208 Areawide Water Quality Management Plan

Municipality of Anchorage

January 1979

ACKNOWLEDGEMENTS

This document presents a plan for protecting water quality in the Anchorage, Alaska, area. The emphasis is on controlling pollution from urban runoff and erosion from urbanizing areas, snow disposal sites, and onsite wastewater disposal systems.

The plan is a product of the efforts of many organizations and agencies. Those most involved from the Municipality of Anchorage staff include Lee Browning and Enayat Aziz of the Department of Public Works, Mike Meehan and Bruce Phelps of the Planning Department, and Rolf Strickland of the Department of Health and Environmental Protection. Other major contributors to the planning process included Col. George Robertson, Lt. Gary Liepitz and Tom Murdock of the U.S. Army Corps of Engineers. Special thanks are also due to Mr. Elliot Lipson of the Alaska Department of Environmental Conservation and Mr. Stan Brust of the U.S. Environmental Protection Agency.

Consultants on the project included Woodward-Clyde Consultants and CH2M HILL. Woodward-Clyde Consultants assisted the U.S. Army Corps of Engineers in developing urban runoff controls for developed areas in the study area. These areas included the Chester, Ship, and Fish Creeks, Lakes Hood and Spenard and the Knik Arm drainage basins. CH2M HILL assisted the Municipality of Anchorage in development of controls for urban runoff in developing areas, most notably Campbell Creek basin, and control of onsite wastewater disposal systems. They also assisted the U.S. Army Corps of Engineers in development of alternatives for snow disposal sites.

This report was financed through a grant from the U.S. Environmental Protection Agency to the Municipality of Anchorage.

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Chapter 1
INTRODUCTION

This report presents the draft areawide waste treatment management plan for the Municipality of Anchorage. The draft plan is the result of 2 years of technical research on the water quality needs of the area by the Municipality of Anchorage, the Corps of Engineers, and consultants. The plan combines a number of best management practices for nonpoint pollutant sources into a coordinated attack on the major water quality problems of the Anchorage area.

WHAT IS 208 PLANNING?

This plan is a result of Section 208 of Public Law 92-500, popularly known as the 1972 Clean Water Act. Under Section 208, state governors can designate special areas where there is a concern for existing and/or future water quality. These areas are then eligible to receive grants under Section 208 to carry out a 2-year planning program to develop specific management plans for maintaining and improving water quality. The Municipality of Anchorage, which comprises an area of 1,700 square miles, was designated by Governor Hammond as a 208 planning area because of the impacts of urbanization on water quality in the area. The planning area boundaries are shown on Figure 1-1.

The plan focuses on the urban and urbanizing areas within the Municipality. The approximate urban area is highlighted on Figure 1-1. Only about 240 square miles of the Municipality is classified as developable land. The remainder of the Municipality is undevelopable, primarily mountainous terrain.

In addition to designating the area, the Governor must designate an agency to carry out the planning. The Municipality of Anchorage was designated by the Governor and undertook the management of the 208 program. The U.S. Army Corps of Engineers and various consulting firms were employed by the Municipality to help produce the information needed to develop a plan.

WHAT ARE THE WATER QUALITY GOALS?

The 1972 Clean Water Act, which created the 208 planning process, mandates the achievement of two national goals: (1) "That wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation

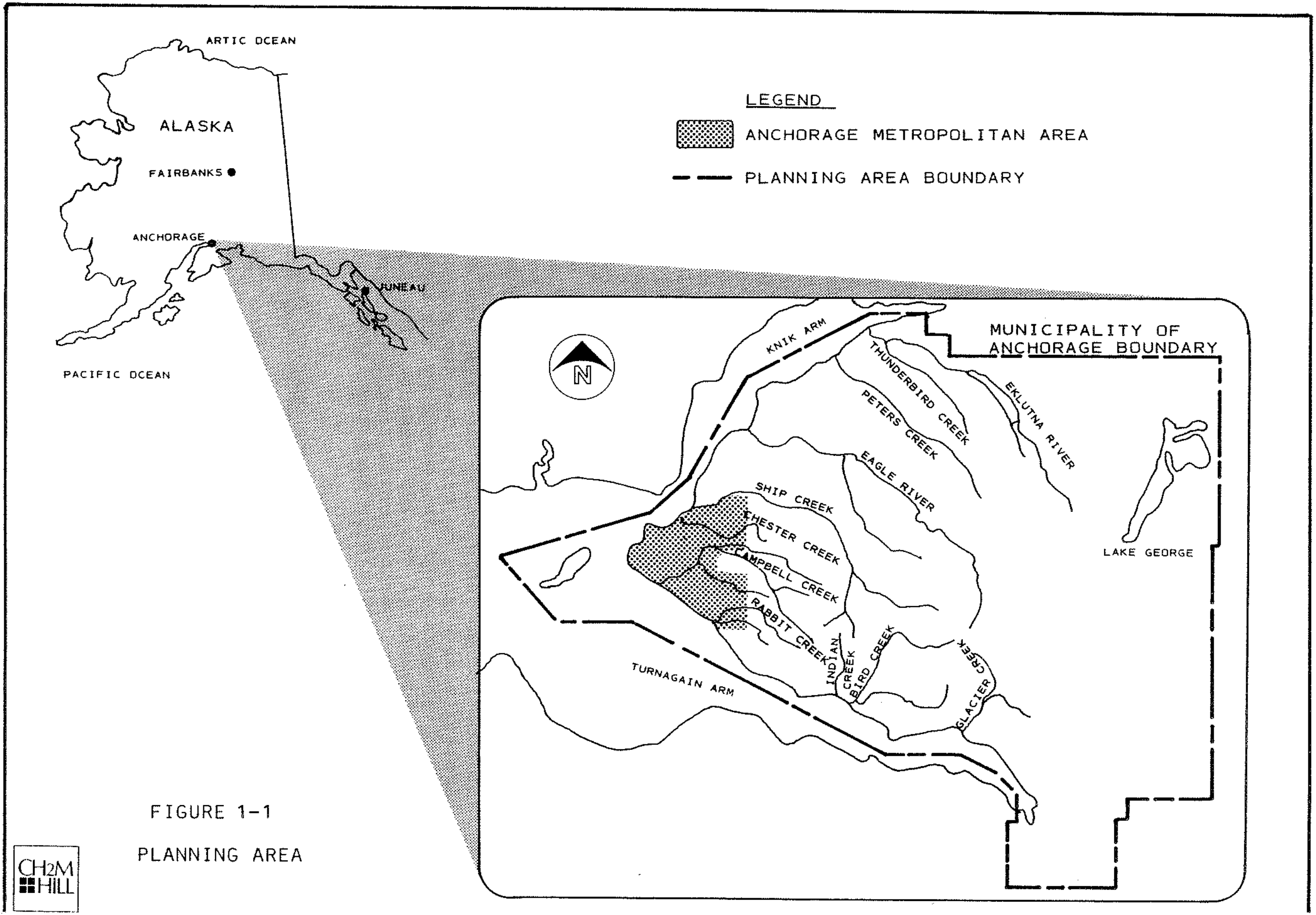


FIGURE 1-1

PLANNING AREA

CH2M HILL

in and on the water be achieved by July 1, 1983," and (2) "That the discharge of pollutants into navigable waters be eliminated by 1985." The interim goal, commonly referred to as the fishable/swimmable goal, is the primary objective of 208 planning.

In Anchorage, natural conditions like low flows and low temperatures make fishable/swimmable conditions unattainable in some streams. Irreversible activities associated with development, like channelization, have also made fishable conditions unattainable. Therefore, a water quality goal was developed specifically for Anchorage which achieved fishable/swimmable conditions where they appeared possible. This goal also protected all the existing water uses in the area.

A water quality management plan was drafted to achieve that water quality goal. In order to achieve it, the plan had to contain certain elements which were controversial in one way or another. Some elements were considered by certain people and agencies to have excessively high costs. Others were questioned from the standpoint of technical, legal, or administrative feasibility. Still others were judged by some to have significant negative environmental and socio-economic impacts. Therefore, a second, less ambitious water quality goal was designed based on continuation of existing practices only.

In contrast, certain people and agencies felt that neither of the two water quality goals adequately protected the existing and possible future water uses in the area. Therefore, an ambitious water quality goal was designed to protect more uses in more streams within the study area. One of these uses was drinking water supplies in the surface waters within the urban area.

These three alternative water quality goals were assumed to provide a reasonable choice among different water quality approaches. Water quality management plans were developed to achieve each of the three alternative water quality goals. Of course, a whole spectrum of water quality goals, ranging from the least ambitious based on existing practices to the most ambitious described above, could be generated by mixing elements of the three alternative goals and associated management plans. Therefore, in reality, this report offers many more than three alternatives.

WHAT IS THE APPROACH TO WATER QUALITY MANAGEMENT?

The purpose of a 208 areawide waste treatment management plan is to develop management controls of pollution sources on an areawide basis in order to achieve water quality levels consistent with desired beneficial uses of the water.

In general, a 208 plan is to consist of a set of implementable actions which include the following:

- o The identification of needed industrial and municipal waste treatment facilities over a 20-year period, including the establishment of construction permits and regulatory programs to assure the implementation of identified control measures.

- o The identification, where appropriate, of controls and programs for all significant nonpoint sources of pollution including the following:

  1. urban storm runoff
  2. agricultural activities
  3. forest land runoff and logging activities
  4. urban land development and construction activity
  5. mining and subsurface excavations
  6. solid waste disposal activities
  7. saltwater intrusion into freshwater

In addition, a 208 plan is to identify a planning process by which effective management of all waste sources will be continued in the future.

The Anchorage 208 work plan does not address all of the above objectives. It deals specifically with the control and management of urban runoff and soil and erosion control. In the Municipality's 208 grant application work plan (May 14, 1976, and May 24, 1976), a broad range of planning activities was identified. In the EPA's notification of grant award to the Municipality of Anchorage (May 26, 1976), funds were limited to programs relating to urban runoff needs. This limitation was done for two reasons:

1. Funds were not available to cover other elements identified in the Municipality's grant application work program.

2. The U.S. Army Corps of Engineers, Alaska District, was conducting a concurrent urban studies program for the Municipality of Anchorage (referred to as the MAUS Study). This program addressed a wide range of water resources planning needs, including a wastewater management program which provided for 201-type wastewater treatment facilities planning.

The relationship between the MAUS study and the 208 study is illustrated on Figure 1-2. Those responsible for each report are also identified on the figure. The MAUS study and the 208 planning study will be integrated in a summary report at the completion of the two studies.

WHAT HAS BEEN ACCOMPLISHED SO FAR?

The water quality management process has been organized to address the 16 planning elements defined in the Environmental Protection Agency's (EPA's) Regulations on Preparation of Water Quality Management Plan (40 CFR 131.11(a-p)). The degree to which the Municipality of Anchorage must address each of these 16 elements is described in a document entitled "Municipality of Anchorage 208 Water Plan." This information is summarized on Table 1-1. Most of these elements are covered in summary form in this report. More complete presentations of the material are included in other reports financed through the 208 grant from EPA to the Municipality of Anchorage or through the MAUS study. These 20 reports are listed below:

1. CH2M HILL. 20 January 1979. Task Memorandum Number 7, Methodology Manual.

2. CH2M HILL. August 1978. Criteria and Siting of Snow Disposal Operations.

3. CH2M HILL. July 1978. Task Memorandum Numbers 4 and 5, Formulation and Evaluation of Alternatives.

4. CH2M HILL. May 1978. Snow Disposal Impact Analysis.

5. CH2M Hill. May 1978. Task Memorandum Number 3, Definition of Water Quality Problem Areas.

6. CH2M HILL. February 1978. Task Memorandum Number 2, Computer Model Selection and Calibration.

7. CH2M HILL. January 1978. Possible Methods to Control Urban Runoff Pollution.

8. CH2M HILL. September 1977. Task Memorandum Number 1, Existing Drainage System and Available Environmental Data.

9. Corps of Engineers, Alaska District. November 1978. M.A.U.S. Snow Disposal Study, Draft.

10. Corps of Engineers, Alaska District. November 1978. StormwaterQuality Management Plan for Existing Urban Areas, Draft.

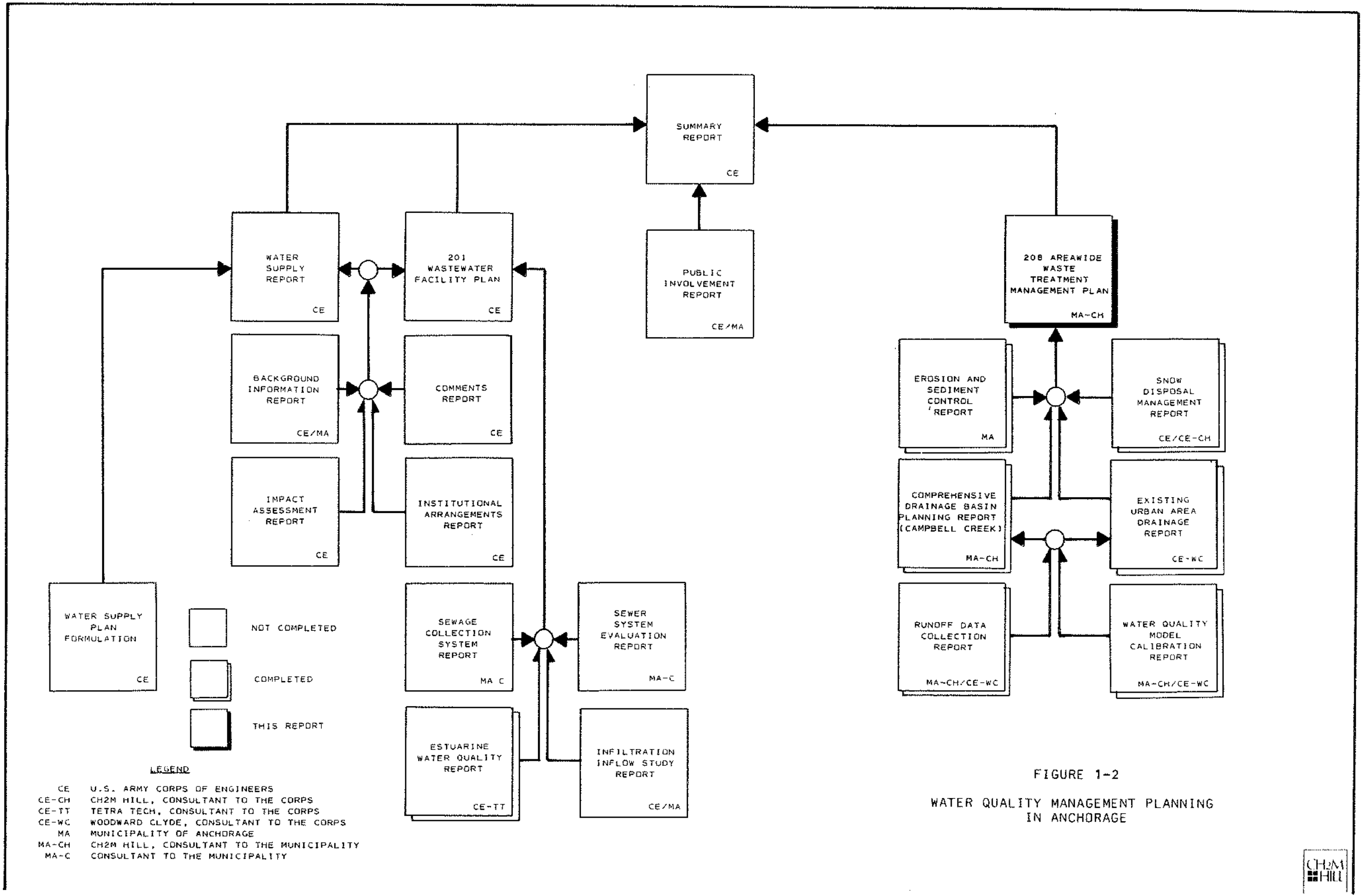


FIGURE 1-2

WATER QUALITY MANAGEMENT PLANNING IN ANCHORAGE

Table 1-1
Scope of Work

Item	Description	Reference: This Report	Reference: Other Reports (1)
1. Planning boundaries	Will be fully delineated along with information showing stream classifications and monitoring stations.	Chapter 1 Chapter 4 Chapter 5	5, 10, 14, 15, 17
2. Water quality assessment and segment description	Existing water quality will be characterized. Pollutant loads from runoff will be determined. An assessment of impacts will be made with respect to water quality standards and uses.	Chapter 5	5, 10, 15, 17
3. Inventories and projections	Existing demographic, economic and land use projections will be used and summarized. They will serve as the basis for projecting runoff loads.	Chapter 3	5, 8, 10, 12, 15, 18
4. Nonpoint source assessment	Will be accomplished for urban runoff and snowmelt only.	Chapter 5 Chapter 6	4, 5, 9, 10, 12, 15, 17
5. Water quality standards	Will be included.	Chapter 4	5, 10, 15, 17
6. Total maximum daily loads	Will be determined for runoff design events and on average annual basis.		5, 15, 18
7. Point source load allocations	Will be addressed in MAUS Study, not in initial 208 Plan.		
8. Municipal waste treatment systems	Will be addressed in MAUS Study, not in initial 208 Plan.		
9. Industrial waste treatment systems	Will be addressed in MAUS Study, not in initial 208 Plan.		
10. Nonpoint source control needs	Will be fully addressed only for urban drainage related elements.	Chapter 6 Chapter 7	2, 3, 7, 9, 10, 13, 15, 16
11. Residual waste control needs	Will be addressed for urban runoff control measures involving treatment facilities.		
12. Urban and industrial storm water systems needs	Improvements will be completely defined for those areas studied.	Chapter 8	2, 3, 9, 10, 13, 15, 16
13. Target abatement dates	Will be developed.	Chapter 9	
14. Regulatory programs	Will be defined and partially implemented.	Chapter 8	2, 3, 9, 10, 13, 15, 16
15. Management agencies	Have been identified. A thorough description of implementation responsibilities will be developed.	Chapter 9	2, 3, 9, 10, 13, 15, 16
16. Environmental, social economic impact	Will be prepared in conjunction with each plan report.	Chapter 7 Chapter 9	3

(1) Refer to list of reports in text of this chapter.

11. Corps of Engineers, Alaska District. 1977. Water Quality Data Report, Chester Creek, Ship Creek, Eagle River.

12. Corps of Engineers, Alaska District. June 1977. Stage Two Report, Metropolitan Anchorage Urban Study.

13. Municipality of Anchorage, Public Works Department, Engineering Division. November 1978. Erosion and Sedimentation Control, Municipality of Anchorage.

14. Municipality of Anchorage, Department of Public Works and Planning. January 1977. Final 208 Work Plan.

15. Woodward-Clyde Consultants, September 1978. Study of Storm Water Quality Management, Urbanized Areas of Anchorage, Alaska.

16. Woodward-Clyde Consultants. August 1978. Technical Memorandum Number Five, Alternative Control Measures.

17. Woodward-Clyde Consultants. August 1978. Technical Memorandum Number Four, Assessment of Pollution Significance.

18. Woodward-Clyde Consultants. May 1978. Technical Memorandum Number Three, Selection of Test Events and Generation of Pollutant Washoff.

19. Woodward-Clyde Consultants. March 1978. Technical Memorandum Number Two, Runoff Model Calibration.

20. Woodward-Clyde Consultants. October 1977. Technical Memorandum Number One, Drainage Basin Description.

The goal of this plan is to provide a process which will lead to a water quality acceptable to the local citizens, the Municipality of Anchorage, the State of Alaska, and the Federal Government. In order to reach this goal, this report has sought to answer the following questions:

- What are the existing water uses, environmental conditions, and public works and land use practices which will provide the foundation for the alternative water quality management plans (Chapters 2 and 3)?

- What are the water quality goals for the local citizens, the State and the Federal Government (Chapter 4)?

- What are the existing and future water quality problems and what are the contaminant sources causing these problems (Chapter 5)?

- What are the water quality management alternatives to alleviate or eliminate the water quality problems (Chapter 6)?

- What appear to be the relative merits of the alternative water quality management plans (Chapter 7)?

- What are the elements of the recommended management plan (Chapter 8)?

- How can this plan be implemented (Chapter 9)?

WHAT HAPPENS NOW?

This draft plan is only one step of the 208 planning process. In order to translate this document into a series of actions related to water quality control, the following steps must yet be taken:

- A water quality management plan must be approved by the Municipality of Anchorage.

- The Governor must certify the Plan.

- The Environmental Protection Agency must approve the Plan.

- Agencies at the local, State, and Federal levels must act where called upon in the Plan.

No 208 planning process to date anywhere in the country has yet to result in an unconditionally approved plan by the governor and in a coordinated effort to enhance water quality. The Municipality has attempted to improve the chances for implementation of this Plan (1) by aspiring to reasonable goals rather than to lofty ideals, (2) by considering and incorporating the needs of local citizens and State agencies throughout the formation of this Plan, (3) by using existing laws, agencies, and customs wherever possible, and (4) by identifying clearly who is responsible for doing what action under what authority, at what cost, and for what purpose.

Chapter 2
DESCRIPTION OF EXISTING CONDITIONS

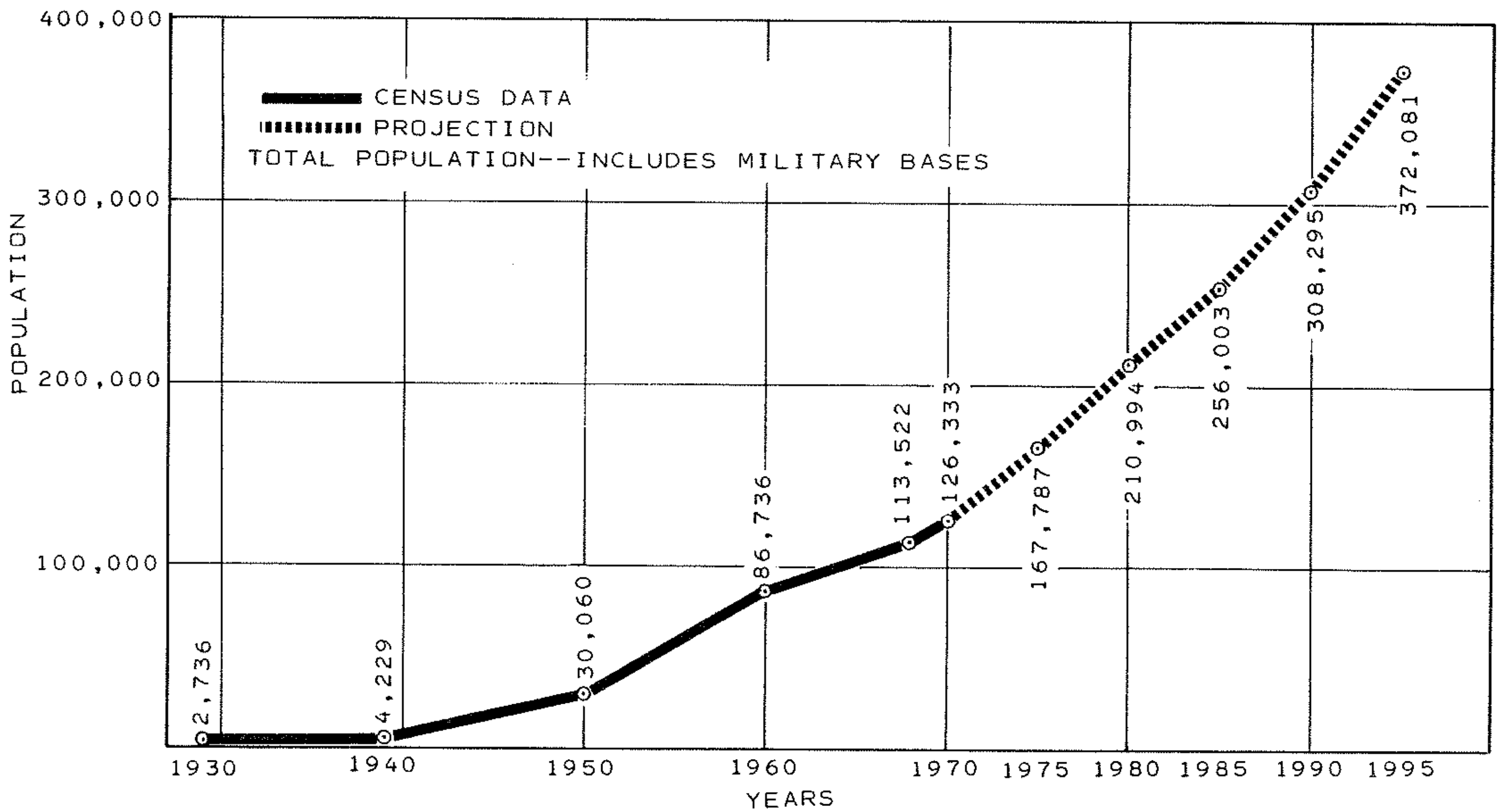
Inasmuch as planning is preparation for the future, knowledge of current conditions and projections is mandatory. These data justify proposed plans. This section describes projected population, environmental features that affect water quality, and current water uses.

POPULATION

There are many factors that will affect future growth in the Anchorage area. Among the most significant are federal policy decisions on Outer Continental Shelf leasing; State decisions on investment and taxation policies; native corporation investment decisions; and State and native petroleum leasing policies. The rate of growth will depend largely on the level of petroleum development. Because of these uncertainties, accurate population projections, even for the near term, are impossible. However, it can be concluded that the Anchorage area will certainly experience rapid growth, at least doubling in population within the next 20 years. Since more population will undoubtedly increase the potential for pollution, this forecast greatly influences 208 planning.

Based on econometric modeling, detailed population projections (taken from the AMATS Long Range Element 1977-1995) indicate past growth trends are expected to continue (see Figure 2-1), sending the population of Anchorage from 167,787 (1975) to 372,000 in 1995. Table 2-1 shows the interim population growth in 5-year increments.

Although there is population growth expected in all areas of the city, the increases are expected to be most dramatic in the Sand Lake area and the area south of Dimond Boulevard, Abbott, and Muldoon, which are both located within the Campbell Creek basin.



SOURCE: AMATS LONG RANGE ELEMENT 1977-1995

FIGURE 2-1

ANCHORAGE POPULATION 1929-1995

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Table 2-1
Anchorage Population Projections (1)

	Population	
Year	AMATS Projection (Component Method)	MAUS Projections
1975	167,787	---
1980	210,994	205,775
1985	256,003	267,610
1990	308,295	317,934
1995	372,081	376,652

(1) Population figures include an estimated constant military population of 18,897 for AMATS and 21,000 for MAUS.

Sources: AMATS Long Range Element 1977-1995
U.S. Army Corps of Engineers, Alaska District
Metropolitan Anchorage Urban Study Stage 2 Report

LAND USE

As discussed in detail in the subsequent chapter, changes in land use also cause changes in water quality. Absent controls, the more an area is urbanized the lower the quality of the area's streams and lakes. The information in this section on existing land uses and projected land use changes was taken from the AMATS Long Range Element 1977-1995 and the Metropolitan Anchorage Urban Study, Stage Two Report.

Existing Land Use

Table 2-2 gives a breakdown of existing land use for the entire Anchorage area and Table 2-3 presents land use information by major drainage basin. Of the major basins, Fish Creek and Chester Creek are the most highly urbanized, while Campbell Creek and Ship Creek are the least. Campbell Creek basin has the largest amount of vacant but developable land.

Anchorage is an evolving multicentered urban area. There are two major commercial centers, the central business district (CBD) and the commercial strip along Northern Lights Boulevard. The CBD is the major employment center in

Table 2-2
AMATS Summary of 1975 and 1995 Land Use

Land Use Category	1975 Acreage	1975 Percent of Developed Land (not inc. military)	1995 Acreage	1995 Percent of Developed Land (not inc. military)	Change in Acreage	% Change of Total Area
Residential	11,627	38.1	15,266	30.2	+ 3,639	+ 31.3
Commercial	1,930	6.3	7,546	14.9	+ 5,616	+291.0
Industrial	567	1.9	986	2.0	+ 419	+ 73.9
Public/Semi-Public	2,523	8.3	2,920	5.8	+ 397	+ 15.7
Water & Recreation	2,446	8.0	7,535	14.9	+ 5,089	+208.1
Highways	6,608	21.7	11,645	23.1	+ 5,037	+ 76.2
Transportation, Communication, Utilities	4,800	15.7	4,578	9.1	- 222	- 4.6
Military	87,110	--	87,110	--	-19,975	- 45.2
Vacant	43,694	--	23,719	--		
TOTAL AREA	161,305	--	161,305	--		
TOTAL DEVELOPED	30,501	100.0	50,476	100.0	+19,975	+ 65.5

Table 2-3
Total Existing Land Use Composition
By Drainage Basin (in acres)

Drainage Basin	Residential: Single Family	Residential: Multi-Family	Commercial	Industrial	Vacant	Total	Percent Developed
Campbell Creek	3,962	393	152	2,034	14,108	20,649	32
Chester Creek	2,354	1,913	1,386	341	4,317	10,311	58
Ship Creek	69	428	588	828	5,350	7,263	26
Fish Creek	839	606	727	50	1,021	3,243	69
Lakes Hood & Spenard	10	2	135	690	623	1,460	57
Knik Arm	150	451	287	1,109	7,381	9,377	21
TOTALS	7,384	3,793	3,275	5,052	32,800	52,303	37

SOURCE: Woodward-Clyde Consultants, Draft Stormwater Management Study: Technical Memorandum Number One, Drainage Basin Description, for Alaska District Corps of Engineers

Anchorage. However, difficult access to the downtown area has contributed to the development of new commercial activity, particularly in the Northern Lights - C Street area. It is anticipated that this area's importance will increase in the future as commercial and office uses expand into the vacant areas. Three major clusters of industrial and wholesaling developments are located in the Ship Creek-Port-Merril Field area, the area surrounding International Airport, and the area bordering the Alaska Railroad south of International Airport Road.

The major centers of high density residential development are in Government Hill, Fairview, Mountain View, and Spenard. Moderate residential densities are in Spenard, Inlet View-Fairview, Mountain View, City View, and parts of Muldoon and Sand Lake. Low density residential development occupies most of the remaining developed area in Anchorage. Although many of the dwellings in the older residential areas (Government Hill, Inlet View-Fairview and Mountain View - City View) are currently single-family, an increasing number of multi-family units are emerging as a result of higher land costs and the proximity of these areas to major employment.

Rapid development is occurring in the Muldoon, Sand Lake, and Campbell-Klatt areas. Muldoon is comprised primarily of low density residential development; a large portion remains underdeveloped. This community is expected to attract a large portion of the future residential development in Anchorage. Development of low to medium density residences is continuing in the Sand Lake and Campbell-Klatt areas, and is causing overloads on major access routes to employment centers. The development of gravel excavation in the area would have an additional adverse impact on the transportation problem.

Low density residential use predominates in the Abbott-O'Malley and Rabbit Creek Hillside communities. There are large tracts of vacant land and open public lands in the area. Further growth of residential development is anticipated.

The major center of public and institutional land use is in the University-Hospital Institution Complex around Goose Lake.

Future Land Use

Water quality in storm runoff depends on the mix of land uses. Undeveloped lands and open space areas used for recreation tend to deliver the best quality of urban runoff. Areas under development tend to deliver the worst, particularly in terms of sediment. Runoff from developed urban areas tends to fall between the two extremes. Within the developed urban areas themselves, runoff from commercial and industrial areas and highways tends to be of poorer quality in most respects than that from residential areas.

As shown by Table 2-2, the total developed area in Anchorage will increase by 65.6 percent from 30,501 acres in 1975 to 50,476 acres in 1995. Absent controls, runoff from the approximately 20,000 acres undergoing development can be expected to significantly degrade water quality. This development will result in large percentage gains in commercial and industrial land uses and highways. These three types of land uses tend to deliver the poorest water quality from urban areas.

The Northern Lights Boulevard commercial area is projected to continue to grow. By 1995, it is expected to exceed the CBD in employment and traffic generation. The CBD will become more of a major office center, with hotels and entertainment facilities. Community shopping centers will be scattered throughout the Anchorage area, mostly at or near major arterial intersections, as shown on Figure 2-2.

An increase in the density of the older residential areas is expected as aging single-family homes are replaced, especially between the CBD and the Northern Lights commercial area, and in parts of Spenard and Mountain View. Newly developing residential areas (Muldoon, Sand Lake, and Abbott-O'Malley-Hillside) are expected to continue to have relatively low densities.

Industrial and wholesaling development is expected to continue along the Alaska Railroad, but the center of this activity is projected to shift to the south of International Airport Road and at the International Airport itself. This shift is expected to be beneficial to Anchorage by placing a major employment center nearer to where people live. Substantial industrial growth is also projected in the Campbell Creek basin, west of Old Seward Highway and north of Klatt Road. Growth in the Ship Creek Valley is not expected to be substantial.

It is expected that the University-Medical Complex in the Goose Lake area will be mostly developed by 1995. By that time the University of Alaska will be serving at least 20,000 students, becoming by far the largest contributor to this area's growth. Some expansion of the medical facilities is also expected.

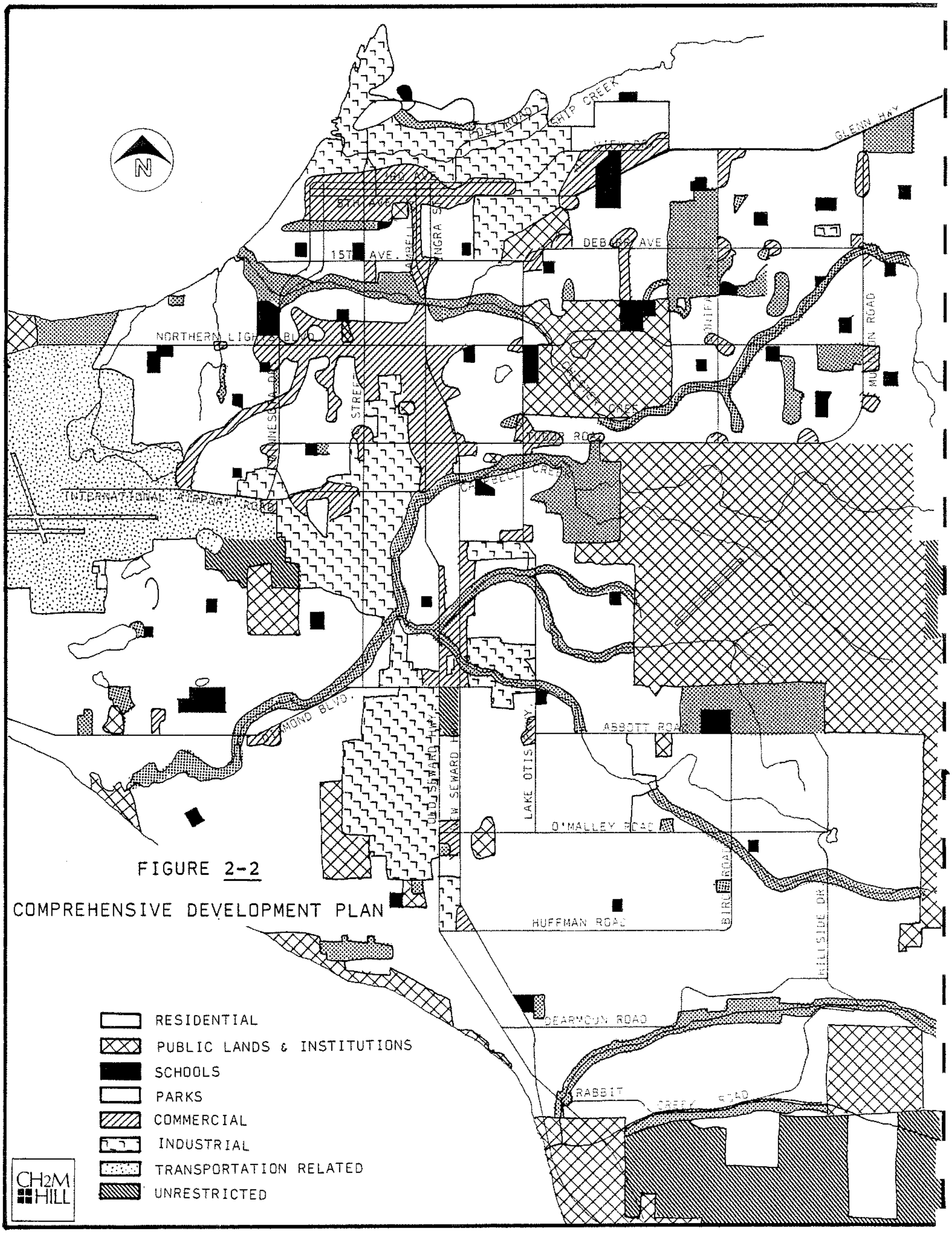

FIGURE 2-2

COMPREHENSIVE DEVELOPMENT PLAN

EMPLOYMENT

On the basis of the employment data and projections presented in the AMATS Long Range Element, there were an estimated 79,661 persons employed in Anchorage in 1975, and 47 percent of the total population was employed. The projection for 1995 shows 163,357 persons employed, equivalent to 44 percent of the total projected population.

Table 2-4 depicts the breakdown of Anchorage area employment. The data were taken from the MAUS study, which covered a slightly different study area than the AMATS study, but the data are still appropriate for showing trends. The most noticeable conclusion is that federal employment, which now plays a significant role in the total, is projected to decline precentagewise in the future. The only other area showing a relative decline is state and local government employment. All other sectors will experience significant gains in employment, with the most significant being experienced in the service sector.

CLIMATE

The climate in Anchorage is cold and semiarid. Mean monthly high and low temperatures are illustrated on Figure 2-3. Daily temperatures average below freezing from late October to early April. May 15 is the average date for the last freeze, while September 16 is the average date for the first freeze.

Temperatures would be much colder in winter except for the influence of the Alaska Mountain Range, which lies in a long arc from southwest through northwest to northeast, approximately 100 miles distant from Anchorage. During the winter, this Range is an effective barrier to the influx of very cold air from the north side of the Range. Extreme cold winter weather, associated with a high pressure system over interior Alaska, may lead to a succession of clear days in Anchorage, with temperatures dropping to -15 degrees to -30 degrees, as contrasted to the -50 degree and even -60 degree readings in the interior.

Mean monthly precipitations are illustrated on Figure 2-4. Spring is the driest season, while late summer is the wettest. Mean annual precipitation in Anchorage is 14.6 inches, including a mean annual snowfall of 70.1 inches. Thus, Anchorage could technically be described as semiarid. However, it has ample water supplied by snow accumulation and runoff from the mountains and glaciers to the east. The Chugach Range acts as a barrier to the influx of warm, moist air from the Gulf of Alaska, so the average annual precipitation in Anchorage is only 10 to 15 percent of that at stations

Table 2-4
Projected Percent Change in Employment

Industry	1977 (percent)	1990 (percent)
Agriculture, Forestry Fisheries	<1	<1
Mining	1	1
Construction	6	6
Manufacturing	2	2
Transportation	5	6
Federal Government	27	13
Communications	1	1
Public Utilities	<1	1
Wholesale Trade	4	5
Retail Trade	13	16
Finance, insurance, real estate	4	6
Service	14	23
State & Local Government	13	11

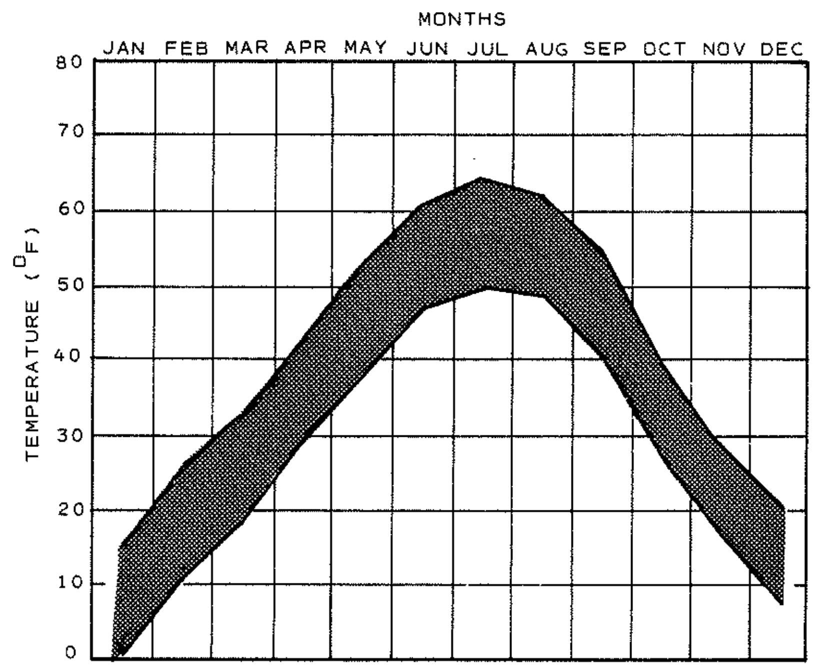

FIGURE 2-3

MEAN MONTHLY HIGH AND LOW TEMPERATURE

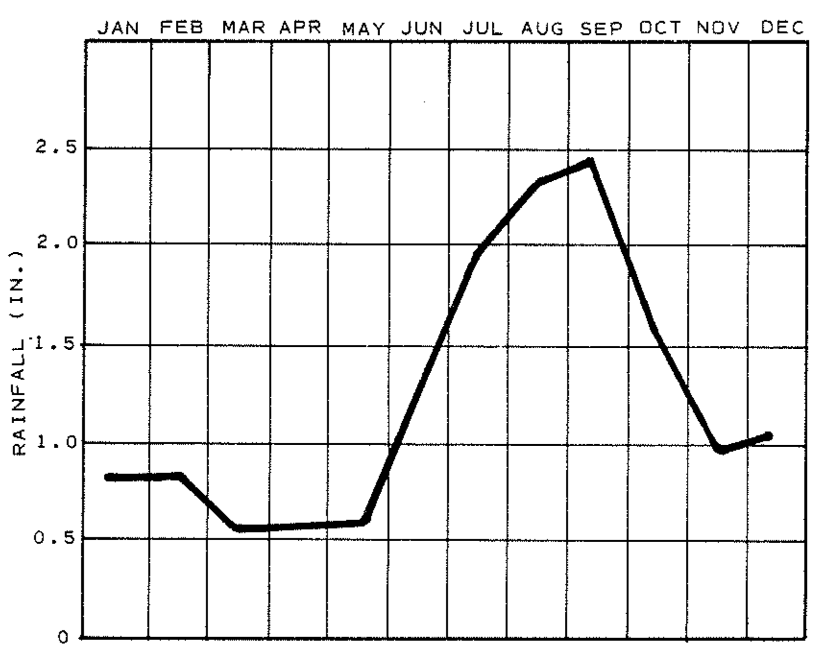

FIGURE 2-4

MEAN MONTHLY RAINFALL

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located in the mountains on the Gulf of Alaska side of the Chugach Range.

The four seasons are well marked in the Anchorage area; but in length and some major characteristics, they differ considerably from the usually accepted standards in middle latitudes. The seasons are described in a narrative climatological summary published by the National Oceanic and Atmospheric Administration (NOAA, 1976):

> "Winter is considered to be the period during which the ponds, streams, and lakes are frozen; this normally extends from mid-October to mid-April. The shortest day of the year has 5 hours and 28 minutes of possible sunshine. Periods of clear, cold weather normally alternate with cloudy, mild weather during the Anchorage winter. The clear, cold weather is frequently accompanied by significant fog because of the important low-level moisture source provided by the arms of Cook Inlet which surround the area on three sides; while considerable floating ice is prevalent, the high tides maintain some open water throughout the winter.... The first measurable snow occurs, on the average, on October 15, but has been as early as September 20; latest measurable snow in the spring averages April 14, but has been as late as May 6. Snow occurs on 20 to 25 percent of the midwinter days, and most of the snow falls in relatively small daily amounts, with only 2 percent of the midwinter days having more than 4 inches. The heavier snows occur in conjunction with vigorous storm centers moving northward across south-central Alaska. Normally, the depth of snowfall on the ground does not exceed 15 inches. Strong, gusty, north winds which occur, on the average, once or twice during the winter will, under favorable snow conditions, cause drifting and packing of snow cover. Although normally an area of light winds, strong "Northers" at Anchorage occasionally result from the rapid deepening of storms in the nearby Gulf of Alaska at a time when the interior is covered by an extensive mass of quite cold air.
>
> Spring is the period immediately following the famed Alaska "Break-up." This season is characterized by warm, pleasant days and chilly nights; the mean temperature rises rapidly; precipitation amounts are exceedingly small.
>
> Summer comprises the period from June through early September, and is, in reality, two seasons of about equal length, the first of which is dry, the second wet. At the time of the summer solstice, possible sunshine in Anchorage amounts to almost 19-1/2 hours, and the sound of singing birds and pounding hammers is nearly as common at midnight as at noon. About the

middle of July average cloudiness increases markedly, and the remainder of the summer usually accounts for about 40 percent of the annual precipitation.

Autumn is brief in Anchorage, beginning shortly before mid-September and lasting until mid-October. The frequency of cloudy days and precipitation drops sharply in early October. Measurable amounts of snow are rare in September, but substantial snowfalls sometimes reaching 10 or 12 inches occasionally occur in mid-October.

Some of the stronger southerly winds, a few with damaging effects, occur in the late summer or fall; these are post-frontal winds following the movement of a storm from the southern Bering Sea or Bristol Bay, north-eastward across the Alaskan interior. Somewhat less frequent, but more damaging, are the southeasterly "Chugach" winds which are funneled down the creek canyons on the northwestern slopes of the Chugach mountains east of the city; gusts estimated at 80 to 100 mph have caused considerable damage to roofs, power lines and trailers on a few occasions."

TOPOGRAPHY

Anchorage is in a broad alluvial valley with adjacent narrow bodies of water. Cook Inlet, including Knik Arm and Turnagain Arm, lies approximately 2 miles to the west, north and south. The terrain rises gradually to the east for about 10 miles. Marshes are interspersed with glacial moraines, shallow depressions, small streams, and knolls. More than 90 percent of the lowland has less than a 12 percent slope. The entire lowland is separated from the sea by steep bluffs except along the valleys of major streams where the land approaches sea level. Beyond this alluvial valley, the Chugach Mountains rise abruptly into a range oriented north-northeast to south-southwest, with average elevation 4,000 to 5,000 feet and some peaks to 8,000 or 10,000 feet.

SOILS

The location of the two most prevalent soil types in the study area is controlled almost entirely by topography. A thin soil mantle overlying parent material covers the sloping, well drained lands in the eastern sections of the Municipality. Soil horizons are generally lacking in these areas. Further to the west, soils of the filled lakes and other poorly drained sites in the lowlands are essentially unmodified peat. Peat thicknesses range up to 30 feet and more. The areas of peat are widespread throughout the urban area, as illustrated on Figure 2-5. Much of the new development is occurring on drained peat bogs.

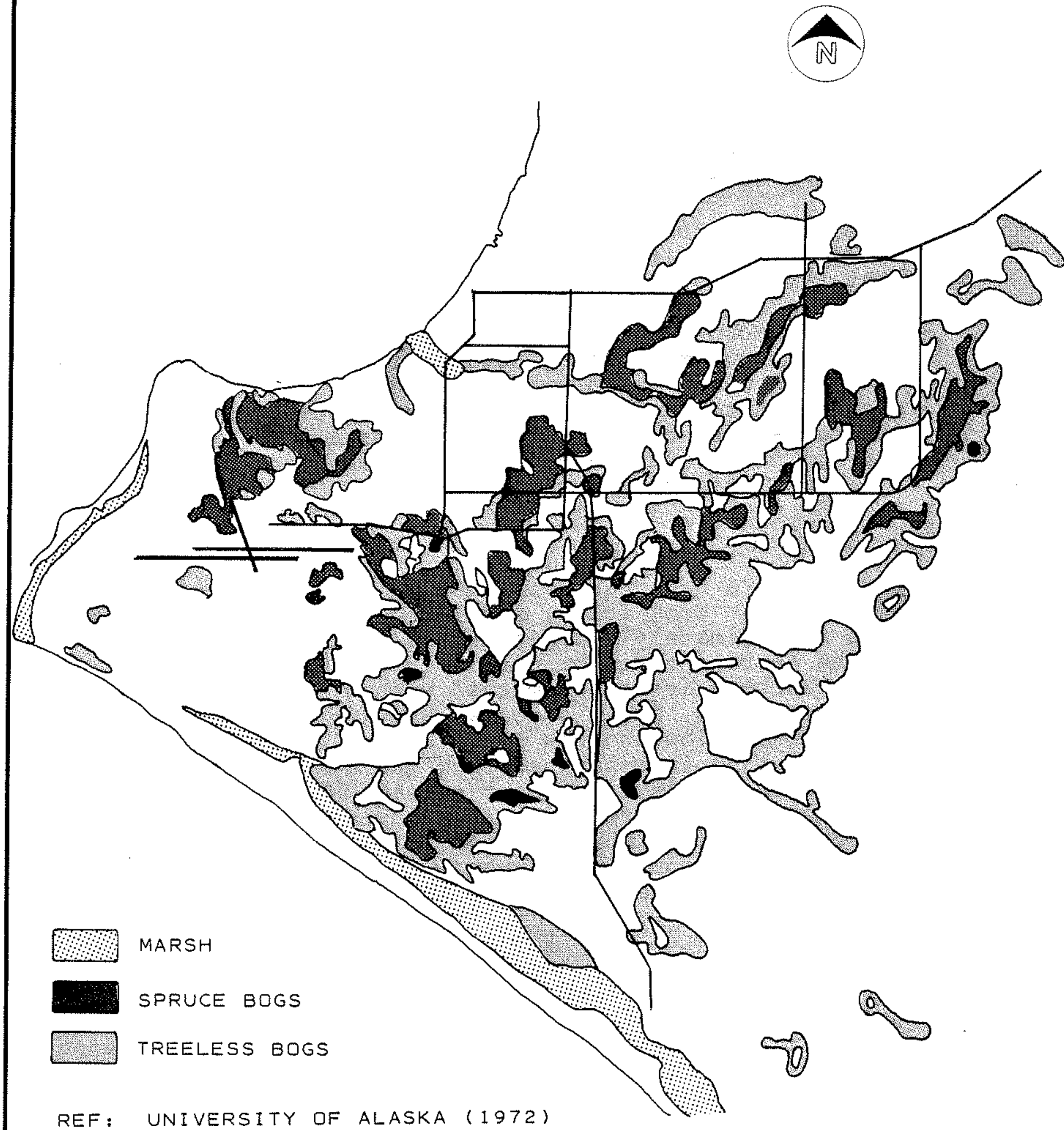

FIGURE 2-5

BOG OR MARSH AREAS

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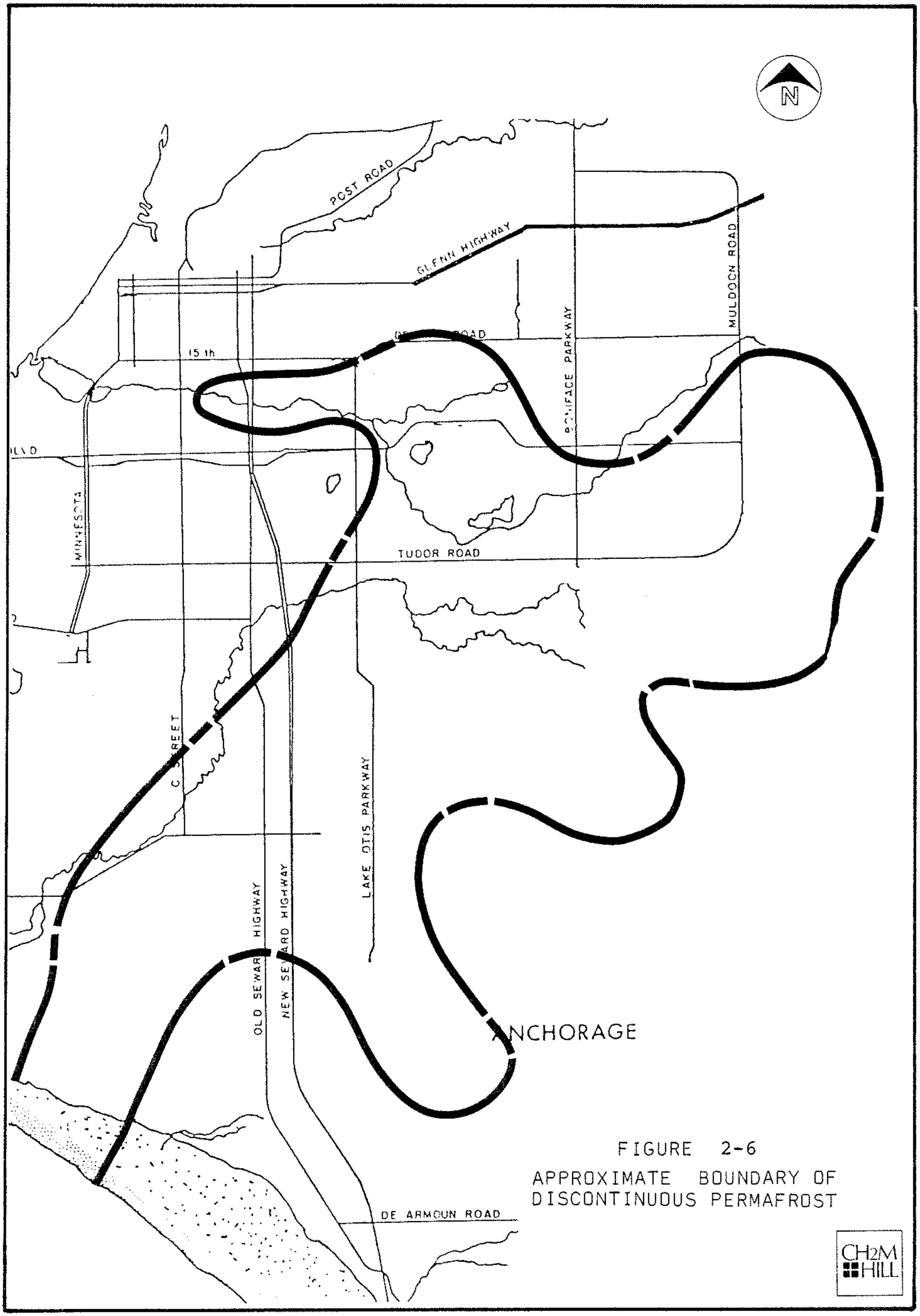

FIGURE 2-6

APPROXIMATE BOUNDARY OF DISCONTINUOUS PERMAFROST

CH2M HILL

wastewater interceptors cracked during the earthquake may be an important source of fecal coliform and other pollutants in the area's creeks.

SURFACE WATERS

The stream system generally runs from the Chugach Mountains westward across the lowlands to Cook Inlet. Four creeks flow through the urban Anchorage area, including Campbell Creek, Chester Creek, Ship Creek, and Fish Creek. Other major streams within the study area which may experience water quality problems are the Eklutna River, Eagle River, and Rabbit Creek. Average annual flows and approximate drainage basins of these seven major streams are shown on Figure 2-7.

The variation in monthly streamflows is extreme, as illustrated for Campbell Creek on Figure 2-8. The mean monthly temperature in the mountains is generally below freezing from October to May so that most precipitation is stored as snow. During this period the streamflow is sustained by the gradual seepage of ground water from alluvium and bedrock into the creeks. Appreciable snowmelt in the mountains commonly begins in May. Peak streamflow is reached by early June, and most snow storage is depleted by the end of July. During August and September, high streamflow is maintained mostly by rainfall, which is at a maximum during this period.

Several lowland lakes are found in the Anchorage area. The most important of these from a use standpoint are Campbell Lake, which is on Campbell Creek, and Lakes Hood and Spenard, which are located near the International Airport. Water levels in Lakes Hood and Spenard are maintained by the shallow ground water aquifers.

Campbell Creek

Campbell Creek has a drainage area of over 69 miles (178.6 sq. km). It flows from the edge of the Chugach Mountains through southern Anchorage to the Turnagain Arm of Cook Inlet. The gradient of the stream is relatively steep in the upper reaches, but flattens considerably as the stream flows through the urban and urbanizing areas. These flatter gradients in the lower reaches are not conducive to extensive bank erosion, but are contributing factors to major overbank flooding. Three main tributaries, Little Campbell, North Campbell, and South Campbell Creek, flow together to form Campbell Creek.

From the confluence of the North and South Fork to its entrance to Campbell Lake, Campbell Creek measures 7.0 miles in length. It is a meandering stream in stretches, particularly between Dowling Road (Mile 4.1) and the Alaska Railroad

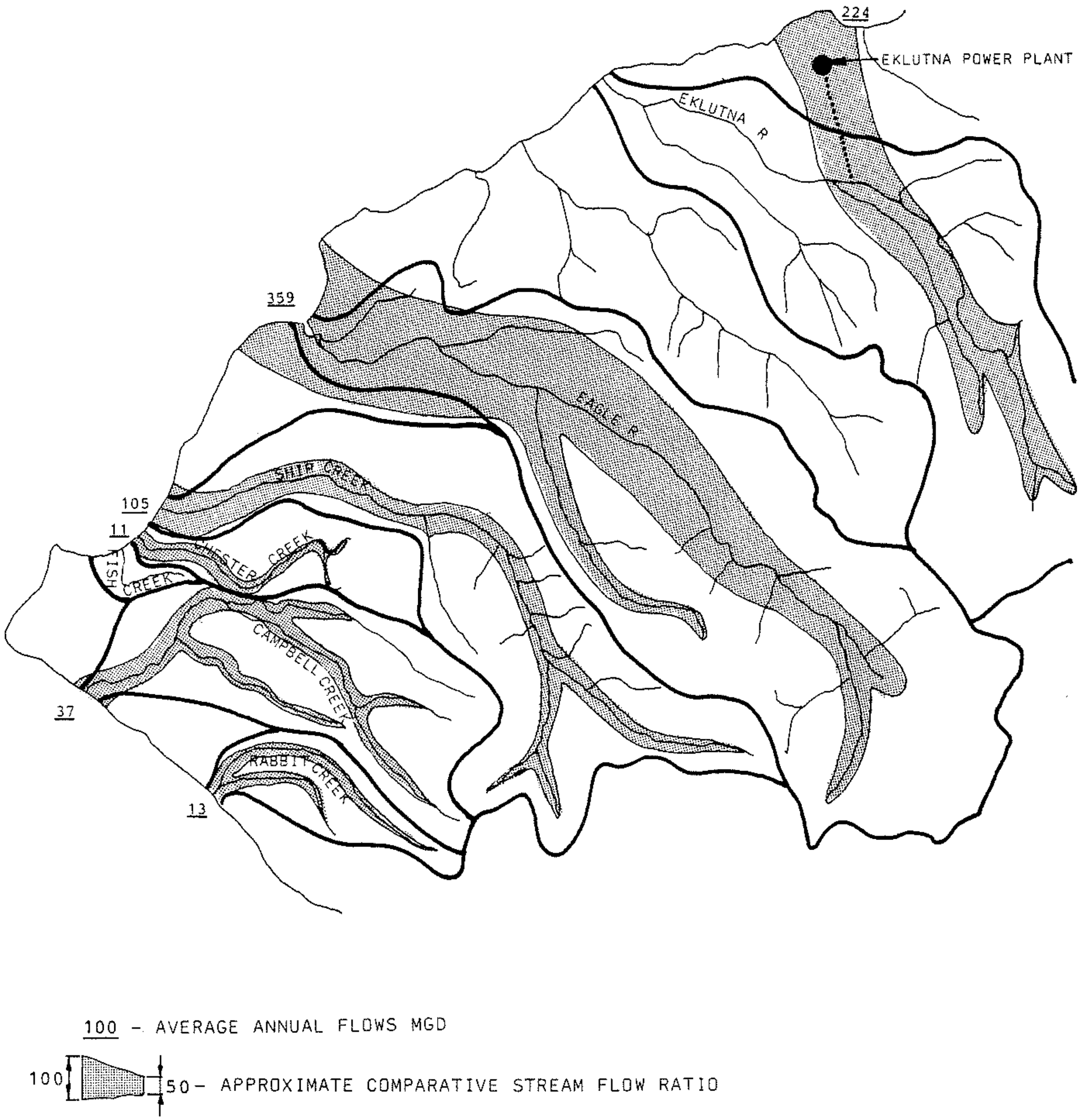

FIGURE 2-7

MAJOR STREAM BASINS
AND AVERAGE ANNUAL FLOWS

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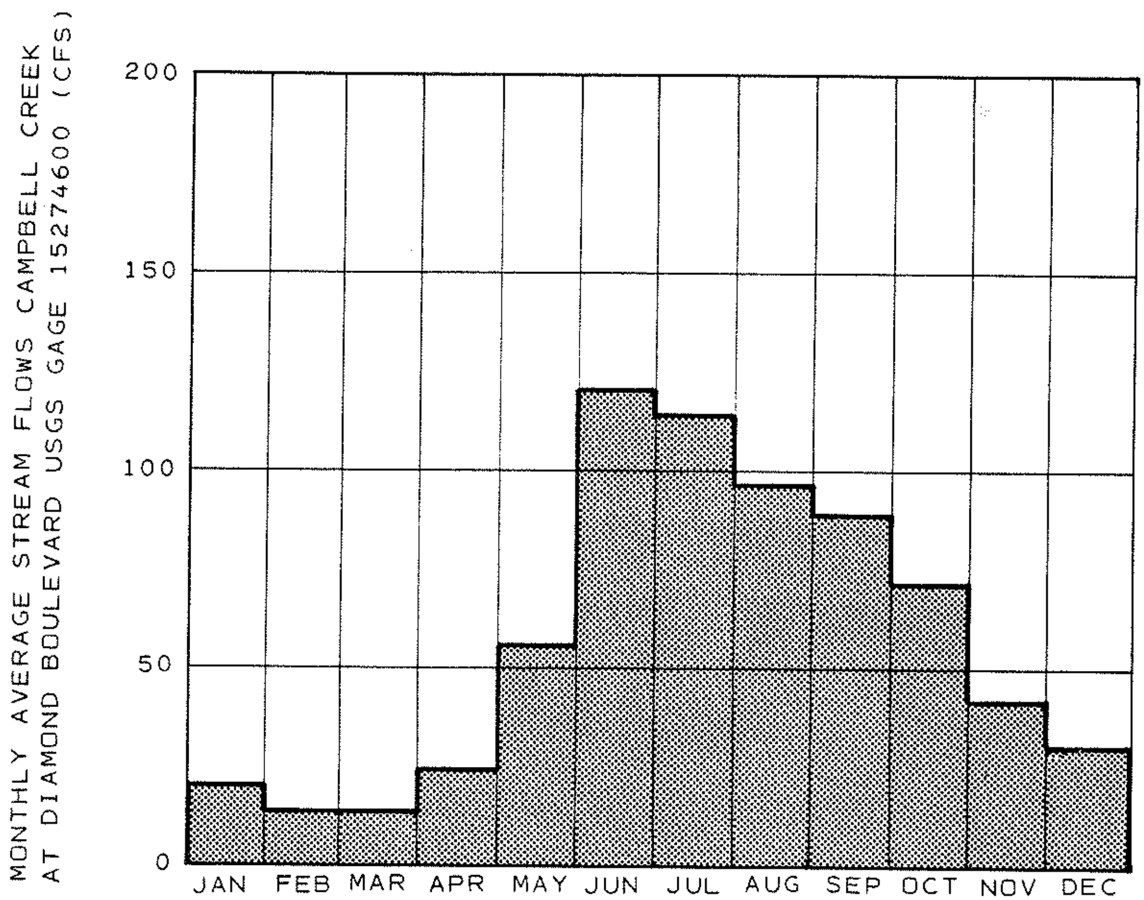

FIGURE 2-8

AVERAGE MONTHLY FLOWS IN CAMPBELL CREEK

CH2M HILL

(Mile 2.9) and between Artic Boulevard (Mile 1.7) and Mentra Street (Mile 1.1). Its average stream velocity is about 3 feet per second during summertime flows, with a corresponding time of water travel of 3 hours.

Flooding occurs in Campbell Creek. Flood characteristics are described below (Corps of Engineers, 1975):

> "High flows have occured in the study area during all seasons. Winter and spring, however, are the primary seasons in which flooding problems occur. Winter floods may result from glaciation where the water will freeze down to the stream bed during extremely low temperatures, forcing the water on top of the ice. This can continue until the stream bed is higher than the banks, at which time a new water course is formed and flooding occurs. Glaciation at culverts is a frequent cause of winter flooding.
>
> Spring floods may occur as a result of an above-normal snowfall during the preceding winter, followed by an unusually cold spring and then a rapid snowmelt. Floods during summer or fall usually result from a rainfall of high intensity and short duration.
>
> Except for glaciation, floods are of relatively short duration on Campbell Creek. Stream stages can rise from normal to extreme flood peaks in a relatively short period of time."

Poor drainage causes localized flooding throughout the Campbell Creek watershed. The primary causes are:

- Extremely flat land surface slopes in the lowland areas.
- Numerous waterlogged areas throughout the watershed.
- Areas of geologically "tight" surficial lake and pond deposits and exposed bedrock yielding high runoff.
- Areas overlain by "sponge-like" peat.
- Lack of a comprehensive drainage plan to guide drainage design in rapidly developing areas.

Figure 2-9 is a map of potentially poor drainage areas. This map does not account for developed areas with inadequate drainage design.

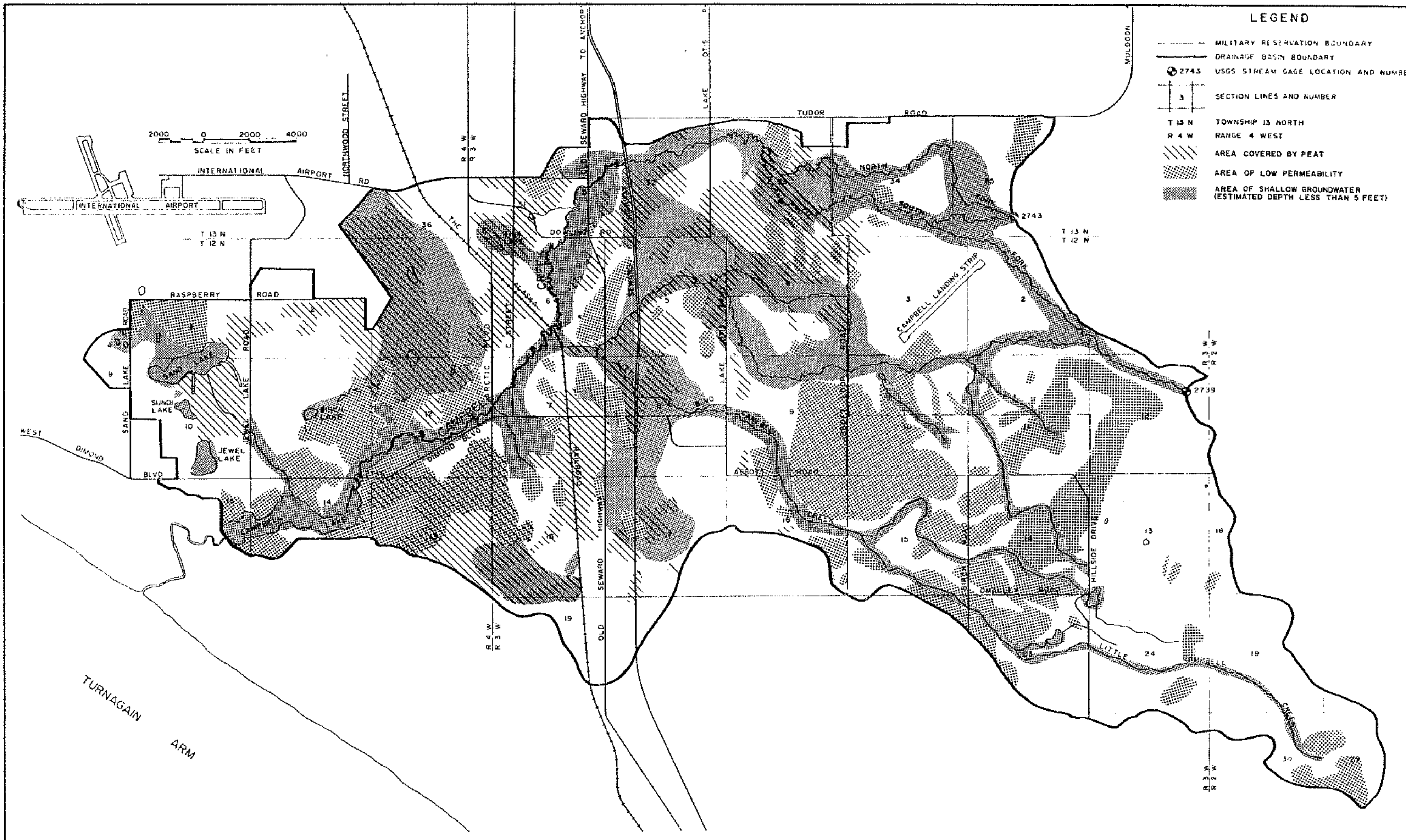

FIGURE 2-9
AREAS OF POTENTIALLY POOR DRAINAGE

Campbell Creek drains into Campbell Lake and then into the Turnagain Arm of Cook Inlet. Campbell Lake is man-made, and the old meandering stream channel under it is clearly visible on low altitude color aerial photography. Campbell Lake drained during the 1964 Alaska Earthquake, and the outlet dam was repaired to refill the lake.

Chester Creek

Chester Creek and its tributaries drain approximately 30 square miles (48.2 km) of terrain. Its headwaters arise on the eastern slope of the Chugach Mountains, above Anchorage. It then flows through the urbanized lowlands west of Muldoon Road. The upper reaches of the creek flow across bedrock in steep mountainous terrain and then across the glacial deposits of the foothills. Much of the channel of Chester Creek has been straightened and lowered.

The lowland portions of the basin originally contained large swamp-muskeg areas which served as vast reservoirs that stabilized streamflow. Most of these areas have been drained and developed. Infiltration of precipitation has also been greatly reduced by development and increased impervious surface areas. Storm drains now conduct large runoff volumes rapidly to the creek. Thus, flows in Chester Creek vary much more abruptly now. Because of reduced ground water storage, average annual flows have decreased. In the period from 1959 to 1970, average annual flow was 20.6 cfs. In recent years it has dropped to 18.7 cfs.

Stream hydrology and morphology have been greatly altered by channelization, another aspect of urbanization. Implemented to meet the objectives of flood control and storm drainage, channelization has occurred over most of the three forks of the creek. Straightening, deepening, and widening of the channels increase their discharge capability, but bank support modifications have been required in many locations to prevent higher erosion rates caused by the more "energetic" flows.

A dam and control structure has been built near the mouth of Chester Creek. Westchester Lagoon, the shallow lake that formed behind the dam, was designed for recreational purposes.

Ship Creek

Ship Creek is the largest of the four urban watersheds, with a drainage area of approximately 90 square miles (233 sq. km). The creek rises in the Chugach Mountain Range east of Anchorage. A network of creeks that drain the range flows together into a single channel which is about 24 miles (28.6 km) long. The stream flows northwesterly to a point about 10 miles east of Anchorage, where it emerges from the mountains through a steep-sided rocky canyon that is the site of the Ship Creek Reservoir, supplier of most of the water for the area. The last few miles of the stream have a shallow gradient, passing through urbanized Anchorage before emptying into Knik Arm.

The flow of Ship Creek is currently recorded at two stations. The upstream gage is located below the water supply diversion dam on Fort Richardson at 10.5 miles upstream of the mouth. Mean annual flow at this point is 141 cfs (Freethley, 1976). The other gage is located downstream on Elmendorf Air Force Base at mile 4.7 and has a mean annual flow of 125 cfs. The mean loss in flow using these figures in this 5.8 mile reach is 16 cfs. Recharge of ground water from Ship Creek is the accepted explanation for this loss in flow. But below the Elmendorf Air Force Base gage station, Ship Creek regains nearly all the flow lost to ground water by seepage from the shallow, unconfined ground water aquifers, and by vertical containment of the streamflow by clay layers (Freethley, 1976).

Aside from ground water interaction, the fluctuation of Ship Creek's flow is also a function of precipitation, snowmelt, and diversion for municipal, military, and industrial uses. Average flows have been declining over the past 10 years probably due to additional demand for drinking water. Peak flows occur in June; minimum flows occur in the winter, before breakup (January through April). The Flood Hazard Report (U.S. Corps of Engineers, 1975) assigns a value of 2,000 cfs to the peak flow of a 100-year, intermediate regional flood.

Fish Creek

The Fish Creek drainage basin is located in a largely residential and commercial district of Anchorage. It is bounded on the north and east by the Chester Creek drainage, on the south by the Campbell Creek drainage, and on the west by the Knik Arm, Lake Hood and Lake Spenard drainages.

There is very little hydrological information available for Fish Creek. The channel is indiscernible through swampy areas. The total channel length is approximately 5 miles. Most of the year there is no actual flow, but the little flow that does occur is the product of unconfined ground water seepage, precipitation, and storm water runoff. Flows in the channel are assumed to have decreased as a result of the draining and subsequent development of marshy upstream areas, thereby lowering the water table. For all practical purposes, Fish Creek is little more than a conduit for storm water runoff. A major portion of Fish Creek has been diverted through underground pipe systems. It has also been channelized and deepened in some reaches to better serve drainage needs from the developed areas.

Other Major Surface Waters

Three other rivers are located in the study area, but outside of the immediate Anchorage urban area. These rivers are the Eklutna River, the Eagle River, and Rabbit Creek. A final important surface water body in the study area is Cook Inlet, which receives the flows from all seven rivers described in this section.

Eklutna River. The Eklutna River orignates at Eklutna Glacier, approximately 20 miles (32.2 km) east of the community of Eagle River, Alaska. The river enters Eklunta Lake and then flows another 10 miles (16 km) before entering Knik Arm. The river is glacial with high color levels and suspended solids. Little development has occurred along the river. The lake has been dammed and is used for power production.

Eagle River. Eagle River heads at Eagle Glacier, drops swiftly for approximately 16 miles (25.7 km), then flattens into a mile wide flood plain, and eventually flows into Cook INlet. Its major tributary, the South Fork, heads in Eagle Lake and drops gradually for 8 miles (12.9 km) before joining the main branch. The river is highly turbid throughout the year, a result of its glacial origin. Clearer tributaries are important salmon spawning areas. Water quality has not been reduced significantly by settlement in the area, although Eagle River valley is undergoing some development.

Rabbit Creek. Rabbit Creek, with a drainage area of almost 14 square miles (22.5 km), has its headwaters just north of Suicide Peak in the Chugach Mountains. From the headwagers, the stream flows northwest and then west for a total distance of 11.5 miles (18.5 km) to its confluence with Turnagain Arm, 9 miles (14.5 km) south of Anchorage. The stream has a generally steep gradient, falling over 3,000 feet (914 m) in the length of the stream.

Urbanization is beginning along sections of Rabbit Creek, but the stream has not yet been severely impacted. Water quality remains high and much of the original stream channel is in tact.

Cook Inlet. Cook Inlet is a large tidal estuary of the Gulf of Alaska. The Inlet is bounded on the west, north and east by the Alaska, Talkeetna, and chugach Mountains, respectively. It is fed by numerous streams and the Matanuska, Knik, and Susitna Rivers. The Inlet is a major cargo transport route linking the bulk of Alaska with the rest of the world, a base for petroleum exploration and production, and an important fishing center.

The upper third of the Inlet is separated hydrologically from the lower two-thirds by the East and West Forelands. The Upper Inlet, highly turbid and variable in salinity, heads in Knik and Turnagain Arms, which embrace Anchorage to the west and south. The waters of both Arms are characterized by high suspended sediment loads. Below the Forelands, turbidity decreases as turbulent tidal mixing no longer maintains the sediments in suspension.

Tides in Cook Inlet are among the highest in the world with average diurnal ranges from 13.7 feet (4.1 m) at the entrance to 29.6 feet (9 m) at Anchorage. Currents associated with tidal flow are moderate; maximum velocity averages 3.8 knots at the Forelands and 2.8 to 3.0 knots elsewhere above the Forelands.

GROUND WATER

There are two principal sources of ground water in the Anchorage area. One is the unconfined aquifer system, composed primarily of sands and gravels. It is usually less than 50 feet (15 m) deep and is underlain by an impermeable layer of clay and silt which prevents the water from infiltrating to a lower depth.

The other principal source of ground water is the confined aquifer system, which is also composed of porous sands and gravels. It is 70 to 300 feet (21 m to 91 m) deep and is underlain and overlain by impermeable geologic formations. The permeability of the overlying confining layer gradually increases eastward toward the mountains forming a transition zone where water is partially confined. In this eastern transition zone and in an adjacent zone in the foothills, surface water percolates downward and recharges the sand and gravel aquifers that extend westward into the confined zone, as shown on Figure 2-10.

Water enters the aquifers in relatively large quantities compared to the fairly low amount of rainfall in the bowl area. An estimated 75 million gallons per day (mgd) enter the unconfined aquifers in the lowland between Little Rabbit Creek drainage basin on the south and Ship Creek drainage basin on the north. The ground water flows westward to Knik and Turnagain Arms. Recharge of the confined system occurs from bedrock seepage (25 mgd), from infiltration along streams and seepage along the mountain front and the foothills (20 mgd), and from the direct recharge of rainfall, snowmelt, and streamflow losses in the lowland (30 mgd).

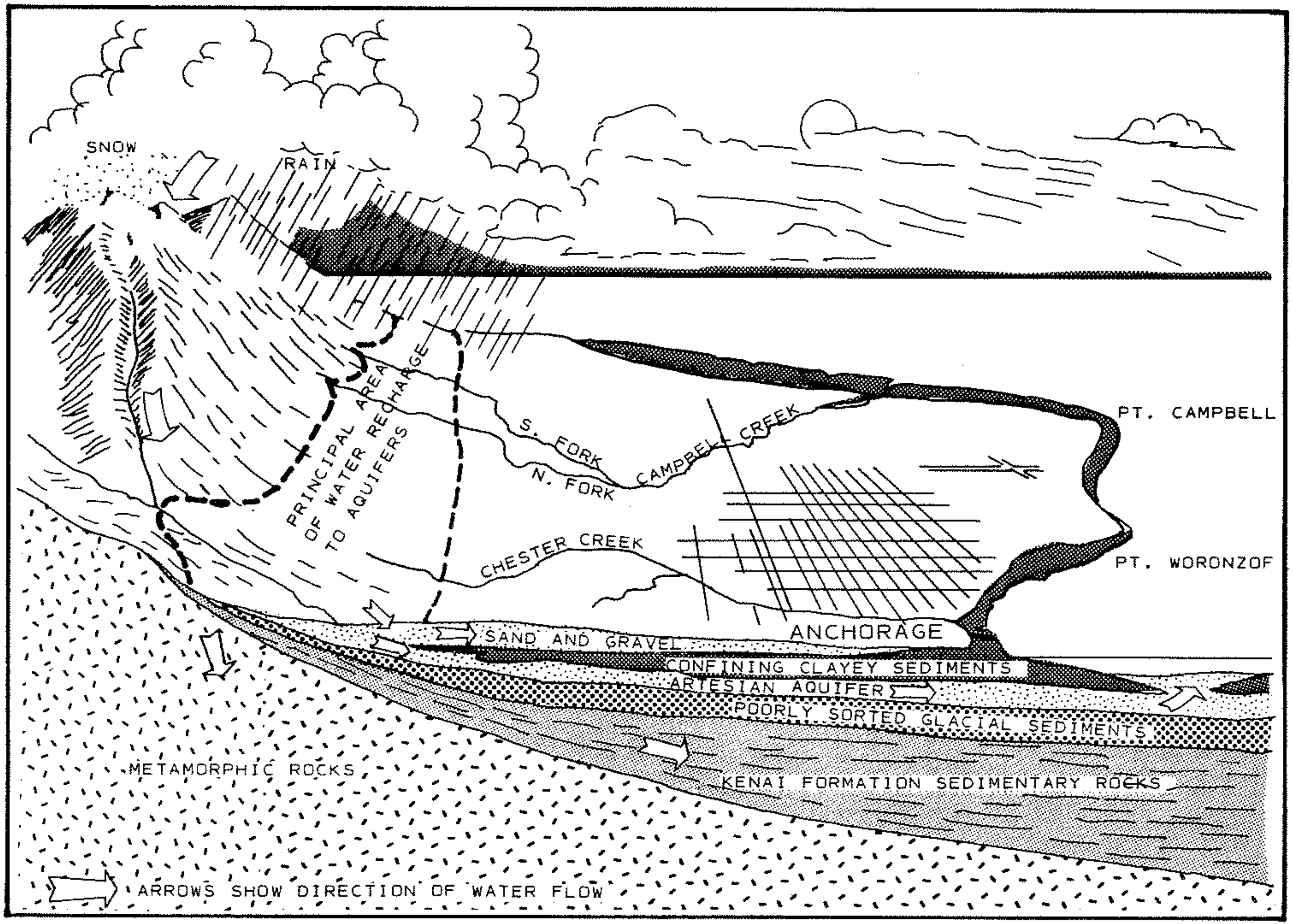

FIGURE 2-10

GENERAL GROUND WATER MOVEMENT

ADAPTED FROM WATER FOR ANCHORAGE, BARNWELL, ET. AL., U.S. GEOLOGICAL SURVEY, 1972.

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CURRENT WATER USES

Surface waters play an important role in providing recreational opportunities and drinking water for the Anchorage area. The current uses of the surface waters which could be impacted by changes in water quality include:

- drinking water supplies
- cooling water supplies
- fishing
- other recreational activities

These current uses of surface waters are described below.

Drinking and Cooling Water Supplies

Water from Ship Creek is used both for drinking water supplies and power plant cooling. Nearly one-third of the combined municipal and military drinking water demands are satisfied by water from Ship Creek. The remainder of the drinking water supplies for the Anchorage area come from the unconfined and confined ground water aquifers. Water is also withdrawn from Ship Creek to cool three steam-electric power plants.

Drinking water supplies are withdrawn from Ship Creek at the diversion dam at Mile 10.5. As shown on Figure 2-11, the diversion point is well upstream from the urban area and any possible urban runoff pollution. Diversions, averaged over an entire year, have ranged from 11.9 mgd to 14.5 mgd. The maximum diversion capacity at this dam is 16 mgd.

Water is also withdrawn from Ship Creek for three power plants, whose locations are shown on Figure 2-11. Average annual diversions are 7.0 mgd. Most of this withdrawal is eventually returned to the creek via cooling ponds, but the temperature of the return flow is elevated several degrees over the stream temperatures. Urban runoff may have some impact on the quality of water used at the two downstream plants.

The water diversions for drinking water and cooling water supplies severely reduce streamflow during the low-flow period in Ship Creek preceding spring breakup. Periods of no flow have occasionally been reported during this time of year. Excessive withdrawals of shallow ground water for drinking water supplies have further aggravated the low-flow problem by reducing the natural ground water recharges into the lower reaches of the creek.

No drinking water or cooling water supplies are withdrawn from Campbell Creek, Chester Creek, or Fish Creek at the present time.

FIGURE 2-11

MAJOR DIVERSION POINTS
IN SHIP CREEK

Fishing

Game fish, including Dolly Varden, salmon, and rainbow trout, exist within the study area in both anadromous and resident forms. The five species of Pacific salmon that can be found at certain times of the year within the study area are chinook (king), coho (silver), sockeye (red), chum (dog), and pink (humpback). All salmon species travel up Knik Arm during their annual migrations to freshwater streams to spawn in the gravel streambeds. All five species die shortly after spawning.

The salmon eggs remain in the stream until late winter or early spring following the summer and fall spawning. The eggs incubate, but they cannot tolerate high levels of siltation or low streamflows. After hatching, the salmon remain in the gravel for a number of weeks--a critical stage in their lives. Any depletion of the subsurface waterflow, high siltation or decreases in dissolved oxygen levels can increase mortality among the young fish. Young red, king and silver salmon spend from 2 to 3 years in freshwater before migrating to sea. Young chum and pink salmon go directly to sea soon after emerging from the gravel spawning beds.

The salmon are valuable to both commercial and sport fishing interests. The Cook Inlet salmon run supports an important commercial fishery. Most of the small creeks and rivers in the study area do not currently support large enough runs to be of commercial value; however, the potential exists for at least some of these to support larger runs.

Grayling, rainbow trout, Dolly Varden, whitefish, sculpin, burbot, and lake trout, the main resident species of the area, have little commercial value but support a popular recreational fishery. Valuable sport fishing exists in many lakes and streams within the study area. Local lakes have been planted with rainbow trout, grayling, and coho salmon. These lakes have been developed into important recreational fisheries, supplying over 80,000 man-days of fishing each year. The more important of these lakes include Jewell, Campbell Point, Lower Fire, Otter, Hillberg, Green, Six Mile, Triangle, and Sand Lakes.

Long-time residents recall when local rivers would produce phenomenal numbers of salmon and trout. Today overfishing, habitat depletion, pollution, and poaching have caused the populations in these streams to be depressed to a point where special regulations have been imposed. Reestablishing these populations through habitat improvement, new regulations, and water treatment could allow for the unique possibility of having an important recreational fishery within a densely populated metropolitan area.

Campbell Creek. Campbell Creek is important to the community as a salmon stream. Stream gradient, water quality flows and substrate are suitable for salmon spawning. Areas below Lake Otis Drive are less suitable because of the effects of nearby development. Principal fish species are king, pink, silver, and red salmon and Dolly Varden. The upper watershed has been stocked with arctic grayling. Population data for these species are not available.

Chester Creek. Major fish species in Chester Creek are limited to a few Dolly Varden, rainbow trout, and char. Salmon spawning habitat has been lost primarily because of channelization and reduced flows. A biological investigation was conducted in 1973 by Alaska Department of Fish and Game (ADFG) to assess the suitability of Chester Creek for salmonid production. The main conclusion of this study was that Chester Creek is no longer an "attractive or productive sport fishery" and that attempts to manage it as an anadromous stream would not be feasible (Kubick, 1974a).

Ship Creek. The major fish species of Ship Creek include king, silver, pink, and chum salmon, Dolly Varden and rainbow trout. Most spawning occurs below the Ship Creek Reservoir and above the Chugach Electric Company's holding pond. The water diversion dam at Mile 10.5 has no fish passage facilities and is the maximum point upstream accessible to spawning fish. Substrate and water quality are acceptable for salmon spawning, but water flow is often marginal, particularly during the winter and spring months. Withdrawals from the stream during these low-flow periods lead to insufficient water for spawn survival. Construction activities and channelization of Ship Creek near its mouth, through the EAFB golf course, and near the Fort Richardson power plant have also degraded and depleted habitat.

Despite the low flows, construction activities, and channelization, large numbers of salmon return to Ship Creek to spawn. The numbers of salmon enumerated passing through the Chugach Dam fish trap are presented on Figure 2-12 for the years 1966-1978. While the numbers vary widely from year to year, urbanization in the Ship Creek basin cannot be correlated with any decrease in the numbers of salmon. It is important to note that the escapement data do not account for all salmon because some avoid the fish traps. This number depends on the flows in Ship Creek and the tide range.

To improve fishery resources of Ship Creek, a hatchery facility was put into operation in 1963 to rear king and silver salmon. Located in the cooling ponds at the Fort Richardson power plant, this hatchery marked and released two million anadromous fish in its first 10 years of operation.

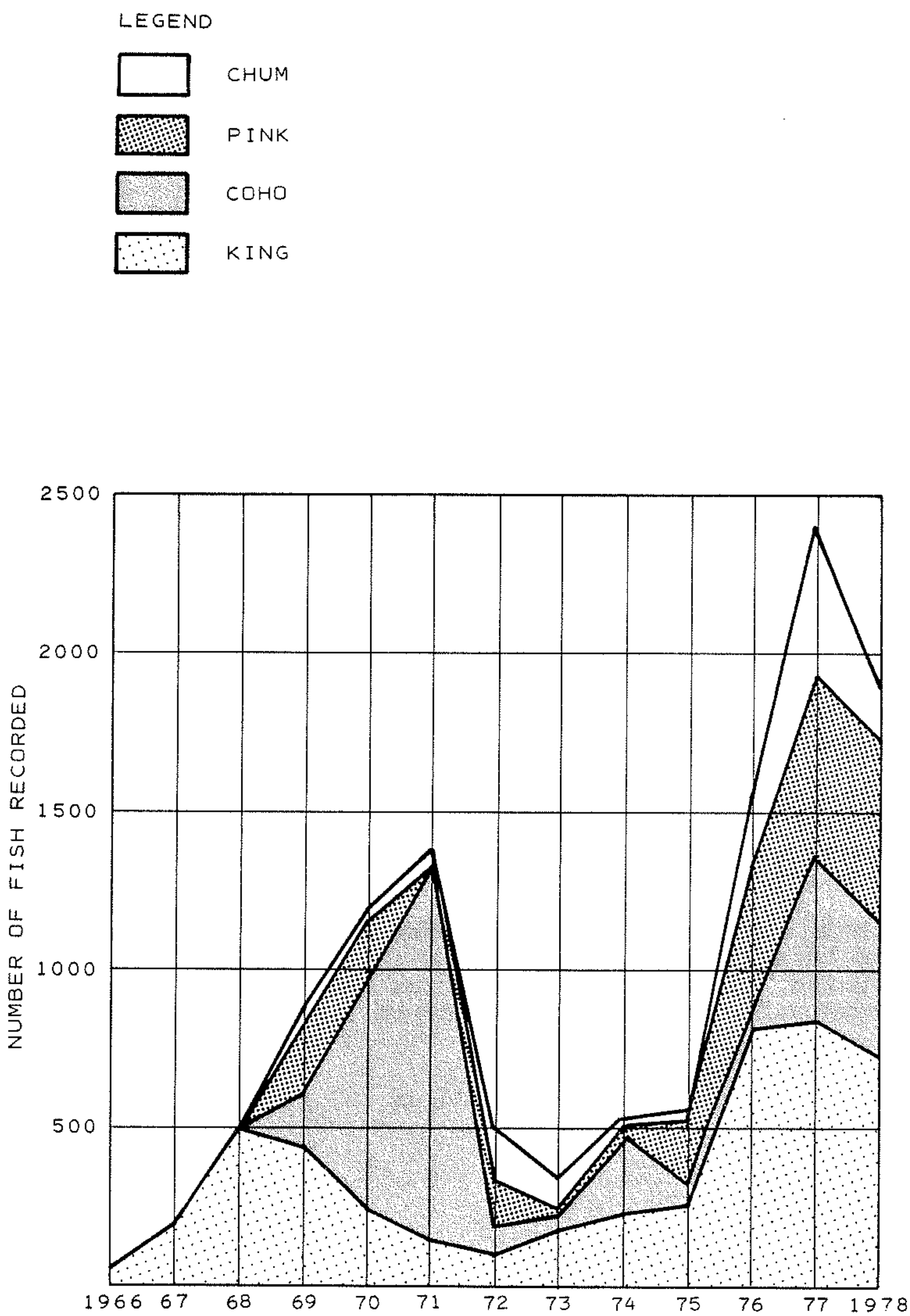

FIGURE 2-12

NUMERS OF SALMON ENUMERATED
AT THE CHUGUCH DAM FISH TRAP,
SHIP CREEK

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As a recreational resource, Ship Creek is no longer the popular sport fishery for local anglers it once was. The salmon season was closed in 1961 and remained closed until 1970, when severe restrictions were placed on a short season. In 1973, there was another complete closure.

The value of Ship Creek as a commercial resource is not known. Samples of commercial catches in the Cook Inlet have been taken and counts of Ship Creek marked salmon compiled. However, sufficient data have not been collected to evaluate the overall contribution of the Ship Creek hatchery to the commercial fishing industry.

In the face of ever increasing pressures, the future of Ship Creek as a fishery resource is questionable. According to ADFG policy, "...every attempt should be given to the maintenance and perpetuation of existing/potential fishery resources on Ship Creek" (Kubick, 1974b). To illustrate this committment, a new hatchery is now under construction at the EAFB power plant cooling ponds which will be several times larger than the Fort Richardson facility.

Other Recreation

The surface waters are used for other recreational activities than fishing. Some of these uses may be impaired or eliminated by degrading water quality. Most of the other types of current recreational opportunities occur in and along Campbell Creek and Chester Creek.

Swimming is not a popular activity in the Anchorage area because of the commonly cold air temperatures and even colder water temperatures. However, tubing and canoeing occasionally are done on Campbell Creek.

Linear parks stretch along lower sections of Campbell Creek and Chester Creek. Activities in these parks include jogging, hiking, biking, picnics and sports. The creeks are important assets to the beauty of the parks.

Chapter 3
DESCRIPTION OF EXISTING CONTROLS

The Municipality of Anchorage generally has a strong planning program for environmental protection. Many of the existing regulations were not designed to meet specific water quality criteria and others have not been adopted as formal policy. Nonetheless, the existing program for nonpoint source pollution control is one of the most advanced in the United States. The existing program for urban runoff, erosion and sediment control, snow disposal and onsite wastewater disposal is presented below. Each section is preceded by a brief discussion of the problem and how it relates to the Anchorage 208 planning effort.

URBAN RUNOFF

Rain water and snowmelt which run off of urban landscapes make up urban runoff. This runoff is much more polluted than that which flows from natural landscapes. The more urban an area, the more polluted the runoff. As shown on Figures 3-1 and 3-2, five occurrences are common to increased levels of urbanization: 1) grading and clearing of natural landscapes; (2) installation of runoff facilities to accommodate storm and surface runoff; (3) construction of impervious surfaces, such as roads and parking lots; (4) withdrawal of surface water and ground water to provide for both domestic needs and drainage; and (5) increased concentrations of development, population, transportation and utility systems.

Regarding urban runoff control, occurrences numbered 2, 3, and 5 are the most significant as numbers 1 and 4 are generally covered by other programs. Impervious areas allow accumulation of urban debris (litter, oils, fertilizers, animal manure, decaying vegetation) and increase wash-off. In some cases, this debris can result in a waste load similar to domestic sewage. Under natural conditions both the debris and runoff would be much less and that which occurred would be absorbed in the soil and ground cover. Installation of drainage facilities results in concentration and direct discharge of available urban pollutants to area streams.

When considering that existing water quality is generally good (especially compared to other metropolitan areas of similar size), and that about 20,000 additional acres will be developed in Anchorage by 1995, the major challenge of 208 planning will be to accommodate growth without degradation of water quality. This can be partially attained through

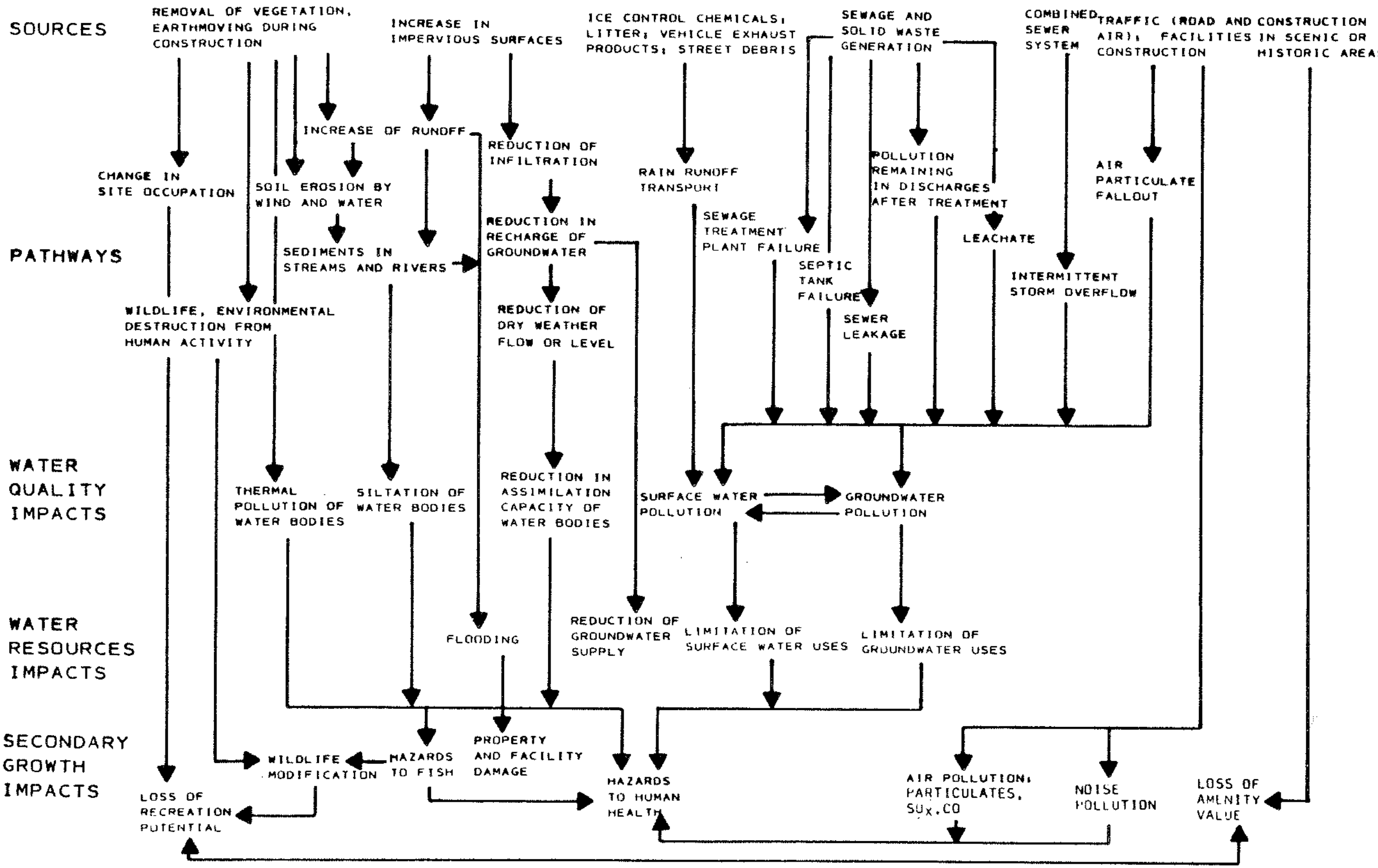

FIGURE 3-1

RESIDENTIAL LAND USE IMPACTS OF URBAN RUNOFF·

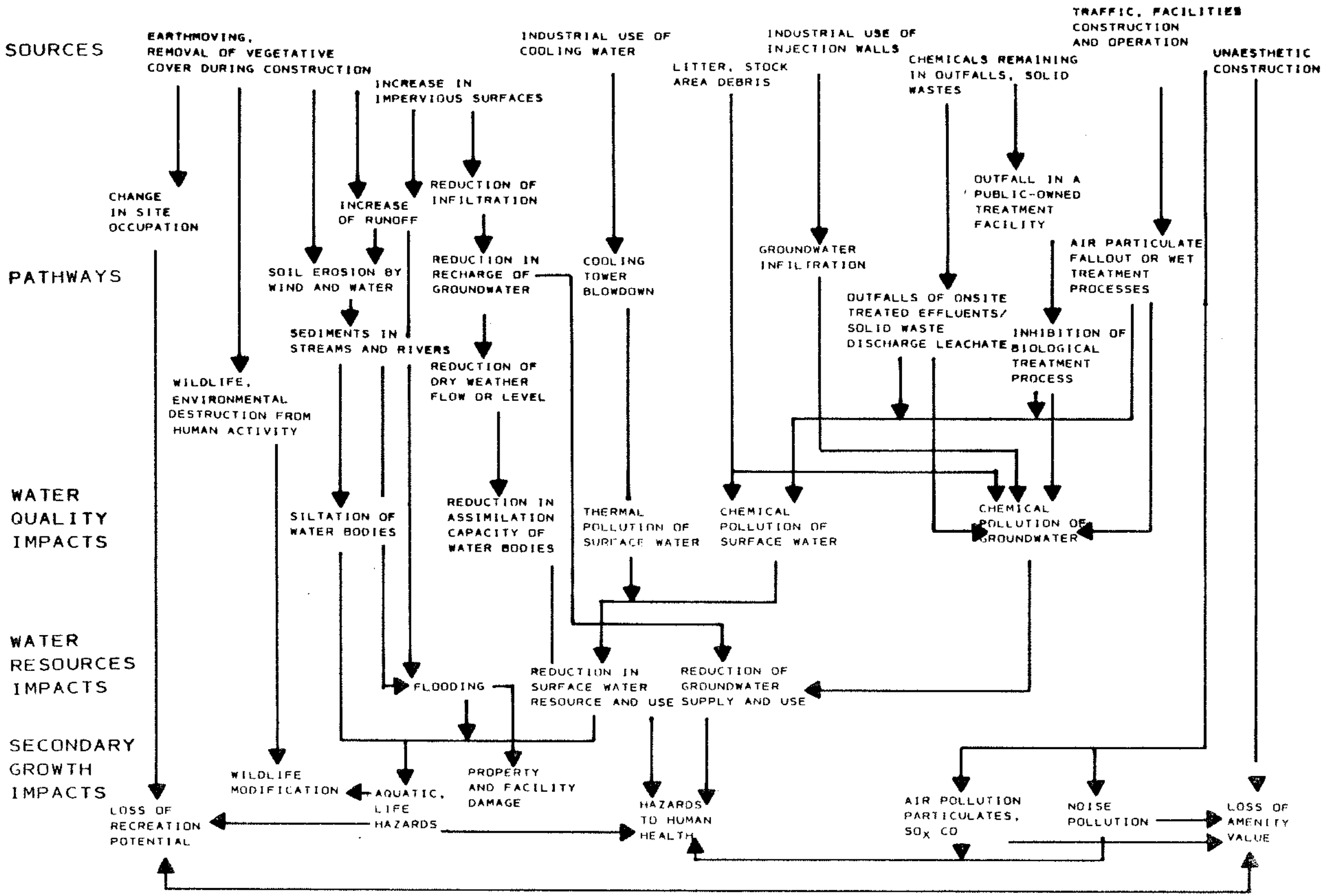

FIGURE 3-2

INDUSTRIAL AND COMMERCIAL LAND USE IMPACTS.

land use controls. They can further be supplemented by urban cleanliness programs. A description of existing programs which relate to urban runoff control is presented below.

LAND USE CONTROL

The basis for all land use control in Anchorage is contained in a document entitled, Land Use Planning, Title 21. It includes all the basic land use controls that currently, both inadvertently and by design, have a major impact on water quality. These include (1) comprehensive plan; (2) zoning regulations; (3) standards for special exceptions; (4) flood plain regulations; and (5) subdivision regulations. As presented later in this section, there are other planning programs in the Anchorage area that also have an impact on water quality.

Comprehensive Plan

The Anchorage Comprehensive Plan sets forth goals, objectives, and policies regarding the future development of the area. Although the plan has been adopted as an ordinance, it does not represent final regulatory authority over the use of land. Rather, this authority is vested with the Planning and Zoning Commission and the Assembly and effectuated through the Zoning Ordinance and Subdivision Regulations.

The emphasis of the Comprehensive Plan is primarily centered around the special patterns and segregation of land uses and the suitability and capability of an area to accommodate a given land use. Such factors as the availability of transportation, water, sewer, public schools, and other facilities are the common criteria. Although the plan does not address the issues of nonpoint source pollution directly, it does provide goals and objectives for environmental quality, including soil, vegetation, air, water, and local aesthetics. The environmental objectives of the Anchorage Comprehensive Plan which relate directly to water quality are cited as follows:

1. To encourage activities that preserve existing vegetation and promote more of it in the urban area;

2. To establish standards for air and water quality with appropriate surveillance and enforcement to insure that there will be no significant deterioration below current levels and so that there will be improvements in quality as the State law permits;

3. To establish policies to protect water recharge, watershed and flood plain areas;

4. The impact of development proposals on wildlife habitat areas should be evaluated;

5. High quality wetlands and marshes should be identified so that they may be protected and preserved as open space.

Pages 21-42 of the Comprehensive Plan discuss implementation for improving future land use regulation. That section states that zoning and subdivision regulations, which are subject to modification, will serve as the legal base for land use regulation. These are established legal tools, defined by extensive application and litigation. Refinements of these tools will be considered to provide flexibility. These refinements include, but are not limited to, the following: performance standards; contract zoning; incentive zoning; development rights transfer; timed development zoning; special district zoning; impact zoning; land banking and lease hold development. Obviously, the foundation for future land use regulations, as applied to water quality improvements, has been established.

Zoning Ordinance

As mentioned above, the Zoning Ordinance, along with Subdivision Regulations, provide the legal tool for the Comprehensive Plan. Modifications of the Zoning Ordinance are prepared by the Planning and Zoning Commission and recommended to the Assembly as a mechanism for implementing the Comprehensive Plan. In accordance with the Comprehensive Plan, the Assembly utilizes the Zoning Ordinance to regulate and restrict the use of land and improvements by districts.

There are no existing zoning regulations which are geared directly for improving surface or ground water quality. Rather, existing regulations are directed toward segregation of incompatible land uses; height and size of structures; number of stories and buildings; and stimulating systematic development of transportation, water, sewer, schools, etc.

By of way of contrast, provisions in the zoning ordinance control the amount of lot coverage and setback requirements, and control population density and distribution. Inasmuch as the amount of impervious area is inversely correlated to water quality, the control of lot coverage presents a potentially powerful tool for control of urban runoff and enhancement of water quality. Under present regulations, low density single-family residential lot coverage is limited to 5 percent. One-family residential districts are limited to 30 percent and two-family residential districts to 40 percent maximum lot coverage. Depending upon circumstances, multifamily residential districts are limited to 40 to 50 percent. It is important to note that industrial districts have no minimum lot coverage requirements. The central business district area also has no minimum lot coverage requirement, but development is influenced by a "bonus point system," which is perhaps one of the most progressive in the nation.

The bonus point system provides an incentive for the developer to incorporate certain design amenities into development plans. Basically, it allows increases over the base height permitted. Each bonus point allows an additional 400 square feet of office space. Bonus points are awarded for amenities such as bicycle racks, seating units, trees, open air plazas, landscaped parks, preservation areas, etc. Presently, there are no bonus points directed specifically to minimization of urban runoff pollution problems. However, the existing bonus point incentive provides a solid foundation for minimizing urban runoff problems.

Standards for Special Exceptions

Special exceptions which are related to the zoning ordinance, may be granted by the Planning and Zoning Commission. Analysis of these regulations indicates that certain sections can be interpreted to be directly beneficial to water quality. These include standards for gasoline service stations, natural resource extraction, storage yards, junkyards, and standards for planned unit developments. A brief discussion of the aspects pertinent to water quality follows.

Standards for Gasoline Stations. Section 21.50.060.4B requires that drainage flow lines be shown on site plans for all gasoline service stations. If it is shown that the storm drainage will be carried off site, it is required that the plan be approved by the Public Works Department.

Natural Resource Extraction. Similarly, a drainage plan is required as part of the site plan for natural resources extraction, as required under section 21.50.070.A.3. The drainage plan must provide for safe disposal of surface water both during the extraction period and after site restoration, which is also required under these regulations. Similar to the above, when it is evident that storm drainage will be conveyed to adjacent properties, the plan must be subject to approval by the Public Works Department.

Storage Yards. Regulations for storage yards fall under Section 21.50.080. Subsection E cites that provisions shall be made to prevent any contamination of the domestic water supply or to prevent excessive surface runoff from the site onto adjoining lands or streams. A drainage plan which carries water off the site shall be subject to approval of the Public Works Department. Failure to prevent contamination of the domestic water supply or to prevent excessive surface runoff from the site onto adjoining lands or streams shall be cause for the exception to be rescinded and the storage yard shall be removed at the cost of the owner of the land upon which it is located.

Junkyards. Runoff problems from junkyards are controlled under Section 21.50.090. The language in this section reads exactly the same as that presented above under Storage Yards.

Planned Unit Developments. These developments are regulated under Section 21.50.130. Of particular interest to water quality is the requirement that a minimum of 30 percent of the site shall be reserved as usable open space. In addition, the regulations provide protection of water courses by requiring a landscaped buffer zone having a minimum width of 50 feet.

Flood Plain Regulations

The Municipality of Anchorage has implemented flood plain regulations which basically prohibit development in the area's "flood hazard districts." It is important to note that Section 21.60.060,A3 infers that development such as excavation of sand and gravel and other natural resources, railroad and tramway tracks, streets, bridges, utility installations and pipelines, storage yards for equipment and materials, commercial farming, landfill, and land reclamation activities are permitted by acquisition of a special flood hazard permit. Many of these activities, especially landfills, could prove injurious to water quality if allowed to be developed in the flood plain. Requirement of an environmental review prior to granting these permits is a possible method for protecting water quality.

Subdivision Regulations

Subdivision regulations have been adopted by the Municipality of Anchorage as a legal tool to implement land use control. As an implementation tool, they provide the same legal teeth that zoning does. Existing subdivision regulations have not been directed toward the minimization of urban runoff pollution problems, but several sections included in the ordinance certainly provide environmental benefits. These are cited in the paragraphs below.

Easements. Section 21.80.075B protects water quality by requiring "maintenance easements along streamways." Easements are required to be wide enough to protect the stream but to be no less than 25 feet wide along each bank. These easements can benefit water quality as they function as a filter, minimizing the amount of sediments carried to the stream. Provision of easements is one of the least expensive (provided it is done before development) and effective preventive measures for preserving high water quality.

Environmental Design. Section 21.80.120 requires environmental design. It states that lots are to be designed to minimize the impact of urbanization on environment, and that environmental factors may be considered as justification for variation from any of the standards. Because of the generality of this regulation, it is doubtful that it is currently effective at protecting water quality. However, with some fortification, it could become a powerful mechanism for water quality protection.

Subdivision Regulations--Improvements

These regulations include two sections which are beneficial to water quality.

Drainage. Section 21.85.050 regulates drainage systems for new subdivisions. It requires an adequate drainage system which takes into consideration the preservation of designated high quality wetlands critical to the water table levels and wildlife habitat. The requirements of each subdivision are established by the Departments of Public Works and Health and Environmental Protection. For this reason, there are no uniform requirements. In some cases, highly protective controls such as onsite detention basins are required. However, this is the exception rather than the rule.

Erosion and Sedimentation Control Plan. This control is discussed in detail later in this chapter.

Parks and Recreation Planning

The Municipality of Anchorage has an aggressive greenbelt acquisition program. Fortunately, for water quality, the program is directed toward acquiring stream corridor properties. Greenbelts have been obtained along Campbell Creek and Chester Creek. And others are planned for Little Campbell, Ship, and Rabbit Creeks. They are a minimum of 50 feet wide on either side of the streams, with jogging and bicycle trails. Proposed parkland is shown on Figure 2-2 in Chapter 2. Establishment of linear parks benefits water quality, because the parkland acts as a filter strip which strains the pollutants from runoff prior to stream discharge.

Of particular significance to Campbell Creek, is the recent designation of the Campbell Airstrip area (previously owned by the U.S. Air Force) as open space. This land encompasses the creek's headwaters and major spawning areas, so its protection will have a dramatic benefit to water quality.

Anchorage Coastal Resource District Program

The Municipality is currently engaged in developing a "District Coastal Management Program," in response to the Federal Coastal Zone Management Act of 1972 and the Alaska Coastal Management Act of 1977. The program will include the following elements upon completion:

1. A delineation within the district of the boundaries of the coastal area subject to the district coastal management program;

2. A statement, list, or definition of the land and water uses and activities subject to the district coastal management program;

3. A statement of policies to be applied to the land and water uses subject to the district coastal management program;

4. Regulations, as appropriate, to be applied to the land and water uses subject to the district coastal management program;

5. A description of the uses and activities which will be considered proper and the uses and activities which will be considered improper with respect to the land and water within the coastal area;

6. A summary or statement of the policies which will be applied and the procedures which will be used to determine whether specific proposals for land or water uses or activities shall be allowed; and

7. A designation of, and the policies which will be applied to the use of, areas within the coastal resource district which merit special attention.

Since it has been proposed that the coastal management plan will cover the "zone of direct influence" (1,000-foot contour) it will include all of the more urban portions of the 208 study area. The schedule for plan completion is similar to that of the 208 plan, presenting a great opportunity for coordination.

URBAN CLEANLINESS

The pollutant load associated with urban runoff is directly related to the level of cleanliness. And urban cleanliness is determined by the level of litter and refuse control, animal control, sanitary code enforcement, street and parking lot sweeping, and road maintenance.

Solid Waste Control

Litter, yard debris, discarded "white" goods, and junked cars can influence the quality of urban runoff. Secondly, landfills, which are used as a depository for these wastes, can produce a highly polluting leachate caused by infiltrating water. Entry of leachate to ground and surface waters can be highly injurious.

Municipal refuse is hauled entirely by the Municipality. Collection for residential users is once per week and up to six times per week for some business users. Regular compaction trucks are used, and the waste is hauled to the municipal landfill at 15th and Lake Otis.

The Municipality does not supply a pickup service for "white" goods or other large bulky items. Instead, this is left up to the individual. Citizens are allowed to haul these goods to the landfill at a fee of $5 per ton, with a minimum charge of $1.

Junked cars are hauled by the police department when located in a public right-of-way. In other cases, vehicles either are not hauled or are removed by private property owners.

In September of 1975, the Municipality furnished its "Solid Waste Management Master Plan." Future plans call for a milling plant for shredding the refuse, located in the vicinity of Tudor and C Street. This facility will reduce the volume of waste and prepare it for resource recovery. Ultimate disposal will occur at a new landfill located near the Fort Richardson Military Reserve. A study determining the feasibility of burning milled solid waste in one of the area's powerplants is recommended by the plan.

Animal Control

As mentioned previously, the majority of the fecal coliform and a portion of the BOD loading in urban runoff is from animal manure. Assuming the average pet weighs 10 pounds, and that daily manure production ranges from 5 to 8 percent of their body weight, the annual waste load is between 180 and 300 pounds per animal. This is certainly a problem worth consideration.

Currently the Municipality of Anchorage has a leash law which includes the entire area from Eklutna to Girdwood. The law requires the owner to have custody of the dog unless it is confined or restrained on his own premises or under his immediate control. However, the ordinance does not require the owner to control the area where the dog litters, or to clean up after the pet where it messes on a public area, such as a sidewalk or street.

Dogs and other domestic animals may be legally harbored in most residential areas within the project area. The Municipality's Zoning Ordinance cites that "paddocks, stables, or similar structures for keeping animals other than dogs shall be at least 100 feet from any lot line in all areas zoned R-1, R-1A, R-2, R-2A, and R-2D." If granted a "special exception," a similar facility can be operated in R-3, or multifamily zones. Rural residential areas, including R-5, R-6, and R-8, allow paddocks and stables etc., within 25 feet from a property line.

It is apparent that these regulations have evolved for the protection of adjacent property owners from the noise and odors often associated with the harboring of animals. It should be noted that the existing regulations do not cover the proximity of animal impoundments to surface water bodies, nor require control of drainage from these facilities.

<u>Street and Parking Lot Sweeping</u>

<u>Campbell Creek</u>. Streets are cleaned by the State and by the Municipality of Anchorage Public Works Department. Parking lots are cleaned by the owner or by private sweeping contractors.

The State Department of Highways is responsible for all of the major streets in the study area, most notably Seward Highway, Lake Otis Parkway, Old Seward Highway, and C Street. The State uses both vacuum and broom sweepers to clean the urban portions of these roadways. In outlying rural areas the streets are not swept. In general, streets are cleaned after ice breakup and an additional two to four times during the 6-month warm weather season. Streetsweepings are picked up from streets with curbs and gutters and are brushed to the side of streets without improvements. Seward Highway is not swept because the high speed vehicles blow dirt from the street surface and because of the hazard caused by streetsweeper operations.

The Municipality of Anchorage uses two vacuum and one broom sweeper to clean approximately 100 miles of what are mostly residential streets. The streets are cleaned about three times during the 6-month sweep season. Special problems encountered by the Municipality's street cleaning crew include (1) areas around apartments and lower income subdivisions, (2) parked cars, (3) dumping of debris into the gutter, and (4) high costs.

Conversation with the Municipality's crew revealed that streets in apartment and lower income areas have a much greater buildup of debris than found in the middle and upper-middle income areas. These problem areas are estimated to encompass about 45 percent of the study area. It was felt that much more attention, perhaps weekly cleaning, was needed in these areas and that additional cleaning of the higher income areas was not merited, at least not from an urban aesthetics standpoint.

Although the Municipality has an ordinance prohibiting parked cars on streets during sweeping, it is reportedly not strongly enforced in the Campbell Creek area. Conversely, this ordinance is well enforced in the more urban (and northern) portions of the Municipality. The presence of parked cars drastically reduces sweeping efficiency, as the sweepers cannot get next to the curb where more of the debris accumulates.

A third problem mentioned by the streetsweeping crew is littering and the tracking of debris onto the streets by vehicles moving to and from construction sites. The littering problem is most severe in the lower income areas and around construction sites. Additional problems are caused by homeowners raking grass clippings and other vegetative yard debris to the gutter. The current policy, albeit unwritten, is to not sweep up the yard debris to discourage this practice. Possible solutions would include an antitracking ordinance (prohibiting the tracking of sediments from construction sites to the street) for developers and an ordinance prohibiting raking of yard debris to the gutter.

The fourth problem concerning streetsweeping in the Anchorage area is the extremely high cost. Due to the heavy loadings of debris left on the road surfaces after spring breakup, sweeping progress is very slow. High costs and slow progress result in an average cost of over a $100 per curb mile per cleaning. This compares to a typical cost of about $7 in the lower 48 states.

<u>Chester Creek</u>. Most streets within the upper subbasin[(1)] are swept about once every two weeks, while the major streets (e.g., Debarr, Northern Lights, and Muldoon Road) are swept

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(1) See Figure 3-4 later in chapter for delineation of subbasins.

weekly. There are also many unpaved roads which receive the dust control program described below for Ship Creek. Streets within the middle subbasin are swept weekly.

In the lower portions of the basin, streets are swept weekly, except for streets in the CBD maintenance zone (1st to 10th, L Street to Ingra), which are swept two or three times per week. Except for isolated areas, all streets within this subbasin are paved.

Ship Creek. As in the Chester Creek basin, streetsweeping frequency increases with progression downstream. The Fort Richardson study area has very limited streetsweeping practices. Following spring breakup, the entire area is flushed and swept thoroughly. This serves until the following spring, except for occasional maintenance emergencies. Thus, pollutant buildup on the well-travelled roads throughout the summer is considerable.

Sanitary conditions of the lower subbasin (near the CBD and industrial area) vary quite significantly, as the diversified land use would indicate. The residential streets of the Mountain View and east Government Hill are flushed and swept weekly, and streets within the CBD are flushed and swept on the average of two to three times per week. Problem areas are the industrial zones between Sitka Street and Mountain View, the railroad facilities, and the adjacent industrial facilities bordering Ship Creek near its mouth. Many of the roads in these areas are unpaved, so they are not swept. However, a dust control program is used. It consists of dampening, grading, and oiling the street surfaces three or four times each summer.

Fish Creek. Streetsweeping occurs weekly on nearly all streets of the drainage basin. Exceptions to this are State maintained roads, which are swept on an "as-needed" priority basis. These include the main throughfares in the basin: C Street, Minnesota Drive, Tudor Road, and the Old and New Seward Highways. Although no strict criteria exist for this priority system, it can be assumed that these streets are swept twice monthly.

Knik Arm. Elmendorf Air Force Base maintenance crews and equipment are not able to clean streets and drainage facilities adequately. Sand, grit, and debris accumulate in catchbasins and storm sewers and require periodic flushing that is not provided. The Ocean Dock industrial area streets are swept infrequently. Pollutant buildup on this heavily travelled section of port-and-oil related facilities is undoubtedly high. Streets of the Knik-drained portions of the CBD receive regular flushing and sweeping two or three times per week. The residential area to the southwest is swept weekly.

Lakes Hood and Spenard. Anchorage International Airport runways, taxiways, and adjacent paved areas are swept about once per week.

Stockpile Protection

The City currently has no regulations regarding the covering of, or control of, runoff from stockpiles. However, flood plain regulations, Section 21.60.050.00, prohibit the storage of equipment or materials that are buoyant, flammable, explosive, or injurious to safety upon contact with water in all flood hazard districts. This could be modified to exclude stockpiling of all materials potentially injurious to water quality from flood plain districts.

Road Maintenance

Road maintenance in the Anchorage area is difficult due to severe climatic conditions. Repair of unpaved roads is given priority and potholes and other signs of winter wear are corrected once a year. Since a large percentage of the suburban roads (up to 50 percent in some cases) are unpaved, maintenance is difficult and street surface pollutant loadings are high. To control dust, unpaved roads are dampened, graded and oiled three or four times each summer. This probably results in eventual increases of oil and sediments to area streams.

DRAINAGE FACILITIES

The general pattern of drainage in each basin is by overland flow through natural channels in the upper portions and by underground structural facilities in the lower portions. The storm water drainage facilities are separate from the wastewater drainage facilities. Drainage in each of the four urban basins is briefly described below.

Campbell Creek

Very few storm drains and drainage ditches have been built in the Campbell Creek basin. As shown on Figure 3-3, the drains and ditches that have been built are almost all located below Artic Boulevard, and discharge to the reaches furthest downstream in Campbell Creek. Drainage in the middle and upper portions of the basin is by overland flow along highways or through natural channels.

Chester Creek

Chester Creek drainage can be considered in terms of three subbasins. The three basins are delineated on Figure 3-4. The upper subbasin is defined as all Chester-drained areas

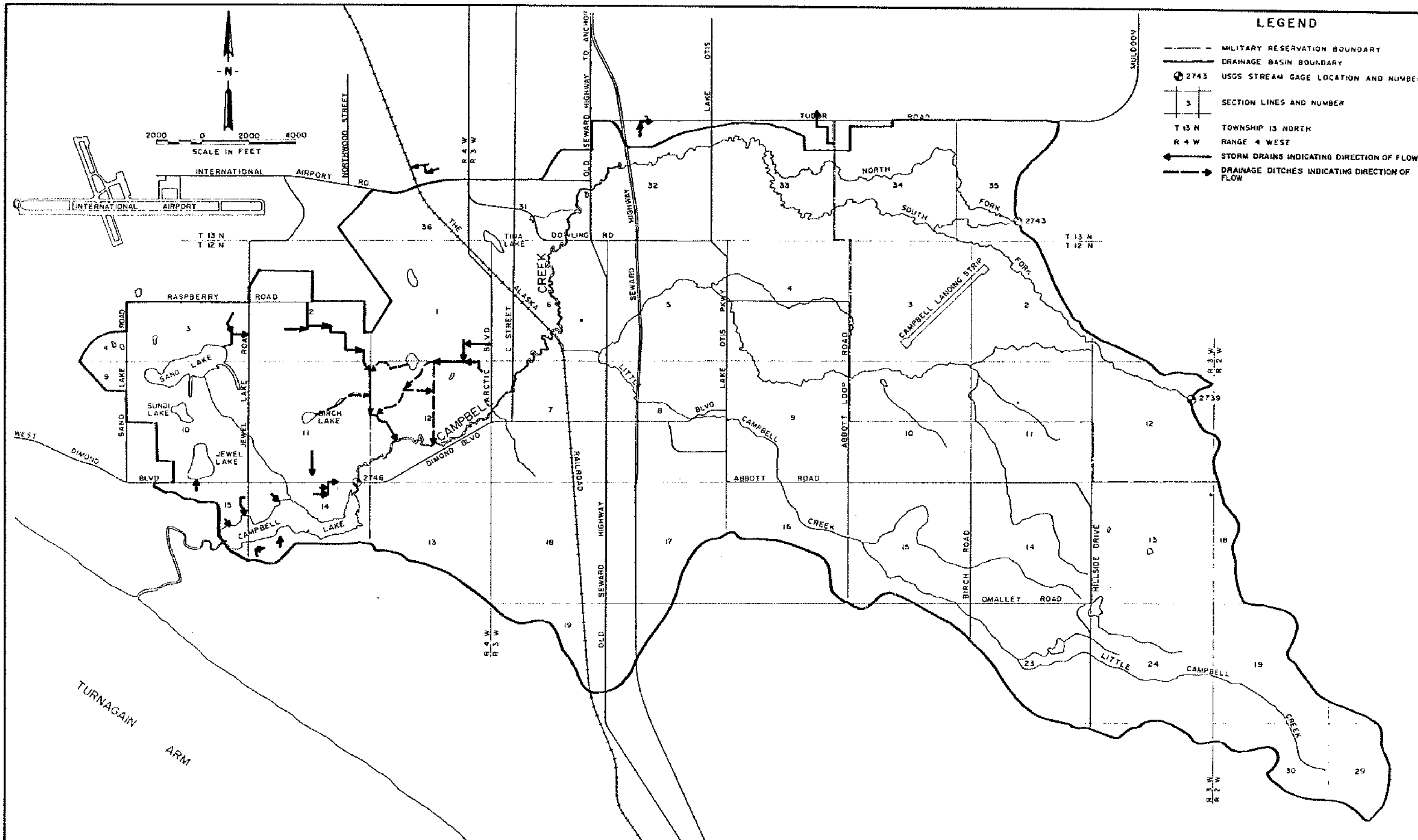

FIGURE 3-3

STORM DRAINS & DRAINAGE DITCHES
IN THE CAMPBELL CREEK BASIN

CH2M HILL

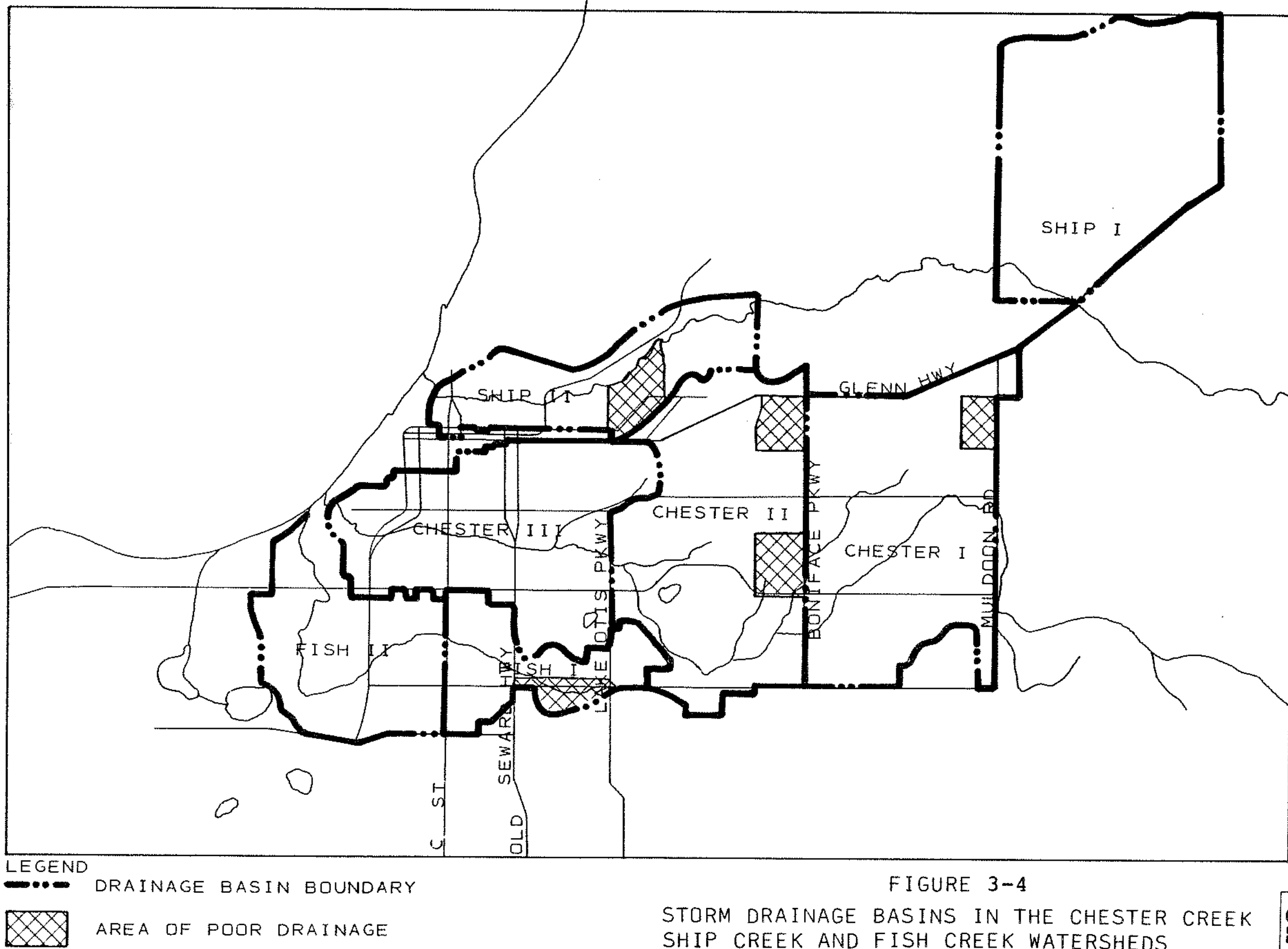

FIGURE 3-4

STORM DRAINAGE BASINS IN THE CHESTER CREEK SHIP CREEK AND FISH CREEK WATERSHEDS east of Boniface Parkway. Typically, drainage in this subbasin occurs by overland flow directly into one of the two branches of the South Fork of Chester Creek or into low-lying muskeg or wooded areas. Storm drains are not common and serve only scattered, small areas that lack the definitive topographic expression required for effective overland flow drainage. A problem area of standing water is shown on the figure.

The middle subbasin is defined as all Chester-drained areas between Boniface Parkway and Lake Otis Parkway. This subbasin contains large expanses of undeveloped lands having no structural drainage facilities. The developed lands for the most part possess adequate underground drainage facilities that are directed toward the nearest branch or fork of the creek. The system is comprised of concrete and metal piping, catchbasins, culverts, subdrains, and some open ditches. There are two problem areas, shown on Figure 3-4, that have no structural drainage facilities. Both are largely unpaved residential subdivisions with open ditches.

The lower subbasin contains all Chester-drained areas west of Lake Otis Parkway. This subbasin includes Merrill Field, a large portion of commercial properties within the central business district and along the Northern Lights Boulevard and Benson Boulevard, and a large residential community. Structural, underground drainage facilities exist for virtually all areas of this subbasin, and are comprehensive in design. These facilities consist of solid and perforated concrete and metal piping, catchbasins, gutters and culverts. If properly maintained, they are adequate to transport runoff.

Ship Creek

The Ship Creek drainage basin has been divided into two subbasins, Fort Richardson and the Municipality's commercial/industrial district near the lower reaches of the creek. These two subbasins are delineated on Figure 3-4.

The drainage facilities of the upstream subbasin at Fort Richardson are adequately and comprehensively designed. Most of the runoff is handled by catchbasins and underground concrete and metal conduits of various sizes. Bryant Air Field and the storage area north of the main garrison are drained by open ditches and culverts. The boundary between surface and subsurface drainage is approximated by Davis Highway.

The lower subbasin includes approximately the northern half of the Mountain View residential area, the commercial/industrial area between Fifth Avenue and Elmendorf Air Force Base, the north central portion of the central business district, the eastern portion of Government Hill, and the industrial section between the central business district and Government Hill. Drainage facilities serving these areas were constructed at different times as needs arose and therefore lack the comprehensive design typified by the upstream subbasin at Fort Richardson. Drainage in the area west of Sitka Street and south of Ship Creek is handled adequately through a system of underground metal and concrete pipes, catchbasins, and perforated piping. Similar systems exist for the Mountain View and Government Hill areas, with the exception that the underground systems empty into open ditches leading to Ship Creek. The industrial areas between Sitka Street and Mountain View have no real drainage facilities other than what occurs naturally through overland flow. Standing water in these areas is a frequent problem.

Fish Creek

The Fish Creek Basin has been divided into two subbasins as shown on Figure 3-4. Underground, structural drainage facilities are not common anywhere in the drainage basin. A long trunk sewer runs along Benson Boulevard serving much of the Benson/Northern Lights commercial district and empties into Fish Creek near Benson's western intersection with Northern Lights. A long storm sewer runs along Spenard from McRae Street before emptying into the Benson Trunk line. The area served by this line is almost entirely composed of commercial properties. Two short sewers exist near the mouth in a residential area between the creek and Turnagain Parkway. These facilities are composed of concrete piping, catchbasins, and gutter drains. The remaining drainage is largely overland flow, which is facilitated to some extent by open ditches and culverts. Standing water is frequently a problem in the low-lying areas upstream of the New Seward highway near Tudor Road.

CONCLUSIONS

Regarding urban runoff controls the following conclusions can be drawn:

1. The greatest challenge facing the 208 program is determining a method to accomodate burgeoning urbanization while at the same time maintaining high water quality.

2. Anchorage already has many land use controls that benefit water quality. A solid foundation has been set. Only modest modifications are required to better direct these controls to water quality protection. Many of the present controls require no modification but their indirect benefits to environmental quality should be made better known to public officials, developers and the public.

3. The City Department of Parks and Recreation has already developed a linear park system along Chester and Campbell Creeks. This is one of the most important controls for preserving water quality, and it has already been adopted. Again, this sets a solid foundation from which to initiate 208 water quality planning.

4. Because land use controls are administrated by only one entity, the Municipality of Anchorage, the institutional complications experienced in most areas, where many entities regulate land use, are avoided.

5. The District Coastal Management Program being developed by the Municipality will cover the 208 planning area, so the opportunity for meshing the two programs is afforded. Coordination is required.

6. Collection of large bulky items and "white" goods is not provided, so improper disposal of these waste items is encouraged.

7. Review of the "Solid Waste Management Plan" indicates that future landfills will be sited to avoid future water quality problems.

8. Animal controls are on the books but are difficult to enforce. They are probably ineffective for controlling fecal coliform and BOD loadings in urban runoff for this reason.

9. Streetsweeping responsibilities are shared by the State of Alaska and the Municipality of Anchorage. Major thoroughfares are swept by the State on an as needed basis. Sweeping frequency by the Municipality is 2 to 3 times per week in the CBD (downtown area), generally about two times per month in more established residential areas and from once every 4 weeks to once every 6 weeks in the outlying suburban areas.

10. Protection of stockpiles is not provided.

11. Road maintenance is difficult because of severe winter conditions. Nearly 50 percent of the streets in the study area are unpaved. Unusually high sediment loads are realized because of road breakup and unpaved conditions.

12. With the exception of the Ship Creek basin, urban drainage is typically provided by roadside ditches or swales. Curb drainage is also common. The lack of storm sewers is thought to be beneficial to water quality as runoff is not so readily conveyed to area streams. The absence of storm sewers allows pollutants and runoff to be absorbed in ditch bottoms and sides, lawns and open spaces.

SOIL EROSION AND SEDIMENT CONTROL

Soil erosion is a relatively minor water quality problem in the Anchorage area due to short spring and fall periods, frozen ground, and low runoff. However, because of the strict suspended solids and sediment water quality criteria (for protection of salmon spawning areas) protective controls are necessary. This is especially important due to the high level of construction activity in the Anchorage area. As referenced earlier, about 20,000 acres will be developed during the planning period. Runoff and soil tracking by truck traffic from construction sites, road sanding during winter, unpaved roads, and lawn and bank erosion all contribute to the sediment problem in Anchorage.

EROSION CONTROL PLANS

Construction plans are reviewed by the Engineering and Construction Divisions of the Public Works Department. This includes all construction within public rights-of-way and drainage easements. The criteria used in reviewing the plans includes conformance with Municipality of Anchorage Standard Specifications as well as the GAAB Improvement Standards and Design Criteria. The latter is used as a temporary guideline until the revised Design Criteria and Improvement Standards, which is currently under review, is adopted by the Municipality. Erosion and sedimentation are briefly addressed in the GAAB Design Criteria which call for energy dissipators and settling basins at storm drain outfalls and specify allowable velocities for erodible channels. Recently, drainage improvements have received special attention with regard to erosion and icing. Steam thaw pipes have been specified in all culverts, storm drain inlets and outfalls, and subdrains; rock slope protection, filtering channels, and oil and grease separators have been specified by the Engineer on a number of projects recently submitted for review.

In addition, Title 21, Land Use Planning, Chapter 21.85, Subdivision Regulations-Improvements, requires a plan for erosion and sedimentation control be submitted to the Department of Public Works for approval prior to any recontouring or denudation unless there has been a prior determination by the platting authority that a plan is not necessary. The ordinance requires these plans to contain adequate measures for control of erosion and siltation, where necessary. It states that control measures to be used include:

- The smallest practical area of land should be exposed at any one time during development.
- When land is exposed during development, the exposure should be kept to the shortest practical period of time.
- Sediment basins (debris basins, desilting basins or silt traps) should be installed and maintained to remove sediment from runoff waters from land undergoing development.
- Provisions should be made to effectively accommodate the increased runoff caused by changed soil and surface conditions during and after development.
- Ground cover should be replaced as soon as practical in the development.
- The development plan should be fitted to the topography and soil conditions so as to create the least erosion potential.
- Wherever feasible, natural vegetation should be retained and protected.
- All slopes within a subdivision resulting from cut and fill operations shall not exceed a maximum slope of 50 percent unless a lesser slope is deemed necessary by the platting officer due to soil conditions. If slopes of greater than 50 percent are desired, such slopes will be supported by a retaining structure approved by the Public Works Department (GAAB 21.10.050C).

CONCLUSIONS

1. The foundation for erosion control is set in existing regulations. However, specific criteria have not been developed. Universal application of control is improbable given the current program.

SNOW DISPOSAL

A majority of urban contaminants are directly and indirectly deposited on urban streets. Additional sediments and salt are added to the "street debris loading" during winter for snow and ice control. The pollutant loading as well as the need for snow disposal are severest on the most heavily travelled streets. Inasmuch as street pollutants are picked up during snow removal operations, improper diposal can be a significant water pollution problem because the pollutants are carried to proximate streams when the snow melts. However, snow disposal sites which are located properly pose no water quality problems. In fact, the removal and proper disposal of snow from heavily travelled urban streets is a method of pollution control. By contrast, in areas where snow is stockpiled (parking lots) or piled at the curb, an entire winter's accumulation of street contaminants can be carried to area streams during breakup.

EXISTING PROGRAMS

Snow disposal operations are presently conducted by three institutions as discussed below:

Public Snow Removal

Snow removal encompasses over 500 miles of roadway in Anchorage which is divided into two sections for snow removal purposes. The northernmost crew is primarily responsible for the downtown area and residential areas immediately adjacent to the downtown commercial section. The entire area lies north and east of Benson Boulevard and Turpin Road and covers approximately 230 miles of roadway. The remaining area in the bowl is maintained by both Department of Public Works Road Maintenance Section and the State Highway Department.

The current method of removal consists of windrowing the snow into the street, loading the snow into trucks via a snow blower and then dumping it at one of the closest snow dumping sites maintained by the Municipality. A crawler tractor is used to stockpile the snow at these dumping sites. A typical snow removal crew for the city consists of 3 motor graders, 1 snow blower, and 8 to 10 dump trucks. Three shifts are used which allow heavily traveled roadways to be maintained during hours of least use. Both the Department of Public Works and the State Highway Department use private contractors for removal of snow in addition to their own equipment and labor force.

Liquid calcium chloride is applied directly to the roadways as well as combined with the aggregate material to be spread. Application rates vary, but average 8 gallons per minute while the applicator travels at 5 to 10 mph. This yields approximately 100 gallons of liquid calcium chloride per 16 yards of aggregate. An increase in application rates occurs at intersections and along curves in the roadway. High speed intersections receive augmented applications of salt and aggregate material for a distance of 800 feet approaching the intersection.

Private Contract Snow Removal

There are numerous private snow removal operations in the Anchorage area ranging from heavy equipment and truck fleets to the individual with snow blower or shovel and a pickup truck. Few snow disposal sites are available to the private contractor that are readily accessible and ecologically acceptable. Confrontations between individuals and municipal officials have occurred over snow disposal practices. Chains blocking off municipal and private snow dump entrances have been cut and indiscriminate dumping has occurred in the recent past. Minimum space availability and spring dump cleanup costs are the two primary pressure points which cause friction between snow dump users.

Military Snow Removal Operations

Fort Richardson Army Post and Elemendorf Air Force Base both maintain snow removal equipment and crews to dispose of snow deposited on roadway and airfields in their local areas. Their equipment and methods are much the same as those of the Municipality and the Department of Highways. The excess ice and snow is bladed to the roadside or blown from the roadway. Snow pushed up in parking lots or intersections is loaded into trucks and hauled to snow dump sites in the immediate area. The snow is then condensed by crawler tractors at the dump sites.

Salts and aggregate materials are applied extensively at intersections and along main artery roadways.

CONCLUSIONS

1. Snow disposal is currently handled by three different groups--federal, municipal and private--which complicates management.

2. No formalized criteria exist for development or location of snow disposal sites.

ONSITE WASTEWATER DISPOSAL SYSTEMS

The majority of the onsite wastewater disposal systems in the study area are septic tanks followed by either a standard drain field or a seepage pit. Malfunctioning onsite systems are a threat to water quality as they are sources of (1) phosphates, (2) fecal coliform, (3) ammonia, (4) nitrates, and (5) BOD. Effective planning and management can help reduce these problems. However, even with properly designed and installed septic systems, phosphates and nitrates can be persistent problems. Initially, phosphate loadings fix to the soil underlying the system. Within a short time the soil becomes saturated with phosphate, and subsequent loadings are discharged to the ground water and can then be carried to surface waters where they contribute to algal blooms and eutrophication. Nitrates are a problem because they pass directly through the soil and on to the ground water. This can be a problem if ground water is used for domestic supplies.

EXISTING PROGRAM

Onsite systems can be caused to malfunction by improper (1) initial design, (2) installation and (3) maintenance. Design failures result when a system is placed in areas with unsuitable soils and geology and when it is undersized. Systems which were sized correctly at installation can become overloaded if structural additions are made to the structure serviced, or if the household size is increased. This can be controlled by requiring adherence to appropriate design criteria and periodic inspection.

Malfunctions can either be surface or subsurface. Surface failures are more conspicuous and result from plugging of the drain field. The wastewater cannot then be absorbed, surfaces and flows over land, often to a local stream. A subsurface failure occurs when the underlying soils and geology are unsuited for wastewater disposal and insufficiently treated pollutants are carried to the ground water. Pollution of wells and streams or lakes fed by ground water is the principal concern.

The drain field is the principal problem area resulting from improper installation. If the sides or bottom of the trench are smeared or compacted, drainage will be hampered. Likewise, movement of heavy equipment over the completed drain field can destroy the tiles and preclude proper draining. Aggresive inspection or requiring developers to post performance bonds are ways to minimize poor installation.

In order to maintain a systems properly, it should be pumped every 2 or 3 years. When maintenance is absent, solids which accumulate in the tank pass through and plug the drain field. This results in either the backing up of wastewater into the home, in which case reparation is usually immediate, or a surface failure, where correction is often postponed. Correction in this latter instance is then dependent on neighbor complaint or public agency inspection. Preventative maintenance can be encouraged by public education or mailing postcard reminders.

The Department of Health and Environmental Protection (DHEP) regulates onsite waste disposal systems through administration of Chapter 15.65, Waste Disposal Regulations. The current program is strong and provides a solid foundation for further planning. Each major element of the current program is described below.

Permits and Inspection

In order to build an onsite system, it is necessary to obtain a written permit from DHEP and to use only DHEP approved and permitted onsite system contractors. To obtain this permit, it is required that a soils test be verified by a DHEP approved professional engineer and two visual inspections by DHEP during construction be performed. The soils test consists of a visual inspection to a depth of at least 4 feet below the bottom of the proposed disposal system or to a depth of 16 to 20 feet. If the soils are classified as requiring greater than 150 square feet of drainage area per bedroom (moderately tight soils), a percolation test is required. If the percolation test shows the absorption capacity of the soils to be greater than 15 minutes per inch, special written permission of DHEP is required to build an onsite system. It is important to note that if it is evident that the soils test has been falsified the professional engineer responsible is held liable. In several cases this has resulted in outright purchase of the lot when it was not possible to develop a satisfactory onsite system.

Regulation 15.65 requires an inspection by DHEP prior to backfilling any septic tank, drainage field or seepage pit. Departmental policy requires an inspection after the seepage pit or trench has been dug in order to verify the soils test and to ensure that the soil properties are constant throughout the drainage area. The backfill material is required to be screened gravel, 1/2-inch to 2-1/2 inches in diameter.

Design Criteria

Present design criteria, listed below, are based on the Manual of Septic Tank Practice published by the U.S. Public Health Service. These include minimum lot size, system size and minimum distances.

- Current regulations require a minimum lot size of 1-1/4 acres, and provisions for at least two replacement systems need to be considered.

- DHEP requires house plans to be submitted prior to granting a permit for an onsite system so that the number of potential bedrooms may be determined and the system designed for this size. Gray water bypasses are not allowed. The onsite system must also be designed to handle the waste produced by garbage disposals. The sizing of the onsite system is standardized by the regulation.

- Septic tanks, drain fields or seepage trenches are not permitted within 100 feet of any river, stream or lake; 100 feet from any source of domestic water supply; 10 feet from any water main; or 5 feet from any property line or building foundation. The bottom of a seepage trench or drain field is not allowed to be within 4 feet of the ground water table. The same criteria apply for seepage pits except that they may not be within 20 feet of any building foundation or property line, 15 feet from a septic tank or 10 feet from other seepage pits. Seepage pits are only allowed where soil conditions or topography preclude the use of a seepage trench or conventional drain field.

One concern with existing design criteria is that its applicability to the Anchorage area is unfounded.

Permits Required for Installers and Septage Haulers

Permits are required for persons who construct, sell or install any septic tank, seepage pit, seepage trench, drain field or package waste treatment plant as a business. These persons must be bonded in order to obtain the permit by DHEP to practice. Permits are also issued on an annual basis for septage haulers or pumpers by the Sewer Utilities Department. The permit defines where and in what manner septage may be disposed. Illegal septage disposal is in violation of State law and offenders have been sentenced to prison terms.

Approval by Lending Institutions

Although not required by any regulations, current DHEP and lending institution policies require DHEP approval of all homes seeking loans that have onsite systems prior to sale. To obtain DHEP approval, a visual inspection of the lot, drainage system location, septic tank size and number of bedrooms in the house, and possibly a soils test, are required. If the system is not operating properly, the owner is required to make the necessary repairs. This practice has improved many inadequately designed or improperly operated systems, and is eliminating many cesspools that were once allowed but now are forbidden by State and local regulations.

Public Education

DHEP currently distributes a leaflet entitled Care and Maintenance of Sewage Disposal Systems to prospective users of onsite systems. The leaflets are distributed with receipt of a permit to build an onsite system.

Alternative Systems

The regulation encourages the use of new technology and alternative onsite systems to septic tanks. However, in order to assure the protection of public health and water quality, it requires a maintenance contract between the owner and the local distributor or maintenance concern, and the contract must comply with the National Sanitation Foundation Standard No. 40. Failure to perform the maintenance agreed to in the contract can result in a suit for civil penalties and injunctive relief. Several alternative systems have been tried in the area with only limited success.

Connection to Sanitary Sewers Required

Septic tanks cannot be used if a sanitary sewer main is within 100 feet of any corner of a parcel of land that touches the sewer right-of-way or easement.

CONCLUSIONS

Review of existing regulations for onsite disposal systems leads to the following conclusions:

1. The existing method for controlling onsite wastewater disposal is septic tanks in most areas.

2. Septic tank placement is regulated by the Department of Health and Environmental Protection. The location of septic tanks is primarily based on percolation tests. A better method for determining site suitability of onsite disposal systems merits consideration.

3. Existing regulations may not be stringent enough to protect ground water.

4. There is presently a general lack of data on number, condition, and location of onsite disposal systems.

5. Several of the current controls are policy and not legally formalized. With a change in staff, continuity could be lost.

6. Proper installation is assured by visual inspection by a representative of the Department of Health and Environmental Protection. Additional measures for assuring proper installation are probably needed.

7. There are presently no controls requiring proper operation and maintenance of septic tank systems. Failed systems will only be required if complaints are logged with the Municipality. Thus, there is no control over malfunctioning systems that are inconspicuous.

Chapter 4
WATER QUALITY REQUIREMENTS

ROLE OF WATER QUALITY REQUIREMENTS

Water quality requirements are a central element of any wastewater management program. They form the foundation of any successful plan by providing a method of translating narrative goals and objectives into specific physical/chemical parameters which can be measured and monitored. Water quality requirements also provide criteria for monitoring the plan's performance and determining success or failure.

Agreement on water quality criteria requirements is mandatory for the plan's acceptance and eventual implementation. Often there is disagreement among the various governmental agencies regarding water quality objectives and what water quality standards are required to achieve these objectives. If agreement among the various governmental agencies is not achieved, delays in obtaining plan approval could jeopardize plan implementation. Acceptance of a common set of objectives is the first step toward plan implementation.

PROCEDURE FOR ESTABLISHING WATER QUALITY REQUIREMENTS

GENERALIZED PROCEDURE

The procedure for establishing water quality requirements for a specific stream can be generalized as a four-stepped process. The first step involves the definition of beneficial water uses and narrative goals and objectives. The second step is the definition of specific physical/chemical water quality standards which can be used to translate the narrative goals and objectives into specific water quality standards. Thirdly, each of the surface streams and ground water systems in the area must be classified as to the desired beneficial uses. The last step involves combining the water quality standards developed previously with the desired beneficial uses and objectives for a specific stream resulting in a set of site-specific physical/chemical water quality requirements.

INSTITUTIONAL RESPONSIBILITIES

Currently, several levels of government have responsibilities for establishing water quality goals or objectives, standards and requirements. In order to ensure that local objectives and desires are incorporated into the water quality requirements, an understanding of the roles of various institutions is needed. Three levels of government involved with setting water quality standards are: (1) the Federal government through the EPA, (2) the State of Alaska through the Department of Environmental Conservation, and (3) local government through the municipalities' planning and engineering departments.

Role of the Federal Government

With the adoption of Public Law 92-500, Congress established national water quality objectives. The objective of primary concern to the 208 study is contained in section 101(a) (2): "it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the waters be achieved by July 1, 1983." In later sections of the law, EPA is directed to establish water quality criteria which will accomplish these goals. To satisfy this requirement, EPA has published a volume entitled Quality Criteria for Water, numbered EPA-440/9-76-023, which outlines specific physical/chemical water quality criteria designed to achieve the national water quality objective.

Public Law 92-500 directs the EPA to supervise the establishment of water quality standards by the states. In fulfillment of this role, EPA has developed a set of guidelines entitled Guidelines for State and Area Water Quality Management Program Development, Chapter 5, Water Quality Standards, which was published in November of 1976. Chapter 5 requires states to review and update the water quality standards once every 3 years. The mandatory 3-year review presents an interesting problem for water quality management planning which is to be accomplished for a 20-year planning period. If changes in future water quality standards are on the same order of magnitude as changes in the last 10 years, significant differences can be expected.

Chapter 5 of the Guidelines also defines "wherever attainable," a phrase which is used in the national objective quoted above. States may establish less restrictive water quality requirements provided one of the following conditions exists:

- The water quality standards for beneficial uses cannot be achieved because of natural background conditions.

- The water quality standards cannot be achieved because of irreversible man-made conditions or changes.

- The application of effluent limitations required to achieve the water quality standards would result in substantial and widespread adverse economic and social impacts.

Finally, Chapter 5 also outlines the role of EPA in the review, approval, and promulgation of water quality standards. It is important to note that should the State fail to promulgate acceptable water quality standards, EPA is empowered to establish these standards for the State. Additionally, all changes which the State makes in the water quality standards must be approved by EPA. Again, if the changes proposed by the State do not meet with EPA approval, EPA is empowered to promulgate acceptable standards for the State.

Role of the State

The state governments have been delegated the primary authority for promulgating water quality standards. They have three basic functions which are: (1) to establish local objectives, (2) to develop specific water quality criteria or standards, and (3) to adopt statutory water quality standards. The first function, that of establishing local objectives, involves classifying all of the various streams and ground water systems for desired beneficial water uses. The second function requires the state to adopt water quality criteria based on local stream conditions. Specific water quality standards must be developed by the state using the EPA's Quality Criteria for Water (1976) and other suitable references. The adoption of water quality standards which deviate significantly from the criteria published in EPA's Quality Criteria for Water (1976) may require justification by the state.

As outlined above, the third basic state function is the adoption of standards. Adoption of these standards usually requires public notice and hearings. It must also have EPA approval. The water quality standards adopted by the state become the foundation of all water quality management planning in the state.

Role of Local Governments

The primary role of local governments such as municipalities and planning agencies is to advise the state and federal government of local desires and requirements, local cost and financial abilities, and to build and implement the needed treatment systems and statutory requirements. If a local municipality desires to change the water quality standards adopted by the state, its role is limited to presenting evidence which may be used by the state and federal government in modifying the water quality standards or requirements. The local governments have been given the primary responsibility to complete the planning and development of the various controls required to meet the water quality standards. As a result, local municipalities and governments become the implementing agency for the policies and objectives adopted at the federal and state levels.

WATER QUALITY CRITERIA

The goal of 208 water quality planning, mandated by Public Law 92-500 (the Clean Water Act), is to achieve fishable and swimmable conditions by 1983, wherever possible. Fishing and swimming require a certain water quality; if that water quality is not maintained, the use may become impaired or lost. Other uses, such as drinking water or industrial water supplies, also require a certain water quality.

Water quality criteria are used to judge the suitability of water for different uses on the basis of water quality. They include a list of desired water uses and the levels of water quality that must be maintained to protect those uses. The water quality criteria for the study area are developed below.

WATER USES

The current Alaska water quality standards consider seven beneficial uses of fresh water. These uses are noted on Table 4-1. Of these seven, only Class C uses (water contact recreation) and Class D uses (growth and propagation of fish and other aquatic life) are currently exercised in the part of the study area impacted by urban runoff.

The current set of standards is undergoing review and revision by the State of Alaska. A new list of fresh water uses has been developed for the draft water quality standards. This new list is presented on Table 4-1, along with the corresponding uses in the current water quality standards.

The current and draft water quality standards cover the same major types of water uses. However, two important differences exist between the current list and proposed list of water uses. The proposed list differentiates between contact recreation uses, such as swimming, and secondary recreation uses, such as boating, while the current list of uses does not. However, the proposed list does not differentiate for fresh waters between "growth and propagation of fish and other aquatic life" (Class D in the current standards) and "shellfish growth and propagation" (Class E in the current standards).

Table 4-1
Beneficial Water Use

Existing Alaska Water Quality Standards--October 1973		Draft Alaska Water Quality Standards--Published 2 March 1978
Class A	Water supply, drinking, culinary, and food processing without the need for treatment other than simple disinfection and simple removal of naturally present impurities;	(1) Fresh waters (A) Water supply (i) Drinking, culinary, and food processing.
Class B	Water supply, drinking, culinary, and food processing with the need for treatment equal to coagulation, sedimentation, filtration, disinfection, and any other treatment processes necessary to remove naturally present impurities;	(1) Fresh waters (A) Water supply (i) Drinking, culinary, and food processing.
*Class C	Water contact recreation. "Contact recreation" means any form of recreation involving deliberate or accidental contact with water, including but not limited to swimming, water skiing, fishing, and commercial and recreational boating;	*(1) Fresh waters (B) Water recreation (i) Contact recreation. "Contact recreation" means activities in which there is direct and intimate contact with water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard. Examples of primary contact recreation include wading and dabbling, swimming, diving, water skiing, surfing and contact with water directly associated with shoreline activities.
*Class D	Growth and propagation of fish and other aquatic life, including waterfowl and furbearers;	*(1) Fresh waters (C) Growth and propagation of fish, shellfish and other aquatic life, and wildlife, including waterfowl and furbearers. "Wildlife" means all species of mammals, birds, reptiles and amphibians.
Class E	Shellfish growth and propagation including natural and commercial growing areas;	*(1) Fresh waters (C) Growth and propagation of fish, shellfish and other aquatic life, and wildlife, including waterfowl and furbearers. "Wildlife" means all species of mammals, birds, reptiles and amphibians.
Class F	Agricultural water supply, including irrigation, stock watering and truck farming;	(1) Fresh waters (A) Water supply (ii) Agricultural, including irrigation and stock watering.
Class G	Industrial water supply (other than food processing).	(1) Fresh waters (A) Water supply (iv) Industrial (other than food processing). "Industrial" uses means any water which is used in association with a manufacturing or production enterprise.
		(1) Fresh waters (A) Water supply (iii) Aquaculture.
		*(1) Fresh waters (B) Water recreation (ii) secondary recreation. "Secondary recreation" means recreation activities in which water use is incidental, accidental, or sensory and includes fishing, boating, camping, hunting, hiking, and vacationing.

* Currently exercised in the study area.

The proposed list appears to better describe and better differentiate among the uses currently exercised in the part of the study area impacted by urban runoff. These uses include:

- o Growth and propagation of fish, shellfish, and other aquatic life
- o Contact recreation
- o Secondary recreation

This study will develop and assess water quality management plans to protect these three types of water uses.

In addition to these three uses, the State of Alaska may designate water supply as a protected use in all creeks within the study area. That use is not currently exercised in the portion of the study area impacted by urban runoff, although it may be exercised sometime in the future if ground water supplies become depleted. This study will develop and assess a management plan for the Campbell Creek basin to protect that water use in order to indicate what sort of costs, management and institutional arrangements, and environmental and social impacts would occur in the protection of that use.

STANDARDS

A summary of the current Alaska water quality standards is presented on Table 4-2. These standards are in the process of being revised. A draft of the revised standards is presented on Table 4-3. Both sets of standards are organized in the same manner; for each water use, a level of water quality has been defined to protect that use. However, as noted in the previous section, some of the uses have been redefined in the draft standards. In addition, some changes have been made in the standards for certain water quality parameters. For example, the fecal coliform standards have become much more strict in the draft standards.

The proposed Alaska water quality standards have been established in the study as the water quality criteria for the study area for all uses except aquaculture and aquatic life. The criteria for this one use have been taken from the Alaska Department of Fish and Game criteria for hatching, rearing and holding of salmon.

The set of proposed standards has been selected for several reasons. First, as noted in the previous section, the proposed standards differentiate among the water uses currently exercised in the study area better than the current standards. Second, the proposed standards are near adoption by the

Table 4-2
Existing Alaska Water Quality Standards

Water Quality Parameters / Water Uses	(1) Organisms of the Coliform Group (see note 1)	(2) Dissolved Oxygen mg/l or % Saturation	(3) pH	(4) Turbidity, measured in Jackson Turbidity Units (JTU)	(5) Temperature, as measured in degrees Fahrenheit (°F)	(6) Dissolved inorganic substances
A. Water supply, drinking, culinary and food processing without the need for treatment other than simple disinfection and simple removal of naturally present impurities	Mean of 5 or more samples in any month less than 50 per 100 ml	Greater than 75% saturation or 5 mg/l	Between 6.5 and 8.5 (see note 3)	Less than 5 JTU	Below 60°F	Total dissolved solids from all sources may not exceed 500 mg/l
B. Water supply, drinking, culinary and food processing with the need for treatment equal to coagulation, sedimentation, filtration, disinfection, and any other treatment processes necessary to remove naturally present impurities	Mean of 5 or more samples in any month less than 5000 per 100 ml, and not more than 20% of samples during one month may exceed 5000 per 100 ml	Greater than 60% saturation or 5 mg/l	Between 6.5 and 8.5 (see note 3)	Less than 5 JTU above natural conditions	Below 60°F	Numerical value is inapplicable
C. Bathing, swimming, recreation	Same as B.1	Greater than 5 mg/l	Between 6.5 and 8.5 (see note 3)	Below 25 JTU except when natural conditions exceed this figure effluents may not increase the turbidity	Numerical value is inapplicable	Numerical value is inapplicable
D. Growth and propagation of fish and other aquatic life including water fowl and furbearers	Same as B.1 to protect associated aesthetic values	Greater than 6 mg/l in salt water and greater than 7 mg/l in fresh water	Between 7.5 and 8.5 for salt water. Between 6.5 and 8.5 for fresh water. Max. pH change permitted is 0.5 (see note 3)	Less than 25 JTU when attributable to solids which result from other than natural origin	May not exceed natural temp. by more than 2°F for salt water. May not exceed natural temp. by more than 4°F for fresh water. No change shall be permitted for temp. over 60°F. Maximum rate of change permitted is 0.5°F per hour	Within ranges to avoid chronic toxicity or significant ecological change
E. Shellfish growth and propagation including natural and commercial growing areas	Not to exceed limits specified in National Shellfish Sanitation Program Manual of Operations, Part I, USPHS (see note 2)	Greater than 6 mg/l in the larval stage. Greater than 5 mg/l in the adult stage	Between 7.5 and 8.5 (see note 3)	Less than 25 JTU of natural origin	Less than 60°F	Within ranges to avoid chronic toxicity or significant ecological change
F. Agricultural water supply including irrigation, stock watering, and truck farming	Mean of 5 or more samples less than 1,000 per 100 ml with 10% of samples not to exceed 2,000 per 100 ml for livestock watering, for irrigation of crops for human consumption, and for general farm use	Greater than 3 mg/l	Between 6.5 and 8.5 (see note 3)	Numerical values are inapplicable	Between 40°F and 70°F for optimum growth to prevent physiological shock to plants	Conductivity less than 1,500 micromhos at 25°C. Sodium adsorption ratio less than 2.5, sodium percentage less than 60%, residual carbonate less than 1.25 mg/l and boron less than 0.3 mg/l
G. Industrial water supply (other than food processing)	Same as B.1 whenever worker contact is present	Greater than 5 mg/l for surface water	Between 6.5 and 8.5 (see note 3)	No imposed turbidity that may interfere with established levels of water supply treatment	Less than 70°F	No amounts above natural conditions which may cause undue corrosion, scaling, or process problems

(13) Water Quality Parameters / Water Uses	(7) Residues, including Oils, Floating Solids, Sludge Deposits and Other Wastes	(8) Sediment	(9) Toxic or Other Deleterious Substances, Pesticides, and Related Organic and Inorganic Materials	(10) Color, as measured in color units	(11) Radioactivity	(12) Aesthetic considerations
Water supply, drinking, culinary and food processing without the need for treatment other than simple disinfection and simple removal of naturally present impurities. A.	Same as B.7	Below normally detectable amounts	Carbon chloroform extracts less than 0.1 mg/l and other chemical constituents may not exceed USPHS Drinking Water Standards (see note 4)	True color less than 15 color units	Conform with USPHS Drinking Water Standards (see note 4)	May not be impaired by the presence of materials or their effects which are offensive to the sight, smell, taste or touch
Water supply, drinking, culinary and food processing with the need for treatment equal to coagulation, sedimentation, filtration, disinfection, and any other treatment processes necessary to remove naturally present impurities. B.	Residues may not make the receiving water unfit or unsafe for the uses of this classification, nor cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines, nor cause a sludge or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom or upon adjoining shorelines	No imposed loads that will interfere with established levels of water supply treatment	Chemical constituents shall conform to USPHS Drinking Water Standards (see note 4)	Same as A.10	Conform with USPHS Drinking Water Standards (see note 4)	Same as A.12
Bathing, swimming, recreation. C.	Same as B.7	No visible concentrations of sediment	Below concentrations found to be of public health significance	Same as A.10	Conform with USPHS Drinking Water Standards (see note 4)	Same as A.12
Growth and propagation of fish and other aquatic life including water fowl and furbearers. D.	Same as B.7	No deposition which adversely affects fish and other aquatic life reproduction and habitat	None affecting public health or the ecological balance and less than an amount that causes tainting of flesh	True color less than 50 color units	Conform to USPHS Drinking Water Standards except where concentration factors of aquatic flora and fauna exceed USPHS radiation factors, then maximum permissible concentrations of radionuclides shall be reduced below acute or chronic problem levels (see note 4)	Same as A.12
Shellfish growth and propagation including natural and commercial growing areas. E.	No visible evidence of residues. Less than acute or chronic problem levels as revealed by bioassay or other appropriate methods	No deposition which adversely affects growth and propagation of shellfish	Less than acute or chronic problem levels and below concentrations affecting the ecological balance. Less than an amount that causes tainting of flesh. Pesticides may not exceed 0.01 of the median lethal test concentration for the most sensitive organism on 96 hour exposure	True color less than 50 color units	Concentrations shall be less than those resulting in radionuclide concentrations in shellfish meats which exceed the recommendations of the National Shellfish Sanitation Program, Manual of Operations, Part I, USPHS (see note 2)	Same as A.12
Agricultural water supply, including irrigation, stock watering and truck farming. F.	None in sufficient quantities to cause soil plugging and reduced yield of crops	For sprinkler irrigation, water free of particles of 0.074 mm or coarser. For irrigation or water spreading not to exceed 200 mg/l for an extended period of time	Less than that shown to be deleterious to livestock or plants or their subsequent consumption by humans	Inapplicable	Conform with USPHS Drinking Water Standards	Same as A.12
Industrial water supply (other than food processing). G.	No visible evidence of residues	No imposed loads that will interfere with established levels of treatment	Chemical constituents may not exceed concentrations found to be of public health significance	True color less than 50 color units	Conform with USPHS Drinking Water Standards (see note 4)	Same as A.12

Table 4-3
Summary of Alaska's Draft Water Quality Standards Published 2 March 1978

Parameter	Unit	Fresh Water Supply Drinking, Culinary and Food Processing	Fresh Water Supply Agriculture, Irrigation and Stock Watering	Fresh Water Supply Aquaculture	Fresh Water Supply Industrial	Fresh Water Contact Recreation	Fresh Water Secondary Recreation	Fresh Water Growth and Propagation of Fish, Shellfish, Other Aquatic Life and Wildlife Including Waterfowl and Furbearers
		1(A)(i)	1(A)(ii)	1(A)(iii)	1(A)(iv)	1(B)(i)	1(B)(ii)	1(C)
Fecal Coliform Bacteria Mean Value (1) 90 Percentile Value (1)		20 FC/100 ml 40 FC/100 ml	200 FC/100 ml 400 FC/100 ml	200 FC/100 ml 400 FC/100 ml	200 FC/100 ml 400 FC/100 ml	20 FC/100 ml 400 FC/100 ml	200 FC/100 ml 400 FC/100 ml	200 FC/100 ml 400 FC/100 ml
Dissolved Oxygen (D.O.) Average Minimum (1) 10 Percentile Minimum (1) Minimum		4 mg/l 3 mg/l -	- - 3 mg/l	- - 7 mg/l	Shall not cause detrimental affects on established levels of water supply treatment	4 mg/l - -	4 mg/l - -	4 mg/l 3 mg/l - For resident fish spawning waters, minimum D.O. 7 mg/l. Interstitial waters of the gravel bed minimum D.O. 5 mg/l.
pH		6.0 to 8.5	5.0 to 9.0	6.5 to 8.5	5.0 to 9.0	6.5 to 8.5	5.0 to 9.0	6.5 to 9.0 Shall not vary more than 0.1 pH units from natural conditions.
Turbidity Maximum Increase When natural turbidity is less than 50 NTU		5 NTU	Shall not cause detrimental affects on indicated use	Max Secchi disk depth Reduction 10%	Shall not cause detrimental affects on established levels of water supply treatment	5 NTU	10 NTU	Maximum Secchi disk Depth Reduction 10%
When natural turbidity is more than 50 NTU		10% or max 25 NTU increase		Maximum turbidity increase 25 NTU above natural conditions		10% or max 25 NTU increase	20% or max 50 NTU increase	Maximum turbidity increase 25 NTU above natural conditions.
Temperature Maximum		15°C (59°F)	30°C (86°F)	Natural + 2°C (3.6°F) Max Rate 0.5°C (0.9°F)/hr	25°C (77°F)	30°C (86°F)	Not applicable	Natural +2°C (3.6°F) Max Rate 0.5°C (0.9°F)/hr
Dissolved Inorganic Substances		TDS Max = 500 mg/l Chlorides and Sulfates + 250 mg/l	TDS max = 1000 mg/l Sodium adsorption ratio max 2.5. percent Sodium max 60%. Residual Carbonate max 1.25. Boron max 0.3 mg/l.	TDS max = Natural conditions + 33% or 1500 mg/l which ever is lower	No amounts above natural conditions which may cause corrosion, scaling, or process problems	Not applicable	Not applicable	TDS Max = Natural conditions + 33% or 1500 mg/l whichever is lower
Sediment		No measurable increase	Sprinkler Irrigation =	No load that will interfere with	No load that will interfere with	No measurable increase	No measurable increase	Sediment 4.0 mm max increase 5% Max = 30%

Table 4-3 (Continued)

Parameter	Unit	Fresh Water Supply Drinking, Culinary and Food Processing	Fresh Water Supply Agriculture, Irrigation and Stock Watering	Fresh Water Supply Aquaculture	Fresh Water Supply Industrial	Fresh Water Contact Recreation	Fresh Water Secondary Recreation	Fresh Water Growth and Propagation of Fish, Sellfish, Other Aquatic Life and Wildlife Including Waterfowl and Furbearers
		1(A)(i)	1(A)(ii)	1(A)(iii)	1(A)(iv)	1(B)(i)	1(B)(ii)	1(C)
Toxic, deleterious substances, including herbicides, pesticides, related organic or inorganic material		Alaska Drinking Water Standards or EPA's Criteria For Water	For subsequent human consumption - Alaska Drinking Water Standards or EPA's Criteria For Water 0.01 96 hr LC 50 value Not to exceed concentrations which impart undesirable taste and odor Dissolved gas limit 110% saturation	0.01 96 hr LC50 value lowest measured value for most sensitive biologically important species Not to exceed concentrations which impart undesirable taste and odor Dissolved gas limit 110% saturation	Concentrations shall not pose hazards to workers	Alaska Drinking Water Standards or EPA's Criteria For Water	Concentrations shall not pose hazards to immediate contact	0.1 96 hr LC50 value lowest measured value for most sensitive biologically important species Not to exceed concentrations which impart undesirable taste and odor Dissolved gas limit 110% saturation
Color		Treated supply 75 units Untreated supply 5 units	Not applicable	15 units - true color	Treated supply 75 units Untreated supply 5 units	15 units - true color	Free of substances producing objectionable color	In combination with turbidity limit reduction of compensation point for photosynthetic activity depth by 10% and Secchi disk depth by 10% 0.01 96 hr LC50 value
Petroleum hydrocarbons animal fats and vegetable oils		No visible sheen Not to exceed concentrations which impart undesirable taste and odor	No visible sheen	0.01 96 hr LC 50 value Prefer continuous flow test - static test acceptable	No visible evidence of residues	No visible sheen	No visible sheen	Prefer continuous flow test - static test acceptable No deleterious chronic effects Virtually free from floating oils
Radioactivity		Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69	Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69	Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69	Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69	Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69	Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69	Shall not exceed limits in ■ Alaska Drinking Water Standards ■ 10 CFR 20 Federal Regulations ■ National Bureau of Standards Handbook 69
Total Residual Chlorine		Not applicable	Not applicable	Salmonoid Fish 2.0 μg/l 10 μg/l	Not applicable	Not applicable	Not applicable	Salmonoid Fish 2.0 μg/l 10 μg/l

(1) Based on a minimum of five samples taken over a period of 30 days.

State of Alaska, and thus the current standards will soon be outdated. Finally, the new standards when adopted will be the criteria used by the State of Alaska to judge water quality, and thus this study will be consistent with future water quality assessments by the State.

The proposed water quality standards applicable to this study area are summarized on Table 4-4. These values represent the criteria against which existing and future water quality will be judged. Where more than one use is designated for a stream or stream reach, the most restrictive standard for each parameter becomes the water quality criterion. For example, the arsenic criterion is 0.02 mg/l for streams in the study area, because the proposed arsenic standard of 0.02 mg/l for aquatic life is more restrictive than the proposed arsenic standards for the other designated water uses.

Table 4-4
Water Quality Criteria

Parameter	Units	Fresh Water Supply Drinking, Culinary and Food Processing	Fresh Water Contact Recreation	Fresh Water Secondary Recreation	Fresh Water Aquaculture and Fresh Water Growth and Propagation of Fish, Shellfish, Other Aquatic Life and Wildlife Including Waterfowl and Furbearers
Alkalinity	mg/l	-	-	-	20 min
Aluminum	mg/l	-	-	-	0.01
Arsenic	mg/l	0.05	0.05	-	0.02
Bacteria					
Fecal Coliform	#/100 ml	20(mean) 40(90 percentile)	20(mean) 400(90 percentile)	200(mean) 400(90 percentile)	200 400(90 percentile)
Total Coliform	#/100 ml	1 (treated water)	-	-	-
Iron		-	-	-	Free From.
Barium	mg/l	1.0	1.0	-	-
Cadmium	mg/l	0.010	0.010	-	0.0005
Chloride	mg/l	250	-	-	-
Chlorine, Total Resid.	mg/l	-	-	-	0.002
Chromium	mg/l	0.050	0.050	-	0.03
Color	units	5	15	Free From Objectionable Color	Secchi Disk Depth 10% Max. Reduction
Copper	mg/l	1.0	-	-	0.06
Cyanide	mg/l	-	-	-	0.005
Fluoride	mg/l	2.4	2.4	-	0.5
Iron	mg/l	0.3	-	-	0.1
Lead	mg/l	0.050	0.050	-	0.02
Magnesium	mg/l	-	-	-	15
Manganese	mg/l	0.050	0.050	-	0.01
Mercury	mg/l	0.002	0.002	-	0.2
Nickel	mg/l	-	-	-	0.01
Nitrogen					
Nitrogen (N_2)	%	-	-	-	103%
Ammonia (NH_3^--N)	mg/l	-	-	-	0.02
Nitrate	mg/l	10.0	10.0	-	1.0
Nitrite	mg/l	-	-	-	0.1
Oil	mg/l	No Visible Sheen	No Visible Sheen	No Visible Sheen	0.01 96 LC50 Value
Organics					
Endrin	mg/l	0.0002	0.0002	-	0.0002
Lindane	mg/l	0.004	0.004	-	0.004
Methoxychlor	mg/l	0.100	0.100	-	0.100
Toxaphene	mg/l	0.005	0.005	-	0.005
2.4.D	mg/l	0.1	0.1	-	0.1
2.4.5-TP Silvex	mg/l	0.01	0.01	-	0.01
Oxygen Dissolved	mg/l	4	4	4	8
pH	units	6.0-8.5	6.5-8.5	5.0-9.0	6.5-8.0
Phenol	mg/l	0.001	-	-	0.005
Potassium	mg/l	-	-	-	5.0
Sediment	-	No Measurable Increase	-	-	Max Increase 5%
Selenium	mg/l	0.010	0.010	-	0.01
Silver	mg/l	0.05	0.05	-	0.003
Sodium	mg/l	250	-	-	-
Solids					
Suspended	mg/l	-	-	-	80
Total Dissolved	mg/l	500	-	-	400
Sulfate	mg/l	250	-	-	50
Sulfide	mg/l	-	-	-	0.003
Temperature	°C	15	30	-	0-15
Turbidity	NTU	5 Max Increase	5 Max Increase	10 Max Increase	25 Max Increase
Vanadium	mg/l	-	-	-	0.1
Zinc	mg/l	5	5	-	0.5

Chapter 5
EVALUATION OF WATER QUALITY

Existing and future water quality is evaluated in this chapter in the principal surface waters of the study area--Campbell Creek, Chester Creek, Ship Creek, Fish Creek and Lakes Spenard and Hood. Water quality is basically good in the study area. Surface waters appear generally to sustain fish and wildlife, not to pose any health hazards, and to be suitable for recreational purposes. However, violations of State water quality standards occur in many of the creeks, and violations are expected to become more numerous in the rapidly urbanizing basins like Campbell Creek.

This chapter begins by discussing the available water quality data base for the study area. These data were used to assess water quality and to calibrate and verify water quality computer models. The computer models, described in the section after "Water Quality Data," were used to simulate existing and future water quality conditions. In the final section of this chapter, water quality problems are identified based on the information contained in the available water quality data and the computer simulations.

WATER QUALITY DATA

Water quality data for the study area were obtained from five sources:

- U.S. Geological Survey (1975 and 1974-1976),
- Alaska Mineral and Materials (1975),
- U.S. Army Corps of Engineers (1977),
- Alaska Department of Environmental Conservation (1977), and
- Municipality of Anchorage (1978)

The most extensive of these four sources was the USGS monitoring data which covered all of the water bodies within the study area (with the exception of Lake Hood) for the period 1948 to 1976. The other data sources covered much shorter time periods and fewer water bodies, but tended to be more comprehensive. The Alaska Mineral and Materials study, for example, covered only Chester and Fish Creeks during 1974.

The U.S. Army Corps of Engineers report covered both Chester and Ship Creeks for just 3 months (February-April 1977), and the Alaska Department of Environmental Conservation data covered only Chester Creek for 6 months (April to September of 1977). The Municipality of Anchorage data were collected on Campbell Creek over a 4-day period in April, 1978.

Data were most abundant for Campbell Creek and Chester Creek. Most frequently monitored constituents were pH, temperature, iron, total dissolved solids and nitrate. Some data were also available for Ship Creek, primarily on the same five constituents, while little data were collected on the water quality of Fish Creek and Lake Spenard, and no data were collected on the water quality of Lake Hood. The locations of water quality monitoring stations are shown on Figure 5-1. The figure indicates that the sampling programs have been widespread. Stations are positioned along most of the length of Campbell Creek, Chester Creek and Ship Creek. However, although widespread, sampling has been infrequent at many of the stations shown on the figure.

APPROACH

Water quality can be evaluated and water quality problems defined in a number of ways. Some people consider any degradation of water quality to be a water quality problem. Others consider a violation of the State water quality standards to be a water quality problem. And others do not consider a water quality problem to exist unless water pollution causes a fishkill, a beach closing, or some other serious loss.

In this study, the evaluation of water quality was accomplished by comparing the water quality defined by available water quality data and by computer simulations with the water quality criteria developed in the previous chapter. Whenever an actual or simulated pollutant concentration violated the water quality criterion, a water quality problem was said to occur.

Violations of the criteria were tabulated for all available surface water quality data. In addition, computer modeling was used to simulate existing and future water quality in two of the four principal creek basins, Campbell Creek and Chester Creek. Violations of the water quality criteria by simulated data were also tabulated.

Existing conditions were modeled in Campbell Creek and Chester Creek in order to gain a better understanding of the current temporal and spatial changes in pollutant loadings and concentrations. Future conditions were also modeled in these two creeks in order to predict the impacts of urbanization on water quality.

MODELING OF CAMPBELL CREEK

The Campbell Creek basin was selected for modeling because it is largely undeveloped at the present time, but is undergoing rapid urbanization. Therefore, absent controls, water quality is expected to degrade significantly over the next 25 years. The constituents analyzed through modeling of Campbell Creek were fecal coliform, total suspended solids and ammonia, all of which were expected to violate the water quality criteria in the future.

Two models were used in the Campbell Creek basin, the Systems Analysis Model (SAM) and the Water Quality River-Reservoir System (WQRRS) model. The two models are described in the user's manuals (CH2M HILL, 1979; Hydrologic Engineering Center, 1977).

Two approaches were taken in the modeling of water quality in the Campbell Creek basin. In one approach, SAM was used to determine pollutant washoffs from the watershed. These washoffs were then inputs into the WQRRS model, which routed the pollutants down Campbell Creek. In the second approach, SAM was used both to determine pollutant washoffs and to route the pollutants down Campbell Creek.

The results of the two modeling approaches are compared in Task Memorandum No. 3 (CH2M HILL, 1978). Differences between the two approaches were insignificant in terms of which constituents violated the criteria, where and when the violations occurred, and what changes in constituent loadings and concentrations were projected for Campbell Creek. Thus, either modeling approach would predict essentially the same water quality. The second modeling approach, use of SAM alone, was selected because of lower costs.

SAM and WQRRS were calibrated to existing conditions in the Campbell Creek basin. The calibration was based on an intensive sampling program conducted in the spring of 1978.

Figure 5-2 shows the subbasins which were used in the modeling and the three points at which simulated water quality was outputted.

MODELING OF CHESTER CREEK

The Chester Creek basin was selected to be modeled for two reasons:

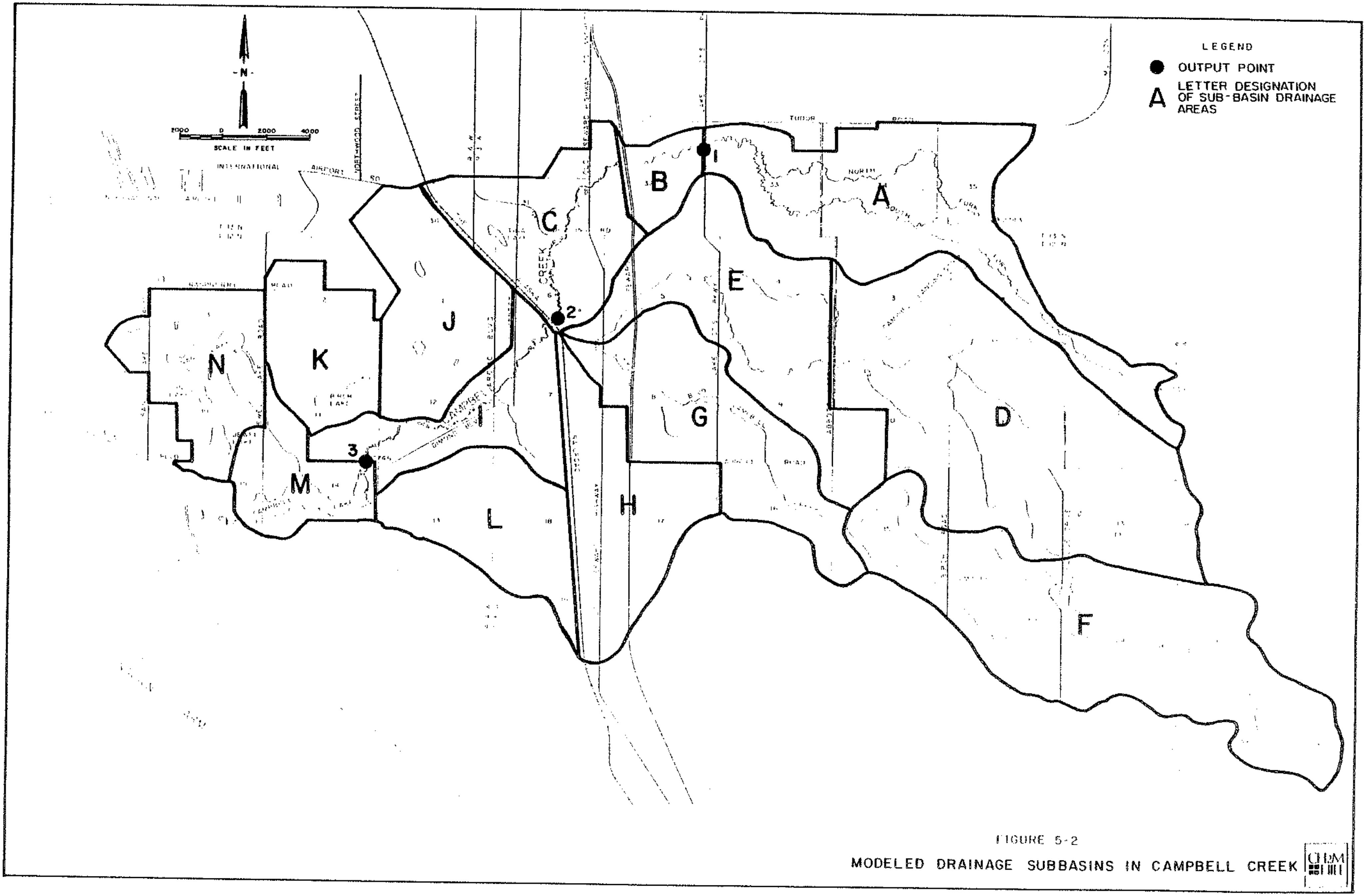

FIGURE 5-2

MODELED DRAINAGE SUBBASINS IN CAMPBELL CREEK

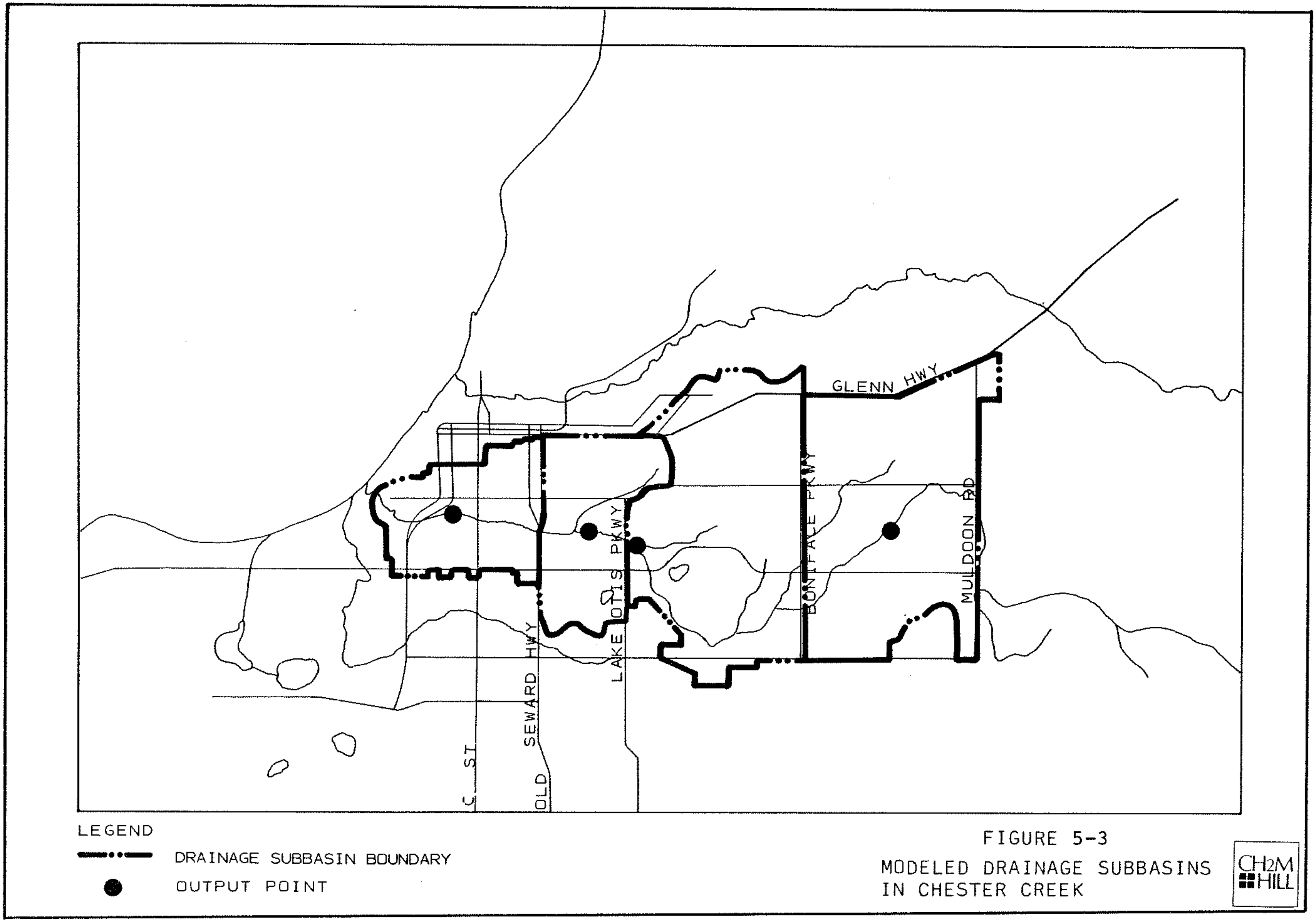

FIGURE 5-3

MODELED DRAINAGE SUBBASINS IN CHESTER CREEK

CH2M HILL

- The basin had the best water quality data base with which to document water quality problems and to calibrate and verify the modeling

- Modeling of this basin could indicate existing and future water quality in a watershed that is already largely urbanized and has a large number of different land uses.

The results of modeling in this basin were assumed to reflect future changes in water quality in Ship Creek and Fish Creek, which also flow through watersheds where the rate of urbanization is slow. The constituents modeled in the Chester Creek basin were fecal coliform, total suspended solids, BOD_5, nitrate and orthophosphate. A slightly different approach to modeling was applied in the Chester Creek basin than in the Campbell Creek basin. The Storage, Treatment, Overflow, Runoff Model (STORM) was used to determine pollutant washoffs from the watershed. These washoffs were then inputted into the WQRRS model, which routed the pollutants down Chester Creek.

The models were calibrated to existing conditions in Chester Creek. The calibration was based on an intensive sampling program conducted in the spring of 1977.

Figure 5-3 shows the subbasins which were used in the modeling and the four points at which simulated water quality was outputted.

SELECTION OF RUNOFF EVENTS

Modeled runoff events were selected using two criteria:

- The events should have the maximum water quality impact

- The events should encompass a wide range of annual probability of recurrence.

The most critical runoff period appeared to occur during snowmelt in the spring, because high concentrations of pollutants were discharged to the creeks during a low-flow period. Two representative snowmelt events (March 1969 and March 1974) were selected in the Campbell Creek basin and one (March 1965) in the Chester Creek basin.

A second period, occurring during late summer, was considered to be almost as critical to water quality as the snowmelt period. During this period, three important factors are present:

- Relatively low streamflows because headwater snowfields are mostly melted and the rainy season has not started

- Long rainless periods in Anchorage, which allow heavy build-ups of pollutants on roadways and other impervious surfaces

- Relatively high water temperatures, which promote the conversion of a larger percentage of ammonia to the toxic form, which slow the die-off rate of fecal coliform, and which quicken biological decay processes and oxygen consumption.

Four representative storms during this period were selected and modeled for the Campbell Creek basin.

Results were obtained for existing water quality conditions in Campbell and Chester Creeks and for future water quality conditions in 1995 in Campbell Creek and in 2000 in Chester Creek. These results are presented in the next section on water quality problems.

WATER QUALITY PROBLEMS

Water quality problems are summarized on Table 5-1. The problems have been defined as violations of the criteria and standards presented in Chapter 4. Violations under four use classifications were investigated for Campbell Creek, while violations under three use classifications were investigated for the lakes and other creeks.

Suspected pollutant sources are summarized on Table 5-2. The sources have been separated into manmade and natural or man-induced. Certain natural sources have become more important to contaminant loadings because of the activities of man. For example, development of peat bogs has increased peat bog drainage, while urbanization has increased stream bank erosion. Both of these activities have had a negative effect on water quality.

Based on the limited data available, all of the streams and lakes in the area have been defined as "water quality limited." That is, water quality standards will not be met by application of effluent limitations required under Sections 301(b)(1)(A) and (B) of the Clean Water Act (PL 92-500). Violations of the standards and criteria occur because of pollutant contributions from manmade, man-induced, and natural nonpoint sources, for which effluent limitations were not set under the Act. Effluent limitations were set for point sources, such as municipal and industrial wastewater discharges. However, there are no documented point source discharges to any of the streams and lakes in the study area.

Table 5-2
Suspected Pollutant Sources

	Manmade Sources										Natural and Man-Induced Sources				
Problem Constituents	Septic Tanks	Sewer Exfiltration	Waste Oil Disposal	Construction Activity	Snow Disposal Sites	Road Salting and Sanding	Unpaved Streets	Street Breakup	Automobiles	Domestic Pets	Peat Bog Drainage	Ground Water	Stream Bank Erosion	Wildlife	Sources Outside Area
Aluminum					●				●		●	●			
Ammonia	●	●								●				●	
Dissolved Oxygen											●				
Dissolved Solids					●	●									
Fecal Coliform	●	●								●				●	●
Iron					●				●		●	●			
Lead					●				●						
Manganese					●				●		●	●			
Oil and Grease			●						●						
Suspended Solids				●		●	●	●					●		●

CAMPBELL CREEK BASIN

The Campbell Creek basin is a rapidly urbanizing area. Thus, while some water quality problems already exist in the basin, as shown on Table 5-1, the potential for further water quality degradation is extremely high.

The Campbell Creek basin, like the other basins, has several characteristics which allow it to handle large loads of certain types of pollutants. Campbell Creek has a steep gradient and is short, two qualities which result in rapid transport of water through the system. In addition, water temperatures are low throughout most of the year. These characteristics allow the stream to maintain high dissolved oxygen levels, even when subjected to relatively high BOD loadings. The low temperatures also cause relatively rapid die-off of fecal coliform and a conversion of most of the ammonia to the nontoxic ionized form.

Violations of the water quality criteria and standards have been determined through inspection of existing water quality data and modeling. Water quality violations have been found for fecal coliform, suspended solids, heavy metals (aluminum, iron and manganese), and perhaps oil and grease, depending on how toxic are the chemicals which constitute the oil and grease in the creek. Because of the rapid urbanization in the basin, all of the constituents mentioned above will be water quality problems in the future in the absence of control measures. In addition, ammonia may become a water quality problem in the future.

Fecal Coliform

Fecal coliform is not injurious; rather it is an indicator of pathogens that can cause harmful disease in humans. Any occurrence of fecal coliform in water is prime evidence of contamination by wastes from warm-blooded animals; as the fecal coliform densities increase, potential health hazards become greater.

Existing Violations. Present concentrations of fecal coliform in Campbell Creek violate proposed standards for drinking water supply, contact recreation, secondary recreation and aquatic life. The proposed standards for the first two uses call for 20/100 ml, a level which appears to be quite restrictive. It is important to note that violations as high as 138/100 ml have been found at the Creek's headwaters. Because water flows rapidly through the Campbell Creek system, resulting in a low die-off of fecal coliform, meeting future standards may be difficult simply due to background concentrations.

Modeled results for fecal coliform are presented on Figure 5-4. Concentrations for fecal coliform and the other constituents were determined at three points in Campbell Creek (see Figure 5-2):

- o at Lake Otis Parkway
- o at the confluence with Little Campbell Creek
- o at the inflow to Campbell Lake.

As shown on Figure 5-4, fecal coliform concentrations increase with progression downstream for all six modeled events. Computer simulated concentrations greatly surpass proposed standards during runoff periods. The highest concentrations are evidenced during the summer runoff events. As expected, the concentrations found during spring snowmelt events are lower, due to low fecal coliform survival during the winter.

Future Violations. As shown on Figure 5-4, fecal coliform violations in 1995 are projected to be more severe, with measurements as high as 700/100 ml during storm events. Under future conditions, proposed standards are frequently surpassed for all water uses: drinking water supply, contact recreation, secondary recreation and aquatic life.

Existing Sources. Runoff from industrial and multifamily lands are the major sources of fecal coliform loadings in Reach 1 (headwaters to Lake Otis Parkway). During dry periods, natural background conditions appear to account for all violations. Droppings from moose and other wild animals are the anticipated source.

In Reach 2 (Lake Otis Parkway to Little Campbell Creek), the major source is runoff from industrial land in the area bounded by Seward Highway, Little Campbell Creek, and Campbell Creek. Commercial and high-density, single-family lands in this same area are considered sources of secondary importance. During dry-weather periods, septic tanks and natural background concentrations are the primary sources.

In Reach 3 (Little Campbell Creek to the mouth), the major loadings of fecal coliform during wet and dry weather come from the Little Campbell Creek basin. Industrial land in this basin represents the largest single source during runoff periods. Septic tanks in the upper portions of Little Campbell Creek basin are considered the most significant contributor of fecal coliform during dry-weather conditions. (Approximately 1,500 dwellings are serviced by septic tanks in this area.) This deduction is reinforced by the high concentrations of fecal coliform found in Little Campbell Creek during dry-weather periods. Another possible source of fecal coliform in Reach 3 is exfiltration from the sanitary sewer interceptor that parallels Campbell Creek. However, at present this problem cannot be documented.

Future Sources. Future wet weather loadings of fecal coliform are directly related to the amount of new commercial and industrial development. As indicated under existing sources, most of the present loadings come from industrial and commercial developments in Subbasins C and G. (See Figure 5-2 for the location of subbasins.) Current zoning and land use planning encourage additional commercial and industrial development in these approximate locations; thus, greater loadings will be contributed from these general areas in the future. In addition, much of what is now lowland forest and bogs in Subbasins H and L is planned for industrial development. This planned development represents a major land use change and could have a significant impact on water quality.

Future dry-weather fecal coliform concentrations will be lessened if centralized sewage facilities are extended into the areas now serviced by septic tanks, or if existing septic tanks are operated more efficiently.

Suspended Solids

Concentrations of suspended and settleable solids in surface waters are important because of their effect on light penetration, water temperature, solubility products and aquatic life. The presence of suspended solids can reduce light penetration and thus upset the growth of fixed and suspended aquatic plants. Likewise, because turbid water is darker in color, it absorbs more sunlight and water temperature can be increased. In addition, the suspended mineral particles also have large irregular surface areas with electrostatic charges, which can sorb pesticides and heavy metals. These substances can be carried to the water with sediments and later released causing harmful results. Lastly, the presence of suspended and settleable solids can impair fisheries by preventing successful development of eggs and larvae, reducing food supplies, modifying natural migration and movement, and reducing fish growth rates and resistance to disease.

Existing Violations. Currently, sediment or turbidity standards for Campbell Creek are violated for drinking water supply and for aquatic life. These violations are apparently only a problem during runoff and snowmelt events. It is important to note that violations have been found in the creek as it enters the urban area. Because of the turbulence and velocity of the creek, suspended solids and turbidity standards may be difficult to meet in the future due to background conditions.

Modeled results for total suspended solids are presented on Figure 5-5. Concentrations have been modeled in Campbell Creek at Lake Otis Parkway, at the confluence of Little Campbell Creek, and at the inflow to Campbell Lake (see Figure 5-2 for locations). As shown on Figure 5-5, total suspended solids concentrations increase with progression downstream for all six modeled events. Computer simulated concentrations greatly surpass the criterion of 80 mg/l within the urban area during runoff and snowmelt periods. Concentrations are slightly higher during storm runoff events than during snowmelt events.

Future Violations. Criteria for drinking water and aquatic life continue to be violated under the anticipated future conditions; however, the problems become more significant as a result of urbanization. As shown on Figure 5-5, computer simulation runs indicate that concentrations for Reaches 1, 2 and 3 can be as high as 100, 635 and 730 mg/l, respectively, during summer runoff events. Again, summer runoff events show slightly higher concentrations than do spring snowmelt events.

Existing Sources. Most of the existing loadings are from the industrial and commercial acreages in Subbasins C and G (see Figure 5-2 for locations). The strip of commercial land along Seward Highway is also suspected to be a high contributor of sediments. In addition, substantial new development is occurring below Seward Highway and in Little Campbell Creek basin. Runoff from construction sites in these areas will continue to be a major sediment source. Streets, paved and unpaved, are a final major sediment source. Sediment on the streets comes from street breakup and from the sand used in the snow and ice control programs.

Future Sources. Future sources of sediment will continue to be contributed by runoff from construction sites, industrial and commercial land uses, and urban streets. The greatest increase in future loadings will occur in Reach 3, where an additional 7,200 acres are projected to be developed by 1995. This figure compares with 630 acres projected for development in Reach 2. Some of the sediment load will be generated during the construction phase. Additional loadings will also result from street breakup, road sanding, and erosion after urbanization. It is envisioned that even if all of these sources are carefully controlled, sediment standards may be difficult to meet consistently in the future because of background loadings entering the urban area.

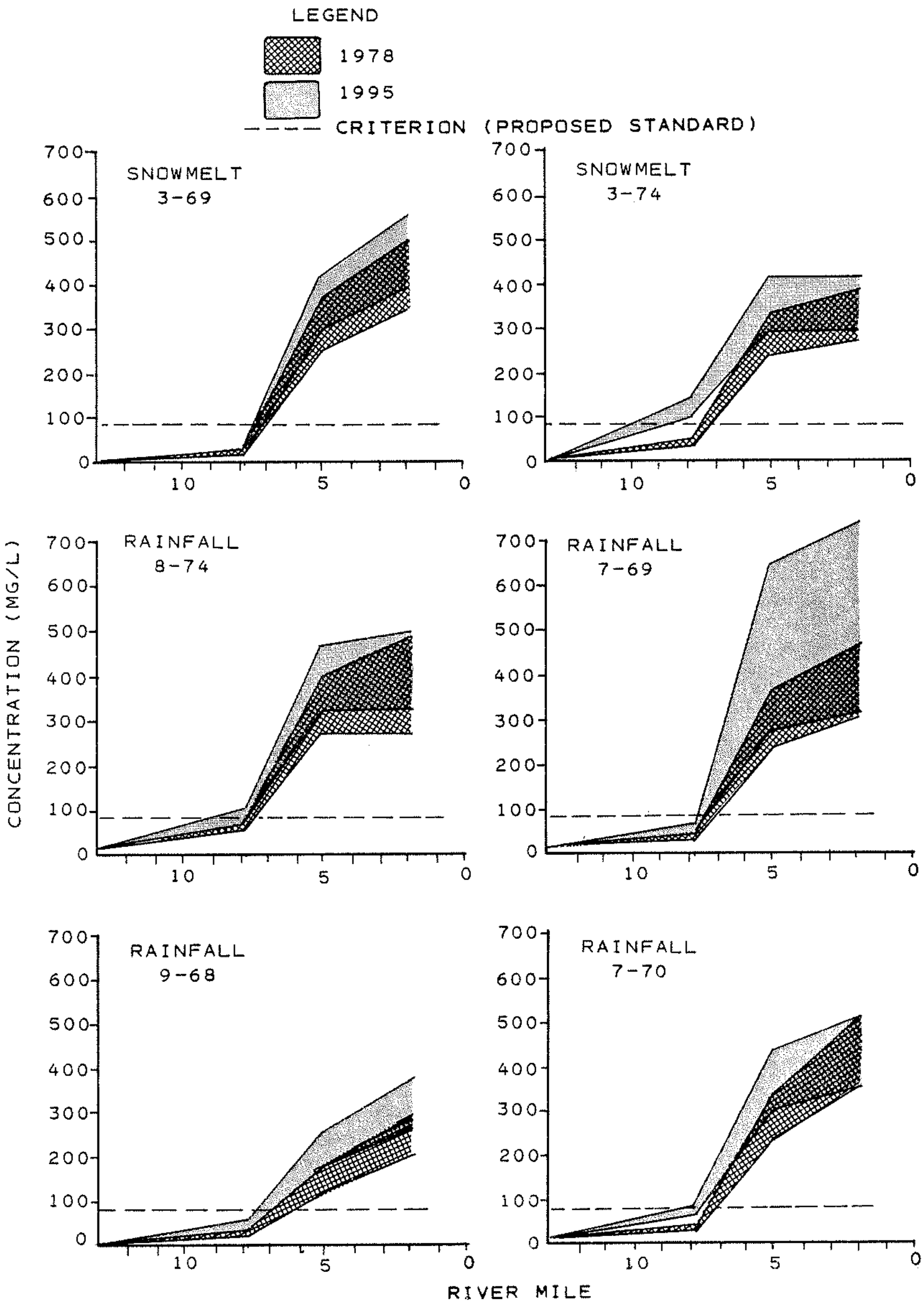

FIGURE 5-5
MAXIMUM TOTAL SUSPENDED SOLIDS CONCENTRATIONS
CAMPBELL CREEK

CH2M HILL

Oil and Grease

Floating, soluble and sedimented oils can be toxic to fish, benthic organisms and aquatic plants. In addition, oils may impair the taste of fish and waterfowl. Floating oil and grease can also reduce water aesthetics.

Existing Violations. Oil and grease concentrations in Campbell Creek were found to range between 0.5 and 1.0 mg/l. This level is a suspected water quality violation for aquatic life. It is only a suspected violation because the toxicity of oils is highly variable and the analytical test for these substances lumps all oil and grease substances into a single category. For example, if creosol compounds were present in the observed oil and grease concentrations, toxic concentrations of oil and grease would exist in Campbell Creek and the standard would be violated; but if the oil and grease consisted of cutting oil, the observed levels in Campbell Creek would be safe for fish life, and the standard would not be violated.

Future Violations. It can be anticipated with some certainty that the oil and grease standard will be violated in 1995. Additional discharges of this pollutant are closely correlated with additional urbanization. Developed areas of the basin are anticipated to increase by approximately 250 percent.

Existing Sources. Three snow dump sites are located in Reach 1. Snow samples from snow dump sites in Anchorage show that concentrations of oil and grease can be as high as 100 mg/l. Concentrations of oil and grease found in Campbell Creek during the spring sampling period were probably strongly impacted by runoff from these snow dumps.

Oil and grease concentrations evidenced in Reaches 2 and 3 are probably influenced by runoff from commercial, industrial and multifamily land uses, parking lots and heavily travelled streets. During the summer, it is expected that the operation of float planes on Campbell Lake is responsible for oil and grease concentrations in and below the lake. A final source is illegal discharges of waste oil and other petroleum products to storm sewer systems and directly to the surface waters.

Future Sources. Future sources of oil and grease will be closely correlated to new development. The majority of the loadings will still result from runoff from commercial and industrial lands in Subbasins C and G. However, the overall increase of urbanization in the Campbell Creek area will result in higher volumes of vehicular traffic, which will augment pollutant loadings on streets and parking lots. It is suspected that the most significant increases in oil and grease will occur below the confluence of Campbell and Little Campbell Creeks. New snow disposal sites may also contribute to oil and grease in the creeks.

In order to meet future standards, oil and grease will have to be controlled from all industrial and commercial areas, major parking lots, heavily travelled roadways and snow disposal sites. It is important to note that methods that reduce urban sediments will also lessen oil and grease loadings because these substances tend to sorb to sediment.

Ammonia

Ammonia is a water quality concern because it is toxic to fish, and during its decomposition can also reduce dissolved oxygen. Ammonia gas is soluble in water in the form of ammonium hydroxide, which readily disassociates into ammonium and hydroxyl ions. The unionized ammonia is acutely toxic to fish, while the ions are not. The percentage of ammonia in the unionized form depends strongly on pH and temperature. Most of the total ammonia is converted to the nontoxic ionized form at the low pH values and low temperatures found in Campbell Creek.

Existing Violations. Due to the low pH values and low temperatures found in Campbell Creek, ammonia is currently not a water quality problem. Figure 5-6 shows the computer simulated concentrations of total ammonia. The concentrations generally increase with progression downstream, but concentrations are always less than the criteria. The criteria indicate what concentration of total ammonia is necessary to produce 0.02 mg/l of toxic unionized ammonia in the stream. The criteria have been based on the most critical pH and temperature conditions likely to occur in Campbell Creek. These conditions are stated below:

- In summer, pH of 8.0 and temperature of 12 degrees C
- In winter, pH of 7.2 and temperature of 5 degrees C

It is interesting to note that the ammonia criterion is 10 times higher in winter because of lower pH values and temperatures.

Future Violations. Figure 5-6 indicates that simulated concentrations of ammonia may get as high as 1.4 mg/l at Campbell Lake during some runoff events. This level is a marginal violation at the pH and temperature used to calculate the criterion. However, pH and temperature typically increase with urbanization, so it is possible that the is suspected that the most significant increases in oil and grease will occur below the confluence of Campbell and Little Campbell Creeks. New snow disposal sites may also contribute to oil and grease in the creeks.

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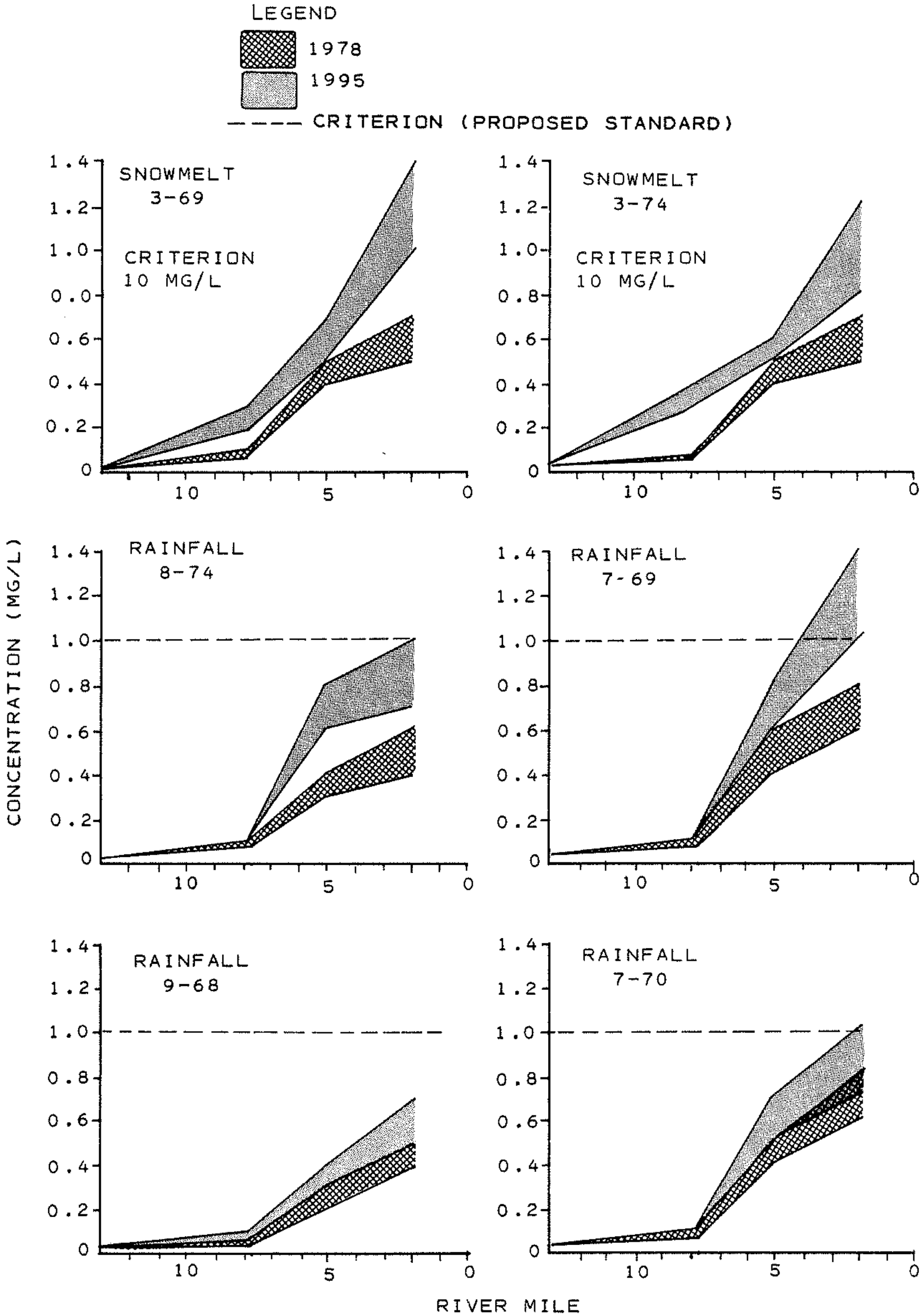

FIGURE 5-6
MAXIMUM AMMONIA CONCENTRATIONS
CAMPBELL CREEK

criterion level would be lowered in response to higher pH and temperatures and the simulated concentrations could cause toxicity problems for fish life. Future violations, should they occur, would probably be limited to the stream reaches below Lake Otis Parkway.

Existing Sources. In Reach 2, significant amounts of ammonia are probably carried in runoff from commercial and industrial lands located just above the confluence of Little Campbell and Campbell Creeks. A second source is seepage from septic tanks just east and south of Tina Lake.

In Reach 3, runoff from commercial and industrial lands in Subbasin G, strip commercial lands along Seward Highway, and industrial and high-density residential lands in Subbasin J are probably the major wet-weather sources. During dry-weather conditions, effluents from septic tanks in the upper portions of Little Campbell Creek basin are considered to be the most significant source. The highest loadings of ammonia are generated from the Little Campbell Creek basin, according to the modeling results. A final possible, but undocumented, source is exfiltration from sanitary sewers.

Future Sources. Modeling results indicate that the greatest ammonia loadings will continue to be contributed by Little Campbell Creek basin. New and existing commercial and industrial land uses in Subbasins C, G, H and L are anticipated to be the major pollution sources. Provided that centralized collection is extended to the upper reaches of the Campbell Creek basin, future ammonia loadings from septic tanks should be reduced. It is important to note that the effective use of future programs to control urban runoff pollution may help maintain the pH and temperature levels in Campbell Creek, and therefore lower the potential for ammonia violations.

Heavy Metals

Heavy metals are a water quality concern because of their toxicity in drinking water supplies and to fish. Iron is an additional concern for fisheries because it can coat stream bottoms and impair spawning and benthic productivity. Iron is also objectionable in drinking water supplies; it affects taste, stains plumbing fixtures and can result in deposits in distribution systems.

Existing Violations. Presently, heavy metal violations in Campbell Creek are found for aluminum, iron and manganese. Aluminum standards for aquatic life are violated in both Reaches 2 and 3. Iron standards are violated for aquatic life in all three reaches, and the drinking water standards are violated in Reaches 2 and 3. Iron standards are violated for drinking water supplies and aquatic life in Reaches 2 and 3. The limited water quality data indicate that heavy metal concentrations increase with progression downstream, but that increases are dramatic just above the confluence of Campbell and Little Campbell Creeks.

Future Violations. Although future heavy metal concentrations have not been simulated in the computer model, it can safely be assumed that increases are imminent as a consequence of additional urbanization.

Existing Sources. Heavy metals have not been modeled, so determination of pollution sources is difficult. It is assumed that existing loadings are mostly from runoff from commercial and industrial lands and from heavily travelled streets such as Seward Highway. Waste snow probably contributes to metal loadings during snowmelt. It is also possible that heavy metals are contributed by ground water. Area wells sampled by the U.S. Geological Survey (USGS) have shown high concentrations of various heavy metals. A final important source is peat bog drainage, which can have particularly high concentrations of iron, manganese and aluminum. This is a natural water quality problem which can be increased, at least for the short term, by man-induced drainage for development. This is discussed later in Chapter 7 under "Water Quality Impact."

Future Sources. Runoff from industrial land is anticipated to be the principal source of future heavy metal loadings. Runoff from commercial lands, parking lots and streets will continue to be a significant source, as will waste snow during the spring. Peat bogs may become an increasingly important source of iron and other metals as they are drained for development.

CHESTER CREEK BASIN

The Chester Creek basin is a largely urbanized watershed. Little development is expected to occur in the basin. As shown on Figure 5-7, only a 10 percent increase in runoff due to urbanization is predicted over the next 22 years in the modeled event for Chester Creek. The small change in flow suggests little change in water quality in the future from urbanization. Some water quality problems exist in the basin, as shown on Table 5-1. These problems are expected to persist in the future.

Water quality problems in the Chester Creek basin arise from most of the same pollutants and pollutant sources as were found in the Campbell Creek basin. Water quality violations have been found for fecal coliform, suspended solids, heavy metals (iron and lead), and dissolved solids. Violations of the water quality criteria and standards have been determined through inspection of existing water quality data and modeling.

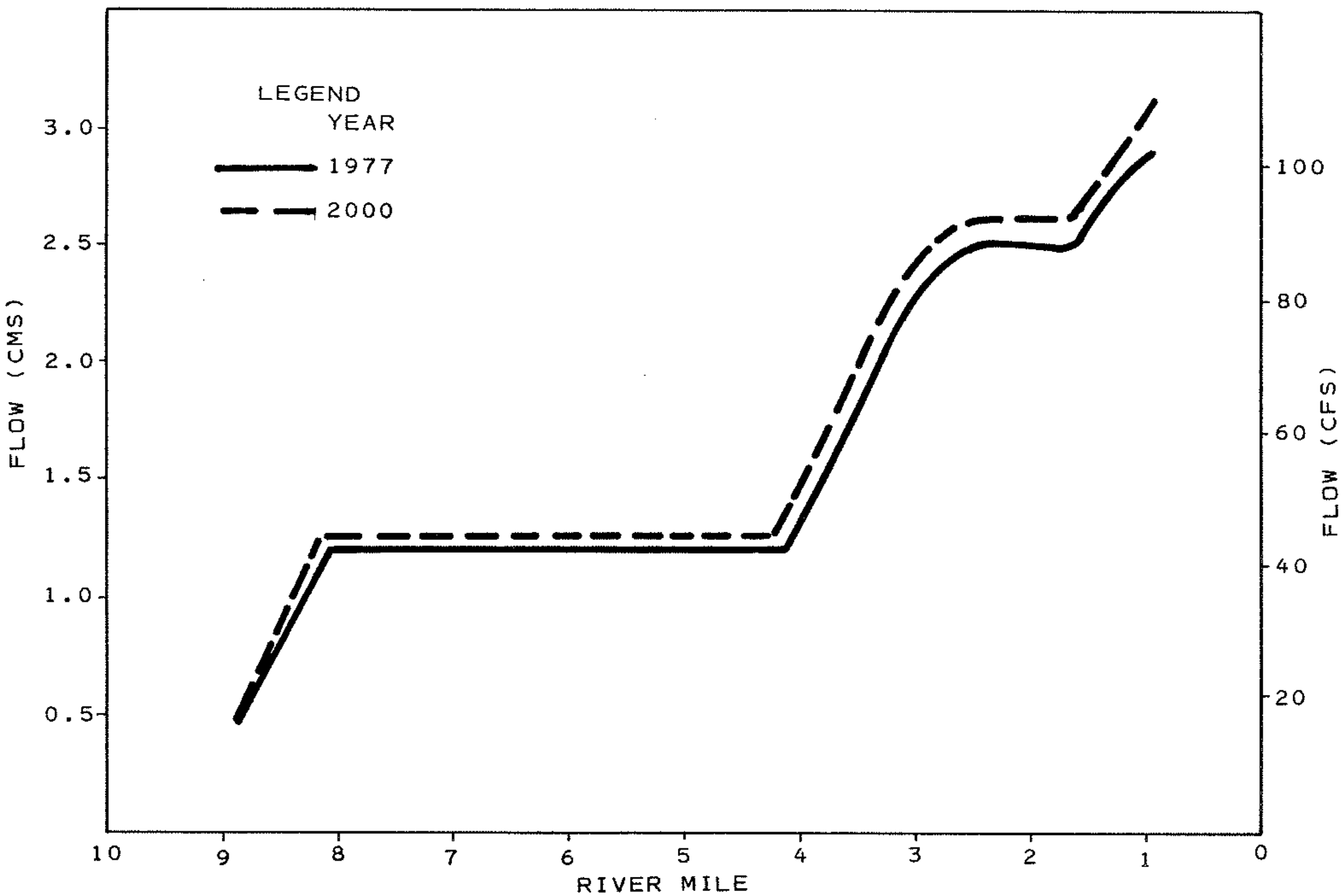

FIGURE 5-7
MAXIMUM FLOW
CHESTER CREEK

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Fecal Coliform

Existing Violations. Violations of aquatic life, contact recreation and secondary recreation proposed standards occur during dry weather, runoff periods, and snowmelt periods. Modeled results for fecal coliform are presented on Figure 5-8. As shown on the figure, concentrations greatly exceed the criterion throughout the urban area. A comparison of the information on this figure with the information presented on Figure 5-4 shows that fecal coliform concentrations are several times higher in Chester Creek than in Campbell Creek.

Future Violations. The model predicts only a slight increase in fecal coliform concentrations in Chester Creek over the next 22 years, as shown on Figure 5-8. Concentrations in the creek will continue to exceed the criterion by one to two orders of magnitude, however.

Sources. Possible pollutant sources include septic tank leachate, exfiltration from sanitary sewers and urban runoff.

Sediment

Existing Violations. Violations of the aquatic life criterion for turbidity have been found during runoff and snowmelt periods. Modeled results for suspended solids concentrations are shown on Figure 5-9. As shown on the figure, concentrations greatly exceed the criterion throughout the urban area. It is important to note also that simulated concentrations greatly exceed the criterion as the creek enters the urban area. Thus, the criterion may be difficult to achieve during runoff events because of natural background conditions.

Future Violations. Figure 5-9 indicates that future suspended solids concentrations are projected to increase by less than 10 percent. Concentrations will continue to exceed the criterion in Campbell Creek within and above the urban areas, however.

Sources. The most important sources of sediment to the streams are probably street breakup and sand used in the snow and ice control programs. Erosion from lawns and gardens is expected to be slight by comparison.

Heavy Metals

Existing Violations. Violations of aquatic life and body contact proposed standards occur and generally intensify

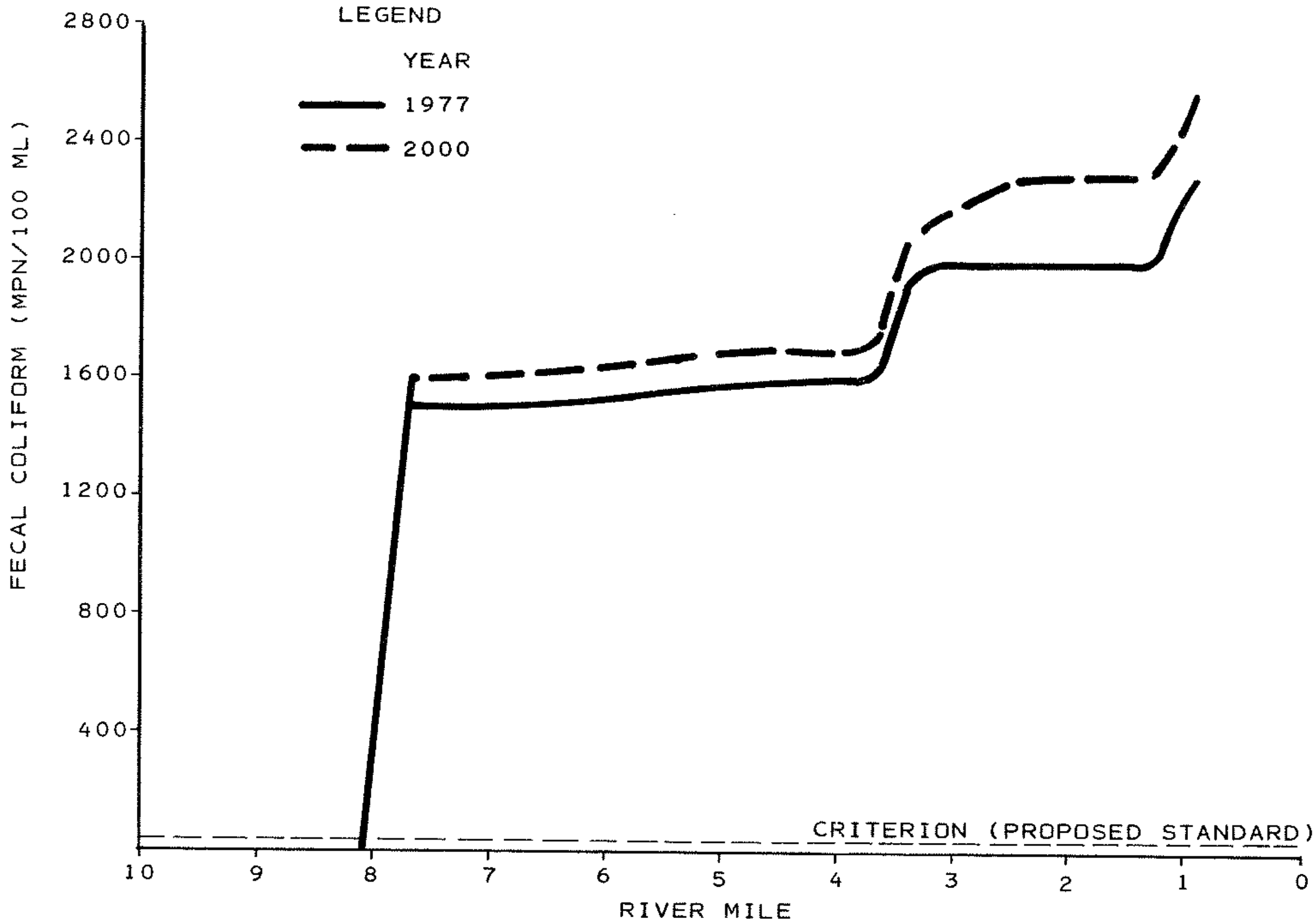

FIGURE 5-8
MAXIMUM FECAL COLIFORM CONCENTRATIONS
CHESTER CREEK

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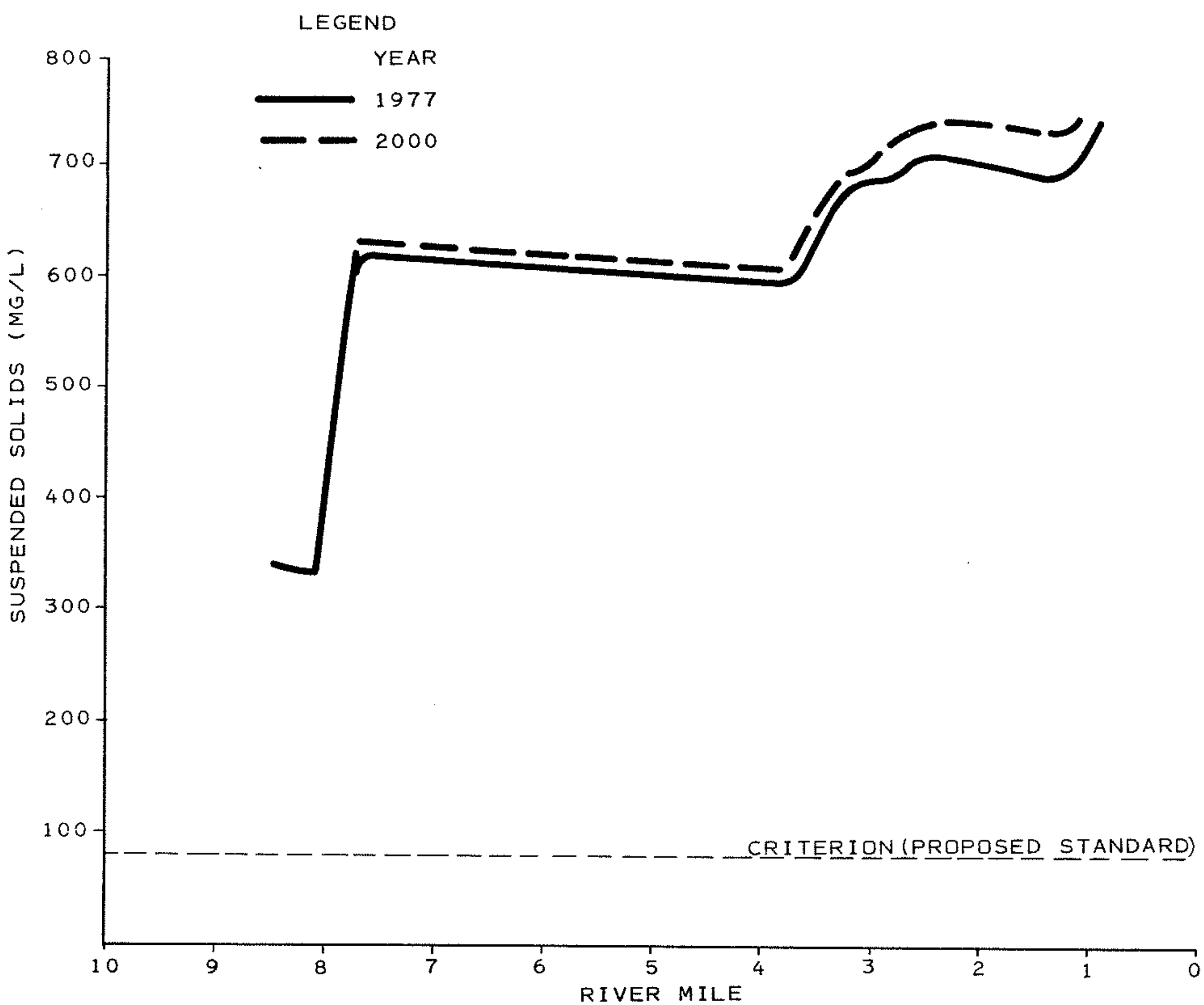

FIGURE 5-9

MAXIMUM SUSPENDED SOLIDS CONCENTRATIONS

CHESTER CREEK

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downstream for dry-weather, rainfall, and snowmelt conditions. During wet weather, iron and lead violations occur in the upstream nonurbanized portion of the stream as well as in the urban areas. Thus, iron and lead appear to be both a dry- and wet-weather problem which is aggravated (but not caused solely) by urban runoff.

Future Violations. Iron and lead concentrations were not modeled, and therefore quantitative predictions of future concentrations cannot be made. Concentrations of both constituents may increase in the future because of the greater amounts of traffic passing through the basin on the way to and from new housing developments in the Campbell Creek basin and beyond. Offsetting the increase in lead due to more traffic will be a decrease due to Federal regulations on unleaded gasoline.

Sources. Suspected sources of lead and iron are traffic, paint, rusting of automobiles and structures, and runoff from industrial and commercial areas. The automobile and the use of it probably produce the largest loadings of the two heavy metals. Waste snow at snow dumps have particularly large concentrations of lead and iron. Peat bog drainage and ground water flows also contribute to iron loadings in the streams.

Dissolved Solids

Existing Violations. Violations of aquatic life criteria occur for dry-weather and snowmelt conditions, but not for rainfall runoff conditions. The number of violations increase downstream in both cases.

Future Violations. Dissolved solids concentrations were not modeled. However, dissolved solids concentrations are expected to fluctuate according to the amount of salt used in the snow-and-ice control programs.

Sources. The major source of dissolved solids is the salt used in the snow-and-ice control programs. Salt is delivered to the creek in snowmelt and runoff from streets and snow dumps, as well as in ground water discharges to the creek.

Dissolved Oxygen

Simulated BOD_5 levels are presented on Figure 5-10. Concentrations range up to 500 mg/l. However, no dissolved oxygen violations have been found in any of the data or have been predicted by the computer model. Low temperatures and

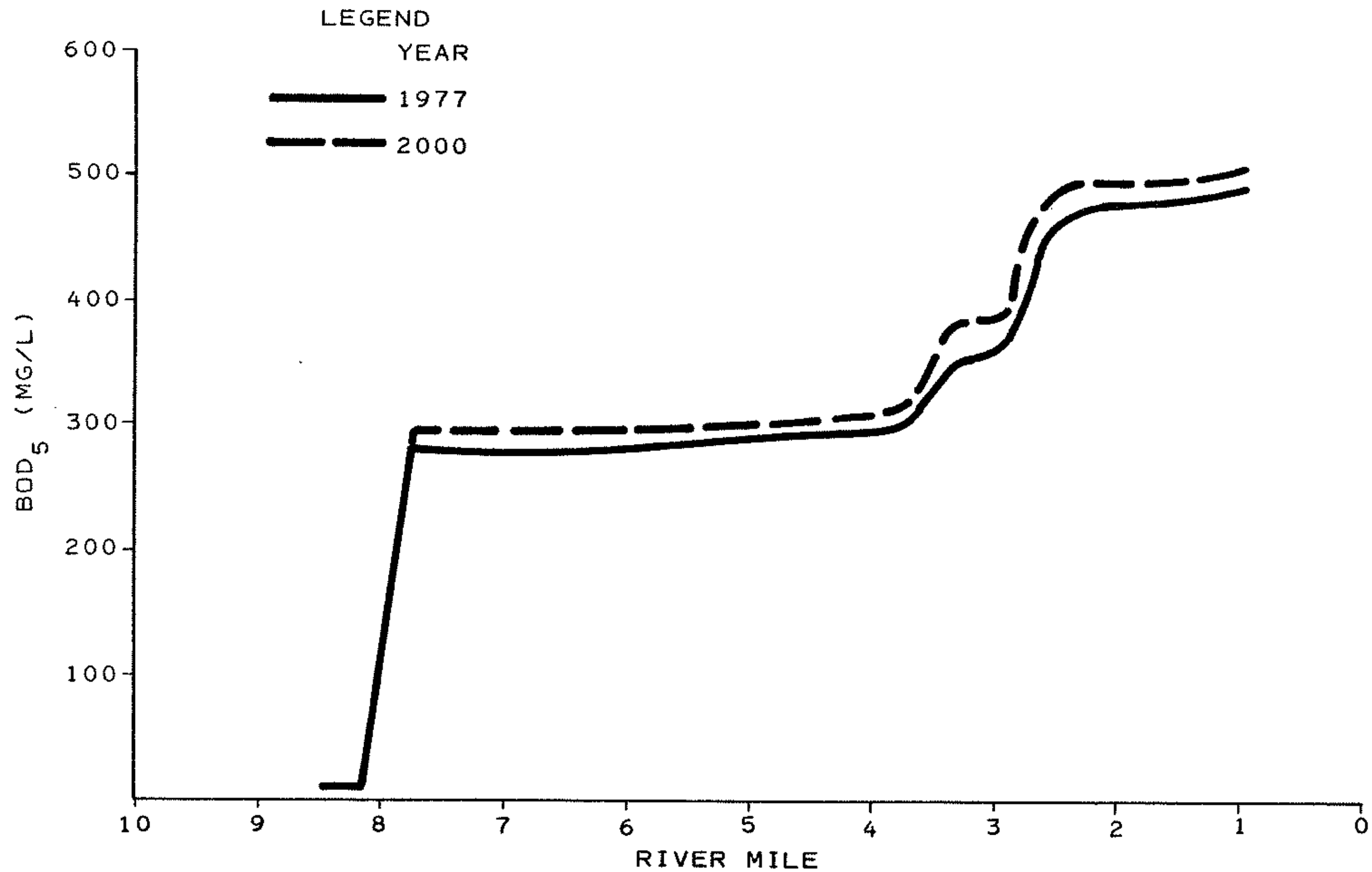

FIGURE 5-10
MAXIMUM BOD_5 CONCENTRATIONS
CHESTER CREEK

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short travel times limit the consumption of oxygen in Chester Creek. Thus, BOD_5 levels are high but do not appear to cause any water quality problems.

SHIP CREEK BASIN

The Ship Creek basin is largely undeveloped. In fact, at 26 percent developed overall it is the least urbanized basin analyzed in the 208 Study. By contrast, however, the lower reaches of the basin contain the central business district and other areas which are the most densely developed in the entire study area.

Little water quality data are available for this basin; those that are available are concentrated during dry-weather periods. Few water quality problems have been identified, probably because of the lack of data. Fecal coliform, iron and dissolved solids have been found to violate the water quality criteria. Other constituents like suspended solids and lead may also violate criteria, but there are no water quality data to either support or deny this assertion.

Extensive development is not expected to occur in the Ship Creek basin. Therefore, water quality should not degrade due to urbanization. In fact, water quality may actually improve if paving of roads continues in the basin. This activity will have the strongest impact on suspended solids concentrations. Its impact on concentrations of fecal coliform, heavy metals and dissolved solids will probably be less.

Fecal Coliform

Existing Violations. There are two violations (from a total of three samples) of the proposed aquatic life and body contact recreation standards. These violations occurred under dry-weather and rainfall conditions. No data were available for snowmelt conditions.

Future Violations. No modeling was done of water quality conditions in Ship Creek. Therefore, it is difficult to quantitatively predict changes in fecal coliform concentrations and loadings. However, because little development is expected to occur in the basin, fecal coliform concentrations and loadings are not expected to change significantly in the future.

Sources. Possible fecal coliform sources include septic tanks, exfiltration from sanitary sewers, urban runoff and natural sources such as animal manure.

Heavy Metals

Existing Violations. There is one observed violation of the proposed aquatic life standard for iron and 13 violations of the proposed body contact recreation standards for iron. Most of these violations occur during dry-weather, though some occur during rainfall conditions.

Future Violations. Future conditions are not expected to significantly change iron concentrations. Therefore, violations of the iron criteria are probable in the future during dry weather and runoff.

Sources. Ground water discharges and peat bog drainage appear to be the most important sources because of the preponderance of violations during dry-weather.

Dissolved Solids

Existing Violations. Violation of the aquatic life criterion for total dissolved solids has occurred in the downstream reach during dry-weather. No violations have been found anywhere else under any conditions, although data are extremely limited.

Future Violations. The periods and locations of dissolved solids violations are expected to remain the same as the current ones.

Sources. The only major source of dissolved solids is the road salt used in the snow and ice control programs.

FISH CREEK BASIN

Fish Creek basin is a very small, urbanized watershed. Water quality data are very limited for this basin. Sampling has been done during two rainfall events, and a few data are available to assess water quality during dry-weather. No sampling has taken place during snowmelt.

Violations of criteria have been found for fecal coliform, suspended solids (or turbidity), iron, and dissolved oxygen. No sources have been documented; however, visual inspection of the creek indicates that it has been abused by dumping practices and general negligence.

LAKE HOOD AND LAKE SPENARD

There are only three recorded water quality data points for Lake Spenard; temperature, pH, TDS, iron, and nitrate were measured. One sample was taken during rainfall conditions; the other two samples were obtained during dry-weather. No violations of standards were noted. There are no water quality data during the selected period for Lake Hood. In the absence of sufficient data, no statement regarding water problems in Lakes Hood and Spenard is possible.

SUMMARY

Water quality problems have been summarized on Table 5-1. Water quality problems, denoted by violations of the water quality criteria, have occurred in all major creeks within the study area.

Suspected pollutant sources are identified on Table 5-2. All of the significant pollutant sources identified in the study are nonpoint.

The following conclusions are based on the water quality analysis of Campbell Creek:

1. Existing and simulated water quality data indicate that fecal coliform, suspended solids, oil and grease, and heavy metals are current water quality problems. These same constituents, plus ammonia, are expected to be future water quality problems. Water quality decreases with progression downstream.

2. Water quality problems in Campbell Creek are solely caused by nonpoint sources. Consequently, the most significant water quality violations occur during runoff events.

3. Two critical runoff periods have been identified. The first occurs in March and April when snow and ice melt, resulting in runoff. The second period is in mid-summer when surface pollutant buildups are heaviest.

4. The residence time of water in Campbell Creek and Campbell Lake is short due to a relative small drainage area and steep gradient, so pollutants do not have time to chemically react instream. Therefore, instream concentrations of dissolved oxygen remain high despite high BOD loadings.

5. The most significant existing wet weather loadings of fecal coliform, suspended solids, ammonia, and oil and grease come from commercial and industrial lands in Subbasins C and G (see Figure 5-2 for locations) and from Lake Otis Parkway, Seward

Highway, Old Seward Highway, C Street and Diamond Boulevard. During dry weather, the major fecal coliform and ammonia loadings are from 1,500 onsite treatment systems, most of which are located in Little Campbell Creek basin.

6. Future pollutant sources are anticipated to parallel existing sources, with the greatest loadings being contributed from commercial, industrial and high-density residential land in Subbasins C, G, H and L. Heavily traveled streets will continue to be a significant pollution source. As the overall urban density increases, the loadings and the necessity to control pollutants from developed lands will also increase. If septic tanks continue to be installed at present rates, they will be a serious water quality problem in Little Campbell Creek in the future.

7. About 8,000 additional acres will be urbanized during the 20-year planning period. The sediments generated during this process will have to be controlled to meet water quality standards in Campbell Creek.

8. Future controls should be directed toward lessening the impact of development by (1) containing sediments onsite during construction, (2) promoting urban cleanliness to reduce the buildup of pollutants, (3) designing developments to imitate natural hydrologic conditions, (4) altering human actions that cause pollution and (5) capturing nonpoint source pollutants before entry to the stream system.

The following conclusions are based on the water quality analysis of Chester Creek:

1. Existing and simulated water quality data indicate that fecal coliform, suspended solids, dissolved solids, and heavy metals are present water quality problems in Chester Creek. These same constituents are expected to be future water quality problems. Water quality in the creek decreases with progression downstream.

2. Water quality problems in Chester Creek are solely caused by nonpoint sources. Consequently,

most water quality violations occur during runoff events. Fecal coliform, iron and dissolved solids violations occur during dry weather as well.

3. The residence time of water in Chester Creek is short due to a relative small drainage area and steep gradient, so pollutants do not have time to chemically react instream. Therefore, instream concentrations of dissolved oxygen remain high inspite of heavy BOD loadings.

4. Future controls should be directed toward pollutant control on roads and other paved surfaces, at snow disposal sites, and in septic tank areas.

Very limited water quality information is available on Ship Creek or Fish Creek. However, because the type and extent of urban development in their watersheds is similar to that in the Chester Creek watershed, water quality problems, sources, and solutions for these watersheds should parallel those for the Chester Creek watershed in most respects.

No water quality problems have been identified in Lakes Hood and Spenard, probably because of the lack of water quality data needed to define any problems.

Chapter 6
ALTERNATIVE WATER QUALITY PLANS

FORMULATION OF ALTERNATIVE PLANS

The water quality goal developed in Chapter 4 consists primarily of the proposed State water quality standards. As shown in the last chapter, water quality in the urban creeks does not meet the goal represented by these standards. The achievement of that goal will require high removals of existing and future pollutant loadings from nonpoint sources such as urban runoff and onsite wastewater disposal systems. For example, achievement of that goal in Campbell Creek would require better than a 90 percent removal of fecal coliform, suspended solids, and other pollutants. Such a high removal of nonpoint pollutant loadings will be very expensive and may cause severe social and environmental impacts.

The water quality goal developed in Chapter 4 may not be realistic for the Anchorage area. Therefore, two less ambitious water quality goals have been defined. The three alternative goals have been termed--

- Level 1--Water quality achieved by continuation of existing practices
- Level 2--Water quality achieved by protection of existing uses
- Level 3--Water quality defined by the proposed State water quality standards

Each of these goals requires a different level of water pollution control.

Level 1 is not a "do nothing" alternative. The existing practices for the control of nonpoint pollution, as described in Chapter 3, go a long way toward protecting future water quality. In fact, some 208 water quality management plans for other urban areas recommend public works and land use practices similar to those already practiced in Anchorage. However, the computer modeling results presented in Chapter 4 predict a degradation of water quality over the next 20 years, given the current practices. Thus, continuation of the existing practices is not likely either to protect the existing water uses in the creeks or provide for the new uses in the proposed State water quality standards.

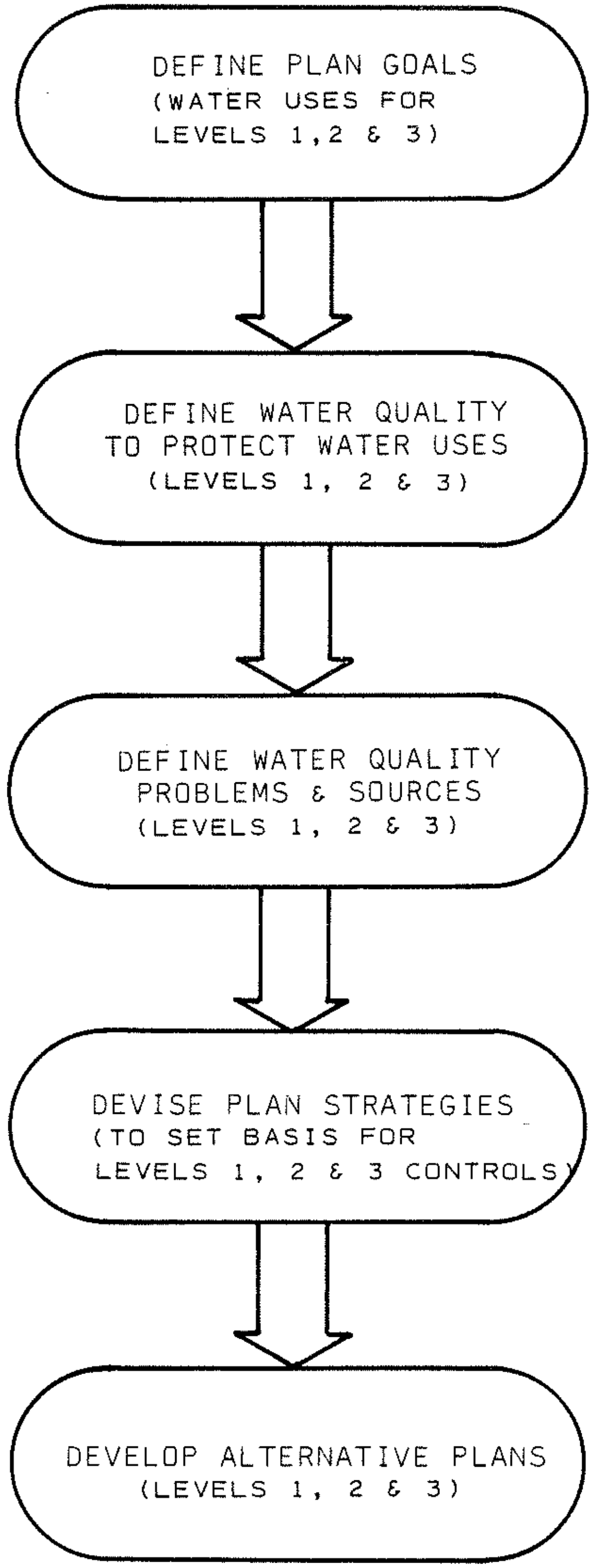

FIGURE 6-1
PROCEDURE FOR DEVELOPMENT
OF ALTERNATIVE PLANS

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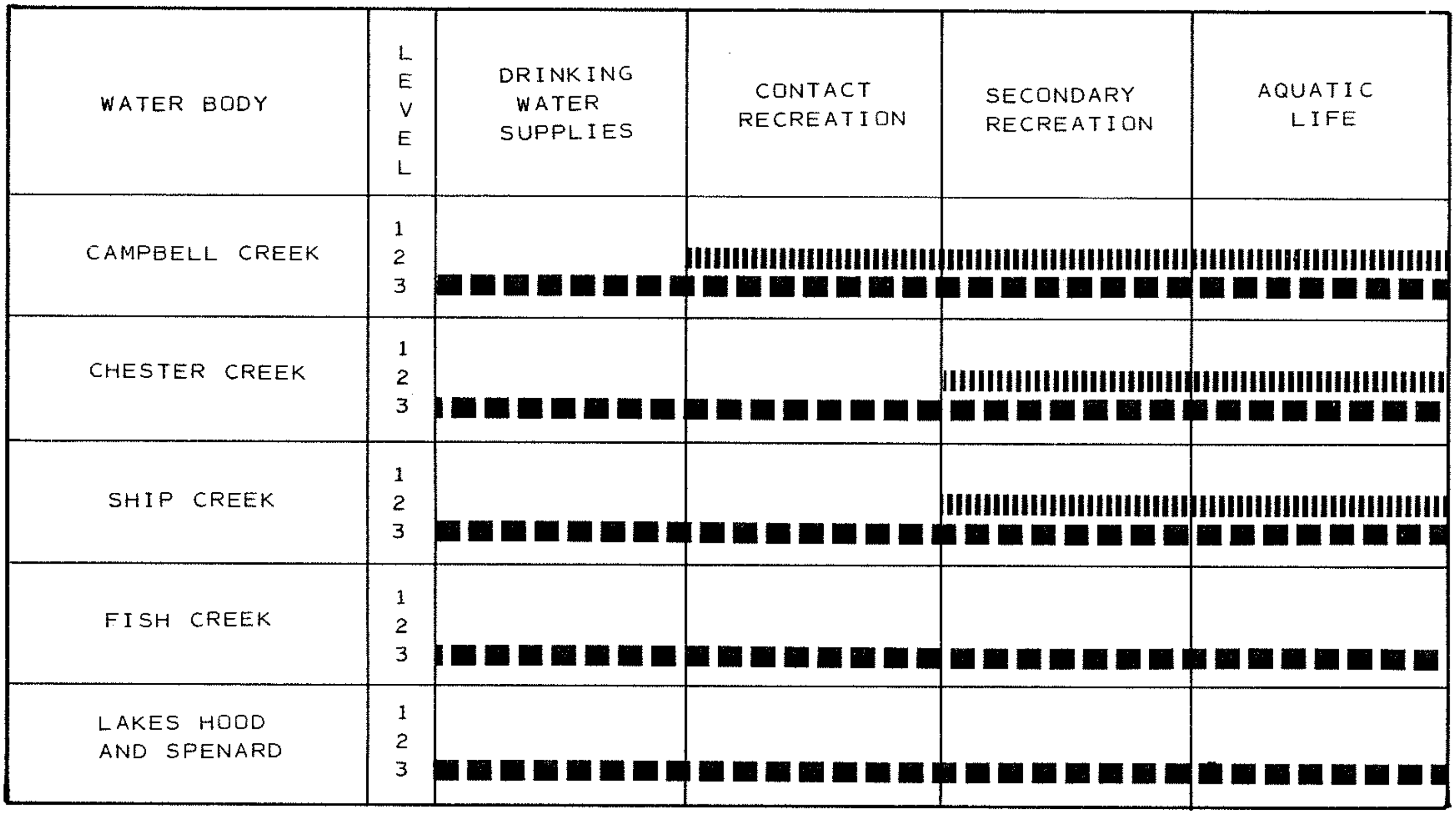

FIGURE 6-2

PLAN GOALS (IN TERMS OF URBAN AREA WATER USES)

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temperatures seldom exceed 70°F (21°C). However, Level 2 does provide for contact recreation in Campbell Creek, where tubing has been observed.

Level 3

The goal for Level 3, fulfillment of the proposed State water quality standards, provides for all water uses listed on Figure 6-2, including drinking water supply. Some of the uses protected under the level are existing. Others, like fishing and swimming in Fish Creek or use of urban streams for drinking water supply, are unlikely ever to materialize for reasons other than water quality. In summary, while Level 3 provides for more uses, achievement of Level 3 is not expected to actually change the current uses of the stream in the near future.

This level, like Level 2, satisfies the requirements of PL 92-500. It provides for the highest water quality of any of the three levels.

WATER QUALITY CRITERIA

The water quality criteria are used to define what water quality is needed to protect each type of water use. The water quality criteria for each level are described below.

Level 1

No quantitative water quality criteria exist under Level 1, because no water uses have been specified for protection under this level. The existing regulating program recognizes the sources of water quality degradation resulting from rapid urbanization. These sources include urban runoff, construction site runoff, and onsite wastewater disposal systems. Controls have been developed in response to these problems. Their effectiveness is not measured in terms of achieving certain water quality criteria, but rather in terms of addressing and alleviating water quality problems clearly recognized by the public and public officials.

Level 2

Water quality under Level 2 was originally intended to be judged according to the water quality criteria developed in Chapter 4 (See Table 4-4). These criteria relate to the uses protected under Level 2. However, it was found in Chapter 5 that water quality frequently violated the criteria without any apparent loss or impairment of a water use. This situation suggested that some criteria are more stringent than needed to protect the existing uses in the manner in which they are currently exercised. The criteria for fecal coliform and suspended solids are particularly suspect.

The proposed State fecal coliform criteria are 20 colonies per 100 ml for contact recreation and 200 colonies per 100 ml for secondary recreation and aquatic life. These criteria are violated during dry weather and runoff periods, yet no use loss or impairment can be attributed to the violations. Many other states have standards of 200 colonies per 100 ml for primary contact recreation and 1,000 colonies per 100 ml for secondary contact recreation. These standards have proven to adequately protect water uses in other states. Thus, they have been adopted as water quality criteria for Level 2 in this study.

Violations of the revised secondary recreation criterion have been simulated by computer modeling in Chester Creek (See Figure 5-8), but not in Campbell Creek (See Figure 5-4). That criterion has also been violated by actual data in all creeks except Campbell Creek. The contact recreation criterion has been violated by actual or simulated concentrations in all four urban creeks.

The proposed total suspended solids standard appears to be overly protective of fisheries where spawning does not occur. Fisheries without spawning grounds are located in Chester Creek and the lower reaches of Campbell Creek and Ship Creek. Salmon migrate without apparent harm through the mainstem of the Eagle River, where turbidities are extremely high because of the river's glacial origin, to spawning grounds in the clearer tributaries. Thus, fisheries without spawning grounds can probably accommodate suspended solids concentrations greater than the standards or criteria.

The precise suspended solids criterion for creeks with fisheries but without spawning grounds is impossible to define with the available information. Research with native species could indicate the proper suspended solids criterion. Because of a lack of information to set a criterion, the approach to suspended solids under Level 2 has been to set limits on erosion. A tolerable erosion rate is defined in the final chapter on the "Recommended Plan."

Level 3

The water quality criteria for Level 3 have been developed in Chapter 4 (See Table 4-4). In most cases, these criteria are the proposed State water quality standards.

PLAN STRATEGIES

A plan strategy is the transformation step between the identification of water quality problems and goals and the formulation of control measures. More simply, it states what has to be done to meet the water quality objectives but does not technically describe specific control measures. Plan objectives are discussed below for Levels 2 and 3. Because Level 1 represents the existing program, development of strategies is obviously inapplicable.

Level 2

Basic Premise. The current water quality in Campbell Creek is apparently high enough to support the existing uses of water (recreation, both contact and secondary, and fresh water fish propagation). Although some improvement to existing water quality might be advantageous, the major thrust of the pollution control program is to protect the existing high water quality and prevent further degradation through improvement of existing regulations and practices. The overriding strategy is to prevent, to the extent possible, pollution from future development, even though some control of pollution from existing land uses will undoubtedly be necessary. Maintenance of existing water quality will require a 50 to 60 percent reduction in the anticipated 1995 pollutant loading in developing basins and no additional pollution sources in developed basins.

Existing water quality is also apparently high enough to support the existing uses in the other urban creeks, although water quality frequently violates the proposed standards. The approach to Chester Creek, Ship Creek, and Fish Creek is to prevent further degradation by extending the recommended plan for Campbell Creek to these basins. This approach is logical since almost all changes in policies and practices recommended for the Campbell Creek basin will be administered by the Municipality, which also has authority over the same policies and practices in the other three basins. In addition to the preventative measures, a few corrective measures will be recommended. These involve streetsweeping and onsite wastewater disposal.

Fecal Coliform. Measurement of fecal coliform concentrations indicates the presence of possible pathogenic organisms. The Level 2 objective for fecal coliform control is to eliminate those pathogenic organisms that are associated with discharges of improperly treated human waste and that would make water unsafe for swimming in the future. Specific controls will not be developed for other waste, because only fecal coliform from human excreta are reliable indices of pathogenic organisms. Few organisms that are pathogenic to man come from the intestinal tracts of birds and animals. Excreta from birds and animals are the anticipated major source of fecal coliform in urban and natural runoff.

The measurement of fecal coliform should be continued on a regular basis. Recognition of high instream values through monitoring (above 200 or 1,000 colonies/100 ml, or a major increase above background levels) should initiate an investigation to define sources and assess their significance.

Unionized Ammonia Nitrogen. Presently, this pollutant is not a problem, although future problems are possible. Ammonia toxicity increases with higher water temperature and pH. As a basin develops and additional and more frequent discharges of urban runoff enter the basin's waters, pH values and temperatures increase. The Level 2 strategy for ammonia is to reduce future pollutant loadings from urban runoff to area waters by 60 percent and to assure maintenance of luxuriant vegetation on all stream banks.

Heavy Metals. Although high heavy metal levels have been observed, they have had no apparent effect on existing uses. Consequently, the strategy is to maintain instream concentrations at existing levels by controlling future peat bog drainage, by reducing pollutant loadings from developing areas from urban runoff by 50 to 60 percent, and by assuring no heavy metal increase in runoff from developed areas. The control of natural peat bog drainage and ground water sources is not recommended.

Oil and Grease. Similar to heavy metals, high instream values have been observed but with no noticeable impact on existing water uses. Therefore, the strategy for Level 2 is to limit additional loadings of oil and grease by reducing urban runoff pollution by 60 percent in developing areas. Oil and grease loadings from developed areas are to experience no increase.

Sediment and Suspended Solids. Maintenance of existing instream conditions in Campbell Creek will require a 60 percent reduction of total 1995 sediment and suspended solids loadings from urban runoff. Erosion and sediment loadings from construction sites will be controlled using the best practical methods. Erosion control plans assuming no more than 15 tons per acre per year escapement of sediments will be required prior to receipt of building permits.

Level 3

Basic Premise. The proposed State water quality standards call for several additional water uses not currently exercised in Anchorage streams. The combination of additional water uses and restrictive water quality standards will require not only tight control of nonpoint pollution from future development, but also will require controls to be retroactively applied to existing development. The strategy is to achieve an overall pollutant removal of 90 to 95 percent.

Fecal Coliform. The proposed fecal coliform standards call for a mean value of 20 colonies/100 ml and a 90 percentile value of 40 colonies/100 ml. The strategy to fulfill this standard is to eliminate all sources of fecal coliform through the control of septic tank effluents, other sources of human wastes and the disinfection or diversion of urban runoff from both existing and future development.

Unionized Ammonia Nitrogen. The proposed standard for ammonia nitrogen is 0.02 mg/l. Future ammonia concentrations are expected to exceed the proposed State standards. To meet the requirements of the Level 3 alternative, it will be necessary to control both existing and future sources of ammonia. Similar to Level 2, methods that maintain a low pH in the stream (less than 7.0) and cool water temperatures will be required.

Heavy Metals. The proposed standards for aluminum and manganese are both 0.01 mg/l. The standard for iron is 0.1 mg/l. These standards are presently being violated and future violations are projected. The difference between Levels 2 and 3 is that existing high observed values are not tolerated for the latter level. Consequently, all present and future man-induced sources of heavy metals will be stringently controlled.

Oil and Grease. The proposed oil and grease standard for Level 3 is no visible sheen or 0.01 96 LC_{50} value, whichever is lower. The major strategic difference between Levels 2 and 3 is that existing instream oil and grease loadings are not tolerated for the latter alternative. The present oil and grease concentrations found in area creeks could be reducing biologic productivity depending upon the chemical makeup of the oil. (This is not a concern for Level 2 because preservation of the existing fishery is the goal.) In order to assure protection of fish, oil and grease loadings from runoff from both existing and future developments will have to be virtually eliminated.

Sediment and Suspended Solids. The proposed State sediment standards call for "no measurable increase" and 80 mg/l suspended solids for fishery protection. To achieve the "no measurable increase" standard, extensive sediment controls on future development will be required. However, to achieve the 80 mg/l suspended solids standard, extensive sediment controls will be required on both existing and future development. For example, the achievement of the 80 mg/l standard in Campbell Creek will limit sediment discharges to an annual stream loading of from 200 to 500 pounds per acre per year. In other terms, suspended solids concentrations in storm runoff entering the creek must be between 150 and 300 mg/l depending on the amount of dilution and the instream quality of the creek.

DESCRIPTION OF CONTROL PLANS

An extensive analysis of water pollution control options has been undertaken, and three alternative water quality management plans have been developed with the most favorable options. Each one of the alternative plans is designed to satisfy one of the water quality levels described earlier in this chapter. The elements of each plan are summarized in detail on Table 6-1. More complete descriptions of each element, as well as descriptions of those elements considered but not included in any of the three plans, can be found in the other 208 technical reports referenced in the introductory chapter of this report.

The three plans cover the following eleven areas of control:

- Storm water detention
- Stream corridor protection
- Streetsweeping
- Control of untreated wastewater discharges
- Paved roads and parking lots
- Land use controls
- Discharge/diversion of storm runoff
- Water quality monitoring
- Construction site erosion and runoff
- Waste snow disposal
- Onsite wastewater disposal systems

The first eight areas address primarily urban runoff, while the remaining three address the other major potential pollution sources. Although controls in these eleven areas are found in all three plans, the intensity varies for each. The controls for Level 1 are represented by the existing program. The emphasis of Level 2 is to improve existing ordinances to maximum benefit to water quality. Nonstructural solutions are given priority. In contrast, the Level 3 programs are directed toward extensive structural control. This obviates the need for many of the nonstructural controls recommended for Levels 1 and 2.

The major technical differences in each area among the three alternative plans are identified below.

Storm Water Detention. Under existing practices (Level 1), drainage plans must be submitted to the Department of Public Works, which decides if the plans are sufficient to prevent degradation of surface water quality and drinking water supplies. Under Level 2, detention of urban runoff and

Table 6-1
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting From Achievement of Proposed State Water Quality Standards
URBAN RUNOFF CONTROL			
1. Storm Water Detention	o Subdivision Regulations give power for onsite detention and treatment but control is not widely used to date o Standards for Special Exceptions require gas stations, storage yards and junkyards to control drainage o Existing practices involve frequent use of gravel filled "detention facilities" in parking lots and along roadways between the sidewalks and curb	o Amendment of Subdivision Regulations to require detention of storm runoff prior to entry to fresh water, where necessary to protect existing uses and prevent further water quality degradation. The objective is to reduce peak flows and reduce pollutant loadings through settling.	o Continuation of existing practices. Additional storm water detention is not required from a quality standpoint. The Level 3 concept is to parallel streams with interceptor storm sewers to convey all runoff to Cook Inlet. This would result in a near zero discharge of storm reunoff to area creeks
2. Stream Corridor Protection	o Campbell Creek Linear Park o Flood plain regulations o Stream corridor easements o Planned bank stabilization for Campbell Creek Linear Park (to be initiated by the Department of Parks and Recreation)	o Continuation of the present program with the following amendments: 1. Restrict the stockpiling or storage of petroleum or other hazardous products within 100' of any water course 2. All inwater work should be discouraged but that which is unavoidable should be done between 15 May and 1 July to avoid conflict with salmon spawning. Disturbed stream banks should be returned to a slope no greater than 2 horizontal and 1 vertical with replacement of natural vegetation	o Same as recommended for Level 2

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(Stream Corridor Protection Continued)		3. Any planned crossing of Salmon spawning areas should be accomplished by bridge when possible 4. Any water appropriation project should include 3/16' mesh screens on suction pumps and barriers or diversion channels to prohibit entrance of adult fish 5. Extention of the existing linear park program should receive priority along Little Campbell, Ship, Rabbit, and Chester Creeks. The park width should be a minimum of 50' on each side of the creek(s)	
3. Streetsweeping	o Improved roads are swept using both broom and vacuum street sweepers after breakup and about once every 4 weeks thereafter during the summer months	o Continuation of present practices with the following additions: 1. Better enforcement of parking ordinances 2. Better enforcement of litter ordinances to prevent the raking of yard debris to the gutter 3. Increase frequency in urban areas on a selected basis	o Continuation of present practices
4. Control of Untreated Waste Discharges	o Discharges of untreated wastewater and for other toxic substances to storm sewers, curbs, streets or water courses are illegalized under Chapter 15.65	o Modification of existing regulations to prohibit discharges of any municipal or industrial point sources to fresh water streams and lakes in the Anchorage area and illegalize hosing down or washing	o Same as recommended for Level 2

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(Control of Untreated Waste Discharge Continued)	"Wastewater Disposal Regulations," Section 15.65.020, "Prohibit Wastewater Discharges and Practices"	of trucks, facilities and/or machinery in areas where discharge to fresh water is inevitable, i.e., flood plains, lake shore areas. Management plans and designs should direct effluent discharges to Cook Inlet.	
5. Paved Roads and Parking Lots	o Subdivision Regulations require all new subdivisions to have paved roads. Areas with unpaved roads can finance improvements through formation of road improvement districts. There is no control requiring paving of parking lots	o Continuation of existing control with the following amendments: 1. Require that all future parking lots in incorporated areas be paved and well maintained, i.e., yearly sealing and repair of potholes 2. Encourage paving of dirt roads through formation of road improvement districts	o Continuation of present practices
6. Land Use Control	o <u>Comprehensive Development Plan Ordinance</u>. This document does not address the control of nonpoint source pollution directly but provides goals and objectives for environmental quality, including water quality. In sum, these are-- 1. Promotion of urban vegetation 2. Maintenance of existing water quality	o Continuation of existing land use planning and control with the following amendments: 1. Development controls should be administered so that the impact of peat bog drainage on water quality is is kept to a minimum. For example, extensive drainage of peat bogs should be avoided spawning areas during the spawning season. And discharge of peat bog drainage water should take place, as much as possible, during periods of high stream flow when dilution capabilities are more favorable. 2. The "Bonus Point System" should be expanded to developments outside of the central business district (CBD). Subdividers, and developers of PUD's and industrial parks should be allowed to increase	o Continuation of present practices

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(Land Use Control Continued)	3. Protection of ground water recharge areas, watershed and flood plain areas 4. Preservation of high quality wetlands and marshes as open space Controls called for in the plan which benefit water quality include-- 1. Greenbelts along Campbell and Little Campbell Creeks 2. Large lot zoning south of Abbott Loop Road, in the upper reaches of Little Campbell Creek 3. Parkland encompassing the area of confluence between the north and south forks of Campbell Creek o <u>Zoning Ordinance</u>. This ordinance provides teeth to the Comprehenisve Development Plan. Other than the zoning map which parallels the Land Use Plan in the former document,	the intensity of land use if they provide amenities that enhance and protect water quality, i.e. provision of vegetation along stream easements, open space for infiltration, site plans which eliminate runoff, etc. 3. The concept of "Environmental Design" mentioned in existing subdivision regulations should be integrated with the bonus point system mentioned above. That is, if new subdivisions are designed to provide onsite detention, so that peak runoff is maintained at predevelopment levels, they should be allowed to increase housing densities. If local onsite detention is provided, the cost of developing the treatment ponds mentioned under the first control would be lessened	

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(Land Use Control Continued)	zoning controls that influence water quality include-- 1. Control of maximum lot coverage, i.e., limitation of percent impervious. Present maximum lot coverage is 5% for low density single family; 30% for single family; 40% to 50% for multifamily; and unlimited for commercial and industrial uses 2. "Bonus Point System" which allows developers of commercial land in the CBD to increase base heights for provision of amenities bicycle racks, seating units, trees, open-air plazas, etc. o <u>Subdivision Regulations</u>. Existing regulations call for "Environmental Design," stating that "lots are to be designed to minimize the impact of urbanization on the environment, and that environmental factors may be considered for justification for variation from any of the standards."		

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
7. Discharge/Diversion of Storm Runoff	o Presently, only a small portion of the Campbell Creek basin is storm sewered	o The general thesis of Level 2 is that the less emphasis placed on provision of storm sewers the better. Storm sewers should only be used in areas where use of grass-lined ditches and swales would cause significant flooding problems. In other cases, the present use of grass-lined ditches and swales is recommended. Given the requirement for storm water detention and environmental design, the necessity for storm sewers is lessened	o As mentioned earlier, this plan involves development of interceptor storm sewers adjacent to area streams to collect all storm runoff and snowmelt for discharge to Cook Inlet. This offsets the need for the source controls required for Level 2
8. Water Quality Monitoring	o Water quality monitoring has been recently initiated on Campbell Creek. However, little data are now available	o An aggressive planning oriented water quality monitoring program involving seasonal sampling of dry-weather flows and sampling of six runoff events. In addition, selected ground water sampling sites would be monitored	o Same as Level 2 but with no sampling of runoff events. In addition, sampling Cook Inlet at the mouth of each of the proposed interceptor storm sewers would be required
<u>SOIL EROSION AND SEDIMENT CONTROL</u>	o <u>Subdivision Regulations</u>. Erosion control plans are required upon the discretion of the Department of Public Works	o Amendment of current regulations with the following: 1. Construction drawings to include drainage patterns, permanent drainage plan, details for temporary structural measures, and access road location 2. Specifications and contract documents should include requirement for erosion and sediment management during construction, including maintenance of controls	o Same as for Level 2

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting from Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(SOIL EROSION AND SEDIMENT CONTRO Continued)		3. Provisions outlining responsibility for erosion control should be included in subdivision regulations and reflected in subdivision agreement 4. Soil loss should not be allowed to exceed 15 tons/ac/yr 5. Sediment basins should be required in the vicinity of all surface waters	
<u>SNOW DISPOSAL</u>	o Selection of new snow disposal sites largely by experience and trial and error	o Use of an evaluation screening system to select new sites (see Appendix C) o An intensive monitoring program of runoff, ground water, and waste snow quality to identify if snow disposal sites are a significant pollution source	o Structural controls at snow disposal sites to control surface runoff o Use of an evaluation screening system to select new sites (see Appendix C)
<u>ONSITE WASTE DISPOSAL CONTROL</u>	o <u>Permits/Inspection</u>. Necessary to obtain a permit from DHEP after submittal of acceptable soils test. Inspection required after excavation to verify soils	o Continuation of present program with the following amendments: 1. Conduct a <u>Comprehensive Sanitary Survey</u> to identify problem systems and areas	o Inclusion of present practices plus Nos. 1, 2, 3, 4, 8, 9, 10, 11 and 12 recommended for Level 2, and the recommendations below: 1. <u>EPA 201 Facilities Plan</u>. Clean Water Act of 1977 allows 75% funding of

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(ONSITE WASTE DISPOSAL CONTROL Continued)	test and prior to backfilling o Design Criteria. DHEP has design criteria which include requirements for minimum lot requirements, minimum system size, and minimum distances, based primarily on U.S. Public Health Service Criteria o Permits for Installers and Septage Haulers. Installers must be bonded before receipt of permit. Permits issued annually to septage haulers. o Approval by Lending Institutions. Lending institutions' policy requires DHEP approval before loans are granted to assure septic system operates properly o Alternate Systems. Use of new technology is encouraged. Maintenance contract between owner and local distributor required	2. Computerization of Onsite System Data. To complement management system by making data more readily accessible 3. Certification of Soils Technicians to avoid honest incompetence and to generate standard procedures and results 4. Increased Inspection to complement the two already done. A third inspection would be held once system is backfilled and home nearly complete to verify that heavy construction machinery had not compacted the drainage system or that system was not under a driveway, etc. 5. Voluntary Maintenance. Leaflet would be sent out reminding persons when septic tank needed pumping 6. Continued Inspection. Systems would be inspected every 5 years to assure proper operation if they were not, homeowners would be responsible for replacement 7. Dual Absorption System. In areas where installation of sanitary sewers is not planned, all new systems would have to be equipped with dual	correction of failing onsite systems through the 201 Facilities Planning Process. For this alternative it is recommended that the Municipality apply for this funding to correct all problem systems. Under this program, O&M of the revamped systems is centralized so system performance is better assured and systems that continue to fail are constantly identified 2. Development of a Septic Suitability Map. A committee would be formed to determine the cost and usefulness of a detailed onsite soil suitability map for the Anchorage area for use as a long-range planning tool to avoid future problems and as a verification of site-specific soils testing 3. Soils Testing Improvements. Existing practices should be complemented by use of the "Crust Test" for sites assured to be of marginal suitability

Table 6-1 (Continued)
Summary of Alternative Plans

Control	Level 1--Water Quality Resulting from Existing Practices	Level 2--Water Quality Resulting Protection of Existing Uses	Level 3--Water Quality Resulting from Achievement of Proposed State Water Quality Standards
(ONSITE WASTE DISPOSAL CONTROL Continued)	o <u>Connection of Sanitary Sewers</u>. Septic tank cannot be used if it is within 100 feet of sanitary sewer right-of-way	absorption systems to increase reliability 8. <u>DHEP Approval of Title Transfers</u>. Would legally require DHEP approval of all title transfers. Present lending institution policy is not law 9. <u>Water Conservation</u>. This is recommended to reduce hydraulic failures 10. <u>Formalization of DHEP Operating Procedure</u>. This would formalize existing strong policy (which is practiced but not written) so that programs would persist given change in personnel 11. <u>Public Education</u>. Program to help persons adequately main- 12. In areas where installation of sanitary sewers is imminent the above controls would not all be applicable. Therefore, revised controls would include an exemption clause(s) to avoid improper application, i.e. require a home to be equipped with a dual absorption system only to have sanitary sewerage service available 2 or 3 years later.	

proper drainage considerations are required for all new development. Under Level 3, storm water detention has not been recommended for water quality purposes, because all runoff would be collected and discharged directly to Cook Inlet.

Stream Corridor Protection. Under Level 1, the Municipality's aggressive stream corridor protection program is continued through setback requirements and bank stabilization and revegetation on Campbell Creek. Under Level 2 and Level 3, extension of the green belt program to Little Campbell, Rabbit and Ship Creeks is recommended, along with five other stream corridor protection measures.

Streetsweeping. Under Level 1 and Level 3, streetsweeping continues at the current frequencies. Under Level 2, better enforcement of the existing parking and litter ordinances is sought along with increasing sweeping frequencies in the more heavily urbanized areas surrounding the central business district (CBD).

Untreated Wastewater Discharges. Under Level 1, control of discharges continues to be provided by the Municipality's ordinance entitled "Wastewater Disposal Regulation." Under Levels 2 and 3, municipal and industrial point source discharges to Campbell, Ship, Fish Chester and Rabbit Creeks, or lakes in the study area, would not be allowed, through amendment of this ordinance.

Paved Roads and Parking Lots. Under Level 1 and Level 3, all new developments in the urban and suburban portions of the Municipality must have paved streets as required by existing Subdivision Regulations, but not necessarily paved parking lots. Under Level 2, the Plan strongly encourages paving and maintenance of all existing and new parking lots and the paving of all existing dirt roads in urban and suburban areas through street improvement districts.

Land Use Controls. Under Level 1 and Level 3, land use controls continue to be provided by the existing Comprehensive Development Plan ordinance, zoning ordinances, and subdivision regulations. Under Level 2, the "bonus point" system in the zoning ordinance is extended to developments outside of the central business district, to provide developer incentives for protecting water quality. In addition, the concept of "environmental design" contained in existing Subdivision Regulations would be meshed with the requirement of storm water detention mentioned earlier.

Discharge/Diversion of Storm Runoff. Under Level 1 and Level 2, existing practices which generally utilize grass swales and ditches in storm drainage would be continued where possible. Random installation of storm sewers would be discouraged in areas not subject to severe storm drainage problems. For Level 3, interceptor storm sewers, conveying all urban runoff to Cook Inlet, would be developed initially on Campbell and Ship Creeks and possibly at a later date on Chester Creek.

Water Quality Monitoring. Under Level 1, the U.S. Geologic Survey continues to routinely monitor primarily base flow quality at a relatively few locations. Under Level 2, an expanded monitoring program of base flows, ground water, and runoff is inititated. Under Level 3, the quality of base flow and ground water is monitored, along with the quality of the discharges at the storm sewer outfall in Cook Inlet.

Construction Site Erosion. Under Level 1, erosion control plans continue to be required upon the discretion of the Department of Public Works. Under Level 2 and Level 3, specific performance and design criteria are included in the existing Department of Public Works' Design criteria and Improvement Standards. One of the design criteria is a maximum soil loss from developing areas of 15 tons per acre per year.

Snow Disposal. Under Level 1, the current selection technique for new snow disposal sites is continued. Under Level 2, nonstructural measures are implemented, including an expanded water quality monitoring program to define problem areas and an evaluation screening system to select new sites. Under Level 3, structural measures at snow disposal sites are implemented to control surface runoff.

Onsite Wastewater Disposal. Under Level 1, the strong current programs continue. Under Level 2, the current programs are strengthened by a comprehensive sanitary survey to define problem areas, certification of soils technicians, increased inspections, requirements for dual absorption systems, and other measures. These would be required as an interim solution in areas where installation of sanitary sewers is imminent. Because of apparent sewer installation ordinance amendments would include exemption clauses to allow less stringent control on a case by case basis. Under Level 3, many of the practices listed above continue. In addition, 201 funding would be sought to correct failing systems, and an organized maintenance program established.

Chapter 7
EVALUATION OF ALTERNATIVES

The three alternative programs described in the previous chapter have been evaluated using the criteria on Table 7-1. The assessment for the areawide program has been extracted from a detailed assessment done for Campbell Creek. Because the Campbell Creek basin now has relatively high water quality, and will experience the most development pressure in the future, it provides a sensitive bench mark for assessing program efficiency. This is, if a proposed program works for Campbell Creek, it surely will fulfill similar goals in other area streams. In all cases, impacts are defined only to sufficient detail to determine the most advantageous alternative for each parameter.

WATER QUALITY IMPACT

LEVEL 1

The current program for controlling water pollution from nonpoint sources is one of the strongest in the country. It has the potential to be even stronger, because many water pollution control practices are not being implemented to the full extent allowed by the regulations and ordinances. However, based on the current application of controls, water quality in Campbell Creek is predicted through modeling to degrade because of rapid urbanization in the basin. Modeling also predicts a degradation of water quality in Chester Creek, although the degree of degradation is much less in Chester Creek than in Campbell Creek. Future water quality was not modeled in Ship Creek or Fish Creek, but some degradation of water quality in Ship Creek may also be anticipated due to urbanization.

Several pollutant sources will probably not be controlled under Level 1 to the extent necessary either to achieve the fishable/swimmable goal mandated by PL 92-500 or to eliminate or alleviate the water quality problems documented in Chapter 5. These pollutant sources include runoff from urban and urbanizing areas, man-induced peat bog drainage which is only a temporary problem, and failing onsite waste disposal systems.

The present drainage controls, particularly those which might benefit water quality, have not been uniformly applied in the past; in fact, the use of storm water detention is only in the nascent stages. Combining this control and the policy to pave future streets will undoubtedly result in lower sediment loadings. Detention ponds, where they are

Table 7-1
Evaluation Criteria

1.	**Water Quality Impacts**	
	o Water quality improvements	Potential for eliminating or alleviating a documented water quality problem
	o Compatibility with desired objectives	Contribution to the goal of PL 92-500, which provides for the protection and propagation of fish and other aquatic life and for recreation in and on the water by 1983
		Contribution to the achievement and protection of locally defined water uses or quality goals
2.	**Technical Reliability**	
	o Capability to function as planned	Ability to reduce nonpoint pollution during breakup and during summer storm season
		Estimated pollution reduction
		Ability to function in cold weather and with a short growing season
	o Avoidance of operational failure	Simplicity of operation and availability of skilled manpower
		Proven reliability in other areas with similar climatic, environmental and pollutional conditions
		Ability to respond to changing conditions, i.e., increased treatment requirements, increased capacity, changing land uses and levels of development

3. Monetary Costs

o Capital cost	Public, private and total capital cost including discounted deferred cost
o Operation and maintenance cost	Public, private and total operation and maintenance cost

4. Environmental Impacts

o Hydrology	Effects on timing and volume of flows and water levels in surface and ground waters
	Potential for floods
o Vegetation/wildlife	Effects on plant and animal populations
	Effects on habitats and ecosystems
	Effects on rare and endangered species
o Soil/geology/air quality	Potential for erosion, subsidence and other impacts on soil and geology
	Generation of vehicular, dust and other atmospheric emissions
	Potential for natural hazards
o Land use and development	Effects on existing or planned land uses
	Effects on environmentally sensitive areas
	Effects on type and amount of development
o Urban aesthetics	Impacts on general visual quality, recreational, scientific and cultural values

o Resource commitments	Requirements for energy, chemicals, land, water and other renewable and nonrenewable resources Preemption of resources
5. Social and Economic Impacts	
o Population	Effects on rate, level and distribution of growth Correlation with local or regional projections and planning
o Economics	Effects on personal incomes Effects on economic activity of mining, manufacturing, services and other economic sectors Impact on desirability and value of property
o Dislocations	Dislocation of individuals, businesses and public services
o Public health	Effects on public health
6. Implementability	
o Legal authority	Identification of clear and sufficient legal authority Present existence of required legal authority Requirement for additional legal authority
o Financing	Existence of adequate and flexible financial power Ability to obtain State and Federal grants Taxation authority Ability to establish and levy user charges

o	Geographic authority	Existence of sufficient geographic authority for complete implementation in study area
		Requirement for public management agencies for complete implementation in study area
o	Management	Existence of effective management and administrative structure
		Existence of adequate technical and administrative personnel
		Ability to coordinate with other institutional or service agencies

7. Public Acceptability

o	Political acceptance	Acceptance by local, State and Federal authorities
o	Public accountability	Use of management agency accountable to general public through election

used, will also reduce fecal coliform by 35 to 40 percent, oil and grease by 60 percent, and heavy metals by 30 to 35 percent. However, the degree to which storm water detention is implemented depends on individuals in the Department of Public Works, and therefore, it is unclear how widespread will be the implementation of this control under Level 1.

The existing Comprehensive Development Plan calls for development of many of the peat bogs in Anchorage, particularly in the Campbell Creek basin. Inasmuch as peat bog development often requires drainage and the drainage usually has high concentrations of aluminum, iron and manganese, this practice can affect water quality in Campbell Creek. However, it should be pointed out that possible increase in heavy metals loadings would only be temporary. That is, once the bog has been drained subsequent discharges would be minimal. In fact, the discharge would probably be less than experienced under natural conditions because increased impervious surfaces (rooftops, roads, parking lots) accompanying development would reduce water infiltration and subsequent subsurface drainage to adjacent water courses. Inasmuch as the upper reaches of Campbell Creek include the majority of the creek's spawning areas, and these reaches are protected from development due to public ownership, impacts on the fishery that may occur would be negligible. The salmon fishery in Ship's Creek would be largely unaffected by peat bog development because of the infrequency of peat in developable areas in that drainage basin.

Although difficult to document, it is felt that onsite waste disposal system failures are a source of pollution, especially in Chester and Campbell Creeks and in shallow ground water aquifers. The principal pollutants of concern contributed by these failures would be total and fecal coliform bacteria, phosphorus, and ammonia-nitrogen.

The possibility also exists for deeper ground water pollution, which could present a health hazard to municipal drinking water supplies. This type of problem would be likely from a cesspool or an inadequately operating seepage pit. The primary pollutants expected are fecal coliform bacteria, nitrate-nitrogen and chlorides.

The most significant contributions of the existing program to the control of pollution from onsite waste disposal systems are (1) the requirement of DHEP approval for home loans and (2) the imminent sanitary sewer expansion in the Hillside area, southeast of downtown Anchorage. Many existing systems, principally those built pre-1975, are undersized, poorly constructed, have insufficient drainage areas and use poor quality gravel in the drainage system. As a result, they frequently fail. Eliminating some of these systems with the sewer expansion and upgrading them by the loan approval practice is the primary management program for existing onsite systems. Given the existing program, septic tanks will be a lesser water quality problem in the future, although they are likely to still deliver significant amounts of fecal coliform and other pollutants to Campbell and Chester Creeks.

In summary, it can be concluded that continuation of the existing program would not meet proposed water quality standards or the goal of PL 92-500. Proposed fecal coliform standards would be violated simply because they are so stringent that only disinfection or conveyance of runoff out of the basin could achieve compliance. Proposed heavy metals standards could be surpassed due to increased urban runoff and peat bog drainage, especially in Campbell Creek. Proposed oil and grease and sediment standards would probably be violated, principally from urban runoff and construction site runoff. Oil and grease violations may impair the salmon fishery in Campbell Creek. Injury to the salmon fishery from oil and grease violations in Ship Creek are not anticipated, as land use in that basin will remain basically unchanged. (This statement implies that existing oil and grease discharges, of which little is known, have not harmed the fishery in Ship Creek.)

Even given a worst case situation, a salmon fishery would remain in the upper reaches of Campbell Creek, due to the preservation of the Campbell Airstrip area, and in the upper reaches of Ship Creek, due to large undevelopable tracts of military and mountainous land. Under this worst case scenario, the fishery could be expected to be less productive than present, as the lower stream reaches would not provide as suitable habitat for the juveniles because of higher ammonia and oil and grease levels during runoff events. However, severe deterioration of the salmon fishery in this lower stream reaches is not probable.

LEVEL 2

Many of the water pollution controls recommended under Level 2 are similar to those under Level 1, although they may be applied more widely or with more detail. An effective water quality monitoring program, such as the one described for Level 2, is instrumental in quantifying future water quality impacts. However, some qualitative conclusions on future water quality impacts can be advanced.

Level 2 has been devised to maintain current water uses and to attain the fishable/swimmable goal mandated by PL 92-500. The current water quality in area creeks does not always meet proposed standards, yet it accommodates the existing water uses. For example, neither fish propagation nor water-based recreation in Campbell or Ship Creeks is impaired by water quality. Water quality is theoretically insufficient for salmon in Chester Creek but irreversible manmade changes, especially channelization, have had a greater impact. Fish Creek is physically unsuitable for fishing or swimming, so attainment of water quality standards is moot.

Under the Level 2 program, future water quality may still be impaired by additional peat bog development. Because of the tenuous profitability of developing peat bog acreage, it is probable that development of these areas will be slow and piece meal. Consequently, the impacts of peat bog drainage, which are short term, will also be inadvertently phased. Limiting drainage discharges, as much as possible, to periods of high flow (spring and early summer) would greatly offset potential negative impacts. The "bonus point" system is one mechanism that is suggested to provide incentive to developers to schedule drainage of peat bogs during the high flow periods and avoid the salmon spawning season.

Although the Level 2 program endorses the scheduled drainage of peat bogs to mitigate water quality impacts, it should be emphasized that curtailment of peat bog development cannot be economically, socially or environmentally justified from a water quality standpoint. Peat bog development has occurred in the Campbell Creek basin (the greatest potential impact area) for years without a reduction in water uses. If data from the proposed water quality monitoring program indicate that such development is causing serious destruction to indigenous fisheries, more restrictive controls, such as discharge of peat bog drainage to sanitary sewers, may then merit application.

The proposed Level 2 program for storm water detention and erosion control is expected to provide protection of existing water uses. In combination these two controls should easily be capable of reducing future sediment and oil and grease loading by 60 percent. (Sixty percent is the amount of reduction needed to maintain current instream quality based on computer simulated future loadings. The projection is based on changes in future land use.) Due to low pH temperature and high dissolved oxygen in Ship and Campbell Creeks, ammonia toxicity is not anticipated to be a future impediment to fish propagation.

Water quality from septic tanks and other onsite wastewater disposal systems will improve as the existing program is formalized and as planned sanitary sewers are installed in problem areas. In particular, the Comprehensive Sanitary Survey, DHEP House Titles Transfer Approval Program and ongoing inspection program will identify failing systems and reduce pollution from this source. The maintenance program, soil testing, public education, onsite system testing and monitoring, use of dual absorption systems, third onsite inspection and water conservation programs will improve the reliability and useful lifetimes of onsite systems, where applicable. Computerizing data and developing departmental regulations will improve administration of the management programs and allow for rapid data retrieval essential to a management program that encompasses such complexity. In areas where sanitary sewers are installed, the problem of failing septic systems will be obviated, of course.

LEVEL 3

Like the Level 2 plan, this plan is designed to satisfy the fishable/swimmable goal mandated by PL 92-500. In addition, the Level 3 plan is designed to protect the surface waters for drinking supplies. However, it is not certain that even the drastic control measures recommended under Level 3 can improve water quality to the point where it satisfies all proposed standards. Also, while Level 3 is designed to provide water quality in all creeks suitable for contact recreation, secondary recreation, aquatic life, and drinking water supplies, the improved water quality probably would not, and in some cases could not, result in additional water uses.

The plan is envisioned to eliminate urban runoff pollution through extensive structural control. Both storm sewers conveying storm water to Cook Inlet and treatment facilities would be employed. However, even given these draconian measures, it is doubtful the proposed standards could be met. This is especially true for the proposed 20/100 ml fecal coliform standards, which are currently violated at times in the study area by contributions from natural sources outside of the urban area. Proposed heavy metals and sediment standards would also probably be "violated" because of natural or uncontrollable sources such as natural ground water contributions, bank erosion, and natural peat bog drainage. Sources outside the scope of this study are probably also important and would have to be controlled if the proposed standards were ever to be achieved. For example, leakage from sanitary sewers, damaged by earthquakes and other natural phenomena, probably contribute large loadings of fecal coliform to the creeks. If such is the case, it will be documented upon completion of the I/I portion of the MAUS study.

The Level 3 controls for erosion control from construction sites are the same as for Level 2 so no differences in water quality benefit are anticipated. The Level 3 controls for snow disposal sites and onsite wastewater treatment are more intensive, so they potentially would provide greater environmental protection. However, snow disposal sites have not been documented as water quality problems so Level 3 controls may provide no perceivable water quality benefit. Likewise, septic tanks are an implied water quality problem but data do not indicate that choice of Level 3 controls would offer any marked advantage.

It can be stated with reasonable certainty that water quality will be better under Level 3 than under the other two levels. However, even if the Level 3 plan achieves the proposed water quality standards for each use, it is unlikely that any additional uses of the stream would be exercised. For example, Level 3 is designed to provide for drinking water quality; however, all plans call for continued use of ground water and reservoirs upstream of the urban area for drinking water supplies. Similarly, low water and air temperatures and low flows tend to discourage swimming, while channelization and low flows are probably more important than water quality in impairing or eliminating fisheries in Chester Creek and Fish Creek. Therefore, protection of existing uses (Level 2) appears to be a more reasonable water quality goal for this study area than provision of water quality suitable for additional uses (Level 3).

TECHNICAL RELIABILITY

LEVEL 1

Inasmuch as there is no universal requirement for onsite detention in existign regulations, reliability of the current program is not high. In addition, the lack of specific design criteria for detention facilities has been an impediment to system reliability. (It should be noted that the Municipality is presently drafting criteria for onsite detention.) A well-designed sedimentation facility equipped with oil skimming (the facility that would most likely be used given existing policy) will have an overall pollutant removal efficiency of about 50 percent, depending on local soils and the particle sizes of street surface contaminante. However, if the facility is not well operated and maintained, its efficiency is greatly reduced. Given the typical lack of maintenance, the facility can shortly become virtually ineffective for pollution control.

The reliability of land use controls that prevent development in the Campbell Airstrip area and along Campbell and Chester Creeks, as a result of the linear parks, is high. Obviously, the no development situation in the Campbell Airstrip area prevents man-caused pollution and is highly reliable. The linear parks provide an effective "filter strip" along Campbell and Chester Creeks and will generally cleanse runoff that flows directly to it. In some cases storm runoff is discharged to the boggy areas along the creek, where reliable, yet natural and inadvertent, treatment occurs. The effectiveness of the linear park is reduced in areas where storm sewers are routed from adjacent developments directly to the creeks. In the few areas that have storm sewers, a direct route to the creek is generally used. This is more often a problem in Chester than in Campbell Creek.

No data exist on the number of failing onsite systems within the Campbell Creek basin or the Municipality of Anchorage. A study performed in 1975 indicated a failure rate of 50 percent of 4-year-old onsite systems in good soils and 50 percent of 1-year-old systems in barely acceptable soils based on a data base of 75 homeowners. Based on limited soils and geologic information in the Campbell Creek basin, it is estimated that 40 to 70 percent of the 1,500 existing onsite systems are susceptible to failure within a 10-year period after installation. This failure rate is probably applicable to the entire Anchorage area.

Since the publication of that report, it is felt that the number of failures has decreased substantially for new onsite systems. The practice of requiring DHEP approval on loans for homes that have onsite systems is slowly improving the reliability of obviously failed systems and is also decreasing the number of remaining cesspools. Since 1974, the number of valid complaints regarding onsite system failures has been reduced by more than 75 percent (from around 400 to less than 100 per year) in the Municipality. Typically, the number of complaints about failures is much smaller, by a factor of 10, than the number of actual failures.

Presently, there are tentative plans to extend a sanitary sewer up to Hillside Drive area, which would greatly reduce, perhaps by two-thirds, the number of failing septic systems. The feasibility of extending sanitary sewers to outlying areas is the subject of an ongoing study entitled the "Greater Anchorage Sewer Study."

LEVEL 2

The reliability of Level 2 would be higher than Level 1 but not as high as Level 3. It is lower than Level 3 simply because the component programs are more dependent on good management and human judgment.

The reliability of storm water detention facilities for Level 2 would be higher than for Level 1 simply because existing regulations would be amended to include specific design criteria and to require universal application. Therefore, the possibility of a critical area within the basin going uncontrolled would be lessened. Once the controls are in place, their impact on water quality would be dependent upon good operation and maintenance. Since it is recommended that the Municipality be responsible for maintenance, the hazards often encountered when a centralized maintenance program is not provided would be avoided for the most part. The requirement for generally maintaining runoff at predevelopment levels will assure that all systems installed by developers would be effective at reducing pollutant loads from urban runoff.

The reliability of land use controls and other recommended control ordinances depend on the level of enforcement. Given a high degree of enforcement the controls would be technically effective. Since the existing management system is as advanced, there is no reason to assume the proposed modifications would not also be rigourously applied.

Paving of streets and parking lots is a reliable method of reducing sediments. Vacuum streetsweeping can be a reliable method of reducing street (paved) surface contaminants, assuming proper operation maintenance and enforcement of parking ordinances. However, streetsweeping cannot be done during winter or early spring because of snow and ice on the roads.

Implementation of the Level 2 controls, where required, would nearly eliminate the occurrence of onsite system failures and increase the average lifetime of the new systems to 20 years or more. The elimination of most failed systems by the sanitary sewer expansion program (see Level 1 alternatives), the Comprehensive Sanitary Survey, the DHEP House Title Transfer Approval Program and the ongoing inspection program will account for the largest initial decrease in the number of failed systems. The ongoing inspections will act as monitors for additional systems that might fail in the future. The alternatives designed to improve new systems should result in less than 15 percent failures per year if DHEP guidelines are strictly followed and the design criteria are valid. No single alternative is a "cure-all," and the joint improvements of all the alternatives discussed will produce the best results. The Comprehensive Sanitary Survey, maintenance program, soil testing and the use of dual absorption systems are most strongly recommended in areas where installation of sanitary sewers is not planned.

<u>LEVEL 3</u>

The Level 3 alternative for Campbell Creek is based on the installation of interceptor storm sewers along the creek for conveyance of runoff to Cook Inlet. A similar proposal is also suggested for Ship Creek. Obviously this structurally based program would be more reliable for controlling urban runoff than the management-oriented measures suggested for Level 2. The Level 3 option eliminates the problem of uniform application (and regulation) and human error. However, Level 3 would lose its technical reliability if another severe earthquake occurs.

The Level 3 program for onsite waste disposal control is also the most reliable as it involves an organized management and operation program administered by the Municipality as opposed to individual homeowner maintenance required for Levels 1 and 2. This program will avoid the situation where septic tanks are pumped insufficiently or where dual drain fields are not switched on schedule, and it will assure that failures are immediately corrected. Level 1, and to a lesser extent Level 2, allows more room for procrastination in both maintenance and repair of onsite waste disposal systems.

MONETARY COST

LEVEL 1

Maintenance of the existing program would result in no additional costs. This is not to say the present program has no cost, however. A large portion of the current budgets for the Departments of Public Works, Planning, and Parks and Recreation is used for programs which directly and indirectly benefit water quality. The more costly activities include administration of drainage, land use and septic tank controls, acquisition of land for greenbelts, road improvements and maintenance, and snow removal and disposal. These costs are borne by Anchorage area residents through taxation and as a part of housing costs.

LEVEL 2

This alternative would cost more than Level 1 and less than Level 3. Detailed cost estimates have been developed for the Campbell Creek basin for areawide application. These are summarized on Table 7-2, with a detailed discussion presented in Appendix A.

Comparison of Level 1 and Level 2 is difficult because the requirements for existing controls are not fixed. For example, requirement of facilities for drainage and erosion control is now up to the discretion of the Department of Public Works. It is not possible to determine if all new developments would be required under Level 1 to exercise stringent control, or if only a few. Similarly, it is not possible to determine what percentage of current costs for

Table 7-2
Monetary Cost Summary for Campbell Creek Basin

Control	Level 1 Capital ($)	Level 1 O&M ($/yr)	Level 2 Capital ($)	Level 2 O&M ($/yr)	Level 3 Capital ($)	Level 3 O&M ($/yr)
URBAN RUNOFF						
o Storm Water Detention	--	--	$ 3,400,000	$ 170,000	--	--
o Stream Corridor Protection	--	--	$ 6,000,000 but not a 208 responsibility	--	$ 6,000,000 but not a 208 responsibility	--
o Streetsweeping	--	--	--	$ 7,000	--	--
o Control of Untreated Wastewater Discharge	--	--	--	$ 11,700	--	$ 11,700
o Paved Roads and Parking Lots	--	--	$82,000,000 but not a 208 responsibility	$22,300,000 but not a 208 responsibility	--	--
o Land Use Control	--	--	--	--	--	--
o Discharge Diversion of Storm Runoff	--	--	--	--	$ 7,600,000	$ 38,000
o Water Quality Monitoring	--	--	--	$ 45,000	$ 6,000	$ 13,000
SUBTOTAL			$ 3,400,000	$ 233,000	$ 7,606,000	$ 62,700
EROSION AND SEDIMENT CONTROL (1)	--	--	$ 7,500,000	$ 18,750	$ 7,500,000	$ 18,750
SNOW DISPOSAL	--	--	--	$ 20,000	$ 300,000	$ 15,000
ONSITE WASTEWATER DISPOSAL (2)	--	--	$ 1,690,000	$ 71,000	$ 438,000	$ 137,250
TOTAL CAMPBELL CREEK BASIN			$12,590,000	$ 342,750	$15,844,750	$ 233,700

(1) This assumes an average cost of $1,000 an acre for control.

(2) This assumes the worst case situation, assuming no installation of sanitary sewers in problem areas. If sewers are installed in the Hillside area as planned this cost would be much less, possibly 2/3 less than shown.

road improvement, streetsweeping, linear park acquisition and land use controls should be attributed to water quality. However, more control will undoubtedly be exercised with Level 2, at a concomitant increase in cost.

Urban runoff and erosion control costs will increase with a more universal application. However, it would be unfair to say they would increase by the amounts shown on Table 7-2. In fact, a diligent application of current controls by the Municipality could result in a Level 1 cost that approached that of Level 2 for urban runoff control. The most important additional expenditures will be users' costs, as opposed to public agency costs. Users' costs will be incurred in the acquisition of permits and in higher housing costs passed through to the consumer by the developer. Additional agency costs will be incurred for administration, which, when compared to the total cost impact, will be minimal. These can be covered in building permit costs and possibly inspection fees.

Capital costs for snow disposal will not increase with the implementation of Level 2. However, some increase in costs will be incurred because of the expanded water quality monitoring program.

The Level 2 program for onsite wastewater disposal control will be more costly than the current program. As a rough estimate, one additional staff may be required to administer the program. The most expensive element, which is the requirement for dual absorption systems on all new houses serviced by onsite disposal facilities, would be included in new housing costs. This requirement is projected to increase the cost of the average new home by about $1,000. However, this would not apply in areas where installation of sanitary sewers is imminent. At this point it is, therefore, not possible to exactly predict the cost impact.

LEVEL 3

The Level 3 plan has higher capital costs than the Level 2 plan, but lower operation and maintenance costs, as shown on Table 7-2. Specifically, urban runoff controls and snow disposal controls have higher construction costs under Level 2, and onsite wastewater disposal controls have higher operation and maintenance costs. Level 3 costs for urban runoff controls in the test basin, Campbell Creek, were about $7,606,000 for capital and $63,000 for annual operation and maintenance versus $3,400,000 and $233,000, respectively, for Level 2. Achievement of Level 3 urban runoff control is expected to be proportionately as expensive in the remainder of the study area.

As shown on Table 7-2, erosion and sediment control would cost the same for Level 3 as for Level 2, because the Level 2 performance criteria are as strict as needed to control the problem. These costs assume an average cost of $1,000 per acre for control, which may be an overstatement for some areas. The cost of control on relatively flat, well-vegetated areas will probably be minimal, given the low runoff generally experienced in the study area. More stringent criteria are not justified technically or economically.

The Level 3 snow disposal program would require structural controls with a cost of $300,000; the average annual operation and maintenance cost is about $15,000. This compares to no additional capital cost for Level 2.

Capital costs for onsite wastewater disposal costs are less for Level 3 than for Level 2, because it has been assumed that many of the structural improvements required under Level 3 would be financed by the Federal government under Section 201. This funding would, however, only apply to reparation costs for systems built prior to December 1977. However, operation and maintenance costs for onsite systems are anticipated to be greater under Level 3. Eligibility for 201 funding requires an organized operation and maintenance program for onsite systems which is expected to cost more than the voluntary program mentioned under Level 2.

ENVIRONMENTAL IMPACTS

LEVEL 1

The objective of the Level 1 program is, of course, to preserve a high quality environment in the Anchorage area. The achievement of the objective may result in some possibly negative impacts as described below. Overall, Level 1 would result in the lowest construction impact of any of the three alternatives, simply because it involves fewer structural modifications. However, it also provides the least long-term environmental benefit.

Although it is not possible to determine the nature of the storm water detention practices that would be implemented under existing regulations, some generalizations can be made. For example, in areas where detention ponds are built, there would be attendant construction impacts such as the noise and dust created by the movement of large vehicles and the operation of equipment to build the facilities. These would be accompanied by the usual negative visual impacts associated with a construction site. In addition, the ponds would require a long-term and possibly irretrievable commitment of land.

Detention ponds can also be visual eyesores. This impact is proportional to the level of maintenance. A lack of maintenance causes a buildup of sediments and trash in the basin and results in poor system efficiency. Likewise, ponded stagnant water in the bottom of the basin can result in odor and mosquito problems. Deep ponds can be a hazard to local children when full of water.

Level 1 land use controls generally have beneficial environmental impacts. The existing stream corridor protection program is environmentally beneficial. The linear parks along Campbell and Chester Creeks afford recreational opportunity and habitats for small mammals and birdlife. In addition, land use controls that prohibit development in flood plain areas can result in protection of private property and lives. The environmental impact of the existing "bonus point system" is beneficial as it presents the opportunity for more innovative and attractive development in the Anchorage area. The only problem is that application is restricted to the central business district. The only projected land use change that is environmentally deleterious is the planned development of peat bogs. Although loss of these areas to urbanization involves mostly water quality impacts, some adverse impacts on wildlife can be expected due to habitat reduction.

Streetsweeping is considered to have a beneficial impact because it improves urban aesthetics and the general level of public health, and reduces particulate air pollution by removing debris from the urban area. The only environmental disadvantage of streetsweeping is that the operation of the machines can result in road hazards and increase vehicular accidents. This disadvantage is typical of all streetsweeping operations and is not unique to Anchorage.

Existing Subdivision Regulations, which require paving of streets in future subdivisions, are viewed as environmentally beneficial. Paving of streets reduces dust and the air pollution problems it causes, and it enhances urban aesthetics. However, paving of roads also involves commitment of additional scarce resources, such as petroleum products, gravel, fill and concrete. These materials are then not available for other uses. Given the severe shortage of gravel and fill material in the Anchorage area, this impact is not insignificant.

Existing Wastewater Disposal Regulations do not, in themselves, have an environmental impact. Their effect is primarily on water quality. Controlling discharges of untreated wastewater also prevents public health and odor problems and enhances local aesthetics.

LEVEL 2

Level 2 would have a greater construction impact than Level 1, but would also have more long-term environmental advantages.

The universal requirement for storm water detention may result in more detention facilities than would be found under the Level 1 condition. The impacts of these facilities would be the same as described under Level 1 only greater as a result of more facilities.

The universal requirement for detention may have a strongly beneficial impact on the hydrology of Campbell Creek. First of all, detention will reduce peak flows and, therefore, decrease the potential for stream bank erosion. Second, detention will promote recharge to the badly depleted ground water aquifers. This additional recharge will help sustain low, dry-weather flows in Campbell Creek and preserve aquatic habitat.

The impact of Level 2 streetsweeping, control of untreated waste discharges and requirement for paved roads and parking lots would be, for all practical purposes, analogous to those mentioned under Level 1. The establishment of additional linear parks would have a beneficial impact--more recreational opportunity, wildlife habitat and improved urban aesthetics. However, these expansions would probably occur regardless of 208 planning efforts.

The Level 2 requirement for increased environmental design and the application of the "bonus point system" in areas outside the central business district should result in more innovative and aesthetically pleasing developments in the suburban areas. The combination of these controls with the requirement for storm water detention was suggested to promote more innovative site planning and encourage the use of planned unit development.

The Level 2 policy which discourages, where practical, the use of storm sewers for urban drainage could result in the inconveniences associated with temporary local flooding. If the recommended grass-lined ditches and swales are not well maintained, adverse visual conditions and mosquito problems could follow. These impacts must be compared against the benefit to water quality.

Like the Level 1 controls, the proposed onsite wastewater disposal program for Level 2 would be in ordinance form, and as such would have no environmental impact. Its effect, however, would have beneficial impacts on water quality, and it would help protect public health by reducing the potential for human exposure to untreated sewage. In areas where sanitary sewers were installed, some disruption would be caused during construction. These impacts would be offset by removing the water quality problems associated with failed septic systems.

The proposed Level 2 erosion control and snow disposal alternatives have no foreseeable adverse environmental impacts. Erosion control for new developments will reduce streetsweeping problems, result in improved urban aesthetics, and will reduce storm sewer maintenance costs. Adoption of the site selection criteria for future snow disposal will help assure that the most environmentally sound areas are used for this purpose.

LEVEL 3

Because of the amount of construction required to build the necessary facilities for attainment of Level 3 goals, this alternative would certainly have the greatest environmental impact.

Construction of the storm sewer interceptor along Campbell Creek and Little Campbell Creek would result in the greatest construction impact of any of the three presented alternatives. If a similar pipeline(s) were constructed along Ship Creek, somewhat analogous impacts could be expected. Although the pipeline would be routed to mitigate environmental impacts, temporary damage would be done to vegetation and private property along the route. The installation would require a 50-foot construction right-of-way. In areas where room for construction activities is limited, a 25-foot right-of-way would probably be sufficient. The most significant impacts of the man-made environment would occur from Lake Otis Parkway to just east of Seward Highway, as a majority of this area is already developed. Installation of the pipeline would require tearing up local roadways and cause traffic congestion and inconvenience. Noise and dust would be especially significant problems in this area. The greatest impact would occur just east of Lake Otis Parkway, where the pipeline would traverse a high density residential area. The installation process would impact primarily industrial uses near Seward Highway. Likewise, the installation of the pipeline along Little Campbell Creek would result in similar impacts on industrial land uses located from Lake Otis Parkway east to Old Seward Highway.

The remainder of the construction impact would occur on the natural environment where the pipeline would pass through lowland forest and peat bog areas. The most significant impact would be destruction of natural vegetation in the pipeline corridor. Although the vegetation would eventually be reestablished, a scar would be evident for many years after the installation. Because the pipeline would be located near the two creeks, high ground water would be a problem and require the dewatering of pipe trenches. Although proper disposal of trench water is anticipated, either in temporary sedimentation basins or by discharge to proximate vegetation, the opportunity for short-term increases in instream turbidity from erosion is present.

Provision of the storm sewer interceptor would also result in necessary stream crossings for connection to individual storm water collection systems. All inwater work for such connections should be done between the 15th of May and the 1st of July to avoid conflicts with salmon spawning. However, increases in turbidity would occur during installation. To minimize impacts it would be necessary to immediately replace natural vegetation, both to control erosion and to minimize the impact of solar radiation on water temperatures.

An interceptor sewer system which discharges to Cook Inlet will strongly change the hydrology of Campbell Creek. Peak flows in summer will be greatly reduced, thereby decreasing the potential for stream bank erosion and increasing deposition of sediment in the lower reaches. Also, the combination of urbanization and piping of storm water directly to the Inlet will decrease ground water recharge and, therefore, decrease dry-weather flows in Campbell Creek.

The impact of the Level 3 program for controlling erosion from construction sites would be analogous to Level 2, as the recommendations are the same.

The Level 3 snow disposal site recommendations would have a much greater impact than the counterpart for Levels 1 and 2. Development of the structural facilities to renovate existing sites would involve earthwork and removal of vegetation not required for Levels 1 and 2. However, the physical requirements for future sites would be the same for Levels 2 and 3, as new locations would be based on the same site selection criteria.

The majority of the impacts associated with the Level 3 onsite waste disposal management program relate to water quality, or are discussed under the section on "Socioeconomic Impacts."

SOCIOECONOMIC IMPACTS

LEVEL 1

The existing program has some practices which influence water quality and which require construction operation and maintenance, or administration. These activities will result in costs to the Municipality and others. However, continuation of the existing program should not significantly alter the level of economic impact currently being experienced.

Maintenance of the existing program could, theoretically, contravene existing policy which calls for maintaining existing high quality water in the Anchorage area. Although the existing program is much more advanced and more effective than many in the country, its operation is anticipated to result in a general lowering of water quality as the Anchorage area urbanizes. This impact would be more notable in the Campbell Creek basin.

Continuation of existing onsite wastewater disposal controls would eventually result in improved conditions. Many of these problems would be removed with installation of sanitary sewers as planned. During the interim, however, older systems that have failed may cause potential health problems. Pollution of private wells and the opportunity for the direct contact of humans with untreated wastewater are possibilities.

It should be noted that continuation of the existing program is not anticipated to result in a lowering of water quality severe enough to cause significant health problems. But the use of urban streams (Campbell, Ship, Chester and Fish Creeks) for contact recreation would not be recommended in the future.

Although it is anticipated that the existing salmon fishery in Campbell Creek would be reduced given continuation of existing controls, this reduction would result in no measurable economic loss to commercial fishermen. Some impairment of the salmon fishery may also occur in Ship Creek, although probably less than that in Campbell Creek. It is important to note that salmon runs in Ship Creek have apparently increased, as discussed earlier.

LEVEL 2

In general, Level 2 would have a lower socioeconomic impact than Level 3 simply because it has a lower implementation cost. Conversely, Level 2 will have a higher impact than the status quo, Level 1.

The cost of providing detention of storm water will undoubtedly be passed on to the homebuyer. Given that the existing drainage control program has evolved (during the 208 studies) to what is essentially the same program as required for Level 2, little additional economic impact can be attributed to the implementation of the Level 2 onsite detention requirement.

Administration of the recommended land use controls should not result in additional public costs. The formulation for these controls is already in place. Implementation will be handled by existing staff.

Although only indirectly related to 208 planning, paving of existing dirt roads and parking lots involves enormous capital and maintenance investments. Retroactively requiring these improvements would have deleterious impacts on the cost of doing business and would increase the taxes of residents within all of the required road improvement districts. The impact of paving roads and parking lots would occur under Level 2 but not Level 3, because these improvements are not required (from a water quality standpoint) for Level 3, as all runoff would be piped to Cook Inlet.

Although variable on a site by site basis, the cost of erosion control from construction sites is generally around $1,000 to $1,200 per acre. Assuming an average lot size of 1/4 acre, this represents an additional $250 to $300 per new home. This cost is somewhat affected by the savings realized by reduced streetsweeping and storm sewer maintenance costs. These savings could be transferred to people through lower taxes.

Adoption of the Level 2 site selection criteria will result in use of more acceptable areas for future snow disposal. New sites will probably have fewer socioeconomic impacts related to loss in property values, noise, traffic congestion, trash, and dust. However, the problems resulting from existing sites, principally noise and aesthetics, will not be abated.

The Level 2 onsite waste disposal control program is anticipated to cost more than Level 1. With the exception of the requirement of a dual soil absorption system, the recommended controls are primarily oriented toward consumer protection. These controls will undoubtedly increase developer costs and, consequently, the cost of housing, but they are considered to impose no significant economic impact when the benefits to private wells and public health are taken into consideration. The cost of requiring a dual soils absorption system, which is about an additional $1,000, will generally result in a 1-1/2 percent increase in the average cost of housing.

LEVEL 3

Development of the Level 3 structural costs would most probably have a greater socioeconomic impact than either Levels 1 or 2. Embarking on such a capital intensive program, given a general lack of data, is difficult to justify. That is, a substantial public investment could be undertaken under Level 3 without a clear understanding of the benefits. If unnecessary investment was made, the socioeconomic impact would be adverse.

The Level 3 erosion control recommendations are the same as those for Level 2, so the impacts are analogous. Conversely, the Level 3 snow disposal recommendations would increase the current cost for this service. The cost impact would not be substantial when compared to the Level 3 urban runoff control program, but nevertheless, it would result in additional public expenditures. Inasmuch as current snow disposal operations are not documented water quality problems, additional costs appear unjustified.

The Level 3 program recommended for control of onsite waste disposal systems is considered to have a lower socioeconomic impact than the program recommended for Level 2 because of the 75 percent Federal funding available under PL 92-500. Although capital costs for homeowners with malfunctioning septic tanks built prior to 1977 would be lower, it is anticipated that operational costs for all onsite system owners would be somewhat increased. Because organized public operation would be required, it is anticipated that administrative costs would increase as would the frequency of maintenance, which under the current situation is up to the individual homeowner and typically less frequent.

IMPLEMENTABILITY

LEVEL 1

The existing program has obviously been implemented. However, the long-term implementability of Level 1 is doubtful because Federal regulations (PL 92-500) call for fishable/swimmable waters where attainable by 1983. More importantly, State as well as Federal regulations have an "anti-degradation" clause which means water quality is nowhere allowed to degrade below current conditions. If government regulations are not fulfilled, Federal assistance programs will be eliminated and fines levied.

LEVEL 2

The Municipality of Anchorage has the legal, financial, geographic and management authority to carry out all of the controls recommended for Level 2.

The proposed storm water detention and environmental design requirements could be accomplished simply by modifying existing Subdivision Regulations and Standards for Special Exceptions. These ordinances would continue to be administered by the Departments of Public Works and Planning.

The controls recommended for "stream corridor protection" could also be easily incorporated into existing ordinances. At the recommendation of the Planning and Zoning Commission, existing flood plain regulations could easily be modified to (1) restrict the stockpiling for storage of petroleum or other hazardous products within 100 feet of any water course, (2) require all water work to be done between the 15th of May and the 1st of July to avoid conflicts with salmon spawning, (3) require all planned road crossings to be accomplished by bridge and (4) control any water appropriation that could have an impact on water quality. Planning and administration of new linear parks is under the jurisdiction of the Municipality of Anchorage Parks and Recreation Department.

Existing Subdivision Regulations presently have a clause which pertains to erosion control from construction activities. Implementation of the performance criteria developed for the 208 plan should, therefore, pose no institutional problems.

The Level 2 snow disposal site criteria recommendations can be implemented by the Municipality of Anchorage through modification of existing land use controls.

The onsite wastewater disposal controls recommended for Level 2 could readily be managed by the Department of Health and Environmental Protection. Enforcement of these recommendations would require modification of Chapter 15-65, Wastewater Disposal Regulations.

LEVEL 3

The Municipality of Anchorage also has the authority to implement all of the controls recommended for Level 3. Implementation of Level 3 would require fewer modifications of existing regulations than Level 2. This is because the requirements for storm water detention, streetsweeping, paving of roads and parking lots, and land use controls for protection of peat bogs would not be required. The implementation requirements for stream corridor protection would be analogous to those mentioned in Level 2.

The implementability of Level 3 centers around the environmental impact of the proposed interceptor storm sewer. As mentioned earlier, the construction impact of the proposed facility would be significant in several areas. Consequently, heavy resistance from private landowners and special interest groups should be anticipated. It is possible that an active public relations program sponsored by the Municipality could alleviate possible resistance by presenting the long-term environmental benefits associated with the proposed facility.

The proposed onsite waste disposal controls for Level 3 are technically implementable. The Municipality has the legal and financial authority to administer an EPA 201 Facilities Plan for onsite waste disposal systems. Conversely, the implication of this program may be publicly unacceptable due to increased Federal control. However, this may be offset by the reduced costs realized by the 75 percent Federal funding.

The development of a septic suitability map for the Anchorage metropolitan area would have to be coordinated through several municipal departments and possible State agencies. This is not anticipated to present implementation problems. It is also anticipated that the map could be financed through 208 continuing planning funding. Technical improvements for soils testing could be readily implemented by modifications of existing Wastewater Disposal Regulations.

PUBLIC ACCEPTABILITY

LEVEL 1

The existing program is obviously publicly acceptable. For this reason, Levels 2 and 3 have been molded around the existing program. However, because the intensities of the two higher levels vary as do the economic costs and levels of freedom, differences in public acceptability are anticipated.

LEVEL 2

Level 2 was obviously more acceptable than Level 3 when presented to the public and special interest groups. The people in Anchorage were found to have a strong commitment to preserving water quality, as is evident from the advanced planning controls that have been implemented. It is apparent that modifications to the existing program are also acceptable. This should be evident from review of the citizen participation summary report.

LEVEL 3

This program, especially the urban runoff control aspects, is generally not acceptable because of high cost and environmental impact. The primary concern is that existing water uses and data base cannot justify the required expenditure. Added to this is the uncertainty about the technical capability of Level 3 control to meet the proposed state standards. In fact, it is possible that no technology is available to meet the proposed standards. The environmental impact of installed parallel interceptor storm sewers and treatment facilities is obviously greater than the Level 2 program requirements.

CONCLUSIONS

The results of the preceding evaluation are summarized on Table 7-3. The conclusion from the analysis appears fairly straightforward: Level 2 is the best solution. Level 1 cannot be justified because it is not acceptable to the Federal government. Level 3 is not satisfactory because it would involve spending money for unwanted and unneeded water uses, which also may not be technically attainable even assuming the most thorough structural control. Conclusions for each of the seven evaluation criteria are presented below:

1. Level 3 would result in the greatest removal of pollutants from area streams. However, this may be for naught as water uses are not expected to change and, even given the extreme structural measures suggested, attainment of proposed State standards may not be possible. This situation is especially true for the proposed fecal coliform and sediment standards, and certain proposed heavy metals standards.

2. Level 3 would have higher technical reliability than Levels 1 or 2 because structural controls usually have a higher reliability than the management controls called for in Level 2. Level 1 would have the lowest reliability because the requirement for controls is based on discretion of the Municipality in many cases, rather than uniform application.

3. The analysis indicates that Level 3 would be the most costly, followed respectively by Levels 2 and 1.

4. Level 3 would have the severest adverse environmental impact because of the amount of construction required. Level 2 would have the second highest and Level 1 the least.

5. Social and economic impacts are related primarily to cost, so Level 3 would have the most unfavorable impact. Of course, the amount people are willing to pay for water quality improvements is variable. What is important, though, is the fact that additional tax dollars may be spent without an increase in water uses. In this sense, Level 2 not only would have a lower dollar impact, but also presents a lesser risk of wasteful expenditure of tax monies. Under Level 1, socioeconomic impact would remain at status quo.

Table 7-3
Summary Evaluation[1]

	Level 1	Level 2	Level 3
o Water Quality Impact	3	2	1
o Technical Reliability	3	2	1
o Monetary Cost	1	2	3
o Environmental Impact	1	2	3
o Social and Economic Impact	1	2	3
o Implementability	3	1	2
o Public Acceptability	1	2	3

(1) Ranking 1, 2, and 3 where Number 1 is the most beneficial, or favorable.

6. Level 2 would be the most implementable, as it represents an intermediate approach. Level 1, the current program, would probably be the most favored locally, but the need to comply with the PL 92-500 criteria of "fishable/swimmable" waters by 1983, as well as State requirements, would make long-term implementation legally impossible. Level 3 is too expensive, and the benefits too cloudy, for it to be adopted locally.

7. Level 3 is publicly unacceptable due to cost and environmental impact. In general, large expenditures of funds to provide unwanted uses are not acceptable in Anchorage.

Chapter 8
RECOMMENDED PLAN

The creeks and lakes in the Anchorage area are valuable recreational resources. They attract Anchorage residents and visitors who want to fish, boat, float, or just enjoy the park areas lining their banks and shores. These recreational uses can be impaired or even eliminated by poor water quality.

Current water quality, although it violates some of the existing and proposed standards, appears to support the existing recreational uses in the creeks and lakes. Through the process described in Chapters 6 and 7, a water quality management plan (termed Level 2) has been developed to maintain current water quality and uses. This proposed plan, summarized in this chapter, is divided into four subplans, one for each of the four types of pollution considered to be a threat to water quality in the Anchorage area:

- Urban runoff.
- Erosion primarily from construction sites
- Runoff and percolation from snow disposal sites
- Failures of onsite wastewater disposal systems.

Water quality modeling has predicted that these four pollutant sources will degrade water quality by less then 10 percent in Chester Creek over the next couple of decades. The situation is expected to be similar in Ship Creek and Fish Creek, because of similar development patterns. In contrast, water quality in Campbell Creek is expected to degrade significantly because of rapid urbanization there; the degradation may impair or eliminate some of the valuable recreational uses in and along Campbell Creek. Thus, the emphasis of the subplans is on maintenance of water quality and water uses in Campbell Creek.

Most of the elements of the subplans will be administered by the Municipality through stronger, more explicit ordinances. Because of this institutional arrangement, the elements of the subplans, although designed to maintain water quality in Campbell Creek, will also be capable of maintaining or improving the quality of other waters within the Municipality's jurisdiction. In this sense, then, the water quality management plan applies as much to Chester Creek, or Ship Creek, or Fish Creek, as to Campbell Creek.

URBAN RUNOFF

The water quality in Campbell Creek and Chester Creek was found to degrade as the creeks passed into and through the urban and urbanizing areas. Urban runoff was identified as a possible source of pollution contributing to this degradation. Runoff from roads, parking lots, and other impervious areas appeared to carry enough sediment, heavy metals, and fecal coliform to cause violations of the water quality criteria in the two creeks. Although water quality data were too sparse in Ship Creek and Fish Creek to confidently document water pollution or identfy sources, urban runoff was expected to cause similar water quality degradation in these creeks.

Urban runoff control studies have been conducted, to varying detail, for all the major drainage basins in the Anchorage area. The most detailed studies were conducted in Campbell Creek, a developing basin just south of downtown Anchorage. The emphasis was to develop a battery of generic preventive controls to be applied there and in other developing areas within the Municipality. The objective being to minimize pollution from new development and to maintain the high quality environment presently enjoyed by Anchorage residents.

The Chester Creek basin received the second highest consideration. The purpose of this analysis was to complement the Campbell Creek basin study to determine whether the controls found applicable for developing areas also applied to more urbanized basins. Ship Creek, Fish Creek, Lakes Hood and Spenard, and Knik Arm received only cursory analysis as called for in the Municipality of Anchorage work plan. They will be studied in more detail in later analyses.

CAMPBELL CREEK

The urban runoff program developed for this basin consists of the following eight components:

- Storm water detention
- Stream corridor protection
- Streetsweeping
- Control of untreated wastewater discharges
- Paved roads and parking lots
- Land use controls
- Discharge/diversion of storm runoff
- Water quality monitoring

The purposes of these components are to control pollutants at the source or to control them as they are being transported toward the creek. Some of the controls are intended to be applied only in developing areas; these controls include storm water detention, stream corridor protection, land use controls, and discharge/diversion of storm runoff. To apply them in already developed areas appears to be excessively expensive and cause excessive social impacts. The other components can be applied effectively in urbanized or urbanizing areas.

All of the eight components which constitute the urban runoff program for Campbell Creek basin are extensions or formalizations of programs and policies currently in effect in the basin. The extensions or formalizations appear necessary to maintain the high water quality in Campbell Creek.

Storm Water Detention

One purpose here is to trap sediment and allow it to settle out before entry into a stream or lake. A second purpose is to reduce peak runoff, and thus the amount of sediment that can be washed to natural waters. Since many other pollutants adhere to sediment, its reduction is one of the most effective strategies for protecting water quality.

Existing Subdivision Regulations, Standards for Special Exceptions and Design Criteria and Improvement Standards give the Municipality power to require adequate drainage facilities that can provide for protection of environmental quality. Each development is reviewed on a case by case basis and controls are recommended.

In past applications the primary emphasis was placed on getting rid of storm water for drainage with little or no emphasis on detention and water quality protection. More recently, however, after increased recognition of the need for controlling nonpoint sources of pollution the Municipality has been placing a strong emphasis on storm water detention. In several cases both detention ponds and oil removal facilities have been required. The current trend is to preplan for proper drainage facilities and detention on a large scale, with developers paying their proportionate share of the costs encountered. This has been evidenced to a significant degree in the Campbell Creek basin.

Recommendation. The foresight of the Department of Public Works' staff is the principal reason that storm water controls, such as detention, are receiving emphasis. Although existing controls allow for environmental and water quality considerations the degree to which these controls are applied is now up to individual interpretation. A change of staff could result in a program with a minimal emphasis on water quality protection. Therefore, it is recommended that existing design criteria be amended to include more emphasis on storm water detention and water quality protection. This would provide guidance and policy objectives in case of a change in staff.

Controls could include sedimentation-type detention ponds, infiltration ponds, dry-wells, multiuse areas and the like. The objective would be to assure that storm water was detained either onsite, along the line, or at the outfall, for a time sufficient to remove about 60 percent of the sediment load. It is important that controls be flexible so redundancies do not occur. For example, if provisions for control are made onsite, the same storm water should not again receive treatment at the point of discharge.

Analyses done by the U.S. Army Corps of Engineers found that 50 to 60 percent of the fine sediment found in the Anchorage area settles out in 1 hour using a standard column test. Therefore, a detention time of 2 hours should be sufficient to routinely achieve the 60 percent reduction defined for Level 2 under "Plan Strategies" in Chapter 6. (The 60 percent reduction was determined through analysis of computer simulated load productions from future land use. It was determined that maintenance of current water quality would require this degree of removal.)

Stream Corridor Protection

The existing linear park system described in Chapter 3 and sponsored by the Department of Parks and Recreation, the Standards for Planned Unit Development, and the Subdivision Regulations and Flood Plain Regulations, generally assures stream corridor protection. Open space adjacent to streams and lakes provides a filter for surface runoff, protects the water from siltation and helps maintain cool water temperature by preserving overhanging vegetation. The Department of Parks and Recreation has also proposed a development plan for the Campbell Creek linear park which includes a program for bank stabilization and revegetation for erosion control.

Recommendations. This program calls for continuation of the present stream corridor protection program with the following additions:

- Restrict the stockpiling or storage of petroleum and other hazardous products within 100 feet of any water course to avoid the deleterious impact of spills.

- All inwater construction work should be discouraged. That which is unavoidable should be conducted between 15 May and 1 July to avoid conflict with spawning salmon. Disturbed stream banks should be returned to a slope no greater than two horizontal to one vertical with replacement of natural vegetation.

- Any planned road crossing in the vicinity of salmon spawning areas should be accomplished by bridge wherever possible.

- Any water appropriation project should include 3/16-inch mesh screens on suction pumps to prevent entry of young salmon. In no cases should barriers that impair salmon migration be placed across the stream.

- Flood Plain Regulations should be amended so the acquisition of a special flood hazard permit would not be approved for any activities causing water quality degradation or other environmental hazards.

- Additions to the Little Campbell Creek linear park system should be implemented. The minimum width of the park should be 50 feet on either side of the creek.

Streetsweeping

Chapter 3 presents a detailed overview of the current streetsweeping program. The streetsweeping program is adequate for its intended purpose--urban aesthetics. Because so many of the Campbell Creek basin's streets either have no curb and gutter or are unpaved, this control cannot be justified solely for water quality improvement. As an additional consideration, the use of onsite detention facilities (mentioned above) somewhat negates the need for additional streetsweeping, as sediments from street surfaces will be trapped in the ponds.

Recommendation. Existing streetsweeping programs are certainly a benefit to water quality (especially the spring cleanup program) and are endorsed by the 208 Plan. The following recommendations have been made to supplement the existing program:

- Better enforcement of the existing parking ordinance.

- Better enforcement of litter ordinances to prevent the raking of yard debris to the gutter.

Control of Untreated Wastewater Discharges

No point source discharges have been documented or authorized in Campbell Creek. The absence of point sources is one major reason why the creek's water quality is so high. The purpose of this control is to assure that no point sources are discharged to Campbell Creek in the future.

Control of discharges of untreated wastewater and other pollutants to streams, lakes, streets, sidewalks, etc., is provided by Wastewater Disposal Regulations, Section 15.65.020, Prohibited Wastewater Discharges and Practices. Existing regulations have no provision prohibiting the discharge of point sources to area creeks.

Recommendations. Existing Wastewater Disposal Regulations should be modified to prohibit discharge of any point source, whether it be a sewage treatment plant outfall, industrial discharge, etc., to fresh water streams and lakes in the Anchorage area. Likewise, washing of trucks, facilities and other machinery, such that discharges of the wastewater to fresh water is inevitable, should be prohibited.

Prohibition of stream discharge will encourage discharges to Cook Inlet where the dilution capacity is extensive. The ability to discharge wastewater without injurious effects is a resource opportunity which should not be overlooked.

Storm water discharges to the Creek and area lakes should be considered on a case-by-case basis. The overall intent being to reduce, by as much as possible, the impact of storm sewer discharges. This regulation should be supported by the program for storm water detention previously mentioned. In general major storm sewers should not discharge to the Creek without abatement, usually a form of storm water detention. However, the type of abatement could be at the source, along the line, or at the point of discharge. In some cases the incorporation of design features in storm drainage facilities may eliminate the need for treatment at the outfall. The overall objective would be to assure that 60 percent of the sediment load, on an overall basis, was retained prior to entry to fresh water fisheries, such as Campbell Creek, and area lakes.

This control would be administered on a commonsense basis. It would be especially directed toward storm sewer outfalls draining basins larger than 40 acres. Drainage basins smaller than 40 acres with outfalls 12 inches or larger would also be subject to control, but reviewed on a case-by-case basis. To be realistic, the control would not be directed at the single homesite but rather on a basin-wide basis, with major new developments as the primary focus. Likewise, the ordinance should be written with an exemption clause to avoid redundant and/or unnecessary control.

Paved Roads and Parking Lots

The paving of roads would reduce the sediment loading to the urban runoff treatment facilities recommended earlier. The relationship between road condition and levels of urban runoff pollution has been thoroughly studied. It has been concluded that paved streets in poor condition generate total solids loadings 2-1/2 times as great as streets in good to excellent condition. Obviously, dirt streets contribute even heavier loadings. Consequently, paving of streets and parking lots should be encouraged to improve the operating effectiveness of storm water conveyance and treatment facilities. Maintenance costs of storm sewers and treatment facilities would also be lessened, though not by enough to defray the cost of road paving. Obviously, benefits such as urban aesthetics and dust control in addition to water quality must be considered in the decision to pave dirt roads. The cost of paving dirt roads cannot be justified solely for water quality improvement.

Municipality of Anchorage Subdivision Regulations require all new developments in the urban and suburban portions of the City to have paved streets. There is no provision for paved parking lots, however. Areas with unpaved roads (approximately 50 percent in the Campbell Creek basin) are not legally required to pave their roads but can finance improvements through formation of road improvements districts.

Recommendations. This plan calls for the continuation of existing practices with the following additions:

- The Municipality should strongly encourage the paving and maintenance of all parking lots in urban and suburban areas. Potholes should be repaired on a yearly basis and surfaces sealed as required to prevent the escape of sediments.

- The Municipality should strongly encourage paving of all dirt roads in urban and suburban areas through use of street improvement districts.

Land Use Controls

As discussed in Chapter 3 three land use controls affect water quality in the Campbell Creek basin--(1) the Comprehensive Plan, (2) Zoning Ordinance and (3) Subdivision Regulations.

Land use planning in the Campbell Creek basin, reported in the Comprehensive Plan and other planning documents published by the Municipality's Planning Department, has fostered high instream water quality by calling for park land along Campbell and Little Campbell Creeks, large lot zoning in the upper reaches of Little Campbell Creek, and by designating park land in the area of confluence between the North and South Forks of Campbell Creek. It should also be noted that the upper reaches of the Campbell Creek stream system will be protected from development due to the recent acquisition by the Municipality of the Campbell Air Strip Reserve land from the Federal Govenment. This land has been dedicated as a park and is therefore protected from development. The impact of preserving the upper reaches of Campbell Creek is very beneficial as this area is used by salmon for spawning.

Existing Subdivision Regulations call for "environmental design", stating that lots should be designed to minimize environmental impact. Although no criteria are recommended, this policy sets the stage for requiring developers to build projects which respond to water quality needs.

Recommendations. It is recommended that existing land use policy, planning and control be continued by the same implementing agencies with the following additions:

- The Comprehensive Development Plan calls for preservation of high quality wetlands and marshes as open space. Presently, peat bogs and marshy areas that drain to Campbell Creek and Little Campbell Creek do not fall into the Plan's classification for preservation as open space.

  Because of the shortage of land in Anchorage and high land costs, designation of all areas covered by peat, as open space would be unrealistic. Maps depicting peat bog areas are being developed as part of the ongoing Coastal Zone Management Plan. Peat bogs in the Campbell Creek basin are shown on Figure 8-1. It is recommended that these areas be given priority consideration in future open space acquisition plans. Because of the high cost of development, certain peat bog areas may have marginal investment value, so acquisition may be more reasonable in selected cases. This should be investigated further in both the 208 Continuing Planning Program and the Coastal Zone Management Plan.

  Secondly, developers should be encouraged to drain peat bogs in a manner which is least injurious to area streams. This should be investigated on a case by case basis. When possible, surface drainage discharges should occur during high stream flow when dilution ratios are favorable. Land application or discharge to infiltration areas should also be given preference to direct stream discharge during

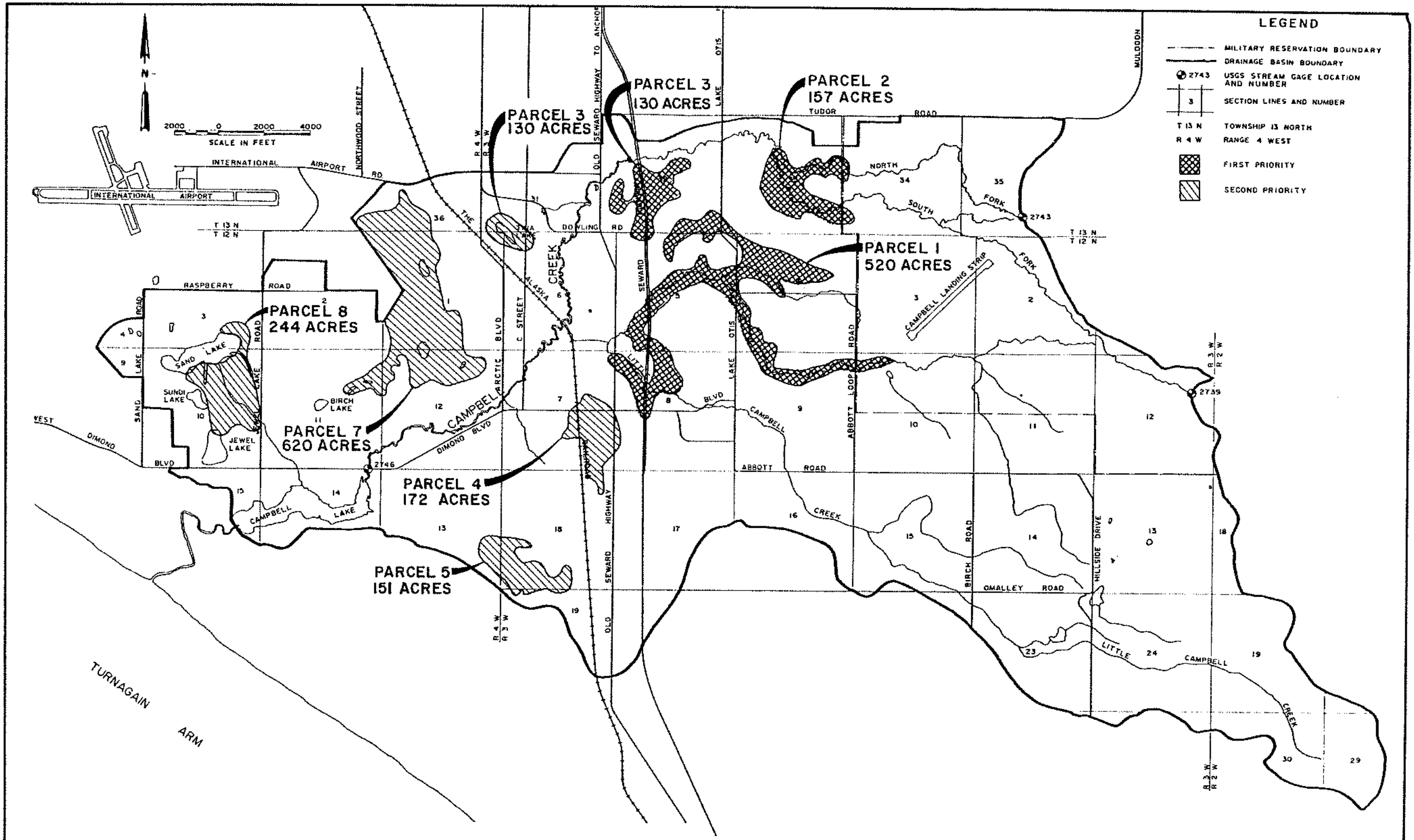

FIGURE 8-1
PROTECTION OF PEAT BOGS

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low flow periods. If discharge to a sanitary sewer, or a storm sewer which discharges to Cook Inlet, is practical, it should be considered. Drainage to known salmon spawning areas should be avoided through any of the measures mentioned above. The program for environmentally sound peat bog development should be tied in with the "bonus point" system discussed further below.

- It is recommended that the "bonus point" system in the Zoning Ordinance be expanded to developments outside of the central business district and be used as an implementation tool for the "environmental design" called for in existing Subdivision Regulations. Developers should be allowed to increase the intensity of land use by providing amenities that enhance water quality. The concept of onsite detention (so that peak runoff approximates predevelopment levels) should be especially encouraged, as reducing the volume of runoff will reduce the size and improve the efficiency of the storm water treatment facilities recommended earlier. Development of retention ponds and other methods that avoid drainage to creeks and lakes in peat bog areas should be strongly encouraged. The bonus point system in peat bog areas is especially critical, as it is not only important to water quality, but it also will help developers defray the high cost of water quality protection.

  The methods used to reduce runoff should be up to the discretion of the developer to foster creativity and cost effectiveness. Examples include open space for infiltration, grading to reduce runoff, permanent retention ponds, underground storage, parking lot and rooftop detention, etc.

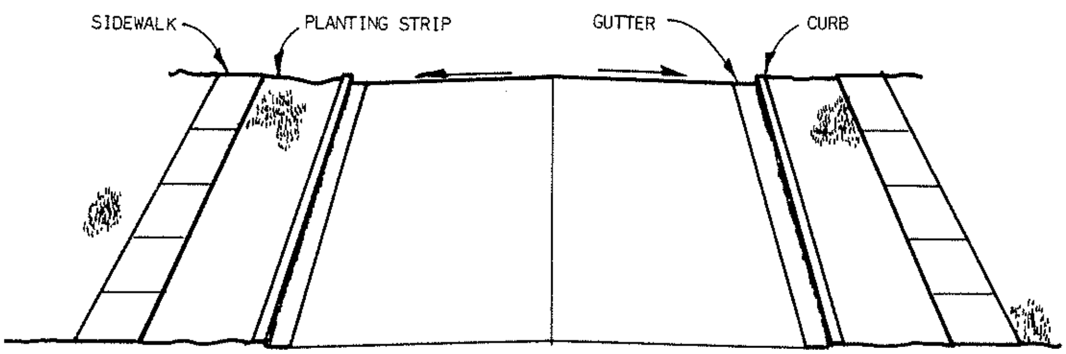
Discharge/Diversion of Storm Runoff

Presently, most of the Campbell Creek basin is without storm sewers. Instead, storm drainage is provided by grass swales and roadside ditches as shown on Figure 8-2. This same practice is also found in most of the low density developments in the urban study area. By contrast, the central business district in the Ship Creek Basin and the surrounding developments have storm sewerage facilities.

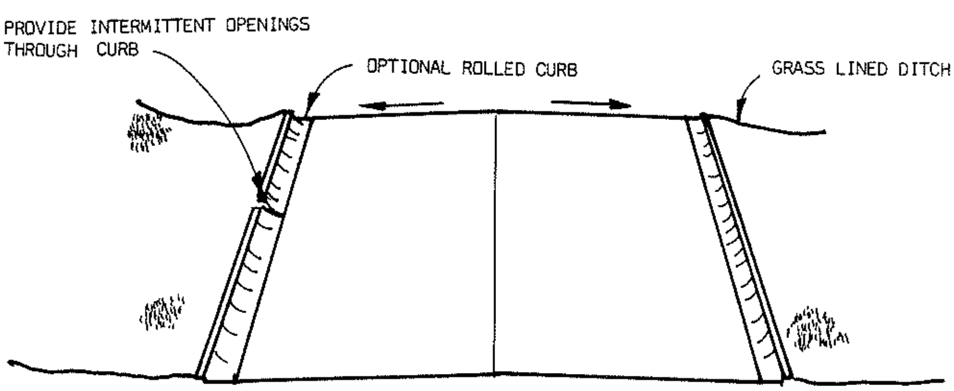
Recommendations. In many areas in Anchorage storm sewers equipped with provisions for deicing are the only viable alternative. Use of open channels and ditches can result in glaciation, a process where freezing restricts subsequent flows, causing impoundment of water and flooding. However,

FIGURE 8-2

TYPICAL GRASS-LINED DITCH
FOR CONTROL OF URBAN RUNOFF



TYPICAL CENTER CROWN STREET WITH CURB & GUTTER



CENTER CROWN STREET WITH ROLLED CURB & SWALE

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use of swales and open ditches is practiced widely without flooding problems. In fact, this is the rule rather than the exception in the Campbell Creek basin.

Since swales and ditches promote infiltration and, when compared to storm sewers, reduce peak runoff, continuation of this practice is strongly recommended where practical. Areas serviced by swales and ditches without severe drainage problems should not be provided with storm sewers and new developments should utilize swales and ditches to the extent possible through provisions provided by Subdivision Regulations and Design Criteria and Improvement Standards. Major revisions of these regulations will not be required, they only have to be interpreted with an emphasis toward water quality.

Water Quality Monitoring

The existing water quality monitoring program in the Campbell Creek basin is characterized by few sampling locations and infrequent samplings. The surface water quality is routinely monitored by the U.S. Geologic Survey (USGS) at three locations:

- North fork of Campbell Creek near Anchorage (#15274300)
- South fork of Campbell Creek at canyon mouth near Anchorage (#15273900)
- Campbell Creek near Spenard (#15274600)

The locations of these stations have been shown on Figure 5-1. Water quality data published by USGS indicate that no ground water wells in the basin are routinely monitored. Changes A second component of the monitoring program would be annual sampling of the deep aquifer production wells and approximately six shallow ground water wells to determine if ground water quality is significantly degrading. The monitored shallow ground water wells should be concentrated in areas of septic tanks.

The third component, which is the monitoring of snowmelt and storm water runoff, would be developed to obtain data to evaluate the proposed control measures. The parameters monitored in the runoff events would include at a minimum those mentioned above. Locations of the runoff monitoring stations would include the three mentioned above, as well as at least two others which would be indices of water quality in Campbell and Little Campbell Creeks as they enter urban areas where controls have been implemented. If possible, six events should be monitored, including two during snowmelt, two during the summer period, and two in autumn. Six samples or more per event may be necessary to accurately measure the quality of runoff during the events.

CHESTER CREEK BASIN

The eight urban runoff controls discussed for Campbell Creek are also generally applicable to Chester Creek. The storm water detention ordinance will be applied to major new developments. It does not appear justifiable to make this requirement retroactive to existing subdivisions. However, if a new detention facility were being built and incorporation of an existing subdivision was possible, this should be done.

The Chester Creek linear park provides stream corridor protection; the park is complete so additional land acquisitions are unneccessary. Like Campbell Creek, the recommendation for "control of untreated wastewater discharges" prohibiting discharges of point sources to Chester Creek is suggested. New development in Chester Creek would be subject to the same land use controls suggested for Campbell Creek. A similar water quality monitoring program is also recommended.

The only controls that are markedly different for Chester Creek are streetsweeping and catch basin maintenance.

Streetsweeping

Streetsweeping is potentially more effective in Chester Creek than in the Campbell Creek basin, because of the much higher percentage of paved amd guttered roads. Under the current practice all land uses are swept about once to four times per month. An increase in sweeping frequency should be considered for all developed land uses, with special emphasis placed on the most heavily traveled roads which have curb and gutter. Industrial and commercial areas should also receive priority. The intial objective would be to make sure that sweeping dollars were being spent in the areas contributing the most significant pollution loads. Use of existing equipment is recommended. After the results from the water quality monitoring program are available an overall increase in streetsweeping may be justified. Modelling has indicated that this control would achieve the greatest benefit during the driest months of the rainfall period (i.e., June and July). This control would probably have an insignificant impact on pollutant concentrations during snowmelt, because the sweeping program does not usually commence until after this period.

Catch Basin Maintenance

This control calls for increasing the priority of catch basin inspection and cleaning to the same level of importance as streetsweeping. That is control should be geared to the dirtiest land uses. Priority should be given in relation to intensity or density of use. The objective is to reduce the transport of solids to the creek during rainfall runoff events. Up to a ton of organic matter can accumulate in a standard catch basin.

SHIP CREEK BASIN

The general control program recommended for Campbell and Chester Creeks is also applicable for Ship Creek. Storm water detention will be required for new developments as will the land use controls recommended earlier. The use of the stream for point source discharges will be prohibited. Water quality monitoring is also needed. Paving of dirt roads and parking lots is endorsed by the 208 plan, but its cost cannot be justified from a water quality standpoint alone.

Controls meriting special emphasis are discussed below.

Stream Corridor Protection

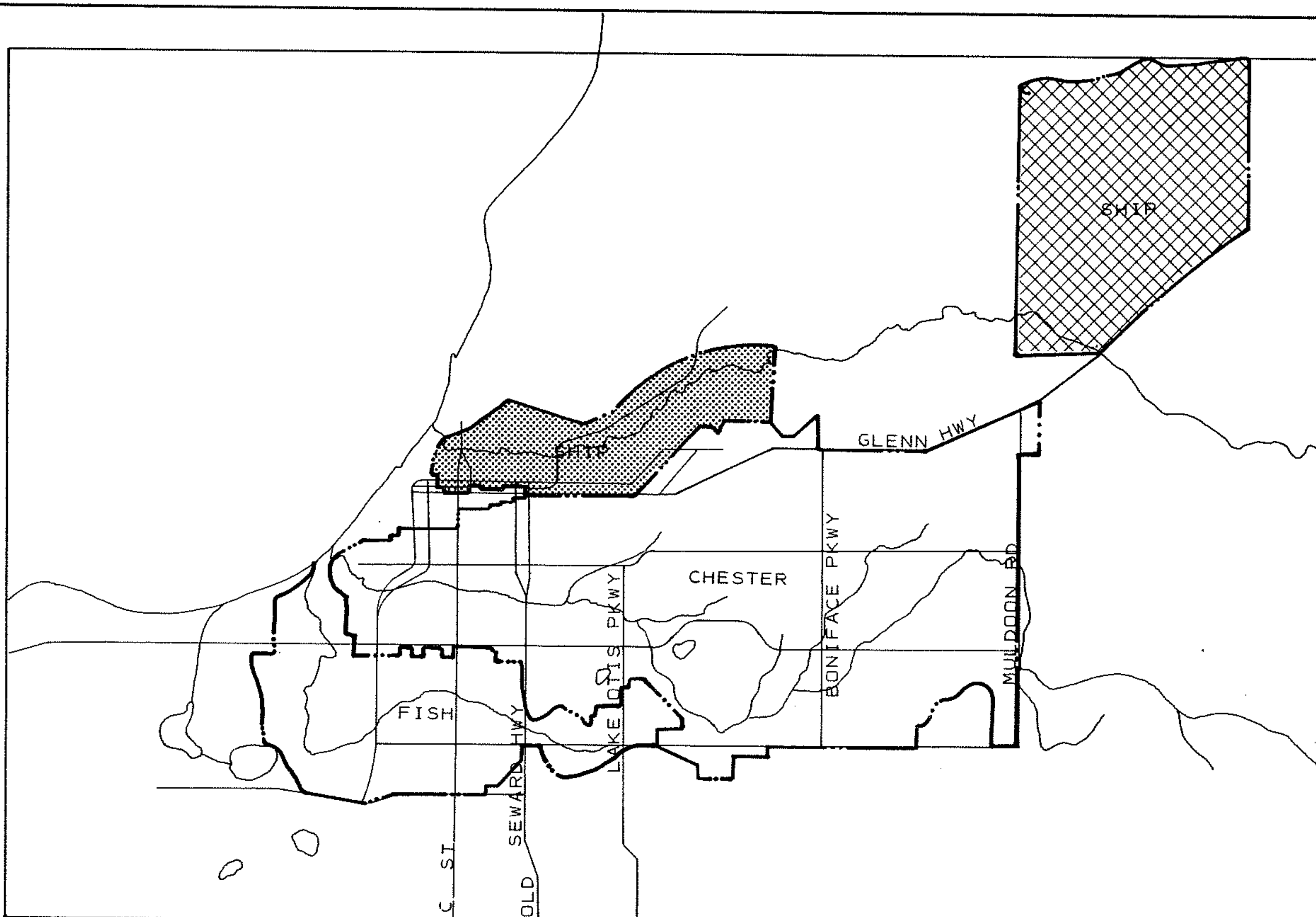
The proposal to establish a recreational corridor and bikeway/pedestrian path along Ship Creek (recently described in the Municipality's Ship Creek Recreational Resources Plan) should be implemented. From a water quality perspective, these greenways are valuable buffer and filtration zones. They have been applied to the Chester and Campbell Creek basins, providing Anchorage residents with unique recreational and transportation opportunities on a scale virtually unmatched by other cities of its size.

Fort Richardson Detention Pond

This control will be required only in Subdivision I (shown on Figure 8-3), which is under the jurisdiction of the U.S. Army (Fort Richardson) and cannot be integrated into the same areawide strategy designed for implementation within the Municipality's jurisdiction. A single, structural control measure is recommended for serious consideration. A retention/settling basin near the Fort Richardson power plant could collect surface runoff before it discharges into Ship Creek. An oil and grease separating device located at the basin's outlet weir is also recommended. The objectives of this basin would be to reduce solids concentration in runoff by simple settling mechanisms, remove most of the oil and grease, and attenuate the peak rate of discharge to Ship Creek.

Discharge/Diversion

This control will be limited to Subdivisions III and IV (see Figure 8-3) which constitute the lower Ship Creek Basin,



LEGEND

FORT RICHARDSON DETENTION POND CONTROL AREA

DISCHARGE/DIVERSION CONTROL AREA

FIGURE 8-3

LOCATION OF RECOMMENDED SHIP CREEK CONTROLS

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bordered by Elmendorf Air Force Base on the north and commercial and industrial districts of Anchorage on the south.

A structural measure that should be considered in the 208 Continuing Planning Program is the construction of parallel storm sewers, one on each side of the creek. Each interceptor would be roughly 2-1/2 miles long, and receive flow along its length from smaller connecting storm sewers and inlets. The outfalls would be near the mouth of Ship Creek. The size of the interceptors would be relatively small, due to the relatively small drainage area. A likely route for the north interceptor would be along Post and Whitney Roads. The south interceptor could be located along Viking Drive for much of its length or be located beneath the proposed bike path. The feasibility of this strategy cannot be determined until futher data are available through the proposed monitoring program. Inasmuch as observed salmon counts have increased in recent years, as presented earlier, it seems doubtful this measure will be required. However, should there be significant changes in the tributary land use in the future, this alternative may then be required.

In addition the feasibility of this tentative recommendation is based on the assumption that, within the planning period of this study (1977-2000), streets in the lower Ship Creek basin will be paved and some type of drainage system will be required. If the interceptors' construction were one element within a larger program to provide paved streets, curbs, gutters, and storm sewers, the incremental costs would be reasonable.

FISH CREEK BASIN

The general control program recommended for Campbell Creek will also apply to the Fish Creek basin. Land use controls should encourage storm water detention and environmental design and the discharge of municipal or industrial point sources to Fish Creek should be prohibited.

Both available data and field observations of Fish Creek support the opinion that a purposeful, and probably costly, control program may be necessary to adequately deal with the current and anticipated water quality problems. The creek is readily accessible to many Anchorage residents, a fact which adds to its potential amenity value. However, this accessibility transforms the high bacterial levels into a potential public health hazard.

The choices for dealing with this problem are difficult because the sources of pollution are only suspected. The stream shows general degradation associated with urban development, the most obvious being enclosure in pipe and channelization. High fecal coliform counts during low flow periods suggest that a major pollution source is exfiltration from the sanitary sewer that parallels the creek. A general lack of storm sewers suggests that urban runoff cannot, by way of comparison, be a signficant water quality problem.

Although support data are scarce, it is evident that recommendation of a costly structural control program for control of urban runoff would be irresponsible until the integrity of the interceptor sanitary sewer which parallels Fish Creek is determined. This information should be developed during the ongoing 201 (MAUS) Study. If the sewer is determined to be the most significant pollution source, then its reparation combined with the general urban runoff control program referred to earlier would be sufficient to protect desired water uses.

LAKES HOOD AND SPENARD

It is recommended that the Muncipality encourage the State Department of Transportation (who has jurisdiction over this water body) to define the suitable protected uses, conduct a water quality monitoring program, and enforce the use(s) and quality standards stipulated. Until this recommendation is executed, the Municipality is advised to restrict contact recreation activities in either lake, despite the fact that such a policy would be unpopular during warm weather.

KNIK ARM

On the basis of recent biological investigations sponsored by the Alaska District, it is felt that direct discharge of urban runoff into Knik Arm does not currently constitute a problem. The recent Congressional waiving of the requirement for secondary treatment for Anchorage's sanitary sewage supports this viewpoint.

SOIL EROSION AND SEDIMENT CONTROL

Erosion rates are generally low in Anchorage for three reasons. First, large rainfalls are infrequent and usually of low intensity. Second, the ground is partially frozen during spring runoff and retards erosion. Finally, the natural vegetative cover is thick and uniform, and therefore stabilizes the land. Most of the erosion that does occur in the Anchorage area is associated with construction activities. Construction site erosion is particularly widespread in the Campbell Creek basin, where new development is most intense.

As referenced in Chapter 3, existing Subdivision Regulations require soil erosion plans at the discretion of the Public Works Department. However, no specific performance criteria are recommended.

Recommendation. A chapter on erosion and sediment control at construction sites is recommended for addition to the existing Department of Public Works' Design Criteria and Improvement Standards. This chapter is included in Appendix B. The chapter has been drafted by staff of the Department of Public Works during the course of this 208 study and will be presented to the assembly for approval within the next year. Upon approval, the provisions called for in the chapter will be implemented for all new construction sites. The program described in Appendix B is expected to reduce erosion from construction sites to levels necessary to protect the current uses of the creeks and lakes.

The chapter recommends that existing controls for construction site runoff be supplemented by the following:

- All construction drawings should include proposed drainage patterns during actual construction periods as well as the permanent drainage plan. Standard details for temporary structural measures for erosion and sediment control should be shown on the drawings as applicable. Access to and from the construction site onto paved public roads should be clearly shown or noted on the drawings.

- Specifications and contract documents should include erosion and sedimentation management during construction. Contractors should be held responsible for erosion and sedimentation control; the Engineer must be given the responsibility for erosion and sediment management and planning. Items such as dust control, soil tracking onto paved public roads, and proper loading and maintenance of dump and gravel trucks should be clearly pointed out in the specifications and contract documents.

- Provisions outlining the responsibility for erosion and sediment control should be included in the subdivision regulations and reflected in subdivision agreements in compliance with the erosion and sediment control ordinance.

- Soil loss from developing areas should not exceed 15 tons per acre per year. This is the criterion used in some states where conditions are similar to Alaska; however, it is a tentative limit and will be adjusted for Anchorage and vicinity on a local basis as more information becomes available. Soil loss should be determined by the USLE method until the SAM and ETD simulation system is verified and calibrated.

- Sediment basins or other appropriate controls should be constructed temporarily at the construction site as applicable, and at all discharge points to the natural streams. Sediment basins should be provided for all storm water discharge points to natural streams and lakes where necessary. This requirement calls for additional funding in order to accomplish these goals. Sediment basins should be designed to handle loads as determined by the USLE method or the ETD simulation system with a life expectancy to be determined by field conditions, zoning classification and growth potential of the drainage basin. Maintenance of sediment basins should be scheduled when 60 percent of total capacity of the basin is extrapolated.

These policies would be implemented through specific design criteria included in Appendix B.

SNOW DISPOSAL

The limited water quality data collected during snowmelt did not conclusively link runoff from snow disposal sites to instream violations of the water quality criteria or standards. However, waste snow collected at five dump sites exhibited the following characteristics:

- Total dissolved solids concentrations which exceeded the criteria for drinking water and aquatic life.
- Iron and lead concentrations which exceeded the criteria for drinking water and aquatic life.
- Concentrations of oil and grease up to 710 mg.

Thus, the apparent lack of pollution attributed to snow disposal sites may be a result of the absence of data to document it.

The present approach is to select snow disposal sites on a trial-and-error basis. This approach has led to many public complaints and the eventual abandonment of several sites for environmental and other reasons.

Recommendations. No structural controls can be recommended for any existing snow disposal sites in the absence of documented water quality problems attributable to runoff or percolation from the sites. The structural controls have costs which would be considered excessively high unless serious water quality problems can be identified. Except for Federal limitations on unleaded gasoline and miles per gallon, implementation of nonstructural controls is also not recommended because of social inconveniences and high costs. The unleaded gasoline alternative is being be implemented at the Federal level.

A Management subplan is recommended to assess the impact of existing snow disposal sites on ground and surface water quality and to reduce the potential for pollution from future sites by formalizing the site selection process.

In addition to the water quality monitoring program described in the earlier section on "Urban Runoff," a 2-year intensive water quality monitoring program should be initiated to define whether or not water quality problems related to snow disposal sites actually exist. The shallow ground water aquifer should be monitored in the vicinity of at least two sites. The best sites appear to be Spar Road (Site 9 on Figure 8-4) and San Roberto Avenue (Site 17), because some data have already been collected at these sites. One well should be located upgradient from each site, and at least four wells should be located downgradient within 1,000 feet of the site. Parameters to be monitored should include at a minimum total dissolved solids or specific conductance, lead, and iron, which have been found in this study to violate the water quality criteria. Chloride could also be monitored as a tracer. The recommended monitoring frequency is once every 2 weeks; this frequency should be reviewed in light of the data collected early in the program.

One monitoring well at each site should also be placed through the Bootlegger clay into the confined aquifer and cased through the shallow aquifer. The locations should be downgradient of the sites and in close proximity to the shallow monitoring wells. Specific conductance, lead, and iron should be monitored at these wells.

The quality of waste snow and surface runoff should also be monitored at these two sites. The parameters and frequencies would be the same as in the ground water monitoring program.

The potential for water pollution from future snow disposal sites can be minimized by selection of future sites through the evaluation screening system developed in an earlier section of this report and presented in Appendix C. This system identifies the major technical, social, and environmental factors that should be considered in the selection of future sites. Consistent application of the system will result in better sites for snow disposal, probably fewer public complaints concerning snow disposal, and more defensible sites in the face of any public complaints.

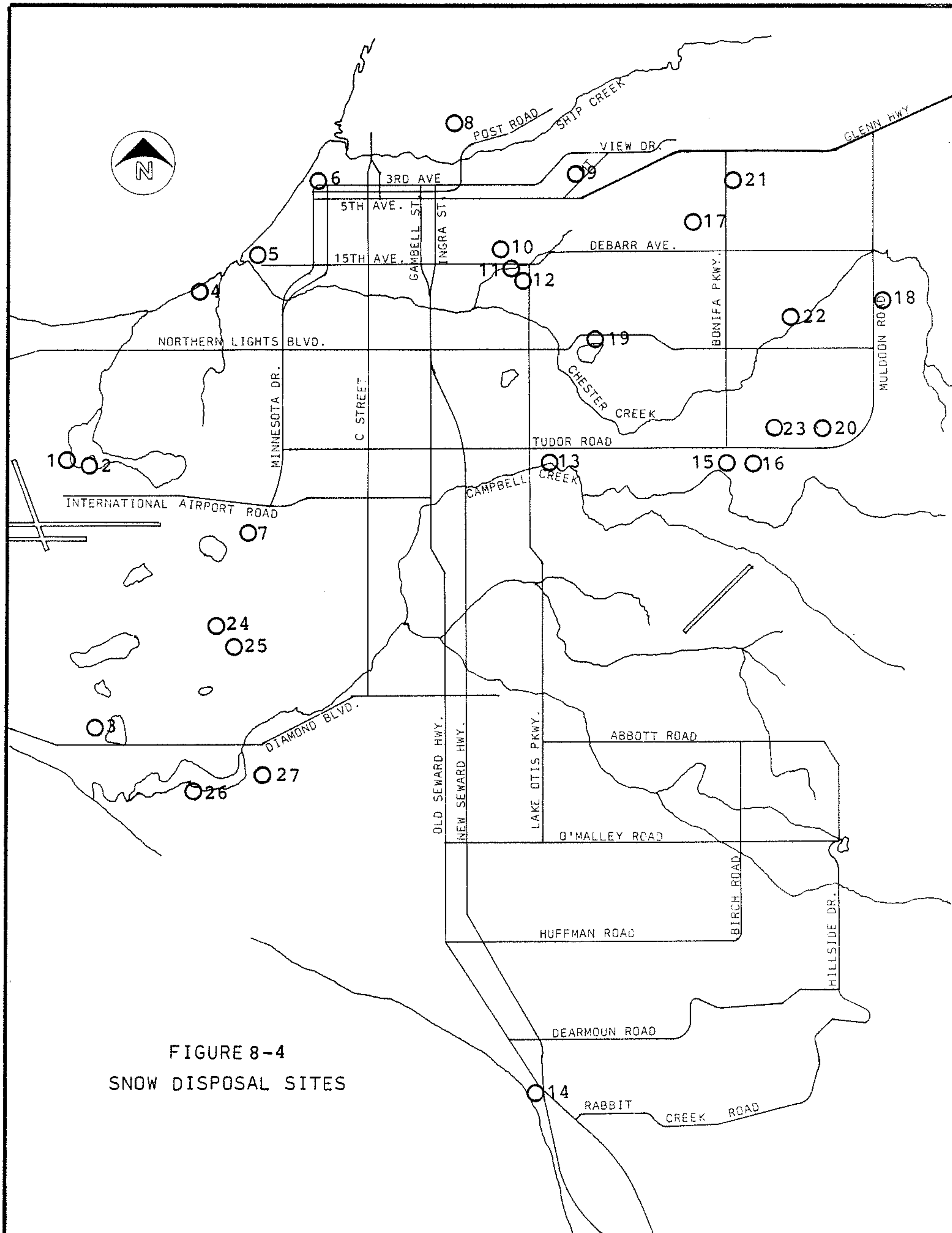

FIGURE 8-4
SNOW DISPOSAL SITES

ONSITE WASTEWATER DISPOSAL REQUIREMENTS

The existing program consists of (1) permits and inspection, (2) design criteria, (3) permits for installers and septage haulers, (4) approval by lending institutions, (5) public education, (6) provisions for alternative systems, and (7) requires connection to sanitary sewers. The program is considered strong; however, improvements are needed to correct older failing systems, provide for better maintenance and assure proper installation. Also, many current practices have to be formalized to assure continued uniform application.

Recommendations. The existing program should be supplemented through addition of the controls listed below. These controls should only be exercised in areas where sanitary sewers are not planned for the future.

- Comprehensive Sanitary Survey. In order to identify the location, age, type and working condition of all onsite systems, a Comprehensive Sanitary Survey should be conducted. For those systems built before 1968 and without a permit, a soils test should be performed to determine if the system was properly designed. Determination of whether expansions to the house have resulted in an undersized system should be made. It is suggested that questionnaires similar to Figure 8-5 be used. The data obtained from the questionnaire should be verified and selected well water samples taken. Houses that should be using sanitary sewer services, and are not, should be required to hook up to the sanitary sewer. Any homes serviced by cesspools or failed systems should be required to upgrade their systems.

- Computerization of Onsite System Data. The usefulness of the Comprehensive Sanitary Survey can be significantly reduced if the data collected cannot be easily assessed or correlated to other existing data. Presently, it is a very time-consuming task to locate onsite system permits, complaint reports, modifications to systems, soils data, well water samples and other such information for a home, subdivision or selected area of the Municipality. If this data and the results of the Comprehensive Sanitary Survey were input to an accessible and responsive central data system that would be easy to cross reference, a much more effective, stronger and receptive management system would be possible. Due to the vast amount of existing data and the new data to be generated by the Comprehensive

1. Name of resident: ______________________________
____

2. Address and/or Location: ______________________________
____
Phone Number: ______________________________

3. Structure Number: ______________ Date: ______________

4. Approximately how old is your house? ______________

5. How many bedrooms are in the house? _____ one _____ two _____ three _____ four or more

6. How many people live in your house? _____ one _____ two or three _____ four or five _____ six or seven _____ eight or more

7. Do you have a washing machine, dishwasher, or garbage disposal? _____

8. What kind of water supply do you use? If a well, how deep is your well? _____ public water supply _____ deep well _____ shallow well _____ dug well _____ surface supply _____ none

9. Do you use public sanitary sewer, a septic tank, privy, cesspool, or some other kind of facility? ______________
____

10. If a septic tank, do you use _____ a seepage pit, _____ a seepage trench, _____ a drainfield, _____ don't know.

11. On the back, would you draw a rough of your lot indicating location of house, sewage disposal system from the house and the well.

12. As best you can recall, has your sink or toilet drained slowly in the past several years? _____ yes _____ no. Explain ______________________________
____

13. Does your yard pond water after heavy rains? _____ yes _____ no. Explain ______________________________
____

14. If yes to question 13, how long does the water stay? _____ one day _____ several days _____ week or more.

15. Do you see water above your drainfield during heavy rains? _____ yes _____ no. Explain ______________
____

16. Does water (perhaps foul smelling) occasionally seep from the drainfield to the surface? _____ yes _____ no. Explain ______________________________
____

17. Have you had problems with your sewage system in the past several years that required your attention? _____ yes _____ no. Explain ______________________________
____

18. Has your septic tank been pumped out in the last year? _____ yes _____ no. Has it ever been pumped out? _____ yes _____ no. How often is it pumped? ______________

19. Has anyone in the neighborhood had problems with their septic systems? Explain ______________________________
____
____

Figure 8-5
Suggested Comprehensive Sanitary Survey
Questionnaire to Mail to Occupants of Homes

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Sanitary Survey, a computerized system is the most feasible means to accomplish this centralization. Discussions with DHEP have shown a strong desire for such a system and a willingness to gather all available soils and ground water data from other departments within the Municipality to aid DHEP in determining the suitability of an area for onsite soil absorption systems. A computerized system could become the key to other management alternatives that will be discussed subsequently.

- <u>Certification of Soils Technicians</u>. The purpose of this control is to assure that all those involved with soils testing would be qualified. To become certified it would be necessary to pass a test developed by local soil scientists and engineers and administered by DHEP. Recertification would be required every three years. Certification would be suspended for incompetence.

- <u>Increased Inspection During Construction</u>. Numerous reports recommended three inspections of onsite systems during their construction. Two of these inspections are currently being made. The third inspection should be done after the septic system has been backfilled and the house is nearly completed. Its purpose is to verify that heavy construction machinery has not compacted the soils of the drainage system.

- <u>Voluntary Maintenance</u>. This is to consist of an annual post card or letter informing homeowners that they have an onsite system, that it requires maintenance, and that it should be pumped if they have had trouble with they system or it it has not been pumped within the past two years. DHEP currently has a leaflet titled "Care and Maintenance of Sewage Disposal Systems" that could be sent along with the annual reminder. With the computerized system discussed previously, this program could also serve to inform those people who have dual absorption fields when it is time to switch fields. Homes or areas that have chronic problems could be listed for special followup phone calls or visits.

- <u>Continued Inspection</u>. Inasmuch as the voluntary maintenance program would not afford the opportunity for periodic inspections of existing systems it is recommended that each system be inspected once every five or six years. recommended. This would provide information regarding failures of systems and would prevent the necessity of conducting repeated Comprehensive Sanitary Surveys. Data gathered from this program and the Comprehensive Sanitary Survey could be used as a guide in establishing priorities for sanitary sewer expansion. Priority for expanded sewer service should be given to those areas with the highest density of failing onsite systems and thus reduce the chance for environmental degradation of the area's waters.

- Dual Absorption Systems. It is recommended that dual absorption systems with a flow diversion valve be required for future onsite soil absorption systems where installation of sanitary sewers is not imminent. The dual absorption system allows one drainage system to recover while the other is in use. This provides better treatment of the wastewater and significantly reduces the chances of failure due to clogged soils hindering drainage of the septic tank effluent. Dual absorption systems are required in other parts of the country and have been highly successful. Fairfax County, Virginia estimates septic tank system lifetimes of fifty years or more using dual absorption systems.

  In order for this type of system to be successful, the drainage systems must be alternated, preferably annually. Homeowners could be reminded to switch drainage systems as part of the maintenance or public education programs previously discussed.

- DHEP Approval for Title Transfers. Under current practices, DHEP approval is necessary for all home loans. This is due to DHEP's strong interest in public health and environmental quality; it is not a statutory requirement. By making DHEP approval required for all title transfers of homes using onsite systems, a built-in inspection and review process would be accomplished. This would allow DHEP to ensure that homes that are sold without loans, or with loans that might not otherwise be submitted to their review have a properly operating onsite sewage system. With an average turnover rate of approximately every three years, this would be an excellent quality control program and would take care of the majority of the workload required by the previously recommended inspection program. Once again, a computerized data system would be an invaluable aid for this program.

- Water Conservation. Reducing the volume of water that an onsite system has to treat will reduce the possibility that the system will fail. Many water saving devices are available and more are currently being designed. A major water conservation practice particularly applicable to the Anchorage area is the use of electric tape to heat water pipes or water pipes that are otherwise electrically heated to keep them from freezing. The common practice of constantly running a faucet to keep pipes from freezing not only wastes valuable water supplies, but also can quite easily hydraulically overload an onsite soil absorption system. Consideration should be given to requiring all new houses to use either electric tape or heated pipes. The same requirement should be made for existing houses with failed onsite systems if hydraulic overloading is a potential cause of a failure.

- <u>Formation of DHEP Operating Procedure</u>. Many current practices are carried out because of the Department's high level of dedication and interest in preserving water quality and public health in the Anchorage area. With a change in personnel or emphasis within DHEP, many of these practices could be discontinued. Departmental operating procedures or regulations should be prepared to ensure that current beneficial practices are continued and documented.

- <u>Public Education</u>. A more comprehensive public education program needs to be carried out. The program should initially be very intensive, using newspaper, radio, and TV news reports to explain how an onsite system works, what can cause it to fail, how to recognize a failure, how to avoid failures, and how to reach DHEP if a homeowner suspects he is having problems. Followup newspaper articles and letters mailed to homes with onsite systems should explain DHEP regulations and policies. This should stress that DHEP is trying to help the homeowners and not harass them. DHEP has already done a very good job in obtaining public confidence. The followup educational program should discuss the above plus ways of reducing water usage, organic loadings, the potentially severe problems of discharging grease into the system, the need to expand the system if the house has expanded, and changes to DHEP regulations or policies. The followup and initial campaigns should be informative, understandable by the layman, and as entertaining as possible. The followup program could easily be incorporated with the maintenance program previously discussed.

- <u>Development of a Septic Suitability Map</u>. A detailed map showing the opportunity and hazard areas for septic tanks should be developed as funds become available. It should be used as a long range planning test to prioritize installation of sanitary sewers and for land use planning.

- <u>EPA 201 Facilities Plan</u>. The Clean Water Act Amendments of 1977 provide up to 75 percent funding for correction of failed onsite wastewater disposal systems, though the 201 Facilities Planning process. The Muncipality of Anchorage should should investigate their eligibility for this funding, as one alternative for correcting deficient septic tanks. It should be recognized that acceptance of these funds would require the Municipality or a new special district to oversee operation and management of the required systems.

Chapter 9
PLAN MANAGEMENT AND IMPLEMENTATION

This section discusses the institutional capability of existing management agencies to carry out the recommended plan, the environmental impacts and methods of mitigation, and an implementation schedule for the water pollution control measures.

INSTITUTIONAL ARRANGEMENTS

The proposed plan has been built from existing ordinances and programs, all of which are now administered by the Municipality of Anchorage. In most cases, it formalizes and somewhat improves practices now in effect. No significant management or institutional modifications are required. Departments and agencies that are currently responsible will continue to manage the same (albeit slightly amended in some cases) programs in the future.

The Municipality of Anchorage 208 Work Plan, in essence, defined the management structure at the initiation of the 208 program. Page 38 of the Work Plan states:

> "It is anticipated that three departments within the municipal government will be responsible for implementing and accomplishing solutions proposed: the Department of Public Works, the Department of Planning, and the Department of Health and Environmental Protection. The Department of Health and Environmental Protection will have the responsibility for monitoring water quality problem areas and evaluating the improvements resulting from implementation of solutions. They will have the long-term responsibility of monitoring conformance to new regulations and development criteria. The Planning Department will have the responsibility for drafting ordinances and amending existing subdivision regulations and land use plans, where necessary. The Public Works Department will be responsible for implementing modified operational procedures and design regulations, administering capital improvement programs to correct existing problems and reviewing proposed development plans for private lands and by other agencies. They will be responsible for development of technical design guidelines and technical portions of the ordinances developed by the Planning Department."

A more detailed discussion of the responsibility of each of the aforementioned agencies in implementing and administering the plan is presented below.

DEPARTMENT OF PUBLIC WORKS

As shown on Table 9-1, the Department of Public Works will be the major actor in the implementation of 208 controls. Regarding urban runoff, the Department will have prime responsibility for enforcing storm water detention requirements, regulating instream construction activities and reviewing plats for stream corridor protection, enforcing ordinances which affect streetsweeping, and managing all facets of street maintenance. In the latter, Public Works will be assisted by the State of Alaska. (The State is obviously responsible for cleaning and maintaining State-owned roadways.) Public Works will also regulate development of peat bog areas. It will review specifications and drawings and provide consultation to the developer on measures to mitigate potential water quality impacts, i.e., staging discharges during high flow, etc.

Public Works will also have primary responsibility for administering and enforcing, through inspection, the proposed soil erosion and sediment control requirements. Lastly, it will continue to play the major role in existing snow disposal operations and will be the lead agency for selection of future snow disposal sites.

DEPARTMENT OF PLANNING

A major responsibility of the Department of Planning will be administration and enforcement of land use controls. This will include enforcing measures which alleviate land use impact on stream corridor areas and protect environmentally sensitive areas. This Department will also administer the "bonus point" system and the requirements for environmental design. Inasmuch as these elements are directed toward water quality and the reduction of runoff, coordination with the Department of Public Works is implied. The Planning Department will play a support role in assisting the Department of Public Works in identification of suitable future snow disposal sites. The Department of Planning will also be responsible for continued planning efforts associated with the 208 program. This will involve assurance that the plan is constantly updated to respond to local developmental changes, to provide coordination between land use planning and water quality management, and to coordinate the 208 plan with other planning activities. Coordination of 208 and Coastal Zone Management planning is an obvious example.

DEPARTMENT OF HEALTH AND ENVIRONMENTAL PROTECTION

As evident from Table 9-1, this Department's role will be in water quality monitoring and the control of onsite wastewater disposal. The Department will be responsible for issuing permits for onsite wastewater disposal systems, controlling the location of such systems, setting design criteria, inspection during installation to ensure conformance with criteria, and assuring that failed systems are repaired. The Department will also continue to provide information on the operation and management of all forms of individual treatment.

This agency will work closely with the U.S.G.S. in all monitoring efforts and will be responsible for compilation of data and its dissemination to other departments and agencies for planning and enforcement purposes.

CORPS OF ENGINEERS

The Corps of Engineers has taken an active part in the 208 planning program. They have provided analysis of water quality problems resulting from urban runoff and recommended controls for the urban portion of the study area. They are also developing the 201 facility plan, which is better known as the Metropolitan Anchorage Urban Study (MAUS).

The Corps of Engineers will continue to assist in the administration and planning for floodplain regulations and will act as a consultant for solving future urban runoff and snow disposal problems. The Corps, however, will not be directly responsible for administering or enforcing any of the controls recommended in this plan.

STATE OF ALASKA

There appears to be a disparity between proposed State standards for existing water uses in the Anchorage area and the level of water quality actually needed to accommodate those uses. The State is to work with the Municipality of Anchorage in developing mutually acceptable water quality standards. By Federal mandate, these standards have to be reviewed once every 3 years. The proposed monitoring program will provide a better data base from which to assess the effectiveness of proposed controls to achieve the water quality standards, as well as the adequacy of standards for protecting water uses. The success of the plan will be dependent upon the close working relationship between the State and the Municipality to assure maintenance of the highest possible water quality while at the same time avoiding adverse economic impact.

UNITED STATES GEOLOGIC SURVEY

This agency is to assist the Department of Health and Environmental Protection in the proposed water quality monitoring programs. Presently, the U.S.G.S. is responsible for virtually all of the water quality data collected in the Anchorage area.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

This agency will function as a monitor and consultant, rather than as an administrator and manager. Therefore, it does not appear as a management agency on Table 9-1. However, the agency will play an important role in future water quality management by reviewing water quality planning activities and making recommendations for technical improvements. It will also play the important role of providing funds for continuing planning and implemention of water pollution controls in the Anchorage area.

ENVIRONMENTAL IMPACTS AND MITIGATION

All of the controls recommended for the 208 plan have been subjected to environmental screening, and adverse impacts appear to be minimal (See Appendix D). However, it is an important part of any management plan to provide mitigation for its associated adverse environmental impacts. Anticipated environmental impacts are discussed below for both the natural and manmade environments.

NATURAL ENVIRONMENT

Air Quality

In general, the 208 plan will have little impact on air quality. About the only beneficial impact would be that the requirements for the erosion control plans and additional paving of parking lots and roadways would reduce the level of fugitive dust. It is also possible that implementation of improved septic tank controls could reduce possible odors from failing systems. In contrast, stagnant water trapped in onsite detention basins could cause local odor problems. During dry periods, sediments that have been retained in the basins could also cause fugitive dust problems during windy periods.

Mitigation. Frequent maintenance of detention basins is the most important mitigating measure. The basins should be thoroughly cleaned after breakup and at least bimonthly thereafter until October.

Topography

Obviously, implementation of the 208 program will have no marked effect on topography in the Anchorage area. On the other hand, the program could have a slight benefit with respect to topography. This will result if natural topographic features are incorporated into the design of future subdivisions. For example, natural topography could be used in plans to minimize runoff. Conversely, topographic alterations will be necessary to retain runoff on unfavorably sloped sites.

Mitigation. Natural topographic features and natural drainage patterns should be used to the extent possible for onsite detention. Use of structural detentions such as storm sewers should be minimized in all cases.

Soil and Geology

The most obvious impact the 208 program would have on this environmental feature is reduction of soil erosion. The recommended criteria would limit soil losses to 15 tons per acre per year. Given a no control situation, erosion from construction sites can be 10 times this amount or more. A second beneficial impact is that stream corridor protection will reduce streambank erosion. This will result principally from the maintenance of streamside vegetation and reductions in peak flow. The amount of benefit received cannot be quantified at this time, however.

The requirement for dual soil absorption systems, surcharging of peat bogs, and paving of parking lots and roadways will increase the local demand for sand and gravel and for clean fill. Presently, sand and gravel are in short supply in the Anchorage area. As a result of the aforementioned requirements, the price of this resource will certainly escalate. In addition, the possibility of adverse environmental impacts realized at the site of extraction can be anticipated. The severity of this impact cannot be assessed until the location of potential sand and gravel mining is identified.

Mitigation. The Municipality should identify readily extractable sand and gravel resources to anticipate increased demands. The sites should preferably be in areas that minimize environmental impacts, while at the same time be within reasonable transport distances to Anchorage. During any periods of shortage, requirements deserving highest priority should be identified.

Vegetation and Wildlife

Vegetation and wildlife should benefit from implementation of the 208 program. Preservation of the creek corridor areas as linear parks would not only retain streamside flora, but it would also provide refuge for small birds and animals. Likewise, additional emphasis on erosion control will result in prompt revegetation. However, seeding of barren dirt areas would have more of an aesthetic impact than impact on vegetation. Thirdly, the extension of the "bonus point" system and the requirement for the environmental design, coupled with the requirements for onsite detention, could lead to more innovative site plans emphasizing natural vegetation. Retention of vegetation for onsite detention is certainly more economical than provision of structural facilities.

The only possible negative impact any of the 208 elements would have on vegetation is the recommendation of using peat bogs as snow disposal sites. This use may result in destruction of the vegetation species (none are "rare or endangered" species) found in the affected peat bogs. Such destruction would only occur in disposal areas used for disposal of snow from heavily traveled areas, such as downtown, where large quantities of sand are used. Waste snow from residential areas has little sand and other debris and has been found to have no noticeable impact on vegetation.

Mitigation. Review of all site plans in the Anchorage area should place high emphasis on maintenance of existing vegetation. The "bonus point" system should be used as an incentive for retaining natural vegetation for drainage control. Regarding vegetative damage in peat bog areas, emphasis should be placed on obtaining the most environmentally insignificant sites for snow disposal. During the site selection process, it is recommended that biologists be retained on the selection team.

Aesthetics

Inasmuch as the 208 program has been devised to reduce pollution problems in the Anchorage area, an overall improvement in local aesthetics is implied. Improved streetsweeping and litter controls will provide an obvious benefit to urban aesthetics. Likewise, the recommendation for additional linear parks, paving of dirt roads and parking lots, and erosion control at construction sites will undoubtedly have a positive visual impact. In addition, use of the "bonus point" system to retain natural vegetation and encourage innovative site planning will also have a beneficial impact on urban aesthetics. Adoption of the recommended site selection criteria for snow disposal sites will result in selection of the most aesthetically acceptable sites for this purpose.

The only negative visual impact associated with the 208 program is the possible impact of poorly maintained detention basins. As mentioned previously, these basins can retain ponded stagnant water if not cleaned on a regular basis. In some cases, this can be visually unpleasing, and in others, result in the propagation of nuisance insects. If the ponds are deep, they may pose a danger to neighborhood children.

Mitigation. Storm water detention ponds, where required, should be cleaned on a regular basis as mentioned earlier. They should also be designed to drain dry (unless a permanent pond is desired) and to be easily accessible for cleaning. If a permanent pond is desired, it should be designed with sufficient capacity to provide long-term storage of sediments without visual disamenity. It should also have sufficient dilution capacity so as to maintain a reasonable water quality even after receipt of urban runoff. In all cases the ponds should be designed in harmony with their surrounding environment, with maximum use of screening and natural vegetation. It is also suggested to use open recreation fields for detention purposes. When not inundated, these areas can be used as playing fields and as open space.

Water Quality

The proposed 208 program has been devised to maintain local water uses and to fulfill the Federal requirements of fishable/swimmable waters by 1983, where attainable. However the plan will not fulfill proposed State water quality standards, most notably for fecal coliform. Consequently, water quality may not accommodate certain water uses, the most significant being drinking water, as a result of implementation of the proposed 208 plan. The other less significant water uses not specifically protected by the proposed plan include fresh water supply for aquaculture, industrial uses, and culinary and food processing. It is important to note, however, that none of these uses are now experienced in any of the streams in the immediate project area.

The nonpoint source water pollution problem in the Anchorage area still is not fully understood in some aspects. It is possible that the recommendations that have been made for the proposed program will not meet the fishable/swimmable objectives. However, there is no evidence at this time to suggest that this would be the case. As a response to these uncertainties, an aggressive water quality monitoring program has been suggested to test plan performance.

Mitigation. Under Federal law, water quality standards are reviewed every 3 years. If it is found that the water quality standards proposed for this 208 program do not fulfill their intended objectives, then revision will be necessary. The most reasonable method to test the performance of the proposed standards and the accompanying plan will be an aggressive water quality monitoring program. The data from this program should be used for planning purposes first and for enforcement second. After 3 years of operation, the data should be sufficient to revise the plan as necessary.

MANMADE ENVIRONMENT

Population

None of the components recommended for the proposed 208 program is anticipated to affect the distribution, socio-economic characteristics, or rate of population growth in the Anchorage area. The proposed program is not so restrictive as to discourage industrial development in the area, so losses of job opportunity are certainly not suspected. More realistically, the rapid growth projected for the Anchorage area is due to economic opportunity and the mystique of the Last Frontier. The level of the area's water quality or the management plans associated with it will have no impact upon the personal or business decisions of those using Anchorage as a home.

Mitigation. Other than implementation of the 208 recommendations, the best mitigation for offsetting the impact of projected population growth is continuation of the strong planning and engineering programs currently sponsored by the Municipality of Anchorage.

Land Use

The proposed 208 controls should not markedly affect the amount of development anticipated in the Anchorage area for the reasons mentioned above. Regardless of whether or not the 208 plan is implemented, approximately 20,000 additional acres will undergo urbanization by the year 1995. Hopefully, the recommended controls will result in the type of urbanization which minimizes the impact on water quality. Perhaps the most significant land use impact will be the requirement of environmental design and storm water detention. As mentioned throughout this assessment, it is anticipated that these controls plus the incentive provided by the "bonus point" system will result in more innovative site planning. These controls may result in site plans that emphasize planned unit development and cluster housing. However, deemphasis of the traditional single family home unit will probably be brought about more by increased construction costs than by the proposed controls.

It is possible that increased develop controls, such as the requirement for erosion control, will encourage development outside of the jurisdictional boundaries of Anchorage. This may partially encourage sprawled development which may increase the costs of providing the usual public services, such as schooling, fire and police protection.

Mitigation. The exemption clause discussed under mitigation of socioeconomic impacts also applies here.

Socioeconomics

Adoption of the 208 plan will be just one more element which makes Anchorage a nice place to live. It will continue to be one of the few areas where a cold water fishery is maintained in several streams through town. The salmon fisheries in Ship and Campbell Creeks provide both a sense of civic identity and a tourist attraction. The stream corridor protection program will provide both urban aesthetics and recreation--jogging and hiking in the summer, and cross country skiing and dogsledding in the winter. However, it should be noted that the 208 plan only endorses, and not is responsible for, the implementation of the excellent linear park program.

Improvement in the existing onsite wastewater treatment controls would further reduce the chance of well contamination and possible health problems associated by human exposure to sewage. Correction of failed septic systems will obviously provide neighborhood improvements.

The 208 program will also have some unfavorable impacts. Provision of erosion control will have a slight impact on the cost of housing. This cost could range from negligible to up to $400 per dwelling unit. Compliance with proposed onsite wastewater treatment controls will require installation of dual soil absorption systems for all new homes. For homes with onsite treatment, this could increase the development costs by $1,000. In addition, the administration of the nonpoint source controls mentioned throughout this report will increase the local tax burden. More on this is discussed below.

By way of contrast, compliance with the storm water detention and environmental design requirements could somewhat reduce costs. Reducing peak storm runoff allows installation of smaller storm sewers, and even offset the need for storm sewers entirely in some cases. The amount of saving will be dependent upon policy decisions by the Department of Public Works.

Mitigation. Perhaps the most important mitigation measure to offset the economic cost of nonpoint source controls would be to include an exemption clause in each ordinance. Although the involved regulations should be comprehensive and should not be loosely enforced, they should not be blindly applied in areas where they are not required. For example, onsite detention facilities or peat bog drainage controls should not be applied on sites that drain directly to the ocean, or have no direct drainage to fresh water. Likewise, intensive erosion control measures such as sedimentation basins should not be required on sites where runoff would be negligible. The exemption clause, although it should be used infrequently, should be available to allow for good judgment on the part of the Municipality. Controls should only be used for protection of water quality; they should not be used as a means for delaying projects.

Public Agency Budgets

As mentioned earlier, the proposed program may result in some increase in administrative costs. The magnitude of this increase is hard to calculate exactly because the proposed program is based around the existing ordinances and staff capabilities. Thus it is difficult to determine what is actually a new cost. The proposed program will basically require only a reapplication of existing resources. Ideally, the 208 planning program has served as a tool for education, with the result that current controls will now emphasize water quality as well as their originally intended purpose(s). Even so, some additional manpower will probably be required, as staff responsibilities will undoubtedly increase. (Of course, the work load can be expected to increase simply due to the rapid growth taking place in the Anchorage area.)

It is anticipated that the Department of Public Works may need an additional engineer or engineering technician to assist with the administration and enforcement of proposed drainage and soil erosion controls. Likewise, the Department of Planning would ideally require an additional staff person to administer and work on the 208 Continuing Planning Program. Proposed land use controls will be administered by existing staff. The Department of Health and Environmental Protection may require an additional staff person to assist with the proposed recommendations. The level of new positions required is greatly affected by the extent to which sanitary sewers are installed. Obviously, the more areas sewered, the less emphasis on management of septic tanks and other onsite waste disposal systems. Because of high land costs in the Anchorage area, it has been assured that large lot development and septic systems will be less prevalent in the future.

Mitigation. The most equitable way to mitigate additional costs associated with the 208 program is to assure that the user (source of pollution) pays. Nearly all of the future potential sources of water pollution in the Anchorage area are associated with more people and the accompanying development. However, proper development can result in growth with no loss of important water uses. Accurate accounting of the additional Municipal costs associated with administration of the proposed controls should be kept. As more data becomes available unit costs, perhaps shown as cost per acre, can be developed. Subsequently fees should be developed for plat review and onsite inspection. These should be included in the fee charged for building permits. Although this cost will ultimately be transferred to the consumer(s) of new homes, it will at least provide a system by which new growth pays for itself.

IMPLEMENTATION SCHEDULE

The implementation schedule is presented on Table 9-2. The schedule suggests that all of the nonstructural controls recommended for urban runoff control be implemented from early 1979 to early 1980. Water quality monitoring should begin in the spring of 1979 on Campbell and Ship Creeks and approximately a year to 18 months later on Chester and Fish Creeks. The need to increase catch basin maintenance and streetsweeping frequency should be reconsidered after 1 calendar year of data has been collected from the water quality monitoring of Campbell and Ship Creeks. After 2 years of water quality data collection, a possibility of paralleling Ship and Campbell Creeks with interceptor storm sewers should again be evaluated. This would be to ensure protection of the salmon fisheries there. Amendment of subdivision regulations to incorporate new criteria for erosion control should be adopted by the 1979 construction season. After 2 years of operation, the criteria should be reevaluated for adequacy, if there is reason to believe inadequacies exist.

The proposed criteria for selection of new snow disposal sites should be adopted early in 1979. Water quality monitoring of selected existing snow disposal sites should be conducted in the spring of 1979. A review of the environmental adequacy of the snow disposal program should be done the winter of 1982.

Existing Wastewater Disposal Regulations should be amended to include a third inspection during installation of septic systems, and require certification of soils technicians by the end of 1979. Formalization of existing DHEP policy procedures should also be done before the end of 1979. In early 1980, the Comprehensive Sanitary Survey and the

Table 9-2
Implementation Schedule

	1979	1980	1981	1982	1983
URBAN RUNOFF					
o Amend Subdivision Regulations To:					
1. Require Storm Water Detention (Revised Criteria)	■				
2. Require Environmental Design to Minimize Runoff	■				
3. Extend "Bonus Point" System to Suburbs	■				
4. Require Paving of New Parking Lots	■				
5. Mitigation Measures for Peat Bog Development	■				
6. Minimize Use of Storm Sewers (Encourage Swales, Ditches)	■				
o Amend Flood Plain Regulations To:					
1. Prohibit Storage of Toxics Within 100 Feet of Surface Waters	■	■			
2. Limit Inwater Work to the Period From 15 May to 1 July	■	■			
3. Require Bridge Crossings Rather Than Culverts	■	■			
o Amend Wastewater Disposal Regulations To:					
1. Prohibit Municipal/Industrial Point Sources, and Direct Storm Sewer Discharges to Fresh Water	■				
2. Prohibit Washing Down of Trucks and Equipment Such That Direct Runoff to Fresh Water Is Inevitable		■			
o Expand Water Quality Monitoring					
1. Campbell Creek	■	■			
2. Chester Creek		■	■		
3. Ship Creek	■				
4. Fish Creek			■		
o Streetsweeping					
1. Better Enforce Parking Ordinance and Litter Ordinance	■				
2. Review Need to Increase Sweeping Frequency		■			

Table 9-2 (Continued)

	1979	1980	1981	1982	1983
o Increase Catch Basin Maintenance		X			
o Review Need For Interceptor Storm Sewers on Campbell and Ship Creeks				X	
SOIL AND EROSION CONTROL					
o Amend Subdivision Regulations To:					
1. Require Erosion Control Plans Under New Criteria	X				
2. Review Adequacy of Criteria				X	
SNOW DISPOSAL					
o Adopt Site Selection Criteria	X				
o Initiate Water Quality Monitoring at Snow Disposal Sites	X				
o Review Criteria				X	
o Review Need For Structural Controls				X	
ONSITE WASTEWATER DISPOSAL SYSTEMS					
o Amend Wastewater Disposal Regulations To:					
1. Require a Third Inspection During Installation	X				
2. Require at Least One Spot Inspection Every 5 Years		X			
3. Require Dual Adsorption System On All New Units, as Appropriate		X			
4. Require Certification of Soils Technicians	X	X			
o Comprehensive Sanitary Survey		X			
o Computerize Data		X			
o Institute Voluntary Maintenance Program	X				
o Formalize Approval of Title Transfers (i.e., Banks Requiring DHEP Review of Septic Systems Before Loan Approval)	X				
o Formalization of DHEP Policy	X				
o Public Education	X				
o Review Adequacy of Control Program				X	

Public Education Program should be initiated. The requirement of at least one spot inspection every 5 years, dual absorption systems for new homes in areas not be to sewered, and computerization of onsite system data should be also initiated in that same year. It is suggested that the adequacy of this program be reviewed in the first half of 1982.

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APPENDIX A
ALTERNATIVE CONTROL COSTS FOR CAMPBELL CREEK BASIN

FIGURES

Appendix A
ALTERNATIVE CONTROL COSTS FOR CAMPBELL CREEK BASIN

Cost estimates for Levels 1, 2, and 3 control programs for the Campbell Creek basin were developed to determine the cost effectiveness of attaining three levels of water use objectives. The results were then to be applied to areawide planning decisions. The costs estimates were developed to detail sufficient to decipher the comparative costs of bring to fruition each of the three alternatives.

URBAN RUNOFF

LEVEL 1

Implementation of Level 1 would result in no additional capital or operation and maintenance costs. This, of course, does not infer that Level 1 has no costs, but only that no additional costs would occur as a direct result of 208 planning. Given existing budgetary information, an accurate estimate of Level 1 costs cannot be made. However, some assumptions can be drawn and are presented in the Level 2 evaluation.

LEVEL 2

A verbal description of the cost analysis for each major urban runoff control each is presented below.

Storm Water Detention

Unit costs for the Level 2 treatment facilities were developed by designing controls for an exemplary subbasin in the Campbell Creek basin. Sedimentation ponds (2-hour detention) were assumed as the method of control. This does not mean that other measures were not possible, such as infiltration basins or land application, only that detention ponds were used as a basis to determining realistic cost estimates for comparison purposes.

Costs for both aboveground and underground facilities were developed. They ranged from $400,000 to $700,000 per cfs for the underground facilities to $32,000 to $36,000 per cfs for the aboveground facilities. It was assumed that the aboveground facilities would be used. Assuming that the design storm (September 4, 1968) delivers 100.2 cfs of runoff to Campbell Creek, provision of Level 2 storm water treatment is estimated to cost about $3.4 million in 1995. Operation and maintenance costs are assumed to range from 3 to 5 percent of construction costs, or $102,000 to $170,000 per year. Given a large number of small facilities, operation and maintenance costs would be higher than for one large facility. Consequently, the higher cost, $170,000 per year in 1995, is assumed as more reliable.

Stream Corridor Protection

Costs for extending the Campbell Creek linear park system to Little Campbell Creek is estimated to range from $5 to $6 million. These estimates were obtained by the Anchorage Department of Parks and Recreation in July of 1978. Inasmuch as the park expansion is shown on the Comprehensive Development Plan and is intended to be implemented in the future by the Municipality, the cost should not be attributed to the 208 program. Rather, it is the intent of the 208 to foster and endorse existing trends and programs contemplated by the Municipality which will benefit water quality.

Streetsweeping

No additional streetsweeping is recommended for Level 2, strictly from a water quality standpoint. However, any increases that may occur are supported because this would reduce storm sewer and detention facility maintenance costs. The Level 2 recommendation for enforcement of parking and litter ordinances would have a minimal cost. Nevertheless, any additional work over existing conditions can be assumed to have a cost. Assuming a 6-month sweeping season, and that attending to the aforementioned duties would require at least 2 person days per week, including administrative costs, an additional public expense of about $7,000 in the Campbell Creek basin would be realized.

Control of Untreated Wastewater Discharges

The effectiveness of sanitary ordinances is somewhat a function of enforcement. Although a point of diminishing returns is possible, sanitary ordinances in most areas are less than optimally efficient due to a lack of enforcement.

In order to carry out the Level 2 controls, it was assumed that close coordination with the water quality monitoring program discussed below would be necessary. That is, data collected from the water quality program could be used to enforce the recommended amendments to existing Wastewater Disposal Regulations. Of course, time would also be necessary for administration. Enforcing the proposed Level 2 recommendations in the Campbell Creek basin would require no more than 4 person months or about $11,700.

Paved Roads and Parking Lots

Paving costs for roads and parking lots are expensive in the Anchorage area. Although the costs for paving these facilities cannot be justified for water quality improvement alone, the 208 program should encourage paving to reduce sediment loadings carried in urban runoff. Since the 208 recommendations may indirectly affect the decision to pave roads and parking lots, the economic impact has roughly been estimated.

According to local officials about 50 percent, or 100 miles, of the roadways in the Campbell Creek basin are dirt. Costs for paving range from $75 to $133 per linear foot, depending on street classification. Most of the dirt roads service residential areas. The average cost for paving is approximately $92 per linear foot. Given these assumptions, paving all the dirt roads in the Campbell Creek basin would cost $48,580,000. Annual operation and maintenance, at $4,000 per linear mile, would cost $400,000.

Paving and maintaining dirt parking lots is anticipated to be even more costly. Parking lot costs were based on the following assumptions:

- o There were 152 and 2,034 acres of commercial and industrial land, respectively, in the Campbell Creek Basin in 1975.
- o Sixty percent of the commercial land and 20 percent of the industrial land were devoted to parking.
- o Twenty-five percent of the commercial and 50 percent of the industrial parking lots were unpaved.
- o Parking lot paving and maintenance costs are $30 per square yard and $20 per square yard, respectively.

Under existing conditions, it can be estimated that paving all dirt commercial parking lots would cost about $3,340,000 and annual operation and maintenance would cost $2,226,000. The same costs for paving and maintaining industrial parking lots are $30,000,000 and $19,650,000, respectively.

Land Use Control

Land use controls are presently administered by the Municipality of Anchorage Planning Department. Requirements for environmental protection are enforced during siting and plat reviews by the Department of Public Works, Planning, and Health and Environmental Protection. The Level 2 recommendations--extending the "bonus point" system to the suburbs, coordinating storm water detention requirements with "environmental design" and prohibiting direct drainage of peat bogs--can readily be integrated into the existing review process. This integration should be accomplished without additional administrative cost because these recommendations correlate well with the current review procedures.

Regarding private or developer costs, the enforcement of these controls could have mixed fiscal impacts. For example, environmental design can, through development of permanent ponds or infiltration basins, offset the need for installation of storm interceptor sewers and result in significant savings. In some cases the development of permanent ponds for landscaping and storm water detention can increase real estate values as well.

Discharge Diversion of Storm Runoff

Level 2 calls for a deemphasis of storm sewer construction were pragmatic, so projected costs for this element should be less than continuation of existing practices, Level 1. The amount of cost savings cannot be estimated at this point, but it could be substantial.

Water Quality Monitoring

The Level 2 water quality monitoring program for Campbell Creek is estimated to cost $45,000 per year. The costs were based on the following assumptions:

- Three surface water sampling sites, sampling of eight parameters four times per year during dry-weather periods

- Ten ground water sampling sites, sampling of eight parameters once per year

- Five surface water sampling sites, sampling of eight parameters six times per year during runoff events, and six samples per event.

The annual cost for chemical and biological analysis is estimated to require $36,000 per year. Collection and delivery of the samples would cost $4,000 per year, and data compilation and publication $5,000 per year. About 85 percent of the cost is attributable to the runoff sampling component.

LEVEL 3

Storm water detention of urban runoff, streetsweeping, paved roads and parking lots and land use controls, are not required for Level 3, so no cost estimates are provided. Likewise, stream corridor protection and control of untreated wastewater discharges are the same as for Level 2, so cost methodology for these controls is not repeated.

Discharge Diversion of Storm Runoff

The interceptor storm sewer for Level 3 is estimated to cost $7,600,000. A cost of $165 per linear foot was assumed; this estimate was based on bids submitted in the Anchorage area and checked against computer output assuming Seattle costs adjusted for Alaska. The cost, if anything, is conservative. Engineering and legal costs were assumed at 25 percent of construction costs. Annual operation and maintenance costs were estimated at 0.005 percent of the construction cost or $38,000.

Water Quality Monitoring

The water quality monitoring cost for Level 3 is estimated at $19,000 per year. It involves the first two components of Level 2 but does not include sampling during the six runoff events recommended for Level 2, hence the lower cost. However, monitoring of the storm sewer outfall would be required, and this would somewhat offset cost savings.

The annual cost of water quality analysis is estimated at $6,000 per year. The ammortized annual capital cost of an automatic, flow-actuated sampler required for monitoring the outfall to Cook Inlet is estimated at $6,000. An additional $5,000 per year in labor costs is estimated to be needed to service the sampler, pick up samples, and deliver them to the laboratory.

SOIL EROSION AND SEDIMENT CONTROL FROM CONSTRUCTION SITES

LEVEL 1

Under this level, erosion controls would be required on a selected basis at no additional cost.

LEVELS 2 AND 3

Between 1975 and 1995 the amount of developed land in the Campbell Creek basin will go from 6500 acres to 14000 acres, for a change of 7500 acres. Costs for erosion control are generally related to the number of acres protected. Soils, slope and precipitation are major determinants of cost also.

Perhaps one of the best erosion control programs in the United States is the one administered by the Montgomery County, Maryland, Department of Environmental Protection, Building Permits Department. This agency has assessed costs in detail and found that capital costs for erosion control for construction sites average $870 per acre and agency administrative costs $87 per acre. This latter cost is for plat review and inspection as well as administration. This cost compares favorably to the $600 to $1400 per acre typically assumed for erosion control in the "Lower 48." (However, cost per acre for erosion control, through revegetation, can be as high as $3500 to $4000 in the arid plains environment found in the western U.S.)

To date, the Municipality of Anchorage has not calculated costs for erosion control. Because of the low runoff, gentle precipitation, long periods of frozen ground, and benign slopes of most developing areas in Anchorage, and the fact that programs now exist for plat review and inspection (negating the need to train personnel and start up entirely new programs), it can logically be concluded that erosion control will be less difficult here than in places like Montgomery County, Maryland. Even considering a 37 percent increase in the cost of living in Anchorage over the U.S. as a whole, a fair estimate of the cost of erosion control would be $1000 per acre for capital cost. Due to the experience of the existing Department of Public Works personnel, administrative costs are assumed to be 5 percent rather than the 10 percent required at Montgomery County. Assuming that 7500 acres will be developed in the Campbell Creek basin over the 20 year planning period, enforcement of erosion control will increase development costs by about $7,500,000. The average annual O&M cost, assuming 5 percent, would be $18,750 per year, or $50 per acre.

SNOW DISPOSAL

LEVEL 1

The cost of snow disposal will probably increase under Level 1 because of inflation and the urbanization of the Campbell Creek basin. However, no changes in existing snow disposal practices are recommended for water quality improvement under Level 1, and therefore none of the cost increase can be attributed to water pollution control.

LEVEL 2

The two additions to current practices recommended under Level 2 are a water quality monitoring program and an evaluation screening system for selection of new sites. Costs for both of these additions have been estimated for the Campbell Creek basin and for the study area as a whole.

Campbell Creek Basin

Both sites selected for monitoring lie outside the Campbell Creek basin. Thus, no monitoring costs will be incurred within the basin itself.

Costs will be incurred in administering the evaluation screening system, however. At present, three snow disposal sites are located in the Campbell Creek basin (Sites 13, 15, and 16 on Figure A-1). Urbanized areas in the basin are projected to increase from approximately 6500 acres in 1975 to approximately 14000 acres in 1995. Based on this growth, an additional three to four sites may be expected in the basin. At three days per site, administration of the evaluation screening system is estimated to cost $900 to $1200 over the next 20 years, or $45 to $60 per year.

It is important to note that the evaluation screening system may save money for the Municipality in the long run. Consistent use of the system should result in better sites for snow disposal, fewer public complaints concerning snow disposal, more defensible sites in the fact of any public compliants, and therefore fewer numbers of sites that must be abandoned and rehabilitated.

Study Area

Sites to be monitored for water quality are located in Chester Creek basin (Site 17 on Figure A-1) and Ship Creek basin (Site 9). Costs to monitor shallow ground water, deep ground water, surface runoff and waste snow, to compile the data, and to complete a report are estimated at $20,000 per year.

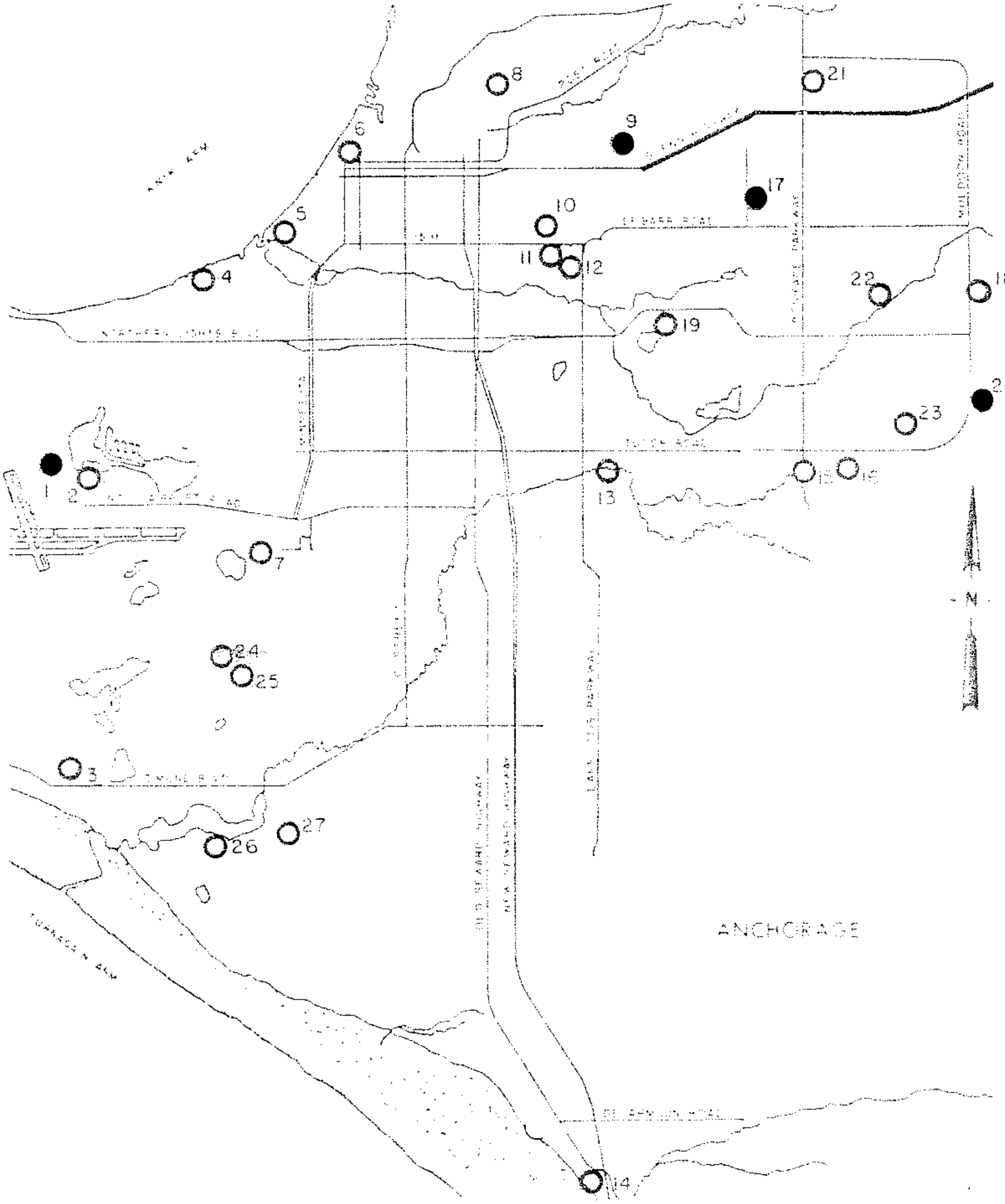
Costs to administer the evaluation screening system will be incurred by the Municipality. Twenty-seven snow disposal sites have been identified in the study area. Based on this current number of sites and the projected increase in acreage within the study area, discussed in Chapter 2, 18 additional snow disposal sites may be expected over the next 20 years. At three days per site, administration of the evaluation screening system is estimated to cost $5400 over the next 20 years, or $270 per year.

LEVEL 3

Structural measures to control surface runoff from snow disposal sites are recommended under Level 3. Costs of these measures have been estimated for the Campbell Creek basin and for the study area as a whole.

Campbell Creek Basin

Controls have been designed for four existing snow disposal sites in order to promote the favorable conditions of no surface runoff and discharge to the Inlet, whenever possible. These four sites, shown on Figure A-1, are all located outside of the Campbell Creek basin. However, cost estimates



LEGEND

● SITES WITH CONTROLS DESIGNED

○ SITES WITHOUT CONTROLS DESIGNED

FIGURE A-1

SNOW DISPOSAL SITES

developed for these sites have been used to estimate control costs at the three sites in the basin (Sites 13, 15, 16).

Schematics of the controls at each site are shown on Figure A-2 thru Figure A-6. The controls are basically similar at all four sites. Berms have been designed at all four sites to control surface runoff; the height of the berm is a factor of topography and the amount of snowmelt to be contained. Access ramps have been provided for the trucks hauling snow. Overflow systems have been added to control any excessive snowmelt runoff. Finally, fences have been designed to surround the sites for safety and protection from vandalism.

The basic assumption of this type of design is that water contained within the berms will percolate through the soils. This assumption should be tested by percolation tests at any sites where infiltration/percolation ponds are planned.

Most of the sites have some unusual conditions that were taken into account in the design. These differences are described below. Approximate construction costs are also presented below for each control system. Design, geotechnical work, resident engineering, and contingencies will add 25-50 percent to the construction costs presented below. Operation and maintenance costs will also be incurred at each site for policing and spring cleanup.

- <u>International Airport (Site 1)</u>. This site is built on an old sanitary landfill. Subsurface drains have been designed to collect the recharge at the site and prevent the leachate from polluting the ground water and possibly even Lake Hood. A 12-inch line delivers the leachate approximately 6,000 feet to a sanitary sewer interceptor along Northern Lights Boulevard. The approximate construction cost of the control shown at this site is $400,000.

- <u>Spar Road (Site 9)</u>. This site has the basic design described earlier, except the overflow is delivered by a 4-inch force main to a storm sewer at 2nd Avenue and "F" Street. The outfall for this sewer is onto the tidal flats. A pump station is located on the overflow line, but outside the area shown on the figure. An emergency overflow drain has also been included; this emergency system utilize the existing ditches for drainage. The approximate construction cost for the control shown at this site is $400,000.

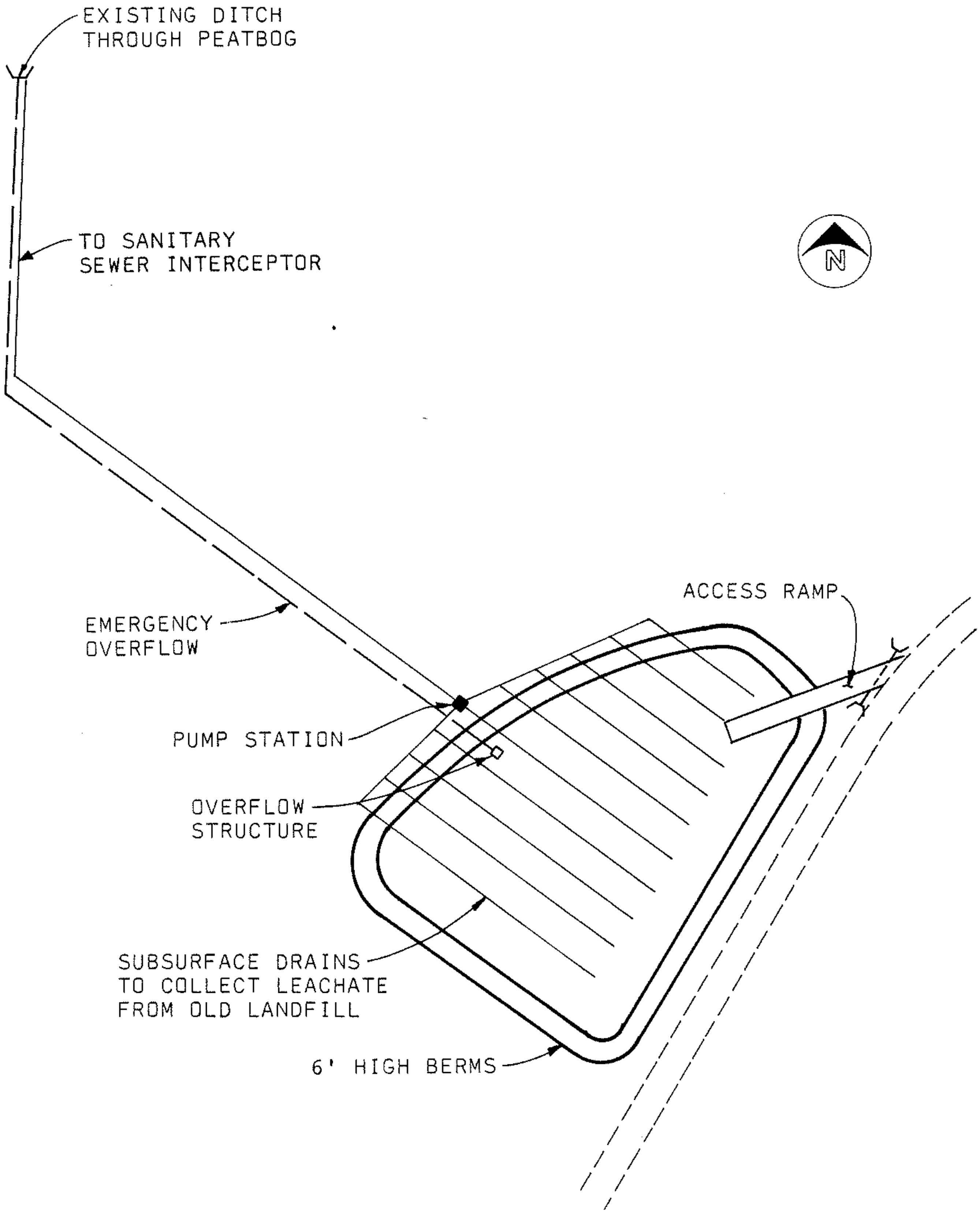


FIGURE A-2
SITE NO. 1
STRUCTURAL CONTROL

CH2M HILL

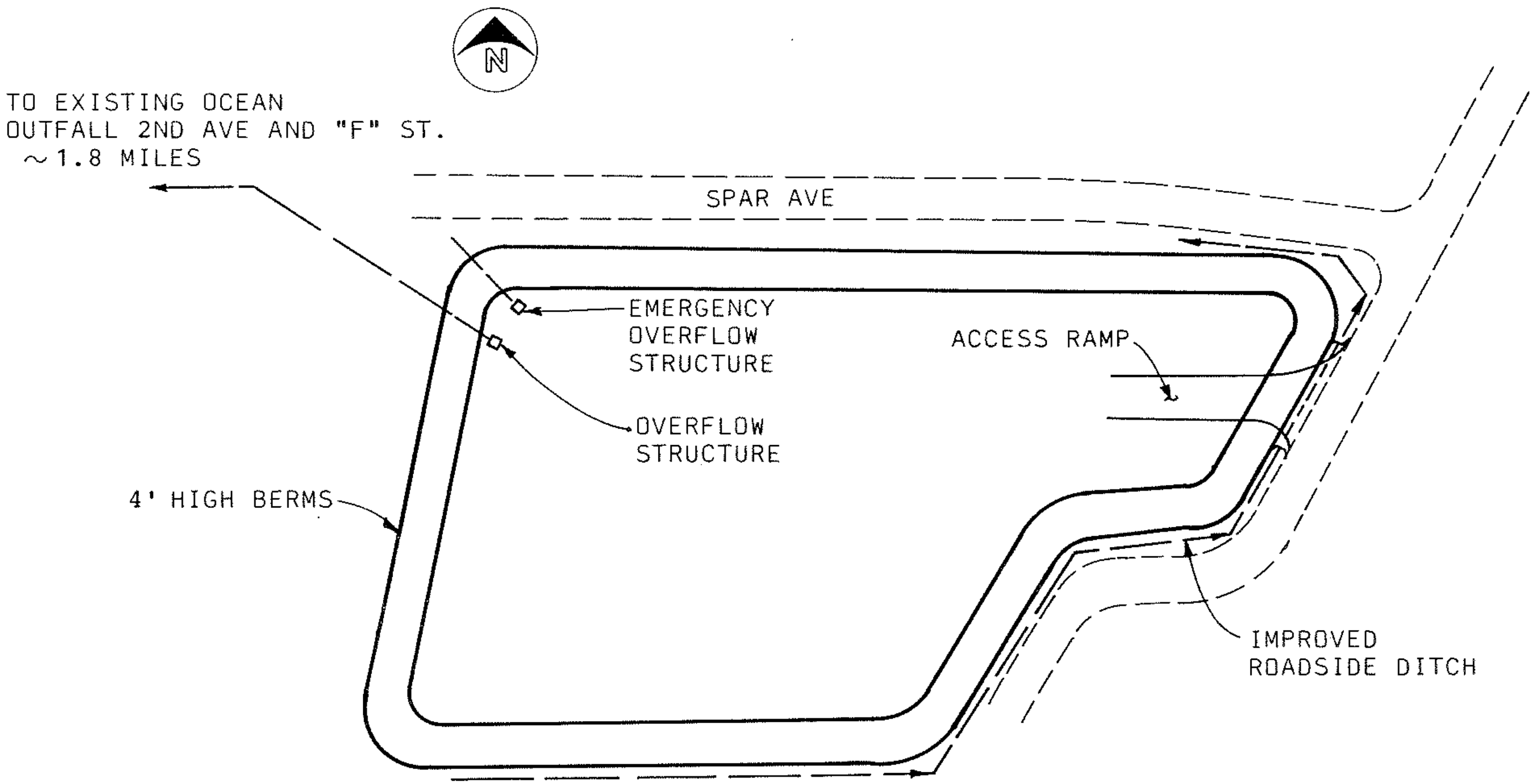


FIGURE A-3

SITE NO. 9

STRUCTURAL CONTROL

CH2M HILL

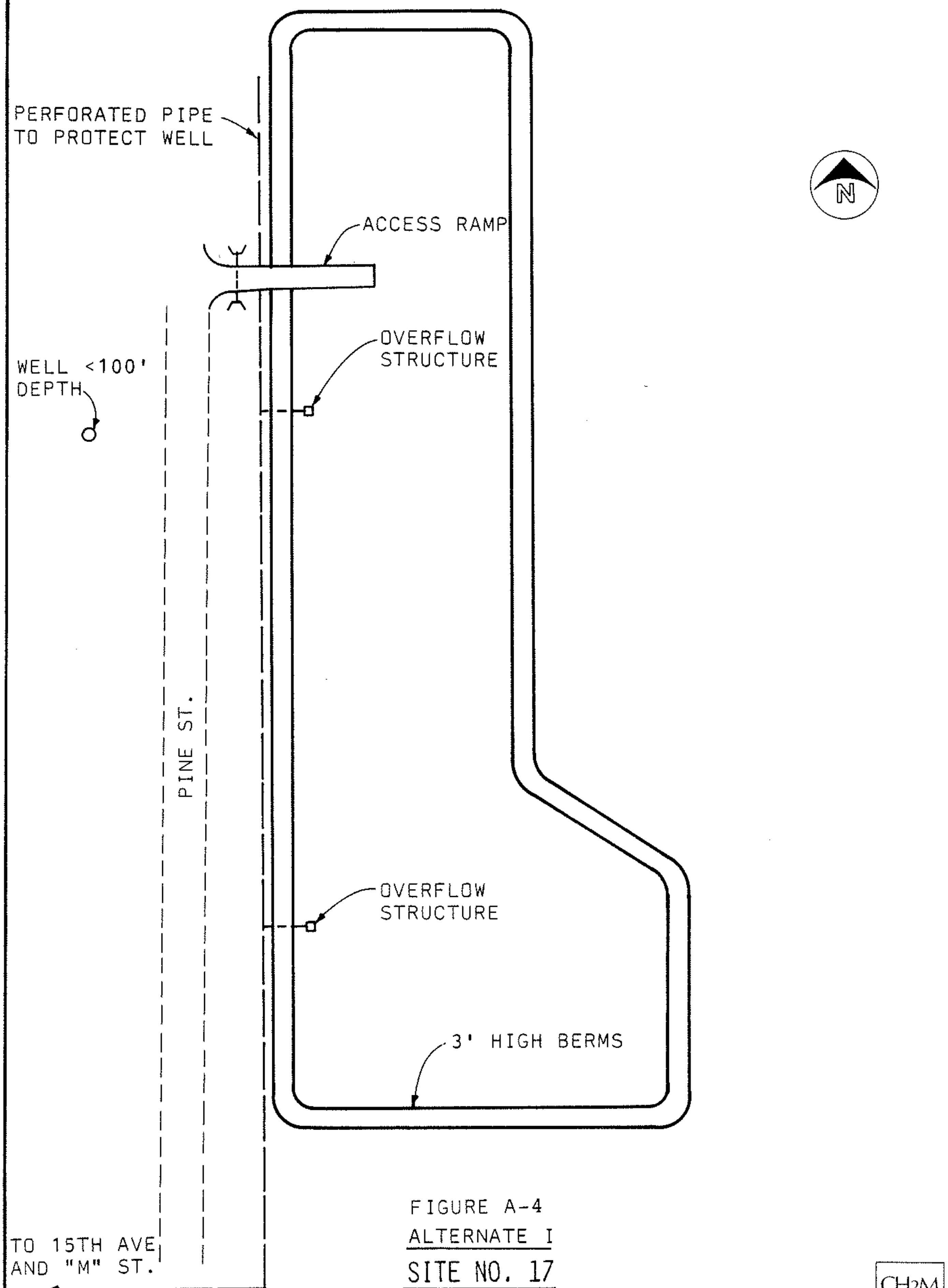


FIGURE A-4
ALTERNATE I
SITE NO. 17
STRUCTURAL CONTROL

CH2M HILL

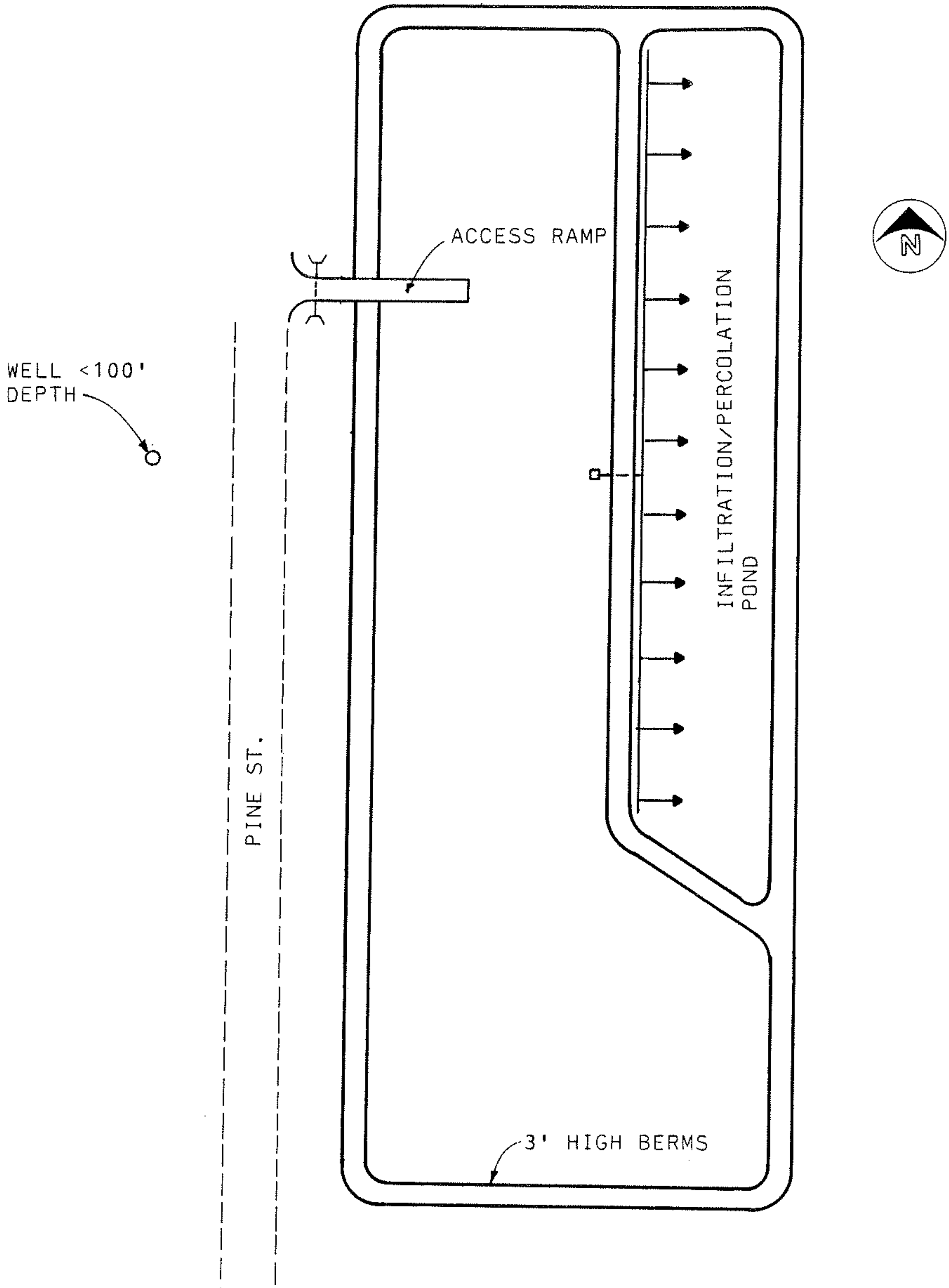


FIGURE A-5

ALTERNATE II

SITE NO. 17

STRUCTURAL CONTROL

CH2M HILL

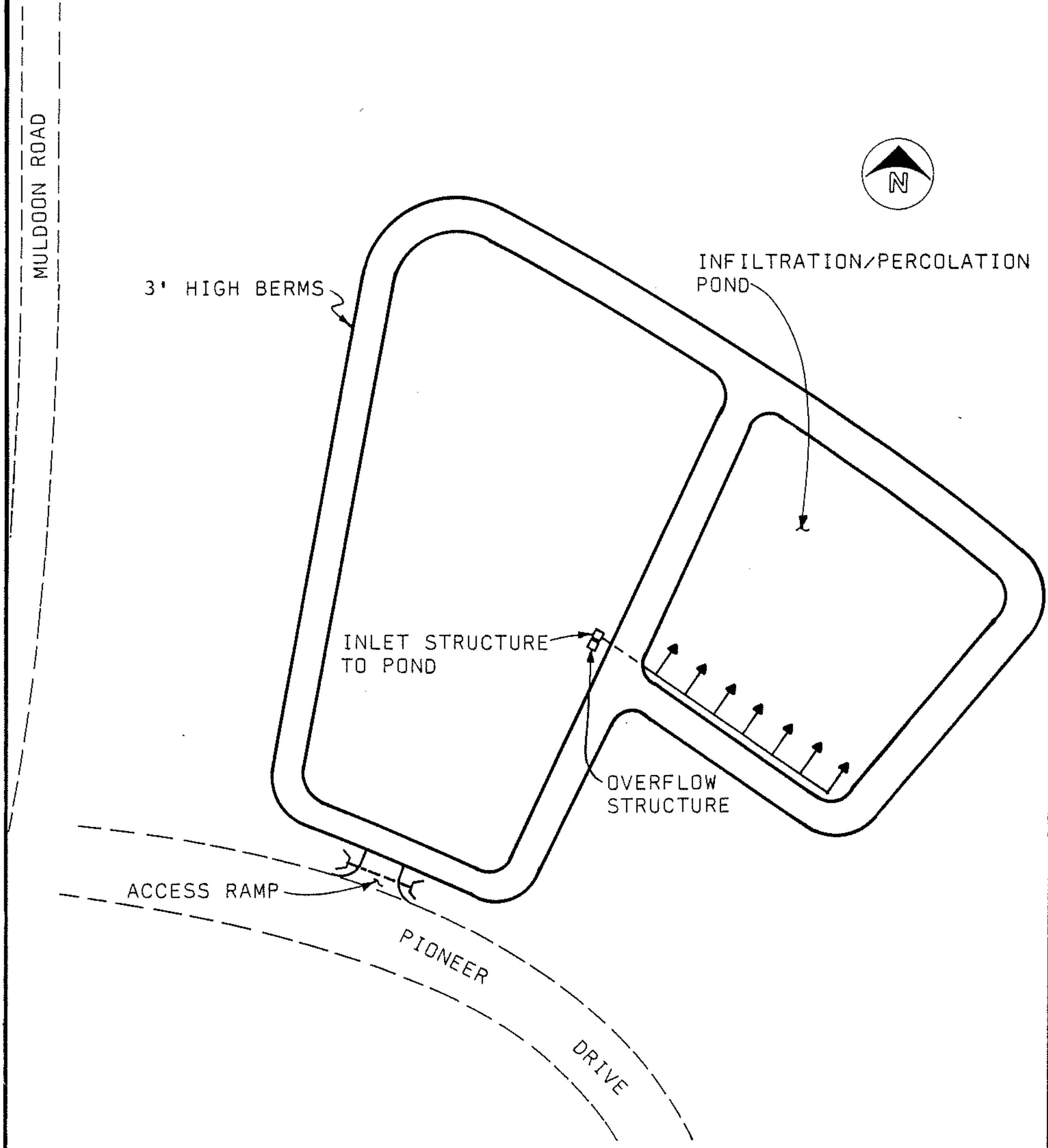


FIGURE A-6

SITE NO. 20

STRUCTURAL CONTROL

- San Roberto Drive (Site 17). Two alternatives are shown for this site. The first alternative has a small storage and infiltration/percolation basin, and a 10-inch gravity overflow pipe to a storm sewer at 15th Avenue and "M" Street. This storm sewer has an outfall onto the tidal flats. A pump station is located on the overflow line, but outside the area shown on the figure. The estimated cost for this alternative is $700,000. The second alternative emphasizes infiltration and percolation. The basin controlling runoff is enlarged. Overflow drainage is by existing drainage to the peat bog. The estimated construction cost for this alternative is $200,000.

- Pioneer Drive (Site 20). This site has the basic design. Overflow can be handled by natural drainage to the peat bog. The estimated construction cost of this system is $50,000.

Controls at these four sites are estimated to cost $1.1 to $1.8 million for construction and $0.3 to $0.9 million for design, geotechnical work, resident engineering, and contingencies. The four sites are estimated to contain 220,000 cubic yards of waste snow in an average year. The three sites in the Campbell Creek basin contain an estimated 36,000 cubic yards of waste snow. By simple ratioing, therefore, the estimated costs of control at the three sites in Campbell Creek are $0.2 to $0.4 million. New sites to handle urbanizing areas and maintenance of all sites will add to this cost, of course. Annual maintenance costs are estimated at 5 percent of the total construction cost, or approximately $15,000 per year.

Study Area

Costs of the Level 3 controls for the entire study area have been calculated in the same manner as those for the Campbell Creek basin alone. The estimated costs of control at the 27 snow disposal sites identified in the study area are $5 to $9 million for construction and $250,000 to $450,000 per year for maintenance.

ONSITE WASTEWATER DISPOSAL

LEVEL 1

Continuation of existing practices would result in no additional costs. The existing program is comprehensive and, as such, has a definite cost. However, because of the numerous responsibilities of the Department of Health and Environmental Protection personnel and the fact that they receive assistance from the Planning and Public Works departments for some aspects of the program, determining the cost of current septic tank control is not possible.

LEVEL 2

The additional costs associated with Level 2 are presented for each new program element. Most of the cost are user costs, to be borne by the developer and homeowners. It is important to note that these costs do not assume extention of sanitary sewers to the Hillside area. It is expected that as much as 2/3 of the problem septic tanks are located in this area. Consequently, extention of sanitary sewers to this area would reduce the cost of administration of the proposed program and reparation of factured systems by as much as 2/3. The costs given below, therefore, represent the worst case situation. Since the same assumptions were made for both Level 2 and Level 3 programs, the results of the comparative assessment are not affected.

Comprehensive Sanitary Survey

This would take 6 to 9 months of one person's time and require a budget of $30,000. This estimate is based on figures provided by DHEP and assumes mailing of a questionnaire to each house, followed by visits as needed.

Assuming that there will be 900 onsite systems in areas that will not be sewered by 1995 and that 45 percent of these will fail, upgrading will cost about $1,100,000. This assumes that 75 percent of the failed systems will require only a new drainfield at $2,100 and that 25 percent will have to be replaced at a cost of $4,500. Although these costs would be paid by the homeowner, they can be attributed to the 208 program.

Computerize Onsite System Data

This task could take up to 18 months and cost $80,000 if all available soils data were to be put into a uniform classification. Using only data at DHEP, it would take from 6 to 12 months and cost $30,000 to $60,000. The Municipality already has a computer system that would have to be made available to DHEP, since DHEP's computer facilities are inadequate for this task. Once the initial programming of existing data is completed, an ongoing updating program would be needed. This would require about one-third to one-half a person year and cost around $12,000 annually.

Certification of Soils Technicians

A certification program could be initiated for about $7,000 per year. This cost would principally be for administration.

Increased Inspection

If the continuing inspection program is implemented, it is anticipated that no additional personnel would be required and around $2,000 would be needed for administration.

Voluntary Maintenance

A voluntary maintenance program would cost about $5,000 per year for sending out reminders to owners of onsite systems. Private costs for pumping septic tanks would also be realized. However, this cost is a part of responsible ownership and should not be attributed to the 208 program.

Continued Inspection

This practice would be closely correlated with the voluntary maintenance program mentioned above. It would require hiring of an additional inspector and minor expenses. A yearly cost of $35,000 is projected.

Dual Absorption System

The additional cost to install a second drainage system is from $700 to $1,200 for a typical three-bedroom house if it is done while the septic system is being installed. For a septic system that has already been installed and backfilled, the cost for a second drainage system would be from $1,800 to $2,400. These costs would be paid by the homeowner. Assuming that 400 new onsite systems would be built in the Hillside area by 1995, the total cost for installing dual absorption systems would be $480,000.

DHEP Approval for Home Title Transfer

The majority of this program is already in effect and only administrative costs of about $5,000 annually would be required.

Water Conservation

These costs would be paid by the homeowner and are anticipated to be negligible.

Formulization of DHEP Operating Procedures

This practice should be accomplished within the existing budget.

Public Education

This practice should be coordinated with the voluntary maintenance program. An additional $5,000 per year would be required for administration, writing up of a pamphlet and postage.

LEVEL 3

This plan calls for all of the Level 2 controls, excepting voluntary maintenance. The major difference is that capital costs would be lower because 75 percent EPA Section 201 funding is anticipated. This funding would be popular with area house owners needing to upgrade their onsite systems. In contrast administrative costs would be higher because one criterion for receipt of 201 funds is provision of organized maintenance and operation as opposed to privately controlled maintenance as is now practiced.

EPA 201 Facilities Plan

An EPA 201 Facilities Plan would be conducted for the entire Anchorage area serviced by onsite waste disposal systems. A cost of $100,000 for Step I (the study) is a reasonable estimate. This cost could be higher but many of the aforementioned controls, especially the Comprehensive Sanitary Survey, should provide invaluable information to the study.

EPA would fund 75 percent of the Step I study and 75 percent of the costs for upgrading failed systems that were built prior to 1977. Thus, local capital costs, assuming the same program as recommended for Level 2, would be $428,750, or 25 percent of the Level 2 costs.

Although 201 funding could greatly reduce capital costs, operation and maintenance costs are not subsidized under the 201 program. In addition to the O&M costs of $66,000, (Level 2 costs minus voluntary mainteance costs) additional costs under Level 3 would be realized for public maintenance of all onsite systems. (In this case the Campbell Creek basin is considered in total as a "special maintenance district.") Assuming the Campbell Creek basin will have about 1900 onsite wastewater disposal systems in 1995, or 400 more than present, and the average cost for pumping is $75 every 2 years, average annual operational costs would be $71,250. Total annual O&M for the Campbell Creek basin would therefore be $66,000 + $71,250, or $137,250. These costs could be financed through monthly sewer utility bills.

APPENDIX B
PROPOSED DESIGN CRITERIA AND IMPROVEMENT STANDARDS

SECTION 10.04 DRAINAGE IMPROVEMENTS

Article 4.8 Soil Erosion and Sediment Control

A. General.

Criteria and standards established herein were developed as a requirement of Public Law 92-500, Section 208 which pertains to areawide waste water treatment management planning. The purpose of the criteria and standards is to accomplish water pollution abatement planning relative to the control of erosion and sedimentation. The ultimate goal is to achieve levels of quality of surface waters consistent with Alaska Water Quality Standards (18 AAC 70).

B. References.

1. Erosion and Sediment Control, Municipality of Anchorage 1977.

2. Environmental Protection Agency publication, EPA 430/9-73-007, "Processes, Procedures, and Methods to Control Pollution Resulting From All Construction Activity."

3. U.S. Soil Conservation Service; Palmer, Alaska 1977, "Soils of The Anchorage Area, Alaska."

4. U.S. Soil Conservation Service; College Park, Maryland 1975, "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas."

5. A number of other SCS publications pertaining to erosion and sediment control in urbanizing areas.

6. Alaska Statutes Title 18; Environmental Conservation, Chapter 70 Water Quality Standards.

7. Prevention and Control of Icing Problems in Culverts and Storm Drainage Facilities, J. R. Floden 1976, unpublished.

C. Site Planning.

1. Site drainage. All construction drainages should include interim drainage patterns that are proposed to be used during the actual construction period; and also, the permanent drainage plans. Drainage patterns should be denoted by drainage arrows with corresponding gradients or slopes specified. Temporary drainage swales, surface water diversion berms, straw bale diversion dikes, sediment basins and other temporary structural erosion and sediment control measures specified hereafter should be shown on construction drainage plans as applicable. The plans should contain estimated duration of construction periods, as well as time periods during which individual areas will be left unprotected. Construction should immediately follow clearing and

grubbing operations; premature stripping of land should be avoided. A notice-to-proceed for clearing and stripping should be obtained from the Public Works Department for all construction activities within the R.O.W.'s.

2. Erosion and Sediment Management. Project specifications and contract documents should contain provisions outlining responsibility for erosion and sedimentation control; the owner's contractor should be held responsible for erosion and sediment control, and the engineer must be responsible for erosion and sediment management and planning.

3. Access During Construction. All access points used during construction should be noted on the plans; access to paved public roads should be avoided where other alternates exist. When egress from construction sites involves paved roads, a crushed aggregate "wash strip" (plus 1" to minus 4", LA Abrasion not exceeding 30% loss) should be specified. The wash strip should be placed in a 6" lift and should extend 50 feet from the pavement, see Fig.______, on page ______. The "wash strip" should slope away from the pavement if possible. Contract documents and project specifications should state concern for soil-tracking by truck traffic onto paved roads. Limits of loading for dump trucks should be specified and the owner's contractor should be held responsible for proper maintenance of his dump trucks and gravel trucks, so that soil/aggregate spillage is completely eliminated. Trucks which do not comply with the requirements stated in the contract documents are not permitted to operate on paved roads.

4. Soil Loss Computation. Soil loss should not exceed 15 tons per acre per year. The Universal Soil Loss Equation should be used to estimate soil loss from developing areas. Wash-off Simulation Models such as SAM ETD System may be used once calibrated and verified by the Public Works Department. The use and limitations of the Universal Soil Loss Equation is discussed in References 1, 4, and 5. Information on SAM ETD System may be obtained from the Public Works Department.

If soil loss determined in accordance with the above mentioned methods is in excess on 15 tons per acre in a design year, erosion and sediment control measures specified in Article 4.8 D should be used in order to limit the soil loss.

D. Erosion Control.

1. Where soil loss as determined by the methods specified in Article 4.8, C4 is in excess of 15 tons per acre per year; or where construction is to take place adjacent to a natural lake or stream, and/or the site is drained by an existing drainage system, erosion control measures shall be employed as described below.

   a. Diversion Berms. This structure shall consist of a compacted earth berm immediately above cut or fill slopes and constructed with sufficient grade to provide drainage. The purpose of diversion dikes is to intercept storm runoff from small upland areas and divert it from exposed slopes to an acceptable outlet temporarily until permanent drainage features are installed and/or slopes are stabilized. The drainage area should be less than ten acres. A typical section of a compacted earth berm is shown in Fig.______, on page______, as applicable to surface water diversion, interceptor dikes, or spoil fill stabilization. Flow channels should be stabilized where slopes are in excess of 5%, and where flow velocities exceed the permissible limits for the given soil conditions. Outlets shall lead directly to undisturbed, stabilized areas with a minimum of erosion or into a level spreader, a flume, or a rock channel and conveyed to a sediment-trapping device, or a sediment basin as necessary.

Interceptor dikes are constructed across distrubed right-of-way's such as streets, graded parking lots or landfills. The purpose of interceptor dikes is to shorten the length of exposed slopes, thereby reducing the potential for erosion. The drainage area should be less than 10 acres, with an outlet that functions with a minimum of erosion.

Perimeter dikes with the same design requirements as other diversion berms should be constructed for the purpose of preventing offsite storm or snowmelt runoff from entering the disturbed area; and to prevent sediment laden on-site runoff from leaving the disturbed area, before the sediment is trapped. Straw bale dikes, described under Sedimentation, may be substituted for compacted earth berms by approval on a case-by-case basis.

b. Interceptor Swales. The purpose of an interceptor swale is to reduce the potential for erosion by intercepting storm and snowmelt runoff on exposed slopes and diverting it to a stabilized outlet or sediment-trapping device. The minimum grade for swales is 1%; swales which exceed 5% grade should be stabilized as specified in Item "c" below. Side slopes shall not be steeper than 2:1; bottom width may vary on a case-by-case basis. At all points where several vehicle crossings per day is anticipated, the swale shall be stabilized according to Item "c" below, except the stone lining shall be at least 6" in thickness for the full width of the traffic crossing or roadway. Swales may be substituted for diversion berms described above where applicable as determined by icing conditions. Standard details for interceptor swales is shown in Fig.______, on page______.

c. Channel Stabilization. Where permissible velocities for a given soil type is in excess of allowable limits, channels, including roadside ditches, should be stabilized by one of the following methods:

(1) Grassed Water Ways. This method can be used successfully for grades up to 10% when the flow area is stabilized by use of protective fabric materials such as jute, excelsior, or glass fiber matting on prepared seed or planting bed of a channel . Matting shall be installed according to manufacturer's instructions. The Public Works Department shall be provided with copies of the instructions during design

review or at the time of application for a construction permit. Typical details for channel matting and erosion stops are shown in Fig.______, on page______.

(2) Energy Dissipators, or Rock Lining. Energy dissipators will be required when minimum design flow velocities (determined by using 10 year storm data) are in excess of permissible limits (See Tables______, Articles______and ______). Energy dissipators shall consist of rock checks as illustrated in Fig.______, on page______. Stilling basins will not be allowed due to icing problems. Riprap-lined channels may be required at the outfalls, 90^{o} bends, and on steep slopes as an alternate to flumes. Riprap shall have a filter blanket placed under it when either of the following conditions exist: 1) the riprap is not well graded down to the 1" size particle, AASHTO M43 size No. 2 or No. 24. 2) the riprap is placed on fine sands or silts with a plasticity index, PI, less than 10. The criteria for the design of aggregate filter is as follows:

$$\frac{d_{15} \text{ riprap}}{d_{85} \text{ Filter}} \quad 5 \qquad \frac{d_{15} \text{ Filter}}{d_{85} \text{ base}} \quad 5$$

where:

d, is particle diameter

d_{xx}, is particle diameter at xx percent fines, on particle-size-distribution, "gradation", curves.

The "base" means the soil layer under the filter, top 4". Plastic filter cloth (Poly-Filter X, by Carthage Mills, Inc., or equal) manufactured for that express purpose may be used as an alternate to sand filter; however, a 4" minimum thickness blanket of gravel shall be placed over the filter cloth to protect it from tearing caused by dumping riprap.

For details of designing riprap for bank protection in natural streams refer to State Department of Transportation and Public Facilities Hydraulics Manual. Stones used in stabilizing the flow area in channel shall meet the requirements of AASHTO M43 size No. 2 or No. 24. Plus 4" washed-aggregate-oversize may be substituted on a case-by-case basis. Stone lining shall be placed in a layer at least 3" in thickness extending across the bottom and up both sides of the channel a height of at least 8" above the bottom. Riprap shall consist of field stone or quarry stone of approximate rectangular shape, the specific gravity of which shall be at least 2.5 for use in natural streams or major storm channels. Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and aesthetics are of no concern. The riprap shall be of such quality that it will not disintegrate on exposure to water or weathering. Magnesium Sulfate Soundness Test may be required in critical cases, as applicable.

(3) Stream Bank Stabilization.

(4) Mulching for Slope Protection or Channel Stabilization. Cutback asphalt - rapid curing or medium curing, and emulsified asphalts may be used in accordance with Asphalt Institute Specifications; synthetic binders may be used as recommended by the manufacturer. See Reference 4, and Asphalt Institute Publication MS-7 for details.

d. Construction of Stabilized Crushed Aggregate "Wash-Strips" At Entrances to Construction Sites. The purpose of a stabilized construction entrance is to reduce or eliminate soil-tracking or flowing of sediment onto paved streets. This applies to all points of construction ingress and egress in urban areas, and in suburban areas where 60% of the streets are paved or where storm drains are directly involved.

Stone size - Crushed Only, AASHTO M43, Size No. 2 (2 1/2 to 1 1/2")

Thickness - Minimum 6"
Width - Minimum full width of driveway
Length - Minimum 50'

The entrance shall be maintained in a condition which will prevent soil-tracking onto paved roads. This may require periodic maintenance by adding additional layers of crushed stone or washing by water. A sediment trap as outlined under sedimentation should be provided and periodically repaired and cleaned. All sediment tracked, spilled, or washed onto paved streets must be removed immediately. When necessary, wheels must be cleaned to remove sediment prior to entrance onto paved public roads. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch, or watercourse through the use of sand bags, gravel berms, boards or other approved methods. Details for a stabilized construction entrance are shown on page______.

e. Stone Outlets. The purpose of the stone outlet structure is to provide a protected outlet for a diversion dike, interceptor dike, or perimeter dike, to provide for diffusion of concentrated flow, and to allow the area behind the dike to dewater. Standard details for the outlets is shown in Fig.______, on page______. The stone shall be crushed or angular, gravel may be used if stone is not available; and it shall meet the requirements of AASHTO M43 size No. 2 or No. 24.

f. Paved Chutes or Flumes and Pipe Slope Drains. Although rock slope drains with filter blankets are preferred, paved chutes or flumes and rigid or flexible pipe slope drains may be specified. Paved chutes or flumes must be bedded in non-frost susceptible base material. Half-pipe-section flumes and rigid or flexible pipe slope drains shall be installed in accordance with manufacturer's recommendations copies of which shall be provided to the Public Works Department for review. Inlets for pipe slope drains shall be of steel, aluminum, concrete, or other stabilized material capable of resisting erosion around the inlet. Staggered pipe system or icing control will be required in accordance with Article 4.8 D. All pipes and flumes shall outlet onto a rock apron and sediment trap.

g. Aprons and Sediment Traps For Pipe Outfalls. Pipes should outlet onto riprap aprons and sediment traps as specified in Fig.______, on page______. Riprap shall consist of 6" diameter stone, and shall be placed with a minimum thickness of 12". The depth of aprons shall equal the pipe size. Other typical dimensions for aprons are shown in Fig.______, on page______.

E. Sediment Control.

1. Sediment trapping procedures/devices as outlined below will be required on the project site as applicable. Sediment basins will be required on all discharge points into natural streams and lakes. The size, spacing and number of sediment trapping devices shall be determined according to computed sediment loading quantities by using the Universal Soil Loss Equation or SAM ETD Simulation System.

a. On-Site Sediment Traps. The purpose of a sediment trap is to intercept sediment-laden runoff and remove the suspended solids in order to protect drainage ways, properties, and streets below the sediment trap. The sediment trap should be located to obtain the maximum storage benefit from the terrain, for ease of maintenance of the trap, and to minimize interference with construction activities. Each sediment trap shall be delineated on the plans in such a manner that it will not be confused with any other features. The following types of sediment traps are hereby suggested. The engineer may design his own, which will be subject to approval by the Municipality.

(1) Earth Outlet Sediment Trap - typical details shown in Fig.______, on page______.

(2) Pipe Outlet Sediment Trap - typical details shown in Fig.______, on page______.

(3) Stone and Straw Bale Outlet Sediment Trap - typical details shown in Fig.______, on page______.

(4) Board Outlet Sediment Trap - typical details shown in Fig.______, on page______.

(5) Storm Inlet Sediment Trap - typical details shown in Fig.______, on page______.

b. Lawn and Bank Sediment Control. The slopes behind sidewalks and curbs shall be 1% toward the street extending 5' from the back of curb and, the slope shall intercept the outside edge of the sidewalk or curb 1" below the top. This permits fine material washed from newly planted lawns to settle out before the water enters the street. This small detention basin will, of course, become silted in but in most cases the lawn will be established by that time and little, if any, additional erosion will occur. This concept is shown in Fig.______, on page______.

c. Settling Basins at Outfalls onto Natural Streams and Lakes. The purpose of the sediment treatment system is to intercept sediment-laden runoff; reduce nutrient levels, heavy metals, dissolved solids, soaps, and grease and oil. Oil and grease separation shall be accomplished at the last manholes in the storm system designed in accordance with Article 4.8, E4. Aeration shall be accomplished by a rock-lined water fall type outfall where practical. Aeration will help organisms use up the nutrients in the flow, thus reducing BOD downstream. It will also cause some dissolved iron to precipitate out, and will increase the available oxygen in the water. A zoological film should become established in the rocks which will act similar to a trickling filter. In addition, outfalls with sufficient fall are highly desirable in regard to icing control as described in Article 2.8, F.

Settling basins shall consist of a compacted earth berm, pipe outlet with icing control and anti-seep collars and an emergency spillway. The spillways must be designed to safely handle the normal flow and the maximum design flow without erosion. Details and minimum dimensions of settling basins is shown in Figures______through______, on pages______through______.

(1) Compacted Earth Berm. The berm shall be constructed of impervious clay materials placed in 12" lifts and the successive lifts compacted by haulage and earth-moving equipment. The shape of the berm shall conform to typical details shown in Fig.______, on page______. The emergency spillway may be incorporated into the berm structures according to outlet details shown in Fig.______, on page______. The earth embankment shall be high enough to have 1' of free board between the maximum design flow elevation in the emergency spillway and the top of the drain. The embankment shall be stabilized by vegetation.

(2) Pipe Outlet and Riser. Pipe outlet shall be constructed of CMP or equal with seepage collars as shown in Fig.______, on page ______. The capacity of the pipe shall be determined by using SAM or ILLUDAS simulation models; it shall be equal to the storm drain capacity otherwise. The pipe shall be placed in a solid impervious bed, compacted in 4" lifts, using a trench compactor to at least the same density as the adjacent embankment. All pipe joints and anti-seep collars are shown in Fig.______, on page______. At least two seepage collars are required per pipe riser.

F. Icing Control.

1. Icing control should be determined in accordance with applicable design alternatives. Either electric thaw cables or steam thaw pipes shall be specifed for culverts crossing under roads, and for other drainage systems where necessary. Electric thaw cables shall be specified according to manufacturer's recommendations and the Public Works Department shall be provided with copies of the manufacturer's brochure for review. Steam thaw pipes shall be specified in accordance with typical details shown in Fig.______, on page______. The following note for installation of thaw pipes shall be placed on construction plans:

   a. Install 1/2" galv. iron steam thaw pipe in the top of pipes greater than 24" diameter and in the bottom for pipes less than 24" diameter. The ends of the thaw pipes shall be turned up 2.5' above the top of culvert, secured to culvert and capped with threaded plugs. Fill with antifreeze.

   Standard details for securing thaw pipes to culverts and storm drain pipes are shown in Fig.______, on page______. Typical details should be referred to in the plans.

   The need for "culvert closures" and "staggered pipes" or other icing control methods will be determined on a case-by-case basis.

   Where natural streams are intercepted by storm drain systems, pipe inlets shall be designed in accordance with the typical details, staggered pipe inlet manholes, shown in Fig.______, on page______.

APPENDIX C
EVALUATION SCREENING SYSTEM

TABLES

FIGURES

OVERLAYS

APPENDIX C
EVALUATION SCREENING SYSTEM

The present system is to select snow disposal sites on a trial-and-error basis. This approach has led to many public complaints and the eventual abandonment of several sites. A logical and consistent approach to snow disposal site selection could decrease the number of complaints, as well as reduce the potential of water pollution from the sites.

A set of screening criteria has been developed in order to provide this logical and consistent approach. These criteria are presented on the table at the end of this report. The evaluation has been divided into two steps. The first step, termed the area screening, identifies broad areas within which to locate future snow disposal sites. The second step, termed the site screening, evaluates and compares specific sites within a favorable area. The logic behind each criterion is discussed below.

This evaluation screening system should only be one part of an overall program to find the most effective ways of snow and ice control. For example, this system cannot be used to weigh the merits of snow disposal onsite along right-of-ways against those of snow disposal offsite in snow dumps. Similarly, this system cannot be used to select the most efficient types of equipment for snow and ice control. However, the evaluation screening system can provide a logical and consistent process to choose among alternative snow disposal sites.

AREA FACTORS

- <u>Location of Service Area</u>. This factor has been the most important concern in the past. Snow hauling costs are one of the largest cost items for snow removal. The current contract rental rate for the Municipality of Anchorage for a truck and operator is \$37.50 per hour. Based on this hauling cost and an average truck speed of 15 miles per hour, the unit cost increase for snow hauling is 30 cents per cubic yard of snow per additional mile of distance between the service area and snow disposal site ($\$0.30/yd^3/mi$). If all major snow disposal sites in the Municipality of Anchorage were moved 1 mile further from their service areas, the additional costs would average approximately \$200,000 per year.

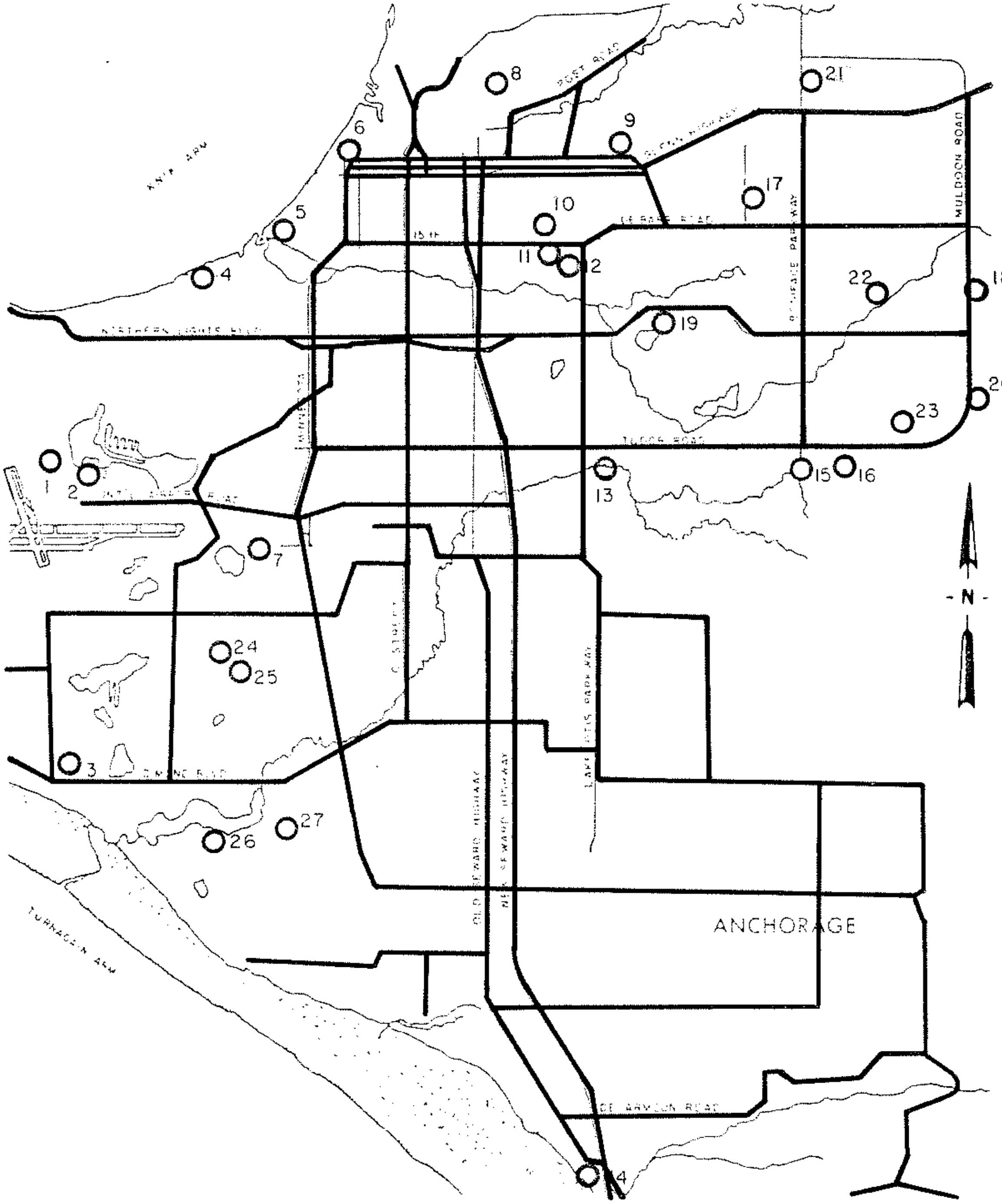
- Access. Major arterials can provide more rapid and safer access to the snow disposal sites. Noise impacts will also be minimized if trucks hauling snow use primarily the major arterials. The designated truck routes in the central business district and the major arterials outside it are shown on Overlay A.

- Receiving Waters. Although the existing snow disposal sites have not been conclusively linked to any water quality problems, data from the water quality analysis of snow in the Anchorage area and information from the literature indicate the potential for pollution. Potential pollutants include chloride, nitrate, suspended solids, oil and grease, and heavy metals such as iron and lead. Impacts from chloride and nitrate will be mitigated by discharge of snowmelt to Cook Inlet. Impacts from suspended solids, oil and grease, and heavy metals will be mitigated by prevention of surface drainage. Drainage to creeks and percolation through to the deep aquifers are the least favored alternatives.

- Surface Waters. Disposal near or on surface water bodies can be unsightly. It also eliminates the potential that soils have to filter out pollutants before they reach the creeks and lakes. Surface waters are shown on Overlay B.

- Flood Plains. Disposal on flood plains has the same drawbacks as disposal on or near surface waters. Flood plains have been delineated on a map prepared by the Planning Department of the Municipality of Anchorage. As shown on Overlay C, flood plains are generally located within a narrow band of several hundred feet along the major creeks.

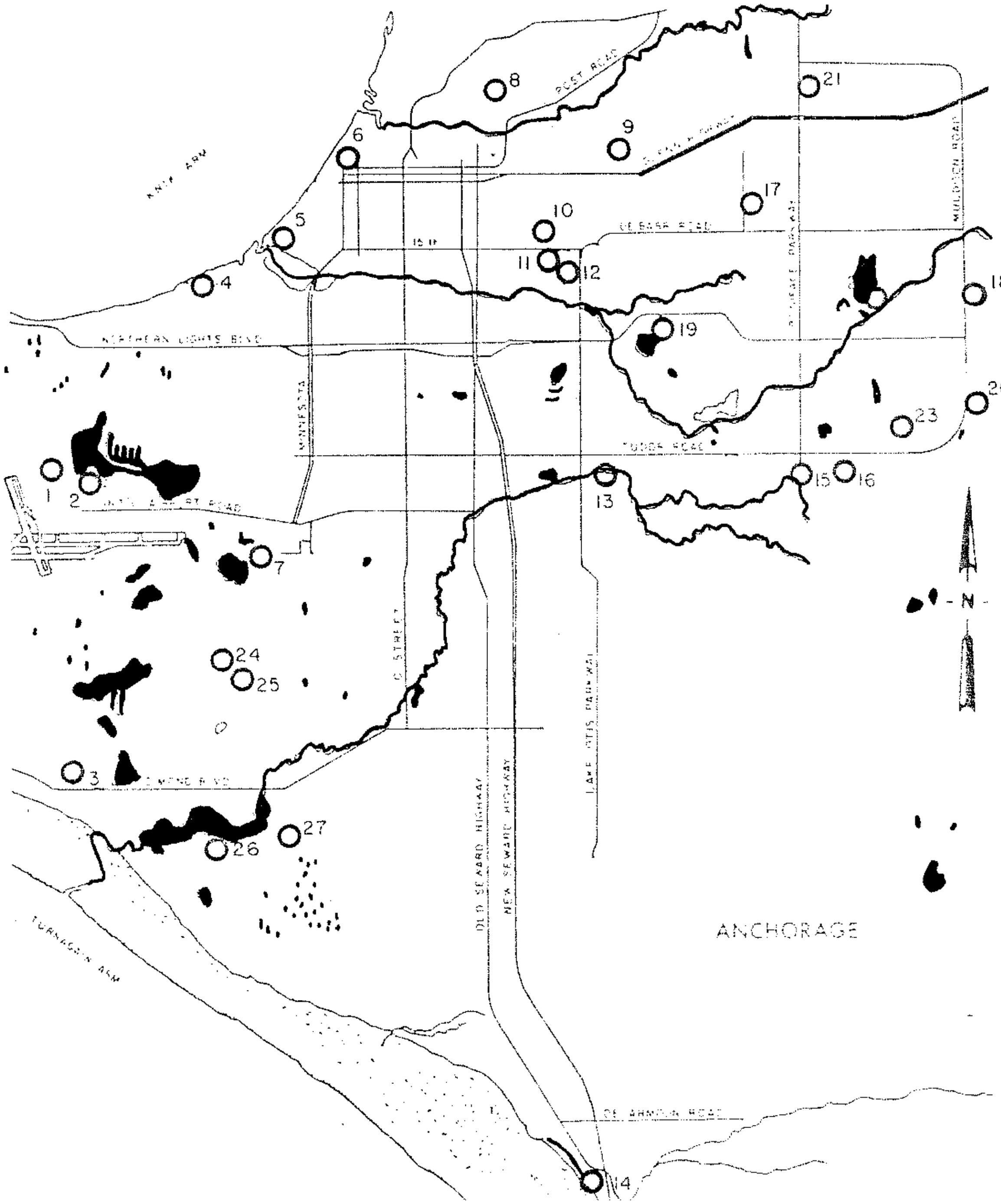
- Ground Waters. The extent of potential water pollution can be restricted by locating sites in areas of ground water discharge or local flow. The recharge area, whose approximate extent is shown on Overlay D, is not recommended for snow disposal sites because of the potential to broadly pollute the shallow and deep ground water aquifer systems. The most favorable areas appear to be those underlain by the Bootlegger clays, which seem to act as an aquiclude between the shallow and deep ground water aquifers. Much of the Anchorage Bowl is underlain at some depth by the



OVERLAY A

MAJOR ARTERIALS

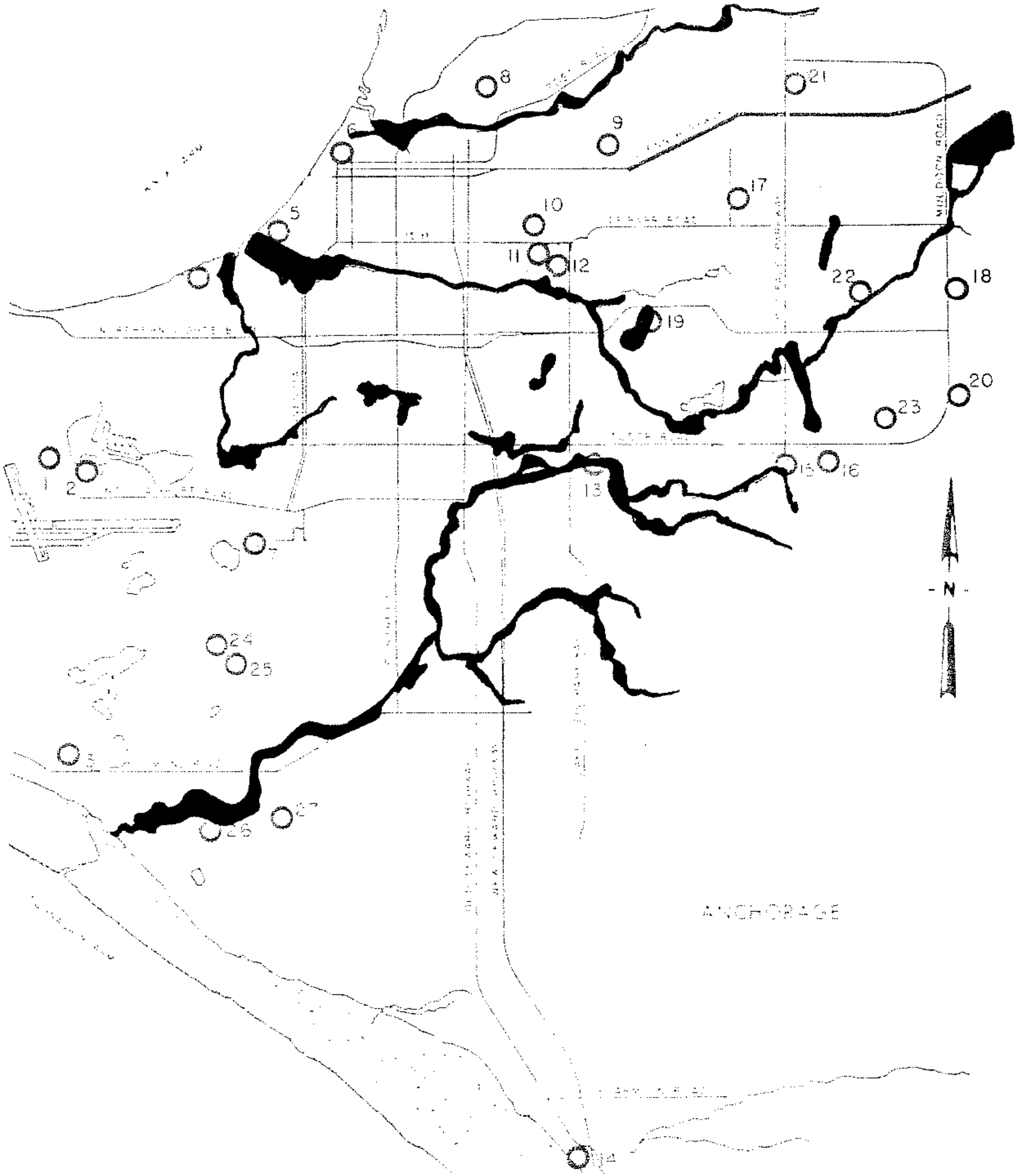
CH2M HILL



OVERLAY B

SURFACE WATERS

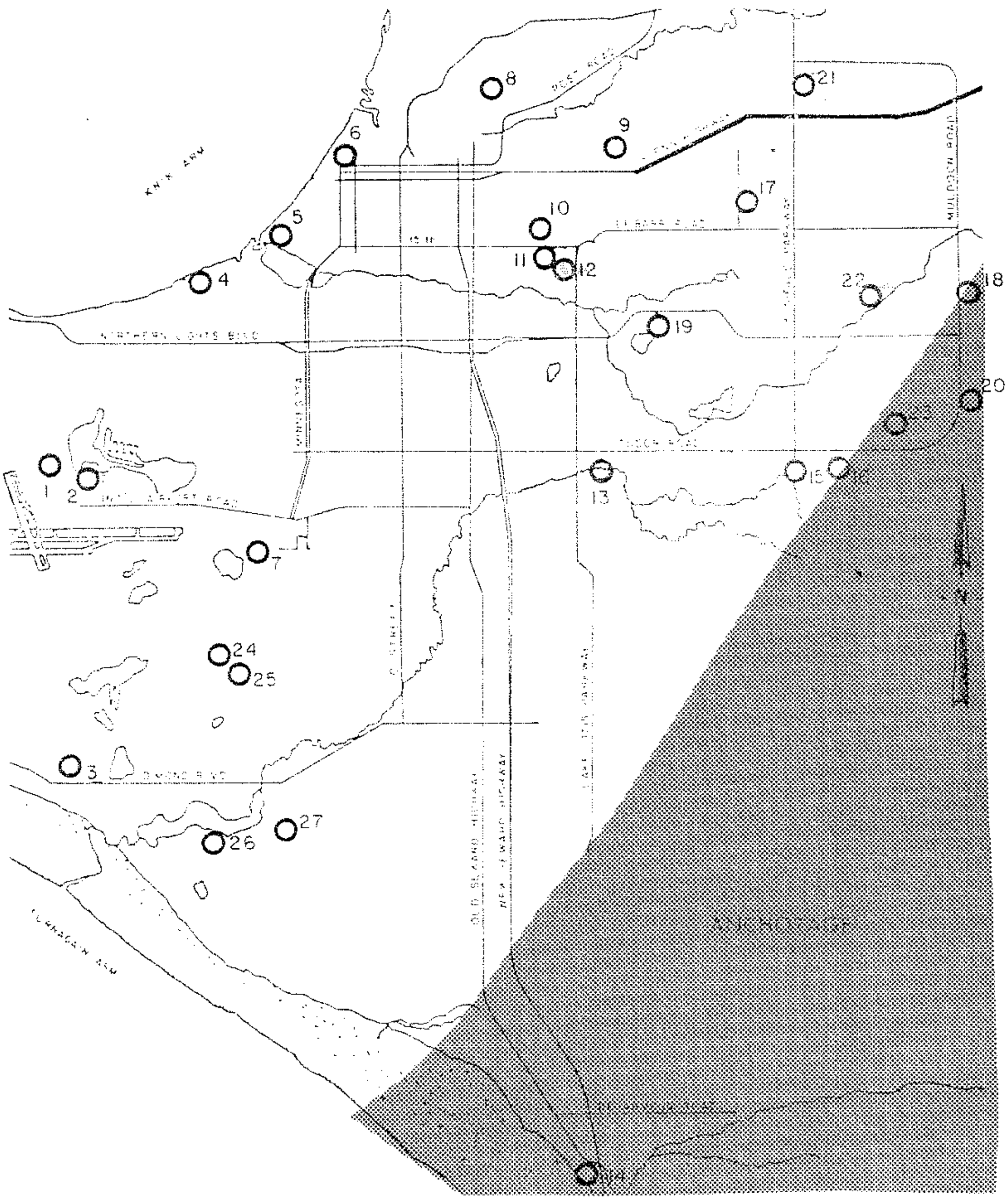
CH2M HILL



OVERLAY C

FLOOD PLAINS

CH2M HILL



OVERLAY D

RECHARGE AREA

CH2M HILL

Bootlegger clays. Areas where those clays make up the surface geology and probably most strongly restrict regional ground water flow are shown on Overlay F.

- Slopes. The greatest erosion in the Anchorage area occurs during spring snowmelt runoff. Glaciation is a major cause of the erosion increase. Snowmelt runoff from sites located in moderately to steeply sloped areas can further increase erosion rates. Areas of generally moderate to steep slopes are shaded on Overlay E. Although a few suitable sites may be found in the shaded areas, most land in those areas will be too steeply sloped for environmentally sound snow disposal sites.

- Historical and Archaeological Sites. A report on historical and archaeological sites in the Anchorage area will be published in summer 1978 by the Historical Landmarks Preservation Commission of the Municipality of Anchorage. The report will be titled "Patterns of the Past: An Inventory of Anchorage's Heritage Resources." This publication should be adequate for area screening of snow disposal sites. The value of a historical or archaeological site will be impaired, or in some cases irretrievably lost, if the site is used for snow disposal.

SITE FACTORS

- Area Screening. The area screening process should be redone on a site-specific basis to ensure the selection of the most favorable site.

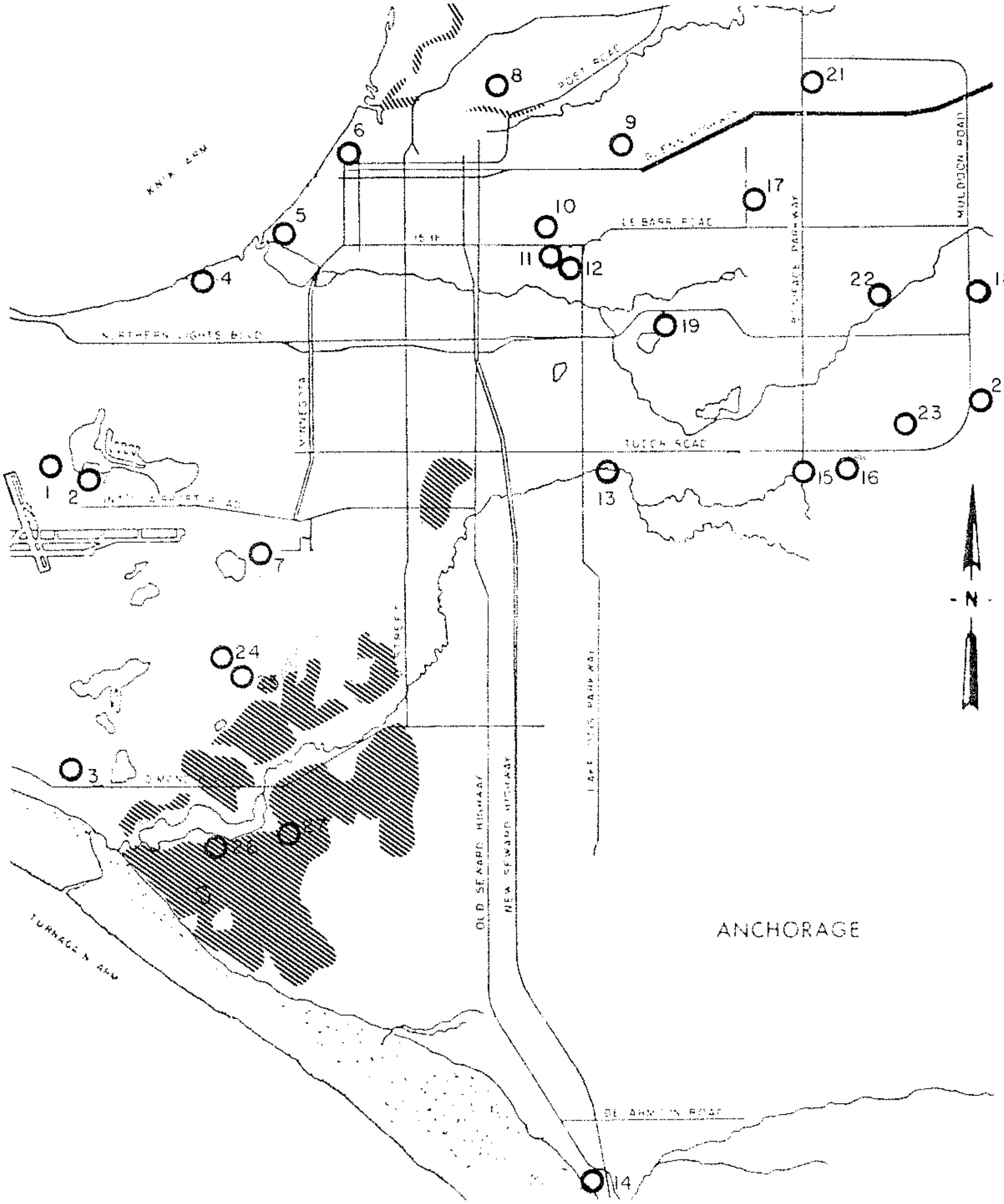
- Site Size. Present practice is to select a certain snow disposal site and then determine by trial-and-error how much service area that site can handle. Estimates of snow volumes to be wasted at each site could be determined, based on average snowfall, compaction, melting on roadways, and sublimation at the site. Until a system to make these estimates is formulated, present practice is adequate.

- Access. Poor access can result in safety hazards and delays in snow disposal. Difficult left turns into oncoming traffic, steeply inclined and slick roads, and dangerous intersections are several situations which can create poor access.

OVERLAY E

STEEP SLOPES

CH2M HILL



OVERLAY F

AREAS UNDERLAIN BY BOOTLEGGER CLAYS (SURFACE GEOLOGY)

CH2M HILL

- *Drainage*. No surface drainage is preferable. In locations where this is not possible, drainage should be controlled by ditches or storm sewers to discourage erosion and flooding. Drainage should be adequate to handle snowmelt runoff. A "Snow Disposal Impact Analysis" by CH2M HILL (1978a) estimated runoff from a 20,000 cubic yard waste snow pile to average 0.05 cubic feet per second. The runoff analysis should also consider any other drainage that may flow through the site.

- *Soils*. The best "filtering" soils are those with moderately high to high permeability to permit the infiltration and percolation of snowmelt runoff, yet with sufficient adsorption and ion exchange capacity to remove dissolved pollutants and with the proper consistency to remove particulate pollutants. The best soil type is a silty sand. Peat bogs are not highly permeable, particularly when underlain by tight clays. However, most have sufficient porosity to soak up limited quantities of water; and under enough hydraulic head, water can be surcharged through shallow peat material and out of the bog. Peat has an excellent capacity to filter out particulate matter and to absorb heavy metals under conditions of high oxygen and low acidity. Under more typical conditions of low oxygen and high acidity, heavy metals such as aluminum and iron may be released by the peat. Gravels have a high permeability and some capability to remove coarser particulate matter. However, they have a limited capacity to remove dissolved pollutants.

- *Slope*. Snowmelt runoff at excessive velocities will cause sheet and rill erosion, as well as erosion of drainage ditches. Site-specific analyses of erosion potential should be completed before a site is used. Velocities of 3-5 feet per second appear to be in the acceptable range, but more accurate allowable velocities for a particular site should be determined.

- *Glaciation*. Icing may radically change the pattern of drainage from a site. Areas of glaciation must be anticipated and accomodated in a drainage design. Potential areas of glaciation include low-flow and ponded areas.

- *Jurisdiction*. Long-term commitments to a site can relieve the pressures of identifying new sites.

Ownership of the site or a long-term agreement with the owner are necessary to ensure those long-term commitments.

- <u>Compatible Uses</u>. Snow disposal sites can be located so that they complement the designated use of the land. For example, development of peat bogs where peat thickness is deeper than 10 feet is usually cheaper by surcharging rather than by excavation. The sands and gravels trapped in waste snow are good fill material for surcharging the peat bogs. Thus, a private developer may want to encourage a snow disposal site on his bog in order to obtain inexpensive fill material. If not complementary, snow disposal sites may be at least compatible with the other uses of the land. For example, the same piece of land may be used for snow disposal in the winter and a recreational park in the summer if snowmelt runoff can be drained from the site before recreation season begins.

- <u>Aesthetics</u>. Waste snow piles have an unpleasant appearance. Snow disposal sites typically have large amounts of trash, either entrapped during the snow removal process or thrown into the site by passersby. The waste snow is also an undesirable dirty gray color, and leaves behind piles of dirt after it has melted.

- <u>Noise</u>. The snow disposal process can be noisy. The noisiest aspects include the bulldozing of snow at the site itself and the hauling of snow in large trucks. At least one site in a residential area has had to be abandoned because of complaints about noise from nearby residents.

- <u>Dust Control</u>. Waste snow entraps large quantities of dirt. After snow piles have melted, the residual piles of dirt may cause considerable dust problems if exposed to strong winds.

- <u>Trash Control</u>. Snow disposal sites collect large amounts of trash, either entrapped during the snow removal process or thrown into the site by passersby. The trash can be transported from a site by wind or water. Control of trash at the site is extremely important in order to minimize the areal extent of environmental degradation.

- <u>Wildlife Habitat</u>. No endangered species are found in the Anchorage area. Peat bogs, particularly near the shoreline, are nesting sites for a variety of colorful shorebirds and migratory waterfowl. Gravel pits are an extremely poor wildlife habitat. The Knik Arm and Upper Cook Inlet are also extremely poor wildlife and fisheries habitats (Corps of Engineers, 1978b), although large populations of salmon pass through the arm and inlet during the annual salmon runs.

- Plant Habitat. No endangered species are found in the Anchorage area. The destruction of large trees is discouraged because they create a pleasant mood and provide important visual and sound barriers.

- Ground Water. Snowmelt infiltration and percolation has been found to pollute shallow ground water aquifers in other parts of the country. The most commonly identified water quality problem is excessively salty water in domestic water supplies. Snow disposal sites should be located so as to minimize the potential for pollution of domestic water supplies in the Anchorage area.

- Water Table. Water levels have dropped drastically in some of the lowland lakes because of the draining of peat bogs, because of urban development which has increased surface runoff but decreased ground water recharge, and because of excessive pumping of the ground water aquifers. Snow disposal sites can have some impact, although probably small, on increasing ground water recharge and restoring lake levels. They may also have some effect, in this case detrimental, on raising the water table and causing failures of septic tank systems.

EVALUATION OF EXISTING SITES

The 27 existing snow disposal sites identified on Figure 1 have been evaluated according to the area and site screening criteria developed in the previous section. The purpose of this evaluation is not to recommend the abandonment of some of the existing sites, but to illustrate the effectiveness of the screening process in identifying certain trouble spots.

An examination of the information presented on Overlay A through Overlay D indicates that some of the sites appear unfavorable according to the criteria used for area screening. For example, Site 13 and Site 19 are located near to Campbell Creek and Goose Lake respectively. Site 14 is located in an area of steep slopes. Site 4 and Site 5 are located a long distance away from any major arterials. These five sites would have been evaluated as unfavorable under the area screening system. Because of the unfavorable rating, these sites probably would not have been recommended for snow disposal unless no other sites could be found to serve nearby service areas.

Site screening can yield additional information about potential problems at existing sites. For example, Site 8 is located near residential areas and is not owned by the entity using the site for snow disposal. Therefore, it would be given an unfavorable rating according to the site screening criteria. In contrast, Site 16 appears to have good access and no surface drainage, is protected from the wind, and is not highly visible. All of these qualities make Site 16 favorable for snow dumping.

The evaluation screeing criteria developed in the previous section appear to be effective at defining favorable and unfavorable existing snow disposal sites. They are expected to be just as effective in defining favorable and unfavorable future sites and discouraging the use of the unfavorable sites for snow disposal.

Table C-1
Screening Criteria For Snow Disposal Siting

AREA SCREENING

Factor	Evaluation Criteria	Evaluation: Favorable	Evaluation: Unfavorable	Evaluation: Elimination	Evaluation: No Data
■ Location of service area	Proximity of site to service area is favored				
■ Access	Proximity to major arterials is favored				
■ Receiving waters	No surface drainage or drainage to Cook Inlet are favored				
■ Surface waters	Areas located on creeks or lakes or within 50 feet of the banks are eliminated				
■ Flood plains	Areas located in flood plains are eliminated				
■ Ground water	Areas located in discharge areas are favored over those in recharge areas. Sites located in areas of local flow regimes are favored				
■ Slopes	Moderately to steeply sloped areas (greater than 15 percent) are eliminated.				
■ Historical and archaeological sites	Areas of historical and archaeological significance are eliminated				

Table C-2
Screening Criteria for Snow Disposal Siting

SITE SCREENING

Factor	Evaluation Criteria	Evaluation			
		Favorable	Unfavorable	Elimination	No Data
■ Area screening	Apply area criteria on site-specific basis				
■ Site size	Site should be adequate to handle estimated volumes of snow				
■ Access	Difficult left turns, steeply inclined roads, dangerous intersections should be avoided				
■ Drainage	Any drainage from the site should be controllable by ditches or storm sewers. Drainage network should be adequate to handle snowmelt flows as well as any other drainage that may flow through the site				
■ Soils	Silty sand is favored. Gravels are unfavorable. Soils with moderately high to high permeabilities are favored				
■ Slope	Snowmelt runoff velocities should not exceed 2-5 feet per second in order to prevent erosion				
■ Glaciation	Icing should not cause flooding or erosion				
■ Jurisdiction	Land owned by the entity disposing the snow is favored for sites. Otherwise, long-term agreements are favored				

Table C-2 (Continued)
Screening Criteria For Snow Disposal Siting

SITE SCREENING (Cont.)

Factor	Evaluation Criteria	Evaluation: Favorable	Unfavorable	Elimination	No Data
▪ Compatible uses	Multi-purpose areas are favored, where snow disposal is compatible or synergistic with other uses				
▪ Aesthetics	Sites which are not highly visible are favored. Sites which block scenic vistas are eliminated				
▪ Noise	Sites in typically noisy areas are favored. Sites less than 200 yards from residences are eliminated				
▪ Dust control	Sites protected from wind are favored				
▪ Trash control	Sites protected from wind are favored. Sites without floatable trash controls are eliminated				
▪ Wildlife habitat	Sites on tidal flats and gravel pits are favored. Peat bogs are also somewhat favorable				
▪ Plant habitat	Sites which destroy large trees are not favored				
▪ Ground water	Sites which are located downgradient from shallow ground water wells in use for domestic water supply are favored. Sites less than 200 feet upgradient from such wells are eliminated				
▪ Water table	Sites which can recharge shallow ground water aquifers and restore natural lake and pond water levels are favored. Sit which may raise the water table and cause failures in septic tanks are unfavorable				

APPENDIX D
ASSESSMENT OF CANDIDATE SUBPLANS

TABLES

APPENDIX
ASSESSMENT OF CANDIDATE SUBPLANS

As presented earlier, there are many subplans available for control of nonpoint source pollution from urban runoff and onsite disposal systems. For the most part, these subplans work synergistically, so careful combination of those that are most preferable is necessary to develop alternate plans for the protection of water quality in Campbell Creek.

CRITERIA

The evaluation criteria for the candidate subplans are--

1. Water quality impact
2. Technical reliability
3. Monetary cost
4. Environmental impact
5. Social and economic impact
6. Implementation feasibility
7. Public acceptability

These same criteria are used for evaluating the alternate plans developed in Chapter 3. However, the latter evaluation is more detailed than that for assessing the subplans. The evaluation of the subplans has been taken only to the detail needed to dismiss obviously infeasible solutions. A definition of each criteria, as used for evaluation of the subplans, follows.

WATER QUALITY IMPACT

This is the effectiveness to which a subplan reduces pollution problems in Campbell Creek. Pollution problems are interpreted as constituent concentrations that limit intended water uses for Campbell Creek.

TECHNICAL RELIABILITY

Reliability is the capability of a control to continually perform as intended. It is dependent upon the level of operation expertise required, the track record of a given control, ability to function under changing physical circumstances and whether or not performance can be measured or if it is merely assumed.

MONETARY COST

This is self-explanatory; it includes both capital and operation and maintenance costs.

ENVIRONMENTAL IMPACT

This criteria measures the positive and negative influences a subplan would have on the physical and biological environments. Severity of construction impact and benefits to the biotic and aesthetic environments, other than to water quality, are the major issues.

SOCIAL AND ECONOMIC IMPACT

This deals with the impact on the human environment. It covers issues such as the effect of project cost on the local economy and protection of public health, resulting from higher water quality.

IMPLEMENTATION FEASIBILITY

This is assessed to determine the amount of legislative or management agency changes required to adopt a subplan, where the greater the number of institutional changes required the lower the implementability. It also is used to evaluate the difficulty of control enforcement. Controls that are so hard to enforce that reliability is lessened are considered unimplementable.

PUBLIC ACCEPTABILITY

Public acceptability is analogous to political acceptance. It is, of course, closely correlated to cost and environmental impact. Subplans with low anticipated public acceptability usually do not merit further evaluation.

ASSESSMENT

The candidate subplans are evaluated on Tables B-1 through B-6. The subplans that survived the evaluations, from which alternate plans will be developed, are presented below. A discussion of why certain controls were dismissed from further evaluation follows this section.

URBAN RUNOFF

Sources Controls

- Land use controls
- Onsite detention ordinances

Table D-1
Assessment of Urban Runoff
Source Controls

Source Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Air Pollution Controls	No measureable benefit	Impact on water quality uncertain	High if justified from a water quality standpoint	Beneficial	Beneficial. Cleaner air and water environments	Can be done within existing Federal and State regulations	Favorable		Although an attractive control from a general environmental standpoint, it does not solve identfied water quality problems in Campbell Creek
Animal Control	Will help achieve fecal coliform standards	Strongly suspected to be beneficial but is not documented	Negligible	Beneficial	Neutral. Cleaner environment, less nuisance, but will result in loss of personal freedom	Municipal ordinance available. Some modification required	Generally unfavorable		Are politically very unfavorable; and because effectiveness is uncertain and hard to justify. Is not enforceable or implementable
Auto Inspections	No measurable benefit	Uncertain	Very high if justified from a water quality standpoint	Beneficial	Beneficial. Cleaner, urban environment, and safer vehicles	Regulations would have to be developed	Unfavorable		Cannot be justified because benefits to water quality cannot be measured
Fertilizer/ Irrigation Controls	Area has no need for nutrient control	Can reduce nutrients	Negligible	Beneficial	Negative. No environmental advantage yet will result in less luxurient urban vegetation	Regulations would have to be developed	Unfavorable		Is not required for the Campbell Creek drainage because nutrients (NO_3, PO_4) are not water quality problems due to short flow through of water in the creek system
Land Use Controls	Can be used to protect environmentally sensitive areas, and to reduce runoff	Strongly suspected to be beneficial but is not documented	Controls themselves inexpensive to enforce; cost to local economy can be high	Beneficial	Neutral. Will affect real estate values and freedoms but will also improve environment	Municipal ordinance available	Unfavorable	Merits further consideration, especially given existing policy of protection of wetlands and marshes	
Leaf Collection	Area has few deciduous trees; no nutrient problem from fallen leaves	Negligible for study area	High if justified from a water quality standpoint	Beneficial	Neutral. Increase taxes for collection, but will be a useful public convenience	Municipality has authority	Favorable		Is not required for the Campbell Creek drainage because nutrients (NO_3, PO_4) are not water quality problems due to short flow through of water in the creek system
Litter Ordinances	Would not help solve documented problems. Stream aesthetics would be improved	Ineffective	Very high if justified from a water quality standpoint	Beneficial	Neutral. Will increase taxes for enforcement, but improve urban aesthetics	Municipal ordinances available	Favorable		Controls already available
Onsite Detention, Retention Ordinances	Very helpful for solving identified problems	Reliable	Relatively low if done during development	Beneficial	Beneficial. Lower storm sewer costs, less flood hazard, less erosion	Municipal ordinance available	Neutral	Merits further consideration especially since it parallels existing policy	
Refuse Collection	Not relevant to known water quality problems	Ineffective	High if justified only from a water quality standpoint	Beneficial	Beneficial. Reduce potential health hazards	Municipality has authority	Favorable		Control of refuge is already provided
Reduce Road Salting and Sanding	Reduced sanding would lower sediment loads	Strongly suspected to be benéficial but undocumented	Negative cost	Beneficial. Avoids salf damage to vegetation and sedimentation of receiving water	Neutral. Increased accidents and delays; but less damage to vehicles and lawns	Municipality has authority	Unfavorable		Control highly contraversial and probably unimplementable
Sanitary Code Enforcement	Could reduce oil discharges to roadside ditches	Uncertain	Negligible	Beneficial	Beneficial. Avoids possible public health and aesthetics problems	Municipality has ordinance	Favorable	Merits further consideration	
Stockpile Protection	Could reduce sediment loads	Uncertain	Negligible, unless structure is built	Beneficial	Neutral. Increases the cost of storage yet protects adjacent property owners	Municipality has authority	Favorable	Merits further consideration	
Studded Snow Tire Restriction During Off-season	Reduces road wear and accompanying sediment loads, in some cases	Uncertain	Negligible	Beneficial	Beneficial. Reduces road wear	State has authority	Favorable		Field observation indicated that few motorist leave studded tires on vehicles during warm months. Reductions of the few that do would have no measureable impact on water quality
Unleaded gas	Lead is not an identified water quality problem in Campbell Creek	Over the long term it will reduce P6 in urban runoff	Significant if to be used by older cars	Beneficial	Beneficial	Would require State legislation	Unfavorable		Requiring older cars to use unleaded gas cannot be justified for water quality improvement. This control is obviously in effect for newer cars
Waste Oil Recycling	An effective program could reduce waste oil discharges to the environment	Uncertain because little is known about the magnitude of waste oil dumping	A high cost has to be paid to provide incentive for recycling. This cost is expected to outweight the benefits	Beneficial	Beneficial	Would require State legislation	Favorable		Nearly impossible to provide sufficient incentive to recycle unless the price paid for waste oil is high. High price results in cost ineffectiveness of the control especially when the problem of illegal discharges of oil is undocumented
Covered Parking Lot Structures	Eliminates pollutant washoff from parking lots	Reliable	High if justified for water quality purposes only	Beneficial. Less runoff, less land consumed	Neutral. Results in more land available for other purposes but increases the cost of development in most cases, except areas with very high land costs	Municipality has authority	Unfavorable if required on a uniform basis		The cost is too high to justify only for water quality benefits

Table D-1 (Continued)
Assessment of Urban Runoff
Source Controls

Source Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Environmental Design	Very beneficial to reducing the flow and pollutant load from development	Fairly reliable	Negligible if done during development	Beneficial	Neutral. Ponds and swales can present a danger to children and can harbor insects	Municipality has authority	Generally favorable but controls would be opposed by developers	Merits further consideration. Should be used in tandem with onsite detention	
Rain Gutter Runoff Control	Beneficial to sediment and runoff control (providing lawn is in place)	Reliable	Negligible	Beneficial	Neutral. Lessens erosion but may cause temporary lawn ponding	Municipality has authority	Favorable	Merits further consideration. Should be incorporated into environmental design	
Bank Stabilization	Reduces instream erosion	Reliable for reducing local erosion problems	Moderate	Beneficial if urbanization has resulted in bank failure. Structural measures (riprap, etc.) can reduce fish habitat. Use of vegetation is preferable from an environmental standpoint	Favorable. Protects property along stream bank	Municipality has authority	Favorable	Merits further consideration. Parallels existing parks and recreation future plans	

Table D-2
Assessment of Urban Runoff
Transport Controls

Transport Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Private Parking Lot Maintainence and Improvement	Control of sediments, oil and organics, some metals	Locally reliable	High private cost low public cost	Beneficial	Neutral. Improves urban aesthetics but increases cost of business	Municipality has authority	Neutral	Merits further evaluation	
Streetsweeping	Controls of sediments, oil and grease, organics, some metals. May be redundant if ponds are used	Variable. Effectiveness is dependent upon the operator and number of illegally parked cars	High in Anchorage area	Beneficial	Generally beneficial. Improves urban aesthetics	Municipality has authority	Favorable	Merits further evaluation, as program is already underway	
Parking Ordinances	Markedly improves streetsweeper efficiency	Unreliable unless strictly enforced	Negligible. Should produce revenue	None	Neutral. Results in cleaner streets but also inconveniences to motorists.	Ordinance is on books but often not enforced	Favorable	Merits further evaluation. Should be incorporated with streetsweeping program	
Catch Basin Maintenance	Can reduce the amount of solids discharged from storm sewers	Generally unreliable even with proper maintenance	Negligible, since proper cleaning should already be part of a good management system	None, other than benefits to water quality	Beneficial. Proper maintenance should reduce insect problems	Municipality has authority	Favorable		Because the Campbell Creek area has virtually no storm sewerage system, there are no catch basins
Road Maintenance and Improvement	Control of sediments	Reliable	High if justified only for water quality.	Beneficial	Neutral. Improved property value and aesthetics but is costly to owner	Would require development of road improvement districts	Neutral	Merits further evaluation	
Gravel or Grassed Swales	Is very beneficial to water quality as infiltration is increased and runoff reduced, especially when compared to the alternative of storm sewers	Gravel is better than grass because of salting in winter and resultant die off. Requires maintenance	Negligible when compared to storm sewer	Gravel less attractive than grass	Neutral. Possible ponding and insect breeding, yet less costly than storm sewers. Maintenance can be a problem	Municipal has authority	Favorable to neutral, as lower cost should lower housing cost	Merits further consideration. This is already being done in some cases. Formalization is needed	

Table D-3
Assessment of Urban Runoff
Discharge Controls

Discharge Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Sedimentation Basins	Will result in a major improvement although the proposed standard may not be achieved	Good since there is very little equipment to operate. Reliability is dependent on cleaning the basins	Low when compared to other treatment systems. Land costs are significant	Require the long term commitment of land. Pond if not properly maintained could be a source of odor.	Requires the use of expensive land which will increase cost of housing	Good since controls are already in use. Implementation becomes a matter of enforcement of existing regulations	Should be good but some resistance could be expected due to increase housing cost and land requirements	Merits further consideration, especially in light of existing municipality policy	
Dissolved Air Flotation	Will result in a major improvement although the proposed standards may not be achieved	Fair since the process should be used with some other process like flow equalization or sedimentation	Moderate with a high O&M cost and energy requirements	Would require the building of a treatment plant	Could have adverse impacts due to location of treatment plants in residential areas	Small system could be built by developers: large system would require municipal action. Cost could hinder development	May be unfavorable since costs are high and numerous treatment systems must be constructed		No. Is consumptive from an energy standpoint and and requires hiring of trained operators, yet offers no advantage over sedimentation ponds
Oil Skimming	Some improvement although full impact not known	Good depending on specific process. Usually used with some other process	Low to moderate when applied in conjunction with other process	Beneficial but will require the building of treatment plants	Could have adverse impacts due to locations of treatment plants in residential areas	Small system could be built by developers; large system would require municipal action. Cost could hinder development	Good when used with sedimentation basins. Otherwise same as above.	Merits further consideration when used in combustion with sedimentation ponds	
Disinfection	Major improvement but will require special system to protect fish. Major benefit is for recreation which is limited	Fair to good	High since large system will be required to treat urban runoff	Of limited benefit since it will require major treatment system and high chemical and resource use	Probably adverse due to cost, chemical usage and required truck O&M traffic	Poor due to cost and limited value of recreation	Probably unfavorable due to cost and the construction of numerous treatment plants		Disinfection would be very costly for the Campbell Creek situation. It would also be unreliable without experienced operators
Screening	Major improvement	Fair to poor since intermittent operation is required. Will require a lot of equipment	High to very high	Limited benefit due to the need for numerous treatment plant or large collection systems	Could be adverse due to the location of treatment plants in residential areas	Poor due to cost and the location of treatment systems in residential areas	Local resistance but large scale		No. Has a high cost and questionable technical reliability for the Anchorage requirements
Biological	Limited improvements	Poor due to intermittent operation and low organic content of runoff	High	Probably adverse due to low effectiveness and high cost and land requirements	Could be adverse due to the location of treatment plants in residential areas	Poor due to cost and the location of treatment systems in residential areas	Locally unfavorable		Technically not reliable for storm water (intermittent) treatment
P/C Treatment	Could result in major improvements depending on process used	Fair to good System can be operated intermittently but does require skilled operation	Moderate to high	Of limited benefit since there is a major commitment of land chemicals, energy and other resources	Could be adverse due to the location of treatment plants in residential areas	Poor due to cost and the location of treatment systems in residential areas	Locally unfavorable		Although it is a good method for advanced rebars runoff treatment it is very costly
Land Treatment	Could result in major improvement depending on process and land used	Good, can be operated intermittently and could provide a broad range of of treatment	Low to high depending on the location and cost of suitable land	Possible adverse effects on vegetation	Would be adverse if linear park use or utility was reduced. Could be of benefit if additional park land was created.	Fair to poor due to the need of a large amount of expensive land	Unfavorable if park land was used. Developers and realtors would object because of large land requirement		Although it is fairly cost competitive it would present operational problems during cold weather, it is land consumptive and is anticipated to be injurious to the receiving vegetation
Discharge Diversion (of Little Campbell Creek)	Good impact on Campbell Creek but will reduce use of Little Campbell Creek	Good	Low to moderate	Flow reduction in Campbell Creek. Would destroy the adronomone fishery in Little Campbell Creek	Failure to clean up Little Campbell Creek could result in public health problems	State may object to to destruction of fishery	Unfavorable during construction		Would destroy the fishery in Little Campbell Creek which is antithetical to the objectives of PL 92-500 which calls for fishable-swimmable water where attainable
Discharge Diversion (of Urban Runoff)	Would result in near zero discharge of runoff to Campbell Creek	High as all of the runoff, and hence pollutants, would be captured. Would not require sophistocated operation	Low when compared to advanced mechanical wastewater treatment	High construction impact. Once in place little impact. Impact on Cook Inlet is anticipated to be negligible	Would increase local costs for sewerage. However, easement could be used to supplement linear park system. No long term visual or odor impacts	Some resistance due to construction impact	Unfavorable during construction	Merits further consideration; provides the effect of advanced storm water treatment without the operational problems	
Discharge Permits	Effective if well enforced and administered	Totally dependent upon enforcement	Fairly high administrative costs	None	Would increase the local cost of business, which could reduce amount of local industrial activity	Highly implementable due to outcry by business community	Unfavorable		Is highly unimplementable due to socioeconomic and political impact
Water Quality Monitoring	None in itself but is mandatory planning tool	Relatively high	Moderate	None	Negligible: may vary, slightly increase local taxes for support	High. Should receive few objections		Will be essential for future water quality planning	

Table D-4
Assessment of Onsite Waste Disposal
Location Controls

Location Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Require Connection to Centralized Treatment	Would eliminate water quality problems associated with septic tanks	Very reliable	High when considering the low densities in the Hillside area	High construction impact	High hookup charges would be onerous	Municipality has authority	Controversial in the Hillside area		Further study is not required because control is already in ordinance form
Increase Minimum Lot Requirements	Would reduce impact by diluting waste load	Reliable at reducing gross waste load. Does not necessarily result in fail-safe operation	Range from minimal to severe depending on zoning	Increases urban sprawl	Restricts area to high income persons because of high lot, hence housing, costs	Municipality has authority	Neutral. People in Hillside area would probably be supportive, developers would resist		Minimum lot size is as required in current regulations is 1-1/4 acres; in the study area most are 2 acres or larger. There is not justification for increasing lot sizes
Land Use Control i.e. Restrict Development of Onsite Systems in Physically Unsuitable Areas	Would prevent future problems caused by malfunctioning systems	Very reliable	High if it results in no development of land	Generally favorable but can increase sprawl	Can result in loss of property value to owner and can increase the cost of housing	Municipality has authority	Resistance is anticipated		Existing zoning calls for large lot development in Hillside area. Land use controls cannot be justified until development of a Detailed Septic System Suitability Map. See below
Comprehensive Sanitary Survey	Would greatly reduce impact of septic system failures	Fairly reliable; would resolve surface failures but would not disclose subsurface failures	Low	Favorable	May result in making poor pay more for wastewater treatment than affordable	Would require reallocation of Municipal budget to finance	Residents of areas with septic systems would be resentful	Yes	
Computerization of Onsite System Data	Control would have no impact on water quality itself but would enhance the effectiveness of any onsite management system program resulting in indirect benefits	It is not possible to quantify the reliablity of this method on improving water quality. Benefits can only be implied by improved management	Moderate. Would offset a significant amount of labor cost to perform sound duties	None	Better management of onsite systems would help protect public health, albeit indirectly	Municipality has authority		Yes	
Certification of Soils Technicians	Would logically be beneficial	Fairly reliable at assuring honest, technically sound work is done	Minimal	Favorable	Favorable. Would, in effect, provide consumer protection	Municipality has authority	Favorable	Yes	
Hold PE Liable for Soils Test	Would avoid placement of onsite systems in the same area	Reliable. Personnel responsible could not afford to be dishonest or do shoddy work	Minimal	Favorable	Favorable. Would, in effect, provide consumer protection	Municipality has authority	Favorable		PE is already held responsible if results of soils test are falsified. However, liability is not justified in cases where soils test is positive but septic system fails once installed
Develop a Detailed Septic System Suitability Map	Would help assure placement of onsite systems in proper areas	Fairly reliable	Moderate. Would depend upon availability of information	Favorable	Favorable. Would provide consumer protection and protect public health	Municipality has authority; would require a reallocation of funds or receipt of additional funds	Favorable	Yes	
Require Design by Registered PE	Would help assure that the right type of system would be placed in the proper area	Reliable. PE would be liable for financial restitution	Would significantly increase the cost of onsite treatment to the homeowner	Favorable	May result in making the poor pay more for onsite disposal than affordable	Municipality has authority; no significant problems foreseen	Some resistance by public because of the increased costs involved		Custom design not usually required once detailed soils data are available. Ubiquitous custom design, at about $1,000 per unit, would greatly increase costs in nonsewered areas
Adopt Design Criteria	Hard to assess as existing criteria has not been tested sufficiently	If criteria can be improved then reliability would be dependent upon enforcement	Minimal	Favorable	Could increase costs but would also protect public health	Municipality has authority	Favorable		The municipality already has design criteria that should be used until data are available that prove existing criteria are inadequate
Alternate Onsite Systems	Can be an improvement over septic tanks if operated properly	Given proper maintenance reliability is good; otherwise it is poor	Most are competitive with septic tanks	Minimal construction impact	Favorable if well maintained as public health is protected	Municipality has authority	Often some initial resistance not anticipated		Municipality already has a policy which encourages new technology so long as a maintenance contract with a local representative is provided. There is not evidence that unique systems or new technology would perform better than existing systems
Require Replacement of Failing Systems	Would greatly reduce impact of failed systems	Reliable if system is operated properly. Would prove unreliable without good maintenance	Lower than installation of sanitary service given existing densities in Hillside area	Minimal construction impact	May be burdensome to low income family but, in general, would protect public health	Municipality has authority	Would be politically controversial	Yes	
Installation of Sanitary Sewers	Would eliminate most wastewater related problems in Little Campbell Creek	Highly reliable assuming proper installation	Very high given the low density of the Hillside area	Major construction impact	Would be an economic burden to most home-owners	Municipality has authority	Would be politically controversial		Is not cost effective given existing densities. Secondly, it would require increased densities which would be more injurious to water quality than additional onsite systems

Table D-5
Assessment of Onsite Waste Disposal Installation Controls

Installation Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Increased Inspection	Results in better installation and helps avoid construction related failures	Good inspection is a fairly reliable with ad of quality control. However, inspection itself will not protect water quality	Small compared to benefits received. Hiring of an additional inspector may be needed	None	Favorable, as it would provide consumer protection and help protect public health	Municipality has authority	Favorable to public; developers may resist	Yes	
Performance Bonds	Same as above. In addition, the developer is liable for replacement of faulty systems	Reliable for improving system installation, but, it alone, will not protect water quality	Minimal public cost; however, increases developer cost	None	Since it would increase developer cost, it would result in somewhat higher housing costs	Municip ity has authority	Favorable to public; developers may resist		This control would be redundant to increased inspection. Since an inspection program is already underway continuance of this method of control was favored over introduction of a new control
Licensing of Septic Tank Installers	Same as above. In addition, the developer is liable for replacement of faulty systems	Reliable for improving system installation, but, it alone, will not protect water quality	Minimal	None	Results in consumer protection	Municipality has authority	Favorable		This control is already in ordiance form
Certification of Onsite Systems	Results in a higher quality product which given proper operation, will benefit water quality	Results in a good quality product but will not, by itself, protect water quality	Minimal	None	Results in consumer protection	Municipality has authority	Favorable		Septic tanks are fairly well standardized and additional certification is not required. Certification of "Alternate Systems" is covered by requirement for maintenance contract
Dual Absorption Systems	Greatly improves operation which is very beneficial to water quality	Very reliable if systems are alternated as required	Adds about 1/3 to the cost of a septic system	Minimal additional construction impact	Increases the cost of onsite disposal, yet it will help protect public health	Municipality has authority	Resistance expected due to increased cost	Yes	

Table D-6
Assessment of Onsite Waste Disposal Operation Controls

Operation Controls	Water Quality Impact	Technical Reliability	Monetary Cost	Environmental Impact	Social/Economic Impact	Implementability (Legal/Institutional)	Public Acceptability	Recommended For Further Study	Not Recommended
Water Conservation	Has an indirect benefit as it will foster better system operation	Reliable at improving problems resulting from hydraulic overloading	Minimal increase to homeowner for electric tape (to prevent freezing pipes in winter)	None	Some increase in household cost	Municipality has authority but control is very hard to enforce without water metering	Generally unfavorable unless accompanied by a strong public education program	Yes	
Public Education	Has an indirect benefit as it will foster better system operation	Requires substantial agency commitment to be reliable	Can be minimal to moderate depending upon effort	None	Can result in vast improvement of system operation and public health, for relatively little cost	Municipality has authority but implementation will take a strong commitment	No opposition but public apathy often a problem	Yes	
Operation Permits	Will help assure that well designed and installed systems will function well during operational life	Is a reliable way to make sure septic tanks are frequently pumped	Would probably require 0.5 to 1.0 person year to implement	None	Increases costs to those who now do not maintain their systems, yet it helps protect the the public at large	Municipality has authority	Generally unfavorable as it can be viewed as government invasion of privacy		It is felt that the voluntary program should be tried first. If this fails then the operation permit option should then be initiated
Voluntary Maintenance	If well followed it would clearly benefit water quality. Must be accompanied by a strong public education program	Reliability is dependent upon effectiveness of public involvement program	Minimal	None	Should assist in protecting public health in areas serviced by onsite systems, especially protection of private wells	Municipality has authority	Favorable	Yes	
Agency Approval for Title Transfers	Would help eliminate the water quality impact of failed systems	Reliable at reducing conspicuous (surface) failures but not helpful at solving groundwater failures	Minimal	None	Provides the benefit of consumer protection	Municipality has authority	Favorable	Yes	

- Stockpile protection
- Sanitary code enforcement
- Environmental design
- Rain gutter runoff control
- Bank stabilization

Transport Controls

- Private parking lot improvements and maintenance
- Streetsweeping
- Parking ordinances
- Road improvements and maintenance
- Gravel or grassed swales

Discharge Controls

- Sedimentation basins
- Oil skimming
- Discharge/diversion of storm runoff

ONSITE DISPOSAL SYSTEMS

Location Controls

- Comprehensive sanitary survey
- Computerization of onsite system data
- Certification of soils technicians
- Develop detailed septic system suitability map
- Require replacement of failing systems

Installation Controls

- Increased inspection
- Dual absorption systems

Operation Controls

- Water conservation
- Public education
- Agency approval for title transfers
- Voluntary maintenance
- Continued inspection of onsite system performance

JUSTIFICATION FOR DISMISSING ALTERNATIVE SUBPLANS

A brief discussion is presented below that summarizes the information provided in Tables B-1 through B-6 regarding the reasons certain subplans were dismissed from further consideration.

URBAN RUNOFF SUBPLANS

Source Controls

Air Pollution Controls. The implementation of additional air pollution controls in the Campbell Creek Basin was considered infeasible because fallout from air pollution is not considered to be a major source of any of the present or projected water quality problems in Campbell Creek. The one major possible exception, suspended solids, that could in part be contributed to the stream by fugitive dust from unpaved roads. It is presently being controlled by the Municipality through their road oiling program. In addition, it can be anticipated that many dirt roads will be paved in the future through road improvement districts. Likewise, air quality will improve with implementation of increasingly stringent emission controls for automobiles.

Animal Control. This control can help reduce nonpoint sources of fecal coliform; however, the level of effectiveness is impossible to assess. It was rejected from further consideration because present municipal ordinances provide what is considered to be the only feasible level of control. Additional controls would be difficult and costly to enforce, especially given the uncertainty of their water quality benefit. Strict animal control has been found to be politically unpopular in many other areas. However, continuity of the existing program is endorsed by the 208.

Auto Inspections. Auto inspections are not recommended for further investigation because they are expected to have no measureable benefit on water quality. Even though oil and grease are demonstrated water quality problems, and the source is most notably the automobile, inspecting vehicles for oil and gasoline leakages would be a cumbersome and ineffective method of controlling the problem. Since only the most severe leakages would be immediately apparent, owners would have to leave their vehicle overnight with the inspection agency so that longer term leaks could be identified. This would result in citizen inconvenience and is anticipated to be met with a high level of resistance.

Fertilizer/Irrigation Controls. Control of fertilizer and irrigation rates can reduce the delivery of landscape-oriented nutrients to nearby water courses. Because of the rapid flow rate of water in the Campbell Creek system, nutrients and their attendent eutrophication problems are avoided. Nutrient discharges to other lakes in the study area may be a water quality problem. Runoff from pervious areas in the basin is anticipated to be near zero, so conveyance of lawn fertilizer to water courses would be unlikely. Lastly, it is nearly impossible to control the amount of fertilizer that homeowners place on their lawns. Given the problems associated with implementing this control, and in light of the fact that there is no demonstrated problem with lawn fertilizers, it was discarded from further assessment.

Leaf Collection. Dead and decaying leaves on urban landscapes can impart additional BOD and phosphate loadings to receiving waters. However, as mentioned above, the fast flow through of water in the Campbell Creek system not only reduces the concern for nutrient introduction but also obviates the need to control BOD loadings, as dissolved oxygen levels were found to be high after all tested storm events.

Litter Ordinances. The Municipality presently has litter ordinances in effect. Although accelerated enforcement of existing ordinances may result in a small increase in urban cleanliness and a reduction in pollutant loadings, the amount of effort involved is not commensurate to the benefit to water quality. The impact of litter on water quality is anticipated to be mostly one of reduced aesthetics, with minimal increases in BOD and ammonia loadings. Pollutant loadings are correlated with the small particles of debris that would not be markedly reduced by effective litter control.

Because it cannot be documented that accelerated enforcement of litter ordinances does in fact benefit water quality, accelerated enforcement of existing litter ordinances was not considered further. However, continuity of existing practices is supported by the 208.

Refuse Collection. As referred to above, a cleaner city results in a higher quality urban runoff, and so an effective refuse collection system will, in theory, benefit water quality. However, the correlation between the amount of refuse collection and litter control, and high water quality is vague at best. It is assumed that refuse collection is relatively ineffective at controlling the small particle sizes that have the greater effect on the quality of urban runoff. Consequently, attempts to improve upon the existing municipal refuse collection program were not considered further. Reductions in the existing program would be undesirable from a water quality standpoint.

Studded Snow Tire Restriction During Off-season. Control of studded snow tires on dry pavement can reduce the amount of street surface sediments. The amount of additional street surface sediments caused by the use of studded snow tires off-season is unknown, but it is expected to be minimal. In addition, in a case where 50 percent of the roads in the study area are unpaved, this approach appears illogical. For this reason, and because very few vehicles were observed as being equipped with studded snow tires during the warm months, this control was eliminated from further consideration.

Unleaded Gas. The use of unleaded gas is meritorious from an environmental standpoint. However, requiring older cars to use unleaded gas for water quality improvement cannot be justified because lead was not identified as a problem in Campbell Creek. Discharges of lead to the environment will gradually be reduced as newer model cars replace the old.

Waste Oil Recycling. Although oil and grease is an identified water quality problem in Campbell Creek, there is no evidence that illegal dumping of these substances is the source of the problem. Waste oil recycling is, again, a meritorious activity from an environmental standpoint, but its benefit to water quality cannot be measured with available data. In addition, the amount of money that has to be paid for the waste oil to provide an incentive to recycle is greater than the economic value of the oil. It cannot be justified to recommend further evaluation of this control because the water quality benefits of recycling cannot be compared against the costs.

Transport Controls

Covered Parking Lot Structures. Requiring that all parking lots be enclosed in a structure would not only reduce runoff and save land, it would also reduce the pollutant loading to area creeks. However, this control is an extremely costly method to reduce runoff from parking lots; in most portions of the Anchorage area land costs are not high enough to justify the use of high-rise parking rather than traditional parking lots. Consequently, it was concluded that there are better means to control parking lot runoff, such as use of detention facilities and other environmental design alternatives.

Catch Basin Maintenance. This control was eliminated from further consideration simply because there are almost no catch basins in the study area. If the Municipality installs trapped catch basins in the future, an aggressive maintenance program is recommended.

Discharge Controls

Dissolved Air Flotation. This process involves use of compressors to dissolve air in the wastewater under pressure. Wastewater contains suspended pollutants that are fixed to bubbles which form when pressure is released. The pollutants are then carried to the surface to be skimmed off for disposal. As could be anticipated, this process has high energy and operator requirements. It would require development of treatment facilities throughout the Campbell Creek Basin and the hiring and training of treatment plant operators. Dissolved air flotation provides about the same level of treatment as sedimentation basins. The use of sedimentation basins was considered more feasible because of simpler operation and lower operational cost.

Disinfection. It was initially felt that disinfection would be required to meet the stringent fecal coliform standards in Campbell Creek. However, in the case of Campbell Creek, if chlorination was used for disinfection, then dechlorination would be necessary in order to avoid injury to the salmon fishery in Campbell Creek. An alternative would be to use ozonation. In either case, the costs would be very high, plant operators would be required and development of numerous facilities within the basin would result. Even assuming the development of an efficiently operating disinfection system, attainment of the proposed fecal coliform standard is not assured.

In order to meet proposed fecal coliform standards it will be necessary to collect all urban runoff and convey it to convenient locations for treatment. It was concluded that if installation of a storm water collection system was required, conveyance to Cook Inlet rather than a treatment facility would be more logical. This logic also applies to all of the advanced storm water treatment systems mentioned below.

Screening. Screening was eliminated from further consideration due to high costs. It would also involve the installation of numerous small treatment plants and an extensive storm sewer network. If a storm sewer network were to be installed, a more logical approach would be to convey storm water to the ocean rather than to treat and discharge it to Campbell Creek.

Biological Treatment. Biological treatment was eliminated for many of the same reasons mentioned above. However, the most important reason for eliminating this control is that it is not a technically reliable method for storm water treatment. Typically, biological processes involve treatment of a continuous flow, thus allowing development of a culture of microorganisms that decompose the waste matter. With the storm water system, a continuous flow situation is not available and the process has to be "started up" for each storm event. This results in a loss of treatment efficiency and reliability.

Physical/Chemical Treatment. Physical/chemical treatment is one step beyond sedimentation, as flocculents are used as an aid to remove some of the smaller suspended particles by settling and filtration. The system is fairly reliable for storm water treatment because it is readily adaptable to intermittent flow conditions. Physical/chemical treatment can be a reasonable method for storm water treatment if the level of removal required is one step beyond sedimentation. It is not applicable for Campbell Creek because it would be excessive for Level 2, yet would not provide the level of removal for Level 3, estimated at 95 to 97 percent. Physical/ chemical treatment combined with extensive filtration and disinfection could attain the level of removal required for Level 3. However, development of an advanced treatment facility for urban runoff would be very costly, require skilled operators and mandate development of an extensive collection system. When considering the need for the collection system, discharge to Cook Inlet rather than a treatment facility appeared more sensible.

Land Treatment. A properly designed land treatment system would be capable of meeting proposed water quality standards for Level 3, although it would provide more treatment than needed for Level 2. Land treatment, however, was not considered a feasible alternative for Level 3 for several important reasons.

To be most effective, all of the storm water in the basin should be collected and routed to a central point for application to the land. This site should be at the lowest point in the basin, preferably in the vicinity of Campbell Lake, to avoid pumping. In order to treat the design flow of 100 cfs, about 100 acres of well-drained land would be required. Most of the land in the lower portions of the basin either have high water tables, are covered by peat or have low permeability. Therefore, location of an adequate size poses difficulties.

Use of land application presents problems for controlling heavy metals. Firstly, a collection system for peat bog drainage would be required and discharge to a site with favorable cation exchange characteristics would be needed to remove heavy metals. Given the need for an extensive collection system to convey both storm water and urban runoff to land application site(s), direct discharge to the ocean seemed more reliable.

Land application could result in operational problems during cold weather in the spring. Application to frozen ground could cause freezing and ice buildup or direct runoff. Direct runoff would result in inadequate treatment and water quality violations for Level 3. Damage to vegetation due to freezing water could also be a problem, especially if the water was applied with sprinklers. For this reason, use of the linear park along Campbell Creek is not recommended for land application. Possible loss of vegetation along the creek would not only reduce park aesthetics, it would also raise water temperatures.

Discharge Diversion of Little Campbell Creek. This control was dropped from further consideration due to severe environmental impact. Since it would involve diversion of Little Campbell Creek to the ocean, entry of salmon would be precluded. In essence, the control involved sacrifice of one stream for the betterment of another, which proves antithetical to the goal of PL 92-500 for fishable/swimmable waters where attainable. Little Campbell Creek is presently a salmon fishery (albeit very marginal) so its degradation cannot be justified from a 208 Plan standpoint.

ONSITE WASTE DISPOSAL SYSTEM SUBPLANS

Location Controls

Require Connection to Centralized Treatment System. Further analysis of this control is not required because existing ordinances already require hookup to a sanitary sewer when the property line is within 100 feet of the sewer right-of-way. Although the control itself does not need improvement, there is a need for better enforcement as there is evidence that homes within the required distance to sanitary sewers are not connected. Resolution of this problem can be attained through the Comprehensive Sanitary Survey subplan that is recommended for further study.

Increase Minimum Lot Requirements. Presently, a minimum lot size of at least 1-1/4 acres is required before a septic tank permit will be issued. However, in the Hillside area most of the lots are larger than 2 acres. An overall requirement for larger minimum lot sizes cannot be justified because of the unique conditions for each site. That is, 1 acre may be appropriate for a septic system in one area while 3 acres may not be sufficient in another. Resolution of this issue cannot be achieved until development of a detailed septic system suitability map is completed. This map would better identify the limitations of specific areas. Initiation of a blanket requirement for larger lot sizes can result in oversizing and economic waste.

Land Use Controls. Presently, the Hillside area is zoned for large lot development; this appears appropriate for septic tank usage given existing data. Additional land use controls cannot presently be justified.

Hold Professional Engineer Liable for Soils Test. Under the present system, the professional engineer is already held responibile if it can be proven that the soils tests results were falsified. Where soils tests results were reported correctly and the septic system still failed, it would be inappropriate to hold the responsible professional engineer liable. Present methods for assessing soil suitability are not infallible and the results cannot always guarantee that a given site will be suitable for a septic system. In addition, it is possible that a professional engineer could be held liable when mismanagement on the part of the homeowner, not the underlying soil, was responsible for a system failure.

Require Design by a Registered Professional Engineer. Requiring that new systems be designed by an engineer could increase the cost of new systems by almost $1,000. Given that most systems do not require specialized design, but rather can use standard criteria for given site characteristics, this requirement would result in increased cost with very little benefit. It would also be somewhat redundant to the ongoing Department of Health and Environmental Protection (DHEP) inspection program. Because inspection is presently being practiced it was felt that augmenting this program would be better than introducing a new program.

Adopt Design Criteria. The Municipality already has design criteria based on the U. S. Public Health Service criteria. Since these criteria are generic and not specific to the Anchorage area, weaknesses are certainly a possibility. It has been recommended that existing criteria continue to be used until proven inadequate. Presently, there is no evidence of inadequacy.

Alternate Onsite Systems. The Municipality currently encourages the use of new technology for onsite waste disposal. If a person opts to use such a system, current policy requires that a contract between the owner and a local manufacturer's representative be provided. Inasmuch as there is already a local policy encouraging new technology, further analysis of alternate systems is not merited. In addition, there is no evidence that existing technology (septic tank-soil absorption system) is inadequate or that a more reliable substitute is available. Use of alternate systems is often inadvisable because of complicated operation requirements and unavailability of replacement parts and repair personnel. Lack of appropriate operation has resulted in serious problems with alternate onsite systems in many areas of the country.

Installation of Sanitary Sewer. As mentioned previously, present zoning in the Hillside area is for large lot development. Extension of a sanitary sewer to this area would be very expensive on a per household basis. In order for it to be cost effective, changes in zoning densities would be needed to permit higher housing. From a water quality impact standpoint, increasing the density in the Hillside area would be more deleterious than additional septic tanks, given existing zoning. Increases in density would result in increases in runoff and pollutant loadings associated with urbanization. In addition, most of the residents of the Hillside area have moved there because of a desire for large lot living; attempts to increase densities are anticipated to be controversial. This control was dropped from further evaluation because it is considered unimplementable due to local politics.

Installation Controls

Performance Bonds. This control was dropped from further consideration because it was felt to be less desirable than simply expanding the existing inspection program. It could also make developers liable for systems that failed due to homeowners mismanagement rather than faulty installation. In addition, the administration of this control would increase Municipal operating costs and the bond itself would increase developer costs and the cost of housing.

Licensing Septic Tank Installers. Under the existing program installers are granted an annual permit by the Municipality for installation of onsite systems. The existing control was considered adequate and so the licensing option was dropped from further consideration. However, continuation of the existing program is considered beneficial to local water quality.

Certification of Onsite Systems. Septic tanks are fairly well standardized and additional certification is not required for that portion of the system. It is important to note that most of the problems result from the soil absorption system that is not amenable to certification, but more appropriately controlled during installation. Although certification may be appropriate for certain "alternative onsite systems," the present Municipal practice of requiring a contract between the owner and a local manufacturing representative for operation obviates the need for additional certification.

Operation Controls

Operation Permits. Efficient administration of an operation permit program requires biannual inspection by Municipal officials, which can be interpreted as an invasion of privacy. In addition, Municipal costs are increased for administration of the program. It was felt that a voluntary operation program should be initiated prior to an operation permit system. If the voluntary system proves to be unsuccessful, it is recommended that an operation permit program be undertaken.