATION

23.1 Schedule

Previous studies have shown that under adverse conditions, the yield in Bridge Creek reservoir will barely meet probable water demands in 1985. Consequently, a schedule was developed to complete the project in the earliest possible time. The proposed schedule is shown in Figure 23.1. The feasibility studies and the report are scheduled to be finished by June 1983. It is assumed that financing negotiations will be initiated soon after. Land acquisition must also start in 1983 so that construction can begin in the spring of 1984 and be finished in the latter part of 1985. Delay in financing negotiations or land acquisition will cause the schedule to slip.

Geotechnical explorations should be undertaken in the summer of 1983, to be followed by design. The construction period will require two years. The earliest that the project will be completed will be the latter part of 1985. The reservoir will be filled by June of 1986.

23.2 Proposed Geotechnical Investigations

It is proposed to perform the following geotechnical investigations in the next phase of the work. The program recommended is as follows:

a. Seven drill holes varying in depth from 50 feet to 100 feet for an approximate total of 550 feet. The locations of those holes are: two 100-foot holes each at the top of both abutments, two 75-foot holes halfway down the abutments and one 100-foot deep and two

50-foot deep holes at the valley bottoms. Of these the first five shall be at or near the dam axis, while the last two shall be located near the upstream and downstream toe of the dam. The holes shall be logged and sampled. Standard blow counts shall be taken at, say, 5-foot intervals and in-situ permeability observations shall be made. The drilling will require a suitable rotary drill rig, casing, sampling tools including a 2-mil diameter "standard" split spoon and 140-lb. hammer, parker, water pump and sample containers;

b. The investigation might have to be augmented by seismic surveys:

c. In-situ measurements of stress-strain and strength behavior of the foundation soils in their undisturbed state are also proposed to be made by pressure-meter. For these purposes, special equipment and special crew shall be brought to the site to make the necessary tests in the boreholes; and,

d. At borrow areas, test pits shall be excavated. Samples obtained from the pits will require simple laboratory identification and compaction testing.

A "budget" estimate for the proposed work outlined above was obtained from the Anchorage, AK office of Shannon and Wilson (see Appendix B). Their estimated cost of the work was $74,000 for a track-mounted operation, or $123,000 if it is necessary to use a helicopter-assisted operation.

24.0 CONCLUSIONS AND RECOMMENDATIONS

24.1 Conclusions

Based on the studies made, it is concluded that:

a. The expected yield from the existing reservoir in Bridge Creek during low flow periods is estimated to be significantly less than was previously estimated by others. Compared to the 1982 demand of 0.56 MGD, the yield of Bridge Creek is close to being reached.

b. Bridge Creek dam was not originally designed to be raised. Structural and hydraulic considerations indicate that raising the dam is not feasible.

c. Fritz Creek is the most viable alternative for supplying demands in the future. It has 50% more yield than Twitter and consequently can meet future demands over a longer period. Secondly, the cost per acre-foot of yield at Fritz Creek is 76% of that at Twitter.

d. Instream flows have a significant impact on water yield. Discussions should be held with the Alaska Department of Fish and Game to apprise them of the impact of their instream flow requirements to water yield.

e. A dam can be built at Fritz Creek. The best site would be Alternative Site 3 provided that there are no environmental constraints;

f. The reservoir size can only be determined after instream flows are firmed up. It should be between 2300 and 5800 acre-feet;

g. The spillway design flood will be 570 cfs, a 500-year flood. Provisions to handle extreme floods (10,000-year recurrence interval) should be provided. The construction design flood will be 260 cfs, a 10-year flood;

h. The project will consist of an earth-fill dam about 100 feet high with 1 on 3 slopes, a glacial till core and sand and random fill shells. The service spillway will be a morning glory spillway while the auxiliary spillway will be an open chute type. The low level outlet work pipe will be a steel pipe within a gallery under the dam;

i. Total construction costs are about $2,200,000 per acre-foot of yield (1983 dollars); costs will range between $14,800,000 and $23,600,000 depending upon the size of the reservoir; and

j. Geotechnical explorations will be required prior to design.

24.2 Recommendations

It is recommended that geotechnical investigations be undertaken in the summer/fall of 1983 so that construction can proceed and the project will be completed in time to meet 1986 demands. Land acquisition and financing negotiations must be initiated immediately since these are critical tasks for project implementation.

Based on Item (a) above, it is recommended that the City actively pursue immediately plans for the development of Fritz Creek and/or evaluate means by which to keep demands from growing rapidly.

SECTION III

PROJECT FINANCING AND IMPACT ANALYSIS

25.0 PROJECT ECONOMIC AND FINANCIAL ANALYSIS

25.1 General Financing

Previous chapters have examined the technical, environmental and cost aspects for the alternative means of expanding Homer's water source capacity. The purpose of this chapter is to analyze the effects of pursuing any of the three alternatives involving development of a dam, reservoir and water treatment plant on Fritz Creek.

A number of previous studies have developed information which is useful in examining economic aspects of the project. Recent reports which can be utilized include a water and sewer rate study completed in 1983, a water plan update completed in 1982 and a comprehensive plan update completed in 1983.

The comprehensive plan update contains projections of population and economic growth in Homer and surrounding areas for the next several decades. In general, the entire Homer area is projected to continue to grow at a rapid pace for the next decade, with somewhat slower growth during the following two decades.

In addition, the water plan update provides that service will be extended to additional areas of the city, increasing the fraction of the city's population served from the present 60 percent to 90 percent by the year 2010. The result of rapid population growth, coupled with extending service to increasingly large fractions of the community, would be a dramatic rise in annual water consumption for most uses. The sole exception to this is in the area of fish processing, where future growth depends on economic and biological factors well outside of the control of Homer. Table 25.1 summarizes these figures.

Developing the new water improvement will have major impacts on the finances of Homer's water utility. As of this writing, the City is currently considering rate increases averaging 39 percent simply to bring the utility's operations to a point where revenues are sufficient to cover direct and indirect costs of service. Future increases averaging 6 percent per year will also be needed to continue to cover direct and indirect costs through Fiscal Year 1989 without allowing for major capital improvements such as the water supply expansion (Brown and Caldwell, 1983).

When the costs of constructing and operating the water supply expansion are figured into the system's operations, it becomes obvious that further substantial rate increases would be needed to pay for the project. Without allowing for outside financing (for example, Legislative grants from the State), financing the project by incurring long-term debt would require rate increases totalling from four to eight times rates projected for Fiscal Year 1987 by Brown and Caldwell (1983). For the smallest dam and reservoir alternative, average FY 1987 charges for residential customers would rise from $18.28 to $104.83 per month. For the medium and high cost alternatives, monthly residential charges would be $125.07 and $144.43, respectively. In terms of percentages, these represent respective increases of 474, 584 and 690 percent, respectively.

If areas adjacent to the transmission line are also served, some savings could be realized by spreading the capital costs over a larger number of customers. Average increases in monthly charges, however, would nevertheless be substantial. Increases over average monthly charges (based on rate projections prepared by Brown and Caldwell (1983)) would be 407, 500 and 590 percent for the low, medium and high cost alternatives, respectively. Average monthly charges per residential customer for Fiscal Year 1987 would increase from the projected

Table 25.1

EXISTING AND PROJECTED WATER USAGE AND CUSTOMERS
Fiscal Years Ending 1983 to 2006

	Fiscal Years Ending		
	1983	1987	2006
Number of Customers			
Residential	550	818	3,083
Commercial	109	159	600
Public Authority	20	29	111
Homer Spit	25	37	116
Total	713	1,043	3,911
Average Total Water Usage per Customer per Year (MG)			
Residential	0.07	0.07	0.07
Commercial	0.26	0.26	0.26
Public Authority	0.54	0.54	0.54
Homer spit	3.07	3.07	3.07
Total Water Usage (MG)			
Residential	39.13	60.85	229.37
Commercial	28.34	40.94	154.51
Public Authority	10.80	15.73	60.29
Homer Spit	76.75	113.65	357.51
Total	155.02	231.17	801.67

Source: Olympic Associates Company, based on data from CH2M Hill (1982) and Brown and Caldwell (1983).

$18.28 to $92.64, $109.75 and $126.10 for the three water supply expansion alternatives. Table 25.2 summarizes these figures.

If State and Federal grant financing were to be obtained, it would be possible to avoid many of the rate increases; however, increased operating costs would still require an increase over Fiscal Year 1987 rates. For example, if grants could be secured to pay for 90 percent of the project cost and only City of Homer residents were served, Fiscal Year 1987 rates would still need to increase by 46 to 80 percent over currently projected rates for that year. Average monthly charges for residential customers would increase from the projected $18.28 to $27.30, $29.33 and $31.26 for the three water supply expansion alternatives.

If Kachemak City and other areas adjacent to the transmission line were served, the required rate increase would be about one quarter less, with projected Fiscal Year 1987 average monthly residential charges of $24.98, $26.69 and $28.33 for the three expansion alternatives. Table 25.3 summarizes these figures. Prospects of obtaining this level of aid are discussed in the following section.

25.2 Financing Sources

Three different approaches can be taken to financing a capital project such as the water improvement. They have been described as:

a. Pay as you acquire,
b. Pay as you use, and
c. Get someone else to pay (Faas, et al., 1982).

These approaches are described separately in the sections below.

Table 25.2

PROJECTED RATE IMPACTS OF WATER SUPPLY EXPANSION ALTERNATIVES ASSUMING NO GRANT FINANCING

Cost Range Alternative	Construction Cost (Millions of 1983 $)	Projected No. of Customers FY 1987	Average Increase Over FY 1987 Rates	Average Monthly Charge for Residential Customers FY 1987
Service provided to City of Homer customers only				
(No Action)	na	1,043	na	$ 18.28
1	$19.45	1,043	474%	$104.83
2	$24.00	1,043	584%	$125.07
3	$28.35	1,043	690%	$144.43
Service provided to all customers adjacent to transmission line				
1	$20.00	1,572	407%	$ 92.64
2	$24.55	1,572	500%	$109.75
3	$28.90	1,572	590%	$126.10

Source: Olympic Associates Company

Table 25.3

PROJECTED IMPACTS OF WATER SUPPLY EXPANSION ALTERNATIVES ASSUMING 90 PERCENT GRANT FINANCING

Cost Range Alternative	Construction Cost (Millions of 1983 $)	Projected No. of Customers FY 1987	Average Increase Over FY 1987 Rates	Average Monthly Charge for Residential Customers FY 1987
Service provided to City of Homer customers only				
(No Action)	na	1,043	na	$18.28
1	$19.45	1,043	49%	$27.30
2	$24.00	1,043	60%	$29.33
3	$28.35	1,043	71%	$31.26
Service provided to all customers adjacent to transmission line				
1	$20.00	1,572	37%	$24.98
2	$24.55	1,572	46%	$26.69
3	$28.90	1,572	55%	$28.33

Source: Olympic Associates Company

a. Pay as You Acquire Approach

Under the Pay as You Acquire approach, cash reserves and accumulated reserve funds are used to pay for the project. This approach saves interest cost (which can equal the construction cost over the life of the project), helps preserve borrowing capacity for unforeseen major outlays, avoids the inconvenience associated with planning and marketing bonds, and helps foster favorable bond ratings on the occasions when long-term financing is used.

The primary disadvantage of this method is that current users pay an additional charge to cover the cost of improvements to be used in the future. Essentially, this amounts to a subsidy from present to future residents, and is often considered an inequitable method of financing a project. In addition, unless the City were to exercise extraordinary fiscal restraint, have relatively modest capital projects needs AND have access to a large tax base, Pay as You Acquire would not be suited to finance the project alone unless combined with other approaches.

b. Pay as You Use Approach

Under the Pay as You Use approach, capital projects are paid for by borrowing against future revenues with bonds, government or private loans or other forms of debt. Extending the financing avoids the large fluctuations in budgets which large capital projects can cause, and it may be cheaper to borrow and pay today's price rather than wait and pay tomorrow's price when inflation is driving up construction costs.

Many believe that a long life asset should be paid for by its users during its normal life, rather than all at once by those who may or may not have the use of it for its full life, and that Pay as You Acquire amounts to an unwarranted subsidy from existing to future users. Higher interest costs may also be offset by spreading the costs over a larger number of users in a growing population, and allows costs to be better synchronized with benefits (Faas, et al., 1982).

Two basic types of bonds are most frequently used by local governments. General obligation bonds pledge the taxing power and full faith and credit of the City to meeting the required payments on the bonds. Under state law, general obligation financing must be approved by the voters, particularly for a project of this size.

However, general obligation bond financing has limited potential for this type of project. The City's current policy is that its net general obligation debt may not exceed eight percent of total assessed property value (Pacific Rim Planners and Engineers, Olympic Associates Company, 1983). At the end of Fiscal Year 1982, the City had total assessed valuaton of $125 million, and a net general obligation bonded debt of $1.8 million, representing 1.5 percent of total valuation.

Therefore, 6.5 percent of total valuation, or $8.2 million, is approximately the maximum additional general obligation debt which can be incurred for all projects at the present time. Even with projected increases in assessed valuation and no new general obligation debt, the maximum general obligation debt capacity is likely to be no more than $12.0 million by Fiscal Year 1987.

Limited liability or revenue bonds are those to which the income from a public enterprise (in this instance, the City's Water Utility) is pledged toward repayment of the debt, but are not backed by the unlimited taxing power and the full faith and credit of the City (Faas, et al., 1982). For example, Homer has used revenue bonds to fund some previous water system improvements, and has pledged water system revenues towards their repayment.

There is no fixed limit in terms of debt capacity for revenue bonds except for the underlying feasibility and creditworthiness of the project. The financing package supplied to lenders must be accompanied by market studies, rate studies and other documentation to support the project. In addition, convenants or restrictions are typically included in the bond agreements which stipulate that sufficient revenues be maintained for the enterprise to cover operating costs and debt service (exclusive of depreciation) plus allow a substantial cushion to protect for the unexpected. Thus, charges need to be set higher than for general obligation financing in order to simply meet the lending requirements. In addition, since less security is offered to lenders, revenue bond financing often involves interest rates of one or more percentage points higher than general obligation financing.

Private notes or government loans are alternatives to bond financing within the Pay as You Go approach. Included among these are short-term notes issued by local banks or statewide banking establishments, and low interest loans from State and Federal agencies (Faas, et al., 1982). For example, Federal Coastal Energy Impact loans are available through the Alaska Department of Community and Regional Affairs to communities impacted by outer continental shelf energy development. The loans offer a low interest rate, and the principal may be forgiven if the energy development the project was designed to serve does not materialize.

A third type of device for Pay as You Go financing is the lease purchase arrangement. A private developer builds the project to the specifications of the agency, and leases it to the agency for a monthly or annual rental. At the end of the lease period, title to the facility can be conveyed without any further payments. While this circumvents debt limits and the need to call special elections, it is costly and is not well suited to the size and nature of the water project.

c. Get Someone Else to Pay Approach

Under the Get Someone Else to Pay approach, responsibility is shifted to other jurisdictions, who in turn must decide whether to use the Pay as you Acquire or the Pay as you Use approach to cover the cost of the project. For example, private developers may be forced, through subdivision or zoning ordinances, to pay for both on- and off-site capital project costs attributable to their developments. Property owners may be charged for street or utility improvements benefiting their property through the use of special assessment bonds (Faas, et al., 1982).

More important to the water project, if more than one jurisdiction is served, all benefiting jurisdictions can jointly finance the project. Or, if appropriate jurisdictions do not exist (such as the unincorporated areas along East End Road who might be served by the project), new jurisdictions such as a water service area might need to be created to pay for the project.

The other important category of this type of financing is grants-in-aid from other governments. State and Federal grants have been the largest source of financing for capital projects in the City of Homer, and will continue to be an important source in the future.

The major source of grant financing currently is direct grants by the Alaska State Legislature. Funding by this means depends in part on the priority placed on the project by the community, and on the effort by the community to secure state funding. Oil revenues, which constitute the major source of funds for the State, are forecast to generally decline over the next decade, so it will likely be difficult to secure funding for the entire project. The project will be aided, though, by the fact that it would contribute to the economic growth of the region and the state, which has been a consistent funding priority of both the Administration and the Legislature.

25.3 Financing Prospects

Because of the sheer size of the project, it is likely that a combination of approaches will be needed to finance the project. Clearly, current paying users of the system cannot shoulder more than a small fraction of the cost of the project without raising serious questions of inequities between current paying users and both those who use the system now but do not pay for it (i.e., those who haul water) and future paying users.

Financing will probably need to come from a combination of State grants and long-term debt. Additional users will need to be brought into the system to help shoulder the cost of increased capacity, as well as to improve the economic justification for State grant funding. Some general obligation debt financing could be used to keep interest costs low, but due to the limited debt capacity, revenue bond financing will probably be in order.

Both legal counsel and bond counsel should be employed to explore the specific legal and financial mechanisms which could be employed. In addition, market studies ought to be conducted prior to obligating the financing to determine whether users would in fact be willing to shoulder the additional costs of expanding the capacity, or would prefer other devices to limit growth in demand (such as higher user fees, voluntary conservation programs or moratoriums on new hookups) to delay the time at which the new water source will be needed.

26.0 ENVIRONMENTAL ASSESSMENT

26.1 Introduction

The purpose of this study is to provide the City of Homer with an additional source of water supply. To this end alternatives were evaluated and a dam site on Fritz Creek was determined to be the best solution.

The proposed dam will be of earthfill construction basically using on-site materials. The dam will form a reservoir approximately 100 acres in size.

In conjunction with the dam, a water treatment plant will be constructed. This plant will function similar to the existing plant on Bridge Creek. The tentative location for the treatment plant will be about a mile downstream of the dam and one-half mile upstream from East Road. The treated water will be carried to the end of the existing line near Kachemak City through approximately 30,000 feet of water transmission main.

The impact of this project will be the loss of a part of the moose wintering grounds used during extreme winters, an occasional reduction in the stream flow in Fritz Creek and excavation of material to be utilized in the dam construction.

This environmental analysis has been forwarded to and reviewed by the Department of Natural Resources. Their comments are included as Appendix B.

26.2 Summary of Proposed Action

General

The dam design discussed here is preliminary. Extensive geotechnical investigations will be required prior to final design. The height of the dam will depend on the required reservoir volume which can only be determined after instream flows are firmed up.

Dam and Reservoir

1. Dam Construction

It is assumed that no more than 10 feet depth of stripping will be required. The dam embankment shall be constructed using:

- a. A massive impervious core and some impervious blanket material constructed of compacted clay-silt-sand-gravel and cobble mixtures, i.e., of compacted glacial till;
- b. A minimum amount of compacted clean sand in the upstream shell zone which is subject to drawdown;
- c. Processed clean, coarse sand, or coarse sand and gravel for an internal drain layer, frost-proof crest and "rock" toe;
- d. Random organics-free sand or glacial till fill for the downstream shell; and
- e. Riprap on filter cloth protecting the upstream reservoir slope as well as the dam toe at tailwater.

Except for a shallow, dike-like part of the dam up on the left abutment which will be protected by an impervious blanket, the main dam will feature a sheet pile cutoff wall to varying depths. This depth might be 2/3 of the dam head measured vertically down, or 5 times the dam head measured horizontally into the slopes, whichever measure yields the deeper sheet piling. Both the blanket as well as the sheet piling will protect the very erodible foundation (in some places) against internal erosion ("piping"). The dam will tentatively have 1 vertical over 3 horizontal slopes. Figure V-1 shows a typicl dam section.

2. Service Spillway

The service spillway will be a morning glory spillway designed to pass 570 cfs, a 500-year flood. The weir will be 14 feet in diameter set at normal pool level. The spillway shaft will join to an inclined buried 7-foot diameter conduit. The conduit will be steel-lined where it will pass under the impervious core and downstream face of the dam. Flows will be dissipated before being diverted back to the creek.

3. Auxiliary Spillway

The service spillway will be augmented by an open-chute auxiliary spillway on one side of the dam. The combined capacity will be 740 cfs, which is equivalent to a 10,000-year flood.

4. Low Level Outlet Works

The low level outlet works conduit will serve as a diversion conduit during construction and for releasing flows during operation into the creek or to the treatment plant. During construction, the lower conduit will be open. When the dam is completed, a low gate at the portal will be closed and the conduit will be plugged. Because some parts of the foundation may be flexible, the outlet-works pipe will be placed within a gallery to avoid possible flexing of the pipe as the dam is constructed.

5. Construction Materials Required

The materials required for dam construction are:

a. Glacial Till - Numerous deposits near the dam sites at elevations suitable for downhill hauling.

b. Clean Sand - Beds of moderately indurated sandstone which may be extracted selectively from quarries; such as that on the right bank of Fritz Creek and one observed on the left bank of Bridge Creek.

c. Clean Coarse Sand or Coarse Sand and Gravel - Alluvial deposits at Anchor Point and beach deposits on Homer Spit.

d. Random Fill - Beds of moderately indurated sandstone, siltstone, and claystone in quarries such as those described in (2) or glacial till as described in (1).

e. Riprap and Coarse Rock for Gabion Construction - Present in scattered deposits along creekbeds in sizes commonly up to 2 feet in diameter and in beach deposits of Kachemak Bay in sizes up to 2 feet and through the processing of glacial drift deposits near the dam site.

The following assumptions were made for the purpose of estimating costs of the dam:

f. Till material is available within one mile of the dam site.

g. Pit-run sand can be obtained on the right bank of Fritz Creek.

h. Filter material will be trucked from Anchor Point about 16 miles away.

i. Random fill can be obtained from excavation in the vicinity.

j. Riprap and coarse rock for gabion construction will be available from observed beach deposits at Kachemak Bay.

k. Ready mix can be purchased locally.

It was also assumed that no campsite will be constructed and the labor force will be located at Homer. These assumptions indicate the locations from which dam construction materials will be obtained. Table 26.1 shows the amounts required of these materials for construction of the three alternative dam sizes.

6. Reservoir

Although the reservoir size is not finalized, it is anticipated that the reservoir will cover approximately 100 acres. Under flood conditions, the maximum acreage covered by the reservoir shall be no more than about 200 acres.

Table 26.1

DAM CONSTRUCTION - Material Quantities in Cubic Yards

Material	Reservoir Size 2300 A-F	 4000 A-F	 5800 A-F
Till Fill	200,000	302,000	408,000
Pit Run Sand (Upstream Sand Shell)	179,000	235,000	298,000
Sand Filters	138,000	192,000	246,000
Random Fill	90,000	164,000	225,000
Riprap	60,555	62,625	65,625

Water Transmission Main

The water transmission main will consist of two major sections. The first section will run from the dam to the water treatment plant site near the intersection of Fritz Creek with East Road. The second section will run from the treatment plant to a tie-in with the present water system at Kachemak City.

The first section (from the dam to the treatment plant) will be approximately 5000 feet in length and will probably follow the west side of Fritz Creek. As this section will run through private property, easements will be required. This pipeline section will run through virgin land; therefore, some loss of trees and brush will occur.

The second section of the transmission main will follow the East Road from the treatment plant to a tie-in with the existing water system.

The exact point of tie-in is not yet identified. The pipeline can be laid within the highway right of way and will require permission from the the Alaska Department of Transportation and Public Facilities. The pipeline will be buried to a depth of 7 feet with hydrants along the way. No vegetation other than grass will be disturbed by construction, and the length of this section will be approximately 29,600 feet.

Treatment Plant

The water treatment plant process will consist of chlorination, chemical addition, and filtration to remove solids and ensure sanitation. Major elements of the process plant will include the chlorination equipment, chemical addition equipment, filters, pumps, air compressors and backwash settling ponds. The plant equipment will be housed within a building (approximately 3200 square feet) on the treatment plant site.

26.3 Existing Conditions

Physical

1. Geology

The main geomorphic elements of the area are an escarpment of sedimentary bedrock immediately north of Homer and beyond this to the north an upland area of the same bedrock almost entirely covered by glacial deposits.

The entire area is underlain at shallow depth by the Kenai Formation which consists of moderately indurated sandstone, siltstone and claystone, mainly in thin beds and lenses, interbedded with a few thin lenses of fine conglomerate and many thin beds of subbituminous or lignitic coal (1). Ferruginous masses and ironstone concretions are common (1). The Kenai Formation is of Tertiary age and is believed to be up to 20,000 feet in thickness (2). Where observed in the study area the beds dip northerly about 4 degrees below horizontal.

Excavated rock of the Kenai Formation, observed in quarries during a reconnaissance of the area, is broken down to sand and gravel sizes. Confirmation of the softness of the material is given by descriptions of the bedrock at the Bridge Creek dam site where it is described as "generally semiconsolidated into a moderately soft rock . . . cut easily with a knife and sometimes scratched with a fingernail" (2). It is therefore expected that for dam construction purposes quarries in the bedrock would not represent a source of rock fill but could well serve as a source of sand.

The Homer Spit consists of coarse beach gravel and boulders. Apart from the Spit, the only known sizeable source of alluvial sand and gravel is a pit at Anchor Point, located about 16 miles by paved highway west of Homer.

2. Topography

In the downstream reaches of Fritz Creek, the creek has cut deeply into the soil mantle, resulting in relatively steep, continuous valley slopes with gradients commonly in the order of 40% to 60% rising from the floodplain which is limited to widths in the order of 50 feet. Numerous indications of soil instability, such as slumped zones extending 100 feet or so along the base of the slopes and extensive tilting of trees, indicate that at least the upper 10 or 20 feet of the soil is loosely consolidated and subject to failure on steep slopes.

Proceeding upstream, the valley gradually changes in form with the floodplain widening and the slopes becoming far more gentle with no significant evidence of slope instability (2).

3. Soils

As a relatively short time has elapsed since the ice sheet that formerly covered the area receded, the Kenai Formation is mantled by nearly continuous deposits of glacial drift. The deposits of this material observed during the reconnaissance appear to be unsorted mixtures apparently deposited directly by glaciers and consisting of clay, silt, sand, gravel and boulders. These deposits are referred to herein as glacial till. The largest boulders observed in this material are in the order of 2-foot diameter. While it is reported by others that some of the glacial drift deposits consist of stratified gravelly outwash material, and a few boulders greater than 2-foot diameter were observed during the reconnaissance, for general planning purposes it is taken that the overburden at the dam site discussed herein consists essentially of the unstratified glacial till described.

This material is believed to have extremely low permeability and, while not well consolidated near the surface, appears to be suitable to serve as a dam foundation and as impervious core material for an earth-fill dam.

As shown in Figure V-2, the soil composition of area covered by the impoundment area created by the dam consists primarily of soils of the Mutnala-Salamatof association. The pipeline will run through soils primarily of the Beluga association.

Water Rights

The water rights granted by the Department of Natural Resources (DNR) in the Fritz Creek Drainage Area include only four small appropriations of water from Fritz Creek and one small appropriation from a tributary to Fritz Creek. The total amount of water included in these five appropriations is only about 1975 cubic feet per day, less than one-quarter of one percent of the annual mean simulated stream flow. Table 26.2 summarizes the Fritz Creek water appropriations.

Table 26.2
FRITZ CREEK WATER APPROPRIATIONS

Water Right Holder	Appropriation Source	Quantity and Use
F. W. Wilkens	Fritz Creek	500 gpd; domestic use
M. Kwochka	Fritz Creek	500 gpd; domestic use
F. Pavloff	Fritz Creek	1600 gpd; domestic use
K. B. Star	Fritz Creek	500 gpd; domestic use 4500 gpd; commercial use
P. A. Carlson	Fritz Creek tributary	700 gpd; domestic use 6500 gpd; irrigation

Biology

The vegetation of Fritz Creek contains three major habitats. These habitats in combination provide shelter and forage for wildlife. The Fritz Creek Drainage Basin provides an abundant resource for upland wildlife. Fritz Creek itself has a natural barrier to anadromous fish. This section reviews the existing conditions of the flora and fauna of the Fritz Creek Drainage Area.

1. Flora

The native vegetation in the Fritz Creek Drainage Area occurs as three major habitats:

- Sitka Spruce Forest
- Native Grasslands
- Freshwater Marsh and Muskeg

In the lower elevations of the southern Kenai Peninsula, forests are the dominant vegetation (2). Normally forests are found only up to the 1000 to 1500-foot level. Variation in the forested land at different elevations relates to soil and drainage characteristics. The Sitka spruce forests are usually found in the drainage basins of creeks and rivers. They are scattered throughout the area between the lowlands and the steep bluffs. The Sitka spruce forest consists of Sitka spruce, white spruce, alder, quaking aspen, paper birch, and black cottonwood. The majority of the forests in the Fritz Creek Drainage Basin have not been commercially lumbered. Trees have been cut from dense forests for electrical transmission lines, for roads, and for homesteads. Sitka alder occurs on the slopes and along the large drainage-ways, while willow is common on the slopes and draws (1). Both densely forested areas and isolated clumps of spruce are separated by grassland in the Fritz Creek area. A unique character is provided by the Sitka spruce and open meadows. The forested areas' understory varies from ferns, grass and low-growing berries, depending on soil and light conditions. The forest land is an important feeding habitat for small ground animals, birds, and other wildlife (1, 3).

The grasslands habitat of the Fritz Creek Drainage Area consist of native grasses and wild berries. The common species of berries are high and low cranberries, elderberries, raspberries, watermelon berries, crowberries, and blueberries (2). The dominant grass in the native grasslands on the benches and steep slopes of the area is the blue joint reedgrass. Other common plants in this area are fescue, bluegrass, fireweed, and lupine (1).

The Fritz Creek Drainage Area also includes freshwater marshes along Fritz Creek, a tidal marsh at the confluence of Kachemak Bay, and muskeg in flat, poorly drained areas. Common freshwater marsh plants include cottonsedge, bog birch, draft willow, lingenberry, and bog blueberry. The tidal marsh of Fritz Creek is a transition zone between the estuarine environment at the mouth of Fritz Creek and Kachemak Bay and the upland habitats. Most tidal marshes include lyngbye sedge, tufted hairgrass, and beach rye grass (1).

2. Fauna

The wildlife and fisheries of the Fritz Creek Drainage Area coincide with the vegetative habitats. The forest land is an important feeding and rearing ground for the bald eagle. Other birds utilizing the forested areas are owls, hawks, and spruce grouse. The grasslands are areas that provide habitat for small ground animals, birds, and other wildlife including spruce grouse and ptarmigans. The freshwater marshes are important for small fur-bearing animals, including wolverines, rabbits, coyotes, wolves, beaver, mink, martin, fox, lynx, and muskrats. Moose also utilize the marshes for winter feeding on the sedges, grasses, and other aquatic plants.

In combination the vegetative habitats provide both protection and feeding grounds for Kenai moose, and brown and black bears. The coastal area and tidal marsh of Fritz Creek are used by a variety of migratory birds, waterfowl, eagles, and ravens (1, 2).

The Alaska Fish and Game Department (ADF&G) has stated that the Fritz Creek Drainage assumes a critical role in moose survival in the area during severe winters. During normal winters, the drainage supports probably less than one dozen moose. During severe winters, however, the drainage supports higher moose concentrations, 50 to 100 individuals. This is probably due to extreme snow depths in the South Fork Anchor River and the Beaver Flats.

The Kenai Peninsula waters are an abundant source of fish for commercial and sport fishing. Halibut, salmon, spotted side stripe, coon stripe shrimp, dungeness crab, king crab, and tanner crab are commercially fished in Kachemak Bay (2). Fritz Creek has been specified by the Alaska Fish and Game Department as important for the migration, spawning, or rearing of anadromous fish. The creek is used to stock coho salmon, and the ADF&G has stated the creek supports pink salmon. The creek also contains some land-locked Dolly Vardins (4).

26.4 Impacts and Mitigation

General

In the initial submittal, four alternatives for the Homer Water Supply improvement were considered:

- nearby surface sources,
- groundwater sources,
- distant surface sources, and
- desalination.

Desalination and development of distant surface sources were ruled out by high costs. Groundwater sources were also found uneconomical largely due to the low yield of individual wells and resulting necessity for a large number of wells to supply sufficient water. In evaluation of the nearby surface sources, Fritz Creek was found to be the only feasible site. In analyzing the unavoidable environmental impacts of the Fritz Creek site, it is important to consider that environmental impacts of developing this site are comparable to other surface sites and less than development of distant surface water sources.

Physical Impacts

The primary physical impacts will be environmental disruption due to:

- excavation of dam materials,
- pipeline construction (especially along Fritz Creek), and
- building a road to the dam site.

Table 26.3 shows materials required for dam construction, quantities required, and availability as outlined in previous sections. Restoration of excavation sites will be an important element in mitigating adverse environmental impacts. If material is excavated from state lands, excavation will require a Material Extraction Permit from the

Table 26.3
DAM CONSTRUCTION MATERIALS

Material	Quantity Needed (CY)	Availability
Glacial Till Fill	200,000 - 408,000	Near dam site
Clean sand (Pit run sand)	179,000 - 298,000	Quarries right bank of Fritz Creek
Sand Filters (Coarse sand & gravel)	138,000 - 246,000	Anchor Point
Random Fill	90,000 - 225,000	Near dam site
Riprap	60,500 - 65,625	Kachemak Bay*

*Kachemak Bay is a Critical Habitat Zone and removal of beach deposits may not be permitted.

Department of Natural Resources. DNR evaluates each application and establishes requirements for excavation operations and site restoration on a site-specific basis. The requirements are formally established when the Material Extraction Permit is granted. Initial cost estimates for the dam were developed with the assumption that coarse rock for riprap could be obtained from Kachemak Bay. This option may not be feasible for environmental reasons. Kachemak Bay has been designated a Critical Habitat Area by the Alaska Department of Fish and Game. Initial contact with the Department of Natural Resources indicates granting of a permit to remove beach deposits from Kachemak Bay is questionable for this reason.

To the extent possible, glacial till and random fill required for dam construction should be removed from the reservoir area to minimize environmental disruption and restoration expenses.

Biological Impacts

Initial responses from the Alaska Department of Fish and Game have indicated that preservation of moose habitat in the vicinity of the Fritz Creek drainage is an important environmental issue. Beaver Creek Flats will not be affected by construction of the dam or reservoir. However, the ability of the Fritz Creek drainage to support relatively large moose concentrations during severe winters may be impacted by the loss of land inundated by the reservoir. Although the exact effects on the moose population are difficult to assess, ADF&G has stated that it is reasonable to conclude the loss would significantly lower the moose carrying capacity of the South Fork Anchor River.

The second important wildlife issue is the maintenance of Fritz Creek as habitat for anadromous fish. The blockage approximately 100 yards upstream from Kachemak Bay limits natural fish runs in the creek. ADG&F, however, will require instream flows to maintain the coho stocking program (flow rates to be determined).

In addition to the above wildlife issues, ADF&G has indicated general concerns relating to projects of this nature including:

- deviations of water quality from ambient conditions (i.e., temperature, pH, suspended solids, turbidity, nutrients, etc.),
- gravel removal from floodplain areas,
- pipeline construction and burial in floodplains,
- road construction in floodplains, and
- construction timing.

Mitigating measures for these potential biological impacts will be specified as terms of the Habitat Protection Permit.

Construction of the dam may enhance Fritz Creek as a wildlife habitat by mitigating the effects of dry weather on the creek. In the past, dry weather stream flows have been less than 30% of the mean average flow.

The existance of the reservoir could tend to reduce natural fluctuation of stream flow rates, thus maintaining higher minimum stream flows than those occurring naturally during dry weather.

26.5 Permits and Regulations

Federal and State Requirements

The proposed project will require permits and certificates from the U.S. Army Corps of Engineers and from several State Departments and Commissions. A narrative summary of permit and certificate requirements is given below. Table 26.4 tabulates permits and certificate requirements.

1. U.S. Army Corps of Engineers

The Corps of Engineers (COE) will require a permit for construction of the dam and a permit for excavation of sand and gravel from beach deposits. Application for each permit can be made by submission of completed COE Form ENG 4345, together with a set of project drawings. If there are no objections to the project activity, a permit will usually be issued within 60 to 90 days after submission of the completed application. COE recommends that applicants contact the District Engineer Office before submitting the application. Further information is available in the U.S. Army Corps of Engineers Booklet EP 1145-2-1, "PERMIT PROGRAM, A Guide for Applicants."

2. State of Alaska Governor's Office

All projects which require Corps of Engineers' permits must be approved by the Governor's office for consistency with the State Coastal Management Program. The approval is formally granted by means of the Certificate of Consistency with the Alaska Coastal Management Program.

TABLE V-4
SUMMARY OF PERMITS AND CERTIFICATES

Federal or State Agency	Permit or Certificate	Application Procedure	Time Required
U.S. Army Corps of Engineers	Department of the Army Permit	Submit COE Application Form ENG 4345.	60 to 90 days if there are no objections.
Alaska Governor's Office	Certificate of Consistency with the Alaska Coastal Management Program.	Submit application form with the COE Permit.	Processed with COE permit.
Department of Natural Resources	Permit to modify or Construct a Dam	Application currently on file with DNR.	
	Water Rights Permit	Application currently on file with DNR.	
	Gravel Extraction Permit	Submit DNR Material Application Form.	3 to 4 months, possibly longer.
Department of Environmental Conservation	Certificate of Reasonable Assurance	No specific procedure, evaluation completed as part of COE permit process.	Processed with COE permit.

TABLE 26.4 (continued)

Federal or State Agency	Permit or Certificate	Application Procedure	Time Required
Department of Environmental Conservation	Construction and Operation Certificate	Applicant must inform DEC of project and submit design plans for preconstruction approval.	Construction permit granted within 30 days. Interim authorization to operate granted up project completion. Final operation certification granted within 90 days.
Public Utilities Commission	Certificate of Public Convenience & Necessity	Submit Certificate Application Form to PUC.	3 months.
Department of Fish and Game	Habitat Protection Permit	Submit full plans and specifications to Habitat Division of ADF&G.	30 days if sufficient data for evaluation is available.

The Certificate of Consistency application form is a simple one page form issued to the applicant along with the COE permit application form. The application for the Certificate should be submitted with the COE application and will be evaluated as part of the COE application. The Governor's office must grant the Certificate of Consistency as a prerequisite for a COE permit.

3. Department of Natural Resources

The Department of Natural Resources requires three permits:

a. Permit to Modify or Construct a Dam
b. Water Rights Permit
c. Gravel Extraction Permit

Applications for the Permit to Construct or Modify a Dam and the Water Rights Permit are already on file with the Department of Natural Resources. The Gravel Extraction Permit is issued after a Material Application is submitted to the Department of Natural Resources. Processing of the application requires at least 3 to 4 months and can take longer depending upon the material quantity requested and conditions at the site. A charge is levied by DNR based on the fair market value of the material removed.

4. Department of Environmental Conservation

The Department of Environmental Conservation (DEC) requires two certificates:

a. Certificate of Reasonable Assurance
b. Construction and Operation Certificate

The Certificate of Reasonable Assurance refers to water quality effects of the proposed project and is issued as part of the COE permit process. No separate application is required to obtain this Certificate. The COE permit application will be reviewed by the Department of Environmental Conservation and the Certificate issued if no significant adverse water quality effects will result from the proposed project.

The Construction and Operation Certificate is issued by the Department following a Plan Review for Sewage System or Water and Wastewater Treatment Works. There is no formal application for this Certificate; rather, the applicant should inform DEC of the proposed project via correspondence. After the project design is completed, the applicant must submit the plans to DEC for the Plan Review. Plans for all elements, the dam, treatment plant, and transmission line will be reviewed and ruled upon within 30 days. If the plans are acceptable, DEC will issue the construction portion of the Certificate authorizing construction of the project. After construction, DEC will authorize plant operation for a 90-day interim period during which DEC will verify the project was built according to the authorized plans. After verification of the construction, DEC will issue the operation portion of the Certificate.

5. Public Utilities Commission

The Public Utilities Commission (PUC) of the Alaska Department of Commerce requires a Certificate of Public Convenience and Necessity for operation of an installation that provides water or sells electricity to the public. The certificate is granted on the basis of service area, and new facilities which serve previously certified service areas do not require a new certificate. If a new certificate is required, an application packet is available from PUC. The application information includes financial statements of the applicant, managerial experience of the applicant, and the proposed service area. The time frame to obtain the Certificate is approximately 3 months.

6. Department of Fish and Game

The Department of Fish and Game requires permits under two state laws. The laws protect habitats of anadromous fish and require a permit for any blockage of streams with fish runs, and also require a permit for construction in any state waterway containing fish. The permit process usually lumps all requirements for the project into one permit known as the Habitat Protection Permit. The Department of Fish and Game also has jurisdiction over maintenance of instream flows which is reflected in the terms of the permits. The time frame for issuance of permits is 30 days after submission of the application provided sufficient data for evaluation is included.

REFERENCES

1. Water Resources and Surficial Geology of the Homer Area, South-Central Alaska, Roger M. Waller, Alvin J. Feulner, and Donald A. Morris, Hydrologic Investigations Atlas HA-187, Dept. of the Interior, U.S.G.S., 1968.

2. Foundation Investigation for City of Homer Dam on Bridge Creek, Hill-Harned & Associates, April 1974.

3. Homer-Ninilchik Area, Alaska, Soil Survey, U.S. Dept. Agriculture, July 1971.

4. Homer Comprehensive Plan - Olympic.

5. Homer Comprehensive Plan Revision, 1978, CH2MHill.

6. Soil Conservation Service, 1971 (referred to in the Comprehensive Plan - Olympic).

7. Water Reservoir Study, CH2MHill, October 1980.

SECTION IV

PUBLIC PARTICIPATION

FISH AND GAME MEETING

MAY 5, 1983

City Engineer Jan Keiser opened the meeting and called for introductions around the table:

Present:
Jan Keiser, City of Homer, Engineer
Phil Brna, ADF&G Habitat Division
Joe Wallis, ADF&G Sport Fish Division
Brent Leslie, Crippen Consultants
Dave Swenson, Olympic Associates
John Nagy, Olympic Associates, Anchorage
Nick Dudiak, ADF&G, FRED Div. Homer
Tom Schroeder, ADF&G, Commercial Fisheries, Homer
Dave Holderman, ADF&G, Game Division, Homer

The City Engineer Keiser thanked the representatives present for their quick response and their presence in Homer. She explained that the City has been studying the possible development of a new water source. Olympic and Associates and Crippen have been contacted for preliminary studies. Material has been gathered and the City feels that input from Fish and Game is now necessary.

Ms. Keiser reviewed work to date stating that the City and Olympic have been working together since September, 1982. It was determined, that the city does need a new water supply. Indications show that on a dry year, with water demand projections now evident, Homer could have a problem with the present supply of water. Other sources have been studied: ground water, 3 different surface water sources, desalinazation etc. Engineer Keiser reported that, according to the studies so far, it appears that a surface water source will be the most practical. Three potential sites have been identified: Bridge Creek (the existing source), Twitter Creek (north of Bridge Creek), and Fritz Creek. Each was studied as to how much water could be produced, what the economics would be in capturing that water and the possibility of that water satisfying the projected demands. Fritz Creek seems to be the best source to provide the projected demand. Fritz Creek also provides a better quality water.

Ms. Keiser stated that three potential sites for a structure on Fritz Creek had been identified and now the environmental questions, the in-stream requirements etc. had to be answered.

ADF&G representatives stated that they have two basic areas of concern: moose and fish. Mr. Holderman stated that he was concerened about the proposed dam sites as it would conflict with moose resources in that area. Fritz Creek drainage is a broad river bottom and it's part of a larger wintering area north and west (Beaver flats and south fork of the Anchor River). Mr. Holderman stated that the area is heavily used by moose during winters of heavy snow concentration.

City Engineer Keiser presented a map of the proposed three sites. Site #1 will occupy 22 surface acres. Site #2 will occupy 46 and site #3, the preferred site for geotechnical and hydraulic reasons, will require 157 acres for a 100 foot damn. Brent Leslie explained that the lower in the creek the site is located, the higher the damn would necessarily be.

Mr. Holderman stated that due west of the Fritz Creek site, is the Beaver Creek watershed which is extremely important as a wintering area for moose. In a normal mild winter, Mr. Holderman estimated that there would be a dozen to two dozen moose in the flood area. By developing the preferred dam site, he feared that the carrying capacity of the entire south fork drainage would be lowered.

Mr. Holderman stated that the other species which will be adversely affected by a dam site would be the beaver, the population of which the City would obviously want to keep at a minimum in the dam area.

Mr. Holderman stated that the annual harvest for the sub-unit (everything south of Tustumena) would average 200 bulls/season. He could provide statistics for the harvest in the specific drainage. The resource is used primarily by those living on the south end of the Kenai Peninsula.

Mr. Holderman stated that his desire from the City would be that they consider Twitter Creek. If the Fritz Creek site does come to be, he suggested a land swap wherein land could be obtained that would be beneficial to the moose resource.

Mr. Vernon stated that Fish & Game would ask for an alternate dam configuration which would minimize habitat disturbance such as going with one of the lower stream alternatives, or lower the level of the dam, or something, to minimize the impact.

It was explained that the peak demand for water occurred when the cannery required processing water. Service would be provided to everyone along the pipeline from Fritz Creek into the city limits.

Discussion was held about the possibilities of damming below the confluence of Twitter and Bridge Creek. It was explained that some silver salmon and some dolly varden use Twitter creek. Bridge Creek is not presently used to full capacity. It was explained by ADF&G representatives that when the Bridge Creek structure was built it was done so with the understanding that all of the creek would not be dammed so that fish habitat would not be impacted; to go back and reverse that decision would not be wise at this point.

Engineer Keiser asked the Fish and Game representatives as a whole to advise the City what steps would have to be taken regarding the site on Fritz Creek or make a definite statement that the site is not suitable. Fish and Game asked for as much information as far as size, price, exact location etc. for each of the sites as possible. Engineer Keiser stated that the estimated construction costs for #3 were 14 million; for #2, 16 million; and for #3, 23 million because of the construction difficulties. Fish & Game representatives stated that moose would be the number one priorty, the number one species impacted and fish would be second.

Discussion was held about the future use of the uplands area of Beluga Lake. The land is held by Department of Transportation and zoned commercial II and residential. Mr. Holderman stated that it is an area that Fish & Game would be interested in. Ms. Keiser reported that when DOT was in Homer recently for a public meeting on the Airport Master Plan they stated that the Department had no plans to protect the area. She suggested that Fish & Game contact DOT soon since they are in the process of putting together information for their master plan.

Fish and Game representatives explained that Homer is growing so quickly that moose habitat is suffering and as more subdivisions are put in, land like Fritz Creek becomes mre important if we are going to keep moose in the Homer.area.

Mr. Holderman explained that at one time the Homer Bench area was the most important moose wintering range on the entire peninsula. At present it's being developed so quickly that it's being lost. Fox River Valley, the number 2 wintering area, is also being encroached upon.

Engineer Keiser explained that some municipalities have ordinances that provide for watershed protection. By building the Fritz Creek dam, the habitat would be protected whereas now, that land is in the hands of others and there are no provisions for protection. The representatives from Olympic Associates and Crippen explained that it is a mixture of ownership at this point. There is University, Borough, and private property involved in the area.

Fish and Game asked Olympic Associates and the City to produce some calculations on areas of inundation at the three sites based on optimum dam configurations and also on various flow releases. This will allow them to weigh fish and moose against economics and come up with an alternative.

Mr. Swenson explained to Fish & Game that it would be presumptuous for Olympic to come up with the flows required for the fisheries and asked that Fish & Game provide that information for the City.

Mr. Wallis from Fish & Game expressed the feeling that the major impact at any of the three sites would be on the moose population. Anything that was done would improve the habitat for fisheries. At present there is a small population of Dolly Varden in the stream. It is not an important or significant fishery. There is a program of planting silver salmon smolts at the highway culvert. Mr. Dudiak stated that the smolts are released between mid-May and mid-June. At times they will remain in the stream for a month before they head out to sea. Their only concern is that there be an in-stream flow during that time. Adults return between August and October and stream flow should be maintained during that time also. If there is a possibility of stocking coho salmon in some other area to get the same fish into that area, then the in-stream flow can be reduced or eliminated during that time. Homing would not be to Fritz Creek. There is no need for spawning or rearing flow. The 60% mentioned in the water source study is not a firm figure. Additional study would be needed to determine the needed flow. When the stream flow has been monitored during release, it has been about 10 CFS in the month of June. It was the feeling that about half that would be sufficient for the smolt.

If there was some way to re-channel the outlet of Beluga Slough so that it would flow into Miller's Landing, that would provide a return for adult cohos and smolt could be stocked in Beluga Lake and the adults would come back there. A small channel could be dredged through the existing swamp without endangering the moose habitat.

Mr. Brna stated that an in-stream flow analysis is a very simple thing and will have to be done before a final opinion could be arrived at. The main concern is to provide transportation water for the fish from the road to the outlet of Fritz Creek. It was explained that it is not really a concern that returning adults enter the streams once they reach Mud Bay area.

Mr. Schroeder explained that one experiment that ADF&G is interested in pursuing is to dump fry into a reservoir. A rainbow trout fishery is also badly needed and could be experimented with in conjunction with the water project. Dangers in allowing a fishery around a water source were discussed.

It was discussed that the total flow in Fritz Creek could not be cut off. Residents would complain. There are existing water rights. People are presently using Fritz Creek as a water supply. Engineer Keiser pointed out that were the Fritz Creek dam implemented, these people using Fritz Creek water would be supplied by the City eliminating the needs for water rights.

In summary it was stated that different dam configurations need to be looked at to minimize adverse environmental impacts and maximize economic return. The two environmental concerns, moose and fish, may be contrary to each other so the different configurations need to be looked at based on different in-stream flow requirments and relate that back to the moose habitat that would be lost. ADF&G would also like to study the possibilities of stocking fish in the reservoir created.

Engineer Keiser stated that the City and Olympic Associates will conduct an in-stream survey to project the in-stream flow requirement. This will be used for the basis for development the alternate dam configurations.

Fish and Game reported that there is no smolt release scheduled for 1983. There are no fish available. Olympic Associates and the City agreed that the in-stream flow study would be conducted during the last two weeks of May or the early weeks of June when fish normally would be released. Further discussion on in-stream flow requirements could be held toward the end of June.

Engineer Keiser estimated that the project will be considered sometime between five and ten years in the future. There are political and social issues which will take many years to answer.

ADF&G representatives asked that a land ownership map be provided.

City Engineer Keiser thanked the Fish and Game representatives for their attendance at the meeting.

SEC. 27.2

HOMER WATER SOURCE IMPROVEMENT STUDY

PUBLIC WORKSHOP

Tuesday, September 13, 1983   7:30 PM

Homer High School Team Teaching Room

The City of Homer has been studying ways of obtaining more water to supply a growing population.

The workshop will offer an opportunity for you to speak with members of the consultant team studying the project. Questions raised and information collected at the workshop will be incorporated into a draft report to be published this fall.

Topics to be covered at the workshop will include:

- Capacity of Homer's existing water supply.
- Plans for expansion of Homer's water distribution system and need for additional water supplies.
- Costs and feasibility of possible sources of additional water.
- Environmental and water rate impacts of developing a dam on Fritz Creek as a new water source.
- Long range timetable for study, design, permit application and construction.

All interested residents are encouraged to attend. For further information, please call 235-6368

Costs for developing the system vary depending on the size of the reservoir desired. The smallest dam size studied would have five times the storage capacity of Bridge Creek reservoir, and would cost a total of $19 million, while the largest would have ten times the storage of Bridge Creek's reservoir and would cost $28 million. The City of Homer probably could not afford to build the project on its own, since there would not be enough customers at least initially to support a project of this size. A combination of State grants, expanding the service area to include Kachemak City and other east end areas, and perhaps building the project in stages would be needed to make the project feasible.

The purpose of this workshop is to inform interested persons of the work which has been completed to date, and to allow an opportunity to consider suggestions and new information. If you are interested in receiving a summary of the report when it is prepared, please clip out the coupon below.

NAME ______________________________

ADDRESS ______________________________

____

TELEPHONE ______________________________

WORKSHOP SUMMARY

HOMER WATER IMPROVEMENTS STUDY

September 13, 1983

INTRODUCTION

Homer has grown rapidly over the past two decades, and at its current rate of growth, its population is doubling every seven to eight years. This population growth has put a strain on existing public water supply sources.

Homer's existing water source, Bridge Creek, was first developed in 1974, but is likely to be insufficient to meet demands within the next several years. Conservation programs could help avoid a shortage, but if population continues to grow and additional fish processing plants are established as planned, a new water source will still be needed before the end of the decade. In fact, in a dry year, water shortages could occur as early as 1985.

Recognizing the need to begin developing water supply solutions now, the City of Homer retained Olympic Associates Company and Crippen Consultants, Inc. to evaluate water supply alternatives, prepare preliminary design and cost estimates of the preferred alternative, evaluate environmental and rate impacts, and prepare a detailed plan of action for developing the new water source.

WATER SUPPLY ALTERNATIVES

All practical alternatives were investigated. Initial study showed that there were a total of six possible sources. They included:

(1) Raising the existing dam on Bridge Creek to increase storage capacity;

(2) Construct a dam and reservoir on Twitter Creek;

(3) Construct a dam and reservoir on Fritz Creek;

(4) Develop new wells to tap groundwater supplies;

(5) Construct a submarine transmission line to carry water from China Poot Lake to the end of Homer Spit; and

(6) Construct and operate a reverse osmosis desalinization plant on Homer Spit.

All six were given equal consideration in the first phase of the study. The list was narrowed down based on cost, physical potential and other factors as the study progressed.

Bridge Creek was ruled out since the existing dam is constructed in a manner which would not allow it to be safely raised, as well as the fact that the limited additional quantity available would not justify the cost of essentially constructing a new dam.

China Poot Lake was found to be prohibitively expensive due to the high cost of constructing a submarine water transmission line across Kachemak Bay. In addition, since the lake is within Kachemak Bay State Park, the project might be considered to have excessive environmental impacts.

The technology of desalinization of seawater by reverse osmosis is developing rapidly, but operating costs are very high. Major factors are the high cost of energy to pump the seawater under high pressure past the reverse osmosis membranes, as well as the need to heat the water to a temperature which is suitable for efficient operation of the plant.

Groundwater was utilized by the City prior to development of Bridge Creek. Currently, wells serve as the major source of water for most Homer area homes not on public water supplies. Predicted yields of individual wells are low, and many wells would need to be drilled to satisfy water demands. The cost of drilling, power, treatment and pipelines would not be cost effective.

Twitter Creek was found to have a slightly higher flow than Bridge Creek, but due to watershed terrain, dam construction costs would be high. Cost per gallon of water produced would be higher than for Fritz Creek. In addition, a Twitter Creek dam would only satisfy another 10 to 15 years growth in water demand before another new source would be needed.

Fritz Creek drains a large watershed, producing more water than Bridge and Twitter Creeks combined. Topography of the watershed is such that the dam could be constructed safely and without complications and water treatment needs would be less than for Twitter Creek. Cost per gallon produced would be less than for other alternatives and the transmission line could be tapped to supply Kachemak City and other east end areas if desired.

FRITZ CREEK PROJECT CHARACTERISTICS

From economic, environmental and safety standpoints, Fritz Creek would be best developed by constructing a dam and storage reservoir. Three possible sites were studied on Fritz Creek, and cost estimates and preliminary designs were prepared for all three. Preliminary designs and cost estimates were also prepared for a water treatment plant and transmission line to Homer's existing system.

KBBI PROGRAM re: FRITZ CREEK WATER SUPPLY STUDIES

LF: As most of you are probably aware, the engineers have been doing some study regarding the water supply for the HOmer area for some time. Tonight they're here for what they call a workshop, to present the workshop summary to deal with questions and answers and your concerns in relation to the ...to bring you up to date where they are. So that everybody will know who these people are I would like to introduce first Jan Keiser who is the City Engineer and who will, in turn, present to you the consultants who are going to be doing the presentation.

Does everybody have one of these handouts?

OK.

JK: We've got four people with us who represent the engineering company that worked on the study which has been in progress for almost a year now or so and we're to the point where we've got a draft report and what we'd like to do is summarize that report for you tonight and answer questions in case any comments that you folks might have and put that into a ...compile that into our report and then go ahead and publish a final one.

Let me just introduce the folks that are here tonight...we've got Dave Swenson with Olympic & Assoc. who was the project engineer from Olympic. Howard Hillinger with Pacific Rim who can speak about environmental and land - use type questions if anyone has any particular questions on that. We've got Rolf Scrindy with Olympic and Assoc. who can speak on a wide variety of topics on just about anything but specifically the geotechnical portions of the dam and Brent Leslie from Crippen & Assoc. who is a water expert.

David is going to give you a brief summary of the report and then we'll just open it up to questions. I told them not to talk a minute longer than 30 minutes so just bear with us while we go through that and then you can have at it. And Eileen is going to be taping this so try and speak clearly and loudly from the back there if you do have a comment, so we can get it on record.

Approximately 30 minutes of discussion by the various consultants.

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Questions from audience:

MR. GRAY:

I'd like to have someone address...this is kind of a lengthy thing. First of all, if, let us say, Fritz Creek is selected, there are three different volumes of water storage that are being proposed, is that correct or are you talking just on the top one there?

JK: There are three specific sites that have been looked at, that first site...

GRAY: At Fritz Creek?

JK: At Fritz Creek. Our preferred site is the upper most one here.

GRAY: OK, given that as a selection, what is the size, the area size of this, how many acre feet are you going to be able to store and how much rate of water use, inthat you have two different varying amounts of run off that you have to guarantee, how much is left in that facility for use by the City? I think in volumes of water that large, acre/feet is perhaps the smallest volume designator that we can use.

JK: Let me see if I've got your question right. You want to know what volume of water would be left to the City if we built a dam that we're proposing and still leave the flow that we're required to leave in that stream?

GRAY: That's right.

JK: That's a good question. We don't...we have a range of answers but because the size of the dam and the volume of water behind it is based on primarily what Fish & Game requires us to release out of...

GRAY: That's what I say. Take the two figures, 60% and 28%...

JK: Well, there's even a wide range beyond that. 60% is very very conservative figure. That was a figure that they gave us when they didn't even really know what we were doing. They just kind of give you 60% as a stock answer when you call up and ask them that question.

GRAY: Let's use 60...what are you looking at?

JK: Well, with...so when we took a closer look at it, we thought that maybe the range could vary as much as...vary as low as 28% and then we had a discussion with F&G and their prime interest really wasn't so much with the fish, so much as it was with the moose habitat and we thought well maybe we could get by with as little as 15% and so we need to go through and do these. Brent can go through and give you the specific figures on the acreage behind the various ranges but it just varies so much, Robert, that it's really hard to give you a specific figure.

GRAY: Well, I'd like to know, when the dam is full up is what we're talking about, how much water is going to be behind the dam and what volume are we talking about in the...in the range of acre/feet unless you want to use a bigger figure, I mean a bigger...

A. Well, let's go for the gusto here. I'll give you the biggest number you're going to get out of me all night, how's that?

If we're required to use 60% in-stream flow, if we decided to meet the City's demand for year 2030, if the city demand is that high, that's based on the assumption that you're going to receive atleast 2 additional canneries between now and then and maybe your population will continue to grow, and also assuming we can build the dam that high without the environmental problems of the moose people, saying "no, you're not going to flood the moose out", then we're talking about a volume of 5800 acre/feet.

GRAY: OK, ah...I figured 1033 would meet the...well, that's splendid.

A. You see...that's the absolute, way off the end of the scale spectrum that is almost an impossibility to happen. It's not a realistic number. But that is...the worse case that we've looked at in our study. 1

GRAY: And in addition to this, is this in a seismic sensitive area?

A. Well, the entire region is in zone 3. In other words, if you're familiar with seismic zones. If you're not, that means you're in a...not the worst zone, but you're in the second worst zone. However, all of Alaska, pretty much, is in that zone, along with southern California...

GRAY: Well, it was just a matter of curiousity. This figure that you gave me, this great big figure, I think I can live with thatone. Thank you.

Q. Can you tell me why Beaver Creek wasn't explored for water? You don't even have it mentioned here...it has a far greater watershed than Fritz Creek does?

JK: Why wasn't Beaver Creek explored? Brent? I don't think it was ever even really mentioned as a...

Q. Well, I think it certainly should have been if you're looking for water. Everybody knows Homer needs water.

JK: I've only been in Homer for about a year, so I'm not really sure I even know where Beaver Creek is.

Q. Beaver Creek watershed is enormous.

JK: Oh, well, that's even farther away than... 2

Q. Well, you have the water here and it flows into Anchor River, this is Beaver Creek right here.

JK: Oh, OK, I see. Oh, it's a fork of the Anchor River?

Q. Yes, that's right.

JK: Oh, OK. That was the problem. With several of the forks off the Anchor River is Anchor River is a very sensitive fish area. The F&G were entirely upset when we even discussed using any fork of the Anchor River that would reduce its flow. Fritz Creek is not so sensitive because it's not actually a spawning area. But Anchor River, they were adamant about taking anything out of the Anchor River watershed that would reduce its flow.

Q. Well, I think you should put the pressure on them to build the dam up there instead of coming down here in to a residential area and jeopardizing the people here. This gentleman talks about the earthquake...are you a geologist?

A. I'm trained to geotechnical engineering, yes.

Q. Are you a geologist?

A. No, I'm not a geologist.

Q. Then you're not academically qualified to talk about.

A. I am academically qualified to talk about it. But I am not a geologist.

Q. Another question I want to know is...have soil tests been made on this property?

JK: No. Soil tests, as I said before, have not been made on Fritz Creek.

Q. Then you don't know what the saturation point of the mud flats out there, whether it would hold that or not?

JK: Not for the Fritz Creek site specifically. We did have some geologists come down and look over the area and they were able to look at the area, compare it to some of theother soil tests that were made in the Homer area and make some comparisions and they didn't feel that there would be a problem but we haven't done soil tests specifically.

Q. Did they do this from the ground or from the air? 3

JK: They did it from the air and from the ground. They did make...

Q. They got in some helicopters and just flew around.

JK: That's true...they did fly around in the helicopter cause I was in that helicopter but they also made, it was walked over the ground.

Q. They made one landing.

JK: Well, they made several trips or maybe you didn't catch everytime that they were up there but I do know that they did walk the area because they did tell me that at one point they were told not to cross private property so they had to have been on the ground.

Any other questions? Yes, sir?

Q. Yes, two. One is to the cost exposition on the present existing facility at Bridge Creek...mainly why in the existing facilities there that you know pump station and reservoir and chlorination tank...why couldn't that be expanded, and a larger area....(inaudible).-.you have existing facilities in and out, there's no problem as far as access to it, that was one of my questions. Just on cost exposition in that situation.

Another one would be ecologically speaking, what happens if you innundate that whole situation at Fritz Creek and recently there's been 50 acres of Timothy plant there, plus there's a lot of other vegetation, to the best of my knowledge, when you innundate an area like that, you have a rotting situation going on with the present and the existing vegetation that's under water and this creates a toxic situation along the whole outlet for a couple years and so that...has that been considered? 4

JK: Well, let me answer your first question first. Let me see if I've got your first question straight. You were...your question is, was the expansion or building of an expansion of Bridge Creek looked at and #2 was building another dam below Bridge Creek looked at, is that your question?

Q. Yes.

JK: OK, expansion of Bridge Creek dam itself was looked at and it was determined not to be feasible because of the way they built bridge Creek in the first place.

Q. How about exploring below it? I mean, couldn't you have a series of steps or terraces?

JK: If we have one lower then we'll have a head problem on being able to get water back in to the treatment plant, we'd have to pump it up and get it back in the treatment plant and then the...

Q. You could use another pumping station.

JK: Yes, but then the other problem is of the stream flowed that we're required to release in Bridge Creek.

Q. This was determined by the magic people at Fish & Game?

JK: To a certain extent, yes, that's true. Now, to your question about the decaying vegetation and the dam itself, it's something you just deal with in water treatment. 4

Q. But I don't know what you would control the spill over to the point where there would be no toxicity below the dam. In other words, with water rights, how do we get protected?

JK: How do you get protected from the toxicity?

A. This is a subject that people learn more about as they develop water reservoirs. The vegetation in the water reservoir causes tannens to be released and discolored and so on...because of that, although they can be treated, removed in a treatment plant, it's been increasingly common to remove as much vegetation as possible from that reservoir before it becomes filled up with water, although a lot of places don't do that, it certainly gives you the problems of color especially downstream. There's no toxicities even (inaudible)provides poorer water quality, it's a little bit acidic...

Q. I would dispute that. You have to take into consideration the tons and tons of fertilizer that's been dumped on that land back there...

JK: On the University's land? No, this is something that would have to be looked at too. Yes, sir, in the back.

Q. I have a question about the first chart. You said you studied the flow of each individual creek and the amount of flow in a dry year. When did you do that on Fritz Creek? 5

JK: I'm sorry, when was it done?

Q. How many gallons a day did the flow pass...I presume that that's what that chart was? When did you do that on Fritz Creek?

JK: Ah...well, it wasn't done at a specific time. Brent, do you want to discuss the hydrology, just a little?

BRENT: The hydrology, as you know, is a very adaptable science to the computer. And what was done is because of the lack of a gauging station on Fritz Creek and you need a gauging station if you're (inaudible) of atleast 20 years to establish anything to work with, we had to go to the Anchor River, where the nearest gauging station for that period of record, and then, by interpolating the percipitation records in the Homer area the range area, what we did was we actually simulated on the computer the flows. Then we cross checked those by the records that were available on other streams that we simulated here in the area - there are 2 other streams in the area which have records which are less than 20 years close to Fritz Creek and we checked our computer simulation model against the short-term record and we found that it was extremely accurate within 1% so we were satisfied that we've modeled the stream to a degree of accuracy sufficient to predict the supply of water that's available. Does that answer your question?

Q. Yeah, it does but the reason I asked that question was because just two or three years ago that thing was dry as a bone in the winter. We take our water out of it. (simultaneous speech - inaudible) revert back to your in-stream flow of 60% instream flow or whatever, if you put that at 60% or 28%, people who have water rights, who are taking their water out of there now, are just not going to have any water at all.

JK: Well, one thing that we would like to do as part of this detail work is put a gauging station on Fritz and collect more data on the creek itself, rather than rely entirely on the model.We'd be able to go back and correlate the model a little bit better.

Q. That would take 20 years?

JK: Well, I don't know if it would take 20 years but...

Q. The engineer just said 20 years to get a correct deal.

JK: 20 years if you're starting from scratch with no data. We do have a model that we would be able to use as a comparison. All we...we have a model, what you need is then some records that you can go back in and verify whether or not your model is telling you the truth or not. And it wouldn't necessarily take 20 years for that.

Q. Well, basically then, this 600, 000 gallons you've given us is just something you've plucked out of the air?

JK: If you want to put it like that...something the computer plucked out of the air.

A. I would like to answer another question that didn't get answered before and that was the question on the water rights...people who are already taking water out of the creek. As some of you probably know, the state has a block model or a water code and that code provides that people have prior right depending on when they acquired the water rights, but it also provides that public water supplies have priority provided that if the people who have prior rights are destructed that they be compensated. That compensation might be monetary or it could be water. It could be that in some cases the municipalities...when they built water...water supply systems and deprived people from being able to pull the water out of the creek, part of those agreements might be to sell water to those people at a certain price but state law does require that people that the prior rights, either be protected or they be compensated. So that would be a matter of...discussion. Usually those people get water from the municipality.

Q. What percentage of that water would go to the two canneries that this other gentleman mentioned and what percentage would go to the general population for commercial...or residential use.

A. Well, I don't have the exact figures. It was actually the projection was for one additional cannery. I think you can see it there over on the chart on the wall, it's not easy to see from here but you're talking about, oh at the present time, you've probably got, oh, about a quarter a third of the demand, is by the processors. As the population grows, that's going to be a smaller and smaller percentage of the demand. 6

Q. I have a report here from the U.S. Government and it says, fault is 3 km. NE of the mouth of Fritz Creek, where is that at on that...

JK: That would be...well, there's a fault that runs approximately like this up through here, not just in one spot, it's...you know, it runs along the length of the...a certain portion of the length of the creek and then goes off into the hill.

Q. Can you tell me now why you would even consider putting a dam that close a proximity to a fault?

A. Well, the fault is considered an inactive fault by seismologists.

Q. In '64 it was sure not inactive.

Q. The seismologists figured that big quake we had in Anchorage was inactive and they're all inactive until they move. 7

JK: Well, you know, that's certainly true.

Q. So, why even consider putting a dam there and jeopardizing people in the area?

A. There is a fault that runs across here, it comes all the way from Kamchatka Bay. Now in that...you're correct, there was an earth quake here years ago you're incorrect, it was not caused by that fault. If it was caused by that fault, you would have been able to go up there and see where the earth had moved. You'd be able to see a line all the way across the countryside where that moved. It was caused by a...

Q. Want to take a walk someday?

A. Pardon me?

Q. Want to take a walk someday?

A. OK, well, we surveyed it aerially and we also have USGS reports. FAults are highly visible from the air, they're very obvious if you know what you're looking for in an aerial photograph. It's very simple to see them. The fault that caused the earthquakes around here is not located here it's located on the other side of those mountains. YOu will have earthquakes here. There's no doubt about it. But that's not the point. The point is, will the fault shift this way. Not whether you will get shaking...there's no doubt in our minds that the ground's going to get shaken here. It has in the past, you've all felt it, it will in the future, you're going to get some good shakes. That's not a problem from a design point of view. The only thing that even comes close to a problem would be a major shift, vertically, in the soils crust right underneath the dam. In other words, we would have to build the structure across this fault and it would have to shift, on a soils structure like this, a minimum of three feet before there would be any consideration of a problem. If.. and even then it's not likely to have a problem because this dam is just like the dirt out there, that's all it is. It's not that big of a problem.

Now, back to the question of active fault and inactive fault. An inactive fault is a fault line where there's a dip or a strike in the earth's crust. All that means is sometime during the formation of the earth beyond a million years ago, OK? To be classified as an active fault it has to move in the last million years. That fault hasn't moved in the last million years, according to the USGS report and according to their maps. And if anybody wants to discuss that further we can get into it in mass and get very heavy and complicated.

Q. But we're still a zone 3.

A. Right, but what I'm saying is Alaska is zone 3. Zone 3 doesn't make any difference, OK? You can shake it all you want, as long as you don't displace a significant erruption, you can shake it all day long, it ain't gonna hurt it, it don't care. What I'm saying is the earth can shake, move, accelerate in any direction it wants to and it's not going to bother the structure that can be overcome very simply, in thedesign plans. The only thing is an act..that could be a problem, is that you build it right on an active fault and it shifted a large amount.

Q. Where is the closest active fault?

A. OK, well...I'll tell you what we ought to do...rather than waste this whole meeting on a fault geotechnical discussion which a lot of people don't care about...the people that care about that, let's get together, right after we have this question and answer session and we'll get out the maps and...

Q. We all care about it...this room needs to be educated.

A. OK, do you have a map. Zone 3 doesn't have anything to do with this, all we're talking about is an active fault.

Q. Oh, yes it does.

Q. The question to me is why are you going to put that there when you get that from China Poot...

(simultaneous speech - inaudible)

JK: Sir?

Q. I would like to know how you're going to finance this project?

JK: That's a problem, a real problem. We don't have the answers to that. We looked at various ways of raising the money, the obvious ones, of course are grants from the state or the feds, we did look to see if the water rate increases in the water rates could finance the project and that was totally unfeasible and out of everybody's pocket book so that is a major problem. 8

Q. Not to whip a dead horse on the fault issue here. In the event of a breakage of the dam, what's the projected flood point there...have you... do you know just how...

A. Extremely limited because of the...if you're familiar with Fritz Creek, it's pretty much a canyon all the way down to the...

Q. To the pavement...

Q. But what happens below the pavement? 9

A. We haven't actually plotted the flood plain that is something that will actually be plotted in the design phase. You have to understand, this is a preliminary study and you're starting to ask some almost design type questions and it's very difficult for me to speculate on what the flood plain would be. In the first place, we haven't even decided on the size of the dam.

Q. Well, it seems like you would do that before you propose the design.

JK: We're not...

Q. ...just as far as the risk factor, you know.

A. Well, the (inaudible) dam near Susitna is an earth filled dam. It's going to be 800' high...800' high...and that's in the fault zone.

Q. That's still under question also.

A. The tunnel to Bradley Lake is going to be through three fault zones.

Q. That's still in question also.

A. Those who build earth filled dams find that earth filled dams are very forgiving of potential faults and potential earth moving. 10

JK: Sir, did you have a question?

Q. 60-minutes had a program about them a year or two ago. ABout the sad state of affairs for our dams, in that the life span of them isn't very long. And there was broken...

Q. One in Colorado and one in Idaho in recent years. I saw the results of the Idaho one.

Q. But that wasn't my question. If I could still have my question...you project Fritz Creek in 2030, is that right? The useful...(tape ran out)

SIDE 2

JK: ...28% in stream flow and we believe that we can get considerably less than that. We can get it reduced.

Q. OK, what I can't understand also is why it does last 50 years in the expense of it and 50 years its going to be out and your man said a while ago that China Poot was an inexhaustable supply, it would last forever. So it seems to me that it would be better to just go ahead with the additional expense that you don't know where you're going to get the money anyway and go with something that will be forever. 11

Q. There you go.

Q. Well, at Twitter Creek and Bridge Creek it said 10 or 15 years, so are we looking at the same thing in Fritz Creek as far as the life...actual life of the dam, not the water supply

A. Yes.

Q. So why not do it right in the first place, do it...instead of doing it six times like the Spit Road or the post office.

GRAY: Could you have the engineers address just because there's interest in it, address the China Poot problem and if they are in a position to do that.

JK: Sure.

A. China Poot Lake is in Kachemak Bay State Park and there are severe restrictions
to using that as a water supply. It is designated as a recreational lake.
Now. There can be negotiations and so on but in our discussions with the
State regulatory agencies, they have lead us to believe that it would be
almost impossible for them to approve taking drinking water supply out of
that lake. That's one issue. Another is simply the cost and the uncer-
tainties of the submarine type...the connecting from the other end of
the bay to Homer Spit and so it can be further studied, no doubt. Further 12
work done on trying to get approval to use China Poot Lake. It's a
beautiful...a beautiful quality of water.

GRAY: Construction wise, how does it compare in difficulty or in ease with the other proposed locations?

A. It would be the most difficult to construct as far as the pipeline is concerned. Getting the water, having a water intake structure in the lake, is a normal structural problem. But then there are several miles between the lake and the Kachemak Bay and there again, that's an environmentally sensitive area that would be difficult to get permitted. We have been discouraged, up and down the line, from using China Poot Lake.

JK: Excuse me, the gentleman right behind you had a question.

Q. Yeah, we keep talkin' about these water projects. In my opinion
the main reason why you're going after Fritz Creek is because the
City needs an additional tax base to pay for it. It's as simple as that. 13
You have no taxable property over in China Poot, you have
none up here in the hills except at Fritz Creek.

JK: We'll certainly note your comment. Yes, sir?

Q. Have you approached the legislature about enacting legislation to get into Beaver Creek or get into China Poot?

JK: Oh, we haven't taken it anywhere near that, we're just in the...and that's one thing, let me just...

Q. Before I finish then, let me...why weren't these meetings...these alternative 14
explored instead of coming out here and it looks like you're already got
this thing already made up in your mind, this is where you want to do it.

JK: The ah...I know it looks like that and to a certain extent, that might be true, you know.

Q. I believe it is.

JK: People have been talking about a new water source for the City of Homer
for I don't know how many years...a good number of years...and Fritz
Creek always comes on top of the list for one reason or the other so
I can't help but say "yeah, there probably...there might have been a
kind of leading you to an answer thatyou knew you were supposed to get"
to kind of a thing, I can't deny that's probably not true. There may
have been some other sources that we could have taken a closer look at
and maybe we should go back and take a closer look at some of 'em but
chasing after some of them that because of construction difficulties
or operation and maintenance difficulties is, I think, chasing after
windmills. It...you know, futile exercise that if you take a cursory
look at you really can't deny that that's true. And as far as approaching
the legislature on any of these, no, of course, we haven't done that.
We're not to the point where we're going to go out and start moving ground
tomorrow, for heaven's sake, we are just to the point where it has become
apparent that as Homer grows the need for water is going to grow and something
is going to need to be done. ANd we have taken a look at what other sources 15
could be used. And we have identified Fritz Creek as what we feel, right
now, is one of the most feasible sources, and we are here tonight to see
what you folks think about it. We're not going to go out and start building
anything tomorrow.

Q. I believe everyone in this room is aware of the needs for Homer to have water. And I think you're going to be in tough shape in about three or four years and that's compounded with the expansion down here. But you had sources of water that isn't on an earthquake fault and where ou're going to endanger people's lives and everything else and it seems like you haven't considered it, like you're just callous about it.

JK: Well, I don't think callous is quite the point but I don't want to argue that with you. You're complaints are noted and we'll take care of what we feel we need to take care of.

Q. Well, I still think it should go to the City Council and go to the legislature about exploring these other areas, if you can get in there.

JK: Your comments will be noted, sir. Yes sir?

Q. I just want to mention that our comment about some of theFish & Game on that little creek down there, you know. YOu stated about China Poot and the fisheries people didn't want any part of it...

JK: I'm sorry, which creek is this?

Q. I'm talking about Fritz Creek. That you stated that one reason why China Poot wasn't selected was because of the fisheries. Well, what about Fritz Creek? It's plum full of trout and mink and weasels and otters and everything else below the dam and above it.

Q. You also have to know it's the last moose habitat area and you're going to get a bitter fight on that one.

JK: The...we had a meeting with Fish & Game a couple of months ago and there
were essentially two areas of the fish and game...there were people from
fish and people from game and essentially our feelings was that 16
the fish people did not feel as strongly about the creek as the moose
people did. You're right, the moose people were very very upset and
concerned. But the fish people felt that the only reason why they're
particularly interested in the creeek is because they use it to release
smolts during the spring.

Q. I mean realistically you are looking at the last winter habitat untouched.

Q. What about the natural fish in that creek that aren't planted or returned from the sea? It's plumb full of them.

JK: One thing that we need to do is...it's called an in-stream flow study, and you go out there and you'll actually count the fish and the plant life and the biological life that currently exists in the stream and then you figure out how much water was the minimum flow that's required to sustain that . The Fish & Game has told us that they're going to require us to do that before they even discuss any further, how much water to release and that's when we'll get into the natural fish that are there. Yes, ma'am?

Q. How far back is that lake supposed to go, once they fill that thing?

JK: I can't remember exactly, how far was that, Brent?

BRENT: That depends on the heighth of the dam which goes back to the same problem that we're at of...it also depends on where the dam is located which site is chosen.

Q. Say the farthest one back. 17

BRENT: OK, which would be the up stream one, it would be the highest one, that would go back the farthest and that one can probably go back about a mile.

Q. What would that do that high tension power line back there then?

A. It shouldn't have any effect on it at all.

It would just span right over it, it's not going to be very wide. It would
be less than the spaces between the standards.

Yes, sir?

Q. To bring my retrospective or my understanding of this...this supply of water
you're speaking of, using Fritz Creek, will supply the City of Homer 'til
when, under your present projection?

A. 50 years.

JK: We are projecting 50 years because that is about as long as when you're dealing
with these type of things, you can reasonably project. We have three...there
are three population projections for the City, a low, intermediate and a
high. And a high is based upon the growth rate we have now continuing just
continuing on now. The low is leveling off in about a year or so and the 18
intermediate is continuing like we are now for a few years and then kind
of leveling off a little bit more.

Q. Which one did you use?

JK: We are using the intermediate one.

Q. The intermediate? So the statement of 7 to 8 years doubling population
that you quote here has nothing to do with your projections.

A. No, that's what the intermediate projections are.

Q. That is the intermediate projection?

JK: Yeah, it goes on the same level that we're at now for a few years and then
it kind of slacks off after that.

Q. Well, I've gotta go back with the rest of them, you're looking at a supply
that you say will carry you 50 years, what happens to your supply 7 years
after the 50 years when you've doubled that population? Why don't you
look at the possibilities of unlimited water than what you're looking
at of very limited water? It doesn't...I've had so many figures thrown
at me tonight that were pulled out of a computer that, to me, don't
seem to be very realistic. Another one is your right of way costs...
not right of way costs, the total cost of your dam upon what were these
figures...today's costs, when you're going to get this funding, 20 years
from now, does this include right of way buys, does this include buying 19
people out in the flood plain, what are we looking at?

JK: The cost estimate does not include any compensation to property owners and
it's on today's prices and, yeah, you're right, it would definitely go up
with inflation.

Q. Well, that would significantly increase that $5.00/thousand gallon deal
then in your...and you're calling China Poot a $9.00 saying that's twice
but...you have not come close to computing all the costs in that $5.00 price.

A : Well the inflation on the construction costs, affects all types of construction
so when you do these kind s of analyses, you try to bring them all in today's
dollars and try to compare it on that basis.

Q. You've over allowed then, is what you're saying? I mean that $5.00 is kind of included some of this stuff...I mean you're saying thatis the high cost...is that?

A. No, what I'm saying is that is today's dollars if you could build it today and put it in operation. It's obviously going to be more but as inflation continues, the construction costs on one alternative...they'll go up just as much for other alternatives.

Q. The other thing is you do have an estimated cost for buy-out below the flood plain if nothing else, the right of ways and so on...and that whole area is developing south and along that Fritz Creek basin you've got subdivisions going in and so on...that's not going to happen with either (inaudible) with undoubtedly the technology by the time you're there, has made giant strides already. Undoubtedly by the time this thing is ready to fly, we'll be talking lowering costs.

A. Well, if you're talking about buy-out costs, the total assessed value is strictly.....

Q. No, but I'm saying compare that to either to your desalinization plant and the technology bringing that cost down which is I think probably reasonably expectable, or, again, an unlimited source from China Poot.

JK: Well, the point that we did not include...that this...the figures are $2.24/thousand gallons if at the more realistic flood level or dam level for Fritz. But at $4.09 is for the 60% down stream release which we don't believe we'll have to meet. Thepoint that we did not include, compensation costs, right of way costs this kind of thing, in that...is well taken, we did not do that.

Q. Well, I guess I'm also concerned as I think Bob said, in 2010 we may find that estimate is not realistic and we're gonna be doubling it and increasing rate in math...you're squaring your population every year...is going up by that much more, and when you do run short, where do you go from there? Why not go at whatever the cost, again for an unlimited, or a relatively unlimited source or can you not...may I ask you this, can you expand a desalinization plant? That may ultimately be the answer for this area. Is it...is the technology such that you can add another unit at a later time, as you need more water?

A. Desalinization happens to be something I've worked in for about 15 or 20 years. There have been great strides made in desalinization, they are using it to desalt sea water in Saudi Arabia where...where there is an unlimited amount of money available and the other alternative is distillation and they're reducing 90 million gallons a day in Jeddah Saudi Arabia. Now there they have warm water and they have a great deal of money and they're extremely energy intensive. That pressure has to be at 800 pounds per square inch and the membranes are so tight that it just trickles through the membrane so you have to pump a great deal of water past these membranes at high pressure. And as the temperature of the water gets lower to the temperatures that you'd find here, the efficiency goes down to about 50% normal efficiency. So it's capital intensive and that the electrical energy costs here in Homer, it would be just very very expensive to operate. The technology is here but the cost is just fabulous. So there's no doubt that it's an option but....

A. But to make that feasible, you have to get the energy costs down and all the projections for electrical energy costs and all of the projections for Chugach are going up. They don't look like they're gonna be lowering their rates for some time.

Q. Then perhaps some more intensive study at China Poot Lake would be the...
that's a long-term thing and ultimately we're going to run out of water
in 2040, if not 2030, we're going to be scrambling this whole show again
and I know an underwater aqueduct was discussed in town 20, 25 year...15 years
ago atleast and the cost at that time seemed astronomical but they'd be
darn well underway to being paid for by today and we wouldn't be facing 19
this rolling effect that now we're looking at some other creeek or...I
just wonder if we shouldn't take a longer look down the road rather than
just 50 years because I'll bet we'll all...some of us will still be around
20 years from now...

A. Can I ask you a question. How do you think public reaction would be to the thought of running a pipeline across Kachemak Bay that all of the oil companies have talked about doing.

Q. What's a water line going to do when it breaks down there? There's a power line there (simultaneous speech - inaudible)

JK: Are there any other specific questions anyone has? Yes, sir?

Q. I have one real short comment. I think you're barking up the wrong tree anyway because if you had your dam there built last year, that thing would be absolutely empty. You go up there right now and see how much water's in there, or two days ago before it rained. Thre's no water up there...what do you do on a year like this? You're gonna be out of water before 1985. I think it's a wrong move. There's no water there unless it's a real rainy year.

Q. There was no water there last February. 20

Q. And I'm not a computer but I've seen it with my own eye balls... (laughter)

Q. I was wondering since why the focus was on Fritz Creek that you didn't come out there to us at McNeil Canyon School, a lot of people that came in here.

JK: Well, the...no, you do have a point there, but it doesn't effect simply Fritz Creek, it affects the City of Homer as well.

Q. Look around this room. How many people are here from the City of Homer?

(simultaneous speech, in audible)

JK: Well, I want to thank everybody for coming. Feel free to stick around and ask specific questions of whoever if you need information or if you want more information on something, we'll help with that too. I think I got a pretty good idea of what you want more information on.

27.4 Response to Public Workshop

General

This meeting was a workshop for the purpose of soliciting public input but was not a formal public hearing. It was felt that public input would be more candid in this type of a setting. Therefore, the usual formality of statement of the participant's name and address was not adhered to.

The questions or responses where germaine to the study, are numbered and identified by enclosing the text with a bar along the right-hand side of the minutes. These responses are then made in the same order.

Responses

1. Mr. Robert E. Gray expressed considerable interest in the study and was specifically concerned with the possibility of the utilization of China Poot Lake as an unlimited source of supply of water. He further followed up his workshop comments with written comments expressing his support for additional consideration and study of the feasibility of China Poot Lake as the source of supply. This study gave a preliminary assessment of China Poot Lake in Section 4.2.

2. This discussion involved Beaver Creek to the northeast of Homer, as a source of supply. Contrary to the statements made as to the size of the Beaver Creek drainage basin, it drains an area (10 sq.mi.) smaller than Fritz Creek and has a significantly greater area used as a moose wintering habitat. The Beaver Creek assessment was covered in Section 7.2, part a.

3. The preliminary soils assessment was covered in Section 8.0, Regional Geology; and as site specifically for Bridge, Twitter and Fritz Creeks in Sections 9.5, 10.4 and 11.4, respectively. Only a

soils reconnaissance was authorized by this contract. Detailed soils borings and logs would be accomplished after a site is selected and prior to design.

4. The expansion of the Bridge Creek facility has been discussed in Section 9.0.

5. The questions on flow rates, in-stream requirements and hydrology in general were answered in detail in the minutes of the workshop. In addition, hydrology had been addressed in Section 6.0.

6. The present and projected demand on the Homer water system includes commercial (and canneries) demands. This demand was addressed in Section 2.0.

7. The general question on seismic faults received considerable discussion and received lengthy discussion at the workshop. The subject of earthquakes, faults and potential dam failure can be more subjective than objective. The subject had been reported in Section 8.4.

8. Financing was discussed in Section 25.0.

9. The detailed identification of a flood plain is not a part of this preliminary study, but would be part of design after a site was selected.

10. This discussion is a follow-on of workshop discussion item number 7, on seismicity. Again, refer to Section 8.4 of the report.

11. Comment noted.

12. This is a continuation of workshop discussion item number 1.

13. Comment noted.

14. Comment noted.

15. Comments noted.

16. Comments noted. See also Section 27.1 for Fish & Game meeting comments.

17. See report Sections 11.0, 12.0 and 13.0.

18. Discussion on population and usage projections had been covered in Chapter 2.0.

19. Costs of alternatives had been discussed in Chapters 14.0 and 22.0.

20. Comments noted.

APPENDICES

HOMER PROJECT
CONSTRUCTION COST ESTIMATE

			2300 A-F		4000 A-F		5800 A-F	
		Unit Price	Quantity	$	Quantity	$	Quantity	$
1.0	DAM							
1.01	Diversion and Care of Water	LS	1	70,000	1	70,000	1	70,000
1.02	Clearing Including Reservoir Area	4,100.00/ac	92	377,000	170	697,000	267	1,095,000
1.03	Foundation Preparation	5.00/cy	190,000	950,000	265,000	1,325,000	300,000	1,500,000
1.04	Sheet Piling	48.00/sf	37,000	1,776,000	53,000	2,544,000	68,000	3,264,000
1.05	Filter Cloth	0.37/sf	277,000	103,000	300,000	111,000	330,000	122,000
1.06	Drain Wells	80.00/lf	2,250	180,000	3,050	244,000	3,600	288,000
1.07	Random Fill	5.57/cy	90,000	501,000	164,000	913,000	225,000	1,254,000
1.08	Till Fill	11.00/cy	200,000	2,200,000	302,000	3,322,000	408,000	4,488,000
1.09	Upstream Sand Shell	8.00/cy	179,000	1,432,000	235,000	1,880,000	298,000	2,384,000
1.10	Filters	16.80/cy	138,000	2,318,000	192,000	3,226,000	246,000	4,133,000
1.11	Riprap	25.80/cy	60,000	1,548,000	62,000	1,600,000	65,000	1,677,000
1.12	Access Roads	307,000.00/mi	1.5	461,000	1.5	461,000	1.5	461,000
	SUBTOTAL			11,916,000		16,393,000		20,736,000
2.0	SERVICE SPILLWAY							
2.01	Clearing (Included in Above)							
2.02	Excavation	5.90/cy	7,000	41,000	7,000	41,000	7,000	41,000
2.03	Backfill	10.00/cy	9,720	97,000	9,720	97,000	9,720	97,000
2.04	Concrete Outlet	500.00/cy	50	25,000	50	25,000	50	25,000
2.05	Concrete Inlet	600.00/cy	65	39,000	65	39,000	65	39,000
2.06	Concrete Conduit	500.00/cy	1,250	625,000	1,250	625,000	1,250	625,000
2.07	Concrete Pipe	200.00/ft	200	40,000	200	40,000	200	40,000
2.08	Steel Liner	3.00/lb	125,000	375,000	125,000	375,000	125,000	375,000
	SUBTOTAL			1,242,000		1,242,000		1,242,000
3.0	EMERGENCY SPILLWAY							
3.01	Clearing (Included in Above)							
3.02	Excavation, Unclassified	3.80/cy	1,900	7,000	1,900	7,000	1,900	7,000
3.03	Riprap/Gabions	25.80/cy	555	14,000	625	16,000	625	17,000
3.04	Filter Cloth	0.37/ft^2	5,000	2,000	5,500	2,000	6,000	2,000
3.05	Concrete	500.00/cy	375	188,000	375	188,000	375	188,000
	SUBTOTAL			211,000		213,000		214,000

HOMER PROJECT
CONSTRUCTION COST ESTIMATE
Page 2

			2300 A-F		4000 A-F		5800 A-F	
		Unit Price	Quantity	$	Quantity	$	Quantity	$
4.0	OUTLET WORKS							
4.01	Excavation	5.90/cy	18,000	106,000	18,000	106,000	18,000	106,000
4.02	Backfill	10.00/cy	14,000	140,000	14,000	140,000	14,000	140,000
4.03	Concrete Outlet	500.00/cy	50	25,000	50	25,000	50	25,000
4.04	Concrete Inlet	500.00/cy	75	38,000	75	38,000	75	38,000
4.05	Concrete Conduit	500.00/cy	1,900	450,000	1,900	950,000	1,900	950,000
4.06	Concrete Plug	400.00/cy	25	10,000	25	10,000	25	10,000
4.07	Gate	15,000.00/LS	1	15,000	1	15,000	1	15,000
4.08	Steel Pipe 55#/ft. + 5000 lb. of supports	3.00/lb	38,000	114,000	41,000	123,000	45,000	135,000
	SUBTOTAL			1,398,000		1,407,000		1,419,000
	GRAND TOTAL			14,767,000		19,255,000		23,611,000

APPENDIX A

DETAILED CONSTRUCTION COST ESTIMATE

W.T.P. SITE IMPROVEMENTS

	Quantity	Unit	Unit Price	Total Amount
Yard Piping:				
16" D.I. Infl/Effluent to Storage	100	LF	$ 75	$ 7,500
12" D.I. Overflow & Sludge	950	LF	55	52,250
8" D.I. Storage Tank Overflow	100	LF	30	3,000
16" BFV	3	EA	2,500	7,500
12" GV	3	EA	2,000	6,000
8" GV	1	EA	1,000	1,000
San. Sew.; Septic Tank & Drainfld	1	L.S.	5,000	5,000
Subtotal				82,250
Miscellaneous				
Fencing	1,000	LF	20	20,000
Primary Power, Incl Poles & Trans.	3,000	LF	-	25,700
Telephone (wire only)	3,000	LF	1	3,000
Sludge Lagoons: Excav. & Constr.	15,000	C.Y.	5	45,000
Asphalt Paving	330	T	30	9,900
Subtotal				103,600
Total Site Improvements				$ 185,850

TRANSMISSION MAIN

	Quantity	Unit	Unit Price	Total Amount
Dam to WTP:				
16" D.I. Pipe	5,000	LF	75	375,000
WTP to East Road (@ Fritz):				
16" D.I. Pipe	2,900	LF	75	217,500
East Road to Kachemak:				
16" DI. Pipe	27,600	LF	75	2,070,000
45° Bend, 16"	5	EA	600	3,000
22-1/2° Bend, 16"	4	EA	600	2,400
16" BFV	16	EA	2,500	40,000
Blow-Off Valve	5	EA	2,000	10,000
Hydrant Tees & G.V. (No Hyd.)	18	EA	1,500	27,000
Hydrant Assy., Incl. Tee & GV	21	EA	2,500	52,500
Pit Run Gravel	19,500	T	4	78,000
Asphalt Patching	2,000	%	30	60,000
Transmission Main Total				$2,935,400

WATER TREATMENT PLANT

Description	Quantity	Unit	Unit Price	Total Amount
Building Shell				$ 240,000
Internal Rooms				28,600
Soil Allowance				16,000
Heating				24,000
Dehumidifier				4,700
Lighting				12,000
Wiring & Acc.				31,500
Misc. Equipment				2,100
Lab Equipment				3,000
Filters & Instrumentation				350,000
Insulation				25,000
Chemical Feed Equipment				41,225
Pumps				13,989
Air Compressors				4,400
Aux. Generator				25,000
Storage Tank (Fuel)				5,000
Plant Piping				161,360
Pipe Insulation				11,600
Equipment Installation				77,100
Grating				12,750
Freight				30,000
Storage Tank 0.5 MG				313,740
Level Controls				1,500
Telemetry Equipment				2,700
Static Mixer				8,000
Flow Meter & Tube	2	Ea		7,200
18" Isolation Valves	6	Ea		5,270
Misc. Valves				8,000
WTP TOTAL				$1,443,234

APP. B

CONSULTANTS
William L. Shannon, P.E.
Stanley D. Wilson, P.E.

SHANNON & WILSON, INC.
Geotechnical Consultants
2055 Hill Road, P.O. Box 843 • Fairbanks, Alaska 99707 • Telephone (907) 452-6183

March 28, 1983

RECEIVED
1983

KP-522

Crippen Consultants
916 Plaza 600 Building
Seattle, WA 98101

Attn: Mr. Brent Leslie

RE: PRELIMINARY PROPOSAL FOR SUBSURFACE EXPLORATIONS AND LABORATORY TESTING, EARTHFILL DAM, HOMER, ALASKA

Gentlemen:

In accordance with your request of March 22, 1983, we are pleased to submit our preliminary proposal for conducting subsurface explorations and laboratory testing for the proposed earthfill dam on Fritz Creek near Homer, Alaska. The purpose of our studies would be to develop information to assist you with the design of the proposed facility. We understand that the proposed dam will be approximately 100 feet high.

The purpose of this proposal is to provide you with a rough estimate of the costs involved in an exploration program for the proposed dam so that you can present this estimate to the City of Homer. The estimated costs in the proposal are slightly modified from those given to you verbally on March 24, 1983.

Based on your comments, we understand that there is no bedrock exposed in the area, and that you do not anticipate encountering rock in the exploratory borings. For purposes of preliminary estimating, we understand that you wish to explore the site with three borings to a depth of 100 feet, two to a depth of 75 feet, and two to a depth of 50 feet. The borings would be sampled with split-spoon drive samples. If weathered bedrock is encountered above the target depth of the borings, it would be penetrated as deep as possible with the auger. Resistant bedrock

Rohn D. Abbott, P.E.
Vice President and Manager

could be diamond cored, but our estimate is not based on the borings requiring diamond coring.

The drilling and sampling would be observed by an experienced engineer or geologist from our firm, who would visually classify all samples in the field and prepare descriptive soil logs for all borings. The samples would be returned to our Fairbanks laboratory for tests that would be pertinent to our studies, such as natural water content, density, grain-size gradation, organic content, and Atterberg limits.

In-hole permeability testing, such as falling head permeability tests or packer tests, would be performed in each boring as appropriate.

In addition to the test boring work, backhoe test pits would be excavated and sampled at selected locations to explore surficial soil conditions.

The locations and elevations of all borings would be spotted on a map by our engineer or geologist after they had been drilled. This would be accomplished by tape and hand level referenced to existing features and an assumed elevation. If precise surveying is desired it should be accomplished by a professional surveyor. The cost for precise surveying has not been included in our estimate.

A report would be prepared which would summarize the geology of the area, field explorations, subsurface conditions, laboratory test results, and material properties and engineering parameters. At your request, we have not included the cost of detailed engineering or design studies in our estimate.

We understand that at present there is no road access to at least some of the boring locations, and that a helicopter-portable drill would be required to access these locations. However, due to the large cost for heavy-lift helicopters, it may be cost effective to have trails made to the drilling locations so that a track-mounted drill rig could be used. Two estimates have been prepared, one for a helicopter-portable drill rig, the other for a track-mounted drill rig. The difference in estimated cost between the two reflects not only helicopter costs but also the greater production rate of the larger track-mounted drill rig. The cost of trail building is not included in our estimate.

SUMMARY OF ESTIMATED COSTS
HELICOPTER-PORTABLE DRILLING OPERATION

Mobilization/Demobilization	$ 11,000
Drilling, Sampling, and Logging of Borings	39,800
Down-Hole Testing (estimated one day per boring)	20,600
Helicopter Support	35,200
Backhoe Test Pits (estimated two days)	2,800
Laboratory Testing	4,900
Report Preparation	8,400
Estimated Total	$122,700

SUMMARY OF ESTIMATED COSTS
TRACK-MOUNTED DRILLING OPERATION

Mobilization-Demobilization	$ 11,000
Drilling, Sampling, and Logging of Borings	23,600
Down-hole Testing (estimated one day per boring)	22,700
Backhoe Test Pits (estimated two days)	2,800
Laboratory Testing	4,900
Report Preparation	8,400
Estimated Total	$ 73,400

At the present time we are negotiating a scope of work for geotechnical investigations for the Bradley Lake Hydroelectric Project, which would be based in Homer. This project may involve drilling this summer, which could reduce the mobilization costs on your project if both projects could be performed in the same time period.

We understand that this proposal is not a binding agreement at this time, but is merely required in order to seek funding for further design studies. When a decision is made to proceed with further studies, we will be pleased to prepare a detailed estimate. At that time we could help you develop a detailed scope of work, and would assess the impact of site accessibility, anticipated subsurface conditions, and logistics on our estimate. We would also be pleased to prepare a proposal for assisting you with developing engineering and design recommendations for the project.

If you have any questions or comments, or wish to discuss alterations to the proposed scope of services, please contact either John Cronin or me. We look forward to the opportunity to work with you on this project and appreciate your continued confidence in our firm.

Sincerely,
SHANNON & WILSON, INC.

By Rohn D. Abbott

Rohn D. Abbott, P.E.
Vice President and Manager

JEC/RDA/lkd

APP.C

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF PARKS

BILL SHEFFIELD, GOVERNOR

619 WAREHOUSE AVE. SUITE 210
ANCHORAGE, ALASKA 99501
PHONE: (907) 276-2653

May 5, 1983

Re: 3130-4 (Olympic Associates)

RECEIVED
MAY 12 1983
OLYMPIC ASSOCIATES CO.
SEATTLE

John Lenart
Project Engineer
Olympic Associates Company
P.O. Box 9310
Seattle, Washington 98109

Dear Mr. Lenart:

We have reviewed the proposed Fritz Creek Water Project for Homer project and would like to offer the following comments:

STATE HISTORIC PRESERVATION OFFICER

There are currently no known cultural resource sites in the Fritz Creek dam and reservoir area. However, we feel the area has high potential for having such sites.

The history of cultural resource site survey in the Kenai Peninsula is such that the concentration has been on the coast where the larger, more easily accessible sites are. There have been no surveys up the rivers and major creeks. These waterways are natural access routes to the uplands for potential hunting. We would expect to find sites associated with this type of activity along the waterways and in the uplands.

We recommend a preconstruction cultural resource survey of the project area (per 36 CFR 800). Should you have any questions, please contact Diana Rigg at 264-2132.

Ty L. Dilliplane
State Historic Preservation Officer

STATE PARK PLANNING

No probable or significant impact on existing, proposed or potential state park or other public recreation values.

LAND & WATER CONSERVATION FUND GRANT PROGRAM

No comment.

Sincerely,

Neil C. Johannsen
Director

DR:clk

FIGURES

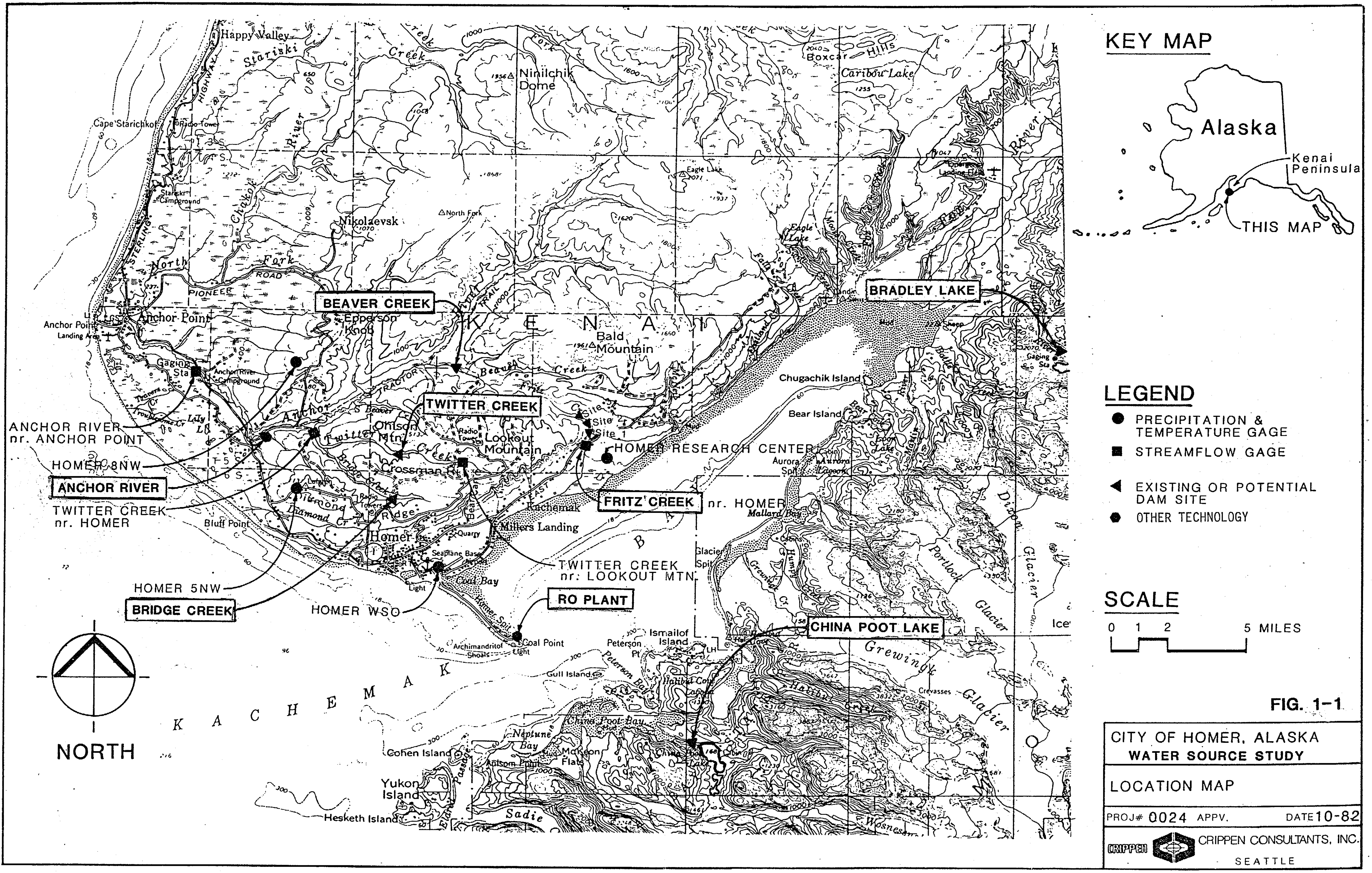


FIG. 1-1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

LOCATION MAP

PROJ# 0024	APPV.	DATE 10-82

CRIPPEN CONSULTANTS, INC.
SEATTLE

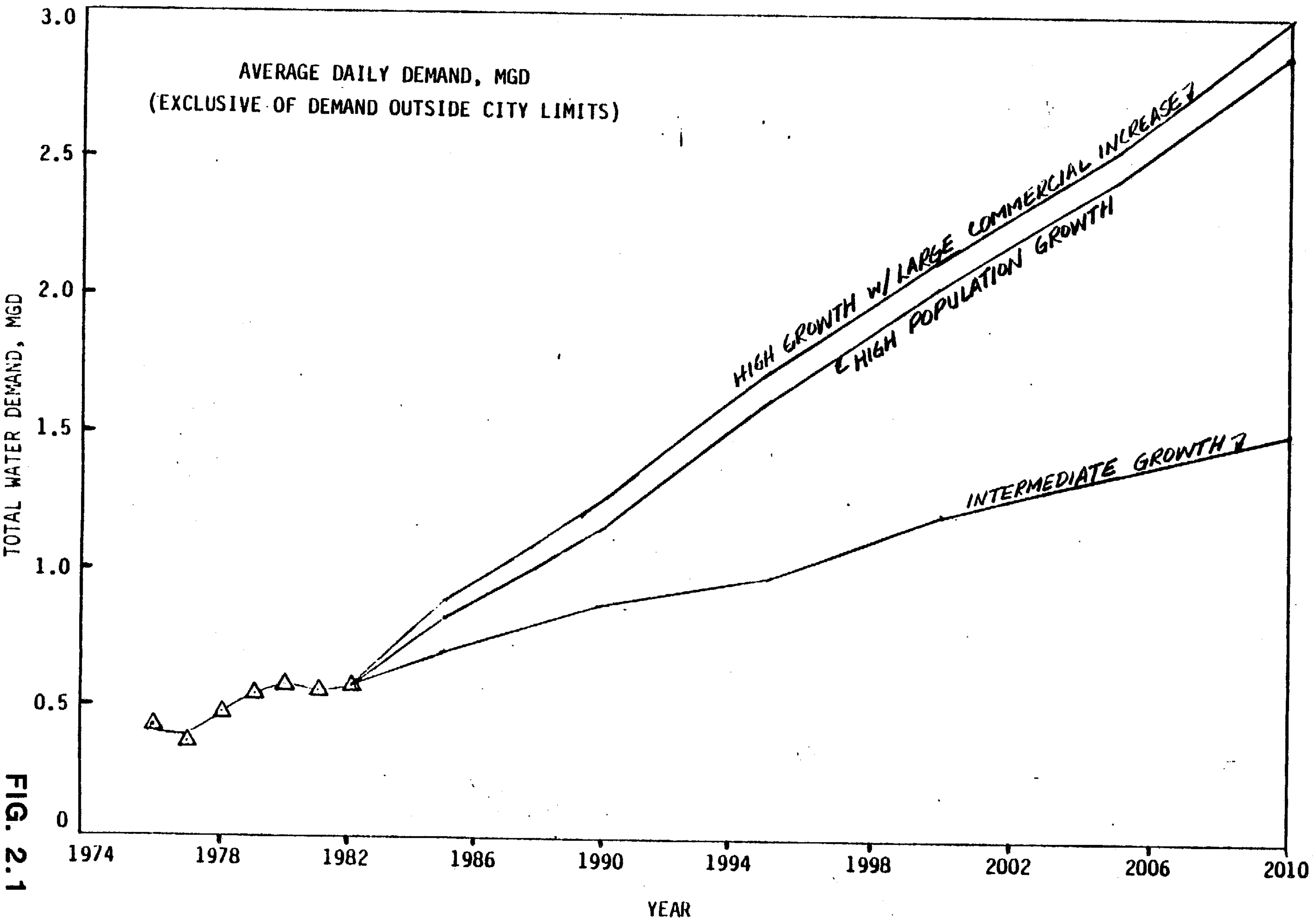

AVERAGE DAILY DEMAND, MGD
(EXCLUSIVE OF DEMAND OUTSIDE CITY LIMITS)
HIGH GROWTH W/ LARGE COMMERCIAL INCREASE
HIGH POPULATION GROWTH
INTERMEDIATE GROWTH
TOTAL WATER DEMAND, MGD
3.0
2.5
2.0
1.5
1.0
0.5
0
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
YEAR

FIG. 2.1

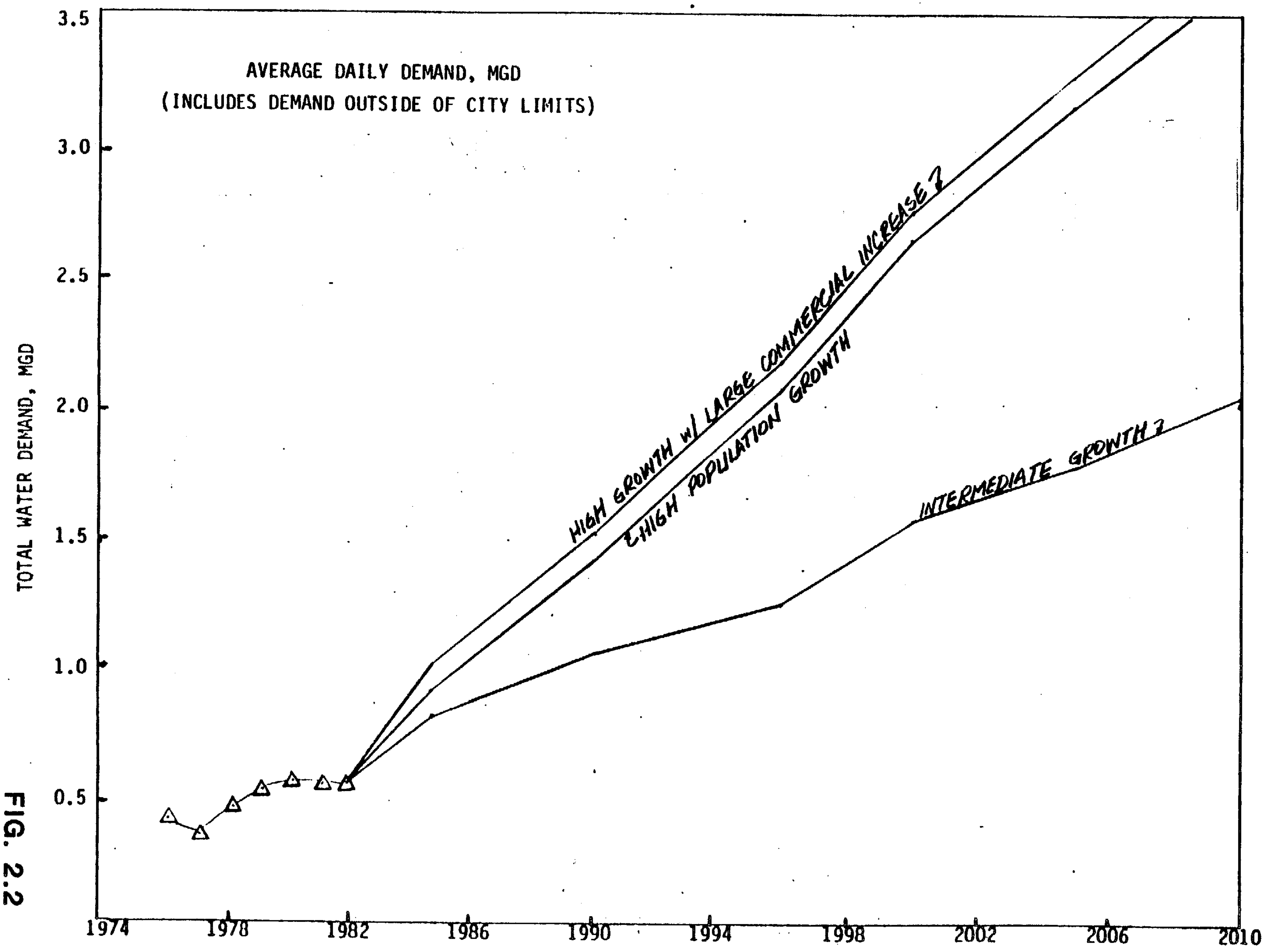

AVERAGE DAILY DEMAND, MGD
(INCLUDES DEMAND OUTSIDE OF CITY LIMITS)
TOTAL WATER DEMAND, MGD
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
HIGH GROWTH w/ LARGE COMMERCIAL INCREASE ?
HIGH POPULATION GROWTH
INTERMEDIATE GROWTH ?

FIG. 2.2

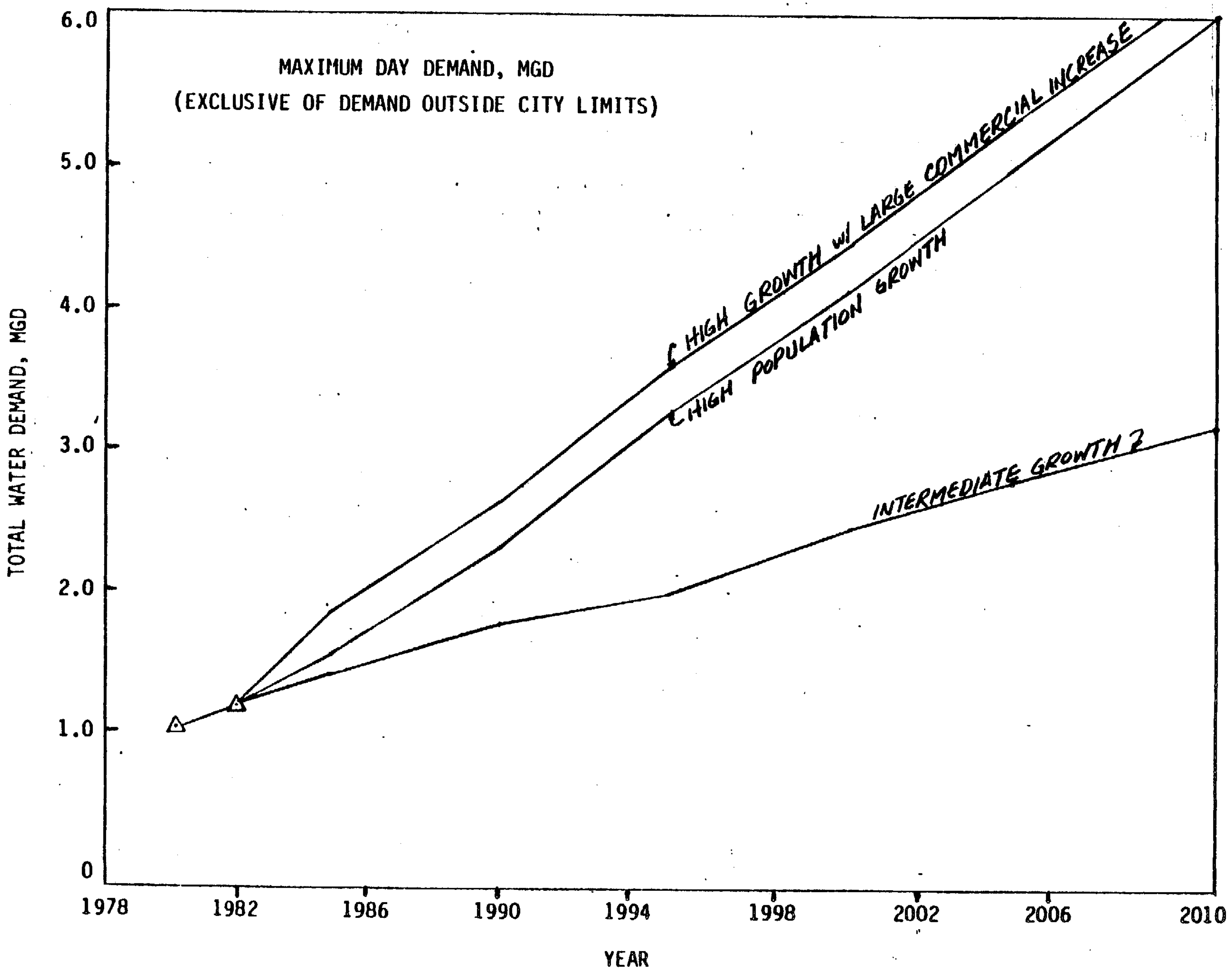

MAXIMUM DAY DEMAND, MGD
(EXCLUSIVE OF DEMAND OUTSIDE CITY LIMITS)
TOTAL WATER DEMAND, MGD
6.0
5.0
4.0
3.0
2.0
1.0
0
1978
1982
1986
1990
1994
1998
2002
2006
2010
YEAR
HIGH GROWTH w/ LARGE COMMERCIAL INCREASE
HIGH POPULATION GROWTH
INTERMEDIATE GROWTH

FIG. 2.3

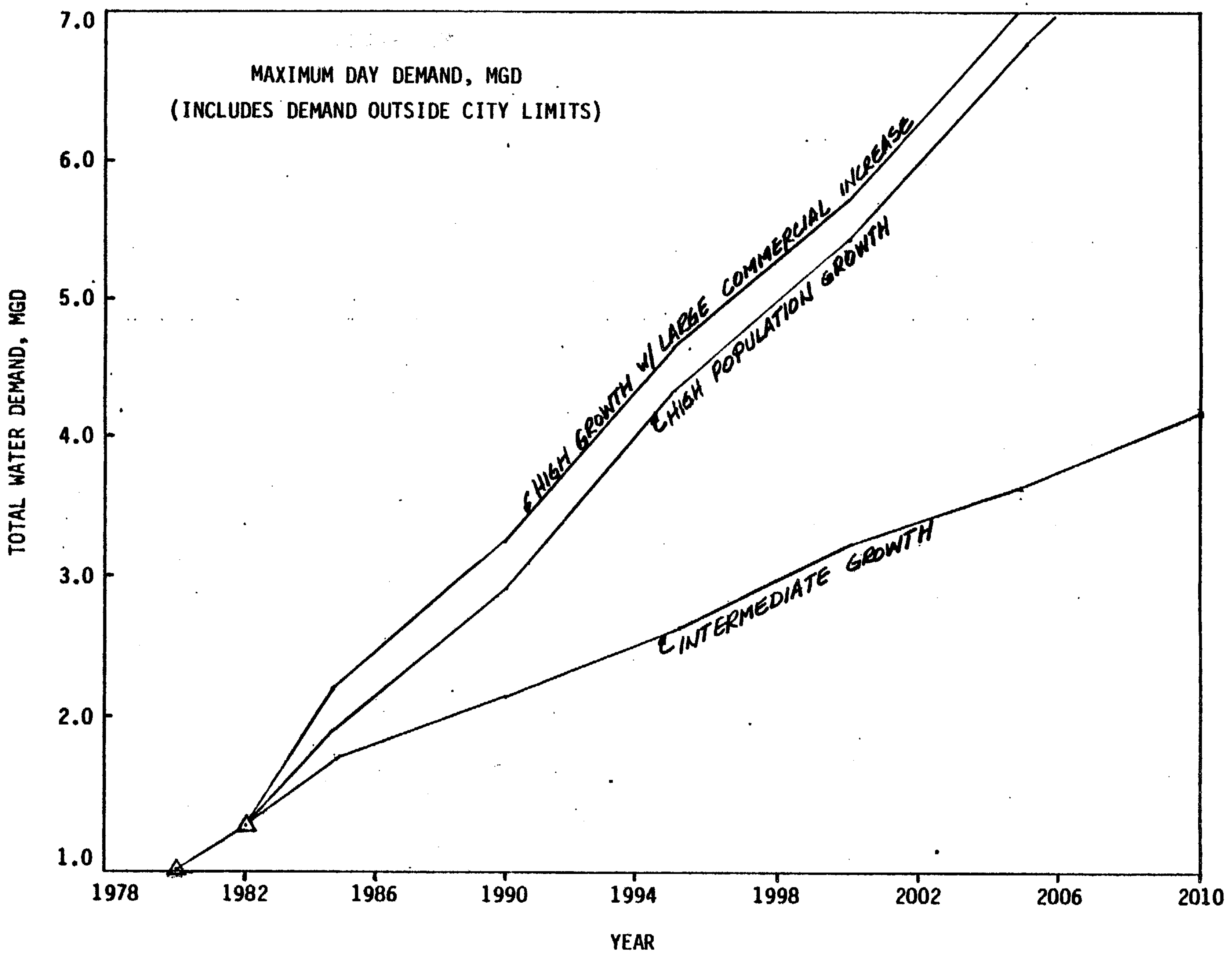
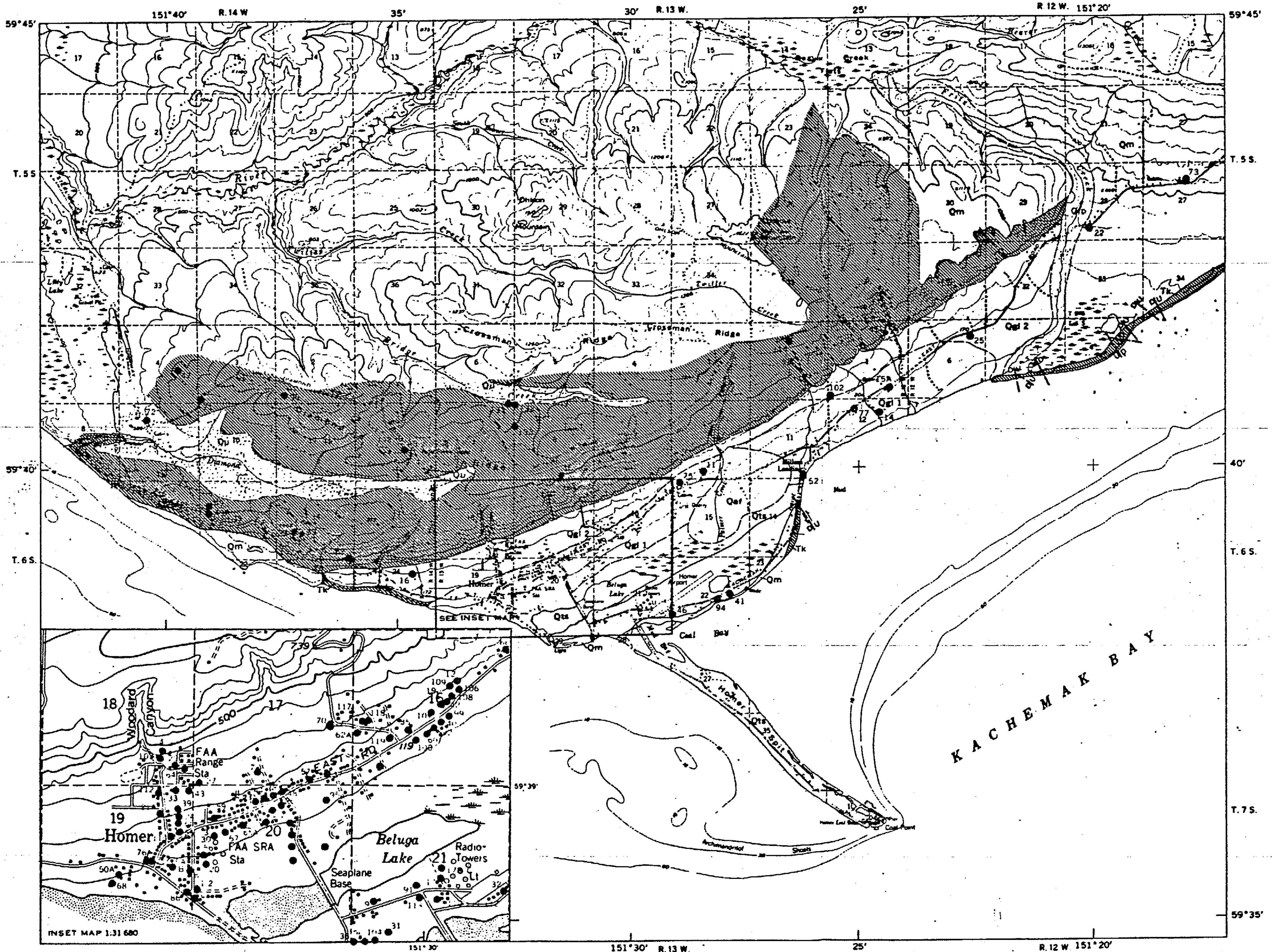

MAXIMUM DAY DEMAND, MGD
(INCLUDES DEMAND OUTSIDE CITY LIMITS)
TOTAL WATER DEMAND, MGD
7.0
6.0
5.0
4.0
3.0
2.0
1.0
1978
1982
1986
1990
1994
1998
2002
2006
2010
YEAR
℄ HIGH GROWTH W/ LARGE COMMERCIAL INCREASE
℄ HIGH POPULATION GROWTH
℄ INTERMEDIATE GROWTH

FIG. 2.4

SURFICIAL GEOLOGIC MAP



Base from U.S. Geological Survey Topographic quadrangles 1948-1952

SCALE 1:63 360

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL

Geology after Barnes and Cobb (1959) and Karlstrom (1964)

EXPLANATION

QUATERNARY

Recent

Qfp

Flood-plain deposits

Silt, sand, and gravel in channels, valley floors, and low terraces. May yield 5 gpm of water to shallow wells

Qaf

Alluvial-fan deposits

Poorly sorted sand and silt. May yield 25 gpm of water to shallow wells

Qts

Elevated tidal silt and beach deposits

Silt and organic material adjacent to Beluga Lake; well-sorted beach gravel and sand on Homer Spit; postglacial. Yields only saline and brackish water on the Homer Spit

Pleistocene

Qgl 1 / Qgl 2

Glaciolacustrine deposits

Qgl 1, *subunit 1, deposits more than 20 feet thick. Proglacial lake-bottom and deltaic sediments; principally poorly sorted clay and silt with sand at base of deposit in vicinity of Homer. Yields of 5 to 25 gpm of water may be expected from the sands*

Qgl 2, *subunit 2, deposits less than 20 feet thick. Principally clay and colluvium. Occurs higher on benches. Virtually not water bearing*

Naptowne Glaciation

Qu

Undifferentiated deposits

Sand and gravel of Barnes and Cobb (1959); postglacial, may contain pre-Naptowne glacial drift redeposited in Naptowne or later time. Yield 5 to 10 gpm of water to shallow wells

Qm

Morainal deposits

Till, ice-contact, and outwash-stream deposits; formed during last glaciation of Homer area. Poor water-bearing formation except in local sand and gravel beds where yields of 10 to 20 gpm may be obtained

TERTIARY

Oligocene(?), Miocene, and Pliocene

Tk

Kenai Formation

Interbedded poorly consolidated sandstone, siltstone, and claystone, with minor amounts of conglomerate. Contains many beds of subbituminous coal and lignite. The most extensive and best potential aquifer in the Homer area

Contact

Dashed where inferred

U
D

Fault, approximately located

Arrows show relative direction of displacement. U, *upthrown side;* D, *downthrown side*

Strike and dip of beds

● **Well or test hole**

Number corresponds to those in text

● **Spring**

Number corresponds to those in text

Source: Waller, R.M., Feulner, A.J., and Morris, D.A., 1968

LOCATION OF WELLS and SPRINGS

FIG. 3.1

PROCESS FLOW DIAGRAM - SEAWATER REVERSE OSMOSIS CONVERSION

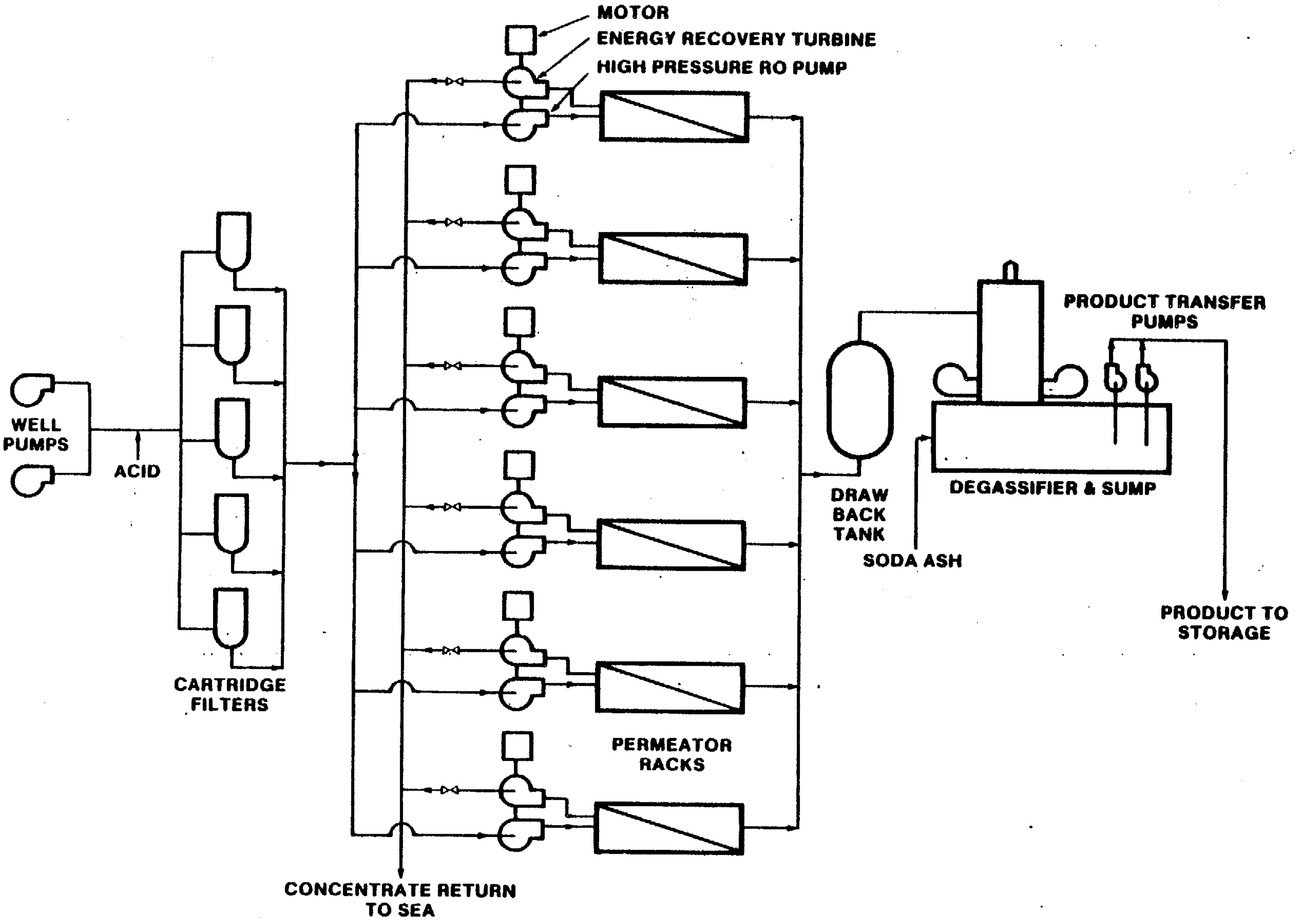
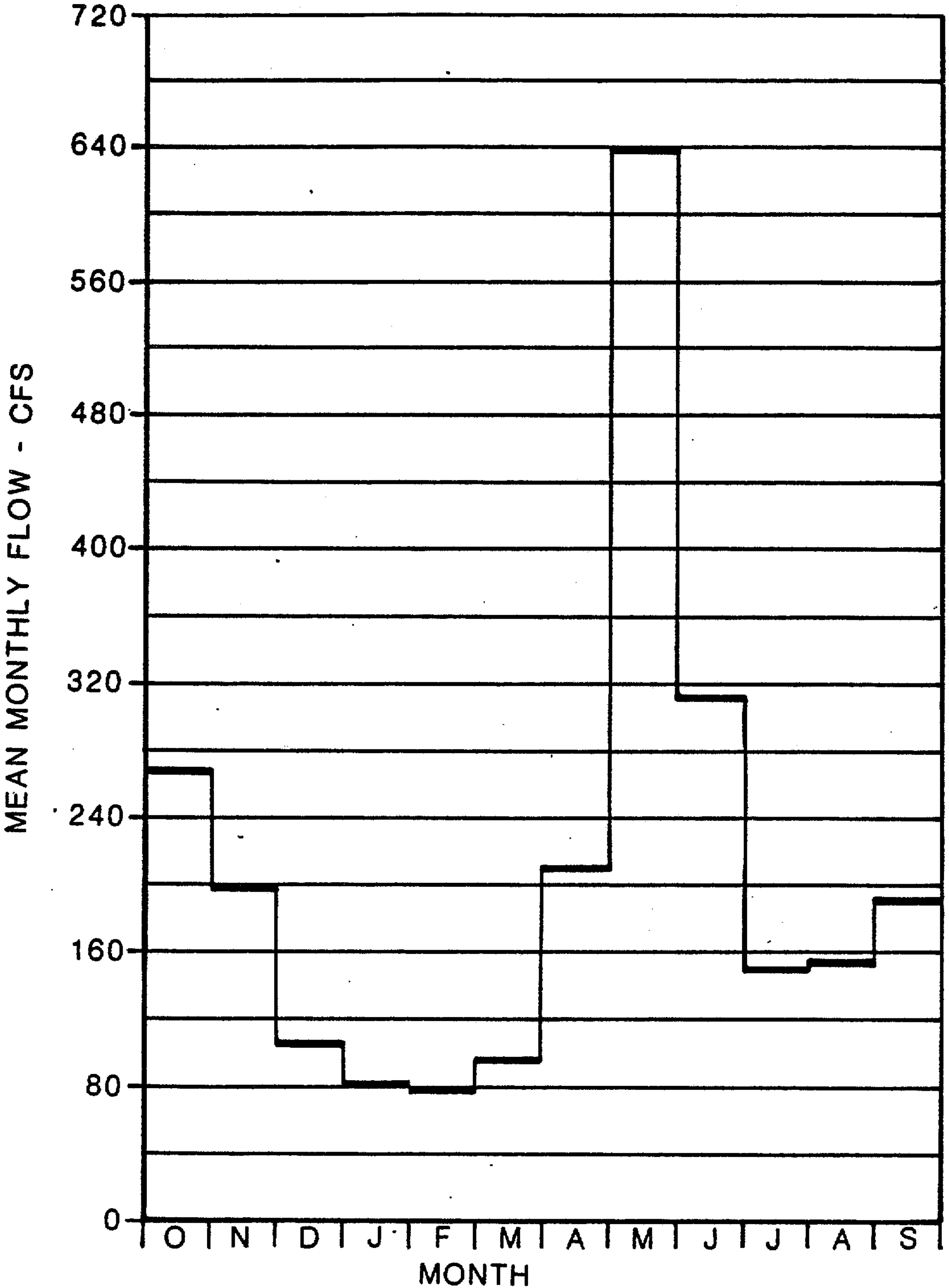


FIG. 5.1

Source: DuPont Corp., 1981



PERIODS: 1966-73, 1979-81
(Anchor River near Anchor Point)

FIG. 6.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

MEAN MONTHLY FLOW
ANCHOR RIVER

PROJ# 0024 APPV. DATE 10-82

CRIPPEN CONSULTANTS, INC.
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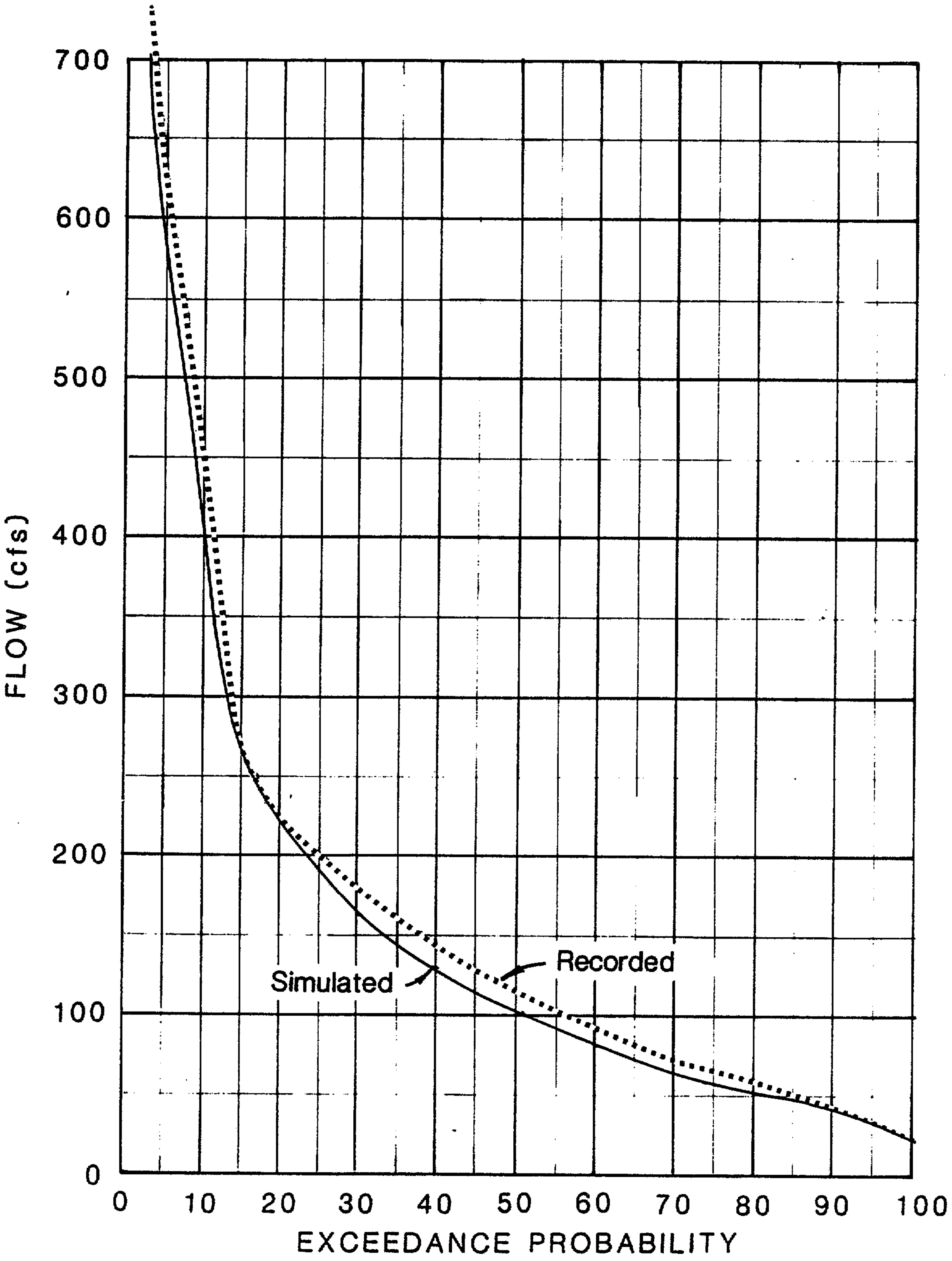

FIG. 6.2

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

FLOW DURATION CURVE
ANCHOR RIVER

PROJ# 0024 APPV. DATE 9-82

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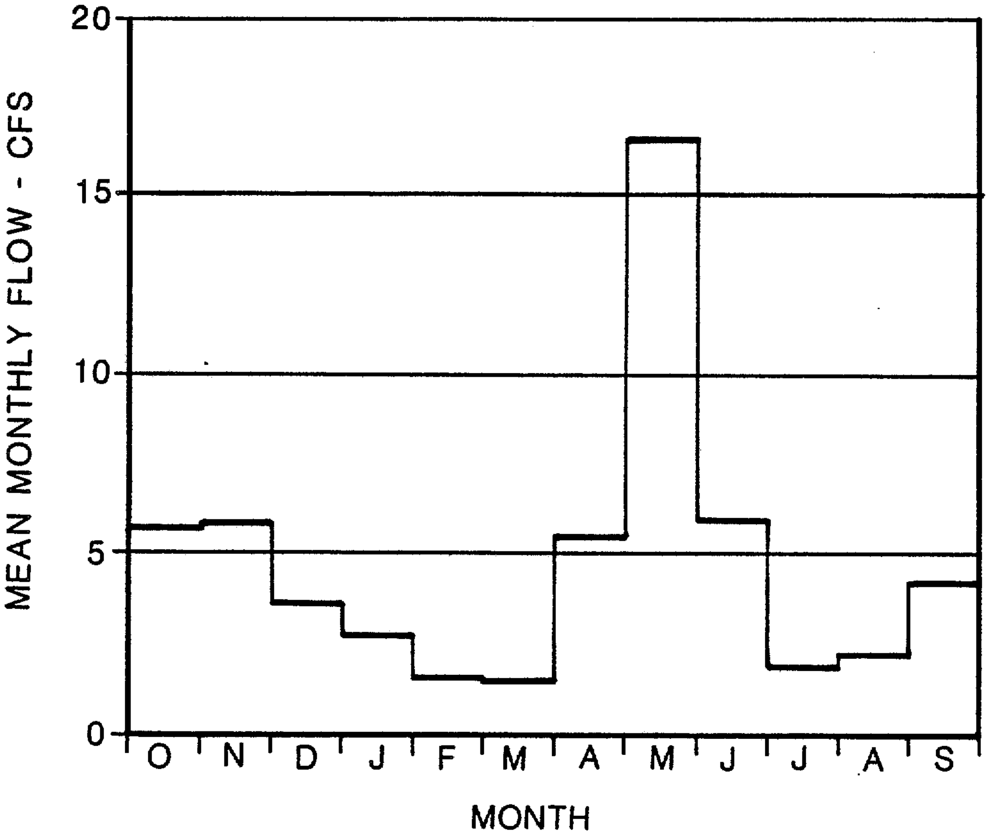

SIMULATED FLOWS
PERIOD: 1949-72

FIG. 9.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

MEAN MONTHLY FLOW
BRIDGE CREEK

PROJ# 0024 APPV. DATE 12-82

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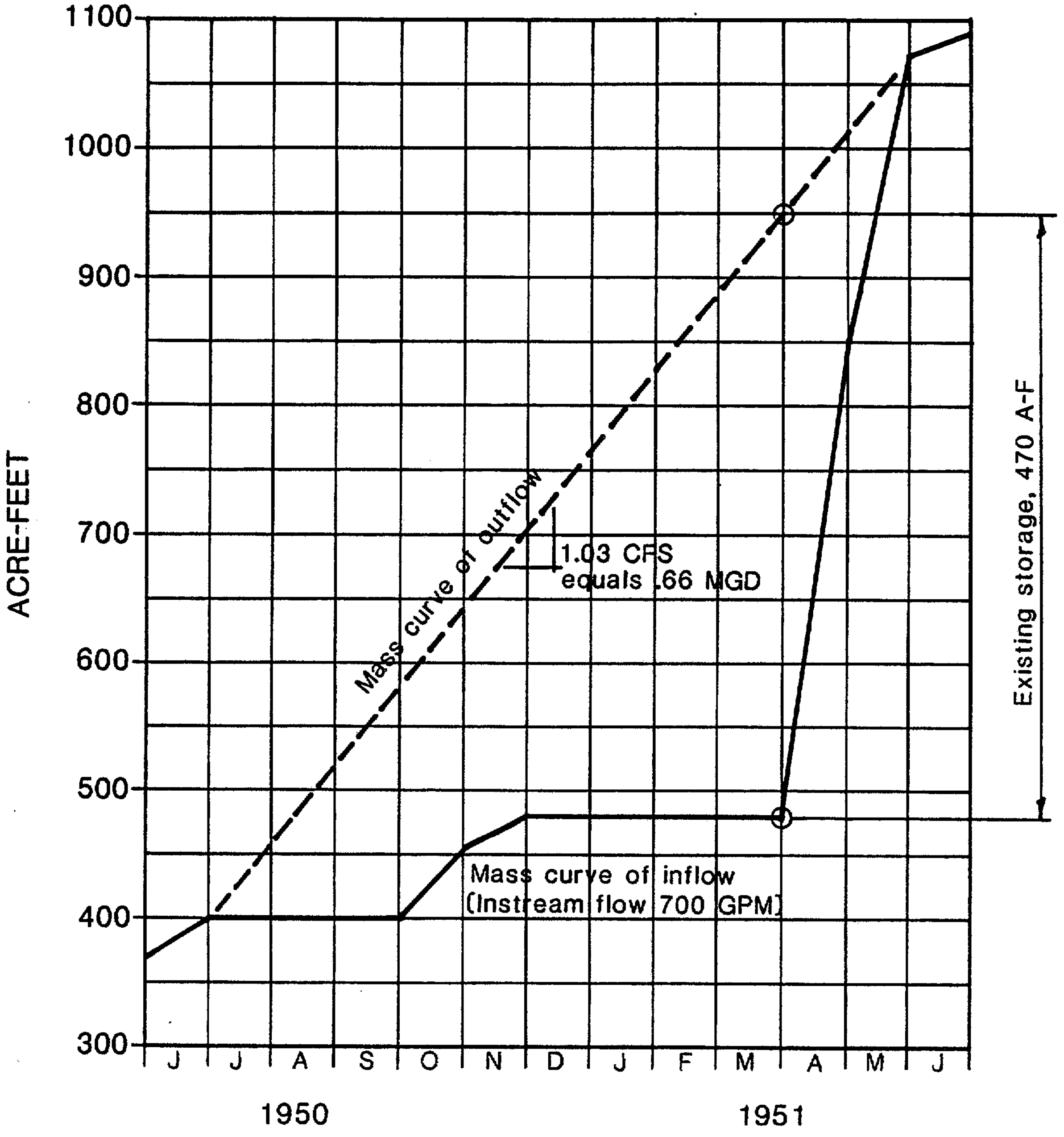

FIG. 9.2

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

BRIDGE CREEK
MASS CURVE - 1950-51

PROJ# 0024 APPV. DATE 11-82

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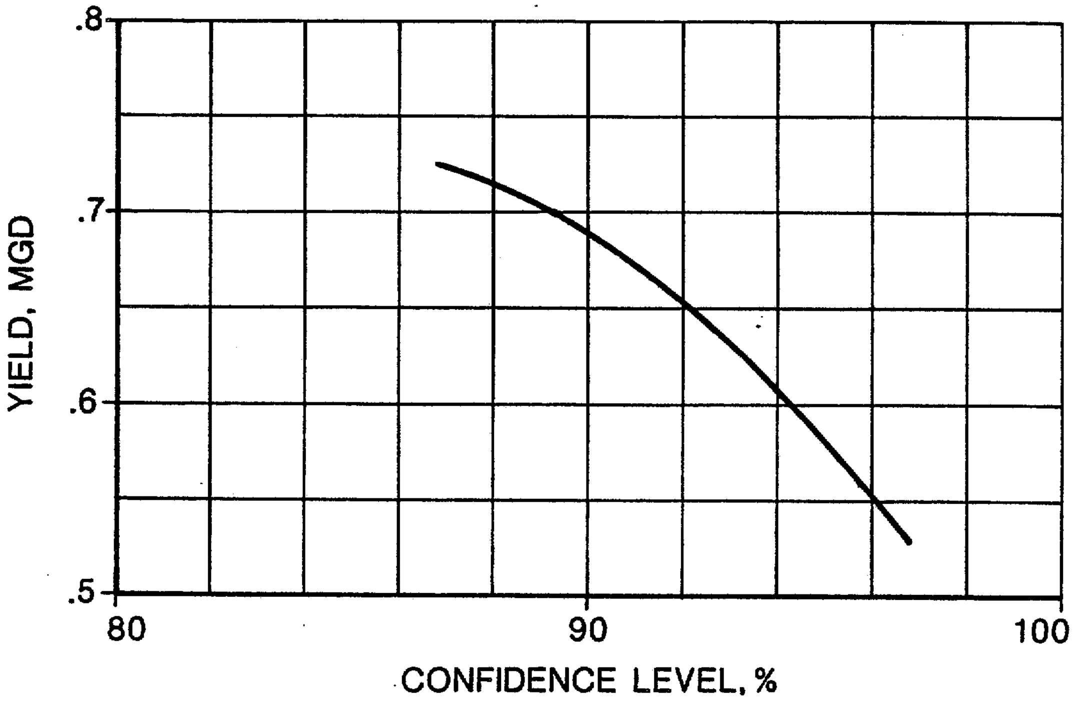

700 GPM Instream flow

FIG. 9.3

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

BRIDGE CREEK
WATER YIELD

PROJ# 0024 APPV. DATE 11/82

CRIPPEN CONSULTANTS, INC.
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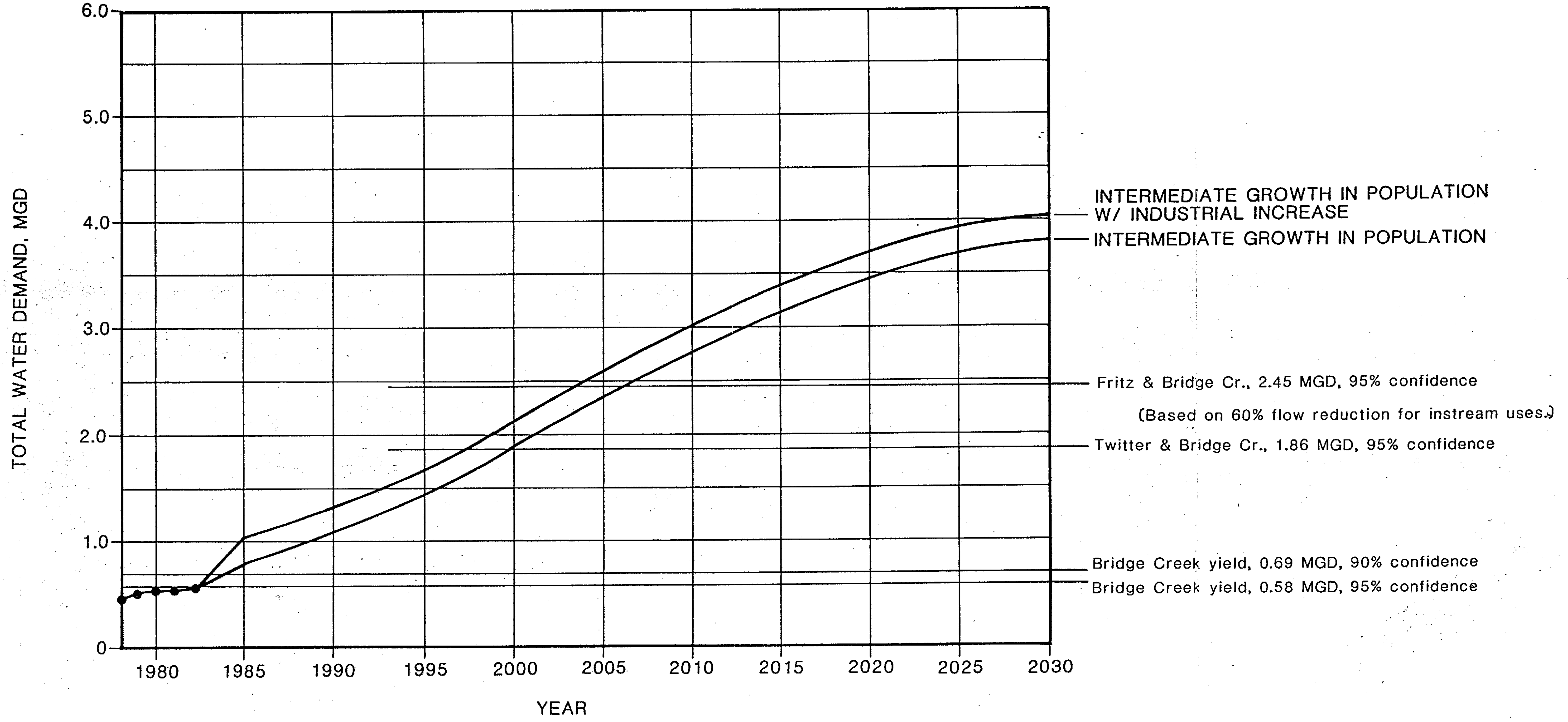

AVERAGE DAILY DEMAND, MGD
(Inclusive of demand outside city limits)

NOTE: CURVES INDICATE MOST PROBABLE DEMANDS TO BE EXPERIENCED.

FIG. 9.4

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

YIELD vs. DEMAND

PROJ# 0024 APPV. DATE 11-82

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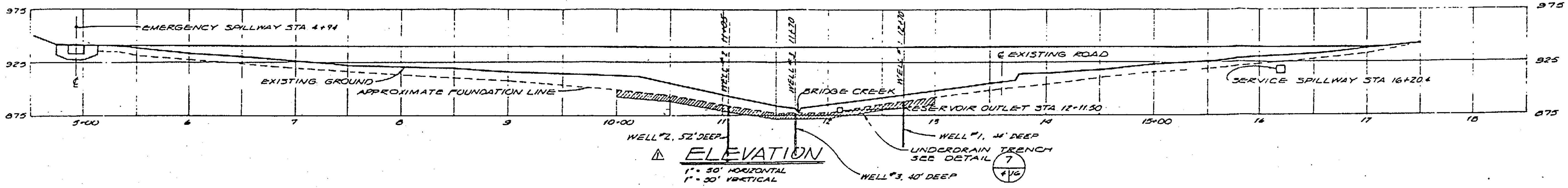
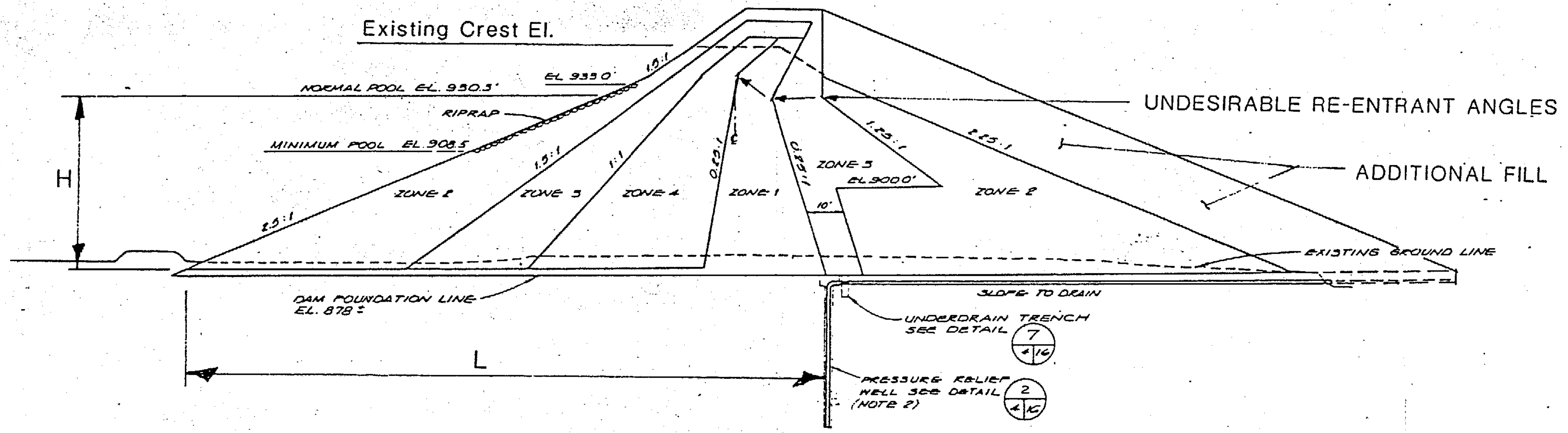


⚠ ELEVATION

1" = 50' HORIZONTAL
1" = 50' VERTICAL



NOTES
1 CAMBER EQUALS 5.0% OF VERTICAL DISTANCE FROM ELEV 940.0' TO FOUNDATION
2 PRESSURE RELIEF WELL SHOWN FOR ILLUSTRATION ONLY. DOES NOT OCCUR AT MAXIMUM SECTION
3 ELEVATION DATUM IN VICINITY OF DAM BASED ON VERTICAL ANGLE ELEVATIONS FROM USC&GS TRIANGULATION STATION HOMAIR

⚠ MAXIMUM SECTION

1" = 20'

ADAPTED TO SHOW PROPOSED METHOD OF RAISING EXISTING DAM.

Adapted From CH2M Hill (Alaska):
Dwg. # 3017-15, May 1974
- Revision 1, March 1976

FIG. 9.5

CITY OF HOMER, ALASKA
BRIDGE CREEK DAM

PROJ# 0024 APPV. DATE 10-82

CRIPPEN CONSULTANTS, INC.
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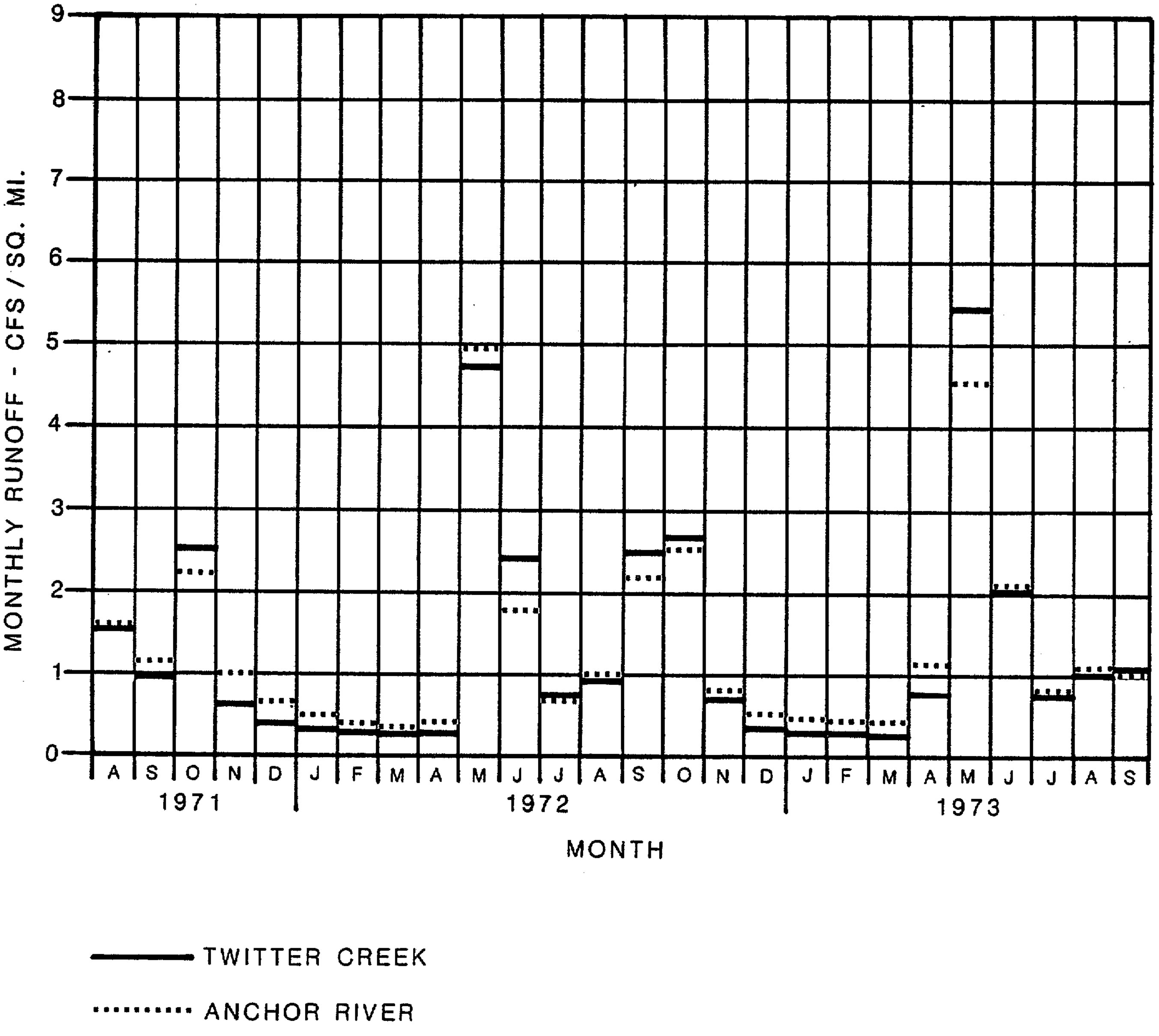

FIG. 10.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

MONTHLY FLOWS,
ANCHOR R. & TWITTER CR.

PROJ# 0024 APPV. DATE 10-82

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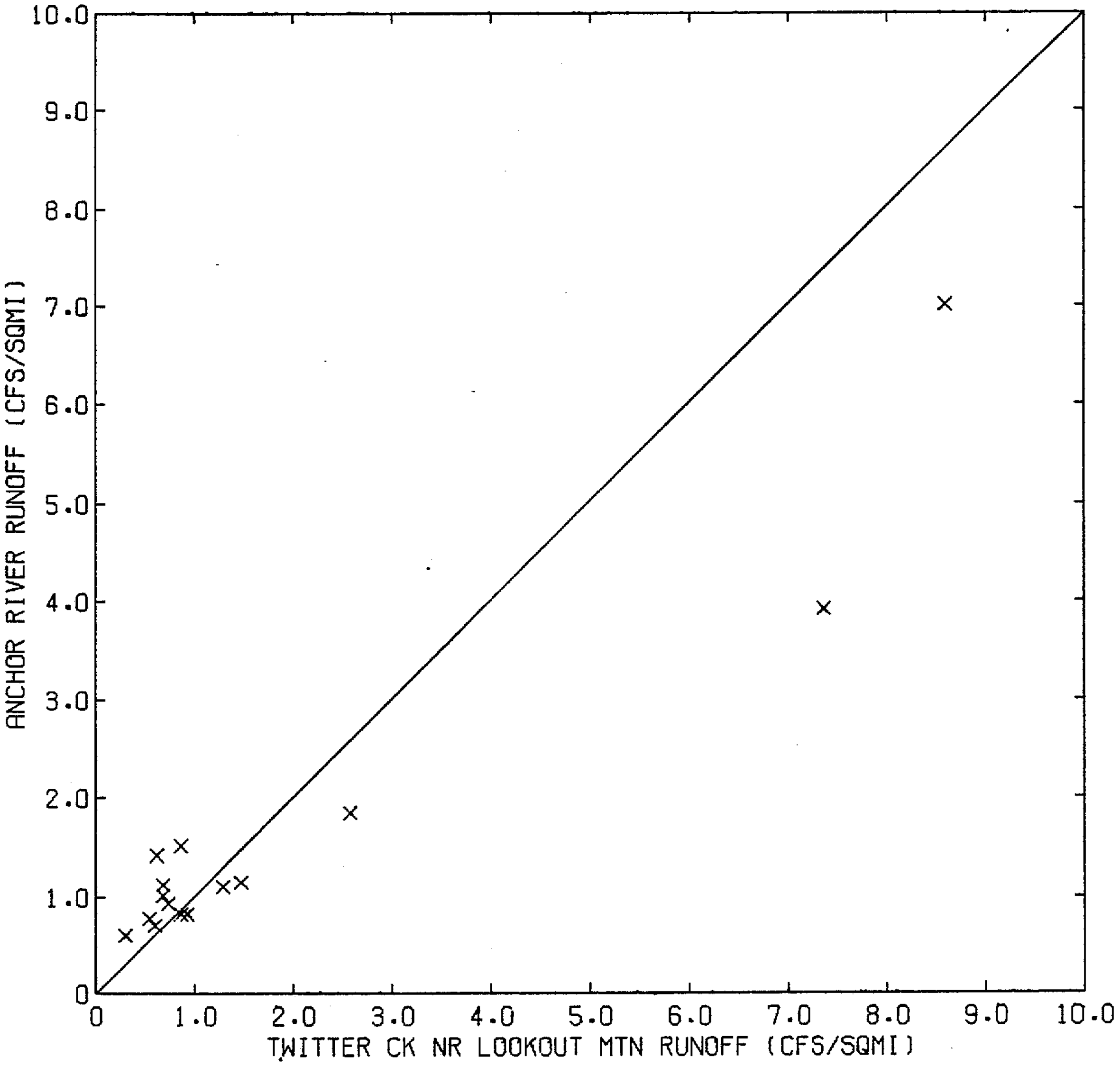


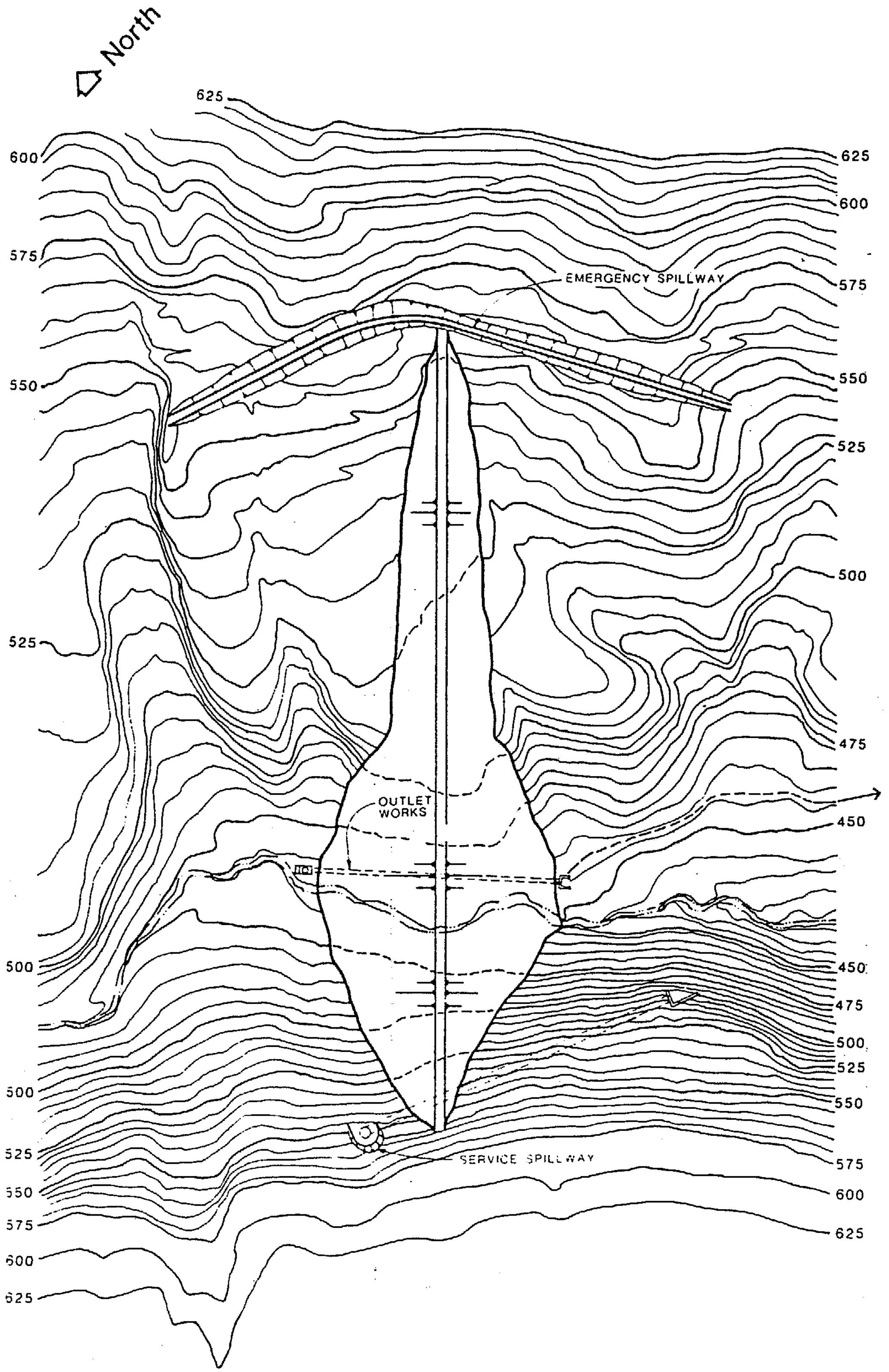
FIG. 10.2

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

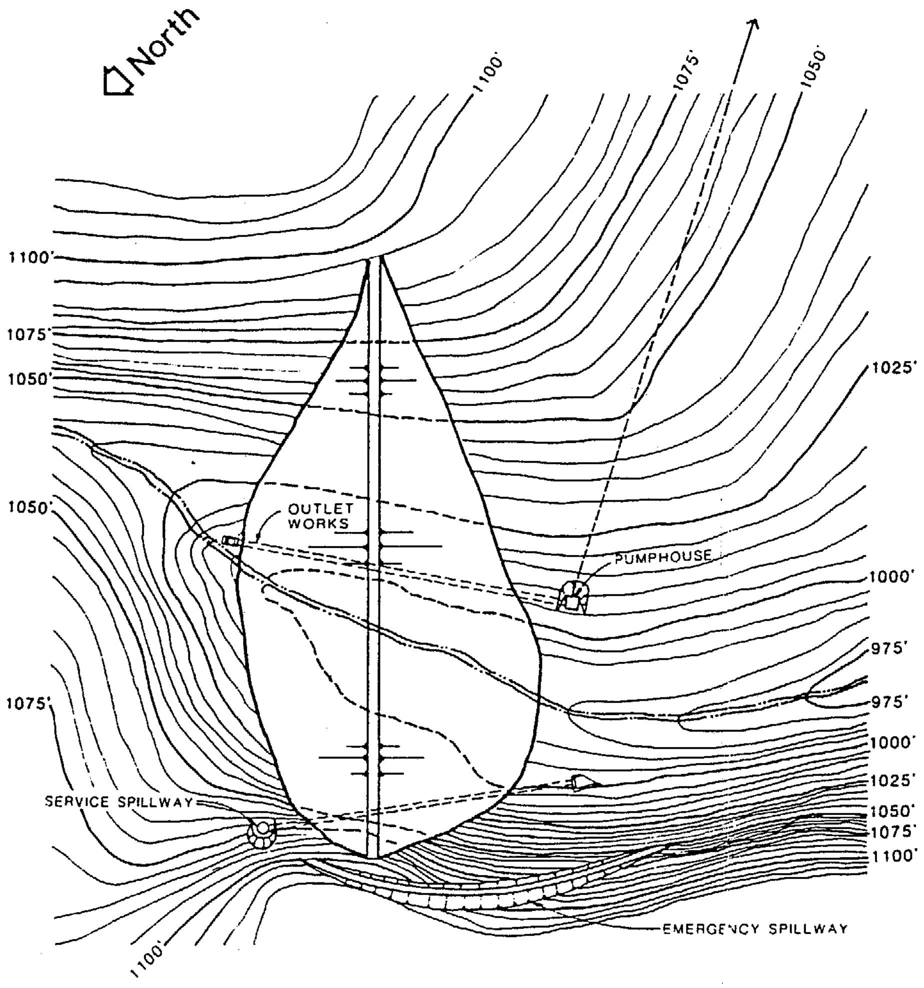
DISCHARGE MEASUREMENTS
ANCHOR R. vs. TWITTER CR.

PROJ# 0024 APPV. DATE 10-82

CRIPPEN CRIPPEN CONSULTANTS, INC.
SEATTLE



FRITZ CREEK DAM



TWITTER CREEK DAM

NOTE The topography of the Twitter Creek damsite has been approximated from the scale 1:62 500 USGS quadrangle Seldovia (C-5) Alaska map

Approximate scale in feet 100 200 500 1000

FIG. 10.3

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

PROJECT ALTERNATIVES
FRITZ & TWITTER CREEK DAMS

PROJ.# 0024 APPV DATE 12-82

CRIPPEN CONSULTANTS, INC.
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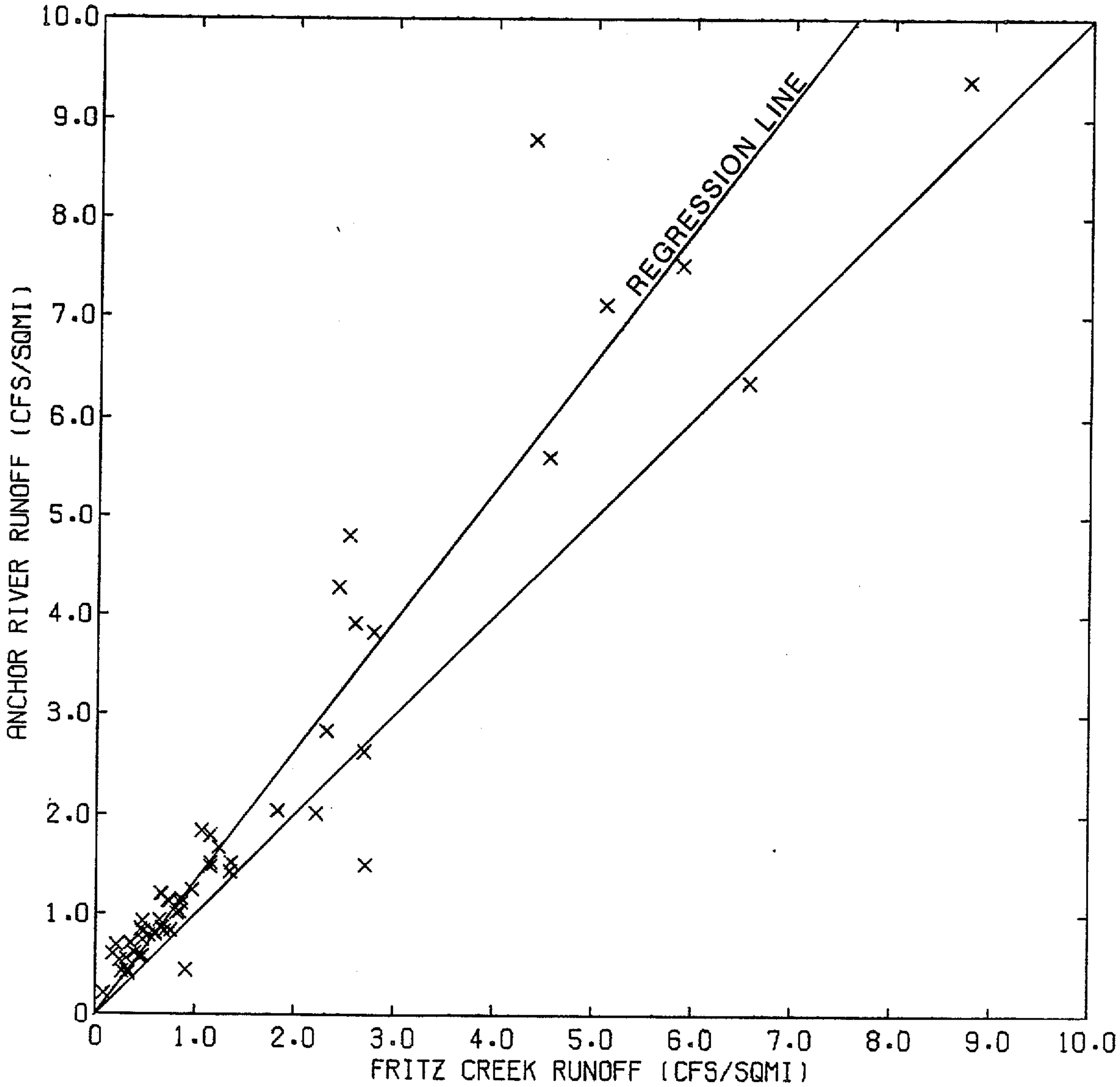

FIG. 11.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

DISCHARGE MEASUREMENTS
FRITZ CREEK vs. ANCHOR RIVER

PROJ# 0024 APPV. DATE 10-82

CRIPPEN CONSULTANTS, INC.
SEATTLE

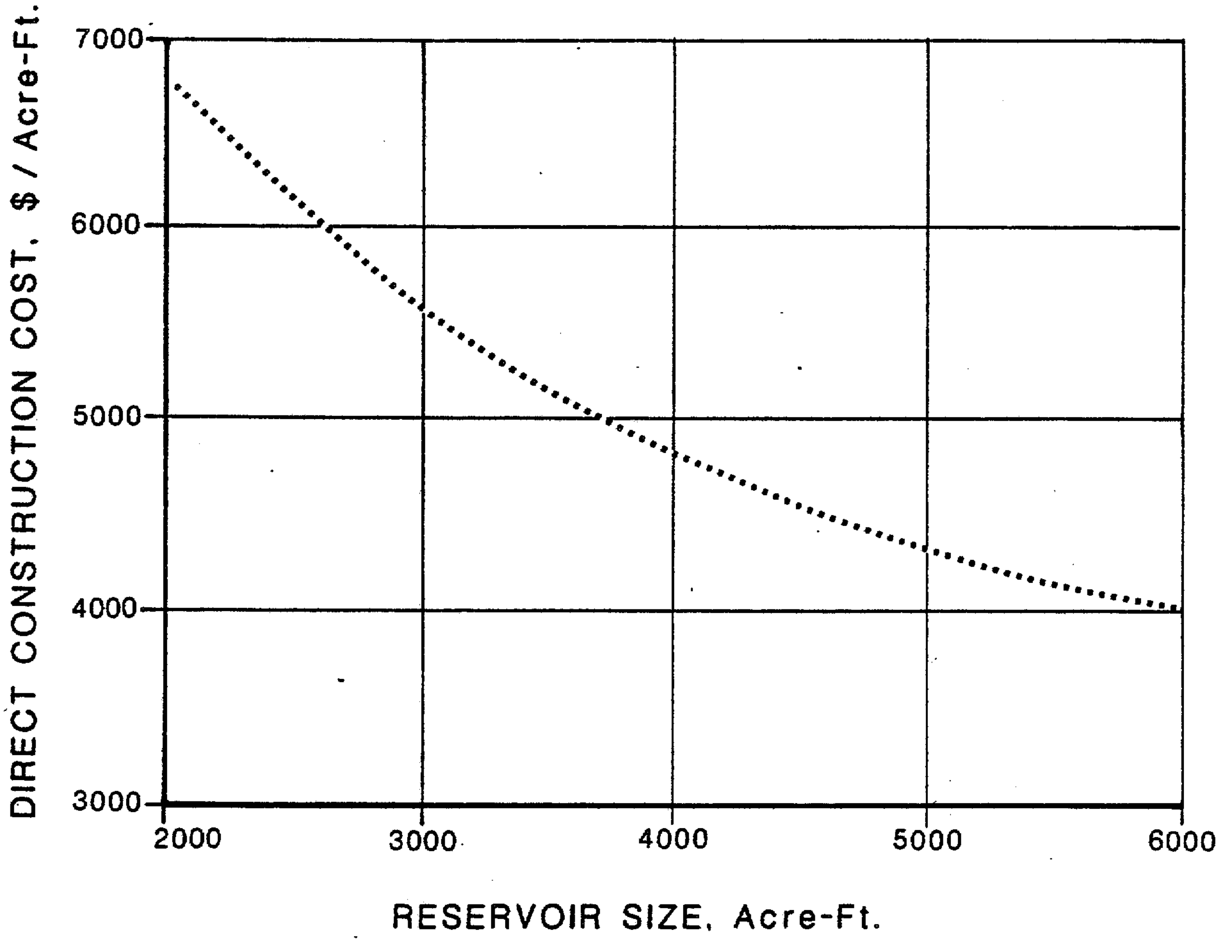

FIG. 15.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

OPTIMUM SIZE OF RESERVOIR

PROJ# 0024 APPV. DATE 3-83

CRIPPEN CONSULTANTS, INC.
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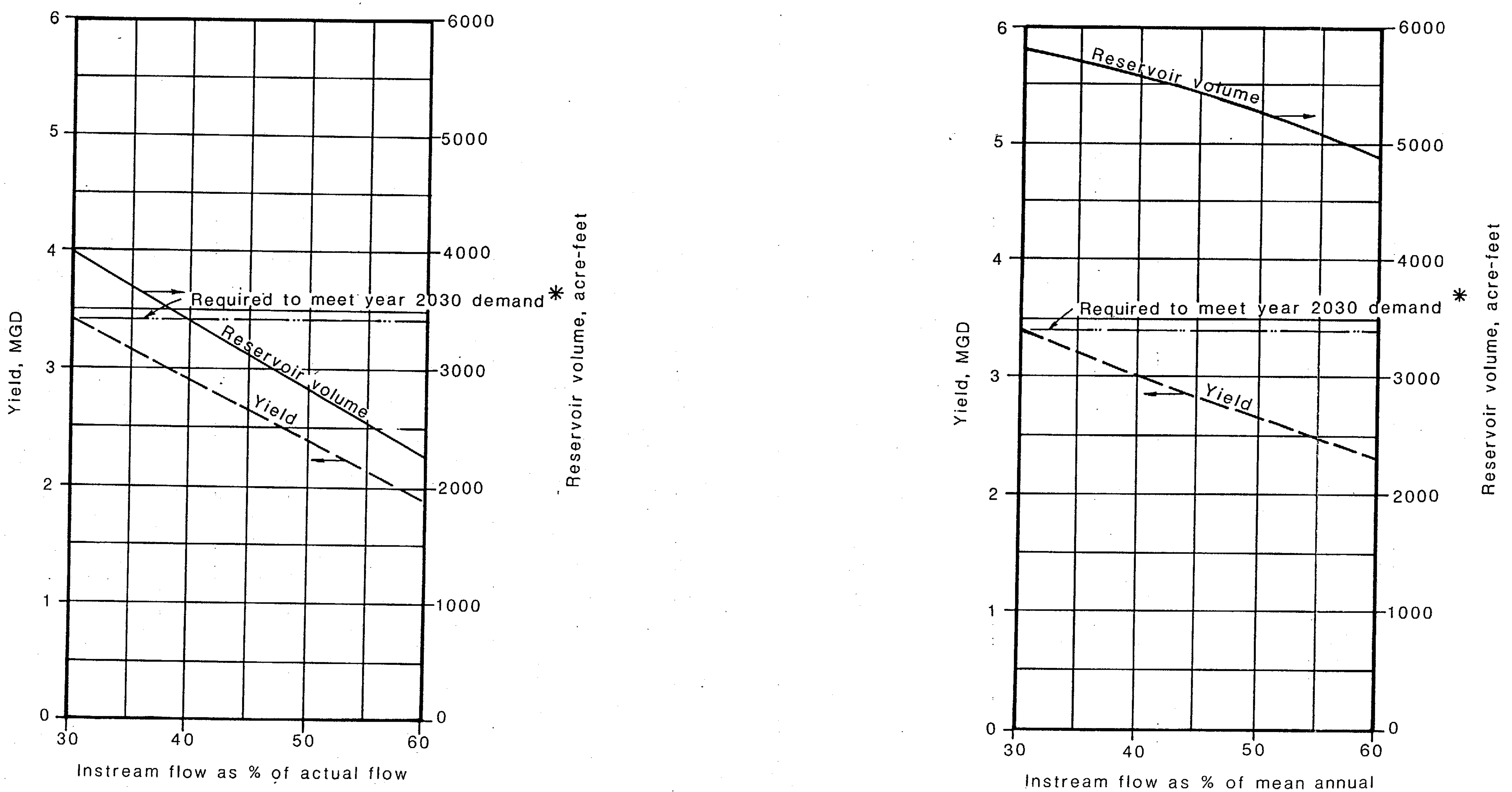

CRITERION 1

CRITERION 2

*Add Bridge Creek yield to obtain total yield = 4MGD

FIG. 15.2

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

EFFECTS OF INSTREAM FLOW
ON YIELD & RESERVOIR SIZE

PROJ.# 0024 APPV. aXd DATE 02-83

CRIPPEN CONSULTANTS, INC.
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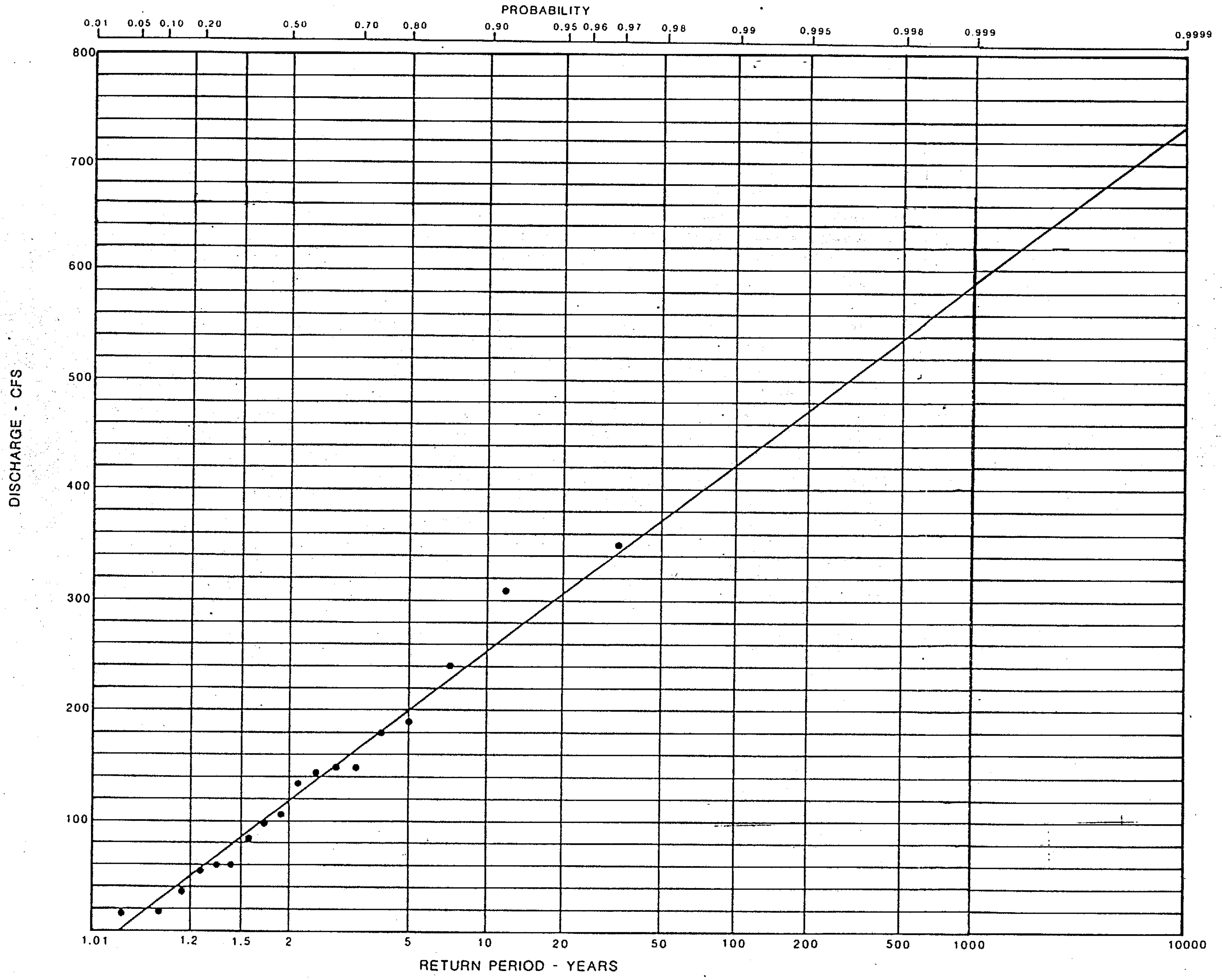

FIG 16.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

FLOOD FREQUENCY CHART

PROJ# 0024 APPV. A.X. Sean DATE 02-83

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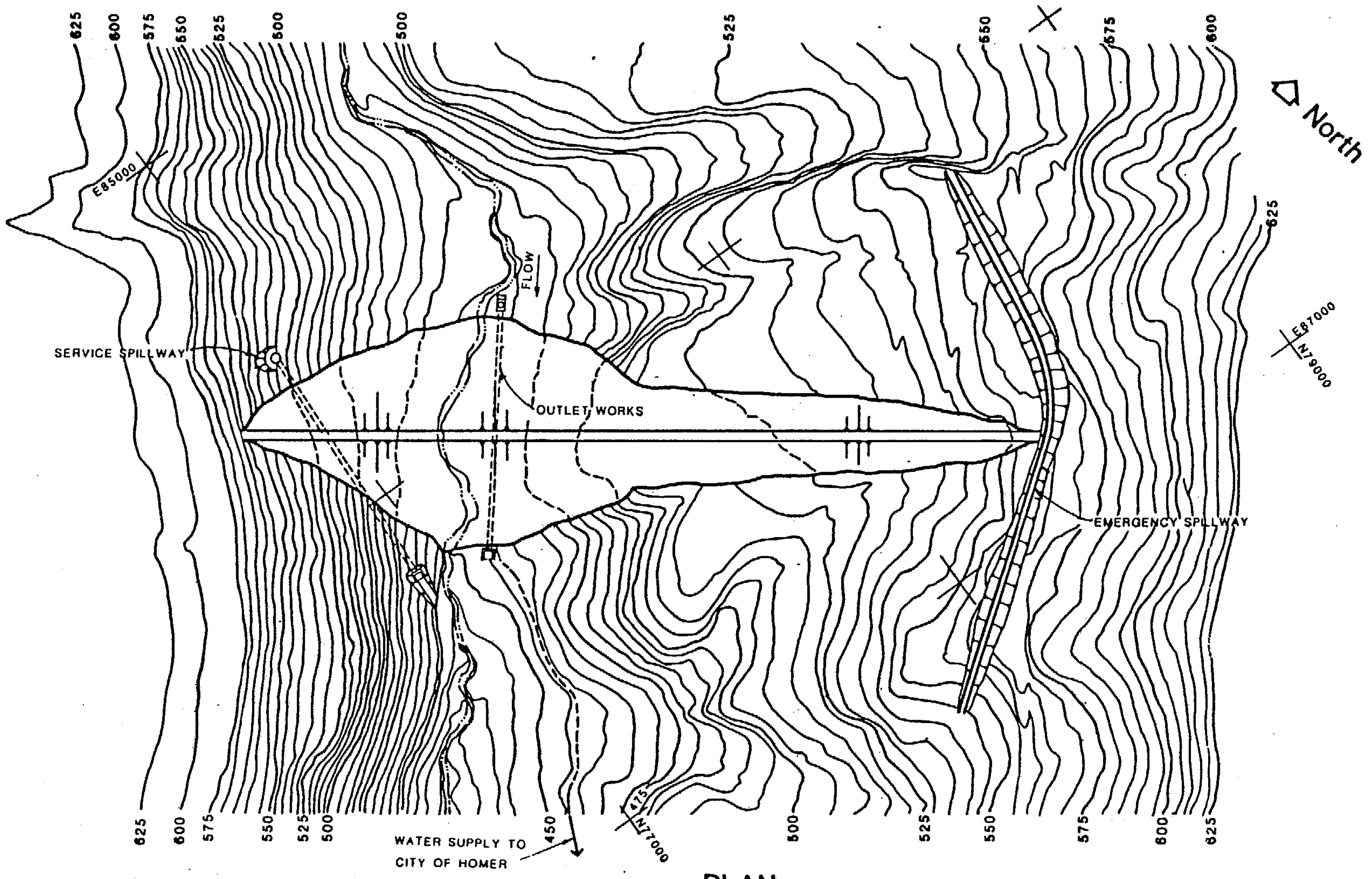
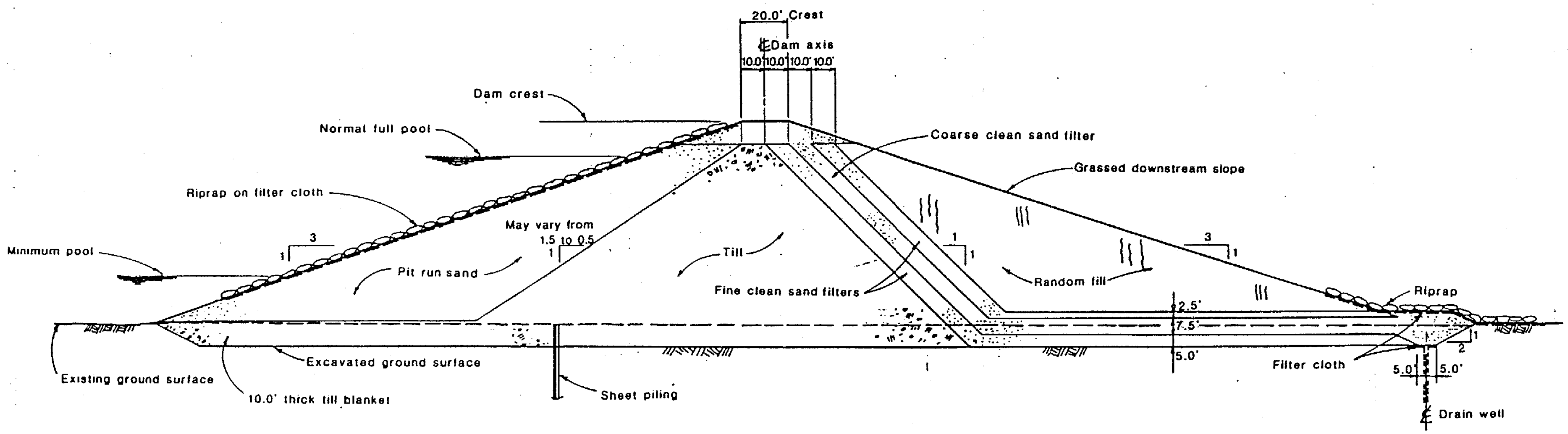


PLAN

Approximate scale in feet: 0 100 200 500 1,000



TYPICAL DAM SECTION

Scale 0 10 20 50 100 Feet

FIG. 17.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

FRITZ CREEK DAM
PLAN & SECTION

PROJ# 0024 APPV. axd DATE 02-83

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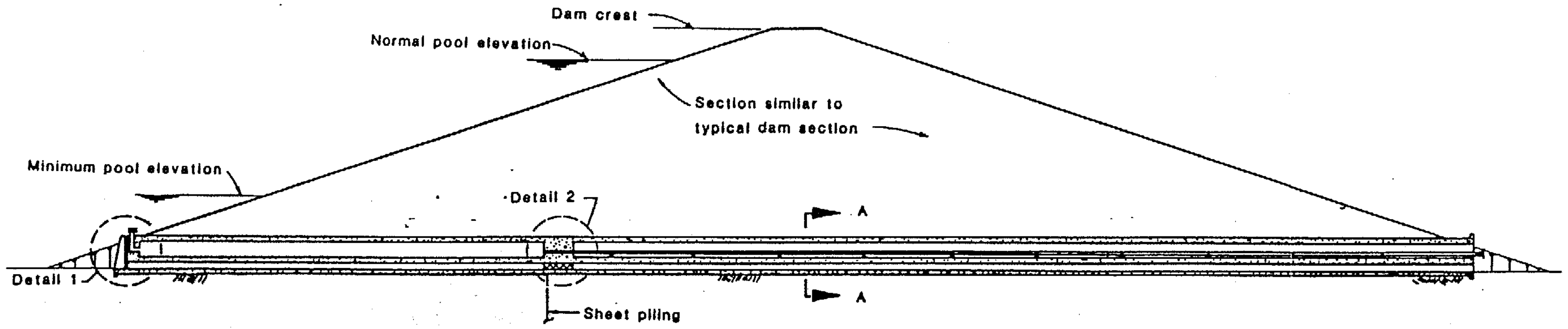
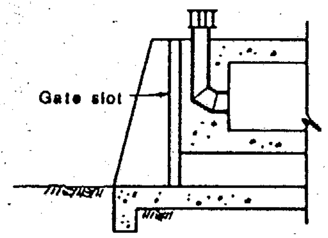
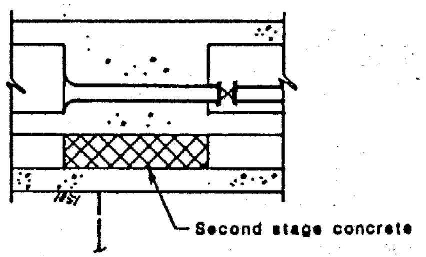


SECTION THROUGH OUTLET WORKS

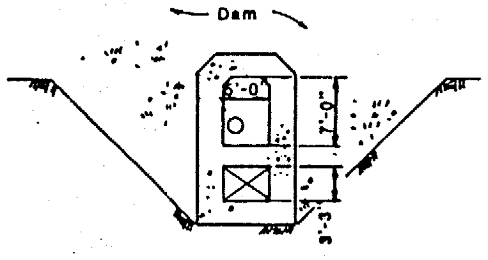
Scale 0 10 25 50 100 Feet



DETAIL 1

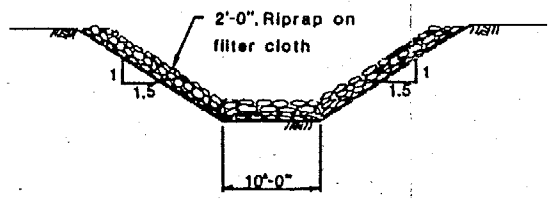


DETAIL 2

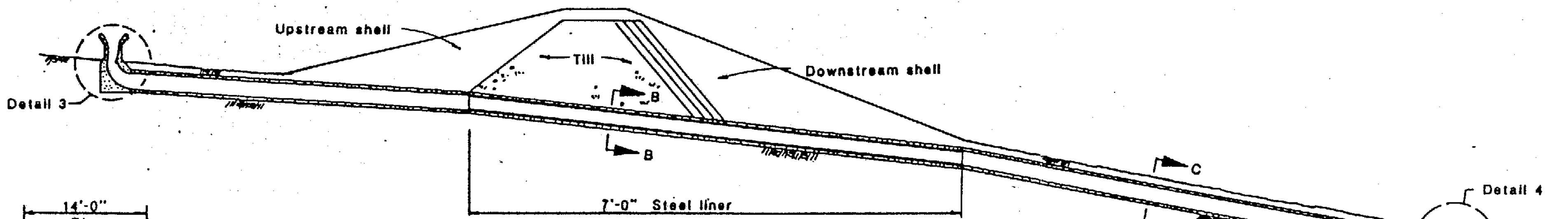


SECTION A-A

Scale 0 5 10 25 Feet

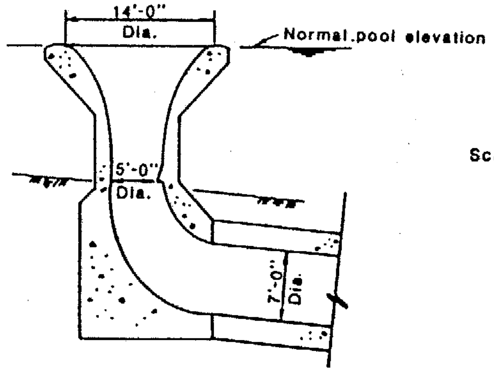


SECTION THROUGH EMERGENCY SPILLWAY

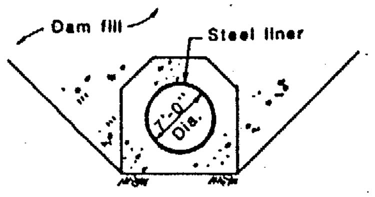


SECTION THROUGH SERVICE SPILLWAY

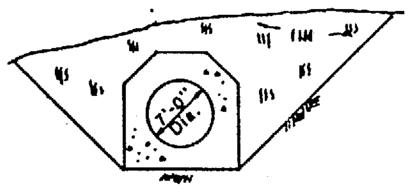
Scale 0 10 25 50 100 Feet



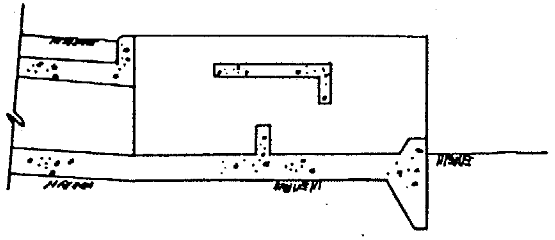
DETAIL 3



SECTION B-B



SECTION C-C



DETAIL 4

Scale 0 5 10 25 Feet

FIG. 17.2

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

FRITZ CREEK DAM
SECTIONS & DETAILS

PROJ# 0024 APPV. axd DATE 02-83

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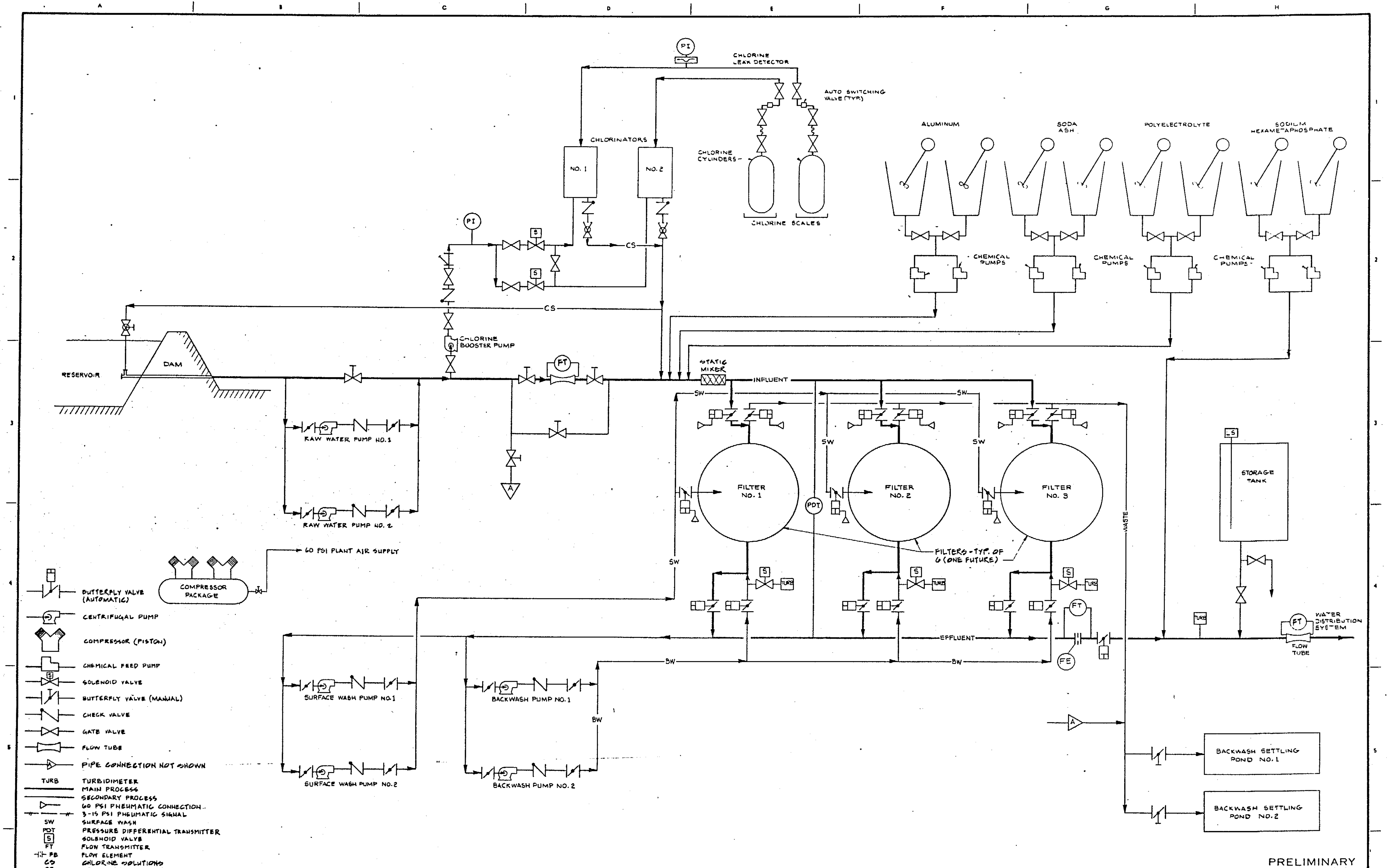

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
DATE

FIG. 20.1

NO.	DATE	TABLE OF REVISIONS DESCRIPTION	BY	APP'D	NO.	DATE	TABLE OF REVISIONS DESCRIPTION	BY	APP'D

Olympic Associates Company
PO Box 9330
1509 Dexter Avenue North
Seattle Washington 98109

SCALE
DATE
DESIGN
DRAWN
APPROVED
CHECKED

FLOW DIAGRAM
PROPOSED FRITZ CREEK
WATER TREATMENT PLANT
HOMER, ALASKA

JOB NO. 2060
DRAWING NO. 22

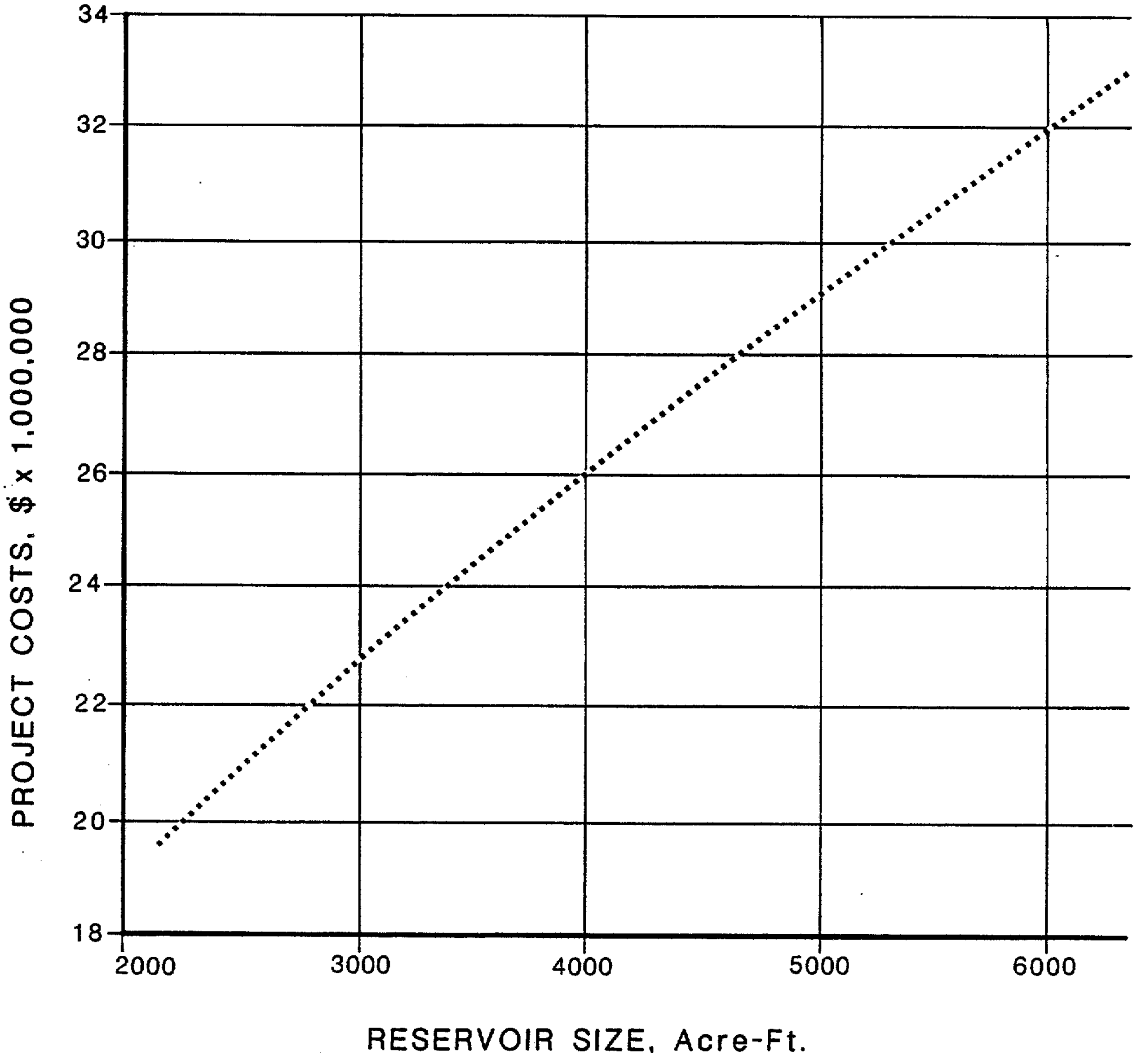

FIG. 22.1

CITY of HOMER, ALASKA
WATER SOURCE STUDY

PROJECT COSTS vs.
RESERVOIR SIZE

PROJ# 0024 APPV. DATE 3-83

CRIPPEN CONSULTANTS, INC.
SEATTLE

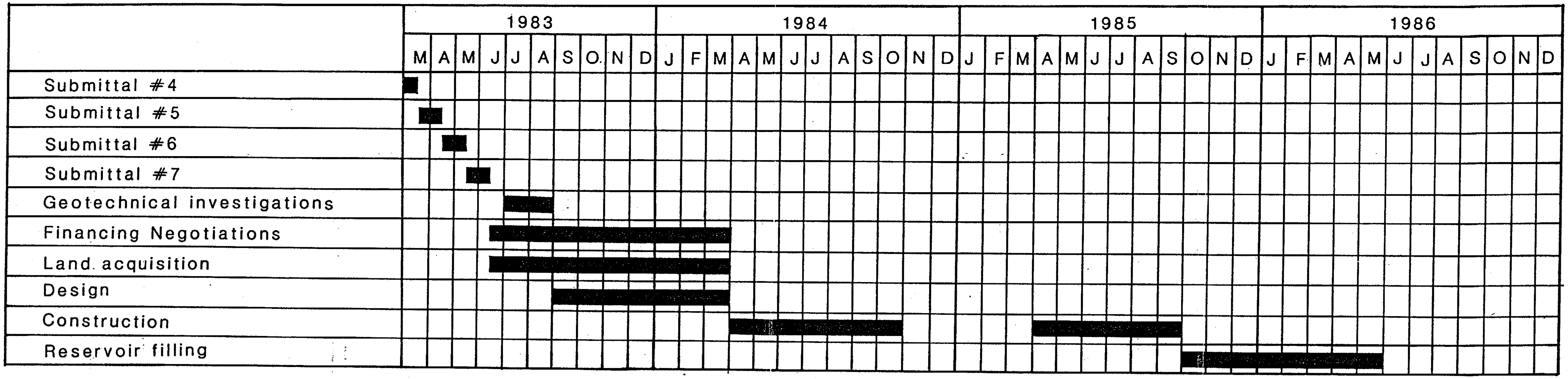

FIG. 23.1

CITY OF HOMER, ALASKA
WATER SOURCE STUDY

PROJECT SCHEDULE

PROJ# 0024 APPV. axd DATE 02-83

CRIPPEN CONSULTANTS, INC.
SEATTLE

GLOSSARY

GLOSSARY

Alluvium. Soil material, such as gravel, sand, silt or clay, that has been deposited on land by streams.

Aquifer. A body of rock that contains sufficient saturated permeable material to conduct ground water and to yield economically significant quantities of ground water to wells and springs.

Bed. A subdivision of a stratified sequence of rocks, internally composed of relatively homogeneous material exhibiting some degree of lithologic unity. The term is used primarily for a sedimentary unit.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Compaction testing. Refers to a procedure designed by Ralph R. Proctor (1894-1962), U.S. Civil Engineer, to establish water content-density relationships of a remolded soil by application of compactive effort under standardized conditions; gives the "Proctor curve" (or compaction curve) and the "Proctor density" of soil.

Concretion. A hard, compact, normally subspherical mass or aggregate of mineral matter generally formed by orderly and localized precipitation from aqueous solution in the pores of a sedimentary rock and usually of a composition widely different from that of the rock in which it is found.

Dip. The angle that a structural surface, e.g. a bedding plane, makes with the horizontal, measured perpendicular to the strike of the structure. (Strike is the direction that a structural surface takes as it intersects the horizontal.)

E-Log. A log obtained by using an electronic device in a borehole to detect and record geophysical characteristics of strata.

Escarpment. A long, more or less continuous cliff or relatively steep slope facing in one general direction, breaking the general continuity of the land by separating two level or gently sloping surfaces, and produced by erosion or by faulting.

Ferruginous. Pertaining to or containing iron, e.g. a sandstone that is cemented with iron oxide.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial drift. Material transported by glacial ice and then deposited; also includes assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial till. Unassorted, nonstratified glacial drift consisting of clay, silt, sand, gravel, and boulders transported and deposited by glacial ice.

Identification testing. Refers to testing, usually in a laboratory, to determine the classification of soil particularly with respect to gradation of particle sizes.

Indurated. Said of a compact rock or soil hardened by the action of pressure, cementation, and especially heat.

In-situ testing. Refers to testing of material in place, e.g. testing performed in a drill hole with a "pressure meter" which stresses the walls of the drill hole and measures wall deformations.

Kachemak soils. Refers to the Kachemak series which consists of dark-coloured, well-drained, shallow to moderately deep soils that occur on uplands and are nearly level to steep. These soils formed in volcanic ash mixed with silt blown from recently exposed glacial drift. Below the volcanic ash are layers of moderately consolidated shale and sandstone. The elevations range from 800 to 2000 feet.

Loam. Soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Log. A detailed, systematic, and sequential record of the progress made in drilling a well or borehole. It may include notes on the depths and thicknesses of the rocks and earth materials penetrated, geologic structure (dips), and water conditions.

Mantle. A general term for an outer covering of material of one kind or another.

Muskeg. A bog, usually an acid, very wet, freshwater bog, containing abundant peat moss, frequently with dense tufts of grass or grass-like plants forming deep accumulations of organic material, growing in wet, poorly drained boreal regions.

Packer test. Packer testing is used to determine the permeability of a rock mass. A packer consists of a rubber sleeve which can be expanded against the wall of a drill hole. The test consists of pumping water under pressure into a section of a drill hole sealed off with a packer or packers. The quantity of water and the pressure are measured and the "coefficient of permeability" can then be computed.

Peat. An unconsolidated deposit of semicarbonized plant remains of a water-saturated environment, such as a bog, and of persistently high moisture content.

Permeability. The property or capacity of rock or soil for transmitting water; it is a measure of the relative ease of water flow under unequal pressure.

Piping. Erosion by percolating water in a layer of subsoil, resulting in caving and in the formation of narrow conduits, tunnels, or "pipes" through which soluble or granular soil material is removed; especially the movement of material, from the permeable foundation of a dam, by the flow or seepage of water along underground passages.

Pressure meter. See in-situ testing.

Profile, soil. A vertical section of the soil through all its horizons.

Richter scale. The range of numerical values of earthquake magnitude, devised in 1935 by the seismologist C.F. Richter. In theory there is no upper limit to the magnitude of an earthquake. However, the strength of Earth materials produces an actual upper limit of slightly less than 9.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters.

Seismic zone. A zone of a "seismic probability map" based on a scale established in the United States, which divided the country into four zones: 0, 1, 2 and 3, corresponding to zones of anticipated zero, minor, moderate or major damage from earthquakes.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very find sand (0.05 millimeter).

Standard blow counts. Said of the "standard penetration test" used to determine the relative densities of soils. The test determines the number of blows required by a standard weight, when dropped from a standard height (30 in. per blow), to drive a standard sampling spoon a standard penetration (12 in.).

Tertiary age. Said of material deposited in the geologic period thought to have covered the span of time between 65 and three to two million years ago.

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REFERENCES

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21. Homer-Ninilchik Area, Alaska, Soil Survey, U.S. Dept. Agriculture, July 1971.

22. Feasibility Report for Water Project, City of Homer, Clair A. Hill & Associates, Anchorage, Alaska, Jan. 1972.

23. Seismicity Study, Homer Hospital, Homer, Alaska, CTA Architects-Engineers-Planners, Alaska Testlab, May 1974.

24. Series of Record Drawings on Bridge Creek Dam including Plan of Borings and Logs of Test Pits, CH_2M-Hill, May 1974.