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October 23, 2001

LCMF Incorporated
139 E. 51st Avenue
Anchorage, AK 99503

Attention: Wiley Wilhelm, P.E.

Subject: Takotna Water, Sewer and Landfill
Preliminary soils evaluation
DM&A Job No. 4095.81

On July 10 and 11, 2001, Duane Miller & Associates geologist Mr. Walter Phillips, PG, visited Takotna, Alaska, to review the site of the proposed water tank and other water and sewer improvements planned by Village Safe Water and the City of Takotna. While in Takotna he also visited the existing landfill and evaluated the potential for its expansion. Mr. Tom Winkler, Design Engineer for LCMF, Inc., made the initial arrangements for the trip and supplied maps and other documentation. Mr. Dick Newton of the Takotna Community Association (TCA), made housing and other support arrangements, including excavating equipment, operators and local transportation. During Mr. Phillips' visit, Mrs. Nell Huffman provided valuable on-site support in Dick's absence.

On the morning of the July 10th, Mr. Phillips met with the Community Association and Village Council staff to discuss the project scope and to set a tentative schedule for equipment use. This meeting provided an opportunity to evaluate foundation conditions and potential materials sources as described by local builders, operators and maintenance personnel. Existing data points were reviewed, adjustments to the planned field program were made to minimize any redundant work and a local college student with an interest in geology, Jesse Grady, was assigned to aid in the investigation. In addition to digging test pits and acting as a gun bearer, he served as an able and knowledgeable guide to useful soil and rock outcrops in and near the community. The following morning Mr. Phillips reviewed his findings with Mr. Newton and other members of the Community Association staff.

Soils information for the Takotna area is available from a number of sources. A regional geologic map of the Iditarod Quadrangle (Miscellaneous Field Studies Map MF-2219-A) has been prepared by the Alaska Department of Geological and Geophysical Surveys in cooperation with the U. S. Geological Survey. The Takotna Airport Master Plan Draft prepared by USKH in May 2000 presents an overview of soil and bedrock conditions in the area. Numerous test holes provide site-specific information at many locations throughout the Community. The descriptive logs of test holes dug for Village Safe Water (VSW), for a community-wide Mutual Housing Survey and for the school were tabulated by Eagle River Engineering Services (ERES) in December 1998.

Mr. Phillips collected additional soil information from 12 specific "Field Sites" within the project area. The Village Council owns a John Deere 410B with backhoe, which has been utilized for grading and for opening borrow sources throughout the community. In addition to these "exposures", a test pit was hand dug at the proposed water tank site and riverbank exposures were mapped at two locations. Due to lack of access for heavy equipment, the investigations in the vicinity of the proposed sewage lagoon were limited to a walkover and hand probing.

The soil, groundwater and frost conditions were noted at each field site and representative soil samples were collected, where appropriate. The samples were sealed in plastic bags and shipped to the laboratory for further evaluation. In the laboratory the samples will be reexamined to confirm the field classification. A summary of the Field Sites is presented in Table 1 at the end of this letter and the location of each pertinent data point from this investigation is shown on the project maps, Plates 1 and 2.

General geology and soils

Takotna is located on the north bank of the Takotna River in interior Alaska, about 20 miles west of McGrath. The project lies within the Kuskokwim Mountain Section of the Western Alaska Physiographic Province. The low mountains and rolling hills that make up the Kuskokwim Mountains are northeast trending ridges with rounded summits and broad gentle slopes. Tightly folded Cretaceous rocks make up the core of these mountains; graywacke is predominant beneath the ridges and argillite underlies the valleys.

The Takotna River and its tributaries provide drainage in the project area. The Takotna River is a shallow slow-moving river that meanders across a broad mature valley. Oxbow lakes and meander scars are common and muskeg deposits are developing along the borders of ponds and sloughs. A major tributary (Gold Creek) is incised in the hills behind town and forms an alluvial fan where it spills onto the Takotna floodplain.

The topography is mostly flat on the Takotna Valley floodplain and part of the Community lies on the gently sloping alluvial fan of Gold Creek. A moderately steep, bedrock cored hill rises abruptly behind town. The existing airport is on a ridge of the hill, about 400 feet above town, and is founded on and constructed of slatey argillite which was mined on-site.

Alluvial deposits consisting of discontinuous gravel bars interbedded with sand and silty sand are present near the river and on the alluvial fan. Near the base of the ridge, silty gravel composed of colluvial material overlies and is intermixed with the alluvial deposits. Bedrock rubble is present at the base of the slope and shallow rock was encountered during airport construction. Peat and organic silt deposits have accumulated in poorly drained low-lying areas (as much as 10 feet of fine-grained material was reported at school site test pit #1--see ERES, Dec. 1998). Wind-blown (eolian) silt is often intermingled locally with the surficial organic deposits.

Permafrost is discontinuous in the region and thin frozen zones have been reported at several locations within town. These thin zones generally thaw within a season or two after being disturbed. Consequently, the soils throughout most of the developed community are unfrozen. Commonly, the moss covered and black spruce growths on the lower hills and lowlands are underlain by permafrost.

Soil conditions within town vary considerably depending on the depositional environment. Slatey bedrock is present on the steep hillsides. On the hills, a one to two foot blanket of eolian silt (loess) covers the rock and on the lower slopes the loess and frost fractured rock is mixed by frost and gravity action to form an angular silty gravel (colluvium). These conditions exist along the road to the airport and on the ridges west of Gold Creek, near the DOT&PF complex and the community store and post office.

At the base of the hills, the silty gravel colluvium forms a broad gentle slope that extends down to the river. In some low-lying areas thick sequences of silt mixed with organic debris has accumulated in the upper portions of the colluvial deposits. This landform, which underlies much of the community east of Gold Creek, sometimes extends out over old Takotna River terrace gravel and the more recent gravel deposits laid down by Gold Creek.

Water Tank

The proposed water tank location is near Elevation 300, on the hill northwest of the existing water treatment building. A forest of mixed birch, aspen and spruce covers the hillside. At the "Clinton House" (Field Site 1), about 300 feet above the tank, 1.5 to 2.5 feet of brown eolian silt is present beneath a thin vegetal cover. Beneath the silt, fractured slate with interstitial silt is present to a depth of at least nine feet (Housing Test Pit 7--see ERES, Dec. 1998). The fractured bedrock appeared to be in place, but some down-slope movement may have occurred. At the existing airstrip (Field Site 18), near the top of the hill, black fractured slate is present immediately beneath the surficial silt.

A test hole dug at the outer edge of the proposed tank footprint (Field Site 2) showed that fractured rock is present beneath a thin (less than two feet) surface cover of light brown loess. The tree covered slope below the test pit is standing at about 28 degrees. Above the pit, the slope is less steep.

At the base of the hill (Field Site 3), in a cut behind the existing water treatment plant, a 20-foot high face in the fractured rock is standing at an inclination of 1.6 horizontal to 1 vertical (1.6:1). Another "borrow cut" about 600 feet to the east (Field Site 16) exposed bedded slate that is standing on a near vertical face. The rock bedding at this location has a strike of about N 30° E and dips steeply (45° to 60°) into the hill.

Lagoon

The proposed sewage lagoon will be located in the low-lying area immediately east of the community limits. Situated between the hillside to the north and the active river floodplain to the south, the selected area supports a thick mossy tundra cover and black spruce is the predominant tree type.

The underlying soil type will depend on the specific location of the facility. Near the river, terrace gravel may be present but this alluvial material may be intermixed with and covered by rocky colluvial silt. The extent and thickness of the colluvial cover increases to the north. Windblown silt and organic material form the upper portion of the soil column.

Except for a narrow band of thawed material immediately adjacent to the river, the material in the vicinity of the lagoon is expected to be perennially frozen. By mid-July the seasonal thaw had extended to about 18 inches in the area. Permafrost temperatures in the area are generally warm so the frost will be sensitive to surface disturbance. Segregated ice masses have not been reported in the Takotna area but, when allowed to thaw, some settlement and loss of bearing strength should be expected wherever silty zones occur near the surface.

Water and Sewer lines and On-Site Systems

The recent Gold Creek sediments generally consist of sandy gravel that is quite permeable. The main community water supply is obtained from a galley placed in the Gold Creek floodplain (Field Site 17). The Gold Creek deposits are mostly restricted to the present Gold Creek floodplain but in the past overflow channels may have extended through town, east of the present Gold Creek location.

The Takotna terrace deposits vary from well-rounded sandy gravel to silty gravel with a mix of rounded and angular clasts. Gray bands of silt are interbedded with the terrace gravel and parts of the terrace material have been discolored and in some cases cemented with a reddish brown iron stain. Both the silt layers and the iron cementing tend to restrict drainage within the terrace materials. This material overlies the bedrock immediately west of Gold Creek and forms a thin band to the east, along the present Takotna River Bank.

The unfrozen ground cover and underlying fractured bedrock provide reasonably good vertical drainage so the groundwater level in the area is generally controlled by the Takotna River level and locally by the flow in Gold Creek. In permanently frozen areas, some thaw water may be perched at the base of seasonal thaw bulb. In general, however, free water is not anticipated within normal ditching limits except in the immediate vicinity of Gold Creek.

Landfill

The existing community landfill (Field Site 13) is located about 1.5 miles southeast of town. It is operated on a trench and cover basis and, although the facility is technically uncontrolled, bulk metal is routinely separated prior to placing in the trench. The area that had been set aside for trash disposal and cleared of trees is essentially full so the site must be moved or expanded very soon.

The existing facility is sited on a west-facing hillside just west of and below the road. The area supports a dense birch-spruce forest with alder and willow underbrush. The lower portion of the present pit is about 500 feet from a small drainage way that feeds a tributary of the Takotna River.

As the trenches are excavated, organic silt, loess and gravelly silt (fractured bedrock and colluvium mixed with loess) are stockpiled and then used to cover the trash as each trench is filled. An exposure in a borrow pit about 700 feet to the south (Field Site 14) indicates that the loess and silty gravel extends to a depth of about 10 feet. Cleaner fractured rock is present at depth. The bedrock in the area is highly fractured slate with some harder, more massive zones. The structural trend is generally north to south.

Conclusions

- The water tank can be constructed on the bedrock hillside behind town. Site specific inspection of the excavated face during benching is recommended to determine the final backslope grade.

- The proposed lagoon east of town will probably be sited on perennially frozen colluvial material. Development of the lagoon will cause the permafrost to degrade and thaw. The soils will settle as they thaw. The settlement will cause the lagoon dikes to drop and maybe slump. Pre-thawing or maintenance will probably be needed to insure the long-term stability of the facility.

- Pipeline ditching should present no particular difficulties. The slate-like rock can generally be dug with larger excavators, but some ripping may be needed.

- On-site septic system performance is dependent on site specific soil conditions. Subsurface drainage is poor in the silty colluvial deposits, but underlying fractured rock or alluvial deposits commonly provide adequate drainage. High silt content, iron bonding or permafrost will restrict the permeability of the fractured rock and alluvium.

- The active portion of the landfill should probably not be moved down-slope because of the proximity to the drainage but it appears that suitable conditions exist both northwest and southeast of the existing facility. A move to the northeast seems preferable because it places the facility farther from the Takotna River.

Very truly yours,

Duane L. Miller, P.E.

Attachments: Table 1, Field Site Summary
Plate 1 Field Site Locations
Plate 2, Photographs

Table 1: Summary of Field Site Observations

Field Site 1 - Hand dug pit at Clinton Good Home
- 2.5 ft. organic mat and brown silt, over
- 2.0 ft. weathered (fractured) slate with brown silt fracture filling.

Field Site 2 - Hand dug pit at Proposed Tank Location
- Thin forest turf, about 0.1 ft. of organic root mat and duff, over
- 1.5 ft. of light brown silt with mottled gray streaks (loess), over weathered (fractured) slate.
- The hillside has a 27.5° (2:1) downward slope and 14° (4:1) upward slope.

Field Site 3 - Cut bank (borrow source) at base of hill behind Water Plant
- Thin surface organic and silt mat, over
- 20 ft. exposure of fractured slate with interstitial silt.
- Backslope standing at 32° (1.6:1).

Field Site 4 - Cut bank (borrow source) in Gold Creek Terrace, west of bridge
- Approximately 1.0 ft. organic and silt cover, over

- 6 ft. exposure of iron-stained alluvial gravel (to 5-inch diameter) with a 1.0 ft. zone of "clay", dark gray silt.

Field Site 5 - Takotna River Bluff, 250 ft. west of Gold Creek
- Organic mat, over
- 2 to 3 ft. of gravelly silt colluvium, over
- 10 ft. of thinly fractured rock, over
- firm, bedded slate with 0.5 to 6.0 inch layers and strong jointing with at least one 3.0 ft. wide shear zone.

Field Site 6 - Takotna River Bluff, below TCA Office (Sayer House)
- 2.0 ft. organic mat and silt, over
- 5.0 ft. of sandy gravel with minor iron staining and a trace of silt, over
- 2.0 ft. of gray silt with interbedded iron-stained sand, over
- 6.0 ft. of gray silty gravel with a mix of rounded and angular clasts.

Field Site 13 - Landfill
- Birch and spruce forest with alder and willow underbrush.
- Brown silt (loess) beneath forest root mat.
- Material appears to be similar both to north and south.
- A move to north (towards town) will maximize distance from Takotna River.

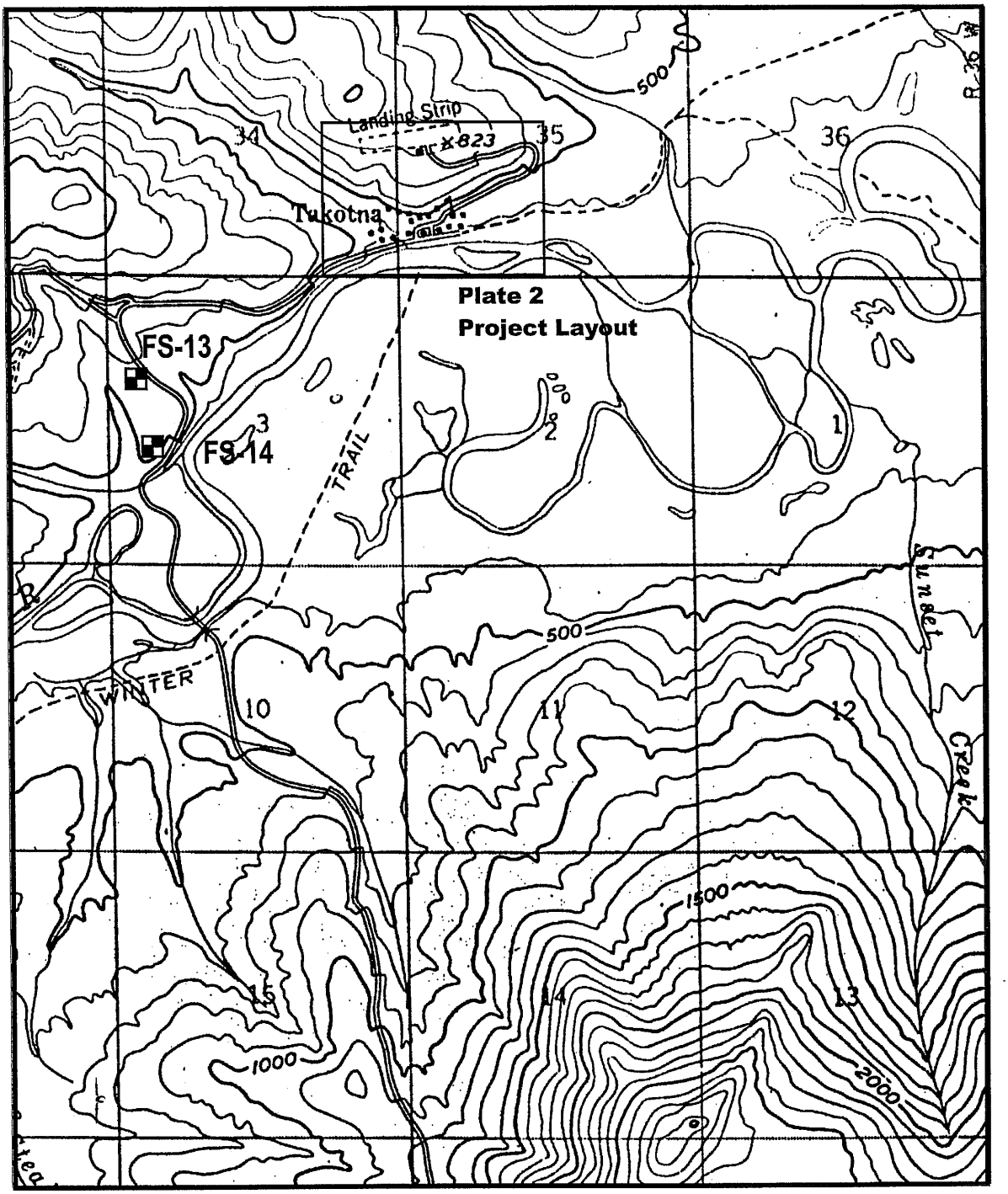
Field Site 14 - Rock Pit; borrow source at toe of slope on road, south of landfill
- Massive sandstone in road cut has a sheared north south interface with shattered black slate (slate has been mined for road fill).
- 2.0 ft. of organic and silt cover, over
- approximately 10.0 ft. of silt filled fractured rock, over
- clean fractured slate.

Field Site 15 - School Yard; shallow pit to repair water line
- Lawn cover over 0.5 ft. of dark brown organic silt, over
- 3.0 ft. of brown silt (previous logs indicate similar material to 10 ft.).

Field Site 16 - Local borrow source at base of hill behind church
- Organic mat and thin colluvium, over
- Bedded slate (0.5 to 4.0 inch layers), fractured to 0.25 to1.0 inch thick shards and plates to 1.0 by 6.0 inches.
- Strike is N 30° E with Dip 45° to 60° into hill.

Field Site 17 - Fresh water intake Gallery in Gold Creek
- "Clean gravel" reported to at least 14 ft.

Field Site 18 - Existing Airport
- Less than 2.0 ft. overburden, over
- Black slate broken to 1.0-inch pieces was side borrowed for embankment construction.
- Backslope was finished to two horizontal to one vertical.



Field Site Location No.

See Eagle River Engineering Services,
1997 Summary of Previous Test Hole locations

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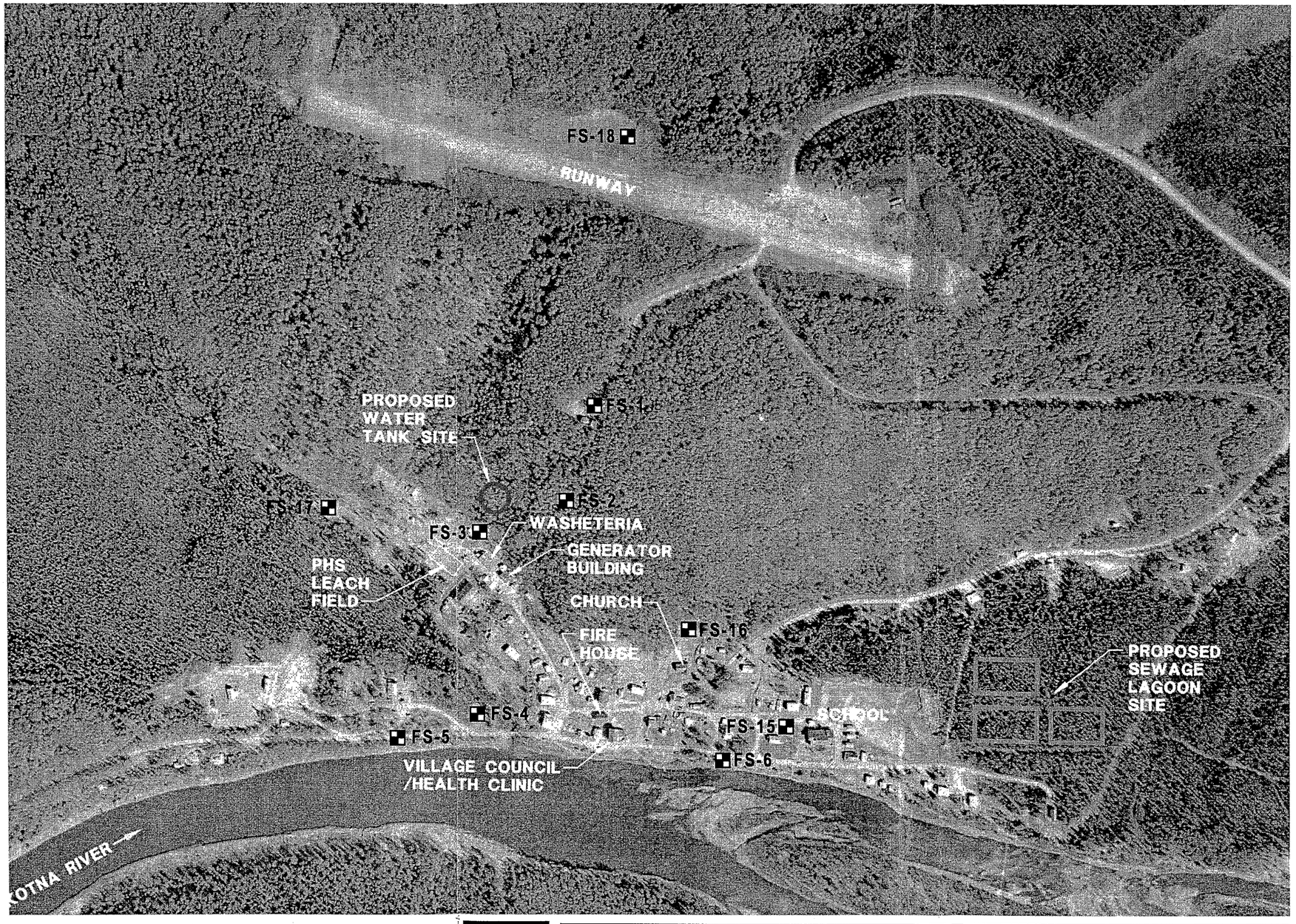
LOCATION MAP
Water & Sewer Upgrades
Takotna, Alaska

Plate
1



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■ Field Site Location No.

See Eagle River Engineering Services,
1997 Summary of Previous Test Hole locations

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PROJECT LAYOUT
Water & Sewer Upgrades
Takotna, Alaska

Plate
2