# Appendix A:

# Sanitation Facilities Engineering Study Supplement

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## EXECUTIVE SUMMARY

Residents of the Kuskokwim River community of Tuluksak (population 443) obtain water for in-home use by hauling it in buckets from the community watering point, or from natural water bodies. Many collect rainwater. Human wastes generated in the home are collected in "honey buckets" (five gallon plastic pails lined with plastic bags). Honey buckets are dumped by residents into shallow, plywood covered pits dug near each home. Laundry and showers are available at the community washeteria. Solid waste is hauled by residents to an open dump at the edge of town.

In June 1995 the Village Safe Water Program completed a Sanitation Facilities Preliminary Engineering Study for Tuluksak. At that time, the Community couldn't reach consensus on the best option for improved sanitation. Both a truck haul system and piped utilities were being considered.

In June 1999 CE2 Engineers was retained by the Tuluksak Native Community, (under a $25,000 grant from the Village Safe Water Program funded by EPA 1994 Indian Set Aside Funds), to provide technical advice on sanitation options and to facilitate community selection of a preferred sanitation option. The truck haul system and piped utilities were examined in detail. (Other options including on-site wells and septic tanks were briefly reviewed, but then rejected).

Members of a local Study Team traveled to St. Mary's and Napakiak to observe the operation of a piped system and a haul system.

Concepts were developed for serving the entire community by truck haul and by piped utilities. A preliminary piped water and sewer system layout drawing was developed. Component elements for both types of systems were identified and defined. Capital and operation and maintenance (O&M) costs were estimated. Three tables were developed to explain and compare features of the truck haul system vs. the piped system.

A summary of some key items from the comparative analysis follows:

| Parameter | Truck Haul | Piped Utilities |
|---|---|---|
| Water Use | 3 gal/person/day of fresh water generating 2 gal/person/day of wastewater | 65 gal/person/day |
| Laundry | At washeteria | At home |
| Showers | At washeteria | At home |
| Water Distribution | By truck over improved roads from the water treatment plant to a holding tank inside each home | By circulating pressurized pipes from the water treatment plant to each home |
| Wastewater Collection | By truck over improved roads from the holding tank outside each home to a treatment lagoon | By gravity sewer pipes and pumping stations to a treatment lagoon |

| Parameter | Truck Haul | Piped Utilities |
|---|---|---|
| Estimated monthly cost per household at completion of construction | Varies with size of household – generally **$23 per person per month plus washeteria fees for laundry and showers** | **$130/month without regard to the size of the household** (assuming the school district pays $30,000 per year for service) |
| Estimated construction cost for all water, sewer, and solid waste facilities (1999 dollars) | $10.5 million | $12.2 million |
| **Other Characteristics** | | |
| Service to the school | Does not provide service to the school complex | Assumes the school complex is a customer paying $2,500/mo for service |
| Site Control | Requires rights-of-way for road corridors | Requires rights-of-way for pipe corridors |

**The Community debated the pros and cons of the two alternatives and ultimately selected piped utilities based on the increased customer convenience and greater health benefit afforded by the piped system option.** A seven year phased development program was proposed to complete construction of the piped utility system.

The Community also passed a resolution to close the individual honey bucket pits and implement a community wide honey bucket haul system, as an interim measure, until the piped utility system can be completed.

Local leaders recognize that the Community presently lacks the organizational and financial management skills necessary to operate a piped utility system. Operation of the simpler, honey bucket haul system for a few years will prepare the Community for the greater responsibility associated with operating the future piped utility system. Another key step in developing operations skills would be for the Council to take back operation of its water treatment plant from the school district and succeed in operating the plant at a profit.

In September 1999, the Community completed the Village Safe Water FY01 Capital Budget Questionnaire seeking grant funds to implement the honey bucket haul system, obtain utility management training, and begin work on the piped utility system.

## BACKGROUND

The Tuluksak Native Community (population 443) is located 35 miles upriver from Bethel at the confluence of the Tuluksak and Kuskokwim Rivers. Approximately 80 residences and an assortment of commercial and industrial buildings occupy 70 acres near the river banks. The Community is governed by a Traditional Council.

Sanitation within the community is poor. The Council owns a well, water plant/washeteria and watering point. Piped water is supplied to the school complex. All other users haul water from the community watering point or from natural water bodies. Many collect rainwater. Human waste is dumped into shallow pits on each lot. The pits are covered with plywood and are "bucket charged" through a dump chute mounted on the plywood cover. Most "honey bucket" disposal pits are currently full or near full.

Wastewater from the school complex is piped to a fenced lagoon east of the elementary school. Wastewater from the washeteria is piped to a second fenced lagoon on the south edge of the community.

Solid waste is hauled by individuals to an open burning dump located adjacent to the washeteria's lagoon

The community seeks improved sanitation.

In June 1995 the State of Alaska Village Safe Water Program completed a "Sanitation Facilities Preliminary Engineering Study" for Tuluksak. The study explored alternatives for improved sanitation. At completion of the study the Community had not reached consensus regarding the type of public water and sewer system that would best fit the town. Both **piped water and sewer** and a **truck haul system** were being considered.

In June 1999 the Tuluksak Native Community engaged CE2 Engineers, Inc. to help it revisit issues pertaining to water/wastewater system options. The Village Safe Water program suggested examining a third option – on-site wells and septic tanks. Thus, the three options to be considered in the 1999 Supplemental Study included:

- Piped Water and Sewer
- Truck Hauled Water and Sewer
- On-Site Wells and Septic Systems

This Supplemental Study was funded by a $25,000 grant from the State of Alaska.

## OBJECTIVE

The objective of the study was to provide additional technical information to help citizens decide what type of improved sanitation facilities would best suit the community. The information provided would generally address the following issues:

- ✓ Engineering feasibility of alternatives (given the constraints imposed by the physical setting)
- ✓ Cost of service to the customer
- ✓ Relative health benefit associated with each alternative system
- ✓ Convenience to the customer
- ✓ Susceptibility to failure
- ✓ Skill required to operate and maintain the completed facilities
- ✓ Capital cost
- ✓ Time to implement

Once the community selected its preferred alternative the information developed through the course of the Supplement Study would be used to seek grant funds to design and construct the improvements.

## APPROACH

In general the Engineer was tasked with:

- Reviewing existing information to include the 1995 VSW Study and pertinent engineering data from various sources.
- Traveling to Tuluksak to examine existing sanitation facilities and to get a feel for the engineering feasibility of the various options.
- Meet with the Council and a local Study Team to hear the community's ideas for improving sanitation; to gage the community's institutional, organizational and financial capability for operating various types of systems and to confirm the sanitation options for which technical information would be developed.
- Develop the necessary technical information to allow the Community to evaluate each of the options.
- Revisit Tuluksak to present the technical information and facilitate discussion to allow the community to select the preferred alternative.
- Collect the technical information in a report to be entitled "Supplement #1" to the 1995 VSW Study.

## PHYSICAL SETTING

The feasibility of a sanitation option is often governed by physical constraints such as soil conditions, snow drifting, flooding, etc.

The Supplemental Study reviewed available information pertaining to the physical environment in which the community is set. Additional information was obtained through discussions with community members and through field observations. Relevant physical characteristics of the community which affect utilities are summarized below:

***Topography***

The topography is generally flat with approximately a 1% slope toward the north (toward the Tuluksak River).

***Soils***

The soil section underlying the community generally consists of 1-3 feet of surface organics and organic silts overlaying 3-8 ft of wet silt (50-60% moisture content). Fine sand and silty sands lie beneath the silt cap to a depth of 40 to 50 ft. Occasional peat pockets containing methane were reported above 50 ft.

Soils are generally thawed to 40 ft with sporadic permafrost at shallower depths. The thickness of the permafrost is believed to be 50 to 75 feet near the river, thickening with distance from the river. (Wheaton, 1979). The closest known gravel source is at Kalskag, 45 miles up the Kuskokwim River.

***Water Table***

The water table generally varies between 10 and 30+ feet below ground depending on river stage.

***Aquifer Potential***

Some drill logs report a $\pm$5 ft thick black sand aquifer near 50 ft. The aquifer can produce about 2.5 gpm per foot of drawdown (Wheaton, 1979), implying a production rate of approximately 30-40 gpm per well, at low river stage.

Other aquifers probably exist at greater depth but their potential is unknown.

***Ground Water Quality***

The black sand aquifer produces waters high in iron (16-70 mg/l) and manganese (0.5-2.0 mg/l). Other representative aquifer characteristics as measured at the washeteria / watering point well in 1994 include:

| | |
|---|---|
| pH | 6.7 |
| Total dissolved solids | 180 mg/l |
| Hardness as $CaCo_3$ | 103 mg/l |
| Alkalinity as $CaCo_3$ | 110 mg/l |
| Langelier Index | -1.0 |
| Calcium | 29.8 mg/l |
| Magnesium | 7.04 mg/l |
| Sodium | 4.73 mg/l |
| Chloride | 8.13 mg/l |
| Sulfate | 8.46 mg/l |

Removing the iron and manganese will produce a palatable and aesthetically pleasing water.

Water quality from deeper aquifers is unknown.

***Flooding***

Tuluksak is subject to flooding. Waters greater than four feet deep have been reported in the village.

***Vegetation***

Ground cover consists of grasses, brush and trees, mostly birch and spruce to 12 inch diameter.

***Existing Roads***

Existing roads and pathways within the community are generally constructed of silt and are passable by trucks and 4-wheeler during most of the summer. Drainage structures are few. Road maintenance is poor. Dedicated public rights-of-way exist for fewer than half of the traveled ways.

## COMMUNITY WATER AND SEWER ALTERNATIVES

After an on-site review of the physical setting and initial discussions with the Council, the universe of practical options for community water and sewer service were reduced to two:

- Truck haul
- Piped water and gravity sewer

All terrain vehicle haul (4-wheelers or snow machines pulling trailer or sled mounted water and wastewater tanks) was ruled out because operating costs would be higher than for a truck haul systems. ATV haul is much less efficient and much more labor intensive than truck haul because of the small size of the haul trailers.

On-site wells were ruled out based on the widespread distribution of active and abandoned honey bucket pits and the relatively shallow depth to groundwater. In addition, operation and maintenance of individual water treatment units was judged burdensome to homeowners.

On-site septic tanks and drainfields were ruled out based on small lot size, the thickness of the relatively impermeable surface silt layer and the potential for flooding.

Vacuum sewers were also suggested by VSW but were ruled out based on higher operational cost and greater mechanical complexity than gravity sewers.

## DESCRIPTION OF ALTERNATIVES

To compare the truck haul alternative with piped water and sewer, the components and features of both types systems were first conceptualized and described.

Both systems were conceived to serve 562 persons in the design year 2020. The piped system has capacity to deliver 65 gallons of water per person per day, while the truck haul system assumes each resident will, on average, purchase three gallons of water per day from the utility and pay the utility to haul off two gallons of wastewater each day.

Component elements for each system are defined in the following table.

## DESCRIPTION OF COMPONENT ELEMENTS FOR BOTH THE TRUCK HAUL AND PIPED UTILITY SYSTEM

| Component Element | Truck Haul Alternative | Piped System Alternative |
|---|---|---|
| Water Supply | Two wells, both high in iron, on airport property southwest of town | Two wells, both high in iron on airport property southwest of town. |
| Water Transmission | 1,600 LF 3"x12" transmission main to a utility building | 1,600 LF of 3"x12" transmission main to a utility building. |
| Utility Building Complex Consisting Of:<br>• Water Treatment Plant | Batch oxidation/sedimentation treatment for iron and manganese removal (10,000 gpd capacity) | Flow through oxidation, coagulation, sedimentation treatment plant for iron and manganese removal (40,000 gpd capacity). |
| • Washeteria | New washeteria with laundry and shower facilities | No washeteria required. Laundry and showering will be done at home. |
| • Vehicle Storage Building | Facilities to garage a 1,000 gallon water delivery truck, an 800 gallon truck mounted vacuum sewage collection truck and snow removal equipment | Single bay garage for storing sewer jetting equipment and miscellaneous tools. |
| Water Storage | 50,000 gallon, ground level, insulated water storage tank | 300,000 gallon ground level, insulated water storage tank. |
| Water Distribution | 1,000 gallon truck mounted water tanker operating on 14,650 lf of reconstructed road | 13,060 LF of 4x12 water distribution loop piping with 90 EA, 1" circulating water services. No fire hydrants. |
| In-House Plumbing (each home) | 200 gallon water holding tank, pressurization pump, hydropneumatic tank, water heater, lavatory, low water use toilet, outdoor 400 gallon wastewater holding tank | Flush toilet, lavatory, water heater, bathtub and/or shower, kitchen sink. |
| Wastewater Collection | 800 gallon truck mounted vacuum trailer operating on 14,650 LF of reconstructed road<br>4x12 force main from washeteria to wastewater lagoon | 90 EA 4x12 gravity sewer service lines, 9,700 LF 8x12 gravity sewer main, 37 manholes, 4 lift stations. |

## DESCRIPTION OF COMPONENT ELEMENTS FOR BOTH THE TRUCK HAUL AND PIPED UTILITY SYSTEM

| Component Element | Truck Haul Alternative | Piped System Alternative |
|---|---|---|
| Wastewater Treatment | Two cell facultative lagoon sized for 10,000 gpd | Two cell facultative lagoon sized for 40,000 gpd |
| Solid Waste Collection | Self haul to landfill (no community facilities required) | Self haul to landfill (no community facilities required) |
| Solid Waste Disposal | Sanitary landfill sized for 40 yr life | Sanitary landfill sized for 40 yr life |

## COMPARISON OF ALTERNATIVES

The Engineer's role in the Supplemental Study was to "frame the options" for consideration by the Community – to present technical information to assist the Community make a choice between a truck haul system and a piped utility system.

The relevant technical information was presented in several handouts which included a conceptual piped utility system layout drawing, capital and O&M cost estimates for both the truck haul and piped utility systems, and three tables which compare features of both systems.

**Note that the Preliminary Piped Water and Sewer System Layout is conceptual only, and was developed with limited input from the Community. Land ownership and site control issues were not addressed. The drawing appears in the Appendix.**

The handouts used to present the capital and O&M cost estimates follow. The following three pages address the truck haul system. The three pages after that address piped water and sewer.

# TULUKSAK SANITATION FACILITIES
# ESTIMATED CAPITAL COST AND ESTIMATED ANNUAL O&M BUDGET
# FOR TRUCK HAUL SYSTEM

***Assumptions:***

*Water supply* – two wells, both high in iron

* *Water treatment* – batch oxidation, sedimentation treatment for removal of iron and manganese

*Water storage* – 50,000 gallon ground level, insulated storage tank

* *Laundry and shower facilities* – washeteria to be built in conjunction with the water treatment plant

* *Water distribution* – truck mounted 1,000 gallon water tanker with pump (requires road upgrades and a vehicle storage garage to be built as part of the water plant, washeteria complex)

*In-house plumbing* – 200 gallon water holding tank, pressurization pump, hydropneumatic tank, water heater, lavatory, low water use toilet, outside 400 gallon wastewater holding tank

* *Wastewater collection* – truck mounted 800 gallon vacuum tanker (requires road upgrades and a vehicle storage garage to be constructed as part of the washeteria complex)

*Wastewater treatment* – two cell facultative lagoon

*Solid waste collection* – self haul trash to the disposal area

*Solid waste disposal* – sanitary landfill

*Design year* – 2020

*Design population* – 562 (3% growth rate)

*Estimated number of customers at completion of construction* – 90

*Number of customers in the design year 2020* – 119

*Water purchased from utility* – 3 gal/cap/day

*Wastewater hauled by utility* – 2 gal/cap/day

* The water plant, washeteria, and haul vehicle storage building will be constructed as a single building complex

# TULUKSAK SANITATION FACILITIES
# TRUCK HAUL SYSTEM
# ESTIMATED CAPITAL CONSTRUCTION COST

| ITEM | UNIT | UNIT PRICE | QTY. | COST |
|---|---|---|---|---|
| Water well | EA. | $75,000 | 2 | $150,000 |
| Water transmission line | LF | $125 | 1,600 | $200,000 |
| Water treatment plant, washeteria, haul vehicle garage, force main to lagoon | EA. | $2,000,000 | 1 | $2,000,000 |
| Water storage tank (50,000 gallons) | EA. | $80,000 | 1 | $80,000 |
| Road reconstruction (including right-of-way acquisition) | LF | $100 | 14,650 | $1,465,000 |
| Snow removal equipment | LS | $150,000 | 1 | $150,000 |
| 1,000 gallon truck mounted all-weather water tanker | LS | $75,000 | 1 | $75,000 |
| House plumbing including 200 gallon water holding tank, 400 gallon wastewater holding tank and appurtenances | EA. | $33,000 | 90 | $2,970,000 |
| 800 gallon truck mounted all-weather vacuum wastewater hauler | EA. | $90,000 | 1 | $90,000 |
| Dual cell wastewater treatment lagoon | EA. | $200,000 | 1 | $200,000 |
| Landfill including on-site access road | EA. | $300,000 | 1 | $300,000 |
| Landfill maintenance equipment | LS | $80,000 | 1 | $80,000 |
| Closeout existing lagoon and landfill | LS | $75,000 | 1 | $75,000 |
| | | | **TOTAL** | **$7,835,000** |

| | |
|---|---|
| **TOTAL ESTIMATED CONSTRUCTION COST** | $7,835,000 |
| **CONTINGENCY (10%)** | $783,500 |
| **SUBTOTAL** | **$8,618,500** |
| **ENGINEERING & ADMINISTRATION (10%)** | $861,850 |
| **CONSTRUCTION ADMINISTRATION (12%)** | $1,034,220 |
| **TOTAL PROJECT COST** | **$10,514,570** |

# TULUKSAK SANITATION FACILITIES
# TRUCK HAUL SYSTEM
# ESTIMATED ANNUAL O&M BUDGETED COST*

| ITEM | COST |
|---|---|
| Water treatment operator | |
| 709 hr/yr x $23/hr (fully burdened) | $16,307 |
| Water / waste haul operator | |
| 1,853 hr/yr @ $15.60/hr (fully burdened) | $28,907 |
| Snow removal operator | |
| 200 hr/yr @ $15.60/hr (fully burdened) | $3,120 |
| Road maintenance operator | |
| 70 hr/yr @ $15.60/hr (fully burdened) | $1,092 |
| Mechanic | |
| 120 hr/yr @ $21.60/hr (fully burdened) | $2,592 |
| Vehicle and heavy equipment fuels, lubes and expendables | $8,000 |
| Vehicle and heavy equipment parts | $15,000 |
| Electricity, water plant and garage (35,400 kwh @ $0.42/kw) | $14,868 |
| Heating fuel, - water plant and garage (4,550 gal @ $2.25/gal) | $10,238 |
| Treatment chemicals, supplies and expendables | $3,200 |
| Water plant equipment repairs and maintenance | $2,650 |
| Office and administrative costs | $10,600 |
| **Total Estimated Annual O&M Cost =** | **$116,574** |

## REVENUE REQUIREMENT**

| | |
|---|---|
| **ESTIMATED TOTAL ANNUAL O&M EXPENSE** | **$116,574** |
| **ESTIMATED NUMBER OF CUSTOMERS (RESIDENTAL AND COMMERCIAL) AT COMPLETION OF CONSTRUCTION =** | **90** |
| **ESTIMATED AVERAGE COST PER CUSTOMER (WITHOUT SUBSIDY) AT COMPLETION OF CONSTRUCTION =** | **$1,295/YR**<br>**$108/MO** |

* The O&M cost for the washeteria is not included in this analysis. It is assumed that the washeteria user fees will generate enough revenue to support its operation.

** Note that the school district facilities will not be served by the haul system and will not contribute to the support of the haul system.

# TULUKSAK SANITATION FACILITIES
# ESTIMATED CAPITAL COST AND ESTIMATED ANNUAL O&M BUDGET
# FOR PIPED WATER AND SEWER

***Assumptions:***

- *Water supply* – two wells, both high in iron
- *Water treatment* – flow through, oxidation, coagulation, sedimentation treatment plant for removal of iron and manganese
- *Water storage* – 300,000 gallon ground level, insulated storage tank
- *Water distribution* – 4" buried, insulated, circulating distribution loops with circulating 1" service lines
- *Fire protection* – none
- *In-house plumbing* – flush toilet, lavatory, water heater, bathtub and/or shower, kitchen sink
- *Wastewater collection* – 4" buried, insulated gravity sewer service lines; 8" buried insulated, gravity sewer mains; manholes, lift stations, and force main
- *Wastewater treatment* – two cell facultative lagoon
- *Solid waste collection* – self haul trash to the disposal area
- *Solid waste disposal* – sanitary landfill
- *Design year* – 2020
- *Design population* – 562 (3% growth rate)
- *Estimated number of customers at completion of construction* – 90
- *Number of customers in design year 2020* – 119
- *Water consumption* – 65 gal/person/day

# TULUKSAK SANITATION FACILITIES
# PIPED SYSTEM
# ESTIMATED CAPITAL CONSTRUCTION COST

| ITEM | UNIT | UNIT PRICE | QTY. | COST |
|---|---|---|---|---|
| Water well | EA. | $80,000 | 2 | $160,000 |
| Water transmission line | LF | $125 | 1,600 | $200,000 |
| Water treatment plant with vehicle storage | EA. | $1,300,000 | 1 | $1,300,000 |
| Water storage tank (200,000 gallons) | EA. | $200,000 | 1 | $200,000 |
| 4x12 water distribution loop piping | LF | $100 | 13,060 | $1,306,000 |
| 1" circulating water service | EA. | $8,000 | 90 | $720,000 |
| House plumbing | EA. | $20,000 | 90 | $1,800,000 |
| 4" gravity sewer services | EA. | $7,000 | 90 | $630,000 |
| 8x15 gravity sewer | LF | $130 | 9,700 | $1,261,000 |
| Manholes | EA. | $8,000 | 37 | $296,000 |
| Lift stations | EA. | $80,000 | 4 | $320,000 |
| Force main (various sizes) | LF | $100 | 1200 | $120,000 |
| Dual cell wastewater treatment lagoon | EA. | $300,000 | 1 | $300,000 |
| Landfill including on-site access road | EA. | $300,000 | 1 | $300,000 |
| Maintenance equipment (landfill and pipes) | LS | $120,000 | 1 | $120,000 |
| Closeout existing lagoon and landfill | LS | 75,000 | 1 | $75,000 |
| | | | **TOTAL** | **$9,108,000** |

| | |
|---|---|
| **TOTAL ESTIMATED CONSTRUCTION COST** | $9,108,000 |
| **CONTINGENCY (10%)** | $910,800 |
| **SUBTOTAL** | **$10,018,800** |
| **ENGINEERING & ADMINISTRATION (10%)** | $1,001,880 |
| **CONSTRUCTION ADMINISTRATION (12%)** | $1,202,256 |
| **TOTAL PROJECT COST** | **$12,222,936** |

# TULUKSAK SANITATION FACILITIES
# PIPED SYSTEM
# ESTIMATED ANNUAL O&M BUDGETED COST

| ITEM | COST |
|---|---|
| Full time operator including overtime and benefits | $46,000 |
| Part time operator | $10,000 |
| Electricity (86,600 kwh @ $0.42/kwh) | $36,400 |
| Heating fuel (14,800 gal/yr x $2.25/gal) | $33,300 |
| Treatment chemicals, supplies and expendables | $20,000 |
| Vehicle Expense | $6,000 |
| Office and administrative costs | $7,000 |
| Equipment repair and maintenance | $12,000 |
| **Total Estimated Annual O&M Cost =** | **$170,700** |

## REVENUE REQUIREMENT

| | |
|---|---|
| **ESTIMATED TOTAL ANNUAL O&M EXPENSE** | $170,700 |
| **ESTIMATED REVENUE FROM SCHOOL DISTRICT FACILITIES** | <$30,000> |
| **SUBTOTAL*** | **$140,700** |
| **ESTIMATED NUMBER OF CUSTOMERS (RESIDENTAL AND COMMERCIAL) IN THE DESIGN YEAR 2020 =** | **119** |
| **ESTIMATED COST PER CUSTOMER (WITHOUT SUBSIDY) IN DESIGN YEAR 2020 =** | **$1,182 /YR**<br>**$98.50/MO** |
| **ESTIMATED NUMBER OF CUSTOMERS (RESIDENTIAL AND COMMERCIAL) AT COMPLETION OF CONSTRUCTION =** | **90** |
| **ESTIMATED COST PER CUSTOMER (WITHOUT SUBSIDY) AT COMPLETION OF CONSTRUCTION =** | **$1,563/YR**<br>**$130/MO** |

* The revenue estimate is based on typical school district charges in similar sized communities in rural Alaska

## OTHER CONSIDERATIONS IN CHOOSING BETWEEN TRUCK HAUL AND PIPED WATER AND SEWER

In addition to economic considerations, the Engineer was asked to develop information to address how service to the homeowner might differ under the two options. Three tables were developed.

Table 1 is entitled "Household Water Use Activities and How Each Activity is Generally Performed Under Three Water and Sewer Options". The table compares how water is handled and used in the home under three service options:

- Self Haul / Honey Bucket (the type of service that currently exists in Tuluksak)
- Truck Haul / Holding Tank
- Piped Water and Sewer

Table 1 follows.

**Table 1. Household Water Use Activities and How Each Activity is Generally Performed Under Three Water and Sewer Options**

| Household Activity | Traditional "Honeybucket" | Truck Haul / Holding Tank | Piped Utilities |
|---|---|---|---|
| Delivery of water to the home and storage of water in the home | Individuals haul water to the home in pails from potable "watering points", rain barrels or natural water bodies. At home the water is generally stored in a covered plastic drum. Water from community watering points is generally disinfected. Water from natural water bodies is generally not disinfected. | Water is delivered by the utility tanker and pumped into the customer's indoor potable water storage tank. An in-home pressure pump and pressure tank pressurize the water so it can be delivered to the plumbing fixtures. The water delivered by the utility is generally disinfected, but long residence time in the holding tank reduces the level of protection. | Pipes are run to the home to provide water at suitable pressure. Water is available, on demand, at the plumbing fixtures. No water is stored in the home. The water is disinfected. |
| Food Preparation, washing floor, house cleaning, etc. | Water is dipped from the storage container, heated on the stove if necessary, and used to wash food, prepare food, clean floors, etc. Wastewater is generally discarded on the ground near the house. | Water is drawn from plumbing taps. Wastewater goes down the drain pipes to be stored in the customer's wastewater holding tank for pickup by the Utility's sewage haul tanker, or is dumped on the ground near the home. | Water is drawn from plumbing taps. Wastewater goes down the drain pipe to the community wastewater treatment facility. (There is no wastewater holding tank at the home). |
| Washing hands and face, shaving, etc. | Water is dipped from the storage container, heated on the stove and poured into the washbasin. Wastewater is generally discarded on the ground near the house. | Hot and cold water from the taps are blended to a comfortable temperature in the lavatory. Wastewater is piped to the customer's wastewater holding tank. | Hot and cold water from the taps are blended to a comfortable temperature in the lavatory. Wastewater goes down the drain pipe to the community wastewater treatment and disposal facility. |

**Table 1. Household Water Use Activities and How Each Activity is Generally Performed Under Three Water and Sewer Options**

| Household Activity | Traditional "Honeybucket" | Truck Haul / Holding Tank | Piped Utilities |
|---|---|---|---|
| Toilet | The household toilet usually consists of a five gallon plastic pail with a polyethylene liner bag. The pail is positioned beneath a toilet seat. When the "honey bucket" is full the pail is generally set outside where it is picked up by Community workers, or dumped into a nearby waste collection bin by a household member, or transported to the wastewater disposal facility and dumped there by a household member. (Human waste is handled by household members and possibly by Community workers). | The low water use toilet installed in the home is flushed and the human waste goes down the drain pipes to be stored in the customer's wastewater holding tank. When the tank is full, Community workers pump the tank and haul the wastewater to the treatment and disposal facility. | A conventional or low water use toilet is "flushed" and the human waste goes down the pipes to the community wastewater treatment and disposal facility. |
| Bathing / Showering | Household members use a steam bath, or heat water and sponge off at home, or take a sauna or shower at the washeteria. Wastewater from bathing at home, and the cleanup associated with changing diapers, is generally discarded on the ground near the house. | A shower is an optional fixture which is often not installed. If installed, wastewater from the shower is piped to the customer's wastewater holding tank. Generally, because of the high cost per gallon for tanker hauled water and wastewater, only very short showers are economical. | Bathtubs and / or showers are standard in each home. Household members can use as much water as they like and bathe as frequently as they like. Wastewater from the shower goes down the drain pipe to the community wastewater treatment facility. |

A second table entitled "Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Three Water and Sewer Options" was also prepared. Table 2 lists various measures of customer health and convenience and compares how honey bucket, truck haul / holding tank and piped utility service differ in the degree of health protection and convenience afforded to the customer. Table 2 follows.

**Table 2. Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Three Water and Sewer Options**

| Measure of Customer Health/Convenience | Traditional "Honeybucket" | Truck Haul/Holding Tank | Piped Utilities |
|---|---|---|---|
| **Quantity** of water "provided" to the home | None, members of the household must haul water. | Only a limited amount of delivered water is affordable. That amount is much less than most customers would prefer. Customers sometimes haul their own water, rather than pay for water delivery. | An ample amount of water is available at the tap. Water is much less expensive, on a cost per gallon basis, than for the tanker haul / holding tank system. |
| **Quality** of the water available to household members | Poor to good depending on the water source and how the water is hauled and stored. Self hauled water is not routinely tested for purity. | Fair to good – the water is generally warm and possibly affected by long storage time and buildup of sediments and / or biological growth in the holding tank. Water from customer holding tanks is not routinely tested for purity. | Excellent and regularly tested. |
| Household floor space occupied by water and sewer devices | Least amount required (almost none). | Greatest amount required. Space must be available to install the typical plumbing fixtures plus a holding tank, pressure pump, pressure tank, etc. | Moderate amount of space is required to install the typical plumbing fixtures. |
| Mechanical complexity of water and sewer devices installed in the home | Least complex | Most complex – more mechanical devices than for piped utilities. | Second most complex. |
| Noise in the house from water and sewer devices | None | Most noise- pressure pumps can be noisy. | Depends on the type of piped sewer system. Gravity systems are the quietest. Vacuum systems and pressure systems are generally noisier. |

**Table 2. Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Three Water and Sewer Options**

| Measure of Customer Health/Convenience | Traditional "Honeybucket" | Truck Haul/Holding Tank | Piped Utilities |
|---|---|---|---|
| Puddle on the floor from the water holding tank "sweating" | Slight possibility | Probable unless the water holding tank is insulated. | Not applicable |
| Ease of draining / protecting the water and sewer devices if the house is left without heat | Least complex | Most complex – more devices have to be drained than for piped utilities. | Second most complex |
| Ability to bathe at home | Generally limited to taking sponge baths. | If showers are installed, even a very short shower at home is generally more expensive than showering at the washeteria. | Baths and full showers are possible at no additional charge. |
| Ability to do laundry at home. | Limited to items washed by hand or with a bucket fed wringer washer. | Anything more than washing a few items by hand is generally more expensive at home than at the washeteria. | Most families eventually buy washers and dryers and do laundry at home. |
| Fire protection for the home | Essentially none | Essentially none | Some |
| Odors in the home from human waste | Generally pervasive | Some odor, depending on frequency of toilet flushing. | No odor. There in no incentive not to flush the toilet after each use. |
| Requires household members to handle (and potentially spill) human waste | Yes | No | No |

**Table 2. Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Three Water and Sewer Options**

| Measure of Customer Health/Convenience | Traditional "Honeybucket" | Truck Haul/Holding Tank | Piped Utilities |
|---|---|---|---|
| Characterized by wastewaters other than toilet waste (often called "greywater") being dumped on the ground outside the home. ( Note that greywaters often contain organisms that can make people sick.) | Yes | Most probable. Users may remove fixture traps and collect wastewater in a bucket for disposal on the ground (to reduce waste haul charges). Some communities have ordinances prohibiting the indiscriminate dumping of greywater. Fines can be imposed. | No, there is no incentive to dispose of greywater on the ground. |
| Odors from human waste or decomposing greywater in the yard outside the home or along public thoroughfares | Yes (Generally) | Probably, the wastewater holding tanks are vented and may cause odors. Greywater may cause odors. | No |
| Amount of contact utility workers have with human waste | Highest amount | Moderate amount | Least amount |
| Homeowner time involved with "operating" the facilities installed in the home | Highest, must haul water and waste | Second highest. Must monitor holding tank levels, call for water deliveries and waste pickup, and maintain more devices. | Least |
| Monetary cost to the household per gallon of water used in the home | Least expensive | Most expensive, at least five times more expensive per gallon than for piped utilities. [1] | Less expensive per gallon than tanker haul / holding tank. |

A third table entitled "Other Consideration in Comparison of Piped Utilities and a Truck Haul System" was also prepared. Table 3 provides a comparison of piped utilities and a truck haul system under several additional criteria that were suggested by the Community and / or VSW representatives during the course of the Supplemental Study. Table 3 follows.

**Table 3. Other Considerations in the Comparison of Piped Utilities and a Truck Haul System**

| Criteria | Piped Utilities | Truck Haul System |
|---|---|---|
| Maintenance skill level required | Requires more treatment plant operating skill, greater knowledge of process control | Requires a little less treatment plant operating skill, but much greater mechanical skill to maintain the washeteria equipment, in-home pressure systems and haul vehicle / road maintenance equipment |
| Susceptibility to catastrophic failure | Requires conscientious operator attention to avoid catastrophic failure, but failures are extremely rare in well designed systems which utilize modern materials | More components can fail (washeteria, haul vehicles, individual home pressurization units, etc.) but failures may inconvenience fewer customer |
| What happens if one-third of the residential customers can't pay their water and sewer bill? | Service will be shut off to those who don't pay. The annual cost to operate the system will decrease by approximately 10 percent. The monthly cost of service to both the School District and the remaining residential customers will increase by approximately 25% percent to $37,500/year for the school and $162/mo for the residential customer. As more customers subscribe to the service the monthly user bill will decrease. Those who can't afford the service will return to the honey bucket. | Those who can't pay won't receive service. The cost of service will remain about the same for the people who can pay. Operators would work fewer hours and get paid less. Those who can't afford the service will return to the honey bucket. |

**Table 3. Other Considerations in the Comparison of Piped Utilities and a Truck Haul System**

| Criteria | Piped Utilities | Truck Haul System |
|---|---|---|
| Does household size affect the monthly cost of service? | Most small Alaskan communities charges residential customer a flat monthly fee for piped water and sewer service. That fee allows the household to use as much water as it needs for domestic purposes regardless of household size. Some communities install water meters and charge residential customers per gallon of water used. The use of water meters makes billing more complicated. | The cost of haul service varies with household size and water use practices within the home. The criteria used in the economic analysis that follows assumes an average of 4.7 persons per household, each using three gallons of water per day, of which two gallons per day go to the wastewater holding tank. Under these assumptions the monthly cost of service would vary with household size as follows:<br><br>Size of household — Estimated monthly cost of service<br>1 — $23.00<br>2 — $46.00<br>3 — $69.00<br>4 — $92.00<br>5 — $114.90<br>6 — $137.90<br>7 — $160.85<br>8 — $183.80<br>9 — $206.80<br>10 — $229.80<br>11 — $252.75<br>12 — $275.75<br><br>As a practical matter, small households may use more water than the assumed three gallons per persons day and therefore may pay more on average than the estimated costs shown in the table. |

**Table 3. Other Considerations in the Comparison of Piped Utilities and a Truck Haul System**

| Criteria | Piped Utilities | Truck Haul System |
|---|---|---|
| How would School District facilities be served with water and sewer? | The School District would probably subscribe to piped water and sewer service from the Community and pay 17-24% of the operating cost of the new piped system. The community's existing water treatment plant would be abandoned. The school sewage lagoon would be abandoned. Wastewater generated at the school would be piped through community sewer lines to a new community wastewater lagoon southeast of town. | The School District uses too much water to be on a haul system. The school would either continue operating the existing water treatment plant or build its own plant. The school will either be required to install pipes to pump its wastewater to the community's new wastewater treatment lagoon or be allowed to continue using the existing school lagoon. |
| When can service start? | Half of the homes within the community can be served in the third year of construction. The remaining half can be served in year four. It will take approximately four years to complete the construction, assuming funds are available. | If approximately $80,000 of additional money is spent to purchase ATV powered water and wastewater haul units, up to ten homes could receive haul service in year two, or possibly as early as next year – if the existing water plant has capacity to supply water prior to completion of the new water plant. It will take approximately four years to serve all homes within the community, assuming funds are available. |

## SELECTION OF THE PREFERRED ALTERNATIVE

The Community met with a representative of the Village Safe Water Program and with CE2 Engineers on September 21, 1999 to consider the alternatives. Those in attendance included:

| | |
|---|---|
| Joseph Alexie | President, Tuluksak Native Community |
| Paul J. Alexie | Council Member |
| Sharon B. Alexie | Head Start Director |
| Joe Demantle, Sr. | Airport Manager |
| John Issac, Sr. | Community Member |
| Jack Kinegak, Sr. | School Maintenance |
| John Napoka, Jr. | School Board Member |
| Noel Owens | Council Member |
| Debra Addie | Village Safe Water |
| Chuck Eggener | CE2 Engineers |

Those present reviewed the following information:

- Drawing entitled "Preliminary Piped Water and Sewer System Layout"
- Capital and O&M cost estimates for both the truck haul and piped water and sewer alternatives
- Table 1, entitled "Household Water Use Activities and How Each Activity is Performed Under Three Water and Sewer Options" (honey bucket, truck haul, and piped utilities)
- Table 2, entitled "Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Three Water and Sewer Options" (honey bucket, truck haul, and piped utilities)
- Table 3, entitled "Other Considerations in the Comparison of Piped Utilities and a Truck Haul System"

In addition, some attendees described what they saw when they traveled, on a VSW sponsored trip, to St. Mary's to view the operation of a piped system and to Napakiak to view a haul system.

After in depth discussions of the alternatives, the attendees **unanimously decided that a piped water and sewer system would best serve the needs of the community**. The group chose to pursue grants to construct a piped water and sewer system. The decision was based primarily on the increased customer convenience and greater potential health benefit afforded by piped utilities.

The decision was not made without trepidation. Managing, operating and maintaining a sophisticated piped water and sewer system is no easy task. The Community currently lacks the organizational structure and administrative capability to succeed. Community leaders know that funding agencies will not grant monies for construction until Tuluksak takes steps to develop the necessary administrative and management capabilities.

## RECOMMENDED PHASED DEVELOPMENT PLAN

The following phased development plan is based on the conceptual layout and cost estimate for piped water and sewer presented earlier in this Study.

It is almost certain that the phased development plan will change as the project takes shape; land ownership, land use and other community development issues will need to be resolved.

Note also that year one of the phased development plan contains some interim improvements, such as closeout of existing honey bucket pits and implementation of an interim honey bucket haul system. These improvements are deemed necessary to provide minimal service to the Community until the piped utility system can be commissioned.

### Year One

| | |
|---|---|
| Modifications to the existing water treatment plant | $125,000 |
| Implementation of an interim community wide honey bucket haul system | 200,000 |
| Lagoon access road | 150,000 |
| Lagoon | 300,000 |
| Community equipment repair | 30,000 |
| Mapping / site control | 150,000 |
| Water source investigations | 20,000 |
| Community water well (2 ea.) | 160,000 |
| Utility Management Training | 40,000 |
| Design Engineering for future phases | 300,000 |
| *Year One Total* | *$1,475,000* |

### Year Two*

| | |
|---|---|
| Water transmission line | $268,400 |
| Water treatment plant with vehicle garage | 1,744,600 |
| Water storage tank | 268,400 |
| *Year Two Total* | *$2,281,400* |

### Year Three*

| | |
|---|---|
| West side water loop, loop 2 (6,032 lf) | $809,495 |
| West side sewer system with conveyance to lagoon | |
| Gravity main (7,515 lf) | 1,311,067 |
| Manhole (31 ea.) | 332,816 |
| Lift station (3 ea.) | 322,080 |
| Force main (1,150 lf) | 154,300 |
| *Year Three Total* | *$2,929,758* |

* Includes Engineering, Construction Management, and 10% Contingency

## Year Four*

| | | |
|---|---|---|
| West side house plumbing, phase I (45 ea.) | | $1,207,800 |
| West side water services, phase I (45 ea.) | | 483,120 |
| West side sewer services, phase I (45 ea.) | | 422,730 |
| | *Year Four Total* | *$2,113,650* |

## Year Five*

| | | |
|---|---|---|
| West side plumbing, phase II (30 units) | | $805,200 |
| West side water services, phase II (30 ea.) | | 322,080 |
| West side sewer services, phase II (30 ea.) | | 281,820 |
| North side sewer system | | |
| Gravity main (2,185 lf) | | 381,195 |
| Manhole (6 ea.) | | 64,416 |
| Lift station (1 ea.) | | 107,360 |
| Force main (50 lf) | | 6,710 |
| | *Year Five Total* | *$1,968,781* |

## Year Six*

| | | |
|---|---|---|
| North east water loop, loop 2 (7,025 lf) | | $942,755 |
| North east house plumbing (15 units) | | 402,600 |
| North east water services (15 ea.) | | 161,040 |
| North east sewer services (15 ea.) | | 140,910 |
| Landfill and access road | | 402,600 |
| | *Year Six Total* | *$2,049,905* |

## Year Seven*

| | | |
|---|---|---|
| Close out existing lagoon and landfill | | $100,650 |
| Maintenance equipment | | 161,040 |
| | *Year Seven Total* | *$261,690* |

**TOTAL PROJECT COST (1999 DOLLARS)** **$13,079,534**

* Includes Engineering, Construction Management, and 10% Contingency