Matanuska River Watershed

Review of Resources

A report for

The Matanuska Susitna Borough

by

Palmer Soil and Water Conservation District

Matanuska River Information Office

in cooperation with

Alaska Division of Mining and Water Management

William E. Long, Editor

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MATANUSKA RIVER WATERSHED HYDROLOGY

The purpose of this paper is to describe the hydrologic and climatic characteristics of the Matanuska River drainage basin. Emphasis will be on description of parameters effecting and determining the hydrologic properties of the river, and hydrology of the river and some of its tributaries.

Matanuska Basin Description

The Matanuska River is one of the major tributaries in the Cook Inlet Basin of Southcentral Alaska. It is a major agricultural area of the state due to its unique setting. The Matanuska River itself flows roughly 80 miles from the terminus of the Matanuska Glacier in a southwesterly direction past Palmer, and on to its mouth a the head of Knik Arm, 35 miles northeast of Anchorage. The valley is bounded on the north by the Talkeetna Mountains, and on the south by the Chugach Mountains. Total watershed area is approximately 2,070 square miles.

Glacier Features

Approximately 12% of the Matanuska watershed is occupied by the active Matanuska Glacier. The Matanuska Glacier is a large valley glacier that flows north approximately 40 miles from ice fields in the Chugach Mountains. At its terminus the glacier is a little over 3 miles wide. Its terminus position has been relatively stable, lying within approximately 3 miles of its present position for the past 8,000 years. At its point of maximum advance the glacier extended to the upper part of the Cook Inlet south of Anchorage. The Matanuska Glacier is an important feature exerting great influence on the Matanuska River and Valley. The hydrologic significance of the glacier is described later in the hydrology section.

Geomorphology & Hydrogeomorphology

Technically, the Matanuska Valley is a narrow structural feature 5 to 10 miles wide, however the features of the present valley are primarily the result of glacial movement during the Pleistocene, and by the actions of the river itself. Geomorphically the valley has the characteristic U-shaped cross-sectional shape, typical of glaciated valleys. The lower Matanuska Valley is a wide, flat - floored valley. Faulting occurs throughout the region. Major faults include to the north the Castle Mountain Fault in the Talkeetna Mountains, and to the south in the Chugach Mountains the Border Ranges fault.

The Matanuska River flows through a variety of deposits. Glacial outwash deposits are common, and consist of primarily stratified sediments, chiefly sand and gravel with some silt and clay intermixed. Outwash is characteristically removed or washed out material from a glacier by meltwater streams and deposited in front of or beyond the terminal moraine or the margin of the active glacier. Materials generally grade to a finer texture with increasing distance from its glacial source. Glacial outwash deposits generally form as long narrow deposits confined by valley walls downstream of terminal moraines, or as fans or other broad alluvial sheets of glacial outwash sediments downstream of the glacier.

Moraines and other unsorted glacial drift also occupy the Matanuska Valley. Glacial drift includes all material deposited by glacial ice, without reworking by water. These deposits are unsorted, unstratified heterogeneous mixtures of clay, sand, gravel, and boulders that vary widely in composition and size. Floodplains, terraces, and alluvial fans also occupy the Matanuska Valley. These types of deposits are commonly well stratified silt, sand, and gravel with coarser grained materials near the mountains, grading to sand and silt further from the mountains.

Climate

The climate of the Matanuska Valley is a combination of maritime and continental influences, frequently termed a transitional climate. The Chugach Mountains to the south and east form an effective coastal barrier to all flow of moist Pacific air, except from the southwest over Cook Inlet. Maritime airmasses are generally modified by the time they are over the Matanuska Valley. The Alaska Range and Talkeetna Mountains to the north and the Chugach Mountains to the east protect the valley from the extreme winter colds of the Alaska Interior. Thawing temperatures can occur in midwinter under the occasional invasion of warm maritime air from the south and southwest.

Normal winter circulation patterns show a northeasterly flow of continental air prevailing over the valley resulting in little precipitation (snow) or cloudiness. Prevailing flows change slowly to an easterly direction with spring breakup in March or April. Spring is the driest, sunniest period of the year. Clouds and precipitation increase during the summer months under prevailing southwesterly circulation patterns.

The Matanuska Valley is the primary agricultural region of the state. The growing season extends from 59 to 140 days. The following summarizes the precipitation data for the Matanuska Valley at the Alaska Agricultural Station.

Precipitation Data

Inch	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	0.99	0.68	0.52	0.42	0.66	1.34	1.97	2.92	2.70	1.80	0.97	0.99
Max.	2.89	3.16	1.42	1.64	2.31	4.62	3.75	6.37	7.55	4.61	3.71	3.81
Min.	0.26	0.10	0.00	0.00	0.10	0.16	0.55	0.45	0.51	0.39	0.04	0.04

Mean annual precipitation at this site is 15.96 inches. The wettest months of August and September result from the Aleutian low centering over Bristol Bay with the characteristic southwesterly flow patterns. April is typically the driest month. Mean annual snowfall at the Agricultural Station is nearly 4 feet.

Average temperatures vary from a high of 57.6 F in July, to 13.4 F in January. Mean annual temperature is 35.8 F. Temperature data for the Agricultural Station are summarized below.

Temp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	13.4	18.1	25.0	36.5	46.9	55.2	57.6	55.5	47.8	36.6	23.4	14.3
Max.	21.4	27.3	33.6	45.5	57.8	66.4	67.7	64.9	56.7	44.0	30.0	21.5
Min.	3.7	9.3	15.1	26.9	35.7	43.7	47.4	45.9	38.5	28.5	15.0	5.5

Matanuska River Hydrology

The Matanuska River is a classic example of a large, braided, glacial outwash stream. The Matanuska Glacier is a dominant influencing factor on the hydrology of the Matanuska River. Glaciers act as large storage parameters, serving to both attenuate peak flows during large rainfall/runoff events, and conversely increase baseflows during dry periods. Glaciers thus act to dampen the amplitude of the discharge oscillations between high and low flows. Although lakes do exist in the Matanuska watershed, they are small and not significant as storage components. The only other substantial source of storage within the Matanuska Valley is ground water. During periods of baseflow, discharge is largely the result of a combination of glacial melt water and ground water discharge.

Elevations of the watershed vary from sea level to over 6000 feet. The steepness of the terrain and lack of heavy vegetative cover on much of the watershed would indicate the basin is likely to respond quickly to a rainfall event. However this may vary due to the presence of the attenuating influence of the glaciers.

Matanuska River Discharge: Seasonal Variation

Mean monthly flows are lowest during March, with an average discharge of 466 cfs (cubic feet per second). This coincides well with climatologic data, which shows March to be the month with the second least precipitation, and the last month with a mean monthly temperature below freezing. During March the Matanuska River reaches its closest point to annual baseflow. Ground water discharge becomes the dominant supply of water to the river during March.

Mean monthly maximum discharges occur in July, at 12,840 cfs. The explanation of the mean monthly maximums occurring in July is a bit more complex than that for low flows. Primary factors contributing to maximum mean monthly flows are snow and ice melt and increased precipitation. Ground water contribution to total discharge becomes relatively less significant as surface water sources become dominant during the peak summer flow period. July has the highest mean temperature but both August and September have higher mean monthly precipitation values than July. These issues suggest the single most important factor contributing to peak monthly mean discharge is glacial ice and snow melt.

Annual peak flows as a general rule result from rainstorms in late summer and early fall. Maximum discharge (derived from extension of rating curves) for the Matanuska River is 82,100 cfs, occurring August 10, 1971. That peak is 350 times greater than the minimum measured flow of 234 cfs. This extreme peak was due to the breakout of a lake on Granite Creek, a tributary of the Matanuska. Maximum discharge attributable to a rainfall/runoff event was 47,500 cfs that occurred on that same day.

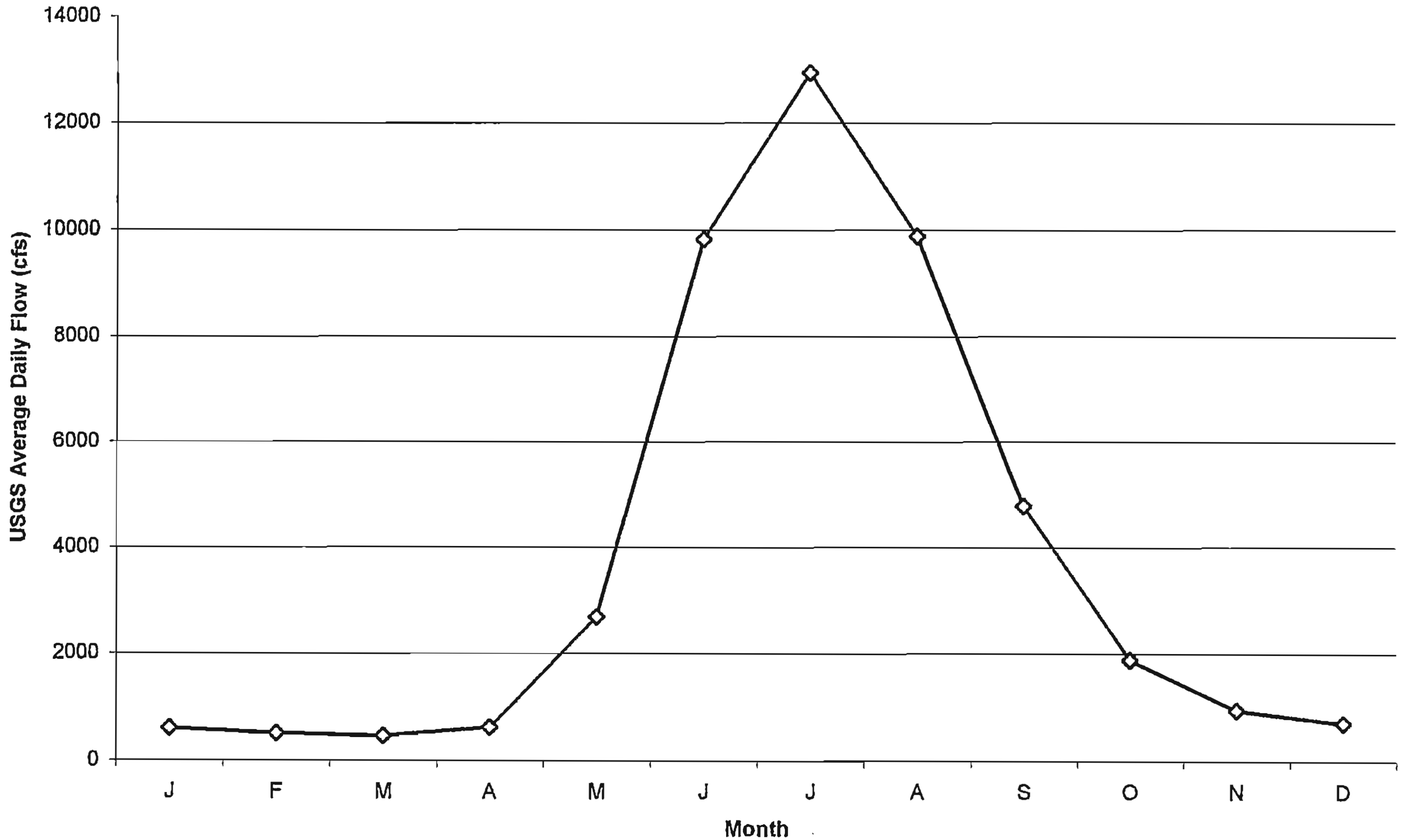
From the peak monthly flows in July, mean monthly discharge begins to decrease in August and reaches a minimum in March. From December through March, 5% of the annual flow is discharged, with March the lowest month contributing less than 1% of the annual flow. Streamflow begins to increase in April due to snow and ice melt and increases to its peak in July. Recession begins in August. Late summer and early fall rains tend to moderate the rate of recession so that August mean flow values are only slightly less than July. Figure 1 shows the annual hydrograph, while Figure 2 gives historical daily flow values for the Matanuska River.

Mean annual discharge is 3826 cfs, or 1.85 cfs per square mile of drainage area. Other drainages in the Cook Inlet area range from 0.51 to 7.56 cfs per square mile of drainage area. The USGS gaged the river at the Glenn Highway bridge from 1949 through 1973, and 1985 through 1986, and again in 1991. USGS estimated the two year recurrence interval flows at 24,000 cfs, and a 100 year recurrence interval at 50,500 cfs.

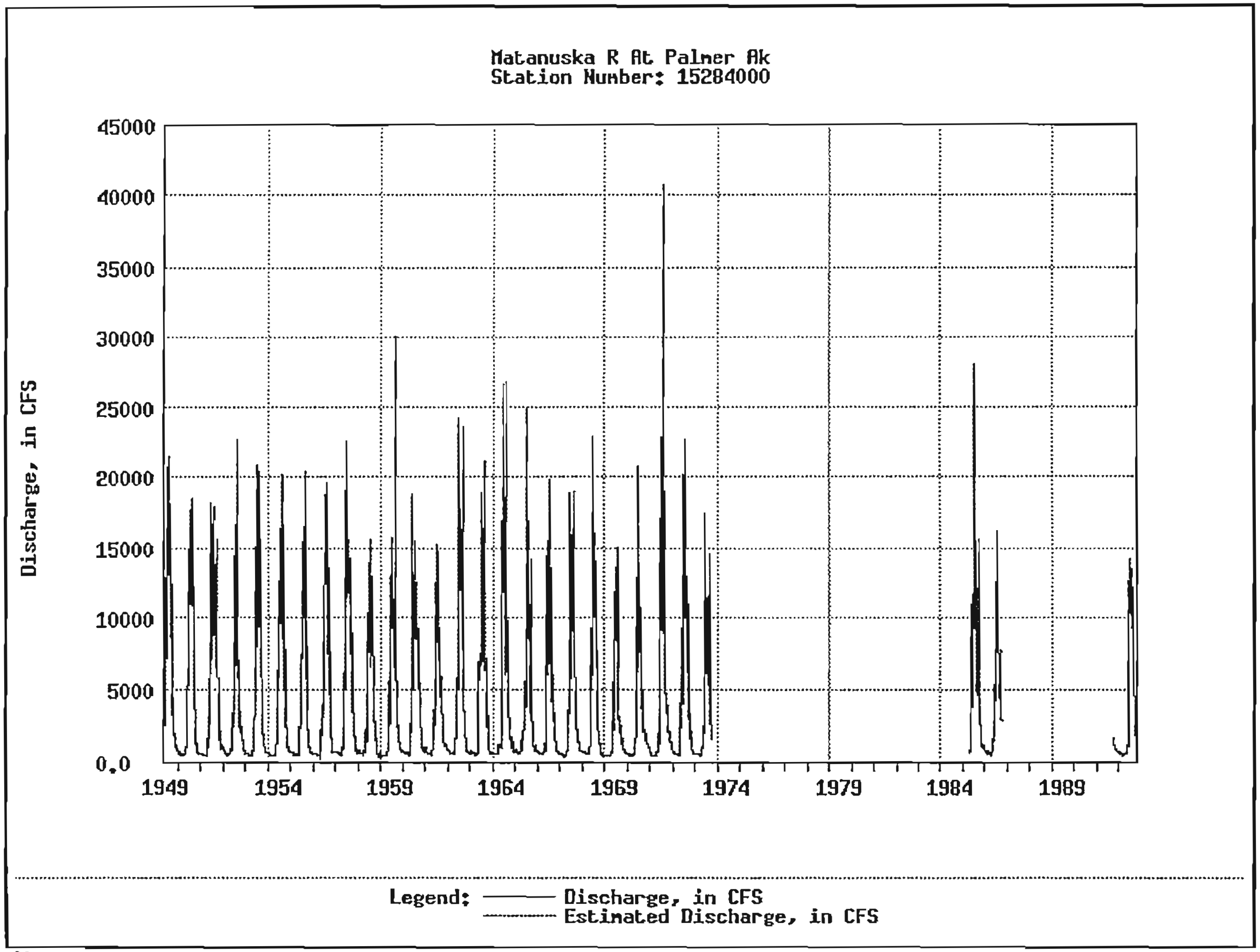
Tributary Discharge

In addition to collection of continuous record at the Matanuska River at Palmer, the USGS collected continuous discharge data at two sites tributary to the Matanuska River. These sites include Camp Creek near Sheep Mountain Lodge (station 15281500); Caribou Creek near Sutton (station 1528200). Several locations were also gaged at locations just outside of the Matanuska Watershed, including Cottonwood and Wasilla Creeks near Wasilla. Peak flow sites were also maintained by the USGS at several sites in addition to the continuous discharge sites. These sites include Hicks Creek near Sutton (station

FIGURE 1: MATANUSKA RIVER ANNUAL HYDROGRAPH



Historical Streamflow Daily Values Graph for Matanuska R At Palmer Ak (15284000)



15282200); Pinochle Creek near Sutton (station 1528230); Purinton Creek near Sutton (station 1528240); Eska Creek near Sutton (station 1528350) Golder Associates Inc. (Golder 1989) also collected stream discharge data for streams near the proposed surface coal mine near Wishbone Hill.

Flooding of greatest record at sites in the Matanuska Watershed occurred in August of 1971 (Lamke, 1972). Flooding on tributaries to the Matanuska near Sutton in August of 1971 was estimated by Lamke to be 1.8 to 8.9 times the probable 50 year recurrence interval flow. Refer to the flooding history section near the end of this report for greater detail pertaining to flooding.

The Alaska Hydrologic Survey (AHS) collected surface water discharge and water quality data on ungaged streams in the Matanuska watershed from 1984 to 1998. The purpose of this effort was to provide water resource information to the Matanuska Valley Moose Range Management Plan (a joint project with ADNR, and ADF&G), and the Alaska Abandoned Mines Lands program. This data is summarized in a report entitled *Hydrologic Data for the Matanuska Watershed, Southcentral Alaska*, by Mary Maurer (PDF 98-41). Data presented in this report include 21 sites (Wolverine Creek, Moose Creek above unnamed tributary, and unnamed tributary to Moose Creek, Moose Creek at the Glenn Highway, Eska Creek, Granite Creek, Kings River, Carpenter Creek, Carbon Creek, Spring at Luster property, Spring at California Creek road, California Creek, Chickaloon River, Coal Creek, Gravel Creek, Hicks Creek, Glacier Creek, Caribou Creek, South Fork of the Matanuska, and the East Fork of the Matanuska).

Sediment Load Discharge: Suspended Load

High suspended sediment load in the Matanuska River is readily evident. Turbidity is very high due to the high suspended sediment load. The glacial source of the Matanuska is directly responsible for the high suspended sediment. The most extensive suspended load data is for the Matanuska River at Palmer, where the USGS collected information for 15 years.

Tributaries to the Matanuska have generally lower suspended sediment loads, which is evidenced by the markedly less turbid water. Limited information is available on suspended load data for the rivers tributary to the Matanuska. The USGS collected suspended load data at Caribou Creek near Sutton, Moose Creek near Palmer, and on the Matanuska River at Palmer. Idemitsu Alaska, Inc. did collect suspended load data as apart of their Wishbone Hill Coal Mine Surface Coal Mining Permit Application process (Golder, 1989). Their conclusion was that suspended loads were generally low for the streams in the vicinity of their proposed mine, but were likely to increase significantly during storm/peak flow events. This conclusion is largely corroborated (Carrick, 1988) for streams in the adjacent Little Susitna watershed.

Sediment Load Discharge: Bed Load

Several attempts have been made over the years at estimating Matanuska River bed load. In the mid-eighties there was pressure to mine some of the alluvium along the lower reaches of the Matanuska River. The management objective in the approval of the mining of the lower reaches was to approve no more annual harvest than the value of total bed load movement. To that end, both the U.S. Geological Survey (USGS) and the State Alaska Hydrologic Survey (AHS) made estimates of total bed load movement within the Matanuska River (see attachments).

The USGS based their estimates on nine bedload samples collected between June 1985 and October 1986. These samples were taken over a range of discharges, from a low of 880cfs to a high of 18,100cfs. These values were then used in developing the log transformed data into an equation relating bed load and water quality discharge. After completion of the statistical work on bedload transport, a flow duration analysis of the Matanuska River was completed using historic continuous streamflow data from 1950 -1973. Combining the results of the bedload measurements and statistical interpretations, with the flow duration analysis resulted in an annual bedload yield of 397,000 tons. Using a conversion factor of 110 pounds per cubic foot, the USGS estimate can also be expressed as an estimated annual yield of 267,000 cubic yards.

AHS took a slightly different approach in making an estimate of bedload transport. This approach looked at three other Southcentral Alaska rivers upon which to base a ratio of bedload to suspended sediment load. The conclusion of this approach was that a value to use for the ratio is 0.10. Using that value an estimate of annual bedload yield of 300,000 cubic yards was derived. AHS tried to emphasize in their approach that the value derived was likely a conservative estimate. The Matanuska is a classic braided glacial river. Braided channel forms are traditionally thought of as ones where there is a greater supply of bedload than the capacity of the river to move bedload.

These two estimates made by the USGS and AHS are considered corroborative. These values have been used since by State management agencies in determining the maximum allowed proposed removal of alluvium from the lower Matanuska flood plain. An opportunity exists for future researchers to obtain accurate measurements of Matanuska River bedload.

Matanuska River Erosion

Characteristic of any braided channel morphology is the constant erosion and deposition of alluvial material. The evidence of that continual cycle of movement and redeposition is evident throughout the Matanuska Valley. The classic wide braided channels, with many interfingering channels washing around unvegetated bars, and the continual motion of these bars are all indicators of the constant movement of materials by the river. The presence of larger vegetation on some bars and banks, combined with the relatively short history of human development and memory in the area have lulled people into the belief that the river is stable in its current morphology. This is a faulty assumption. The Matanuska River is a large dynamic system that within recent geologic time has moved all over the floodplain, only ultimately controlled by structural limits imposed by bedrock outcroppings. The inherent instability of the Matanuska River system makes any prediction of its expected behavior nearly impossible.

History and Areas of Erosion

Perhaps the most noted area of erosion in recent years along the Matanuska River is at the Circle View Estates subdivision and Stampede Estates subdivision. These subdivisions are downstream of the Old Glenn Highway bridge, and just upstream of Bodenburg Butte. Dramatic photos of houses falling into the river resulting from erosion of the banks upon which the houses stood have been shown on many television news programs.

Prior to 1989-90 the Matanuska River flowed down the channel that ultimately joined Knik Arm just to the north of the mouth of the Knik River. Beginning about 1989-90 there was a substantial shift in channel pattern of the lower Matanuska River. The dominant flow prior to 1989-90 had been down braided channels occupying the central and west side of the Matanuska floodplain immediately adjacent to and upstream of the Circle View Estates subdivision. In 1989-90 this flow pattern began to change, shifting most of its flow to the east side of the channel adjacent to the Circle View Estates subdivision. Apparent aggradation occurring downstream of the Circle View area also caused the development of a major new channel connecting the Matanuska River to the Knik River. The slough, formerly known as Ezi Slough, acted as an overflow channel during high flow events in the past. In the period following the shift to the east side of the channel, Ezi Slough changed from a minor overflow channel, to the dominant channel of the Matanuska River. In the current configuration, it has been estimated that from 80 to 90% of the flow of the Matanuska River now flows through what had been Ezi Slough to the Knik River. Much of the Matanuska can now technically be considered a tributary to the Knik River.

There has been speculation on the causes behind this significant change in lower Matanuska River morphology. One theory postulated by the AHS as the reason for the hydrogeomorphic change is aggradation in the channel down the central and western portions of the flood plain, between the Alaska Rail Road dikes and a point upstream somewhere just above of the Circle View/Stampede Estates vicinity. Evidence of this aggradation are most notable along the upstream side of the Alaska Rail Road dike. The dike was constructed in the late 1940's and into the 1950's by the Rail Road to prevent flooding that damaged Rail Road property, particularly in the Rabbit Slough area. Visual inspection clearly shows aggradation on the upstream side of the dike estimated at 6 to 8 feet. This much aggradation is substantial, and can have a major change on the profile/gradient of the river, directly impacting the ability of the river to transport materials.

This aggradation upstream of the Rail Road dike effectively reduces the channel gradient, that reduces stream velocity, that in turn reduces the capacity of the river to move its bed and suspended load. That reduction in capacity to move bed load has resulted in the aggradation of alluvium. That aggradation has worked itself upstream, and likely according to the AHS evidence to just above the Circle View Estates area. Survey data made by AHS in the fall of 1995 indicated that the western portion of the floodplain adjacent to and just upstream from the Circle View Estates is four to six feet higher on average than the eastern side of the flood plain immediately impinging on the Circle View Estates area. These two areas of evidence, the aggradation at the Rail Road dike and the survey data of cross sections at the Circle View Estates area, strongly suggest that aggradation occurring along the most recently used western Matanuska flood plain channels is of sufficient magnitude to force a channel shift to the eastern side of the flood plain, and also eventually down Ezi Slough. Following this line of logic, it is highly unlikely that the channel will shift again to the western side of the flood plain, because to do so would dramatically reduce the overall gradient.

Further research into this indication of channel aggradation stemming from the construction of the Rail Road dike is warranted. Suggestions for future work include the completion of channel profiles from above Circle View Estates down both the historic western channel to Knik Arm, and the now occupied eastern channel to the confluence with the Knik River. If this theory is correct, it would be expected that a steeper gradient is evident down the eastern channel to Knik River, and a clear reduction of gradient is visible from the Rail Road dike to somewhere above the Circle View area.

In July of 1991, then-Governor Walter Hickel declared a disaster emergency within the Matanuska Susitna Borough. This disaster declaration was due to "serious damage and threats to life and property resulting from erosion of the Matanuska River, in the vicinity of Circle View Estates." This emergency declaration precipitated the funding of $500,000, that ultimately led to the construction of four finger dikes in 1992 designed specifically to control erosion, and protect property within the Circle View Estates subdivision. These dikes were originally designed as a series of eight dikes, but were cut back to four because of lack of sufficient funding.

As of the time of this writing, the dikes are still in place, and have apparently provided some protection to the property in the Circle View Estates subdivision. Some question remains as to the effects of the dikes both upstream and downstream. Substantial channel incision has resulted immediately upstream of the most upstream dike. That incision is estimated to be as high as 6 feet. The long term effects of these dikes is unknown. In order for the dikes to remain effective, maintenance work, involving rearmoring or replacement of eroded material, must be completed on a regular basis.

Other areas of erosion have, and are occurring along the banks of the Matanuska. These areas may or my not be related to human activities. Without any human influence, an inherently unstable braided river such as the Matanuska River would always find new areas for erosion and deposition that change seasonally. The largest hydrogeomorphic changes occur in response to peak flow events.

Prior to the channel shifting to the eastern flood plain in the reach adjacent to Circle View Estates subdivision, the main channel had been on the far opposite side of the floodplain, impinging on the western banks. Landowners in that vicinity, including farmers, developers, and homeowners reported problems and tried some bank protection work of their own, usually involving the dumping of junk cars to line the bank.

Moving upstream, off the Old Glenn Highway at Ye Olde River Road, a dike was constructed by the Matanuska Susitna Borough to protect some low-lying property. This was an area subject to flooding after during the flood of 1971. Moving further upstream to just east of Sutton, some minor erosion has taken place near the Carroll Residence. Although there is large vegetation at this site, there is also evidence that some of the material being eroded was fill.

Still further upstream near milepost 66 of the Glenn Highway, the Matanuska Susitna Borough and Alaska Department of Transportation (ADOT) constructed a series of dikes to control erosion. The construction at this location failed, and according to local residents aggravated the situation, and caused erosion of their property.

Finally, in 1994 ADOT constructed a finger dike and bank armoring just downstream of the Kings River confluence. The purpose of the construction at this site was the physical protection of the Glenn Highway.

<u>Bank loss and Rates of Erosion</u>

Erosion, particularly in a large inherently unstable system such as the Matanuska River, is an episodic event. At any given location there is likely to be a prolonged period with little to no erosion usually due to the dominant channel being elsewhere, followed by a period of rapid erosion. This is a normal situation for a river such as the Matanuska, and the change from a period of non-erosion to erosion, or erosion to non-erosion, results from dominant channel shifts, and or high flow events. Given time, the Matanuska river will erode and rework all of the material within the flood plain.

Due to the episodic nature of erosion the establishment of a rate of erosion is a meaningless task. As an example, over a 50 year period there may be completely stable banks with no erosion for 49 years, and on the 50th year there may be 100 feet of bank loss. The average rate of erosion over the 50 year period would then be 2 feet per year. However, instead of sampling over a 50 year period, sampling was made over a 5 year period. That 5 years may or may not include the single year during which the 100 feet of bank loss occurred. If it did include the year of bank loss, than the average for that 5 year period would be 20 feet per year. Conversely, if the 5 year sampling did not include the year with the 100 feet of bank loss the average for that 5 year period would be 0 feet per year of bank loss. Added to this problem are many others with regard to the establishment of a rate of erosion. In the example above, the measured values of bank loss are a point measurement. One hundred feet upstream or downstream the measured bank loss could be 100% greater or less, dependent upon the morphology and flow conditions. As for the example above, all three erosion rates could be considered correct, or incorrect dependent upon how one chooses to sample.

In reality, all that can be done is establish how much bank loss has occurred at a particular point over a given period of time. Unfortunately, many people misuse a published value of a rate of erosion as an indicator of the relative stability of a given portion of a river bank. This leads to both false securities with regard to the expected longevity of a particular portion of a river bank, and the other extreme of expected erosion far in excess of what will actually occur. No general rates of erosion should be presented or used as an indicator of bank longevity.

At the Circle View Estates vicinity, AHS in conjunction with DMWM engineering staff located a series of erosion transects from which bank erosion losses could be accurately determined and documented (see attachment). A total of 18 transects were established. Measured bank loss varied from undetectable, to a maximum of 71 feet at transect 17 over the period of record extending from May 1995 to September 1996. At transect 17 the majority of bank loss was documented during the period from early June 1995 to late July 1995. During that 6 to 7 week period, 67 feet or 94% of the total documented loss at that location for the period of record was recorded. That loss in such a short period of time is a documented example of the episodic nature of erosion on the Matanuska River.

<u>Flooding</u>
The summer of 1971 saw the greatest floods of record for the Matanuska River (Lamke, 1972). Mountain snowpack was 150 percent on May 1 of that year, and caused local snowmelt flooding from mid May to Mid July. Major flooding of 1971 occurred in the August 8-11 timeframe. From August 5-11, totals of 3 to 9 inches of precipitation were measured in an area from Ilaimna Lake northeast to Palmer, Talkeetna, and Paxson.

The worst flooding resulting from these storms occurred in the Matanuska Valley. On an unnamed tributary to Granite Creek a lake breached its embankment, releasing a peak discharge of 58,600 cfs on August 9 and 10. That flow was statistically determined to be 23.4 times the probable 50 year recurrence interval flood. Other streams tributary to the Matanuska also had peak flows during that time period that ranged from 1.8 to 8.9 times the expected 50 year recurrence interval flows. Moose Creek peaked at an estimated flow of 18,000 cfs, Eska Creek peaked at 1680 cfs, and Kings River a the eastern edge of the flooding peaked at 9,800 cfs.

The Matanuska River had an apparent peak discharge on August 10, 1971 at 6:00 am of 47,500 cfs, and then began a recession. At roughly that same time the Granite Creek surge began. This surge resulted in a rapidly rising hydrograph that peaked on the Matanuska River at 9:15 am at 82,100 cfs. By 11:30 that same morning the Matanuska flow had diminished to 38,600 cfs.

East of Palmer the Glenn Highway was washed out in four places on the afternoon of August 9, and remained closed until August 12. In 1971 the Glenn Highway was the only road link out from Anchorage, either northbound or southbound. Washouts of the road occurred at Moose Creek, Granite Creek, Eska Creek, and Kings River. The Sutton area sustained substantial damage to homes and businesses.

In all, it was estimated that Southcentral Alaska sustained $8 million to $10 million in damage from the floods of August of 1971. Of that amount, roughly $6 million was directly from damage occurring in the Matanuska Valley.

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HYDROLOGIC DATA FOR THE MATANUSKA RIVER WATERSHED, SOUTHCENTRAL ALASKA

by

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July 1998

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TABLES

INTRODUCTION

The Alaska Department of Natural Resources (ADNR), Division of Mining and Water Management, Alaska Hydrologic Survey collected hydrologic data on ungaged streams in the Matanuska River watershed from 1984 to 1998 to provide water resource information for the Matanuska Valley Moose Range Management Plan (ADNR and Alaska Department of Fish and Game, 1986) and Alaska's Abandoned Mine Lands program. Water is an essential natural resource that sustains fish and wildlife. In addition, an adequate water supply is needed for residential, recreational, commercial, and industrial development within the watershed. The need for water data is expected to increase in conjunction with renewed interest in surface coal mining near Sutton. The purpose of this report is to make previously unpublished Alaska Hydrologic Survey hydrologic data for the Matanuska River watershed available to the public.

WATERSHED DESCRIPTION

The Matanuska River watershed encompasses 2070 square miles within the Cook Inlet drainage basin in Southcentral Alaska. The Matanuska River flows southwestward for 75 miles to its terminus in the Knik Arm of Cook Inlet, about 40 miles northeast of Anchorage, Alaska (fig. 1). The river is glacial and has a broad, braided floodplain with a few bedrock constrictions along its length. The Matanuska Glacier in the Chugach Mountains contributes glacial meltwater and a heavy sediment load to the river during summer months. The largest tributaries flow south from the Talkeetna Mountains (fig. 1). The Chickaloon River is the largest tributary. The middle and lower reaches of Moose Creek, Eska Creek, Granite Creek, Boulder Creek, Kings River and Chickaloon

River lie within the Matanuska Valley Moose Range. Streamflow measurement and water-quality sampling sites are shown on figure 1. Descriptions of specific sampling locations are listed on table 1.

METHODS

Streamflow was measured with a Marsh-McBirney current meter according to U.S. Geological Survey methods (Carter and Davidian, 1968). In-situ water temperature, dissolved oxygen, and specific conductance were measured with a Model 4041 Hydrolab that was pre- and post-calibrated according to the user manual. On-site pH was measured with a Hydrolab or an Orion pH meter. Turbidity was measured with a Model 16800 Hach turbidimeter. Bicarbonate alkalinity was measured on-site by titrating an untreated, unfiltered 100-ml water sample with 0.01639 N sulfuric acid to an end-point of pH 4.5 (U.S. Environmental Protection Agency, 1983).

No quality assurance plan was written for the project. Sample collection and handling procedures of the U.S. Geological Survey (1977) were followed. Pre-cleaned plastic bottles were used. Grab samples were taken approximately mid-depth and mid-channel. All samples were field treated. Samples for total recoverable trace-element analysis were treated with double-distilled 70 percent nitric acid. Samples for dissolved trace-element analysis were filtered through a 0.45-µm membrane filter and acidified with double-distilled 70 percent nitric acid. Samples for major ion analysis were filtered through a

0.45-µm membrane filter. Samples were placed in a cooler with blue ice during transit to the laboratory.

The Alaska Hydrologic Survey water quality laboratory in Fairbanks, Alaska (formerly known as the hydrology laboratory of the Alaska Division of Geological and Geophysical Surveys) performed the major ion and trace element analyses. All samples were analyzed in accordance with the methods of the U.S. Environmental Protection Agency (1983) or the American Public Health Association (1980).

RESULTS AND DISCUSSION

Streamflow and on-site water-quality measurements are shown on table 1. Water temperatures are relatively cool in the summer, which is typical of mountain streams in southcentral Alaska. The pH ranges from slightly acid to slightly basic. Specific conductance varies among sites, ranging from 68 to 564 µS/cm @ 25°C. During the winter, the specific conductance of streams is a good indicator of the dissolved mineral content in groundwater. The highest specific conductance (564 µS/cm at 25 °C) was measured in Caribou Creek (site 19). Alkalinity ranges from 23 to 70 mg/L, indicating low to moderate acid-neutralizing capacity. Dissolved oxygen concentrations are high except in one spring in the Chickaloon area (site 11).

The major ion and trace element concentrations for three streams are shown on table 2. The majority of analyses have an ion balance error less than 10 percent, which indicates no major analytical errors. The analysis for site 2 has a higher error (13.7%) because the alkalinity titration was performed under difficult cold weather conditions. The calculated total dissolved solid concentration ranges from 64 to 87 mg/L, indicating low dissolved mineral content. Likewise, calculated hardness values range from 52 to 59 mg/L as $CaCO_3$, indicating soft water (Hem, 1985).

Total and dissolved trace element concentrations for streams are either below detection limits or are present in low concentrations (table 2). Arsenic concentrations in streams are low, ranging from 0.9 to 2.1 µg/L. Concentrations of aluminum, barium, and zinc generally are less than 50 µg/L. Boron concentrations range up to several hundred micrograms per liter (µg/L). Generally, total recoverable and dissolved concentrations of trace elements are similar. Iron and aluminum total recoverable concentrations are noticeably higher than dissolved concentrations in the Moose Creek tributary (site 3) under baseflow conditions. A small amount of suspended sediment or inorganic particulate matter could produce these results.

The dissolved major ion concentrations and trace element concentrations for three springs are shown on table 3. Alkalinity for the springs was not determined in the field. A calculated alkalinity value was obtained by solving for the bicarbonate ion (HCO_3^-) in the cation/anion balance. Hardness values are variable. The spring along Chickaloon River

Road (site 22) has a higher mineral content than the other two springs; a hardness value of 159 mg/L as $CaCO_3$ indicates hard water (Hem, 1985).

Trace element concentrations in the springs are similarly low (table 3). Most trace elements are either undetected or have concentrations ranging from 1 to 50 µg/L. Two springs have a boron concentration of 55 µg/L, which is acceptable for all freshwater uses. The arsenic concentration is <5 mg/L in the spring along California Creek Road (site 11). Area residents reportedly use this spring as a public water supply.

A trilinear diagram shows the percentages of total cations (positively charged ions) and anions (negatively charged ions) for four streams and three springs (fig. 2). Upper Moose Creek, Lower Moose Creek, an unnamed tributary to Moose Creek, Eska Creek and the spring along Chickaloon River Road have calcium bicarbonate water. The other two springs in the Chickaloon area have sodium bicarbonate water.

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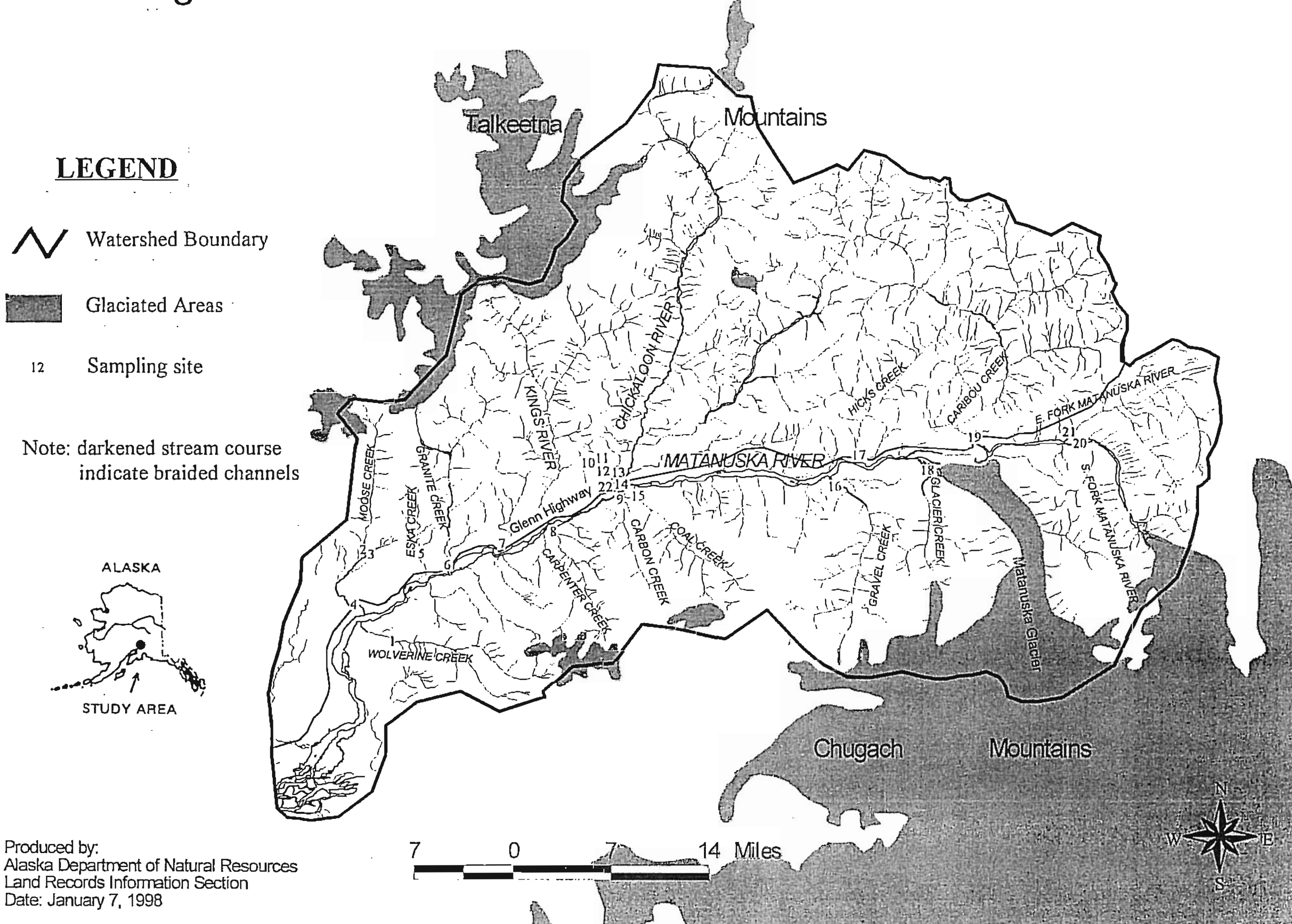
Figure 1. The Matanuska River Watershed



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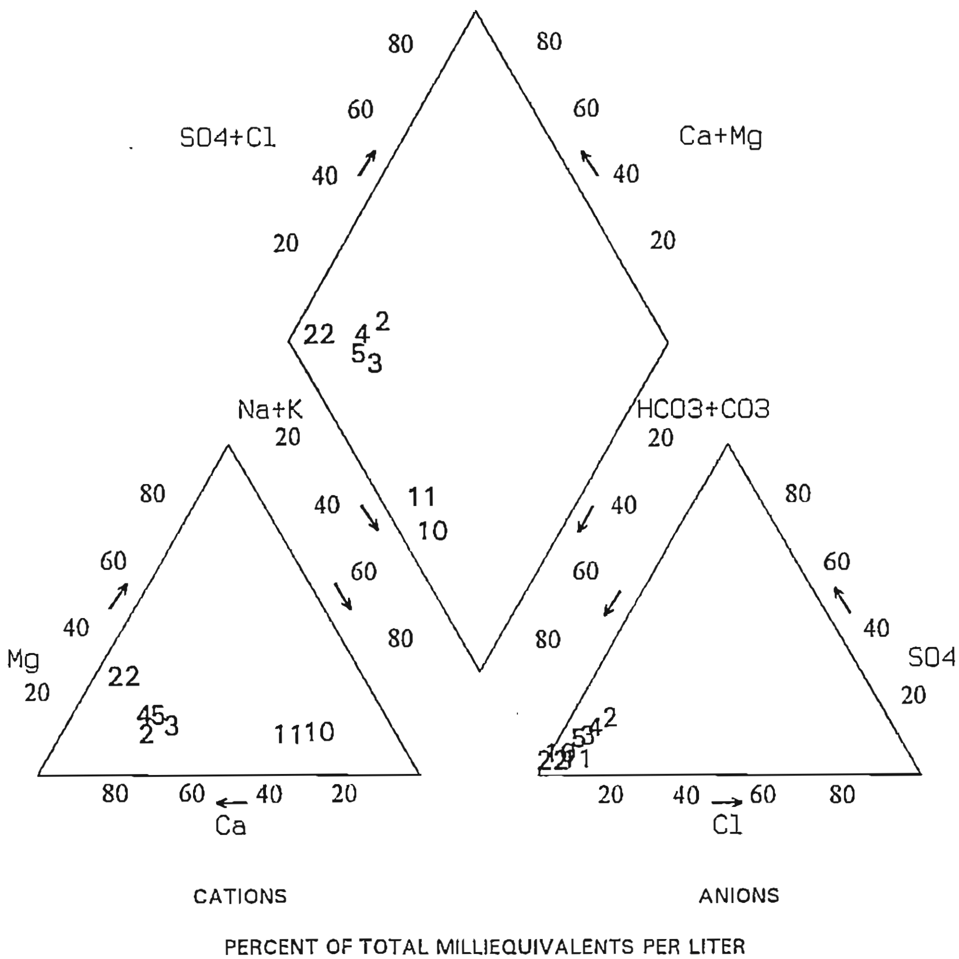

EXPLANATION

Site No.	Location	Water Type
2	Upper Moose Creek	Calcium bicarbonate
3	Moose Creek tributary	Calcium bicarbonate
4	Lower Moose Creek	Calcium bicarbonate
5	Eska Creek	Calcium bicarbonate
10	Spring on Luster property	Sodium bicarbonate
11	Spring along California Creek Road	Sodium bicarbonate
22	Spring along Chickaloon Road	Calcium bicarbonate

Figure 2. Trilinear diagram of water analyses from seven sites in the Matanuska River watershed, 1985-1991.

Table 1. Streamflow and on-site water-quality measurements taken in the Matanuska River watershed, 1984–1998.

Site No.	Site	Date	Time	Streamflow (cfs)	Air Temperature (°C)	Water Temperature (°C)	pH (units)	Specific Conductance (µS/cm @25°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (percent saturation)	Alkalinity (mg/L as $CaCO_3$)	Turbidity (NTU)
1	Wolverine Creek	4-11-84	1020	36	1.7	1.0	6.5	139	14.9	100	--	--
2	Moose Creek above unnamed tributary	6-21-85	1430	164	12.2	5.7	6.9	68	13.1	100	23	1.0
		8-28-85	1200	172	12.8	--	--	--	--	--	--	--
		4-9-86	1445	5.2	-3.0	0.0	6.1	140	15.7	100	37	--
		6-25-86	1445	113	18.3	--	--	--	--	--	--	--
		10-2-86	1530	114	7.2	5.5	--	--	--	--	--	--
		11-3-86	1345	38	-1.1	1.0	--	--	--	--	--	--
		5-21-87	1155	63	--	--	--	--	--	--	--	--
		9-17-87	1400	128	--	--	--	--	--	--	--	--
		10-29-87	1510	39	--	--	--	--	--	--	--	--
3	Unnamed tributary to Moose Creek	6-21-85	1540	10	12.2	7.1	7.5	199	11.3	97	--	--
		4-9-86	1525	4.1	-5.0	0.0	7.1	151	15.8	100	58	--
4	Moose Creek at Glenn Hwy	4-11-84	1215	19	3.3	2.1	6.8	156	13.8	100	--	--
		8-15-84	1530	145	22	12.3	--	230	--	--	--	--
		6-21-85	1140	198	10	5.6	6.6	81	13.0	100	31	1.8
		4-16-86	0945	17	3	0.8	6.4	146	16.1	100	53	--
		6-25-86	1315	151	18.3	--	--	--	--	--	--	--
		11-3-86	1225	66	--	--	--	--	--	--	--	--
5	Eska Creek 1.5 mi Jonesville Rd	6-25-85	1015	39	9.5	4.5	6.8	75	13.4	100	34	14
		8-20-85	1245	41	12.8	6.6	7.4	80	12.8	100	39	8.9
		8-28-85	--	32	--	--	--	--	--	--	--	--
		4-7-86	1225	2.3	-7.0	0.1	6.4	142	15.8	100	70	--
		6-25-86	1145	23	15.6	--	--	--	--	--	--	--
		7-21-86	1330	111	20.0	--	--	--	--	--	--	--
		9-29-86	1140	27	4.4	--	--	--	--	--	--	--
		11-13-86	1130	14	--	--	--	--	--	--	--	--
		5-21-87	1520	13	--	--	--	--	--	--	--	--
		5-27-87	1130	11	--	--	--	--	--	--	--	--
		7-13-87	0950	53	18.3	--	--	--	--	--	--	--
		9-17-87	1225	30	12	--	--	--	--	--	--	--
		5-18-98	1500	8.5	--	4.1	6.7	189	13.0	98	--	--

Table 1. Streamflow and on-site water-quality measurements taken in the Matanuska River watershed, 1984–1998 (continued).

Site No.	Site	Date	Time	Streamflow (cfs)	Air Temperature (°C)	Water Temperature (°C)	pH (units)	Specific Conductance (µS/cm @25°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (percent saturation)	Alkalinity (mg/L as $CaCO_3$)	Turbidity (NTU)
6	Granite Creek	4-10-84 7-11-85	1620 1515	22 --	-1.1 --	1.8 9.3	6.8 7.7	181 80	14.0 11.1	100 97	-- --	-- 7
7	Kings River	4-10-84 7-11-85	1530 1450	52 --	-1.1 --	2.5 9.3	6.9 7.8	196 103	13.9 11.0	100 96	-- --	-- 24
8	Carpenter Creek	4-12-84	1445	24	1.7	2.2	7.3	199	13.3	100	--	--
9	Carbon Creek	4-12-84	1330	9.7	4.4	2.4	7.4	269	13.1	98	--	--
10	Spring on Luster property	7-11-85	1300	--	--	8.3	6.9	164	10.6	93	--	--
11	Spring along California Creek Rd	7-11-85	1335	--	--	3.7	7.2	262	9.1	71	--	--
12	California Creek near Chickaloon	7-11-85	1400	7.3	--	9.1	em	190	10.8	96	--	--
13	Chickaloon River	4-12-84	1400	125	1.7	1.9	7.4	298	13.5	100	--	--
14	Chickaloon River at Glenn Hwy	7-11-85	1100	--	--	6.9	em	127	12.0	100	--	620
15	Coal Creek	4-12-84	1300	26	1.7	1.4	7.5	312	13.6	100	--	--

Table 1. Streamflow and on-site water-quality measurements taken in the Matanuska River watershed, 1984–1998 (continued).

Site No.	Site	Date	Time	Streamflow (cfs)	Air Temperature (°C)	Water Temperature (°C)	pH (units)	Specific Conductance (µS/cm @25°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (percent saturation)	Alkalinity (mg/L as $CaCO_3$)	Turbidity (NTU)
16	Gravel Creek	4-12-84	1230	23	1.7	1.1	7.0	388	14.1	96	--	--
17	Hicks Creek	4-10-84	1350	5.8	2.2	0.1	7.2	536	14.5	100	--	--
18	Glacier Creek	4-12-84	1145	19	3.3	0.0	7.5	344	14.0	94	--	--
19	Caribou Creek	4-10-84	1200	29	4.4	-0.1	7.4	564	14.0	93	--	--
20	South Fork Matanuska River	4-12-84	1000	35	3.3	-0.2	6.6	259	15.4	100	--	--
21	East Fork Matanuska River	4-12-84	1100	11	3.3	2.9	6.7	20[1]	12.0	87	--	--

-- = no measurement made
em = erroneous measurement
[1] questionable reading

Sampling locations:
Site 1: Wolverine Creek, 20 yds upstream of Wolverine Rd bridge
Site 2: Moose Creek upstream of Wishbone Hill, 50 ft above confluence of unnamed tributary (site 3)
Site 3: Unnamed Moose Creek tributary immediately north of Wishbone Hill, 100 ft above mouth
Site 4: Moose Creek, 30 yds downstream of Glenn Hwy bridge
Site 5: Eska Creek, culvert at 1.5 mi Jonesville Rd (50 ft downstream for discharge, 50 ft upstream for QW)
Site 6: Granite Creek, 30 yds downstream of Glenn Hwy bridge
Site 7: Kings River, ¼ mi above Matanuska River confluence
Site 8: Carpenter Creek, 200 yds above Matanuska River confluence
Site 9: Carbon Creek, 200 yds above Matanuska River confluence
Site 10: spring on Luster property, near California Creek
Site 11: spring with pipe outlet, along road near California Creek
Site 12: California Creek, along road opposite pullout
Site 13: Chickaloon River, 2 miles above Matanuska River confluence
Site 14: Chickaloon River, above Glenn Hwy bridge
Site 15: Coal Creek, ⅛ mile above Matanuska River confluence
Site 16: Gravel Creek, 1½ miles above Matanuska River confluence
Site 17: Hicks Creek, at Glenn Hwy bridge
Site 18: Glacier Creek, above Matanuska River confluence
Site 19: Caribou Creek, at Glenn Hwy bridge
Site 20: S.F. Matanuska River, 1 mile above East Fork confluence
Site 21: E.F. Matanuska River, 1 mile above South Fork confluence

Table 2. Laboratory analyses of major ions and trace elements for three streams in the Matanuska River watershed, 1986.

Parameter	Site 2 Upper Moose Creek		Site 3 Moose Creek tributary		Site 4 Lower Moose Creek		Site 5 Eska Creek	
DATE	4-9-86		4-9-86		4-16-86		4-7-86	
Major Ions, Dissolved (mg/L)								
Calcium	17.6		17.7		18.2		18.4	
Magnesium	2.0		2.7		3.0		3.2	
Sodium	6.5		9.0		6.2		7.2	
Potassium	0.6		0.7		0.6		0.5	
Alkalinity (as HCO_3^-)	45		71		65		85	
Chloride	1.8		1.8		1.8		1.8	
Sulfate	8.4		8.4		8.4		8.5	
Nitrate (as N)	0.8		0.8		0.8		0.8	
Silica	1.4		1.2		1.5		1.5	
Sum of Ions								
Cations (meq/L)	1.34		1.51		1.44		1.51	
Anions (meq/L)	1.02		1.45		1.35		1.68	
Ion Balance error	13.7%[1]		2.1%		3.1%		5.2%	
Total Dissolved Solids, calculated (mg/L)	64		80		75		87	
Hardness, calculated (mg/L as $CaCO_3$)	52		55		58		59	
Trace Elements, (µg/L)	TR	DISS	TR	DISS	TR	DISS	TR	DISS
Aluminum	30	20	144	22	35	21	68	25
Antimony	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	1.6	1.0	2.1	1.6	1.1	0.9	1.4	1.4
Barium	48	51	35	41	44	43	40	45
Beryllium	<1	<1	<1	<1	<1	<1	<1	<1
Boron	115	142	99	111	158	86	90	63
Cadmium	<10	<10	<10	<10	<10	<10	<10	<10
Chromium	<2	<2	<2	<2	<2	<2	<2	<2
Cobalt	<10	<10	<10	<10	<10	<10	<10	<10
Copper	<5	<5	<5	<5	<5	<5	<5	<5
Iron	<30	<30	356	76	<30	<30	33	<30
Lead	<30	<30	<30	<30	<30	<30	<30	<30
Manganese	<5	<5	29	14	<5	<5	<5	<5
Mercury	<1	<1	<1	<1	<1	<1	<1	<1
Molybdenum	<10	<10	<10	<10	<10	<10	<10	<10
Nickel	<50	<50	<50	<50	<50	<50	<50	<50
Selenium	<20	<20	<20	<20	<20	<20	<20	<20
Zinc	21	<20	<20	<20	33	<20	<20	<20

[1] high error due to low air temperature during alkalinity titration
TR = total recoverable concentration
DISS = dissolved concentration

Table 3. Laboratory analyses of major ions and trace elements for three springs in the Matanuska River watershed, 1985 and1991.

Parameter	Site 10 Spring on Luster property		Site 11 Spring along California Creek Road [1]		Site 22 Spring along Chickaloon River Road [2]	
DATE	7-11-85		7-11-85		10-16-91	
Major Ions, Dissolved (mg/L)						
Calcium	4.3		8.3		43.7	
Magnesium	1.6		2.2		12.2	
Sodium	15.9		19.7		5.3	
Potassium	0.5		0.7		1.5	
Alkalinity (as HCO_3^-)	58 [3]		79 [3]		191 [3]	
Chloride	1.2		4.0		3.9	
Sulfate	2.8		2.7		8.7	
Nitrate (as N)	--		--		<0.02	
Phosphate (as P)	--		--		<0.1	
Silica	2.9		3.3		--	
Fluoride	--		0.09		0.52	
Hardness, Calculated (mg/L as $CaCO_3$)	17		30		159	
Trace Elements, (μg/L)	TR	DISS	TR	DISS	TR	DISS
Aluminum	--	--	27	--	--	--
Antimony	--	--	--	--	--	--
Arsenic	--	--	<5	--	--	18
Barium	--	5	<1	--	--	--
Beryllium	--	--	--	--	--	--
Boron	--	55	55	--	--	--
Cadmium	--	--	--	--	--	<1
Chromium	--	--	<2	--	--	<1
Cobalt	--	--	--	--	--	--
Copper	--	--	<5	--	--	<1
Iron	--	--	39	--	50	30
Lead	--	--	<30	--	--	--
Manganese	--	--	1	--	<10	<10
Mercury	--	--	--	--	--	--
Molybdenum	--	--	--	--	--	--
Nickel	--	--	--	--	--	<10
Selenium	--	--	<20	--	--	--
Zinc	--	--	21	--	--	--

[1] Area residents reportedly use spring as a public water supply
[2] Spring is located near a fish hatchery, 100 yards above Chickaloon River Road bridge
[3] Calculated value determined by solving for HCO_3^- in cation/anion balance
-- = not analyzed
TR = total recoverable concentration
DISS = dissolved concentration

MATANUSKA RIVER WATERSHED GEOLOGY

Introduction

The geology of the Matanuska River watershed is a complex assemblage of igneous, metamorphic, and sedimentary rocks that have been mantled with surficial deposits of geologically recent glaciation. Sandwiched between the Chugach Mountains to the south and the Talkeetna Mountains to the north, the Matanuska River valley is an extension of the Cook Inlet-Susitna Lowland. The Castle Mountain fault separates the Talkeetna Mountains from the valley, while the Border Ranges fault is the major structural discontinuity that separates the Chugach Mountains from the valley. Glacial erosion carved the valley where the Matanuska River flows today, and as recently as 10,000 years ago glaciers occupied the valley. The Matanuska River primarily drains the Chugach and Talkeetna Mountains, with a basin area of approximately 2,070 sq mi.

Bedrock Geology

The oldest rocks of the Matanuska River drainage basin actually began as plutonic, volcanic, and sedimentary rocks that formed in the northern Gulf of Alaska over an oceanic subduction zone in Paleozoic time, beginning 570 to 360 million years ago (Ma). This group of rocks is called the Peninsular Terrane and they are found in a broad band extending from coastal British Columbia to the western Alaska Peninsula (Plafker, G. and others, 1994). In the Matanuska River basin the rocks are the foundation of the Talkeetna Mountains.

The Peninsular Terrane is, "composed of the plutonic core and extrusive portions of an intraoceanic island arc of Jurassic age and younger sedimentary rocks," (Burns and others, 1991). The older volcanic and metavolcanic rocks make up the Talkeetna Formation, while the intrusive granitic plutonic rocks formed the Talkeetna batholith. Near the end of the Jurassic, the Peninsular Terrane moved northward towards what is now coastal Alaska, and the island arc became extinct. It was during the Late Jurassic, 140 Ma, that movement commenced along what is now known as the Border ranges fault that occurs along the north side of the Chugach Mountains.

During the Cretaceous, 65-135 Ma, shallow and deep marine sediments of the Matanuska Formation were deposited unconformably on Peninsular Terrane rocks. The Matanuska Formation consists of approximately 4,000 ft of shales and sandstones, some with marine fossils (Alaska Geological Society, 1963), and is found throughout the Matanuska Valley on both sides of the Border Ranges fault.

About the time the Peninsular Terrane island arc became extinct, sediments of the Chugach Terrane that now make up much of the rock in the Chugach

Mountains, began to get scraped off from their oceanic plate, under and onto the Peninsular Terrane rocks. The Chugach Terrane consists of oceanic rocks and arc-related volcanic rocks. Two main rock units comprise the Chugach Terrane: the McHugh Complex and the Valdez Group. The Mchugh Complex is the older of the two units, middle Jurassic to early Cretaceous, and consists of oceanic trench slope sediments that were broken and deformed during the subduction and faulting along the Peninsular Terrane margin. McHugh Complex rocks are primarily a mixture of argillite, metavolcanic rocks, graywacke, chert, and pillow basalts all metamorphosed to various degrees. The Border Ranges fault , became active during the McHugh Complex subduction, and today generally forms the northern boundary of the McHugh Complex (Burns and others, 1991).

The Valdez Group is a thick unit of oceanic trench fill deposits that was underthrust beneath the McHugh Complex. Today the Valdez Group consists primarily of metagraywacke, argillite, phyllite, and siltstone, again all metamorphosed to various to varying degrees (Burns and others, 1991).

Until approximately 80 Ma, during Cretaceous time, the Chugach and Peninsular Terranes were separated from the "Alaska mainland" by a narrow sea. By the beginning of the Paleocene, the terranes were sutured onto the continent as the their plate moved north, and associated granitic plutonism took place in both terranes. This suturing and northward plate movement, and the concurrent subduction of the oceanic plate beneath the Chugach and Peninsular Terranes eventually resulted in intense deformation of the existing rocks and mountain-building during late Cenozoic time (Plafker, G. and others, 1994).

While both the Peninsular and Chugach Terranes were being uplifted and faulted during Early Cenozoic (40-65 Ma), there was the usual simultaneous fluvial (stream) erosion of the rocks. The sediments derived from the fluvial erosion of the two terranes make up the Chickaloon Formation, the primary coal-bearing formation in the Matanuska Valley. The Chickaloon Formation is over 5,000 ft thick in places (Alaska Geological Society, 1963), and includes interbedded conglomerate, sandstone, mudstone, and bituminous coal. The sediments originated in a warm, humid environment of alluvial fans, swampy floodplains, meandering rivers, and shallow lakes. Deciduous leaf fossils and petrified wood are found throughout the formation. Coal of the Chickaloon Formation occurs in the upper half of the sequence, and consists of four groups with several beds in each group. Mining of the Chickaloon Formation coals took place regularly from 1917 until 1967.

In early Eocene time, about 50 Ma, erosion of the Talkeetna Mountains produced gravels and sand that formed the Wishbone Formation that overlies the Chickaloon Formation. The Wishbone Formation is approximately 2,000 ft thick on Wishbone Hill and is composed of a massive pebble conglomerate with interbedded sandstone. Lying unconformably over the Wishbone and

Chickaloon Formations in the Wishbone Hill and Moose Creek areas, is the 700 ft thick Tsadaka Formation (Alaska Geological Society, 1963). The Tsadaka Formation was deposited 35-40 Ma during the Late Eocene and early Oligocene epochs, and includes course conglomerate, sandstone, and siltstone.

Surficial Geology

The Matanuska River drainage basin has been glaciated repeatedly for over 2.5 million years. Cook Inlet and the Matanuska River valley have experienced numerous glacial advances and recessions during that time that range as far south as Kodiak Island. Today, mountain valley glaciers exist in both the Chugach Mountains and Talkeetna Mountains. Not only have the glaciers shaped the surface of the Matanuska River basin, but streams have reshaped the glacial landforms and deposited glacial sediments throughout the basin.

The oldest glaciation in the Matanuska River basin was the Mt. Susitna glaciation, 2.5-3.0 Ma, though little hard evidence exists in the study area. The next major glacial advance, the Caribou Hills glaciation, left behind more evidence, such as ice-scoured benches in the Matanuska River valley along the Talkeetna Mountains. No age for the Caribou Hills glaciation has been fixed, but it is thought to have occurred approximately 200,000 years ago (Pewe, T.L. and Reger, R.D., 1983).

After an interglaciation period, another glacial advance took place in upper Cook Inlet from 130,000-200,000 years ago. This glacial advance called the Eklutna glaciation, filled the Matanuska Valley and its tributary valleys to nearly 3,000 ft elevation. Another interglaciation period took place lasting approximately 55,000 years until 75,000 years ago when another glacial advance occurred (Pewe, T.L. and Reger, R.D., 1983). This next glacial advance, called the Knik glaciation, lasted until about 50,000 years ago and extended onto the Kenai Lowlands. Ice thickness reached 2,400 ft elevation in the Cook Inlet-Susitna Lowland.

The last major glacial advance, and the one most in evidence today, was the Naptowne glaciation. Much of the surface topography of the Matanuska Valley and Upper Cook Inlet to the Sterling Highway is a result of Naptowne glaciation. From about 50,000 to 10,000 years ago, glacial ice left behind a complex of glacial lake and marine deposits, moraines, drumlins, crevasse-fill-ridge deposits, eskers, kames, and glaciofluvial deposits that have shaped the area.

Two major stades or advances of the Naptowne glaciation have been documented, with the last resurgence ending approximately 12,000 years ago with the development of the Elmendorf Moraine. At that time, the Matanuska-Knik lobes of the Naptowne glaciation began to stagnate, and about 10,000 years ago the Matanuska Glacier began a continuous retreat to a point near its present-day terminus (Pewe, T.L. and Reger, R.D., 1983). During this glacial recession, the lower Matanuska River valley was filled with stagnant ice and meltwater deposited large accumulations of sand and gravel.

Eight thousand years ago the Matanuska Glacier advanced 2.5-5 mi downvalley from its position near today's present location. This advance blocked the drainages of the Matanuska River, Caribou Creek and Glacier Creek, and meltwater ponded up into a lake. When this lake would occasionally overtop the lower divides, the rapid erosion created deep spillways at Pinochle Creek and in a now-abandoned drainage, the Lake Creek Spillway to the west of Glacier Creek. The terminus of the Matanuska Glacier has been relatively stable and within 2 miles of its present location for the past 4,000 years (Pewe, T.L. and Reger, R.D., 1983).

Rock glaciers are relatively common in the Matanuska River basin, usually occurring between 3,500 and 5,000 ft elevation in the Chugach and Talkeetna Mountains. These features form in rockslides or talus slopes, where water freezes in the center of the rock deposit and cements the core of rock glacier. These rock glaciers move downslope similar to ice glaciers, but at much slower rate of movement. A prominent rock glacier is located north of the Glenn Highway across from the Matanuska Glacier.

Today's Matanuska River basin is being actively shaped by the mountain glaciers, streams, the glacial-braided Matanuska River, rock slides, and even the wind. Wind blown sand and silt from the Matanuska Valley have deposited sand dunes 1 mi north of Palmer. An excellent source of information on the geology of the Matanuska River Valley, is Pewe and Reger's Guidebook 1, Richardson and Glenn Highways, Alaska (Pewe, T.L. and Reger, R.D., 1983).

Economic Geology

The two most important geologic resources in the Matanuska River basin are sand and gravel, and coal. In 1993, 65% of the sand and gravel mined in Southcentral Alaska came from the Palmer-Wasilla area (DGGS, 1993). Sand and gravel deposited by the Matanuska River is the primary source of the material, and in 1997, 2,970,000 tons of gravel were hauled on the Alaska Railroad from Palmer to Anchorage (Alaska Railroad Corporation, pers. commun., 1998), an amount that translates to a retail value of approximately $16 million. In addition to the Alaska Railroad, other smaller operators in the valley supply sand and gravel to the construction industry. Most of the sand and gravel mined in the Matanuska River valley is glaciofluvial deposited by the Matanuska River.

Historically, coal has been an important economic resource of the Matanuska Valley. Today there is no active coal mining taking place, but coal was mined from 1917 until 1967. The Matanuska coal field lies in the Matanuska Valley graben, and occurs in the Paleocene-lower Eocene Chickaloon Formation, made up of claystone, siltstone, sandstone and numerous coal beds. The coal-bearing part of the Chickaloon Formation stretches east from Moose Creek 20 mi to Anthracite Ridge.

There are four primary coal areas in the Matanuska Valley (Wahrhaftig, C. and others, 1994), and include:

1) the Wishbone Hill district between Moose and Granite Creeks (where most of the past production has taken place) consisting of high-volatile bituminous coal;
2) the Young Creek district that also consists high-volatile bituminous coal;
3) the Castle Mountain and Chickaloon districts with low-volatile bituminous coal; and
4) the Anthracite Ridge district that also has low-volatile bituminous coal.

Matanuska Valley coal was initially mined in 1917 at the west end of the Wishbone Hill district, and was primarily used for Alaska Railroad locomotives. Between 1917 and 1967, nine mines operated at one time or another in the Wishbone Hill district, and four mines operated at one time or another in the Chickaloon and Castle Mountain districts (Wahrhaftig, C. and others, 1994). In the 1950's and 1960's, coal was used by the Anchorage military bases, but the introduction of natural gas in 1967 eliminated the need for coal. Coal production in the Matanuska Valley coal field was primarily underground until the early 1950's , at which point surface mining took its place.

According to Merritt and Belowich (1984), a total of 7.7 million tons of coal was produced from the Matanuska Valley coal fields from 1917-1967, of which 43% was taken from open pit surface mining. The amount of remaining potentially minable Matanuska Valley coal resources vary, but general estimates indicate approximately 120 million tons of coal could still be mined in the area. Currently, Usibelli Coal Mine Inc. has preliminary approval to begin mining on 1350 acres of the Wishbone Hill Mine, but no coal has been mined as of 1998.

Structural Geology

The structural geology of the Matanuska River basin is complex and the knowledge of the structural relationships continues to evolve. An overview of the general tectonic history of the area is given above. The mainly plutonic and volcanic rocks of the Talkeetna Mountains to the north are separated from the Matanuska River valley by the Castle Mountain fault (also known locally as the Caribou fault), while the metasedimentary and metamorphic rocks of the Chugach Mountains to the south are separated from the valley by the Border Ranges fault. The Castle Mountain fault is a high-angle, large displacement reverse fault where the older rocks of the Talkeetna Mountains have been upthrown against the younger Matanuska Valley rocks. The Border Ranges fault is a large-scale regional fault, or actually a system of faults, that has both dip- and strike-slip movement, and separates the Peninsular and Chugach Terranes (Burns and others, 1991).

The Matanuska River valley is referred to as a graben (structural trough) by Wahrhaftig (1994), and it is 5-10 mi wide and nearly 60 mi long. Sedimentary rocks within the valley are generally strongly folded, highly faulted in places, and with steeply dipping beds and a complex structure throughout the valley. Tertiary basalts and igneous dikes and sills are found throughout the valley, and the structural complexity and amount of tertiary igneous activity increase eastward to the Anthracite Ridge area.

Wishbone Hill, the center of most coal mining activity in the Matanuska River valley, is a doubly plunging syncline with beds that dip 20°-40° on both sides of the syncline. In addition, Wishbone Hill is cut by two sets of transverse (strike-slip movement) faults that offset the Chickaloon Formation beds. Farther east in the Chickaloon River area, the beds dip as much as 90° and in the old Chickaloon mine the beds are overturned and sharply faulted (Wahrhaftig, C. and others, 1994). In the vicinity of Anthracite Ridge, the Chickaloon beds are tightly folded and locally overturned synclines are highly faulted, some faults having high-angles and large displacements. See Barnes (1962), Burns and others (1991), Wahrhaftig (1994), and Merritt and Belowich (1984) for additional information.

Geologic Hazards

Earthquakes and rockfalls/landslides are the main geologic hazards of the area of a non-hydrologic nature. Snow avalanches also occur, but most often in remote areas where the effects are not significant. Local and regional earthquakes are commonplace throughout southcentral Alaska and can take place at any time. The Border Ranges fault system shows no displacement in the area for at least 300 years (Pewe, T.L. and Reger, R.D., 1983). Rockfalls and modest landslides are in evidence in the Matanuska River basin, with the most prominent landslide occurring on the south side of Anthracite Ridge near cascade Creek and the Glenn Highway. This landslide measures approximately 4 mi wide by 3 mi long. For additional mapping of landslides, see Merritt and Belowich (1984).

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MATANUSKA RIVER WATERSHED

FISH AND WILDLIFE

HABITAT

FISH OF THE MATANUSKA RIVER

The Matanuska River watershed supports both anadromous and resident fish populations. The 11 species of fish that inhabit the waters within the Matanuska Valley Moose Range are chinook, coho, and chum salmon, Dolly Varden char, rainbow trout, arctic grayling, round whitefish, burbot, three-spine stickleback, nine-spine stickleback, and the longnose sucker (ADNR & ADFG, 1986). Several species of salmon spawn in Moose Creek, Eska Creek, Granite Creek, Kings River, and the Chickaloon River (Table 1). Chum salmon spawn in the mainstem Matanuska River (ADFG, 1984).

Moose Creek has populations of chinook and coho salmon, Dolly Varden char, and rainbow trout. The waterfalls on Moose Creek at river mile 3.2 is an apparent blockage to upstream movement of spawning salmon (Table 2). However, coho salmon have been reported above the falls (Plangraphics, 1986). Fish count records show a steadily increasing number of spawning chinook salmon in Moose Creek during the 1980's (Table 3). Surveys of juvenile coho salmon revealed that one year fish were not present in Moose Creek. It is suggested that the fish are outmigrating in the autumn to more suitable overwintering habitat, such as dowstream beaver ponds and sloughs (Idemitsu Alaska, Inc., 1989). Buffalo Creek, a tributary of Moose Creek, has resident populations of Dolly Varden char and rainbow trout. Densities of salmonids in Moose and Buffalo Creeks are very low compared to other streams in Alaska (Idemitsu Alaska, Inc., 1989).

Eska Creek has populations of coho and chum salmon, and Dolly Varden char. Granite Creek has spawning populations of chinook, coho, and chum salmon. Dolly Varden char are also present.

The Kings River has populations of chinook and chum salmon, Dolly Varden char, and rainbow trout. The Chickaloon River has populations of coho and chum salmon. Chinook salmon are also documented in the Chickaloon River (ADFG, 1984).. Resident fish include Dolly Varden char, rainbow trout, and grayling. Boulder Creek, a tributary to the Chickaloon River, has populations of chum salmon, rainbow trout, and grayling.

The habitat requirements of the fish found in the Matanuska River watershed vary with the species itself, the life stage, and the season of the year. The main life stages of anadromous species are upstream migration of adults, spawning, incubation, juvenile rearing, and seaward migration of smolt. For both anadromous and resident fish, an important habitat parameter is maintenance of streamflow for spawning and incubation success.

The fishery habitat types associated with the Matanuska River include mainstem, slough, side channel, tributary mouth, and tributary. The changing morphology of side channels affects the number of salmon that spawn at the tributary mouth. The greatest numbers of salmon occur when the main channel shifts to the north, near the confluence of the above-

TABLE 1

FISH INVENTORY

Reference Source: Alaska Department of Natural Resources and Alaska Department of Fish and Game, 1986, Matanuska Valley Moose Range Management Plan, 256 p.

WATERBODY	ANADROMOUS FISH (Escapment)			RESIDENT FISH			Effort
	Chinook	Coho	Chums	Dolly Varden	Rainbow	Grayling	(Angler Days)
Wasilla Creek	200-300	500-4000	--	P	P	--	4500-6260 est.
Moose Creek	400-600	100	?	P	P	--	500-1000 est.
Eska Creek	?	P	P N/A	P	?	?	500± est.
Granite Creek	P N/A	P N/A	P N/A	P	?	?	?
Boulder Creek	?	?	P N/A	?	P	P	?
Kings River	P N/A	?	P N/A	P	P	?	500± est.
Chickaloon River	?	P N/A	P N/A	P	P	P	?
Slipper Lake	--	--	--	--	P	?	
Fish Lake	--	--	--	--	P	--	?
Wishbone Lake	--	--	--	--	P	--	?
Seventeen Mile Lake	--	--	--	--	?	P	?
Chain Lakes	--	--	--	--	P	?	?

N/A = Numbers Not Available ? = Presence Undetermined P = Present -- = Not Present

Compiled by ADF&G 12-85 through personal communications with Larry Engel, and ADF&G Regional Guides.

TABLE 2

Reference Source: Idemitsu Alaska, Inc., 1989, Wishbone Hill Coal Mine, Surface coal mining permit application. Submitted to Alaska Department of Natural Resources, Division of Mining, Anchorage, Alaska.

Counts of live and dead salmon spawners in Moose Creek during 1988

Stream Segment	Location	Survey (9/26)		Survey (10/10)	
		Live Coho	Carcass Count	Live Coho	Carcass Count
1	Above Glenn Hwy.	0	11	0	38
2		2	5	0	11
3		0	0	0	5
4		0	6	0	8
5		2	4	0	3
6		0	1	0	5
7		0	9	0	4
8		7	8	0	13
9		1	8	0	4
10		3	0	0	18
11		1	1	2	0
12		1	1	2	0
13		4	2	3	0
14		0	0	2	1
15		3	1	2	1
16		6	0	1	0
17	Above falls	0	0	0	0
18	Above falls	0	0	0	0
19	Above falls	0	0	0	0
Total		30	57	12	111

TABLE 3

Reference Source: Idemitsu Alaska, Inc., 1989, Wishbone Hill Coal Mine, Surface coal mining permit application. Submitted to Alaska Department of Natural Resources, Division of Mining, Anchorage, Alaska.

Moose Creek spawner survey records

(All data are from ADF&G except the 1988 coho survey)

Chinook		Coho		Chum	
Date	Count	Date	Count	Date	Count
07/24/70	126	10/05/78	23	10/05/78	118
07/28/71	22	10/03/83	11		
07/29/71	40	10/01/87	73		
07/28/72	15	09/26/88	30 *		
07/31/72	6	10/10/88	12 *		
08/01/73	36				
08/01/74	32				
08/01/75	55				
07/28/76	101				
07/25/77	153				
07/17/78	245				
07/23/79	253				
07/27/81	238				
07/20/82	406				
07/19/83	452				
07/30/84	541				
08/02/85	475				
07/19/86	419				
07/21/87	957				
07/27/88	1072				

* From Dames & Moore survey between Glenn Highway and bridge at Premier Creek.

red-tailed hawk, American kestrel, peregrine falcon, gyrfalcon, boreal owl, saw-whet owl, great gray owl, great horned owl, short-eared owl, snowy owl, and hawk owl. The northern goshawk was the only raptor observed in summer and winter (Idemitsu Alaska, Inc., 1989). Many of these species may use the watershed as a migration corridor to Interior Alaska in early spring.

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WILDLIFE OF THE WATERSHED

The Matanuska River watershed contains a variety of wildlife habitats that support large mammals, small furbearers, and numerous bird species. The Matanuska Moose Range was established in 1984 to maintain, improve and enhance moose populations and habitat and other wildlife resources on State land. The Range includes 132,500 acres of land within the Matanuska River watershed. The State has management authority for approximately 76% of this land. The Range includes a large portion of the drainages of Moose, Eska, Granite and Boulder Creeks and the Kings and Chickaloon River. The southern boundary is just north of the Matanuska River. There are no Range lands south of the Matanuska River.

Moose are generally distributed throughout the watershed. In 1986, the Alaska Department of Fish and Game estimated there were between 426 and 986 moose within the Range (ADNR and ADF&G, 1986). Generally, moose are found above 1500 ft until late fall. When snowfall accumulates they move to lower elevations. In February 1989 moose activity on the Matanuska River floodplain increased due to moose moving in from areas to the south of the river (Idemitsu Alaska, Inc., 1989). The general and winter distributions of moose in the Range are shown in Figure 1.

The watershed supports other large mammals such as brown bear, black bear, caribou, Dall sheep, and mountain goat (ADF&G, 1982). Black bears are found throughout the watershed. Brown bears are generally at higher elevations. Streams with salmon runs may attract bears in summer and autumn. Table 1 shows the distribution of Dall sheep and caribou within the Matanuska Valley Moose Range.

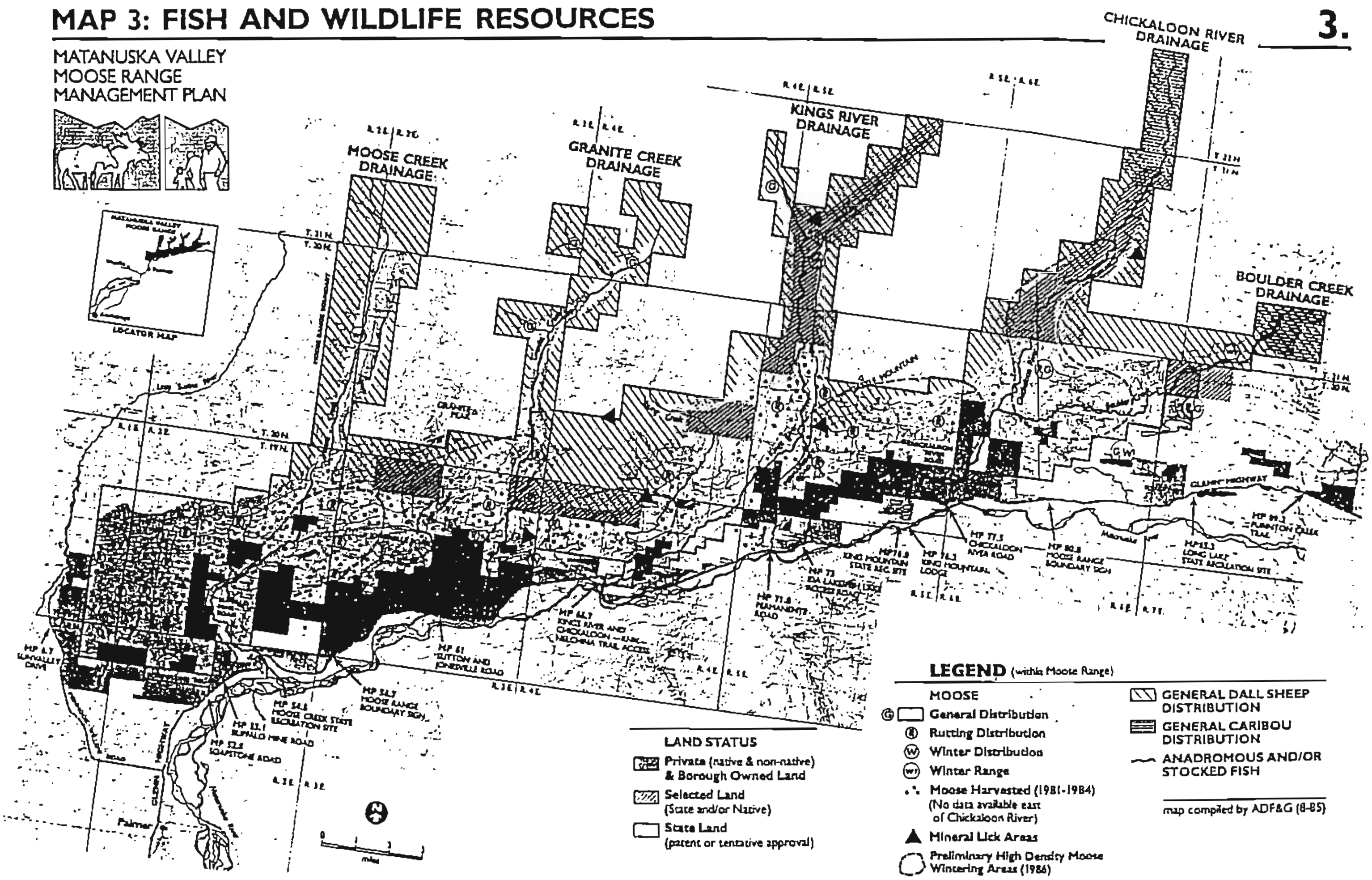
Many furbearer species inhabit the watershed (ADF&G, 1982). They include wolf, coyote, red fox, lynx, wolverine, mink, marten, weasel, red squirrel, arctic ground squirrel, snowshoe hare, hoary marmot, pica, porcupine, beaver, muskrat, land otter, vole, lemming, little brown bat, mouse, and shrew.

Approximately 134 species of birds inhabit the Matanuska Moose Range (ADNR & ADF&G, 1986). Bird surveys in the Wishbone Hill area documented 46 species of birds in 1988 and 1989 (Idemitsu Alaska, Inc., 1989). The most abundant birds were the dark-eyed junco, yellow rumped warbler, orange-crowned warbler, blackpoll warbler, Swainson's thrush and alder flycatcher. The 'open mixed forest' habitat type had the greatest species richness with a total of 24 species. Many of these species are summer residents only. Raven, black-billed magpie, northern shrikes, and ptarmigan were the only species found in late winter. Waterfowl and shorebirds are present in the watershed. Barrow's goldeneye, common goldeneye, green-winged teal, mallard, and common merganser were observed on Wishbone Lake.

Raptors likely to occur in the watershed include bald eagle, golden eagle, northern harrier, sharp-shinned hawk, northern goshawk, merlin, rough-legged hawk, Swainson's hawk,

FIGURE 1

Reference Source: Alaska Department of Natural Resources and Alaska Department of Fish and Game, Matanuska Valley Moose Range Management Plan, 256 p.



named tributaries (Plangraphics, Inc., 1983). Such a channel shift would also allow salmon to migrate into and out of tributary streams more easily.

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MATANUSKA RIVER WATERSHED

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A report for

The Matanuska Susitna Borough

by

Palmer Soil and Water Conservation District

Matanuska River Information Office

in cooperation with

Alaska Division of Mining and Water Management

William E. Long, Editor

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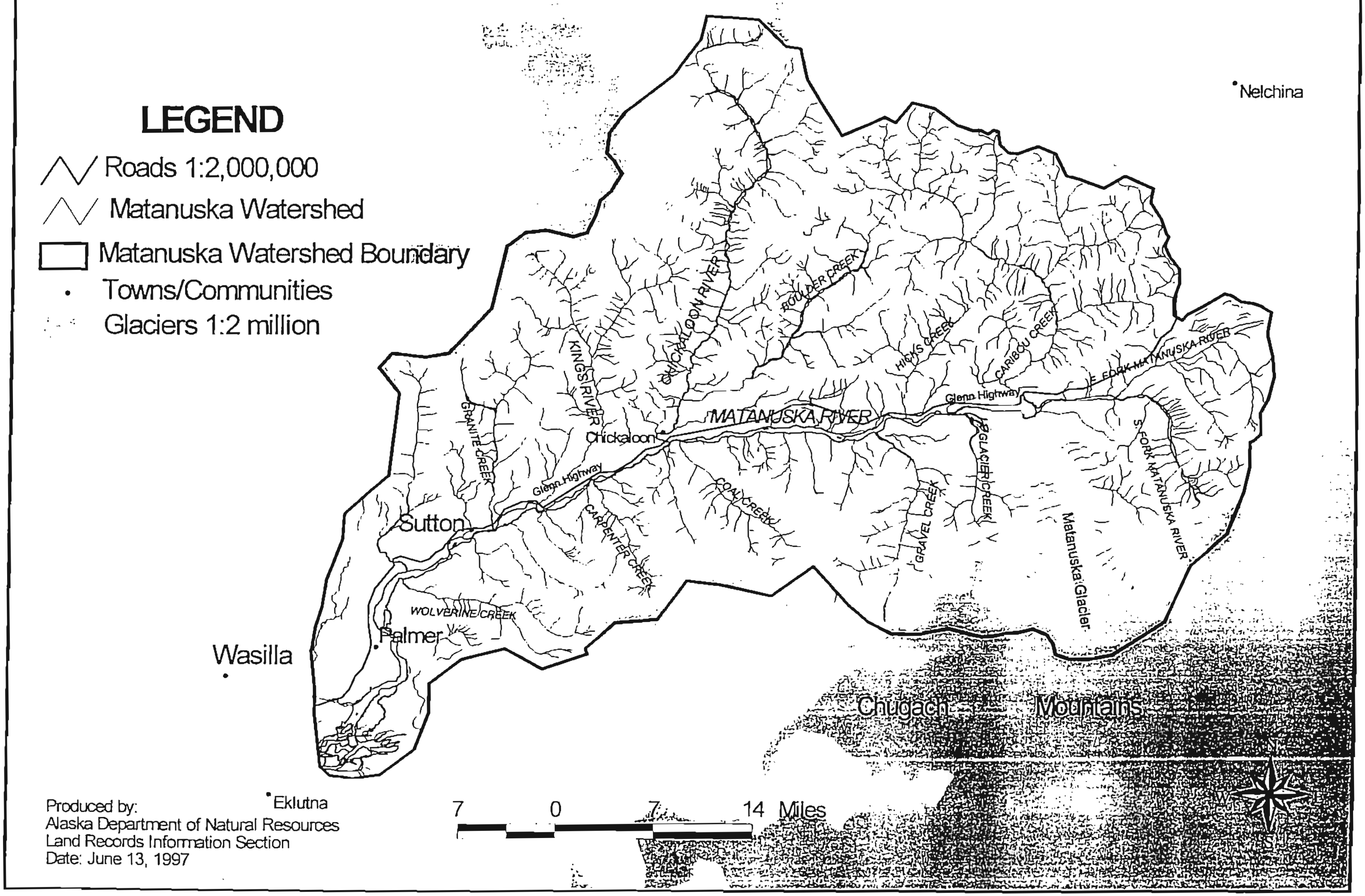

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A report for

The Matanuska Susitna Borough

by

Palmer Soil and Water Conservation District

Matanuska River Information Office

in cooperation with

Alaska Division of Mining and Water Management

William E. Long, Editor

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Note: Vita.
Note: Thesis (Ph. D.)--University of Illinois at Urbana-Champaign, 1977.
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AN: 59-31063

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Marked Record
BK: The Wishbone Hill District, Matanuska coal field, Alaska.
BA: Barnes-Farrell-Francis; Payne-Thomas-Gibson
SO: U. S. Geological Survey Bulletin. 1956.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 88. 1956.
PY: 1956
RN: B 1016
AN: 59-42317

[Hard copy of report located at Alaska Department of Natural Resources, Division of Mining and Water Management, 3601 C Street, Suite 800, Anchorage, AK 99503]

28 of 63
Marked Record
TI: Property studies of Alaskan silts in the Matanuska Valley, Big Delta, and Fairbanks areas.
AU: Stump-Richard-W; Davidson-Donald-Thomas; Handy-Richard-Lincoln; Roy-Chalmer-John
SO: The Proceedings of the Iowa Academy of Science. 63; Pages 477-513. 1956.
PB: Iowa Academy of Science. Des Moines, IA, United States. 1956.
PY: 1956
AN: 59-29926

29 of 63
Marked Record
BK: Properties and geologic occurrence of silt deposits in the Matanuska Valley, Alaska, Final Rept. 1.
BA: Stump-Richard-W; Thomas-Leo-Almor; Davidson-Donald-Thomas; Handy-Richard-Lincoln; Roy-Chalmer-John
SO: 186; 1956.
PB: Pages: 89. 1956.
PY: 1956

AN: 59-29925

30 of 63
Marked Record

BK: Properties of silt deposits in Matanuska Valley, Alaska.
BA: Stump-Richard-Webster
PY: 1956
AN: 88-77653

31 of 63
Marked Record

TI: Geology and ground-water resources of the Matanuska Valley agricultural area, Alaska.
AU: Trainer-Frank-Wilson
SO: Science. 119; 3089, Pages 356. 1954.
PB: American Association for the Advancement of Science. Washington, DC, United States. 1954.
PY: 1954
AN: 59-31062

32 of 63
Marked Record

BK: Preliminary report on the geology and ground-water resources of the Matanuska Valley agricultural area, Alaska.
BA: Trainer-Frank-Wilson
SO: U. S. Geological Survey Circular. 1953.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 43. 1953.
PY: 1953
RN: C 0268
AN: 59-31061

33 of 63
Marked Record

BK: Geology and ground-water resources of the Matanuska Valley agricultural area, Alaska.
BA: Trainer-Frank-Wilson
PY: 1953
AN: 91-72301

34 of 63
Marked Record

BK: Coal prospects and coal exploration and development in the Lower Matanuska Valley, Alaska, in 1950.
BA: Barnes-Farrell-Francis; Ford-Donald-Merle
SO: U. S. Geological Survey Circular. 1952.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 5. 1952.
PY: 1952
RN: C 0154
AN: 59-42316

35 of 63
Marked Record

BK: Bituminous-coal deposits in the vicinity of Eska, Matanuska Valley coal field, Alaska.
BA: Jolley-Theodore-Roosevelt; Toenges-Albert-Louis; Turnbull-Louis-Allan
SO: Bureau of Mines Report of Investigations. 1952.
PB: U. S. Bureau of Mines. Washington, DC, United States. Pages: 82. 1952.
PY: 1952
AN: 59-16053

36 of 63
Marked Record
TI: Exploration and evaluation of petroleum possibilities in southwestern Alaska.
AU: Kellum-Lewis-Burnett
SO: Oil and Gas Journal. 45; 47, Pages 116. 1947.
PB: PennWell. Tulsa, OK, United States. 1947.
PY: 1947
AN: 49-08989

37 of 63
Marked Record
BK: Molybdenite investigations in southeastern Alaska.
BA: Twenhofel-William-Stephens; Robinson-Gershon-Duvall; Gault-Hugh-Richard
SO: U. S. Geological Survey Bulletin. Pages 7-38. 1946.
PB: U. S. Geological Survey. Reston, VA, United States. 1946.
PY: 1946
RN: B 0947-B
AN: 49-17132

38 of 63
Marked Record
BK: Geologic and topographic map of the eastern part of the lower Matanuska Valley coal field, Alaska.
BA: Tuck-Ralph; Barnes-Farrell-Francis; Byers-Frank-Milton Jr.; Scott-T-N
SO: Miscellaneous Map. 1945.
PB: U.S. Geol. Surv.. Reston, VA, United States. 1945.
PY: 1945
AN: 49-17047

39 of 63
Marked Record
TI: Stratigraphic and structural features, lower Matanuska Valley coal field, Alaska.
AU: Payne-Thomas-Gibson
SO: Economic Geology. 40; 1, Pages 93. 1945.
PB: Economic Geology Publishing Company. Lancaster, PA, United States. 1945.
PY: 1945
AN: 49-13001

40 of 63
Marked Record
BK: Geology and coal resources of the western part of the lower Matanuska Valley coal field, Alaska.
BA: Payne-Thomas-Gibson; Hopkins-David-Moody
SO: Other Special Book. 1945.
PB: U.S. Geol. Surv.. Reston, VA, United States. Pages: 22. 1945.
PY: 1945
AN: 49-12999

41 of 63
Marked Record
BK: Geology and coal resources of the eastern part of the lower Matanuska Valley coal field, Alaska.
BA: Barnes-Farrell-Francis; Byers-Frank-Milton Jr.
SO: Other Special Book. 1944.
PB: U.S. Geol. Surv.. Reston, VA, United States. Pages: 21. 1944.
PY: 1944

AN: 49-20093

42 of 63
Marked Record

BK: Moose Creek District of Matanuska coal fields, Alaska.
BA: Apell-Gideon-Asof
SO: Bureau of Mines Report of Investigations. 1944.
PB: U. S. Bureau of Mines. Washington, DC, United States. Pages: 36. 1944.
PY: 1944
AN: 49-19637

43 of 63
Marked Record

TI: Surface features of the Matanuska Valley, Alaska.
AU: Martin-Paul-F
SO: Annals of the Association of American Geographers. 32; 1, Pages 127-128. 1942.
PB: Association of American Geographers. Washington, DC, United States. 1942.
PY: 1942
AN: 49-11264

44 of 63
Marked Record

TI: The loess of the Matanuska Valley, Alaska.
AU: Tuck-Ralph
SO: Journal of Geology. 46; 4, Pages 647-653. 1938.
PB: University of Chicago Press. Chicago, IL, United States. 1938.
PY: 1938
AN: 39-19504

45 of 63
Marked Record

TI: The Matanuska coal field, Alaska.
AU: Tuck-Ralph
SO: Journal of the Washington Academy of Sciences. 27; 8, Pages 359-360. 1937.
PB: Washington Academy of Sciences. Washington, DC, United States. 1937.
PY: 1937
AN: 39-19502

46 of 63
Marked Record

TI: The Eska Creek coal deposits, Matanuska Valley, Alaska.
AU: Tuck-Ralph
SO: U. S. Geological Survey Bulletin. Pages 185-214. 1937.
PB: U. S. Geological Survey. Reston, VA, United States. 1937.
PY: 1937
RN: B 0880-D
AN: 39-19501

[Hard copy of report located at Alaska Department of Natural Resources, Division of Mining and Water Management, 3601 C Street, Suite 800, Anchorage, AK 99503]

47 of 63
Marked Record

TI: The Matanuska Valley of southern Alaska.
AU: Shearer-M-H
SO: Journal of Geography. 35; 5, Pages 186-193. 1936.
PB: National Council for Geographic Education, Western Illinois University. Macomb, IL, United States. 1936.
PY: 1936
AN: 39-17257

48 of 63
Marked Record

TI: Igneous rocks of the upper Matanuska Valley.
AU: Mertie-John-Beaver Jr.
SO: U. S. Geological Survey Bulletin. Pages 55-72. 1927.
PB: U. S. Geological Survey. Reston, VA, United States. 1927.
PY: 1927
RN: B 0791
AN: 28-07532

49 of 63
Marked Record

BK: Geology of the Knik-Matanuska District, Alaska.
BA: Landes-Kenneth-K
SO: U. S. Geological Survey Bulletin. Pages 51-72. 1927.
PB: U. S. Geological Survey. Reston, VA, United States. 1927.
PY: 1927
RN: B 0792-B
AN: 28-06341

50 of 63
Marked Record

BK: Geology of the upper Matanuska Valley, Alaska.
BA: Capps-Stephen-Reid; Mertie-J-B Jr.
SO: U. S. Geological Survey Bulletin. 1927.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 92. 1927.
PY: 1927
RN: B 0791
AN: 28-01704

51 of 63
Marked Record

TI: Mining developments in the Matanuska coal fields [Alaska].
AU: Chapin-Theodore
SO: U. S. Geological Survey Bulletin. Pages 197-199. 1921.
PB: U. S. Geological Survey. Reston, VA, United States. 1921.
PY: 1921
RN: B 0714-D
AN: 28-01901

52 of 63
Marked Record

TI: Mining developments in the Matanuska coal fields [Alaska].
AU: Chapin-Theodore
SO: U. S. Geological Survey Bulletin. Pages 131-167. 1920.
PB: U. S. Geological Survey. Reston, VA, United States. 1920.
PY: 1920
RN: B 0712-E
AN: 28-01898

53 of 63
Marked Record

TI: Geologic problems at the Matanuska coal mines [Alaska].
AU: Martin-George-Curtis
SO: U. S. Geological Survey Bulletin. Pages 269-282. 1919.
PB: U. S. Geological Survey. Reston, VA, United States. 1919.
PY: 1919
RN: B 0692-D
AN: 28-07203

[Hard copy of report located at Alaska Department of Natural Resources, Division of Mining and Water Management, 3601 C Street, Suite 800, Anchorage, AK 99503]

Marked Record
TI: Mineral resources of the upper Matanuska and Nelchina valleys [Alaska].
AU: Martin-George-Curtis; Mertie-J-B Jr.
SO: U. S. Geological Survey Bulletin. Pages 273-299. 1914.
PB: U. S. Geological Survey. Reston, VA, United States. 1914.
PY: 1914
RN: B 0592-H
AN: 18-25496

55 of 63
Marked Record
TI: The Matanuska River coal field by districts [Alaska].
AU: Crane-Walter-Richard
SO: Coal Age. Pages 148-152. 1913.
PB: McGraw Hill. New York, NY, United States. 1913.
PY: 1913
AN: 18-08308

56 of 63
Marked Record
TI: A brief account of the Matanuska [coal] field [Alaska].
AU: Crane-Walter-Richard
SO: Coal Age. Pages 630-632. 1913.
PB: McGraw Hill. New York, NY, United States. 1913.
PY: 1913
AN: 18-08307

57 of 63
Marked Record
BK: Geology and coal fields of the lower Matanuska Valley, Alaska.
BA: Martin-George-Curtis; Katz-F-J
SO: U. S. Geological Survey Bulletin. 1912.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 98. 1912.
PY: 1912
RN: B 0500
AN: 18-25493

58 of 63
Marked Record
TI: Preliminary report on a detailed survey of part of the Matanuska coal fields.
AU: Martin-George-Curtis
SO: U. S. Geological Survey Bulletin. Pages 128-138. 1911.
PB: U. S. Geological Survey. Reston, VA, United States. 1911.
PY: 1911
RN: B 0480-F
AN: 18-25490

59 of 63
Marked Record
BK: Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska.
BA: Paige-Sidney; Knopf-Adolph
SO: U. S. Geological Survey Bulletin. 1907.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 71. 1907.
PY: 1907
RN: B 0327
AN: 18-28843

TI: Reconnaissance in the Matanuska and Talkeetna basins, with notes on the placers of the adjacent region.
AU: Paige-Sidney
SO: U. S. Geological Survey Bulletin. Pages 104-125. 1907.
PB: U. S. Geological Survey. Reston, VA, United States. 1907.
PY: 1907
RN: B 0314-F
AN: 18-28842

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Marked Record

BK: A reconnaissance of the Matanuska coal field, Alaska, in 1905.
BA: Martin-George-Curtis
SO: U. S. Geological Survey Bulletin. 1906.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 36. 1906.
PY: 1906
RN: B 0289
AN: 18-25482

62 of 63
Marked Record

TI: Preliminary statement of the Matanuska coal field.
AU: Martin-George-Curtis
SO: U. S. Geological Survey Bulletin. Pages 88-100. 1906.
PB: U. S. Geological Survey. Reston, VA, United States. 1906.
PY: 1906
RN: B 0284
AN: 18-25481

63 of 63
Marked Record

TI: The Matanuska coal field, Alaska.
AU: Griffith-William
SO: Mines and Minerals (Scranton). Pages 433-437. 1906.
PB: Mines and Minerals. Scranton, PA, United States. 1906.
PY: 1906
AN: 18-14903

1 of 36
Marked Record

TI: Review of coking phenomena in relation to an occurrence of prismatically fractured natural coke from the Castle Mountain Mine, Matanuska coal field, Alaska.
AU: Merritt-Roy-D
SO: International Journal of Coal Geology. 4; 4, Pages 281-298. 1985.
PB: Elsevier. Amsterdam,. International. 1985.
PY: 1985
AN: 85-65762

2 of 36
Marked Record

TI: Genesis and sedimentary sequences of hummocks, Matanuska Glacier, Alaska.
AU: Lawson-Daniel-E
BK: In: The Geological Society of America, North-Central Section, 19th annual meeting.
BA: Berg-Jonathan-H (chairperson)
SO: Abstracts with Programs - Geological Society of America. 17; 5, Pages 298. 1985.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1985.
PY: 1985
AN: 86-48184

3 of 36
Marked Record

TI: Moraine development along an oscillating, terrestrial glacier margin.
AU: Lawson-Daniel-E
BK: In: The Geological Society of America, North-Central Section, 19th annual meeting.
BA: Berg-Jonathan-H (chairperson)
SO: Abstracts with Programs - Geological Society of America. 17; 5, Pages 298. 1985.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1985.
PY: 1985
AN: 86-48183

4 of 36
Marked Record

TI: Paleogene volcanic rocks of the Matanuska Valley area and the displacement history of the Castle Mountain Fault.
AU: Silberman-Miles-L; Grantz-Arthur
BK: In: The United States Geological Survey in Alaska; accomplishments during 1981.
BA: Coonrad-Warren-L (editor); Elliott-Raymond-L (editor)
SO: U. S. Geological Survey Circular. Pages 82-86. 1984.
PB: U. S. Geological Survey. Reston, VA, United States. 1984.
PY: 1984
RN: C 0868
AN: 84-44944

5 of 36
Marked Record
BK: Coal geology and resources of the Matanuska Valley, Alaska.
BA: Merritt-R-D; Belowich-M-A
SO: Report of Investigations - Alaska, Division of Geological & Geophysical Surveys. 84-24; 1984.
PB: Alaska Division of Geological and Geophysical Surveys. College, AK, United States. Pages: 64. 1984.
PY: 1984
AN: 85-25278

6 of 36
Marked Record
BK: Guide to the Willow Creek gold mining district, with stops at the Castle Mountain Fault and the Alaska Tsunami Warning Center.
BA: Blackford-Michael; Clardy-Bruce-I; Dorff-Anthony-C; Visconty-Greg
PB: Alaska Geol. Soc.. Anchorage, AK, United States. Pages: 24. 1984.
PY: 1984
AN: 85-13426

7 of 36
Marked Record
BK: Guide to the bedrock and glacial geology of the Glen Highway, Anchorage to the Matanuska Glacier and the Matanuska coal mining district.
BA: Clardy-Bruce-I; Hanley-Peter-T; Hawley-Charles-C; LaBelle-Joseph-C
PB: Alaska Geol. Soc.. Anchorage, AK, United States. Pages: 63. 1984.
PY: 1984
AN: 85-13425

8 of 36
Marked Record
TI: Debris entrainment and the erosive capacity of ice sheets and glaciers.
AU: Gow Anthony-J; Lawson-Daniel-E
BK: In: The Geological Society of America, Northeastern Section, 19th annual meeting.
BA: Anonymous
SO: Abstracts with Programs - Geological Society of America. Pages 19. 1984.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1984.
PY: 1984
AN: 86-45816

9 of 36
Marked Record
TI: Deposition and preservation of diamictons and glacial debris in the Matanuska Glacier environment.
AU: Lawson-Daniel-E
BK: In: The Geological Society of America, Northeastern Section, 19th annual meeting.
SO: Abstracts with Programs - Geological Society of America. 16; 1, Pages 46. 1984.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1984.
PY: 1984
AN: 87-07777

10 of 36
Marked Record
BK: Geology, alteration and sulfide mineralization of Sheep Mountain in the Matanuska Valley, southcentral Alaska.
BA: McMillin-Steven

PY: 1984
AN: 91-78799

Marked Record
TI: Upper Cook Inlet region and the Matanuska Valley.
AU: Reger-Richard-D; Updike-Randall-G
BK: In: Guidebook to permafrost and Quaternary geology along the Richardson and Glenn highways between Fairbanks and Anchorage, Alaska.
BA: Pewe-Troy-L (editor); Reger-R-D (editor)
SO: Pages 185-263. 1983.
PB: Alaska, Dep. Nat. Resour., Div. Geol. & Geophys. Surv.. Fairbanks, AK, United States. 1983.
PY: 1983
AN: 83-51619

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Marked Record
TI: Overview of the Matanuska Glacier.
AU: Lawson-Daniel-E
BK: In: Guidebook to permafrost and Quaternary geology along the Richardson and Glenn highways between Fairbanks and Anchorage, Alaska.
BA: Pewe-Troy-L (editor); Reger-R-D (editor)
SO: Pages 177-183. 1983.
PB: Alaska, Dep. Nat. Resour., Div. Geol. & Geophys. Surv.. Fairbanks, AK, United States. 1983.
PY: 1983
AN: 83-51618

13 of 36
Marked Record
TI: Characteristics of subaerial sediment flow deposits, Matanuska Glacier, Alaska.
AU: Lawson-Daniel-E
BK: In: American Geophysical Union 29th Pacific Northwest regional meeting and Alaska Science Conference (AAAS) 33rd meeting.
BA: Anonymous
SO: Eos, Transactions, American Geophysical Union. 64; 9, Pages 88. 1983.
PB: American Geophysical Union. Washington, DC, United States. 1983.
PY: 1983
AN: 83-43105

14 of 36
Marked Record
TI: Stratigraphy, depositional history, and reservoir potential of Cretaceous and early Tertiary rocks of lower Cook Inlet, Alaska.
AU: Hastings-D-S; Robinson-Andrew-G; Robinson-N-M Jr.
BK: In: AAPG annual convention with divisions SEPM/ EMD/ DPA.
SO: AAPG Bulletin. 67; 3, Pages 480. 1983.
PB: American Association of Petroleum Geologists. Tulsa, OK, United States. 1983.
PY: 1983
AN: 84-28192

15 of 36
Marked Record
TI: Paleocene ash parting within the Chickaloon Formation in the Matanuska Valley, Alaska.
AU: Collett-T-S; Triplehorn-D-M

BK: In: Alaska/ Canada north; neighbours in sciences.
BA: Anonymous
SO: Proceedings - Alaska Science Conference. 34; Pages 63. 1983.
PB: American Association for the Advancement of Science, Alaska Division. College, AK, United States. 1983.
PY: 1983
AN: 85-01836

16 of 36
Marked Record

TI: Penecontemporaneous partial disaggregation and/ or resedimentation during the formation and deposition of subglacial till.
AU: Dreimanis-A
BK: In: INQUA Commission on Genesis and lithology of Quaternary deposits.
BA: Serrat-David
SO: Acta Geologica Hispanica. 18; 3-4, Pages 153-160. 1983.
PB: Instituto Nacional de Geologia. Barcelona, Spain. 1983.
PY: 1983
AN: 87-36457

17 of 36
Marked Record

TI: Mobilization, movement and deposition of active subaerial sediment flows, <u>Matanuska</u> Glacier, Alaska.
AU: Lawson-Daniel-E
SO: Journal of Geology. 90; 3, Pages 279-300. 1982.
PB: University of Chicago Press. Chicago, IL, United States. 1982.
PY: 1982
AN: 82-53088

18 of 36
Marked Record

TI: A rockhound's trip to Alaska's <u>Matanuska</u> Valley.
AU: Mitchell-James-R
SO: Lapidary Journal. 36; 1, Pages 14, 16, 18-19. 1982.
PB: Lapidary Journal, Inc.. San Diego, CA, United States. 1982.
PY: 1982
AN: 82-36605

19 of 36
Marked Record

TI: Late Cenozoic deformation in the <u>Matanuska</u> Valley, Alaska; three-dimensional strain in a forearc region.
AU: Bruhn-Ronald-L; Pavlis-Terry-L
SO: Geological Society of America Bulletin. 92; 5, Pages I 282-I 293. 1981.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1981.
PY: 1981
AN: 81-52852

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Marked Record

TI: Distinguishing characteristics of diamictons at the margin of the <u>Matanuska</u> Glacier, Alaska.
AU: Lawson-Daniel-E
BK: In: Proceedings of the symposium on processes of glacier erosion and sedimentation.
BA: Gold-L-W (editor); Clarke-G-K-C (editor); Macqueen-A-D (editor)
SO: Annals of Glaciology. 2; Pages 78-84. 1981.
PB: International Glaciological Society. Cambridge, International. 1981.

PY: 1981
AN: 84-11940

21 of 36
Marked Record

TI: Petrographic, mineralogical and chemical characterization of certain Alaskan coals and washability products.
AU: Rao-P-Dharma; Wolff-Ernest-N
BK: In: Focus on Alaska's coal '80.
BA: Rao P -harma (editor); Wolff-Ernest-N (editor)
SO: MIRL Report. 50; Pages 194-235. 1981.
PB: University of Alaska, Mineral Industry Research Laboratory.. Fairbanks, AK, United States. 1981.
PY: 1981
AN: 86-56124

22 of 36
Marked Record

TI: Remaining coal resources of the Matanuska Field.
AU: Patsch-Benno-J-G
BK: In: Focus on Alaska's coal '80.
BA: Rao P -harma (editor); Wolff-Ernest-N (editor)
SO: MIRL Report. 50; Pages 144-151. 1981.
PB: University of Alaska, Mineral Industry Research Laboratory.. Fairbanks, AK, United States. 1981.
PY: 1981
AN: 86-56120

23 of 36
Marked Record

TI: Coal resources of Alaska.
AU: Sanders-Robert-B
BK: In: Focus on Alaska's coal '80.
BA: Rao P -harma (editor); Wolff-Ernest-N (editor)
SO: MIRL Report. 50; Pages 11-31. 1981.
PB: University of Alaska, Mineral Industry Research Laboratory.. Fairbanks, AK, United States. 1981.
PY: 1981
AN: 86-56110

24 of 36
Marked Record

TI: Extensional volcanism in the Matanuska Valley region.
AU: Silberman-M-L-(investigator); Grantz-Arthur-(investigator)
SO: U. S. Geological Survey Professional Paper. Pages 111. 1980.
PB: U. S. Geological Survey. Reston, VA, United States. 1980.
PY: 1980
RN: P 1175
AN: 81-30930

25 of 36
Marked Record

TI: Trace-fossil evidence for deep-water sedimentation in Cretaceous arc-trench gap, South-central Alaska.
AU: Ekdale-A-A
SO: AAPG Bulletin. 63; 3, Pages 443. 1979.
PB: American Association of Petroleum Geologists. Tulsa, OK, United States. 1979.
PY: 1979

AN: 79-25858

26 of 36
Marked Record

TI: Characteristics and origins of the debris and ice, Matanuska Glacier, Alaska.
AU: Lawson-D-E
BK: In: Symposium on glacier beds; the ice-rock interface.
BA: Glen-J-W (editor); Adie-R-J (editor); Johnson-D-M (editor); Homer-D-R (editor); Macqueen-A-D (editor)
SO: Journal of Glaciology. 23; 89, Pages 437-438. 1979.
PB: International Glaciological Society. Cambridge, United Kingdom. 1979.
PY: 1979
AN: 80-34296

27 of 36
Marked Record

TI: A comparison of the pebble orientations in ice and deposits of the Matanuska Glacier, Alaska.
AU: Lawson-D-E
SO: Journal of Geology. 87; 6, Pages 629-645. 1979.
PB: University of Chicago Press. Chicago, IL, United States. 1979.
PY: 1979
AN: 80-25861

28 of 36
Marked Record

BK: Sedimentological analysis of the western terminus region of the Matanuska Glacier, Alaska.
BA: Lawson-D-E
SO: CRREL Report. 79-9, 1979.
PB: U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory. Hanover, NH, United States. Pages: 122. 1979.
PY: 1979
AN: 80-03692

29 of 36
Marked Record

TI: An oxygen isotope investigation of the origin of the basal zone of the Matanuska Glacier, Alaska.
AU: Lawson-D-E; Kulla-J-B
SO: Journal of Geology. 86; 6, Pages 673-685. 1978.
PB: University of Chicago Press. Chicago, IL, United States. 1978.
PY: 1978
AN: 79-08405

30 of 36
Marked Record

TI: Framework grain mineralogy and provenance of sandstones from the Arkose Ridge and Chickaloon formations, Matanuska Valley.
AU: Winkler-Gary-R
SO: U. S. Geological Survey Circular. Pages B70-B73. 1978.
PB: U. S. Geological Survey. Reston, VA, United States. 1978.
PY: 1978
RN: C 0772-B
AN: 87-08297

31 of 36
Marked Record

BK: Sedimentation in the terminus region of the Matanuska Glacier, Alaska.
BA: Lawson-D-E
PY: 1977
AN: 78-29740

Marked Record
TI: An oxygen isotope investigation of the origin of the basal ice of the Matanuska Glacier, Alaska.
AU: Lawson-D-E; Kulla-J-B
SO: Eos, Transactions, American Geophysical Union. 58; 6, Pages 385. 1977.
PB: American Geophysical Union. Washington, DC, United States. 1977.
PY: 1977
AN: 78-19823

Marked Record
BK: Mordenite deposits and zeolite zonation in the Horn Mountains area, South-central Alaska.
BA: Hawkins-D-B
SO: Special Report - Division of Geological & Geophysical Surveys. 9, 1976.
PB: Alaska Division of Geological and Geophysical Surveys. College, AK, United States. Pages: 9. 1976.
PY: 1976
AN: 78-22970

Marked Record
TI: Mordenite deposits and zeolite zonation in the Horn Mountains area, south-central Alaska.
AU: Hawkins-D-B
SO: Special Report - Division of Geological & Geophysical Surveys. 9; Pages 1-9. 1976.
PB: Alaska Division of Geological and Geophysical Surveys. College, AK, United States. 1976.
PY: 1976
AN: 84-31870

Marked Record
TI: Depositional processes in the terminus of the Matanuska Glacier, Alaska.
AU: Lawson-D-E
SO: Abstracts with Programs - Geological Society of America. 7; 7, Pages 1163-1164. 1975.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1975.
PY: 1975
AN: 77-02980

Marked Record
TI: Earthquake hazards investigated along Castle Mountain Fault in Matanuska Valley.
AU: Detterman-R-L; Plafker-George; Hudson-Travis; Tysdal-Russell-G
BK: In: United States Geological Survey Alaska Program, 1975.
BA: Yount-M-E (editor)
SO: U. S. Geological Survey Circular. Pages 48. 1975.
PB: U. S. Geological Survey. Reston, VA, United States. 1975.
PY: 1975
RN: C 0722
AN: 82-11126

1 of 32
Marked Record

TI: Recent net freeze-on to the base of the Matanuska Glacier, Alaska, as indicated by (super 3) H, delta (super 18) O and delta D.
AU: Larson-Grahame-J; Strasser-J-C; Evenson-E-B; Lawson-D-E
BK: In: Geological Association of Canada; Mineralogical Association of Canada; annual meeting; program with abstracts--Association Geologique du Canada; Association Mineralogique du Canada; reunion annuelle; programme et resumes.
BA: Anonymous
SO: Program with Abstracts - Geological Association of Canada; Mineralogical Association of Canada; Canadian Geophysical Union, Joint Annual Meeting. 19; Pages 61. 1994.
PB: Geological Association of Canada. Waterloo, ON, Canada. 1994.
PY: 1994
AN: 94-51826

2 of 32
Marked Record

TI: Sediment entrainment and net freeze-on to the base of the Matanuska Glacier, Alaska, as indicated by bomb-produced tritium.
AU: Strasser-J-C; Evenson-E-B; Larson-G-J; Lawson-D-E
BK: In: Geological Society of America, Northeastern Section, 29th annual meeting.
BA: Anonymous
SO: Abstracts with Programs - Geological Society of America. 26; 3, Pages 75. 1994.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1994.
PY: 1994
AN: 94-30174

3 of 32
Marked Record

TI: Liquefaction features of the 1964 great Alaska earthquake at Portage and Knik/ Matanuska rivers.
AU: Walsh-T-J; Combellick-R-A; Black-G-L
BK: In: AGU 1994 fall meeting.
BA: Anonymous
SO: Eos, Transactions, American Geophysical Union. 75; 44, Suppl., Pages 452. 1994.
PB: American Geophysical Union. Washington, DC, United States. 1994.
PY: 1994
AN: 95-43047

4 of 32
Marked Record

TI: Crystallographic and mesoscale analyses of basal zone ice from the terminus of the Matanuska Glacier, Alaska; evidence for basal freeze-on in an open hydrologic system.
AU: Strasser-J-C; Lawson-D-E; Evenson-E-B; Larson-G-J
BK: In: Geological Society of America, 1994 annual meeting.
BA: Anonymous

SO: Abstracts with Programs - Geological Society of America. 26; 7, Pages 177. 1994.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1994.
PY: 1994
AN: 95-27852

5 of 32
Marked Record

TI: Coalbed methane potential for Alaska.
AU: Smith-Thomas-N; Clough-James-G
BK: In: American Association of Petroleum Geologists 1993 annual convention.
BA: Anonymous
SO: Annual Meeting Abstracts - American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists. 1993; Pages 184. 1993.
PB: American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists. Tulsa, OK, United States. 1993.
PY: 1993
AN: 93-37178

6 of 32
Marked Record

BK: The Alaska Mineral Resource Assessment Program; background information to accompany mineral-resource and geologic maps of the Anchorage Quadrangle, south-central Alaska.
BA: Madden-McGuire-D-J; Winkler-G-R
SO: U. S. Geological Survey Circular. 1993.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 23. 1993.
PY: 1993
RN: C 1094
AN: 93-17166

7 of 32
Marked Record

TI: Early Cenozoic depositional systems, Wishbone Hill District, Matanuska coal field, Alaska.
AU: Flores-Romeo-M; Stricker-Gary-D
BK: In: Geologic studies in Alaska by the U.S. Geological Survey, 1992.
BA: Dusel-Bacon-Cynthia (editor); Till-Alison-B (editor)
SO: U. S. Geological Survey Bulletin. Pages 101-117. 1993.
PB: U. S. Geological Survey. Reston, VA, United States. 1993.
PY: 1993
RN: B 2068
AN: 94-23083

8 of 32
Marked Record

TI: Frazil ice growth at the terminus of the Matanuska Glacier, Alaska, and its implications for sediment entrainment in glaciers and ice sheets.
AU: Strasser-J-C; Lawson-D-E; Evenson-E-B; Gosse-J-C; Alley-R-B
BK: In: Geological Society of America, Northeastern Section; 27th annual meeting.
BA: Ashley-Gail-M (chairperson)
SO: Abstracts with Programs - Geological Society of America. 24; 3, Pages 78. 1992.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1992.
PY: 1992
AN: 93-47852

9 of 32

Marked Record
TI: Case histories of lateral spreads caused by the 1964 Alaska earthquake.
AU: Bartlett-Steven-F; Youd-T-Leslie
BK: In: Case studies of liquefaction and lifeline performance during past earthquakes; Volume 2, United States case studies.
BA: O-Rourke-T (editor); Hamada-M (editor)
SO: Pages 2:1-127. 1992.
PY: 1992
RN: NCEER-92-0002
AN: 93-45002

Marked Record
TI: Soil transfer for reforestation of mined lands.
AU: Helm-D-J; Carling-D-E
BK: In: Proceedings of the 2nd international symposium on Mining in the Arctic.
BA: Bandopadhyay-Sukumar (editor); Nelson-Michael-G (editor)
SO: Proceedings of the International Symposium on Mining in the Arctic. 2; Pages 253-263. 1992.
PB: A.A. Balkema. Rotterdam, Netherlands. 1992.
PY: 1992
AN: 93-26431

Marked Record
TI: Economic Alaskan coal deposits.
AU: Stricker-Gary-D
BK: In: Economic geology, U.S.
BA: Gluskoter-H-J (editor); Rice-D-D (editor); Taylor-R-B (editor)
CT: In the collection: The geology of North America. 1991.
SO: Pages 591-602. 1991.
PB: Geol. Soc. Am.. Boulder, CO, United States. 1991.
PY: 1991
AN: 92-01006

Marked Record
TI: Thermal alteration and rank variation of coals in the Matanuska Field, south-central Alaska.
AU: Merritt-Roy-D
SO: International Journal of Coal Geology. 14; 4, Pages 255-276. 1990.
PB: Elsevier. Amsterdam, International. 1990.
PY: 1990
AN: 90-48805

Marked Record
TI: Alaska has 4.0 trillion tons of low-sulfur coal; is there a future for this resource?.
AU: Stricker-G-D
BK: In: AAPG annual convention with DPA/ EMD divisions and SEPM, an associated society; technical program with abstracts.
BA: Anonymous
SO: AAPG Bulletin. 74; 5, Pages 772. 1990.
PB: American Association of Petroleum Geologists. Tulsa, OK, United States. 1990.
PY: 1990
AN: 91-43582

Marked Record
TI: Upper Cook Inlet region and Matanuska Valley.
AU: Reger-Richard-D; Updike-Randall-G
BK: In: Glacial geology and geomorphology of North America; Volume 1, Quaternary geology and permafrost along the Richardson and Glenn highways between Fairbanks and Anchorage, Alaska.
BA: Pewe-Troy-L (leader); Reger-Richard-D (leader); Westgate-John-A (leader); Ferrians-Oscar-J Jr.(leader)
CT: In the collection: Field trips for the 28th international geological congress. 1989.
CL: Hanshaw-Penelope-M (editor)
SO: Pages 45-54. 1989.
PB: Am. Geophys. Union. Washington, DC, United States. 1989.
PY: 1989
AN: 90-35047

15 of 32
Marked Record
TI: A lacustrine record of late Holocene climate change from south-central Alaska.
AU: Forester-Richard-M; Delorme-L-Denis; Ager-Thomas-A
BK: In: Aspects of climate variability in the Pacific and the western Americas.
BA: Peterson-David-H (editor)
SO: Geophysical Monograph. 55; Pages 33-40. 1989.
PB: American Geophysical Union. Washington, DC, United States. 1989.
PY: 1989
AN: 90-27824

16 of 32
Marked Record
TI: Paleomagnetism of Cretaceous and Paleocene sedimentary rocks across the Castle Mountain Fault, South Central Alaska.
AU: Stamatakos-J-A; Kodama-K-P; Vittorio-Louis-F; Pavlis-Terry-L
BK: In: Deep structure and past kinematics of accreted terranes.
BA: Hillhouse-John-W (editor)
SO: Geophysical Monograph. 50; Pages 151-177. 1989.
PB: American Geophysical Union. Washington, DC, United States. 1989.
PY: 1989
AN: 90-19108

17 of 32
Marked Record
TI: BRANCH flow model of the Knik and Matanuska rivers, Alaska.
AU: Lipscomb-Stephen-W
BK: In: Proceedings of the advanced seminar on one-dimensional, open-channel flow and transport modeling.
BA: Schaffranek-Raymond-W (compiler)
SO: Water-Resources Investigations - U. S. Geological Survey. Pages 62-64. 1989.
PB: U. S. Geological Survey. [Reston, VA], United States. 1989.
PY: 1989
RN: WRI 89-4061
AN: 90-12225

18 of 32
Marked Record
TI: Basal ice formation and deformation; a review.
AU: Hubbard-Bryn; Sharp-Martin

SO: Progress in Physical Geography. 13; 4, Pages 529-558. 1989.
PB: Edward Arnold Publishers. London, United Kingdom. 1989.
PY: 1989
AN: 90-09488

19 of 32
Marked Record
TI: Paleomagnetism of Eocene plutonic rocks, Matanuska Valley, Alaska.
AU: Stamatakos-John-A; Kodama-K-P; Pavlis-Terry-L
SO: Geology (Boulder). 16; 7, Pages 618-622. 1988.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1988.
PY: 1988
AN: 88-48327

20 of 32
Marked Record
BK: Paleomagnetism of Late Cretaceous sedimentary rocks, Matanuska and Boulder Creek valleys, south central Alaska.
BA: Vittorio-Louis-F
PB: 36. 1988.
PY: 1988
AN: 90-53290

21 of 32
Marked Record
BK: Paleomagnetism of Eocene plutonic rocks, Matanuska Valley, Alaska.
BA: Stamatakos-John-A
PB: 70. 1988.
PY: 1988
AN: 90-53289

22 of 32
Marked Record
TI: Proxy data on subglacial conditions and processes.
AU: Lawson-D-E
BK: In: AGU 1988 fall meeting.
BA: Anonymous
SO: Eos, Transactions, American Geophysical Union. 69; 44, Pages 1210. 1988.
PB: American Geophysical Union. Washington, DC, United States. 1988.
PY: 1988
AN: 90-19643

23 of 32
Marked Record
BK: Holocene tephrochronology of the Matanuska Valley, Alaska.
BA: Fontana-Michael-R
PB: 99. 1988.
PY: 1988
AN: 91-78630

24 of 32
Marked Record
TI: Multiple Holocene tephra layers in southcentral Alaska.
AU: Fontana-Michael-R; Beget-J-E
BK: In: Geological Society of America, Cordilleran Section, 83rd annual meeting with the Paleontological Society of America, Pacific Coast Section.
BA: Anonymous
SO: Abstracts with Programs - Geological Society of America. 19; 6, Pages 378. 1987.

PB: Geological Society of America (GSA). Boulder, CO, United States. 1987.
PY: 1987
AN: 87-80276

25 of 32
Marked Record
TI: Subglacial conditions affecting terrestrial glacier sedimentation and flow.
AU: Lawson-Daniel-K
SO: Congress of the International Union for Quaternary Research. Pages 208. 1987.
PB: [International Union for Quaternary Research], International. 1987.
PY: 1987
AN: 89-48290

26 of 32
Marked Record
TI: Implications of apatite and zircon fission track ages for the thermal history of Paleogene rocks along the Border Ranges fault system, southern Alaska.
AU: Little-T-A; Naeser-C-W
BK: In: Geological Society of America, 1987 annual meeting and exposition.
BA: Dickinson-William-R (chairperson)
SO: Abstracts with Programs - Geological Society of America. 19; 7, Pages 748. 1987.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1987.
PY: 1987
AN: 89-46865

27 of 32
Marked Record
TI: Calibration and verification of a one-dimensional flow model to the Knik and Matanuska rivers, southcentral Alaska.
AU: Lipscomb-Stephen-W
BK: In: Water quality in the great land; Alaska's challenge; proceedings.
BA: Huntsinger-Ronald-G (chairperson)
SO: Report - Institute of Water Resources, University of Alaska. 109; Pages 41-54. 1987.
PB: University of Alaska, Institute of Water Resources. Fairbanks, AK, United States. 1987.
PY: 1987
AN: 89-01252

28 of 32
Marked Record
TI: Significance of the Border Ranges fault system in the Mesozoic tectonics of the northern Cordillera.
AU: Pavlis-Terry-L
BK: In: Geological Society of America, 1987 annual meeting and exposition.
BA: Dickinson-William-R (chairperson)
SO: Abstracts with Programs - Geological Society of America. 19; 7, Pages 801. 1987.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1987.
PY: 1987
AN: 90-02049

29 of 32
Marked Record
TI: Is the Castle Mountain Fault, Matanuska Valley, Alaska, a strike-slip terrane boundary? A paleomagnetic test.

AU: Kodama-K-P; Stamatakos-J; Vittorio-L; Pavlis-T-L
BK: In: International Union of Geodesy and Geophysics (IUGG), XIX general assembly; abstracts--Union Geodesique et Geophysique Internationale (UGGI), XIX assemblee generale; resumes.
BA: Anonymous
SO: International Union of Geodesy and Geophysics, General Assembly. 19, Vol. 1; Pages 108. 1987.
PB: International Union of Geodesy and Geophysics (IUGG). Vancouver, BC, Canada. 1987.
PY: 1987
AN: 91-03636

30 of 32
Marked Record
TI: New radiocarbon dates from the Matanuska Glacier bog section.
AU: Williams-John-R
BK: In: Geologic studies in Alaska by the U.S. Geological Survey during 1985.
BA: Bartsch-Winkler-Susan (editor); Reed-Katherine-M (editor)
SO: U. S. Geological Survey Circular. Pages 85-88. 1986.
PB: U. S. Geological Survey. Reston, VA, United States. 1986.
PY: 1986
RN: C 0978
AN: 86-59784

31 of 32
Marked Record
TI: Paleoenvironmental and tectonic controls in major coal basins of Alaska.
AU: Merritt-Roy-D
BK: In: Paleoenvironmental and tectonic controls in coal-forming basins of the United States.
BA: Lyons-Paul-C (editor); Rice-Charles-L (editor)
SO: Special Paper - Geological Society of America. 210; Pages 173-200. 1986.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1986.
PY: 1986
AN: 87-32275

32 of 32
Marked Record
TI: Paleomagnetic study of early Tertiary sediments along the Castle Mountain Fault, Matanuska Valley, Alaska.
AU: Stamatakos-J; Kodama-K-P; Pavlis-T-L
BK: In: AGU 1986 fall meeting and ASLO winter meeting.
BA: Anonymous
SO: Eos, Transactions, American Geophysical Union. 67; 44, Pages 921. 1986.
PB: American Geophysical Union. Washington, DC, United States. 1986.
PY: 1986
AN: 87-24116

1 of 4
Marked Record

BK: Subglacial ice growth, basal accretion, and debris entrainment at the Matanuska Glacier, Alaska.
BA: Strasser-Jeffrey-Charles
PY: 1996
AN: 97-12191

2 of 4
Marked Record

TI: Observations and analysis of self-similar branching topology in glacier networks.
AU: Bahr-David-B; Peckham-Scott-D
SO: Journal of Geophysical Research, B, Solid Earth and Planets. 101; 11, Pages 25,511-25,521. 1996.
PB: American Geophysical Union. Washington, DC, United States. 1996.
PY: 1996
AN: 97-09046

3 of 4
Marked Record

TI: Freeze-on of tritium-enriched basal ice, Matanuska Glacier, Alaska.
AU: Strasser-J-C; Evenson-E-B; Lawson-D-E; Larson-G-J; Alley-R-B
BK: In: Geological Society of America, Northeastern Section, 31st annual meeting.
BA: Anonymous
SO: Abstracts with Programs - Geological Society of America. 28; 3, Pages 102. 1996.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1996.
PY: 1996
AN: 96-65166

4 of 4
Marked Record

TI: Subglacial supercooling, ice accretion, and sediment entrainment at the Matanuska Glacier, Alaska.
AU: Lawson-D-E; Evenson-E-B; Strasser-J-C; Alley-R-B; Larson-G-J
BK: In: Geological Society of America, Northeastern Section, 31st annual meeting.
BA: Anonymous
SO: Abstracts with Programs - Geological Society of America. 28; 3, Pages 75. 1996.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1996.
PY: 1996
AN: 96-65017

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NISC DISC REPORT

FISH & FISHERIES WORLDWIDE December 1996

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TITLE: Lake and Stream Investigations: Population Studies of Game Fish and Evaluation of Managed Lakes in the Upper Cook Inlet Drainage.
AUTHOR: Havens, A.C.
SOURCE: Alaska Department of Fish and Game; 30 pp., 1984
PROJECT No.: AK F-009-16/Job G-III-D/Study No. G-III
ABSTRACT:
Annual Performance Report for Research Project Segment. Period Covered: 1 July 1983
KEY TERMS:
*Lakes; *Trout, Rainbow; *Stickleback, Threespine; *Stocking; *Drainage; *Fish Management; *Survival; *Growth; *Length-Frequency Measurements; *Size; *Standing Crop; Sucker, Longnose; Salmon, Coho; Interspecies Relationships; Fingerlings; Fishing Pressure; Population Size; Strain; Year Class
GEO. AREA: north america; united states; alaska; southcentral region; cook inlet; matanuska-susitna valley
PUB. TYPE: Unpublished Fish Report
RECORD ID: FWRS508540119
DATABASE: FISH & WILDLIFE REFERENCE SERVICE

TITLE: Sport Fish Investigations of Alaska. Inventory and Cataloging: Inventory and Cataloging of Sport Fish and Sport Fish Waters in Cook Inlet.
AUTHOR: Bentz, R.W.
SOURCE: Alaska Dept. Fish and Game; 45 pp. Vol. 24, 1983
PROJECT No.: AK F-009-15/Job G-I-D/Study G-I
NOTES: Annual Performance Report. Research Project Segment. Period Covered: 1 July 1982
KEY TERMS:
*Salmon, Coho; *Salmon, Chinook; *Lakes; *Creel Census; *Growth; *Survival; Catch; Fisheries; Stocking; Evaluation; Fishing Pressure; Sex Ratio; Size
GEO. AREA: north america; united states; alaska; cook inlet; matanuska-susitna valley
PUB. TYPE: Unpublished Fish Report
RECORD ID: FWRS508640098
DATABASE: FISH & WILDLIFE REFERENCE SERVICE

Not in Mary's files

1 of 63
Marked Record

TI: Sediment Discharge by Two Glacial Meltwater Streams in Alaska.
AU: Everts-Craig-H
SO: Eos, Transactions, American Geophysical Union. 55; 4, Pages 253. 1974.
PB: American Geophysical Union. Washington, DC, United States. 1974.
PY: 1974
AN: 74-31657

2 of 63
Marked Record

TI: Mesozoic foraminiferal zonation, Turonian to Tithonian stages, Pacific Coast Province.
AU: Berry-K-D
BK: In: SEPM Preprints, Pacific Section Meeting.
SO: Pages 1-29. 1974.
PB: Soc. Ec. Paleontol. Mineral., San Diego, California. 1974.
PY: 1974
AN: 75-05207

3 of 63
Marked Record

BK: Origin of the lower and middle Tertiary Wishbone and Tsadaka formations, Matanuska Valley, Alaska.
BA: Clardy-Bruce
PB: 74. 1974.
PY: 1974
AN: 89-48751

4 of 63
Marked Record

TI: Knik and Matanuska rivers, Alaska: a contrast in braiding.
AU: Fahnestock-R-K; Bradley-W-C
BK: In: Fluvial Geomorphology. ✓
SO: Pages 221-250. 1973.
PB: State Univ. N.Y., Binghamton, New York. 1973.
PY: 1973
AN: 75-07670

5 of 63
Marked Record

TI: Structural elements and biostratigraphical framework of Lower Cretaceous rocks in southern Alaska.
AU: Jones-David-L
BK: In: The Boreal Lower Cretaceous.
SO: Pages 1-18. 1973.
PB: Seel House Press, Liverpool, England. 1973.
PY: 1973
AN: 75-03509

6 of 63

Marked Record

TI: Sedimentary zeolite deposits of the upper Matanuska Valley, Alaska.
AU: Hawkins-D-B
SO: Special Report - Division of Geological & Geophysical Surveys. 6; Pages 1-17. 1973.
PB: Alaska Division of Geological and Geophysical Surveys. College, AK, United States. 1973.
PY: 1973
AN: 84-32404

7 of 63
Marked Record

BK: Water-resources reconnaissance of a part of the Matanuska-Susitna Borough, Alaska.
BA: Feulner-Alvin-J
SO: Hydrologic Investigations Atlas. 1971.
PB: U. S. Geological Survey. Reston, VA, United States. 1971.
PY: 1971
RN: HA-0364
AN: 71-28640

8 of 63
Marked Record

BK: Cretaceous ammonites from the lower part of the Matanuska Formation, southern Alaska with a stratigraphic summary.
BA: Jones-David-L; Grantz-Arthur
SO: U. S. Geological Survey Professional Paper. 1967.
PB: U. S. Geological Survey. Reston, VA, United States. Pages: 49. 1967.
PY: 1967
RN: P 0547
AN: 67-16578

9 of 63
Marked Record

TI: Resume of the Quaternary geology of the Upper Cook Inlet area and Matanuska River valley.
AU: Karlstrom-Thor-N-V
BK: In: Guidebook for Field Conference F, Central and south central Alaska--Internat. Assoc. Quaternary Research, 7th Cong., U.S.A., 1965.
SO: Pages 114-141. 1965.
PY: 1965
AN: 65-20132

10 of 63
Marked Record

BK: Guidebook for Field Conference F, Central and south central Alaska; INQUA, 7th Cong., U.S.A., 1965.
PY: 1965
AN: 65-20098

11 of 63
Marked Record

TI: Stratigraphic reconnaissance of the Matanuska Formation in the Matanuska Valley, Alaska.
AU: Grantz-Arthur
SO: Pages I1-I33. 1964.
PY: 1964
AN: 64-12222

12 of 63
Marked Record
TI: Geologic road log of the Matanuska Valley, Sutton to Caribou Creek.
AU: Grantz-Arthur-W; Fay Leo-F
BK: In: Guidebook, field trip routes, Anchorage to Sutton, 1963; Sutton to Caribou Creek, 1964--Oil fields, earthquake, geology.
SO: Pages 16-22. 1964.
PY: 1964
AN: 65-18615

13 of 63
Marked Record
BK: Guidebook, field trip routes, Anchorage to Sutton, 1963; sutton to Caribou Creek, 1964; Oil fields, earthquake, geology.
PB: 36. 1964.
PY: 1964
AN: 65-18594

14 of 63
Marked Record
TI: Regional geology of the Cook Inlet area, Alaska.
AU: Ayres-Marshall-G
BK: In: Alaska Geological Society guidebook; field trip routes, Anchorage to Sutton, 1963, Sutton to Caribou Creek, 1964; oil fields, earthquake, geology.
BA: Borden-J-L (editor)
SO: Pages 28-36. 1964.
PB: Alaska Geol. Soc.. Anchorage, AK, United States. 1964.
PY: 1964
AN: 89-28954

15 of 63
Marked Record
TI: Geologic road log of the Matanuska Valley, Sutton to Caribou Creek.
AU: Grantz-Arthur-W; Fay Leo-F
BK: In: Alaska Geological Society guidebook; field trip routes, Anchorage to Sutton, 1963, Sutton to Caribou Creek, 1964; oil fields, earthquake, geology.
BA: Borden-J-L (editor)
SO: Pages 16-22. 1964.
PB: Alaska Geol. Soc.. Anchorage, AK, United States. 1964.
PY: 1964
AN: 89-28951

16 of 63
Marked Record
BK: Bituminous coal deposits of the Matanuska coalfield, Alaska; central and western parts, Wishbone [Hill] district.
BA: Warfield-Robert-S
SO: Bureau of Mines Report of Investigations. 1962.
PB: U. S. Bureau of Mines. Washington, DC, United States. Pages: 190. 1962.
PY: 1962
AN: 62-13056

17 of 63
Marked Record
BK: Topographic and geologic map of the Knob Creek area of the Wishbone Hill District, Matanuska coal field, Alaska.
BA: Barnes-Farrell-Francis
SO: Coal Investigations Map. 1962.
PB: U. S. Geological Survey. Reston, VA, United States. 1962.

PY: 1962
RN: C-0051
AN: 62-10230

18 of 63
Marked Record

BK: Geologic map of Lower Matanuska Valley, Alaska.
BA: Barnes-Farrell-Francis
SO: Miscellaneous Investigations Series - U. S. Geological Survey. 1962.
PB: U. S. Geological Survey. Reston, VA, United States. 1962.
PY: 1962
RN: I-0359
AN: 62-08730

19 of 63
Marked Record

TI: Palynological investigation of coals from the Chickaloon Formation, Alaska.
AU: Ames-H; Riegel-W
SO: Pollen et Spores. 4; 2, Pages 328. 1962.
PB: Museum National d'Histoire Naturelle. Paris, France. 1962.
PY: 1962
AN: 62-06749

20 of 63
Marked Record

TI: Late Wisconsin and recent history of the Matanuska Glacier, Alaska.
AU: Williams-John-Ropes; Ferrians-Oscar-John Jr.
SO: Arctic. 14; 2, Pages 82-90. 1961.
PB: Arctic Institute of North America. Calgary, AB, Canada. 1961.
PY: 1961
AN: 61-11767

21 of 63
Marked Record

TI: Eolian deposits of the Matanuska Valley agricultural area, Alaska.
AU: Trainer-Frank-W
SO: Pages C1-C35. 1961.
PY: 1961
AN: 61-07374

22 of 63
Marked Record

TI: Stratigraphy and age of the Matanuska Formation, south-central Alaska.
AU: Grantz-Arthur; Jones-David-Lawrence
SO: U. S. Geological Survey Professional Paper. Pages B347-B350. 1960.
PB: U. S. Geological Survey. Reston, VA, United States. 1960.
PY: 1960
RN: P 0400-B
AN: 60-08668

23 of 63
Marked Record

TI: Coal-bearing strata of the Matanuska coal field, Alaska.
AU: Barnes-Farrell-Francis
SO: Geological Society of America Bulletin. 71; 12, Part 2, Pages 1820-1821. 1960.
PB: Geological Society of America (GSA). Boulder, CO, United States. 1960.
PY: 1960
AN: 60-06622