Executive Summary

Introduction

CRW Engineering Group, LLC was hired to prepare assessments of communities throughout Alaska that do not have piped water and sewer systems. These communities are considered "unserved" as their current water and sewer service consists of small-haul, self-haul and/or honey buckets. Assessment work included drafting conceptual-level layouts of piped water and sewer systems, estimating the size of needed associated infrastructure and estimating both the O&M and capital costs of these systems.

Initially 36 village were identified as being "unserved." A few more were added for a total of 38 communities. This executive summary provides a brief overview of how the assessments were prepared and what conclusions could potentially be derived from the analysis. This was a desk-top level effort. Site visits were not included as part of the effort. The basis for the assessments was previous community information provided by VSW, available mapping from the DCCED and limited input from the communities and currently assigned engineers/project managers for those communities.

Sizing Model

The first step was to develop a system sizing model. Using industry-standard rules of thumb, we developed an excel-based spreadsheet that used the following:

- 20 year population growth of 1.5%
- Water demand of 50 gallons per person per day
- Max circulating water loop length 10,000 feet
- Water treatment facility-additions of 800 square feet for "good water" i.e. groundwater with minimal-required treatment and 1,200 for "poor water", i.e. surface water or groundwater high in iron and manganese
- Water storage tanks were sized based on daily demand, fire flows and 3 days of storage reserve. If the source is surface water, chlorine contact time was also factored into the sizing.
- Commercial, residential and school service numbers were obtained from the HITS database and a review of the DCCED Community Maps
- Upgraded two-cell sewage lagoons were sized to provide secondary treatment based on organic loading rates of 0.17 lbs of BOD5 per capita per day or hydraulic loading, whichever was greater

Soils & Foundation

We hired Golder Associates Inc. who provided us with a summary of soils information for each community. The recommendations for above grade vs below grade piping and the foundation type for buildings and water storage tanks, were based on the following:

- A review of the soils information from Golder. Generally speaking:
    - Soft, poorly drained soils or discontinuous permafrost = Pile foundations
    - Firm soils or continuous permafrost = Thermosyphon stabilized gravel pads
    - Stiff soils and no permafrost = Gravel pads
- Photographic research of existing foundations within the community (i.e. the school)
- Unique circumstances i.e. some communities may have soils suitable for a buried system but have a significant amount of buried historical resources, posing problems for a below grade system.

Water Mains & Services

All the water mains were laid out to be circulating loops with a max length of 10,000 feet. Multiple loops were used in several communities. All water services were assumed to be an average length of 75 feet and all use circulating pumps.

Gravity vs. Pressure Sewer

Most of the unserved communities are in flatter areas with ice-rich silty soils that are not conducive to gravity sewer systems. Where topo showed suitable elevation gain and soils were better, we proposed buried gravity sewer mains and service lines in combination with community lift stations as needed to pump waste to the lagoon. Systems in flatter areas are shown with above grade, pressure systems that use individual sewage pump stations at each structure. The systems for some communities included a combination of gravity and pressure sewer systems.

Capital and O&M Costs

The system components were input in the state-provided capital cost model, last updated in 2010. Additional costs were added for items not included in the model including sewage grinder pump stations and electrical service upgrades. Each capital cost estimate includes inflation (3%), 15% construction contingency and 20% for design and construction administration.

The O&M costs are a function of the population, number of services and local energy costs. Administration costs are fixed at $500 per month. Labor costs are a function of the size of the system (i.e. less than 50 services equates to 24 hours per week of operator time, etc.). Repair/replacement costs were calculated at 5% of the labor, fuel and electricity. Because of the desk-top nature of these assessments, it is not recommended that decision-making be solely based on the estimated O&M costs.

User Fees

Each assessment includes an estimate of the user fees that would be required to cover the costs of operating the piped water and sewer system. The user fee breakdown generally follows ARUC averages. As directed by the state, the following percentages were used:

- Residential Rate 59% of total O&M cost
- Commercial Rate 14.5% of total O&M cost
- School Rate 26.5% of total O&M cost

Since proposed user fees are based on the O&M estimates and the above directed percentages, it is not recommended that decision-making be solely based on these numbers. Those systems that show residential user fees within 10% to 20% of the estimated users' ability to pay, may benefit from future study.

Findings & Conclusions

The attached Chart 1 lists the communities in order by population, along with the estimated residential user fee and the Homeowners' ability to pay the fee. The ability to pay is based on 5% of the median household income for that community (obtained from US Census data). As can be seen on the chart, there is a clear and obvious relationship between the population and residential O&M costs. The smaller the community, the higher the user fee and vice versa. Based on the results of the assessment and with a few exceptions, Chart 1 generally shows that a piped system is unlikely to be affordable for a community with less than 100 residents.

Chart 2 lists the communities in order of population density, along with the overall population and estimated capital costs of the piped water and sewer system. Density was calculated as a function of population over the length of circulating water mains. The general trend of higher capital costs per person with lower community density can be seen. This shows the benefit to more dense community planning, in order to keep costs down for future projects. Additionally, some variation was found in the graph trend aside from density, which could usually be explained by the increased cost of transporting workers and materials to more remote communities.

Finally, there are a handful of other factors that can impact the costs of building and maintaining a piped water and sewer system:

1) Seasonal Water Source – A piped water system requires year round flows. Many communities use a seasonal water source. In these cases, we assumed a large raw water reservoir (storage tank) would be needed to provide the flows for a piped system. Heat add and circulation of such a large tank increases O&M costs. If this community has poor soils, a large tank could require a pile supported foundation which drives the costs up even further.

2) Functioning School – Because of the user fee breakdown, not having a school to cover almost 30% of the system O&M means residential and commercial customers carry a higher financial burden.

3) Community Population – As noted above, the population base covers the cost of operating and maintaining the system. The smaller the population, the larger the user fee.

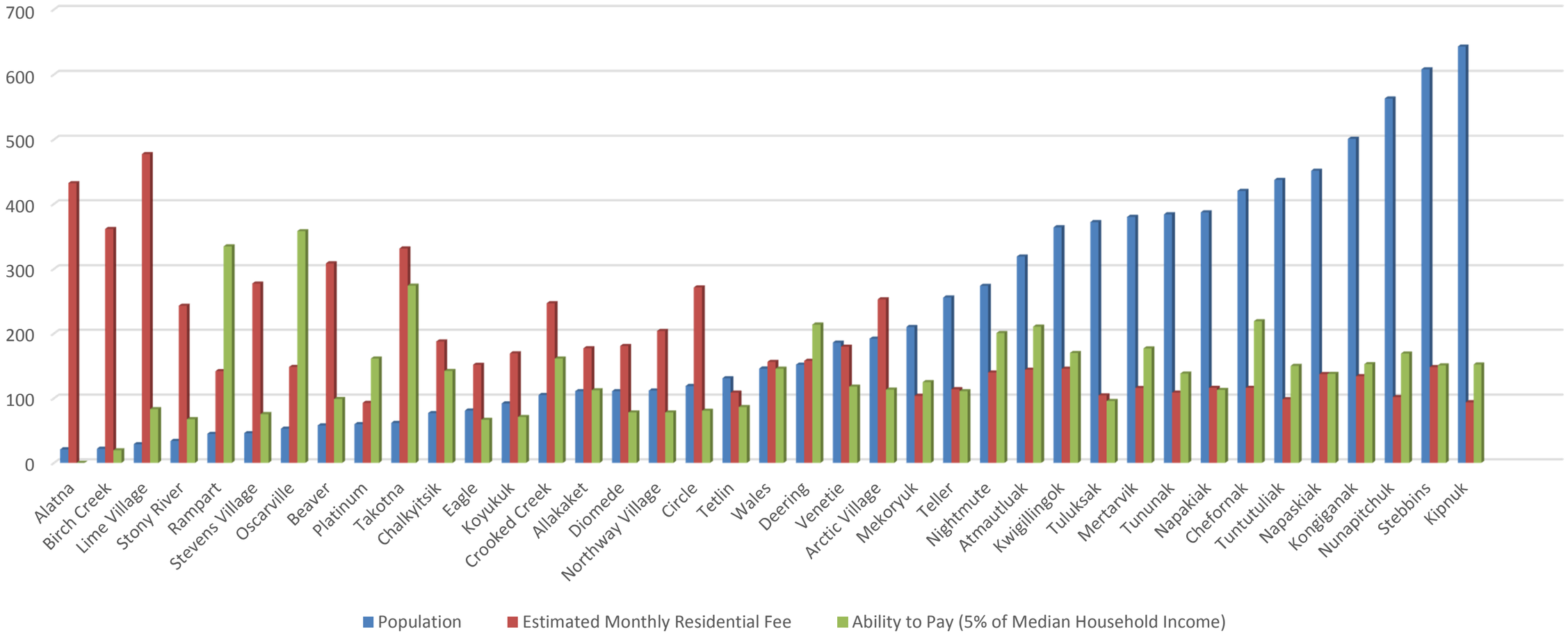
4) Community Layout/Density – If the community is spread out, pipe runs are longer which translates to increased capital costs. Longer pipe runs also increase the costs of heating and circulating, which means higher O&M costs.

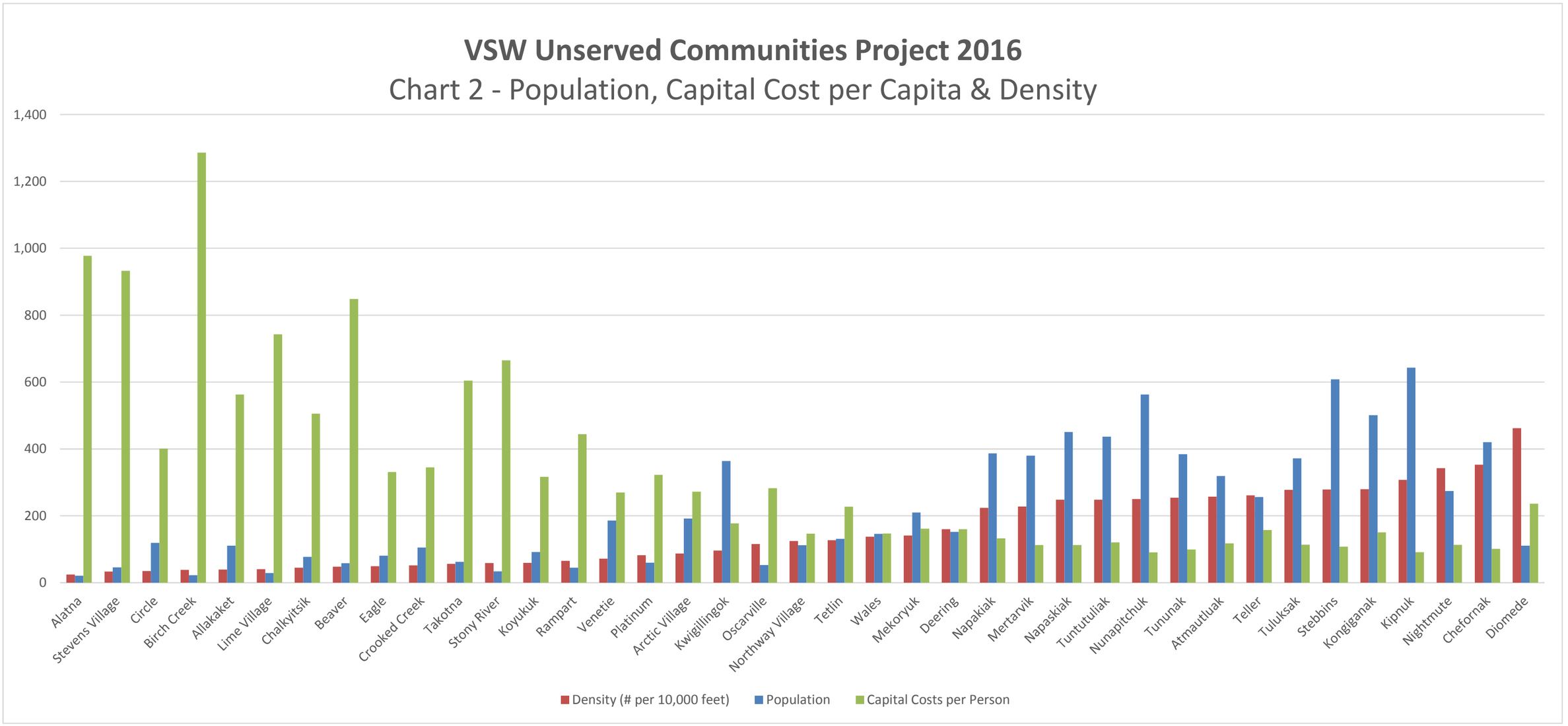
Generally speaking, those communities that have a year-round water source, a functioning school and are densely populated are good candidates for further study of a piped water and sewer system.

Attachments: Chart 1 – Population, Estimated Monthly Residential Fee & Ability to Pay
Chart 2 – Population, Capital Cost per Capita & Density

VSW Unserved Communities Project 2016

Chart 1 - Population, Estimated Monthly Residential Fee and Ability to Pay (5% Median Household Income)




VSW Unserved Communities Project 2016
Chart 2 - Population, Capital Cost per Capita & Density
1,400
1,200
1,000
800
600
400
200
0
Alatna
Stevens Village
Circle
Birch Creek
Allakaket
Lime Village
Chalkyitsik
Beaver
Eagle
Crooked Creek
Takotna
Stony River
Koyukuk
Rampart
Venetie
Platinum
Arctic Village
Kwigillingok
Oscarville
Northway Village
Tetlin
Wales
Mekoryuk
Deering
Napakiak
Mertarvik
Napaskiak
Tuntutuliak
Nunapitchuk
Tununak
Atmautluak
Teller
Tuluksak
Stebbins
Kongiganak
Kipnuk
Nightmute
Chefornak
Diomede
Density (# per 10,000 feet)
Population
Capital Costs per Person

Alatna, Alaska

Community Information & Existing Infrastructure

The Village of Alatna is an Inupiaq community of 21 people located on the north bank of Koyukuk River, southwest of its junction with the Alatna River. There are 17 residential units and 4 commercial/public facilities for a total of 21 services. The existing water and sewer services provided in Alatna consist of self-haul system from the central watering point attached to the water treatment plant and honey buckets. Only the washeteria/clinic discharge to the lagoon through a force main. The existing water and sewer infrastructure consists of the following:

- Well Water – 10 gpm transfer pump
- Treated Water Storage – 4,800 gallons
- Water Treatment Plant/Multi-Purpose Building – 2,312 SF, built in 2008
- Water Treatment – Filtration, chlorination, and potassium permanganate
- Sewage Lagoon – Two Cell, 1.2 acres

Soils around Alatna consist of non-plastic silt material with permafrost approximately 8-18 feet below surface.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 8,500 feet of pipe, and the pressure sewer system approximately 5,900 feet of pipe. The water system will consist of a single circulating loop. The pressure sewer system would require individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	2	10	-
Water Storage (gallons)	40,200	4,800	35,400
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	0.4	1.2	-
Required Foundation System for WTP and/or WST			
Pile Foundation	1,840	-	1,840
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	8,500	-	8,500
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,900	-	5,900
Individual Grinder Pump Stations (GPS) (ea)	21	-	21
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	1,600	-	1,600
Pressure Sewer Service Lines (lf)	1,600	-	1,600

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Alatna. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Alatna	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	21	$28,096.69	$590,031
3	Sewage collection mains or services (gravity or force), above ground	LF	7,500	$323.17	$2,423,773
12	Water distribution, mains or services, above ground	LF	10,100	$435.26	$4,396,125
14	Water storage tank, no foundation	Gal	35,400	$12.80	$453,226
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
18	Foundation - freeze back piles	SF	1,840	$692.10	$1,273,464
				Total Estimated Cost in 2010 dollars (rounded):	**$12,112,000**
				Total with Inflation (3% per year for 6 years)	**$14,462,400**
27	Individual Grinder Pump Stations	EA	21	$30,000	$630,000
28	Electrical Service Upgrades	EA	21	$5,500	$115,500
				Subtotal	**$15,207,900**
29	Construction Contingency (15%)	LS	1	$2,281,200	$2,281,200
30	Design & Construction Administration Services (20%)	LS	1	$3,041,600	$3,041,600
				Total	**$20,530,700**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$40,500
Electricity	$21,900
Other (R&R, Training, etc.)	$13,000
Total	**$106,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Alatna are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 432	17	85%	**$ 74,900**
Public/Commercial Service	$ 648	4	100%	**$ 31,100**
School Service	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 106,000**

OSCAR'S WAY

CLINIC & WASHETERIA

EDWARDS LANE

SEWAGE LAGOON

SAMS DRIVE

WATER TREATMENT PLANT

ALATNA RIVER DRIVE

COMMUNITY WELL

KOYUKUK RIVER

KOYUKUK RIVER

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

250' 0 250' 500'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

ALATNA

DATE MAR 2015

SCALE GRAPHIC

FIGURE 1

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Alatna.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	2/26/2016
Community	Alatna
Input	

Existing Community & System Data

2015 Population	21
2015 Number of Services	21
HITS Database (E1 & H1-H7)	17
DCED Mapping Commerical/Public Facilities/School	4
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	4800
Water Treatment Capacity	10
Existing Sewage Lagoon Size	1.2

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	5854	8464
Gravity Sewer Main		0	
Pressure Sewer Main	x	5854	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Alatna**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**2**	
Req Water Storage (gallons) (less existing)	**35,400**	**640 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**-**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,840**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**8,500**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**5,900**	
	Individual Grinder Pump Stations (GPS) (ea)	**21**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**1,600**	
	Pressure Sewer Service Lines (lf)	**1,600**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	2	10	-
Water Storage (gallons)	40,200	4,800	35,400
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	0.4	1.2	-
Required Foundation System for WTP and/or WST			
Pile Foundation	1,840	-	1,840
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	8,500	-	8,500
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,900	-	5,900
Individual Grinder Pump Stations (GPS) (ea)	21	-	21
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	1,600	-	1,600
Pressure Sewer Service Lines (lf)	1,600	-	1,600

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 2/26/2016

Community Alatna

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	21	people	2015 ADOL
2015 Number of Services	21	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***26***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	10	gpm	
Average Day (ADD)	1,281	gpd	50 gallons per Capita
Max Day (MDD)	2,562	gpd	2 x ADD
Peak Hour	5	gpm	3 x MDD
Treatment Capacity	***2***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	2	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	4,800	gallons	Built in 2010
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	2,562	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	7,687	gallons	3 days x DO
Water Storage Tank Volume	40,250	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	9,077	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***40,200***	***gallons***	
Required Additional Storage	***35,400***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***640***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	3	acres	
Organic Loading Based Size	0.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	79.1		
Hydraulic Loading Based Size	0.4	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***0.4***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Alatna

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	21	$28,096.69	$590,031
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	7,500	$323.17	$2,423,773
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	10,100	$435.26	$4,396,125
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	35,400	$12.80	$453,226
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	1,840	$692.10	$1,273,464
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$12,112,277**

O&M Cost Estimate
Piped Water & Sewer System

Community: Alatna

General Community Data

Current population	21	persons
Average number of people per house	1.2	
Service Connections		
Number of houses	17	
Number of public/commerical buildings	4	
Number of schools	0	
Total number of service connections	21	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.66	kWh
Electricity cost (Residential service)	$0.24	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	1280	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	3512	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	40,200	gallons
Length of water line to/ from tank	75	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	8500	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains	4810	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	990	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$1,076	/month		$8,609.51
Raw water line	$0	/month		$0.00
Raw water heat addition	$77	/month		$919.30
Water storage tank	$37	/month		$293.30
Water storage tank line	$16	/month		$131.33
Water mains	$1,860	/month		$14,884
Service lines	$345	/month		$2,758
Wastewater system				
Sewer mains	$1,053	/month		$8,423
Service lines	$345	/month		$2,758
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$217	/month		$1,734
			Subtotal	$40,500
Electricity				
Water system				
WTP building				
Lights and controls	$676	/month		$8,118
HVAC/hydronic system	$676	/month		$5,412
Water treatment	$11	/month		$126
Pumps				
Intake or well	$11	/month		$126.40
WST circulation	$89	/month		$713
Pressure/booster	$16	/month		$189.60
Main line circulation	$709	/month		$5,671
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$177	/month		$1,415
Lagoon discharge pump	$152	/year		$152
			Subtotal	$21,900
Other Costs				
Equipment R&R	$4,368	/year		$4,368
Miscellaneous materials & supplies	$2,621	/year		$2,621
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$13,000

Summary

Administration	$6,000
Labor	$25,000
Fuel	$40,500
Electricity	$21,900
Other	$13,000
Total	$106,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 432	17	85%	**$ 74,900**
Public/Commerc	$ 647.92	4	100%	**$ 31,100**
School Service (	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 106,000**

Allakaket, Alaska

Community Information & Existing Infrastructure

The City of Allakaket is a Koyukon community of 111 people located on the south bank of the Koyukuk River, southwest of the Alatna River junction. There are 68 residential units, 13 commercial/public facilities and one school for a total of 82 services. The existing water and sewer services provided in Allakaket consist of self-haul system from watering points and honey buckets. The water treatment plant and washeteria discharge to the lagoon through a force main. The existing water and sewer infrastructure consists of the following:

- Well Water – 20 gpm transfer pump
- Treated Water Storage – 100,000 gallons
- Water Treatment Plant/Washeteria – 2,048 SF, built in 1996
- Water Treatment – Addition of chlorine and fluoride
- Sewage Lagoon – Two Cell, 0.8 acres

City of Allakaket is located within the continuous permafrost region of Alaska. Most areas are underlain by fine-grained frozen soils varying in depth.

Piped System Description

The piped water and sewer system will be a combination of above and below grade piping. The northern part of the community is flat terrain and would best be served by an above ground pressure sewer system (10,600 LF) and circulating water loop (16,300 LF). The southern area of the community is built on a hillside and can likely accommodate a buried gravity sewer system (7,600 linear feet) and circulating water main (11,600 LF). A total of 22 services will be connected to the buried gravity sewer will not require individual grinder pump stations (GPS). Approximately 55 homes and buildings on the north side would require GPS units. The pressure sewer system including the force main will require two sewer main lift stations, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 800 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	20	-
Water Storage (gallons)	84,200	100,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	800	-	800
Sewage Lagoon Size (acre)	2.4	0.8	1.6
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	800	-	800
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	27,900	-	27,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	20,200	-	20,200
Individual Grinder Pump Stations (GPS) (ea)	55	-	55
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	6,200	-	6,200
Pressure Sewer Service Lines (lf)	4,200	-	4,200
Gravity Sewer Service Lines (lf)	2,000	-	2,000

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Allakaket. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs

Village: Allakaket

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	82	$28,096.69	$2,303,929
2	Sewage collection mains or services (gravity or force), buried	LF	9,600	$585.53	$5,621,061
3	Sewage collection mains or services (gravity or force), above ground	LF	16,800	$308.62	$5,184,824
4	Sewage lift station	EA	2	$1,172,426.77	$2,344,854
10	Sewage lagoon, barrow, local material	Acre	1.6	$1,157,613.17	$1,852,181
12	Water distribution, mains or services, above ground	LF	34,100	$426.53	$8,701,122
13	Water distribution, mains or services, buried	LF	13,700	$594.07	$8,138,772
15	Water treatment plant, no foundation	SF	800	$2,542.06	$2,033,649
19	Foundation - thermosyphen stabilized gravel pad	SF	800	$1,049.95	$839,957
				Total Estimated Cost in 2010 dollars (rounded):	**$37,020,000**

Estimated Capital Costs (cont.)					
				Total with Inflation (3% per year for 6 years)	**$44,203,800**
27	Individual Grinder Pump Stations	EA	60	$30,000	$1,650,000
28	Electrical Service Upgrades	EA	82	$5,500	$451,000
				Subtotal	**$46,304,800**
29	Construction Contingency (15%)	LS	1	$6,945,700	$6,945,700
30	Design & Construction Administration Services (20%)	LS	1	$9,261,000	$9,261,000
				Total	**$62,511,500**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$26,600
Fuel	$116,700
Electricity	$38,100
Other (R&R, Training, etc.)	$20,500
Total	**$207,900**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Allakaket are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 177	68	85%	**$ 122,995**
Public/Commercial Service	$ 186	13	100%	**$ 29,046**
School Service	$ 6,206	1	100%	**$ 55,858**
Local Capital Contribution				**$ -**
Total Revenue				**$ 207,900**

Due to the layout of the community and the required water main length needed to serve the north and south sections of town, this project would be ideal for the incorporation of a heat recovery system.

KOYUKUK RIVER

SCHOOL SEWAGE LAGOON

SCHOOL

UTILITY BUILDING

EXISTING WELL

RAW WATER LINE

SEWAGE LAGOON

LIFT STATION #1

ABOVE GRADE PIPE SECTION

WATER WELL ROAD

LIFT STATION #2

BURIED PIPE SECTION

WASHETERIA

SCHOOL ROAD

WATER ROAD

SEWER ROAD

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

300' 0 300' 600'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

ALLAKAKET

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 2

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Allakaket.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/4/2016
Community	Allakaket
Input	

Existing Community & System Data

2015 Population	111
2015 Number of Services	82
HITS Database (E1 & H1-H7)	68
DCED Mapping Commerical/Public Facilities/School	14
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Good
Water Storage Tank	100000
Water Treatment Capacity	20
Existing Sewage Lagoon Size	0.8

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	20200	27900
Gravity Sewer Main	x	7600	
Pressure Sewer Main	x	12600	
Typical Service Line Length (ea)		75	75

Piped System Requirements — **Community** **Allakaket**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**9**	
Req Water Storage (gallons) (less existing)	**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**800**	**800 sf**
Req Sewage Lagoon Size (acre) (less existing)	**1.6**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**800**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**27,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**20,200**	
	Lift Stations for Gravity Sewer Mains	**2**	
	Individual Grinder Pump Stations (GPS) (ea)	**55**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**6,200**	
	Gravity Sewer Service Lines (lf)	**2,000**	
	Pressure Sewer Service Lines (lf)	**4,200**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	9	20	-
Water Storage (gallons)	84,200	100,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	800	-	800
Sewage Lagoon Size (acre)	2.4	0.8	1.6
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	800	-	800
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	27,900	-	27,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	20,200	-	20,200
Individual Grinder Pump Stations (GPS) (ea)	55	-	55
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	6,200	-	6,200
Pressure Sewer Service Lines (lf)	4,200	-	4,200
Gravity Sewer Service (lf)	2,000	-	2,000

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/4/2016
Community Allakaket

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	111	people	2015 ADOL
2015 Number of Services	82	services	Only 55 will require GPS units
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***135***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	20	gpm	
Average Day (ADD)	6,772	gpd	50 gallons per Capita
Max Day (MDD)	13,544	gpd	2 x ADD
Peak Hour	28	gpm	3 x MDD
Treatment Capacity	***9***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	9	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	100,000	gallons	Built in 2010
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	13,544	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	40,632	gallons	3 days x DO
Water Storage Tank Volume	84,176	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	47,980	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***84,200***	***gallons***	
Required Additional Storage	***-***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***-***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Good		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***800***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0.8	acres	
Organic Loading Based Size	1.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	181.8		
Hydraulic Loading Based Size	2.4	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***2.4***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Allakaket

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	82	$28,096.69	$2,303,929
2	Sewage collection mains or services (gravity or force), buried	LF	9,600	$585.53	$5,621,061
3	Sewage collection mains or services (gravity or force), above ground	LF	16,800	$308.62	$5,184,824
4	Sewage lift station	EA	2	$1,172,426.77	$2,344,854
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.6	$1,157,613.17	$1,852,181
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	20,400	$426.53	$8,701,122
13	Water distribution, mains or services, buried	LF	13,700	$594.07	$8,138,772
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	800	$2,542.06	$2,033,649
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	800	$1,049.95	$839,957
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$37,020,349**

O&M Cost Estimate
Piped Water & Sewer System

Community: Allakaket (North Side Plus)

General Community Data

Current population		111	persons
Average number of people per house		2.4	
Service Connections (North Side)			
Number of houses		46	
Number of public/commerical buildings		8	
Number of schools		1	
	Total number of service connections	55	
Burdened labor rate		$16	hr
Electricity cost (Public facilty)		$0.66	kWh
Electricity cost (Residential service)		$0.24	kWh
Cost per gallon for heating oil		$6.00	gal
Water consumption per capita		50	gpd
Wastewater generation per capita		50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	2532	ft
Water line heated for freeze protection (Yes or No)	Y	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Treatment

Size of water treatment plant building	2848	sf
Raw water quality (Good or Poor)	Good	

Water Storage

Size of tank(s)	100,000	gallons
Length of water line to/ from tank	60	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main (North Side)	16300	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	51	
Number of facilities served by lift/pump station #2	82	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains (North Side)	10600	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	1970	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$26,624
Fuel (Heating Demand)				
Water system				
WTP building	$873	/month		$6,981.75
Raw water line	$0	/month		$0.00
Raw water heat addition	$405	/month		$4,859.14
Water storage tank	$91	/month		$729.60
Water storage tank line	$13	/month		$105.06
Water mains	$3,568	/month		$28,542
Service lines	$903	/month		$7,223
Wastewater system				
Sewer mains	$2,320	/month		$18,561
Service lines	$903	/month		$7,223
Lift/pump station buildings	$306	/month		$2,451.46
Force main to lagoon	$431	/month		$3,450
			Subtotal	$80,100
Electricity				
Water system				
WTP building				
Lights and controls	$549	/month		$6,583
HVAC/hydronic system	$549	/month		$4,389
Water treatment	$11	/month		$134
Pumps				
Intake or well	$56	/month		$668.13
WST circulation	$89	/month		$713
Pressure/booster	$84	/month		$1,002.20
Main line circulation	$709	/month		$5,671
Wastewater system				
Lift /pump station buildings				
Lights and controls	$193	/month		$2,311
HVAC/hydronic system	$193	/month		$1,541
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$193	/month		$2,318.12
Sewer/force main glycol circulation	$177	/month		$1,415
Lagoon discharge pump	$802	/year		$802
			Subtotal	$27,500
Other Costs				
Equipment R&R	$6,711	/year		$6,711
Miscellaneous materials & supplies	$4,027	/year		$4,027
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$16,700

Summary (North Side Plus)

Administration	$6,000
Labor	$26,600
Fuel	$80,100
Electricity	$27,500
Other	$16,700
Total	$157,000

Summary (North & South)

Administration	$6,000
Labor	$26,600
Fuel	$116,700
Electricity	$38,100
Other	$20,500
Total	$207,900

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 177	68	85%	**$ 122,995**
Public/Commerc	$ 186.19	13	100%	**$ 29,046**
School Service (	$ 6,206.50	1	100%	**$ 55,858**
Local Capital Contribution				**$ -**
Total Revenue				**$ 207,900**

O&M Cost Estimate
Piped Water & Sewer System

Community: Allakaket (South Side)

General Community Data

Current population		persons
Average number of people per house	0.0	
Service Connections (South Side)		
Number of houses	22	
Number of public/commerical buildings	5	
Number of schools	0	
Total number of service connections	27	
Burdened labor rate	$16	hr
Electricity cost (Public facilty)	$0.66	kWh
Electricity cost (Residential service)	$0.24	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))		
Length of raw water line		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Treatment		
Size of water treatment plant building		sf
Raw water quality (Good or Poor)		
Water Storage		
Size of tank(s)		gallons
Length of water line to/ from tank		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	11600	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains	7600	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main		ft
Force main heated for freeze protection (Yes or No)		
Location of force main (Above ground (AG) or Buried)		
Lagoon discharged seasonally with pump (Yes or No)		

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management		/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$0	/month		$0
Labor (WTP Operator)	24	hrs/week		$0
Fuel (Heating Demand)				
Water system				
WTP building	$0	/month		$0.00
Raw water line	$0	/month		$0.00
Raw water heat addition	$0	/month		$0.00
Water storage tank	$0	/month		$0.00
Water storage tank line	$0	/month		$0.00
Water mains	$1,523	/month		$18,281
Service lines	$266	/month		$3,191
Wastewater system				
Sewer mains	$998	/month		$11,977
Service lines	$266	/month		$3,191
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$0	/month		$0
			Subtotal	$36,600
Electricity				
Water system				
WTP building				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Water treatment	$0	/month		$0
Pumps				
Intake or well	$0	/month		$0.00
WST circulation	$0	/month		$0
Pressure/booster	$0	/month		$0.00
Main line circulation	$709	/month		$8,506
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$177	/month		$2,123
Lagoon discharge pump	$0	/year		$0
			Subtotal	$10,600
Other Costs				
Equipment R&R	$2,360	/year		$2,360
Miscellaneous materials & supplies	$1,416	/year		$1,416
Water quality testing	$0	/year		$0
Operator training	$0	/year		$0
Insurance	$0	/year		$0
			Subtotal	$3,800

Summary (South Side)

Administration	$0	Covered in North Plus Estimate
Labor	$0	Covered in North Plus Estimate
Fuel	$36,600	
Electricity	$10,600	
Other	$3,800	
Total	$51,000	

Arctic Village, Alaska

Community Information & Existing Infrastructure

Arctic Village is a Gwichin community of 192 people located on a terrace above the east fork of the Chandalar River, a tributary of the Yukon River. There are 59 residential units, 15 commercial/public facilities and one elementary/high school for a total of 75 services. The existing water and sewer services provided in Arctic Village consist of self-haul water system from the water treatment building and outhouses. The water treatment plant/washeteria and school are served with piped water and sewer. The existing water and sewer infrastructure consists of the following:

- Chandalar River – 25 gpm portable transfer pump
- Treated Water Storage – 100,000 gallons
- Water Treatment Plant/Washeteria – 2,158 SF, built in 2015/2016
- Water Treatment – Conventional filtration and chlorination
- Sewage Lagoon – Single Cell, 0.8 acres

Arctic Village is situated on the northern edge of the Porcupine Plateau Physiographic Province just south of the eastern Brooks Range. The area is generally underlain by frozen sand and silt. The thickness of the permafrost ranges from 5 to 10 feet deep.

Piped System Description

The piped water and sewer system will be buried and consist of approximately 22,000 feet of circulating water mains, and 13,100 feet of pressure sewer mains. The water system will consist of three circulating loops. The pressure sewer system would require individual grinder pump stations at each building, glycol heat trace for freeze protection, and one lift station to transport wastewater to the lagoon. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 600 sf facility is included to house the equipment needed for water distribution equipment. The existing 100,000 gallon water storage tank is sufficient to meet the CT-required volume of 83,000 gallons and provide a small reserve for fire flows.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	16	25	-
Water Storage (gallons)	83,000	100,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	600	-	600
Sewage Lagoon Size (acre)	4.1	0.8	3.3
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	600	-	600
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	22,000	-	22,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	13,100	-	13,100
Individual Grinder Pump Stations (GPS) (ea)	74	-	74
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,600	-	5,600
Pressure Sewer Service Lines (lf)	5,600	-	5,600

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Arctic Village. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs

Village: Arctic Village

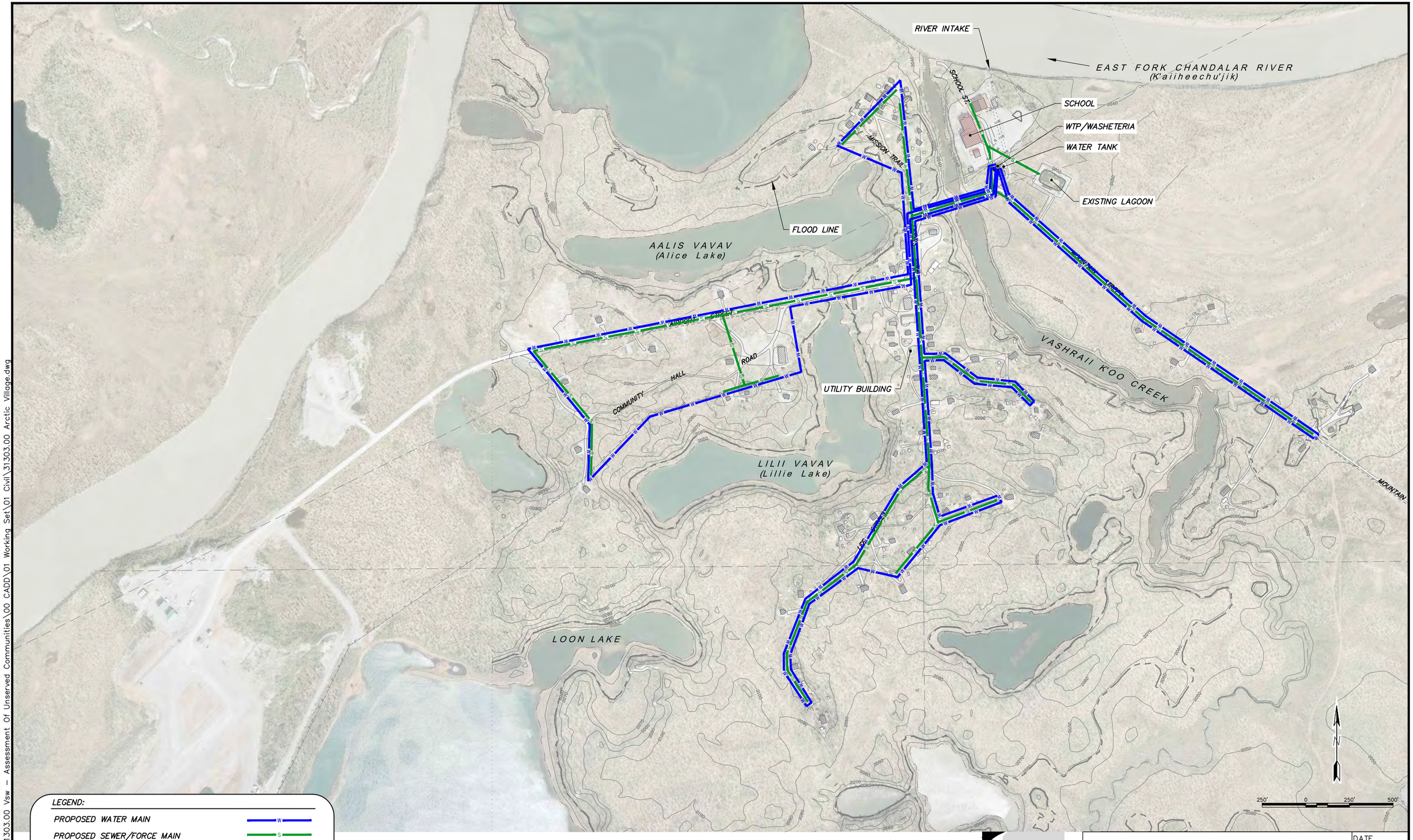
Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	74	$28,096.69	$2,079,155
2	Sewage collection mains or services (gravity or force), buried	LF	12,750	$566.33	$7,220,716
3	Sewage collection mains or services (gravity or force), above ground	LF	350	$860.09	$301,030
4	Sewage lift station	EA	1	$1,097,461.43	$3,292,384
10	Sewage lagoon, barrow, local material	Acre	3.3	$997,504.08	$3,291,763
12	Water distribution, mains or services, above ground	LF	27,600	$424.29	$11,710,440
15	Water treatment plant, no foundation	SF	600	$2,604.41	$1,562,645
19	Foundation - thermosyphen stabilized gravel pad	SF	600	$1,329.95	$797,967
				Total Estimated Cost in 2010 dollars (rounded):	**$30,256,000**
				Total with Inflation (3% per year for 6 years)	**$36,127,200**
27	Individual Grinder Pump Stations	EA	75	$30,000	$2,220,000
28	Electrical Service Upgrades	EA	75	$5,500	$407,000
				Subtotal	**$38,754,200**
29	Construction Contingency (15%)	LS	1	$5,813,100	$5,813,100
30	Design & Construction Administration Services (20%)	LS	1	$7,750,800	$7,750,800
				Total	**$52,318,100**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$26,600
Fuel	$177,100
Electricity	$44,600
Other (R&R, Training, etc.)	$25,900
Total	**$280,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Arctic Village are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 253	59	85%	**$ 152,382**
Public/Commercial Service	$ 266	15	100%	**$ 47,857**
School Service	$ 8,862	1	100%	**$ 79,761**
Local Capital Contribution				**$ -**
Total Revenue				**$ 280,000**



LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00
STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES
ARCTIC VILLAGE

DATE: MAR 2015
SCALE: GRAPHIC
FIGURE: 3

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Arctic Village.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/6/2016
Community	Arctic Village
Input	

Existing Community & System Data	
2015 Population	192
2015 Number of Services	75
HITS Database (E1 & H1-H7)	59
DCED Mapping Commerical/Public Facilities/School	16
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	100000
Water Treatment Capacity	25
Existing Sewage Lagoon Size	0.8

Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	13100	22000
Gravity Sewer Main		0	
Pressure Sewer Main	x	13100	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Arctic Village**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**16**	
Req Water Storage (gallons) (less existing)		**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**600**	**600 sf**
Req Sewage Lagoon Size (acre) (less existing)		**3.3**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**600**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**22,000**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**13,100**	
	Individual Grinder Pump Stations (GPS) (ea)	**74**	school already connected
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**5,600**	
	Pressure Sewer Service Lines (lf)	**5,600**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	16	25	-
Water Storage (gallons)	83,000	100,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	600	-	600
Sewage Lagoon Size (acre)	4.1	0.8	3.3
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	600	-	600
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	22,000	-	22,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	13,100	-	13,100
Individual Grinder Pump Stations (GPS) (ea)	74	-	74
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,600	-	5,600
Pressure Sewer Service Lines (lf)	5,600	-	5,600

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/6/2016

Community Arctic Village

System Parameters	Model Results			Criteria & Calculations
Design Population				
Duration (n)	20	years		20 years
2015 Population (P)	192	people		2015 ADOL
2015 Number of Services	74	services		Decrease to 74 because the school is already served
Growth Rate (i)	1%			1%
2035 Design Population (Capita)	***234***	***people***		Px(1+i)^n
Water Demand Estimates				
Existing Capacity	25	gpm		
Average Day (ADD)	11,714	gpd		50 gallons per Capita
Max Day (MDD)	23,428	gpd		2 x ADD
Peak Hour	49	gpm		3 x MDD
Treatment Capacity	***16***	***gpm***		MDD
Water Source Assumptions				
Type (surface water or groundwater)	SW			
Required Capacity	16	gpm		MDD
Water Storage Tank Sizing				
Existing Water Storage Tank	100,000	gallons		
Demand Based Volume (if source is GW)	Check Min CT Requirements			
Daily Operation (DO) (gallons)	23,428	gallons		Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons		500 gpm for 60 minutes
Reserve Volume (RV)	70,283	gallons		3 days x DO
Water Storage Tank Volume	123,711	gallons		DO + FF + RV
CT Based Volume (min if source is SW)	Required			
Chlorine Residual Concentration (RC)	0.4	mg/L		0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation		1.0-log Inactivation
Temperature (T)	4.4	C		4.4 celsius/40 F
pH (PH)	7			7
Contact Time Required (CT)	49	minutes		LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1			0.1
Required Volume to meet CT*	82,992	gallons		CT/RCxPeak Hour/BF
Required Water Storage	***83,000***	***gallons***		Existing Tank is larger than CT-Required Tank
Required Additional Storage	-	***gallons***		0
Estimate of Min Platform Size (3' clearance around)	-	***sf***		D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
				0
Water Treatment Plant Requirements*				
Water Quality	Poor			Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***600***	***sf***		Good Water Quality (no treatment other than CL) = 800 sf The WTP is brand new. Additional space of 600 sf is sufficient to accommodate distribution system equipment.
Foundation (WST and WTP)				
Soft poorly drained soils or discontinuous permafrost	**0**			Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**			Gravel pad
Water Distribution (Check either or both)				
Buried system with no permafrost	**0**			Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***		Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)				
Buried system with no permafrost	**0**			Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***		Sewer main with glycol heat trace
Gravity Sewer Main	**0**			Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)				
Static Water Main	**0**			Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***		Circulating Water Service Lines
Gravity Sewer Main	**0**			Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***		Pressure Service Line with GPS
Sewage Lagoon Size				
Existing Sewage Lagoon	0.8	acres		
Organic Loading Based Size	2.0	acres		0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	239.1			
Hydraulic Loading Based Size	4.1	acres		Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***4.1***	***acres***		Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Arctic Village

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	74	$28,096.69	$2,079,155
2	Sewage collection mains or services (gravity or force), buried	LF	12,750	$566.33	$7,220,716
3	Sewage collection mains or services (gravity or force), above ground	LF	350	$860.09	$301,030
4	Sewage lift station	EA	3	$1,097,461.43	$3,292,384
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	3.3	$997,504.08	$3,291,763
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	27,600	$424.29	$11,710,440
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	600	$2,604.41	$1,562,645
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	600	$1,329.95	$797,967
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$30,256,100**

O&M Cost Estimate
Piped Water & Sewer System

Community: Arctic Village

General Community Data

Current population	192	persons
Average number of people per house	3.3	
Service Connections		
Number of houses	59	
Number of public/commerical buildings	15	
Number of schools	1	
Total number of service connections	75	
Burdened labor rate	$16	hr
Electricity cost (Public facilty)	$0.54	kWh
Electricity cost (Residential service)	$0.36	kWh
Cost per gallon for heating oil	$12.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	600	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	2758	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	100,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	3	
Total length of Water Main	22000	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	75	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	12750	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	350	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$26,624
Fuel (Heating Demand)				
Water system				
WTP building	$1,690	/month		$13,522.23
Raw water line	$263	/month		$2,101.25
Raw water heat addition	$1,401	/month		$11,206.66
Water storage tank	$182	/month		$1,459.20
Water storage tank line	$22	/month		$175.10
Water mains	$5,778	/month		$69,341
Service lines	$1,477	/month		$17,729
Wastewater system				
Sewer mains	$3,349	/month		$40,186
Service lines	$1,477	/month		$17,729
Lift/pump station buildings	$306	/month		$2,451.46
Force main to lagoon	$153	/month		$1,226
			Subtotal	$177,100
Electricity				
Water system				
WTP building				
Lights and controls	$435	/month		$5,216
HVAC/hydronic system	$435	/month		$5,216
Water treatment	$79	/month		$946
Pumps				
Intake or well	$79	/month		$945.56
WST circulation	$73	/month		$583
Pressure/booster	$118	/month		$1,418.34
Main line circulation	$1,740	/month		$20,879
Wastewater system				
Lift /pump station buildings				
Lights and controls	$79	/month		$946
HVAC/hydronic system	$79	/month		$630
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$120	/month		$1,442.38
Sewer/force main glycol circulation	$434	/month		$5,210
Lagoon discharge pump	$1,135	/year		$1,135
			Subtotal	$44,600
Other Costs				
Equipment R&R	$12,416	/year		$12,416
Miscellaneous materials & supplies	$7,450	/year		$7,450
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$25,900

Summary

Administration	$6,000
Labor	$26,600
Fuel	$177,100
Electricity	$44,600
Other	$25,900
Total	$280,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 253	59	85%	**$ 152,382**
Public/Commerc	$ 266	15	100%	**$ 47,857**
School Service (	$ 8,862	1	100%	**$ 79,761**
Local Capital Contribution				**$ -**
Total Revenue				**$ 280,000**

Atmautluak, Alaska

Community Information & Existing Infrastructure

Atmautluak is a Yup'ik community of 319 people located on the west bank of the Pikmiktalik River, 20 miles northwest of Bethel within the Yukon-Kuskokwim Delta. There are 63 residential units, 19 commercial/public facilities, one elementary school and one high school for a total of 84 services. The existing water and sewer services provided in Atmautluak consist of self-haul system from a watering point located at the water treatment plant, and sewage bunkers throughout the community. The existing water and sewer infrastructure consists of the following:

- Well Water – 20 gpm transfer pump
- Treated Water Storage – 10,000 gallons
- Water Treatment Plant/Washeteria – 2,048 SF, built in 1980
- Water Treatment – Greensand filter and potassium permanganate

The community currently utilizes a tundra honeybucket lagoon and pond, which equates to a little over 10 acres to dispose of the community's waste. While not uncommon in the region, tundra sewage lagoons can be extremely difficult to quantify, properly maintain, and permit. For the purposes of this assessment, the tundra lagoons are not included as an existing "usable" facility.

The area around Atmautluak is generally underlain by continuous permafrost with thawed areas adjoining large bodies of water. The soil is characterized as poorly drained, medium loam with a medium erosion potential. The surface layer consists of poorly drained, non-arable fibrous peat.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 14,900 feet of pipe, and the pressure sewer approximately 8,700 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require individual grinder pump stations at each house, glycol heat treat for freeze protection, and a lift station to transport wastewater to the lagoon. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	27	20	7
Water Storage (gallons)	185,700	10,000	175,700
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	6.8	-	6.8
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	3,620	-	3,620
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	12,400	-	12,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,500	-	9,500
Individual Grinder Pump Stations (GPS) (ea)	84	-	84
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	6,300	-	6,300
Pressure Sewer Service Lines (lf)	6,300	-	6,300

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Atmautlauk. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30):

Estimated Capital Costs

Village: Atmautluak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	84	$26,403.25	$2,217,873
3	Sewage collection mains or services (gravity or force), above ground	LF	15,800	$200.95	$3,174,979
4	Sewage lift station	EA	1	$678,792.59	$678,793
10	Sewage lagoon, barrow, local material	Acre	6.8	$694,724.45	$4,724,126
12	Water distribution, mains or services, above ground	LF	18,700	$331.68	$6,202,500
14	Water storage tank, no foundation	Gal	175,700	$2.73	$479,969
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
18	Foundation - freeze back piles	SF	3,620	$326.71	$1,182,688
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$20,777,000**
				Total with Inflation (3% per year for 6 years)	**$24,808,800**
27	Individual Grinder Pump Stations	EA	84	$30,000	$2,520,000
28	Electrical Service Upgrades	EA	84	$5,500	$462,000
				Subtotal	**$27,790,800**
29	Construction Contingency (15%)	LS	1	$4,168,600	$4,168,600
30	Design & Construction Administration Services (20%)	LS	1	$5,558,200	$5,558,200
				Total	**$37,517,600**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$33,300
Fuel	$87,100
Electricity	$33,900
Other (R&R, Training, etc.)	$18,300
Total	**$179,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Atmautluak are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 144	63	85%	**$ 92,613**
Public/Commercial Service	$ 151	19	100%	**$ 34,503**
School Service	$ 2,882	2	100%	**$ 51,884**
Local Capital Contribution				**$ -**
Total Revenue				**$ 179,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	2/29/2016
Community	Atmautluak
Input	

Existing Community & System Data

2015 Population	319
2015 Number of Services	84
HITS Database (E1 & H1-H7)	63
DCED Mapping Commerical/Public Facilities/School	21
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	10000
Water Treatment Capacity	20
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	9450	12400
Gravity Sewer Main		0	
Pressure Sewer Main	x	9450	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Atmautluak**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**27**	
Req Water Storage (gallons) (less existing)	**175,700**	**2,420 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**6.8**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**3,620**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**12,400**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**9,500**	
	Individual Grinder Pump Stations (GPS) (ea)	**84**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**6,300**	
	Pressure Sewer Service Lines (lf)	**6,300**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	27	20	7
Water Storage (gallons)	185,700	10,000	175,700
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	6.8	-	6.8
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	3,620	-	3,620
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	12,400	-	12,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,500	-	9,500
Individual Grinder Pump Stations (GPS) (ea)	84	-	84
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	6,300	-	6,300
Pressure Sewer Service Lines (lf)	6,300	-	6,300

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 2/29/2016

Community Atmautluak

System Parameters	Model Results			Criteria & Calculations
Design Population				
Duration (n)	20	years		20 years
2015 Population (P)	319	people		2015 ADOL
2015 Number of Services	84	services		
Growth Rate (i)	1%			1%
2035 Design Population (Capita)	***389***	***people***		Px(1+i)^n
Water Demand Estimates				
Existing Capacity	20	gpm		
Average Day (ADD)	19,462	gpd		50 gallons per Capita
Max Day (MDD)	38,924	gpd		2 x ADD
Peak Hour	81	gpm		3 x MDD
Treatment Capacity	***27***	***gpm***		MDD
Water Source Assumptions				
Type (surface water or groundwater)	GW			
Required Capacity	27	gpm		MDD
Water Storage Tank Sizing				
Existing Water Storage Tank	10,000	gallons		
Demand Based Volume (if source is GW)	Applicable			
Daily Operation (DO) (gallons)	38,924	gallons		Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons		500 gpm for 60 minutes
Reserve Volume (RV)	116,772	gallons		3 days x DO
Water Storage Tank Volume	185,696	gallons		DO + FF + RV
CT Based Volume (min if source is SW)	Not Required			
Chlorine Residual Concentration (RC)	0.4	mg/L		0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation		1.0-log Inactivation
Temperature (T)	4.4	C		4.4 celsius/40 F
pH (PH)	7			7
Contact Time Required (CT)	49	minutes		LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1			0.1
Required Volume to meet CT*	137,888	gallons		CT/RCxPeak Hour/BF
Required Water Storage	***185,700***	***gallons***		
Required Additional Storage	***175,700***	***gallons***		
Estimate of Min Platform Size (3' clearance around)	***2,420***	***sf***		D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
Water Treatment Plant Requirements*				
Water Quality	Poor			Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***		Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)				
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***		Pile Foundation
Firm soils, or continuous permafrost	0			Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0			Gravel pad
Water Distribution (Check either or both)				
Buried system with no permafrost	0			Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***		Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)				
Buried system with no permafrost	0			Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***		Sewer main with glycol heat trace
Gravity Sewer Main	0			Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)				
Static Water Main	0			Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***		Circulating Water Service Lines
Gravity Sewer Main	0			Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***		Pressure Service Lines
Sewage Lagoon Size				
Existing Sewage Lagoon	0	acres		
Organic Loading Based Size	3.3	acres		0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	308.2			
Hydraulic Loading Based Size	6.8	acres		Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***6.8***	***acres***		Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Atmautluak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	84	$26,403.25	$2,217,873
2	Sewage collection mains or services (gravity or force), buried	LF		#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	15,800	$200.95	$3,174,979
4	Sewage lift station	EA	1	$678,792.59	$678,793
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	5.2	$704,910.88	$3,665,537
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	18,700	$331.68	$6,202,500
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	175,700	$2.73	$479,969
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	3,620	$326.71	$1,182,688
19	Foundation - thermosyphen stabilized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$19,718,648**

POSSIBLE AREA FOR NEW SEWAGE LAGOON

LIFT STATION

LAUNDROMAT/WATERING POINT

SCHOOL

PIKMIKTALIK RIVER

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

150' 0 150' 300'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

ATMAUTLUAK

DATE MAR 2015

SCALE GRAPHIC

FIGURE 4

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00_Atmautluak.dwg

O&M Cost Estimate
Piped Water & Sewer System

Community: Atmautluak

General Community Data

Current population	319	persons
Average number of people per house	5.1	
Service Connections		
Number of houses	63	
Number of public/commerical buildings	19	
Number of schools	2	
Total number of service connections	84	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.54	kWh
Electricity cost (Residential service)	$0.36	kWh
Cost per gallon for heating oil	$6.50	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	500	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	3248	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	185,700	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	12400	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	84	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	8360	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1140	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$33,280
Fuel (Heating Demand)				
Water system				
WTP building	$1,078	/month		$8,625.86
Raw water line	$0	/month		$0.00
Raw water heat addition	$1,261	/month		$10,085.50
Water storage tank	$183	/month		$1,467.77
Water storage tank line	$24	/month		$189.70
Water mains	$2,940	/month		$23,522
Service lines	$1,494	/month		$11,951
Wastewater system				
Sewer mains	$1,982	/month		$15,859
Service lines	$1,494	/month		$11,951
Lift/pump station buildings	$166	/month		$1,327.87
Force main to lagoon	$270	/month		$2,163
			Subtotal	$87,100
Electricity				
Water system				
WTP building				
Lights and controls	$512	/month		$6,142
HVAC/hydronic system	$512	/month		$4,095
Water treatment	$131	/month		$1,571
Pumps				
Intake or well	$131	/month		$1,571.01
WST circulation	$73	/month		$583
Pressure/booster	$196	/month		$2,356.52
Main line circulation	$1,160	/month		$9,279
Wastewater system				
Lift /pump station buildings				
Lights and controls	$79	/month		$946
HVAC/hydronic system	$79	/month		$630
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$209	/month		$2,513.62
Sewer/force main glycol circulation	$289	/month		$2,316
Lagoon discharge pump	$1,886	/year		$1,886
			Subtotal	$33,900
Other Costs				
Equipment R&R	$7,714	/year		$7,714
Miscellaneous materials & supplies	$4,628	/year		$4,628
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$18,300

Summary

Administration	$6,000
Labor	$33,300
Fuel	$87,100
Electricity	$33,900
Other	$18,300
Total	$179,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 144	63	85%	**$ 92,613**
Public/Commerc	$ 151.33	19	100%	**$ 34,503**
School Service (	$ 2,882.45	2	100%	**$ 51,884**
Local Capital Contribution				**$ -**
Total Revenue				**$ 179,000**

Beaver, Alaska

Community Information & Existing Infrastructure

The village of Beaver is a predominately mixed Gwitchin/Koyukuk Athabascan and Inupiat community of 58 people located along the north bank of the Yukon River in north-central Alaska. There are 27 residential units (2 additional units are out of the service area range, and were not included in the model), 13 commercial/public facilities and one school for a total of 41 services. The existing water and sewer services provided in Beaver consist of large truck haul. The existing water and sewer infrastructure consists of the following:

- Well Water – 6-10 gpm transfer pump
- Treated Water Storage – 66,000 gallons
- Water Treatment Plant/Washeteria – 1,708 SF, built in 1978 and refurbished in 1990
- Water Treatment –Filtration, chlorine, and polymer
- Sewage Lagoon – Two Cell, 0.74 acres (too close to the runway to be considered usable)

The area around Beaver consists of permafrost soil conditions. Layer of frozen silts sits between stable sand and gravel layer typically found 6 feet deep.

Piped System Description

The piped water and sewer system will be a below grade system. The water system will consist of approximately 12,200 feet of pipe, and the sewer system approximately 14,300 feet of pipe. The water system will consist of two circulating loops. The gravity sewer system would require glycol heat treat for freeze protection, and 5 lift stations to collect and transport wastewater to the lagoon. The limitations posed by the runway and the Joe Guay Slough, would likely require the new lagoon to be sited one mile north of the community off the existing road to the landfill. It is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	5	8	-
Water Storage (gallons)	58,300	66,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.2	-	1.2
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	12,200	-	12,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,300	-	14,300
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,100	-	3,100
Gravity Sewer Service Lines (lf)	3,100	-	3,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Beaver. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30):

Estimated Capital Costs				**Village** Beaver	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	41	$28,096.69	$1,151,964
2	Sewage collection mains or services (gravity or force), buried	LF	17,400	$550.70	$9,582,112
4	Sewage lift station	EA	5	$1,037,489.17	$5,187,446
10	Sewage lagoon, barrow, local material	Acre	1.2	$1,261,213.17	$1,513,456
13	Water distribution, mains or services, buried	LF	15,300	$588.38	$9,002,171
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$769.95	$923,935
				Total Estimated Cost in 2010 dollars (rounded):	**$30,337,000**
				Total with Inflation (3% per year for 6 years)	**$36,224,000**
28	Electrical Service Upgrades	EA	41	$5,500	$225,500
				Subtotal	**$36,449,500**
29	Construction Contingency (15%)	LS	1	$5,467,400	$5,467,400
30	Design & Construction Administration Services (20%)	LS	1	$7,289,900	$7,289,900
				Total	**$49,206,800**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$22,500
Fuel	$101,600
Electricity	$41,600
Other (R&R, Training, etc.)	$19,300
Total	**$191,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Beaver are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 308	27	85%	**$ 84,951**
Public/Commercial Service	$ 324	13	100%	**$ 50,526**
School Service	$ 6,169	1	100%	**$ 55,523**
Local Capital Contribution				**$ -**
Total Revenue				**$ 191,000**

LAGOON & FORCE MAIN (1 MILE)

LIFT STATION #5

LIFT STATION #4

LIFT STATION #3

LIFT STATION #2

LIFT STATION #1

SEWAGE LAGOON

SCHOOL

WATER TANK

WTP

WASHETERIA

COMMUNITY WELL

FIFTH AVENUE

FOURTH AVENUE

THIRD AVENUE

SECOND AVENUE

FIRST AVENUE

B STREET

C STREET

YUKON RIVER

N

200' 0 200' 400'

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

BEAVER

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 5

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Beaver.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/4/2016
Community	Beaver
Input	

Existing Community & System Data

2015 Population	58
2015 Number of Services	41
HITS Database (E1 & H1-H7)	27
DCED Mapping Commerical/Public Facilities/School	14
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	66000
Water Treatment Capacity	8
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	14300	12200
Gravity Sewer Main	x	9000	
Pressure Sewer Main		5300	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Beaver**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**5**	
Req Water Storage (gallons) (less existing)	**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**1.2**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**12,200**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**14,300**	
	Lift Stations for Gravity Sewer Mains	**5**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**3,100**	
	Gravity Sewer Service Lines (lf)	**3,100**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	5	8	-
Water Storage (gallons)	58,300	66,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.2	-	1.2
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	12,200	-	12,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,300	-	14,300
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,100	-	3,100
Gravity Sewer Service Lines (lf)	3,100	-	3,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/4/2016
Community Beaver

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	58	people	2015 ADOL
2015 Number of Services	41	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***71***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	8	gpm	
Average Day (ADD)	3,539	gpd	50 gallons per Capita
Max Day (MDD)	7,077	gpd	2 x ADD
Peak Hour	15	gpm	3 x MDD
Treatment Capacity	***5***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	5	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	66,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	7,077	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	21,231	gallons	3 days x DO
Water Storage Tank Volume	58,308	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	25,071	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***58,300***	***gallons***	
Required Additional Storage	***(7,700)***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	-	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	6
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains(ea)***	Lift stations for gravity sewer mains
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.6	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	131.4		
Hydraulic Loading Based Size	1.2	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.2***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Beaver

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	41	$28,096.69	$1,151,964
2	Sewage collection mains or services (gravity or force), buried	LF	17,400	$550.70	$9,582,112
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	5	$1,037,489.17	$5,187,446
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.2	$1,261,213.17	$1,513,456
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	15,300	$588.38	$9,002,171
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$769.95	$923,935
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$30,336,742**

O&M Cost Estimate
Piped Water & Sewer System

Community: Beaver

General Community Data

Current population	58	persons
Average number of people per house	2.1	
Service Connections		
Number of houses	27	
Number of public/commerical buildings	13	
Number of schools	1	
Total number of service connections	41	
Burdened labor rate	$18	hr
Electricity cost (Public facilty)	$0.54	kWh
Electricity cost (Residential service)	$0.36	kWh
Cost per gallon for heating oil	$9.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	335	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Treatment

Size of water treatment plant building	2908	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	66,000	gallons
Length of water line to/ from tank	25	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	12200	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations	5	
Number of facilities served by lift/pump station #1	6	
Number of facilities served by lift/pump station #2	19	
Number of facilities served by lift/pump station #3	30	
Number of facilities served by lift/pump station #4	38	
Number of facilities served by lift/pump station #5	41	
Number of facilities served by lift/pump station #6		
Size of lift stations	500	sf
Total length of sewer mains	9000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	5300	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$22,464
Fuel (Heating Demand)				
Water system				
WTP building	$1,337	/month		$10,693.25
Raw water line	$0	/month		$0.00
Raw water heat addition	$317	/month		$3,808.51
Water storage tank	$90	/month		$722.30
Water storage tank line	$0	/month		$0.00
Water mains	$2,403	/month		$28,840
Service lines	$606	/month		$7,269
Wastewater system				
Sewer mains	$1,773	/month		$21,275
Service lines	$606	/month		$7,269
Lift/pump station buildings	$1,149	/month		$9,192.96
Force main to lagoon	$1,044	/month		$12,529
			Subtotal	$101,600
Electricity				
Water system				
WTP building				
Lights and controls	$458	/month		$5,499
HVAC/hydronic system	$458	/month		$5,499
Water treatment	$24	/month		$286
Pumps				
Intake or well	$24	/month		$285.64
WST circulation	$73	/month		$583
Pressure/booster	$36	/month		$428.46
Main line circulation	$1,160	/month		$13,919
Wastewater system				
Lift /pump station buildings				
Lights and controls	$394	/month		$4,728
HVAC/hydronic system	$394	/month		$3,152
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$142	/month		$1,701.14
Sewer/force main glycol circulation	$434	/month		$5,210
Lagoon discharge pump	$343	/year		$343
			Subtotal	$41,600
Other Costs				
Equipment R&R	$8,283	/year		$8,283
Miscellaneous materials & supplies	$4,970	/year		$4,970
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$19,300

Summary

Administration	$6,000
Labor	$22,500
Fuel	$101,600
Electricity	$41,600
Other	$19,300
Total	$191,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 308	27	85%	**$ 84,951**
Public/Commerc	$ 323.89	13	100%	**$ 50,526**
School Service (	$ 6,169.25	1	100%	**$ 55,523**
Local Capital Contribution				**$ -**
Total Revenue				**$ 191,000**

Birch Creek, Alaska

Community Information & Existing Infrastructure

The village of Birch Creek is a Dendu Gwichin Athabascan community of 22 people located along the Birch Creek River. There are 18 residential units and 8 commercial/public facilities for a total of 26 services. The existing water and sewer services provided in Birch Creek consist of self-haul system and waste disposal at the sewage lagoon or backyard pit privies. The existing water and sewer infrastructure consists of the following:

- Underneath Birch Creek River – 20 gpm transfer pump
- Treated Water Storage – 80,000 gallons
- Water Treatment Plant/Washeteria – 640 SF, built in 1988
- Water Treatment –Sand filters and chlorination
- Sewage Lagoon – Single Cell, 0.3 acres

Soil investigations in the Birch Creek area revealed a fairly consistent subsurface of frozen soils made up of sandy silt and silty sand with gravel with no groundwater to a depth of approx. 25 feet.

Piped System Description

The piped water and sewer system will be a below grade system. The water system will consist of approximately 5,700 feet of pipe, and the sewer system approximately 3,800 feet of pipe. The water system will consist of two circulating loops. The gravity sewer system would require glycol heat treat for freeze protection, and two lift stations to collect and transport wastewater to the lagoon. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	2	20	-
Water Storage (gallons)	40,700	80,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	0.5	-	0.5
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	5,700	-	5,700
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	3,800	-	3,800
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,000	-	2,000
Gravity Sewer Service Lines (lf)	2,000	-	2,000

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Birch Creek. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30):

Estimated Capital Costs				Village: Birch Creek	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	26	$28,096.69	$730,514
2	Sewage collection mains or services (gravity or force), buried	LF	5,800	$636.43	$3,691,317
4	Sewage lift station	EA	3	$1,097,461.43	$3,292,384
10	Sewage lagoon, barrow, local material	Acre	0.5	$1,841,373.17	$920,687
13	Water distribution, mains or services, buried	LF	7,700	$636.50	$4,901,027
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$769.95	$923,935
				Total Estimated Cost in 2010 dollars (rounded):	**$17,436,000**
				Total with Inflation (3% per year for 6 years)	**$20,819,500**
28	Electrical Service Upgrades	EA	26	$5,500	$143,000
				Subtotal	**$20,962,500**
29	Construction Contingency (15%)	LS	1	$3,144,400	$3,144,400
30	Design & Construction Administration Services (20%)	LS	1	$4,192,500	$4,192,500
				Total	**$28,299,400**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$30,900
Electricity	$33,100
Other (R&R, Training, etc.)	$13,100
Total	**$108,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Birch Creek are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 361	18	85%	**$ 66,361**
Public/Commercial Service	$ 434	8	100%	**$ 41,639**
School Service	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 108,000**

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

BIRCH CREEK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 6

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Birch Creek.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/5/2016
Community	Birch Creek
Input	

Existing Community & System Data	
2015 Population	22
2015 Number of Services	26
HITS Database (E1 & H1-H7)	18
DCED Mapping Commerical/Public Facilities/School	8
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	80000
Water Treatment Capacity	20
Existing Sewage Lagoon Size	0
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	3750	5700
Gravity Sewer Main	x	3300	
Pressure Sewer Main		450	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Birch Creek**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**2**	
Req Water Storage (gallons) (less existing)	**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.5**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**5,700**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**3,800**	
	Lift Stations for Gravity Sewer Mains	**2**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**2,000**	
	Gravity Sewer Service Lines (lf)	**2,000**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	2	20	-
Water Storage (gallons)	40,700	80,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	0.5	-	0.5
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	5,700	-	5,700
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	3,800	-	3,800
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,000	-	2,000
Gravity Sewer Service Lines (lf)	2,000	-	2,000

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/5/2016

Community Birch Creek

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	22	people	2015 ADOL
2015 Number of Services	26	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***27***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	20	gpm	
Average Day (ADD)	1,342	gpd	50 gallons per Capita
Max Day (MDD)	2,684	gpd	2 x ADD
Peak Hour	6	gpm	3 x MDD
Treatment Capacity	***2***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	2	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	80,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	2,684	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	8,053	gallons	3 days x DO
Water Storage Tank Volume	40,738	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	9,510	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***40,700***	***gallons***	
Required Additional Storage	-	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	-	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	80.9		
Hydraulic Loading Based Size	0.5	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***0.5***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Birch Creek

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	26	$28,096.69	$730,514
2	Sewage collection mains or services (gravity or force), buried	LF	5,800	$636.43	$3,691,317
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	3	$1,097,461.43	$3,292,384
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.5	$1,841,373.17	$920,687
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	7,700	$636.50	$4,901,027
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$769.95	$923,935
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$17,435,522**

O&M Cost Estimate
Piped Water & Sewer System

Community: Birch Creek

General Community Data

Current population	22	persons
Average number of people per house	1.2	
Service Connections		
Number of houses	18	
Number of public/commerical buildings	8	
Number of schools	0	
Total number of service connections	26	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.55	kWh
Electricity cost (Residential service)	$0.40	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	290	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	2340	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	80,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	5700	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	15	
Number of facilities served by lift/pump station #2	27	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	3300	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	450	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$717	/month		$5,736.41
Raw water line	$0	/month		$0.00
Raw water heat addition	$80	/month		$963.07
Water storage tank	$73	/month		$583.68
Water storage tank line	$11	/month		$87.55
Water mains	$749	/month		$8,983
Service lines	$256	/month		$3,073
Wastewater system				
Sewer mains	$433	/month		$5,201
Service lines	$256	/month		$3,073
Lift/pump station buildings	$306	/month		$2,451.46
Force main to lagoon	$59	/month		$709
			Subtotal	$30,900
Electricity				
Water system				
WTP building				
Lights and controls	$376	/month		$4,507
HVAC/hydronic system	$376	/month		$4,507
Water treatment	$9	/month		$110
Pumps				
Intake or well	$9	/month		$110.35
WST circulation	$74	/month		$594
Pressure/booster	$14	/month		$165.53
Main line circulation	$1,181	/month		$14,177
Wastewater system				
Lift /pump station buildings				
Lights and controls	$161	/month		$1,926
HVAC/hydronic system	$161	/month		$1,284
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$26	/month		$308.99
Sewer/force main glycol circulation	$442	/month		$5,306
Lagoon discharge pump	$132	/year		$132
			Subtotal	$33,100
Other Costs				
Equipment R&R	$4,448	/year		$4,448
Miscellaneous materials & supplies	$2,669	/year		$2,669
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$13,100

Summary

Administration	$6,000
Labor	$25,000
Fuel	$30,900
Electricity	$33,100
Other	$13,100
Total	$108,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 361	18	85%	**$ 66,361**
Public/Commerc	$ 433.73	8	100%	**$ 41,639**
School Service (	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 108,000**

Chalkyitsik, Alaska

Community Information & Existing Infrastructure

The village of Chalkyitsik is a Gwichin Athabascan community of 77 people located along the Black River. There are 51 residential units, 16 commercial/public facilities and one school for a total of 68 services. The existing water and sewer services provided in Chalkyitsik consist of self-haul water system and honey buckets/outhouses for waste disposal. The water treatment plant (WTP) distributes water from the water storage tank (WST) to the washeteria, community water point, village council building, clinic, and the school's wood-stave WST. The washeteria, WTP, council building, and the clinic discharge wastewater to a lift station under the WTP that is piped to the sewage lagoon. The existing water and sewer infrastructure consists of the following:

- Black River – 15 gpm transfer pump
- Treated Water Storage – 95,000 gallons
- Water Treatment Plant/Washeteria – 2,314 SF, upgraded in 2008
- Water Treatment – Treated with coagulant, filtered, passed through a granulated carbon filter, and chlorinated
- Sewage Lagoon – Two Cell, 1.0 acres

Subsurface conditions in Chalkyitsik typically consist of several feet of organic soils overlying ice-rich silts to depths of 16.5 to 27.5 feet.

Piped System Description

The piped water and pressure sewer system will be a buried system. The system will consist of approximately 17,100 feet of circulating water mains, and 9,300 feet of pressure sewer mains. The water system will consist of two circulating loops. The pressure sewer system would require individual grinder pump stations at each house, glycol heat trace for freeze protection, and one lift station. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment. The existing 95,000 gallon water storage tank is sufficient to meet the CT-required volume and provide a reserve for fire flows and/or emergencies.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	7	15	-
Water Storage (gallons)	67,600	95,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.6	1.0	0.6
Required Foundation System for WTP and/or WST			
Thermosyphon Stabilized Gravel Pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,100	-	17,100
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,300	-	9,300
Individual Grinder Pump Stations (GPS) (ea)	68	-	68
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,100	-	5,100
Pressure Sewer Service Lines (lf)	5,100	-	5,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Chalkyitsik. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30):

Estimated Capital Costs

Village: Chalkyitsik

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	68	$28,096.69	$1,910,575
3	Sewage collection mains or services (gravity or force), above ground	LF	14,400	$310.58	$4,472,295
4	Sewage lift station	EA	1	$1,397,322.77	$1,397,323
10	Sewage lagoon, barrow, local material	Acre	0.6	$1,675,613.17	$1,005,368
12	Water distribution, mains or services, above ground	LF	22,200	$425.83	$9,453,451
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$769.95	$923,935
				Total Estimated Cost in 2010 dollars (rounded):	**$22,139,000**
				Total with Inflation (3% per year for 6 years)	**$26,435,100**
27	Individual Grinder Pump Stations	EA	68	$30,000	$2,040,000
28	Electrical Service Upgrades	EA	68	$5,500	$374,000
				Subtotal	**$28,849,100**
29	Construction Contingency (15%)	LS	1	$4,327,400	$4,327,400
30	Design & Construction Administration Services (20%)	LS	1	$5,769,800	$5,769,800
				Total	**$38,946,300**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$30,000
Fuel	$95,500
Electricity	$37,100
Other (R&R, Training, etc.)	$19,000
Total	**$188,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Chalkyitsik are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 188	51	85%	**$ 97,661**
Public/Commercial Service	$ 207	16	100%	**$ 39,650**
School Service	$ 5,632	1	100%	**$ 50,689**
Local Capital Contribution				**$ -**
Total Revenue				**$ 188,000**

SEWAGE LAGOON

WASHETERIA

WATER STORAGE TANK

BLACK RIVER

LIFT STATION #1

SCHOOL

SCHOOL WATER TANK

SCHOOL SEWAGE LAGOON

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

300' 0 300' 600'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

CHALKYITSIK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 7

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Chalkyitsik.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	2/29/2016
Community	Chalkyitsik
Input	

Existing Community & System Data	
2015 Population	77
2015 Number of Services	68
HITS Database (E1 & H1-H7)	51
DCED Mapping Commerical/Public Facilities/School	17
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	95000
Water Treatment Capacity	15
Existing Sewage Lagoon Size	1
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	9300	17100
Gravity Sewer Main			
Pressure Sewer Main	x	9300	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Chalkyitsik**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**7**	
Req Water Storage (gallons) (less existing)		**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**0.6**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**17,100**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**9,300**	
	Individual Grinder Pump Stations (GPS) (ea)	**68**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**5,100**	
	Pressure Sewer Service Lines (lf)	**5,100**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	7	15	-
Water Storage (gallons)	67,600	95,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.6	1.0	0.6
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,100	-	17,100
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,300	-	9,300
Residential Grinder Pump Stations (GPS) (ea)	68	-	68
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,100	-	5,100
Pressure Sewer Service Lines (lf)	5,100	-	5,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 2/29/2016

Community Chalkyitsik

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	77	people	2015 ADOL
2015 Number of Services	68	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***94***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	15	gpm	
Average Day (ADD)	4,698	gpd	50 gallons per Capita
Max Day (MDD)	9,395	gpd	2 x ADD
Peak Hour	20	gpm	3 x MDD
Treatment Capacity	***7***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	7	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	95,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	9,395	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	28,186	gallons	3 days x DO
Water Storage Tank Volume	67,582	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	33,283	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***67,600***	***gallons***	
Required Additional Storage	-	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	-	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	1	acres	
Organic Loading Based Size	0.8	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	151.4		
Hydraulic Loading Based Size	1.6	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.6***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Chalkyitsik

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	68	$28,096.69	$1,910,575
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	14,400	$310.58	$4,472,295
4	Sewage lift station	EA	1	$1,397,322.77	$1,397,323
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.6	$1,675,613.17	$1,005,368
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	22,200	$425.83	$9,453,451
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$769.95	$923,935
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$22,138,605**

O&M Cost Estimate
Piped Water & Sewer System

Community: Chalkyitsik

General Community Data

Current population	77	persons
Average number of people per house	1.5	
Service Connections		
Number of houses	51	
Number of public/commerical buildings	16	
Number of schools	1	
Total number of service connections	68	
Burdened labor rate	$18	hr
Electricity cost (Public facilty)	$0.55	kWh
Electricity cost (Residential service)	$0.40	kWh
Cost per gallon for heating oil	$8.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	460	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Treatment

Size of water treatment plant building	3514	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	95,000	gallons
Length of water line to/ from tank	40	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	17100	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	10	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	8700	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	600	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$29,952
Fuel (Heating Demand)				
Water system				
WTP building	$1,436	/month		$11,485.89
Raw water line	$0	/month		$0.00
Raw water heat addition	$375	/month		$4,494.34
Water storage tank	$116	/month		$924.16
Water storage tank line	$12	/month		$93.39
Water mains	$2,994	/month		$35,931
Service lines	$893	/month		$10,716
Wastewater system				
Sewer mains	$1,523	/month		$18,281
Service lines	$893	/month		$10,716
Lift/pump station buildings	$204	/month		$1,634.30
Force main to lagoon	$105	/month		$1,261
			Subtotal	$95,500
Electricity				
Water system				
WTP building				
Lights and controls	$564	/month		$6,768
HVAC/hydronic system	$564	/month		$6,768
Water treatment	$32	/month		$386
Pumps				
Intake or well	$32	/month		$386.23
WST circulation	$74	/month		$594
Pressure/booster	$48	/month		$579.35
Main line circulation	$1,181	/month		$14,177
Wastewater system				
Lift /pump station buildings				
Lights and controls	$80	/month		$963
HVAC/hydronic system	$80	/month		$642
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$8	/month		$90.88
Sewer/force main glycol circulation	$442	/month		$5,306
Lagoon discharge pump	$464	/year		$464
			Subtotal	$37,100
Other Costs				
Equipment R&R	$8,128	/year		$8,128
Miscellaneous materials & supplies	$4,877	/year		$4,877
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$19,000

Summary

Administration	$6,000
Labor	$30,000
Fuel	$95,500
Electricity	$37,100
Other	$19,000
Total	$188,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 188	51	85%	**$ 97,661**
Public/Commerc	$ 207	16	100%	**$ 39,650**
School Service (	$ 5,632	1	100%	**$ 50,689**
Local Capital Contribution				**$ -**
Total Revenue				**$ 188,000**

Chefornak, Alaska

Community Information & Existing Infrastructure

Chefornak is a Yup'ik Eskimo community of 420 people located on the south bank of the Kinia River, at its junction with the Keguk River, in the Yukon Kuskokwim Delta. There are 83 residential units, 24 commercial/public facilities, and one K-12 school for a total of 108 services. The existing water and sewer services provided in Chefornak consist of a self-haul system from watering points for water and honey buckets for waste disposal. The school has a treatment system, but purchases raw water from the City. There is a piped distribution loop with about 10 watering points throughout the community that provide service to the washeteria, clinic, and school. The existing water and sewer infrastructure consists of the following:

- Well Water – 6 gpm transfer pump
- Treated Water Storage – 4,000 gallons (very poor condition)
- Water Treatment Plant – 768 SF, built in 1984 (very poor condition)
- Water Treatment – Chlorination (water quality is very poor, high in salinity and not consumed by the community, only used for washing/bathing)
- Sewage Lagoon – Two cell, 4.2 acres

The soil section underlying the community generally consists of a matrix of large pumice boulders with organics and/or silt. There is peat 1-2 feet below ground surface, and organic silt up to 3-5 feet below ground surface; typically frozen. Groundwater encountered around 10 feet at one test pit.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 11,900 feet of pipe, and the pressure sewer approximately 8,500 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require individual grinder pump stations at each house in addition to one sewer main lift station, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 2,500 sf facility is included to house the equipment needed for water treatment and distribution equipment. A new well is also proposed.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	36	6	30
Water Storage (gallons)	235,000	-	235,000
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,500	-	2,500
Sewage Lagoon Size (acre)	8.9	4.2	4.7
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	5,630	-	5,630
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	11,900	-	11,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,000	-	9,000
Individual Grinder Pump Stations (GPS) (ea)	108	-	108
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,100	-	8,100
Pressure Sewer Service Lines (lf)	8,100	-	8,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Chefornak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs

Village: Chefornak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	108	$26,342.77	$2,845,020
3	Sewage collection mains or services (gravity or force), above ground	LF	17,100	$196.77	$3,364,753
4	Sewage lift station	EA	1	$662,130.80	$662,131
10	Sewage lagoon, barrow, local material	Acre	4.7	$702,902.35	$3,303,641
12	Water distribution, mains or services, above ground	LF	20,000	$328.15	$6,563,015
14	Water storage tank, no foundation	Gal	235,000	$2.45	$576,884
15	Water treatment plant, no foundation	SF	2,500	$1,582.62	$3,956,543
18	Foundation - freeze back piles	SF	5,360	$299.71	$1,606,470
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$23,032,000**
				Total with Inflation (3% per year for 6 years)	**$27,501,400**
27	Individual Grinder Pump Stations	EA	108	$30,000	$3,240,000
28	Electrical Service Upgrades	EA	108	$5,500	$594,000
				Subtotal	**$31,335,400**
29	Construction Contingency (15%)	LS	1	$4,700,300	$4,700,300
30	Design & Construction Administration Services (20%)	LS	1	$6,267,100	$6,267,100
				Total	**$42,302,800**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$90,900
Electricity	$30,100
Other (R&R, Training, etc.)	$17,700
Total	**$170,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Chefornak are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 116	83	85%	**$ 98,307**
Public/Commercial Service	$ 122	24	100%	**$ 35,115**
School Service	$ 4,064	1	100%	**$ 36,578**
Local Capital Contribution				**$ -**
Total Revenue				**$ 170,000**

KINIA RIVER
(OOKSOKWAK)

EXISTING WATER TREATMENT PLANT

LIFT STATION

PROPOSED SEWAGE LAGOON

SCHOOL

PROPOSED WTP

COMMUNITY WELL

THIRD STREET

SECOND STREET

FIRST STREET

E STREET

D STREET

MAIN STREET

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

200' 0 200' 400'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES

CHEFORNAK

DATE
SEP 2016

SCALE
GRAPHIC

FIGURE
8

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Chefornak.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	9/7/2016			
Community	Chefornak			
Input				
Existing Community & System Data				
2015 Population	420			
2015 Number of Services	108			
HITS Database (E1 & H1-H7)	83			
DCED Mapping Commerical/Public Facilities/School	25			
Type (surface water or groundwater)	GW			
Water quality (Poor or Good)	Poor	**High in salinity**		
Water Storage Tank	0	**Existing tank in poor condition**		
Water Treatment Capacity	6			
Existing Sewage Lagoon Size	4.2			
Soil Conditions (check only one)				
Soft poorly drained soils or discontinuous permafrost	x			
Firm soils, or continuous permafrost				
Stiff soils, no permafrost				
Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**	
Buried system with no permafrost				
Above ground system or buried with permafrost	x	9000	11900	
Gravity Sewer Main				
Pressure Sewer Main	x	9000		
Typical Service Line Length (ea)		75	75	

Piped System Requirements	**Community**	**Chefornak**		
Output for Cost Model (calculated)				
			Foundation Size	
Water Treatment Capacity (gpm)		**36**		
Req Water Storage (gallons) (less existing)		**235,000**	**3,130 sf**	
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**2,500**	**2,500 sf**	
Req Sewage Lagoon Size (acre) (less existing)		**4.7**		

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**5,630**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**11,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**9,000**	
	Individual Grinder Pump Stations (GPS) (ea)	**108**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**8,100**	
	Pressure Sewer Service Lines (lf)	**8,100**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	36	6	30
Water Storage (gallons)	235,000	-	235,000
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,500	-	2,500
Sewage Lagoon Size (acre)	8.9	4.2	4.7
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	5,630	-	5,630
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	11,900	-	11,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,000	-	9,000
Individual Grinder Pump Stations (GPS) (ea)	108	-	108
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,100	-	8,100
Pressure Sewer Service Lines (lf)	8,100	-	8,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 9/7/2016

Community Chefornak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	420	people	2015 ADOL
2015 Number of Services	108	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***512***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	6	gpm	
Average Day (ADD)	25,624	gpd	50 gallons per Capita
Max Day (MDD)	51,248	gpd	2 x ADD
Peak Hour	107	gpm	3 x MDD
Treatment Capacity	***36***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	36	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	-	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	51,248	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	153,744	gallons	3 days x DO
Water Storage Tank Volume	234,992	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	181,545	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***235,000***	***gallons***	
Required Additional Storage	***235,000***	***gallons***	
Estimate of Min Platform Size (3' clearance around)	***3,130***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***2,500***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf Existing WTP<800 sf and in poor condition

Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**x**	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	**0**		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Lines

Sewage Lagoon Size			
Existing Sewage Lagoon	4.2	acres	
Organic Loading Based Size	4.4	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	353.6		
Hydraulic Loading Based Size	8.9	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***8.9***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Chefornak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	108	$26,342.77	$2,845,020
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	17,100	$196.77	$3,364,753
4	Sewage lift station	EA	1	$662,130.80	$662,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	4.7	$702,902.35	$3,303,641
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	20,000	$328.15	$6,563,015
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	235,000	$2.45	$576,884
15	Water treatment plant, no foundation	SF	2,500	$1,582.62	$3,956,543
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	5,360	$299.71	$1,606,470
19	Foundation - thermosyphen stabilized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$23,032,054**

O&M Cost Estimate
Piped Water & Sewer System

Community: Chefornak

General Community Data

Current population	420	persons
Average number of people per house	5.1	
Service Connections		
Number of houses	83	
Number of public/commerical buildings	24	
Number of schools	1	
Total number of service connections	108	
Burdened labor rate	$12	hr
Electricity cost (Public facilty)	$0.47	kWh
Electricity cost (Residential service)	$0.19	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	2560	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	2500	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	235,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	11900	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	108	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	8000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	1000	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$766	/month		$6,128.64
Raw water line	$560	/month		$4,482.66
Raw water heat addition	$1,532	/month		$12,257.28
Water storage tank	$214	/month		$1,714.56
Water storage tank line	$11	/month		$87.55
Water mains	$2,605	/month		$20,837
Service lines	$1,773	/month		$14,183
Wastewater system				
Sewer mains	$1,751	/month		$14,008
Service lines	$1,773	/month		$14,183
Lift/pump station buildings	$153	/month		$1,225.73
Force main to lagoon	$219	/month		$1,751
			Subtotal	$90,900
Electricity				
Water system				
WTP building				
Lights and controls	$343	/month		$4,115
HVAC/hydronic system	$343	/month		$2,743
Water treatment	$150	/month		$1,800
Pumps				
Intake or well	$150	/month		$1,800.29
WST circulation	$63	/month		$508
Pressure/booster	$225	/month		$2,700.43
Main line circulation	$1,010	/month		$8,076
Wastewater system				
Lift /pump station buildings				
Lights and controls	$69	/month		$823
HVAC/hydronic system	$69	/month		$549
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$234	/month		$2,811.05
Sewer/force main glycol circulation	$252	/month		$2,015
Lagoon discharge pump	$2,162	/year		$2,162
			Subtotal	$30,100
Other Costs				
Equipment R&R	$7,298	/year		$7,298
Miscellaneous materials & supplies	$4,379	/year		$4,379
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$17,700

Summary

Administration	$6,000
Labor	$25,000
Fuel	$90,900
Electricity	$30,100
Other	$17,700
Total	$170,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 116	83	85%	**$ 98,307**
Public/Commerc	$ 122	24	100%	**$ 35,115**
School Service (	$ 4,064	1	100%	**$ 36,578**
Local Capital Contribution				**$ -**
Total Revenue				**$ 170,000**

Circle, Alaska

Community Information & Existing Infrastructure

The village of Circle is an Athabascan community of 119 people located at the terminus of the Steese Highway on the west bank of the Yukon River. There are 38 residential units, 14 commercial/public facilities and one school for a total of 53 services. The existing water services provided in Circle consist of self-haul water system from the washeteria building watering point. The existing sewer service consists of individual septic and leach fields for a few commercial facilities such as the the post office, and clinic. The school and the washeteria discharge into the lagoon through a piped sewer line. Residents without wastewater facilities use outhouses/honey buckets. The existing water and sewer infrastructure consists of the following:

- Well Water – 10 gpm transfer pump
- Treated Water Storage – 3,500 gallons
- Water Treatment Plant/Washeteria – 1,400 SF, built in 1994
- Water Treatment – Addition of chlorine
- School Sewage Lagoon – Single Cell, 0.5 acres

The general soil profile in the area consists of 1-4 feet of organic layer overlaying 6-7 feet of silts and clay, which is underlain by gravel beds. There is discontinuous permafrost in the area.

Piped System Description

The piped water and sewer system will be a buried system consisting of approximately 34,200 feet of circulating water mains and approximately 18,800 feet of gravity sewer mains. The water system will consist of two circulating loops. The sewer system will require glycol heat trace for freeze protection, and 10 lift stations throughout the system. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 800 sf facility is included to house the equipment needed for additional treatment and water distribution.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	10	10	-
Water Storage (gallons)	88,100	3,500	84,600
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	800	-	800
Sewage Lagoon Size (acre)	2.5	-	2.5
Required Foundation System for WTP and/or WST			
Thermosyphon Stabilized Gravel Pad (sf)	2,090	-	2,090
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	34,200	-	34,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	18,800	-	18,800
Lift Stations for Gravity Sewer Mains (ea)	10	-	10
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,000	-	4,000
Gravity Sewer Service Lines (lf)	4,000	-	4,000

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Circle. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30):

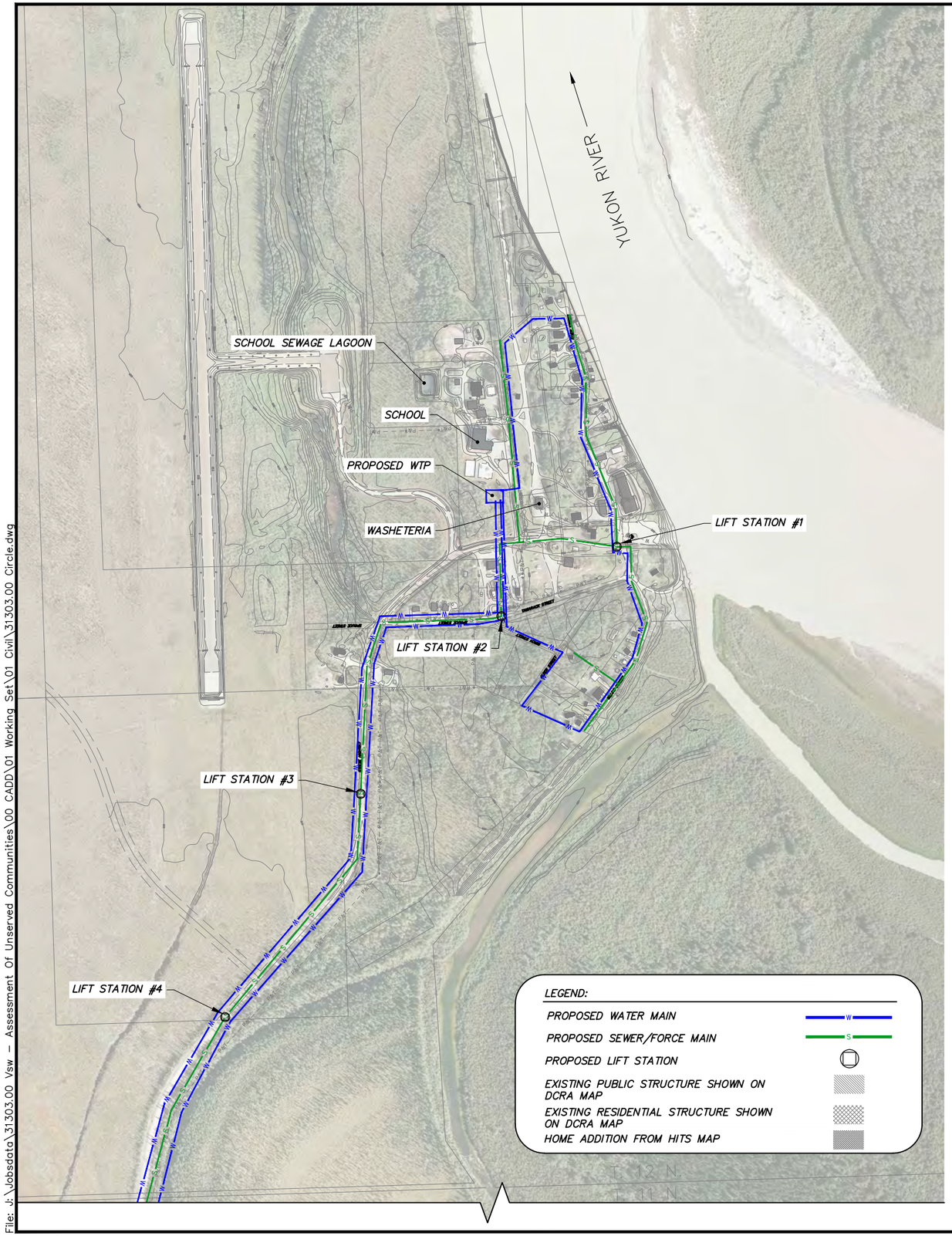
Estimated Capital Costs				Village: Circle	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	53	$26,191.57	$1,388,153
2	Sewage collection mains or services (gravity or force), buried	LF	22,800	$352.90	$8,046,061
4	Sewage lift station	EA	10	$430,053.92	$4,300,539
10	Sewage lagoon, barrow, local material	Acre	2.5	$672,606.85	$1,681,517
12	Water distribution, mains or services, above ground	LF	38,200	$316.71	$12,098,262
14	Water storage tank, no foundation	Gal	84,600	$2.38	$201,540
15	Water treatment plant, no foundation	SF	800	$1,515.91	$1,212,732
19	Foundation - thermosyphen stabilized gravel pad	SF	2,090	$207.24	$433,136
				Total Estimated Cost in 2010 dollars (rounded):	**$29,362,000**
				Total with Inflation (3% per year for 6 years)	**$35,059,800**
28	Electrical Service Upgrades	EA	53	$5,500	$291,500
				Subtotal	**$35,351,300**
29	Construction Contingency (15%)	LS	1	$5,302,700	$5,302,700
30	Design & Construction Administration Services (20%)	LS	1	$7,070,300	$7,070,300
				Total	**$47,724,300**

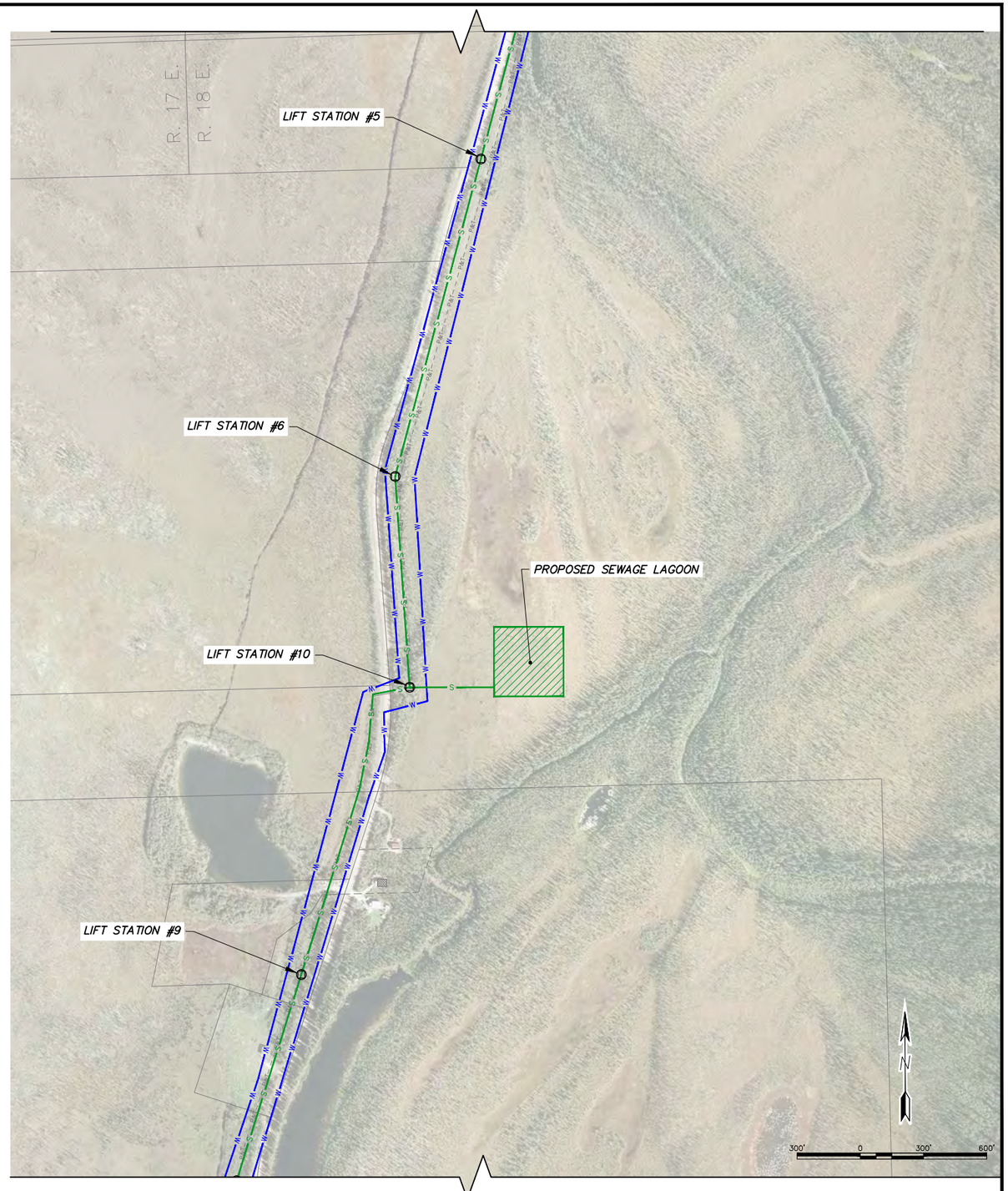
The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$99,700
Electricity	$50,800
Other (R&R, Training, etc.)	$20,000
Total	**$202,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Circle are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 272	38	85%	**$ 105,235**
Public/Commercial Service	$ 285	14	100%	**$ 47,894**
School Service	$ 5,430	1	100%	**$ 48,871**
Local Capital Contribution				**$ -**
Total Revenue				**$ 202,000**





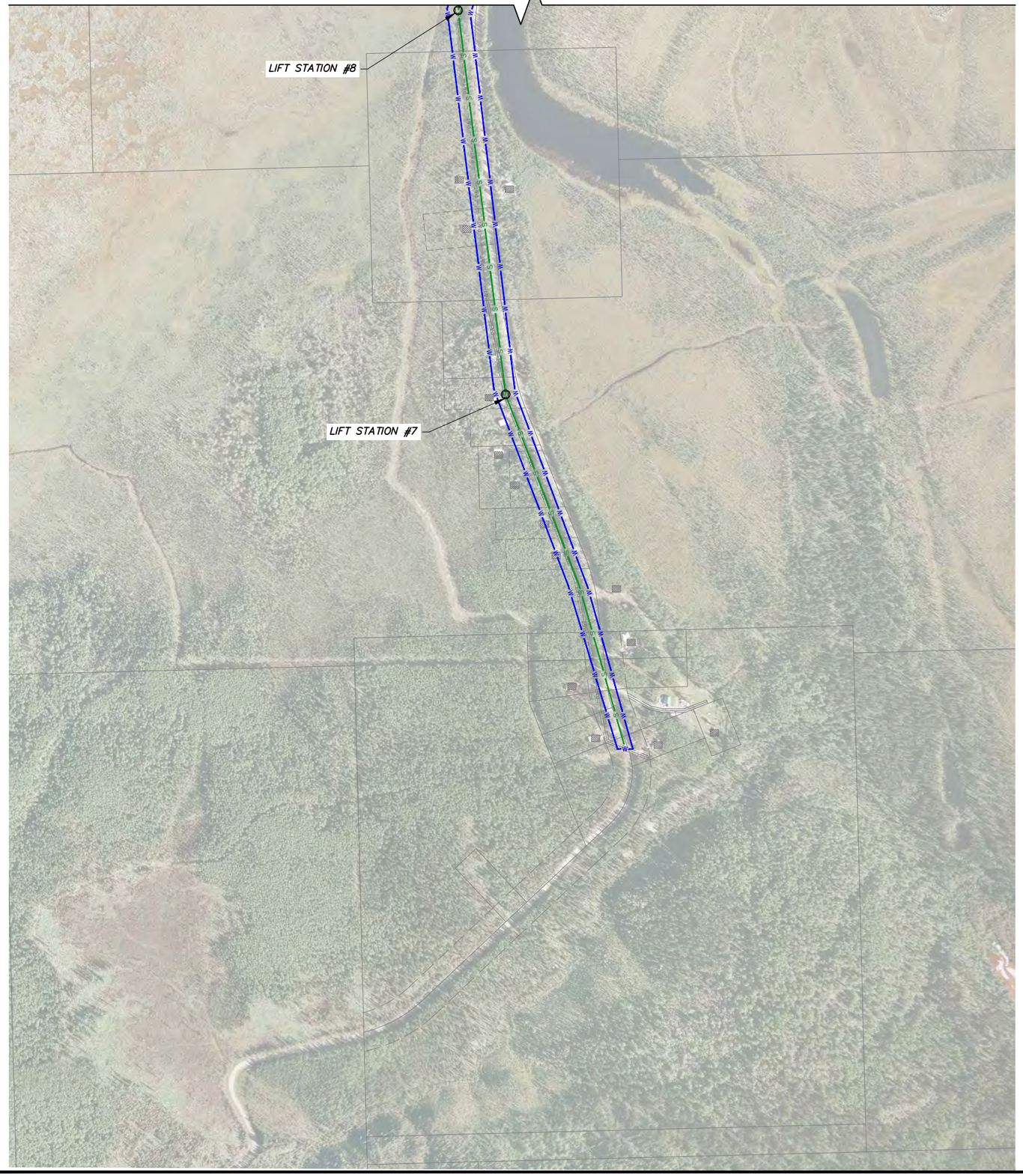
CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00
STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES
CIRCLE – (1 OF 2)

DATE: MAR 2015
SCALE: GRAPHIC
FIGURE: 9

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Circle.dwg



LEGEND:

- PROPOSED WATER MAIN — W
- PROPOSED SEWER/FORCE MAIN — S
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

300' 0 300' 600'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

CIRCLE (2 OF 2)

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 10

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Circle.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/4/2016
Community	Circle
Input	

Existing Community & System Data

2015 Population	119
2015 Number of Services	53
HITS Database (E1 & H1-H7)	38
DCED Mapping Commerical/Public Facilities/School	15
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Good
Water Storage Tank	3500
Water Treatment Capacity	10
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	18800	34200
Gravity Sewer Main	x	18400	
Pressure Sewer Main		400	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Circle**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**10**	
Req Water Storage (gallons) (less existing)	**84,600**	**1,290 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**800**	**800 sf**
Req Sewage Lagoon Size (acre) (less existing)	**2.5**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**2,090**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**34,200**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**18,800**	
	Lift Stations for Gravity Sewer Mains (ea)	**10**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**4,000**	
	Gravity Sewer Service Lines (lf)	**4,000**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	10	10	0
Water Storage (gallons)	88,100	3,500	84,600
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	800	-	800
Sewage Lagoon Size (acre)	2.5	-	2.5
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,090	-	2,090
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	34,200	-	34,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	18,800	-	18,800
Lift Stations for Gravity Sewer Mains (ea)	10	-	10
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,000	-	4,000
Gravity Sewer Service Lines (lf)	4,000	-	4,000

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/4/2016
Community Circle

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	119	people	2015 ADOL
2015 Number of Services	53	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***145***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	10	gpm	
Average Day (ADD)	7,260	gpd	50 gallons per Capita
Max Day (MDD)	14,520	gpd	2 x ADD
Peak Hour	30	gpm	3 x MDD
Treatment Capacity	***10***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	10	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	3,500	gallons	Built in 2010
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	14,520	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	43,561	gallons	3 days x DO
Water Storage Tank Volume	88,081	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	51,438	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***88,100***	***gallons***	
Required Additional Storage	***84,600***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,290***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Good		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***800***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains (ea)***	Lift stations for gravity sewer mains, every 1,000 ft +/-
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	1.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	188.2		
Hydraulic Loading Based Size	2.5	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***2.5***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Circle

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	53	$26,191.57	$1,388,153
2	Sewage collection mains or services (gravity or force), buried	LF	22,800	$352.90	$8,046,061
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	10	$430,053.92	$4,300,539
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	2.5	$672,606.85	$1,681,517
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	38,200	$316.71	$12,098,262
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	84,600	$2.38	$201,540
15	Water treatment plant, no foundation	SF	800	$1,515.91	$1,212,732
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	2,090	$207.24	$433,136
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$29,361,940**

O&M Cost Estimate
Piped Water & Sewer System

Community: Circle

General Community Data

Current population	119	persons
Average number of people per house	3.1	
Service Connections		
Number of houses	38	
Number of public/commerical buildings	14	
Number of schools	1	
Total number of service connections	53	
Burdened labor rate	$15	hr
Electricity cost (Public facilty)	$0.55	kWh
Electricity cost (Residential service)	$0.26	kWh
Cost per gallon for heating oil	$5.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	870	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	2200	sf
Raw water quality (Good or Poor)	Good	
Water Storage		
Size of tank(s)	88,100	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	34200	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	10	
Number of facilities served by lift/pump station #1	21	
Number of facilities served by lift/pump station #2	32	
Number of facilities served by lift/pump station #3	38	
Number of facilities served by lift/pump station #4	38	
Number of facilities served by lift/pump station #5	38	
Number of facilities served by lift/pump station #6	38	
Number of facilities served by lift/pump station #7	11	
Number of facilities served by lift/pump station #8	14	
Number of facilities served by lift/pump station #9	14	
Number of facilities served by lift/pump station #10	53	
Size of lift stations	500	sf
Total length of sewer mains	18400	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	400	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$562	/month		$4,494.34
Raw water line	$0	/month		$0.00
Raw water heat addition	$362	/month		$4,341.12
Water storage tank	$67	/month		$535.65
Water storage tank line	$9	/month		$72.96
Water mains	$3,743	/month		$44,914
Service lines	$435	/month		$5,220
Wastewater system				
Sewer mains	$2,014	/month		$24,164
Service lines	$435	/month		$5,220
Lift/pump station buildings	$1,277	/month		$10,214.40
Force main to lagoon	$44	/month		$525
			Subtotal	$99,700
Electricity				
Water system				
WTP building				
Lights and controls	$353	/month		$4,238
HVAC/hydronic system	$353	/month		$4,238
Water treatment	$10	/month		$119
Pumps				
Intake or well	$50	/month		$596.90
WST circulation	$74	/month		$594
Pressure/booster	$75	/month		$895.36
Main line circulation	$1,181	/month		$14,177
Wastewater system				
Lift /pump station buildings				
Lights and controls	$803	/month		$9,631
HVAC/hydronic system	$803	/month		$6,420
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$467	/month		$5,598.33
Sewer/force main glycol circulation	$295	/month		$3,538
Lagoon discharge pump	$717	/year		$717
			Subtotal	$50,800
Other Costs				
Equipment R&R	$8,773	/year		$8,773
Miscellaneous materials & supplies	$5,264	/year		$5,264
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$20,000

Summary

Administration	$6,000
Labor	$25,000
Fuel	$99,700
Electricity	$50,800
Other	$20,000
Total	$202,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 272	38	85%	**$ 105,235**
Public/Commerc	$ 285	14	100%	**$ 47,894**
School Service (	$ 5,430	1	100%	**$ 48,871**
Local Capital Contribution				**$ -**
Total Revenue				**$ 202,000**

Crooked Creek, Alaska

Community Information & Existing Infrastructure

The village of Crooked Creek is a mixed Yup'ik Eskimo and Athabascan community of 105 people located on the Kuskokwim River at its junction with Crooked Creek in the Kilbuk-Kuskokwim Mountains. The community is spread out over a distance of approximately 2 miles. There are 43 residential units, 10 commercial/public facilities and one school for a total of 54 services. The existing water and sewer service consists primarily of a haul system from the river, and honeybuckets. There is piped water and sewer to the washeteria, school, and clinic. The existing water and sewer infrastructure consists of the following:

- Well Water – 10 gpm transfer pump
- Treated Water Storage – 3,800 gallons
- Water Treatment Plant/Washeteria – 1,200 SF, built in 1998
- Water Treatment – Potassium permanganate, polymer, greensand filter, chlorine, and fluoride
- Sewage Lagoon – Two Cell, 0.5 acres

The general subsurface condition in the area consists of discontinuous permafrost and wetlands.

Piped System Description

The piped water and pressure sewer system will be a buried system. The water system will consist of approximately 20,200 feet of pipe, and the pressure sewer approximately 14,800 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require individual grinder pump stations at each house, glycol heat trace for freeze protection, and 1 lift station throughout the system. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new well and two new 1,200 sf facilities are included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	10	-
Water Storage (gallons)	81,200	3,800	77,400
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	2.2	0.5	1.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	3,600	-	3,600
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	20,200	-	20,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,800	-	14,800
Individual Grinder Pump Stations (GPS) (ea)	54	-	54
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,100	-	4,100
Pressure Sewer Service Lines (lf)	4,100	-	4,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Crooked Creek. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30):

Estimated Capital Costs				Village: Crooked Creek	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	54	$26,403.25	$1,425,776
2	Sewage collection mains or services (gravity or force), buried	LF	18,900	$260.13	$4,916,364
4	Sewage lift station	EA	1	$762,792.59	$762,793
10	Sewage lagoon, barrow, local material	Acre	1.7	$847,406.81	$1,440,592
13	Water distribution, mains or services, buried	LF	24,300	$283.67	$6,893,232
14	Water storage tank, no foundation	Gal	77,400	$4.66	$360,897
15	Water treatment plant, no foundation	SF	2,400	$1,623.65	$3,896,751
19	Foundation - thermosyphen stabilized gravel pad	SF	3,600	$276.71	$996,146
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$20,846,000**
				Total with Inflation (3% per year for 6 years)	**$24,891,200**
27	Individual Grinder Pump Stations	EA	54	$30,000	$1,620,000
28	Electrical Service Upgrades	EA	54	$5,500	$297,000
				Subtotal	**$26,808,200**
29	Construction Contingency (15%)	LS	1	$4,021,200	$4,021,200
30	Design & Construction Administration Services (20%)	LS	1	$5,361,600	$5,361,600
				Total	**$36,191,000**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$20,000
Fuel	$81,800
Electricity	$57,300
Other (R&R, Training, etc.)	$18,700
Total	**$184,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Crooked Creek are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 247	43	85%	**$ 108,384**
Public/Commercial Service	$ 259	10	100%	**$ 31,136**
School Service	$ 4,942	1	100%	**$ 44,480**
Local Capital Contribution				**$ -**
Total Revenue				**$ 184,000**

FLOOD LINE

AIRPORT

PROPOSED WTP

CROOKED CREEK

KUSKOKWIM RIVER

SCHOOL

LIFT STATION #1

CLINIC

WASHETERIA

EXISTING LAGOON

PROPOSED WTP

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

250' 0 250' 500'

N

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

CROOKED CREEK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 11

File: J:\Jobsdata\31303.00 VSW - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Crooked Creek.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/4/2016
Community	Crooked Creek
Input	

Existing Community & System Data	
2015 Population	105
2015 Number of Services	54
HITS Database (E1 & H1-H7)	43
DCED Mapping Commerical/Public Facilities/School	11
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	3800
Water Treatment Capacity	10
Existing Sewage Lagoon Size	0.5
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	14800	20200
Gravity Sewer Main		0	
Pressure Sewer Main	x	14800	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Crooked Creek**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**9**	
Req Water Storage (gallons) (less existing)		**77,400**	**1,200 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**2,400**	**2,400 sf**
Req Sewage Lagoon Size (acre) (less existing)		**1.7**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**3,600**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**20,200**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**14,800**	
	Individual Grinder Pump Stations (GPS) (ea)	**54**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**4,100**	
	Pressure Sewer Service Lines (lf)	**4,100**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	10	-
Water Storage (gallons)	81,200	3,800	77,400
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	2.2	0.5	1.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	3,600	-	3,600
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	20,200	-	20,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,800	-	14,800
Individual Grinder Pump Stations (GPS) (ea)	54	-	54
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,100	-	4,100
Pressure Sewer Service Lines (lf)	4,100	-	4,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/4/2016

Community Crooked Creek

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	105	people	2015 ADOL
2015 Number of Services	54	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***128***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	10	gpm	
Average Day (ADD)	6,406	gpd	50 gallons per Capita
Max Day (MDD)	12,812	gpd	2 x ADD
Peak Hour	27	gpm	3 x MDD
Treatment Capacity	***9***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	9	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	3,800	gallons	Built in 2010
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	12,812	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	38,436	gallons	3 days x DO
Water Storage Tank Volume	81,248	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	45,386	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***81,200***	***gallons***	
Required Additional Storage	***77,400***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,200***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***2,400***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf Need two facilities to accommodate both sides of community
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Lines
Sewage Lagoon Size			
Existing Sewage Lagoon	0.5	acres	
Organic Loading Based Size	1.1	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	176.8		
Hydraulic Loading Based Size	2.2	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***2.2***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Crooked Creek

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	54	$26,403.25	$1,425,776
2	Sewage collection mains or services (gravity or force), buried	LF	18,900	$260.13	$4,916,364
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	1	$762,792.59	$762,793
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.7	$847,406.81	$1,440,592
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	24,300	$283.67	$6,893,232
14	Water storage tank, no foundation	Gal	77,400	$4.66	$360,897
15	Water treatment plant, no foundation	SF	2,400	$1,623.65	$3,896,751
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	3,600	$276.71	$996,146
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$20,846,148**

O&M Cost Estimate
Piped Water & Sewer System

Community: Crooked Creek

General Community Data

Current population	105	persons
Average number of people per house	2.4	
Service Connections		
Number of houses	43	
Number of public/commerical buildings	10	
Number of schools	1	
Total number of service connections	54	
Burdened labor rate	$12	hr
Electricity cost (Public facilty)	$0.85	kWh
Electricity cost (Residential service)	$0.35	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	200	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	3600	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	81,200	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	20200	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	54	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Size of lift stations	500	sf
Total length of sewer mains	14600	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	200	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$19,968
Fuel (Heating Demand)				
Water system				
WTP building	$1,103	/month		$8,825.24
Raw water line	$0	/month		$0.00
Raw water heat addition	$383	/month		$3,064.32
Water storage tank	$74	/month		$592.44
Water storage tank line	$13	/month		$157.59
Water mains	$2,653	/month		$31,834
Service lines	$532	/month		$6,383
Wastewater system				
Sewer mains	$1,917	/month		$23,009
Service lines	$532	/month		$6,383
Lift/pump station buildings	$153	/month		$1,225.73
Force main to lagoon	$26	/month		$315
			Subtotal	$81,800
Electricity				
Water system				
WTP building				
Lights and controls	$893	/month		$10,716
HVAC/hydronic system	$893	/month		$10,716
Water treatment	$68	/month		$814
Pumps				
Intake or well	$68	/month		$813.96
WST circulation	$115	/month		$918
Pressure/booster	$102	/month		$1,220.94
Main line circulation	$1,826	/month		$21,910
Wastewater system				
Lift /pump station buildings				
Lights and controls	$124	/month		$1,488
HVAC/hydronic system	$124	/month		$992
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$102	/month		$1,226.62
Sewer/force main glycol circulation	$456	/month		$5,467
Lagoon discharge pump	$977	/year		$977
			Subtotal	$57,300
Other Costs				
Equipment R&R	$7,953	/year		$7,953
Miscellaneous materials & supplies	$4,772	/year		$4,772
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$18,700

Summary

Administration	$6,000
Labor	$20,000
Fuel	$81,800
Electricity	$57,300
Other	$18,700
Total	$184,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 247	43	85%	**$ 108,384**
Public/Commerc	$ 259	10	100%	**$ 31,136**
School Service (	$ 4,942	1	100%	**$ 44,480**
Local Capital Contribution				**$ -**
Total Revenue				**$ 184,000**

Deering, Alaska

Community Information & Existing Infrastructure

The City of Deering is an Inupiaq community of 152 people located on Kotzebue Sound at the mouth of the Inmachuk River. There are 68 residential units and 9 commercial/public facilities and one K-12 school for a total of 78 services. The existing water service provided in Deering consists of self-haul system from the central watering point located at the washeteria. The community operates a vacuum sewer collection system hooked up to the existing homes. Only the washeteria, health clinic, and school are served with piped water service. The existing water and sewer infrastructure consists of the following:

- Inmachuk River – 30 gpm (Seasonal)
- Treated Water Storage – 21,000 gallons
- Raw Water Storage – 425,000 & 440,000 gallons
- Community-wide buried vacuum sewer collection system
- Water Treatment Plant – 1,500 SF, built in 1993, Renovated between 1993-2002
- Water Treatment – Pressure sand filtration & chlorination
- Sewage Lagoon – Single Cell, 1.7 acres

Deering is built on a flat sand and gravel spit approximately 300 feet wide and a half-mile long. The terrain upstream of the community consists of treeless tundra.

Piped System Description

The piped water system will consist of approximately 9,500 feet of buried pipe in two circulating loops. The existing vacuum sewer system is old but reportedly in good condition. Service lines have had minimal issues with failed heat tapes and will not be replaced. As the mains are glycol traced, it is recommended that new vacuum sewer system service lines with glycol heat trace lines are installed. Based on average per capita water consumption of 50 gallons per person per day, the existing water storage capacity would need to be increased to provide sufficient water year round. Approximately 2.8 million gallons of raw water in addition to the treated water would need to be stored during the operation of the seasonal water source to provide water for the piped system when the source is non-producing. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	13	30	-
Raw Water Storage (gallons)	2,800,000	865,000	1,935,000
Treated Water Storage (gallons)	104,200	21,000	83,200
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	3.2	1.7	1.5
Required Foundation System for WTP and/or WST			
Thermosyphon Stabilized Gravel Pad	24,400	-	24,400
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	9,500	-	9,500

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Deering. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs

Village: Deering

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	78	$22,235.73	$1,734,387
10	Sewage lagoon, barrow, local material	Acre	1.5	$787,792.89	$1,181,689
13	Water distribution, mains or services, buried	LF	9,500	$269.86	$2,563,693
14	Water storage tank, no foundation	Gal	2,018,200	$1.80	$3,625,138
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
19	Foundation - thermosyphen stabilized gravel pad	SF	24,400	$159.13	$3,882,806
				Total Estimated Cost in 2010 dollars (rounded):	**$14,747,000**
				Total with Inflation (3% per year for 6 years)	**$17,608,700**
28	Electrical Service Upgrades	EA	78	$5,500	$429,000
				Subtotal	**$18,037,700**
29	Construction Contingency (15%)	LS	1	$2,705,700	$2,705,700
30	Design & Construction Administration Services (20%)	LS	1	$3,607,500	$3,607,500
				Total	**$24,350,900**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment. The O&M cost for the existing vacuum sewer system was provided by the City of Deering.

Estimated O&M Costs			
Description	**Cost**	**Existing Vacuum Sewer O&M**	**Water + Vaccum Sewer O&M**
Administration	$6,000	$10,000	$16,000
Labor	$33,300	$0	$33,300
Fuel	$57,800	$10,000	$67,800
Electricity	$36,600	$12,000	$48,600
Other (R&R, Training, etc.)	$16,200	$3,200	$19,400
		Total	**$185,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Deering are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 158	68	85%	**$ 109,616**
Public/Commercial Service	$ 237	9	100%	**$ 25,602**
School Service	$ 5,531	1	100%	**$ 49,782**
Local Capital Contribution				**$ -**
Total Revenue				**$ 185,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	9/6/2016
Community	Deering
Input	

Existing Community & System Data

2015 Population	152
2015 Number of Services	78
HITS Database (E1 & H1-H7)	68
DCED Mapping Commerical/Public Facilities/School	10
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	886000
Water Treatment Capacity	30
Existing Sewage Lagoon Size	1.7

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x		9467
Gravity Sewer Main			
Pressure Sewer Main			
Typical Service Line Length (ea)		0	0

Piped System Requirements	**Community**	**Deering**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**13**	
Req Water Storage (gallons) (less existing)		**2,018,200**	**23,200 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**1.5**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**9,500**	
Wastewater Collection System			
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**-**	
	Vaccum Sewer Service Lines (lf)	**-**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	13	30	-
Raw Water Storage (gallons)	2,800,000	865,000	1,935,000
Treated Water Storage (gallons)	104,200	21,000	83,200
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	3.2	1.7	1.5
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	24,400	-	24,400
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	9,500	-	9,500

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 9/6/2016

Community Deering

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	152	people	2015 ADOL
2015 Number of Services	78	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***185***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	30	gpm	
Average Day (ADD)	9,273	gpd	50 gallons per Capita
Max Day (MDD)	18,547	gpd	2 x ADD
Peak Hour	39	gpm	3 x MDD
Treatment Capacity	***13***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	13	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	886,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	18,547	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	55,641	gallons	3 days x DO
Water Storage Tank Volume	104,188	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	65,702	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***104,200***	***gallons***	
Required Additional Storage	***2,018,200***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***23,200***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Vacuum Sewer Main	**x**	***Vacuum Sewer Service Lines (lf)***	Vacuum Service Line
Sewage Lagoon Size			
Existing Sewage Lagoon	1.7	acres	
Organic Loading Based Size	1.6	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	212.7		
Hydraulic Loading Based Size	3.2	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***3.2***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Deering

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	78	$22,235.73	$1,734,387
2	Sewage collection mains or services (gravity or vacuum), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.5	$787,792.89	$1,181,689
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	9,500	$269.86	$2,563,693
14	Water storage tank, no foundation	Gal	2,018,200	$1.80	$3,625,138
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	24,400	$159.13	$3,882,806
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$14,746,580**

O&M Cost Estimate
Piped Water & Sewer System

Community: Deering

General Community Data

Current population	152	persons
Average number of people per house	2.2	
Service Connections		
Number of houses	68	
Number of public/commerical buildings	9	
Number of schools	1	
Total number of service connections	78	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.70	kWh
Electricity cost (Residential service)	$0.45	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	11275	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	2700	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	2,904,200	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	9500	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)		Used O&M cost for existing vacuum sewer.
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		
Total length of sewer mains		
Sewer mains heated for freeze protection (Yes or No)		
Number of circulating glycol loops		
Location of the mains (Above ground (AG) or Buried)		
Average service line length		
Wastewater Treatment / Disposal		
Length of force main	750	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Septic system discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$33,280
Fuel (Heating Demand)				
Water system				
WTP building	$827	/month		$6,618.93
Raw water line	$0	/month		$0.00
Raw water heat addition	$554	/month		$4,435.97
Water storage tank	$2,649	/month		$21,189.04
Water storage tank line	$13	/month		$157.59
Water mains	$1,248	/month		$14,971
Service lines	$768	/month		$9,219
Wastewater system				
Sewer mains	$0	/month		$0
Service lines	$0	/month		$0
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$98	/month		$1,182
			Subtotal	$57,800
Electricity				
Water system				
WTP building				
Lights and controls	$552	/month		$6,619
HVAC/hydronic system	$552	/month		$6,619
Water treatment	$81	/month		$970
Pumps				
Intake or well	$81	/month		$970.37
WST circulation	$95	/month		$756
Pressure/booster	$121	/month		$1,455.55
Main line circulation	$1,504	/month		$18,043
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$0	/month		$0
Lagoon discharge pump	$1,165	/year		$1,165
			Subtotal	$36,600
Other Costs				
Equipment R&R	$6,384	/year		$6,384
Miscellaneous materials & supplies	$3,830	/year		$3,830
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$16,200

Summary

		Existing Vacuum Sewer	Total W+S
Administration	$6,000	$10,000	$16,000
Labor	$33,300	$0	$33,300
Fuel	$57,800	$10,000	$67,800
Electricity	$36,600	$12,000	$48,600
Other	$16,200	$3,200	$19,400
		Total	$185,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Service	$ 158	68	85%	**$ 109,616**
Public/Commercial	$ 237.06	9	100%	**$ 25,602**
School Service [3]	$ 5,531.35	1	100%	**$ 49,782**
Local Capital Contribution				**$ -**
Total Revenue				**$ 185,000**

EXISTING SEWAGE LAGOON

EXISTING VACUUM SEWER COLLECTIONS BUILDING

KOTZEBUE SOUND

NANA REGIONAL CORPORATION IC-735

WASHETERIA/WATER TREATMENT PLANT

WATER STORAGE TANK

SCHOOL

KOTZEBUE SOUND

LEGEND:

- PROPOSED WATER MAIN (W)
- EXISTING VACUUM SEWER MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

150' 0 150' 300'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

DEERING

DATE: SEP 2016

SCALE: GRAPHIC

FIGURE: 40

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Deering.dwg

Diomede, Alaska

Community Information & Existing Infrastructure

The community of Diomede is an Ingalikmiut Eskimo community of 111 people located on the west coast of Little Diomede Island in the Bering Straits, 135 miles northwest of Nome. There are 41 residential units, 9 commercial/public facilities, one elementary school, and one high school for a total of 52 services. The existing water service provided in Diomede consists of a self-haul system from the water storage tank. Gray water is disposed of onto the ground, and black water is disposed of onto the sea ice or thrown into the ocean. There is a piped utilidor system that provides water services to the washteria/clinic and the school. The existing water and sewer infrastructure consists of the following:

- Seasonal Runoff Stream – 5 gpm
- Treated Water Storage – 424,000 gallons
- Water Treatment Plant Building –600 SF, built in 1992
- Water Treatment – Carbon filter, pH neutralization filter, bag filters, and chlorine (Not potable)
- Sewage Lagoon – None

Little Diomede Island is a mass of boulders, covered in light gray granite. There is black, sandy gravel with coarser gravel above bedrock near the shore up to 13-feet thick.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 2,400 feet of pipe, and the sewer system approximately 1,000 feet of gravity and pressure pipe. The water system will consist of a single circulating loop. The sewer system including the force main will require one sewer main lift station and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet water pipe and 100 feet of gravity sewer pipe would be required for each service. Upgrades to the existing seasonal water source will be needed to provide adequate flow for a piped system. A 2012 study indicated that improvements could be made to achieve 50 gpm on a seasonal basis (~60 days per year). Approximately 2 million gallons of raw water would need to be stored during the operation of the seasonal water source to provide water for the piped system when the source is non-producing. The existing 424,000 gallon water storage tank is sufficient for storing treated water and meeting the systems CT requirements. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The sewage treatment system would consist of construction of septic tanks, and a primary outfall. As evaluated in a 2012 Master Plan by CRW Engineering Group, the system would be installed in place of the existing septic tanks that serve the washeteria and clinic. The 2012 study assumed a community water demand of 18 gpcd and sized the facility accordingly. For this assessment, the system has been increased to accommodate a community water use of 50 gpcd.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	5	4
New Water Source (gpm)	50	-	50
Raw Water Storage (gallons)	2,000,000	-	2,000,000
Treated Water Storage (gallons)	84,200	424,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Septic Tank System (gallons)	30,000	-	30,000
Required Foundation System for WTP and/or WST			
Pile Foundation	1,200	-	1,200
Conventional, Local Gravel Material	23,000	-	23,000
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	2,400	-	2,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	1,000	-	1,000
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,900	-	3,900
Gravity Sewer Service Lines (lf)	5,200	-	5,200

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Diomede. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 23.1 & 28-30).

Estimated Capital Costs

Village: Little Diomede

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	52	$22,235.73	$1,156,258
3	Sewage collection mains or services (gravity or force), above ground	LF	6,200	$202.72	$1,256,855
4	Sewage lift station	EA	1	$ 722,316.38	$ 722,316
7	Septic tank, community	EA	2	$311,494.26	$622,989
12	Water distribution, mains or services, above ground	LF	6,300	$302.61	$1,906,414
14	Water storage tank, no foundation	Gal	2,000,000	$1.80	$3,594,426
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
17	Foundation - conventional, local gravel material	SF	23,000	$183.21	$4,213,790
18	Foundation - freeze back piles	SF	1,200	$442.34	$530,809
				Total Estimated Cost in 2010 dollars (rounded):	**$15,763,000**
				Total with Inflation (3% per year for 6 years)	**$18,821,800**
23.1	Upgrade Seasonal Stream Intake*	EA	1	$336,000	$336,000
28	Electrical Service Upgrades	EA	52	$5,500	$286,000
				Subtotal	**$19,443,800**
29	Construction Contingency (15%)	LS	1	$2,916,600	$2,916,600
30	Design & Construction Administration Services (20%)	LS	1	$3,888,800	$3,888,800
				Total	**$26,249,200**

* From 2012 water and sewer master plan by CRW. Adjusted for inflation.

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs

Description	Cost
Administration	$6,000
Labor	$33,300
Fuel	$59,300
Electricity	$18,400
Other (R&R, Training, etc.)	$14,900
Total	**$132,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Diomede are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 181	41	85%	**$ 75,661**
Public/Commercial Service	$ 190	9	100%	**$ 20,516**
School Service	$ 1,990	2	100%	**$ 35,822**
Local Capital Contribution				**$ -**
Total Revenue				**$ 132,000**

HIGH SCHOOL

ELEMENTARY SCHOOL

EXISTING WATER TANK

WASHETERIA/CLINIC

WATER TREATMENT PLANT

LIFT STATION #1

PROPOSED RAW WATER TANK

BERING STRAIT

TO UPGRADED WATER SOURCE
(STREAM AND CATCHMENT AREA)

LEGEND:

- PROPOSED WATER MAIN
- RAW WATER LINE
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

100' 0 100' 200'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES

DIOMEDE

DATE
MAR 2015

SCALE
GRAPHIC

FIGURE
12

File: J:\Jobsdata\31303.00 VSW - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Diomede.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/29/2016
Community	Diomede
Input	

Existing Community & System Data

2015 Population	111
2015 Number of Services	52
HITS Database (E1 & H1-H7)	41
DCED Mapping Commerical/Public Facilities/School	11
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	424000
Water Treatment Capacity	5
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	1000	2374
Gravity Sewer Main			
Pressure Sewer Main	x	1000	
Typical Service Line Length (ea)		100	75

Piped System Requirements **Community** **Diomede**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**9**	
Req Water Storage (gallons) (less existing)	**2,000,000**	**23,000 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**SEPTIC TANKS**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**2,400**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**1,000**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**3,900**	
	Gravity Sewer Service Lines (lf)	**5,200**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	5	4
New Water Source (gpm)	50	-	50
Raw Water Storage (gallons)	2,000,000	-	2,000,000
Treated Water Storage (gallons)	84,200	424,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Septic Tank System (gallons)	30,000	-	30,000
Required Foundation System for WTP and/or WST			
Pile Foundation	1,200	-	1,200
Conventional, Local Gravel Material	23,000	-	23,000
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	2,400	-	2,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	1,000	-	1,000
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,900	-	3,900
Gravity Sewer Service Lines (lf)	5,200	-	5,200

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/29/2016

Community Diomede

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	111	people	2015 ADOL
2015 Number of Services	52	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***135***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	5	gpm	
Average Day (ADD)	6,772	gpd	50 gallons per Capita
Max Day (MDD)	13,544	gpd	2 x ADD
Peak Hour	28	gpm	3 x MDD
Treatment Capacity	***9***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	9	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	424,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	13,544	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	40,632	gallons	3 days x DO
Water Storage Tank Volume	84,176	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	47,980	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***84,200***	***gallons***	
Required Additional Storage	***2,000,000***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***23,000***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**x**	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	**0**		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size	**NOT SUITABLE FOR DIOMEDE. SEPTIC TANKS ARE PROPOSED.**		
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.0	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	0.0		
Hydraulic Loading Based Size	0.0	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	-	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Little Diomede

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	52	$22,235.73	$1,156,258
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	6,200	$202.72	$1,256,855
4	Sewage lift station	EA	1	$722,316.38	$722,316
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	2	$311,494.26	$622,989
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	6,300	$302.61	$1,906,414
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	2,000,000	$1.80	$3,594,426
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	23,000	$183.21	$4,213,790
18	Foundation - freeze back piles	SF	1,200	$442.34	$530,809
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$15,762,724**

O&M Cost Estimate
Piped Water & Sewer System

Community: Diomede

General Community Data

Current population	111	persons
Average number of people per house	2.7	
Service Connections		
Number of houses	41	
Number of public/commerical buildings	9	
Number of schools	2	
Total number of service connections	52	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.46	kWh
Electricity cost (Residential service)	$0.14	kWh
Cost per gallon for heating oil	$7.32	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	1237	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	1800	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	2,424,000	gallons
Length of water line to/ from tank	800	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	1600	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	47	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	1000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	100	ft
Wastewater Treatment / Disposal		
Length of force main	100	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Septic Tanks discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$33,280
Fuel (Heating Demand)				
Water system				
WTP building	$673	/month		$5,383.40
Raw water line	$0	/month		$0.00
Raw water heat addition	$494	/month		$3,952.10
Water storage tank	$2,697	/month		$21,576.31
Water storage tank line	$214	/month		$1,709.02
Water mains	$427	/month		$3,418
Service lines	$1,041	/month		$8,331
Wastewater system				
Sewer mains	$267	/month		$2,136
Service lines	$1,389	/month		$11,109
Lift/pump station buildings	$187	/month		$1,495.39
Force main to lagoon	$27	/month		$214
			Subtotal	$59,300
Electricity				
Water system				
WTP building				
Lights and controls	$242	/month		$2,900
HVAC/hydronic system	$242	/month		$1,933
Water treatment	$39	/month		$466
Pumps				
Intake or well	$39	/month		$465.67
WST circulation	$62	/month		$497
Pressure/booster	$58	/month		$698.50
Main line circulation	$988	/month		$7,905
Wastewater system				
Lift /pump station buildings				
Lights and controls	$67	/month		$805
HVAC/hydronic system	$67	/month		$537
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$53	/month		$640.58
Sewer/force main glycol circulation	$123	/month		$986
Lagoon discharge pump	$559	/year		$559
			Subtotal	$18,400
Other Costs				
Equipment R&R	$5,549	/year		$5,549
Miscellaneous materials & supplies	$3,329	/year		$3,329
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$14,900

Summary

Administration	$6,000
Labor	$33,300
Fuel	$59,300
Electricity	$18,400
Other	$14,900
Total	$132,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 181	41	85%	**$ 75,661**
Public/Commerc	$ 189.97	9	100%	**$ 20,516**
School Service (	$ 1,990.13	2	100%	**$ 35,822**
Local Capital Contribution				**$ -**
Total Revenue				**$ 132,000**

Eagle City, Alaska

Community Information & Existing Infrastructure

Eagle City is a traditional Han Kutchin Indian community of 81 people located on the left bank of the Yukon River at the mouth of Mission Creek, on the Taylor Highway. There are 41 residential units, 12 commercial/public facilities, and one school for a total of 54 services. The existing water service provided in Eagle City consists of a self-haul system and septic systems/outhouses for wastewater disposal. The existing water and sewer infrastructure consists of the following:

- Well – 12 gpm
- Treated Water Storage – 87 gallons
- Well house – 196 SF, built in 1905
- Water Treatment –Filters, UV disinfection
- Sewage Lagoon – None

Soil in the area consists of 1-3 inches of organic mat with 2-3 feet of a silt layer underneath. No permafrost encountered but lenses are known to exist in the area.

Piped System Description

The piped water and pressure sewer system will be a buried system. The water system will consist of approximately 16,400 feet of pipe, and the pressure sewer system approximately 14,900 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system will require individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	6	12	-
Water Storage (gallons)	69,500	87	69,413
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.7	-	1.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,300	-	2,300
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	16,400	-	16,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,900	-	14,900
Individual Grinder Pump Stations (GPS) (ea)	54	-	54
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,100	-	4,100
Pressure Sewer Service Lines (lf)	4,100	-	4,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Eagle City. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Eagle	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	54	$26,191.57	$1,414,345
3	Sewage collection mains or services (gravity or force), above ground	LF	19,000	$183.70	$3,490,342
10	Sewage lagoon, barrow, local material	Acre	1.7	$688,671.60	$1,170,742
12	Water distribution, mains or services, above ground	LF	20,500	$317.45	$6,507,780
14	Water storage tank, no foundation	Gal	69,413	$2.54	$176,378
15	Water treatment plant, no foundation	SF	1,200	$1,507.42	$1,808,905
19	Foundation - thermosyphen stablized gravel pad	SF	2,300	$202.08	$464,773
				Total Estimated Cost in 2010 dollars (rounded):	**$15,033,000**
				Total with Inflation (3% per year for 6 years)	**$17,950,200**
27	Individual Grinder Pump Stations	EA	54	$30,000	$1,620,000
28	Electrical Service Upgrades	EA	54	$5,500	$297,000
				Subtotal	**$19,867,200**
29	Construction Contingency (15%)	LS	1	$2,980,100	$2,980,100
30	Design & Construction Administration Services (20%)	LS	1	$3,973,400	$3,973,400
				Total	**$26,820,700**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$63,400
Electricity	$16,100
Other (R&R, Training, etc.)	$14,400
Total	**$125,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Eagle City are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 152	41	85%	**$ 63,502**
Public/Commercial Service	$ 190	12	100%	**$ 27,332**
School Service	$ 3,796	1	100%	**$ 34,165**
Local Capital Contribution				**$ -**
Total Revenue				**$ 125,000**

WELL HOUSE

YUKON RIVER

SCHOOL

PROPOSED SEWAGE LAGOON

Image © 2016 DigitalGlobe

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

200' 0 200' 400'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

EAGLE CITY

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 13

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Eagle.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/21/2016
Community	Eagle City
Input	

Existing Community & System Data	
2015 Population	81
2015 Number of Services	54
DCCED Community Housing Info	41
DCED Mapping Commerical/Public Facilities/School	13
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	87
Water Treatment Capacity	12
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	14900	16400
Gravity Sewer Main			
Pressure Sewer Main	x	14900	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Eagle City**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**7**	
Req Water Storage (gallons) (less existing)		**69,413**	**1,100 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**1.7**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**16,400**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**14,900**	
	Individual Grinder Pump Stations (GPS) (ea)	**54**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**4,100**	
	Pressure Sewer Service Lines (lf)	**4,100**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	7	12	-
Water Storage (gallons)	69,500	87	69,413
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.7	-	1.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,300	-	2,300
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	16,400	-	16,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,900	-	14,900
Individual Grinder Pump Stations (GPS) (ea)	54	-	54
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,100	-	4,100
Pressure Sewer Service Lines (lf)	4,100	-	4,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/21/2016
Community Eagle City

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	81	people	2015 ADOL
2015 Number of Services	54	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***99***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	12	gpm	
Average Day (ADD)	4,942	gpd	50 gallons per Capita
Max Day (MDD)	9,884	gpd	2 x ADD
Peak Hour	21	gpm	3 x MDD
Treatment Capacity	***7***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	7	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	87	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	9,884	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	29,651	gallons	3 days x DO
Water Storage Tank Volume	69,534	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	35,012	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***69,500***	***gallons***	
Required Additional Storage	***69,413***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,100***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.8	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	155.3		
Hydraulic Loading Based Size	1.7	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.7***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Eagle Village

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	54	$26,191.57	$1,414,345
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	19,000	$183.70	$3,490,342
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.7	$688,671.60	$1,170,742
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	20,500	$317.45	$6,507,780
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	69,413	$2.54	$176,378
15	Water treatment plant, no foundation	SF	1,200	$1,507.42	$1,808,905
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	2,300	$202.08	$464,773
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$15,033,265**

O&M Cost Estimate
Piped Water & Sewer System

Community: Eagle City

General Community Data

Current population	81	persons
Average number of people per house	2.0	
Service Connections		
Number of houses	41	
Number of public/commerical buildings	12	
Number of schools	1	
Total number of service connections	54	
Burdened labor rate	$15	hr
Electricity cost (Public facilty)	$0.48	kWh
Electricity cost (Residential service)	$0.24	kWh
Cost per gallon for heating oil	$5.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	1396	sf
Raw water quality (Good or Poor)	Good	

Water Storage

Size of tank(s)	69,500	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	16400	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	14900	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	444	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$356	/month		$2,851.86
Raw water line	$0	/month		$0.00
Raw water heat addition	$246	/month		$1,969.92
Water storage tank	$53	/month		$422.56
Water storage tank line	$0	/month		$0.00
Water mains	$2,991	/month		$23,931
Service lines	$739	/month		$5,910
Wastewater system				
Sewer mains	$2,718	/month		$21,742
Service lines	$739	/month		$5,910
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$81	/month		$648
			Subtotal	$63,400
Electricity				
Water system				
WTP building				
Lights and controls	$196	/month		$2,347
HVAC/hydronic system	$196	/month		$1,564
Water treatment	$6	/month		$71
Pumps				
Intake or well	$30	/month		$354.59
WST circulation	$65	/month		$518
Pressure/booster	$44	/month		$531.88
Main line circulation	$1,031	/month		$8,248
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$257	/month		$2,058
Lagoon discharge pump	$426	/year		$426
			Subtotal	$16,100
Other Costs				
Equipment R&R	$5,223	/year		$5,223
Miscellaneous materials & supplies	$3,134	/year		$3,134
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$14,400

Summary

Administration	$6,000
Labor	$25,000
Fuel	$63,400
Electricity	$16,100
Other	$14,400
Total	$125,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 152	41	85%	**$ 63,502**
Public/Commerc	$ 189.81	12	100%	**$ 27,332**
School Service (	$ 3,796.16	1	100%	**$ 34,165**
Local Capital Contribution				**$ -**
Total Revenue				**$ 125,000**

Kipnuk, Alaska

Community Information & Existing Infrastructure

The Community of Kipnuk is a Yupik community of 643 people located on the west bank of Kugkaklik River in the Yukon-Kuskokwim Delta. There are 157 residential units, 31 commercial/public facilities and one school for a total of 189 services. The existing water and sewer services provided in Kipnuk consist of self-haul from the central watering point attached to the water treatment plant and honey buckets. Raw water is pumped from the reservoir to the WTP through a 4-inch arctic pipe. The raw water reservoir is replenished by a combination of surface water runoff, rain, and snow. The fish plant, clinic, and triplex housing have cowater haul systems installed. The school and the water treatment plant have piped water and sewer. The existing water and sewer infrastructure consists of the following:

- Raw Water Reservoir – 17.5 million gallons
- WTP Treatment Capacity – 40 gpm
- Two Water Storage Tanks – 212,000 gallons & 100,000 gallons
- Water Treatment Plant/Washeteria – 8,000 SF, built in 2012
- Water Treatment – Calcium chlorite, potassium permanganate, soda ash
- Sewage Lagoon – Four Cell, 7.14 acres

Soils around Kipnuk were observed to be marginally frozen soil and unfrozen soil; inorganic silt observed to be medium stiff and silty fine sand/fine sand observed to be medium dense.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 20,900 feet of pipe, and the pressure sewer system approximately 16,300 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require one sewer main lift station, individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment. The existing water storage tank is sufficient to meet CT requirements (278,000 gallons) and provide a small reserve for fire flows.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	54	40	14
Water Storage (gallons)	343,800	312,000	31,800
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	13.7	7.1	6.6
Required Foundation System for WTP and/or WST			
Pile Foundation	1,760	-	1,760
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	20,900	-	20,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	16,300	-	16,300
Individual Grinder Pump Stations (GPS) (ea)	189	-	189
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	14,200	-	14,200
Pressure Sewer Service Lines (lf)	14,200	-	14,200

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Kipnuk. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Kipnuk	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	189	$26,342.77	$4,978,784
3	Sewage collection mains or services (gravity or force), above ground	LF	30,500	$194.04	$5,918,082
4	Sewage lift station	EA	1	$ 662,130.80	$ 662,131
10	Sewage lagoon, barrow, local material	Acre	7	$689,113.57	$4,548,150
12	Water distribution, mains or services, above ground	LF	35,100	$326.34	$11,454,672
14	Water storage tank, no foundation	Gal	43,800	$5.41	$236,919
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
18	Foundation - freeze back piles	SF	1,760	$374.51	$659,140
22	Water source - surface water intake	EA	1	$444,987.75	$444,988
				Total Estimated Cost in 2010 dollars (rounded):	**$30,833,000**
				Total with Inflation (3% per year for 6 years)	**$36,816,200**
27	Individual Grinder Pump Stations	EA	189	$30,000	$5,670,000
28	Electrical Service Upgrades	EA	189	$5,500	$1,039,500
				Subtotal	**$43,525,700**
29	Construction Contingency (15%)	LS	1	$6,528,900	$6,528,900
30	Design & Construction Administration Services (20%)	LS	1	$8,705,100	$8,705,100
				Total	**$58,759,700**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$27,000
Fuel	$143,900
Electricity	$45,000
Other (R&R, Training, etc.)	$23,300
Total	**$245,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Kipnuk are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 94	157	85%	**$ 150,358**
Public/Commercial Service	$ 141	31	100%	**$ 52,391**
School Service	$ 4,695	1	100%	**$ 42,251**
Local Capital Contribution				**$ -**
Total Revenue				**$ 245,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/21/2016
Community	Kipnuk
Input	

Existing Community & System Data

2015 Population	643
2015 Number of Services	189
HITS Database (E1 & H1-H7)	157
DCED Mapping Commerical/Public Facilities/School	32
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	312000
Water Treatment Capacity	40
Existing Sewage Lagoon Size	7.14

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	16300	20900
Gravity Sewer Main			
Pressure Sewer Main	x	16300	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Kipnuk**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**54**	
Req Water Storage (gallons) (less existing)	**31,800**	**590 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**6.6**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**20,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**16,300**	
	Individual Grinder Pump Stations (GPS) (ea)	**189**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**14,200**	
	Pressure Sewer Service Lines (lf)	**14,200**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	54	40	14
Water Storage (gallons)	343,800	312,000	31,800
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	13.7	7.1	6.6
Required Foundation System for WTP and/or WST			
Pile Foundation	1,790	-	1,790
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	20,900	-	20,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	16,300	-	16,300
Individual Grinder Pump Stations (GPS) (ea)	189	-	189
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	14,200	-	14,200
Pressure Sewer Service Lines (lf)	14,200	-	14,200

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/21/2016

Community Kipnuk

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	643	people	2015 ADOL
2015 Number of Services	189	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***785***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	40	gpm	
Average Day (ADD)	39,229	gpd	50 gallons per Capita
Max Day (MDD)	78,458	gpd	2 x ADD
Peak Hour	163	gpm	3 x MDD
Treatment Capacity	***54***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	54	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	312,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	78,458	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	235,375	gallons	3 days x DO
Water Storage Tank Volume	343,833	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	277,937	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***343,800***	***gallons***	
Required Additional Storage	***31,800***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***590***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	7.14	acres	
Organic Loading Based Size	6.7	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	437.5		
Hydraulic Loading Based Size	13.7	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***13.7***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Kipnuk

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	189	$26,342.77	$4,978,784
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	30,500	$194.04	$5,918,082
4	Sewage lift station	EA	1	$662,130.80	$662,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	6.6	$689,113.57	$4,548,150
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	35,100	$326.34	$11,454,672
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	43,800	$5.41	$236,919
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	1,760	$374.51	$659,140
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	1	$444,987.75	$444,988
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$30,832,641**

O&M Cost Estimate
Piped Water & Sewer System

Community: Kipnuk

General Community Data

Current population	643	persons
Average number of people per house	4.1	
Service Connections		
Number of houses	157	
Number of public/commerical buildings	31	
Number of schools	1	
Total number of service connections	189	
Burdened labor rate	$13	hr
Electricity cost (Public facilty)	$0.40	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$5.40	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	2400	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	9200	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	344,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	20900	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	130	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	13100	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	3200	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$27,040
Fuel (Heating Demand)				
Water system				
WTP building	$2,537	/month		$20,298.06
Raw water line	$0	/month		$0.00
Raw water heat addition	$2,111	/month		$16,888.78
Water storage tank	$282	/month		$2,258.84
Water storage tank line	$0	/month		$0.00
Water mains	$4,117	/month		$32,937
Service lines	$2,792	/month		$22,339
Wastewater system				
Sewer mains	$2,581	/month		$20,645
Service lines	$2,792	/month		$22,339
Lift/pump station buildings	$138	/month		$1,103.16
Force main to lagoon	$630	/month		$5,043
			Subtotal	$143,900
Electricity				
Water system				
WTP building				
Lights and controls	$1,074	/month		$12,888
HVAC/hydronic system	$1,074	/month		$8,592
Water treatment	$195	/month		$2,346
Pumps				
Intake or well	$195	/month		$2,345.66
WST circulation	$54	/month		$432
Pressure/booster	$293	/month		$3,518.50
Main line circulation	$859	/month		$6,874
Wastewater system				
Lift /pump station buildings				
Lights and controls	$58	/month		$700
HVAC/hydronic system	$58	/month		$467
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$194	/month		$2,330.72
Sewer/force main glycol circulation	$214	/month		$1,715
Lagoon discharge pump	$2,816	/year		$2,816
			Subtotal	$45,000
Other Costs				
Equipment R&R	$10,797	/year		$10,797
Miscellaneous materials & supplies	$6,478	/year		$6,478
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$23,300

Summary

Administration	$6,000
Labor	$27,000
Fuel	$143,900
Electricity	$45,000
Other	$23,300
Total	$245,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 94	157	85%	**$ 150,358**
Public/Commerc	$ 140.84	31	100%	**$ 52,391**
School Service (	$ 4,694.57	1	100%	**$ 42,251**
Local Capital Contribution				**$ -**
Total Revenue				**$ 245,000**

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

KUGUKLIK RIVER
(KUGKAKTLIK RIVER)

SCHOOL

TO SEWAGE LAGOON

SWAN LAKE ROAD

LIFT STATION #1

WTP/WASHETERIA

BACKWASH LAGOON

TO WATER RESERVOIR

150' 0 150' 300'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

KIPNUK

DATE MAR 2015

SCALE GRAPHIC

FIGURE 15

File: J:\Jobsdata\31303.00 VSW – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Kipnuk.dwg

Kongiganak, Alaska

Community Information & Existing Infrastructure

The Community of Kongiganak is a Yupik community of 501 people located on the west shore of Kuskokwim Bay, west of the mouth of the Kuskokwim River. There are 89 residential units, 31 commercial/public facilities and one school for a total of 121 services. The existing water and sewer services provided in Kongiganak consist of self-haul system from the central watering point attached to the water treatment plant and honey buckets. The washeteria and water treatment plant have piped water and sewer services, but the school only has a piped sewer service. The existing water and sewer infrastructure consists of the following:

- Contractor's Lake – 50 gpm transfer pump (Seasonal)
- Treated Water Storage – 10,000 gallons
- Raw Water Storage – 1.2 MG & 500,000 gallons
- Water Treatment Plant/Multi-Purpose Building – 2,400 SF, built in 2002 (20 gpm)
- Water Treatment – Bag filters, flocculation tanks, chlorine, and soda ash
- Sewage Lagoon – Single Cell, 5.3 acres

The community is underlain by deep permafrost that has started to degrade at the surface.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 17,900 feet of pipe, and the pressure sewer system approximately 11,000 feet of pipe. The water system will consist of four circulating loops. The pressure sewer system would require one sewer main lift station, individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. Upgrades to the existing seasonal water source will be needed to provide adequate flow for a piped system. Approximately 7 million gallons of raw water would need to be stored during the operation of the seasonal water source to provide water for the piped system when the source is non-producing. In order to fill and store 7 million gallons of raw water, the existing transfer pump would need to be increased to transfer a minimum of 60 gpm. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	42	20	22
Raw Water Storage (gallons)	7,000,000	1,700,000	5,300,000
Water Storage (gallons)	274,500	10,000	264,500
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	10.7	5.3	5.4
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	1,200	-	1,200
Thermosyphon stabilized gravel pad (sf)	61,990	-	61,990
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,900	-	17,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	11,000	-	11,000
Individual Grinder Pump Stations (GPS) (ea)	121	-	121
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,100	-	9,100
Pressure Sewer Service Lines (lf)	9,100	-	9,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Kongiganak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Kongiganak	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	121	$26,342.77	$3,187,476
3	Sewage collection mains or services (gravity or force), above ground	LF	20,100	$195.84	$3,936,394
4	Sewage lift station	EA	1	$ 662,130.80	$ 662,131
10	Sewage lagoon, barrow, local material	Acre	5	$696,693.37	$3,762,144
12	Water distribution, mains or services, above ground	LF	27,000	$327.06	$8,830,671
14	Water storage tank, no foundation	Gal	5,565,000	$1.81	$10,053,951
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
18	Foundation - freeze back piles	SF	1,200	$426.48	$511,777
19	Foundation - thermosyphen stablized gravel pad	SF	61,990	$160.34	$9,939,782
22	Water source - surface water intake	EA	1	$444,987.75	$444,988
				Total Estimated Cost in 2010 dollars (rounded):	**$43,259,000**
				Total with Inflation (3% per year for 6 years)	**$51,653,500**
27	Individual Grinder Pump Stations	EA	121	$30,000	$3,630,000
28	Electrical Service Upgrades	EA	121	$5,500	$665,500
				Subtotal	**$55,949,000**
29	Construction Contingency (15%)	LS	1	$8,392,400	$8,392,400
30	Design & Construction Administration Services (20%)	LS	1	$11,189,800	$11,189,800
				Total	**$75,531,200**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$22,900
Fuel	$145,600
Electricity	$28,800
Other (R&R, Training, etc.)	$21,800
Total	**$225,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Kongiganak are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 134	89	85%	**$ 121,798**
Public/Commercial Service	$ 148	31	100%	**$ 54,902**
School Service	$ 5,367	1	100%	**$ 48,301**
Local Capital Contribution				**$ -**
Total Revenue				**$ 225,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/21/2016
Community	Kongiganak
Input	

Existing Community & System Data	
2015 Population	501
2015 Number of Services	121
HITS Database (E1 & H1-H7)	89
DCED Mapping Commerical/Public Facilities/School	32
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	10000
Water Treatment Capacity	20
Existing Sewage Lagoon Size	5.3
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	11000	17900
Gravity Sewer Main			
Pressure Sewer Main	x	11000	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Kongiganak**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**42**	
Req Water Storage (gallons) (less existing)		**5,565,000**	**61,990 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**5.4**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
	Thermosyphon stabilized gravel pad (sf)	**61,990**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**17,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**11,000**	
	Individual Grinder Pump Stations (GPS) (ea)	**121**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**9,100**	
	Pressure Sewer Service Lines (lf)	**9,100**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	42	20	22
Raw Water Storage (gallons)	7,000,000	1,700,000	5,300,000
Water Storage (gallons)	274,500	10,000	264,500
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	10.7	5.3	5.4
Required Foundation System for WTP and/or WST			
Pile Foundation	1,200	-	1,200
Thermosyphon stabilized gravel pad (sf)	61,990	-	61,990
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,900	-	17,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	11,000	-	11,000
Individual Grinder Pump Stations (GPS) (ea)	121	-	121
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,100	-	9,100
Pressure Sewer Service Lines (lf)	9,100	-	9,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/21/2016

Community Kongiganak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	501	people	2015 ADOL
2015 Number of Services	121	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***611***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	20	gpm	
Average Day (ADD)	30,566	gpd	50 gallons per Capita
Max Day (MDD)	61,132	gpd	2 x ADD
Peak Hour	127	gpm	3 x MDD
Treatment Capacity	***42***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	42	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	10,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	61,132	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	183,395	gallons	3 days x DO
Water Storage Tank Volume	274,526	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	216,558	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***274,500***	***gallons***	
Required Additional Storage	***5,565,000***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***61,990***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**x**	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	5.3	acres	
Organic Loading Based Size	5.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	386.2		
Hydraulic Loading Based Size	10.7	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***10.7***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Kongiganak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	121	$26,342.77	$3,187,476
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	20,100	$195.84	$3,936,394
4	Sewage lift station	EA	1	$662,130.80	$662,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	5.4	$696,693.37	$3,762,144
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	27,000	$327.06	$8,830,671
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	5,565,000	$1.81	$10,053,951
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	1,200	$426.48	$511,777
19	Foundation - thermosyphen stablized gravel pad	SF	61,990	$160.34	$9,939,782
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	1	$444,987.75	$444,988
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$43,259,089**

O&M Cost Estimate
Piped Water & Sewer System

Community: Kongiganak

General Community Data

Current population	501	persons
Average number of people per house	5.6	
Service Connections		
Number of houses	89	
Number of public/commerical buildings	31	
Number of schools	1	
Total number of service connections	121	
Burdened labor rate	$11	hr
Electricity cost (Public facilty)	$0.30	kWh
Electricity cost (Residential service)	$0.35	kWh
Cost per gallon for heating oil	$5.43	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	9800	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	3600	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	7,275,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	4	
Total length of Water Main	17900	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	104	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	11000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	4	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	435	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$22,880
Fuel (Heating Demand)				
Water system				
WTP building	$998	/month		$7,986.84
Raw water line	$0	/month		$0.00
Raw water heat addition	$1,654	/month		$13,232.17
Water storage tank	$6,004	/month		$48,035.95
Water storage tank line	$0	/month		$0.00
Water mains	$3,546	/month		$28,366
Service lines	$1,798	/month		$14,381
Wastewater system				
Sewer mains	$2,179	/month		$17,432
Service lines	$1,798	/month		$14,381
Lift/pump station buildings	$139	/month		$1,109.28
Force main to lagoon	$86	/month		$689
			Subtotal	$145,600
Electricity				
Water system				
WTP building				
Lights and controls	$315	/month		$3,782
HVAC/hydronic system	$315	/month		$2,521
Water treatment	$114	/month		$1,371
Pumps				
Intake or well	$114	/month		$1,370.74
WST circulation	$41	/month		$324
Pressure/booster	$171	/month		$2,056.10
Main line circulation	$1,289	/month		$10,310
Wastewater system				
Lift /pump station buildings				
Lights and controls	$44	/month		$525
HVAC/hydronic system	$44	/month		$350
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$160	/month		$1,922.11
Sewer/force main glycol circulation	$322	/month		$2,573
Lagoon discharge pump	$1,646	/year		$1,646
			Subtotal	$28,800
Other Costs				
Equipment R&R	$9,864	/year		$9,864
Miscellaneous materials & supplies	$5,918	/year		$5,918
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$21,800

Summary

Administration	$6,000
Labor	$22,900
Fuel	$145,600
Electricity	$28,800
Other	$21,800
Total	$225,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 134	89	85%	**$ 121,798**
Public/Commerc	$ 147.58	31	100%	**$ 54,902**
School Service (	$ 5,366.73	1	100%	**$ 48,301**
Local Capital Contribution				**$ -**
Total Revenue				**$ 225,000**

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES

KONGIGANAK

DATE
SEP 2016

SCALE
GRAPHIC

FIGURE
16

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Koyukuk, Alaska

Community Information & Existing Infrastructure

The Community of Koyukuk is an Athabascan community of 92 people located on the Yukon River near the mouth of the Koyukuk River. There are 50 residential units, 10 commercial/public facilities and one school for a total of 61 services. The existing water and sewer services provided in Koyukuk consist of self-haul system from the washeteria and honey buckets/pit privies. The existing water and sewer infrastructure consists of the following:

- Well Water – 14 gpm transfer pump
- Treated Water Storage – 5,000 gallons
- Water Treatment Plant/Washeteria – 1,200 SF, built in 1975, renovated in 1987
- Water Treatment – Greensand filters, oxidation chamber, carbon filter, chlorine
- Sewage Lagoon – Single Cell, 0.28 acres

Soils around Koyukuk consist of dark brown peaty silt approximately 1.5-3 feet, and sand mixed with silt below 3 feet. The community is in a continuous permafrost zone with varying depths between 6-15 feet.

Piped System Description

The piped water and pressure sewer system will be a buried system. The water system will consist of approximately 15,500 feet of pipe, and the pressure sewer system approximately 12,000 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	8	14	-
Water Storage (gallons)	74,900	5,000	69,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.0	0.3	1.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,300	-	2,300
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	15,500	-	15,500
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	12,000	-	12,000
Individual Grinder Pump Stations (GPS) (ea)	61	-	61
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,600	-	4,600
Pressure Sewer Service Lines (lf)	4,600	-	4,600

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Koyukuk. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Koyukuk	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	61	$26,403.25	$1,610,598
3	Sewage collection mains or services (gravity or force), above ground	LF	16,600	$202.45	$3,360,590
10	Sewage lagoon, barrow, local material	Acre	2	$847,406.81	$1,440,592
12	Water distribution, mains or services, above ground	LF	20,100	$332.88	$6,690,809
14	Water storage tank, no foundation	Gal	69,900	$4.97	$347,198
15	Water treatment plant, no foundation	SF	1,200	$1,660.79	$1,992,952
19	Foundation - thermosyphen stablized gravel pad	SF	2,300	$344.23	$791,733
				Total Estimated Cost in 2010 dollars (rounded):	**$16,234,000**
				Total with Inflation (3% per year for 6 years)	**$19,384,200**
27	Individual Grinder Pump Stations	EA	61	$30,000	$1,830,000
28	Electrical Service Upgrades	EA	61	$5,500	$335,500
				Subtotal	**$21,549,700**
29	Construction Contingency (15%)	LS	1	$3,232,500	$3,232,500
30	Design & Construction Administration Services (20%)	LS	1	$4,309,900	$4,309,900
				Total	**$29,092,100**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$80,100
Electricity	$19,800
Other (R&R, Training, etc.)	$16,000
Total	**$147,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Koyukuk are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 170	50	85%	**$ 86,471**
Public/Commercial Service	$ 187	10	100%	**$ 22,381**
School Service	$ 4,239	1	100%	**$ 38,149**
Local Capital Contribution				**$ -**
Total Revenue				**$ 147,000**

PROPOSED SEWAGE LAGOON

WATER TREATMENT PLANT/WASHETERIA

SCHOOL SEWAGE LAGOON

COMMUNITY WELL

SCHOOL

YUKON RIVER

LEGEND:

- PROPOSED WATER MAIN — W
- PROPOSED SEWER/FORCE MAIN — S
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

200' 0 200' 400'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

KOYUKUK

DATE MAR 2015

SCALE GRAPHIC

FIGURE 17

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Koyukuk.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/22/2016
Community	Koyukuk
Input	

Existing Community & System Data	
2015 Population	92
2015 Number of Services	61
HITS Database (E1 & H1-H7)	50
DCED Mapping Commerical/Public Facilities/School	11
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	5000
Water Treatment Capacity	14
Existing Sewage Lagoon Size	0.28
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	12000	15500
Gravity Sewer Main			
Pressure Sewer Main	x	12000	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Koyukuk**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**8**	
Req Water Storage (gallons) (less existing)		**69,900**	**1,100 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**1.7**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**15,500**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**12,000**	
	Individual Grinder Pump Stations (GPS) (ea)	**61**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**4,600**	
	Pressure Sewer Service Lines (lf)	**4,600**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	8	14	-
Water Storage (gallons)	74,900	5,000	69,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.0	0.3	1.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,300	-	2,300
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	15,500	-	15,500
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	12,000	-	12,000
Individual Grinder Pump Stations (GPS) (ea)	61	-	61
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,600	-	4,600
Pressure Sewer Service Lines (lf)	4,600	-	4,600

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/22/2016
Community Koyukuk

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	92	people	2015 ADOL
2015 Number of Services	61	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***112***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	14	gpm	
Average Day (ADD)	5,613	gpd	50 gallons per Capita
Max Day (MDD)	11,226	gpd	2 x ADD
Peak Hour	23	gpm	3 x MDD
Treatment Capacity	***8***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	8	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	5,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	11,226	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	33,677	gallons	3 days x DO
Water Storage Tank Volume	74,903	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	39,767	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***74,900***	***gallons***	
Required Additional Storage	***69,900***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,100***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0.28	acres	
Organic Loading Based Size	1.0	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	165.5		
Hydraulic Loading Based Size	2.0	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***2.0***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Koyukuk

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	61	$26,403.25	$1,610,598
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	16,600	$202.45	$3,360,590
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.7	$847,406.81	$1,440,592
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	20,100	$332.88	$6,690,809
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	69,900	$4.97	$347,198
15	Water treatment plant, no foundation	SF	1,200	$1,660.79	$1,992,952
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	2,300	$344.23	$791,733
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$16,234,472**

O&M Cost Estimate
Piped Water & Sewer System

Community: Koyukuk

General Community Data

Current population	92	persons
Average number of people per house	1.8	
Service Connections		
Number of houses	50	
Number of public/commerical buildings	10	
Number of schools	1	
Total number of service connections	61	
Burdened labor rate	$15	hr
Electricity cost (Public facilty)	$0.49	kWh
Electricity cost (Residential service)	$0.46	kWh
Cost per gallon for heating oil	$6.50	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	30	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	2400	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	74,900	gallons
Length of water line to/ from tank	25	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	15500	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	12000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	360	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$797	/month		$6,373.79
Raw water line	$0	/month		$0.00
Raw water heat addition	$364	/month		$2,908.67
Water storage tank	$74	/month		$592.01
Water storage tank line	$0	/month		$0.00
Water mains	$2,205	/month		$26,463
Service lines	$651	/month		$7,811
Wastewater system				
Sewer mains	$1,707	/month		$20,487
Service lines	$651	/month		$7,811
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$51	/month		$615
			Subtotal	$73,100
Electricity				
Water system				
WTP building				
Lights and controls	$343	/month		$4,118
HVAC/hydronic system	$343	/month		$4,118
Water treatment	$34	/month		$411
Pumps				
Intake or well	$34	/month		$411.13
WST circulation	$66	/month		$529
Pressure/booster	$51	/month		$616.69
Main line circulation	$1,053	/month		$12,630
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$263	/month		$3,152
Lagoon discharge pump	$494	/year		$494
			Subtotal	$26,500
Other Costs				
Equipment R&R	$6,228	/year		$6,228
Miscellaneous materials & supplies	$3,737	/year		$3,737
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$16,000

Summary

Administration	$6,000
Labor	$25,000
Fuel	$73,100
Electricity	$26,500
Other	$16,000
Total	$147,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 170	50	85%	**$ 86,471**
Public/Commerc	$ 186.51	10	100%	**$ 22,381**
School Service (	$ 4,238.75	1	100%	**$ 38,149**
Local Capital Contribution				**$ -**
Total Revenue				**$ 147,000**

Kwigillingok, Alaska

Community Information & Existing Infrastructure

The Community of Kwigillingok is a Yupik community of 364 people located on the western shore of Kuskokwim Bay near the mouth of the Kuskokwim River. There are 95 residential units, 29 commercial/public facilities and one K-12 school for a total of 125 services. The existing water and sewer services provided in Kwigillingok consist of a self-haul system. Raw water is stored in a reservoir that supplies water year round. The raw water reservoir is replenished by a combination of surface water runoff, rain, and snow. The existing water and sewer infrastructure consists of the following:

- Reservoir – 40 gpm (Year round supply)
- Treated Water Storage – 215,000 gallons
- Water Treatment Plant – 2,760 SF, built in 2008
- Water Treatment – Soda ash, potassium permanganate, cationic polymer, greensand filtration, and chlorine
- Sewage Lagoon – Single Cell, 0.57 acres

Soils around Kwigillingok consist of a thin organic mat with peat and ice up to approximately 4 inches thick. There is ice-rich organic silt 25-30 feet deep, overlaying sandy silt. Permafrost is present sporadically.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 37,700 feet of pipe, and the pressure sewer system approximately 27,000 feet of pipe. The water system will consist of four circulating loops. The pressure sewer system would require three sewer main lift stations, individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, two new 1,200 sf facilities are included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment. The existing water storage tank is sufficient to meet CT requirements (157,400 gallons) and provide reserve for fire flows.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	31	40	-
Water Storage (gallons)	207,700	215,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	7.8	0.6	7.2
Required Foundation System for WTP and/or WST			
Pile Foundation	2,400	-	2,400
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	37,700	-	37,700
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	27,000	-	27,000
Individual Grinder Pump Stations (GPS) (ea)	125	-	125
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,400	-	9,400
Pressure Sewer Service Lines (lf)	9,400	-	9,400

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Kwigillingok. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Kwigillingok	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	125	$26,342.77	$3,292,847
3	Sewage collection mains or services (gravity or force), above ground	LF	36,400	$193.47	$7,042,309
4	Sewage lift station	EA	2	$ 563,234.80	$ 1,126,470
10	Sewage lagoon, barrow, local material	Acre	7	$686,271.14	$4,941,152
12	Water distribution, mains or services, above ground	LF	47,100	$325.73	$15,342,081
15	Water treatment plant, no foundation	SF	2,400	$1,583.60	$3,800,638
18	Foundation - freeze back piles	SF	2,400	$344.81	$827,554
				Total Estimated Cost in 2010 dollars (rounded):	**$36,373,000**
				Total with Inflation (3% per year for 6 years)	**$43,431,300**
27	Individual Grinder Pump Stations	EA	125	$30,000	$3,750,000
28	Electrical Service Upgrades	EA	125	$5,500	$687,500
				Subtotal	**$47,868,800**
29	Construction Contingency (15%)	LS	1	$7,180,300	$7,180,300
30	Design & Construction Administration Services (20%)	LS	1	$9,573,800	$9,573,800
				Total	**$64,622,900**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$33,300
Fuel	$138,800
Electricity	$41,900
Other (R&R, Training, etc.)	$23,100
Total	**$243,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Kwigillingok are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 146	95	85%	**$ 141,269**
Public/Commercial Service	$ 160	29	100%	**$ 55,808**
School Service	$ 5,103	1	100%	**$ 45,923**
Local Capital Contribution				**$ -**
Total Revenue				**$ 243,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/22/2016
Community	Kwigillingok
Input	

Existing Community & System Data	
2015 Population	364
2015 Number of Services	125
HITS Database (E1 & H1-H7)	95
DCED Mapping Commerical/Public Facilities/School	30
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	215000
Water Treatment Capacity	40
Existing Sewage Lagoon Size	0.57
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	27000	37700
Gravity Sewer Main			
Pressure Sewer Main	x	27000	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Kwigillingok**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**31**	
Req Water Storage (gallons) (less existing)	**(7,300)**	**-** **sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**2,400**	**2,400** **sf**
Req Sewage Lagoon Size (acre) (less existing)	**7.2**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**2,400**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**37,700**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**27,000**	
	Individual Grinder Pump Stations (GPS) (ea)	**125**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**9,400**	
	Pressure Sewer Service Lines (lf)	**9,400**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	31	40	-
Water Storage (gallons)	207,700	215,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	7.8	0.6	7.2
Required Foundation System for WTP and/or WST			
Pile Foundation	2,400	-	2,400
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	37,700	-	37,700
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	27,000	-	27,000
Individual Grinder Pump Stations (GPS) (ea)	125	-	125
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,400	-	9,400
Pressure Sewer Service Lines (lf)	9,400	-	9,400

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/22/2016

Community Kwigillingok

System Parameters	Model Results			Criteria & Calculations
Design Population				
Duration (n)	20	years		20 years
2015 Population (P)	364	people		2015 ADOL
2015 Number of Services	125	services		
Growth Rate (i)	1%			1%
2035 Design Population (Capita)	***444***	***people***		Px(1+i)^n
Water Demand Estimates				
Existing Capacity	40	gpm		
Average Day (ADD)	22,207	gpd		50 gallons per Capita
Max Day (MDD)	44,415	gpd		2 x ADD
Peak Hour	93	gpm		3 x MDD
Treatment Capacity	***31***	***gpm***		MDD
Water Source Assumptions				
Type (surface water or groundwater)	SW			
Required Capacity	31	gpm		MDD
Water Storage Tank Sizing				
Existing Water Storage Tank	215,000	gallons		
Demand Based Volume (if source is GW)	Check Min CT Requirements			
Daily Operation (DO) (gallons)	44,415	gallons		Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons		500 gpm for 60 minutes
Reserve Volume (RV)	133,245	gallons		3 days x DO
Water Storage Tank Volume	207,660	gallons		DO + FF + RV
CT Based Volume (min if source is SW)	Required			
Chlorine Residual Concentration (RC)	0.4	mg/L		0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation		1.0-log Inactivation
Temperature (T)	4.4	C		4.4 celsius/40 F
pH (PH)	7			7
Contact Time Required (CT)	49	minutes		LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1			0.1
Required Volume to meet CT*	157,339	gallons		CT/RCxPeak Hour/BF
Required Water Storage	***207,700***	***gallons***		
Required Additional Storage	***(7,300)***	***gallons***		0
Estimate of Min Platform Size (3' clearance around)	-	***sf***		D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
				0
Water Treatment Plant Requirements*				
Water Quality	Poor			Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***		Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)				
Soft poorly drained soils or discontinuous permafrost	x		***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0			Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0			Gravel pad
Water Distribution (Check either or both)				
Buried system with no permafrost	0			Static Water Mains
Above ground system or buried with permafrost	x		***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)				
Buried system with no permafrost	0			Bare sewer main, no heat trace
Above ground or buried with permafrost	x		***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0			Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x		***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)				
Static Water Main	0			Static Water Service Line
Circulating Water Main	x		***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0			Gravity Service Line
Pressure Sewer Main	x		***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size				
Existing Sewage Lagoon	0.57	acres		
Organic Loading Based Size	3.8	acres		0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	329.2			
Hydraulic Loading Based Size	7.8	acres		Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***7.8***	***acres***		Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Kwigillingok

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	125	$26,342.77	$3,292,847
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	36,400	$193.47	$7,042,309
4	Sewage lift station	EA	2	$563,234.80	$1,126,470
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	7.2	$686,271.14	$4,941,152
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	47,100	$325.73	$15,342,081
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	2,400	$1,583.60	$3,800,638
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	2,400	$344.81	$827,554
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$36,373,051**

O&M Cost Estimate
Piped Water & Sewer System

Community: Kwigillingok

General Community Data

Current population	364	persons
Average number of people per house	3.8	
Service Connections		
Number of houses	95	
Number of public/commerical buildings	29	
Number of schools	1	
Total number of service connections	125	
Burdened labor rate	$16	hr
Electricity cost (Public facilty)	$0.42	kWh
Electricity cost (Residential service)	$0.19	kWh
Cost per gallon for heating oil	$4.65	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	3100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	4560	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	212,000	gallons
Length of water line to/ from tank	25	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	4	
Total length of Water Main	37700	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	60	
Number of facilities served by lift/pump station #2	122	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	27000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	4	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	4070	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$33,280
Fuel (Heating Demand)				
Water system				
WTP building	$1,083	/month		$8,663.45
Raw water line	$0	/month		$0.00
Raw water heat addition	$1,029	/month		$8,232.81
Water storage tank	$150	/month		$1,198.73
Water storage tank line	$0	/month		$0.00
Water mains	$6,395	/month		$51,161
Service lines	$1,590	/month		$12,722
Wastewater system				
Sewer mains	$4,580	/month		$36,641
Service lines	$1,590	/month		$12,722
Lift/pump station buildings	$237	/month		$1,899.88
Force main to lagoon	$690	/month		$5,523
			Subtotal	$138,800
Electricity				
Water system				
WTP building				
Lights and controls	$559	/month		$6,707
HVAC/hydronic system	$559	/month		$4,471
Water treatment	$116	/month		$1,394
Pumps				
Intake or well	$116	/month		$1,394.27
WST circulation	$57	/month		$454
Pressure/booster	$174	/month		$2,091.40
Main line circulation	$1,804	/month		$14,435
Wastewater system				
Lift /pump station buildings				
Lights and controls	$123	/month		$1,471
HVAC/hydronic system	$123	/month		$981
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$267	/month		$3,205.34
Sewer/force main glycol circulation	$450	/month		$3,602
Lagoon discharge pump	$1,674	/year		$1,674
			Subtotal	$41,900
Other Costs				
Equipment R&R	$10,699	/year		$10,699
Miscellaneous materials & supplies	$6,419	/year		$6,419
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$23,100

Summary

Administration	$6,000
Labor	$33,300
Fuel	$138,800
Electricity	$41,900
Other	$23,100
Total	$243,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 146	95	85%	**$ 141,269**
Public/Commerc	$ 160.37	29	100%	**$ 55,808**
School Service (	$ 5,102.59	1	100%	**$ 45,923**
Local Capital Contribution				**$ -**
Total Revenue				**$ 243,000**

RIVER

KWIGILLINGOK

LIFT STATION #1

LIFT STATION #2

PROPOSED WTP

SCHOOL

WATER TREATMENT PLANT/WASHETERIA

TO RAW WATER RESERVOIR

SEWAGE LAGOON

Extent of Topographic Limits

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

300' 0 300' 600'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

KWIGILLINGOK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 18

File: J:\Jobsdata\31303.00 VSW – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Kwigillingok.dwg

Lime Village, Alaska

Community Information & Existing Infrastructure

Lime Village is a Denaina Athabascan Indian community of 29 people located on the south bank of the Stony River, 50 miles southeast of its junction with the Kuskokwim River. There are 11 residential units and 8 commercial/public facilities for a total of 19 services. The existing water and sewer services provided in Lime Village consist of self-haul system from the watering point attached to the washeteria and pit privies. The existing water and sewer infrastructure consists of the following:

- Well Water – 20 gpm Well Capacity
- Treated Water Storage – 1050 gallons
- Water Treatment Plant – 1590 SF, built in 2006
- Water Treatment – No treatment
- Sewage Lagoon – N/A

Soils around Lime Village consist of 6 inch of vegetative mat overlying dense sandy silts Coarse sand, gravel and cobbles underneath. Moisture contents indicate seasonally frozen material is wet and soft when unfrozen.

Piped System Description

The piped water and pressure sewer system will be a buried system. The water system will consist of approximately 7,200 feet of pipe, and the pressure sewer system approximately 4,900 feet of pipe. The water system will consist of a single circulating loop. The pressure sewer system would require one sewer main lift station, individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 800 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	2	15	-
Water Storage (gallons)	44,200	95	44,105
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	800	-	800
Sewage Lagoon Size (acre)	0.6	-	0.6
Required Foundation System for WTP and/or WST			
Pile Foundation	1,560	-	1,560
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	7,200	-	7,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	4,900	-	4,900
Individual Grinder Pump Stations (GPS) (ea)	19	-	19
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	1,400	-	1,400
Pressure Sewer Service Lines (lf)	1,400	-	1,400

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Lime Village. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Lime Village	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	19	$28,096.69	$533,837
2	Sewage collection mains or services (gravity or force), buried	LF	6,300	$417.48	$ 2,630,154
4	Sewage lift station	EA	1	$ 1,397,322.77	$ 1,397,323
10	Sewage lagoon, barrow, local material	Acre	1	$1,675,613.17	$1,005,368
13	Water distribution, mains or services, buried	LF	8,600	$417.57	$3,591,126
14	Water storage tank, no foundation	Gal	44,105	$10.90	$480,951
15	Water treatment plant, no foundation	SF	800	$2,542.06	$2,033,649
18	Foundation - freeze back piles	SF	1,560	$720.07	$1,123,307
				Total Estimated Cost in 2010 dollars (rounded):	**$12,796,000**
				Total with Inflation (3% per year for 6 years)	**$15,279,100**
27	Individual Grinder Pump Stations	EA	19	$30,000	$570,000
28	Electrical Service Upgrades	EA	19	$5,500	$104,500
				Subtotal	**$15,953,600**
29	Construction Contingency (15%)	LS	1	$2,393,000	$2,393,000
30	Design & Construction Administration Services (20%)	LS	1	$3,190,700	$3,190,700
				Total	**$21,537,300**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$31,700
Electricity	$28,800
Other (R&R, Training, etc.)	$12,800
Total	**$104,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Lime Village are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 478	11	85%	**$ 53,576**
Public/Commercial Service	$ 525	8	100%	**$ 50,424**
School Service	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 104,000**

STONY RIVER

OLD WASHETERIA

WASHETERIA

WELL

LIFT STATION

SEWAGE LAGOON

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

100' 0 100' 200'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

LIME VILLAGE

DATE MAR 2015

SCALE GRAPHIC

FIGURE 19

File: J:\Jobsdata\31303.00 VSW – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Lime Village.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/23/2016
Community	Lime Village
Input	

Existing Community & System Data	
2015 Population	29
2015 Number of Services	19
HITS Database (E1 & H1-H7)	11
DCED Mapping Commerical/Public Facilities/School	8
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Good
Water Storage Tank	95
Water Treatment Capacity	15
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	4900	7200
Gravity Sewer Main			
Pressure Sewer Main	x	4900	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Lime Village**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**2**	
Req Water Storage (gallons) (less existing)	**44,105**	**760 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**800**	**800 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.6**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**800**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**7,200**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**4,900**	
	Individual Grinder Pump Stations (GPS) (ea)	**19**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**1,400**	
	Pressure Sewer Service Lines (lf)	**1,400**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	2	15	-
Water Storage (gallons)	44,200	95	44,105
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	800	-	800
Sewage Lagoon Size (acre)	0.6	-	0.6
Required Foundation System for WTP and/or WST			
Pile Foundation	1,560	-	1,560
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	7,200	-	7,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	4,900	-	4,900
Individual Grinder Pump Stations (GPS) (ea)	19	-	19
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	1,400	-	1,400
Pressure Sewer Service Lines (lf)	1,400	-	1,400

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/23/2016

Community Lime Village

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	29	people	2015 ADOL
2015 Number of Services	19	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***35***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	15	gpm	
Average Day (ADD)	1,769	gpd	50 gallons per Capita
Max Day (MDD)	3,539	gpd	2 x ADD
Peak Hour	7	gpm	3 x MDD
Treatment Capacity	***2***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	2	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	95	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	3,539	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	10,616	gallons	3 days x DO
Water Storage Tank Volume	44,154	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	12,535	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***44,200***	***gallons***	
Required Additional Storage	***44,105***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***760***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Good		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***800***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.3	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	92.9		
Hydraulic Loading Based Size	0.6	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***0.6***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Lime Village

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	19	$28,096.69	$533,837
2	Sewage collection mains or services (gravity or force), buried	LF	6,300	$417.48	$2,630,154
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	1	$1,397,322.77	$1,397,323
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.6	$1,675,613.17	$1,005,368
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	8,600	$417.57	$3,591,126
14	Water storage tank, no foundation	Gal	44,105	$10.90	$480,951
15	Water treatment plant, no foundation	SF	800	$2,542.06	$2,033,649
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	1,560	$720.07	$1,123,307
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$12,795,715**

O&M Cost Estimate
Piped Water & Sewer System

Community: Lime Village

General Community Data

Current population	29	persons
Average number of people per house	2.6	
Service Connections		
Number of houses	11	
Number of public/commerical buildings	8	
Number of schools	0	
Total number of service connections	19	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.82	kWh
Electricity cost (Residential service)	$0.96	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	750	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	1472	sf
Raw water quality (Good or Poor)	Good	
Water Storage		
Size of tank(s)	44,200	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	7200	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	18	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	4900	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1340	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$451	/month		$3,608.54
Raw water line	$0	/month		$0.00
Raw water heat addition	$106	/month		$846.34
Water storage tank	$40	/month		$322.48
Water storage tank line	$0	/month		$0.00
Water mains	$946	/month		$11,347
Service lines	$187	/month		$2,246
Wastewater system				
Sewer mains	$644	/month		$7,722
Service lines	$187	/month		$2,246
Lift/pump station buildings	$153	/month		$1,225.73
Force main to lagoon	$176	/month		$2,112
			Subtotal	$31,700
Electricity				
Water system				
WTP building				
Lights and controls	$352	/month		$4,227
HVAC/hydronic system	$352	/month		$4,227
Water treatment	$4	/month		$43
Pumps				
Intake or well	$18	/month		$216.87
WST circulation	$111	/month		$886
Pressure/booster	$27	/month		$325.31
Main line circulation	$881	/month		$10,568
Wastewater system				
Lift /pump station buildings				
Lights and controls	$120	/month		$1,436
HVAC/hydronic system	$120	/month		$957
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$35	/month		$425.86
Sewer/force main glycol circulation	$440	/month		$5,274
Lagoon discharge pump	$260	/year		$260
			Subtotal	$28,800
Other Costs				
Equipment R&R	$4,273	/year		$4,273
Miscellaneous materials & supplies	$2,564	/year		$2,564
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$12,800

Summary

Administration	$6,000
Labor	$25,000
Fuel	$31,700
Electricity	$28,800
Other	$12,800
Total	$104,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 478	11	85%	$ **53,576**
Public/Commerc	$ 525.25	8	100%	$ **50,424**
School Service (	$ -	0	100%	$ -
Local Capital Contribution				$ -
Total Revenue				$ **104,000**

Mekoryuk, Alaska

Community Information & Existing Infrastructure

The City of Mekoryuk is a Yupik community of 210 people on Nunivak Island. There are 97 residential units, 19 commercial/public facilities and one school for a total of 117 services. The existing water and sewer services provided in Mekoryuk consist of a Cowater flush, tank and haul system at each building. The existing water and sewer infrastructure consists of the following:

- River Infiltration Gallery - 100 gpm transfer pump
- Raw Water Reservoir - 7.5 million gallons
- Direct Filtration Treatment - 25 gpm
- Water Treatment Plant/Washeteria - 1540 sf, built in 1990
- Treated water storage - 125,000 gallons
- Sewage Lagoon - 4.3 acres

Soil conditions in the community generally consist of a mix of thaw stable sand and wet or ice-rich silts. Discontinuous permafrost, shallow groundwater and occasional basalt flows exist. Any new foundations should consist of driven piles or thermosyphen stabilized gravel pads.

Piped System Description

The piped water system will be an above grade system roughly 14,900 feet in length. The pressure sewer will consist of roughly 6,500 feet of pipe above grade and 3,000 below grade. Only areas east of the school can be buried due to soil conditions. The pressure sewer system would require individual grinder pump stations at each house, and glycol heat trace for freeze protection. Approximately 8,800 feet of water and sewer service piping would be required; and a third of this could be buried (2,900). For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment. The existing water storage tank is sufficient to meet CT requirements (91,000 gallons) and provide a small reserve for fire flows.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	18	25	-
Water Storage (gallons)	91,000	125,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.9	4	-
Required Foundation System for WTP and/or WST			
Thermosyphen stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	14,900	-	14,900
Wastewater Collection System			
Insulated Sewer Main with Glycol Heat Trace (lf)	9,500	-	9,500
Residential Grinder Pump Stations (GPS) (ea)	117	-	117
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,800	-	8,800
Pressure Sewer Service w GPS (lf)	8,800	-	8,800

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Mekoryuk. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Mekoryuk	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	117	$ 26,342.77	$ 3,082,104
2	Sewage collection mains or services (gravity or force), buried	LF	5,900	$293.55	$ 1,731,936
3	Sewage collection mains or services (gravity or force), above ground	LF	12,400	$201.57	$ 2,499,422
4	Sewage lift station	EA	1	$ 746,130.80	$ 746,131
12	Water distribution, mains or services, above ground	LF	23,700	$328.77	$7,791,873
15	Water treatment plant, no foundation	SF	1,200	$1,633.35	$1,960,015
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$513.76	$616,510
				Total Estimated Cost (rounded):	**$18,428,000**
				Total with Inflation (3% per year for 6 years)	**$22,004,000**
27	Residential Grinder Pump Stations	EA	117	$30,000	$3,510,000
28	Electrical Service Upgrades	EA	117	$5,500	$643,500
				Subtotal	**$26,157,500**
29	Construction Contingency (15%)	LS	1	$2,615,800	$2,615,800
30	Design & Construction Administration Services (20%)	LS	1	$5,231,500	$5,231,500
				Total	**$34,004,800**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Annual Cost**
Administration	$6,000
Labor	$45,800
Fuel (Heating)	$94,800
Electricity	$18,600
Other (R&R, Training, etc.)	$18,700
Total	**$184,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Mekoryuk are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 104	97	85%	**$ 102,783**
Public/Commercial Service	$ 192	19	100%	**$ 43,818**
School Service	$ 4,155	1	100%	**$ 37,398**
Local Capital Contribution				**$ -**
Total Revenue				**$ 184,000**

CITY WATER RESERVOIR

TO SEWAGE LAGOON

TO WATER SOURCE

EXISTING WTP/WASHETERIA

NEW UTILITY BUILDING FOR WATER DISTRIBUTION AND SEWER SYSTEM EQUIPMENT

SCHOOL

SHOAL BAY

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

150' 0 150' 300'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

MEKORYUK

DATE: DEC 2015

SCALE: 1"=150'

FIGURE: 20

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Mekoryuk.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	2/9/2016
Community	Mekoryuk
Input	

Existing Community & System Data	
2015 Population	210
2015 Number of Services	117
HITS Database (E1 & H1-H7)	97
DCED Mapping Commerical/Public Facilities/School	20
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	poor
Water Storage Tank	125000
Water Treatment Capacity	25
Existing Sewage Lagoon Size	4.3
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	9500	14900
Gravity Sewer Main		0	
Pressure Sewer Main	x	9500	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Mekoryuk**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**18**	
Req Water Storage (gallons)		**91,000**	**1,370 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre)		**2.9**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**2,570**	Only need foundation for bldg, not tank.
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**14,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**9,500**	
	Residential Grinder Pump Stations (GPS) (ea)	**20**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**8,800**	
	Pressure Sewer Service w/GPS (lf)	**8,800**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	18	25	-
Water Storage (gallons)	91,000	125,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.9	4.3	-
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	14,900	-	14,900
Wastewater Collection System			
Insulated Sewer Main with Glycol Heat Trace (lf)	9,500	-	9,500
Residential Grinder Pump Stations (GPS) (ea)	20	-	20
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,800	-	8,800
Pressure Sewer Service w GPS (lf)	8,800	-	8,800

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 2/9/2016

Community Mekoryuk

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	210	people	2015 ADOL
2015 Number of Services	117	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***256***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	25	gpm	
Average Day (ADD)	12,812	gpd	50 gallons per Capita
Max Day (MDD)	25,624	gpd	2 x ADD
Peak Hour	53	gpm	3 x MDD
Treatment Capacity	***18***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		SW or GW
Required Capacity	18	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	125000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	25,624	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	76,872	gallons	3 days x DO
Water Storage Tank Volume	132,496	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	90,773	gallons	CT/RCxPeak Hour/BF
Required Water Storage (CT or demand)	***91,000***	***gallons***	Vg = volume in gallons
Estimate of Min Platform Size (3' clearance around)	***1,374***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
Water Treatment Plant Requirements*			
Water Quality	poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Residential Grinder Pump Stations (GPS) (ea)***	Residential Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Water Service Type	**0**		Static Water Service Line
	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service w/GPS (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	4.3	acres	
Organic Loading Based Size	2.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	250.0		
Hydraulic Loading Based Size	2.9	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1
Two cell lagoon, combined acreage	***2.9***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Mekoryuk

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	117	$26,342.77	$3,082,104
2	Sewage collection mains or services (gravity or force), buried	LF	5,900	$293.55	$1,731,936
3	Sewage collection mains or services (gravity or force), above ground	LF	12,400	$201.57	$2,499,422
4	Sewage lift station	EA	1	$746,130.80	$746,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	23,700	$328.77	$7,791,873
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$1,633.35	$1,960,015
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	1,200	$513.76	$616,510
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$18,427,991**

O&M Cost Estimate
Piped Water & Sewer System

Community: Mekoryuk

General Community Data

Current population	210	persons
Average number of people per house	2.2	
Service Connections		
Number of houses	97	
Number of public/commerical buildings	19	
Number of schools	1	
Total number of service connections	117	
Burdened labor rate	$22	hr
Electricity cost (Public facilty)	$0.42	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	22100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	1200	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	125,000	gallons
Length of water line to/ from tank	30	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	14850	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Number of service line circ pumps		
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	9500	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	5100	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Service line circulation	34	kWh/month/service
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$45,760
Fuel (Heating Demand)				
Water system				
WTP building	$368	/month		$2,941.75
Raw water line	$0	/month		$0.00
Raw water heat addition	$766	/month		$6,128.64
Water storage tank	$114	/month		$912.00
Water storage tank line	$7	/month		$52.53
Water mains	$3,250	/month		$26,003
Service lines	$1,921	/month		$15,365
Wastewater system				
Sewer mains	$2,079	/month		$16,635
Service lines	$1,921	/month		$15,365
Lift/pump station buildings	$306	/month		$2,451.46
Force main to lagoon	$1,116	/month		$8,930
			Subtotal	$94,800
Electricity				
Water system				
WTP building				
Lights and controls	$147	/month		$1,765
HVAC/hydronic system	$147	/month		$1,177
Water treatment	$67	/month		$804
Pumps				
Intake or well	$67	/month		$804.38
WST circulation	$57	/month		$454
Pressure/booster	$101	/month		$1,206.58
Main line circulation	$902	/month		$7,217
Service line circulation	$0	/month		$0.00
Wastewater system				
Lift /pump station buildings				
Lights and controls	$123	/month		$1,471
HVAC/hydronic system	$123	/month		$981
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$225	/month		$1,801
Lagoon discharge pump	$966	/year		$966
			Subtotal	$18,600
Other Costs				
Equipment R&R	$7,958	/year		$7,958
Miscellaneous materials & supplies	$4,775	/year		$4,775
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$18,700

Summary

Administration	$6,000
Labor	$45,800
Fuel	$94,800
Electricity	$18,600
Other	$18,700
Total	$184,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 104	97	85%	$ 102,783
Public/Commerc	$ 192	19	100%	$ 43,818
School Service (	$ 4,155	1	100%	$ 37,398
Local Capital Contribution				$ -
Total Revenue				**$ 184,000**

Mertarvik, Alaska

Community Information & Existing Infrastructure

Mertarvik is the new site for the village of Newtok. Newtok is a traditional Yupik Eskimo village of 380 people. Mertarvik is located on the Nelson Island off the coast of Baird Inlet. There will be approx. 92 residential units, 7 commercial/public facilities and one school for a total of 100 services.

Mertarvik is situated on a side of a hill where the elevation difference between the highest point and lowest point of the community is greater than 200 feet. The only existing infrastructure in Mertarvik is the Mertarvik Evacuation Center (MEC) and a mat stabilized road from the boat landing to the MEC building.

The soil in Mertarvik generally consists of approx. 18 inches of peat layer on the surface, and a layer of silt with organics under the layer of peat. Bedrock was encountered from as little as 4 feet to more than 31.5 feet below ground surface.

Piped System Description

The piped water and gravity sewer system will be a buried system. The water system will consist of approximately 16,700 feet of pipe, and the gravity sewer system approximately 19,200 feet of pipe. The water system will consist of two circulating loops. It is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	32	15	17
Water Storage (gallons)	215,500	-	215,500
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	8.1	-	8.1
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	1,200	-	1,200
Thermosyphon Stabilized Gravel Pad (sf)	2,900	-	2,900
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	16,700	-	16,700
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	19,200	-	19,200
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	7,500	-	7,500
Gravity Sewer Service Lines (lf)	7,500	-	7,500

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Mertarvik. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs				Village: Newtok	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	100	$26,342.77	$2,634,277
2	Sewage collection mains or services (gravity or vacuum), buried	LF	26,700	$248.45	$6,633,553
4	Sewage lift station	EA	1	$ 662,130.80	$ 662,131
10	Sewage lagoon, barrow, local material	Acre	8.1	$682,797.07	$5,530,656
13	Water distribution, mains or services, buried	LF	24,200	$276.80	$6,698,458
14	Water storage tank, no foundation	Gal	215,500	$2.52	$542,212
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
18	Foundation - freeze back piles	SF	1,200	$426.48	$511,777
19	Foundation - thermosyphen stabilized gravel pad	SF	2,900	$261.95	$759,659
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$26,056,000**
				Total with Inflation (3% per year for 6 years)	**$31,112,200**
28	Electrical Service Upgrades	EA	100	$5,500	$550,000
				Subtotal	**$31,662,200**
29	Construction Contingency (15%)	LS	1	$4,749,300	$4,749,300
30	Design & Construction Administration Services (20%)	LS	1	$6,332,400	$6,332,400
				Total	**$42,743,900**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$33,300
Fuel	$103,000
Electricity	$28,900
Other (R&R, Training, etc.)	$19,200
Total	**$190,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Mertarvik are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 116	92	85%	**$ 108,691**
Public/Commercial Service	$ 347	7	100%	**$ 29,188**
School Service	$ 5,791	1	100%	**$ 52,121**
Local Capital Contribution				**$ -**
Total Revenue				**$ 190,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	9/9/2016
Community	Mertarvik
Input	

Existing Community & System Data	
2015 Population	380
2015 Number of Services	100
HITS Database (E1 & H1-H7)	92
DCED Mapping Commerical/Public Facilities/School	8
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Good
Water Storage Tank	0
Water Treatment Capacity	15
Existing Sewage Lagoon Size	0
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	19200	16700
Gravity Sewer Main	x	19200	
Pressure Sewer Main			
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Mertarvik**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**32**	
Req Water Storage (gallons) (less existing)		**215,500**	**2,900 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**8.1**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
	Thermosyphon stabilized gravel pad (sf)	**2,900**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**16,700**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**19,200**	
	Lift Stations for Gravity Sewer	**1**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**7,500**	
	Gravity Sewer Service Lines (lf)	**7,500**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	32	15	17
Water Storage (gallons)	215,500	-	215,500
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	8.1	-	8.1
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	1,200	-	1,200
Thermosyphon stabilized gravel pad (sf)	2,900	-	2,900
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	16,700	-	16,700
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	19,200	-	19,200
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	7,500	-	7,500
Gravity Sewer Service Lines (lf)	7,500	-	7,500

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 9/9/2016

Community Mertarvik

System Parameters	Model Results			Criteria & Calculations
Design Population				
Duration (n)	20	years		20 years
2015 Population (P)	380	people		2015 ADOL
2015 Number of Services	100	services		
Growth Rate (i)	1%			1%
2035 Design Population (Capita)	***464***	***people***		Px(1+i)^n
Water Demand Estimates				
Existing Capacity	15	gpm		
Average Day (ADD)	23,184	gpd		50 gallons per Capita
Max Day (MDD)	46,367	gpd		2 x ADD
Peak Hour	97	gpm		3 x MDD
Treatment Capacity	***32***	***gpm***		MDD
Water Source Assumptions				
Type (surface water or groundwater)	GW			
Required Capacity	32	gpm		MDD
Water Storage Tank Sizing				
Existing Water Storage Tank	-	gallons		
Demand Based Volume (if source is GW)	Applicable			
Daily Operation (DO) (gallons)	46,367	gallons		Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons		500 gpm for 60 minutes
Reserve Volume (RV)	139,102	gallons		3 days x DO
Water Storage Tank Volume	215,469	gallons		DO + FF + RV
CT Based Volume (min if source is SW)	Not Required			
Chlorine Residual Concentration (RC)	0.4	mg/L		0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation		1.0-log Inactivation
Temperature (T)	4.4	C		4.4 celsius/40 F
pH (PH)	7			7
Contact Time Required (CT)	49	minutes		LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1			0.1
Required Volume to meet CT*	164,255	gallons		CT/RCxPeak Hour/BF
Required Water Storage	***215,500***	***gallons***		
Required Additional Storage	***215,500***	***gallons***		0
Estimate of Min Platform Size (3' clearance around)	***2,900***	***sf***		D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
				0
Water Treatment Plant Requirements*				
Water Quality	Good			Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***800***	***sf***		Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)				
Soft poorly drained soils or discontinuous permafrost	x		***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	x		***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0			Gravel pad
Water Distribution (Check either or both)				
Buried system with no permafrost	0			Static Water Mains
Above ground system or buried with permafrost	x		***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)				
Buried system with no permafrost	0			Bare sewer main, no heat trace
Above ground or buried with permafrost	x		***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	x		***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	0			Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)				
Static Water Main	0			Static Water Service Line
Circulating Water Main	x		***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	x		***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	0			Pressure Service Line with GPS
Sewage Lagoon Size				
Existing Sewage Lagoon	0	acres		
Organic Loading Based Size	3.9	acres		0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	336.3			
Hydraulic Loading Based Size	8.1	acres		Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***8.1***	***acres***		Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Newtok

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	100	$26,342.77	$2,634,277
2	Sewage collection mains or services (gravity or vacuum), buried	LF	26,700	$248.45	$6,633,553
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	1	$662,130.80	$662,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	8.1	$682,797.07	$5,530,656
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	24,200	$276.80	$6,698,458
14	Water storage tank, no foundation	Gal	215,500	$2.52	$542,212
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	1,200	$426.48	$511,777
19	Foundation - thermosyphen stablized gravel pad	SF	2,900	$261.95	$759,659
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$26,056,095**

O&M Cost Estimate
Piped Water & Sewer System

Community: Mertarvik

General Community Data

Current population	380	persons
Average number of people per house	4.1	
Service Connections		
Number of houses	92	
Number of public/commerical buildings	7	
Number of schools	1	
Total number of service connections	100	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.40	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	155	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	1200	sf
Raw water quality (Good or Poor)	Good	
Water Storage		
Size of tank(s)	215,500	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	16700	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations	0	
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	100	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	19200	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	5	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	3200	ft
Force main heated for freeze protection (Yes or No)	No	
Location of force main (Above ground (AG) or Buried)	Buried	
Septic system discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Septic system discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

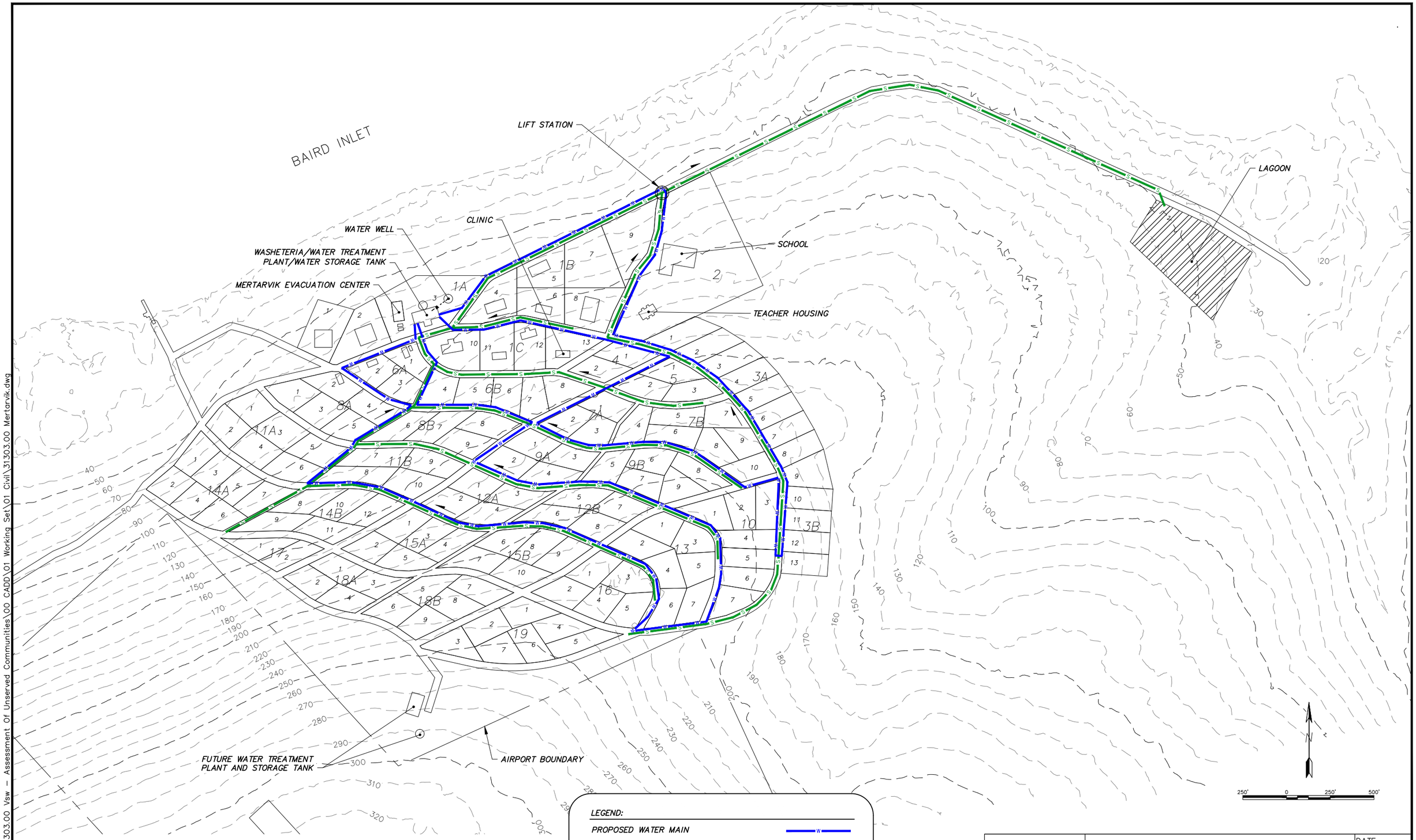
O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$33,280
Fuel (Heating Demand)				
Water system				
WTP building	$368	/month		$2,941.75
Raw water line	$20	/month		$244.27
Raw water heat addition	$1,386	/month		$16,634.88
Water storage tank	$197	/month		$1,572.29
Water storage tank line	$13	/month		$157.59
Water mains	$2,193	/month		$26,318
Service lines	$985	/month		$11,820
Wastewater system				
Sewer mains	$2,521	/month		$30,258
Service lines	$985	/month		$11,820
Lift/pump station buildings	$153	/month		$1,225.73
Force main to septic system	$0	/month		$0
			Subtotal	$103,000
Electricity				
Water system				
WTP building				
Lights and controls	$140	/month		$1,681
HVAC/hydronic system	$140	/month		$1,681
Water treatment	$23	/month		$277
Pumps				
Intake or well	$116	/month		$1,386.24
WST circulation	$54	/month		$432
Pressure/booster	$173	/month		$2,079.36
Main line circulation	$859	/month		$10,310
Wastewater system				
Lift /pump station buildings				
Lights and controls	$58	/month		$700
HVAC/hydronic system	$58	/month		$467
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$151	/month		$1,808.14
Sewer/force main glycol circulation	$536	/month		$6,432
Septic system discharge pump	$1,664	/year		$1,664
			Subtotal	$28,900
Other Costs				
Equipment R&R	$8,259	/year		$8,259
Miscellaneous materials & supplies	$4,955	/year		$4,955
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$19,200

Summary

Administration	$6,000
Labor	$33,300
Fuel	$103,000
Electricity	$28,900
Other	$19,200
Total	$190,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 116	92	85%	$ **108,691**
Public/Commerc	$ 347.48	7	100%	$ **29,188**
School Service (	$ 5,791.27	1	100%	$ **52,121**
Local Capital Contribution				$ -
Total Revenue				$ **190,000**



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PROJECT: 31303.00
STATUS: PRELIM

CRW ENGINEERING GROUP, LLC
3940 ARCTIC BLVD, SUITE 300
ANCHORAGE, ALASKA 99503
PHONE: (907) 562-3252
#AECL882-AK

VSW ASSESSMENT OF UNSERVED COMMUNITIES

MERTARVIK

DATE: SEP 2016
SCALE: GRAPHIC
FIGURE: 41

Napakiak, Alaska

Community Information & Existing Infrastructure

Napakiak is a Yupik Eskimo community of 387 people located on the north bank of the Kuskokwim River, 15 miles southwest of Bethel. There are 98 residential units, 15 commercial/public facilities and one school for a total of 114 services. The existing water and sewer services provided in Napakiak consist of a self-haul system and honey buckets. The school and washeteria have piped sewer that discharges into the school sewage lagoon. The existing water and sewer infrastructure consists of the following:

- Well Water – 20 gpm transfer pump
- Treated Water Storage – 5,000 gallons
- Water Treatment Plant – 480 SF, built in 1986
- Water Treatment – Potassium permanganate, greensand filter, chlorination, and fluoridation
- Sewage Lagoon – Single Cell, 0.9 acres

Soils around Napakiak consist of poorly drained silt and muck on top of fine silt and black mud. There is shallow groundwater in the area.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The west water system will consist of approximately 9,300 feet of pipe, and the east water system will consist of approximately 8,000 feet of pipe. The pressure sewer system will consist of approximately 14,400 feet of pipe. The west water system will consist of two circulating loops, and the east side will consist of a single loop. The pressure sewer system would require two sewer main lift stations, individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, two new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	33	20	13
Water Storage (gallons)	218,900	5,000	213,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	8.2	0.9	7.3
Required Foundation System for WTP and/or WST			
Pile Foundation	5,280	-	5,280
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,300	-	17,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,400	-	14,400
Individual Grinder Pump Stations (GPS) (ea)	114	-	114
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,600	-	8,600
Pressure Sewer Service Lines (lf)	8,600	-	8,600

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Napakiak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Napakiak	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	114	$26,403.25	$3,009,971
3	Sewage collection mains or services (gravity or force), above ground	LF	23,000	$198.84	$4,573,319
4	Sewage lift station	EA	2	$ 579,896.59	$ 1,159,793
10	Sewage lagoon, barrow, local material	Acre	7	$692,456.93	$5,054,936
12	Water distribution, mains or services, above ground	LF	25,900	$330.44	$8,558,286
14	Water storage tank, no foundation	Gal	215,100	$2.57	$551,936
15	Water treatment plant, no foundation	SF	2,400	$1,611.05	$3,866,511
18	Foundation - freeze back piles	SF	5,280	$309.69	$1,635,146
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$28,563,000**
				Total with Inflation (3% per year for 6 years)	**$34,105,700**
27	Individual Grinder Pump Stations	EA	114	$30,000	$3,420,000
28	Electrical Service Upgrades	EA	114	$5,500	$627,000
				Subtotal	**$38,152,700**
29	Construction Contingency (15%)	LS	1	$5,722,900	$5,722,900
30	Design & Construction Administration Services (20%)	LS	1	$7,630,500	$7,630,500
				Total	**$51,506,100**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$20,800
Fuel	$91,000
Electricity	$46,600
Other (R&R, Training, etc.)	$18,700
Total	**$183,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Napakiak are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 116	98	85%	**$ 116,100**
Public/Commercial Service	$ 139	15	100%	**$ 25,088**
School Service	$ 4,646	1	100%	**$ 41,813**
Local Capital Contribution				**$ -**
Total Revenue				**$ 183,000**

JOHNSON SLOUGH
(AKA SLOUGH)

KELUIRARUN SLOUGH

PROPOSED WTP

LIFT STATION #2

SEWAGE LAGOON

LIFT STATION #1

JOHNSON SLOUGH
(AKA SLOUGH)

PROPOSED WTP

SCHOOL

KUSKOKWIM RIVER

EXISTING WELL WATERING BUILDING

CITY OFFICE/WASHETERIA

SCHOOL SEWAGE LAGOON

Proposed Landfill

N

200' 0 200' 400'

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES

NAPAKIAK

DATE
MAR 2015

SCALE
GRAPHIC

FIGURE
21

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VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/23/2016
Community	Napakiak
Input	

Existing Community & System Data

2015 Population	387
2015 Number of Services	114
HITS Database (E1 & H1-H7)	98
DCED Mapping Commerical/Public Facilities/School	16
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	5000
Water Treatment Capacity	20
Existing Sewage Lagoon Size	0.9

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	14400	17300
Gravity Sewer Main			
Pressure Sewer Main	x	14400	
Typical Service Line Length (ea)		75	75

Piped System Requirements — **Community** **Napakiak**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**33**	
Req Water Storage (gallons) (less existing)	**213,900**	**2,880 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**2,400**	**2,400 sf**
Req Sewage Lagoon Size (acre) (less existing)	**7.3**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**2,400**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**17,300**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**14,400**	
	Individual Grinder Pump Stations (GPS) (ea)	**114**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**8,600**	
	Pressure Sewer Service Lines (lf)	**8,600**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	33	20	13
Water Storage (gallons)	218,900	5,000	213,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	8.2	0.9	7.3
Required Foundation System for WTP and/or WST			
Pile Foundation	5,280	-	5,280
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,300	-	17,300
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,400	-	14,400
Individual Grinder Pump Stations (GPS) (ea)	114	-	114
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,600	-	8,600
Pressure Sewer Service Lines (lf)	8,600	-	8,600

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/23/2016
Community Napakiak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	387	people	2015 ADOL
2015 Number of Services	114	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***472***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	20	gpm	
Average Day (ADD)	23,611	gpd	50 gallons per Capita
Max Day (MDD)	47,221	gpd	2 x ADD
Peak Hour	98	gpm	3 x MDD
Treatment Capacity	***33***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	33	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	5,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	47,221	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	141,664	gallons	3 days x DO
Water Storage Tank Volume	218,885	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	167,281	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***218,900***	***gallons***	
Required Additional Storage	***213,900***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***2,880***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0.9	acres	
Organic Loading Based Size	4.0	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	339.4		
Hydraulic Loading Based Size	8.2	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***8.2***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Napakiak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	114	$26,403.25	$3,009,971
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	23,000	$198.84	$4,573,319
4	Sewage lift station	EA	2	$579,896.59	$1,159,793
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	7.3	$692,456.93	$5,054,936
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	25,900	$330.44	$8,558,286
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	215,100	$2.57	$551,936
15	Water treatment plant, no foundation	SF	2,400	$1,611.05	$3,866,511
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	5,280	$309.69	$1,635,146
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$28,563,495**

O&M Cost Estimate
Piped Water & Sewer System

Community: Napakiak

General Community Data

Current population	387	persons
Average number of people per house	3.9	
Service Connections		
Number of houses	98	
Number of public/commerical buildings	15	
Number of schools	1	
Total number of service connections	114	
Burdened labor rate	$10	hr
Electricity cost (Public facilty)	$0.61	kWh
Electricity cost (Residential service)	$0.29	kWh
Cost per gallon for heating oil	$5.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	860	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	2880	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	218,900	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	3	
Total length of Water Main	17300	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	24	
Number of facilities served by lift/pump station #2	114	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	14400	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	750	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$20,800
Fuel (Heating Demand)				
Water system				
WTP building	$735	/month		$5,883.49
Raw water line	$0	/month		$0.00
Raw water heat addition	$1,176	/month		$9,411.84
Water storage tank	$166	/month		$1,330.91
Water storage tank line	$0	/month		$0.00
Water mains	$3,156	/month		$25,244
Service lines	$1,560	/month		$12,476
Wastewater system				
Sewer mains	$2,627	/month		$21,012
Service lines	$1,560	/month		$12,476
Lift/pump station buildings	$255	/month		$2,042.88
Force main to lagoon	$137	/month		$1,094
			Subtotal	$91,000
Electricity				
Water system				
WTP building				
Lights and controls	$513	/month		$6,152
HVAC/hydronic system	$513	/month		$4,102
Water treatment	$179	/month		$2,153
Pumps				
Intake or well	$179	/month		$2,152.96
WST circulation	$82	/month		$659
Pressure/booster	$269	/month		$3,229.44
Main line circulation	$1,965	/month		$15,723
Wastewater system				
Lift /pump station buildings				
Lights and controls	$178	/month		$2,136
HVAC/hydronic system	$178	/month		$1,424
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$303	/month		$3,638.06
Sewer/force main glycol circulation	$327	/month		$2,616
Lagoon discharge pump	$2,585	/year		$2,585
			Subtotal	$46,600
Other Costs				
Equipment R&R	$7,920	/year		$7,920
Miscellaneous materials & supplies	$4,752	/year		$4,752
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$18,700

Summary

Administration	$6,000
Labor	$20,800
Fuel	$91,000
Electricity	$46,600
Other	$18,700
Total	$183,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 116	98	85%	**$ 116,100**
Public/Commerc	$ 139.38	15	100%	**$ 25,088**
School Service (	$ 4,645.85	1	100%	**$ 41,813**
Local Capital Contribution				**$ -**
Total Revenue				**$ 183,000**

Napaskiak, Alaska

Community Information & Existing Infrastructure

Napaskiak is a Yupik Eskimo community of 451 people located on the east bank of the Kuskokwim River, along the Napaskiak Slough, 7 miles southeast of Bethel. There are 105 residential units, 22 commercial/public facilities and one school for a total of 128 services. Existing water service provided in Napaskiak consists of a self-haul system from either the primary or secondary water plant dispensing points. The existing sewer service consists of honey buckets that are disposed of in honey bucket dump stations located throughout the village. The existing water and sewer infrastructure consists of the following:

- Well Water – 40 gpm
- Primary Water Storage – 22,000 gallons, Secondary Water Storage – 22,00 gallons
- Primary Water Treatment Plant – 1120 SF, built in 1978, Upgraded in 2004
- Secondary Water Treatment Plant – 640 SF, built in 1994, Upgraded in 2010
- Water Treatment – Potassium permanganate, filtration, chlorination
- Sewage Lagoon – Two Cell, 2.8 acres

Soils around Napaskiak consist of organic mat underlain by silt and sandy silt. There is a permafrost layer approximately 2-6 feet below ground. Groundwater is present 4.5 feet below surface.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The west water system will consist of approximately 9,700 feet of pipe with two circulating loops. The east water system will consist of approximately 8,500 feet of pipe with a single circulating loop. The pressure sewer system will consist of approximately 12,800 feet of pipe. The pressure sewer system would require one additional sewer main lift station, individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility (West side) and a new 800 sf facility (East side) is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	38	40	-
Water Storage (gallons)	250,100	44,000	206,100
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,000	-	2,000
Sewage Lagoon Size (acre)	9.6	2.8	6.8
Required Foundation System for WTP and/or WST			
Pile Foundation	4,780	-	4,780
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	18,200	-	18,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	12,800	-	12,800
Individual Grinder Pump Stations (GPS) (ea)	128	-	128
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,600	-	9,600
Pressure Sewer Service Lines (lf)	9,600	-	9,600

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Napaskiak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Napaskiak	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	128	$26,403.25	$3,379,616
3	Sewage collection mains or services (gravity or force), above ground	LF	22,400	$198.96	$4,456,791
4	Sewage lift station	EA	1	$ 678,792.59	$ 678,793
10	Sewage lagoon, barrow, local material	Acre	7	$694,724.45	$4,724,126
12	Water distribution, mains or services, above ground	LF	27,800	$330.21	$9,179,951
14	Water storage tank, no foundation	Gal	206,100	$2.60	$535,497
15	Water treatment plant, no foundation	SF	2,000	$1,615.96	$3,231,912
18	Foundation - freeze back piles	SF	4,780	$313.57	$1,498,864
				Total Estimated Cost in 2010 dollars (rounded):	**$27,686,000**
				Total with Inflation (3% per year for 6 years)	**$33,058,500**
27	Individual Grinder Pump Stations	EA	128	$30,000	$3,840,000
28	Electrical Service Upgrades	EA	128	$5,500	$704,000
				Subtotal	**$37,602,500**
29	Construction Contingency (15%)	LS	1	$5,640,400	$5,640,400
30	Design & Construction Administration Services (20%)	LS	1	$7,520,500	$7,520,500
				Total	**$50,763,400**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$31,200
Fuel	$149,900
Electricity	$32,200
Other (R&R, Training, etc.)	$23,100
Total	**$242,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Napaskiak are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 137	105	85%	**$ 147,179**
Public/Commercial Service	$ 172	22	100%	**$ 45,349**
School Service	$ 5,497	1	100%	**$ 49,472**
Local Capital Contribution				**$ -**
Total Revenue				**$ 242,000**

KUSKOKWIM RIVER

NAPASKIAK SLOUGH

NAPASKIAK SLOUGH

NAPASKIAK

LIFT STATION #1

PRIMARY WATER TREATMENT BUILDING

SCHOOL

SECONDARY WATER TREATMENT BUILDING

EXISTING LIFT STATION

SEWAGE LAGOON

N

200' 0 200' 400'

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

NAPASKIAK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 22

File: J:\Jobsdata\31303.00 VSW - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Napaskiak.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/25/2016
Community	Napaskiak
Input	

Existing Community & System Data

2015 Population	451
2015 Number of Services	128
HITS Database (E1 & H1-H7)	105
DCED Mapping Commerical/Public Facilities/School	23
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	44000
Water Treatment Capacity	40
Existing Sewage Lagoon Size	2.8

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	12800	18200
Gravity Sewer Main			
Pressure Sewer Main	x	12800	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Napaskiak**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**38**	
Req Water Storage (gallons) (less existing)	**206,100**	**2,780 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**2,000**	**2,000 sf**
Req Sewage Lagoon Size (acre) (less existing)	**6.8**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**2,000**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**18,200**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**12,800**	
	Individual Grinder Pump Stations (GPS) (ea)	**128**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**9,600**	
	Pressure Sewer Service Lines (lf)	**9,600**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	38	40	-
Water Storage (gallons)	250,100	44,000	206,100
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,000	-	2,000
Sewage Lagoon Size (acre)	9.6	2.8	6.8
Required Foundation System for WTP and/or WST			
Pile Foundation	4,780	-	4,780
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	18,200	-	18,200
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	12,800	-	12,800
Individual Grinder Pump Stations (GPS) (ea)	128	-	128
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,600	-	9,600
Pressure Sewer Service Lines (lf)	9,600	-	9,600

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/25/2016

Community Napaskiak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	451	people	2015 ADOL
2015 Number of Services	128	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***550***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	40	gpm	
Average Day (ADD)	27,515	gpd	50 gallons per Capita
Max Day (MDD)	55,031	gpd	2 x ADD
Peak Hour	115	gpm	3 x MDD
Treatment Capacity	***38***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	38	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	44,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	55,031	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	165,092	gallons	3 days x DO
Water Storage Tank Volume	250,122	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	194,945	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***250,100***	***gallons***	
Required Additional Storage	***206,100***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***2,780***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	2.8	acres	
Organic Loading Based Size	4.7	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	366.4		
Hydraulic Loading Based Size	9.6	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***9.6***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Napaskiak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	128	$26,403.25	$3,379,616
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	22,400	$198.96	$4,456,791
4	Sewage lift station	EA	1	$678,792.59	$678,793
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	6.8	$694,724.45	$4,724,126
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	27,800	$330.21	$9,179,951
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	206,100	$2.60	$535,497
15	Water treatment plant, no foundation	SF	2,000	$1,615.96	$3,231,912
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	4,780	$313.57	$1,498,864
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$27,685,550**

O&M Cost Estimate
Piped Water & Sewer System

Community: Napaskiak

General Community Data

Current population	451	persons
Average number of people per house	4.3	
Service Connections		
Number of houses	105	
Number of public/commerical buildings	22	
Number of schools	1	
Total number of service connections	128	
Burdened labor rate	$15	hr
Electricity cost (Public facilty)	$0.36	kWh
Electricity cost (Residential service)	$0.34	kWh
Cost per gallon for heating oil	$7.65	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	200	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	3760	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	250,100	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	3	
Total length of Water Main	18200	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	67	
Number of facilities served by existing lift/pump station	128	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	12800	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1700	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$31,200
Fuel (Heating Demand)				
Water system				
WTP building	$1,469	/month		$11,752.28
Raw water line	$0	/month		$0.00
Raw water heat addition	$2,098	/month		$16,781.53
Water storage tank	$291	/month		$2,326.53
Water storage tank line	$0	/month		$0.00
Water mains	$5,079	/month		$40,633
Service lines	$2,679	/month		$21,433
Wastewater system				
Sewer mains	$3,572	/month		$28,577
Service lines	$2,679	/month		$21,433
Lift/pump station buildings	$391	/month		$3,125.61
Force main to lagoon	$474	/month		$3,795
			Subtotal	$149,900
Electricity				
Water system				
WTP building				
Lights and controls	$395	/month		$4,740
HVAC/hydronic system	$395	/month		$3,160
Water treatment	$123	/month		$1,481
Pumps				
Intake or well	$123	/month		$1,480.72
WST circulation	$49	/month		$389
Pressure/booster	$185	/month		$2,221.08
Main line circulation	$1,160	/month		$9,279
Wastewater system				
Lift /pump station buildings				
Lights and controls	$105	/month		$1,261
HVAC/hydronic system	$105	/month		$840
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$275	/month		$3,299.90
Sewer/force main glycol circulation	$289	/month		$2,316
Lagoon discharge pump	$1,778	/year		$1,778
			Subtotal	$32,200
Other Costs				
Equipment R&R	$10,665	/year		$10,665
Miscellaneous materials & supplies	$6,399	/year		$6,399
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$23,100

Summary

Administration	$6,000
Labor	$31,200
Fuel	$149,900
Electricity	$32,200
Other	$23,100
Total	$242,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 137	105	85%	**$ 147,179**
Public/Commerc	$ 171.78	22	100%	**$ 45,349**
School Service (	$ 5,496.88	1	100%	**$ 49,472**
Local Capital Contribution				**$ -**
Total Revenue				**$ 242,000**

Nightmute, Alaska

Community Information & Existing Infrastructure

Nightmute is a Yupik Eskimo community of 274 people located on the Nelson Island, in western Alaska. There are 47 residential units, 28 commercial/public facilities and one school for a total of 76 services. The existing water service provided in Nightmute consists of self-haul system from the central watering point attached to the water treatment plant, and a flush tank and haul system for sewer. The school operates a separate water and sewer system which includes a water supply well, water and wastewater piping and fixtures, three lift stations, wastewater discharging piping, and a sewage lagoon. The existing water and sewer infrastructure consists of the following:

- Summer Seasonal Spring – 25 gpm peak flow
- Treated Water Storage – 880 gallons
- Water Treatment Plant – 480 SF, built in 1986
- Water Treatment – Filtration and chlorination

The community currently utilizes a tundra pond approximately 5.6 acres to dispose of the community's waste. While not uncommon in the region, tundra ponds can be extremely difficult to quantify, properly maintain, and permit. For the purposes of this assessment, the tundra pond is not included as an existing "usable" facility.

Soils around Nightmute consist of thin layer of soft, saturated silt occasionally overlain by organic silt 1 foot thick. Permafrost is present approximately 3.5 – 14 feet deep. There is groundwater perched on underlying permafrost near ground surface.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 8,000 feet of pipe, and the pressure sewer system approximately 6,900 feet of pipe. The water system will consist of a single circulating loop. The pressure sewer system would require four sewer main lift stations, individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment. The existing water storage tank is not sufficient to meet CT requirements (118,500 gallons).

The existing water source currently produces enough water to meet the demand of a piped system; however, the water source is seasonal and only provides water during the summer. For the purposes of this assessment, a new well is included to provide year round water to the community. Since the system would rely on both surface water and groundwater sources, water storage would still be subject to meeting CT.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	23	25	-
Water Storage (gallons)	163,700	880	162,820
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	5.8	-	5.8
Required Foundation System for WTP and/or WST			
Pile Foundation	3,460	-	3,460
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	8,000	-	8,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	6,900	-	6,900
Individual Grinder Pump Stations (GPS) (ea)	76	-	76
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,700	-	5,700
Pressure Sewer Service Lines (lf)	5,700	-	5,700

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Nightmute. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs

Village: Nightmute

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	76	$26,342.77	$2,002,051
3	Sewage collection mains or services (gravity or force), above ground	LF	12,600	$201.39	$2,537,532
10	Sewage lagoon, barrow, local material	Acre	6	$709,459.65	$4,114,866
12	Water distribution, mains or services, above ground	LF	13,700	$332.29	$4,552,365
14	Water storage tank, no foundation	Gal	162,820	$3.13	$509,024
15	Water treatment plant, no foundation	SF	1,200	$1,633.35	$1,960,015
18	Foundation - freeze back piles	SF	3,460	$328.53	$1,136,730
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$16,966,000**
				Total with Inflation (3% per year for 6 years)	**$20,258,300**
27	Individual Grinder Pump Stations	EA	76	$30,000	$2,280,000
28	Electrical Service Upgrades	EA	76	$5,500	$418,000
				Subtotal	**$22,956,300**
29	Construction Contingency (15%)	LS	1	$3,443,400	$3,443,400
30	Design & Construction Administration Services (20%)	LS	1	$4,591,300	$4,591,300
				Total	**$30,991,000**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$41,600
Fuel	$86,400
Electricity	$12,100
Other (R&R, Training, etc.)	$17,200
Total	**$163,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Nightmute are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 140	47	85%	**$ 67,132**
Public/Commercial Service	$ 154	28	100%	**$ 51,757**
School Service	$ 4,901	1	100%	**$ 44,111**
Local Capital Contribution				**$ -**
Total Revenue				**$ 163,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	3/25/2016
Community	Nightmute
Input	

Existing Community & System Data	
2015 Population	274
2015 Number of Services	76
HITS Database (E1 & H1-H7)	47
DCED Mapping Commerical/Public Facilities/School	29
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	880
Water Treatment Capacity	25
Existing Sewage Lagoon Size	0
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	6900	8000
Gravity Sewer Main			
Pressure Sewer Main	x	6900	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Nightmute**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**23**	
Req Water Storage (gallons) (less existing)	**162,820**	**2,260 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**5.8**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**8,000**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**6,900**	
	Individual Grinder Pump Stations (GPS) (ea)	**76**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**5,700**	
	Pressure Sewer Service Lines (lf)	**5,700**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	23	25	-
Water Storage (gallons)	163,700	880	162,820
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	5.8	-	5.8
Required Foundation System for WTP and/or WST			
Pile Foundation	3,460	-	3,460
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	8,000	-	8,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	6,900	-	6,900
Individual Grinder Pump Stations (GPS) (ea)	76	-	76
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,700	-	5,700
Pressure Sewer Service Lines (lf)	5,700	-	5,700

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 3/25/2016

Community Nightmute

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	274	people	2015 ADOL
2015 Number of Services	76	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***334***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	25	gpm	
Average Day (ADD)	16,717	gpd	50 gallons per Capita
Max Day (MDD)	33,433	gpd	2 x ADD
Peak Hour	70	gpm	3 x MDD
Treatment Capacity	***23***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	23	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	880	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	33,433	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	100,300	gallons	3 days x DO
Water Storage Tank Volume	163,733	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	118,437	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***163,700***	***gallons***	
Required Additional Storage	***162,820***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***2,260***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	2.8	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	285.6		
Hydraulic Loading Based Size	5.8	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***5.8***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Nightmute

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	76	$26,342.77	$2,002,051
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	12,600	$201.39	$2,537,532
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	5.8	$709,459.65	$4,114,866
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	13,700	$332.29	$4,552,365
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	162,820	$3.13	$509,024
15	Water treatment plant, no foundation	SF	1,200	$1,633.35	$1,960,015
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	3,460	$328.53	$1,136,730
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$16,966,180**

O&M Cost Estimate
Piped Water & Sewer System

Community: Nightmute

General Community Data

Current population	274	persons
Average number of people per house	5.8	
Service Connections		
Number of houses	47	
Number of public/commerical buildings	28	
Number of schools	1	
Total number of service connections	76	
Burdened labor rate	$25	hr
Electricity cost (Public facilty)	$0.34	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$8.50	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	1150	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	1680	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	163,700	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	8000	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	6900	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	915	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$41,600
Fuel (Heating Demand)				
Water system				
WTP building	$729	/month		$5,834.47
Raw water line	$0	/month		$0.00
Raw water heat addition	$1,416	/month		$11,328.26
Water storage tank	$212	/month		$1,692.00
Water storage tank line	$0	/month		$0.00
Water mains	$2,481	/month		$19,845
Service lines	$1,767	/month		$14,140
Wastewater system				
Sewer mains	$2,140	/month		$17,116
Service lines	$1,767	/month		$14,140
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$284	/month		$2,270
			Subtotal	$86,400
Electricity				
Water system				
WTP building				
Lights and controls	$167	/month		$2,000
HVAC/hydronic system	$167	/month		$1,334
Water treatment	$71	/month		$850
Pumps				
Intake or well	$71	/month		$849.62
WST circulation	$46	/month		$367
Pressure/booster	$106	/month		$1,274.43
Main line circulation	$365	/month		$2,921
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$182	/month		$1,458
Lagoon discharge pump	$1,020	/year		$1,020
			Subtotal	$12,100
Other Costs				
Equipment R&R	$7,005	/year		$7,005
Miscellaneous materials & supplies	$4,203	/year		$4,203
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$17,200

Summary

Administration	$6,000
Labor	$41,600
Fuel	$86,400
Electricity	$12,100
Other	$17,200
Total	$163,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 140	47	85%	**$ 67,132**
Public/Commerc	$ 154.04	28	100%	**$ 51,757**
School Service (	$ 4,901.20	1	100%	**$ 44,111**
Local Capital Contribution				**$ -**
Total Revenue				**$ 163,000**

WATER INTAKE

TOKSOOK RIVER

PROPOSED WTP

SCHOOL

SCHOOL SEWAGE LAGOON

PROPOSED SEWAGE LAGOON

N

150' 0 150' 300'

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

NIGHTMUTE

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 23

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Nightmute.dwg

Northway Village, Alaska

Community Information & Existing Infrastructure

Northway Village is an Athabascan community of 112 people located between Nabesna River and Skate Lake, on a 9-mile spur road off of the Alaska Highway. There are 34 residential units and 3 commercial/public facilities for a total of 37 services. The existing water and sewer services provided in Northway Village consist of self-haul system and honey buckets. The washeteria/clinic/water treatment plant and the water/sewer truck haul garage have piped water and sewer services. The existing water and sewer infrastructure consists of the following:

- Well – 30 gpm capacity
- Treated Water Storage – 3,800 gallons
- Water Treatment Plant/Washeteria – 2,270 SF, built in 1997
- Water Treatment – Potassium permanganate, polymer, and greensand filter
- Northway Village Sewage Lagoon – Two Cell, 1.84 acres

The soil conditions around Northway Village consist of an organic mat 1.5-3 feet deep with groundwater around 4 feet. Permafrost present in some areas as shallow as 2 feet deep.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 8,950 feet of pipe, and the pressure sewer system approximately 5,600 feet of pipe. The water system will consist of a single circulating loop. The pressure sewer system would require individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	30	-
Water Storage (gallons)	84,700	3,800	80,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.4	1.8	0.5
Required Foundation System for WTP and/or WST			
Pile Foundation	2,450	-	2,450
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	9,000	-	9,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,600	-	5,600
Individual Grinder Pump Stations (GPS) (ea)	37	-	37
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,800	-	2,800
Pressure Sewer Service Lines (lf)	2,800	-	2,800

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Northway Village. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Northway	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	37	$26,191.57	$969,088
3	Sewage collection mains or services (gravity or force), above ground	LF	8,400	$182.10	$1,529,638
10	Sewage lagoon, barrow, local material	Acre	0.5	$674,757.25	$337,379
12	Water distribution, mains or services, above ground	LF	11,800	$316.36	$3,733,036
14	Water storage tank, no foundation	Gal	80,900	$1.81	$146,129
15	Water treatment plant, no foundation	SF	1,200	$1,495.47	$1,794,569
18	Foundation - freeze back piles	SF	2,450	$246.64	$604,273
				Total Estimated Cost in 2010 dollars (rounded):	**$9,114,000**
				Total with Inflation (3% per year for 6 years)	**$10,882,600**
27	Individual Grinder Pump Stations	EA	37	$30,000	$1,110,000
28	Electrical Service Upgrades	EA	37	$5,500	$203,500
				Subtotal	**$12,196,100**
29	Construction Contingency (15%)	LS	1	$1,829,400	$1,829,400
30	Design & Construction Administration Services (20%)	LS	1	$2,439,200	$2,439,200
				Total	**$16,464,700**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$22,500
Fuel	$32,600
Electricity	$16,200
Other (R&R, Training, etc.)	$11,700
Total	**$89,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Northway Village are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 204	34	85%	**$ 70,662**
Public/Commercial Service	$ 509	3	100%	**$ 18,338**
School Service	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 89,000**

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES

NORTHWAY VILLAGE

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 24

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Northway Village.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/18/2016
Community	Northway Village
Input	

Existing Community & System Data	
2015 Population	112
2015 Number of Services	37
HITS Database (E1 & H1-H7)	34
DCED Mapping Commerical/Public Facilities/School	3
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	3800
Water Treatment Capacity	30
Existing Sewage Lagoon Size	1.84
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	5600	8950
Gravity Sewer Main			
Pressure Sewer Main	x	5600	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Northway Village**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**9**	
Req Water Storage (gallons) (less existing)	**80,900**	**1,250 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.5**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**9,000**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**5,600**	
	Individual Grinder Pump Stations (GPS) (ea)	**37**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**2,800**	
	Pressure Sewer Service Lines (lf)	**2,800**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	9	30.0	-
Water Storage (gallons)	84,700	3,800	80,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.4	1.8	0.5
Required Foundation System for WTP and/or WST			
Pile Foundation	2,450	-	2,450
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	9,000	-	9,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,600	-	5,600
Individual Grinder Pump Stations (GPS) (ea)	37	-	37
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,800	-	2,800
Pressure Sewer Service Lines (lf)	2,800	-	2,800

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/18/2016

Community Northway Village

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	112	people	2015 ADOL
2015 Number of Services	37	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***137***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	30	gpm	
Average Day (ADD)	6,833	gpd	50 gallons per Capita
Max Day (MDD)	13,666	gpd	2 x ADD
Peak Hour	28	gpm	3 x MDD
Treatment Capacity	***9***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	9	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	3,800	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	13,666	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	40,998	gallons	3 days x DO
Water Storage Tank Volume	84,665	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	48,412	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***84,700***	***gallons***	
Required Additional Storage	***80,900***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,250***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	1.84	acres	
Organic Loading Based Size	1.2	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	182.6		
Hydraulic Loading Based Size	2.4	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***2.4***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Northway

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	37	$26,191.57	$969,088
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	8,400	$182.10	$1,529,638
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.5	$674,757.25	$337,379
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	11,800	$316.36	$3,733,036
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	80,900	$1.81	$146,129
15	Water treatment plant, no foundation	SF	1,200	$1,495.47	$1,794,569
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	2,450	$246.64	$604,273
19	Foundation - thermosyphen stabilized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$9,114,112**

O&M Cost Estimate
Piped Water & Sewer System

Community: Northway Village

General Community Data

Current population	112	persons
Average number of people per house	3.3	
Service Connections		
Number of houses	34	
Number of public/commerical buildings	3	
Number of schools	0	
Total number of service connections	37	
Burdened labor rate	$18	hr
Electricity cost (Public facilty)	$0.44	kWh
Electricity cost (Residential service)	$0.23	kWh
Cost per gallon for heating oil	$4.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	3470	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	84,700	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	9000	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by existing lift/pump station		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	5600	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	670	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$22,464
Fuel (Heating Demand)				
Water system				
WTP building	$709	/month		$5,671.03
Raw water line	$0	/month		$0.00
Raw water heat addition	$272	/month		$2,179.07
Water storage tank	$51	/month		$411.98
Water storage tank line	$0	/month		$0.00
Water mains	$1,313	/month		$10,506
Service lines	$405	/month		$3,239
Wastewater system				
Sewer mains	$817	/month		$6,537
Service lines	$405	/month		$3,239
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$98	/month		$782
			Subtotal	$32,600
Electricity				
Water system				
WTP building				
Lights and controls	$446	/month		$5,347
HVAC/hydronic system	$446	/month		$3,565
Water treatment	$37	/month		$449
Pumps				
Intake or well	$37	/month		$449.43
WST circulation	$59	/month		$475
Pressure/booster	$56	/month		$674.15
Main line circulation	$473	/month		$3,780
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$118	/month		$943
Lagoon discharge pump	$540	/year		$540
			Subtotal	$16,200
Other Costs				
Equipment R&R	$3,563	/year		$3,563
Miscellaneous materials & supplies	$2,138	/year		$2,138
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$11,700

Summary

Administration	$6,000
Labor	$22,500
Fuel	$32,600
Electricity	$16,200
Other	$11,700
Total	$89,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 204	34	85%	**$ 70,662**
Public/Commerc	$ 509.39	3	100%	**$ 18,338**
School Service (	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 89,000**

Nunapitchuk, Alaska

Community Information & Existing Infrastructure

The City of Nunapitchuk is a Yup'ik community of 563 people located along the west and east side of Johnson River. There are 138 residential units, 21 commercial/public facilities and one school for a total of 160 services. Most of the existing water and sewer services provided in Nunapitchuk consist of a Cowater flush, tank and haul system at each building. The existing water and sewer infrastructure consists of the following:

- Groundwater well -20 gpm
- Raw water - High in Fe & Mn
- Direct Filtration Treatment - 20 gpm
- Water Treatment Plant/Washeteria – 2,050 sf, built in 1978
- Treated water storage - 84,500 gallons
- Sewage Lagoon - 3 acres (LKSD lagoon)

Soil conditions in the community consist of ice-rich silts, discontinuous permafrost and a shallow active layer. Any new foundations should consist of driven piles.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 22,500 feet of pipe, and the pressure sewer system approximately 13,700 feet of pipe. Both the west and east side of Nunapitchuk will consist of two circulating water mains, and pressure sewer systems. The pressure sewer system would require individual grinder pump stations at each service, and glycol heat trace for freeze protection. For the purposes of this assessment, a new 1200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment; a new groundwater well will be installed and an additional 220,300 gallons of water storage will be needed (304,800-84,500).

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	48	20	28
Water Storage (gallons)	304,800	84,500	220,300
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	7.7	3.0	4.7
Required Foundation System for WTP and/or WST			
Pile Foundation	4,150	-	4,150
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	22,500	-	22,500
Wastewater Collection System			
Insulated Sewer Main with Glycol Heat Trace (lf)	13,700	-	13,700
Residential Grinder Pump Stations (GPS) (ea)	160	-	160
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	12,000	-	12,000
Pressure Sewer Service w GPS (lf)	12,000	-	12,000

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Nunapitchuk. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				**Village** Nunapitchuk	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	160	$26,403	$4,224,521
3	Sewage collection mains or services (gravity or force), above ground	LF	25,700	$198	$5,097,696
10	Sewage lagoon, barrow, local material	Acre	4.7	$709,516	$3,334,727
12	Water distribution, mains or services, above ground	LF	34,500	$330	$11,372,141
14	Water storage tank, no foundation	Gal	220,300	$3	$561,434
15	Water treatment plant, no foundation	SF	1,200	$1,636	$1,962,712
18	Foundation - freeze back piles	SF	4,150	$320	$1,327,147
23	Water source - ground water well	EA	1	$153,597	$153,597
				Total Estimated Cost:	**$28,033,975**
				Total with Inflation (3% per year for 6 years)	**$33,474,000**
27	Residential Grinder Pump Stations	EA	160	$30,000	$4,800,000
28	Electrical Service Upgrades	EA	160	$5,500	$880,000
				Subtotal	**$39,154,000**
29	Construction Contingency (15%)	LS	1	$3,915,400	$3,915,400
30	Design & Construction Administration Services (20%)	LS	1	$7,830,800	$7,830,800
				Total	**$50,900,200**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Annual Cost**
Administration	$6,000
Labor	$31,200
Fuel (Heating)	$142,000
Electricity	$30,500
Other (R&R, Training, etc.)	$22,300
Total	**$232,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Nunapitchuk are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 102	138	85%	**$ 143,305**
Public/Commercial Service	$ 188	21	100%	**$ 47,463**
School Service	$ 4,581	1	100%	**$ 41,232**
Local Capital Contribution				**$ -**
Total Revenue				**$ 232,000**

SEWAGE LAGOON

WEST SIDE WATERING POINT FACILITY

WTP

SCHOOL

JOHNSON RIVER

JOHNSON RIVER

SEWAGE LAGOON EXPANSION

EXISTING SEWAGE LAGOON

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

250' 0 250' 500'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

NUNAPITCHUK

DATE: DEC 2015

SCALE: 1"=250'

FIGURE: 25

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Nunapitchuk.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	2/9/2016
Community	Nunapitchuk
Input	

Existing Community & System Data

2015 Population	563
2015 Number of Services	160
HITS Database (E1 & H1-H7)	138
DCED Mapping Commerical/Public Facilities/School	22
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	poor
Water Storage Tank	84500
Water Treatment Capacity	20
Existing Sewage Lagoon Size	3

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	13660	22480
Gravity Sewer Main		0	
Pressure Sewer Main	x	13660	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Nunapitchuk**

Output for Cost Model (calculated)

			Foundation Size
Water Treatment Capacity (gpm)		**48**	
Req Water Storage (gallons) (less existing)		**220,300**	**2,950 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**4.7**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**4,150**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**22,500**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**13,700**	
	Residential Grinder Pump Stations (GPS) (ea)	**160**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**12,000**	
	Pressure Sewer Service w/GPS (lf)	**12,000**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	48	20	28
Water Storage (gallons)	304,800	84,500	220,300
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	7.7	3.0	4.7
Required Foundation System for WTP and/or WST			
Pile Foundation	4,150	-	4,150
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	22,500	-	22,500
Wastewater Collection System			
Insulated Sewer Main with Glycol Heat Trace (lf)	13,700	-	13,700
Residential Grinder Pump Stations (GPS) (ea)	160	-	160
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	12,000	-	12,000
Pressure Sewer Service w GPS (lf)	12,000	-	12,000

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 2/9/2016
Community Nunapitchuk

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	563	people	2015 ADOL
2015 Number of Services	160	services	
Growth Rate (i)			138
2035 Design Population (Capita)			
Growth Rate (i)	1%	GW	1%
2035 Design Population (Capita)	***687***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	20	gpm	
Average Day (ADD)	34,348		50 gallons per Capita
Max Day (MDD)	68,697	gpd	2 x ADD
Peak Hour	143	gpm	3 x MDD
Treatment Capacity	***48***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	48	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	84,500	gallons	Built in 2010
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	68,697	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	206,090	gallons	3 days x DO
Water Storage Tank Volume	304,787	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	243,357	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***304,800***	***gallons***	
Required Additional Storage	***220,300***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***2,950***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Residential Grinder Pump Stations (GPS) (ea)***	Residential Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
	0		Static Water Service Line
Water Service Type	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service w/GPS (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	3	acres	School lagoon only
Organic Loading Based Size	5.8	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	409.4		
Hydraulic Loading Based Size	7.7	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1
Two cell lagoon, combined acreage	***7.7***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Nunaptichuk

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	160	$26,403.25	$4,224,521
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	25,700	$198.35	$5,097,696
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	4.7	$709,516.44	$3,334,727
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	34,500	$329.63	$11,372,141
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	220,300	$2.55	$561,434
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	4,150	$319.79	$1,327,147
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$28,033,975**

O&M Cost Estimate
Piped Water & Sewer System

Community: Nunapitchuk

General Community Data

Current population	563	persons
Average number of people per house	4.1	
Service Connections		
Number of houses	138	
Number of public buildings	21	
Number of schools	1	
Total number of service connections	160	
Burdened labor rate	$15	hr
Electricity cost (Public facilty)	$0.35	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line		ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	200	
Water Treatment		
Size of water treatment plant building	3250	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	304,800	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	4	
Total length of Water Main	22480	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Number of service line circ pumps		
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains	13660	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	4	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1030	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Service line circulation	34	kWh/month/service
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$31,200
Fuel (Heating Demand)				
Water system				
WTP building	$996	/month		$7,967.23
Raw water line	$0	/month		$0.00
Raw water heat addition	$2,054	/month		$24,645.89
Water storage tank	$278	/month		$2,223.82
Water storage tank line	$11	/month		$87.55
Water mains	$4,920	/month		$39,363
Service lines	$2,627	/month		$21,012
Wastewater system				
Sewer mains	$2,990	/month		$23,919
Service lines	$2,627	/month		$21,012
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$225	/month		$1,804
			Subtotal	$142,000
Electricity				
Water system				
WTP building				
Lights and controls	$332	/month		$3,984
HVAC/hydronic system	$332	/month		$2,656
Water treatment	$150	/month		$1,797
Pumps				
Intake or well	$150	/month		$1,797.10
WST circulation	$47	/month		$378
Pressure/booster	$225	/month		$2,695.64
Main line circulation	$1,504	/month		$12,029
Service line circulation	$0	/month		$0.00
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$375	/month		$3,002
Lagoon discharge pump	$2,158	/year		$2,158
			Subtotal	$30,500
Other Costs				
Equipment R&R	$10,185	/year		$10,185
Miscellaneous materials & supplies	$6,111	/year		$6,111
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$22,300

Summary

Administration	$6,000
Labor	$31,200
Fuel	$142,000
Electricity	$30,500
Other	$22,300
Total	$232,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 102	138	85%	**$ 143,305**
Public/Commerc	$ 188	21	100%	**$ 47,463**
School Service	$ 4,581	1	100%	**$ 41,232**
Local Capital Contribution				**$ -**
Total Revenue				**$ 232,000**

Oscarville, Alaska

Community Information & Existing Infrastructure

Oscarville is a Yupik community of 53 people located on the north bank of the Kuskokwim River, across the river from Napaskiak. There are 16 residential units, 15 commercial/public facilities and one school for a total of 32 services. The existing water and sewer services provided in Oscarville consist of self-haul system from the watering point and honey buckets. The school has a separate water treatment module for potable water, and sewer service that discharges into a timber lined wastewater lagoon. The existing water and sewer infrastructure consists of the following:

- Well – 3.5 gpm transfer pump
- Treated Water Storage – 2,100 gallons
- Watering Point Building – 640 SF, built in 1988
- Water Treatment – Potassium permanganate, greensand filter, chlorine, and fluoride
- Sewage Lagoon – Two Cell, 0.25 acres

Soils in the region consist of stratified deposits of sand, silty sands, and fine silt. Permafrost is locally absent and drainage is fairly good in town, however, much of the surrounding land is poorly drained.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 4,600 feet of pipe, and the pressure sewer system approximately 3,100 feet of pipe. The water system will consist of a single circulating loop. The pressure sewer system would require individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	4	3.5	0.5
Water Storage (gallons)	55,900	2,100	53,800
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.1	0.3	0.9
Required Foundation System for WTP and/or WST			
Pile Foundation	2,090	-	2,090
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	4,600	-	4,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	3,100	-	3,100
Individual Grinder Pump Stations (GPS) (ea)	32	-	32
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,400	-	2,400
Pressure Sewer Service Lines (lf)	2,400	-	2,400

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Oscarville. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Oscarville	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	32	$26,403.25	$844,904
3	Sewage collection mains or services (gravity or force), above ground	LF	5,500	$213.56	$1,174,576
10	Sewage lagoon, barrow, local material	Acre	1	$911,751.90	$820,577
12	Water distribution, mains or services, above ground	LF	7,000	$339.19	$2,374,347
14	Water storage tank, no foundation	Gal	53,800	$4.78	$257,310
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
18	Foundation - freeze back piles	SF	2,090	$366.35	$765,662
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$8,354,000**
				Total with Inflation (3% per year for 6 years)	**$9,975,100**
27	Individual Grinder Pump Stations	EA	32	$30,000	$960,000
28	Electrical Service Upgrades	EA	32	$5,500	$176,000
				Subtotal	**$11,111,100**
29	Construction Contingency (15%)	LS	1	$1,666,700	$1,666,700
30	Design & Construction Administration Services (20%)	LS	1	$2,222,200	$2,222,200
				Total	**$15,000,000**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$28,700
Electricity	$8,700
Other (R&R, Training, etc.)	$11,000
Total	**$79,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Oscarville are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 148	16	85%	**$ 24,225**
Public/Commercial Service	$ 156	15	100%	**$ 28,055**
School Service	$ 2,969	1	100%	**$ 26,719**
Local Capital Contribution				**$ -**
Total Revenue				**$ 79,000**

OSCARVILLE SLOUGH

SCHOOL

WATERING POINT/WATER TREATMENT PLANT

KUSKOKWIM RIVER

SEWAGE LAGOON

LEGEND:

- PROPOSED WATER MAIN
- PROPOSED SEWER/FORCE MAIN
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

150' 0 150' 300'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

OSCARVILLE

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 26

File: J:\Jobsdata\31303.00 VSW - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Oscarville.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/1/2016
Community	Oscarville
Input	

Existing Community & System Data

2015 Population	53
2015 Number of Services	32
HITS Database (E1 & H1-H7)	16
DCED Mapping Commerical/Public Facilities/School	16
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	2100
Water Treatment Capacity	3.5
Existing Sewage Lagoon Size	0.25

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	3100	4600
Gravity Sewer Main			
Pressure Sewer Main	x	3100	
Typical Service Line Length (ea)		75	75

Piped System Requirements — **Community** **Oscarville**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**4**	
Req Water Storage (gallons) (less existing)	**53,800**	**890 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.9**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**4,600**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**3,100**	
	Individual Grinder Pump Stations (GPS) (ea)	**32**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**2,400**	
	Pressure Sewer Service Lines (lf)	**2,400**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	4	3.5	0.5
Water Storage (gallons)	55,900	2,100	53,800
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.1	0.3	0.9
Required Foundation System for WTP and/or WST			
Pile Foundation	2,090	-	2,090
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	4,600	-	4,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	3,100	-	3,100
Individual Grinder Pump Stations (GPS) (ea)	32	-	32
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,400	-	2,400
Pressure Sewer Service Lines (lf)	2,400	-	2,400

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/1/2016
Community Oscarville

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	53	people	2015 ADOL
2015 Number of Services	32	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***65***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	3.5	gpm	
Average Day (ADD)	3,234	gpd	50 gallons per Capita
Max Day (MDD)	6,467	gpd	2 x ADD
Peak Hour	13	gpm	3 x MDD
Treatment Capacity	***4***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	4	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	2,100	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	6,467	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	19,401	gallons	3 days x DO
Water Storage Tank Volume	55,868	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	22,909	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***55,900***	***gallons***	
Required Additional Storage	***53,800***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***890***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf

Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS

Sewage Lagoon Size			
Existing Sewage Lagoon	0.25	acres	
Organic Loading Based Size	0.5	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	125.6		
Hydraulic Loading Based Size	1.1	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.1***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Oscarville

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	32	$26,403.25	$844,904
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	5,500	$213.56	$1,174,576
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.9	$911,751.90	$820,577
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	7,000	$339.19	$2,374,347
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	53,800	$4.78	$257,310
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	2,090	$366.35	$765,662
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$8,353,685**

O&M Cost Estimate
Piped Water & Sewer System

Community: Oscarville

General Community Data

Current population	53	persons
Average number of people per house	3.3	
Service Connections		
Number of houses	16	
Number of public/commerical buildings	15	
Number of schools	1	
Total number of service connections	32	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.35	kWh
Electricity cost (Residential service)	$0.15	kWh
Cost per gallon for heating oil	$5.90	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	1840	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	55,900	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	4600	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	3100	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	430	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$554	/month		$4,435.50
Raw water line	$0	/month		$0.00
Raw water heat addition	$190	/month		$1,520.97
Water storage tank	$50	/month		$401.05
Water storage tank line	$0	/month		$0.00
Water mains	$990	/month		$7,921
Service lines	$517	/month		$4,132
Wastewater system				
Sewer mains	$667	/month		$5,338
Service lines	$517	/month		$4,132
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$93	/month		$740
			Subtotal	$28,600
Electricity				
Water system				
WTP building				
Lights and controls	$188	/month		$2,255
HVAC/hydronic system	$188	/month		$1,504
Water treatment	$14	/month		$169
Pumps				
Intake or well	$14	/month		$169.18
WST circulation	$47	/month		$378
Pressure/booster	$21	/month		$253.76
Main line circulation	$376	/month		$3,007
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$94	/month		$750
Lagoon discharge pump	$203	/year		$203
			Subtotal	$8,700
Other Costs				
Equipment R&R	$3,113	/year		$3,113
Miscellaneous materials & supplies	$1,868	/year		$1,868
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$11,000

Summary

Administration	$6,000
Labor	$25,000
Fuel	$28,600
Electricity	$8,700
Other	$11,000
Total	$79,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 148	16	85%	**$ 24,225**
Public/Commerc	$ 155.86	15	100%	**$ 28,055**
School Service (	$ 2,968.81	1	100%	**$ 26,719**
Local Capital Contribution				**$ -**
Total Revenue				**$ 79,000**

Platinum, Alaska

Community Information & Existing Infrastructure

Platinum is a Yupik community of 60 people located on the Bering Sea coast, below Red Mountain on the south spit of Goodnews Bay. There are 19 residential units, 13 commercial/public facilities and one school for a total of 33 services. Piped water is distributed to approximately 7 homes, the school, and 20 yard hydrants. Residents self-haul water from the hydrants. Sewer services consist of individual septic systems and honeybuckets. The existing water and sewer infrastructure consists of the following:

- Groundwater under the direct influence of surface water – 53 gpm
- Water Storage – 430 gallons
- Pump House Building – 48 SF
- No Treatment
- Sewage Lagoon – N/A

Soils in the region consist of loose and moist to wet. There is a layer of organics across the tundra that overlies 3-8" of poorly graded sand layer. Under the poorly graded sand layer is a layer of poor to well graded sand and gravel. Groundwater is generally present around 8 feet below ground surface. No frozen ground encountered.

Piped System Description

The piped water system will be a below grade system with static water mains. The water system will consist of approximately 7,300 feet of pipe. The sewer system for the community will consist of individual residential on-site septic systems that include septic tanks and drainfields. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment and water distribution equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	5	53	-
Water Storage (gallons)	59,300	430	58,870
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Residential On-Site Septic System (ea)	33	-	33
Required Foundation System for WTP and/or WST			
Pile Foundation	2,160	-	2,160
Water Distribution System			
Static Water Main (lf)	7,300	-	7,300
Water & Sewer Service Lines			
Static Water Service Lines (lf)	2,475	-	2,475
Gravity Sewer Service Lines (lf)	2,475	-	2,475

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Platinum. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs				Village: Platinum	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	33	$26,342.77	$869,312
2	Sewage collection mains or services (gravity or force), buried	LF	2,475	$367.63	$ 909,880
6	Septic tank, and drainfield, individual household	EA	33	$125,292.93	$4,134,667
13	Water distribution, mains or services, buried	LF	9,775	$299.80	$2,930,587
14	Water storage tank, no foundation	Gal	58,870	$5.51	$324,194
15	Water treatment plant, no foundation	SF	1,200	$1,633.35	$1,960,015
18	Foundation - freeze back piles	SF	2,160	$341.96	$738,638
				Total Estimated Cost in 2010 dollars (rounded):	**$11,867,000**
				Total with Inflation (3% per year for 6 years)	**$14,169,800**
28	Electrical Service Upgrades	EA	33	$5,500	$181,500
				Subtotal	**$14,351,300**
29	Construction Contingency (15%)	LS	1	$2,152,700	$2,152,700
30	Design & Construction Administration Services (20%)	LS	1	$2,870,300	$2,870,300
				Total	**$19,374,300**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$21,200
Fuel	$5,000
Electricity	$4,600
Other (R&R, Training, etc.)	$8,500
Total	**$45,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Platinum are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 93	19	85%	**$ 17,989**
Public/Commercial Service	$ 93	13	100%	**$ 14,480**
School Service	$ 1,392	1	100%	**$ 12,531**
Local Capital Contribution				**$ -**
Total Revenue				**$ 45,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	9/7/2016
Community	Platinum
Input	

Existing Community & System Data	
2015 Population	60
2015 Number of Services	33
HITS Database (E1 & H1-H7)	19
DCED Mapping Commerical/Public Facilities/School	14
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	430
Water Treatment Capacity	53
Existing Sewage Lagoon Size	0
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost	x		7300
Above ground system or buried with permafrost			
Gravity Sewer Main			
Pressure Sewer Main			
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Platinum**	
Output for Cost Model (calculated)			**Foundation Size**
Water Treatment Capacity (gpm)		**5**	
Req Water Storage (gallons) (less existing)		**58,870**	**960 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System	**Static Water Main (lf)**	**7,300**	
Water & Sewer Service Lines	**Static Water Service Line (lf)**	**2,475**	
	Gravity Sewer Service Lines (lf)	**2,475**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	5	53.0	-
Water Storage (gallons)	59,300	430	58,870
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Residential On-Site Septic System (ea)	33	-	33
Required Foundation System for WTP and/or WST			
Pile Foundation	2,160	-	2,160
Water Distribution System			
Static Water Main (lf)	7,300	-	7,300
Water & Sewer Service Lines			
Static Water Service Line (lf)	2,475	-	2,475
Gravity Sewer Service Lines (lf)	2,475	-	2,475

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 9/7/2016
Community Platinum

System Parameters	Model Results			Criteria & Calculations
Design Population				
Duration (n)	20	years		20 years
2015 Population (P)	60	people		2015 ADOL
2015 Number of Services	33	services		
Growth Rate (i)	1%			1%
2035 Design Population (Capita)	***73***	***people***		Px(1+i)^n
Water Demand Estimates				
Existing Capacity	53	gpm		
Average Day (ADD)	3,661	gpd		50 gallons per Capita
Max Day (MDD)	7,321	gpd		2 x ADD
Peak Hour	15	gpm		3 x MDD
Treatment Capacity	***5***	***gpm***		MDD
Water Source Assumptions				
Type (surface water or groundwater)	GW			
Required Capacity	5	gpm		MDD
Water Storage Tank Sizing				
Existing Water Storage Tank	430	gallons		
Demand Based Volume (if source is GW)	Applicable			
Daily Operation (DO) (gallons)	7,321	gallons		Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons		500 gpm for 60 minutes
Reserve Volume (RV)	21,963	gallons		3 days x DO
Water Storage Tank Volume	59,285	gallons		DO + FF + RV
CT Based Volume (min if source is SW)	Not Required			
Chlorine Residual Concentration (RC)	0.4	mg/L		0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation		1.0-log Inactivation
Temperature (T)	4.4	C		4.4 celsius/40 F
pH (PH)	7			7
Contact Time Required (CT)	49	minutes		LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1			0.1
Required Volume to meet CT*	25,935	gallons		CT/RCxPeak Hour/BF
Required Water Storage	***59,300***	***gallons***		
Required Additional Storage	***58,870***	***gallons***		#VALUE!
Estimate of Min Platform Size (3' clearance around)	***960***	***sf***		D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
				#VALUE!
Water Treatment Plant Requirements*				
Water Quality	Poor			Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***		Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)				
Soft poorly drained soils or discontinuous permafrost	x		***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0			Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0			Gravel pad
Water Distribution (Check either or both)				
Buried system with no permafrost	x		***Static Water Main (lf)***	Static Water Mains
Above ground system or buried with permafrost	0			Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)				
Buried system with no permafrost	0			Bare sewer main, no heat trace
Above ground or buried with permafrost	0			Sewer main with glycol heat trace
Gravity Sewer Main	0			Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	0			Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)				
Static Water Main	x		***Static Water Service Line (lf)***	Static Water Service Line
Circulating Water Main	0			Circulating Water Service Lines
On-Site Septic System	x		***Gravity Sewer***	Gravity Service Line
Pressure Sewer Main	0			Pressure Service Line with GPS
Sewage Lagoon Size				
Existing Sewage Lagoon	0	acres		
Organic Loading Based Size	0.6	acres		0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	133.7			
Hydraulic Loading Based Size	1.3	acres		Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.3***	***acres***		Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Platinum

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	33	$26,342.77	$869,312
2	Sewage collection mains or services (gravity or force), buried	LF	2,475	$367.63	$909,880
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	33	$125,292.93	$4,134,667
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	9,775	$299.80	$2,930,587
14	Water storage tank, no foundation	Gal	58,870	$5.51	$324,194
15	Water treatment plant, no foundation	SF	1,200	$1,633.35	$1,960,015
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	2,160	$341.96	$738,638
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$11,867,293**

O&M Cost Estimate
Piped Water & Sewer System

Community: Platinum

General Community Data

Current population	60	persons
Average number of people per house	3.2	
Service Connections		
Number of houses	19	
Number of public/commerical buildings	13	
Number of schools	1	
Total number of service connections	33	
Burdened labor rate	$17	hr
Electricity cost (Public facilty)	$0.40	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$5.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	2200	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Treatment

Size of water treatment plant building	1200	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	59,300	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Static	
Number of circulating water loops	0	
Total length of Water Main	7300	ft
Water mains heated for freeze protection (Yes or No)	No	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)		
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains		ft
Sewer mains heated for freeze protection (Yes or No)		
Number of circulating glycol loops		
Location of the mains (Above ground (AG) or Buried)		
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main		ft
Force main heated for freeze protection (Yes or No)		
Location of force main (Above ground (AG) or Buried)		
Septic system discharged seasonally with pump (Yes or No)		

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Septic system discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

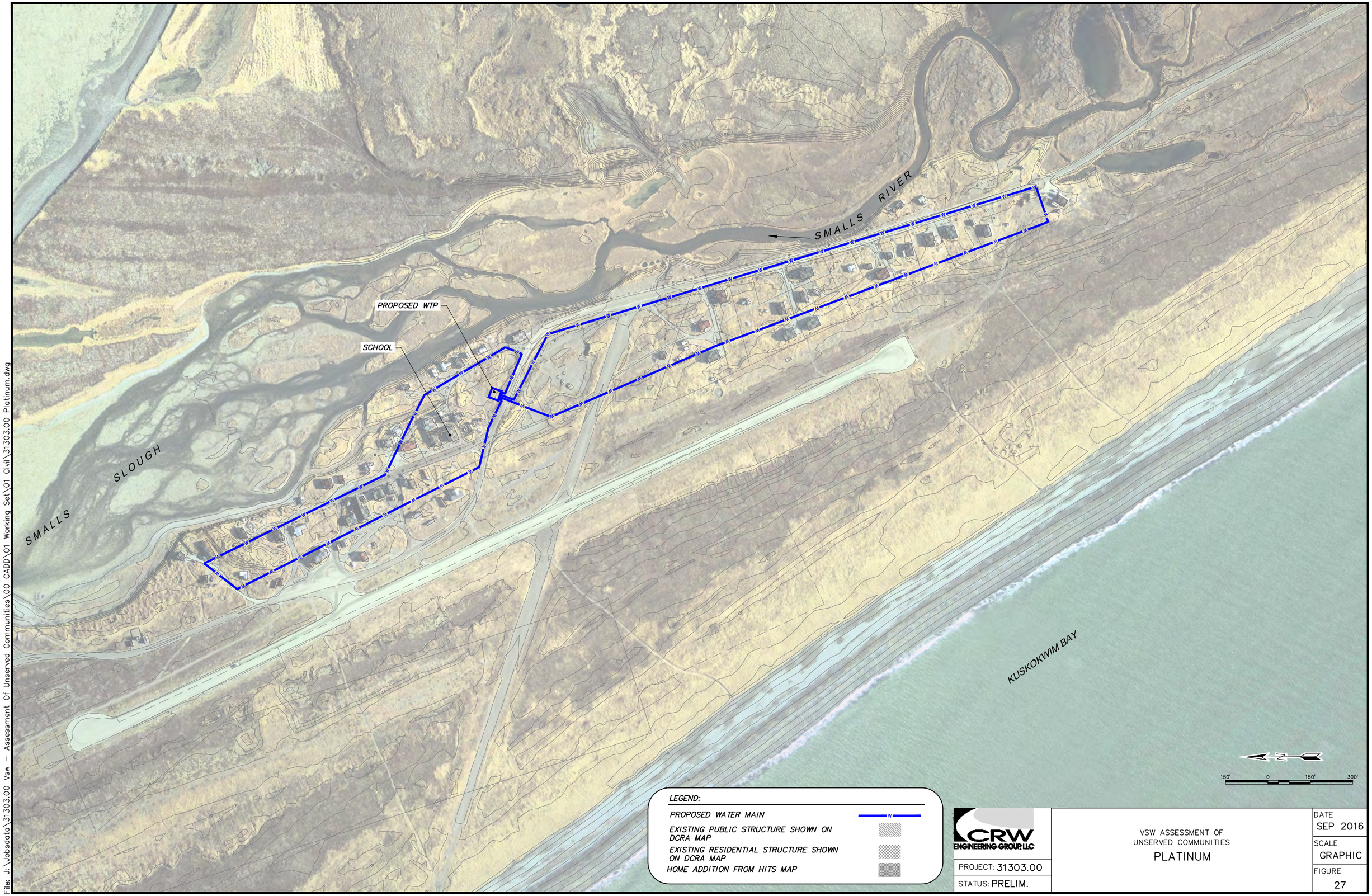
O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$21,216
Fuel (Heating Demand)				
Water system				
WTP building	$306	/month		$2,451.46
Raw water line	$0	/month		$0.00
Raw water heat addition	$182	/month		$2,188.80
Water storage tank	$45	/month		$360.54
Water storage tank line	$0	/month		$0.00
Water mains	$0	/month		$0
Service lines	$0	/month		$0
Wastewater system				
Sewer mains	$0	/month		$0
Service lines	$0	/month		$0
Lift/pump station buildings	$0	/month		$0.00
Force main to septic system	$0	/month		$0
			Subtotal	$5,000
Electricity				
Water system				
WTP building				
Lights and controls	$140	/month		$1,681
HVAC/hydronic system	$140	/month		$1,681
Water treatment	$18	/month		$219
Pumps				
Intake or well	$18	/month		$218.88
WST circulation	$54	/month		$432
Pressure/booster	$27	/month		$328.32
Main line circulation	$0	/month		$0
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$0	/month		$0
Septic system discharge pump	$0	/year		$0
			Subtotal	$4,600
Other Costs				
Equipment R&R	$1,541	/year		$1,541
Miscellaneous materials & supplies	$924	/year		$924
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$8,500

Summary

Administration	$6,000
Labor	$21,200
Fuel	$5,000
Electricity	$4,600
Other	$8,500
Total	$45,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 93	19	85%	**$ 17,989**
Public/Commerc	$ 92.82	13	100%	**$ 14,480**
School Service C	$ 1,392.33	1	100%	**$ 12,531**
Local Capital Contribution				**$ -**
Total Revenue				**$ 45,000**



LEGEND:

- PROPOSED WATER MAIN
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

PLATINUM

DATE: SEP 2016

SCALE: GRAPHIC

FIGURE: 27

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Platinum.dwg

Rampart, Alaska

Community Information & Existing Infrastructure

Rampart is a Koyukon Athabascan community of 45 people located on the south bank of the Yukon River, approximately 75 miles upstream from the Tanana River junction. There are 30 residential units and 19 commercial/public facilities for a total of 49 services. The existing water services provided in Rampart consist of a self-haul system from the watering point and the community water pickup truck. The sewer services consist of outhouses. The school, washeteria, and health clinic have piped water and sewer services. The existing water and sewer infrastructure consists of the following:

- Well – 13 gpm
- Treated Water Storage – 4,000 gallons
- Water Treatment Plant – 2,148 SF, built in 1998
- Water Treatment – Potassium permanganate, greensand filter, and chlorine
- Sewage Lagoon – Single cell, 0.2 acres

Soils around Rampart consist of brown to gray silt with scattered organic material and ice lenses from 1/8" to 1.2'. Material becomes coarser with depth, consisting of interbedded frozen silt and gravel, frozen gravel, and bedrock.

Piped System Description

The piped water and sewer system will be an above ground system. The water system will consist of approximately 6,900 feet of pipe. The water system will consist of two circulating loops. The sewer system will be a combination of gravity and pressure system. Homes located on the hills can likely accommodate a gravity sewer system (1,950 LF). A total of 19 services will be connected to the gravity sewer and will not require individual grinder pump stations (GPS). The remaining 30 homes and buildings on the lower portion of the community will be connected to the pressure sewer system (3,200 LF) and would require GPS units. The sewer system would require one sewer main lift station, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	4	13	-
Water Storage (gallons)	52,000	4,000	48,000
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (sf)	1.0	0.2	0.8
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	2,020	-	2,020
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	6,900	-	6,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,200	-	5,200
Individual Grinder Pump Stations (GPS) (ea)	30	-	30
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,700	-	3,700
Gravity Sewer Service Lines (lf)	1,425	-	1,425
Pressure Sewer Service Lines (lf)	2,250	-	2,250

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Rampart. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs

Village: Rampart

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	49	$26,403.25	$1,293,759
3	Sewage collection mains or services (gravity or force), above ground	LF	8,875	$209.61	$1,860,288
4	Sewage lift station	EA	1	$762,792.59	$762,793
10	Sewage lagoon, barrow, local material	Acre	0.8	$1,056,418.57	$845,135
12	Water distribution, mains or services, above ground	LF	10,600	$337.97	$3,582,480
14	Water storage tank, no foundation	Gal	48,000	$6.40	$307,196
15	Water treatment plant, no foundation	SF	1,200	$1,660.79	$1,992,952
18	Foundation - freeze back piles	SF	2,020	$384.57	$776,823
				Total Estimated Cost in 2010 dollars (rounded):	**$11,421,000**
				Total with Inflation (3% per year for 6 years)	**$13,637,300**
27	Individual Grinder Pump Stations	EA	30	$30,000	$900,000
28	Electrical Service Upgrades	EA	49	$5,500	$269,500
				Subtotal	**$14,806,800**
29	Construction Contingency (15%)	LS	1	$2,221,000	$2,221,000
30	Design & Construction Administration Services (20%)	LS	1	$2,961,400	$2,961,400
				Total	**$19,989,200**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$43,200
Electricity	$20,400
Other (R&R, Training, etc.)	$13,000
Total	**$108,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Rampart are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 142	30	85%	**$ 43,370**
Public/Commercial Service	$ 283	19	100%	**$ 64,630**
School Service	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 108,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	9/29/2016
Community	Rampart
Input	

Existing Community & System Data

2015 Population	45
2015 Number of Services	49
HITS Database (E1 & H1-H7)	30
DCED Mapping Commerical/Public Facilities/School	19
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	4000
Water Treatment Capacity	13
Existing Sewage Lagoon Size	0.2

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	5150	6900
Gravity Sewer Main	x	1950	
Pressure Sewer Main	x	3200	
Typical Service Line Length (ea)		75	75

Piped System Requirements — **Community** **Rampart**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**4**	
Req Water Storage (gallons) (less existing)	**48,000**	**820 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.8**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**2,020**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**6,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**5,200**	
	Lift Stations for Sewer Mains	**1**	
	Individual Grinder Pump Stations (GPS) (ea)	**30**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**3,700**	
	Gravity Sewer Service Lines (lf)	**1,425**	
	Pressure Sewer Service Lines (lf)	**2,250**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	4	13	-
Water Storage (gallons)	52,000	4,000	48,000
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.0	0.2	0.8
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	2,020	-	2,020
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	6,900	-	6,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,200	-	5,200
Individual Grinder Pump Stations (GPS) (ea)	30	-	30
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,700	-	3,700
Gravity Sewer Service Lines (lf)	1,425	-	1,425
Pressure Sewer Service Lines (lf)	2,250	-	2,250

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 9/29/2016

Community Rampart

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	45	people	2015 ADOL
2015 Number of Services	49	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***55***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	13	gpm	
Average Day (ADD)	2,745	gpd	50 gallons per Capita
Max Day (MDD)	5,491	gpd	2 x ADD
Peak Hour	11	gpm	3 x MDD
Treatment Capacity	***4***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	4	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	4,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	5,491	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	16,473	gallons	3 days x DO
Water Storage Tank Volume	51,963	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	19,451	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***52,000***	***gallons***	
Required Additional Storage	***48,000***	***gallons***	
Estimate of Min Platform Size (3' clearance around)	***820***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf Existing WTP<800 sf and in poor condition
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**x**	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	**0**		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Insulated sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Lines
Sewage Lagoon Size			
Existing Sewage Lagoon	0.2	acres	
Organic Loading Based Size	0.5	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	115.7		
Hydraulic Loading Based Size	1.0	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.0***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Rampart

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	49	$26,403.25	$1,293,759
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	8,875	$209.61	$1,860,288
4	Sewage lift station	EA	1	$762,792.59	$762,793
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.8	$1,056,418.57	$845,135
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	10,600	$337.97	$3,582,480
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	48,000	$6.40	$307,196
15	Water treatment plant, no foundation	SF	1,200	$1,660.79	$1,992,952
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	2,020	$384.57	$776,823
19	Foundation - thermosyphen stabilized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$11,421,426**

O&M Cost Estimate
Piped Water & Sewer System

Community: Rampart (Pressure)

General Community Data

Current population	45	persons
Average number of people per house	3.8	
Service Connections (Lowland)		
Number of houses	12	
Number of public/commerical buildings	18	
Number of schools	0	
Total number of service connections	30	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.40	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	3348	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	52,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main (Lowland)	6900	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	42	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains (Pressure)	3200	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	200	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$1,026	/month		$8,207.47
Raw water line	$22	/month		$175.10
Raw water heat addition	$164	/month		$1,313.28
Water storage tank	$47	/month		$379.39
Water storage tank line	$11	/month		$87.55
Water mains	$1,510	/month		$12,082
Service lines	$492	/month		$3,940
Wastewater system				
Sewer mains	$700	/month		$5,603
Service lines	$492	/month		$3,940
Lift/pump station buildings	$153	/month		$1,225.73
Force main to lagoon	$44	/month		$350
			Subtotal	$37,300
Electricity				
Water system				
WTP building				
Lights and controls	$391	/month		$4,690
HVAC/hydronic system	$391	/month		$3,127
Water treatment	$14	/month		$164
Pumps				
Intake or well	$14	/month		$164.16
WST circulation	$54	/month		$432
Pressure/booster	$21	/month		$246.24
Main line circulation	$859	/month		$6,874
Wastewater system				
Lift /pump station buildings				
Lights and controls	$58	/month		$700
HVAC/hydronic system	$58	/month		$467
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$57	/month		$689.47
Sewer/force main glycol circulation	$214	/month		$1,715
Lagoon discharge pump	$197	/year		$197
			Subtotal	$19,500
Other Costs				
Equipment R&R	$4,088	/year		$4,088
Miscellaneous materials & supplies	$2,453	/year		$2,453
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$12,500

Summary (Pressure)

Administration	$6,000
Labor	$25,000
Fuel	$37,300
Electricity	$19,500
Other	$12,500
Total	$100,000

Summary (Pressure + Gravity)

Administration	$6,000
Labor	$25,000
Fuel	$43,200
Electricity	$20,400
Other	$13,000
Total	$108,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 142	30	85%	**$ 43,370**
Public/Commerc	$ 283.46	19	100%	**$ 64,630**
School Service [3]			100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 108,000**

O&M Cost Estimate
Piped Water & Sewer System

Community: Rampart (Gravity)

General Community Data

Current population		persons
Average number of people per house	0.0	
Service Connections (South Side)		
Number of houses	18	
Number of public/commerical buildings	1	
Number of schools	0	
Total number of service connections	19	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.40	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))		
Length of raw water line		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Treatment		
Size of water treatment plant building		sf
Raw water quality (Good or Poor)		
Water Storage		
Size of tank(s)		gallons
Length of water line to/ from tank		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Distribution		
Type of system (Static or Circulating (Circ))		
Number of circulating water loops		
Total length of Water Main		ft
Water mains heated for freeze protection (Yes or No)		
Location of the mains (Above ground (AG) or Buried)		
Average service line length		ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains (Gravity)	1950	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main		ft
Force main heated for freeze protection (Yes or No)		
Location of force main (Above ground (AG) or Buried)		
Lagoon discharged seasonally with pump (Yes or No)		

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

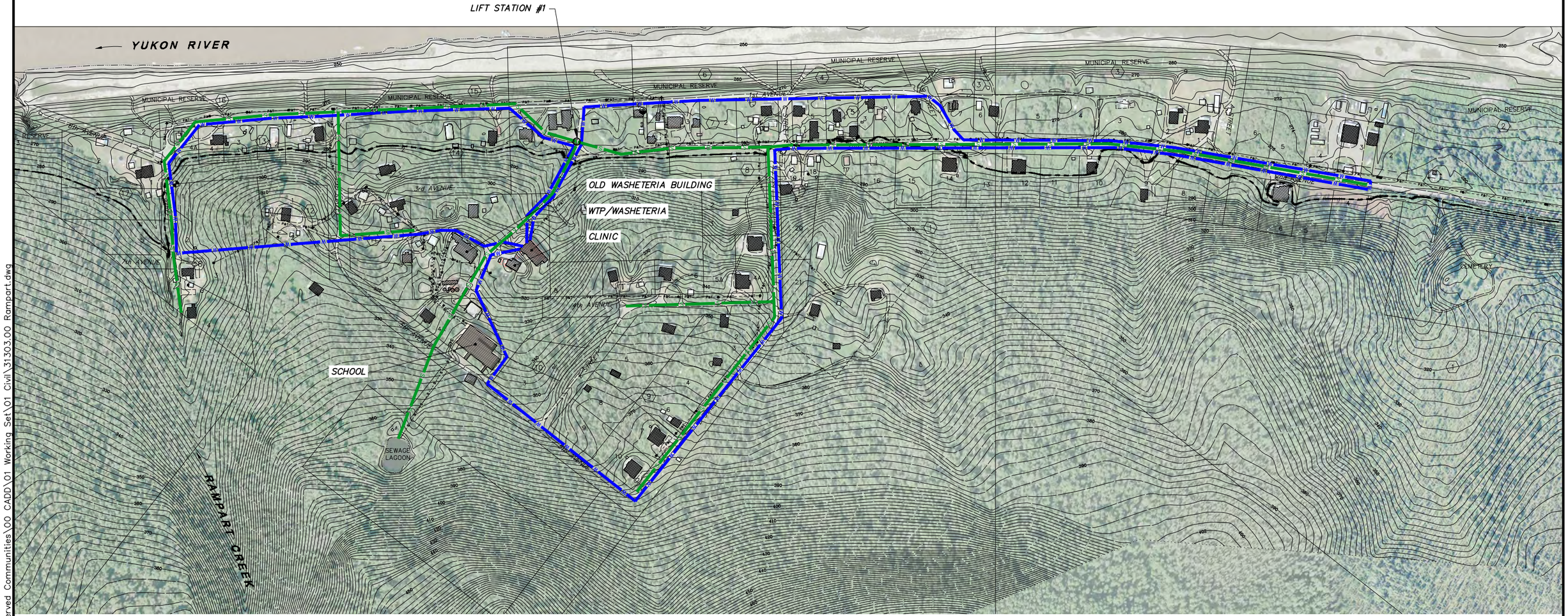
Administration		
Billing, CCR and management		/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$0	/month		$0
Labor (WTP Operator)	24	hrs/week		$0
Fuel (Heating Demand)				
Water system				
WTP building	$0	/month		$0.00
Raw water line	$0	/month		$0.00
Raw water heat addition	$0	/month		$0.00
Water storage tank	$0	/month		$0.00
Water storage tank line	$0	/month		$0.00
Water mains	$0	/month		$0
Service lines	$0	/month		$0
Wastewater system				
Sewer mains	$427	/month		$3,415
Service lines	$312	/month		$2,495
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$0	/month		$0
			Subtotal	$5,900
Electricity				
Water system				
WTP building				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Water treatment	$0	/month		$0
Pumps				
Intake or well	$0	/month		$0.00
WST circulation	$0	/month		$0
Pressure/booster	$0	/month		$0.00
Main line circulation	$0	/month		$0
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$107	/month		$858
Lagoon discharge pump	$0	/year		$0
			Subtotal	$900
Other Costs				
Equipment R&R	$340	/year		$340
Miscellaneous materials & supplies	$204	/year		$204
Water quality testing	$0	/year		$0
Operator training	$0	/year		$0
Insurance	$0	/year		$0
			Subtotal	$500

Summary (Upland)

Administration	$0	Covered in Pressure Estimate
Labor	$0	Covered in Pressure Estimate
Fuel	$5,900	
Electricity	$900	
Other	$500	
Total	$7,000	



LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP

N

100' 0 100' 200'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00
STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES
RAMPART

DATE: SEP 2016
SCALE: GRAPHIC
FIGURE: 42

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Stebbins, Alaska

Community Information & Existing Infrastructure

Stebbins is a Yupik community of 608 people located on the northwest coast of St. Michael Island, on Norton Sound. There are 133 residential units, 25 commercial/public facilities and one school for a total of 159 services. The existing water and sewer services provided in Stebbins consist of self-haul system from the washeteria or through a community watering point and honey buckets. The washeteria, school, and clinic have piped water and sewer services. The existing water and sewer infrastructure consists of the following:

- Clear Lake – 70-80 gpm (Seasonal)
- Treated Water Storage – 500,000 gallons (Recommended for replacement in 2010)
- School Water Storage – 750,000 gallons (Also used for community)
- Water Treatment Plant – 2,432 SF, built in 2015
- Water Treatment – Coagulant, calcium hypo chloride
- Sewage Lagoon – Honeybucket dump

Stebbins was built on discontinuously frozen beach deposits. It has silty soil and high groundwater near the coast.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 21,800 feet of pipe, and the pressure sewer system approximately 13,700 feet of pipe. The water system will consist of three circulating loops. The pressure sewer system would require four sewer main lift stations, individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. Previous analysis by ANTHC (2010 Community Development Plant) suggests that Clear Lake water source could be developed into a year-round source. Needed improvements would include a new 22,000 feet raw water transmission line, and new source intake structure. The existing water storage tank at the school is sufficient for meeting the systems CT requirements (263,000 gallons). For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	52	70	-
Water Storage (gallons)	326,800	750,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	13.0	-	13.0
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	21,800	-	21,800
Raw Water Transmission Line with Heat Trace (lf)	22,000	-	22,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	13,700	-	13,700
Individual Grinder Pump Stations (GPS) (ea)	159	-	159
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	11,900	-	11,900
Pressure Sewer Service Lines (lf)	11,900	-	11,900

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Stebbins. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs

Village: Stebbins

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	159	$22,235.73	$3,535,482
3	Sewage collection mains or services (gravity or force), above ground	LF	25,600	$186.02	$4,762,042
4	Sewage lift station	EA	2	$ 581,420.38	$ 1,162,841
10	Sewage lagoon, barrow, local material	Acre	13	$601,528.27	$7,819,868
12	Water distribution, mains or services, above ground	LF	55,700	$286.52	$15,959,332
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
19	Foundation - thermosyphen stablized gravel pad	SF	1,200	$499.91	$599,886
22	Water source - surface water intake	EA	1	$482,502.97	$482,503
				Total Estimated Cost in 2010 dollars (rounded):	**$36,081,000**
				Total with Inflation (3% per year for 6 years)	**$43,082,600**
27	Individual Grinder Pump Stations	EA	159	$30,000	$4,770,000
28	Electrical Service Upgrades	EA	159	$5,500	$874,500
				Subtotal	**$48,727,100**
29	Construction Contingency (15%)	LS	1	$7,309,100	$7,309,100
30	Design & Construction Administration Services (20%)	LS	1	$9,745,400	$9,745,400
				Total	**$65,781,600**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$37,400
Fuel	$179,600
Electricity	$40,700
Other (R&R, Training, etc.)	$26,600
Total	**$290,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Stebbins are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 148	133	85%	**$ 201,070**
Public/Commercial Service	$ 185	25	100%	**$ 55,581**
School Service	$ 3,705	1	100%	**$ 33,349**
Local Capital Contribution				**$ -**
Total Revenue				**$ 290,000**

NORTON SOUND

WTP

WASHETERIA

SCHOOL

SOUTHERN STREET

CENTRAL STREET

KENNEDY STREET

CARIBOU STREET

REINDEER STREET

BIA ROAD

ABEL STREET

PROPOSED SEWAGE LAGOON

LIFT STATION #2

LIFT STATION #1

LEGEND:

- PROPOSED WATER MAIN
- RAW WATER LINE
- PROPOSED SEWER/FORCE MAIN
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

200' 0 200' 400'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

STEBBINS

DATE MAR 2015

SCALE GRAPHIC

FIGURE 28

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Stebbins.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/4/2016
Community	Stebbins
Input	

Existing Community & System Data

2015 Population	608
2015 Number of Services	159
HITS Database (E1 & H1-H7)	133
DCED Mapping Commerical/Public Facilities/School	26
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	750000
Water Treatment Capacity	70
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	13700	21800
Gravity Sewer Main			
Pressure Sewer Main	x	13700	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Stebbins**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**52**	
Req Water Storage (gallons) (less existing)	**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**13.0**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**21,800**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**13,700**	
	Individual Grinder Pump Stations (GPS) (ea)	**159**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**11,900**	
	Pressure Sewer Service Lines (lf)	**11,900**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	52	70	-
Water Storage (gallons)	326,800	750,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	13.0	-	13.0
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	21,800	-	21,800
Raw Water Transmission Line with Heat Trace (lf)	22,000	-	22,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	13,700	-	13,700
Individual Grinder Pump Stations (GPS) (ea)	159	-	159
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	11,900	-	11,900
Pressure Sewer Service Lines (lf)	11,900	-	11,900

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/4/2016

Community Stebbins

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	608	people	2015 ADOL
2015 Number of Services	159	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***742***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	70	gpm	
Average Day (ADD)	37,094	gpd	50 gallons per Capita
Max Day (MDD)	74,188	gpd	2 x ADD
Peak Hour	155	gpm	3 x MDD
Treatment Capacity	***52***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	52	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	750,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	74,188	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	222,563	gallons	3 days x DO
Water Storage Tank Volume	326,750	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	262,809	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***326,800***	***gallons***	
Required Additional Storage	-	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	-	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	6.3	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	425.4		
Hydraulic Loading Based Size	13.0	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***13.0***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Stebbins

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	159	$22,235.73	$3,535,482
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	25,600	$186.02	$4,762,042
4	Sewage lift station	EA	2	$581,420.38	$1,162,841
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	13	$601,528.27	$7,819,868
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	55,700	$286.52	$15,959,332
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	1,200	$499.91	$599,886
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	1	$482,502.97	$482,503
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$36,080,821**

O&M Cost Estimate
Piped Water & Sewer System

Community: Stebbins

General Community Data

Current population	608	persons
Average number of people per house	4.6	
Service Connections		
Number of houses	133	
Number of public/commerical buildings	25	
Number of schools	1	
Total number of service connections	159	
Burdened labor rate	$18	hr
Electricity cost (Public facilty)	$0.40	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	22000	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	3632	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	750,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	3	
Total length of Water Main	21800	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	150	
Number of facilities served by lift/pump station #2	159	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	13700	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	1500	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$37,440
Fuel (Heating Demand)				
Water system				
WTP building	$1,113	/month		$8,903.69
Raw water line	$4,815	/month		$38,522.88
Raw water heat addition	$2,218	/month		$17,743.87
Water storage tank	$684	/month		$5,472.00
Water storage tank line	$0	/month		$0.00
Water mains	$4,772	/month		$38,173
Service lines	$2,610	/month		$20,881
Wastewater system				
Sewer mains	$2,999	/month		$23,989
Service lines	$2,610	/month		$20,881
Lift/pump station buildings	$306	/month		$2,451.46
Force main to lagoon	$328	/month		$2,627
			Subtotal	$179,600
Electricity				
Water system				
WTP building				
Lights and controls	$424	/month		$5,088
HVAC/hydronic system	$424	/month		$3,392
Water treatment	$185	/month		$2,218
Pumps				
Intake or well	$185	/month		$2,217.98
WST circulation	$54	/month		$432
Pressure/booster	$277	/month		$3,326.98
Main line circulation	$1,289	/month		$10,310
Wastewater system				
Lift /pump station buildings				
Lights and controls	$117	/month		$1,401
HVAC/hydronic system	$117	/month		$934
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$515	/month		$6,183.67
Sewer/force main glycol circulation	$322	/month		$2,573
Lagoon discharge pump	$2,663	/year		$2,663
			Subtotal	$40,700
Other Costs				
Equipment R&R	$12,887	/year		$12,887
Miscellaneous materials & supplies	$7,732	/year		$7,732
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$26,600

Summary

Administration	$6,000
Labor	$37,400
Fuel	$179,600
Electricity	$40,700
Other	$26,600
Total	$290,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 148	133	85%	**$ 201,070**
Public/Commerc	$ 185.27	25	100%	**$ 55,581**
School Service (	$ 3,705.41	1	100%	**$ 33,349**
Local Capital Contribution				**$ -**
Total Revenue				**$ 290,000**

Stevens Village, Alaska

Community Information & Existing Infrastructure

Stevens Village is a Kutchin Native community of 46 people located on the north bank of the Yukon River, 17 miles upstream of the Dalton Highway bridge crossing. There are 41 residential units and 10 commercial/public facilities for a total of 51 services. The existing water and sewer services provided in Stevens Village consist of self-haul system from the watering point located at the WTP and honey buckets/outhouses. The existing water and sewer infrastructure consists of the following:

- Well – 40 gpm
- Treated Water Storage – 7,000 gallons
- Water Treatment Plant – 2,000 SF, built in 1981, Upgraded in 1993
- Water Treatment – Calcium hypochlorite, sand filter, and one-micron cartridge filter
- Sewage Lagoon – Single Cell, 0.7 acres

The area around Stevens Village is generally underlain by continuous permafrost. Frozen soils observed near clinic and at power plant location. Thaw bulbs observed at slough near the school.

Piped System Description

The piped water and sewer system will be a below grade system. The water system will consist of approximately 13,900 feet of pipe, and the gravity sewer system approximately 8,500 feet of pipe. The water system will consist of two circulating loops. The gravity sewer system would require 2 sewer main lift stations and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	4	40	-
Water Storage (gallons)	52,500	7,000	45,500
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.0	0.7	0.3
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,980	-	1,980
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	13,900	-	13,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	8,500	-	8,800
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,800	-	3,800
Gravity Sewer Service Lines (lf)	3,825	-	3,825

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Stevens Village. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs				Village: Stevens Village	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	51	$28,096.69	$1,432,931
2	Sewage collection mains or services (gravity or force), buried	LF	12,325	$568.35	$ 7,004,890
4	Sewage lift station	EA	2	$ 1,172,426.77	$ 2,344,854
10	Sewage lagoon, barrow, local material	Acre	0.3	$2,504,413.17	$751,324
13	Water distribution, mains or services, buried	LF	17,700	$581.77	$10,297,270
14	Water storage tank, no foundation	Gal	45,500	$10.67	$485,394
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
19	Foundation - thermosyphen stabilized gravel pad	SF	1,980	$549.34	$1,087,693
				Total Estimated Cost in 2010 dollars (rounded):	**$26,380,000**
				Total with Inflation (3% per year for 6 years)	**$31,499,100**
28	Electrical Service Upgrades	EA	51	$5,500	$280,500
				Subtotal	**$31,779,600**
29	Construction Contingency (15%)	LS	1	$4,766,900	$4,766,900
30	Design & Construction Administration Services (20%)	LS	1	$6,355,900	$6,355,900
				Total	**$42,902,400**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$26,600
Fuel	$83,400
Electricity	$32,100
Other (R&R, Training, etc.)	$17,400
Total	**$166,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Stevens Village are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 277	41	85%	**$ 116,050**
Public/Commercial Service	$ 416	10	100%	**$ 49,950**
School Service	$ -	0	100%	**$ -**
Local Capital Contribution				**$ -**
Total Revenue				**$ 166,000**

OLD RUNWAY ROAD

HUSKY ROAD

ALDER ROAD

3rd STREET

SALMON ROAD

KUSKOKWIM ROAD

STEVENS ROAD

CONTINENTAL ROAD

LANGSTON ROAD

1st STREET

LIFT STATION #1

LIFT STATION #2

YUKON RIVER

SCHOOL (CLOSED)

EXISTING SEWAGE LAGOON

WASHETERIA & WATER TREATMENT PLANT

CLINIC & TRIBAL COUNCIL OFFICE

EXISTING WELL HOUSE

N

200' 0 200' 400'

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

STEVENS VILLAGE

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 29

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Stevens Village.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/5/2016
Community	Stevens Village
Input	

Existing Community & System Data	
2015 Population	46
2015 Number of Services	51
HITS Database (E1 & H1-H7)	41
DCED Mapping Commerical/Public Facilities/School	10
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	7000
Water Treatment Capacity	40
Existing Sewage Lagoon Size	0.7
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	8500	13900
Gravity Sewer Main	x	8500	
Pressure Sewer Main			
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Stevens Village**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**4**	
Req Water Storage (gallons) (less existing)		**45,500**	**780 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**0.3**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**13,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**8,500**	
	Lift Stations for Gravity Sewer Main	**2**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**3,800**	
	Gravity Sewer Service Lines (lf)	**3,825**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	4	40.0	-
Water Storage (gallons)	52,500	7,000	45,500
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.0	0.7	0.3
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,980	-	1,980
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	13,900	-	13,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	8,500	-	8,500
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	3,800	-	3,800
Gravity Sewer Service Lines (lf)	3,825	-	3,825

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/5/2016

Community Stevens Village

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	46	people	2015 ADOL
2015 Number of Services	51	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***56***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	40	gpm	
Average Day (ADD)	2,806	gpd	50 gallons per Capita
Max Day (MDD)	5,613	gpd	2 x ADD
Peak Hour	12	gpm	3 x MDD
Treatment Capacity	***4***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	4	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	7,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	5,613	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	16,839	gallons	3 days x DO
Water Storage Tank Volume	52,451	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	19,884	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***52,500***	***gallons***	
Required Additional Storage	***45,500***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***780***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0.7	acres	
Organic Loading Based Size	0.5	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	117.0		
Hydraulic Loading Based Size	1.0	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.0***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Stevens Village

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	51	$28,096.69	$1,432,931
2	Sewage collection mains or services (gravity or force), buried	LF	12,325	$568.35	$7,004,890
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	2	$1,172,426.77	$2,344,854
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.3	$2,504,413.17	$751,324
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	17,700	$581.77	$10,297,270
14	Water storage tank, no foundation	Gal	45,500	$10.67	$485,394
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	1,980	$549.34	$1,087,693
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$26,380,014**

O&M Cost Estimate
Piped Water & Sewer System

Community: Stevens Village

General Community Data

Current population	46	persons
Average number of people per house	1.1	
Service Connections		
Number of houses	41	
Number of public/commerical buildings	10	
Number of schools	0	
Total number of service connections	51	
Burdened labor rate	$16	hr
Electricity cost (Public facilty)	$0.50	kWh
Electricity cost (Residential service)	$0.25	kWh
Cost per gallon for heating oil	$8.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	3200	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	52,500	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	13900	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	12	
Number of facilities served by lift/pump station #2	46	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	8500	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1830	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$26,624
Fuel (Heating Demand)				
Water system				
WTP building	$1,307	/month		$10,459.55
Raw water line	$29	/month		$233.47
Raw water heat addition	$224	/month		$1,789.95
Water storage tank	$64	/month		$510.72
Water storage tank line	$15	/month		$116.74
Water mains	$2,434	/month		$29,207
Service lines	$670	/month		$8,037
Wastewater system				
Sewer mains	$1,488	/month		$17,861
Service lines	$670	/month		$8,037
Lift/pump station buildings	$409	/month		$3,268.61
Force main to lagoon	$320	/month		$3,845
			Subtotal	$83,400
Electricity				
Water system				
WTP building				
Lights and controls	$467	/month		$5,603
HVAC/hydronic system	$467	/month		$5,603
Water treatment	$17	/month		$210
Pumps				
Intake or well	$17	/month		$209.76
WST circulation	$68	/month		$540
Pressure/booster	$26	/month		$314.64
Main line circulation	$1,074	/month		$12,888
Wastewater system				
Lift /pump station buildings				
Lights and controls	$146	/month		$1,751
HVAC/hydronic system	$146	/month		$1,167
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$30	/month		$356.08
Sewer/force main glycol circulation	$268	/month		$3,216
Lagoon discharge pump	$252	/year		$252
			Subtotal	$32,100
Other Costs				
Equipment R&R	$7,106	/year		$7,106
Miscellaneous materials & supplies	$4,264	/year		$4,264
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$17,400

Summary

Administration	$6,000
Labor	$26,600
Fuel	$83,400
Electricity	$32,100
Other	$17,400
Total	$166,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 277	41	85%	$ **116,050**
Public/Commerc	$ 416.25	10	100%	$ **49,950**
School Service (	$ -	0	100%	$ -
Local Capital Contribution				$ -
Total Revenue				$ **166,000**

Stony River, Alaska

Community Information & Existing Infrastructure

Stony River is a mix of Athabascan Indian and Yupik Eskimo community of 34 people located on the north bank of the Kuskokwim River, 2 miles north of its junction with the Stony River. There are 18 residential units, 7 commercial/public facilities and one school for a total of 26 services. The existing water and sewer services provided in Stony River consist of individual well and septic tanks and absorption fields. The existing water and sewer infrastructure consists of the following:

- Well – 18 gpm
- Treated Water Storage – 3,800 gallons
- Watering Point Building – 914 SF, built in 1990
- Water Treatment – Potassium permanganate, chlorination, fluoridation
- Sewage Lagoon – Individual septic tanks & absorption fields

There is shallow groundwater in the area. The estimated maximum depth of freeze is between 7-10 feet below ground surface.

Piped System Description

The piped water and pressure sewer system will be a buried system. The water system will consist of approximately 5,800 feet of pipe, and the pressure sewer system approximately 6,400 feet of pipe. The water system will consist of a single circulating loop. The pressure sewer system would require individual grinder pump stations at each house, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	3	18	-
Water Storage (gallons)	46,600	3,800	42,800
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	0.7	-	0.7
Required Foundation System for WTP and/or WST			
Pile Foundation	1,950	-	1,950
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	5,800	-	5,800
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	6,400	-	6,400
Individual Grinder Pump Stations (GPS) (ea)	26	-	26
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,000	-	2,000
Pressure Sewer Service Lines (lf)	2,000	-	2,000

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Stony River. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Stony River	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	26	$28,096.69	$730,514
2	Sewage collection mains or services (gravity or force), buried	LF	8,400	$397.75	$ 3,341,112
10	Sewage lagoon, barrow, local material	Acre	0.7	$1,557,213.17	$1,090,049
13	Water distribution, mains or services, buried	LF	7,800	$423.50	$3,303,326
14	Water storage tank, no foundation	Gal	42,800	$11.14	$476,795
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
18	Foundation - freeze back piles	SF	1,950	$683.31	$1,332,454
				Total Estimated Cost in 2010 dollars (rounded):	**$13,250,000**
				Total with Inflation (3% per year for 6 years)	**$15,821,200**
27	Individual Grinder Pump Stations	EA	26	$30,000	$780,000
28	Electrical Service Upgrades	EA	26	$5,500	$143,000
				Subtotal	**$16,744,200**
29	Construction Contingency (15%)	LS	1	$2,511,600	$2,511,600
30	Design & Construction Administration Services (20%)	LS	1	$3,348,800	$3,348,800
				Total	**$22,604,600**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$33,500
Electricity	$11,700
Other (R&R, Training, etc.)	$11,600
Total	**$88,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Stony River are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 243	18	85%	**$ 44,657**
Public/Commercial Service	$ 255	7	100%	**$ 21,453**
School Service	$ 2,432	1	100%	**$ 21,891**
Local Capital Contribution				**$ -**
Total Revenue				**$ 88,000**

PROPOSED SEWAGE LAGOON

SCHOOL

AIRPORT

SOUTH COFFEE ROAD

CHURCH ROAD

BIRCH ROAD

LOW ROAD

NORTH ROAD

EXISTING COMMUNITY WELL

WASHETERIA/WTP

CRANBERRY ROAD

KUSKOKWIM RIVER

KUSKOKWIM

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

100' 0 100' 200'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

STONY RIVER

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 30

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Stony River.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/6/2016
Community	Stony River
Input	

Existing Community & System Data	
2015 Population	34
2015 Number of Services	26
HITS Database (E1 & H1-H7)	18
DCED Mapping Commerical/Public Facilities/School	8
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	3800
Water Treatment Capacity	18
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	6400	5800
Gravity Sewer Main			
Pressure Sewer Main	x	6400	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Stony River**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**3**	
Req Water Storage (gallons) (less existing)	**42,800**	**750 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.7**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**5,800**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**6,400**	
	Individual Grinder Pump Stations (GPS) (ea)	**26**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**2,000**	
	Pressure Sewer Service Lines (lf)	**2,000**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	3	18.0	-
Water Storage (gallons)	46,600	3,800	42,800
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	0.7	-	0.7
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	1,950	-	1,950
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	5,800	-	5,800
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	6,400	-	6,400
Individual Grinder Pump Stations (GPS) (ea)	26	-	26
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,000	-	2,000
Pressure Sewer Service Lines (lf)	2,000	-	2,000

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/6/2016

Community Stony River

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	34	people	2015 ADOL
2015 Number of Services	26	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***41***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	18	gpm	
Average Day (ADD)	2,074	gpd	50 gallons per Capita
Max Day (MDD)	4,149	gpd	2 x ADD
Peak Hour	9	gpm	3 x MDD
Treatment Capacity	***3***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	3	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	3,800	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	4,149	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	12,446	gallons	3 days x DO
Water Storage Tank Volume	46,595	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	14,697	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***46,600***	***gallons***	
Required Additional Storage	***42,800***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***750***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**x**	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	**0**		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.4	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	100.6		
Hydraulic Loading Based Size	0.7	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***0.7***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Stony River

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	26	$28,096.69	$730,514
2	Sewage collection mains or services (gravity or force), buried	LF	8,400	$397.75	$3,341,112
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.7	$1,557,213.17	$1,090,049
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	7,800	$423.50	$3,303,326
14	Water storage tank, no foundation	Gal	42,800	$11.14	$476,795
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	1,950	$683.31	$1,332,454
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$13,249,908**

O&M Cost Estimate
Piped Water & Sewer System

Community: Stony River

General Community Data

Current population	34	persons
Average number of people per house	1.9	
Service Connections		
Number of houses	18	
Number of public/commerical buildings	7	
Number of schools	1	
Total number of service connections	26	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.35	kWh
Electricity cost (Residential service)	$0.15	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	90	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	2114	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	46,600	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	5800	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	6400	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	600	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$648	/month		$5,182.38
Raw water line	$12	/month		$141.83
Raw water heat addition	$124	/month		$1,488.38
Water storage tank	$42	/month		$339.99
Water storage tank line	$7	/month		$78.80
Water mains	$762	/month		$9,140
Service lines	$256	/month		$3,073
Wastewater system				
Sewer mains	$840	/month		$10,086
Service lines	$256	/month		$3,073
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$79	/month		$946
			Subtotal	$33,500
Electricity				
Water system				
WTP building				
Lights and controls	$216	/month		$2,591
HVAC/hydronic system	$216	/month		$2,591
Water treatment	$9	/month		$109
Pumps				
Intake or well	$9	/month		$108.53
WST circulation	$47	/month		$378
Pressure/booster	$14	/month		$162.79
Main line circulation	$376	/month		$4,511
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$94	/month		$1,126
Lagoon discharge pump	$130	/year		$130
			Subtotal	$11,700
Other Costs				
Equipment R&R	$3,508	/year		$3,508
Miscellaneous materials & supplies	$2,105	/year		$2,105
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$11,600

Summary

Administration	$6,000
Labor	$25,000
Fuel	$33,500
Electricity	$11,700
Other	$11,600
Total	$88,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 243	18	85%	**$ 44,657**
Public/Commerc	$ 255.39	7	100%	**$ 21,453**
School Service (	$ 2,432.28	1	100%	**$ 21,891**
Local Capital Contribution				**$ -**
Total Revenue				**$ 88,000**

Takotna, Alaska

Community Information & Existing Infrastructure

Takotna is a mix of non-Native, Ingalik Athabascan, and Yupik community of 62 people located on the north bank of the Takotna River, 17 air miles west of McGrath. There are 16 residential units, 11 commercial/public facilities, 1 high school, and 1 community school for a total of 29 services. The existing water and sewer services provided in Takotna consist of self-haul system from the watering point and on-site septic tanks/pit privy/honey buckets for wastewater disposal. The existing water and sewer infrastructure consists of the following:

- Gold Run Creek – 37 gpm
- Treated Water Storage – 11,000 gallons
- Washeteria/Watering Point Building – 1,800 SF, built in 1980, Upgraded in 1991
- Water Treatment – Sand filters, cartridge filter, chlorine, carbon filter
- Sewage Lagoon – N/A

There is discontinuous permafrost in the region with thin frozen zones reported at several locations in towns. Soils throughout most of developed community are unfrozen except for moss covered lower hills and lowlands are underlain by permafrost.

Piped System Description

The piped water and sewer system will be a below grade system. The water system will consist of approximately 11,000 feet of pipe, and the gravity sewer system approximately 8,000 feet of pipe. The water system will consist of two circulating loops. The gravity sewer system would require 2 sewer main lift stations and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment. Existing water storage tank does not meet the minimum CT requirements (26,800 gallons).

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	5	37	-
Water Storage (gallons)	60,300	11,000	49,300
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.3	-	1.3
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,030	-	2,030
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	11,000	-	11,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	8,000	-	8,000
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,200	-	2,200
Gravity Sewer Service Lines (lf)	2,175	-	2,175

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Takotna. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs				Village: Takotna	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	29	$28,096.69	$814,804
2	Sewage collection mains or services (gravity or force), buried	LF	10,175	$581.14	$ 5,913,061
4	Sewage lift station	EA	2	$ 1,172,426.77	$ 2,344,854
10	Sewage lagoon, barrow, local material	Acre	1	$1,229,336.25	$1,598,137
13	Water distribution, mains or services, buried	LF	13,200	$596.13	$7,868,960
14	Water storage tank, no foundation	Gal	49,300	$10.09	$497,497
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
19	Foundation - thermosyphen stabilized gravel pad	SF	2,030	$540.98	$1,098,190
				Total Estimated Cost in 2010 dollars (rounded):	**$23,111,000**
				Total with Inflation (3% per year for 6 years)	**$27,595,700**
28	Electrical Service Upgrades	EA	29	$5,500	$159,500
				Subtotal	**$27,755,200**
29	Construction Contingency (15%)	LS	1	$4,163,300	$4,163,300
30	Design & Construction Administration Services (20%)	LS	1	$5,551,000	$5,551,000
				Total	**$37,469,500**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$49,700
Electricity	$41,500
Other (R&R, Training, etc.)	$15,300
Total	**$138,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Takotna are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 331	16	85%	**$ 54,086**
Public/Commercial Service	$ 365	11	100%	**$ 48,121**
School Service	$ 1,988	2	100%	**$ 35,793**
Local Capital Contribution				**$ -**
Total Revenue				**$ 138,000**

WASHETERIA/WATERING POINT

WATER INFILTRATION GALLERY

GOLD CREEK

AIRPORT ROAD

SCHOOL

EAST END ROAD

PROPOSED SEWAGE LAGOON

HIGH SCHOOL

LIFT STATION #2

LIFT STATION #1

TRIBAL OFFICE, CLINIC & PUBLIC HALL

TAKOTNA RIVER

N

200' 0 200' 400'

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

TAKOTNA

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 31

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Takotna.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/7/2016
Community	Takotna
Input	

Existing Community & System Data

2015 Population	62
2015 Number of Services	29
HITS Database (E1 & H1-H7)	16
DCED Mapping Commerical/Public Facilities/School	13
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	11000
Water Treatment Capacity	37
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	8000	11000
Gravity Sewer Main	x	8000	
Pressure Sewer Main			
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Takotna**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**5**	
Req Water Storage (gallons) (less existing)	**49,300**	**830 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**1.3**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**11,000**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**8,000**	
	Lift Stations for Gravity Sewer Main	**2**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**2,200**	
	Gravity Sewer Service Lines (lf)	**2,175**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	5	37.0	-
Water Storage (gallons)	60,300	11,000	49,300
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	1.3	-	1.3
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,030	-	2,030
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	11,000	-	11,000
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	8,000	-	8,000
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	2,200	-	2,200
Gravity Sewer Service Lines (lf)	2,175	-	2,175

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/7/2016

Community Takotna

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	62	people	2015 ADOL
2015 Number of Services	29	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***76***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	37	gpm	
Average Day (ADD)	3,783	gpd	50 gallons per Capita
Max Day (MDD)	7,565	gpd	2 x ADD
Peak Hour	16	gpm	3 x MDD
Treatment Capacity	***5***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	5	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	11,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	7,565	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	22,696	gallons	3 days x DO
Water Storage Tank Volume	60,261	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	26,800	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***60,300***	***gallons***	
Required Additional Storage	***49,300***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***830***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	0.6	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	135.9		
Hydraulic Loading Based Size	1.3	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***1.3***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Takotna

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	29	$28,096.69	$814,804
2	Sewage collection mains or services (gravity or force), buried	LF	10,175	$581.14	$5,913,061
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	2	$1,172,426.77	$2,344,854
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	1.3	$1,229,336.25	$1,598,137
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	13,200	$596.13	$7,868,960
14	Water storage tank, no foundation	Gal	49,300	$10.09	$497,497
15	Water treatment plant, no foundation	SF	1,200	$2,479.71	$2,975,658
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	2,030	$540.98	$1,098,190
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$23,111,161**

O&M Cost Estimate
Piped Water & Sewer System

Community: Takotna

General Community Data

Current population	62	persons
Average number of people per house	3.9	
Service Connections		
Number of houses	16	
Number of public/commerical buildings	11	
Number of schools	2	
Total number of service connections	29	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.64	kWh
Electricity cost (Residential service)	$0.38	kWh
Cost per gallon for heating oil	$5.75	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	470	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Treatment

Size of water treatment plant building	3000	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	60,300	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	11000	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	20	
Number of facilities served by lift/pump station #2	27	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	8000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	820	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	24	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$881	/month		$7,047.94
Raw water line	$59	/month		$709.83
Raw water heat addition	$217	/month		$2,601.02
Water storage tank	$53	/month		$421.62
Water storage tank line	$6	/month		$75.51
Water mains	$1,384	/month		$16,613
Service lines	$274	/month		$3,285
Wastewater system				
Sewer mains	$1,007	/month		$12,082
Service lines	$274	/month		$3,285
Lift/pump station buildings	$294	/month		$2,349.31
Force main to lagoon	$103	/month		$1,238
			Subtotal	$49,700
Electricity				
Water system				
WTP building				
Lights and controls	$560	/month		$6,724
HVAC/hydronic system	$560	/month		$6,724
Water treatment	$30	/month		$362
Pumps				
Intake or well	$30	/month		$361.88
WST circulation	$86	/month		$691
Pressure/booster	$45	/month		$542.82
Main line circulation	$1,375	/month		$16,497
Wastewater system				
Lift /pump station buildings				
Lights and controls	$187	/month		$2,241
HVAC/hydronic system	$187	/month		$1,494
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$106	/month		$1,275.63
Sewer/force main glycol circulation	$343	/month		$4,116
Lagoon discharge pump	$434	/year		$434
			Subtotal	$41,500
Other Costs				
Equipment R&R	$5,808	/year		$5,808
Miscellaneous materials & supplies	$3,485	/year		$3,485
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$15,300

Summary

Administration	$6,000
Labor	$25,000
Fuel	$49,700
Electricity	$41,500
Other	$15,300
Total	$138,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 331	16	85%	**$ 54,086**
Public/Commerc	$ 364.55	11	100%	**$ 48,121**
School Service (	$ 1,988.47	2	100%	**$ 35,793**
Local Capital Contribution				**$ -**
Total Revenue				**$ 138,000**

Teller, Alaska

Community Information & Existing Infrastructure

Teller is a Kawerak Eskimo community of 256 people located on a spit between Port Clarence and Grantley Harbor on the Seward Peninsula. There are 89 residential units, 16 commercial/public facilities, one head start school, and one K-12 school for a total of 107 services. The existing water and sewer services provided in Teller consist of self-haul system from the watering point and honey buckets. The school has piped water and sewer service that discharges into the school sewage lagoon. The existing water and sewer infrastructure consists of the following:

- Coyote Creek – 60 gpm (Seasonal)
- Treated Water Storage – 1,000,000 gallons
- Watering Point Building – 3,300 SF, built in 1978, Upgraded in 1993
- Water Treatment – Sand filters, chlorine
- Honeybucket Lagoon – 0.12 acres

Soils in the region consist of sands and gravelly sands low in fines and moderately well-sorted. Active zone varies from a few inches to several feet.

Piped System Description

The piped water and pressure sewer system will be a buried system. The water system will consist of approximately 12,400 feet of pipe, and the pressure sewer system approximately 10,700 feet of pipe. There will be two separate water and sewer systems for the current Townsite area and the Newsite area in the Coyote Subdivision. The existing Townsite water system will consist of two circulating loops, and the Newsite will consist of a single circulating loop. The pressure sewer system would require glycol heat trace for freeze protection. Both areas would utilize a large septic system. The Newsite would rely on gravity systems whereas the Townsite area would require a lift station. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. Based on average per capita water consumption of 50 gallons per person per day, the existing water storage capacity would need to be increased to provide sufficient water year round. Approximately 2.5 million gallons of raw water in addition to the treated water would need to be stored during the operation of the seasonal water source to provide water for the piped system when the source is non-producing (Assume freezing season is 9 months). The existing 1,000,000 gallon tank located at the Townsite would be used as a raw water tank and a new smaller treated water tank would be installed. Newsite would also have raw water and treated water storage tanks. For the purposes of this assessment, a new 1,200 sf facility is included at both the existing Townsite and the Newsite to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	22	60	-
Raw Water Storage (gallons)	2,500,000	1,000,000	1,500,000
Treated Water Storage (gallons)	100,000	-	100,000
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Septic System (sf)	40,000	-	40,000
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	20,970	-	20,970
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	9,800	-	9,800
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	8,000	-	8,000
Individual Grinder Pump Stations (GPS) (ea)	79	-	79
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,000	-	8,000
Gravity Sewer Service Lines (lf)	2,100	-	2,100
Pressure Sewer Service Lines (lf)	5,900	-	5,900

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Teller. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Teller	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	107	$22,235.73	$2,379,223
2	Sewage collection mains or services (gravity or force), buried	LF	4,000	$274.11	$ 1,096,424
3	Sewage collection mains or services (gravity or force), above ground	LF	12,000	$189.55	$2,274,557
4	Sewage lift station	EA	1	$ 638,316.38	$ 638,316
7	Septic tank, community	EA	2	$293,350.26	$586,701
8	Drainfield, community	SF	40,000	$20.82	$832,964
12	Water distribution, mains or services, above ground	LF	13,900	$290.52	$4,038,161
13	Water distribution, mains or services, buried	LF	3,900	$294.34	$1,147,923
14	Water storage tank, no foundation	Gal	1,600,000	$1.79	$2,858,965
15	Water treatment plant, no foundation	SF	2,400	$1,415.98	$3,398,341
19	Foundation - thermosyphen stablized gravel pad	SF	20,970	$156.25	$3,276,483
				Total Estimated Cost in 2010 dollars (rounded):	**$22,528,000**
				Total with Inflation (3% per year for 6 years)	**$26,899,600**
27	Individual Grinder Pump Stations	EA	79	$30,000	$2,370,000
28	Electrical Service Upgrades	EA	107	$5,500	$588,500
				Subtotal	**$29,858,100**
29	Construction Contingency (15%)	LS	1	$4,478,700	$4,478,700
30	Design & Construction Administration Services (20%)	LS	1	$5,971,600	$5,971,600
				Total	**$40,308,400**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$33,300
Fuel	$86,500
Electricity	$34,200
Other (R&R, Training, etc.)	$18,300
Total	**$178,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Teller are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 114	89	85%	**$ 103,622**
Public/Commercial Service	$ 120	16	100%	**$ 23,012**
School Service	$ 5,707	1	100%	**$ 51,366**
Local Capital Contribution				**$ -**
Total Revenue				**$ 178,000**

WASHETERIA/WTP

SCHOOL

PORT CLARENCE

PROPOSED SEPTIC SYSTEM

LIFT STATION #1

GRANTLEY HARBOR

FRESHWATER LAKE

LEGEND:

- PROPOSED WATER MAIN — W
- PROPOSED SEWER/FORCE MAIN — S
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

250' 0 250' 500'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

TELLER (1 OF 2)

DATE: MAR 2016

SCALE: GRAPHIC

FIGURE: 32

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Teller.dwg

PROPOSED SEPTIC SYSTEM

COYOTE CREEK DISPOSAL ACCESS ROAD

COYOTE CREEK

PROPOSED WTP

N

200' 0 200' 400'

LEGEND:

PROPOSED WATER MAIN — W

PROPOSED SEWER/FORCE MAIN — S

EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP

EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP

HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

TELLER (2 OF 2)

DATE: MAR 2016

SCALE: GRAPHIC

FIGURE: 33

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Teller.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/8/2016
Community	Teller
Input	

Existing Community & System Data

2015 Population	256
2015 Number of Services	107
HITS Database (E1 & H1-H7)	89
DCED Mapping Commerical/Public Facilities/School	18
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	1000000
Water Treatment Capacity	60
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	8000	9800
Gravity Sewer Main	x	1900	
Pressure Sewer Main	x	6100	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Teller**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**22**	
Req Water Storage (gallons) (less existing)	**1,600,000**	**18,570 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**2,400**	**2,400 sf**
Req Septic System w/ Drainfield (sf) (less existing)	**40,000**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**2,400**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**9,800**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**8,000**	
	Individual Grinder Pump Stations (GPS) (ea)	**107**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**8,000**	
	Gravity Sewer Service Lines (lf)	**2,100**	
	Pressure Sewer Service Lines (lf)	**5,900**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	22	60	-
Raw Water Storage (gallons)	2,500,000	1,000,000	1,500,000
Treated Water Storage (gallons)	100,000	-	100,000
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Septic System (sf)	40,000	-	40,000
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	20,970	-	20,970
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	9,800	-	9,800
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	8,000	-	8,000
Individual Grinder Pump Stations (GPS) (ea)	79	-	79
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,000	-	8,000
Gravity Sewer Service Lines (lf)	2,100	-	2,100
Pressure Sewer Service Lines (lf)	5,900	-	5,900

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/8/2016

Community Teller

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	256	people	2015 ADOL
2015 Number of Services	107	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***312***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	60	gpm	
Average Day (ADD)	15,618	gpd	50 gallons per Capita
Max Day (MDD)	31,237	gpd	2 x ADD
Peak Hour	65	gpm	3 x MDD
Treatment Capacity	***22***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	SW		
Required Capacity	22	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	1,000,000	gallons	
Demand Based Volume (if source is GW)	Check Min CT Requirements		
Daily Operation (DO) (gallons)	31,237	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	93,711	gallons	3 days x DO
Water Storage Tank Volume	154,947	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	110,656	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***154,900***	***gallons***	
Required Additional Storage	***1,600,000***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***18,570***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	2.7	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per acre
check	276.1		
Hydraulic Loading Based Size	5.5	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***5.5***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Teller

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	107	$22,235.73	$2,379,223
2	Sewage collection mains or services (gravity or force), buried	LF	4,000	$274.11	$1,096,424
3	Sewage collection mains or services (gravity or force), above ground	LF	12,000	$189.55	$2,274,557
4	Sewage lift station	EA	1	$638,316.38	$638,316
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	2	$293,350.26	$586,701
8	Drainfield, community	SF	40,000	$20.82	$832,964
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	13,900	$290.52	$4,038,161
13	Water distribution, mains or services, buried	LF	3,900	$294.34	$1,147,923
14	Water storage tank, no foundation	Gal	1,600,000	$1.79	$2,858,965
15	Water treatment plant, no foundation	SF	2,400	$1,415.98	$3,398,341
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	20,970	$156.25	$3,276,483
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$22,528,058**

O&M Cost Estimate
Piped Water & Sewer System

Community: Teller (Newsite)

General Community Data

Current population		persons
Average number of people per house	0.0	
Service Connections (Newsite)		
Number of houses	28	
Number of public/commerical buildings		
Number of schools		
Total number of service connections	28	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.42	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))		
Length of raw water line		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Treatment		
Size of water treatment plant building		sf
Raw water quality (Good or Poor)		
Water Storage		
Size of tank(s)		gallons
Length of water line to/ from tank		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	1800	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)		
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains	1900	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	500	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Septic system discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management		/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Septic system discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$0	/month		$0
Labor (WTP Operator)	24	hrs/week		$0
Fuel (Heating Demand)				
Water system				
WTP building	$0	/month		$0.00
Raw water line	$0	/month		$0.00
Raw water heat addition	$0	/month		$0.00
Water storage tank	$0	/month		$0.00
Water storage tank line	$0	/month		$0.00
Water mains	$236	/month		$2,837
Service lines	$276	/month		$3,309
Wastewater system				
Sewer mains	$250	/month		$2,994
Service lines	$276	/month		$3,309
Lift/pump station buildings	$0	/month		$0.00
Force main to septic system	$66	/month		$788
			Subtotal	$13,200
Electricity				
Water system				
WTP building				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Water treatment	$0	/month		$0
Pumps				
Intake or well	$0	/month		$0.00
WST circulation	$0	/month		$0
Pressure/booster	$0	/month		$0.00
Main line circulation	$451	/month		$5,413
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$113	/month		$1,351
Septic system discharge pump	$0	/year		$0
			Subtotal	$6,800
Other Costs				
Equipment R&R	$1,000	/year		$1,000
Miscellaneous materials & supplies	$600	/year		$600
Water quality testing	$0	/year		$0
Operator training	$0	/year		$0
Insurance	$0	/year		$0
			Subtotal	$1,600

Summary (Newsite)

Administration	$0	Covered in Townsite Estimate
Labor	$0	Covered in Townsite Estimate
Fuel	$13,200	
Electricity	$6,800	
Other	$1,600	
Total	$22,000	

O&M Cost Estimate
Piped Water & Sewer System

Community: Teller (Townsite)

General Community Data

Current population	256	persons
Average number of people per house	4.2	
Service Connections (Townsite)		
Number of houses	61	
Number of public/commerical buildings	16	
Number of schools	2	
Total number of service connections	79	
Burdened labor rate	$20	hr
Electricity cost (Public facilty)	$0.42	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	SW	
Length of raw water line	11500	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	4500	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	1,050,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main (Lowland)	8000	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	55	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains (North Side)	6100	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	215	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Septic system discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Septic system discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$33,280
Fuel (Heating Demand)				
Water system				
WTP building	$1,379	/month		$11,031.55
Raw water line	$0	/month		$0.00
Raw water heat addition	$934	/month		$7,471.10
Water storage tank	$958	/month		$7,660.80
Water storage tank line	$11	/month		$87.55
Water mains	$1,751	/month		$14,008
Service lines	$1,297	/month		$10,375
Wastewater system				
Sewer mains	$1,335	/month		$10,681
Service lines	$1,297	/month		$10,375
Lift/pump station buildings	$153	/month		$1,225.73
Force main to septic system	$47	/month		$376
			Subtotal	$73,300
Electricity				
Water system				
WTP building				
Lights and controls	$552	/month		$6,619
HVAC/hydronic system	$552	/month		$4,413
Water treatment	$82	/month		$981
Pumps				
Intake or well	$82	/month		$980.58
WST circulation	$57	/month		$454
Pressure/booster	$123	/month		$1,470.87
Main line circulation	$902	/month		$7,217
Wastewater system				
Lift /pump station buildings				
Lights and controls	$61	/month		$735
HVAC/hydronic system	$61	/month		$490
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$88	/month		$1,060.96
Sewer/force main glycol circulation	$225	/month		$1,801
Septic system discharge pump	$1,177	/year		$1,177
			Subtotal	$27,400
Other Costs				
Equipment R&R	$6,699	/year		$6,699
Miscellaneous materials & supplies	$4,019	/year		$4,019
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$16,700

Summary (Townsite)

Administration	$6,000
Labor	$33,300
Fuel	$73,300
Electricity	$27,400
Other	$16,700
Total	$157,000

Summary (Townsite & Newsite)

Administration	$6,000
Labor	$33,300
Fuel	$86,500
Electricity	$34,200
Other	$18,300
Total	$178,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 114	89	85%	**$ 103,622**
Public/Commerc	$ 119.85	16	100%	**$ 23,012**
School Service (	$ 5,707.32	1	100%	**$ 51,366**
Local Capital Contribution				**$ -**
Total Revenue				**$ 178,000**

Tetlin, Alaska

Community Information & Existing Infrastructure

Tetlin is an Athabascan community of 131 people located along the Tetlin River, between Tetlin Lake and the Tanana River. There are 43 residential units, 10 commercial/public facilities and one school for a total of 54 services. The existing water and sewer services provided in Tetlin consist of self-haul system from the watering point located at the washeteria and pit privies/honey buckets. Few homes in the community have 350 gallon sewer holding tanks for wastewater disposal. The existing water and sewer infrastructure consists of the following:

- Well – 40 gpm
- Treated Water Storage – N/A
- Watering Point Building – 1,500 SF, built in 1999
- Water Treatment – Grit separator, bag filter
- Sewage Lagoon – Two Cell, 0.25 acres

Soils in the region consist of fine, medium dense, stiff silty sands and silts. Permafrost is pervasive throughout the community; however, cleared areas were found to be thawed to depths of 5-6 feet.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 10,300 feet of pipe, and the pressure sewer system approximately 6,600 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	11	40	-
Water Storage (gallons)	93,900	-	93,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.8	0.3	2.5
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,610	-	2,610
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	10,300	-	10,300
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	6,600	-	6,600
Individual Grinder Pump Stations (GPS) (ea)	54	-	54
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,100	-	4,100
Pressure Sewer Service Lines (lf)	4,100	-	4,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Tetlin. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Tetlin	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	54	$28,096.69	$1,517,221
3	Sewage collection mains or services (gravity or force), above ground	LF	10,700	$301.01	$3,220,820
10	Sewage lagoon, barrow, local material	Acre	2.5	$880,950.77	$2,202,377
12	Water distribution, mains or services, above ground	LF	14,400	$420.25	$6,051,565
14	Water storage tank, no foundation	Gal	93,900	$3.84	$360,441
15	Water treatment plant, no foundation	SF	1,200	$2,372.01	$2,846,410
19	Foundation - thermosyphen stablized gravel pad	SF	2,610	$255.26	$666,230
				Total Estimated Cost in 2010 dollars (rounded):	**$16,865,000**
				Total with Inflation (3% per year for 6 years)	**$20,137,700**
27	Individual Grinder Pump Stations	EA	54	$30,000	$1,620,000
28	Electrical Service Upgrades	EA	54	$5,500	$297,000
				Subtotal	**$22,054,700**
29	Construction Contingency (15%)	LS	1	$3,308,200	$3,308,200
30	Design & Construction Administration Services (20%)	LS	1	$4,410,900	$4,410,900
				Total	**$29,773,800**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$28,300
Fuel	$27,500
Electricity	$10,500
Other (R&R, Training, etc.)	$11,300
Total	**$84,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Tetlin are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 109	43	85%	**$ 47,748**
Public/Commercial Service	$ 114	10	100%	**$ 13,717**
School Service	$ 2,504	1	100%	**$ 22,535**
Local Capital Contribution				**$ -**
Total Revenue				**$ 84,000**

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

TETLIN

DATE MAR 2015

SCALE GRAPHIC

FIGURE 34

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Tetlin.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/11/2016		
Community	Tetlin		
Input			
Existing Community & System Data			
2015 Population	131		
2015 Number of Services	54		
HITS Database (E1 & H1-H7)	43		
DCED Mapping Commerical/Public Facilities/School	11		
Type (surface water or groundwater)	GW		
Water quality (Poor or Good)	Poor		
Water Storage Tank	0		
Water Treatment Capacity	40		
Existing Sewage Lagoon Size	0.25		
Soil Conditions (check only one)			
Soft poorly drained soils or discontinuous permafrost			
Firm soils, or continuous permafrost	x		
Stiff soils, no permafrost			
Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	6600	10300
Gravity Sewer Main			
Pressure Sewer Main	x	6600	
Typical Service Line Length (ea)		75	75

Piped System Requirements	**Community**	**Tetlin**	
Output for Cost Model (calculated)			
			Foundation Size
Water Treatment Capacity (gpm)		**11**	
Req Water Storage (gallons) (less existing)		**93,900**	**1,410 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)		**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)		**2.5**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**10,300**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**6,600**	
	Individual Grinder Pump Stations (GPS) (ea)	**54**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**4,100**	
	Pressure Sewer Service Lines (lf)	**4,100**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	11	40	-
Water Storage (gallons)	93,900	-	93,900
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	2.8	0.3	2.5
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,610	-	2,610
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	10,300	-	10,300
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	6,600	-	6,600
Individual Grinder Pump Stations (GPS) (ea)	54	-	54
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	4,100	-	4,100
Pressure Sewer Service Lines (lf)	4,100	-	4,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/11/2016

Community Tetlin

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	131	people	2015 ADOL
2015 Number of Services	54	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***160***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	40	gpm	
Average Day (ADD)	7,992	gpd	50 gallons per Capita
Max Day (MDD)	15,984	gpd	2 x ADD
Peak Hour	33	gpm	3 x MDD
Treatment Capacity	***11***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	11	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	-	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	15,984	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	47,953	gallons	3 days x DO
Water Storage Tank Volume	93,938	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	56,625	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***93,900***	***gallons***	
Required Additional Storage	***93,900***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,410***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0.25	acres	
Organic Loading Based Size	1.4	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	197.5		
Hydraulic Loading Based Size	2.8	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***2.8***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Tetlin

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	54	$28,096.69	$1,517,221
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	10,700	$301.01	$3,220,820
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	2.5	$880,950.77	$2,202,377
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	14,400	$420.25	$6,051,565
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	93,900	$3.84	$360,441
15	Water treatment plant, no foundation	SF	1,200	$2,372.01	$2,846,410
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	2,610	$255.26	$666,230
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$16,865,064**

O&M Cost Estimate
Piped Water & Sewer System

Community: Tetlin

General Community Data

Current population	131	persons
Average number of people per house	3.0	
Service Connections		
Number of houses	43	
Number of public/commerical buildings	10	
Number of schools	1	
Total number of service connections	54	
Burdened labor rate	$17	hr
Electricity cost (Public facilty)	$0.24	kWh
Electricity cost (Residential service)	$0.21	kWh
Cost per gallon for heating oil	$2.80	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	

Water Treatment

Size of water treatment plant building	2700	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	93,900	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	10300	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	6600	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	1130	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$28,288
Fuel (Heating Demand)				
Water system				
WTP building	$386	/month		$3,088.83
Raw water line	$3	/month		$36.77
Raw water heat addition	$223	/month		$2,676.17
Water storage tank	$40	/month		$319.71
Water storage tank line	$5	/month		$40.86
Water mains	$1,052	/month		$8,417
Service lines	$414	/month		$3,309
Wastewater system				
Sewer mains	$674	/month		$5,393
Service lines	$414	/month		$3,309
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$115	/month		$923
			Subtotal	$27,500
Electricity				
Water system				
WTP building				
Lights and controls	$189	/month		$2,269
HVAC/hydronic system	$189	/month		$1,513
Water treatment	$24	/month		$287
Pumps				
Intake or well	$24	/month		$286.73
WST circulation	$32	/month		$259
Pressure/booster	$36	/month		$430.10
Main line circulation	$516	/month		$4,124
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$129	/month		$1,029
Lagoon discharge pump	$344	/year		$344
			Subtotal	$10,500
Other Costs				
Equipment R&R	$3,314	/year		$3,314
Miscellaneous materials & supplies	$1,989	/year		$1,989
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$11,300

Summary

Administration	$6,000
Labor	$28,300
Fuel	$27,500
Electricity	$10,500
Other	$11,300
Total	$84,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 109	43	85%	**$ 47,748**
Public/Commerc	$ 114.31	10	100%	**$ 13,717**
School Service (	$ 2,503.89	1	100%	**$ 22,535**
Local Capital Contribution				**$ -**
Total Revenue				**$ 84,000**

Tuluksak, Alaska

Community Information & Existing Infrastructure

Tuluksak is a Yupik Eskimo community of 372 people located on the south bank of the Tuluksak River at its junction with the Kuskokwim River. There are 92 residential units, 21 commercial/public facilities and one school for a total of 114 services. The existing water and sewer services provided in Tuluksak consist of self-haul system from the watering point attached to the washeteria and pit privies. The existing water and sewer infrastructure consists of the following:

- Well – 20 gpm
- Treated Water Storage – 100,000 gallons
- Water Treatment Plant – 2,048 SF, built in 1982, Upgraded in 2003
- Water Treatment – Chlorine, Potassium permanganate, Greensand filter
- Sewage Lagoon – Two cell, 0.52 acre

Soils around Tuluksak consist of silt with silty sand. Groundwater level is close to the level of the river.

Piped System Description

The piped water and sewer system will be a buried system. The water system will consist of approximately 13,400 feet of pipe, and the gravity sewer system approximately 12,200 feet of pipe. The water system will consist of two circulating loops. The pressure sewer system would require one sewer main lift station (existing), individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	32	20	12
Water Storage (gallons)	211,600	100,000	111,600
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	7.9	0.5	7.4
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,830	-	2,830
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	13,400	-	13,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	12,200	-	12,200
Individual Grinder Pump Stations (GPS) (ea)	114	-	114
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,600	-	8,600
Gravity Sewer Service Lines (lf)	8,550	-	8,550

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Tuluksak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs				Village: Tuluksak	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	114	$26,403.25	$3,009,971
2	Sewage collection mains or services (gravity or force), buried	LF	20,750	$254.26	$ 5,275,960
10	Sewage lagoon, barrow, local material	Acre	7.4	$692,040.19	$5,121,097
13	Water distribution, mains or services, buried	LF	22,000	$280.91	$6,179,961
14	Water storage tank, no foundation	Gal	111,600	$3.25	$362,886
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
19	Foundation - thermosyphen stablized gravel pad	SF	2,830	$266.47	$754,111
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$22,820,000**
				Total with Inflation (3% per year for 6 years)	**$27,248,300**
27	Individual Grinder Pump Stations	EA	114	$30,000	$3,420,000
28	Electrical Service Upgrades	EA	114	$5,500	$627,000
				Subtotal	**$31,295,300**
29	Construction Contingency (15%)	LS	1	$4,694,300	$4,694,300
30	Design & Construction Administration Services (20%)	LS	1	$6,259,100	$6,259,100
				Total	**$42,248,700**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$26,000
Fuel	$99,900
Electricity	$24,000
Other (R&R, Training, etc.)	$18,000
Total	**$174,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Tuluksak are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 104	92	85%	**$ 98,032**
Public/Commercial Service	$ 115	21	100%	**$ 28,958**
School Service	$ 5,223	1	100%	**$ 47,010**
Local Capital Contribution				**$ -**
Total Revenue				**$ 174,000**

TULUKSAK RIVER

WATER TREATMENT PLANT/LAUNDROMAT

TULUKAKUTE AVENUE

MISHEMK ROAD

SOUTH ROAD

SCHOOL

TULUKSAK RIVER

EXISTING LIFT STATION

TO SEWAGE LAGOON

N

150' 0 150' 300'

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

TULUKSAK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 35

File: J:\Jobsdata\31303.00 Vsw – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Tuluksak.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/19/2016
Community	Tuluksak
Input	

Existing Community & System Data	
2015 Population	372
2015 Number of Services	114
HITS Database (E1 & H1-H7)	92
DCED Mapping Commerical/Public Facilities/School	22
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	100000
Water Treatment Capacity	20
Existing Sewage Lagoon Size	0.52
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	12200	13400
Gravity Sewer Main	x	12200	
Pressure Sewer Main			
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Tuluksak**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**32**	
Req Water Storage (gallons) (less existing)	**111,600**	**1,630 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**7.4**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**13,400**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**12,200**	
	Lift Stations for Gravity Sewer Mains	**1**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**8,600**	
	Gravity Sewer Service Lines (lf)	**8,550**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	32	20	12
Water Storage (gallons)	211,600	100,000	111,600
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	7.9	0.5	7.4
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	2,830	-	2,830
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	13,400	-	13,400
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	12,200	-	12,200
Individual Grinder Pump Stations (GPS) (ea)	114	-	114
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	8,600	-	8,600
Gravity Sewer Service Lines (lf)	8,550	-	8,550

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/19/2016

Community Tuluksak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	372	people	2015 ADOL
2015 Number of Services	114	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***454***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	20	gpm	
Average Day (ADD)	22,696	gpd	50 gallons per Capita
Max Day (MDD)	45,391	gpd	2 x ADD
Peak Hour	95	gpm	3 x MDD
Treatment Capacity	***32***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	32	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	100,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	45,391	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	136,173	gallons	3 days x DO
Water Storage Tank Volume	211,564	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	160,797	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***211,600***	***gallons***	
Required Additional Storage	***111,600***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***1,630***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0.52	acres	
Organic Loading Based Size	3.9	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	332.8		
Hydraulic Loading Based Size	7.9	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***7.9***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Tuluksak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	114	$26,403.25	$3,009,971
2	Sewage collection mains or services (gravity or force), buried	LF	20,750	$254.26	$5,275,960
3	Sewage collection mains or services (gravity or force), above ground	LF	0	#DIV/0!	$0
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	7.4	$692,040.19	$5,121,097
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	0	#DIV/0!	$0
13	Water distribution, mains or services, buried	LF	22,000	$280.91	$6,179,961
14	Water storage tank, no foundation	Gal	111,600	$3.25	$362,886
15	Water treatment plant, no foundation	SF	1,200	$1,635.59	$1,962,712
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stablized gravel pad	SF	2,830	$266.47	$754,111
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$22,820,295**

O&M Cost Estimate
Piped Water & Sewer System

Community: Tuluksak

General Community Data

Current population	372	persons
Average number of people per house	4.0	
Service Connections		
Number of houses	92	
Number of public/commerical buildings	21	
Number of schools	1	
Total number of service connections	114	
Burdened labor rate	$13	hr
Electricity cost (Public facilty)	$0.30	kWh
Electricity cost (Residential service)	$0.66	kWh
Cost per gallon for heating oil	$6.13	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	3248	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	211,600	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	13400	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by existing lift/pump station	114	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	12200	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	2125	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$26,000
Fuel (Heating Demand)				
Water system				
WTP building	$1,017	/month		$8,134.85
Raw water line	$7	/month		$80.50
Raw water heat addition	$1,386	/month		$16,637.51
Water storage tank	$197	/month		$1,577.28
Water storage tank line	$11	/month		$89.45
Water mains	$1,798	/month		$21,575
Service lines	$1,147	/month		$13,766
Wastewater system				
Sewer mains	$1,637	/month		$19,643
Service lines	$1,147	/month		$13,766
Lift/pump station buildings	$157	/month		$1,252.29
Force main to lagoon	$285	/month		$3,421
			Subtotal	$99,900
Electricity				
Water system				
WTP building				
Lights and controls	$284	/month		$3,412
HVAC/hydronic system	$284	/month		$3,412
Water treatment	$85	/month		$1,018
Pumps				
Intake or well	$85	/month		$1,017.79
WST circulation	$41	/month		$324
Pressure/booster	$127	/month		$1,526.69
Main line circulation	$644	/month		$7,733
Wastewater system				
Lift /pump station buildings				
Lights and controls	$44	/month		$525
HVAC/hydronic system	$44	/month		$350
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$126	/month		$1,513.41
Sewer/force main glycol circulation	$161	/month		$1,930
Lagoon discharge pump	$1,222	/year		$1,222
			Subtotal	$24,000
Other Costs				
Equipment R&R	$7,495	/year		$7,495
Miscellaneous materials & supplies	$4,497	/year		$4,497
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$18,000

Summary

Administration	$6,000
Labor	$26,000
Fuel	$99,900
Electricity	$24,000
Other	$18,000
Total	$174,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 104	92	85%	**$ 98,032**
Public/Commerc	$ 114.91	21	100%	**$ 28,958**
School Service (	$ 5,223.34	1	100%	**$ 47,010**
Local Capital Contribution				**$ -**
Total Revenue				**$ 174,000**

Tuntutuliak, Alaska

Community Information & Existing Infrastructure

Tuntutuliak is a Yupik Eskimo community of 437 people located on the Qinaq River, approximately 3 miles from its confluence with the Kuskokwim River. There are 105 residential units, 19 commercial/public facilities and one school for a total of 125 services. The existing water and sewer services provided in Tuntutuliak consist of self-haul system from either the watering point attached to the washeteria or rainwater/ice collection, and pit privies/honey bucket bunkers. The existing water and sewer infrastructure consists of the following:

- Well – 12 gpm
- Treated Water Storage – 20,000 gallons
- Water Treatment Plant – 2,240 SF, built in 1983, Upgraded in 2015
- Water Treatment – Greensand filter, chlorine, potassium permanganate
- Sewage Lagoon – Single cell, 1.4 acre

Soils around Tuntutuliak consist of ice rich silt. High settlement in soil is anticipated if thawed due to high ice content and fine grained and organic materials.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 17,600 feet of pipe, and the pressure sewer system approximately 14,700 feet of pipe. The water system will consist of two separate systems for the east and west sides of the community. Each system will have a single circulating loop. The pressure sewer system would require one sewer main lift station, individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, two new 1200 sf facilities are included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	37	12	25
Water Storage (gallons)	243,300	20,000	223,300
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	9.3	1.4	7.9
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	5,390	-	5,390
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,600	-	17,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,700	-	14,700
Individual Grinder Pump Stations (GPS) (ea)	125	-	125
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,400	-	9,400
Pressure Sewer Service Lines (lf)	9,400	-	9,400

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Tuntutuliak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Tuntutuliak	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	125	$26,342.77	$3,292,847
3	Sewage collection mains or services (gravity or force), above ground	LF	24,100	$194.96	$4,698,582
4	Sewage lift station	EA	1	$ 662,130.80	$ 662,131
10	Sewage lagoon, barrow, local material	Acre	7.9	$683,500.68	$5,399,655
12	Water distribution, mains or services, above ground	LF	27,000	$327.06	$8,830,671
14	Water storage tank, no foundation	Gal	223,300	$2.49	$556,081
15	Water treatment plant, no foundation	SF	2,400	$1,583.60	$3,800,638
18	Foundation - freeze back piles	SF	5,390	$299.51	$1,614,365
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$29,009,000**
				Total with Inflation (3% per year for 6 years)	**$34,638,300**
27	Individual Grinder Pump Stations	EA	125	$30,000	$3,750,000
28	Electrical Service Upgrades	EA	125	$5,500	$687,500
				Subtotal	**$39,075,800**
29	Construction Contingency (15%)	LS	1	$5,861,400	$5,861,400
30	Design & Construction Administration Services (20%)	LS	1	$7,815,200	$7,815,200
				Total	**$52,752,400**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$25,000
Fuel	$97,600
Electricity	$31,600
Other (R&R, Training, etc.)	$18,300
Total	**$179,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Tuntutuliak are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 98	105	85%	**$ 105,485**
Public/Commercial Service	$ 128	19	100%	**$ 29,193**
School Service	$ 4,925	1	100%	**$ 44,322**
Local Capital Contribution				**$ -**
Total Revenue				**$ 179,000**

EXISTING SEWAGE LAGOON

LIFT STATION

SCHOOL SEWAGE LAGOON

KELUQLIQ
NANVAQ

PROPOSED WATER
TREATMENT PLANT
AND NEW WELL

SCHOOL

KINAK RIVER

WATER TREATMENT
PLANT/WASHETERIA

COMMUNITY WELL

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

250' 0 250' 500'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF
UNSERVED COMMUNITIES

TUNTUTULIAK

DATE
MAR 2015

SCALE
GRAPHIC

FIGURE
36

File: J:\Jobsdata\31303.00 VSW – Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Tuntitutuliak.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/20/2016
Community	Tuntutuliak
Input	

Existing Community & System Data

2015 Population	437
2015 Number of Services	125
HITS Database (E1 & H1-H7)	105
DCED Mapping Commerical/Public Facilities/School	20
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	20000
Water Treatment Capacity	12
Existing Sewage Lagoon Size	1.4

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	14700	17600
Gravity Sewer Main			
Pressure Sewer Main	x	14700	
Typical Service Line Length (ea)		75	75

Piped System Requirements — **Community:** **Tuntutuliak**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**37**	
Req Water Storage (gallons) (less existing)	**223,300**	**2,990 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**2,400**	**2,400 sf**
Req Sewage Lagoon Size (acre) (less existing)	**7.9**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**2,400**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**17,600**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**14,700**	
	Individual Grinder Pump Stations (GPS) (ea)	**125**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**9,400**	
	Pressure Sewer Service Lines (lf)	**9,400**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	37	12	25
Water Storage (gallons)	243,300	20,000	223,300
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	2,400	-	2,400
Sewage Lagoon Size (acre)	9.3	1.4	7.9
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	5,390	-	5,390
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	17,600	-	17,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	14,700	-	14,700
Individual Grinder Pump Stations (GPS) (ea)	125	-	125
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,400	-	9,400
Pressure Sewer Service Lines (lf)	9,400	-	9,400

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/20/2016

Community Tuntutuliak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	437	people	2015 ADOL
2015 Number of Services	125	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***533***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	12	gpm	
Average Day (ADD)	26,661	gpd	50 gallons per Capita
Max Day (MDD)	53,322	gpd	2 x ADD
Peak Hour	111	gpm	3 x MDD
Treatment Capacity	***37***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	37	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	20,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	53,322	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	159,967	gallons	3 days x DO
Water Storage Tank Volume	243,289	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	188,894	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***243,300***	***gallons***	
Required Additional Storage	***223,300***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***2,990***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	x	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	0		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	0		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	0		Static Water Mains
Above ground system or buried with permafrost	x	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	0		Bare sewer main, no heat trace
Above ground or buried with permafrost	x	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	0		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	x	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	0		Static Water Service Line
Circulating Water Main	x	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	0		Gravity Service Line
Pressure Sewer Main	x	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	1.4	acres	
Organic Loading Based Size	4.5	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	360.7		
Hydraulic Loading Based Size	9.3	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***9.3***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Tuntutuliak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	125	$26,342.77	$3,292,847
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	24,100	$194.96	$4,698,582
4	Sewage lift station	EA	1	$662,130.80	$662,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	7.9	$683,500.68	$5,399,655
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	27,000	$327.06	$8,830,671
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	223,300	$2.49	$556,081
15	Water treatment plant, no foundation	SF	2,400	$1,583.60	$3,800,638
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	5,390	$299.51	$1,614,365
19	Foundation - thermosyphen stablized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$29,008,567**

O&M Cost Estimate
Piped Water & Sewer System

Community: Tuntutuliak

General Community Data

Current population	437	persons
Average number of people per house	4.2	
Service Connections		
Number of houses	105	
Number of public/commerical buildings	19	
Number of schools	1	
Total number of service connections	125	
Burdened labor rate	$12	hr
Electricity cost (Public facilty)	$0.41	kWh
Electricity cost (Residential service)	$0.24	kWh
Cost per gallon for heating oil	$4.88	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	4640	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	243,300	gallons
Length of water line to/ from tank	100	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	17600	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	125	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	14700	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1800	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	40	hrs/week		$24,960
Fuel (Heating Demand)				
Water system				
WTP building	$1,156	/month		$9,251.47
Raw water line	$18	/month		$142.42
Raw water heat addition	$1,297	/month		$10,372.77
Water storage tank	$180	/month		$1,443.76
Water storage tank line	$18	/month		$142.42
Water mains	$3,133	/month		$25,066
Service lines	$1,669	/month		$13,352
Wastewater system				
Sewer mains	$2,617	/month		$20,935
Service lines	$1,669	/month		$13,352
Lift/pump station buildings	$125	/month		$996.93
Force main to lagoon	$320	/month		$2,564
			Subtotal	$97,600
Electricity				
Water system				
WTP building				
Lights and controls	$555	/month		$6,662
HVAC/hydronic system	$555	/month		$4,442
Water treatment	$136	/month		$1,634
Pumps				
Intake or well	$136	/month		$1,634.03
WST circulation	$55	/month		$443
Pressure/booster	$204	/month		$2,451.05
Main line circulation	$881	/month		$7,045
Wastewater system				
Lift /pump station buildings				
Lights and controls	$60	/month		$718
HVAC/hydronic system	$60	/month		$479
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$195	/month		$2,334.33
Sewer/force main glycol circulation	$220	/month		$1,758
Lagoon discharge pump	$1,962	/year		$1,962
			Subtotal	$31,600
Other Costs				
Equipment R&R	$7,708	/year		$7,708
Miscellaneous materials & supplies	$4,625	/year		$4,625
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$18,300

Summary

Administration	$6,000
Labor	$25,000
Fuel	$97,600
Electricity	$31,600
Other	$18,300
Total	$179,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 98	105	85%	**$ 105,485**
Public/Commerc	$ 128.04	19	100%	**$ 29,193**
School Service ((	$ 4,924.62	1	100%	**$ 44,322**
Local Capital Contribution				**$ -**
Total Revenue				**$ 179,000**

Tununak, Alaska

Community Information & Existing Infrastructure

Tununak is a Yupik Eskimo community of 384 people located in a small bay on the northeast coast of Nelson Island. There are 99 residential units, 22 commercial/public facilities and one school for a total of 122 services. The existing water and sewer services provided in Tununak consist of self-haul system from watering points and honey buckets. There are two septic tanks in the community. One septic tank serves the water treatment plant/washeteria, school, and teacher housing. The second septic tank is used for the disposal of wastewater collected from haul system. The water treatment plant provides service to the washeteria and the clinic. The existing water and sewer infrastructure consists of the following:

- Unnamed Creek – N/A
- Treated Water Storage – 50,000 gallons
- Water Treatment Plant/Washeteria – 2,048 SF, built in 1980
- Water Treatment – Granular media filtration, bag filtration, chlorination
- Septic Tanks – 12,000 gallons (failing)
- Sewage Lagoon – N/A

The area around Tununak is underlain by discontinuous permafrost. Conditions vary considerably from toe of hill to vicinity of creek. There is a very high ice content in organic soils blanketing the area, and is very thaw unstable.

Piped System Description

The piped water and sewer system will be a combination of above and below grade piping. The lowland part of the community is flat terrain and would best be served by an above ground pressure sewer system (4,800 LF) and circulating water loop (9,300 LF). The upland part of the community is built on a hillside and can likely accommodate a buried gravity sewer system (5,100 linear feet) and circulating water main (5,800 LF). A total of 22 services will be connected to the buried gravity sewer will not require individual grinder pump stations (GPS). Approximately 100 homes and buildings on the lower portion of the community would require GPS units. The current water source is seasonal; however, many residents obtain drinking water from the school which uses a well. For the purposes of this assessment a new well is proposed. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The following table summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	33	-	33
Water Storage (gallons)	217,400	50,000	167,400
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Septic System (sf)	40,000	-	40,000
Required Foundation System for WTP and/or WST			
Pile foundation (sf)	3,520	-	3,520
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	15,100	-	15,100
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,900	-	9,900
Individual Grinder Pump Stations (GPS) (ea)	100	-	100
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,200	-	9,200
Pressure Sewer Service Lines (lf)	7,500	-	7,500
Gravity Sewer Service Lines (lf)	1,700	-	1,700

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Tununak. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Tununak	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	122	$26,342.77	$3,213,818
2	Sewage collection mains or services (gravity or force), buried	LF	6,800	$273.12	$1,857,230
3	Sewage collection mains or services (gravity or force), above ground	LF	12,300	$199.20	$2,450,128
4	Sewage lift station	EA	1	$662,130.80	$662,131
7	Septic tank, community	EA	2	$298,917.16	$597,834
8	Drainfield, community	SF	40000	$21.63	$865,249
12	Water distribution, mains or services, above ground	LF	16,800	$328.95	$5,526,373
13	Water distribution, mains or services, buried	LF	7,500	$297.51	$2,231,320
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
18	Foundation - freeze back piles	SF	3,520	$318.83	$1,122,279
23	Water source - ground water well	EA	1	$153,596.80	$153,597
				Total Estimated Cost in 2010 dollars (rounded):	**$20,610,000**
				Total with Inflation (3% per year for 6 years)	**$24,609,400**
27	Individual Grinder Pump Stations	EA	100	$30,000	$3,000,000
28	Electrical Service Upgrades	EA	122	$5,500	$671,000
				Subtotal	**$28,280,400**
29	Construction Contingency (15%)	LS	1	$4,242,100	$4,242,100
30	Design & Construction Administration Services (20%)	LS	1	$5,656,100	$5,656,100
				Total	**$38,178,600**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$23,300
Fuel	$118,000
Electricity	$22,200
Other (R&R, Training, etc.)	$19,100
Total	**$189,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Tununak are listed below:

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 109	99	85%	**$ 109,875**
Public/Commercial Service	$ 114	22	100%	**$ 30,162**
School Service	$ 5,440	1	100%	**$ 48,964**
Local Capital Contribution				**$ -**
Total Revenue				**$ 189,000**

TUNUNAK BAY

TUNUNAK RIVER

NORTH TUNUNAK RIVER

PROPOSED SEPTIC SYSTEM

BELOW GRADE PIPE SECTION

SCHOOL

WATER TREATMENT PLANT/WASHETERIA

LIFT STATION

CLINIC

ABOVE GRADE PIPE SECTION

UNNAMED CREEK

PROPOSED SEPTIC SYSTEM

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- PROPOSED LIFT STATION
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

150' 0 150' 300'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

TUNUNAK

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 37

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Tununak.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/22/2016
Community	Tununak
Input	

Existing Community & System Data

2015 Population	384
2015 Number of Services	122
HITS Database (E1 & H1-H7)	99
DCED Mapping Commerical/Public Facilities/School	23
Type (surface water or groundwater)	SW
Water quality (Poor or Good)	Poor
Water Storage Tank	50000
Water Treatment Capacity	0
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	x
Firm soils, or continuous permafrost	
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	9900	15100
Gravity Sewer Main	x	5100	
Pressure Sewer Main	x	4800	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Tununak**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**33**	
Req Water Storage (gallons) (less existing)	**167,400**	**2,320 sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Septic System w/ Drainfield (sf) (less existing)	**40,000**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Pile Foundation (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**15,100**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**9,900**	
	Lift Stations for Gravity Sewer Mains	**1**	
	Individual Grinder Pump Stations (GPS) (ea)	**100**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**9,200**	
	Gravity Sewer Service Lines (lf)	**1,700**	
	Pressure Sewer Service Lines (lf)	**7,500**	

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	33	-	33
Water Storage (gallons)	217,400	50,000	167,400
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	40,000	-	40,000
Required Foundation System for WTP and/or WST			
Pile Foundation (sf)	3,520	-	3,520
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	15,100	-	15,100
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	9,900	-	9,900
Individual Grinder Pump Stations (GPS) (ea)	100	-	100
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	9,200	-	9,200
Pressure Sewer Service Lines (lf)	7,500	-	7,500
Gravity Sewer Service (lf)	1,700	-	1,700

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/22/2016

Community Tununak

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	384	people	2015 ADOL
2015 Number of Services	122	services	Only 55 will require GPS units
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***469***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	0	gpm	
Average Day (ADD)	23,428	gpd	50 gallons per Capita
Max Day (MDD)	46,855	gpd	2 x ADD
Peak Hour	98	gpm	3 x MDD
Treatment Capacity	***33***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	33	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	50,000	gallons	Built in 2010
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	46,855	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	140,566	gallons	3 days x DO
Water Storage Tank Volume	217,421	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	165,984	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***217,400***	***gallons***	
Required Additional Storage	***167,400***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***2,320***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**x**	***Pile Foundation (sf)***	Pile Foundation
Firm soils, or continuous permafrost	**0**		Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	4.0	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	338.1		
Hydraulic Loading Based Size	8.2	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***8.2***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Tununak

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	122	$26,342.77	$3,213,818
2	Sewage collection mains or services (gravity or force), buried	LF	6,800	$273.12	$1,857,230
3	Sewage collection mains or services (gravity or force), above ground	LF	12,300	$199.20	$2,450,128
4	Sewage lift station	EA	1	$662,130.80	$662,131
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	2	$298,917.16	$597,834
8	Drainfield, community	SF	40,000	$21.63	$865,249
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	16,800	$328.95	$5,526,373
13	Water distribution, mains or services, buried	LF	7,500	$297.51	$2,231,320
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$1,608.15	$1,929,775
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	3,520	$318.83	$1,122,279
19	Foundation - thermosyphen stabilized gravel pad	SF	0	#DIV/0!	$0
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	1	$153,596.80	$153,597
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$20,609,734**

O&M Cost Estimate
Piped Water & Sewer System

Community: Tununak (Lowland)

General Community Data

Current population	384	persons
Average number of people per house	7.1	
Service Connections (Lowland)		
Number of houses	54	
Number of public/commerical buildings	19	
Number of schools	0	
Total number of service connections	73	
Burdened labor rate	$14	hr
Electricity cost (Public facilty)	$0.34	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.95	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))		
Length of raw water line		ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	Buried	
Water Treatment		
Size of water treatment plant building	3248	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	217,400	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main (Lowland)	9300	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains (North Side)	4800	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	565	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$23,296
Fuel (Heating Demand)				
Water system				
WTP building	$1,153	/month		$9,223.03
Raw water line	$0	/month		$0.00
Raw water heat addition	$1,623	/month		$19,471.56
Water storage tank	$230	/month		$1,837.29
Water storage tank line	$13	/month		$101.41
Water mains	$2,358	/month		$18,863
Service lines	$1,388	/month		$11,105
Wastewater system				
Sewer mains	$1,217	/month		$9,736
Service lines	$1,388	/month		$11,105
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$143	/month		$1,146
			Subtotal	$82,600
Electricity				
Water system				
WTP building				
Lights and controls	$322	/month		$3,867
HVAC/hydronic system	$322	/month		$2,578
Water treatment	$99	/month		$1,191
Pumps				
Intake or well	$99	/month		$1,190.71
WST circulation	$46	/month		$367
Pressure/booster	$149	/month		$1,786.06
Main line circulation	$365	/month		$2,921
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$91	/month		$729
Lagoon discharge pump	$1,430	/year		$1,430
			Subtotal	$16,100
Other Costs				
Equipment R&R	$6,100	/year		$6,100
Miscellaneous materials & supplies	$3,660	/year		$3,660
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$15,800

Summary (Lowland)

Administration	$6,000
Labor	$23,300
Fuel	$82,600
Electricity	$16,100
Other	$15,800
Total	$144,000

Summary (Lowland & Upland)

Administration	$6,000
Labor	$23,300
Fuel	$118,000
Electricity	$22,200
Other	$19,100
Total	$189,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 109	99	85%	**$ 109,875**
Public/Commerc	$ 114.25	22	100%	**$ 30,162**
School Service (	$ 5,440.41	1	100%	**$ 48,964**
Local Capital Contribution				**$ -**
Total Revenue				**$ 189,000**

O&M Cost Estimate
Piped Water & Sewer System

Community: Tununak (Upland)

General Community Data

Current population		persons
Average number of people per house	7.1	
Service Connections (South Side)		
Number of houses	45	
Number of public/commerical buildings	3	
Number of schools	1	
Total number of service connections	49	
Burdened labor rate	$14	hr
Electricity cost (Public facilty)	$0.34	kWh
Electricity cost (Residential service)	$0.20	kWh
Cost per gallon for heating oil	$6.95	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))		
Length of raw water line		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Treatment		
Size of water treatment plant building		sf
Raw water quality (Good or Poor)		
Water Storage		
Size of tank(s)		gallons
Length of water line to/ from tank		ft
Water line heated for freeze protection (Yes or No)		
Location of water line (Above ground (AG) or Buried)		
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	1	
Total length of Water Main	5800	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)		
Number of individual facility pump stations		
Number of community lift/pump stations	1	
Number of facilities served by lift/pump station #1	22	
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations		sf
Total length of sewer mains	5100	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	1	
Location of the mains (Above ground (AG) or Buried)	Buried	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	1167	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	Buried	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management		/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$0	/month		$0
Labor (WTP Operator)	24	hrs/week		$0
Fuel (Heating Demand)				
Water system				
WTP building	$0	/month		$0.00
Raw water line	$0	/month		$0.00
Raw water heat addition	$0	/month		$0.00
Water storage tank	$0	/month		$0.00
Water storage tank line	$0	/month		$0.00
Water mains	$882	/month		$10,588
Service lines	$559	/month		$6,709
Wastewater system				
Sewer mains	$776	/month		$9,310
Service lines	$559	/month		$6,709
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$178	/month		$2,130
			Subtotal	$35,400
Electricity				
Water system				
WTP building				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Water treatment	$0	/month		$0
Pumps				
Intake or well	$0	/month		$0.00
WST circulation	$0	/month		$0
Pressure/booster	$0	/month		$0.00
Main line circulation	$365	/month		$4,382
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$48	/month		$581.21
Sewer/force main glycol circulation	$91	/month		$1,093
Lagoon discharge pump	$0	/year		$0
			Subtotal	$6,100
Other Costs				
Equipment R&R	$2,075	/year		$2,075
Miscellaneous materials & supplies	$1,245	/year		$1,245
Water quality testing	$0	/year		$0
Operator training	$0	/year		$0
Insurance	$0	/year		$0
			Subtotal	$3,300

Summary (Upland)

Administration	$0	Covered in Lowland Estimate
Labor	$0	Covered in Lowland Estimate
Fuel	$35,400	
Electricity	$6,100	
Other	$3,300	
Total	$45,000	

Venetie, Alaska

Community Information & Existing Infrastructure

Venetie is a Gwich'in community of 186 people located on the north side of the Chandalar River. There are 76 residential units, 16 commercial/public facilities and one school for a total of 93 services. The existing water and sewer services provided in Venetie consist of self-haul system from the watering point attached to the water treatment plant and pit privies/honey bucket. The school, clinic, teacher housing have piped water and sewer services. The existing water and sewer infrastructure consists of the following:

- Well – 30 gpm
- Treated Water Storage – 428,000 gallons
- Water Treatment Plant – 1,536 SF, built in 1987, Upgraded in 2013
- Water Treatment – Bag filters, hypochlorite
- Sewage Lagoon – Three cell, 3.3 acre

Soils around Venetie generally consist of soft poorly drained soils with discontinuous permafrost. Sandy gravel underlies Venetie at depths of 3-7 feet and extends to depths of 30 feet or more.

Piped System Description

The piped water and pressure sewer system will be an above grade system. The water system will consist of approximately 25,900 feet of pipe, and the pressure sewer system approximately 16,000 feet of pipe. The water system will consist of three circulating loops. The pressure sewer system would require individual grinder pump stations at each house and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	16	30	-
Water Storage (gallons)	120,800	428,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	4.0	3.3	0.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	25,900	-	25,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	16,000	-	16,000
Individual Grinder Pump Stations (GPS) (ea)	93	-	93
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	7,000	-	7,000
Pressure Sewer Service Lines (lf)	7,000	-	7,000

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Venetie. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 27-30).

Estimated Capital Costs				Village: Venetie	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	93	$28,096.69	$2,612,992
3	Sewage collection mains or services (gravity or force), above ground	LF	23,000	$303.80	$6,987,444
10	Sewage lagoon, barrow, local material	Acre	0.7	$1,461,213.17	$1,022,849
12	Water distribution, mains or services, above ground	LF	32,900	$422.45	$13,898,753
15	Water treatment plant, no foundation	SF	1,200	$2,467.77	$2,961,322
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$691.55	$829,855
				Total Estimated Cost in 2010 dollars (rounded):	**$28,313,000**
				Total with Inflation (3% per year for 6 years)	**$33,807,200**
27	Individual Grinder Pump Stations	EA	93	$30,000	$2,790,000
28	Electrical Service Upgrades	EA	93	$5,500	$511,500
				Subtotal	**$37,108,700**
29	Construction Contingency (15%)	LS	1	$5,566,300	$5,566,300
30	Design & Construction Administration Services (20%)	LS	1	$7,421,700	$7,421,700
				Total	**$50,096,700**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$23,300
Fuel	$164,900
Electricity	$30,900
Other (R&R, Training, etc.)	$23,500
Total	**$249,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Venetie are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 180	76	85%	**$ 139,388**
Public/Commercial Service	$ 234	16	100%	**$ 44,880**
School Service	$ 7,192	1	100%	**$ 64,731**
Local Capital Contribution				**$ -**
Total Revenue				**$ 249,000**

VENETIE SLOUGH

CHANDALAR RIVER

SCHOOL

WATER TREATMENT PLANT/WASHETERIA

LITTLE LAKE (DRIED UP)

EXISTING COMMUNITY WELL

SEWAGE LAGOON

LEGEND:

- PROPOSED WATER MAIN (W)
- PROPOSED SEWER/FORCE MAIN (S)
- EXISTING PUBLIC STRUCTURE SHOWN ON DCRA MAP
- EXISTING RESIDENTIAL STRUCTURE SHOWN ON DCRA MAP
- HOME ADDITION FROM HITS MAP

N

250' 0 250' 500'

CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

VENETIE

DATE: MAR 2015

SCALE: GRAPHIC

FIGURE: 38

File: J:\Jobsdata\31303.00 Vsw - Assessment Of Unserved Communities\00 CADD\01 Working Set\01 Civil\31303.00 Venetie.dwg

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	4/22/2016
Community	Venetie
Input	

Existing Community & System Data	
2015 Population	186
2015 Number of Services	93
HITS Database (E1 & H1-H7)	76
DCED Mapping Commerical/Public Facilities/School	17
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	428000
Water Treatment Capacity	30
Existing Sewage Lagoon Size	3.3
Soil Conditions (check only one)	
Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	16000	25900
Gravity Sewer Main			
Pressure Sewer Main	x	16000	
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Venetie**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**16**	
Req Water Storage (gallons) (less existing)	**-**	**- sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200 sf**
Req Sewage Lagoon Size (acre) (less existing)	**0.7**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**25,900**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**16,000**	
	Individual Grinder Pump Stations (GPS) (ea)	**93**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**7,000**	
	Pressure Sewer Service Lines (lf)	**7,000**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	16	30	-
Water Storage (gallons)	120,800	428,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Sewage Lagoon Size (acre)	4.0	3.3	0.7
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	25,900	-	25,900
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	16,000	-	16,000
Individual Grinder Pump Stations (GPS) (ea)	93	-	93
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	7,000	-	7,000
Pressure Sewer Service Lines (lf)	7,000	-	7,000

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 4/22/2016

Community Venetie

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	186	people	2015 ADOL
2015 Number of Services	93	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***227***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	30	gpm	
Average Day (ADD)	11,348	gpd	50 gallons per Capita
Max Day (MDD)	22,696	gpd	2 x ADD
Peak Hour	47	gpm	3 x MDD
Treatment Capacity	***16***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	16	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	428,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	22,696	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	68,087	gallons	3 days x DO
Water Storage Tank Volume	120,782	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	80,399	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***120,800***	***gallons***	
Required Additional Storage	-	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	-	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**0**		Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**x**	***Individual Grinder Pump Stations (GPS) (ea)***	Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**0**		Gravity Service Line
Pressure Sewer Main	**x**	***Pressure Sewer Service Lines (lf)***	Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	3.3	acres	
Organic Loading Based Size	1.9	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	235.3		
Hydraulic Loading Based Size	4.0	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***4.0***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Venetie

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	93	$28,096.69	$2,612,992
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	23,000	$303.80	$6,987,444
4	Sewage lift station	EA	0	#DIV/0!	$0
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	0	#DIV/0!	$0
8	Drainfield, community	SF	0	#DIV/0!	$0
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0.7	$1,461,213.17	$1,022,849
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	32,900	$422.45	$13,898,753
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$2,467.77	$2,961,322
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$691.55	$829,855
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$28,313,215**

O&M Cost Estimate
Piped Water & Sewer System

Community: Venetie

General Community Data

Current population	186	persons
Average number of people per house	2.4	
Service Connections		
Number of houses	76	
Number of public/commerical buildings	16	
Number of schools	1	
Total number of service connections	93	
Burdened labor rate	$14	hr
Electricity cost (Public facilty)	$0.54	kWh
Electricity cost (Residential service)	$0.36	kWh
Cost per gallon for heating oil	$8.50	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source		
Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	1350	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Treatment		
Size of water treatment plant building	2736	sf
Raw water quality (Good or Poor)	Poor	
Water Storage		
Size of tank(s)	428,000	gallons
Length of water line to/ from tank	125	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	
Water Distribution		
Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	3	
Total length of Water Main	25900	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Collection		
Type of system (Gravity or Pressure)	Pressure	
Number of individual facility pump stations		
Number of community lift/pump stations		
Number of facilities served by lift/pump station #1		
Number of facilities served by lift/pump station #2		
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	16000	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	3	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft
Wastewater Treatment / Disposal		
Length of force main	435	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Lagoon discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$23,296
Fuel (Heating Demand)				
Water system				
WTP building	$1,188	/month		$9,501.84
Raw water line	$419	/month		$3,348.86
Raw water heat addition	$961	/month		$7,689.98
Water storage tank	$553	/month		$4,423.81
Water storage tank line	$39	/month		$310.08
Water mains	$8,031	/month		$64,249
Service lines	$2,163	/month		$17,302
Wastewater system				
Sewer mains	$4,961	/month		$39,690
Service lines	$2,163	/month		$17,302
Lift/pump station buildings	$0	/month		$0.00
Force main to lagoon	$135	/month		$1,079
			Subtotal	$164,900
Electricity				
Water system				
WTP building				
Lights and controls	$431	/month		$5,174
HVAC/hydronic system	$431	/month		$3,449
Water treatment	$76	/month		$916
Pumps				
Intake or well	$76	/month		$916.01
WST circulation	$73	/month		$583
Pressure/booster	$115	/month		$1,374.02
Main line circulation	$1,740	/month		$13,919
Wastewater system				
Lift /pump station buildings				
Lights and controls	$0	/month		$0
HVAC/hydronic system	$0	/month		$0
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$0	/month		$0.00
Sewer/force main glycol circulation	$434	/month		$3,473
Lagoon discharge pump	$1,100	/year		$1,100
			Subtotal	$30,900
Other Costs				
Equipment R&R	$10,955	/year		$10,955
Miscellaneous materials & supplies	$6,573	/year		$6,573
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$23,500

Summary

Administration	$6,000
Labor	$23,300
Fuel	$164,900
Electricity	$30,900
Other	$23,500
Total	$249,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 180	76	85%	**$ 139,388**
Public/Commerc	$ 233.75	16	100%	**$ 44,880**
School Service (	$ 7,192.37	1	100%	**$ 64,731**
Local Capital Contribution				**$ -**
Total Revenue				**$ 249,000**

Wales, Alaska

Community Information & Existing Infrastructure

Wales is a Kinugmiut Eskimo community of 146 people located on Cape Prince of Wales, at the western tip of the Seward Peninsula. There are 58 residential units, 9 commercial/public facilities and one school for a total of 68 services. The existing water and sewer services provided in Wales consist of self-haul system from the watering point attached to the washeteria and honey buckets. The school, teacher's housing, clinic, and the old city office has piped water service. The existing water and sewer infrastructure consists of the following:

- Well – 40 gpm
- Treated Water Storage – 500,000 gallons
- Water Treatment Plant – 2,912 SF, built in 1979
- Water Treatment – No treatment
- Sewage Lagoon – N/A

Soils around Wales consist of soft poorly drained soils near the beach and firm soils away from the beach area. Geotechnical explorations along the beach identified permafrost approximately 20-25 feet below ground surface.

Piped System Description

The piped water and sewer system will be an above ground system. The community is located in an area that is archeologically sensitive, and therefore would greatly increase the capital costs if the system was buried. The water system will consist of approximately 10,600 feet of pipe, and the gravity sewer system approximately 5,600 feet of pipe. The water system will consist of two circulating loops. The gravity sewer system would require two sewer main lift stations, and glycol heat trace for freeze protection. Additionally, it is assumed that approximately 75 feet of pipe would be required for each service line for both water and sewer services. For the purposes of this assessment, a new 1,200 sf facility is included to house the equipment needed for additional treatment, water distribution and wastewater collection equipment.

The table below summarizes the results of the Piped System Model. The full model output is attached to this assessment.

Piped System Analysis Model Results

System Description	Piped System Need	Existing Facility	Net Need
Water Treatment Capacity (gpm)	12	40	-
Water Storage (gallons)	101,300	500,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Septic System (sf)	20,000	-	20,000
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	10,600	-	10,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,600	-	5,600
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,100	-	5,100
Gravity Sewer Service Lines (lf)	5,100	-	5,100

Project Cost Summary

The following tables summarize the estimated capital and O&M costs for a piped system in Wales. The capital costs were determined using the State-provided capital cost model. Additional items not included in the cost model are noted below (items 28-30).

Estimated Capital Costs				Village: Wales	
Item No.	**Line Item Description**	**Unit**	**Estimated Quantity**	**Adjusted Unit Cost**	**Total Cost**
1	Household water and sewer plumbing	EA	68	$22,235.73	$1,512,030
3	Sewage collection mains or services (gravity or force), above ground	LF	10,700	$193.45	$2,069,913
4	Sewage lift station	EA	2	$581,420.38	$1,162,841
7	Septic tank, community	EA	1	$377,798.26	$377,798
8	Drainfield, community	SF	20000	$47.42	$948,482
12	Water distribution, mains or services, above ground	LF	15,700	$291.75	$4,580,451
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$499.91	$599,886
				Total Estimated Cost in 2010 dollars (rounded):	**$13,010,000**
				Total with Inflation (3% per year for 6 years)	**$15,534,600**
28	Electrical Service Upgrades	EA	68	$5,500	$374,000
				Subtotal	**$15,908,600**
29	Construction Contingency (15%)	LS	1	$2,386,300	$2,386,300
30	Design & Construction Administration Services (20%)	LS	1	$3,181,700	$3,181,700
				Total	**$21,476,600**

The O&M Costs were estimated based on the current population and community and system specific assumptions. Note that O&M costs are largely dependent on labor, fuel and electricity costs which can be highly variable. The assumptions and model results of both the cost models are included with this assessment.

Estimated O&M Costs	
Description	**Cost**
Administration	$6,000
Labor	$30,000
Fuel	$78,100
Electricity	$29,000
Other (R&R, Training, etc.)	$17,000
Total	**$160,000**

The estimated user fees that would be needed to cover the costs of operating the proposed pipe system in Wales are listed below.

Estimated User Fees				
Revenue Source	**Monthly Rate**	**# of Customers**	**Collection Rate**	**Yearly Revenues**
Residential Service	$ 156	58	85%	**$ 92,474**
Public/Commercial Service	$ 234	9	100%	**$ 25,322**
School Service	$ 4,689	1	100%	**$ 42,204**
Local Capital Contribution				**$ -**
Total Revenue				**$ 160,000**

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date	9/6/2016
Community	Wales
Input	

Existing Community & System Data

2015 Population	146
2015 Number of Services	68
HITS Database (E1 & H1-H7)	58
DCED Mapping Commerical/Public Facilities/School	10
Type (surface water or groundwater)	GW
Water quality (Poor or Good)	Poor
Water Storage Tank	500000
Water Treatment Capacity	40
Existing Sewage Lagoon Size	0

Soil Conditions (check only one)

Soft poorly drained soils or discontinuous permafrost	
Firm soils, or continuous permafrost	x
Stiff soils, no permafrost	

Piping Configurations (check all that apply)		**Sewer Main Length (ft)**	**Water Main Length (ft)**
Buried system with no permafrost			
Above ground system or buried with permafrost	x	5600	10600
Gravity Sewer Main	x	5600	
Pressure Sewer Main			
Typical Service Line Length (ea)		75	75

Piped System Requirements **Community** **Wales**

Output for Cost Model (calculated)

		Foundation Size
Water Treatment Capacity (gpm)	**12**	
Req Water Storage (gallons) (less existing)	**(398,700)**	**-** **sf**
Req W&S Utility Bldg/Water Treatment Plant/Addition (sf)	**1,200**	**1,200** **sf**
Req Septic System w/ Drainfield (sf) (less existing)	**20,000**	

		Quantity	Notes
Required Foundation System for WTP and/or WST	**Thermosyphon stabilized gravel pad (sf)**	**1,200**	
Water Distribution System			
	Circulating Water Main with Pitorifices (lf)	**10,600**	
Wastewater Collection System			
	Sewer Main with Glycol Heat Trace (lf)	**5,600**	
	Lift Stations for Gravity Sewer Mains	**2**	
Water & Sewer Service Lines			
	Circulating Water Service Lines (lf)	**5,100**	
	Gravity Sewer Service Lines (lf)	**5,100**	

System Description	**Piped System Need**	**Existing Facility**	**Net Need**
Water Treatment Capacity (gpm)	12	40	-
Water Storage (gallons)	101,300	500,000	-
W&S Utility Bldg/Water Treatment Plant/Addition (sf)	1,200	-	1,200
Septic System (sf)	20,000	-	20,000
Required Foundation System for WTP and/or WST			
Thermosyphon stabilized gravel pad (sf)	1,200	-	1,200
Water Distribution System			
Circulating Water Main with Pitorifices (lf)	10,600	-	10,600
Wastewater Collection System			
Sewer Main with Glycol Heat Trace (lf)	5,600	-	5,600
Water & Sewer Service Lines			
Circulating Water Service Lines (lf)	5,100	-	5,100
Gravity Sewer Service Lines (lf)	5,100	-	5,100

VSW Unserved Communities - Piped Water & Sewer System Type and Sizing Model

Date 9/6/2016
Community Wales

System Parameters	Model Results		Criteria & Calculations
Design Population			
Duration (n)	20	years	20 years
2015 Population (P)	146	people	2015 ADOL
2015 Number of Services	68	services	
Growth Rate (i)	1%		1%
2035 Design Population (Capita)	***178***	***people***	Px(1+i)^n
Water Demand Estimates			
Existing Capacity	40	gpm	
Average Day (ADD)	8,907	gpd	50 gallons per Capita
Max Day (MDD)	17,815	gpd	2 x ADD
Peak Hour	37	gpm	3 x MDD
Treatment Capacity	***12***	***gpm***	MDD
Water Source Assumptions			
Type (surface water or groundwater)	GW		
Required Capacity	12	gpm	MDD
Water Storage Tank Sizing			
Existing Water Storage Tank	500,000	gallons	
Demand Based Volume (if source is GW)	Applicable		
Daily Operation (DO) (gallons)	17,815	gallons	Max Day (MDDx1 day)
Fire Flow (FF)	30,000	gallons	500 gpm for 60 minutes
Reserve Volume (RV)	53,444	gallons	3 days x DO
Water Storage Tank Volume	101,259	gallons	DO + FF + RV
CT Based Volume (min if source is SW)	Not Required		
Chlorine Residual Concentration (RC)	0.4	mg/L	0.4 mg/L
Disinfection/Log Inactivation (LI)	1.0	log inactivation	1.0-log Inactivation
Temperature (T)	4.4	C	4.4 celsius/40 F
pH (PH)	7		7
Contact Time Required (CT)	49	minutes	LI x (5.057) x (e^-0.0693T)x(e^0.361PH)x(e^0.113RC)
Baffling Coefficient (BF)	0.1		0.1
Required Volume to meet CT*	63,109	gallons	CT/RCxPeak Hour/BF
Required Water Storage	***101,300***	***gallons***	
Required Additional Storage	***(398,700)***	***gallons***	0
Estimate of Min Platform Size (3' clearance around)	***-***	***sf***	D = 0.103xVg^(1/2) H=16 assumed (H is height of tank)
			0
Water Treatment Plant Requirements*			
Water Quality	Poor		Poor Water Quality (CF or DF) = 1200 sf
Minimum WTP Size	***1,200***	***sf***	Good Water Quality (no treatment other than CL) = 800 sf
Foundation (WST and WTP)			
Soft poorly drained soils or discontinuous permafrost	**0**		Pile Foundation
Firm soils, or continuous permafrost	**x**	***Thermosyphon stabilized gravel pad (sf)***	Thermosyphon stabilized gravel pad
Stiff soils, no permafrost	**0**		Gravel pad
Water Distribution (Check either or both)			
Buried system with no permafrost	**0**		Static Water Mains
Above ground system or buried with permafrost	**x**	***Circulating Water Main with Pitorifices (lf)***	Circulating Water Main with Pitorifices
Wastewater Collection (Check all that apply)			
Buried system with no permafrost	**0**		Bare sewer main, no heat trace
Above ground or buried with permafrost	**x**	***Sewer Main with Glycol Heat Trace (lf)***	Sewer main with glycol heat trace
Gravity Sewer Main	**x**	***Lift Stations for Gravity Sewer Mains, every 1,000 ft (ea)***	Lift stations for gravity sewer mains, every 1,000 ft
Pressure Sewer Main	**0**		Individual Grinder Pump Stations
Water & Sewer Services (Check all that apply)			
Static Water Main	**0**		Static Water Service Line
Circulating Water Main	**x**	***Circulating Water Service Lines (lf)***	Circulating Water Service Lines
Gravity Sewer Main	**x**	***Gravity Sewer Service Lines (lf)***	Gravity Service Line
Pressure Sewer Main	**0**		Pressure Service Line with GPS
Sewage Lagoon Size			
Existing Sewage Lagoon	0	acres	
Organic Loading Based Size	1.5	acres	0.17 lbs of BOD5 per capita day x Design Population / 20 lbs BOD5 per
check	208.5		
Hydraulic Loading Based Size	3.1	acres	Volume is based on ADDx365x20% factor to account for precipitation, Lagoon depth assumed to be 5 ft, berm slopes 3:1, Factor of 1.3 for top of berms (area to be fenced)
Two cell lagoon, combined acreage	***3.1***	***acres***	Either organic loading based or hydraulic, whichever is greater

Capital Cost Estimate
Piped Water & Sewer System

Village
Wales

Item No.	Line Item Description	Unit	Estimated Quantity	Adjusted Unit Cost	Total Cost
1	Household water and sewer plumbing	EA	68	$22,235.73	$1,512,030
2	Sewage collection mains or services (gravity or force), buried	LF	0	#DIV/0!	$0
3	Sewage collection mains or services (gravity or force), above ground	LF	10,700	$193.45	$2,069,913
4	Sewage lift station	EA	2	$581,420.38	$1,162,841
5	Vacuum sewer plant, no foundation	SF	0	#DIV/0!	$0
6	Septic tank, and drainfield, individual household	EA	0	#DIV/0!	$0
7	Septic tank, community	EA	1	$377,798.26	$377,798
8	Drainfield, community	SF	20,000	$47.42	$948,482
9	Utilidors, above ground, including water and sewer, mains or services	LF	0	#DIV/0!	$0
10	Sewage lagoon, barrow, local material	Acre	0	#DIV/0!	$0
11	Sewage ocean outfall	LF	0	#DIV/0!	$0
12	Water distribution, mains or services, above ground	LF	15,700	$291.75	$4,580,451
13	Water distribution, mains or services, buried	LF	0	#DIV/0!	$0
14	Water storage tank, no foundation	Gal	0	#DIV/0!	$0
15	Water treatment plant, no foundation	SF	1,200	$1,465.72	$1,758,867
16	Washeteria, no foundation	SF	0	#DIV/0!	$0
17	Foundation - conventional, local gravel material	SF	0	#DIV/0!	$0
18	Foundation - freeze back piles	SF	0	#DIV/0!	$0
19	Foundation - thermosyphen stabilized gravel pad	SF	1,200	$499.91	$599,886
20	Boardwalk	LF	0	#DIV/0!	$0
21	Road, local gravel source	LF	0	#DIV/0!	$0
22	Water source - surface water intake	EA	0	#DIV/0!	$0
23	Water source - ground water well	EA	0	#DIV/0!	$0
24	Solid waste site - closure, local material	Acre	0	#DIV/0!	$0
25	Solid waste site - development, local material w/ equipment	Acre	0	#DIV/0!	$0
26	Shop / Garage, no foundation, concrete floor	SF	0	#DIV/0!	$0

Total Estimated Cost: **$13,010,268**

O&M Cost Estimate
Piped Water & Sewer System

Community: Wales

General Community Data

Current population	146	persons
Average number of people per house	2.5	
Service Connections		
Number of houses	58	
Number of public/commerical buildings	9	
Number of schools	1	
Total number of service connections	68	
Burdened labor rate	$18	hr
Electricity cost (Public facilty)	$0.48	kWh
Electricity cost (Residential service)	$0.21	kWh
Cost per gallon for heating oil	$7.00	gal
Water consumption per capita	50	gpd
Wastewater generation per capita	50	gpd

Water & Sewer System Characteristics

Water Source

Type of system (Surface(SW) or Groundwater(GW))	GW	
Length of raw water line	6350	ft
Water line heated for freeze protection (Yes or No)	No	
Location of water line (Above ground (AG) or Buried)	AG	

Water Treatment

Size of water treatment plant building	4112	sf
Raw water quality (Good or Poor)	Poor	

Water Storage

Size of tank(s)	500,000	gallons
Length of water line to/ from tank	50	ft
Water line heated for freeze protection (Yes or No)	Yes	
Location of water line (Above ground (AG) or Buried)	AG	

Water Distribution

Type of system (Static or Circulating (Circ))	Circ	
Number of circulating water loops	2	
Total length of Water Main	10600	ft
Water mains heated for freeze protection (Yes or No)	Yes	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Collection

Type of system (Gravity or Pressure)	Gravity	
Number of individual facility pump stations		
Number of community lift/pump stations	2	
Number of facilities served by lift/pump station #1	21	
Number of facilities served by lift/pump station #2	45	
Number of facilities served by lift/pump station #3		
Number of facilities served by lift/pump station #4		
Number of facilities served by lift/pump station #5		
Size of lift stations	500	sf
Total length of sewer mains	5600	ft
Sewer mains heated for freeze protection (Yes or No)	Yes	
Number of circulating glycol loops	2	
Location of the mains (Above ground (AG) or Buried)	AG	
Average service line length	75	ft

Wastewater Treatment / Disposal

Length of force main	100	ft
Force main heated for freeze protection (Yes or No)	Yes	
Location of force main (Above ground (AG) or Buried)	AG	
Septic system discharged seasonally with pump (Yes or No)	Yes	

O&M Cost Estimate
Piped Water & Sewer System

Operation & Maintenance Cost Assumptions

Administration		
Billing, CCR and management	$500	/month
Labor (Operator)		
Hours per week		
Less than 50 services	24	hrs/week
Between 50 and 100 services	32	hrs/week
More than 100 services	40	hrs/week
Fuel (Heating)		
Available energy per gallon of heating fuel	100,000	BTUs/gallon
Heating season (above ground components)	8	months
Heating season (buried components)	12	months
Buildings	7	BTU/hr/sf
Raw water heat addition (5F)	40	BTU/gallon
Water storage tank	0.5	BTU/gal-day
Above ground mains	5	BTU/hr/ft
Buried mains (permafrost conditions)	3	BTU/hr/ft
Electricity		
WTP building		
Lights and controls	0.4	watts/hr/sf
HVAC/hydronic system	0.4	watts/hr/sf
Water treatment		
Good quality water	0.1	watts/gallon
Poor quality water	0.5	watts/gallon
Water system pumps		
Intake or well	0.5	watts/gallon
WST circulation	135	kWh/month
Pressure/booster	0.75	watts/gallon
Main line circulation	1074	kWh/month/loop
Sewer system pumps		
Individual facility pump stations	0.7	watts/gallon/service
Community lift stations	0.6	watts/gallon
Sewer main glycol circulation	268	kWh/month/loop
Force main	0.6	watts/gallon
Lagoon discharge	0.6	watts/gallon
Other Costs		
Equipment R&R	5	% of labor, fuel and electricity
Miscellaneous materials & supplies	3	% of labor, fuel and electricity
Water quality testing	$2,000	per year
Operator training	$2,500	per year
Insurance	$1,500	per year

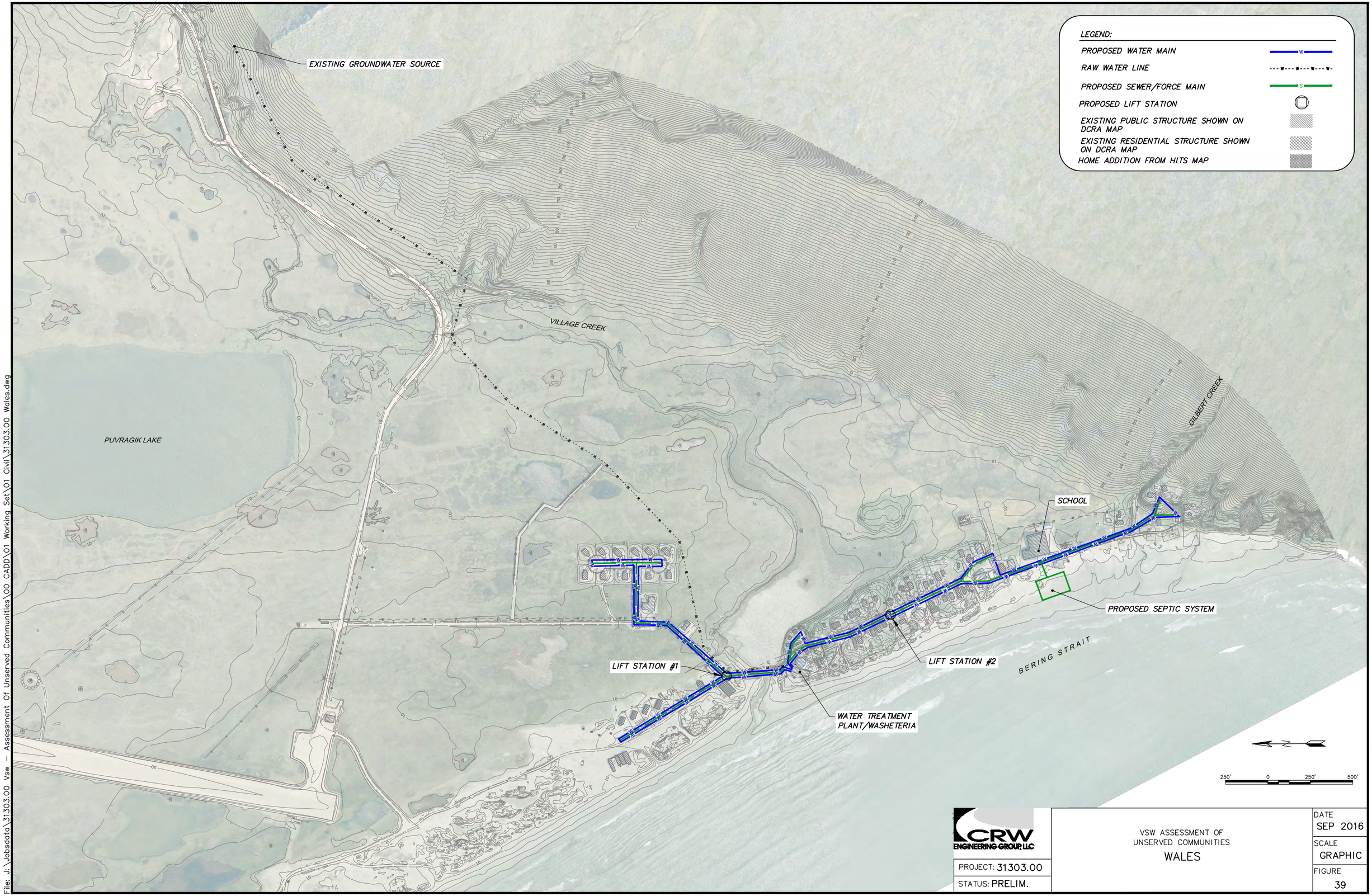
O&M Cost Estimate
Piped Water & Sewer System

Estimated O& M Costs				Annual Cost
Administration (Utility management, billings, etc.)	$500	/month		$6,000
Labor (WTP Operator)	32	hrs/week		$29,952
Fuel (Heating Demand)				
Water system				
WTP building	$1,470	/month		$11,760.45
Raw water line	$0	/month		$0.00
Raw water heat addition	$621	/month		$4,971.01
Water storage tank	$532	/month		$4,256.00
Water storage tank line	$13	/month		$102.14
Water mains	$2,707	/month		$21,655
Service lines	$1,302	/month		$10,419
Wastewater system				
Sewer mains	$1,430	/month		$11,440
Service lines	$1,302	/month		$10,419
Lift/pump station buildings	$358	/month		$2,860.03
Force main to lagoon	$26	/month		$204
			Subtotal	$78,100
Electricity				
Water system				
WTP building				
Lights and controls	$576	/month		$6,912
HVAC/hydronic system	$576	/month		$4,608
Water treatment	$53	/month		$639
Pumps				
Intake or well	$53	/month		$639.13
WST circulation	$65	/month		$518
Pressure/booster	$80	/month		$958.69
Main line circulation	$1,031	/month		$8,248
Wastewater system				
Lift /pump station buildings				
Lights and controls	$140	/month		$1,681
HVAC/hydronic system	$140	/month		$1,121
Pumps				
Individual facility pump stations	$0	/month		$0
Community lift/pump station(s)	$73	/month		$872.74
Sewer/force main glycol circulation	$257	/month		$2,058
Lagoon discharge pump	$767	/year		$767
			Subtotal	$29,000
Other Costs				
Equipment R&R	$6,853	/year		$6,853
Miscellaneous materials & supplies	$4,112	/year		$4,112
Water quality testing	$2,000	/year		$2,000
Operator training	$2,500	/year		$2,500
Insurance	$1,500	/year		$1,500
			Subtotal	$17,000

Summary

Administration	$6,000
Labor	$30,000
Fuel	$78,100
Electricity	$29,000
Other	$17,000
Total	$160,000

Revenue Source	Monthly Rate	# of Customers	Collection Rate	Yearly Revenues
Residential Serv	$ 156	58	85%	**$ 92,474**
Public/Commerc	$ 234.47	9	100%	**$ 25,322**
School Service (	$ 4,689.33	1	100%	**$ 42,204**
Local Capital Contribution				**$ -**
Total Revenue				**$ 160,000**



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CRW ENGINEERING GROUP, LLC

PROJECT: 31303.00

STATUS: PRELIM.

VSW ASSESSMENT OF UNSERVED COMMUNITIES

WALES

DATE SEP 2016

SCALE GRAPHIC

FIGURE 39