CITY OF HOMER
Department of Public Works
3575 Heath St.
HOMER, AK 99603

DRAINAGE MANAGEMENT PLAN
HOMER, ALASKA
CH2M HILL
AUGUST, 1979
COST $25.00

FIRST CLASS MAIL

DRAINAGE MANAGEMENT PLAN

HOMER, ALASKA

Prepared by:

CH2M HILL

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SUMMARY

This study of surface water drainage in Homer analyzes the existing drainage system and proposes a drainage management plan to cope with existing and future drainage problems. Design criteria and methods are presented so that the city and developers will have a standardized approach to construction of drainage facilities. No immediate capital improvements to the existing drainage system are required. Rather, a phased evolution of the system as development occurs and as priority remedial projects are recommended.

PLANNING CRITERIA

The study area characteristics, population, and land use information presented in this drainage plan are a thorough update of the planning analysis presented in the *Comprehensive Sewer Plan* and the *Comprehensive Water Plan* prepared in May of 1977 by CH2M HILL.

The population of Homer in 1990 is estimated to be between 4,500 and 6,500, projecting 7- and 10-percent average annual growth rates. The 1978 population was 2,050.

Current and expected future land use maps were prepared to update those presented in the previous plans. The future land use map is consistent with the city's new comprehensive plan.

A detailed review of the Soil Conservation Service soils reports was performed to determine what effect soil types and ground slopes have on patterns of development and expected runoff rates.

EXISTING DRAINAGE SYSTEM

The existing surface water drainage system for the City of Homer is a combination of natural creeks and manmade drainageways. The natural creeks have either year-round or intermittent flow and have steep or flat gradients. Creeks with steep gradients normally have adequate channel capacity for most floods; whereas those with flatter slopes do not.

Manmade modifications to the natural drainageways are usually associated with roads. Roadside ditches collect and concentrate the runoff, and culvert crossings restrict the channel capacity of the natural creeks. An inventory of the existing major culverts is presented in appendix A. These culverts are shown in figures 5, 6, 7, and 8 in the main part of the report.

Current drainage management includes maintenance by city and state Department of Transportation crews within their respective jurisdictions. Most existing culverts are corrugated metal types with no headwalls, inlets, or thaw wire protection. The major culverts for the Homer bypass (now under construction) will include headwalls and thaw wires.

The minimal drainage design considerations contained in the Homer city code and the borough subdivision ordinance are not adequate to ensure proper construction of additions to the city's drainage system.

Runoff Determination

A standardized method of determining the peak rate of surface water runoff in Homer was developed. Rainfall at Homer is relatively light compared to other cities in Alaska. However, heavy rainfall is likely to occur in late fall when snow is on the ground. The peak rate of runoff, including a reasonable amount of snowmelt, was determined for the range of drainage areas between 10 and 500 acres and for the 5-, 10-, 25-, 50-, and 100-year storms. These rates are shown in figure 9.

It is recommended that the 25-year storm be used to design drainage facilities for drainage areas less than 200 acres. Because of the extra hazard associated with larger drainageways, the 50-year storm is recommended for design of drainage facilities for drainage areas larger than 200 acres.

Proposed Drainage System

A complete drainage system for the City of Homer is proposed and shown in figures 5, 6, 7, and 8. The drainage system is made up of trunk drainageways and local drainageways. The trunk drainageways are a combination of natural creeks and manmade ditches which collect and convey runoff to Kachemak Bay or Beluga Lake. The local drainageways are the roadside ditches and culverts which convey water from small drainage subareas to the nearest trunk drainageway.

Because of icing and sediment blockage problems, open ditches and natural creeks are preferred drainage system components. Buried storm drainage systems and storage detention ponds are not suggested because of high capital and maintenance cost as compared to the open drain concept. Buried storm drainage systems could become part of the city's system if the city believes they are especially desirable and worth the additional cost in certain areas.

Drainage and erosion control guidelines have been developed to provide a common basis for the construction of drainage facilities and for the control of erosion during construction. These guidelines are presented in appendix C and were developed from the standard specifications of the State of Alaska Department of Transportation and erosion control methods developed by the Soil Conservation Service.

Drainage Plan Implementation

Several legal means of implementing the drainage management plan were investigated. The drainage control ordinance presented in appendix D is the recommended legal means to implement the drainage management plan. An intergovernmental agreement with the Kenai Peninsula Borough is recommended to ensure that areas in the borough that drain into the city meet the design requirements of the city.

In order to effectively administer the drainage management plan, the city should identify staff persons responsible for reviewing plans for proposed system expansion. At a minimum, the public works director should review and approve all drainage system improvements. It is recommended that the city require drainage plans be designed and field certified by a civil engineer registered in the State of Alaska.

The city needs to adopt a set of standard design criteria which incorporate sound engineering practice and meet local requirements. The drainage and erosion control guidelines presented in appendix C should be modified by the city, as required, and made available to developers and others who would construct portions of the drainage system.

The rate at which capital improvements to the drainage system are implemented is limited by the budget available. Therefore, it is recommended that improvements to the existing drainage system be made in accordance with a priority list developed and maintained by the public works director.

Easements should be obtained for all drainage system components not within city rights-of-way. Drainage improvements should then be scheduled, designed, financed, and constructed through the public works department.

Recommendations

The major recommendations contained in the drainage management plan are listed below:

1. A drainage ordinance similar to the model ordinance in appendix D should be enacted by the city to implement the drainage management plan.

2. The city should establish an intergovernmental agreement with the Kenai Peninsula Borough giving the city review authority over activities affecting drainage management, including subdivision design, road construction, and drainage improvments.

3. The drainage management plan should be coordinated with the city's master road plan and the comprehensive sewer and water plans.

4. The public works director should review all improvements and proposed additions to the existing drainage system. The capability of the city's current staff to carry out this function should be reviewed, and any additional staff needs identified.

5. Improvements to the existing drainage system should be made in accordance with a priority list developed and maintained by the public works director. As funds become available, system upgrading should occur.

6. A capital improvement program should be developed, approved by the city council, and administered by the public works department to coordinate drainage system improvement and expansion with road construction projects. Acquisition of drainage easements should be included as part of the capital improvement program.

7. Drainage system components should be designed using the runoff design curve, figure A-1, which is based on using the 25-year design event for drainage areas less than 200 acres, and the 50-year design storm for drainage areas 200 acres and larger.

8. The city's public works department should modify, as required, the drainage and erosion control guidelines in appendix C and make them available to developers and others who would construct portions of the drainage system.

9. The city should require that drainage plans prepared by developers be designed, inspected, and field certified by a civil engineer registered in the State of Alaska.

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Chapter 1
INTRODUCTION

Recent rapid development and expected future growth have prompted local concern over storm water drainage control in Homer. Rain and snowmelt flooding, glaciation, and erosion have been identified as problems that are expected to increase in severity unless a comprehensive drainage management plan is developed and implemented.

This study analyzes the existing drainage system for current problem areas and predicts future system requirements in light of expected land use changes and local hydrologic conditions. Alternative approaches to storm water drainage control are considered, and as a result of close interaction with city and borough officials a recommended drainage management plan is presented.

PREVIOUS STUDIES

Several studies, either recently completed or currently underway, provide the basis for this drainage management study. These studies were reviewed and their major findings considered in developing the drainage management plan. The following is a brief discussion of the studies as they relate to the drainage plan.

City of Homer Comprehensive Plan, 1978

The City of Homer revised its Comprehensive Plan in 1978. The plan, officially adopted by the Kenai Borough Assembly in March 1979, recommends areas for future residential, industrial, and commercial development. The Comprehensive Plan also contains the following recommendations relating to drainage problems:

1. Prepare and adopt a drainage management plan.
2. Consider responsibility for erosion and sedimentation control before approval by the Planning Commission of any proposed subdivision. The proposed methods for alleviating erosion and sedimentation control problems should be reflected in the developmental design specifications, where applicable.
3. Include stringent control measures stipulating responsibility for erosion and sediment control during foundation excavations with the issuance of building permits.
4. Require that developers submit drawings including proposed drainage patterns during actual construction periods, as well as permanent drainage plans. Temporary structural measures for erosion and sediment control

should be required as necessary (diversion berms, interceptor swales, energy dissipators, channel lining, crushed aggregate, mulching, etc.).

5. Require that developers and/or subdividers submit drawings indicating those areas most likely to be subject to glaciation as a result of construction, development, or interruption of natural drainage patterns, together with proposed methods for elimination, amelioration, or control of same. Such regulations should be applicable to any adjoining properties or other areas subject to such effects, as well as the subject property itself.

City of Homer Zoning Ordinance, September 1979

The city is substantially revising its zoning ordinance, with an expected completion date of September 1979. The revisions will include new zoning district boundaries and regulations governing permitted uses.

Potential Flooding, City of Homer, Kenai Peninsula Borough, U.S. Department of Agriculture, Soil Conservation Service (SCS), Anchorage, Alaska, June 1978

This study provides a technical assessment of flooding problems in Homer. It includes a description of the Homer area and its historical flooding problems. Reduced flow capacity of the natural drainageways by either manmade or natural obstructions is identified as the most common cause of flooding. The study concludes that, with the expected development, future flooding problems will be similar to, but more numerous than, current problems. Several recommendations were included, the most important of which was that the City of Homer should develop a drainage management plan.

Homer, Alaska, History of Flooding, Aufeis (Glaciation), Erosion and Sedimentation. Sandra Stringer, The Scotia Group, Fairbanks, Alaska, November 1976

A detailed study of flooding and related problems in Homer prepared for the Anchorage office of the SCS. The study was based on a literature search and numerous interviews with knowledgeable Homer residents. Glaciation was frequently mentioned as a local problem, but extensive or damaging floods seem to be infrequent. The most serious flood events were two outbreak floods in Palmer Creek. In 1937 and again in 1952, landslides blocked Bear Canyon during rain and snowmelt floods that occurred in late fall. Floodwaters backed up behind the slides and then broke out, sending a wall of water and debris down Palmer Creek. Seventeen historical flood and glaciation areas were described and mapped in the study.

Soil Surveys, Homer, Alaska, and Homer-Ninilchik Area, Alaska. U.S. Department of Agriculture, Soil Conservation Service, Anchorage, Alaska, July 1971

This publication is a result of two separate soil surveys, one (Homer-Ninilchik area) a more general survey; the other (Homer) a detailed survey. Other than the difference in level of detail, both surveys map and catalog various soil types and list their agricultural and engineering properties.

The detailed survey of Homer was of particular value in projecting likely areas of future development and determining the amount of runoff expected from different soil types.

Comprehensive Water Plan, Homer, Alaska, and Comprehensive Sewer Plan, Homer, Alaska, CH2M HILL, May 1977

Both studies present current and expected future utility service for water and sewerage. Detailed population and land use projections were included, as well as recommended system improvements. Annual reviews and updates of the plans were recommended to keep pace with actual population growth and development. Much of the population and land use data was incorporated into the drainage management study with appropriate modifications to reflect recent trends.

Master Roads and Street Plan, Silvers Engineering, 1979

A master roads and streets plan for the City of Homer was completed in June 1979. The plan contains a summary of existing traffic conditions and an analysis of trip generation characteristics. The study recommends a plan for major arterials and establishes a set of operating design standards for future roads, including surface widths, grades, and traffic volumes.

SCOPE OF STUDY

The purpose of this study is to develop enough data for the city to make management decisions on storm water drainage controls. The following tasks were accomplished with that purpose in mind:

1. A collection and review of all available reports and data.

2. An update of population and land use data in light of recent developments.

3. An examination of the existing drainage system and a rating of its flow capacity.

4. A review of historical drainage-related problems.

5. The development of appropriate drainage planning criteria.

6. An estimate of the expected change in rate of runoff due to future development.

7. The development of a drainage management plan to deal with expected problems.

8. An assessment of alternative means of implementing the drainage plan and the development of model ordinances, regulations, and guidelines.

Chapter 2
PLANNING CRITERIA

This chapter discusses the general planning criteria that were considered in preparing the drainage management plan for the City of Homer. It provides information on the physical and economic characteristics of the study area, population trends, and land use. The information presented is limited to those items that are pertinent to planning for storm water drainage control.

STUDY PERIOD

This drainage management plan is prepared for ultimate development within the city and the larger drainage area around the city. In addition, specific improvements are to be recommended for both a short- and a long-range time frame. The city will review and update this plan on a regular basis.

STUDY AREA CHARACTERISTICS

Boundaries and Topography

The boundaries of the study area are shown in figure 1. They encompass all the area within the city and the adjacent area in the borough that drains to Kachemak Bay, Beluga Slough, Beluga Lake, and the lowlands northeast of the Homer Airport to Millers Landing. The areas near the airport and on either side of Ocean and Kachemak Bay Drives, as well as all of Homer Spit, were not studied, but drainage management measures developed for the city would be generally applicable to all areas within the city limits. The area within the boundaries of the City of Homer is approximately 6,400 acres. The total drainage area that was studied is about 6,500 acres, which include approximately 4,500 acres within the city and 2,000 acres of borough land north of the city.

The topography of the area rises moderately from sea level at Kachemak Bay to the steep bluff that runs along the northern boundary of the city. At the top of the bluff, at about elevation 1200 in the northeast section of the study area and 900 in the southwest, the topography gradually slopes down and out of the study area into the Diamond and Bridge Creek drainage basins.

Climate

Homer has a maritime climate that is influenced by airflow from the Gulf of Alaska and modified by the intervening Kenai Mountains. The mountains are located about 20 miles

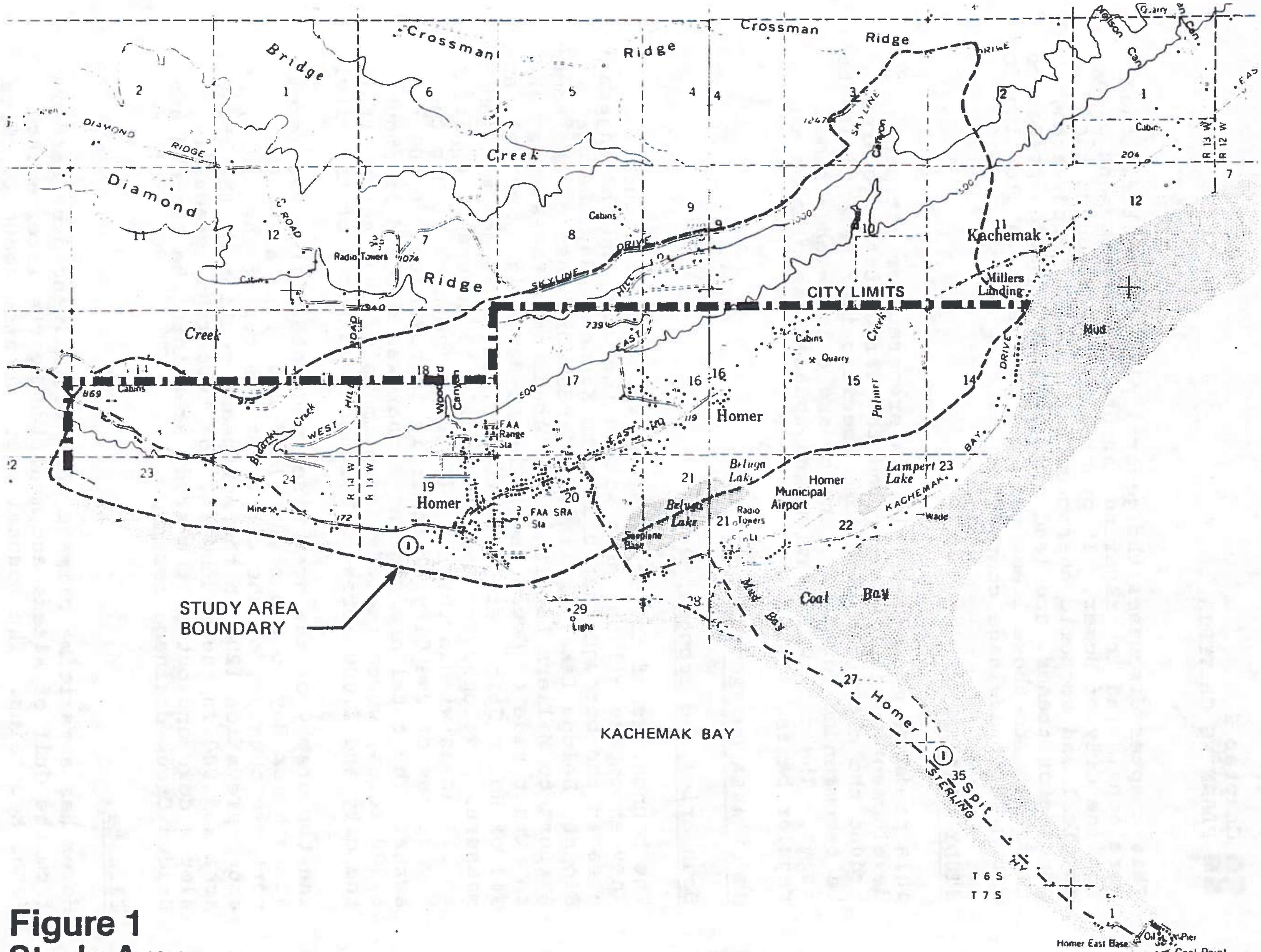


Figure 1
Study Area

from Homer and have a northeast-southwest orientation with elevations between 4,000 and 6,000 feet. The average annual precipitation is approximately 23 inches; whereas, other areas along the gulf coast experience normal precipitation as high as 60 inches. The average precipitation amounts on a monthly basis are shown in figure 2.

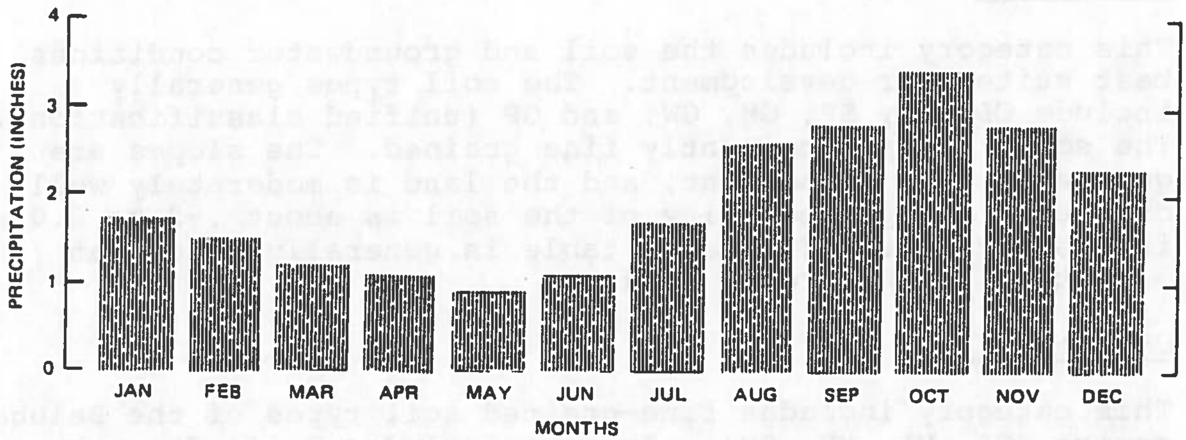


Figure 2
Average Monthly Precipitation

The normal annual snowfall of approximately 50 inches occurs mainly from November through March. Winter temperatures seldom drop below zero degree F. January is normally the coldest month of the year and July and August are normally the warmest.

Soil Conditions

The types of soil and the depth to groundwater in the study area were catalogued and mapped in two 1971 soil survey reports by the U.S. Department of Agriculture, Soil Conservation Service. The data in those reports were condensed for planning purposes to guide the delineation of expected development areas and to determine the expected rate of storm water runoff for this study.

The total area within the city limits, plus the drainage area tributary to the city, was divided into three geotechnical categories:

I Moderately good soil and drainage conditions
II Marginal soil and drainage conditions
III Poor soil and drainage conditions

Of the total area, about 10 percent falls in category I, 30 percent falls in category II, and 60 percent falls in category III.

Category I

This category includes the soil and groundwater conditions best suited for development. The soil types generally include CL, ML, SP, GM, GW, and GP (unified classification). The soils are predominantly fine grained. The slopes are generally 3 to 12 percent, and the land is moderately well drained. The permeability of the soil is about .63 to 2.0 inches per hour. The water table is generally more than 5 feet below the ground surface.

Category II

This category includes fine-grained soil types of the Beluga series (CL, ML, MH, SM). It also includes soils from the Kachemak, Spenark, Beluga-Mutnala, and Moose River series. Slopes range from zero to 12 percent generally, and the land is moderately well drained to poorly drained. The water table is generally within 5 feet of the ground surface. Erosion and stability of the steeper slopes are more of a hazard than with category I soils.

Category III

This category is relatively poorly suited for development in general. The soil is fine grained in most areas. Soil types include CL, ML, MH, SM, SW, SP, GM, GP, GW, OL, and pt (unified classification). Slopes range from level to greater than 45 percent. Water tables are at the ground surface in many areas and it is poorly drained. Other areas are very steep and erosion and stability of slopes are a significant concern.

Some of the major limiting factors that inhibit development, especially in category III, and to some extent in category II, are as follows.

1. Shallow, slowly permeable substratum
2. High water table or seepage conditions
3. Susceptibility to flooding or to inundation by high tides
4. Steep slopes or rough topography
5. Clayey material at shallow depths (groundwater problems)
6. Higher-than-average susceptibility to frost action
7. Erosion hazard
8. Organic material
9. Possibility of contaminating groundwater

As indicated above, 60 percent of the land area falls in category III. Much of this land is very steep (bluffs near the ocean and in back of town) or is swampy and peaty. Drainage in many of the swampy areas is limited because of the terrain.

Much of the present development is in category III areas which contain soils of the Beluga series. Where construction has occurred in these areas, drainage and control of the groundwater have usually been a primary consideration and will continue to be an important concern.

Because it is prime view property, development on the steep bluffs has occurred in some areas. Constraints to development are severe, especially in the case of higher density development. Erosion, slope stability, road construction, and difficulty in providing utilities all tend to severely inhibit growth in these areas. Many areas in category III can be developed, but special measures must be taken. Category II or category I areas are not generally as limited, but many category II areas also need special care in development.

A work map was prepared showing the areal extent of the three geotechnical categories. This work map was used as a guide in determining future land use patterns.

Economy

Commercial fishing, fish processing, retail services and trades, and tourism all make a strong contribution to Homer's economy. Twenty-four percent of the city's employed adults are service workers, 21 percent are in the professional-technical occupational category, and another 20 percent work as fishermen and laborers. Homer's average family income is about $22,000. Unemployment and seasonal employment fluctuations are still a problem in Homer despite rapid growth. The industries causing the greatest seasonal fluctuations are fishing, food processing, and tourism-related retail trades and services.

Commercial fishing for salmon, crab, halibut, shrimp, and herring will continue to play an important role in the economy. Two large and two small processing plants are located on Homer Spit. Expansion of the fish processing industry to include bottomfish is expected as a result of the extension of the 200-mile limit. The city is undertaking a port study to assess the probability and facility requirements of bottomfish-related development.

A federal oil and gas lease sale, held in October 1977, has resulted in offshore exploration activity near Homer. The Homer city dock is located approximately 40 miles from the central area of the lease sale and the city will experience economic and population impacts if oil and gas are discovered and developed.

As of spring 1979, two drilling rigs were operating in Lower Cook Inlet, with no reported discoveries. During the exploration phase, Homer will provide water and fuel for supply boats, and the Homer Airport will serve as a transfer point for drilling rig crews. If major discoveries are made, there will be an increasing demand for onshore facilities, staging areas, and dock space in the Homer area.

In addition to the economic potential of both bottomfish and oil development, the retail services and trades are growing employment sectors. Between 1976 and 1978, a total of 46 commercial building permits were issued. These included construction of a new shopping mall, office space, and a bank branch. Tourism and recreation are also increasing with most tourist-related commercial activity located on Pioneer Avenue and on Homer Spit.

Homer's highway, air, and water-based transportation facilities enhance the city's potential for economic development. Homer's port facilities include a 410-foot, city-owned dock that serves the U.S. Coast Guard, the state ferry, and the Standard Oil tanker. The city's small boat harbor has a long waiting list, but expansion is planned. The State of Alaska owns and maintains an airport at Homer with a 7,400-foot runway. Expansion and upgrading of airport support facilities are also planned within the next 5 years.

POPULATION

Population Trends

The City of Homer was incorporated in 1964, with an estimated population of 800. Population figures through 1978, along with annual percentage growth rates, are shown in table 1. The annual growth rate for the period from 1964 to 1968 was 5.1 percent per year. This growth rate increased to 7.8 percent per year for the period from 1972 to 1975, and to 11 percent a year from 1975 to 1978.

Table 1. POPULATION GROWTH

Year	Population	Average Annual Percent Increase
1964[a]	800	
1968[b]	975	5.1
1970[c]	1,083	5.4
1972[d]	1,243	5.7
1975[e]	1,583	7.8
1978[f]	2,050	11.0

[a] City incorporated with present boundaries. Population estimated by city personnel.
[b] Estimate by Alaska State Housing Authority.
[c] U.S. Census, April.
[d] Official City Census, October.
[e] Special U.S. Census, August.
[f] Special U.S. Census, September.

Growth rates in other Kenai Peninsula Borough cities have varied from an average annual rate of 4 percent for Seward, 5 percent for Seldovia and Kenai, to 8 percent for Soldotna. The Kenai Borough as a whole has grown at an average annual rate of about 6.5 percent.

Future Population Growth

Although not always accurate, population projections serve as a guide for predicting future land use and development trends. The factors most likely to affect future population growth in Homer are (1) the development of bottomfishing and fish processing, (2) oil and gas development activity in Lower Cook Inlet, (3) tourism, and (4) the general attractiveness of Homer as a place to live for both permanent and seasonal residence.

Table 2 shows estimated population growth for the City of Homer at both a 7- and 10-percent average annual rate of growth. These rates correspond to the city's growth rates for the period from 1972-1978. A continuation of the 10-percent rate to 1990 assumes some development of either oil or bottomfish or both. The 7-percent growth rate assumes a more moderate level of development in these industries. Using these rates of growth, Homer's population could increase by 2,500 to 4,500 residents by the year 1990. This, in turn, increases the amount of land devoted to residential and commercial uses both within and just outside the city boundaries.

Table 2. CITY OF HOMER POPULATION PROJECTIONS

	7-percent Growth Rate		10-percent Growth Rate	
Year	Population	Number of Households[a]	Population	Number of Households[a]
1978	2,050	640	2,050	640
1980	2,350	765	2,480	810
1985	3,200	1,055	3,995	1,315
1990	4,490	1,490	6,435	2,140

[a] The U.S. Census Bureau projects that average household size will drop for the country as a whole. These estimates assume a decreasing average household size as follows: 1978-3.2; 1980-3.07; 1985-3.04; 1990-3.01.

Major oil or gas development would probably result in population increases over and above those indicated by the 10-percent growth rate. Estimates of population growth related to outer continental shelf development are contained in *Offshore Oil Development In Lower Cook Inlet* (CH2M HILL, 1978). The high case projection (which has a 5-percent probability of occurring) shows a possible 1,700 people added to the Homer population by 1990 due to oil and gas development alone.

The use of a 7- or 10-percent average annual rate of growth can be somewhat misleading since this "straight-line" method of projection does not show the variations in the rate that are likely to occur from year to year. The method is intended to give a general indication of future population levels. The estimates should be revised when more information is available on the likelihood of new or expanded industrial activity. Future population is estimated to the year 1990 only; it is nearly impossible to foresee all the factors that could influence population growth beyond this date.

LAND USE AND DEVELOPMENT

Knowledge of current and future land use patterns is generally required to determine the magnitude of storm water runoff. Existing and future land use within the city's boundaries and drainage area was estimated based on the inventory contained in the city's water and sewer plan, building permit data, the new comprehensive plan, and anticipated zoning ordinance revisions.

Current Land Use

Current land use in the study area is shown in figure 3. The majority of new residential construction has been occurring in the central part of the city in areas currently served by water and sewer. The extension of water and sewer service out East Hill Road has stimulated new residential construction in that area. Some building is also occurring along West Hill Road, an area not served by water or sewer.

The central commercial area is fairly well established along Pioneer Avenue between Olsen Lane and Lake Streets, and it is continuing to grow. The construction of stores and offices within this area and the new shopping mall on the east side of Lake Street are examples of recent additions to Homer's emerging central business district. When the Homer bypass opens, additional commercial establishments can be expected there.

Many subdivisions have been approved in the area just above the northern city boundary over the last several years. A number of these subdivisions are located within the city's drainage boundaries. Lot sizes within the subdivisions vary, ranging from 1/3 acre to 5 acres.

The number of housing units and commercial establishments authorized by building permit for the City of Homer is shown in table 3. There were 117 housing units authorized in 1977 and 90 units authorized in 1978. No data exist to indicate how many of these units might be for seasonal use only.

Table 3. HOUSING UNITS AUTHORIZED BY BUILDING PERMITS
CITY OF HOMER, 1976-78

	1976		1977		1978	
	Number	Percent	Number	Percent	Number	Percent
Single-family	33	55	68	58	42	46
Multifamily	27	45	36	31	29	31
2-4 units					(17)	
5+ units					(12)	
Mobile Homes	Not available		13	11	21	23
Total	60	100	117	100	92	100
Commercial	12		15		19	

Source: Staff Economist, U.S. Department of Housing and Urban Development, Anchorage.

Future Land Use

The population projections presented earlier can be used to estimate future housing and land use requirements. These estimates, in conjunction with the land use recommendations in the city's comprehensive plan, indicate future land use.

Tables 4 and 5 estimate the housing and land requirements that could result from the 7- and 10-percent population growth rates. The number of new units needed for a given period is an estimate based on the existing housing stock, the expected growth in population and households from table 2, and the number of additional units required to sustain a reasonable vacancy rate.

In each table, the average annual housing requirement for the period is further broken down by housing type (single-family, multifamily, and mobile home). This breakdown is an estimate of future trends based on percentages observed over the last several years in Homer.

The amount of land that will be required to accommodate this growth in housing units is estimated using an expected density of about 4 units per acre for single-family units, 12 units per acre for multifamily units, and 8 units per acre for mobile homes. At a 7-percent rate of growth, a total of about 154 acres would be required for residences from 1978 to 1990. At a 10-percent growth rate, about 263 residential acres would be required. These estimates are for population growth within the city limits only.

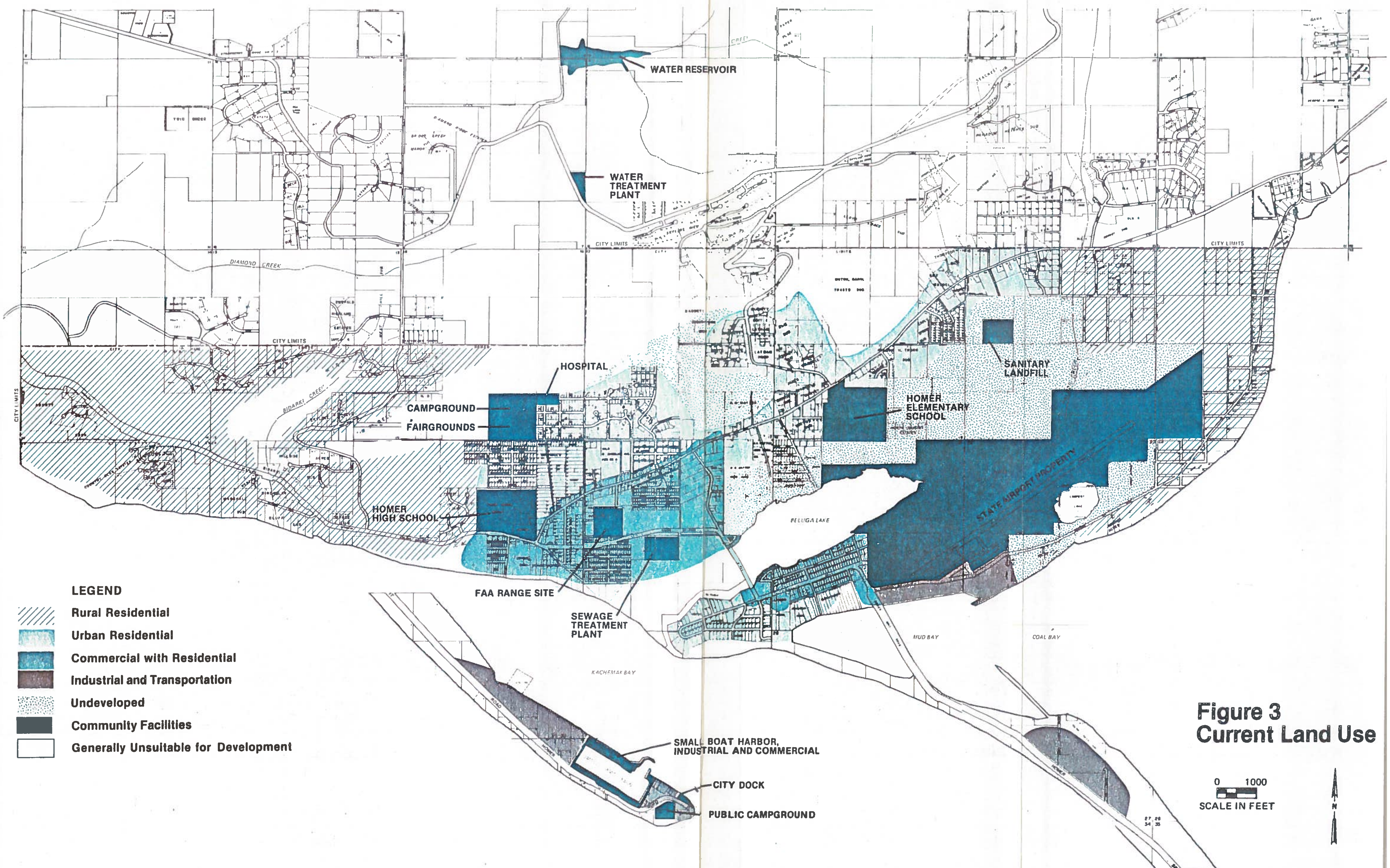


Figure 3
Current Land Use

Table 4. ESTIMATED HOUSING AND LAND REQUIREMENTS FOR RESIDENTIAL GROWTH, CITY OF HOMER 7-PERCENT GROWTH RATE

	1978-80	1980-85	1985-90
1. Housing Stock (beginning of period)	740	770	1,070
2. Anticipated Household Growth	125	290	435
3. Requirements for 3.5-percent Vacancy Rate	4	10	15
4. New Units Needed			
50% single-family	64	150	225
30% multifamily	40	90	135
20% mobile home	26	60	90
Total	130	300	450
5. Land Requirements (acres)			
Single-family (4/acre)	16	38	56
Multifamily (12/acre)	3	8	11
Mobile home (8/acre)	3	8	11
Total	22	54	78

NOTE: Total additional residential land required = 154 acres.

Table 5. ESTIMATED HOUSING AND LAND REQUIREMENTS FOR RESIDENTIAL GROWTH, CITY OF HOMER 10-PERCENT GROWTH RATE

	1978-80	1980-85	1985-90
1. Housing Stock (beginning of period)	640	815	1,340
2. Anticipated Household Growth	170	505	820
3. Requirements for 3.5-percent Vacancy Rate	6	18	29
4. New Units Needed			
50% single-family	88	260	425
30% multifamily	52	160	255
20% mobile home	36	103	170
Total	176	523	850
5. Land Requirements (acres)			
Single-family (4/acre)	22	65	102
Multifamily (12/acre)	4	13	20
Mobile home (8/acre)	4	13	20
Total	30	91	142

NOTE: Total additional residential land required = 263 acres.

Although future requirements for commercial land are difficult to estimate, a rough estimate can be obtained by applying a ratio of land to population, as reported in current planning studies. If about 0.2 acre of commercial land is required for each 100 new residents, then an additional 5 to 10 acres of land in commercial use could be required by 1990. It should be noted that the demand for commercial acreage is tied to increases in tourism and population growth outside the city limits, as well as to increases in permanent residents within the city.

Industrial land use needs are more difficult to estimate. They will be influenced, to a large extent, by oil and gas development and growth in the demand for fish processing plants.

When these land use needs are compared with the amount of land proposed for residential, commercial, and industrial uses in the city's comprehensive plan, it appears that these needs can be easily accommodated within the city limits. The comprehensive plan recommends that about 14 percent of the city's land be designated industrial (880 acres), 9 percent as commercial (530 acres), and 56 percent as residential (3,380 acres). Another 6 percent would be reserved for recreation and open space and about 15 percent as government reserve land.

A future land use map is shown in figure 4. The map is based on the city's comprehensive plan (adopted March 1979) with some modifications made to distinguish between low- and medium-density residential areas and between the central and highway-oriented commercial uses.

The location and density of future development in the City of Homer will be influenced by the following factors.

1. Proposed zoning district boundaries and lot size regulations.

2. The location and capacity of water and sewer lines. Development is most likely to occur where water and sewer are available. Ultimate densities of 4 single-family to 12 multifamily units can be expected in the areas served by water and sewer. This would result in a population density of 12 to 36 persons per acre.

3. Development is likely to occur at a density of .5 to 1 unit per acre in areas not served by public water and sewer. This includes areas both within and outside the city limits. The resulting population density would be about 1 to 3 persons per acre.

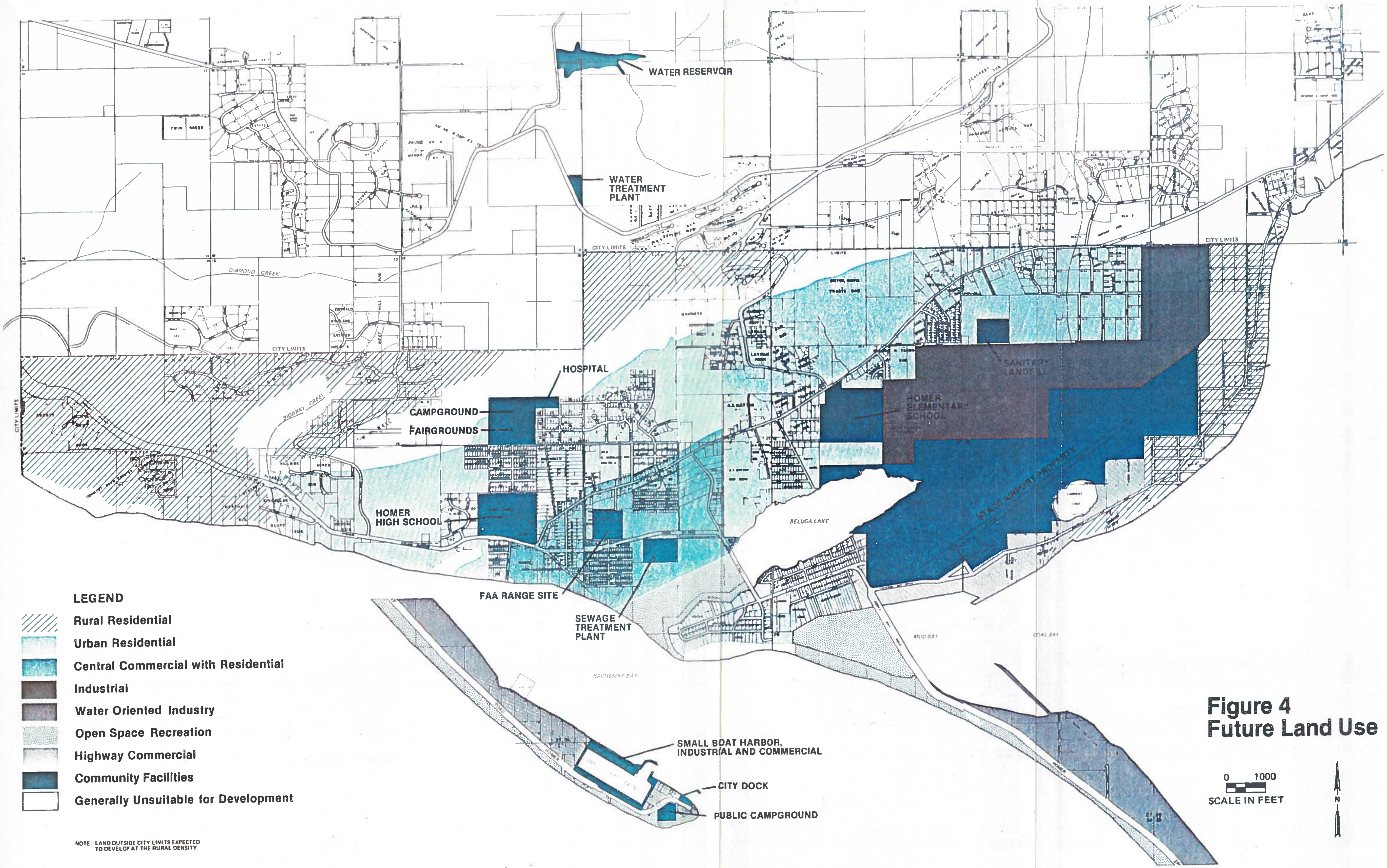


Figure 4
Future Land Use

4. Some multifamily residential development is likely to occur in the central commercial area.

5. A demand for residential development on prime view property can be expected to continue. Even without any further development controls, densities will be restricted in those areas by topography and soils, especially as these limit the approval of septic systems. Densities in some subdivisions will also be restricted by special covenants established by the developer.

Chapter 3
EXISTING DRAINAGE SYSTEM

The components of the existing surface water drainage system in the City of Homer are presented in this chapter. Excerpts from and references to previous reports will be used to provide detail.

NATURAL DRAINAGE

The natural drainageways in the City of Homer are of two types. The first type is the large drainageways that have flow in them for most of the year (perennial) and usually have larger drainage areas. Bidarki Creek, Woodward Canyon, and Palmer Creek are three such drainageways and are the only ones in Homer that have been named. They have total drainage areas of approximately 280, 400, and 830 acres, respectively. The larger drainageways are generally identified by their deep, steep-sided channels, which under natural conditions extend down from the bluffs all the way to Kachemak Bay or the lowlands around Beluga Lake. These larger drainageways have channel lengths of approximately 1 mile, with Palmer Creek the longest with a length of 2.3 miles.

The second type of natural drainages is the smaller drainages with drainage areas less than 50 acres. The areas near and just east of West Hill Road are typical of this type of natural drainage. Drainage water collects in small, steep ravines on the bluff and appears as streamflow in the bottoms of the ravines only during rainy periods (intermittent). When the flow from the ravines reaches the flatter grassed slopes below the bluffs, it fans out, infiltrates the soil, and enters the groundwater. As a result, no defined channels are apparent in the field or on aerial photographs.

Under natural conditions most of the drainageways with 10 percent gradient or steeper have adequate channel capacity to contain even a 100-year flood. If the channel slope remains steep all the way to the discharge point, as in the case of Bidarki Creek, no flooding would be likely to occur outside the channel banks. However, if the slope of the channel becomes flatter than 10 percent before reaching its discharge point, an alluvial fan develops. An alluvial fan is a broad topographic feature caused by the natural outwash of debris from a steep canyon. Drainage channels on alluvial fans are generally intermittent and can change course during floods.

For example, the Palmer Creek alluvial fan dominates the topography in the northeast part of Homer and can be recognized on a contour map by the fan-shaped concentric contour lines. The Palmer Creek fan is made up of all the material which has naturally washed off the bluffs above to form Bear Canyon. The process of building the Palmer Creek fan was furthered by the outbreak floods in 1937 and the early 1950's, as described by Stringer (1976). The drainageways that have alluvial fans and ill-defined channels in their lower reaches are subject to overflow during even minor floods.

The natural drainageways in Homer can therefore be categorized as either perennial or intermittent streams, which are either flood-prone or not based on their natural channel geometry and slopes. The topography and natural drainageways in Homer and the tributary drainage areas in the borough can be seen in figures 5, 6, 7, and 8.

MANMADE MODIFICATIONS

The development of the City of Homer has imposed numerous structural changes to the natural drainageways. Generally, the changes have modified the natural channel capacity and/or alignment. The existing drainage system is comprised of roadside ditches and cross culverts tied into the natural drains. In areas where no natural drains exist, manmade ditches have been constructed.

Roads and highways have had three main impacts on the natural drainageways. The first and most obvious is the necessary crossing of the drainageways. Road fills block the natural drainageways and force all the flow through the culvert that is provided. If the flow in the drainageway exceeds the culvert capacity, flow backs up behind the road embankment and overtops the roadway, which in some cases can lead to flooding of nearby properties and possible loss of the road embankment due to erosion. Culvert capacity is often reduced by blockage from debris, sediment, or ice.

The second, less obvious, impact of roads on the natural drainage is the tendency for roadside ditches to collect and redirect drainage water from its natural course into a route paralleling the road. Runoff is often diverted out of the subbasin from which it originated. This impact is common, especially in areas where no well-defined drainage channels exist. The construction of roads in Homer has, in several cases, redefined the alignment of the drainageways and redirected additional runoff to compound drainage problems.

The third impact is associated not only with the roads but with the land development that comes with them. The introduction of impervious surfaces and drainage ditches normally

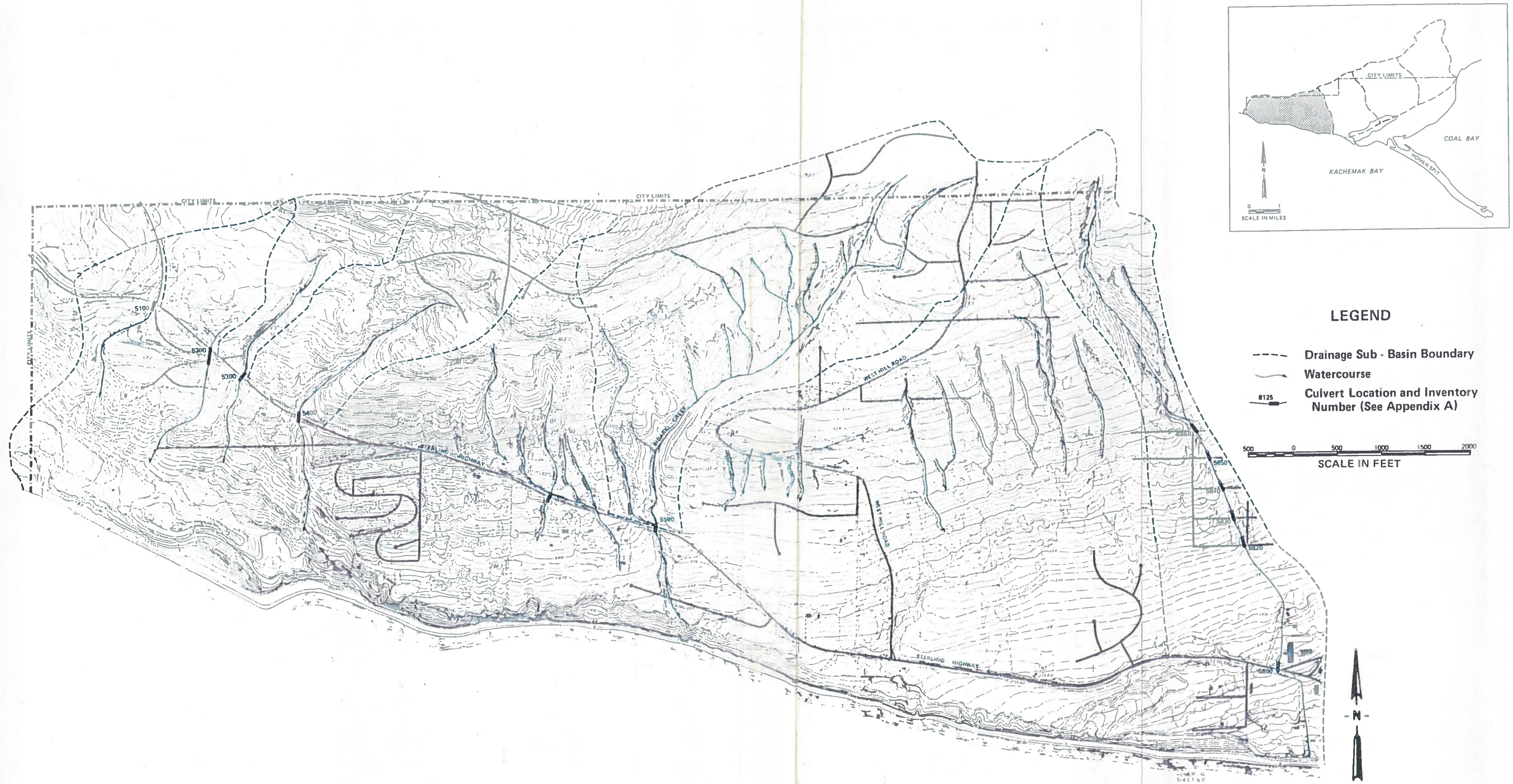
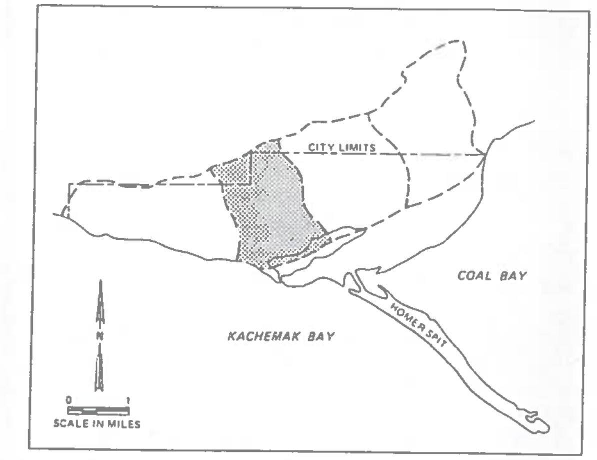


Figure 5
Drainage System Map

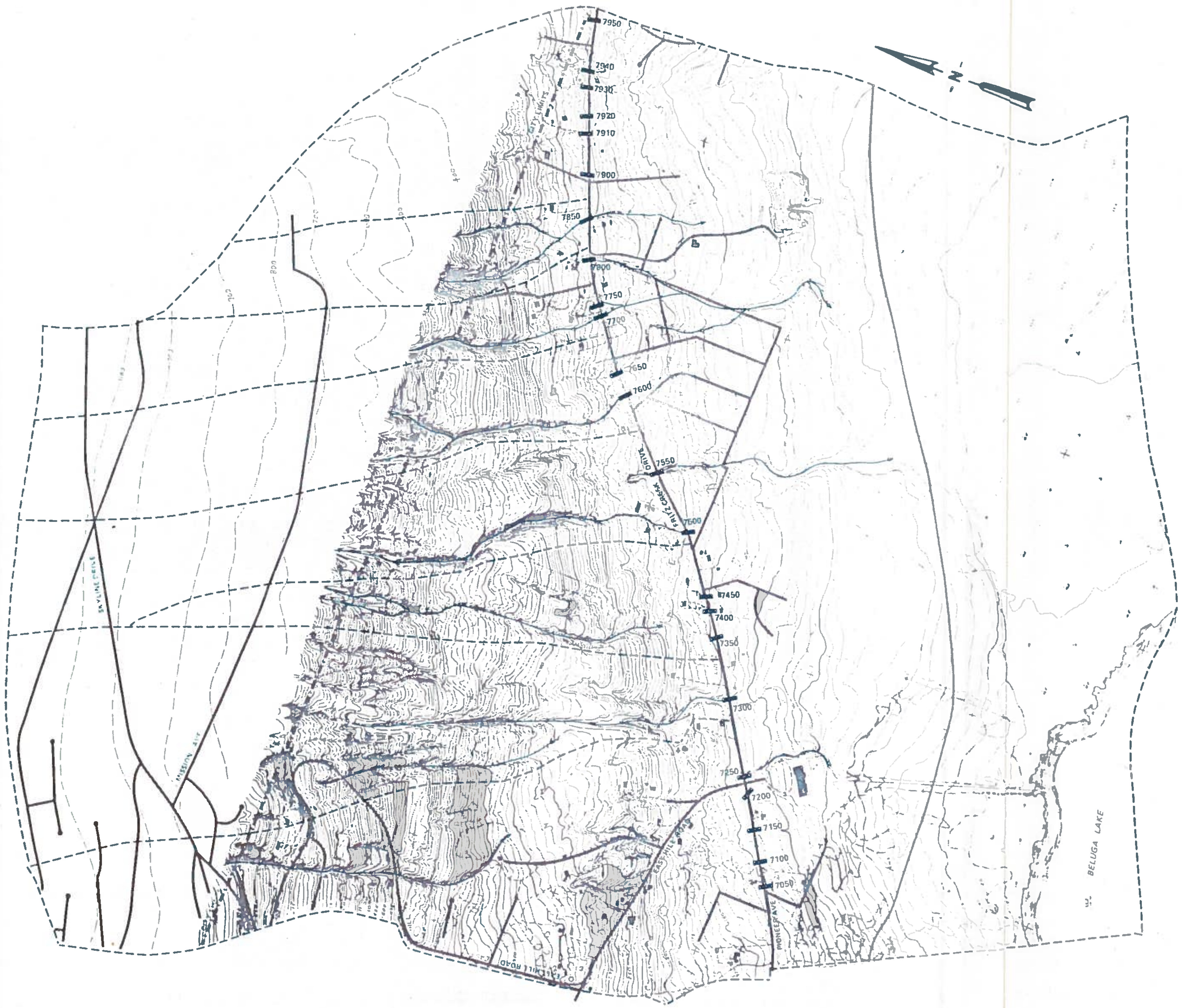


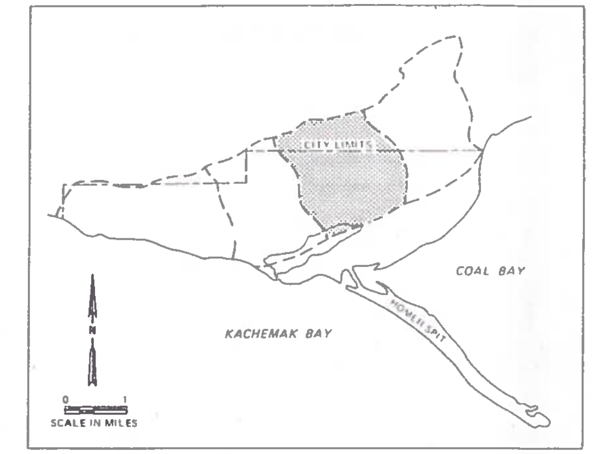
LEGEND

- Drainage Sub - Basin Boundary
- Watercourse
- 6125 — Culvert Location and Inventory Number (See Appendix A)

500 0 500 1000 1500 2000
SCALE IN FEET

Figure 6
Drainage System Map





LEGEND

- Drainage Sub - Basin Boundary
- Watercourse
- 8125 Culvert Location and Inventory Number (See Appendix A)

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SCALE IN FEET

Figure 7
Drainage System Map

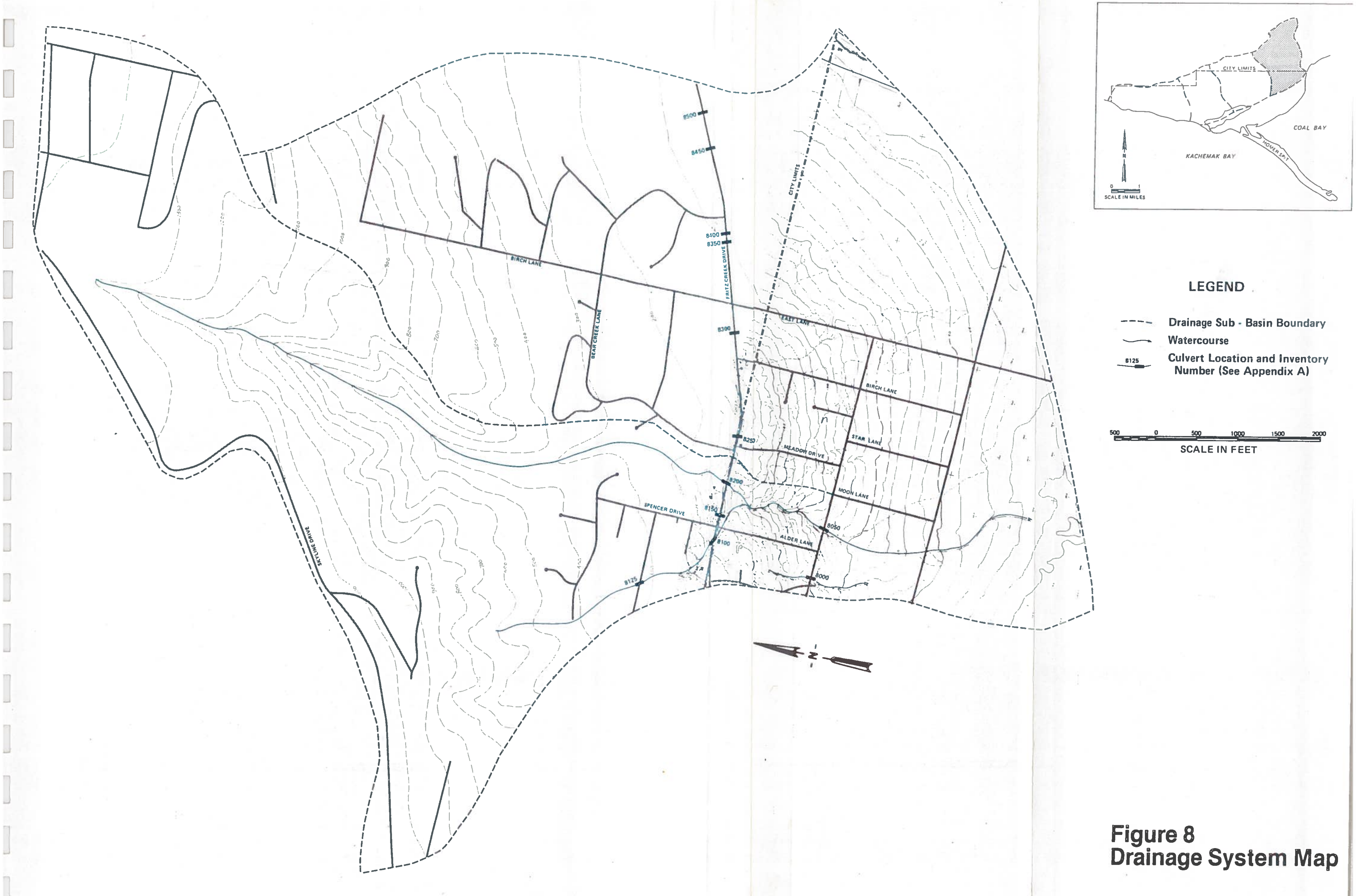


Figure 8
Drainage System Map

increases the rate and amount of runoff from a drainage area by providing a more hydraulically efficient flow path and by reducing the amount of pervious area that can accept infiltration.

The impact of road construction on the drainage system in Homer is shown in figures 5, 6, 7, and 8. The maps show all existing roads and those that are currently under construction or platted on approved subdivisions. Roads planned for the Master Roads Plan being prepared by Silvers Engineering were also included in this report.

The major drainageways are shown on the maps, as well as the location of the existing culvert crossings. Each culvert crossing is assigned an index number that is shown on the maps and cross-referenced to a culvert inventory in appendix A. The inventory shows the culvert number, existing size, cumulative tributary drainage area, existing flow capacity, and expected design flood flow. Existing flow capacity is based on the assumption that the culvert is not blocked with sediment, ice, or debris, which under present conditions is not always a valid assumption.

CURRENT DRAINAGE MANAGEMENT

Current drainage management in the City of Homer falls into the categories of system maintenance and control regulations. The drainage system maintenance includes the maintenance of ditches and culverts as provided by the City Public Works Department and the State of Alaska Department of Transportation, within their respective jurisdictional rights-of-way. The management philosophy to date has been to clean and maintain culverts on a priority basis and to replace culverts which are damaged or washed out.

The state has two electrical thaw wire installations in Homer to prevent ice from blocking the culverts during the winter months. Four such installations are planned for the Homer bypass now under construction. These systems replace the steam-thaw pipe systems which are becoming outdated due to the high labor cost associated with the steam trucks. The Municipality of Anchorage, for example, is phasing out all the old steam-thaw pipe systems and anticipates over 6,000 thaw wire installations.

Most of the culverts in Homer are corrugated metal type made of either galvanized steel or aluminum. Some have prefabricated metal inlet and outlet sections. Few have concrete headwalls. Most culverts protrude from the road embankment with no special inlet or outlet treatment.

The existing regulations regarding road construction and drainage are contained in the city code and the borough subdivision ordinances. City code requirements related to drainage are contained in Articles 4 and 5. Article 4, concerning driveway and right-of-way construction permits (Section 14-400g), requires that permit applications be accompanied by a plan showing complete details on drainage. The code requirements contain the following language:

> All driveways and buffer areas should be constructed so as not to impair the drainage within the street or road right-of-way nor alter the stability of the roadway subgrade and at the same time not impair or materially alter drainage of the adjacent areas. All culverts, catch basins, drainage channels, and other drainage structures required within the buffer area and under driveways as the result of the property being developed, shall be installed in accordance with the standards set by the city, said standard being available at City Hall.

Article 5 of the code contains the following standards for street construction (Section 14-500.4.):

A. Cross Culverts

1. Shall be sized for stream flow based on a 25-year flood.

2. Shall be 18-inch minimum inside diameter.

B. Driveway Culverts

1. Shall be 18-inch minimum diameter.
2. Minimum length shall be 21 feet - maximum length 35 feet.

    a. Special conditions requiring longer culvert lengths will be subject to the approval of the Public Works Director.

3. Driveway elevation at road ditch line shall be 0.1 foot below the elevation of the edge of shoulder.

4. Driveway ditches shall be constructed in such a manner so that no scour will occur to road ditch.

The borough has a subdivision ordinance which is administered by the Borough Planning Commission for areas both within and outside the Homer boundaries. Applications for subdivision approval are submitted to the Plat Committee of the Borough Planning Commission. Subdivision applications for areas within the city are referred by the Plat Committee to the City's Advisory Planning Commission for review and comment. Decisions of the Plat Committee can be appealed to the Planning Commission as a whole, with subsequent appeal to the Borough Assembly.

The subdivision ordinance requires that only limited information on topography, soil conditions, or drainage patterns be submitted with the plat application. These information requirements are listed below (from Subdivision Ordinance, Section 20.12.060).

1. A vicinity map showing natural and manmade features, such as shorelines and streams.

2. Approximate locations of areas subject to inundation, flooding or stormwater overflow; when adjacent to lakes or nontidal streams, the line of ordinary high water; wetlands.

3. Contours at suitable intervals when any roads are to be dedicated, unless the Planning Director or Commission finds evidence that road grades will not exceed 6 percent on arterial streets, 10 percent on other streets.

4. Approximate locations of slopes over 20 percent in grade.

The subdivision ordinance (Section 20.20.070) also limits grades on roads within subdivisions to 6 percent on arterial streets and 10 percent on other streets.

Chapter 4
RUNOFF DETERMINATION

The work done by the Soil Conservation Service in their study, "Potential Flooding, City of Homer," provided a starting point for the determination of runoff. The specific methods used to determine the expected runoff for the purpose of drainage management planning are presented in this chapter.

PRECIPITATION

The average annual and monthly precipitation were presented in chapter 2 of this report. The design of drainage systems requires determination of specific runoff events usually tied to an estimated probability of occurrence. A specific design event may contain more precipitation in one day than is normally expected for a whole month.

Meteorological data are collected at the Homer Airport weather station and published by the National Oceanic and Atmospheric Administration (NOAA). The maximum daily precipitation amount for each year during the period 1932 to 1978 was determined using the published records. Records completed after 1951 included both daily rain and snow amounts and, for some years, the maximum daily precipitation was in the form of snowfall. Several maximum precipitation events started as snow and changed to rain.

A precipitation frequency analysis was performed on the available data under the assumption that all annual maximum daily precipitation values were rainfall events. The data were ranked and plotted on log probability paper in accordance with the Weibull plotting position formula. The maximum daily rainfall of record, which fell in November 1952, was 3.02 inches. That data point was a high outlier on the frequency plot at the 48-year recurrence interval, and was therefore subjectively assigned a 100-year recurrence interval to give a less positive skew to the distribution.

The frequency data based on daily rainfall records were increased by 13 percent in accordance with accepted practice to determine the maximum 24-hour rainfall for the various recurrence intervals. Table 6 lists the rainfall frequency data developed from this analysis.

Table 6. RAINFALL FREQUENCY DATA, HOMER AIRPORT

Recurrence Interval (years)	24-Hour Precipitation (inches)
2	1.42
5	1.85
10	2.06
25	2.41
50	2.80
100	3.39

Adjustment of the rainfall frequency data due to orographic effects of the steep bluffs at the north end of Homer was not considered necessary for development of runoff criteria. Comparison of the 25-year, 24-hour precipitation at Homer with totals for several other Alaskan cities is shown in table 7.

Table 7. 25-YEAR, 24-HOUR RAINFALL AT SELECTED LOCATIONS

City	Inches
Homer	2.4
Fairbanks	2.5
Anchorage	2.9
Kenai	3.1
Juneau	5.0
Seward	7.0

RUNOFF DETERMINATION

There are several accepted methods of determining the expected rate of runoff resulting from a specific design rainfall event. Because of the previous work done by the SCS on potential flooding in the City of Homer, the SCS method of runoff determination was chosen for use in developing the drainage management plan for Homer. The SCS method is based on extensive empirical studies of the relationships between rainfall, soil types, land use, and runoff. Both peak rates and volumes of runoff can be determined by the SCS method. Only the peak rates of runoff were determined for this study.

More than half of the annual maximum rainfall events in Homer occur in the late fall, when very wet or frozen ground is common. Individual extreme runoff events have occurred as a result of rain falling on snow-covered frozen ground. These conditions are common enough to justify their inclusion in the runoff determination.

A reasonable amount of snowmelt was added to the previously determined rainfall amounts to be representative of the expected conditions. U.S. Army Corps of Engineers snowmelt equations were used to calculate that approximately 0.1 inch of water would result from melting of the snowpack during the maximum hour of the extreme rainfall events. An equivalent 24-hour amount of snowmelt water was added to the 24-hour rainfall amount to give a total 24-hour precipitation for each event. A 24-hour melt of 0.6 inch was used for all recurrence intervals. This results in 25- and 50-year, 24-hour rainfall plus snowmelt totals of 3.01 inches and 3.40 inches, respectively.

The SCS type IA storm was chosen as appropriate for the Homer area. A curve number of 95 was used to represent the expected frozen ground condition. The SCS Standard Drawing Number ES 1029, sheet 24 of 24, dated 15 March 1971, was used to determine the peak rates of runoff for drainage areas comprising 5 and 1,000 acres. The results of this analysis are shown in figure 9.

ALTERNATIVE DESIGN FREQUENCIES

The recurrence interval chosen for the design of storm drainage facilities is rarely based on detailed cost/benefit analyses. More commonly, it is established by local practice. For example, the 5-year recurrence interval is used for design of drainage systems for most residential areas and 10- to 25-year design events are commonly used in commercial areas. Major stream and river crossings are usually designed for 50- or 100-year events. The design frequency is chosen with consideration of the consequences of having an event occur that is even bigger than the design event. Minor street flooding in a residential area is much more tolerable than the washout of a major arterial highway. Thus, different design frequencies may be selected for different areas.

The runoff versus drainage area curves presented in figure 9 were used to compute runoff flows for various design frequencies in order to assess the existing capacity of parts of the present drainage systems. Two drainage subbasins, each discharging to Kachemak Bay, were analyzed. The Woodward Canyon subbasin drains an area of about 370 acres in a steep, natural channel that has a number of road crossings at the lower end. The second subbasin drains about 111 acres through a series of both natural drainageways and manmade ditches that are crossed at several points by roads and driveways. The general alignment of this drainage is along Svedlund Street.

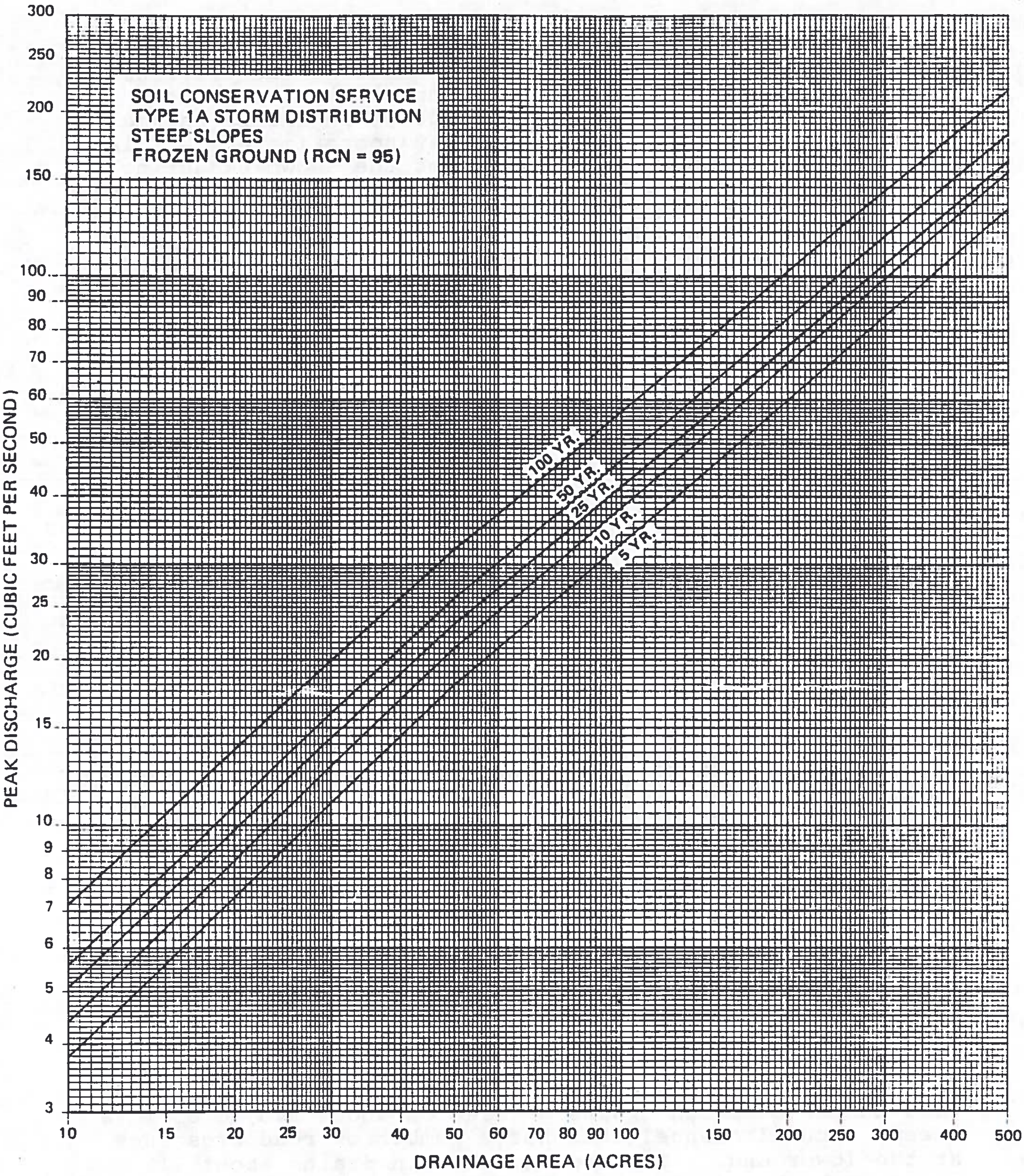


Figure 9
Relationship of Peak Discharge and Drainage Area For Average Recurrence Intervals

The analysis showed that 40 percent of the existing culverts in the two subbasins are inadequate to convey 10-year runoff flows. An additional 20 percent are undersized for passing 100-year flows. Lack of field data makes it difficult to assess the adequacy of channels and ditches. However, because most such drainageways flow on steep gradients, their channels have been cut to depths that provide ample capacity to pass anticipated design flows.

Planning level cost estimates were made to determine the costs for upgrading the existing systems to the 25-, 50- and 100-year level of protection. It was found that designing for the 50-year event would increase costs about 20 percent above those for the 25-year design, while 100-year costs would be approximately 70 percent higher than those for the 25-year design period.

In light of expected operational problems such as culvert blockage with sediment, ice, or debris, it is recommended that the 25-year design event be used for the design of most drainage system components. Extra protection should be provided, however, at major culvert crossings. At those points where the tributary drainage is 200 acres or more, a 50-year design event is recommended. The Homer city code currently requires that culverts be designed for the 25-year flood with an 18-inch minimum diameter.

Chapter 5
PROPOSED DRAINAGE SYSTEM

A complete definition of the proposed drainage system for the City of Homer is provided in this chapter. Methods of determining the size and location of drainage system components, the expected cost of upgrading portions of the existing system, and suggested sediment control measures are given. The proposed system is designed to reduce drainage, flooding, and erosion problems in Homer. These problems are generally described in the SCS study of potential flooding in Homer and are described in detail in the 1976 report on flooding by the Scotia Group. A discussion of the site-specific flooding problems will not be repeated in this report.

TRUNK DRAINAGE SYSTEM

The physical description of the Homer drainage system includes delineation of a trunk drainageway system and its tributary subdrainage areas. The existing drainage facilities, as described in chapter 3, form the basis of a complete drainage system. Reliance on these natural drainageways and pre-existing manmade drainage ditches is the most cost-effective way to develop the complete drainage system. Although it would be possible to redefine the course of an existing drainageway or to put the entire flow in pipes, the cost of those alternatives would always be higher than the cost of improving the existing system.

Figures 5, 6, 7, and 8 show the proposed trunk drainage system for the City of Homer. The trunk drainage system is that portion of the city's drainage network that conveys runoff collected from small land areas (subareas) to a logical disposal point such as Kachemak Bay or Beluga Lake.

The total drainage area tributary to an individual drainage trunk can be subdivided into subareas. Generally, each subarea has a culvert at its lower end. The cumulative drainage area and the drainage area versus discharge curves are used to calculate the design flow capacity required for each segment of a trunk drainageway, and for the outlet culvert. The channel of the trunk drainageway should have sufficient capacity throughout the reach to carry the flow calculated for the lower end of the subarea.

Some of the trunk drainageways shown on the maps already exist and have adequate channel capacity to carry the design flow. Others currently exist but are estimated to be too small to carry the expected flow. Still others do not yet exist and must be constructed to meet future needs. Several of the existing trunk drainageways have adequate channel capacity but are restricted by undersized or plugged cross culverts.

Figure 6 will be used as an example of how the trunk drainageways and subareas were determined. There are three major natural drainageways on this figure: Woodward Canyon in the west and two unnamed drainages in the east. The intervening areas are served by manmade ditches and minor natural drainageways. The locations of the trunk drainageways were determined from the available topographic maps, recent aerial photographs, and field inspections. Subdrainage areas are generally determined by the location and orientation of the existing and planned roads. Locations of future roads were taken from subdivision plats that to date have been approved by the city. Drainage from all land within a given subarea should be conveyed through roadside ditches to the trunk drainageway serving that area.

In areas where road plans were not available, the trunk drainageways were laid out along the natural low spots in the topography. If these alignments prove to be inconsistent with future development plans for those areas, the alignment of the drainageway may be changed in the future if a properly designed alternative is constructed.

A field inventory of existing culverts was performed, and the hydraulic capacity of each existing culvert in the trunk drainage system was determined. In areas where the trunk drainageways cross proposed roads, assumptions as to the depth of the roadfill were made in order to size the appropriate culvert. Each existing and proposed new culvert was given a four-digit identification number, the first digit being the same as the number of the figure on which the culvert is shown.

The selection of recommended design storms used to size components of the trunk drainage system is discussed in the preceding chapter. Portions of the system that drain areas 200 acres and larger are sized to convey 50-year flows, while the remainder of the system is designed for the 25-year event. Hydraulic analyses of existing trunk system culverts indicate that a significant percentage is undersized for the appropriate design storm. Most trunk channels have adequate capacity, although insufficient data are available to do detailed hydraulic analyses.

Two subbasins were selected for which data for upgrading the trunk drainage system were developed. The Woodward Canyon subbasin encompasses an area of 370 acres and is drained by a natural channel. The Svedlund Street drainage serves an area of 111 acres with a series of natural channels and manmade roadside ditches. Need for improvements was based on a preliminary engineering analysis of existing capacities and estimated flow requirements, and used available data. No detailed design of improvement work was undertaken. Cost figures are planning level estimates, in 1979 dollars, and were developed by extrapolating the bid tabulation data from the Homer bypass project and local construction costs. The estimated cost to upgrade the Woodward Canyon trunk drainage system is $111,000 and the estimated cost to upgrade Svedlund Street trunk drainage is $11,000. Methods for implementation of these improvements are presented in the next chapter. Recommended improvements and associated costs for these two subbasins are tabulated in appendix B, and are meant to serve as an example only. Detailed reconnaissance and engineering design effort are required prior to actual construction of the improvement projects.

ALTERNATIVE PHYSICAL SYSTEMS

Buried storm drains and storm water detention ponds were eliminated from consideration as components of the Homer drainage system for several reasons. Piped storm drainage systems typically cost from $50 to $100 per linear foot; whereas, a comparable roadside ditch, when included in the original road construction, costs $5 to $10 per linear foot. Open ditches are subject to blockage by glaciation, although modern design techniques can alleviate some of these problems. Piped systems can also fail as a result of ice blockage, and the economic consequences can be extreme.

Other advantages of open ditches and natural drainageways are associated with water quality and groundwater recharge. Well-maintained ditches and natural streams tend to filter out sediments and pollutants, especially if the ditches are grass lined. Evapotranspiration is also enhanced by natural drains and open ditches. Groundwater control is enhanced by open ditches because they act as drains and lower the groundwater table during low flow periods and store water, thus reducing peak runoff during high flow periods.

Storm water detention ponds are used in many areas in the Lower 48 states where peak flow reduction is desirable. Peak flow reduction by detention ponds reduces the size and therefore the cost of the downstream trunk drainage system. These types of systems were considered impractical for Homer for the following reasons.

- In Homer the distance and time of travel from the upper end of any subbasin to its discharge point are relatively short.

- A certain amount of peak flow reduction can be achieved by utilizing open ditches that provide for infiltration and channel routing.

- The steady and relatively light rainfall/snowmelt events in Homer are not well suited for peak flow reduction.

- Operation of such ponds in cold environments is very difficult. In the case of Homer, if the pond is glaciated during breakup, it would be of no value.

Most importantly, the construction, operation, and maintenance of storage detention ponds are extremely difficult to administrate. Jurisdictions that have successfully implemented such programs employ large professional staffs to oversee the proper functions of the facilities. A good example of the difficulties associated with implementing such a program is the experience of the Municipality of Anchorage. The Public Works Department has not found storage detention ponds very useful, except where they are installed and maintained exclusively by the municipality for the purpose of water quality improvement prior to discharge to sensitive receiving waters. Limited success has been achieved in Anchorage in requiring large commercial developers to provide detention storage to reduce downstream peak flows.

For the above-mentioned reasons, the drainage management plan for the City of Homer is based on the maintenance and expansion of the existing open drainage system without the use of storage detention ponds.

LOCAL DRAINAGE SYSTEMS

The Homer trunk drainage system is defined as a combination of natural drains and open ditches. Local drainage systems serve areas tributary to the trunk system and should be provided with roadside ditches and appropriately sized driveway and cross culverts. The areas tributary to local drainage systems are generally small and system components are therefore sized for the 25-year event. Local drainage systems were not specifically laid out in this report, but the following general guidelines apply.

Drainage water should be conveyed via the local drainage system to the designated trunk drainageway serving the specific subarea of concern. Conveyance should be by way of approved ditches and culverts. The tributary drainage area for each local drainage ditch should be determined and the associated design flow calculated using the appropriate runoff design curve. Discharge of local drainage waters into the trunk drainageway should be done in such a way as to minimize erosion potential at the discharge point.

DRAINAGE AND EROSION CONTROL GUIDELINES

The combination of the trunk and local drainage systems makes up the city's entire drainage system. The design of the various components of the system should be based on sound engineering principles which are presented in the form of design guidelines. The intent of these criteria is to allow for a planned, logical expansion of the city's existing drainage system to meet future needs and solve current problems.

The recommended design guidelines are presented in appendix C. The material in this appendix was compiled from design references currently being used by the Alaska Department of Transportation, the Federal Highway Administration, and the U.S. Department of Agriculture Soil Conservation Service, as well as hydrologic data developed specifically for Homer and explained in chapter 4. These design standards should be used by anyone who plans to construct any drainage system components in the city.

Appendix C includes recommended procedures for the control of erosion and sedimentation that are related to the expansion of the drainage system. Erosion and the subsequent deposition of sediment are natural processes that can be greatly aggravated by the activities of man. In many areas of the country, sediment control is practiced to preserve valuable topsoil for agricultural uses. In other areas, especially those that are rapidly urbanizing, sediment control is practiced to reduce water quality degradation caused by the presence in surface runoff of soil particles and the pollutants associated with them.

Although incidences of soil erosion in Homer are not directly linked to operation of the drainage system, such erosion can have a major impact on the maintenance of system components. Many of the existing culverts in the city are partially blocked with sediment; therefore, a major concern in Homer is the reduction of sediment to ensure that the capacity of the drainage system is not reduced. Water quality impacts due to erosion are generally not significant in Homer.

In summary, the recommended drainage system for the City of Homer consists of a series of natural and manmade drainage components. The system utilizes existing facilities as much as possible and includes improvements to upgrade the present system capacity. System layout is based on topography and proposed land development plans. Under the recommended plan the city area has been divided into a number of drainage subareas, each served by a trunk drainage system consisting of a combination of natural channels, open ditches, and appropriately sized culverts. Local drainage systems convey flow to the designated trunk drainageway via open ditches and cross culverts.

It is recommended that the design of drainage system components be in accordance with the criteria and guidelines presented in appendix C. The purpose of these design criteria and standard specifications is to direct the development of the city's drainage system according to a logical expansion plan which incorporates accepted engineering methods.

Chapter 6
DRAINAGE PLAN IMPLEMENTATION

The proposed drainage management plan, as presented in the previous chapter, can be implemented in several ways. Although maintenance of the status quo is an alternative, it will not be considered a desirable one because of an expected continuation of drainage problems in Homer. This chapter contains several legal, administrative, and financial options which could be used to implement the drainage management plan.

LEGAL IMPLEMENTATION

The basic need for a legal mechanism to implement the plan lies in the fact that much of the city's drainage system will be designed and constructed by developers. If all drainage system components were to be constructed and maintained by the city, the city could use the drainage management plan as an internal document for the design of the system. However, as the city grows, road, sewer, water, and drainage services will have to be provided. Connection of all these utilities to the existing city systems should be accomplished by the developers in accordance with standard design specifications. The various alternative legal mechanisms that are available to implement the Drainage Management Plan are described below.

Adoption by Resolution

At a minimum the City Council could adopt this report by resolution and use its recommendations as general guidelines. This approach would be the easiest form of implementation but it would not be very effective in guiding the development of the drainage system.

Drainage Control Ordinance

The next level of implementation is to develop a new ordinance that would require that certain drainage control measures be accomplished. Ideally, the ordinance would provide for the orderly development of the city's drainage system and provide for control powers to be extended to areas in the borough which physically drain into the city.

The intent of a drainage ordinance is to document the city's policy and procedures for maintaining and expanding the drainage system. For the most part, the ordinance is designed to provide guidelines for future development. The city will have to pursue a parallel course of obtaining easements for the portions of the drainage system which go through developed private property and of initiating a capital improvement program to upgrade the existing system.

In September 1978 the Washington State Chapter of the American Public Works Association developed a draft model comprehensive drainage ordinance. This model ordinance contains several parts which are applicable to Homer with regard to the content and structure of a drainage control ordinance. The model ordinance, as amended to suit the needs of the City of Homer, is presented in appendix B. Further revisions to the drainage ordinance may be required to ensure that it meets the needs of Homer and is acceptable to city officials and legal counsel.

The model ordinance would require developers to submit a drainage plan as part of their application for a subdivision approval, building permit, zone change, conditional use, and other such applications (see Section 7D, appendix D.) Construction work would not be permitted until the drainage plan is approved. The ordinance would allow certain exceptions to the drainage plan requirement if the public works director makes certain findings.

Section 9 of the ordinance specifies the contents of the drainage plan. The plan would contain:

1. A depiction of the drainage area with topography and other site features.

2. Description of the peak discharge and surface water currently entering or leaving the property.

3. Proposed facilities for handling the runoff.

Guidelines to aid developers in preparing a proper drainage plan would be available as a handout from the Department of Public Works (see appendix C). The ordinance would also establish performance standards to minimize downstream damage and erosion, to guide construction practices, and to protect water quality (Section 11).

Sections 12 through 14 describe the review, approval, and appeals process and standards for granting a variance. The proposed ordinance would give the public works director a key role in drainage plan review. He would make a finding as to the adequacy of the technical data and would recommend to the planning commission that they approve, approve with conditions, or reject the application. The review by the public works department should include an assessment of the relationship between the proposed drainage system and proposed road design and construction. After receiving the public works department recommendation, the planning commission would act on the application as a whole (subdivision, rezone, etc.), considering all aspects of the proposed development, including drainage.

Under Section 15, easements would be required for all drainage system components as is required for other utilities such as sanitary sewers. The size and location of particular easements for existing developed property have not been determined as part of this study, but these would be similar to those required of new developments, as shown in the model ordinance.

In some instances, it may be necessary to grant a variance from the requirement that a local drainage system connect to the trunk drainage system. As implied in Section 15, a developer is normally required to provide a physical connection to the city drainage system and to provide an easement for these connections. A variance might be appropriate when a development is isolated by undeveloped land downhill from its site. In such a case, there would be no logical point at which the discharge from the site could be connected to the city system. The public works director would then have to decide if a connection to the nearest component of the city system would be required or if another discharge method would be appropriate. Whichever method is selected, written permission from the owner and/or easements on or through neighboring property must be obtained.

Sections 16 through 21 of the model ordinance cover bonds and liability insurance that could be required of developers to ensure that drainage system improvements are constructed and maintained. These sections also set forth a possible city policy on maintenance and enforcement.

Modifications to Model Ordinance

Several revisions could be made to the model drainage ordinance if city officials find that it is too restrictive in its present form. These possible changes are described below.

1. Omit the requirement that drainage plans be submitted with building permit applications and conditional use requests. Retain the drainage plan requirement for subdivisions, rezonings, contract zonings, and planned unit developments.

   If this option if chosen, the city should make information about drainage concerns available to building permit applicants, especially relating to the location of the trunk drainage systems and any easement requirements.

2. Omit the requirement that the drainage plan be prepared, inspected, and field certified by a civil engineer.

   If this requirement is deleted, the city staff and planning commission will have to assume greater responsibility for reviewing the drainage plans. The city would also need to expand its budget to pay for additional staff involvement.

3. Modify the section that requires bonding and 2-year maintenance of drainage improvements by the developer.

Modifications to Existing Ordinances

A possible alternative to a new city drainage ordinance is to include drainage and erosion control requirements in existing ordinances. Whether there is a new ordinance or controls are added to existing ordinances, the primary objective is to ensure that basic data are available to assess how well proposed developments will meet drainage and erosion control criteria. Both the subdivision ordinance and zoning ordinance could be revised to include drainage requirements.

Borough Subdivision Ordinance

The proposed subdivision ordinance (draft March 1979) requires that only limited information on topography, soil conditions, or drainage patterns be submitted with the plat application. The ordinance does not require runoff calculations, a drainage system plan, or drainage easements. As currently written, the subdivision ordinance offers few tools for evaluating or solving drainage problems.

Making changes to the borough subdivision ordinance may be more difficult than passing a citywide drainage ordinance since it requires approval by both the borough planning commission and assembly. However, it may be worthwhile to recommend such changes since the subdivision ordinance is the only mechanism currently available to address drainage problems related to development outside the city's boundaries.

The major area of concern with regard to drainage control outside the city limits is that of the adequate construction of cross culverts. Although erosion control and proper local drainage are generally recommended for areas outside the city, construction of cross culverts is the primary concern.

The city should, at a minimum, ensure that crossings of the trunk drainage system, as shown in figures 5, 6, 7, and 8, be in accordance with the recommended guidelines regardless of whether the subject crossing is within the city or the borough.

Possible additions to the subdivision ordinance are listed below.

1. More specific requirements for information on drainage, topography, and soils to be included with the preliminary plat application. (Add to Section 20.12.060.)

2. Requirements for the dedication of drainageway easements. (Add to Section 20.20.040.)

3. Setback and other design standards for lots within a subdivision that abut or include a natural or manmade drainage channel. (Add to Section 20.20.230.)

4. Provisions for review of the subdivision plat by the borough engineer or another certified engineer. That review process would include an assessment of drainage data and recommendations to alleviate potential drainage problems. (Add to Section 20.12.080.)

5. Procedural changes whereby the city advisory planning commission would be permitted to review and comment on applications for subdivisions in areas which are tributary to the city. This procedure could be initiated through a change in the ordinance itself or possibly through an intergovernmental agreement between the city and the borough.

These suggested revisions to the subdivision ordinance may be difficult to achieve. As an alternative, the city may be able to utilize Section 20.16.060 of the current subdivision ordinance to achieve its objectives. That section does not allow the borough to give final approval to a plat until there is compliance with all city-required improvements. The section reads as follows:

> <u>Improvements--Installation agreement required</u>. No final plat of a subdivision located within a first class or home rule city shall be recorded prior to compliance with any city ordinances concerning the installation of improvements. Evidence of such compliance shall be provided by the subdivider in the form of a written statement from the appropriate city official that improvements required by city ordinance are or will be installed. Such evidence of compliance shall be a part of the final plat submission and the time for action by the Commission as required by 20.16.170 shall not commence until said evidence is submitted.

If drainage improvements are required through a city ordinance, the city may then refuse to sign-off on the subdivision until the developer posts a bond or otherwise guarantees to the city that the drainage improvements will be constructed.

Section 20.20.250 of the proposed subdivision ordinance gives the cities another opportunity to use the subdivision ordinance to enforce more stringent requirements for subdivisions within their boundaries. This section of the proposed ordinance is quoted below:

> Different Standards in Cities. Where cities have enacted by ordinance different design standards than those set forth in this chapter, the Planning Commission may apply such city standards in lieu of those set forth in this chapter.

Drainage design standards for subdivisions within the city would have to be established through a city drainage ordinance as discussed earlier in this chapter before enforcement through Section 20.20.250 of the proposed subdivision ordinance would be possible. Even then, the application of these standards would be at the discretion of the borough planning commission.

Zoning Ordinance

Another opportunity for enacting drainage regulations is through the city's zoning ordinance. Possible options are listed below.

1. The zoning map could be revised to include a drainageway overlay zone. Within this zone, special regulations and design standards relating to drainage could be imposed.

2. All critical drainageways could be included in the government reserve district. This would involve purchasing the land outright, or acquiring easements. The city could then keep the land in its natural state or develop it as park land.

3. Drainage regulations and data requirements could be added to existing zoning district regulations (residential, commercial, industrial). These requirements might include (a) a site plan showing drainage, topography, and proposed location of structures; (b) runoff data; and (c) a minimum setback for structures from drainage channels. These regulations could also be cross-referenced to the city drainage plan or ordinance if adopted.

REQUIREMENTS FOR IMPLEMENTATION

In addition to legal implementation, the city will have to take several other steps to ensure proper management of the drainage system.

Management and Administration

The city currently does not have the staff to administer the requirements of the drainage management plan and ordinance. The actual staff requirements to upgrade the existing system and to review plans for system expansion depend on the rate at which improvements to the existing system are required and the rate of new development.

At a minimum, the public works director should review all improvements to the existing drainage system and the proposed addition of any new drainage system components. Inspection of drainage-related construction activities would also be desirable and should be accomplished by a building (construction) inspector in conjunction with other construction inspection duties. The success or failure of the drainage management plan is directly related to the availability and quality of the staff assigned to the implementation.

Standard Design Criteria

In addition to staff requirements, an adequate set of standard design criteria for drainage improvements needs to be developed. Much of the material presented in appendix C, Design Criteria and Standard Specifications, could be used for that purpose. Standard drawings and specifications should be adjusted by the public works director to meet the particular requirements of the city. These design standards should be available to developers at the public works department and city hall. These would supplement and elaborate any standards referenced in a city drainage ordinance.

Capital Improvements

The rate of capital improvements to the existing drainage system is directly related to the budget available. It is recommended that improvements to the existing drainage system be made in accordance with a priority list developed and maintained by the public works director.

Two separate bases should be used to set the priorities. The first is improvements to eliminate a current chronic drainage problem. For example, if the section of the Woodward Canyon drainage behind the Pratt Museum is a constant problem, then it should be entered on the priority list. The second basis for inclusion as a priority is any street improvement project within the city's rights-of-way. For example, when Lucky Shot Street is improved, the ditch along the west side of the street is to be part of the trunk drainage system and should be constructed to accommodate the appropriate design flow.

Before each project on the priority list comes up for funding, it should be properly designed and an up-to-date cost estimate prepared, as is done for all capital improvement projects.

Easements

In order to maintain, repair, and replace drainage system components, easements for all such components not within city rights-of-way should be obtained. Acquisition of easements for newly developed property is spelled out in Section 16 of the recommended model ordinance.

For areas currently developed and subdivided, drainage easements should be acquired as part of any capital improvement program and elsewhere on an as-needed basis. That is, easements should be acquired as soon as the need arises to perform capital improvement of the drainage system components. Ultimately, the city should acquire easements to all trunk drainageways. An average easement 40 feet in width would result in 4.8 acres per mile of drainage system trunk.

Financing Requirements

Implementation of the drainage plan will require the expenditure of funds by the city. Financing will be required for capital improvements, maintenance, administration, and review of development proposals. Bonds for the required capital improvements can be sold by the city. As indicated in the drainage ordinance, private developers can also be required to bear some of these costs. Typical costs for drainageway improvements and other system requirements are presented in appendix B.

The proposed drainage ordinance in appendix D provides the city with the option of taking over maintenance of drainage facilities located on private property that discharge into the trunk drainage system. The city would then have to determine how best to finance the maintenance. Two basic financing options exist: (1) the general fund, supported by taxes, and (2) a service utility charge or assessment charge. One drawback of use of the general fund is that drainage system maintenance must compete with other city budget items for those funds. The service utility charge is, however, very difficult to administer equitably. For Homer, it is recommended that maintenance of drainage facilities be funded from the general fund and included in the public works budget.

Acquiring drainage easements would also be an additional cost if the city chooses to obtain easements in existing developments. Easements may be acquired in new developments by requiring that they be dedicated as part of the subdivision approval process. The city may wish to consider compensating the developer in certain circumstances, such as when a lot, or lots, becomes unbuildable, specifically because of the drainage easement requirement.

The cost of city staff time to implement the drainage plan is also an important consideration. As mentioned above, staff requirements and costs will increase as the rate of development increases. To minimize the time required by city staff, the city can require that the drainage plan be prepared and certified by a civil engineer registered in the State of Alaska, and that the same engineer provide for inspection during construction and certify that the project was constructed in accordance with the drainage management plan.

GENERAL PRINCIPLES OF IMPLEMENTATION

Overall, the following general principles should be considered in implementation of the drainage management plan:

- The upgrading and expansion of the physical drainage system should be in accordance with the drainage management plan.

- A priority list for upgrading the existing system components should be established by the City Council. As funds become available, system upgrading should occur.

- As new system components are added, they should be designed and maintained in accordance with standard design criteria.

- Whenever possible, the trunk drainage systems should be improved from downstream ends to upstream ends to avoid the transfer of problems along the trunk system.

- Although the design recurrence interval suggested in this report is fairly high for a drainage system, it should be remembered that there is always the chance that a given storm event will overtax the system.

- Buying drainage easements or buying the land outright will make it easier to maintain the system, but it will not solve all the drainage problems. It may, in fact, open up the city to damage suits if a flood greater than the design flood occurs.

- The drainage plan can be partially implemented through existing or new city and borough ordinances. The choice of a regulatory strategy should be guided by the ability of the city to administer and enforce the proposed regulations.

RECOMMENDATIONS FOR IMPLEMENTATION

Of the several ways presented in this chapter to implement the drainage management plan, the following are recommended as being most appropriate for the City of Homer.

- Adopt a new drainage ordinance similar to the model presented in appendix D. Modification of existing city ordinances would have to be extensive to be comparable with a new ordinance.

- Establish an interagency agreement with the Kenai Peninsula Borough to provide the city with the power to review and approve any construction and subdivision design that could affect the functioning of the city's designated trunk drainage system, as shown in figures 5, 6, 7, and 8.

- Review the city's current staff availability and determine whether there is adequate staff to implement the drainage management plan. The amount of staff involvement will depend on how much is required of the developer.

- Modify, as required, the Design Criteria and Standard Specifications as presented in appendix C, and make them available to developers and others who would construct portions of the city's drainage system.

- A capital improvement program should be established to relieve chronic drainage problems and to provide for future drainage needs. Much of this work can be accomplished in conjunction with the capital improvements to the streets and roads.

- Drainage easements should be required for new developments and should be acquired, on an as-needed basis, for existing developments.

- Drainage improvements should be scheduled, designed, constructed, and financed through the public works department, as are street, road, water, and sewer improvements. Local improvement districts should be used to add drainage improvements.

Appendix A
CULVERT INVENTORY

This appendix is an inventory of existing road culverts and those required in the future as roads currently planned are constructed. Data for existing culverts were compiled from field inspections and design drawings. The drainage area tributary to each culvert was planimetered from topographic maps, and the corresponding design flow determined using figure A-1.

This inventory should be expanded to include a narrative description of the current condition of the culverts and any associated problems. Jurisdictional responsibility should also be indicated, such as city or state ownership. Inlet and outlet conditions and the presence or lack of thaw wires should also be noted. Channel sections could be added by designation of the numbers of the culverts located at the upstream and downstream reaches of the channel.

The basic inventory plus the required additional data should be maintained by the public works director.

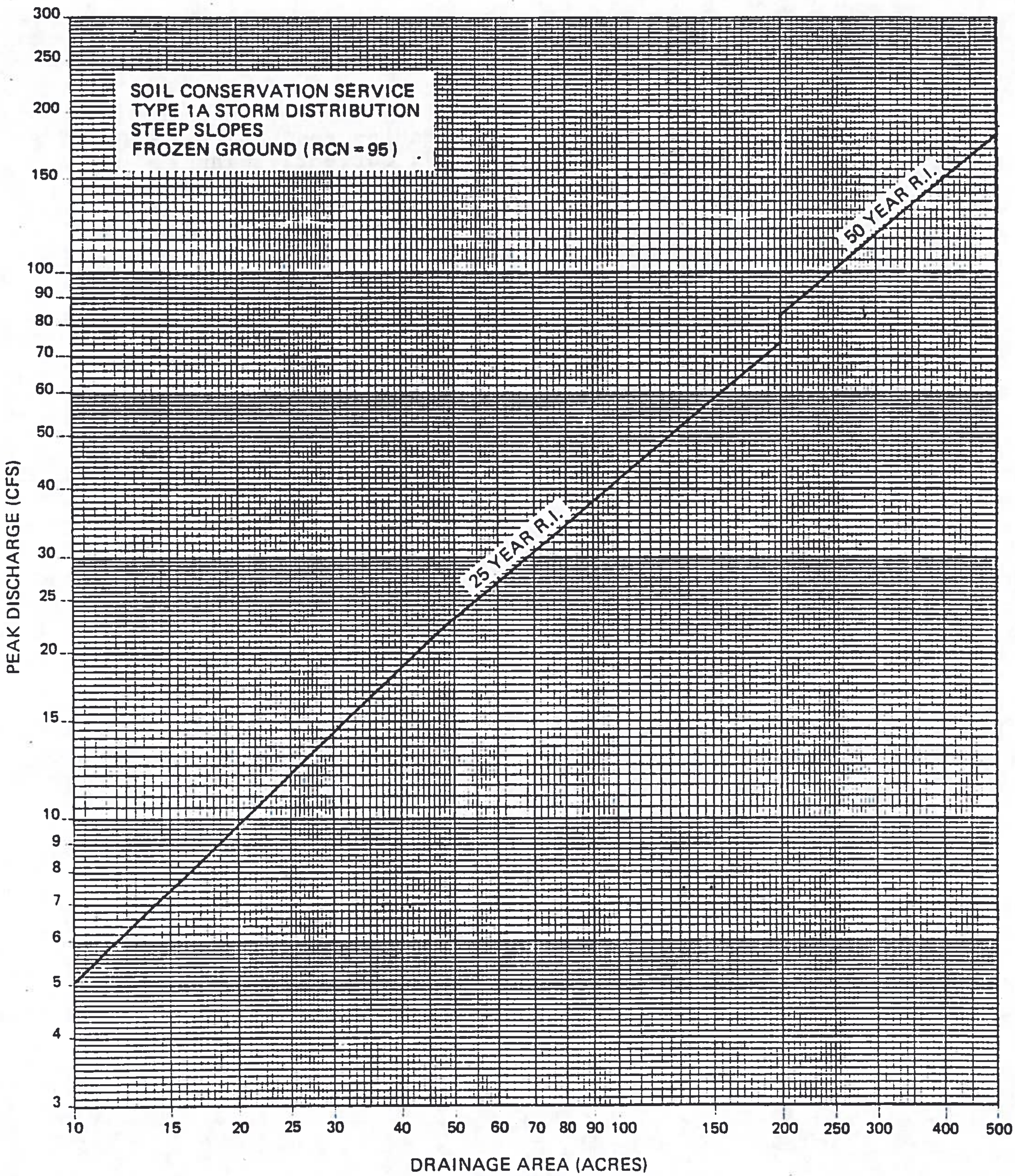


Figure A-1
Runoff Design Curve

CULVERT INVENTORY

Culvert Number*	Culvert Size (inches)	Culvert Material	Head Water (ft)	Contributing Drainage Area (acres)	Existing Culvert Capacity (cfs)	Design Capacity (cfs)
5100	36	CMP	7	10	80	5
5200	24	CMP	15	35	33	16
5300	36	CMP	20	39	90	19
5400	36	CMP	20	107	90	44
5500	48	CMP w/HW	20	269	210	111
5800	two 50 x 31	CMP	5	149	110	58
5820	None Existing			75	--	32
5830	None Existing			75	--	32
5840	18	CMP	3	75	8	32
5850	None Existing			64	--	28
5860	48	CMP	10	64	130	28
6000	48	CMP	9	370	125	141
6010	two 65 x 40	CMP	6	368	220	140
6020	30	CMP	4	363	28	138
6030	36 x 24 box	Conc. wing walls	8	355	81	136
6040	24	CMP	3.5	355	16	136
6050	two 24	CMP	6	340	43	132
6060	24	CMP	13	320	30	125
6070	30	CMP	0	320	0 Pipe is uncovered	124
6080	None Existing			12	--	6
6085	None Existing			11	--	6
6090	24	CMP	3	10	15	5
6095	18	CMP	5	8	10	4
6100	two 48	CMP	7	203	203	84
6105	two 48	CMP	8	200	206	83
6110	None Existing			31	--	15
6115	24	CMP	4	31	18	15
6120	24	CMP	5	13	20	7
6130	36 x 18	CMP	4	153	24	60
6140	24	CMP	3.5	18	16	9
6150	24	CMP	12	130	30	52
6160	24	CMP	5	123	20	46
6162	None Existing			90	--	38
6164	None Existing			80	--	35
6166	None Existing			75	--	33
6170	18	CMP	5	68	10	30
6172	None Existing			24	--	12
6180	24	CMP	5.5	12	21	6
6190	30	CMP	10	11	57	6
6200	30	CMP	10	39	45	19

* First digit of culvert number corresponds to figure number of drainage map on which it is located.

Culvert Number	Culvert Size (inches)	Culvert Material	Head Water (ft)	Contributing Drainage Area (acres)	Existing Culvert Capacity (cfs)	Design Capacity (cfs)
6220	30 x 48	CMP	4	11	46	6
6240	30	CMP	8	28	40	14
6260	30 x 18	CMP	4	16	15	8
6300	30	CMP	9	111	43	46
6305	None Existing			90	--	38
6310	None Existing			85	--	36
6315	None Existing			80	--	34
6320	None Existing			75	--	33
6330	30 x 18	CMP	6	67	18	30
6335	None Existing			60	--	27
6340	None Existing			55	--	25
6345	None Existing			50	--	23
6350	24	CMP	5	38	20	18
6360	None Existing			30	--	15
6370	None Existing			27	--	13
6400	30	CMP	4.5	116	30	47
6410	30	CMP	10	116	45	47
6412	None Existing			100	--	42
6414	None Existing			95	--	40
6416	None Existing			90	--	38
6418	None Existing			25	--	12
6420	30 x 18	CMP	6	20	18	10
6430	18	CMP	4	70	9	41
6440	30 x 18	CMP	5	66	17	30
6442	None Existing			60	--	27
6444	None Existing			55	--	25
6446	None Existing			50	--	23
6450	18	CMP	5	44	11	21
6452	None Existing			44	--	21
6454	None Existing			40	--	19
6456	None Existing			35	--	18
6458	None Existing			30	--	15
6460	None Existing			25	--	12
6470	18	CMP	5	23	11	11
6500	65 x 40	CMP	7	296	65	117
6505	24	CMP	3	7	15	4
6510	30	CMP	4	250	28	100
6515	24	CMP	6	250	22	100
6520	48	CMP	8	250	103	100
6530	one 36	CMP	7		30	
	one 24	CMP	3.5	233	+16 = 46	96
6540	18	CMP	6	29	12	14
6550	24	CMP	3.5	29	16	14
6560	48	CMP	10	204	130 w/ thaw wire	85
6570	None Existing			103	--	42
6580	None Existing			48	--	23
6590	24	CMP	5	11	20	6
6600	24	CMP	5	27	20	13

Culvert Number	Culvert Size (inches)	Culvert Material	Head Water (ft)	Contributing Drainage Area (acres)	Existing Culvert Capacity (cfs)	Design Capacity (cfs)
6610	24	CMP	5	27	20	13
6620	24	CMP	5	30	20	15
6700	None Existing			155	--	60
6702	None Existing			150	--	59
6704	None Existing			145	--	58
6706	None Existing			140	--	56
6708	None Existing			135	--	54
6710	36	CMP	7	122	55 w/ thaw wire	49
6720	two 24	CMP	one 14 one 12	103	62	42
7000	24	CMP	5	22	20	11
7050	24	CMP	5	33	20	16
7100	24	CMP	5	33	20	16
7150	24	CMP	6	109	22	45
7200	24	CMP	6	109	22	45
7250	24	CMP	4	39	18	19
7300	two 24	CMP	one 7.0 one 7.5	193	47	73
7350	24	CMP	--	6	--	3
7400	two 24	CMP	4	35	36	17
7450	24	CMP	5	29	20	14
7500	24	CMP	5	79	20	34
7550	24	CMP	6.5	34	22	16
7600	36	CMP	10	83	70	35
7650	24	CMP	6	24	22	11
7700	24	CMP	7.5	57	24	25
7750	24	CMP	5	13	20	6
7800	24	CMP	6	4	22	2
7850	24	CMP	--	54	--	24
7900	24	CMP	7	28	23	14
7910	24	CMP	--	9	--	5
7920	24	CMP	--	9	--	5
7930	24	CMP	--	9	--	5
7940	24	CMP	6	26	22	12
7950	24	CMP	7	5	23	3
8000	None Existing		--	12	--	6
8050	None Existing		--	765	--	245
8100	48	CMP	9	246	150	102
8125	None Existing		--	230	--	94
8150	None Existing		--	--	--	--
8200	two 36	CMP	one 7 one 8	507	117	190
8250	24	CMP	--	--	--	--
8300	24	CMP	--	--	--	--
8350	24	CMP	--	--	--	--
8400	36	CMP	--	--	--	--
8450	24	CMP	--	--	--	--
8500	24	CMP	--	--	--	--

APPENDIX B
DRAINAGE SYSTEM COST ESTIMATES

This appendix presents an example of the process used to determine necessary drainage system improvements for the design storm. Two subbasins were selected for analysis: the Woodward Canyon drainage and the Svedlund Street drainage, which can be seen on figure 6 in the main text. Assessment of existing culvert capacities was based on data from appendix A. Channel capacities were estimated using data from topographic maps. Channel cross section data were not available.

The sequence of hydraulic structures was taken in an upstream to downstream order. The design flow for each hydraulic component was determined from figure A-1 for the upstream tributary area. Required channel capacities were based on flows for the contributing area at the downstream end of the reach.

Improvements are recommended wherever design flows exceed the capacity of the existing system. The recommended improvements are the result of a preliminary engineering effort only and do not constitute final design. Costs are planning level estimates based on actual bid costs for the Homer bypass project. Detailed design and cost estimating are necessary prior to implementation of any of the recommended drainage system improvements.

Appendix B
Drainage System Cost Estimates

Sequence of Hydraulic Structures	Existing Conditions: Culverts No.	Size (in.)	Type	Capacity (cfs)	Channels: D.A. (Ac)	Slope (%)	Capacity (cfs)	Proposed Improvements: Culverts No.	Size (in.)	Type	Channels	Planning Level Costs: Culverts	Channels	Total
Woodward Canyon														
Culvert 6070	1 Culvert is broken	30	CMP	0				Remove old culvert				$ 200		$ 200
Natural Channel: 6070-6060, 700'					320	~5 deep	100				None			
Culvert 6060, 60'	1	24	CMP	30				1 w/end section	42	CMP		5,200 1,200		6,400
Natural Channel: 6060-6050, 700'					341	~7 deep	118				None			
Culvert 6050, 60'	2	24	CMP	60				2 w/headwall	36	CMP		14,700 1,200		15,900
Natural Channel: 6050-6040, 700'					355	~6 deep	109							
Culvert 6040 Private Driveway	1	24	CMP	16				Upgrade by Owner						
Natural Channel: 6040-6030, 200'					355	~7 deep	118				None			
Culvert 6030, 100'	1	3'x2' box	Conc.	81				1 w/headwall	48	CMP		11,700 1,200		12,900
Natural Channel: 6030-6020, 500'					363	~4	89				Improve capacity to 144 cfs as part of street project		$15,000	15,000
Culvert 6020, 60'	1	30	CMP	28				1 1 w/headwall	58x36 50x31	CMP CMP		21,800 2,400		24,200
Natural Channel: 6020-6010, 800'					368	~4	89				Improve capacity to 145 cfs as part of street project		23,500	23,500
Culvert 6010	2	65x40	CMP	220										
Natural Channel: 6010-6000, 500'					370	~5	100				None			
Culvert 6000, 60'	1	48	CMP	125				1 w/headwall	54	CMP		11,700 1,200		12,900
														$111,000

Sequence of Hydraulic Structures	Existing Conditions: Culverts No.	Size (in.)	Type	Capacity (cfs)	Channels D.A. (Ac)	Slope (%)	Capacity (cfs)	Proposed Improvements: Culverts No.	Size (in.)	Type	Channels	Planning Level Costs: Culverts	Channels	Total
Svedlund Street Trunk														
Culvert 6370	None existing							1 w/end section	18	CMP		$ 2,100 1,200		$ 3,300
Natural Channel: 6370–6360, 300'					30	~13	100+				None			
Culvert 6360	None existing							1 w/end section	18	CMP		2,100 1,200		3,300
Channel and Ditch 6360–6350, 900'					38	D, ~6 Ch, ~8	50+ 100+				None			
Culvert 6350	1	24	CMP	20										
Natural Ditch: 6350–6330, 2,300'					67	5-10	70+				None			
Culvert 6330, 60'	1	30x18	CMP	18				1 w/end section	24	CMP		3,200 1,200		4,400
Natural Ditch/Channel: 6330–6300, 2,100'					111	~6	100+				None			
Culvert 6300	1	30	CMP	43				None						
														$11,000

APPENDIX C
DRAINAGE AND EROSION CONTROL GUIDELINES

All developments being constructed within the City of Homer shall be protected from drainage problems through the use of proven engineering techniques, as described in these guidelines.

DRAINAGE BASIN AREAS

The drainage basin area includes the total land area of the subject site in acres and all upstream tributary watersheds, and may encompass portions of the basin which lie outside the development. Determination of the drainage basin's areal extent should be accomplished by using the city's 5-foot contour interval maps. If part of a basin lies outside the area covered by these maps, a combination of USGS topographic maps and field inspection should be used to determine the extent of the drainage basin.

RUNOFF

Runoff determination should be made using figure C-1, Runoff Design Curves.

HYDRAULIC DESIGN CRITERIA

To provide the city with an efficient and uniform drainage system, the following criteria will be used for the hydraulic design of drainage system components, unless specific exception is made by the public works director.

Standard Ditch/Trunk Ditch

Standard ditches shall be provided in combination with street and road improvements, and as required to upgrade the capacity of the natural drainage system. The standard ditch shall conform to that shown on the typical roadway cross section adopted by the city.

Maximum flow velocity allowed in a ditch shall be such that no erosion or scour will take place to the sides or bottom of the ditch during normal flow or design storm flow. Where design flow velocities exceed 6 feet per second, the ditch shall be lined to prevent erosion. Typical lined ditch cross sections are shown in figure C-2. Ditch lining shall consist of a layer of well-graded Anchor Point gravel riprap with a minimum thickness of 4 inches and minimum particle size of 4 inches, or a 3-inch-thick layer of asphalt paving. Linings shall be underlain by a 4-inch layer of 4-inch minus subbase material. Ditch lining shall extend up the sides to the design flow depth.

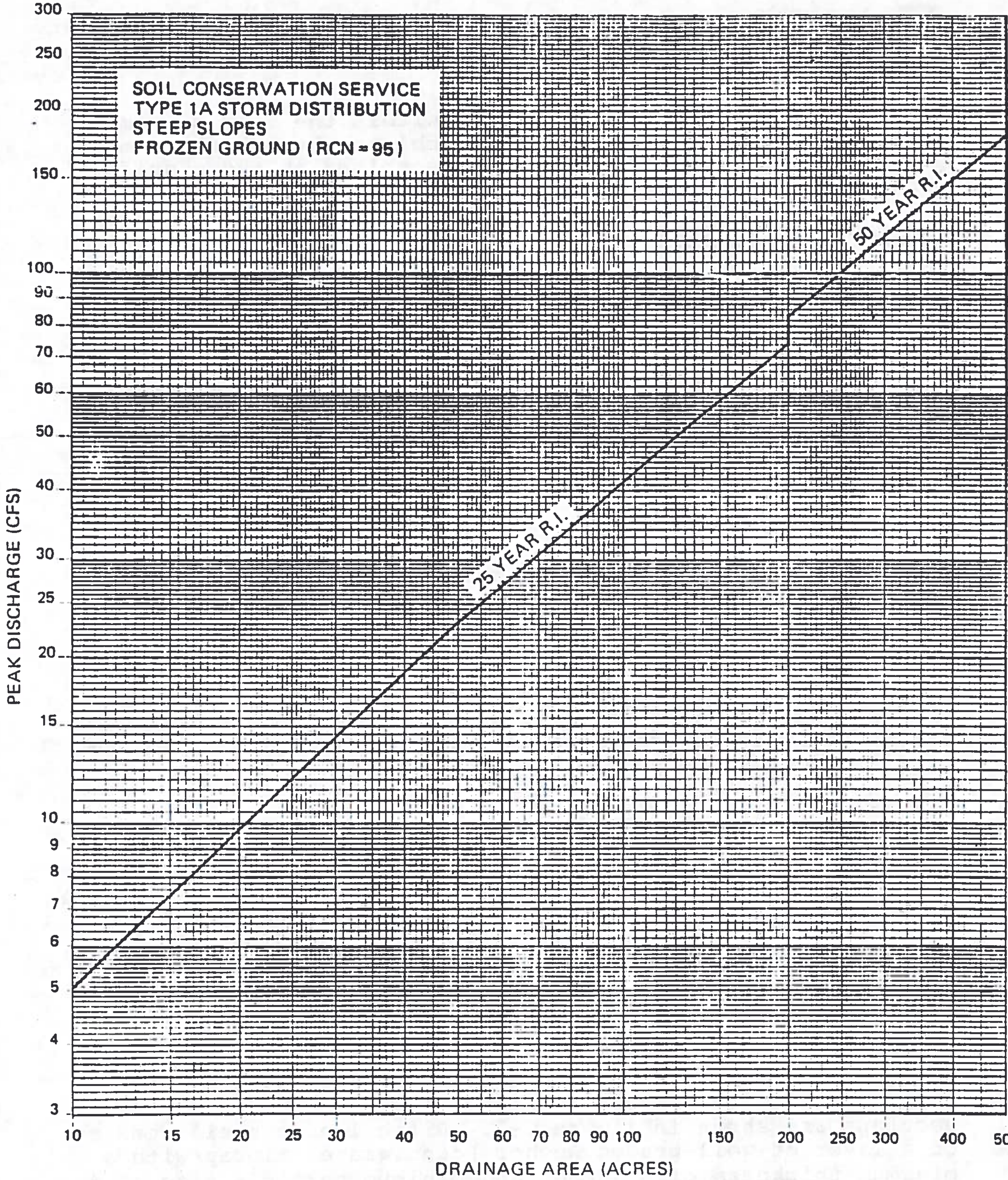
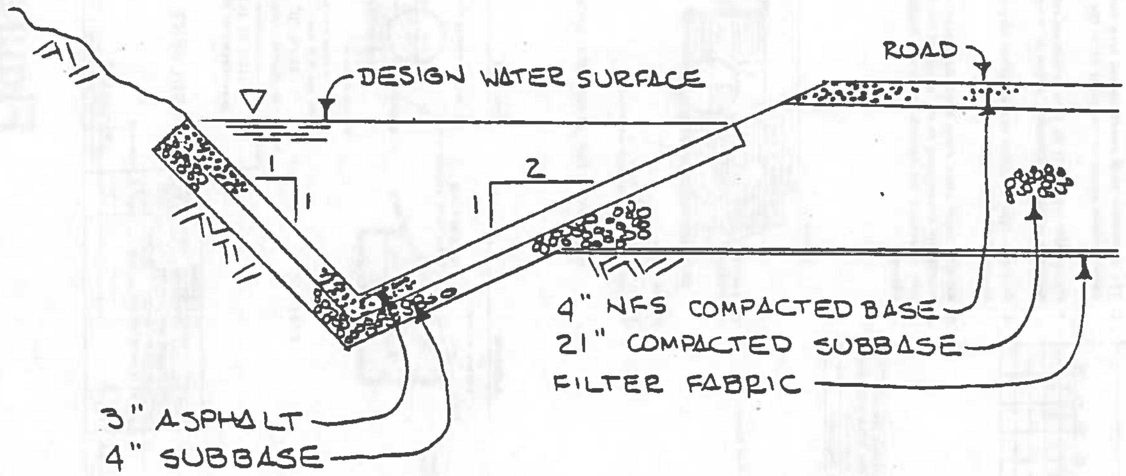
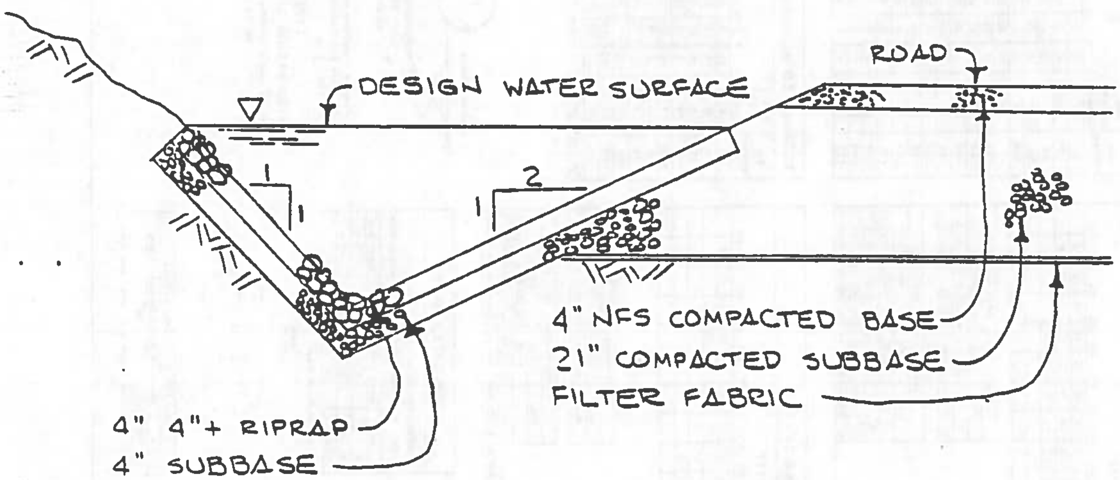


Figure C-1
Runoff Design Curve



TYPICAL SECTION - PAVED DITCH
NTS



TYPICAL SECTION - RIPRAP LINED DITCH
NTS

Figure C-2
Typical Lined Ditch Sections

HIGHWAY (H-20) LOADING - CORRUGATED STEEL PIPE, CORRUGATED ALUMINUM PIPE AND CORRUGATED STRUCTURAL PLATE PIPE

D-02.02

PIPE CONDUIT

CORRUGATED STEEL PIPE GAGE TABLE (2⅔" x ½")

Dia (Inches)	MIN COVER (Inches)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
12	12	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	14	14	12	12	
15	12	16	16	16	16	16	16	16	16	16	16	16	16	16	14	14	12	12	12	10	8	
18	12	16	16	16	16	16	16	16	16	16	14	14	12	12	12	10	10	8				
24	12	16	16	16	16	16	14	12	12	10	8	8										
30	12	16	16	16	16	16	14	14	12	10	8											
36	12	14	14	14	14	14	12	10	8													
42	12	14	14	14	14	14	14	12	10	8												
48	12	14	14	14	14	14	14	12	10	8												
54	12	12	12	12	12	12	12	10	8													
60	12	10	10	10	10	10	10	10	8													
66	12	10	10	10	10	10	10	8														
72	12	10	10	10	10	10	8															
78	12	8	8	8	8	8																
84	12	8	8	8	8																	

HEIGHT OF COVER IN FEET

For Conditions Right of Heavy Line, 5% Elongation of Pipe is Required

LONGITUDINAL SPOT WELDED

Dia	REQUIRED SPOT WELDS
12" - 36"	SINGLE WELDED 4 ½ per ft
42" & Over	DOUBLE WELDED 9 per ft

LONGITUDINAL RIVETED

Dia	GAGE	RIVETS
12" - 36"	14, 16	5/16" SINGLE RIVETS
12" - 36"	8, 10, 12	3/8" SINGLE RIVETS
42" & Over	14, 16	5/16" DOUBLE RIVETS
42" & Over	8, 10, 12	3/8" DOUBLE RIVETS

CORRUGATED STEEL PIPE GAGE TABLE (3" x 1")

Dia (Inches)	MIN COVER (Inches)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	105	115
36	12	16	16	16	16	16	16	16	16	14	14	14	12	12	12	12	12	12	12	10	8	
42	12	16	14	14	14	14	14	14	14	14	14	12	12	12	12	12	10	10	8			
48	12	14	14	14	14	14	14	14	14	14	12	12	12	10	8	8						
54	12	12	12	12	12	12	12	12	12	12	12	10	8	8								
60	12	10	10	10	10	10	10	10	10	10	10	8										
66	12	10	10	10	10	10	10	10	10	10	8											
72	12	10	10	10	10	10	10	10	10	8												
78	12	10	10	10	10	10	10	10	10	8												
84	12	10	10	10	10	10	10	10	8													
90	12	10	10	10	10	10	10	10	8													
96	12	10	10	10	10	10	10	10	8													
102	24	10	10	10	10	10	10	8														
108	24	10	10	10	10	10	10	8														
114	24	10	10	10	10	10	8															
120	24	10	10	10	10	10	8															

HEIGHT OF COVER IN FEET

For Conditions Right of Heavy Line, 5% Elongation of Pipe is Required

LONGITUDINAL SPOT WELDED

Dia	REQUIRED SPOT WELDS
ALL	DOUBLE WELDED 9 per ft

LONGITUDINAL RIVETED

Dia	GAGE	RIVETS
ALL	14, 16	3/8" DOUBLE RIVETS
ALL	8, 10, 12	3/8" DOUBLE RIVETS

¾" Dia ASTM A325 Bolts may be used in lieu of Rivets

CORRUGATED ALUMINUM PIPE GAGE TABLE (2⅔" x ½")

Dia (Inches)	MIN COVER (Inches)	0	5	10	15	20	25	30	35	40	45	50
12	8	16	16	16	16	16	16	16	16	14		
18	18	16	16	16	16	16	14	12				
24	18	16	16	16	14	12	10					
30	18	14	14	14	12	12	10	8				
36	18	14	14	12	12	10	8					
42	18	12	12	12	12	12	12	10	8			
48	18	12	12	12	12	12	10	8				
54	18	10	10	10	10	8						
60	18	8	8	8	8							
66	18	8	8	8								
72	18	8	8									

HEIGHT OF COVER IN FEET

For Conditions Right of Heavy Line, 5% Elongation of Pipe is Required

LONGITUDINAL RIVETED

Dia	GAGE	RIVETS
12" - 36"	14, 16	5/16" SINGLE RIVETS
12" - 36"	8, 10, 12	3/8" SINGLE RIVETS
42" & Over	14, 16	5/16" DOUBLE RIVETS
42" & Over	8, 10, 12	3/8" DOUBLE RIVETS

CORRUGATED BANDS

CIRCUMFERENTIAL STEEL & ALUMINUM		HELICAL STEEL & ALUMINUM	
Dia	Band Size*	Dia	Band Size*
8" - 30"	[illegible]	12" - 54"	10 ½"
36" - 60"	12"	OVER 60"	16 ¼"
OVER 60"	24"		

* Minimum Band Size

MULTIPLE INSTALLATIONS

Dia	Minimum Space Between Pipes
0" - 42"	24"
48" & Over	½ Dia of pipe or 3' which ever is less

STRUCTURAL PLATE PIPE

CORRUGATED STEEL PIPE GAGE TABLE (6" x 2" Corr.)

Dia (Inches)	MIN COVER (Inches)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
60	12	10	10	10	10	10	10	10	10	10	10	10	10	8	8	8	8	7	7	5	5	
72	12	10	10	10	10	10	10	10	10	10	10	8	8	8	7	7	5	5	5	3	3	
84	12	10	10	10	10	10	10	10	10	10	8	8	7	7	5	5	3	1				
96	12	10	10	10	10	10	10	10	10	10	8	7	5	3	1							
108	24	10	10	10	10	10	10	10	8	7	5	3	1									
120	24	10	10	10	10	10	8	7	5	3	1											
132	24	10	10	10	10	8	7	5	3	1												
144	24	10	10	10	10	8	7	5	3	1												
156	24	10	10	10	8	7	5	3	1													
168	24	10	10	10	8	7	5	3	1													
180	24	10	10	10	8	7	5	3	1													
192	24	10	10	10	8	7	5	3	1													
204	36	10	8	8	7	5	3	1														
216	36	8	8	8	7	5	3	1														
228	36	8	8	7	5	3	1															
240	36	7	7	5	3	1																
252	36	5	5	3	1																	

HEIGHT OF COVER IN FEET

For Conditions Right of Heavy Line, 5% Elongation of Pipe is Required

LONGITUDINAL BOLTED
USE 4 - ¾" Dia ASTM A325 Bolts per ft of seam

CORRUGATED ALUMINUM PIPE THICKNESS TABLE (9" x 2½")

Dia (Inches)	MIN COVER (Inches)	0	5	10	15	20	25	30	35	40	45	50	55	60
72	18	15	15	15	15	15	15	15	175	175	20	225	25	
84	18	15	15	15	15	15	15	175	20	225	25			
96	18	15	15	15	15	15	175	20	225	25				
108	24	15	15	15	15	175	20	225	25					
120	24	15	15	15	175	20	225	25						
132	24	15	15	175	20	225	25							
144	24	15	175	175	20	225	25							
156	24	175	175	20	225	25								
168	24	175	175	20	225	25								
180	24	20	20	225	25									

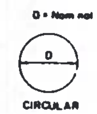
HEIGHT OF COVER IN FEET

Plate Thickness is in Inches

For Conditions Right of Heavy Line, 5% Elongation of Pipe is Required

LONGITUDINAL BOLTED
USE 5½ - ¾" Dia ASTM A325 Bolts per ft of seam

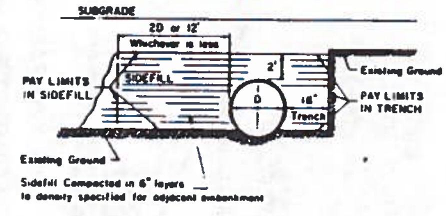
D = Nominal Pipe Diameter



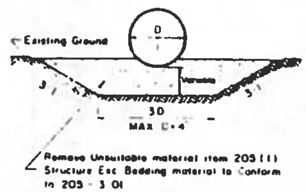
CIRCULAR

GENERAL NOTES:

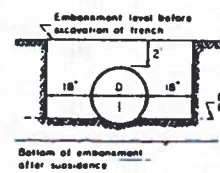
1. All material and workmanship shall be in accordance with State of Alaska, Standard Specifications for Highway Construction, latest edition.
2. The contractor shall select conduit type meeting height of cover criteria shown on the plans or in the special provisions.
3. No conduit type shall be used which exceeds maximum or minimum cover requirements shown in the tables.
4. Only one type of metal or fabrication may be used on any single or multiple installation.
5. All structural plate pipes shall be placed on a pre-shaped foundation conforming to the depth of the bottom plates with clearance for assembling to the adjacent plates allowed.



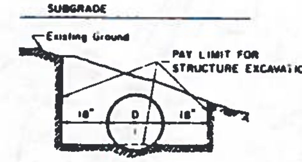
PAY LIMITS FOR STRUCTURE BACKFILL



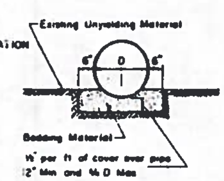
TYPE "A"
FOUNDATION STABILIZATION
To be used in unstable areas as directed by the Engineer



TYPE "B"



TYPE "C"



TYPE "D"
ROCK OR UNYIELDING MATERIAL

REVISIONS		
Date	Description	By
3/17/72	Changed spec numbers	RF
4/8/73	New Insert Number Effective	CHA
11/4/76	Type A Dimension	[illegible]

Recommended for Approval
[signature] Chief Road Design Engineer | Title

STATE OF ALASKA
DEPARTMENT OF HIGHWAYS

CULVERT PIPE

Approved
[signature] Commissioner of Highways | Date 2/4/73

Figure C-3

HIGHWAY (H-20) LOADING - CORRUGATED STEEL PIPE ARCH, CORRUGATED ALUMINUM PIPE ARCH AND CORRUGATED STRUCTURAL PLATE PIPE ARCH

D-03.01

PIPE ARCH CONDUIT

CORRUGATED STEEL PIPE ARCHES GAGE TABLE (2 2/3" X 1/2" Corr.)

PIPE SIZE SPAN (Inches)	PIPE SIZE RISE (Inches)	CORNER RADIUS (Inches)	MINIMUM COVER Top of Pipe to Top of Subgrade (Inches)	MIN GAGE	MAXIMUM FILL For 2 Tons Corner Bearing Pressure (Feet)
8		3 1/2	18	16	13
27	13	4	18	16	12
25	5	4	18	16	10
29	8	4 1/2	18	16	9
36	22	5	18	14	9
43	27	5 1/2	18	14	7
50	31	6	18	12	7
58	36	7	18	10	7
65	40	8	18	10	7
72	44	9	18	10	7
79	49	10	18	8	7
85	54	11	18	8	8

CORRUGATED STEEL PIPE ARCHES GAGE TABLE (3" X 1" Corr.)

PIPE SIZE SPAN (Inches)	PIPE SIZE RISE (Inches)	CORNER RADIUS (Inches)	MINIMUM COVER Top of Pipe to Top of Subgrade (Inches)	MIN GAGE	MAXIMUM FILL For 2 Tons Corner Bearing Pressure (Feet)
43	27	7 3/4	18	14	12
50	31	9	18	12	12
58	36	9 1/2	18	10	12
65	40	12	18	10	12
72	44	13 1/4	18	10	12
73	55	18	18	10	15
81	59	18	18	10	15
87	63	9	18	10	14
95	67	18	18	10	12
103	71	18	24	10	11
112	75	18	24	10	10
117	79	18	24	10	10
128	83	18	24	10	10

CORRUGATED ALUMINUM PIPE ARCHES GAGE TABLE (2 2/3" X 1/2" Corr.)

PIPE SIZE SPAN (Inches)	PIPE SIZE RISE (Inches)	CORNER RADIUS (Inches)	MINIMUM COVER Top of Pipe to Top of Subgrade (Inches)	MIN GAGE	MAXIMUM FILL For 2 Tons Corner Bearing Pressure (Feet)
18	11	4 3/4	18	16	15
22	13	4 3/4	18	16	14
25	16	4 1/2	18	16	13
29	18	4 1/2	18	14	11
36	22	5	18	14	9
43	27	5 1/2	18	12	7
50	31	6	18	10	7
58	36	7	18	8	7
65	40	8	18	8	7
72	44	8	18	8	7

STRUCTURAL PLATE PIPE ARCH

CORRUGATED STEEL STRUCTURAL PLATE PIPE ARCHES GAGE TABLE (6" X 2" Corr.)

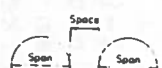
PIPE SIZE SPAN	PIPE SIZE RISE	CORNER RADIUS (Inches)	MINIMUM COVER Top of Pipe to Top of Subgrade (Inches)	MIN GAGE	MAXIMUM FILL For 2 Tons Corner Bearing Pressure (Feet)
6'-[illegible]	4'-[illegible]	18	18	10	15
7'-[illegible]	5'-[illegible]	18	18	10	15
7'-11"	5'-[illegible]	18	18	10	12
8'-10"	6'-[illegible]	18	24	10	11
9'-9"	6'-7"	18	24	10	10
10'-11"	7'-1"	18	24	10	9
11'-10"	7'-[illegible]	18	24	10	7
12'-10"	8'-4"	18	24	10	6
14'-1"	8'-9"	18	24	10	5
13'-3"	9'-4"	31	24	10	13
14'-2"	9'-10"	31	24	10	12
15'-4"	10'-4"	31	24	10	11
16'-3"	10'-10"	31	36	10	11
17'-2"	11'-4"	31	36	8	10
18'-1"	11'-10"	31	36	8	9
19'-3"	12'-4"	31	36	8	9
19'-11"	12'-10"	31	36	7	8
20'-7"	13'-2"	31	36	5	7

CORRUGATED ALUMINUM STRUCTURAL PLATE PIPE ARCHES GAGE TABLE (9" X 2 1/2" Corr.)

PIPE SIZE SPAN	PIPE SIZE RISE	CORNER RADIUS (Inches)	MINIMUM COVER Top of Pipe to Top of Subgrade (Inches)	MIN PLATE THK (Inches)	MAXIMUM FILL For 2 Tons Corner Bearing Pressure (Feet)
5'-11"	5'-4"	28.8	18	0.15	15
6'-11"	5'-9"	28.8	18	0.15	15
8'-0"	6'-2"	28.8	18	0.15	15
9'-0"	6'-8"	28.8	24	0.15	15
10'-0"	7'-1"	28.8	24	0.15	15
11'-2"	7'-6"	28.8	24	0.175	14
12'-2"	8'-0"	28.8	24	0.175	13
13'-1"	8'-5"	28.8	24	0.175	12
14'-3"	8'-10"	28.8	24	0.175	11
15'-5"	9'-4"	28.8	24	0.200	10
16'-0"	10'-7"	28.8	24	0.200	10
16'-11"	10'-1"	28.8	24	0.225	9

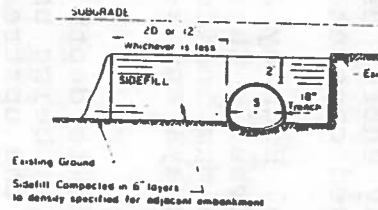
S = Nominal Pipe Arch Span

PIPE - ARCH

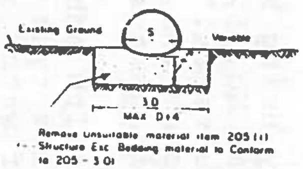


MULTIPLE INSTALLATIONS

Span	Minimum Space Between Pipes
0 - 42"	24"
48" & Over	1/2 Span of pipe arch or 3', whichever is less



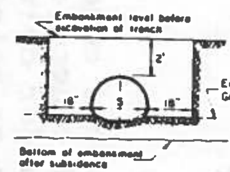
PAY LIMITS FOR STRUCTURE BACKFILL



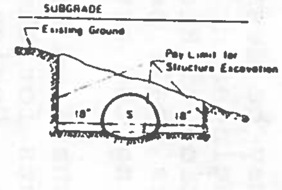
TYPE "A"

FOUNDATION STABILIZATION

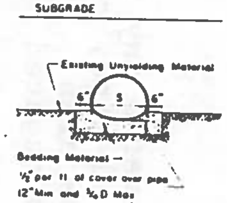
To be used in unstable areas as directed by the Engineer



TYPE "B"



TYPE "C"



TYPE "D"

ROCK OR UNYIELDING MATERIAL

GENERAL NOTES:

1. All material and workmanship shall be in accordance with State of Alaska, Standard Specifications for Highway Construction, latest edition.
2. The contractor shall select conduit type meeting height of cover criteria shown on the plans or in the special provisions.
3. No conduit type shall be used which exceeds maximum or minimum cover requirements shown in the tables.
4. Only one type of metal or fabrication may be used on any single or multiple installation.
5. All structural plate pipes shall be placed on a pre-shaped foundation conforming to the depth of the bottom plates with clearance for assembling to the adjacent plates allowed.

REVISIONS		
Date	Description	By
6/8/73	New Index Number	[illegible]
[illegible]	Changed Dimension	[illegible]

Recommended for Approval: [signature] Chief Road Design Engineer, Date

STATE OF ALASKA
DEPARTMENT OF HIGHWAYS

CULVERT PIPE ARCH

Approved: [signature] Commissioner of Highways, Date

Figure C-3 Cont.

The minimum sideslope shall be 1:1. The invert width shall be determined using the Manning's equation. Roadside ditches shall be excavated at least 6 inches below the subgrade.

All ditches that are located above sanitary sewer routes shall be paved with impervious lining.

Sideslopes of ditches shall be seeded from the top of the bank down to normal channel flow depth to help in preventing erosion. Species being seeded will be subject to approval by the public works director.

Culverts

Cross culverts may be reinforced concrete box type, corrugated metal pipe, reinforced concrete pipe, or corrugated metal pipe arch. Culverts under driveway entrances shall be either corrugated metal pipe or reinforced concrete pipe.

Culverts may be designed by using Federal Highway Administration Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts." Minimum inside diameter of culverts shall be 18 inches for driveways and 24 inches for crossing the trunk drainageways.

Culverts shall be designed with adherence to depth of cover requirements for the size and type of pipe being used. See figure C-3. Design head of water above the upstream invert of the culvert shall not exceed three (3) culvert diameters.

Culvert thaw wires shall be provided, as required by the public works director, to control icing development in the culverts. Installation shall be in accordance with standard specifications, and as shown in figure C-4.

A painted 2-inch by 4-inch post, or approved equivalent, shall be installed at each end of all cross culverts and at the upstream end of all driveway culverts to serve as a maintenance marker.

End sections shall be provided on the upstream end of all cross culverts. Concrete headwalls shall be provided on all double- and multiple-barrel installations and on culverts 48 inches and larger. End section and headwall details are shown in figures C-5 and C-6, respectively. Trashracks and metal beam guardrails may be required where necessary.

Where a standard ditch discharges into a trunk ditch, an energy dissipator of the type shown in figure C-7 shall be provided for protection against erosion.

Closed Conduit Systems

Pipe material used shall be either cast-in-place or precast reinforced concrete pipe or corrugated metal pipe of the proper class or grade. Storm drains shall be sized using the Manning's formula. Hydraulic nomographs may be used.

Minimum allowable flow velocity shall be 2.5 feet per second. Hydraulic gradient shall not be higher than 0.5 foot below the elevations of inlet grates and manhole covers.

Manholes shall be located at major junctions, changes in vertical or horizontal alignment, and changes in pipe size or shape. Spacing of manholes shall be nearly equal wherever possible and shall not exceed 400 feet for pipes 48 inches or less in diameter.

Inlets shall be spaced so that a single inlet does not intercept drainage from more than about 1,200 feet or curb line or so that gutter flows do not exceed gutter capacity. Where an inlet is placed in an unpaved area or on a gravel street, an asphalt and concrete pad shall be placed around the inlet.

When the outfall is from a pipe to a natural, unprotected channel, an energy dissipator of an approved type shall be provided to protect against erosion. If the natural channel is subject to flooding, headwalls, gabions, or other suitable means of protecting the outfall from damage shall be provided.

The outfall invert of a drainage system should be a minimum of 2 feet above the water surface of the natural drainage feature in order to provide storage for icing accumulations.

All outfalls shall have icing control devices placed in them in accordance with standard specifications.

SEDIMENT CONTROL DURING CONSTRUCTION

Development being constructed on any land area should include control measures to reduce erosion and sedimentation. Principles of erosion and sediment control include the following:

- Plan the development to fit the particular topography, soils, waterways, and natural vegetation at a site. Where possible, steep slopes should be left undistrubed. Natural vegetation should be retained and protected wherever feasible.

- Expose the smallest practical area of land for the shortest possible time. Plan the phases of development so that only the areas that are actively being

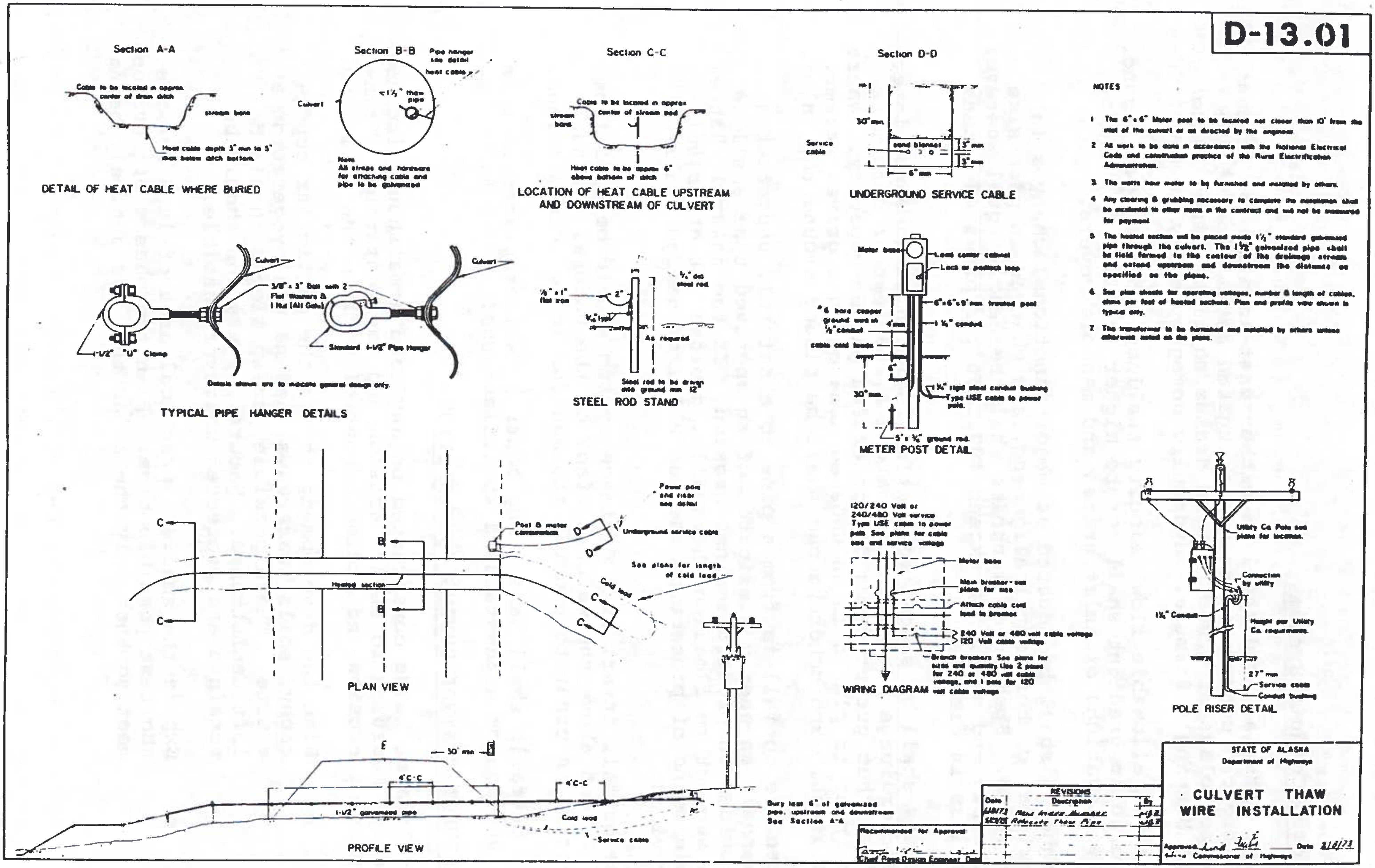

D-13.01
Section A-A
DETAIL OF HEAT CABLE WHERE BURIED
Section B-B
Section C-C
LOCATION OF HEAT CABLE UPSTREAM AND DOWNSTREAM OF CULVERT
Section D-D
UNDERGROUND SERVICE CABLE
NOTES
TYPICAL PIPE HANGER DETAILS
STEEL ROD STAND
METER POST DETAIL
PLAN VIEW
WIRING DIAGRAM
POLE RISER DETAIL
PROFILE VIEW
STATE OF ALASKA
Department of Highways
CULVERT THAW WIRE INSTALLATION
REVISIONS

Figure C-4

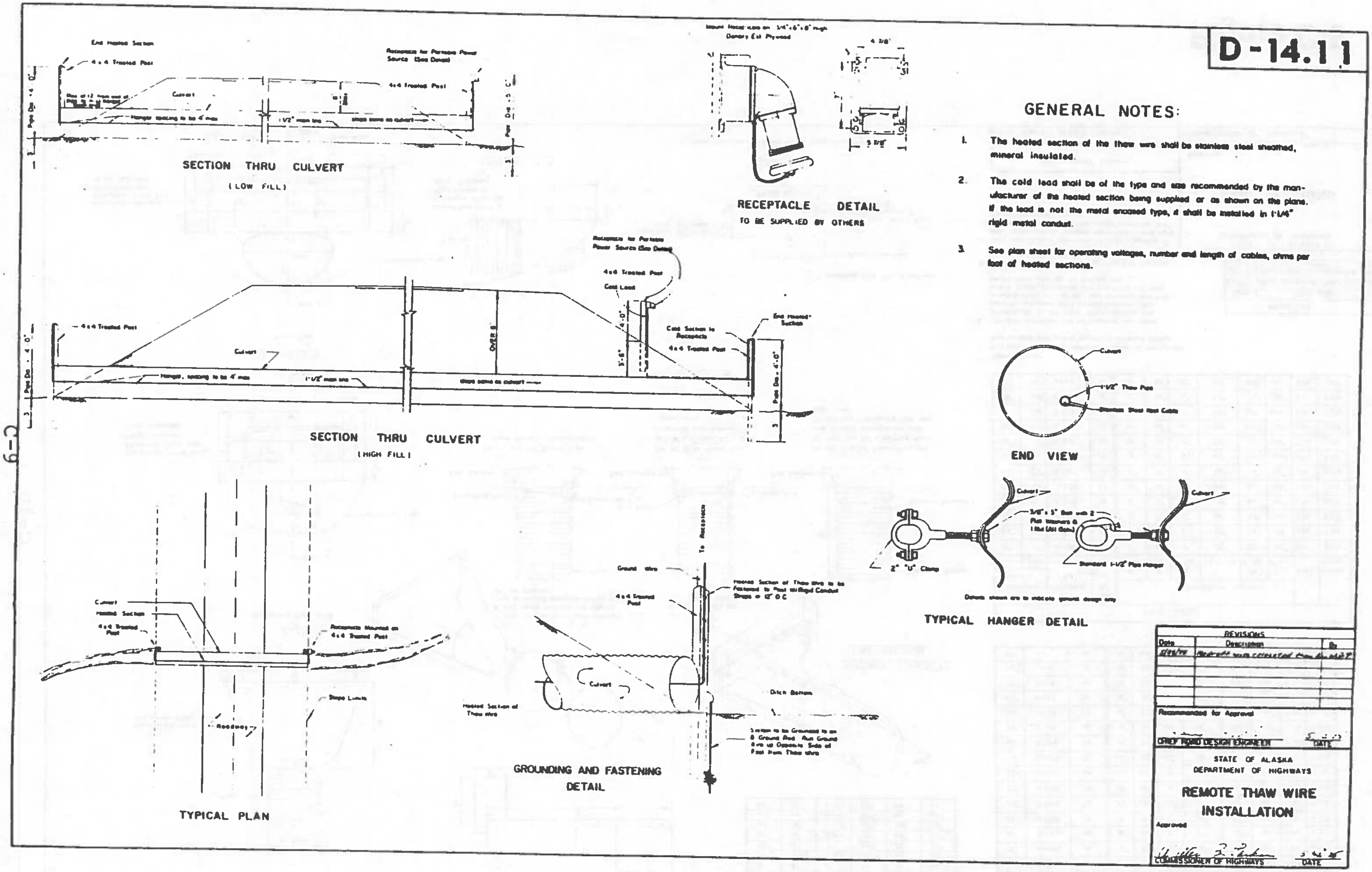
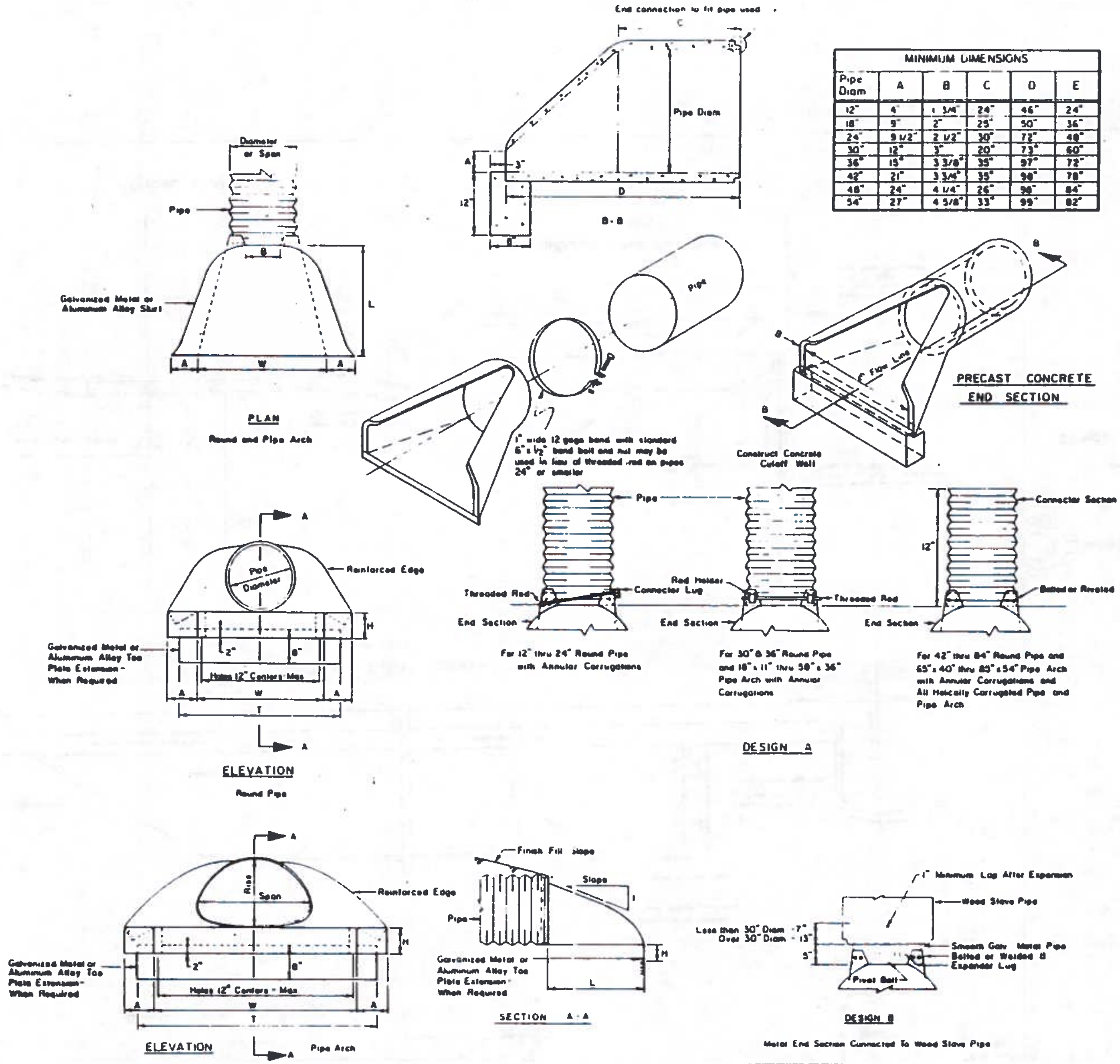


Figure C-4 Cont.

D-06.10



MINIMUM DIMENSIONS					
Pipe Diam	A	B	C	D	E
12"	4"	1 3/4"	24"	46"	24"
18"	9"	2"	25"	50"	36"
24"	9 1/2"	2 1/2"	30"	72"	48"
30"	12"	3"	20"	73"	60"
36"	15"	3 3/8"	35"	97"	72"
42"	21"	3 3/4"	35"	98"	78"
48"	24"	4 1/4"	26"	98"	84"
54"	27"	4 5/8"	33"	99"	82"

ROUND PIPE

Pipe Diam Inches	Thickness for Aluminum	Gage for Galv Metal	A 1" Tol	B Max	H 1" Tol	L 1 1/2" Tol	W 2" Tol	T 2" Tol	Skirt	Approx. Slope
12"	0.060	16	6"	6"	6"	21"	24"	34"	1 Pc	2 1/2
15"	0.060	16	7"	8"	6"	26"	30"	40"	1 Pc	2 1/2
18"	0.060	16	8"	10"	6"	31"	36"	46"	1 Pc	2 1/2
21"	0.060	16	9	12"	6"	36"	42"	52"	1 Pc	2 1/2
24"	0.075	16	10"	13"	6"	41"	48"	58"	1 Pc	2 1/2
30"	0.075	14	12	16"	8	51"	60"	70"	1 Pc	2 1/2
36"	0.105	14	14"	19"	9"	60"	72"	94"	2 Pc	2 1/2
42"	0.105	12	16"	22"	11"	69"	84"	106"	2 Pc	2 1/2
48"	0.105	12	18"	27"	12"	78"	90"	112"	2 Pc	2 1/4
54"	0.105	12	18"	30"	12	84"	102"	122"	2 Pc.	2 1/4
60"	0.135	12	18"	33"	12	87"	114"	134"	3 Pc	2 1/4
66"	0.135	12	18"	36"	12	87"	120"	142"	3 Pc	2 1/4
72"	0.135	12	18"	39"	12	87"	126"	146"	3 Pc	2 1/4
78"	---	12	18"	42"	12	87"	132"	152"	3 Pc	1 1/4
84"	---	12	18"	45"	12	87"	138"	158"	3 Pc	1 1/6

PIPE - ARCH

Span	Rise	Thickness for Aluminum	Gage for Galv. Metal	A 1" Tol	B Max	H 1" Tol.	L 1 1/2" Tol	W 2" Tol.	T 2" Tol	Skirt	Approx Slope
18"	11"	0.060	16	7"	9"	6"	19"	30"	40"	1 Pc.	2 1/2
22"	13"	0.060	16	7"	10"	6	23"	36"	46"	1 Pc	2 1/2
25"	16"	0.060	16	8"	12"	6"	28"	42"	52"	1 Pc	2 1/2"
29"	18"	0.075	16	9"	14"	6"	32"	48"	58"	1 Pc	2 1/2
36"	22"	0.075	14	10"	16"	6"	39"	60"	70"	1 Pc.	2 1/2
43"	27"	0.105	14	12"	18"	8"	46"	75"	85"	1 Pc.	2 1/2
50"	31"	0.105	12	13"	21"	9"	53"	85"	103"	2 Pc.	2 1/2
58"	36"	0.105	12	18"	26	12"	63"	90"	114"	2 Pc.	2 1/2
65"	40"	0.105	12	18"	30"	12"	70"	102"	130"	2 Pc.	2 1/4
72"	44"	0.135	12	18"	33"	12"	77"	114"	144	3 Pc	2 1/4
79"	49"	0.135	12	18"	36"	12"	84"	120"	158"	3 Pc.	2 1/4
85"	54"	0.135	12	18"	39"	12"	90"	126"	170"	3 Pc.	2 1/4

General Notes:

1. End section not of the same base metal as the culvert may be used with proper insulation between metals.
2. Toe plate extensions will be required only when provided for on the plans. When required, the toe plate extensions shall be punched with holes to match those in lip of skirt and fastened with 3/8 inch or larger galvanized nuts and bolts and shall be the same gage as the end section.
3. Galvanized Metal or Aluminum Alloy End Sections may be used on Wood Stave Pipe.
4. All 3 piece bodies shall have 12 gage sides and 10 gage center panels. Multiple panel bodies shall have lap seams which are to be tightly joined by 3/8" galvanized rivets or bolts.

REVISIONS		
Date	Description	By
6/8/73	New Index Number	[illegible]
11/1/75	Removed Pay Limits	[illegible]
3.2.77	1" Band option	[illegible]

STATE OF ALASKA
DEPARTMENT OF HIGHWAYS

END SECTIONS

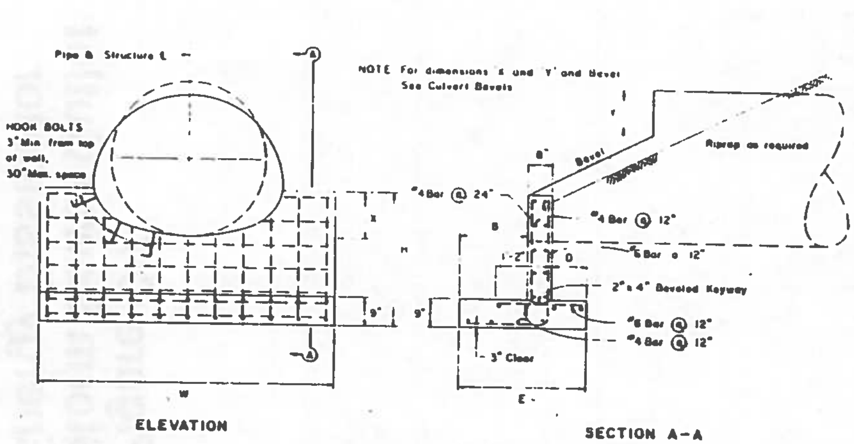
Recommended Approval
_______________ Date _______
CHIEF ROAD DESIGN ENGINEER

Approved: [signature] Date .../72
COMMISSIONER OF HIGHWAYS

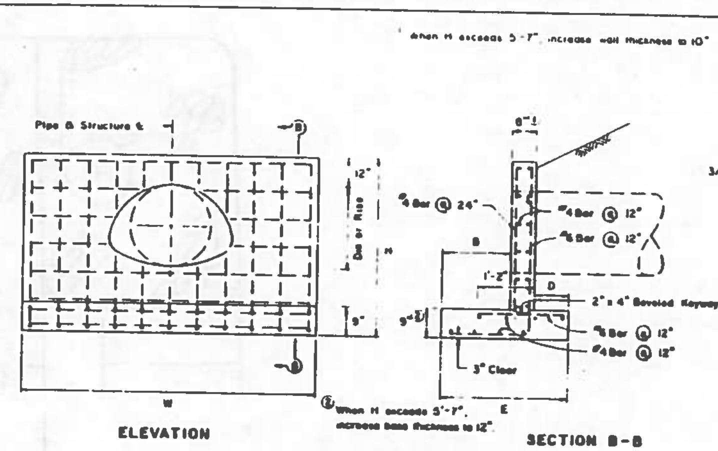
Figure C-5

D-30.10

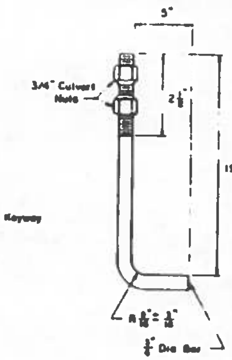
¹ When H exceeds 5'-7", increase wall thickness to 10"



HEADWALL I



HEADWALL II



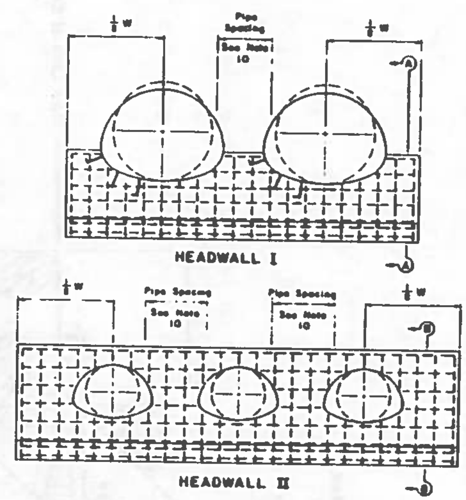
HOOK BOLT

CORRUGATED METAL PIPE - USE HEADWALL II						Cu Yd Conc. 1 Hd Wl
DIA	W	H	B	D	E	
18"	6'-0"	4'-6"	1'-8"	0'-10"	3'-2"	1.0
21"	7'-0"	4'-9"	1'-9"	0'-11"	3'-4"	1.3
24"	8'-0"	5'-0"	1'-10"	0'-11"	3'-5"	1.5
30"	10'-0"	5'-6"	2'-0"	1'-0"	3'-8"	2.1
36"	12'-0"	6'-0"	2'-3"	1'-2"	4'-1"	3.5
42"	14'-0"	6'-6"	2'-6"	1'-3"	4'-5"	4.5
48"	16'-0"	7'-0"	2'-8"	1'-4"	4'-8"	5.5
54"	18'-0"	7'-6"	2'-11"	1'-6"	5'-1"	6.7

CORRUGATED METAL PIPE ARCH - USE HEADWALL II							Cu Yd Conc. 1 Hd Wl
SPAN	RISE	W	H	B	D	E	
18"	11"	6'-6"	3'-11"	1'-5"	0'-9"	2'-10"	1.0
22"	13"	7'-0"	4'-1"	1'-6"	0'-7"	2'-11"	1.1
25"	16"	7'-0"	4'-4"	1'-7"	0'-10"	3'-1"	1.2
29"	18"	7'-6"	4'-6"	1'-8"	0'-10"	3'-2"	1.3
36"	22"	8'-0"	4'-10"	1'-9"	0'-11"	3'-4"	1.4
43"	27"	9'-0"	5'-3"	2'-0"	1'-0"	3'-6"	1.8
50"	31"	9'-0"	5'-7"	2'-1"	1'-1"	3'-10"	1.8
58"	36"	10'-0"	6'-0"	2'-3"	1'-2"	4'-1"	2.8
65"	40"	10'-6"	6'-4"	2'-4"	1'-2"	4'-2"	3.0
72"	44"	11'-0"	6'-8"	2'-7"	1'-4"	4'-7"	3.3

STRUCTURAL PLATE PIPE - USE HEADWALL I						Cu Yd Conc. 1 Hd Wl
DIA	W	H	B	D	E	
60"	9'-0"	4'-0"	1'-5"	0'-9"	2'-10"	1.4
66"	10'-0"	4'-6"	1'-8"	0'-10"	3'-2"	1.8
72"	11'-0"	4'-6"	1'-8"	0'-10"	3'-2"	1.9
78"	12'-0"	4'-6"	1'-8"	0'-10"	3'-2"	2.1
84"	13'-0"	4'-6"	1'-8"	0'-10"	3'-2"	2.2
90"	14'-0"	5'-0"	1'-10"	0'-11"	3'-5"	2.6
96"	15'-0"	5'-0"	1'-10"	0'-11"	3'-5"	2.9
102"	16'-0"	5'-0"	1'-10"	0'-11"	3'-5"	3.0
108"	17'-0"	5'-6"	2'-0"	1'-0"	3'-8"	3.5
114"	17'-6"	5'-6"	2'-0"	1'-0"	3'-8"	3.6
120"	18'-0"	5'-6"	2'-0"	1'-0"	3'-8"	3.6
126"	19'-0"	5'-6"	2'-0"	1'-0"	3'-8"	3.8
132"	20'-0"	5'-6"	2'-0"	1'-0"	3'-8"	4.2
138"	21'-0"	5'-6"	2'-0"	1'-0"	3'-8"	4.4
144"	22'-0"	5'-6"	2'-0"	1'-0"	3'-8"	4.6
150"	23'-0"	5'-6"	2'-0"	1'-0"	3'-8"	4.7
156"	24'-0"	5'-6"	2'-0"	1'-0"	3'-8"	4.9
162"	25'-0"	6'-0"	2'-3"	1'-2"	4'-1"	5.6
168"	26'-0"	6'-6"	2'-6"	1'-3"	4'-5"	6.5
174"	26'-0"	6'-6"	2'-6"	1'-3"	4'-5"	6.4
180"	28'-0"	6'-6"	2'-6"	1'-3"	4'-5"	6.7

STRUCTURAL PLATE PIPE ARCH - USE HEADWALL I							Cu Yd Conc. 1 Hd Wl
SPAN	RISE	W	H	B	D	E	
6'-1"	4'-7"	16'-0"	5'-0"	1'-10"	0'-11"	3'-5"	2.9
6'-4"	4'-9"	16'-4"	5'-0"	1'-10"	0'-11"	3'-5"	3.0
6'-9"	4'-11"	16'-9"	5'-0"	1'-10"	0'-11"	3'-5"	3.0
7'-0"	5'-1"	17'-0"	5'-0"	1'-10"	0'-11"	3'-5"	3.1
7'-3"	5'-3"	17'-3"	5'-0"	1'-10"	0'-11"	3'-5"	3.1
7'-8"	5'-5"	17'-8"	5'-0"	1'-10"	0'-11"	3'-5"	3.1
7'-11"	5'-7"	18'-0"	5'-0"	1'-10"	0'-11"	3'-5"	3.2
8'-2"	5'-9"	18'-3"	5'-0"	1'-10"	0'-11"	3'-5"	3.3
8'-7"	5'-11"	18'-6"	5'-0"	1'-10"	0'-11"	3'-5"	3.3
8'-10"	6'-1"	19'-0"	5'-0"	1'-10"	0'-11"	3'-5"	3.4
9'-4"	6'-3"	19'-4"	5'-0"	1'-10"	0'-11"	3'-5"	3.4
9'-6"	6'-5"	19'-6"	5'-0"	1'-10"	0'-11"	3'-5"	3.4
9'-9"	6'-7"	19'-9"	5'-0"	1'-10"	0'-11"	3'-5"	3.5
10'-3"	6'-9"	20'-0"	5'-0"	1'-10"	0'-11"	3'-5"	3.5
10'-8"	6'-11"	21'-8"	5'-6"	2'-0"	1'-0"	3'-8"	4.1
10'-11"	7'-1"	21'-11"	5'-6"	2'-0"	1'-0"	3'-8"	4.2
11'-5"	7'-3"	22'-5"	5'-6"	2'-0"	1'-0"	3'-8"	4.3
11'-7"	7'-5"	22'-7"	5'-6"	2'-0"	1'-0"	3'-8"	4.3
11'-10"	7'-7"	22'-10"	5'-6"	2'-0"	1'-0"	3'-8"	4.4
12'-4"	7'-9"	23'-4"	5'-6"	2'-0"	1'-0"	3'-8"	4.4
12'-6"	7'-11"	23'-6"	5'-6"	2'-0"	1'-0"	3'-8"	4.4
12'-8"	8'-1"	25'-8"	5'-6"	2'-0"	1'-0"	3'-8"	4.5
12'-10"	8'-4"	23'-10"	5'-6"	2'-0"	1'-0"	3'-8"	4.6
13'-5"	8'-5"	24'-5"	5'-6"	2'-0"	1'-0"	3'-8"	4.6



MULTIPLE INSTALLATION

GENERAL NOTES:

1. Class W concrete shall be used on all headwalls
2. All exposed concrete corners shall be chamfered ¾".
3. If unsuitable foundation material is encountered, it shall be removed and backfilled with suitable material as directed by the engineer.
4. Furnishing and installing hook bolts in place shall be incidental to cost of Class W concrete.
5. Hook bolts and nuts shall be galvanized.
6. Headwalls for skewed culverts to be parallel to road centerline. Dimensions for openings in headwalls for skewed culverts require special design
7. All material and workmanship shall be in accordance with State of Alaska, Standard Specifications for Highway Construction.
8. Reinforcement shall be placed 2" clear from surface of concrete unless otherwise noted.
9. Reinforcement steel shall be of intermediate grade.
10. Multiple, Pipe or Pipe Arch, Installation Spacing

Dia. or Span	Minimum Space Between Pipes
0 - 42"	24"
48" & Over	½ Dia. or Span of Pipe or Pipe Arch, or 3'-0", whichever is less.

REVISIONS		
Date	Description	By
10 27 71	spacing	[illegible]
4 10 72	added conc. quants	R F
6/18/73	New Index Number	[illegible]
6/4/75	Wall Thickness + Tables	[illegible]

Recommended for Approval
[signature] 9/20/71
Chief Road Design Engineer Date

STATE OF ALASKA
DEPARTMENT OF HIGHWAYS

HEADWALLS

APPROVED
[signature] 9-20-71
COMMISSIONER OF HIGHWAYS DATE

Figure C-6

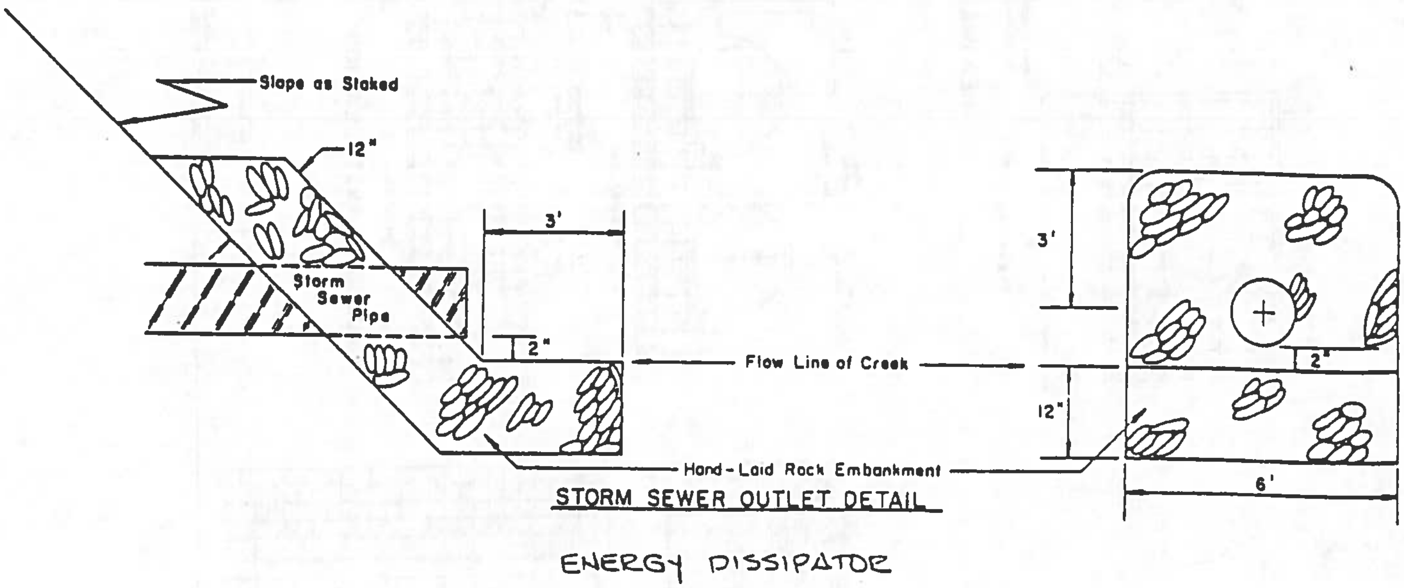


Figure C-7
Storm Sewer Outlet Energy Dissipator

developed are exposed. Ground cover should be replaced as soon as practical in the development. Minimize grading of large or critical areas during the season of maximum erosion potential (October through March).

- Apply soil erosion control practices to prevent excessive sediment from being produced. Keep soil covered as much as possible with temporary or permanent vegetation or with various mulch materials. Where possible, divert surface runoff away from exposed soils.

- Apply sediment control practices to remove sediment from runoff waters to prevent off-site damage. Generally, sediment can be retained by two methods: filtering runoff as it flows through an area or impounding the sediment-laden runoff for a period of time so that the soil particles settle out.

- Implement a thorough maintenance and followup operation. Make periodic checks to ensure that all erosion and sediment control practices are working effectively.

The above principles should be integrated into a system of temporary and permanent vegetative and structural measures, along with management techniques to develop a plan for erosion and sediment control. The Soil Conservation Service publication, "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas," contains design guidelines for the application of standard erosion and sediment control measures.

The following publications referred to in the guidelines are to be used by all developers in adhering to the drainage system design procedures stated herein.

- U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts," December 1965. This publication is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

- State of Alaska, Department of Highways, Standard Specifications for Highway Construction 1972, Supplemental Specifications 1975 and Standard Plans. These are available for purchase through the Alaska Department of Highways, Box 1467, Juneau, Alaska 99801.

- U.S. Department of Agriculture, Soil Conservation Service, Standards and Specifications for Soil Erosion and Sedimentation Control in Developing Areas, July 1975. This document is available through the Anchorage office of the Soil Conservation Service.

Appendix D
DRAFT DRAINAGE ORDINANCE

Adapted from:

Washington State Chapter
American Public Works Association, September 1978
<u>Model Comprehensive Drainage Ordinance</u>

In September 1978 the Washington State Chapter of the American Public Works Association developed a draft model comprehensive drainage ordinance. This model ordinance contains several parts which are applicable to Homer with regard to the content and structure of a drainage control ordinance. Following is the model ordinance, as amended to suit the needs of the City of Homer. Further revisions to the drainage ordinance may be required to ensure that it meets the needs of Homer and is acceptable to city officials and legal counsel.

CONTENTS

ORDINANCE NO. _____

AN ORDINANCE establishing a new chapter in the City code requiring a storm water drainage plan to be submitted in conjunction with certain permits, specifying the contents thereof, regulating access to the storm water facility of the City, providing for enforcement thereof and penalties, requiring surety and cash bonds, and authorizing City assumption of storm water drainage facilities.

WHEREAS, the City Council finds that an expanding population and increased development of land has led to drainage and storm water runoff problems within the City, and to water quality degradation, that uncontrolled water runoff on streets and highways poses a safety hazard to both lives and property, and finally that continuation of present drainage planning and practices, to the extent that they exist, will lead to erosion, property damage, and endanger the health and safety of the inhabitants of the City, and

WHEREAS, the City Council finds that future such problems and dangers will be reduced and avoided if developers, both private and public, provide for storm water drainage of their respective properties, NOW, THEREFORE,

THE CITY COUNCIL of Homer DOES ORDAIN as follows:

SECTION 1. TITLE AND AUTHORITY

There is hereby created a new chapter in the City Code, Chapter _____, with the short title, "Drainage Management Ordinance." This ordinance may be cited by its short title.

SECTION 2. NEED

The City Council finds that this chapter is necessary in order to minimize water quality degradation and prevent the sedimentation of the natural creeks, and city drainageways; to protect property owners adjacent to developing land from increased runoff and erosion of abutting property; to promote sound development policies which respect and preserve the City's watercourses; to ensure the safety of city roads and rights-of-way; to decrease drainage-related damage to public and private property; and to protect the health, safety and welfare of the inhabitants of the City.

SECTION 3. PURPOSE

The purpose of the rules and regulations described herein is to guide and advise all who desire to make use of or alter the city drainage system. The rules and regulations establish the minimum level of compliance which must be met to permit a property to drain to the city drainage system.

The concept of the trunk drainage system is to make maximum use of the natural drainage system of streams, lakes, and wetlands and to allow the continued functioning of the natural hydrologic cycle.

To accomplish this, the drainage system will only accept for service the drainage from those properties which meet discharge requirements for storm water runoff as described herein.

No building permit will be issued or subdivision and road construction approved by the City until a drainage plan has been approved by the City.

SECTION 4. DEFINITIONS

(1) Applicant: The person making application for a drainage use permit.

(2) City: Refers to City of Homer.

(3) Drainage Management Plan: An analysis of each drainage basin which compares the capabilities and needs for runoff accommodation due to various combinations of development, land use, structural and nonstructural management alternatives. The plan recommends the form, location, and extent of drainage control measures which optimally would meet the City's community objectives as well as identifying the institutional and funding requirements for plan implementation. The most recent version of the City's Drainage Management Plan is included in a report dated June 1979.

(4) Runoff Design Curve: The design curve developed by the Public Works Department to relate the peak rate of runoff to drainage area.

(5) Developer: The individual(s) or corporation(s) applying for the permit required by Section 7 of this chapter.

(6) Developmental Coverage: All developed surface areas within the subject property including, but not limited to, rooftops, driveways, carports, accessory buildings, and parking areas.

During construction developmental coverage shall include the above in addition to the full extent of any alteration of previously occurring soils, slope, or vegetation due to grading, temporary storage, access areas, or any other short-term causes.

(7) Drainage Area: The subject property together with the watershed (acreage) contributing water runoff to and receiving water runoff from the subject property.

(8) Drainage Basin: Those lands draining to a common watercourse or outlet including the headwaters of said watercourse.

(9) Drainage Facilities: Any facilities installed or constructed in conjunction with a drainage plan for the purpose of conveying runoff.

(10) Drainage Plan: A plan for collection, transport, and discharge of water within the subject property.

(11) Drainage System: The system of conveying storm water runoff as described in Exhibit 1 and as may be further defined by the drainage management plan.

(12) Flood Plain: The low lying lands adjacent to watercourses onto which excessive water flows during periods of prolonged and intense precipitation. The flood plain for a particular watercourse is a geographic area flooded by a storm of specified intensity. The flood plain usually includes all adjacent wetlands and may include other lands not normally classified as wetlands.

(13) Natural Location: The location of those channels, swales, and other non-manmade conveyance systems as defined by the first documented topographic contours existing for the subject property from either maps or photographs.

(14) Peak Discharge: The maximum water runoff rate in cubic feet per second (cfs) determined from the runoff design curve.

(15) Project: Any construction, grading, clearing, covering, or other act which directly involves the watercourses, wetlands, lakes, or exposed ground surfaces.

(16) Project Area: The actual ground area affected by the project. The project area may be equal to or less than the project site.

(17) Project Site: The lot or lots upon which a project is to be undertaken.

(18) Receiving Bodies of Water: Creeks, streams, lakes, and other bodies of water to which waters are directed, whether naturally, in manmade ditches, or closed conduit systems.

(19) Sedimentation: Disposition of erosional debris-soil sediment displaced by erosion and transported by water from a high elevation to an area of lower gradient where sediments are deposited as a result of slack water.

(20) Subject Property: The tract of land which is the subject of the permit or approval action, as defined by the full legal description of all parcels involved in the proposed development.

(21) Trunk Drainage System: The trunk drainage system is that portion of the drainage system of the City which receives waters from an adjacent land area. The trunk drainage system may consist of watercourses or manmade facilities such as pipes, ditches, and culverts. The trunk drainage system is the primary conveyance system for drainage waters and is illustrated in figures 5, 6, 7, and 8 of the drainage management plan.

(22) <u>Watercourse</u>: The course or route followed by waters draining from the land generally formed by nature and consisting of a channel with a bed, banks, sides, and associated wetlands and headwaters. A watercourse shall receive surface and subsurface drainage waters and shall flow with some regularity but not necessarily continuously, naturally, and normally, in draining from higher to lower lands. The watercourse shall terminate at the point of discharge into a larger receiving body such as a lake. Watercourses shall include, without limitation, sloughs, streams, creeks, and wetlands.

(23) <u>Wetlands</u>: Those lands adjacent to watercourses or isolated therefrom which may normally or periodically be inundated by the waters from the watercourse or the drainage waters from the drainage basin in which it was located. These include swamps, bogs, sinks, marshes, and lakes, all of which are considered to be part of the watercourse and drainage system of the City, and shall include the headwater areas where the watercourse first surfaces. They may be but are not necessarily characterized by special soils such as peat, muck, and mud.

<u>SECTION 5.</u> DESCRIPTION OF THE TRUNK DRAINAGE SYSTEM

The City of Homer has a trunk drainage system consisting of watercourses, sloughs, streams, ponds, lakes, swamps, streets, ditches, conduit, culverts, bridges, and catch basins, among others. The extent of this trunk drainage system is indicated in figures 5, 6, 7, and 8 of the drainage management plan. The City controls this system either through fee ownership, through formal easements, or by its prescriptive rights to pass storm and surface waters over private or public lands.

SECTION 6. STATEMENT OF AUTHORITY

The Director of Public Works, or the Director's designated representative, is charged with the administration of and compliance with the rules and regulations.

SECTION 7. APPLICABILITY

In addition to other requirements for compliance with the drainage rules and regulations, the following conditions shall also apply:

A. Area of Applicability. These rules and regulations shall apply to all property within Homer as indicated on the map of the drainage area and system, Exhibit 1, and may also apply to the full extent provided by law to those lands which are outside the city limits which discharge storm and surface waters into, from, and through the City. Jurisdiction in those areas not within the city limits shall be subject to the provisions of intergovernmental agreements as they now exist or shall be later entered into or modified between the City and the Kenai Peninsula Borough.

The City Council further finds that construction or development of the following projects requires such regulation:

1. Subdivisions of land

2. Projects which include the construction of industrial, commercial, and single- or multi-family dwellings

3. All projects in areas identified as hazardous and subject to flooding or erosion by the

comprehensive drainage management plan. No such areas have been identified to date.

B. Alteration of the Existing Drainage System. As designated in Exhibit 1, a considerable portion of the drainage system of the City presently exists as natural watercourses and wetlands. No person shall undertake a project which would encroach upon, modify, realign, or change in any manner any of the existing drainage system as shown in figures 5, 6, 7, and 8 of the drainage management plan except for normal maintenance to keep property accessible as provided for by the rules and regulations and with prior approval of the City.

C. Degradation of Water Quality. No person, or property owner within or without the City shall cause or permit the discharge of storm water runoff from property under their control into the city drainage system, which discharge does not meet the minimum water quality standards, as described in Section 11.

D. Relationship to Other Permits. All persons applying for any of the following permits or approvals shall submit for approval a drainage plan with their application or request:

1. Subdivision approval

2. Rezones

3. Conditional use permits

4. Contract zonings

5. Planned unit development

6. Road construction (if instituted)

7. Building permits

Final subdivision design or commencement of construction work under any of the above permits or applications shall not begin until such time as final approval of the drainage plan is obtained. Failure to comply with this provision shall result in revocation of all permits for the proposed development. Final plat approval shall be denied if it does not comply with the drainage plan.

E. Exceptions. The plan requirement established in this section will apply except when the developer demonstrates to the satisfaction of the Department of Public Works that the proposed permit or activity:

1. Will neither seriously nor adversely impact the water quality conditions of any affected receiving bodies of water, and

2. Will not alter the drainage patterns or peak discharge, or cause any other adverse effects in the drainage area.

<u>SECTION 8.</u> APPLICABILITY TO GOVERNMENTAL ENTITIES

To the extent not prohibited, or as permitted or provided by law, all municipal corporations and governmental entities shall be required to submit a drainage plan and comply with the terms of this chapter when undertaking such projects or applying for such permits as stated in Section 7. This shall include road building and widening within the areas of the City. No state or municipal government shall permit a project which does not comply with this ordinance.

It is recognized that many other city, borough, state, and federal permit conditions may be applied to the proposed action and that compliance with the provisions of this chapter does not constitute compliance with other such requirements.

SECTION 9. CONTENTS OF A DRAINAGE PLAN

All person applying for any of the permits listed in Section 7 shall provide a drainage plan, prepared by a civil engineer registered for practice in the State of Alaska, for surface and pertinent subsurface water flows entering, flowing within, and leaving the subject property. The contents of the drainage plan shall include the following information:

a. Background computations for sizing drainage facilities:

   i. Depiction of the drainage area on a topographical map of scale 1 inch equals 200 feet and 5-foot contours, with acreage of the site, and developmental coverage indicated as well as the total area tributary to the site

   ii. Indication of the peak discharge of surface water currently entering and leaving the subject property as determined by the runoff design curves.

b. Proposed drainage management system, including facilities for handling the design runoff.

c. Arrangements by the developer to provide for continuing maintenance of the drainage management system and facilities.

d. The requirements of this section may be modified if, in the City Public Works Director's professional opinion, such additional or reduced amount of information is necessary or appropriate to carry out the expressed purpose and intent of the ordinance.

SECTION 10. STANDARDS

The following standards shall apply to all projects subject to these rules and regulations. Additionally, the water quality standards shall apply to all properties discharging storm and surface water runoff into the drainage system. Except where specifically described, it shall be the applicant's responsibility to determine the method by which he will comply with the standards.

A. Design

The following design requirements shall apply to all projects and are intended to be consistent with the drainage management plan.

1. Mandatory Requirements

a. Surface water entering the subject property shall be received at the naturally occurring location and surface water exiting the subject property shall be discharged at the natural location with adequate energy dissipators within the subject property to minimize downstream damage and with no diversion at any of these points

b. Where open-ditch construction is used to handle drainage within the tract, a minimum of fifteen (15) feet will be provided between any structures and the top of the bank of the defined channel.

i. In open-channel work the water surface elevation will be indicated on the plan and profile drawings. The configuration of the finished grades constituting the banks of the open channel will also be shown on the drawings.

ii. Proposed cross sections of the channel will be shown with stable sideslopes as approved by the Public Works Director.

iii. The water surface elevation of the flow for the design storm will be indicated on the cross section.

c. When a closed system is used to handle drainage within the tract, all structures will be a minimum of ten (10) feet from the closed system.

2. Construction

Construction materials and methods shall be in accordance with "Standards and Specifications" as developed by the Public Works Department. Copies of this publication are available for the public at the office of the Public Works Director.

3. Erosion Control

Where drainage facilities discharge to natural drainage ways or watercourses, energy dissipation facilities shall be provided to prevent erosion and deterioration of the stream-bed or banks. Energy dissipation facilities shall be constructed of natural materials or materials fabricated solely for that purpose. Material such as broken concrete slabs, pipe, tires, scrap metal, or debris is prohibited. No person shall discharge drainage waters from their project to any point or in any manner not approved by the City.

4. Watercourses and Streams

Except on bridges or over culverts, or immediate approaches to them, no building, fences, construction, or obstructions shall be permitted within 25 horizontal feet of any stream or watercourse except as may be necessary to improve or stabilize the existing drainage. All construction within 50 feet of a watercourse shall be subject to careful control of filling and grading to assure that no erosion products are permitted to enter the natural drainage system.

B. Performance

The performance standards are set as the minimum level of compliance.

1. Runoff Quality

No one shall introduce into the drainage waters any liquid or solid foreign substances of biodegradable or other nature which shall cause the water quality to degrade from applicable state standards. Products of erosion shall be prevented from entering the natural drainage system at all times, during both the construction on the property and the subsequent operation of the facilities provided. All trash and debris shall be prohibited from entering the drainage system at any point within the property.

It shall be prohibited and in violation of this ordinance for any person to:

a. Cause or permit litter, trash, rubbish, or debris to enter the drainage system of the City.

b. Cause or permit liquid or water-carried pollutants to enter the drainage system of the City including but not limited to oils and petroleum products, pesticides, fertilizers, soaps, detergents, and washing wastes.

c. Cause or permit horses, cattle, or other domestic animals other than dogs or cats to enter any watercourses or wetlands that are part of the drainage system of the City. Stables, pastures, or other animal enclosures shall be drained so as to prevent polluted drainage waters from entering the drainage system of the City.

d. Cause or permit grading, clearing, filling, or other land surface changes to take place in such a way as to allow drainage from the property to carry any suspended or dissolved matter into the drainage system of the City.

e. Cause or permit to take place in the streams, watercourses, or wetlands that are part of the drainage system any work that would result in the transmission of silt, pollutional materials, or other foreign substances from one part of the system to another.

2. Runoff Rate

The storm water runoff discharging from a project or property which directly or indirectly enters the drainage system of the City shall be released in such a manner as to be compatible with the drainage management plan or such other consideration as the City may deem appropriate.

3. Vegetation Removal

When a project involves clearing of land, operations shall be conducted so as to expose the smallest practical area of soil to erosion for the least possible time during construction. Erosion control measures shall be undertaken from the time of beginning of clearing. Vegetation shall be restored or control measures instituted at the earliest possible date.

On-site drainage shall be handled in such a way as to control erosion and to return waters to the natural drainage course free of sedimentation or other pollution. Drainage from areas above the developed site shall be temporarily diverted from the construction area to preclude erosion and sedimentation.

The following are considered erosion and sediment control measures:

a. Vegetation

b. Mulch

c. Natural or synthetic matting
d. Riffles
e. Impervious linings, including polyethylene and asphalt concrete
f. Terraces, grassed waterways
g. Drop structures
h. Storm drains
i. Energy dissipation devices
j. Debris basins
k. Sedimentation ponds
l. Filters

SECTION 11. FEES AND CHARGES

A. Permit Fee

The City shall levy such fees as are necessary to review and administer the drainage permit for the specific improvement and the basic permit fee shall be $_____.

The permit fee for projects requiring additional services by the City shall be on the basis of the minimum fee plus all direct costs incurred by the City including, but not limited to, the following:

1. Costs of engineering - review time
2. Costs for inspection time
3. Costs for testing completed facilities

B. Cost of Facilities on Private Property

All costs of providing drainage facilities on private property to meet the requirements of these rules and regulations shall be borne by the owner.

C. Cost of Future Public Facilities

It is intended that funds for future trunk drainage system construction will be provided from the general fund or special assessments.

SECTION 12. REVIEW AND APPROVAL OF THE PLAN

Upon filing of the completed drainage plan and all supporting data as required by the City and upon payment of all applicable fees, the Public Works Director shall expeditiously review the plan in accordance with the procedures established by the City. The Public Works Director will review the drainage plan for technical accuracy and will recommend to the Planning Commission that the drainage plan be accepted, accepted with conditions, or disapproved. The City will then act upon the application of which the drainage plan is a part. Final approval and acceptance of the drainage facilities provided will only be made upon the completion of the project following necessary inspection and testing.

The same plan submitted during one permit/approval process may be subsequently submitted with further required applications. The plan shall be supplemented with such additional information that is requested by the Department of Public Works.

SECTION 13. VARIANCES

Variances from any of the foregoing requirements may be permitted only after a determination by the Planning Commission that the proposed variance is in accord with the intent of the drainage management plan.

SECTION 14. APPEALS

In the event of disapproval of a drainage plan, the Planning Commission shall state the reasons for the denial and measures necessary to attain approval. The applicant shall have the right to have the denial reviewed by the full City Council or to make corrective measures to the project as necessary to obtain approval. Denial by full City Council shall leave the applicant with the choice of correcting the project or permit as suggested by the City or appeal through the judicial process.

SECTION 15. EASEMENTS

Easements for maintenance access to all drainage system components on private property must be provided. The easement shall be 15 feet back from the top of each bank on any natural or manmade open channel and 10 feet on either side of the centerline of any closed conduit.

In addition to the appropriate easements for drainage ways within the subject property, an applicant must obtain easements required to pass drainage water from his property to an approved point of discharge to the City's drainage system. These easements shall be obtained by the applicant at his sole cost and expense.

A true copy of such easement shall be delivered to the City prior to final plat approval and prior to the time the applicant commences work on his project. Upon completion of the project and prior to acceptance of said project by the City in accordance with the provisions hereof, the original easement and easement releases shall be delivered to the City. Said easement shall provide for the perpetual access of the City for maintenance, repair, and replacement of drainage-related facilities.

SECTION 16. BONDS AND LIABILITY INSURANCE REQUIRED

The Department of Public Works is authorized to require all persons constructing drainage facilities to post surety and cash bonds. The City shall not authorize approval of a final subdivision plat until such bonds are presented.

Where such persons have previously posted, or are required to post, other such bonds on the facility itself or on other construction relating to the facility, such person may, with the permission of the Director of Public Works and to the extent allowable by law, combine all such bonds into a single bond, provided that at no time shall the amount thus bonded be less than the total amount which would have been required in the form of separate bonds, and provided further that such a bond shall on its face clearly delineate those separate bonds which it is intended to replace.

A. Construction Bond

Prior to commencing construction, the person constructing the facility shall post a construction bond in an amount sufficient to cover the cost of conforming said construction with the approved drainage plans.

B. Maintenance Bond

After satisfactory completion of the facilities and release of the construction bond by the City, the person constructing the facility shall commence a two (2)-year period of satisfactory maintenance of the facility. A cash bond to be used at the discretion of the Public Works Director to correct deficiencies in said maintenance affecting public health, safety, and welfare must be posted and maintained throughout the two-year maintenance period. The amount of the cash bond shall be determined by the Public Works Director but shall not be in excess of ten percent nor less than five percent of the estimated construction cost of the drainage facilities. In addition, a surety bond or cash bond to cover the cost of design defects or failures in workmanship of the facilities shall also be posted and maintained throughout the two-year maintenance period. Alternatively, an equivalent cash deposit to an escrow account administered by a local bank designated by the City could be required at the City's option.

C. Liability Policy

The person constructing the facility shall maintain a liability policy in the amount of one hundred thousand dollars per individual, three hundred thousand dollars per occurrence, and fifty thousand dollars property damage, which shall name the City as an additional insured and which shall protect the City from any liability up to those amounts for any accident, negligence, failure of the facility, or any other liability whatsoever relating to the construction or maintenance of the facility. Said liability policy shall be maintained for the duration of the facility by the owner of the facility, provided that, in the case of facilities assumed by the City for maintenance pursuant to Section 20 of this ordinance, said liability policy shall be terminated when said City maintenance responsibility commences.

SECTION 17. INSPECTION AND ACCEPTANCE

After approval of the initial drainage plan the City shall be notified at the time any construction or alteration affecting drainage on the site shall begin and shall have the right to make periodic inspections during the construction or alteration to ensure that the requirements stated in the permit and elsewhere in this ordinance are met.

It will be the responsibility of the property owner to see that the construction inspections are performed and "as-built" drawings are prepared for the project and certified by a professional civil engineer registered to practice in the State of Alaska.

SECTION 18. ENFORCEMENT AND PENALTIES

The City reserves the right to enter the subject property from time to time to ascertain that all drainage facilities are functioning. In the event deficiencies are found, the property owner shall make such corrections as are necessary within 15 days of the date of notice by the City. In the event the property owner shall fail to make such corrections, the City may revoke the right to occupancy of the subject property, may charge the property owner with a misdemeanor punishable by fines, and may enter on to the subject property and take such corrective action as may be required by the drainage permit. All costs for corrective measures and enforcement actions shall be borne by the property owner.

Any person causing material to be discharged to or enter the drainage system of the City shall be liable for all costs incurred by the City or others in cleaning up or correcting said action and may be charged with a misdemeanor punishable by fines.

The City Council may institute a suit for a mandatory injunction directing a person to remove a structure or facility erected in violation of the provisions of this ordinance, or make the same comply with its terms. If the

City Council is successful in its suit, the respondent shall bear the costs of the action, including reasonable attorney fees.

The failure or refusal of the City to enforce any provision of this ordinance, and as hereafter amended, shall not constitute a waiver or bar to prevent enforcement thereof against any person for a subsequent violation hereof, or for any other violation by any other person.

SECTION 19. MAINTENANCE

Maintenance of the trunk drainage system on public or private property shall be the responsibility of the City, provided maintenance easements are granted in favor of the City where necessary by the private and public owners. Where such easements are not granted, the private or public owner shall be responsible and liable for maintenance.

Maintenance of drainage facilities on private property discharging into the City's trunk discharge system (Exhibit 1) shall be the responsibility of the owner thereof unless otherwise provided herein.

SECTION 20. CITY ASSUMPTION OF MAINTENANCE

The City may assume the maintenance of any drainage facilities after the expiration of the two (2)-year maintenance period in connection with the subdivision of land if:

a. All of the requirements of Section 17 of this ordinance have been fully complied with.

b. The facilities have been inspected and approved by the Public Works Department after two (2) years of operations.

c. All necessary easements entitling the City to properly maintain the facility have been conveyed to the City and recorded with the City Auditor.

d. The surety bond required in Section 17B has been extended for one year, covering the City's first year of maintenance.

e. The developer has supplied to the City an accounting of capital, construction, and maintenance expenses or other items for the drainage facilities up to the end of the two-year period, for the purpose of establishing the basis for future bonding requirements for other developments.

In the event that the City elects not to assume the maintenance responsibility for the facilities, it will be the responsibility of the developer to make arrangements with the occupants or owners of the subject property for assumption of maintenance in a manner subject to the approval of the Department of Public Works. Such arrangements shall be reported as part of the drainage plan required in Section 9.

SECTION 21. RETROACTIVITY RELATING TO CITY MAINTENANCE OF DRAINAGE FACILITIES

If any person has constructed any drainage facilities, or has received approval of drainage plans prior to the effective date of this ordinance, the City may assume maintenance of the facilities if the facility so constructed or the plan so approved is re-evaluated according to the requirements of this ordinance and is found in compliance to the Public Works Director's satisfaction and all bonds specified in Section 17 are inspected, posted, acknowledged, and approved.

In cases in which all or part of the drainage facilities are not accessible for maintenance purposes due to overlying structures or other causes, the City shall be held harmless for damages which might occur due to failure of design or workmanship of those segments and, further, will not be responsible for their maintenance.

SECTION 22. EXPIRATION/RENEWAL

Every permit issued under the provisions of this ordinance shall expire at the end of the period of time set out in the permit. If the permittee shall be unable to complete the work within the specified time, he shall, prior to expiration of the permit, present in writing to the City a request for an extension of time, setting forth therein the reasons for an extension of time. If in the opinion of the Public Works Director such an extension is necessary, he may grant additional time for the completion of the work.

SECTION 23. EFFECTIVE DATE

The requirements of this chapter shall apply to all plats receiving preliminary approval subsequent to ________ ____________________________. In the case of all additional actions enumerated in Section 7 of this ordinance, the terms of this chapter shall apply where final action by the City has not been taken prior to the effective date of this ordinance.

SECTION 24. SEVERABILITY

If any provision of this chapter or its application to any person or property is amended or held invalid, the remainder of the chapter or the application of the provision to other persons or circumstances shall not be affected.