CITY & BOROUGH OF JUNEAU, ALASKA

NATURAL RESOURCE
SAND, GRAVEL & QUARRY ROCK
INVENTORY REPORT

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JUNEAU, ALASKA

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NATURAL RESOURCE INVENTORY
SAND, SAND AND GRAVEL, AND QUARRY ROCK
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INTRODUCTION

A mineral deposit which consists of sand, sand and gravel or in-place rock usually denotes a natural deposit of said substance which may be extracted commercially for use as a construction material. The degree of feasibility of extraction depends largely on the economic or strategic value any specific deposit may posses. This value is, in turn, dependent largely on the natural characteristics of the deposit, the requirements of the intended usage and the cost of extraction and transport.

In the actual determination of commercial feasibility of a given sand, sand and gravel or quarry rock deposit, a variety of factors are involved. These include quality, quantity, depth of overburden, location of deposit, and demand for the resulting mineral product. In addition, each of these factors may vary with the intended use of the resource. Prior to reviewing a sand and gravel natural resource inventory, it would be well that the reader understood the relationship of such a commercial entity within our region.

The City and Borough of Juneau, unlike other communities in Southeast Alaska, contains extensive deposits of sand and gravel. Annual production of aggregate over the past ten years has ranged between 75,000

cubic yards to well over 1 million cubic yards. These figures conceivably could increase as demand increases in seemingly aggregate deficient areas such as the Mendenhall Valley. With seemingly abundant supplies, long range commercial feasibility is sometimes difficult to determine. This difficulty is due primarily to the fact that such determinations are based essentially on supply and demand functions of the market. If scarcities and limited resources exist within an area and demand for such a resource is high, it becomes a relatively easy task to determine how resources must be protected and conservatively utilized. When resources are abundant, the protection of such a resource becomes a long range consideration which is more seriously impacted only when such resources are abused. When such abuses occur, it is usually because of conflicts of priority that arise amongst the sand and gravel industry, government, private industry, and the citizens of an area as a whole. The problems caused by such conflicts have been apparent within the central Mendenhall Valley area for some time. These problems stem from various causes, some of which may include;

1). Urban and suburban expansion has been most often motivated by short term profit with little regard to the presence of sand and gravel deposits which may underly such areas.

2). Flood plain and low terrace lands appeal to many home buyers and developers for ease of construction but often such lands are prime sources of quality mineral deposits. If such development occurs, the sand and gravel deposits cannot be extracted.

3). Many areas of extensive aggregate extraction which were once well beyond growth areas are now surrounded by new development, forcing gravel trucks to operate through residential zones and congested commercial districts. Because of such growth, extractors have encountered strong resistance from a variety of special interest groups concerned with the effects on mining operations, truck traffic, proximity to residential areas, rehabilitation or lack thereof, of mined areas, and potential damage to the ecosystems.

4). Urbanization, as it covers valuable aggregate deposit, forces extractors to mine farther away from principal markets. The increased cost of transportation and labor necessary to produce the raw products is paid by the consumer.

5). In recent times, sand and gravel companies have been required, in most instances, to rehabilitate the land they have mined. Previous to this, no rehabilitation plan was made for productive mineral deposit areas and they now lay as wastelands. To the recent entryman of the extraction industry, restrictive operational and rehabilitative ordinances may not seem fair in light of the riches gained in the past by indivdiuals not then affected by these ordinances.

Each of these problems must be viewed with the critical concern within the City and Borough of Juneau if we are to most efficiently use the natural resources remaining.

Within the City and Borough of Juneau, it seems apparent that we are fortunate in the aspect that a large portion of our area is underlain by deposits of sand and gravel resources of varying quality and quantity. A great portion of these deposits remain accessible. Although to many, it may seem that certain areas have been unduly subjected to impact associated with open pit mining accomplished without concerted reclamation efforts, this possibly and probably, is not the case. In general, the City and Borough of Juneau has the opportunity to insure that utilization of our mineral resource in the form of sand, gravel and quarry rock may be possible, not only in current times, but also in future years. The guarded utilization of this natural resource with applied concerns for land use policies and practices must be developed with reference to and within the framework of our existing comprehensive plan. With this in mind, it is the undertaking of this inventory and resource report to ascertain the extent used and the estimated quantities remaining of this vital construction material within this "limited" and initial undertaking.

SCOPE OF WORK

R & M Consultants, Inc. was awarded a contract to perform this inventory, the results of which are the subject of this report.

It is the purpose of this report, as described above, to accomplish the following tasks;

1). Locate and inventory all existing significant borrow and quarry sites in the Juneau area from Berner's Bay to Point Bishop, including Douglas Island.

2). Classify the individual sources with regard to location, estimated remaining volume, and type of material available.

3). Locate and estimate the quality and quantity of material available from yet undeveloped sources without the benefit of field exploration, but based on study of aerial photographs and our general knowledge of the geology and topography of the Juneau area and permissable land use patterns.

4). Estimate the areawide needs for borrow and aggregate for Juneau through 1990, based on studies by others.

5). Develop conclusions and recommendations based on all information available to date.

GEOLOGY OF SAND, GRAVEL AND MINERAL AGGREGATE DEPOSITS

The accumulation of sand and gravel deposits in the study area is the result of a series of erosional processes which has occurred since the last glacial advance which, some say, buried the region to a maximum depth of 4000' to 6000' with glacial ice.

When the ice advance began, the mechanical action of the moving ice "tilled" massive amounts of rock and soil from some areas and deposited them in other areas. These deposits are known as "glacial till". As the glacial ice mass retreated from the area (a phenomena which began approximately 10,000 years before present time), melt water along the ice margins deposited granular materials in bodies which were often bordered by scoured bedrock on one side and ice on the other, forming ice contact deposits or moraines. As the valley glaciers which occupied all the major drainages in the Juneau area retreated, melt water streams cut through the morainal deposits, redepositing them downstream where the gradient decreased or where a depositional basin was reached. The "basin" in most cases, was the Gastineau Channel and its contemporaneous shoreline areas which may have existed at an elevation as much as 600' higher than those of present time. Shorelines extended a considerable distance "up" the drainage basins and melt water deposited large amounts of material in the form of deltas and alluvial fans. As the continental ice sheet melted and relieved the earth's crustal load in the region, the land returned toward former levels by a geomorphic process termed isostatic rebound and the retreating sea level caused the streams in the region to cut into their formerly submerged deltaic deposits, leaving them as terraces. Typical terrace deposits exist in the Montana Creek, Lemon Creek, Gold Creek and Sheep Creek valleys to name just a few. Material eroded from the terraces has been redeposited in the alluvial plains of these streams. This material has thus been eroded and deposited two to four times and is generally subrounded, well graded with a

relatively low "fine" content. Typical of such material is that found on the Juneau Ready Mix property at Lemon Creek.

The soils of the Mendenhall Valley area present a special case, differing from those discussed above. These soils are primarily "very young" glacial outwash deposits eroded from terminal, lateral and ground moraines of the rapidly retreating Mendenhall Glacier, then deposited a short distance downstream in river bars and flood channels as alluvium.

Naturally occurring granular soils in the study area which are not included in the above genetic classifications, are generally thin, occurring as long, narrow bodies in plan view, having formed as deposits on beaches now elevated by isostatic rebound. Soils of this type are common on the Mendenhall Peninsula and the Douglas area where thin granular soils overly the parent material, i.e., glacial till or the finer grained glacio-marine or glacio-lacustrine drift.

Of minor importance are colluvial deposits such as the "21 Mile" borrow site and the A-J mine tailings which are quite limited in extent and will likely be utilized only on local projects in the far future.

Modern exposed beaches within the urbanized area were largely ignored as borrow sources in this report due to the "ecologically" sensitive nature of all shoreline habitat.

Based on the above discussion, it may be stated that soils which provide an economic borrow deposit are limited to three genetically related deposit types, listed below in descending order of economic value.

1). Reworked alluvial and morainal deposits existing as alluvial flood plain material.

2). Alluvial fans and stream terrace deposits.

3). Morainal deposits.

All other soils in the project area are either too limited in extent or have a too-high "fines" content to be useful, except under ideal conditions.

In contrast to the above described granular borrow, borrow from quarries cannot be readily classified with respect to grain size distribution nor can it be described according to geologic origin, at least in context relevant to this report. Instead, quarries were classified in the summary table based on estimated rock quality. Rock quality information gained from Southeastern District, Alaska Department of Transportation and Public Facilities was most helpful in establishing the probable rock quality in sources they are familiar with. Other rock sources were classified as to rock quality based on a general knowledge of rock type distribution in the Juneau area.

Due to the general ease of access to rock in most of the Juneau and Douglas area, quarry location is mainly governed by public acceptance factors such as proximity to developed land and dwellings and the possibility of adverse visual impact which could influence tourism and related industries.

Second to these "political" problems is the cost of production, transportation, and rehabilitation after production has ended. Ideally, a quarry should be located where removal of rock is unseen by the general public and results in an improvement such as that which would result if the quarry was to be developed, as proposed by Alaska Department of Transportation and Public Facilities, in the "cut" on the Mendenhall Peninsula. In that particular case, the rock could be utilized for massive, close-by public works projects such as small boat harbor development in Auke Bay. After development is completed, increased clearances for commercial aviation would be appreciated by all.

As a final stage, quarries lend themselves well to development as parking and commercial building sites especially in areas where the availability of level land with firm foundation conditions is limited.

CLASSIFICATION OF BORROW

For the purposes of this report, we have categorized the various sources in terms of the type of material which is known or estimated to predominate there. The three categories are Sand, Sand and Gravel, and Rock.

Sand

Sources which are classified under the "Sand" heading are those which produce or are likely to produce material having 70% or more of their total dry weight passing the No. 4 (4.75 mm) U.S. Standard sieve and less than 10% passing the No. 200 (.074 mm) U.S. Standard sieve. The material is generally free draining and has a low frost susceptibility rating. (See Chart S-1.)

Geologically, sand is most often found in alluvial deposits but it also occurs in elevated terraces and mine tailing deposits. Notable sand deposits in the project area include the Joe Smith Pit west of the Mendenhall River and the Smith-Honsinger Pit northeast of the airport and south west Egan Expressway. Helin, Horn & Shanks Valley Court uplands pit is also predominantly sand.

In this report, sand is considered to be that material primarily usable as common borrow, not to be subjected to heavy traffic or dynamic loads without a suitable "topping" material. Sand is unstable when above or below its optimum moisture content, therefore it must be covered or armored when its use is planned for areas of traffic or dynamic loading. Sand is a necessary component of asphalt or concrete aggregate, but generally occurs in sufficient quantity within "gravel" deposits to satisfy these requirements. Often, in production of aggregate from quarry rock, sand must be imported. This type of operation is not anticipated in the Juneau area in the time frame of this report, but is common in the Petersburg, Sitka and Ketchikan areas.

The large quantities of sand existant in the Gastineau Channel would be a relatively inexpensive source of common borrow if suitable stockpiling areas could be located which would not conflict with existing land uses such as the Mendenhall wetlands.

Gravel

Sources classified as "Gravel" are those which have more than 30% of their total dry weight retained on the No. 4 (4.75 mm) U.S. Standard sieve. At the lower end of the scale, no more than 10% of the dry weight should pass the No. 200 U.S. Standard sieve size. (See Chart S-2.)

Gravel is most valuable for use as aggregate for the production of bituminous paving materials and Portland cement concrete and as easily compactable free draining stable select fill for roadways and foundations.

In the project area, known supplies of high quality gravel are limited to the alluvium occurring in the Mendenhall Valley as sporadic channel fill and river bars and in the Lemon Creek and Salmon Creek alluvial and intertidal lands. Other gravel deposits generally require processing such as screening, crushing and washing to produce a high quality product. These sources are generally glacial in origin, occurring as morainal bodies such as the Toner Pit in the Juneau service area and the Ludwig Pit at 1½ Mile, North Douglas.

Rock

Rock is that material produced by quarrying, utilizing "drilling and shooting" methods to reduce the rock to manageable size. Generally, rock found in the project area is metamorphic in origin and is of a high variable quality from a durability standpoint. Greenstone and meta volcanic rock such as that found in the upper Fish Creek Road quarry and the Mendenhall flight path quarry respectively, is a hard, durable rock usable for a variety of purposes ranging from large size riprap to concrete aggregate. Other quarries, such as the one at 8 Mile, Glacier Highway, have a moderate to low quality schist and phyllite with usefulness primarily as common borrow not exposed to wheel traffic. The more durable quarry rock could be utilized for the full range of borrow uses from common fill to selected aggregate provided the costs of processing are justified. At this time in the project area, these costs are estimated to be 100% to 300% higher, locally for processed rock to replace natural granular material except in special applications such as riprap or use at remote locations.

Special Sources (Sand)

At least one borrow source which deserves special consideration existing in the project area is the massive submerged sand deposit within Gastineau Channel off the Mendenhall River and Salmon/Lemon Creeks mouths. The deposits consist chiefly of well to poorly graded sand and constitute a nuisance to navigation of small boats. The volume of material is great enough to satisfy the need for common borrow in the area for many years.

To be most beneficial, a dredging plan would have to be implemented which would result in formation of easily accessible stockpiles on both North Douglas and near the airport. If dredging was concentrated in the hazardous channel area, fishing and sport boat owners would benefit as would developers utilizing the fill and, ultimately, buyers of the real estate being developed. Less happy would possibly be the owners of local borrow sources supplying common borrow as well as conservation minded individuals due to the stockpiling required for economic reasons.

To be economically and environmentally feasible, areas of stockpiling would have to be designated within the "pumping" limits of a dredge. This could result in the "filling" of designated areas of Gastineau wetlands with relatively high mounds of stockpiled material. Such stockpiles would probably be characterized as having "negative visual impact" by individuals who are highly sensitive to man-made alterations of the landscape in an area which is for the most part, a designated preserve. This factor plus the high cost of "double handling" (first dredging, then conventional loading and trucking), will undoubtedly result in this being a "future resource".

BORROW USAGE

Development, whether it be for residential, commercial, or public works oriented improvements of the landscape generally requires the recontouring of existing land form to be compatible with the final utilization of

the land with its surrounding features and drainage characteristics. Generally, land easiest to develop and settle is done so first, followed by the improvement of less desirable land.

However, Juneau was developed at a site that was undesirable for easy habitation by man. Because of the wealth generated by gold mining activities, the development of Juneau was made possible by the increase of level land area by mine tailing fill operation. As development progressed during post-war years, easier land to be developed was sought after by the residents of the area. This lead to the development of Lemon Creek and Mendenhall Valleys. Mendenhall Valley, a land shaped most easily developed was improved faster than the Lemon Creek Valley. However, in the instance of both valleys, the land requiring the least work was that land first developed. For those first parcels chosen for development, in most instances, only surficial site grading had to be accomplished to ready the land for habitation by man.

As the area population grew, so did the requirements for improvements, both residential needs as well as the commercial and public works needs. As development progressed, the most easily developed land was utilized first, followed in progression by those parcels of land needing more site improvements. As one can readily see within the Mendenhall/ Lemon Creek Valleys, most of the land developed to date has required a low to moderate level of site grading. As the most useful land is developed, less desirable land remains for future development. This less desirable land requires additional site grading and drainage work

for preparation of habitat. In doing so, the replacement or overlay of poor sublying soils requires importation of stable foundation materials, as well as does the raising of building site grades above runoff and flood level conditions. Thus, the need for area development borrow pits is implemented.

Prior to area zoning, borrow materials were generally taken immediately adjacent the proposed site improvements. This is especially evident along the Mendenhall Loop Road from its present intersection of Egan Drive to the Glacier Valley School. During construction of Mendenhall Loop Road, borrow was removed from both sides of the proposed roadway prism to achieve a stable embankment above tentative flood conditions that the road would encounter. In subsequent years, these borrow areas continued to be used for residential as well as commercial site improvements.

Borrow is generally required and used for all site improvements, from recreational needs to residential, commercial and public works improvement projects. The borrow may be an unclassified sand, sand and gravel, and/or quarry rock. It can be further classified into select material specified by the general dynamic load requirements of a project. Borrow materials can be acquired in many different units of contract measurement ranging from the bank yard to the compacted yard, in-place.

ECONOMICS OF BORROW OPERATIONS

As the large, high quality deposits of sand and gravel with minimum overburden which are located close to market areas are depleted, smaller, low quantity deposits covered with greater amounts of overburden and located in areas more distant from market saleable becomes more attractive for use. As this process continues, the only deposits which will eventually remain are those which are considered by today's standards, to be marginal. This factor, in some instances, is taking place. (Example of the Red Samm mining/asphalt production facility within U.S. Survey No. 1284, Mendenhall Valley, wherein as much as 12' of overburden consisting mainly of silts was stripped to obtain the sublying sand and gravel). As the major urban centers increase around sand and gravel operations, the conflict between the urban center and the mining operation also enters into the economics of continual development. This further restricts mining operations. The land value is also another consideration of the economics as to whether the highest and best use of the land can be for subdivided lots, commercial development or recreational development. Finally, location is an especially important consideration in the mining of sand and gravel operations. Transportation costs from the extraction site to the market area can account for a major portion of the total product price to the consumer.

Within the appendix of this report is a hypothetical problem of relative transportation costs for the amount of mined sand and gravel delivered to a point in the Mendenhall Valley from;

a). a borrow pit located in the Mendenhall Valley

b). a borrow pit located in the Lemon Creek Valley

c). a borrow pit located in the Eagle River area.

This hypothetical problem has been established to denote the relatively high transportation cost involved in a major sand and gravel operation. Figures used for this cost comparison analysis were derived from wage rates as established by the State of Alaska, Department of Labor and equipment rates as established by the rental rate "Blue Book" for construction equipment as accepted by the Alaska General Contractors.

The results of this hypothetical problem denote that transportation cost borne by the consumer may add to the site improvement costs from 2.5 to 3.5 times a central "base cost".

INVENTORY OF KNOWN AND POTENTIAL BORROW SOURCES

Existing source areas in the City and Borough of Juneau have been inventoried in this report and are shown on the attached tables and map. In this tabulated summary, we have organized the location, estimated reserve, type and quality of material available from each source. The information utilized in the tabular summary was derived from several sources including the Alaska Department of Transportation and Public Facilities, Alaska Department of Natural Resources, U.S. Forest Service,

U.S. Bureau of Mines, the City and Borough of Juneau planning department, and personal communications with the owners of many private sources. All significant sources of borrow and rock quarries which have been utilized in the last ten years or so were examined, and an estimate of the volume remaining in each was rendered based on information from the above sources. Information from these sources was combined in most cases, with current information obtained through aerial photographs to obtain what we consider to be a reasonable estimate of available reserves under present extraction methods. Existing land use patterns and zoning restrictions were utilized to help render volume estimates where more detailed information was not available.

Utilizing the above criteria, approximately 60 borrow and quarry sites were identified which ranged in use status from "worked out" to "potentially productive".

The type of material available from each site was estimated based on direct observation of in-place material, owner-supplied information (as in the case of Juneau Ready Mix) or our own material test records.

The material reserve estimate is to a specified depth, as shown on the accompanying resource inventory summary. As many of the existing borrow sources do not have any at-depth exploration, the figure could be misleading. Even with an exploration program, the possibility of encountering large volumes of moist silt is extremely strong, in which case

the material would not be usable even as common borrow. Thus, as was the case of the Stock & Grove pit located within Lakewood Subdivision, at depth the amount of usable sand and gravel "played out" at a depth higher than anticipated even with the previous owner having conducted an exploration program. This could also be the case with the Joe Smith and the Smith-Honsinger pits. Without an exploration program, true quantities as well as quality can only be "guesstimates".

INVENTORY OF POTENTIAL BORROW SOURCES

The list of potential borrow sources is limited in this report to those sources substantially unaffected by the physical, economic, and political bounds which exist in the project study area.

Of the physical limitations, the geology of the potential sources is the chief limiting factor. The highest quality granular borrow is found in the alluvial deposition zones of streams having large flow volume and steep gradient. The list of such streams in the project area is short, consisting of Eagle and Herbert Rivers and Hilda and Kowee Creeks, all beyond economical haul range, save for local use projects. Deposits farther down the geologically related quality list are stream terrace and glacial drift deposits. The material from deposits of this nature, if not processed by washing or screening, is generally usable as common borrow only. Processing costs are simply too high to allow inclusion of these deposits on the list of sources of potentially valuable borrow.

Examples of such deposits are those located in the "logged off" upper Lemon Creek area to the northwest of the correctional facility and "overburden" in Tonsgard's 1¼ Mile, North Douglas property.

Hauling distance/cost is another physical factor affecting our potential source list. The massive sand and gravel deposits of the Herbert and Eagle Rivers are denoted, however, due to economics (hauling cost), their use will remain limited. The same is true for the Berner's Bay deposits. Hilda Creek alluvium is on the list only because of its proximity to Juneau.

Political limitations overlap other considerations on most of the above referenced potential source areas and they are the primary limiting factor on several others. The Mendenhall wetlands bounded by the Mendenhall Peninsula, the Egan Expressway and the Gastineau Channel contains a large volume of sand and somewhat lower quantity of gravel, but future expansion of borrow operations on the wetlands will not be allowed in the foreseeable future. A significant quantity of high quality gravel is available in the Gold Creek basin, but is also out of consideration at this time, for political and practical reasons related to the Juneau water supply. Other areas containing high quality borrow, which are listed but unusable at this time due to political considerations, include the Mendenhall Recreation area owned by the U.S. Forest Service and lower Fish Creek and its intertidal zone alluvium.

Sources not mentioned above are numerous, but are generally too small to mention in the context of the report.

The quarries included on the potential source list are those which have been under active consideration by the owner for development, but have been limited to date by permit restrictions or related matters. All the quarries listed are known to have a good potential for production of high quality rock products ranging from riprap to concrete aggregate.

As mentioned previously in this report, rock quality and quantity are not significant factors affecting quarry location in our area. Instead, aesthetics, economics and political factors predominate. This is in contrast to the Fairbanks area, for instance, where the nearest rock aggregate source is 10 to 15 miles to the south and the material available is of relatively low quality.

AREA GROWTH AND POPULATION

Juneau's growth, from the founding of the community until the close of mining activities during World War II, could be classified as moderately progressive. Since the closing of mining operations, the population growth can be linked directly to the increase in government employment, both for territorial needs and later, Statehood needs. The 1960 census showed an area population slightly less than 10,000 individuals. By 1970 the Juneau area was reported to have a population slightly less

than 14,000 denoting an overall increase in population of some 40% in 10 years. The current population of Juneau is estimated to be approximately 22,105 which is an additional increase in areawide population of 49%.

Distribution of the population has also undergone drastic change. In 1960 the urban area of the cities of Juneau and Douglas contained approximately 80% of the total areawide population. By 1970, the population of the Juneau/West Juneau/Douglas urban area represented less than 55% of the areawide population. This percentage is currently estimated to be approximately 40% to 45% of the total population, due primarily to the rapid growth of the Lemon Creek Vally, Mendenhall Valley, and Auke Bay areas. (See Chart P-1.)

Population projections are somewhat difficult to make at this time due to the uncertainty of the initiative which mandated the State of Alaska to move the capital site from Juneau to a point, generally speaking, near the Wasilla/Houston, Alaska communities. Population figures are, therefore at this time, greatly speculative, however a generally agreeable concensus of the population growth until 1990 is shown by Chart P-1. This tabulation of population also denotes the area residential land usage within the service areas specified. This has been done as borrow usage must be associated primarily around the areas of residential and public works developments, which are centered in the populated areas of the community.

Utilized as a population data sheet, was that information obtained by Applied Economic Associates, Inc. of Seattle, Washington for the City and Borough of Juneau, Planning Department. With that supplied data, the Planning Department attempted to determine "saturation" populations for our local government boundary and estimate the number of dwelling units within these specific areas. From this data, it appears that only the Juneau service area could conceivably reach a saturation population rate during or prior to the year 1990. For consistency purposes, the area "saturation population" or "saturation dwelling" units were not utilized for this study's purpose.

ESTIMATED DEMAND AND AVAILABLE RESOURCE

The section entitled "Inventory of Potential Sources" offered on Pages 19 through 21 of this report, is largely a description of selected sources and the methodology utilized in their designation. To be of value to the reader, this inventory should be readily usable as a planning and forecasting tool.

In an attempt to determine the approximate utilization of such an inventory of available materials, we have also attempted to estimate the amount of sand and gravel that will be demanded for utilization on various projects that are known within the City and Borough of Juneau. In doing so, we have contacted such agencies as the Department of Transportation and Public Facilities (Division of Highway Design & Construction, Division of General Design & Construction, and Division of Harbor

Design & Construction); the City and Borough of Juneau (Public Works Department, Planning Department); private developers and from population projection made an estimate of demand by the private consumer for the potential lot developments within the area.

This estimate is greatly limited as most state agencies accomplishing public works projects for the study period (present to 1990), only make projections for their work load for a two to five-year period. Thus, this estimate for potential demands of our sand and gravel resources within the City and Borough of Juneau can best be termed "extremely approximate". Within the appendix of this report is a listing of potential projects within the City and Borough of Juneau over the next 5 years for public works projects and 11 years for residential needs. The estimate does determine that within the Mendenhall Valley all known and potential sources of sand and gravel materials will be at or near depletion utilizing present extraction methods. Even within special methods, it is questionable whether any sources will remain after 1990 within the Mendenhall Valley of the City and Borough of Juneau. Other areas of the Borough such as the Lemon Creek area, Eagle River area, quarry sites on Douglas Island, Mendenhall Peninsula, etc. will have some materials remaining. However, the conservation of our natural sand and gravel resources will have to be considered for all future development.

CONCLUSIONS

In conducting this natural resource inventory of sand, gravel and quarry

rock mineral deposits located within the limits of the City and Borough of Juneau, over 60 sources have been identified. The majority of these sources were identified as the existing pits, operating or potentially operational, either with and without permits, which are located in and around the populated areas of the City and Borough, near the area of greatest consumer need. The greatest need for borrow, of course, is in the City-Borough's most rapidly expanding area, the Mendenhall Valley. Within this area an excess of 3,400,000 cubic yards of sand, sand and gravel is known to exist within existing pits. The vast majority of this reserve is in three source locations;

the City and Borough of Juneau float pond borrow pit

Joe Smith's Mendenhall River pit located on the west side of Mendenhall River

the Smith-Honsinger pit located northeast of the Juneau International Airport runway and south southwest of Egan Expressway

These three pits are chiefly sand sources degrading to sand with traces of silt to sandy silt. Although such pits may be operated to an extended depth (in the case of Smith-Honsinger pit, an approved depth of 50' is applicable), the practicality of extracting materials to such a depth remains questionable. It can only be accomplished through the usage of a "Salamander" and/or hydraulic dredges of which one does exist within our local government confines. Since little to no exploration has been done at depth within these areas, a study assumption is that the sand

will be largely usable to a depth of 50'. However, such a statement must be made with caution as large volumes of silt may, in all probability, be discovered within these sources, thus greatly reducing the estimated resource amount. Where a great amount of the usage of this borrow material, dredging is practical for such projects as the airport runway taxiway improvements, airport access road, fire crash station, fire training center. For other projects, to utilize this material as common borrow, double handling would undoubtedly be required. In the context of this report, "double handling" refers to the two-stage process wherein the material must be dredged and stockpiled to drain within a given stockpile area. Once stockpiled and drained, the material may be then handled by truck hauling units. The material would then have to be loaded into such units and hauled to their place of usage. This cost may, in all probability, equal the hauling cost from the Lemon Creek valley to Mendenhall Valley.

Untreated as yet in this report are the climatic factors which affect the utilization of borrow in this community. The residents of this area realize that we have an average precipitation in excess of 100" per year in the Juneau area and an excess of 50" per year in the Valley area. This, combined with the moisture content of the soil in its natural condition, renders the sand, in some instances, unusable as common borrow due to dynamic loading of the hauling units placed on such material. In almost all instances, if the sand is not within the grading specifications of those recommendations shown by graph form within this

report, the material will not bind and set-up and thus can only be used as a subbase fill capped by a more appropriate select borrow containing gravel materials for binder. Again this somewhat reduces the large volumes of sand to be used as common borrow. Within this report and anticipated usage, we did not reflect a factor for this loss of usable material due to such unusual conditions but instead listed the gravel and sand that could be used in a lump sum.

Given this summary data within the Mendenhall Valley, it reflects that at present approximately 3.4 million cubic yards of material is usable common borrow. Over the next 5 to 11 years, at least 2.8 million cubic yards of borrow will be utilized for either public works projects, commercial development, and/or residential development, leaving a reserve of approximately 20% to 25% of the known resources. This reserve can and may be greatly reduced again by the questionable nature of such reserves as; the Kaiser pit on the west Mendenhall Valley, the Barrett pit on the west Mendenhall Valley, the Joe Smith pit to the north of Lengthy Acres. This questionable nature of the known pits as well as the accuracy of this forecast leaves the highest probability of no known quantities with the current permitted or unpermitted resources within the Mendenhall Valley. Thus, new resources within the Mendenhall Valley will have to be opened up or the consumer will pay the increased hauling cost from the Lemon Creek Valley to the Mendenhall Valley for borrow utilization. Please refer to "Hypothetical Hauling Comparison Table".

The second greatest area of borrow resource (and area of need) that can be utilized as both select and common borrow would be the Lemon Creek Valley. This is the second most economical area of extraction for the potential growth areas of our community. It is currently being used extensively in development for the Mendenhall Valley due to urbanization-related restrictions affecting the established Mendenhall Valley sources which in turn reflects the rapidly increasing population of this area within our community. The utilization of such Lemon Creek Valley resources over the utilization of other common borrow sources (sand) in the Mendenhall Valley reflects the costs of double handling, i.e., bailing and stockpiling, then loading and hauling. These costs evidently exceed the transportation cost from the Lemon Creek Valley where double handling is not necessary.

It may also be concluded from the inventory of known sources within the City and Borough of Juneau that over the past one to two decades, the materials uage has been in excess of 10 million cubic yards of borrow resources within our community. As the community expands for current needs, the mineral resources available for relatively economical borrow material needs within the populated growth areas of this community will be lost. As experienced over the last two to five years, borrow materials cost to the consumer will continue to climb as the availability declines and thus, the consumer will have to pay this increase usage. What must be corrected within the community is the indiscriminate uses of borrow materials for land development purposes and the construction

of community facilities over deposits of known resources. Subdivision site grading and drainage practices that have been followed in the past should be discarded. That is, the building up of roadway embankments higher than the surrounding ground and either flooding lots and/or thus the building up of lots so they will be higher than the roadway prism to keep our roadway drainage should be discontinued. The examples of Erin Manor Subdivision, Riverwood Subdivision and Lakewood Subdivision should be followed wherein the roadway prisms and drainage facilities are constructed lower than the average surrounding ground level, where practical, to achieve maximum utilization of the land as well as our remaining borrow resources. In many instances this will be extremely hard to achieve due to our relatively high ground water table and poor sublying soil conditions. In these instances, embankment depths should be limited by utilizing such new products as Marafi 140 or Dupont Typar, etc. to reduce the total depth of borrow needed over poor sublying soils to achieve adequate resistance to damage from dynamic wheel loads caused by highway use traffic. Should development begin around areas of potential mineral deposits, all care must be taken to denote whether the maximum multiple land utilization can be accomplished in conjunction with that development. It must be realized that one of the goals of conserving our natural resource base is to realize a number of given considerations. Some of these considerations are;

1). It must be realized that our mineral resources are the result of a geological process and that their distribution is limited.

2). The mining of these natural resources may only occur where the resources exist.

3). It must be realized that the greatest demands exist upon these resources for a variety of usages and these demands are reflected by consumer needs and the economics involved in such needs.

4). With the needs of the consumer and lack of apparent achievable quality mineral resources, the conflict between the extractor and the consumer will increase by inverse proportion to the diminishing resource abundance.

5). If the potential of these valuable and limited resource deposits are to be realized, we must protect these resources by discouraging usage which would preclude further extraction. Area development should only occur after such a resource is depleted so as not to achieve direct conflict with man, the builder versus man, his home and recreational pleasures.

Of the 60 or more resource areas denoted by this inventory, in all probability, at least half are impractical due to the relative economics of the extraction method or the apparent conflict with urban and preserve land. It appears that within a relatively short period of time, all natural mineral deposits of sand and gravel resources within the Mendenhall Valley and possibly the Lemon Creek Valley of the City and Borough of Juneau will be depleted. Based on anticipated population

growth and knowledge of only limited short-term public works projects, over 3 million cubic yards of material will be depleted within the next five to ten years. As our population continues to increase with the growth of the state of Alaska, greater demands will be made on this resource. The nature of this inventory is too limited in scope to correctly define limits and guidelines for mineral extraction within the City and Borough of Juneau.

In closing, it is apparent that, at least with a surficial review, mineral resources area available for the immediate future, but lacking for the far future. In conjunction with the comprehensive plan of our community, it may be considered now that long term planning for the utilization of our resources begin. In doing so, we would like to suggest joint planning with the Alaska Department of Fish and Game and the U.S. Forest Service to determine if those resources within the Dredge Lake area may be added to our available resource base. It appears possible that, as in the past, these resources could be employed in a joint multiple use program. That is, the borrowing of materials to create added fisheries rehabilitation and/or recreational usage of the remaining land area. A cooperative program of management and sale with a specific goal could supply the most critical area of rapid growth within our community with economic mineral resources for an extended period into the future.

LIMITED GLOSSARY OF BORROW-RELATED TERMS

Aggregate: Crushed rock or natural gravel screened to size for use in road surfaces, and bituminous or Portland cement mixtures.

Alluvium: Soil, the constituents of which have been transported predominantly in suspension in flowing water and subsequently deposited by sedimentation.

Angle of Repose: Angle between the horizontal and the maximum slope that a soil assumes through natural processes.

Bank Yard: Soil material in its natural state, "in-the-bank" or at its borrow location (pit, quarry, etc.).

Borrow: In road construction, materials used in embankment construction which have been excavated from natural sources, generally close by.

Borrow Pit: An excavation made for the purpose of obtaining earth for construction use.

Boulder: Rounded or subrounded rock particles in excess of 12" or greater average dimension.

Clay: Soil particles finer than 0.002 mm.

Cobble: Rounded or subrounded rock particles having an average dimension ranging between 3" and 12".

Colluvium: A general term applied to loose and incoherent deposits usually at the foot of a slope or cliff and usually brought there chiefly by gravity. Talus and cliff debris are included in such deposits.

Contemporaneous: Existing together or at the same time.

Cubic Yard: Unit of measurement employed in earthmoving operations for payment purposes. (3'x3'x3'= 27 cubic feet = 1 cubic yard)

Cycle Time: The time it takes for a hauling unit to be loaded with borrow, the borrow hauled and dumped at a site and return to the point of beginning.

Fines: Soil particles capable of passing through a No. 200 (0.074 mm) U.S. Standard sieve.

Frost Susceptible: Soil or aggregate having more than 3% by weight particles smaller than 0.002 mm.

Glacial Till: Material deposited by glaciation, usually composed of a wide range of particle sizes which have not been subjected to the sorting action of water. (Locally, such material is referred to as "blue clay".)

Glacial Drift: Sediment (a) in transport in glacier, (b) deposited by glaciers, and (3) predominantly of glacial origin deposited in the sea or bodies of glacial melt water. (This material too, is referred to locally as "blue clay".)

Haul: The distance from a material source to its "area of need".

Gravel: Rounded or subrounded rock particles that will pass a 3" and be retained on a No. 4 (4.75 mm) U.S. Standard sieve.

Load Factor: The percentage decrease in borrow material density (pounds per cubic yard) from a material in its natural state to a loose state.

Loose Yard: Soil taken from its "bank" or natural state and measured loose, either within its hauling container (truck) and/or "dumped", but not spread and/or compacted at its usable site.

Metamorphic Rock: This term includes all those rocks which have formed in the solid state in response to pronounced changes in temperature, pressure and chemical environment which takes place in general, below the shells of weathering and cementation.

Moraine: An accumulation of drift having initial constructional topography, built within a glacial region chiefly by the direct action of glacial ice.

Quarry: An open or surface working usually for the extraction of building stone.

Sand: Rock particles that will pass the No. 4 (4.75 mm) and be retained on the No. 200 (74-micron) U.S. Standard sieve.

Shrink: The volume decrease in material from its natural state to its hauled, placed and compacted final state. Also referred to as a "compacted yard".

Silt (Silt Size): That portion of soil finer than 0.02 mm and coarser than 0.002 mm.

Swell: The volume increase of a material (sand, sand and gravel, or rock) when it is removed from its natural state.

Talus: Sloping mass of rock fragments below a cliff or a steep rock face. Does not, technically, describe the material composing the talus.

Well-Graded: A soil mixture or aggregate mixture having all grains sizes represented, i.e., a mixture with minimum void space. Opp. is "well sorted".

Well-Sorted: A soil mixture generally of alluvial origin having one or two predominent grain sizes...also termed poorly graded.

TABLE P-1
TABULATION OF POPULATION AND AREA RESIDENTIAL LOT USAGE

Service Area	1978 Population	1980 Estimated Population	1990 Estimated Population	Area "Saturation" Population	Existing Average Area Lot Size	City-Borough Recommended Average Lot Size at Saturation	No. of Dwelling Units (Present)	Estimate No. of Dwelling Units at Saturation
Juneau (Old City)	6131	6875	7,000*	7,000*	6,500 sf SF 9,000 sf MF	8,500 sf SF 10,500 sf D 4,000 sf MF	1752	1800
Douglas (Old City)	1606	1801	3,862*	3,862	8,500 sf SF 8,500 sf D 11,000 sf MF	8,500 sf SF 10,500 sf D 4,000 sf MF	502	620
West Juneau	1128	1265	3,226*	3,226	11,900 sf SF 11,900 sf D 16,000 sf MF	8,500 sf SF 10,500 sf D 4,000 sf MF	389	706
North Douglas	719	806	1,238	1,959	2.44 Acres	15,000 sf	257	799
Thane	115	129	198	397	2.98 Acres	15,000 sf	50	173
Norway Point to Airport	2861	3208	4,924	7,346	1.56 Acres SF 17,000 sf MF	8,500 sf SF 10,500 sf D 4,000 sf MF	1021	2623
East Mendenhall Valley	5846	6555	11,232*	18,921	10,200 sf SF 10,200 sf D 15,000 sf MF	8,500 sf SF 10,500 sf D 4,000 sf MF	?	?
West Mendenhall Valley	1518	1702	2,613	12,450	1.89 Acres SF 1.31 Acres MF	8,500 sf SF 10,500 sf D 4,000 sf MF	?	?
Point Louisa to Herbert River	541	607	931	4,241	1.41 Acres SF 18,000 sf MF	8,500 sf SF 10,500 sf D 4,000 sf MF	146	1146

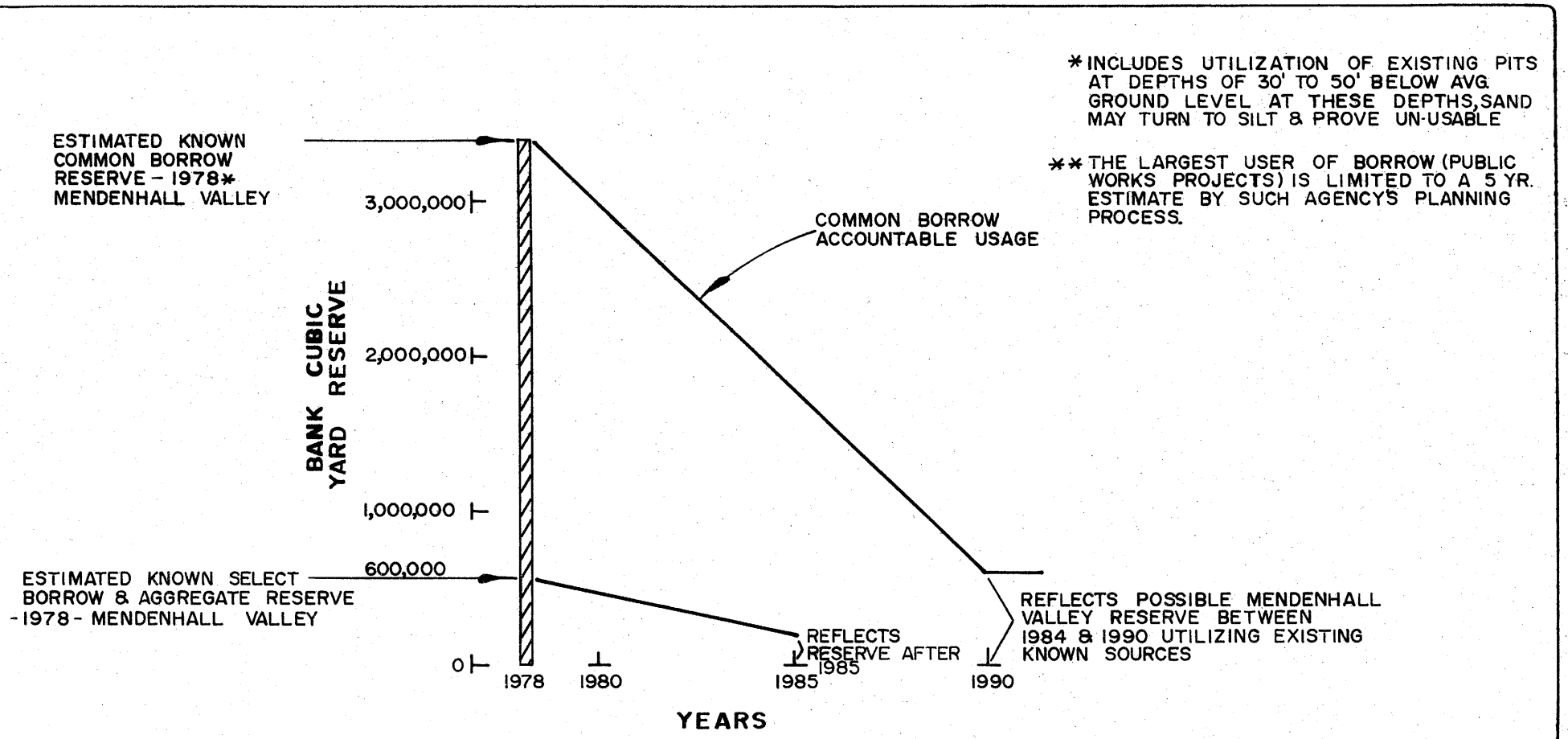
*Reflects Juneau Service Area reaching saturation with overflow going to Douglas, West Juneau and East Mendenhall Valley

SF = Single Family
D = Duplex
MF = Multiple Family

TABLE P-1A

FUTURE EXPANSION AREAS

Service Area	1978 Population	Area "Saturation" Population	No. of Dwelling Units (Present)	Estimate No. of Dwelling Units at Saturation
South Douglas	-0-	1,440	-0-	450
North Douglas	-0-	1,680	-0-	525
Lemon Creek Valley	-0-	2,646	-0-	827
Douglas Island	-0-	26,188	-0-	8184
Echo Cove	-0-	22,500	-0-	7047
Eagle River	-0-	9,546	-0-	2981
Southeast Douglas Island	-0-	748	-0-	234
Montana Creek	-0-	4,259	-0-	1331



MENDENHALL VALLEY KNOWN SAND & GRAVEL RESERVE VS. KNOWN USAGE - 1978 to 1990**

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ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

HYPOTHETICAL HAULING COMPARISON

MENDENHALL VALLEY VERSUS LEMON AND HERBERT RIVER VALLEYS

Assume borrow extractor has for equipment; a 966 loader; D-6 push cat and five 6x4 10 cubic yard dumps (on-off highway). Also assume the material was previously stockpiled at extractor's source, either by dragline and/or dozer methods. The object is to place 200 cubic yards (compacted) to the site. Employing average swell-shrink factors, 240 cubic yards (bank) must be hauled.

Labor Rates are:

Title	Wage	Benefit	Payroll Burden	Total
Teamster	13.28/hr.	4.43/hr.	5.31/hr.	23.02/hr.
Cat Skinner (D-6)	13.99/hr.	4.20/hr.	5.46/hr.	23.64/hr.
Loader Operator	14.88/hr.	4.20/hr.	5.72/hr.	24.80/hr.

Equipment Rates are:

Equipment	Bare Rate	Operation/Maintenance Cost	Total
10 CY Truck	23.94/hr.	8.30/hr.	32.24/hr.
966 Loader	43.61/hr.	10.60/hr.	54.21/hr.
D-6 Cat	42.50/hr.	4.60/hr.	47.10/hr.

CASE I
Valley Pit to Mendenhaven
(U.S. Survey No. 1284 Pit to Mendenhaven)

Load:	966 to Load Truck	3.0 minutes
Haul:	Pit to Loop Road = 0.5 mile/20 mph (60 min/hr) = 1.5 min. + .5 min. stop	2.0 minutes
	Loop Road to Mendenhaven = 1 mile/40 mph(60) + .5 min. stop	2.0 minutes
	Turn and Dump	3.0 minutes
	Return trip (at 1 stop)	3.5 minutes
	Load, Dump and Cycle Time of Truck Return	13.5 minutes
	Cycle/Hour	4.4

10 CY/load at 4.4 loads/hour (5 trucks) = 220 C.Y./hour

Time to Deliver and Spread: 240 cubic yards/220/cycle ($426.06/hour) = $464.79
$464.79/200 in-place cubic yards = $2.32/in-place cubic yards without royalty, reclamation, stockpiling, administration, land value depreciation and profit.

CASE II
Lemon Creek Valley to Mendenhaven
(Helin, Horn & Shanks Pit to Mendenhaven)

Load:	966 to Load Truck	3.0 minutes
Haul:	Pit to Glacier Highway = 0.5 miles/15 mph + 0.5 min. stop	2.5 minutes
	Glacier Highway to Egan Expressway = 1 mile/40 mph (60 min/hr) + 0.5 min. stop	2.0 minutes
	Egan Expressway to Loop Road = 3 miles/50 mph (60 min/hr)	3.6 minutes
	Loop Road to Mendenhaven = 1.5 miles/40 mph (60 min/hr) + 0.5 min. stop	2.75 minutes
	Turn and Dump	3.0 minutes
	Return Cycle (+ two 0.5 min. stops)	10.35 minutes
	Load, Dump and Cycle Time/Truck	27.2 minutes
	Cycle/Hour = 60 min/27.2 min./cycle	2.21

10 CY/load at 2.21 loads/hour (5 trucks) = 110.5 C.Y./hour

Time to Deliver and Spread: 240 cubic yards/110.5 load/hour = 2.71 hours ($426.06/hour) = $1154.62
$1154.62/200 in-place cubic yards = $5.77/in-place cubic yards without royalty, reclamation, stockpiling, administration, land value depreciation and profit.

CASE III
Eagle River to Mendenhaven
(Kodzoff Pit to Mendenhaven)

Load:	966 to Load Truck	3.0 minutes
Haul:	Pit to Glacier Highway = 0.5 mile/15 mph (60 min/hr) + 0.5 min. stop	2.5 minutes
	Glacier Highway to Loop Road = 12 miles/50 mph (60 min/hr) + 1 min. stop	15.4 minutes
	Loop Road to Mendenhaven = 1.75 miles/40 mph (60 min/hr) + 0.5 min. stop	3.13 minutes
	Turn and Dump	3.0 minutes
	Return Cycle	20.0 minutes
	Load, Dump and Cycle Time of Truck Return	47.0 minutes
	Cycle/Hour	1.28

10 CY/load at 1.28 loads/hour (5 trucks) = 64 C.Y./hour

Time to Deliver and Spread: 240 cubic yards/64 load/hour = 3.75 hours ($426.06/hour) = $1597.73
$1597.73/200 in-place cubic yards = $7.99/in-place cubic yards without royalty, reclamation, stockpiling, administration, land value depreciation and profit.

With Case I as Base	1
Case II = 5.77 - 2.32/2.32 (100) = % cost increase	148.7%
Case III = 7.99 - 2.32/2.32 (100) = % cost increase	244.4%

The above hypothetical computations utilizing relatively "real cost" figures, denote the percent increase to the consumer with source locations being 1.5 miles, 6 miles and 14.75 miles from the point of "need".

LIMITED ESTIMATE OF BORROW REQUIREMENTS

CITY AND BOROUGH OF JUNEAU

1978 - 1990**

Project Names	Common Borrow	Select Borrow	Asphalt Aggregate and Other Base Materials	Concrete Aggregate
Gastineau Channel Bridge	80,000	87,480	2,500	70,000 (Riprap)
West Juneau to Douglas Widening and Pavement	5,000	4,700	1,900	-
North Douglas Pavement	-	-	1,000	-
Spur Road Pavement	-	4,700	3,800	-
Brotherhood Bridge to Auke Bay	49,500 (from extraction)	16,000	4,880	2,300 (Riprap)
Ferry Terminal Expansion	65,500	4,130	3,300	10,000 (Riprap)
Airport Taxiway and Small Plane Tie-Down	1,226,000	30,000	10,000	
School Sites				
2 Elementary	50,000	2,000	500	
1 High School	35,000	3,000	750	
Fire Crash Stations	24,000	1,000	500	
Airport Access Road	100,000	10,000	2,000	
Fire Training Center	25,000	2,500	500	
Mendenhall Valley Roads (5 Miles Only)	10,000	8,000	3,900	
Commercial Development		See Below		
Mendenhall Village	60,500	5,000	2,750	

Project Names	Common Borrow	Select Borrow	Asphalt Aggregate and Other Base Materials	Concrete Aggregate
Nugget Mall	20,000	2,700	1,300	
Valley Center	50,000	5,000	2,500	
Switzer Community	200,000	20,000	5,000	
Land Fill (Solid Waste)	150,000	-	-	
Juneau Ready Mix	-	-	1,008,000	192,000
New Subdivision Streets* (Mendenhall Valley Only)	196,200	75,000	10,000	
Sewer Interceptors* (Mendenhall Valley Only)	10,250	-	-	
Residential Construction* (Mendenhall Valley Only)	516,000	-	-	-
Thane Road	311,000	10,105	3,200	
Glacier Highway Pavement (Westours to Berner's Bay)	-	26,100	6,500	
Old Glacier Highway (Pavement - 0 to 8 Mile)	1,200	2,800	8,900	
Glacier Highway (Ferry Terminal to End of Pavement)	-	3,630	10,370	
Fish Creek Road	9,000	14,300	3,150	
Fish Creek Road to Boat Ramp	300	-	2,000	
Admiral Way to Ferry Terminal	-	-	150	
Kowee Creek Bridge	43,000	1,900	700	

*Computed for Mendenhall Valley Alone

Building Site Needs:	40'x60' house pad at 1.5' depth	134 cubic yards
	Driveway - 14'x50' pad at 2.5' depth	65 cubic yards
	Resident Requirements	199 cubic yards

*Roadway Subdivision Requirements

15% of land area per subdivision

City and Borough has 60' R/W of which roadway is 24' shoulder to shoulder; hence, 1 acre of roadway = 726 lineal feet of roadway

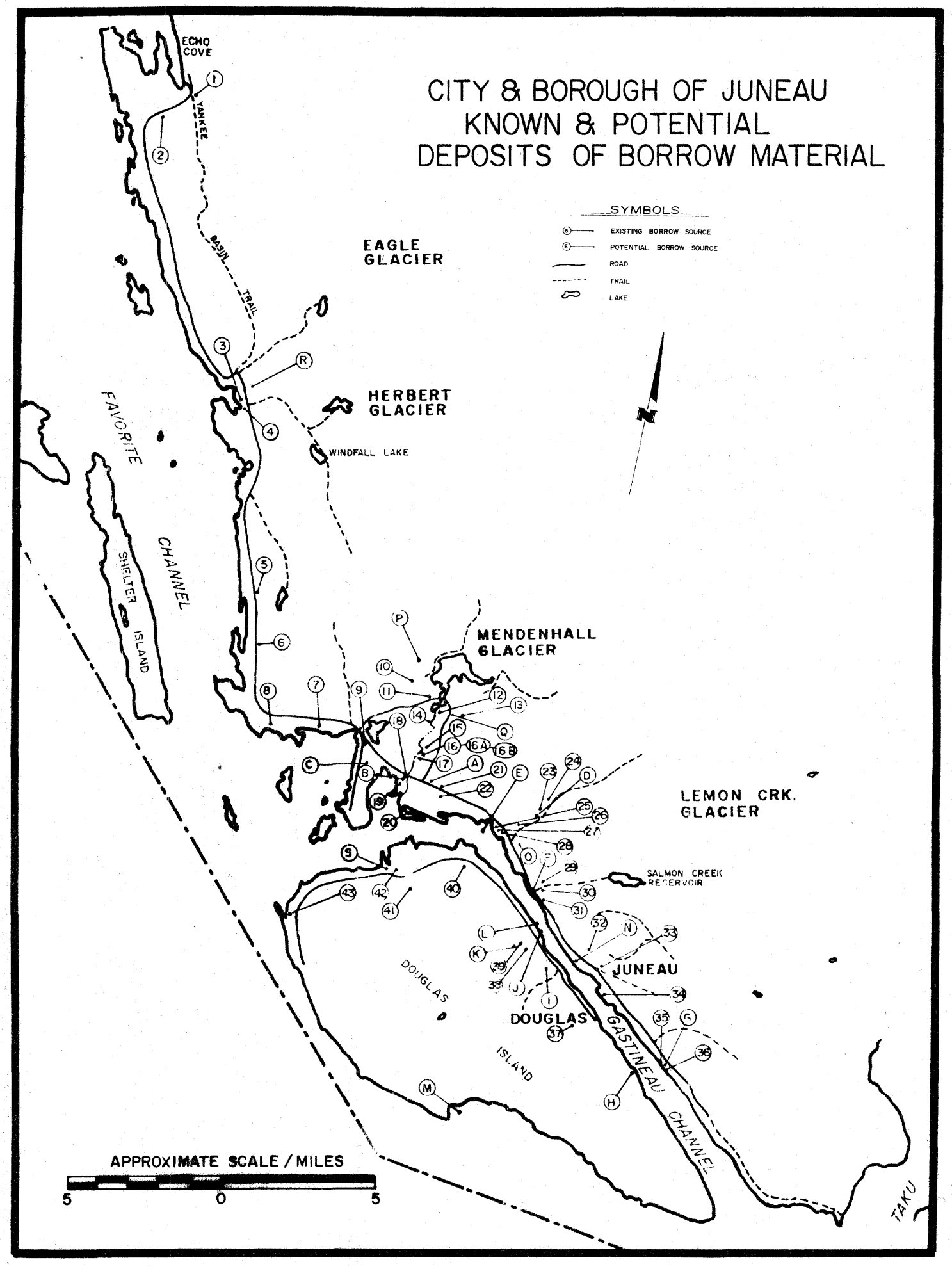
Common Borrow (3'x26'x726'/27 + 726 x 3 x 6/27)	2585 cubic yards/acre
Select Material (1' x 25' x 726'/27)	675 cubic yards/acre
Base Material (6" x 24.5' x 726'/27)	330 cubic yards/acre

*Sewer Construction

With the relatively high density of housing projected, on-site wastewater treatment would, in all probability, be unacceptable. Therefore, wastewater interceptor construction would be required. Assuming such an interceptor would be placed in all new roadway construction and an approximate depth of 6', borrow would be needed for 6" of bedding and 2' of capping. The remaining material would come from the excavation.

2' x .5' x 726'/27 + 2' x 2' x 726'/27 = 135 cubic yards

***Estimate made with knowledge that most, if not all, public agencies only have a two to five year plan for public works projects. Residential need (Mendenhall Valley) is directly proportioned to population growth for the 11 year period. Thus, the summary truly reflects borrow quantity estimate needs for 5 years and residential needs for 11 years.


CITY & BOROUGH OF JUNEAU
KNOWN & POTENTIAL
DEPOSITS OF BORROW MATERIAL
SYMBOLS
EXISTING BORROW SOURCE
POTENTIAL BORROW SOURCE
ROAD
TRAIL
LAKE
ECHO COVE
YANKEE BASIN TRAIL
EAGLE GLACIER
HERBERT GLACIER
WINDFALL LAKE
FAVORITE CHANNEL
SHELTER ISLAND
MENDENHALL GLACIER
LEMON CRK. GLACIER
SALMON CREEK RESERVOIR
JUNEAU
DOUGLAS
DOUGLAS ISLAND
GASTINEAU CHANNEL
TAKU
APPROXIMATE SCALE / MILES
5 0 5

R&M CONSULTANTS, INC.

SUMMARY OF NATURAL RESOURCE BORROW MATERIAL SOURCES WITHIN THE CITY & BOROUGH OF JUNEAU, ALASKA

SOURCE NO.	NAME OF SOURCE	LOCATION AND/OR LEGAL DESCRIPTION	AVAILABLE LAND AREA (SURFACE ACRES)	MAXIMUM PIT AREA (ACRES)	EXISTING PIT AREA (ACRES)	EXISTING REMAINING PIT AREA	AVERAGE DEPTH OF PIT	MAXIMUM PRACTICAL DEPTH	ESTIMATED VOLUME REMOVED	ESTIMATED ORIGINAL VOLUME	ESTIMATED RESERVE VOLUME (CUBIC YDS)	PROCESSED AGGREGATE	SELECT BORROW	COMMON BORROW	HAULING ECONOMICS	ZONING	CURRENT PERMIT	COMMENTS
A	SMITH/ST. PAUL	NORTH OF GLACIER HIGHWAY - EAST OF LOOP ROAD (U.S.S. 1194)	100+	10	N/A	10	N/A	15	0	250,000	250,000	X	X	X	GOOD-EXC.	R-7	NO	PART OF ABANDONED DAIRY FARM NORTH OF EGAN EXPRESSWAY
B	TOM FILE	MENDENHALL FLATS (U.S.S. 2136 & ACCRETED LANDS	47	43	N/A	43	N/A	30	0	2,100,000	0	X	X	X	GOOD	I	NO	SAND SOURCE ONLY - OWNERSHIP CLAIM - IN COURT LITIGATION
C	STATE OF ALASKA - MS 95-8-011-3	ENGINEER'S CUT-OFF/F.A.A. FLIGHT PATH (U.S.S. 3817, L-1)	7.5	7.5	N/A	7.5	N/A	10	0	1,800,000	1,800,000	X	X	X	GOOD	R-40	NO	QUARRY ROCK SOURCE
D	BOY SCOUT'S	LEMON CREEK (U.S.S. 2557)	300	10	N/A	10	N/A	20	0	270,000	270,000			X	FAIR	R-40	NO	SERIES OF ADJOINING PLACER CLAIMS - UNPROVEN RESERVE
E	BURGESS/WILLAMETTE-WESTERN, J.V.	GASTINEAU CHANNEL DREDGING	N/A	N/A	N/A	N/A	N/A	30	1,250,000	3,000,000	1,750,000			X	GOOD	N/A	YES	RECLAIMABLE SOURCE - SAND WITH SOME SILT
F	SALMON CREEK FAN/DREDGE AREA	SOUTHWEST OF EXPRESSWAY/SALMON CREEK CROSSING SUBMERGED ALLUVIUM	UNKNOWN	7.4	N/A	7.4	N/A	8	0	95,000	95,000		X	X	POOR-FAIR	N/A	YES	HIGH SILT CONTENT WITH POCKETS OF ACCEPTABLE SAND & GRAVEL
G	GASTINEAU MILL SITE	EAST SIDE THANE ROAD AT MILL SITE	UNKNOWN	2	N/A	2	N/A	20	0	60,000	60,000	X	X	X	FAIR	R-40	YES	ROCK QUARRY - GREENSTONE
H	TREADWELL MILL SITE	DOUGLAS	UNKNOWN	4.2	N/A	4.2	N/A	15	0	99,000	99,000			X	POOR	R-40	NO	MINE TAILINGS (FINE)
I	TONSGARD	1 1/2 MILE NORTH DOUGLAS HIGHWAY (WEST 1/2 MAINE LODE)	20	20	N/A	20	N/A	40	3,000	2,000,000	2,000,000	X	X	X	FAIR-GOOD	R-12	NO	PLANNING COMMISSION & CITY-BOROUGH ASSEMBLY TURNED DOWN PERMIT FOR SOURCE
J	STATE OF ALASKA	OPPOSITE LUDWIG PIT/NORTH DOUGLAS HIGHWAY/CHANNEL TIDELANDS	UNKNOWN	8.8	N/A	8.8	N/A	8	0	125,000	125,000			X	FAIR-GOOD	R-12	NO	HIGH SILT CONTENT, SHALLOW DEPTH OF RESERVE
K	U.S. FOREST SERVICE	ADJACENT LUDWIG PIT/NORTH DOUGLAS HIGHWAY	UNKNOWN	11.5	N/A	11.5	N/A	20	0	370,000	370,000		X	X	GOOD	R-12	NO	MATERIAL SIMILAR TO LUDWIG BUT UNPROVEN, PARTIAL QUARRY OPERATION
L	VAN KIRK TIDELANDS	2 MILE NORTH DOUGLAS HIGHWAY (EAGLE CREEK) SUNSET TRAILER COURT	4	4	N/A	4	N/A	7	1,000	45,000	45,000			X	FAIR	R-12	NO	SIMILAR TO "J"
M	HILDA CREEK FAN	WEST SIDE DOUGLAS ISLAND (NATIVE LAND SELECTION)	100+	100+	N/A	104	N/A	10	0	1,665,000	1,665,000	X	X	X	POOR	R-40	NO	LARGE SANDY GRAVEL WITH SOME SILT "FAN" - UNPROVEN SOURCE
N	GOLD CREEK FAN	SOUTHEAST OF TAKU TWINS THEATRE (SUBMERGED ALLUVIUM)	17	15	N/A	15	N/A	30	0	400,000	400,000			X	EXC.	R-5	NO	MATERIAL USAGE PROBABLE WITH PORT CONSTRUCTION
O	VANDERBILT HILL	5 MILE GLACIER HIGHWAY - LOGGED AREA (U.S.S. 3264)	100+	N/A	N/A	N/A	N/A	N/A	0	10,000	10,000			X	FAIR	R-7	NO	QUESTIONABLE SAND-GRAVEL & QUARRY SOURCE
P	MONTANA CREEK ROAD BACK SLOPE	EAST OF RIFLE RANGE ON ROADSIDE	1	1	0.3	0.7	HILL SIDE	N/A	1,000	10,000	9,000		X	X	GOOD-EXC.	R-12	NO	HIGH SILT-MOISTURE CONTENT, QUESTIONABLE USAGE
Q	U.S.S. 1529/1527	SOUTH AND SOUTHWEST OF ERIN MANOR SUBDIVISION	10	4	1	3	20	30	25,000	135,000	110,000		X	X	GOOD	R-7	NO	SAND & GRAVEL RESOURCE BETWEEN TWO DEVELOPED AREAS
R	EAGLE/HERBERT RIVER BASINS	VALLEY BASIN, NORTH OF HIGHWAY	N/A	N/A	N/A	N/A	N/A	N/A	0	1,000,000	1,000,000	X	X	X	POOR	R-40	NO	POSSIBLE SOLE SOURCE OF CONCRETE AGGREGATE IN JUNEAU IN FUTURE
S	NORTH DOUGLAS - FISH CREEK	NORTH OF U.S.S. 1082, WEST OF U.S.S. 2560	3	3	N/A	N/A	20	30	0	96,000	96,000			X	POOR	R-12	NO	USE IN DEVELOPMENT OF ADJACENT LANDS AND ROADS

VOLUMES OF GRAVEL PITS COMPUTED BY UTILIZING SURFACE PIT AREA, CUT BACK TO GROUND WATER AT 2:1, THEN AT THE SUBMERGED SOILS ANGLE OF REPOSE FOR FINAL DEPTH.
WITHOUT SOIL SAMPLES, AT DEPTH, THIS IS TRULY A "GUESSTIMATE". SOILS COULD GRADE TO SILT, BECOMING TOTALLY UNWORKABLE EVEN AS COMMON BORROW.

R&M CONSULTANTS, INC.

SUMMARY OF NATURAL RESOURCE BORROW MATERIAL SOURCES

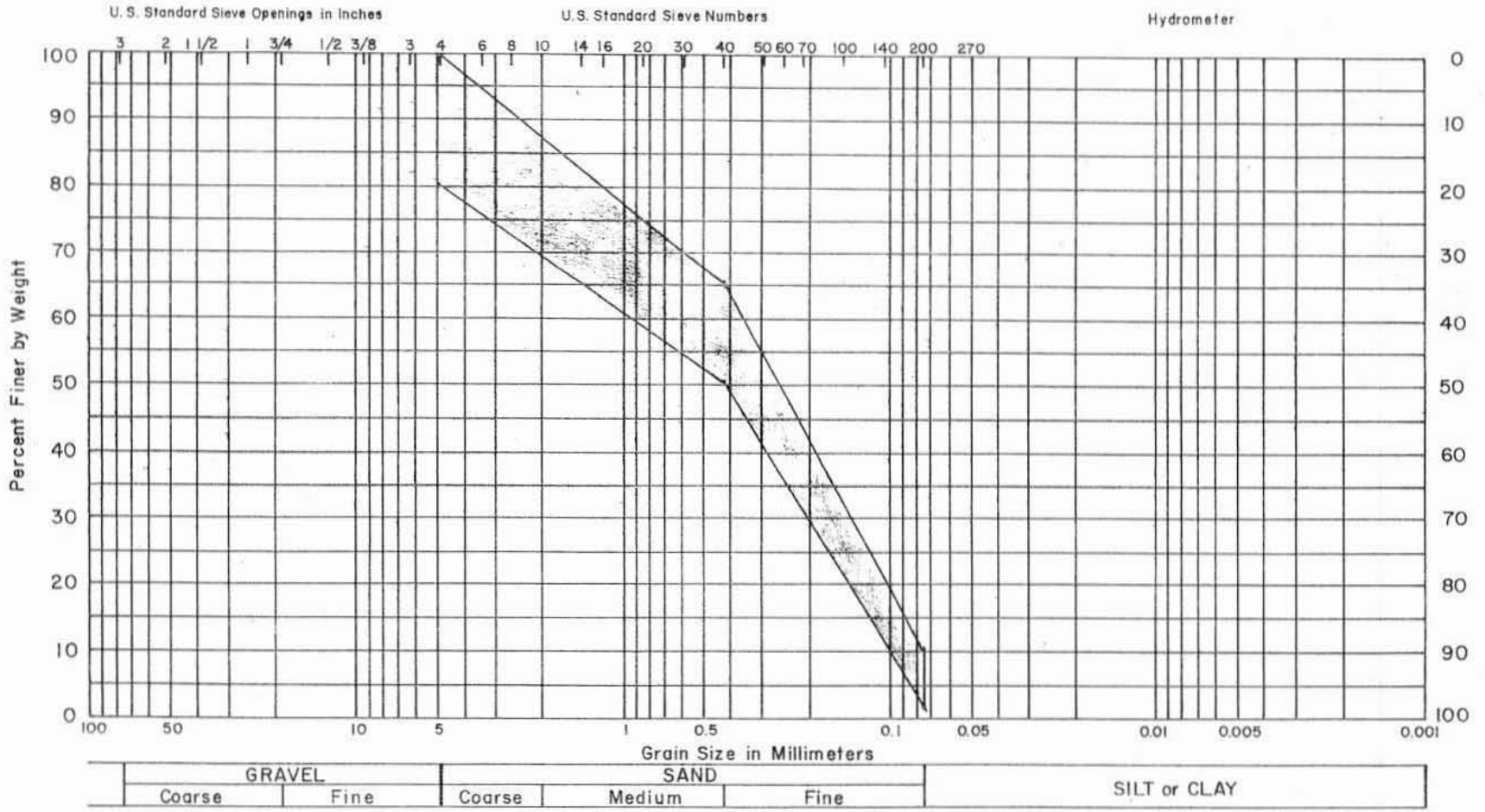
WITHIN THE CITY & BOROUGH OF JUNEAU, ALASKA

SOURCE NO	NAME OF SOURCE	LOCATION AND/OR LEGAL DESCRIPTION	AVAILABLE LAND AREA (SURFACE ACRES)	MAXIMUM PIT AREA (ACRES)	EXISTING PIT AREA (ACRES)	EXISTING REMAINING PIT AREA	AVERAGE DEPTH OF PIT	MAXIMUM PRACTICAL DEPTH	ESTIMATED VOLUME REMOVED	ESTIMATED ORIGINAL VOLUME	ESTIMATED RESERVE VOLUME (CUBIC YDS)	PROCESSED AGGREGATE	SELECT BORROW	COMMON BORROW	HAULING ECONOMICS	ZONING	CURRENT PERMIT	COMMENTS
1	UPPER END ECHO COVE SPUR	END OF GLACIER HIGHWAY	10	6	3.2	2.7	25	40	104,000	250,000	146,000	X	X	X	VERY POOR	USFS	NO	MOUNTAIN SIDE QUARRY, MAY BE EXPANDED BY "BENCHING"
2	USFS/BPR - KOWEE CREEK	36 MILE GLACIER HIGHWAY	10	5	2.6	2.4	30	40	125,000	350,000	225,000	X	X	X	VERY POOR	USFS	NO	MOUNTAIN SIDE QUARRY, MAY BE EXPANDED BY "BENCHING"
3	STATE OF ALASKA - EAGLE RIVER	28 MILE GLACIER HIGHWAY	2.1	40	NONE	35.4	N/A	8	0	520,000	520,000	X		X	VERY POOR	R-40	NO	RIVER & ADJACENT LAND, SAND & GRAVEL PIT FOR HIGHWAY MAINTENANCE PURPOSES
4	KODZOFF	HERBERT RIVER (U.S.S. 1174)	10.5	10.5	4.8	5.6	5	5	40,000	90,000	50,000	X	X	X	POOR	R-40	NO	UTILIZED TO DATE FOR HIGHWAY CONSTRUCTION & MAINTENANCE WITH MINOR RESIDENTIAL USE
5	TALUS	21 MILE GLACIER HIGHWAY	3	3	3	N/A	N/A	N/A	10,000	N/A	N/A			X	POOR-FAIR	R-40	NO	UNSAFE FOR FURTHER EXPLORATION WITHOUT MAJOR WORK EFFORT
6	STATE OF ALASKA - MS 961-008-3	18 1/2 MILE GLACIER HIGHWAY (U.S.S. 3765) TEE HARBOR	7.8	7	3	4	20	20	115,000	180,000	65,000		X	X	POOR-FAIR	R-12	NO	HILLSIDE SLOPE STABILITY LIMITS AREA DEVELOPMENT. MATERIAL HAS HIGH SILT CONTENT
7	STATE OF ALASKA	13 3/4 MILE GLACIER HIGHWAY - AUKE BAY FERRY TERMINAL - NORTH SIDE	4	4	4	4	N/A	20	0	130,000	130,000	X	X	X	GOOD	R-12	NO	PLANNED FOR UTILIZATION FOR FERRY TERMINAL EXPANSION
8	LENA BEACH ROAD	LENA POINT (U.S.S. 3809, L-2E)	5	5	1.5	3.5	20	20	40,000	150,000	110,000		X	X	FAIR	R-12	NO	GRAVEL SOURCES FOR CONSTRUCTION OF LENA POINT ROAD
9	STATE OF ALASKA - AUKE LAKE	11 MILE GLACIER HIGHWAY (U.S.S. 2386)	5	5	3.5	1.5	10	20	60,000	125,000	65,000		X	X	GOOD	R-12	NO	LIMITED RESIDENTIAL AREA WITH POOR HIGHWAY CROSSING. MATERIAL IS SILTY AND HAS EXCESSIVE BOULDERS
10	GREEN	MONTANA CREEK (U.S.S. 2079)	7	7	4.6	2.4	25	35	175,000	315,000	140,000	X	X	X	FAIR-GOOD	R-40	NO	HELD IN RESERVE BY NATIONAL CONTRACTORS FOR A QUALITY MATERIAL SOURCE
11	BARRETT	BACK LOOP ROAD (U.S.S. 1796)	11.5	6	N/A	6	N/A	17	0	160,000	160,000			X	GOOD	R-12	YES	MATERIAL QUALITY & QUANTITY UNPROVEN, APPEARS SILTY WITH HIGH ORGANIC CONTENT
12	STATE OF ALASKA/U.S. FOREST SERVICE	MOOSE LAKE/DREDGE LAKE	N/A	N/A	5	MANY AREAS AVAIL.	20	40	1,000,000		10,000,000(+)	X	X	X	GOOD	R-40 USFS	NO[II]	BORROW UTILIZED ON RECENT USFS/F&G HATCHERY POND PROJECTS-UNAVAILABLE OTHERWISE
13	REED	LOOP ROAD/THUNDER MOUNTAIN (U.S.S. 3752)	6.6	6.5	5.6	1	30	40	220,000	250,000	30,000	X	X	X	GOOD	RML	NO	DEPTH OF EXCAVATION MAY INCREASE QUANTITY, DRAINAGE PATTERNS WOULD NEED DEFINING
14	KAISER	UPPER MENDENHALL RIVER (U.S.S. 4598 - L-2)	7.2	7.2	7.2	2	N/A	10	50,000	170,000	120,000			X	FAIR	R-12	YES	APPEARS TO BE ADEQUATE FOR MATERIAL NEEDS ON WEST SIDE OF VALLEY - NO RESTORATION PLANNED
15	SMITH	LENGTHY ACRES/WEST END GEE STREET (U.S.S. 3872)	13.2	10	7.6	2.4	6	10	60,000	250,000	150,000		X	X	GOOD	R-7	NO	HIGH SAND/SILT CONTENT, MUCH OF THE REMAINING MATERIAL MAY HAVE TO BE WASTED
16	STOCK & GROVE/SOUTHEAST LAND & DEVELOPMENT	LAKEWOOD SUBDIVISION/MENDENHALL RIVER (U.S.S. 4598, L-6)	10	10	6.8	3.2	N/A	45	250,000	500,000	0			X	GOOD	R-7	YES	PIT DEPLETED, SITE RESTORATION PROCEEDING IN CONJUNCTION WITH LAKEWOOD SUBDIVISION
16-A	SOUTHEAST LAND & DEVELOPMENT	FRACTION OF L-11, U.S.S. 4598	9	7.5	4	3.5	20	30	20,000	40,000	20,000	X	X	X	GOOD	R-7	YES	HIGH CONTENT OF FINES (SANDY SILT). COULD REPLENISH ITSELF THRU ALLUVIUM
16-B	SOUTHEAST LAND & DEVELOPMENT/RED SAMM	FRACTION OF L-11, U.S.S. 4598	15	5	5	15	30+	30+	10,000	580,000	570,000	X	X	X	GOOD	R-7	YES[III]	OWNER UTILIZING FOR SELECT MATERIAL & PROCESSING FOR ASPHALT AGGREGATE ONLY. 5 ACRES UNDER PERMIT ONLY
17	RED SAMM ASPHALT PLANT/VALLEY INVESTMENT	MENDENHALL RIVER (U.S.S. 1284)	23	20	19.9	0	25-30	30+	900,000	1,200,000	0	X	X	X	GOOD	R-7	YES	PIT DEPLETED, POSSIBLE MATERIAL UNDERLYING SHOP BUILDINGS, RESTORATION ON GOING.
18	BARRETT & GALLAGHER - MENDENHALL RIVER BAR	900' S. BROTHERHOOD BRIDGE (U.S.S. 1193)	33	N/A	1	N/A	N/A	N/A	10,000	60,000	50,000	X	X	X	GOOD	R-7	YES	RESIDENTIAL BUILD-UP OF AREA NATURALLY RESTRICTS CONTINUING UTILIZATION OF THIS SOURCE
19	SMITH	WEST MENDENHALL FLATS (U.S.S. 1536/1919)	39.6	32	20	12	20	50	900,000	2,400,000	1,500,000			X	GOOD	I	NO	LONG TERM SOURCE OF SAND. INDUSTRIAL DEVELOPMENT COULD RAPIDLY REDUCE RESERVE
20	AIRPORT FLOAT PLANE PONDS	SOUTH AND WEST OF RUNWAY	104	90	85	5	20	25±	1,700,000	2,500,000	300,000			X	EXC.	C-3	NO	AN EXCESS OF 500,000 C.Y. UTILIZED IN 1977 FILLING OLD BORROW PITS FOR TAXIWAY. DEPLETE BY 1980.

R&M CONSULTANTS, INC.

SUMMARY OF NATURAL RESOURCE BORROW MATERIAL SOURCES
WITHIN THE CITY & BOROUGH OF JUNEAU, ALASKA

SOURCE NO.	NAME OF SOURCE	LOCATION &/OR LEGAL DESCRIPTION	AVAILABLE LAND AREA (SURFACE ACRES)	MAXIMUM PIT AREA (ACRES)	EXISTING PIT AREA (ACRES)	EXISTING REMAINING PIT AREA	AVERAGE DEPTH OF PIT	MAXIMUM PRACTICAL DEPTH	ESTIMATED VOLUME REMOVED	ESTIMATED ORIGINAL VOLUME	ESTIMATED RESERVE VOLUME (CUBIC YDS)	PROCESSED AGGREGATE	SELECT BORROW	COMMON BORROW	HAULING ECONOMICS	ZONING	CURRENT PERMIT	COMMENTS
21	STATE OF ALASKA	8 MILE GLACIER HIGHWAY (U.S.S. 2477/3801)	3.4	NONE	1.8	1.6	25	40	50,000	175,000	0	X	X	X	GOOD	R-12	NO	CHURCH/SCHOOL SITE & RESIDENTIAL SUBDIVISION RESTRICTS CONTINUED USE OF QUARRY
22	SMITH/HONSINGER	SMITH DAIRY FLATS (U.S.S. 1568/1852)	84	50	36.2	13.8	35	50	1,310,000	2,600,000	1,290,000			X	GOOD	R-12	YES	WITH DEPTH, LARGE RESERVE OF SAND EXISTS, HOWEVER, SILT CONTENT COULD INCREASE AT DEPTH
23	HELIN, HORN & SHANKS	VALLEY COURT - LEMON CREEK SOUTH (U.S.S. 2487)	55	36	15.7	12.3	25	50	680,000	2,880,000	2,200,000	X	X	X	GOOD	RML	NO	EXCELLENT QUALITY AREA RESERVE. OWNERS HAVE RESTORATION PLAN WHICH WOULD NOT UTILIZE ALL MATERIAL
24	STATE OF ALASKA - MS 95-8-001-3	LEMON CREEK (U.S.S. 5504, L-5)	31.5	20	3.1	16.8	20	40	17,000	957,000	940,000	X	X	X	FAIR-GOOD	RML	NO	EXCELLENT RESERVE WITH MANY RESTORATION OPTIONS AVAILABLE FOR RESIDENTIAL DEVELOPMENT
25	SCOTT & SCHNEIDER	LEMON CREEK FLATS (U.S.S. 2121)	18.6	14	15.9	0	20	30	450,000	1,160,000	700,000	X	X	X	GOOD	R-40	YES	SILT "POCKETS" APPEARING AT DEPTH. RESERVE MAY BE LIMITED.
26	JUNEAU READY MIX	LEMON CREEK FLATS (MS 204/609)	50	25	15	25	N/A	20	385,000	700,000	315,000	X	X	X	GOOD	I	NO	WITH PROCESS, EXCESSIVE SAND/SILT REMAINS RESERVE FOR QUALITY MATERIAL (PROCESSED) WITH SAND/SILT COMMON
27	HILDRE SAND & GRAVEL	LEMON CREEK FLATS - SOUTHEAST OF JUNEAU READY MIX	23	23	10.8	12.2	N/A	30-40	100,000	700,000	600,000	X	X	X	GOOD	I	YES	QUALITY SOURCE FOR CONCRETE AGGREGATE. HIGH SILT/SAND REMAINS, UTILIZE IN PART FOR COMMON BORROW
28	CHANNEL SANITATION (STROHMEYER)	LEMON CREEK FLATS - DUMP AREA SOUTH (MS 204)	10	10	7.5	2.5	30	30	50-75,000	300,000+	225,000	X	X	X	GOOD	I	YES	MATERIAL LARGELY UTILIZED FOR LAND FILL OPERATION & CONSTRUCTION IN IMMEDIATE AREA
29	GEORGE BROTHERS	NORTHEAST AND WEST, SALMON CREEK (TRACT "A", U.S.S. 1075)	4.2	3.4	0.6	2.8	N/A	15	10,000	80,000	0			X	GOOD	C-3	NO	HIGH MOISTURE CONTENT, MATERIAL MUST BE STOCKPILED TO DRAIN, HILLSIDE STEEP AND UNSAFE
30	HENRI	SALMON CREEK (MS 955)	8	6	4	0	25	50	200,000	350,000	0	X	X	X	FAIR	C-3	YES	SOURCE IN LEGAL CONFLICT OF MINERAL CLAIM (GOLD) BEING USED AS CONSTRUCTION MATERIAL
31	GREEN (PIT & D-1 STOCKPILE)	SOUTHWEST, SALMON CREEK	4.8	3.5	3.5	0	20	0	240,000	300,000	60,000	X	X	X	GOOD	C-3	NO	DUE TO LOCATION, WILL NOT BE USED EXCEPT IN POSSIBLE FUTURE MARINE PROJECT
32	TONER	CITY OF JUNEAU - NORTH OF MARTIN STREET AT IRWIN STREET	2.5	2.5	1.9	0	25	25	55,000	75,000	20,000		X	X	FAIR	R-5	NO	URBAN EXPANSION & HILLSIDE STABILITY LIMITS FUTURE FULL EMPLOYMENT OF SOURCE
33	A.E.L. & P. COMPANY	CITY OF JUNEAU - SOUTH FRANKLIN STREET	10	5	3.5	1.5	20	20	68,000	150,000	20,000(+)		X	X	FAIR	I	NO	HILLSIDE STABILITY WITH URBAN EXPANSION LIMITS USEFULLNESS OF TAILING SOURCE
34	UNION OIL ROCK DUMP	SOUTH OF JUNEAU - THANE ROAD	62.5	62.5	62.5	0	30	30	150,000	2,000,000	0		X	X	FAIR	I	NO	SITE PROPOSED USE IS INDUSTRIAL (SAWMILL & PORT) LAND VALUE PROBABLY EXCEEDS BORROW VALUE
35	BELARDI & SCHNEIDER	THANE ROAD AT SHEEP CREEK - MEXICO MILL SITE (MS 718/ATS 203)	23	10	1	9	4.5	5-8	15,000	1,740,000	1,000,000		X	X	FAIR	I	NO	HIGH SILT CONTENT LIMITS USEFULLNESS, RESERVE PROBABLY ESTIMATED HIGH
36	STATE OF ALASKA	SHEEP CREEK MOUTH (INTERTIDAL ALLUVIUM AND TAILINGS)	20	5	5	0	5	5-10	10,000	40,000	30,000		X	X	FAIR	R12/40	NO	UTILIZED FOR HIGHWAY MAINTENANCE
37	SIMPSON	1/2 MILE NORTH OF DOUGLAS - WEST SIDE OF ROAD	10	5	2	3	25	25	50,000	165,000	115,000	X	X	X	FAIR-GOOD	R-40	NO	STEEP HILLSIDE, MUST CHANGE QUARRY METHODS RESULTING IN LESS AVAILABLE MATERIAL
38	HANNA & WYNN	1 1/2 MILE NORTH DOUGLAS HIGHWAY (U.S.S. 2433)	18.5	16	4	12	20	30	100,000	450,000	350,000		X	X		R-12	NO	LARGE BOULDERS, HIGH SILT & MOISTURE CONTENT FURTHER LIMITS THE SOURCE
39	LUDWIG	1 1/2 MILE NORTH DOUGLAS HIGHWAY (U.S.S. 2225)	20.2	18	14.1	4	25	50	375,000	1,025,000	650,000	X	X	X	FAIR-GOOD	R-12	NO	LARGE BOULDERS, HIGH SILT & MOISTURE CONTENT FURTHER LIMITS THE SOURCE
40	BARRETT & CAMPBELL	7 MILE NORTH DOUGLAS HIGHWAY (U.S.S. 3546, L-217 - 219)	6+	5.5	1	4.5	20	20	25,000	176,000	150,000			X	POOR	R-12	NO	ROCK IS DEGRADABLE, USEFUL AS COMMON BORROW ONLY (PERMIT EXPIRED)
41	STATE OF ALASKA - MS 953-003-3	FISH CREEK - .67 MILE EAGLECREST ROAD SPUR (U.S.S. 3599, L-1)	25.3	9	3	6	25	25	125,000	375,000	250,000	X	X	X	POOR	R-12	YES	WILL LARGELY BE USED AS RIPRAP SOURCE & FURTHER DEVELOPMENT OF EAGLECREST
42	STATE OF ALASKA - MS 959-001-3/ BURGESS	FISH CREEK (U.S.S. 1548/2561, L-E)	44.1	20	37.5	17	20	20	197,000	451,000	254,000	X	X	X	POOR-FAIR	R-12	YES	NO FURTHER "BORROWING" ALLOWED DUE TO RECREATIONAL USAGE. RESERVE IS SILTY
43	STATE OF ALASKA/BERG	END OF NORTH DOUGLAS HIGHWAY/OUTER POINT (ATS 951)	10	N/A	7.5	10	N/A	10	30,000	125,000	95,000	X	X	X	POOR-GOOD	R-40	NO	SOURCE COULD ONLY BE USED IN ESTUARY AREA - MARINA RESULTING



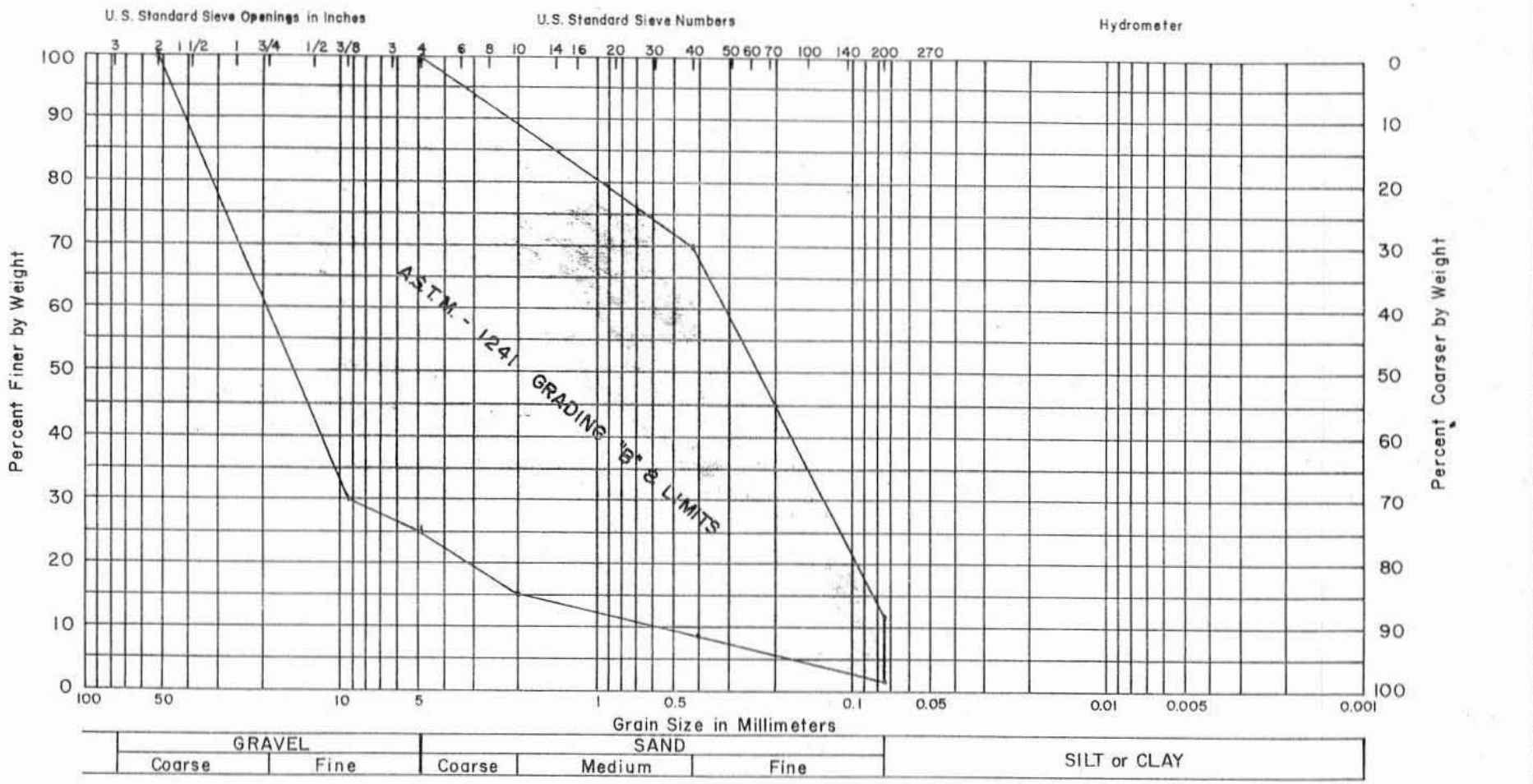
SAMPLE NO.	W. C.	LL	PL	PI	CLASSIFICATION
					A.A.S.H.O. CLASSIFICATION A-3
					U.S.C. CLASSIFICATION S.W.

CHART S-1
IDEAL SAND GRADING FOR BORROW RESOURCES

CITY & BOROUGH OF JUNEAU, ALASKA

R & M
ENGINEERING & GEOLOGICAL CONSULTANTS
Fairbanks ALASKA Juneau

DRAWN	APPROVED	DATE	PROJ. NO.
M.E.S.	J.L.C.	11-78	



SAMPLE NO.	W. C.	LL	PL	PI	CLASSIFICATION
					A.S.T.M. D-1241
					A.A.S.H.O. CLASSIFICATION M147-65

GRADING "B" & LIMITS SOIL AGGREGATE SUBBASE, BASE & SURFACE COARSE MATERIALS

CITY & BOROUGH OF JUNEAU, ALASKA

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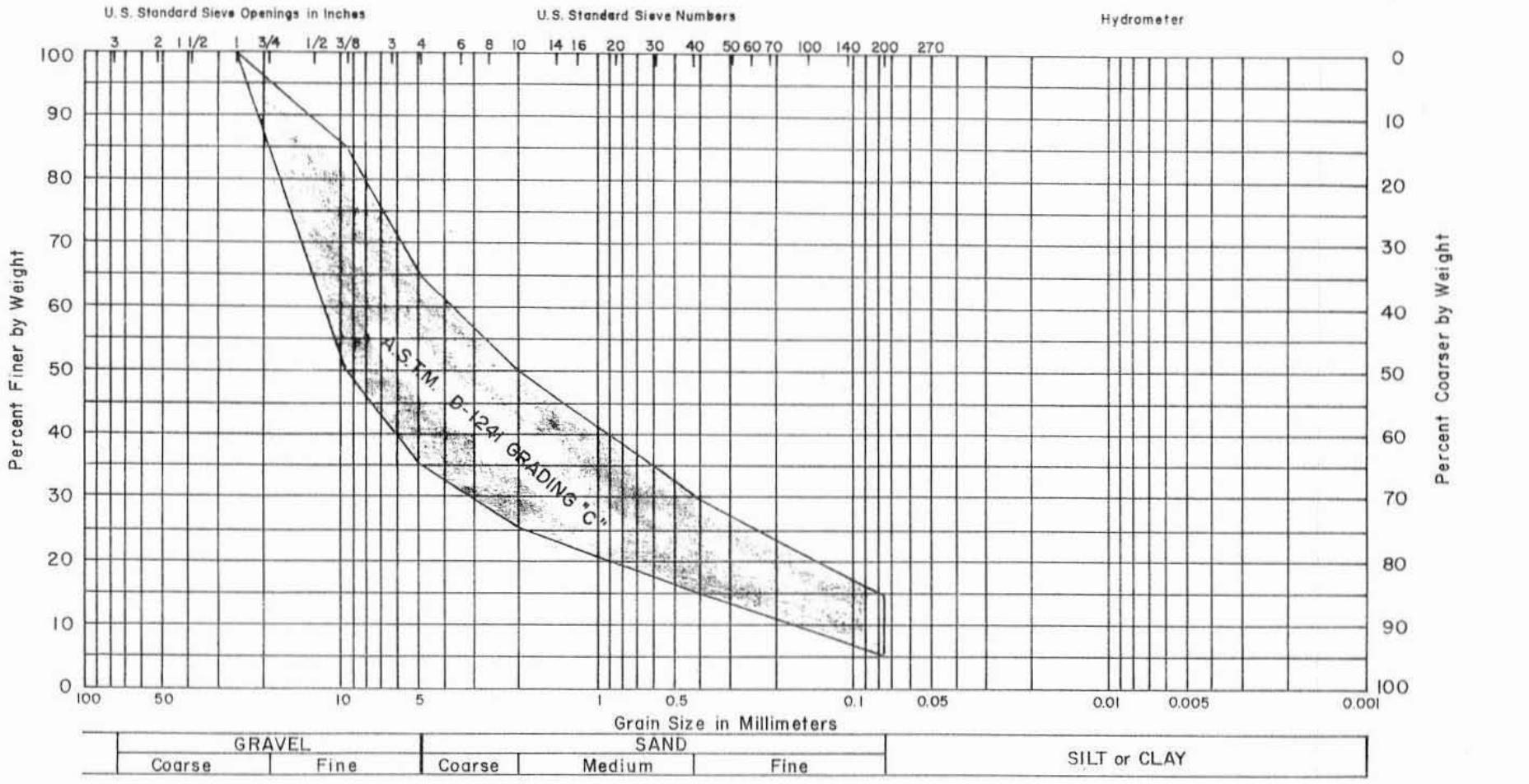
Fairbanks ALASKA Juneau

DRAWN	APPROVED	DATE	PROJ. NO.
M.E.S.	J.L.C.	10-31-78	



SAMPLE NO.	W. C.	LL	PL	PI	CLASSIFICATION
					A.S.T.M. D-1241 GRADING "C"
					U.S.C. CLASSIFICATION GW - SW
					A.A.S.H.O. CLASSIFICATION A-1-a

CHART S-2
IDEAL GRAVEL GRADING FOR BORROW RESOURCES

CITY & BOROUGH OF JUNEAU, ALASKA

R & M
ENGINEERING & GEOLOGICAL CONSULTANTS
Fairbanks ALASKA Juneau

DRAWN	APPROVED	DATE	PROJ. NO.
M. E. S.	J. L. C.	10-31-78	

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Barbara