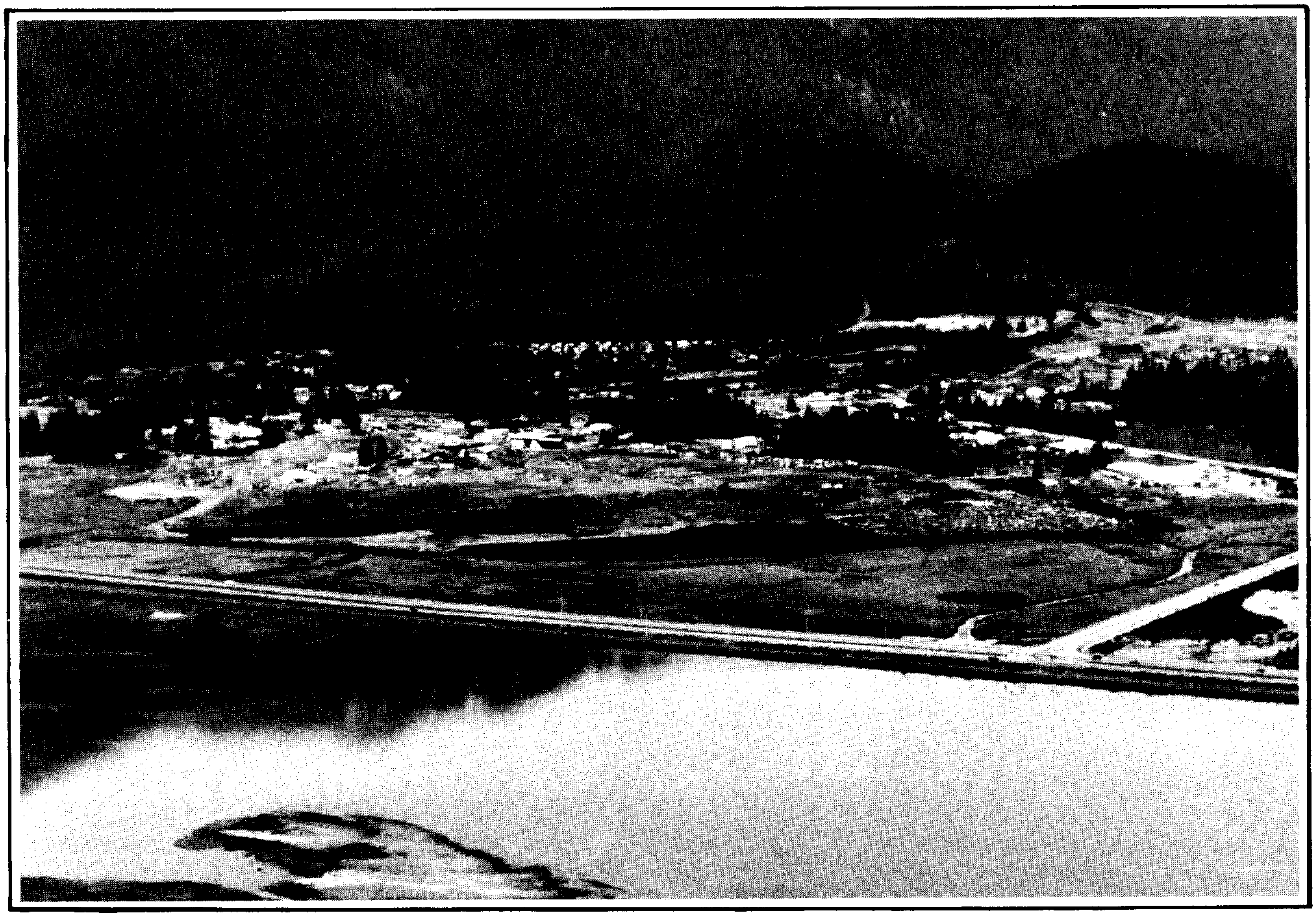
Special Publication

Mineral Investigations in the Juneau Mining District, Alaska, 1984-1988

VOLUME 3
INDUSTRIAL MINERALS



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BUREAU OF MINES ★ EIGHTY YEARS OF SERVICE

Special Publication

MINERAL INVESTIGATIONS IN THE JUNEAU MINING DISTRICT, ALASKA, 1984-1988

VOLUME 3
INDUSTRIAL MINERALS

By Kenneth Maas

UNITED STATES DEPARTMENT OF THE INTERIOR
Manuel Lujan, Jr., Secretary

BUREAU OF MINES
T S Ary, Director

Cover photograph: Active sand and gravel operations in lower Lemon Creek, Juneau, Alaska. Photo by Joe Connolly, courtesy of R & M Engineering, Inc.

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

hr	hour	ft^3	cubic foot
%	per cent	yd^3	cubic yard
ton	short ton	oz/yd^3	troy ounce per cubic yard
mi^2	square mile		

BUREAU OF MINES MINERAL INVESTIGATIONS IN THE JUNEAU MINING DISTRICT, ALASKA, 1984-1988

VOLUME 3 - INDUSTRIAL MINERALS

by Kenneth M. Maas[1]

ABSTRACT

The Bureau of Mines devoted portions of the 1987-1988 field seasons to investigate the mineral aggregate industry in Juneau, Skagway, Haines, and Gustavus, Alaska, as part of the Juneau Mining District study. Statistics compiled for current suppliers include location, activity, reserve estimates, expected mine life, and types of commodities available. Each population center, except for Gustavus, is well endowed with suitable mineral aggregate to last at least 20 years.

The Bureau of Mines quantified the mineral aggregate resource in many large potential sites within each area. Sampling, engineering and soil-index testing, site descriptions, deposit dimensions, and gold recovery information is described. Refraction seismic studies performed at three localities revealed gravel thicknesses in excess of 40 to 80 feet.

In the Juneau area, the Herbert/Eagle Rivers outwash area, East Fork Lace River, Antler/Gilkey Rivers, and Grizzly Bar (Taku Inlet) individually contain in excess of 60 million yd^3 of excellent-quality aggregate with minor accessory gold credits. Haines is also well endowed with aggregate resources; large, quality deposits occur along and at the confluences of the Chilkat, Katzehin, Klehini, Tsirku, and Kicking Horse Rivers. Large deposits of granitic aggregate exist in the Skagway River and East Fork Skagway River.

[1] Geologist, Alaska Field Operations Center, Juneau, Alaska.

INTRODUCTION

In 1984, the Bureau of Mines (Bureau) initiated the Juneau Mining District Study (JMD) to evaluate mineral resources of the northern portion of southeast Alaska. The project was designed to determine mineral development potential for locatable minerals, but was later amended to include industrial minerals[2]. The main industrial minerals produced in the district include sand and gravel and to a lesser extent quarry rock. During 1987 and 1988, Bureau personnel visited operating pits and quarries within these areas and conducted field investigations at several large potential sites.

Discussions were held with major operators in the district as well as with City, State and Federal experts to gain a general overview of the industry, including current trends, future material requirements, and general problems, both environmental and legal.

This report provides detailed information on current and potential supplies of aggregate material within the City and Borough of Juneau (CBJ), and briefly discusses potential for industrial minerals in Skagway, Haines, and Gustavus.

LOCATION

The JMD was divided into four subareas for use in this volume of the report (fig. 1). The Juneau area encompasses those lands within CBJ extending from Taku Inlet to Berners Bay and includes Douglas Island. The Skagway area includes the Taiya River, Skagway River (including East Fork) and West Creek. The Haines area extends north-south from Klehini River to Endicott River, and east-west from Katzehin River to Glacier Creek, including the Porcupine mining area and West Lynn Canal. The Gustavus area includes the Salmon River alluvial plain.

Bureau field investigations were concentrated in areas containing large amounts of unconsolidated material, including broad river valleys, large deltas, and glacial outwash terrains. Proximity to the existing road system was not a factor in selecting sites; however, strict management closures were considered. Mendenhall Wetlands, Glacier Bay National Park, and Klondike Gold Rush National Historical Park were omitted from the study because they are closed to mineral entry and development.

LAND STATUS

Most land within each study area is included within the boundaries of Tongass National Forest. The proximity of Klondike Gold Rush National Historical Park to Dyea in the Skagway area restricts gravel extraction from the Taiya River. A large portion of the land in the Haines area is within the Haines State Forest. The presence of Glacier Bay National Park limits gravel extraction near Gustavus.

Both State and Municipal governments own land parcels within the Tongass National Forest as do Native regional and village corporations and private citizens. Status plats delineating land ownership boundaries within these areas can be found in Juneau at the U. S. Forest Service (USFS) or the State of Alaska Department of Natural Resources (DNR) offices.

Most potential borrow sites described in this report occur on land managed by the USFS, Bureau of Land Management (BLM), or DNR. These sites are also located within the coastal zone and on wetlands and both of these factors will influence the permitting process required prior to extraction. Active pits and quarries in the study area are located on private land included within U.S. surveys (USS), patented mineral surveys (USMS) or Native properties.

PREVIOUS STUDIES

Few reports have been prepared on the availability of mineral aggregates within the JMD. A thesis describing the distribution of gravel and sediments of the Norris Glacier area (Grizzly Bar) was prepared by Roger M. Slatt in 1967 (*26*)[3]. Since 1972, four studies on areawide surficial deposits and mineral aggregates have been published.

The first areawide study entitled, "Surficial Geology of the Juneau Urban Area and Vicinity, Alaska", was prepared by Robert D. Miller of the U.S. Geological Survey (USGS) in 1972 (*14*). A map detailing surficial geology of the Juneau area (USGS Map I-855) was published in 1975 to accompany it (*15*). The report discusses potential geologic effects of an earthquake or other catastrophic event on various surficial units recognized in the Juneau area. In doing so, Miller delineated 10 depositional environments from which 36 subunits, or deposit types, have been identified. This information is useful for comparing areas currently being developed as borrow sites to

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[2] This and many other terms are defined in Appendix A.

[3] Italicized numbers in parentheses refer to list of references preceding the appendices.

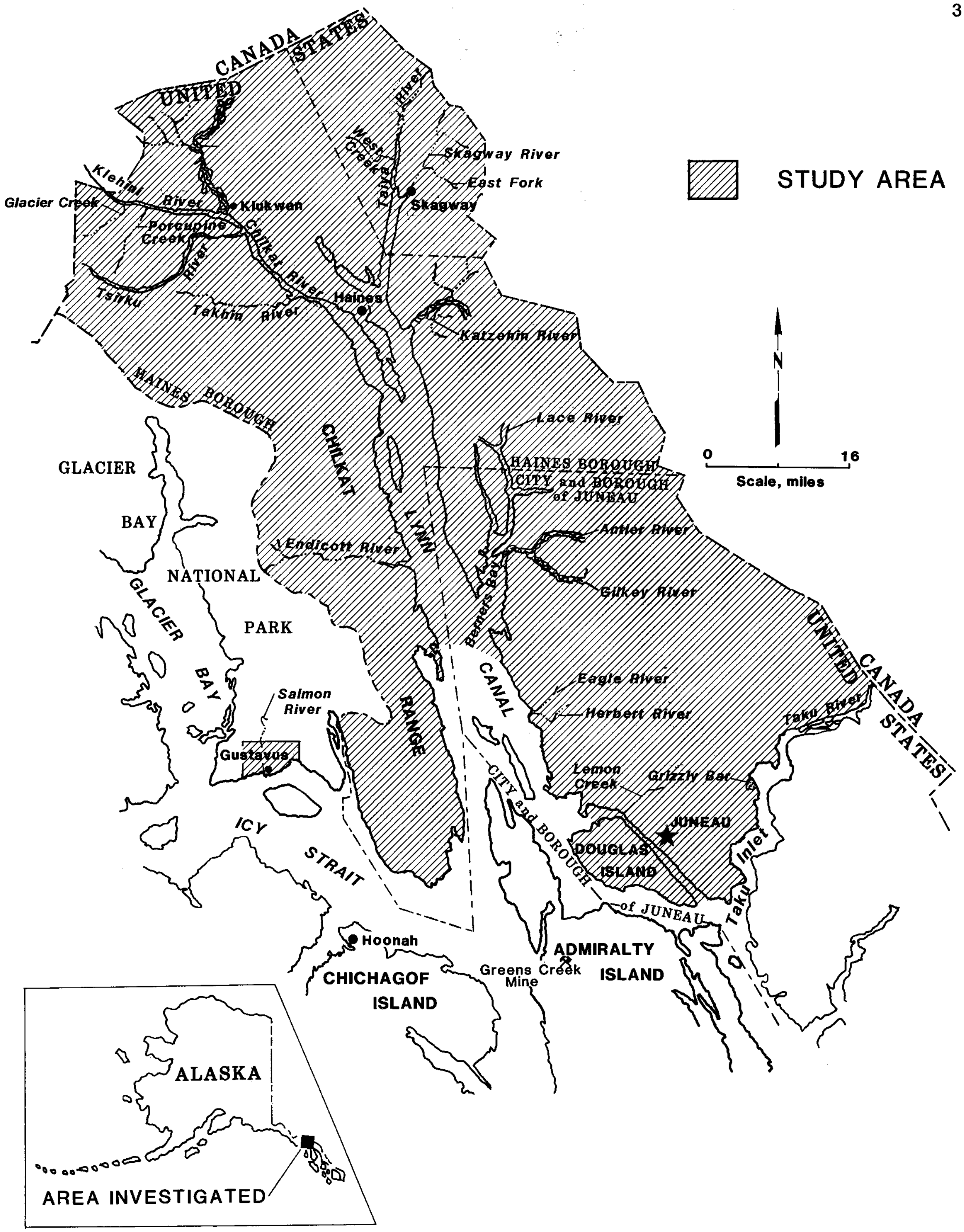


Figure 1. - Location map depicting the Juneau, Haines, Skagway and Gustavus study areas.

sites having potential for similar deposits. The likelihood of suitable materials occurring in Fish Creek Valley on North Douglas Island was discerned in this way.

The CBJ contracted with R & M Consultants, Inc. (R & M), of Juneau, on two occasions to prepare reports assessing mineral aggregate resources within CBJ boundaries. The first of these reports was completed in 1978 (*18*). The purposes of the report were: 1) to locate, inventory, and assess all existing, as well as potential borrow and quarry sites from Berners Bay to Point Bishop, including Douglas Island; 2) to classify these sources by the type of material and reserves available; and 3) to estimate areawide needs for mineral aggregate materials through 1990. Conclusions and recommendations were passed to the CBJ planning department. The report stressed that Juneau is rich in mineral aggregates relative to other Southeast Alaska communities, but the availability of the resource is limited by legal and management closures, residential conflicts, and economics. These conflicts have not substantially changed to this day, except that continued residential growth has further lessened the availability of the resource.

The second report by R & M was completed in 1985 (*19*). The report discusses work done by R & M to determine the depth and lateral extent of several potential sand and gravel borrow sites and one rock quarry site on CBJ land in upper (West) Lemon Creek. R & M concluded that a limited borrow resource occurs on CBJ lands there. However, when shot rock becomes economic due to the depletion of viable borrow alternatives, a large rock quarry is a possible option. R & M updated their 1978 mineral aggregate assessment for the CBJ in 1988 (*22*).

The CBJ published a report called, "Land Use Ordinance-Ordinance Serial 87-49 (*4*)," in 1987 as a means to achieve the goals and implement the policies established in "The Comprehensive Plan" published in 1984 (*5*). CBJ recognized the demand and economic potential for sand and gravel in the Juneau area. The Land Use Ordinance discusses sand and gravel operations in Chapter 49.65, sections 200-265.

Three policy decisions concerning sand and gravel resources are: 1) CBJ will conserve and protect from conflicting land uses known gravel deposits and those identified in the future; 2) CBJ will prohibit commercial and industrial development in floodways and regulate development in floodplains; and 3) CBJ will designate sensitive areas on Land Use Designation overlays for the gravel resource and will guide and review any proposal for development within those areas.

The Haines Borough Comprehensive Plan of May, 1986 (7), discusses sand and gravel resources. This report identifies abundant resources in glacial river floodplains, talus slopes, moraines, and beach deposits throughout the borough. State and Federal permitting regulations and economics control the development of these resources.

Many local sand and gravel operators have had laboratory tests performed on their resource to determine if the material meets State of Alaska Department of Transportation (DOT) specifications for durability, abrasion and size distribution. The DOT lab facility in Juneau has the results. Many local pits have been evaluated by local consulting firms, but site plans and conclusions may not be available to the public.

ACKNOWLEDGMENTS

The author wishes to thank sand and gravel operators who contributed information on the local industry through phone requests and on-site visits. In addition, Tricia Parr, a planning aide for CBJ provided a list of permitted operators in the Juneau area. Personnel from the Bureau's Western Field Operations Center (WFOC), in Spokane, assisted with gathering samples and information in the Haines and Skagway areas. The author also wishes to thank Terry Hayden, physical science technician, and Jeffrey T. Kline, geologist for Alaska Division of Geological and Geophysical Surveys, for assistance during field investigations. Charles Merrill Jr., a Bureau geologist, provided valuable assistance throughout the project.

SCOPE AND METHODOLOGY

Information presented in this report is intended to give the reader a basic understanding of the aggregate industry in Juneau, Skagway, Haines, and Gustavus. Information on local production, expected future demand, and current reserves for local operations is discussed. A general history of major aggregate use in the Juneau area is also included.

Figure 2. - Bureau personnel collect plus 1-inch material for pebble count (lithology) information. (photo by K. Maas)

This report also addresses potential supplies of sand and gravel deposits in the four subareas. Forty-five 0.25yd^3 reconnaissance samples were taken with engineering and gold-recovery tests performed on each sample. Pebble counts were made to determine lithologies of samples collected in the Juneau area (fig. 2). Refraction seismic tests were conducted at three locations in the Juneau area to determine probable depth to bedrock (*21*). Data were provided by DOT on past use of aggregate supplies as well as future needs for large capital improvement projects.

SAMPLING

Potential sample sites were chosen after scanning topographic maps for large depositional features. Moraine and outwash deposits as well as braided alluvial systems were the most obvious targets. Representative sample sites were chosen after viewing the general nature of each deposit from a helicopter.

Vegetation and overburden were removed from the surface at each site and usually a 0.25 yd^3 sample was obtained (a 4-foot-wide cone extending 1-foot into the earth yields this volume). This method produces a statistically representative yield of material sizes and compositions. Excavating three different holes from various locations on the deposit and accumulating a total of 0.25 yd^3 of material may be a reasonable alternative, but it is not statistically representative.

A portable hopper device utilizing a 6-inch and a 3-inch screen was erected at each site (fig. 3). Oversize (plus 6-inch) material coming out of the hole was noted, but not removed from the site for testing. Material was bagged into two size categories at the site: a plus 3-inch to minus 6-inch fraction and a minus 3-inch fraction.

At large homogenous sandy deposits, e.g. Berners Bay and the mouth of Chilkat River, only 2 ft^3 of material was removed for testing because this amount was thought to be representative.

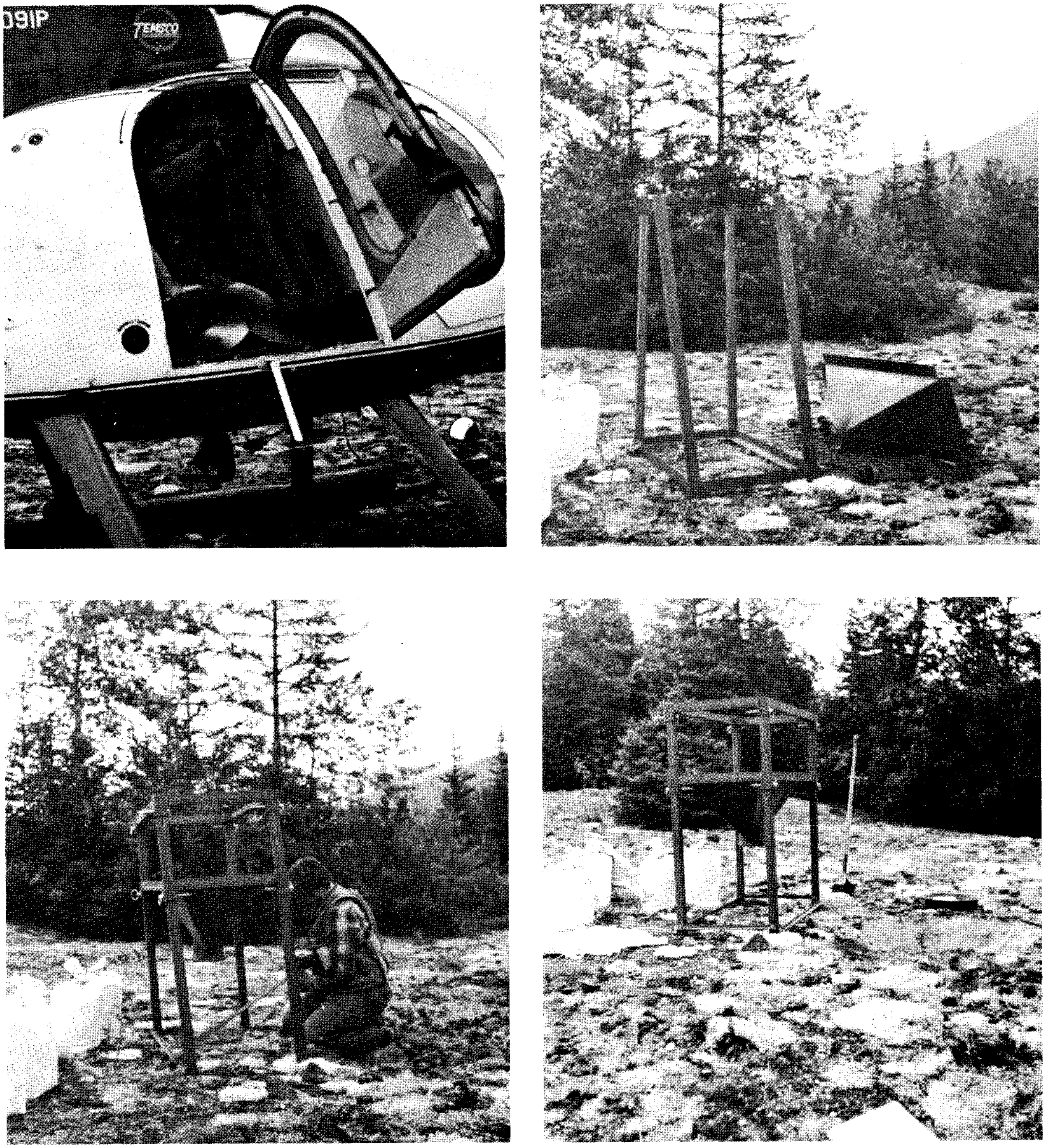


Figure 3. - Sequence showing portability of hopper from helicopter transport stage to complete set up. Note sample pit next to hopper in lower right. (photos by K. Maas)

TESTING PROCEDURES

The samples were separated into a plus 3-inch to minus 6-inch portion and a minus-3 inch portion and weighed. The minus 3-inch portion was sent to ABC Control Engineering (ABC), in Spokane, WA, for engineering tests. Tests were performed using methods prescribed by the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM), or both. These tests include:

1) sieve analysis for both coarse (greater than 0.185 inch or 4-mesh) and fine (less than 0.185 inch) aggregates, AASHTO T-27; this test determines size characteristics. Two important parameters are that no more than 45% of the material passes two consecutive sieve sizes and no more than 5% passes the 200-mesh screen (*13*).

2) abrasion of coarse aggregate by the Los Angeles Machine, AASHTO T-96; this test determines strength and wear characteristics of material by measuring the proportion of fines produced by abrasion in a revolving metal drum. The standard specification from the DOT handbook for this test is 50% maximum loss (*1*).

3) soundness of aggregate by use of sodium sulfate for both coarse and fine fractions, AASHTO T-104; this test determines strength and susceptibility of a material to frost damage by expansion of absorbed water. The test is performed separately for coarse and fine aggregates and specifications for these two tests are 12% maximum loss and 10% maximum loss, respectively (*1*).

4) specific gravity and absorption of fine and coarse aggregates, AASHTO T-84 and T-85; this test determines material mass and the absorption after wetting. Specific gravity should be more than 2.55 and absorption should not exceed 3.0% (*13*).

5) moisture and unit-weight of each sample; this test determines mass of the material contained in a standard ft^3 measure.

6) sand equivalent value of fine aggregate, ASTM D-2419; this test quantifies the ratio between sand and clay sized particles when suspended in solution in a specific manner. The value (ratio X 100) should not be less than 75 (*13*).

Standard specifications for material quality are available from the DOT handbook entitled, "Standard Specifications for Highway Construction, 1988" (*1*). Specifications for any single test may vary according to the intended use of the material, e.g. subbase vs concrete aggregate vs bituminous aggregate. However, generalized specifications for the abrasion test (AASHTO T-96) and the soundness test (AASHTO T-104) are provided in the DOT handbook (*1*) and our sample results relative to these two tests are highlighted in each property description.

The specification manual suggests the use of Alaska Test T-7 for determining the amount of material passing a 200-mesh screen (sieve analysis). Bureau samples were screened using the AASHTO T-27 method; however, results obtained from either test yield similar results (*9*).

A special degradation test (similar to AASHTO T-96) for Alaska conditions is warranted for base course and bituminous-aggregate materials, however this test was not performed. This additional test may be necessary for deposits containing sedimentary rocks and rocks with limy coatings; such rocks occur at Gustavus and Endicott River locales.

After conducting engineering tests, ABC lab forwarded the minus 0.25-inch fractions from the original samples to WFOC for gold analysis. Gold recovery was performed by wet lab analysis, which included weighing the material, panning and visual identification of gold particles from the minus 0.25-inch to plus 14-mesh fractions, and tabling minus 14-mesh materials for gold content. Samples from Grizzly Bar received additional treatment during gold recovery (see individual property description).

Pebble counts were made to determine rock types at each sample site in the Juneau area. Visual estimates of lithology were made at each sample location in Haines and Skagway and results are discussed in the property descriptions.

Seismic studies performed at three locations within the Juneau area were carried out by H4M Corp., Inc. of Anchorage, Alaska, under subcontract to R & M. Seismic lines were established to examine probable depth of bedrock at selected sites. The results of H4M's work is summarized in the individual descriptions for the East Fork Lace River, Antler/Gilkey Rivers, and Endicott River sites. A detailed account of the fieldwork is provided in R & M's contract report (*21*) available from the Bureau's Juneau-branch library.

CONSUMPTION AND USAGE

Industrial minerals, specifically sand, gravel, and crushed stone, serve an important purpose in our daily lives. It has been estimated that per-capita consumption of stone, sand, gravel, and cement during a lifetime is over one million pounds (*33*). Construction sand and gravel, and crushed stone industries produced $7.5 billion dollars in raw material during 1987, the largest portion of non-fuel mineral production in the United States (*32*). In Alaska, 1987 figures show sand, gravel, and stone production at $54.3 million compared to gold production valued at $104.5 million (*3*). This is the first time during the 1980s that the value of gold production has exceeded construction materials in Alaska.

The major market for sand and gravel is the construction industry. Sand and gravel is used as aggregate for portland cement and asphaltic concretes, as subbase under pavings, and as fill (common borrow). Crushed stone can be used to supplement sand and gravel aggregate or it can be used specifically as roadstone, railroad ballast, riprap and jetty stone for river and harbor work, or as filter stone for water treatment (*13*). During most of the 1980s, the major use of sand and gravel and building stone in Alaska has been in government-sponsored capital-improvement projects in the four major urban areas (Anchorage, Fairbanks, Juneau, and Ketchikan) and infrastructural development in North Slope oilfields. The decline of oil revenues severely impacted sand and gravel usage in 1986 and 1987, with both dollar value and volume estimates falling substantially from the previous year (*3*).

Industrial mineral usage in Alaska may increase in the near future. Recently successful State and Federal offshore oil-lease sales on the North Slope may spur gravel-island development for drilling purposes and the gradual development of hardrock mines throughout the State will also require construction materials for roadbase and foundation purposes. As examples, both the Red Dog Mine in Northwest Alaska and Greens Creek Mine in Southeast Alaska, required substantial quantities of materials to build access roads, harbor facilities and foundations for their concentrating plants, and support buildings (fig. 4).

In Southeast Alaska, mineral exploration expenditures are increasing and projects are moving into various stages of development. Renewed interest in the historic gold properties of the Juneau Gold Belt (especially Jualin and Kensington Mines in Berners Bay, and Alaska Juneau Mine (AJ)) could directly affect sand and gravel usage and supply (waste rock, tailings) in Juneau's immediate future.

The Juneau-Haines-Skagway road or a complete road around Douglas Island, if initiated, will require between 12,500 and 24,000 tons/mile of aggregate, depending on the type of road built (*13*). A second bridge across Gastineau Channel in the Juneau area will also require substantial amounts of borrow and aggregate as will an expansion of runway facilities at the Juneau International Airport.

Haines and Skagway will be affected to a much lesser extent because mineral development is not imminent there. Major uses of aggregate in these two areas would be tied to airport runway expansion, increased port facilities, or additional road construction and subdivision preparation. Haines Borough is very large and essentially undeveloped outside of the city center and potential exists for growth and expansion of the road system, subdivisions, and harbor facilities.

Since its founding in 1880, Juneau has produced and extensively used sand, gravel, and riprap. In the early years, major construction projects utilizing aggregate were associated with development of the Treadwell, Alaska Gastineau, and Alaska Juneau Mines. Some construction materials were derived and used on site, including 1) tailings produced from Treadwell mills used to create waterfront facilities that supported the Treadwell complex; 2) crushed rock and washed sand used to construct Salmon Creek Dam; and 3) tailings from Gastineau mills that were used as foundation materials for support facilities below the mill.

Use of tailings from AJ was more widespread throughout the development of Juneau. Three main reasons for this are 1) the large tonnage created as tailings (88 million tons); 2) the centralized location of the tailings disposal; and 3) the variety of aggregate sizes available. Riprap and smaller sized material was used to create a large portion of the downtown Juneau waterfront area and create the embankment along Egan Expressway. It was also used to build both the Harris and Aurora boat harbors, create a base for the airport runway in Juneau, and numerous residential foundations. The 60-acre rock dump south of town was created from AJ waste rock and tailings and is currently used for oil-tank storage, but additional industrial use is a possibility (*28*) (fig. 5).

As population growth and road building progressed past the core areas of downtown Juneau and Douglas, new natural aggregate sources were tapped. Abandoned quarries along old Glacier Highway at Salmon Creek and 8-mile, as well as Tee Harbor, Cowee Creek, and Echo Cove attest to locally derived materials for road building projects. The use of gravel

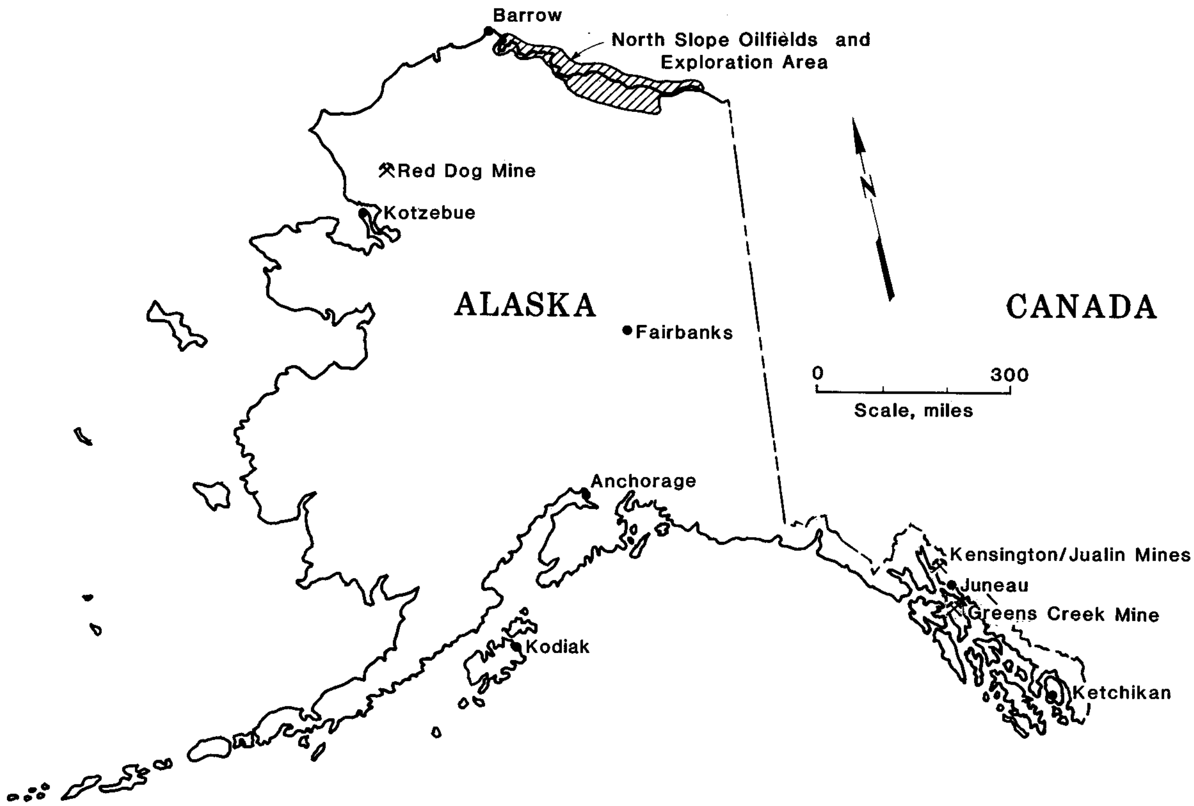


Figure 4. - Major urban areas and significant users of aggregate in Alaska.

resources from both Lemon Creek and Mendenhall Valleys increased markedly during and after subdivision construction.

Major uses of aggregate in the Haines area include construction of the Haines Highway, port and harbor facilities in the downtown area, and the local airstrip.

Most of this construction used aggregate or fill materials found near the site (borrow). Major projects in Skagway have included construction of the railroad to Whitehorse, the paved highway crossing White Pass into Canada, port facilities for the ferry system, harbors for local users, loading facilities for export of lead and zinc concentrates, and an airstrip.

GEOLOGIC SETTING

JUNEAU SUBAREA

Suitability of country rock for quarrying is dependant on rock type present and economics of extraction. Bedrock of the Juneau area is composed of progressively metamorphosed metasedimentary, metavolcanic and metaplutonic rocks that trend northwest and dip moderately to steeply northeast. Individual rock types include black and felsic phyllite; massive to schistose mafic volcanic flows, breccias, dikes, and sills of various compositions; and diorite and foliated quartz diorite (*24*). Other less common rock types are also present. Historically, most quarry rock in the Juneau area was derived from massive volcanic flows and altered diorite.

Surficial deposits in the Juneau area consist of a variety of natural and manmade materials of late Pleistocene to Holocene age. The types of unconsolidated materials suitable for the production of aggregates include glacial deposits (moraines and outwash-Berners Bay area and Herbert/Eagle River valley); glaciomarine deposits (diamicton or till-Peter Ludwig Pit); alluvial deposits (stream, river and terrace

Figure 5. - City of Juneau and the town of Douglas. At the middle right are the waste rock and tailings from the Alaska Juneau Mine, which is the "rock dump". At the bottom right are tailings from the Treadwell 300- and 240-stamp mills, which created "Sandy Beach", a popular recreational area. (photo by E. Redman)

deposits-upper Lemon Creek); deltaic deposits (alluvial sediments deposited in a still body of water-lower Lemon Creek); marine deposits (intertidal deposits composed of reworked deltaic material-Mendenhall Flats); beach deposits (wave and shore currents that carry and rework sediments-Tee Harbor); and mine dumps (tailings and waste rock from the milling process-AJ Rock Dump). Glaciomarine, deltaic, marine, and raised beach deposits developed or became available because of sea-level changes (isostatic rebound) related to deglaciation.

SKAGWAY SUBAREA

Bedrock within the Skagway area is composed of granodiorite and other felsic intrusive rocks, high-grade gneissic rocks, and subordinate volcanic and schistose rocks. Most intrusive and gneissic rocks are durable and make excellent crushed stone products. The abundance of natural aggregate precludes the need or existence for quarries; slopes of large boulder scree that can be crushed or used as riprap occur on the east side of town.

Surficial deposits in the Skagway area are concentrated in Skagway and Taiya River valleys. The city center is located within Skagway River valley (fig. 6). Alluvial deposits from both rivers have been exploited for sand and gravel resources. There are a number of exploitable rock-fall deposits on the valley floor east of Skagway River.

HAINES SUBAREA

Bedrock geology of the Haines area is complex, but it is generalized by geographic region for the purposes of this report. The area north-northeast of Chilkat River contains predominantly intrusive rocks ranging in composition from granite to gabbro, with an ultramafic occurrence cropping out between Klukwan and Mt. Rapinski. A wedge of basaltic rocks parallels these intrusive rocks along the highway from Haines to Klukwan. These rock types are well suited for quarrying, although natural slide deposits of this material are available and are currently being exploited (Northern Timber Corp. pit). South of Klehini River, predominant rock types are a metasedimentary-metavolcanic package (characterized as the Glacier Creek Volcanics and Porcupine Slate/Marble) containing subordinate dioritic intrusive rocks. Chilkat Peninsula contains basaltic to ultramafic volcanic rocks with small diorite bodies (*27*).

There is an abundance of natural aggregate and borrow materials throughout Haines Borough. The Borough contains major glacial river floodplains (Chilkat, Klehini, Tsirku, Katzehin Rivers), deltaic deposits, talus slopes (occurring at miles 4, 19, and 23 along the Haines Highway), glacial moraines and outwash deposits (Davidson Glacier), and beach deposits (Chilkat Peninsula). Although a surplus of materials exists, availability of aggregate from any one source will depend on economics of extraction, and regulatory requirements imposed by State and Federal agencies.

GUSTAVUS SUBAREA

The bedrock underlying Gustavus is almost entirely concealed by recent surficial deposits with only a few outcrops of mudstone, graywacke, and turbidite occurring east of the airport (*6*). Major categories include alluvium-outwash, colluvium, tidal-mudflat deposits, and minor glaciofluvial deposits. These sediments are characterized by their fine-grained nature. Modern Salmon River does not emanate from a true catchment basin draining runoff from mountains, but meanders along a very shallow course maintaining a low carrying capacity for sediments. There are locations within Glacier Bay National Park where glaciofluvial deposits of a more gravelly nature occur; however these are not extensive nor available for development.

BUREAU OF MINES STUDIES

JUNEAU SUBAREA

The Bureau gathered data on the current industrial minerals market by conducting interviews with local operators and conducting on-site visits where possible. Most operators were willing to share information about their projects; however most of them requested that production figures be kept confidential. For this reason, we have lumped production data from the various producers for 1987 and 1988.

The CBJ describes specified-use provisions related to sand and gravel extraction in Chapter 49.65.200-265 of the Land Use Ordinance 87-49 (*4*). For any off-site use or sale of material, an extraction permit is required. Figure 7 shows locations of the permitted operators within CBJ.

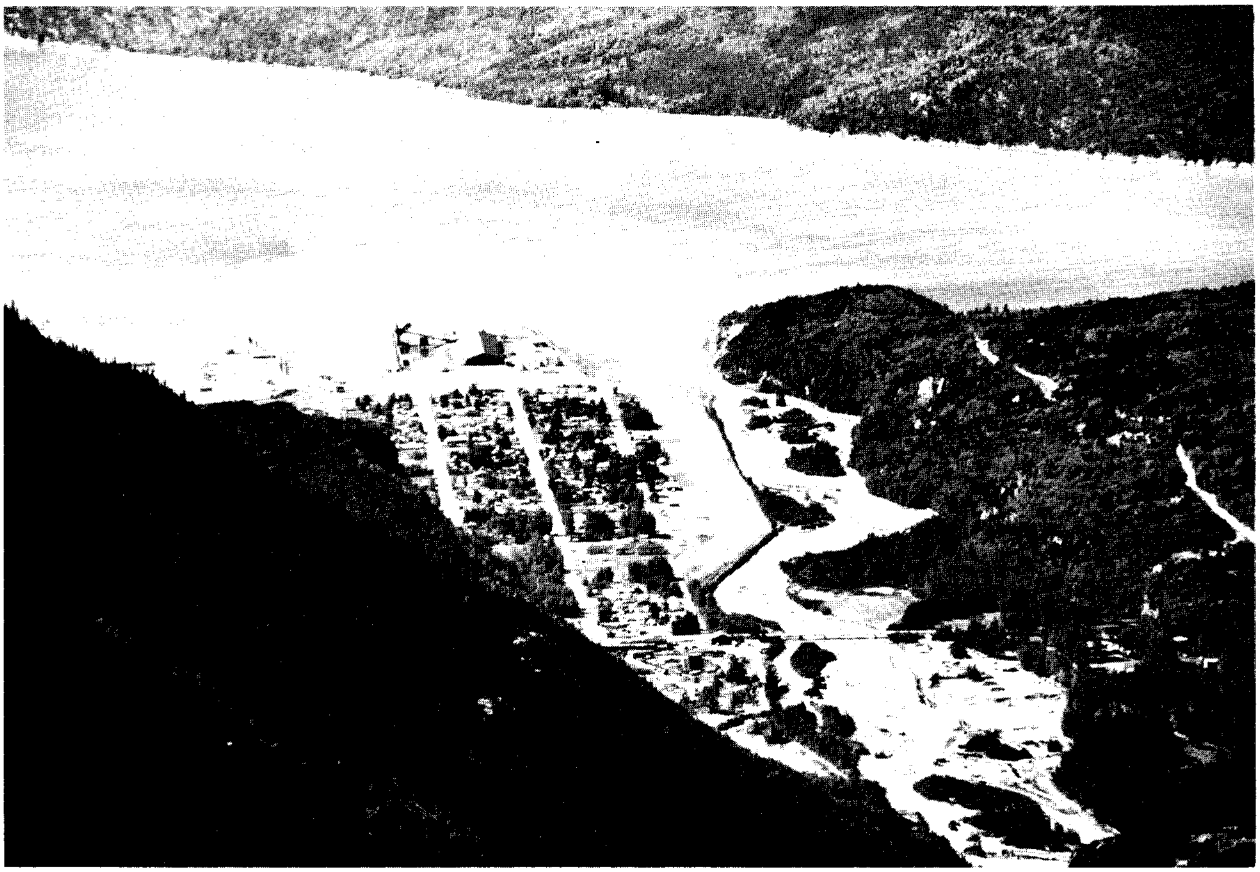


Figure 6. - Looking south over City of Skagway. Skagway River (lower middle half of photo) is the major source of sand and gravel in the area. The population center, airstrip, and ore loading facility are also seen. Dikes can be seen along the west river bank, as can the H & H operation. (photo by A. Clough)

The Bureau also conducted field investigations in order to qualitatively and quantitatively describe some potential sites that may be utilized in the future when local sources are depleted, economics are suitable, or when a major construction project requires a more distant source of material.

CURRENT SUPPLIERS

There are 12 operators currently permitted (1988) to extract and/or process sand, gravel and quarry rock within the CBJ (table 1). Six of these operators are active producers in the local market; the other six are permitted but have minor production or are inactive.

Lemon Creek Valley (cover photo) is the location for four of the major operators, including Hildre Sand and Gravel Co., Gastineau Sand and Gravel, Inc., Hidden Valley Associates, and Channel Corp. (landholder for Juneau Asphalt). Dwain Reddekopp, Inc. quarries greenstone rock at Lena Point. Barana Company extracts gravel from a site in Montana Valley. This company is a sporadic producer, however, in 1988 they were a major operator. The following profiles summarize permitted operations in the area.

Barana Company (1)[4]: The Barana Company processes sand and gravel at their Montana Creek Road pit located on USS 2079. They produce D-1 aggregate and other sizes of screened gravel and common borrow. The deposit contains alluvial and outwash gravel that was reworked from a lateral moraine left by the retreat of Mendenhall Glacier. Current owners maintain a reserve base in excess of 1 million yd^3 and this can be increased if nearby land is purchased. The company operates only during the construction season and is closed during winter months.

[4]Numbers in parentheses following operator name refer to map numbers used in Figure 7 and Table 1.

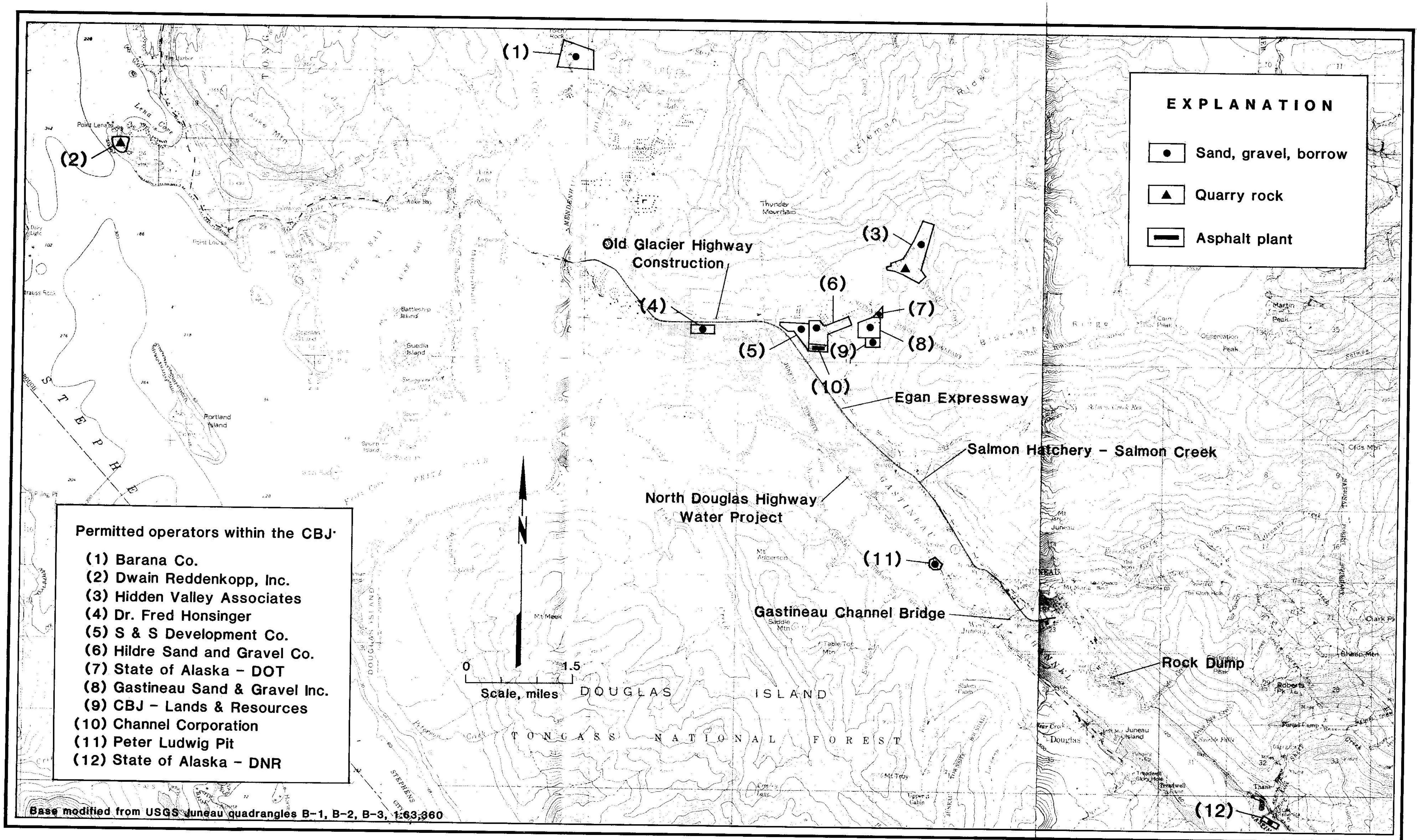


Figure 7. - Current operators permitted within City and Borough of Juneau. Includes locations of major construction projects and features occurring in Juneau.

Table 1. - Permitted operators within City and Borough of Juneau

Map #	Name/location	Permit expiration	Type of operation/ (level of activity) main products	Comments
1	Barana Company/ USS 2079-Montana Creek	Aug. 9, 1998	Gravel pit (major) sand, gravel, processed aggregates	Quality processed D-1 aggregate
2	Dwain Reddekopp, Inc./ Tract B USS 3808-Lena Pt.	Sept. 2, 1991	Rock quarry (major) crushed aggregate/road metal	Obtained barge loading permit valuable road metal for Greens Creek
3	Hidden Valley Associates/ MS 526-Upper Lemon Creek	Oct. 9, 1994	Gravel pit/rock quarry (major) processed aggregates/fill/shotrock	Lease/royalty operation-vacant land-trade w/CBJ increased reserves
4	Dr. Fred Honsinger/ Airport Wetlands Area	Feb. 11, 1996	Dredge pond (none) common borrow	Last used for Fred Meyer job, core drilled-homogenous material
5	S & S Development Co./ SE Fraction of USS 2121	Jan. 19, 1996	Borrow pit (none) pit-run borrow	No use since Eagle's Edge completion, resource has potential for processing
6	Hildre Sand and Gravel Co./USS 204-Lemon Creek	Jan. 26, 2001	Gravel pit/processing plant (major) processed aggregates, concrete products	Supplies Juneau Redi-Mix, Juneau asphalt, public sales
7	State of Alaska-DOT/ USS 5504-Lemon Creek	1994	Borrow pit (minor) fill material	High silt content limits usefulness
8	Gastineau Sand & Gravel Inc./USS 2487-Lemon Creek	May 14, 1991	Borrow pit (major) pit-run/quality borrow	High quality borrow/roadbase
9	CBJ-Lands & Resources/ USS 1762-Lemon Creek	Jan. 1, 1989	Borrow pit (minor) sand, gravel, borrow	Public works projects/resurfacing/ no sales
10	Channel Corporation/ USS 204-Lemon Creek	Jan. 29, 1995	Landholder for asphalt plant (major) bituminous aggregate/paving materials	Juneau Asphalt lessee/use of products is temperature dependent
11	Peter Ludwig Pit/ USS 2225-North Douglas	Jan. 10, 2014	Borrow pit (minor) common borrow, boulders, top soil	Material meets specs for aggregate favorable economics will trigger use
12	State of Alaska-DNR/ ATS 203-Sheep Creek	July 22, 1991	Public use borrow site (minor) fill material	Maximum of 100 yd^3/person, with permit \$1.00/yd^3 royalty

Dwain Reddekopp, Inc.(2): Dwain Reddekopp, Inc. has produced a large amount of greenstone shot rock as a consequence of site preparation for a terraced subdivision and road grade on tracts A and B of USS 3808, at the west end of Lena Point. Initially, the owners were permitted to remove but not process the waste rock produced during blasting. The rock is a high-quality massive greenstone that does not fracture easily. The company contracted with a processing company to crush the material and various sizes of aggregate were produced, including D-1, 0.375-inch pea gravel, minus 2-inch gravel, and riprap up to and exceeding 3 feet in diameter. These products meet or exceed DOT specifications for subbase, base coarse, and bituminous and concrete aggregate.

During 1988, the company succeeded in obtaining barge loading and processing permits that will secure Reddekopp's position in the Juneau aggregate market. However, the quarry is 10 miles farther from the local market than other major producers. The company has been negotiating with Greens Creek Mining Co. to supply road metal for the mine workings. Although Reddekopp is not presently adding to its reserve base of 250,000 yd^3, the subdivision site may be leveled to produce an additional one million yd^3 if the local housing market does not improve and lots do not sell. Reddekopp's D-1 product is sold for $9.00/ton and the company will transport the material at a flat rate of $60/hr for a 15-ton truckload (*23*).

Hidden Valley Associates, Inc. (3): Hidden Valley Associates, Inc. is a subsidiary of Goldbelt, Inc., the local Native village corporation created legislatively through the Alaska Native Claims Settlement Act (ANCSA) of 1971. Goldbelt owns 269 acres of land included in USMS 526, 582, and 585, all located in upper Lemon Creek valley. These parcels were originally patented as placer mining claims and were subsequently obtained by the Boy Scouts of America. Goldbelt acquired this land from the Boy Scouts rather than through the ANCSA selection process. This type of acquisition precludes regional corporation involvement in a subsurface resource (sand and gravel, and quarry rock are classified as a sub-surface resource by court decree) and allows Goldbelt to reap monetary benefits. In addition, Goldbelt acquired 20 acres adjacent to these holdings by means of a land trade with CBJ for a 6-acre parcel that Goldbelt owned in Echo Cove. These land holdings will secure Goldbelt's position in the local sand and gravel economy for many years.

There are four main types of deposits on the property. These include glacial outwash containing abundant boulders, cobbles, and pebbles in a sandy matrix; alluvium containing gravel and cobbles in a fine-grained matrix; and terrace alluvium with a weathered-soil layer developed over gravel and sand. A greenstone knob located on the southwest portion of the holdings has been quarried on a small scale for riprap and crushed stone products. The company is currently assessing the potential of its resource and a strategic development plan is forthcoming.

Hidden Valley does not actually process their resource. They strip overburden from a portion of the land and then lease the underlying material to a private operator, who pays royalties of $1.25-$1.75/ton, depending on the product. During 1985 and 1986, lessees payed royalties on nearly 150,000 tons of material. There is no current lease on the resources. There are approximately 600,000 yd^3 of reserves available from this property.

Dr. Fred Honsinger (4): Honsinger pit is located within portions of USS 1568 and 1852 in the airport wetlands area. This pit occurs in an intertidal deposit of sandy silt with minor gravel. Core drilling has revealed a homogenous sandy gravel overlying silt. Marine dredging is the only practical method of removing the remaining material. Common borrow has been extracted from this pit for use on nearby construction projects. There was no extraction during 1986-88, although a permit is currently active through February, 1996. Because the pit is located on wetlands, U. S. Army Corps of Engineers requires permit renewal every 3 years. Estimated reserves exceed 300,000 yd^3.

S & S Development Co.(5): S & S Development Co. has a CBJ permit to extract sand and gravel from their borrow pit northwest of Lemon Creek on the southeast fraction of USS 2121. The material consists of terrace alluvium and marine sediments. Although used mainly as pit-run fill, this high-quality borrow material can be processed into a variety of aggregate products. A dragline is the most suitable means of excavation because the deposit is presently submerged. There was no production from this source during 1987 and 1988, but over 800,000 yd^3 of material is delineated as a reserve.

Hildre Sand and Gravel Co.(6): Hildre Sand and Gravel Co. extracts gravel adjacent to and in lower Lemon Creek on USS 204. The company is working both modern alluvium and terrace deposits containing a high proportion of gravel-sized material. Because their landholding is adjacent to Lemon Creek, one of many anadromous-fish streams in the Juneau area, mitigation measures to counter turbidity and recreation classifications must be resolved. As an example, their land holdings adjacent to Lemon Creek also include USS 609 and USS 2557; however, restoration work on these parcels mandated by the State of Alaska Department of Environmental Conservation (DEC), continues and Hildre is no longer permitted to mine there.

Hildre Sand and Gravel Co. is the major source of processed aggregates in the Juneau area. The company supplies Juneau Redi-Mix and Juneau Asphalt with aggregate to make their concrete and bituminous products and provides a large variety of products for local contractors and the general public. Products and services offered by Hildre include:

1) sand for concrete, masonry and blasting purposes;
2) gravel in four size categories (1 inch to 1.5 inch, D-1, 0.75 inch, and 0.375 inch pea gravel);
3) crushed stone in sizes ranging between riprap boulders to 0.25 inch;
4) concrete aggregate (mixture of sand and gravel used to make concrete with the addition of portland cement);
5) common borrow as a byproduct from gravel processing;
6) industrial grouts;
7) cellular foam concrete;
8) pre-mix concrete;
9) mobile crushing for individual needs; and
10) hauling of materials with both 10-yd^3 and 12-yd^3 trucks.

Cost for these products varies, however, most commodities are in the \$9.00-\$10.00/ton range (1 ton = 0.66 yd^3). Trucking costs are approximately \$72/hr. Reserves are estimated to be approximately 375,000 yd^3.

State of Alaska-DOT (7): This common borrow source used by DOT is adjacent to the operations of Gastineau Sand and Gravel, Inc. , in the Lemon Creek area on USS 5504. The deposit is deltaic in origin and contains poor-quality material due to excessive silt and clay. DOT uses this general borrow for fill and obtains asphalt aggregate for road maintenance from other sources. DOT does not provide aggregate for major State highway construction projects. The subcontractor is responsible for providing this material, therefore DOT does not need a high-quality, high-volume gravel operation. In 1987, between 1,000-1,500 yd^3 of material was used from this pit. There was no usage in 1988 (*8*).

Gastineau Sand and Gravel, Inc.(8): Operations of Gastineau Sand and Gravel, Inc. are located in Lemon Creek valley at the site of the former Valley Court trailer park on USS 2487. The borrow pit is composed of deltaic material similar to that found at the CBJ pit (see below). The material is a high-quality borrow which meets or exceeds DOT specifications for roadbase material. It was used extensively in creating the roadbed during repaving of Old Glacier Highway (1986-87), and the North Douglas water line extension in 1987-88. Between 1987 and 1988, Gastineau extracted approximately 150,000 tons of pit-run material. The operators estimate reserves of between 150,000 yd^3 and 200,000 yd^3 which should allow them to work for 4 more years at current production rates.

CBJ Lands and Resources (9): The CBJ pit is located on 12 acres of land in Lemon Creek valley on USS 1762, adjacent to property being worked by Gastineau Sand and Gravel, Inc. This borrow pit contains post-glacial deltaic materials that were deposited by Lemon Creek in Gastineau Channel. CBJ sold borrow to the public as recently as 1986; however, problems associated with price undercutting forced the City to discontinue this practice. CBJ presently extracts borrow for minor public works projects and resurfacing. Nearly 34,000 tons of sand and gravel were used from the pit during 1987 and 1988. Estimated reserves exceed 400,000 yd^3.

Channel Corporation (10): Channel landfill is located on USS 204, south of Lemon Creek between Old Glacier Highway and Egan Expressway. Channel Corporation owns the land and leases it to Juneau Asphalt which operates a concrete-asphalt batch plant. Juneau Asphalt only sells material if they emplace it on a construction project. Hildre Sand and Gravel Co. supplies aggregate, and Chevron supplies the oil needed to produce bituminous aggregate. The operation is temperature and weather dependant, limiting operations to between April and October. Repaving of Old Glacier Highway and the upcoming repaving of Egan Expressway are examples of major jobs performed by Juneau Asphalt.

Peter Ludwig Pit (11): Peter Ludwig pit is located on 15 acres of land on USS 2225 at 2-mile North Douglas Highway and is owned and operated by Bruce and Judy Morley. The pit occurs in a diamicton member of the Gastineau Channel Formation (*16*). Small-scale production has occurred since 1986 and 30,000 yd^3 have been mined to obtain backfill material for roadbeds and foundations; riprap boulders are selectively mined and minor amounts of topsoil are produced. Historically, the material was used in foundations for Gastineau Channel Bridge (Douglas Bridge) and construction of North Douglas Highway.

The owners were unsure of the utility of their resource, so density tests and sieve analyses were performed on selected, screened minus 0.75-inch material. Density tests exceeded the 98% compaction requirement for aggregate base coarse which has the most stringent requirement according to DOT specifications. Sieve analysis revealed a small amount of deleterious substances and size gradations conformed to requirements for most aggregate usage (*20*).

Site-development plans have been completed for full pit development, but favorable local economics must precede major development. Reserves are estimated to exceed 900,000 yd^3.

State of Alaska-DNR (12): State of Alaska operates a personal-use material site on the Sheep Creek delta in Thane on Alaska Tideland Survey (ATS) 203. The State was issued a permit through the U. S. Army Corps of Engineers to operate this site.

The resource consists of reworked deltaic and alluvial materials originating from Sheep Creek valley, as tailings from the Alaska Gastineau millsite, and from beach sediments carried by waves and currents along the shores of Gastineau Channel. The site has been terraced because Sheep Creek has cut channels through the deposit during postglacial isostatic rebound. Clasts are composed mainly of platy phyllite, schist, and greenstone with abundant shell fragments. Minor amounts of boulders are present. Surface lag deposits have developed, but these are localized. Extreme horizontal and vertical variation in particle size occurs throughout the deposit.

Public use of this site requires a personal-use permit from DNR and paying a \$1.00/yd^3 royalty in advance up to a maximum of 100 yd^3. The area of use is clearly outlined by red flags and is only accessible at low tide. During the last 3 years over 1,100 yd^3 of material have been removed (*17*). Dimensions of the current area are roughly 300 feet by 1,000 feet and, if excavated to a depth of 15 feet, the site will yield over 160,000 yd^3 of fill material.

Special use sources

Depending on the scope and location of a major construction effort, (e.g. the salmon hatchery at Salmon Creek, road building at Berners Bay mines, restabilizing slopes on Old Glacier Highway, etc.) fill material and riprap can be obtained from a suitable location using a special-use permit for a one-time use. This is a feasible alternative when building on Forest Service or State of Alaska land near a naturally occurring gravel source or quarry site. Certain stipulations may be required to counter any negative impacts from development, but, in general, the land-managing agencies will cooperate and assist in permitting the operation.

Potential resources

The Bureau investigated several potential material sites within the boundaries of CBJ. These sites were chosen after determining that they contain sufficient quantities of sand and gravel, offer reasonable access for mining equipment, and occur in unrestricted management areas. Samples of up to 0.25 yd^3 were taken at most sites to determine engineering qualities (appendix B), lithology, and gold content (appendix C). Major features of each deposit were summarized, including:

1) location;
2) Bureau sampling and analytical highlights for abrasion (AASHTO T-96) and degradation (AASHTO T-104) tests according to limits in the DOT handbook (*1*);
3) nature of deposit;
4) type and amount of vegetation and overburden;
5) deposit dimensions;
6) gold recovery; and
7) proximity to available infrastructure and user conflicts.

It is necessary to qualify the quality and quantity information provided in this section because many assumptions were made about an entire deposit based on surface inspection coupled with a reconnaissance-type sample. To have better portrayed horizontal and vertical variations inherent in most surficial deposits, a superior sampling methodology is to use a backhoe at each site to excavate a series of 3-foot-wide ditches 10 feet deep on lines 20-to 50-feet long. However, this approach was beyond the scope and resources of this project.

Deposits are discussed in sequential order as portrayed in Figure 8.

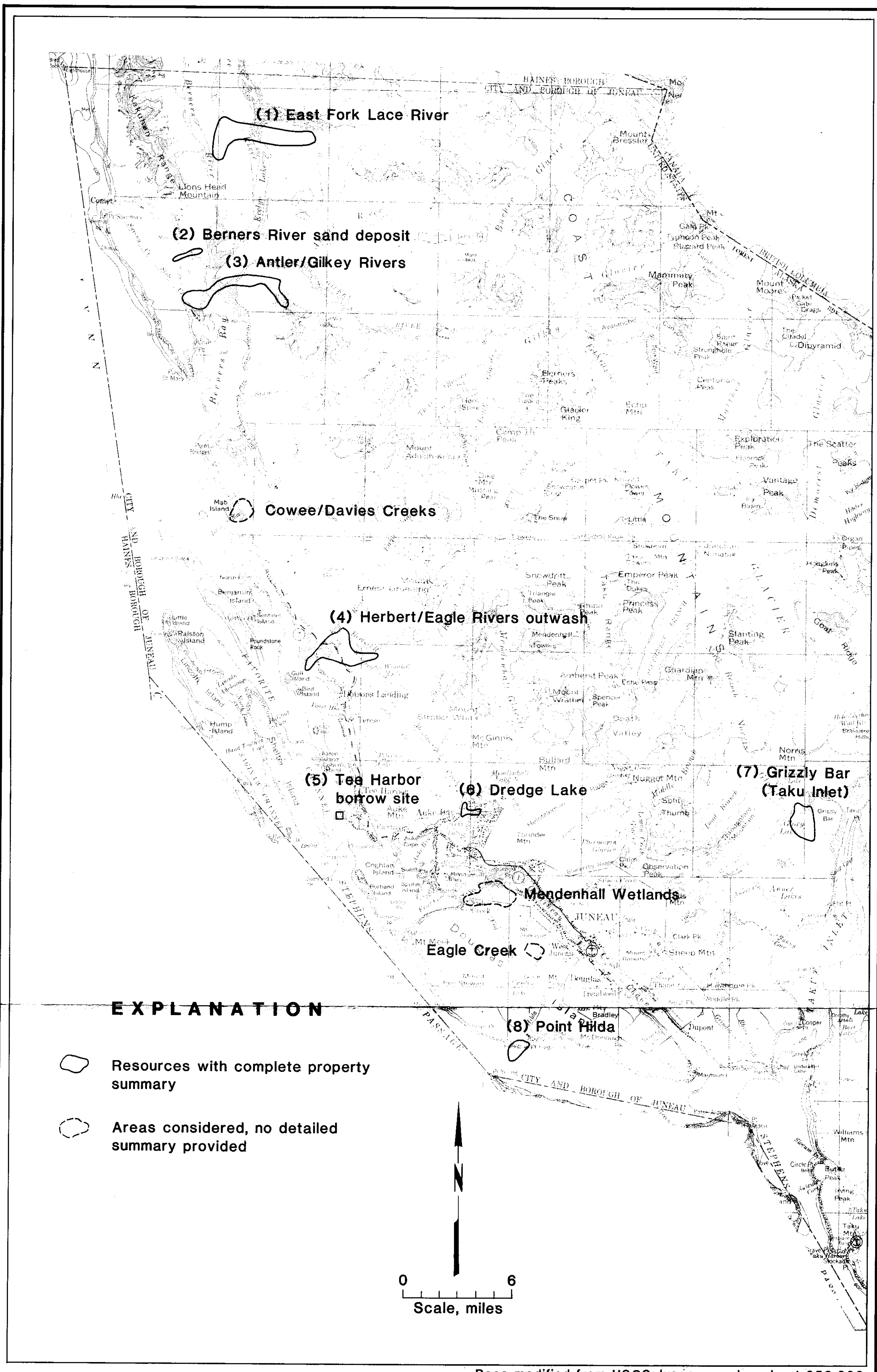


Figure 8. - Potential gravel resources within City and Borough of Juneau.

East Fork Lace River

Location: Juneau D-3 quadrangle
T34S R64E sections 7,8;
T34S R63E sections 3-5,8-14,16,17.

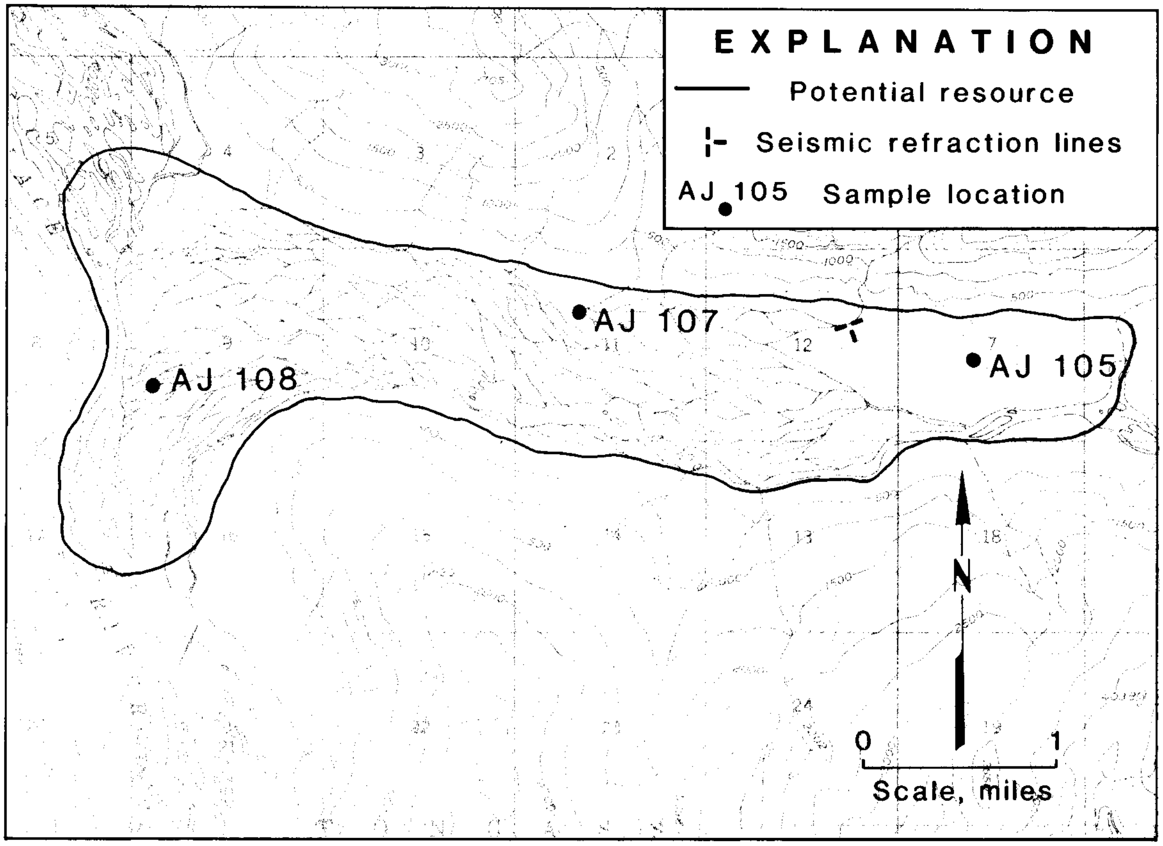


Figure 9. - East Fork Lace River.

Samples Taken: AJ 105, AJ 107, AJ 108 (fig. 9). Seismic refractive methods used 0.75 miles from site AJ 105.

Analytical Results/Highlights: (see Appendix B for complete set of results)

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
AJ 105	12.1 % loss	0.26 % loss	1.03 % loss
AJ 107	12.5 % loss	0.24 % loss	0.47 % loss
AJ 108	10.9 % loss	0.31 % loss	1.49 % loss

Nature of the Deposit: East Fork Lace River is a braided system occurring in a 1-mile wide glacial river valley. The braided nature of the river is a result of large sediment loads, rapid and frequent variations in discharge, and easily erodible banks, which are common to glacial outwash channels. Remnants of lateral and terminal moraines are visible throughout the valley and some terracing has occurred. Lensing of sand and silt is exhibited on a local scale within channels cut into outwash. Generally, the deposit is well graded downstream. Sieve analyses of three samples verify an overall gradation to finer materials downstream.

Little compositional variation of the gravel was observed among the three samples. Pebble counts were performed on a representative shovelful of sifted material (plus 1-inch) from each site. Felsic varieties of volcanic and intrusive rocks account for 68% to 81% of the material. Higher percentages of minus 3-inch material occur downstream and large erratic boulders, which were prevalent near the glacial terminus, were not seen at the confluence of East Fork and Lace River. Iron-oxide coatings were observed on less than 8% of the material.

Vegetation and Overburden: The valley is sparsely vegetated by concentrations of alder, cottonwood, and low brush covering up to 10% of the valley floor (fig. 10). Thicker stands of tall alders and immature spruce occur near the north edge of the valley, but these stands extend only 100-200 feet onto the gravel. An immature soil profile up to 2-inches thick has developed near sample site AJ 105, but elsewhere it is only 0.5-to 1-inch thick.

Deposit Dimensions: East Fork Lace River valley contains a braided stream channel 0.25 miles wide on the south side of the valley. Nearly 1,500 acres could be accessible to a dragline scraper after dikes are constructed to keep out surface flow. Refractive seismic methods employed near sample site AJ 105 reveal gravel thicknesses up to 40 feet (*21*) and, if this is conservatively projected over the entire deposit, nearly 100 million yd^3 of high-quality material exists.

Gold Content: Placer analysis of the minus 14-mesh fraction screened from 0.25 yd^3 samples revealed the following:

Sample	Grade
AJ 105	0.0000154 oz/yd^3
AJ 107	0.0000475 oz/yd^3
AJ 108	0.0000755 oz/yd^3

These numbers show gold grade increasing downstream. At $400/oz for gold, the range of values will be between $0.00616/$yd^3$ and $0.0302/$yd^3$.

Proximity to Infrastructure: The nearest power supply is located near Eagle River, approximately 30 miles south. Barge access from Berners Bay is about 12 miles away. The gradient and depth of adjacent waterways is too shallow to allow direct access so dredging will be required. A conveyor system or road may be necessary to transport the material. A proposed Juneau-Haines-Skagway highway project may improve access to this deposit.

Figure 10. - View east up East Fork Lace River toward the glacier. Note patchy nature of overburden and occurrence of boulders that is typical of the upper valley. (photo by K. Maas)

Berners River sand deposit

Location: Juneau D-3 quadrangle
T35S R62E sections 12,13;
T35S R63E sections 7,8,18.

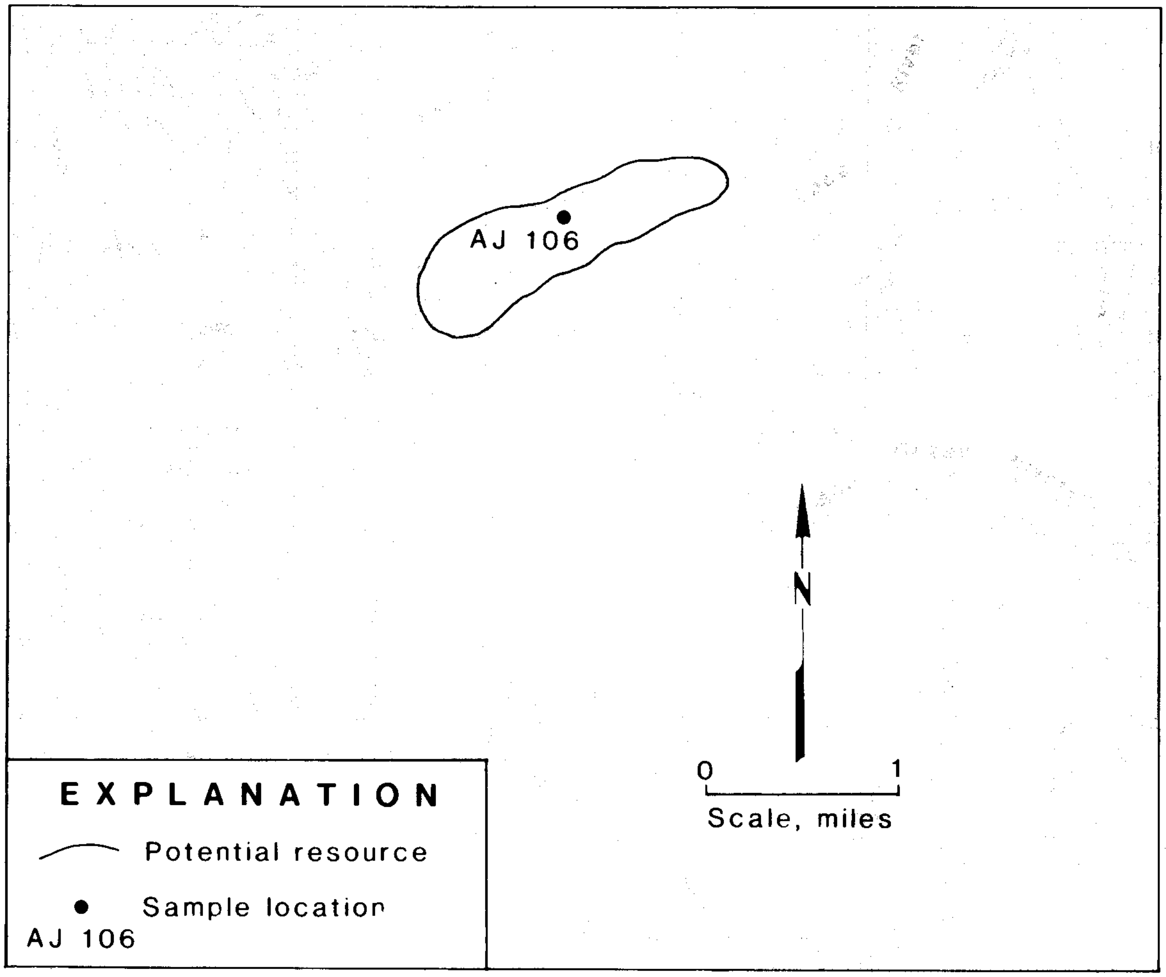


Figure 11. - Berners River sand deposit.

Sample Taken: AJ 106 (fig. 11).

Analytical Results/Highlights: (see Appendix B for complete results).

Sample AJ 106 exceeds specifications for degradation, AASHTO T-104 (fine aggregate only), and sand equivalent, ASTM D-2419, but fails the sieve analysis, AASHTO T-27, test.

Nature of Deposit: The Berners River is a low-gradient, low-energy anadromous-fish stream with a well-developed delta forming at the mouth and older sand bars and terrace deposits occurring downstream. These features all contain sand and silt with no visible coarse material. The main river channel contains small-scale gravel bars, but no major terrace or morainal features were discernible due to heavy vegetation. Deltaic sand is mature and homogenous with quartz and feldspar dominating. Locally, small silt layers overlie sand and were probably deposited after flooding. A few lithic fragments and other deleterious material were noticed in the sample, but minimal degradation (0.33% total weight loss) occurred during the degradation-soundness test (AASHTO T-104).

Vegetation and Overburden: The delta and sand bars at the mouth of Berners River are devoid of vegetation; however, terrace treads to the south are thickly vegetated by spruce, cottonwood, alders, and willows. There is no soil development on sand bars, but nearby terraces have up to 2 inches of organic/oxidized sandy soil.

Deposit Dimensions: The available resource occurs east of the entrance to the river and away from vegetated terraces. Development may occur in conjunction with dredging necessary to access the huge gravel deposits up Lace River. Taking these factors into account, there are approximately 100 acres that could be workable. A working depth of 20 feet appears reasonable after extrapolating refractive seismic results obtained on the nearby Antler River fan (*21*). These parameters delineate over 3.2 million yd^3 of material.

Gold Content: Placer analysis of the minus 14-mesh fraction yielded 0.00000304 oz/yd^3.

Proximity to Infrastructure: The nearest established power supply is near Eagle River, approximately 24 miles south. Barge access is 3 miles to the south and dredging would be required to get near the deposit. A proposed road to Haines would intersect this deposit. If crushed rock is used in road construction, this sand resource could be used to bind the construction aggregate.

Berners River is an anadromous-fish stream and dredging will have to be coordinated to preclude interference with fish spawning. Berners Bay is also a scenic recreational area and visible removal of vegetation or mining will be met with resistance from the environmental community.

Antler/Gilkey Rivers

Location: Juneau D-3 quadrangle
T35S R63E sections 16,19-26,29,30.

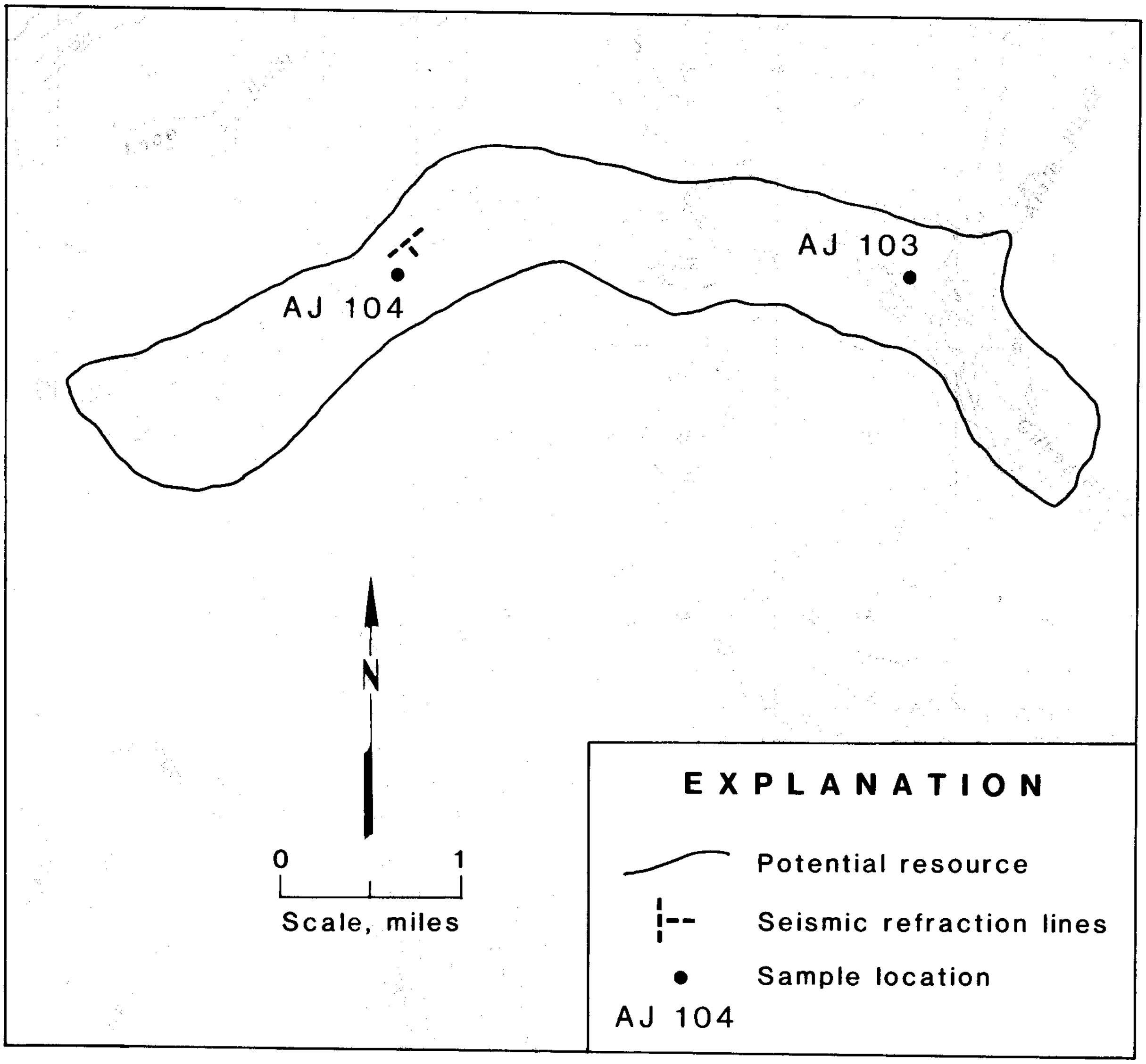


Figure 12. - Antler/Gilkey Rivers.

Samples Taken: AJ 103, AJ 104 (fig. 12). Seismic refractive methods were employed near site AJ 104.

Analytical Results/Highlights: (see Appendix B for complete set of results).

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
AJ 103	9.2 % loss	0.43 % loss	1.15 % loss
AJ 104	11.8 % loss	0.11 % loss	0.70 % loss

Nature of the Deposit: This deposit begins near the confluence of Antler and Gilkey Rivers and continues to the eastern shore of Berners Bay. Gilkey River is a high-energy system relative to the Antler and its sediment load appears to make-up the majority of the deposit. The deposit consists of glacial outwash and river bars mixed into a developing alluvial plain (fig. 13). The material is well graded. There is a low percentage of boulders in the deposit and the material is generally subround to round. Near the mouth of Gilkey River, the deposit contains abundant sand sheets, channel fills, and overbank bars related to annual floods. This creates some vertical and horizontal variation in the deposit.

The gravel material is composed mainly of diorite, granodiorite, gabbro, orthogneiss and minor volcanic constituents. There are iron-oxide coatings on less than 5% of the rocks but, generally, rocks are free of deleterious substances. Because only about 25% of the sample passes the 4-mesh screen, there is considerable potential for a high-quality crushed aggregate product from this source.

Vegetation and Overburden: Antler River floodplain above the confluence with Gilkey River is covered by alder stands, shrubs, grasses, and/or boggy muskeg. This illustrates the low-energy nature of the environment. Below the confluence of the Antler/Gilkey Rivers, scattered stands of cottonwood, alder, and willow thickets cover about 20% of the deposit. Developing river bars are largely unvegetated, but those bars outside of the actual floodplain are vegetated. A 3-inch oxidized soil profile, including silt, sand, and minor organic matter, has developed near sample site AJ 103, but farther downstream no true soil layer has developed.

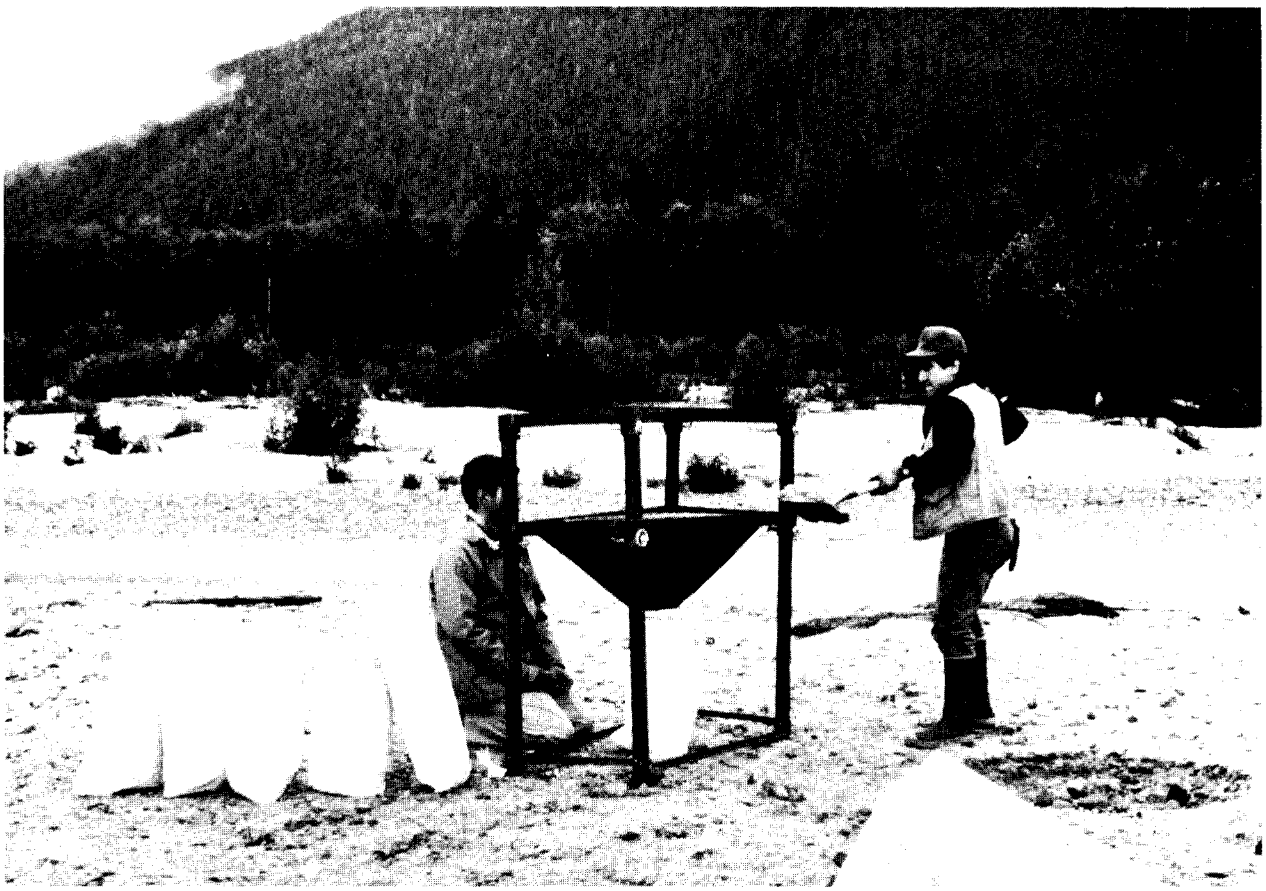


Figure 13. - Sampling gravel along Antler River. Note the vegetation seen in the background. Sample pit is in lower right portion of this photo. (photo by J. Kline)

Deposit Dimensions: The Antler/Gilkey River system is a braided, anadromous-fish stream. Large gravel deposits occur outside the actual waterway but within the floodplain. Using aerial photos in conjunction with the boundaries drawn on Figure 12, a surface area of nearly 1,000 acres was delineated as a resource. Seismic refraction studies performed east of the rock spur dividing Lace and Antler Rivers revealed a depth of 80 feet to bedrock (*21*). Depth probably increases to the east, moving away from bedrock, but a conservative depth of 40 feet was used to make a volume estimate of 64 million yd^3 of material.

Gold Content: Placer analyses of the minus 14-mesh fraction of the above samples revealed the following:

Sample	Grade
AJ 103	0.0000140 oz/yd^3
AJ 104	0.0000493 oz/yd^3

At $400/oz, these grades indicate values ranging from $0.00561 to $0.0197/$yd^3$.

Proximity to Infrastructure: The nearest established power supply is at Eagle River, approximately 22 miles south. Barge-loading facilities can be constructed within 2 miles of the deposit. Transporting material from the confluence of Antler and Gilkey Rivers, about 3.5 miles away, can be accomplished by hauling along temporary gravel roads. Construction of a Juneau-Haines-Skagway highway could utilize the high-quality gravel in this deposit.

Herbert/Eagle Rivers outwash

Location: Juneau C-3 quadrangle
T38S R64E sections 25,35,36;
T38S R65E sections 30-33;
T39S R64E sections 1,2,11;
T39S R65E sections 4-6.

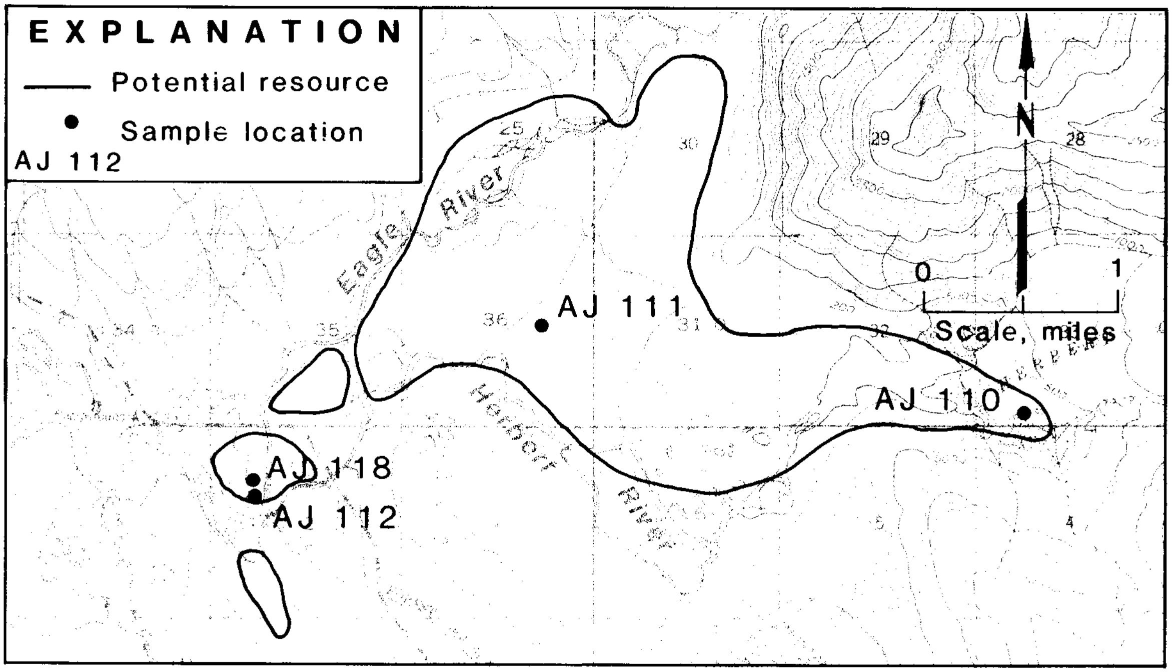


Figure 14. - Herbert/Eagle Rivers outwash.

Samples Taken: AJ 110, AJ 111, AJ 112, AJ 118 (fig. 14).

Analytical Results/Highlights: (see Appendix B for complete set of results).

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
AJ 110	14.2 % loss	0.39 % loss	1.30 % loss
AJ 111	12.3 % loss	0.18 % loss	0.60 % loss
AJ 112	8.5 % loss	0.23 % loss	1.28 % loss
AJ 118	13.9 % loss	0.27 % loss	0.89 % loss

These results suggest that the aggregate quality improves downvalley. Sand equivalent measurements (ASTM D-2419) reveal that more glacial flour occurs near the glacier (sample AJ 118 and sample AJ 110 tested 97 vs 83, respectively, with 75 being the minimum acceptable level) than farther onto the outwash plain.

Nature of the Deposit: The large surficial deposit between the Herbert and Eagle Rivers is mainly reworked glacial outwash material that originated as morainal deposits. The deposit becomes alluvial in nature nearer the confluence of the two rivers as gravel bars and flood deposits become more prevalent. There is some heterogeneity to the outwash plain as unsorted lateral moraines and kames are present within 0.5 miles of retreating Herbert Glacier. These features contain large boulders of granodiorite and orthogneiss in an unsorted matrix. Both active and inactive channels are cut into the deposit on both a large and small scale, forming braids and sinuous lenses of silty material and leaving terraces.

There is minimal compositional variation between sample sites. Quartz diorite, granodiorite, orthogneiss and altered felsic intrusive rocks comprise between 75% and 90% of the material throughout the deposit. Individual particles are generally well rounded but slightly pitted due to breakdown of micas in the rocks. Iron-oxide coatings appear on up to 50% of the rocks excavated from the upper 6 inches of the test pits, but generally this was observed only on quartz rocks containing sulfides.

Material downstream from the highway was once part of a State material site that no longer has a valid permit. Excellent granitic material (sample AJ 112) occurs in bar deposits that are partially overlain by flood deposits 6 to 7 feet thick.

Figure 15. - Samples were carried out from remote locations with helicopter assistance. Slingloaded material is shown leaving the Herbert River area. (photo by K. Maas)

Vegetation and Overburden: Most of the outwash plain is heavily vegetated except for the active plain near Herbert Glacier terminus (sample AJ 110). Abundant spruce trees ranging from 5 to 30 feet in height occur, as do small cottonwoods and alders (fig. 16). Abandoned channels contain dense shorter spruce, small brush and moss. A turf mat and a 0.5 inch thick sandy loam soil horizon were observed on the outwash plain. Near the confluence of the two rivers where gravel bars are active, little vegetation or soil is developed. There is an abundance of vegetation on 75% of the area, which hindered sampling because permits were not obtained to remove excess vegetation.

Deposit Dimensions: Herbert and Eagle Rivers are anadromous fish streams and development will be prohibited within the active channels during specific periods. With this constraint, the available resource encompasses nearly

1,500 acres. It is reasonable to assume that gravel depths exceed 50 feet throughout the outwash deposit; however, in order to reduce the visual impact of gravel extraction, a dry-pit operation without benching will be required east of the highway. A dragline operation will be necessary below the highway bridge because the water table is shallower there. Assuming a 25-foot depth, over 60 million yd^3 of material will be available.

Gold Content: Placer analyses of the minus 14-fraction screened from the 0.25 yd^3 samples yielded the following:

Sample	Grade
AJ 110	0.0000295 oz/yd^3
AJ 111	0.0000336 oz/yd^3
AJ 112	0.0000871 oz/yd^3
AJ 118	0.0000836 oz/yd^3

The gold grade increases nearly three-fold below the highway. At $400/oz for gold, the average gold value below the bridge will be $0.034/$yd^3$.

Proximity to Infrastructure: These deposits are adjacent to an established highway and power supply. The Juneau market is nearly 20 miles away. A barge-loading facility has been permitted at Lena Point, 9 miles away, for possible shipment of aggregate.

The Herbert and Eagle River area is highly valued for its recreational opportunities, and hiking trails exist adjacent to both rivers. A proposed State Park near the highway will also restrict development. If needed, a right-of-way through the park will allow access to both the gravel resource and active mining claims located on both sides of the valley.

Figure 16. - Geologists survey vegetation present at the Herbert/Eagle Rivers outwash deposit. The abundance of overburden made it difficult to sample this deposit. (photo by K. Maas)

Tee Harbor borrow site

Location: Juneau B-3 quadrangle
T40S R65E section 7.

This site occurs adjacent to Glacier Highway across from the Point Stephens Road turnoff. Lynn Canal Fire Station was built within the pit (fig. 17).

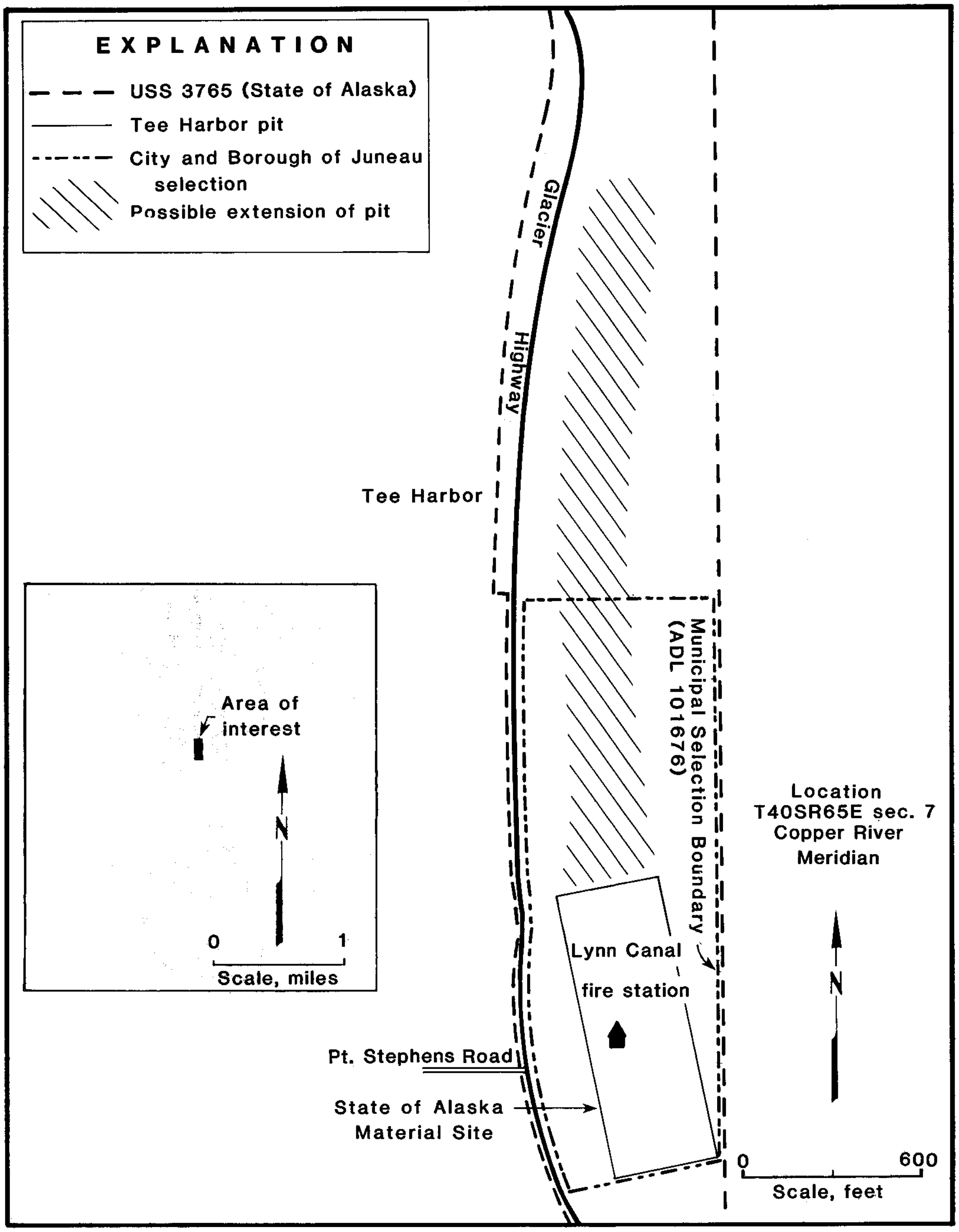


Figure 17. - Tee Harbor borrow site.

Samples Taken: The Bureau did not sample this site. Previous workers have sampled and characterized the deposit (*17, 21*).

Nature of the Deposit: This raised-beach deposit is composed of a mixture of stratified sand, gravel, cobbles and large boulders characteristic of a beach deposit. The material ranges in shape from round to angular. The strata dip about 30 degrees west. Overlying this raised beach is a layer of colluvium and talus boulders that has slid down the steep slopes that extend 1,000 feet above the pit floor. North of the established pit is an undeveloped deposit of similar geology. State of Alaska owns this parcel of land (USS 3765), a portion of which has subsequently been selected by CBJ (ADL #101676).

Although the material is not well graded throughout a 22 foot cross-section, there is some sorting within individual beds. A 2-foot layer of cobbles and gravel in a sandy matrix overlies an 8-foot-thick sandy layer with less gravel and minor cobbles, which overlies a 12-foot section of angular gravel and cobbles with up to 35% sand (*17*). Selective screening may yield D-1 material or pea gravel.

Vegetation and Overburden: The undeveloped area to the north of the pit is heavily vegetated by tall spruce and hemlock with an understory of low brush and alders. An organic mat, locally exceeding 1 foot in thickness, overlies the valuable borrow material. Portions of this organic mat could be screened to produce a topsoil product.

Deposit Dimensions: Applying the dimensions outlined in Figure 17, (1,700 feet x 150 feet x 20 feet), there is a minimum of 190,000 yd^3 of material available. If the deposit extends to Tee Creek, an additional 200,000 yd^3 of material will be present. Width and depth dimensions are subject to variation along the trend of this deposit, due to the steep slope to the east, adding uncertainty to this volume estimate.

Proximity to Infrastructure: This deposit is adjacent to a highway and power lines. A berm will have to be constructed adjacent to the highway to decrease the visual impact associated with gravel extraction. The proposed barge-loading facility at Lena Point is 3.5 miles away.

Dredge Lake

Location: Juneau B-2 quadrangle
T40S R65E sections 7,8,17,18.

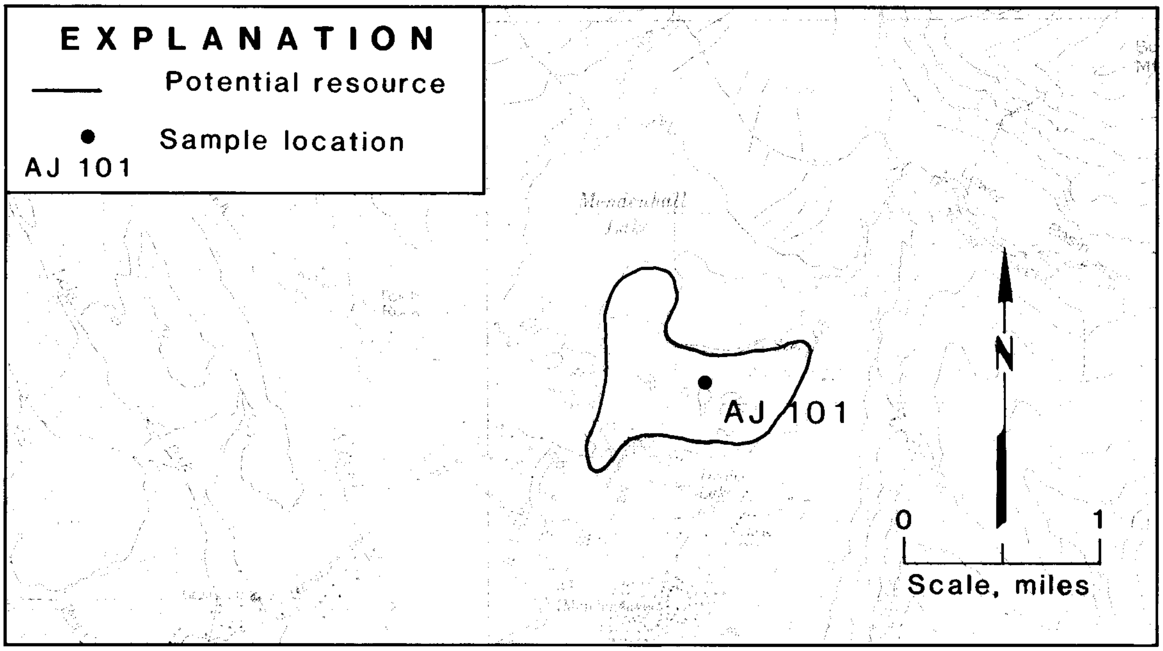


Figure 18. - Dredge Lake.

Sample Taken: AJ 101 (fig. 18).

Analytical Results/Highlights: (see Appendix B for complete set of results).

The abrasion test (AASHTO T-96) for this sample resulted in a 12% loss. The degradation test (AASHTO T-104) revealed a 0.36% loss for coarse aggregate and a 0.69% loss for fine aggregate.

Nature of the Deposit: Dredge Lake was a gravel source during the development of subdivisions and roads in the Back Loop area of Mendenhall Valley.

This area is located on a terminal moraine formed after the last advance of Mendenhall Glacier during the 1800s. The moraine has been modified and dissected by outwash streams. Morainal crests are interrupted by channels of graded outwash creating a terraced effect. There is vertical variation in the quantity of silt throughout the deposit, probably related to this channeling effect, which will affect the usefulness of the material. The northwest corner of the Dredge Lake site is composed of deltaic sediments laid down by Steep Creek where it enters Mendenhall Lake (*15*). This area probably contains siltier material than moraine-outwash deposits to the southeast.

Moraines contain significantly more cobbles and boulders than the outwash. The material is composed primarily of metasedimentary rocks (including phyllite and mica schist), quartz diorite, diorite, orthogneiss and other felsic intrusive rocks. Most of the gravel is round to subround, and metasedimentary rocks are highly pitted due to the breakdown of micas. Iron-oxide coatings occur on 30% of the material (mainly the minus 3-inch fraction) and is mainly the result of oxidization of biotite schist.

Vegetation and Overburden: The area includes patches of alder, cottonwood, and willow that are interrupted by small kettle lakes, stream tributaries and recreational-vehicle trails. The remaining surface area is covered by moss, grass, sedge, and small brush or is devoid of vegetation. Soil development is minimal. A rudimentary "A" horizon with silt enrichment in the upper 1 to 2 inches has developed under vegetated areas.

Deposit Dimensions: Development of at least 250 acres could be possible to depths approaching 20 feet, yielding approximately 8 million yd^3 of workable gravel.

Gold Content: Placer analysis of the minus 14-mesh fraction screened from the original 0.25 yd^3 revealed 0.0000594 oz/yd^3. Sample AJ 101 was taken from outwash and probably contains more gold than could be recovered from the overall deposit.

Proximity to Infrastructure: Dredge Lake is located adjacent to Loop Road, a part of the Juneau road system. Power lines exist along the roadway. A series of existing gravel access roads could be used to access portions of the deposit.

The Dredge Lake project area is within Mendenhall Recreational Area, a USFS park, and under present management guidelines is unavailable for development. Residential subdivisions adjoin the area, making a buffer zone necessary. Existence of valuable borrow material is indisputable, and because Alaska Department of Fish and Game has expressed interest in improving nearby salmon-spawning grounds, gravel extraction could occur in conjunction with this activity.

Grizzly Bar (Taku Inlet)

Location: Juneau B-1 quadrangle
T40S R69E sections 7,17-20,29.

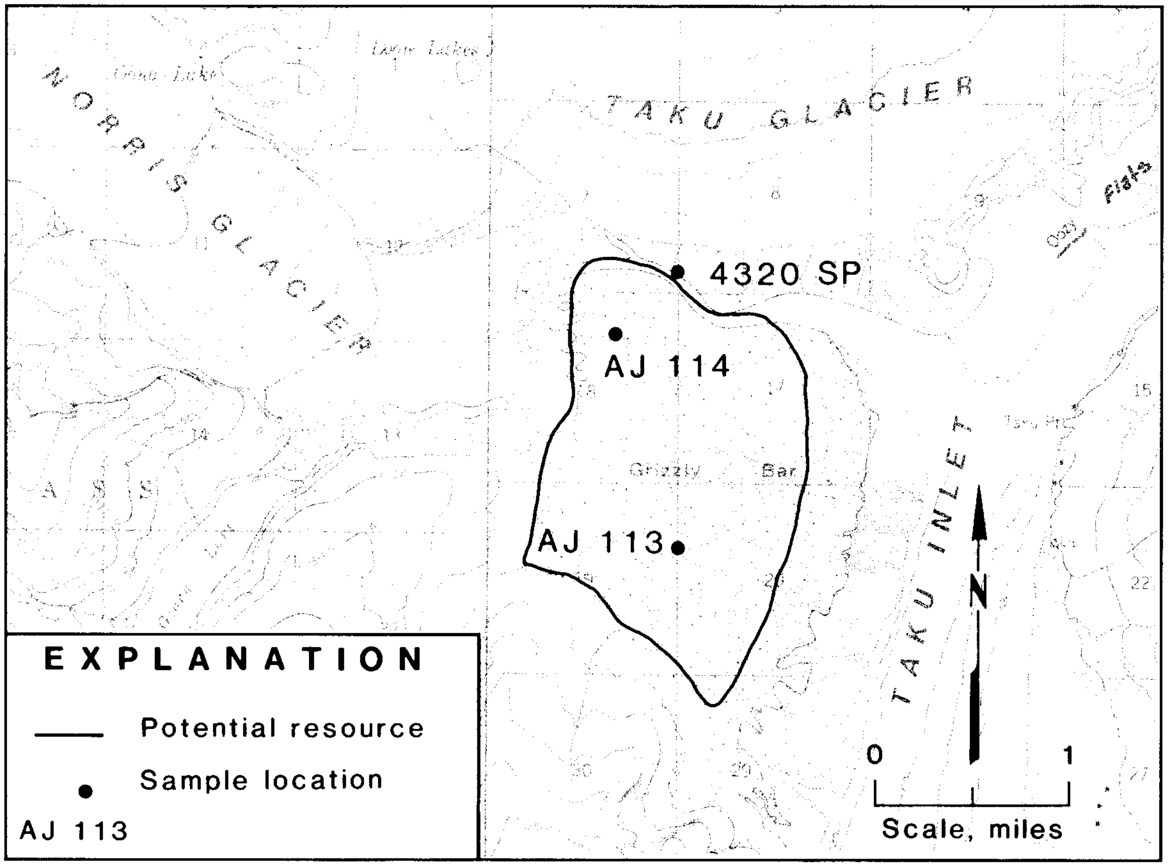


Figure 19. - Grizzly Bar (Taku Inlet).

Samples Taken: AJ 113, AJ 114, 4320 SP (fig. 19).

Analytical Results/Highlights: (see Appendix B for complete results).

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
AJ 113	11.5 % loss	0.24 % loss	0.70 % loss
AJ 114	15.4 % loss	0.20 % loss	0.26 % loss

The amount of material lost during the abrasion test for AJ 114 is abnormally high for the rock types present. This loss may occur in highly fractured, weathered rocks but, observations at the site during sampling do not support this conclusion. Normally, felsic igneous rocks are more durable than these numbers suggest (see Lace River test results).

Sample 4320 SP was a concentrate derived from 0.1 yd^3 of material processed through a 4-foot sluice box. The sample was taken to determine the increase in gold recovery after crushing the original material to 70-mesh. The owners of 91 unpatented mining claims on this deposit reported a five-fold increase in gold recovery would occur using this methodology (*10*) (see gold content section for details).

Nature of the Deposit: Grizzly Bar is a large outwash area extending from the termini of Norris and Taku Glaciers to the waters of Taku Inlet (fig. 20). Material in this outwash fan most likely includes both Norris Glacier outwash and Taku Glacier morainal material. A distinct size sorting exists across the deposit, which is partly due to interaction of outwash streams, tidal currents, and Taku River. Coarser material predominates between Norris Glacier terminus and the forest east of sample site AJ 113. Although the material becomes finer grained east of this forest, there is probably coarser gravel beneath these sediments (*26*). There is a highly variable gradation of particle size in both horizontal and vertical directions on a local scale, which can be attributed to the braided nature of the outwash channels that are ubiquitous. Deposition after flooding has produced fine-grained lenses of sandy material overlying channel fills.

The sampled area occurs on an outwash plain between two morainal mounds that have 3 to 4 feet of surface relief. Large boulders are scattered in the mounds but are rare in outwash channels. Composition of the gravel is predominantly granodiorite and schistose rocks, with other felsic intrusive rocks, volcanic rocks, and metasedimentary rocks present. The material is generally round to subround and there is a very low percentage of iron-oxide coatings on the gravel. Overall, the material appears durable because fractures and weathering effects are minimal.

Vegetation and Overburden: There is a wide variety in the amount and distribution of vegetation and overburden across the deposit. A well-developed spruce/cedar forest grows in the central part of the deposit with subordinate cottonwoods and alder along the fringe. Another smaller forest has colonized on outwash gravel north of sample site AJ 114. An organic mat 1 to 2 inches thick, composed of moss, humus, and lichen, overlies the gravel away from this forest. Scattered clumps of small bushes and thickets, along with unvegetated areas are interspersed with this mat. Soil development is weak, however, loess is concentrated in upper layers of the organic mat.

Deposit Dimensions: Grizzly Bar covers nearly 4 mi^2 but, the portion near tidewater contains abundant fines and has been excluded from this resource projection, leaving nearly 2,000 acres of workable gravel. The deposit is at least 20 feet thick (similar to other glacial outwash deposits in the area) and has an estimated reserve of over 60 million yd^3 of material.

Gold Content: Placer analysis of the minus 14-mesh fraction screened from the original 0.25 yd^3 sample revealed:

Sample	Grade
AJ 113	0.000137 oz/yd^3
AJ 114	0.000178 oz/yd^3

At a gold price of $400/oz, the range of values in these samples is between $0.0547 and $0.0714/yd^3. In addition to gold recovered from the engineering samples, a 0.1 yd^3 sample was taken to determine the presence of gold across the cutbank of the present outwash stream emanating from Norris Glacier (sample 4320 SP). This material was concentrated in a 3-foot sluice box; the concentrate yielded 1.44 ppm gold.

One additional test was performed to determine the presence of gold in this deposit. Claim owners reported a five-fold increase in gold recovery after crushing the original material to 65 mesh or finer (*10*). To test this hypothesis, an additional sample was taken from the 0.25 yd^3 engineering sample holes. The material was screened to three different size fractions, including minus 14-mesh, minus 0.25-inch to plus 14-mesh, and plus 0.25-inch. The minus 14-mesh material was concentrated and amalgamated to extract any gold. Middlings and tails from this process were then crushed to 70-mesh and rerun over the concentrating table to determine if any more gold was liberated. The other two size fractions were then independently crushed to 70-mesh and run over the table to produce a concentrate that was then amalgamated. Results of this test are as follows:

Sample	Size fraction	Dry weight (lb)	Gold weight (oz)
AJ 113 SP	-14 original	31.25	0.000000161
	-14 crushed	31.25	0.000000161
	-1/4 +14 crushed	17.00	0.000000064
	+1/4 crushed	32.50	no gold
AJ 114 SP	-14 original	48.00	0.00001360
	-14 crushed	48.00	0.00000524
	-1/4 +14 crushed	37.50	0.00000579
	+1/4 crushed	101.25	no gold

Sample	Size fraction	Dry weight (lb)	Gold weight (oz)
4320 SP	-14 original	52.75	0.00000402
	-14 crushed	52.75	0.00000553
	-1/4 +14 crushed	48.25	0.00000498
	+1/4 crushed	147.00	0.00000424

Although over eight times as much material was processed in the original state for AJ 113 compared to AJ 113 SP after crushing (253 lb to 31.25 lb, respectively), over 103 times more gold was recovered from AJ 113 (0.0000342 oz compared to 0.000000322 oz). Over three times more material was processed in the original state for AJ 114 than AJ 114 SP as a crushed entity (175 lb to 48 lb, respectively) and gold recovery was over 2.3 times more for AJ 114 (0.0000446 oz to 0.0000188 oz, respectively). The results from this test do not confirm the owners allegations. The action of water on loose sediments concentrates the dense, heavy materials by removing the lighter, surrounding material. Crushing large particles does not guarantee gold liberation unless the material is gold-bearing. There is no geologic evidence that this is the case. Additional evidence is found after crushing the plus 0.25-inch fraction of these two samples to 70 mesh and then processing them across a concentrating table for gold. Both samples contained no gold after this procedure.

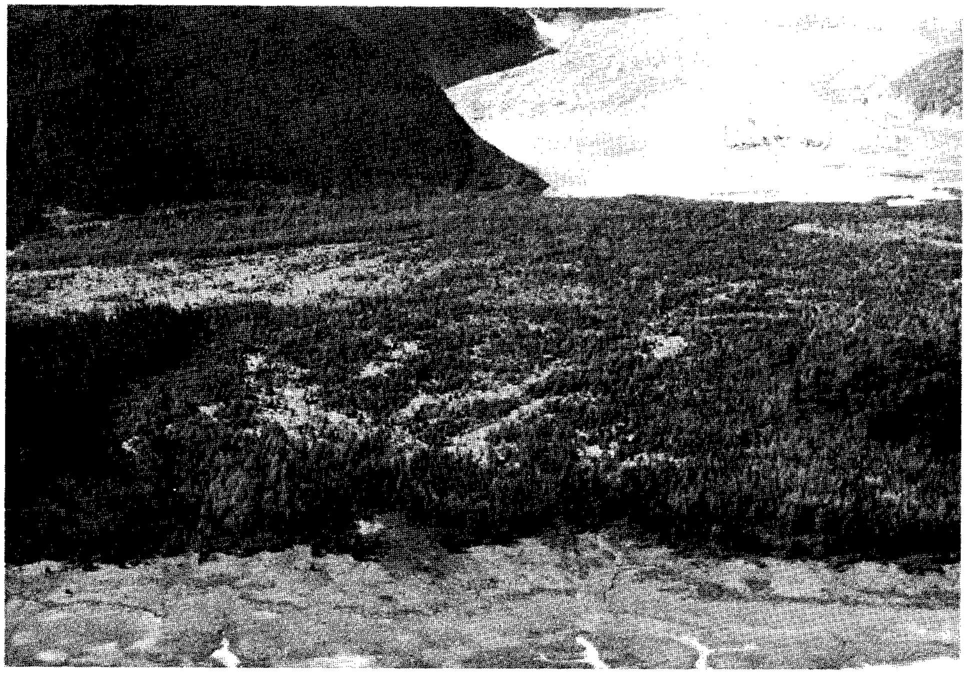
Results from analyzing sample 4320 SP are interesting because more gold is liberated each time a size fraction is crushed. Total gold recovered after crushing all the size fractions was 0.0000188 oz, which is 4.6 times more than was recovered from only the original minus 14-mesh fraction (0.00000402 oz). The heterogeneous nature of the deposit is responsible for these conflicting results. Overall benefit related to crushing Grizzly Bar material to 70 mesh is not supported by this test.

Proximity to Infrastructure: Grizzly Bar is approximately 26 miles from downtown Juneau and about 32 miles from the Greens Creek Mine loading terminal at Youngs Bay on Admiralty Island. There are no roads in the immediate vicinity and this resource will have to be exploited by barges, conveyors and draglines. Taku River is very shallow in this area and port facilities will have to be dredged. There are no existing power lines into the area, but Annex Creek hydroelectric facility is only 6 miles away and connections could be made. This resource could be used if an access road to Juneau is built through Taku River valley. It is also a potential aggregate resource after the reserves are depleted in the immediate Juneau area.

There is a total of 91 active, unpatented State and Federal mining claims covering the deposit and any sand and gravel extraction would have to be coordinated with placer gold recovery. Laws governing locatable minerals (gold) and common variety materials (sand and gravel) are different, and any extractive gravel operation will require a separate lease.

Taku River is an anadromous-fish stream and sports one of the major commercial salmon fisheries in Southeast Alaska. Moose also make their home on Grizzly Bar.

Figure 20. - (next page) Two views of Grizzly Bar: (*upper*) - View NNW toward Norris Glacier. Low-discharge streams transport fine-grain material into Taku Inlet. (*lower*) - View NNE toward Norris River and Taku Glacier. This part of the bar contains relatively coarse material and minimal vegetation. Sample AJ 114 was taken in the open area near top of photo. (photos by J. Connolly)



Point Hilda

Location: Juneau A-2 quadrangle
T42S R67E sections 17-20.

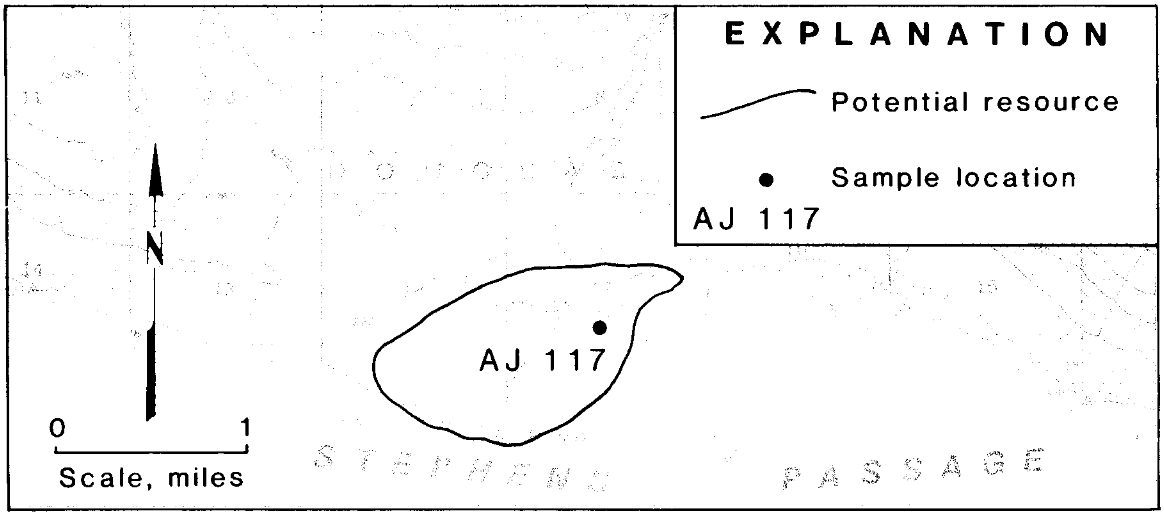


Figure 21. - Point Hilda.

Sample Taken: AJ 117 (fig. 21).

Analytical Results/Highlights: (see Appendix B for complete results).

Sample AJ 117 had a 17.8% loss during the abrasion test (AASHTO T-96). The high percentage breakdown during the AASHTO T-96 abrasion test is probably due to the slaty nature of phyllite and greenschist fragments in the sample.

The degradation test (AASHTO T-104) for coarse and fine aggregates resulted in a 0.19% loss and 0.42% loss, respectively.

Nature of the Deposit: The Point Hilda area is composed of alluvium and beach sediments. Alluvium is derived from volcanic rocks that crop out on the southwest side of Douglas Island. The beach front at Point Hilda is exposed to extreme wave action, and mechanical disintegration of rocks, gravel, and shells is common. Material transported along shore from the south will be deposited there rather than carried to the north because of shoreline geometry.

Sediments are well graded with a few boulders occurring locally. The majority of gravel is in the minus 3-inch fraction. A raised delta extends onshore from the beach front and is densely vegetated with a well-developed organic layer concealing sediments. An extensive berm separates the intertidal zone from this delta and is composed of fine-grained material. This berm represents a horizontal variation that could recur inland in the raised delta. Gravel bars exist along the main reach of Hilda Creek, but large terraces do not appear upstream. Old channels and terraces were inferred from the hummocky topography upvalley but these were largely concealed by vegetation.

Beach sediments are comprised mainly of greenstone and greenschist, with minor occurrences of green and black phyllite; shell fragments are abundant. There is very little iron-oxide coating this material.

Vegetation and Overburden: The beach at Point Hilda contains a sparse cover of grass and sedge but inland the vegetation changes substantially. A thick forest of spruce, alders and fir trees overtops a lower story of grasses and brush. An immature sandy soil mixed with humus and organic detritus more than 12 inches thick covers the raised delta.

Deposit Dimensions: Hilda Creek is an anadromous-fish stream, but the watercourse is confined to a narrow channel. With this limitation, nearly 300 acres of alluvial material could be developed to a depth of 10 feet. These dimensions indicate over 4.8 million yd^3 of borrow material is present. This is not a high-quality borrow source.

Gold Content: Placer analysis of the minus 14-mesh fraction screened from sample AJ 117 revealed 0.0000183 oz/yd^3. At $400/oz for gold, the value obtained there is $0.00731/$yd^3$.

Proximity to Infrastructure: There is no road access to Point Hilda but Stephens Passage is adjacent to the deposit and will allow barge access. Power lines exist along North Douglas Highway, approximately 8-10 miles away. If a road is built around Douglas Island, this is a resource that could assist development, although a hardrock source will produce better aggregate.

Other Areas

There are other areas in the CBJ with potential for gravel, including the Cowee Creek/Davies Creek confluence area, Mendenhall Wetlands State Game Refuge between Lemon Creek and Mendenhall River, and the perched delta on Eagle Creek on Douglas Island (fig. 8). These areas were not assessed in detail during this study.

The Cowee/Davies Creek area is heavily vegetated and sampling was impossible without considerable stripping of overburden. Cowee Creek also supports a major sports fishery. Source rocks in basins drained by both creeks contain considerable phyllite, which lessens their value as an aggregate source. There may be a large borrow resource in this area, but the availability of better-quality greenstone quarry rock in the immediate vicinity will preclude its use as an aggregate material. The proximity of Point Bridget State Park may restrict any development in the area.

Mendenhall Wetlands contains a huge resource of silty, gravelly material that is constantly being resupplied by fresh sediments from Lemon Creek, Mendenhall River, and the tide through Gastineau Channel. A high degree of vertical and horizontal variation is present throughout the deposit. Lenses of gravelly material overlie siltier material and winnowing by wave action has also helped to create variation. If a second bridge crossing the channel is constructed, restrictions on development of the borrow within the Refuge may be lifted because viable alternatives are scarce.

The perched delta along Eagle Creek on Douglas Island is observable from aerial photos, but it is highly vegetated and was not sampled. Judging from bedrock occurrences in this basin, deltaic material probably contains an abundance of durable greenstone. This deposit will warrant further evaluation if a second road is built around Douglas Island.

Suitable quarry rock is widespread in the Juneau area. Quality greenstone exists in many locations on Douglas Island and along the Juneau road system. Many factors influence the use of quarry rock for a particular project, but the main factor is economics. It can cost up to three times more to process crushed stone compared to natural aggregate.

SKAGWAY SUBAREA

Current Suppliers

The City of Skagway does not issue permits to extract sand and gravel. If the site occurs on State of Alaska land, then a permit from DNR, Department of Fish and Game, DEC, and other agencies will be necessary. Sand and gravel operations on private land include the H & H pit, the only private producer in the Skagway area. This pit is located beside and in the Skagway River, about 2 miles north of the city center (figs. 6 and 22). Management of this firm could not be contacted, so detailed information on the operation was not obtained. The operation is close to the State DOT pit, and material mined consists of various sizes of granitic, gneissic, and schistose gravel, cobbles and boulders. Currently, H & H is working out a compromise with the EPA over a citation issued for its diking strategy along Skagway River (*11*).

State of Alaska is removing sand, gravel and riprap materials from three active pits in the area. The main pit (fig. 22) is located just north of Reid Falls Creek along the eastern bank of Skagway River. The deposit has been drilled to 9 feet and generally contains gray, sandy gravel with boulders. The area has been divided into 4 cells for development purposes and contains approximately 100,000 yd^3 of material. At current depletion rates this should last between 20 and 30 years.

Other State material sites occur at the railroad talus slide, located just south of Reid Falls Creek, and at Liarsville (fig. 22), which is located 0.5 mile north of the main State pit.

Potential Resources

The Bureau sampled five locations within the Skagway area to gather reconnaissance information about potential sand and gravel supplies (fig. 22). Each of the samples contained 0.25 yd^3 of material (except for the sample collected near West Creek, which only contained 2.0 ft^3 of sandy material) and were tested for engineering qualities and gold content.

A complete listing of engineering results can be found in Appendix B.

West Creek

The confluence of West Creek and Taiya River occurs within the boundaries of Klondike Gold Rush National Historic Park. Sample WJ 26 was collected from the south side of this confluence. The sample contained an abundance of fines with 63% passing the 4-mesh screen. A winnowing effect on the fine-grained component is apparent after looking at a cross-section of the excavation. Cobbles are concentrated on the top and the material becomes sandier at depth. The sand equivalent value of 76 also confirms this condition. There was a 36.6% loss during the abrasion test of coarse aggregate, although the soundness tests for both fine and coarse aggregates were well within DOT specifications (*1*).

The site is covered by a thin layer of moss and abundant vegetation, including alders, poplar, and birch. The creek was within 50 yards of this sample site and it is an anadromous-fish stream. There is a park road near this site, but power lines were not observed.

No gold was recovered from this sample.

East Fork Skagway River

The junction of East Fork and main Skagway River is braided and reflects the extremely variable discharge and high sediment load that are characteristic of mountain tributaries that feed it. The gravel includes high-grade gneissic and granitic rocks with lesser amounts of intermixed volcanic and metasedimentary rocks. There is less sorting of the gravel there than along Taiya River.

Only 28% of the material sampled (WJ 28) passed the 4-mesh screen, reflecting the gravelly nature of the deposit. There was a 26.2% loss during the Los Angeles Machine test (AASHTO T-96) which is surprising for these durable rock types but this loss may be attributed to thorough fracturing. A high percentage of iron-oxide coatings on the gravel may also explain this degree of abrasion. Soundness tests (AASHTO T-104) of the fine aggregate showed 2.28% loss, which is relatively high for this test, but still within specifications mandated by DOT.

The site is covered by patches of alder, aspen and cottonwood. There is no soil profile, which demonstrates the dynamic nature of the deposit area. If the 80-acre site is developed to a 15-foot depth, there is over 1.9 million yd^3 of gravel resource.

Gold recovery tests done on the minus 14-mesh fraction revealed 0.00000103 oz/yd^3.

Taiya River

The mouth of Taiya River contains a deltaic deposit of clay, sand and minor gravel. Over 83% of the sample (WJ 25) by weight passed the 4-mesh screen and 20.6% passed the 200-mesh screen. Composition of these materials is largely granodiorite,

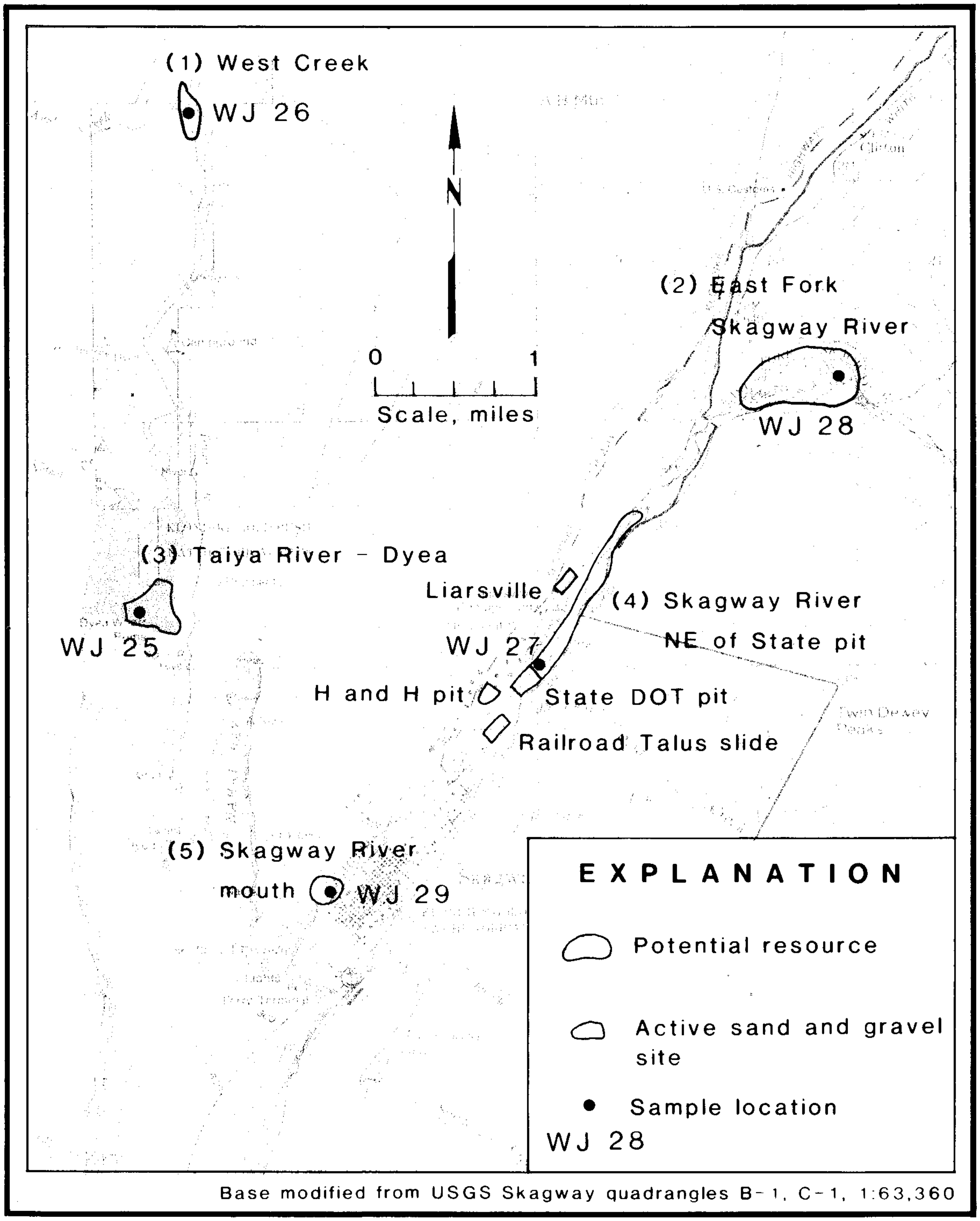


Figure 22. - Sand and gravel resources in Skagway and vicinity.

hornblende gneiss, and felsic intrusive rocks. Iron-oxide coatings occur on less than 5% of the material.

Gradational variation of the material is more prevalent on this site than along Skagway River. Horizontal variation occurs as a result of tidal action reworking deltaic material, leaving gravel berms of a coarser nature than surrounding sediments. Vertical layering was observed locally during excavation in the form of pebbly sands overlying dense clay, that overlies a sandy clay layer with minor intermixed cobbles (up to 4 inch diameter).

Vegetation consists of grasses at this location, and no soil has developed due to tidal action. The deposit occurs at the head of Taiya Inlet, which is accessible by barge and an old road. Klondike Gold Rush National Historical Park is less than 0.5 mile away and is visible from the site, perhaps limiting major development.

Gold recovery from the minus 14-mesh fraction yielded 0.00000553 oz/yd^3.

Skagway River - NE end of State pit

The main reach of Skagway River south of its confluence with East Fork Skagway River and north of Reid Falls is braided and contains high-quality aggregate. The material sampled (WJ 27) at the northeast end of the State pit is composed of subround to round gneiss and diorite cobbles and gravel with iron-oxide coatings. These coatings were probably developed by leaching of pyritized quartz veins cutting intrusive and gneissic rocks. Quartz float is common in these gravels. Erosion has locally removed fine-grained sediments, creating local boulder lags along this reach of the river.

Vegetation is common along riverbanks, but little occurs on bars within the channel. Small alder trees dominate, but grasses and small bushes are also present. The sample site is near the active State pit so transportation and power are available to develop this deposit.

Gold recovery from the minus 14-mesh fraction yielded 0.00000116 oz/yd^3.

Skagway River mouth

Sample WJ 29 was collected near the south end of the airstrip, just west of the mouth of Skagway River. The material contains a high percentage of gneissic and granitic rock, similar to other samples taken farther upriver. The material is well sorted at this locale because nearly 75% of the material was retained on screens larger than 4-mesh. However, no large boulders were encountered. Gradational variation was not readily visible at this site. Iron-oxide coatings were minimal. Soundness tests (AASHTO T-104) of the material gave favorable results as weight loss for coarse and fine aggregates was 0.24% and 1.41%, respectively.

Vegetation consists mainly of low grasses, with alders and cottonwoods increasing along the periphery of the airstrip. This location is adjacent to the city center and the infrastructure necessary to support an operation is present within 0.25 mile.

Gold recovery from the minus 14-mesh fraction was 0.000000514 oz/yd^3.

Skagway Summary

The most favorable location for future aggregate development appears to be in the area from the existing State pit and the H & H pit along the Skagway River north to the confluence with the East Fork Skagway River. This area contains approximately 100 acres of exploitable resource and if excavated to a 10-foot depth will provide at least 1.6 million yd^3 of aggregate material. This development will be met with an array of stipulations as previous extraction from Skagway River was accomplished in a haphazard manner.

A comprehensive plan governing use of Skagway River is being developed and this document will provide details about mining gravel resources (*11*). Our work indicates that the gold content in these gravel is insignificant and probably will not be a factor in the economics of a future project.

HAINES SUBAREA

Current Suppliers

There are three suppliers of sand and gravel and crushed stone in the Haines area. Northern Timber Corporation operates the largest pit and offers a complete line of products and services. Heinmiller gravel pit supplies pit-run borrow material to local building contractors and the general public. Turner Construction has recently acquired a large parcel of land from which pit-run material and talus boulders can be obtained. Waldo Enterprises operates a portable concrete batch plant using aggregate from the Heinmiller pit. Asphalt aggregate is produced when it is needed for a particular highway project and the subcontractor will supply a portable plant to make the material.

City of Haines and Haines Borough do not issue permits to sand and gravel operators. The operator must obtain the necessary permits from the appropriate regulatory agencies of the State of Alaska and the Federal Government prior to extracting the resource.

Note: Numbers following the company name refer to map location designated on Figure 23.

Northern Timber Corporation (1): Northern Timber Corporation operates a gravel pit and processing plant at 4-mile, Haines Highway. The pit is actually a combination of two deposits. An alluvial terrace provides sand and gravel necessary to make screened products and pit-run fill, and an adjacent boulder talus provides the raw material for riprap and crushed-stone products.

Products offered include:

1) Processed D-1: greater than 70% fracture surfaces screened to a minus-1-inch size; used in subbase road construction;
2) Natural D-1: screened gravels in same size range but without fracture surfaces; used in driveway construction;
3) 1.5-inch to 0.375-inch chip: used in drain fields;
4) 0.75-inch to 0.375-inch washed chip: used in sealcoat for road surfacing;
5) 0.375-inch to 4-mesh washed sand: also used in sealcoat for roadways;
6) Minus 4-mesh: used in fine aggregate for concrete;
7) Riprap: rockwalls, stabilizing agent;
8) Pit-run: fill material.

These products range in price from \$2.00/yd^3 for pit-run fill up to \$26.50 for the washed-fractured sealcoat materials. A standard D-1 product goes for \$12/yd^3. The company will haul material at \$55/hr with a \$1/yd^3 loading fee in their 10yd^3, 12yd^3 or 18yd^3 trucks.

The company produced approximately 25,000 yd^3 during 1987 and 1988. They estimate at least 1 million yd^3 of combined talus and gravel are still available (*25*).

Heinmiller Pit (2): Heinmiller gravel pit is located on private land within the Haines city limits near the State fairgrounds. The pit supplies common borrow to local contractors and the general public at \$2/yd^3. The material is alluvial in origin and contains a high percentage of silt and clay, which limits its usefulness. A topsoil product could be made from the overburden material, but the user must make it.

The company does not provide any services related to the pit. Production for 1988 is estimated at 500 yd^3. There are approximately 200,000 yd^3 of fill remaining on the property (*12*). Heinmiller Pit is closed in 1989 because of trespass dumping and will remain closed until the problem is cleaned up.

Turner Construction Co. (3): This local contractor recently purchased a 52-acre parcel within the city limits to more easily obtain rock and gravel for his construction needs. The company will also sell the material to the public for \$2/yd^3, with a \$1/yd^3 loading fee.

The parcel contains about 10 acres of pit-run material composed of both glacial till and slide debris from Mt. Rapinski. There is little overburden covering the estimated 200,000 yd^3 of available fill material. Slide rock in the plus 6-inch size range is used to construct French drains, which are essentially culverts used to channel subsurface flow. The remainder of the property is composed of bedrock.

The company expects to produce a shot-rock product from their property when the market requires it. Talk of expanding harbor facilities in Haines has aroused this company's interest (*30*).

Waldo Enterprises: This company operates the local portable concrete batch plant, producing concrete products from raw materials obtained from the Heinmiller pit. The batch plant will be seeking a new source of raw material in 1989. The owner of the company was not available for further comment.

Potential resources

The Bureau took reconnaissance samples from gravel bars along the banks and within the braided reaches of Klehini and Katzehin Rivers; at the major deltas formed by tributaries along lower Chilkat River (Tsirku, Tahkin, and Kicking Horse Rivers); at the mouth of Ferebee and Endicott Rivers; and from large outwash fans emanating from Davidson Glacier and an unnamed glacier south of it (fig. 24). Engineering tests (app. B) and gold recovery were performed on 18 samples from these 9 areas and site descriptions were performed at 6 additional locales within these areas.

A large portion of the gravel resource in Haines Borough lies within Chilkat Bald Eagle Preserve. Development is against management policy for this area. Exact boundaries for this sensitive area can be found in the Haines State Forest Resource Management Plan (2).

Deposits are discussed in sequential order as they appear on Figure 24.

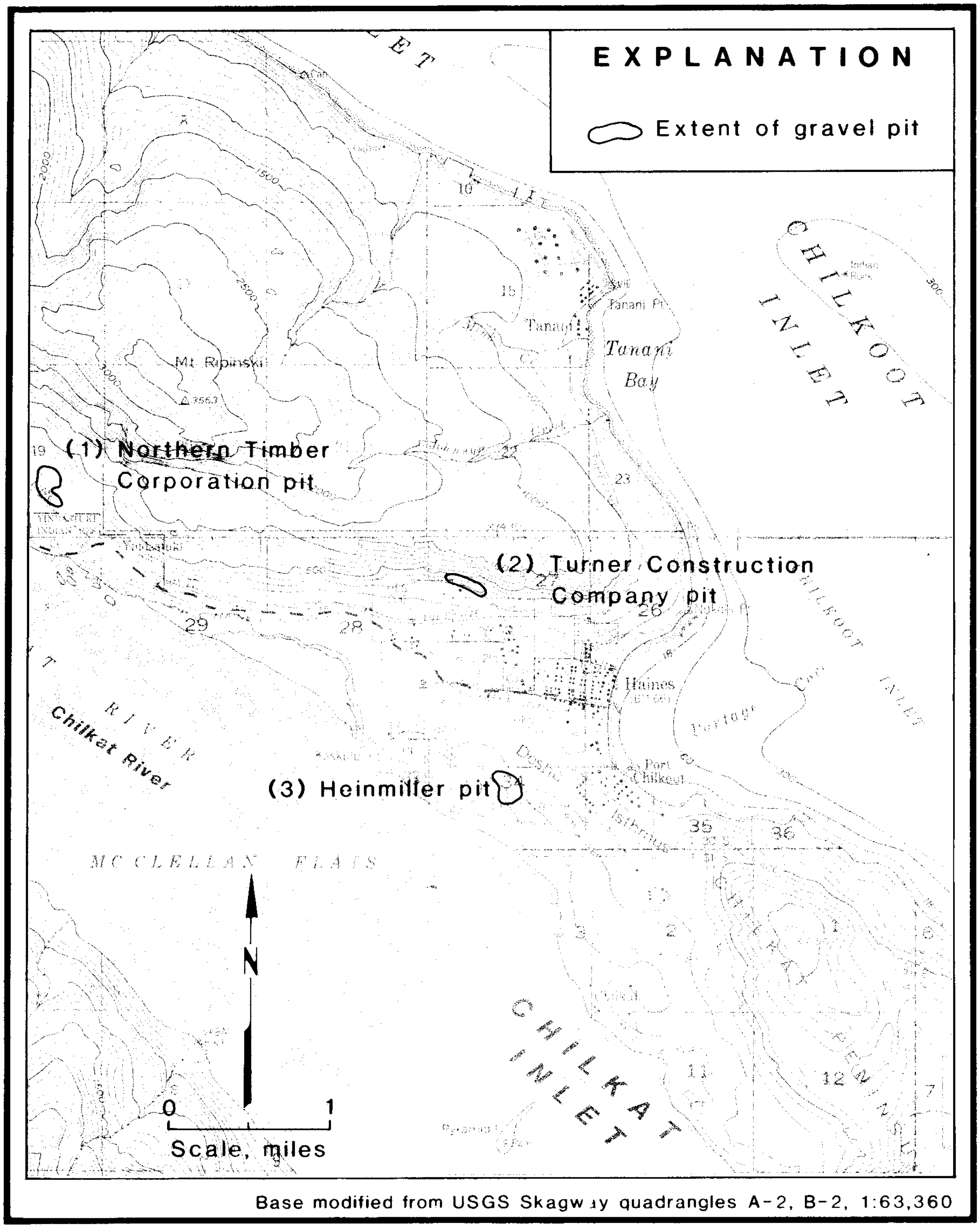
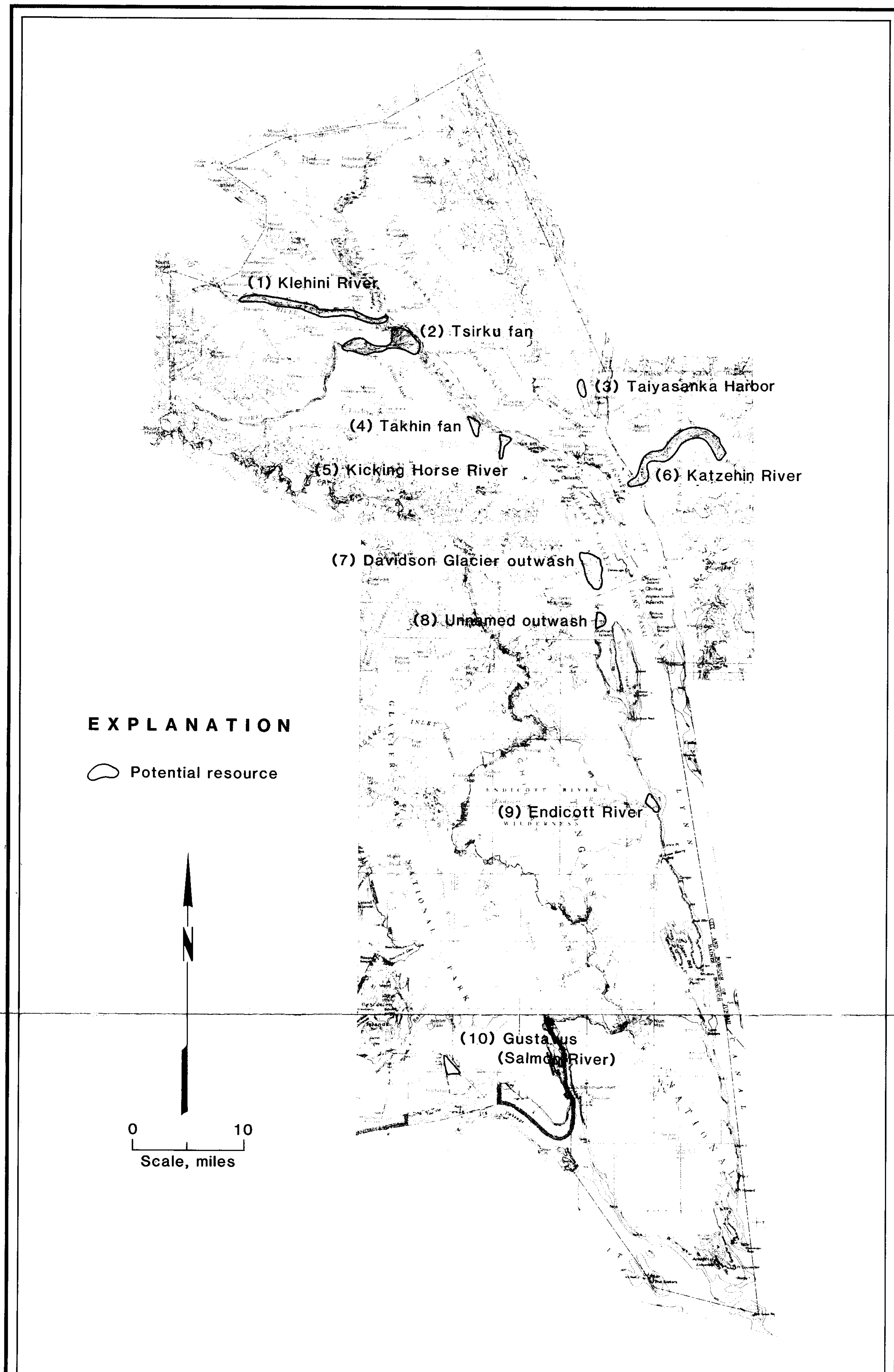


Figure 23. - Current sand and gravel operators in Haines Borough.



Base modified from USGS Juneau and Skagway quadrangles, 1:250,000

Figure 24. - Potential sand and gravel resources within Haines Borough and Gustavus.

Klehini River

Location: Skagway B-3 and B-4 quadrangles
T28S R54E sections 19-26;
T28S R55E sections 19,25-30,36;
T28S R56E sections 29-32.

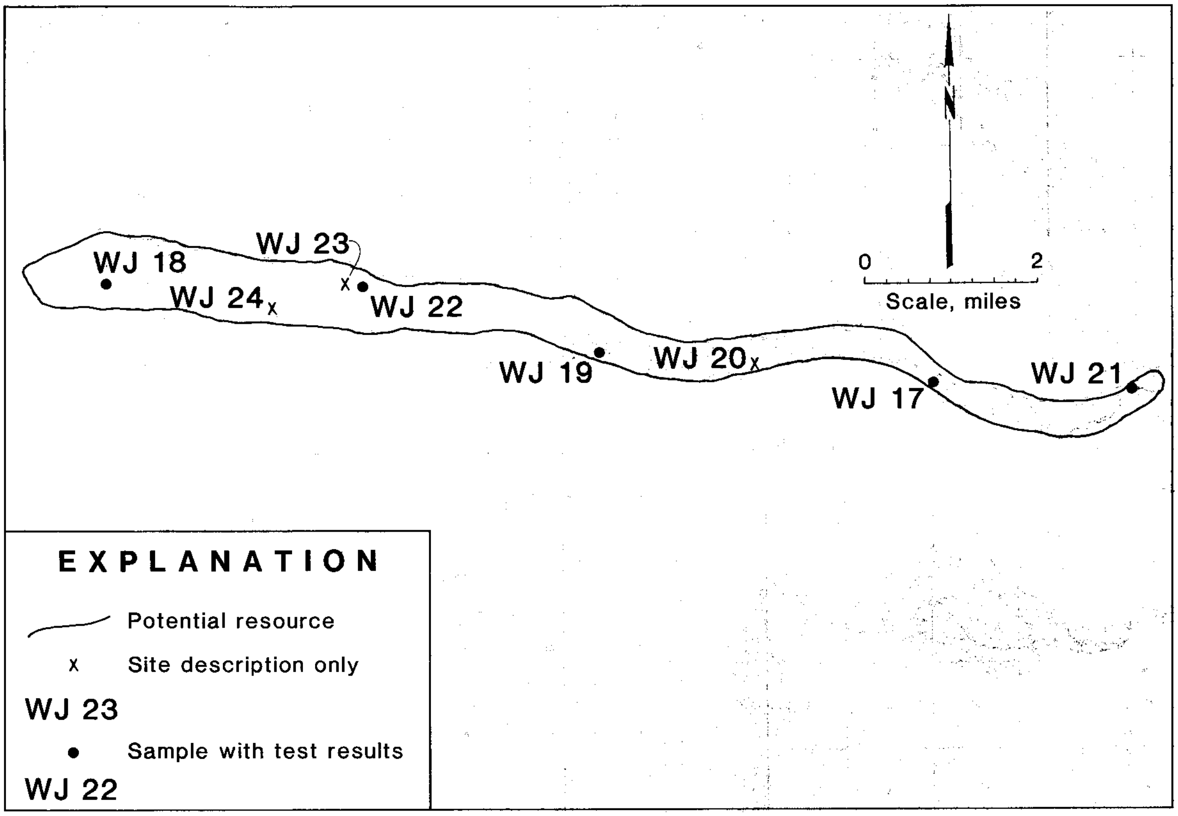


Figure 25. - Klehini River.

Samples Taken: WJ 17, WJ 18, WJ 19, WJ 21, WJ 22 (testing).
WJ 20, WJ 23, WJ 24 (site descriptions only) (fig. 25).

Analytical Results: (see Appendix B for complete set of results).

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
WJ 17	19.5% loss	0.68 % loss	0.80 % loss
WJ 18	18.9% loss	0.58 % loss	0.39 % loss
WJ 19	17.8% loss	0.65 % loss	0.43 % loss
WJ 21	19.3% loss	0.41 % loss	0.33 % loss
WJ 22	26.7% loss	0.37 % loss	1.01 % loss

Nature of the Deposit: Klehini River is a large, braided fluvial system with headwaters in the St. Elias Mountains in Canada. At the U.S. border, coarse glacial sediments from many tributary streams are added to the bed load of the river. Gradient and velocity of the river decrease downstream of Jarvis Creek because the valley broadens markedly. Seasonal fluctuations in discharge alternate the erosional and depositional character of the system. These factors contribute to massive sedimentation in Klehini River valley.

Samples and site descriptions were taken at or near deltas and fans along the banks of Klehini River. No samples were taken in midstream. This technique does not allow an overall analysis of the river system because different tributaries drain different rock types and effects on sediment-size distribution will be unique to each confluence.

An example is the difference between Glacier Creek and Porcupine Creek sites. Gravel lithologies downstream from Glacier Creek (WJ 18) consist of 45% volcanic rocks, 28% metasedimentary rocks, and 27% intermediate intrusive rocks. Clasts are subround to round and occur in all size categories from silt to boulders greater than 12 inches in diameter. Sieve analysis shows that 65% of the 0.25 yd^3 sample did not pass the 4-mesh screen (AASHTO T-27).

Samples taken 2 miles downstream at Porcupine Creek fan (WJ 24) reveal entirely different characteristics. Approximately 80% of the gravel is phyllite or slate and no cobbles larger than 6 inches in diameter were observed. Across the river from Porcupine Creek at Big Boulder Creek fan, the majority (82%) of the gravel is phyllite and schist with a random size distribution. The fan is composed of rockslide material (large angular boulders with minimal size distribution), which has partially overridden deltaic materials from the creek. Downstream near the confluence with Chilkat River, the proportions of marble and limestone in the gravel increase substantially.

Iron-oxide coatings were observed on gravel at each site along Klehini River. These coatings were more prevalent on the south side of the river. This may be due to the abundance of sulfide mineralization in the Porcupine mining district. However, schistose rocks containing biotite on the north side of Klehini River also have this appearance.

Gradational variation of particles within a particular deposit is minimal. Some lensing of sand and silt was observed in channels between terraces along the banks of Klehini River, which can be attributed to post-flood deposition. Variation throughout Klehini River is much more prevalent than can be seen within one site.

Vegetation and Overburden: Gravel bars near the banks of Klehini River contain immature stands of alder, shrubs, willows, and grasses. The amount of vegetation on an individual gravel bar varies throughout Klehini River valley, but in general plant cover is very sporadic and not detrimental to exploitation of the resource. Those areas of the river valley farthest away from the active water course support dense vegetation.

Deposit Dimensions: Klehini River flows for approximately 13.5 miles from Glacier Creek to its confluence with Chilkat River at Klukwan. Average width of the river valley is approximately 0.75 miles. Historically, gravel pits were excavated on both river banks. With this precedent in mind, an average width of 0.25 miles can be considered for future development. A deposit depth of 15 feet is extrapolated from evidence at an old State pit occurring adjacent to sample site WJ 21. These parameters indicate an estimated volume of at least 52 million yd^3 of sand and gravel.

Gold Content: Placer analysis of the minus 14-mesh fraction screened from the original 0.25yd^3 sample reveal:

Sample	Grade
WJ 17	0.0000322 oz/yd^3
WJ 18	0.0000100 oz/yd^3
WJ 19	0.0000336 oz/yd^3
WJ 21	0.0000172 oz/yd^3
WJ 22	0.0000132 oz/yd^3

The range of values obtained from these gold grades at $400/oz is $0.00401 to $0.0134/$yd^3$.

Proximity to Infrastructure: Haines Highway is situated along the north side of Klehini River. At mile 25, near sample site WJ 17, a steel bridge provides access across the river and a dirt road continues west to the abandoned town of Porcupine. Power lines occur along the Haines Highway. There are no railroad facilities in the Haines area. A deep water port for shipping large quantities of material can be found near Haines, approximately 22 miles from the townsite of Wells (near sample site WJ 21). The river supports anadromous fish and is therefore not entirely open to development for its sand and gravel resource.

Tsirku fan

Location: Skagway B-3 quadrangle
T28S R56E sections 32,33;
T29S R56E sections 1,2,4,5,7-12,15,16;
T29S R57E sections 5-8.

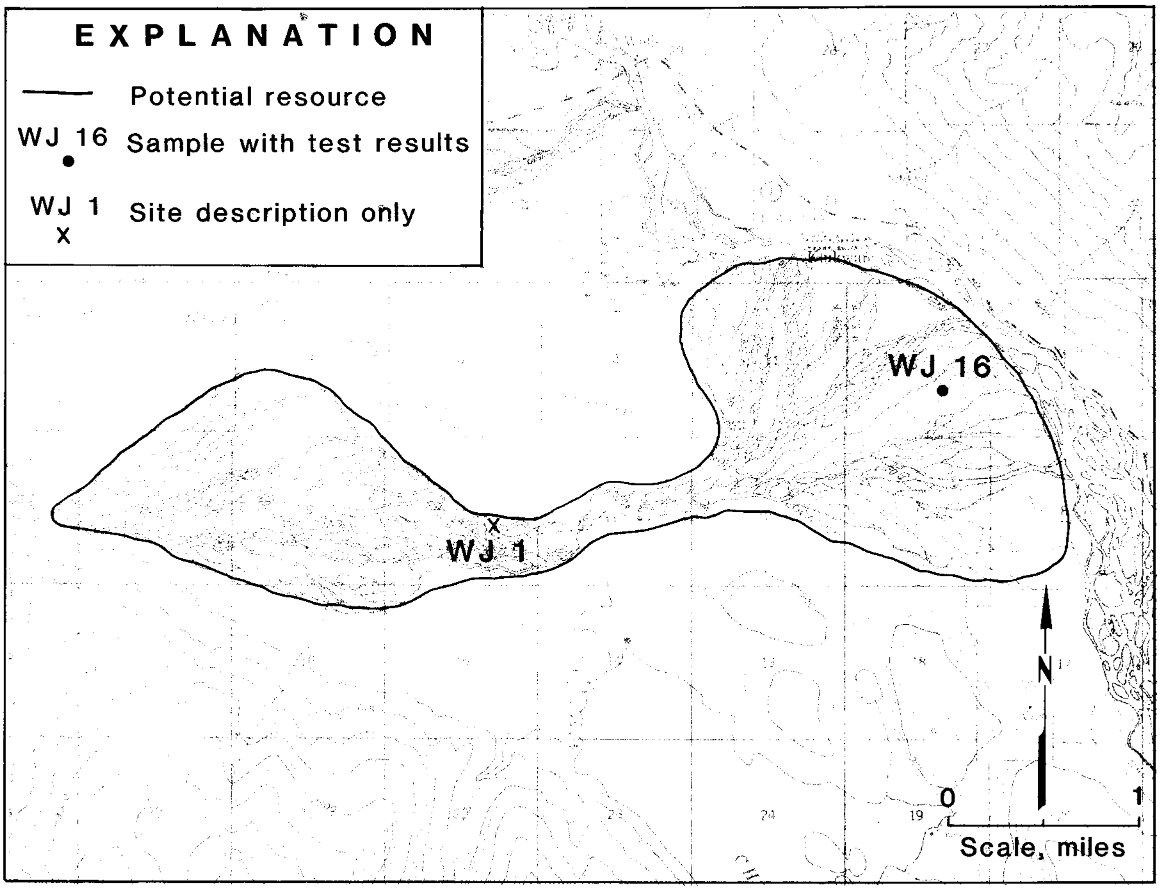


Figure 26. - Tsirku fan.

Samples Taken: WJ 1: site description only; WJ 16: testing (fig. 26).

Analytical Results/Highlights: See Appendix B for complete set of results.

Results of the abrasion test (AASHTO T-96) for sample WJ 16 show a 15.1% loss, which is within the DOT specification for this test. Soundness tests for coarse and fine aggregates (AASHTO T-104) produced a 0.29% loss and 1.14% loss, respectively, both acceptable by DOT specifications (*1*).

Nature of the Deposit: Tsirku fan is composed of alluvium and outwash materials deposited by Tsirku River where it enters Chilkat River (fig. 27). The confluence area has a low gradient. Tsirku fan has been formed by variable discharge rates and sediment loads which move active channels across the available surface area. The area near sample site WJ 1 contains a relatively unsorted assemblage of metasedimentary and igneous rocks. Gneissic boulders up to 15 inches in diameter occur in this area. Downstream near sample site WJ 16, alluvial material is better sorted and few boulders were seen (see sieve analysis results, Appendix B). Horizontal layers of sand are interspersed with lag deposits of gravel throughout the fan. Iron-oxide coatings were observed on all size fractions in the deposit, but overall they affect less than 8% of the material. Silicified rocks were most affected by limonite and hematite precipitation.

Vegetation and Overburden: Most of the interior fan surface is unvegetated, but growth is prevalent along the perimeter of the deposit and on inactive channels. Small stands of cottonwood and low shrubs are infrequent. The main surface of the fan is dotted by occasional tufts of grass. Soil development is minimal.

Deposit Dimensions: The Tsirku fan area delineated on Figure 26 covers nearly 4,500 acres. Judging from the location of bedrock in the area and the overall size of the fan, thickness of the deposit probably exceeds 100 feet. Conventional mining techniques and depth to the water table will be limiting factors for development. Assuming that 1,500 acres are available for development to a depth of 20 feet, nearly 50 million yd^3 of material is available.

Gold Content: Gold recovery from the minus 14-mesh fraction derived from sample WJ 16 yielded 0.0000944 oz/yd^3.

Proximity to Infrastructure: Tsirku fan is located south of the village of Klukwan across Chilkat River. An unimproved road provides pioneer access to the fan. Power lines exist along Haines Highway and at Klukwan, less than 0.5 mile away. High concentrations of eagles nest in the area, especially in the late fall months. Tsirku River supports anadromous-fish runs, so any activity in the main channels will be discouraged.

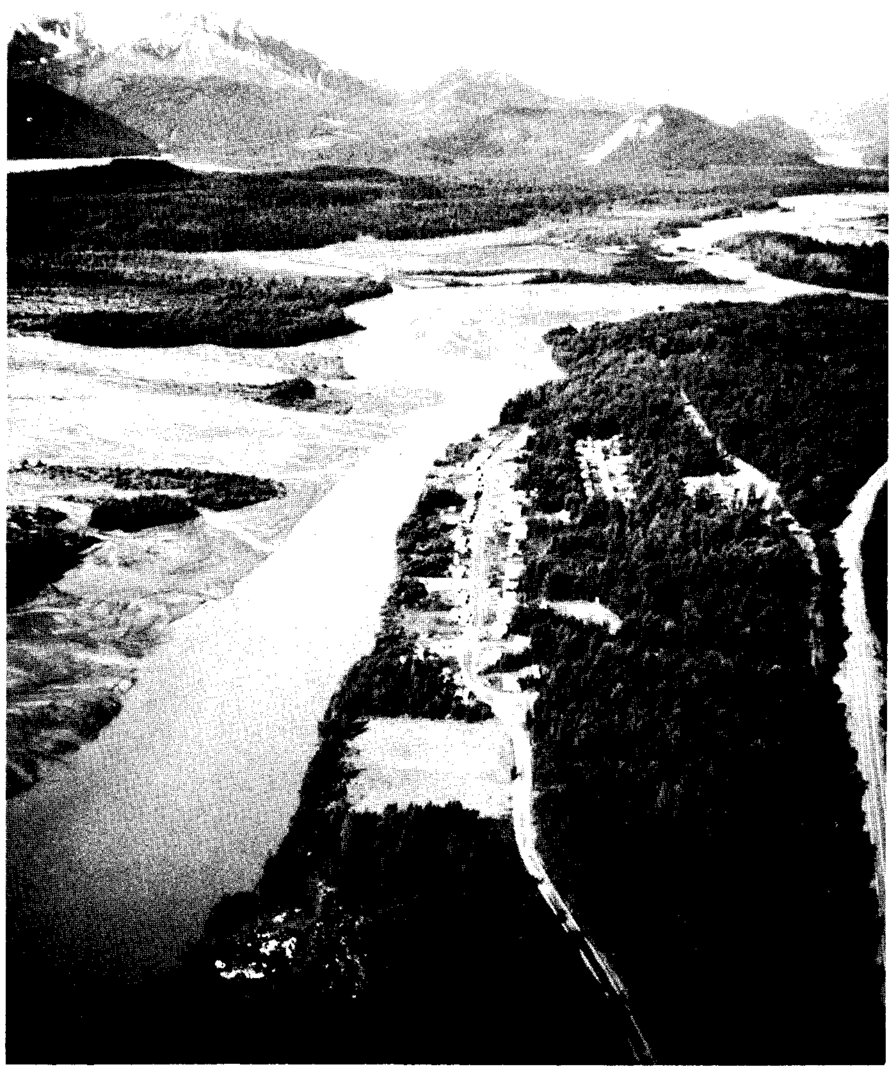


Figure 27. - Tsirku fan (left) where it enters Chilkat River. Klukwan is to the right and Klehini River is in the upper right portion of the photo. (photo by E. Redman)

Taiyasanka Harbor

Location: Skagway B-2 quadrangle
T29S R59E sections 26,27,34,35.

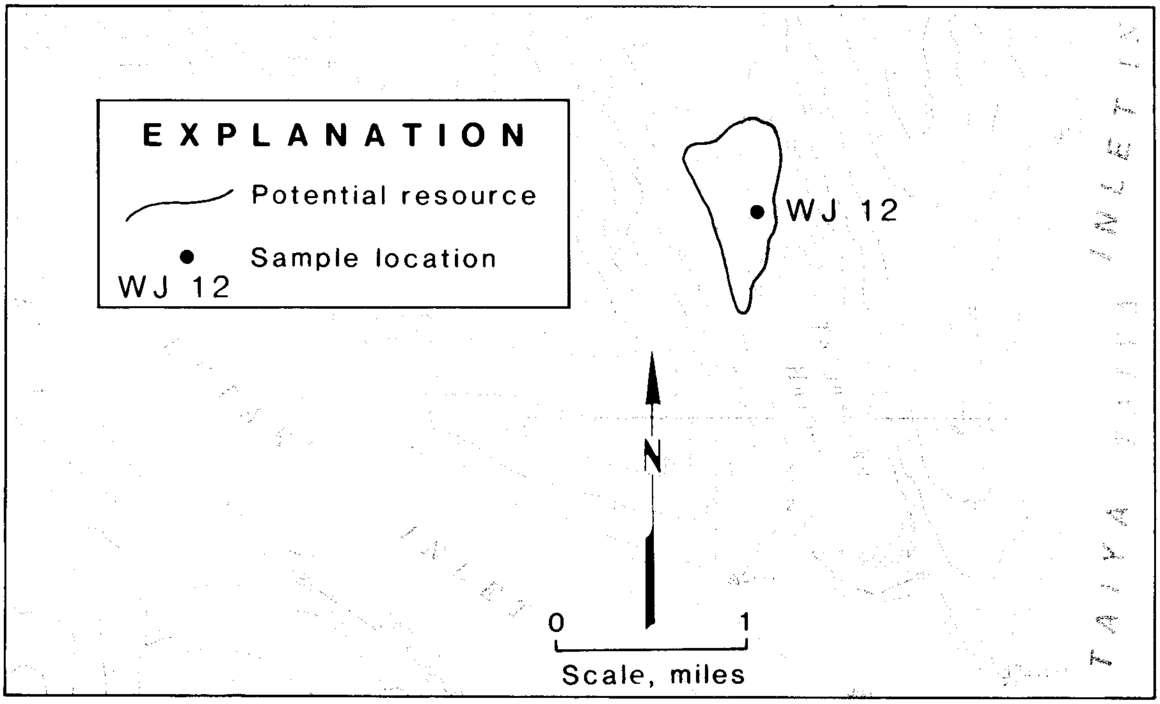


Figure 28. - Taiyasanka Harbor.

Sample Taken: WJ 12 (fig. 28).

Analytical Results/Highlights: (see Appendix B for complete set of results).

The abrasion test (AASHTO T-96) for this sample revealed a 24.7% loss, which is within DOT specifications but is high considering the rock types at the site. Results from the soundness test (AASHTO T-104) for coarse and fine aggregates were 0.55% loss and 0.64% loss, respectively.

Nature of the deposit: Ferebee River drains into Taiyasanka Harbor and is generally a low-gradient, low-energy stream. The deposit contains a uniform assemblage of minus 3-inch gravel; no boulder erratics were observed. The gravel is predominantly granodiorite, quartz monzonite, and schistose rocks. There were iron-oxide coatings on less than 2% of the material. Lensing of silt and sand and lag deposits of gravel were not observed.

Vegetation and Overburden: The mouth of Ferebee River contains low grasses and sedge, and alder growth has not developed. There is an organic layer about 0.5 inch thick, composed of moss and lichens, over parts of the deposit.

Deposit Dimensions: The deposit at the mouth of Ferebee River covers over 100 acres and could be developed to a depth of 10 feet. With these dimensions, more than 1.6 million yd^3 of material exists.

Gold Content: Gold recovered from the minus 14-mesh fraction amounted to 0.00000116 oz/yd^3.

Cultural Features: The nearest road to Taiyasanka Harbor is about 5 miles west at the head of Lutak Inlet. Barge access to the deposit is possible. Power sources are not readily available. A proposed tunnel for the Haines-Skagway road would begin adjacent to this deposit.

Takhin River fan

Location: Skagway B-2 quadrangle
T30S R58E sections 17-20.

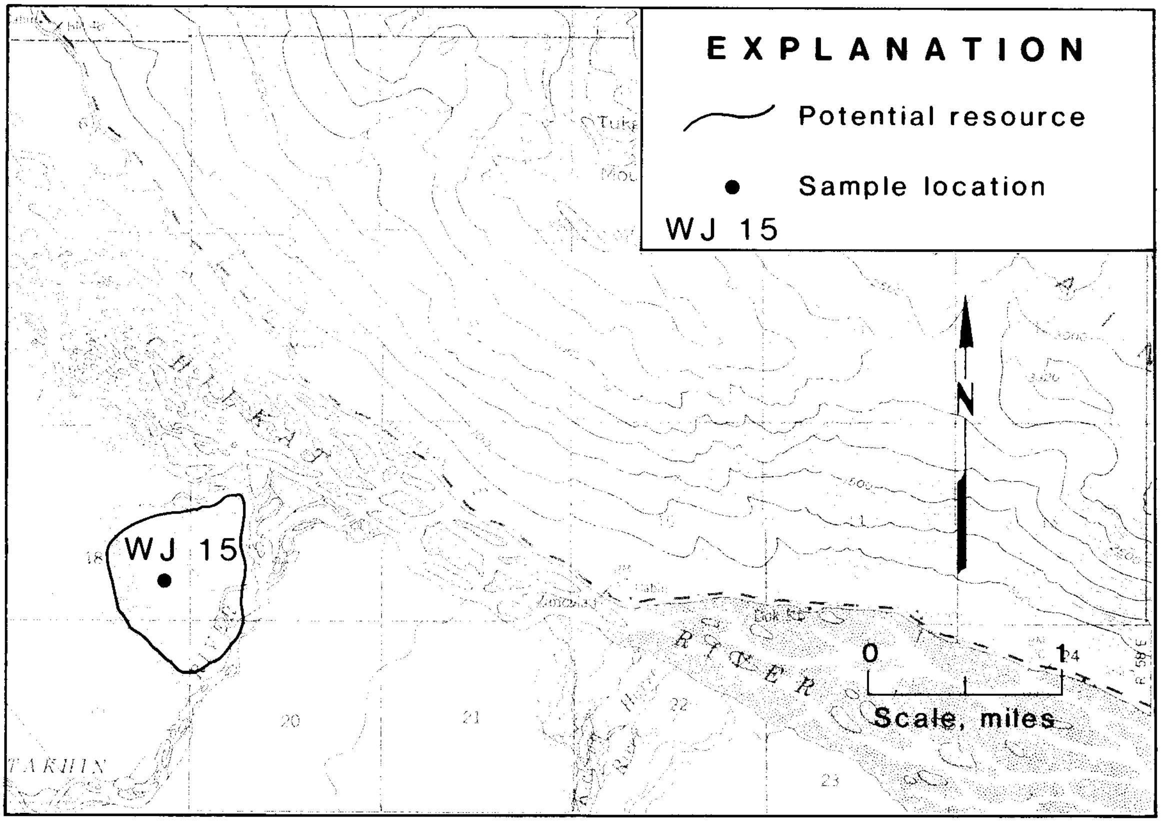


Figure 29. - Takhin River fan.

Samples Taken: WJ 15 (fig. 29).

Analytical Results/Highlights: See Appendix B for complete set of results.

Sample WJ 15 passed the abrasion test (AASHTO T-96) with a 20.9% loss. Results from the soundness test (AASHTO T-104) for coarse and fine aggregates were 0.63% loss and 1.05% loss, respectively. The sand equivalent test (ASTM-2419) produced a value of 77, which is within specifications but indicates a high proportion of silt and clay.

Nature of the Deposit: Takhin fan occurs at the confluence of Takhin and Chilkat Rivers. The deposit is mainly minus 3-inch material in a sandy matrix, and no boulders were observed. Sixty percent of the material by weight passed the 4-mesh screen during sieve analysis. The round to subround gravel is composed mainly of felsic intrusive rocks with lesser amounts of volcanic and schistose rocks.

There is a uniform distribution of particle sizes (see sieve analysis, Appendix B) and layering of sand and silt across the deposit was not observed. Iron-oxide coatings were negligible.

Vegetation and Overburden: Grasses cover some of the fan and dead trees and alder patches cover about 10% of the area. An immature, sandy, semi-oxidized soil layer 0.5-inch thick supports plant growth.

Deposit Dimensions: Takhin fan covers over 600 acres at its confluence with Chilkat River. The area west of the active river channel is a raised delta and could be exploited without disturbing the main stream. Assuming 200 acres of fan material could be developed to a depth of 10 feet, there are over 3.2 million yd^3 present.

Gold Content: Placer analysis of the minus 14-mesh fraction from sample WJ 15 yielded 0.000000257 oz/yd^3.

Proximity to Infrastructure: Access to the fan by barge up Chilkat River could be possible but is unlikely since lower Chilkat River (an anadromous-fish stream) is choked with sediments and 6 miles of restricted dredging would be necessary to reacn Takhin River. The nearest power source is across Chilkat River along Haines Highway.

Kicking Horse River fan

Location: Skagway A-2 and B-2 quadrangles
T30S R58E sections 21,22,27,28.

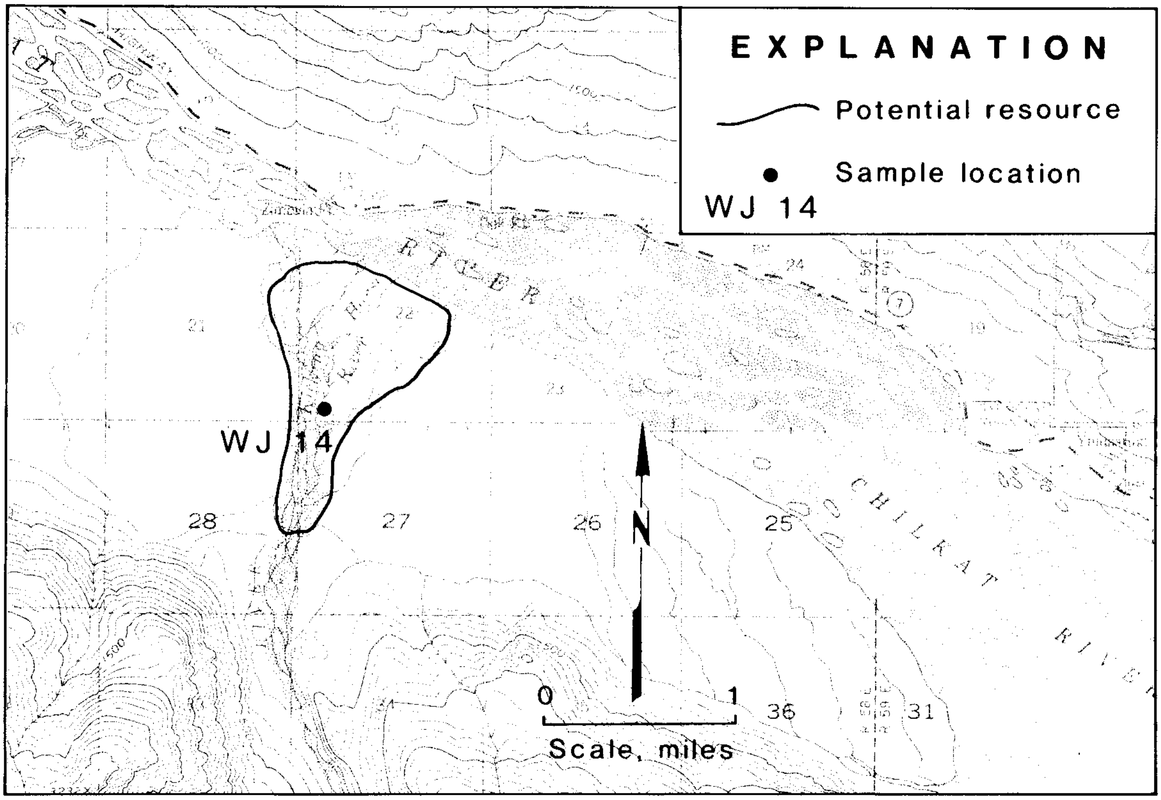


Figure 30. - Kicking Horse River fan.

Samples Taken: WJ 14 (fig. 30).

Analytical Results/Highlights: (see Appendix B for complete set of results).

There was a 26.8% loss from the abrasion test (AASHTO T-96) and results from the soundness test (AASHTO T-104) for coarse and fine aggregates were 0.27% and 0.28% loss, respectively. The sieve analysis (AASHTO T-27) revealed a uniform distribution of material sizes in the deposit.

Nature of the Deposit: Kicking Horse River is an outwash stream originating at Garrison Glacier to the south. The upper portions of the river are contained in a steep walled valley and the glacier is actively depositing drift as it retreats upvalley. The fan developing at the confluence with Chilkat River contains finer grained material than is nearer the glacier. Gravel at the sample site is predominantly composed of granitic material with lesser amounts of volcanic rocks and phyllite. Horizontal layers of sand alternately grade into concentrations of gravel and back to sand across the fan surface. Iron-oxide coatings were observed on 5% of the material.

Vegetation and Overburden: Fan vegetation is scarce; dead trees interspersed with small patches of willows break up the abundant open space. An immature soil has developed locally on the fan but is absent near the sample site.

Deposit Dimensions: Kicking Horse River fan extends farther east than is shown on Figure 30. This is related to the downstream transport of fine-grained deltaic material by Chilkat River. The area outlined on the map encompasses nearly 500 acres; if 300 acres of this is developed to a depth of 10 feet, over 4.8 million yd^3 of material will be available.

Gold Content: Gold recovered from the minus 14-mesh fraction derived from sample WJ 14 yielded 0.00000116 oz/yd^3.

Proximity to Infrastructure: The only access to this deposit is by barge, which will require major dredging to clear Chilkat River. The closest power tie-in occurs across Chilkat River along Haines Highway. The most reasonable hookup will require 17 miles of power lines to reach Wells, located near Klukwan.

Katzehin River

Location: Skagway A-1 and B-1 quadrangles
T30S R61E sections 14-20,22,23,25,26,30;
T30S R60E sections 24-26,34-36;
T31S R60E sections 2,3,9-11.

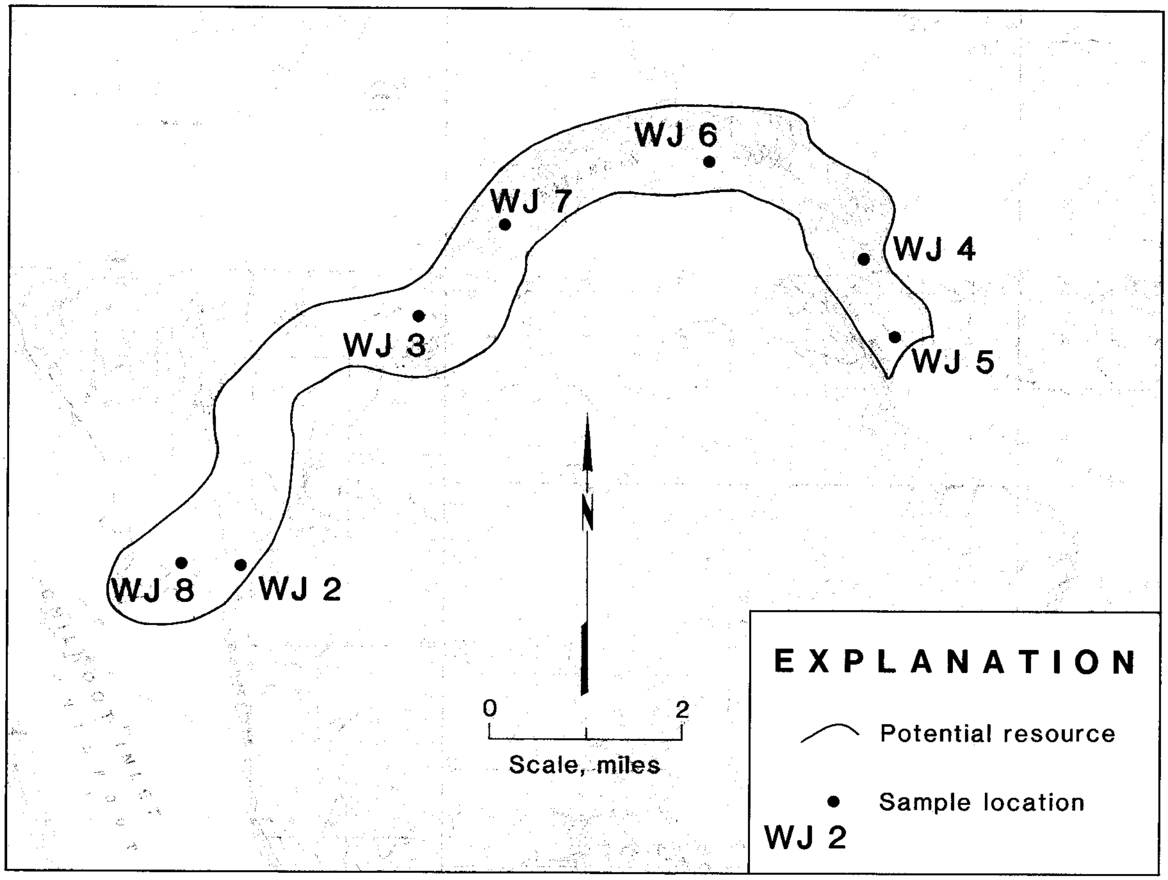


Figure 31. - Katzehin River.

Samples Taken: WJ 2, WJ 3, WJ 4, WJ 5, WJ 6, WJ 8.
WJ 7 (engineering tests only, no gold recovery) (fig. 31).

Analytical Results/Highlights: (see Appendix B for complete set of results).

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
WJ 2	13.8 % loss	0.28 % loss	0.21 % loss
WJ 3	14.2 % loss	0.17 % loss	0.55 % loss
WJ 4	21.6 % loss	0.17 % loss	0.76 % loss
WJ 5	20.2 % loss	0.26 % loss	0.90 % loss
WJ 6	12.4 % loss	0.16 % loss	0.43 % loss
WJ 7	16.0 % loss	0.25 % loss	0.38 % loss
WJ 8	10.9 % loss	0.26 % loss	1.26 % loss

The samples collected near the mouth of Katzehin River (WJ 2 and WJ 8) had sand equivalent values of 75 and 69, respectively, suggesting an excess of clay-sized particles.

Nature of the Deposit: Katzehin River is a braided proglacial river flowing from Meade Glacier. Numerous terraces and dry channels transect the river valley and remnants of lateral and terminal moraines are visible. The braided nature of the river is a result of large sediment loads, rapid and frequent variations in discharge (seasonal), and easily erodible banks. The deposit is well graded in a downstream direction, except for an unusually high percentage of minus 4-mesh material recovered near sample WJ 7. Near the glacier, size variation occurs on a large scale as boulder piles alternate with pebble and sandy layers. Farther downvalley, sediments grade to cobbles and sand layers alternate with sand and silt layers.

Generally, the material consists of felsic intrusive rocks with a minor percentage of metasedimentary rocks. The relative percentage of schist and phyllite increases downstream. Iron-oxide coatings occur on all size fractions throughout the river valley. Coatings occurred on 19% of the material near the glacier and decreased downvalley to nil at the mouth of the river. Sample sites in the upper half of the valley contained gneissic and granitic boulders with up to 3% disseminated pyrite and pyrrhotite. Nearly half of the phyllite found near sample site WJ 5 contained up to 5% pyrite.

Vegetation and Overburden: Upper Katzehin River valley is sparsely vegetated by isolated thickets of brush less than 5 feet high on terraced gravel bars. An immature soil has developed locally and consists of a 1-to 2-inch layer of oxidized sand and silt covered by moss. The vegetative cover increases slightly in the lower valley (past sample site WJ 7) with more growth of shrubs and isolated stands of alders, aspens, and cottonwoods outside of active channels. These occurrences are highly discontinuous and cover less than 5% of the valley floor. This limited vegetation exemplifies the dynamic nature of the braided Katzehin River.

Deposit Dimensions: Katzehin River valley is 11 miles long with an average width of 0.75 mile. The active watercourse occupies nearly one third of the valley floor. After preparing dikes to contain this water prior to development, there will be over 4,100 acres available for development. Topography surrounding Katzehin River valley and the glacial origin of the gravel are similar to the East Fork Lace River. Results from seismic refraction tests at East Fork Lace River (*21*), indicate that the gravel is at least 40 feet thick. These parameters suggest that over 264 million yd^3 of material exists in Katzehin River valley.

Gold Content: Placer analyses of the minus 14-mesh fraction derived from the original 0.25 yd^3 sample yield:

Sample	Grade
WJ 2	0.0000512 oz/yd^3
WJ 3	0.0000549 oz/yd^3
WJ 4	0.0000099 oz/yd^3
WJ 5	0.0000129 oz/yd^3
WJ 6	0.0000467 oz/yd^3
WJ 8	0.0000482 oz/yd^3

Gold recovery was not performed on sample WJ 7. The range of value associated with these gold grades is between \$0.00396/yd^3 and \$0.0220/yd^3. The highest gold values occur in the downstream third of the river valley.

Proximity to Infrastructure: Katzehin River flows into Chilkoot Inlet, the northeastern extension of Lynn Canal. Haines is located across the inlet less than 6 miles away. Power will have to be generated on site to support development because the nearest tie-in occurs at Haines. A proposed Juneau-Haines-Skagway road will cross Lynn Canal south of Katzehin River. The Katzehin area is managed for multiple use by the USFS, and these materials could be used for road building or other construction purposes.

Davidson Glacier outwash

Location: Skagway A-2 quadrangle
T32S R59E sections 11-14,24,25;
T32S R60E sections 18,19,30.

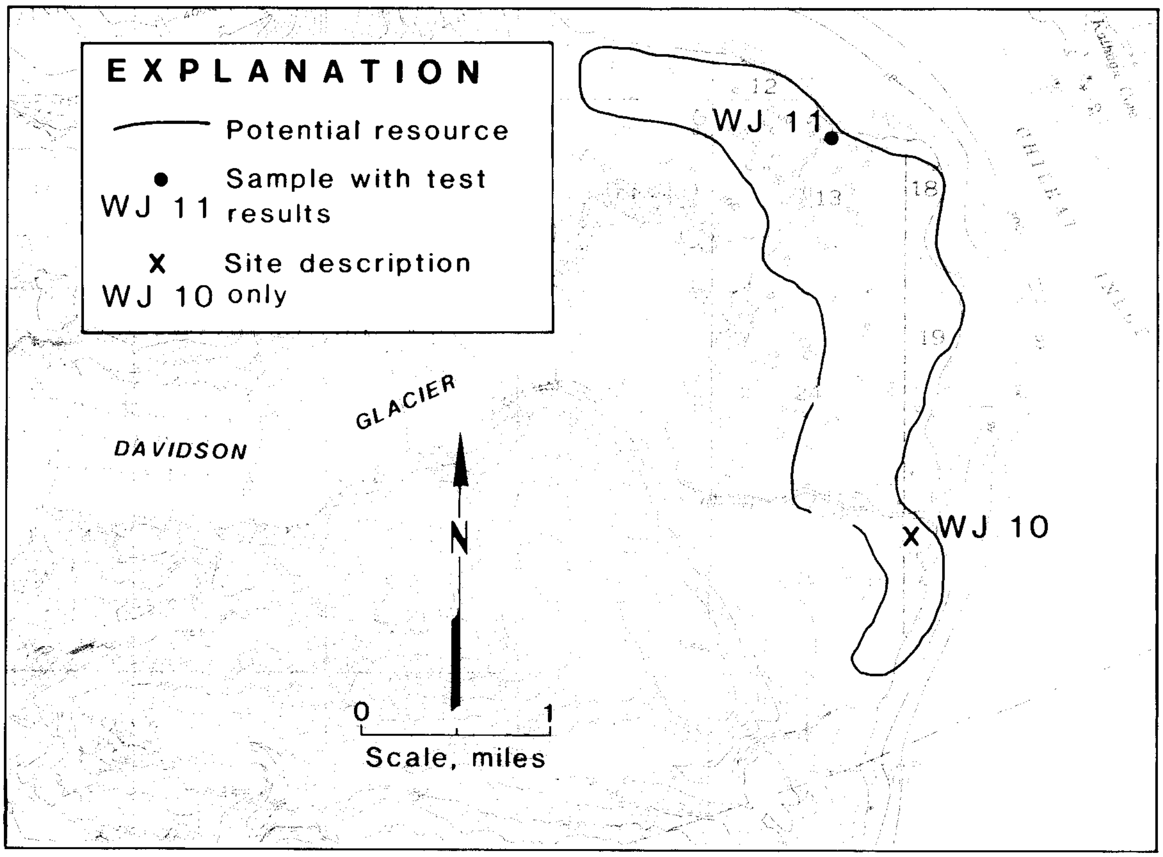


Figure 32. - Davidson Glacier outwash.

Samples Taken: WJ 10 (site description only).
WJ 11 (testing) (fig. 32).

Analytical Results/Highlights: (see Appendix B for complete set of results).

The result of the abrasion test (AASHTO T-96) for sample WJ 11 was a 13.8% loss. Soundness test (AASHTO T-104) results for coarse and fine aggregates were 0.27% and 1.20% loss, respectively. Both tests results are within DOT specifications (*1*).

Nature of the Deposit: The large fan developed below Davidson Glacier is composed of reworked morainal material and glacial outwash. Two outwash rivers cross the fan, and samples were taken near each. .Material near Glacier Point contains poorly to moderately sorted gravel, cobbles, and a few boulders. Rock types present include schist, granodiorite, granite, and dacite, with lesser amounts of phyllite and volcanic rocks. There was no obvious layering in the deposit which suggests a stable fluvial environment.

The area near the mouth of Glacier River contains an abundance of oversize boulders that have been worked into bands 50 to 200 feet long and 10 to 15 feet wide. Nearly half of the material was composed of phyllite. This material was not sent for testing but the high occurrence of phyllite suggests limited application as a construction aggregate.

Iron-oxide coatings occur on material from both sample locations in all size ranges.

Vegetation and Overburden: The main surface of the fan away from active stream channels contains abundant vegetation. Alder and cottonwood dominate and are underlain by mosses, willow, and low grasses. An immature soil is developing locally, typified by a sand/silt oxidation layer mixed with organic debris. This layer is partially developed to a depth of 6 inches.

Deposit Dimensions: The fan covers at least 1,800 acres, but there are private land holdings on the beachfront, which conservatively reduces the acreage to 900 acres. Most of the fan is terraced. If the deposit is developed to a 10-foot depth (similar to Grizzly Bar in Taku Inlet) there will be over 14.5 million yd^3 of material available.

Gold Content: Placer analysis of the minus 14-mesh fraction from sample WJ 11 yielded 0.000000643 oz/yd^3. This grade may increase to the south because the material is better sorted.

Proximity to Infrastructure: The fan occurs on the shore of Chilkat Inlet and can be readily accessed by barge. The nearest available power supply is in Haines, 9 miles north. An alternate route for the proposed Juneau-Haines-Skagway road will cross Lynn Canal south of this deposit at the Endicott River, making this a viable source of material as the road progresses north.

Unnamed outwash

Location: Skagway A-2 quadrangle
T33S R60E sections 3,10.

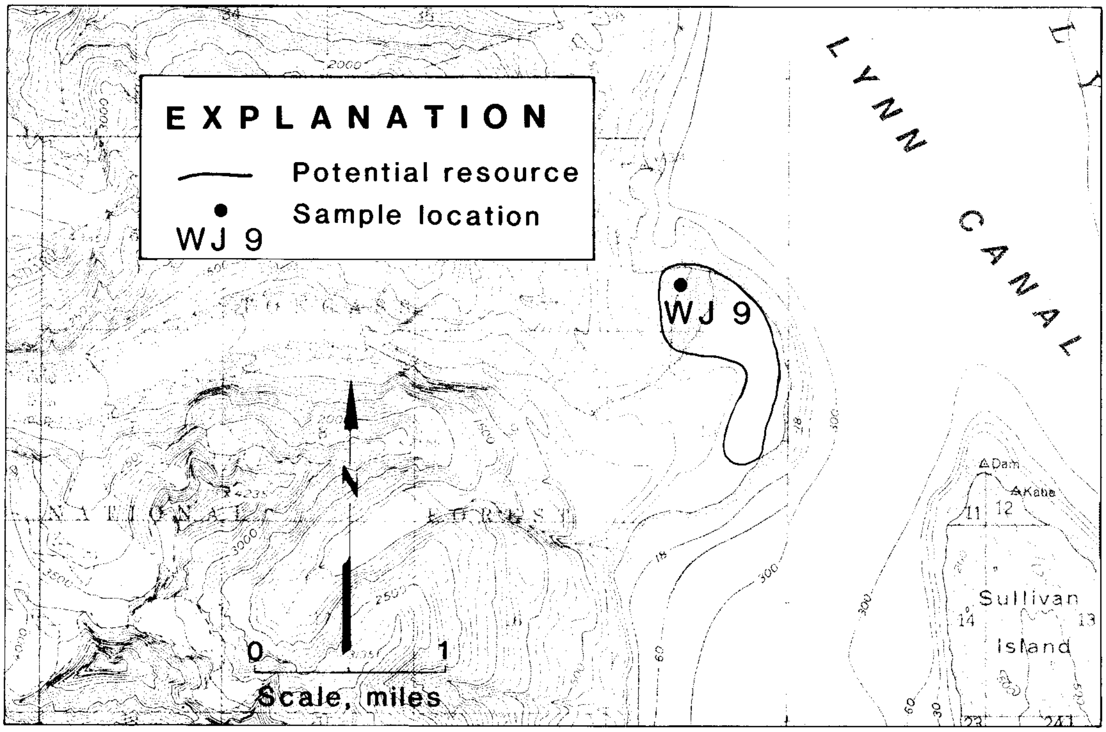


Figure 33. - Unnamed outwash.

Sample Taken: WJ 9 (fig. 33).

Analytical Results/Highlights: (see Appendix B for complete set of results).

The abrasion test (AASHTO T-96) revealed a 16.8% loss, and the soundness test (AASHTO T-104) for coarse and fine aggregates produced a 0.22% loss and 0.19% loss, respectively. The sand equivalent test (ASTM 2419) revealed a value of 78, which reflects a high proportion of clay-sized material.

Nature of the Deposit: This outwash fan is very similar to Davidson Glacier fan. Outwash streams have reworked morainal material producing a deposit of unsorted gravel, cobbles, and boulders in a sandy matrix. A surface concentration of boulders was noticed locally, but this is not widespread. Sieve analysis reveals that 69% of the material is gravel size or larger. Rock types present, in order of decreasing abundance, include granodiorite, greenstone, quartz monzonite, andesite, and lesser schist and phyllite. Iron-oxide coatings appear on less than 1% of the material.

Vegetation and Overburden: Fan surfaces near active streams are unvegetated and soil development has not occurred. Vegetation increases to the south of sample site WJ 9, where stands of alder and poplar are mixed with thickets of low brush. This growth occupies less than 10% of the fan.

Deposit Dimensions: The fan encompasses over 200 acres, but the presence of an airstrip in the southeastern corner will limit development there. If 150 acres are mined to a depth of 10 feet, there will be over 2.4 million yd^3 of material.

Gold Content: Placer analysis of the minus 14-mesh fraction derived from the original 0.25 yd^3 sample yields 0.00000527 oz/yd^3.

Proximity to Infrastructure: This portion of West Lynn Canal is undeveloped. Barge access to the site is possible, but power tie-ins are unavailable, and energy will have to be produced on site. The nearest city is Haines, located about 14.5 miles north. If the proposed Juneau-Haines-Skagway road is developed along West Lynn Canal, this material site may be utilized.

Endicott River fan

Location: Juneau D-4 quadrangle
T35S R61E sections 32,33;
T36S R61E section 4.

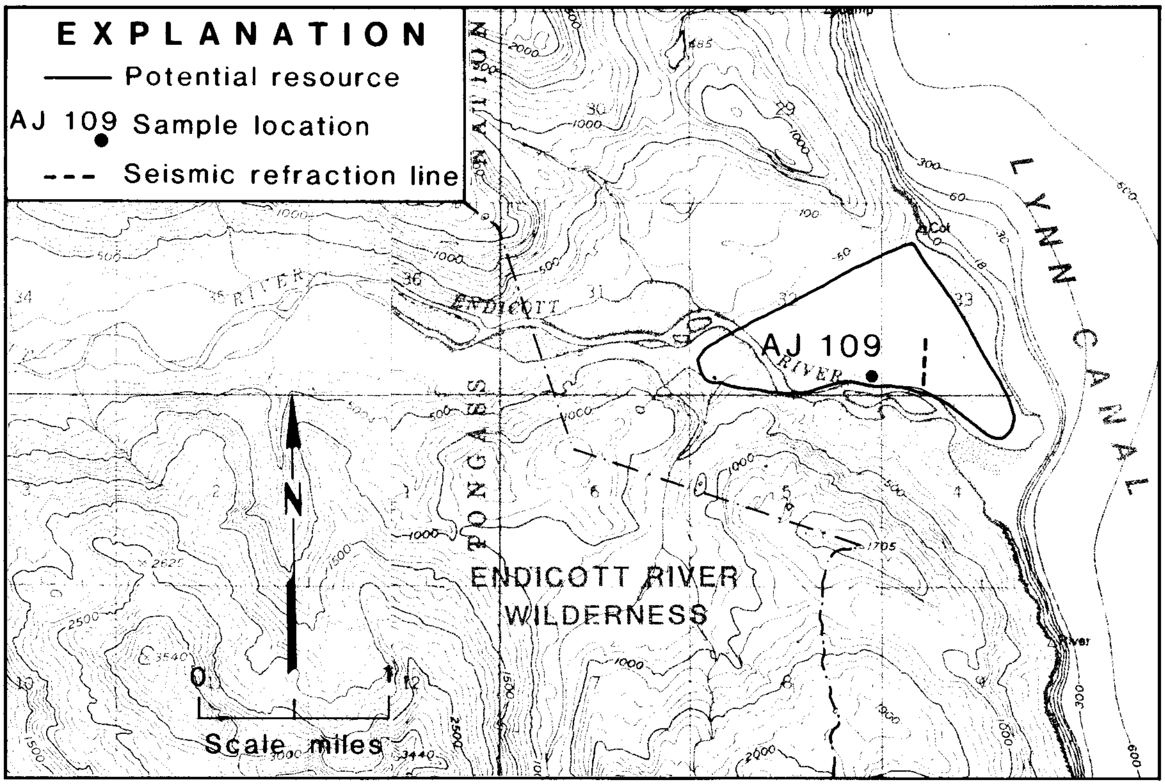


Figure 34. - Endicott River fan.

Sample Taken: AJ 109 (fig. 34).
Seismic refractive methods were used 0.5 mile east of this sample site.

Analytical Results/Highlights: (see Appendix B for complete set of results).

The abrasion test (AASHTO T-96) resulted in a 16.6% loss, and the soundness test (AASHTO T-104) for coarse and fine aggregates produced a 0.53% and a 0.61% loss, respectively. Results from both tests are within DOT specifications.

Nature of the Deposit: Endicott River is a braided system originating from glacial meltwaters and enhanced by tributary flows. Most of the river is within the Endicott River Wilderness, a unit of the Tongass National Forest, and was not studied. This description concentrates on the outwash plain at the river mouth (fig. 35).

The northern portion of the outwash plain is terraced and generally stable, with no stream channels. Gravels there consist of round to subround varieties of greenstone, limestone, and andesite, with lesser amounts of phyllite and marble. There were no boulders visible in this deposit; however, there were large cobbles in side bars of the river adjacent to the site. Parts of the terrace contain concentrations of pebbles and cobbles alternating with sandy/silt lenses ranging from 5 to 20 feet wide and up to 100 feet long. Iron-oxide coatings occur on less than 1% of the material. Calcite coatings were also identified on volcanic rocks.

Vegetation and Overburden: The area surrounding terraces adjacent to the active river contained scattered clumps of grass. The amount of vegetation increased markedly both north and east of this location. Stands of spruce and alder occur to the north as elevation increases. The low plain to the north is covered by thick grasses and immature alder growth is encroaching. Soil development is absent near the sample site.

Deposit Dimensions: The Endicott River is an anadromous-fish stream and development must occur outside of the main stream channel. There is an airstrip on the eastern portion of the deposit. With these limitations, there remain 300 workable acres. Seismic refraction work revealed a depth to bedrock of 70 to 75 feet (*21*). If a reasonable working depth of 20 feet is assumed over the entire surface area, a volume of nearly 9.7 million yd^3 could be available.

Gold Content: Placer analysis of the minus 14-mesh fraction derived from the original 0.25 yd^3 sample reveals 0.00000424 oz/yd^3.

Proximity to Infrastructure: There are no roads or power facilities near this deposit. Barge access via Lynn Canal is possible. Mines at Berners Bay, which are the closest active development projects, are located 8 to 9 miles east. Endicott Wilderness begins two miles upstream from the river mouth and is closed to mineral entry and development.

Figure 35. - Endicott River delta, looking south-southeast toward Lynn Canal and the mainland. (photo by K. Maas)

GUSTAVUS SUBAREA

Local contractors obtain gravel fill material from DNR pits north of the airport runway. Aggregate is not locally available and must be delivered for any major job. The following discussion of the Salmon River gravel resource serves as a comprehensive summary of the Gustavus resource situation. This location is shown in Figure 24.

Gustavus (Salmon River)

Location: Juneau B-6 quadrangle
T40S R58E section 1;
T40S R59E section 6;
T39S R58E sections 25,36;
T39S R59E section 31.

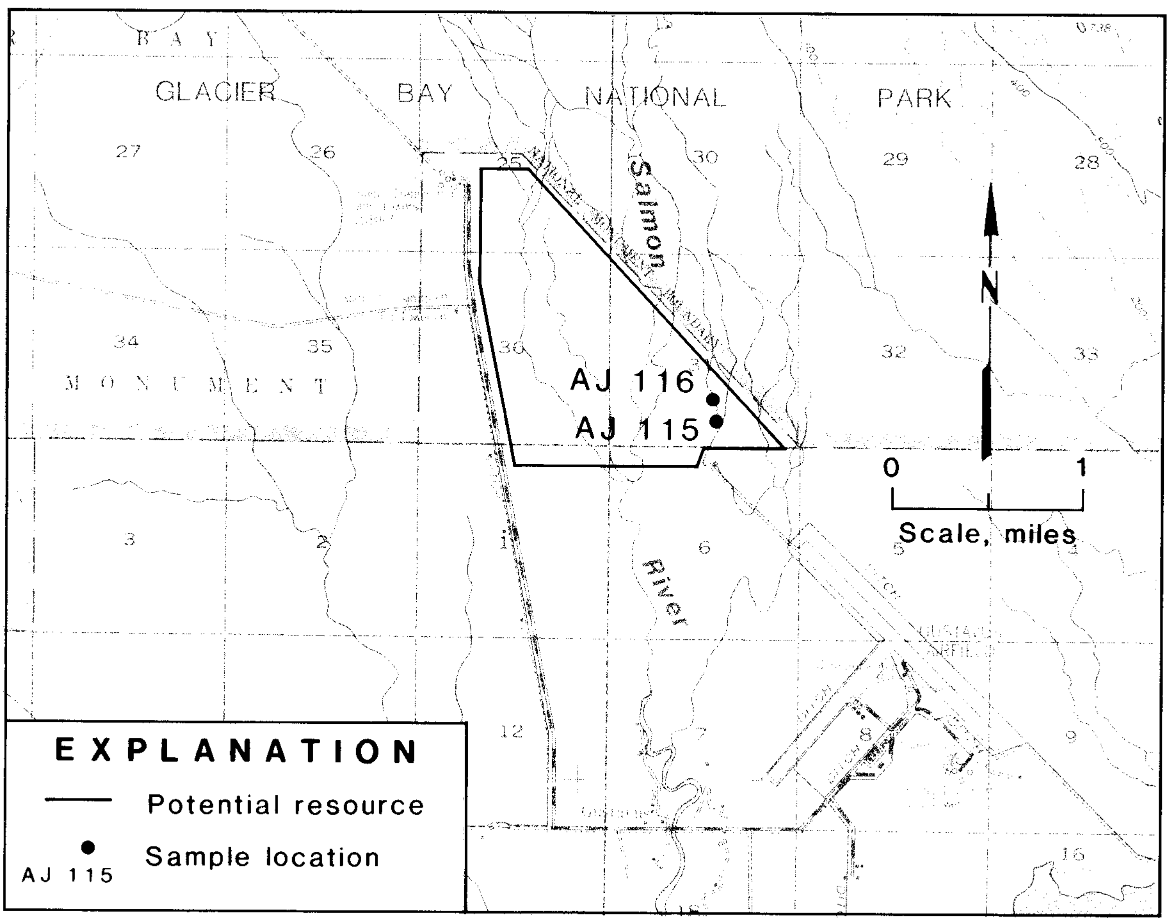


Figure 36. - Gustavus (Salmon River).

Samples Taken: AJ 115, AJ 116 (fig. 36).

Analytical Results/Highlights: (see Appendix B for complete set of results).

Sample	AASHTO T-96	AASHTO T-104 (coarse)	AASHTO T-104 (fine)
AJ 115	10.4 % loss	0.39 % loss	0.95 % loss
AJ 116	9.9 % loss	0.29 % loss	0.43 % loss

Sieve analysis of AJ 115 revealed that 76% of the material passed the 4-mesh screen. This is representative of Salmon River material.

Nature of the Deposit: Gustavus is located near the mouth of the Salmon River alluvial plain, which is a broad, low-gradient surface extending nearly 12 miles from its headwaters in Glacier Bay National Park. Salmon River accumulates waters from individual tributaries along the Chilkat Mountains, but the discharge rate is reduced substantially due to the expanse of the flood plain. Therefore, the river's carrying-capacity for both bed load and suspended sediments is low by the time it empties into Icy Straits. Gustavus has insufficient gravel-and cobble-sized material for this reason.

Material deposited on this low-gradient distal outwash plain is well sorted, but layered, and contains between 59% and 76% minus 4-mesh particles. A cross section of the pits revealed a bedding sequence of sand and minor gravel overlying gravels that overlie a uniform sandy layer. Thin clay beds are also present in the pits. This layering occurs in 6-inch to two-foot beds. Horizontal layering was conspicuous and there were no large cobbles or boulders observed, although a local contractor stated that an occasional ice-rafted, angular boulder is found (*31*).

The material is well rounded and composed of limestone, greenstone, basalt, felsic intrusive rocks, and lesser metasedimentary rock types. There were iron-oxide coatings on less than 2% of the material.

The area sampled is included within a series of three borrow pits designated by DNR as material sites for the Gustavus area. Material within these pits appears well sorted and apparently homogenous, but selective mining is necessary to obtain quality material (*31*). Size distribution and quality improves to the north (*31*). A local contractor assisted the sampling effort with his experience and hydraulic shovel and excavated a sample from a high-grade area within the active State pit (AJ 116) at a depth of 12 feet below water table. It is difficult to predict the presence of a high grade area because of the discontinuous nature of the beds. This high-grade area was less than 20 feet wide and was directly adjacent to poor quality material. There was no gradation in this respect. Consequently, engineering results from AJ 116 should be interpreted with caution.

Vegetation and Overburden: The floodplain is nearly stable, vegetation flourishes, and soils are well developed. Spruce, hemlock, alder, and low brush dominate the landscape and soil thickness ranges from 2 to 6 inches. Buffer areas directly adjacent to the active pits have been stripped of this overburden and similar site preparation will have to precede all new development.

Deposit Dimensions: The area north of the airport outside of the boundaries of Glacier Bay National Park is a potential site. The area downstream from there was neglected because the overall quality of the material decreases. There are approximately 900 acres containing potential for borrow material. If 300 acres are developed to a depth of 15 feet, nearly 7.3 million yd^3 of low-quality borrow will exist.

Gold Content: Placer analysis of the minus 14-mesh fraction derived from the original 0.25 yd^3 sample yields

Sample	Grade
AJ 115	0.0000192 oz/yd^3
AJ 116	0.0000172 oz/yd^3

These gold grades have an average value of \$0.00728/yd^3.

Proximity to Infrastructure: Gustavus is located less than 2 miles from this potential site and road access is available. Power lines parallel the road. Gustavus has no deep water port; shallow tidelands extend 1 mile into Icy Straits.

SUMMARY

The Juneau Mining District contains abundant resources of sand and gravel, and quarry rock. Juneau, Haines, and Skagway all have sufficient supplies of aggregate to maintain current levels of usage for 10 years. It may be necessary to develop a new source of aggregate for prolonged construction projects, either from a quarry source or one of the potential sources discussed in this report. The available resources in Juneau, Skagway, Haines and Gustavus are summarized in Table 2.

Individual properties that possess the most desirable engineering qualities and highest gold grade include the following:

Sieve analysis (AASHTO T-27): Individual samples taken at the Antler/Gilkey Rivers, East Fork Lace River, Katzehin River, Klehini River, and East Fork Skagway River sites all contained less than 30% minus 4-mesh material by weight. Two samples taken at Grizzly Bar (AJ 113, AJ 114) had the lowest percentage (0.1% and 0.3%) of minus 200-mesh material of all samples tested during the study.

Abrasion by Los Angeles machine (AASHTO T-96): The lowest percentage abrasion loss from all samples tested was 8.5% from AJ 112, collected from a gravel bar along Eagle River. Other low values were obtained from Katzehin River and Herbert/Eagle Rivers area.

Soundness test/sodium sulfate (AASHTO T-104): The lowest weighted deterioration of coarse aggregate after frost- resistance tests was 0.11% in sample AJ 104 obtained from Antler/Gilkey Rivers area. Three samples from Katzehin River (WJ 3, WJ 4, and WJ 6) and sample AJ 111 from Herbert River all had less than 0.2% loss.

The lowest loss from the fine aggregate was 0.19%, which came from sample WJ 9 obtained from the unnamed outwash deposit south of Davidson Glacier. Samples from Katzehin River, Grizzly Bar, Kicking Horse River and Berners River sand deposit also tested well.

Specific gravity and absorption (AASHTO T-85): The highest apparent specific gravity from coarse aggregate was 2.96, obtained from sample AJ 111 in the Herbert/Eagle River area. The lowest absorption percentage was from samples AJ 112, and AJ 111 taken at the Herbert/Eagle River area with values of 0.42%, and 0.46%, respectively. There were numerous other samples with values of 0.5%.

The highest specific gravity for fine aggregate was 3.07% which occurred in sample AJ 112 obtained from Eagle River.

Sand Equivalent (ASTM 2419): A sand equivalent value of 100 was obtained from sample WJ 5 taken along Katzehin River.

Gold Grade: The highest gold grades of 0.000178 oz/yd^3 and 0.000137 oz/yd^3 were obtained from samples AJ 114 and AJ 113, respectively, taken at Grizzly Bar.

Table 2. - Sand and gravel/quarry rock resources in Juneau, Skagway, Haines and Gustavus.

Juneau (suppliers)	Resources
Barana Co.	1,000,000 yd^3
Dwain Reddekopp Inc.	250,000 yd^3
Hidden Valley Assoc.	600,000 yd^3
Fred Honsinger	300,000 yd^3
S & S Devp. Co.	800,000 yd^3
Hildre Sand and Gravel Co.	375,000 yd^3
Gastineau Sand and Gravel Inc.	175,000 yd^3
CBJ-Lemon Creek	400,000 yd^3
Peter Ludwig Pit	900,000 yd^3
DNR-Sheep Creek	160,000 yd^3
Total	**4,960,000 yd^3**

Juneau (potential sites)	Resources
East Fork Lace River	100,000,000 yd^3
Berners Bay sand	3,200,000 yd^3
Antler/Gilkey Rivers	64,000,000 yd^3
Herbert/Eagle outwash	60,000,000 yd^3
Tee Harbor borrow site	390,000 yd^3
Dredge Lake	8,000,000 yd^3
Grizzly Bar (Taku Inlet)	60,000,000 yd^3
Point Hilda	4,800,000 yd^3
Total	**300,390,000 yd^3**

Skagway (suppliers)	Resources
H & H Inc.	Not Available

Skagway (potential sites)	Resources
Skagway River (summary)	1,600,000 yd^3
E. Fork Skagway River	1,900,000 yd^3
Total	**3,500,000 yd^3**

Haines (suppliers)	Resources
Northern Timber Corp.	1,000,000 yd^3
Heinmiller Pit	200,000 yd^3
Turner Construction Co.	200,000 yd^3
Total	**1,400,000 yd^3**

Haines (potential sites)	Resources
Klehini River	52,000,000 yd^3
Tsirku fan	50,000,000 yd^3
Taiyasanka Harbor	1,600,000 yd^3
Takhin River fan	3,200,000 yd^3
Kicking Horse River fan	4,800,000 yd^3
Katzehin River	264,000,000 yd^3
Davidson Glacier outwash	14,500,000 yd^3
Unnamed outwash	2,400,000 yd^3
Endicott River fan	9,700,000 yd^3
Total	**402,200,000 yd^3**

Gustavus (total)	Resources
Gustavus (Salmon River)	7,300,000 yd^3
GRAND TOTAL	**719,750,000 yd^3**

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APPENDIX A - GLOSSARY OF TERMS[1]

Aggregate - Any hard, essentially inert material, suitable for forming into a stable mass by either, 1) adding cementing or binding materials that produce a concrete or bituminous product; or 2) compaction or natural settling to produce a roadbase or foundation. Crushed stone, screened gravel, and natural sand are prime examples of aggregate.

Alluvium - Any clastic material that has accumulated from flowing water.

Asphalt - A brown to black bitumen (solid, semisolid hydrocarbon) of variable hardness, comparatively nonvolatile, composed principally of hydrocarbons containing little to no crystallized paraffins. The substance is obtained as a residue from refining of certain petroleum products.

Beach Deposit - An accumulation of sediments deposited at the junction of land and sea; formed by wave and shore currents, which carry and deposit material. Depending on isostatic rebound, ancient beach deposits may be observed at different elevations.

Borrow - Used in embankment construction on roadways. Material usually is derived from a *nearby* natural source. In this report, borrow is synonymous with pit-run gravel and fill material because source proximity is not considered.

Boulder - Generally, any large, round fragment of rock transported by natural means with a size greater than 12 inches in diameter.

Cobble - A rock fragment, round or abraded during transportation, having an average diameter between 3 inches and 12 inches.

Concrete - An intimate mixture of stone, sand, water and a cementing agent (usually portland cement) which hardens to a stonelike mass.

Cubic Yard - Volume measurement equalling 27 cubic feet and being equivalent in weight (average) to 1.5 short tons of broken material.

D-1 - Well-graded surfacing material passing the 1-inch screen with specific weight proportions retained on successive screens down to a 200-mesh screen. The material can be crushed to have 70% fracture surfaces (the highest specification for seal-coat road resurfacing or subbase construction) or it can be used in its natural condition for less specific applications (driveways).

Delta - Sediments that accumulate as a stream drops its load into a standing body of water, where both stream velocity and carrying capacity are severely reduced. Development of foreset beds is a good indication of this type of deposit. This term is used interchangeably with fan and fan delta, although technically the difference between these terms is related to the geography of deposition.

Diamicton - A poorly sorted or unsorted sediment that consists of particles larger than sand in a matrix of sand, silt, and clay-sized particles. The term generally has no genetic implication, although in the Juneau area it is considered a glaciomarine phenomenon (*16*). This term may be synonymous with glacial till.

Glacial Deposit - Covers a wide variety of deposits, including moraines, outwash, and till of various ages, which were formed during the advance and retreat of a glacier.

Gravel - Round or subround rock particles that will pass a 3-inch screen but will be retained on a 4-mesh (4.75 mm) U.S. standard sieve.

Holocene - The most recent unit of geologic time spanning the last 10,000 years, or that time since the last deglaciation. Most surficial deposits in Southeast Alaska were developed during this time.

Industrial Minerals - Any rock, mineral or other naturally occurring substance of economic value, exclusive of metallic ores, mineral fuels and gemstones. Includes the common varieties of sand, gravel, stone, pumice and cinders.

Jetty Stone - Heavy irregular rock chunks used chiefly for river-bank rehabilitation and harbor work.

Lag - Unconsolidated material that remains in place during alluvial or eolian action because the available energy is insufficient to overcome the force of gravity on the particle.

Moraine - A complex landform of earth and stones (drift) carried and finally deposited directly from a glacier. This term can be made more specific by adding the modifiers: terminal, lateral and medial, to define its location.

Outwash - Material that has been reworked from a moraine by meltwater emanating from a glacier and deposited in the proglacial zone.

Quarry - An open or surface working used for extraction of building stone. Material is usually broken into workable pieces during the extraction process.

Pebble - Individual rock particles with a size distribution ranging in diameter from 0.08 in to 2.5 in.

Pit-run - Material that has been removed from a gravel pit in its original condition without processing.

Road Metal - Rock suitable for surfacing either dirt or crushed stone roadways. Also used in foundations for asphalt and concrete roadways.

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[1] Many of these terms are defined by P. W. Thrush (*29*) in his book, "A Dictionary of Mining, Mineral and Related Terms". Others are defined by S. Lefond in "Industrial Minerals and Rocks" (*13*).

Sand - Individual rock particles that will pass a No. 4 sieve (4.75 mm) but, will be retained on a No. 200 sieve (0.074 mm).

Sorting - The mechanism by which material of similar size is selected from a larger heterogenous mass.

Talus - A heap of coarse rock waste at the foot of a cliff or steep rock face. Talus is composed of scree individual rock pieces). Talus is a term used to define an accumulation over time rather than a catastrophic accumulation such as a rock-slide avalanche.

Zoning - A method used by land planners to designate permissible uses of a particular parcel of land within the planners jurisdiction.

APPENDIX B - ENGINEERING TEST RESULTS

DREDGE LAKE: AJ 101

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	16.1	5001.3	0.13	0.02
1 1/2 - 3/4	31.4	1497.7	.27	.08
3/4 - 3/8	27.2	999.5	.44	.12
3/8 - #4	25.3	300.0	.53	.14
Totals	100.0			.36

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	9.7	100	0.7	0.07
#8 - 16	18.4	100	.5	.09
#16 - 30	26.3	100	1.3	.34
#30 - 50	27.3	100	.7	.19
#50 - 100	11.3			
#100	7.0			
Totals	100.0			.69

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.59
Bulk(SSD)............. 2.61
Apparent............... 2.65
Absorption, %....... 1.03

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.50
Bulk(SSD)............. 2.53
Apparent............... 2.57
Absorption, %....... 1.63

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	96	94	
1 1/2"	90	84	
1"	78	65	
3/4"	71	52	
1/2"	61	36	
3/8"	54	25	
#4	39		100
#8	35		90
#16	28		72
#30	18		46
#50	7		18
#100	3		7
#200	1		2.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 12.0% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 124.8 lb/cubic foot at 5.2% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 91

ANTLER/GILKEY RIVERS: AJ 103

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	40.7	5004.3	0.14	0.06
1 1/2 - 3/4	20.1	1509.8	.37	.07
3/4 - 3/8	19.9	1002.0	.49	.10
3/8 - #4	19.3	300.3	1.03	.20
Totals	100.0			.43

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	13.3	100	2.1	0.28
#8 - 16	16.5	100	1.9	.31
#16 - 30	29.1	100	1.1	.32
#30 - 50	23.9	100	1.0	.24
#50 - 100	9.6			
#100	7.6			
Totals	100.0			1.15

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.86
Bulk(SSD)............. 2.87
Apparent............... 2.90
Absorption, %....... 0.55

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.57
Bulk(SSD)............. 2.61
Apparent............... 2.69
Absorption, %....... 1.72

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	96	
2"	83	78	
1 1/2"	69	59	
1"	62	50	
3/4"	54	39	
1/2"	44	27	
3/8"	38	19	
#4	23		100
#8	20		87
#16	14		70
#30	10		41
#50	4		17
#100	2		8
#200	0.9		4

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 9.2% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 117.3 lb/cubic foot at 3.2% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 86

ANTLER/GILKEY RIVERS: AJ 104

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	27.4	5024.0	0.06	0.02
1 1/2 - 3/4	38.1	1498.2	.08	.03
3/4 - 3/8	23.7	1001.3	.17	.04
3/8 - #4	10.8	300.0	.20	.02
Totals	100.0			.11

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	11.2	100	1.1	0.12
#8 - 16	12.8	100	1.1	.14
#16 - 30	40.1	100	0.6	.24
#30 - 50	24.9	100	.8	.20
#50 - 100	7.2			
#100	3.8			
Totals	100.0			.70

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk........................ 2.69
Bulk(SSD)............. 2.71
Apparent............... 2.75
Absorption, %....... 0.80

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk........................ 2.72
Bulk(SSD)............. 2.73
Apparent............... 2.77
Absorption, %....... 0.40

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	98	98	
2"	93	89	
1 1/2"	82	75	
1"	63	51	
3/4"	50	34	
1/2"	38	19	
3/8"	32	11	
#4	24		100
#8	22		89
#16	19		76
#30	9		36
#50	3		11
#100	1		4
#200	0.3		1.2

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 11.8% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 114 lb/cubic foot at 2.8% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 90

EAST FORK LACE RIVER: AJ 105

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	32.0	5007.3	0.06	0.02
1 1/2 - 3/4	31	1500.5	.39	.12
3/4 - 3/8	22	1000.7	.27	.06
3/8 - #4	15	300.0	.37	.06
Totals	100.0			.26

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	13.4	100	0.7	0.09
#8 - 16	18.1	100	1.0	.18
#16 - 30	28	100	2.1	.59
#30 - 50	24.6	100	.7	.17
#50 - 100	11.3			
#100	4.6			
Totals	100.0			1.03

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.70
Bulk(SSD)............. 2.72
Apparent.............. 2.76
Absorption, %....... 0.76

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.48
Bulk(SSD)............. 2.52
Apparent.............. 2.60
Absorption, %....... 1.86

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	98	97	
2"	91	87	
1 1/2"	77	68	
1"	63	49	
3/4"	54	37	
1/2"	45	24	
3/8"	39	15	
#4	27		100
#8	24		87
#16	19		69
#30	11		41
#50	4		16
#100	1		5
#200	0.4		1.5

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 12.1% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 120 lb/cubic foot at 4.3% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 90

BERNERS RIVER SAND DEPOSIT: AJ 106

Soundness of Aggregate by use of Sodium Sulfate
AASHTO T - 104 or ASTM C - 88

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	13.9	100	0.7	0.10
#8 - 16	22.6	100	.2	.05
#16 - 30	31.4	100	.4	.13
#30 - 50	26.0	100	.2	.05
#50 - 100	4.9			
#100	1.2			
Totals	100.0			.33

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
3/8"	100		
#4	99		99
#8	86		86
#16	64		64
#30	32		32
#50	6		6
#100	1		1
#200	0.7		0.7

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk.......................2.57
Bulk(SSD).............2.61
Apparent...............2.69
Absorption, %.......1.72

Unit Weight of Aggregate Loose Unit Weight as Delivered: 104.2 lb/cubic foot at 3.2% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 88

EAST FORK LACE RIVER: AJ 107

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	36	5012.1	0.07	0.03
1 1/2 - 3/4	32	1499.4	.25	.08
3/4 - 3/8	19	1005.1	.24	.05
3/8 - #4	13	300	.60	.08
Totals	100.0			.24

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	10	100	0.3	0.03
#8 - 16	13	100	1.3	.17
#16 - 30	15	100	.7	.11
#30 - 50	27	100	.6	.16
#50 - 100	18			
#100	17.0			
Totals	100.0			.47

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk...................... 2.71
Bulk(SSD)............ 2.73
Apparent.............. 2.76
Absorption, %....... 0.65

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk...................... 2.80
Bulk(SSD)............ 2.83
Apparent.............. 2.86
Absorption, %....... 0.97

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	96	
2"	86	81	
1 1/2"	73	64	
1"	58	43	
3/4"	49	32	
1/2"	40	20	
3/8"	35	13	
#4	25		100
#8	23		90
#16	19		77
#30	16		62
#50	9		35
#100	4		17
#200	2		8

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 12.5% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 115.9 lb/cubic foot at 8.7% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 78

EAST FORK LACE RIVER: AJ 108

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	24	5006.3	0.17	0.04
1 1/2 - 3/4	35	1504.2	.22	.08
3/4 - 3/8	25	1002.5	.40	.10
3/8 - #4	16	300	.57	.09
Totals	100.0			.31

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	12	100	0.6	0.07
#8 - 16	20	100	1.7	.34
#16 - 30	36	100	2.2	.79
#30 - 50	15	100	.8	.29
#50 - 100	9			
#100	8			
Totals	100.0			1.49

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk...................... 2.71
Bulk(SSD)............ 2.72
Apparent.............. 2.75
Absorption, %....... 0.61

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk...................... 2.57
Bulk(SSD)............ 2.61
Apparent.............. 2.67
Absorption, %....... 1.40

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	93	91	
1 1/2"	82	76	
1"	65	54	
3/4"	56	41	
1/2"	44	26	
3/8"	37	16	
#4	25		100
#8	22		88
#16	17		68
#30	8		32
#50	4		17
#100	2		8
#200	1.1		4.2

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 10.9% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 126 lb/cubic foot at 8.5% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 89

ENDICOTT RIVER FAN: AJ 109

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	10	5008.6	0.16	0.02
1 1/2 - 3/4	27	1506.3	.50	.14
3/4 - 3/8	37	1003.1	.39	.14
3/8 - #4	26	300	.87	.23
Totals	100.0			.53

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	20	100	0.3	0.06
#8 - 16	21	100	1.0	.21
#16 - 30	17	100	.6	.10
#30 - 50	22	100	1.1	.24
#50 - 100	13			
#100	7			
Totals	100.0			.61

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.77
Bulk(SSD)............. 2.79
Apparent............... 2.81
Absorption, %....... 0.46

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.58
Bulk(SSD)............. 2.61
Apparent............... 2.67
Absorption, %....... 1.40

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	96	95	
1 1/2"	93	90	
1"	84	77	
3/4"	74	63	
1/2"	60	44	
3/8"	48	26	
#4	29		100
#8	23		80
#16	14		59
#30	12		42
#50	6		20
#100	2		7
#200	1.2		4

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 16.6% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 122.5 lb/cubic foot at 6.4% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 85

HERBERT/EAGLE RIVERS OUTWASH: AJ 110

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	16	2001.1	0.05	0.01
1 1/2 - 3/4	30	1504.6	.36	.11
3/4 - 3/8	28	998.7	.62	.17
3/8 - #4	26	300	.37	.10
Totals	100.0			.39

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	10	100	0.8	0.08
#8 - 16	20	100	1.0	.20
#16 - 30	26	100	2.2	.57
#30 - 50	25	100	1.8	.45
#50 - 100	13			
#100	6			
Totals	100.0			1.30

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk........................ 2.73
Bulk(SSD)............. 2.75
Apparent............... 2.77
Absorption, %....... 0.5

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk........................ 2.56
Bulk(SSD)............. 2.59
Apparent............... 2.64
Absorption, %....... 1.16

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	97	95	
1 1/2"	92	84	
1"	83	67	
3/4"	76	54	
1/2"	67	36	
3/8"	61	26	
#4	47		100
#8	43		90
#16	33		70
#30	21		44
#50	9		19
#100	3		6
#200	1		2.2

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 14.2% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 121.5 lb/cubic foot at 4.4% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 83

HERBERT/EAGLE RIVERS OUTWASH: AJ 111

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	36	5034.2	0.07	0.03
1 1/2 - 3/4	30	1999.7	.16	.05
3/4 - 3/8	20	1001.1	.24	.05
3/8 - #4	14	299.9	.33	.05
Totals	100.0			.18

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	20	100	0.7	0.14
#8 - 16	21	100	.9	.19
#16 - 30	26	100	.4	.10
#30 - 50	19	100	.9	.17
#50 - 100	8			
#100	6			
Totals	100.0			.60

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.92
Bulk(SSD)............. 2.94
Apparent............... 2.96
Absorption, %....... 0.46

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.56
Bulk(SSD)............. 2.59
Apparent............... 2.64
Absorption, %....... 1.19

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	95	
2"	87	79	
1 1/2"	77	64	
1"	65	45	
3/4"	59	34	
1/2"	51	21	
3/8"	46	14	
#4	38		100
#8	30		80
#16	22		59
#30	13		33
#50	5		14
#100	2		6
#200	0.9		2.3

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 12.3% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 129.3 lb/cubic foot at 5.1% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 92

HERBERT/EAGLE RIVERS OUTWASH: AJ 112

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	26	4999.2	0.06	0.02
1 1/2 - 3/4	25	1500.4	.21	.05
3/4 - 3/8	40	1002.8	.31	.12
3/8 - #4	9	299.2	.43	.04
Totals	100.0			.23

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	15	100	0.1	0.02
#8 - 16	19	100	.9	.17
#16 - 30	32	100	2.1	.67
#30 - 50	21	100	2.0	.42
#50 - 100	9			
#100	4			
Totals	100.0			1.28

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk........................ 2.73
Bulk(SSD)............. 2.74
Apparent............... 2.76
Absorption, %....... 0.42

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk........................ 3.06
Bulk(SSD)............. 3.1
Apparent............... 3.16
Absorption, %....... 0.99

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	89	82	
1 1/2"	84	74	
1"	71	53	
3/4"	69	49	
1/2"	54	25	
3/8"	44	9	
#4	38		100
#8	33		85
#16	25		69
#30	13		34
#50	5		13
#100	2		4
#200	0.9		2.3

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 8.5% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 108.5 lb/cubic foot at 2.0% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 92

GRIZZLY BAR (TAKU INLET): AJ 113

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	14	5008.6	0.05	0.01
1 1/2 - 3/4	25	1502.3	.09	.02
3/4 - 3/8	31	1001.4	.29	.09
3/8 - #4	30	300.3	.40	.12
Totals	100.0			.24

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	11	100	0.9	0.10
#8 - 16	17	100	.7	.12
#16 - 30	32	100	.2	.06
#30 - 50	30	100	1.4	.42
#50 - 100	9			
#100	1			
Totals	100.0			.70

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.69
Bulk(SSD)............. 2.70
Apparent............... 2.73
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.71
Bulk(SSD)............. 2.74
Apparent............... 2.78
Absorption, %....... 1.0

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	97	93	
1 1/2"	95	86	
1"	91	73	
3/4"	86	61	
1/2"	80	43	
3/8"	76	30	
#4	65		100
#8	58		89
#16	47		72
#30	26		40
#50	6		10
#100	0.8		1.2
#200	.1		0.2

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 11.5% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 118.5 lb/cubic foot at 2.8% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 92

GRIZZLY BAR (TAKU INLET): AJ 114

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	20	5030.0	0.08	0.02
1 1/2 - 3/4	35	1502.9	.16	.06
3/4 - 3/8	26	998.1	.23	.06
3/8 - #4	19	300.0	.33	.06
Totals	100.0			.20

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	12	100	0.3	0.04
#8 - 16	20	100	.4	.08
#16 - 30	38	100	.1	.04
#30 - 50	24	100	.4	.10
#50 - 100	4			
#100	2			
Totals	100.0			.26

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.66
Bulk(SSD)............. 2.68
Apparent............... 2.74
Absorption, %....... 1.1

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.67
Bulk(SSD)............. 2.69
Apparent............... 2.73
Absorption, %....... 0.88

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	99	
2"	95	91	
1 1/2"	89	80	
1"	79	59	
3/4"	71	45	
1/2"	63	29	
3/8"	57	19	
#4	47		100
#8	42		88
#16	32		68
#30	14		30
#50	3		6
#100	0.7		2
#200	.3		0.7

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 15.4% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 114.6 lb/cubic foot at 1.6% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 92

GUSTAVUS (SALMON RIVER): AJ 115

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	11	2006.3	0.14	0.02
1 1/2 - 3/4	26	1520.4	.28	.07
3/4 - 3/8	27	996.5	.44	.12
3/8 - #4	36	300.4	.50	.18
Totals	100.0			.39

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	9	100	0.7	0.06
#8 - 16	12	100	1.8	.22
#16 - 30	20	100	1.0	.20
#30 - 50	31	100	1.5	.47
#50 - 100	20			
#100	8			
Totals	100.0			.95

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk...................... 2.77
Bulk(SSD)............ 2.80
Apparent.............. 2.85
Absorption, %....... 0.98

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk...................... 2.55
Bulk(SSD)............ 2.60
Apparent.............. 2.72
Absorption, %....... 1.77

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	99	98	
1 1/2"	97	89	
1"	95	79	
3/4"	91	63	
1/2"	87	50	
3/8"	84	36	
#4	76		100
#8	69		91
#16	60		79
#30	44		59
#50	21		28
#100	6		8
#200	2.6		3.5

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 10.4% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 126.0 lb/cubic foot at 11.9% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 89

GUSTAVUS (SALMON RIVER): AJ 116

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	9	1992.8	0.12	0.01
1 1/2 - 3/4	33	1503.4	.23	.08
3/4 - 3/8	40	1003.5	.18	.07
3/8 - #4	18	300.9	.73	.13
Totals	100.0			.29

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	12	100	0.8	0.10
#8 - 16	20	100	.2	.04
#16 - 30	30	100	.6	.18
#30 - 50	30	100	.7	.21
#50 - 100	6			
#100	2			
Totals	100.0			.43

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.68
Bulk(SSD)............. 2.70
Apparent............... 2.74
Absorption, %....... 0.85

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.54
Bulk(SSD)............. 2.59
Apparent............... 2.67
Absorption, %....... 1.84

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	99	98	
1 1/2"	96	91	
1"	89	73	
3/4"	83	58	
1/2"	73	35	
3/8"	66	18	
#4	59		100
#8	52		88
#16	40		68
#30	22		38
#50	5		8
#100	1		2
#200	0.5		0.9

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 9.9% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 125.9 lb/cubic foot at 6.8% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 92

POINT HILDA: AJ 117

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	10	5016.0	0.10	0.01
1 1/2 - 3/4	24	1505.4	.14	.03
3/4 - 3/8	35	999.8	.27	.09
3/8 - #4	31	300.0	.20	.06
Totals	100.0			.19

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	6	100	1.0	0.06
#8 - 16	19	100	0.3	.06
#16 - 30	22	100	.6	.13
#30 - 50	29	100	.6	.17
#50 - 100	16			
#100	8			
Totals	100			.42

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk...................... 2.63
Bulk(SSD)............ 2.67
Apparent.............. 2.73
Absorption, %....... 1.3

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk...................... 2.60
Bulk(SSD)............ 2.64
Apparent.............. 2.70
Absorption, %....... 1.39

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	98	96	
1 1/2"	94	90	
1"	89	82	
3/4"	80	66	
1/2"	72	53	
3/8"	59	31	
#4	41		100
#8	38		94
#16	31		75
#30	22		53
#50	10		24
#100	3		8
#200	1.6		4

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 17.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 122.5 lb/cubic foot at 7.3% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 92

HERBERT/EAGLE RIVERS OUTWASH: AJ 118

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	2	4998.3	0.08	0.00
1 1/2 - 3/4	19	1507.9	.13	.02
3/4 - 3/8	37	1003.4	.22	.08
3/8 - #4	42	300.1	.40	.17
Totals	100.0			.27

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	15	100	2.1	0.32
#8 - 16	22	100	0.9	.20
#16 - 30	21	100	1.0	.21
#30 - 50	23	100	.7	.16
#50 - 100	14			
#100	5			
Totals	100.0			.89

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk........................ 2.65
Bulk(SSD)............. 2.71
Apparent............... 2.83
Absorption, %....... 2.40

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk........................ 2.80
Bulk(SSD)............. 2.83
Apparent............... 2.86
Absorption, %....... 0.81

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	100	99	
1 1/2"	99	98	
1"	97	91	
3/4"	92	79	
1/2"	84	59	
3/8"	78	42	
#4	62		100
#8	53		85
#16	39		63
#30	26		42
#50	12		19
#100	3		5
#200	0.7		1.1

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 13.9% loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 122.6 lb/cubic foot at 2.2% moisture

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 97

KATZEHIN RIVER: WJ 2

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	29	5024.5	0.08	0.02
1 1/2 - 3/4	39	1500.6	.35	.14
3/4 - 3/8	21	1000.2	.34	.07
3/8 - #4	11	300.1	.43	.05
Totals	100.0			.28

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	1	100	0.7	0.01
#8 - 16	3	100	.7	.02
#16 - 30	16	100	.6	.10
#30 - 50	21	100	.4	.08
#50 - 100	44			
#100	15			
Totals	100.0			.21

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.69
Bulk(SSD)............. 2.71
Apparent............... 2.74
Absorption, %....... 0.75

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.71
Bulk(SSD)............. 2.73
Apparent............... 2.77
Absorption, %....... 0.90

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	96	87	
1 1/2"	92	71	
1"	85	47	
3/4"	82	32	
1/2"	76	17	
3/8"	74	11	
#4	71		100
#8	70		99
#16	68		96
#30	57		80
#50	42		59
#100	11		15
#200	2.9		4.1

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 13.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 111.1 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 75

KATZEHIN RIVER: WJ 3

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	42	5161.2	0.07	0.03
1 1/2 - 3/4	38	1505.4	.18	.07
3/4 - 3/8	15	1002.2	.35	.05
3/8 - #4	5	300	.33	.02
Totals	100.0			.17

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	5	100	0.6	0.03
#8 - 16	6	100	.6	.04
#16 - 30	40	100	.6	.24
#30 - 50	34	100	.7	.24
#50 - 100	10			
#100	5			
Totals	100.0			.55

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.67
Bulk(SSD)............ 2.69
Apparent.............. 2.72
Absorption, %....... 0.70

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.70
Bulk(SSD)............ 2.71
Apparent.............. 2.72
Absorption, %....... 0.20

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	96	
2"	87	82	
1 1/2"	70	58	
1"	51	32	
3/4"	42	20	
1/2"	35	10	
3/8"	32	5	
#4	28		100
#8	26		95
#16	24		85
#30	14		51
#50	3		11
#100	1		5
#200	0.7		2.4

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 14.2 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 114.9 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 91

KATZEHIN RIVER: WJ 4

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	34	5048.0	0.04	0.01
1 1/2 - 3/4	33	1507.0	.16	.05
3/4 - 3/8	21	1000.7	.24	.05
3/8 - #4	12	300	.53	.06
Totals	100.0			.17

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	17	100	1.4	0.24
#8 - 16	21	100	0.6	.13
#16 - 30	26	100	1.0	.26
#30 - 50	19	100	.7	.13
#50 - 100	9			
#100	8			
Totals	100			.76

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.75
Bulk(SSD)............. 2.76
Apparent............... 2.79
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.65
Bulk(SSD)............. 2.72
Apparent............... 2.84
Absorption, %....... 2.50

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	95	
2"	91	87	
1 1/2"	78	66	
1"	64	45	
3/4"	56	33	
1/2"	47	19	
3/8"	42	12	
#4	34		100
#8	29		83
#16	21		62
#30	12		36
#50	6		17
#100	3		8
#200	1.6		4.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131): 21.6 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 125.5 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 82

KATZEHIN RIVER: WJ 5

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	46	4998.1	0.11	0.05
1 1/2 - 3/4	35	1508.0	.35	.12
3/4 - 3/8	14	1004.5	.40	.06
3/8 - #4	5	300	.63	.03
Totals	100.0			.26

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	27	100	1.3	0.35
#8 - 16	25	100	1.1	.28
#16 - 30	18	100	0.7	.13
#30 - 50	17	100	.8	.14
#50 - 100	9			
#100	4			
Totals	100.0			.90

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.75
Bulk(SSD)............. 2.76
Apparent............... 2.79
Absorption, %....... 0.60

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.72
Bulk(SSD)............. 2.75
Apparent............... 2.80
Absorption, %....... 1.00

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	96	95	
2"	77	72	
1 1/2"	63	54	
1"	46	33	
3/4"	36	19	
1/2"	28	10	
3/8"	24	5	
#4	20		100
#8	19		96
#16	18		87
#30	14		70
#50	11		52
#100	6		27
#200	2.7		13.3

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 20.2 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 117.3 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 100

KATZEHIN RIVER: WJ 6

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	37	5034.4	0.10	0.01
1 1/2 - 3/4	34	1504.3	.15	.05
3/4 - 3/8	18	999.5	.25	.05
3/8 - #4	11	300	.43	.05
Totals	100.0			.16

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	18	100	0.9	0.16
#8 - 16	21	100	.4	.08
#16 - 30	18	100	.4	.07
#30 - 50	15	100	.8	.12
#50 - 100	10			
#100	18			
Totals	100.0			.43

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.74
Bulk(SSD)............. 2.76
Apparent............... 2.80
Absorption, %....... 0.80

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.75
Bulk(SSD)............. 2.77
Apparent............... 2.80
Absorption, %....... 0.60

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	96	
2"	85	80	
1 1/2"	73	63	
1"	58	41	
3/4"	49	29	
1/2"	41	18	
3/8"	36	11	
#4	28		100
#8	23		82
#16	17		61
#30	12		43
#50	8		28
#100	5		18
#200	2.1		7.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 12.4 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 117.4 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 80

KATZEHIN RIVER: WJ 7

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	36	5030.2	0.16	0.06
1 1/2 - 3/4	30	1502.3	.32	.10
3/4 - 3/8	19	1001.8	.39	.07
3/8 - #4	15	300.3	.10	.02
Totals	100.0			.25

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	2	100	0.5	0.01
#8 - 16	3	100	1.1	.03
#16 - 30	15	100	.6	.09
#30 - 50	35	100	.7	.25
#50 - 100	22			
#100	23			
Totals	100.0			.38

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk...................... 2.71
Bulk(SSD)............ 2.73
Apparent.............. 2.77
Absorption, %....... 0.87

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk...................... 2.67
Bulk(SSD)............ 2.72
Apparent.............. 2.80
Absorption, %....... 1.75

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	95	
2"	96	86	
1 1/2"	89	64	
1"	83	43	
3/4"	80	34	
1/2"	77	23	
3/8"	74	15	
#4	70		100
#8	68		98
#16	66		95
#30	48		80
#50	31		45
#100	16		23
#200	4.9		7

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 16.0 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 113.9 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 74

KATZEHIN RIVER: WJ 8

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	19	5013.6	0.15	0.03
1 1/2 - 3/4	34	1505.3	.20	.07
3/4 - 3/8	29	1001.7	.46	.13
3/8 - #4	18	300	.17	.03
Totals	100.0			.26

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	11	100	1.0	0.11
#8 - 16	13	100	1.6	.21
#16 - 30	25	100	1.7	.43
#30 - 50	23	100	2.2	.51
#50 - 100	14			
#100	14			
Totals	100.0			1.26

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.69
Bulk(SSD)............ 2.71
Apparent.............. 2.75
Absorption, %....... 0.80

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.64
Bulk(SSD)............ 2.71
Apparent.............. 2.83
Absorption, %....... 2.60

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	99	
2"	96	92	
1 1/2"	90	81	
1"	89	61	
3/4"	71	47	
1/2"	62	29	
3/8"	56	18	
#4	46		100
#8	41		89
#16	35		76
#30	23		51
#50	13		28
#100	7		14
#200	4.9		10.7

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 10.9 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 109.3 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 69

UNNAMED OUTWASH: WJ 9

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	43	5013.0	0.10	0.04
1 1/2 - 3/4	29	1507.8	.20	.06
3/4 - 3/8	17	997.7	.28	.05
3/8 - #4	11	300	.67	.07
Totals	100.0			.22

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	1	100	0.8	0.01
#8 - 16	3	100	.8	.03
#16 - 30	12	100	.7	.08
#30 - 50	24	100	.3	.07
#50 - 100	44			
#100	16			
Totals	100.0			.19

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk....................... 2.68
Bulk(SSD)............. 2.71
Apparent............... 2.76
Absorption, %....... 0.90

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk....................... 2.70
Bulk(SSD)............. 2.72
Apparent............... 2.77
Absorption, %....... 0.90

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	96	94	
2"	85	78	
1 1/2"	70	57	
1"	57	38	
3/4"	42	28	
1/2"	40	17	
3/8"	38	11	
#4	31		100
#8	30		99
#16	29		96
#30	26		84
#50	18		60
#100	5		16
#200	1.2		3.9

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 16.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 119.0 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 78

DAVIDSON GLACIER OUTWASH: WJ 11

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	16	5032.6	0.08	0.01
1 1/2 - 3/4	29	1509.6	.42	.12
3/4 - 3/8	28	1003.2	.29	.08
3/8 - #4	27	300.7	.20	.06
Totals	100.0			.27

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	27	100	0.6	0.16
#8 - 16	29	100	1.6	.47
#16 - 30	24	100	1.7	.41
#30 - 50	10	100	1.6	.16
#50 - 100	2			
#100	8			
Totals	100.0			1.20

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk....................... 2.71
Bulk(SSD)............ 2.74
Apparent.............. 2.78
Absorption, %....... 0.90

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk....................... 2.65
Bulk(SSD)............ 2.66
Apparent.............. 2.77
Absorption, %....... 2.30

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	99	
2"	96	93	
1 1/2"	92	84	
1"	83	68	
3/4"	77	55	
1/2"	68	38	
3/8"	62	27	
#4	48		100
#8	35		73
#16	21		44
#30	10		20
#50	5		10
#100	4		8
#200	3		6.2

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 13.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 112.7 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 73

TAIYASANKA HARBOR: WJ 12

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	2	2006.2	0.25	0.01
1 1/2 - 3/4	29	1541.7	.56	.16
3/4 - 3/8	40	1002.8	.60	.24
3/8 - #4	29	300	.47	.14
Totals	100.0			.55

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	21	100	0.4	0.08
#8 - 16	18	100	1.3	.23
#16 - 30	15	100	1.0	.15
#30 - 50	23	100	.8	.18
#50 - 100	14			
#100	9			
Totals	100.0			.64

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.62
Bulk(SSD)............. 2.64
Apparent............... 2.68
Absorption, %....... 0.80

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.60
Bulk(SSD)............. 2.64
Apparent............... 2.72
Absorption, %....... 1.70

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	100	100	
1 1/2"	99	98	
1"	92	86	
3/4"	82	69	
1/2"	68	44	
3/8"	59	29	
#4	42		100
#8	33		79
#16	26		61
#30	15		46
#50	10		23
#100	4		9
#200	1.9		4.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 24.7 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 111.7 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 91

KICKING HORSE RIVER FAN: WJ 14

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	17	1997.8	0.11	0.02
1 1/2 - 3/4	36	1532.4	.34	.12
3/4 - 3/8	29	1003.9	.26	.08
3/8 - #4	18	300	.30	.05
Totals	100.0			.27

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	16	100	0.3	0.05
#8 - 16	17	100	.2	.03
#16 - 30	22	100	.4	.09
#30 - 50	19	100	.6	.11
#50 - 100	12			
#100	14			
Totals	100.0			.28

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.70
Bulk(SSD)............. 2.71
Apparent............... 2.73
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.71
Bulk(SSD)............. 2.74
Apparent............... 2.79
Absorption, %....... 1.00

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	99	
2"	96	94	
1 1/2"	89	83	
1"	74	61	
3/4"	64	47	
1/2"	52	28	
3/8"	45	18	
#4	33		100
#8	27		84
#16	22		67
#30	15		45
#50	8		26
#100	4		14
#200	2		6.1

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 26.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 125.9 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 83

TAKHIN RIVER FAN: WJ 15

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	4	5081.6	0.2	0.01
1 1/2 - 3/4	25	1518.3	.3	.08
3/4 - 3/8	49	1001.0	.7	.34
3/8 - #4	22	300.0	.9	.20
Totals	100.0			.63

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	21	100	0.4	0.08
#8 - 16	20	100	1.5	.30
#16 - 30	18	100	2.1	.38
#30 - 50	16	100	1.8	.29
#50 - 100	12			
#100	13			
Totals	100.0			1.05

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.68
Bulk(SSD)............. 2.69
Apparent............... 2.72
Absorption, %....... 0.60

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.57
Bulk(SSD)............. 2.62
Apparent............... 2.71
Absorption, %....... 2.00

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	99	99	
1 1/2"	98	96	
1"	94	84	
3/4"	88	71	
1/2"	77	43	
3/8"	69	22	
#4	60		100
#8	47		79
#16	36		59
#30	25		41
#50	15		25
#100	8		13
#200	4.3		7.1

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 20.9 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 120.0 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 77

TSIRKU FAN: WJ 16

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	20	5046.5	0.1	0.02
1 1/2 - 3/4	36	1506.7	.2	.07
3/4 - 3/8	27	1003.0	.4	.11
3/8 - #4	17	300.3	.5	.09
Totals	100.0			.29

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	20	100	1.1	0.22
#8 - 16	15	100	1.0	.50
#16 - 30	14	100	1.1	.15
#30 - 50	15	100	1.8	.27
#50 - 100	14			
#100	22			
Totals	100.0			1.14

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.76
Bulk(SSD)............. 2.78
Apparent............... 2.81
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.63
Bulk(SSD)............. 2.69
Apparent............... 2.79
Absorption, %....... 2.10

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	99	
2"	96	93	
1 1/2"	87	80	
1"	72	58	
3/4"	63	44	
1/2"	51	27	
3/8"	45	17	
#4	33		100
#8	27		80
#16	22		65
#30	17		51
#50	12		36
#100	7		22
#200	4.5		13.4

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 15.1 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 132.6 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 56

KLEHINI RIVER: WJ 17

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	4	2006.0	0.24	0.01
1 1/2 - 3/4	28	1509.9	.82	.23
3/4 - 3/8	37	1006.0	.66	.25
3/8 - #4	31	300.5	.60	.19
Totals	100.0			.68

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	18	100	1.0	0.18
#8 - 16	14	100	0.7	.10
#16 - 30	14	100	.6	.08
#30 - 50	26	100	1.7	.44
#50 - 100	17			
#100	11			
Totals	100.0			.80

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.73
Bulk(SSD)............ 2.75
Apparent.............. 2.78
Absorption, %....... 0.60

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.73
Bulk(SSD)............ 2.76
Apparent.............. 2.81
Absorption, %....... 1.00

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	100	100	
1 1/2"	98	96	
1"	91	82	
3/4"	83	68	
1/2"	71	46	
3/8"	63	31	
#4	47		100
#8	38		82
#16	32		68
#30	25		54
#50	13		28
#100	5		11
#200	2		4.3

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 19.5 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 109.7 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 86

KLEHINI RIVER: WJ 18

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	27		0.6	0.16
1 1/2 - 3/4	31	1409.9	.6	.19
3/4 - 3/8	24	993	.5	.12
3/8 - #4	18	300	.6	.11
Totals	100.0			.58

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	22	100	0.2	0.05
#8 - 16	20	100	.6	.12
#16 - 30	18	100	.4	.07
#30 - 50	14	100	1.1	.15
#50 - 100	8			
#100	18			
Totals	100.0			.39

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk........................ 2.45
Bulk(SSD)............. 2.48
Apparent............... 2.53
Absorption, %....... 1.30

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk........................ 2.57
Bulk(SSD)............. 2.67
Apparent............... 2.85
Absorption, %....... 3.70

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	93	89	
1 1/2"	82	73	
1"	70	54	
3/4"	62	42	
1/2"	52	27	
3/8"	46	18	
#4	35		100
#8	27		78
#16	20		58
#30	14		40
#50	9		26
#100	6		18
#200	4.7		13.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 18.9 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 108.3 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 65

KLEHINI RIVER: WJ 19

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	10	5242.8	0.4	0.04
1 1/2 - 3/4	41	1403.7	.6	.25
3/4 - 3/8	30	1001.6	.5	.15
3/8 - #4	19	300	.6	.21
Totals	100.0			.65

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	23	100	0.6	0.14
#8 - 16	3	100	.6	.02
#16 - 30	5	100	1.3	.07
#30 - 50	17	100	1.2	.20
#50 - 100	23			
#100	29			
Totals	100.0			.43

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.49
Bulk(SSD)............. 2.50
Apparent............... 2.52
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.61
Bulk(SSD)............. 2.70
Apparent............... 2.87
Absorption, %....... 3.30

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	100	100	
2"	98	98	
1 1/2"	92	90	
1"	78	72	
3/4"	60	49	
1/2"	45	30	
3/8"	36	19	
#4	21		100
#8	17		77
#16	16		74
#30	15		69
#50	11		52
#100	6		29
#200	3.1		14.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 17.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 119.1 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 76

KLEHINI RIVER: WJ 21

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	22	4984	0.5	0.11
1 1/2 - 3/4	33	1406	.5	.17
3/4 - 3/8	27	1000	.3	.08
3/8 - #4	18	300	.3	.05
Totals	100.0			.41

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	23	100	0.7	0.16
#8 - 16	17	100	.2	.03
#16 - 30	18	100	.2	.04
#30 - 50	9	100	1.1	.10
#50 - 100	19			
#100	14			
Totals	100.0			.33

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.46
Bulk(SSD)............ 2.47
Apparent.............. 2.49
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.65
Bulk(SSD)............ 2.73
Apparent.............. 2.87
Absorption, %....... 0.50

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	95	92	
1 1/2"	85	78	
1"	72	58	
3/4"	63	45	
1/2"	52	29	
3/8"	45	18	
#4	33		100
#8	25		77
#16	20		60
#30	14		42
#50	11		33
#100	5		14
#200	3.2		9.8

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 19.3 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 123.8 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 70

KLEHINI RIVER: WJ 22

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	21	5054	0.9	0.19
1 1/2 - 3/4	29	1488.4	.2	.06
3/4 - 3/8	29	1000.2	.2	.06
3/8 - #4	21	300	.3	.06
Totals	100.0			.37

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	29	100	1.3	0.38
#8 - 16	26	100	0.6	.16
#16 - 30	19	100	1.3	.25
#30 - 50	13	100	1.7	.22
#50 - 100	6			
#100	7			
Totals	100.0			1.01

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.67
Bulk(SSD)............. 2.70
Apparent............... 2.76
Absorption, %....... 1.20

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.47
Bulk(SSD)............. 2.52
Apparent............... 2.60
Absorption, %....... 2.00

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	98	
2"	95	91	
1 1/2"	85	79	
1"	74	62	
3/4"	65	50	
1/2"	53	32	
3/8"	45	21	
#4	30		100
#8	21		71
#16	13		45
#30	8		26
#50	4		13
#100	2		7
#200	1.4		4.8

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 26.7 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 114.5 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 81

TAIYA RIVER: WJ 25

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	22		0.42	0.09
1 1/2 - 3/4	23	1505.3	.42	.10
3/4 - 3/8	26	1002	.40	.10
3/8 - #4	29	300	.53	.15
Totals	100.0			.44

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	4	100	1.4	0.06
#8 - 16	7	100	0.8	.06
#16 - 30	14	100	.4	.06
#30 - 50	29	100	.6	.17
#50 - 100	14			
#100	22			
Totals	100.0			.35

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.66
Bulk(SSD)............. 2.68
Apparent............... 2.72
Absorption, %....... 0.80

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 1.95
Bulk(SSD)............. 2.15
Apparent............... 2.43
Absorption, %....... 9.20

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	99	94	
2"	98	87	
1 1/2"	96	78	
1"	94	64	
3/4"	92	55	
1/2"	90	42	
3/8"	88	29	
#4	83		100
#8	80		96
#16	74		89
#30	62		75
#50	38		46
#100	27		32
#200	17		20.6

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 31.0 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 93.8 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 27

WEST CREEK: WJ 26

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	36	5024	0.31	0.11
1 1/2 - 3/4	31	1504.4	.51	.16
3/4 - 3/8	20	1000.9	.58	.12
3/8 - #4	13	300	.93	.12
Totals	100.0			.51

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	12	100	0.4	0.05
#8 - 16	18	100	.6	.11
#16 - 30	29	100	.8	.23
#30 - 50	22	100	1.7	.37
#50 - 100	12			
#100	7			
Totals	100.0			.76

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk....................... 2.68
Bulk(SSD)............. 2.70
Apparent............... 2.73
Absorption, %....... 0.70

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk....................... 2.57
Bulk(SSD)............. 2.62
Apparent............... 2.72
Absorption, %....... 2.10

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	98	95	
2"	93	82	
1 1/2"	87	64	
1"	79	43	
3/4"	75	33	
1/2"	71	21	
3/8"	68	13	
#4	63		100
#8	55		88
#16	44		70
#30	25		41
#50	12		19
#100	5		7
#200	2.1		3.3

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 36.6 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 121.7 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 76

SKAGWAY RIVER - NE END OF STATE PIT: WJ 27

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	43	5007	0.27	0.12
1 1/2 - 3/4	31	1506.3	.28	.09
3/4 - 3/8	17	1005	.18	.03
3/8 - #4	9	299.9	.33	.03
Totals	100.0			.27

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	14.1	100	0.8	0.11
#8 - 16	21.6	100	1.7	.37
#16 - 30	29.1	100	2.7	.79
#30 - 50	19.0	100	3.6	.68
#50 - 100	8.6			
#100	7.6			
Totals	100.0			1.95

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk....................... 2.68
Bulk(SSD)............ 2.70
Apparent.............. 2.72
Absorption, %....... 0.60

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk....................... 2.63
Bulk(SSD)............ 2.65
Apparent.............. 2.70
Absorption, %....... 1.00

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	94	91	
2"	84	76	
1 1/2"	71	57	
1"	58	37	
3/4"	51	26	
1/2"	44	16	
3/8"	39	9	
#4	33		100
#8	29		86
#16	21		64
#30	12		35
#50	5		16
#100	3		8
#200	1.2		3.7

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 23.8 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 117.9 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 87

EAST FORK SKAGWAY RIVER: WJ 28

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	52.2	4995	0.76	0.40
1 1/2 - 3/4	28.9	1503	.76	.22
3/4 - 3/8	11.3	1000	.21	.02
3/8 - #4	7.6	300	.27	.02
Totals	100.0			.66

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	19.4	103	3.8	0.74
#8 - 16	21.2	101.6	3.2	.68
#16 - 30	21.4	100	2.4	.51
#30 - 50	17.7	100	2.0	.35
#50 - 100	10.5			
#100	9.8			
Totals	100.0			2.28

Specific Gravity and Absorption of Coarse Aggregate
AASHTO T-85 or ASTM C-127

Bulk....................... 2.69
Bulk(SSD)............ 2.71
Apparent.............. 2.73
Absorption, %....... 0.50

Specific Gravity and Absorption of Fine Aggregate
AASHTO T-84 or ASTM C-128

Bulk....................... 2.61
Bulk(SSD)............ 2.66
Apparent.............. 2.76
Absorption, %....... 2.10

Sieve Analysis of Fine and Coarse Aggregate
AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	93	90	
2"	76	67	
1 1/2"	62	48	
1"	48	28	
3/4"	42	19	
1/2"	37	12	
3/8"	34	8	
#4	28		100
#8	23		81
#16	17		59
#30	11		38
#50	6		20
#100	3		10
#200	1.4		5.1

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 26.2 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 118.3 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 84

SKAGWAY RIVER MOUTH: WJ 29

SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE/ AASHTO T-104 OR ASTM C-88

Coarse aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
2 - 1 1/2	37.2	5012	0.17	0.06
1 1/2 - 3/4	39.2	1503.3	.21	.08
3/4 - 3/8	16.0	1002	.37	.06
3/8 - #4	7.6	300	.57	.04
Totals	100.0			.24

Fine aggregate

Sieve Size	Grading of Original Sample %	Wt. of Test Fractions Before Test,g	% Passing Designated Sieve after Test	Weighted % Loss
#4 - 8	14.8	103	2.0	0.30
#8 - 16	16.9	100	1.5	.25
#16 - 30	20.7	100	1.6	.33
#30 - 50	18.3	100	2.9	.53
#50 - 100	15.4			
#100	13.9			
Totals	100.0			1.41

Specific Gravity and Absorption of Coarse Aggregate AASHTO T-85 or ASTM C-127

Bulk........................ 2.65
Bulk(SSD)............. 2.67
Apparent............... 2.71
Absorption, %....... 0.80

Specific Gravity and Absorption of Fine Aggregate AASHTO T-84 or ASTM C-128

Bulk........................ 2.58
Bulk(SSD)............. 2.62
Apparent............... 2.70
Absorption, %....... 1.70

Sieve Analysis of Fine and Coarse Aggregate AASHTO T-27 or ASTM C-36

Screen Size	Total Sample	% Passing Coarse (plus #4) Fraction	% Passing Fine (minus #4) Fraction
2 1/2"	97	95	
2"	87	83	
1 1/2"	72	63	
1"	51	36	
3/4"	42	24	
1/2"	34	13	
3/8"	30	8	
#4	24		100
#8	20		85
#16	16		68
#30	11		48
#50	7		29
#100	3		14
#200	1.5		6.1

Abrasion of Coarse Aggregate by Use of Los Angeles Machine/ AASHTO T-96 or ASTM C-131: 23.2 % loss

Unit Weight of Aggregate Loose Unit Weight as Delivered: 119.0 lb/cubic foot

Sand Equivalent Value of Fine Aggregate/ ASTM D-2419: S.E. = 88

APPENDIX C. - GOLD RECOVERY SUMMARY

Location	Sample #	Grade (oz Au/yd³)	Value (@ $400/oz)
HAINES SUBAREA			
Katzehin River	WJ 2	0.0000512	$0.0205
"	WJ 3	.0000549	.0220
"	WJ 4	.00000990	.00396
"	WJ 5	.0000129	.00516
"	WJ 6	.0000467	.0189
"	WJ 8	.0000482	.0193
Unnamed outwash	WJ 9	.00000527	.00211
Davidson Glacier	WJ 11	.000000643	.000257
Taiyasanka Harbor	WJ 12	.00000116	.000463
Kicking Horse fan	WJ 14	.00000116	.000463
Takhin fan	WJ 15	.000000257	.000103
Tsirku fan	WJ 16	.0000944	.0378
Klehini River	WJ 17	.0000322	.0129
"	WJ 18	.0000100	.00401
"	WJ 19	.0000336	.0134
"	WJ 21	.0000172	.00689
"	WJ 22	.0000132	.00529
SKAGWAY SUBAREA			
Taiya River	WJ 25	.00000553	.00221
West Creek	WJ 26	.0	.0
Skagway River	WJ 27	.00000116	.000463
East Fork Skagway River	WJ 28	.00000103	.000412
Skagway River mouth	WJ 29	.000000514	.000206
JUNEAU SUBAREA			
Dredge Lake	AJ 101	.0000594	.0238
Antler/Gilkey Rivers	AJ 103	.0000140	.00561
"	AJ 104	.0000493	.0197
East Fork Lace River	AJ 105	.0000154	.00616
Berners River sand	AJ 106	.00000304	.00122
East Fork Lace River	AJ 107	.0000475	.0190
"	AJ 108	.0000755	.0302
Endicott River fan	AJ 109	.00000424	.00170
Herbert/Eagle Rivers	AJ 110	.0000295	.0118
"	AJ 111	.0000336	.0134
"	AJ 112	.0000871	.0348
Grizzly Bar	AJ 113	.000137	.0547
"	AJ 114	.000178	.0714
Gustavus-Salmon River	AJ 115	.0000192	.00767
"	AJ 116	.0000172	.00689
Point Hilda	AJ 117	.0000183	.00731
Herbert/Eagle Rivers	AJ 118	.0000836	.0334

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the employment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

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