US Army Corps
of Engineers
Alaska District

Reconnaissance Report Community Water Supply Supplementation Wrangell, Alaska

September 2006

Summary

This report has been prepared by the U.S. Army Corps of Engineers, Alaska District, and presents the reconnaissance-level evaluation of water storage alternatives for the City of Wrangell, Alaska. In addition, dam safety concerns are also addressed. This work falls under the aegis of Public Law 93-251, Section 22, Planning Assistance to States.

The City of Wrangell, Alaska, is located on the north end of Wrangell Island. It is a small community, and its water supply is contained within two reservoirs of limited capacity behind the Upper and Lower Dams. The two small dams were built over 70 and 100 years ago, respectively, and are in need of repair to meet State of Alaska Department of Natural Resources dam safety standards. The existing water supply system is inadequate to provide for peak demand during dry summer months, and does not allow for expanded industries to spur economic development.

Several alternatives were evaluated to accomplish the two-fold purpose of this study, including the development of an alternative water supply, repair and upgrade of the existing dams, and construction of a new dam. Based on the extensive repairs required and the cost associated with all alternatives, the construction of a new dam is the recommended course of action. In addition, this alternative is capable of handling both current and future water demands, improving water quality, and providing a measure of safety for the City of Wrangell.

The new earthen dam would be located just upstream from the existing Upper Dam. The complete construction project would entail the establishment of a new water supply line, repair and update of the Lower Dam, construction of the new dam, and removal of the Upper Dam. The project could be accomplished for a cost of $43 million.

PROJECT PERTINENT DATA Recommended Plan – Construct New Dam & Upgrade Water Treatment Plant	
General	
Location	Wrangell, Alaska
Longitude	132 21.6'W
Latitude	56 27.7'N
Size Classification	Medium
Purpose	Water supply for city
Owner	City of Wrangell Wrangell, AK 99929
Dam	
Type	Rockfill Earthen Embankment
Crest Length	500 feet
Crest Width	20 feet
Crest Elevation	Elev. 365
Maximum Height	65 feet
Spillway	
Type	Uncontrolled emergency - Concrete
Location	Right abutment
Bottom Width	55 feet
Length	250 feet
Crest Elevation	Elev. 360
Side Wall Height	6 feet
Outlet Works	
Location	Upstream embankment
Invert Elevation	Elev. 310
Length	250 Feet
Size	12" Water Supply, 48" Emergency
Outlet Type	Impact basin–discharge into channel
Control	Slide Gates - Manual
Reservoir Data	
Normal Maximum Water Surface Elevation	360 feet
Maximum Storage Volume	161.5 M-Gals
Maximum Surface Area	Approx. 30 acres
Hydrologic Data	
Drainage Area	0.82 square miles
Average Annual Discharge	4.4 cubic feet per second
Project Costs	
Investigations, Planning & Engineering	$12.6M
New Dam System	$26.3M
Upgrade Water Supply System	$4.1M
Project Cost	**$43.0M**

Reconnaissance Report
Community Water Supply Supplementation
Wrangell, Alaska

Summary

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Section 1 - Introduction

1.1 Project Authority

This reconnaissance-level study will be completed as part of the U.S. Army Corps of Engineers' (Corps) Planning Assistance to States Program, commonly referred to as the Section 22 Program. Section 22 of Public Law 93-251 authorizes the Corps to cooperate with the states in the preparation of comprehensive plans for development, utilization, and conservation of water and related resources of drainage basins located within the boundaries of the state. The Corps will then submit reports and recommendations to Congress with respect to appropriate federal participation in the plan. The Corps, Alaska District, has prepared this study in a cost-share arrangement, with 50 percent of the cost provided by the federal government and 50 percent provided by the study sponsor, the City of Wrangell, Alaska.

1.2 Study Purpose

The purpose of this initial assessment was twofold: (1) to gather, analyze, and present information and costs for providing adequate volume and quality of water to meet both current and future needs of the City of Wrangell; and (2) address safety concerns of the existing dams.

This reconnaissance-level report was prepared in conjunction with the City of Wrangell; and is partially in response to an Alaska Department of Natural Resources *Certificate of Approval to Operate a Dam*. In that document, the City was directed to address the safety concerns of both Upper and Lower Wrangell Dams. This report addresses those safety concerns, and offers potential solutions for those concerns.

1.3 Project Location

The community of Wrangell (population 2,308 as of the 2000 United States Census) is located on the north end of 30-mile-long Wrangell Island, and is approximately 42 square miles in size. The island lies within Tongass National Forest and is on the Inside Passage of Southeast Alaska, latitude 56.470N and longitude 132.376W (figure 1). Wrangell Island is located 154 miles southeast of Juneau and 80 miles northwest of Ketchikan. The main industries are fishing and forest products.

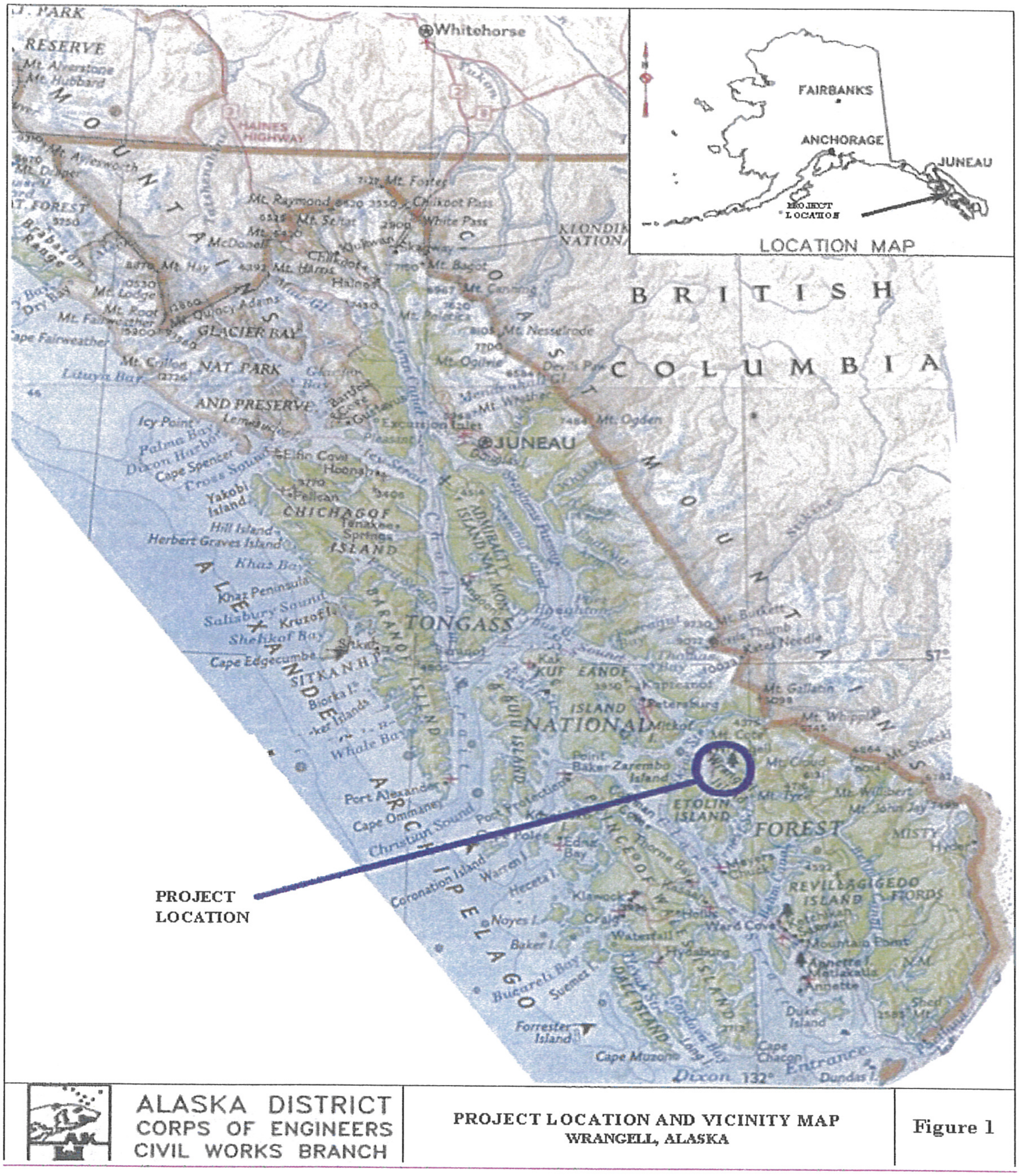

Figure 1 – Project Location and Vicinity Map

The City of Wrangell can only be accessed via either air or water. Alaska Airlines offers regular service from Seattle (a 3-hour trip) and Juneau, as does a regular mainline passenger ferry from the Alaska Marine Highway System. Local air charter services and several marine freight haulers with barge service are also available.

Wrangell is one of the oldest non-native settlements in Alaska. It lies on the Stikine River, a historic trade route to the Canadian interior, and is bordered by the Zimovia Strait. Wrangell is rich in Native Alaskan culture, and gold rush and local history. Only Tlingit native peoples occupied the island until the early 1800's, when Russian and, subsequently, British fur traders established posts in the area. The gold rush of 1861 attracted people from all over the world. At one point, Wrangell's population swelled to over 10,000 as would-be gold miners awaited supplies and transportation. Alaska became part of the United States when it was purchased from Russia in 1867. Two devastating fires, in 1906 and 1952, destroyed most of the city's historic buildings, which dated back to gold rush days. By 1929, salmon, shrimp, and crab canneries provided steady employment for Wrangell residents. The town has persevered to the present day with the help of the timber, fishing, and tourism industries.

1.4 Public Involvement

Wrangell city officials have kept the public and local businesses notified of up-to-date information about the ongoing reconnaissance study. Team members, although separated by great distances, have been on several site visits and frequently participate in conference calls to discuss specifics of the study.

A public information meeting/workshop was held in Wrangell on July 26, 2006, with representatives from the City of Wrangell, Alaska State Department of Natural Resources, news media, and the public. Presenters from the Corps planning team presented various alternatives being considered, and followed the presentation with a question and answer period. Meeting participants then took part in a workshop where water supply issues were identified and prioritized, and discussed possible actions to provide future water for Wrangell (figure 2). A summary of the meeting is located in Appendix D.

1.5 Water Supply

1.5.1 Description of the Study Area

The community of Wrangell lies within the mountainous region of the Coast Range of Southeast Alaska, and is at the northern end of Wrangell Island. Elevations on Wrangell Island can rise from sea level to 3000 feet within a couple of miles. There are few flat or near flat areas on the island. The steep slopes continue below the waterline to form fjords often over 100 fathoms in depth. The mountain slopes throughout the region are vegetated by muskeg, conifer species, and broad leaf trees; and the forest understory is lush and typical of a rainforest. Bedrock, except in valley bottoms, is seldom more then a few feet below the ground surface and is often exposed. Large muskeg areas are

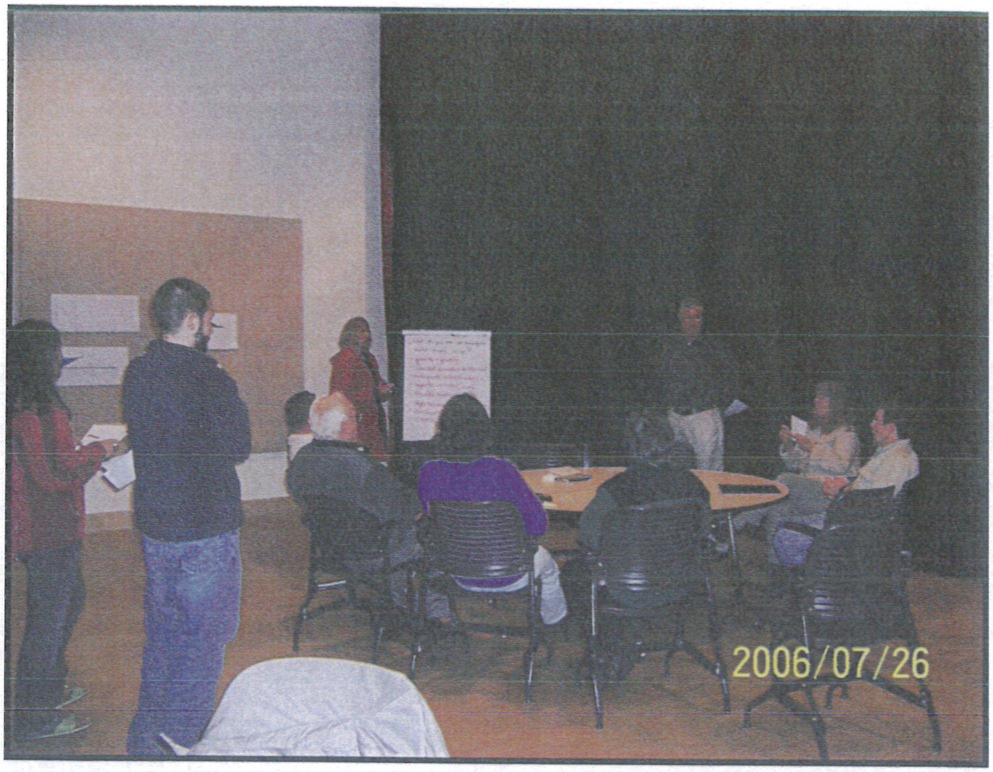

Figure 2 – July 26, 2006 Public Meeting

common, and found on poorly-drained slopes. These areas are composed of organic soils and plant materials in various stages of decomposition. The City of Wrangell encompasses approximately 42 square miles of land area, and has an estimated population of 1.974 (Alaska Department of Community and Economic Development, 2005).

1.5.2 Climate

The weather conditions in Wrangell are typical of a maritime climatic zone; and include cool summers, mild winters, and plentiful precipitation. Temperatures and precipitation can change dramatically over short distances and with small elevation changes in southeast Alaska. Climatic data has been collected at sea level in Wrangell for approximately 60 years. Average temperatures during the winter range from 29 to 44 degrees Fahrenheit while summer temperatures range between 42 and 57 degrees. Precipitation over the past 60 years averages about 82 inches per year at sea level. The average snowfall during winter months ranges from 0.2 to 19.5 inches, and is often mixed with rain. This is common in southeast Alaska, where heavy precipitation occurs in the autumn and early winter months.

1.5.3 Existing Water Supply System

The existing water supply system in the city consists of two small reservoirs, which provide primary storage and pressure for the system. The existing dams (figure 3) date back to the early 1900's. In the 1940's, rock was used to raise and cover the crib dam at the upper reservoir, and a new rock-filled dam was constructed at the lower reservoir using the wood crib as a buttress. Both dams

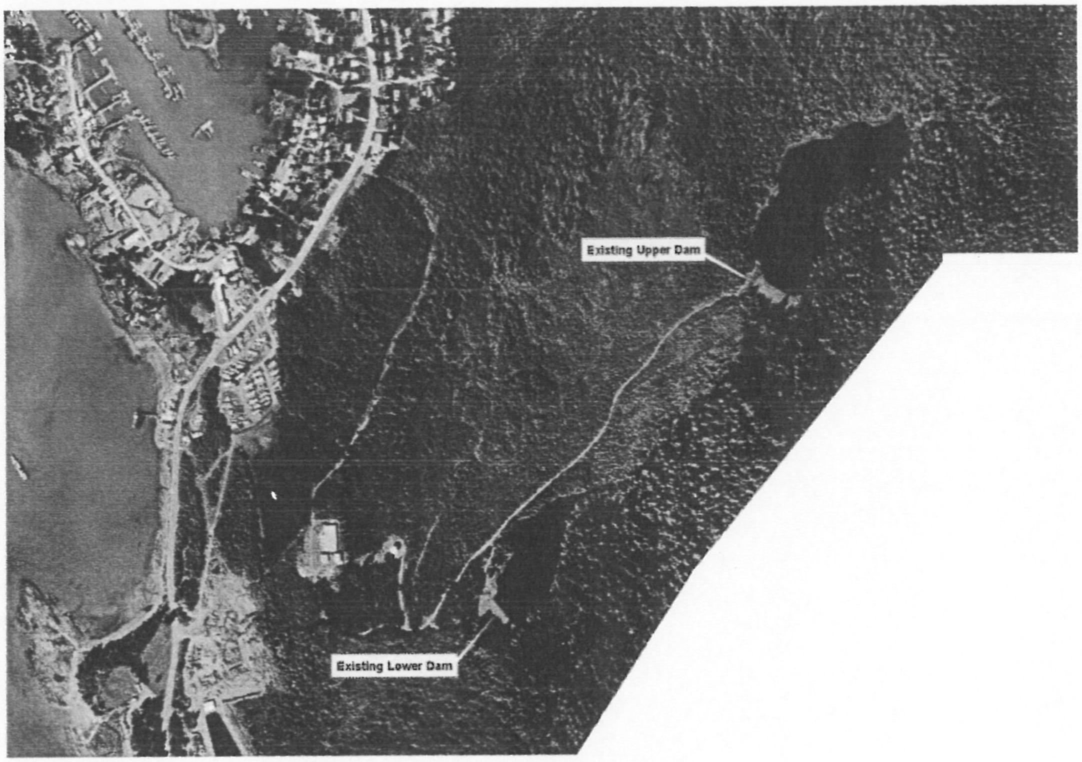

Figure 3 – Existing Dams

were raised again some time in the 1960's. The upper reservoir can hold 45.3 million useable gallons, while the lower reservoir can hold 21.4 million useable gallons, for a combined total active storage equivalent of 66.7 million gallons of water. This is roughly a 60-day supply during the peak demand period, assuming no inflow. The two reservoirs lie in the same drainage basin, which has about 0.82 square miles of catchment area. The average annual flow through the distribution system is 273 million gallons.

Historically, the City of Wrangell's water reservoir system has held an adequate supply for existing users. However, the reservoirs have fallen dangerous low during the summer peak demand a few times in the last 10 years. During 2004, abnormal high temperatures and low rainfall resulted in reservoir levels becoming dangerously low. By September 2, 2004, the total usable water in the reservoirs had dropped to 23 million gallons (figure 4). At that point, the reservoirs were barely able to keep up with the fish processing demands, and the city was experiencing water quality problems.

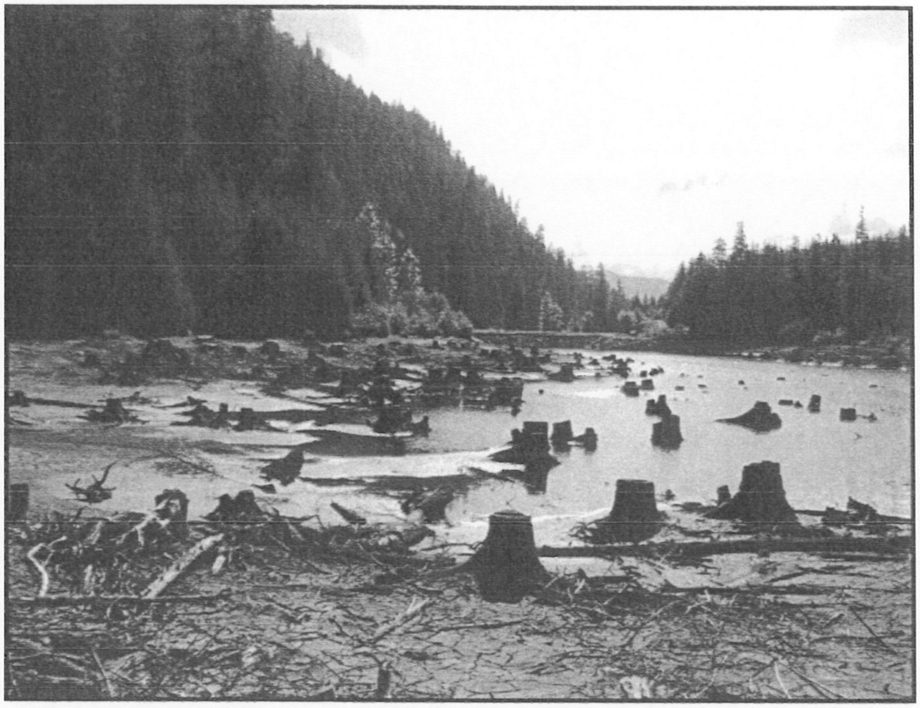

Figure 4—Low reservoir levels in Wrangell Upper Reservoir during summer 2004

In addition to the limited capacity of the reservoirs, the dams need extensive work to bring them in line with industry standards. Major items needing work are the piping and valves in the upper dam. The following paragraphs briefly list some of the other major problems outlined in the referenced dam safety reports.

The spillway for the upper dam needs to be modified, and the buttress on the upper dam should be increased. Access to the upper dam requires improvement. Seismic and inundation studies need to be reviewed and upgraded.

Access to the lower dam should be installed. Emergency drawdown capability needs to be restored. The wood crib dam at the toe of the lower dam is deteriorating. Seismic and inundation studies also need to be reviewed and upgraded.

The upper reservoir is fed by a steep mountainous watershed flowing into small streams. The most eastern stream is diverted from its normal flow by a steel culvert flume. This was done some time in the late 1940's and, although repairs have been made over the years, this flume has reached the end of its useful life and should be replaced.

Another issue in the use of the reservoirs is the planned installation of a water line from the upper reservoir to the water treatment plant. Currently, water is transferred from the upper to the lower reservoirs and piped to the water treatment plant. This transfer is accomplished by opening a valve in the upper dam and spilling the water into a drainage that feeds the lower reservoir. Past testing has indicated that the water quality in the upper reservoir is marginally better than that of the lower reservoir. Feeding water directly from the upper reservoir, considering the marginal difference, would greatly reduce the maintenance at the water plant during high flow periods.

1.5.4 Present and Future Water Demand

Existing demand peaks during the summer months and fall off during fall and early winter. Figure 5 shows monthly demand from September 2004 to August 2005. The community would like to attract an additional fish processing plant to town to spur some economic development. The largest existing fish processor uses up to 400 gallons per minute for up to 16 hours a day, and processes fish for up to 3.5 months during the summer. Assuming a new processor would need similar amounts of water, the system would need to supply an additional 40 million gallons.

The logging and fishing industries have been depressed in recent years, causing the population of the city to drop from 2700 in 1996 to 1,974 in 2005. There has been a recent resurgence in the fishing industry due to name branding of the local fisheries in Alaska and the recognition of the superior taste and nutritional aspects of wild Alaska salmon verse pen reared farmed salmon.

With the resurgence in the fishing industry, a fish processing company could be attracted to town. The population would grow in response to the additional jobs required to operate the plant. A 0.5-percent annual growth rate in population was assumed for the first 10 years following the development of a fish processing plant, but no growth in the next 10 years was used in this analysis. Figure 6 shows projected demand using the above stated assumptions. Future population growth needs to be refined during the feasibility phase, as it is a critical piece of information for the analysis. It is anticipated that the annual demand for drinking water would be approximately 327 million gallons. This estimated future demand exceeds the capacity of the treatment plant during some months, and additional capacity may need to be added.

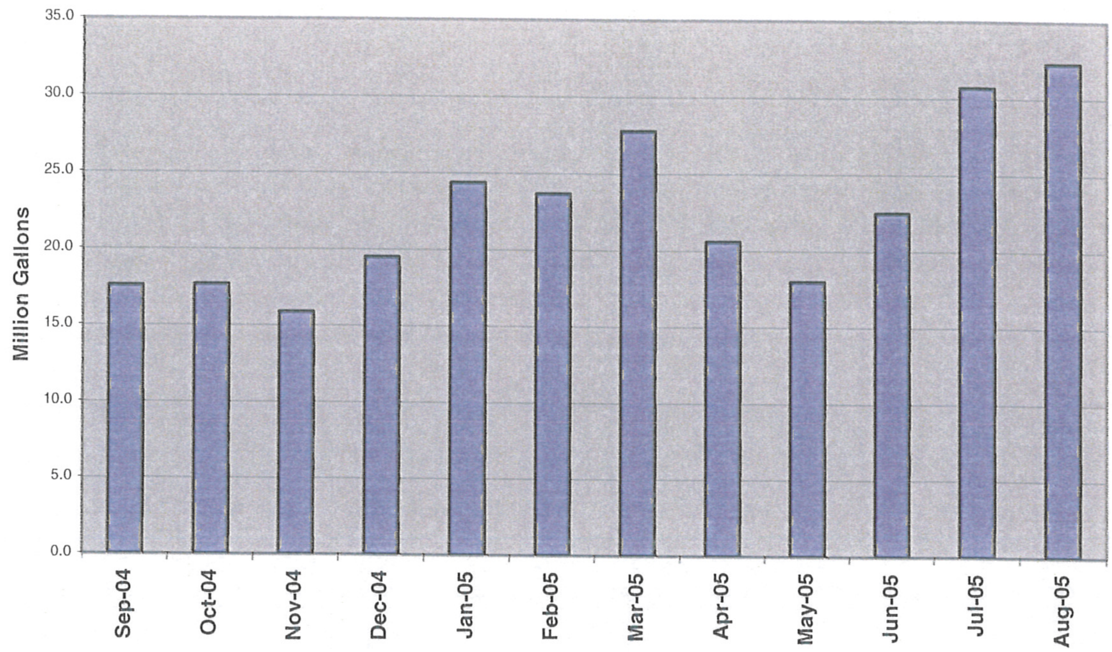

Figure 5 – Current Water Demand

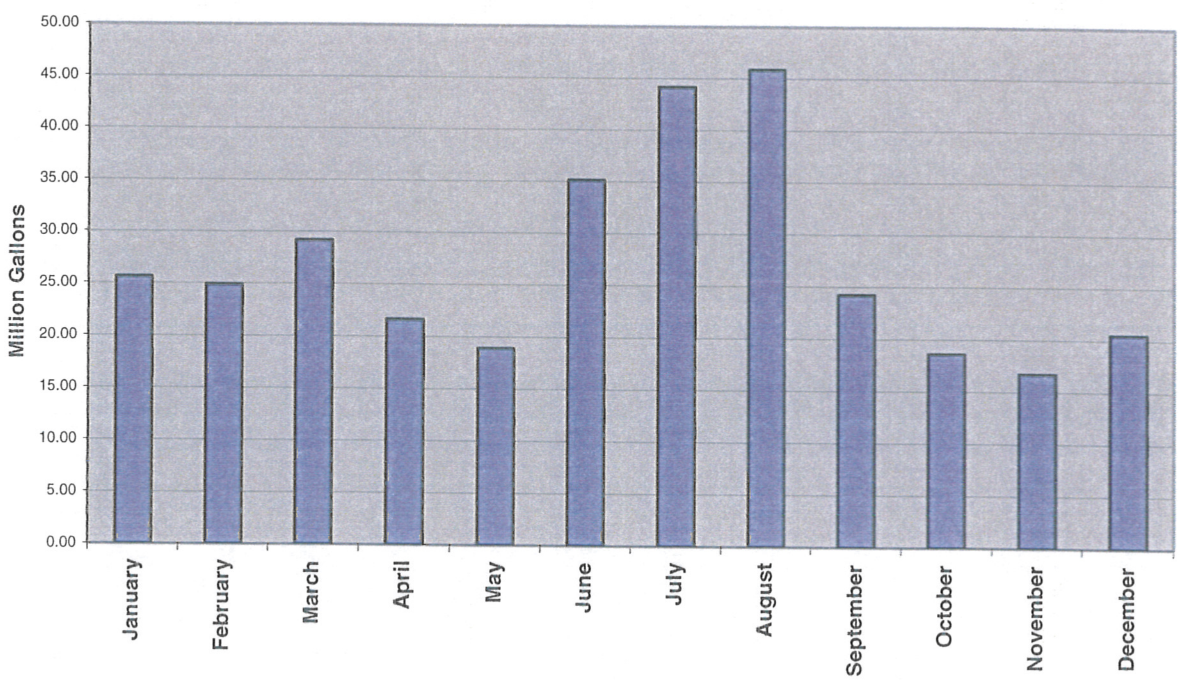

Figure 6 – Predicted Water Demand, 2026

1.5.5 Expected Future Conditions

The existing Wrangell Upper and Lower Dam System does not provide sufficient water to meet the projected water supply needs and requirements for the City of Wrangell. Without modifications to the dams and other changes, the City of Wrangell water supply system will not have sufficient capacity to supply projected water requirements. The lack of sufficient water supply will have significant economic impacts to the community and, in particular, the cannery industry.

Section 2 – Hydrology

2.1 Existing Precipitation Data

No flow or precipitation data collection exists on Wrangell Island at the current time, and no flow or precipitation data could be found for the reservoir drainage. Rainfall data was consistently collected at the City of Wrangell from 1934 to 1995. The United States Geological Survey streamflow data shows that flow was measured on one very small (drainage area=0.09 square mile) stream on the island for 2 years in the 1960's.

2.2 Estimated Streamflow

Average annual flow into the reservoirs was estimated using a United States Department of Agriculture (USDA) regression analysis of flows in Tongass National Forest, where Wrangell is located. The analysis looked at parameters such as drainage area, precipitation, main channel slope, average basin elevation, and other variables to see if they could be used to estimate flows on ungaged streams. A regression equation was developed to estimate average annual flows on an ungaged stream using drainage area and precipitation data. Using a drainage area of 0.82 square miles and an average annual precipitation estimate of 95 inches yields an average annual flow of 4.4 cubic feet per second (cfs). This 4.4 cfs changed to a volume is 1030 million gallons. per year. There is an adequate amount of water generated by the basin to meet expected future demand. Additional storage within the basin would be needed to hold enough water until it is needed by the community, but the amount of storage needed depends on monthly or weekly demand and flow patterns.

The low flow periods appear to exist during summer months when demand is the highest. A critical low flow period needs to be established in order to estimate required additional storage. Reservoir elevation and water usage information for the July through September 2004 low flow period was used to estimate reservoir inflows during this low flow period. Data was not available for April thru June, although May and June were reported to be dry with low inflows to the reservoirs. The estimated inflows from the July and August data were also used for May and June. The rest of the year was estimated by assuming that inflows by month would be half of what they would be in an average year. The USDA regression equations were used to estimate average monthly inflows to the reservoirs. This estimate of the critical sequence of low flows for existing reservoirs needs to be improved during the feasibility phase of the project. An attempt should be made to simulate reservoir inflows based on the long-term precipitation data available for Wrangell.

Figure 7 illustrates the difference between projected demand in 2026 and the rough estimate of a critical sequence of low flows. The analysis shows a supply deficit of approximately 100 million gallons. Storage in the existing reservoirs is about 66 million gallons. The community would like a minimum 30-day reserve supply of water for emergencies. This would amount to approximately 40 million gallons of water. The remaining 26 million gallons in storage would offset part of the estimated deficit. In order to meet the projected increases in demand, 74 million gallons or 221 acre-feet of storage would need to be added to the existing reservoir impoundment.

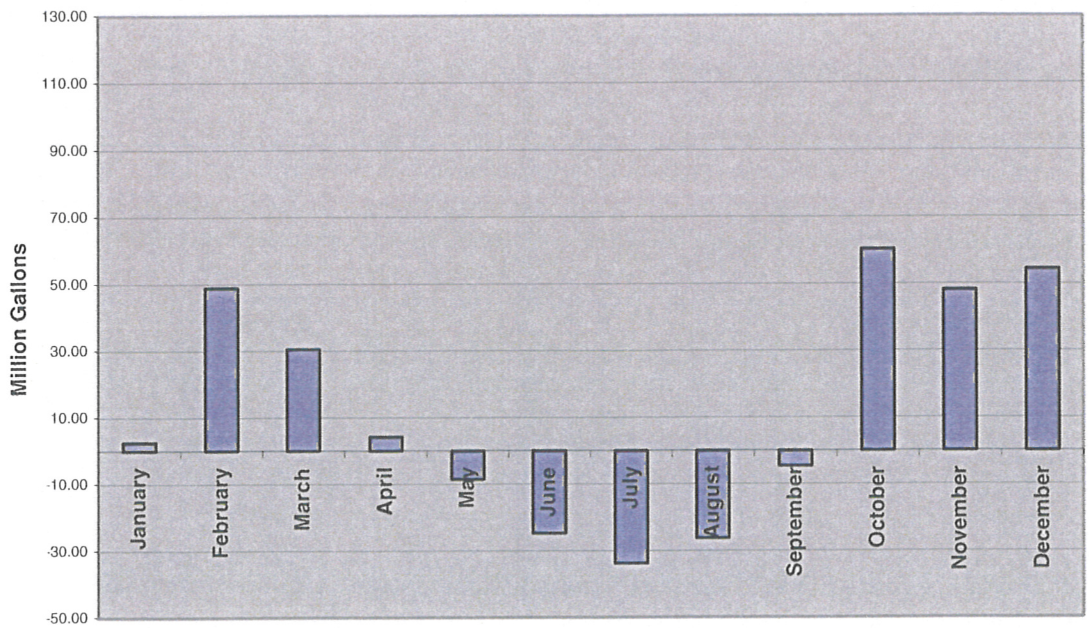

Figure 7 – Difference between low flow supply and predicted demand, year 2026

There is a flume that transfers water from a small drainage basin adjacent to the existing water supply catchments. The flume is in disrepair. Repair of this flume would add an unknown amount of water to the system. However it was originally constructed as part of the water supply system and one would assume that it diverted a relatively significant amount of water to the reservoirs. This would be another inexpensive way to augment the existing water supply and may provide some needed water during another low flow period such as the city experienced in 2004.

Section 3 – Structural and Seismic Conditions

3.1 Historical Background

The two dams, designated Upper (figure 8) and Lower (figure 9), were constructed to provide a year-round source of potable water for residents of the City of Wrangell. The original timber crib structures were constructed circa 1900 for the Lower Dam and 1935 for the Upper Dam. According to records and previous reports, the upper log crib structure leaked badly after construction and did not retain water until its modification around 1958. Since initial construction, both dams have been modified with new designs and raised by covering or partially covering the original log structures with earthfill. Minimal records documenting these changes are available in the form of 1965 to 1967 design sheets and "as built" drawings, which generally indicate what was to be done or what was supposedly done. Discrepancies between the design and as-built sheets and as-built data have been an issue in previous studies. These issues and discrepancies still exist.

The original crib dams were constructed by a private company. The U.S. Forest Service obtained the land where the dams are located around 1940, and maintained them under their inventory until ownership was transferred to the City of Wrangell in the late 1990's. There are drawings indicating that the dams have been raised at least twice, in the 1940's and, again, in the 1960's.

Figure 8. Wrangell Upper Dam

Figure 9. Wrangell Lower Dam

3.2 Site Description

The Wrangell Upper and Lower Dam System consists of two earthfill dams and reservoirs that provide the main water supply to the City of Wrangell, Alaska. The two dams are located on Wrangell Island near the City of Wrangell, and are situated on a single drainage way southeast of the city. The dams and reservoirs are both on Mill Creek. They are about 1500 feet apart, and are situated in a narrow drainage-way between ½ and 1 mile southeast of Wrangell. The dams are owned by the City of Wrangell, and impound approximately 122 and 67 acre feet of water, respectively. The two dams are earthen structures approximately 28 feet high and 310 to 320 feet long. The elevation difference between the dams is 64 feet.

3.3 Hazard Classification

At present, the Dam Safety and Construction Unit (Dam Safety) of the Alaska Department of Natural Resources has assigned both the Upper and Lower Dams a Class I (high) hazard potential classification. The periodic dam safety report, prepared by Shannon & Wilson Engineers and dated June 2004, concluded that both the Upper and Lower Dams should have a hazard rating of Class II. Dam Safety has indicated that a more detailed study will need to be performed in order to justify the lower classification. A Dam Break Analysis would need to be performed to determine the potential for loss of life during a dam break. If there is no potential for loss of life and no loss of critical downstream features the dams may be able to be classified at Class II.

The hazard classification would not negate the requirements for the city to repair the waterlines, outlets, and upper spillway, or upgrade the dams for seismic safety. A lower hazard classification does allow the engineer to use a less stringent form of analysis and provides for less frequent and arduous inspections of the dams.

3.4 Related Reports and Studies

Most available information regarding the dams has been generated from the 1960's drawings and information compiled during an investigation performed by Shannon and Wilson, Inc. (Shannon and Wilson), in 1985. Much of this work relied heavily on the assumption that the limited "as-built" information was correct, and adequately depicted actual conditions within the dam.

In May 1992, the dams were inspected by the U.S. Forest Service as part of their annual inspection program. During this and subsequent inspections, water seepage was observed coming from several feet above the toe of the Upper Dam, triggering concerns about piping and reduced overall dam stability. Shannon and Wilson was requested to perform a safety inspection of the dam in September 1992.

Shannon and Wilson conducted a study of the Upper Dam's toe area with test pits, toe clearing, and installation of weirs in an effort to address stability and toe seepage concerns. These investigations revealed soft or loose foundation sediments in the toe area of the Upper Dam to depths greater than 8 feet. The conclusion was that additional studies were needed.

In May 1993, Shannon and Wilson completed a stability study of the Upper and Lower Wrangell Dams. The study included nine modified Standard Penetration Test (SPT) borings and five probes at the two sites. Laboratory tests included moisture contents, grain size analysis, and R-tests on recompacted disturbed samples, as they were unable to obtain satisfactory undisturbed samples. The SPTs were performed using the standard 140-pound hammer, but the sampler size was 2.5 inches rather than the standard 2-inch sampler.

In June 2004, Shannon and Wilson presented the results of the periodic safety inspection conducted for the Upper and Lower Wrangell Dams on April 15, 2003. The report reiterated the findings of the 1993 report. The dams are marginally stable under static and steady seepage conditions, but are not stable under seismic conditions. There were discussions of a rock buttress having been constructed at the toe of the Upper Dam, but there are no construction records of this buttress. Subsequent surveys indicate that the dam profile has not changed since 1993. Seepage monitoring weirs were placed at the toe of each of the dams at some point, but have since been removed.

In May 2006, the Corps presented the results of the *Upper and Lower Wrangell Dams Seismic Study*. The study included field explorations and laboratory testing of existing conditions at both dams. As part of the seismic study, the expected ground motions for the site were evaluated. The study concluded that, using a direct seismic source, the estimated ground motions for the Maximum Credible Earthquake (MCE) are 0.23g.

The MCE was used to evaluate liquefaction at both damsites. Results of the study indicate that both the Upper and Lower Dams are susceptible to liquefaction, and may be unstable during this seismic event. The study concluded that the City of Wrangell should proceed with an investigation into water supply alternatives to include remediation of the dams, construction of a new structure, and alternative water supplies.

3.5 Dam Safety

3.5.1 Flood/Dam Safety

Approximately 14 mobile homes (figure 10), 1 stick-built home, and the city sewage treatment plant (figure 11) are vulnerable to damages from a collapse of the city dams.

Because of the close proximity of residences to the dams, and the lack of a warning system of any kind, the possibility exists that a loss of life could result from a dam failure.

3.5.2 Persons at Risk

The United States Census of Population reported an average of 2.52 persons per household at Wrangell, Alaska, in 2000. As stated in the previous paragraphs, 15 residential structures are in the likely dam failure floodplain below the city's two water supply dams. Assuming the average number of persons per household accurately reflects the actual population of these 15 structures, the Persons at Risk (PAR) in the city is 38 for an evening or nighttime event when everyone is at home. A daytime event would have a reduced PAR due to many adults being at their place of employment, assumed to be outside of the

Figure 10 - View looking up at area vulnerable to inundation

Figure 11 - City of Wrangell sewage treatment plant

floodplain, and school-age children likely away from home for 6 to 8 hours on school days. Since this is a reconnaissance-level analysis, the worst case scenario is assumed. Accordingly, the full PAR is used in estimating loss of life (LOL).

3.5.3 Warning Time

"Warning time is measured as the difference in time from when a public warning is disseminated, about a potential dam failure until the flood wave reaches each PAR" (Corps, 1986). This is refined as being the time until a life-threatening flood wave reaches the PAR. Notifying residents of the impending damage and urgency of evacuation constitutes the dissemination of the public warning.
No emergency evacuation plan or apparatus exists for notifying residents of an impending failure to one or either of Wrangell's water supply dams. If such a condition was determined to exist, it would be relatively easy to notify threatened parties because of the small number of floodplain residences involved. However, no system is in place to determine an imminent failure. In any case, because of the potential failure type, such a determination might not be easily discerned. Under the worst case scenario, a spontaneous dam failure, no warning time exists. Although non-observed failures are unusual, a failure condition occurring in late evening or early morning hours could be equally as dangerous as a spontaneous dam failure. For purposes of this study, it is assumed that warning time would be 15 minutes or less.

3.5.4 Loss of Life

Life-threatening flows are frequently described as being based on the "rule of nine." In other words, a life-threatening situation is present if the products of flood depth and water velocity, in feet per second, are 9 or greater. While the estimation of flood stages and velocities is beyond the level of detail of a reconnaissance-level investigation, it is believed that PAR in Wrangell would be subjected to life-threatening conditions because of the almost certain rapid release of water during a dam failure condition and the gradient of the floodplain. The LOL is estimated based on a warning time of less than 15 minutes, no emergency management system or plan, a narrow valley of less than 1 mile, and fatality rates developed by the U.S. Bureau of Reclamation. This fatality rate was developed by Wayne Graham for the U.S. Bureau of Reclamation for conditions such as these is 0.75 (U.S. Bureau of Reclamation, 1986). With minor modifications to consider the width of the floodplain, this document is used by the Corps to assess dam safety risk. It is deemed suitable for use in this level of analysis. The LOL for conditions discussed earlier in this document, the LOL for the above-described conditions is estimated to be 28.

Section 4 – Environmental Considerations

4.1 General

The community of Wrangell lies within the mountainous region of the Coastal Range of Southeast Alaska. Large glaciers advanced from the high, mountainous terrain of the adjacent mainland over the Wrangell area during the Pleistocene Era. These glaciers attained altitudes between 4,000 and 5,000 feet, and engulfed the highest peaks of Wrangell Island. Zimovia Strait, which borders Wrangell, is part of the glacially-scoured fjord system that characterizes southeastern Alaska. The waterway has fairly smooth floors, with water depths of 300 to 500 feet. Bedrock consists primarily of metamorphic rock intruded by igneous rocks. The bedrock, except in the valley floors, is seldom more than a few feet below the ground surface; and is often exposed. The terrain is vegetated by the coastal Western hemlock-Sitka spruce forest community interspersed with occasional wetland or muskeg areas. Other tree species include mountain hemlock, Alaska and red cedar, lodge pole and shore pine, black cottonwood, paper birch, and quaking aspen. The forest understory includes a variety of shrubs, including devils club, huckleberry, blueberry, salmonberry, and alder species. Herbs and mosses include club moss, yellow skunk cabbage, sedges, ferns, and liverworts. Muskeg areas are composed of organic soils, and are dominated by sphagnum mosses and sedges interspersed with low shrubs, forbs, and scattered trees. The alpine tundra community lies above the coastal forest, and is composed of low, mat-forming vegetation adapted to snow pack and wind abrasion. Typical plants include crowberry, blueberry, arctic willow, and various herbs and mosses.

4.2 Natural Resources

Wildlife in the Wrangell area is representative of most of southeast Alaska. Terrestrial species of the forest and muskeg include Sitka black-tailed deer; moose; mountain goat; black bear; brown bear; wolf; two species each of squirrel, vole, and shrew; little brown bat; porcupine; pine marten; ermine; wolverine; and lynx. Major terrestrial birds include bald eagle, blue grouse, great horned owl, common raven, woodpeckers, Steller's jays, and various passerine species. Waterfowl use the Stikine estuary extensively, as well as smaller muskeg wetland areas. The muskeg is a break in the forest that provides an important and varied edge habitat for birds and mammals. Mammals that occupy the alpine tundra include the hoary marmot, lemmings, voles, ermine, black-tailed deer, and black bear. Common birds include willow ptarmigan, gray-crowned rosy finch, golden-crowned sparrow, and marsh hawk.

Fish occurring in the coastal marine waters include five species of Pacific salmon (primarily pink and chum), several flounder species, Pacific cod, sculpin, rockfish, Pacific herring, walleye pollock, and sable fish. Species of shellfish include Dungeness, Tanner, and King crab.

The Wrangell water supply reservoirs are in forested terrain on a steep slope above the city. The terrain between the Upper and Lower Dams has areas of muskeg and second growth trees. The existing water supply system in Wrangell was created by fluming the upper drainages to fill the two reservoirs. The Mill Creek drainage reportedly had a resident cutthroat trout population that has been altered by the dams. The creek below the Lower Dam reportedly has occasional salmon usage, though this is not extensive. A biologist with the Department of Natural Resources Habitat and Permitting Office conducted some preliminary fish sampling, but did not trap any fish at the upper creek outlet. Further sampling at the lower creek reaches would need to be done during the feasibility study.

4.3 Woronkofski Island

Woronkofski Island is an uninhabited island in Tongass National Forest, and lies about 4 miles from Wrangell. Sunrise Lake, located on Woronkofski Island, has been studied as a site for proposed hydroelectric power development and water supply for the city of Wrangell (R.W. Beck, 1998). The Lake Tyee Hydroelectric Project transmission line runs from Wrangell Island under Zimovia Strait, and crosses the northern portion of Woronkofski Island to reenter the water in Stikine Strait, near Wedge Point and the outlet stream from Sunrise Lake.

Sunrise Lake (elevation 1,979 feet) is a natural lake of about 50 surface acres, with a maximum depth of about 100 feet. The lake has a watershed of about 1.17 square miles that includes two smaller lakes—Grouse Lake and Deer Lake. Sunrise Lake is drained by Sunrise Creek, which flows for a distance of about 1.7 miles to Stikine Strait. The stream flows through a shallow bedrock canyon with low falls, beaver ponds, and rapids. A 25-foot waterfall about ¼ mile above tidewater prevents all further upstream movement of fish. Conditions are unsuitable for spawning through this lower reach and the inter-tidal zone, as the entire reach is one long rapid. A major tributary enters Sunrise Creek on the left bank about 100 yards downstream from the waterfall. The only fish species present in the Sunrise Lake system is cutthroat trout, although other drainages exist on the island that may have resident and anadromous fish.

Woronkofski Island is within an area identified in the 1997 Tongass Land and Resource Management Plan as having a Land Use Designation as a Scenic View Shed. Direction for management of this area is to provide a sustained yield of timber and a mix of resource activities, while minimizing the visibility of developments to maintain Visual Quality Objectives. There are also designated roadless areas located on the island.

Woronkofski Island is an important subsistence deer hunting area for Wrangell residents. Deer habitat has suffered in recent years as a result of logging activities. The sandy beach north of the Tyee Lake transmission line cable crossing is popular with Wrangell residents. The beach provides habitat for a variety of shellfish, including cockles.

4.4 Threatened and Endangered Species and Species of Special Concern

The bald eagle is a protected species under both the Eagle Protection Act and the Migratory Bird Act. Eagle nests were noted along the shoreline in the area of the Sunrise Creek estuary, but no nests have been noted in the area of the Wrangell city reservoirs. Several species of whales, including humpback, blue, Sei, fin, northern right, and sperm, may occur in area marine waters. Other listed species are the Steller sea lion, and the Snake River sockeye and Chinook salmon populations. The closest Steller sea lion haul out is on the northwest shore of Etolin Island, more than 10 miles from the project sites.

4.5 Cultural Resources

The original Lower Dam was built of log cribs in 1900. The Upper Dam was also built in 1935, also from log cribs. The upper dam leaked, and was never filled until both dams were modified by covering the cribs with earthfill. Both dams have been raised at least twice. Since both dams are more than 70 years old, they have potential for eligibility on the National Register of Historic Places. No other Alaska Heritage Resource Inventory sites are known in the area, but further evaluations are needed to determine the crib dam's eligibility. Criteria for eligibility include structural integrity and importance and association with important events and people.

No cultural resources surveys have been conducted on Woronkofski Island, but there is a report of a grave site on East Point, 2 miles from the project area. Early gold mine claims were filed near Elephants Nose, a rocky feature on the north end of the island. A more complete survey and evaluation would be required.

Section 5 – Plan Formulation

5.1 Measures and Alternatives Considered

The initial process in the formulation of alternatives included development of an extensive list of measures to meet the water demands. The measures included considerations for dam removal, new dams, saltwater desalination, wells, dredging reservoirs, Sunrise Lake, and metering/conservation methods, as well as repair/replacement of leaking lines throughout the city. These options, along with the "no action" alternative were then evaluated, combined, and consolidated into the alternatives being considered in this report.

Reservoir dredging was initially considered, but was eliminated as an alternative due to sediment issues that would require disposal sites for the decaying tree stumps and fine sediments. The disposal action would have adverse impacts if a new disposal site was required for development. Additionally, test pits in the Upper Reservoir indicate rock is only 3 to 5 feet below the surface. This does not provide the volume of water needed for the system. An environmental and water treatment concern in regards to iron floc that precipitates from disturbing the soils at these depths was also part of the decision.

Metering and conservation methods, along with repair and replacement of the city's leaking lines, would not provide sufficient water supply to meet the future needs of Wrangell. Further detailed consideration should be undertaken to determine the feasibility of these measures. Therefore, this was not considered a viable alternative at this time.

Saltwater desalination can not be pursued further without more detailed technical analysis. However, high electricity needs and requirements for thermal energy for feedwater appear to make this measure unfeasible when considering the climate and location of Wrangell Island. The cost of desalination is generally higher than the cost for other water supply alternatives, according to the California Coastal Commission on Saltwater Desalination.

5.1.1 No Action

This option would result in a loss of water supply for the City of Wrangell. Both dams that hold the city's water supply are in need of repair. At present, the city has a conditional use permit granted by the Alaska State Dam Safety Office to operate the dams under current reservoir heights, with the condition that the city actively pursue funding and engineering plans to repair the structures.

5.1.2 Repair and/or Raise Dams

This alternative would repair or modify both the Upper and Lower Dams to meet current state dam safety guidelines. This could include raising the heights of the dams for additional storage capacity. The upstream flume noted in Section 2 would be repaired during this option to provide the maximum amount of capacity for the system.

5.1.3 Construct New Dam

This alternative would involve the construction of a new dam downstream of the existing Upper Dam, removal of the existing Upper Dam, and the clearing and grubbing of organic material from the existing reservoirs. The new dam would be sized to contain the amount of water required to meet the future needs of the community. This alternative would include demolition of portions of the Upper Dam; repair of the Lower Dam and the upstream flume noted in Section 2 would be repaired during this option to provide the maximum amount of capacity for the system.

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5.1.4 Water Wells

This alternative would involve drilling deep wells around the community to provide water. The dams would also be removed or modified to protect the public from a dam failure during a storm or other natural event.

5.1.5 Sunrise Lake Supply Line

This alternative would be to construct an underwater supply line from Sunrise Lake on nearby Woronkofski Island. This would also involve either removing the dams or modifying them to protect the public from a dam failure during a storm or other natural event. In 1998, the engineering firm of R.W.Beck proposed development of nearby Sunrise Lake as a water supply and hydroelectric project. Sunrise Lake is located on Woronkofski Island, about 6 miles southwest of the City of Wrangell. The study determined that Sunrise Lake could supply 3 million gallons of water per day to the treatment plant, which would be more then adequate to meet future water supply demand.

5.2 Plan Selection Criteria

Each alternative was evaluated based on engineering, environmental, economic, and social categories; and then analyzed relative to the other alternatives. The following paragraphs describe the criteria determined necessary for each category.

5.2.1 Engineering Criteria (Physical Characteristics)

The alternatives considered should be adequately designed to provide long-term water supply for the community, be maintainable/operable by the City of Wrangell, and be adequately designed so as not to create a hazard to infrastructure or people downstream from the project.

5.2.2 Environmental Criteria

Environmental considerations include minimizing disruption of the area's natural resources, and using measures to protect or enhance existing environmental values. During the feasibility phase, an evaluation of feasible alternatives under the National Environmental Policy Act would be conducted with full coordination with State and Federal agencies and the public.

5.2.3 Economic Criteria

All alternatives were evaluated to determine if they meet both supply and safety requirements and allow for growth and future development. The alternatives need to provide for water volume, both flow and total storage, and water quality requirements. Alternatives were analyzed using existing data, and were then compared to each other to rate their relative effectiveness and benefits.

5.2.4 Social Criteria

Adequate water supply is critical to the community of Wrangell. Adequate supply needs to meet volume requirements, quality requirements, and emergency needs; and it must also provide for future conditions. Water is critical to Wrangell for not only residential consumption needs, but also for tourism and industrial usage. With the decline of the timber industry, the community relies on tourism and the fishing industry. Both are dependant on an adequate water supply, and provide the majority of employment that supports the social structure in and around Wrangell. The alternatives need to provide water for all users, while balancing social and economic cost and benefits.

Section 6 – Comparison of Alternatives

6.1 Physical Comparison of Alternatives (Engineering Criteria)

6.1.1 No Action

This alternative would not change any of the physical characteristics of the dams. The dams would still have safety and operational needs required to be addressed by the State of Alaska.

6.1.2 Repair and/or Raise Dams

This alternative would involve designing seismic repair and addressing other needs to upgrade the dams to meet State of Alaska Dam Safety Requirement, as well as constructing a new water supply line from the Upper Dam to the water treatment plant.

- Upper Dam Repair (figure 12)
    - Excavate liquefiable material from the downstream portion of dam embankment.
    - Repair existing damaged water supply and emergency drawdown lines.
    - Construct inlet structure with gates and operators along the upstream side of the dam.
    - Re-align spillway away from toe of the dam.
    - Replace downstream material with engineered fill, and construct berm at downstream toe to provide additional stability for a seismic event.
    - Construct water supply line to the water treatment plant
    - While reservoir is empty, remove existing tree stumps from reservoir.
    - Repair upstream flume noted in Section 2. Provide new 36" CMP half pipe for approximately 200 feet of flume.
    - Estimated cost—$6.5 million.

- Lower Dam Repair (figure 13)
    - Excavate liquefiable material from downstream portion of dam embankment.
    - Remove decaying original crib dam structure.
    - Repair existing water supply and emergency drawdown lines.
    - Construct new outlet gates and operator on the upstream side of the dam.

- Replace downstream material with engineered fill, and construct berm at downstream toe to provide additional stability for a seismic event.
- While reservoir is empty, remove existing tree stumps from reservoir.
- Estimated cost—$1.2 million.

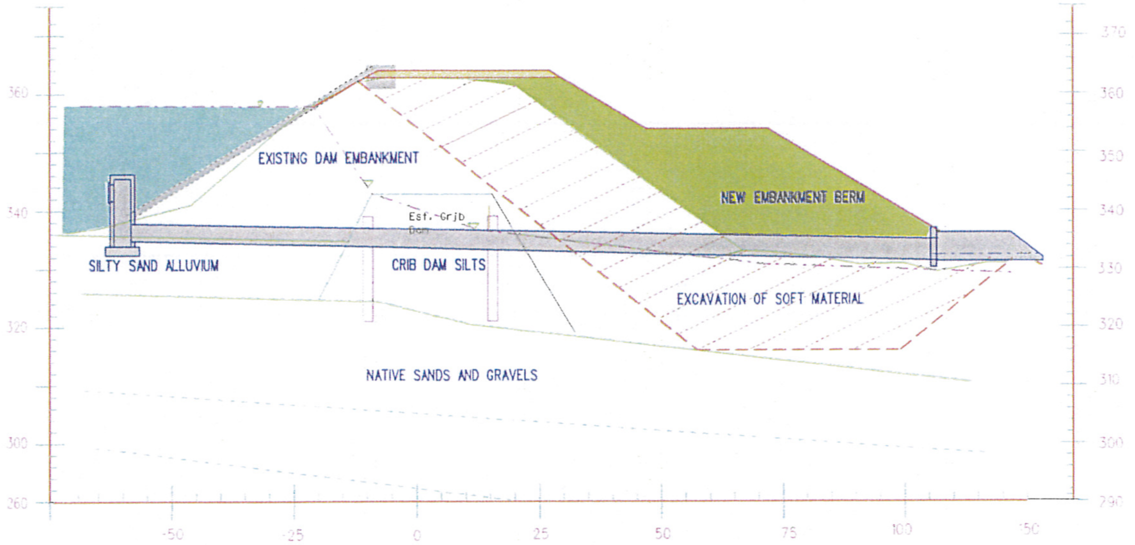

Figure 12 – Seismic Rehab for Upper Dam

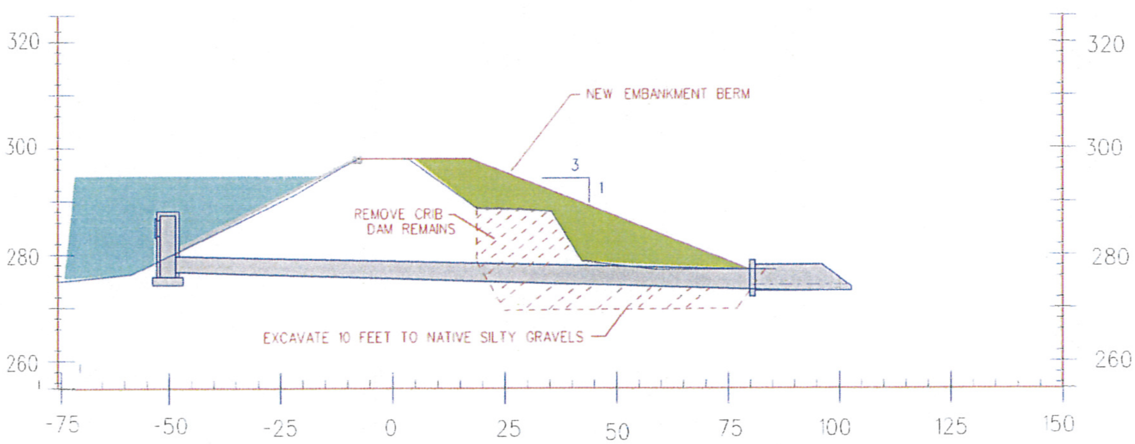

Figure 13 – Seismic Rehab for Lower Dam

The repairs would address stability and operational issues facing the dams but do not address the need for additional water supply or water quality. The Lower Dam is located near the end of the valley. Raising the dam is not feasible because of the way the valley flattens out in that area. The Upper Dam, however, could be raised. A preliminary look at the site indicates that the Upper Dam would need to be raised to Elevation 395 in order to provide the additional

115 million gallons of storage. This would involve totally removing the Upper Dam to provide an adequate foundation for the new 65-foot-tall dam. The cost of building a new Upper Dam was not investigated, but it is assumed to be very close to the costs for building the new 65-foot-tall dam addressed later in this section.

6.1.3 Construct New Dam

This alternative would be to construct a new dam upstream of the existing Lower Dam. The new dam would be high enough to inundate the Upper Dam, so there would be no need for repairs.

The new earthen dam would be approximately 65 feet tall. It would be placed approximately 200 feet upstream of the Lower Dam reservoir. This dam would have a concrete spillway on the right abutment, with vehicle access over the spillway. The proposed dam is shown in figure 14.

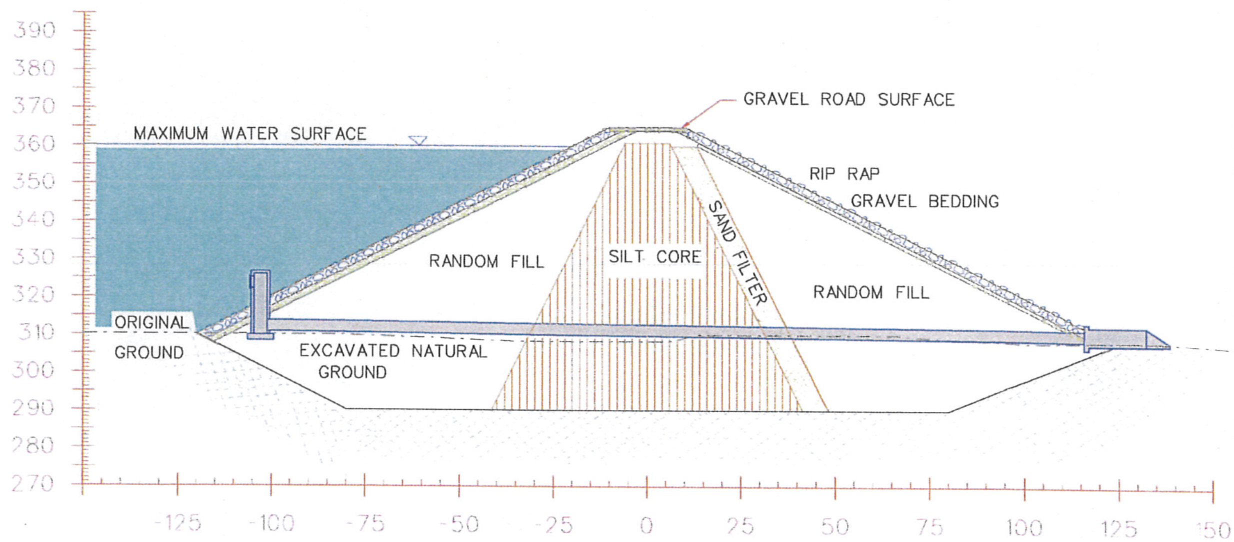

Figure 14 – Proposed New Dam

The construction of a new dam would be accomplished in phases. The first phase would be to establish the water line to the Upper Dam and construct approximately 500 feet of access road above the new pool elevation to maintain access around the reservoir. The upper reservoir would be used to supply water to Wrangell during construction of the new dam. The lower reservoir would be drained to support excavation for the new dam. The reservoir area would be cleared of timber, and select soils from the reservoir would be used to construct the silt core. The random fill material would be obtained from both the rehabilitation of the Lower Dam and from the reservoir area. The Lower Dam would need to be repaired, as discussed in the Repair and/or Raise Dams alternative. The lower reservoir would be filled and the new dam reservoir partially filled to provide water supply to the city. At this time, the Upper Dam would be removed to Elevation 340 or the top of the old crib dam. The material from the Upper Dam would be used to support the access road around the reservoir. The upstream flume noted in Section 2 would be repaired by providing new 36" CMP half pipe for approximately 200 feet of flume. Once the Upper Dam is removed, the entire new dam reservoir would be allowed to fill, thereby covering the removed Upper Dam. An aerial image of this area is presented in figure 15. The estimated cost for construction of this new dam is $36.3 million.

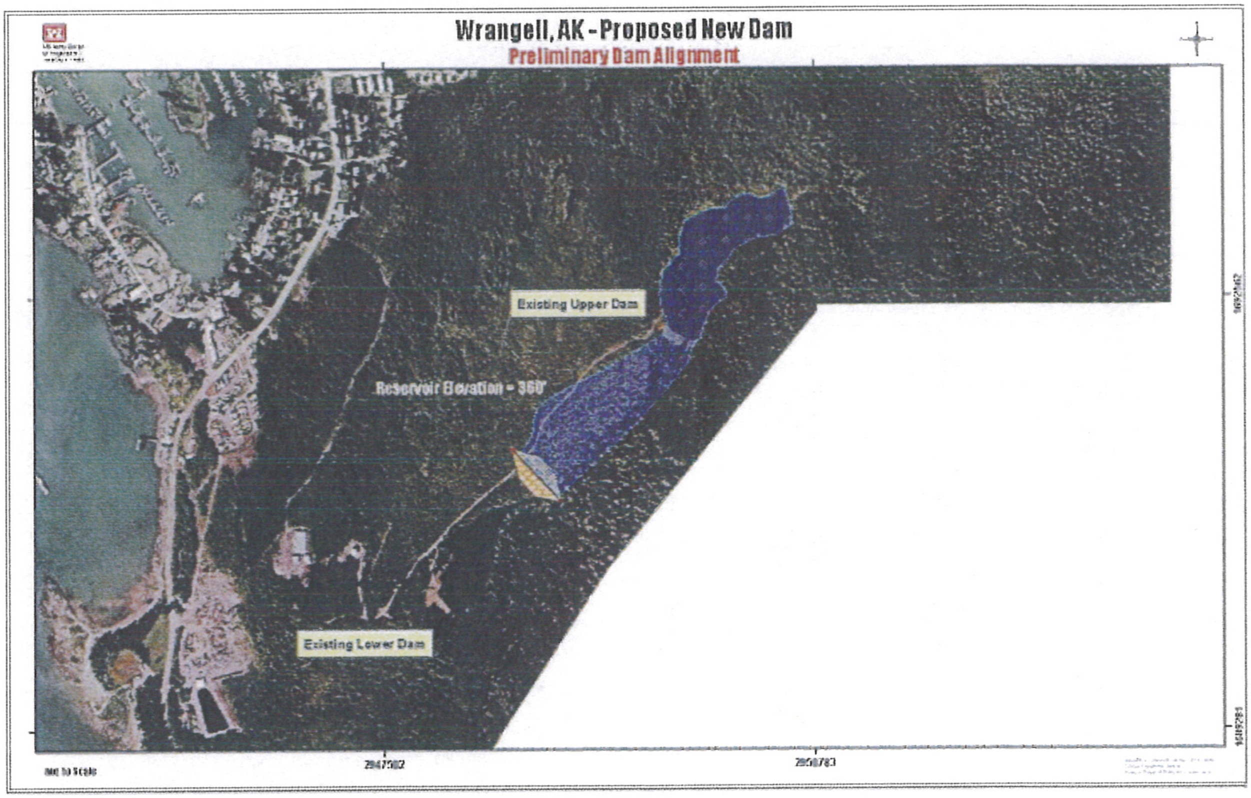

Figure 15. Aerial image of the proposed area for the new dam

6.1.4 Water Wells

Water wells could be used to increase the water supply if there are good sources of underground water to tap. Most of southeast Alaska is mountainous, and has bedrock at very shallow depths. This is usually not conducive to high capacity wells. A brief look at water supply systems in other southeastern Alaska communities illustrated that the vast majority of them use surface water sources for drinking water. Many residences located outside a community service area use individual wells as their water supply. There are several domestic water wells in the Wrangell area. The water quality from these wells is reported to be good. A review of several well logs from the Wrangell area indicates that yield can vary greatly over short distances, as well as with the type of material encountered. Wells that were drilled in shale or clay had relatively low yields of 0.3 to 1.0 gallons per minute. These wells were drilled to depths of 200 to 275 feet. One well drilled to 275 feet in clay yielded no water. Wells that were drilled to 200 to 300 feet and hit slate produced 1.0 to 3 gallons per minute. The most productive wells hit fractured rock or rock with quartz veins at depths from 65 to 200 feet. These wells yielded from 4.5 to 15 gallons per minute. There is an abandoned 6-inch well drilled to 500 feet near the boat harbor that produces about 9,000 gallons a day with good water quality. It is possible that this well would produce many times the amount of water that now flows under its own head, but should be pump tested to determine its yield. If it could produce 5 to 10 times the amount of water that it currently yields, it would be able to supply 1.5 to 3 million gallons a month when pumped. This amount of water would be a major help in meeting demand during a dry period such as that experienced in 2004. Four to five new wells with similar capacity would be needed to meet future demand. Given the hit or miss nature of developing a high-capacity well in Wrangell, this option would need to be explored in more detail before being pursued to meet future demand.

6.1.5 Sunrise Lake Supply Line

This alternative involves the construction of an underwater supply line from Sunrise Lake to supply the city's water (figure 16).

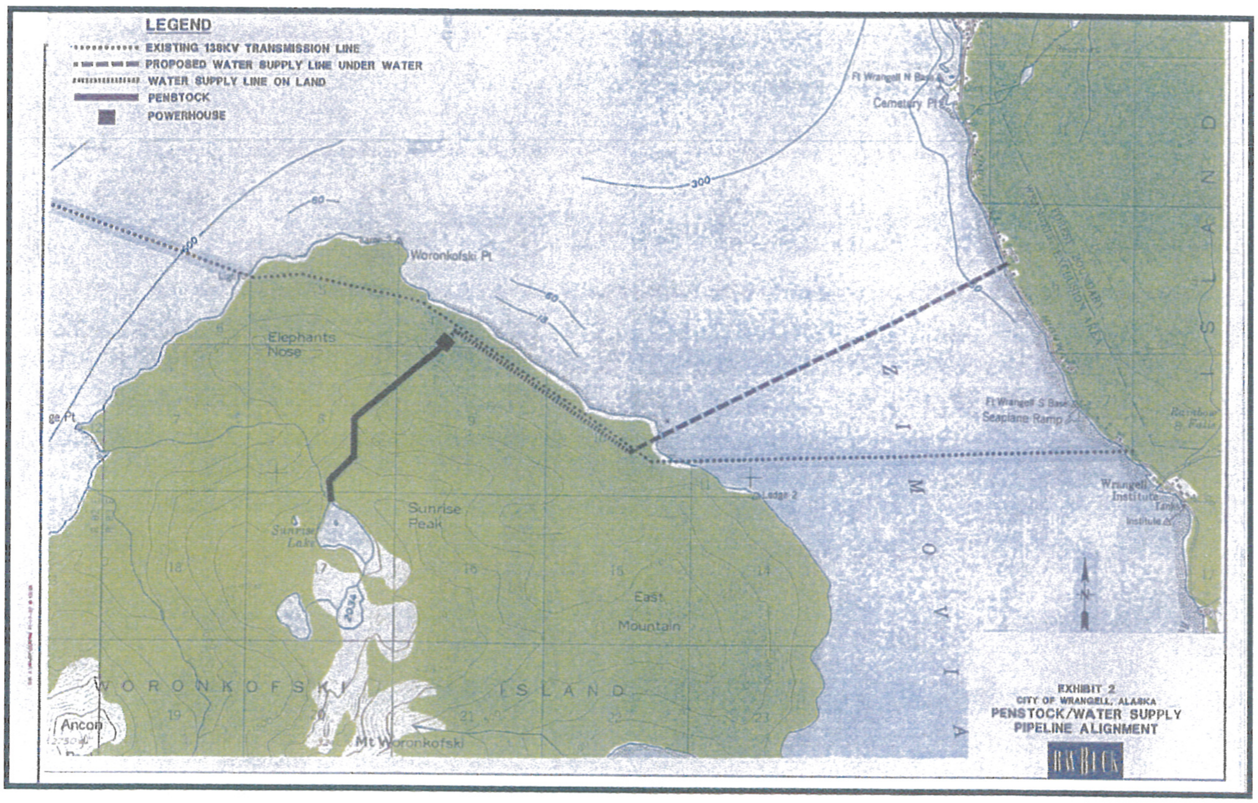

Figure 16 – Proposed Underwater Supply Line

In 1998, the engineering firm, R.W.Beck, proposed to develop Sunrise Lake, a nearby source, as a water supply and hydroelectric project. Sunrise Lake is located on Woronkofski Island, which is about 6 miles southwest of the City of Wrangell. The study determined that Sunrise Lake could supply 3 million gallons of water per day to the treatment plant. This would be adequate for the city's future Water needs.

This alternative would involve constructing a submerged intake in Sunrise Lake and a 10-foot-high dam at the outlet. Approximately 8,000 linear feet of pipe would carry the water from the lake to the shoreline. The water would then be piped along the bottom of the channel in a 16" high-density polyethylene (HDPE) pipe approximately 19,000 feet long. A pump station would be constructed to convey the water to the existing water treatment plant. This alternative also includes the addition of turbines and a generator for power supply. Figure 16 shows water supply pipeline alignment.

The scope and cost for this alternative was prepared in 1998. This current study did not investigate the 1998 study any further, but did escalate the costs for inflation. The estimated cost to complete an underwater supply line from Sunrise Lake based solely on RW Beck's 1998 estimate is $21.8 million. This estimate does not include the additional costs for upgrading the water treatment system, subsurface investigations, or real estate costs. The two existing dams would need to be decommissioned at an estimated cost of $2.0M for both dams. It is estimated that the combination of these additional costs would exceed $20M and the total costs for the Sunrise Lake alternative is $41.8M.

6.2 Environmental Evaluation of Alternatives

6.2.1 No Action

The social affects of no action would be significant. The instability of the dams is a safety concern to people and structures below the dams. The lack of a sufficient and reliable water supply has negative affects to social well being and to future growth within the community.

6.2.2 Repair and/or Raise Dams

The impoundment area would affect mature trees to the water surface area. Additional fill for the dams would cover wetlands and completely cover the old log cribs. A fill borrow source would need to be identified and developed. If the borrow source found is a new site, there could be adverse impacts to the environment.

6.2.3 Construct New Dam

Construction of a new larger dam in the area of the existing dams would require a large amount of tree clearing and the dredging of sediments and soils. Wildlife habitats would be destroyed in the immediate areas. Disposal sites for the grubbed vegetation and soils would be required. Trees could be logged and used beneficially. Suitable soils could be used in the new earthen dam. The creek would be inundated by the reservoir between the Upper and Lower Dams. Fish habitat, although minimal, would be lost in this area. The social affects would be beneficial because of the increased water supply, but the water impoundment also poses a risk for people and structures below the dam. However, the instability of the current dams also poses a risk.

6.2.4 Water Wells

Public wells for water supply, depending on where they are located, would not be expected to have significantly adverse ground disturbing affects. It is unknown what the affects would be to the aquifer.

6.2.5 Sunrise Lake Supply Line

The construction of a water pipeline from Sunrise Lake has the potential to impact more pristine habitats on the island, along the seabed corridor to Wrangell, and in Wrangell because of new infrastructure needs. The corridor could parallel the alignment of the Tyee Lake Transmission line to lessen effects on Woronkofski Island. Developing a hydroelectric facility would have environmental consequences, but could also provide social and economic benefits. Impacts from construction of the dam, penstock transmission line, port facility and access road from the beach to the powerhouse, water supply pipeline (including a marine pipeline), water transmission mains in Wrangell, booster pump facility, and additional storage tanks would add up to significant impacts to the environment. Impacts would be primarily on alpine and forest habitats, creek beds, intertidal zones, subtidal sea bed, and wetlands. Water storage would still need to be addressed, as would the instability of the current dams.

A potential benefit of this alternative is that Sunrise Lake water appears to be of better quality than the current supply, and, therefore may not need the same level of treatment.

Sunrise Lake is within a roadless area designation managed by the United States Forest Service (USFS). The City of Wrangell was permitted to install and monitor stream gauges for investigation of a hydroelectric and drinking water project using Sunrise Lake as the water source. The city holds a preliminary permit from the Federal Energy Regulatory Council (FERC) for the potential hydroelectric project, and an initial scoping document has been issued. Data collection continues, but plans for development are on hold according to the USFS. Special use authorization with an environmental assessment would be needed in order to proceed with this alternative on USFS lands.

6.3 Economic Evaluation of Alternatives

6.3.1 Introduction

The economic evaluation completed in the economic appendix did not attempt to assess the National Economic Development (NED) or Regional Economic Development (RED) impacts of a water supply project in Wrangell. Further analysis during a feasibility-level study would be needed to accurately measure these benefits. This evaluation was to determine only the need for additional water supply and, using existing data, demonstrate that positive economic effects are a likely outcome from such a project.

6.3.2 Existing Conditions

Water demand in Wrangell averages about 700,000 gallons per day, with peak demands of slightly over one (1) million gallons per day (MGD) in the summer months and minimum demands of about one-half MGD in the fall and spring months. Based on the 1998 population of about 2,400 people, the average water use was calculated to be approximately 290 gallons per person per day. The 1995 Water System Assessment projected demand through the year 2020 using an annual growth of 1 percent based on these projections. The peak day demand in 2020 will be 1.3 MGD (R.W. Beck, 1998).

As of 2005, the population of Wrangell is estimated to be 1,974 (Alaska Department of Community and Economic Development, 2005), but peak daily demand has already reached projected demand for 2020. Since population has declined recently, the likely source of increased demand is the growing cannery industry.

During the summer of 2004, insufficient water supply because of a low precipitation levels for that year resulted in the curtailment of water supply for cruise ships docking at Wrangell. As the reservoirs were drawn down, water quality from the reservoir also deteriorated.

6.3.3 Without-Project Conditions

This option would result in a loss of water supply for the City of Wrangell. Both of the dams that hold the city's water supply are in need of repair. At present, the city has a conditional use permit granted by the Alaska State Dam Safety Office to operate the dams under current reservoir heights under the condition that the city actively pursue funding and engineering plans to repair the structures. If this repair is not completed, eventually the dam reservoir heights will be regulated and the city will lose its water supply.

6.3.4 With-Project Conditions

With project conditions would supply the City of Wrangell with an adequate volume and quality of water to meet current and future needs. Annual employment and payroll for 2005 was $33 million. With the decline of the timber industry, fishing and tourism are the main drivers of their economy. Both rely on an adequate supply of water. Other projects completed or proposed have been estimated to bring in an additional $5 million in additional benefits to the City of Wrangell and they also rely on a stable source of water.

With a water supply project it could be expected that fishing industry will continue to grow, with possible expansion into cold storage and additional canneries. As expanded port facilities are completed, more fishing boats will rely on the canneries in Wrangell. The additional boats and canneries will drive demand for construction, operation, and repair of the boats and facilities. This expansion, along with the possible expansion of retirement centers, could drive up demand for other goods and services in Wrangell.

6.3.5 The NED and RED Benefits

Benefits attributable to fishing, canneries, and supporting industry would likely be NED benefits since they are a result of increasing the output of goods and services that did not exist prior to the project. There may be some transfer from other port towns, but much of the benefit is a result of increased resource production (fish).

Benefits attributable to tourism are likely RED in nature because they are likely the result of a transfer from other ports of call. If those ports are Canadian, or there is growth general growth in tourism, the benefits could be considered NED benefits. This would also apply to the secondary jobs that support the tourism industry.

Federal interest is based on NED; however, whether NED or RED, the resulting benefits could have large impacts for a community the size of Wrangell.

6.3.6 Benefits Summary

Table 1 gives the approximate effects that may be expected from each alternative and estimates the ability of the alternative to meet the needs of the City of Wrangell.

The ratings are relative to the other alternatives. A check (√) meets the need, a plus (+) exceeds the need or has positive effect, and a minus (-) does not meet the need or has a negative effect.

Table 1. Alternative Effects and Benefits

Alternatives	Current Volume Needs	Meets Future Volume Needs	Water Quality	Safety	Hydro Revenue	Cost
No Action	-	-	-	-	-	+
Repair and Raise Dams	√	√-	-	√	-	√
New Dam	+	+	+	+	-	√-
Drill Wells	√	√-	√-	-	-	√+
Sunrise Lake	+	+	+	-	+	-

Section 7 – Recommended Plan

7.1 Selection of Recommend Plan

Various alternatives to provide a water supply for the City of Wrangell, Alaska, were evaluated in this report. These alternatives were evaluated for environmental and economic impacts, as well as engineering feasibility. Based on this analysis, the Construct New Dam alternative is recommended. This would include repair to the Lower Dam and inundation of the Upper Dam. In addition, the treatment/storage capacity at the water treatment plant will be expanded. This plan is fully supported by the non-federal sponsor.

The land at the proposed new dam site is city-owned, effectively minimizing real estate issues. Environmental impacts would also be less than those anticipated with other alternatives considered in this report.

7.2 Plan Components

The recommended plan would consist of the following components, discussed in detail in the following paragraphs:

- New 65-foot-tall earthen embankment dam, located approximately 200 feet upstream of the Lower Dam reservoir
- Approximately 3000 feet of reservoir covering an area of 30 acres
- Upgrades to the existing water treatment facility
- Rehabilitation of the Lower Dam to meet current Alaska dam safety standards

7.2.1 New Earthen Embankment Dam

The new main dam will be a middle straight-axis gravity structure approximately 500 feet long at the top. The dam structure will be 65 feet high, measured from the deepest point of the foundation. The hydraulic head will be 60 feet, measured from the assumed invert elevation of the streambed. The embankment dam will require about 5 feet of freeboard for wave action and settlement. The dam will be founded on rock on the right side, and a key trench will be excavated a minimum of 20 feet from the center to the left side of the dam.

The dam center will have an impervious silty-sand core, with a downstream sand filter. The core will be surrounded with random fill. The upstream outer edges of the random fill will be protected with a 12-inch layer of riprap bedding and a 24-inch layer of riprap. The downstream outer edges of the random fill will be protected with a 9-inch layer of gravel bedding and an 18-inch layer of cobbles.

7.2.2 New Main Spillway

An overflow emergency spillway with a 55-foot crest length is proposed. The spillway will be constructed on the right abutment, where natural rock would provide a solid foundation. The spillway features are the approach channel, the formed concrete spillway crest, and the spillway chute. The entire spillway will be formed concrete with training walls, until soil investigations indicated the spillway chute can be constructed in natural rock. A concrete bridge will be constructed over the top of the spillway to allow access across the top of the dam. During further investigations of the site, the spillway may be moved to the left abutment. If this occurs, the need for a bridge will be eliminated. At this time, however, it is unknown if the foundation on the left side is appropriate for a spillway structure.

7.2.3 New Main Outlet Works and Impact Basin

The outlet works will consist of an intake along the upstream embankment with gates and controls, a 12-inch water line, and a 48-inch emergency or low-water outlet conduit, and an impact basin energy dissipater.

A low-level intake structure will be constructed upstream of the dam. It will be connected to the outlet conduit pipe for delivering water downstream through the dam and back into the creek through an outlet structure. This inlet concrete box structure will have two slide gates with operators to control the flow of water through the structure.

The impact basin structure will be constructed downstream from the dam, and will be connected to the outlet conduit pipe for delivering water back into the stream. The concrete box structure will contain baffles to dissipate water energy and allow proper flow back into the stream.

Conventional concrete will be used for construction of the spillway cap, training walls, conduit easement, intake structure, impact basin structure, and foundation bedding.

7.2.4 Reservoir

The reservoir will be approximately 3000 feet in length, and the basin area at the damsite will be approximately 30 acres. Most of the new reservoir is forested, and will need to be cleared and grubbed prior to dam construction. The silt material for the dam core will be obtained from the reservoir area once the upper layer of muskeg is removed. There is concern in the area that clearing and grubbing may cause an increase in treatment for iron floc in the water. This concern would be addressed in greater detail and a decision made regarding extent of clearing and grubbing during feasibility stage of design.

7.2.5 Access Road

Improvements will be required on some 3000 feet of access road. The existing dirt roads will be leveled, graded, and compacted. Four (4) inches of base material will be placed, graded, and compacted; and 2 inches of gravel top course material placed, graded, and compacted on top. This should provide an adequate foundation for vehicles to access the damsite during construction activities. Approximately 1000 feet of additional road will be constructed above the new reservoir to provide access to the upper reservoir area.

7.2.6 Lower Dam Rehabilitation

During dam construction, the Lower Dam reservoir will be evacuated. The original crib dam will be removed, and new water and low-level outlet pipes will be placed in the dam structure. A new outlet works will also be constructed, with gates and operators similar to the main dam. The downstream embankment will be reconstructed with random fill (minimum 40-percent silt), and a berm will also be constructed, as shown in figure 13.

7.3 Construction Considerations

A new pipeline will need to be constructed to the Upper Dam in order to provide water for the City of Wrangell during construction of the new dam. This line will allow water to be removed directly from the Upper Dam reservoir and piped directly to the water treatment plant. This pipe will also be used to divert flows around the main dam construction site for dewatering purposes. The foundation in the area of the new main dam will likely be saturated due to the reservoir level at the Lower Dam. The lower reservoir will need to be evacuated prior to construction. The silt materials obtained from the reservoir area will likely be above optimum moisture content, and will need to be placed so that they dry between lifts.

7.4 Operations and Maintenance

No unusual operation or maintenance issues are expected to occur during construction of the new dam. Both new dam structures will be constructed with appropriate geotechnical instrumentation to allow the City of Wrangell to evaluate their performance both during and after filling. This will requirement that the instruments be read on a monthly basis, but this can be accomplished automatically via computer programs.

The new main dam will be closer to access than the existing Upper Dam. The road around the reservoir will need to be maintained regularly for access to the inlet stream, accomplished by cutting back the brush and replacing the gravel surface when necessary. The riprap/cobble surfaces on the dams should hinder vegetation growth, which should actually lower the present maintenance costs. Vegetation growth along the abutments will need to be controlled on an annual basis.

7.5 Utility Relocations

The water line the currently runs from the Lower Dam reservoir to the water treatment plant will remain in place. A new line has been installed approximately half-way to the Upper Dam reservoir. This line will be extended to the Upper Dam to provide water to the water treatment plant during construction. No other utilities will be affected by the construction.

7.6 Costs

The breakdown for costs for the recommended alternative is shown in Appendix D – Cost Estimate. A summary of these costs is presented in Table 2.

Table 2
Recommended Plan – Construct New Dam

Subsurface Investigations	$5.2M
Planning Engineering & Design	$7.4M
Water Treatment Plan Modifications	$4.1M
Remove Upper Dam, Clear & Grub	$1.1M
New 65' Dam and Retrofit Lower Dam	$18.6M
Upper Reservoir Pipe & New Storage Tank	$2.7M
Construction Management	$3.9M
Total Costs:	**$43.0M**

7.7 Construction Schedule

Table 3 contains an abbreviated construction schedule. A more detailed schedule can be found in Appendix F – Construction Schedule.

Table 3
Wrangell Water Supply Improvement
Construction Schedule

Task Name	Duration
Pipe to Upper Dam, Tank & Clear & Grub	187 days
Reservoirs—Lower Reservoir and New Reservoirs	187 days
Mobilization & Demobilization	187 days
Clearing, Debris, and Stump Removal	57 days
Pipeline Extended to Upper Reservoir	29 days
Water Storage Tank and Piping	60 days

Table 3 (continued) Wrangell Water Supply Improvement Construction Schedule	
Task Name	**Duration**
New Mid & Modify Lower Earth Dams	440 days
Dams (Compacted Earthfill)	440 days
Main Dam – Earthen Structure	440 days
Mob, Demob, and Prework	440 days
Site Access Roads & Parking	296 days
Foundation Work	80 days
Earthwork for Structures	24 days
Compacted Earth Dam	121 days
Earthwork for Structures	90 days
Foundation Work Spillway	5 days
Spillway Overflow Section	110 days
Outlet Works – 48" & 12" Diameter	142 days
Auxiliary Dam (Lower Dam Mods)	31 days
Earth & Rockfill Dam Modification	31 days
Outlet Structure (Extension)	9 days
Remove Upper Dam and Clear/Grub	112 days
Reservoir – Upper Reservoir	112 days
Reservoir	112 days
Clearing and Debris Removal	112 days
Water Treatment Plant Modification	270 days
Dams	270 days
Municipal & Industrial Water	270 days
Mob, Demob, & Preparatory Work	270 days
Water Supply System	94 days

Section 8 – Conclusions and Recommendations

8.1 Conclusions

This reconnaissance-level study has identified the critical need to augment and modify the existing community water system of Wrangell, Alaska. The existing system is inadequate to provide for peak demand during dry summer months, and does not allow for expanded industries to spur economic development. Additional water storage is needed to support projected population growth, fire protection, increased tourism, and the fishing industry. The Upper and Lower Dams, constructed over 70 years ago and used for water storage, have been classified as highly hazardous. Extensive repairs are required if these dams are to meet Alaska dam safety standards. Officials from the City of Wrangell are determined to work through Congress for assistance in resolving the safety and water supply issues.

8.2 Recommendations

Based on the analysis completed for this report, the Construct New Dam Alternative is the recommended plan. This would include repair to the Lower Dam, inundation of the Upper Dam, and expanded treatment/storage capacity at the water treatment plant. Implementation of this alternative would address the safety issues with both dams and provide for future water supply needs for Wrangell. This alternative will yield both economic and safety benefits to the region and, likely, to the Nation.

It is additionally recommended that the City of Wrangell implement metering and conservation measures along with the repair and/or replacement of leaking lines throughout Wrangell. Accurate metering of both domestic and commercial water use is valuable for operations and maintenance management, as well as for future water supply planning.

Even though the Construct New Dam alternative is recommended by this reconnaissance report, other alternatives should be given detailed consideration in a feasibility study. It is in the federal interest to pursue a feasibility-level study to determine the optimum alternative or combination of alternatives that meets these water supply and safety needs.

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Appendix A

Economics

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Tables

Figures

1.0 Introduction/Purpose

This reconnaissance-level study of the City of Wrangell's water supply was initiated in response to the water shortage the city experienced in 2004 and concerns over the stability of the existing dams. The city's water supply reservoirs were drawn down to a very low level during the summer of 2004. Water rationing was initiated to help alleviate the shortage, the sale of water to cruise ships was curtailed, and fish canneries were encouraged to conserve water.

This appendix examines the economic impacts of the existing water supply and estimates potential economic impacts attributable to investments necessary to provide the quantity and quality of water necessary for the City of Wrangell to meet existing and expected future demand for water.

The analysis was developed to determine if investment in City of Wrangell water supply is a good economic decision. Because this study is being done under the Corps' Planning Assistance to States program, recommendations will be provided. However, further analysis will be necessary before a National Economic Development Plan could be determined. The recommended plan must meet current and future water demand, while addressing existing dam stability issues.

2.0 Existing Water Supply System

Water for the City of Wrangell water system is collected from the runoff of a small unnamed creek in two impoundments with a total capacity of 62 million gallons (190 acre feet). This is about a 60-day supply during the peak demand period, assuming no inflow. The two reservoirs are in the same drainage basin, which has about 0.82 square miles of catchment area. The water is filtered with sand filters, with both chlorination and ozonation occurring prior to distribution. (Sunrise Lake Water Supply and Hydroelectric Project Feasibility Study Report, January 1998. p.1-1)

Water demand in Wrangell averages about 700,000 gallons per day, with peak demands of slightly over one (1) million gallons per day (MGD) in the summer months and minimum demands of about one-half MGD in the fall and spring months. Based on the 1998 population of about 2,400 people, the average water use was calculated to be approximately 290 gallons per person per day. The 1995 Water System Assessment projected demand through the year 2020 using an annual growth of 1 percent based on these projections. The peak day demand in 2020 will be 1.3 MGD (Sunrise Lake Water Supply and Hydroelectric Project Feasibility Study Report, January 1998. p.1-3).

As of 2005, the current population of Wrangell is estimated to be 1,974 (Alaska Department of Community and Economic Development, 2005), but peak daily demand has already reached projected demand for 2020. Because the population has declined recently, the likely source of increased demand is the growing cannery industry. During the summer of 2004, insufficient water supply because of low participation levels for that year resulted in the curtailment of water supply for cruise ships docking at Wrangell. As the reservoirs were drawn down, water quality from the reservoir also deteriorated.

3.0 Present and Future Water Demand

Existing demand peaks during the summer months and falls off during the fall and early winter. Figure 1 shows monthly demand from September 2004 to August 2005. There are currently two commercial fish processors with other small custom canneries and packers. The largest existing fish processor uses up to 400 gallons per minute for up to 16 hours a day. They process fish from March to November, with the peak season occurring in June through August.

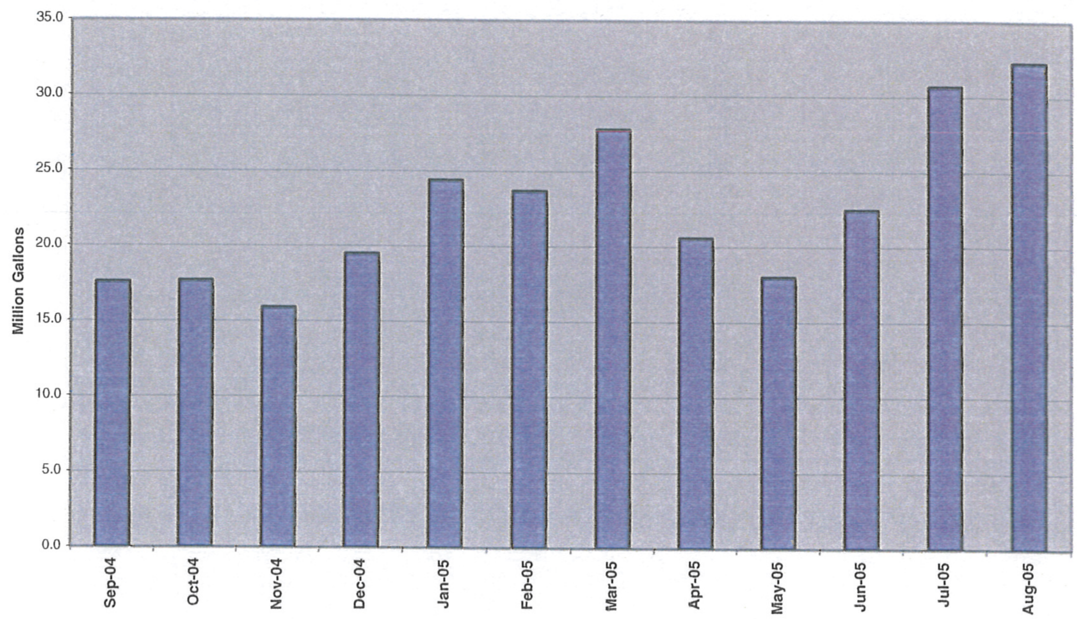


Figure 1 – Current Water Demand

The logging and fishing industries have been depressed in recent years, causing the population of the city to drop from 2700 in 1996 to about 2000 in 2005. There has been a recent resurgence in the fishing industry due to name branding of the local fisheries in Alaska and the recognition of the superior taste and nutritional aspects of wild Alaska salmon verse pen reared farmed salmon.

With the resurgence in the fishing industry, a fish processing company could be attracted to town. The population would grow in response to the additional jobs required to operate the plant. A 0.5-percent annual growth rate in population was assumed for the first 10 years following the development of a fish processing plant, but no growth in the next 10 years was used in this analysis. Figure 2 shows projected demand using the above stated assumptions. Future population growth needs to be refined during the feasibility phase, as it is a critical piece of information for the analysis. It is anticipated that the annual demand for drinking water would be approximately 327 million gallons. This estimated future demand exceeds the capacity of the treatment plant during some months, and it may be necessary to increase capacity.

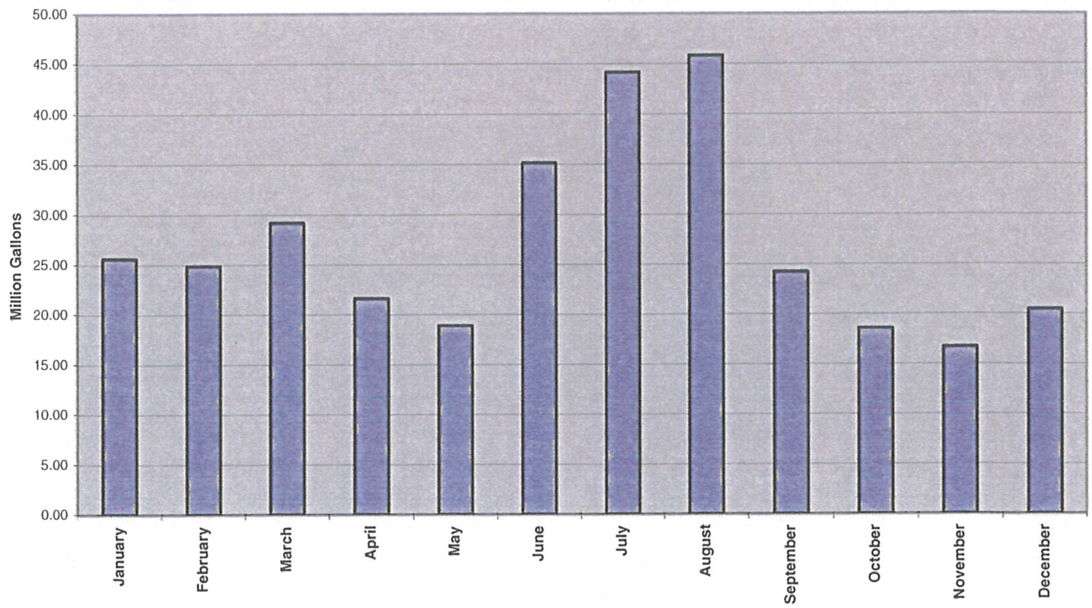


Figure 2 – Predicted Water Demand, 2026

3.1 Existing Water Demand Based on Current Usage

Table 1 illustrates the August 2005 typical peak demand month for the water system. The water treatment plant capacity is 900 gallons per minute (gpm). If running at full capacity 24 hours a day, the total capacity is 1.3 MGD. During summer peak season, it runs around 1200 gpm much of the time. The 2005 data illustrates that, for 9 days, the plant flow capacity was exceeded. On 26 days in the month of August, total volume was over 1 MGD.

Table 1 City of Wrangell Water Meter Data August 2005			
Day	Flow gpm	Totalizer Reading	Total MGD
Prev	8:00	1721958	
1	587	1723070	1.112
2	991	1723821	0.751
3	997	1725107	1.286
4	916	1726256	1.149
5	677	1727292	1.036
6	173	1728366	1.074
7	178	1729440	1.074
8	176	1730515	1.075
9	4	1731535	1.020
10	603	1732706	1.171
11	684	1733931	1.225
12	995	1735060	1.129
13	237	1736094	1.034
14	614	1737128	1.034
15	518	1738163	1.035
16	4	1739187	1.024
17	998	1740339	1.152
18	176	1741554	1.215
19	684	1742685	1.131
20	299	1743716	1.031
21	297	1744747	1.031
22	706	1745778	1.031
23	995	1746449	0.671
24	993	1747588	1.139
25	702	1748783	1.195
26	576	1749700	0.917
27	678	1750738	1.038
28	818	1751776	1.038
29	484	1752815	1.039
30	997	1753394	0.579
31	907	1754299	0.905

3.1.1 Residential, Municipal, and Commercial

The City of Wrangell water system uses metering only at the water treatment plant. There are no individual meters on residential or commercial properties. Therefore, residential, municipal, and commercial usage cannot be calculated with any degree of accuracy.

3.1.2 Industrial, Cannery

Each cannery uses around 400 gpm, with peaks of 500 gpm.

3.1.3 Cruise Ships

A consistent supply of clean water is one criteria used by cruise ships to determine the ports at which they will berth. Cruise ships often use Wrangell water to resupply ship water systems. The cruise ship volumes vary based on the size of the ship. Typical volumes range from 100,000 gallons to 250,000 gallons, with a flow of 200 to 300 gpm. Assuming two ships each week during the cruise season (May through September), cruise ship water brings in $15,000 to $37,000 per year.

3.1.4 System Loss

Because individual metering is not available, further analysis would be required to estimate losses within the system. Older sections of town typically have substation losses. Total system flow during early morning hours may give some indication if system losses are high enough to substantially affect total demand.

3.2 Projected Water Demand

3.2.1 Residential Water Use

Residential and commercial use is expected to be constant, with the only growth resulting from increased growth in housing. Immediate growth is projected to be flat.

3.2.2 Municipal—Fire Hydrant Flushing, Filter Flushing

Fire flow for the city is 433,000 gallons of water. Capacity for fire protection under current conditions is sufficient. However, any substantial growth of residential, commercial, or industrial use would require additional storage capacity to meet fire flow.

3.2.3 Commercial

No metered data exists for commercial use. This sector is relatively constant and is not expected to increase in significant amounts.

3.2.4 Industrial, Cannery

Following the 2004 low water year, both existing canneries (figure 3) installed water conservation measures to minimize usage and ensure sufficient water supply to continue processing. Water demand in the immediate future is

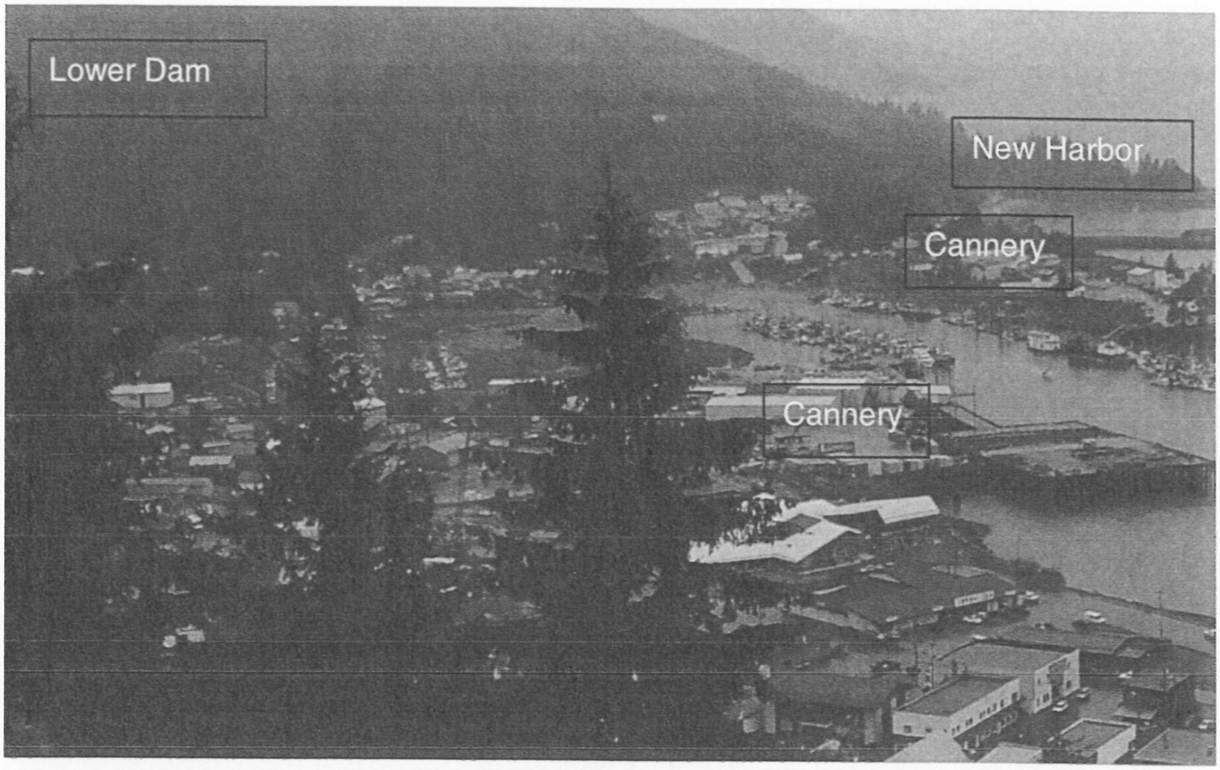


Figure 3 – Location of canneries in relation to the dams and the harbor

expected to remain constant, but this is dependent on current volumes of fish processing. Both canneries have expressed interest in increasing production, but water supply concerns need to be addressed before expansion plans can be seriously considered. The city would like to attract an additional cannery, and it could be assumed that a new processor would need similar amounts of water. The system would need to supply an additional 40 million gallons to provide for an additional cannery. If existing plants expand, additional water would need to be supplied.

3.2.5 Cruise Ships

Current cruise ship volumes should remain constant as long as there are no curtailments in supply like those which occurred in 2004. If another low water condition occurred and the city had to limit water to cruise ships, it could result in cruise lines removing Wrangell from their itinerary. In general, cruise ships are getting larger and will place increased demands for supplies at destination ports. If Wrangell is unable to supply water, they would likely lose cruise ship landings. If supply and quality can be guaranteed and marketed, water demand could increase substantially.

3.3 Water Conservation

Besides conservation measures implemented by canneries as a result of the 2004 water shortage, there appears to be no water conservation program in use in Wrangell. Given the average age of structures it is likely that conservation measures could lower overall demand. However, without individual metering, there is little incentive for home and business owners to invest in conservation measures. Because the population of Wrangell is small and half of the water demand comes from the canneries, the total volume from residential/commercial demand may not be substantial enough to have a large effect on the total water demand.

Reduction of system losses would likely have greater savings potential and more verifiable savings than water conservation measures. Unless a coexisting plan for road replacement is provided, this alternative would have a high cost per gallon.

4.0 Wrangell Economy

The City of Wrangell has always been a resource-dependent economy, and was hit hard by the decline of the logging industry. There has since been some recovery in the logging industry, a resurgence of the fishing industry, and some diversification into other industries. However, the city is still resource-dependent and will be somewhat susceptible to variations in logging and fish resources, as well as tourism. In general, the Wrangell economy is in an upswing at this time.

Table 2 and figures 4 and 5 contain City of Wrangell employment earnings by Industry from 1992 to 2005, along with significant events that occurred during that time.

Table 2
Wrangell's Annual Employment Earnings by Industry

Industry	1992	1993	1994	1995	1996
Mining	*	*	*	*	*
Construction	$1,383,554	$2,304,313	$1,731,112	$1,732,284	$2,575,834
Manufacturing	$6,135,432	$7,143,717	$8,891,718	$2,779,423	$2,225,859
Trans/Com/PU	$3,401,646	$3,755,855	$3,754,505	$3,314,030	$3,141,171
Wholesale	*	$26,555	$113,065	$17,333	*
Retail	$2,296,700	$2,405,266	$2,833,363	$2,563,685	$2,243,815
Finance, Ins & Real Estate	$312,782	$338,182	$350,506	$351,893	$410,681
Services	$1,059,529	$1,055,526	$866,220	$814,063	$774,825
Agri, Forestry & Fish	*	*	*	$396,745	$278,351
Unspecified	$4,771,356	$5,852,155	$3,089,137	$466,256	$583,768
Federal Govt	$1,551,044	$1,795,524	$2,081,510	$2,022,622	$2,154,487
State Govt	$891,486	$911,978	$852,938	$959,293	$744,113
Local Govt	$5,963,394	$6,031,988	$6,612,585	$6,750,578	$7,390,102
Total	$27,766,923	$31,621,059	$31,176,659	$22,168,214	$22,523,006

Table 2
Wrangell's Annual Employment Earnings by Industry (continued)

Industry	1997	1998	1999	2000	2001
Mining	*	*	*	*	*
Construction	$2,048,161	$1,669,568	$3,720,394	$2,557,177	$1,283,910
Manufacturing	$3,111,087	$5,059,945	$6,106,076	$4,471,476	$6,866,098
Tran/Com/PU	$4,030,942	$3,335,793	$3,074,147	$2,996,054	$3,048,874
Wholesale	*	$262,502	*	--	*
Retail	$2,103,280	$2,206,942	$2,475,238	$2,699,776	$2,594,933
Finance, Ins & Real Estate	$418,588	$452,216	$456,082	$608,922	$504,459
Services	$974,540	$1,022,017	$1,108,928	$1,221,991	$6,620,809
Agri, Forestry & Fish	$0	$238,338	*	$258,418	*
Unspecified	$497,247	$3	$432,071	*	$307,555
Federal Govt	$2,173,872	$2,469,956	$2,339,036	$2,262,450	$2,058,884
State Govt	$656,786	$672,733	$671,338	$642,104	$627,995
Local Govt	$7,661,806	$7,374,105	$7,777,997	$7,948,138	$2,834,782
Total	$23,796,357	$24,764,118	$28,249,335	$25,982,381	$26,748,299

Note: Sawmill closed in December 1994
Source: State of Alaska
*Data is not available or could not be provided for confidentiality reasons. See Unspecified Category.

Industry	2002	2003	2004	2005
Natural Resources and Mining	*	*	*	*
Construction	$960,812	$1,231,294	$796,899	*
Manufacturing	$4,743,382	$274,885	$1,824,664	*
Trains Comm PU	(former classification)			
Trade, Transportation and Utilities	$4,143,910	$3,753,587	$3,521,365	$3,091,730
Wholesale	(former classification, included in Trade, Transportation and Utilities)			
Retail	(former classification, included in Trade, Transportation and Utilities)			
Fin Ins/R Estat	(former classification)			
Information	$330,442	$314,681	$561,888	$580,344
Financial Activities	$405,978	$407,416	$320,970	$429,526
Services	(former classification)			
Agric For Fish	(former classification)			
Professional and Business Services	$309,607	$242,426	$269,431	$298,171
Education and Health Services	*	$950,445	*	*
Leisure and Hospitality	$802,987	$845,932	$841,131	$900,239
Other Services	$181,418	*	*	*
Federal Govt	*	*	*	*
State Govt	$752,189	$872,724	$783,254	$884,772
Local Govt	$8,452,256	$8,237,223	$7,729,936	$7,542,322
Sub Total	$21,082,981	$17,130,613	$16,649,538	$13,727,104
*Unspecified or confidential reports	$3,855,258	$5,610,415	$13,777,812	$18,817,598
Total Industries	$24,938,239	$22,741,028	$30,427,350	$32,544,702

Table 2
Wrangell's Annual Employment Earnings by Industry
(continued)

*confidential information, not enough firms report

EXCLUDED GROUPS:
Certain segments of Alaska's employed population are excluded from unemployment insurance coverage, and no ongoing method of collecting employment and payroll information is available for these individuals. Research and analysis acknowledges the importance of this economic activity, but has no reliable method to augment the data published here.

The largest segments of the employed population excluded from these data include:

- Self-employed individuals
- Fishers
- Unpaid family help
- Domestics
- Most individuals engaged in agriculture.

ANNUAL EMPLOYMENT: Represents a count of jobs as opposed to individual workers. It is not an unduplicated count of the number of individuals because workers holding more than one job or who change jobs during the measuring timeframe may be reported by more than one employer.

TOTAL EARNINGS: All remuneration paid to workers during the quarter/year, including commissions, bonuses, and other gratuities when paid in connection with the job. Earnings may include remuneration for work done in previous time periods since date of payment rather than date of service is the determining factor.

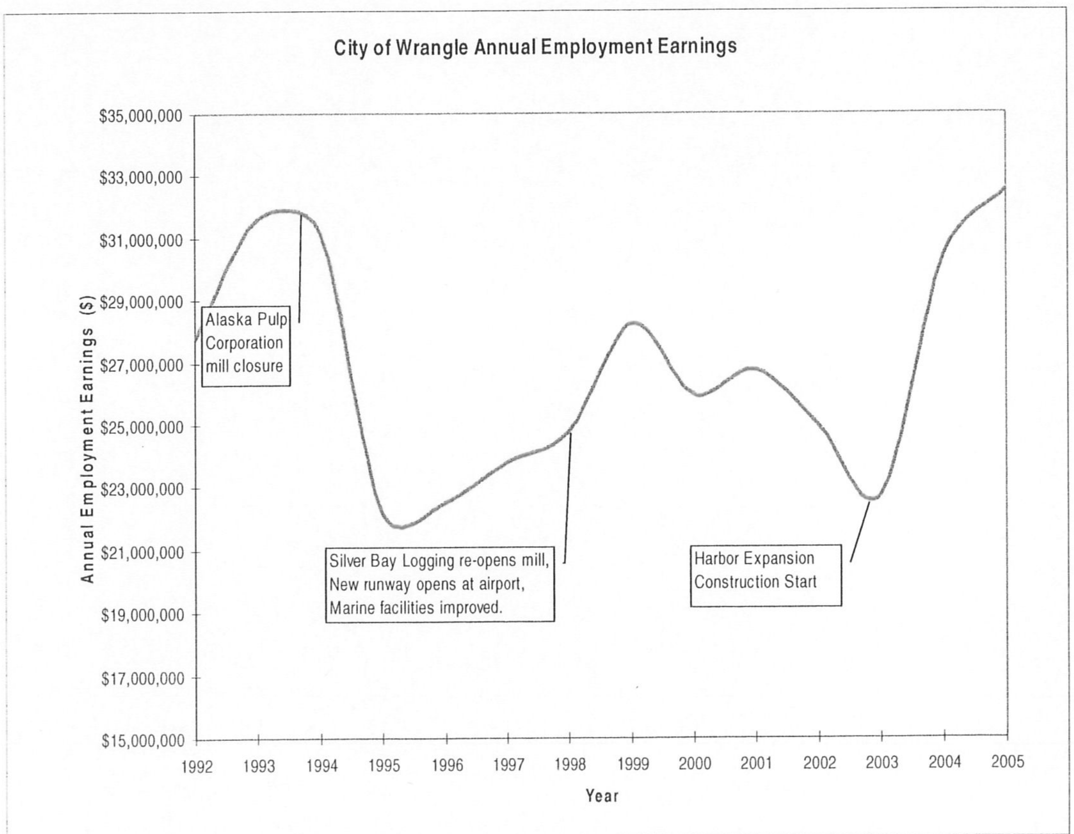


Figure 4 – City of Wrangell Annual Employment Earnings

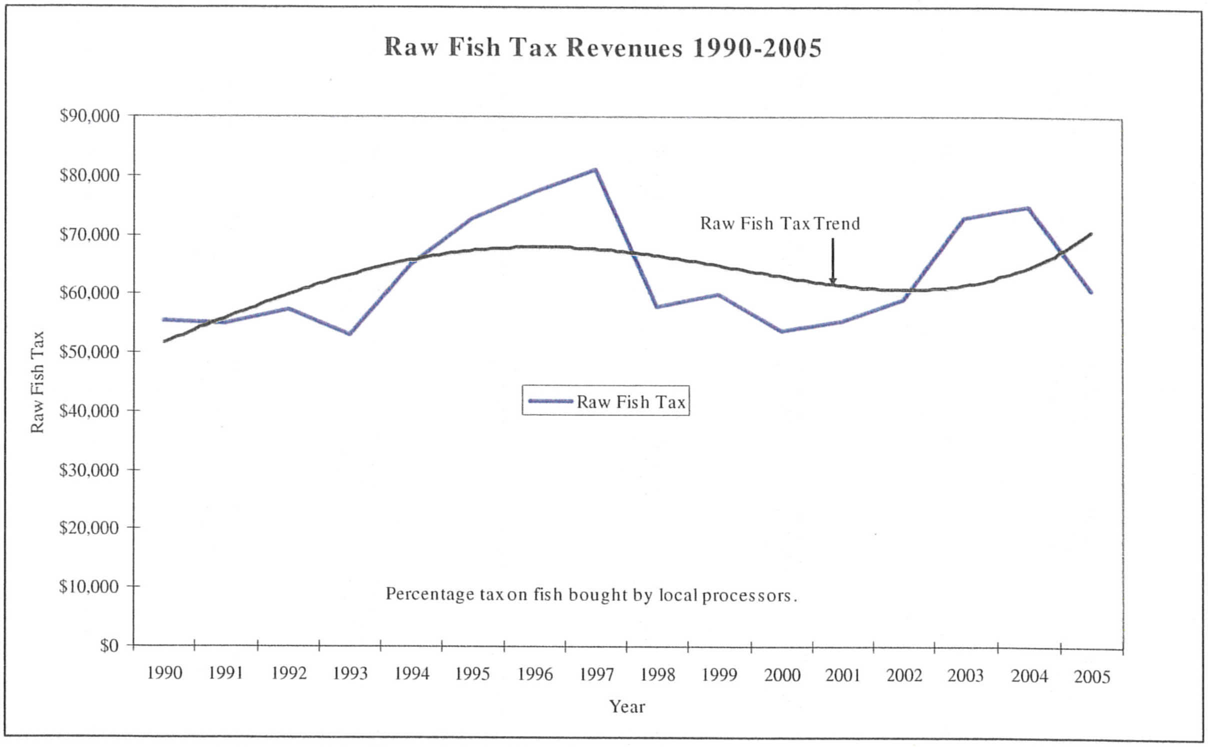


Figure 5 – Raw Fish Tax Revenues, 1990 to 2005

5.0 Economic Impacts

5.1 Residential/Commercial

Future plans in Wrangell include the possibility of up to 94 residential units for senior housing, along with support facilities for education and wellness. If fully developed, an assisted living and independent senior housing development could bring over $22 million in construction. As a result of a construction project such as this, there would be higher demand for goods and services, as well as increased employment opportunities.

5.2 Canneries and Fishing

There are currently two canneries within the City of Wrangell. Both are showing some growth, but any sizable increase in production would be limited by water supply during low water years. Both canneries could increase production levels over current levels.

One of the canneries reported annual sales of 3 million pounds of salmon; 1 million pounds of halibut; 1.5 million pounds crab; and 50,000 pounds of miscellaneous fish. Their output could increase by 50 percent with modernization, but this would be dependent on the firm water supply needed to increase capacity. During typical seasons, this cannery employs around 75 people for a 45-day season. Approximately half of their employees work around 4 months, while 6 are permanent year-round employees.

The other major cannery processes around 10 million pounds of product, and has sales around $7.5 million. With a secure water supply, they could increase production to 20 million pounds. Their season runs from March through November. About 130 people are employed from June through August, dropping down to 50 in September, and then to 30 in October. Approximately 80 percent of these employees are from outside of Wrangell, and must pay rent during the canning season. Typical rent for an employee is $900 per month.

The use of air shipment for fish has increased with the expansion of the runway and regular jet service by airlines. Currently, 30 percent of their products are shipped by air.

In addition to the direct labor supported by canneries, the fishing boats serving the canneries provide employment in Wrangell. For one cannery, 92 boats provide fish for processing at one cannery. These boats employ between 152 to 244 crew members.

5.3 Cruise Ships

The continuation of cruise ship stops in Wrangell is vital to the city's economy. In addition to direct revenue to the city from water sales, the cruise ships provide the largest base of tourism dollars to the community. If the cruise business continues to grow and becomes stable, it is likely that more tourist-centered businesses will develop in Wrangell.

5.4 Addition Economic Impacts

A new harbor addition, completed in 2005, expanded the moorage in Wrangell. The estimated National Economic Development (NED) annual benefit was estimated be $2,256,800 (1999 dollars), with a net annual NED benefit of $388,000 (1999 dollars) (*Navigation Improvements Final Interim Feasibility Report and Environmental Assessment,* September 1999, Appendix B, Economic Analysis, page B74).

The *Feasibility Study of a Marine Center in Wrangell* (City of Wrangell, February 2002, Northern Economics Inc.) estimated the economic benefic of building a marine center and marine Travelift in Wrangell to be between $2.4 and $2.5 million.

Erecting a cold storage facility in Wrangell was estimated to bring revenues of $270,000 per year to the city (*Business Plan and Feasibility Study for a Public Cold Storage*, December 2003, McDowell Group).

The benefit estimates for these projects are dependent on a viable cannery industry in Wrangell which, in turn, is dependent on consistent the quantity and quality of water.

6.0 Safety

6.1 Fire

Adequate fire protection is currently available; however, the expansion of residential, commercial, or industrial sectors would require additional water for fire protection.

6.2 Flood/Dam Safety

Approximately 14 mobile homes (figure 6), 1 stick-built home, and the city sewage treatment plant (figure 7) are vulnerable to damages from a collapse of the city dams.

Because of the close proximity of residences to the dams, and the lack of a warning system of any kind, the possibility exists that a loss of life could result from a dam failure.

Figure 6 - View looking up at area vulnerable to inundation

Figure 7 - City of Wrangell sewage treatment plant

6.2.1 Persons at Risk

The United States Census of Population reported an average of 2.52 persons per household at Wrangell, Alaska, in 2000. As stated in the previous paragraphs, 15 residential structures are in the likely dam failure floodplain below the city's two water supply dams. Assuming the average number of persons per household accurately reflects the actual population of these 15 structures, the Persons at Risk (PAR) in the city is 38 for an evening or nighttime event when everyone is at home. A daytime event would have a reduced PAR due to many adults being at their place of employment, assumed to be outside of the floodplain, and school-age children likely away from home for 6 to 8 hours on school days. Since this is a reconnaissance-level analysis, the worst case scenario is assumed. Accordingly, the full PAR is used in estimating loss of life (LOL).

6.2.2 Warning Time

"Warning time is measured as the difference in time from when a public warning is disseminated, about a potential dam failure until the flood wave reaches each PAR" (Corps, 1986). This is refined as being the time until a life-threatening flood wave reaches the PAR. Notifying residents of the impending damage and urgency of evacuation constitutes the dissemination of the public warning.

No emergency evacuation plan or apparatus exists for notifying residents of an impending failure to one or either of Wrangell's water supply dams. If such a condition was determined to exist, it would be relatively easy to notify threatened parties because of the small number of floodplain residences involved. However, no system is in place to determine an imminent failure. In any case, because of the potential failure type, such a determination might not be easily discerned. Under the worst case scenario, a spontaneous dam failure, no warning time exists. Although non-observed failures are unusual, a failure condition occurring in late evening or early morning hours could be equally as dangerous as a spontaneous dam failure. For purposes of this study, it is assumed that warning time would be 15 minutes or less.

6.2.3 Loss of Life

Life-threatening flows are frequently described as being based on the "rule of nine." In other words, a life-threatening situation is present if the products of flood depth and water velocity, in feet per second, are 9 or greater. While the estimation of flood stages and velocities is beyond the level of detail of a reconnaissance-level investigation, it is believed that PAR in Wrangell would be subjected to life-threatening conditions because of the almost certain rapid release of water during a dam failure condition and the gradient of the floodplain. The LOL is estimated based on a warning time of less than 15 minutes, no emergency management system or plan, a narrow valley of less than 1 mile, and fatality rates developed by the U.S. Bureau of Reclamation. This fatality rate was developed by Wayne Graham for the U.S. Bureau of Reclamation for conditions such as these is 0.75 (U.S. Bureau of Reclamation, 1986). With minor modifications to consider the width of the floodplain, this document is used by the Corps to assess dam safety risk. It is deemed suitable for use in this level of analysis. The LOL for conditions discussed earlier in this document, the LOL for the above-described conditions is estimated to be 28.

7.0 Alternatives

The following alternatives were examined to supply additional water to the City of Wrangell and meet the requirements for dam safety of exiting dams. The alternatives examined were: (1) No Action; (2) Repair and/or Raise Dams; (3) Construct New Dam; (4) Water Wells; and (5) Sunrise Lake Supply Line.

7.1 No Action

This option would result in a loss of water supply for the City of Wrangell. Both dams that hold the city's water supply are in need of repair. At present, Wrangell has a conditional use permit granted by the Alaska State Dam Safety Office to operate the dams under current reservoir heights, with the condition that the city actively pursue funding and engineering plans to repair the structures. If repair is not done eventually, the dam reservoir heights will be regulated and the city will lose its water supply.

7.2 Repair and/or Raise Dams

This alternative would involve the repair and/or modification of both the Upper and Lower Dams to meet current state dam safety guidelines. This would include raising the dam heights for additional storage.

7.3 Construct New Dam

This alternative would construct a new dam downstream of the existing Upper Dam, demolish portions of the existing Upper Dam, repair the Lower Dam, and clear and grub existing reservoirs of organic material. The new dam would be sized to contain the amount of water necessary to meet the community's future needs.

7.4 Water Wells

Water wells could be used to increase the water supply if there are good sources of underground water to tap. Most of southeast Alaska is mountainous, and has bedrock at very shallow depths. This is usually not conducive to high capacity wells. A brief look at water supply systems in other southeastern Alaska communities illustrated that the vast majority of them use surface water sources for drinking water. Many residences located outside a community service area use individual wells as their water supply. There are several domestic water wells in the Wrangell area. The water quality from these wells is reported to be good. A review of several well logs from the Wrangell area indicates that yield can vary greatly over short distances, as well as with the type of material encountered. This amount of water would be a major help in meeting demand during a dry period such as that experienced in 2004. Four to five new wells with similar capacity would be needed to meet future demand. Given the hit or miss nature of developing a high-capacity well in Wrangell, this option would need to be explored in more detail before being pursued to meet future demand.

7.5 Sunrise Lake Supply Line

Another way to meet the projected increase in demand is to develop a new source of water. In 1998, R.W.Beck, an engineering firm, proposed the development of Sunrise Lake as a water supply and hydroelectric project. Sunrise Lake is located on Woronkofski Island, about 6 miles southwest of the City of Wrangell. The study determined that Sunrise Lake could supply 3 million gallons of water to the treatment plant each day. This amount would be more then adequate to meet future water supply demand. In addition to water supply, Sunrise Lake has the potential to provide hydroelectric revenue to the city.

This alternative would involve constructing a pipeline from Sunrise Lake to supply water. This alternative would also either remove the dams or modify them to protect the public from a dam failure during a storm or other natural event.

8.0 Recommendation

Table 3 gives the approximate effect from each alternative, and estimates its ability to meet the needs of the City of Wrangell.

The ratings are all relative to the other alternatives. A check (√) meets the need, a plus (+) exceeds the need or has a positive effect, and a minus (-) does not meet the need or has a negative effect.

Table 3. Alternative Effects and Benefits

Alternatives	Current Volume Needs	Meets Future Volume Needs	Water Quality	Safety	Hydro Revenue	Cost
No Action	-	-	-	-	-	+
Repair and Raise Dams	√	√-	-	√	-	√
New Dam	+	+	+	+	-	√-
Drill Wells	√	√-	√-	-	-	√+
Sunrise Lake	+	+	+	-	+	-

Adding additional storage to the existing water supply system and solving the stability problems of the existing dams is a clear need for the City of Wrangell. Additional storage will yield economic and safety benefits to the region. Based on preliminary reconnaissance-level estimates and safety considerations, the Construct New Dam alternative is recommended. It is in the interest of the United States to pursue a feasibility study to determine the optimum alternative or combination of alternatives in order to meet these water supply and safety needs.

Appendix B

Project Data

	Wrangell Upper Dam	Wrangell lower Dam
General		
Location	Wrangell, Alaska	Wrangell, Alaska
Longitude	132 21.6' W	132 22.5' W
Latitude	56 27.7' N	56 27.3' N
Year built	1935, overbuilt 1967	1900, overbuilt 1967
Inventory of Dams I.D.	AK00013	AK000014
Hazard Potential Classification	Class II (Moderate)	Class III (Low)
Size Classification	Small	Small
Purpose	Water supply for City	Water supply for City
Owner	City of Wrangell	City of Wrangell Public Works Department PO Box 531 Wrangell, AK 99929
Dam		
Type	Rockfill (Timber crib core)	Rockfill (Timber/sheetpile cutoff)
Crest Length	320 feet	315 feet
Crest Width	25-33 feet	12 feet
Crest Elevation	363 feet	299 feet
Maximum Height	28 feet	28 feet
Spillway		
Type	Uncontrolled (side) rock channel	Uncontrolled (side) rock channel
Location	Right abutment	Right abutment
Bottom Width	18 feet	18 feet
Length	250 feet	335 feet
Crest Elevation	358 feet	294 feet
Side Wall Height	5 feet	5 feet
Discharge Cap. (At dam crest)	533 cfs	533 cfs
Outlet Works		
Location	Center of Dam	Center of Dam
Type	Wood Stave (W.S.) to C.I. Pipe	Corrugated Metal Pipe
Invert Elevation	335.1 feet	Approx. 273 feet
Length	128 & 135 feet (W.S. plus C.I.)	92 feet
Size	8 & 10 inches	24 inches
Outlet Type	Direct discharge into channel	Direct discharge into channel

Outlet Works (continued)		
Control	Valves to upstream crest (2 steel stand pipes to dam crest)	Gate valve at upstream toe (valve stem cut off in 1995)
Discharge Capacity at Dam Crest	18.5 cfs (both pipes)	40 cfs
Reservoir Data		
Normal Maximum Water Surface Elevation	358 feet	294 feet
Water Elevation at Dam Crest	363 feet	299 feet
Maximum Storage Volume at Dam Crest	190 acre feet	102 acre feet
Maximum Surface Area at Dam Crest	approx. 13.5 acres	approx. 7 acres
Storage Volume at Spillway Crest	122 acre feet	67.5 acre feet
Surface Area at Spillway Crest	12.3 acres	5.9 acres
Hydrologic Data		
Drainage Area	0.73 square miles	0.96 square miles
Average Annual Discharge	5.4 cfs	5.4 cfs
Flood of Record	None recorded	None recorded
Project Design Flood*	400 cfs	680 cfs
Return Period*	100 years	100 years
*Assumes the dams have a (Class II) significant or (Class III) low hazard classification.		

Appendix C

Real Estate Plan

This appendix contains legal descriptions and copies of ownership documents for the lands surrounding the Wrangell reservoirs.

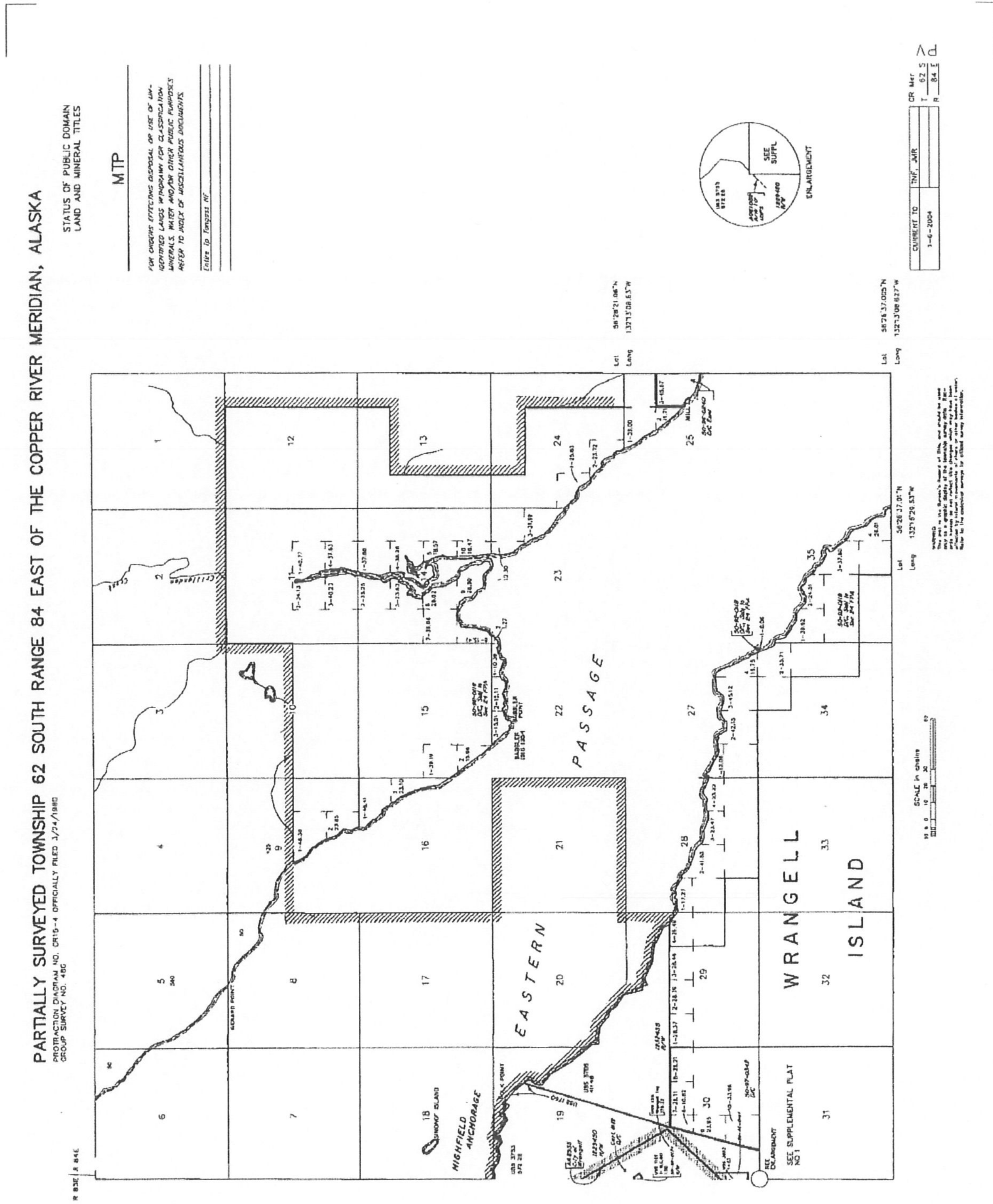
1.0 Legal Descriptions:

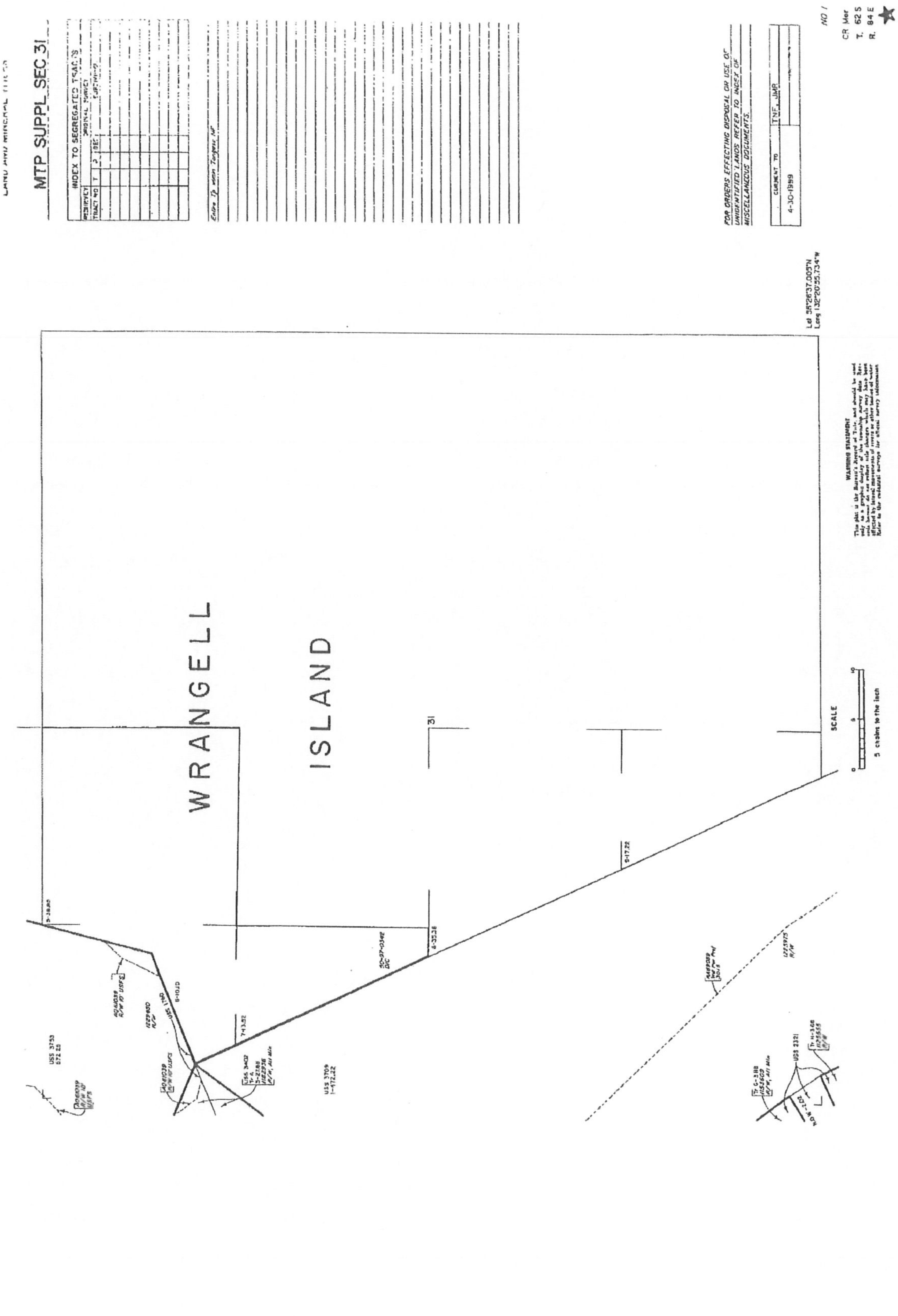
Lots 6-10, Section 30, Township 62 South, Range 84 East,
Copper River Meridian
SE1/4, Section 30, Township 62 South, Range 84 East,
Copper River Meridian
Lots 5-7, Section 31, Township 62 South, Range 84 East,
Copper River Meridian

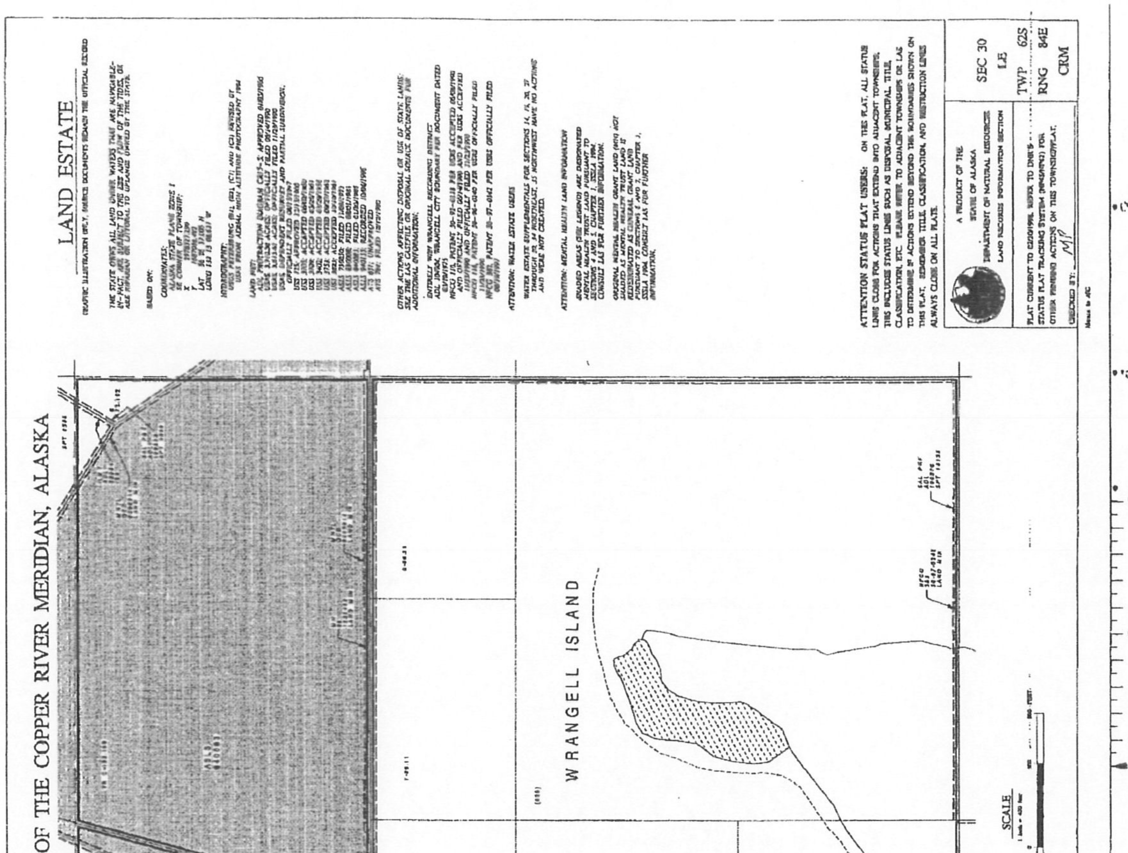
2.0 Ownership Documents:

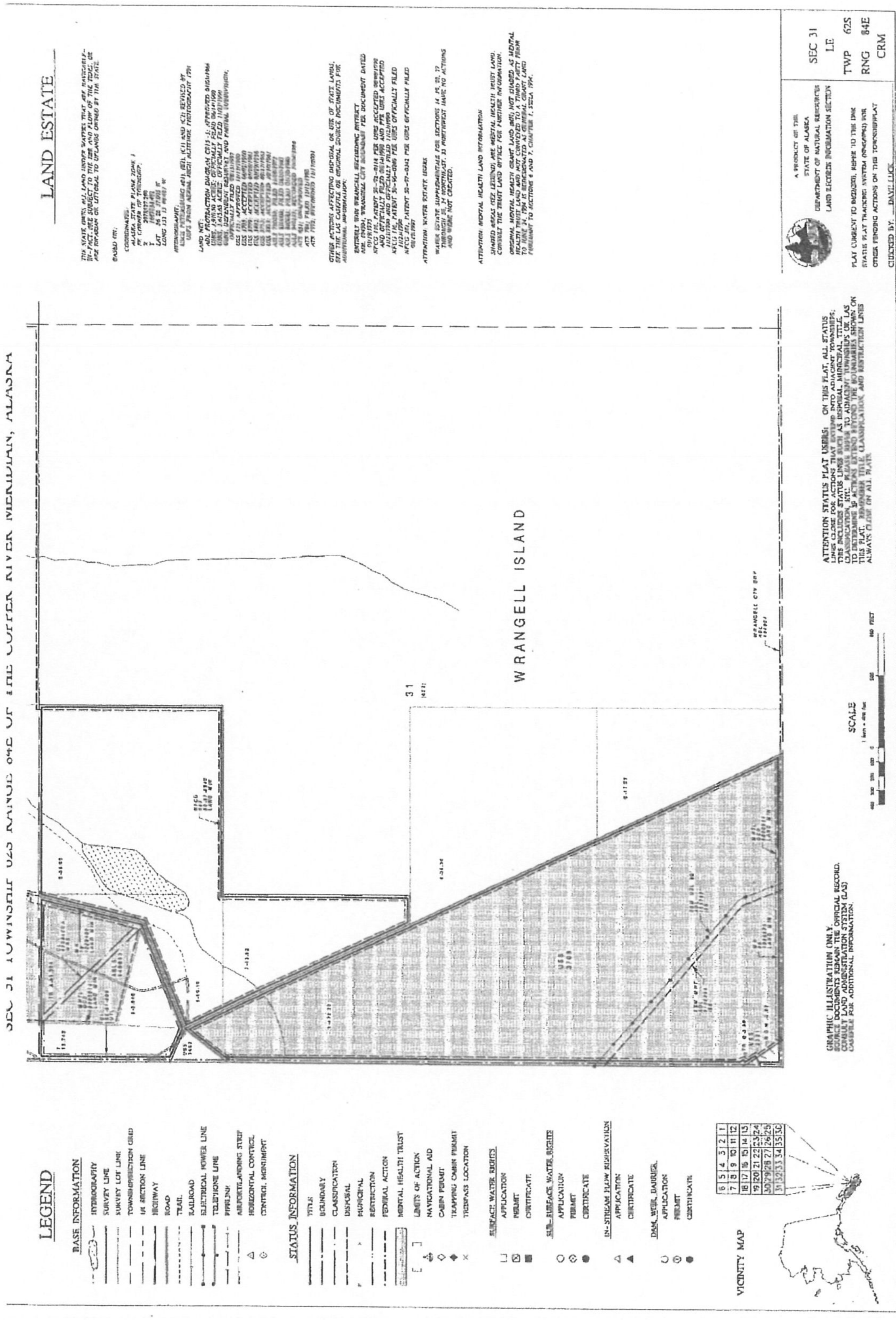
Document Year: 1997 Number: 000479 Suf: 0	District: 104 - WRANGELL
Date Recorded: 10/02/1997 *Time:* 12:14PM *Book:* 28 *Page:* 464 *Pages:* 3	
Index: D - DEEDS	
Desc: PATENT	
Grantor - ALASKA STATE OF	
Grantor - NATURAL RESOURCES DEPARTMENT OF	
Grantee - WRANGELL CITY OF	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C *Q.Quarter:*SE	
Location: Lot: 6	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 7	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	

Document Year: 1997 Number: 000479 Suf: 0	District: 104 - WRANGELL
Date Recorded: 10/02/1997 *Time:* 12:14PM *Book:* 28 *Page:* 464 *Pages:* 3	
Index: D - DEEDS	
Desc: PATENT	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C *Q.Quarter:*SE	
Location: Lot: 6	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 7	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 8	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 9	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 10	
Location: Section: 30 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Section: 31 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 5	
Location: Section: 31 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 6	
Location: Section: 31 *Township:* 062S *Range:* 084E *Meridian:* C	
Location: Lot: 7	
Location: Section: 31 *Township:* 062S *Range:* 084E *Meridian:* C	


PARTIALLY SURVEYED TOWNSHIP 62 SOUTH RANGE 84 EAST OF THE COPPER RIVER MERIDIAN, ALASKA
STATUS OF PUBLIC DOMAIN
LAND AND MINERAL TITLES
MTP
EASTERN PASSAGE
WRANGELL ISLAND
HIGHFIELD ANCHORAGE
ENLARGEMENT
SEE SUPPLEMENTAL PLAT NO 1
CURRENT TO
1-6-2004


MTP SUPPL_SEC 31
INDEX TO SEGREGATED TRACTS
FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS REFER TO INDEX OF MISCELLANEOUS DOCUMENTS
CR Mer
T. 62 S
R. 84 E
WRANGELL
ISLAND
31
SCALE
5 chains to the inch
WARNING STATEMENT


SEC 30 TOWNSHIP 62S RANGE 84E OF THE COPPER RIVER MERIDIAN, ALASKA
LAND ESTATE
LEGEND
BASE INFORMATION
STATUS INFORMATION
WRANGELL ISLAND
SCALE
VICINITY MAP
SEC 30
LE
TWP 62S
RNG 84E
CRM


SEC 31 TOWNSHIP 62S RANGE 84E OF THE COPPER RIVER MERIDIAN, ALASKA
LEGEND
BASE INFORMATION
HYDROGRAPHY
SURVEY LINE
SURVEY LOT LINE
TOWNSHIP/SECTION GRID
1/4 SECTION LINE
HIGHWAY
ROAD
TRAIL
RAILROAD
ELECTRICAL POWER LINE
TELEPHONE LINE
PIPELINE
AIRPORT/LANDING STRIP
HORIZONTAL CONTROL
CONTROL MONUMENT
STATUS INFORMATION
TITLE
BOUNDARY
CLASSIFICATION
DISPOSAL
MUNICIPAL
RESTRICTION
FEDERAL ACTION
MENTAL HEALTH TRUST
LIMITS OF ACTION
NAVIGATIONAL AID
CABIN PERMIT
TRAPPING CABIN PERMIT
TRESPASS LOCATION
SURFACE WATER RIGHTS
APPLICATION
PERMIT
CERTIFICATE
SUB-SURFACE WATER RIGHTS
APPLICATION
PERMIT
CERTIFICATE
IN-STREAM FLOW RESERVATION
APPLICATION
CERTIFICATE
DAM, WEIR, BARRIER
APPLICATION
PERMIT
CERTIFICATE
VICINITY MAP
WRANGELL ISLAND
31
SCALE
GRAPHIC ILLUSTRATION ONLY.
SOURCE DOCUMENTS REMAIN THE OFFICIAL RECORD.
CONSULT LAND ADMINISTRATION SYSTEM (LAS) CASEFILE FOR ADDITIONAL INFORMATION.
ATTENTION STATUS PLAT USERS:
LAND ESTATE
A PRODUCT OF THE STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
LAND RECORDS INFORMATION SECTION
SEC 31
LE
TWP 62S
RNG 84E
CRM

Appendix D

Cost Estimate

1.0 Goals for City of Wrangell Water Improvement Construction

- Increase availability of water
- Increase water plant capacity, currently operating at the maximum possible
- Increase water quality
- Increase safety of residents downstream of the dam
- Throughout improvement process, keep city water supply potable.

2.0 Basis of Design

This estimate has been prepared for the *Reconnaissance Report, Community Water Supply Supplementation, Wrangell, Alaska*, dated September 2006.

3.0 Construction Schedule

The construction periods are unknown at this time and will be dictated by the final alternative selection.

4.0 Construction Windows

Construction windows of all work are unknown at this time.

5.0 Overtime

This estimate contains overtime to complete the project because of the short construction seasons caused by local weather conditions.

Overtime was used in the development of this estimate for the following item costs:

- Quarry, drilling, and blasting work
- Drilling and grouting work
- High volume earthmoving work
- High volume concrete work

The standard contingency for a project of this nature is 25 percent.

6.0 Sub-Contracting Plan

The following are subcontractors on this project:

- Crushing and Batching Subcontractor (AH)
- Drilling Subcontractor (AG)
- Blasting Subcontractor (AI)
- Grouting Subcontractor (AK)
- Fencing Subcontractor (AF)
- Site Work Subcontractor ()

It is assumed that the prime contractor will do the remainder of work.

7.0 Project Construction

7.1 Site Access

The Wrangell Water Supply System consists of two earthfill dams and reservoirs that provide the main water supply to the City of Wrangell, Alaska. The two dams are located on Wrangell Island near the City of Wrangell, and are situated on a single drainage way southeast of the city. The site is accessed via the gravel road that the City Water Treatment Plant is located on. The road is at the end of Wood Street and is gated to prevent general access by the public. The Lower Dam is approximately 1 mile from the gate and the Upper Dam is approximately a ¼ mile further upstream.

7.2 Borrow Areas

The borrow sources for the new Wrangell earth embankments are as follows:

7.2.1 Impervious Core Material (SM)

The SM will be obtained by excavating the valley floor in the reservoir area. The SM material will be approximately 5 to 6 feet thick within the first 400 feet of the proposed dam. The silt will be underlain by clay-like sand to clay-like gravel, and will be approximately 4 to 6 feet thick. Additional clay-like gravel can be obtained up the valley to the extent of the investigations.

7.2.2 Random Fill Material

Random fill material will be obtained from the excavation of the valley floor.

7.2.3 Sand Filter, Cobbles or Gravel Bedding, Riprap, or Cobbles

The sand filter, cobbles or gravel bedding, riprap, or cobbles will be available by process crushing (simultaneously) materials from the spillway excavation, left abutment quarry, or access road quarry. At the quarry site and at a depth of about 15 feet, rocks of 8- to 24-inches in size are suitable for processing into riprap or cobble.

7.2.4 Concrete Aggregates

The borrow sources for concrete aggregates will be available by process crushing material from the same sources. Cement can be hauled in from outside sources and stored onsite.

7.2.5 Water Source for Earth Compaction and Concrete Production

The water source for earth compaction and concrete production will be available from surface water. Upstream of the embankment material sources, a small dike with a culvert will be built. This structure will be built to store water for earth compaction and concrete requirements. Groundwater may be a viable option, but no active wells exist in the vicinity of the construction site. The effects of water on properties of concrete should be investigated during the production of mix design trials.

8.0 Construction Methodology

The construction is standard dam construction. The site must be dewatered because water runs through the proposed damsite. The Upper Dam will divert water into a pipe for dewatering. This pipe will become part of the outlet and water treatment works.

9.0 Unusual Conditions

The upper topsoil layer is referred to as Muskeg. This soil is very high in organics and not suitable for construction. The muskeg layer will need to be removed from all new construction areas and may extend to a depth of 10 feet. No other unusual soil, water, or weather conditions are expected to occur at this site.

10.0 Unique Techniques of Construction

No unique construction techniques will be used during construction of the proposed dam.

11.0 Equipment and Labor Availability

Very little large equipment is available on Wrangell Island. Presently the FAA is extending the runway emergency length at the airport and there is large earthmoving and rock blasting equipment being used there. This job is supposed to be completed by the end of 2007. The large equipment for excavation, coring, drilling and earthmoving will need to be mobilized to the island.

There is a minimal labor workforce locally available. There are heavy equipment operators and general laborers available for hire. The recent construction of a new harbor in Wrangell used mostly the local workforce.

12.0 Environmental Concerns

- This estimate has built-in provisions for Monthly Anticipated Adverse Weather
- Delays, as specified in the contract clauses.
- This estimate acknowledges no amendments at this time.
- This work will not be performed by a contractor under the Small Business Administration 8a program.
- Prices are good for the period.

13.0 Evaluation of Dam and Water Treatment Alternatives

Time and material construction costs were developed for Government estimates for each dam and water treatment plant alternative. It is important to understand that these cost estimates were based on a conceptual design, and were completed without the benefit of detailed mapping and geotechnical investigations. Although every reasonable effort was made to ascertain the system construction requirements and associated costs, these estimates are based on reconnaissance-level information. Costs were development using a variety of sources, including previous successful bids, Davis Bacon labor rates, fuel adjusted equipment costs, equipment and material suppliers, contractors, and published construction cost data. In addition, considerable professional engineering experience and judgment were applied.

The following additional assumptions were made for the cost estimates:

- The 12-inch ductile pipeline to the upper reservoir must be finished. With water being diverted at the upper reservoir, reservoir clearing and grubbing and construction runoff from the building of the dam will not get into the City of Wrangell water supply.

- A new water storage tank and piping will be built near the existing water treatment storage tank. This tank will add water storage both during and after the construction period. This system will also allow repair and maintenance to be accomplished on both tanks in the future.

- The lower reservoir will be drained to allow stump removal, and dry up the soil at the damsite in preparation for dam construction and repair. Over the dam, water from the reservoir will be diverted into the 12-inch ductile pipeline. Wells around the new damsite will be dewatered.

- The reservoir below the Upper Dam will be cleared and grubbed, and all stumps will be removed. Removing stumps should help water quality in the future and reduce maintenance costs at the water supply plant.

- New dam construction and the reinforcement of the Lower Dam can begin.

- After the dams are complete, the lower two reservoirs will be filled up to the lower reservoir to allow for clearing and grubbing in the upper reservoir, and the Upper Dam will be removed.

- Water supply will be switched to the new lower two reservoirs where construction is complete. The upper reservoir will be drained. The upper creek will be diverted at the flume, and the lower creek will be diverted by a temporary pipeline.

- The upper reservoir will be cleared and grubbed, along with the removal of all stumps.

- The duration of this work is determined by the amount of water stored in the lower two reservoirs.

- Water treatment modification will start with the addition of two slow sand filters and one roughing filter in order to increase the availability of water. The water plant is currently running at capacity, and needs to be increased to meet current and future demands.

- A flood warning system will be added downstream of the dam.

14.0 Total Contract Cost Summary for New Dam Construction

The costs estimate summary for the construction of the new dam, rehabilitation of the Lower Dam and upgrading of the water treatment plant is located on pages D-8 thru D-12. The total project costs summary will account for inflation.

15.0 Evaluation of Sunrise Lake Water Conveyance Alternative

It is important to understand that the cost estimates for Sunrise Lake were based on a conceptual design, and were completed without the benefit of detailed mapping and geotechnical investigations. Although every reasonable effort was made to ascertain the system construction requirements and associated costs, these estimates are based on reconnaissance-level information. Costs were development using a variety of sources, including previous successful bids, Davis Bacon labor rates, fuel adjusted equipment costs, equipment and material suppliers, contractors, and published construction cost data. In addition, considerable professional engineering experience and judgment were applied.

The following items or costs have been excluded from this estimate:

- Land easement acquisition costs
- Environmental considerations
- Phased construction
- Future inflation beyond 1998
- Increasing the capacity of the water treatment plant
- Requirement to rehab or remove the two existing dam structures.

The following additional assumptions were made for the cost estimates:

- The marine pipeline costs include trench excavation, hauling and disposal of unsuitable material, bedding, and backfill. Trench restoration includes saw cutting. The estimates assume a batch plant in the Wrangell area. Road excavation road fill includes drainage ditches.

- All excavated material is unusable for the pipe in Zimovia Highway. Material is hauled and disposed offsite. A disposal site is located within 1 to 2 miles of the project area.

- All bedding and backfill for the Zimovia Highway pipe are imported materials.

- Because the utilities are much more extensive along the Zimovia Highway, construction would be more challenging and difficult than constructing the pipeline along the access road. Additionally it is likely the cost will be significantly higher than indicated in the estimate.

- For both trench and road excavation, it is assumed that all rock can be excavated/ripped, and that rock blasting would not be required or is minimal. If more extensive blasting is required, constructions costs will be higher than estimated. If blasting is required in residential or commercial areas, appropriate measures and precautions must be taken.

- For the access road to the water treatment plant, it is assumed that cut/fill is essentially balanced, and *in situ* soils are generally suitable for road construction and the road foundation (*e.g.*, minimal muskeg). The placement of excess shot rock will not be required to stabilize the road's foundation.

- Bedding material for the pipe in the access road to the water treatment plant is imported. The majority (50+ percent) of the excavated material is suitable for use as backfill. Improvements and/or modifications required at the water treatment plant consist of connecting the 16-inch transmission main to the 12-inch influent supply line just outside of the control building.

16.0 Summary of Costs for Sunrise Lake Alternative

The summary of costs that were prepared by RW Beck in 1998 for the Sunrise Lake Alternative is located in Page D-13. These costs do not include costs for upgrading the water treatment plant , addressing the safety issues of the existing dams, nor have the costs been escalated for inflation.

**** TOTAL PROJECT COST SUMMARY ****

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE CONCEPT DESIGNS, DATED: OCT 2006

PROJECT: Watersupply Improvements
LOCATION: Wrangell, Alaska

DISTRICT: Alaska/Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: OCT 2006 EFFECTIVE PRICING LEVEL: 1 OCT FY07 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2008 EFFECT. PRICING LEVEL: 1 OCT 07 COST ($K)	CNTG ($K)	TOTAL ($K)	SPENT THRU FY 06 ($K)	FULLY FUNDED ESTIMATE COST ($K)	CNTG ($K)	FULL ($K)
04---	DAM	19,763	4,941	25%	24,704	20,188	5,047	25,235		21,151	5,288	26,439
	TOTAL CONSTRUCTION COSTS ==>	19,763	4,941	25%	24,704	20,188	5,047	25,235		21,151	5,288	26,439
01---	LANDS AND DAMAGES											
21---	RECONNAISSANCE STUDIES								100			100
22---	FEASIBILITY STUDIES (Environmental Documents)	200	40	20%	240	204	40	244		204	40	244
30---	PLANNING, ENGINEERING & DESIGN	4,761	1,185	25%	5,946	4,863	1,210	6,073		4,977	1,238	6,215
31---	CONSTRUCTION MANAGEMENT	2,473	617	25%	3,090	2,526	630	3,156		2,646	659	3,305
	TOTAL PROJECT COSTS ========>	27,197	6,783	25%	33,980	27,781	6,927	34,708	100	28,978	7,225	36,303

____________________ CHIEF, COST ENGINEERING, Kim Callan

____________________ PROJECT MANAGER, Boguslaw Wierzbicki

TOTAL FEDERAL COSTS ==============> 36,303
TOTAL NON-FEDERAL COSTS ==========>

THE MAXIMUM PROJECT COST IS =======> $ ~~~~~~~ ~~~~~~~

THIS TPCS REFLECTS A PROJECT COST CHANGE OF $ ~~~~~~~

**** TOTAL CONTRACT COST SUMMARY ****

PROJECT: Watersupply Improvements
LOCATION: Wrangell, Alaska

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE CONCEPT DESIGNS, DATED: OCT 2006
DISTRICT: Alaska/Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

			CURRENT MCACES ESTIMATE PREPARED: OCT 2006 EFFECTIVE PRICING LEVEL: 1 OCT FY07				AUTHORIZ./BUDGET YEAR: 2008 EFFECT. PRICING LEVEL: 1 OCT 07				FULLY FUNDED ESTIMATE				
ACCOUNT NUMBER		FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
04---		PIPE LINE TO UPPER DAM/RESERVOIR 5,000,000 Water Storage Tank Clearing, Grubbing and Stump Removal, 37 Acre	2,032	508	25%	2,540	2.1%	2,076	519	2,595	1 QTR 09	2.1%	2,120	530	2,650
		TOTAL CONSTRUCTION COSTS ===>	2,032	508	25%	2,540		2,076	519	2,595			2,120	530	2,650
01---		LANDS AND DAMAGES													
22---		FEASIBILITY STUDIES (Environmental Documents)	50	10	20%	60	2.1%	51	10	61	1 QTR 08		51	10	61
30---		PLANNING, ENGINEERING & DESIGN													
	2.5%	Project Management	51	13	25%	64	2.1%	52	13	65	3 QTR 08	1.1%	53	13	66
	1.0%	Planning & Environmental Compliance	22	5	25%	27	2.1%	22	5	27	3 QTR 08	1.1%	22	5	27
	15.0%	Engineering & Design	308	77	25%	385	2.1%	315	79	394	3 QTR 08	1.1%	318	80	398
	1.0%	Engineering Tech Review & VE	22	5	25%	27	2.1%	22	5	27	3 QTR 08	1.1%	22	5	27
	1.0%	Contracting & Reprographics	22	5	25%	27	2.1%	22	5	27	3 QTR 08	1.1%	22	5	27
	3.0%	Engineering During Construction	62	16	25%	78	2.1%	63	16	79	1 QTR 09	2.1%	64	16	80
		Planning During Construction													
		Project Operation:			25%										
31---		CONSTRUCTION MANAGEMENT													
	10.0%	Construction Management	204	51	25%	255	2.1%	208	52	260	1 QTR 09	2.1%	212	53	265
		Project Operation:			25%										
	2.5%	Project Management	51	13	25%	64	2.1%	52	13	65	1 QTR 09	2.1%	53	13	66
		TOTAL COSTS ===============>	2,824	703	25%	3,527		2,883	717	3,600			2,937	730	3,667

****** TOTAL CONTRACT COST SUMMARY ******

PROJECT: Watersupply Improvements
LOCATION: Wrangell, Alaska

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE CONCEPT DESIGNS, DATED: OCT 2006
DISTRICT: Alaska/Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: OCT 2006 EFFECTIVE PRICING LEVEL: 1 OCT FY07				AUTHORIZ./BUDGET YEAR: 2008 EFFECT. PRICING LEVEL: 1 OCT 07				FULLY FUNDED ESTIMATE				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
04---	New 65 high Dam Seismic Retrofit Lower Existing Dam	14,009	3,502	25%	17,511	2.1%	14,310	3,577	17,887	1 QTR 10	4.2%	14,917	3,729	18,646
	TOTAL CONSTRUCTION COSTS ==>	14,009	3,502	25%	17,511		14,310	3,577	17,887			14,917	3,729	18,646
01---	LANDS AND DAMAGES													
22---	FEASIBILITY STUDIES (Environmental Documents)	50	10	20%	60	2.1%	51	10	61	1 QTR 08		51	10	61
30---	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	357	89	25%	446	2.1%	365	91	456	1 QTR 09	2.1%	373	93	466
1.0%	Planning & Environmental Compliance	143	35	25%	178	2.1%	146	36	182	1 QTR 09	2.1%	149	37	186
15.0%	Engineering & Design	2,146	536	25%	2,682	2.1%	2,192	548	2,740	1 QTR 09	2.1%	2,238	559	2,797
1.0%	Engineering Tech Review & VE	143	35	25%	178	2.1%	146	36	182	1 QTR 09	2.1%	149	37	186
1.0%	Contracting & Reprographics	143	35	25%	178	2.1%	146	36	182	1 QTR 09	2.1%	149	37	186
3.0%	Engineering During Construction	420	105	25%	525	2.1%	429	107	536	1 QTR 10	4.2%	447	112	559
	Planning During Construction			25%		2.1%								
	Project Operation:			25%		2.1%								
31---	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	1,401	350	25%	1,751	2.1%	1,431	358	1,789	1 QTR 10	4.2%	1,492	373	1,865
	Project Operation:			25%		2.1%								
2.5%	Project Management	350	87	25%	437	2.1%	358	89	447	1 QTR 10	4.2%	373	93	466
	TOTAL COSTS ===============>	19,162	4,784	25%	23,946		19,574	4,888	24,462			20,338	5,080	25,418

****** TOTAL CONTRACT COST SUMMARY ******

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE CONCEPT DESIGNS, DATED: OCT 2006

PROJECT: Watersupply Improvements
LOCATION: Wrangell, Alaska

DISTRICT: Alaska/Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER		FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: OCT 2006 EFFECTIVE PRICING LEVEL: 1 OCT FY07 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2008 EFFECT. PRICING LEVEL: 1 OCT 07 OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
12---		Remove Upper Dam Clearing, Grubbing and Stump Removal, 25 Acre	790	198	25%	988	2.1%	807	202	1,009	1 QTR 11	6.4%	859	215	1,074
		TOTAL CONSTRUCTION COSTS ===>	790	198	25%	988		807	202	1,009			859	215	1,074
01---		LANDS AND DAMAGES													
22---		FEASIBILITY STUDIES (Environmental Documents)	50	10	20%	60	2.1%	51	10	61	1 QTR 08		51	10	61
30---		PLANNING, ENGINEERING & DESIGN													
	2.5%	Project Management	22	5	25%	27	2.1%	22	5	27	1 QTR 09	2.1%	22	5	27
	1.0%	Planning & Environmental Compliance	9	2	25%	11	2.1%	9	2	11	1 QTR 09	2.1%	9	2	11
	15.0%	Engineering & Design	123	30	25%	153	2.1%	126	31	157	1 QTR 09	2.1%	129	32	161
	1.0%	Engineering Tech Review & VE	9	2	25%	11	2.1%	9	2	11	1 QTR 09	2.1%	9	2	11
	1.0%	Contracting & Reprographics	9	2	25%	11	2.1%	9	2	11	1 QTR 09	2.1%	9	2	11
	3.0%	Engineering During Construction	23	6	25%	29	2.1%	24	6	30	1 QTR 09	6.4%	26	6	32
		Planning During Construction			25%										
		Project Operation:			25%										
31---		CONSTRUCTION MANAGEMENT													
	10.0%	Construction Management	79	20	25%	99	2.1%	81	20	101	1 QTR 11	6.4%	86	21	107
		Project Operation:			25%										
	2.5%	Project Management	21	5	25%	26	2.1%	21	5	26	1 QTR 11	6.4%	22	5	27
		TOTAL COSTS ================>	1,135	280	25%	1,415		1,159	285	1,444			1,222	300	1,522

**** TOTAL CONTRACT COST SUMMARY ****

PROJECT: Watersupply Improvements
LOCATION: Wrangell, Alaska

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE CONCEPT DESIGNS, DATED: OCT 2006
DISTRICT: Alaska/Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: OCT 2006 EFFECTIVE PRICING LEVEL: 1 OCT FY07 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2008 EFFECT. PRICING LEVEL: 1 OCT 07 OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
04---	Water Treatment Plant Modification Adding 2 Slow Sand Filters and Roughing Filters	2,932	733	25%	3,665	2.1%	2,995	749	3,744	1 QTR 12	8.7%	3,255	814	4,069
	TOTAL CONSTRUCTION COSTS ===>	2,932	733	25%	3,665		2,995	749	3,744			3,255	814	4,069
01---	LANDS AND DAMAGES													
22---	FEASIBILITY STUDIES (Environmental Documents)	50	10	20%	60	2.1%	51	10	61	1 QTR 08		51	10	61
30---	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	78	20	25%	98	2.1%	80	20	100	1 QTR 09	2.1%	82	20	102
1.0%	Planning & Environmental Compliance	31	8	25%	39	2.1%	32	8	40	1 QTR 09	2.1%	33	8	41
15.0%	Engineering & Design	468	116	25%	584	2.1%	478	119	597	1 QTR 09	2.1%	488	122	610
1.0%	Engineering Tech Review & VE	31	8	25%	39	2.1%	32	8	40	1 QTR 09	2.1%	33	8	41
1.0%	Contracting & Reprographics	31	8	25%	39	2.1%	32	8	40	1 QTR 09	2.1%	33	8	41
3.0%	Engineering During Construction	88	22	25%	110	2.1%	90	22	112	1 QTR 12	8.7%	98	24	122
	Planning During Construction			25%										
	Project Operation:			25%										
31---	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	294	73	25%	367	2.1%	300	75	375	1 QTR 12	8.7%	326	81	407
	Project Operation:			25%										
2.5%	Project Management	73	18	25%	91	2.1%	75	18	93	1 QTR 12	8.7%	82	20	102
	TOTAL COSTS ================>	4,076	1,016	25%	5,092		4,165	1,037	5,202			4,481	1,115	5,596

TABLE 4-1
SUNRISE LAKE WATER SUPPLY AND HYDROELECTRIC PROJECT
CONSTRUCTION COST ESTIMATE SUMMARY

FERC Account Code	Description	Total Project Cost	Water Component	Hydro Component
60	MOBILIZATION	$ 335,000	$ 188,000	$ 147,000
330	LAND AND LAND RIGHTS			-
331	STRUCTURES AND IMPROVEMENTS			
331.1	Powerhouse	519,000	52,000	467,000
331.2	Switchyard	100,000		100,000
332	RESERVOIR, DAM AND WATERWAY			
332.1	Reservoir	44,000	44,000	-
332.2	Dam, Concrete-Faced Rockfill	278,000	278,000	-
332.3	Waterway			
332.31	Siphon Intake	295,000	249,000	46,000
332.32	Penstock	1,982,000	1,216,000	766,000
332.33	Water Supply/Marine Pipeline	2,344,000	2,344,000	
332.34	Booster Pump and Transmission Main	923,000	923,000	
333	TURBINES AND GENERATORS	1,220,000		1,220,000
334	ACCESSORY ELECTRICAL EQUIPMENT	110,000	40,000	70,000
335	MISCELLANEOUS POWER PLANT EQUIPMENT	190,000	100,000	90,000
336	ROADS, JETTY	299,000	299,000	-
380	TRANSMISSION & INTERCONNECTION	1,395,000	20,000	1,375,000
	DIRECT CONSTRUCTION COST (Bid 1/98) (rounded)	$10,030,000	$5,750,000	$4,280,000
	Contingencies	2,510,000	1,440,000	1,070,000
	Engineering & Owner Administration	2,510,000	1,440,000	1,070,000
	TOTAL CONSTRUCTION COST (Bid 1/98)	$15,050,000	$8,630,000	$6,420,000
	Escalation	920,000	530,000	390,000
	TOTAL CONSTRUCTION COST (Bid 1/00)	$15,970,000	$9,160,000	$6,810,000
	Interest During Construction			230,000
	TOTAL INVESTMENT COST (Rounded)			$7,040,000

Appendix E

Public Involvement

City of Wrangell
Community Water Supply Reconnaissance Study
Public Information Meeting Summary

A public information meeting was held on July 26, 2006 in the City Community Center Wrangell, Alaska with a total of 12 participants attending the open house and formal meeting with breakout session.

Meeting participants included City of Wrangell staff, Alaska State Department of Natural Resources representatives, media and local citizens.

Table 1 contains the presenters and panel for the meeting.

Table 1
Presenters and Panel
Public Information Meeting

Wrangell, Alaska
July 26, 2006

Yvonne Gibbons	Geotech and Civil Design, Walla Walla District
Karl Pankaskie	Cost Engineering, Walla Walla District
Diane Karnish	Plan Formulation Section, Walla Walla District
Dave Dankel	Plan Formulation Section, Walla Walla District
Bo Wierzbicki	Project Management, Alaska District
Lizette Boyer	Planning, Environmental Compliance, Alaska
Bob Prunella	City Manager, Wrangell
Charlie Cobb	Safety Engineer, Alaska Department of Natural Resources

The public meeting had the following four major objectives:

- Present draft alternatives to the public.
- Provide public understanding of potential projects and process.
- Create an opportunity for public questions/answers about the plan.
- Receive public input on concerns, issues and ideas.

The meeting began with an open house where participants were able to view drawings and the draft alternatives about the potential project and to discuss one-on-one with technical staff. The formal portion of the meeting began with a welcoming from Bob Prunella, City Manager of Wrangell and a brief history of the community's water supply issues. Dave Dankel, planner and meeting facilitator with the Corps of Engineers, gave a brief explanation of the objectives of the meeting and outlined the agenda. Bo Wierzbicki, Project Manager, gave a PowerPoint presentation that discussed the reconnaissance study purpose and scope as well briefly detailing the various alternatives that have been evaluated to this point in the study. Bo presented six draft alternatives to consider for providing an upgrading of Wrangell's community water supply, storage and treatment systems. Following the presentation a panel of team members fielded questions from the audience. During the questions and answers, participants had the opportunity to inquire or comment about the various draft alternatives under consideration.

A workshop session facilitated by Dave Dankel followed that was designed to have participants identify and prioritize issues, concerns, and visions for the future of Wrangell's water system. Two questions were provided to the participants in a small group setting. All issues, concerns, and ideas that originated from the participants were listed on a flip chart for each question by note taker Diane Karnish. Participants were then asked to select their most significant issues/concerns and future visions. The responses are listed by number and rated according to participant's prioritization. Numerals positioned beside some of the responses represent the number of individuals who identified the concern or action as most significant to them. Figures 1 and 2 are photographs of the public meeting, while table 2 contains the questions discussed in the breakout sessions and the participant responses.

Table 2 – Discussion Questions and Participant Responses	
1. What do you see as Wrangell's water supply issues?	
10	**Quantity and quality**
2	**Safety concerns (fire protection)**
	Limited economic development
	Inadequate infrastructure
	Safety concerns (dams)
	Storage capacity limits
	Treatment plant size
	Operations and Maintenance funding (rate increases)
	Distribution issues (expand use area)

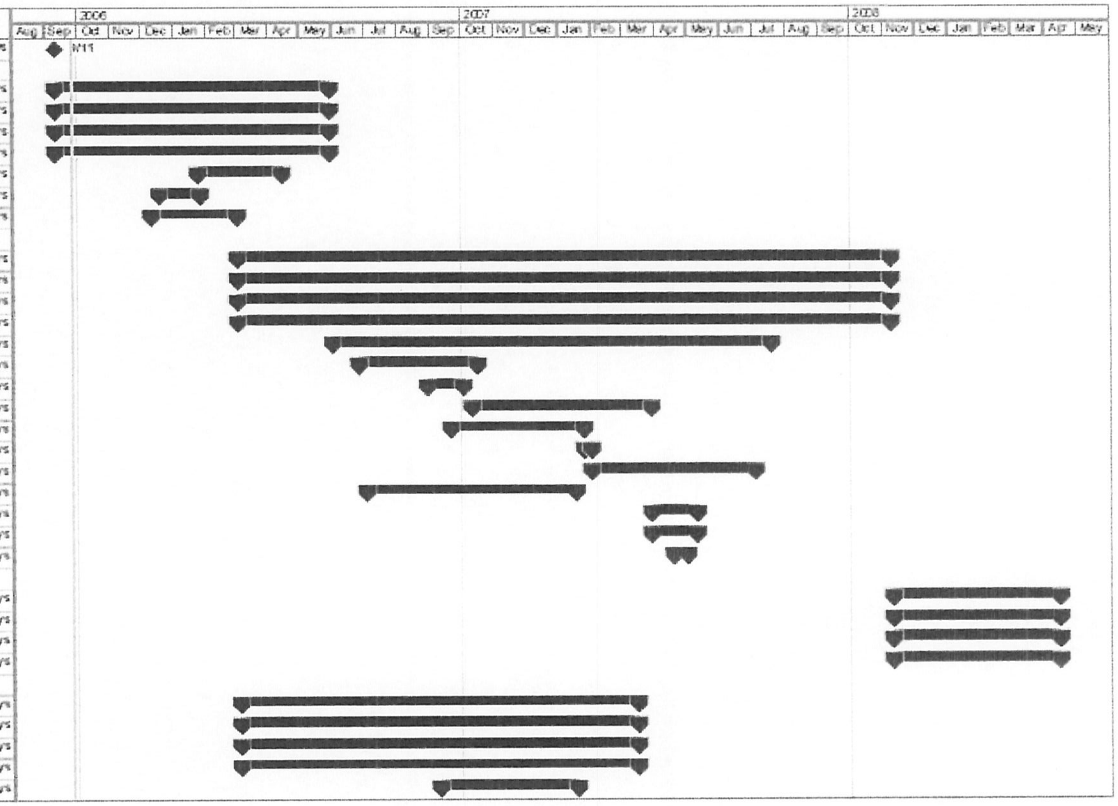
Table 2 – Discussion Questions and Participant Responses (continued)	
2. What actions do you think would help provide a future water supply for Wrangell?	
3	Dams first – phase II Sunrise Lake
3	Expansion of water treatment plant and storage capacity (treated)
2	Multiple sources for water back-up supply
1	Desalination (hydropower)
1	Sunrise Lake
1	Good, solid alternatives analysis
1	Lobbying for funding, dam safety legislation & appropriations (people of Wrangell)
	Metered water use/user fees
	Increase public awareness


2006/07/26

Appendix F

Construction Schedule

ID	Task Name	Duration
1	WRANGELL WATER SUPPLY IMPROVEMENT	0 days
2		
3	PIPE TO UPPER DAM, TANK & CLEAR & GRUBB	187 days
4	RESERVOIRS-LOWER RESERVOIR & NEW R	187 days
5	RESERVOIRS	187 days
6	MOBILIZATION & DEMOBILIZATION	187 days
11	CLEARING, DEBRIS & STUMP REMOVAL	57 days
18	PIPELINE EXTENDED TO UPPER RESER	29 days
24	WATER STORAGE TANK & PIPING	60 days
33		
34	NEW MID & MODIFY LOWER EARTH DAMS	440 days
35	DAMS (COMPACTED EARTH FILL)	440 days
36	MAIN DAM - EARTHEN STRUCTURE	440 days
37	MOB., DEMOB., AND PREWORK	440 days
52	SITE ACCESS ROADS & PARKING	296 days
71	FOUNDATION WORK	80 days
91	EARTHWORK FOR STRUCTURES	24 days
98	COMPACTED EARTH DAM	121 days
118	EARTHWORK FOR STRUCTURES	90 days
125	FOUNDATION WORK SPILLWAY	5 days
128	SPILLWAY OVERFLOW SECTION	110 days
142	OUTLET WORKS - 48" & 12" DIA	142 days
174	AUXILIARY DAM - (LOWER DAM MODS)	31 days
175	EARTH & ROCKFILL DAM MODIFICATION	31 days
188	OUTLET STRUCTURE (EXTENSION)	9 days
193		
194	REMOVE UPPER DAM & CLEAR/GRUBB	112 days
195	RESERVOIR - UPPER RESERVOIR	112 days
196	RESERVOIR	112 days
197	CLEARING AND DEBRIS REMOVAL	112 days
210		
211	WATER TREATMENT PLANT MODIFICATION	270 days
212	DAMS	270 days
213	MUNICIPAL & INDUSTRIAL WATER	270 days
214	MOB, DEMOB & PREPARATORY WORK	270 days
219	WATER SUPPLY SYSTEM	94 days



Project: WRANGELL SCHEDULE 9 2t
Date: Tue 9/26/06

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

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