STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

CHUGACH MOUNTAINS BURNT BUTTE

March 23, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: Bedrock that is resistant to erosion, including those located on Bodenburg and Burnt buttes and Matanuska Peak, align themselves in a northeastern trend. The buttes resisted glacial scouring during the Pleistocene in an area where the Matanuska and Knik glaciers merged. Rocks on Bodenburg Butte are unweathered, hard, and show only limited fracturing and jointing. Bedrock on Burnt Butte has the potential to be similar. These rocks and similar rocks projecting to the northeast into the Chugach Mountains may be a promising source of hard aggregate. Two miles south of the Buttes, near MP 10.4 of the Old Glenn Highway, the Premier Pit has yielded a Nordic abrasion value of 9.3 in glacial outwash gravels. Other gravels in the area may also have low Nordic Abrasion values.

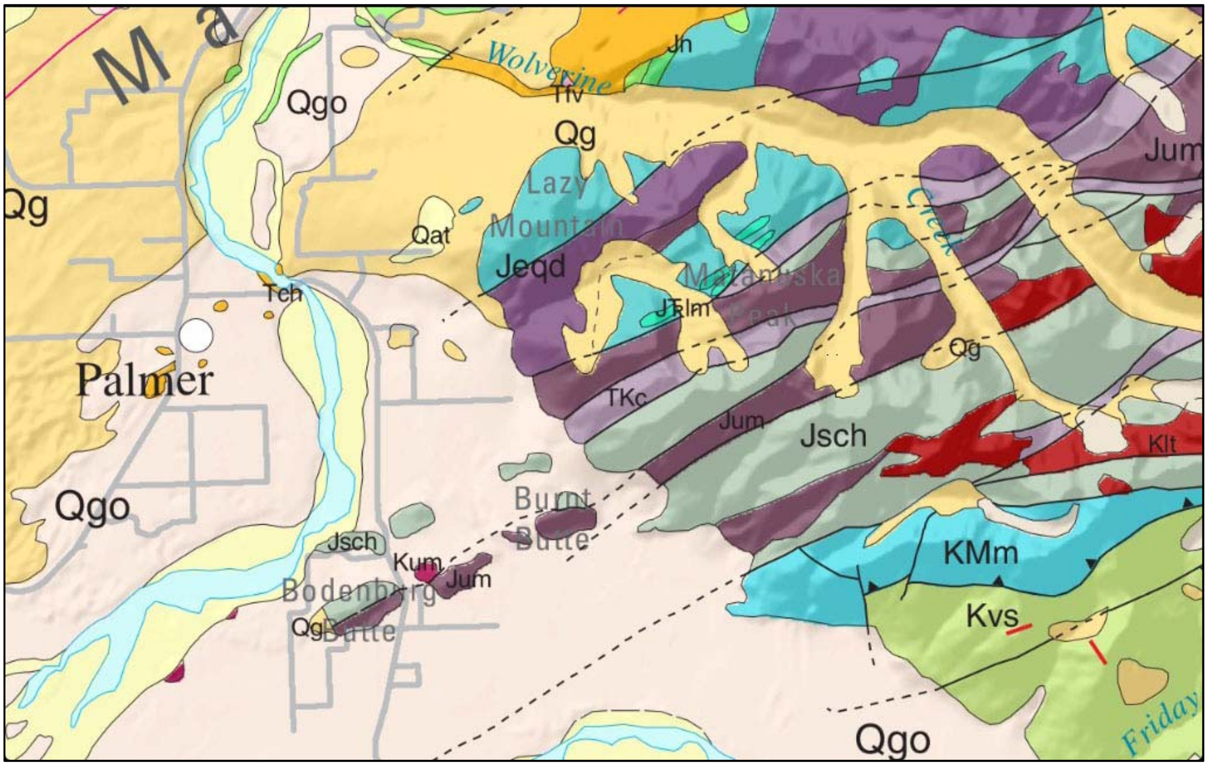
Burnt Butte lies on lands owned by Eklutna, Inc. (surface PA 50-88-0395) and Cook Inlet Region, Inc. (CIRI) (subsurface 50-88-0396).

LOCATION OF BURNT BUTTE SOURCE

Site ID	Source Name	Latitude	Longitude
HA-A1	Burnt Butte	61.561286	-148.968555

Access: A series of roads near the community of Butte provide access to within a mile of all of the butte areas as well as the southeastern side of Matanuska Peak. Additional access to similar rock types may be possible by constructing a road up along Wolverine Creek to the northeastern side of Matanuska Peak. Similar rock types continue to project to the northeast. The construction of other roads parallel to Wolverine Creek may lead to viable deposits.

GEOLOGIC MAP MATANUSKA PEAK AREA
(From Wilson, et al., 2009)



Geology: The following rock types are mapped near Matanuska Peak (Winkler, 1992 and Wilson et al., 2009).

> Jmip/Jum: Mafic and intermediate plutonic rocks. (Middle and Early Jurassic) – These are mapped as a complexly intermixed series of mafic and intermediate plutonic rocks. Plutons consist of gabbronorite, hornblende gabbro, diorite, quartz diorite, and tonalite. Diorite is the predominate lithology in the Wolverine Creek area. These rocks form the southern half of Bodenburg and Burnt buttes, projecting northeast into Matanuska Peak. Xenoliths of gabbro show ductile deformation. Migmatitic textures are common at contacts between lithologies. Hence, much of the mixing may have been caused by multiple intrusions, and entire series of plutonic rocks may have been mostly coeval (Burns, 1985). The rocks on Bodenburg Butte's south side have also been hydrothermally altered, turning the mafic minerals a lighter green with diffuse grain boundaries. This alteration may contribute to the rock reportedly being extremely strong and almost impossible to break with a rock hammer.

Jqt/Jeqd: Quartz diorite and tonalite (Middle Jurassic) – Series of discordant intermediate plutons. Plutons are relatively homogeneous, fine to medium-grained quartz diorite and tonalite. Large areas are sheared and altered.

Kt/Kit: Leucotonalite and trondhjemite (Early Cretaceous) – Medium-grained plugs and elongate, irregular-shaped, sill-like bodies of leucocratic plutonic rocks in a zone about 5 km wide near Border Ranges fault. Rocks generally are foliated and contain less than 10 percent mafic minerals including muscovite, biotite, or hornblende. Due to the foliation these rocks typically would make poor hard aggregate sources.

Jg: Gabbronorite (Middle and Early Jurassic) Fine to coarse-grained gabbroic rocks, exposed as fault-bound slices, or layers and dikes in the Wolverine ultramafic complex. Primarily consist of gabbronorite, leucogabbronorite, and pyroxene-hornblende gabbro.

Jum: Ultramafic and mafic rocks (Middle and Early Jurassic) - A small exposure of Late Cretaceous ultramafics rocks is exposed just east of Bodenburg Butte.

TKc: Cataclasite (Eocene and Early Cretaceous) – Chlorite-rich fine-grained granular rocks formed by cataclasis alteration of mafic and ultramafic plutonic rocks and mafic volcanic rocks. May represent central zones or major strands of Border Ranges fault system where rocks from both upper and lower plates were cataclastically deformed, mixed, and metamorphosed.

JTRk: Talkeetna Formation (Early Jurassic and Late Triassic) – Andesitic, dacitic, and basaltic flows, flow breccia, tuff, shallow sills, and agglomerate. Contains subordinate interbedded volcaniclastic sandstone, conglomerate, and fossiliferous marine siltstone and shale. The Talkeetna Formation is altered in many places. An isolated exposure (Sec. 17 and 18, T18N, R4E, SM) in Lower Wolverine Creek, contains fine-grained, highly altered, massive greenstones that presumably are a mafic part of the Talkeetna Formation (Pavlis, 1986).

JPzm/Jsch: Metamorphic Rocks (Jurassic to Middle Paleozoic?). Diverse metasedimentary and metavolcanic rocks along northern flank of Chugach Mountains, cropping out near the Jum unit. Rocks are strongly to weakly foliated and variably metamorphosed from middle greenschist to amphibolite facies. Rocks are intruded by mafic and intermediate plutons of units Jmip and Jg. Sedimentary protoliths consist of shale chert, tuffaceous arenite, and limestone, and volcanic protoliths are most probably basalt. Diversity of protoliths may indicate tectonic mixing prior to metamorphism. In most places the fabric is cataclastic or recrystallized.

Tc: Chickaloon Formation (Eocene and Paleocene) Predominately fluvatile and alluvial carbonaceous mudstone, siltstone, conglomeratic sandstone, and polymictic conglomerate; contains beds of bituminous coal.

Conclusions: Rock exposures in the northeastern trending sequence containing Bodenburg Butte and Burnt Butte show promising rock lithologies likely to produce low Nordic abrasion values. The rock exposures are readily accessible by existing roads. Rocks in the Chugach Range to the east may also contain rock units that would produce hard aggregate. Some of the glaciofluvial gravels in the area may also contain hard gravels that can produce low Nordic Abrasion values. Processing of the gravels will likely be required to decrease the value.

References:

Burns, L.E., Pessel, G.H., Little, T.A., Palvis, T.L., Newberry, R.L., Winkler, G.R., and Decker, J.E., 1991, Geology of the northern Chugach Mountains, south-central Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 94, 63 p., 2 sheets, scale 1:63,360.

Burns, L.E., Little, T.A., Newberry, R.J., Decker, J.E., and Pessel, G.H., 1983, Preliminary geologic map of parts of the Anchorage C-2, C-3, D-2, and D-3 quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 83-10, 3 sheets, scale 1:25,000.

Clark, S.H.B., 1972, Reconnaissance bedrock geologic map of the Chugach Mountains near Anchorage, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map 350, 1 sheet, scale 1:250,000.

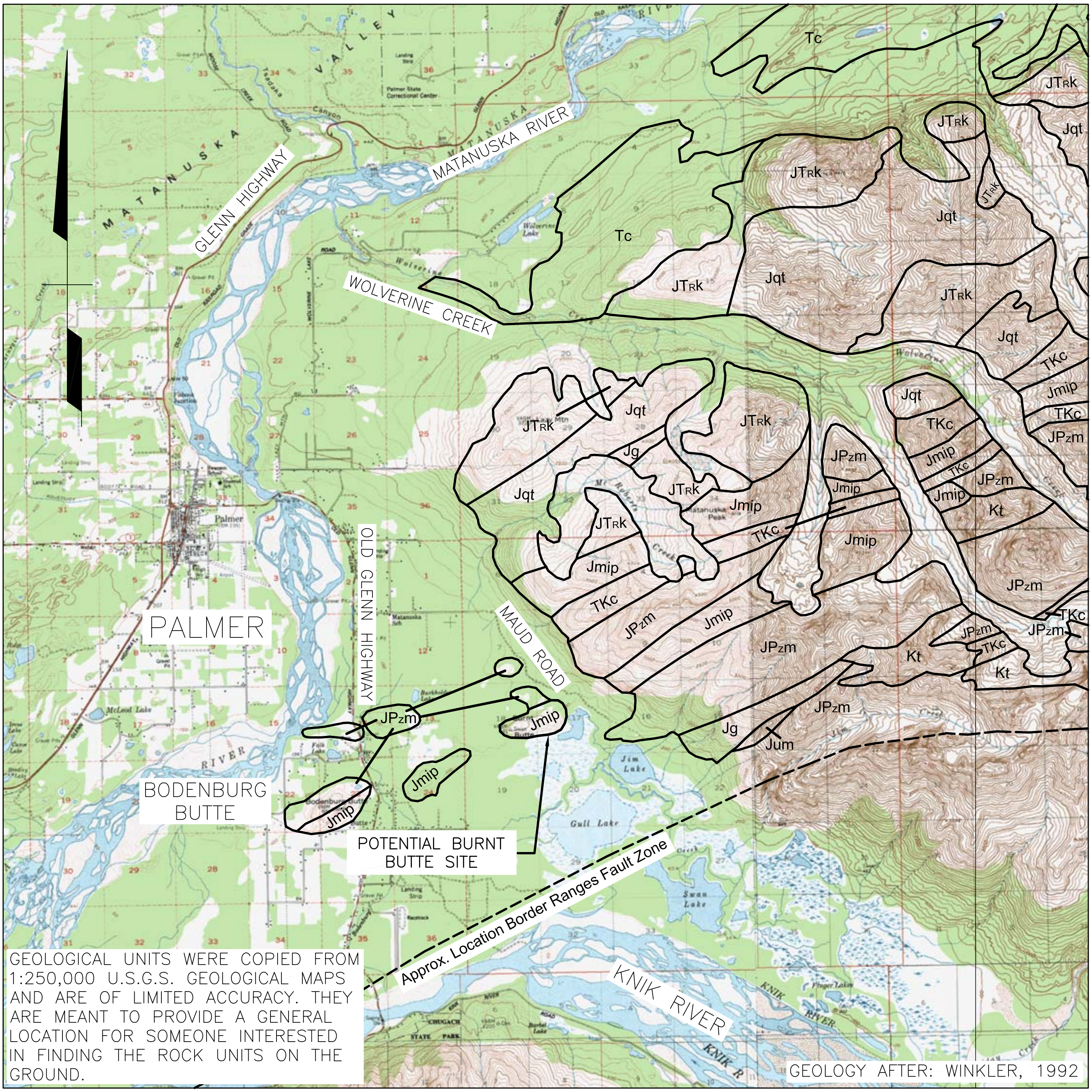
Clark, S.H.B., 1983, Reconnaissance geologic map of the Chugach Mountains in the Anchorage C-5 and C-6 quadrangles, Alaska: U.S. Geological Survey Open-File Report 83-336, 1 sheet, scale 1:63,360.

Pavlis, T.L., 1986, Geologic map of the Anchorage C-5 Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Public Data File 86-7, 57 p., 3 sheets, scale 1:63,360.

Wilson, F.H., Hults, C.P., Schmoll, H.R., Haeusler, P.J.., Schmidt, J.M., Yehle, L.A., Labay, K.A. (map compilers) Wilson, F.H., Hults, C.P., Labay, K.A., Shew, N. (Digital Files Preparers), 2009, Preliminary geologic map of the Cook Inlet Region, Alaska-including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak 1:250,000-scale quadrangles, U.S. Geological Survey Open-File Report 2009-1108, Version 1.

Winkler, G.R., (map compiler), 1992, Geologic map and summary geochronology of the Anchorage 1x3° quadrangle, southern Alaska, U. S. Geological Survey Miscellaneous Investigations Series Map I-2283, 1 sheet, scale1:250,000.

LOCATION MAP (HA-A1)



U.S.G.S. QUADRANGLE: ANCHORAGE (B-5), (B-6), (C-5) & (C-6)

POTENTIAL HARD AGGREGATE SOURCE CHUGACH MOUNTAINS

0 1 2 4 6

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
BURNT BUTTE

SCALE	DESIGNED	DRAWN	PAGE
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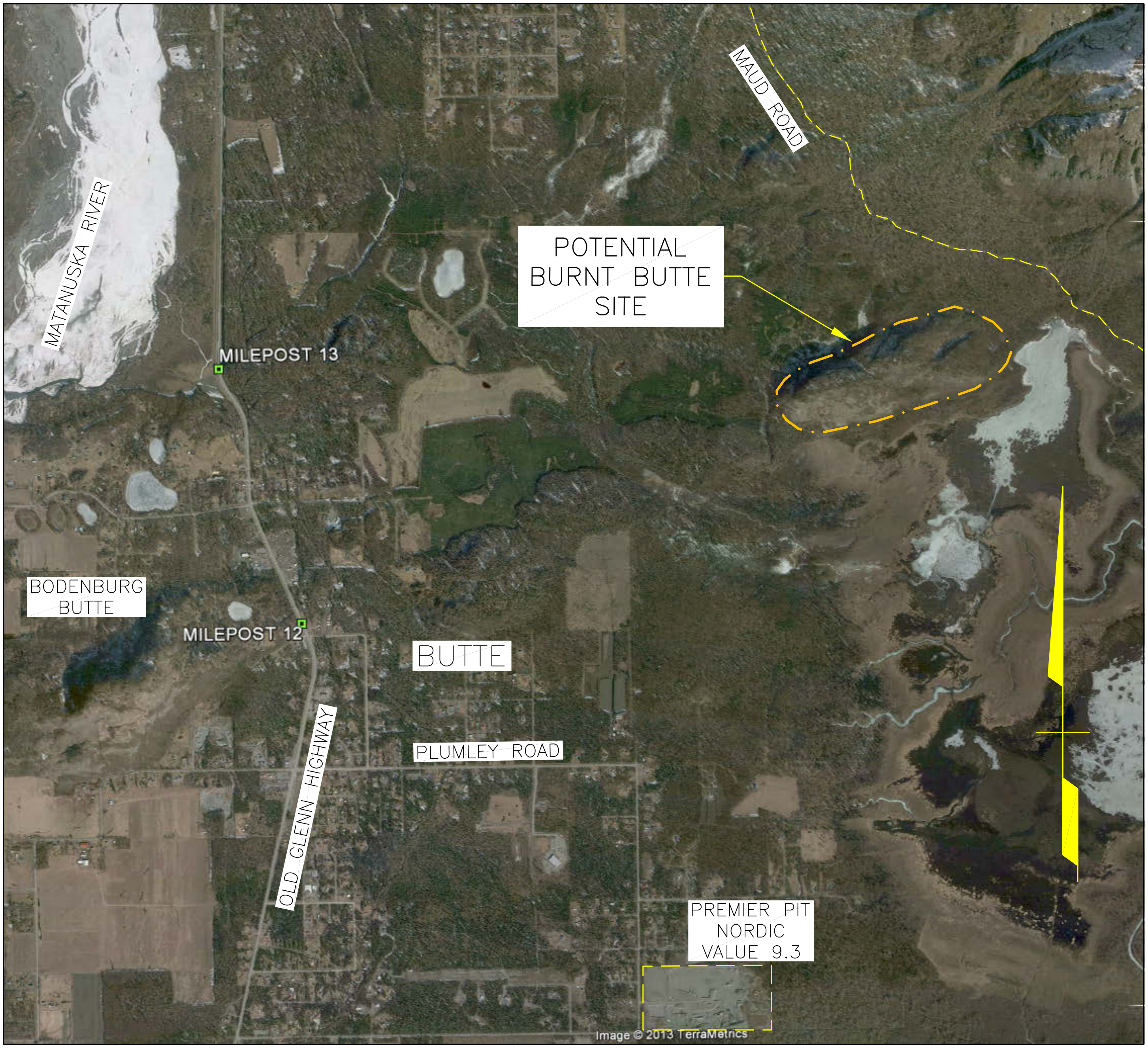
SITE MAP (HA-A1)



BASE MAP IS APRIL 14, 1997 GEOEYE SATELLITE IMAGERY.
THIS IS A PLANNING DOCUMENT ONLY.

POTENTIAL HARD AGGREGATE SOURCE CHUGACH MOUNTAINS

0 1500 3000 6000 9000

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/3/2013

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STATE OF ALASKA
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STATEWIDE MATERIAL SITE INVENTORY

BURNT BUTTE

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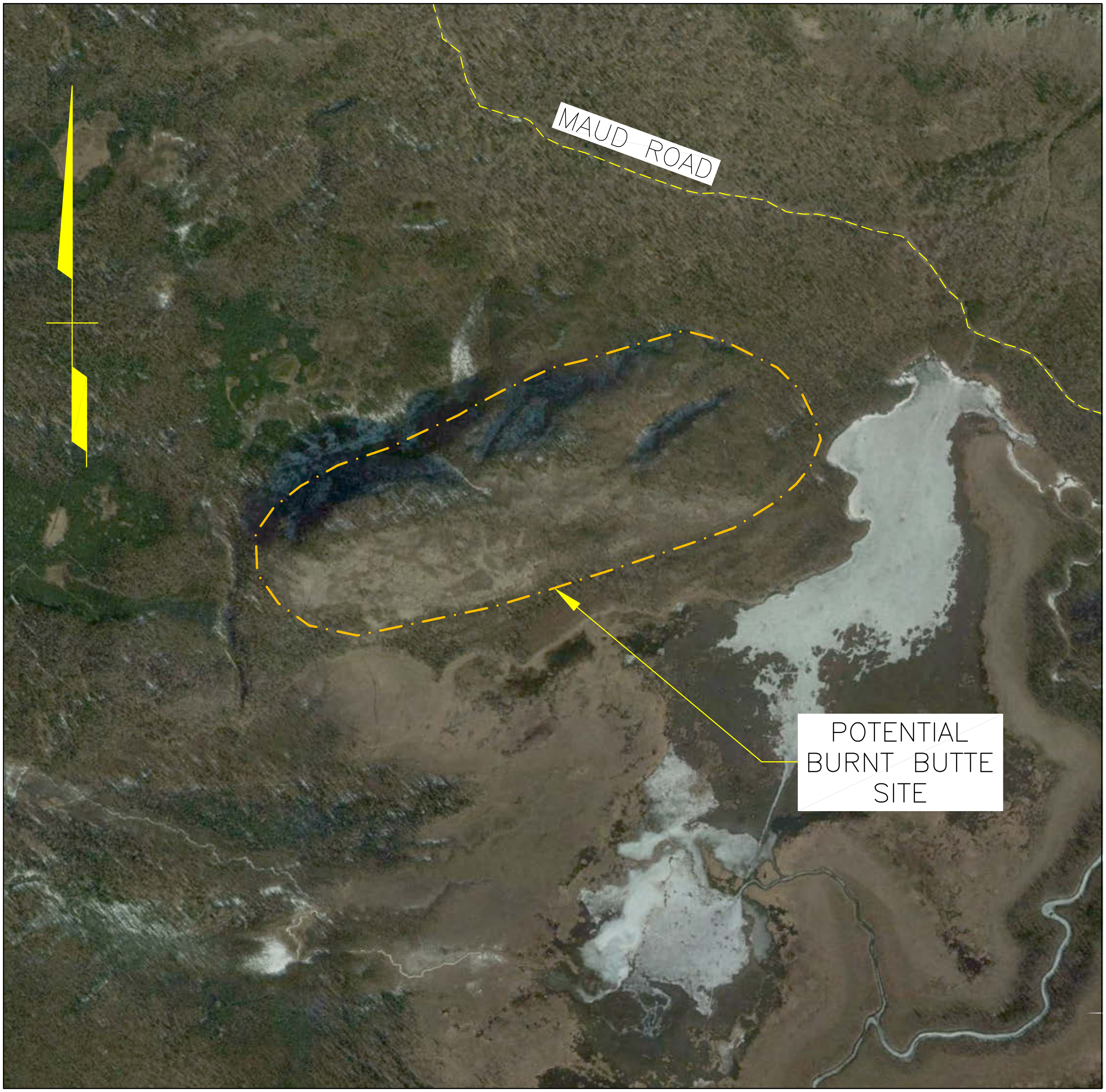
SITE MAP (HA-A1)



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POTENTIAL HARD AGGREGATE SOURCE CHUGACH MOUNTAINS

0 600 1200 2400 3600

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/3/2013

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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY

BURNT BUTTE

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE
SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

NANWALEK
POINT BEDE

February 16, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: There are three exposures of potentially usable hard aggregate along the shoreline within the Seldovia Quadrangle. The larger deposit (quartz diorite) is located along the coast around Point Bede, seven miles southwest of the town of Nanwalek. Two smaller exposures of fine-grained felsite are located five miles further south near the tip of a peninsula, south of Koyuktolik Bay (Bradley et al, 1999).

POINT BEDE POTENTIAL HARD AGGREGATE SOURCE

Site ID	Source Name	Latitude	Longitude
HA-B1	Point Bede	59.311215	-151.986317

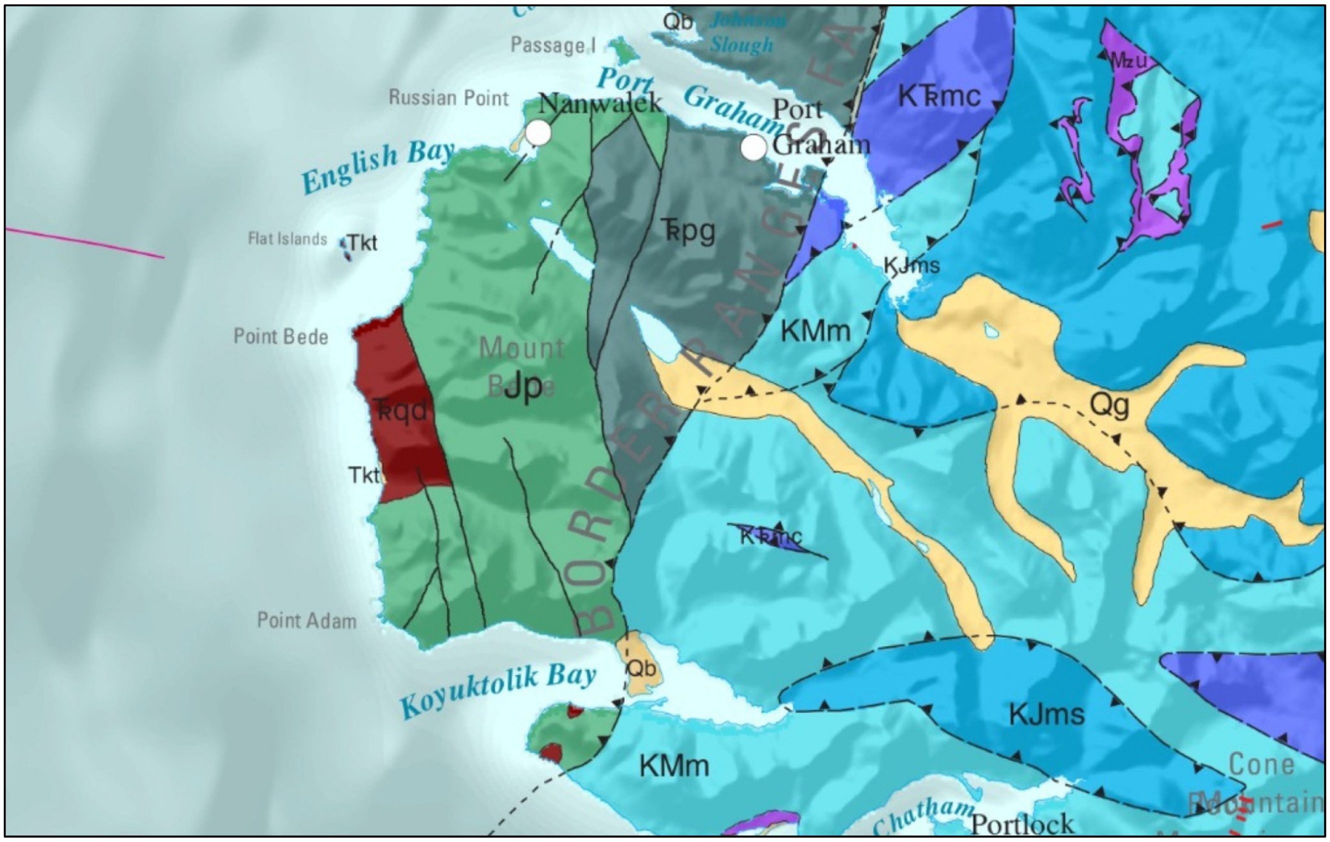
It is our understanding that the English Bay Corporation owns the surface rights (PA 50-98-0487) and Chugach Alaska Corporation owns the subsurface rights (PA 50-98-0488) in the vicinity of Point Bede.

Access: There are no protected harbors along the shore near Point Bede. The nearest is at Nanwalek, but a better port would be Port Graham to the north. Koyuktolik Bay to the south could also be used. Access would require construction of a new 3 to 4 mile road following existing roads and trails to Nanwalek or a new 10 mile road south to Koyuktolik Bay (also called Dog Fish Bay).

Geology: The T_{R}qd (Jbd) unit is a fine to medium-grained, nonfoliated quartz diorite consisting chiefly of plagioclase, quartz, chloritized biotite, and chloritized hornblende (Wilson et al., 2009 and Kelley, 1984).

GEOLOGIC MAP POINT BEDE AREA

(From Wilson et al., 2009)



Unit T_{R}qd is the quartz diorite of interest.

Conclusions: There are shoreline outcrops of probable Jurassic intrusives by Point Bede and near Koyuktolik (Dogfish) Bay. The diorite (T_{R}qd) of Point Bede is a fine-to medium grained, nonfoliated quartz diorite consisting chiefly of plagioclase, quartz, cholitized biotite, and chloritized hornblende. A small exposure of tonalite, is reported along the shores of Koyuktolik (Dogfish) Bay. These rocks are medium-grained and nonfoliated consisting of plagioclase, quartz, and chloritized biotite. The chloritic alteration is very similar to that in the Point Bede diorite. Along the shore just south of the tonalite outcrop is another small igneous outcrop, a fine-grained, aphanitic, light grey felsite. The fine-grained outcrop at Point Bede may have the potential for producing hard aggregates with low Nordic Abrasion values.

References:

Bradley, D.C., Kusky, T.M., Haeussler, P.J., Karl, S.M., and Donley, D.T., 1999, Geologic map of the Seldovia quadrangle, south-central Alaska: U.S. Geological Survey Open-File Report 99-18, 1 sheet, scale 1:250,000.

Kelley, J.S., 1984, Geologic map and sections of the southwestern Kenai Peninsula west of the Port Graham fault, Alaska: U.S. Geological Survey Open-File Report 84-152, 1 sheet, scale 1:63,360.

Wilson, F.H., Hults, C.P., Schmoll, H.R., Haeusler, P.J.., Schmidt, J.M., Yehle, L.A., Labay, K.A. (Map Compilers) Wilson, F.H., Hults, C.P., Labay, K.A., Shew, N. (Digital Files Preparers), 2009, Preliminary geologic map of the Cook Inlet Region, Alaska-including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak 1:250,000-scale quadrangles, U.S. Geological Survey Open-File Report 2009-1108, Version 1.

LOCATION MAP (HA-B1)

U.S.G.S. QUADRANGLE: SELDOVIA (A-5), (A-6), (B-5) & (B-6)

POTENTIAL HARD AGGREGATE SOURCE NANWALEK

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
POINT BEDE

SCALE	DESIGNED	DRAWN	PAGE
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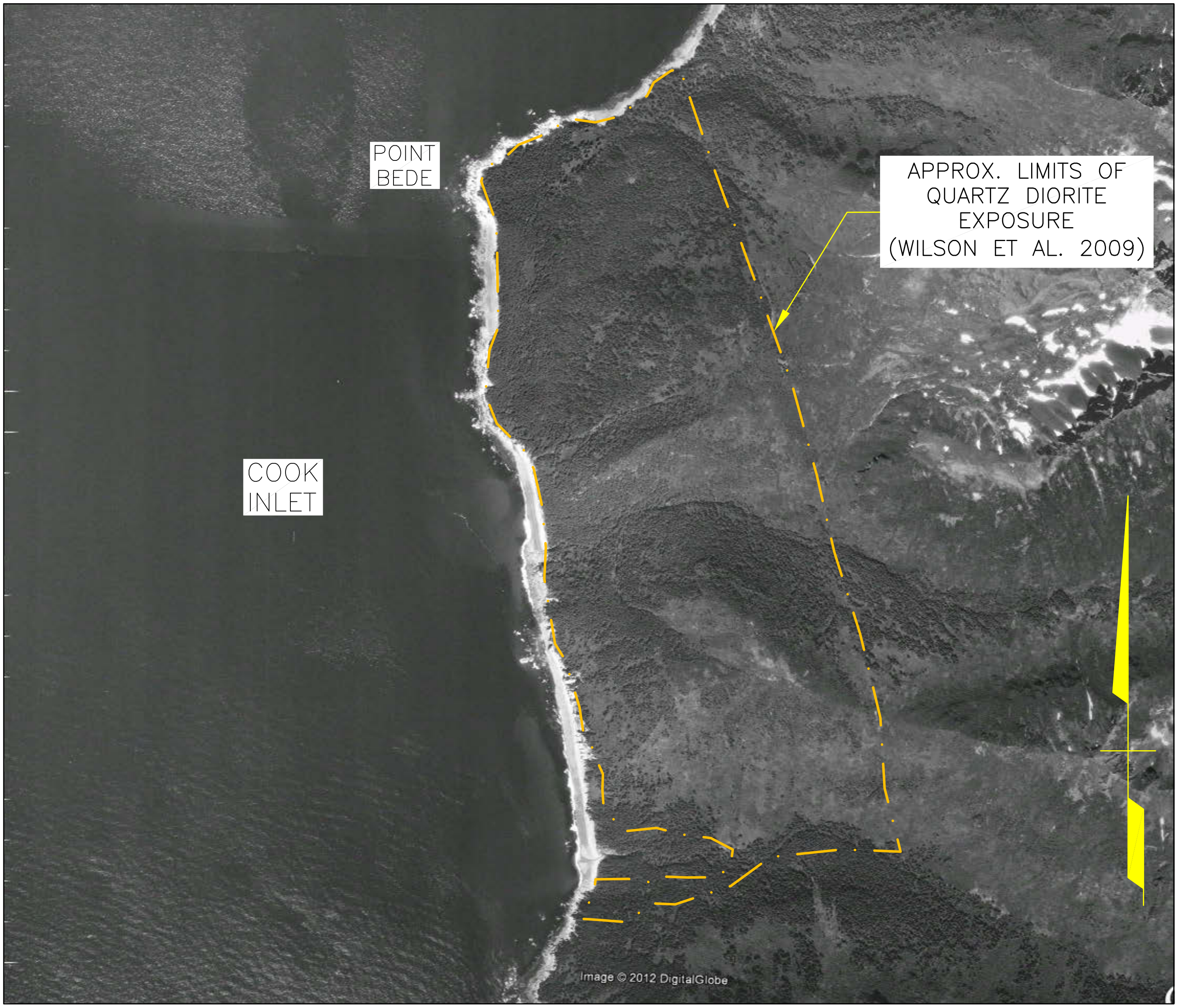
SITE MAP (HA–B1)



BASE MAP IS JUNE 25, 1997 U.S.G.S. AERIAL PHOTOGRAPHY.
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POTENTIAL HARD AGGREGATE SOURCE NANWALEK

0 0.25 0.5 1 1.5

GRAPHIC SCALE IN MILES

BASE MAP FROM GOOGLE EARTH PRO 2/3/2013

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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
POINT BEDE

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE
SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

COPPER RIVER HIGHWAY
SHERIDAN GLACIER

March 20, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: The Sheridan Glacier site is located on the east side of the Sheridan and Sherman Glaciers at 19 mile of the Copper River Highway. It is a potential thermal contact (hornfels) deposit along the eastern edge of a Tertiary igneous pluton.

The site lies on Chugach National Forest land and is apparently within the Scott-Sheridan Travel Management Area, which is open to motorized vehicles use yearlong, according to the U.S. Forest Service Motor Vehicle Use Chugach National Forest Map #3.

SHERIDAN GLACIER POTENTIAL HARD AGGREGATE SOURCE

Site ID	Source Name	Latitude	Longitude
HA-C1	Sheridan Glacier	60.473414	-145.262355

Access: From the Copper River Highway to Cordova.

Geology: Bedrock at the Sheridan Glacier Site is mapped (Nelson et al., 1985 - Map 2B /Winkler & Plafker, 1993 - Map 2A) as:

> Tgg/ Tg: Granites and Granodiorite (Eocene). The older of the two intrusive events is represented by plutons in the central and eastern parts of Prince William Sound, and intrudes both the Orca and Valdez Groups. Surface exposures range from less than 0.3 mile (Ragged Mountain) to greater than 55 miles at the Sheep Bay pluton. Faults truncate a few of the bodies, but elsewhere the plutons are surrounded by contact-metamorphic aureoles. Plutons of this unit are generally medium to coarse-grained hypidiomorphic-granular biotite-granite with border phases of biotite- hornblende-granite to granodiorite and tonalite. Found on Wells Bay, Sheep Bay, and at Sheridan Glacier.
>
> Tos/Tos: Tertiary sedimentary rocks of the Orca Group.
>
> Qu/Qs, Qm, Qsm, Qls: Undifferentiated Surficial deposits / Surficial deposits, Glacial Moraines, Supraglacial moraines, and Landslides.

Potential contact metamorphism (hornfelsing) is mapped where sedimentary rocks predominate adjacent to the intrusive igneous rocks. The Contact zone between the igneous granite and granodiorite (Tgg) and the Orca Group sedimentary rock (Tos) lies between two creeks and is mapped between the highway and the headwaters of Salmon Creek.

Conclusions: There are no test results or other direct observations to verify the presence of rock capable of producing hard aggregate near Sheridan Glacier. However, the conditions exist for these types of rock (hornfels) to occur to the east of the glacier. Access to these potential hornfels sites is from the Copper River Highway. It is unknown how much hornfels rock is available, or where it is available. This source appears to warrant consideration.

A source at Sheep Bay may be considered if this site is not selected. However, the Sheep Bay site does not have highway access and much of the peninsula is steep and rugged, therefore difficult to access.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

References:

Moffit, F.H., 1954, Geology of the Prince William Sound region, Alaska: U.S. Geological Survey Bulletin 989-E, p. 225-310, 1 sheet.

Nelson, S.W., Dumoulin, J.A., and Miller, M.L., 1985, Geologic map of the Chugach National Forest, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map 1645-B, 16 p., 1 sheet, scale 1:250,000.

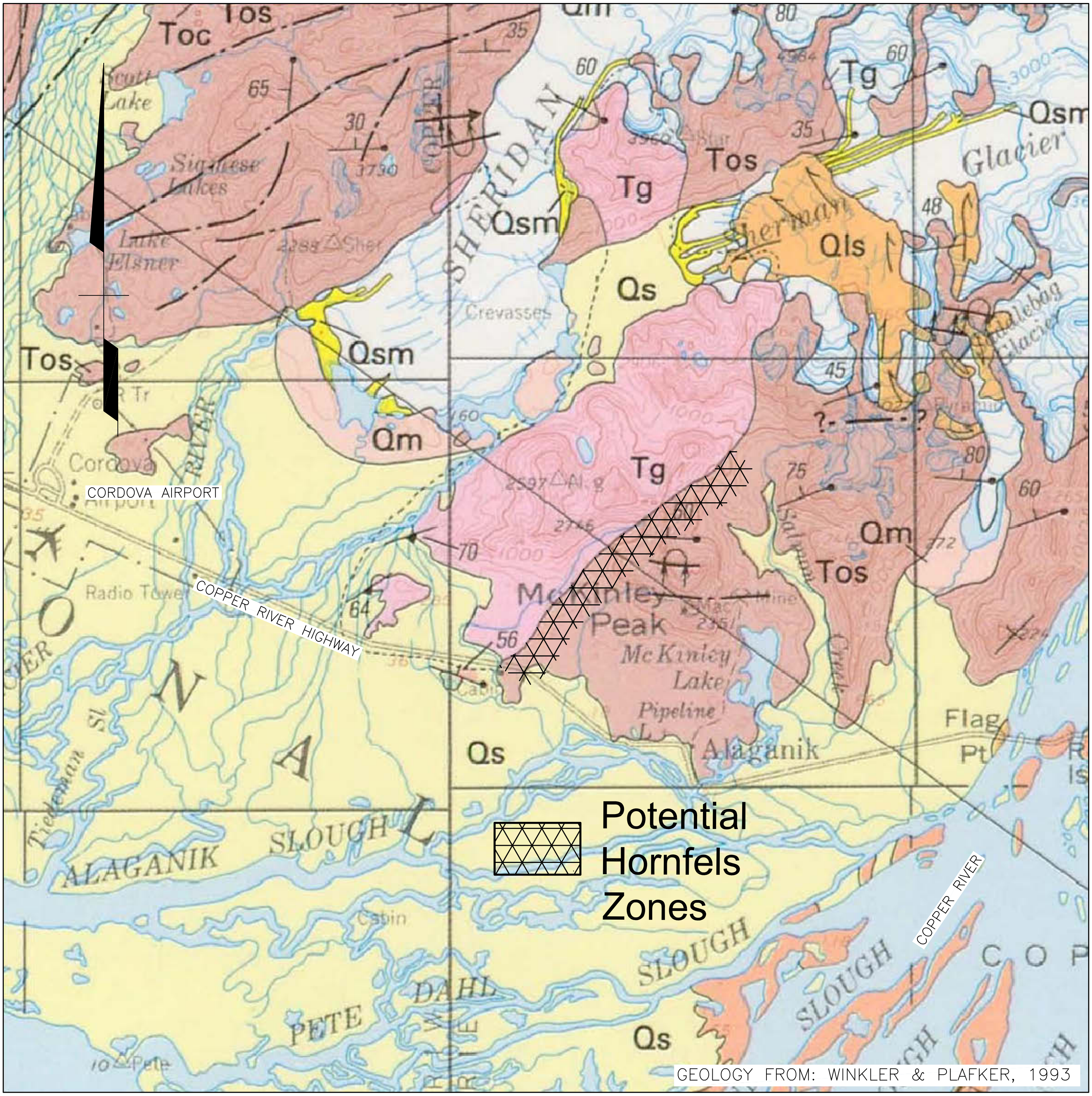
Richter, D.H., 1965, Geology and mineral deposits of central Knight Island, Prince William Sound, Alaska: Alaska Division of Mines and Minerals Geologic Report 16, 40 p., 1 sheet, scale 1:40,000.

Tysdal, R.G. and Case, J.E., 1979, Geologic map of the Seward and Blying Sound quadrangles, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1150, 12 p., 1 sheet, scale 1:250,000

Wilson, F.H., Hults, C.P., Labay, K.A., and Shew, Nora, 2008, Preliminary integrated geologic map databases for the United States: digital data for the reconnaissance geologic map for Prince William Sound and the Kenai Peninsula, Alaska: U.S. Geological Survey Open-File Report 2008-1002, 1 p.

Winkler, G.R. and Plafker, George, 1993, Geologic map of the Cordova and Middleton Island quadrangles, southern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1984, 1 sheet, scale 1:250,000.

LOCATION MAP (HA-C1)



U.S.G.S. QUADRANGLE: CORDOVA

Tg-Granite
Tos-Orca Sedimentary Rock
Qls-landslide
Qs- Surficial Deposits
Qm/Qsm-Glacial Deposits

POTENTIAL HARD AGGREGATE SOURCE COPPER RIVER HWY.

0 1 2 4 6

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
SHERIDAN GLACIER

SCALE	DESIGNED	DRAWN	PAGE
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BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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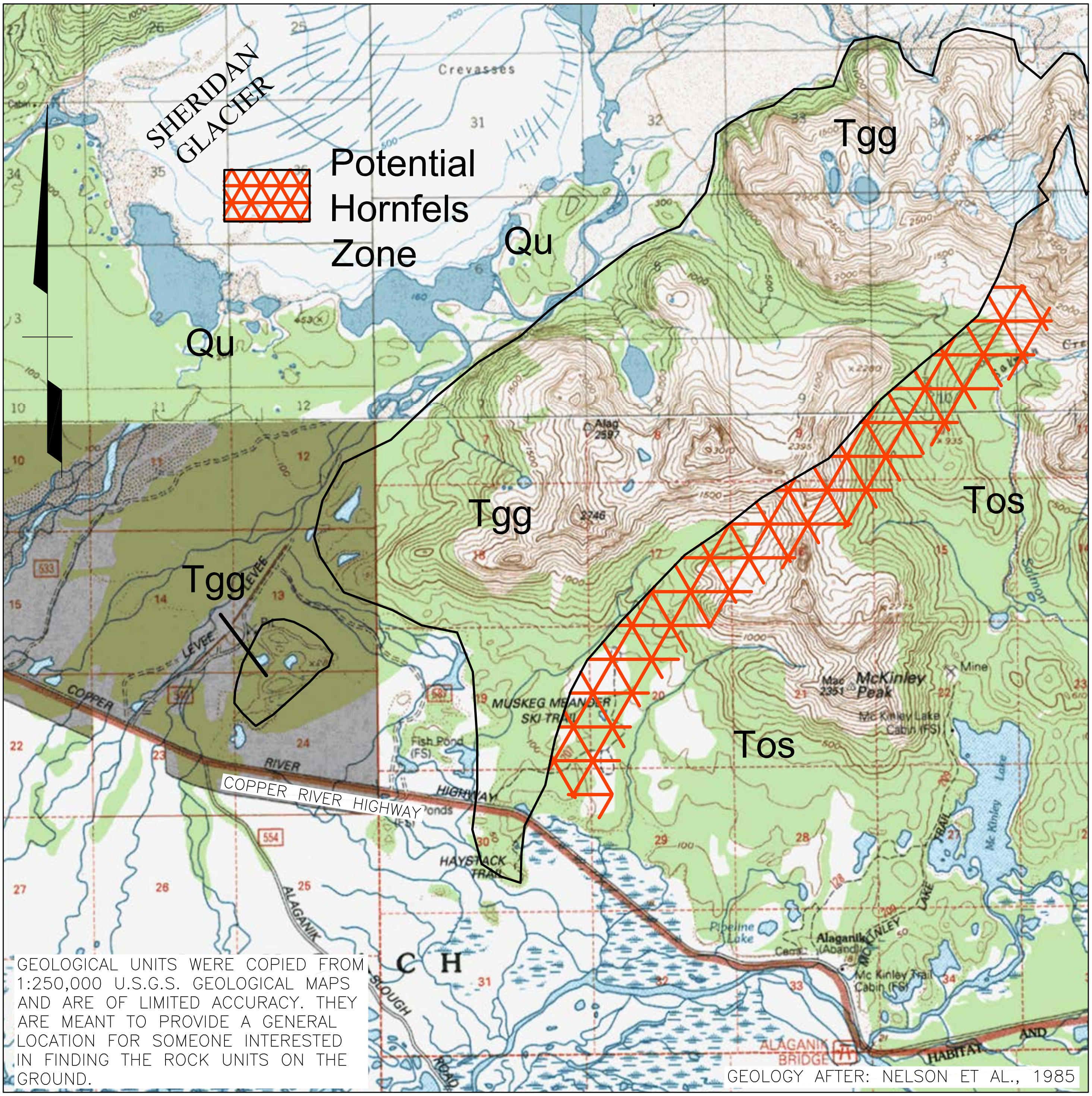
LOCATION MAP (HA–C1)



U.S.G.S. QUADRANGLE: CORDOVA (B–4) & (C–4)

Tgg–Granite & Granodiorite
Tos–Orca sedimentary rock
Qu–Undivided Surficial

POTENTIAL HARD AGGREGATE SOURCE COPPER RIVER HWY.

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
SHERIDAN GLACIER

SCALE	DESIGNED	DRAWN	PAGE
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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

HAINES HIGHWAY
MILE 4.5, 5.5 AND 25 SITES

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS:

General Site Description: There are three sites along the Haines Highway noted for having hard aggregate. Sites at MP 4.5 and 5.5 are reportedly owned by Mr. Roger Schnabel of Southeast Roadbuilders. These sites appear to be at the base of steep alpine fans or talus cones along the southern end of the Takshanuk Mountains. A request (ADL 108049) for a material sale, apparently to expand the MP 5.5 site into the northwest quarter of Section 19, T30S, R59E, CRM, was denied due to inconsistencies with the Haines State Forest Management Plan.

A third site is located south of the Haines Highway at MP 25, on the Klehini River floodplain. This site appears to be on State land.

HAINES HIGHWAY POTENTIAL HARD AGGREGATE SOURCES

Site ID	Source Name	Nordic Values	Latitude	Longitude
HA-D1	Mile MP 4.5 Site	6.6, 8, 9.3, 9.6, 11.4, 17.5	59.253884	-135.538934
HA-D2	Mile 5.5 Site	6.8	59.260689	-135.558706
HA-D3	Mile 25 Klehine River Site	10	59.407787	-135.964659

Access: Access to all three sites is from the Haines Highway.

Geology: It should be noted that some of the geologic symbols change between references when identifying similar rock types as one goes up the Chilkat River. Geologic symbols on Location Map 2A are from (Redman et al., 1984 - Skagway B-3) while geologic symbols on Location Map 2B are from (MacKevett, Jr. et al., 1974 - Skagway B-3).

As shown on Location Maps 2A and 2B, metabasalt (Kmb) is exposed in a northwest-trending belt as much as one-half a mile wide along the base of the Takshanuk Mountains, bordering the northeast side of the Chilkat River where it is in contact with a gabbro-diorite complex (Kgd/Kkhd). Most of the metabasalt in the Skagway B-3 Quadrangle near Klukwan (Location Map 2B) is reportedly characterized by near-vertical foliation that strikes northwestward approximately parallel to the Chilkat River and the Takshanuk Mountains. The gabbro-diorite complex occupies an extensive northwest-trending belt, as much as 2 miles wide, along the southwest flank of the Takshanuk Mountains. It is in gradational contact with the metabasalt and quartz diorite to the east, and is intruded by pyroxenite (Kp/Kum) along sharp, steep contacts that strike mainly northwestward and generally transect foliation of the gabbroic rocks (MacKevett, Jr. et al., 1974).

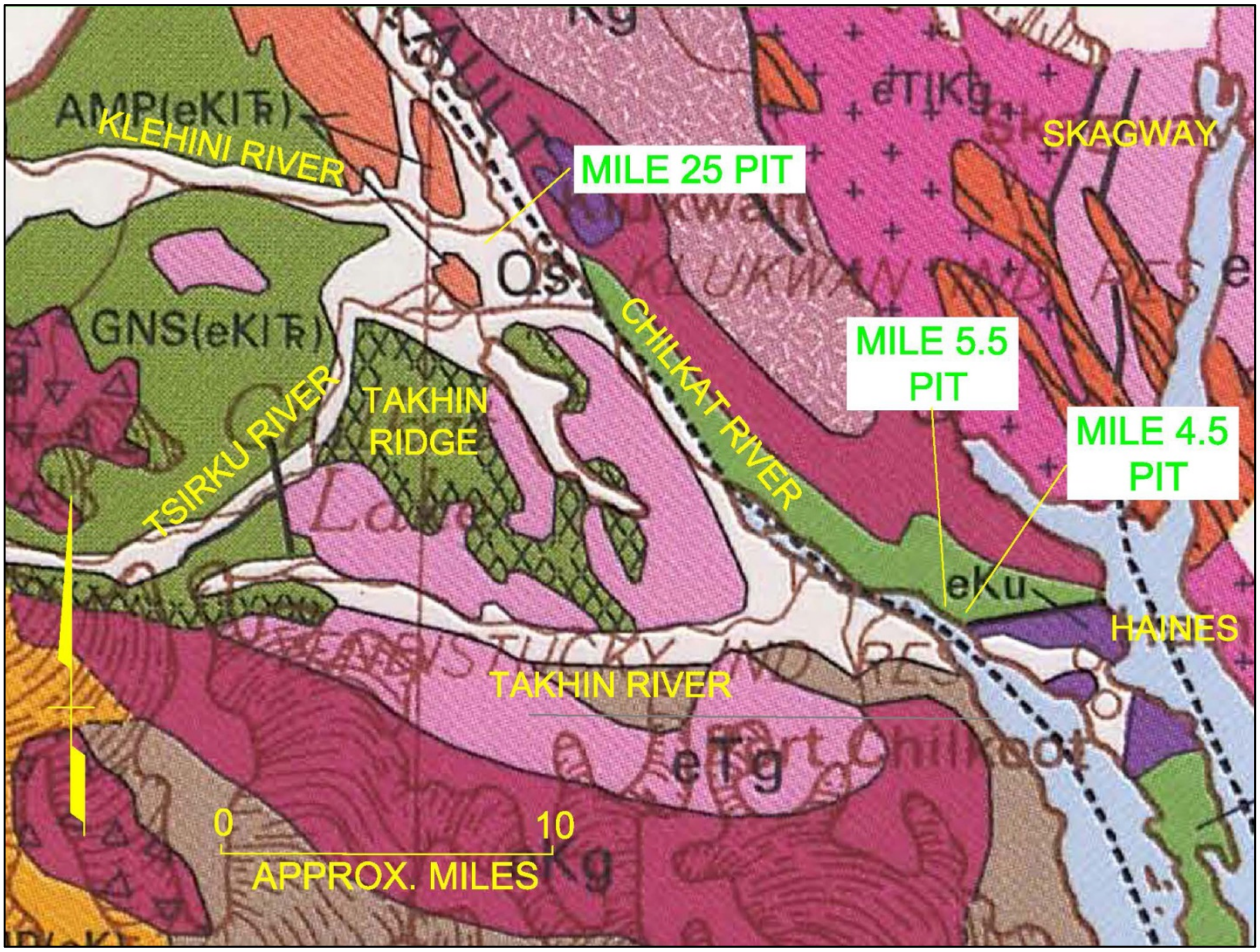
Kmb: Metabasalt. Rock occurs as black to dark-green, massive, dense, metabasalt flows, with local phyllitic interbeds. Rocks have undergone Abukuma-type high temperature, low pressure metamorphism. It is commonly flow-banded, porphyritic, and/or amygdaloidal and contains rare pillows. Rocks are composed of almost equal amounts of hornblende and plagioclase, with minor chlorite and epidote. Pods, zones and veins of replacement epidote are common (Redman et. al., 1984).

Kgd/Kkhd: A complex of gabbro and diorite occupies an extensive northwest-trending belt as much as two miles wide, along the southwest flank of the Takshanuk Mountains. It is a gradational contact with the metabasalt (Kmb) downslope and is intruded by pyroxenite (Kp). Rocks of the gabbro and diorite complex exhibit various degrees of alteration. The alteration is most intense near the pyroxenite (Kp) where the gabbroic rocks are strongly epidotized and saussuritized. The gabbro and diorite are light to medium greenish gray, fine or medium-grained, and mainly equigranular (MacKevett, Jr. et al., 1974).

Kp/Kum: Pyroxenite forms an irregular main outcrop approximately one mile wide and 4 miles long with several small isolated outcrops, high on the southwest flank of the Takshanuk Mountains northeast of Klukwan. The pyroxenite is well exposed throughout vertical extents of as much as 3,000 feet. It intrudes rocks of the gabbro and diorite complex along sharp, irregular contacts that mainly dip steeply northeastward and generally crosscut foliation of the invaded rocks. The pyroxenite is dark green to black, medium or coarse-grained, and mainly xenomorphic granular in texture (MacKevett, Jr. et al., 1974).

As shown on the following Chilkat River/Haines Metamorphic Facies Map, hornfels zones are mapped south of the Klehini River on Takhin Ridge, between the Tsirku River and the Takhin Rivers (Dusel-Bacon et al., 1996). Erosion of these zones may have carried hornfels down into the floodplains of the surrounding rivers and into the Klehini River floodplain.

CHILKAT RIVER/HAINES METAMORPHIC FACIES MAP
(From Dusel-Bacon et al., 1996)



Map showing the interpreted hornfels zones on Takhin Ridge. The pink, red and purple units are igneous intrusives, the green, orange and brown units are metamorphic rocks generally derived from sedimentary and volcanic units and the cross hatches are the interpreted hornfels zones. The hornfels zones are subject to differing interpretations by different authors.

Nordic Abrasion Values were made available by Mr. Mitch McDonald of DOT&PF Southeast Region. He provided the five (5) laboratory reports that are attached giving Nordic Abrasion values of 6.6, 9.3, 11.4 and 17.5 for the 4.5 mile site and a value of 10 for the 25 mile site. Mr. McDonald also reported a value of 6.8 for the 5.5 mile site. An undocumented value of 8 was also provided by DOT&PF on a map of Alaska as part of background data, which was assumed to be for the 4.5 mile site.

Conclusions: There are three known sites with Nordic Abrasion values equal to or lower than 10 along this stretch of the highway, but other sources may be found between 5.5 mile and Klukwan at MP 22. Operations in two sites at MP 4.5 and 5.5 near Haines appear to be mining talus slopes and alpines fans composed of material fallen from the Takshanuk Mountains. These loose materials are likely composed of metabasalt and gabbro or diorite rubble. This rubble is apparently fine to medium-grained igneous rocks that typically can give low Nordic Abrasion values. However, the Nordic values are not as low overall as one might expect for the rock types mapped. This may be due to local weakening of the rock during cataclastic processes or the material being coarser grained than reported. Geologic reports indicate more foliation may be present upriver of these two sites (MacKevett, Jr. et al., 1974) and thus Nordic values may increase as you near Klukwan. The area around Milepost 25 is in the floodplain of the Klehini River and a Nordic Abrasion value of 10 was achieved on a sample of the river gravel. One interpretation of this low result is that hornfels south of Klehini River makes up a significant amount of the material in the gravel of this part of the Klehini floodplain. If this is the case, it may be possible that other gravel in the Tsirku and Takhin River floodplains may have low Nordic Abrasion values.

Most of the land adjacent to the Haines Highway along the Chilkat River is in Unit 7A of the Haines State Forest, therefore land use issues may arise if mining is attempted on State lands. However, there appear to be numerous private parcels along the highway.

References:

Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of Southeastern Alaska; distribution, facies, and ages of regionally metamorphosed rocks: U.S. Geological Survey Professional Paper 1497-D, p. 1-42, 2 sheets, scale 1:1,000,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Gilbert, W.G., Burns, L.E., Redman, E.C., and Forbes, R.B., 1987, Preliminary bedrock geology and geochemistry of the Skagway B-3 quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 87-2, 2 sheets, scale 1:36,200.

MacKevett, E.M., Jr., Robertson, E.C., and Winkler, G.R., 1974, Geology of the Skagway B-3 and B-4 quadrangles, southeastern Alaska: U.S. Geological Survey Professional Paper 832, 33 p., 1 sheet, scale 1:63,360.

Redman, E.C., Retherford, R.M., and Hickok, B.D., 1984, Geology and geochemistry of the Skagway B-2 quadrangle, southeastern Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 84-31, 34 p., 4 sheets, scale 1:40,000.

Redman, E.C., Gilbert, W.G., Jones, B.K., Rosenkrans, D.S., and Hickok, B.D., 1985, Preliminary bedrock-geologic map of the Skagway B-4 quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 85-6, 1 sheet, scale 1:40,000.

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LAB REPORT (U.S. STAND.)

PRECONSTRUCTION	☐	CONSTRUCTION	☑
ACCEPTANCE	☐	QUALITY	☑
ASSURANCE	☐	INFORMATION	☐

TEST OF **HOT MIX ASPHALT (PROCESSED AGGREGATE FOR)** ITEM NO. **401** LAB NO. **08C-92**

PROJECT NO.	**STP-0003(104)**	PROJECT NAME	**HNS UNION ST REFURBISHMENT & THIRD AVE RECONSTRUCTION**		
SAMPLED FROM	**SOURCE**	EXAMINED FOR	**DEG, LA, NORDIC, SPG, ABSORPTION**		
DEPTH		FIELD NO.		DATE SAMPLED	**11/02/07**
SOURCE	**HAINES 4 MILE PIT**	SUBMITTED BY	**Z. FERRIN**	DATE RECEIVED	**01/29/08**
LOCATION	**HAINES, ALASKA**	REPRESENTS	**SOURCE**	DATE REPORTED	**04/23/08**

AS RECEIVED

% PASSING SIEVE	QUALITY	ACCEPTANCE	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"	100		
1/2"	85		
3/8"	69		
#4	45		
#8	30		
#10			
#16	20		
#20			
#30	14		
#40			
#50	10		
#80			
#100	8		
#200	6.0		
0.02 MM			
.005 MM			

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D

DRY DENSITY - POUNDS / CUBIC FOOT

5 10 15

PERCENT MOISTURE

PROPERTIES	
LIQUID LIMIT	NV
PLASTIC INDEX	NP
DELETERIOUS	FREE
FRACTURE %	100
THIN ELONGATED %	1
FINENESS MODULUS	
ORGANIC CONTENT %	
AASHTO CLASS	

QUALITY	COARSE	FINE
DEGRADATION VALUE	84	
L.A. ABRASION % B	11	
NORDIC ABRASION %	9.3	
BULK SPG	3.012	
BULK SSD SPG	3.029	
APPARENT SPG	3.064	
ABSORPTION %	0.6	

REMARKS: **SENT TO ANCHORAGE FOR SODIUM SULFATE SOUNDNESS**

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: MATERIALS LAB COORDINATOR

SIGNATURE: REGIONAL MATERIALS ENGINEER

THE MATERIAL AS SUBMITTED CONFORMS TO SPECIFICATIONS

YES ( ) NO ( ) N/A ( )

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

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R-1/2007
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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

LAB REPORT (U.S. STAND.)

PRECONSTRUCTION	[ ]	CONSTRUCTION	[X]
ACCEPTANCE	[ ]	QUALITY	[X]
ASSURANCE	[ ]	INFORMATION	[ ]

JAH

TEST OF **CRUSHED AGGREGATE BASE, GRADING D-1** ITEM NO. **301** LAB NO. **10C-~~215~~** 255

PROJECT NO.	AARA-0956(032)	PROJECT NAME	HNS FRONT STREET TO UNION STREET		
SAMPLED FROM	STOCKPILE	EXAMINED FOR	LA ABRAS, DEGRADATION, NORDIC ABRAS, SPG'S, ABSORPTION		
DEPTH		FIELD NO.	Q-BC-1	DATE SAMPLED	07/13/10
SOURCE	HNS HWY 4.5 MILE PIT	SUBMITTED BY	S. MEREDITH	DATE RECEIVED	07/13/10
LOCATION	HAINES, ALASKA	REPRESENTS	SOURCE	DATE REPORTED	07/21/10

AS RECEIVED

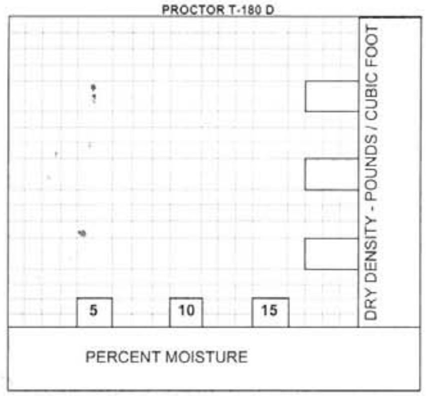
% PASSING SIEVE	QUALITY	ACCEPTANCE	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#10			
#16			
#20			
#30			
#40			
#50			
#80			
#100			
#200			
0.02 MM			
.005 MM			

PROPERTIES			
LIQUID LIMIT			
PLASTIC INDEX			
DELETERIOUS			
FRACTURE %			
THIN ELONGATED %			
FINENESS MODULUS			
ORGANIC CONTENT %			
AASHTO CLASS			

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D



QUALITY	COARSE	FINE
DEGRADATION VALUE	51	
L.A. ABRASION % B	12	
NORDIC ABRASION %	11.4	
BULK SPG	3.011	
BULK SSD SPG	3.022	
APPARENT SPG	3.043	
ABSORPTION %	0.4	

REMARKS: **SENT TO ANCHORAGE FOR SODIUM SULFATE SOUNDNESS**

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeffrey A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: For [signature]
REGIONAL MATERIALS ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

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S.E. REGION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
LAB REPORT (U.S. STAND.)

PRECONSTRUCTION		CONSTRUCTION	X
ACCEPTANCE		QUALITY	X
ASSURANCE		INFORMATION	

TEST OF **ASPHALT CONCRETE, TYPE II; CLASS B (BLENDED AGG FOR)** ITEM NO. **401(1)** LAB NO. **12C-248**

PROJECT NO.	**NH-0956(33)**	PROJECT NAME	**HNS 2ND AVENUE - UNION STREET TO MAIN STREET**		
SAMPLED FROM	**SOURCE**	EXAMINED FOR	**VARIOUS QUALITY TESTS**		
DEPTH		FIELD NO.		DATE SAMPLED	**CONTRACTOR**
SOURCE	**4.5 MILE HNS HWY - KIANA PIT**	SUBMITTED BY	**CONTRACTOR FOR MIX DESIGN**	DATE RECEIVED	**02/06/12**
LOCATION	**HAINES, ALASKA**	REPRESENTS	**SOURCE**	DATE REPORTED	**06/06/12**

% PASSING SIEVE	AS RECEIVED QUALITY	QUALITY	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"	100		
1/2"	90		
3/8"	83		
#4	63		
#8		49	
#10			
#16		38	
#20			
#30		29	
#40			
#50		19	
#80			
#100		12	
#200		7.0	
0.02 MM			
.005 MM			

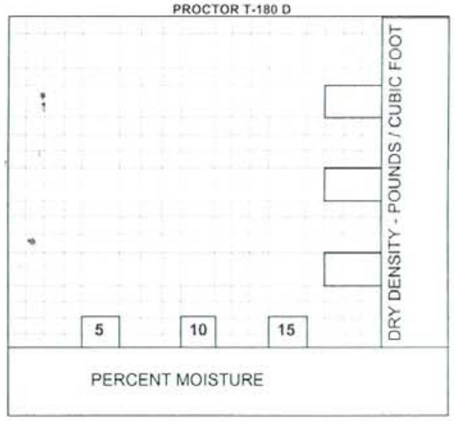
PROPERTIES			
LIQUID LIMIT		NV	
PLASTIC INDEX		NP	
DELETERIOUS		FREE	
FRACTURE %		100	
THIN ELONGATED %		2	
FINENESS MODULUS			
FINE AGG ANGUL.		44.3	
SAND EQUIVALENT		44	

QUALITY	COARSE	FINE
DEGRADATION VALUE	79	
L.A. ABRASION % B	19	
NORDIC ABRASION %	17.5	
BULK SPG	3.007	3.044
BULK SSD SPG	3.030	3.076
APPARENT SPG	3.077	3.146
ABSORPTION %	0.8	1.1

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D



REMARKS: **SENT TO ANCHORAGE FOR SODIUM SULFATE SOUNDNESS**

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeffry A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: [signature] for Bruce Brunette
REGIONAL MATERIALS ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

LAB REPORT (U.S. STAND.)

PRECONSTRUCTION	☐	CONSTRUCTION	☑
ACCEPTANCE	☐	QUALITY	☑
ASSURANCE	☐	INFORMATION	☐

TEST OF **CLASS A CONCRETE (COARSE CONCRETE AGGREGATE FOR)** ITEM NO. **501(1)** LAB NO. **08C-96**

PROJECT NO.	**HRM-0003(114)**	PROJECT NAME	**HNS SAWMILL CREEK CULVERT**		
SAMPLED FROM	**STOCKPILE**	EXAMINED FOR	**DEG, LA, NORDIC, SPG, ABSORPTION**		
DEPTH		FIELD NO.	**CA-Q-1**	DATE SAMPLED	**04/22/08**
SOURCE	**NORTHERN CONSTRUCTION PIT**	SUBMITTED BY	**J. STOCKBRIDGE**	DATE RECEIVED	**04/24/08**
LOCATION	**HAINES, ALASKA**	REPRESENTS	**SOURCE**	DATE REPORTED	**04/29/08**

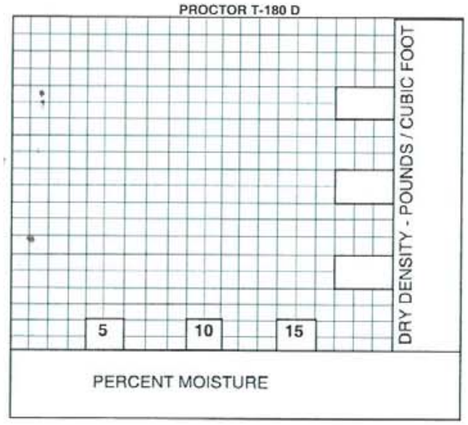
% PASSING SIEVE	AS RECEIVED QUALITY	ACCEPTANCE	SPECS
4"			
3"			
2"			
1-1/2"			
1"	100		
3/4"	92		
1/2"	59		
3/8"	40		
#4	2		
#8	1		
#10			
#16	0		
#20			
#30	0		
#40			
#50	0		
#80			
#100	0		
#200	0.2		
0.02 MM			
.005 MM			

PROPERTIES	
LIQUID LIMIT	
PLASTIC INDEX	
DELETERIOUS	FREE
FRACTURE %	
THIN ELONGATED %	
FINENESS MODULUS	
ORGANIC CONTENT %	
AASHTO CLASS	

QUALITY	COARSE	FINE
DEGRADATION VALUE	85	
L.A. ABRASION % B	14	
NORDIC ABRASION %	6.6	
BULK SPG	2.858	
BULK SSD SPG	2.878	
APPARENT SPG	2.915	
ABSORPTION %	0.7	

MOISTURE / DENSITY RELATIONS	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D



REMARKS: **SENT TO ANCHORAGE FOR CONCRETE AGGREGATE TESTS**

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeff A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: Bruce O. Brunette
REGIONAL MATERIALS ENGINEER

THE MATERIAL AS SUBMITTED CONFORMS TO SPECIFICATIONS

YES ( ) NO ( ) N/A ( )

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

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R-1/2007
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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

LAB REPORT (U.S. STAND.)

PRECONSTRUCTION [ ] CONSTRUCTION [X]
ACCEPTANCE [ ] QUALITY [X]
ASSURANCE [ ] INFORMATION [ ]

TEST OF SIDEWALK, CURB & GUTTER (COARSE CONCRETE AGG FOR) ITEM NO. 608 & 609 LAB NO. 12C-141

PROJECT NO.	NH-0956(33)	PROJECT NAME	HNS 2ND AVENUE - UNION ST TO MAIN ST PAVEMENT REHAB		
SAMPLED FROM	STOCKPILE	EXAMINED FOR	LA ABRAS, NORDIC ABRAS, DEG, SPG, ABSP, GRAD, UNIT WT		
DEPTH	N/A	FIELD NO.	Q-CA-1	DATE SAMPLED	04/27/12
SOURCE	KLEHINI 25 MILE PIT	SUBMITTED BY	T. SWEN #175	DATE RECEIVED	05/02/12
LOCATION	HAINES, AK	REPRESENTS	SOURCE	DATE REPORTED	05/07/12

AS RECEIVED

% PASSING SIEVE	QUALITY	ACCEPTANCE	SPECS
4"			
3"			
2"			
1-1/2"			
1"	100		100
3/4"	91		90 - 100
1/2"	51		
3/8"	32		20 - 55
#4	2		0 - 10
#8	1		0 - 5
#10			
#16	0		
#20			
#30	0		
#40			
#50	0		
#80			
#100	0		
#200	0.3		1.0 MAX
0.02 MM			
.005 MM			

PROPERTIES		
LIQUID LIMIT		
PLASTIC INDEX		
DELETERIOUS	FREE	FREE
FRACTURE %		
THIN ELONGATED %		
DRY RODDED UNIT WT	116.0	
ORGANIC CONTENT %		
AASHTO CLASS		

QUALITY	COARSE	FINE
DEGRADATION VALUE	77	
L.A. ABRASION % B	19	
NORDIC ABRASION %	10.0	
BULK SPG	2.770	
BULK SSD SPG	2.785	
APPARENT SPG	2.812	
ABSORPTION %	0.5	

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D

5 10 15

PERCENT MOISTURE

DRY DENSITY - POUNDS / CUBIC FOOT

REMARKS: SENT TO ANCHORAGE FOR FURTHER TESTING

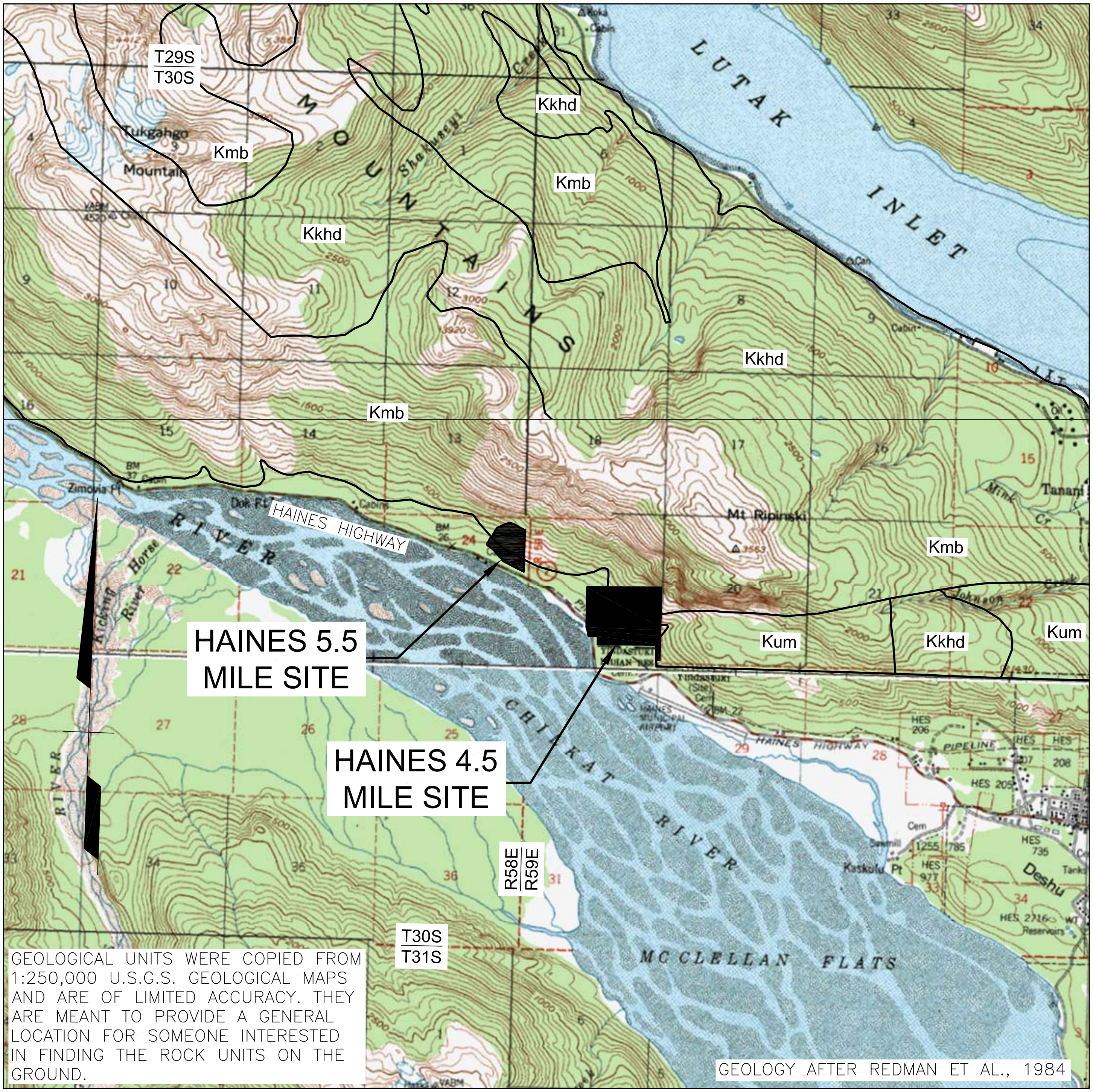
INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeffrey A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: Bruce [signature]
REGIONAL MATERIALS ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

LOCATION MAP (HA-D1 & HA-D2)



U.S.G.S. QUADRANGLE: SKAGWAY (B-2)

Kmb-Metabasalt
Kkhd-Diorite
Kum-Pyroxenite

POTENTIAL HARD AGGREGATE SOURCE HAINES HIGHWAY

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY

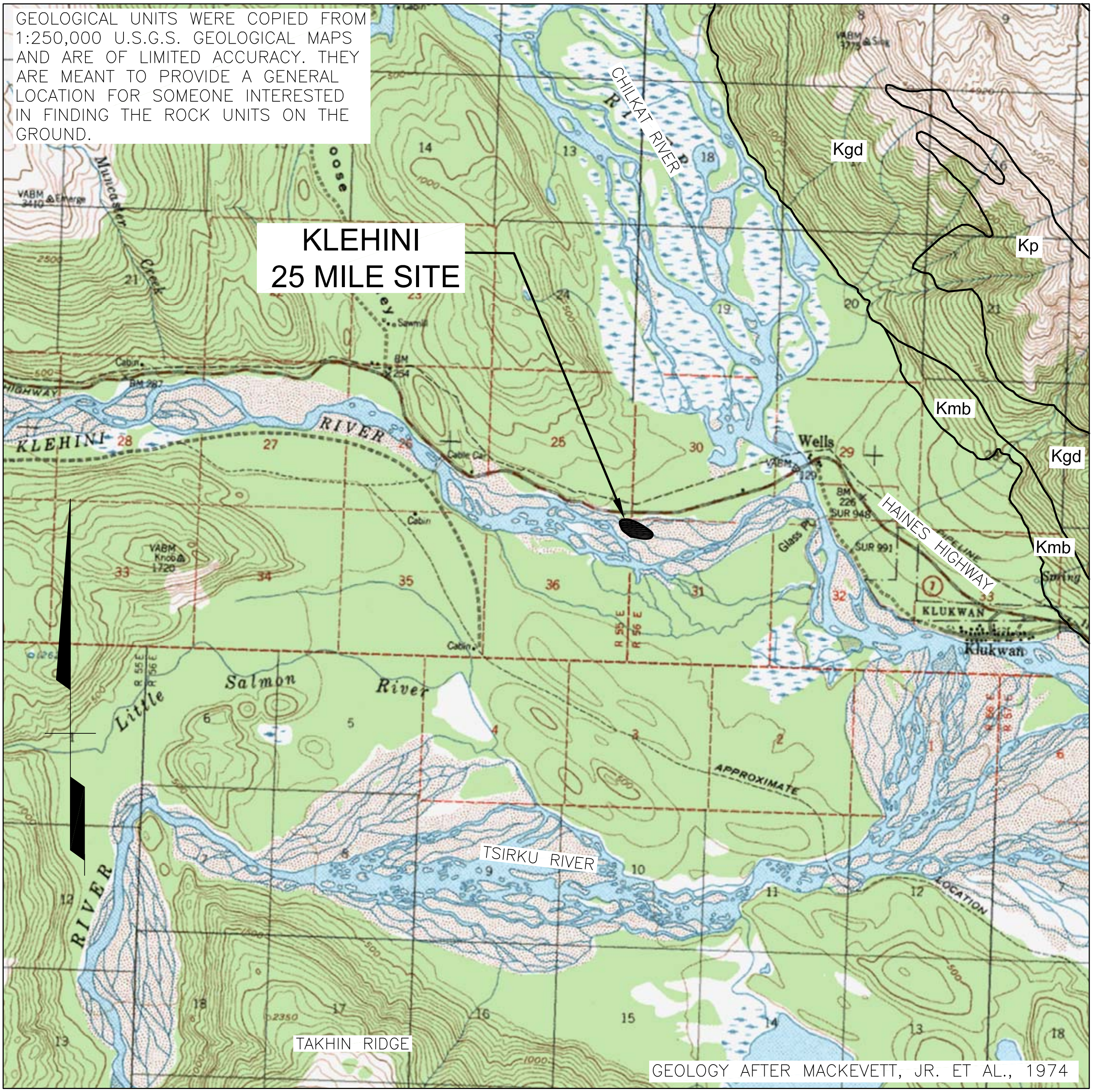
HAINES 4.5/5.5 MILE SITE

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	J.D.N.	2A
	CHECKED C.H.R.	DATE FEB 2013	

Z:\project\1443.07 DOT_SWM Cantwell Agreegate Feasibility Study\Earth\Hard Aggregate Location Study\Haines\Acad\MS_Topo_Map_Haines.dwg

Plotted 3/28/2013 3:37 PM by Pete Hardcastle

LOCATION MAP (HA-D3)



U.S.G.S. QUADRANGLE: SKAGWAY (B-3)

Kmb-Metabasalt
Kgd-Diorite/Gabbro
Kp-Pyroxenite

POTENTIAL HARD AGGREGATE SOURCE HAINES HIGHWAY

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
KLEHINI 25 MILE SITE

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	J.D.N.	2B
	CHECKED C.H.R.	DATE FEB 2013	

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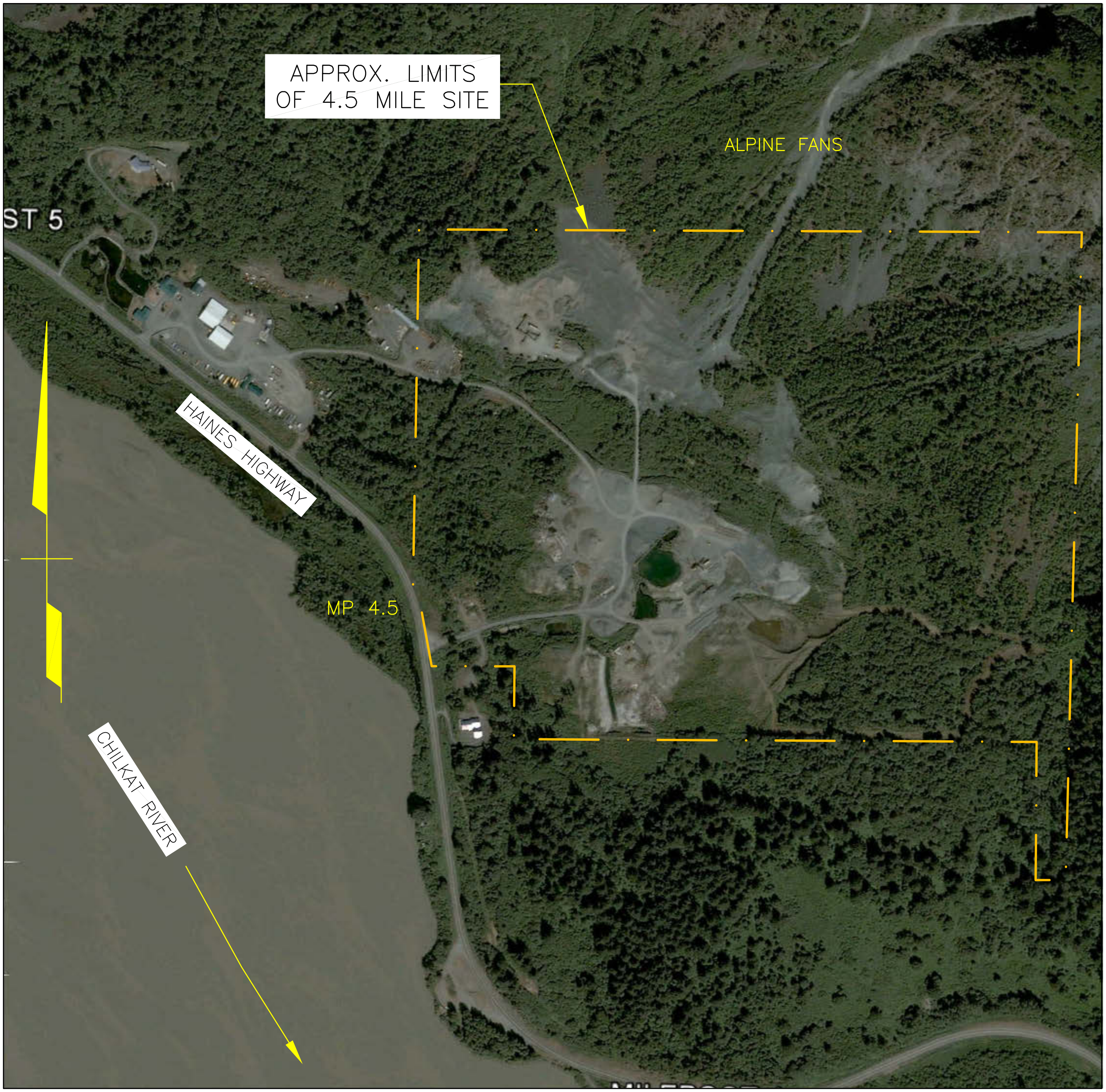
Plotted 3/28/2013 3:37 PM by Pete Hardcastle

SITE MAP (HA-D1)



BASE MAP IS JULY 18, 2004 DIGITALGLOBE SATELLITE IMAGERY.
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POTENTIAL HARD AGGREGATE SOURCE HAINES HIGHWAY

0 300 600 1200 1800

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/6/2013

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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
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STATEWIDE MATERIAL SITE INVENTORY

HAINES 4.5 MILE SITE

SCALE	DESIGNED	DRAWN	PAGE
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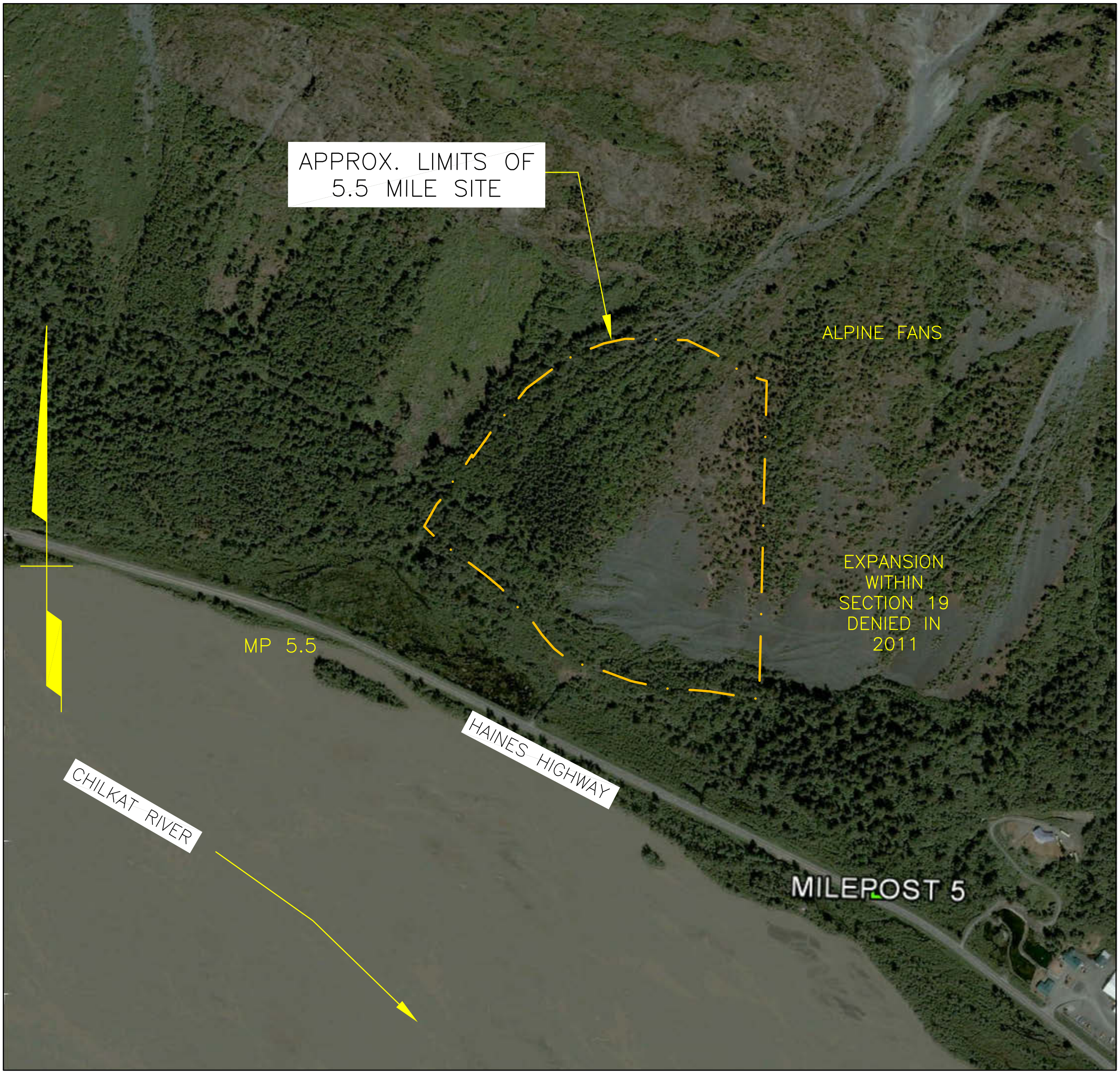

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POTENTIAL HARD AGGREGATE SOURCE HAINES HIGHWAY

0 300 600 1200 1800

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/6/2013

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AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY

HAINES 5.5 MILE SITE

SCALE	DESIGNED	DRAWN	PAGE
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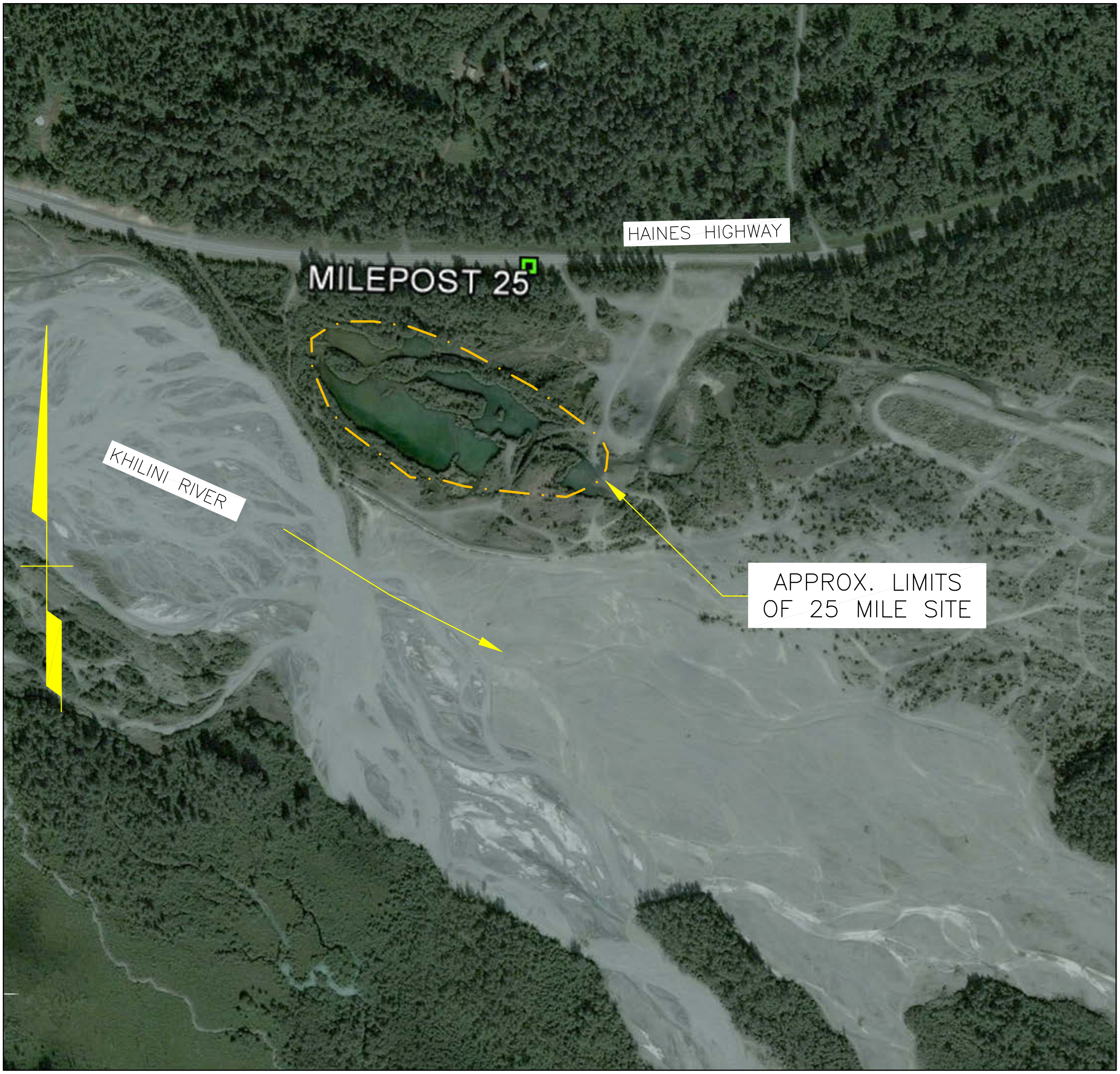
SITE MAP (HA-D3)



BASE MAP IS JULY 18, 2004 DIGITALGLOBE SATELLITE IMAGERY.
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POTENTIAL HARD AGGREGATE SOURCE HAINES HIGHWAY

0 300 600 1200 1800

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/6/2013

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STATEWIDE MATERIAL SITE
INVENTORY

MILE 25 KLEHINI SITE

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

KUPREANOF ISLAND
AREA "A" THRU AREA "I"

February 15, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: Potential hard aggregate sources on Kupreanof Island are located along the southern and eastern shores of the island (Areas "A" thru "H") but also include an existing Forest Service quarry (Area "I") in the interior of the island. The sources lie within the Tongass National Forest, although portions of the basalt are mapped underlying Sumner Strait, Duncan Canal and Kah Sheets Bay. Besides the existing quarry in the interior of the island, there was an existing quarry on Kah Sheets Bay that was reportedly mined as early as the 1970's for paving aggregate.

Access: Portions of the area apparently can be accessed by gravel surfaced Forest Service roads from Kake, although most of the areas are accessible only from the coast.

Geology: The deposits have been divided into eight (8) areas based on geologic mapping and one (1) area based on exposure in an existing quarry.

KUPREANOF ISLAND POTENTIAL HARD AGGREGATE SOURCES

Site ID	Source Name	Site Description	Latitude	Longitude
HA-E1	Area “A”	Sumner Straits	56.445424	-133.650459
HA-E2	Area “B”	Sumner Straits	56.439241	-133.520885
HA-E3	Area “C”	Totem Bay	56.455001	-133.460536
HA-E4	Area “D”	Totem Bay	56.505468	-133.437401
HA-E5	Area “E”	SE Kupreanof Island	56.457785	-133.196343
HA-E6	Area “F”	Kah Sheets Bay Quarry	56.513813	-133.126340
HA-E7	Area “G”	Duncan Canal	56.672651	-133.170506
HA-E8	Area “H”	Duncan Canal	56.708212	-133.253637
HA-E9	Area “I”	Forest Service Quarry	56.763233	-133.523917

The only known laboratory testing data from this rock unit was from an exposure unmapped by the U.S.G.S. in a U.S. Forest Service quarry in the interior of the island (Area “I”). Generally, the rock in this existing quarry was dense, very fine-grained, relatively unaltered Quaternary basalt that had a petrographic description similar to the rock described along the south coast of Kupreanof Island by Brew in 1997. Alaska T-13 degradation results from the existing interior quarry reportedly ranged from 81 to 91. The rock in the Forest Service quarry was almost impossible to break with a rock hammer and could not be split with a point load testing apparatus. Unconfined compressive strength was estimated to exceed 29,000 psi (extremely strong). There was an undocumented Nordic abrasion test result of 7 provided by DOT&PF for the quarry.

Geology: The Geologic Unit Description (Brew, 1997) from the rock described along the south coast is as follows:

> Qb - Extrusive Basaltic Rocks and Underlying Sediments (Holocene and (or) Pleistocene) - Fresh, locally polygonally jointed, dark greenish-gray, dense, very fine-grained to aphanitic, magnetite-bearing, olivine basalt and minor pyroxene basalt. Individual flows are as much as 10 meters thick and are columnar jointed; most flows are less than 1 meter thick. Underlain locally by aa (lava) flows and mafic volcanic breccia in layers up to 0.5 meters thick and by locally derived, poorly sorted, well-bedded brown- to gray-weathering conglomerate, pebbly sandstone, sandstone, and minor siltstone deposited in fluvial or beach environment.

The Qb unit is similar to extensive flows of the QTb basalt unit found in the interior of the island. Brew stated that it may be included within the QTb unit “particularly along Rocky Pass and near the mouth of Irish Creek”. Observations during Forest Service road construction found the QTb basalt unit to be more vesicular and highly weathered, traits that would be unsuitable for hard aggregate production. It appears from the geologic literature that the mapping of the two units may not be well defined.

Conclusions: This basalt has potential for making hard aggregate and may have been used for paving aggregates in the past. Some variability in the rock within the unit may create problems locating the best rock sources. Additionally, conflicts with dedicated Forest Service uses of the land may make locating potential quarries difficult. Finding a site with access to a sheltered deep water harbor may also be problematic. However, there appears to be potential for developing a quarry that may produce hard aggregate as well as other aggregates (including riprap) that can be transported throughout southeast Alaska as well as into central and western Alaska.

References:

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84-405, 43 p., 2 sheets, scale 1:250,000.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg B-4 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-F, 20 p., 1 sheet, scale 1:63,360.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg B-5 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-G, 19 p., 1 sheet, scale 1:63,360.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg C-4 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-J, 21 p., 1 sheet, scale 1:63,360.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg C-5 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-K, 18 p., 1 sheet, scale 1:63,360.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg D-5 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-M, 22 p., 1 sheet, scale 1:63,360.

Karl, S.M, Haeussler, P.J., and McCafferty, A., 1999, Reconnaissance geologic map of the Duncan Canal-Zarembo Island area, southeastern Alaska: U.S. Geological Survey Open-File Report 99-168, 30p., 1 sheet, scale 1:150,000.

LOCATION MAP (HA–E1 & HA–E2)

U.S.G.S. QUADRANGLE: PETERSBURG (B–5) & (C–5)

Qb–DenseBasalt

POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
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STATEWIDE MATERIAL SITE INVENTORY
SUMNER STRAITS

SCALE	DESIGNED	DRAWN	PAGE
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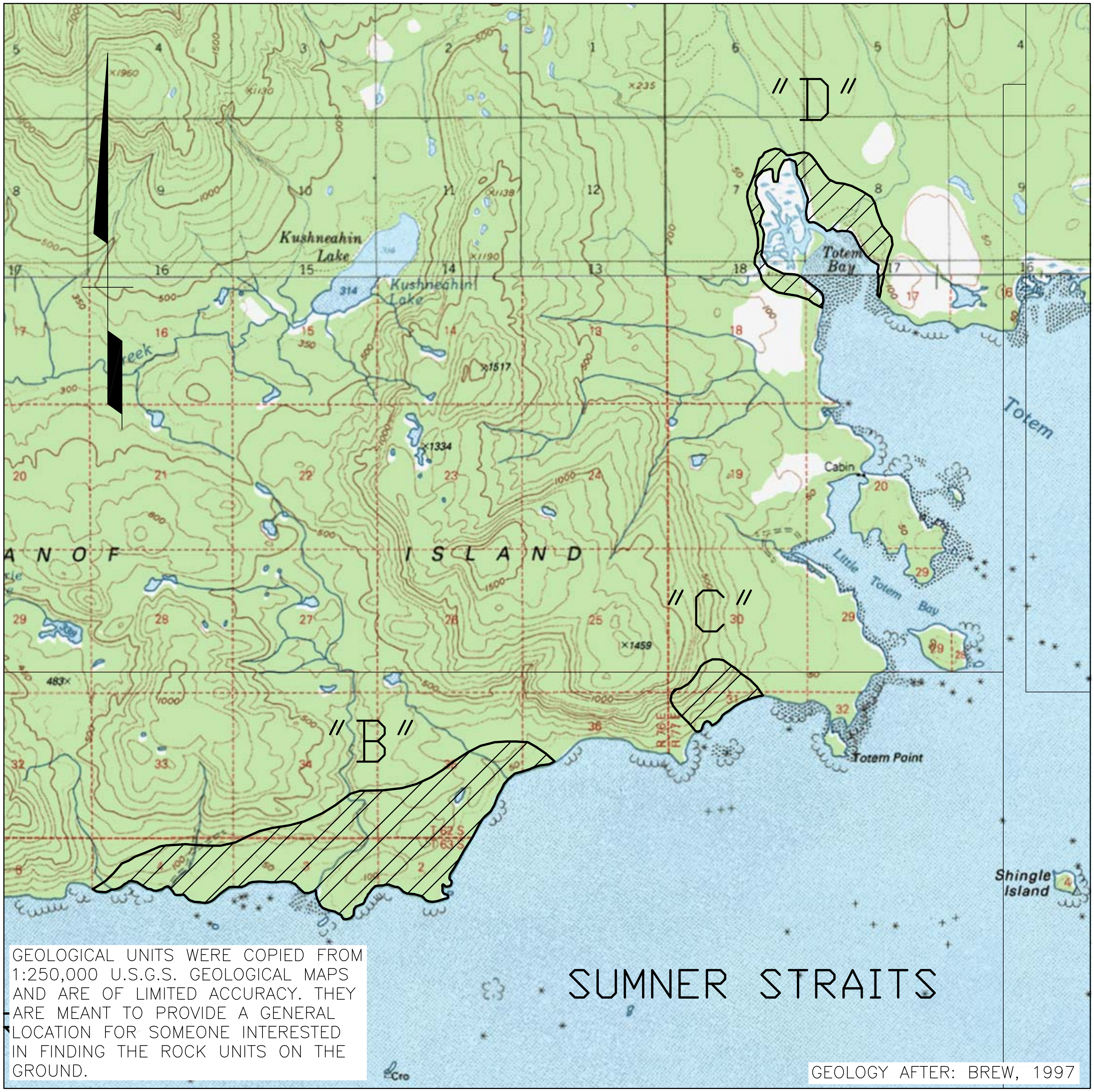
LOCATION MAP (HA–E3 & HA–E4)



U.S.G.S. QUADRANGLE: PETERSBURG (B–5)

POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

Qb–DenseBasalt

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY
TOTEM BAY

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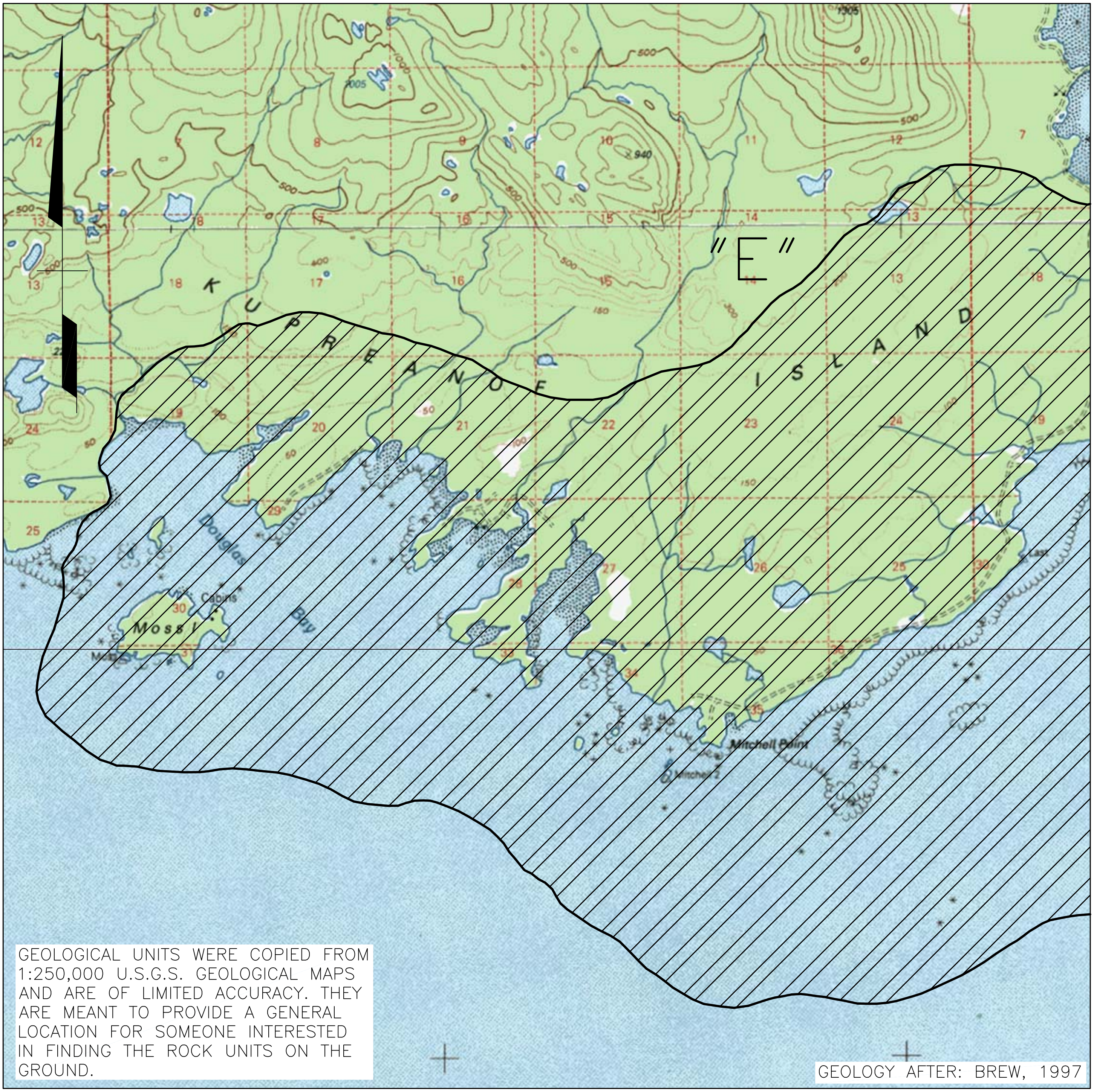
LOCATION MAP (HA-E5)



U.S.G.S. QUADRANGLE: PETERSBURG (B-4) & (B-4)

POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

Qb-DenseBasalt

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY
SE KUPREANOF ISLAND

SCALE	DESIGNED	DRAWN	PAGE
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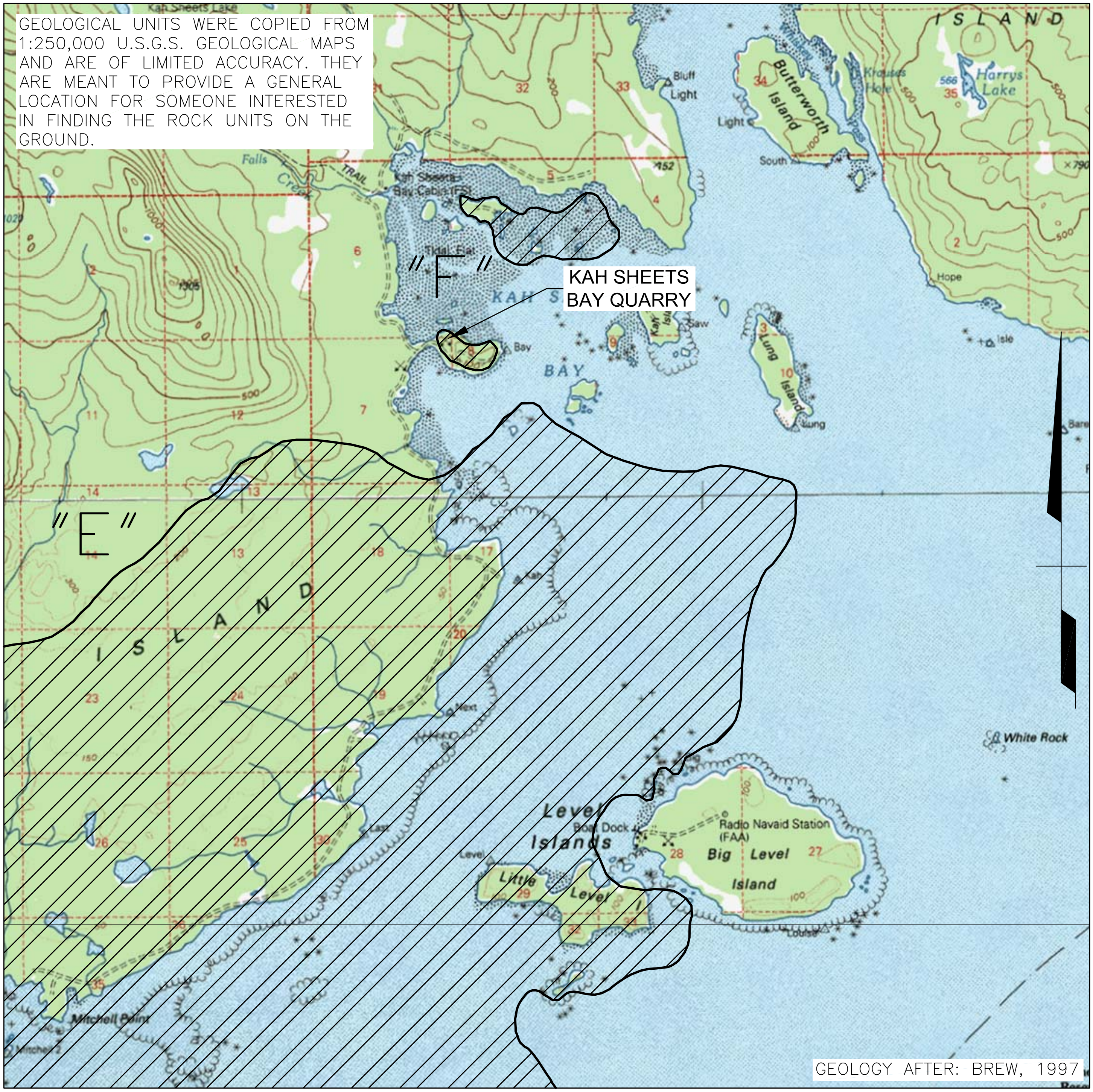
LOCATION MAP (HA–E6)



U.S.G.S. QUADRANGLE: PETERSBURG (B–4) & (C–4)

Qb–DenseBasalt

POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY
KAH SHEETS QUARRY

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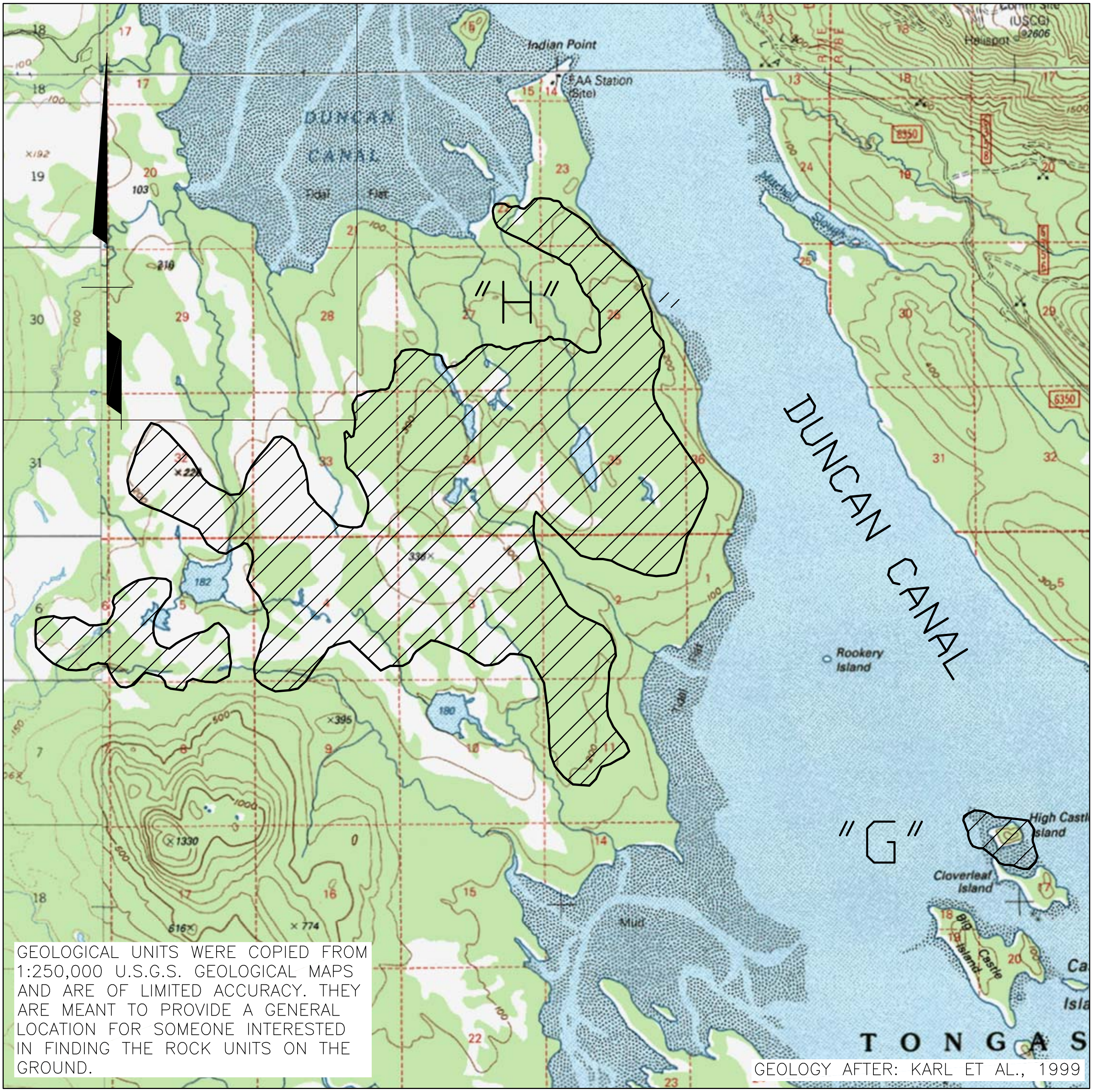
LOCATION MAP (HA-E7 & HA-E8)



U.S.G.S. QUADRANGLE: PETERSBURG (C-4), (C-5), (D-4) & (D-5)

Qb-DenseBasalt

POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY

DUCAN CANAL

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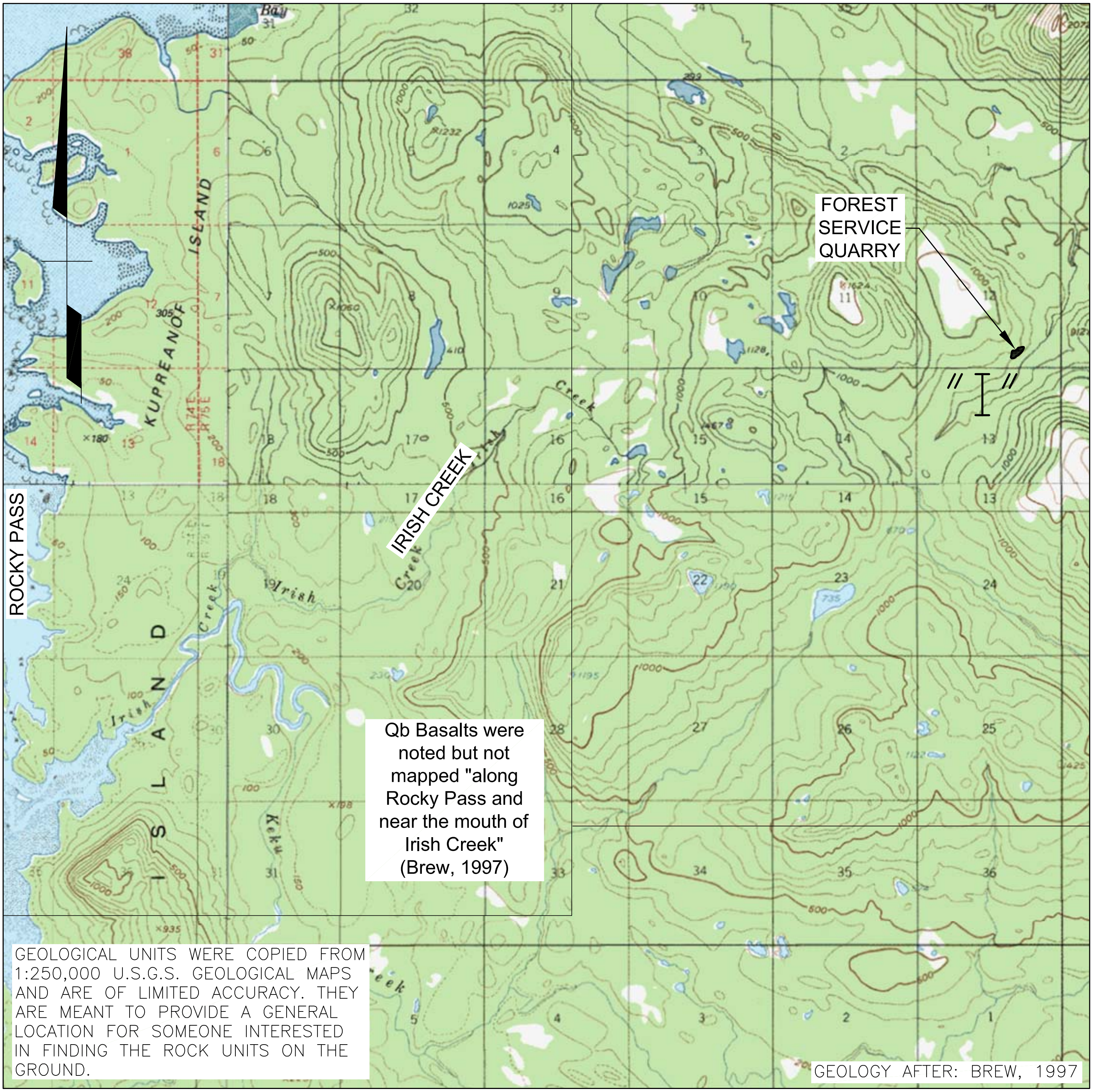
LOCATION MAP (HA-E9)



U.S.G.S. QUADRANGLE: PETERSBURG (C-5) & (D-5)

Qb-DenseBasalt

POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY
FOREST SERVICE QUARRY

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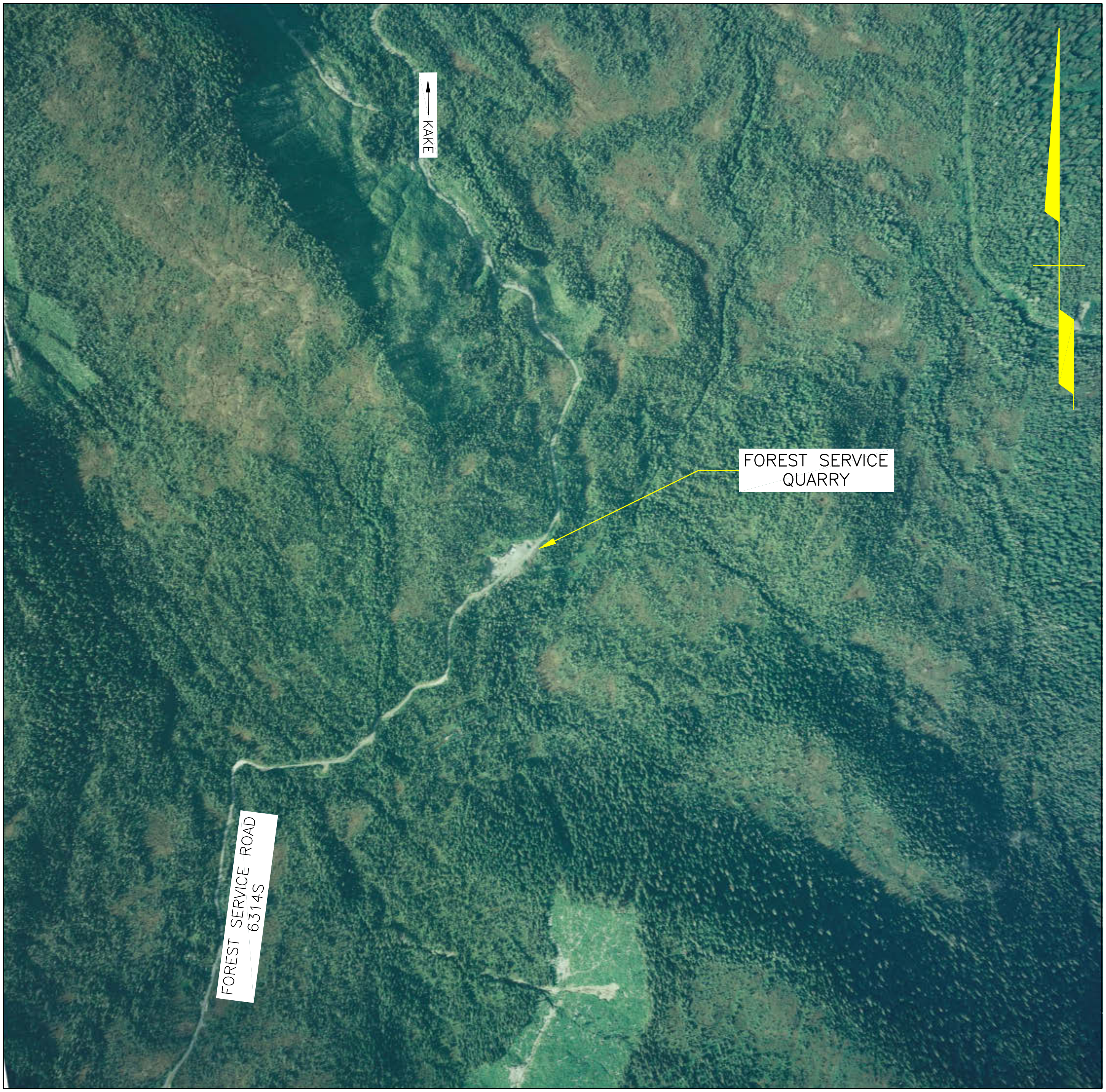
SITE MAP (HA-E9)



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POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 600 1200 2400 3600

GRAPHIC SCALE IN FEET

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STATEWIDE MATERIAL SITE INVENTORY

FOREST SERVICE QUARRY

SCALE	DESIGNED	DRAWN	PAGE
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SITE MAP (HA-E9)

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POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 150 300 600 900

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STATEWIDE MATERIAL SITE INVENTORY

FOREST SERVICE QUARRY

SCALE	DESIGNED	DRAWN	PAGE
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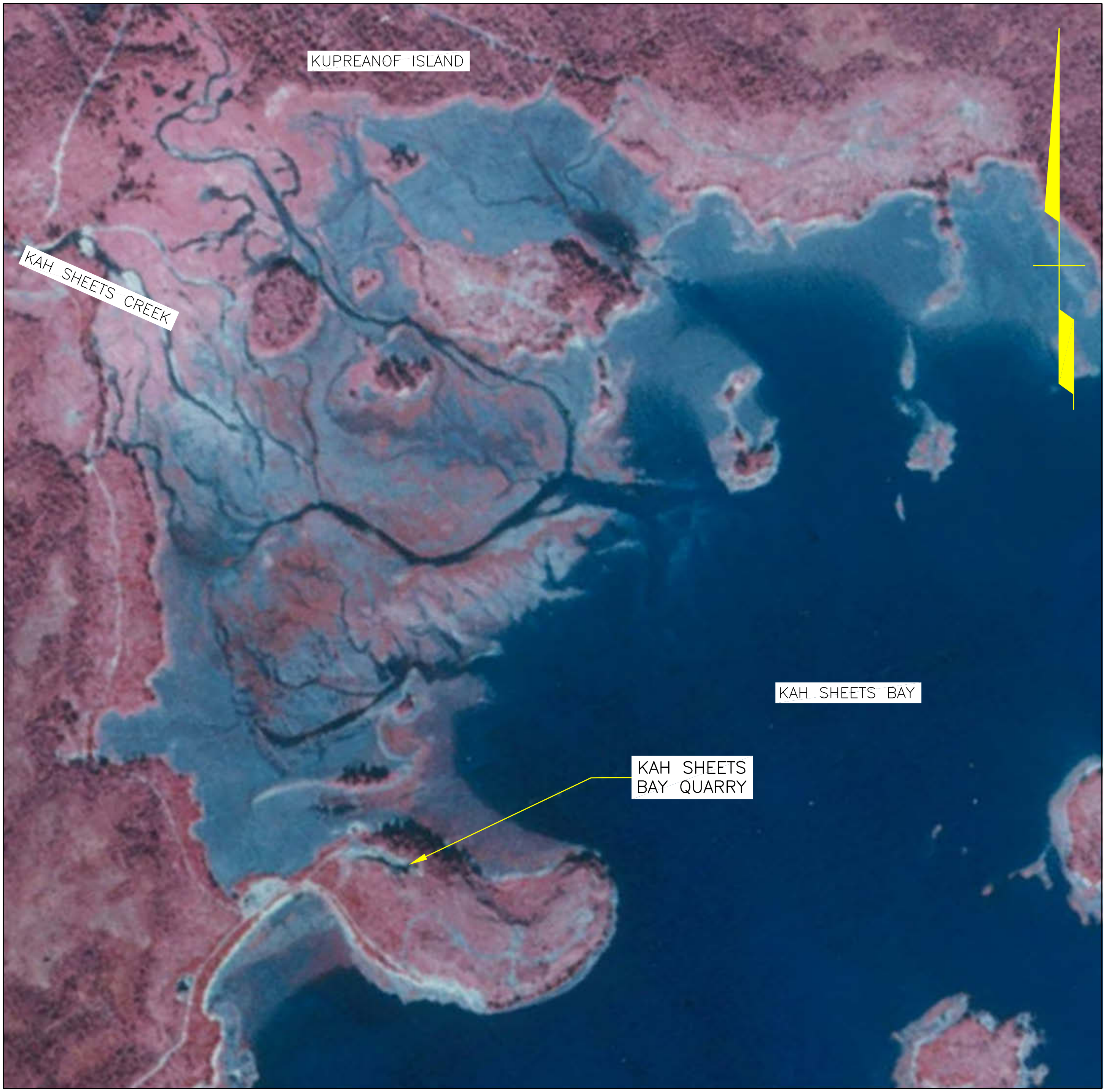
SITE MAP (HA–E6)



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POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 600 1200 2400 3600

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STATEWIDE MATERIAL SITE INVENTORY

KAH SHEETS BAY QUARRY

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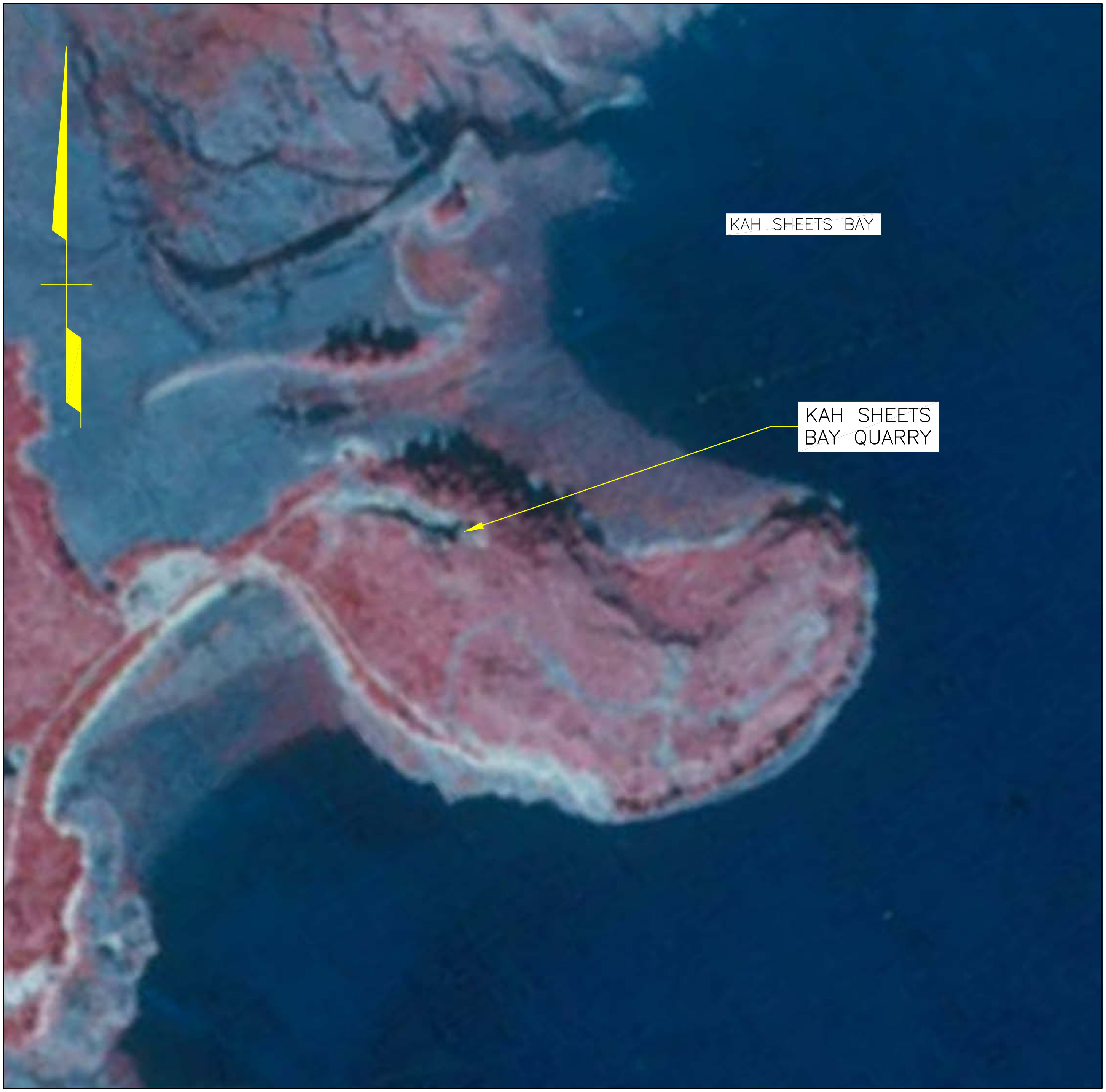
SITE MAP (HA–E6)



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POTENTIAL HARD AGGREGATE SOURCE KUPREANOF ISLAND

0 300 600 1200 1800

GRAPHIC SCALE IN FEET

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STATEWIDE MATERIAL SITE INVENTORY

KAH SHEETS BAY QUARRY

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

KUIU ISLAND ROWAN AND SECURITY BAY

February 15, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: The potential hard aggregate sources on Kuiu Island are located along the northwestern coast of the island between Rowan Bay and Security Bay. Potential sources include two granodiorite/gabbro intrusives in a sandstone country rock. The potential hard aggregate sources are hornfelses associated with the intrusives. Locations of these hornfelses are mapped as being along the boundary of the two intrusives as shown on the following maps. The two sources lie entirely within the Tongass National Forest on lands managed by the U.S. Forest Service.

KUIU ISLAND POTENTIAL HARD AGGREGATE SOURCES

Site ID	Source Name	Latitude	Longitude
HA-F1	Security Bay	56.808520	-134.360498
HA-F2	Rowan Bay	56.695866	-134.296529

Access: Access to and from the potential sources would be from logging roads to the coast at Washington, Rowan, Security or Saginaw Bays.

Geology: Two small plutons have intruded the sandstones between Rowan Bay and Security Bay on the northwest corner of Kuiu Island. Hornfelses were mapped as occurring along the edge of and between the two intrusive bodies. Geologic mapping was obtained from two sources (Muffler, 1967 and Brew et al., 1984). Within the following text, are instances where these two sources used differing bedrock symbols for similar rock types, Muffler's is shown first with Brew's succeeding. Muffler does not map the hornfels units. All bedrock symbols presented on the location maps are derived from Brew et al.

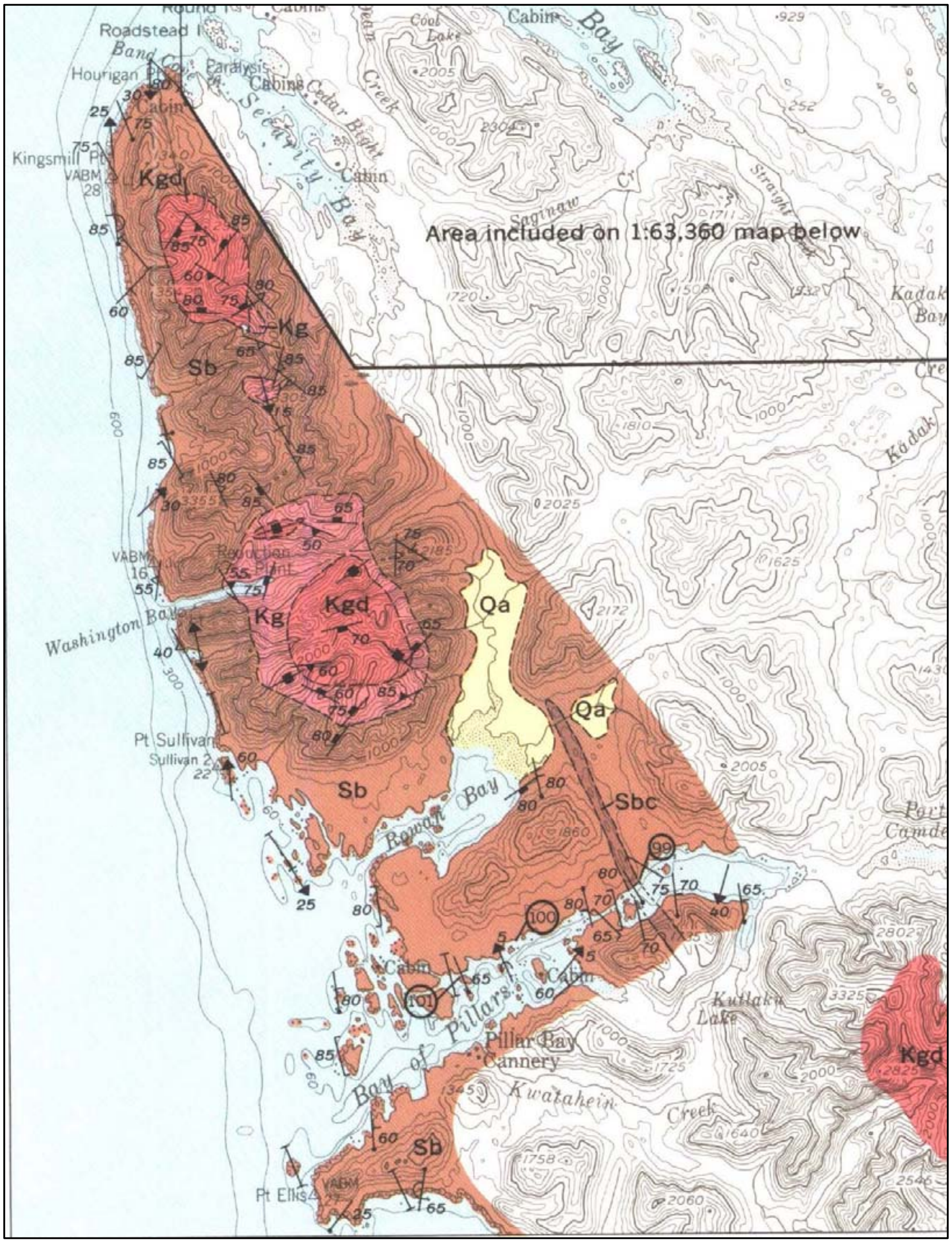
The Bay of Pillars Formation (Sb/Stbg) is composed primarily of medium-grained light-gray calcareous lithic sandstone. The sand grains are subangular to subrounded and consist of volcanic rock, calcite, slate, plagioclase (ranging in composition from albite to andesine), and quartz. Matrix usually makes up less than 15 percent of the rock, and calcite cement is commonly subordinate to the matrix.

The pluton southeast of Washington Bay is a composite Gabbro/Diorite (Kg/Tmdk) deposit and forms a roughly elliptical outer ring one-quarter to one and one-half miles wide. Foliation, where detected in gabbro, dips toward the center of the pluton. Where the ring is widest, at the northwestern part of the pluton, the rocks are predominantly fine to medium-grained layered hypersthene-augite-olivine gabbro. Biotite is a minor interstitial and secondary constituent that is conspicuous on weathered surfaces. The eastern and southern parts of the outer ring are composed of amphibole-bearing augite gabbro that contains minor biotite. The amphibole is light brownish green in thin section and is only slightly pleochroic; it replaces clinopyroxene. The core of this composite pluton is fine to medium-grained hornblende-biotite adamellite and granodiorite. The plagioclase is oligoclase. The hornblende is euhedral and is pleochroic from dark green to light tan.

A pluton west of Security Bay is dominantly fine to medium-grained quartz-bearing hornblende diorite (Kgd/Kwgd). Biotite-hornblende adamellite crops out at the south margin, and hornblende granodiorite near the northeast margin. Medium-grained hornblende gabbro forms the southeast projection of the pluton. The hornfels along the ridge between these two major plutons are intruded by numerous irregularly shaped plutonic bodies, most of which are too small to show at the map scale. Quartz-bearing hornblende-pyroxene diorite is dominant; biotitic hornblende-pyroxene gabbro and hornblende adamellite are subordinate (Muffler, 1967).

Hornfelsed Bay of Pillars Formation rocks of albite-epidote to hornblende hornfels (Tbh) and biotite-quartz-feldspar-hornfels (Kbh) facies metamorphic rocks; dominantly biotite-quartz-feldspar hornfels, fine to medium-grained, brownish-gray; original sedimentary structures and bedding of graywacke and mudstone turbidite sequence locally preserved; includes minor metaconglomerate. Metamorphosed from the Graywacke and Mudstone Turbidite Unit in Bay of Pillars Formation (Brew et al., 1984).

RECONNAISSANCE GEOLOGIC MAP, NW KUIU ISLAND
(Muffler, 1967)



Conclusions: There are no test results or other direct observations to verify the presence of rock capable of producing hard aggregate. However, the conditions exist for these types of rock (hornfels) to occur. Access to roads and locations on the coast where materials can be loaded on barges also appears to be available. These sources appear to warrant further consideration. Large-scale mapping indicates that similar intrusives intrude the Bay of Pillars Formation in the southern portion of the island but there is no detailed mapping available and it is unclear if hornfelses have formed (Gehrels and Berg, 1992).

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate, testing for acid rock drainage should be performed when using these sources.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

References:

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84-405, 43 p., 2 sheets, scale 1:250,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Muffler, L.J. Patrick., 1967, Stratigraphy of the Keku Islets and neighboring parts of Kuiu and Kupreanof Islands, southeastern Alaska: U.S. Geological Survey Bulletin 1241-C, p. C1-C52, 1 sheet, scale 1:63,360.

LOCATION MAP (HA-F1)

U.S.G.S. QUADRANGLE: PORT ALEXANDER (D-1) & (D-2)

Stbg-Sandstone
Tmdk-Gabbro/Diorite
Tbh/Kbh-Hornfels
Kwgd-Granodiorite

POTENTIAL HARD AGGREGATE SOURCE KUIU ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
SECURITY BAY

SCALE	DESIGNED	DRAWN	PAGE
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	CHECKED C.H.R.	DATE FEB 2013	

Prepared By:
R&M CONSULTANTS, INC.

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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LOCATION MAP (HA-F2)

U.S.G.S. QUADRANGLE: PORT ALEXANDER (C-1), (C-2), (D-1) & (D-2)

Stbg-Sandstone
Tmgk-Granite
Tmdk-Gabbro/Diorite
Tbh-Hornfels

POTENTIAL HARD AGGREGATE SOURCE KUIU ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
ROWAN BAY

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BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE
SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

WRANGELL ISLAND
WRANGELL AIRPORT QUARRY

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: The Wrangell Airport Quarry is located at the north tip of Wrangell Island at the north end of the Wrangell Airport. It lies on a bedrock knob that forms Point Highfield. It consists of a tonalite intrusive, part of a series of Cretaceous tonalite (and other igneous) intrusives that stretch from Admiralty Island to Revillagigedo Island (Gehrels and Berg, 1992). The Wrangell Airport Quarry appears to be on Airport managed property. Two other intrusives near the City of Wrangell appear to be on state or private lands. Intrusives further to the south are in the Tongass National Forest.

WRANGELL ISLAND POTENTIAL HARD AGGREGATE SOURCE

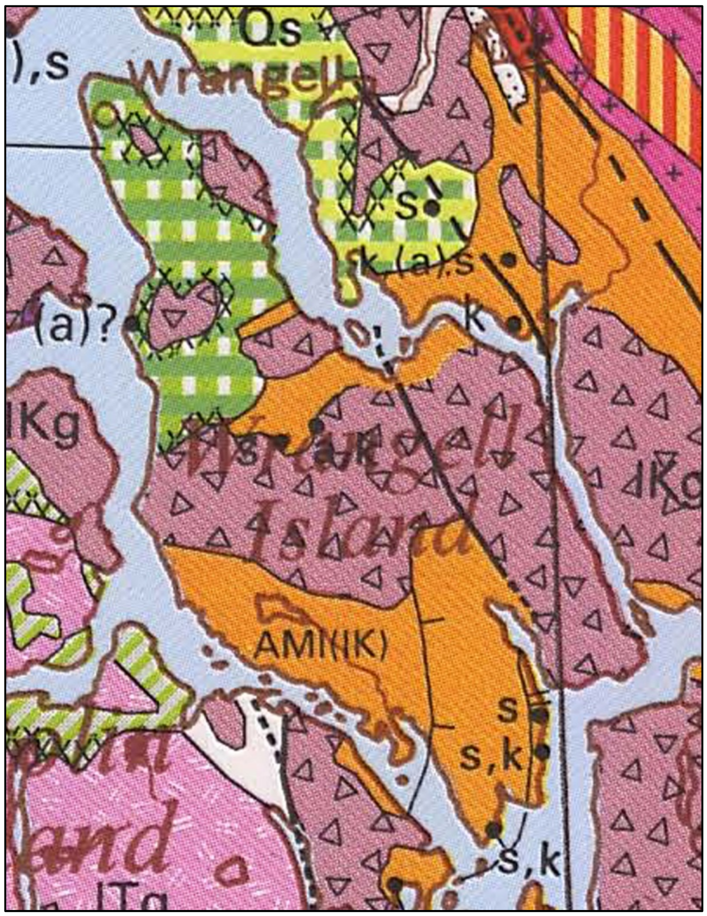
Site ID	Source Name	Nordic Values	Latitude	Longitude
HA-G1	Wrangell Airport Quarry	7, 17.1	56.487009	-132.386582

Access: By road from Wrangell. The other intrusive bodies on the island are accessible from a series of roads that run the length of the island or from the coast.

Geology: Bedrock on Wrangell Island has been described as follows (Brew et al., 1984)

Ktoc: Garnet biotite tonalite and minor granodiorite. Nonfoliated plagioclase rock; inequigranular to porphyritic; very fine to medium-grained; color index 14 to 29; medium-gray fresh; weathers light-gray; forms small elongate bodies less than 3 square kilometers in area; also makes up one larger body on northern Wrangell Island. Mineralogy includes reddish brown garnet, clinozoisite and local muscovite. Biotite and quartz is commonly interstitial to closely-spaced and includes plagioclase laths.

WRANGELL ISLAND METAMORPHIC FACIES MAP
(From Dusel-Bacon et al., 1996)



Map showing the interpreted hornfels zones on Wrangell Island. The pink/purple units are igneous intrusives, the green/orange units are metamorphic rocks generally derived from sedimentary and volcanic units and the cross hatched areas along the intrusives are the interpreted hornfels zones. These zones are subject to differing interpretations by different authors. The dotted areas are unmetamorphosed rocks.

Ktef: Hornblende biotite tonalite and granodiorite, quartz monzodiorite, and quartz diorite. Foliated to massive equigranular; average grain size is medium, fine-grained near some margins; color index 17 to 50; light to medium gray fresh, weathers to brownish to dark gray. Foliation varies both in direction and development and ranges from moderately developed on the west side to very well-developed on the east side of Wrangell Island; locally semischistose and cataclastic.

Ksp: Phyllite. Subgreenschist and greenschist facies metamorphic rocks inferred to be derived from fine-grained sediments; original textures and structures generally obscure; dominantly very fine-grained, dark-gray weathering, carbonaceous chlorite-quartz-feldspar phyllite; some interlayered graywacke and graywacke semischist; locally extensive layers and lenses of very fine-grained, light to dark-green weathering chlorite-rich phyllite interpreted to have been metamorphosed from fine-grained volcanic sediments.

Kss: Schist and Greenschist. Subgreenschist to greenschist facies rocks within the phyllite unit (Ksp); fine to medium-grained, relict pyroxene phenocrysts bearing epidote albite chlorite greenstone; poorly foliated, weathers dark greenish gray, grayish-green fresh; probably derived from intermediate composition volcanic breccias; forms poor rounded outcrops.

The units are shown on the maps on pages 2, 3A and 3B of this report. Hornfelses are noted by Brew et al. as occurring along the edges of the tonalite intrusives although he doesn't map them. Hornfelses are mapped in the phyllites and schists surrounding the tonalite intrusives on the north end of the island as shown on the metamorphic facies map above. They are not mapped surrounding the intrusives in the amphibolite-facies schist and gneiss on the south end of the island (Dusel-Bacon et al., 1996). Karl et al. in 1999 indicated hornfels can be found over the entire island. Nordic abrasion values of 7 and 17.1, apparently from the Wrangell Airport Quarry, have been reported. The value of 7 was taken from a map of Alaska provided by DOT&PF. The 17.1 value was provided by DOT&PF Southeast Region with the laboratory report being attached to this report. The location, weathering and type of rocks tested are unknown. It is possible the 17.1 value may represent a test in the tonalite and the 7 may represent a test in the hornfels, or the test may represent different grain sizes in the tonalite.

Conclusions: There appears to be some rock capable of producing hard aggregate at the Wrangell Airport Quarry, however further investigations will be necessary to delineate where and how much is available. Additional rock with potential for hard aggregate production may be available on the Wrangell Island.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

<u>References:</u>

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84-405, 43 p., 2 sheets, scale 1:250,000.

Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of southeastern Alaska; distribution, facies, and ages of regionally metamorphosed rocks: U.S. Geological Survey Professional Paper 1497-D, p. 1-42, 2 sheets, scale 1:1,000,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. eological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Karl, S.M, Haeussler, P.J., and McCafferty, A., 1999, Reconnaissance geologic map of the Duncan Canal-Zarembo Island area, southeastern Alaska: U.S. Geological Survey Open-File Report 99-168, 30 p., 1 sheet, scale 1:150,000.

25-229
R-1/2007
S.E. REGION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

LAB REPORT (U.S. STAND.)

PRECONSTRUCTION	☐	CONSTRUCTION	X
ACCEPTANCE	☐	QUALITY	X
ASSURANCE	☐	INFORMATION	☐

TEST OF **BORROW 10" MINUS SHOT ROCK (QUARRY ROCK FOR)** ITEM NO. **203(19)** LAB NO. **11C-438**

PROJECT NO.	**HPRM-0003(135)**	PROJECT NAME	**WRG WRANGELL ROAD AND UTILITY IMPROVEMENT**		
SAMPLED FROM	**STOCKPILE**	EXAMINED FOR	**QUALITY**		
DEPTH		FIELD NO.	**Q-SR-1**	DATE SAMPLED	**08/25/11**
SOURCE	**AIRPORT PIT**	SUBMITTED BY	**B. KLEIN**	DATE RECEIVED	**08/25/11**
LOCATION	**WRANGELL, ALASKA**	REPRESENTS	**SOURCE**	DATE REPORTED	**09/12/11**

% PASSING SIEVE	AS RECEIVED QUALITY	QUALITY	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#10			
#16			
#20			
#30			
#40			
#50			
#80			
#100			
#200			
0.02 MM			
.005 MM			
PROPERTIES			
LIQUID LIMIT		NV	
PLASTIC INDEX		NP	6 MAX
DELETERIOUS	FREE	FREE	FREE
FRACTURE %	100		50 MIN 2 FACES
THIN ELONGATED %			
FINENESS MODULUS			
ORGANIC CONTENT %			
AASHTO CLASS			

MOISTURE / DENSITY RELATIONS	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D

DRY DENSITY - POUNDS / CUBIC FOOT

5 10 15

PERCENT MOISTURE

QUALITY	COARSE	FINE	
DEGRADATION VALUE	81		
L.A. ABRASION % B	34		30 MAX
NORDIC ABRASION %	17.1		
BULK SPG	2.678		
BULK SSD SPG	2.701		
APPARENT SPG	2.742		
ABSORPTION %	0.9		

REMARKS: **SENT TO ANCHORAGE FOR FURTHER TESTING**

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeffrey A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: [signature] 9/20/11 for
REGIONAL MATERIALS ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

State of Alaska
Department of Transportation & Public Facilities
Central Materials Lab
5750 East Tudor Road
Anchorage, AK 99507
Phone (907) 269-6200 FAX (907) 269-6201

Laboratory Report

Quality

Laboratory No.: 2011A-3004

Name: **WRG Wrangell Road and Utility Improvements** Project No.: **68828 / HPRM-0003(135)**
Sample: **Borrow 10 inch minus shot rock** Item/Specification No.: **203(19)** Field No.: **11C-438**
Sampled From: **Stockpile at Crusher** Date Sampled: **08/25/2011**
Source: **Airport Quarry** Quantity Represented: **Source** Date Received: **09/01/2011**
Location: **Wrangell** Submitted By: **J. Hart** Date Completed: **09/08/2011**
Examined For: **Sulfate Soundness** Date Reported: **09/08/2011**

Sieve Analysis	Lab	Field	Specs
4"			
3"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#8			
#10			
#16			
#30			
#40			
#50			
#80			
#100			
#200			
.02 mm			
.002 mm			
Fineness Modulus			
% Fracture			
Single Face			
Double Face			
Atterburg Limits			
Liquid Limit			
Plastic Limit			
Plastic Index			
Flat / Elongated			
1:3			
1:5			

	Lab	Specs
% Organic		
% Natural Moisture		
pH of Soil		
% Sticks & Roots		
Dry Unit Weight, pcf		
% Lightweight Particles		
Uncompacted Voids of FA		
Specific Gravity of Soil		
Sand Equivalent		
Expansion Breakdown		

		Coarse Lab	Coarse Specs	Fine Lab	Fine Specs
	Friable Particles				
AASHTO T104	Sulfate Soundness, % Loss	1	9 max		
	Agg. Specific Gravity, Bulk				
	Agg. Specific Gravity, SSD				
	Agg. Specific Gravity, App.				
	% Absorption				
	LA Abrasion, Total % Loss				
	@ 100 revs % Loss				
	Degradation				
	Nordic Abrasion				

FSV Class
AASHTO Class
Unified Class

% +3"
% Gravel
% Sand
% Silt/Clay
% Clay

California Bearing Ratio
Organic Impurities Plate #3
Mortar Making Properties of Sand - Compressive Strength

Age	Sample	Control	Ratio	Spec
7 Day				
28 Day				

Remarks:

DRAFT

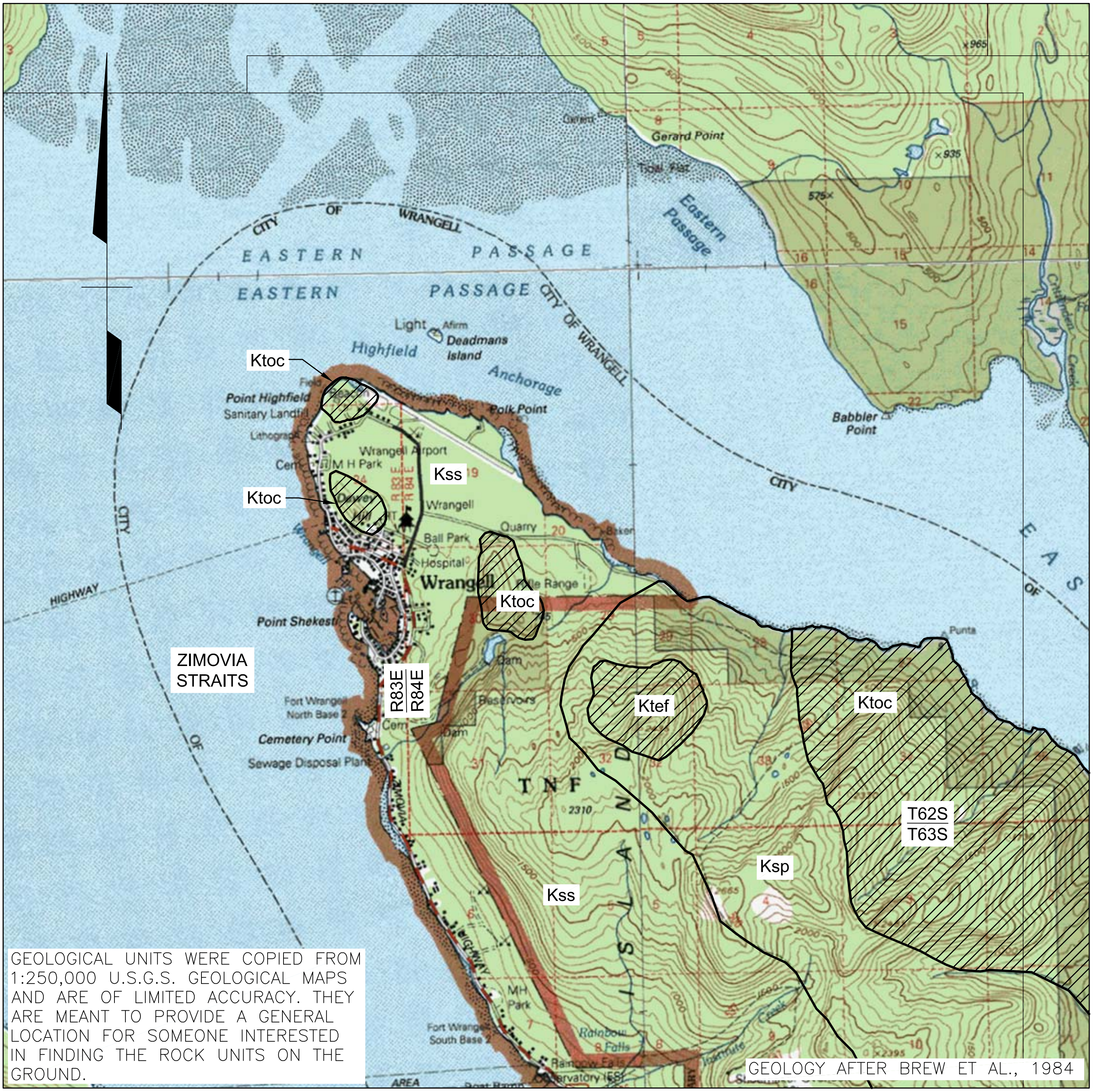
D5 The Material as Submitted Conforms to Specifications
Yes [X] No [ ] NA [ ]

Signature:

Newton J. Bingham, PE
Regional Materials Engineer

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED

LOCATION MAP (HA-G1)



U.S.G.S. QUADRANGLE: PETERSBURG (B-1), (B-2), (C-1) & (C-2)

- Ktoc/Ktif-Tonalite
- Ksp-Phyllite
- Kss-Schist

POTENTIAL HARD AGGREGATE SOURCE WRANGELL ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY

WRANGELL AIRPORT QUARRY

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H. / CHECKED C.H.R.	P.K.H. / DATE FEB 2013	2

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
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SITE MAP (HA-G1)

BASE MAP IS JULY 24, 2012 GEOEYE SATELLITE IMAGERY.
THIS IS A PLANNING DOCUMENT ONLY.

Ktoc-Tonalite
Kss-Schist

POTENTIAL HARD AGGREGATE SOURCE WRANGELL ISLAND

0 600 1200 2400 3600

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/4/2013

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R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
WRANGELL AIRPORT QUARRY

SCALE	DESIGNED	DRAWN	PAGE
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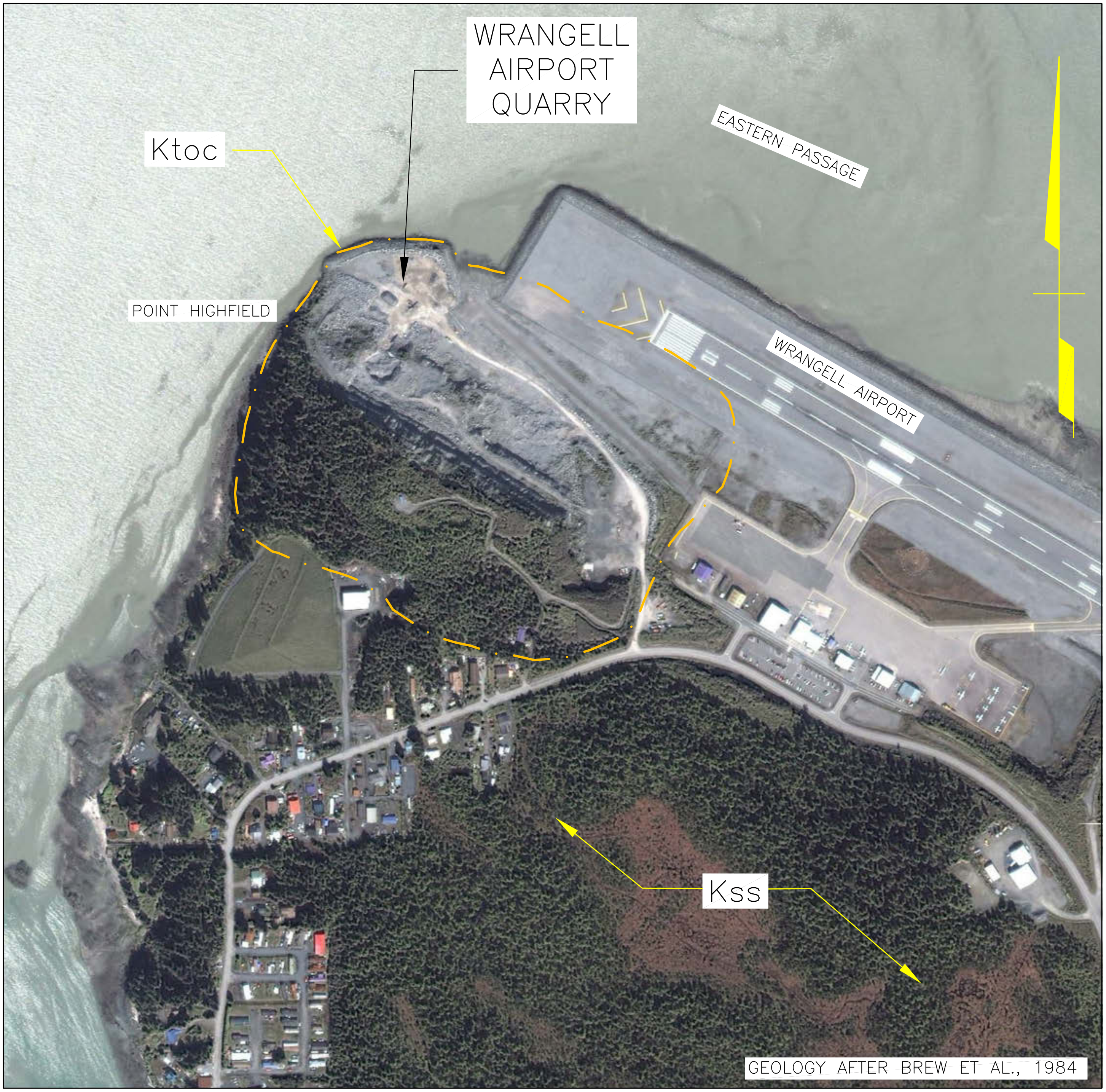
SITE MAP (HA-G1)



BASE MAP IS JULY 24, 2012 GEOEYE SATELLITE IMAGERY.
THIS IS A PLANNING DOCUMENT ONLY.

Ktoc-Tonalite
Kss-Schist

POTENTIAL HARD AGGREGATE SOURCE WRANGELL ISLAND

0 300 600 1200 1800
GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 2/4/2013

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
WRANGELL AIRPORT QUARRY

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE
SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

ZAREMBO ISLAND
NORTHERN ZAREMBO ISLAND

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: Zarembo Island is located to the west of Wrangell Island and south of Kupreanof Island. The bedrock on Zarembo Island can be separated into two parts, a northern portion generally composed of Cretaceous granodiorite to diorite intrusives surrounded by semischist and phyllite and a southern portion generally composed of Tertiary to Quaternary volcanic and igneous rocks. The two parts are separated by a wide valley that cuts across the island from northwest to southeast. Hornfels zones are mapped along the edges of the intrusives in the northern part of the island (Dusel-Bacon et al., 1996). These areas may be sources of hard aggregates. The approximate locations of the mapped hornfels zones are shown on the Location Maps attached to this report.

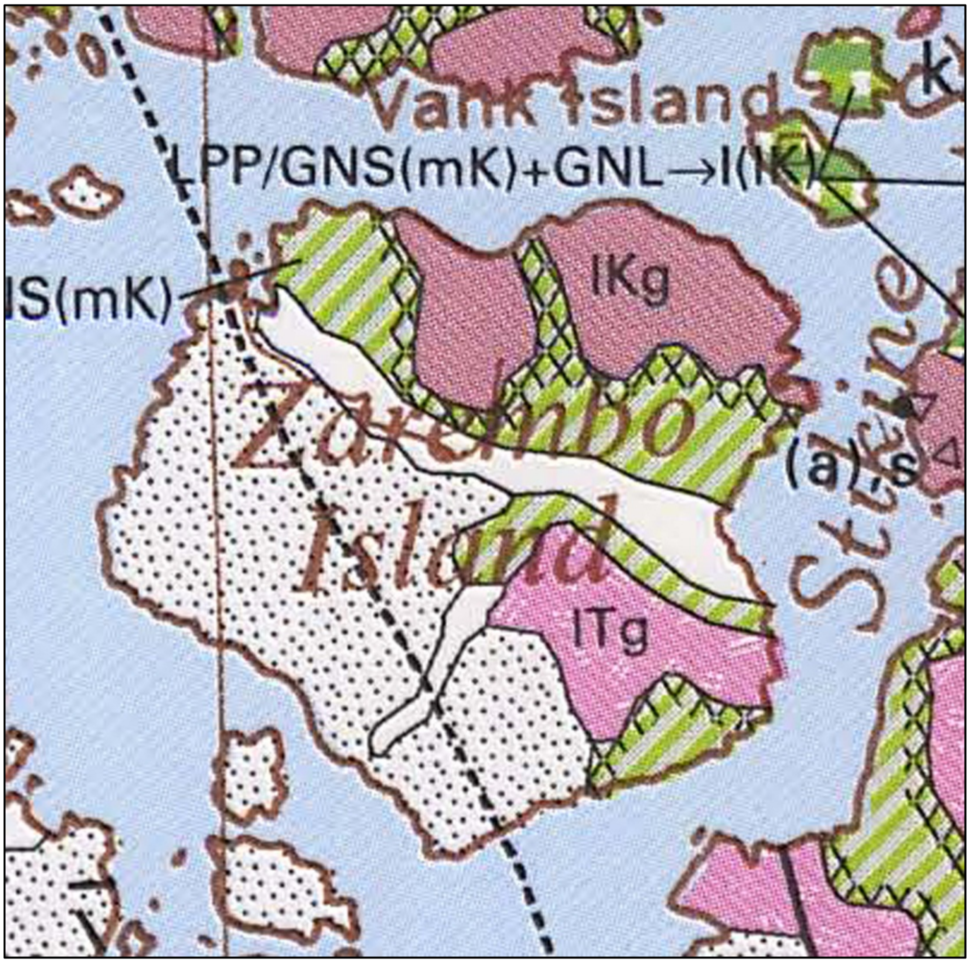
ZAREMBO ISLAND POTENTIAL HARD AGGREGATE SOURCE

Site ID	Source Name	Latitude	Longitude
HA-H1	Northern Zarembo Island	56.401017	-132.785403

Zarembo Island is within the Tongass National Forest. All lands appear to be managed by the U.S. Forest Service. There are numerous existing quarries shown on the U.S.G.S. topographic maps. The U.S. Forest Service may have information available about these quarries.

Access: There appears to be numerous Forest Service roads crossing the island, particularly on the northern part (See Location Map 2B) and several small harbors where aggregate could be loaded.

ZAREMBO ISLAND METAMORPHIC FACIES MAP
(From Dusel-Bacon et al., 1996)



Map showing the interpreted hornfels zones on Zarembo Island. The purple units are igneous intrusives, the green units are metamorphic rocks generally derived from sedimentary and volcanic units and the cross hatch along the edges of the intrusives are the interpreted hornfels zones. These zones are subject to differing interpretations by different authors. The dotted areas are unmetamorphosed rocks.

Geology: Bedrock on northern Zarembo Island has been described as follows (Brew et al., 1984).

Ktif (lKg): Hornblende-biotite tonalite, granodiorite, quartz monzodiorite, and quartz diorite: Equigranular to sparsely porphyritic, massive to weakly foliated; medium-grained; color index 14 to 52; light gray fresh, weathers yellowish-gray, elongate very fine-grained dioritic and local ultramafic inclusions.

Kqop (lKg): Biotite-epidote-hornblende-quartz-monzodiorite: Locally foliated; plagioclase phophyritic with medium and coarse-grained phenocrysts (to 12mm), fine to medium-grained groundmass to 3mm and a color index range of 17 to 48; weathers brownish-gray, gray and white fresh; body margins are commonly more mafic and have a very fine to fine-grained ground groundmass.

Mzs: Semischist and phyllite: Metamorphosed from graywacke and siltstone; Low grade (probably sub-greenschist facies) metamorphic rocks; locally highly folded; generally poorly foliated but finer-grained phases have good cleavage; brownish-gray fresh, gray to brown weathered; relict textures and sedimentary structures indicate derivation from a graywacke and siltstone or mudstone turbidite sequence.

Mzv: Greenschist and greenstone: Metamorphosed from intermediate to mafic volcanic rocks. Greenschist, greenstone, phyllite, minor semischist; weathers light to dark green, locally brownish pillow breccia, agglomerate flows, and possible tuffs.

KJsv: Brothers Volcanics/Douglas Island Volcanics: Augite bearing flows, volcanic breccias and intercalated tuff, volcanic graywacke, phyllite and slate. Andesitic to probably basaltic composition; weathers dark greenish-gray, gray, and green; generally lighter colored where fresh; relict augite phenocrysts conspicuous in most outcrops.

Units are outlined on the Location Map on Page 2A of this report. Hornfelses are mapped by Dusel-Bacon et al. as occurring along the edges of the intrusives as shown on the Zarembo Island Metamorphic Facies Map on Page 1B. There were no Nordic Abrasion test results found for Zarembo Island.

Conclusions: Rock in the hornfels zones on the northern part of Zarembo Island may be capable of producing hard aggregate, however additional investigations will be necessary to delineate where and how much material is available.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

<u>References:</u>

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84-405, 43 p., 2 sheets, scale 1:250,000.

Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of Southeastern Alaska; distribution, facies, and ages of regionally metamorphosed rocks: U.S. Geological Survey Professional Paper 1497-D, p. 1-42, 2 sheets, scale 1:1,000,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Karl, S.M, Haeussler, P.J., and McCafferty, A., 1999, Reconnaissance geologic map of the Duncan Canal-Zarembo Island area, southeastern Alaska: U.S. Geological Survey Open-File Report 99-168, 30p., 1 sheet, scale 1:150,000.

LOCATION MAP (HA–H1)

U.S.G.S. QUADRANGLE: PETERSBURG (B–2) & (B–3)

POTENTIAL HARD AGGREGATE SOURCE ZAREMBO ISLAND

Ktif/Kqop-Intrusives
Mzs/Msv-Schist, Phyllite & Greenstone
KJvs-Volcanics
Hornfels zone

0 0.75 1.5 3 4.5

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
NORTHERN ZAREMBO ISLAND

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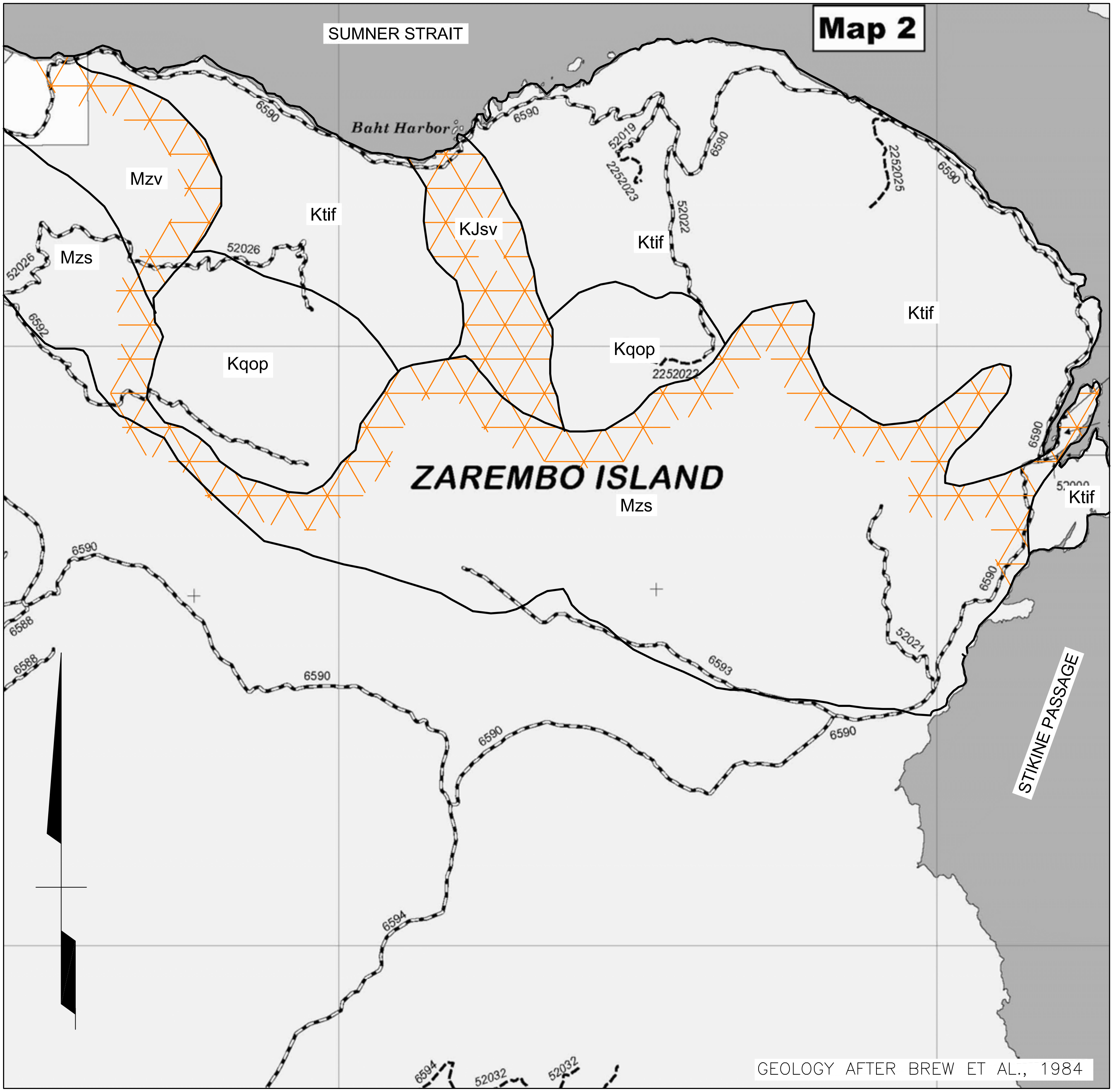
Plotted 3/28/2013 11:07 AM by Pete Hardcastle

LOCATION MAP (HA-H1)



ROAD LAYOUT FROM U.S.FOREST SERVICE MAP, JANUARY,2013

POTENTIAL HARD AGGREGATE SOURCE ZAREMBO ISLAND

Ktif/Kqop-Intrusives
Mzs/Msv-Schist, Phyllite & Greenstone
KJvs-Volcanics
Hornfels zone

0 0.75 1.5 3 4.5

GRAPHIC SCALE IN MILES

BASE MAP FROM MOTOR VEHICLE USE MAP
TONGASS NATIONAL FOREST WRANGELL RANGER DISTRICT

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
NORTHERN ZAREMBO ISLAND

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	2B
	CHECKED C.H.R.	DATE FEB 2013	

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Plotted 3/28/2013 11:06 AM by Pete Hardcastle

STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

ETOLIN ISLAND
NORTHERN AND CENTRAL ETOLIN ISLAND

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: Etolin Island is located to the southwest of Wrangell Island and southeast of Zarembo Island. The island is generally composed of Cretaceous and Tertiary granitic rocks of the Kuiu-Etolin Volcanic Plutonic Belt surrounded by semischist and phyllite of the Seymour Canal Formation. Hornfelses are inferred along the edges of the intrusives (Dusel-Bacon et al., 1996). These may be sources for hard aggregates. Locations of the mapped hornfelses are shown on the location map attached to this report and on Etolin Island Metamorphic Facies Map shown on Page 1C. The island is in the Tongass National Forest and is managed by the U.S. Forest Service. The south end of the island has been designated as the South Etolin Wilderness and was not considered for hard rock sources during this study.

ETOLIN ISLAND POTENTIAL HARD AGGREGATE SOURCES

Site ID	Source Name	Latitude	Longitude
HA-I1	Northern Etolin Island	56.246532	-132.470702
HA-I2	Central Etolin Island	56.144496	-132.464071

Access: There appear to be numerous forest service roads on the island, particularly on the north half in addition to several small harbors. There are numerous existing quarries shown on the U.S.G.S. topographic maps. The U.S. Forest Service may have information available about these sites.

Geology: Bedrock on Etolin Island has been described as follows (Brew et al., 1984 and Karl et al., 1999):

Ktef: Hornblende-biotite-tonalite and granodiorite, quartz monzodiorite, and quartz diorite: Foliated to massive equigranular; average grain size is medium, fine-grained near some margins; color index 17 to 50; light to medium gray fresh, weathers to brownish to dark gray. Foliation varies both in direction and development, and ranges from moderately developed on the west side to very well developed on the east side; locally semischistose and cataclastic.

Tmae: Alkali granite to granite: Biotite amphibole alkali granite, granite, and alkali quartz syenite with minor amounts of quartz syenite to syenite. Massive, nonfoliated; equigranular to seriate; medium to very coarse-grained; color index 01 to 13; weathers from a distinctive pale orange to white; generally homogeneous at outcrop scale.

Tmge: Granite: Hornblende biotite granite, alkali granite, quartz syenite, and alkali quartz syenite: Massive, nonfoliated; equigranular to seriate; medium to coarse-grained; color index 01 to 07; weathers from a distinctive pale orange to white; often rusty weathering; generally quite homogenous at outcrop scale.

Tmme: Migmatitic granitic rock: Hornblende biotite pyroxene quartz monzodiorite, quartz monzonite, granodiorite, quartz diorite, and diorite as well as granite, alkali granite, and quartz syenite. Massive, extremely heterogeneous, and generally nonfoliated; equigranular to seriate to porphyritic; generally fine to medium-grained; color index 03 to 50.

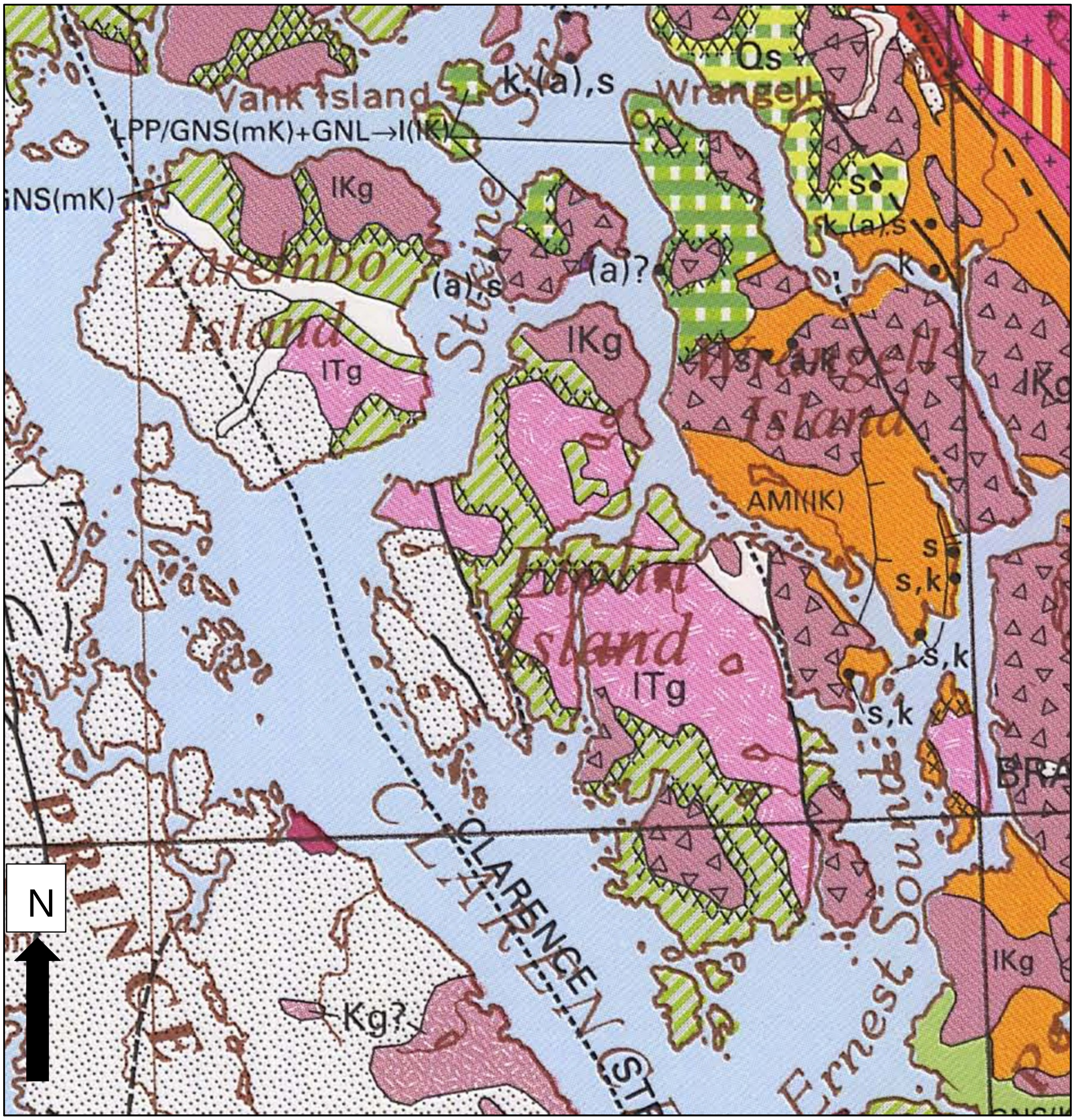
Ktgp: Biotite tonalite quartz diorite, and granodiorite: Porphyritic and foliated: medium to coarse-grained; color index 11 to 35; cut by pegmatite and basalt dikes; local cataclastic texture; inclusions of country rock; foliation parallels that of the country rock; petrographic features include zoned, complexly twinned plagioclase, quartz, interstitial K-feldspar, partly chloritized biotite, epidote, minor local hornblende; and garnet, sphene, apatite and allanite as accessories.

KJsv: Brothers Volcanics/Douglas Island Volcanics: Augite bearing flows, volcanic breccias and intercalated tuff, volcanic graywacke, phyllite and slate. Andesitic to probably basaltic composition; weathers dark greenish-gray, gray, and green; generally lighter colored where fresh; relict augite phenocrysts conspicuous in most outcrops.

KJss: Seymour Canal Formation: Graywacke, slate, and minor conglomerate. Composed largely of volcanic debris, except for the conglomerates, which are polymictic and contain granitic clasts; most are turbidites, but nothing more is known of the depositional environment: weathers dark greenish-gray, brownish gray, and very dark gray; graywacke and slate/argillite are locally calcareous and lighter colored; sedimentary structures common, although few directional features have been noted.

These units are outlined on the Location Map on Page 2A of this report. Hornfelses were mapped by Dusel-Bacon et al. as occurring along the edges of the intrusives as shown on the map on Page 1C. There were no Nordic Abrasion test results available for this island.

ETOLIN ISLAND METAMORPHIC FACIES MAP
(From Dusel-Bacon et al., 1996)



Map showing the interpreted hornfels zones on Etolin Island. The pink/purple units are igneous intrusives, the green units are metamorphic rocks generally derived from sedimentary and volcanic units and the cross-hatched areas along the intrusives are the interpreted hornfels zones. These zones are subject to differing interpretations by different authors. The dotted areas are unmetamorphosed rocks.

Conclusions: There appears to be rock capable of producing hard aggregate on Etolin Island, however additional investigations will be necessary to delineate where and how much material is available.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

References:

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84-405, 43 p., 2 sheets, scale 1:250,000.

Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of southeastern Alaska; distribution, facies, and ages of regionally metamorphosed rocks: U.S. Geological Survey Professional Paper 1497-D, p. 1-42, 2 sheets, scale 1:1,000,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Karl, S.M, Haeussler, P.J., and McCafferty, A., 1999, Reconnaissance geologic map of the Duncan Canal-Zarembo Island area, southeastern Alaska: U.S. Geological Survey Open-File Report 99-168, 30 p., 1 sheet, scale 1:150,000.

LOCATION MAP (HA-I1)

U.S.G.S. QUADRANGLE: PETERSBURG (A-2), (A-3), (B-2) & (B-3)

POTENTIAL HARD AGGREGATE SOURCE ETOLIN ISLAND

Ktef/Kqop-Intrusives
Mzs/Msv-Schist, Phyllite & Greenstone
KJsv-Volcanics
Hornfels zone

0 0.75 1.5 3 4.5

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
NORTHERN ETOLIN ISLAND

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	2A
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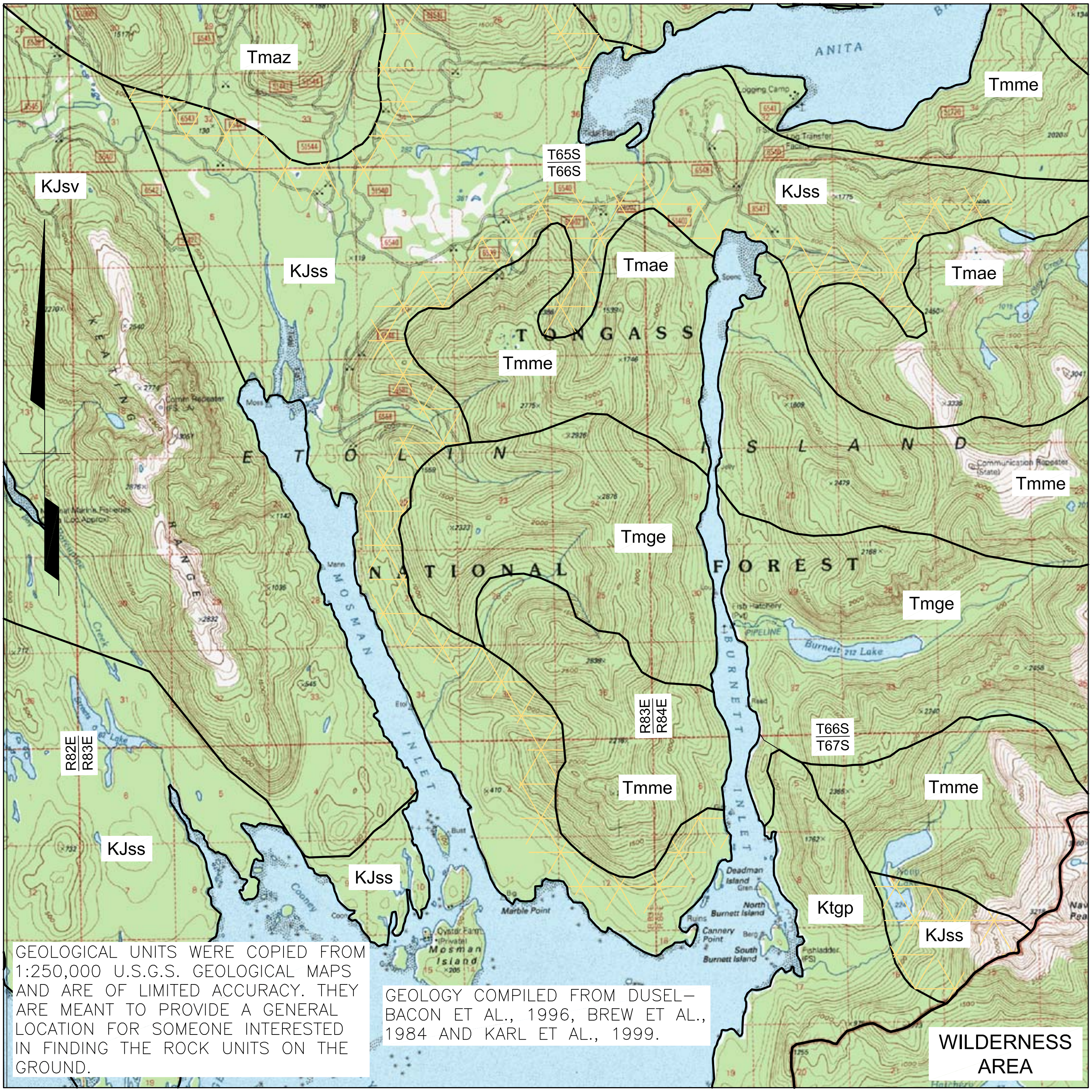
Plotted 3/28/2013 3:29 PM by Pete Hardcastle

LOCATION MAP (HA-12)



U.S.G.S. QUADRANGLE: PETERSBURG (A-2), (A-3), (B-2) & (B-3)

POTENTIAL HARD AGGREGATE SOURCE ETOLIN ISLAND

Ktgp/Tmme/Tmge/Tmae/Tmaz - Granitic Rocks
KJss-Sedimentary Rocks
KJsv-Volcanics
Hornfels zone

0 0.75 1.5 3 4.5

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
CENTRAL ETOLIN ISLAND

SCALE	DESIGNED	DRAWN	PAGE
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BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE
SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

KRUZOF ISLAND
HORNFELS

March 8, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: This site is located in the middle of Kruzof Island to west of Sitka. Mount Edgecumbe, an active volcano, lies on the south end of the island. Bedrock on the south end of the island consists of Quaternary volcanic rocks and on the north end there are sedimentary rocks of the Sitka Graywacke formation and metamorphic rocks of the Khaz Formation. A Tertiary igneous pluton intruded the central portion of the island where extensive hornfelses are mapped along its northern boundary (Loney et al., 1975). The central part of the island appears to be located in the Tongass National Forest and is managed by the U.S. Forest Service, Sitka Ranger District.

KRUZOF ISLAND POTENTIAL HARD AGGREGATE SOURCE

Site ID	Source Name	Latitude	Longitude
HA-J1	Kruzof Island	57.200676	-135.713812

Access: Based on the USGS geologic maps and Forest Service road maps, Forest Service roads reach up from the south to the north edge of the intrusive (See Location Map 2B). There is also an existing road in the valley to the north. Forest Service roads may not be useable as haul roads. Access to the island is by sea approximately 12 miles from Sitka. There do not appear to be any port facilities; barges would be required to land on the beach.

Geology: Bedrock on Kruzof Island has been described as follows (Loney et al., 1975):

> Tegd: A pluton composed of Tertiary biotite granodiorite, muscovite-bearing biotite adamellite, and muscovite-bearing biotite albite granite cut by albite dikes and biotite-bearing alaskite.
>
> Tet: Tertiary Hornblende-biotite tonalite.
>
> Qe: Edgecumbe Volcanics consist of gently dipping flows, composite cones and air-fall ash and lapilli from the eruptions of Mount Edgecumbe.
>
> KJsh: A Hornfels Zone.
>
> KJs: The Sitka Graywackes are poorly sorted fine to coarse-grained sandstones. The poor sorting results from the amount of silt and clay size matrix material present. Most of the matrix has been neocrystallized to quartz, muscovite, albite, chlorite, epidote, sphene, calcite, tourmaline and prehnite. There are interbedded shale or argillite beds. The Sitka Graywacke is tightly and complexly folded.
>
> JTRk: The Khaz Formation is a chaotic formation composed largely of greenstone, greenschist, graywacke, and phyllite with minor limestone. The deposit was intensely deformed. Typical cataclasites consist of streaked greenschist and phyllite in which lenses of more resistant rock swim in a highly foliated mylonitic matrix. The matrix consists of epidote, chlorite, muscovite, sphene, calcite, and angular grains of quartz and plagioclase.
>
> Qu: Undifferentiated Surficial deposits.

Contact metamorphism is mapped as prevalent where sedimentary rocks predominate. The sedimentary rocks are classified as clastic sedimentary, volcanic, and carbonaceous rocks, undivided of Cretaceous to Permian age. The fine-grained contact metamorphic rocks as well as fine-grained margins of the plutonic rocks may show promise for a source of hard aggregate.

Conclusions: There are no test results or other direct observations to verify the presence of rock capable of producing hard aggregate at Kruzof Island. However, the conditions exist for hard aggregate rock (hornfels) to occur across the middle of the island. Access to these potential hornfelses along Forest Service roads and then access to locations on the coast where materials can be loaded on barges may be available. It is unknown how much hornfels rock is available. These sources appear to warrant further consideration.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

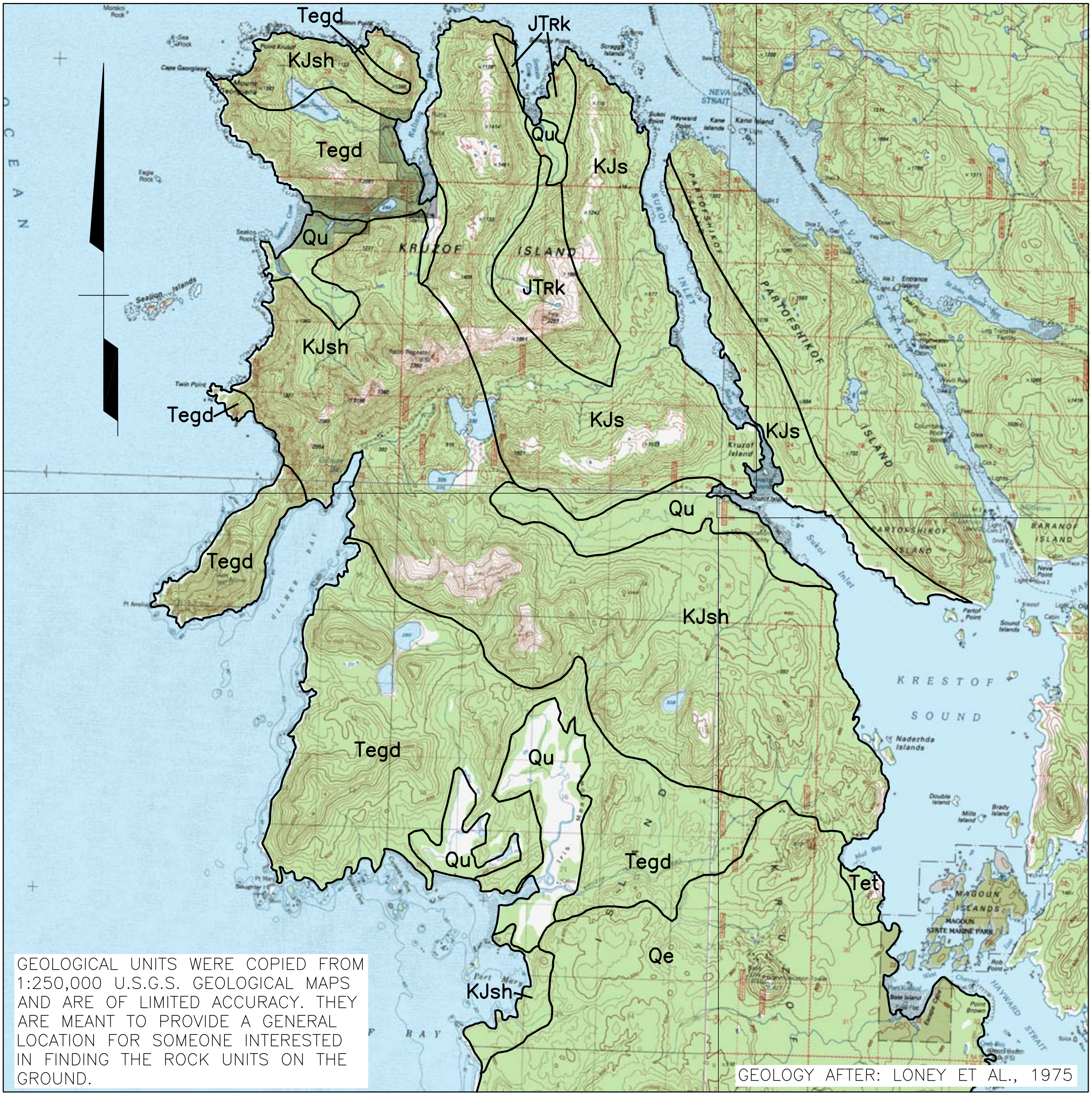
The rock within the contact zones or aureoles varies considerably in composition and strength, especially as you move away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

<u>References:</u>

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Loney, R.A., Brew, D.A., Muffler, L.J.P., and Pomeroy, J.S., 1975, Reconnaissance geology of Chichagof, Baranof, and Kruzof islands, southeastern Alaska: U.S. Geological Survey Professional Paper 792, 105 p., 4 sheets, scale 1:250,000.

LOCATION MAP (HA-J1)



U.S.G.S. QUADRANGLE: SITKA (A-5), (A-6), (B-5) & (B-6)

KJsh-Hornfels Zone
Tegd/Tet/Qe-Igneous Rock
KJs-Sitka Graywacke
JTRk-Khaz Formation
Qu-Suficial Deposits

POTENTIAL HARD AGGREGATE SOURCE KRUZOF ISLAND

0 1 2 4 6

GRAPHIC SCALE IN MILES

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
KRUZOF ISLAND

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	2A
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BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

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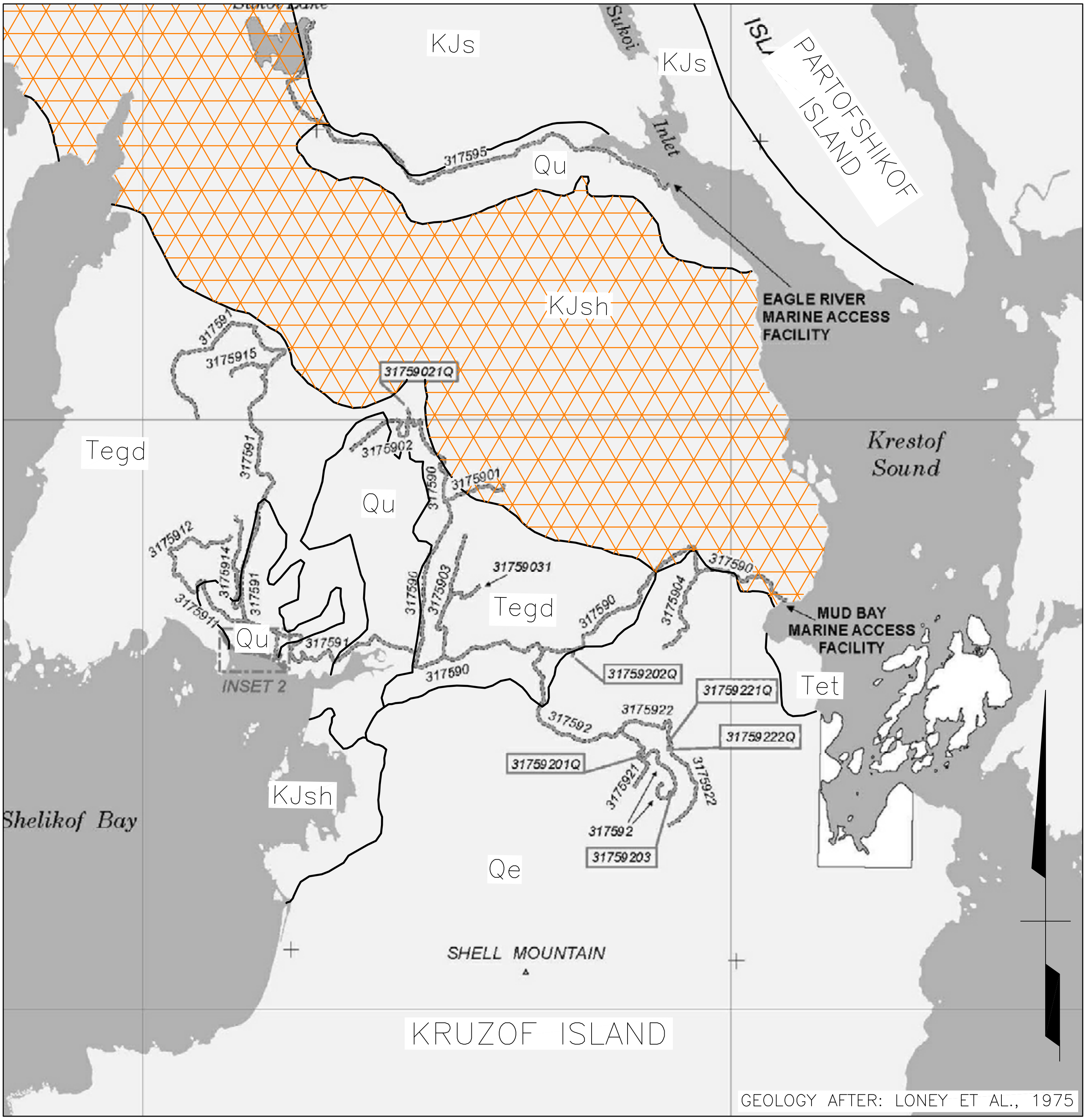
LOCATION MAP (HA-J1)



ROAD LAYOUT FROM U.S.FOREST SERVICE MAP, JANUARY,2013

POTENTIAL HARD AGGREGATE SOURCE KRUZOF ISLAND

0 0.75 1.5 3 4.5

GRAPHIC SCALE IN MILES

KJsh-Hornfels
Tegd/Tet/Qe-Igneous
KJs-Sitka Graywacke
Qu-Suficial Deposits

BASE MAP FROM MOTOR VEHICLE USE MAP
TONGASS NATIONAL FOREST SITKA RANGER DISTRICT

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
KRUZOF ISLAND

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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

REVILLAGIGEDO ISLAND KETCHIKAN

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS

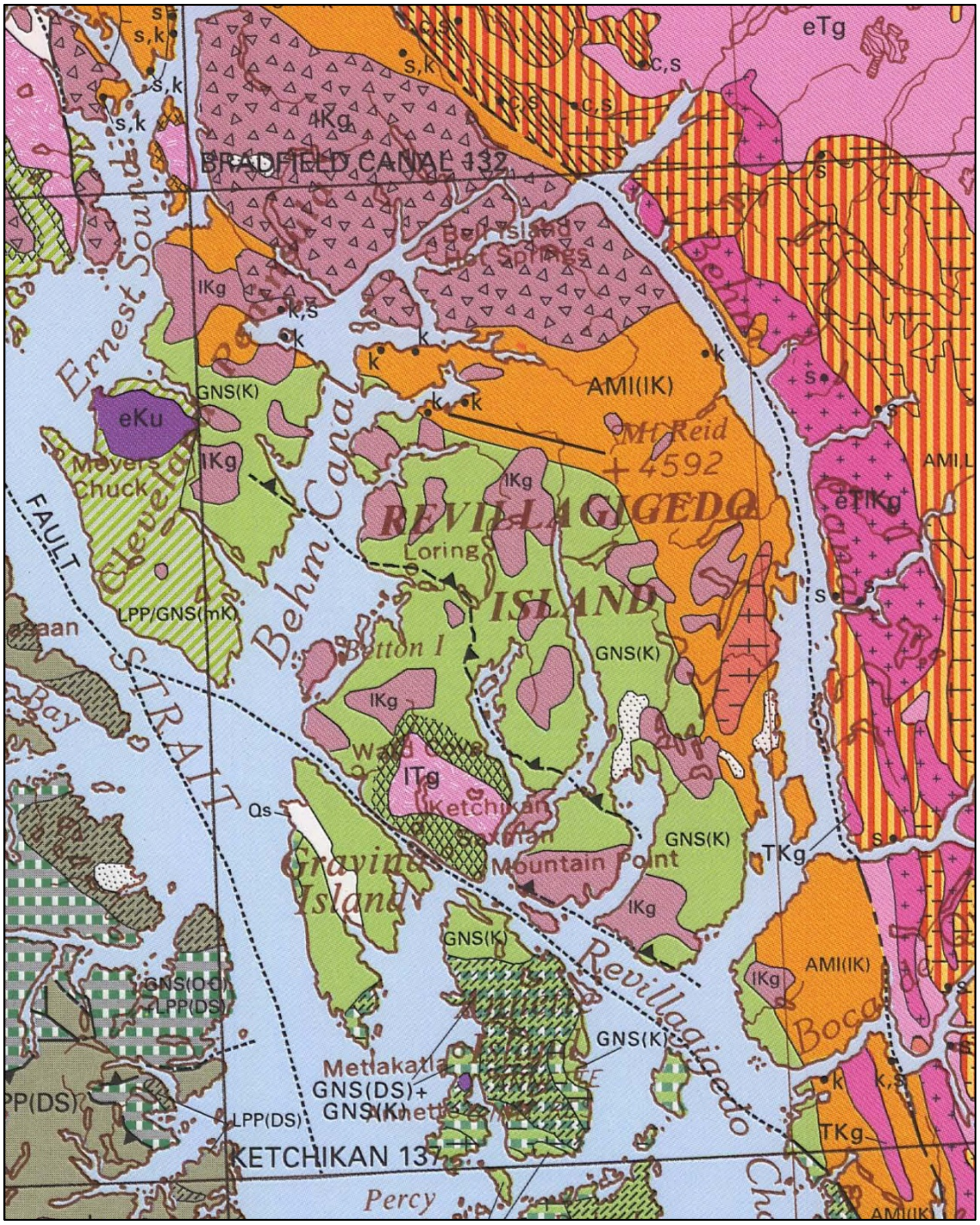
General Site Description: The site is located on southern Revillagigedo Island near Milepost 9 of the South Tongass Highway, northeast of Herring Bay. A new aquarium is being constructed nearby. A gabbro pluton has been intruded into the metamorphosed sedimentary and volcanic rocks at this location. The altered rock consists of a spotted hornfels adjacent to the gabbro pluton surrounded by spotted schists. Generally, the alteration decreases with distance from the edge of the gabbro pluton. The site north of Herring Bay appears to be on State Land.

REVILLAGIGEDO ISLAND POTENTIAL HARD AGGREGATE SOURCE

Site ID	Source Name	Latitude	Longitude
HA-K1	Ketchikan	55.333238	-131.507959

Access: Directly from the South Tongass Highway or from the beach. The water depth increases quickly in front of the beach.

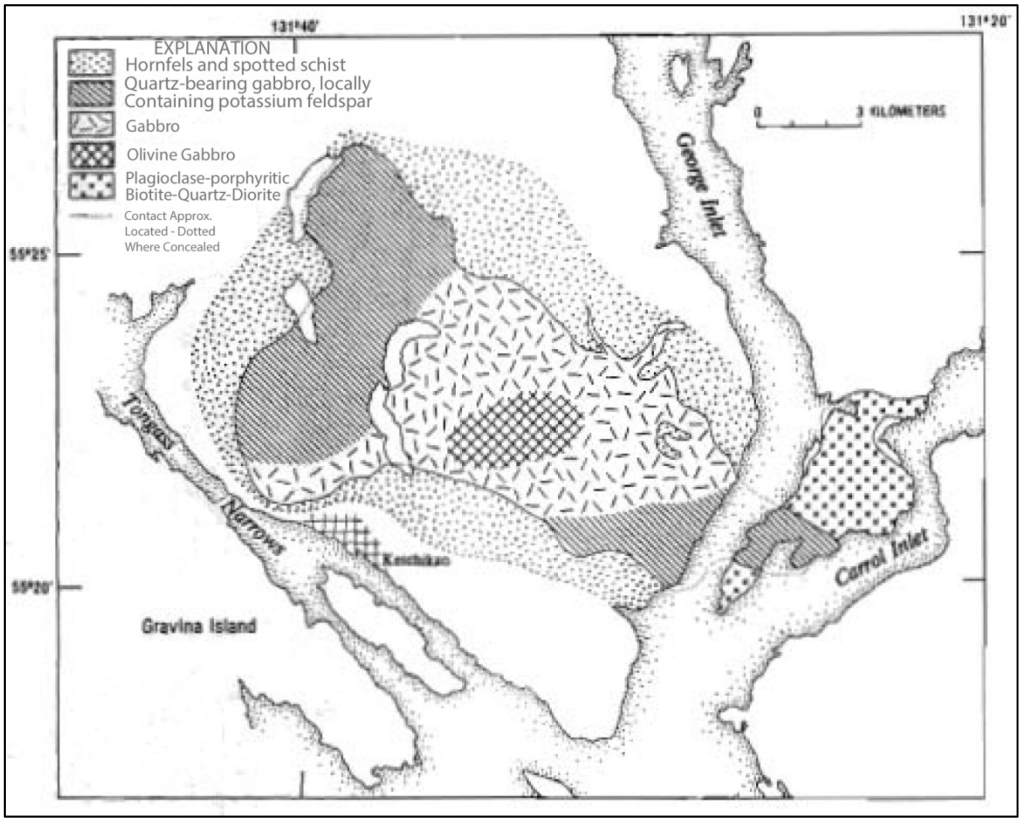
REVILLAGIGEDO ISLAND AREA METAMORPHIC FACIES MAP
(From Dusel-Bacon et al., 1996)



Map showing the interpreted hornfels zones on Revillagigedo Island. The pink/purple units are igneous intrusives, the green/gray-green and orange units are metamorphic rocks generally derived from sedimentary and volcanic units, and the cross hatched area along the intrusives are the interpreted hornfels zones. These zones are subject to differing interpretations by different authors.

KETCHIKAN GABBRO PLUTON MAP

(Modified from Koch & Elliott, 1984)



<u>Geology:</u> Bedrock at the Ketchikan Hornfels site has been described as follows (Berg et al., 1988):

<u>Tgb (ITg):</u> A gabbro complex that forms an elongate pluton. An olivine-bearing two-pyroxene gabbro that makes up the core of the complex: biotite-hornblende two-pyroxene gabbro surrounds the core; and a discontinuous zone of quartz-bearing gabbro underlies two areas at the ends of the complex. The gabbro intrudes the metasedimentary and metavolcanic rocks and quartz diorite intrusive rocks. Thermal metamorphism has produced a zone of spotted hornfels and spotted schist apparently as wide as 3 kilometers in the adjoining country rocks. Generally, the spotted schist still maintains its schistosity, while the hornfels is fine-grained and massive.

<u>MzPzms:</u> Metasedimentary rock: Rocks derived from pelitic and semipelitic flysch interbedded with relatively minor amounts of andesitic or basaltic volcanic or volcaniclastic rocks. The prevailing lithology is dark-gray and silvery-gray phyllite and fine-grained semischist; there are subordinate layers of green phyllite and semischist.

<u>MzPzmv:</u> Metavolcanic rocks: Rocks derived primarily from submarine andesitic or basaltic lava flows, tuff, and agglomerate and from subordinate gradationally intertonguing pelitic and semipelitic flysch. In this area the unit consists chiefly of dark-green, silvery-green, greenish-gray phyllite, semischist, and schist, minor marble, with some gray phyllite and semischist.

Units are outlined on the Location Map on Page 2 of this report. Hornfelses are noted by Berg et al. as occurring along the edges of the intrusive. A wider zone was shown by Dusel-Bacon et al. on the Revillagigedo Island Area Metamorphic Facies Map shown on Page 1B. There were no Nordic Abrasion test results available for this source. Limited testing of the spotted hornfels gave unconfined compressive strengths of approximately 30,000 psi and for the spotted schists of approximately 21,000 psi. The gabbro is fine to medium-grained (Koch and Elliott, 1984). The distribution of various rock types are shown on the Ketchikan Gabbro Pluton Map on Page 1C. Along the South Tongass Highway near Milepost 9 the hornfelses were observed to be approximately 600 feet wide. Diorite boulders were noted in the area.

Conclusions: Very strong hornfels rock that has the potential for producing hard aggregate is available in this area. The gabbro may also be durable enough to make hard aggregates. The quantities of available rock are unknown; therefore further investigations will be required.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

References:

Berg, H.C., Elliott, R.L., and Koch, R.D., 1988, Geologic map of the Ketchikan and Prince Rupert quadrangles, southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1807, 27 p., 1 sheet, scale 1:250,000.

Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of southeastern Alaska; distribution, facies, and ages of regionally metamorphosed rocks: U.S. Geological Survey Professional Paper 1497-D, p. 1-42, 2 sheets, scale 1:1,000,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

Koch, R.D., and Elliott, R.L., 1984, Late Oligocene gabbro near Ketchikan, southeastern Alaska, in Coonrad, W.L., and Elliot, R.L., eds., The U.S. Geological Survey in Alaska: Accomplishments during 1981: U.S. Geological Survey Circular 868, p. 126-128.

LOCATION MAP (HA-K1)

U.S.G.S. QUADRANGLE: KETCHIKAN (B-5)

Tgb-Gabbro Pluton
MzPzms-Sedimentary Rocks
MzPzmv-Volcanic Rocks
Hornfels zone

POTENTIAL HARD AGGREGATE SOURCE REVILLAGIGEDO ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
KETCHIKAN

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	J.D.N.	2
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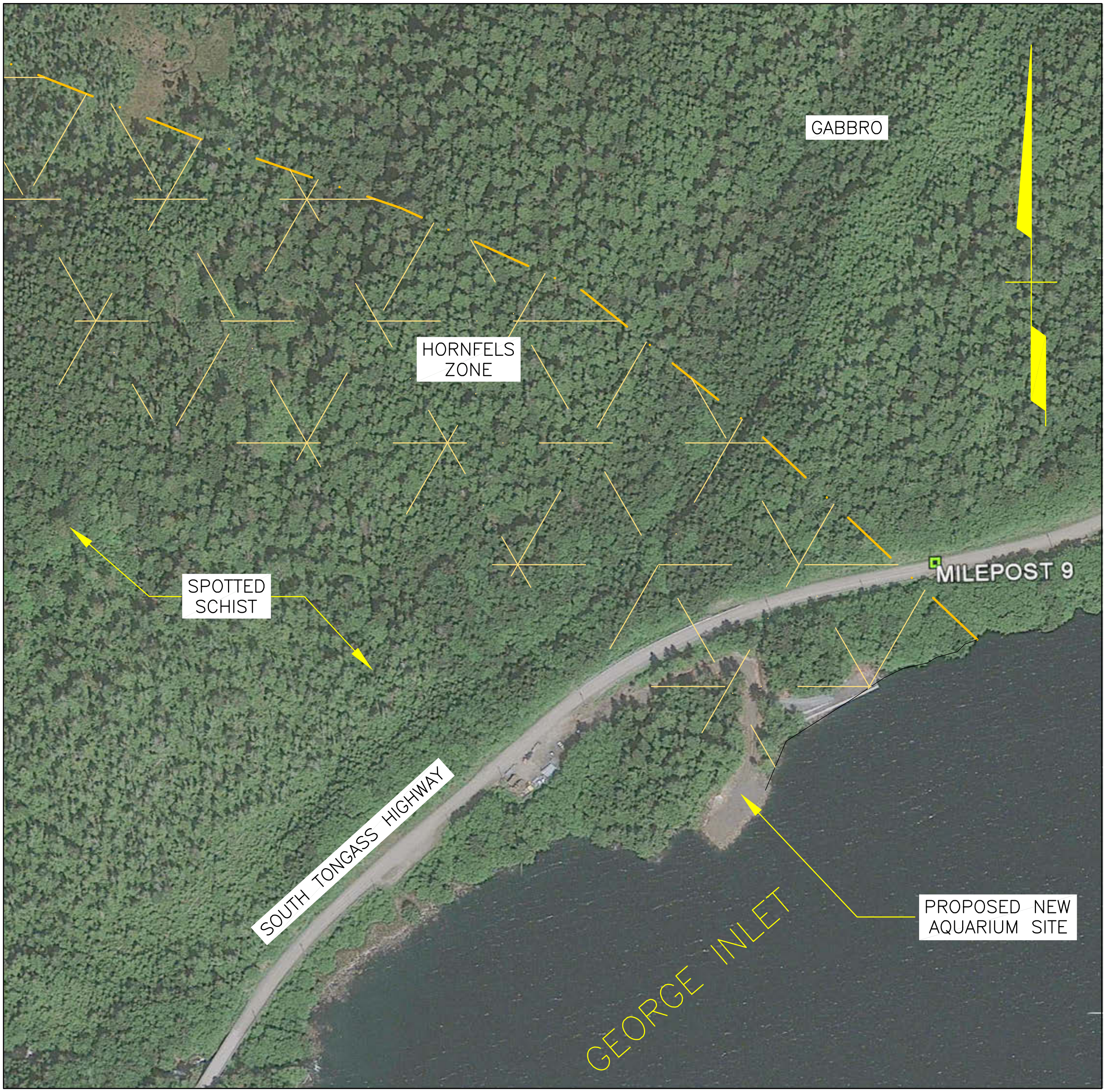
SITE MAP (HA-K1)



BASE MAP IS MAY 26, 2010 GEOEYE SATELLITE IMAGERY.
THIS IS A PLANNING DOCUMENT ONLY.

POTENTIAL HARD AGGREGATE SOURCE REVILLAGIGEDO ISLAND

0 300 600 1200 1800

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 7/18/2010

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
KETCHIKAN

SCALE	DESIGNED	DRAWN	PAGE
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STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

PRINCE OF WALES ISLAND COFFMAN COVE

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: The potential hard aggregate source is located in an area surrounding Coffman Cove on Prince of Wales Island in Southeast Alaska. There are several Nordic Abrasion test values from this area (5.6, 9, 12.3, and 13.7), although it is not known from which quarries the samples were taken or from which rock types. Sample results for two of the sample results (5.6 and 13.7) are attached to this report. The other two (9 and 12.3) from a location referred to as Coffman Cove Rock-Ex were included in the GIS database provided by DOT&PF (Pavey et al., 2012). Much of the area has been developed and subdivided and may now be in private hands. There are numerous small quarries noted on the maps. Due to the subdivision roads that have been built, there may be more small quarries in Coffman Cove than elsewhere in the forested areas.

PRINCE OF WALES POTENTIAL HARD AGGREGATE SOURCES

Site ID	Source Name	Nordic Values	Latitude	Longitude
HA-L1	Coffman Cove	5.6, 13.7	56.010422	-132.818347
62	Coffman Cove Rock Ex	9, 12.3	55.976533	-132.807419

Access: Most of the area is connected by road to Coffman Cove.

Geology: The area has been mapped on two different quadrangles (Petersburg and Craig) at two different times and means by the same author, and the mapping, while generally similar, does not match precisely. This appears to have been due to the more detailed 1:63,360 scale of mapping in the Petersburg Quadrangle and the compilation mapping at 1:250,000 in the Craig Quadrangle.

Bedrock in the area is mapped as a Silurian Graywacke (SOtgd), part of the Descon Formation (Brew, 1997); a grayish green, buff weathering, volcaniclastic graywacke and siliceous shale. It consists of massive amalgamated beds, graded beds, thin rhythmic beds, slump deposits, sedimentary breccia and conglomerate, suggesting a proximal depositional environment. Sandstones and conglomerates include mainly mafic volcanic rock fragments, with feldspar, quartz, graywacke, mudstone, chert, limestone, and plutonic rock fragments in a chloritic matrix. Graptolites are found on partings in siliceous argillite. Some greenschist facies sandstones are pyritic.

In the area immediately underlying and surrounding Coffman Cove, bedrock is mapped (Brew, 1997) as a biotite-feldspar-quartz hornfels (Kdh): fine to coarse-grained, brown and gray; with original textures and structures obliterated; includes minor calc-silicate hornfels layers. The Kdh unit is mapped only in the Petersburg Quadrangle but may also be found in the Craig Quadrangle.

There is a hornblende quartz monzodiorite (Brew, 1997) with minor tonalite, granodiorite, quartz diorite, diorite, quartz monzonite, and monzodiorite (Kwqo) in the northern Coffman Cove area: massive to foliated, equigranular to locally porphyritic; medium-grained; color index 2 to 48, averaging about 15; pyroxene commonly altering to hornblende and biotite to chlorite; accessories are apatite and sphene. This unit is mapped within the hornfels unit in the Petersburg Quadrangle. Thermal alteration caused by the intrusion may have created the hornfels (Kdh). A second monzodiorite intrusive was mapped (Brew, 1996) in the Craig Quadrangle. Hornfels were not mapped surrounding it, although it is likely that some thermal alteration occurred. It is possible other intrusives and associated hornfels occur south of Coffman Cove.

Problems with pyritic rock were encountered in construction of a two lane road (FS 3030300) near Sweetwater Lake. Pyrite in the rock used for fill created an acidic solution that dissolved metals from the rock, which contaminated ground and surface waters. Approximately 100,000 cubic yards of road embankment was removed and replace with limestone to neutralize the acid. It is not known which quarry or quarries the pyritic rock was mined from.

Conclusions: It is likely the hornfelses are the source of most of the lower Nordic Abrasion test values in the north Coffman Cove area. Based on what we have found elsewhere, lower Nordic values may be encountered along the boundary between the Kdh and Kwqo units. However, these boundaries primarily appear to lie in tidal zones or in developed areas. Alteration can be found a significant distance away from an igneous intrusive, therefore hornfelses may be found outside the area shown on the attached location map.

It is unknown how much hornfels rock is available, how consistent the character of the rock is, and which quarries are still available to mine. Due to the inability to tie sample data to known quarries and rock types, the existing Nordic Abrasion test data is of limited value. If hard aggregate is desired from Coffman Cove it may be worth the effort to map the numerous existing quarries and road cuts, noting the rock types and strength, obtaining samples and performing petrographic analysis and Nordic tests on the most promising rock. Testing for the potential for acid rock drainage should be conducted for all quarries in which mineralization is apparent.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

References:

Brew, D.A., (compiled by), 1996, Geologic map of the Craig, Dixon Entrance, and parts of the Ketchikan and Prince Rupert quadrangles, southeastern Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF 2319, 53 p. 1:250,000.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg A-2 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-A, 20 p., 1 sheet, scale 1:63,360.

Brew, D.A., 1997, Reconnaissance geologic map of the Petersburg A-3 quadrangle, southeastern Alaska: U.S. Geological Survey Open-File Report 97-156-B, 24 p., 1 sheet, scale 1:63,360.

Condon, W.H., 1961, Geology of the Craig quadrangle, Alaska: U.S. Geological Survey Bulletin 1108-B, B-1 – B-43, 1 sheet, scale 1:250,000.

Eberlein, G.D., Churkin, Jr. C.C., Berg, H.C. and Ovenshine, A.T., 1983 Geology of the Craig quadrangle, Alaska: U.S. Geological Survey Open-File Report 83-91, 52 p. 1 sheet, scale 1:250,000.

Karl, S.M, Haeussler, P.J., and McCafferty, A., 1999, Reconnaissance geologic map of the Duncan Canal-Zarembo Island area, southeastern Alaska: US. Geological Survey Open-File Report 99-168, 30 p. 1 sheet, scale 1:150,000.

Pavey, Finkbiner, Bingham, 2012, Web interface: http://10.200.100.100/hard/aggregatestudy/ (Note this web interface is available only to DOT&PF personnel).

25-229
R-1/2007
S.E. REGION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

LAB REPORT (U.S. STAND.)

PRECONSTRUCTION ☐ CONSTRUCTION ☐
ACCEPTANCE ☐ QUALITY ☐
ASSURANCE ☐ INFORMATION ☒

TEST OF ASPHALT CONCRETE, TYPE II; CLASS B (QUARRY ROCK FOR) ITEM NO. 401(1) LAB NO. 09C-653

PROJECT NO.	HPRM-0003(124)	PROJECT NAME	POW COFFMAN COAVE ROADS PAVING		
SAMPLED FROM	SOURCE	EXAMINED FOR	LA ABRAS., DEGRADATION, SPG & ABSORPTION, NORDIC ABRAS.		
DEPTH		FIELD NO.		DATE SAMPLED	CONTRACTOR
SOURCE	QUARRY @ MINKE LOOP	SUBMITTED BY	CONTRACTOR	DATE RECEIVED	12/22/09
LOCATION	COFFMAN COVE, ALASKA	REPRESENTS	SOURCE	DATE REPORTED	01/04/10

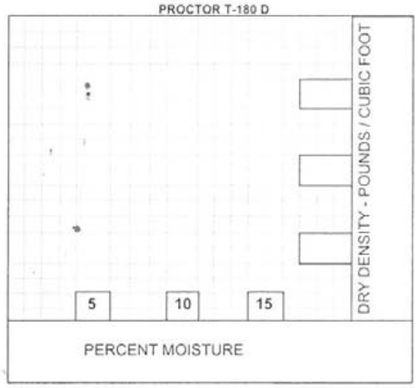
AS RECEIVED

% PASSING SIEVE	INFORMATION	ACCEPTANCE	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#10			
#16			
#20			
#30			
#40			
#50			
#80			
#100			
#200			
0.02 MM			
.005 MM			

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D



PROPERTIES	
LIQUID LIMIT	
PLASTIC INDEX	
DELETERIOUS	
FRACTURE %	
THIN ELONGATED %	
FINENESS MODULUS	
ORGANIC CONTENT %	
AASHTO CLASS	

QUALITY	COARSE	FINE
DEGRADATION VALUE	79	
L.A. ABRASION % B	10	
NORDIC ABRASION %	5.6	
BULK SPG	2.913	
BULK SSD SPG	2.930	
APPARENT SPG	2.965	
ABSORPTION %	0.6	

REMARKS:
NOT FOR SOURCE
ACCEPTANCE FOR
PROJECT

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeffrey A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: Bruce E. Brunette
REGIONAL MATERIALS ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

25-229
vR-1/2007
S.E. REGION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

LAB REPORT (U.S. STAND.)

PRECONSTRUCTION		CONSTRUCTION	X
ACCEPTANCE		QUALITY	X
ASSURANCE		INFORMATION	

TEST OF **ASPHALT CONCRETE, TYPE II, CLASS B (QUARRY ROCK FOR)** ITEM NO. **401(1)** LAB NO. **11C-240**

PROJECT NO.	HPRM-0003(124)	PROJECT NAME	POW COFFMAN COVE ROADS PAVING		
SAMPLED FROM	SOURCE	EXAMINED FOR	LA ABRAS, NORDIC ABRAS, DEG, SPG, ABSP, LIMITS, FRACT, F/E		
DEPTH		FIELD NO.		DATE SAMPLED	06/13/11
SOURCE	CHAMBERLAIN QUARRY	SUBMITTED BY	E. STICKLE	DATE RECEIVED	06/15/11
LOCATION	COFFMAN COVE, ALASKA	REPRESENTS	SOURCE	DATE REPORTED	06/30/11

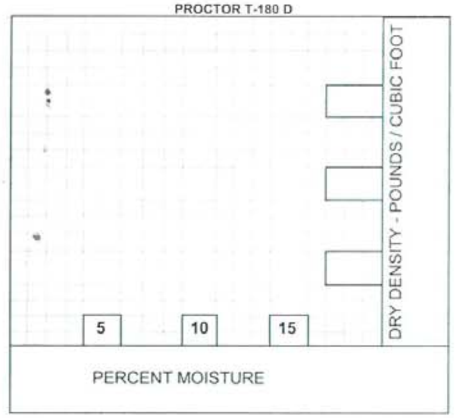
AS RECEIVED

% PASSING SIEVE	QUALITY	QUALITY	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#10			
#16			
#20			
#30			
#40			
#50			
#80			
#100			
#200			
0.02 MM			
.005 MM			

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D



PROPERTIES			
LIQUID LIMIT		NV	
PLASTIC INDEX		NP	4 MAX
DELETERIOUS	FREE	FREE	FREE
FRACTURE %	100		80 MIN 1 FACE
THIN ELONGATED %	0		8 MAX
FINENESS MODULUS			
ORGANIC CONTENT %			
AASHTO CLASS			

QUALITY	COARSE	FINE	
DEGRADATION VALUE	62		30 MIN
L.A. ABRASION % B	14		45 MAX
NORDIC ABRASION %	13.7		
BULK SPG	2.880		
BULK SSD SPG	2.895		
APPARENT SPG	2.922		
ABSORPTION %	0.5		

REMARKS: SENT TO ANCHORAGE FOR FURTHER TESTING

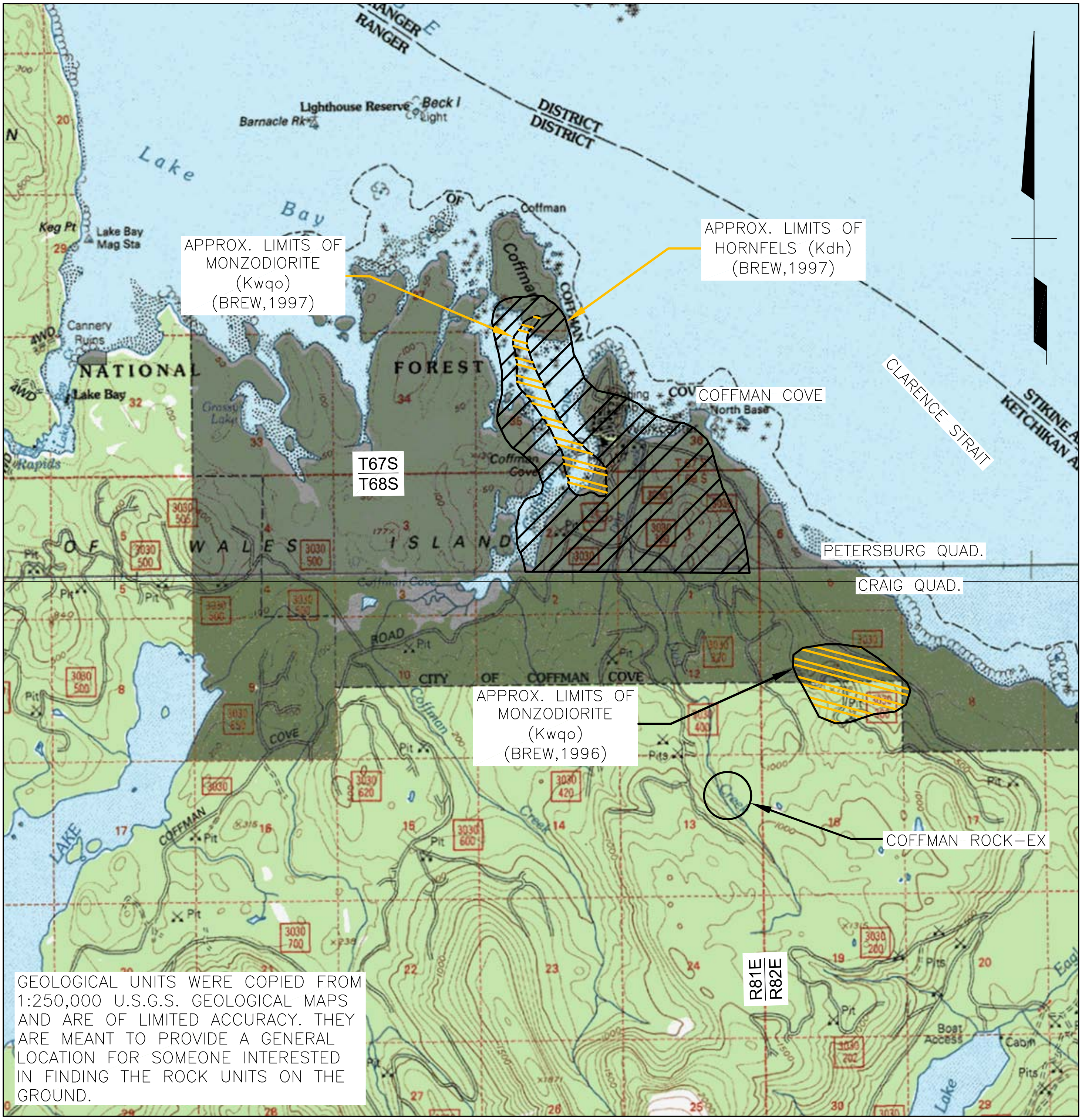
INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: Jeffrey A. Hart
MATERIALS LAB COORDINATOR

SIGNATURE: Bruce Brunette
REGIONAL MATERIALS ENGINEER

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

LOCATION MAP (HA-L1)



U.S.G.S. QUADRANGLE: PETERSBURG (A-3) & CRAIG (D-3)

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
COFFMAN COVE

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	2
	CHECKED C.H.R.	DATE FEB 2013	

Plotted 3/28/2013 11:40 AM by Pete Hardcastle

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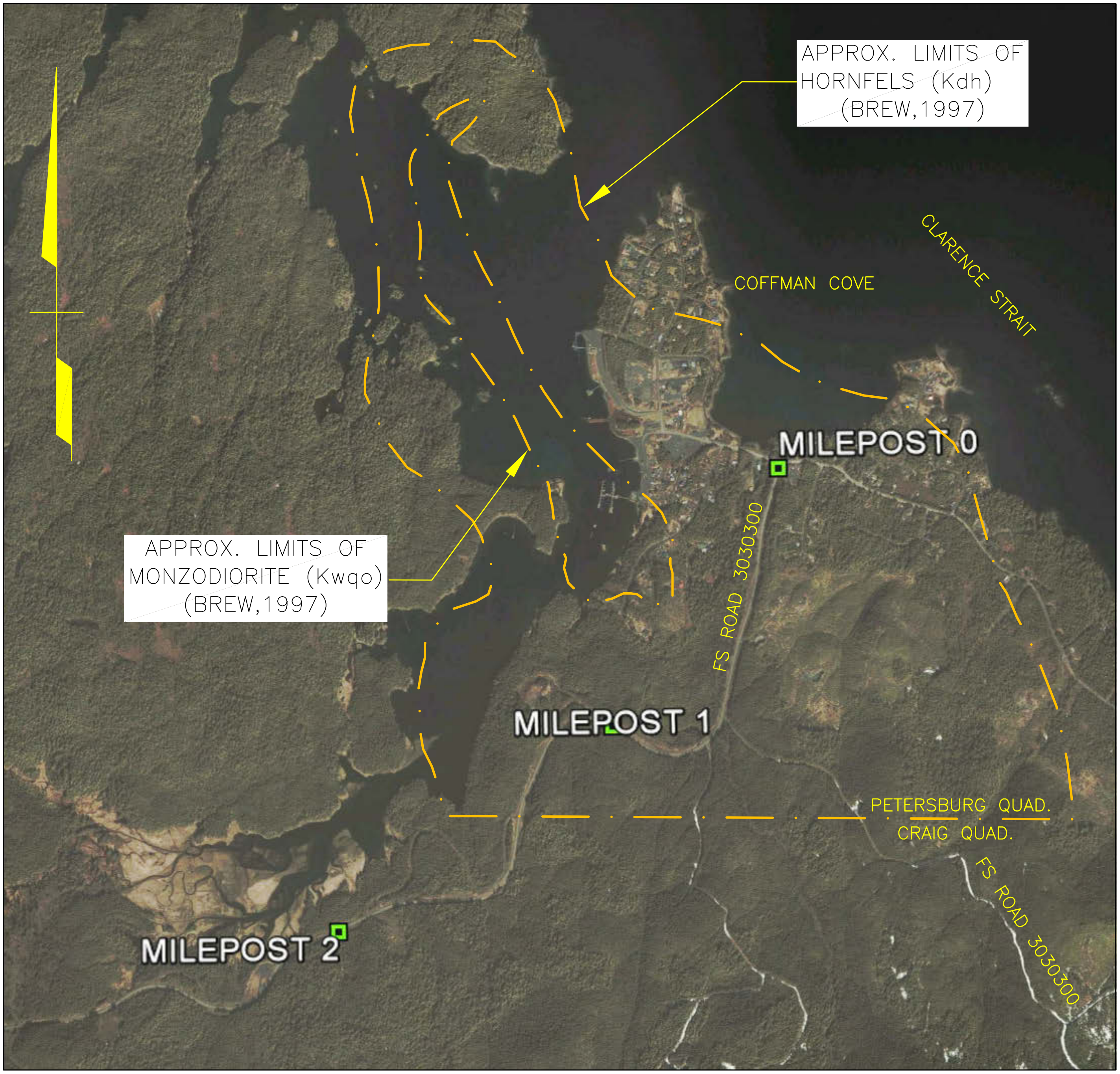
SITE MAP (HA-L1)



BASE MAP IS APRIL 15, 2012 DIGITALGLOBE SATELLITE IMAGERY.
THIS IS A PLANNING DOCUMENT ONLY.

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 1,000 2,000 4,000 6,000

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 3/1/2013

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

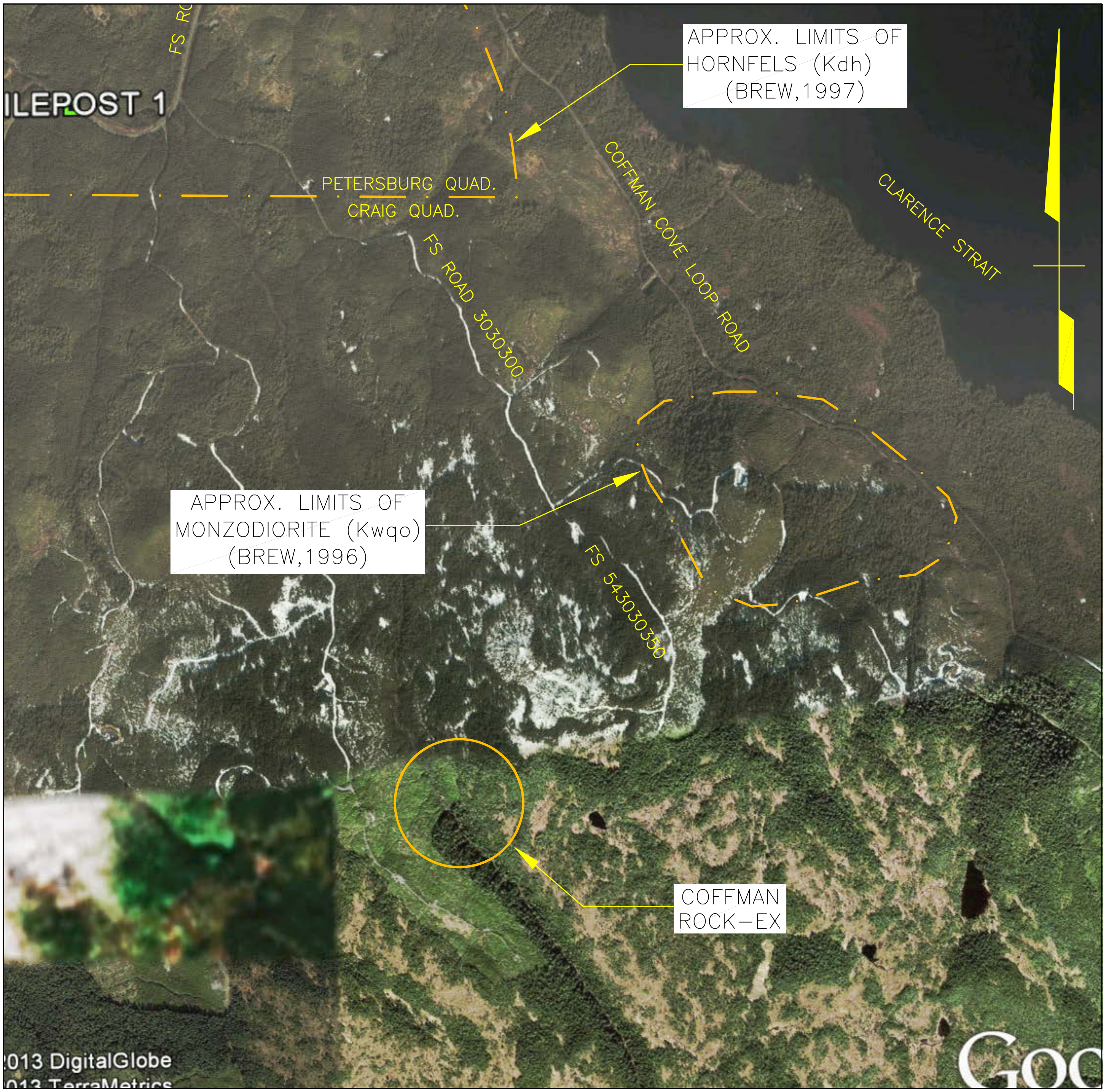
STATEWIDE MATERIAL SITE
INVENTORY

COFFMAN COVE

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	3A
	CHECKED C.H.R.	DATE MAR 2013	

Plotted 3/28/2013 11:43 AM by Pete Hardcastle Z:\project\1443.07 DOT_SWM Cantwell Agreegate Feasibility Study\Earth\Hard Aggregate Location Study\Prince Of Wales Island\Coffman Cove\Acad\MS_Site_Map_Coffman_Cove.dwg

SITE MAP (HA-L1)



BASE MAP IS APRIL 15, 2012 DIGITALGLOBE SATELLITE IMAGERY.
THIS IS A PLANNING DOCUMENT ONLY.

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 1,000 2,000 4,000 6,000

GRAPHIC SCALE IN FEET

BASE MAP FROM GOOGLE EARTH PRO 3/1/2013

Prepared By:
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STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY

COFFMAN COVE

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	3B
	CHECKED C.H.R.	DATE FEB 2013	

STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE
SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

PRINCE OF WALES ISLAND
RED BAY MOUNTAIN AND TOKEEN PEAK

February 24, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: Potential hard aggregate sources on the north end of Prince of Wales Island are located south of Sumner Strait, east of El Capitan Passage and north of Tokeen Bay. The potential sources include three monzodiorite intrusives and related aureoles in a sedimentary country rock (see Page 1C). Potential hard aggregate source(s) are hornfelses associated with the intrusives. Locations of these hornfelses are mapped as being along the boundary of the three intrusives as shown on the following maps. The three sources are within the Tongass National Forest and except for small blocks of land along El Capitan Passage (see dark blocks of land on Location Map 2B) are managed by the U.S. Forest Service. Portions of the southern intrusive appear to lie within Mt. Calder/Mt. Holbrook LUD II Lands.

PRINCE OF WALES ISLAND POTENTIAL HARD AGGREGATE SOURCES

Site ID	Source Name	Latitude	Longitude
HA-M1	Red Bay Mountain	56.217549	-133.382180
HA-M2	Tokeen Peak	56.117709	-133.406904

Access: Access to and from the potential sources would appear to be on logging roads to the area from El Capitan Passage, Red Bay and Tokeen Bay.

Geology: Three small plutons have intruded the sandstones between Tokeen Bay and Sumner Strait on the north end of Prince of Wales Island. Hornfels and marble were mapped as occurring along the edge of and between the three intrusive bodies. The units shown on Page 1D were described (Brew et al., 1984) as follows and shown in more detail on Location Maps 2A through 2C.

> Kwqo: Hornblende quartz monzodiorite with minor tonalite, granodiorite, quartz diorite, quartz monzonite, and monzonite: Massive to foliated; equigranular to locally porphyritic; medium-grained; color index 2 to 48, average (approx.) 15; locally hornblende porphyritic; local rounded fine-grained mafic inclusions; includes common aplite, less common pegmatite, and several mafic dikes. Lacks garnet and epidote.

Metamorphic Rocks in the Chilkat-Prince of Wales Plutonic Province: Aureoles around plutons of the Chilkat Prince of Wales plutonic province on Kosciusko and northern Prince of Wales Islands; are divided into:

> Khh: Marble: Medium to coarse-grained, white fresh, light gray weathering; original bedding and structures largely obliterated. Metamorphosed from the Heceta Limestone (Sch).

> Kch: Biotite-Quartz-Feldspar-Hornfels: Metapolymictic conglomerate with 1 to 35 cm diameter rounded clasts of syenite (?), granodiorite, feldspar porphyry, chert, intermediate volcanic rock, and mudstone in 1 to 10 meter thick beds. Metamorphosed from the Polymictic Conglomerate Unit of the Bay of Pillars Formation (Stbg).

> Kbh/Koh: Biotite-Quartz-Feldspar-Hornfels: Fine to medium-grained, brownish-gray; original sedimentary structures and bedding of graywacke and mudstones turbidite sequence locally preserved; includes minor metaconglomerate like that described in Kch Unit. Metamorphosed from the Graywacke and Mudstone Turbidite Unit in the Bay of Pillars Formation (Stbg).

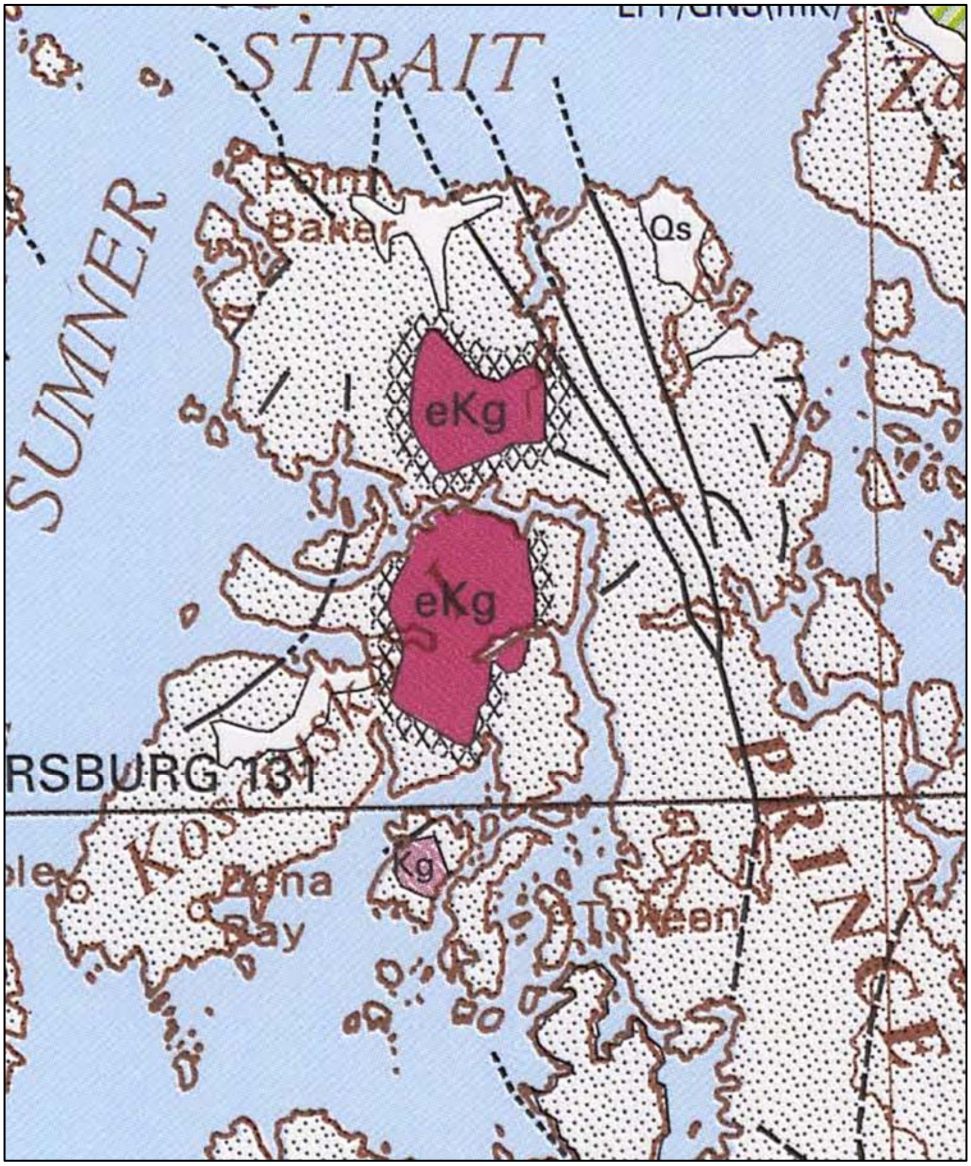
Conclusions: There are no test results or other direct observations to verify the presence of rock capable of producing hard aggregate. However, the conditions exist for these types of rock (hornfels) to occur. Access to roads and locations on the coast where materials can be loaded on barges also appear to be available. It is unknown how much hornfels rock is available, and where it is available. These sources appear to warrant consideration.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as you move away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

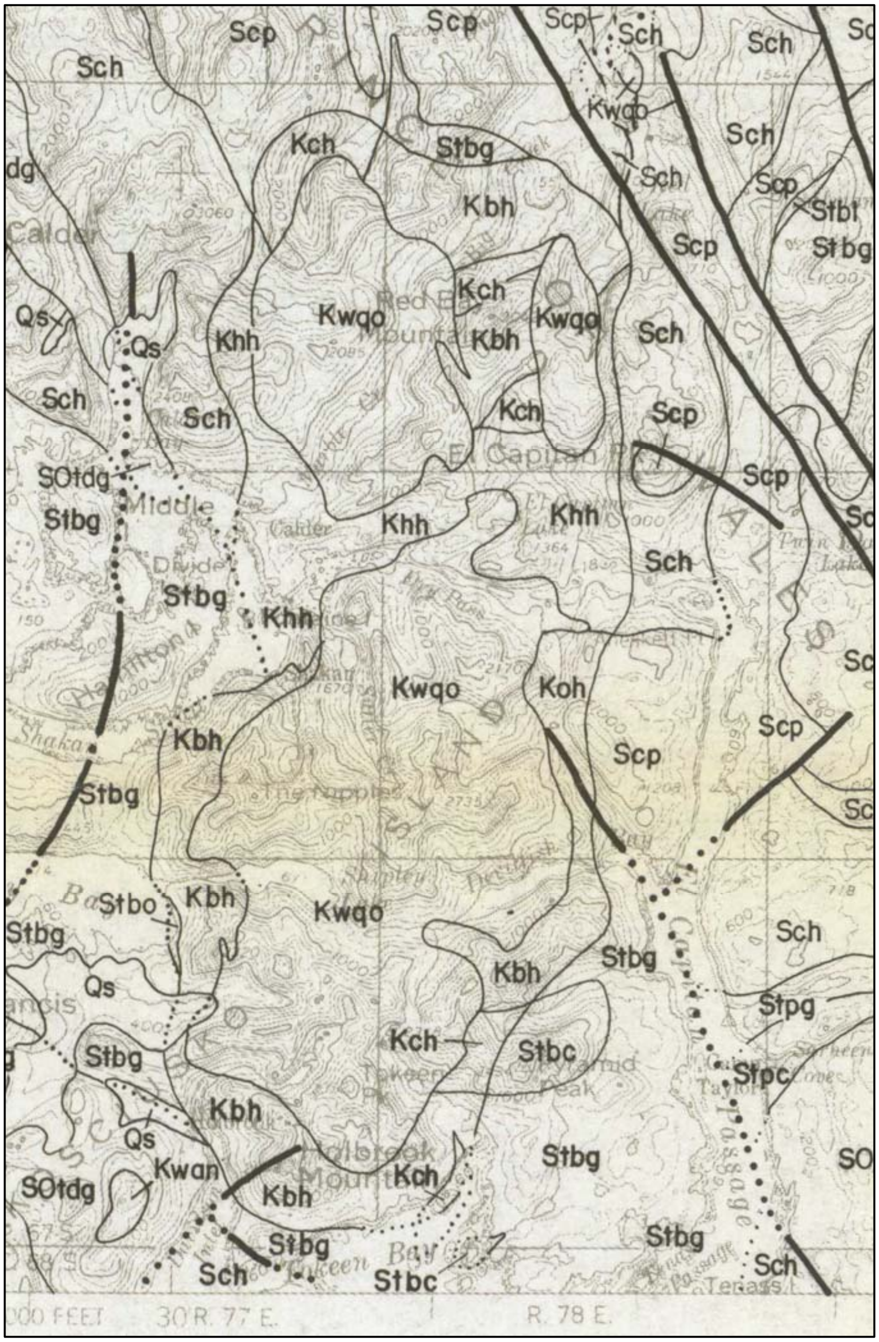
NORTH PRINCE OF WALES ISLAND METAMORPHIC FACIES MAP

(From Dusel-Bacon et al., 1996)



Map showing the interpreted hornfels zones on North Prince of Wales Island. The pink units are igneous intrusives and the cross-hatch along the edge of the intrusives are the interpreted hornfels zones. These zones are subject to differing interpretations by different authors. The dotted areas without cross-hatching are unmetamorphosed rocks.

GEOLOGIC MAP OF NORTH PRINCE OF WALES ISLAND
(From Brew et al., 1984)



Kwqo - Monzodiorite Kbh/Kch/Koh – Hornfels Khh - Marble
Kwan – Andesite Stbg – Bay of Pillars Formation Sch- Hecta Limestone
Scp – Polymictic Conglomerate Stbg/Stbo/Stbl – Turbidites
SOtdg – Descon Formation Qs – Surficial Deposits

References:

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84-405, 43 p., 2 sheets, scale 1:250,000.

Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of southeastern Alaska; distribution, facies, and ages of regionally metamorphosed rocks: U.S. Geological Survey Professional Paper 1497-D, p. 1-42, 2 sheets, scale 1:1,000,000.

Gehrels, G.E. and Berg, H.C., 1992, Geologic map of southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map 1867, 24 p., 1 sheet, scale 1:600,000.

LOCATION MAP (HA-M1)

U.S.G.S. QUADRANGLE: PETERSBURG (A-4), (A-5), (B-4) & (B-5)

Kwqo-Monzodiorite
Khh-Marble
Kbh/Kch-Hornfels

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

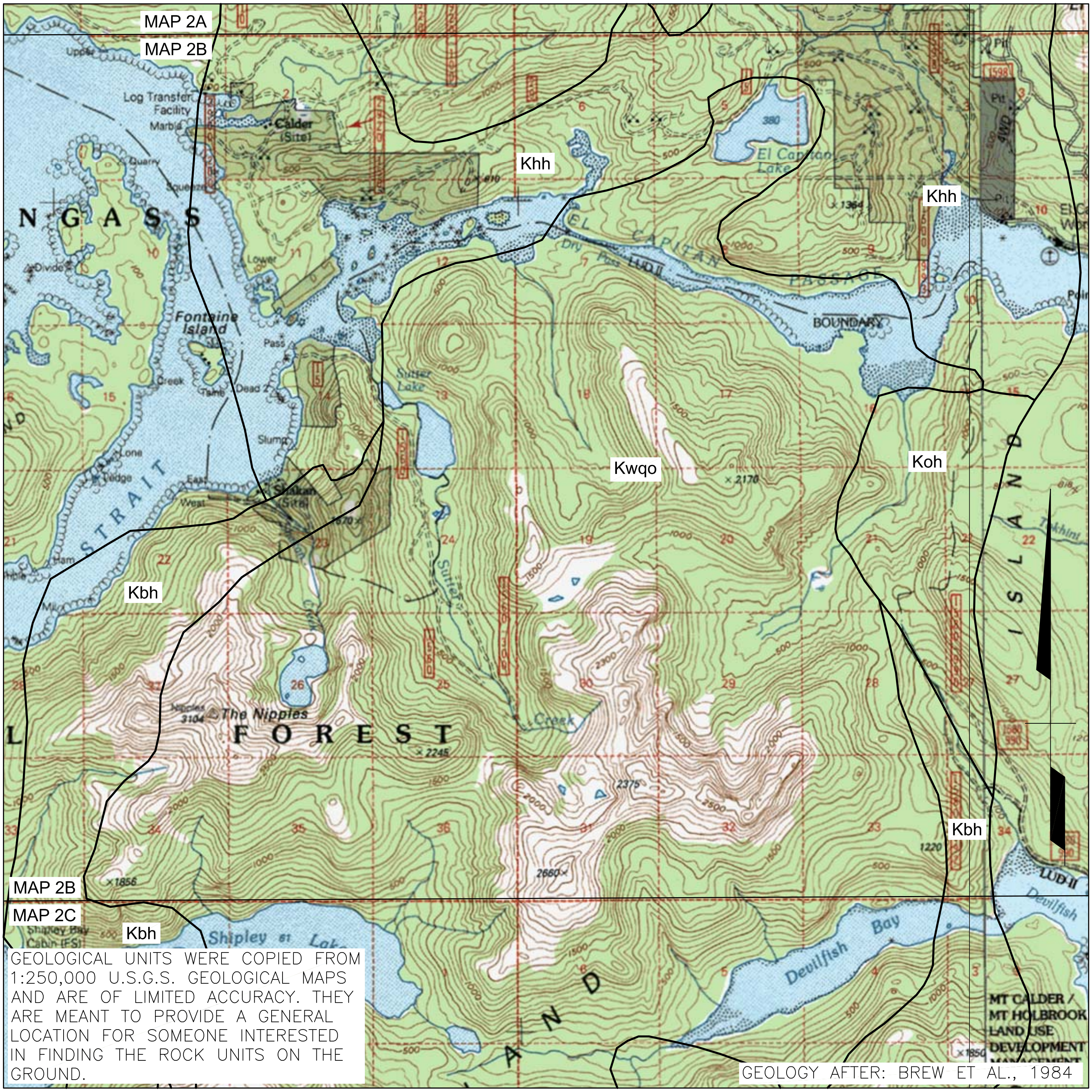
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
RED BAY MOUNTAIN

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	J.D.N.	2A
	CHECKED C.H.R.	DATE FEB 2013	

Plotted 3/28/2013 12:15 PM by Pete Hardcastle Z:\project\1443.07 DOT_SWM Cantwell Agreegate Feasibility Study\Earth\Hard Aggregate Location Study\Prince Of Wales Island\North Prince Of Wales\Acad\MS_Topo_Map_North_Prince_of_Wales.DWG

LOCATION MAP (HA–M2)



U.S.G.S. QUADRANGLE: PETERSBURG (A–4) & (A–5)

Kwqo-Monzodiorite
Khh-Marble
Kbh/Koh-Hornfels

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

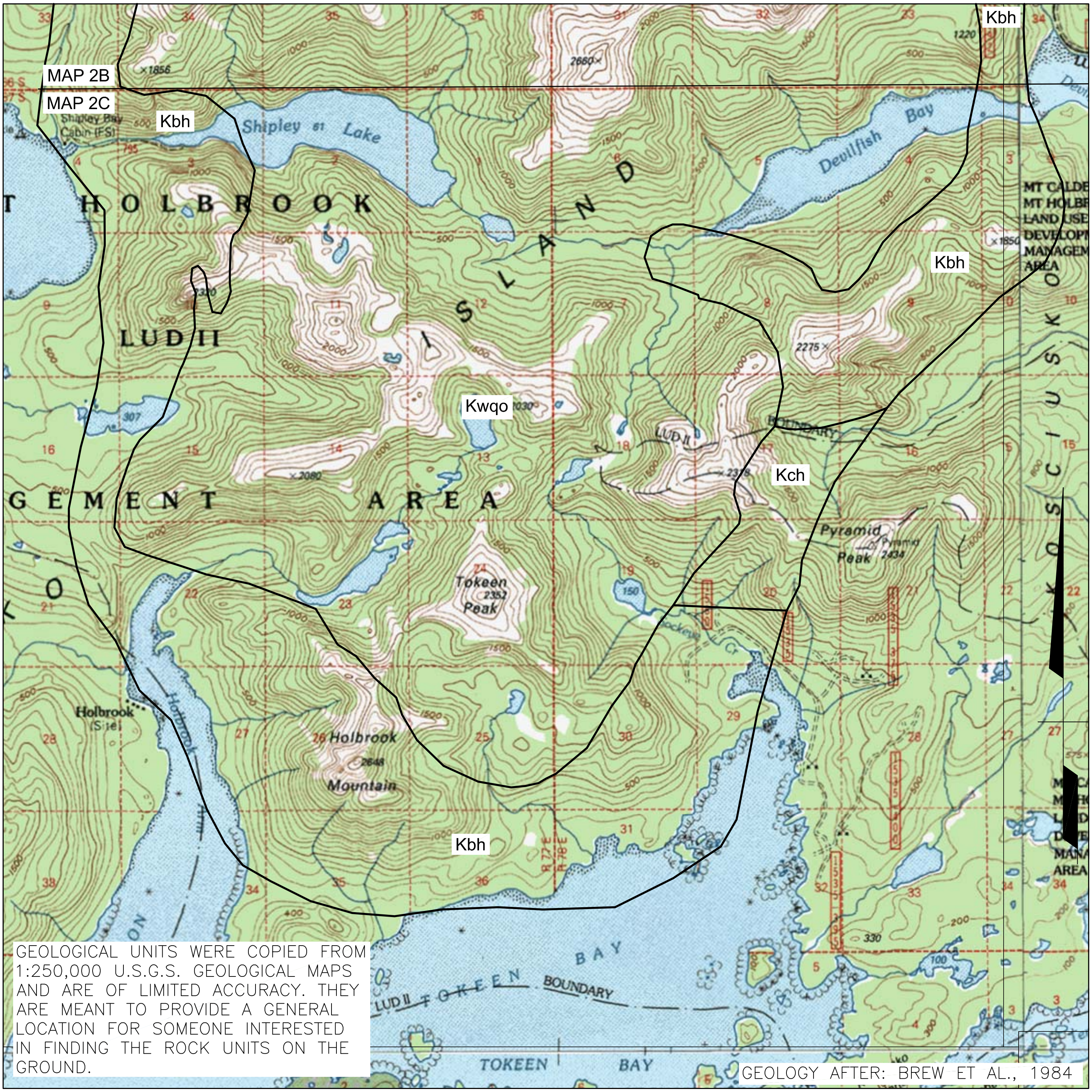
Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
TOKEEN PEAK

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	J.D.N.	2B
	CHECKED C.H.R.	DATE FEB 2013	

LOCATION MAP (HA–M2)



U.S.G.S. QUADRANGLE: PETERSBURG (A–4) & (A–5) AND CRAIG (D–4) & (D–5)

Kwqo–Monzodiorite
Khh–Marble
Kbh/Kch–Hornfels

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY
TOKEEN PEAK

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H. / CHECKED C.H.R.	J.D.N. / DATE FEB 2013	2C

Plotted 3/28/2013 12:16 PM by Pete Hardcastle Z:\project\1443.07 DOT_SWM Cantwell Aggregate Feasibility Study\Earth\Hard Aggregate Location Study\Prince Of Wales Island\North Prince Of Wales\Acad\MS_Topo_Map_North_Prince_of_Wales.DWG

STATEWIDE MATERIAL SITE INVENTORY

POTENTIAL HARD AGGREGATE SOURCE REPORT

Federal Project No. STP-000S(823)
AKSAS Project No. 76149

PRINCE OF WALES ISLAND KLAWOCK RIVER QUARRY

February 23, 2013

CONTENTS PAGE

SITE CONDITIONS

General Site Description: This potential hard aggregate source appears to consist of two existing quarries located on a low ridge south of the Klawock River and along the Craig to Klawock Highway. The rock is mapped as being an igneous leucosyenite intruded into sedimentary limestones, sandstones and siltstones (Brew, 1996). A Nordic Abrasion test value of 8.4 percent was obtained from a sample in this area in 2008 (see the sample result attached to this report). It is not known from which quarry the sample was obtained.

The quarries appear to lie on lands owned by the Klawock Heenya Corporation (PAT 50-2007-0080).

PRINCE OF WALES ISLAND POTENTIAL HARD AGGREGATE SOURCE

Site ID	Source Name	Nordic Values	Latitude	Longitude
HA-N1	Klawock River Quarry	8.4	55.545702	-133.096303

Access: The area is connected by road to Klawock and Craig.

<u>Geology:</u> Bedrock is reportedly a leucosyenite intrusive found at Klawock and on Sukkwan Island (Early Permian and Late Pennsylvanian): A biotite and hornblende bearing syenite (PIPsy) with color index 15 was described near Klawock. There was no mention of a hornfels at the Klawock site (Brew, 1996).

There is a sphene-apatite-amphibole/augite-bearing biotite leucosyenite mapped on Sukkwan Island which was described as surrounded by extensive hornfels aureole (Brew, 1996). This second potentially larger hornfels deposit on Sukkwan Island was removed from this study when it was found that Sukkwan Island was in a roadless area within the Tongass National Forest.

<u>Conclusions:</u> It is not known from exactly which quarry the Nordic test result (8.4) included in this report came. It is assumed that the hornfelses that are mentioned at Sukkwan Island also occur at Klawock. These hornfels may have given the low Nordic Abrasion test value at Klawock. It is unknown how much hornfels rock is available, and in which locations it is available. The southern extent of the leucosyenite is also unknown, but there are several small quarries to the south of the Klawock Quarry that could be used to trace the extent of the intrusive.

Grain size of the syenite at Klawock is not known. It is possible that the syenite rock was responsible for the low Nordic Abrasion test value. If this is so, the deposit would be much more useful and easier to mine.

Contact metamorphic rocks are commonly associated with mineralization that can cause acid rock drainage when disturbed. Testing for acid rock drainage should be performed when using these sources, even though the mineralized zones in the contact aureoles are generally not durable enough to provide rock for hard aggregate.

The rock within the contact zones or aureoles varies considerably in composition and strength, especially as one moves you move away from the intrusive. Generally, the most durable rock that has the greatest potential for producing hard aggregate is found closest to the intrusive body.

<u>References:</u>

Brew, D.A., (compiled by), 1996, Geologic map of the Craig, Dixon Entrance, and parts of the Ketchikan and Prince Rupert quadrangles, southeastern Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF 2319, 53 p. 1:250,000.

Condon, W.H., 1961, Geology of the Craig quadrangle, Alaska: U.S. Geological Survey Bulletin 1108-B, B-1 – B-43, 1 sheet, scale 1:250,000.

Eberlein, G.D., Churkin, Jr. C.C., Berg, 1983, H.C. and Ovenshine, A.T., 1983 Geology of the Craig quadrangle, Alaska: U.S. Geological Survey Open-File Report 83-91, 52 p. 1 sheet, scale 1:250,000.

25-229
R-1/2007
S.E. REGION

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
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LAB REPORT (U.S. STAND.)

PRECONSTRUCTION	☐	CONSTRUCTION	☑
ACCEPTANCE	☐	QUALITY	☒
ASSURANCE	☐	INFORMATION	☐

TEST OF **HOT MIX ASPHALT TYPE II, CLASS C (QUARRY ROCK FOR)** ITEM NO. **P-401** LAB NO. **08C-22**

PROJECT NO.	**DTFAWA-06-A-00013**	PROJECT NAME	**KLW AIRPORT PROFILE IMPROVEMENTS AND OVERLAY**		
SAMPLED FROM	**SOURCE**	EXAMINED FOR	**DEG, LA, NORDIC, SPG, ABSORPTION**		
DEPTH		FIELD NO.		DATE SAMPLED	**03/07/08**
SOURCE	**KLAWOCK RIVER QUARRY**	SUBMITTED BY	**S. MIELKE**	DATE RECEIVED	**03/10/08**
LOCATION	**KLAWOCK, ALASKA**	REPRESENTS	**SOURCE**	DATE REPORTED	**03/20/08**

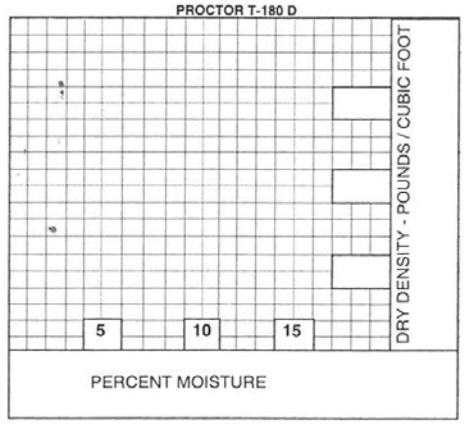
AS RECEIVED

% PASSING SIEVE	QUALITY	ACCEPTANCE	SPECS
4"			
3"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#10			
#16			
#20			
#30			
#40			
#50			
#80			
#100			
#200			
0.02 MM			
.005 MM			

MOISTURE / DENSITY RELATIONS

	ASSURANCE	ACCEPTANCE	SPECS
DEPTH OF PROBE			
LAB STD NO			
STANDARD TYPE			
OPT. MOISTURE %			
DENSITY STD			
CORRECTED STD			
FIELD DENSITY			
FIELD MOISTURE %			
PLUS 3/4" / #4 %			
BULK SPG +3/4" / #4			
COMPACTION %			

PROCTOR T-180 D



PROPERTIES	
LIQUID LIMIT	
PLASTIC INDEX	
DELETERIOUS	
FRACTURE %	
THIN ELONGATED %	
FINENESS MODULUS	
ORGANIC CONTENT %	
AASHTO CLASS	

QUALITY	COARSE	FINE
DEGRADATION VALUE	62	
L.A. ABRASION % B	14	
NORDIC ABRASION %	8.4	
BULK SPG	2.676	
BULK SSD SPG	2.701	
APPARENT SPG	2.745	
ABSORPTION %	0.9	

REMARKS: **SENT TO ANCHORAGE FOR SODIUM SULFATE SOUNDNESS**

INDEPENDENT ASSURANCE / ACCEPTANCE
TEST RESULT COMPARISON
ACCEPTABLE UNACCEPTABLE

CHECKED BY: [signature]
MATERIALS LAB COORDINATOR

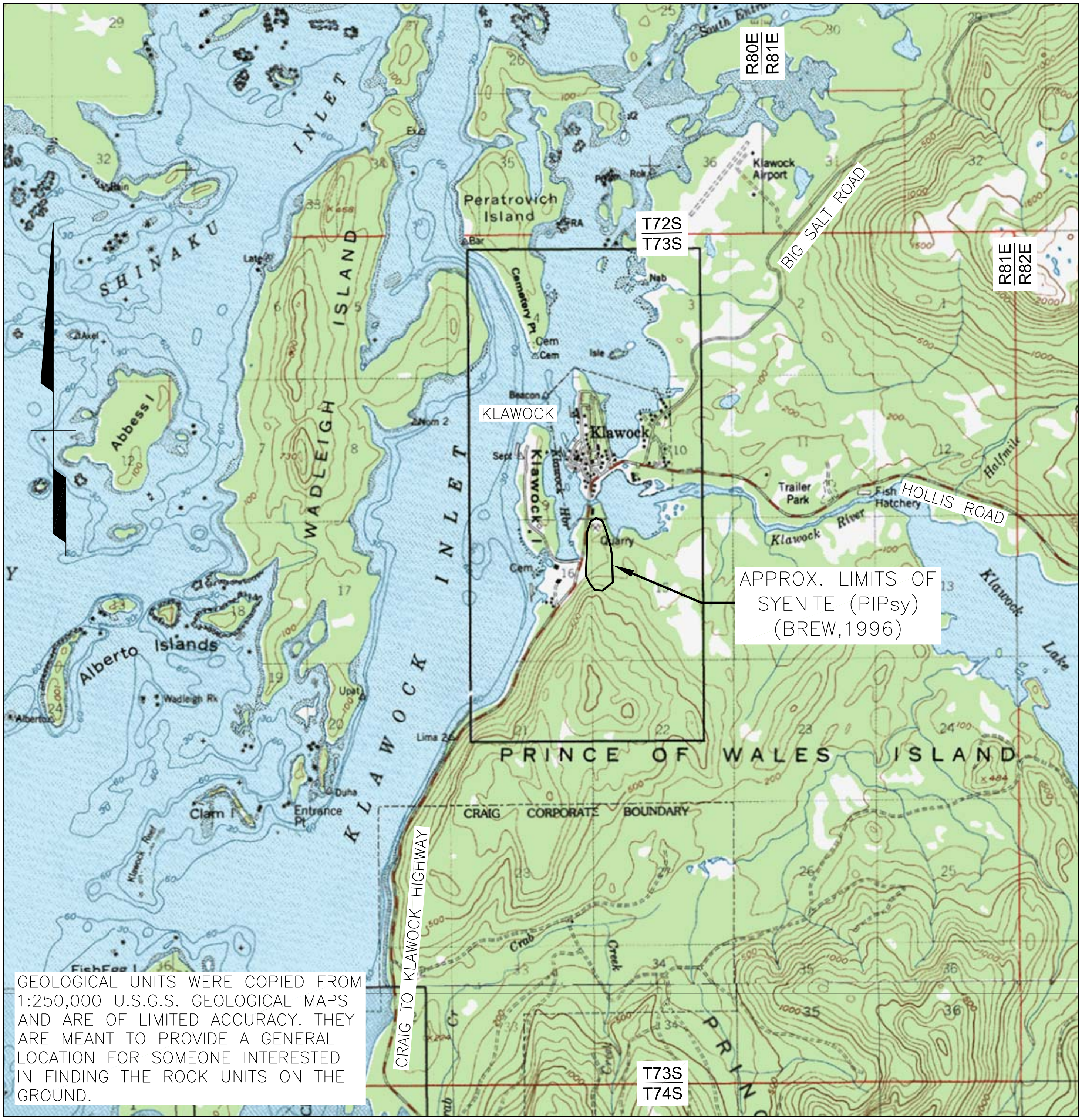
SIGNATURE: Bruce [signature]
REGIONAL MATERIALS ENGINEER

THE MATERIAL AS SUBMITTED CONFORMS TO SPECIFICATIONS

YES ( ) NO ( ) N/A ( )

THE TEST RESULTS ARE ONLY REPRESENTATIVE OF THE MATERIAL AS SUBMITTED
TESTS ARE PERFORMED IN ACCORDANCE WITH STANDARD AASHTO/ASTM OR FHWA/FAA APPROVED ATM TEST PROCEDURES

LOCATION MAP (HA-N1)



U.S.G.S. QUADRANGLE: CRAIG (C–4)

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 0.5 1 2 3

GRAPHIC SCALE IN MILES

BASE MAP CREATED WITH TERRAIN NAVIGATOR PRO

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

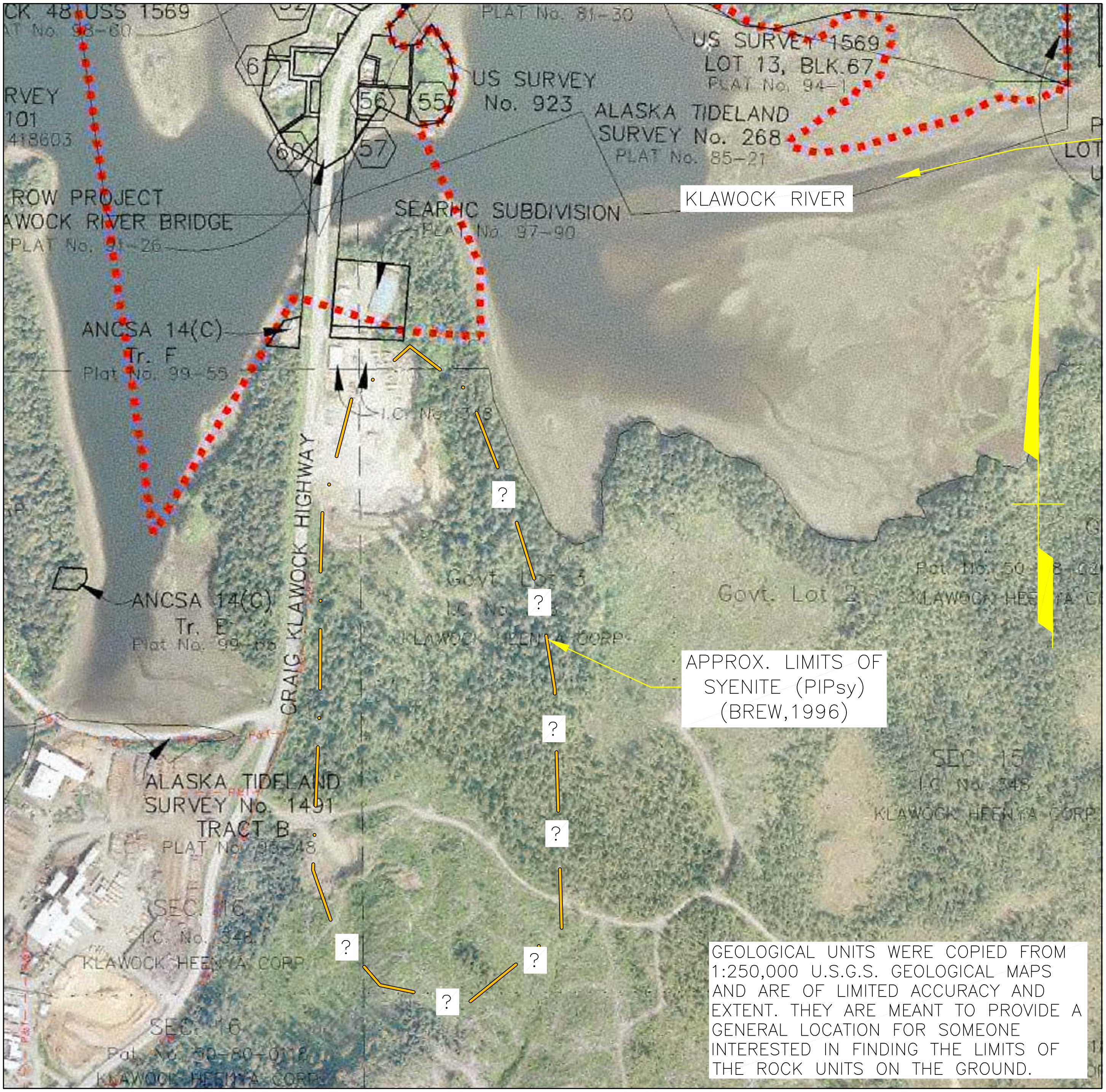
STATEWIDE MATERIAL SITE INVENTORY

KLAWOCK RIVER QUARRY

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	2
	CHECKED C.H.R.	DATE FEB 2013	

Plotted 3/28/2013 11:50 AM by Pete Hardcastle Z:\project\1443.07 DOT_SWM Cantwell Agreegate Feasibility Study\Earth\Hard Aggregate Location Study\Prince Of Wales Island\Klawok River Quarry\Acad\MS_Topo_Map_Klawok_River_Quarry.dwg

SITE MAP (HA-N1)



BASE MAP IS MAY 22, 2004 AERIAL PHOTOGRAPHY.
THIS IS A PLANNING DOCUMENT ONLY.

POTENTIAL HARD AGGREGATE SOURCE PRINCE OF WALES ISLAND

0 300 600 1200 1800

GRAPHIC SCALE IN FEET

BASE MAP FROM SOA DCRA KLAWOCK COMMUNITY PROFILE MAP

Prepared By:
R&M CONSULTANTS, INC.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

STATEWIDE MATERIAL SITE INVENTORY

KLAWOCK RIVER QUARRY

SCALE	DESIGNED	DRAWN	PAGE
AS SHOWN	P.K.H.	P.K.H.	3
	CHECKED C.H.R.	DATE FEB. 2013	

Plotted 3/28/2013 4:03 PM by Pete Hardcastle Z:\project\1443.07 DOT_SWM Cantwell Agreegate Location Study\Earth\Hard Aggregate Feasibility Study\Prince Of Wales Island\Klawok River Quarry\Acad\MS_Site_Map_Klawok_River_Quarry.dwg