CITY AND BOROUGH OF WRANGELL, ALASKA

WATER TREATMENT PLANT UPGRADES PROJECT

PRELIMINARY ENGINEERING REPORT

March 2017

USDA

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The City and Borough of Wrangell

City and Borough of Wrangell

Preliminary Engineering Report

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The technical material and data contained in this report were prepared under the supervision and direction of the undersigned whose seal as a Professional Engineer is affixed below.

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Acronyms and Abbreviations

%	percentage
˚F	degree Fahrenheit
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADD	average daily demand
AOC	"assimilable" organic carbon
APDES	Alaska Pollutant Discharge Elimination System
ATV	all-terrain vehicle
BDOC	"biodegradable" DOC
$CaCO_3$	calcium carbonate
CBW	City and Borough of Wrangell
CRW	CRW Engineering Group, LLC
DAF	Dissolved Air Flotation
DBPs	disinfection byproducts
DOC	Dissolved Organic Carbon
EPA	Environmental Protection Agency
ft	feet
FY	fiscal year
GAC	granular activated carbon
gpcd	gallons per capita per day
gpm	gallons per minute
gpm/sf	gallons per minute per square foot
HAA_5	five Haloacetic Acids
HDPE	high density polyethylene
kW	kilowatt
MCL	maximum contaminant level
MDD	max daily demand
mgd	million gallons per day
mg/L	milligrams per liter
NPV	net present value
NTU	nephelometric turbidity units
O&M	operation and maintenance
PER	Preliminary Engineering Report
psig	pounds per square inch gauge
SUVA	Specific UVA
SWTR	Surface Water Treatment Rule
TOC	Total Organic Carbon
TTHM	Total Trihalomethanes
USACE	U.S. Army Corps of Engineers
USDA-RD	U.S. Department of Agriculture, Rural Development
USPW	uniform series present worth factor
UVA_{254}	Ultraviolet absorbance at 254 nm
WST	water storage tank
WTP	water treatment plant
WWTP	waste water treatment plant

1 Introduction

The City and Borough of Wrangell (CBW), in cooperation the U.S. Department of Agriculture, Rural Development (USDA-RD) has retained CRW Engineering Group, LLC (CRW) to provide engineering services related to improving the community's water treatment plant (WTP). The CBW currently operates a Community Public Water System (PWSID # AK2120143) using a surface water source under the requirements of the U.S. Environmental Protection Agency (EPA) surface water treatment rules.

This Preliminary Engineering Report (PER) has been written in accordance with the USDA-RD's Bulletin for water and sewer facilities and evaluates project need, existing conditions, and reasonable alternatives.

2 Project Planning

2.1 Location

Wrangell is located on the northwest side of Wrangell Island, south of Juneau and northwest of Ketchikan (Figure 1). The community is located near the mouth of the Stikine River, which historically was a trade route to the Canadian interior. Access to the community is by air or water. A state-owned, paved, lighted runway allows for jet service. There are three harbors for recreational and commercial vessels with a deep draft dock, state ferry terminal, and three boat launches.

2.2 Environmental Resources Present

2.2.1 History and Culture Summary

Wrangell is one of the oldest non-Native settlements in Alaska. In 1811, the Russians began fur trading with area Tlingits and built a stockade named Redoubt St. Dionysius in 1834. In the late 1800s, the community served as an outpost for gold prospectors. The City was incorporated in 1903. In the early 1900s, fishing and forest products were the primary industries. Recently, tourism and growth in the seafood processing and marine services industries have become important economic activities. On May 30, 2008, the City was dissolved and reincorporated as the CBW.[1]

2.2.2 Climate and Weather

The community is within the southeast maritime climate zone, which is characterized by cool summers, mild winters, and heavy rain throughout the year. Fog is common from September through December. The average annual temperature is 49 degrees Fahrenheit (^{o}F). Temperature, precipitation, and snowfall data is presented in Table 1.

Table 1 – Climate Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	33.9	37.7	42	49.1	56.3	61.7	64	63.5	57.7	49.4	41.1	36.4	49.4
Average Min. Temperature (F)	24.7	27.7	30.8	35.3	41.1	46.5	49.8	49.7	45.9	39.2	32.1	27.6	37.5
Average Total Precipitation (in.)	6.71	5.72	5.49	4.65	4.21	3.93	4.88	5.98	9.62	13.32	9.08	7.92	81.51
Average Total Snow Fall (in.)	18.4	12.4	7.9	0.8	0	0	0	0	0	0.1	5.8	12.6	58
Average Snow Depth (in.)	4	5	1	0	0	0	0	0	0	0	1	3	1

Source: Western Regional Climate Center, Period of Record: 11/01/1917 to 02/19/2013
Key: in. = inches

[1] Alaska Department of Commerce, Community, and Economic Development (DCCED). 2016. Community Database Online. Division of Community and Regional Affairs, State of Alaska.

2.2.3 Topography

Wrangell Island lies in the foothills of the Coastal Range. Topography is dominated by blocks of mountains separated by valleys and straits.

2.2.4 Geology and Soil Conditions

The bedrock on Wrangell Island is characterized by sedimentary (marine greywacke, mudstone, and limestone), andesitic to volcanic rocks, and intrusive rocks (plutons, batholiths of granodiorite, tonalite, and subordinate quartz diorite). Inland areas may be covered with surficial deposits up to 30 feet deep. The primary surficial materials are beach, alluvial, and glacial deposits.[2]

2.2.5 Flood, Erosion, and Seismic Hazards

The community does not have a history of waterfront flooding. A storm on October 26, 1978, caused some waterfront damage due to a combination of high winds and tide cycle. Riprapping of exposed land formations has provided flood protection along Zimovia Strait and the Eastern Passage.

Wrangell Island lies within the circum-Pacific seismic belt. The Chatham Strait Fault, Fairweather Fault, and numerous smaller faults traverse the area.

2.2.6 Vegetation and Wetlands

The predominant vegetation on Wrangell Island is coastal western hemlock-Sitka spruce forest. Sitka spruce, western hemlock, and Alaska yellow cedar characterize the overstory; blueberry, five-leaved bramble, single delight, skunk cabbage, and mosses comprise the understory. Sub-tidal wetlands exist throughout the island, comprised of silverweed, hair grass, yarrow, buttercup, and sedges. Above 2,000 feet, alpine vegetation consists of mountain hemlock, deer cabbage, heather, lichen, berries, and willow.

2.2.7 Surface Hydrology

Wrangell Island is characterized by small, steep, coastal watersheds. Two earthfill dams and reservoirs on Mill Creek provide the water supply for the CBW. The Stikine River delta is located north of Wrangell island. The drainage area for the Stikine River is approximately 20,000 square miles (mi^2) and the average flow during the summer is about 116,000 cubic feet per second (cfs).

2.2.8 Historic Sites

St. Philip's Episcopal Church (AHRS Site No. PET-315), built in 1903 and located at 446 Church Street, is on the National Registrar of Historical Sites.

2.3 Population Trends

According to the U.S. Census Bureau, the estimated population of CBW for year 2014 is 2,364. From 2000 to 2014, the population increased by a total of 2.6%, an average of 0.3% per year. To accommodate the possibility of future growth, an annual population increase of 0.8% is assumed for the next 20 years [3]. Using this growth rate, the future population of CBW would be 2772.

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[2] U.S. Geological Survey (USGS). 1995. Overview of Environmental and Hydrogeological Conditions of Wrangell, Alaska.

[3] This growth rate is the same forecasted as an average rate for the State of Alaska for the same timeframe. The 20-year period is assumed to begin in 2017, which, for the purposes of this report, is the assumed year that water treatment improvements would be ready for CBW use.

2.4 Community Engagement

The following community meetings were held by CBW regarding the WTP upgrades:

- *February 18, 2016* – Borough Assembly Meeting to review evaluation methods for improving the treatment process used at the CBW WTP. Described CRW's desktop assessment and the five alternates analyzed for pilot study, as well as each alternative's estimated capital and operating costs. Received the Assembly's concurrence with the recommended testing alternative, the Dissolved Air Flotation (DAF) system.
- *July 19, 2016* – Town Hall Meeting with the Borough Assembly to discuss the treated water shortage crisis, due to the WTP's inability to treat water fast enough to keep up with the water demand. Community members and business owners, including both seafood processors, were present. The Borough Assembly issued a declaration of local disaster and emergency, and water conservation measures were established, seafood processors discussed ways in which they could modify their potable water usage, and ideas for short-term WTP improvements were reviewed.
- *July 26, 2016* – Borough Assembly meeting in which the WTP's capacity was on the Borough Assembly's agenda. Public Work Director and Borough Manager provided an update regarding completing the pilot study and aggressively pursuing recommendations from the pilot testing project.

3 Existing Sanitation Facilities

3.1 History and Condition of Existing Facilities

Principal components of the existing facility and water treatment process are described in the following subsections and shown on Figure 2. A diagram of the existing water treatment process is shown on Figure 3.

3.1.1 Water Source

CBW's surface water source is comprised of two mountain lakes—an upper and a lower reservoir. These lakes are located east of and above the WTP, the lower reservoir being about a quarter mile away, via gravel road (Figure 2). The original wooden crib structures for the reservoir dams were constructed in 1900 for the lower dam and 1935 for the upper dam. The crib structures leaked badly and, as a result, earthen fill was placed over the crib structures in 1958. Additional improvements were later made to the dams in 1965. According to CBW, the upper reservoir has a storage volume of approximately 45,300,000 gallons. The lower reservoir has about 21,400,000 gallons of storage capacity.

Photo 1 Water Source

The upper reservoir is located about a half mile from the lower reservoir, and is fed by a forested watershed formed by an elevated valley between two mountain peaks. The upper reservoir is dammed and, through a submerged intake, flows into a small creek that feeds the lower reservoir. The spillway of the upper reservoir is elevated about 64 vertical feet above the lower reservoir spillway, which in turn is located about 34 feet above the control building floor elevation. The lower reservoir is also dammed, and features a submerged intake pipe that gravity-feeds raw water to the WTP via a 1,500 linear foot (LF), 12-inch diameter ductile iron and high density polyethylene (HDPE) pipeline. At the peak design flow of 900 gallons per minute (gpm), and accounting for friction losses in the pipeline, the pressure at the influent flow meter in the Control Building is calculated to be about 11 pounds per square inch gage (psig)[4]. The influent pipeline is valved so that the WTP could be entirely bypassed.

According to CBW staff, the reservoirs have thus far continuously supplied water to the community with no drought-related interruptions. Water levels fall during dry periods, which expose the reservoir's shoreline to increased erosion when rainfall resumes. This condition tends to increase turbidity levels in the raw water entering the WTP. Water levels tend to rise to spillway levels within a few days of when rainy weather returns. Two valves at the upper reservoir discharge pipe can increase the flow to the lower reservoir if the level of the lower reservoir falls below the spillway elevation during periods of high water usage.

The CBW reportedly has a watershed management plan. The CBW has not observed any algal growth in the reservoirs.

About 10 years ago, a piped bypass was planned for connecting the upper reservoir directly with the WTP for the purposes of improving water supply reliability, and for facilitating maintenance on the lower reservoir. This project was stopped due to wetlands permitting and funding concerns. The current

[4] *CBW WTP Operations and Maintenance Manual,* Wilson Engineering, Sept 1999.

process of filling the lower reservoir through the channel that connects the two reservoirs tends to increase turbidity as water flows to the lower reservoir. The piped connection of the two reservoirs would tend to increase water quality when the water is transferred from the upper reservoir to the lower. CBW currently has funding to complete the project and, pending completion of the design and permitting, anticipates construction to occur in 2018.

3.1.1.1 Raw Water Quality

CBW's raw water has elevated concentrations of organics, turbidity and color, which generally fall within the following ranges:

- Total organic carbon (TOC): 4 to 9 mg/L.
- Turbidity: 0.8 to 5 NTU.
- Color: 28 to 80 Platinum-Cobalt Color (Pt-Co) units.

The raw water also has a slightly elevated iron content, ranging between 0.4 and 1 mg/L. Raw water pH ranges between 5.4 in the colder seasons and 6.9 in the warmer seasons. Alkalinity is very low, generally ranging between 9 and 15 mg/L as $CaCO_3$.

Raw water samples were collected in July 2015 and tested for numerous contaminants. Laboratory testing results for principal contaminants and properties are summarized in Table 2.

Table 2 – July 2015 Raw Water Characteristics

Contaminant or Property	Units	Value	Limit
Turbidity	NTU	nm	1.49
Total Organic Carbon (TOC)	mg/L	5.3 – 6.4	n/a
Dissolved Organic Carbon (DOC)	mg/L	3.9 – 6.1	n/a
True Color	Pt-Co units	60	15
Iron	mg/L	1.0	0.3
Manganese	mg/L	0.1	0.05
pH	--	6.8	6.5 to 8.5
Alkalinity	mg/L as $CaCO_3$	9	n/a
Hardness	mg/L as $CaCO_3$	9	n/a
Total Dissolved Solids (TDS)	mg/L	34	500
Ultraviolet Absorbance (UVA_{254})	cm^{-1}	0.14 – 0.18	n/a
Specific UVA (SUVA)	L/mg-m	2.9 – 3.6	n/a

Key: NTU = nephelometric turbidity units.
Pt-Co = Platinum-Cobalt Color
nm = not measured in laboratory testing
n/a = not applicable
mg/L = milligrams per liter
$CaCO_3$ = calcium carbonate
cm^{-1} = reciprocal centimeters
mg/L-m = milligrams per liter - meter

In general, these water characteristics reflect the following implications:

- With the variants of the Surface Water Treatment Rule (SWTR), consistent turbidity removal and disinfection will be a principal focus of the water treatment process.
- With the Disinfectant/Disinfection Byproduct Rule, organics removal will also be an important emphasis of the treatment process.
- Color, iron, and manganese removal and pH adjustment will be needed to meet Secondary Contaminant objectives and provide acceptable palatability to customers.
- Low pH, hardness, and total dissolved solids indicate a corrosive tendency in the water, which is a concern addressed by the Lead and Copper Rule.
- Low alkalinity indicates a low capacity to accommodate the addition of strong acidic chemicals (like alum or ferric chloride as coagulants), which may significantly change the water chemistry.
- Relatively low ultraviolet absorbance (UVA_{254}),[5] and corresponding specific UVA_{254} (SUVA) values, suggest that the chemistry of organic matter is largely "hydrophilic" and not amenable to removal by typical coagulation/filtration methods.

These parameters are discussed in more detail in Appendix A.

Raw water turbidity, color, temperature, and pH are measured on a daily basis by CBW operating staff. Measurements taken from 2012 to 2015 were summarized into average values and graphed to discern general seasonal trends, which are summarized below. These graphs are provided in Appendix B.

- Turbidity tends to peak in August and September, with a smaller spike in May.
- Color tends to peak in August through November.
- Temperature tends to peak in June through September.
- pH tends to be highest in the summer months and lowest in the winter months.

3.1.2 Water Treatment Plant

Photo 2 Water Treatment Plant

The WTP was constructed in 1998 and is comprised of three buildings (Figure 2): the roughing filters building (44 feet (ft) by 44 ft), control building (44 ft by 44 ft), and slow sand filter building (165 ft by 77 ft). The buildings are rigid steel frame, bolted flange, pre-manufactured buildings, with galvanized cold-formed secondary structural members and pre-coated metal roofing. The roughing filter and slow sand filter beds are constructed of 4,000 pounds per square inch (psi) concrete. The process piping is primarily

[5] See Appendix C for a brief discussion of UVA_{254} and SUVA parameters.

flanged ductile iron, although the header piping for the slow sand filters is polyvinyl chloride (PVC). The building has a 600 amp, 480 volt, 3 phase electrical service.

3.1.2.1 Water Treatment Process

Gravity-fed raw water is received at the control building through a 12-inch influent pipeline comprised of HDPE and ductile iron pipe (Figure 3). CBW measures the flow rate of water as it enters the treatment process using a flow meter. An automated valve controls the influent flow by opening and closing proportionally to the level of treated water in the plant's storage tanks. The flow meter is also used to "flow-pace"[6] the injection of the following chemicals:

- Sodium hydroxide
- Ozone
- Sodium hypochlorite

The raw water is first injected with sodium hydroxide (caustic soda) to raise its pH to levels between 8 and 8.5. The purpose for this step is reportedly to improve the oxidation capabilities of ozone[7] and to reduce the corrosivity of the water. The dosage for this chemical generally ranges around 1 mg/L or less. Originally, the treatment design specified sodium carbonate (soda ash) to be used for this purpose, using a dosage of 8 mg/L, but CBW switched to using sodium hydroxide, probably as a cost savings measure. Sodium hydroxide is a corrosive chemical and, therefore, is hazardous to work with, whereas sodium carbonate is generally not hazardous. However, sodium hydroxide is a stronger basic chemical, and can cause pH changes with smaller dosages relative to sodium carbonate. At the dosages used by CBW, the use of sodium hydroxide does not significantly increase the water's alkalinity.

After the pH adjustment step, the raw water is treated with ozone (O_3) [8]. This is accomplished by flowing the raw water through a subsurface concrete tank having a volume of 9,000 gallons. At dosages of up to 10 mg/L (or 80 lbs/day), a 10% concentration of ozone is injected into the tank through an array of fine-bubble disk diffusers located on the tank floor and, being water-soluble, is taken up in the raw water. At the design peak flow rate of 900 gpm, the tank provides a nominal contact time of 10 minutes. Excess ozone that is off-gassed into the air chamber above the tank water is delivered to aboveground destructors that convert the ozone to oxygen, which is then discharged to the atmosphere.

After ozonation, the chemically-treated water is conveyed to two parallel roughing filters where it is up-flowed through a piped underdrain and coarse granular media to reduce its suspended solids content. At the peak flow rate of 900 gpm, the design loading rate on the roughing filters is 1.15 gpm per square foot area of media. The original design specified two layers of media: 1 millimeter (mm) sand particles overlying 4 mm "pea-gravel" particles. This media was reportedly used for a period of time before it was replaced by larger river gravel, because it reportedly clogged relatively fast and, as a result, could not meet water demands.

Filtered water exits the roughing filters above the media through a header-and-lateral piping system and into a splitter box, which distributes flow to downstream slow-sand filters. The roughing filter design also

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[6] "Flow-pace" means to speed up or slow down the chemical feed pump injection rates in proportion to the flow of the water passing through the pipeline. This is accomplished by electrical signals sent from the flow meter, through a controller to each connected feed pump.

[7] Higher pH levels tend to improve oxidation capabilities of ozone through the generation of hydroxyl ions, while lower dosages tend to improve its disinfection capabilities through the generation of longer lasting ozone molecules. CBW uses ozone primarily as an oxidant in its water treatment process.

[8] Ozone is generated using oxygen that is also generated on-site.

includes a "backwashing" feature. For this purpose, a pipeline connects the water storage tanks (WSTs) to the roughing filter. This connection is configured to allow potable water to be flowed downward through the filters and to a drainage sump that discharges to an exterior ditch.

Rough-filtered water is then conveyed to four 3,040 sf slow sand filters and flowed downward through 3.5 feet of sand media. As the water is flowed through the media, particulates are removed and dissolved solids are biologically treated. Over time after a filter cleaning, a sludge of microbes grows on the media surface (called *"schmutzdecke"*) where most of the biological treatment occurs. As treatment progresses, the filter gradually becomes clogged and the energy needed to drive the water through the media becomes greater. This energy need is exhibited by a growing depth of water that forms over the media surface. When the water depth (called "freeboard depth") approaches a maximum of 6 feet, the water in that particular filter is drained-to-waste to a level of about 1 foot above the media surface. Using an all-terrain vehicle (ATV) fitted with a disk harrow, CBW staff ploughs the *schmutzdecke* layer, which re-suspends the biomatter in the remaining freeboard water, and which is thereafter flushed out of the system as wastewater.

Water passing through the slow sand filters is collected in a central clearwell. The clearwell functions like a "storage tank" that supplies two booster pumps which lift treated water to two WSTs located above the WTP (Figure 2). The booster pumps are controlled by a sensor that measures the water level in the clearwell and operate in "lead-lag" fashion. When the water level in the clearwell is low, just the lead booster pump will operate. When the clearwell level is high, both pumps will operate in parallel.

Prior to reaching the WSTs, the filtered water is disinfected with sodium hypochlorite (i.e. "chlorine"). Sodium hypochlorite is generated at the WTP using water and salt in an electrolysis process. Using a saturator, CBW consumes an average of 50 lbs of salt per day for generating the sodium hypochlorite solution. Upon injection, the sodium hypochlorite readily inactivates bacteria and viruses, as well as reacts with any remaining "oxidizable" compounds in the filtered water. The disinfection process happens relatively quickly (in a matter of minutes to hours, depending on a number of variables in the water like pH, temperature, and microbial characteristics), but the oxidation process can continue indefinitely, as discussed in Section 3.1.3.

3.1.3 Water Storage and Distribution System

The distribution system is typically considered to include the WSTs and the piping network that extends to points of use for consumers and fire protection. Current water storage volume is approximately 0.85 million gallons, as provided by two aboveground tanks. To accommodate the design maximum daily demand (MDD) of 1.8 million gallons per day (mgd) (see Section 5.1.1.2) the system would need an additional 0.95 million gallons of storage.

The system is pressurized by virtue of the WSTs being located 328 feet above sea level. The available pressure at a particular location depends on the difference in elevation between the tank and the point of use (called "elevation head"), and how much energy loss is caused by pipe friction. CBW intentionally uses pressure-reducing valves to lower the pressure to usable levels in two zones. One ("high") pressure zone serves the upper elevations encompassing the downtown Wrangell area and allows up to 100 psig pressure. The other ("low") pressure zone serves the downtown area located next to the harbors with up to 70 psig pressure.

Hydrant testing reports from CBW in 2000 indicate that all but one hydrant in the system produced flow results that would exceed 1,000 gpm at 20 psig residual pressure, with the majority of the hydrants testing above 1,500 gpm at 20 psig. Residentially zoned one and two-family dwellings (Group R-3 and R-4) are typically required to have a minimum flow of 1,000 gpm at 20 psig residual pressure (per Appendix B of the 2015 International Fire Code). A copy of the testing results is provided in Appendix B.

The majority of the water distribution system is comprised of ductile iron pipe. The system has experienced widespread breaks and leaks over the past several years resulting in disruption of service, potential contamination of the water system, and road and property damage. CBW is currently pursuing funding for replacement of the water mains deemed to be in the worst condition.

This PER is focused on the water quality within the distribution system. The quality of this water is primarily affected by the water chemistry leaving the treatment process, the interior conditions of the WSTs and piping network, and the "residence time" of the water in the system. These aspects are discussed in the following section.

3.1.3.1 Distribution System Water Quality

The time that a particular quantity of water stays in the distribution system is called "residence" time, and significantly affects the quality of water used by consumers. The residence time spent in WSTs can be less than a day (when stored water volume is relatively small) to many months (as is the case for "fill and draw" systems [9]). Typically, the longer the residence time, the lower the water quality can become, because the water within the system has a longer time to be affected by on-going chemical reactions that occur in the distribution system.

One major type of chemical reaction that is common to distribution systems is the oxidation process involving chlorine. This oxidation process continues as long as there are two ingredients available in the water: chlorine and oxidizable compounds. This process can last many days and weeks in the distribution system, and causes two conditions of primary concern to water treatment professionals:

- First, oxidation consumes chlorine. As long as chlorine is measurable in the water, it is present to protect public health by being available to inactivate pathogens. When it is not present, chlorine needs to be added so that it can continue providing disinfection—otherwise the desired protection is not available. This concern is addressed by the Total Coliform Rule and the disinfection requirements of the Surface Water Treatment Rule [10].
- Second, the oxidation process can create disinfection byproducts (DBPs), many of which are identified as potentially carcinogenic (cancer-causing) substances. The generation of DBPs will generally occur as long as the disinfectant and organic precursors are present. The more precursors that can be removed from the water by the treatment process, the less the potential will be for generating DBPs. This concern is addressed by the Disinfectant/Disinfection By-Product Rule [8].

A second type of chemical reaction of particular importance is the corrosive action of low pH or otherwise aggressive water on interior piping materials. When in contact with lead or copper-containing materials, corrosive water can leach these substances into suspension and increase their concentrations in the drinking water used by consumers. This concern is addressed by the Lead and Copper Rule [8]. CBW

[9] "Fill and draw" systems are those that treat a sufficient quantity of drinking water in the summer season so that it can be stored and used over the course of winter. Relatively large volumes of stored water are needed for this purpose.

[10] See Appendix C for a brief summary of various water treatment regulations that are relevant to this project.

operators report that they generally target a pH range of 7.25 to 7.5 in the distribution system to reduce corrosion.

CBW monitors the water quality in its distribution system according to the schedule summarized in Table 3. This monitoring regimen is imposed by ADEC.

Table 3 – Monitoring Summary for CBW

Requirement	Sampling Frequency[1]
Total Coliform	2 samples every month
Total Trihalomethanes (TTHM)[1]	1 sample every quarter
Five Haloacetic Acids (HAA_5)[1]	1 sample every quarter
Lead and Copper	10 samples every 3 years
Synthetic Organic Chemicals	1 sample every quarter
Bromate	
Nitrate	1 sample every year
Volatile Organic Chemicals	
Arsenic	1 sample every 9 years
Inorganics	
Radium 226 & 228	
Total Gross Alpha	

Key: 1 – Sampling dates are: February, May, August, and November.

Generally, CBW's water has complied with its monitoring and drinking water quality requirements, having no violations recorded since 2009. Color is substantially reduced by the ozonation process when a sufficient dosage is applied to the raw water [11]. Turbidity is readily removed in the filtration process, according to CBW's daily measurements, averaging around 0.35 NTU in the finished water according to CBW staff. In 2014 regulatory sampling for lead and copper, CBW had no lead samples exceeding the action level of 0.015 mg/L [12]. Further, no samples exceeded the copper action level of 1.4 mg/L [13].

For DBP sampling over the course of the last two years, three HAA_5 samples exceeded the maximum contaminant level (MCL) of 0.060 mg/L and the locational running average appears to have been exceeded once [14]. All TTHM samples tested below the MCL for this contaminant [15]. In general, HAA_5 levels measure closer to its MCL and in higher concentrations than do TTHMs, despite that the low SUVA measurements of CBW's water indicate a largely "hydrophilic" organic character (which would tend to yield more TTHMs

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[11] Per CBW's operating staff, color removal has not been as effective with one of its two aging ozone generators unable to produce its maximum dosage.

[12] Reference *ADEC Drinking Water Watch* website. One lead sample measured at 0.012 mg/L.

[13] *Ibid.* Three copper samples exceeded 1.0 mg/L.

[14] *Ibid.* These HAA_5 samples measured 79, 116 and 94 µg/L. Two others measured above 50 µg/L.

[15] *Ibid.* Three TTHM samples measured between 40 and 60 µg/L.

[16]). CBW staff has reported that its program for flushing lines in the distribution system has helped meet DBP Rule requirements.

Total organic carbon levels in the distribution system water have been elevated, ranging between 3 and 4 mg/L. Although no MCLs exist for this parameter, elevated organic content is problematic in CBW's system for three primary reasons:

- Increased demand on chlorine.
- Potential for increased DBP concentrations.
- Increased potential for accelerating internal corrosion.

Therefore, in addition to meeting drinking water regulations, a primary treatment objective is reducing the organic content in its treated water, to address the concerns listed above. Another important objective is reducing the corrosivity of the treated water. Both are included in the evaluation of water treatment options.

3.1.4 Operator Certifications

CBW's water treatment facility is operated by three certified operators, as summarized below.

Wayne McHolland, the primary WTP operator since 2009, currently holds the following certifications:

- Water Treatment: Level II.
- Water Distribution: Level I.
- Wastewater Treatment: Level II.
- Wastewater Collection: Level I.

Brian Christian currently holds the following certifications:

- Water Treatment: Level II.
- Wastewater Treatment: Level II.

Jeffry Davidson currently holds the following certifications:

- Water Treatment: Level I.
- Wastewater Treatment: Level I.

The certifications for all three operators expire in 2017.

3.2 Financial Status

CBW tracks the expenditures and revenue for the water system. For the 2016-2017 Fiscal Year (FY), the approved revenue was $1,007,827 (Table 4), the approved expenditures was $1,017,694 (Table 5), with an estimated reserves of $420,641 expected to cover the balance of $9,867 between the expenditures and revenue.

For FY 2015-2016, CBW had an expenditure of $89,987 on repayment of a 1999 DEC loan for the WTP. The CBW also had an expenditure of $14,270 on a 1997 USDA-RD water bond.

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[16] Liang and Singer, *Factors Influencing the Formation and Relative Distribution of HAAs and THMs under Controlled Chlorination Conditions,* 2001, AWWA.

The utility rates for the CBW water system are presented in Table 6. Monthly rates for metered charge types are listed at the base rate. The following applies to Table 6:

- For the small commercial metered, the base rate covers the first 4,000 gallons, after which the rate is an additional $2.52 per 1,000 gallons.
- For the large commercial metered, the base covers the first 500,000 gallons, after which the rate is an additional $0.84 per 1,000 gallons.

3.1 Water/Energy/Waste Audits

No known energy audits of the WTP have been conducted.

Table 4 – FY 2016-2017 Water Fund Revenue

DESCRIPTION	AMOUNT
PERS Refund	$9,340
Water Sales	$620,000
Water Connections	$2,500
Material Sales	$500
WTP Pilot Study Grant Revenue	$85,000
Upper Reservoir Connection Grant	$150,000
Interest Income	$8,000
Hydrant Rental	$42,500
Redemption Fund WTP DEC	$89,987
Total Revenue	$1,007,827

Table 5 – FY 2016-2017 Water Fund Expenditures

DESCRIPTION	
Wages and Salaries	$75,420
Overtime	$7,500
Benefits	$67,170
Travel and Training	$3,500
Telephone Expense	$3,000
Electricity Expense	$85,000
Materials and Supplies	$15,000
Chemical Expense	$24,000
Facility Repair and Maintenance	$50,000
Equipment Repair and Maintenance	$2,500
System Repair and Maintenance	$25,000
Garage Vehicle Expense	$35,830
Water Plant Pilot Study Grant	$85,000
Upper Reservoir Connection Grant	$150,000
Capital Additions / Improvements	$151,000
Compliance Testing	$15,000
Charges from Other Departments	$80,000
Audit Expense	$3,600
Credit Card Expense	$3,510
General Insurance Expense	$7,250
1999 DEC WTP Loan Interest	$6,456
1999 DEC WTP Loan Principal	$84,784
1997 Bond Interest	$9,108
1997 Bond Principal	$5,162
Bad Debt Expense	-
Charges from Finance and Admin	$22,904
Total Expenditures	$1,017,694

Table 6 – CBW Water Utility Rates

Charge Type	Revenue Source	Monthly Rate	No. of Customers
Residential	Apartment	$ 122.25	2
	Residential Apartment	$ 40.75	1
	Single Family	$ 40.75	844
Commercial Residential	Apartment	$ 122.25	1
	B&B	$ 73.35	3
	Flat Rate	$ 40.75	2
Small Commercial	Apartment	$ 262.61	10
	Bar	$ 154.27	3
	Beauty Shop - 2 basin	$ 69.40	2
	Church/Misc Stores	$ 38.54	11
	Clubs w/ Restaurant	$ 77.08	3
	Dental Clinic	$ 131.09	1
	Everything Else	$ 38.54	25
	Fountain	$ 38.54	1
	Garage	$ 76.96	4
	Hotel - up to 10 rooms	$ 115.68	1
	RV Park	$ 32.60	1
	Fire Hydrants	$ 24.44	2
	Small Com'l Hotel - over 10	$ 244.38	2
	Multi-Family Units	$ 749.28	1
	Offices	$ 42.82	27
	Office/Per Employee	$ 10.08	1
	Office Unplumbed	$ 8.98	2
	Medical Office	$ 131.09	1
	Ranger District	$ 395.16	1
	School per classroom	$ 203.76	1
	School per classroom	$ 203.76	1
	Restaurant - over 30 seats	$ 154.28	2
	Restaurant - Up to 30 seats	$ 115.68	3
	Small Commercial - Flat Rate	$ 40.75	25
Large Commercial	Grocery w/ meat	$ 119.38	2
	School per classroom	$ 331.11	1
	Multi-family - per unit	$ 218.54	1
	Office	$ 77.08	1
	Office - per employee	$ 10.08	1
	Office	$ 115.62	2
	Hospital	$ 306.56	1
Metered - Small Commercial	Small Commercial - Metered	$ 26.76	4
Metered - Large Commercial	Large Commercial - Metered	$ 401.47	3

4 Need for Project

4.1 Health, Sanitation, and Security

In July 2016, the CBW passed a Disaster Declaration with Request for State Assistance (see Appendix D) due to inadequacy of the filtration system to provide sufficient flow to meet community water consumption. The CBW requested that the public ration water use by 30% to 50% in an effort to decrease overall water use. The inability to provide sufficient water to meet local needs directly impacts local residents, medical facilities, seafood processing plants, and the ability to respond to local fires.

Furthermore, the CBW has received notifications that it has exceeded the levels permitted in the Stage 2 Disinfection and Disinfection Byproducts rule. The violations of allowable HAA_5 levels occurred in 2015 and 2016 and are indicative of the inadequacies of the current treatment system. Copies of the exceedance reports are included in Appendix D.

4.2 Significant WTP Process Concerns

The concerns expressed by CBW as significantly impacting the water treatment process are summarized below.

Roughing Filter Performance: CBW operators report that occasionally the turbidity leaving the roughing filters is greater than that entering the filters. This condition appears to be a symptom of poor cleaning performance by the backwashing system, which would result in the accumulation of contaminants within the media that would occasionally be discharged in relatively high concentrations. These issues may be aggravated by the use of media particles that are larger than specified.

Ozone Residual: CBW operators have also reported a strong ozone smell that lingers in the roughing filter building and in the slow sand filter buildings during water treatment. This condition may indicate that a significant ozone residual continues to be present in the treated water downstream of the contactor. If present in the slow sand filters, the ozone would tend to inhibit biological formation. The ozone residual will tend to be more persistent when the pH of the water is between 6 and 8, and when the water is colder (35°F to 55°F).

Slow Sand Filter Cleaning: Although the slow sand filtration system design anticipated a cleaning frequency of about four times per year, the actual need to clean filters arises about every 10 to 14 days on average (more frequently with higher summer flows and less frequently with lower winter flows). This condition appears to be due to the slow sand filters being subjected to a higher-than-anticipated solids loading rate, since the roughing filters are not performing effectively. ADEC has also expressed concern that the ATV used in cleaning the filters could contaminate the water.

Filtration Capacity: During summer months, when fish processors and other commercial users are consuming potable water, the water demand increases to the point where it is difficult to take filters off-line for cleaning. All filters are needed in these conditions to meet the water demand. Further, in a 2012 Sanitary Survey performed by ADEC, concern was expressed that the slow sand filters were not allowed to properly "ripen" (i.e., redevelop a sufficient biomat for effective treatment) prior to being placed back on-line. This requirement does not appear to be possible with the frequency currently needed for cleaning, and for the WTP to function in peak demand conditions.

4.3 Reasonable Growth

The current water treatment process does not provide sufficient treatment capacity to meet distribution system demands, as was evident by the Disaster Declaration by CBW in July 2016. Future population growth and increased industry water usage, which is discussed further in Section 5.1, will exacerbate this situation. Furthermore, CBW is in the planning stages for development of a 134-acre parcel for single family lots, medium density housing, and an Alaska Native Science & Engineering Program (ANSEP) campus. This development will tend to increase water demand by CBW.

5 Alternatives Considered

5.1 Design Criteria

5.1.1 Design Flow Rates

CBW's design flow rates are estimated in this evaluation for the purpose of scaling the economic comparison between options, as well as for scaling the pilot testing. These rates are based on existing water usage that is increased according to anticipated growth rates of population and water consumption by significant users, both of which are assumed to be 0.8%. These design flow rates are considered conceptual at this stage of the project, and should be confirmed or adjusted, as needed, during the design phase. Existing water usage and design flow rate calculations are summarized in Appendix E.

5.1.1.1 Average Daily Demand

Average daily demand (ADD) is based on the CBW's water usage measured in 2014. The 2014 ADD was determined by summing the total volume of water consumed and dividing this value by 365 days. The ADD was further divided into two general categories and is summarized in Table 7:

- Residential usage plus system water losses (unmetered).
- Commercial usage by fish processors, passenger ships, boat harbors, dock facilities, etc. (metered).

Table 7 – Average Daily Water Demand

System	2014 ADD (gpd)[1]	2037 ADD (gpd)
Residential & System Losses	641,000	788,000
Commercial Users	177,000	212,000
TOTAL	856,000	1,000,000

Key: 1 - Data from 2014 water production meter records is used in this report. However, water production data from November 2015 to October 2016 was evaluated to verify that the 2014 usage records were still consistent with current system use. For the November 2015 to October 2016 time period, the total ADD for the system was 831,000 gpd, which is consistent with the 2014 data.

The water volume for the Residential and System Losses category was determined by subtracting the total metered volume of commercial users from the total volume of water that was measured in the WTP. This volume is also estimated as a simplified, "per capita" daily rate by dividing it by the 2014 population and 365 days, which amounts to about 251 gallons per capita-day (gpcd). As residential service lines are not metered, it is not known how much of this volume is attributable to system water losses (pipeline leaks, water wasting at plant and hydrants, and others).

For the purposes of this evaluation, the per-capita daily rate is assumed to decrease by about 5%, to 240 gpcd, in 2037. This decrease is assumed to be due to replacement of some leaking CBW water lines during the 20-year span, eventual re-use of backwash water at the WTP, and a continuing national trend of lower water consumption from conservation efforts.

5.1.1.2 Maximum Daily Demand (MDD)

MDD is estimated by multiplying the ADD by a peaking factor, which is commonly 150% for municipalities. However, a peaking factor of 175% is used for CBW, based on a review of the daily plant flow variation recorded between 2012 and June of 2015 (Appendix B). Year 2014 and 2037 MDD rates are summarized in Table 8.

Table 8 – Maximum Daily Water Demand

System	2014 MDD (gpd)	2037 MDD (gpd)
Residential & System Losses	1,189,000	1,375,000
Commercial Users	309,000	371,000
TOTAL	1,498,000	1,746,000

It is noteworthy that the peaking factor is a simplified planning number that reflects the variability of the total water demand on CBW's distribution system. The water flow data reflects peaking factors for the commercial users alone that are much higher (as much as 350%), but this flow volume accounts for only 20% to 40% of the estimated MDD. Nevertheless, the water storage system should be sized such that CBW can accommodate the occasional peaks in demand which exceed the 175% factor.

5.1.1.3 Peak Hourly Demand

The peak hourly demand (PHD) is estimated by applying another peaking factor to the ADD, and is used for specific hydraulic sizing of distribution piping and pumping equipment. These peaking factors generally vary from 2.0 to 4.5 depending on population, and the factored flow rate for PHD is typically expressed in gallons per minute (gpm). Since sufficient water storage should be provided as a volumetric buffer between the WTP and the hourly demand variations in the water distribution system, the MDD is typically used for sizing the treatment process. Therefore, the PHD rate is not used in this PER.

5.2 Regulations

ADEC is responsible for interpreting and enforcing the regulations regarding water and sewer systems.

CBW's water system is identified by the State of Alaska as PWSID# AK 2120143, serving 2,000 year-round residents and 300 transient people. As required by the Safe Drinking Water Act (SDWA) and State and Federal regulations, the water treated by CBW must meet certain water quality standards established by the EPA and adopted and enforced by environmental regulators at the state government level.

Principal treatment objectives for CBW are briefly summarized below:

- 99% (2-log) removal of *Cryptosporidium*.
- 99.9% (3-log) removal of *Giardia lamblia*.
- 99.99% (4-log) removal/inactivation of viruses.
- Continuous combined filter effluent (CFE) monitoring of turbidity.
- Maximum CFE turbidity value of 1.49 NTU in 95% of samples measured every month.
- Primary and secondary contaminants provisions met.
- Total coliform provisions met in distribution system.
- Lead and copper levels met in distribution system.

- Disinfection by-product (DBP) provisions met in distribution system for TTHM and HAA_5.
- Minimum disinfectant residual of 0.2 mg/L entering the distribution system.
- Detectable disinfectant residual within distribution system.
- Sanitary survey required every 3 years.
- Meet APDES general permit stipulations for wastewater discharges.

CBW must comply with all applicable drinking water regulations and most particularly the following:

- Primary Contaminants.
- Secondary Contaminants.
- Total Coliform Rule (TCR) and Revised TCR.
- Surface Water Treatment Rule (SWTR).
- Long Term 1 Enhanced SWTR (LT1ESWTR).
- Long Term 2 Enhanced SWTR (LT2ESWTR).
- Stage 1 and Stage 2 Disinfectant/Disinfection Byproducts Rule (D/DBPR).
- Lead and Copper Rule (LCR).
- Alaska Pollutant Discharge Elimination System (APDES).

These and other standards are summarized in more detail in Appendix C, and form the basis of CBW's minimum treatment requirements.

5.3 Permitting

5.3.1 Federal Permits

United States Army Corps of Engineers (USACE) Section 404 Permit: The USACE issues a permit that combines its authorities under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. The project will require a Section 404 permit if any wetlands will be filled or excavated.

National Historic Preservation Act Section 106 Consultation: If historical resources are likely to be affected, a cultural resources assessment may be required.

5.3.2 State Permits

ADEC Permits: All construction plans for water and sewer projects must be submitted to ADEC for review and approval prior to construction. A Construction General Permit will also be required for storm water discharge activities related to construction.

5.3.3 Local Permits

There are currently no local permitting requirements in CBW.

5.4 Water Treatment Alternatives

The alternatives formulated for this PER were developed by considering the relative feasibilities of various WTP options for CBW. These considerations were largely qualitative, being based on the inputs and experience of water treatment professionals, and on engineering judgment. This evaluation does not intend to scrutinize alternatives for all possible options and permutations that may come to mind. It instead considers a limited number of options that appear to be reasonably promising for use in Wrangell.

The following water treatment alternatives were evaluated for this PER:

1. Alternative 1 – Improve Existing Water Treatment Process
2. Alternative 2 – MIEX Process with Multimedia (Conventional) Filtration
3. Alternative 3 – Ozonation with MIEX and Biological Filtration
4. Alternative 4 – Dissolved Air Flotation (DAF) with Multimedia Filtration
5. Alternative 5 – Nanofiltration with Multimedia (Two-Stage) Filtration
6. Alternative 6 – No Action Alternative

Each alternative is evaluated relative to various criteria, including: capital costs, operation and maintenance (O&M) costs, life-cycle costs, treatment performance and capacity, complexity, reliability, sustainability, operator certification, and operator safety.

5.5 Alternative 1 – Improve Existing Water Treatment Process

5.5.1 Description

Alternative 1 primarily features the following water treatment steps (Figures 4 and 5):

- pH adjustment
- Ozonation
- Roughing Filtration
- Slow Sand Filtration
- Disinfection

The existing water treatment process is described in Section 3.1. Improvements are considered below for all aspects of the treatment process.

5.5.1.1 pH Adjustment

The pH level in CBW's raw water is generally low, ranging between 5.4 and 6.9, and its alkalinity is also low, ranging around plus or minus 10 mg/L as $CaCO_3$. Originally, CBW added soda ash (sodium carbonate) to elevate the water's pH and increase its alkalinity. Due to the high cost of adding large of amounts of soda ash, CBW now uses caustic soda (sodium hydroxide), a much stronger base that can increase the pH with a smaller dosage. However, at the dosages used by CBW, caustic soda does not add much alkalinity, and, therefore, the alkalinity level remains low in CBW's water, leaving it prone to significant pH changes in downstream processes.

Due to the cost of using soda ash and other pH adjustment chemicals like sodium bicarbonate, CBW would likely continue using caustic soda for this alternative. However, CBW's chemical feed system should be modified with a ventilated hopper system that reduces or eliminates the tendency for operators to contact airborne dust containing this chemical as it is poured into a solution tank.

5.5.1.2 Ozonation

CBW recently purchased new, more-efficient ozone generators to replace the worn-out existing units. It is expected that the WTP's oxidation performance will be improved with the new system after it is installed. The new system offers a larger maximum output of ozone (nearly four times that of the existing system), with lower power requirements and features that enhance maintenance and replacement of critical components. Per CBW operating staff, it is expected that the new generators will be readily piped into the existing layout of the plant, to receive oxygen (O_2) from the existing O_2 generators, and discharge ozone into downstream piping that feeds the ozone contactor.

5.5.1.3 Roughing Filters

It appears that a capable cleaning system is needed for the roughing filters, in addition to the replacement of the existing media. Typically, roughing filters are intended to be cleaned on a frequent basis, with rapid, downward flowing water using only gravity as the energy source. However, with a perforated collection system below the media, the existing facility does not appear to be configured to promote rapid draining.

One way to improve a rapid drawdown of water is providing large valved openings in the roughing filter basin that would allow water to readily flow in the adjacent waste sump. Further, the construction of an underdrain space below the media would also promote rapid downflow. With this configuration, the discharge-to-waste piping would likely be the flow-limiting element.

Another way would be to provide a more positive means of cleaning. If the backwash flow direction were reversed and allowed to flow upward, then an air scour could be applied simultaneously, which would more effectively clean the media relative to the rapid drain-down approach. With relatively large media particles used in these filters, an air scour is needed to sufficiently agitate and scrub solids that are trapped within the media. This objective is not readily accomplished with backwashing only. Before initiating the backwash process, the WTP flow can be directed to the waste line.

To backwash the filters in this fashion, a pump would be activated to increase the upflow through the filter media. Air scouring would then occur by pumping air though a piped grid placed below the media. After media agitation and scouring, the backflow upflow would continue until a targeted clarity was achieved in the water. Then the backwash pump would be deactivated, and the WTP flow redirected to the slow sand filters. By cleaning solids upstream beforehand, the loading rate on the slow sand filters could be reduced, thereby allowing them to run longer.

Along with replacing the existing media with that of the proper size, a granular activated carbon (GAC) cap might be considered for converting any residual ozone into oxygen. Doing so would better facilitate the biological growth needed for optimizing the performance of the slow sand filters downstream, and may improve the system's ability to remove turbidity. However, because it will likely absorb dissolved organics and other substances over time, replacement of the GAC would be needed on a periodic basis, which would increase the cost of WTP operation.

5.5.1.4 Slow Sand Filters

An improved system for removing the *schmutzdecke* layer and recovering spent sand and backwash water should also be considered for reducing operational costs. Relative to scraping, CBW's use of an ATV offers a quicker method for cleaning the filters, which would be even less of a burden on time and money if cleaning frequencies could be greatly lengthened—from once every two weeks to once every 2 or 3 months. However, in the process of draining up to 6 feet of treated water to allow filter cleaning, CBW wastes a significant amount of water (as much as 135,000 gallons per filter—about 17 million gallons total in 2014) that might otherwise be pumped directly to a standby slow sand filter, or captured in a tank and recycled to a reentry point upstream of either the ozonation process or the roughing filters. An on-site sand cleaning unit is recommended to facilitate cleaning the sand.

5.5.1.5 On-Site Chlorine Generation

Sodium hypochlorite is produced at the WTP with the use of a chlorine generator and salt brine. The salt brine is made by soaking high-purity salt in water. The brine is fed through an electrolytic cell within the generator, which, through the process of electrolysis, converts sodium chloride (salt) into sodium hypochlorite and hydrogen. The sodium hypochlorite is stored in a tank for subsequent injection in the process stream as disinfectant, while the hydrogen is exhausted to the atmosphere outside of the WTP building. A water softener is commonly needed with an on-site chlorine generation system to reduce mineral build-up on the electrodes in the generator, as well as a heater/chiller to maintain water temperature within a range that will best sustain the electrolytic cells. Due to the age and condition of the existing facilities, the on-site chlorine generation facilities would be replaced as part of the WTP upgrades.

5.5.1.6 Hydraulic and Treatment Capacity

Hydraulic and treatment capacity would be improved with longer slow sand filter runs resulting from the aforementioned pre-treatment improvements, but an increase in treatment flow is not likely without increasing the size of the ozonation, rough filtering, and slow sand filtering processes. Raising the plant flow rate from 900 gpm (1.3 mgd) to 1,250 gpm (1.8 mgd) represents a 40% increase, and to 1,390 gpm (2.0 mgd) represents over a 50% change. Based on inputs from CBW, it appears that the new ozone generators could accommodate these increases. However, the oxygen generators and ozone contactor would need proportionate upsizing. The footprints of the roughing filters and slow sand filters would also need to be made larger proportional to the increased flow rate, and doing so would require additional site area. At a minimum, the number of roughing filters would need to increase from two cells to three cells, and two slow sand filters would be added to the existing four filters - for a total of six.

Further, with cold water temperatures, the unit process flow rate may need to be decreased (i.e., "de-rated") to improve biological treatment. Doing so may require additional upsizing of the unit processes previously described. A second additional roughing filter cell and a seventh slow sand filter as standby would facilitate the off-line cleaning of the other filters and allow newly-cleaned filters to properly ripen prior to being returned into service.

Increased water storage would better buffer the water treatment process from peak water demands in the distribution system. By providing another 1 million gallons in water storage, the increased stored volume (1.8 million gallons) would nearly equal the peak daily demand (which would occur only a few times per year), and provide nearly 2 days of average daily demand. Further, this larger storage capacity would:

- Allow CBW to operate the WTP at a lower flow rate, as needed to maintain sufficient volumes of stored water for particular seasonal usages by customers.
- Allow CBW to better address any system failures that would diminish or shut down WTP flow.
- Better accommodate system maintenance, such as taking filters off-line for cleaning.

However, increased storage volumes would create longer residence times in the distribution system. CBW staff has expressed concern that, with the current water treatment process, the chlorine concentration in the finished water needs to be boosted to counter losses that occur in the WST. As much as 0.8 mg/L is provided in the water leaving the WTP so that water entering the piped system would have at least a 0.2 mg/L chlorine residual, in accordance with ADEC regulations [17]. With relatively high organic concentrations leaving the WTP, the longer residence time in the WST would create increased potential for DBP generation. The more that the treatment process can remove organic material, the less DBP generation would occur.

For comparing this option, the following improvements are considered for meeting the future peak daily demand:

- Increased ozonation capacity in added oxygen generator and ozone destructor, plus a 50% increase in ozone contactor volume.
- Addition of two roughing filters and media replacement in existing two filters.
- Use of a one-foot deep GAC cap in the roughing filter.
- Revising the backwashing configuration to provide upflow through the roughing filters with new backwashing pumps.
- Addition of an air scour feature for the roughing filters.
- Addition of three slow sand filters.
- Larger booster pumps.
- A freeboard recapture tank and associated transfer pumps.
- Sand cleaning equipment.

5.5.2 Advantages/Disadvantages

One of the main objectives of the original WTP design was to simplify its operations with a relatively cost effective process. The original design strived to meet this objective primarily in the following steps:

- Use of sodium hydroxide (caustic soda) to raise the pH for oxidation and reduce corrosivity of the water.
- Use of ozone as an oxidant to remove iron, manganese, color, tastes, and odor.
- Use of a roughing filter to remove suspended solids.
- Use of a slow sand filter to reduce dissolved and biodegradable substances.
- Use of on-site generation of chlorine for disinfection.

The pros and cons of each of these steps are generally discussed below.

5.5.2.1 pH Adjustment

Primary advantages of pH adjustment include:

- Water chemistry can be made more suitable for oxidation and coagulation processes.
- In association with added calcium, pH levels can be made more neutral to reduce the corrosivity of the treated water.

[17] Chlorine residual establishment in the WST is complicated by the disconnection between plant flow rate and the flow rate leaving the tank. Pumping rate to the WST varies according to the difference between low water level and the level at which the pumps are automatically deactivated. If flow rates leaving the WSTs are relatively low, chlorine tends to accumulate in the tank and its concentrations tend to be higher. When flow rates leaving the WST are relatively low, the converse tends to be true for chlorine concentration.

- With the use of soda ash, sodium bicarbonate, or a lime contactor, alkalinity can be added to the treated water, which stabilizes it from significant pH changes and replaces any alkalinity lost in the water treatment process.

The primary disadvantages of pH adjustment include:

- Added chemical treatment costs. CBW being located in a relatively remote community, these costs can be substantial.
- Added complexity to the water treatment process. Although the chemical feed systems are not difficult to operate, adding pH adjustment to the overall water treatment scheme increases the number of unit processes that need to be monitored. Water systems can often circumvent the need for pH adjustment by using different oxidants and coagulants that are not as pH-sensitive.
- In the case of using caustic soda, which is a corrosive chemical, extra safety measures are needed to protect the health of operators working with it.

Generally, the decision to use pH adjustment boils down to determining whether or not the added cost and complexity of this step is justified by its benefits to the water treatment process. With the use of alkalinity-consuming processes like coagulation and nanofiltration, pH adjustment is ordinarily needed in the treatment of low-alkalinity water.

5.5.2.2 Ozone

Ozonation is an older but relatively sophisticated water treatment technology, and consequently is not common in small Alaskan communities. The systems that generate ozone on site are relatively complex and need skilled personnel to operate and maintain them. However, ozone is a very strong, multi-dimensional oxidant that can provide a number of benefits in the treatment of water. Primary benefits for CBW's water treatment process include:

- Reduces larger weight organic molecules into compounds that are smaller and more biodegradable in the downstream filtration processes.
- Inactivates microbial and viral contaminants.
- Reduces color.
- Removes disagreeable tastes and odors associated with organic materials in the water.
- Reduces the amount of chlorine needed after treatment to maintain a disinfectant residual in the distribution system water.

Because ozone is fairly reactive with the types of organic molecular structures that are also associated with the formation of certain types of DBPs, its use by CBW probably reduces the concentration of DBP precursors in the raw water, which would lead to lower DBP levels in the distribution system [18]. Ozone may also benefit downstream coagulation processes.

In short, CBW gets "a lot of bang for the buck" because, in one step, its use of ozone provides many benefits that otherwise might be achieved by multiple processes and additional chemicals.

The primary disadvantages of ozone usage are:

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[18] In some water conditions, the use of ozone reportedly can increase the concentration of DBP precursors (Reckhow, AWWA *Formation and Control of Disinfection By-Products in Drinking Water*, 1999, edited by Singer).

- Complexity: the ozone system used by CBW is comprised of four sub-systems: oxygen generation, ozone generation, ozone contact, and ozone destruction. Three of these subsystems feature sophisticated electro/mechanical equipment that requires specialized knowledge for operating, maintaining, and repairing them.
- Power consumption: these subsystems require a significant amount electrical power to perform the required chemical conversions for the process to function.
- Short residual times: Being highly reactive, ozone will not produce a long-lasting residual. Another disinfectant is required for meeting the drinking water requirement of having a detectible residual in the distribution system.
- Safety concerns: being a very strong oxidant, ozone can also be harmful to human health if not properly contained. Typically, ozone dosages range between 1 and 5 mg/L, but waters with color often require dosages greater than 5 mg/L. CBW uses a dosage as high as 10 mg/L.

These concerns constitute some of the reasons for discouraging its usage in smaller Alaskan communities.

As long as the ozone system functions as intended, it can be a very advantageous component of CBW's water treatment process. However, if the system is not functioning correctly, it can present significant challenges and, possibly, unsafe conditions to operating personnel.

5.5.2.3 Roughing Filters

The roughing filters (also called "up-flow clarifiers") provide an environment in which two processes can occur: flocculation and filtration. Flocculation is a process wherein particles that have previously been coagulated can clump together into larger solids that are more readily removed by filtration. In the existing process, ozone performs the coagulation that is intended to neutralize the electrostatic charges of particles which would otherwise prevent them from clumping together. The turbulent water flowing in between the media particles promotes the collisions and "agglomeration" of solids that is intended to facilitate their removal during filtration.

The filtration process occurs in three ways: first by solids adhering to media particles; second, by adsorption of solids to the solids mass already adhered to media particles; and third, by physically straining out particles that become trapped in confined pore spaces. As these removal processes continue, the filters become clogged, which increases the hydraulic energy needed to drive water through them. Backwashing is then needed to dislodge solids from the media and flush them out of the system to waste.

The primary advantage of this method of removing solids is that it is a relatively simple alternative to sedimentation processes featured in conventional filtration. Roughing filters are intended to provide sedimentation within the filter media with the use of relatively large particles. Roughing filters are commonly used with ozonation and slow sand filtration when the turbidity of raw water is higher than that which can be readily treated by the latter process. Roughing filters might also be advantageously used for some biological filtration if amenable conditions can be maintained.

The primary disadvantage of roughing filters is they can become a liability to downstream filtration if not properly cleaned. In this situation, they can become prematurely clogged and cause the effluent to have worse water quality than the influent, as contaminants accumulate in the media. With an effective cleaning system, this disadvantage would not likely become apparent.

5.5.2.4 Slow Sand Filters

Slow sand filtration is an old but proven technology for treating water having moderately low quality. It primarily uses a biological process to remove biodegradable and assimilable substances, which are not readily removed by ordinary granular filtration methods. As water slowly flows through fine-grained sand media, a biological mat (*schmutzdecke*) develops on its surface, which provides a medium for microbes to encounter, break down, and assimilate dissolved compounds. As this process continues, the *schmutzdecke* thickens to the point where it needs to be physically scraped away.

Primary advantages of this technology are:

- No chemicals are needed to facilitate the removal of dissolved substances. The *schmutzdecke* effectively performs this task.
- It is a largely self-governing process when operating properly, and self-indicating when filter cleaning is needed.
- The cleaning of *schmutzdecke* is relatively "low-tech"—it is a physical task that requires no special skill set. The vast bulk of the treatment performance occurs on the upper surface of the media and within the *schmutzdecke*. A relatively thin scraping of the media surface (about 1/2 inches) is all that's needed for media cleaning.
- From a regulatory standpoint, a significant advantage of using slow sand filtration is the relatively high MCL for turbidity (1 NTU—or 1.49 NTU rounded down). The turbidity limit for other filtration methods is 0.3 NTU. The recent updates to the SWTR require regulatory action (comprehensive performance evaluations) if the turbidity MCL is exceeded at an established frequency. The higher turbidity MCL of 1.49 NTU is a readily achievable and sustainable goal when slow sand filtration is operating properly, thereby making the triggering of regulatory action readily avoidable as well.

However, a number of disadvantages are associated with slow sand filtration, such as the following:

- Slow sand filtration is vulnerable to poor upstream water quality. Having fine-grained media, slow sand filters are not capable of handling large solids loading without prematurely clogging. Therefore, these types of filters are more appropriate for treating raw water with relatively decent clarity (i.e., having less than 1.0 NTU of turbidity).
- Relatively large areas of land are needed for constructing these types of filters. Slow sand filters are so-called because the loading rate used (0.04 to 0.10 gpm/sf) is very small relative to conventional filters (1.0 to 5.0 gpm/sf). Therefore, to handle large flow rates, large surface areas of sand are required, making the cost of expansion relatively expensive.
- Long ripening periods are needed to generate a biomat that will produce the desired water quality. As much as 4 to 6 weeks can be required to ripen sand before the filter can be placed on-line [19]. This ripening time is currently not practical for CBW when summer-time water demands are peaking.
- Another disadvantage is the physical nature of removing the *schmutzdecke:* while the approach is simple, it is also a laborious task when large filters are being cleaned. Cleaning one filter takes

[19] As much as 12 weeks could be required for ripening new, clean sand.

CBW staff about 5 hours of draining water and ploughing with the ATV before bringing it back on line. In CBW's case, this condition is made more challenging in the summer time when peaking water demands require that all filters stay in operation.

5.5.2.5 On-Site Chlorine Generation

The primary advantage of on-site chlorine generation is avoiding the handling of stronger concentrations of chlorine. Only the inert ingredients of salt and water are needed to generate chlorine. A maximum of 0.8% solution (8,000 mg/L) of hypochlorite can be produced, which is a low concentration relative to liquid sodium hypochlorite (12% to 15%) or calcium hypochlorite (60% to 70%). Further, for moderate and large sizes of WTPs, on-site generation is a more cost effective approach relative to importing these other two forms of chlorine, and when salt can be economically supplied in bulk. In general, CBW staff is pleased with their on-site chlorine generator and expects to continue using this technology in any future water treatment process.

The primary disadvantage of this approach is the complexity of the equipment. The equipment used to perform the electrolysis is sophisticated and takes special skills to repair and maintain. Maintenance typically involves the cleaning of electrodes with an acid solution. Repairing and replacing components usually requires a trained specialist. Another disadvantage is that large chemical feed pumps are needed with the low concentration if a large chlorine dosage is required to meet a sizeable disinfectant demand. This is not the case at CBW's WTP.

5.5.3 Treatment Performance

In general, slow sand filtration alone is capable of the following treatment performance or contaminant reduction capacities [20]:

- Less than 1.0 NTU turbidity.
- Between 1 to 3 log units of coliform bacteria.
- Between 2 and 4 log units of viruses and *Giardia* cysts.
- Greater than 4 log units of *Cryptosporidium* oocysts.
- Between 15% and 25% of TOC and dissolved organic carbon (DOC).
- Up to 50% removal of biodegradable DOC [21].
- Between 20% and 30% removal of TTHM precursors.

Currently, CBW's WTP produces water of good quality, with turbidity levels ranging between 0.1 and 0.5 NTU in the finished water, and color generally ranging between 0.10 and 0.25 units using the full capacity of the ozone generators. The extent of color removal strongly varies with raw water color and the ozone dosage.

The capability of slow sand filtration to remove organics ranges from average to considerably less relative to other technologies. Yet, this approach has evidently been sufficient to avoid high DBP concentrations in CBW's distribution system. Based on available testing data, CBW's organics removal performance generally ranges between 25% and 50%, leaving a relatively high concentration of organics (3 to 4 mg/L)

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[20] Table 9-3, *AWWA Water Treatment Plant Design*, 3rd Edition,1998, McGraw-Hill, and Table 1, *Tech Brief - Slow Sand Filtration,* National Drinking Water Clearinghouse, June 2000.
[21] Biodegradable DOC typically represents 10 to 20% of raw water DOC, per Techneau, *Ozonation and Biofiltration in Water Treatment—Operational Status and Optimization Issues,* Dec. 2006.

in the finished water after treatment. These remaining concentrations can impose a continual chlorine demand throughout the distribution system and promote interior pipe corrosion.

5.5.4 Operational Considerations: Complexity, Reliability, Safety & Sustainability

The unit processes within the existing water treatment process have varying levels of complexity, reliability, safety, and sustainability. These considerations are generally described as:

- Complexity – relates to the training and skill levels needed to properly operate and maintain the unit process as intended. A high degree of complexity usually requires a high skill set of the operator and vice versa. Complexity could be apparent in the sophisticated technology of a particular component, or in the number of steps and degree of system balance needed to operate a process.
- Reliability – relates to how readily a process is prone to function as intended over its useful life. High levels of reliability indicate systems that inherently or readily perform well. Low levels of reliability indicate systems that are prone to upsets or a frequent need for adjustments and close supervision to perform well.
- Safety – relates to the possibility of hazards to human health during operation. A high degree of safety indicates a relatively innocuous process. A low degree of safety indicates that hazards are apparent and extra precautions are necessary.
- Sustainability – relates to the combination of technical and financial resources needed by the public water system to operate the process beneficially for the life of the facility. High need for technical expertise and/or high operating costs indicate low sustainability, and vice versa. With low sustainability, a community will tend to be at risk of being unable to sustain operations of a particular process with the loss of a particular operator, or with deficient operating revenues. With high sustainability, the risk of being unable to sustain operations of a process is reduced, because relatively little expertise or operating revenues are needed.

Assuming an improved process as described in this section, the levels of these operational considerations are anticipated as noted in Table 9.

Table 9 – Operational Considerations for Alternative 1

Process	Complexity	Reliability	Safety	Sustainability
pH Adjustment, Raw Water[1]	Moderate	High	Low	Moderate
Ozonation	High	High	Low	Low
Roughing Filtration	Moderate	Moderate	High	Moderate
Slow Sand Filtration	Low	High	High	Moderate
On-Site Chlorination	High	High	Moderate	Moderate

Key: 1 – assuming use of sodium hydroxide (caustic soda).

These considerations are further discussed in Section 6 in comparison to the other alternatives.

5.5.5 Certification Requirements

Operator certification requirements for Alternative 1 are summarized in Section 6.2. For Alternative 1, it is estimated that a Level III operator certification will be required.

5.5.6 Environmental Impacts

Expansion of the slow sand filters would require clearing of the land on the north end of the WTP site. Expansion of the roughing filter building would require drilling and blasting on the south end of the site.

5.5.7 Land Requirements

The construction of additional sand filters will require expansion of the WTP site to the north. The expansion will occur on land owned by CBW.

5.5.8 Potential Construction Problems

No significant construction problems are anticipated. Drilling and blasting of bedrock will be required for construction of the new sand filter beds.

5.6 Alternative 2 – MIEX Process with Multimedia Filtration

5.6.1 Description

Alternative 2 primarily features the following water treatment steps (Figures 6 and 7):

- pH adjustment using soda ash
- MIEX
- Multimedia filtration
- Disinfection

This alternative assumes that a MIEX system would be installed downstream of the pH adjustment system, which would feature the use of soda ash to increase the raw water's alkalinity (instead of caustic soda). The ozonation system would not be used in this alternative. Alum is assumed to be used as the coagulant, and rapid-mixed with the raw water. The use of MIEX is assumed to allow a lower dosage of alum that would be optimized more for turbidity removal, and less for organics removal. The roughing filter building would be modified to house a conventional filtration system comprised of three parallel flocculation/sedimentation/filtration trains, with a redundant fourth filter for backwashing purposes (Appendix F). The existing disinfection system would be re-used and the existing slow sand filters would be converted to a serpentine clearwell for storing disinfected water after filtration.

The pH adjustment and disinfection steps are described in Section 5.5.1. The MIEX and Multimedia Filtration processes are described in Section 5.6.1.1.

5.6.1.1 MIEX

MIEX is a proprietary ion exchange process marketed by Ixom Watercare, Inc. (Ixom, formerly Orica Watercare) that is effective in removing DOC and color in drinking water applications. This process features a "magnetic" ion exchange resin that exhibits a strong affinity for adsorbing low weight molecular organic substances that are not effectively removed by coagulation and multimedia filtration processes. When combined with multimedia filtration, MIEX can help remove a wide spectrum of both small and large organic compounds that produce DBPs. This technology is currently being used in Saxman, Alaska (south of Ketchikan) and Gulkana, Alaska. It is also being implemented in Buckland, Alaska.

The MIEX process (Photo 3) differs from typical "fixed bed" ion exchange systems in that it provides continuous regeneration of its resin[22] using automated controls. The system features a "high rate" contactor module, a resin regeneration vessel, a brine tank, a salt saturator, and multiple pumps. The regeneration, brine, and reactor tanks are packaged together on a single skid frame. The MIEX process continuously regenerates its resin using brine made from salt, which is a process already employed by CBW for on-site generation of sodium hypochlorite.

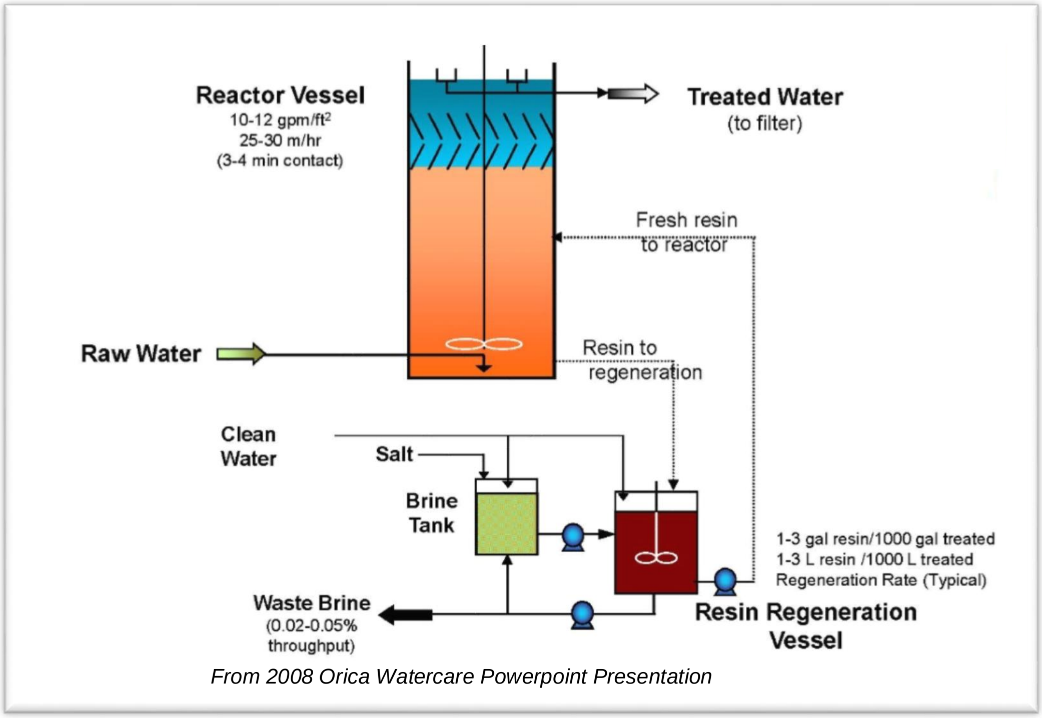

Photo 3 MIEX Process Diagram

In the operation of this system, water is conveyed through the bottom of the contactor and flows upward through the magnetic resin. Treated water flows out of the top of the contactor to downstream processes. A relatively high up-flow rate (10 to 12 gpm/sf) and an agitator keeps the resin in suspension. However, the weak magnetic properties of the resin allow beads to agglomerate into larger clumps that sink by gravity to the bottom of the contactor. Settling tubes are provided near the top of the contactor to facilitate separation of the resin from the water prior to its exit from the contactor. A small proportion (1 gallon of resin slurry per 1,000 gallons of water treated) of the settled resin is continuously directed out of the contactor and into the regeneration tank and is replaced by regenerated resin. A secondary cycle of salt brine is circulated from the brine tank to the regeneration tank. The salt saturator continuously feeds the brine tank. Despite the use of magnetic resin and tube settlers, a fractional amount of resin (1 to 2 gallons per 1,000,000 gallons of water treated) is lost due to physical attrition and overflow. This condition requires that the lost resin be replaced with new resin and also be captured by a downstream filtration process.

5.6.1.2 Multimedia Filtration

As MIEX does not remove suspended solids, a filtration process would follow downstream to meet SWTR drinking water regulations and receive the treatment credits required for a surface water source.

[22] "Resin" is a synthetic media made of organic compounds.

Filtration would also remove turbidity, color, additional organics, and other contaminants. The multimedia filtration process, which would also be a component of Alternatives 2 through 5, is discussed here.

For the purpose of this assessment, "multimedia" filtration will refer to the use of more than one type of granular media to filter water. Usually, the different media types are installed in layers and specific thicknesses, depending on the filtration approach. Materials commonly used as filter media include silica sand, garnet, greensand, and anthracite coal. A commonly used media profile is a layer of fine sand that is overlain by a layer of larger anthracite coal particles.

Multimedia filtration also refers to "rapid" sand filtration (as opposed to "slow" sand filtration). Relative to the slow sand method, much higher filtration rates (1 to 5 gpm per square foot of media surface) can be used with multimedia filtration, which allows much smaller area requirements for water treatment. As an example, for the same treatment capacity provided by slow sand filtration, rapid sand filtration can provide the same capacity with 10% or less surface area. With less sand to clean during the backwash process, smaller pumps are used and less water is wasted or recycled.

For the purpose of this PER, two types of multimedia filtration are considered for meeting the microbial removal requirements imposed by the SWTR:

1. Conventional Filtration
2. Two-stage Filtration

Conventional filtration is an older technology that is commonly used for water treatment. In industry terminology, "conventional" filtration refers to a process involving coagulation, flocculation, and sedimentation upstream of granular media filtration. This type of process intends to remove a considerable amount of suspended solids from water before it is passed through the filters. Removing a large percentage of solids upstream of the filters improves the filtration process by allowing longer filter runs between backwashing. The longer that filters can run, the more efficient is the process, because a lower percentage of water is used in the backwashing step that is either wasted afterward or recycled.

To accomplish the solids removal objective, a "coagulant [23]" is first injected and mixed with raw water (Photo 4) to neutralize the natural electrical charge of particles that would otherwise cause them to repel each other. Next, in the flocculation step, the treated water is gently agitated so that the neutralized particles will collide and clump into larger particles that they can either be settled out or removed by the filters. After flocculation, the treated water is conveyed through a quiescent basin to encourage particles to settle out by gravity. Settling tubes are commonly used in this step to produce a calm, laminar flow that facilitates the sedimentation process. With colder water temperatures, such as that experienced by CBW during the winter, floc sizes and/or settling times need to be increased to account for slower settling rates. This adjustment is usually accomplished by increasing the size of the settling basin, which lowers the flow rate of the water (also called "de-rating" the flow rate).

Filter cleaning is accomplished with the use of backwashing and an air-scour feature. Depending on the manufacturer's preference, this process more commonly occurs either by first air-scouring and then backwashing, or by simultaneously doing both. After the water above the media is lowered to within several inches of the media surface, air scouring is accomplished by pumping air upward through the media using a piped grid. This step agitates media particles to dislodge captured solids. After a few

[23] Most common types of coagulants are metal salts (such as aluminum sulfide—"alum", polyaluminum chloride, and ferric chloride), polymers, and blends of both.

minutes, the air scouring process is stopped and the media is then backwashed by flowing water upward through the media bed. Typically, potable water is used for this cleaning process. Backwashing flow is established such that the media bed will be expanded by 40%. The backwashing process re-suspends and conveys the solids to waste. When the backwash water reaches a prescribed clarity, the process is terminated.

Relative to conventional filtration, Two-stage filtration is a newer filtration technology that accomplishes the solids removal objective with similar steps, but without the use of sedimentation. A two-stage filter plant (also called "adsorption-clarifier") first up-flows coagulant-treated water through a course media filter to promote flocculation within. The course media (called an "up-flow clarifier") removes larger flocculated solids. In this manner, the water is "rough-filtered" before being conveyed downward through a multimedia filter as a polishing step (similar to the roughing filter technology used by CBW in the existing water treatment process).

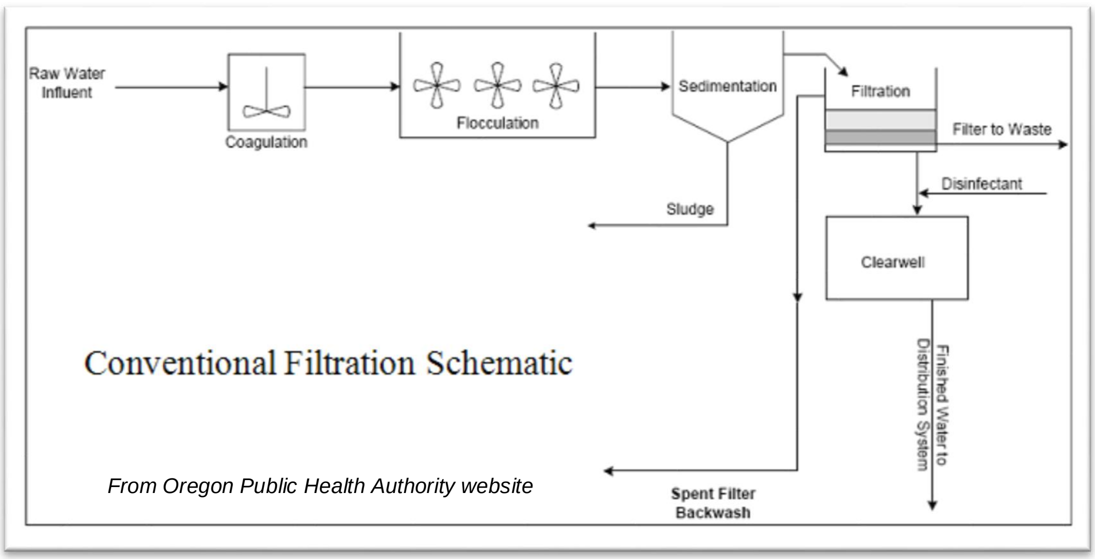

Photo 4 Typical Conventional Filtration Process Diagram

Both the up-flow clarifier and multimedia filter are backwashed with an air-scour feature. The multi-media filter is cleaned with potable water as described above for conventional filtration. The up-flow clarifier is typically cleaned using unfiltered, chemically-treated water for backwashing. Air-scouring is commonly employed simultaneously with backwashing in order to clean the course media used in this filtration step. The direction of backwash and air scour flow is the same as used for up-flow clarification, except that out-flowing water is directed to waste instead of to the multimedia filter. This configuration facilitates automated backwashing and air scouring for cleaning the filters.

5.6.2 Advantages/Disadvantages

5.6.2.1 pH Adjustment

While pH adjustment will not significantly impact the MIEX process, it is needed for replacing alkalinity consumed in the coagulation process associated with multimedia filtration. Soda ash is assumed for this purpose. General advantages and disadvantages of pH adjustment are described in Section 5.5.2.1.

5.6.2.2 MIEX

Primary advantages of using the MIEX process are:

- Ability to remove low weight molecular organic compounds, and its usage complements the ability of multimedia filtration to remove larger weight molecular organics. This arrangement can substantially reduce the generation of DBPs and the chlorine demand in the distribution system.
- When used upstream of multimedia filtration, MIEX will tend to reduce the need for coagulants and facilitate longer filter runs.
- Relative to "fixed bed" ion exchange processes, a smaller equipment footprint is needed. Further, less salt and less brine is needed to regenerate the media.
- Relatively low energy usage.
- Less brine disposal is required, relative to "fixed bed" ion exchange.
- Salt used for brine generation is similar to that used for on-site chlorine generation. The CBW is accustomed to importing salt, and may realize some economies of scale in the procurement of salt for both of these processes.

Disadvantages of using MIEX are:

- The contaminant selectivity of MIEX process is limited to certain kinds and sizes of organic compounds. It adds significant expense to the overall treatment process while targeting only one specific function.
- Relative to other technologies reviewed, MIEX does not readily accommodate changes in raw water quality or finished water demand.
- The system is relatively complicated. Relatively high operator attention is needed to monitor system performance, particularly the resin regeneration process, to avoid organics fouling.
- Resin is continually lost through attrition and carry-over to downstream processes, and is expensive to replace.
- Some brine disposal is required.

5.6.2.3 Multimedia Filtration

Primary advantages of using multimedia filtration are:

- Multimedia filtration is an older, proven process, with a lot of expertise available within the water treatment profession, including: studies, operator experience, regulations, and manufacturers. By using multimedia filtration, CBW would have access to a substantial amount of experience and knowledge to draw from.
- The performance and troubleshooting capabilities of multimedia filtration are well-known.
- Multimedia filtration is effective in handling a wide range of solids and contaminant loadings.
- The multimedia filtration process offers a "regenerate-able" media cleaning process through air-scouring and backwashing. The useful life of granular media can exceed 10 to 15 years, if well-maintained.
- Relative to slow sand filtration, multimedia filter cleaning is relatively easy and quickly accomplished.

Primary disadvantages are:

- Optimizing coagulation to maximize the reduction of organics (i.e., "enhanced" coagulation) may cause finished water turbidity levels to increase.
- With the use of "enhanced" coagulation, multimedia filtration can require large quantities of chemicals and generate large amounts of waste sludge, the disposal of which adds operational costs.
- When using "enhanced" coagulation, pH adjustment is often required to produce the optimum pH at which best organics removal is achieved. Although CBW already employs this step, it complicates the overall water treatment process, especially if a pH re-adjustment is needed prior to conveying the treated water into the distribution system.
- With variable raw water quality, these technologies constantly need coagulant dosage adjustments. This need can be addressed through the use of a streaming current detector.
- The capabilities of conventional and two-stage filtration are limited in removing dissolved substances.

Comparing conventional and two-stage filtration technologies:

- Conventional filtration can treat water with higher contamination levels, and offers better dissolved solids removal. However, to achieve this better performance, conventional filtration tends to use more coagulant and generate more waste sludge.
- Conventional filtration tends to provide better control of the treatment process, but involves more process variables to do so.
- Two-stage filtration is a relatively simpler technology and tends to require less floor space than conventional filtration.
- The construction and O&M costs of two-stage filtration tend to be less relative to conventional filtration.
- Both technologies are commonly manufactured as package plants.

The turbidity levels in CBW's raw water (up to 5 NTU) are well within the treatment capability of two-stage filtration (up to 50 NTU). However, it is less effective in removing color and DOC. Therefore, it will be assumed that two-stage filtration will be used in alternatives that feature other unit processes for removing color and dissolved organic carbon. Therefore, the use of multimedia filtration will be assumed as follows:

- Alternative 1 – not applicable.
- Alternative 2 – conventional filtration.
- Alternative 3 – conventional filtration (as a biological filter).
- Alternative 4 – multimedia filtration integral to the DAF process.
- Alternative 5 –two-stage filtration.

5.6.3 Treatment Performance

5.6.3.1 MIEX

Tests have shown that MIEX alone is generally capable of removing 60% to 80% of DOC and of 40% to 90% of UVA_{254} depending on the character of organic material and "dosage" of resin. Higher removals of these constituents are generally achievable when MIEX is used in association with multimedia filtration.

MIEX performs better in removing "hydrophilic" organic matter. This type of organic matter is generally characterized by low weight molecular organics having SUVA values less than 3.0 L/mg-m. CBW's raw water exhibits SUVA values ranging between 2.9 to 3.6 L/mg-m, indicating that MIEX is very suitable for removing dissolved organic carbon in the water.

In the testing performed by Ixom on CBW's raw water (Appendix G), the use of MIEX alone provided the following removals:

- 78% of DOC.
- 69% of UVA_{254}.
- 58% of color.

When MIEX was used in association with coagulation and filtration, the following removals were achieved:

- 90% of DOC.
- 83% of UVA_{254}.
- 94% of color.

While the addition of coagulation and filtration improved removals of these constituents by 15% for DOC to over 60% for color, the coagulant dosage was in excess of 100 mg/L (using ferrous sulfate). It is further noted that the MIEX process significantly reduced the coagulant dosage while producing better DOC, UVA_{254} and color, relative to using coagulation alone. However, with the MIEX + coagulation/filtration testing, pre-filtration turbidity still increased from less than 2 NTU (raw water) to about 50 NTU. This turbidity level would be at the maximum practical loading for two-stage filtration, and at an elevated loading for conventional filtration. With conventional filtration, this turbidity would need to be substantially removed in the sedimentation step to avoid overly-frequent backwashing.

5.6.4 Multimedia Filtration

While multimedia filtration is effective in removing large amounts of suspended particulate matter, the collective experience of WTPs nationwide has shown a limited effectiveness in removing dissolved substances that cause color and form DBPs when disinfected. For alkalinities similar to CBW's, this testing showed that "enhanced" coagulation and conventional filtration generally removes between 30% and 60% of TOC, depending on coagulant dosage and characteristics of the water [24]. With CBW's low alkalinity, and raw water TOC ranging between 4 and 9 mg/L, the Disinfectant/Disinfection Byproducts Rule would require that a minimum 45% to 50% TOC be removed if "enhanced" coagulation were used.

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[24] Archer and Singer, *Evaluating the Relationship between SUVA and the Susceptibility of Water to Enhanced Coagulation using the Information Collection Rule Database,* Table 3. "Enhanced" coagulation refers to increased dosages of coagulant used to optimize removal of organics.

Two-stage filtration can generally reduce raw water turbidities ranging between 3 and 30 NTU to less than 0.1 NTU in the finished water [25]. Convention filtration can produce the same quality, but with much higher raw water turbidity (as high as 1,000 NTU). Both filtration technologies can provide greater than 99.9% removal of *Giardia* cysts [26]. Relative to technologies like ozone, dissolved air flotation, or nanofiltration, neither is effective in removing color without large coagulant dosages.

Bench testing performed individually by CRW, Ixom, and AWC Water Solutions on CBW raw water indicates that use of coagulants with multimedia filtration will not likely be amenable to achieving adequate color and organics removal of CBW water. This testing showed a need for large dosages of different types of coagulants to achieve significant color removal. Using various polymers in jar testing, CRW needed dosages of 9 to 32 mg/L to optimize coagulation, but was only able to produce modest organic and color removals in the filtered water. As noted above, in its testing for MIEX, Ixom needed in excess of 100 mg/L of the metal salt ferrous sulfate to achieve decent removal of DOC and color. Finally, testing performed by Corix (now AWC Water Solutions) indicated that well over 100 mg/L of a proprietary polyaluminum chloride and over 150 mg/L of soda ash may be needed to produce a settleable size of floc.

These results indicate a high degree of difficulty in treating highly-colored, low-turbidity water with commonly-used coagulants and granular filtration. This high coagulation effort appears to be consistent with the relatively low SUVA values noted in the raw water quality testing summary of Section 3.1.1.1. This testing also confirms the need for supplementing multimedia filtration with other unit processes in order to effectively remove the dissolved substances comprising color and organic content. For Alternative 2, the MIEX technology would provide this function.

5.6.5 Operational Complexity, Reliability, Safety and Sustainability

Assuming the unit processes of Alternative 2, as described in this section, the levels of operational considerations are anticipated as noted in Table 10.

Table 10 – Operational Considerations for Alternative 2

Process	Complexity	Reliability	Safety	Sustainability
pH Adjustment [1]	Moderate	High	High	Low
MIEX	High	Moderate	High	Low
Conventional Filtration	Moderate	Moderate	High	Moderate
On-Site Chlorination	High	High	Moderate	Moderate

Key: 1 – Assuming use of soda ash (sodium carbonate).

Descriptions of these considerations are provided in Section 5.5.4. They are further discussed in Section 6.4 in comparison to the other alternatives.

5.6.6 Certification Requirements

Operator certification requirements for Alternative 2 are summarized in Section 6.2. For Alternative 2, it is estimated that a Level III operator certification will be required.

[25] Kim, *Performance of a Two-Stage Water Treatment System Employing Contact Clarification and Filtration.*
[26] *Ibid.*

5.6.7 Environmental Impacts

Construction of the new treatment building would require drilling and blasting to the south of the project site.

5.6.8 Land Requirements

The required expansion of the water treatment facilities will occur within the existing site; however, some blasting of the bedrock face to the south of the site will be required. No additional land acquisition will be required.

5.6.9 Potential Construction Problems

No significant construction problems are anticipated. Some drilling and blasting of bedrock will likely be required for foundation work of the new treatment building.

5.7 Alternative 3 – Ozonation with MIEX and Biological Filtration

5.7.1 Description

Alternative 3 primarily features the following water treatment steps (Figures 8 and 9):

- pH adjustment using soda ash
- MIEX
- Ozonation
- Biological filtration
- Disinfection

This alternative is considered as a variation of Alternate 2, in light of CBW's forthcoming upgrade of its ozone generators. It assumes that a MIEX would be installed in between the pH adjustment and the ozone systems. Alum is assumed to be used as the coagulant, and rapid-mixed with the raw water. The use of MIEX and ozonation is assumed to allow a lower dosage of alum that would be optimized more for turbidity removal, and less for organics removal. The roughing filter building would be modified to house four biological filters in a similar configuration as for Alternative 2 (Appendix F). The existing disinfection system would be re-used and the existing slow sand filters would be converted to a serpentine clearwell for storing disinfected water after filtration.

The pH adjustment, MIEX, and disinfection steps are further described in Sections 5.5.1 and 5.6.1. The ozone and biological filtration processes are described below.

5.7.1.1 Ozonation

The ozonation process has largely been described in Section 3 and Section 5.5.1. In this section, ozonation is discussed in terms of its need to be followed by a process that removes biodegradable organics caused by the use of ozone.

Ozone is one of the most powerful oxidants used in water treatment. When dissolved in water, it strongly reacts with "oxidizable" compounds as molecular ozone (0_3) or as hydroxyl (OH-) ions that form when ozone reacts with water. The relative amounts of ozone and hydroxyl ions depend largely on the pH of the water, but both of these constituents can readily break down high molecular weight organic compounds into smaller, lower weight compounds. Portions of these compounds become characterized as "biodegradable" dissolved organic carbon (BDOC) and "assimilable" organic carbon (AOC), both of which can be metabolized by bacteria present in the treated water. If BDOC and AOC are conveyed into the distribution system, biological growth problems can develop in storage tanks and pipelines, because this carbon is food for bacteria that can persist in zones that are not well-disinfected.

To address this potential wherever ozone is used, a downstream barrier is needed to capture and substantially remove the BDOC and AOC from the water prior to it being delivered to the distribution system. Because the organic structures of BDOC and AOC are very small, processes that readily remove these forms of carbon are needed. In CBW's existing system, slow sand filtration provides this capability biologically with the *schmutzdecke,* and hence is considered to be a form of biological filtration. Newer forms of biological filtration are being increasingly used currently to enhance DOC removal performance by targeting BDOC and AOC. The conversion of multimedia filters to biological filters is a common way to achieve this objective.

5.7.1.2 Biological Filtration

Biological filtration is a variation of multimedia filtration and is operated to enhance and sustain colonies of microorganisms within the media. The high surface area provided by media particles allows bacteria to attach, grow, and biologically treat drinking water contaminants. "Biofiltration" (as this process is often called) is suitable for removing low molecular weight organics, and biodegradable contaminants such as BDOC and AOC.

Generally, the primary difference between a biofilter and a standard multimedia filter is that bacteria are permitted and encouraged to grow in a biofilter as "biofilm" on the surface of filter media particles. This technology removes dissolved substances primarily through two processes:

- Adsorption of contaminants onto the surface of media particles.
- Biodegradation of contaminants by microorganisms inhabiting sites on the media particles.

By capturing and reducing these organics through biofiltration, the water conveyed to the distribution system can be more "biologically stabilized". This means that water in the distribution system would have a lower tendency to promote biological activity that would otherwise lead to biofilm growth, accelerated corrosion, and taste and odor problems in WSTs and pipelines. Further, enhancing the removal of dissolved organics through biofiltration will tend to reduce the DBP formation potential of the water.

Factors that affect the biodegradability of organics material include:

- Character of organics: smaller, "hydrophilic" organics tend to be more readily biodegraded than "hydrophobic" organics. CBW's raw water tends to be more hydrophilic than hydrophobic; therefore, appears to be amenable to biofiltration in this regard.
- Ozone dosage: Ozone increases the biodegradability of larger, hydrophobic organics, and would tend to reduce the time needed to biologically-treat this portion of the TOC in the water.
- Contact time and temperature: Larger organic molecules require more time to be biologically-treated. Lower temperatures also tend to slow the rate of biological activity. Therefore, providing longer contact times will be more favorable for treating CBW's water. For the purpose of this PER, an "empty-bed contact time" (EBCT) of 20 minutes is assumed.
- Backwashing flow rate: Backwashing is a critical function with all forms of filtration, to clean accumulated contaminants from the surface of media particles and pores. With biofiltration, backwashing needs to be performed at flow rates higher than normal for conventional multimedia filters. Therefore, filters will likely need to be sized with extra volume to accommodate larger media expansion.

Various studies have shown that the use of GAC as media outperforms sand and anthracite media in colder water temperatures, intermittent operation, and periodic exposure to chlorine. For the purpose of this evaluation, it is assumed that GAC will be used as biofilter media. However, as the contaminant removal capabilities of GAC will depend in part on adsorption, it will need to be periodically replaced—generally every 5 to 6 years. It is, therefore, assumed for this PER that the GAC will require replacement every 5 years.

Biofilters can be operated as "rapid" media filters, with loading rates ranging from less than 2 gpm/sf up to 10 gpm/sf. For this PER, the loading rate is assumed to be 2 gpm/sf, the same as used for conventional filtration in this PER.

Alternative 3 essentially adds ozone to the overall process of Alternative 2, and the addition of ozone requires that biological filtration be included as well. Biological filtration may add some redundancy to the MIEX process in the enhanced removal of DOC, but for the purpose of this evaluation, it is considered only for removing the biodegradable and assimilable fractions of DOC generated by the use of ozone. As a variation to Alternative 3, biofiltration might be considered in conjunction with ozone usage, but without the use of MIEX. However, whether biofiltration alone can perform as well as MIEX in the enhanced removal of DOC is uncertain.

5.7.2 Advantages/Disadvantages

Advantages and disadvantages for pH adjustment, ozone, and MIEX are provided in Sections 5.5.2 and 5.6.2. This section describes the advantages and disadvantages of using ozone in combination with MIEX and biological filtration.

5.7.2.1 Ozone and MIEX

The primary advantage of the ozone and MIEX combination is:

- Enhanced water quality: ozone and MIEX provide different but complementary benefits. Ozone effectively removes color and breaks down larger organic molecules into smaller organic molecules. MIEX alone does not remove color as well as ozone, but does effectively remove smaller-weight dissolved organics. Using MIEX upstream of ozone tends to lower the ozone demand. Using ozone in front of MIEX tends to improve the amount of dissolved organics targeted by MIEX.

The primary disadvantage of the ozone and MIEX combination is:

- Increased operational costs and complexity: both technologies feature components and systems that require significant degree of proprietary manufacturer support during breakdowns and malfunctions. Therefore, providing on-the-floor redundancy would be beneficial to keep the WTP in service during any repairs of these facilities.

5.7.2.2 Biological Filtration

Primary advantages of biological filtration are:

- Biological filtration is a natural process that can enhance the treatment of water when it is working as intended. Biofiltration is effective in removing dissolved organics, pesticides, and taste-and-color compounds.

- Biofiltration removes biodegradable organics to decrease and control biofilm-related problems in the distribution system.
- Biofilters are operated very much like standard multimedia filters and are relatively easy and inexpensive to operate and implement by retrofitting existing multimedia filters.
- Operated like multimedia filters, biofilters can be "ripened" much quicker (several hours) after backwashing, relative to slow sand filtration after removal of the *schmutzdecke* (up to 16 weeks).

Primary disadvantages of biological filtration are:

- Increased headloss accumulation or reduced filter run times over the course of using biofiltration, if the backwashing process is not able to substantially clean the media.
- With higher backwashing rate for cleaning filter media, backwash pumping costs will be higher.
- Potential for conveying increased concentrations of bacteria into the filter effluent if filters are not operating correctly. This issue increases the disinfectant demand.
- Potential for undesirable biofilm or algal growth in various locations within the treatment works, which may require periodic applications of disinfectant.
- Need to replace GAC media on a periodic basis, which significantly increases operational costs.

5.7.3 Treatment Performance

The treatment performance of ozone and MIEX are described in Sections 5.5.3 and 5.6.3, respectively. When used together, they can improve the water quality by enhancing the removal of organics at "dosage" rates that are reduced relative to each technology being used alone. Both technologies were jar tested together by Ixom in two different sequences, with the results provided in Table 11.

Table 11 – Ozone-MIEX Sequence Comparisons

Parameter	Ozone before MIEX	MIEX before Ozone
Relative to Raw Water		
DOC	Reduced by 66%	Reduced by 49%
UVA_{254}	Reduced by 62%	Reduced by 52%
Color	Reduced by 71%	Reduced by 100%
Relative to MIEX Alone		
DOC	Reduced by 29%	Increased by 6%
UVA_{254}	Reduced by 26%	Reduced by 10%
Color	Reduced by 10%	Reduced by 100%

The ozone preceding MIEX sequence provided better removals of DOC and UVA_{254} relative to the MIEX preceding ozone sequence (Table 11). Conversely, the latter sequence provided better removals of color. Color was better removed with MIEX preceding ozone, because the ozone demand was partially alleviated by MIEX removing some of the color beforehand.

Relative to using MIEX alone (see Section 5.6.3), these results show that using ozone with MIEX improved the removal of DOC, UVA_{254}, and color for all categories except for when MIEX preceded ozonation. In that exception, using MIEX alone provided better DOC removals. This converse result could be due to changes in organic structures caused by ozone that are not readily removed by the MIEX process.

For the purpose of this evaluation, the sequence of ozone preceding MIEX was assumed, due to better removals of DOC and UVA_{254}. In this sequence, color removal could still be enhanced with an increased dosage of ozone. The ozone dosage in the testing was well within CBW's maximum dosage range.

5.7.4 Operational Complexity, Reliability, Safety and Sustainability

Assuming the unit processes of Alternative 3, as described in this section, the levels of operational considerations are anticipated as noted in Table 12.

Table 12 – Operational Considerations for Alternative 3

Process	Complexity	Reliability	Safety	Sustainability
pH Adjustment [1]	Moderate	High	High	Low
MIEX	High	High	High	Low
Ozonation	High	High	Low	Low
Biological Filtration	Moderate	Moderate	High	Moderate
On-Site Chlorination	High	High	Moderate	Moderate

Key: 1 – Assuming use of soda ash (sodium carbonate).

Descriptions of these considerations are provided in Section 5.5.4. They are further discussed in Section 6.4 in comparison to the other alternatives.

5.7.5 Certification Requirements

Operator certification requirements for Alternative 3 are summarized in Section 6.2. For Alternative 3, it is estimated that a <u>Level III</u> operator certification will be required without on-site treatment of backwashing wastes. If on-site wastewater treatment is pursued, then a <u>Level IV</u> operator certification would be needed.

5.7.6 Environmental Impacts

Construction of the new treatment building would require drilling and blasting to the south of the project site.

5.7.7 Land Requirements

The required expansion of the water treatment facilities will occur within the existing site; however, some blasting of the bedrock face to the south of the site will be required. No additional land acquisition will be required.

5.7.8 Potential Construction Problems

No significant construction problems are anticipated. Some drilling and blasting of bedrock will likely be required for foundation work of the new treatment building.

5.8 Alternative 4 – Dissolved Air Flotation (DAF) with Multimedia Filtration

5.8.1 Description

Alternative 4 primarily features the following water treatment steps (Figures 10 and 11):

- pH adjustment using soda ash
- DAF
- Multimedia filtration
- Disinfection

This alternative assumes that two parallel DAF plants would be installed downstream of the pH adjustment system in the roughing filter building, which would be modified to suit the DAF process. The two package plants would integrate both DAF and multimedia filtration on the same skid (Photo 5). Alum is assumed as the coagulant, and rapid-mixed with the raw water. The use of DAF is assumed to allow a lower dosage of alum due to the efficiencies of flotation. The existing disinfection system would be re-used and the existing slow sand filters would be converted to a serpentine clearwell for storing disinfected water after filtration.

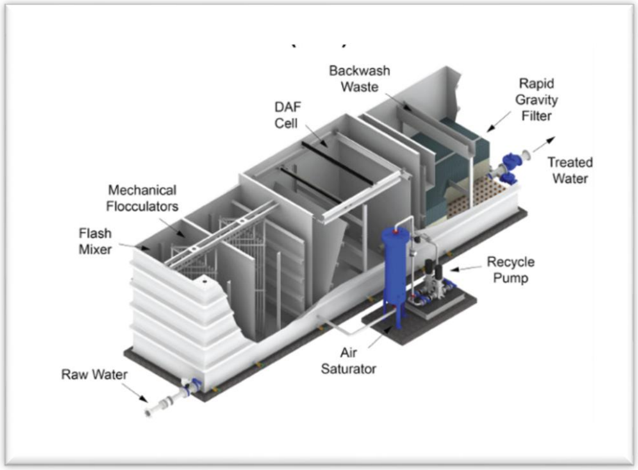


Photo 5 DAF Package Plant

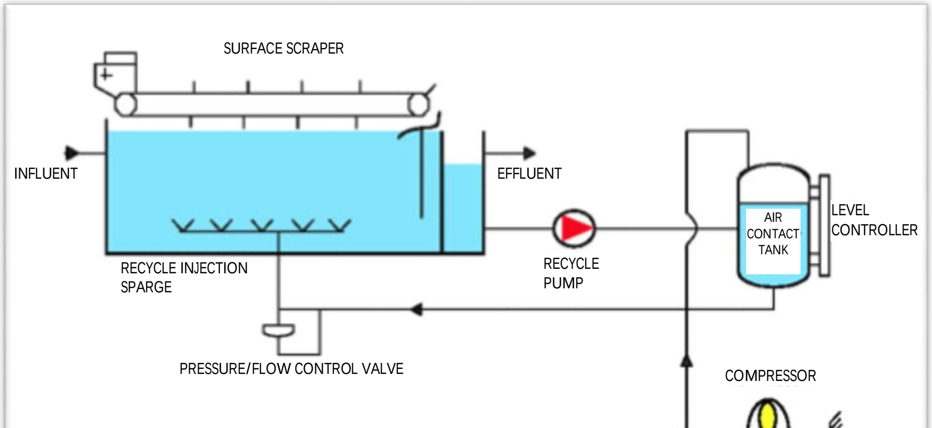
The pH adjustment and disinfection steps are described in Section 5.5.1, the multimedia filtration process is described in Section 5.6.1. DAF is described below.

5.8.2 Dissolved Air Flotation with Multimedia Filtration

DAF is a pre-filtration process that uses the introduction of minute air bubbles to suspend low-density solids like algae and organic compounds, which facilitate the removal of these contaminants from the water treatment stream. These compounds are typically difficult to remove by sedimentation processes, because they settle very slowly, especially when water temperatures are colder. With sedimentation, coagulants are used to increase the mass of these compounds and increase their ability to settle out of the treatment flow and be disposed of. Further, the sedimentation process needs to operate with slower flow rates when water temperatures are relatively cold.

DAF is an effective alternative to sedimentation, as the targeted compounds are floated instead of settled, and are subsequently skimmed from the water surface. With the use of flotation, smaller coagulant dosages can be used to remove contaminants, because it is generally easier to float suspended particles out of the process flow rather than sinking them. With DAF providing a more efficient removal process, the required treatment time can be made considerably shorter than for the sedimentation process. Consequently, DAF flow rates are typically higher, and the equipment can be made smaller relative to conventional filtration.

The upstream end of the DAF process (Photo 6) resembles that of conventional filtration, with rapid mixing and coagulant injection, followed by flocculation basins. These steps are followed by a flotation tank into which tiny air bubbles are released. The air bubbles collide and attach to flocculated particles, carrying them to the water surface where they accumulate and are mechanically skimmed into a collection channel and then conveyed to a hopper or dewatering bin. Within the hopper or bin, the water content is reduced, thereby thickening the solids into smaller volumes of sludge to facilitate disposal. The DAF process is then followed by a multimedia filtration step to receive the filtration credits required for CBW's surface water source. Since DAF is a *pre-treatment* process, it is considered integrally with multimedia filtration for the purposes of evaluating this alternative.



Based on Watericon Diagram

Photo 6 DAF Process Diagram

The floating sludge layer is periodically removed by a mechanical surface skimmer. The DAF sludge would be dewatered with a centrifuge or screw press system. The dewatered sludge would be placed in bins and allowed to further dewater over the period of two months, after which a solids content of 40% to 50% is typically achieved. After the two-month dewatering stage, the sludge would be transported to the landfill for final disposal.

5.8.3 Advantages/Disadvantages

Advantages and disadvantages for pH adjustment and multimedia filtration are provided in Sections 5.5.2 and 5.6.2, respectively. This section describes the advantages and disadvantages of using DAF in combination with multimedia filtration.

5.8.3.1 Dissolved Air Flotation with Multimedia Filtration

Primary advantages of DAF are:

- DAF provides better removals of low-density particles (i.e., flocculated solids) and algae that can otherwise cause short filter runs in conventional filtration. Consequently, lower dosages of coagulants and shorter flocculation times can be used to provide and equal or better treatment performance.
- DAF is a resilient process that can produce consistently good water quality, given considerable variability in TOC, turbidity, and temperature.
- When integrated with multimedia design, higher filtration rates or longer filter runs can be obtained with DAF compared to those obtained after clarification by sedimentation.

- DAF typically requires a smaller equipment footprint relative to conventional filtration and generally has lower capital costs.

Primary disadvantages of DAF are:

- Relatively higher power costs from pumping recycle water and discharging air into the flotation tank.
- DAF produces a greater amount of sludge solids to dispose of relative to conventional filtration. However, this is a result of more effective solids removal.
- The use of additional subsystems, such as air injection and skimming sludge removal, increases the complexity of DAF relative to conventional filtration.

5.8.4 Treatment Performance

5.8.4.1 Dissolved Air Flotation with Multimedia Filtration

DAF is more efficient in removing low-density floc than sedimentation processes like conventional filtration. Effluent turbidities ranging between 0.2 and 0.5 NTU are commonly achieved with DAF prior to multimedia filtration [27]. This technology is particularly effective in removing algae and pathogens like *Giardia* and *Cryptosporidium*, and can also strip some taste and odor compounds from the water.

DAF works well for treating raw water having average turbidities between 0 and 10 NTU, with occasional spikes as high as 50 NTU, and TOC levels ranging between 0 and 14 mg/L [28]. Depending on the coagulation dosage used and flotation time, DAF can also remove high levels of color to below ADEC's secondary MCL of 15 units. In 2011, DAF was recommended as the primary treatment process for a water utility in Lake McNeil, British Colombia, with surface water having the following parameters (similar to CBW's raw water): 7 to 10 mg/L of alkalinity as $CaCO_3$; pH = 6.5 to 6.7; 11 to 38 units of true color; 1 to 8.5 NTU turbidity; and 55% to 68% of ultraviolet transmissivity (0.26 to 0.17 cm^{-1} UVA_{254}). In this pilot testing, over 90% removals of true color and UVA_{254} were achieved [29].

5.8.5 Operational Complexity, Reliability, Safety and Sustainability

Assuming the unit processes of Alternative 4 as described in this section, the levels of operational considerations are anticipated as noted in Table 13.

Table 13 – Operational Considerations for Alternative 4

Process	Complexity	Reliability	Safety	Sustainability
pH Adjustment[1]	Moderate	High	High	Low
DAF w/ Multimedia Filtration	High	Moderate	High	Moderate
On-Site Chlorination	High	High	Moderate	Moderate

Key: 1 – Assuming use of soda ash (sodium carbonate).

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[27] Edzwald and Haarhoff, *Dissolved Air Flotation for Water Clarification,* 2012, AWWA.
[28] *Ibid*.
[29] HDR Engineering, Inc., *Selecting an Advanced Pretreatment Process for Removal of Color and TOC at Lake McNeil, British Columbia,* 2011 AWWA Conference Proceedings.

Descriptions of these considerations are provided in Section 5.5.4.

5.8.6 Certification Requirements

Operator certification requirements for Alternative 4 are summarized in Section 6.2. For Alternative 4, it is estimated that a Level III operator certification will be required without on-site treatment of backwash water. Much of the scoring that leads to this level rating is due to the DAF process alone, as ADEC evidently views this technology as being particularly complicated. If on-site wastewater treatment is pursued, then a Level IV operator certification would be needed.

5.8.7 Environmental Impacts

Construction of the new treatment building would require drilling and blasting to the south of the project site.

5.8.8 Land Requirements

The required expansion of the water treatment facilities will occur within the existing site; however, some blasting of the bedrock face to the south of the site will be required. No additional land will be required.

5.8.9 Potential Construction Problems

No significant construction problems are anticipated. Some drilling and blasting of bedrock will likely be required for foundation work of the new treatment building.

5.9 Alternative 5 – Nanofiltration with Multimedia Filtration

5.9.1 Description

Alternative 5 primarily features the following water treatment steps (Figures 12 and 13):

- pH Adjustment (Raw Water)
- Oxidation by Potassium Permanganate
- Multimedia Filtration (Two-Stage)
- Nanofiltration
- pH adjustment (Finished Water)
- Disinfection

This alternative assumes that a nanofiltration system would be installed downstream of two-stage filtration, all of which would be located in a modified version of the roughing filter building. A pH adjustment system using soda ash and potassium permanganate oxidations step would precede the filtration process. The soda ash would provide sufficient alkalinity for the coagulation process. Alum is assumed as the coagulant. The existing disinfection system would be re-used and the existing slow sand filters would be converted to a serpentine clearwell for storing disinfected water after filtration. A second pH adjustment step featuring soda ash would downstream of the clearwell for increasing alkalinity in the water of the distribution system.

The pH adjustment and disinfection steps are described in Section 5.5.1. The multimedia filtration process is described in Section 5.6.1. Nanofiltration is described below.

Nanofiltration is a membrane filtration technology that is continuing to experience growing usage in the water treatment industry. As a physical separation process, this technology effectively removes dissolved contaminants from water, including colloidal substances like DOC and color, and microbes as small as viruses. As a result, excellent water quality is produced and disinfectant dosages are significantly decreased because pathogens and organics are substantially removed as water passes through the membranes.

Relatively high system pressures (70 to 150 psig) are needed to force water through nanofilter membranes, and, as a result, a significant amount of "reject" water can be generated that will require disposal (10% to 25% of the treatment flow). Since nanofilter membranes have pores that are molecular in size, they are prone to becoming fouled by suspended solids, such as iron and manganese. Hence, pre-treatment processes, like multimedia filtration and anti-scalant injection, are frequently needed upstream of the nanofiltration process to remove substances that can otherwise cause pre-mature clogging of the membranes. Further, as nanofiltration will also remove alkalinity from the water, a post-treatment pH adjustment process using soda ash will be needed after nanofiltration to add it back into the water upstream of the distribution system.

Photo 7 300 gpm Corix Nanofiltration & Filter Plant

The process envisioned for CBW would feature a two-stage ("adsorption-clarifier") filtration unit, followed by two parallel nanofiltration package systems (Photo 7). The two-stage filter would provide removal of suspended solids, including iron and manganese. In addition to a coagulant for turbidity removal, potassium permanganate would be injected upstream of the filter to oxidize iron and be used as a regenerant for the filter media. Anthracite and greensand would be used as the media in this filter to capture the suspended solids, oxidized iron and dissolved manganese. Filter effluent would then be conveyed to the nanofiltration plants.

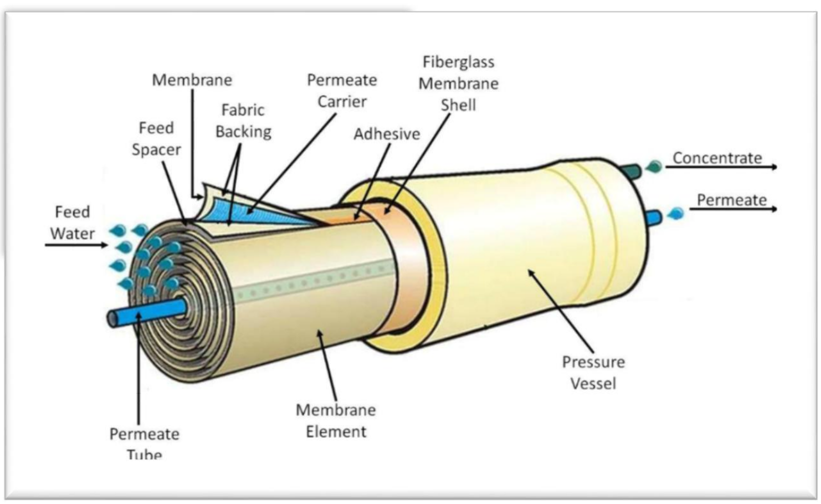

Photo 8 Membrane Element

Nanofiltration plants are typically comprised of modularized racks of membrane elements, the number of which increases proportionally to WTP flow rate and inversely proportional to the "flux" rate that will pass through each membrane element. Membrane elements (Photo 8) are commonly configured as plates or tubes, depending on the manufacturer. Spiral-wound or hollow-fiber tubular elements are most commonly used in treatment applications. Water that passes through the membranes is collected into a central conduit within each element and then conveyed downstream to the next process as “permeate”. Rejected contaminant-laden water is conveyed out of each element through a separate conduit as “concentrate” and sent to waste or is recycled.

The pH adjustment will need to be monitored throughout the process upstream of nanofiltration, and acid added if needed to lower the pH to within the range targeted for operation. Alkalinity will need to be added after nanofiltration, because it will be consumed during the filtration process.

5.9.2 Advantages/Disadvantages

Advantages and disadvantages for pH adjustment and multimedia filtration are provided in Sections 5.5.2 and 5.6.2, respectively. This section describes the advantages and disadvantages of using nanofiltration.

5.9.2.1 Nanofiltration

Primary advantages of nanofiltration are:

- By virtue of its ability to block out nearly all the contaminants targeted by CBW, including organics, bacteria, and viruses, nanofiltration will likely provide the highest quality of all the technologies reviewed in this evaluation.
- When working as intended, nanofiltration can be a very reliable process in providing superior water quality, as little operator intervention is needed to provide excellent contaminant removals.

Primary disadvantages of nanofiltration are:

- High pressures are needed to convey water through the membranes, which tends to increase capital and operational costs.
- A substantial, upstream pre-treatment process is typically needed, especially with surface water sources. This pre-treatment process will impose additional operation costs on CBW, especially with the use of chemicals.
- Alkalinity addition will be needed after nanofiltration, which would add considerable chemical costs.
- Significant quantities of wastewater will be generated that need to be disposed of. Wastewater generation represents an inefficiency of the water treatment process. The efficiency that CBW can expect with the use of nanofiltration is recovering 75% to 90% of the water it treats.
- Membrane replacement can manifest into very high replacement costs that typically requires water utilities to conduct long-term financial planning in preparation for their purchase and installation.
- Membranes are vulnerable to constituents that might be present in the raw water, such as calcium, silica, iron, manganese, and organics, which may shorten membrane life. Application of acid washing or an anti-scalant may be needed to control the adsorption or precipitation of these constituents onto the membrane material.
- Nanofiltration is a relatively complex technology to operate due to its level of sophistication, and requires a great deal of operational knowledge of its various systems. For example, daily

membrane integrity testing is typically needed to protect against contaminant breakthrough. Acid washing and the application of an anti-scalant also increases operational complexity.

5.9.3 Treatment Performance

5.9.3.1 Nanofiltration

Nanofiltration can provide in excess of 5 log removals of both *Giardia* and *Cryptosporidium* and between 70% to 95% removals of TOC and corresponding DBP formation potential [30]. Upstream of nanofiltration, turbidity, iron, and manganese would be removed by two-stage filtration, which is capable of reducing these contaminants to well below the MCLs.

5.9.4 Operational Complexity, Reliability, Safety and Sustainability

Assuming the unit processes of Alternative 5 as described in this section, the levels of operational considerations are anticipated as noted in Table 14.

Table 14 – Operational Considerations for Alternative 5

Process	Complexity	Reliability	Safety	Sustainability
pH Adjustment, Raw Water[1]	Moderate	High	Low	Moderate
Multimedia Filtration	Moderate	Moderate	High	Moderate
Nanofiltration	High	High	Moderate	Low
pH Adjustment, Finished Water[1]	Moderate	High	High	Low
On-Site Chlorination	High	High	Moderate	Moderate

Key: 1 – Assuming use of soda ash.

Descriptions of these considerations are provided in Section 5.5.4. They are further discussed in Section 6.4 in comparison to the other alternatives.

5.9.5 Certification Requirements

Operator certification requirements for Alternative 4 are summarized in Table 18, Section 6.2. For Alternative 5, it is estimated that a Level III operator certification would be required without on-site treatment of plant-generated wastes. If on-site wastewater treatment is pursued, then a Level IV operator certification would be needed.

5.9.6 Environmental Impacts

Construction of the new treatment building would require drilling and blasting to the south of the project site.

[30] Environmental Protection Agency, *Technologies and Costs Document for the Final LT2ESWTR and Final Stage 2 D/DBPR*, EPA 815-R-05-013, Dec 2005.

5.9.7 Land Requirements

The required expansion of the water treatment facilities will occur within the existing site. No additional land acquisition will be required.

5.9.8 Potential Construction Problems

No significant construction problems are anticipated. Some drilling and blasting of bedrock will likely be required for foundation work of the new treatment building.

5.10 Alternative 6 – No Action

The No Action alternative does not meet the CBW's need for long term, reliable, and safe water treatment facilities.

5.11 Backwash Waste Disposal

The backwash waste from each of the Alternatives 1 through 5 is required to be disposed of in accordance with ADEC wastewater regulations. Several alternatives (A1, A2, B, C and D) are presented below for disposal of backwash waste.

Under all of the backwash waste disposal alternatives backwash waste water from the WTP would be piped to an insulated above-ground bolted steel storage tank. Polymer would be injected into the backwash waste water to improve settling of solids in the clarifier tank. Various disposal alternatives are presented for the clarified backwash water.

Under all of the alternatives backwash sludge would undergo primary dewatering with a centrifuge system and secondary dewatering over the course of one to two months through evaporation and gravity drain in outside covered containers. The dewatered sludge would be transported by ocean freight to a landfill facility in eastern Washington (used by CBW for all municipal refuse disposal).

5.12 Backwash Waste Disposal Alternative A1 – Sewer Extension to WWTP (Buried)

5.12.1 Description

Under this alternative, sewer service would be extended uphill from the wastewater treatment plant (WWTP) to the WTP (Figure 14). This would require construction of approximately 1,300 linear feet of buried gravity sewer main. Construction of the sewer main would require clearing and blasting along the proposed alignment. The gravity sewer main would connect to the WWTP where backwash wastewater would be treated.

5.12.2 Advantages/Disadvantages

The primary advantages of this alternative are:

- Most direct route for extension of sewer service to the WTP.
- Treatment of backwash water would occur at the existing WWTP.

The primary disadvantages of this alternative are:

- Would require clearing forest and some drilling and blasting along the proposed pipeline alignment

5.12.3 Environmental Impacts

Clearing would be required along the pipeline alignment. Some drilling and blasting may be required to accommodate the buried pipeline.

5.12.4 Land Requirements

The proposed pipeline alignment would be routed to the WWTP through property owned by CBW, so no additional land acquisition would be required.

5.12.5 Potential Construction Problems

The gravity sewer alignment will be routed along steep terrain from the WTP to the WWTP, so some degree of difficulty is anticipated during construction.

5.13 Backwash Waste Disposal Alternative A2 – Sewer Extension to WWTP (Above Grade)

5.13.1 Description

Under this alternative, sewer service would be extended uphill from the WWTP to the WTP (Figure 14). This would require construction of approximately 1,300 linear feet of gravity sewer main. The pipeline would be above ground, supported by timber sleepers and secured with duckbill or drilled epoxy anchors (depending on depth of bedrock). The pipeline would be insulated and would have electric heat trace to provide freeze protection during the coldest times of the year. The gravity sewer main would connect to the WWTP where clarified backwash wastewater would be treated.

5.13.2 Advantages/Disadvantages

The primary advantages of this alternative are:

- Most direct route for extension of sewer service to the WTP.
- Treatment of backwash water would occur at the existing WWTP.

The primary disadvantages of this alternative are:

- Heat trace and insulation required for aboveground pipeline.
- Would require clearing forest along the proposed pipeline alignment.

5.13.3 Environmental Impacts

Clearing would be required along the pipeline alignment.

5.13.4 Land Requirements

The proposed pipeline alignment would be routed to the WWTP through property owned by CBW, so no additional land acquisition would be required.

5.13.5 Potential Construction Problems

The gravity sewer alignment will be routed along steep terrain from the WTP to the WWTP, so some degree of difficulty is anticipated during construction.

5.14 Backwash Waste Disposal Alternative B – Extend Sewer Service from Zimovia Highway

5.14.1 Description

Under this alternative, sewer service would be extended from the Zimovia Highway, along Wood Street to the WTP (Figure 14). This would require construction of approximately 3,100 linear feet of gravity sewer main. The pipeline alignment would be routed inside the existing road corridor.

5.14.2 Advantages/Disadvantages

The primary advantages of this alternative are:

- Construction would occur within the road corridor, which would not require additional clearing.
- Treatment of backwash water would occur at the existing WWTP.

The primary disadvantages of this alternative are:

- Less direct route than Alternative A1 and A2.

5.14.3 Environmental Impacts

The pipeline alignment would be routed through the existing road corridor, so environmental impacts would be minimal.

5.14.4 Land Requirements

The proposed pipeline alignment would be routed through the existing Wood Street road corridor, so no additional land acquisition would be required.

5.14.5 Potential Construction Problems

No significant construction problems are anticipated.

5.15 Backwash Waste Disposal Alternative C – Marine Outfall

5.15.1 Description

Similar to the other alternatives, the backwash waste water from the WTP would be piped to an insulated, above-ground, bolted steel storage tank (Figure 15). The clarifier would allow solids to settle between backwash cycles. Supernatant from the clarifier would then be routed through a pipeline to a marine outfall for discharge. This would require construction of approximately 2,000 LF of gravity sewer main.

Accumulated backwash sludge would be periodically removed from the clarifier tank, dewatered, and disposed of.

5.15.2 Advantages/Disadvantages

The primary advantages of this alternative are:

- Would not require extension of sewer service to the WTP site.

The primary disadvantages of this alternative are:

- Would require clearing forest along the proposed pipeline alignment.

- Would require an additional discharge permit from ADEC and additional monthly effluent sampling.
- Treatment of backwash water would occur onsite and CBW would be responsible for removal and disposal of sludge from the clarifier chambers, which would involve work in a confined space environment.

5.15.3 Environmental Impacts

Clearing would be required along the pipeline alignment.

5.15.4 Land Requirements

The backwash clarifier tank would be constructed on the existing site. The sewer outfall line would be routed through land owned by CBW.

5.15.5 Potential Construction Problems

The alignment of the sewer line would be through steep terrain, so some degree of difficulty is anticipated during construction.

5.16 Backwash Waste Disposal Alternative D – Recycle of Backwash Water

5.16.1 Description

Similar to the other alternatives, the backwash waste water from the WTP would be piped to an insulated, above-ground, bolted steel storage tank. Polymer would be injected into the backwash waste water to improve settling of solids in the clarifier tank. Supernatant from the clarifier would be routed to the water treatment process, upstream of the treatment process and raw water chemical injection. The recycled backwash water would be blended with influent raw water and undergo treatment through the selected filter system (Figure 16).

5.16.2 Advantages/Disadvantages

The primary advantages of this alternative are:

- Backwash water would be recycled, increasing the overall treatment efficiency.

The primary disadvantages of this alternative are:

- Treatment of backwash water would occur onsite and CBW would be responsible for removal and disposal of sludge from the clarifier chambers, which would involve work in a confined space environment.

5.16.3 Environmental Impacts

Minimal environmental impact is anticipated with this alternative.

5.16.4 Land Requirements

The backwash clarifier would be constructed on the existing site.

5.16.5 Potential Construction Problems

No construction problems are anticipated.

6 Selection of an Alternative

The various alternatives are compared in this section in the following terms:

- Capital, O&M, and Life Cycle Costs
- Operator Certifications
- Use of a Selection Matrix

The selection matrix numerically ranks all the major considerations made in this assessment and, from this exercise, determines a "preferred" alternative. A discussion of this selection process follows the matrix.

6.1 Capital, O&M, and Net Present Value

Capital, O&M and life cycle costs were estimated to compare the relative expense of each alternative. *Capital* costs refer to the estimated costs needed to design and construct the proposed facilities. *O&M* costs are those estimated for operation the facility, including: labor; repairing and replacing malfunctioning or worn-out components; and procurement of consumables, such as power and chemicals. *Net Present Value (NPV)* costs combine capital and O&M costs to compare the theoretical sum of the capital cost, plus the present worth of a uniform series of annual O&M costs.

For comparative purposes, capital costs include only construction costs, including 15% for contractor overhead and profit, as well as a 3% bonding and insurance fee. Total costs assume a 15% contingency to generally account for details that are not ordinarily identified in this level of conceptual evaluation. Design, project management, and administration costs are included in these estimates.

The O&M costs are based on providing the future peak flow of 1.8 mgd. CBW's existing O&M costs are based on providing the current peak flow rate of 1.3 mgd. The only conclusion that can be generally made in comparing existing O&M costs with those of each alternative is that operating costs will, over the life of the improvements increase significantly, especially those alternatives in which large dosages of chemicals are featured.

Table 15 summarizes the capital, O&M, and NPV costs. A net present worth, or life cycle cost analysis, is a technique used to compare alternatives. Also known as a NPV, the analysis identifies the cost of owning and operating an asset for the entirety of its lifespan. The NPV equation and variables are defined as:

$$NPV = C + USPW(O\&M) - SPPW(S)$$

Where *C* is the estimated capital cost of the alternative, *USPW* is the uniform series present worth factor applied to the annual *O&M* costs of the alternative and *SPPW(S)* is the single payment present worth of the salvage value, which, for this project, is assumed to be zero.

The USPW is a function of the OMB "real" discount rate (i) and the lifespan of the asset (n). For a 20-year life (n=20), the discount rate is 1.2%.

Detailed breakdowns of capital and O&M costs are provided in Appendix H.

Table 15 – Comparison of Costs

Cost	Alt 1 – Improve Existing	Alt 2 – MIEX + CF	Alt 3 – MIEX + Ozone + BF	Alt 4 – DAF + Filtration	Alt 5 – Nano + TS Filtration
Capital Cost	$12,543,000	$12,216,000	$13,712,000	$8,191,000	$8,185,000
Annual O&M Cost	$260,646	$351,711	$403,007	$289,614	$417,079
NPV	$17,153,130	$18,436,813	$20,840,101	$13,313,496	$15,561,998

Key: CF - Conventional Filtration
BF - Biological Filtration
TS - "Two-Stage" Filtration

This analysis indicates that Alternative 4 (DAF with Multimedia Filtration) has the lowest life cycle cost of the five alternatives, with relatively low capital and O&M costs. Alternative 1 (Improve Existing Process) offers the second lowest O&M costs, but has one of the highest capital costs, which include the construction of additional concrete basins for slow sand filtration and roughing filtration and the upsizing of various equipment items. As shown in Appendix H, the capital cost of Alternative 1 would be considerably greater with a water recapture tank, associated pumps and piping, and a slow sand filter cleaning system included.

In the consideration of O&M costs, water wasting was reviewed in terms of revenue loss. Treated water lost in the course of cleaning filters (all alternatives) and in the rejection of contaminants (Alternative 5) is assumed to be wasted and not available for re-treatment and subsequent usage in the community. Although this loss of revenue does not strictly represent an O&M cost, it is nevertheless viewed as a cost to account for the influence that water treatment inefficiency has on establishing water rates. Without this revenue, the community would need higher water rates to cover the overall cost of operating the WTP. This revenue loss is assumed to be computed as gallons of non-salable water multiplied by the average per-gallon treatment cost of water. Table 16 summarizes this review.

Table 16 – Comparison of O&M Costs Including Water Wasting

Cost	Alt 1 – Improve Existing	Alt 2 – MIEX + CF [1]	Alt 3 – MIEX + Ozone + BF [2]	Alt 4 – DAF + Filtration	Alt 5 – Nano + TS [3] Filtration
O&M	$260,646	$351,711	$403,007	$289,614	$417,079
Non-salable Water	$40,438	$35,740	$45,584	$26,989	$101,573
Total	$301,084	$387,450	$448,591	$316,603	$518,652

Key: Non-salable Water includes process waste and non-potable water.
CF - Conventional Filtration
BF - Biological Filtration
TS - "Two-Stage" Filtration

Alternative 4 has the lowest O&M cost, and would also provide the smallest loss of revenue associated with non-salable water. This benefit is due to the efficiency of the DAF process, which tends to result in less volume backwashing relative to conventional filtration. Alternative 5 would present the largest impact to water utility revenues. For this alternative, backwashing and nanofiltration reject water streams represent the largest loss of water.

A NPV analysis for the backwash water disposal alternatives is presented in Table 17. The alternative with the lowest NPV is Alternative A2– Sewer Extension to WWTP (Above Grade).

Table 17 – Comparison of Costs for Backwash Water Disposal

Cost	Alt A1 – Sewer Extension to WWTP (Buried)	Alt A2 – Sewer Extension to WWTP (Above Grade)	Alt B – Sewer Extension to Zimovia Hwy	Alt C – Marine Outfall	Alt D – Backwash Recycle
Capital Cost	$1,659,000	$1,574,000	$2,411,000	$1,934,000	$860,000
Annual O&M Cost	$3,500	$5,805	$4,600	$3,600	$2,761
NPV	$1,720,906	$1,676,683	$2,492,362	$1,997,674	$908,839

6.2 Operator Certification

Operator certification requirements are imposed on community water systems by ADEC to ensure that operators have a minimum level of technical understanding for drinking water treatment. Currently, the classification system is rated by the following scoring ranges:

- Class I: 1 to 30 points.
- Class II: 31 to 55 points.
- Class III: 56 to 75 points.
- Class IV: 76 points and above.

Table 18 estimates certification requirements for various treatment scenarios. As made evident in the table, adding treatment process components tends to increase the classification score. It is important to note that the scoring estimates shown in Table 18 do not necessarily reflect the score that would be determined by ADEC.

Table 18 – Comparison of Operator Certification Levels

Component Category [1]	Existing System	Alt 1 - Improve Existing	Alt 2 – MIEX + CF	Alt 3 – MIEX + Ozone + BF	Alt 4 – DAF + Filtration	Alt 5 – Nano + TS Filtration
System Size (1.3 mgd)	16	--	--	--	--	--
System Size (2.0 mgd)	--	16	16	16	16	16
Surface Water Source	6	6	6	6	6	6
Pretreatment - Roughing Filter, Gravel or Rock	4	--	--	--	--	--
Pretreatment - Roughing Filter, Backwashable Granular Media	--	8	--	--	--	--
pH Adjustment	3	3	3	3	3	3

Component Category [1]	Existing System	Alt 1 - Improve Existing	Alt 2 – MIEX + CF	Alt 3 – MIEX + Ozone + BF	Alt 4 – DAF + Filtration	Alt 5 – Nano + TS Filtration
Potassium Permanganate Oxidation	--	--	--	--	--	4
Ion Exchange	--	--	4	4	--	--
Ozonation	10	10	--	10	--	--
Coagulation - Primary	--	--	5	5	5	5
Rapid Mix - In-Line Static	1	1	1	1	1	1
Mechanical Flocculator	--	--	8	8	8	8
Clarification Process - Tube or Inclined Plate Settlers	--	--	2	2	--	2
Clarification Process - DAF	--	--	--	--	16	--
Filtration - Slow Sand	4	4	--	--	--	--
Filtration - Granular Media	--	--	8	8	8	8
Filtration - Membrane Nanofiltration	--	--	--	--	--	10
Disinfection - Sodium Hypochlorite, Generated On-site	5	5	5	5	5	5
Clearwell	3	3	3	3	3	3
SUBTOTAL SCORE	52	56	61	71	71	71
SYSTEM CLASS	II	III	III	III	III	III
On-site Treatment of Sludge or Backwash	0	6	6	6	6	6
TOTAL SCORE	52	62	67	77	77	77
SYSTEM CLASS	II	III	III	IV	IV	IV

Key: 1 – 18 AAC 74, *Water and Wastewater Operator Certification and Testing*, Section 120.
CF - Conventional Filtration
BF - Biological Filtration
TS - "Two-Stage" Filtration

The scoring estimates a Level II certification requirement for the existing CBW treatment system. If the existing system were to be upgraded as described in this evaluation, a Level III certification would be required. The new processes featured in Alternatives 2, 3, 4, and 5 would require Level III certifications and, if on-site backwash and wastewater treatment is pursued by CBW, then Level IV certifications would be required for Alternatives 3, 4, and 5.

If additional coagulants are needed for any of the future scenarios, such as a filter-aid, a score of 3 would be added for each coagulant used, up to a maximum of 12 points for the category. The conventional filtration scenario assumes that a filter aid is not used; however, its usage would not appear to increase the certification requirements for any of the alternatives as envisioned in this evaluation.

To achieve the required certification level, both education and experience are required. Per ADEC's certification regulations for water treatment [31]:

- Level II operators are required to have 12 years of education and 3 years of operation experience.
- Level III operators are required to have 14 years of education and 4 years of operation experience.
- Level IV operators are required to have 16 years of education and 4 years of operation experience.

However, the following equivalencies may be considered by ADEC:

- A year of post-secondary education needed by Level III and IV operators can be counted as a year of trade school, or if the operator receives 45 ADEC-approved continuing education credits (CEUs).
- Two years of accrued excess water treatment experience at a Class II or higher water treatment facility may be used to satisfy up to one year of the post-secondary education requirement for Level III water treatment certification.
- Four years of accrued excess water treatment experience at a Class III or higher water treatment facility may be used to satisfy up to two years of the post-secondary education requirement for Level IV water treatment certification.

Further details on certification requirements and equivalence are found in 18 AAC 74, *Water and Wastewater Operator Certification and Testing.*

6.3 Selection Matrix

The relative advantages and disadvantages of the alternatives are compared in this section using a numerical scoring approach. This scoring process is summarized in a selection matrix, presented in Table 19.

The left column of the matrix contains important criteria that are considered for comparing the alternatives. Next to each criterion is a weighting factor that assigns a relative importance (1 low to 4 high) to each of the criterion. Each alternative was given a score (1 poor to 5 excellent) for each of the criterion. The weighting factor and score were multiplied to give a "Weighted Score" for each criterion, and then summed for each alternative to give the total score.

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[31] 18 AAC 74, *Water and Wastewater Operator Certification and Testing*, Table A.

Table 19 – Alternatives Selection Matrix

Criteria	Weight Factor	Alt 1 – Improved Existing Score	Alt 1 – Improved Existing Weighted Score	Alt 2 – MIEX + CF Score	Alt 2 – MIEX + CF Weighted Score	Alt 3 – MIEX + Ozone + BF Score	Alt 3 – MIEX + Ozone + BF Weighted Score	Alt 4 – DAF + Filtration Score	Alt 4 – DAF + Filtration Weighted Score	Alt 5 – Nano + AC Filtration Score	Alt 5 – Nano + AC Filtration Weighted Score
Treatment Performance	4	3	12	4	16	5	20	4	16	5	20
Treatment Efficiency	2	2	4	3	6	3	6	4	8	1	4
Complexity	3	3	9	2	6	1	3	2	6	1	3
Reliability	3	3	9	2	6	2	6	2	6	3	9
Safety	4	2	8	4	16	2	8	4	16	3	12
Sustainability	4	3	12	2	8	1	4	3	12	1	4
Operator Certification	2	4	8	4	8	2	4	2	4	2	4
Capital Costs	3	1	3	1	3	1	3	3	9	3	9
O&M Costs	4	3	12	2	8	1	4	3	12	1	4
Owner Preference	4	4	16	2	8	3	12	3	12	1	4
Total Score			93		85		70		101		73

Key: CF - Conventional Filtration
BF - Biological Filtration
TS - "Two-Stage" Filtration

Alternative 4 has the highest total score of the five alternatives considered and, consequently, becomes the "preferred" alternative. Alternative 5 scores the lowest. The comparative scoring of the criteria is discussed below.

6.3.1 Treatment Performance

Treatment performance is given the highest weighting factor of 4, because high water quality translates into a higher degree of public health. Further, high water quality indicates that the WTP is operating well. Alternatives 3 and 5 are scored highest, with the ability to produce excellent water by virtue of having more robust barriers against the passage of contaminants into the water distribution system. However, this water quality excellence comes at the expense of higher complexity and higher capital and operational costs. Alternative 1 is given the lowest score based on the limitations of slow sand filtration to remove dissolved organics. Alternatives 2 and 4 are given moderate scores, both being somewhat limited by multimedia filtration in the ability to remove organics and color. In Alterative 2, the MIEX process is expected to excel in the removal of low molecular weight organics and less so for color removal. In Alternative 4, DAF is expected to excel in the removal of color, but possibly less so in the removal of organics.

6.3.2 Treatment Efficiency

Treatment efficiency is given a weighting factor of 2, because efficiency is considered an enhancement of treatment performance, and because small to moderate inefficiencies can be readily overcome by making slight water rate adjustments. Alternative 4 is given the highest score based on its higher treatment rate, lower operational cost, and lower water wastage. Alternative 5 is scored the lowest for this criterion due to the loss of water through backwashing and rejection of contaminates.

6.3.3 Complexity

Plant complexity is given a moderate weighting factor of 3. It is an important criterion with respect to an operator's ability to understand and make adjustments to the process (see Section 5.5.4 for a description of this consideration). However, with training and experience, operators can become accustomed to a system's complexity and it becomes less of a challenge over time. Despite the complexities of the existing ozone system, Alternative 1 is given the highest score, due to the familiarity of operators in working with this unit process. However, only a score of 3 is given, due to the fact that ozonation is complex and would require a significant amount of time for a new operator to arrive at the experience and knowledge needed to be proficient with this technology. Lowest scores are given to Alternatives 3 and 5, both of which feature multiple and relatively sophisticated unit processes.

6.3.4 Reliability

This criterion is given a moderate weighting factor of 3. Reliability is an important consideration for selecting a process or a treatment system as it relates to the ability to consistently produce good water quality (see Section 5.5.4 for description). But a lack of reliability can be substantially offset by the expertise of the operator. Alternatives 1 and 5 are scored the highest in terms of producing good water quality. As long as the process is operating well, good water quality will be produced without a substantial degree of operator intervention. However, these alternatives are scored only 3, because their complexities (via ozonation or nanofiltration) can cause challenges if processes or equipment are not working correctly. All other alternatives are given a score of 2, because each features multimedia filtration, which relies more on operator expertise and execution to produce excellent water quality.

6.3.5 Safety

Safety is given the highest weighting factor of 4 (see Section 5.5.4 for description). By virtue of working with chemicals, no alternative is given the highest score—all feature the use of caustic soda for pH adjustment and chlorine for disinfection, which are corrosive substances and require breathing apparatuses during handling. Beyond the use of these chemicals, Alternatives 2 and 4 are given the highest scores as coagulants are featured, which are relatively innocuous (with some exceptions). Alternatives 1 and 3 are given lowest scores because ozonation is used and can be harmful if significant concentrations become airborne. Alternative 5 is given a moderate score of 3, presuming that the anti-scalant chemical is not very hazardous and that an acid application is not needed.

6.3.6 Sustainability

This criterion is given the highest weighting factor of 4. It combines the need for sound financial and technical capacity of those running the water system (see description in Section 5.5.4), and has high importance: if a community cannot sustain its water system either through the inability to fund its operation, or the inability of its employees to operate the plant, it will fail in meeting its drinking water objectives. Alternatives 1 and 4 are scored highest with a moderate 3. Both of these alternatives offer the lowest O&M costs, and both have moderate complexity scores. But neither is simple to operate. That CBW has proven over the last 15 years that it can sustain an ozone system gives some credence to giving Alternative 1 this higher score. But it has done so because its operators have gained the expertise to operate and repair the ozone system, as needed. With new operators, this scoring would be difficult to justify for Alterative 1. Alternatives 3 and 5 are given the lowest scores due to high O&M costs and complexity in multiple unit processes.

6.3.7 Operator Certification, Capital Costs, and O&M Costs

These criteria are scored for each alternative based on the analyses detailed in this section.

Operation certification is given a weighting factor of 2. It is an important criterion, but one that can be met over time. Relative to most Alaskan communities, CBW has a good financial ability to hire and retain capable operators. A Level IV certification is given half the score of Level III due to the additional requirements needed to achieve this higher level.

The capital cost criterion is given a weighting factor of 3. Capital funding can be difficult to obtain and, for moderately sized Alaskan communities, usually requires loans as well as grants, which are discrete obligations that can be met over time. Higher scores are given to the alternatives presenting the lowest capital costs.

The O&M cost criterion is given the highest weighting factor 4, as it directly relates to the sustainability criterion and represents annual costs that extend into perpetuity. Higher scores are given to the alternatives offering lowest O&M costs.

6.3.8 Owner Preference

This criterion is given the highest weighting factor 4 and scored the alternatives based on CBW's sense of which option it would prefer to pursue in pilot testing. Alternatives were scored based on CBW's familiarity with the use of ozonation and its recent decision to invest in the replacement of its existing ozone generators. This scoring presumes that CBW would prefer to keep using its ozone system in some capacity. If not, it is presumed CBW would next prefer to pursue the alternative that would provide the most cost effectiveness, which would be Alternative 4, based on its life cycle cost.

6.4 Discussion of Alternatives

6.4.1 Alternative 1 – Improve Existing Process

Alternative 1 scored second highest out of the five considered in the selection matrix process. This alternative is attractive primarily for the following reasons:

- CBW is familiar with this water treatment process.
- O&M costs would remain relatively low, primarily because a lesser need for chemicals relative to other alternatives.
- CBW would continue the use of ozone, having recently invested significant funds to replace its aging ozone generators.
- Improved process would require the lowest operator certification level (III).

Conversely, Alternative 1 presents the following primary challenges:

- High capital costs, which will be more difficult to fund relative to other alternatives.
- Unlike the other alternatives, which could make use of the slow sand filter basins as additional water storage, Alternative 1 will experience a continued lack of water storage during the summer, which tends to expose the water treatment process to the fluctuations of community water demands.

- Potential for continued difficulties in post-treatment high chlorine demands and in reducing disinfection by-products, as slow sand filtration has limited organic removal capabilities.

Alternative 1 remains a very strong candidate for pursuit in future improvements

6.4.2 Alternative 2 – MIEX Process with Multimedia Filtration

Alternative 2 scored third highest out of the five considered in the selection matrix process. This alternative is attractive primarily for the following reasons:

- The MIEX process is very effective in removing low weight molecular organics that can produce certain kinds of DBPs.
- When combined with conventional filtration, this alternative will provide effective removal of both small and large molecular organics, which will substantially reduce the tendency for generating a wide spectrum of disinfection by-products, and turbidity.

Conversely, Alternative 2 presents the following primary challenges:

- The MIEX and conventional filtration processes will combine to impose higher O&M costs on CBW, in the need for significant amounts of chemicals and replacement of MIEX resin.
- Without substantial amounts of coagulant, this alternative may not remove color as substantially as ozone.

With Alternative 2, exceptional water quality can be achieved, but at higher O&M costs relative to Alternatives 1 and 4.

6.4.3 Alternative 3 – Ozonation with MIEX and Biological Filtration

Alternative 3 scored the lowest out of the five considered in the selection matrix process. This alternative, which is a variation of Alternative 2, is attractive primarily for the following reasons:

- Same reasons as noted for Alternative 2 above.
- The use of ozone will provide excellent removals of color, taste, and odors, in addition to a probable reduction of coagulant dosage.

Conversely, Alternative 3 presents the following primary challenges:

- The MIEX, ozone, and biological filtration processes will combine to impose very high O&M costs on CBW, in the need for significant amounts of power for ozone and chemicals, and replacement of MIEX resin; therefore, Alternative 3 offers the lowest level of sustainability.
- The multiple processes in this alternative will combine to greatly increase the operational complexity of the WTP. The use of ozone imposes a need for biological filtration, which will be more complex relative to conventional filtration.
- The MIEX process may not readily accommodate significant variability in raw water characteristics, which may result in variable finished water quality.
- This alternative will likely require a Level IV operator certification.

With Alternative 3, superior water quality can be achieved, but at higher O&M costs and complexity relative to Alternatives 1, 2, and 4.

6.4.4 Alternative 4 – DAF with Multimedia Filtration

Alternative 4 scored the highest out of the five considered in the selection matrix process. This alternative is attractive primarily for the following reasons:

- DAF is the most cost effective treatment process based on having the lowest life cycle costs and highest treatment efficiency.
- The use of DAF is expected to provide good organics removal and excellent color removal, in addition to a probable reduction of coagulant dosage relative to Alternatives 2, 3, and 5.
- DAF is a robust process that can accommodate significant variability in raw water quality without substantial adjustments in the treatment process.

Conversely, Alternative 4 presents the following primary challenges:

- This process will probably require a Level IV certification.
- This alternative will probably not remove organics as well as Alternatives 2, 3, and 5 and, therefore, may result in a moderate chlorine demand in the distribution system and some DBP generation, although not as high as Alternative 1.

With Alternative 4, very good water quality can be achieved with high treatment efficiency and lower O&M costs.

6.4.5 Alternative 5 – Nanofiltration with Multimedia Filtration

Alternative 5 scored the fourth highest out of the five considered in the selection matrix process. This alternative is attractive primarily for the following reasons:

- Nanofiltration will provide superior water quality relative to the other alternatives and will remove substantial amounts of organics, color, and microbial contaminants.
- With the use of nanofiltration, the two-stage filtration process can be optimized to remove turbidity, iron, and manganese, which will tend to decrease the coagulant dosage.

Conversely, this alternative presents the following primary challenges:

- This alternative offers the highest O&M costs in terms of chemicals needed and eventual replacement of filter membranes, and hence the lowest level of sustainability.
- This alternative is the most complex of the alternatives considered.
- This process will likely require a Level IV certification.

6.5 Summary

Based on this evaluation, the top two candidates for future action in the water treatment process are:

- Alternative 1 – Improve Existing Process.
- Alternative 4 – Dissolved Air Flotation (DAF) with Multimedia Filtration.

The pursuit of either alternative for future action would be reasonable. In Alternative 1, CBW would be improving a system it is very familiar with, and one that would be the most economical to operate. The high capital costs would be more challenging to fund, but, in phased construction, this objective would be more achievable. In pursuing Alternative 4, CBW would be substantially stepping away from slow sand filtration for a treatment process that would provide better water quality, but would also be able to make considerable re-use of the existing facilities and possibly remodel the slow sand filter basins to cost-effectively provide extra water storage. However, CBW's water treatment challenges involve both water quality and hydraulic capacity concerns, and Alternative 4 would more effectively address both relative to Alternative 1, which is more limited in terms of treatment performance and future plant expansion. Alternative 4 – DAF with Multimedia Filtration is, therefore, affirmed as the "preferred" alternative for CBW.

6.6 DAF Pilot Testing Results

Pilot testing for the DAF process was performed at the WTP from July 27 to September 29, 2016. Skid-mounted pilot testing modules were supplied by AWC Water Solutions, Ltd, Surrey, BC, Canada, and connected to the WTP's influent piping. Raw water was side-streamed into the pilot apparatus, which was comprised of a dissolved air flotation module and a filter module. A third module housed the chemical feed systems. The process was tested with two types of coagulant, alum and aluminum chlorohydrate (ACH), and soda ash for pH adjustment. The process was also tested with ozonated water using intake piping supplied from a basin located downstream of the ozone contact tank (and upstream of the roughing filters).

The best performing chemical scheme featured ACH with no pH adjustment, and produced water with ultraviolet transmissivities (UVTs) approaching 95%, true colors of 5 Pt-Co units, and turbidities less than 0.15 NTU. DOC levels were also reduced by an average of 75%, to less than 2 mg/L as $CaCO_3$. Standard DBP formation testing, with exceptionally-elevated chlorine levels, produced DBP levels 17% to 18% above the MCLs for TTHM and HAA_5. A final round of DBP formation potential testing with a lower-but-still-conservative chlorine dosage indicated that results were below the MCLs for both TTHM and HAA_5.

6.7 Backwash Waste Disposal Alternatives

The waste disposal alternative with the lowest NPV is Alternative D – Recycle of Backwash Water. Under this alternative, the backwash waste water would be directed to an above-ground clarifier tank. A polymer would be injected into the backwash waste water to improve settling of solids in the clarifier tank. Supernatant from the clarifier tank would be directed back into the process stream, upstream of the filter. Recycled backwash water would be blended with raw water and treated.

Sludge from the clarifier tank would be dewatered and transported to a landfill for final disposal.

7 Proposed Project (Recommended Alternatives)

7.1 Preliminary Project Design

A new treatment building would be constructed to house two parallel DAF plants, which would integrate both DAF and multimedia filtration on the same skid. The treatment process would involve dissolved air flotation accompanied with chemical coagulation and gravity filtration, and would have a design flowrate of 1.8 mgd. Chemical feed tanks and associated pumps and control systems would also be located in the new treatment building. The existing slow sand filters would be converted into clearwells to provide CBW with an additional 0.9 million gallons of water storage. With the existing WSTs, the total storage capacity would be 1.75 million gallons, which nearly reaches the design flowrate of 1.8 mgd. A portion of the existing control building will be used for chemical storage. A gravity sewer line would be constructed to transport backwash waste from the new treatment building to the WWTP. A standby generator and bulk fuel tank would also be installed at the site. Estimated capital and O&M costs for all the recommended alternatives are provided in Appendix H. The proposed improvements are shown on Figures 7, 11, 15 and 17.

7.2 Project Schedule

The project schedule will be driven by the availability of design and construction funding. The proposed improvements are expected to be completed over the course of one year.

7.3 Permit Requirements

The following permits will be required for construction of the project:

- ADEC: Drinking water plan review and approval to construct for the improvements to the WTP. Discharge permit for disposal of backwash waste.

7.4 Sustainability Considerations

Like many rural Alaskan communities, CBW faces high energy costs and is concerned with minimizing operational costs. To help minimize energy costs, all new pumps will be equipped with high efficiency motors and all new lighting will feature LED bulbs. Furthermore, the new DAF treatment system has filter efficiencies of 97% to 98%, which results in less water lost to filter backwashing and process waste. This efficiency would be further improved by recycling backwash waste to the front of the treatment process.

7.5 Total Project Cost Estimate

The total estimate cost for the project is presented in Table 20. Detailed capital cost estimates are provided in Appendix H.

Table 20 – Estimated Project Cost

Description	WTP Upgrades	Backwash Disposal
Construction	$6,824,000	$715,000
Design	$615,000	$65,000
Construction Administration	$615,000	$65,000
Project Administration	$137,000	$15,000
Total	$8,191,000	$860,000
	Combined Total	$9,051,000

7.6 Annual Operating Budget

7.6.1 Annual Treatment O&M Costs

The annual O&M cost for the proposed improvements, combined with the cost of water wasting, is anticipated to increase the annual treatment costs of the system by approximately $133,000 (Table 21). For FY 2016-2017, water sales accounted for $620,000 in revenue. To accommodate the increased cost, it is anticipated that user fees will need to be increase by approximately 21%, for a projected water sale revenue of $753,000. Since this increase in rates is based upon estimated annual O&M costs, CBW is encouraged to monitor O&M costs and conduct a rate study after completion of the WTP upgrades. The actual increase in O&M costs will dictate the required increase in rates.

Table 21 – Estimated Annual Treatment O&M Costs

	Existing (Current Flow)	Alt 4 – DAF + Filtration & Alt D - Backwash Recycle
O&M - DAF	$124,312	$289,614
O&M - Backwash Recycle	-	$2,761
Non-salable Water	$61,760	$26,989
Total	$186,071	$319,364

Without this revenue, the community would need higher water rates to cover the overall cost of operating the WTP. This revenue loss is assumed to be computed as gallons of non-salable water multiplied by the average per-gallon treatment cost of water.

7.6.2 Debt Repayment

Where funds can be borrowed from commercial sources at a reasonable interest rate, on an interim basis for the total amount of loan funds needed during construction, such interim financing will be obtained so as to preclude the necessity for multiple advances of Rural Utility Service (RUS) loan funds. The loan amount will be identified once the USDA-RD underwriting effort is complete. The City and Borough of Wrangell would then seek financing quotes from a commercial financial lender. Once a lender is identified and the loan is approved, the City and Borough of Wrangell would notify USDA-RD of the interim lender

The CBW has existing loan repayment obligations for an ADEC loans as follows:

- The CBW has accepted a DEC loan in the amount of $322,650 for the replacement of an ozone generator
- The CBW has accepted a DEC loan in the amount of $542,249 for the design and replacement of water mains.

Copies of the loan resolutions are provided in Appendix I.

7.6.3 Reserves

The CBW had a Water Fund reserve of $410,774 for FY 2016-2017.

7.6.4 Short-Lived Asset Reserve

Replacement costs for short-lived assets for both the water and sewer utility are provided in Appendix J.

8 Conclusion and Recommendations

Based on this evaluation, Alternative 4 – Dissolved Air Flotation (DAF) with Multimedia Filtration is designated the "preferred" alternative for water treatment. For disposal of backwash water, Alternative D – Recycle of Backwash Water is the "preferred" alternative. The improvements associated with these alternatives will allow CBW to continue to provide safe drinking water to the community.

Figures

FILE NAME: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Vicinity Map.dwg

CRW ENGINEERING GROUP, LLC

Project:

STATUS: FINAL

CITY AND BOROUGH OF WRANGELL

PRELIMINARY ENGINEERING REPORT

VICINITY MAP

Project No:	20901.00
Drawn By:	WMK
Scale:	NTS
Date:	3/22/2017
Figure:	1

PROJECT: 20901.00

STATUS: FINAL

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WRANGELL WTP PER

EXISTING AREA MAP

DATE	3/29/17
SCALE	GRAPHIC
FIGURE	2

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Site Plan - Existing Conditions.dwg

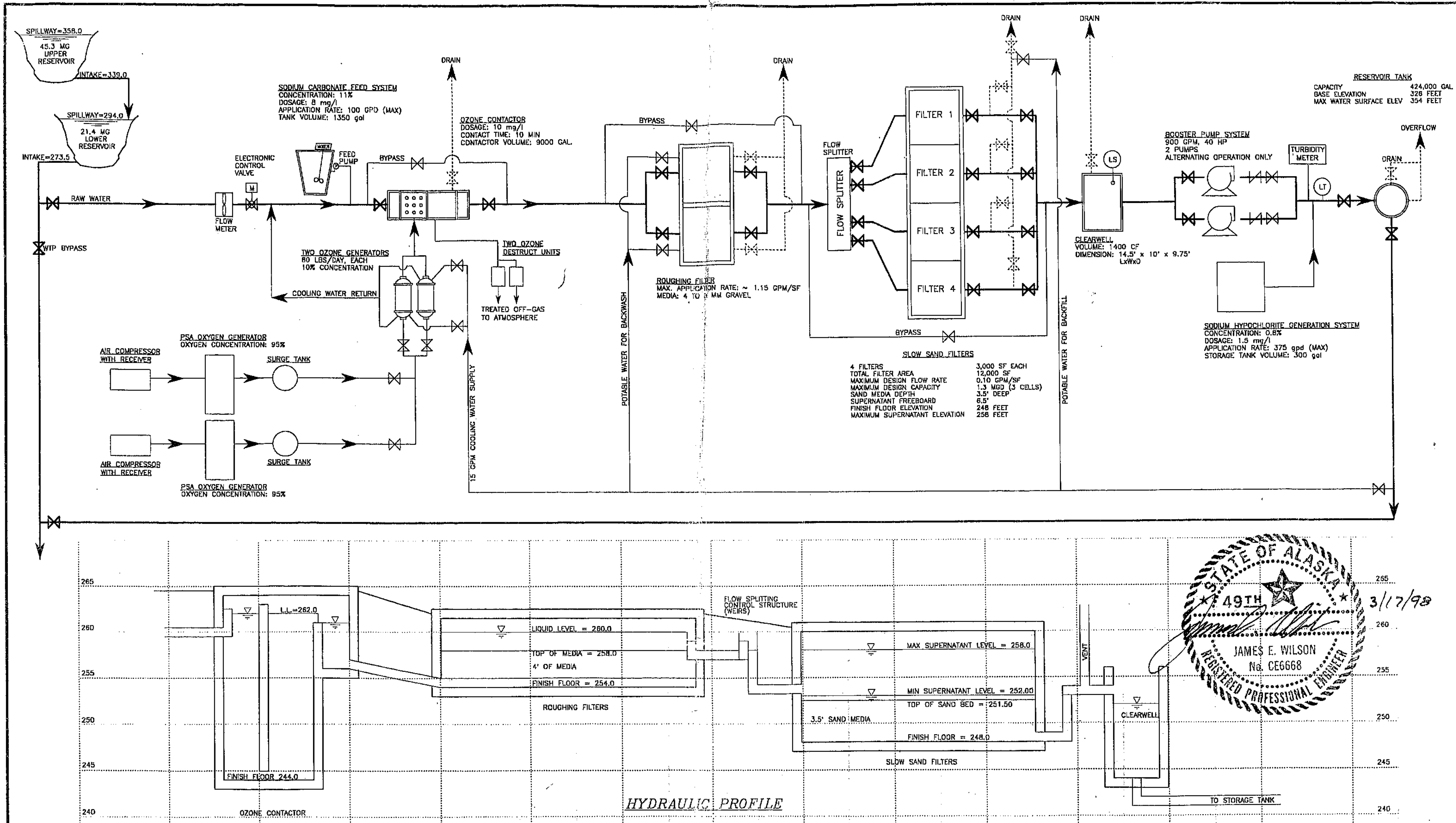


Figure 3
Existing System Schematic

NO.	REVISIONS	BY	DATE

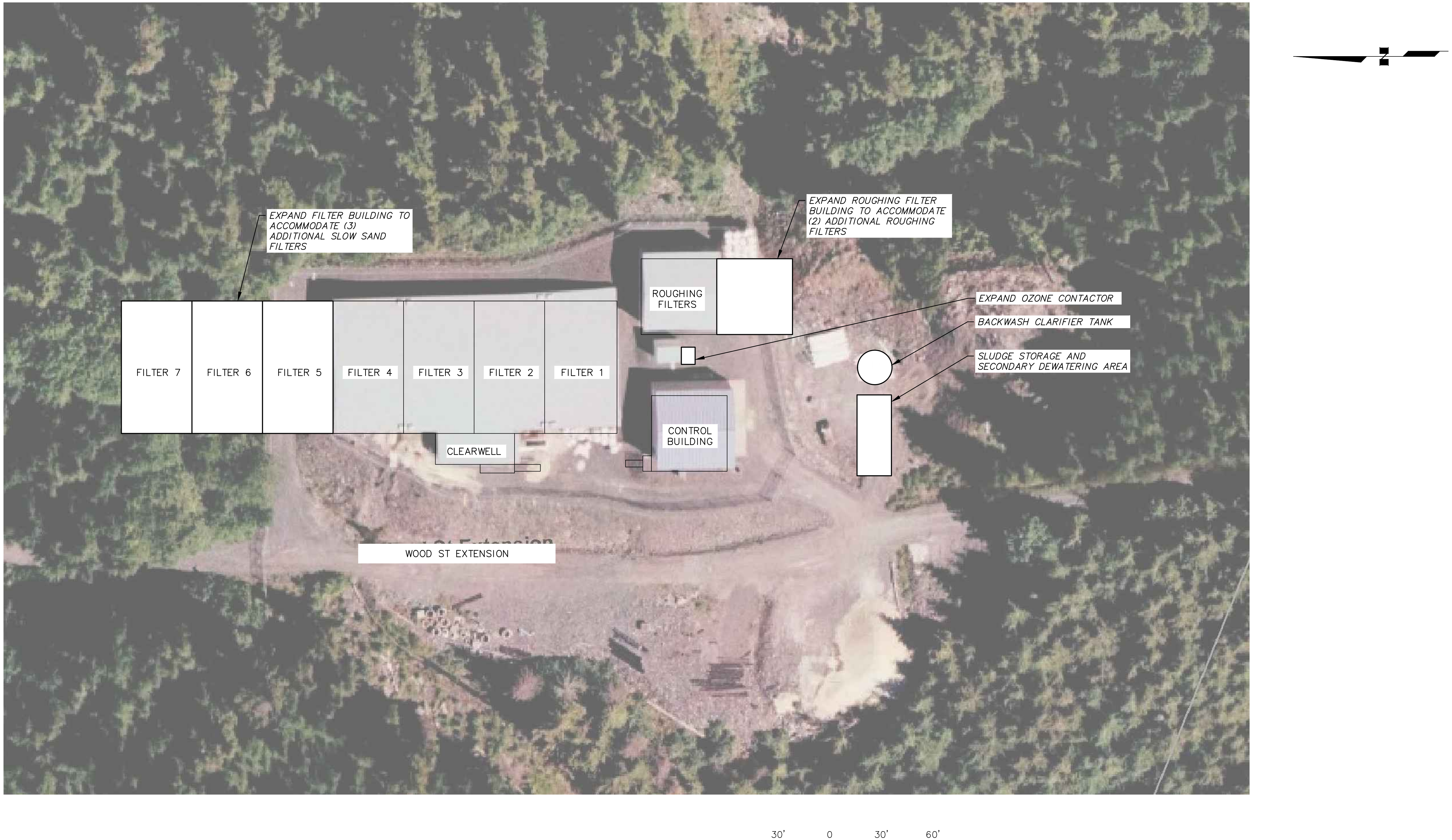
Wilson Engineering
CONSULTING ENGINEERS & SURVEYORS
805 DUPONT STREET
BELLINGHAM, WA 98225
(360) 733-6100
FAX: (360) 647-9061

DESIGNED BY: MAC
DRAWN BY: WAH
CHECKED BY: MAC

CITY OF WRANGELL
WRANGELL ISLAND — ALASKA
PHASE 2 WATER SYSTEM IMPROVEMENTS
HYDRAULIC PROFILE & PROCESS SCHEMATIC

DATE 3/12/98
SCALE AS SHOWN
JOB NUMBER 97070
SHEET C02 OF C09

CT\97070\DWG\97070C02 Thu Mar 12 16:59:31 1998 WAH



PROJECT: 20901.00
STATUS: FINAL

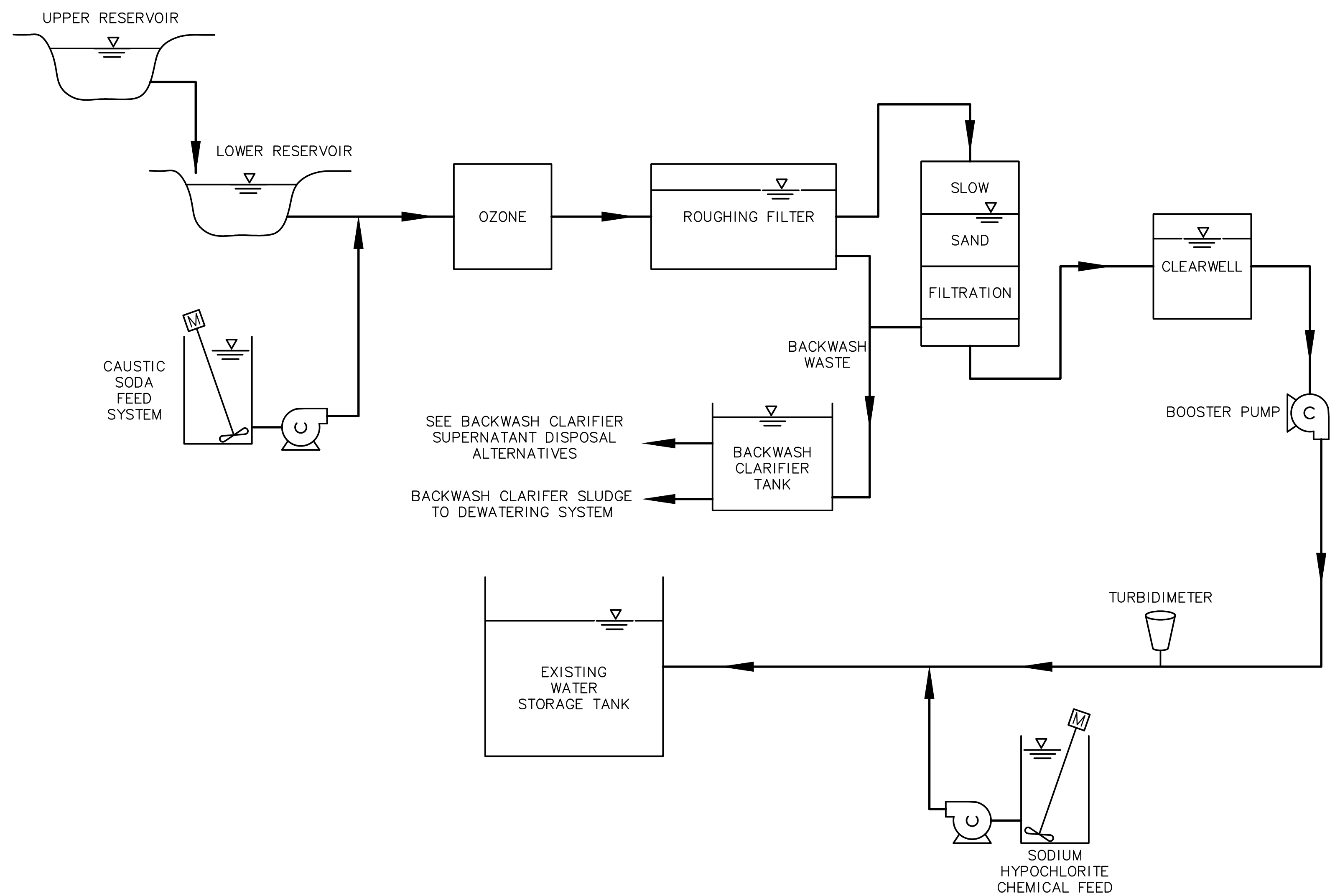
CRW ENGINEERING GROUP, LLC
3940 ARCTIC BLVD, SUITE 300
ANCHORAGE, ALASKA 99503
PHONE: (907) 562-3252
#AECL882-AK

WRANGELL WTP PER

SITE PLAN – ALTERNATIVE 1
IMPROVE EXISTING WATER
TREATMENT PROCESS

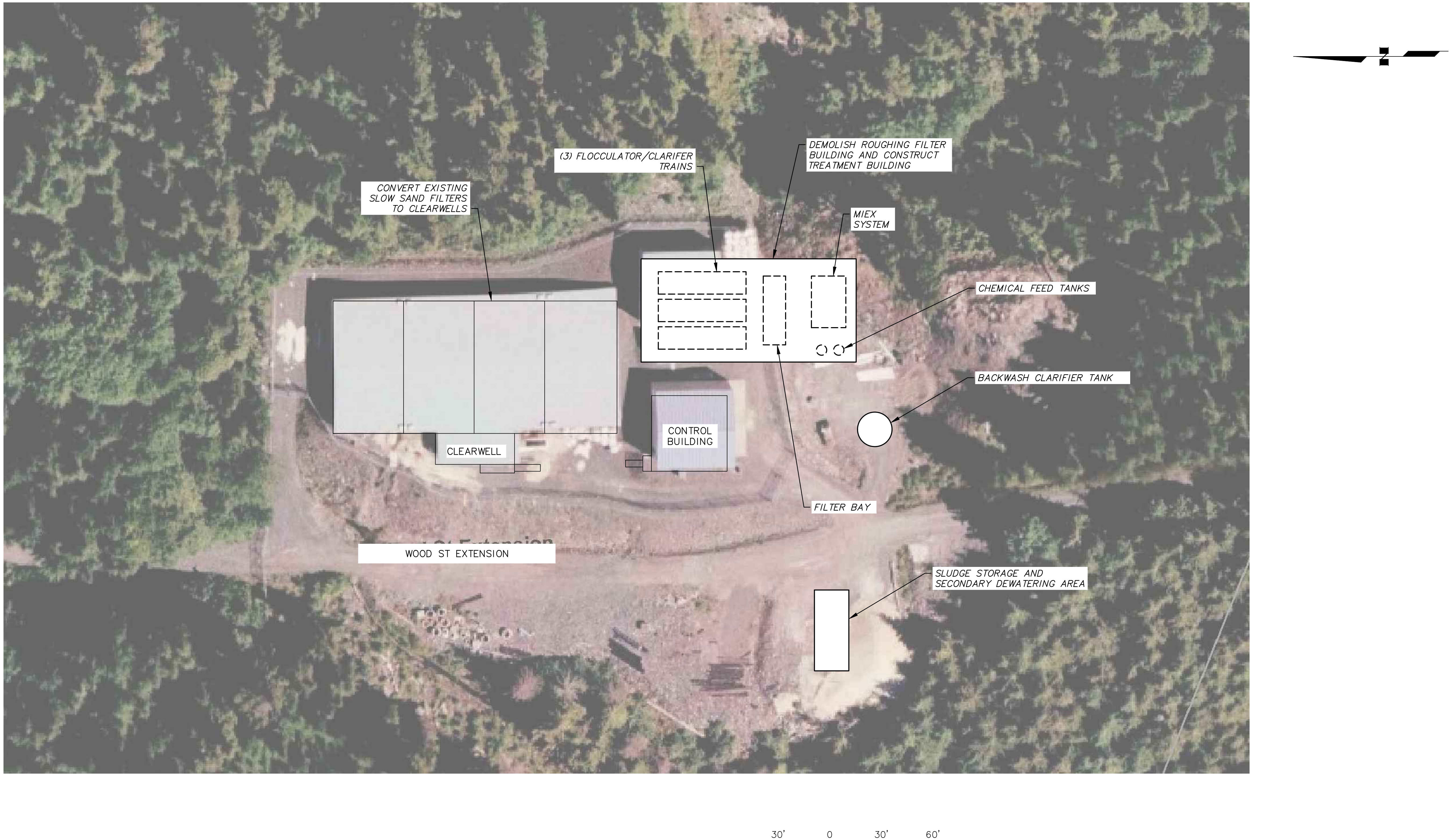
DATE	3/29/17
SCALE	GRAPHIC
FIGURE	4

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Site Plan – Alt 1.dwg



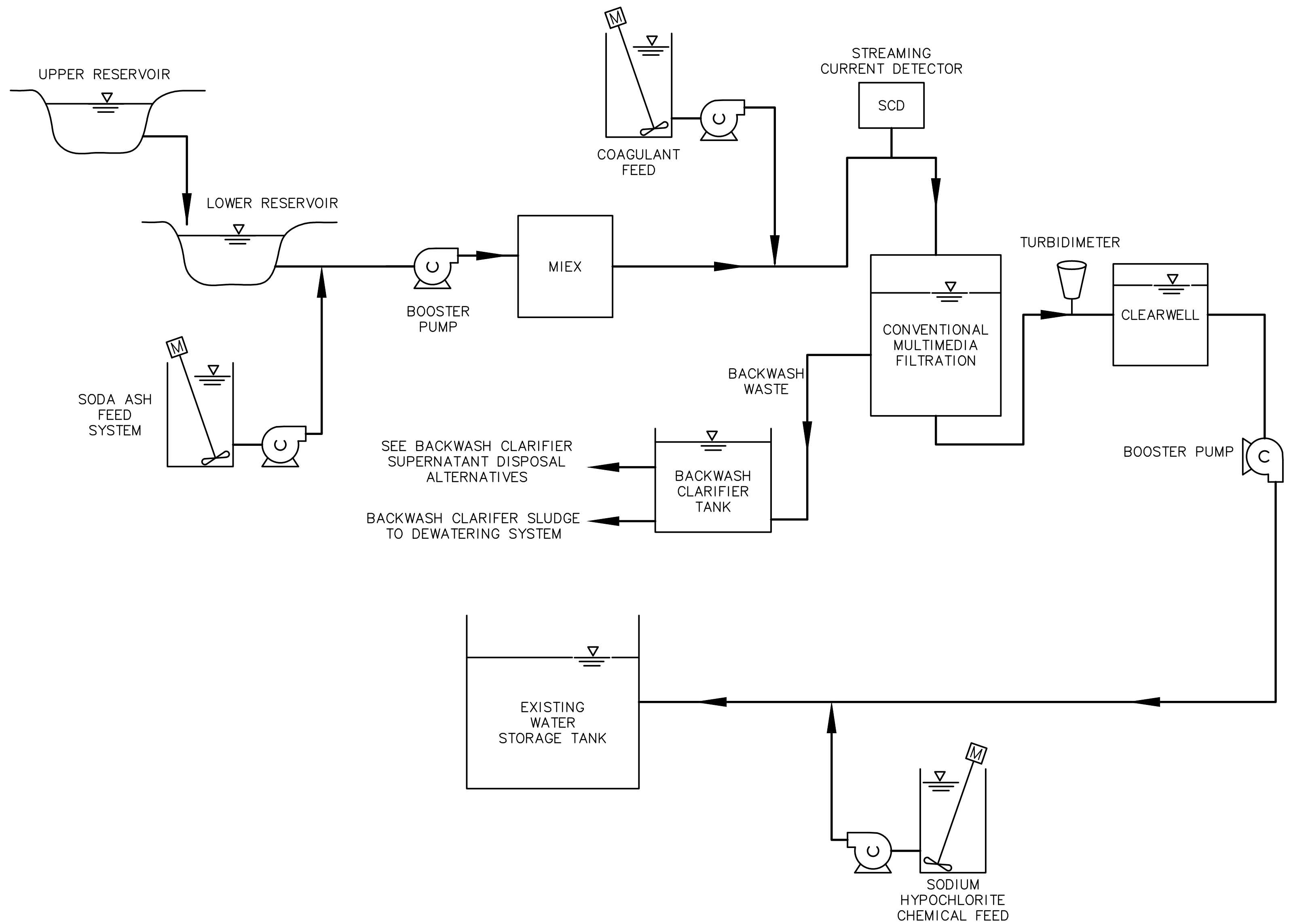
File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Wrangell Process Schematics.dwg

PROJECT: 20901.00	CRW ENGINEERING GROUP, LLC 3940 ARCTIC BLVD. SUITE 300 ANCHORAGE, ALASKA 99503 PHONE: (907) 562-3252 #AECL882-AK	WRANGELL WTP PER	DATE 3/29/17
STATUS: FINAL		PROCESS SCHEMATIC – ALTERNATIVE 1 IMPROVE EXISTING WATER TREATMENT PROCESS	SCALE GRAPHIC
			FIGURE 5



PROJECT: 20901.00 STATUS: FINAL	CRW ENGINEERING GROUP, LLC 3940 ARCTIC BLVD. SUITE 300 ANCHORAGE, ALASKA 99503 PHONE: (907) 562-3252 #AECL882-AK	WRANGELL WTP PER SITE PLAN – ALTERNATIVE 2 MIEX PROCESS AND MULTIMEDIA FILTRATION	DATE 3/29/17 SCALE GRAPHIC FIGURE 6

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 ALT 2 Miex + Direct.dwg



File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Wrangell Process Schematics.dwg

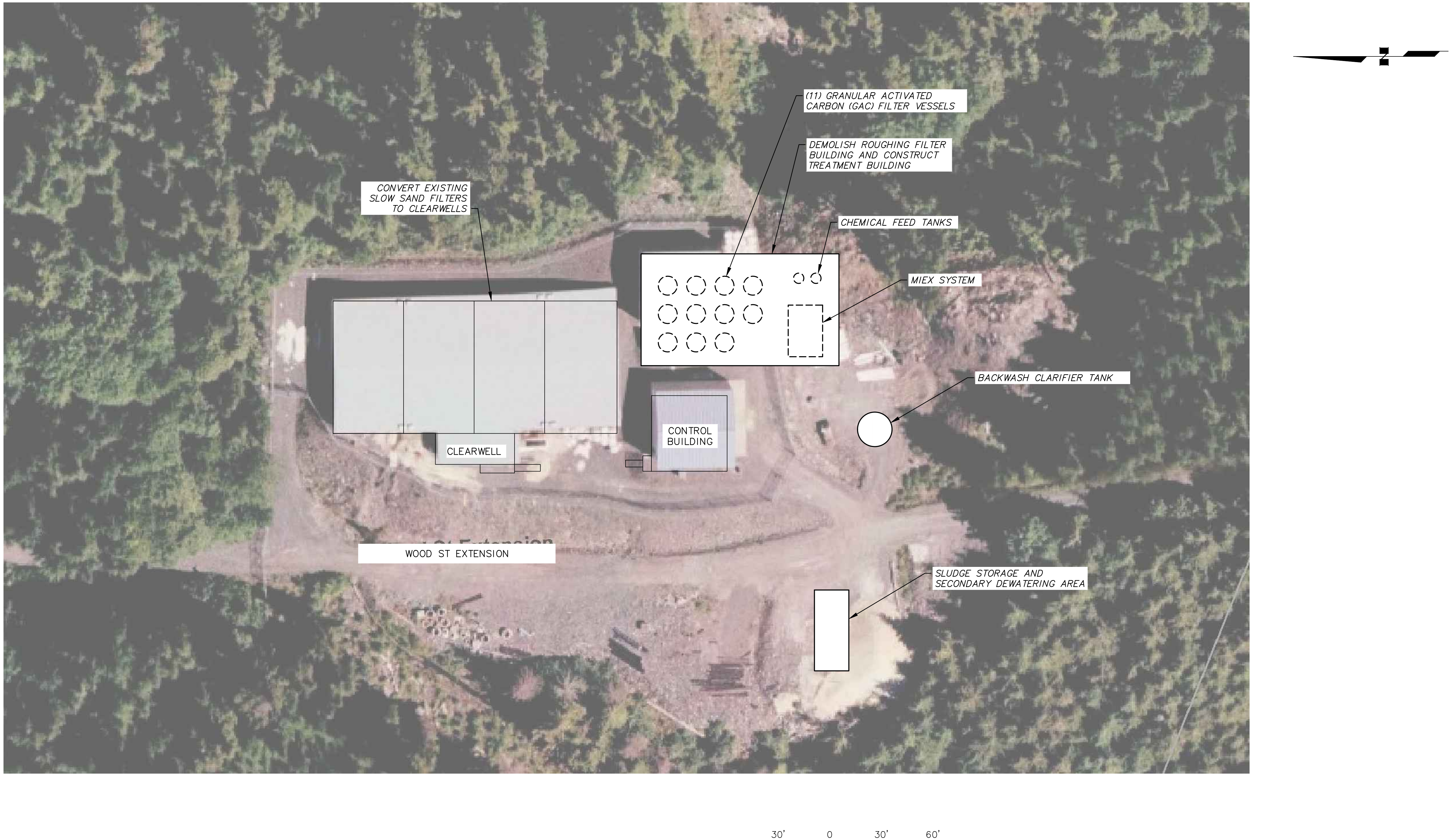
PROJECT: 20901.00
STATUS: FINAL

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

WRANGELL WTP PER

PROCESS SCHEMATIC – ALTERNATIVE 2
MIEX PROCESS AND MULTIMEDIA FILTRATION

DATE	3/29/17
SCALE	GRAPHIC
FIGURE	7



File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 ALT 3 - MIEX And BIO.dwg

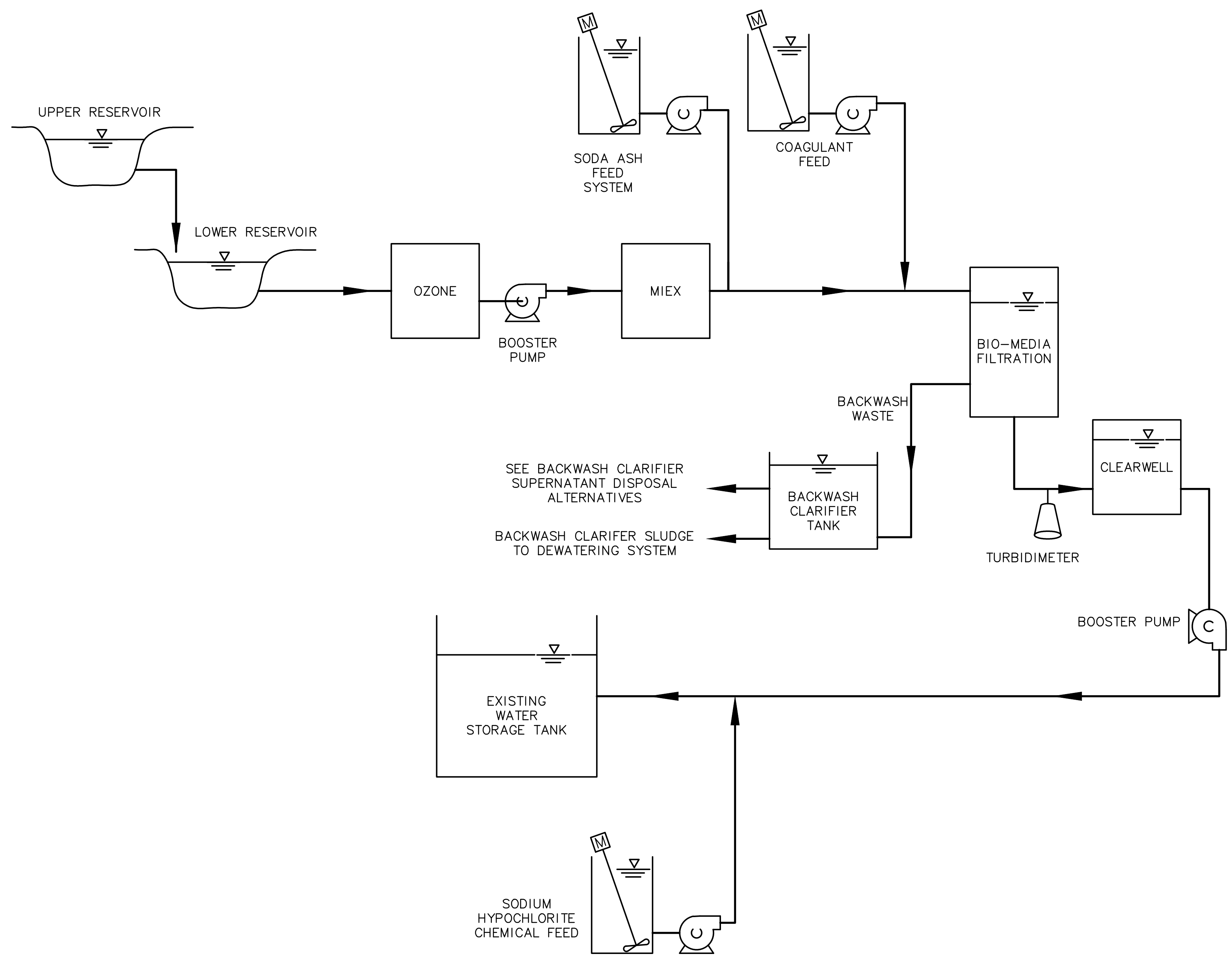
PROJECT: 20901.00
STATUS: FINAL

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

WRANGELL WTP PER

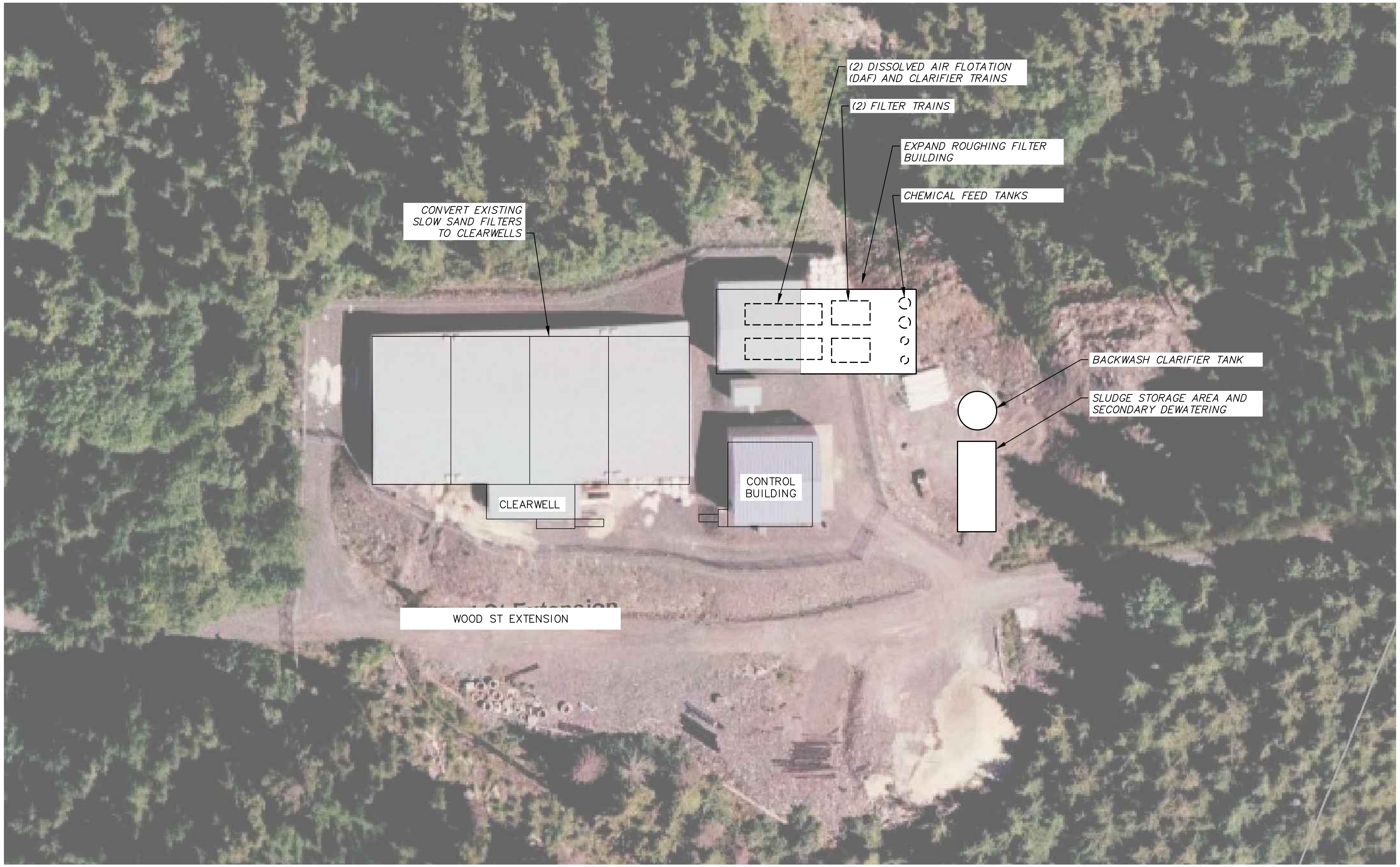
SITE PLAN – ALTERNATIVE 3 OZONATION WITH MIEX AND BIOLOGICAL FILTRATION

DATE 3/29/17
SCALE GRAPHIC
FIGURE 8



PROJECT: 20901.00 STATUS: FINAL	CRW ENGINEERING GROUP, LLC 3940 ARCTIC BLVD. SUITE 300 ANCHORAGE, ALASKA 99503 PHONE: (907) 562-3252 #AECL882-AK	WRANGELL WTP PER PROCESS SCHEMATIC – ALTERNATIVE 3 OZONATION WITH MIEX AND BIOLOGICAL FILTRATION	DATE 3/29/17 SCALE GRAPHIC FIGURE 9

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Wrangell Process Schematics.dwg



File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 ALT 4 DAF.dwg

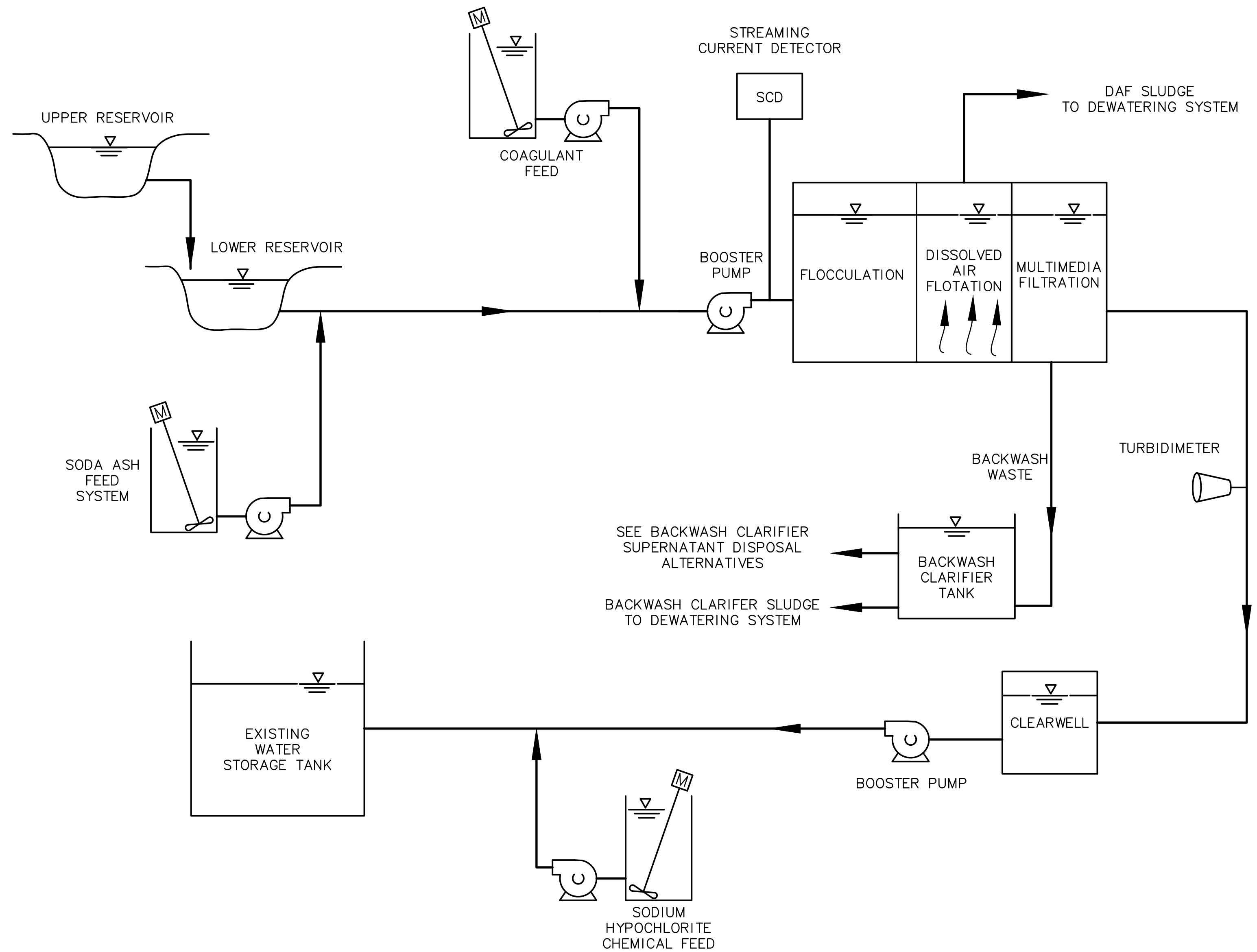
PROJECT: 20901.00
STATUS: FINAL

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

WRANGELL WTP PER

SITE PLAN – ALTERNATIVE 4
DISSOLVED AIR FILTRATION WITH MULTIMEDIA FILTRATION

DATE	SCALE	FIGURE
3/29/17	GRAPHIC	10



File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Wrangell Process Schematics.dwg

PROJECT: 20901.00

STATUS: FINAL

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

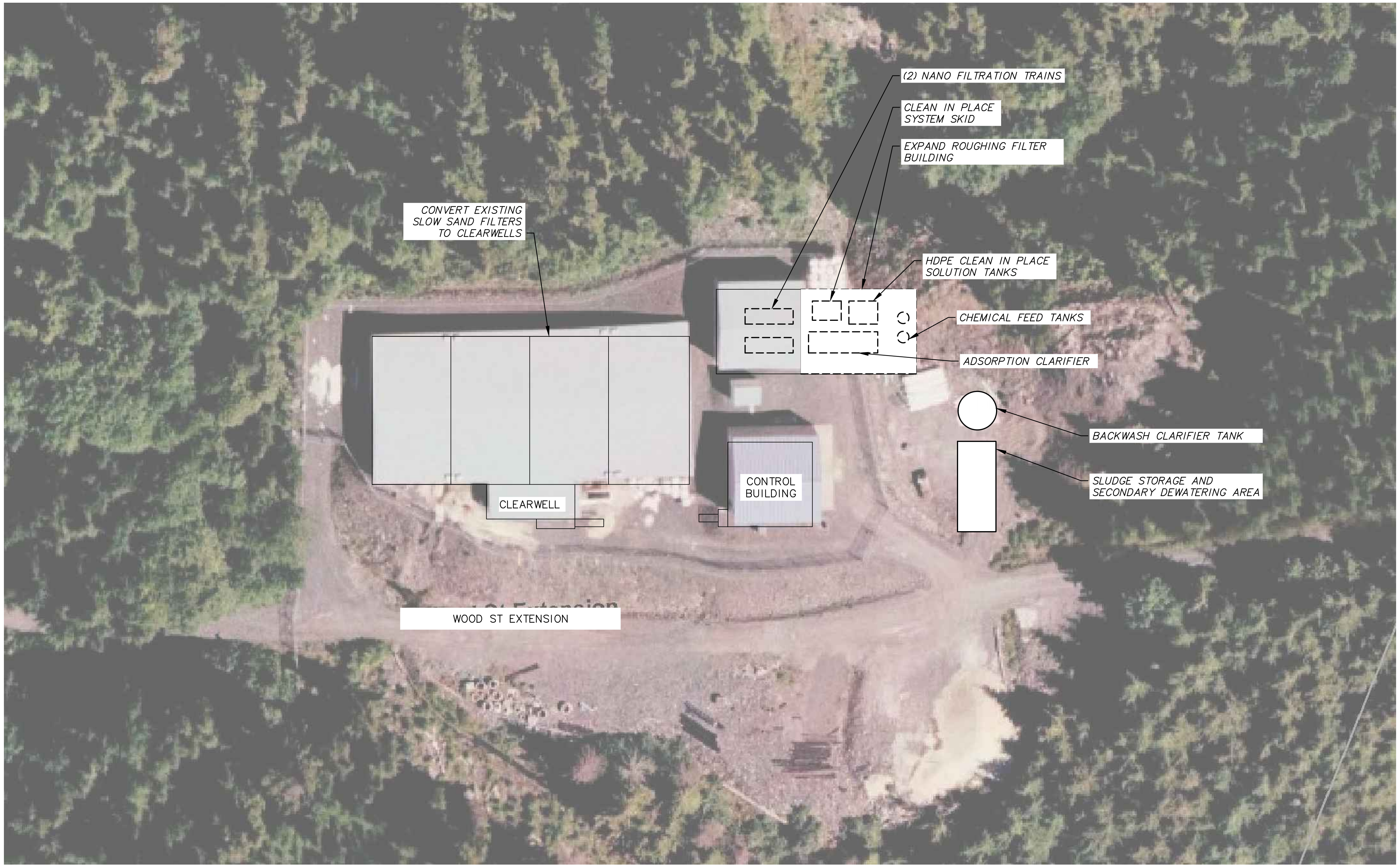
WRANGELL WTP PER

PROCESS SCHEMATIC – ALTERNATIVE 4
DISSOLVED AIR FLOTATION AND
MULTIMEDIA FILTRATION

DATE 3/29/17

SCALE GRAPHIC

FIGURE 11



30' 0 30' 60'

PROJECT: 20901.00

STATUS: FINAL

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

WRANGELL WTP PER

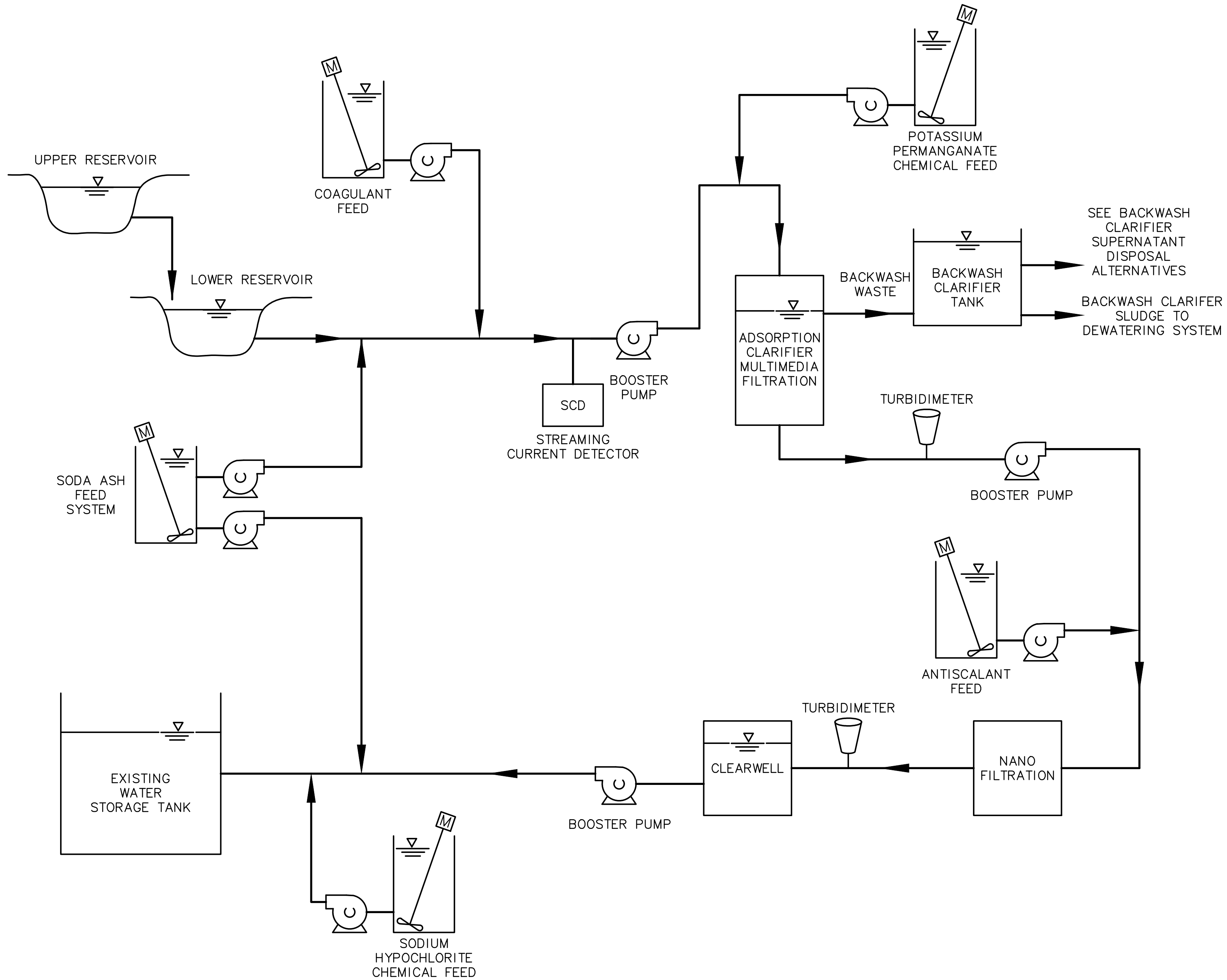
SITE PLAN – ALTERNATIVE 5
NANOFILTRATION WITH MULTIMEDIA FILTRATION

DATE 3/29/17

SCALE GRAPHIC

FIGURE 12

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 ALT 5 AC + NANO.dwg



PROJECT: 20901.00
STATUS: FINAL

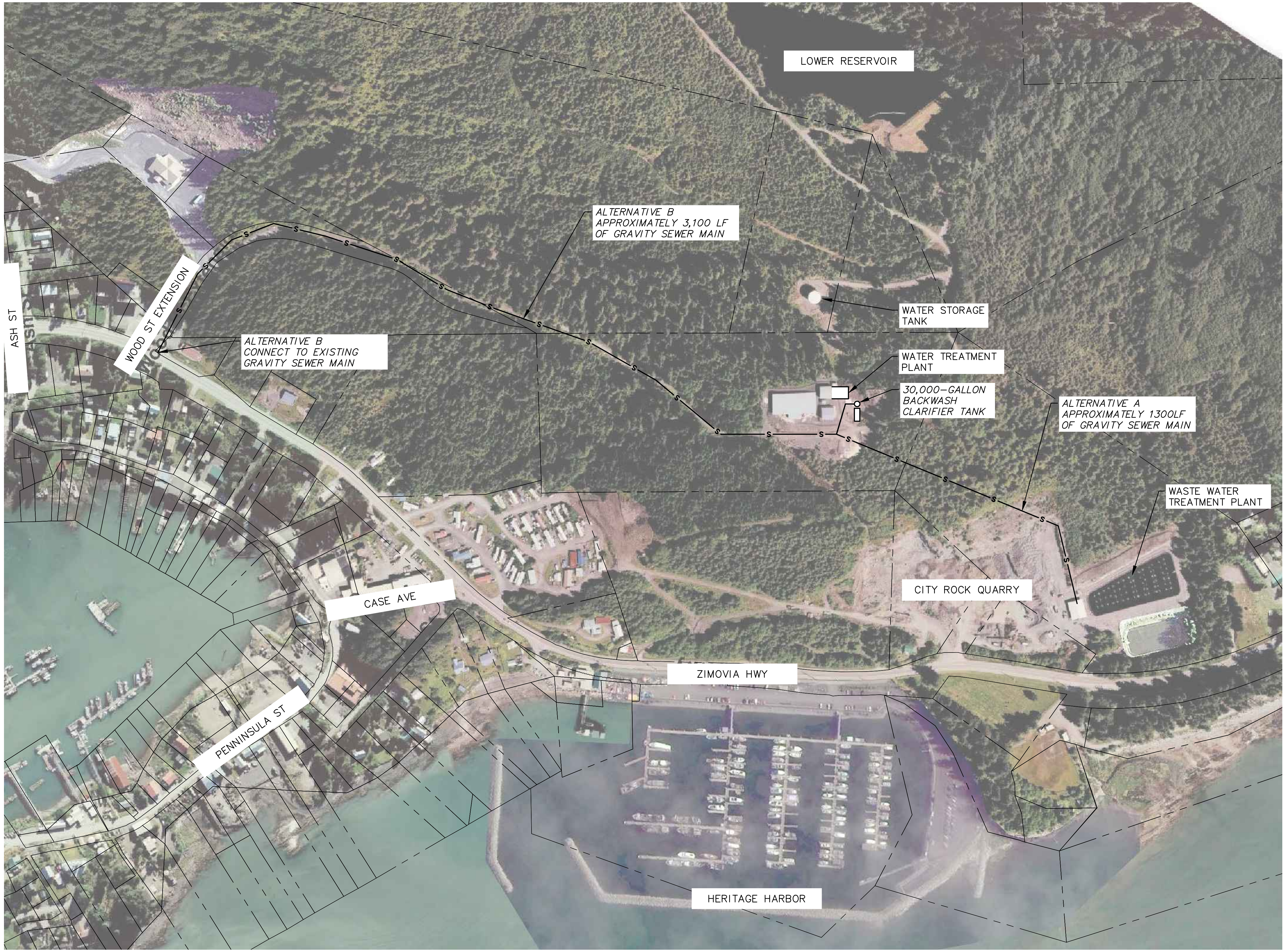
CRW ENGINEERING GROUP, LLC
3940 ARCTIC BLVD. SUITE 300
ANCHORAGE, ALASKA 99503
PHONE: (907) 562-3252
#AECL882-AK

WRANGELL WTP PER

PROCESS SCHEMATIC – ALTERNATIVE 5
NANOFILTRATION WITH MULTIMEDIA FILTRATION

DATE 3/29/17
SCALE GRAPHIC
FIGURE 13

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Wrangell Process Schematics.dwg



200' 0 200' 400'

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

PROJECT:
STATUS: FINAL

WRANGELL WTP PER

BACKWASH WASTE DISPOSAL
ALTERNATIVES A & B

DATE	3/29/17
SCALE	GRAPHIC
FIGURE	14

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Sewer Disposal Alternatives.dwg

200' 0 200' 400'

PROJECT:

STATUS: FINAL

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

WRANGELL WTP PER

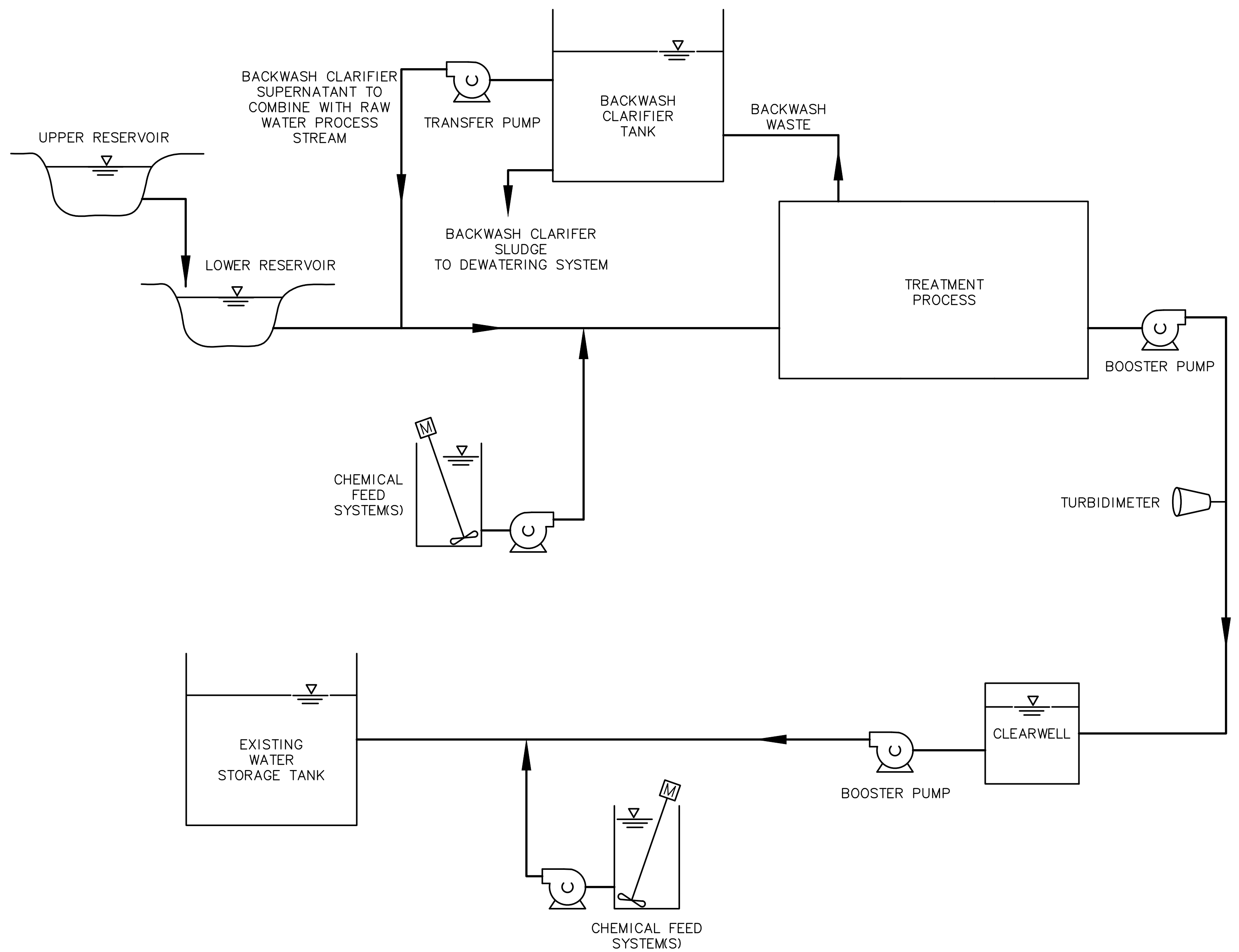
BACKWASH WASTE DISPOSAL
ALTERNATIVE C

DATE 3/29/17

SCALE GRAPHIC

FIGURE 15

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Sewer Disposal Alternatives.dwg



File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 Wrangell Process Schematics.dwg

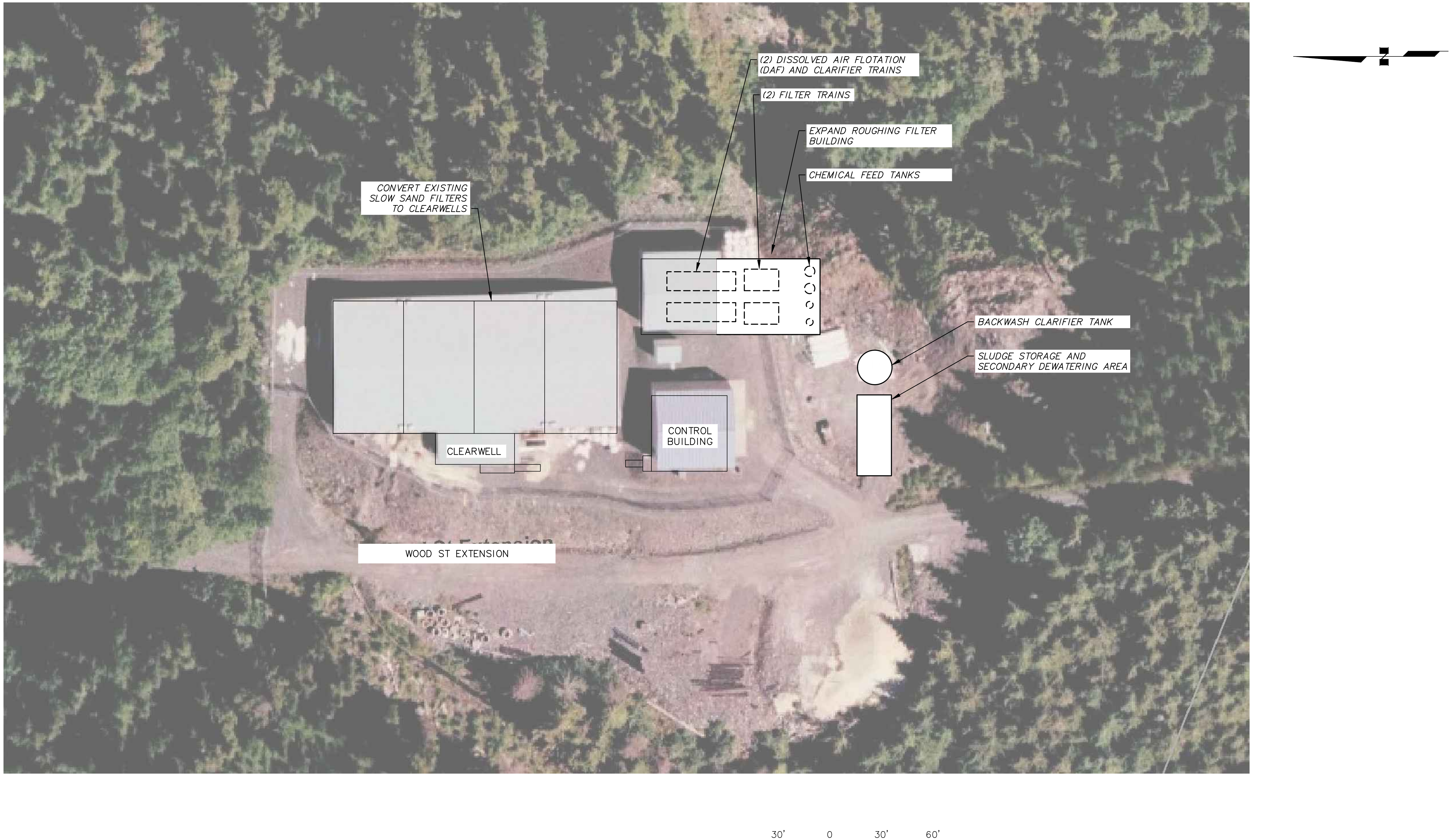
PROJECT: 20901.00
STATUS: FINAL

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

WRANGELL WTP PER

PROCESS SCHEMATIC – ALTERNATIVE D
BACKWASH CLARIFIER AND BACKWASH RECYCLE

DATE 3/29/17
SCALE GRAPHIC
FIGURE 16



PROJECT: 20901.00
STATUS: FINAL

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

WRANGELL WTP PER

SITE PLAN – PREFERRED ALTERNATIVES
ALT 4 – DAF
ALT D – CLARIFIER/ BACKWASH RECYCLE

DATE 3/29/17
SCALE GRAPHIC
FIGURE 17

File: J:\JobsData\20901.00 Wrangell Water Treatment Pilot Study\00 CADD\02 Figures\05 PER\20901.00 ALT 4 DAF.dwg

Appendix A – Raw Water Parameters

1. RAW WATER PARAMETERS

1.1. Turbidity

Turbidity refers to the cloudiness of a fluid caused by suspended particles or air bubbles. For drinking water, turbidity is used as a general surrogate for measuring the amount of suspended particles that may contain harmful substances or microbial contaminants. Studies conducted over many years in the water treatment industry have established strong relationships between the presence of turbidity and the presence of these harmful contaminants. High turbidity levels indicate a higher probability of these contaminants, and low turbidity levels indicate a lower probability. Using turbidity as a surrogate avoids the need for a substantial amount of water testing for specific contaminants.

Based on decades of water treatment experience and related testing throughout the world, EPA has established maximum turbidity limits that, when qualified types of filtration are employed and operated properly, substantial percentages of the targeted microbial contaminants *Giardia* and *Cryptosporidium* can be removed to high degree of certainty (called "log removals"). For example, when slow sand filtration is practiced and operated properly, EPA will credit this process with a 99% (2.0 log) removal of *Giardia*. This type of compliance is called "treatment technology," which means that, with proper operation of the filtration system, and within the regulated turbidity limits, the removal and inactivation of targeted contaminants is considered to be achieved, without the need for water testing.

For drinking water applications, turbidity is determined by measuring scattered light using the nephelometric method as a standard procedure. Turbidity is therefore measured in nephelometric turbidity units (NTU). For direct and conventional filtration systems, the allowable turbidity level is defined in two ways:

- 0.3 NTU above which at least 95% of measurements cannot exceed in a one month period.
- 1 NTU maximum level for any one turbidity measurement.

For slow sand filtration, the allowable turbidity level is:

- 1 NTU above which at least 95% of measurements cannot exceed in a one month period.
- 5 NTU maximum level for any one turbidity measurement.

Using the nephelometric method, turbidity can be readily measured on a regular basis by side-streaming process water through a turbidimeter. CBW is required to measure turbidity from its combined filter effluent every 4 hours using this method, and reported to ADEC every month.

1.2. Organic Parameters: TOC, DOC, UVA and SUVA

Total organic carbon (TOC), dissolved organic carbon (DOC), ultraviolet absorbance at 254-nanometer wavelength (UVA_{254}), and specific UVA (SUVA) are parameters used to characterize the organic content of water. As organic chemistry is extremely complex and very expensive to characterize in the laboratory, these parameters are used as approximate surrogates. The water industry has developed general relationships and an extensive body of experience using these parameters to help predict and assess the removal of targeted organic substances that can create health and palatability concerns with drinking water. TOC measures the total concentration of organic matter that can be oxidized, which is of primary interest in water treatment. DOC is the dissolved fraction of TOC. Because dissolved organics are difficult to remove and because these compounds produce the largest concentrations of disinfection by-products (DBPs), DOC is an important parameter to evaluate when helping a water system comply with the D/DBP Rules.

The study of DBPs over the last 40 years has established a strong relationship between UVA_{254} and organic compounds that contain precursors which create DBPs when combined with chlorine. Generally, the higher the UVA_{254} value, the higher the tendency to produce DBPs in the disinfection process. SUVA is a more refined parameter that is calculated from dividing the UVA_{254} value by the DOC value. SUVA generally indicates the average "amount" of UVA_{254} found in a unit of DOC. Higher SUVA values reflect a largely "hydrophobic" characteristic of the natural organic matter, but also reflect a higher likelihood the DOC can be removed by coagulation and granular filtration methods (depending on the water alkalinity). Hydrophobic organics tend to be less soluble in water, and have larger molecular weights that can be more readily removed by coagulation and filtration. Conversely, lower SUVA values reflect a largely "hydrophilic" character of organics, featuring low molecular weights which are more soluble in water, and therefore more difficult to remove via coagulation and filtration. Wrangell's surface water has relatively low SUVA values, or a largely hydrophilic character, meaning that the coagulation and filtration processes is expected to be only partially effective in removing organics.

1.3. Color

Color is measured using two parameters: apparent color and true color. Apparent color characterizes water that contains solid matter, which imposes a particular color to it. Two common examples of solid matter that cause apparent color are iron and turbidity. When these contaminants are filtered out, the water color improves considerably. True color characterizes water containing only dissolved matter (i.e. that which passes a 0.45 μm filter). A common example of a dissolved substance that causes true color in water is natural organic matter. True color is often used as a rough surrogate for assessing the organics content in water. In Wrangell's case, true color would generally reflect the presence of organics in treated water after color-causing solids have been removed.

1.4. Iron

Iron is a prominent secondary contaminant found in many water sources. It is found in both groundwater and surface water sources throughout the State in various concentrations. In all potential sources, the raw water iron levels are well above the secondary MCL of 0.3 mg/L and cause the water to develop an objectionable yellow color that greatly diminishes its palatability and stains clothing and plumbing fixtures. Generally, iron is readily removed using filtration, ion exchange and other technologies. However, the co-existence of high organics and iron may indicate that the iron is organically-bound. This condition makes difficult the efficient removal of iron without the use of polymers.

1.5. Manganese

Manganese is almost always encountered with the presence of iron, and thus is a secondary contaminant that's commonly found in water sources. Like iron, manganese is a nuisance contaminant that can cause staining. It can also result in the presence of black particles in the potable water, reducing its palatability. The secondary MCL of manganese is 0.05 mg/L and is low because even with a slight excess above this limit, the contaminant can be problematic in large water distribution systems. With a low MCL, manganese concentrations can be difficult to reduce and maintain below acceptable limits. One reason is that manganese can be added to water in two common treatment processes: use of ferric chloride as a coagulant and the use of manganese-coated greensand. A third reason relates to the oxidation process employed in a water treatment process. Oxidation of manganese can result in the creation of solids that are too small to remove with filtration, and which can pass into the filtrate, increasing the manganese concentration. Leaving manganese in soluble form allows it to be more effectively removed by adsorption to greensand media. When potassium permanganate is used as the primary oxidant, manganese is readily oxidized, and as a result, the manganese levels in the filtrate tend to increase.

1.6. pH

The pH of water is a measurement of the hydrogen ion concentration in water. Due to the asymmetrical structure of the water molecule, a certain degree of ionization naturally occurs. Ionization refers to the degree that molecules break down when dissolved in water. Water will ionize by itself into hydrogen ($H+$) and hydroxide ($OH-$) ions, and the pH value measures this degree of ionization. The greater the number of hydrogen ions in the water, the lower the pH value, and the more acidic is the water classified. Conversely, the greater the number of hydroxide ions present, the higher the pH value, and the more basic is the water classification.

When the concentration of hydrogen ions equals the concentration of hydroxide ions, the water is considered neutral. The pH of water significantly affects how chemicals react due to the relative degree that hydrogen and hydroxide ions are available to combine with such chemicals.

Secondary drinking water regulations target a pH range of 6.5 to 8.5 to encourage the supply of water that is generally neutral and less reactive. Wrangell's surface water tends to exhibit a pH range between 5.9 and 6.4, with high pHs measured in the warmer seasons. As the water warms, the solubility of carbon dioxide increases, causing it to off-gas. When this occurs, the pH increases. The application of chlorine in the disinfection process tends to lower the pH slightly.

The pH level is an important parameter when metal salts like ferric chloride and alum are used as coagulants. Ferric chloride typically requires a pH level of about 5.5 for optimum organics removal. Alum typically needs pH levels ranging between 5.5 and 6.0 for optimum performance. The pH can be lowered by increasing the dosages of these coagulants or by adding a strong acid, like sulfuric acid. The pH can be increased with the addition of a basic chemical like soda ash or caustic soda (as currently used by the City).

1.7. Total Dissolved Solids (TDS)

The total dissolved solids parameter generally characterizes the degree that various natural minerals are dissolved in water. Such dissolved compounds are most commonly various types of salts comprised of sodium, calcium, magnesium, chloride, sulfate and carbonate. TDS imparts various tastes to water, which primarily affects its palatability and can create health and maintenance concerns. Water with TDS levels between 1000 and 10,000 mg/L is considered brackish and unfit for use. The secondary MCL for TDS is held at 500 mg/L to encourage the use of a "fresh" source water for treatment and subsequent consumption. Being comprised of dissolved substances, TDS is difficult to remove from water, usually requiring sophisticated treatment processes like reverse osmosis, electrodialysis and distillation.

1.8. Alkalinity

Alkalinity is used to quantify buffering capacity in water. This parameter measures the combined concentration of carbonates, bicarbonates, hydroxides and other minor constituents that are ionized in water, all of which help neutralize acids. These constituents act like a "buffer" that combine with acids to maintain ionic equilibrium in water, and thereby inhibits the tendency for the pH level to drop. As the alkalinity content is consumed, the buffering effect diminishes, and the tendency for lowering the pH increases. As the pH level drops, the water takes on a more acidic chemistry and reacts differently. Some alkalinity is desirable, because it stabilizes the reactivity of potable water. If alkalinity is too low, it can lead to issues like increased corrosion, red water problems and nitrification in the distribution system. However, if alkalinity is too high, chemical addition can be undesirably ineffective. A common problem with high alkalinity is its significant inhibition of the ability of coagulants to remove contaminants like turbidity and organic matter. When it is lacking in water, alkalinity can be added using basic chemicals such as sodium carbonate (soda ash), sodium bicarbonate and sodium hydroxide (caustic soda).

1.9. Calcium, Hardness and LSI

Calcium is commonly found in water and can influence its chemistry in many ways. Of particular interest to the water supply industry is its relationship to the corrosivity and hardness of water. Generally, the more calcium present in water, the less corrosive the water. Also, higher concentrations of calcium usually translate into higher levels of hardness. Hardness is a measure of the combined concentrations of calcium and magnesium, which can cause scaling problems in hydraulic vessels and piping, and reduce the effectiveness of soap products. Wrangell's surface water is very low in hardness (i.e. very "soft"). The Langelier Saturation Index (LSI) measures the tendency of water to dissolve or deposit calcium. The lower the LSI, the greater the tendency for water to dissolve calcium. This relationship is used as a rough, qualitative value to determine corrosivity of water.

1.10. Arsenic

Arsenic is also a common contaminant in waters that also contain iron and manganese, although it doesn't not appear to be a significant concern for CBW. Unlike iron and manganese, arsenic is a primary contaminant that creates health concerns. When the arsenic MCL was reduced from 0.50 mg/L to 0.10 mg/L in 2006, many water systems were faced with treating for this contaminant. Fortunately, many of these same communities also treat for high iron, which facilitates the removal of arsenic. When sufficient concentrations of soluble iron are oxidized into ferric hydroxide, arsenic becomes enmeshed in the gelatinous iron matrix by way of adsorption and co-precipitation processes. When the iron is removed by filtration, the arsenic is removed as well. Therefore, while arsenic is a concern by virtue of its danger to human health, it is considered a readily treatable contaminant.

1.11. Lead and Copper

Lead and copper are metallic elements that can be harmful to human health when ingested in high concentrations. As contaminants, these elements are commonly found in drinking water systems featuring lead, brass, bronze and copper in fittings and piping. These contaminants can become present in high concentrations when drinking water is relatively corrosive and causes these elements to be leached out of the parent materials that are in contact with the water. The Lead and Copper Rule has been established to address this problem (Appendix A). Low-lead solder and brass/bronze fittings are also mandated by building codes to minimize the possibility of leaching lead into drinking water.

Copper levels in water can often be reduced by elevating the pH of the water. Lead levels can be reduced to some extent by this method, but more commonly requires other methods for preventing lead from leaching into the drinking water. One such method is called "passivation," whereby orthophosphates are injected into the water distribution system to coat the interior surfaces of piping and valves. This chemical binds lead compounds, thereby making them less reactive with the water (i.e. passivating the lead), and less likely to be leached into the water.

END

Appendix B – Existing Data Summaries

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #001 Airport (State Office) N-1 DATE 10-17-00

TEST MADE BY Rob & Gary TIME 10:00 A.M.

REPRESENTATIVE OF City of Wrangell

WITNESS Tom Gillen

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine / Evergreen Pump (not running)

FLOW HYDRANTS #001 A1 #002 A2 A3 A4

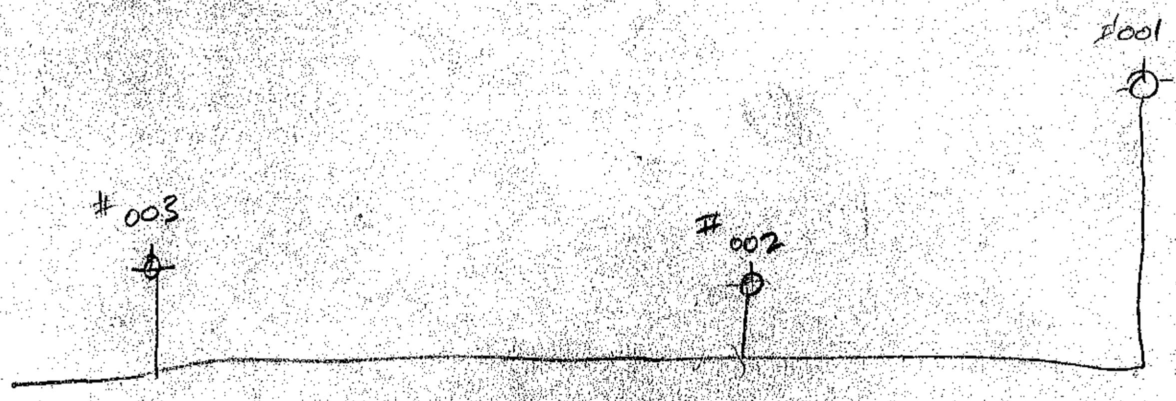
SIZE NOZZLE 2"

PITOT READING 68 psi TOTAL GPM 980

STATIC B 96 psi RESIDUAL B 86 psi

PROJECTED RESULTS @ 20 psi 2928 gpm, or @ 0 psi RESIDUAL 3321 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Airport #N2 DATE 5-2-07

TEST MADE BY Wayne McHolland Derek Meissner TIME 12 P.M.

REPRESENTATIVE OF City of Wrangell

WITNESS Jeff Rooney Sr.

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ~~0~~

FLOW HYDRANTS N2 A1 A2 A3 A4

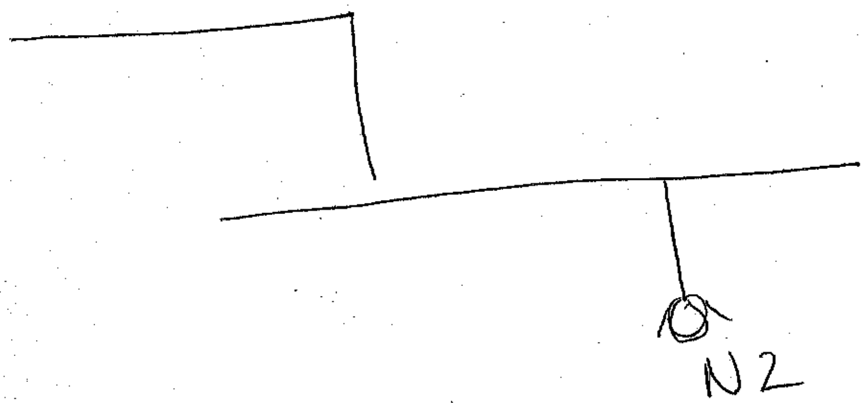
SIZE NOZZLE 2½

PITOT READING 49 (48)→ psi TOTAL GPM 1043

STATIC B 91 psi RESIDUAL B 76 psi

PROJECTED RESULTS @ 20 psi 2412 gpm, or @ ~~0~~ psi RESIDUAL 2760 gpm

REMARKS Total GPM (1043) was taken from flow test data table for 48 psi because no 49 psi exhists in table



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

N-3

LOCATION #002 Airport Between State Bld. & Temposco DATE 10-17-00

TEST MADE BY Rob & Gary TIME 10:00 A.M.

REPRESENTATIVE OF City

WITNESS Tom Gillen

STATE PURPOSE OF TEST Flow Testing

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine / Evergreen (NOT Running)

FLOW HYDRANTS #002 A1 #003 A2 A3 A4

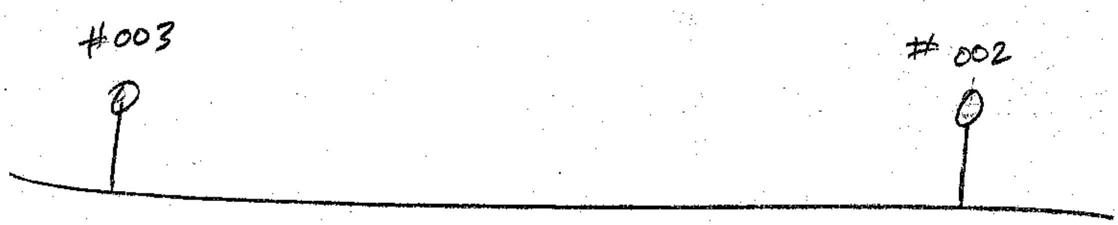
SIZE NOZZLE 2"

PITOT READING 68 psi TOTAL GPM 980

STATIC B 94 psi RESIDUAL B 88 psi

PROJECTED RESULTS @ 20 psi 3808 gpm, or @ psi RESIDUAL 4333 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

N-4

LOCATION #003 Airport Temsco End DATE 10-17-00

TEST MADE BY Rob & Gary → Joe & Rob (10-19) TIME 10:00 A.M.

REPRESENTATIVE OF City Public Works

WITNESS Tom Gillen

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine/Evergreen (NOT RUNNING)

FLOW HYDRANTS #003 A1 #004 A2 A3 A4

SIZE NOZZLE 2"

PITOT READING 76 TOTAL GPM 1036

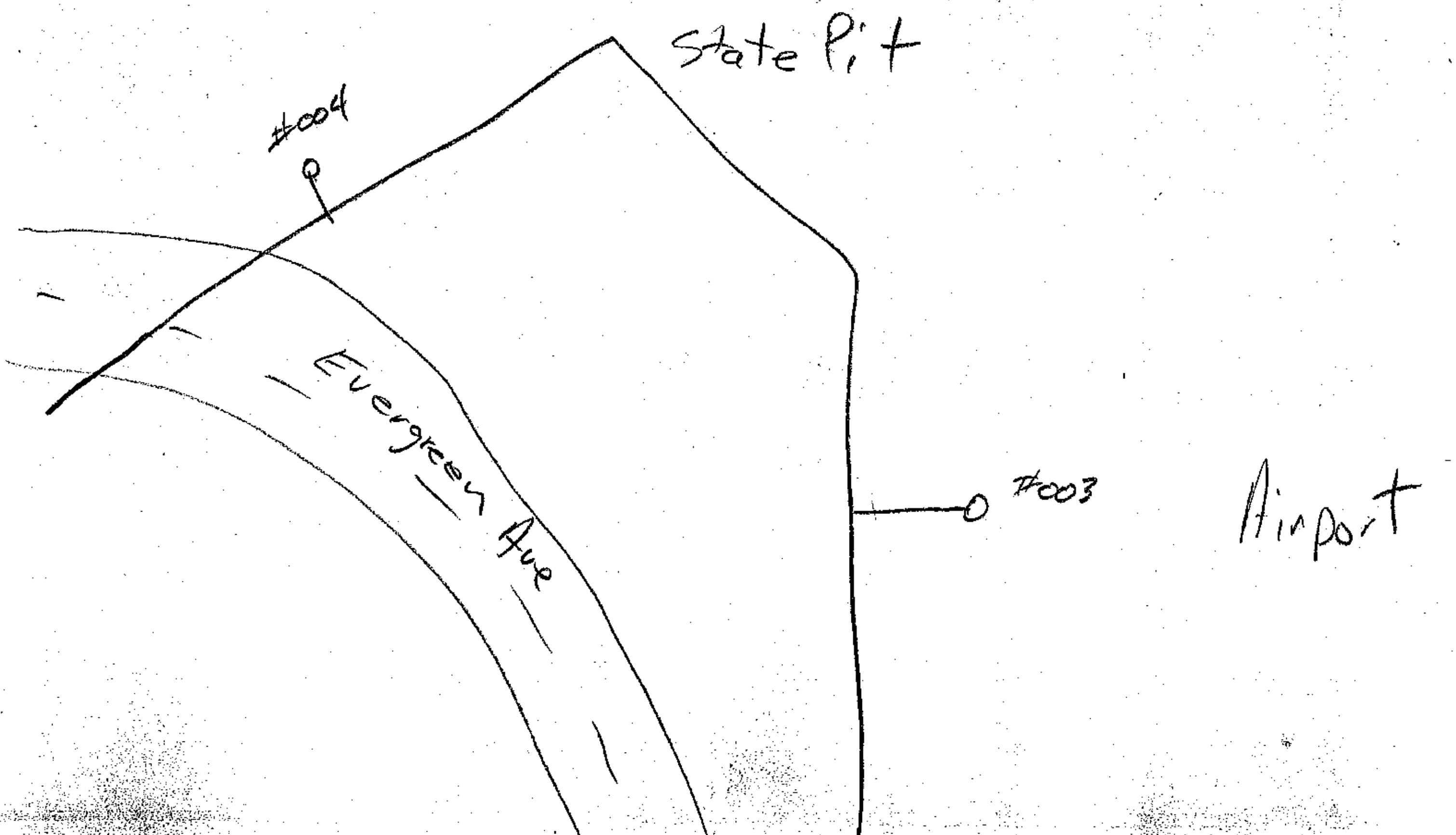
STATIC B 88 psi RESIDUAL B 84 psi

PROJECTED RESULTS @ 20 psi 4792 gpm, or @ 0 psi RESIDUAL 5509 gpm

REMARKS ~~No Test~~ - Hydrant Valve NOT ON

Hydrant needs Ballards

"turned Hydrant on - completed test 10-19"



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#004 N-5

LOCATION State Rock Pit on Evergreen Ave DATE 10-17-00

TEST MADE BY Rob & Gary TIME 11:10 A.M.

REPRESENTATIVE OF Public Works

WITNESS Jeff & Tom

STATE PURPOSE OF TEST Flow testing

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Evergreen Pump (NOT RUNNING)

FLOW HYDRANTS State Pit A1 Gerard Hall A2 A3 A4

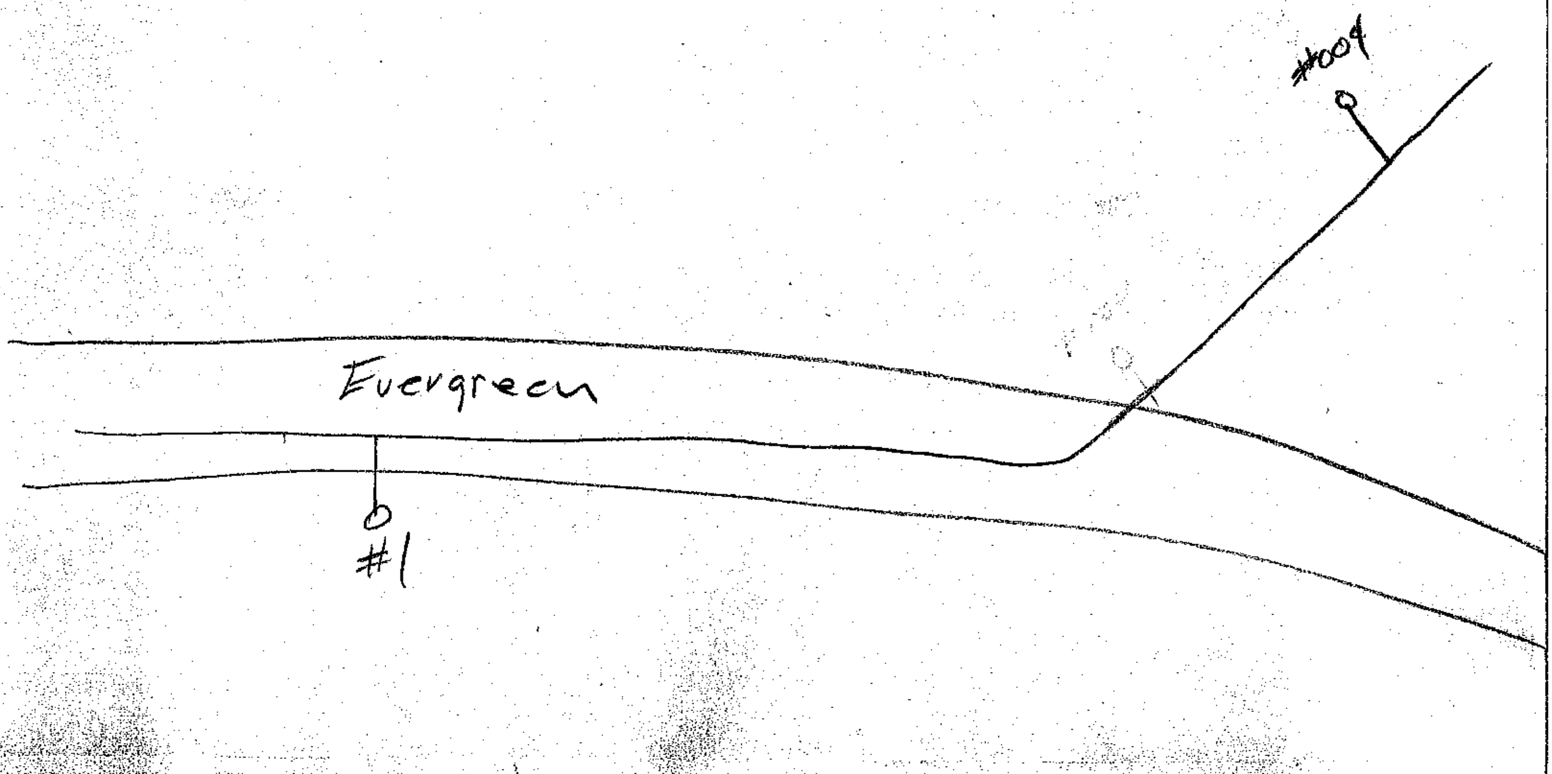
SIZE NOZZLE 2"

PITOT READING 40 psi TOTAL GPM 920

STATIC B 70 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 5247 gpm, or @ 0 psi RESIDUAL 6294 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #1 Evergreen Ave N-6 DATE 10-17-00

TEST MADE BY Rob & Gary TIME 11:00 A.M.

REPRESENTATIVE OF City Public Works

WITNESS Tom Gillen

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine/Evergreen (NOT RUNNING)

FLOW HYDRANTS #1 A1 #2 A2 A3 A4

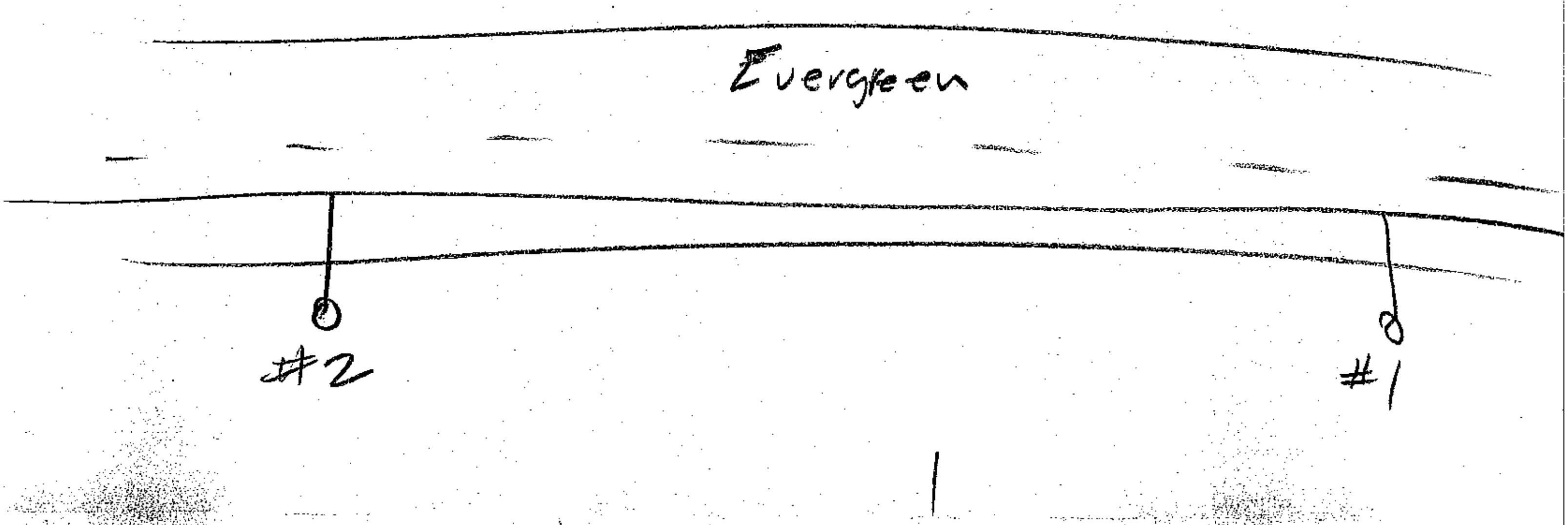
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 66 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 3152 gpm, or @ 0 psi RESIDUAL 3830 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #2 Evergreen Ave N-7 DATE 10-17-00

TEST MADE BY Rob & Gary TIME 11:00 A.M.

REPRESENTATIVE OF City PUBLIC Works

WITNESS Tom Gillen

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine / Evergreen (not running)

FLOW HYDRANTS #2 A1 #3 A2 A3 A4

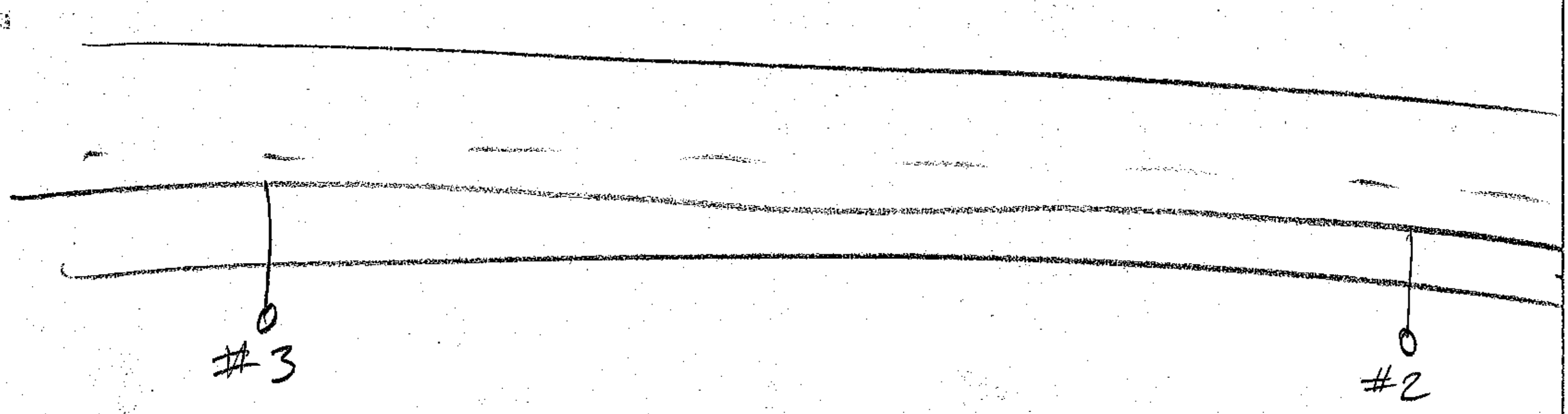
SIZE NOZZLE 2"

PITOT READING 44 psi TOTAL GPM 788

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2528 gpm, or @ 0 psi RESIDUAL 3017 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #3 Evergreen Ave N-10 DATE 10-17-00

TEST MADE BY Rob & Gary TIME 2:00 p .M.

REPRESENTATIVE OF Public Works

WITNESS Tom Gillen

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine / Evergreen (not running)

FLOW HYDRANTS #3 A1 ____ A2 ____ A3 ____ A4 ____

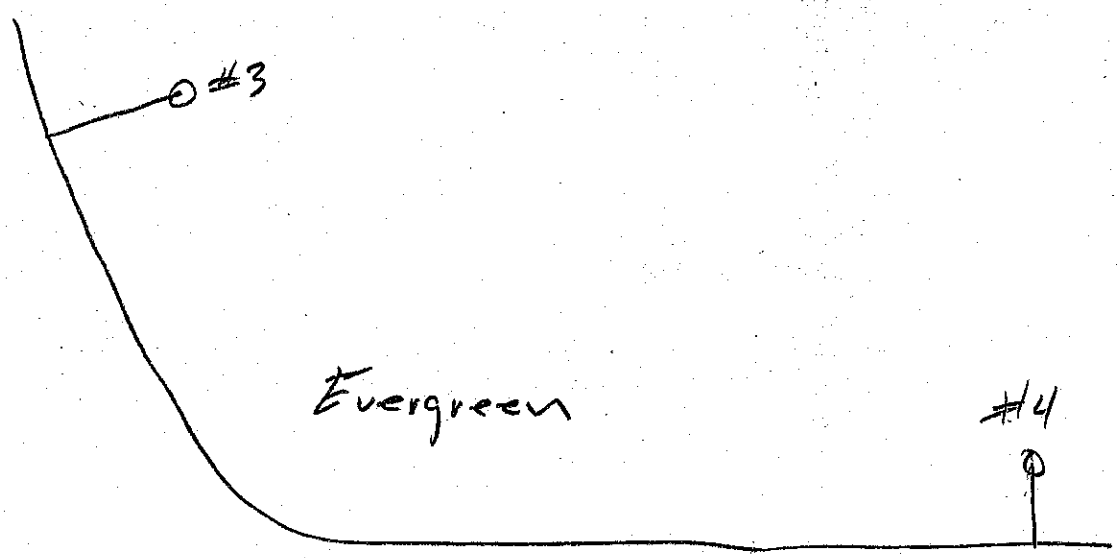
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 66 psi ____ RESIDUAL B 60 psi

PROJECTED RESULTS @ 20 psi 2529 gpm, or @ 0 psi RESIDUAL 3073 gpm

REMARKS ____



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Landfill #1 N-8 DATE 12-27-00

TEST MADE BY Gary and Rob TIME 2:27 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS Landfill #1 A1 Doug Smith A2 A3 A4

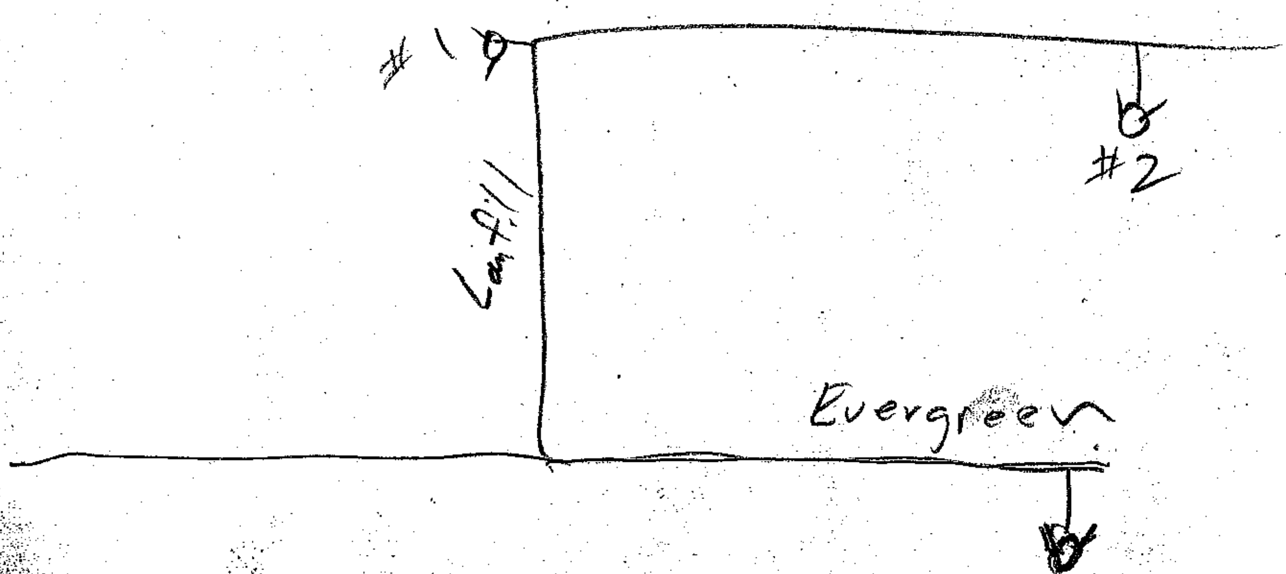
SIZE NOZZLE 1 1/2

PITOT READING 48 TOTAL GPM 394

STATIC B 64 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 2098 gpm, or @ 0 psi RESIDUAL 2567 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION LANDFILL #2 N-9 DATE 12-27-00

TEST MADE BY ROB DAVIDSON & GARY PULLMAN TIME 2-2:30 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine / Evergreen (NOT Running)

FLOW HYDRANTS Landfill #2 A1 Landfill #1 A2 A3 A4

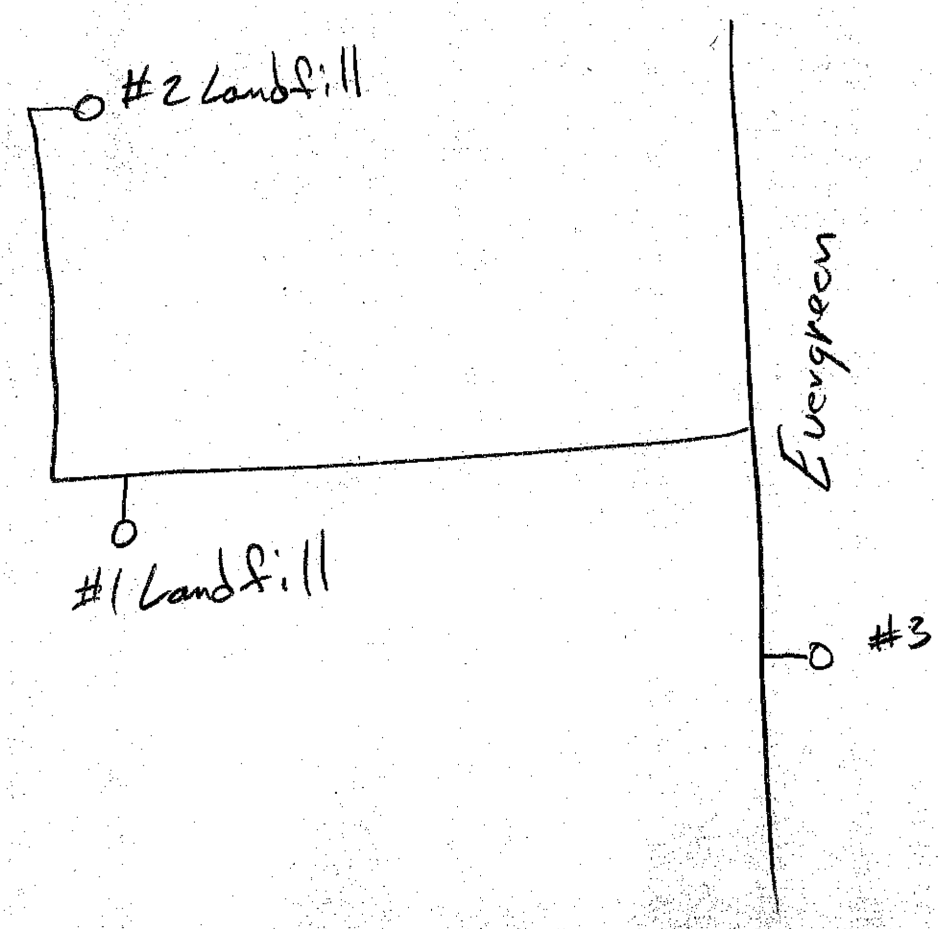
SIZE NOZZLE ~~2"~~ 1 1/2"

PITOT READING 42 ~~2X~~ psi TOTAL GPM 369

STATIC B 52 ~~58~~ psi RESIDUAL B 50 psi

PROJECTED RESULTS @ 20 psi 1654 gpm, or @ 0 psi RESIDUAL 2148 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

N-12

LOCATION #4 Evergreen Ave (N-11) (?) DATE 10-17-00

TEST MADE BY Rob Davidson & Gary Pullman TIME 2:30-3 p.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine/Evergreen (NOT Running)

FLOW HYDRANTS #4 A1 #5 A2 A3 A4

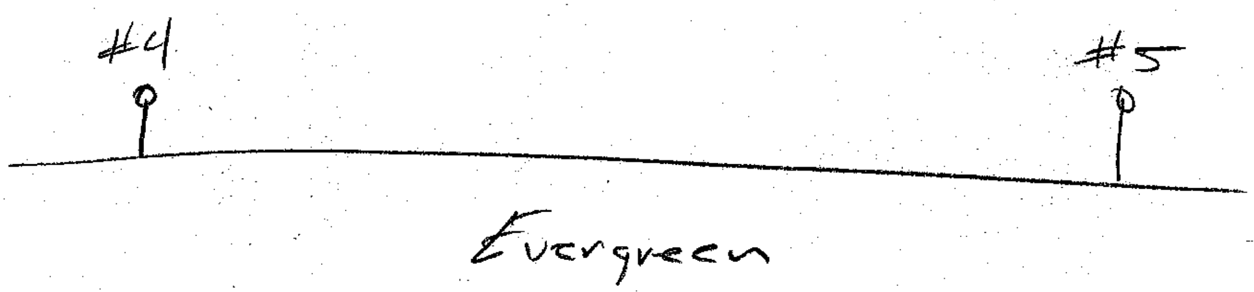
SIZE NOZZLE 2"

PITOT READING 54 psi TOTAL GPM 873

STATIC B 72 psi RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi 2400 gpm, or @ 0 psi RESIDUAL 2864 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

N-13

LOCATION #5 Evergreen Ave (Stuoghs trlcrt) DATE 10-17-00

TEST MADE BY Rob Davidson & Gary Pullman TIME 2:30-3 p.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine/Evergreen (not running)

FLOW HYDRANTS #5 A1 #6 A2 A3 A4

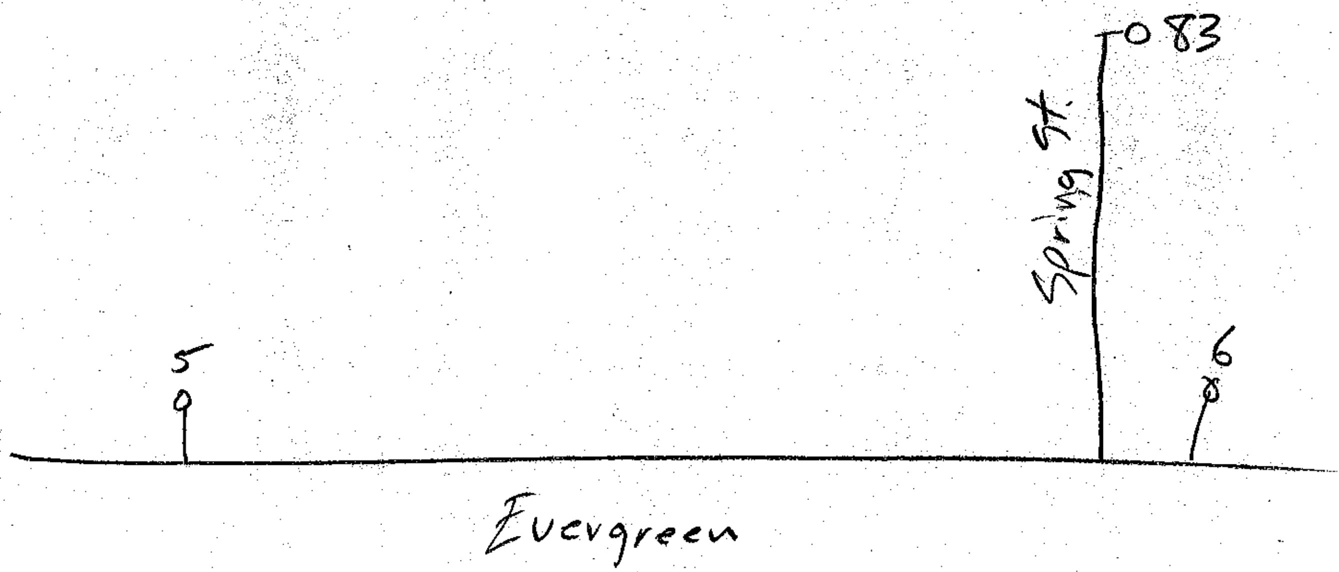
SIZE NOZZLE 2"

PITOT READING 58 psi TOTAL GPM 905

STATIC B 80 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 2378 gpm, or @ 0 psi RESIDUAL 2754 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

N-15

LOCATION #6 Evergreen Ave & Spring St. DATE 10-17-00

TEST MADE BY Rob & Gary TIME 2:30 - 3 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikin/Evergreen (Not running)

FLOW HYDRANTS #6 A1 #7 A2 A3 A4

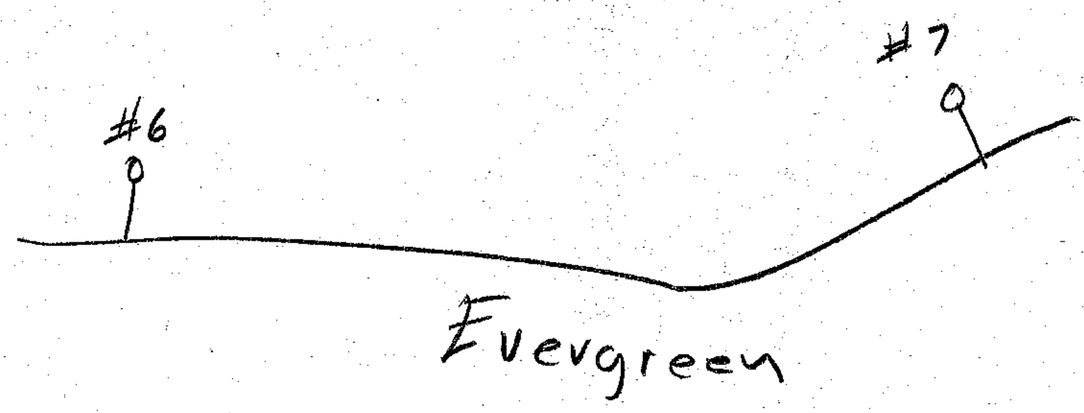
SIZE NOZZLE 2"

PITOT READING 54 psi TOTAL GPM 873

STATIC B 78 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 2548 gpm, or @ 0 psi RESIDUAL 2989 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #7 Evergreen Ave N-16 DATE 10-17-00

TEST MADE BY Rob & Gary TIME 3-3:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine/Evergreen (NOT Running)

FLOW HYDRANTS #7 A1 #8 A2 A3 A4

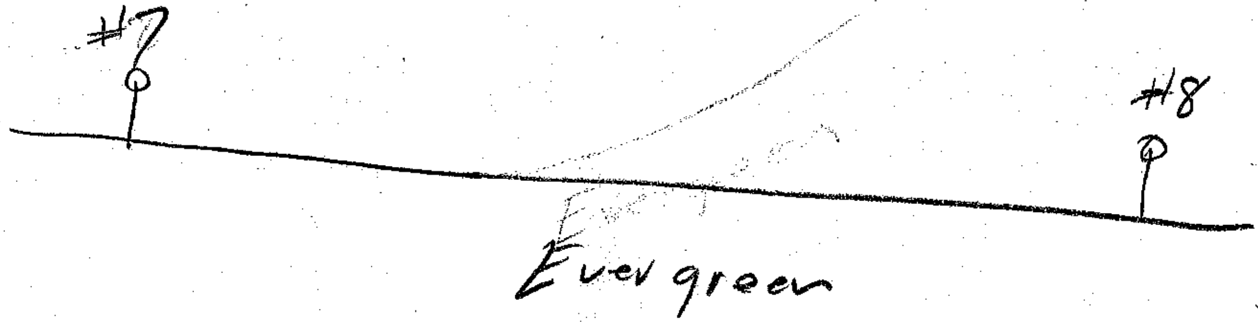
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 80 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 2337 gpm, or @ 0 psi RESIDUAL 2731 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #8 Evergreen Ave N-17 DATE 10-17-00

TEST MADE BY Rob & Gary TIME 3-3:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikin / Evergreen (not running)

FLOW HYDRANTS #8 A1 #9 A2 A3 A4

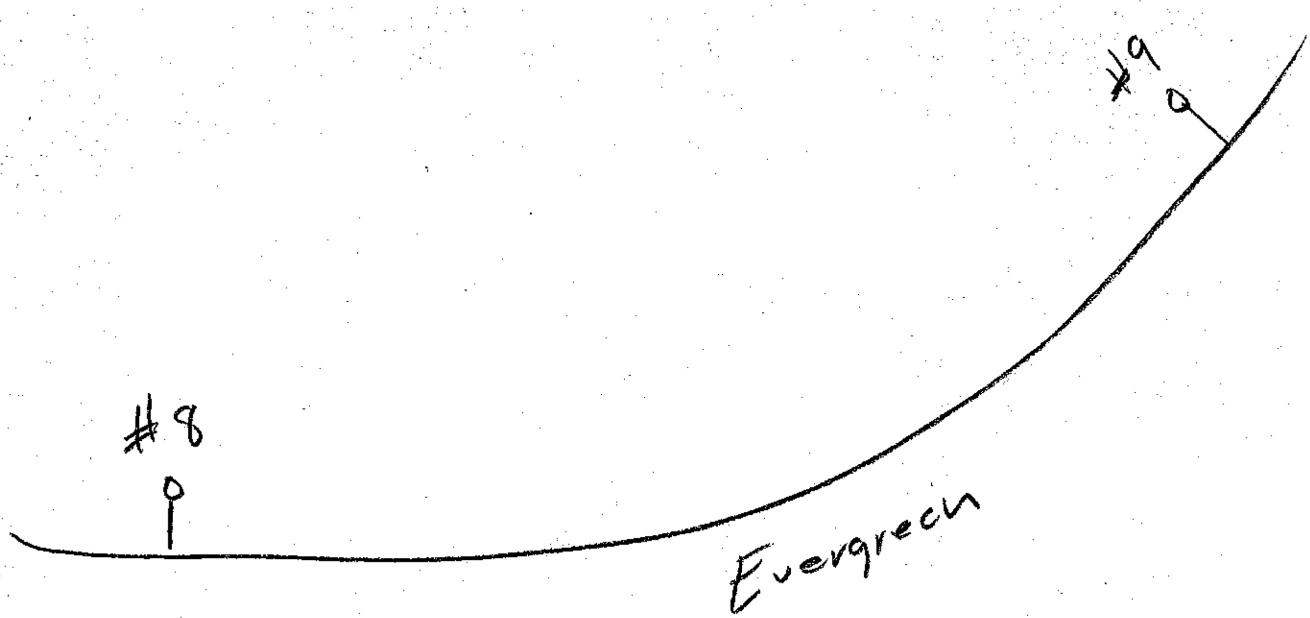
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 80 psi RESIDUAL B 72 psi

PROJECTED RESULTS @ 20 psi 2641 gpm, or @ 0 psi RESIDUAL 3087 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L-18

LOCATION #9 Evergreen Ave DATE 10-17-00

TEST MADE BY Rob & Gary TIME 3:30-4 p.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #9 A1 #10 A2 A3 A4

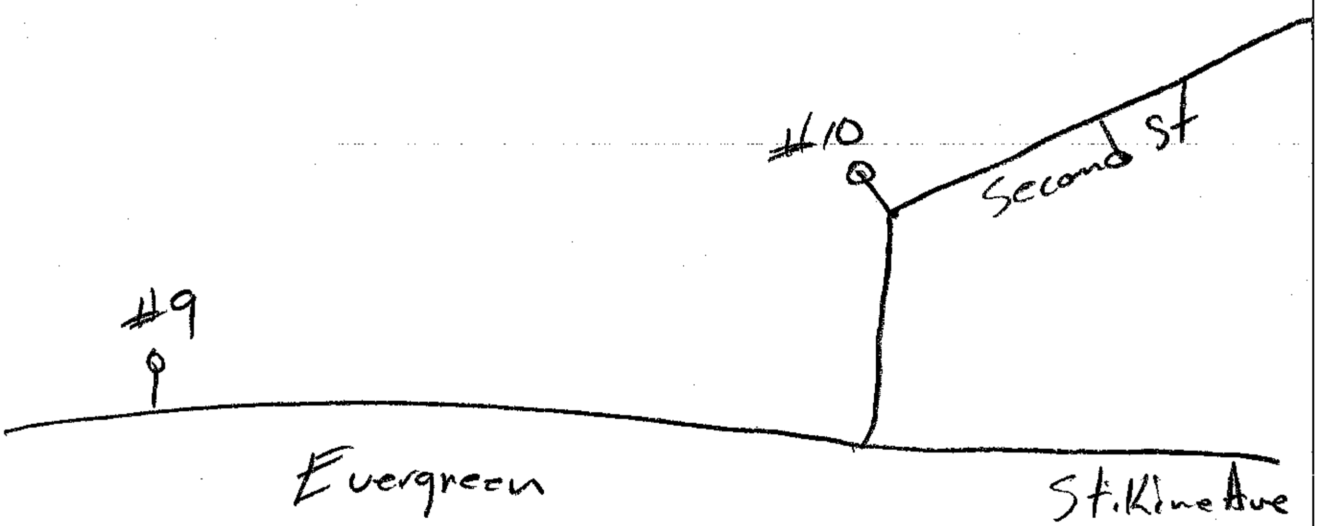
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 74 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 1893 gpm, or @ 0 psi RESIDUAL 2244 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L-19

LOCATION # 10 Second St & McCormick St DATE 10-17-00

TEST MADE BY Rob & Gary TIME 3:30-4 p.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #10 A1 #11 A2 A3 A4

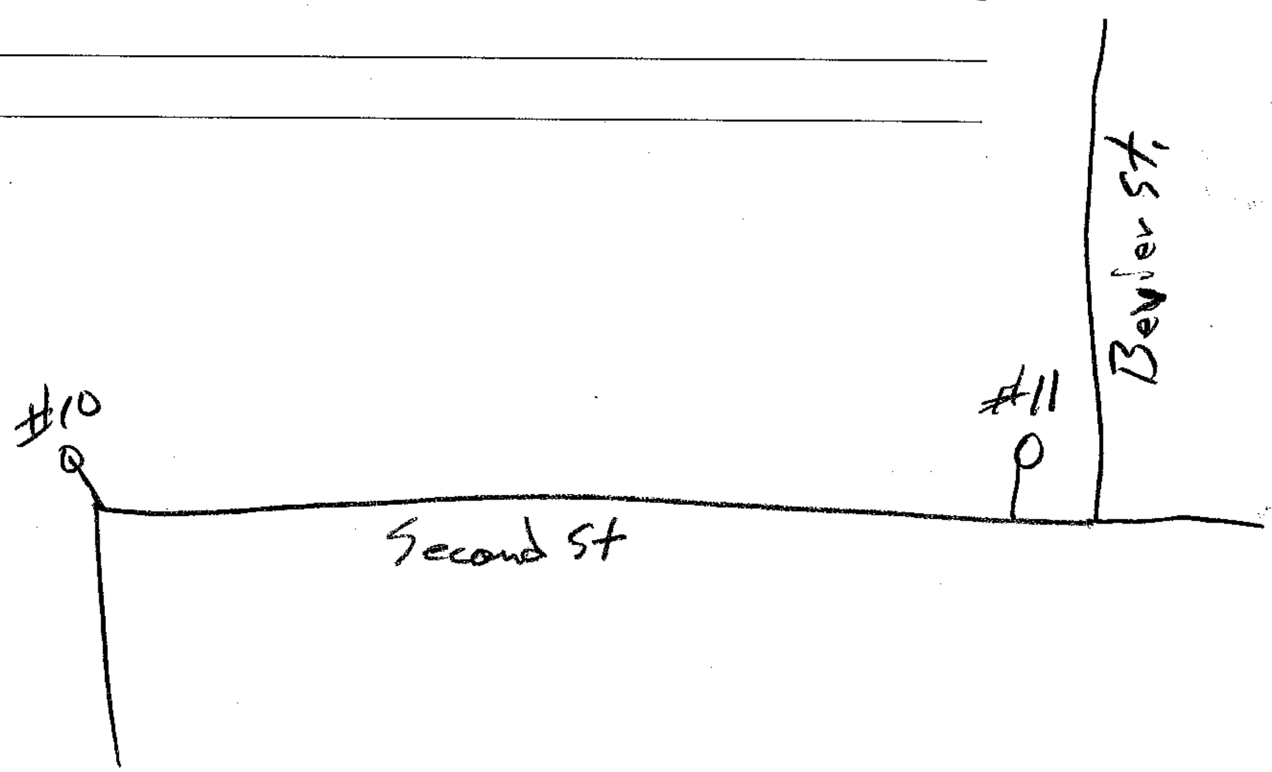
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 68 psi RESIDUAL B 60 psi

PROJECTED RESULTS @ 20 psi 2216 gpm, or @ 0 psi RESIDUAL 2674 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L-20

LOCATION #11 Bevier St & Second St. DATE 10-17-00

TEST MADE BY ROB Davidson & Gary Pullman TIME 3-4 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #11 A1 #12 A2 A3 A4

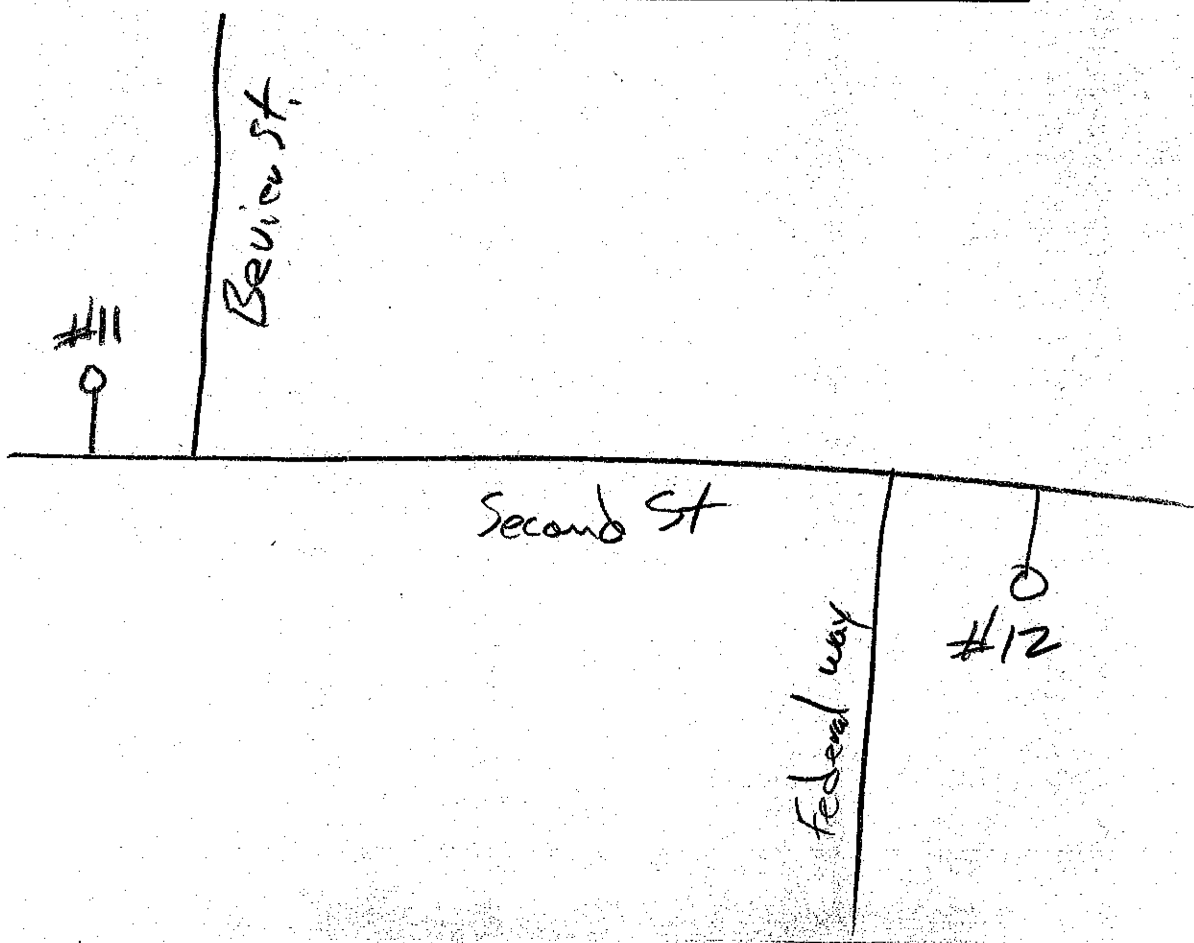
SIZE NOZZLE 2"

PITOT READING 48 psi TOTAL GPM 824

STATIC B 72 psi RESIDUAL B 108 psi

PROJECTED RESULTS @ 20 psi 3296 gpm, or @ 0 psi RESIDUAL 3932 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L-21

LOCATION #12 Second St & Federal Way DATE 10-17-00

TEST MADE BY Rob & Gary TIME 4: - 4:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #12 A1 #13 A2 A3 A4

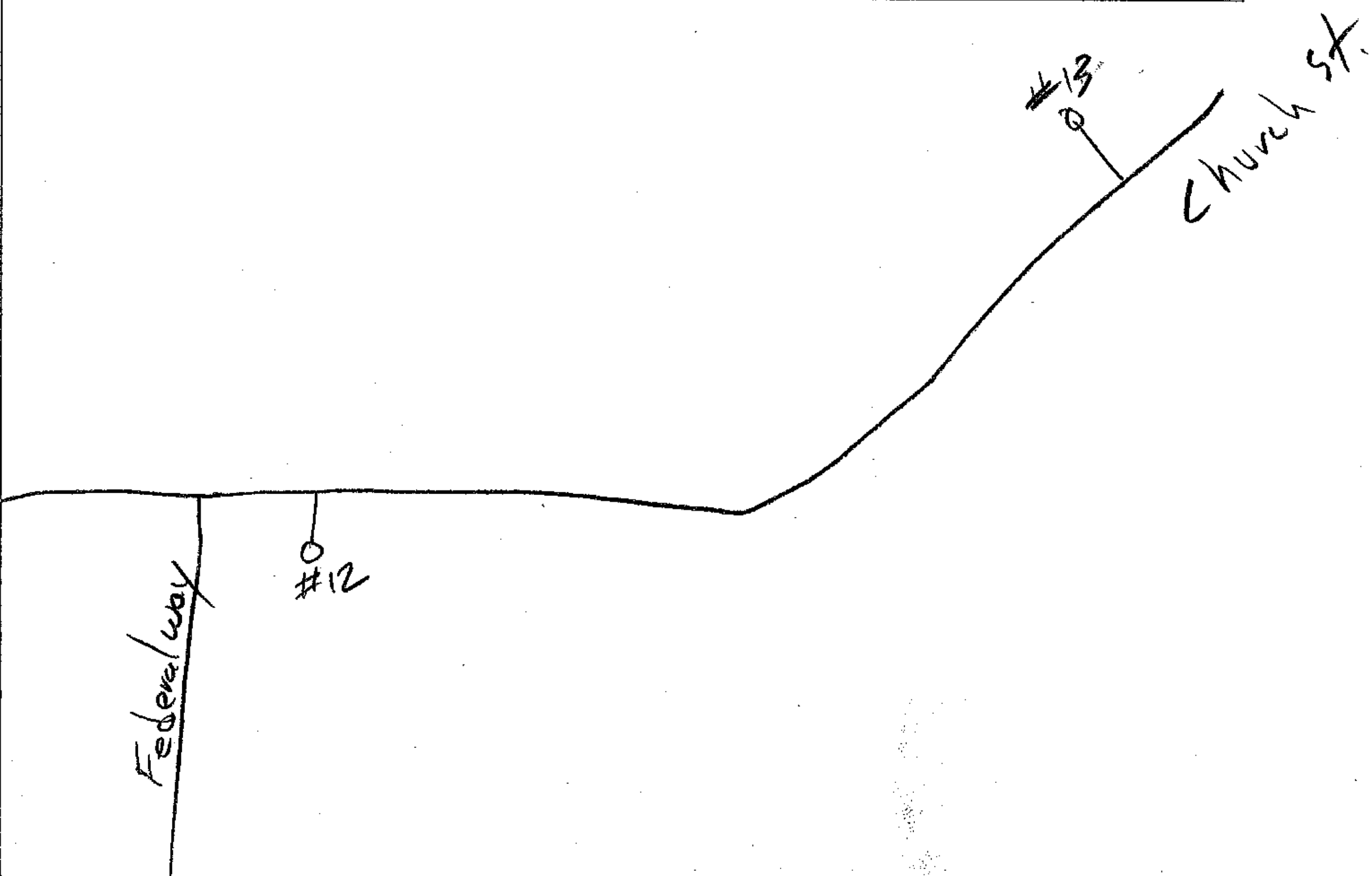
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2699 gpm, or @ 0 psi RESIDUAL 3220 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L-22

LOCATION #13 Church St & McKinnon St DATE 10-17-00

TEST MADE BY Rob & Gary TIME 4-4:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #13 A1 #14 A2 A3 A4

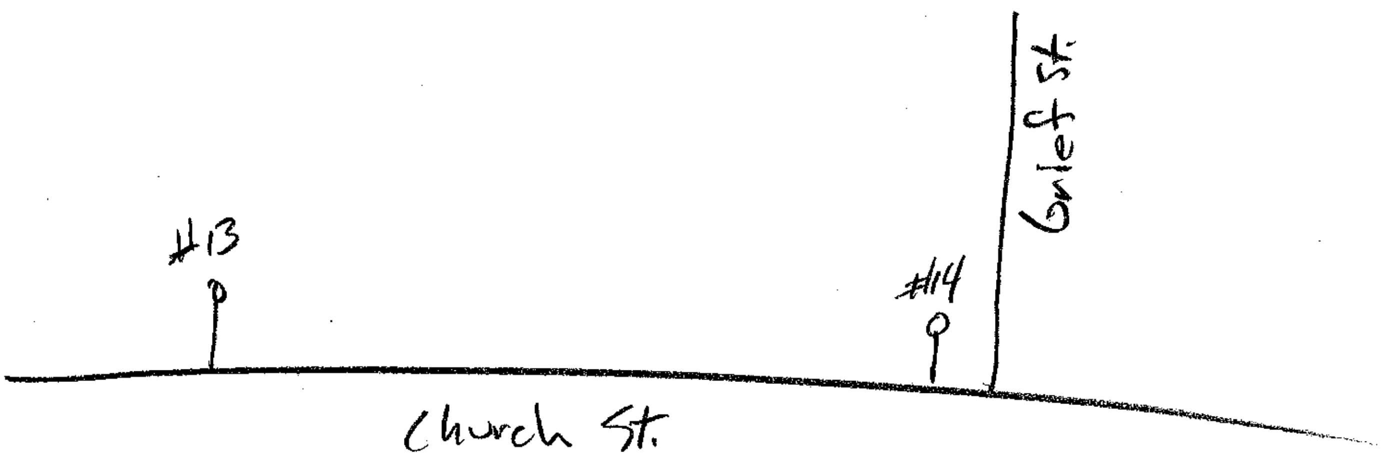
SIZE NOZZLE 2"

PITOT READING 52 psi TOTAL GPM 857

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2750 gpm, or @ 0 psi RESIDUAL 3281 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L - 23

LOCATION #14 Church St & Grief St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 8:30 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #14 A1 #15 A2 A3 A4

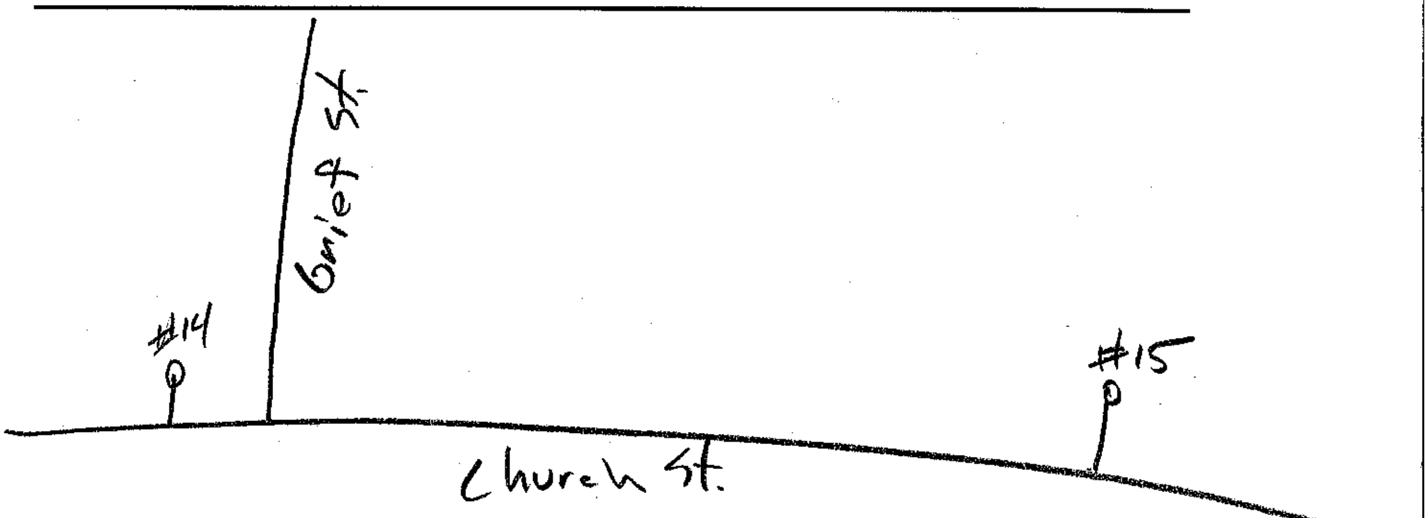
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 54 psi RESIDUAL B 50 psi

PROJECTED RESULTS @ 20 psi 2674 gpm, or @ 0 psi RESIDUAL 3436 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

L-24

LOCATION #15 Church St (Pool) DATE 10-18-00

TEST MADE BY Rob & Gary TIME 8:30-9 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #15 A1 #16 A2 A3 A4

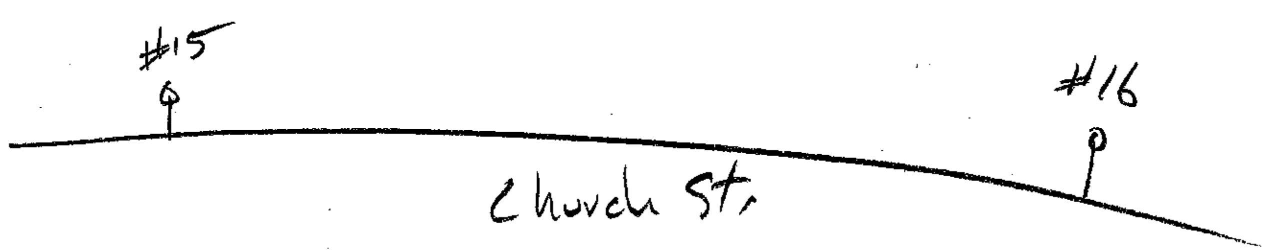
SIZE NOZZLE 2"

PITOT READING 40 psi TOTAL GPM 752

STATIC B 64 psi RESIDUAL B 58 psi

PROJECTED RESULTS @ 20 psi 2207 gpm, or @ 0 psi RESIDUAL 2702 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #16 Church & St. Michaels St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 11:00 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #16 A1 #39 A2 A3 A4

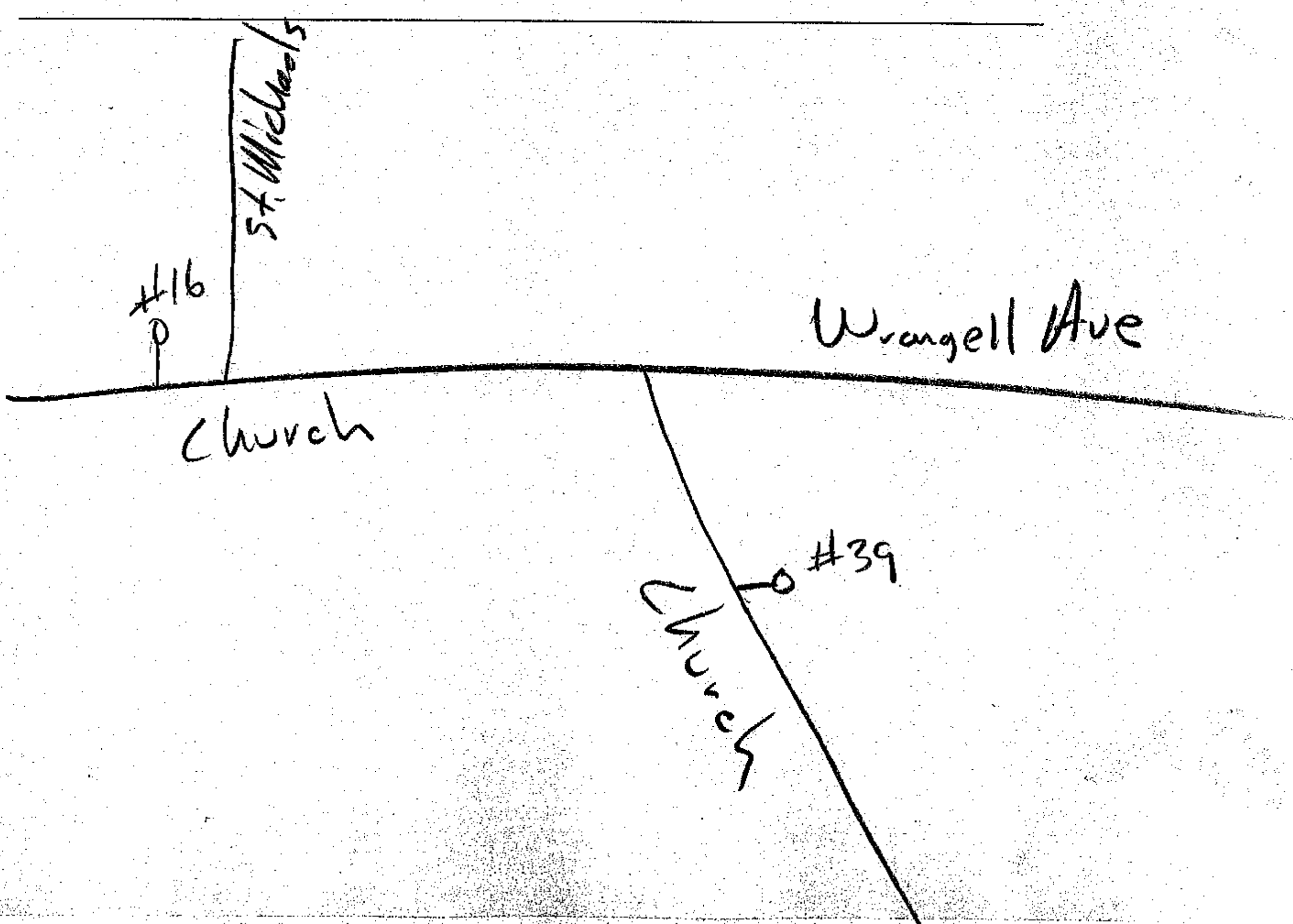
SIZE NOZZLE 2"

PITOT READING 44 psi TOTAL GPM 788

STATIC B 68 psi RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi 3021 gpm, or @ 0 psi RESIDUAL 3645 gpm

REMARKS



HYDRANT FLOW TEST REPORT #17
CITY OF WRANGELL

LOCATION Wrangell Ave. + Bennet DATE 12-27-00

TEST MADE BY Gary and Bob TIME 3:00 P. M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS Wrangell Ave Bennett A1 Church St Michaels A2 ______ A3 ______ A4 ______

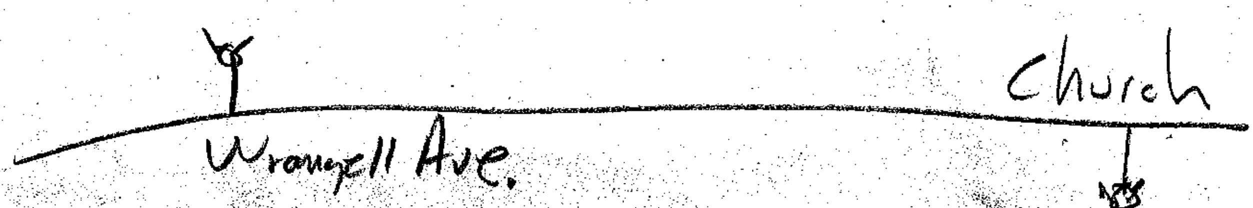
SIZE NOZZLE 3/4

PITOT READING 48 TOTAL GPM ______

STATIC B 58 psi ______ RESIDUAL B 56 psi

PROJECTED RESULTS @ 20 psi ______ gpm, or @ ______ psi RESIDUAL ______ gpm

REMARKS ______



HYDRANT FLOW TEST REPORT #18
CITY OF WRANGELL

LOCATION Salvation Army DATE 10-20-00

TEST MADE BY Gary and Rob TIME 11:00 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J18 A1 J19 A2 A3 A4

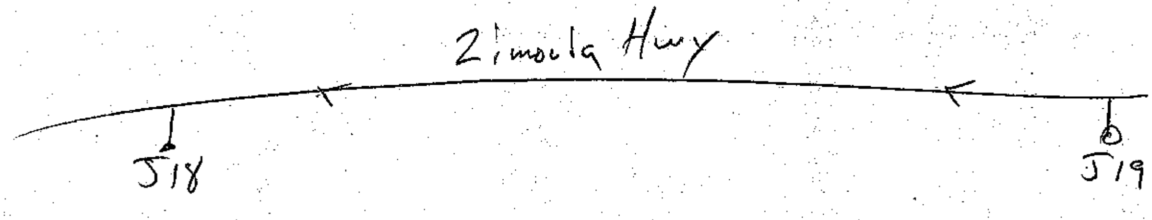
SIZE NOZZLE 2"

PITOT READING 86 TOTAL GPM 1102

STATIC B 120 psi RESIDUAL B 108 psi

PROJECTED RESULTS @ 20 psi 2720 gpm, or @ 0 psi RESIDUAL 2975 gpm

REMARKS



#19

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Zimovia and Ash DATE 10-24-00

TEST MADE BY Gary and Rob TIME 8:54 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #19 A1 High pressure valt A2 A3 A4

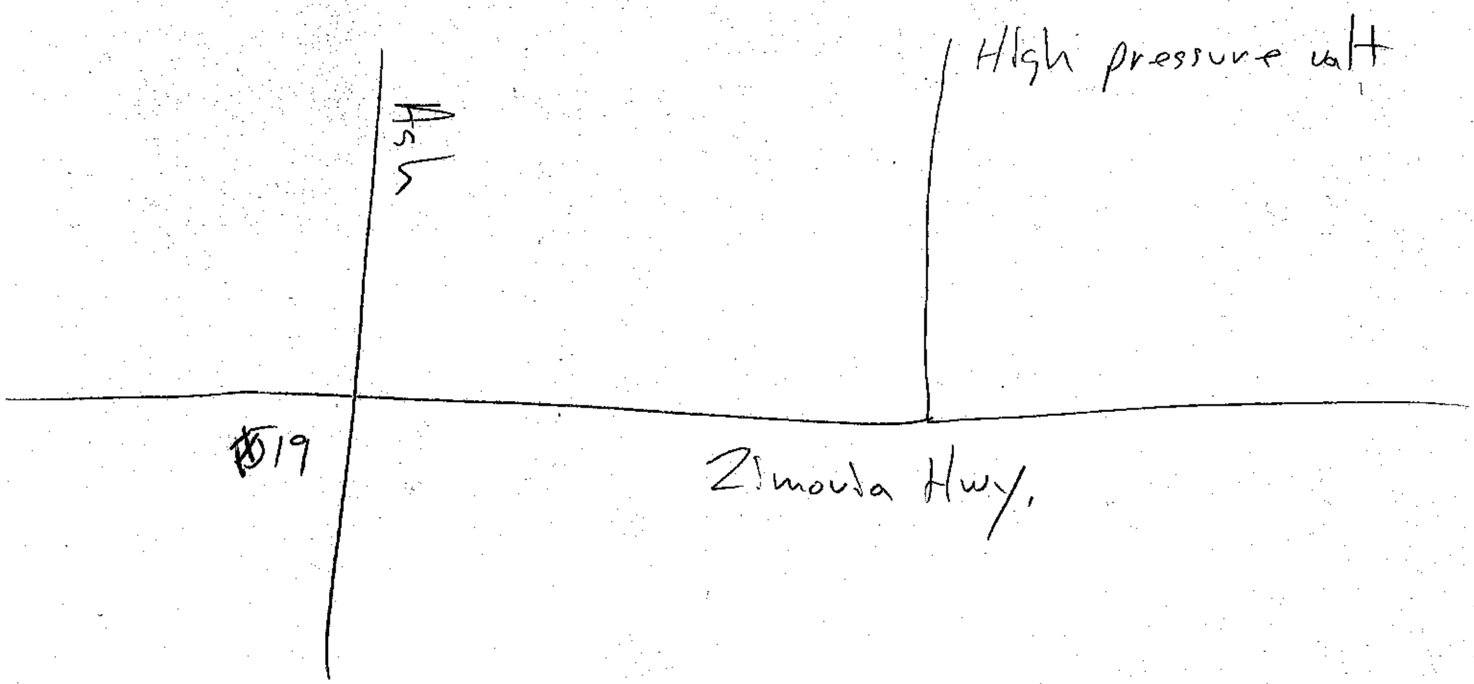
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 110 psi RESIDUAL B 92 psi

PROJECTED RESULTS @ 20 psi 2630 gpm, or @ 0 psi RESIDUAL 2931 gpm

REMARKS



#20

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Anne Armstrong DATE 10-24-00

TEST MADE BY Gary and Rob TIME 9:04 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J20 A1 Low pressure valt A2 A3 A4

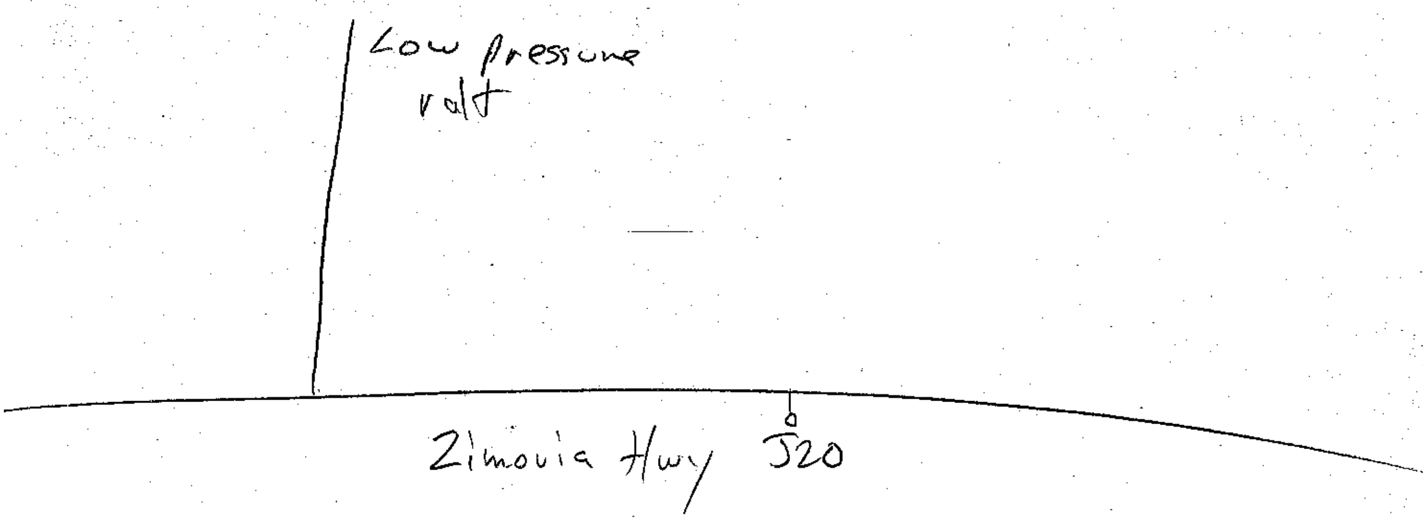
SIZE NOZZLE 2"

PITOT READING 46 psi TOTAL GPM 806

STATIC B 42 psi RESIDUAL B 38 psi

PROJECTED RESULTS @ 20 psi 1960 gpm, or @ 0 psi RESIDUAL 2876 gpm

REMARKS



#24

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION: Sue ~~[illegible]~~ Nikodym DATE: 10-24-00

TEST MADE BY: Cory and Rob TIME: 9:11 .M.

REPRESENTATIVE OF: PUBLIC WORKS

WITNESS: ____

STATE PURPOSE OF TEST: Flow

CONSUMPTION RATE DURING TEST: ____

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING: ____

FLOW HYDRANTS: J21 A1 J-20 A2 ____ A3 ____ A4 ____

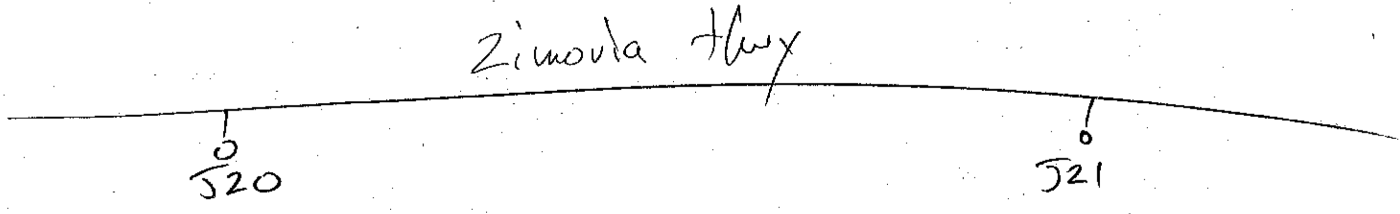
SIZE NOZZLE: 2"

PITOT READING: 48 psi TOTAL GPM: 824

STATIC B: 62 psi RESIDUAL B: 60 psi

PROJECTED RESULTS @ 20 psi 4279 gpm, or @ 0 psi RESIDUAL 5279 gpm

REMARKS: ____



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #22 Case Ave and Bergen St DATE 10-24-00

TEST MADE BY Gary and Rob TIME 9:30 .M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J22 A1 J21 A2 A3 A4

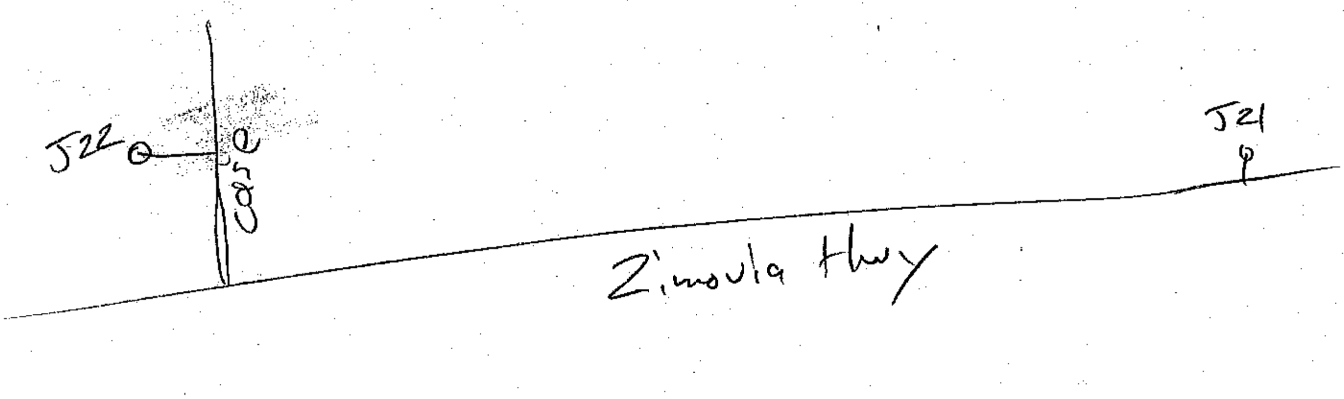
SIZE NOZZLE 2"

PITOT READING 52 psi TOTAL GPM 857

STATIC B 66 psi RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi 4675 gpm, or @ 0 psi RESIDUAL 5679 gpm

REMARKS



#23

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Cemetary DATE 10-24-00

TEST MADE BY Gary and Rob TIME 10:04 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J23 A1 J81 A2 A3 A4

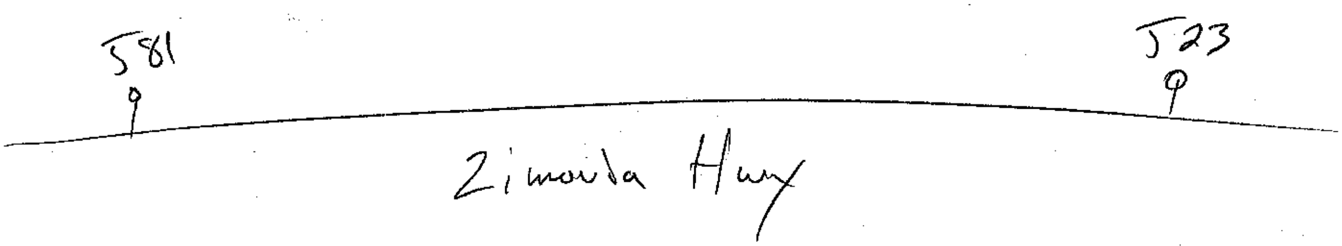
SIZE NOZZLE 2"

PITOT READING 90 psi TOTAL GPM 1128

STATIC B 146 psi RESIDUAL B 108 psi

PROJECTED RESULTS @ 20 psi 2155 gpm, or @ 0 psi RESIDUAL 2334 gpm

REMARKS



#24

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Blooms Trailer Court DATE 10-24-00

TEST MADE BY Gary and Rob TIME 10:11 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J24 A1 J23 A2 A3 A4

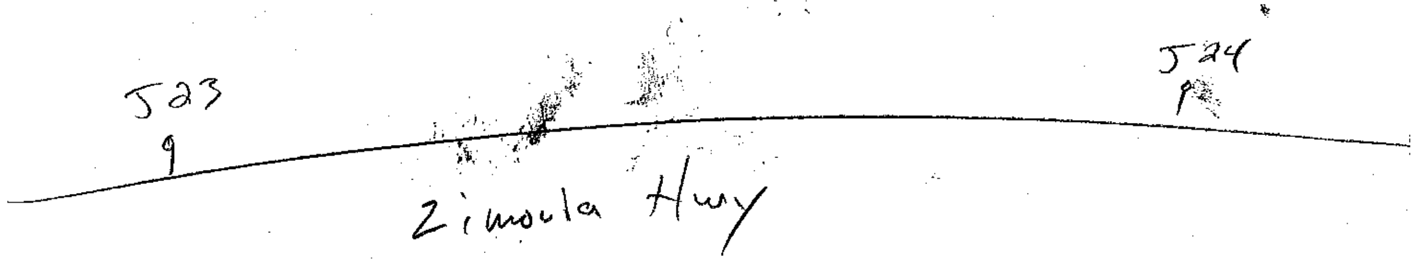
SIZE NOZZLE 2"

PITOT READING 92 psi TOTAL GPM 1140

STATIC B 136 psi RESIDUAL B 112 psi

PROJECTED RESULTS @ 20 psi 2672 gpm, or @ 0 psi RESIDUAL 2910 gpm

REMARKS



#25

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Bakke Apt. DATE 10-24-00

TEST MADE BY Gary and Rob TIME 10:20 M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS J-25 A1 J24 A2 ____ A3 ____ A4 ____

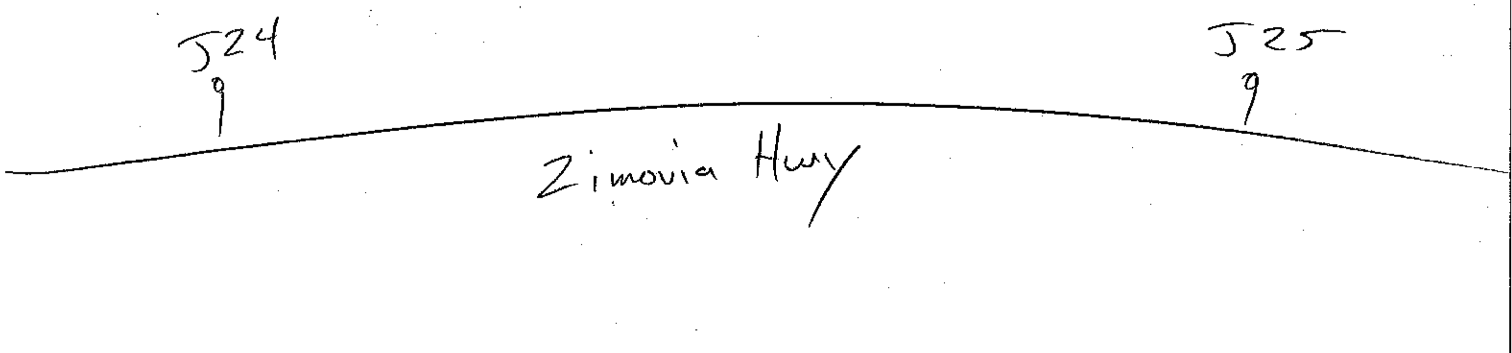
SIZE NOZZLE 2"

PITOT READING 88 psi TOTAL GPM 1115

STATIC B 140 psi RESIDUAL B 104 psi

PROJECTED RESULTS @ 20 psi 2135 gpm, or @ 0 psi RESIDUAL 2320 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #26 Penninsula St. & Shustak St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 3:00 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #26 A1 #27 A2 A3 A4

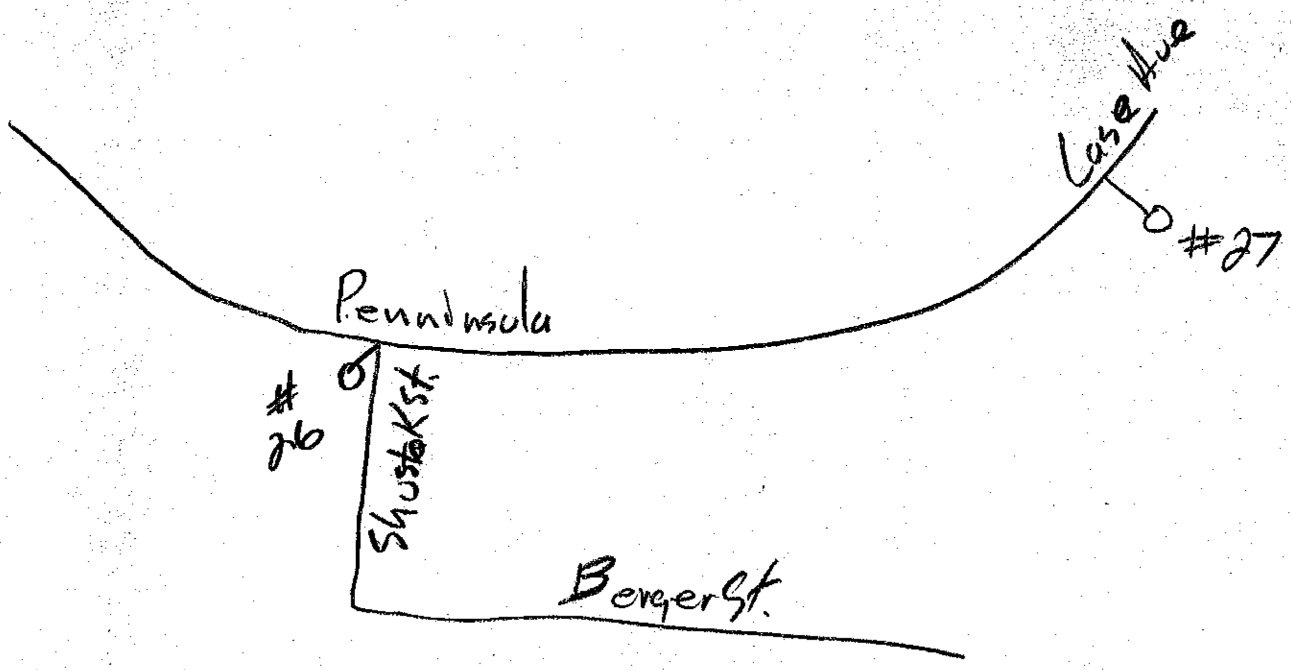
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 76 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 2971 gpm, or @ 0 psi RESIDUAL 3505 gpm

REMARKS Low Hydrant - needs to be raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #27 Case Ave (Power Plant) DATE 10-18-00

TEST MADE BY Rob & Gary TIME 2-2:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #27 A1 22 A2 A3 A4

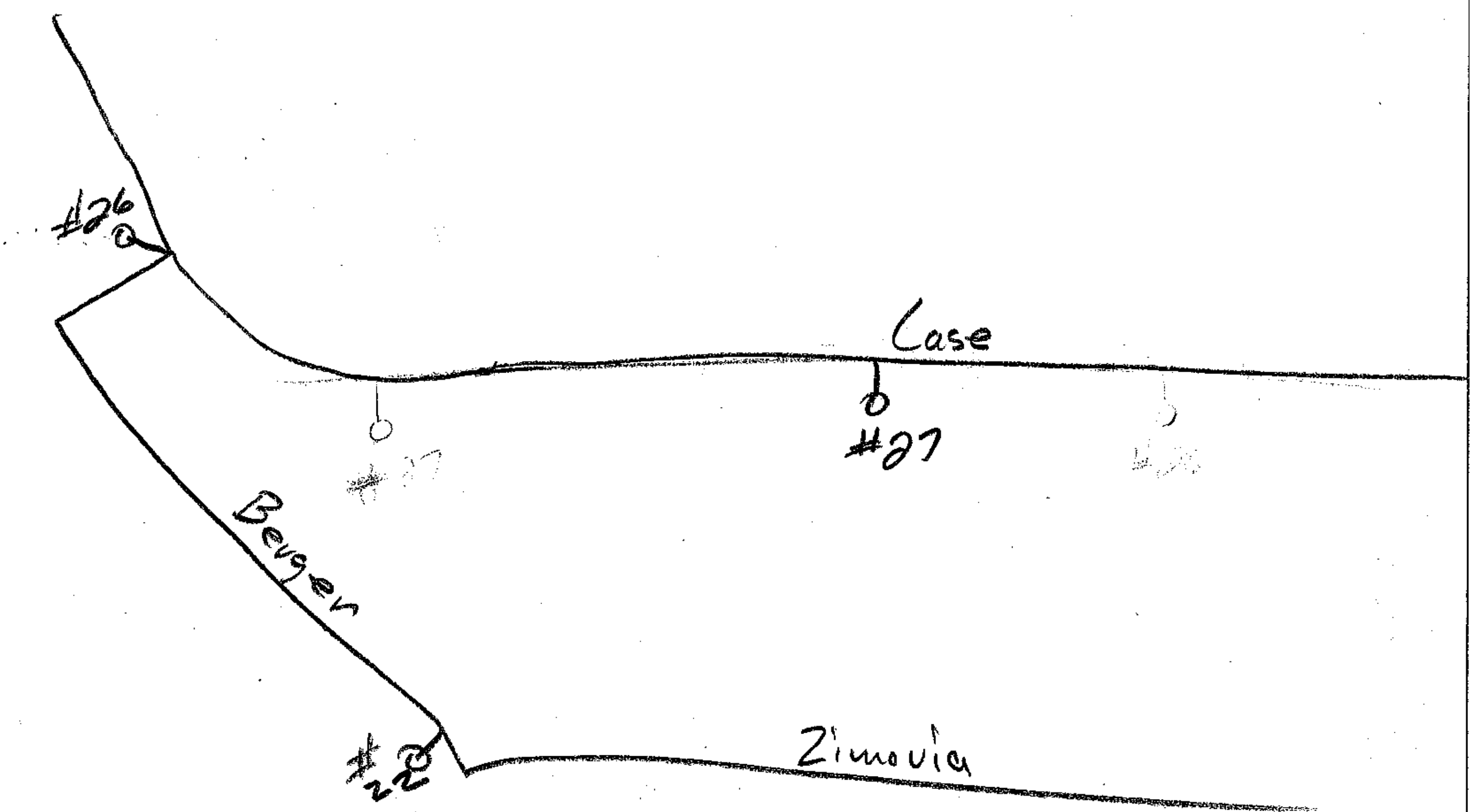
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 920

STATIC B 76 psi RESIDUAL B 72 psi

PROJECTED RESULTS @ 20 psi 3833 gpm, or @ 0 psi RESIDUAL 4522 gpm

REMARKS Hydrant needs to be raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #28 Case Ave DATE 10-18-00

TEST MADE BY Rob & Gary TIME 2-2:30 p.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #28 A1 #27 A2 A3 A4

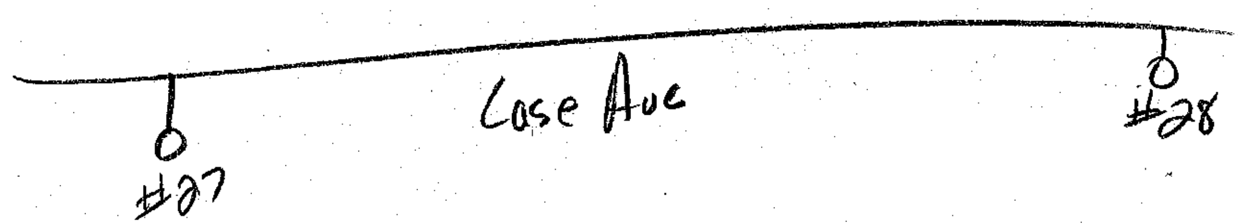
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 82 9.29 psi RESIDUAL B 80 1.45 psi

PROJECTED RESULTS @ 20 psi 5696 gpm, or @ 0 psi RESIDUAL 6622 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION # 29 Case Ave & Ash St DATE 10-18-00

TEST MADE BY Rob & Gary TIME 2:00 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #29 A1 #28 A2 A3 A4

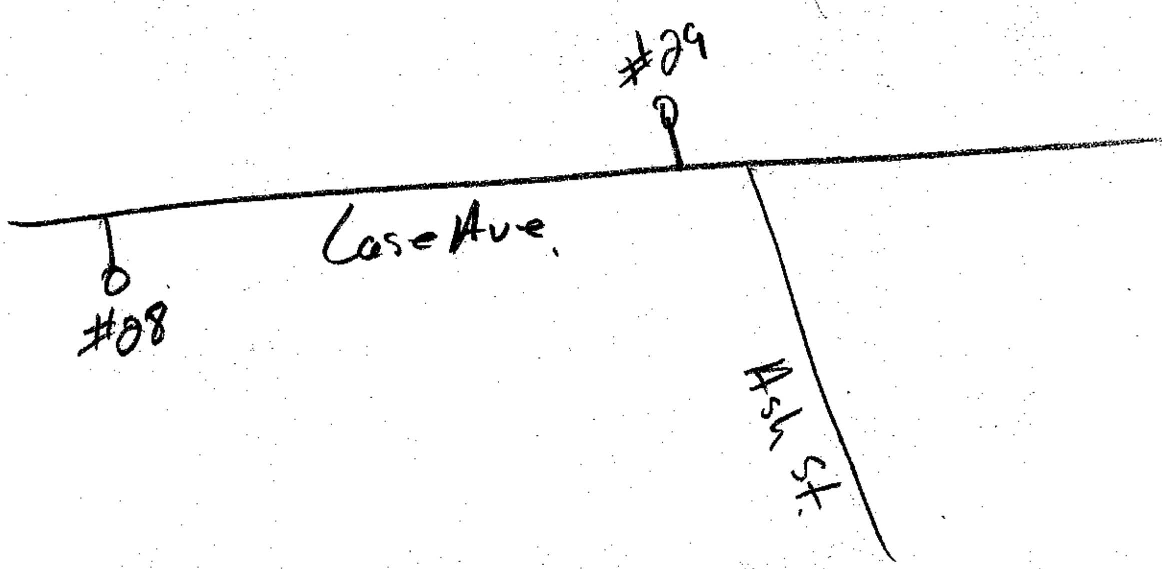
SIZE NOZZLE 2"

PITOT READING 54 psi TOTAL GPM 873

STATIC B 82 psi RESIDUAL B 80 psi

PROJECTED RESULTS @ 20 psi 5593 gpm, or @ 0 psi RESIDUAL 6502 gpm

REMARKS Hydrant needs to be raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #30 Case Ave (Hansen Boat) DATE 10-18-00

TEST MADE BY Rob & Gary TIME 1 - 1:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #30 A1 #29 A2 A3 A4

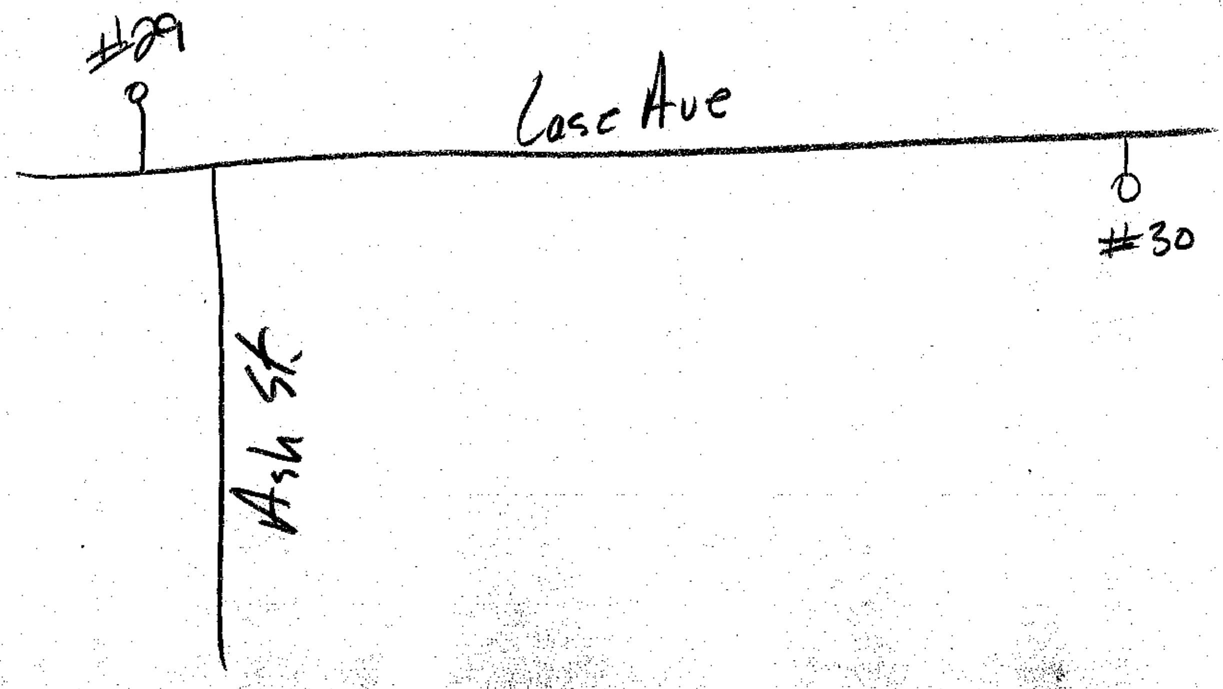
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 920

STATIC B 76 psi RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 5577 gpm, or @ 0 psi RESIDUAL 6580 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #31 Case Ave & Church St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 1:00 P.M.

REPRESENTATIVE OF Public Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS #31 A1 #30 A2 ______ A3 ______ A4 ______

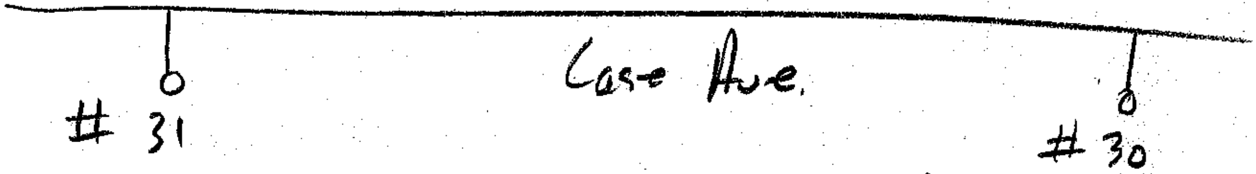
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 920

STATIC B 82 psi RESIDUAL B 80 psi

PROJECTED RESULTS @ 20 psi 5894 gpm, or @ 0 psi RESIDUAL 6852 gpm

REMARKS Turns Head



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #32 Case Ave & Front St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 11:30-12 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #32 A1 #31 A2 A3 A4

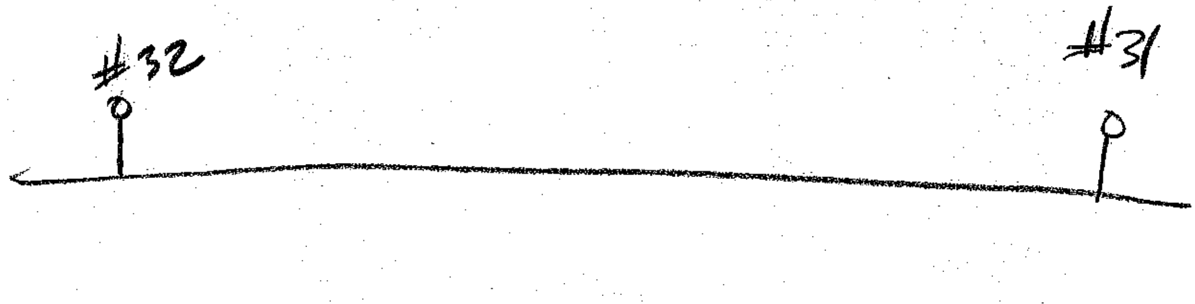
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 920

STATIC B 80 psi RESIDUAL B 78 psi

PROJECTED RESULTS @ 20 psi 5786 gpm, or @ 0 psi RESIDUAL 6764 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #33 Front St. DATE 10-25-00

TEST MADE BY Gary and Rod TIME 6:15 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 33 A1 32 A2 A3 A4

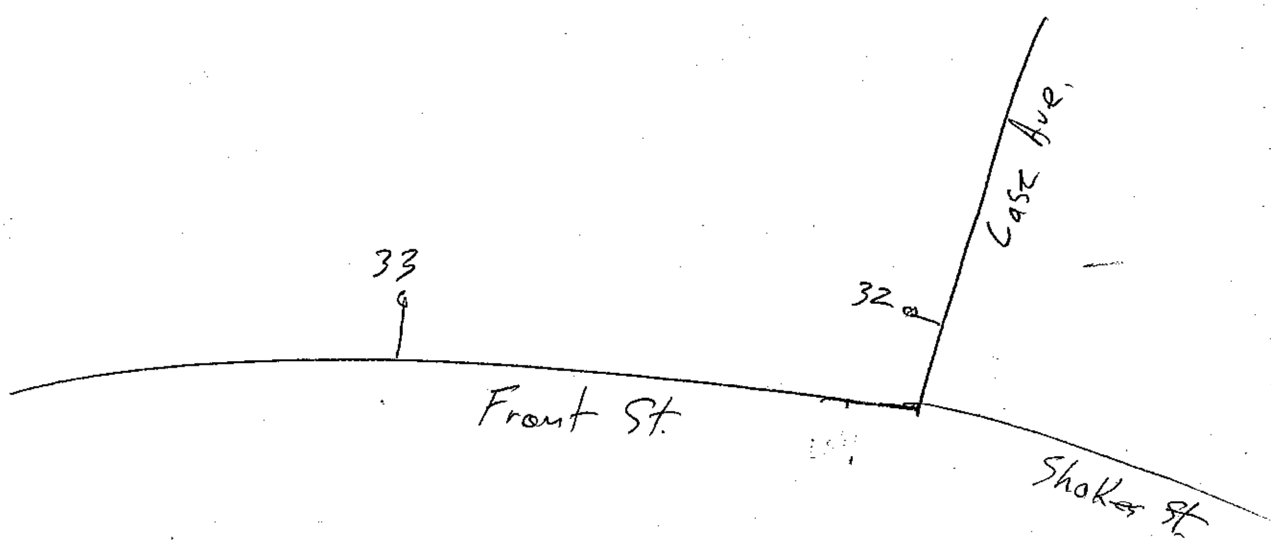
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 921

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3,680 gpm, or @ 0 psi RESIDUAL 4386 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #34 Front St and Episcopal St. DATE 10-25-00

TEST MADE BY Larry and Rob TIME 6:25 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS – 34 A1 33 A2 A3 A4

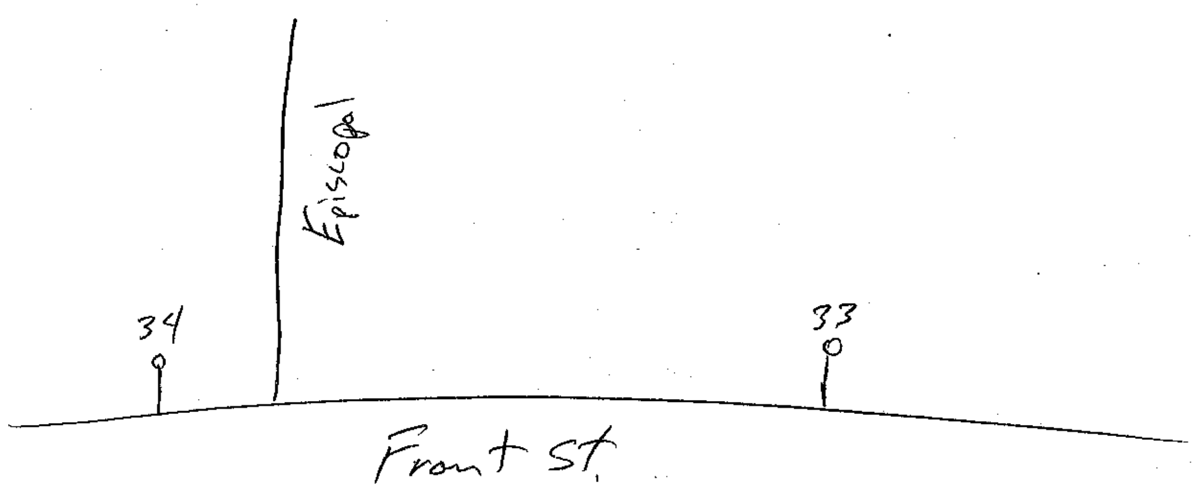
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 920

STATIC B 70 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 5247 gpm, or @ 0 psi RESIDUAL 6294 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #35 Front St and St Michaels DATE 10-25-00

TEST MADE BY Gary and Rob TIME 6:34 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 35 A1 33 A2 A3 A4

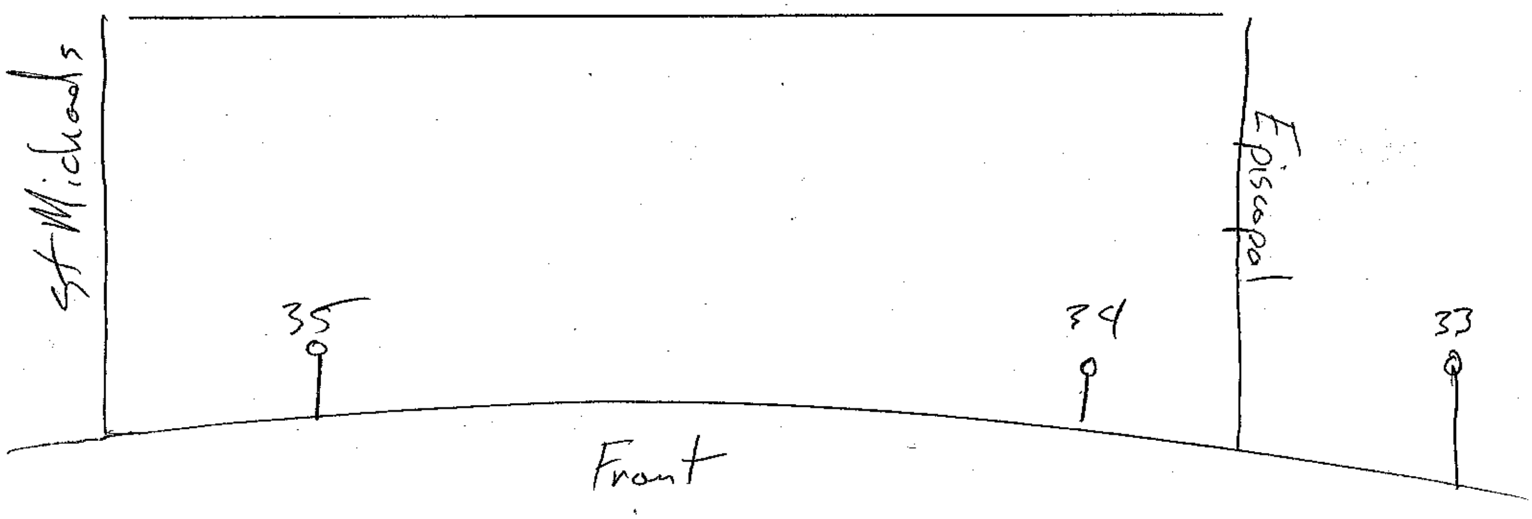
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3556 gpm, or @ 0 psi RESIDUAL 4243 gpm

REMARKS The (open arrow) on the operating nut is backwards.



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #36 Front St, [illegible] DATE 10-25-00

TEST MADE BY Gary and Rob TIME 6:45 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 36 A1 35 A2 ______ A3 ______ A4 ______

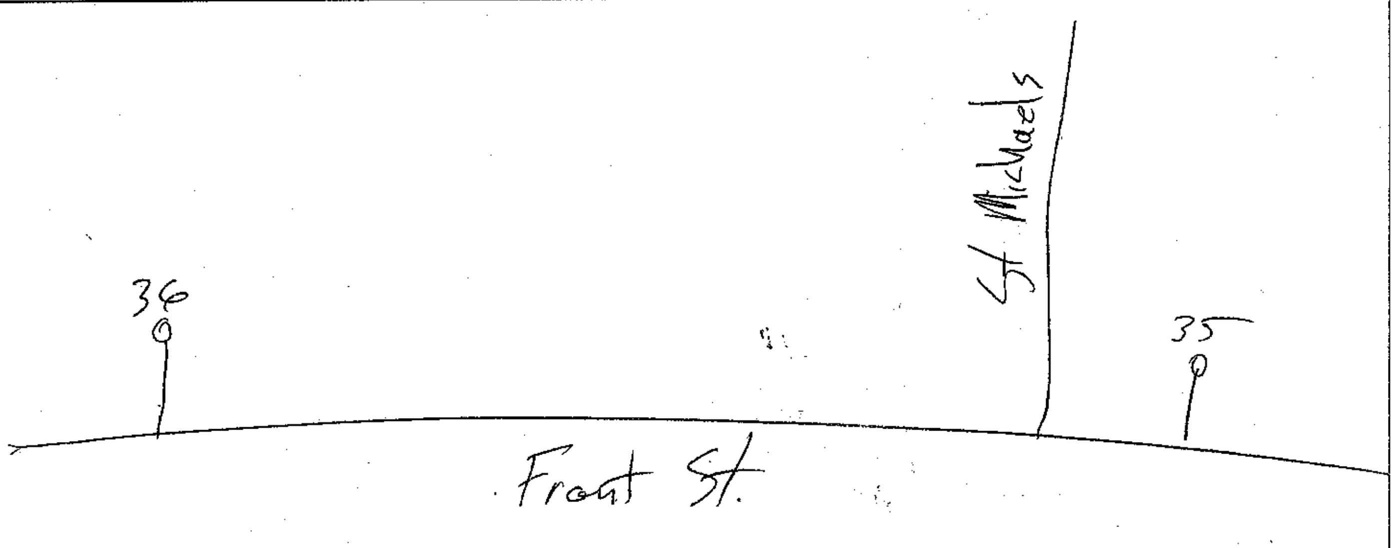
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3556 gpm, or @ 0 psi RESIDUAL 4243 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #37 Front St and Lynch St DATE 10-25-00

TEST MADE BY Gary and Rob TIME 7:00 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS – 37 A1 36 A2 A3 A4

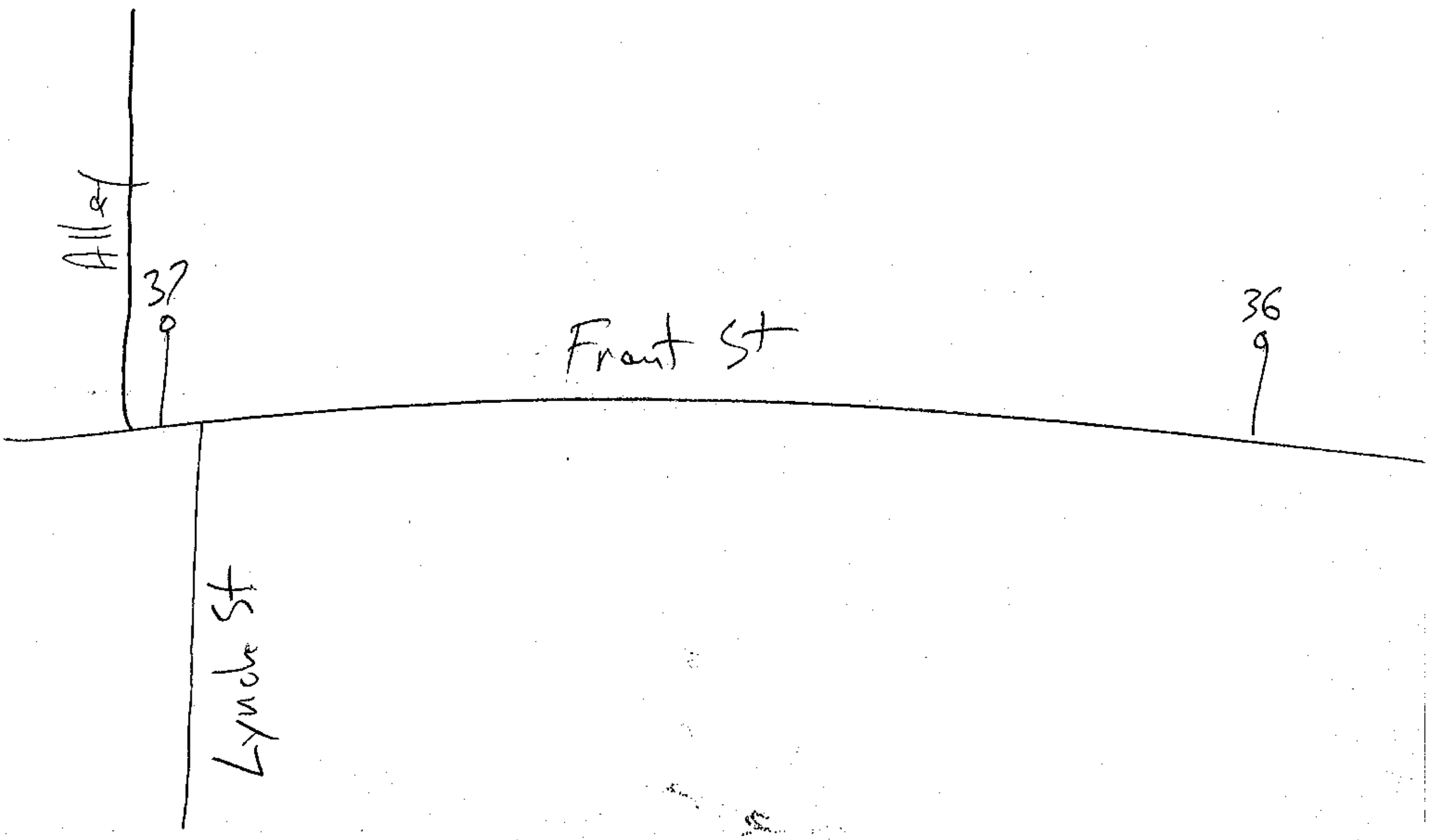
SIZE NOZZLE 2"

PITOT READING 58 psi TOTAL GPM 905

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3620 gpm, or @ 0 psi RESIDUAL 4319 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #38 Front St. (Elks) DATE 10-25-00

TEST MADE BY Gary and Rob TIME 7:05 A.M.

REPRESENTATIVE OF PUBLIL Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS — 38 A1 37 A2 ______ A3 ______ A4 ______

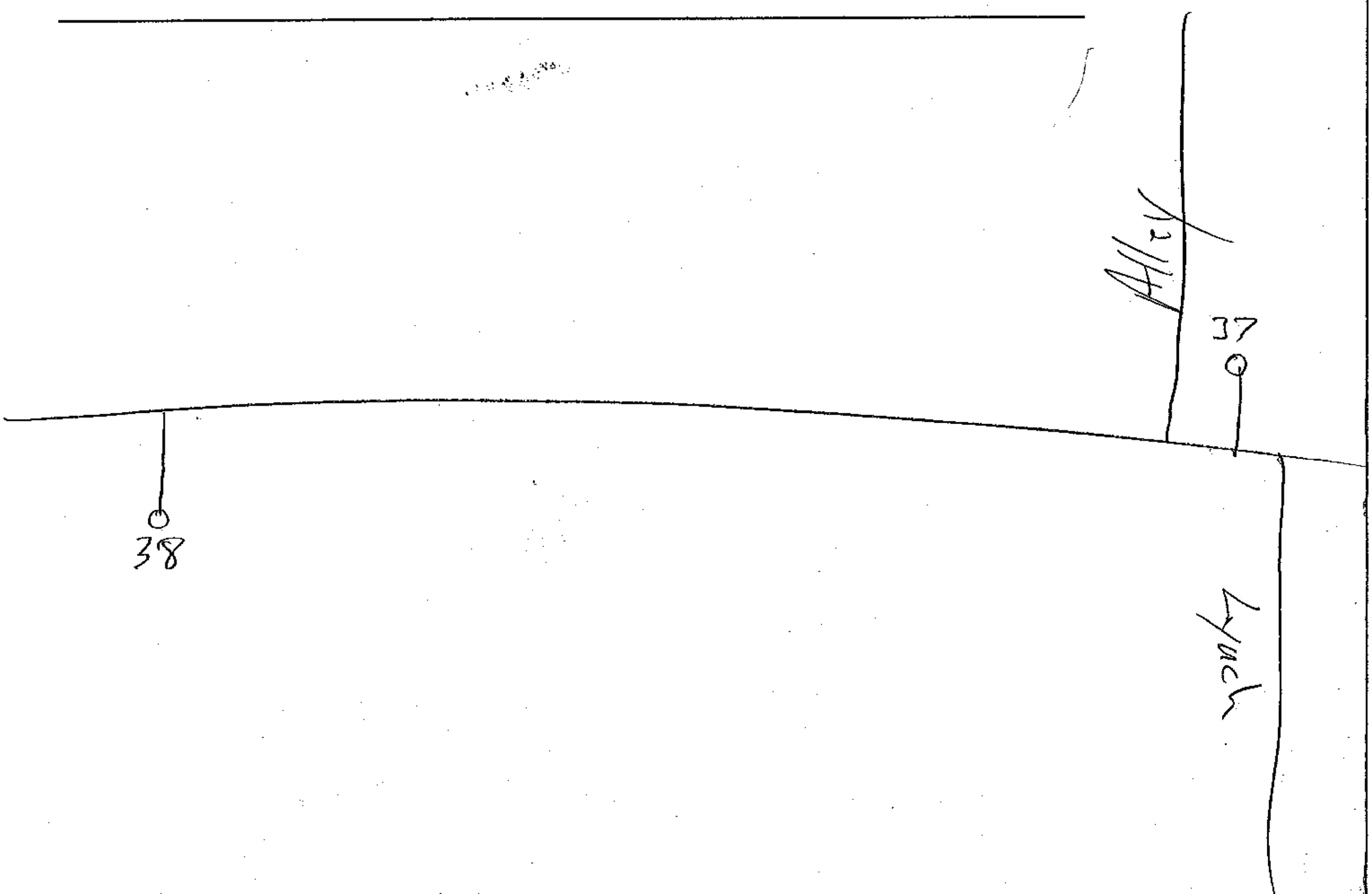
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 886

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2843 gpm, or @ 0 psi RESIDUAL 3392 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL (Harry Churchill)

LOCATION #39 Church St & Wrangell Ave DATE 10-18-00

TEST MADE BY Rob & Gary TIME 11: -11:30 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #39 A1 #40 A2 A3 A4

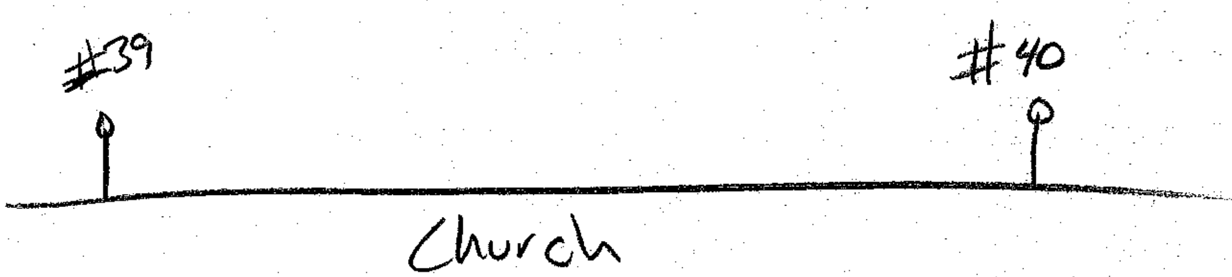
SIZE NOZZLE 2"

PITOT READING 46 psi TOTAL GPM 806

STATIC B 70 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 3159 gpm, or @ 0 psi RESIDUAL 3789 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #40 Church St & Episcopal DATE 10-18-00

TEST MADE BY Rob & Gary TIME 11-11:30 A.M.

REPRESENTATIVE OF Public Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS #40 A1 #41 A2 ______ A3 ______ A4 ______

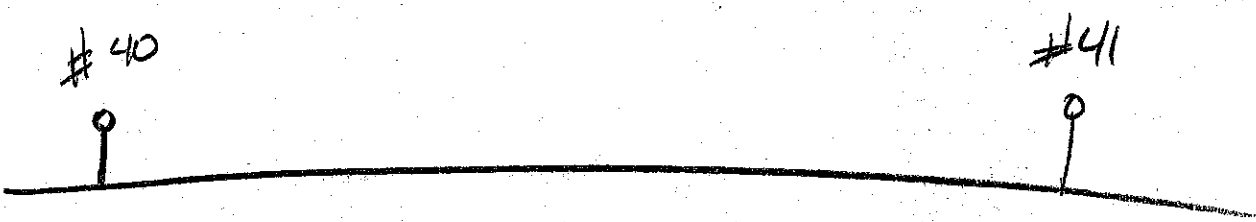
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 72 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 4895 gpm, or @ 0 psi RESIDUAL 5840 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #41 Church St. Between Case & Episcopal DATE 10-18-00

TEST MADE BY Rob & Gary TIME 11:30 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #41 A1 #31 A2 A3 A4

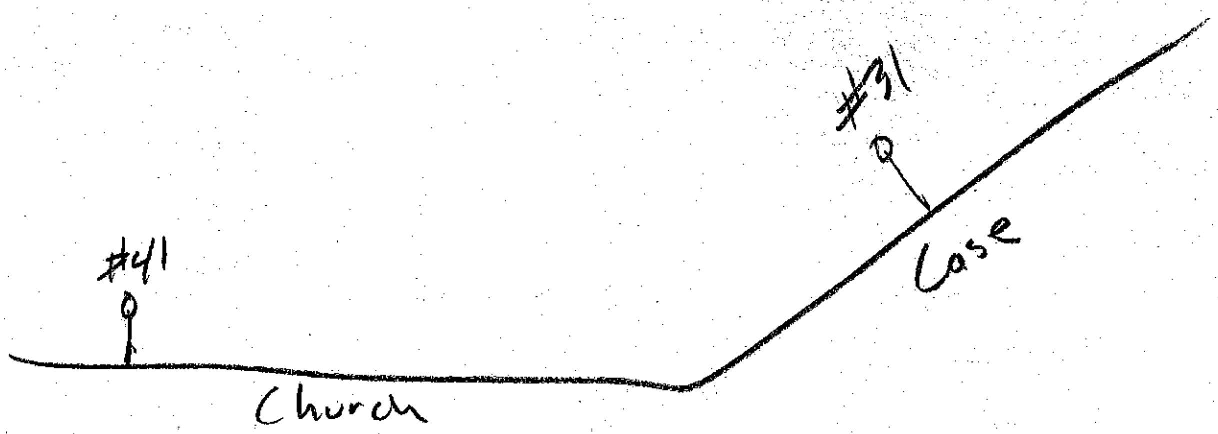
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 80 psi RESIDUAL B 80 psi

PROJECTED RESULTS @ 20 psi gpm, or @ psi RESIDUAL gpm

REMARKS wrong residual reading



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #42 City Dock DATE 10-25-00

TEST MADE BY Gary and Rob TIME 7:25 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 42 A1 82 A2 A3 A4

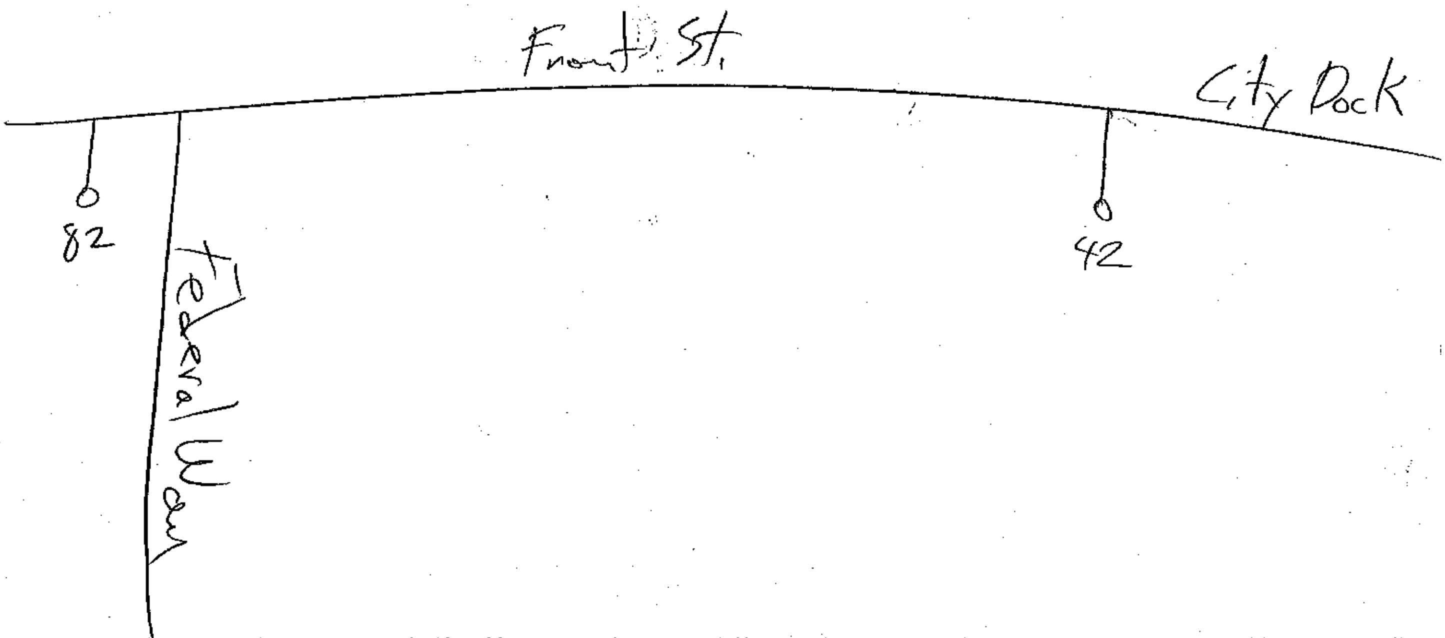
SIZE NOZZLE 2"

PITOT READING 52 psi TOTAL GPM 857

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2750 gpm, or @ 0 psi RESIDUAL 3281 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Boyer Lot #42A DATE 12-27-00

TEST MADE BY Gary Pullman & Rob Davidson TIME 2:57 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 42A A1 82 A2 A3 A4

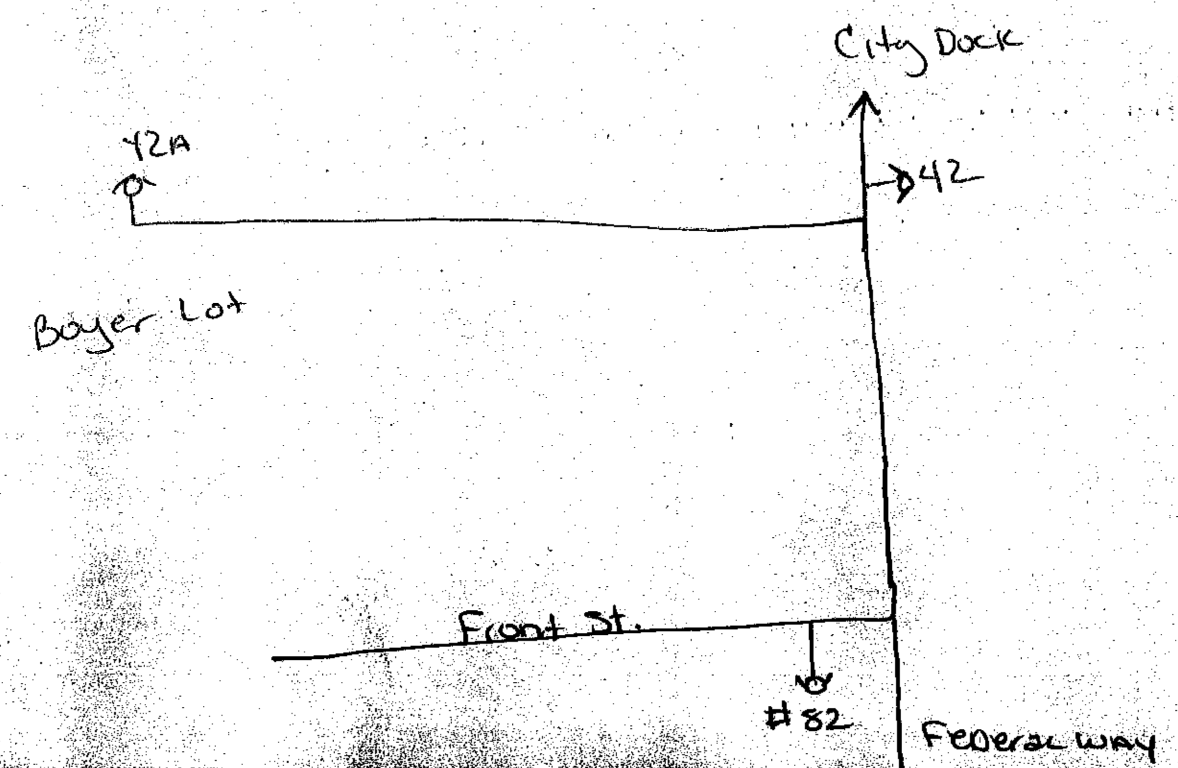
SIZE NOZZLE 1½"

PITOT READING 60 TOTAL GPM 441

STATIC B 74 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 1802 gpm, or @ 0 psi RESIDUAL 2136 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #43 Federal Way DATE 10-25-00

TEST MADE BY Cody and Rob TIME 7:33 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 43 A1 82 A2 A3 A4

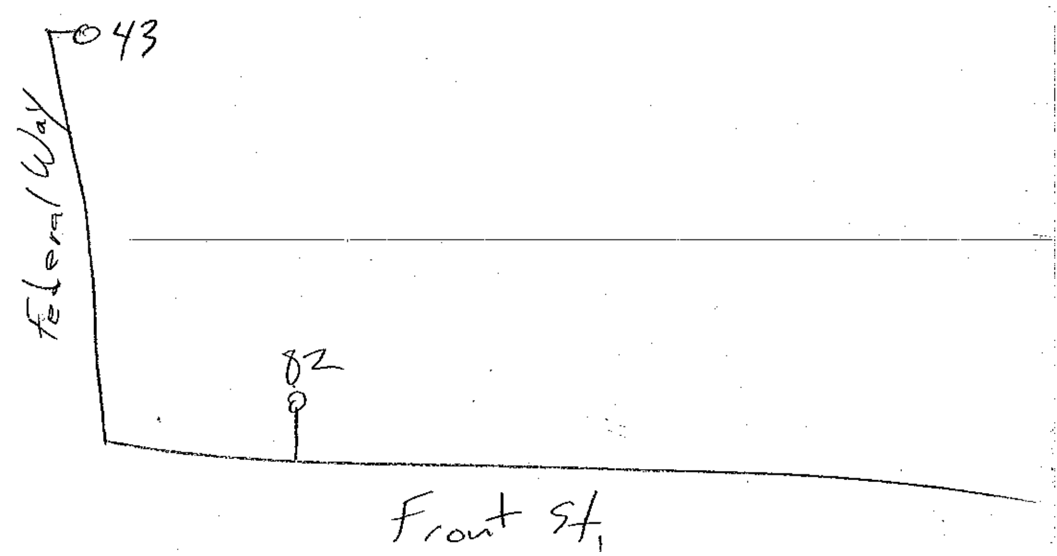
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2699 gpm, or @ 0 psi RESIDUAL 3220 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #44 Stikine Ave DATE 10-25-00

TEST MADE BY Gerry and Rob TIME 7:55 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 44 A1 43 A2 A3 A4

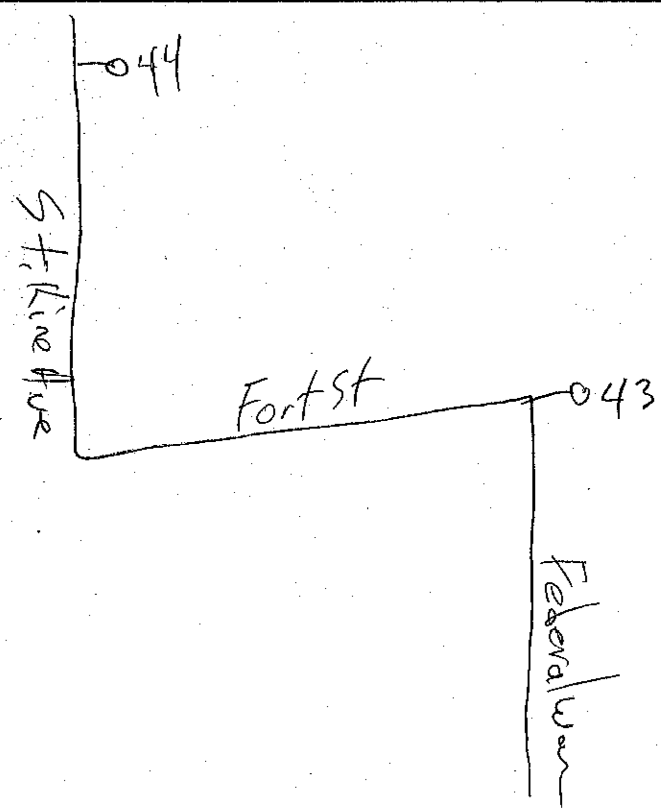
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 62 psi RESIDUAL B 58 psi

PROJECTED RESULTS @ 20 psi 3001 gpm, or @ 0 psi RESIDUAL 3703 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #45 Pine St. & Zimovia Ave. DATE 10-18-00

TEST MADE BY Rob & Gary TIME ________ .M.

REPRESENTATIVE OF Public Works

WITNESS ________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ________

FLOW HYDRANTS ________ A1 ________ A2 ________ A3 ________ A4 ________

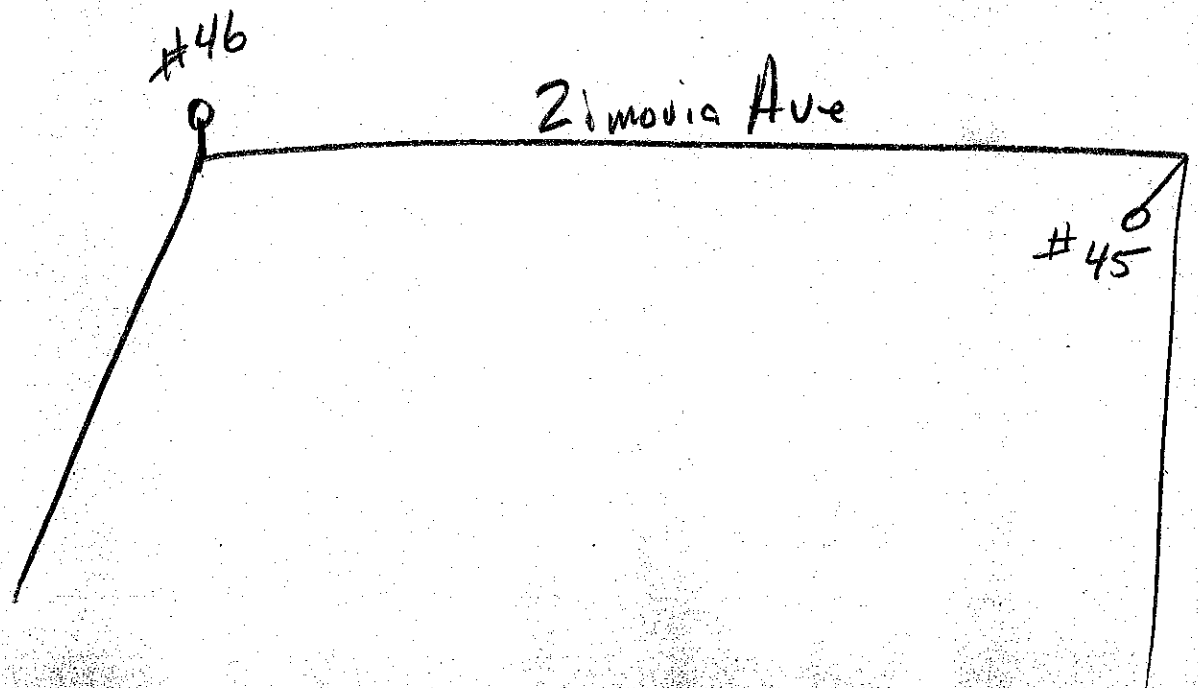
SIZE NOZZLE ________

PITOT READING ________ psi TOTAL GPM ________

STATIC B ________ psi RESIDUAL B ________ psi

PROJECTED RESULTS @ 20 psi ________ gpm, or @ ______ psi RESIDUAL ________ gpm

REMARKS ________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #46 Wrangell Ave & Zimovia Ave DATE 10-18-00

TEST MADE BY Rob & Gary TIME ________ .M.

REPRESENTATIVE OF Public Works

WITNESS ________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ________

FLOW HYDRANTS #46 A1 ____ A2 ____ A3 ____ A4 ____

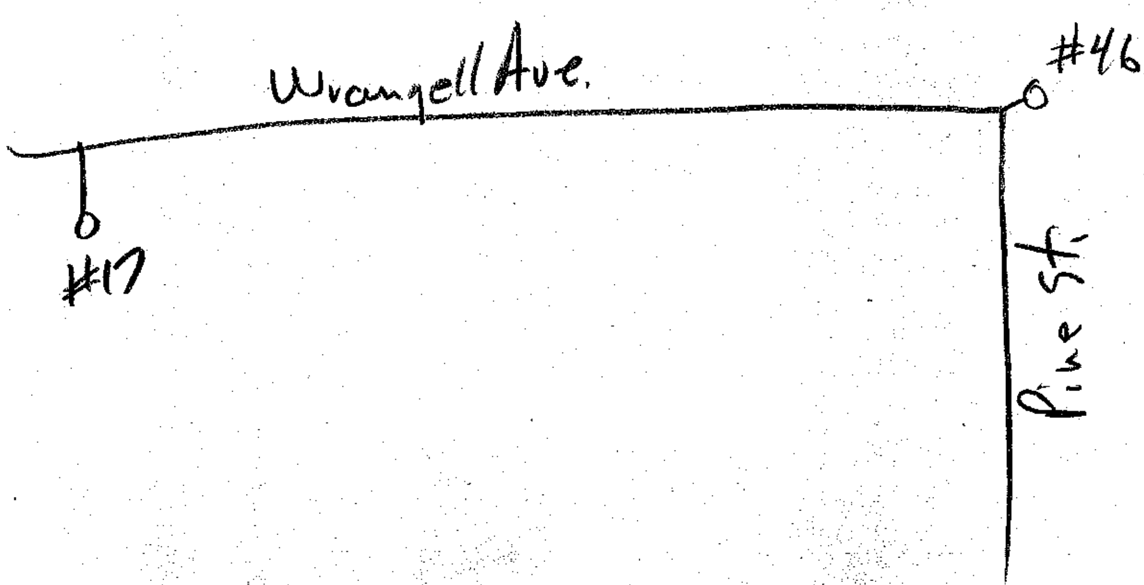
SIZE NOZZLE ________

PITOT READING ________ psi TOTAL GPM ________

STATIC B ________ psi RESIDUAL B ________ psi

PROJECTED RESULTS @ 20 psi ________ gpm, or @ ____ psi RESIDUAL ________ gpm

REMARKS ________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL #47

LOCATION Reid St and Bennet St. DATE 10-20-00

TEST MADE BY Gary and Rob TIME 11:15 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J47 A1 J69 A2 A3 A4

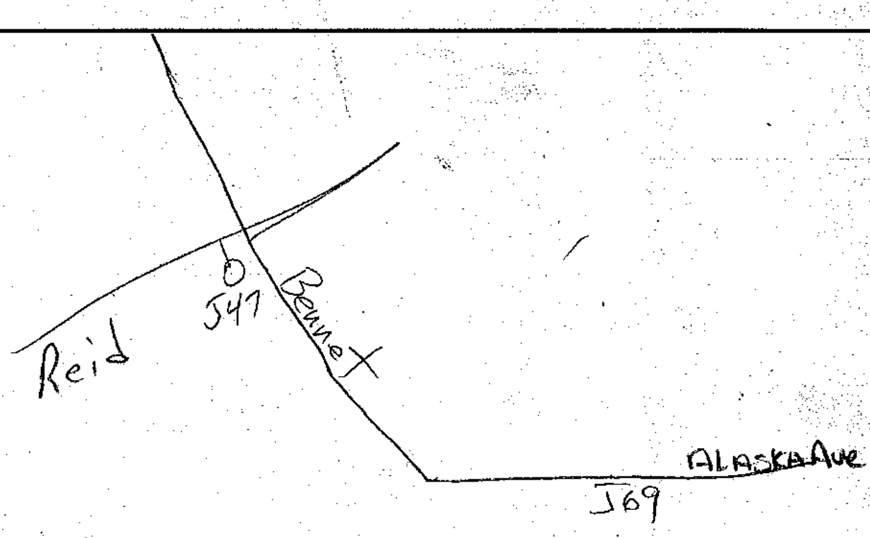
SIZE NOZZLE 2"

PITOT READING 66 TOTAL GPM 965

STATIC B 130 psi RESIDUAL B 106 psi

PROJECTED RESULTS @ 20 psi 2197 gpm, or @ 0 psi RESIDUAL 2404 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL #48

LOCATION Reid St and St Michaels St DATE 10-20-00

TEST MADE BY Gary and Rob TIME 1:25 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ____________________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____________________

FLOW HYDRANTS J48 A1 J39 A2 ______ A3 ______ A4 ______

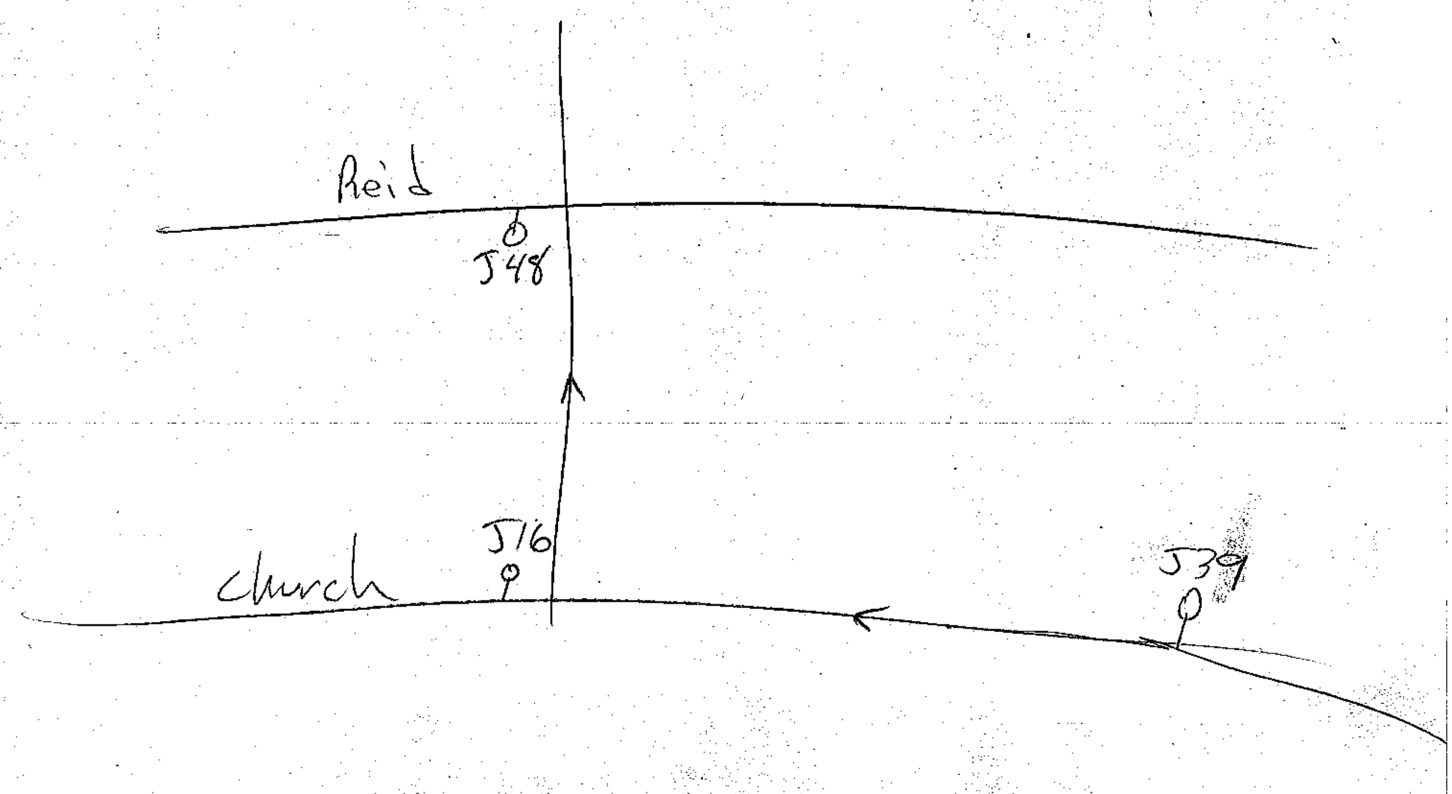
SIZE NOZZLE 2"

PITOT READING 14 TOTAL GPM ?

STATIC B 66 psi ______ RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi ______ gpm, or @ ______ psi RESIDUAL ______ gpm

REMARKS ____________________



HYDRANT FLOW TEST REPORT #49
CITY OF WRANGELL

LOCATION Reid St and Mission St DATE 10-20-00

TEST MADE BY Gary and Rob TIME 1:53 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS ____

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____

FLOW HYDRANTS J49 A1 J48 A2 ____ A3 ____ A4 ____

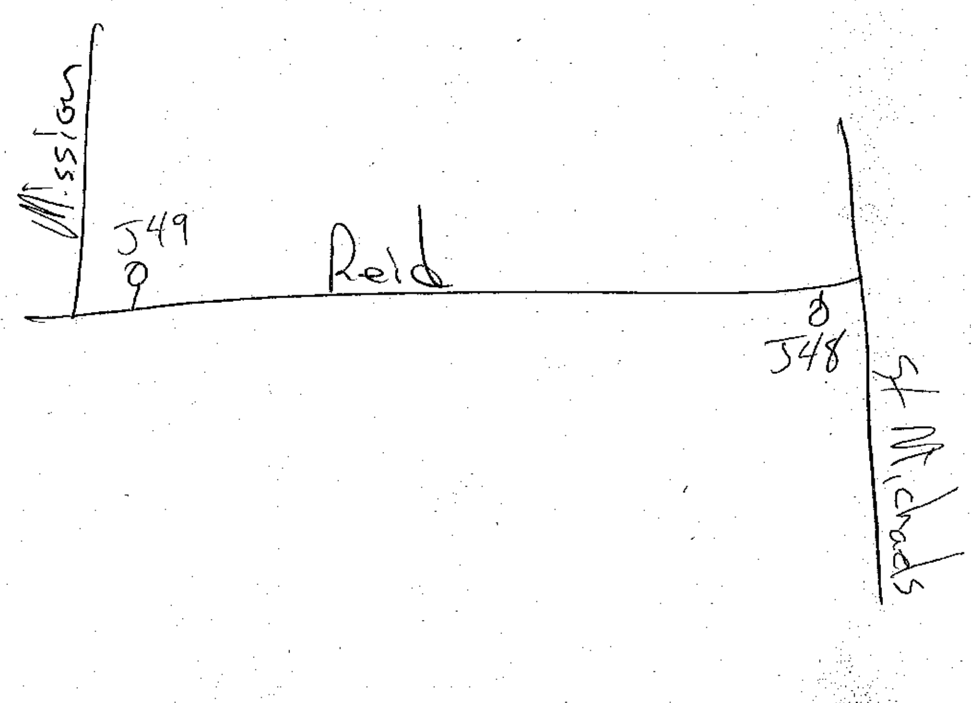
SIZE NOZZLE 2"

PITOT READING 14 TOTAL GPM ?

STATIC B 50 psi ____ RESIDUAL B 22 psi

PROJECTED RESULTS @ 20 psi ____ gpm, or @ ____ psi RESIDUAL ____ gpm

REMARKS ____



HYDRANT FLOW TEST REPORT #50
CITY OF WRANGELL

LOCATION Reid St and Grief St. DATE 10-20-00

TEST MADE BY Gary and Rob TIME 2:00 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J50 A1 J49 A2 A3 A4

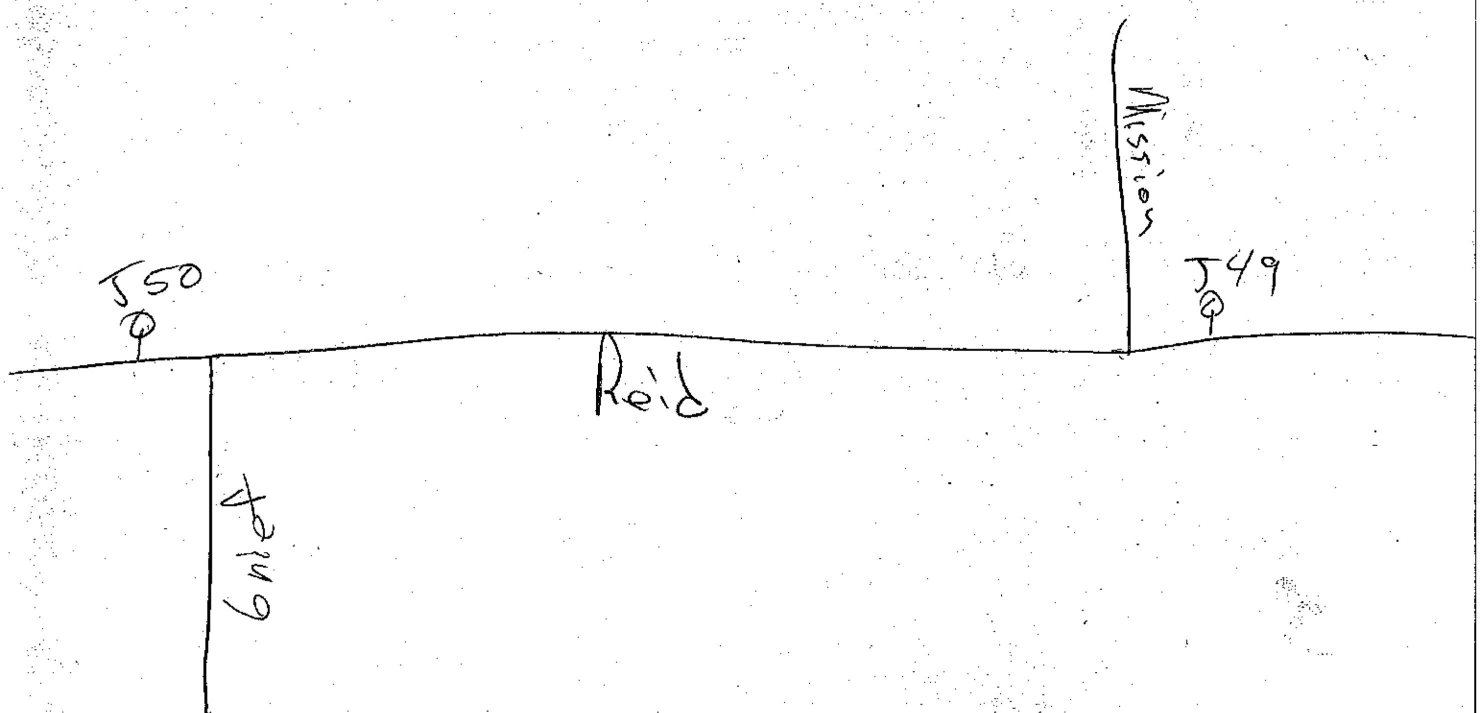
SIZE NOZZLE 2"

PITOT READING 26 TOTAL GPM ?

STATIC B 50 psi RESIDUAL B 48 psi

PROJECTED RESULTS @ 20 psi gpm, or @ psi RESIDUAL gpm

REMARKS Home owner has filled in around hydrant. Needs to be dug out.



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #51 Mission St & 3rd St DATE 11-6-00

TEST MADE BY Rob & Jef TIME 2:20 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #51 A1 #52 A2 A3 A4

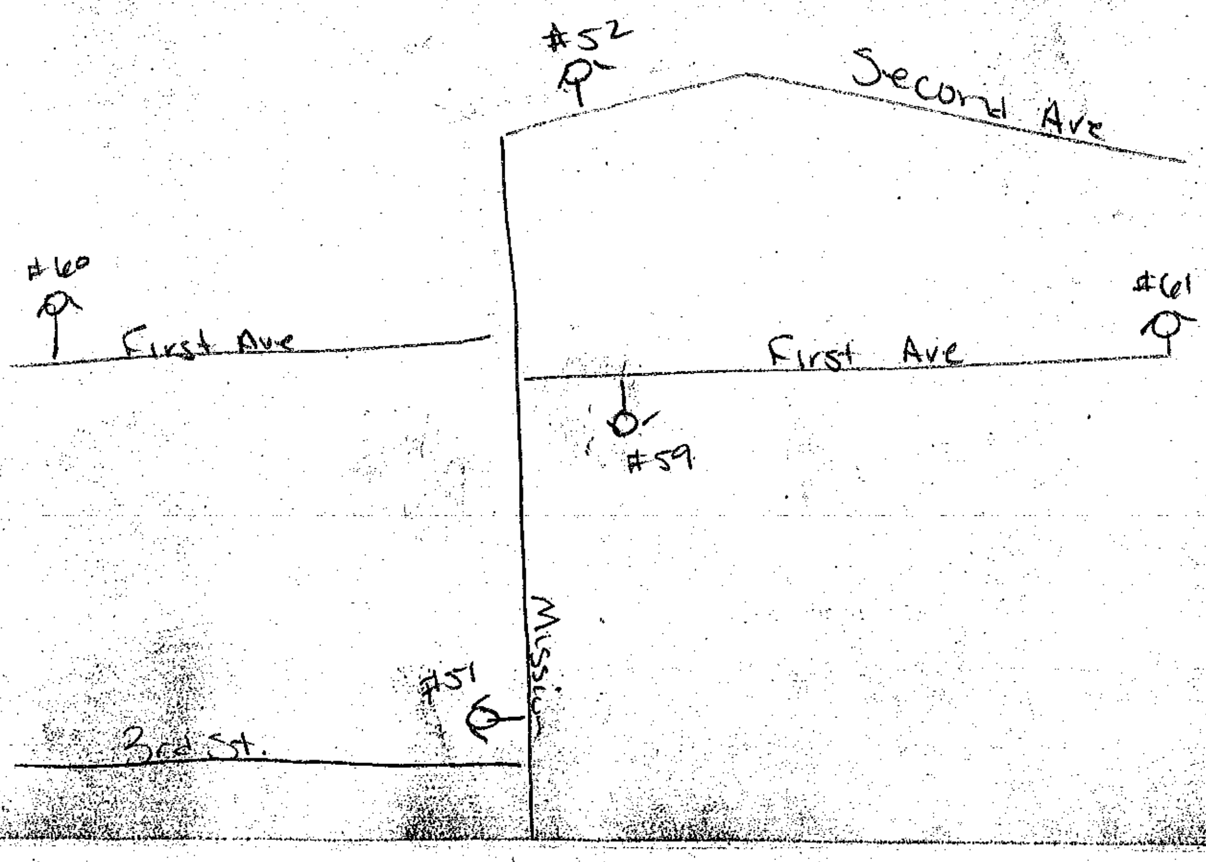
SIZE NOZZLE

PITOT READING 57 psi TOTAL GPM 857

STATIC B 66 psi RESIDUAL B 38 psi

PROJECTED RESULTS @ 20 psi 1120 gpm, or @ 0 psi RESIDUAL 1361 gpm

REMARKS needs to be raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #52 Mission St & Second ~~St~~ Ave DATE 11-6-00

TEST MADE BY Rob & Jef TIME 1:43 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #52 A1 #53 A2 A3 A4

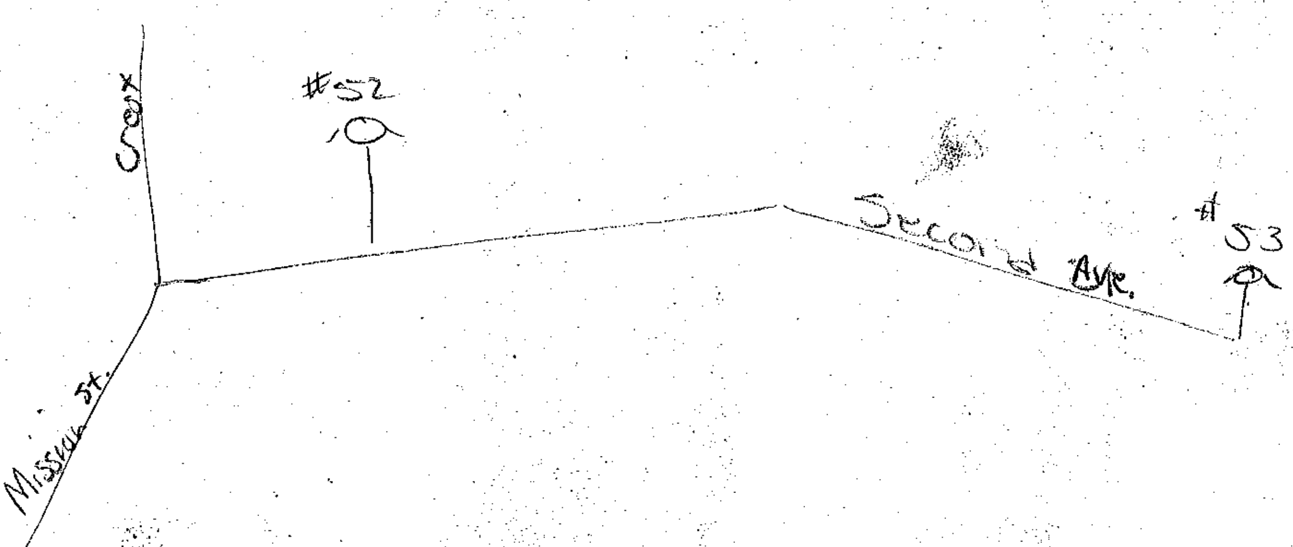
SIZE NOZZLE 2"

PITOT READING 40 TOTAL GPM 752

STATIC B 84 psi RESIDUAL B 60 psi

PROJECTED RESULTS @ 20 psi 1278 gpm, or @ 0 psi RESIDUAL 1480 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#53

LOCATION ST MICHAELS & SECOND AVE DATE 19OCT08

TEST MADE BY ROB & JOE TIME 10:51 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J53 A1 J56 A2 A3 A4

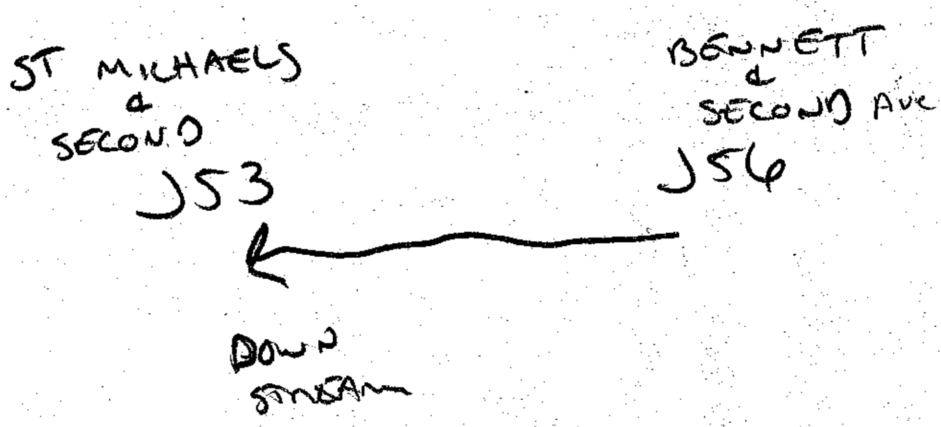
SIZE NOZZLE 2"

PITOT READING 48 TOTAL GPM 824

STATIC B 98 psi RESIDUAL B 86 psi

PROJECTED RESULTS @ 20 psi 2261 gpm, or @ 0 psi RESIDUAL 2558 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION ST MICHAEL & THIRD #54 DATE 19OCT -

TEST MADE BY JOE & ROB TIME 11:10 A .M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J54 A1 J55 A2 A3 A4

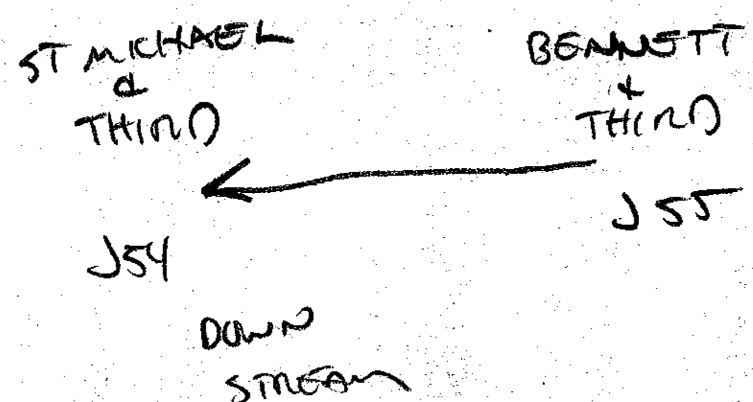
SIZE NOZZLE 2"

PITOT READING 50 TOTAL GPM 841

STATIC B 98 psi RESIDUAL B 78 psi

PROJECTED RESULTS @ 20 psi 1753 gpm, or @ 0 psi RESIDUAL 1984 gpm

REMARKS NEEDS BRUSHED OUT



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION THIRD AVE & BONNETT SS DATE 19OCT 08

TEST MADE BY ROB & JOE TIME 11:03 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J55 A1 J56 A2 A3 A4

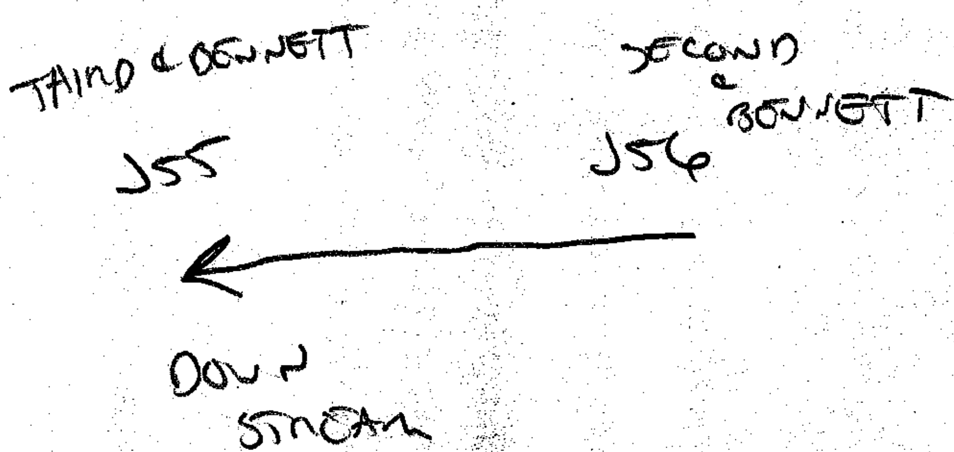
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 98 psi RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 1650 gpm, or @ 0 psi RESIDUAL 1866 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION SECOND Ave & BENNETT St 56 DATE 19 OCT 08

TEST MADE BY ROB & JOE TIME 10:42 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS J56 A1 J57 A2 ______ A3 ______ A4 ______

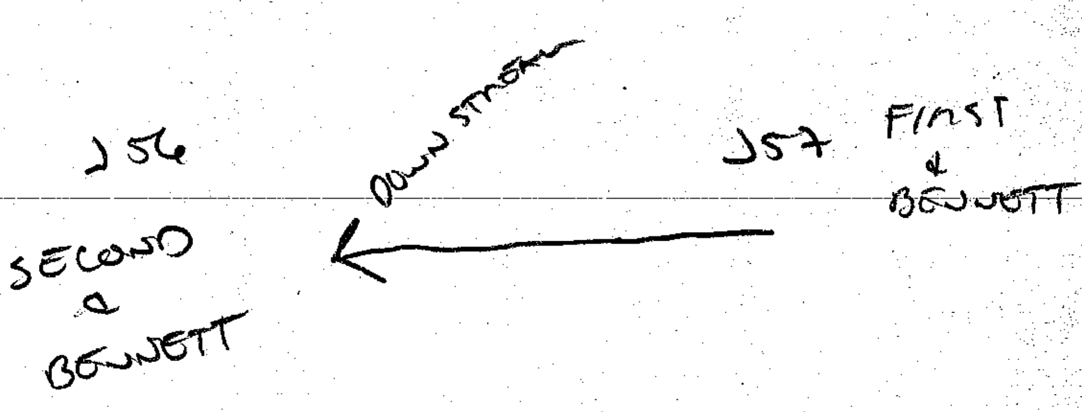
SIZE NOZZLE 2"

PITOT READING 60 TOTAL GPM 920

STATIC B 100 psi ______ RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 1688 gpm, or @ 0 psi RESIDUAL 1903 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION BENNETT St & FIRST AVE #57 DATE 19 OCT 00

TEST MADE BY JOE & ROB TIME 10:19 A.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #J57 A1 @J47 A2 A3 A4

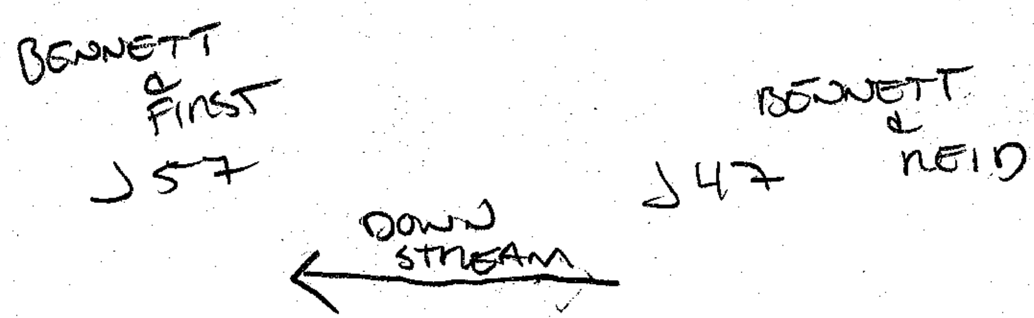
SIZE NOZZLE 2"

PITOT READING 70 TOTAL GPM 994

STATIC B 100 psi RESIDUAL B 90 psi

PROJECTED RESULTS @ 20 psi 3054 gpm, or @ 0 psi RESIDUAL 3443 gpm

REMARKS residual was taken from the incorrect Hydrant.



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#58

LOCATION: HEAD START END OF FIRST AVENUE DATE: 19OCT00

TEST MADE BY: JOE & ROB TIME: 10:34 A.M.

REPRESENTATIVE OF: PUBLIC WORKS

WITNESS:

STATE PURPOSE OF TEST: Flow

CONSUMPTION RATE DURING TEST:

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING:

FLOW HYDRANTS: J58 A1 J57 A2 ___ A3 ___ A4 ___

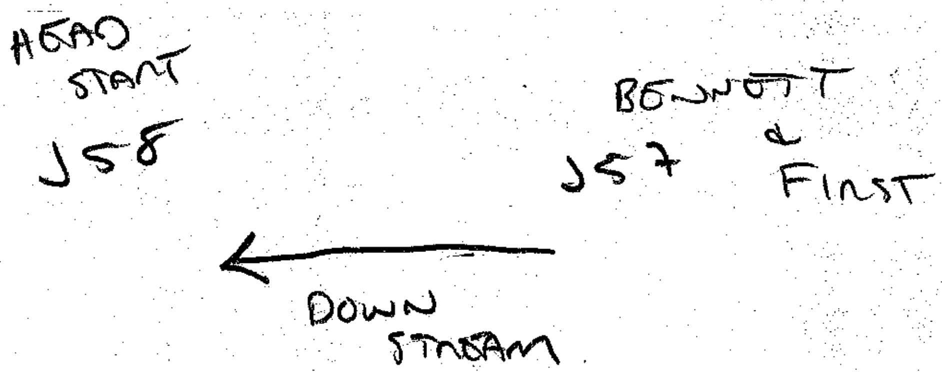
SIZE NOZZLE: 2"

PITOT READING: 52 TOTAL GPM: 857

STATIC B: 100 psi RESIDUAL B: 76 psi

PROJECTED RESULTS @ 20 psi 1643 gpm, or @ 0 psi RESIDUAL 1853 gpm

REMARKS: HYDRANT NEEDS RAISED BADLY



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #59 First Ave (Mark Seimers) DATE 11-6-00

TEST MADE BY Rob & Jef TIME 2:05 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 59 A1 52 A2 A3 A4

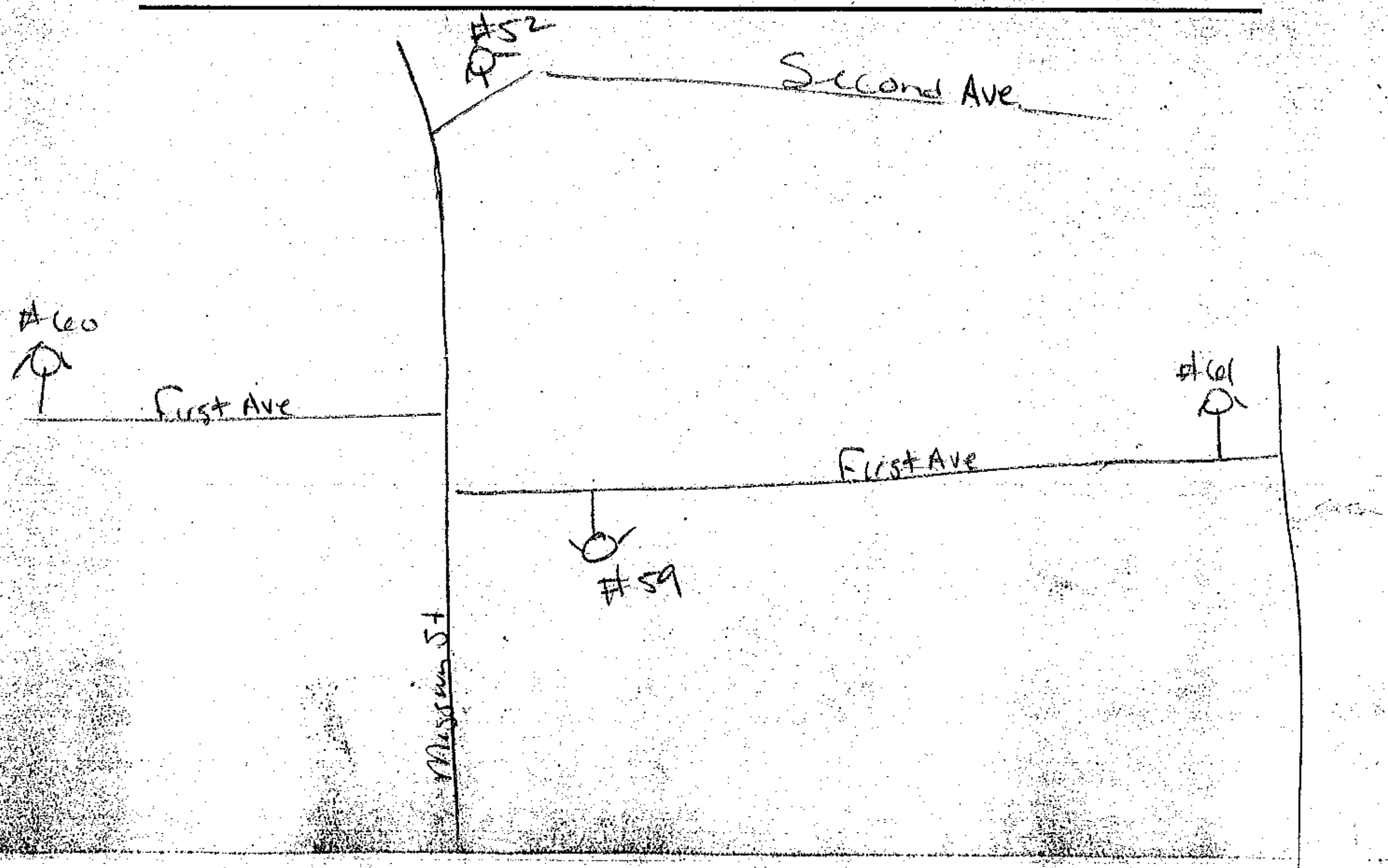
SIZE NOZZLE

PITOT READING 44 TOTAL GPM 788

STATIC B 66 psi RESIDUAL B 42 psi

PROJECTED RESULTS @ 20 psi 1121 gpm, or @ psi RESIDUAL 1362 gpm

REMARKS needs to be raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION # 60 First Ave (Leonard Angerman) DATE 11-6-00

TEST MADE BY Rob : Jet TIME 1:50 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #60 A1 52 A2 A3 A4

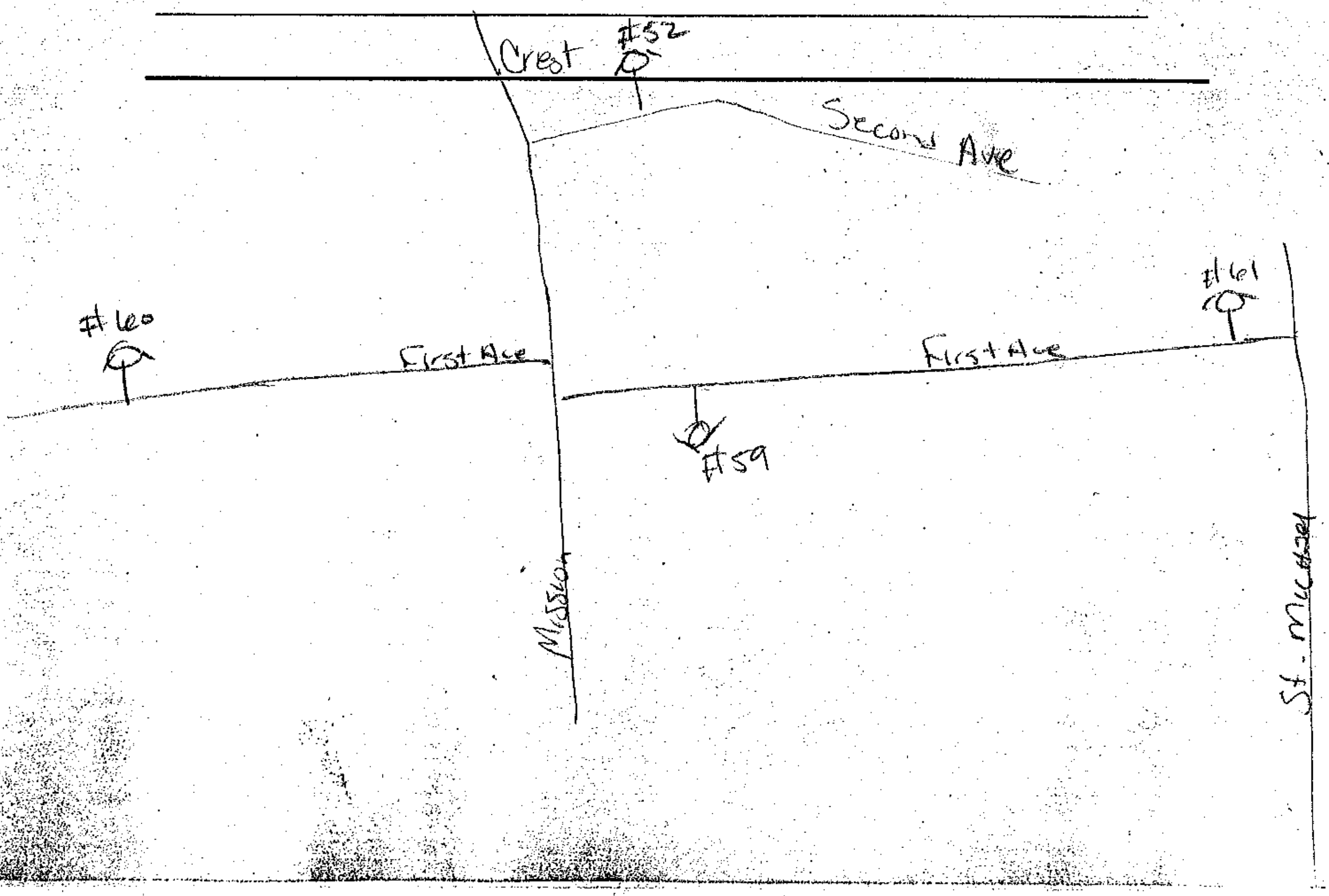
SIZE NOZZLE

PITOT READING 42 psi TOTAL GPM 770

STATIC B 66 psi RESIDUAL B 42 psi

PROJECTED RESULTS @ 20 psi 1095 gpm, or @ 0 psi RESIDUAL 1331 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #61 First Ave & St. Michael St DATE 11-6-00

TEST MADE BY Jef & Rob TIME 2:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #61 A1 #59 A2 A3 A4

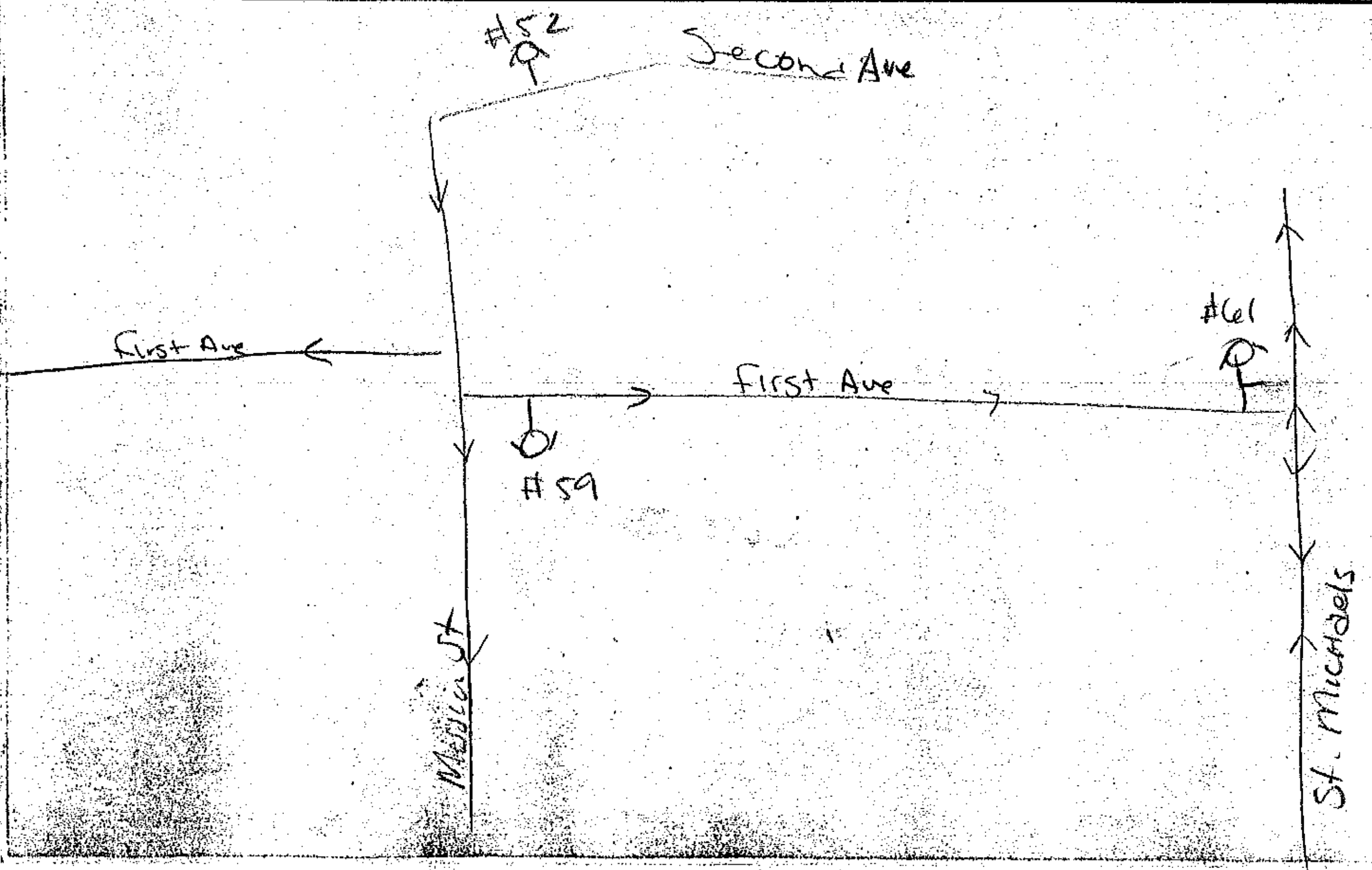
SIZE NOZZLE

PITOT READING 44 TOTAL GPM 788

STATIC B 80 psi RESIDUAL B 52 psi

PROJECTED RESULTS @ 20 psi 1188 gpm, or @ 0 psi RESIDUAL 1388 gpm

REMARKS Dresser - needs to be raised or replaced



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #62 3rd (Gunderson) DATE 12-28-00

TEST MADE BY Gary and Rob TIME 11:22 A.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 3rd (Gunderson) A1 3rd + Mission A2 A3 A4

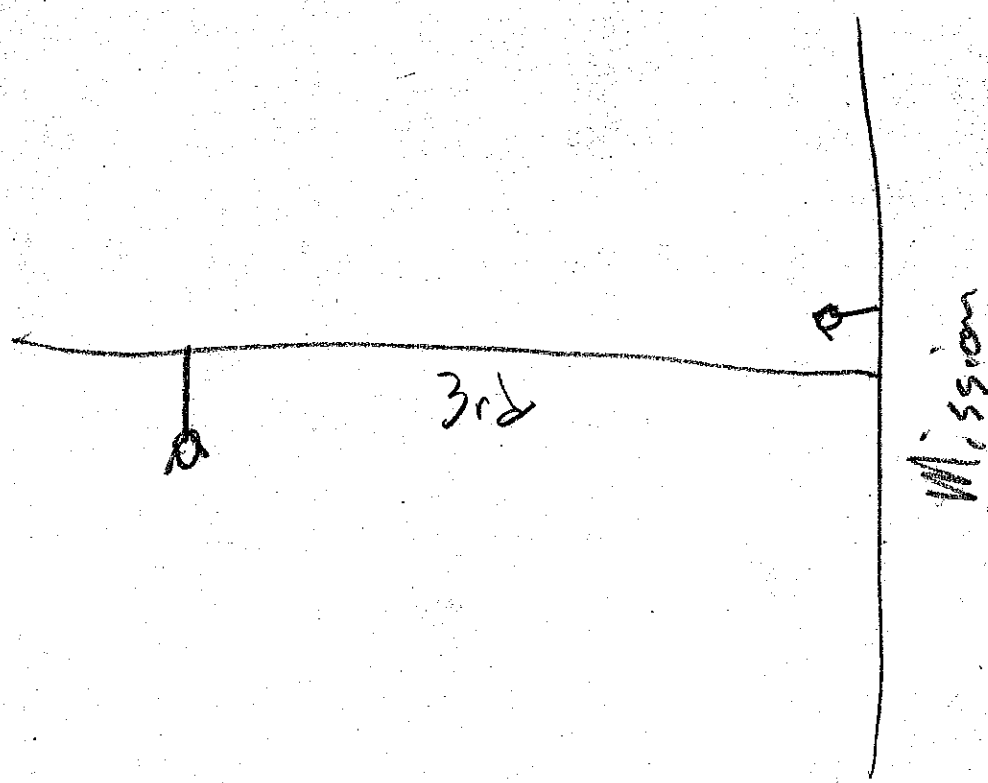
SIZE NOZZLE 2"

PITOT READING 40 psi TOTAL GPM 685

STATIC B 82 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 1263 gpm, or @ 0 psi RESIDUAL 1468 gpm

REMARKS



u

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#62A

LOCATION Mount Dewey DATE 12-28-00

TEST MADE BY Gary and Rob TIME 11:30A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS Mount Dewey/A1 3rd (Gunderson) A2 A3 A4

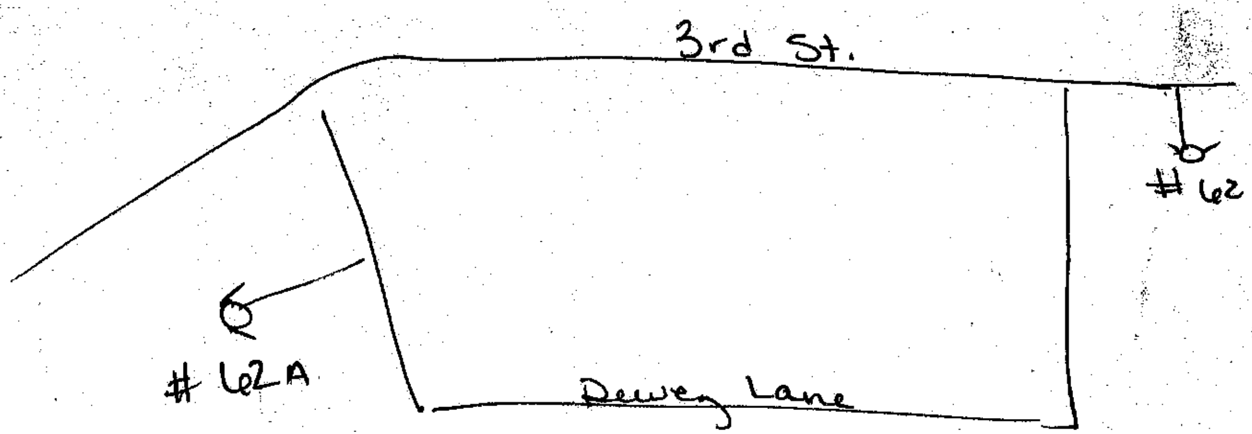
SIZE NOZZLE 1 1/2

PITOT READING 54 psi TOTAL GPM 418

STATIC B 76 psi RESIDUAL B 58 psi

PROJECTED RESULTS @ 20 psi 771 gpm, or @ 0 psi RESIDUAL 911 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #63 Penninsula St DATE 10-18-00

TEST MADE BY Rob & Gary TIME 3-3:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #63 A1 #26 A2 A3 A4

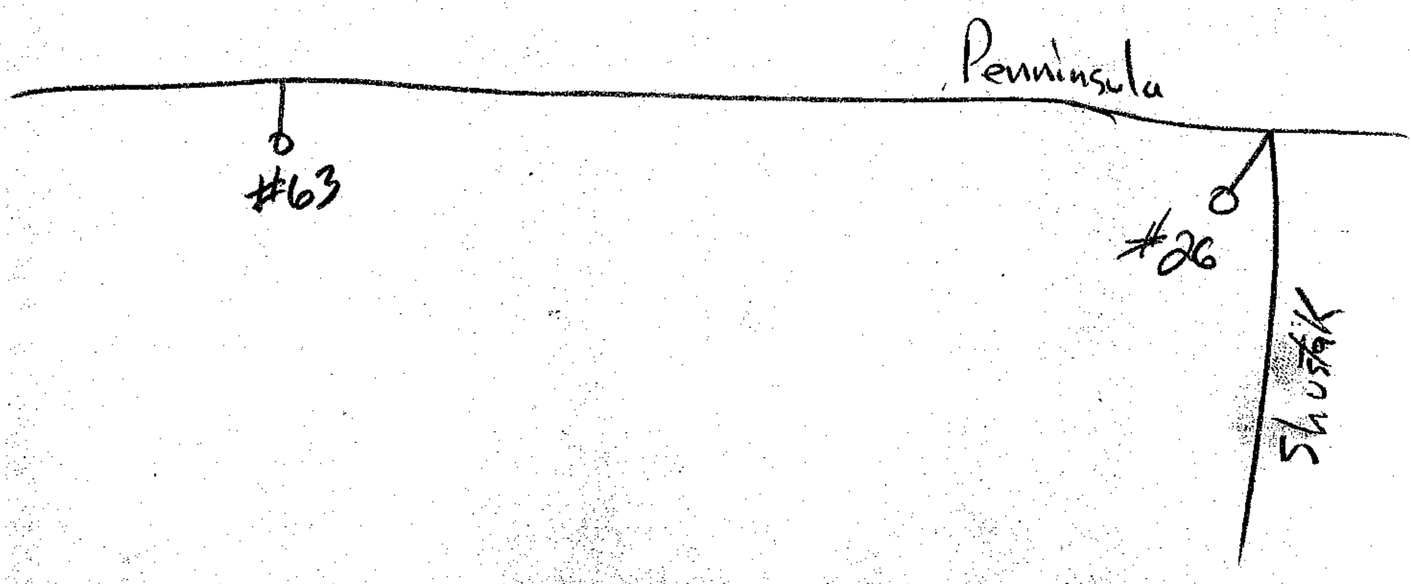
SIZE NOZZLE 2"

PITOT READING 40 psi TOTAL GPM 920

STATIC B 80 psi RESIDUAL B 76 psi

PROJECTED RESULTS @ 20 psi 3976 gpm, or @ psi RESIDUAL 4648 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #64 Penninsula St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 3-330 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #64 A1 #63 A2 A3 A4

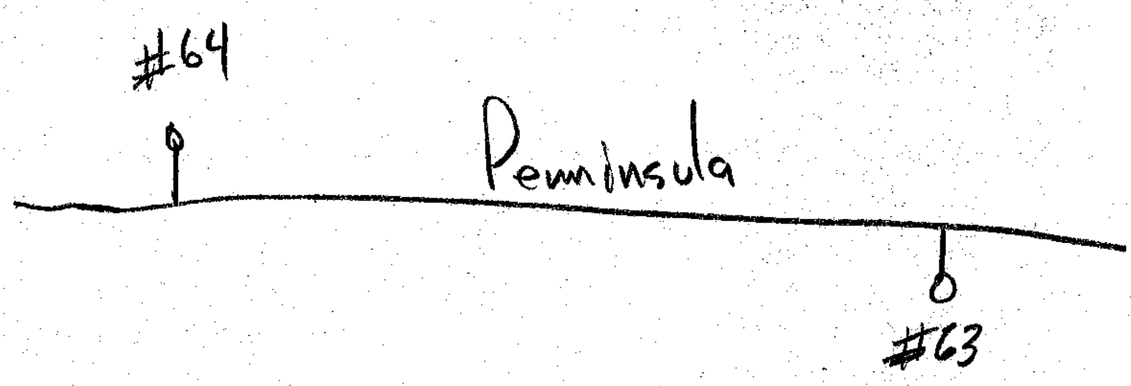
SIZE NOZZLE 2"

PITOT READING 56 psi TOTAL GPM 889

STATIC B 82 psi RESIDUAL B 76 psi

PROJECTED RESULTS @ 20 psi 3140 gpm, or @ psi RESIDUAL 3651 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #65 Pennınsula St (DeltaWestern) DATE 10-18-00

TEST MADE BY Rob & Gary TIME 3:30 - 4 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #65 A1 64 A2 A3 A4

SIZE NOZZLE

PITOT READING psi TOTAL GPM

STATIC B psi RESIDUAL B psi

PROJECTED RESULTS @ 20 psi gpm, or @ psi RESIDUAL gpm

REMARKS Private Hydrant - Not maintained by the city

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #66 Penninsula St. DATE 10-18-00

TEST MADE BY Rob & Gary TIME 3:30 - 4 P.M.

REPRESENTATIVE OF Public Works

WITNESS ____________________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____________________

FLOW HYDRANTS #66 A1 #64 A2 ______ A3 ______ A4 ______

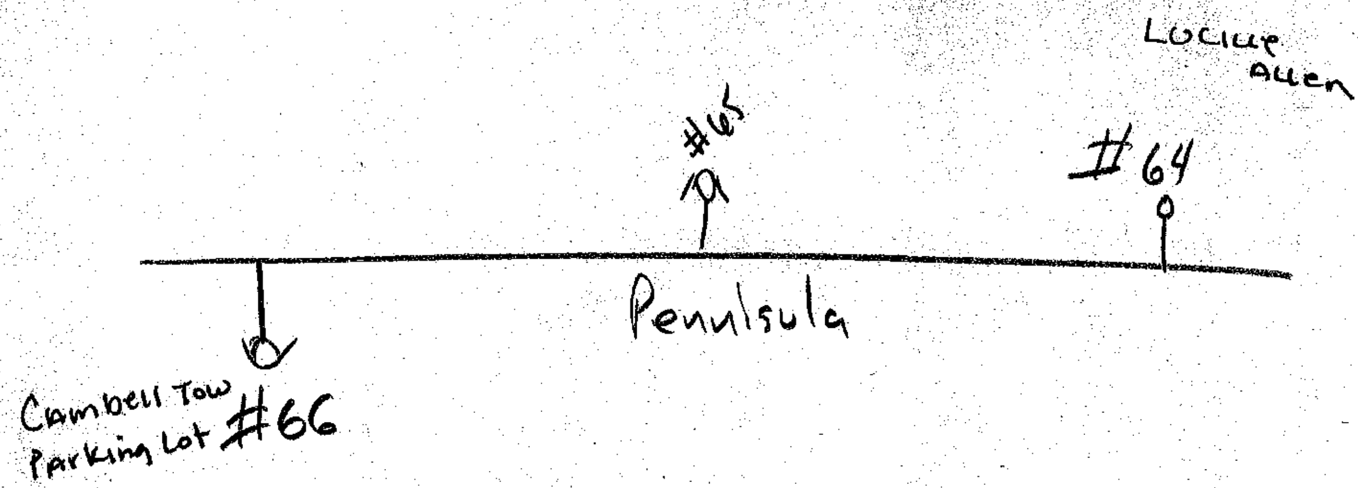
SIZE NOZZLE 2"

PITOT READING 54 psi TOTAL GPM 873

STATIC B 80 psi RESIDUAL B 75 psi

PROJECTED RESULTS @ 20 psi 3331 gpm, or @ 0 psi RESIDUAL 3894 gpm

REMARKS ____________________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #67 Fish and Game Dock DATE 12-28-00

TEST MADE BY Gary and Rob TIME 9:18 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST FLOW

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS F+G Dock A1 Lucille Allen A2 ______ A3 ______ A4 ______

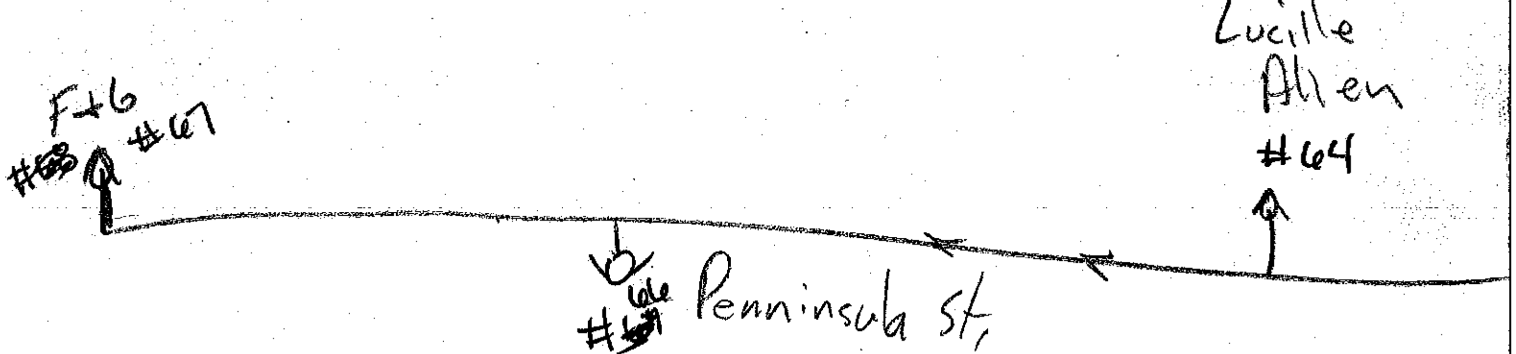
SIZE NOZZLE 2

PITOT READING 55 psi TOTAL GPM ~~[illegible]~~ 811

STATIC B 68 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 4524 gpm, or @ 0 psi RESIDUAL 5458 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #68 Oceanview Dr. & Sunset BLVD DATE 10-18-00

TEST MADE BY Rob & Gary TIME 4:00 P .M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS #68 A1 #66 A2 A3 A4

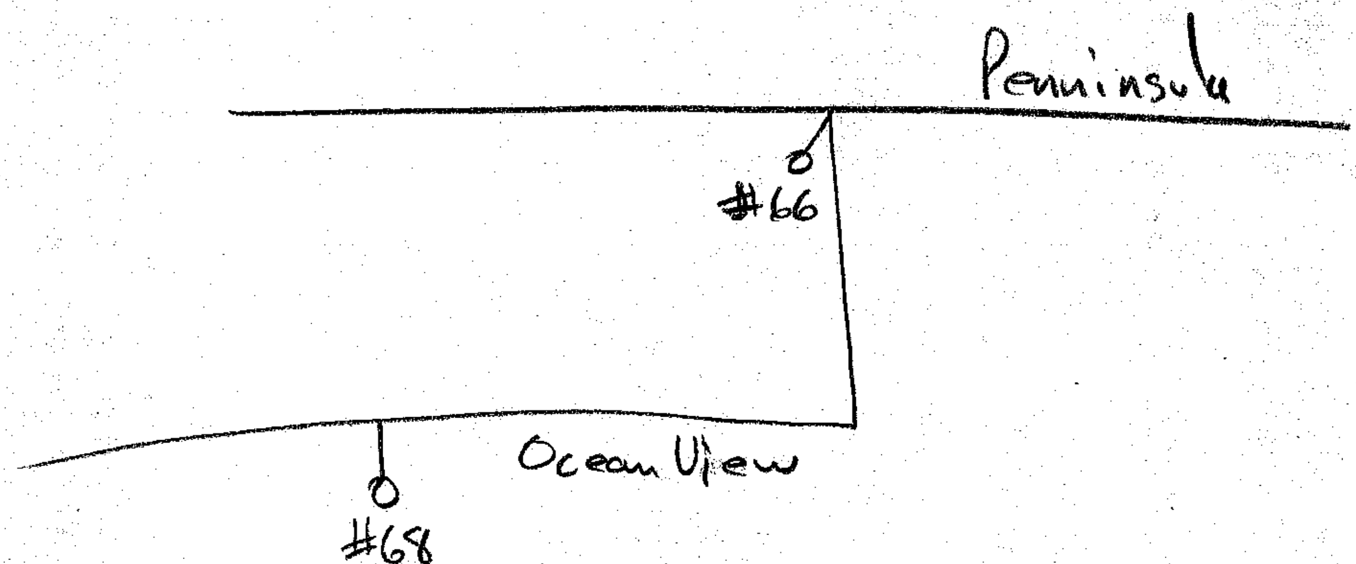
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 76 psi RESIDUAL B 72 psi

PROJECTED RESULTS @ 20 psi 3504 gpm, or @ 0 psi RESIDUAL 4133 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#69

LOCATION Legion Hall DATE 10-20-00

TEST MADE BY Gary and Rob TIME 11:03 A.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J69 A1 J18 A2 A3 A4

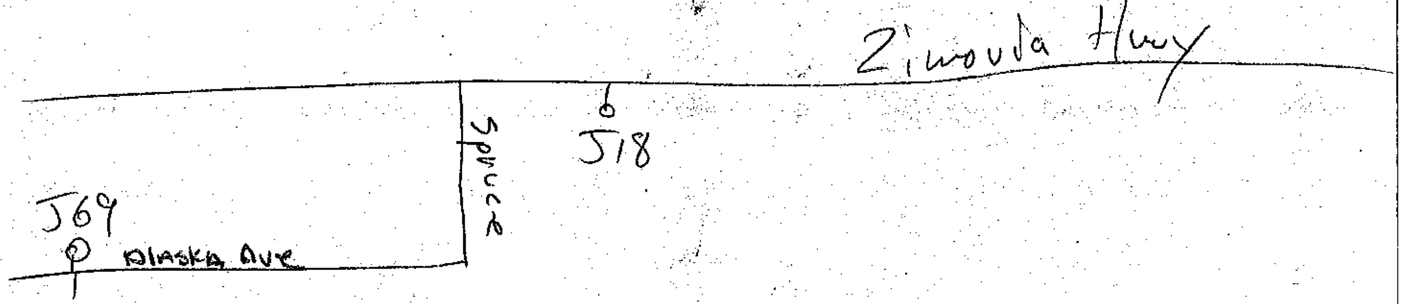
SIZE NOZZLE 2"

PITOT READING 82 TOTAL GPM 1076

STATIC B 128 psi RESIDUAL B 104 psi

PROJECTED RESULTS @ 20 psi 2425 gpm, or @ 0 psi RESIDUAL 2659 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL #71

LOCATION Ash St. DATE 10-20-00

TEST MADE BY Gary and Rob TIME 10:00 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS J71 A1 A2 A3 A4

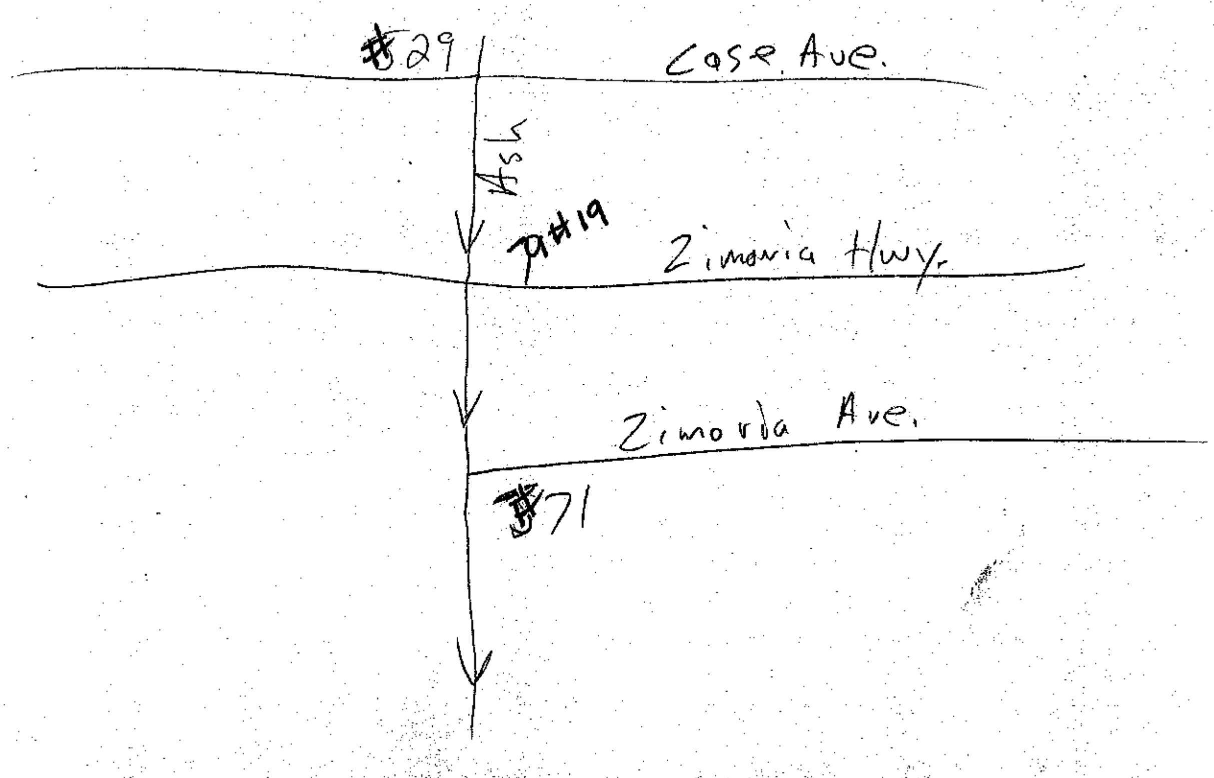
SIZE NOZZLE 2"

PITOT READING 30 TOTAL GPM ?

STATIC B J29 80 psi RESIDUAL B 78 psi

PROJECTED RESULTS @ 20 psi gpm, or @ psi RESIDUAL gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Upper Ash St. #71 DATE 12-28-00

TEST MADE BY Gary and Rob TIME 8:55A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS Uper Ash A1 Low Press. Valt A2 A3 A4

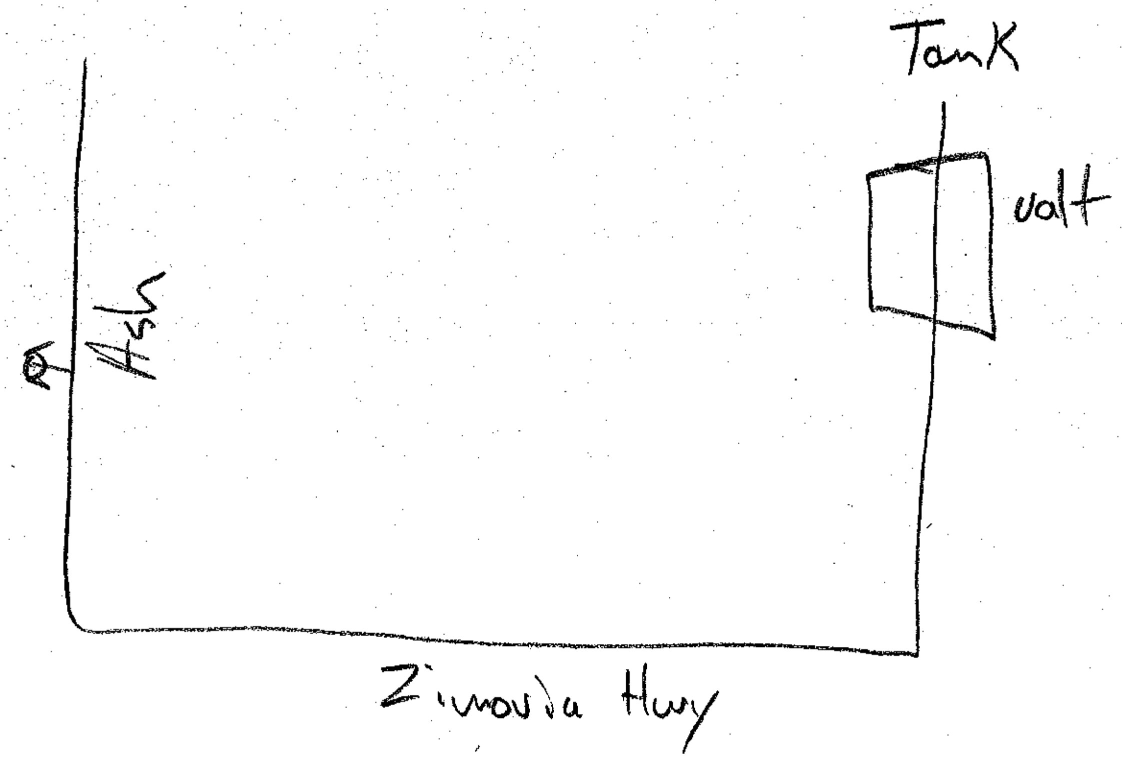
SIZE NOZZLE 3/4

PITOT READING 40 psi TOTAL GPM

STATIC B 40 psi RESIDUAL B 40 psi

PROJECTED RESULTS @ 20 psi gpm, or @ psi RESIDUAL gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #72 Lemieux DATE 12-28-00

TEST MADE BY Gary and Rob TIME 9:00A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS Lemieux A1 upper Ash A2 A3 A4

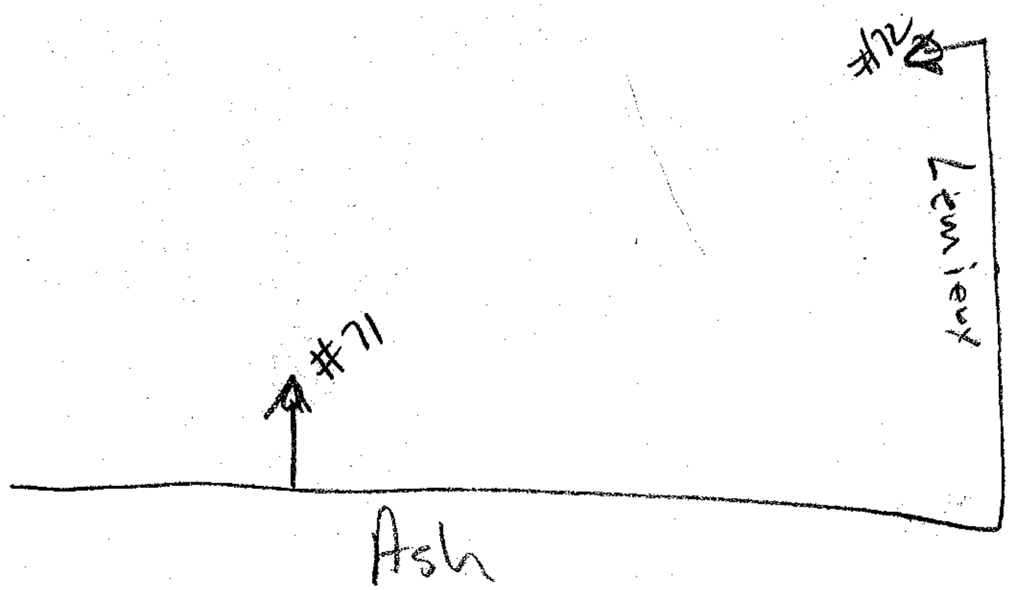
SIZE NOZZLE 3/4

PITOT READING 32 psi TOTAL GPM

STATIC B 42 psi RESIDUAL B 40 psi

PROJECTED RESULTS @ 20 psi gpm, or @ psi RESIDUAL gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL #72

LOCATION Lemieux St DATE 10-20-00

TEST MADE BY Gary and Rob TIME 10:12 A.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS ________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ________

FLOW HYDRANTS J72 A1 J71 A2 ____ A3 ____ A4 ____

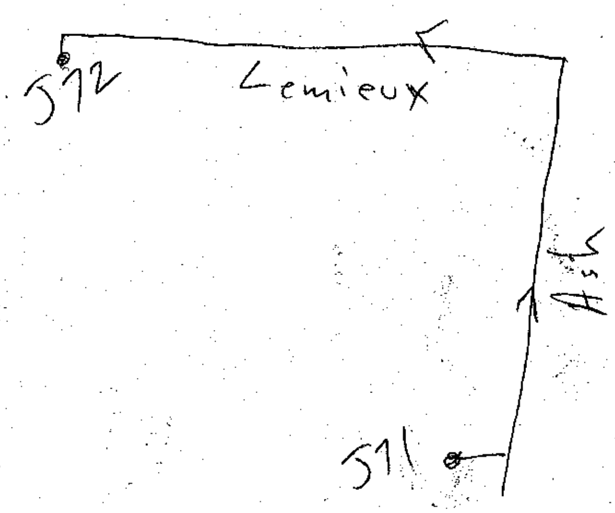
SIZE NOZZLE ________

PITOT READING 20 TOTAL GPM ?

STATIC B J71 52 psi ____ RESIDUAL B 46 psi

PROJECTED RESULTS @ 20 psi ____ gpm, or @ ____ psi RESIDUAL ____ gpm

REMARKS ________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #73 Shakes St L-52 DATE 10-24-00

TEST MADE BY Gary and Rob TIME 8:19 A.M.

REPRESENTATIVE OF Public Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 73 A1 33 A2 ______ A3 ______ A4 ______

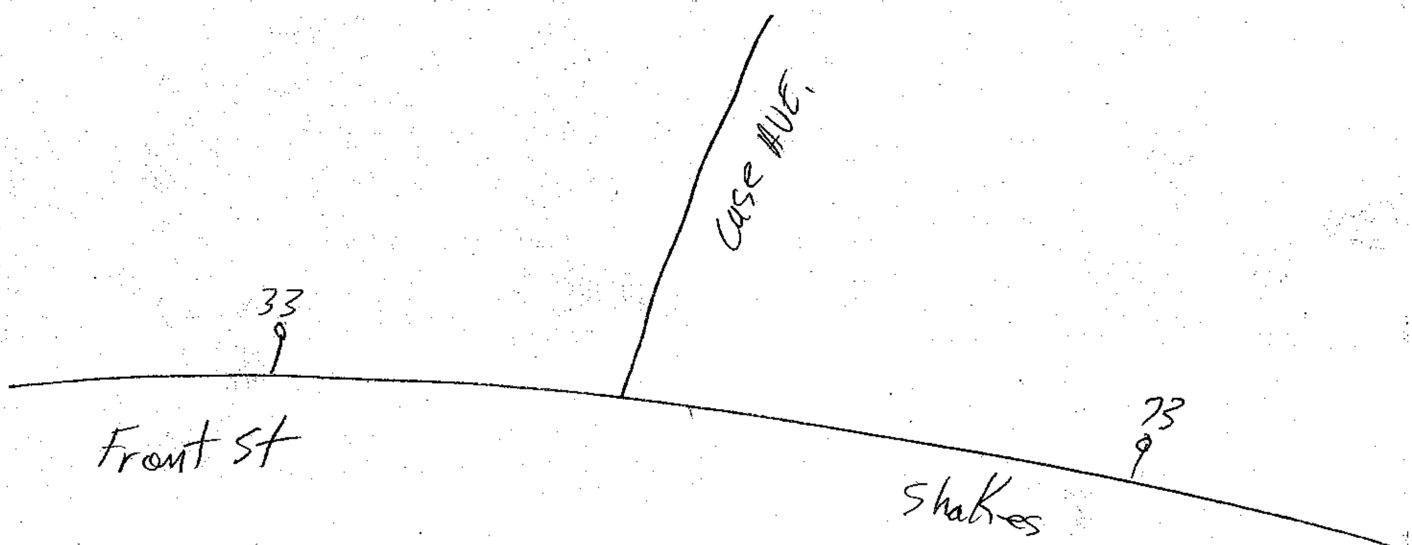
SIZE NOZZLE 2"

PITOT READING ______ psi TOTAL GPM ______

STATIC B ______ psi RESIDUAL B ______ psi

PROJECTED RESULTS @ 20 psi ______ gpm, or @ ______ psi RESIDUAL ______ gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #74 Relience Dock L-53 DATE 10-24-00

TEST MADE BY Gary and Rob TIME 8:30 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ____________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____________

FLOW HYDRANTS #74 A1 73 A2 ____ A3 ____ A4 ____

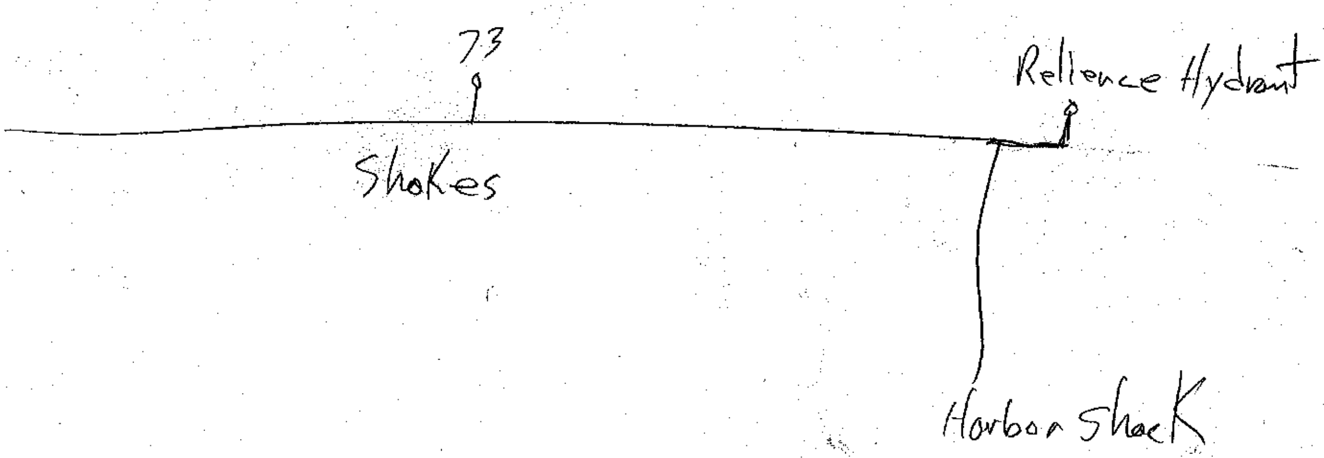
SIZE NOZZLE 2"

PITOT READING 58 psi TOTAL GPM 905

STATIC B 72 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 2904 gpm, or @ 0 psi RESIDUAL 3465 gpm

REMARKS ____________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #75 Berger St. (Bobs' IGA) DATE 10-25-00

TEST MADE BY Gonyoul Rob TIME 8:11 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 75 A1 37 A2 ______ A3 ______ A4 ______

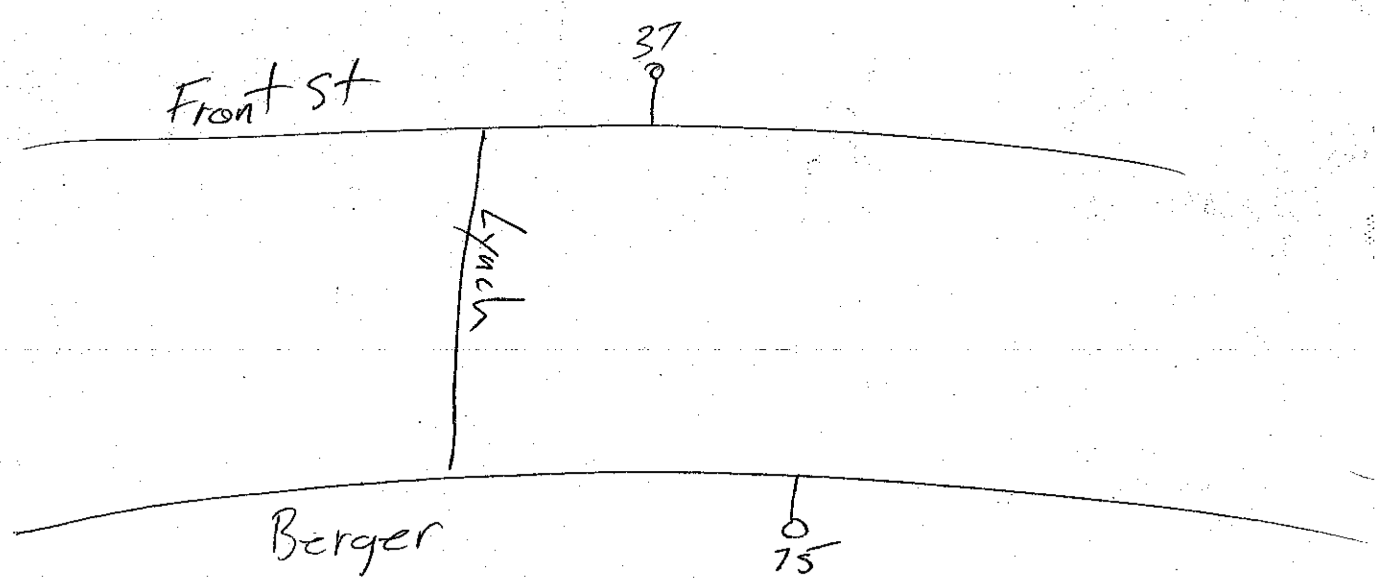
SIZE NOZZLE 2"

PITOT READING 54 psi TOTAL GPM 873

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3492 gpm, or @ 0 psi RESIDUAL 4166 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #76 Berger St DATE 10-25-00

TEST MADE BY Garry and Rob TIME 8:05 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 76 A1 37 A2 A3 A4

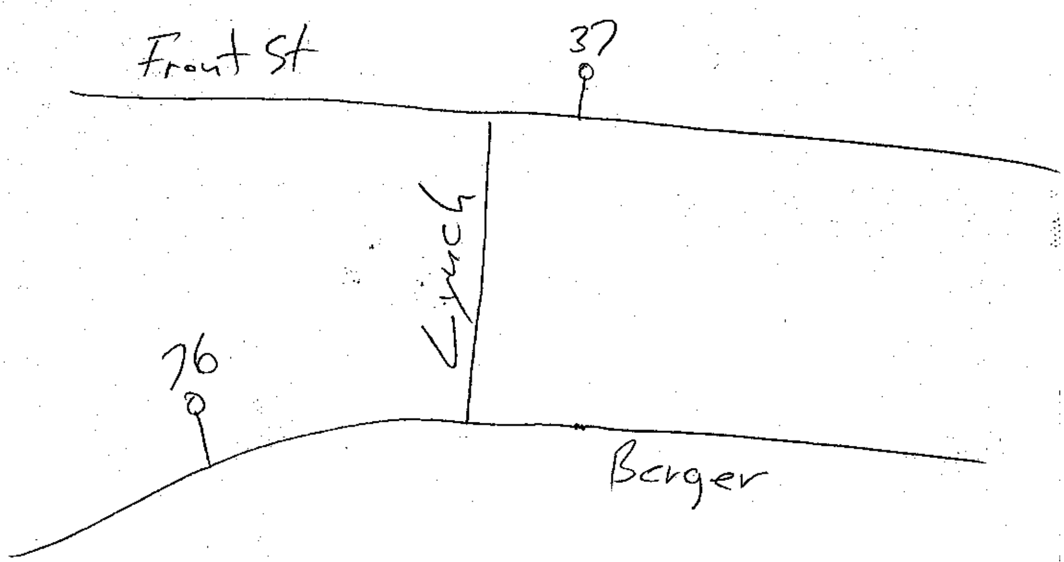
SIZE NOZZLE 2"

PITOT READING 52 psi TOTAL GPM 857

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3428 gpm, or @ 0 psi RESIDUAL 4090 gpm

REMARKS



HYDRANT FLOW TEST REPORT #17
CITY OF WRANGELL

LOCATION: Cassiarst and Bevierst DATE: 10-20-00

TEST MADE BY: Gary and Rob TIME: 2:10 P.M.

REPRESENTATIVE OF: PUBLIC Works

WITNESS: ______

STATE PURPOSE OF TEST: Flow

CONSUMPTION RATE DURING TEST: ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING: ______

FLOW HYDRANTS: J77 A1: J50 A2: ______ A3: ______ A4: ______

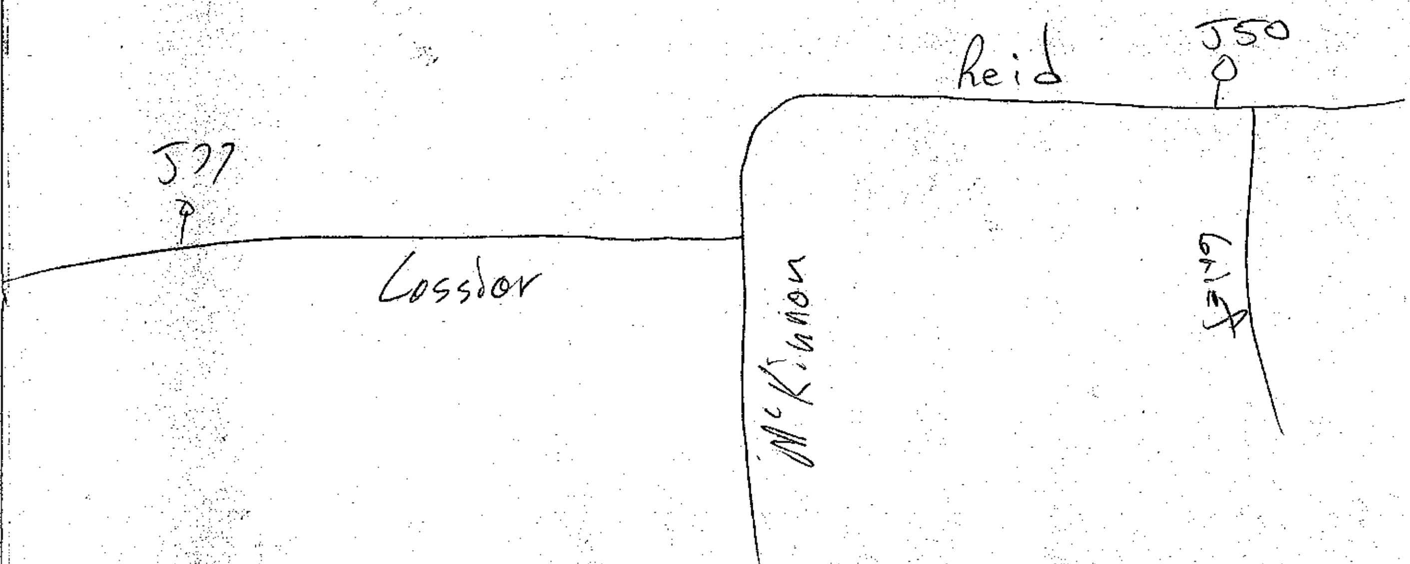
SIZE NOZZLE: 2"

PITOT READING: 36 TOTAL GPM: ______

STATIC B: 58 psi ______ RESIDUAL B: 48 psi

PROJECTED RESULTS @ 20 psi ______ gpm, or @ ______ psi RESIDUAL ______ gpm

REMARKS: ______



HYDRANT FLOW TEST REPORT #78
CITY OF WRANGELL

LOCATION Sam Prilett Cassiar St. DATE 10-20-00

TEST MADE BY Gary and Rob TIME 2:20 P.M.

REPRESENTATIVE OF Public Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS J78 A1 J77 A2 ______ A3 ______ A4 ______

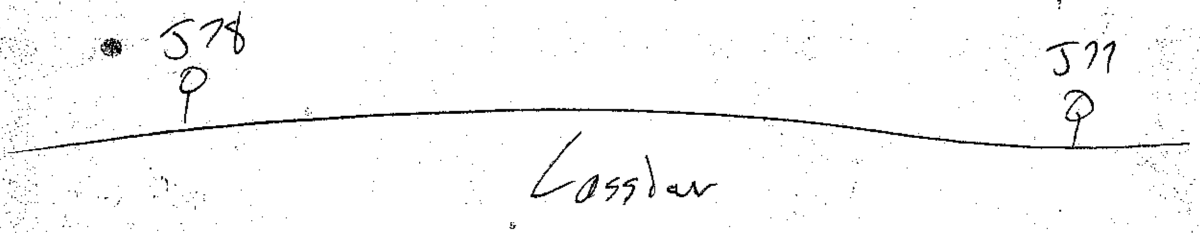
SIZE NOZZLE 2"

PITOT READING 30 TOTAL GPM ______

STATIC B 64 psi ______ RESIDUAL B 58 psi

PROJECTED RESULTS @ 20 psi ______ gpm, or @ ______ psi RESIDUAL ______ gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #79 Evergreen Ave DATE 10-17-00

TEST MADE BY Rob Davidson & Gary Pullman TIME 2-2:30 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine / Evergreen (NOT Running)

FLOW HYDRANTS #79 A1 #4 A2 A3 A4

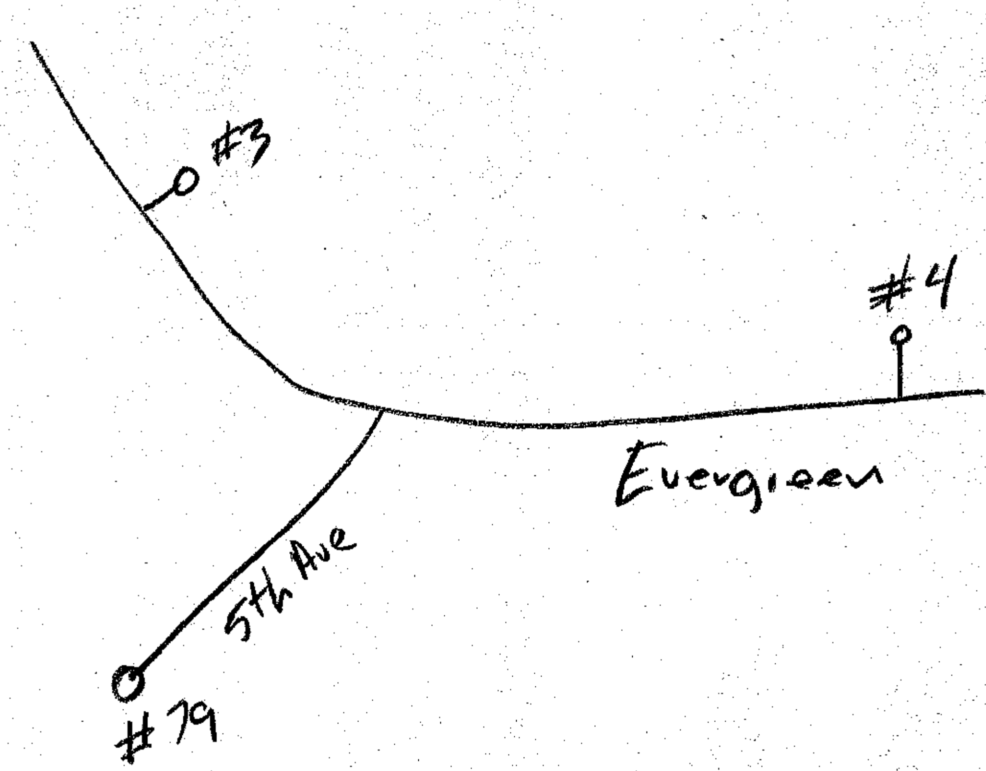
SIZE NOZZLE 2"

PITOT READING 60 psi TOTAL GPM 920

STATIC B 72 psi RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi 2529 gpm, or @ 0 psi RESIDUAL 3017 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #80 Panhandle Trailer Court DATE 10-24-00

TEST MADE BY Gary and Rob TIME 9:19 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS Panhandle A1 J21 A2 A3 A4

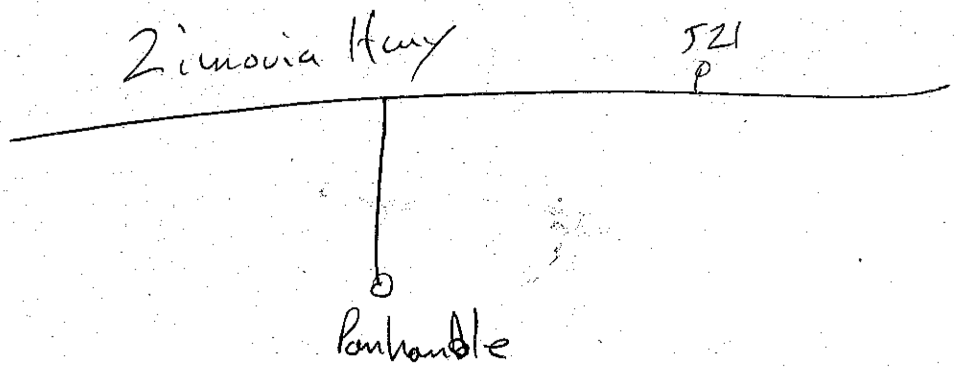
SIZE NOZZLE 2"

PITOT READING 50 psi TOTAL GPM 841

STATIC B 66 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 3153 gpm, or @ 0 psi RESIDUAL 3830 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#81

LOCATION Wastwater Treatment Plant DATE 10-24-00

TEST MADE BY Gary and Rob TIME 9:40 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS J81 A1 City Rock Pit A2 ______ A3 ______ A4 ______

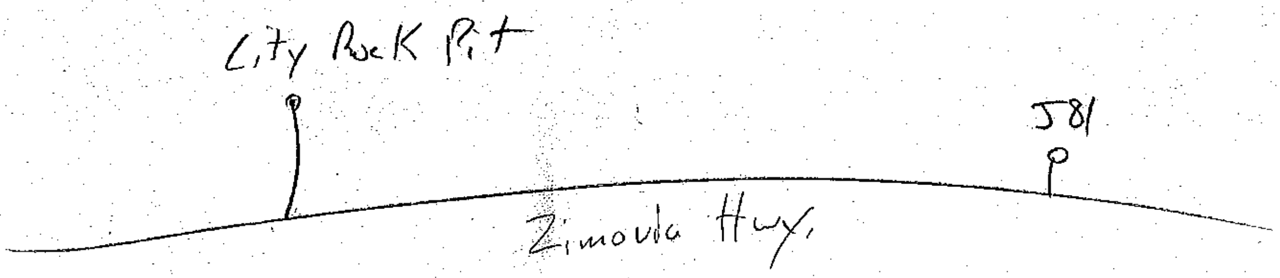
SIZE NOZZLE 2"

PITOT READING 98 psi TOTAL GPM 1176

STATIC B 142 psi RESIDUAL B 110 psi

PROJECTED RESULTS @ 20 psi 2423 gpm, or @ 0 psi RESIDUAL 2629 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #82 Front St and Federal Way DATE 10-25-00

TEST MADE BY Gary and Rob TIME 7:16 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 82 A1 38 A2 ______ A3 ______ A4 ______

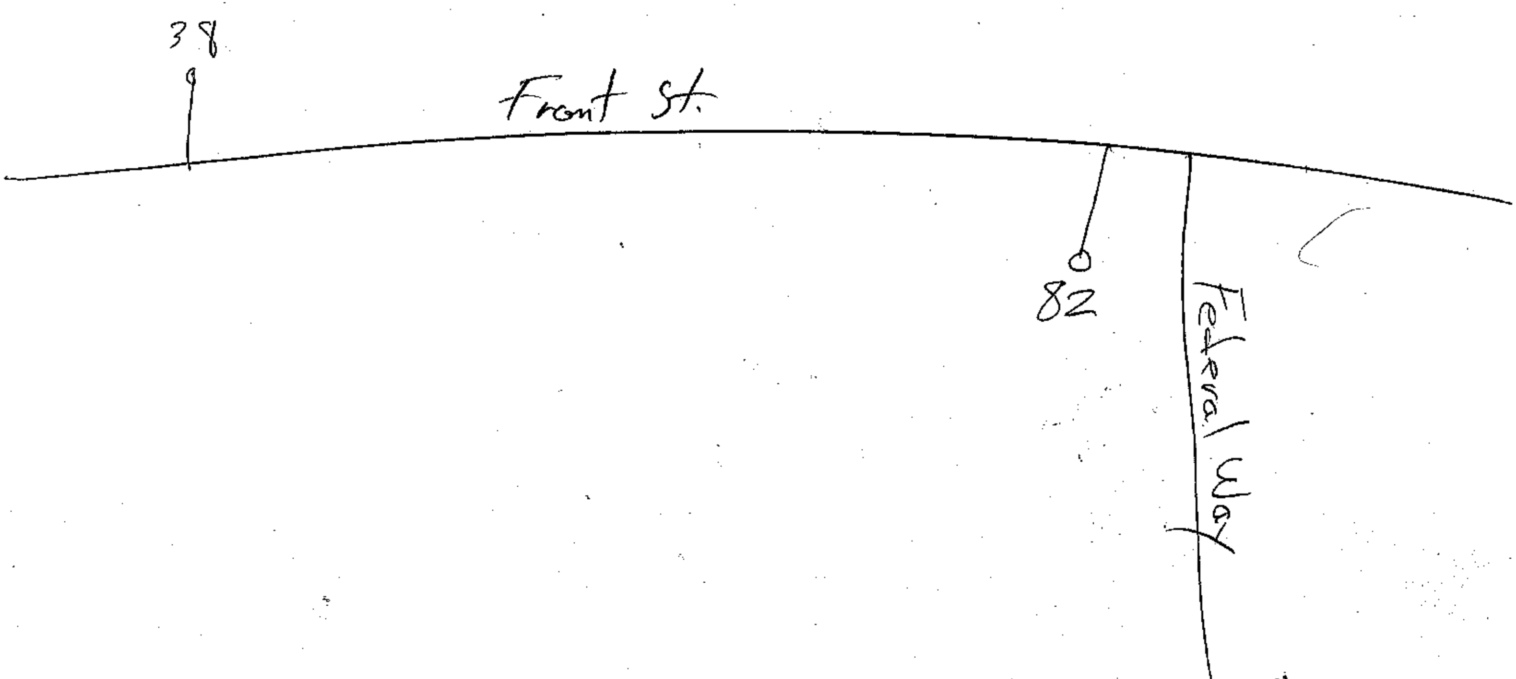
SIZE NOZZLE 2"

PITOT READING 58 psi TOTAL GPM 905

STATIC B 72 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 3626 gpm, or @ 0 psi RESIDUAL 4319 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #83 Spring St. DATE 10-17-00

TEST MADE BY Rob & Gary TIME 3:00-3:30 p.M.

REPRESENTATIVE OF Public Works

WITNESS ____________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING Stikine/Evergreen (NOT Running)

FLOW HYDRANTS #83 A1 #6 A2 ____ A3 ____ A4 ____

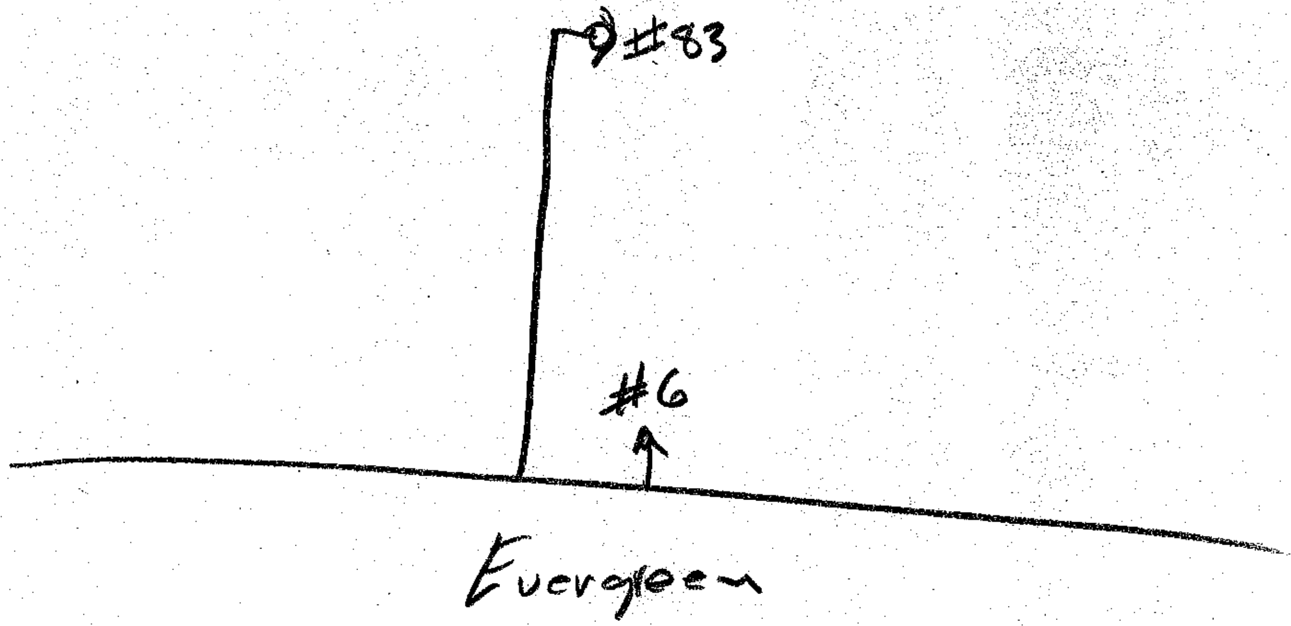
SIZE NOZZLE 2"

PITOT READING 40 psi TOTAL GPM 752

STATIC B 80 psi RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 2608 gpm, or @ 0 psi RESIDUAL 3048 gpm

REMARKS ____________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#84
LOCATION WTP (inside fence) DATE 10-24-00

TEST MADE BY Gary and Rob TIME ____ .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ____

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____

FLOW HYDRANTS WTP A1 City rock pit A2 ____ A3 ____ A4 ____

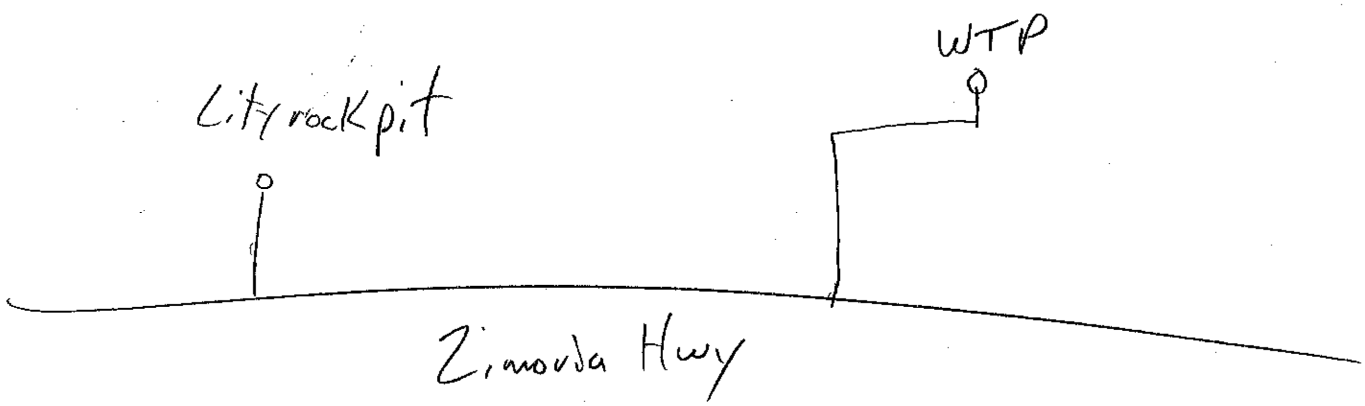
SIZE NOZZLE 2"

PITOT READING 84 psi TOTAL GPM 1089

STATIC B 142 psi RESIDUAL B 120 psi

PROJECTED RESULTS @ 20 psi 2842 gpm, or @ 0 psi RESIDUAL 3084 gpm

REMARKS ____



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL #85

LOCATION ASHA DATE 10-20-00

TEST MADE BY Bony and Rob TIME 10:43 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 85 A1 J19 A2 A3 A4

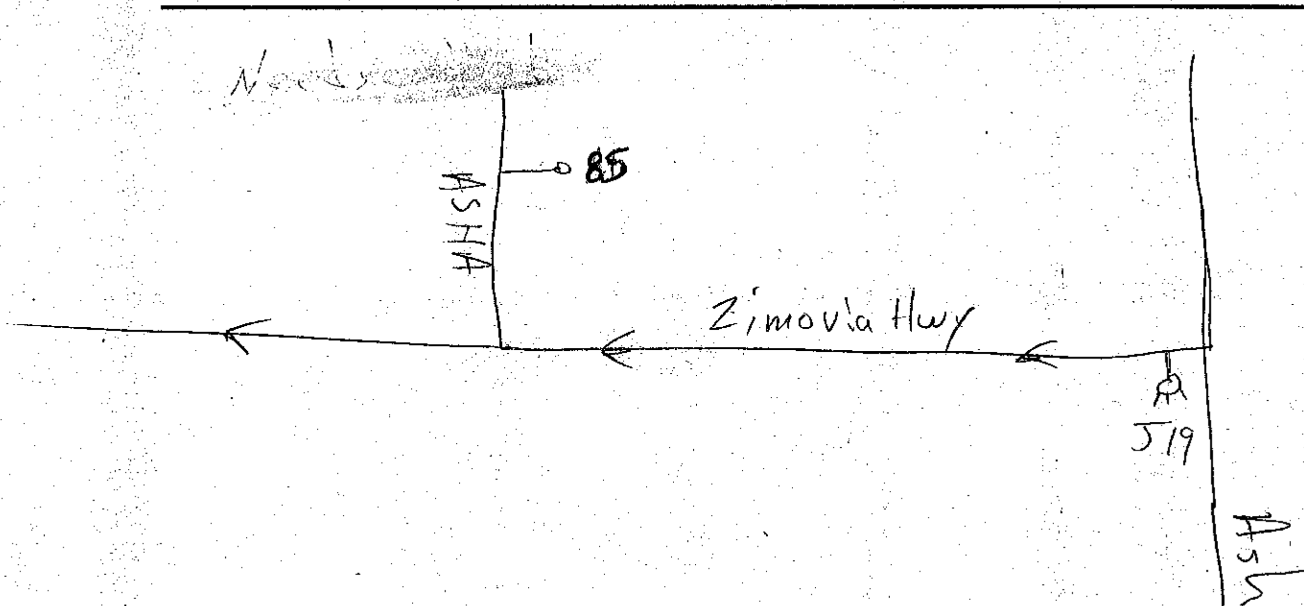
SIZE NOZZLE 2"

PITOT READING 74 TOTAL GPM 1023

STATIC B 120 psi RESIDUAL B 112 psi

PROJECTED RESULTS @ 20 psi 4005 gpm, or @ 0 psi RESIDUAL 4422 gpm

REMARKS Needs Raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Housing top #86 DATE 19 OCT 00

TEST MADE BY ROB & JOE TIME 11:43 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 86 A1 85 A2 ______ A3 ______ A4 ______

SIZE NOZZLE 2"

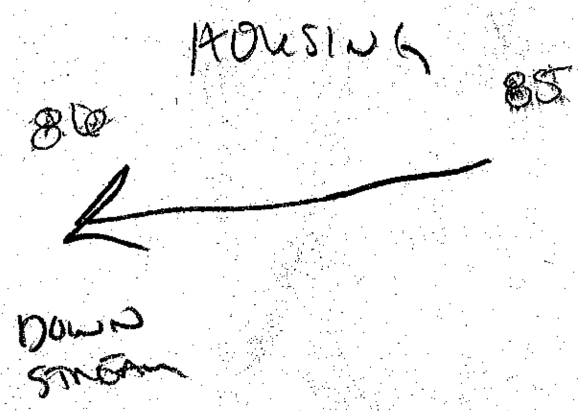
PITOT READING 66 TOTAL GPM 965

STATIC B 98 psi ______ RESIDUAL B 90 psi

PROJECTED RESULTS @ 20 psi 3304 gpm, or @ 0 psi RESIDUAL 3737 gpm

REMARKS A = START AT HOUSING APTS
A1 = TOP OF DRIVEWAY

HYDRANT NEEDS RAISED



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION WEST END OF HOWELL #87 DATE 19OCT08

TEST MADE BY JOE ROB TIME 2:34 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ____________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____________

FLOW HYDRANTS WEST END OF HOWELL A1 J53 A2 ____ A3 ____ A4 ____

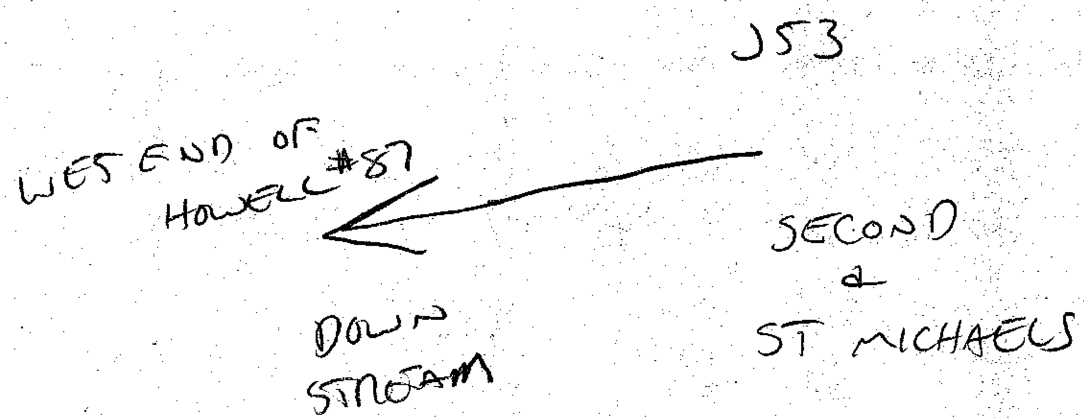
SIZE NOZZLE 2"

PITOT READING 46 TOTAL GPM 806

STATIC B 100 psi ____ RESIDUAL B 75 psi

PROJECTED RESULTS @ 20 psi 1510 gpm, or @ 0 psi RESIDUAL 1703 gpm

REMARKS ____________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION WEST SIDE OF THIRD AVE & ST. MICHAELS DATE 19OCT00

TEST MADE BY JOE & ROB TIME 2:41 .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS WEST SIDE OF THIRD & ST MICHAELS A1 J53 A2 ______ A3 ______ A4 ______

SIZE NOZZLE 2"

PITOT READING 50 TOTAL GPM 841

STATIC B 100 psi ______ RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 1379 gpm, or @ 0 psi RESIDUAL 1555 gpm

REMARKS NO WATER @ [illegible]

J53

WEST SIDE OF
THIRD
&
ST MICHAELS

#88 ← SECOND & ST. MICHAELS

DOWN
STREAM

HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION 4th & St. Michaels #89 DATE 19 Oct. 00

TEST MADE BY Rob & Joe TIME 2:50 P .M.

REPRESENTATIVE OF Public Works

WITNESS ____________________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____________________

FLOW HYDRANTS 89 A1 54 A2 ____ A3 ____ A4 ____

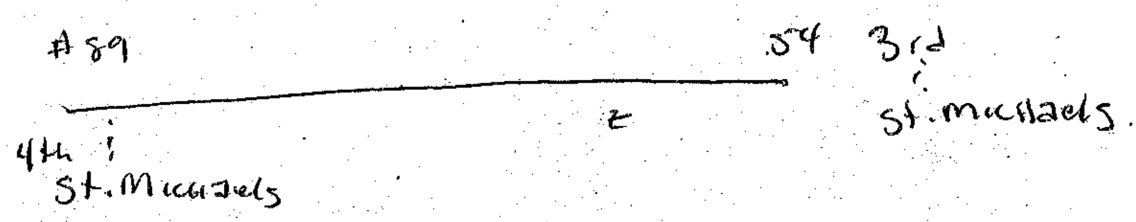
SIZE NOZZLE 2"

PITOT READING 48 TOTAL GPM 824

STATIC B 100 psi ____ RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 1351 gpm, or @ 0 psi RESIDUAL 1524 gpm

REMARKS ____________________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION SHtax'Heen Circle #90 DATE 19 oct 00

TEST MADE BY Rob & Joe TIME 3:05 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 90 A1 86 A2 A3 A4

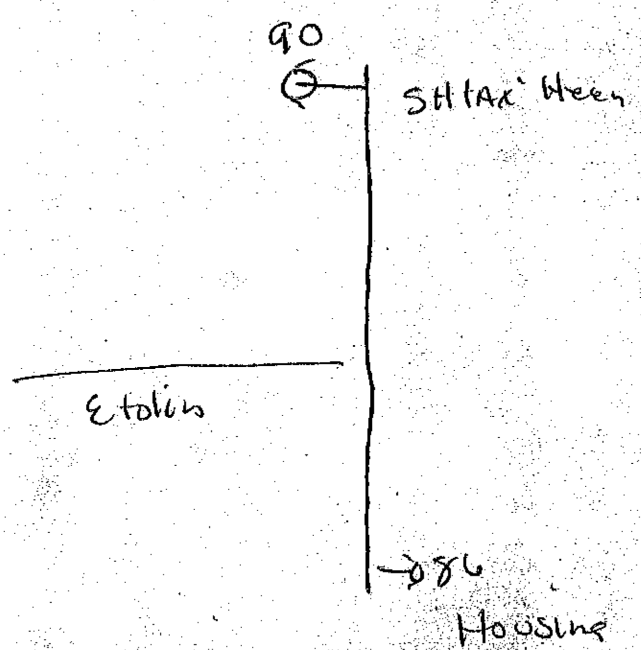
SIZE NOZZLE 2"

PITOT READING 56 TOTAL GPM 889

STATIC B 106 psi RESIDUAL B 84 psi

PROJECTED RESULTS @ 20 psi 1920 gpm, or @ 0 psi RESIDUAL 2151 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Etolin # 91 DATE 19 oct 00

TEST MADE BY Joe & Rob TIME ____ .M.

REPRESENTATIVE OF Public Works

WITNESS ____

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____

FLOW HYDRANTS 91 A1 86 A2 ____ A3 ____ A4 ____

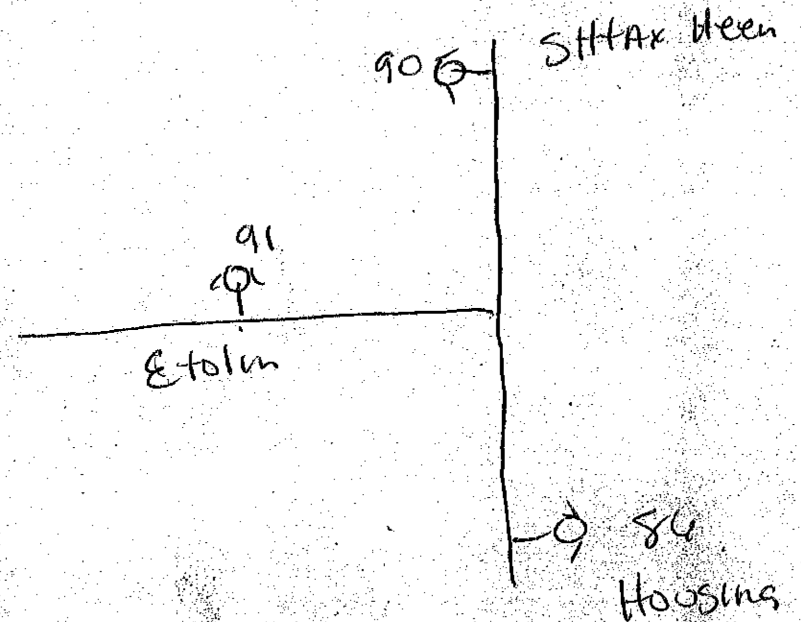
SIZE NOZZLE 2"

PITOT READING 56 TOTAL GPM 889

STATIC B 106 psi ____ RESIDUAL B 86 psi

PROJECTED RESULTS @ 20 psi 1954 gpm, or @ 0 psi RESIDUAL 2189 gpm

REMARKS ____



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Hemlock #92 DATE 19 oct. 00

TEST MADE BY Joe & Rob TIME 3:15 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 92 A1 91 A2 A3 A4

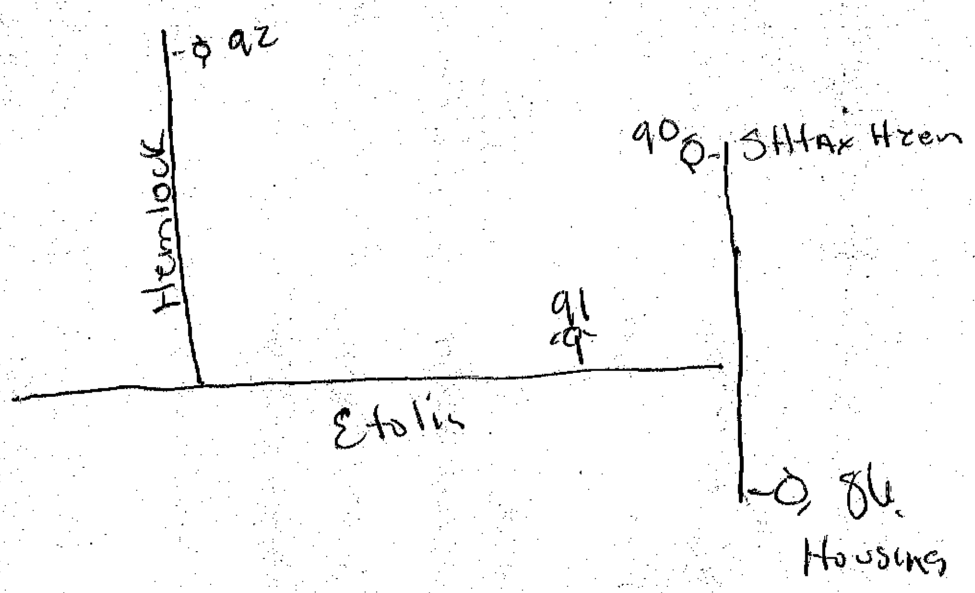
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 98 psi RESIDUAL B 75 psi

PROJECTED RESULTS @ 20 psi 1687 gpm, or @ 0 psi RESIDUAL 1908 gpm

REMARKS needs Raised



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Etolin #93 DATE 19 oct. 00

TEST MADE BY Joe & Rob TIME 3:30 p.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 93 A1 91 A2 A3 A4

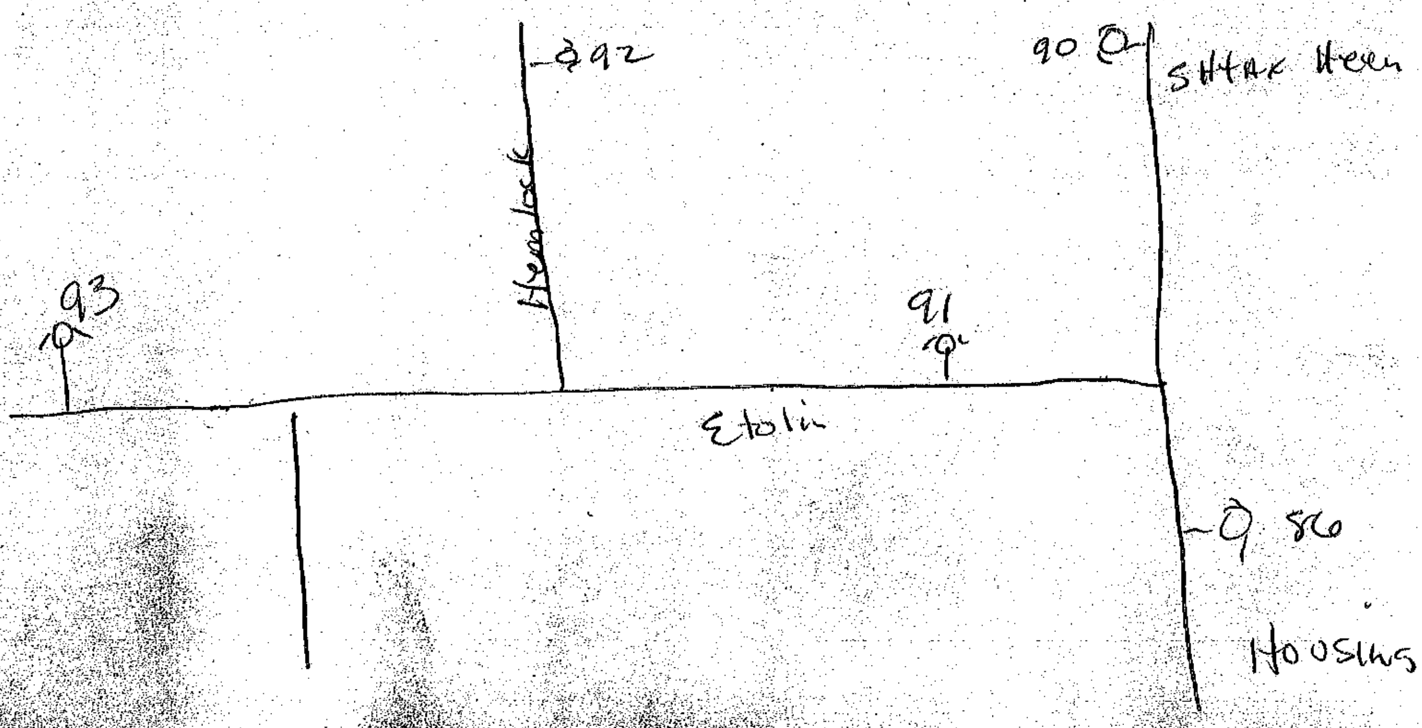
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM

STATIC B 98 psi RESIDUAL B 75 psi

PROJECTED RESULTS @ 20 psi 1687 gpm, or @ 0 psi RESIDUAL 1908 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Council Drive #94 DATE 10-20-00

TEST MADE BY Gary & Rob TIME 9:00 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 94 A1 91 A2 A3 A4

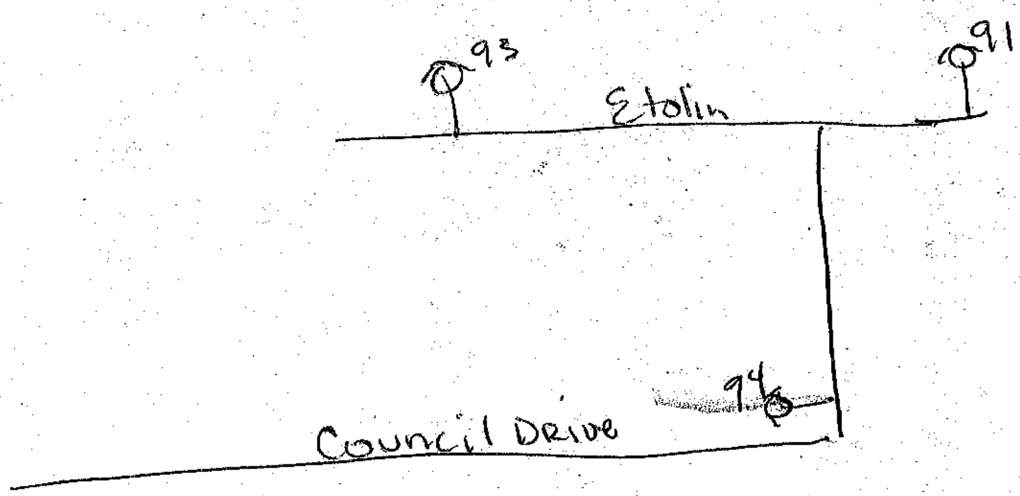
SIZE NOZZLE 2½

PITOT READING 68 TOTAL GPM 980

STATIC B 100 psi RESIDUAL B 76 psi

PROJECTED RESULTS @ 20 psi 1879 gpm, or @ 0 psi RESIDUAL 2119 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Council Drive #95 DATE 10-20-00

TEST MADE BY Gary & Rob TIME 9:38 A .M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 95 A1 94 A2 A3 A4

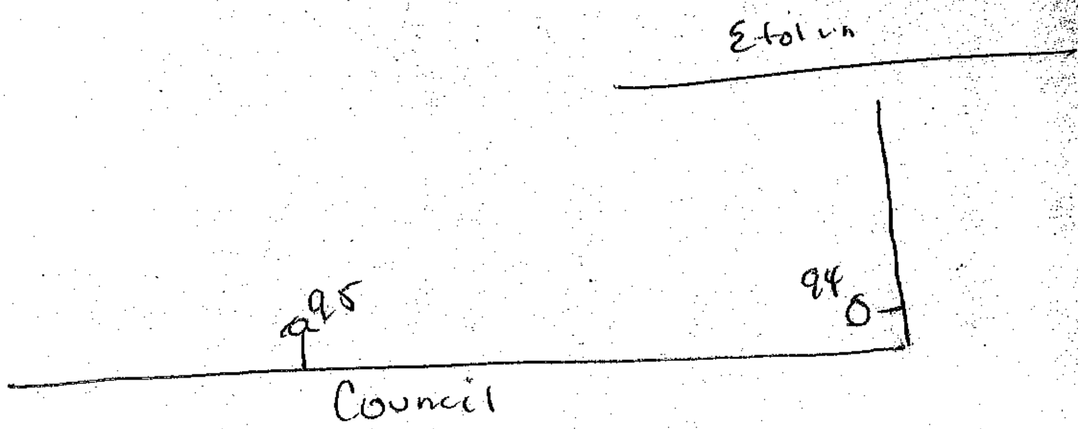
SIZE NOZZLE 2"

PITOT READING 70 TOTAL GPM 994

STATIC B 112 psi RESIDUAL B 92 psi

PROJECTED RESULTS @ 20 psi 2266 gpm, or @ 0 psi RESIDUAL 2521 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Council Drive #96 DATE 10-20-00

TEST MADE BY Gary & Rob TIME 9:40 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 96 A1 95 A2 A3 A4

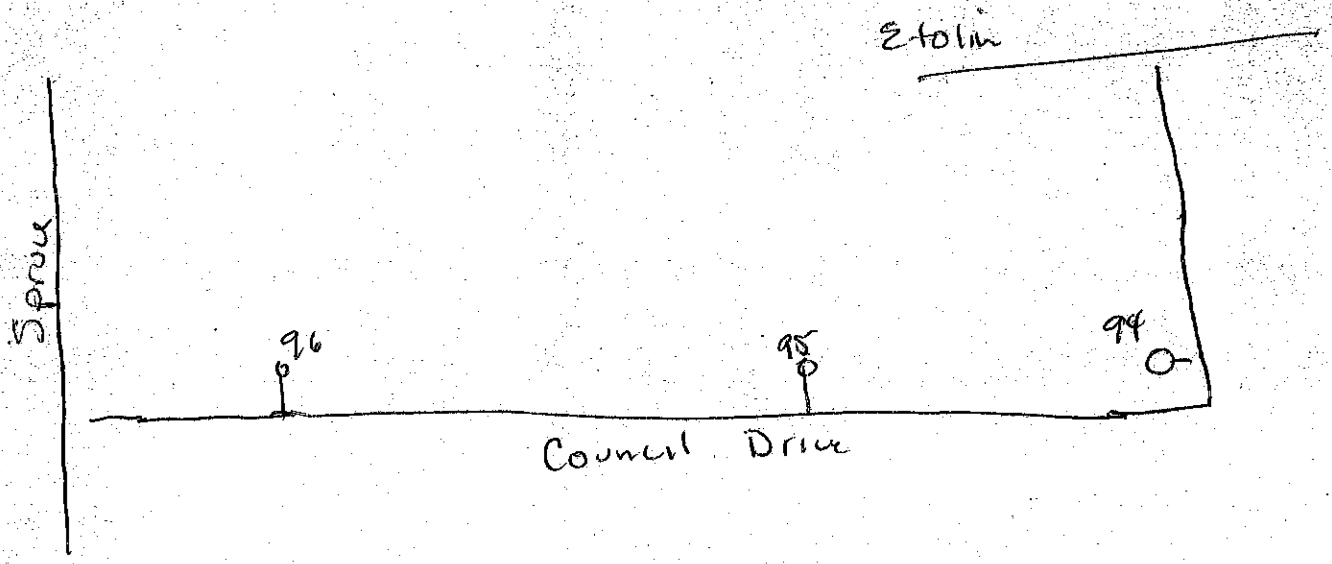
SIZE NOZZLE 2"

PITOT READING 74 TOTAL GPM 1023

STATIC B 114 psi RESIDUAL B 88 psi

PROJECTED RESULTS @ 20 psi 2048 gpm, or @ 0 psi RESIDUAL 2271 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION: John Baker #135 DATE: 10-24-00

TEST MADE BY: Gary and Rob TIME: 10:30 A.M.

REPRESENTATIVE OF: PUBLIC WORKS

WITNESS: ______

STATE PURPOSE OF TEST: Flow

CONSUMPTION RATE DURING TEST: ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING: ______

FLOW HYDRANTS: #135 A1: J25 A2: ____ A3: ____ A4: ____

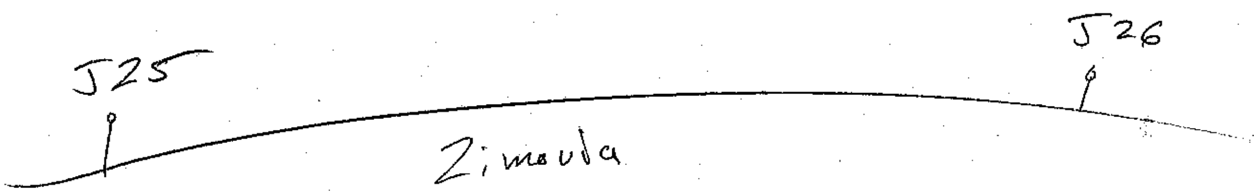
SIZE NOZZLE: 2"

PITOT READING: 92 psi TOTAL GPM: 1140

STATIC B: 140 psi RESIDUAL B: 116 psi

PROJECTED RESULTS @ 20 psi: 2721 gpm, or @ ____ psi RESIDUAL: 2957 gpm

REMARKS: ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION: Zimovia Hwy #136 DATE: 10-24-00

TEST MADE BY: Gary and Rob TIME: 10:40 A.M.

REPRESENTATIVE OF: PUBLIC WORKS

WITNESS: __________

STATE PURPOSE OF TEST: Flow

CONSUMPTION RATE DURING TEST: __________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING: __________

FLOW HYDRANTS: 136 A1: 135 A2: ____ A3: ____ A4: ____

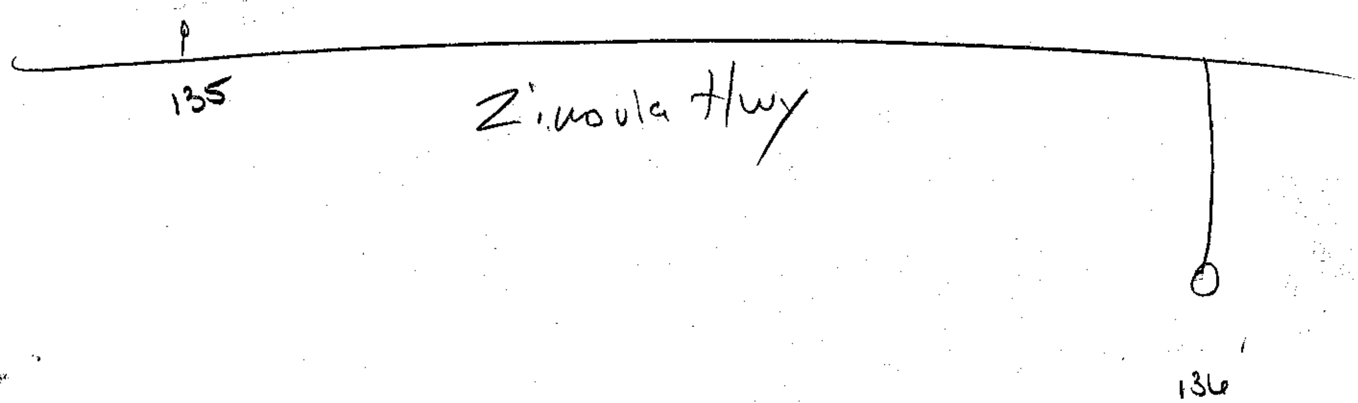
SIZE NOZZLE: 2"

PITOT READING: 88 psi TOTAL GPM: 1115

STATIC B: 142 psi RESIDUAL B: 100 psi

PROJECTED RESULTS @ 20 psi: 1983 gpm, or @ 0 psi RESIDUAL: 2152 gpm

REMARKS: __________



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Zimovia Hwy #137 DATE 10-24-00

TEST MADE BY Gary and Rob TIME 10:47 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 137 A1 136 A2 A3 A4

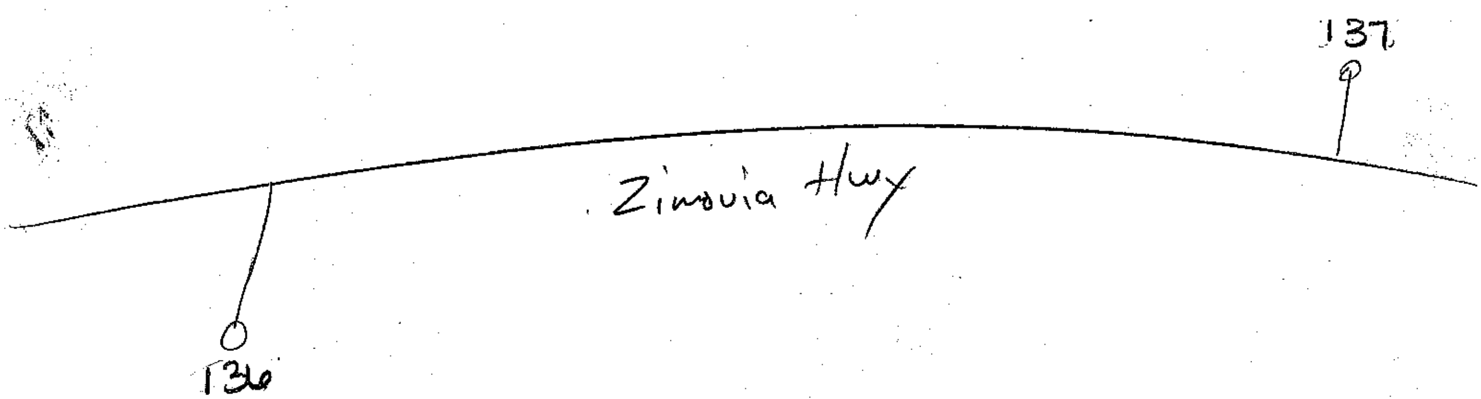
SIZE NOZZLE 2"

PITOT READING 90 psi TOTAL GPM 1128

STATIC B 142 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2006 gpm, or @ 0 psi RESIDUAL 2177 gpm

REMARKS Needs Raised.



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION: Zimovia Hwy #138 DATE: 10-24-00

TEST MADE BY: Gary and Rob TIME: 10:55 .M.

REPRESENTATIVE OF: PUBLIC WORKS

WITNESS:

STATE PURPOSE OF TEST: Flow

CONSUMPTION RATE DURING TEST:

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING:

FLOW HYDRANTS: 138 A1: 137 A2: A3: A4:

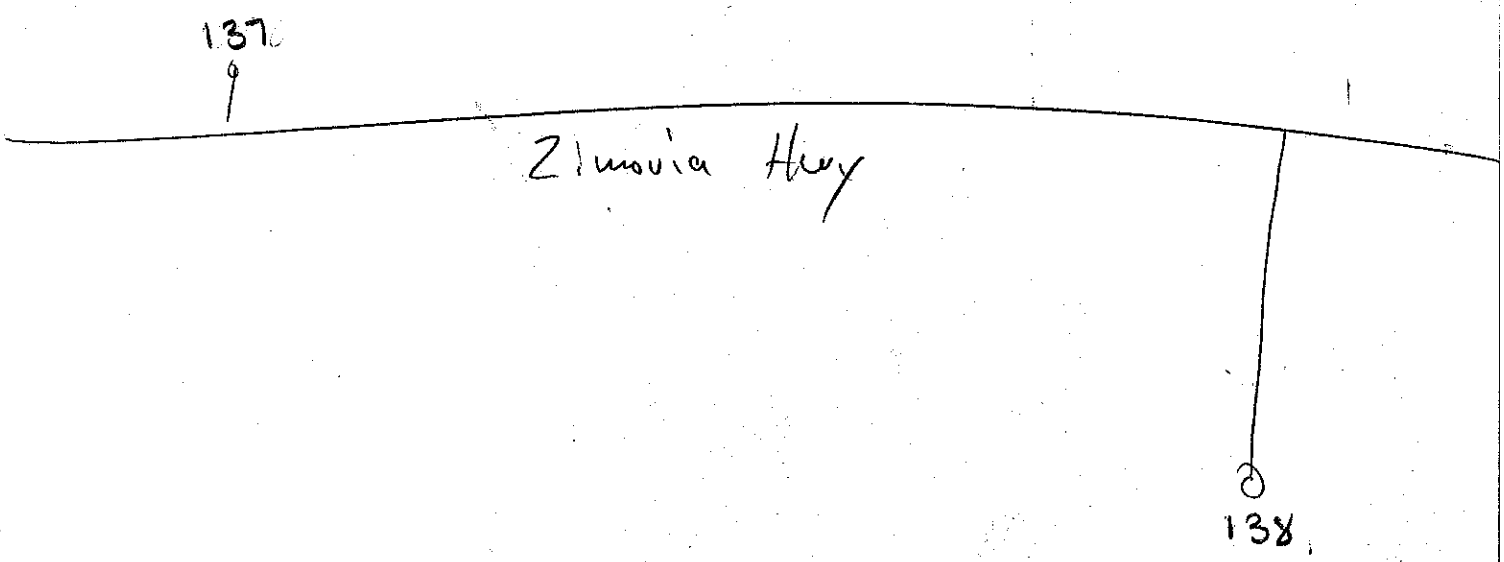
SIZE NOZZLE: 2"

PITOT READING: 88 psi TOTAL GPM: 1115

STATIC B: 142 psi RESIDUAL B: 102 psi

PROJECTED RESULTS @ 20 psi 2037 gpm, or @ 0 psi RESIDUAL 2210 gpm

REMARKS:



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Zimovia Hwy #139 DATE 10-24-00

TEST MADE BY Gary and Rob TIME 11:15 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 139 A1 138 A2 A3 A4

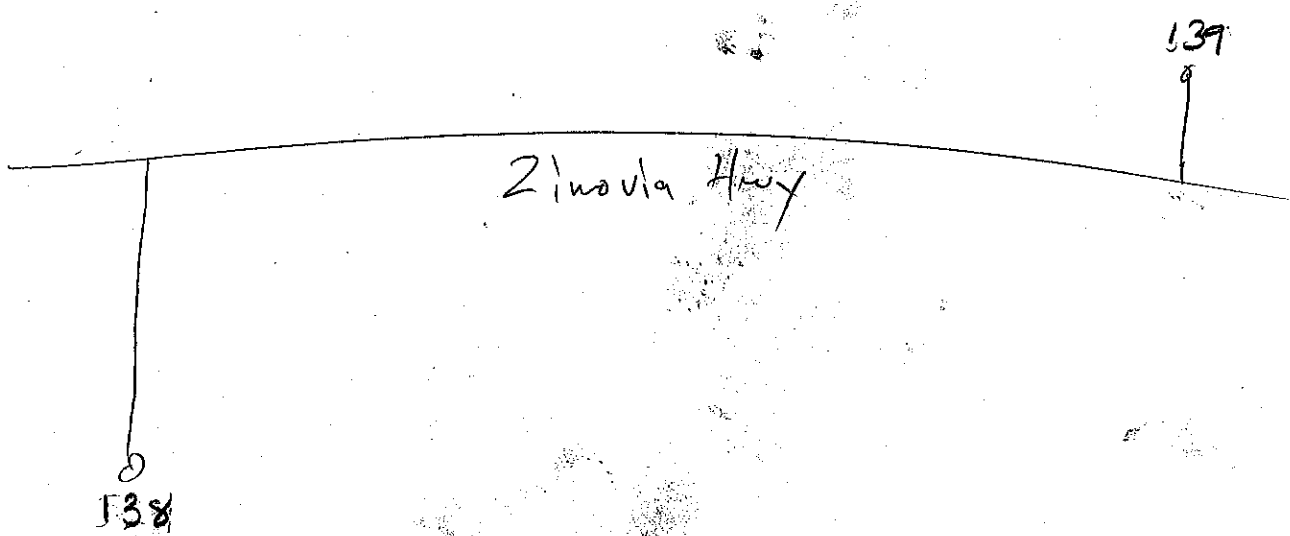
SIZE NOZZLE 2"

PITOT READING 88 psi TOTAL GPM 1115

STATIC B 142 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 1983 gpm, or @ 0 psi RESIDUAL 2152 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Zimovia Hwy #140 DATE 10-24-00

TEST MADE BY Gary and Rob TIME 11:22 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 140 A1 139 A2 A3 A4

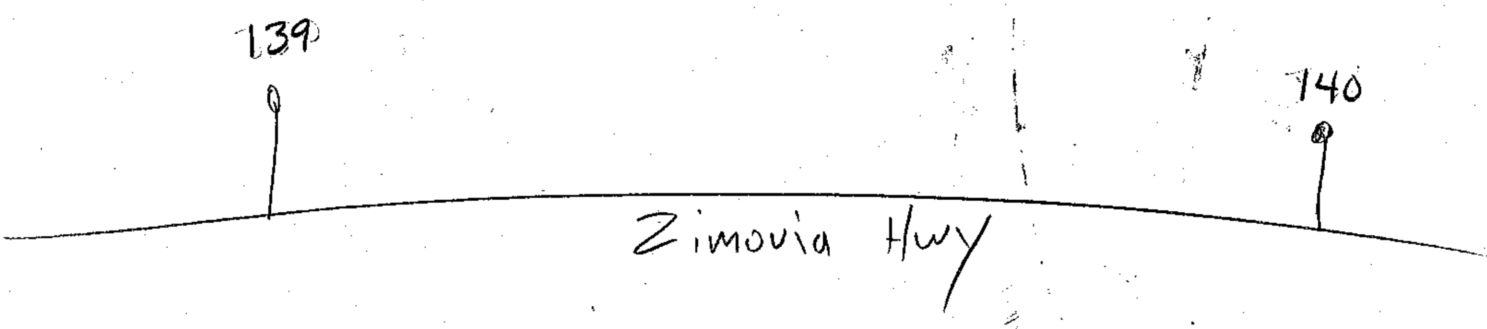
SIZE NOZZLE 2"

PITOT READING 98 psi TOTAL GPM 1128

STATIC B 142 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2006 gpm, or @ 0 psi RESIDUAL 2177 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

#141

LOCATION Zimovia Hwy DATE 10-24-00

TEST MADE BY Cory and Rob TIME 1:56 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 141 A1 140 A2 A3 A4

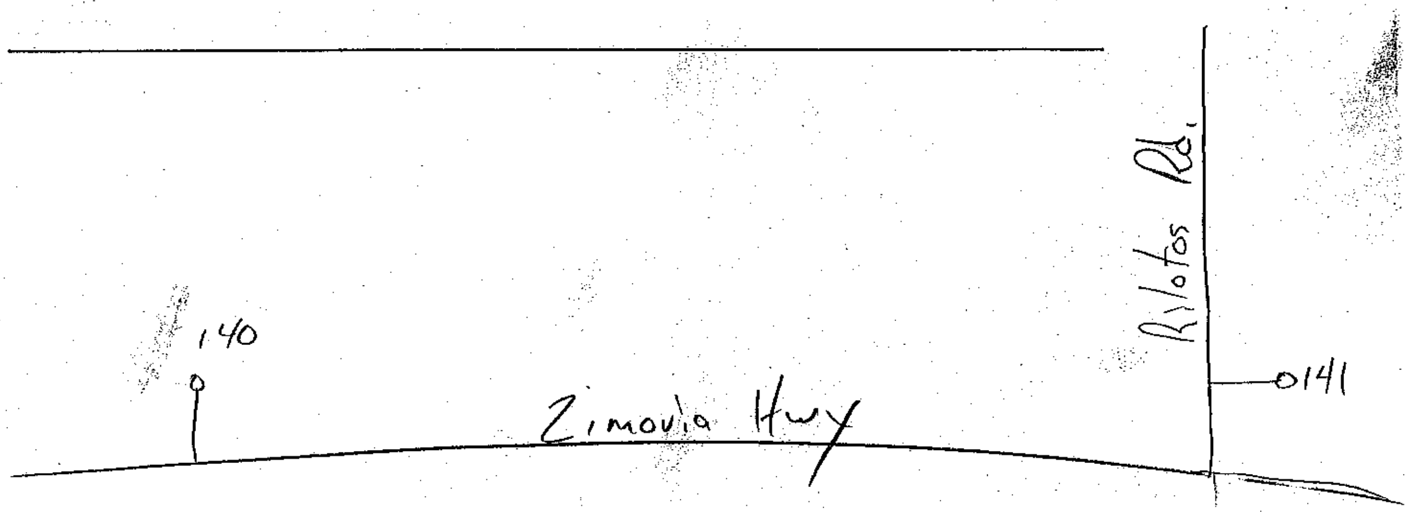
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 132 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2167 gpm, or @ 0 psi RESIDUAL 2368 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #142 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gary and Rob TIME 2:00 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 142 A1 141 A2 A3 A4

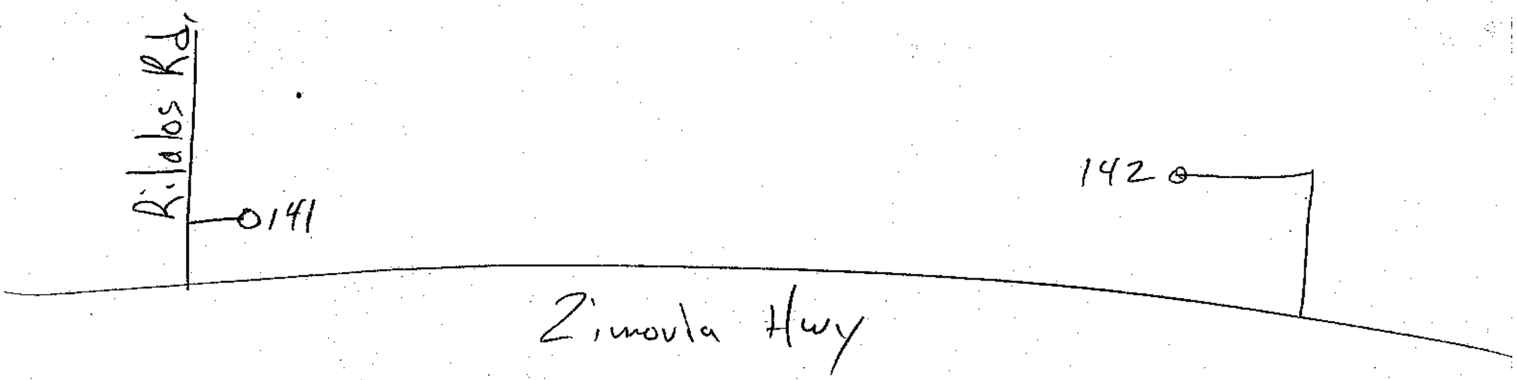
SIZE NOZZLE 2"

PITOT READING 90 psi TOTAL GPM 1128

STATIC B 134 psi RESIDUAL B 102 psi

PROJECTED RESULTS @ 20 psi 2239 gpm, or @ 0 psi RESIDUAL 2443 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #143 Zimovia Hwy DATE 10-24-00

TEST MADE BY Larry and Bob TIME 2:07 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 143 A1 142 A2 A3 A4

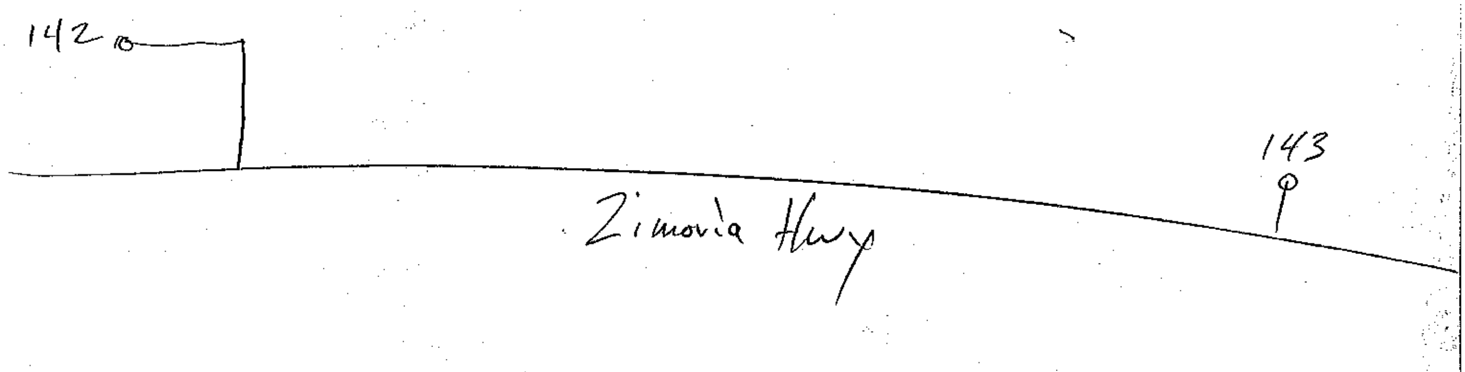
SIZE NOZZLE 2"

PITOT READING 88 psi TOTAL GPM 1115

STATIC B 134 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2144 gpm, or @ 0 psi RESIDUAL 2340 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #144 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gary and Rob TIME 2:16 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 144 A1 143 A2 A3 A4

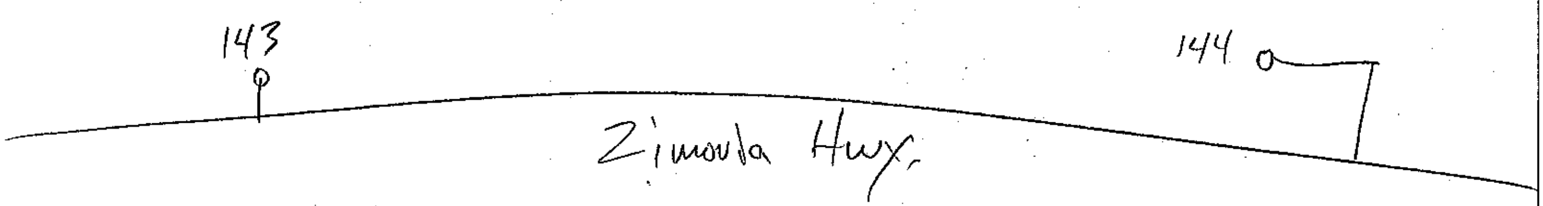
SIZE NOZZLE 2"

PITOT READING 90 psi TOTAL GPM 1128

STATIC B 136 psi RESIDUAL B 102 psi

PROJECTED RESULTS @ 20 psi 2190 gpm, or @ 0 psi RESIDUAL 2385 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #145 Zimovia Hwy. DATE 10-24-00

TEST MADE BY Gary and Rob TIME 2:22 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 145 A1 144 A2 A3 A4

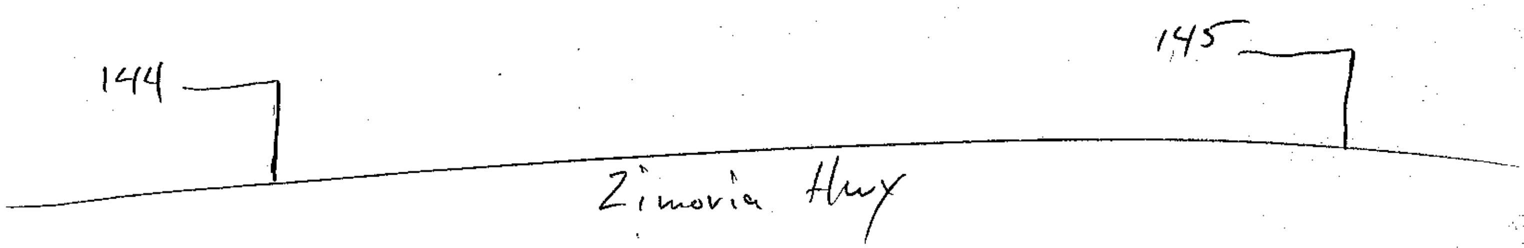
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 136 psi RESIDUAL B 102 psi

PROJECTED RESULTS @ 20 psi 2140 gpm, or @ 0 psi RESIDUAL 2330 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #146 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gony and Rob (Homo) TIME 2:31 .M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 146 A1 145 A2 A3 A4

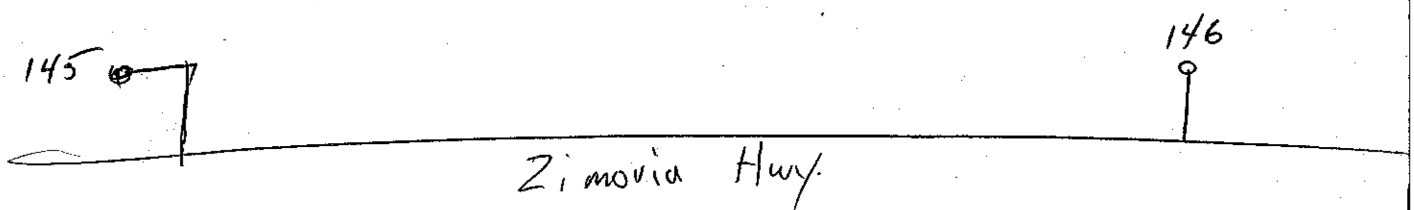
SIZE NOZZLE 2"

PITOT READING 84 psi TOTAL GPM 1089

STATIC B 134 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2094 gpm, or @ 0 psi RESIDUAL 2285 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #147 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gary and Rob Hand TIME 2:40 .M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 147 A1 146 A2 A3 A4

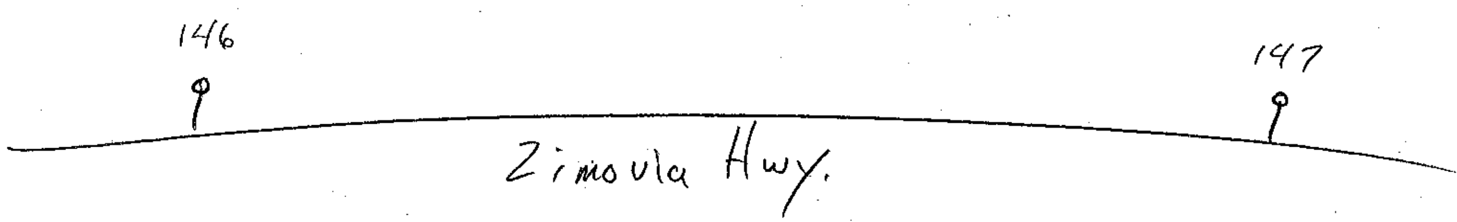
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 134 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2119 gpm, or @ 0 psi RESIDUAL 2312 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #148 Zimovia Hwy. DATE 10-24-00

TEST MADE BY Gary and Rob TIME 2:55 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 148 A1 147 A2 A3 A4

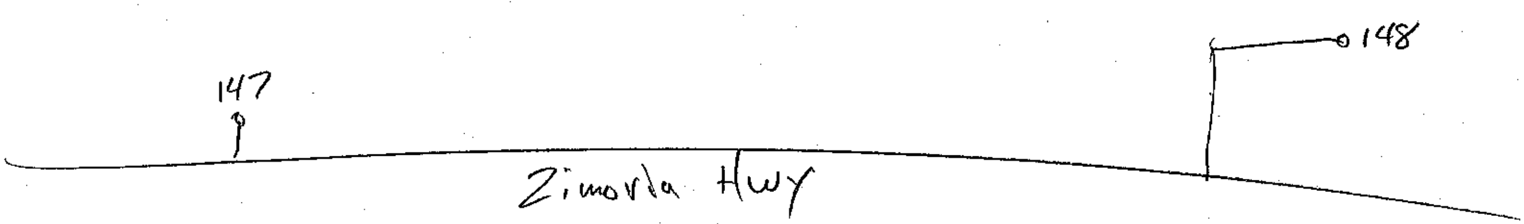
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 134 psi RESIDUAL B 100 psi

PROJECTED RESULTS @ 20 psi 2119 gpm, or @ 0 psi RESIDUAL 2312 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #149 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gary and Rob TIME 3:00 P M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 149 A1 148 A2 A3 A4

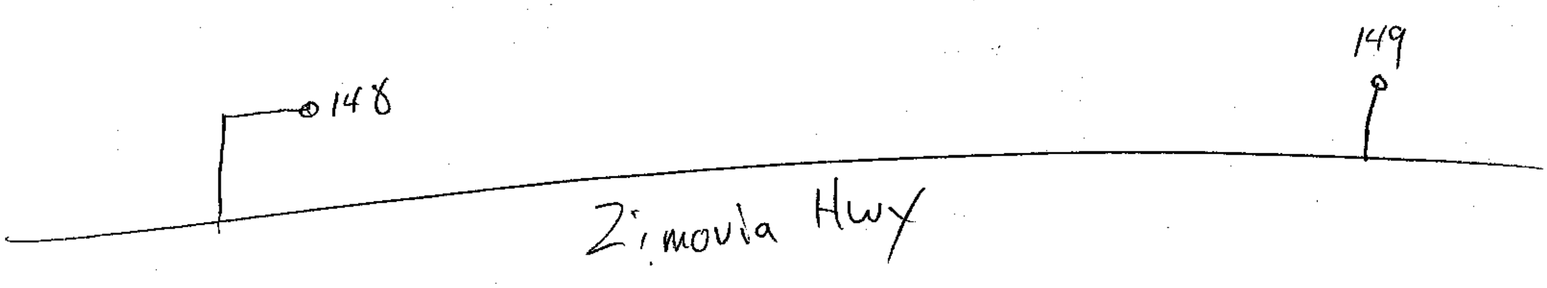
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 134 psi RESIDUAL B 98 psi

PROJECTED RESULTS @ 20 psi 2051 gpm, or @ 0 psi RESIDUAL 2239 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #150 Zimovia Hwy. DATE 10-24-00

TEST MADE BY Gory and Rob TIME 3:09 .M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 150 A1 149 A2 A3 A4

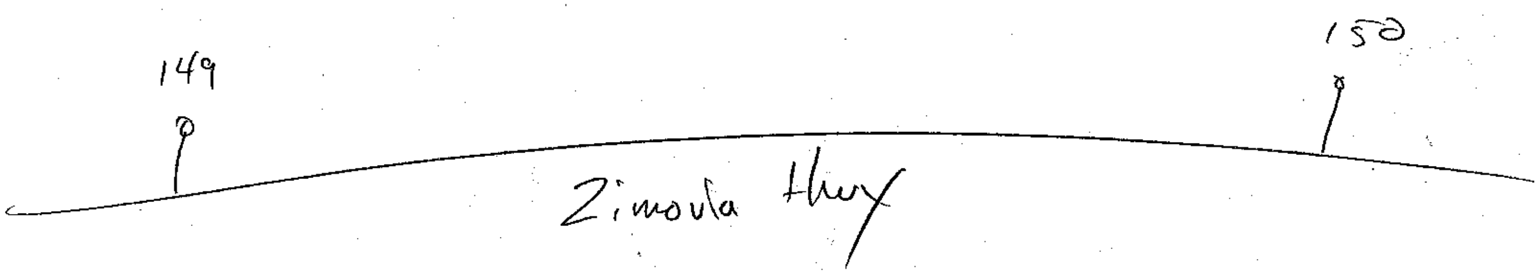
SIZE NOZZLE 2"

PITOT READING 86 psi TOTAL GPM 1102

STATIC B 134 psi RESIDUAL B 98 psi

PROJECTED RESULTS @ 20 psi 2051 gpm, or @ 0 psi RESIDUAL 2240 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #151 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gary and Rob TIME 3:30 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 151 A1 150 A2 A3 A4

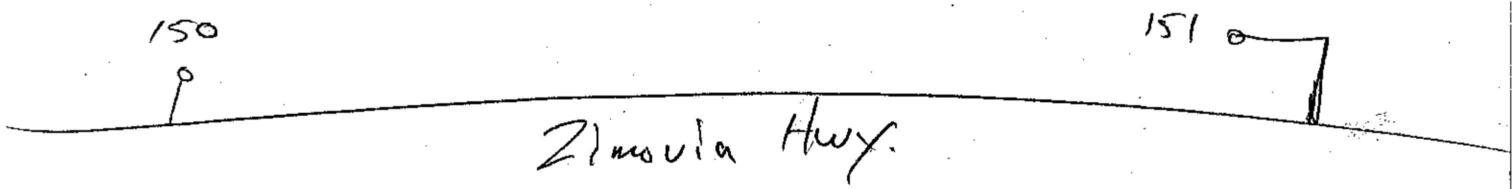
SIZE NOZZLE 2"

PITOT READING 84 psi TOTAL GPM 1089

STATIC B 132 psi RESIDUAL B 98 psi

PROJECTED RESULTS @ 20 psi 2074 gpm, or @ 0 psi RESIDUAL 2267 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #152 Zimovia Hwy DATE 10-24-00

TEST MADE BY Gary and Rob TIME 4:00 P .M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 152 A1 151 A2 ______ A3 ______ A4 ______

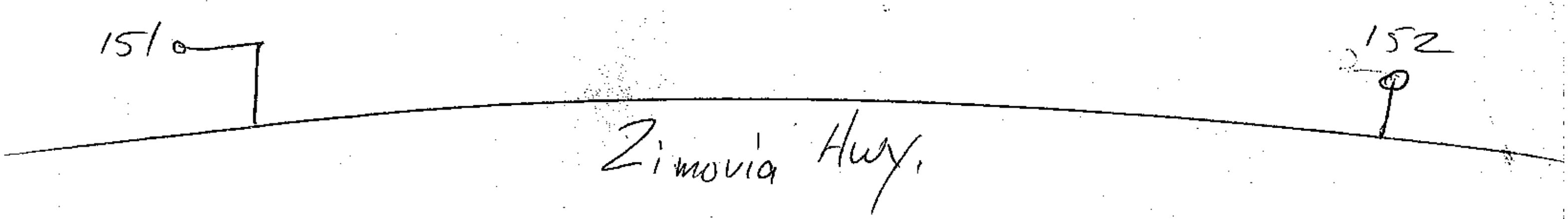
SIZE NOZZLE 2"

PITOT READING 82 psi TOTAL GPM 1076

STATIC B 134 psi RESIDUAL B 96 psi

PROJECTED RESULTS @ 20 psi 1947 gpm, or @ 0 psi RESIDUAL 2125 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #153 Zimovia Hwy DATE 10-27-00

TEST MADE BY Larry and Rob TIME 9:10 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 153 A1 152 A2 A3 A4

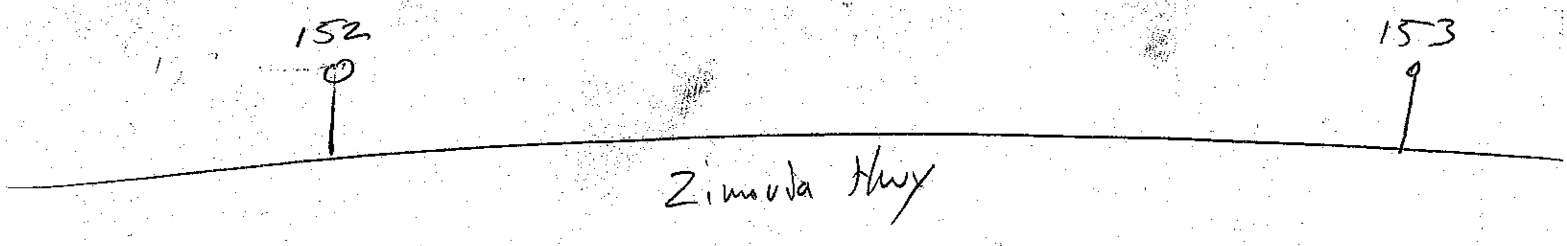
SIZE NOZZLE 2"

PITOT READING 84 psi TOTAL GPM 1089

STATIC B 130 psi RESIDUAL B 93 psi

PROJECTED RESULTS @ 20 psi 1961 gpm, or @ 0 psi RESIDUAL 2145 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #154 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 9:26 .M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 154 A1 153 A2 A3 A4

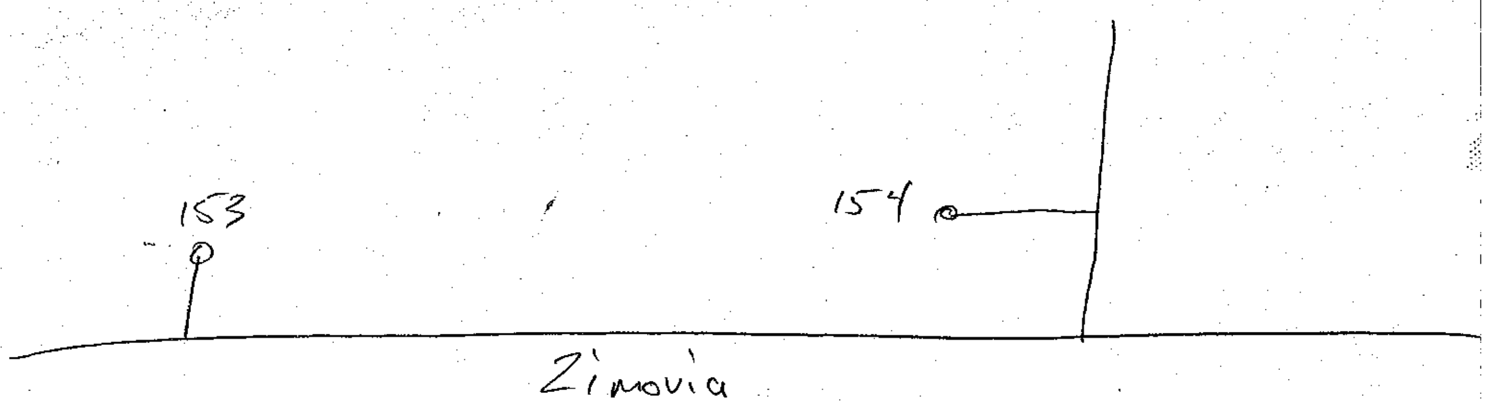
SIZE NOZZLE 2"

PITOT READING 80 psi TOTAL GPM 1063

STATIC B 131 psi RESIDUAL B 93 psi

PROJECTED RESULTS @ 20 psi 1896 gpm, or @ 0 psi RESIDUAL 2074 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #155 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 9:45 A.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 155 A1 154 A2 ______ A3 ______ A4 ______

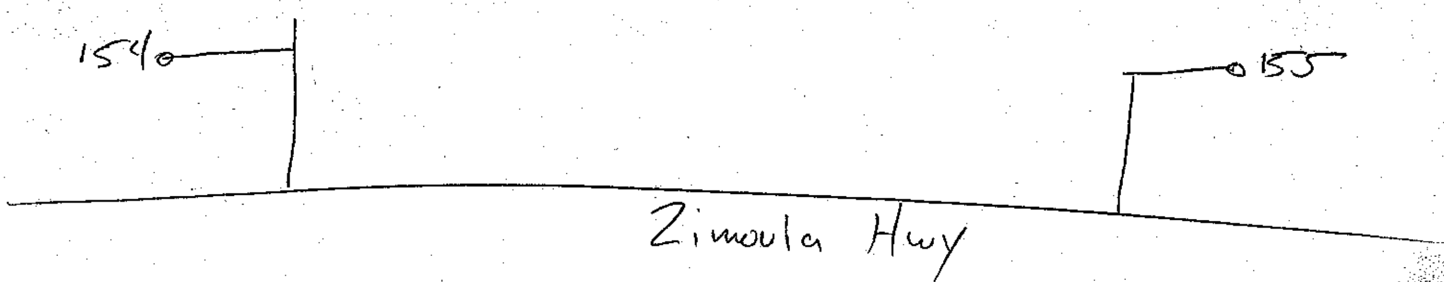
SIZE NOZZLE 2"

PITOT READING 80 psi TOTAL GPM 1063

STATIC B 130 psi RESIDUAL B 93 psi

PROJECTED RESULTS @ 20 psi 1914 gpm, or @ 0 psi RESIDUAL 2094 gpm

REMARKS DID NOT SHUT OFF



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #156 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 10:00 A.M.

REPRESENTATIVE OF Public Works

WITNESS ____________________

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ____________________

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ____________________

FLOW HYDRANTS 156 A1 155 A2 ______ A3 ______ A4 ______

SIZE NOZZLE 2"

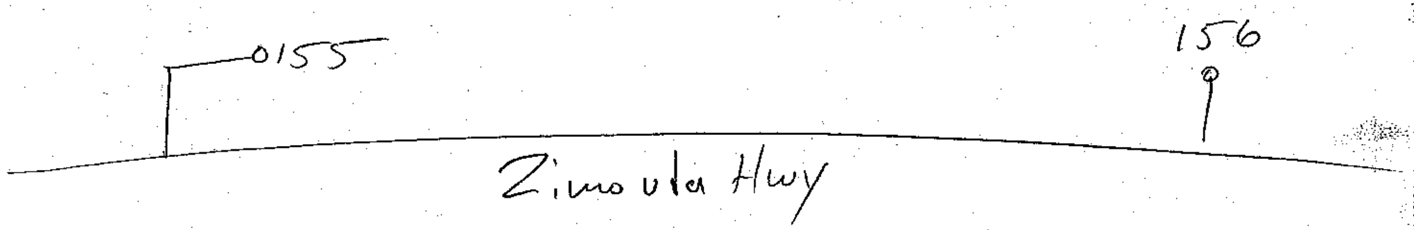
PITOT READING 74 psi TOTAL GPM 1023

STATIC B 125 psi RESIDUAL B 86 psi

PROJECTED RESULTS @ 20 psi 1746 gpm, or @ 0 psi RESIDUAL 1919 gpm

REMARKS Needs raised

155 Did not shut off



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #157 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gony and Rob TIME 10:06 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 157 A1 156 A2 A3 A4

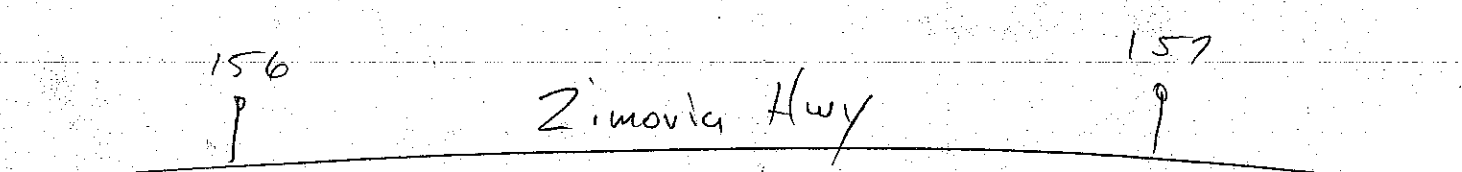
SIZE NOZZLE 2"

PITOT READING 78 TOTAL GPM 1050

STATIC B 128 psi RESIDUAL B 86 psi

PROJECTED RESULTS @ 20 psi 1747 gpm, or @ 0 psi RESIDUAL 1916 gpm

REMARKS Does not shut off!



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION # 158 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 10:31 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 158 A1 157 A2 A3 A4

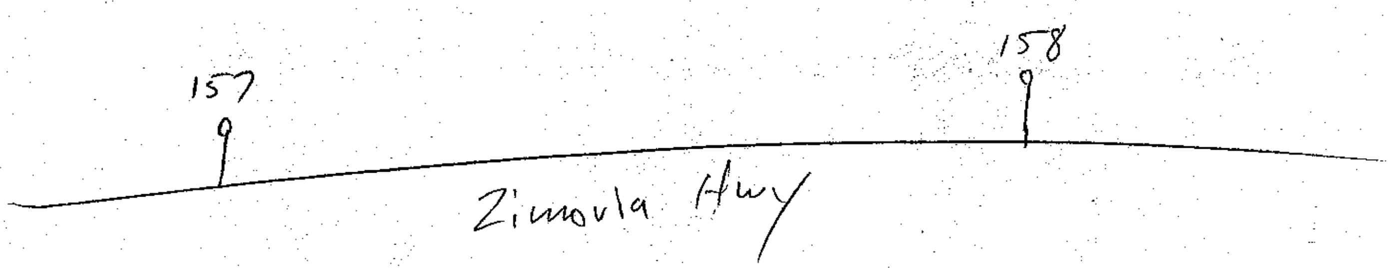
SIZE NOZZLE 2"

PITOT READING 70 TOTAL GPM 994

STATIC B 122 psi RESIDUAL B 86 psi

PROJECTED RESULTS @ 20 psi 1743 gpm, or @ 0 psi RESIDUAL 1921 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #159 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 10:40 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 159 A1 158 A2 A3 A4

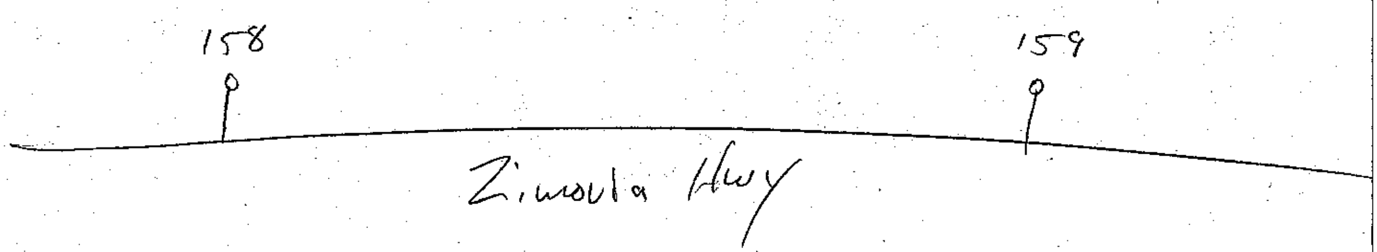
SIZE NOZZLE 2"

PITOT READING 68 TOTAL GPM 980

STATIC B 125 psi RESIDUAL B 80 psi

PROJECTED RESULTS @ 20 psi 1548 gpm, or @ 0 psi RESIDUAL 1702 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Bay DATE 10-27-00

TEST MADE BY Gory and Rob TIME 2:43 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS South Dock A1 North Dock A2 A3 A4

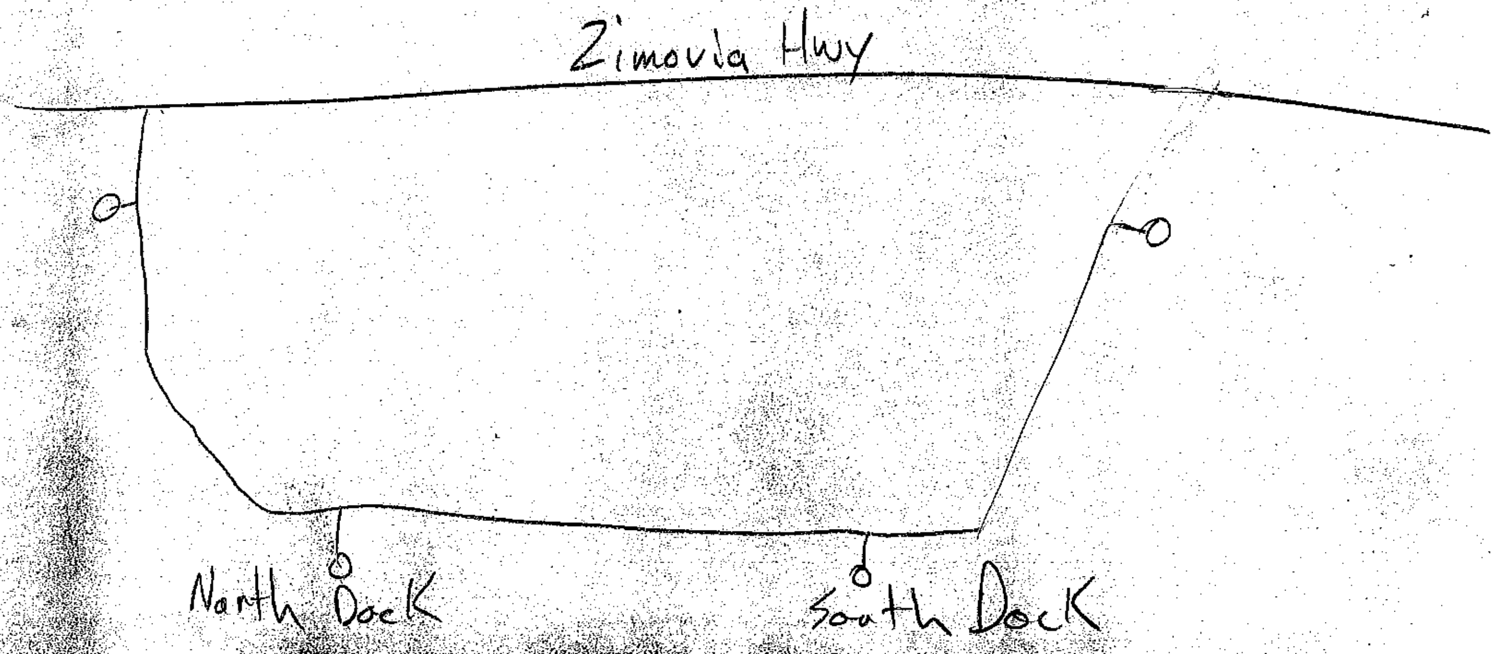
SIZE NOZZLE 2"

PITOT READING 60 TOTAL GPM 920

STATIC B 132 psi RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 1312 gpm, or @ 0 psi RESIDUAL 1434 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Bay DATE 10-27-00

TEST MADE BY Gary and Bob TIME 3:00 P.M.

REPRESENTATIVE OF Public Works

WITNESS ______

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS South Shoemaker A1 South Dock A2 ______ A3 ______ A4 ______

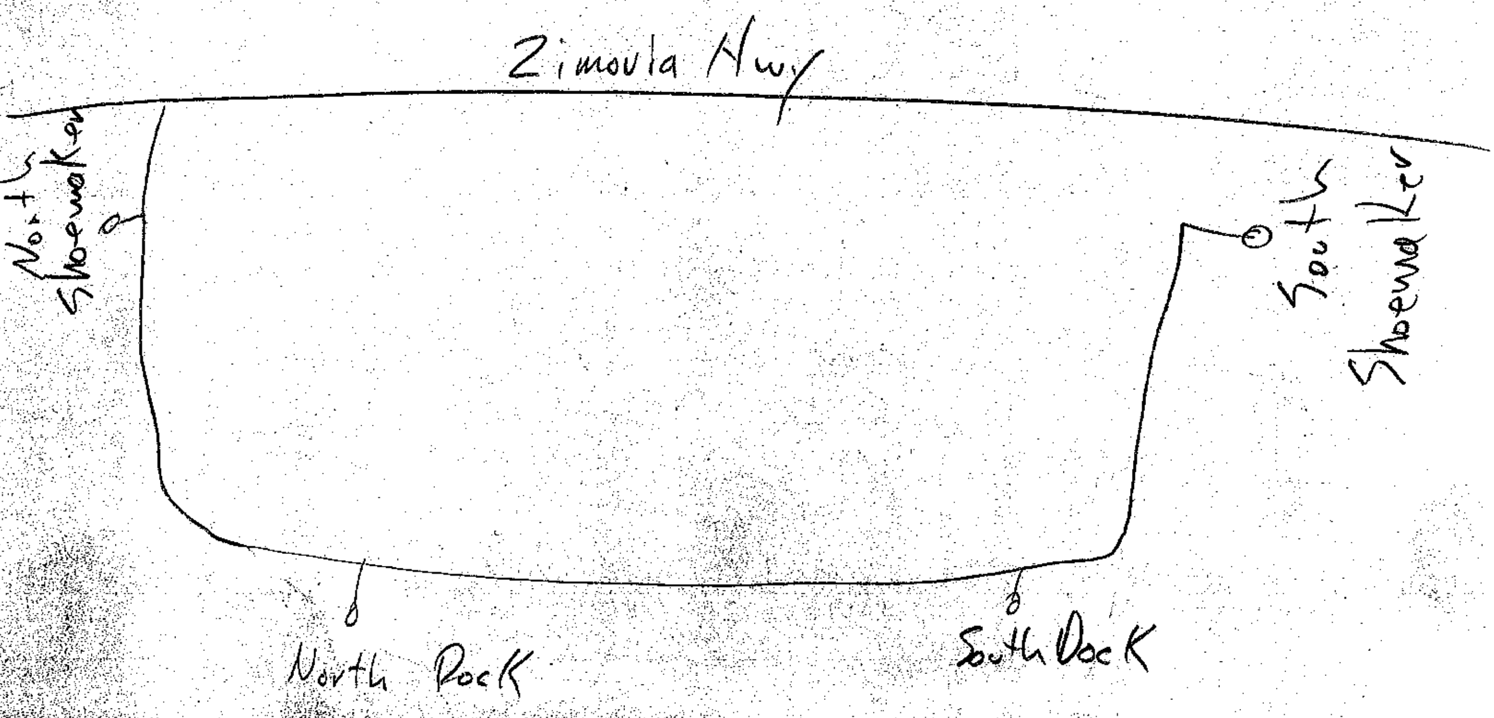
SIZE NOZZLE 2"

PITOT READING 56 TOTAL GPM 889

STATIC B 134 psi ______ RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 1257 gpm, or @ 0 psi RESIDUAL 1372 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY AND BOROUGH OF WRANGELL

LOCATION: Shoemaker Bay Harbor **DATE:** 9-15-15

TESTED BY: G. Pullman and Stan Campbell **TIME:** ______ .M.

REPRESENTATIVE OF: City of Wrangell

WITNESS: ______

PURPOSE OF TEST: Pressure and flow tests for SMB Harbor Construction PND Engineering

CONSUMPTION RATE DURING TEST: ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING: ______

FLOW HYDRANTS: Z240 **A1** Z239 **A2** ______ **A3** ______ **A4** ______

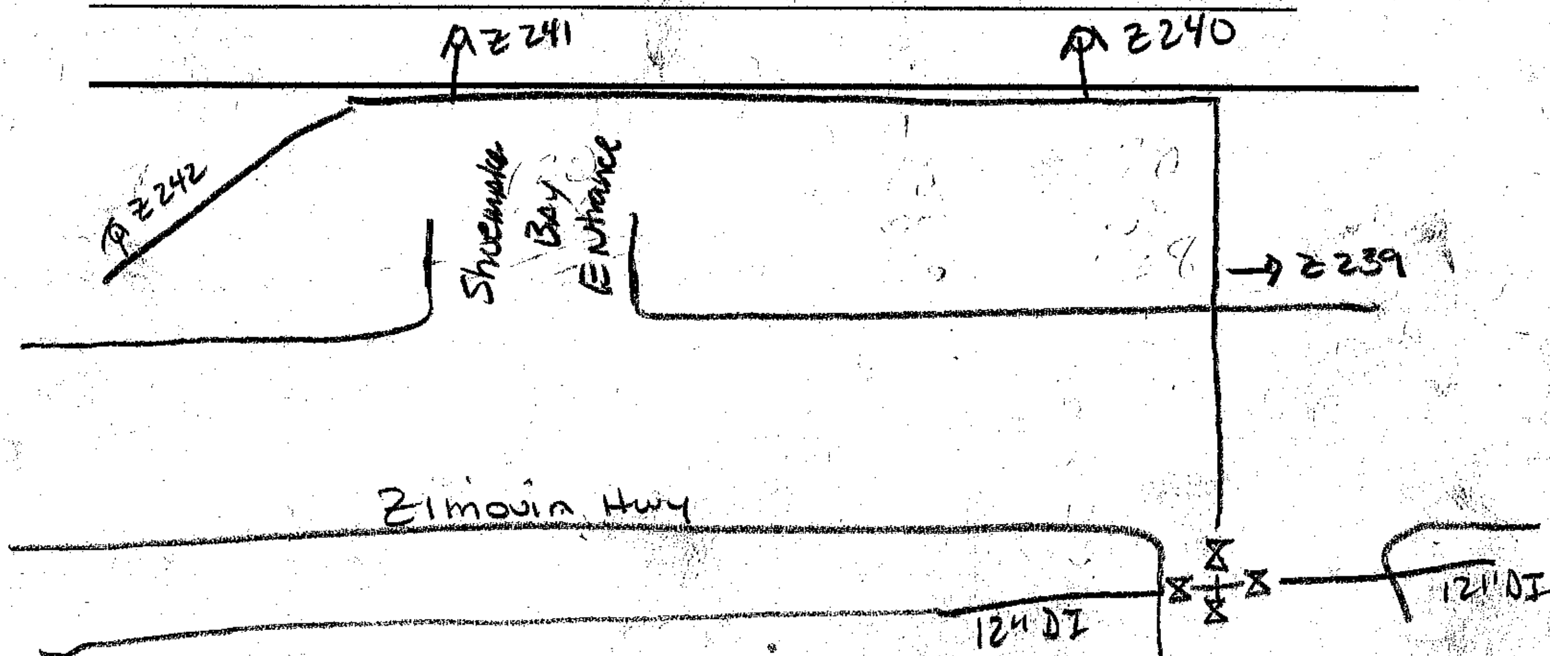
SIZE NOZZLE 2½" Hydrant Port

PITOT READING NA **PSI** **TOTAL GPM** 1116 / 1220

STATIC B Z239 120 **PSI** ______ **RESIDUAL B** 78 **PSI**

PRJECTED RESULTS @ 20 PSI 1862 **GPM, OR @** 0 **PSI RESIDUAL** 2056 **GPM**

REMARKS: Map on Reverse



HYDRANT FLOW TEST REPORT
CITY AND BOROUGH OF WRANGELL

LOCATION: Shoemaker Bay Harbor DATE: 9-15-15

TESTED BY: G. Pollman TIME: ______ .M.

REPRESENTATIVE OF: City of Wrangell

WITNESS: ______

PURPOSE OF TEST: Pressure and flow test for SMB Harbor Construction PND Engineering

CONSUMPTION RATE DURING TEST: ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING: ______

FLOW HYDRANTS: Z242 A1 Z239 A2 ______ A3 ______ A4 ______

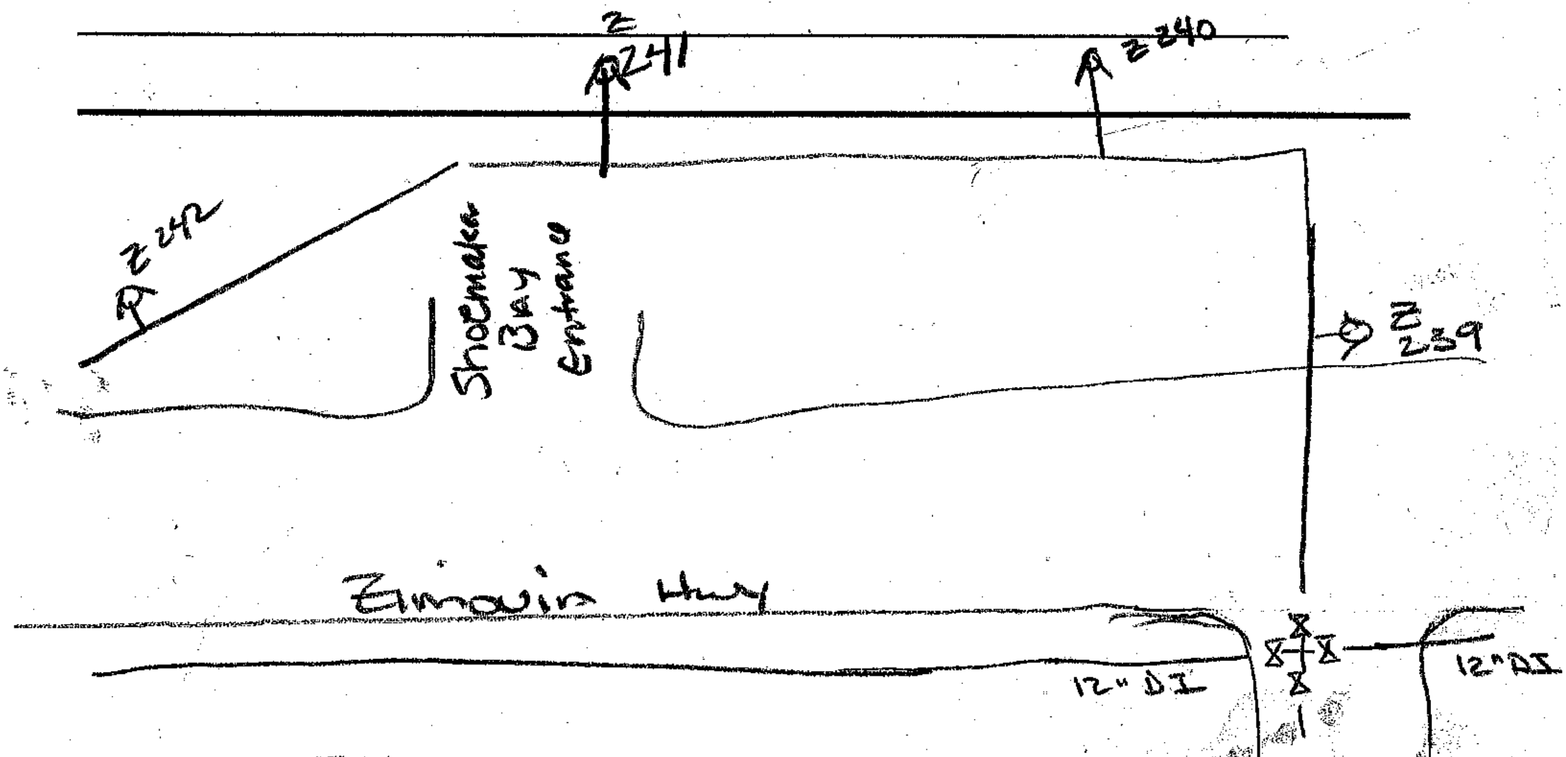
SIZE NOZZLE 2½" Hydrant Port

PITOT READING NA PSI TOTAL GPM 1115

STATIC B 120 PSI ______ RESIDUAL B 80 PSI

PRIJECTED RESULTS @ 20 PSI 1828 GPM, OR @ 0 PSI RESIDUAL 2018 GPM

REMARKS: ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #165 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 3:10 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 165 A1 164 A2 A3 A4

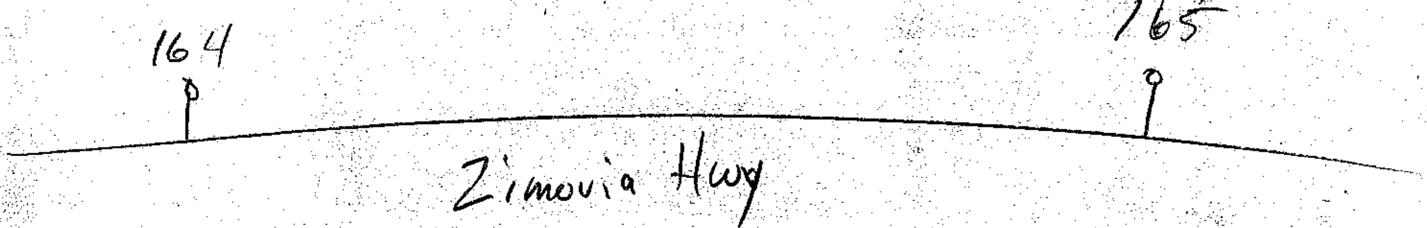
SIZE NOZZLE 2"

PITOT READING 62 TOTAL GPM 936

STATIC B 136 psi RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 1313 gpm, or @ 0 psi RESIDUAL 1430 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #166 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 3:18 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS ______

STATE PURPOSE OF TEST FLOW

CONSUMPTION RATE DURING TEST ______

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING ______

FLOW HYDRANTS 166 A1 165 A2 ______ A3 ______ A4 ______

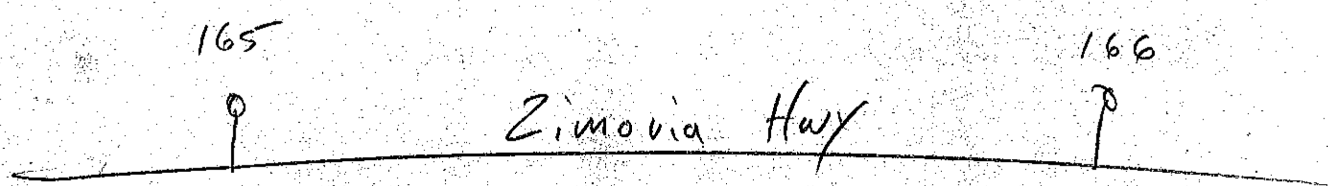
SIZE NOZZLE 2

PITOT READING 60 TOTAL GPM 920

STATIC B 132 psi ______ RESIDUAL B 74 psi

PROJECTED RESULTS @ 20 psi 1312 gpm, or @ 0 psi RESIDUAL 1434 gpm

REMARKS ______



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #167 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 3:27 P.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST FLOW

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 167 A1 166 A2 A3 A4

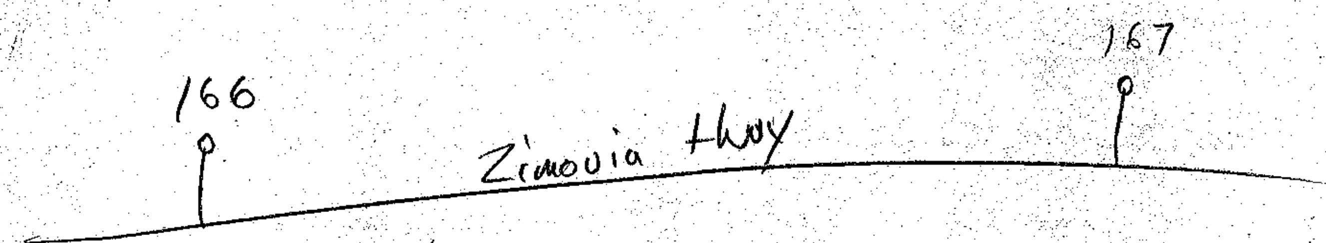
SIZE NOZZLE 2"

PITOT READING 62 TOTAL GPM 936

STATIC B 132 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 1288 gpm, or @ 0 psi RESIDUAL 1408 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #168 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 3:40 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 168 A1 167 A2 A3 A4

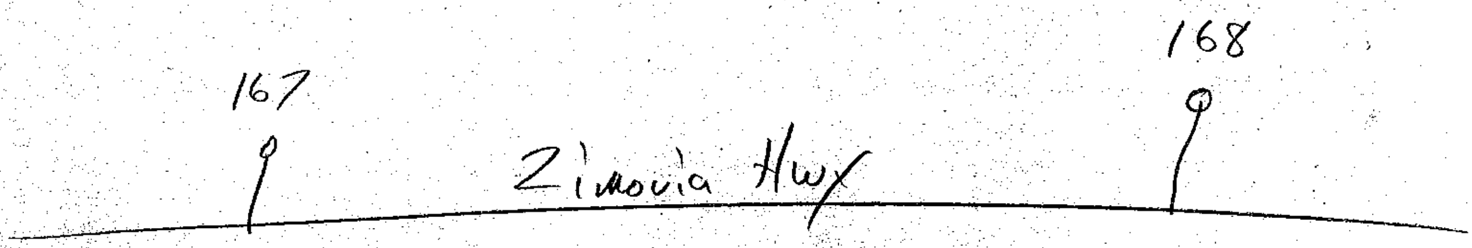
SIZE NOZZLE

PITOT READING 64 TOTAL GPM 957

STATIC B 130 psi RESIDUAL B 72 psi

PROJECTED RESULTS @ 20 psi 1344 gpm, or @ 0 psi RESIDUAL 1470 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #169 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 4:00 P.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 169 A1 170 A2 A3 A4

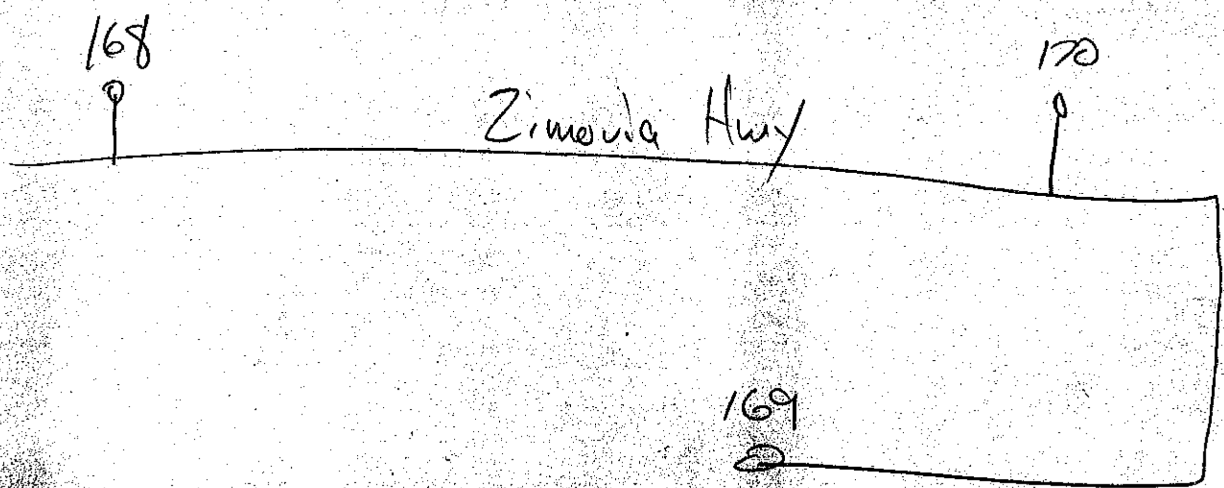
SIZE NOZZLE

PITOT READING 58 TOTAL GPM 905

STATIC B 132 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 1245 gpm, or @ 0 psi RESIDUAL 1360 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION #170 Zimovia Hwy DATE 10-27-00

TEST MADE BY Gary and Rob TIME 3:50 P.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 170 A1 168 A2 A3 A4

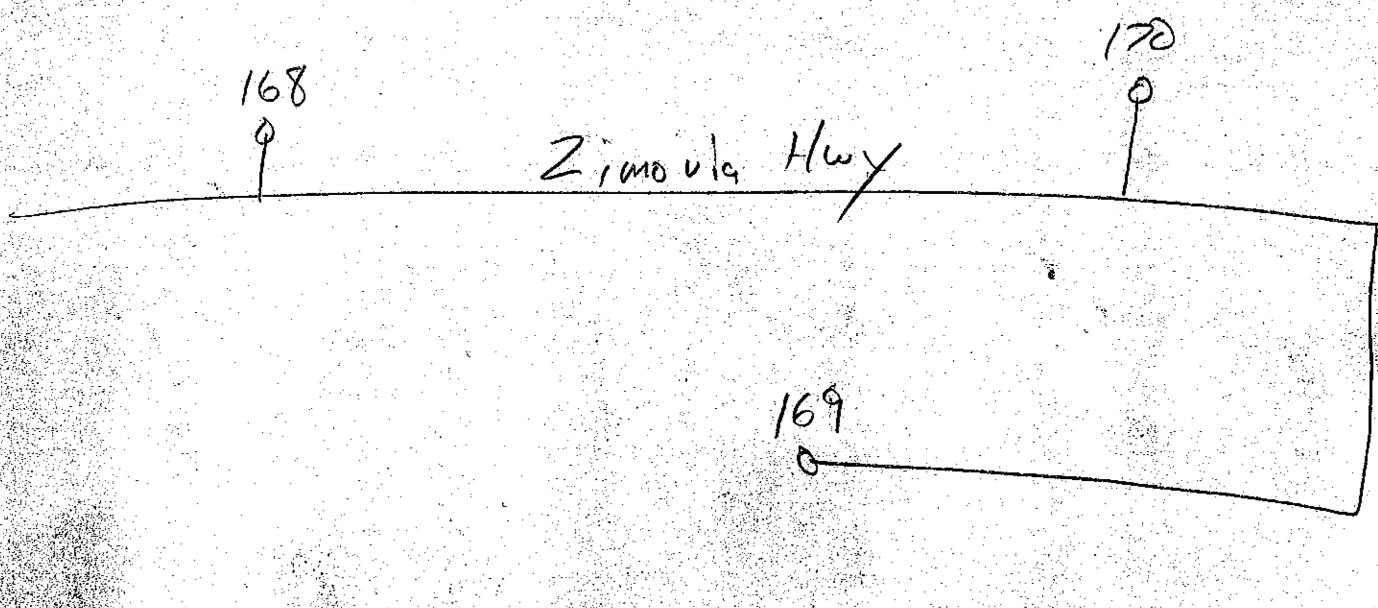
SIZE NOZZLE 2"

PITOT READING 64 TOTAL GPM 951

STATIC B 132 psi RESIDUAL B 76 psi

PROJECTED RESULTS @ 20 psi 1384 gpm, or @ 0 psi RESIDUAL 1511 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #201 DATE 11-3-00

TEST MADE BY Gary and Carl TIME 1:26 A.M.

REPRESENTATIVE OF PUBLIC Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 201 A1 170 A2 A3 A4

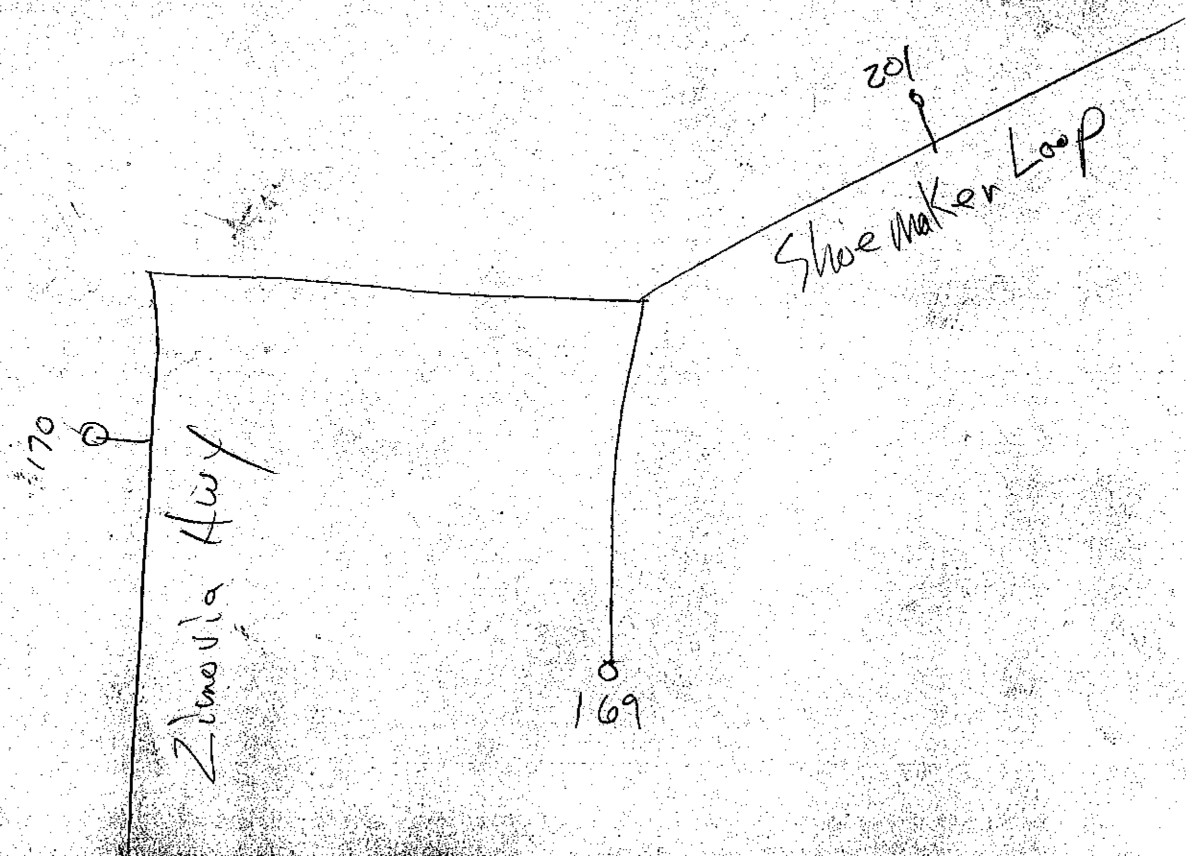
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 126 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 1188 gpm, or @ 0 psi RESIDUAL 1304 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #202 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 8:56 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 202 A1 201 A2 A3 A4

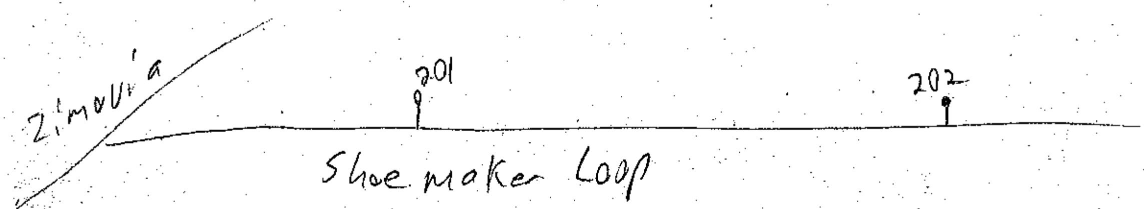
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 126 psi RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi 1166 gpm, or @ 0 psi RESIDUAL 1280 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop Road #203 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 9:05 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 203 A1 202 A2 A3 A4

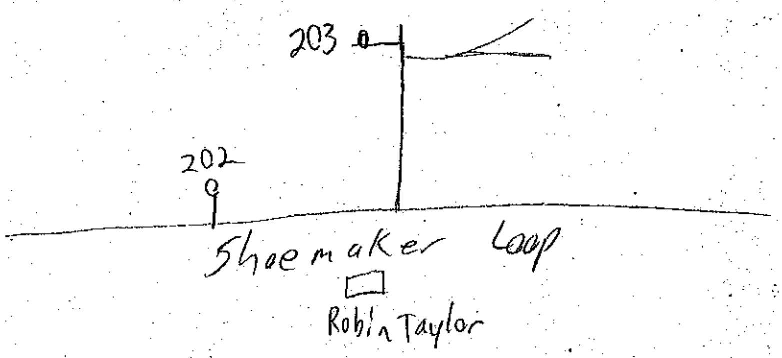
SIZE NOZZLE 2"

PITOT READING 50 TOTAL GPM 841

STATIC B 126 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 1165 gpm, or @ 0 psi RESIDUAL 1278 gpm

REMARKS Hydrant has no riser and lid on the valve.



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #204 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 9:15 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 204 A1 202 A2 A3 A4

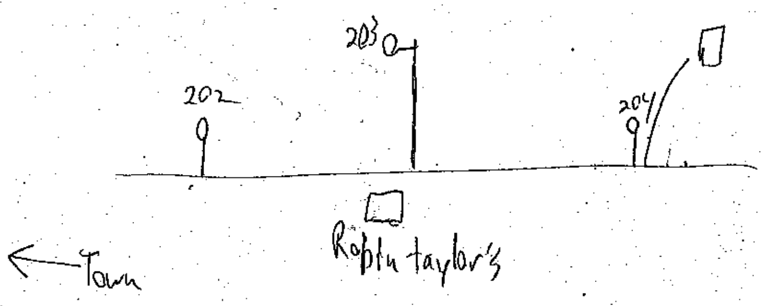
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 126 psi RESIDUAL B 66 psi

PROJECTED RESULTS @ 20 psi 1188 gpm, or @ 0 psi RESIDUAL 1304 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #205 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 9:26 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 205 A1 204 A2 A3 A4

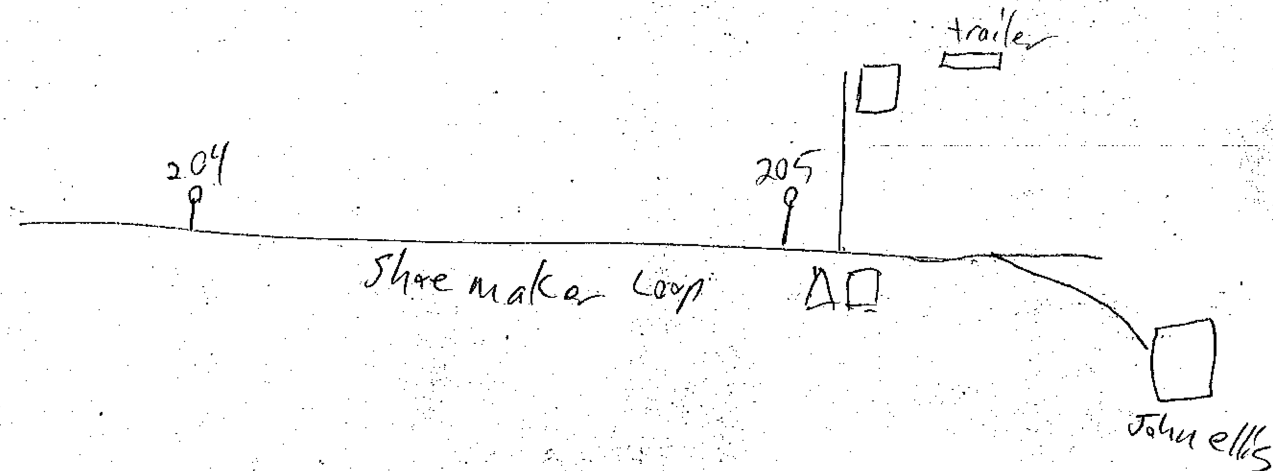
SIZE NOZZLE

PITOT READING 54 TOTAL GPM 873

STATIC B 130 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 1132 gpm, or @ 0 psi RESIDUAL 1239 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Nemeyer Road #206 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 9:35 A.M.

REPRESENTATIVE OF Public Works

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 206 A1 205 A2 A3 A4

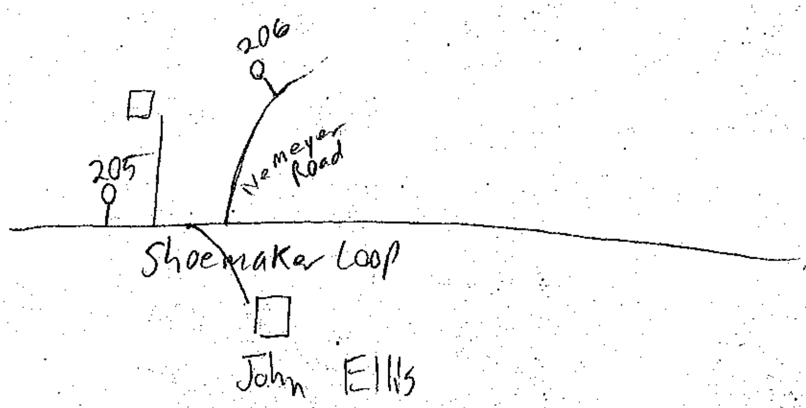
SIZE NOZZLE 2"

PITOT READING 50 TOTAL GPM 841

STATIC B 130 psi RESIDUAL B 70 psi

PROJECTED RESULTS @ 20 psi 1167 gpm, or @ 0 psi RESIDUAL 1277 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #207 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 9:50 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 207 A1 205 A2 A3 A4

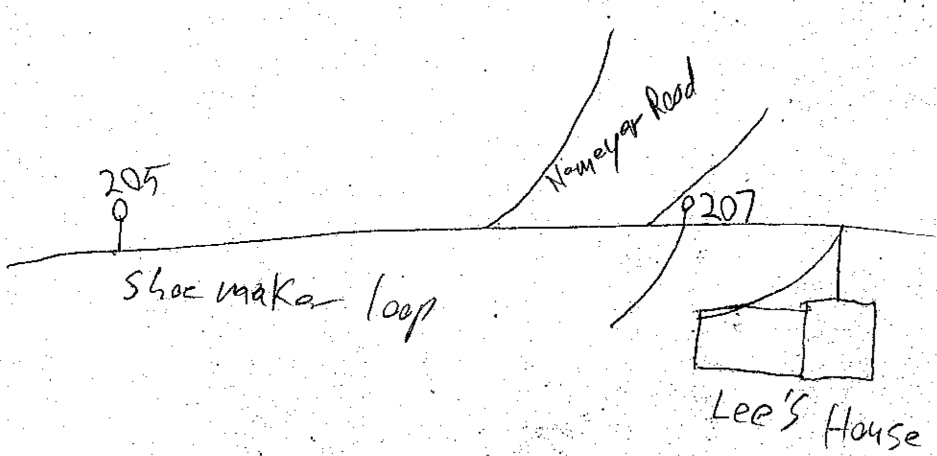
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 130 psi RESIDUAL B 64 psi

PROJECTED RESULTS @ 20 psi 1150 gpm, or @ 0 psi RESIDUAL 1258 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #208 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 9:59 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 208 A1 207 A2 A3 A4

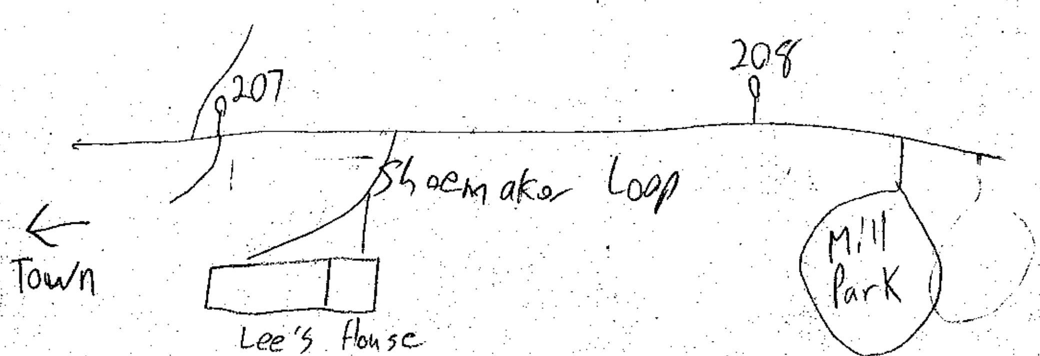
SIZE NOZZLE 2"

PITOT READING 54 TOTAL GPM 873

STATIC B 132 psi RESIDUAL B 62 psi

PROJECTED RESULTS @ 20 psi 1125 gpm, or @ 0 psi RESIDUAL 1229 gpm

REMARKS



HYDRANT FLOW TEST REPORT
CITY OF WRANGELL

LOCATION Shoemaker Loop #209 DATE 11-3-00

TEST MADE BY Carl and Gary TIME 10:11 A.M.

REPRESENTATIVE OF PUBLIC WORKS

WITNESS

STATE PURPOSE OF TEST Flow

CONSUMPTION RATE DURING TEST

IF PUMPS AFFECT TEST, INDICATE PUMPS OPERATING

FLOW HYDRANTS 209 A1 208 A2 A3 A4

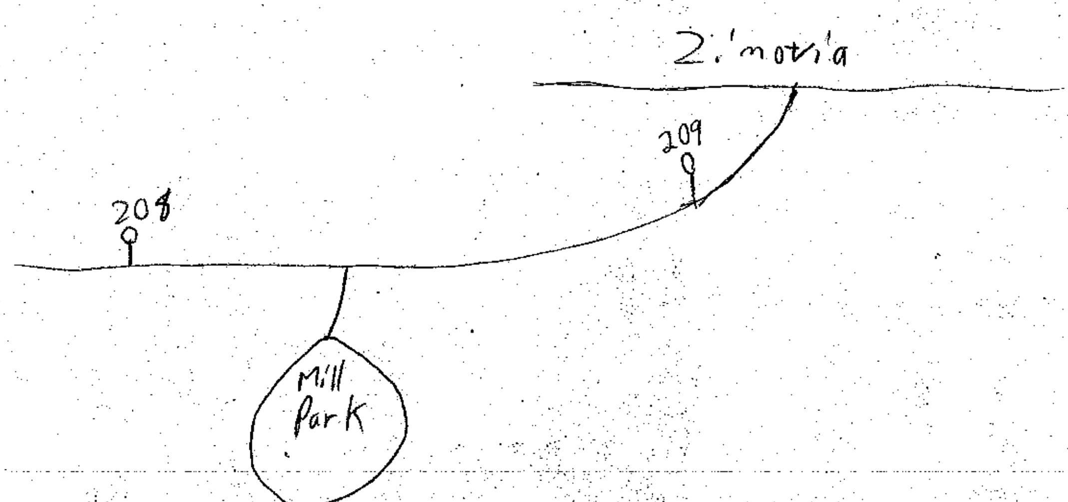
SIZE NOZZLE 2

PITOT READING 48 TOTAL GPM 824

STATIC B 130 psi RESIDUAL B 68 psi

PROJECTED RESULTS @ 20 psi 1123 gpm, or @ 0 psi RESIDUAL 1228 gpm

REMARKS



WRANGELL WATER DISTRIBUTION SYSTEM

Wrangell, Alaska 2012

Influent						
Month	Date	Daily Flow (GPD x 1K)	pH	Temp (C°)	Color (Pt-Co)	Turb (NTU)
April	April -1	646				
	April -2	647	6.6	4.6	33	0.31
	April -3	704	6.2	4.7	30	1.67
	April -4	665	6.3	4.5	33	0.39
	April -5	765	5.5	5.3	31	1.52
	April -6	777	6.2	4.0	30	1.68
	April -7	650				
	April -8	651				
	April -9	651	6.3	5.2	37	1.48
	April -10	926	6.0	6.1	33	1.07
	April -11	788	6.5	5.0	31	1.52
	April -12	716	6.8	5.9	33	1
	April -13	578	6.5	5.7	30	1.1
	April -14	609				
	April -15	609				
	April -16	609	6.5	5.5	37	1.09
	April -17	700	6.4	6.1	33	1.33
	April -18	620	6.4	5.0	34	0.91
	April -19	699	6.5	5.4	32	1.39
	April -20	699	6.5	5.9	32	1.22
	April -21	533				
	April -22	535				
	April -23	533	6.5	6.2	33	0.96
	April -24	753	6.7	5.3	30	1.02
	April -25	536	6.7	5.3	31	1.3
	April -26	802	6.5	6.1	32	1.57
	April -27	549	6.3	6.4	31	1.24
	April -28	543				
	April -29	543				
	April -30	543	6.5	5.9	30	1.18
May	May -1	613	5.6	6.5	42	1.19
	May -2	730	6.5	8.1	33	3.13
	May -3	720	6.5	5.7	30	1.53
	May -4	633	6.4	6.3	34	1.37
	May -5	682				
	May -6	617				
	May -7	617	6.4	6.8	39	1.18
	May -8	713	6.4	6.7	37	1.37
	May -9	655	6.4	7.7	40	1.09
	May -10	574	6.5	6.5	38	1.13
	May -11	419	6.4	7.3	39	2.76
	May -12	634				
	May -13	634				
	May -14	635	6.8	6.6	37	1.45
	May -15	706	6.4	7.0	39	2.06
	May -16	615	6.6	7.2	42	0.81
	May -17	662	6.2	8.5	39	0.98
	May -18	717	6.5	7.3	38	3.41
	May -19		6.4	7.9	40	0.87
	May -20	590	6.4	7.6	36	0.86
	May -21	721	6.3	7.2	39	1.11
	May -22	636	6.3	7.2	45	0.86
	May -23	592	6.4	8.7	37	1.7
	May -24	567				
	May -25					
	May -26	567				
	May -27	568				
	May -28	568				
	May -29	567	6.0	8.2	38	0.63
	May -30	629	6.2	7.9	37	1.56
	May -31	635	6.7	8.3	38	0.91

June	June -1	479	6.7	7.9	32	1.62
	June -2	716				
	June -3	716				
	June -4	715	6.2	7.9	32	0.97
	June -5	723	5.9	9.5	34	0.99
	June -6	638	5.9	9.5	34	1.11
	June -7	548	6.4	9.0	34	1.12
	June -8	536	6.0	10.2	41	2.93
	June -9	556				
	June -10	556				
	June -11	737	6.6	11.0	38	0.86
	June -12	574	6.7	9.4	28	1.32
	June -13	740	5.9	9.1	35	0.96
	June -14	604	6.7	9.6	33	1.01
	June -15	628	6.4	9.7	26	0.88
	June -16	741				
	June -17	741				
	June -18	742	6.3	10.2	32	0.95
	June -19	346	6.3	10.1	31	2.73
	June -20	1020	6.5	9.9	31	0.98
	June -21	722	6.5	10.5	39	0.82
	June -22	760	6.4	9.8	44	1.13
	June -23	889				
	June -24	888				
	June -25	889	6.5	11.4	38	0.89
	June -26	940	6.2	10.9	30	1.03
	June -27	792	6.3	11.1	32	0.85
	June -28	844				
	June -29					
	June -30					
July	July -1	814	5.5	11.2	33	0.91
	July -2	814	5.5	11.1	32	0.89
	July -3	882				
	July -4	911	6.1	11.5	30	0.94
	July -5	910	6.0	11.7	32	0.97
	July -6	927				
	July -7					
	July -8		6.5	12.0	34	0.94
	July -9	829	6.5	12.0	31	1.29
	July -10	1089	6.2	11.8	33	1.03
	July -11	999	6.4	12.3	38	1.06
	July -12	908	6.3	12.9	42	1.12
	July -13	952				
	July -14					
	July -15	829	6.4	13.3	43	1.53
	July -16		6.5	13.0	39	1.73
	July -17	937	6.3	13.3	38	1.88
	July -18	1374	6.5	13.3	36	1.51
	July -19	746	6.4	13.6	37	1.41
	July -20	1017				
	July -21	1015				
	July -22	1015	6.4	13.2	38	1.59
	July -23	1016	6.3	13.4	40	1.39
	July -24	944	6.4	12.6	37	1.29
	July -25	1183	6.2	13.4	36	1.37
	July -26	1218	6.4	13.7	39	1.41
	July -27	1080				
	July -28	1040				
	July -29	1040	6.3	13.3	35	1.67
	July -30	1040	6.5	13.5	35	1.28
	July -31	742				

August	Aug. -1		6.6	13.7	40	1.88
	Aug. -2		6.6	14.4	40	1.67
	Aug. -3	947	6.4	13.8	42	1.52
	Aug. -4	842				
	Aug. -5	842				
	Aug. -6	842	6.1	13.8	46	2.55
	Aug. -7	762	6.3	12.6	30	1.57
	Aug. -8	811	6.3	14.3	46	2.01
	Aug. -9	982	6.3	13.9	43	1.87
	Aug. -10	881	6.4	13.2	41	1.84
	Aug. -11	851				
	Aug. -12	852				
	Aug. -13	532	6.3	12.9	45	1.72
	Aug. -14	1036	6.3	12.4	46	1.64
	Aug. -15	1028	6.5	12.8	3	0.98
	Aug. -16	970	6.3	12.7	48	1.57
	Aug. -17	1036	6.7	12.6	49	1.48
	Aug. -18	804				
	Aug. -19	805				
	Aug. -20	805	6.4	12.8	48	2.04
	Aug. -21	830	6.5	12.7	52	2.23
	Aug. -22	648	6.4	13.8	57	2.12
	Aug. -23	759	6.3	12.9	50	2.59
	Aug. -24	779				
	Aug. -25	541				
	Aug. -26	542				
	Aug. -27	542	6.4	12.6	53	3.01
	Aug. -28	752	6.3	13.0	53	2.5
	Aug. -29		6.4	12.3	52	2.65
	Aug. -30		6.2	12.5	54	2.93
	Aug. -31	781	6.5	12.1	51	2.47
September	Sep. -1	799				
	Sep. -2	800				
	Sep. -3	581				
	Sep. -4	580	6.4	12.8	55	2.87
	Sep. -5	749	6.5	12.5	59	2.92
	Sep. -6	830	6.4	13.7	64	3.4
	Sep. -7	680	6.5	12.1	59	2.15
	Sep. -8	627				
	Sep. -9	627				
	Sep. -10	627	6.5	11.6	66	1.93
	Sep. -11	656	6.7	12.3	74	2.95
	Sep. -12	694	6.2	12.3	74	2.91
	Sep. -13	684			68	3.29
	Sep. -14		6.6	10.7	75	2.99
	Sep. -15	952				
	Sep. -16	953				
	Sep. -17	574	6.5	10.5	64	2.34
	Sep. -18	690	6.4	10.6	68	1.95
	Sep. -19	535	6.4	10.9	67	2.32
	Sep. -20	581	6.1	10.9	70	1.72
	Sep. -21	545	6.1	10.8	67	1.59
	Sep. -22	556				
	Sep. -23	567				
	Sep. -24	547	6.3	10.3	64	1.86
	Sep. -25	795	6.3	10.7	66	1.93
	Sep. -26	478	6.1	11.2	58	1.96
	Sep. -27	564	6.1	11.5	68	1.66
	Sep. -28	486	6.4	10.5	65	2.19
	Sep. -29	541				
	Sep. -30	514				

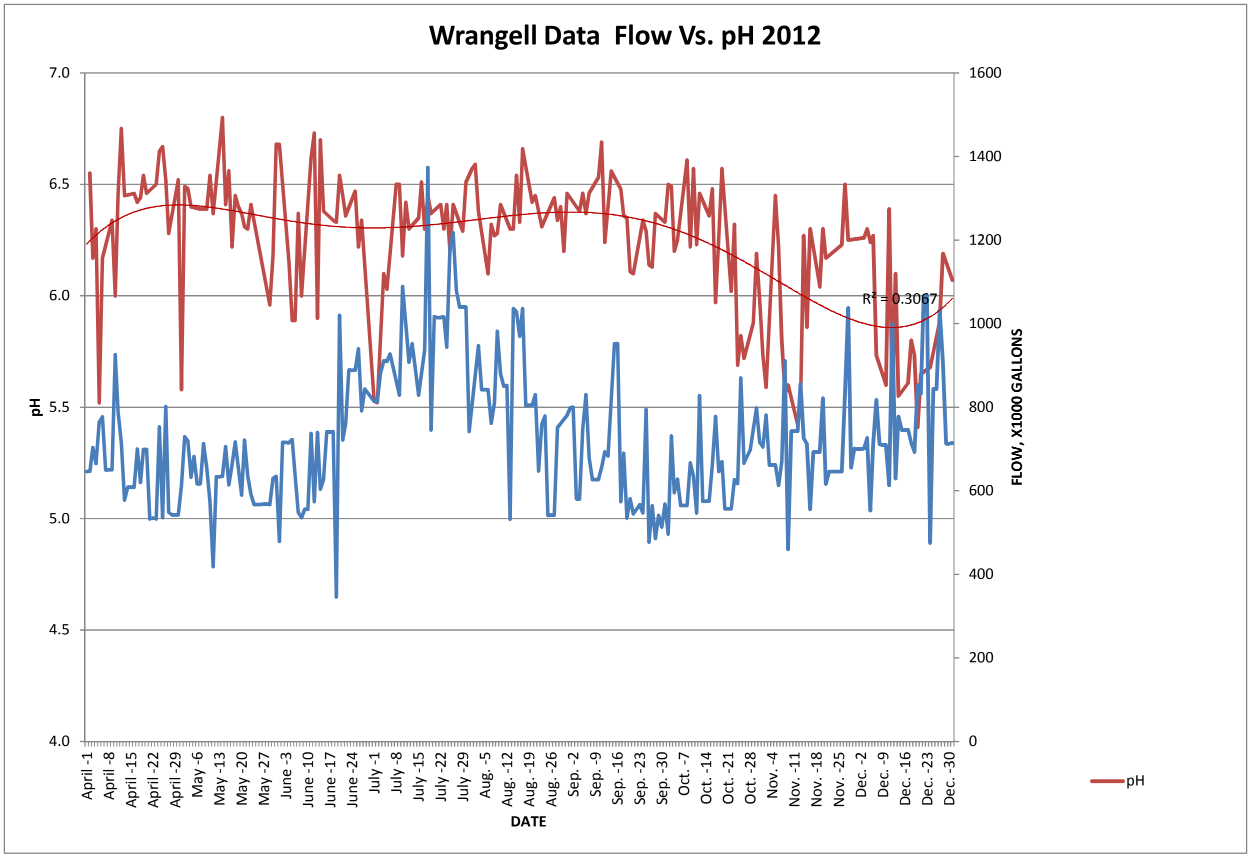
October	Oct. -1	568	6.3	10.1	65	3.12
	Oct. -2	497	6.5	9.9	65	1.79
	Oct. -3	731	6.5	9.5	65	1.47
	Oct. -4	596	6.2	9.4	64	1.39
	Oct. -5	628	6.3	9.3	65	1.59
	Oct. -6	565				
	Oct. -7	565				
	Oct. -8	565	6.6	9.2	65	1.47
	Oct. -9	667	6.2	9.6	62	1.44
	Oct. -10	635	6.6	9.6	63	1.34
	Oct. -11	547	6.2	9.7	63	1.25
	Oct. -12	828	6.5	3.9	62	1.49
	Oct. -13	575				
	Oct. -14	575				
	Oct. -15	576	6.4	9.9	68	1.94
	Oct. -16	664	6.5	9.5	74	1.45
	Oct. -17	778	6.0	8.9	67	1.58
	Oct. -18	646	6.3	9.7	63	1.1
	Oct. -19	670	6.6	8.6	65	1.25
	Oct. -20	557				
	Oct. -21	557				
	Oct. -22	557	6.0	6.7	60	1.47
	Oct. -23	627	6.3	6.4	61	1.14
	Oct. -24	617	5.7	6.3	61	1.15
	Oct. -25	870	5.8	6.0	62	1.23
	Oct. -26	666	5.7	6.7	60	1.13
	Oct. -27					
	Oct. -28	697				
	Oct. -29		5.9	6.0	61	1.13
	Oct. -30	798	6.2	6.1	56	1.08
	Oct. -31	716	6.0	5.1	56	1.23
November	Nov. -1	705	5.7	7.0	58	1.54
	Nov. -2	781	5.6	6.1	66	1.14
	Nov. -3	662				
	Nov. -4	662				
	Nov. -5	662	6.5	5.4	61	1.55
	Nov. -6	613	6.2	5.4	58	1.54
	Nov. -7	670	5.8	5.2	56	1.51
	Nov. -8	911	5.6	5.2	56	1.45
	Nov. -9	460	5.6	5.2	56	1.21
	Nov. -10	743				
	Nov. -11	743				
	Nov. -12	743	5.4	6.4	54	1.29
	Nov. -13	856	5.6	6.2	55	1.2
	Nov. -14	726	6.3	6.3	51	1.52
	Nov. -15	712	5.9	6.0	51	1.17
	Nov. -16	556	6.3	7.3	59	1.37
	Nov. -17	692.67				
	Nov. -18	692.67				
	Nov. -19	692.67	6.0	6.2	53	1.13
	Nov. -20	822	6.3	6.5	59	1.16
	Nov. -21	616	6.2	6.3	54	1.21
	Nov. -22	646.4				
	Nov. -23	646.4				
	Nov. -24	646.4				
	Nov. -25	646.4				
	Nov. -26	646.4	6.2	6.4	52	1.07
	Nov. -27	833	6.5	8.1	56	1.72
	Nov. -28	1038	6.3	6.9	47	1.06
	Nov. -29	655				
	Nov. -30	701				

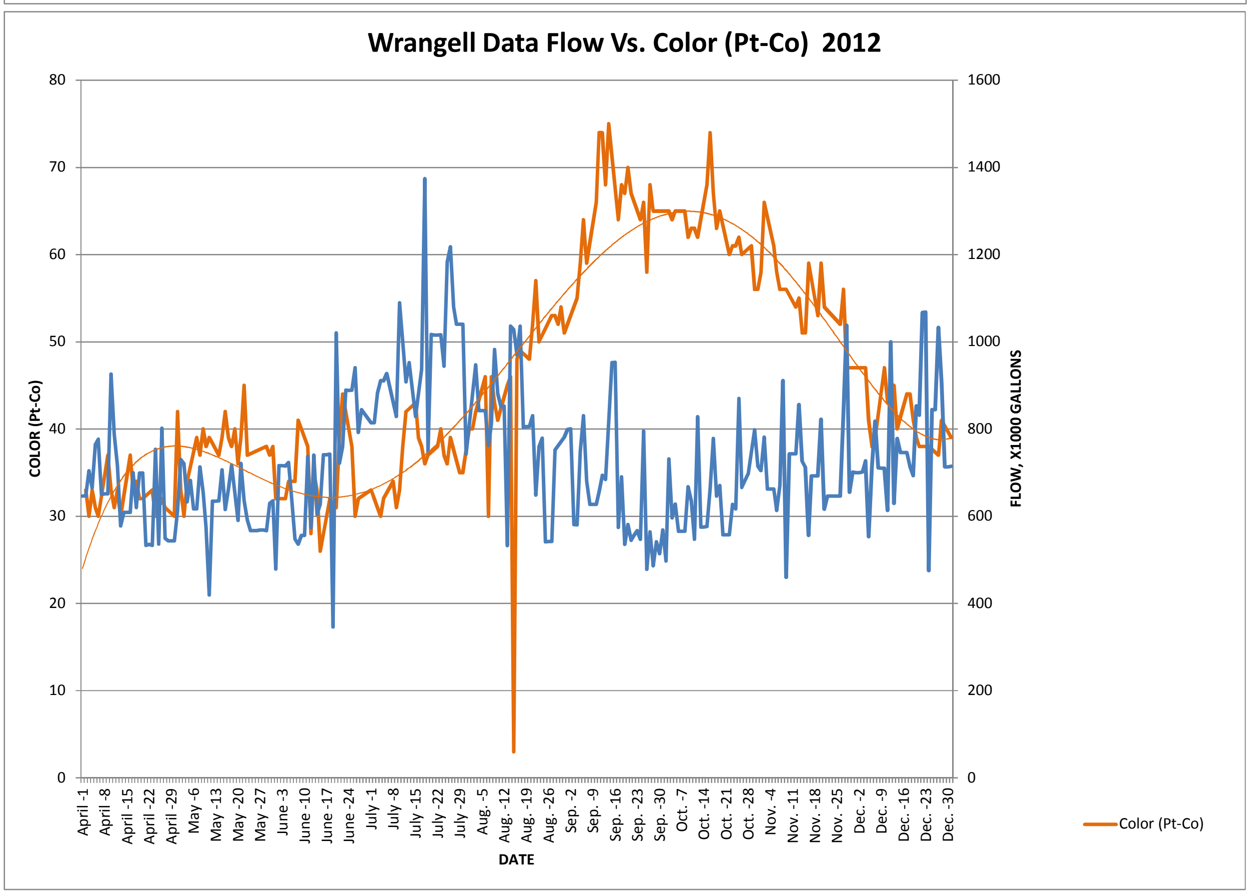
December	Dec. -1	700				
	Dec. -2	700				
	Dec. -3	701	6.3	5.3	47	1.36
	Dec. -4	727	6.3	5.9	47	1.17
	Dec. -5	553	6.2	5.8	41	1.04
	Dec. -6	711	6.3	6.0	38	1.06
	Dec. -7	818	5.7	5.6	39	1.22
	Dec. -8	711				
	Dec. -9	710				
	Dec. -10	710	5.6	7.0	47	1.07
	Dec. -11	613	6.4	5.4	43	1
	Dec. -12	1000	5.5	6.1	45	1.33
	Dec. -13	629	6.1	5.0	45	1.42
	Dec. -14	778	5.6	6.0	40	1.37
	Dec. -15	746				
	Dec. -16	746				
	Dec. -17	746	5.6	5.8	44	1.1
	Dec. -18	713	5.8	4.9	44	1.06
	Dec. -19	693	5.7	5.4	41	1.72
	Dec. -20	853	5.4	5.6	39	1.39
	Dec. -21	832	5.7	5.9	38	1.32
	Dec. -22	1067				
	Dec. -23	1068				
	Dec. -24	475	5.7	5.2	38	1.16
	Dec. -25	844				
	Dec. -26	844				
	Dec. -27	1033	5.9	3.9	37	1.19
	Dec. -28	907	6.2	4.1	41	1.09
	Dec. -29	713				
	Dec. -30	713				
	Dec. -31	714	6.1	3.9	39	1.29

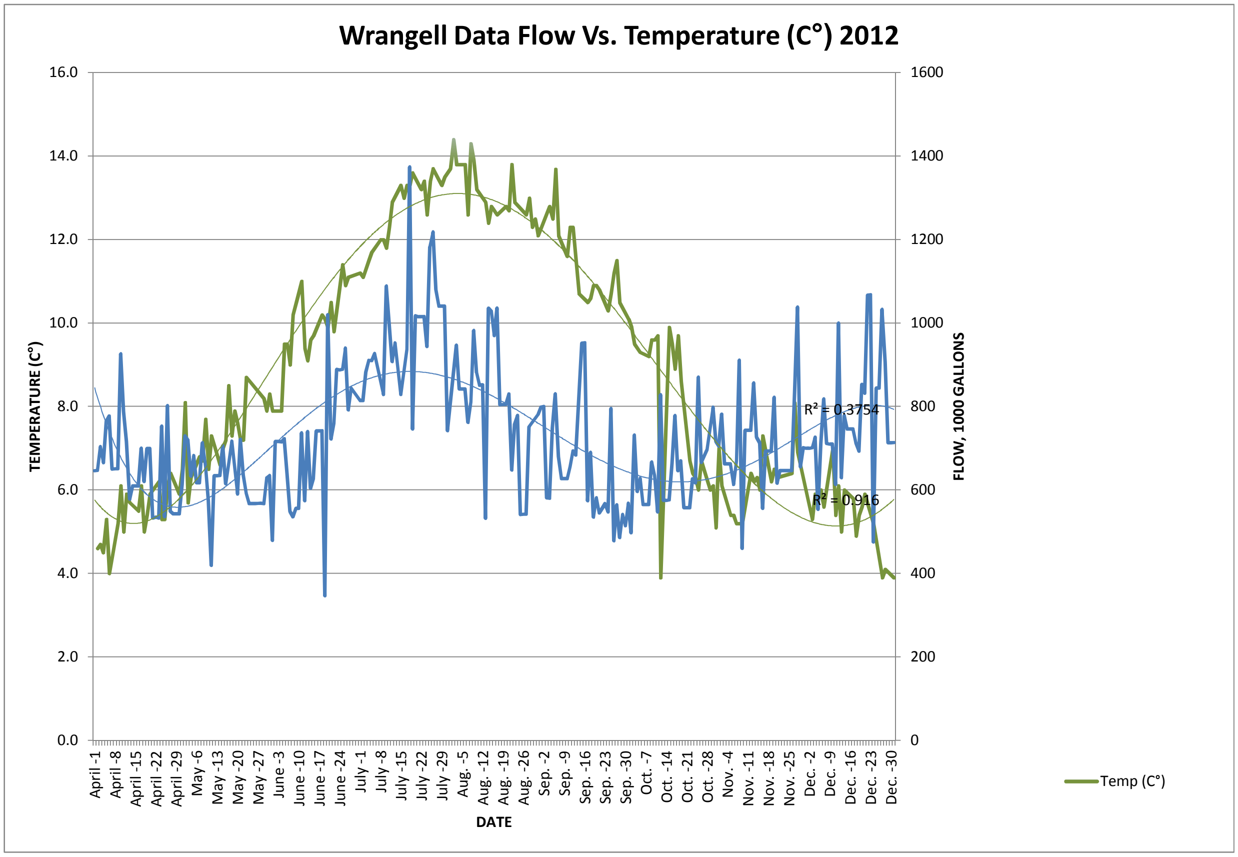
AVG **723**

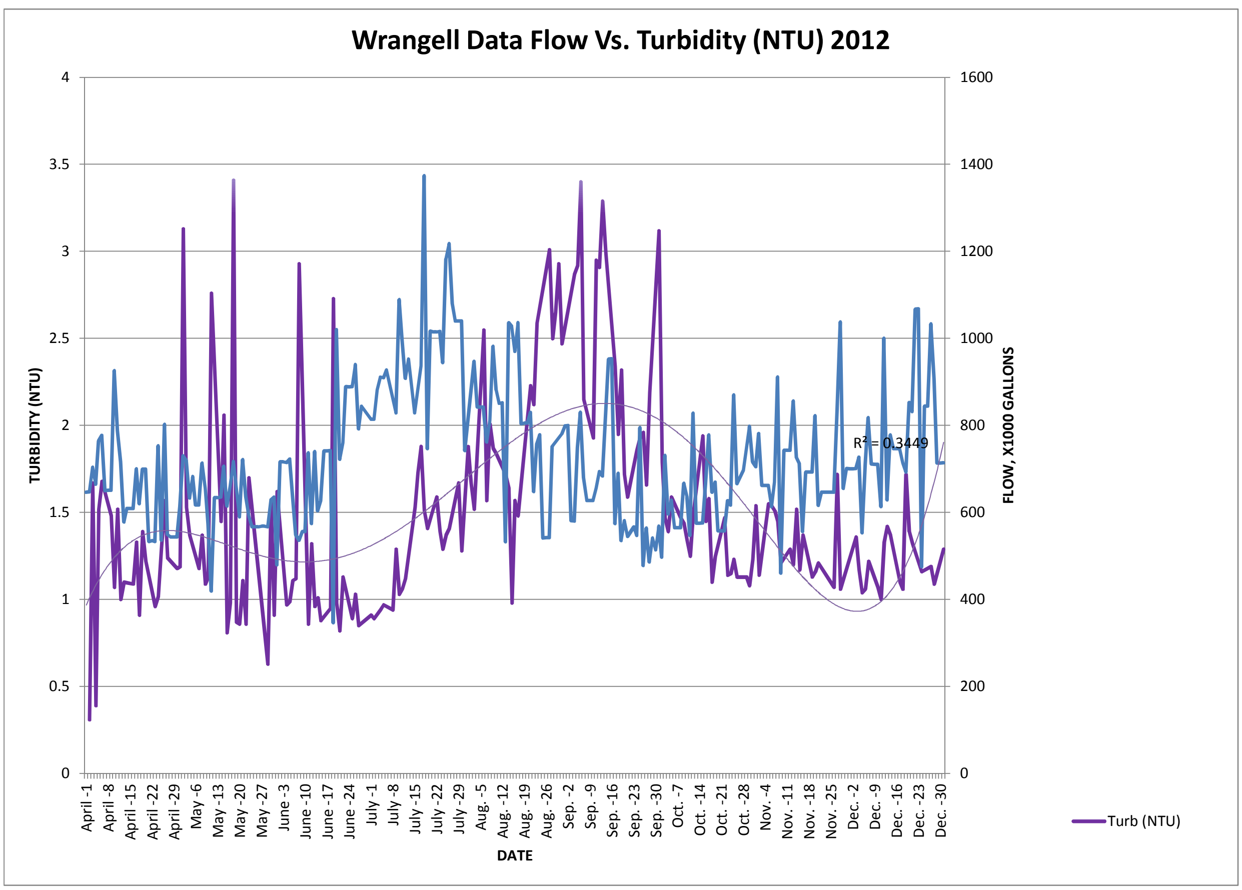
Statistical Analysis

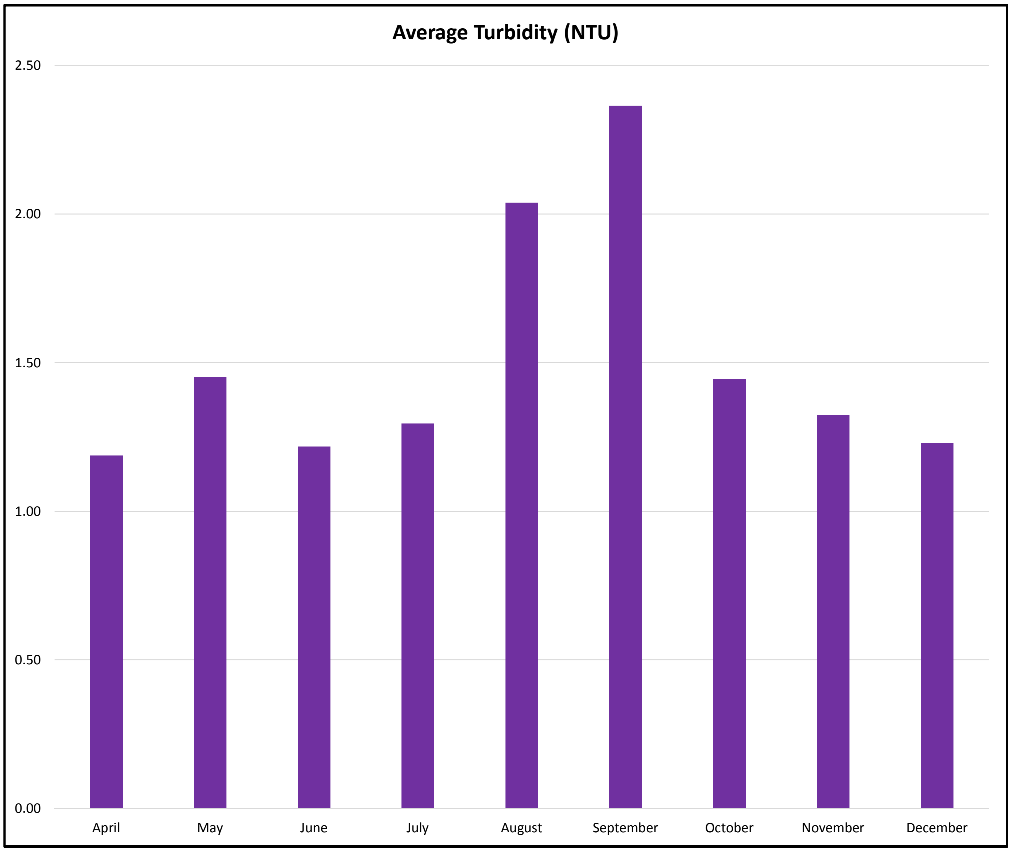
Month	Turbidity (NTU)			Flow (gdp x 1000)			pH			Color (Pt-Co)			Temp (C°)		
	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min
April	1.19	1.68	0.31	653	926	533	6.4	6.8	5.5	32	37	30	5.4	6.4	4.0
May	1.45	3.41	0.63	628	730	419	6.4	6.8	5.6	38	45	30	7.3	8.7	5.7
June	1.22	2.93	0.82	706	1020	346	6.3	6.7	5.9	34	44	26	9.8	11.4	7.9
July	1.30	1.88	0.89	973	1374	742	6.3	6.5	5.5	36	43	30	12.7	13.7	11.1
August	2.04	3.01	0.98	807	1036	532	6.4	6.7	6.1	45	57	3	13.1	14.4	12.1
September	2.36	3.4	1.59	649	953	478	6.4	6.7	6.1	66	75	55	11.4	13.7	10.3
October	1.44	3.12	1.08	639	870	497	6.2	6.6	5.7	63	74	56	8.1	10.1	3.9
November	1.32	1.72	1.06	706	1038	460	6.0	6.5	5.4	56	66	47	6.2	8.1	5.2
December	1.23	1.72	1	767	1068	475	5.9	6.4	5.4	42	47	37	5.4	7.0	4

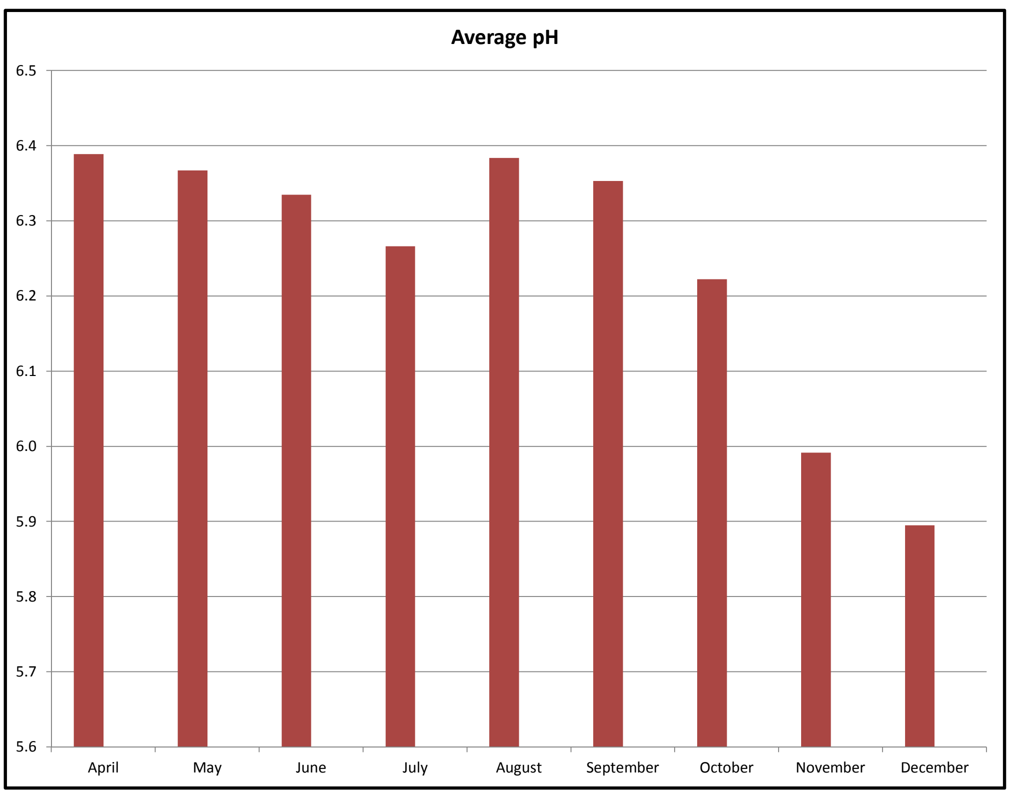

Wrangell Data Flow Vs. pH 2012
pH
FLOW, X1000 GALLONS
DATE
R² = 0.3067
pH
7.0
6.5
6.0
5.5
5.0
4.5
4.0
1600
1400
1200
1000
800
600
400
200
0
April -1
April -8
April -15
April -22
April -29
May -6
May -13
May -20
May -27
June -3
June -10
June -17
June -24
July -1
July -8
July -15
July -22
July -29
Aug. -5
Aug. -12
Aug. -19
Aug. -26
Sep. -2
Sep. -9
Sep. -16
Sep. -23
Sep. -30
Oct. -7
Oct. -14
Oct. -21
Oct. -28
Nov. -4
Nov. -11
Nov. -18
Nov. -25
Dec. -2
Dec. -9
Dec. -16
Dec. -23
Dec. -30

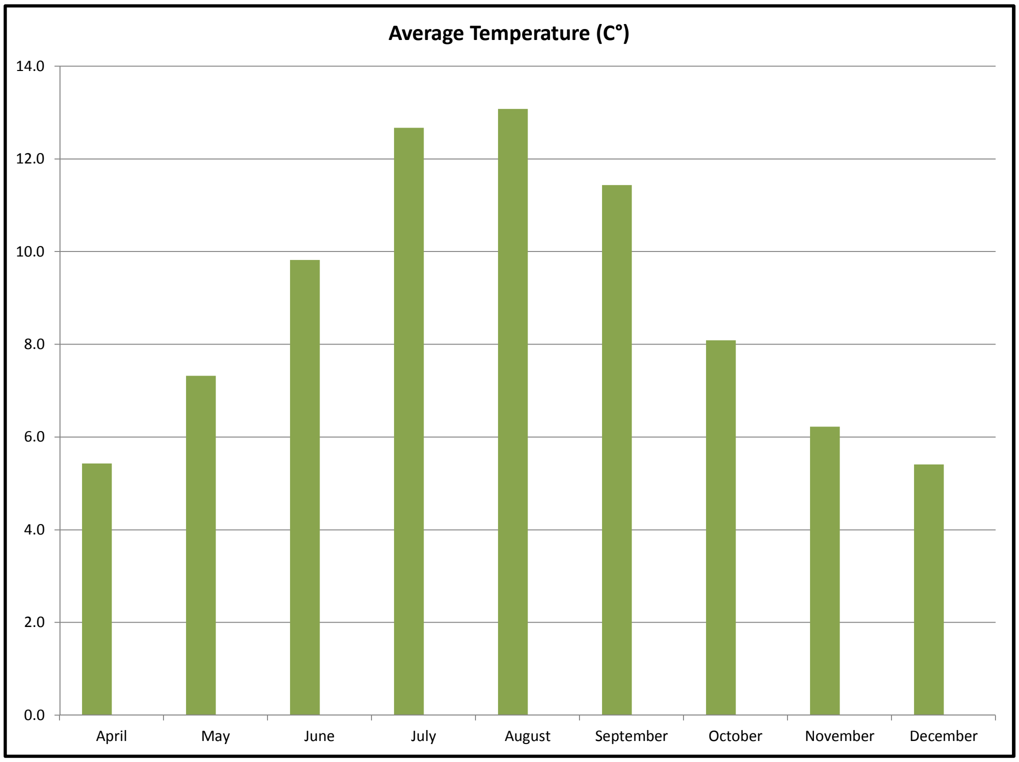

Wrangell Data Flow Vs. Color (Pt-Co) 2012
COLOR (Pt-Co)
FLOW, X1000 GALLONS
DATE
Color (Pt-Co)
80
70
60
50
40
30
20
10
0
1600
1400
1200
1000
800
600
400
200
0
April -1
April -8
April -15
April -22
April -29
May -6
May -13
May -20
May -27
June -3
June -10
June -17
June -24
July -1
July -8
July -15
July -22
July -29
Aug. -5
Aug. -12
Aug. -19
Aug. -26
Sep. -2
Sep. -9
Sep. -16
Sep. -23
Sep. -30
Oct. -7
Oct. -14
Oct. -21
Oct. -28
Nov. -4
Nov. -11
Nov. -18
Nov. -25
Dec. -2
Dec. -9
Dec. -16
Dec. -23
Dec. -30

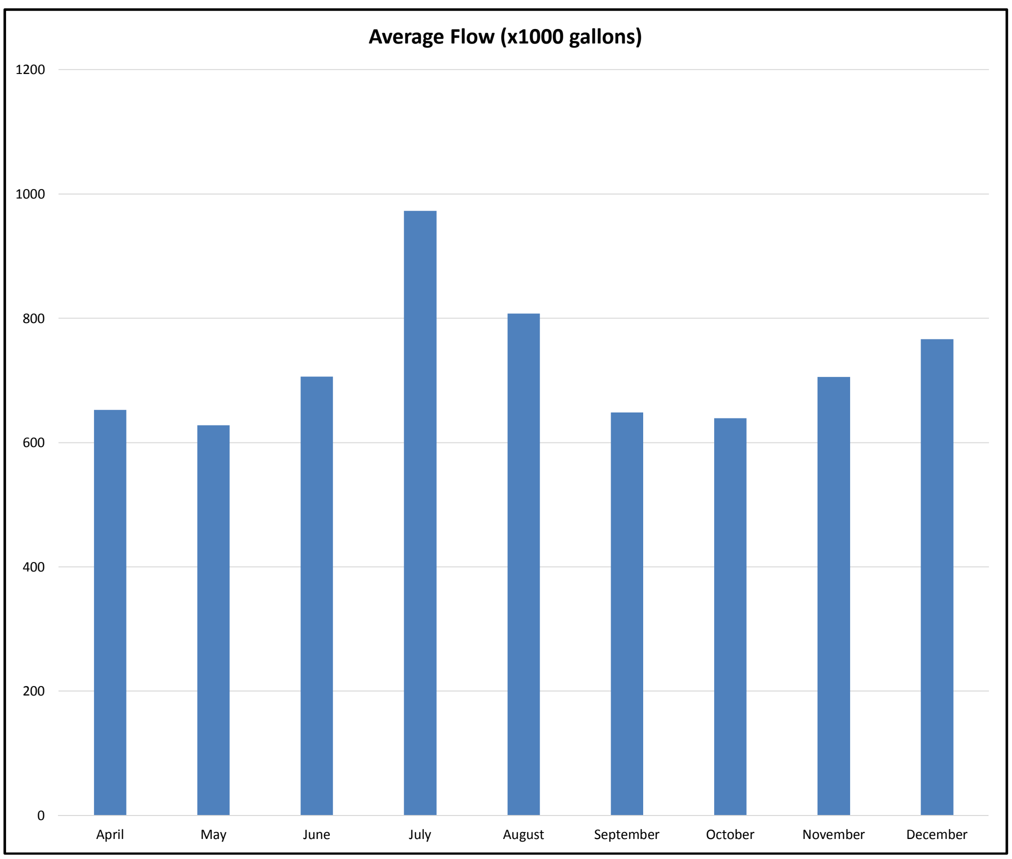

Wrangell Data Flow Vs. Temperature (C°) 2012
TEMPERATURE (C°)
FLOW, 1000 GALLONS
DATE
R² = 0.3754
R² = 0.916
Temp (C°)

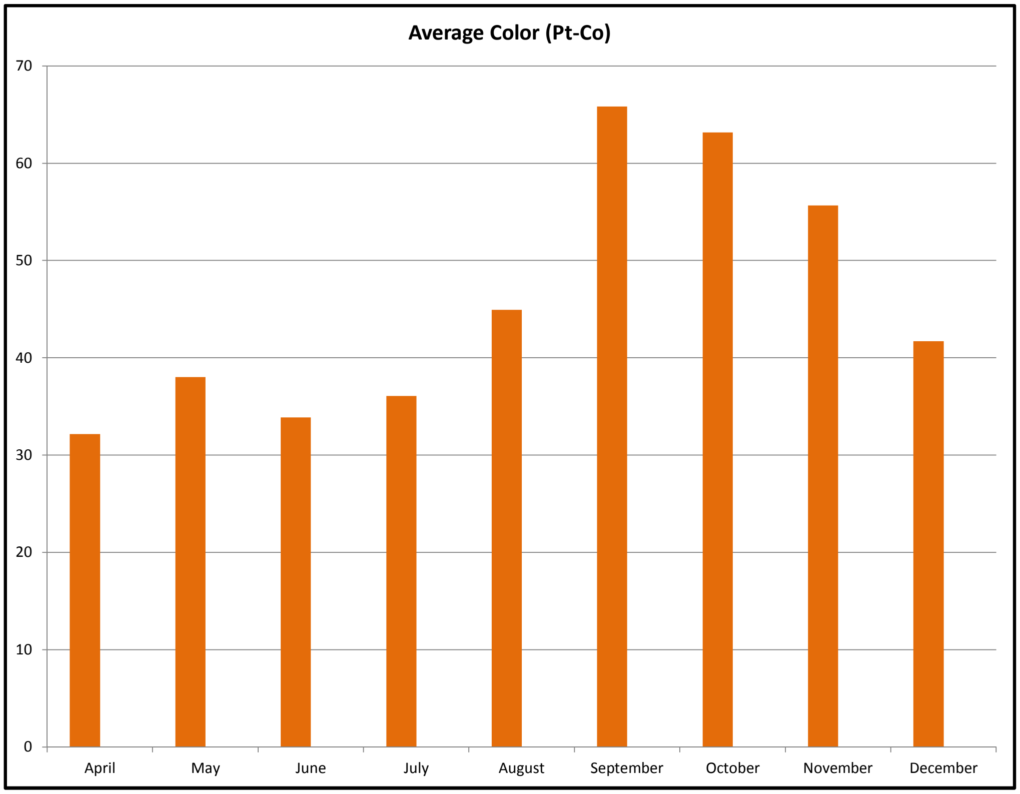

Wrangell Data Flow Vs. Turbidity (NTU) 2012
TURBIDITY (NTU)
FLOW, X1000 GALLONS
DATE
R² = 0.3449
Turb (NTU)


Average Turbidity (NTU)
2.50
2.00
1.50
1.00
0.50
0.00
April
May
June
July
August
September
October
November
December


Average pH
6.5
6.4
6.3
6.2
6.1
6.0
5.9
5.8
5.7
5.6
April
May
June
July
August
September
October
November
December


Average Temperature (C°)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
April
May
June
July
August
September
October
November
December


Average Flow (x1000 gallons)
1200
1000
800
600
400
200
0
April
May
June
July
August
September
October
November
December


Average Color (Pt-Co)
70
60
50
40
30
20
10
0
April
May
June
July
August
September
October
November
December

WRANGELL WATER DISTRIBUTION SYSTEM

Wrangell, Alaska 2013

		Influent				
Month	Date	Daily Flow (GPD x 1K)	pH	Temp (C°)	Color (Pt-Co)	Turb (NTU)
January	January -1	678				
	January -2	678	6.0	5.1	48	1.32
	January -3	634	5.9	4.3	38	1.35
	January -4	770	5.8	5.3	45	1.39
	January -5	650				
	January -6	650				
	January -7	651	6.0	4.1	43	1.49
	January -8	610	6.0	4.3	40	1.49
	January -9	951	5.9	3.9	39	1.39
	January -10	652	5.9	4.0	40	1.61
	January -11	780	5.8	5.0	36	1.4
	January -12	634				
	January -13	634				
	January -14	635	5.8	5.1	41	1.22
	January -15	622	5.8	5.2	38	0.94
	January -16	736	5.9	5.8	39	2.21
	January -17	710	6.2	6.2	39	1.48
	January -18	553	5.7	5.1	29	1.91
	January -19	688				
	January -20	688				
	January -21	689				
	January -22	535	6.4	4.2	34	1.34
	January -23	513	6.3	5.3	41	1.25
	January -24	587	6.3	5.0	41	1.19
	January -25	738	6.1	3.7	36	1.17
	January -26	610.6				
	January -27	610.4				
	January -28	611	5.8	4.0	44	1.01
	January -29	690	5.7	4.9	44	0.97
	January -30	768	5.5	4.0	34	0.91
	January -31	642	6.3	3.8	38	1.05
February	February -1	573	5.6	3.6	40	0.85
	February -2	594				
	February -3	594				
	February -4	595	6.3	4.3	3	1.23
	February -5	569	6.3	4.4	32	1.21
	February -6	812	6.2	4.7	32	0.91
	February -7	472	5.7	3.5	34	0.81
	February -8	640	5.8	4.0	31	1.16
	February -9	740.5				
	February -10		6.1	5.2	27	0.93
	February -11		5.6	4.5	34	1.26
	February -12	610	5.8	5.1	32	0.76
	February -13	646	5.7	5.0	32	0.83
	February -14	827	5.6	5.2	32	0.97
	February -15	458	6.6	5.5	41	1.35
	February -16	560				
	February -17	560				
	February -18	560				
	February -19	560	5.9	3.9	31	0.85
	February -20	509	6.2	4.4	32	1.08
	February -21	680	6.1	4.5	30	1.02
	February -22	499	6.2	4.1	36	0.98
	February -23	685				
	February -24	686				
	February -25	686	6.0	5.0	40	0.72
	February -26	643	5.9	4.7	44	0.7
	February -27	699	5.4	5.3	43	0.72
	February -28	524	5.9	5.6	40	1.02
	February -29					

March	March -1	703	5.4	4.5	40	0.76
	March -2	619.3				
	March -3	619.3				
	March -4	619.4	6.5	4.0	39	0.96
	March -5	575	6.3	3.9	38	0.74
	March -6	645	6.3	5.6	37	0.68
	March -7	672	6.4	4.8	39	0.81
	March -8	649	6.4	5.0	42	0.65
	March -9	670				
	March -10	670				
	March -11	670	6.2	5.7	45	0.68
	March -12	707	6.4	4.9	42	0.68
	March -13	726	6.3	4.5	40	0.61
	March -14	671	6.2	5.0	39	0.58
	March -15	720	6.2	5.1	39	0.61
	March -16	705				
	March -17	706				
	March -18	703	6.4	4.5	40	0.85
	March -19	696	6.5	7.0	48	0.79
	March -20	862	6.3	4.9	31	0.68
	March -21	616	6.2	4.7	36	0.83
	March -22	725	6.4	5.0	41	0.72
	March -23	689				
	March -24	689				
	March -25	689				
	March -26	689	6.3	4.7	37	1.13
	March -27	730	6.5	4.8	40	1.12
	March -28	776	6.3	4.8	36	1.1
	March -29	849	6.2	5.5	46	1.22
	March -30	897				
	March -31	899				
April	April -1	897	6.7	6.0	35	1.25
	April -2	1040	6.5	4.1	35	1.13
	April -3	599	6.5	6.0	37	1.23
	April -4	727	6.5	6.1	37	1.26
	April -5	783	6.4	6.3	36	1.08
	April -6	688				
	April -7	688				
	April -8	689	6.2	6.9	37	1.05
	April -9	722	6.2	5.8	39	1.13
	April -10	832	6.2	6.4	35	1.04
	April -11	733	6.2	5.8	30	0.78
	April -12	555	6.2	6.1	35	1.05
	April -13	683				
	April -14	683				
	April -15	683	6.6	6.2	35	1.07
	April -16	320	6.5	6.6	38	0.89
	April -17	729	6.8	6.6	30	1.26
	April -18		6.3	5.9	33	1.11
	April -19	1472	6.2	6.5	36	1.51
	April -20	591				
	April -21	592				
	April -22	592	6.5	5.8	31	1.06
	April -23	613	6.2	6.6	36	0.91
	April -24	758	6.3	6.4	36	1.19
	April -25	777	6.4	6.8	37	0.8
	April -26	732	6.2	6.9	39	1.17
	April -27	569				
	April -28	569				
	April -29	570	6.5	6.2	42	0.81
	April -30	712	6.4	5.5	44	0.74

May	May -1	683	6.5	6.7	41	0.79
	May -2	622	6.2	6.2	46	0.8
	May -3	821	6.4	7.1	40	0.73
	May -4	869				
	May -5	642				
	May -6	433	6.3	7.0	39	1.52
	May -7	659	6.2	6.7	41	0.94
	May -8	732	6.4	6.2	42	0.7
	May -9	593	6.1	6.3	41	0.74
	May -10	603	6.3	6.2	43	0.72
	May -11	601				
	May -12	600				
	May -13	602	6.3	6.8	45	0.8
	May -14	630	6.3	8.0	44	1.4
	May -15	589	6.3	7.5	42	1.08
	May -16	789	6.3	7.4	45	0.71
	May -17	676	6.3	7.5	43	0.75
	May -18	653				
	May -19	653				
	May -20	653	6.3	7.3	41	0.72
	May -21	697	6.1	7.0	32	0.89
	May -22	802	6.2	7.7	43	0.75
	May -23	862	6.4	7.6	45	0.84
	May -24	866				
	May -25	866				
	May -26	866				
	May -27	866				
	May -28					
	May -29	677	6.5	8.5	43	0.81
	May -30	624	6.2	8.0	41	1.25
	May -31	815	6.4	8.8	45	0.81
June	June -1	687.6				
	June -2	687.6				
	June -3	687.8	6.3	8.7	40	0.9
	June -4	524	6.4	9.5	41	1.02
	June -5	720	6.3	9.5	45	0.86
	June -6	943	6.1	8.8	40	0.83
	June -7	850	6.2	9.4	43	0.84
	June -8	654				
	June -9	654				
	June -10	654	6.6	9.4	37	0.091
	June -11	646	6.4	10.1	38	0.85
	June -12	648	6.3	10.2	37	1.03
	June -13	683	6.4	10.7	34	0.93
	June -14	686	6.4	10.2	35	1.45
	June -15	722.6				
	June -16	722.6				
	June -17	722.8	6.2	11.3	38	0.98
	June -18	860	6.4	10.9	39	1.66
	June -19	827	6.5	10.7	34	1.1
	June -20	905	6.2	11.3	36	1.03
	June -21	918	6.2	11.0	38	0.98
	June -22	740				
	June -23	840				
	June -24	840	6.4	12.4	38	1.16
	June -25	702	6.2	12.0	50	1.84
	June -26	836	6.1	12.4	38	1.26
	June -27	1417	6.2	12.0	34	1.25
	June -28	1308	6.2	12.3	37	1.21
	June -29	893.6				
	June -30	893.6				

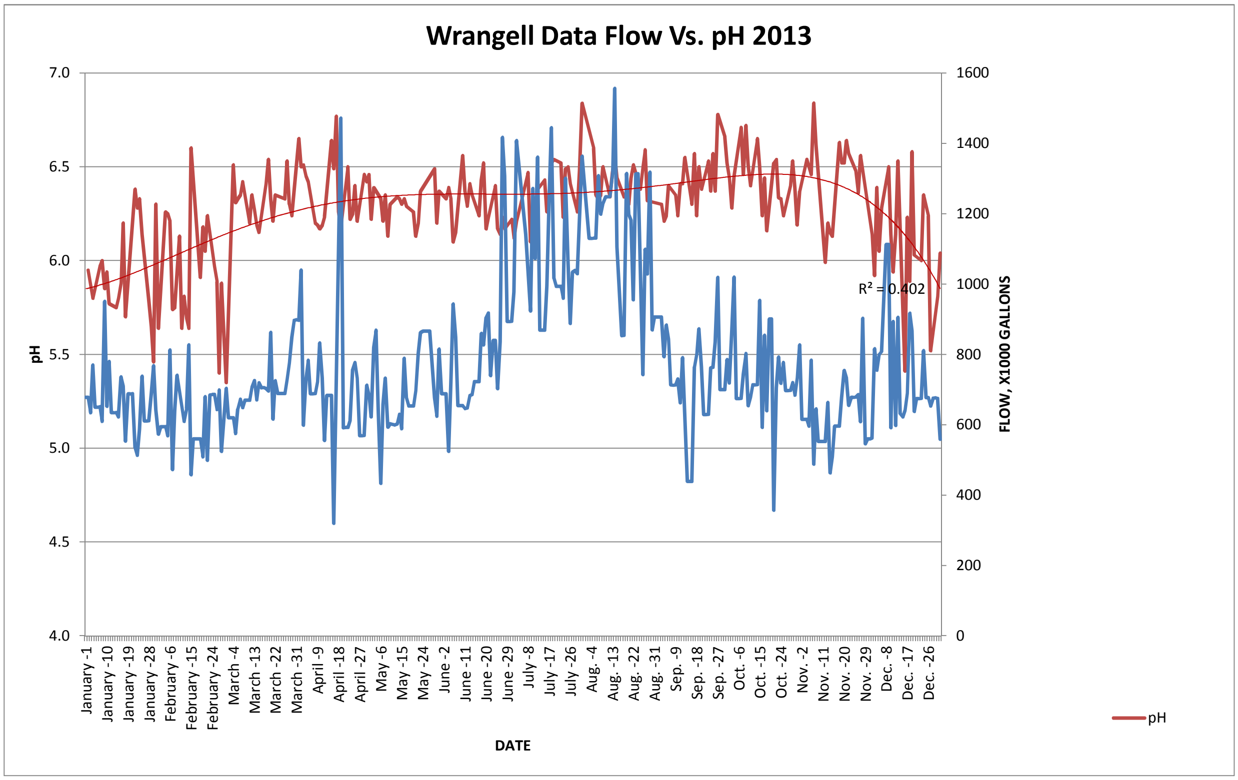
	July -1	893.8	6.2	12.5	39	1.28
	July -2	978	6.1	13.2	35	1.2
	July -3	1408	6.2	12.9	42	1.14
	July -4					
	July -5		6.3	13.0	35	1.34
	July -6					
	July -7	1141.3				
	July -8		6.5	13.0	48	1.61
	July -9	923	6.1	13.4	39	1.62
	July -10	1272	6.3	13.5	43	1.57
	July -11	1072	6.3	14.0	39	1.63
	July -12	1361	6.4	14.0	39	1.64
	July -13	869				
	July -14	869				
	July -15	869	6.4	14.4	42	2.04
July	July -16	995	6.3	14.0	42	2.09
	July -17	1239	6.3	14.4	46	2.12
	July -18	1444	6.5	14.9	41	0.1.96
	July -19	1016	6.5	14.3	40	2.22
	July -20	993				
	July -21	993				
	July -22	993	6.5	13.7	42	2.42
	July -23	960	6.2	14.5	44	2.23
	July -24	1301	6.5	14.6	39	2.14
	July -25	1067	6.5	15.2	51	2.14
	July -26	888	6.4	14.5	51	2.72
	July -27	1034				
	July -28	1039				
	July -29	1030	6.3	14.5	50	2.86
	July -30	1188	6.5	14.9	53	2.54
	July -31	1363	6.8	15.3	57	2.74
	Aug. -1					
	Aug. -2					
	Aug. -3	1130				
	Aug. -4	1130				
	Aug. -5	1131	6.6	14.6	55	3.35
	Aug. -6	1131	6.4	14.7	55	3.1
	Aug. -7	1308	6.3	14.5	57	2.66
	Aug. -8	1199	6.4	15.2	53	2.45
	Aug. -9	1230	6.5	15.4	66	2.72
	Aug. -10	1248				
	Aug. -11	1248				
	Aug. -12	1249	6.3	15.4	60	4.32
	Aug. -13	1316	6.5	15.4	65	4.55
	Aug. -14	1556	6.6	15.6	63	3.23
	Aug. -15	1106	6.4	15.7	64	3.22
August	Aug. -16					
	Aug. -17	853				
	Aug. -18	854	6.3	15.5	66	2.91
	Aug. -19	1314	6.4	15.8	73	3.08
	Aug. -20	1197	6.3	15.2	68	2.61
	Aug. -21	1181	6.4	15.3	70	3.04
	Aug. -22	955	6.5	15.0	69	2.79
	Aug. -23	1313				
	Aug. -24	1313				
	Aug. -25		6.4	15.2	66	3.51
	Aug. -26	742	6.5	14.8	63	4.29
	Aug. -27	1099	6.6	14.6	68	3.27
	Aug. -28	1029	6.3	15.0	67	3.4
	Aug. -29	1318				
	Aug. -30	870				
	Aug. -31	906				

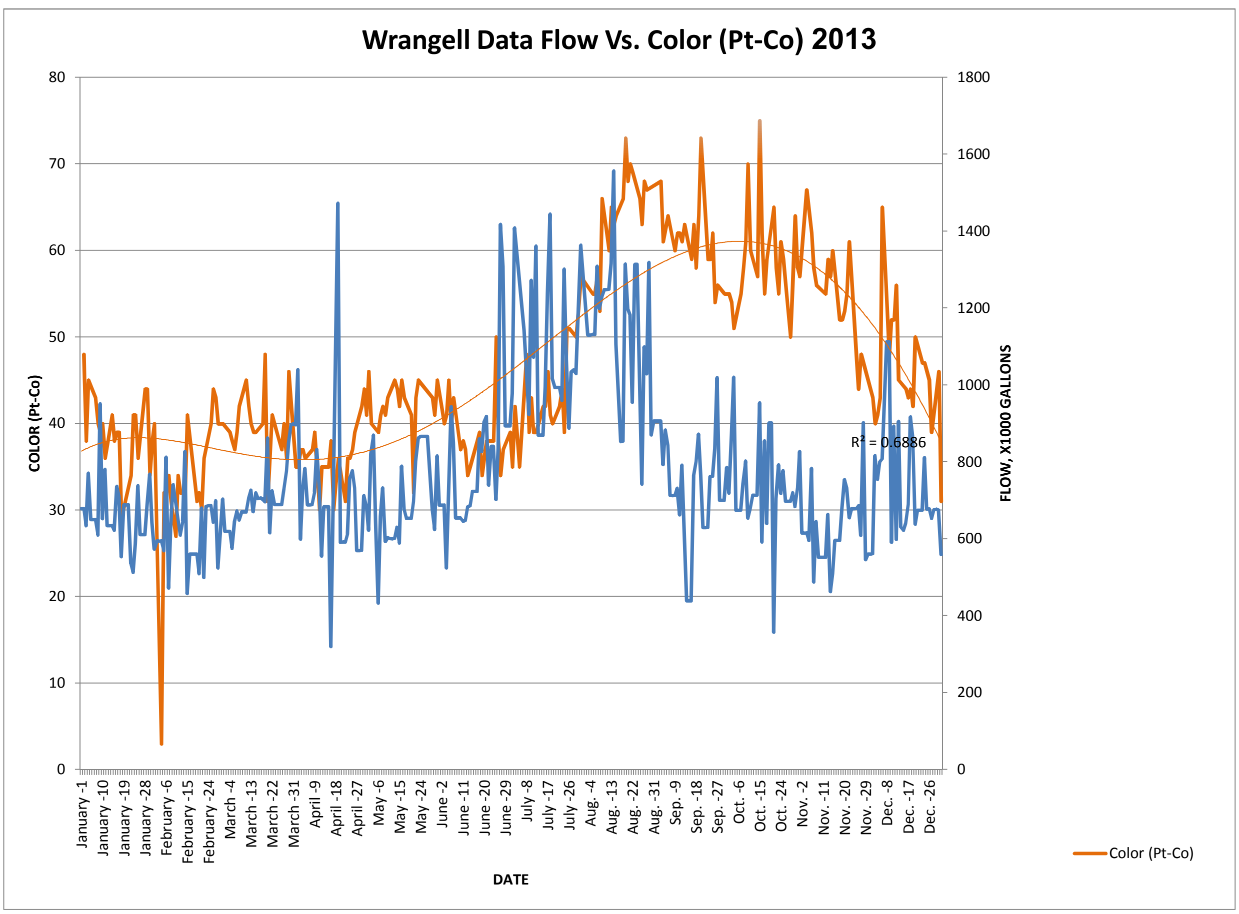
September	Sep. -1	906				
	Sep. -2	906				
	Sep. -3	906	6.3	15.2	68	3.78
	Sep. -4	793	6.2	14.9	61	4.34
	Sep. -5	883	6.2	15.6		
	Sep. -6	843	6.4	14.7	64	3.96
	Sep. -7	713				
	Sep. -8	712				
	Sep. -9	713	6.4	14.9	60	3.14
	Sep. -10	731	6.2	15.0	62	4.01
	Sep. -11	662	6.4	15.0	62	3.63
	Sep. -12	791	6.4	15.4	61	4.28
	Sep. -13		6.6	15.6	63	4.24
	Sep. -14	439				
	Sep. -15	439				
	Sep. -16	439	6.3	15.3	59	4.27
	Sep. -17	765	6.6	14.4	63	4.42
	Sep. -18	801	6.2	13.7	58	5.43
	Sep. -19	872	6.5	14.4	64	3.56
	Sep. -20	765	6.4	15.9	73	3.99
	Sep. -21	629				
	Sep. -22	629				
	Sep. -23	630	6.5	12.4	59	4.13
	Sep. -24	762	6.4	12.6	59	3.4
	Sep. -25	763	6.6	11.7	62	3.02
	Sep. -26	835	6.4	12.3	54	3.13
	Sep. -27	1019	6.8	11.7	56	2.69
	Sep. -28	700				
	Sep. -29	700				
	Sep. -30	700	6.7	11.0	55	2.4
October	Oct. -1	785	6.5	11.1	55	3
	Oct. -2	719	6.4	11.7	55	2.36
	Oct. -3	869	6.3	10.8	54	2.28
	Oct. -4	1020	6.5	10.5	51	2.23
	Oct. -5	674				
	Oct. -6	674				
	Oct. -7	675	6.7	11.1	55	1.86
	Oct. -8	744	6.5	10.2	58	1.72
	Oct. -9	802	6.7	10.3	61	1.36
	Oct. -10	654	6.5	10.1	70	1.39
	Oct. -11	678	6.4	9.8	60	1.44
	Oct. -12	713				
	Oct. -13	713				
	Oct. -14	714	6.7	10.8	57	1.41
	Oct. -15	953	6.5	9.5	75	2.73
	Oct. -16	592	6.2	9.4	62	1.32
	Oct. -17	854	6.4	8.7	55	1.17
	Oct. -18	640	6.2	8.6	59	1.44
	Oct. -19	901				
	Oct. -20	901				
	Oct. -21	357	6.5	9.3	65	1.52
	Oct. -22	705	6.5	9.0	58	1.23
	Oct. -23	792	6.3	10.2	55	1.09
	Oct. -24	718	6.3	9.9	61	1.48
	Oct. -25	777	6.2	10.0	59	1.3
	Oct. -26	697				
	Oct. -27	697				
	Oct. -28	698	6.4	8.8	50	3.16
	Oct. -29	720	6.5	8.4	56	0.99
	Oct. -30	684	6.4	10.4	64	2.19
	Oct. -31	733	6.2	9.2	58	0.96

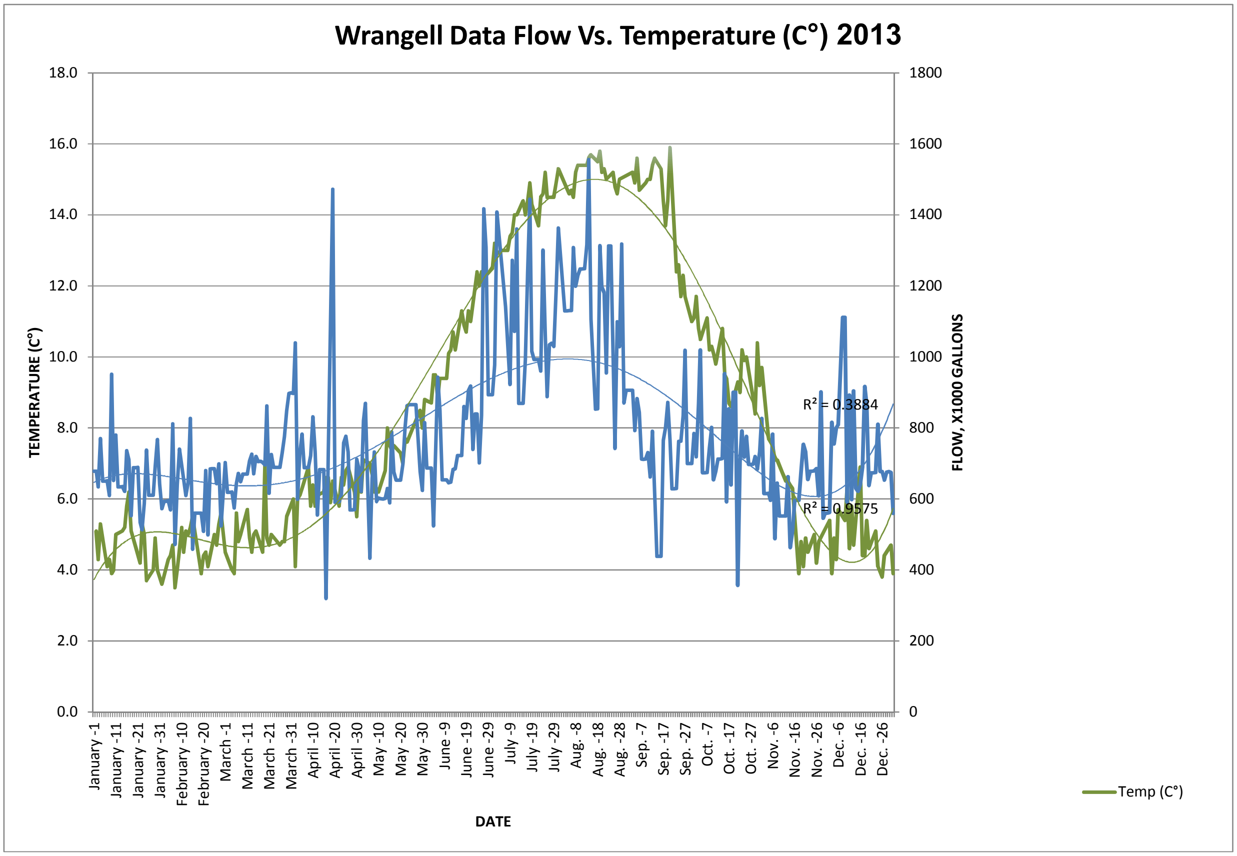
November	Nov. -1	827	6.4	9.7	57	1.15
	Nov. -2	615				
	Nov. -3	615				
	Nov. -4	616	6.5	7.7	67	0.91
	Nov. -5	596				
	Nov. -6	783	6.5	7.5	62	1.06
	Nov. -7	488	6.8	7.1	58	0.98
	Nov. -8	645	6.6	7.1	56	0.77
	Nov. -9	552				
	Nov. -10	552				
	Nov. -11	552				
	Nov. -12	552	6.0	6.5	55	0.96
	Nov. -13	663	6.2	6.5	59	0.76
	Nov. -14	463	6.2	6.4	57	0.81
	Nov. -15	510	6.1	6.3	60	1.27
	Nov. -16	596				
	Nov. -17	596				
	Nov. -18	596	6.6	3.9	52	0.94
	Nov. -19	677	6.5	4.8	52	0.94
	Nov. -20	754	6.5	4.1	53	0.83
	Nov. -21	732	6.6	4.9	55	0.79
	Nov. -22	655	6.6	4.5	61	0.77
	Nov. -23	678				
	Nov. -24	678				
	Nov. -25	679	6.5	5.0	48	0.96
	Nov. -26	686	6.4	4.2	44	0.88
	Nov. -27	609	6.6	4.8	48	0.9
	Nov. -28	902				
	Nov. -29	546				
	Nov. -30	560				
December	Dec. -1	560				
	Dec. -2	562	6.1	5.4	43	1.04
	Dec. -3	816	5.9	3.9	40	1.2
	Dec. -4	755	6.4	4.9	41	0.93
	Dec. -5	800	6.1	4.3	43	0.86
	Dec. -6	809	6.3	5.7	65	1.07
	Dec. -7					
	Dec. -8	1112				
	Dec. -9	1112	6.5	5.4	48	0.85
	Dec. -10	591	6.1	6.3	52	0.75
	Dec. -11	893	5.9	4.6	52	0.91
	Dec. -12	598	6.1	5.8	56	0.85
	Dec. -13	905	6.5	4.7	45	0.91
	Dec. -14	631				
	Dec. -15	622				
	Dec. -16	641	5.4	6.9	44	1.33
	Dec. -17	690	6.2	4.4	43	0.9
	Dec. -18	917	5.9	4.4	44	0.87
	Dec. -19	867	6.6	5.4	42	0.74
	Dec. -20	638	6.0	4.6	50	0.82
	Dec. -21	674				
	Dec. -22	674				
	Dec. -23	675	6.0	5.1	47	0.87
	Dec. -24	811	6.4	4.1	47	0.94
	Dec. -25	677				
	Dec. -26	677	6.2	3.8	45	0.81
	Dec. -27	653	5.5	4.4	39	1.02
	Dec. -28	676				
	Dec. -29	677				
	Dec. -30	675	5.8	4.7	46	0.83
	Dec. -31	559	6.0	3.9	31	1.05
	AVG	**767**				

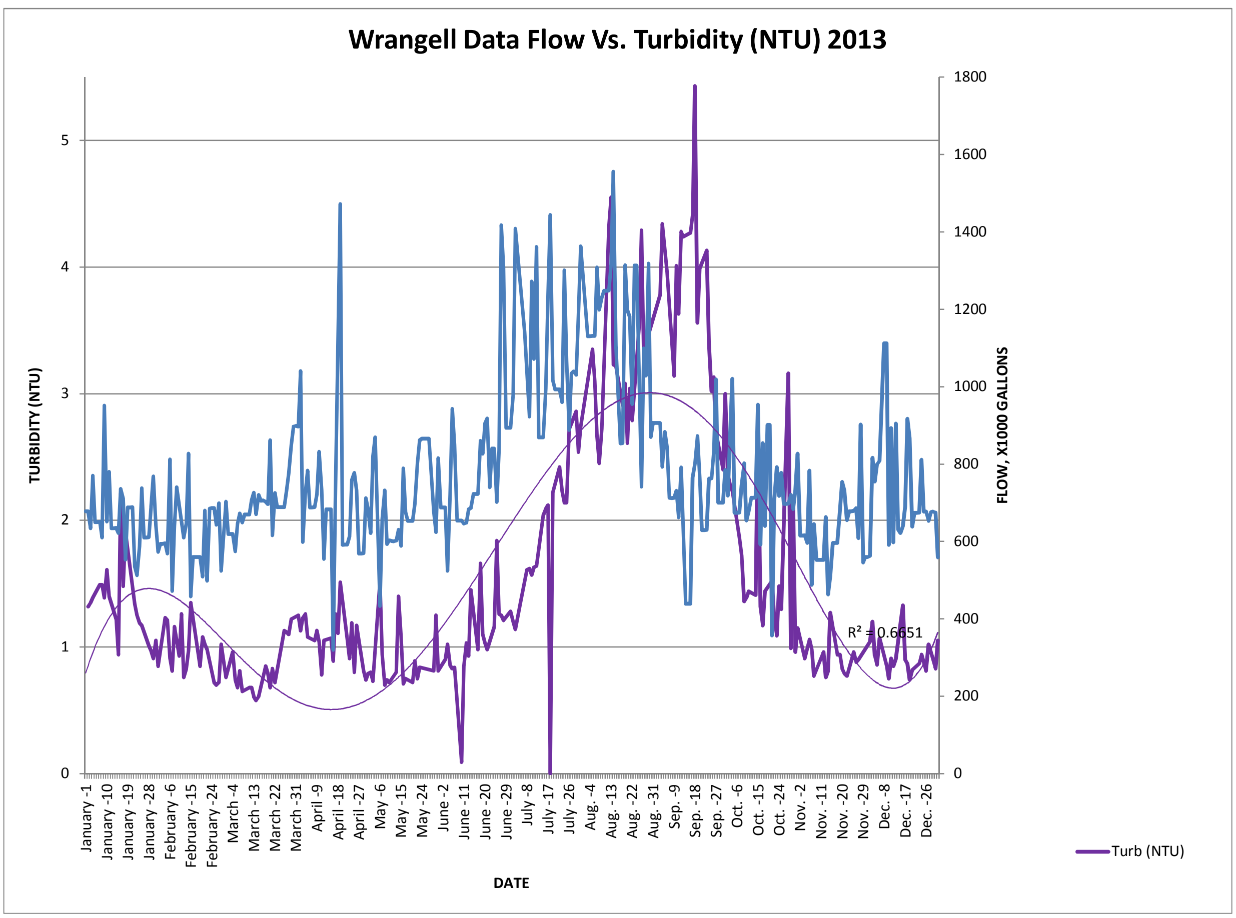
Statistical Analysis

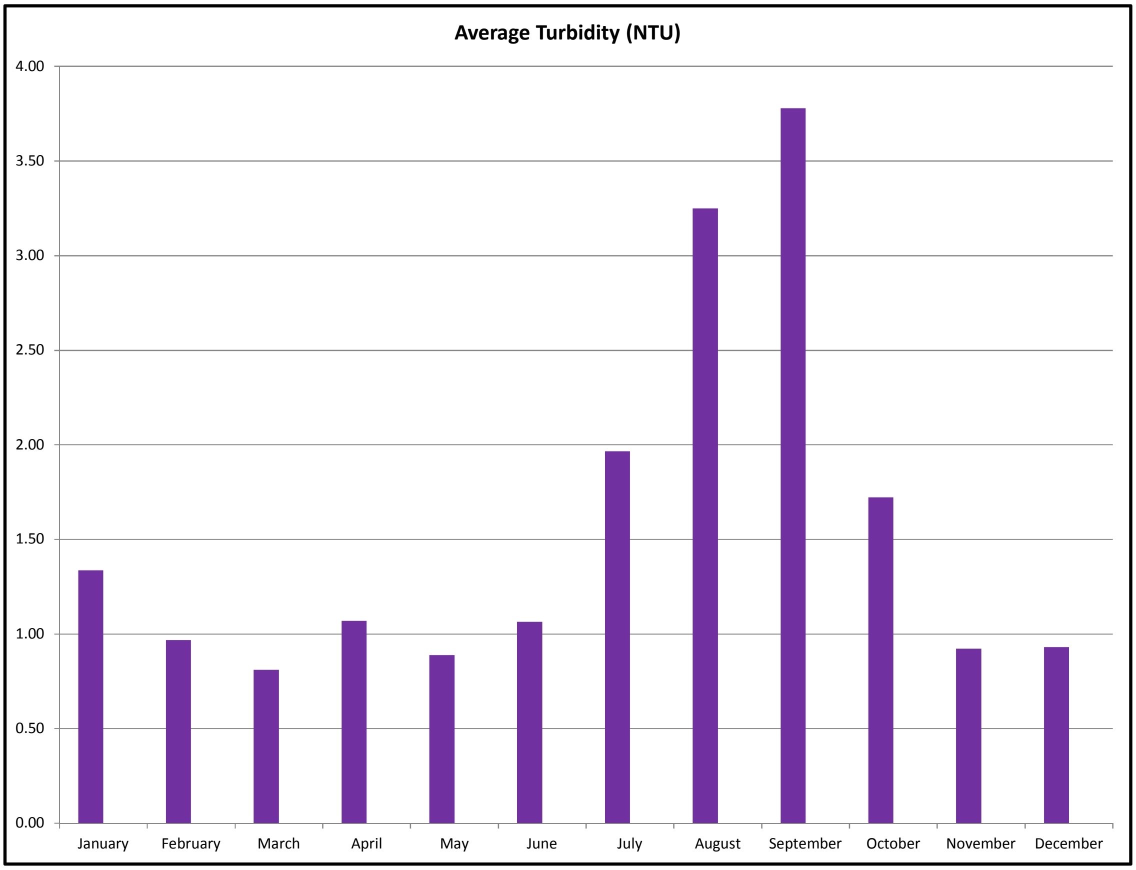
Month	Turbidity (NTU)			Flow (gdp x 1000)			pH			Color (Pt-Co)			Temp (C°)		
	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min
January	1.34	2.21	0.91	664.45	951	513	5.9	6.4	5.5	39	48	29	4.7	6.2	3.7
February	0.97	1.35	0.7	614.67	827	458	5.9	6.6	5.4	33	44	3	4.6	5.6	3.5
March	0.81	1.22	0.58	705.03	899	575	6.3	6.5	5.4	40	48	31	4.9	7.0	3.9
April	1.07	1.51	0.74	710.28	1472	320	6.4	6.8	6.2	36	42	30	6.2	6.9	4.1
May	0.89	1.52	0.7	701.47	869	433	6.3	6.5	6.1	42	46	32	7.2	8.8	6.2
June	1.06	1.84	0.091	795.77	1417	524	6.3	6.6	6.1	39	50	34	10.6	12.4	8.7
July	1.97	2.86	1.14	1081.45	1444	869	6.4	6.8	6.1	44	57	35	14.0	15.3	12.5
August	3.25	4.55	2.45	1145.41	1556	742	6.4	6.6	6.3	64	73	53	15.2	15.8	14.5
September	3.78	5.43	2.4	739.52	1019	439	6.4	6.8	6.2	61	73	54	14.1	15.9	11.0
October	1.72	3.16	0.96	737.19	1020	357	6.4	6.7	6.2	59	75	50	9.9	11.7	8.4
November	0.92	1.27	0.76	632.43	902	463	6.4	6.8	6.0	56	67	44	5.9	9.7	3.9
December	0.93	1.33	0.74	731.57	1112	559	6.1	6.6	5.4	46	65	31	4.9	6.9	4

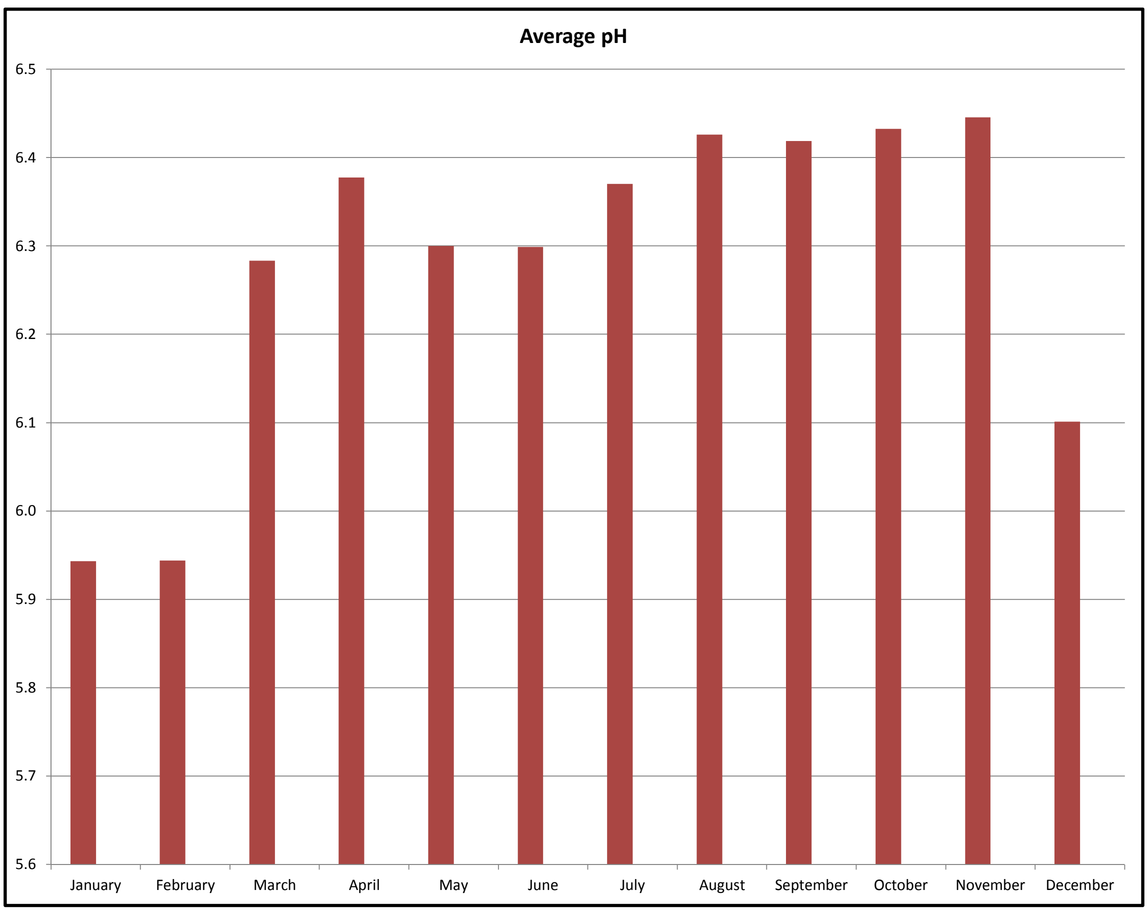

Wrangell Data Flow Vs. pH 2013
pH
FLOW, X1000 GALLONS
DATE
R² = 0.402
pH

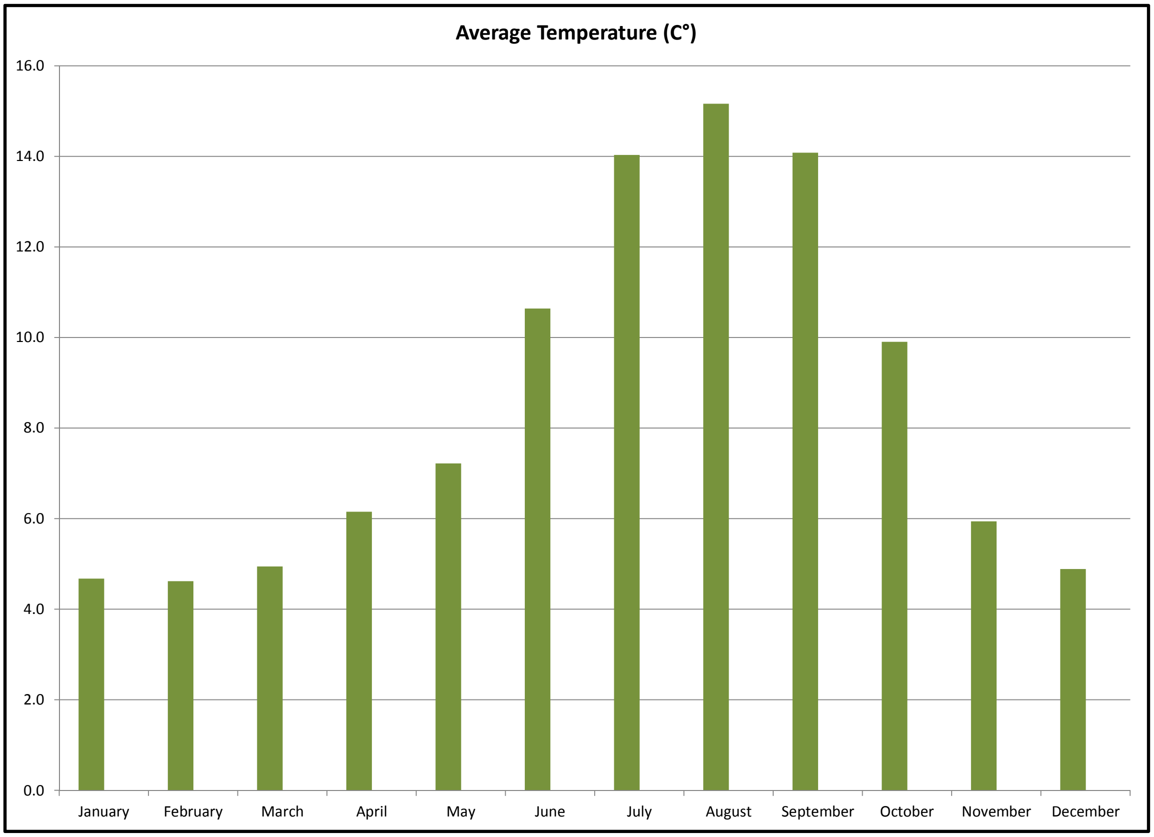

Wrangell Data Flow Vs. Color (Pt-Co) 2013
COLOR (Pt-Co)
FLOW, X1000 GALLONS
DATE
R² = 0.6886
Color (Pt-Co)

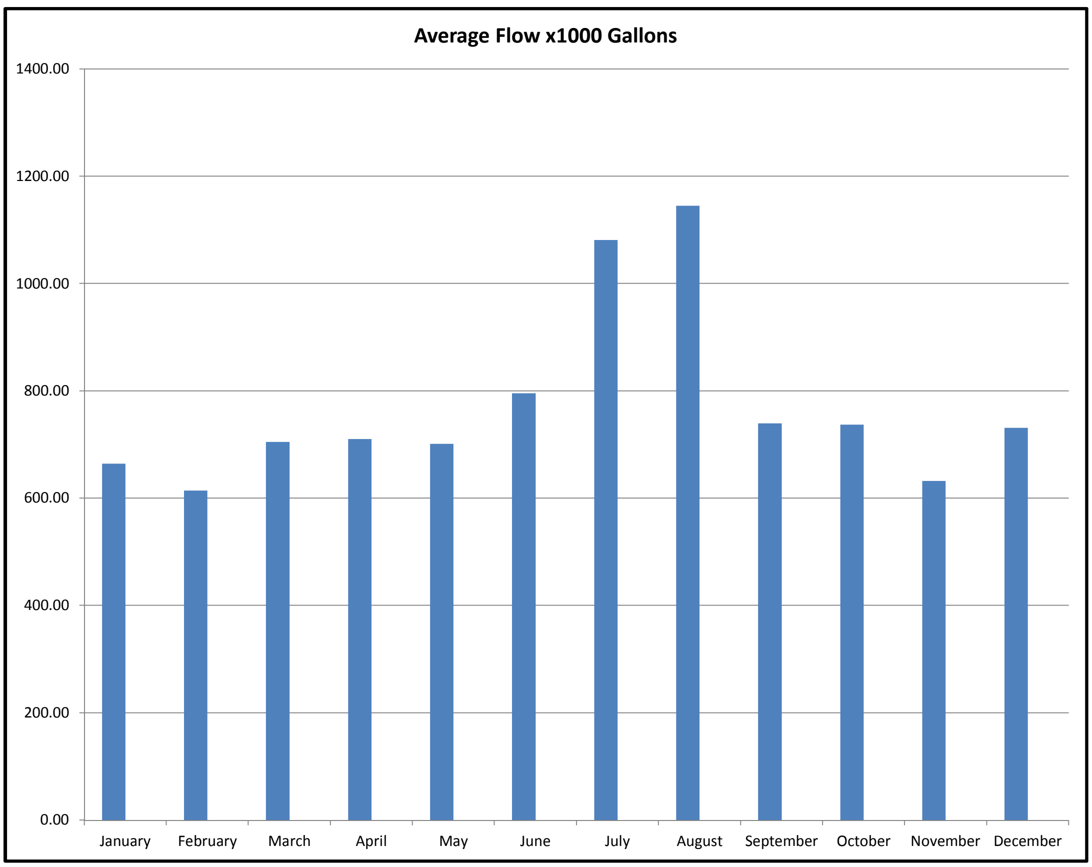

Wrangell Data Flow Vs. Temperature (C°) 2013
TEMPERATURE (C°)
FLOW, X1000 GALLONS
DATE
R^2 = 0.3884
R^2 = 0.9575
Temp (C°)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1800
1600
1400
1200
1000
800
600
400
200
0
January -1
January -11
January -21
January -31
February -10
February -20
March -1
March -11
March -21
March -31
April -10
April -20
April -30
May -10
May -20
May -30
June -9
June -19
June -29
July -9
July -19
July -29
Aug. -8
Aug. -18
Aug. -28
Sep. -7
Sep. -17
Sep. -27
Oct. -7
Oct. -17
Oct. -27
Nov. -6
Nov. -16
Nov. -26
Dec. -6
Dec. -16
Dec. -26

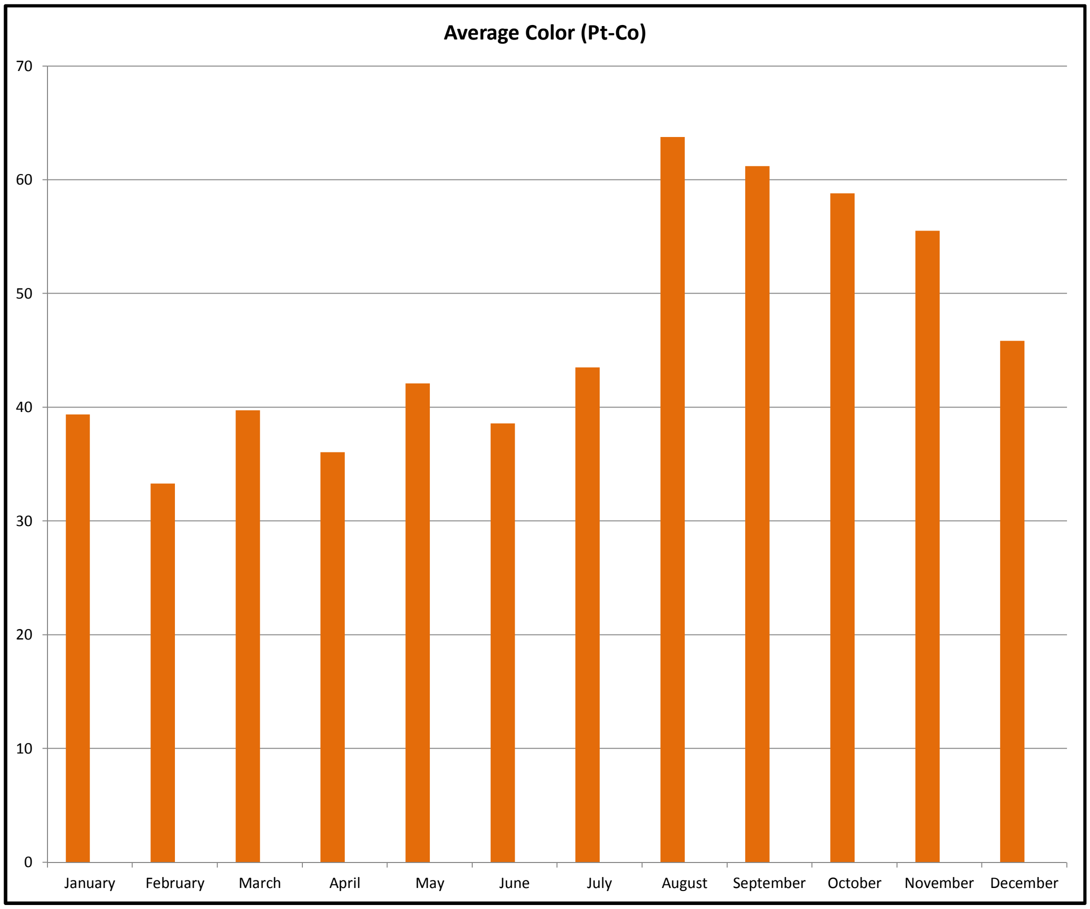

Wrangell Data Flow Vs. Turbidity (NTU) 2013
TURBIDITY (NTU)
FLOW, X1000 GALLONS
DATE
R^2 = 0.6651
Turb (NTU)
5
4
3
2
1
0
1800
1600
1400
1200
1000
800
600
400
200
0
January -1
January -10
January -19
January -28
February -6
February -15
February -24
March -4
March -13
March -22
March -31
April -9
April -18
April -27
May -6
May -15
May -24
June -2
June -11
June -20
June -29
July -8
July -17
July -26
Aug. -4
Aug. -13
Aug. -22
Aug. -31
Sep. -9
Sep. -18
Sep. -27
Oct. -6
Oct. -15
Oct. -24
Nov. -2
Nov. -11
Nov. -20
Nov. -29
Dec. -8
Dec. -17
Dec. -26


Average Turbidity (NTU)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
January
February
March
April
May
June
July
August
September
October
November
December


Average pH
6.5
6.4
6.3
6.2
6.1
6.0
5.9
5.8
5.7
5.6
January
February
March
April
May
June
July
August
September
October
November
December


Average Temperature (C°)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
January
February
March
April
May
June
July
August
September
October
November
December


Average Flow x1000 Gallons
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
January
February
March
April
May
June
July
August
September
October
November
December


Average Color (Pt-Co)
70
60
50
40
30
20
10
0
January
February
March
April
May
June
July
August
September
October
November
December

WRANGELL WATER DISTRIBUTION SYSTEM

Wrangell, Alaska 2014

Influent						
Month	Date	Daily Flow (GPD x 1K)	pH	Temp (C°)	Color (Pt-Co)	Turb (NTU)
January	January -1	518				
	January -2	518	6.3	4.4	33	1.32
	January -3	828	6.6	5.4	36	1.86
	January -4	637				
	January -5	637				
	January -6	637	6.4	4.4	39	1.55
	January -7	823	6.3	5.1	36	0.91
	January -8	657	6.2	3.8	38	0.86
	January -9	584	6.5	4.6	37	1
	January -10	647	6.7	4.2	37	0.98
	January -11	708				
	January -12	708				
	January -13	710				
	January -14	304	6.7	6.1	42	1.69
	January -15	580	6.0	4.7	44	1.88
	January -16	632	6.3	4.6	39	1.6
	January -17	598	6.0	4.8	38	1.69
	January -18	595				
	January -19	595				
	January -20	595				
	January -21	596	6.0	5.2	38	1.14
	January -22	646	6.7	5.3	40	1.24
	January -23	821	6.3	5.3	36	1.34
	January -24	603	6.3	5.5	34	0.84
	January -25	633				
	January -26	633				
	January -27	634	6.2	4.6	41	0.91
	January -28	560	6.3	5.5	40	0.94
	January -29	667	6.3	5.3	37	1.13
	January -30	672	6.1	4.8	37	1.17
	January -31	701	6.1	4.8	36	0.96
February	February -1	715				
	February -2	715				
	February -3	717	6.2	4.9	37	0.97
	February -4	692	6.6	5.7	41	0.89
	February -5	866	5.9	4.3	38	0.91
	February -6	772	6.9	5.2	41	1.18
	February -7	909	6.4	4.3	38	0.97
	February -8	787				
	February -9	788				
	February -10	788	6.2	4.5	38	1.32
	February -11	862	6.3	4.4	37	0.94
	February -12	804	6.4	4.7	35	1.02
	February -13	831	5.4	5.5	39	0.88
	February -14	827	6.2	5.1	40	1.02
	February -15	750				
	February -16	751				
	February -17	750				
	February -18	751	6.1	3.9	35	1.02
	February -19	1122	5.9	4.0	37	1
	February -20	536	6.0	4.0	36	0.9
	February -21	813	6.0	4.7	35	0.99
	February -22	811				
	February -23	811				
	February -24	812	6.1	3.7	37	0.93
	February -25	888	6.4	5.2	39	0.95
	February -26	802	6.5	5.5	40	1.18
	February -27	805	6.1	4.9	38	1.12
	February -28	802	6.2	5.4	39	1.08
	February -29					
	March -1	853				
	March -2	853				
	March -3	855	6.6	3.2	39	1.01
	March -4	803	5.7	4.1	44	1.23
	March -5	1091	6.6	3.6	41	1
	March -6	729	6.3	3.9	37	0.98
	March -7	957	6.5	3.4	35	0.93
	March -8	892				
	March -9	892				
	March -10	892	5.4	5.2	41	1.1
	March -11	916	6.4	4.3	38	1.04
	March -12	1391	6.3	5.0	39	1.06

March	March -13	1117	5.9	6.2	36	1.06
	March -14	1196	6.4	4.5	36	1.16
	March -15	841				
	March -16	840				
	March -17	841	5.6	4.8	33	1.11
	March -18	1054	6.2	4.9	34	1.08
	March -19	943	5.9	5.0	31	1.04
	March -20	932	5.7	3.7	30	0.99
	March -21	969	6.4	4.5	31	0.97
	March -22	934				
	March -23	934				
	March -24	934	6.4	5.1	31	1.06
	March -25	1070	6.0	5.4	34	0.97
	March -26	945	6.4	5.8	31	1.29
	March -27	872	5.8	5.1	33	1.12
	March -28	789	5.7	5.2	26	0.59
	March -29					
	March -30					
	March -31					
April	April -1		5.9	4.2	25	1.05
	April -2	1285	6.6	5.4	25	0.97
	April -3	649	6.7	5.3	29	1.14
	April -4	698	5.9	5.4	24	0.83
	April -5	728.3				
	April -6	728.3				
	April -7	728.4	6.6	5.3	24	0.99
	April -8	816	6.0	3.9	30	3.21
	April -9	699	5.7	4.6	21	1.59
	April -10	769	6.5	5.7	24	1.22
	April -11	683	5.7	6.6	26	1.63
	April -12	683				
	April -13	683				
	April -14	684	6.6	5.8	32	0.82
	April -15	691	6.5	7.5	31	0.85
	April -16	696	6.6	6.9	32	0.86
	April -17	649	6.5	6.0	31	0.81
	April -18	645	5.7	6.6	33	0.74
	April -19	638				
	April -20	638				
	April -21	639	6.1	6.0	33	0.71
	April -22	800	6.7	7.5	34	0.74
	April -23	484	6.3	6.2	33	0.71
	April -24	641	6.1	6.8	42	1.08
	April -25	763	5.9	6.3	32	0.72
	April -26	645				
	April -27	646				
	April -28	646	6.5	7.0	37	1.03
	April -29	682	6.2	8.1	33	1.84
	April -30	809	5.9	5.9	32	0.86

	May -1	774	5.6	6.2	31	1.06
	May -2	695	6.0	6.4	32	0.88
	May -3	686.3				
	May -4	686.3				
	May -5	686.4	5.4	7.1	32	0.94
	May -6		6.4	9.4	34	0.8
	May -7		5.7	7.6	34	0.75
	May -8	800	6.3	8.7	33	0.91
	May -9	840	5.9	6.8	37	0.8
	May -10	765				
	May -11	765				
	May -12	767	6.1	8.4	34	1.51
	May -13	747	5.7	8.8	32	1.09
	May -14	756	5.9	9.0	33	0.82
	May -15	800	6.5	8.9	35	0.8
May	May -16	665	6.0	10.0	34	0.82
	May -17	743				
	May -18	743				
	May -19	743	6.1	10.2	36	1.27
	May -20	667	6.4	9.7	30	0.76
	May -21	593				
	May -22	710	6.0	9.9	30	0.75
	May -23	730	6.7	10.0	37	0.88
	May -24	885				
	May -25	632				
	May -26	637				
	May -27	628	5.9	11.1	32	0.8
	May -28	641	5.6	9.7	31	0.88
	May -29	697	6.2	10.4	36	0.85
	May -30	769	5.6	11.1	32	0.79
	May -31	725				
	June -1	725				
	June -2	725	5.8	10.8	34	0.89
	June -3	684	6.1	10.4	33	0.98
	June -4	918	5.8	10.8	33	0.92
	June -5	601	6.5	10.2	31	1.11
	June -6	760	6.3	10.7	33	1.1
	June -7	930				
	June -8	930				
	June -9	930	6.4	11.2	32	1.05
	June -10		6.2	11.2	31	1.21
	June -11		6.2	11.0	33	2.4
	June -12	693	6.5	11.0	29	0.99
	June -13	823	6.3	11.4	29	1.01
	June -14	756.3				
June	June -15	756.3				
	June -16	756.4	5.4	11.8	31	1.19
	June -17	861	5.6	11.2	34	1.15
	June -18	894	5.6	11.8	32	1.28
	June -19	1231	5.8	13.7	32	1.77
	June -20	996	6.2	11.7	32	1.45
	June -21	1040				
	June -22	1040				
	June -23	1040	6.2	12.1	34	1.21
	June -24		6.4	11.8	39	1.29
	June -25	1007				
	June -26	1008	6.0	11.4	38	2.02
	June -27	1062				
	June -28	1062				
	June -29	1062				
	June -30	1063	6.2	11.9	40	1.56

July	July -1	1215	6.3	12.2	40	1.27
	July -2	1127	6.1	12.1	42	1.36
	July -3	1129	6.6	12.4	39	1.29
	July -4	957.75				
	July -5	975.75				
	July -6	975.75				
	July -7	921.75	6.5	12.2	42	1.31
	July -8	923	5.8	12.6	40	1.69
	July -9	1373	6.0	13.2	47	1.63
	July -10	1223	6.3	13.7	42	1.64
	July -11	1188	6.1	13.0	42	1.7
	July -12	968				
	July -13	912				
	July -14	1024	6.1	13.6	43	1.34
	July -15	1472	5.9	13.1	44	2.02
	July -16	1296	6.3	13.2	44	1.66
	July -17	1437	6.1	13.3	44	1.8
	July -18	1382	6.1	13.7	47	1.83
	July -19	1239				
	July -20	1239				
	July -21	1240	5.8	14.0	48	2.22
	July -22	1232	5.8	13.6	49	2.51
	July -23	1342	6.6	13.9	49	2.23
	July -24	1418	6.3	14.3	48	2.42
	July -25	1438	5.9	13.7	51	2.56
	July -26	1404				
	July -27	1404				
	July -28	1404	6.1	14.3	52	2.17
	July -29	1207	6.6	13.7	49	1.96
	July -30	1401	6.0	14.4	57	2.1
	July -31	1400	5.9	13.8	52	2.17
August	Aug. -1	1234	5.9	13.1	46	2.31
	Aug. -2	1364				
	Aug. -3	1364				
	Aug. -4	1365	5.9	13.4	57	2.3
	Aug. -5		5.7	13.6	49	2.01
	Aug. -6					
	Aug. -7	1395				
	Aug. -8	1396	5.7	13.8	54	2.46
	Aug. -9					
	Aug. -10					
	Aug. -11		6.0	15.2	57	4.48
	Aug. -12	1402	5.4	13.3	54	3.21
	Aug. -13	1080	5.6	13.7	65	2.86
	Aug. -14	1464	5.8	13.9	61	2.97
	Aug. -15	1532	5.8	13.7	58	2.06
	Aug. -16	1314				
	Aug. -17	1314				
	Aug. -18	1314	5.8	13.6	61	3.16
	Aug. -19	1188	6.0	13.8	54	2.64
	Aug. -20	1565	6.1	13.1	52	2.51
	Aug. -21	966	6.2	14.0	62	2.46
	Aug. -22	1316	6.0	13.9	65	2.67
	Aug. -23	1129				
	Aug. -24	1129				
	Aug. -25	1129	6.1	14.1	62	2.45
	Aug. -26	1413	6.0	14.0	60	2.51
	Aug. -27	306	6.2	13.6	67	2.95
	Aug. -28	934	5.9	13.8	62	3.05
	Aug. -29	805	6.0	13.5	68	3.25
	Aug. -30	1004.5				
	Aug. -31	1004.5				

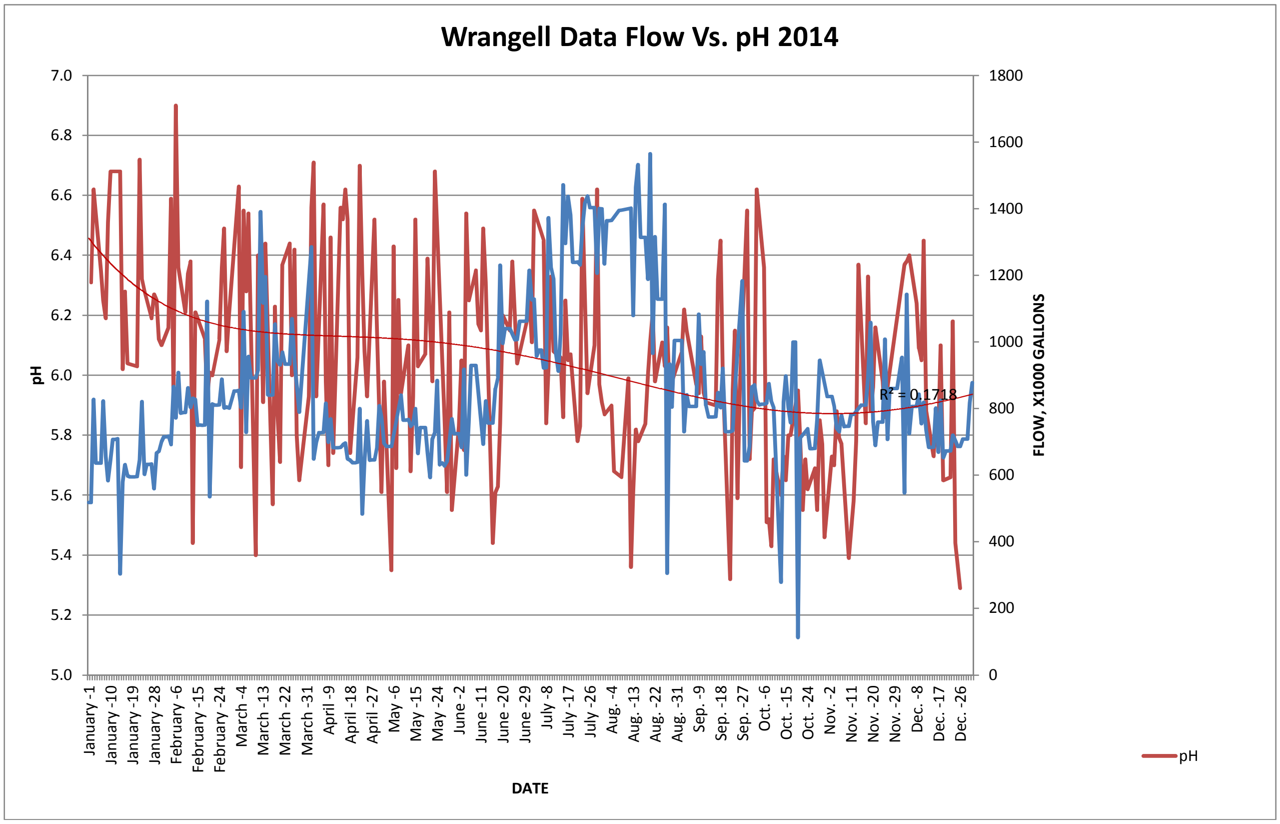
September	Sep. -1	1004.5				
	Sep. -2	1004.5	6.1	13.1	66	2.57
	Sep. -3	731	6.2	12.9	64	2.39
	Sep. -4	841	6.2	13.1	66	2.52
	Sep. -5	806.5				
	Sep. -6	806.5				
	Sep. -7	806.5				
	Sep. -8	806.5	6.0	12.9	66	3.02
	Sep. -9	1084	5.9	12.5	64	2.4
	Sep. -10	934	6.1	12.9	62	2.6
	Sep. -11	970	5.9	12.8	62	2.3
	Sep. -12	810	5.9	12.6	62	2.44
	Sep. -13	775				
	Sep. -14	775				
	Sep. -15	775				
	Sep. -16	776	5.9	12.8	63	2.56
	Sep. -17	848	6.3	12.7	59	2.61
	Sep. -18	803	6.5	12.3	60	2.93
	Sep. -19	921	6.0	12.3	63	3.02
	Sep. -20	730.33				
	Sep. -21	730.33				
	Sep. -22	730.34	5.3	12.4	64	4.32
	Sep. -23	735	6.0	11.8	65	3.18
	Sep. -24	857	6.2	11.4	69	2.54
	Sep. -25		5.6	11.9	65	2.61
	Sep. -26		6.0	12.9	66	2.08
	Sep. -27	1184				
	Sep. -28	643				
	Sep. -29	643	6.6	11.4	65	2.25
	Sep. -30	687	5.7	11.7	67	1.83
October	Oct. -1	865	5.9	11.7	67	1.99
	Oct. -2	871	5.9	10.2	65	1.71
	Oct. -3	825	6.6	11.8	71	1.7
	Oct. -4	812				
	Oct. -5	813				
	Oct. -6	813	6.4	11.3	64	1.4
	Oct. -7	816	5.5	10.8	66	1.26
	Oct. -8	875	5.5	10.9	67	1.18
	Oct. -9	820	5.4	11.7	73	1.33
	Oct. -10	802	5.7	11.4	75	1.07
	Oct. -11					
	Oct. -12					
	Oct. -13	279	5.6	10.8	59	1.38
	Oct. -14	820	5.7	10.5	60	1.17
	Oct. -15	898	5.7	11.1	62	1.01
	Oct. -16	804	5.8	11.7	69	1.55
	Oct. -17	758	5.8	10.6	60	1.12
	Oct. -18	1000				
	Oct. -19	1000				
	Oct. -20	113	6.0	10.0	61	1.4
	Oct. -21	713	5.8	9.7	58	1.38
	Oct. -22		5.6	10.0	62	1.69
	Oct. -23		5.7	10.0	60	0.99
	Oct. -24	739	5.6	10.3	62	1.23
	Oct. -25	680				
	Oct. -26	680				
	Oct. -27	681	5.7	9.2	67	0.95
	Oct. -28	767	5.6	9.2	60	0.97
	Oct. -29	945	5.9	9.5	62	0.97
	Oct. -30		5.8	9.5	62	0.99
	Oct. -31		5.5	9.1	59	1.2

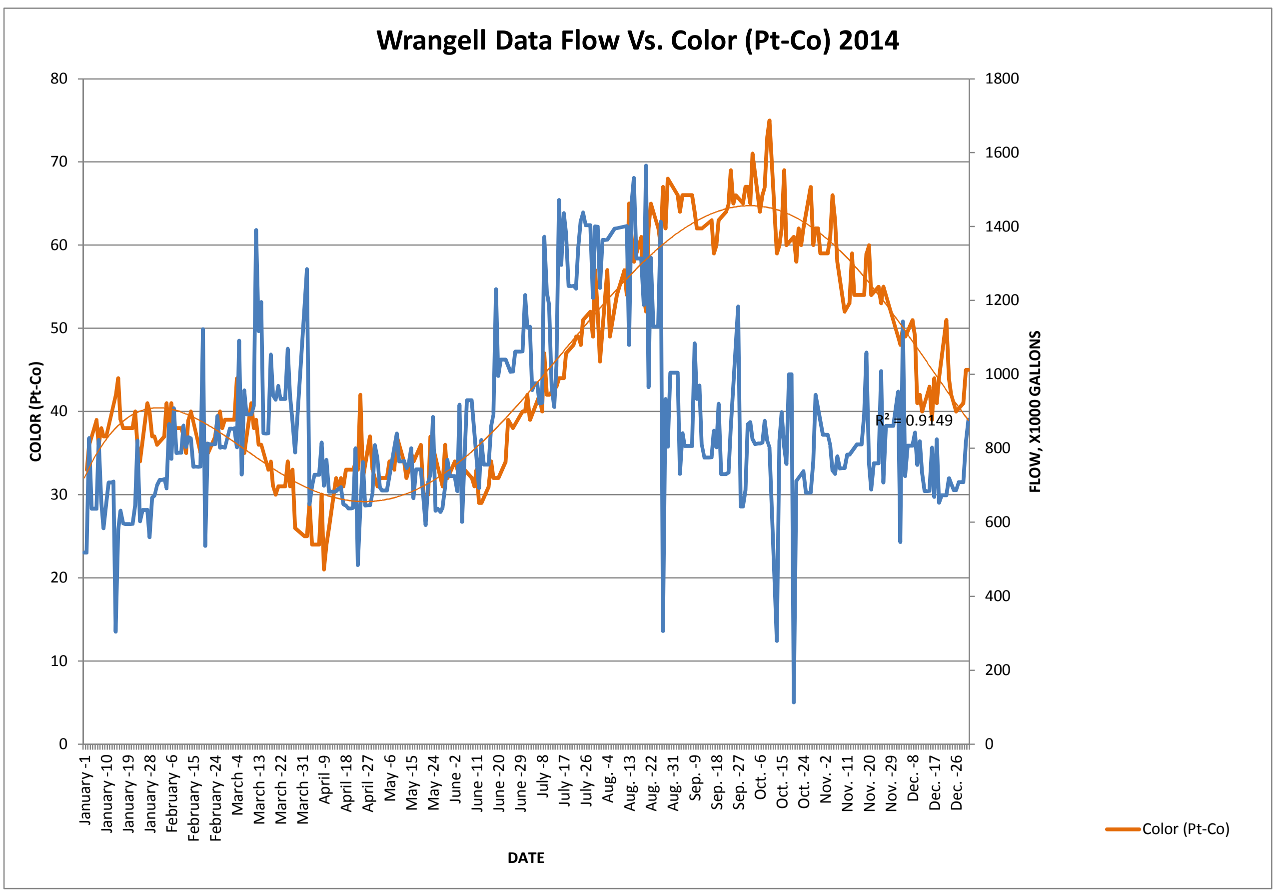
November	Nov. -1	837				
	Nov. -2	837				
	Nov. -3	837	5.7	7.5	59	0.79
	Nov. -4	807	5.7	8.5	61	0.9
	Nov. -5	740	5.9	7.3	66	1.1
	Nov. -6	731	5.8	10.0	63	2.91
	Nov. -7	779	5.8	7.5	58	0.7
	Nov. -8	746				
	Nov. -9	747				
	Nov. -10	747	5.4	6.9	52	0.7
	Nov. -11	783				
	Nov. -12	783	5.6	6.2	53	0.72
	Nov. -13		5.8	5.8	59	0.65
	Nov. -14		6.4	5.6	54	0.67
	Nov. -15	811				
	Nov. -16	811				
	Nov. -17	811	5.8	6.2	54	0.71
	Nov. -18	892	6.3	5.3	54	0.8
	Nov. -19	1059	5.9	6.3	59	0.76
	Nov. -20	761	6.0	6.1	60	0.71
	Nov. -21	689	6.2	5.5	54	0.91
	Nov. -22	759.33				
	Nov. -23	759.34				
	Nov. -24	759.33	6.0	6.8	55	0.86
	Nov. -25	1009	5.9	5.7	53	0.77
	Nov. -26	708	6.0	6.5	55	0.82
	Nov. -27	861				
	Nov. -28	861				
	Nov. -29	861				
	Nov. -30	861				
December	Dec. -1					
	Dec. -2	954				
	Dec. -3	547	6.4	5.2	48	1.01
	Dec. -4	1143	6.4	5.0	50	0.95
	Dec. -5	725	6.4	4.7	49	0.94
	Dec. -6	807				
	Dec. -7	807				
	Dec. -8	807	6.2	5.5	51	1.62
	Dec. -9	843	6.1	5.9	49	0.89
	Dec. -10	755	6.1		41	1
	Dec. -11	819	6.5	5.1	42	1.05
	Dec. -12	735	5.9	5.2	40	0.85
	Dec. -13	684				
	Dec. -14	684				
	Dec. -15	685	5.7	5.8	43	0.75
	Dec. -16	802	5.9	4.5	39	0.84
	Dec. -17	669	5.8	5.4	44	0.73
	Dec. -18	825	6.1	7.1	41	0.88
	Dec. -19	653	5.7	6.5	44	0.79
	Dec. -20	673				
	Dec. -21	673				
	Dec. -22	673	5.7	6.9	51	1.01
	Dec. -23	720	6.2	6.8	44	0.84
	Dec. -24	703	5.4	5.7	42	0.87
	Dec. -25	687				
	Dec. -26	687	5.3	7.2	40	0.8
	Dec. -27	708.6				
	Dec. -28	708.6				
	Dec. -29	708.8			41	0.86
	Dec. -30	817			45	0.83
	Dec. -31	878			45	1.07

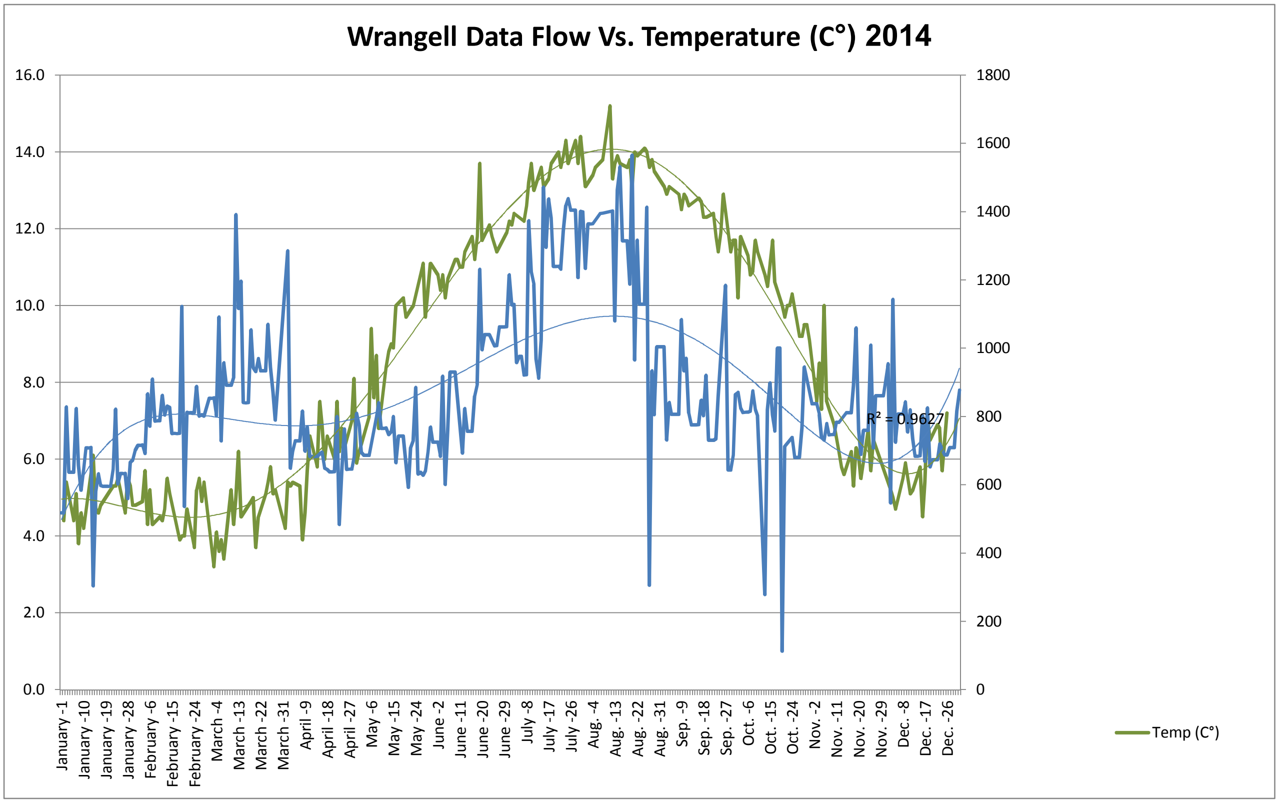
AVG **856**

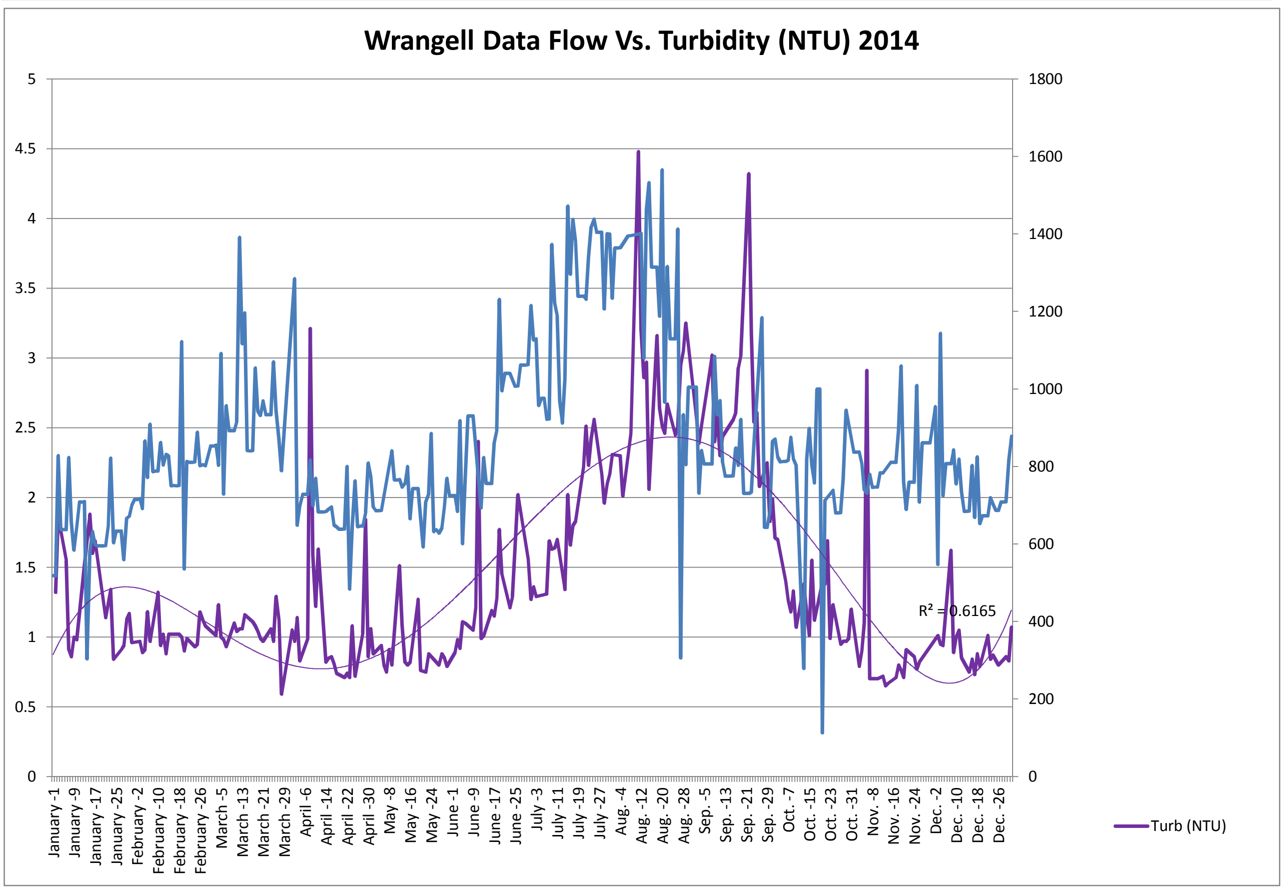
Statistical Analysis

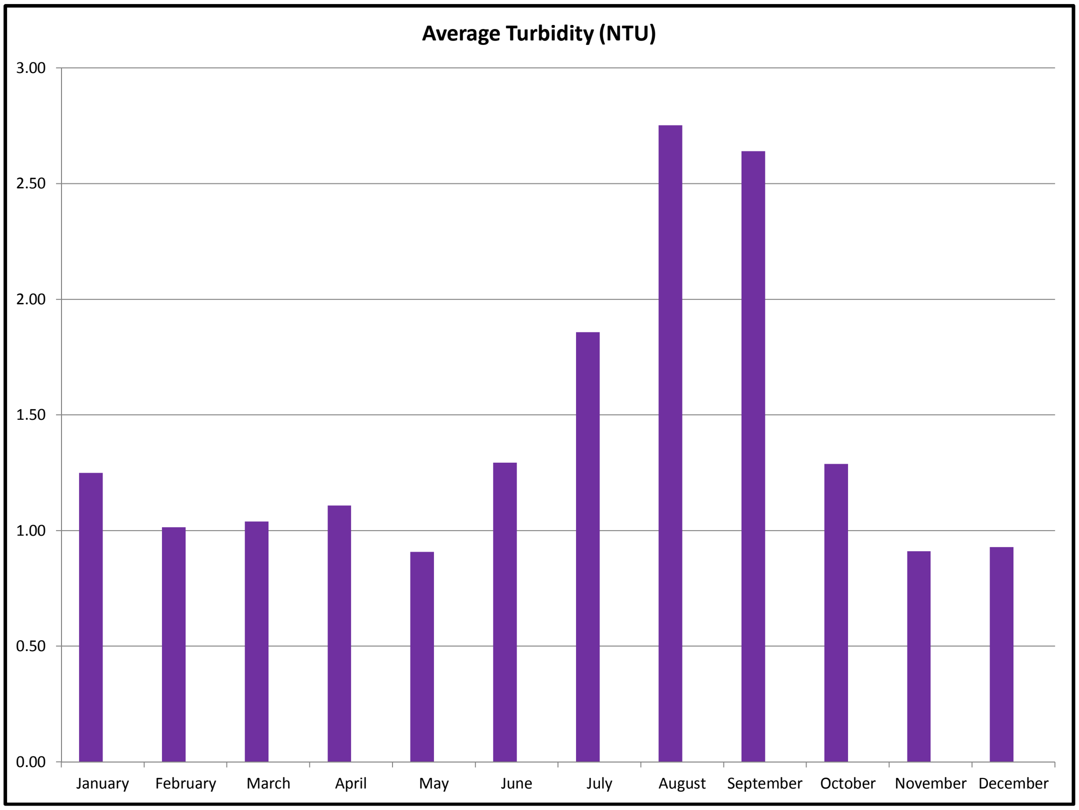
Month	Turbidity (NTU)			Flow (gdp x 1000)			pH			Color (Pt-Co)			Temp (C°)		
	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min
January	1.25	1.88	0.84	634.74	828	304	6.3	6.7	6.0	38	44	33	4.9	6.1	3.8
February	1.01	1.32	0.88	795.61	1122	536	6.2	6.9	5.4	38	41	35	4.7	5.7	3.7
March	1.04	1.29	0.59	940.54	1391	729	6.1	6.6	5.4	35	44	26	4.6	6.2	3.2
April	1.11	3.21	0.71	708.48	1285	484	6.2	6.7	5.7	30	42	21	6.0	8.1	3.9
May	0.91	1.51	0.75	723.31	885	593	6.0	6.7	5.4	33	37	30	9.0	11.1	6.2
June	1.29	2.4	0.89	902.00	1231	601	6.1	6.5	5.4	33	40	29	11.4	13.7	10.2
July	1.86	2.56	1.27	1221.55	1472	912	6.1	6.6	5.8	46	57	39	13.4	14.4	12.1
August	2.75	4.48	2.01	1208.73	1565	306	5.9	6.2	5.4	59	68	46	13.7	15.2	13.1
September	2.64	4.32	1.83	829.21	1184	643	6.0	6.6	5.3	64	69	59	12.4	13.1	11.4
October	1.29	1.99	0.95	767.56	1000	113	5.8	6.6	5.4	64	75	58	10.5	11.8	9.1
November	0.91	2.91	0.65	808.82	1059	689	5.9	6.4	5.4	57	66	52	6.7	10.0	5.3
December	0.93	1.62	0.73	752.70	1143	547	6.0	6.5	5.3	44	51	39	5.8	7.2	5

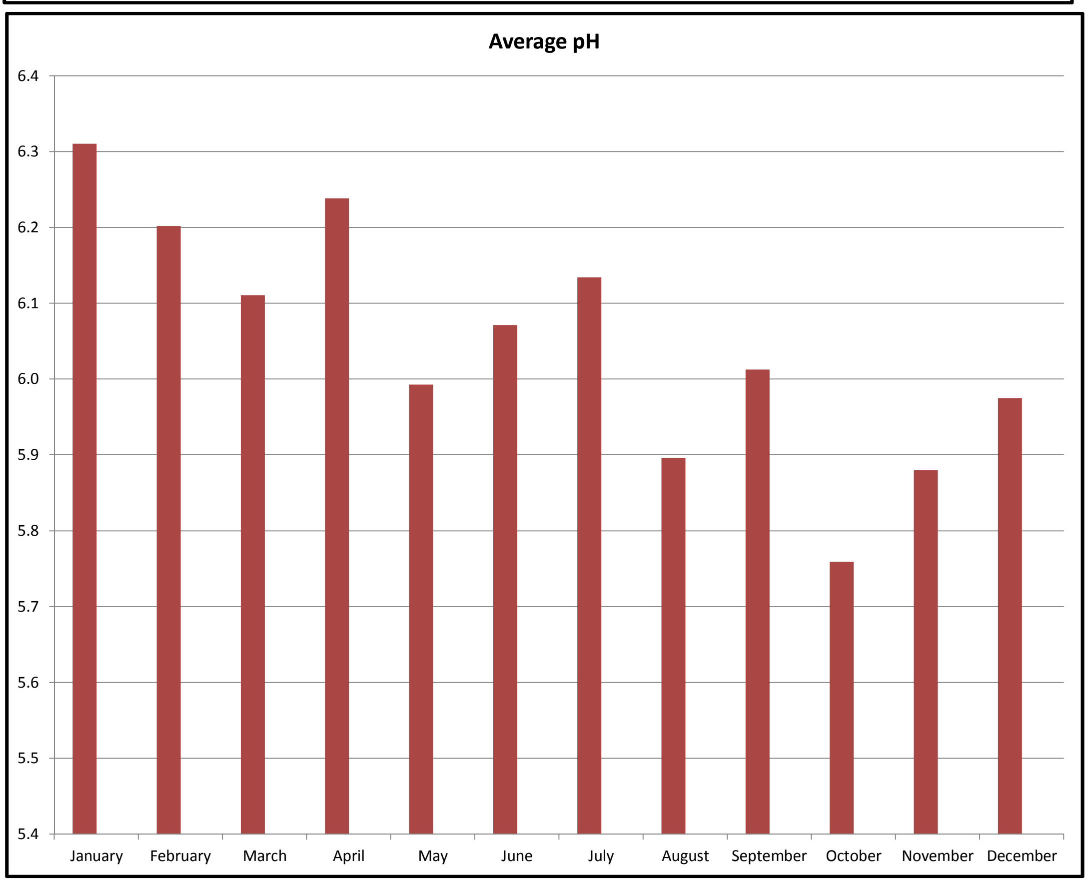

Wrangell Data Flow Vs. pH 2014
pH
FLOW, X1000 GALLONS
DATE
R^2 = 0.1718
pH

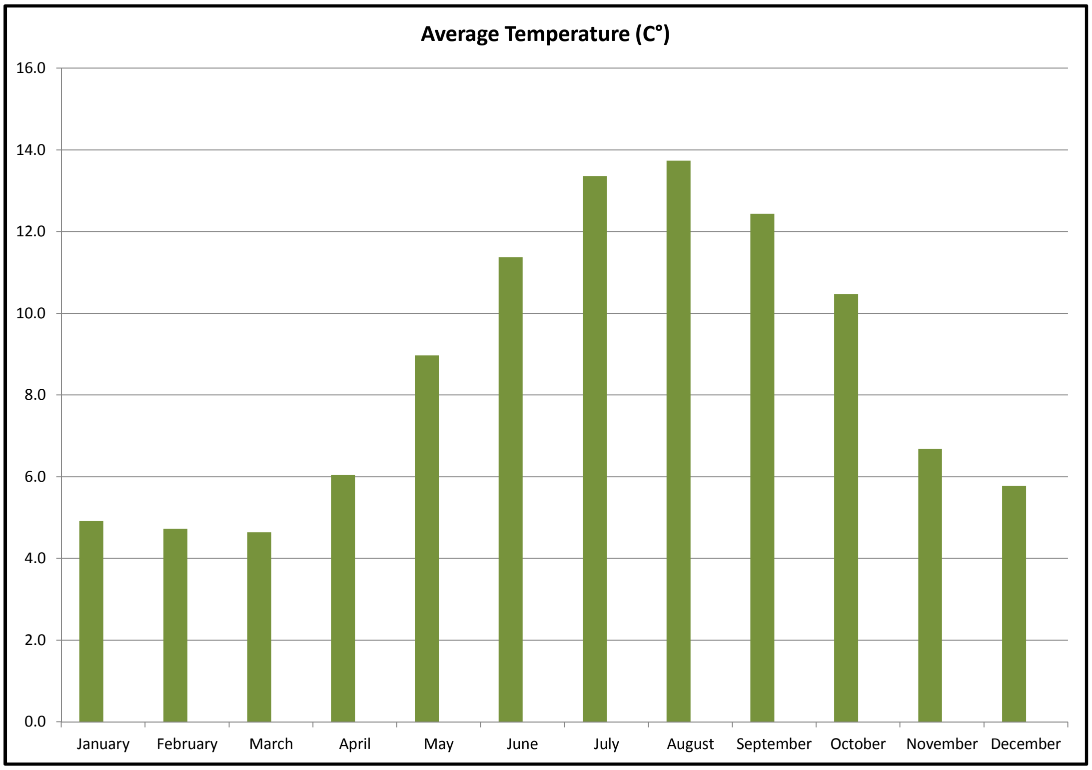

Wrangell Data Flow Vs. Color (Pt-Co) 2014
COLOR (Pt-Co)
FLOW, X1000 GALLONS
DATE
R^2 = 0.9149
Color (Pt-Co)

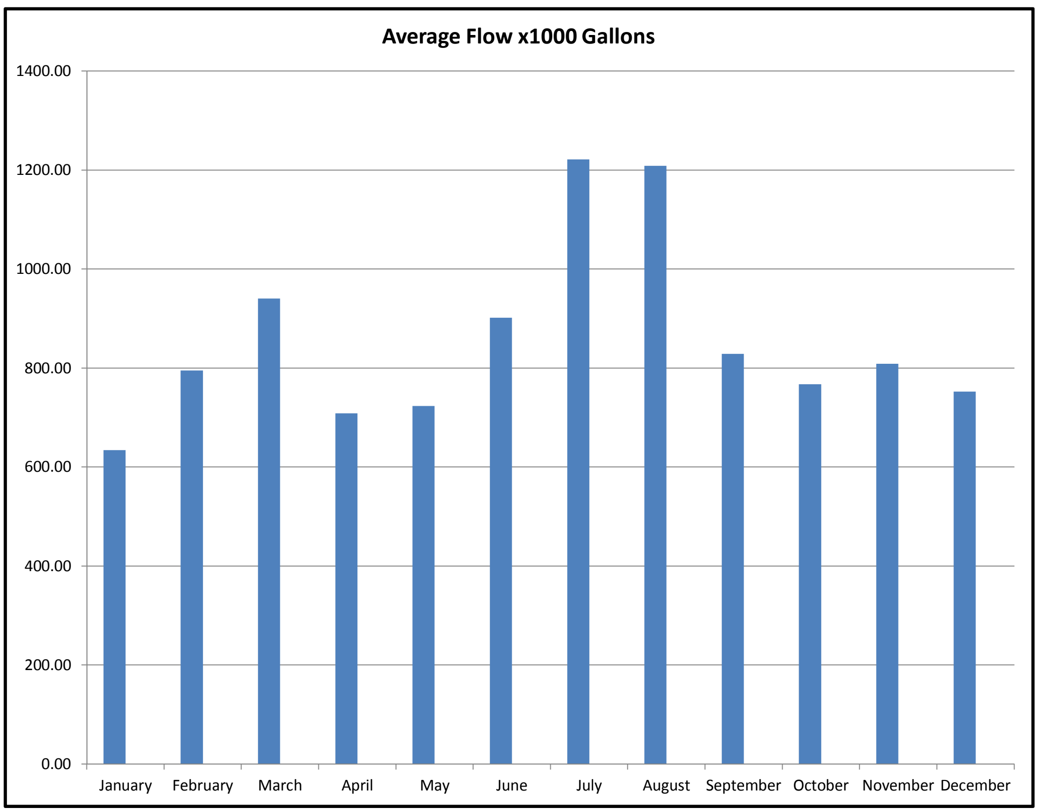

Wrangell Data Flow Vs. Temperature (C°) 2014
R² = 0.9627
Temp (C°)

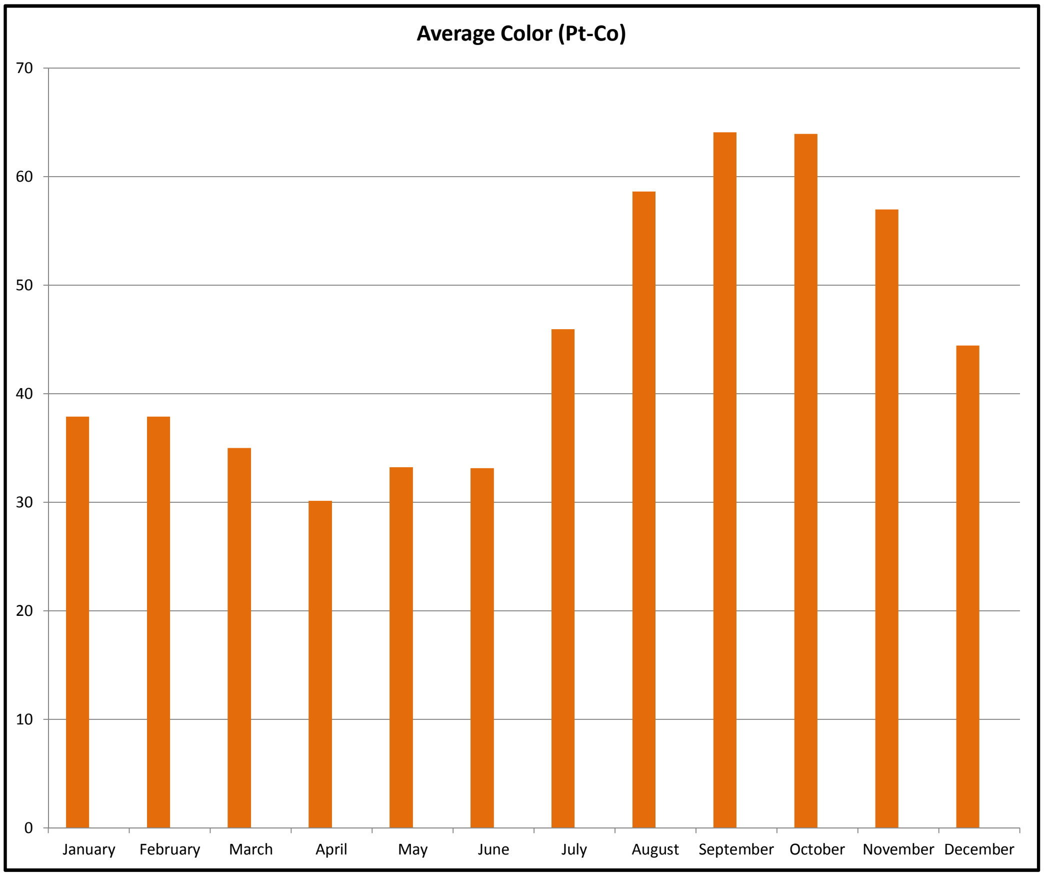

Wrangell Data Flow Vs. Turbidity (NTU) 2014
R² = 0.6165
Turb (NTU)


Average Turbidity (NTU)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
January
February
March
April
May
June
July
August
September
October
November
December


Average pH
6.4
6.3
6.2
6.1
6.0
5.9
5.8
5.7
5.6
5.5
5.4
January
February
March
April
May
June
July
August
September
October
November
December


Average Temperature (C°)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
January
February
March
April
May
June
July
August
September
October
November
December


Average Flow x1000 Gallons
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
January
February
March
April
May
June
July
August
September
October
November
December


Average Color (Pt-Co)
70
60
50
40
30
20
10
0
January
February
March
April
May
June
July
August
September
October
November
December

WRANGELL WATER DISTRIBUTION SYSTEM

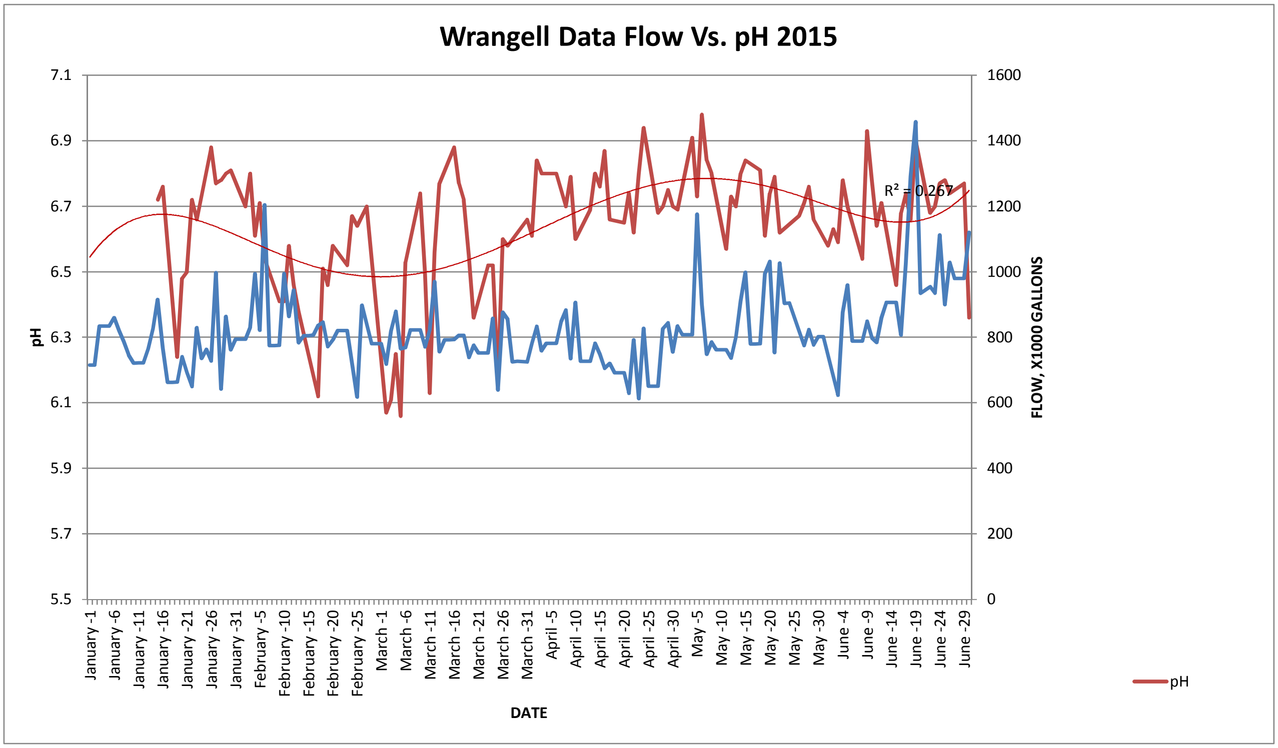
Wrangell, Alaska 2015

		Influent				
Month	Date	Daily Flow (GPD x 1K)	pH	Temp (C°)	Color (Pt-Co)	Turb (NTU)
January	January -1	716				
	January -2	716			45	1.07
	January -3	835				
	January -4	835				
	January -5	835			40	0.9
	January -6	860			42	1.04
	January -7	821			42	0.89
	January -8	787			41	1.08
	January -9	747			42	0.92
	January -10	721				
	January -11	722				
	January -12	722			41	0.95
	January -13	765				
	January -14	827			47	1
	January -15	916	6.7	5.5	55	0.85
	January -16	768	6.8	5.5	60	1.09
	January -17	663				
	January -18	663				
	January -19	664	6.2	6.2	63	0.87
	January -20	741	6.5	6.4	60	0.87
	January -21	693	6.5	5.7	49	1.29
	January -22	650	6.7	6.6	66	2.06
	January -23	830	6.7	7.0	69	1
	January -24	736				
	January -25	763				
	January -26	728	6.9	7.0	64	1.01
	January -27	998	6.8	5.9	67	0.81
	January -28	642	6.8	6.2	68	0.68
	January -29	864	6.8	6.3	61	0.69
	January -30	762	6.8	5.8	60	0.89
	January -31	795				
February	February -1	795				
	February -2	795	6.7	6.4	63	0.76
	February -3	832	6.8	8.0	67	0.79
	February -4	995	6.6	6.9	63	1.61
	February -5	822	6.7	6.4	59	0.78
	February -6	1205	6.5	7.8	59	1.33
	February -7	775				
	February -8	775				
	February -9	776	6.4	5.4	62	0.68
	February -10	995	6.4	6.4	66	0.68
	February -11	864	6.6	7.0	78	8.06
	February -12	944	6.5	5.5	71	
	February -13	784	6.4	7.1	67	0.68
	February -14	805				
	February -15	805				
	February -16	807				
	February -17	837	6.1	5.8	66	0.66
	February -18	846	6.5	5.9	63	0.8
	February -19	772	6.5	5.8	77	0.67
	February -20	793	6.6	7.3	79	0.95
	February -21	821				
	February -22	821				
	February -23	821	6.5	6.4	53	1.48
	February -24		6.7	6.4	43	0.67
	February -25	618	6.6	6.3	52	0.62
	February -26	898	6.7	5.0	56	0.88
	February -27		6.7	5.0	56	0.88
	February -28	781				
	February -29					

March	March -1	781				
	March -2	718	6.1	4.8	57	0.63
	March -3	820	6.1	6.1	55	0.67
	March -4	880	6.3	6.0	56	0.75
	March -5	765	6.1	6.3	59	0.7
	March -6	769	6.5	5.1	49	0.78
	March -7	823.3				
	March -8	823.3				
	March -9	823.4	6.7	5.4	55	0.79
	March -10	771	6.5	5.7	65	0.78
	March -11	825	6.1	6.2	61	0.85
	March -12	970	6.6	7.4	50	0.7
	March -13	757	6.8	7.4	51	0.85
	March -14	793				
	March -15	793				
	March -16	794	6.9	6.7	55	0.72
	March -17	806	6.8	5.1	64	0.67
	March -18	806	6.7	6.2	64	0.63
	March -19	739	6.6	6.4	63	0.64
	March -20	776	6.4	6.3	72	0.6
	March -21	752.33				
	March -22	752.34				
	March -23	752.33	6.5	6.4	58	0.72
	March -24	858	6.5	6.5	59	0.67
	March -25	639	6.2	6.8	55	0.69
	March -26	877	6.6	7.1	43	0.64
	March -27	856	6.6	6.9	54	0.65
	March -28	725				
	March -29	727				
	March -30	726				
	March -31	725	6.7	6.6	49	0.82
April	April -1	783	6.6	8.3	60	0.66
	April -2	834	6.8	8.2	60	0.77
	April -3	759	6.8	7.1	57	0.83
	April -4	782				
	April -5	782				
	April -6	782	6.8	7.9	59	0.85
	April -7	848				
	April -8	883	6.7	6.7	60	0.85
	April -9	735	6.8	8.2	57	0.74
	April -10	907	6.6	7.1	52	0.65
	April -11	727				
	April -12	727				
	April -13	727	6.7	7.8	51	1.01
	April -14	782	6.8	7.1	50	0.89
	April -15	749	6.8	6.9	58	0.73
	April -16	706	6.9	6.6	52	0.79
	April -17	720	6.7	6.7	51	0.86
	April -18	692				
	April -19	692				
	April -20	692	6.7	8.1	53	0.71
	April -21	630	6.7	7.3	61	1.01
	April -22	793	6.6	7.2	55	0.62
	April -23	613	6.8	7.7	57	0.9
	April -24	828	6.9	7.7	62	0.68
	April -25	651				
	April -26	651				
	April -27	651	6.7	8.0	65	0.77
	April -28	827	6.7	7.6	65	0.81
	April -29	844	6.8	8.6	63	1.13
	April -30	756	6.7	9.3	64	0.79

	May -1	835	6.7	8.2	60	1.21
	May -2	808				
	May -3	808				
	May -4	808	6.9	7.9	60	0.79
	May -5	1176	6.7	7.4	59	0.91
	May -6	901	7.0	7.9	57	0.84
	May -7	749	6.8	7.9	57	0.8
	May -8	786	6.8	8.0	66	1.04
	May -9	762				
	May -10	762				
	May -11	762	6.6	7.7	63	0.79
	May -12	737	6.7	8.2	73	0.73
	May -13	801	6.7	7.9	63	0.77
	May -14	911	6.8	8.0	62	0.65
	May -15	999	6.8	9.1	66	0.68
May	May -16	780				
	May -17	780				
	May -18	781	6.8	8.7	60	0.83
	May -19	996	6.6	9.5	70	0.72
	May -20	1032	6.7	9.0	53	0.56
	May -21	754	6.8	9.6	41	0.88
	May -22	1027	6.6	10.8	69	0.77
	May -23	904				
	May -24	904.5				
	May -25					
	May -26		6.7	10.6	69	0.83
	May -27	775	6.7	10.7	63	0.96
	May -28	824	6.8	11.2	66	0.89
	May -29	777	6.7	11.4	67	0.89
	May -30	802				
	May -31	802				
	June -1		6.6	11.8	58	1.1
	June -2		6.6	11.9	63	1.05
	June -3	624	6.6	12.0	58	1.05
	June -4	877	6.8	12.2	55	1.16
	June -5	960	6.7	13.3	69	1.17
	June -6	788.67				
	June -7	788.63				
	June -8	788.7	6.5	13.7	74	1.26
	June -9	849	6.9	11.8	61	1.1
	June -10	799	6.8	11.6	68	1.25
	June -11	785	6.6	11.6	59	1.1
	June -12	860	6.7	11.8	61	1.24
	June -13	907.33				
	June -14	907.34				
June	June -15	907.33	6.5	12.6	64	1.19
	June -16	807	6.7	12.8	63	1.04
	June -17	1024	6.7	13.1	55	1.25
	June -18	1291	6.7	12.3	42	1.82
	June -19	1458	6.9	12.3	58	1.27
	June -20	935				
	June -21	945				
	June -22	955	6.7	12.4	63	1.29
	June -23	935	6.7	12.5	67	1.6
	June -24	1113	6.8	13.1	65	1.41
	June -25	900	6.8	13.9	66	1.5
	June -26	1029	6.7	13.3	64	1.81
	June -27	980				
	June -28	980				
	June -29	980	6.8	14.4	66	1.92
	June -30	1121	6.4	13.2	65	1.66

AVG **819**


Wrangell Data Flow Vs. pH 2015
pH
FLOW, X1000 GALLONS
DATE
pH
R² = 0.267
7.1
6.9
6.7
6.5
6.3
6.1
5.9
5.7
5.5
1600
1400
1200
1000
800
600
400
200
0
January -1
January -6
January -11
January -16
January -21
January -26
January -31
February -5
February -10
February -15
February -20
February -25
March -1
March -6
March -11
March -16
March -21
March -26
March -31
April -5
April -10
April -15
April -20
April -25
April -30
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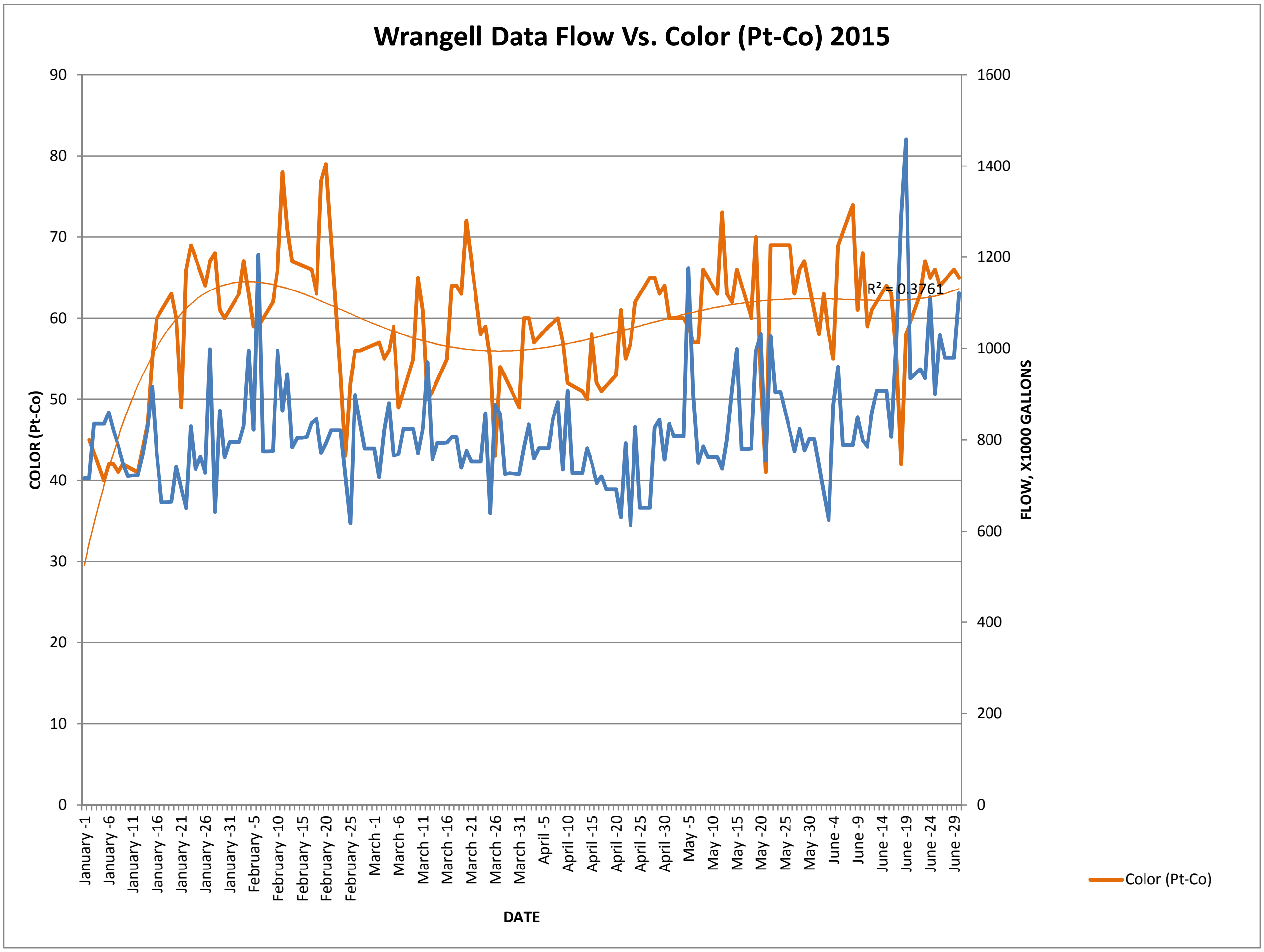
June -19
June -24
June -29


Wrangell Data Flow Vs. Color (Pt-Co) 2015
COLOR (Pt-Co)
FLOW, X1000 GALLONS
DATE
Color (Pt-Co)
R² = 0.3761
90
80
70
60
50
40
30
20
10
0
1600
1400
1200
1000
800
600
400
200
0
January -1
January -6
January -11
January -16
January -21
January -26
January -31
February -5
February -10
February -15
February -20
February -25
March -1
March -6
March -11
March -16
March -21
March -26
March -31
April -5
April -10
April -15
April -20
April -25
April -30
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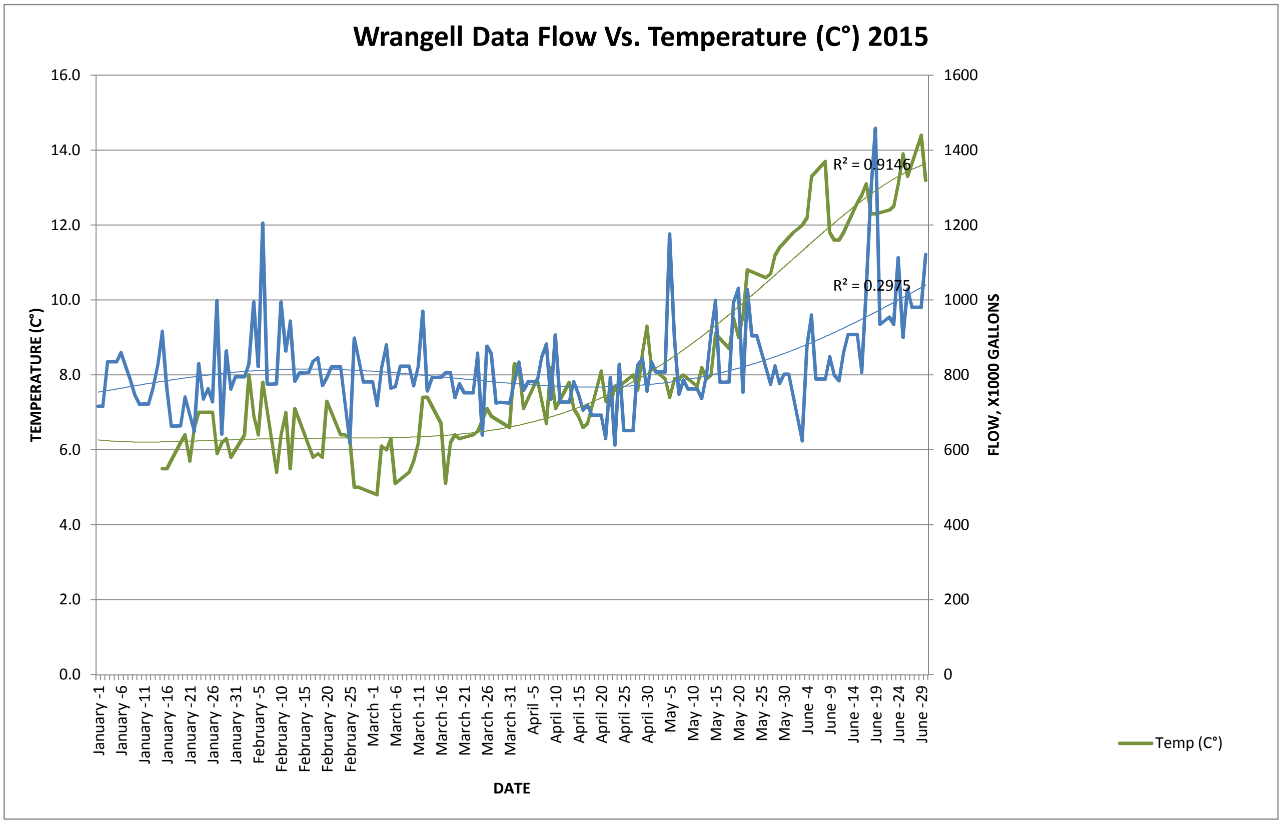
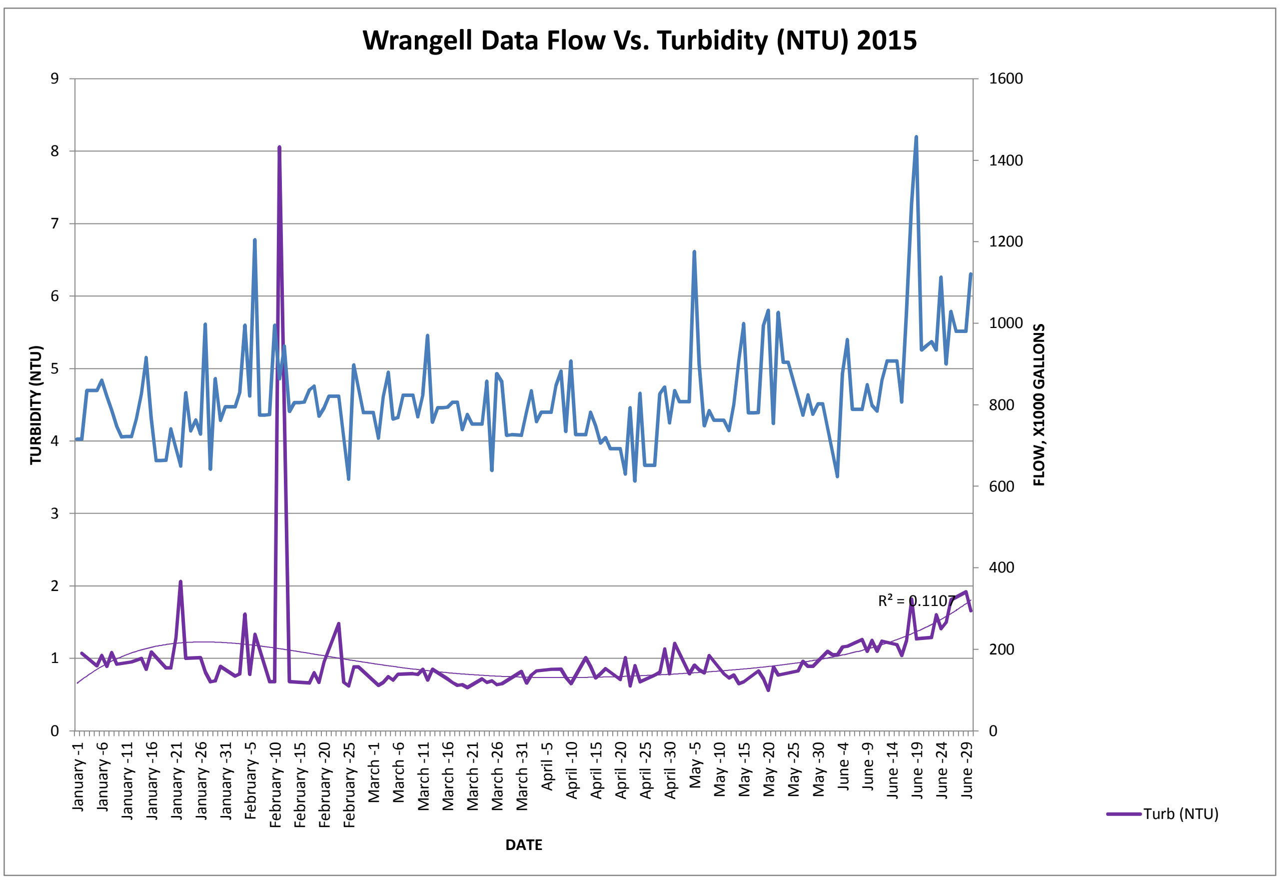
June -19
June -24
June -29


Wrangell Data Flow Vs. Temperature (C°) 2015
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
TEMPERATURE (C°)
1600
1400
1200
1000
800
600
400
200
0
FLOW, X1000 GALLONS
R² = 0.9146
R² = 0.2975
January -1
January -6
January -11
January -16
January -21
January -26
January -31
February -5
February -10
February -15
February -20
February -25
March -1
March -6
March -11
March -16
March -21
March -26
March -31
April -5
April -10
April -15
April -20
April -25
April -30
May -5
May -10
May -15
May -20
May -25
May -30
June -4
June -9
June -14
June -19
June -24
June -29
DATE
Temp (C°)


Wrangell Data Flow Vs. Turbidity (NTU) 2015
9
8
7
6
5
4
3
2
1
0
TURBIDITY (NTU)
1600
1400
1200
1000
800
600
400
200
0
FLOW, X1000 GALLONS
R² = 0.1107
January -1
January -6
January -11
January -16
January -21
January -26
January -31
February -5
February -10
February -15
February -20
February -25
March -1
March -6
March -11
March -16
March -21
March -26
March -31
April -5
April -10
April -15
April -20
April -25
April -30
May -5
May -10
May -15
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May -30
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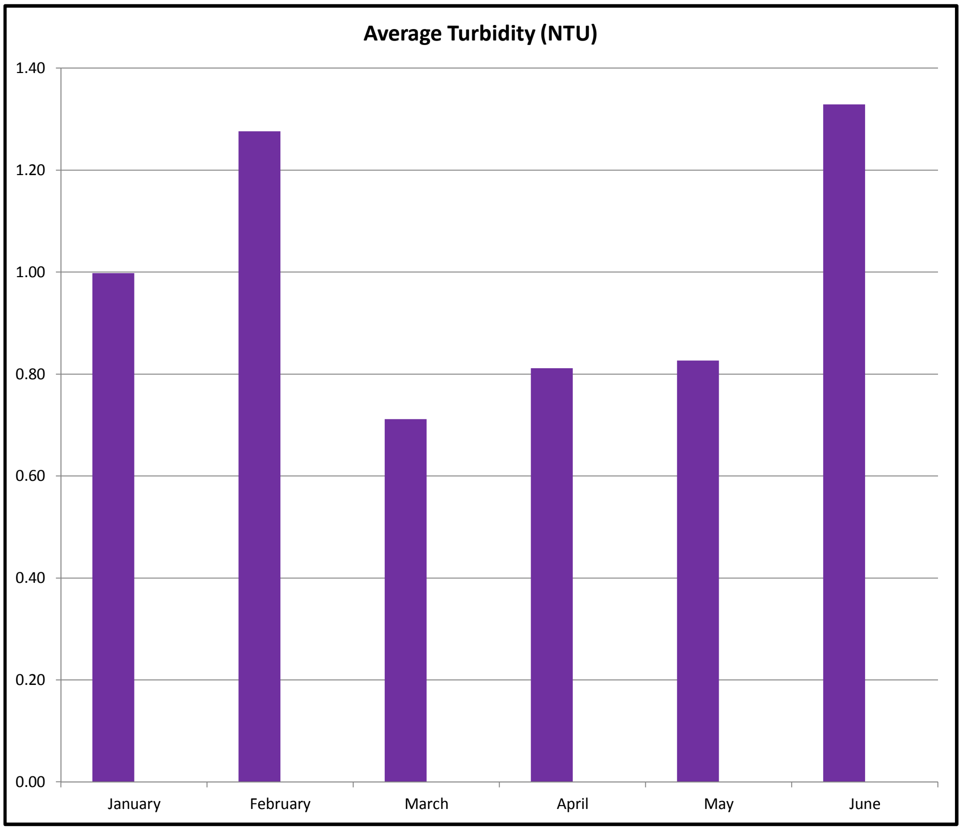
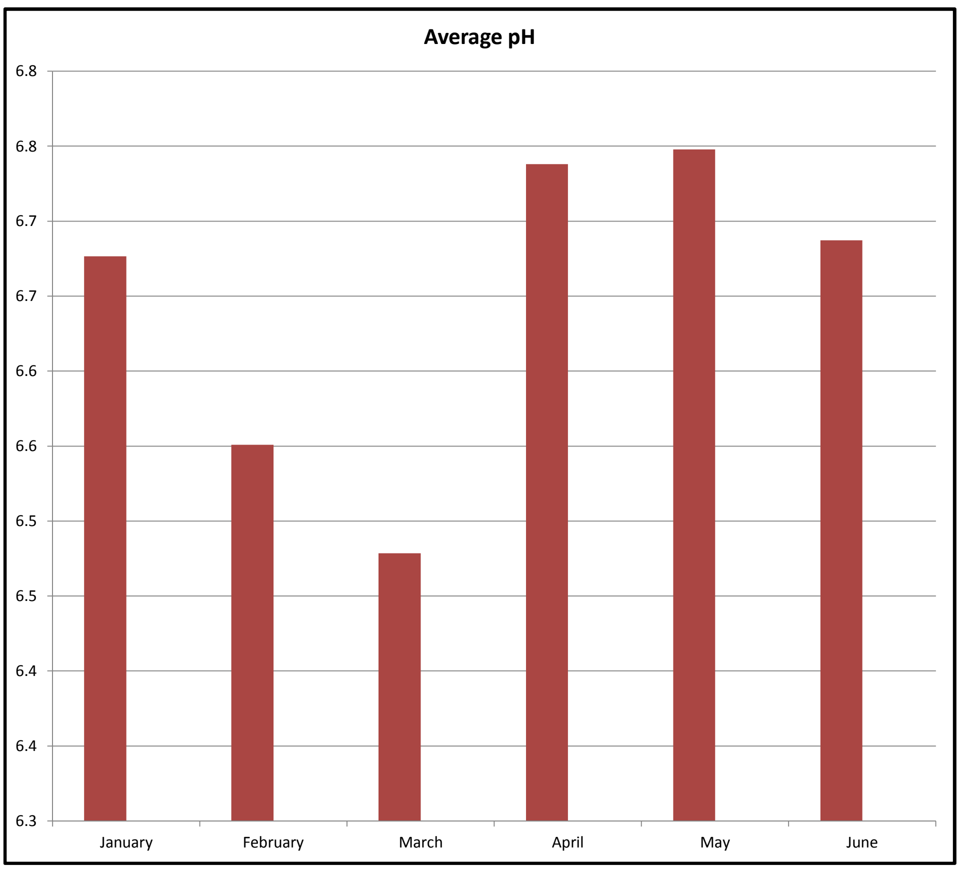
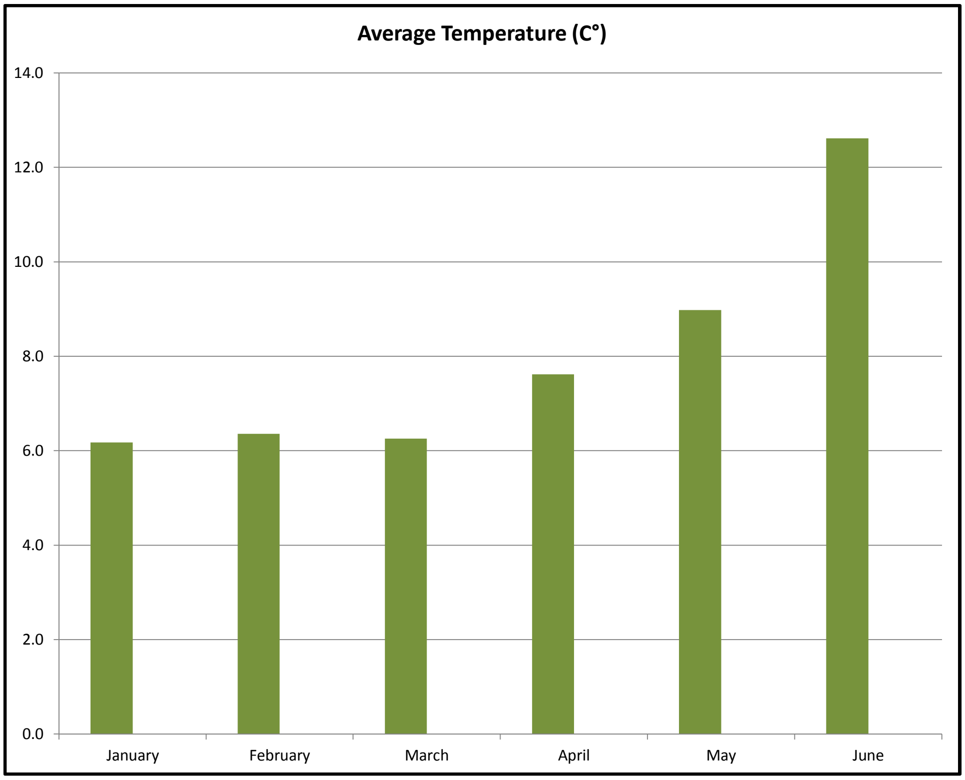
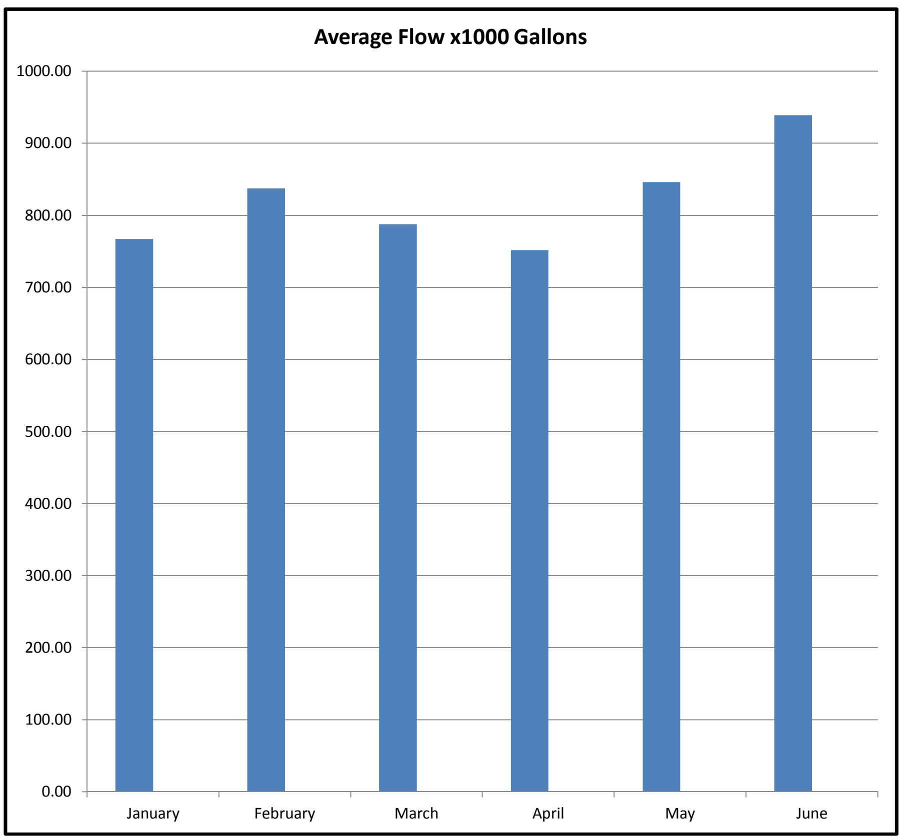
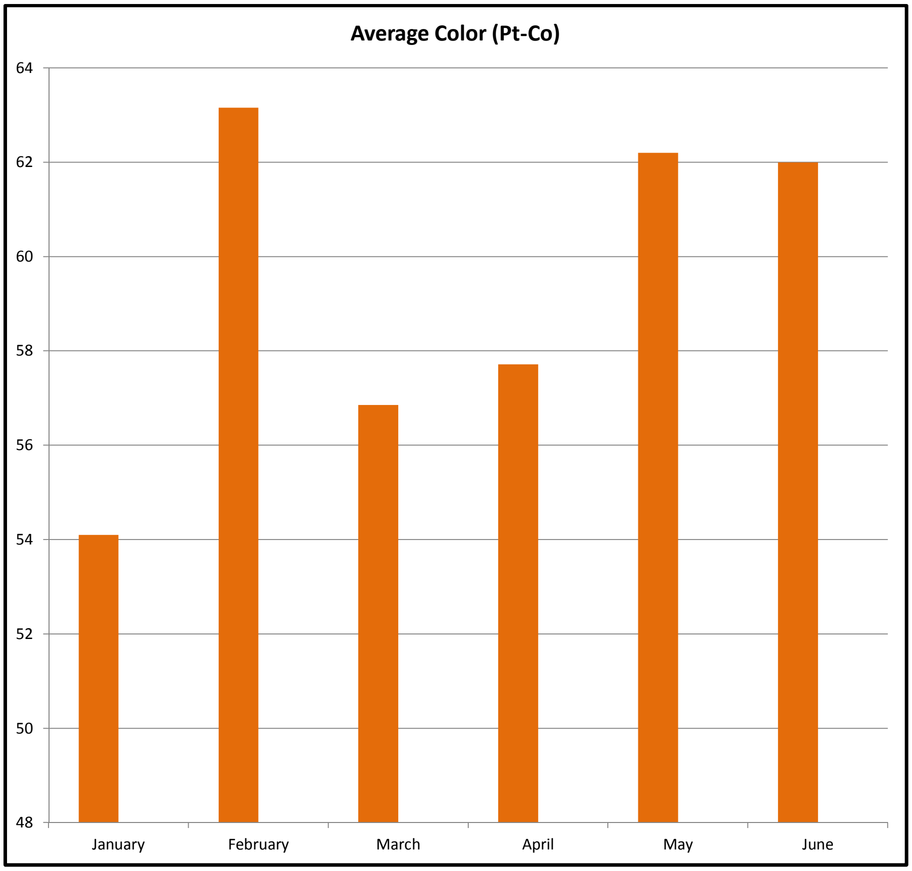
June -9
June -14
June -19
June -24
June -29
DATE
Turb (NTU)


Average Turbidity (NTU)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
January
February
March
April
May
June


Average pH
6.8
6.8
6.7
6.7
6.6
6.6
6.5
6.5
6.4
6.4
6.3
January
February
March
April
May
June


Average Temperature (C°)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
January
February
March
April
May
June


Average Flow x1000 Gallons
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
January
February
March
April
May
June


Average Color (Pt-Co)
64
62
60
58
56
54
52
50
48
January
February
March
April
May
June

Statistical Analysis

Month	Turbidity (NTU)			Flow (gdp x 1000)			pH			Color (Pt-Co)			Temp (C°)		
	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min
January	1.00	2.06	0.68	767.26	998	642	6.7	6.9	6.2	54	69	40	6.2	7.0	5.5
February	1.28	8.06	0.62	837.77	1205	618	6.6	6.8	6.1	63	79	43	6.4	8.0	5.0
March	0.71	0.85	0.6	787.84	970	639	6.5	6.9	6.1	57	72	43	6.3	7.4	4.8
April	0.81	1.13	0.62	751.77	907	613	6.7	6.9	6.6	58	65	50	7.6	9.3	6.6
May	0.83	1.21	0.56	846.33	1176	737	6.7	7.0	6.6	62	73	41	9.0	11.4	7.4
June	1.33	1.92	1.04	939.11	1458	624	6.7	6.9	6.4	62	74	42	12.6	14.4	11.6

Appendix C – Regulations Summary

1. REGULATIONS SUMMARY

1.1. Primary Contaminants

Contaminants are grouped into two general categories: primary contaminants and secondary contaminants. Primary contaminants are delineated into the following subcategories:

- Inorganic Contaminants (also includes arsenic, lead and copper)
- Organic Contaminants (includes volatile and synthetic organics)
- Microbial Contaminants and Turbidity (Sections 1.3 through 1.6)
- Disinfection By-Products (Section 1.8)
- Radionuclides

Primary contaminants are those considered to present health risks if ingested through drinking water. These contaminants are regulated by measuring their concentrations in drinking water and comparing them to “maximum contaminant levels” (MCLs) established by EPA. Every public water system is required to regularly monitor for and report measured concentrations of primary contaminants to ensure that the MCL standards are being met. A summary of the monitoring requirements for CBW is included in this Appendix.

The State of Alaska Department of Environmental Conservation (ADEC) maintains a sample database for CBW which shows sample results, sample schedules, the current monitoring summary, and any violations or enforcement actions. The site can be accessed through State’s Drinking Water Watch website:

http://dec.alaska.gov:8080/DWW/JSP/WaterSystemDetail.jsp?tinwsys_is_number=4115&tinwsys_st_code=AK&wsnumber=AK2120143

1.2. Secondary Contaminants

EPA has established National Secondary Drinking Water Regulations that define non-mandatory water quality standards for 15 “secondary” contaminants. Known as “secondary maximum contaminant levels (SMCLs)", these standards are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations such as taste, color, and odor. At the SMCL, these contaminants are not considered to present risks to human health, but may cause maintenance and palatability issues. Nevertheless, they are used by regulatory agencies to encourage the use of treated drinking water, in lieu of drinking non-potable water that may be perceived to look and taste good.

1.3. Total Coliform Rule (TCR) and Revised TCR.

The TCR requires public water systems to test for the presence of total coliforms in their distribution systems. Coliforms are bacteria that, when present, indicate that water may have been contaminated by human and/or animal waste. The most practical way to reduce the likelihood of coliform bacteria presence is to disinfect the water and maintain a minimum disinfectant residual in the distribution system. This objective is usually accomplished with the addition of a cost effective disinfectant such as chlorine. Systems that do not disinfect are required to undergo water source monitoring.

The TCR requires CBW to:

- Establish a Sample Site Plan identifying the locations in the distribution system where water sampling will be performed.
- Take two monthly water samples to test for the presence of total coliform bacteria.
- Provide public notification and reporting requirements.
- Conduct a system-wide sanitary survey every 3 years.

EPA recently revised the TCR to include the following requirements:

- Public water systems vulnerable to microbial contamination shall assess, identify and fix sanitary deficiencies that lead to contamination.
- Reduced monitoring for “well-operated” water systems.
- Increased monitoring for high-risk systems with unacceptable compliance history.
- Elimination of *total coliform* MCL and MCL goal.
- Implementation of *E. coli* MCL goal of zero.

The Revised TCR will become effective on April 1, 2016.

1.4. Surface Water Treatment Rule (SWTR)

The SWTR, established by EPA in 1989, sets maximum contaminant levels (MCLs) for specific pathogenic microbial contaminants. The SWTR requires the use of filtration and disinfection that will result in a prescribed level of removal or inactivation of specified microbial contaminants. The basic rule requires that filtration and disinfection processes achieve a 3-log (99.9%) removal or inactivation of *Giardia* and a 4-log (99.99%) removal/inactivation of viruses. In addition, disinfectant residual at the distribution system entry point may not be less than 0.2 mg/L. Further, turbidity levels are used as a surrogate for measuring the performance of the filtration process at specified time intervals (continuously, every 4 hours, or daily, depending on population). The SWTR initially established for conventional and direct filtration a threshold of 0.5 NTU, below which 95% of sample measurements are required to fall for each monthly reporting period. This threshold was lowered in later regulatory updates to the SWTR (Section 1.5). For slow sand filtration, the turbidity threshold was established at 1 NTU and continues to be regulated at this level. Turbidity measurements are required to be reported to ADEC every month.

Because CBW uses a surface water source, it currently employs filtration and disinfection processes, and is subject to all SWTR regulations that apply to “small” water systems (i.e., systems that serve populations less than 10,000 persons), including later updates to SWTR as outlined in Sections 1.6 and 1.7.

1.5. Interim Enhanced Surface Water Treatment Rule (IESWTR)

The IESWTR was established in 1998 by EPA to include 2-log (99%) removal/activation of *Cryptosporidium* microbial pathogens and reduce the maximum allowable turbidity level to 0.3 NTU in 95% of measurements for both direct and conventional filtration systems. When turbidity levels are exceeded in certain frequencies, treatment system evaluations are required and performed by the plant operator and/or State agency personnel. With exception to sanitary survey provisions, these requirements initially applied only to “large” public water systems (serving populations greater than 10,000 persons) using surface water sources or “Groundwater under the Direct Influence of Surface Water” (GWDISW). The IESWTR requires that sanitary surveys be conducted on all community water systems every 3 years.

1.6. Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)

The LT1ESWTR, established in 2002, requires that all surface water and GWUDI public water systems, including small systems, meet the drinking water standards established in the IESWTR. This regulatory update also requires that “individual filter effluent” (IFE) streams be monitored continuously for turbidity levels, while “combined filter effluent” (CFE) turbidity levels are measured every 4 hours. For water systems that employ two or less filters, continuous monitoring of CFE can be provided in lieu of IFE monitoring. Similar to the IESWTR, specific incidences of excessive turbidity measurements trigger evaluative action by the operator and by the State agency.

1.7. Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR, established in 2006, imposes more stringent standards on all public water systems using surface water and GWDISW. Over a 1 or 2-year time period, these systems have been required to determine the microbial quality of their source water using prescribed procedures for monitoring *Cryptosporidium* concentrations or surrogate measurements. Depending on the concentration of *Cryptosporidium* in their source water and the filtration system employed, public water systems are required to meet increased removal/inactivation standards (up to 3 log additional removal) and employ various treatment technologies.

"Small" water systems serving a population of less than 10,000 persons have been required to sample for *Escherichia Coli (E. coli)* as a surrogate for *Cryptosporidium* every 2 weeks for 12 consecutive months. If the *E. coli* trigger level is exceeded, the system must conduct an additional 12 to 24 months of source water monitoring for *Cryptosporidium*. In lieu of this monitoring, a filtered water system may commit to providing a total of at least 5.5 log removal of *Cryptosporidium,* which is equivalent to meeting the treatment requirement of Bin 4 (i.e., the base log removal plus additional log removal). CBW has performed this monitoring without the subsequent imposition of any additional log removals.

This Rule also disallows the construction of new uncovered reservoirs for finished (treated) water. Public water systems having uncovered reservoirs at the time the Rule was promulgated are required to provide coverings to protect stored finished water from contamination, or provide additional treatment to the water discharged from these reservoirs.

1.8. Filter Backwash Recycling Rule (FBRR)

The FBRR, promulgated in 2001, requires that water systems operating direct and conventional filtration plants to review their backwash water recycling practices and make approved changes, as necessary, to ensure they do not compromise pathogenic microbial control, particularly in passing *Cryptosporidium* through the filter. Generally, this rule requires that pertinent systems introduce recyclable water to the head of the WTP for treatment using existing unit processes. The FBRR would be applicable to CBW's treatment system if filter backwash recycling is used in the future.

1.9. Stage 1 and Stage 2 Disinfectant/Disinfection Byproducts Rule (D/DBPR)

The D/DBPR requires water systems that disinfect their water to monitor and take corrective action for excessive by-products created as a result of disinfection. Regulated DBPs include total trihalomethanes (TTHMs) and five haloacetic acids (HAA_5). The formation of DBPs is a function of several factors: the existence of precursors (organics in the water), disinfectant dosage, pH level, water temperature, and the reaction time - either initially during storage, or during distribution.

The D/DBPR has been promulgated in two separate rulings: Stage 1 and Stage 2. The Stage 1 ruling establishes MCLs for TTHM and HAA_5 and required testing for DBPs in all sampling areas. This stage required the running annual average (RAA) of DBPs in all sampling areas to meet the MCLs. The Stage 2 ruling requires that each sampled area maintain a "locational" running annual average (LRAA) at or below the MCL. The second stage is implemented by first determining the locations within the distribution system that will likely have the highest concentrations of DBPs. This is accomplished by performing an Initial Distribution System Evaluation (IDSE) whereby DBP monitoring is performed at various locations within the distribution system. The second step in implementing the Stage 2 ruling is meeting the MCLs established in the Stage 1 ruling.

CBW's water source has elevated levels of organic carbon and its treated water is disinfected using chlorine. Consequently, the Stage 1 and Stage 2 D/DBPRs apply. The City's monitoring frequency for the distribution system is once per quarter, averaged on a locational running annual average (LRAA) using two sampling locations.

1.10. Lead and Copper Rule (LCR)

The LCR was established in 1991 to control the levels of lead and copper at the taps of consumers. Treated water can be sufficiently aggressive or corrosive to cause lead and copper to leach out from piping materials or otherwise become suspended in the water. When the "action levels" for lead (0.015 mg/L) or copper (1.3 mg/L) are exceeded in more than 10% of samples taken, a mandated procedure is initiated, with the objective of mitigating the concentrations of lead and copper in the water system. CBW currently samples distribution water from 10 locations every 3 years, most recently in 2014.

First, source waters are tested for specific parameters to provide some understanding of the nature of the water that contributes to high lead and copper levels. Next, a "desk-top" study is performed to identify a corrective action program that will reduce lead and copper concentrations at the customer's tap. Based on this study, recommendations are submitted to ADEC for acceptance. If the recommendations are accepted by ADEC, it then authorizes the implementation of the corrective action strategies. After implementation, water testing follows to evaluate the performance of the corrective action and verify that the water system is brought back into regulatory compliance. Further optimization or pursuit of a different approach may be required if such performance falls short of expectations. In this case, ADEC is obligated to work with the public water system to mitigate copper and lead concentrations.

EPA will be implementing "Long-Term" revisions to the LCR that would improve the effectiveness of corrosion control treatment in reducing exposure to lead and copper, and trigger additional actions that would reduce public exposure to lead and copper when corrosion control treatment is not effective. A final rule is not expected before 2018.

1.11. Arsenic Rule

The "Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring" Rule (Arsenic Rule) was published by the EPA in the Federal Register in January 2001 and supersedes the arsenic MCL established by the U.S. Public Health Services in 1942. Studies have shown a link between the existence of arsenic and different types of cancer, including bladder, lung, and skin cancer. The Arsenic Rule lowered the previous MCL for arsenic from 50 micrograms per liter (µg/L) to 10 µg/L. This new Rule requires community water systems with surface water sources to collect and test water samples each entry point to the water distribution system once each year. Systems that exceed the MCL are required to sample quarterly. The new Arsenic MCL became enforceable in January 2006.

Since arsenic is not present in CBW's source at significant levels, the City is required to sample and test for this contaminant only once every 9 years.

1.12. Emerging Contaminants

The EPA is currently considering other contaminants for future regulation in their Unregulated Contaminant Monitoring (UCM) and Contaminant Candidates List (CCL) programs. Both programs are used to identify drinking water contaminants of concern from those not yet currently regulated.

EPA uses the CCL to identify contaminants that may harm health, may occur in public water systems, and may require drinking water regulation. Many contaminants in the CCL require further research which involves monitoring through the UCM program to discern if and how often various contaminants of concern occur in drinking water. Ultimately such contaminants may become regulated by the EPA in the future.

The EPA is currently considering regulation of the following contaminants:

- Strontium
- Perchlorate
- Nitrosamines
- Chlorate
- Various organic compounds that are deemed carcinogenic
- Various microbial contaminants

Regulatory determinations are made after each 5-year publishing cycle on at least five of the listed CCL contaminants to decide whether or not a formal process should be initiated to begin regulation of any of them. Through the first two of three CCL cycles thus far, EPA identified only one contaminant for regulation, perchlorate, and rejected 20 others. A final rule for perchlorate is not expected before 2018.

In 2014, EPA published its Preliminary CCL3 Determination, which identified strontium for regulation and rejected the regulation of four other contaminants. In the Final Third Regulatory Determination, which is expected in 2015 or 2016, the recommendation to regulate strontium would be finalized, with a final rule expected in 2019 or 2020. EPA also decided to evaluate chlorate and nitrosamines as part of the larger DBP group in its “Third Six-Year” review of existing regulations. Determinations from this review are anticipated to be released in 2016.

1.13. Alaska Pollutant Discharge Elimination System (APDES)

In 2008, regulatory primacy was transferred from EPA to the State of Alaska for wastewater discharges. With this primacy, ADEC manages the APDES program, which regulates certain discharges of pollutants into the environment. By way of an individual permit or general permit, public or private entities are allowed to convey contaminated water and air into receiving environments within established levels and under various stipulations. In July 2014, ADEC promulgated General Permit AKG380000, *Wastewater Discharges from Drinking Water Treatment Facilities,* which now regulates backwash or reject water that is discharged to surface waters of the United States located in the State of Alaska. This general permit provides coverage for potable water treatment systems and condition operations that specifically feature:

- Conventional and direct filtration.
- Ion exchange.
- Membrane filtration.

All of these types of technologies produce wastewater that is contaminated with relatively high concentrations of compounds which may be harmful to the receiving environment. Such compounds may range from high aluminum concentrations from coagulation processes to acids, bases or salts used in media regeneration processes. Discharges from other technologies not listed above may be eligible for coverage under this general permit if approved by ADEC. CBW currently discharges treatment-based wastewater to the environment, but not with a process identified above. Nevertheless, CBW will still need to comply with the MCLs and other regulation stipulated under this general permit.

END

Appendix D – Water Crisis and Disaster Documentation and Exceedance Reports

City and Borough of Wrangell Disaster Declaration with Request for State Assistance

WHEREAS, commencing on July 2, 2016, due to reduced rainfall/snowpack and filtration system insufficiencies, the Wrangell Public Works Water Treatment Plant has been unable to meet the demand for treated water within the community; from July 2-19, the City and Borough of Wrangell has attempted to mitigate the effects by issuing water conservation measures throughout the community and discontinuing water service to all cruise ships, all Ports & Harbors facilities (for one day) and the Public Swimming Pool (for 2 days).

WHEREAS, the City and Borough of Wrangell is a political subdivision within the State of Alaska; and

WHEREAS, the following conditions exist as a result of the reduced ability to treat water: reduced capability to provide treated water to local homes, businesses, medical facilities, and public facilities; reduced capability to respond to local fires; inability to provide sufficient quantities of water to local fish processing plants. The fish processing plants have made drastic changes to their systems in order to operate under reduced water constraints. Any additional reduction will likely result in their inability to operate, causing a large economic impact to the processing plants and the community. Closure of local fish processing plants could result in a reduction of over 250 jobs.

WHEREAS, the severity and magnitude of the emergency is beyond the timely and effective response capability of local resources; the reduced water capabilities will require professional assistance for immediate measures to improve the capacity for treated water.

THEREFORE, be it resolved that the Borough Manager and Borough Assembly of Wrangell (at an emergency meeting held July 19, 2016) does declare a Disaster Emergency per AS 26.23.140 to exist in the City and Borough of Wrangell.

FURTHERMORE, it is requested that the Governor declare a Disaster Emergency to exist as described in AS 26.23 and provide State assistance to the City and Borough of Wrangell in its response and recovery from this event. The City and Borough of Wrangell specifically requests public disaster assistance to assist in evaluating the current conditions and determine repairs needed at the Borough's water treatment facility. The City and Borough has considered the following measures for immediate relief: improvements to specific filtration components of the existing facility, a modular filtration system, or a portable water treatment plant.

FURTHER, the undersigned certifies that the City and Borough of Wrangell has or will expend local resources in the amount of $25,000 as a result of this disaster for which no State or Federal reimbursement will be requested.

SIGNED this 20th day of July, 2016

City and Borough Manager with approval of the City and Borough of Wrangell Assembly

[signature] 7/20/16

CITY AND BOROUGH OF WRANGELL
INCORPORATED MAY 30, 2008

P.O. BOX 531 (907)-874-2381
Wrangell, AK 99929 FAX (907)-874-3952

July 20, 2016

To: All Wrangell Water Users

Subject: **Water Crisis-The Borough Assembly has declared Wrangell's Water Crisis a Disaster and has implemented our Disaster Program.**

The community of Wrangell is experiencing a water crisis. The crisis is because the amount of water we can treat at the treatment plant is less than the current demand or the amount being used. Rain will not solve this problem and the problem will be for the entire summer. This has hit the seafood processors the hardest and they are both large employers and contribute to the community's economic viability.

We need for the public to reduce the amount of water they use by as much as possible, but the goal should be 30% to 50%. I can't tell you how to do that, but I know we waste water as a community because we are not metered and in the past we have only rarely had to conserve. Here are some ideas that could help:

- Don't water lawns- it is likely we will get rain from time to time even in a dry summer.
- Don't wash your car.
- Collect rain water for watering plants or other uses that don't require treated water
- Spend less time in the shower.
- Only have facets running when needed.
- If you have leaks of any kind, get them fixed or if you need assistance from the city, call.
- Use water save cycles on dishwasher and wash machines if available.
- Borough personnel will be empowered to enforce water conservation among our community where violations are witnessed and can discontinue service if conditions are not corrected per Wrangell Municipal Code 15.04.510.

The city is doing everything we can think of both at the treatment plant and within our own facilities and the seafood processors are also making major changes to reduce treated water coming from our plant. We have some long term solutions but we will not have time to do those this summer. The public will have to do their part to make this work. Thank you.

Jeff Jabusch
Borough Manager

Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) Operational Evaluation Report

PWS Name: Wrangell **PWSID #:** 120143

Date of Evaluation: Nov 25, 2016 **Date of Submittal:** ______________

Complete this report to the best of your knowledge and submit it to the DEC **no later than** ______________ **which is 90 days from the date of receiving notification of the sample results that triggered this operational evaluation**. Use additional pages if needed for further explanations. Include your PWSID # on each page.

Operational Evaluation Level exceeded:

	Quarter			**Operational Evaluation Value**
	Results from Two Quarters Ago	Prior Quarter's Results	Current Quarter	
	A	B	C	**D= (A+B+(2xC))/~~4~~3**
Date & location of sample	Feb 18, 2016 N7	May N7	Aug 16, 2016 N7	
TTHM (mg/L)				
HAA5 (mg/L)	0.086	Did not sample	0.06	0.069

Note: The operational evaluation value is calculated by adding the results of the two previous quarters of TTHM or HAA5 plus two times the current quarters' result, then dividing by 4.0. If the value exceeds 0.080 mg/L for TTHM or 0.060 mg/L for HAA5, an OEL exceedance has occurred.

Has an OEL exceedance occurred at this location in the past? ☑ Yes ☐ No

If "No" proceed to Section A. If "Yes" when did exceedance occur? ______________

Was the cause determined for the previous exceedance(s)? ☐ Yes ☐ No

Are the previous evaluations/determination applicable to the current OEL exceedance? ☐ Yes ☐ No

A. Source & Source Water Quality

1. Have you made any changes at the source? *e.g. changed the intake depth or intake structure, changed pumping rates, pumping times or frequency, pumping depth, well rehab, etc.*
☐ Yes ☐ No

2. Have you changed/added sources? *e.g. started using a different raw water source or well, turned on emergency sources, drilled new well, etc.*
☐ Yes ☐ No

3. Have you seen changes in source water quality? *e.g. higher than usual turbidity (other than usual raw water turbidity spikes during specific seasons), TOC, color, pH, temperature, alkalinity, or hardness.*
☐ Yes ☐ No

PWSID # 120143

4. Has anything else changed that could affect your source? *e.g. drought conditions, heavier than usual rainfall, changes in snowmelt/ break up times and intensity, changes in animal movement at the source, agricultural practices, etc. Surface water systems should also consider algae blooms, forest fires in the watershed, mud slides, high or low water levels at the source, etc.*

☐Yes ☐No

If you answered **"Yes"** to any of the questions above (Section A), please explain:

Did the source water quality cause or contribute to your OEL exceedance(s)?

☐Yes ☐No ☐Possibly

If **"Yes"** or **"Possibly"** please explain:

B. Treatment Operations

1. Have you changed the amount or type of disinfectant? *e.g. changed disinfectant dosage, or switched from chlorine to chloramines, etc.*

☐Yes ☐No

2. Have you changed or added locations of disinfectant points? *e.g. added booster stations, etc.*

☐Yes ☐No

3. Other than disinfection, have you changed or made additions or changes to any treatment processes?

☐Yes ☐No

4. Have you made changes to any other chemical applications? *e.g. changed any chemicals (changed coagulant type or filter aid), changes in application points, had to adjust dosages more often or increase dosages of any chemical more than usual, etc.*

☐Yes ☐No

5. Have you had significant changes in chlorine demand to maintain Entry Point Chlorine residuals?

☐Yes ☐No

6. Have you had to increase filter changes or number of backwash cycles due to changes in raw water conditions?

☐Yes ☐No

7. Are you using Granular Activated Carbon (GAC) in your treatment system?

☐Yes ☐No

If **"Yes"** when was filter/media last exchanged? Date: ________________

PWSID # 120143

If you answered **"Yes"** to any of the questions above (Section B), please explain:

Did the treatment system cause or contribute to your OEL exceedance(s)?
☐Yes ☐No ☐Possibly

If **"Yes"** please explain:

C. Distribution System Operations

1. Have you added additional service connections (industry or residential)? *e.g. installed additional distribution mains or annexing additional areas of service which could change water residence times.*
☐Yes ☐No

2. Have you experienced significant increases or decreases in water demand? *e.g. drought restrictions, industry/business opening/closing, population change.*
☐Yes ☐No

3. Have there been any new loops or dead-ends created in the distribution system?
☐Yes ☐No

4. Does your storage tank fill and drain from the bottom (potentially causing stagnation at the top)?
☐Yes ☐No

5. Have there been any water temperature fluctuations?
☐Yes ☐No

6. Has the water residence time of your tank(s) increased or decreased? *e.g. are tanks being filled/drained more or less often.*
☐Yes ☐No

7. How many days' supply do your storage tank(s) hold?____ days

8. What is the longest time that goes by between filling your storage tanks?____days

9. Explain how your storage tanks are interconnected: *e.g. in series/parallel.* ________________________________

10. Have you had distribution or service line breaks or major construction in your distribution system?
☐Yes ☐No

11. If applicable, do you purchase water that has no disinfectant or a different disinfectant than you currently use? *e.g. you purchase water with chloramines and you add chlorine.*
☐Yes ☐No ☐NA

PWSID # 120143

12. Do you have areas in your distribution system where disinfectant residual levels are below the minimum regulatory requirement?
☐ Yes ☐ No

13. Have you had significant changes in chlorine demand to maintain distribution residuals?
☐ Yes ☐ No

14. Have you changed your distribution flushing procedures?
☐ Yes ☐ No

15. Have you had any changes in treatment that occur in distribution? *e.g. changes in booster chlorination or dosage.*
☐ Yes ☐ No

16. Have you had an increase in customer complaints regarding odor, color or taste of the water?
☐ Yes ☐ No

17. Have there been any changes in tank or distribution water temperatures? *e.g. have you had to turn on add heat and circulation earlier or for longer periods of time etc.*
☐ Yes ☐ No

If you answered **"Yes"** to any of the questions above (Section C), please explain:

Did the distribution system cause or contribute to your OEL exceedance(s)?
☐ Yes ☐ No ☐ Possibly

If **"Yes"** or **"Possibly"** please explain:

D. Additional Questions

1. Do you have tank management/operational procedures? *e.g. cleaning schedule, set operational levels of your tank (high and low) etc.*
☐ Yes ☐ No
Date tank(s) was last cleaned?________________

2. Can you allow the tank(s) to drain lower to flush out "older" water?
☐ Yes ☐ No

3. Can you reduce chlorine/chloramines dosage and still maintain required residuals at the entry point to the distribution and in the distribution system?
☐ Yes ☐ No

4. Have you performed Disinfection Profiling and Benchmarking?
☐ Yes ☐ No

PWSID # 120143

5. Do you have a flushing program? Storage tanks: ☐ Yes ☐ No; Distribution System: ☐ Yes ☐ No

6. If applicable, can you work with the system you purchase water from to optimize water age, reducing DBP formations?
☐ Yes ☐ No ☐ NA

If you answered **"No"** to any of the questions above (Section D), please explain:

E. Additional Information

Please explain what steps you could take to minimize future TTHM/HAA5 formations. *e.g. changes in operation, optimizing time frame when pumping raw water, not pumping water during high turbidity/TOC/Color events such as at break-up or after heavy rainfalls, changes to the treatment process, any changes to the tank configurations or operation to minimize water residence time, any changes in inlet configuration, increased tank cleaning schedules or changes to the distribution maintenance including cleaning and flushing lines to decrease chlorine demand.*
Also include any dates for planned upgrades, such as plans for installing a new treatment plant etc.:

I certify that the information in this entire report, including any attachments, is true and accurate to the best of my knowledge.

Signature: ______________________ Date: ______________

Printed Name: ______________________

Contact Email address: ______________________

Contact Phone Number: ______________

Send the completed report to the DEC no later than ____________ which is 90 days from the date of receiving notification of the sample results that triggered this operational evaluation.

Mailing Address
DEC-Drinking Water Program
43335 Kalifornsky Beach Rd
Suite 11
Soldotna, AK 99669-9792

Fax
907-262-2294

Email Address
Kenia Peninsula Systems
DEC.DWData.Kenai@alaska.gov
Southeast Systems
DEC.DWData.Juneau@alaska.gov

Print Form

Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) Operational Evaluation Report

PWS Name: Wrangell **PWSID #:** 120143

Date of Evaluation: Jun 24, 2016 **Date of Submittal:** ______________

Complete this report to the best of your knowledge and submit it to the DEC **no later than ______________ which is 90 days from the date of receiving notification of the sample results that triggered this operational evaluation.** Use additional pages if needed for further explanations. Include your PWSID # on each page.

Operational Evaluation Level exceeded:

	Quarter			**Operational Evaluation Value**
	Results from Two Quarters Ago	Prior Quarter's Results	Current Quarter	
	A	B	C	**D= (A+B+(2xC))/4**
Date & location of sample	Aug 19, 2015 N17	Nov 18, 2015 N17	Feb 2, 2016 N17	
TTHM (mg/L)				
HAA5 (mg/L)	0.094	0.089	0.086	0.089

Note: The operational evaluation value is calculated by adding the results of the two previous quarters of TTHM or HAA5 plus two times the current quarters' result, then dividing by 4.0. If the value exceeds 0.080 mg/L for TTHM or 0.060 mg/L for HAA5, an OEL exceedance has occurred.

Has an OEL exceedance occurred at this location in the past? ☑ Yes ☐ No

If "No" proceed to Section A. If "Yes" when did exceedance occur? Jan 1, 2012

Was the cause determined for the previous exceedance(s)? ☑ Yes ☐ No

Are the previous evaluations/determination applicable to the current OEL exceedance? ☐ Yes ☑ No

A. Source & Source Water Quality

1. Have you made any changes at the source? *e.g. changed the intake depth or intake structure, changed pumping rates, pumping times or frequency, pumping depth, well rehab, etc.*

   ☐ Yes ☑ No

2. Have you changed/added sources? *e.g. started using a different raw water source or well, turned on emergency sources, drilled new well, etc.*

   ☐ Yes ☑ No

3. Have you seen changes in source water quality? *e.g. higher than usual turbidity (other than usual raw water turbidity spikes during specific seasons), TOC, color, pH, temperature, alkalinity, or hardness.*

   ☐ Yes ☑ No

PWSID # 120143

4. Has anything else changed that could affect your source? *e.g. drought conditions, heavier than usual rainfall, changes in snowmelt/break up times and intensity, changes in animal movement at the source, agricultural practices, etc. Surface water systems should also consider algae blooms, forest fires in the watershed, mud slides, high or low water levels at the source, etc.*

☑ Yes ☐ No

If you answered "Yes" to any of the questions above (Section A), please explain:

4) recent dry years have a profound effect on the raw water insofar as turbidity and color levels, making it harder to remove them at the elevated levels.

Did the source water quality cause or contribute to your OEL exceedance(s)?

☑ Yes ☐ No ☐ Possibly

If "Yes" or "Possibly" please explain:

source water higher in turbidity and organics makes treatment difficult.

B. Treatment Operations

1. Have you changed the amount or type of disinfectant? *e.g. changed disinfectant dosage, or switched from chlorine to chloramines, etc.*

☑ Yes ☐ No

2. Have you changed or added locations of disinfectant points? *e.g. added booster stations, etc.*

☐ Yes ☑ No

3. Other than disinfection, have you changed or made additions or changes to any treatment processes?

☐ Yes ☑ No

4. Have you made changes to any other chemical applications? *e.g. changed any chemicals (changed coagulant type or filter aid), changes in application points, had to adjust dosages more often or increase dosages of any chemical more than usual, etc.*

☐ Yes ☑ No

5. Have you had significant changes in chlorine demand to maintain Entry Point Chlorine residuals?

☑ Yes ☐ No

6. Have you had to increase filter changes or number of backwash cycles due to changes in raw water conditions?

☐ Yes ☑ No

7. Are you using Granular Activated Carbon (GAC) in your treatment system?

☐ Yes ☑ No

If "Yes" when was filter/media last exchanged? Date: ______________

PWSID # 120143

If you answered "Yes" to any of the questions above (Section B), please explain:

during the period from September 2014 through January 2016, it was necessary to increase chlorine dosage to account for higher turbidity and organics in the finished water due to the lack of full ozone production.

Did the treatment system cause or contribute to your OEL exceedance(s)?
☑Yes ☐No ☐Possibly

If "Yes" please explain:

it is believed that the lower available levels of ozone for pretreatment of the raw water directly contributed to higher precursor levels, thus higher tthm / haa5 levels in the finished water.

C. Distribution System Operations

1. Have you added additional service connections (industry or residential)? *e.g. installed additional distribution mains or annexing additional areas of service which could change water residence times.*
☐Yes ☑No

2. Have you experienced significant increases or decreases in water demand? *e.g. drought restrictions, industry/ business opening/ closing, population change.*
☐Yes ☑No

3. Have there been any new loops or dead-ends created in the distribution system?
☐Yes ☑No

4. Does your storage tank fill and drain from the bottom (potentially causing stagnation at the top)?
☐Yes ☑No

5. Have there been any water temperature fluctuations?
☐Yes ☑No

6. Has the water residence time of your tank(s) increased or decreased? *e.g. are tanks being filled/ drained more or less often.*
☐Yes ☑No

7. How many days' supply do your storage tank(s) hold? 0.8 days

8. What is the longest time that goes by between filling your storage tanks? 1 days, usual, high demand may stretch this to a week or more.

9. Explain how your storage tanks are interconnected: *e.g. in series/parallel.* parallel

10. Have you had distribution or service line breaks or major construction in your distribution system?
☐Yes ☑No

11. If applicable, do you purchase water that has no disinfectant or a different disinfectant than you currently use? *e.g. you purchase water with chloramines and you add chlorine.*
☐Yes ☐No ☑NA

PWSID #__120143____

12. Do you have areas in your distribution system where disinfectant residual levels are below the minimum regulatory requirement?
 ☑ Yes ☐ No

13. Have you had significant changes in chlorine demand to maintain distribution residuals?
 ☑ Yes ☐ No

14. Have you changed your distribution flushing procedures?
 ☑ Yes ☐ No

15. Have you had any changes in treatment that occur in distribution? *e.g. changes in booster chlorination or dosage.*
 ☐ Yes ☑ No

16. Have you had an increase in customer complaints regarding odor, color or taste of the water?
 ☐ Yes ☑ No

17. Have there been any changes in tank or distribution water temperatures? *e.g. have you had to turn on add heat and circulation earlier or for longer periods of time etc.*
 ☐ Yes ☑ No

If you answered **"Yes"** to any of the questions above (Section C), please explain:

12) our major distribution lines are 12" and there is little demand on them, thus it is difficult to maintain a residual. 13) yes, during the time frame from September 2014 through January 2016, we were operating with only one fully functional ozone generator which greatly lessened our ability to remove precursors. 14) another department is now doing the distribution flushing.

Did the distribution system cause or contribute to your OEL exceedance(s)?
 ☐ Yes ☐ No ☑ Possibly

If **"Yes"** or **"Possibly"** please explain:

Long residence times in the distribution are believed to be of concern.

D. Additional Questions

1. Do you have tank management/operational procedures? *e.g. cleaning schedule, set operational levels of your tank (high and low) etc.*
 ☑ Yes ☐ No
 Date tank(s) was last cleaned? __2006 I think, for old, and new has been online a short Time

2. Can you allow the tank(s) to drain lower to flush out "older" water?
 ☑ Yes ☐ No

3. Can you reduce chlorine/chloramines dosage and still maintain required residuals at the entry point to the distribution and in the distribution system?
 ☐ Yes ☑ No

4. Have you performed Disinfection Profiling and Benchmarking?
 ☐ Yes ☑ No

PWSID # 120143

5. Do you have a flushing program? Storage tanks: ☐ Yes ☑ No; Distribution System: ☐ Yes ☑ No

6. If applicable, can you work with the system you purchase water from to optimize water age, reducing DBP formations?
☐ Yes ☐ No ☑ NA

If you answered "No" to any of the questions above (Section D), please explain:

3) the organics remaining in the treated water, plus the extended residence time in some lines makes this impossible. 4) Perhaps during the original pilot study, but I have not. 5) Tank levels can be and are regulated to minimize residence time, but there is no flushing program in place for the distribution system at this time.

E. Additional Information

Please explain what steps you could take to minimize future TTHM/HAA5 formations. *e.g. changes in operation, optimizing time frame when pumping raw water, not pumping water during high turbidity/TOC/Color events such as at break-up or after heavy rainfalls, changes to the treatment process, any changes to the tank configurations or operation to minimize water residence time, any changes in inlet configuration, increased tank cleaning schedules or changes to the distribution maintenance including cleaning and flushing lines to decrease chlorine demand.*
Also include any dates for planned upgrades, such as plans for installing a new treatment plant etc.:

We are unable to vary when we take raw water, as time required to "build" the treated water is lengthy. We are concentrating on the acquisition of another new ozone generator to reduce / eliminate precursors entirely from the raw water. We are starting a water study in mid July with a different treatment technique which should allow faster production, plus eliminate precursors from the pre-chlorinated water. The primary reason for this study was to meet find a plant design to assist us with tthm / haa5 removal, plus meet other water quality standards. There is a desire to test the new pilot plant with our current ozonation capability to produce an even better water. It is desirous to implement a system wide flushing program which should assist greatly in finished water quality, and detention time, thus reducing tthms and haa5s.

I certify that the information in this entire report, including any attachments, is true and accurate to the best of my knowledge.

Signature: [signature] Date: 6-28-16

Printed Name: WAYNE McHOLLAND

Contact Email address: wrgwtf@aptalaska.net

Contact Phone Number: 907 [redacted] 2381

Send the completed report to the DEC no later than __________ which is 90 days from the date of receiving notification of the sample results that triggered this operational evaluation.

Mailing Address
DEC-Drinking Water Program
43335 Kalifornsky Beach Rd
Suite 11
Soldotna, AK 99669-9792

Fax
907-262-2294

Email Address
Kenia Peninsula Systems
DEC.DWData.Kenai@alaska.gov
Southeast Systems
DEC.DWData.Juneau@alaska.gov

Print Form

Appendix E – Calculations

WRANGELL WATER USE

2014

2014 DCCED Population	2406	
Per Capita Water Use	251	gallons per capita per day
Residential Water Use	**603,906**	gpd

Transient Population	300	(ADEC Water Watch)
Per Capita Water Use	251	gallons per capita per day
Residential Water Use	**75,300**	gpd

ACTUAL DATA

Commercial Customers	monthly			daily (interpolated)			*% of total ADD*
	max flow	min flow	average flow	max flow	min flow	average flow	
IFA	-	-	-	-	-	-	
Trident Seafoods	12,544,588	-	1,785,194	418,153	-	59,506	7.0%
Sea-level SFDS	10,465,198	-	2,299,823	348,840	-	76,661	9.0%
Fish & Game Dock	-	-	-	-	-	-	-
Heritage HBR	1,565,000	-	525,440	52,167	-	17,515	2.0%
Shoemaker HBR	836,600	11,600	153,704	27,887	387	5,123	0.6%
City Dock	301,282	-	55,587	10,043	-	1,853	0.2%
Reliance	1,822,584	49,329	390,017	60,753	1,644	13,001	1.5%
Standard Oil	275,720	656	49,575	9,191	22	1,653	0.2%
Wrangell Oil/Petro Marine	131,001	1,743	26,480	4,367	58	883	0.1%
Travel Lift	52,723	-	11,563	1,757	-	385	0.0%
Projected Summation	**27,994,696**	**63,328**	**5,297,383**	**933,157**	**2,111**	**176,579**	20.6%
Actual Total Flows	**20,295,338**	**928,739**	**5,788,301**	**676,511**	**30,958**	**192,943**	22.5%
% of Project Summation	72%	1467%	109%				

Average Daily Demand (all users)	**855,785**	gal/day	594	gpm
Estimated MDD (all users)	**1,497,625**	gal/day	1,040	gpm
175% ADD residential + MDD commercial	2,121,767.03	gal/day	1,473	gpm

WRANGELL WATER USE

Projected 2037

2037 Predicted Population	2911	
Per Capita Water Use	240	gallons per capita per day
Residential Water Use	698,640	gpd

Transient Population	363	(ADEC Water Watch)
Per Capita Water Use	240	gallons per capita per day
Residential Water Use	87,120	gpd

EXTRAPOLATED DATA ASSUMING YEARLY 0.8% GROWTH IN INDUSTRY

Commercial Customers	monthly			daily (interpolated)			*% of total ADD*
	max flow	min flow	average flow	max	min	average	
IFA	-	-	-	-	-	-	
Trident Seafoods	15,066,050	-	2,144,018	502,202	-	71,467	7.2%
Sea-level SFDS	12,568,703	-	2,762,088	418,957	-	92,070	9.2%
Fish & Game Dock	-	-	-	-	-	-	-
Heritage HBR	1,879,565	-	631,053	62,652	-	21,035	2.1%
Shoemaker HBR	1,004,757	13,932	184,599	33,492	464	6,153	0.6%
City Dock	361,840	-	66,760	12,061	-	2,225	0.2%
Reliance	2,188,923	59,244	468,411	72,964	1,975	15,614	1.6%
Standard Oil	331,140	788	59,540	11,038	26	1,985	0.2%
Wrangell Oil/Petro Marine	157,332	2,093	31,802	5,244	70	1,060	0.1%
Travel Lift	63,320	-	13,887	2,111	-	463	0.0%
Projected Summation	**33,621,630**	**76,057**	**6,362,157**	**1,120,721**	**2,535**	**212,072**	21.3%
Extrapolated Actual Flows	**21,310,105**	**975,176**	**6,077,716**	**710,337**	**32,506**	**202,591**	20.3%
% of Project Summation	63%	1282%	96%	41%			

Average Daily Demand (all users)	**997,832**	gal/day	693	gpm
Estimated MDD (all users)	**1,746,206**	gal/day	1,213	gpm
175% ADD residential + MDD commercial	2,495,801.00	gal/day	1,733	gpm

Appendix F – System Documentation

AWC Water Solutions Ltd.
#101-19074 22nd Avenue
Surrey, British Columbia,
Canada V3Z 3S6
Main: 604 936 4217

Budget Quotation

DATE:	October 16, 2016	**TIME:**	11:09 PM
TO:	Trevor Trask P.E. CRW Engineering Group	**PHONE:** **FAX:**	(907) 562-3252
COPIES	Mike Morris, AWC	**PHONE:**	(360) 886-1396
FROM:	Andrew Stevano	**PHONE:** **FAX:**	(604) 638-0760 (604) 638-0759

Number of pages including this cover 17

Our Ref: 17805

RE: Dissolved Air Flotation (DAF) for Wrangell AK WTP

Thank you for the opportunity to provide our ideas and pricing for our DAF system in Wrangell AK.

We present dissolved air flotation accompanied with chemical coagulation and gravity filtration designed to treat a total flow of 1.8 mgd (1250 gpm) that will be effective for removal of turbidity, color and organics.

These plants are factory assembled, pre-wired and tested and delivered complete with all required controls. Only on-site connections for the raw water feed, treated water discharge, wastewater discharge and power are required. Filter media is shipped separately.

The following provides details and budget pricing.

Pre-Packaged, AWC-DAF-1250-2

Comprises chemical coagulation, DAF clarifier x2, 3 gravity filters to produce 1250 gpm.

DAF System

Plant Type: AWC Water Systems-DAF-1250-2

Two DAF modules each rated at 625 gpm (142 m^3/hr)

Flocculation time:	26.3 mins total
DAF surface loading:	7.72 m/hr (3.16 USgpm/ft^2)
Filter surface loading:	5.31 m/hr (2.17 USgpm/ft^2)
Filter surface loading, max:	8.0 m/hr (3.26 USgpm/ft^2) when 1 in BW

DAF module details:

- Flow splitter and flash mix tank
  - ◊ Powered flash mixer
  - ◊ 5 injection ports
  - ◊ Adjustable wiers
  - ◊ Overflow return
  - ◊ Constructed of marine grade aluminum alloy offering corrosion free service and eliminating the need for painting and tank structure maintenance.
- Inlet flow control valve and meter
- Tank dimensions, flocculation/DAF Clarifier tanks (2):

Width	Height	Length
11 ft	11 ft	43 ft

- Constructed of marine grade aluminum alloy offering corrosion free service and eliminating the need for painting and tank structure maintenance.
- Tank dimensions, filter tank, 3 filters (1):

Width	Height	Length
12 ft	8.5 ft	48 ft

- Constructed of marine grade aluminum alloy offering corrosion free service and eliminating the need for painting and tank structure maintenance.
- Mechanical flocculation
  - ◊ Two stage system, with stilling well, designed to ensure minimal short circuiting
  - ◊ Variable speed drive/mixers and paddles for variable energy input and tapered flocculation
  - ◊ VFDs
- DAF clarifier
  - ◊ Mechanical scraper float removal with adjustable speed and interval timer for float removal
  - ◊ Floor mounted effluent launders for even cell flow distribution
- DAF recycle saturator skid (1) comprising:
  - ◊ Packed tower saturator (1) 30” diameter
  - ◊ Duplex air compressor with receiver and alternating panel

- ◊ Two recycle pumps (1 duty, 1 standby)
- ◊ VFDs

- *Three* dual media, rapid gravity filters
  - ◊ Air/water backwash system
  - ◊ Automatic control valves for effluent, backwash, rinse, air scour
  - ◊ 450 mm (18”) of 1 mm anthracite and 450 mm (18”) of 0.45 mm filter sand

Air scour blower rated for 2.5 scfm/ft^2 at 4.5 psi

Access Stairs, handrails, and walkways as indicated on sketch, see sample drawing

Chemical Systems

- All chemical systems will duplex metering pumps, be pre-plumbed and mounted on a fabricated stand or shelf and will operate by suction lift. Includes multifunction valves, chemical storage day tanks on spill pallets. Pumps are paced to flow.
  - Potassium permanganate (2)
    - ◊ Day tank with powered mixer
  - Coagulant (alum) (2)
  - Soda ash (2)
    - ◊ Automatic volumetric feeder with bag loader and platform with stairs
    - ◊ HDPE mixing tank with powered mixer
  - Sodium hypochlorite (2)
- DAF Instrumentation summary:
  - ◊ Inlet magmeter (1)
  - ◊ Inlet pH (1)
  - ◊ Recycle magmeter. (1)
  - ◊ Turbidity (1 inlet, 3 filtered water)
  - ◊ Saturator and recycle differential pressure transmitter (1)
  - ◊ Filter loss-of-head pressure transmitters (3)
  - ◊ Filter level transmitters (3)
  - ◊ Backwash magmeter (1)
- Junction Boxes

- PLC for fully automatic operation (Allen Bradley CompacLogix with Panelview 1400 HMI) Options for MCC Panels, SCADA systems, and Telemetry systems are available upon request.
- 3 trips, 14 days on-site time by trained AWC commissioning technician for final commissioning and staff training…

O& M manuals / As-Built Drawings

Shipping, FOB Port of Wrangell AK

Budget Price: $1,260,000.00 excluding all applicable taxes

Delivery can usually be made within 12 weeks following approval of final shop drawings

THESE PRICE ESTIMATES DO NOT INCLUDE:

- Any applicable taxes
- Receiving, unloading and suitable storage of material
- Concrete foundation pads
- Field erection of treatment plant and equipment, labor and supervision
- Piping connections, influent and effluent piping, rinse and backwash piping, yard piping, drain piping, interconnecting piping or other piping outside the plant structure
- Field electrical wiring and conduit
- Base meter, split trough, disconnect switches, transformer, if required, are not included
- Field paint or painting labor
- General cleaning of plant
- Installation of chemical feed systems
- Starters and VFDs unless mentioned

Since 1965, AWC's team members have engineered over 500 plants, mostly in Canada and the USA. Our goal is to work closely with engineers, plant owners and operators to develop designs that will provide cost-effective and efficient solutions. AWC Water Systems is a part of AWC Process Solutions. The AWC "one-stop shop" approach allows us to deliver comprehensive, flexible and innovative solutions to our customers' most complex treatment infrastructure challenges.

For more information on our Company and our range of products and services visit our web site at www.awcwater.com.

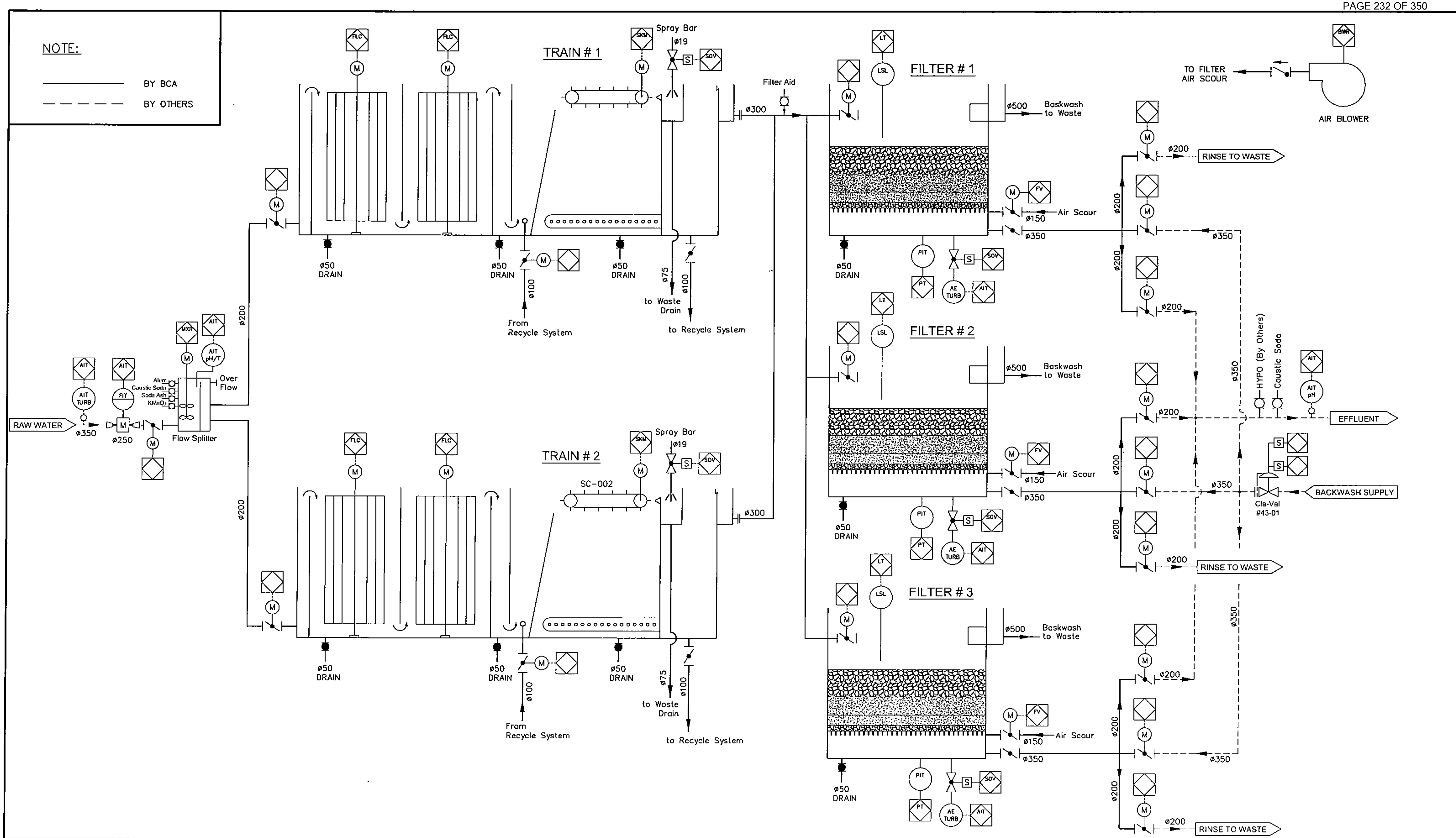
We trust this meets your needs and will be pleased to provide any further information you may require.

Regards,

Andrew Stevano P. Eng.

andrews@adiwater.com

Attachments: Antigonish Sample Drawings



REV	DESCRIPTION	BY	CHK'D	APP'D	DATE
A	Chemical System Added	WW	JB	JY	Jul/19/05

NOTE

THIS DRAWING IS THE PROPERTY OF TERASEN WATRE INC., AND CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION WHICH MUST NOT BE DUPLICATED, USED OR DISCLOSED OTHER THAN EXPRESSLY AUTHORIZED BY TERASEN WATER INC.

Terasen

DRAWN	WW
DESIGN	JY
CHECKED	JY
APPROVED	JY
DATE	May/30/05
SCALE	N.T.S.

ANTIGONISH WTP (S.O#013459)

BCA DAF-1520-2 WTP
PROCESS & INSTRUMENTATION DIAGRAM

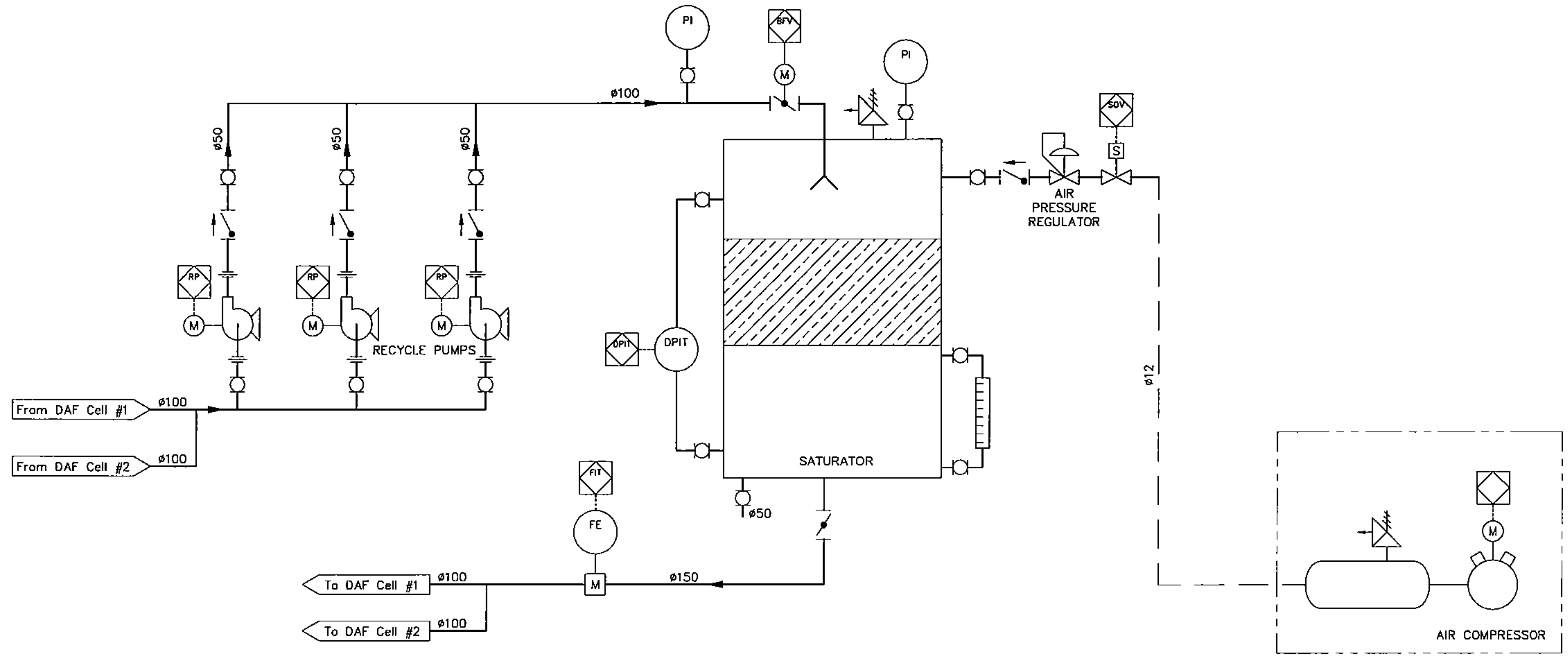
SH.1 OF 3

DRAWING NO. 058342-02 REV A

NOTE:

——— BY BCA

– – – – BY OTHERS



A	Chemical System Added	WW	JB	JY	Jul/19/05
REV	DESCRIPTION	BY	CHK'D	APP'D	DATE

NOTE

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Terasen

DRAWN	WW
DESIGN	JY
CHECKED	JY
APPROVED	JY
DATE	May/30/05
SCALE	N.T.S.

ANTIGONISH WTP (S.O#013459)

BCA DAF-1520-2 WTP
PROCESS & INSTRUMENTATION DIAGRAM

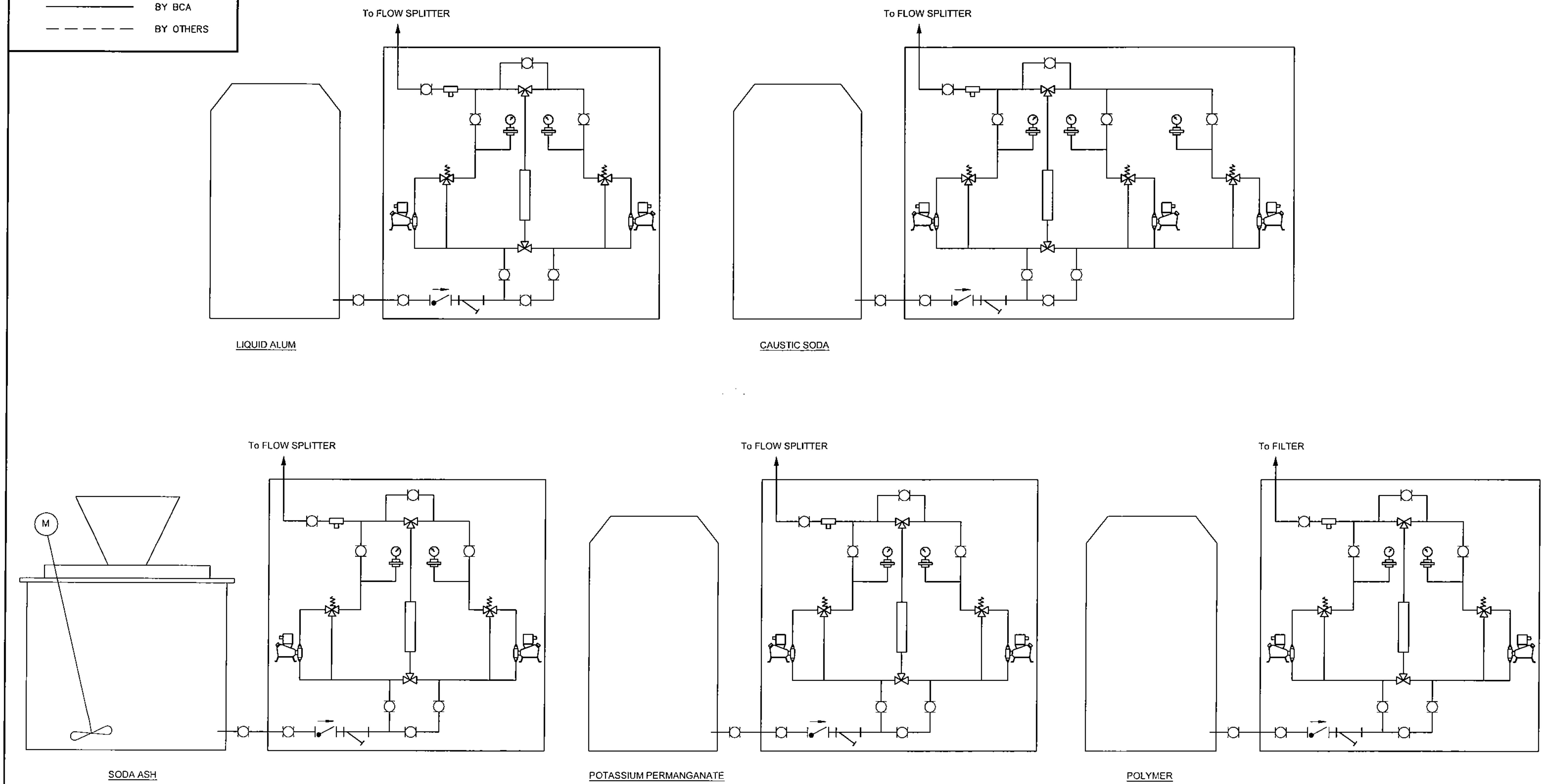
SH.2 OF 3

DRAWING NO. 058342-02 REV A

NOTE:

—————— BY BCA

— — — — — BY OTHERS



REV	DESCRIPTION	BY	CHK'D	APP'D	DATE
A	Chemical System Added	WW	JB	JY	Jul/19/05

NOTE

THIS DRAWING IS THE PROPERTY OF TERASEN WATER INC., AND CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION WHICH MUST NOT BE DUPLICATED, USED OR DISCLOSED OTHER THAN EXPRESSLY AUTHORIZED BY TERASEN WATER INC.

Terasen

DRAWN	WW
DESIGN	JY
CHECKED	JY
APPROVED	JY
DATE	May/30/05
SCALE	N.T.S.

ANTIGONISH WTP (S.O#013459)

BCA DAF-1520-2 WTP

PROCESS & INSTRUMENTATION DIAGRAM

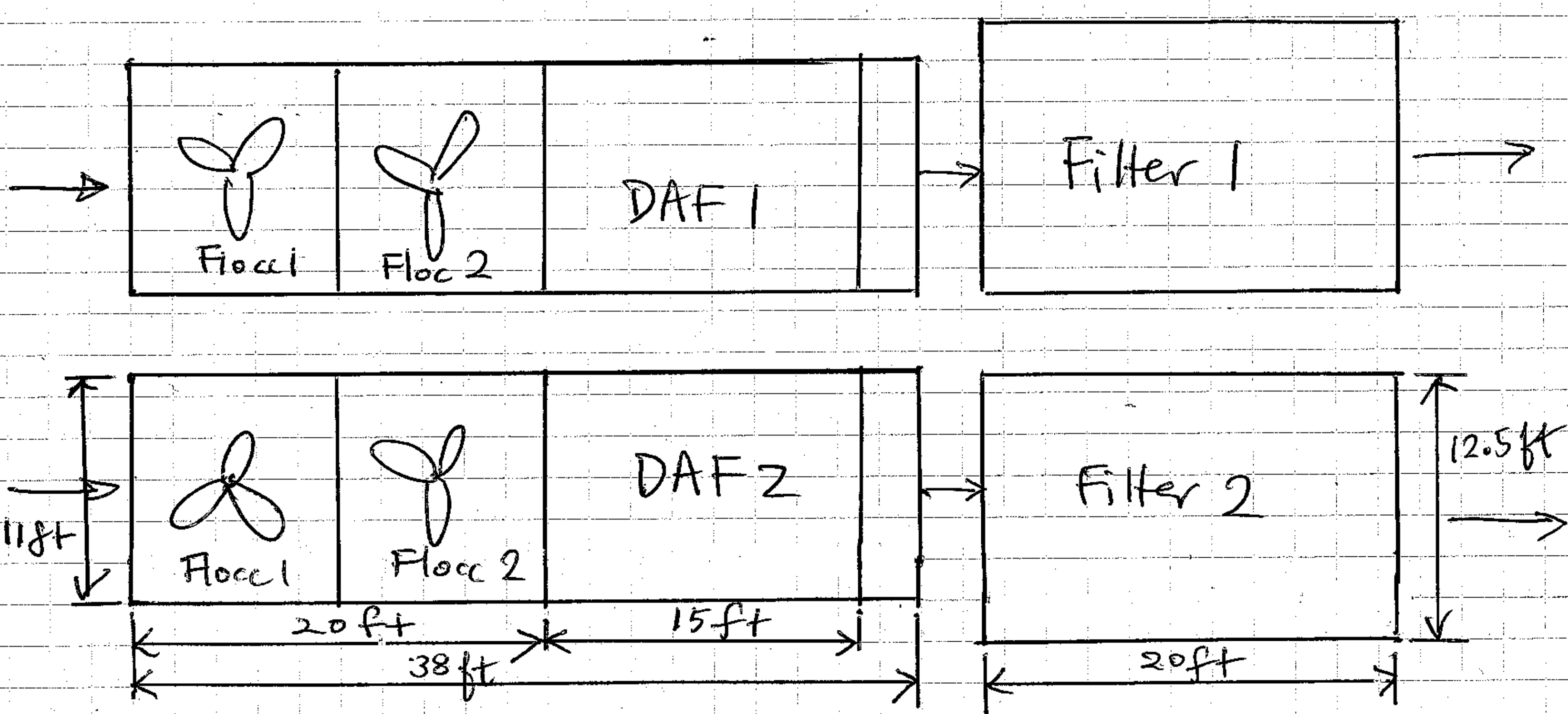
SH.3 OF 3

DRAWING NO. 058342-02 REV A

Wrangell DAF

Design Flow : 1.8 mgd

Flow per Train : 625 gpm



Flocc Time : 25 min

DAF Loading : 3.79 gpm/ft^2

Filter Loading - 2.5 gpm/ft^2

Call: 604-638-0760

PLANTS

AWC Water Solutions offers packaged water treatment plants based on dissolved air flotation (DAF) technology. These plants excel in treating lake and reservoir water containing high levels of color, algae and turbidity, as well as cold waters and high levels of iron and manganese.
Our DAF plants are custom-designed to meet our clients' particular challenges. They can treat capacities up to 1,400 gpm (7,600 m3/d) per train (multiple trains can be combined for higher flows) and reliably achieve less than 0.1 NTU turbidity and 2.5-log, multi-barrier protection against Giardia and Cryptosporidium.

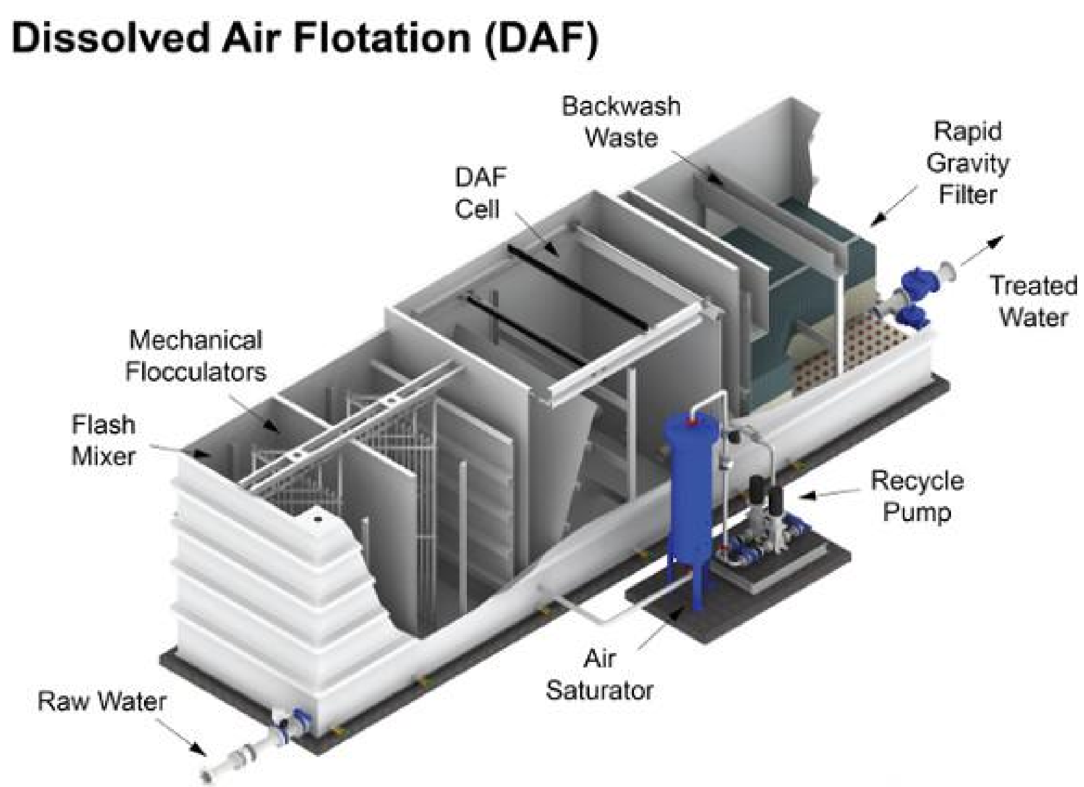
HOW THE DAF PROCESS WORKS

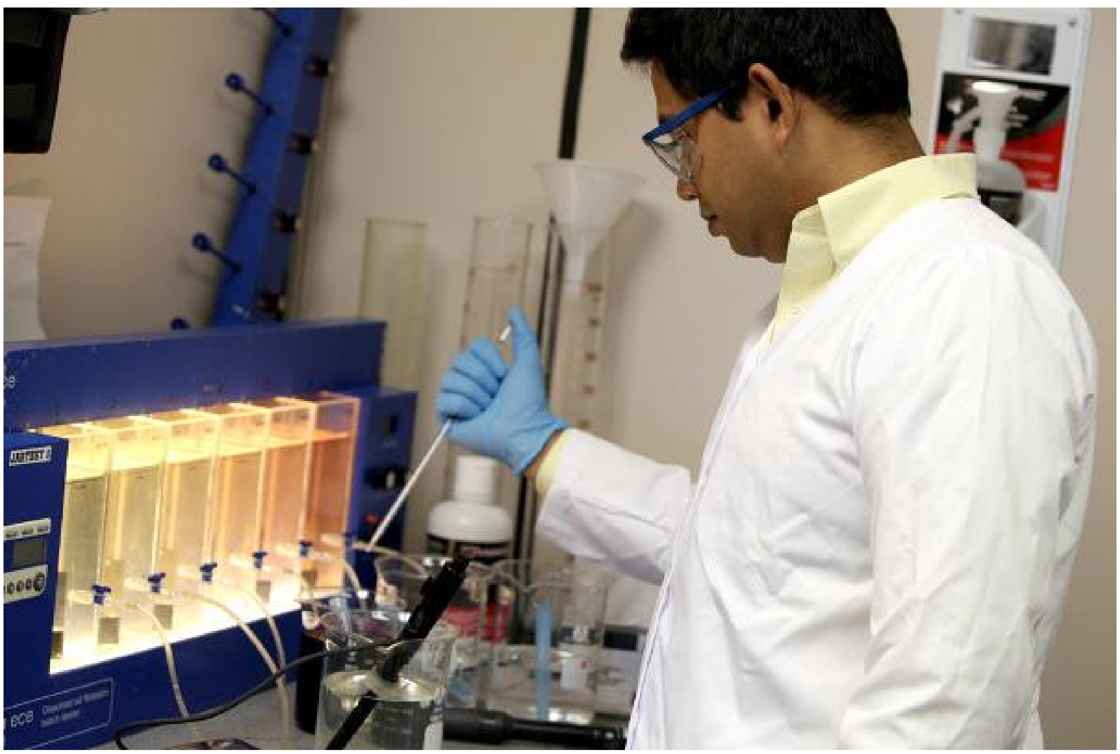
1 Flash Mixing

2 Flocculation

3 Dissolved Air Flotation

4 Filtration





Flash mixing

A coagulant added to the raw water precipitates dissolved contaminants and encourages particles to form "flocs".

- Multi-chemical injection ports for coagulant, polymer, pH adjustment, etc. provides process flexibility

- Static or powered mixers are options

Flocculation

Gentle agitation in the flocculation zone helps these flocs grow before they pass into the flotation zone.

- Multi-stage hydraulic or mechanical flocculation
- Carefully designed to minimize short-circuiting
- Hydraulic flocculation has variable nozzles for site adjustable energy input
- Mechanical flocculators are fitted with variable speed drives

Dissolved air flotation

Once in the flotation zone, microscopic air bubbles are injected. The 50 micron bubbles used for flotation are formed by recycling a small stream of clarified water through an air pressurized, packed tower saturator to specially designed nozzles at the DAF cell inlet. Here, a rapid pressure drop causes the air to come out of the solution and form millions of small bubbles, which are then dispersed through the flocculated raw water. Then, the bubbles rapidly float the flocs to the surface and the accumulated float is skimmed off.

- Inlet/outlet manifolds for even flow distribution
- Mechanical float or hydraulic removal options are available
- "V" hopper bottom for sludge thickening and hydraulic sludge removal option available

Filtration

Clarified water passes to the high-rate filter for final polishing and the filter is periodically cleaned by water or air/water backwashing.

- Mono, dual and multi-media options
- Options for iron, manganese and arsenic removal
- Water backwash with surface wash option
- Air scour/water backwash option for reduced water consumption and improved cleaning
- Nozzle and plenum-type underdrain

Plant Features

Quality tank construction

AWC constructs its tanks out of highly corrosion-resistant marine-grade, 5086 aluminum alloy. This construction eliminates the need for corrosion-protection coatings and prevents premature failures, which can occur with poor surface preparation or coating failures. Sacrificial anodes are used to further increase protection against corrosion. All fasteners in contact with the aluminum are 316 stainless steel to minimize galvanic corrosion. Stainless steel tanks are also available upon request. Our process equipment components can also be supplied for installation into site-constructed concrete tanks or retrofitted into existing tankage. In these circumstances, AWC can provide tank dimensions and other civil criteria.

Electrical systems and control panels

AWC designs, builds, programs and commissions fully integrated automated control and electrical systems. Our systems feature:

- Integrated UL and CSA approved MCC's and control panels

- Fully automatic operation with advanced instruments and controls
- Remote monitoring, control and SCADA options
- Industrial quality PLC's with simple plug-in, pre-programmed modules for reduced training and technical support

Chemical systems

We offer a full range of chemical mixing and dosing systems, including solution tanks, mixers, dosing pumps and safety equipment.

Advantages of AWC DAF Plants

Corrosion-Resistant

Our plants are fabricated with marine-grade aluminum alloys and stainless steel to provide superior resistance to chemicals and corrosion, resulting in longer life.

Cost-Effective

Our packaged DAF plants are pre-assembled and pre-tested in our controlled facility, often saving 50 percent or more over in-situ construction. They can also be integrated into pre-engineered building systems for increased savings and reduced schedule. Their small footprint also reduces building costs.

Simplicity

Our DAF plants are quiet, simple and easy-to-operate with minimal operator input. They are also supplied complete with chemical dosing, water quality instrumentation, automatic controls and monitoring systems customized to meet local needs.

Discover the power of working with the industry's most experienced team.

CONTACT US

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#101 19074 22nd Avenue
Surrey, British Columbia
Canada V3Z 3S6

Tel (604) 936-4217

www.adiwater.com

BUDGET QUOTATION

DATE:	December 4, 2015	**TIME:**	1:13 PM
TO:	**Trevor Trasky** **CRW Engineering**	**PHONE:** **FAX:**	**(907) 562-3252**
COPIES:	Mike Morris, ADI	**FAX:**	(360) 886-1396
FROM:	Andrew Stevano P. Eng.	**PHONE:** **FAX:**	(604) 638-0760 x527

Number of pages including this cover 14

Our Ref: **17805**

RE: **Absorption Clarifier (AC) Pre-Treatment with Nano-Filtration (NF) – Budget Quotation for Wrangell AK WTP**

1) ADI-AC-1260-3
2) ADI-NF-1080-3

We are pleased to submit our preliminary ideas and budget pricing for the above plant.

For the NF option, pre-treatment is required. The AC pre-treatment is effective to remove turbidity, Fe and Mn, and organics.

For the reduction of capital costs, we are employing 1 train of the AC plant followed by 2 trains of the NF system. We have adjusted the AC and NF design flows to account for losses for backwashing water and backwashing down time. We are anticipating the use of a common break tank (by others) for flexibility and the continuous operation of the NF.

We are employing Hydranautics' HYDRACoRe membrane that is chlorine resistant and targets organics only, removing very little hardness.

The "AC" plant utilizes chemical coagulation with hydraulic tortuous path flocculation and solids retention clarification within an up-flow roughing filter followed by dual media filtration in a separate down-flow filter.

These plants are factory assembled and tested and delivered complete with all required controls. Only on-site connections for the raw water feed, treated water discharge, wastewater discharge and power are required. Filter media is shipped separately.

The following provides details and budget pricing.

1) Budget Price Proposal for Pre-Packaged Adsorption Clarifier

Plant Type ADI Model AC-1260

1 module, rated at 1260 gpm or 1.8 MGD

The module comprises a static mix system, clarifier and 2 filters. The filters operate simultaneously, but are backwashed separately.

Clarifier surface loading: 9.55 USgpm/ft^2

Filter Loading: 4.77 USgpm/ft^2

Module details.

- Tank dimensions (1):

Width	Height	Length
11 ft	8 ft 6 in	36 ft

- Constructed of marine grade aluminum alloy offering corrosion free service and eliminating the need for protective coatings and tank structure maintenance. (Tankage is approved by the E.P.A. for an approved tank life in excess of 100 years.)
- Inlet basket strainer, flow control valve, and magnetic flow meter,
- Chemical injection spool for addition of coagulant and inline static flash mixer.
- Upflow flocculator/clarifier, each train
  - ◊ Inlet plenum with non-clogg Orthos nozzles
  - ◊ 1070 mm (42") of crushed quartz media
  - ◊ Backflushing by combined air scour/raw water flush
  - ◊ Automatic control valve for air scour and back-flush to waste cycles
  - ◊ Drain for good housekeeping procedures.
- Rapid rate gravity sand Filter, each train
  - ◊ Plenum with non-clogg Orthos nozzles
  - ◊ 450 mm (18") of Anthracite and 450 mm (18") of high silica filter sand media
  - ◊ Backwashing by combined air scour/water
  - ◊ Automatic control valve for effluent, rinse, air scour and backwash
  - ◊ Drain for good housekeeping procedures.

One Air scour blower rated for 396 scfm at 5 psi c/w starter

Backwash pump rated for 2112 usgpm at 40 ft TDH c/w starter, isolation and check valves

Effluent pumping (1), rated for 1260 gpm @ 35' c/w starters, isolation and check valves

Access ladder and walkways as indicated on sample drawing

Chemical Systems

- Storage and dosing systems for the following chemicals. Each system would comprise 2 dosing pumps (duty and Stand by), shelf or stand mounted, injection ports, day tanks with powered mixing if necessary.
  - ◊ (Primary Coagulant)
  - ◊ (Polymer flocculation aid)
  - ◊ Soda Ash for pH and alkalinity elevation

Instrumentation

- One turbidimeter for raw water turbidity
- pH monitor.
- One Turbidimeter for each filter for filtered water turbidity
- Effluent particle counters and chlorine residual monitors are Optional
- Clarifier differential pressure switch
- Filter pressure transmitter
- Filter Level Transmitter
- Inlet magnetic flowmeter and backwash flowmeter

Allen Bradley Compact Logix PLC and Panelview HMI for fully automatic operation (shares with the downstream NF)

Commissioning technician for final commissioning and staff training

O& M manuals: (2 hard copies and 1 CD)

1) Budget Price: $ 395,000.00 excluding all applicable taxes

Delivery can usually be made within 12 weeks following approval of final shop drawings.

2) Packaged Nano-Filtration CWS-NF-1080-2

System comprises 2 trains on 2 skids, 5 micron pre-filtration, vertical inline NF feed pump, NF elements, clean in place (CIP) system and separate chemical dosing systems. It also includes a fully automatic control system.

Basic Design Parameters

Membrane Type:	Hydranautics' HYDRACoRe
# of trains:	2
Design flow, total:	1080 gpm
Design flow each train:	540 gpm
Required Feed Flow, each train:	600 gpm
Permeate production, each train:	540 gpm
Concentrate Recirc, each train:	35 gpm
Recovery:	90% in 1 pass with 2 stages, each train
Overall Flux:	14.6 gfd

System Details

All equipment, other than chemical feed systems and CIP solution tanks are skid mounted on skids constructed of structural aluminum.

- Skid dimensions (2):

Width	Height	Length
8' - 0" (2.45 m)	8' – 6" (2.6 m)	24' - 10" (7.6 m)

- Feed pumping, each train
  - ◊ One 5 Micron pre-filter, sized for 600 GPM @ less than 5 psi head-loss with clean filter.
  - ◊ PVC and 304SS pipework
  - ◊ 1 booster pump, vertical inline, DP 630 gpm @ 200 psi, VFD, line and load reactors.
  - ◊ Check and isolations valves

- RO System Comprises, each train:
  - ◊ Feed water flow meter with panel indication.
  - ◊ Common temperature and pH transmitter.

- ◊ Pressure protection
- ◊ 1 pass membrane array as detailed below, employing HYDRACoRe membranes.
  - Stage 1 – 13 FRP vessels, with 7, 8" x 40" membranes elements
  - Stage 2 – 6 FRP vessels, with 7, 8" x 40" membrane elements
- ◊ Manual throttling valve for concentrate to waste
- ◊ Stage 1 permeate throttling
- ◊ Direct reading rotameter for each concentrate and permeate stream.
- ◊ Permeate discharge check valve.
- ◊ Automatic concentrate purge control and solenoid valve.
- ◊ Permeate flush

- CIP system, one only, skid mounted except for HDPE tanks (overall footprint 15' x 12')
  - ◊ CIP chemical preparation tank (1350 gal) with heater
  - ◊ CIP waste collection tank (1350 gal)
  - ◊ CIP pump, VFD, – 288 gpm @65 psi
  - ◊ Flow meter
  - ◊ One 5 micron cartridge filter
  - ◊ Associated piping and valves
- Instrumentation summary
  - ◊ Feed, each train
    - ◊ Pressure, Pressure transducer and indicator
    - ◊ pH, sensor/transmitter, common to both trains
    - ◊ Flow, Magnetic flow meter
    - ◊ Conductivity. Hach Conductivity transmitter, high (optional)
  - ◊ Permeate, each train
    - ◊ Pressure, Pressure transducers and indicators
    - ◊ pH, sensor/transmitter
    - ◊ Flow, direct reading Rotameters
    - ◊ Conductivity. Hach Conductivity transmitter, low range (optional)
  - ◊ Concentrate, each train
    - ◊ Pressure, Pressure indicator
    - ◊ Waste Flow. Magnetic flow meter
  - ◊ Concentrate recirc, each train
    - ◊ Flow, magnetic flow meter
- Chemical Systems, each train

  Storage and dosing systems for the following chemicals. Each system would comprise a solution tank with powered mixer (if necessary), shelf mounted pre-plumbed duplex dosing pumps for 100% redundancy with calibration column and multifunction valve, and injection ports.

- ◊ Anti-scalent (1)
- ◊ Acid for inlet pH balancing (1)
- ◊ NaOH for permeate balancing (1)
- ◊ Sodium hypochlorite for disinfection (1)

- Junction Box
- PLC for fully automatic operation (Allen Bradley CompacLogix with Panelview HMI), in common with AC pre-treatment. Options for MCC Panels, SCADA systems, and Telemetry systems are available upon request.
- 2 trips, 12 days on-site time by trained Corix commissioning technician for final commissioning and staff training…

O& M manuals / As-Built Drawings

Shipping, FOB Wrangell AK

2) **Budget Price: $728,000.00 excluding all applicable taxes**

Delivery can usually be made within 10 weeks following approval of final shop drawings

THIS BUDGET PRICE ESTIMATE DOES NOT INCLUDE:

- Any applicable taxes
- Receiving, unloading and suitable storage of material
- Concrete foundation pads
- Field erection and assembly of treatment plant and equipment, labor and supervision
- Piping connections, influent and effluent piping, rinse and backwash piping, yard piping, drain piping, or other piping outside the plant structure
- Field electrical wiring and conduit
- Plant enclosure or building.
- Base meter, split trough, disconnect switches, transformer, if required, are not included
- Field paint or painting labor
- General cleaning of plant
- Installation of chemical feed systems

ADI Water Solutions and its predecessor companies have engineered over 500 similar plants since 1965 and we value the opportunity to work with engineers and the plant owners and operators to develop concepts and final designs so that the final product provides the most cost effective and efficient solution. For more information on our Company and our range of products and services visit our web site at ***www.adiwater.com.***

I trust this meets your needs and will be pleased to provide any further information you may require.

Regards,

Andrew Stevano P. Eng.
E mail: andrews@adiwater.com

Attachments:

- AC Plant Process Description
- Operating Costs AC-NF Plant

PROCESS DESCRIPTION - "AC" Adsorption Flocculating – Clarifier / Filtration

Inlet Flow Control - Raw water enters each plant train through a basket strainer, magnetic flow meter, and Cla-Val hydraulic rate of flow control valve. (Options for electric, pneumatic, or hydraulic valve actuators are available upon request.) A 4-20ma signal from the flow meter is used to modulate the control valve to maintain the desired flow.

Flash Mixing -. Chemicals: typically primary coagulant, polymeric flocculant, and soda ash are injected in an injection spool and the flow passes into a static flash mixer. All chemical rates are paced to flow. (Chemcial oxidizers may be used to precipitate iron and manganese if present.)

Adsorption Clarifier - Following mixing the coagulated water flows to the adsorption clarifier that provides both flocculation and solids separation in a common unit. The coagulated water first passes upward through an array of non-clogg Orthos diffusers and then a 42" layer of 2 mm non-buoyant media. The media encourages first flocculation and then traps the formed floc. A pressure switch provides indication that the total head-loss has exceeded a pre-set limit and that flushing is required. This indication is also provided by elapsed run time. The flushing sequence includes an initial air followed by a flushing water flow using the raw water supply. Dirty wastewater flows to waste through the upper wastewater channel. Manual drain valves permit tank draining and cleaning.

Filtration - From the clarifier section water flows to the top of the filter section and is filtered through a mixed media comprising:

450 mm	18 inches of 1.0 mm No#1 anthracite coal
450 mm	18 inches of 0.45-0.55 mm high silica filtration sand

The filtered water is collected through an array of slotted PP nozzles. Clayton rate of flow level control valves maintain a constant level in each filter. A pressure switch provides indication that total head-loss has exceeded the maximum acceptable level and that backwashing is required. This indication is also initiated through high filtered water turbidity, which is constantly monitored by an on-line Hach turbidimeter on each filter or by elapsed run time.

The filter utilizes a combined air scour and water back-flush filter cleaning system**.** An initial air scour at 2.5 scfm/ft^2 is followed by a combined air water wash at a wash rate of about 4-6 US gpm/ft^2, (10-15 m/hr), followed by a water only back-flush at 12-16 US gpm/ft^2, (30-40 m/hr). The exact rates are established during start up. A Clayton flow control valve with twin flow pilots modulates the backwash flow for the two separate flow rates. (Other valve configurations are available upon request.)

Dirty backwash water is collected through surface launders and directed to waste. For deeper filters, the launders are normally submerged and equipped with an isolating outlet valve with powered actuator.

Following completion of the backwash cycle the filter is run to waste through a waste line fitted with a Cla-Val control valve. The filter gradually matures and effluent turbidity falls to acceptable levels. After a preset time interval the rinse to waste valve closes, the effluent valve opens and the filter returns to normal service.

The full backwashing sequence can be both initiated and controlled either manually or automatically. Automatic operation is through a PLC controller with sequence times easily adjustable by the plant operator.

ORICA WATERCARE

MIEX® Treatment Systems

High Rate Configuration

Advanced ion exchange treatment solutions

MIEX®

The MIEX® Treatment Process

The MIEX® Treatment Process is an advanced ion exchange process that uses MIEX® Resin to remove target contaminants from water and wastewater streams.

MIEX® Treatment Systems have small footprints, very low waste volumes and are not subject to chromatographic peaking, allowing ion exchange to be used in a wide variety of applications and throughputs.

MIEX® Resin

The name MIEX® comes from "Magnetic Ion Exchange". The resin beads have a magnetic property that allows them to agglomerate and settle rapidly, or fluidize at high hydraulic loading rates. Because of this unique feature, MIEX® Resin is used in a continuous process with ion exchange occurring in either a mixed tank or a fluidized bed reactor vessel.

Figure 1
Reactor Vessel

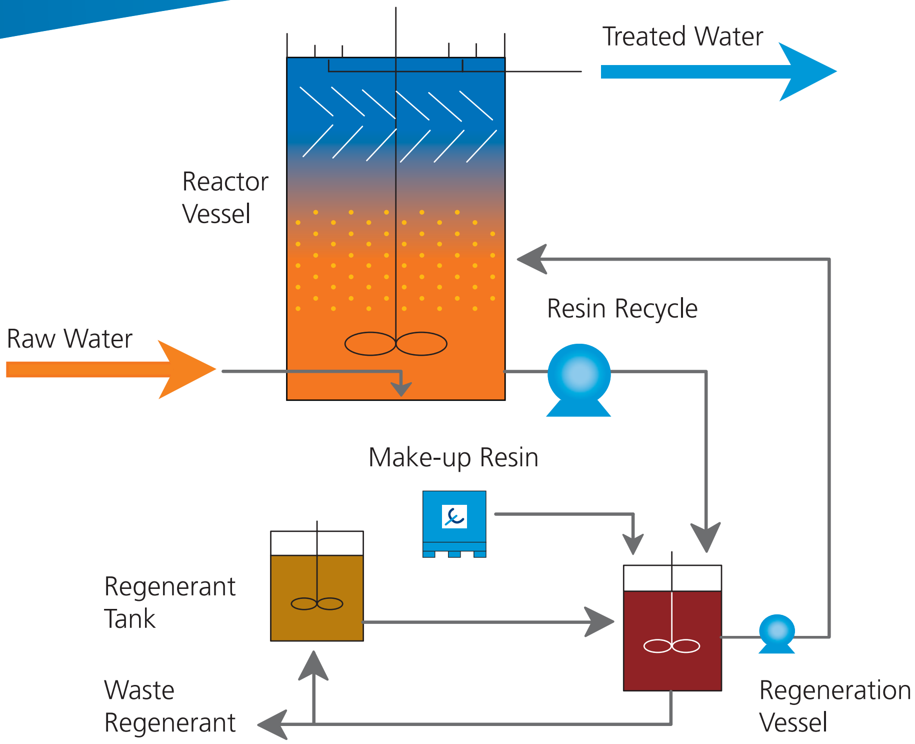

Figure 2
Process Flow Diagram

MIEX® Treatment System: High Rate Configuration

The High Rate configuration refers to a MIEX® System where ion exchange occurs in a fluidized bed reactor *(Figure 2)*.

In this configuration, raw water is fed to the base of the reactor vessel and mixed with the MIEX® Resin. Within the fluidized bed, the magnetic resin beads are attracted to each other to produce large agglomerates that form a uniform resin suspension, allowing design hydraulic loading rates of at least 10 gpm/ft^2.

An agitator operating at low speeds maintains a uniformly mixed resin/water suspension. A small stream of resin is withdrawn from the reactor vessel, regenerated and returned to maintain the ion exchange capacity of the process.

A series of tube settlers (or plates) at the top of the reactor vessel separate the resin from the water. Treated effluent overflows into collection launders to downstream treatment.

Virgin resin is periodically added to the process to make up for minimal quantities of resin that may be carried downstream.

The High Rate configuration can be provided as an open tank gravity flow system or an enclosed pressurized system.

System Sizes

MIEX® Treatment Systems are available as packaged systems up to 2 MGD (MagnaPak™ Systems) and as custom-designed systems for all capacities over 2 MGD.

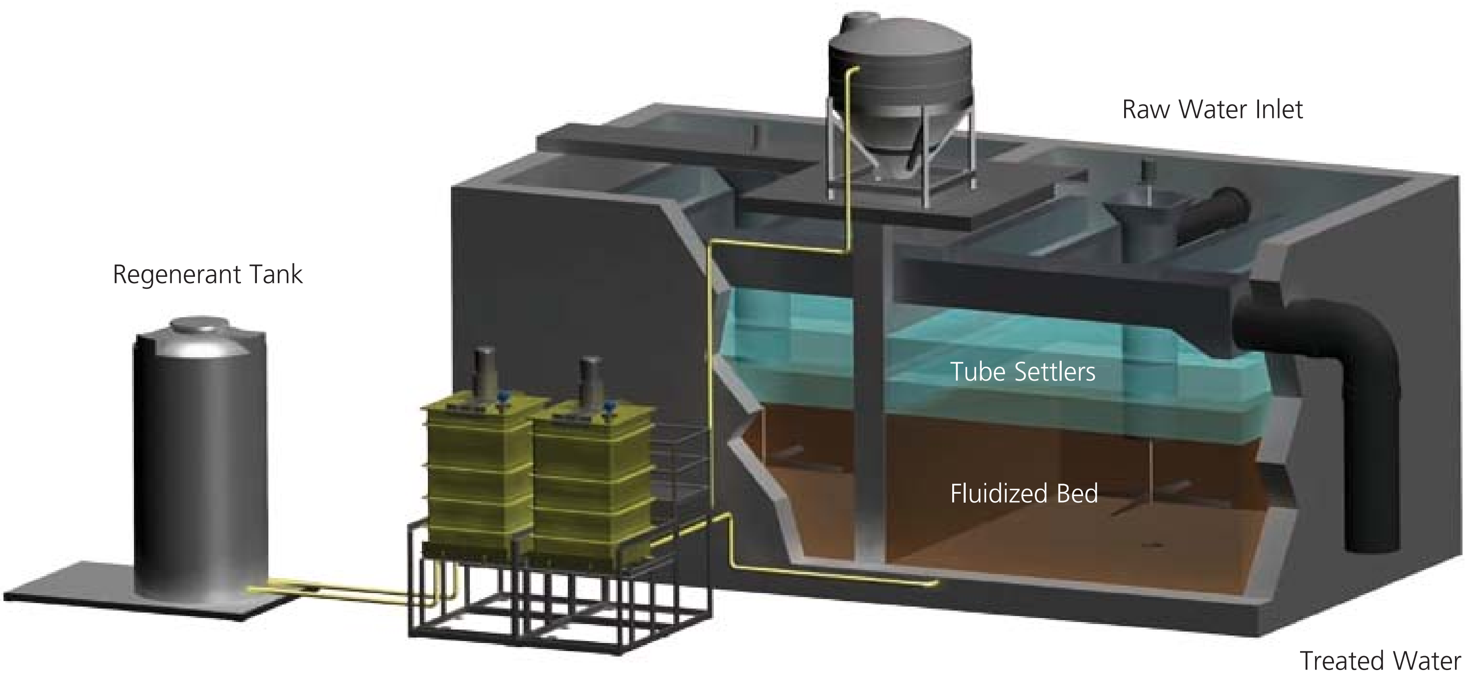

Figure 3
8 MGD MIEX® System

Resin Regeneration Process

The continuous withdrawal of loaded resin and return of fresh regenerated resin ensures a consistent treated water quality which prevents the chromatographic peaking that can occur with conventional ion exchange columns. Regenerant solutions typically consist of sodium chloride but other salts such as potassium chloride, magnesium chloride or sodium bicarbonate can be used if either sodium or chloride is not desired in the waste discharge.

Residuals

The highly efficient regeneration process keeps regenerant use and waste volumes to a minimum. Residual volumes from MIEX® Treatment Systems consist of waste from regeneration and are small, typically 0.02 to 0.06% of the plant throughput. Disposal options include sewer discharge, evaporation or coagulation/recycling of the regenerant solution.

Placement in treatment train

The MIEX® Process can be used as a stand-alone treatment for the removal of contaminants such as nitrate, arsenic or DOC, or in combination with other treatment processes to meet more than one objective.

Since the MIEX® Process is not affected by suspended solids in the source water, it can be placed in a number of locations throughout the treatment train. Typically it is used as a pretreatment step ahead of current processes. When used this way, the efficiency of downstream treatment processes can be greatly improved, resulting in less chemical demand and sludge production, better membrane operability, as well as improved solids separation through DAF and conventional sedimentation/filtration.

The addition of a MIEX® System requires little alteration, if any, to existing treatment systems.

ORICA WATERCARE

Orica Watercare Services

Orica Watercare performs laboratory and pilot evaluations to determine the optimum performance of MIEX® Resin on water and wastewater streams. A design package and budget estimate can be provided based on these feasibility studies. Orica Watercare is also fully equipped to supply equipment and perform system commissioning and optimization upon installation.

Orica Watercare Head Offices

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HRC0207

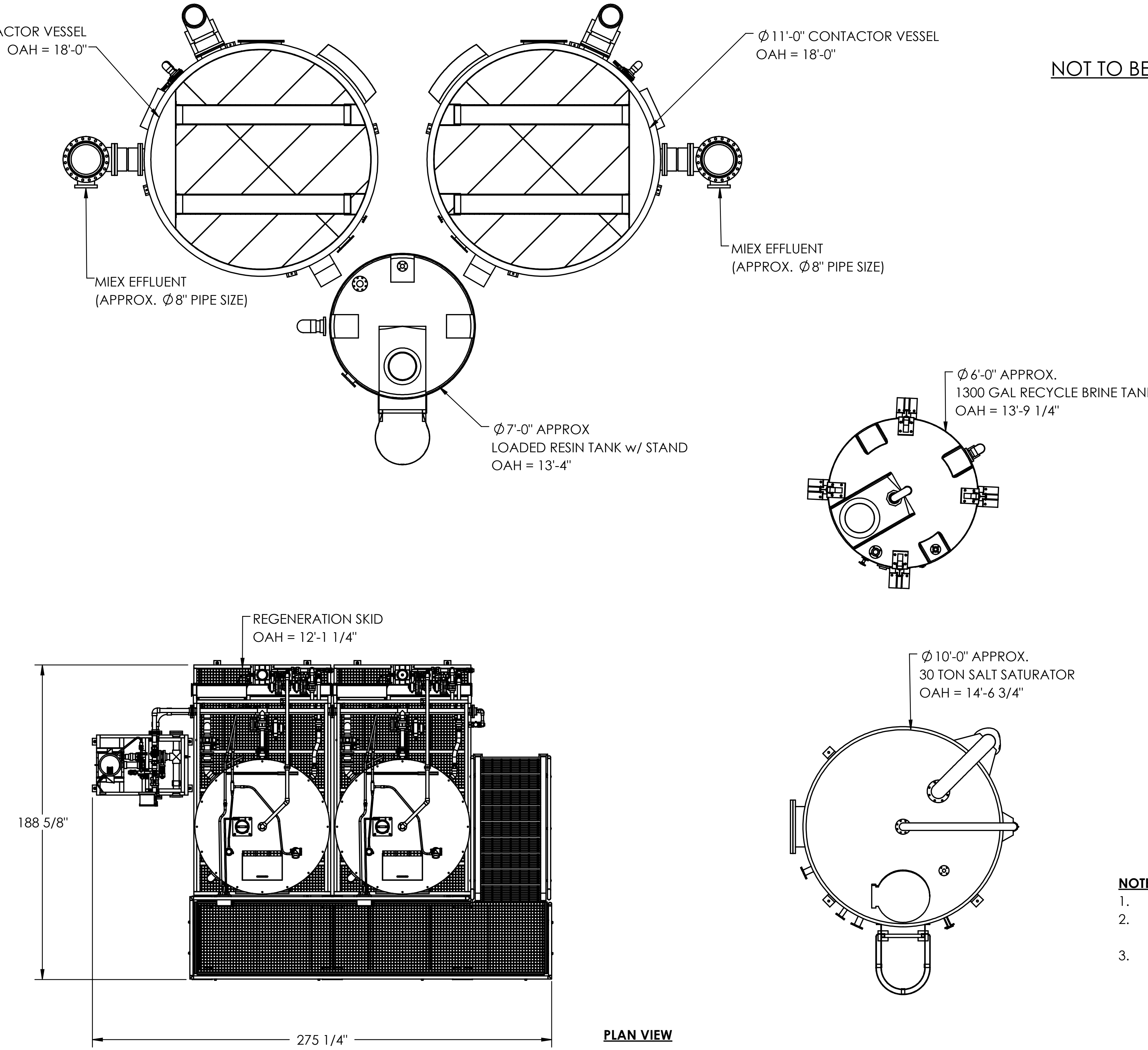
MIEX®

Visit our website at **www.miexresin.com** or contact your nearest Orica Watercare office for more information or to inquire about a specific application.

MIEX® is a registered trademark of Orica Australia Pty. Ltd.

PRELIMINARY

NOT TO BE USED FOR BUILDING DESIGN OR SCOPE DETERMINATION



PLAN VIEW

NOTES:

1. ALL DIMENSIONS APPROXIMATE
2. EQUIPMENT LOCATIONS SUBJECT TO SITE CONSIDERATION AND NOT GIVEN FOR ANY PARTICULAR ARRANGEMENT.
3. CONTACTOR INFLUENT / EFFLUENT PIPING SHOWN IS GENERIC. ALL REQUIRED PIPING IS BY OTHERS.

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ENGINEER	S. MITCHELL	11/03/15
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PROJECT MGR	S. MITCHELL	
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PROJECT: CITY OF WRANGELL, AK 2MGD
SERVICE: MIEX® PRE-TREATMENT
TITLE: **MIEX® SYSTEM GENERAL ARRANGEMENT FULL ASSEMBLY PLAN VIEW**

SIZE: B | DWG NO.: **NAXXX-05-01-001** | REV: X
SCALE: 1:72 | SHEET: 1 OF 1

Jon Hermon

From: Trevor Trasky
Sent: Wednesday, December 09, 2015 2:52 PM
To: Will Kemp
Cc: Jon Hermon
Subject: Wrangell - Conventional Train

Will, some ballpark numbers for a conventional system for 2.0 mgd in Wrangell:

Budgetary cost: $1.0 million USD FOB Wrangell
4 trains total to make up a 2.0 MGD plant with a footprint as follows:
3 flocc/clarifier trains approximately 13'Wx51'Lx10'H with 3' walkways in between each
1 filter train perpendicular to these with 4 filter basins (3+1 redundant) approximately 13'Wx40'L total.

Like this:

Flocc+clar 1	4 filt bay
Flocc+clar 2	
Flocc+clar 3	

O&M for this is very similar to the AC treatment for Nano.

Trevor Trasky, PE
Civil and Environmental Engineer

CRW Engineering Group, LLC
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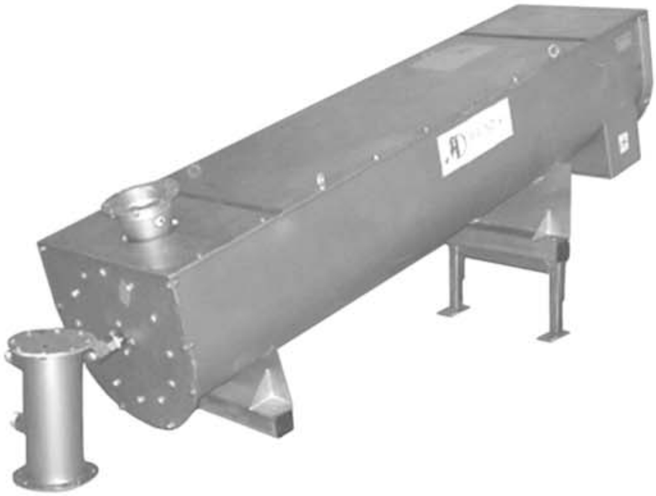
DRYCAKE

Vanderbeken Enterprises Ltd.

1877-DRYCAKE

"DRYCAKE PRESS"

Sludge Thickening & Dewatering



Low Outlay Cost – Low Asset Cost – Low Energy Cost

High Reliability…

DRYCAKE has developed a good reputation with a philosophy of offering high quality at low cost. This has served to provide equipment to smaller industries or applications where previously it was considered unviable and offers a lower purchasing cost for larger applications.

"DRYCAKE PRESS"

DRYCAKE PRESS represents innovation in design and provides an economic solution for either sludge thickening or dewatering at small to medium water, waste water and industrial effluent treatment works in addition to certain larger applications. Low outlay cost, running cost and maintenance costs were fundamental to design objectives and this has culminated with the development of a highly cost-effective process. Sludge export or transportation costs can therefore be significantly reduced with consequential further savings on operational and energy costs.

Sludge thickening up to 15% DS or, sludge dewatering up to 30% DS are attainable. Systems can operate automatically or manually – either continuous, or intermittently for batch processing. Various manufacturers' flocculants may be used and the system can be supplied with or without preparation plant to suit requirements.

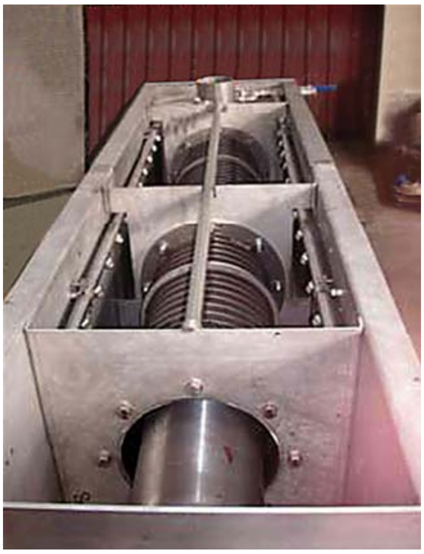
Operation

The patented DRYCAKE PRESS consists of static circular drums with internal screw conveyor. The drums are fabricated in stainless steel using various size special wedge-wire screen profiles with large surface to obtain optimum liquor drainage characteristics. Flocculated sludge enters the inlet chamber into the drum zone where it conveys by spiral movement and is gradually compacted. Liquor continuously drains through the drum wedge-wire screen and gravitates to the filtrate outlet where it can be discharged or returned for treatment. The sludge retained in the drum is subjected to continuous movement and progressive compaction applying the desired effect of releasing more liquor to drain – flocculated sludge is treated gently and flocculent utilization kept low. Spray nozzles provide intermittent wash to the screen sections, however with inlet sludge solids content ≥ 1.5% DS, washing will not be necessary and water consumption is negated. Eventually the solids will pass into the discharge section and to the outlet where it can be collected into a container or conveyed for eventual disposal.

DRYCAKE PRESS sludge thickening and dewatering systems are manufactured with the same philosophy applied to all DRYCAKE equipment comprising of bolted sections to grant far superior inspection and maintenance access which in turn will increase longevity and overall asset life.

Advantages

- Simple mechanized operation
- No rotating synthetic filter cloth requiring periodic attention
- Low speed operation – low energy input
- High solids capture
- Low shear – excellent recovery of all sludge types
- Easy operation and maintenance
- Improved Health & Safety benefits
- High reliability and long asset life
- Non-clogging even with fibrous materials
- Compact, low space requirement



DRYCAKE PRESS with cover removed

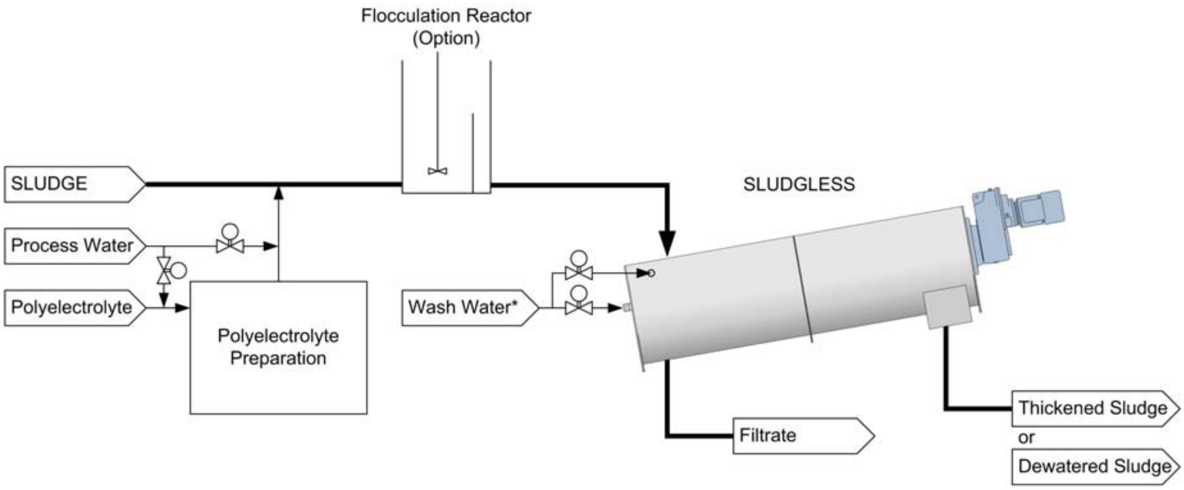
Flocculent

Sludge thickening or dewatering requires initial mixing and flocculation of the incoming sludge using an appropriately selected polymer. Polymer can be supplied as dry solids, beads, emulsions or solutions. Where necessary, other chemicals may be considered such as lime, iron and aluminium salts although, modern polymer solutions generally have superior solid liquid separation and flocculation potential.

Polymer is first activated with water, which depending upon the type of polymer used, may take 5 – 60 minutes to suit process needs. It is then diluted to the required concentration prior to dispersing and mixing with the sludge. Mixing should have sufficient contact time to provide liquid separation and flocculent formation. Typically, adequate flocculation times can range between 30 seconds to 2 minutes.

The quality of treatment will depend upon sludge type, temperature, selected polymer, polymer mixing and adequate flocculation time. Typical polymer usage for waste water sludge varies from 0.3 – 7 kg/ t DS. In general, sludge thickening requires less polyelectrolyte than sludge dewatering. Automated polymer preparation and dosing systems along with the option of a flocculation reactor can be supplied with the DRYCAKE PRESS.

Typical Arrangement



* With inlet sludge solids content ≥ 1.5% DS, intermittent wash water will not be necessary. To reduce potable water usage, wash water may be sourced from the works treated final effluent.

DRYCAKE PRESS is capable of providing automatic sludge thickening or dewatering with continuous 24-hour run time if necessary, without operative attendance being required.

4 DRYCAKE PRESS units positioned in parallel providing sludge dewatering from 1.6% DS to 20% DS

Sludge Dewatering and Thickening

With screw rotation less than 20 rpm, the DRYCAKE PRESS conveys flocculated sludge very gently without high velocity shear, using low energy input and therefore will have an excellent recovery rate for all sludge types.
The inlet sludge flow rate, polymer dosing rate, good flocculent formation and inclined angle determines the optimum operating efficiency, the final dry solids concentration and filtrate quality.

Typical Sludge Dewatering Performance

Typical inlet sludge flows to achieve a mean 22% DS discharge

Model	Drum Diameter (mm)	Inlet Sludge Flow 1% DS (gpm)	Inlet Sludge Flow 3% DS (gpm)	Filtrate Quality (mg/l)
XMD 20	200	4.5	3	≤ 400
XMD 40	400	9	6	≤ 400
XMD 70	700	22	15	≤ 400

Sludge Thickening

When applied to sludge thickening, the same DRYCAKE PRESS models are capable of processing increased inlet sludge flows over the above sludge dewatering capacities and higher, determined by the incoming sludge concentration and the final sludge dry solid content requirement.

Wash Water

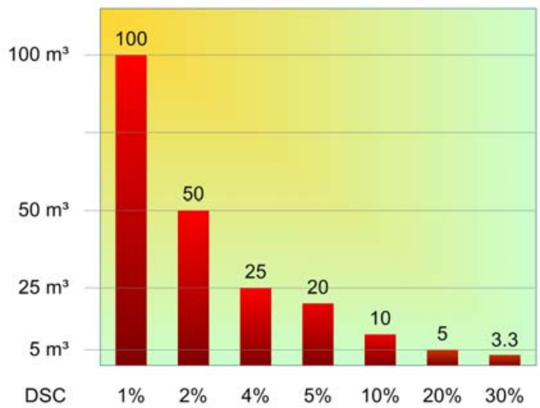
Wash water is standard throughout the DRYCAKE PRESS range; however with inlet sludge concentrations over 1.5% DS, washing will not necessarily be required but may be useful for periodic cleaning purposes.

Model	XMD 20	XMD 40	XMD 70
gph (75 psi)	30	35	55

Dewatered dry solids conveyed into the DRYCAKE PRESS discharge section

XMD 70 DRYCAKE PRESS with TOP 3 Combined Screen, Grit and FOG removal plant installed inside a purpose-built building

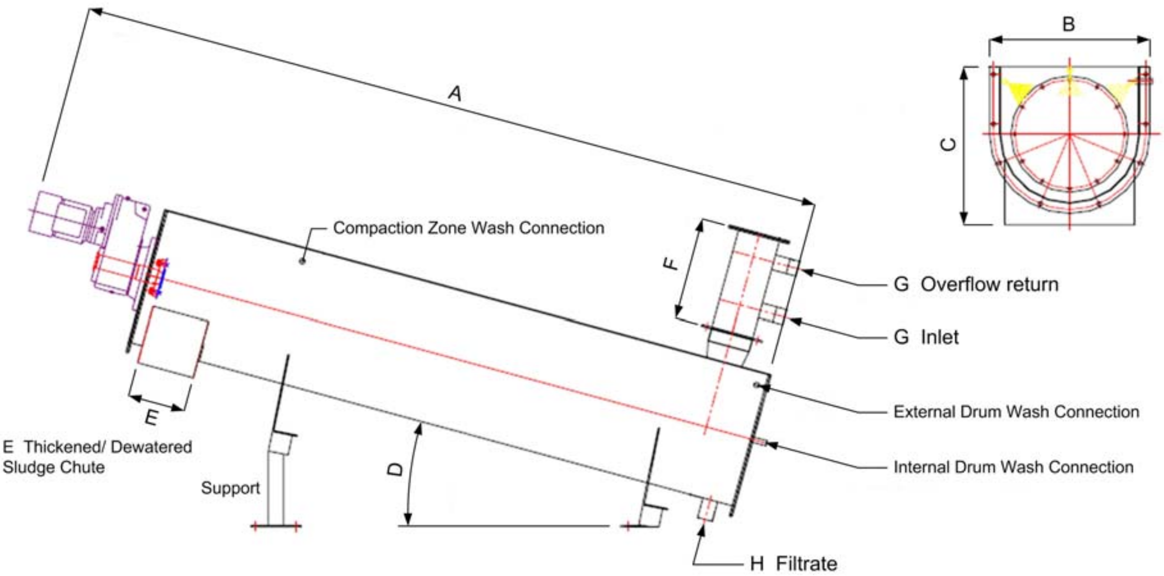
The graph illustrates the significant volume reductions and savings that can be gained by thickening or dewatering 450 gpm of a 1% DS sludge prior to transportation.



DRYCAKE PRESS Nominal Dimensions, Weights and Motor Rating

Dimensions	XMD 20	XMD 40	XMD 70
A	2,320	2,800	3,800
B	400	500	636
C	515	615	640
D	5-15°	5-15°	5-15°
E	230	230	230
F	400	400	400
G	50 DN	50 DN	50 DN
H	60 DN	60 DN	60 DN
Lbs	550	850	1350
HP	1/2	1/2	3/4

Sludge Thickening



The design of the DRYCAKE PRESS facilitates installations to be either inside buildings or outside without any sheltering, allowing direct disposal of thickened or dewatered sludge to a container or holding tank.

Supplementary DRYCAKE products to complement the DRYCAKE PRESS sludge thickening or dewatering systems:

Conveyor Systems

Horizontal

Inclined

Vertical

Appendix G – Water Testing Reports

Wrangell Jar Testing

August 10, 2015 Test

Raw Water Data:

Color: 79 Turbidity: 0.90 pH: 5.40 Temperature: 12.2 deg C Mn = 0.03 mg/L

In 1 Litre of Raw water sample I started with Isopac in order to track chemical dosage, pH adjustment and Flocc formation. Below is the detailed step by step addition of chemicals I added in order to see if flocc is formed. After a short while each step of chemical addition was conducted.

Chemical Added (Isopac)	pH Measurement	Comments
10 mg/L	5.55	No Flocc
20 mg/L	5.24	No Flocc
30 mg/L	4.77	No Flocc
Added 10 mg/L of Caustic	6.36	pH was increased
40 mg/	6.08	No Flocc
50 mg/L	5.80	No Flocc
60 mg/L	5.46	No Flocc
70 mg/L	4.97	No Flocc
Added 15 mg/L of Caustic	8.1	No Flocc
90 mg/L	7.83	Very very very tiny Flocc
110 mg/L	7.24	Very very very tiny Flocc
130 mg/L	5.84	Very tiny Flocc
150 mg/L	4.78	Very tiny Flocc

2nd Test:

1 Litre Jar of Raw Water Sample.

90 mg/L Isopac was added and pH was measured. pH did dropped to 4.5 and then caustic was added to adjust pH. 15 mg/L of caustic was added and pH was raised to 5.67.

No Flocc was seen. No reaction was seen.

Added another 20 mg/L of isopac and also did pH adjustment but still no reaction. pH was about 5.7

No reaction at all.

<u>August 12, 2015 Tests</u>

Raw Water Data:

Color: 81 Turbidity: 0.92 pH: 7.83 Temperature: 12.2 deg C Mn = 0.03 mg/L

Test #1

As per Mike's instructions, raised the pH between 8.5 and 9 and add the coagulant dosage for the flocculation process. (1 Litre JAR only)
100 mg/L of ISOPAC was dosed.
35 mg/L of caustic was added and overtime pH was stable at 8.75.
Medium pin point flocc was observed. Below are the treated water sample results.

Color = 17 Turbidity = 0.28 Mn = 0.005 mg/L pH = 8.5

Test #2
Two Jars of 1 Litre each of raw water samples were used to perform testing.

Jar 1:

100 mg/L of ISOPAC used.

160 mg/L of Soda Ash used. The flocculation timing was regular 20 minutes time 10 minutes for each flocc speed. pH was stabilized at 9.0 during the testing. Below are the results of the treated sample.

Color = 22 Turbidity = 0.4 pH = 8.9 Mn = 0.005 mg/L

Jar 2:

100 mg/L of ISOPAC used.

160 mg/L of Soda Ash used + 1 mg/L of $KMnO_4$ was added as well.

After the addition of $KMnO_4$, sample did turned pink but overtime during flocculation, pink color disappeared. During flocculation pH was stable at 9.1. Flocc size was little bit better than Jar 1. Medium size flocc was seen. Below are the results of the treated water sample.

Color = 17 Turbidity = 0.26 pH = 8.93 Mn = 0.004 mg/L

By: Attinder Dhanoa
August 12, 2015

Date: 9/16/2015

Conducted by: Will Kemp, Andrew Gallagher (CRW Engineering Group, LLC)

Summary Table

		Filtered Water Characteristics			
Polymer	**Dosage**	**UVT**	**Color**	**Turbidity**	**pH**
Nalco 8185	11 mg/L	88	29	0.31	6.88
Nalco 8186	23 mg/L	89	39	0.30	6.89
Nalco 8105	9 mg/L	87	38	0.48	7.09
Nalco 8103	33 mg/L	86	34	0.26	6.87

Laboratory Report

MIEX Resin Test Results

Project Name:	Wrangell Water Treatment Plant		
Site / Location:	Wrangell, Alaska		
Plant Contact:	Unknown		
Contact:	Bill Reilly		
Sample Date:	6/24/2015	**Lab Control ID:**	LC-2015-14
Analysis Subject:	Organics and Color		
Report Date:	9/8/2015	**Document ID:**	LR-2015-14

1. Background / Summary

1.1. Background

Project Background - Wrangell Water Treatment Pilot Study Justification

Based on the TPS Report 54048v1, Wrangell's slow sand and ozone filtration water treatment plant has been in operation for approximately 10 years. In this time, there have been numerous issues that have developed, creating potential health risks and operational/maintenance costs.

Per the TPS report, the current treatment system does not work effectively with Wrangell's surface water supply. Wrangell's water source is surface runoff water that is very high in organics. When these organics are chlorinated, HAA5s and TTHMs levels become high which are known carcinogens. The filtration system attempts to remove organics through ozone and filtration before chlorination; however, not enough of the organics are removed through the existing process. Additional processes are also needed in order to address high levels of lead, copper, and disinfectant byproducts.

Currently, the sand filter screens clog easily, resulting in a failure to supply the necessary filtering or as quickly as customer demands require. The filters have to be scraped or cleaned every 1 to 2 weeks, rather than quarterly as designed. The continual cleaning does not allow the necessary film to build that provides safe filtration.

Based on the aforementioned concerns, Ixom Watercare was commissioned by CRW Engineering Group LLC of Anchorage, Alaska to conduct bench MIEX resin tests to determine its effectiveness for removing dissolved organics and color.

1.2. Summary

Ten (10) gallons of raw water was received from the Wrangell Water Treatment Plant for the removal of dissolved organics and color. The results from the MIEX resin testing showed exceptional removal of the organics and color with minimization of coagulant consumption and pH variation. The MIEX resin results showed the MIEX Gold resin at 800 bed volumes (BV) alone would achieve 78% removal of the DOC (1.7 mg/L DOC) and achieve a color removal of 58% (27 TCU). These results were based on a raw water DOC level of 7.43 mg/L and color of 72 true color units (TCU).

To further reduce the organics and color, coagulant was evaluated as post treatment to the MIEX resin treated water. The results showed additional removal of the DOC and color can be achieved at a minimized coagulant dose and pH variation. The issue regarding pH variation with coagulant addition will be addressed later in this report. Treated raw water with MIEX Gold resin at 800 BV and a coagulant dose of 105 mg/L showed a DOC reduction of 90% (0.71 mg/L) and a color removal of 94% (4 TCU). These are exceptional results for high DOC and color source waters. It should be noted that the organic value varied between the samples (two 5 gallon buckets) collected. For example, Sample A had a raw

water DOC value of 7.9 and Sample B had a raw water DOC value of 7.4. Removals will be based on the respective sample raw water quality.

For comparison, enhanced coagulation was conducted on the raw water. The coagulant screen on the raw water helps to identify the coagulant type and dosage. The required coagulant dose and results are compared to MIEX resin treatment. The raw water was treated with ferrous sulfate at a dose of 170 mg/L. The reduction in the DOC using ferrous sulfate (coagulant only) on the raw resulted in a removal of 30% (5.21 mg/L DOC). It was also observed that as the coagulant increased, turbidity increased appreciably. It had been shown that MIEX resin pretreatment followed by coagulation can reduce the coagulant consumption and achieved improved organic and color removal. All results shown in Table 1 below are from Sample B (Sample A was consumed during the coagulant and resin screening tests). Table 1 summarizes the treatment results.

Table 1. Treatment Summary Results

Jar	Units	Raw Water	Raw Water + Coagulant	MIEX Resin (800 BV)	MIEX Pretreat (800 BV) + Coagulant
Coagulant Type		**---**	**Ferrous Sulfate**	**---**	**Ferrous Sulfate**
Coagulant Dose	mg/L	0	170	0	105
Initial pH		8.41			
Final Water Quality					
DOC	mg/L	7.43	5.21	1.65	0.71
UVA	1/cm	0.355	0.178	0.111	0.059
True Color	PCU	72	67	30	4
pH		8.41	6.73	7.95	7.31
Copper	mg/L	0.22	--	0.02	0.00
Turbidity	NTU	1.85	229.0	2.7	50.4
% DOC Raw Reduction			30	78	90
% UVA Raw Reduction			50	69	83
% True Color Raw Reduction			7	58	94

1.3. Objective

As instructed by CRW Engineering, our objective was to maximize the reduction in organics and using MIEX resin treatment. In addition, coagulant addition post MIEX resin treatment was evaluated to determine the additional DOC and color removal.

2. Testing and Results

2.1. Sample Characterization

Ten gallons (two 5 gallon buckets) of raw water was received from the Wrangell Water Treatment. The characterization showed that each 5 gallon bucket of raw water to have slightly different characteristics. Typically, other raw water samples received in separate containers are close in characteristic and would not require a separate characterization. The raw water characterization is shown in Table 2. Table 2 below also shows the raw water characteristics from CRW Engineering laboratory analysis report dated August 7, 2015.

Table 2. Raw Water Characterization

Parameter	Units	Sample A	Sample B	CRW Raw Water
DOC	mg/L	7.96	7.43	6.41
UVA	1/cm	0.347	0.355	--
SUVA		4.36	4.78	--
True Color	CU	66	72	60
pH	pH Units	7.13	8.41	6.8
T-Alkalinity	mg/L CaCO3	10	**60**	9.237
T-Hardness	mg/L CaCO3	10	11	8.96
Iron	mg/L	0.57	0.54	0.992
Sulfate	mg/L	0.0	0.0	0.861
Chloride	mg/L	10	15	0.543
Turbidity	NTU	1.59	1.85	--
Conductivity	µS/cm	12.37	**82.1**	22.8
TDS	mg/L	--	--	34
Copper	mg/L	--	0.22	--

Note: There appears to be a discrepancy in the alkalinity and conductivity from Sample B.

2.2. Raw Water Coagulant Screening

Coagulant screening was evaluated on the raw to determine the reduction of the DOC and color. Several iron and aluminum base coagulants were evaluated. In addition, alkalinity was added to facilitate the effectiveness of the coagulant on the organics and color removal with potential for lowering the coagulant dose. The use of alkalinity did not show a reduction in the coagulant; however, the results did show improved floc structure. The use of a coagulant at higher dosages showed the effect on the pH and the DOC and color removal. The results of the coagulant addition at 170 mg/L ferrous sulfate reduced the DOC by 29% and the color by 6.9%. Higher coagulant dose resulted in lower pH and increased turbidity. The raw water turbidity went from 1.85 NTU to 229 NTU after 170 mg/L ferrous sulfate addition. Increased turbidity would require pretreatment like a DAF or a clarifier to remove the bulk solids prior to a mixed media filter or membrane filter.

2.3. MIEX Resin Testing

2.3.1. MIEX Resin Preparation

The MIEX® resin concentration is measured as a volume resin contained in a one liter resin water sample (e.g., milliliters of settled resin per liter of slurry). The MIEX® resin used in jar testing consists of resin that has previously been used and regenerated. Regenerated resin is referred to as fresh resin, whereas; virgin resin is resin that has not been previously used. Fresh resin is representative of what would be used in an on-going full-scale treatment process.

2.3.2. MIEX Resin Multiple Loading Test

The resin multiple loading test (MLT) procedure has been shown to best approximate the full-scale continuous plant operation. Results from the MLT will project the regeneration rate required to achieve a target water quality. Treatment performance at several regeneration rates is determined by contacting a measured volume of resin with increasing volumes of raw water.

The volume of raw water treated divided by the volume of resin used to treat the water determines the bed volumes (BV). The highest BV treatment rate with the largest UVA_{254} reduction is typically selected as the optimal treatment rate.

Jar tests are performed with both the MIEX DOC and GOLD resins. Both resins performed well on various water sources containing dissolved organics and color. The results of the MLT showed the GOLD resin performed satisfactorily on this source water. All resin screening was conducted using Sample A. The results of MIEX DOC resin tests are shown in Table 3 and Figure 1. Results of the MIEX GOLD resin tests are shown in Table 4 and Figure 2.

Table 3. MIEX DOC Jar Test Results

	UVA (cm^{-1})			DOC (mg/L)			True Color (PtCo)		
Bed Volumes	**Raw**	**MIEX**	**Removal (%)**	**Raw**	**MIEX**	**Removal (%)**	**Raw**	**MIEX**	**Removal (%)**
1000	0.347	0.207	40%	7.96	4.50	43%	66	45	32%
800	0.347	0.199	43%	7.96	4.27	46%	66	44	34%
600	0.347	0.188	46%	7.96	4.01	50%	66	42	37%
400	0.347	0.172	50%	7.96	3.59	55%	66	39	42%
200	0.347	0.147	58%	7.96	3.06	62%	66	33	50%

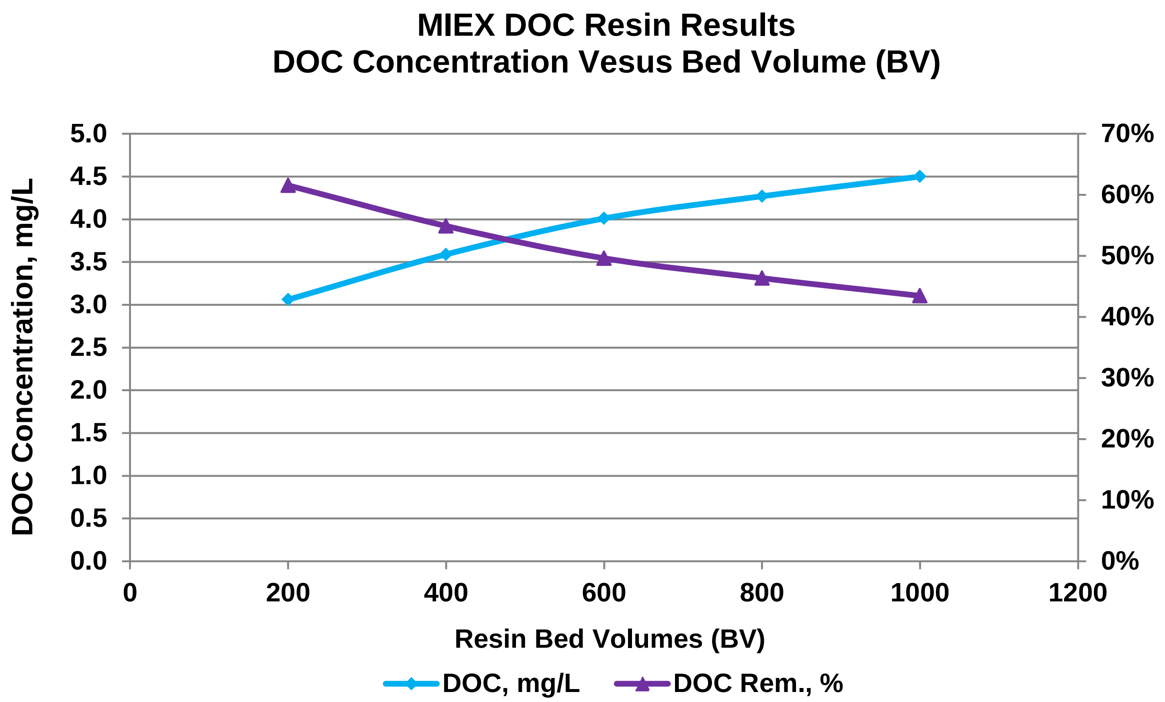


Figure 2: MIEX DOC Jar Test (DOC)

Table 4. MIEX GOLD Jar Test Results

	UVA (cm^{-1})			DOC (mg/L)			True Color (PtCo)		
Bed Volumes	**Raw**	**MIEX**	**Removal (%)**	**Raw**	**MIEX**	**Removal (%)**	**Raw**	**MIEX**	**Removal (%)**
1000	0.347	0.130	63%	7.96	2.87	64%	66	29.6	55%
800	0.347	0.117	66%	7.96	2.57	68%	66	27.0	59%
600	0.347	0.101	71%	7.96	2.19	72%	66	23.7	64%
400	0.347	0.080	77%	7.96	1.76	78%	66	19.0	71%
200	0.347	0.057	84%	7.96	1.34	83%	66	13.0	80%

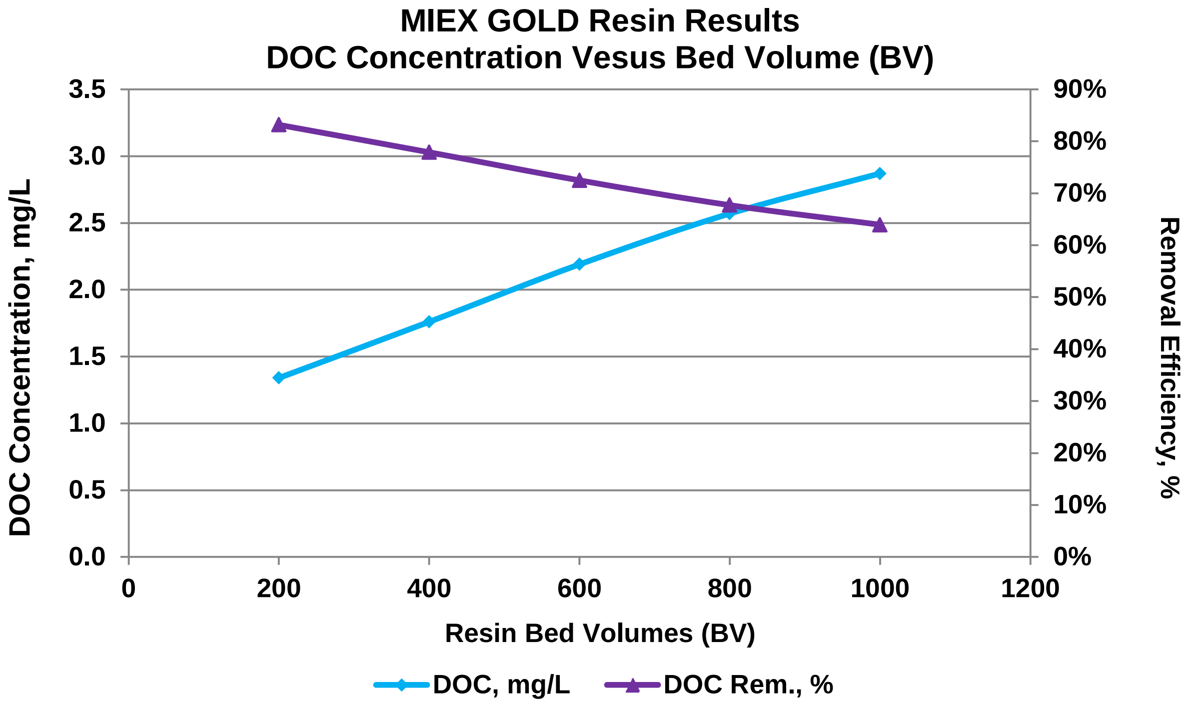


Figure 2. MIEX GOLD Jar Test

2.3.3. MIEX GOLD Post Coagulation Jar Tests

The MIEX GOLD resin treatment was effective at 800 BV. Raw water was treated using MIEX GOLD at 800 BV followed by post coagulant addition. Iron and aluminum coagulants were evaluated based on dose, floc structure, UVA, DOC removal and effluent clarity. Results from the coagulant screen showed the ferrous sulfate performed satisfactorily over the aluminum base coagulants. The ferrous sulfate dose of 105 mg/L was optimal for color and DOC removal.

The MIEX GOLD resin pretreatment can reduce the post coagulant consumption by 38% (compared to the raw water coagulant dosage). Results of water treated at 800 BV of MIEX GOLD resin and ferrous sulfate coagulant additional are presented in Table 5.

Table 5. MIEX GOLD (800 BV) and Coagulant Jar Test Results

Jar	Units	Raw	MIEX Pretreat (800 BV) + Coagulant
Coagulant Type		---	**Ferrous Sulfate**
Coagulant Dose	mg/L	0	105
DOC	mg/L	7.43	0.71
UVA	1/cm	0.355	0.059
True Color	PCU	72	4
pH		8.41	7.31
Copper	mg/L	0.22	0.00
Turbidity	NTU	1.85	50.4
% DOC Raw Reduction			88
% UVA Raw Reduction			82
% True Color Raw Reduction			94

2.4. Ozone Testing

The raw water was treated with the addition of ozonated water at 2 mg/L applied dose, which is a typical dose for many drinking water plants.

The addition of ozone was applied prior to MIEX resin treatment. It may be possible to apply the ozone post-MIEX with the benefit of improved color removal, taste and odor; however, due to the limited raw water available, ozone was applied pre-MIEX. The rationale for evaluating ozone as pre-MIEX was based on the benefit of oxidizing the DOC in the raw water to make it more adsorbable by the MIEX resin. The results showed little benefit on the DOC removal, ; however, there was an immediate reduction in color(70 to 18 PCU).

Ozone addition post-MIEX would be effective in reducing the reducing the color and oxidizing the remaining DOC. If the ozonation is followed by the existing biologically active filter, it would likely result in further reduction of overall DOC. The MIEX treatment would greatly reduce the ozone demand and allow for the application of much less ozone than without MIEX.

3. Conclusions and Recommendations

3.1. Results Summary

The results from this testing clearly shows the MIEX resin process is effective for the removal of organics and color from this source water. The use of MIEX GOLD resins alone removed up to 78% of the dissolved organics. The ozonation showed color reduction from 70 to 18 PCU pre-MIEX® at a dose of 2 mg/L ozone. It would be even more effective at decolorizing the remaining 30 PCU color post-MIEX® due to lower ozone demand from the MIEX® treatment.

Conversely, in order to achieve comparable results to the MIEX resin pretreatment followed by coagulation process, the conventional coagulation system would require a coagulant dose of in excess of 170 mg/L.

Table 6. Treatment Summary Results

Jar	Units	Raw Water	Raw Water + Coagulant	MIEX Resin (800 BV)
Coagulant Type		**---**	**Ferrous Sulfate**	**---**
Coagulant Dose	mg/L	0	170	0
Initial pH		8.41		
Final Water Quality				
DOC	mg/L	7.43	5.21	1.65
UVA	1/cm	0.355	0.178	0.111
True Color	PCU	72	67	30
pH		8.41	6.73	7.95
Copper	mg/L	0.22	--	0.02
Turbidity	NTU	1.85	229.0	2.7
% DOC Raw Reduction			30	78
% UVA Raw Reduction			50	69
% True Color Raw Reduction			7	58

3.2. MIEX Resin Advantages

Based on the results of ozonation and MIEX resin treatment, the following MIEX resin advantages can be realized:

- Less pH adjusting chemicals due to no coagulant dosage
- Improved effluent quality of downstream equipment
- Ability to use free chlorine resulting in simpler and more effective disinfection
- Lower DBP potential
- Ease of operation (automated MIEX system)
- Small footprint (high hydraulic loading rate of 8 gpm/ft^2)
- Reduced ozone demand for color reduction

With the exceptional aforementioned results achieve with the MIEX resin process, on-site pilot testing to validate the performance under varying and continuous condition is recommended.

Laboratory Report

Site / Location:	Wrangell, AK		
Contact:	Trevor Trasky		
Sample Date:	18 October 2015		
Analysis Subject:	MIEX® and Ozone Treatment		
Report Date:	12 November 2015	**Doc ID:**	LR-2015-023

1. Introduction/Background

1.1. Introduction

Ixom Laboratory received a sample of water from Wrangell, Alaska for testing of Disinfection By-Product (DBP) reduction, as measured by Dissolved Organic Carbon (DOC) reduction. The Wrangell water has previously been determined to respond most favorably to the MIEX® Gold Resin and was treated with the same this time. This report is supplemental to the Jar Test Report LR-2015-14, dated September 8, 2015, and includes ozonation results. Table 1 below shows the water quality for this recent sample received on October 19, 2015.

Table 1: As-Received Wastewater Quality

Parameter	Units	Result	Analytical Method*
DOC	mg/L	7.1	Standard Method 5310 C (Filtered with a 0.45 micron filter)
UVA $_{254}$ (nm)	cm^{-1}	0.323	Standard Method 5910 B (Filtered with a 0.45 micron filter)
Specific Ultraviolet Adsorption (SUVA)	L/mg-m	4.55	Calculated
True Color	CU	63	Standard Method 2120 C (Filtered with a 0.45 micron filter)
Apparent Color	CU	6.94	Standard Method 2120 C
pH	-	10	Standard Method 4500 H^+
Total Alkalinity (mg/L $CaCO_3$)	mg/L	11	Standard Method 2320 B
Total Hardness (mg/L $CaCO_3$)	mg/L	0.46	Standard Method 2340 C
Iron	mg/L	< 10	Standard Method 3500- Fe B
Sulfate	mg/L	15	Standard Method 4500-SO_4^{-2} E
Chloride	mg/L	1.55	Standard Method 4500-Cl^- B

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Parameter	Units	Result	Analytical Method*
Turbidity	NTU	Not Measured	Standard Method 2130 B
Conductivity	µS/cm	45	Standard Method 2510 B

2. Testing and Results

2.1. MIEX® and Ozone Treatment

The sample was treated up to 1000 Bed Volume (BV) treatment rate as-is and with a pre-treatment with ozone. Also, a liter of Wrangell water treated as-is with MIEX® Gold was post-treated with ozone as well. The applied dose of ozone was 1.44 mg/L in both cases. DOC is analyzed prior to each run and may vary slightly from original characterization.

The Multiple Loading Test with MIEX® Gold is shown below in Table 2.

Table 2: As-Received MIEX® Gold Treatment

	UVA (cm^{-1})			DOC (mg/L)			True Color (PtCo)		
Bed Volumes	Raw	MIEX®	Removal (%)	Raw	MIEX®	% Removal	Raw	MIEX®	% Removal
1000	0.323	0.165	49%	7.10	3.37	53%	63	36	42%
800	0.323	0.157	51%	7.10	3.17	55%	63	35	44%
600	0.323	0.147	54%	7.10	2.94	59%	63	33	48%
400	0.323	0.134	59%	7.10	2.59	64%	63	30	52%
200	0.323	0.119	63%	7.10	2.21	69%	63	26	59%

Table 3 shows a comparison of pre and post ozonation to MIEX® only treatment.

Table 3: Comparison of MIEX® and Ozone Treatment

Parameter	Raw Water	MIEX 1000 BV	Ozone (Pre) + MIEX 1000 BV	MIEX 1000 BV + Ozone Post
DOC	7.1	3.4	2.4	3.6
UVA	0.323	0.165	0.122	0.150
SUVA	4.55	4.95	3.48	3.14
True Color	63	36	18	0

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3. Summary

3.1. DOC Removal

The use of ozone prior to MIEX® Gold treatment showed the greatest reduction in DOC, while the use of ozone after MIEX® Gold treatment showed the greatest reduction in color. The color reduction was greater with the use of ozone post-MIEX® because the MIEX® reduced the ozone demand of the water, so the ozone could be used more effectively on the color.

Ozone treatment post-MIEX® would not be expected to show much reduction in DOC, as it is generally recognized that ozone will oxidize Natural Organic Matter (NOM) to smaller molecules, while not necessarily reducing the overall amount of DOC. The ozone is typically paired with biological filtration for a net removal of DOC. It is not generally advised to ozonate water as a final process because of likely reduction in biostability.

The target treatment is the reduction of DBPs and it is clear that MIEX® Gold will accomplish this. As the results showed, further reduction of DBPs can be accomplished with pre ozone treatment to MIEX®.

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Appendix H – Cost Estimates

Conceptual Capital Cost Estimate

Alternative No. 1 - Expand Exisitng Slow Sand Filtration System

Project Duration **52** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		2912	day	$60	$174,720
Superintendent		52	weeks	$7,200	$374,400
Project Manager	8 hrs/week	52	weeks	$800	$41,600
Expeditor	40 hrs/week	52	weeks	$2,800	$145,600
Roundtrip Air Fare		35	each	$1,000	$35,000
Allowance for Misc Air Freight		1	ls	$100,000	$100,000
Survey		1	ls	$25,000	$25,000
Erosion Control		1	ls	$10,000	$10,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		104	hours		$10,400
Project Schedule		13	months	$200	$2,600
Shop Drawings		208	hours		$20,800
Equipment					
Pickup (2 each)	Rental/Ownership Cost	52	weeks	$300	$15,600
Flatbed Truck	Rental/Ownership Cost	52	weeks	$500	$26,000
Note: Heavy Equipment Cost Included in Unit Costs for WTP Upgrades					
Other					
Project Office	Office + equipment	13	months	$750	$9,750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	13	months	$500	$6,500
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		12	months	$1,500	$18,000
Housing					
Housing		12	months	$10,000	$120,000
Utilities		12	months	$1,500	$18,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Water Treatment Plant Modifications					
Clearing and Grubbing		0.5	ACRE	$10,000	$5,000
Fill		3000	CY	$35	$105,000
Site Grading and Drainage		1	LS	$125,000	$125,000
Cleaning Existing Filter Sand		1920	CY	$50	$96,000
Addition of (3) Slow Sand Filters					
Bedrock Blasting and Removal		1600	CY	$80	$128,000
Concrete Filter Beds		690	CY	$1,300	$897,000
Filter Piping		800	LF	$120	$96,000
Filter Valves, Fittings, Etc.		1	LS	$72,000	$72,000
Connection to Existing System		1	LS	$30,000	$30,000
Media for Filters		12800	CF	$7	$89,600

Freight for Media		810	TONS	$700	$567,000
Metal Building Over Filters		3176	SF	$250	$794,063
Addition of (2) Roughing Filter					
Bedrock Blasting and Removal		1000	CY	$80	$80,000
Concrete Filter Beds		180	CY	$1,300	$234,000
Filter Piping		500	LF	$120	$60,000
Filter Valves, Fittings, Etc.		1	LS	$45,000	$45,000
Connection to Existing System		1	LS	$20,000	$20,000
Media for Filters		4320	CF	$7	$30,240
1 ft GAC Cap		2160	CF	$35	$75,600
20 hp Backwash Pumps		2	EA	$35,000	$70,000
Freight for Media		270	TONS	$700	$189,000
Metal Building Over Filters		1080	SF	$250	$270,000
Chemical Feed System		1	ea	$35,000	$35,000
Replace Onsite Chlorine Generation System		1	LS	$115,000	$115,000
Caustic Feed System Improvements		1	ea	$30,000	$30,000
Air Scour System		1	LS	$150,000	$150,000
Oxygen Generator		1	EA	$210,000	$210,000
Ozone Destructor		1	EA	$50,000	$50,000
Expansion of Ozone Contactor by 50%					
Bedrock Blasting and Removal		300	CY	$80	$24,000
Concrete Contact Filter		20	CY	$1,300	$26,000
Connection to Existing System		1	LS	$15,000	$15,000
60 hp Booster Pumps		2	ea	$20,000	$40,000
150,000-gal Recaptured Water Storage Tank		150000	gal	$2.50	$375,000
150,000-gal Tank Insulation Package		150000	gal	$0.50	$75,000
10 hp Transfer Pumps		2	ea	$10,000	$20,000
Recapture Water Piping		200	LF	$120	$24,000
Sand Removal System		1	LS	$200,000	$200,000
Sand Cleaning System		1	LS	$400,000	$400,000
Standby Generator		1	LS	$150,000	$150,000
Fuel System		1	LS	$24,000	$24,000
Control Panels		1	LS	$200,000	$200,000
System Startup, Operator Training and O&M Manuals		1	ls	$50,000	$50,000
Project Closeout					
Punchlist Items		1	ls	$25,000	$25,000
Asbuilts of System		1	ls	$15,000	$15,000
Site Cleanup		1	ls	$25,000	$25,000
Demobilization		1	ls	$50,000	$50,000

		Subtotal	$7,655,000
General Contractor Overhead and Profit	15.0%		$1,149,000
General Contractor Bond & Insurance	3.0%		$230,000
Estimating Contingency	15.0%		$1,149,000
Inflation	3.5%		$268,000
		Construction Subt	$10,451,000
Design	9.0%		$941,000

Construction Administration	9.0%	$941,000
City Administration	2.0%	$210,000
Estimated Total Cost (Alternative No. 1)		**$12,543,000**

Conceptual Capital Cost Estimate

Alternative No. 2 - MIEX Process with Multimedia Filtration

Project Duration **40** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Meals and lodging		2240	day	$60	$134,400
Superintendent		40	weeks	$7,200	$288,000
Project Manager	8 hrs/week	40	weeks	$800	$32,000
Expeditor	40 hrs/week	40	weeks	$2,800	$112,000
Roundtrip Air Fare		27	each	$1,000	$27,000
Allowance for Misc Air Freight		1	ls	$75,000	$75,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		80	hours	$100	$8,000
Project Schedule		10	months	$200	$2,000
Shop Drawings		160	hours	$100	$16,000
Equipment					
Pickup (2 each)	Rental/Ownership Cost	40	weeks	$300	$12,000
Flatbed Truck	Rental/Ownership Cost	40	weeks	$500	$20,000
Other					
Project Office	Office + equipment	10	months	$750	$7,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	10	months	$500	$5,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$30,000	$30,000
Fuel, oil and gas for equipment		10	months	$1,500	$15,000
Housing					
Housing		10	months	$10,000	$100,000
Utilities		10	months	$1,500	$15,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Water Treatment Plant					
Bedrock Blasting and Removal		6000	CY	$80	$480,000
Site Grading and Drainage		1	LS	$25,000	$25,000
Demolish Roughing Filter Building		1600	SF	$20	$32,000
Demolish Ozone Generation System		1	LS	$10,000	$10,000
New Treatment Building		7500	SF	$325	$2,437,500
MIEX Treatment System		1	LS	$1,326,000	$1,326,000
Multimedia Filter System		1	LS	$1,000,000	$1,000,000
Conversion of Filters to Clearwells		4	ea	$25,000	$100,000
Process Piping and Instrumentation		1	LS	$350,000	$350,000
Connection to Existing WTP Piping		1	LS	$50,000	$50,000
Chemical Feed Systems		1	ea	$35,000	$35,000
Replace Onsite Chlorine Generation System		1	LS	$115,000	$115,000
Caustic Feed System Improvements		1	ea	$30,000	$30,000
10 hp Transfer Pumpst to Treatment System		2	ea	$12,000	$24,000

60 hp Booster Pumps to WST		2	ea	$20,000	$40,000
Control Panels		1	LS	$150,000	$150,000
Standby Generator		1	LS	$150,000	$150,000
Fuel System		1	LS	$24,000	$24,000
Temporary Water Treatment Facilities		1	ls	$300,000	$300,000
System Startup, Operator Training and O&M Manuals		1	ls	$50,000	$50,000
Project Closeout					
Punchlist Items		1	ls	$25,000	$25,000
Asbuilts of System		1	ls	$15,000	$15,000
Site Cleanup		1	ls	$25,000	$25,000
Demobilization		1	ls	$50,000	$50,000

Subtotal		$7,802,000
General Contractor Overhead and Profit	15.0%	$1,171,000
General Contractor Bond & Insurance	3.0%	$235,000
Estimating Contingency	15.0%	$1,171,000
Inflation	3.5%	$274,000
Construction Subtotal		$10,653,000
Design	9.0%	$703,000
Construction Administration	9.0%	$703,000
City Administration	2.0%	$157,000
Estimated Total Cost (Alternative No. 2)		**$12,216,000**

Conceptual Capital Cost Estimate

Alternative No. 3 - Ozonation with MIEX and Biological Filtration

Project Duration **40** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Meals and lodging		2240	day	$60	$134,400
Superintendent		40	weeks	$7,200	$288,000
Project Manager	8 hrs/week	40	weeks	$800	$32,000
Expeditor	40 hrs/week	40	weeks	$2,800	$112,000
Roundtrip Air Fare		27	each	$1,000	$27,000
Allowance for Misc Air Freight		1	ls	$75,000	$75,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		80	hours	$100	$8,000
Project Schedule		10	months	$200	$2,000
Shop Drawings		160	hours	$100	$16,000
Equipment					
Pickup (2 each)	Rental/Ownership Cost	40	weeks	$300	$12,000
Flatbed Truck	Rental/Ownership Cost	40	weeks	$500	$20,000
Other					
Project Office	Office + equipment	10	months	$750	$7,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	10	months	$500	$5,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$30,000	$30,000
Fuel, oil and gas for equipment		10	months	$1,500	$15,000
Housing					
Housing		10	months	$10,000	$100,000
Utilities		10	months	$1,500	$15,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Water Treatment Plant Modifications					
Bedrock Blasting and Removal		6000	CY	$80	$480,000
Site Grading and Drainage		1	LS	$25,000	$25,000
Demolish Roughing Filter Building		1600	SF	$20	$32,000
New Treatment Building		7475	SF	$325	$2,429,375
MIEX Treatment System		1	LS	$1,326,000	$1,326,000
Bio-media Filter System		1	LS	$1,300,000	$1,300,000
Conversion of Filters to Clearwells		4	ea	$25,000	$100,000
Process Piping and Instrumentation		1	LS	$350,000	$350,000
Connection to Existing WTP Piping		1	LS	$50,000	$50,000
Caustic Feed System Improvements		1	ea	$30,000	$30,000
Replace Onsite Chlorine Generation System		1	LS	$115,000	$115,000
Oxygen Generator		1	EA	$210,000	$210,000
Ozone Destructor		1	EA	$50,000	$50,000
Expansion of Ozone Contactor by 50%					

Bedrock Blasting and Removal		300	CY	$40	$12,000
Rock Removal		300	CY	$20	$6,000
Concrete Contact Filter		20	CY	$1,300	$26,000
Connection to Existing System		1	LS	$15,000	$15,000
10 hp Transfer Pumpst to Treatment System		2	ea	$12,000	$24,000
60 hp Booster Pumps		2	ea	$20,000	$40,000
Control Panels		1	LS	$150,000	$150,000
Standby Generator		1	LS	$150,000	$150,000
Fuel System		1	LS	$24,000	$24,000
Temporary Water Treatment Facilities		1	ls	$300,000	$300,000
System Startup, Operator Training and O&M Manuals		1	ls	$50,000	$50,000
Project Closeout					
Punchlist Items		1	ls	$25,000	$25,000
Asbuilts of System		1	ls	$15,000	$15,000
Site Cleanup		1	ls	$25,000	$25,000
Demobilization		1	ls	$50,000	$50,000

		Subtotal	$8,368,000
General Contractor Overhead and Profit	15.0%		$1,256,000
General Contractor Bond & Insurance	3.0%		$252,000
Estimating Contingency	15.0%		$1,256,000
Inflation	3.5%		$293,000
		Construction Subtotal	$11,425,000
Design	9.0%		$1,029,000
Construction Administration	9.0%		$1,029,000
City Administration	2.0%		$229,000
Estimated Total Cost (Alternative No. 3)			**$13,712,000**

Conceptual Capital Cost Estimate

Alternative No. 4 - Dissolved Air Flotation with Multimedia Filtration

Project Duration **40** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Meals and lodging		2240	day	$60	$134,400
Superintendent		40	weeks	$7,200	$288,000
Project Manager	8 hrs/week	40	weeks	$800	$32,000
Expeditor	40 hrs/week	40	weeks	$2,800	$112,000
Roundtrip Air Fare		27	each	$1,000	$27,000
Allowance for Misc Air Freight		1	ls	$75,000	$75,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		80	hours	$100	$8,000
Project Schedule		10	months	$200	$2,000
Shop Drawings		160	hours	$100	$16,000
Equipment					
Pickup (2 each)	Rental/Ownership Cost	40	weeks	$300	$12,000
Flatbed Truck	Rental/Ownership Cost	40	weeks	$500	$20,000
Other					
Project Office	Office + equipment	10	months	$750	$7,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	10	months	$500	$5,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$30,000	$30,000
Fuel, oil and gas for equipment		10	months	$1,500	$15,000
Housing					
Housing		10	months	$10,000	$100,000
Utilities		10	months	$1,500	$15,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Water Treatment Plant Modifications					
Bedrock Blasting and Removal		1400	CY	$80	$112,000
Site Grading and Drainage		1	LS	$25,000	$25,000
Remodel Roughing Filter Bldg		1936	SF	$50	$96,800
Demolish Ozone Generation System		1	LS	$10,000	$10,000
Expand Roughing Filter Bldg		2640	SF	$325	$858,000
DAF Treatment System		1	LS	$1,360,000	$1,360,000
Streaming Current Detector		1	ea	$25,000	$25,000
Conversion of Filters to Clearwells		4	ea	$25,000	$100,000
Connection to Existing WTP Piping		1	LS	$50,000	$50,000
Process Piping and Instrumentation		1	LS	$350,000	$350,000
Chemical Feed Systems		1	LS	$35,000	$35,000
Replace Onsite Chlorine Generation System		1	LS	$115,000	$115,000
Caustic Feed System Improvements		1	ea	$30,000	$30,000
10 hp Transfer Pumpst to Treatment System		2	ea	$12,000	$24,000

60 hp Booster Pumps		2	ea	$20,000	$40,000
Control Panels		1	LS	$150,000	$150,000
Remodel Part of Control Bldg for Chemical Storage		400	SF	$50	$20,000
Standby Generator		1	LS	$150,000	$150,000
Fuel System		1	LS	$24,000	$24,000
Temporary Water Treatment Facilities		1	ls	$300,000	$300,000
System Startup, Operator Training and O&M Manuals		1	ls	$50,000	$50,000
Project Closeout					
Punchlist Items		1	ls	$25,000	$25,000
Asbuilts of System		1	ls	$15,000	$15,000
Site Cleanup		1	ls	$25,000	$25,000
Demobilization		1	ls	$50,000	$50,000

	Subtotal	$4,999,000
General Contractor Overhead and Profit	15.0%	$750,000
General Contractor Bond & Insurance	3.0%	$150,000
Estimating Contingency	15.0%	$750,000
Inflation	3.5%	$175,000
	Construction Subtotal	$6,824,000
Design	9.0%	$615,000
Construction Administration	9.0%	$615,000
City Administration	2.0%	$137,000
Estimated Total Cost (Alternative No. 4)		**$8,191,000**

Conceptual Capital Cost Estimate

Alternative No. 5 - Nanofiltration with Multimedia Filtration

Project Duration **40** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Meals and lodging		2240	day	$60	$134,400
Superintendent		40	weeks	$7,200	$288,000
Project Manager	8 hrs/week	40	weeks	$800	$32,000
Expeditor	40 hrs/week	40	weeks	$2,800	$112,000
Roundtrip Air Fare		27	each	$1,000	$27,000
Allowance for Misc Air Freight		1	ls	$75,000	$75,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		80	hours	$100	$8,000
Project Schedule		10	months	$200	$2,000
Shop Drawings		160	hours	$100	$16,000
Equipment					
Pickup (2 each)	Rental/Ownership Cost	40	weeks	$300	$12,000
Flatbed Truck	Rental/Ownership Cost	40	weeks	$500	$20,000
Other					
Project Office	Office + equipment	10	months	$750	$7,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	10	months	$500	$5,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$30,000	$30,000
Fuel, oil and gas for equipment		10	months	$1,500	$15,000
Housing					
Housing		10	months	$10,000	$100,000
Utilities		10	months	$1,500	$15,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Water Treatment Plant Modifications					
Bedrock Blasting and Removal		1400	CY	$80	$112,000
Site Grading and Drainage		1	LS	$25,000	$25,000
Remodel Roughing Filter Bldg		1936	SF	$25	$48,400
Demolish Ozone Generation System		1	LS	$10,000	$10,000
Expand Roughing Filter Bldg		2640	SF	$325	$858,000
Adsorption Clarifier Treatment System		1	LS	$455,000	$455,000
Nanofiltration System		1	ea	$950,000	$950,000
Filtration Booster Pumps		2	ea	$10,000	$20,000
Streaming Current Detector		1	ea	$25,000	$25,000
Conversion of Filters to Clearwells		4	ea	$25,000	$100,000
Process Piping and Instrumentation		1	LS	$350,000	$350,000
Connection to Existing WTP Piping		1	LS	$50,000	$50,000
Chemical Feed Systems		1	ea	$35,000	$35,000
Replace Onsite Chlorine Generation System		1	LS	$115,000	$115,000

Caustic Feed System Improvements		1	ea	$30,000	$30,000
10 hp Transfer Pumpst to Treatment System		2	ea	$12,000	$24,000
60 hp Booster Pumps		2	ea	$20,000	$40,000
Control Panels		1	LS	$150,000	$150,000
Standby Generator		1	LS	$150,000	$150,000
Fuel System		1	LS	$24,000	$24,000
Temporary Water Treatment Facilities		1	ls	$300,000	$300,000
System Startup, Operator Training and O&M Manuals		1	ls	$50,000	$50,000
Project Closeout					
Punchlist Items		1	ls	$25,000	$25,000
Asbuilts of System		1	ls	$15,000	$15,000
Site Cleanup		1	ls	$25,000	$25,000
Demobilization		1	ls	$50,000	$50,000

Subtotal		$4,995,000
General Contractor Overhead and Profit	15.0%	$750,000
General Contractor Bond & Insurance	3.0%	$150,000
Estimating Contingency	15.0%	$750,000
Inflation	3.5%	$175,000
Construction Subtotal		$6,820,000
Design	9.0%	$614,000
Construction Administration	9.0%	$614,000
City Administration	2.0%	$137,000
Estimated Total Cost (Alternative No. 5)		**$8,185,000**

Conceptual Capital Cost Estimate

Alternative No. A1 - Extend Sewer Service to Wastewater Treatment Plant (Buried Pipeline)

Project Duration **4** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		224	day	$60	$13,440
Superintendent		4	weeks	$7,200	$28,800
Project Manager	8 hrs/week	4	weeks	$800	$3,200
Expeditor	40 hrs/week	4	weeks	$2,800	$11,200
Roundtrip Air Fare		3	each	$1,000	$3,000
Allowance for Misc Air Freight		1	ls	$10,000	$10,000
Allowance for Misc Barge Freight		1	ls	$15,000	$15,000
Survey		1	ls	$20,000	$20,000
Erosion Control		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		8	hours		$800
Project Schedule		1	months	$200	$200
Shop Drawings		16	hours		$1,600
Equipment					
Pickup (2 each)	Rental/Ownership Cost	4	weeks	$300	$1,200
Four Wheelers (4 each)	Rental/Ownership Cost	4	weeks	$200	$800
Flatbed Truck	Rental/Ownership Cost	4	weeks	$500	$2,000
Note: Heavy Equipment Cost Included in Unit Costs for Sewer Service Extension					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	1	months	$500	$500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Clarifier Tank					
30,000-gal Backwash Water Storage Tank		30,000	gal	$2.50	$75,000
30,000-gal Tank Insulation Package		30,000	gal	$0.50	$15,000
Tank Add Heat System		1	ls	$10,000	$10,000
Connection Piping to WTP		150	LF	$120	$18,000
Fill for Tank Base		100	CY	$30	$3,000
Sludge Dewatering and Disposal Equipment					
Sludge Dewatering System		1	ea	$275,000	$275,000
Containers for Secondary Sludge Dewatering		1	ls	$30,000	$30,000

Sewer Service Extension					
Clearing and Grubbing		1	ACRE	$40,000	$40,000
Excavation (non-bedrock)		1,450	CY	$30	$43,500
Bedrock Blasting and Removal	Assume 50% of excavation	1,450	CY	$40	$58,000
Rock Removal	requires blasting	1,450	CY	$20	$29,000
Backfill and Bedding		1,450	CY	$35	$50,750
Sanitary Sewer Pipe		1,300	LF	$80	$104,000
Sanitary Sewer Manholes		4	EA	$7,500	$30,000
Connection to Wastewater Treatment Plant		1	LS	$5,000	$5,000
Seeding		1	ACRE	$15,000	$15,000

Subtotal		$1,010,000
General Contractor Profit (fee)	15.0%	$152,000
General Contractor Bond & Insurance	3.0%	$31,000
Estimating Contingency	15.0%	$152,000
Inflation	3.5%	$36,000
Construction Subtotal		$1,381,000
Design	9.0%	$125,000
Construction Administration	9.0%	$125,000
City Administration	2.0%	$28,000
Estimated Total Cost (Alternative No. A)		**$1,659,000**

Conceptual Capital Cost Estimate

Alternative No. A2 - Extend Sewer Service to Wastewater Treatment Plant (Above Grade Pipeline)

Project Duration **4** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		224	day	$60	$13,440
Superintendent		4	weeks	$7,200	$28,800
Project Manager	8 hrs/week	4	weeks	$800	$3,200
Expeditor	40 hrs/week	4	weeks	$2,800	$11,200
Roundtrip Air Fare		3	each	$1,000	$3,000
Allowance for Misc Air Freight		1	ls	$10,000	$10,000
Allowance for Misc Barge Freight		1	ls	$15,000	$15,000
Survey		1	ls	$20,000	$20,000
Erosion Control		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		8	hours		$800
Project Schedule		1	months	$200	$200
Shop Drawings		16	hours		$1,600
Equipment					
Pickup (2 each)	Rental/Ownership Cost	4	weeks	$300	$1,200
Four Wheelers (4 each)	Rental/Ownership Cost	4	weeks	$200	$800
Flatbed Truck	Rental/Ownership Cost	4	weeks	$500	$2,000
Note: Heavy Equipment Cost Included in Unit Costs for Sewer Service Extension					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	1	months	$500	$500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Clarifier Tank					
30,000-gal Backwash Water Storage Tank		30,000	gal	$2.50	$75,000
30,000-gal Tank Insulation Package		30,000	gal	$0.50	$15,000
Tank Add Heat System		1	ls	$10,000	$10,000
Connection Piping to WTP		150	LF	$120	$18,000
Fill for Tank Base		100	CY	$30	$3,000
Sludge Dewatering and Disposal Equipment					
Sludge Dewatering System		1	ea	$275,000	$275,000
Containers for Secondary Sludge Dewatering		1	ls	$30,000	$30,000

Sewer Service Extension					
Clearing and Grubbing		1	ACRE	$40,000	$40,000
Sanitary Sewer Pipe, Insulated w/ Aluminum Spir-l-ok Jacket		1,300	LF	$105	$136,500
Heat Trace		1,300	LF	$20	$26,000
Heat Trace Controls and Power Distribution		1	LS	$30,000	$30,000
Timber Pipe Supports w/ Duckbill Anchors and Pipe Strap		65	EA	$300	$19,500
Timber Pipe Supports w/ Drilled Epoxy Anchors and Pipe Strap		65	EA	$350	$22,750
Sanitary Sewer Manholes/Cleanouts		4	EA	$7,500	$30,000
Connection to Wastewater Treatment Plant		1	LS	$5,000	$5,000
Seeding		1	ACRE	$15,000	$15,000

		Subtotal	$960,000
General Contractor Profit (fee)	15.0%		$144,000
General Contractor Bond & Insurance	3.0%		$29,000
Estimating Contingency	15.0%		$144,000
Inflation	3.5%		$34,000
		Construction Subtotal	$1,311,000
Design	9.0%		$118,000
Construction Administration	9.0%		$118,000
City Administration	2.0%		$27,000
Estimated Total Cost (Alternative No. A)			**$1,574,000**

Conceptual Capital Cost Estimate

Alternative No. B - Extend Sewer Service along Wood Street

Project Duration **5** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		280	day	$60	$16,800
Superintendent		5	weeks	$7,200	$36,000
Project Manager	8 hrs/week	5	weeks	$800	$4,000
Expeditor	40 hrs/week	5	weeks	$2,800	$14,000
Roundtrip Air Fare		4	each	$1,000	$4,000
Allowance for Misc Air Freight		1	ls	$10,000	$10,000
Allowance for Misc Barge Freight		1	ls	$15,000	$15,000
Survey		1	ls	$25,000	$25,000
Erosion Control		1	ls	$30,000	$30,000
Equipment Mobilization		1	ls	$75,000	$75,000
Meetings/Coordination					
Project Meetings		10	hours		$1,000
Project Schedule		2	months	$200	$400
Shop Drawings		20	hours		$2,000
Equipment					
Pickup (2 each)	Rental/Ownership Cost	5	weeks	$300	$1,500
Four Wheelers (4 each)	Rental/Ownership Cost	5	weeks	$200	$1,000
Flatbed Truck	Rental/Ownership Cost	5	weeks	$500	$2,500
Note: Heavy Equipment Cost Included in Unit Costs for Sewer Service Extension					
Other					
Project Office	Office + equipment	2	months	$750	$1,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	2	months	$500	$1,000
Housing					
Housing		2	months	$10,000	$20,000
Utilities		2	months	$1,500	$3,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Clarifier Tank					
30,000-gal Backwash Water Storage Tank		30,000	gal	$2.50	$75,000
30,000-gal Tank Insulation Package		30,000	gal	$0.50	$15,000
Tank Add Heat System		1	ls	$10,000	$10,000
Connection Piping to WTP		150	LF	$120	$18,000
Fill for Tank Base		100	CY	$30	$3,000
Sludge Dewatering and Disposal Equipment					
Sludge Dewatering System		1	ea	$275,000	$275,000
Containers for Secondary Sludge Dewatering		1	ls	$30,000	$30,000

Sewer Service Extension					
Excavation (non-bedrock)		3,450	CY	$30	$103,500
Bedrock Blasting and Removal	Assume 50% of excavation	3,450	CY	$40	$138,000
Rock Removal	requires blasting	3,450	CY	$20	$69,000
Backfill and Bedding		3,450	CY	$35	$120,750
Sanitary Sewer Pipe		3,100	LF	$80	$248,000
Sanitary Sewer Manhole		7	EA	$7,500	$52,500
D1 Surfacing		600	CY	$55	$33,000
Connection to Sanitary Sewer System		1	LS	$5,000	$5,000

Subtotal		$1,469,000
General Contractor Profit (fee)	15.0%	$221,000
General Contractor Bond & Insurance	3.0%	$45,000
Estimating Contingency	15.0%	$221,000
Inflation	3.5%	$52,000
Construction Subtotal		$2,008,000
Design	9.0%	$181,000
Construction Administration	9.0%	$181,000
City Administration	2.0%	$41,000
Estimated Total Cost (Alternative No. B)		**$2,411,000**

Conceptual Capital Cost Estimate

Alternative No. C - Marine Outfall

Project Duration **6** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		336	day	$60	$20,160
Superintendent		6	weeks	$7,200	$43,200
Project Manager	8 hrs/week	6	weeks	$800	$4,800
Expeditor	40 hrs/week	6	weeks	$2,800	$16,800
Roundtrip Air Fare		4	each	$1,000	$4,000
Allowance for Misc Air Freight		1	ls	$10,000	$10,000
Allowance for Misc Barge Freight		1	ls	$15,000	$15,000
Survey		1	ls	$15,000	$15,000
Erosion Control		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$50,000	$50,000
Meetings/Coordination					
Project Meetings		12	hours		$1,200
Project Schedule		2	months	$200	$400
Shop Drawings		24	hours		$2,400
Equipment					
Pickup (2 each)	Rental/Ownership Cost	6	weeks	$300	$1,800
Four Wheelers (4 each)	Rental/Ownership Cost	6	weeks	$200	$1,200
Flatbed Truck	Rental/Ownership Cost	6	weeks	$500	$3,000
Note: Heavy Equipment Cost Included in Unit Costs for Clarifier					
Other					
Project Office	Office + equipment	2	months	$750	$1,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	2	months	$500	$1,000
Housing					
Housing		2	months	$10,000	$20,000
Utilities		2	months	$1,500	$3,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Clarifier Tank					
30,000-gal Backwash Water Storage Tank		30,000	gal	$2.50	$75,000
30,000-gal Tank Insulation Package		30,000	gal	$0.50	$15,000
Tank Add Heat System		1	ls	$10,000	$10,000
Connection Piping to WTP		150	LF	$120	$18,000
Fill for Tank Base		100	CY	$30	$3,000
Sludge Dewatering and Disposal Equipment					
Sludge Dewatering System		1	ea	$275,000	$275,000
Containers for Secondary Sludge Dewatering		1	ls	$30,000	$30,000
Sewer Outfall					

Excavation (non-bedrock)		2,250	CY	$30	$67,500
Bedrock Blasting and Removal	Assume 50% of excavation	2,250	CY	$40	$90,000
Rock Removal	requires blasting	2,250	CY	$20	$45,000
Backfill and Bedding		2,250	CY	$35	$78,750
Sanitary Sewer Pipe		2,000	LF	$80	$160,000
Sanitary Sewer Manhole		5	EA	$7,500	$37,500
Marine Outfall		1	LS	$25,000	$25,000

Subtotal		$1,179,000
General Contractor Profit (fee)	15.0%	$177,000
General Contractor Bond & Insurance	3.0%	$36,000
Estimating Contingency	15.0%	$177,000
Inflation	3.5%	$42,000
Construction Subtotal		$1,611,000
Design	9.0%	$145,000
Construction Administration	9.0%	$145,000
City Administration	2.0%	$33,000
Estimated Total Cost (Alternative No. C)		**$1,934,000**

Conceptual Capital Cost Estimate

Alternative No. D - Recycle of Backwash Water to Process

Project Duration **4** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		112	day	$60	$6,720
Superintendent		4	weeks	$7,200	$28,800
Project Manager	8 hrs/week	4	weeks	$800	$3,200
Expeditor	40 hrs/week	4	weeks	$2,800	$11,200
Roundtrip Air Fare		3	each	$1,000	$3,000
Allowance for Misc Air Freight		1	ls	$1,500	$1,500
Allowance for Misc Barge Freight		1	ls	$1,000	$1,000
Equipment Mobilization		1	ls	$5,000	$5,000
Meetings/Coordination					
Project Meetings		8	hours		$800
Project Schedule		0.93	months	$200	$186
Shop Drawings		16	hours		$1,600
Equipment					
Pickup (2 each)	Rental/Ownership Cost	4	weeks	$300	$1,200
Four Wheelers (4 each)	Rental/Ownership Cost	4	weeks	$200	$800
Flatbed Truck	Rental/Ownership Cost	4	weeks	$500	$2,000
Note: Heavy Equipment Cost Included in Unit Costs for Clarifier					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$250	$250
Temporary Power	Generators for Tools	1	months	$500	$500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$1,000	$1,000
Clarifier Tank					
30,000-gal Backwash Water Storage Tank		30,000	gal	$2.50	$75,000
30,000-gal Tank Insulation Package		30,000	gal	$0.50	$15,000
Tank Add Heat System		1	ls	$10,000	$10,000
Connection Piping to WTP		150	LF	$120	$18,000
Fill for Tank Base		100	CY	$30	$3,000
Sludge Dewatering and Disposal Equipment					
Sludge Dewatering System		1	ea	$275,000	$275,000
Containers for Secondary Sludge Dewatering		1	ls	$30,000	$30,000
Backwash Recycle					
Recycle Pump		1	ea	$2,500	$2,500
Recycle Piping		100	LF	$120	$12,000

		Subtotal	$522,000
General Contractor Profit (fee)	15.0%		$79,000
General Contractor Bond & Insurance	3.0%		$16,000
Estimating Contingency	15.0%		$79,000
Inflation	3.5%		$19,000
		Construction Subtotal	$715,000
Design	9.0%		$65,000
Construction Administration	9.0%		$65,000
City Administration	2.0%		$15,000
Estimated Total Cost (Alternative No. D)			**$860,000**

WATER TREATMENT - O & M COST SUMMARY

ANNUAL SYSTEM COSTS						
	Existing (Current Flow)	Option 1 Upgraded Slow Sand	Option 2 Miex and Conventional	Option 3 Ozone, Miex, and Biofiltration	Option 4 DAF	Option 5 AC and Nanofiltration
Building Addition O&M						
Building	$5,000	$5,900	$11,700	$11,700	$10,700	$10,700
Pre-Treatment Processes						
Ozone	$62,917	$79,182	-	$47,416	-	-
Miex	-	-	$125,751	$125,751	-	-
Treatment/Filtration Processes						
DAF	-	-	-	-	$305,903	-
Slow Sand Filtration	$118,154	$216,002	-	-	-	-
Conventional Filtration	-	-	$250,000	-	-	-
Biomedia Filtration	-	-	-	$263,724	-	-
Adsorption Clarifier and Nanofiltration	-	-	-	-	-	$507,952
TOTAL COST	$186,071	$301,084	$387,450	$448,591	$316,603	$518,652

ANNUAL SYSTEM COSTS						
	Existing (Current Flow)	Option 1 Upgraded Slow Sand	Option 2 Miex and Conventional	Option 3 Ozone, Miex, and Biofiltration	Option 4 DAF	Option 5 AC and Nanofiltration
Power	$55,856	$67,027	$55,849	$101,538	$42,192	$117,940
Labor	$31,200	$73,440	$19,710	$14,115	$29,193	$29,193
Chemicals/Salt/Sludge Disposal	$29,552	$39,668	$210,313	$209,666	$197,367	$213,145
Equipment/Material Replacement	$2,704	$74,611	$54,139	$65,988	$10,162	$46,101
Building	$5,000	$5,900	$11,700	$11,700	$10,700	$10,700
SUBTOTAL COST	$124,312	$260,646	$351,711	$403,007	$289,614	$417,079
Sand Cleaner Maintenance	-	$5,000	-	-	-	-
Backwash/Non-salable Water	$61,760	$35,438	$35,740	$45,584	$26,989	$101,573
TOTAL COST	$186,071	$301,084	$387,450	$448,591	$316,603	$518,652

Water Treatment Plant Ozone Costs - Existing Flow (monthly/yearly)

Daily Water Consumption	900,000	gpd
Monthly Water Consumption	27,000,000	gal/month
Yearly Water Consumption	328,500,000	gal/year

11.3	kWh/lb ozone	
$0.1145	/kwh	Electricity
$1.29	$/lb of ozone	

Ozone

	10	mg/l ozone dose required
$	2,246	lb ozone use per month
	$1.29	ozone cost per pound
$	2,906	ozone cost per month
$	2,337	cooling water cost per month
$	5,243	Total monthly ozonation cost

Power Cost per year	$	34,877
wasted water cost per year	$	28,040

Annual Ozonation Cost	$	62,917

Water Treatment Plant Ozone Costs - New Flow (monthly/yearly)

Daily Water Consumption	1,000,000	gpd
Monthly Water Consumption	30,000,000	gal/month
Yearly Water Consumption	365,000,000	gal/year

11.3	kWh/lb ozone	
$0.1145	/kwh	Electricity
$1.29	$/lb of ozone	

Ozone

10	mg/l ozone dose required
$2,496	lb ozone use per month
$1.29	ozone cost per pound
$3,229	ozone cost per month
$2,337	cooling water cost per month
$5,566	Total monthly ozonation cost
$66,792.44	Annual Ozonation Cost

GAC Cap on Roughing Filter (Option 1 only)

1	foot media depth
30	feet length
16	feet wide
2	each
960	ft3 media volume
$32,108	cost of media replacement
3	year service life
5.00	inflation
$12,390	cost per year

Power Cost per year	$38,752
wasted water cost per year	$28,040
material cost per year	$12,390
Total Annual Cost	**$79,182**

Water Treatment Plant Ozone Costs - New Flow (monthly/yearly)

Daily Water Consumption	1,000,000	gpd
Monthly Water Consumption	30,000,000	gal/month
Yearly Water Consumption	365,000,000	gal/year

11.3	kWh/lb ozone	
$0.1145	/kwh	Electricity
$1.29	$/lb of ozone	

Ozone

	5	mg/l ozone dose required
$	1,248	lb ozone use per month
	$1.29	ozone cost per pound
$	1,615	ozone cost per month
$	2,337	cooling water cost per month
$	3,951	Total monthly ozonation cost

Power Cost per year	$	19,376
wasted water cost per year	$	28,040

Annual Ozonation Cost	$	47,416

Water Treatment Plant Miex Costs (monthly/yearly)

Daily Water Consumption	1,000,000	**gpd**
Monthly Water Consumption	30,000,000	**gal/month**
Yearly Water Consumption	365,000,000	**gal/year**

Resin Treatment Rate
600 Bed Volumes
1.67 gallons resin per every 1,000 gallons treated

1. Salt Use
500 lbs / MG of plant throughput
365 MGD/year
500 lbs salt / day
182,500 lbs Salt / year

182,500 lbs annual salt consumption
salt cost $ 0.15 PER WAYNE
$0.22 $/lb including shipping
$ 40,597 Annual salt cost

2. Resin Use
From Ixom
1.3 to 1.5 gallons of resin per 1 MGD water treated
resin is $ 78.12 $/gallon per Ixom

547.5 gallons of resin
10 55-gallon drums or 2.3 totes

$42,771 resin cost

3. Electrical
Assume 25 kw total connected load
(20-25 average, 35 max)
Electricity Service Charge $13.50 /mo
Electricity $0.1145 /kwh

Electrical per month $ 2,095
Electrical per year $ 25,076

4. Labor

assume	0.25	hour per day	$60.00	/hr
=	$5,475.00	$/year in labor		

Labor per year	$ 5,475

5. Waste Brine

Volume of each vessel		1,711	ft3
# of vessels		2	each
Regenerations per year		104	per year
Volume of water used	$	5,322,831	gallons/year
Cost of water used	$	11,832	$/year

Waste Brine per year	$ 11,832

6. Summary

Annual salt cost	$	40,597
resin cost	$	42,771
Electrical per year	$	25,076
Labor	$	5,475
Brine Waste	$	11,832

Total Miex Annual Cost	$125,751

(Bldg O&M Cost is Calculated Separately)

Water Treatment Plant DAF Costs (monthly/yearly)

Daily Water Consumption	1,000,000	**gpd**
Monthly Water Consumption	30,000,000	**gal/month**
Yearly Water Consumption	365,000,000	**gal/year**

User Data:

Design Flow	1	MGD
Design Flow	694.4444444	gpm
Storage Volume	848,000	gallons
Time to Fill Tanks	0.8	days
Annual Water Production	365,000,000	gallons

Operational Costs:

Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Burdened labor rate for an Operator	$60	/hr

Description	Number	Phase	Voltage	kW	Total Connected load kW	Total kWh	Run Time per day Hours
Control Panel							
Rapid mixer	1	3	460	1.5	1.5	36	24
Flocculators	4	3	460	0.56	2.24	53.76	24
Recycle Pumps	1	3	460	7.46	7.46	179.04	24
Air Compressor	1	1	120	3.73	3.73	14.92	4
Instrumentation etc	1	1	240	1	1	24	24
				Sub Total (kW)	15.93		
Backwash pump	1	3	460	29.8	29.8	7.945872	0.26664
Sludge pump	n/a						
Airscour blower	1	3	460	11.2	11.2	1.344	0.12
Mixers							
Alum mixer	1	1	110	0.25	0.37	0.37	1
Soda Ash mixer	1	1	110	0.56	0.37	0.37	1
Polymer mixer	1	1	110	0.25	0.25	0.25	1
Potassium Perm. Mixer	1	1	110	0.37	0.37	0.74	2
				Sub Total (kW)	1.36		
Clearwell Booster Pumps	1	3	460	44.742	44.742	621.4166667	13.88888889
Dosing Pumps							
Chemical dosing pumps	4	1	110	0.03	0.12	2.88	24
				Sub Total (kW)	0.12		

Total load for 1.8 MGD plant (KWH) 943
w/ some reduction for 1.0 MGD usage

Power Cost: $0.1145 per kwh

Daily Power Cost $107.98

Daily Production 1,000,000 gallons
Power cost per 1000 gallons $ $ 0.108

Yearly Power Cost	$39,411.85

Chemical Cost

Estimated Chemical Dosages:		Typical Dosages (ppm)	
Polymer	- PAX XL-19	35	
Alum		0	
Soda Ash (Sodium Carbonate)		5.0	(typ. 50% of alum)
Sodium Hypochlorite		4	
Potassium Permangante		2	

Flowrate in usgpm	694.44	(not used)
Plant Run Hours	24	
Total Galls per Day	1,000,000	

Total Pounds of Chemicals Used Per Day				
	#/day	#/month	$/#	Cost/day
Polymer:	291.98	8905.347594	$1.00	$ 291.98
Alum	-	0	$0.41	$ -
Soda Ash:	41.71	1272.192513	$0.30	$ 12
Sodium Hypochlorite	33.37	1017.754011	$2.25	$ 75
Potassium Permanganate	16.68	508.88	$2.18	$ 36.41
			total	$ 416

Chemical cost /1000 gall. = 0.416

Yearly chemical cost $ 151,811

Total Operating Cost			
Power	$	0.108	
Chemicals	$	0.42	
	$	0.52	per 1000 gal

Chemical cost of soda ash $ 27,420

Sludge Dewatering and Disposal

Plant Flowrate	3.785	MLpd	
Raw Water DOC	7	mg/L	
Solids Content After Dewatering	40%		
Sludge Volume	464	kg/day	kg -> lb
Sludge Volume	1022	lb/day	2.2046
Sludge Volume	187	ton/year	

Backwash Volume

backwash flow rate	1386	gpm		
backwash frequency	0.83	days	per Andrew Stevano - every 20 hours	
backwash duration per filter bed	10	minutes		
# of filter beds	2			0.033264
backwash volume per year	12,141,360	gallons		
cost of water	0.0022	$/gallon		
cost of backwash per year	$ 26,989	$/year		

Capital Equipment Replacement	Cost	Expected Equipment Life	Annual Cost
Chemical Systems	$10,000	7 yr	$2,010
Backwash Pump	$8,000	10 yr	$1,303
Air Scour Blower	$10,000	10 yr	$1,629
Booster Pumps	$20,000	10 yr	$3,258
Sludge Centrifuge Parts	$3,560	2 yr	$1,962
Inflation		5 %	

Operator Labor

labor Requirement:				
average hours/day of operation for chemical preperation, monitoring and adjustment.			1 hrs	
average hours/day for minor maintenance of treatment equipment			0.333 hrs	
labor rate per hour			$60	
labor cost/day for operation of treament equipment				$60
labor cost/year for operation of treament equipment	cost per	365 days		$21,900
labor cost/day for minor maintenance of treatment equipment				$20
labor cost/year for minor maintenance of treatment equipment		365 days		$7,293

Total Yearly Labor $ 29,192.70

Estimated Annual Water Treatment O&M Cost

Yearly Power Cost	$	39,412
Yearly chemical cost	$	151,811
cost of backwash per year	$	26,989
Capital Equipment Replacement:	$	10,162
Operator Labor	$	29,193

Estimated Annual Sludge Dewatering & Disposal O&M Cost (see separate estimate)

Sludge Centrifuge Power Cost $ 2,780

Sludge Chemical Cost	$	15,556
Sludge Disposal	$	30,000

Total Yearly Treatment Operating Cost	**$305,903**

(Bldg O&M Cost is Calculated Separately)

EXISTING WATER TREATMENT SYSTEM
SURFACE WATER TREATMENT w/ SLOW SAND FILTRATION

User Data:		
Design Flow	0.9	MGD
Design Flow	625	gpm
Storage Volume	848,000	gallons
Time to Fill Tanks	0.9	days
Annual Water Production	328,500,000	gallons

Operational Costs:		
Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Burdened labor rate for an Operator	$60	/hr
Labor - Operator	43	hr/mo specific to slow san

Capital Equipment Replacement:	Cost	Expected Equipment Life		Annual Cost
Chemical Systems	$3,500	7	yr	$704
Booster Pumps	$20,000	10	yr	$2,000
Inflation		5	%	

Estimated Yearly Electrical Demand

Equipment			Usage (hrs/year)	Yearly Demand (kwh)	Annual Cost
Chlorine Pump	20	watts	8760	175	$20
Booster Pumps	40	hp	6083	181,454	$20,776
Mixers	0.33	hp	365	181	$21

Drawdown Volume		
water wasted per filter cleaning	145,860	gallons
Filter Cleanings per year	104	
water wasted per year	15,169,440	gallons
cost of wasted water	$ 33,720	

Chemical Feed

Caustic Soda	
3	mg/l casutic soda dose required
683.26	lb caustic soda use per month
$0.45	caustic soda cost per pound FOB Wrangell
$ 309	**caustic soda cost per month**
$ 3,710	**COST PER YEAR**

Sodium Hypochlorite	
4.2	mg/l sodium hypo dose required
957	lb sodium hypo use per month
$ 2.25	chlorine cost per equivalent pound
$ 2,154	**sodium hypo cost per month**
$ 25,842	**COST PER YEAR**

Estimated Annual Water Treatment O&M Cost

Operator Labor	$31,200
Electricity	$20,979
Equipment Replacement	$2,704
Wasted Water	$33,720
Chemical Feed	$29,552
Total Annual Treatment Cost	**$118,154**

(Bldg O&M Cost is Calculated Separately)

PROPOSED WATER TREATMENT SYSTEM
SURFACE WATER TREATMENT w/ SLOW SAND FILTRATION

User Data:		
Design Flow	1	MGD
Design Flow	694	gpm
Storage Volume	848,000	gallons
Time to Fill Tanks	0.8	days
Annual Water Production	365,000,000	gallons

Operational Costs:		
Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Burdened labor rate for an Operator	$60	/hr
Labor	1176	hours yearly
Labor - Operator	98	hr/mo specific to slow sand
Labor - Operator	4	hr/mo specific to recapture tank cleaning

Capital Equipment Replacement:	Cost	Expected Equipment Life		Annual Cost
Chemical Systems	$10,000	7	yr	$2,010
Backwash Pump	$10,000	10	yr	$1,629
Air Scour Blower	$30,000	10	yr	$4,887
Booster Pumps	$20,000	10	yr	$3,258
Sludge Centrifuge Parts	$3,560	10	yr	$580
Inflation		5	%	

Estimated Yearly Electrical Demand

Equipment			Usage (hrs/year)	Yearly Demand (kwh)	Annual Cost
Chlorine Pump	20	watts	8760	175	$20
Backwash pump	20	hp	17	517	$59
Air Scour Blower	100	hp	5	776	$89
Booster Pumps	60	hp	5069	226,817	$25,971
Recapture Tank Pump	10	hp	1787	13,324	$1,526
Mixers	0.33	hp	365	272	$31

Drawdown Volume

water wasted per filter cleaning	145,860	gallons
Filter Cleanings per year	147	
water wasted per year	21,441,420	gallons
cost of wasted water	$ 47,661	$

****This cost is not added to the total, as it is assumed a recapture tank will be used*

Sand Cleaning

Equipment Maintenance cost	$	5,000	$/year
Total yearly sand cleaning cost	$	5,000	

Sand Replacement

Sand Replacement		3,500	ft3/year
	$	49,858	$/year
Total yearly sand replacement cost	$	49,858	

Backwash of Roughing Filter

Roughing Filter		400	SF
Backwash unit flow rate		8	gpm/sf
Backwash flow rate		3,200	gpm
Air scour unit flow rate		7	scfm/sf
Air Scour flow rate		2,800	SCFM
backwash per filter cleaning		32,000	gallons
Filter Cleanings per year		104	
backwash per year		3,328,000	gallons
cost of backwash water	$	7,398	$

Chemical Feed

Caustic Soda

	3	mg/l casutic soda dose required
	759	lb caustic soda use per month
	$0.45	caustic soda cost per pound FOB Wrangell
$	343	**caustic soda cost per month**
$	4,122	**COST PER YEAR**

Sodium Hypochlorite

	4.2	mg/l sodium hypo dose required
	1063	lb sodium hypo use per month
$	2.25	chlorine cost per equivalent pound
$	2,393	**sodium hypo cost per month**
$	28,713	**COST PER YEAR**

Sludge Dewatering and Disposal

Polymer Cost	$14,544	per year	
Centrifuge Electrical Cost	$2,780	per year	
Plant Flowrate	3.785	MLpd	
Raw Water DOC	7	mg/L	
Solids Content After Dewatering	40%		
Sludge Volume	95	kg/day	kg -> lb
Sludge Volume	209	lb/day	2.2046
Sludge Volume	38	ton/year	
Disposal Cost	$120	per ton	
Disposal Cost	$4,569.05	per year	

Estimated Annual Water Treatment O&M Cost

Operator Labor	$73,440
Electricity	$27,857
Equipment Replacement	$62,222
Wasted Water Cost	$0
Sand Cleaning	$5,000
Backwash	$7,398
Chemical Feed	$32,835

Estimated Annual Sludge Dewatering & Disposal O&M Cost (see separate estimate)

Sludge Centrifuge Power Cost	$	417
Sludge Chemical Cost	$	2,333
Sludge Disposal	$	4,500

Total Annual Treatment Cost	**$216,002**

(Bldg O&M Cost is Calculated Separately)

WATER TREATMENT SYSTEM
SURFACE WATER TREATMENT w/ BIOMEDIA FILTRATION

User Data:

Design Flow	1	MGD
Design Flow	3.8	MLD
Design Flow	694.4444444	gpm
Storage Volume	848,000	gallons
Time to Fill Tanks	0.8	days
Annual Water Production	365,000,000	gallons

Operational Costs:

Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Burdened labor rate for an Operator	$60	/hr
Labor - Operator	12	hr/mo specific to biomedia

Capital Equipment Replacement:	Cost	Expected Equipment Life		Annual Cost
Chemical Systems	$10,000	7	yr	$2,010
Backwash Pump	$10,000	10	yr	$1,629
GAC Media Replacement	$52,176	5	yr	$13,318
Booster Pumps	$20,000	10	yr	$3,258
Air Blower	$10,000	10	yr	$1,629
Sludge Centrifuge Parts	$3,560	3	yr	$1,374
Inflation		5	%	

Estimated Yearly Electrical Demand

Equipment			Usage (hrs/year)	Yearly Demand (kwh)	Annual Cost
Chlorine Pump	20	watts	8760	175	$20
Mixers	0.33	hp	365	272	$31
Backwash Pump	25	hp	81	1,512	$173
Air Blower	50	hp	24.3	907	$104
Booster Pumps	60	hp	5069	226,817	$25,971

Backwash Volume

Filter surface area (each)	130	sf
Backwash unit flow rate	24	gpm/sf
Backwash flow rate	3,120	gpm
Air scour unit flow rate	6	scfm/sf
Air Scour flow rate	780	SCFM
backwash flow rate	3,120	gpm
backwash frequency	3	days
backwash duration per filter vessel	10	minutes
# of filter beds	4	
backwash volume per year	15184000	gallons
cost of water	0.002222862	$/gallon
cost of backwash per year	$ 33,751.94	$/year

Chemical Feed

Alum

57.5	mg/l alum dose required
14551	lb alum use per month
$0.41	alum cost per pound FOB Wrangell
$ 6,002	**alum cost per month**
$ 72,019	**COST PER YEAR**

Soda Ash

28.75	mg/l soda ash dose required
7275	lb soda ash use per month
$0.30	soda ash cost per pound FOB Wrangell
$ 2,164	**soda ash cost per month**
$ 25,969	**COST PER YEAR**

Sodium Hypochlorite

4.2	mg/l sodium hypo dose required
1063	lb sodium hypo use per month
$ 2.25	chlorine cost per equivalent pound
$ 2,393	**sodium hypo cost per month**
$ 28,713	**COST PER YEAR**

Flowrate	3.785	MLpd	
Raw Water DOC	7	mg/L	
Solids Content After Dewatering	40%		
Sludge Volume	578	kg/day	kg -> lb
Sludge Volume	1274	lb/day	2.2046
Sludge Volume	232	ton/year	

Estimated Annual Water Treatment O&M Cost

Operator Labor	$8,640
Electricity	$26,461
Equipment Replacement	$23,218
Backwash Water	$33,752
Chemical Feed	$126,701

Estimated Annual Sludge Dewatering & Disposal O&M Cost (see separate estimate)

Sludge Centrifuge Power Cost	$ 2,585
Sludge Chemical Cost	$ 14,467
Sludge Disposal	$ 27,900

Total Annual Treatment Cost	**$263,724**

(Bldg O&M Cost is Calculated Separately)

Water Treatment Conventional Packaged Plant Costs (monthly/yearly)

3.8754
gal->liters

Daily Water Consumption	1,000,000	gpd
Daily Water Consumption	3,875,400	Lpd
Monthly Water Consumption	30,000,000	gal/month
Yearly Water Consumption	365,000,000	gal/year

User Data:

Design MDD Flow	1.8	MGD
Design MDD Flow	1250	gpm
Storage Volume	848,000	gallons
Time to Fill Tanks	0.5	days
Annual Water Production	365,000,000	gallons

Operational Costs:

Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Burdened labor rate for an Operator	$60	/hr

Description	Number	Phase	Voltage	kW	Total Connected load kW	Amps	Total kWh	Run Time per day Hours
Instrumentation etc	1	1	110	1	1	10	24	24
Backwash pump	1	3	460	29.8	29.8		5.066	0.17
Air scour blower	1	3	460	11.2	11.2		0.93296	0.0833
Flocculators	4	3	460	0.19	0.75		18	24
AC Chem. Mixers								
Alum mixer	1	1	110	0.37	0.37		0.74	2
Soda ash mixer	1	1	110	0.37	0.37		0.74	2
Polymer mixer	1	1	110	0.25	0.25		0.125	0.5
Clearwell Booster Pumps	1	3	460	44.74	44.74		621.42	13.88889
AC Dosing pumps								
chem pumps,.	3	1	110	0.03	0.09	3	2.115	23.5

Sub Total (kW)	**88.572**		
Total load for plant (KWH)			**673.135627**
Total amps		**13**	

Power Cost:	$0.1145	$/kWh
Daily Power Cost	$77.07	
Daily Production	1,000,000	gallons
Cost per 1000 gallons	$ 0.08	
Yearly Power cost	$28,132.02	

Estimated Chemical Dosages AC Plant:

	Typical Dosages ppm		
Polymer	0.1	(1	max)
Alum	57.5	(60-300)	
Soda Ash (Sodium Carbonate)	28.75	(typ. 50% of alum)	
Sodium Hypochlorite	4		
Flowrate in usgpm	1050		net daily average
Plant Run Hours	24		
Total Galls per Day production		1,000,000	net daily average

Total Pounds of Chemicals Used Per Day				
	#/day	#/month	$/#	Cost/day
Polymer	1	25	$ 2.51	$ 2.10
Alum	480	14630	$0.41	$ 197.84
Soda Ash	240	7315	$0.30	$ 71.34
Sodium Hypochlorite	33	1018	$ 2.25	$ 75.12

Flowrate	3.875	MLpd	
Raw Water DOC	7	mg/L	
Alum	57.5	mg/L	
Soda Ash	28.75	mg/L	
Polymer	0.1	mg/L	
Solids Content After Dewatering	40%		
Sludge Volume	592	kg/day	kg -> lb
Sludge Volume	1306	lb/day	2.2046
Sludge Volume	238	ton/year	
chemical cost of soda ash	$ 26,039		
Daily typical operations total	$ 346.41		
Chemical cost per	365	days	$126,438

Total yearly chemical cost	$126,438

labor Cost

labor Requirement:				
average hours/day of operation for chemical preperation, monitoring and adjustment.				0.5 hrs
average hours/day for minor maintenance of treatment equipment				0.15 hrs
labor rate per hour				$60
labor cost/day for operation of treament equipment			$	30
labor cost/year for operation of treament equipment	cost per	365 days	$	10,950
labor cost/day for minor maintenance of treatment equipment			$	9.00
labor cost/year for minor maintenance of treatment equipment		365 days	$	3,285

Total Yearly Labor Cost	$	14,235

Backwash Volume

backwash flow rate		2210 gpm	2.0 gpm/SF for conventional
backwash frequency		3 days	
backwash duration per filter bed		10 minutes	
# of filter beds		4	
backwash volume per year		10755333 gallons	
cost of water		0.0022 $/gallon	
cost of backwash per year	$	23,908 $/year	

Capital Equipment Replacement:	Cost	Expected Equipment Life	Annual Cost
Chemical Systems	$10,000	7 yr	$2,010
Backwash Pump	$10,000	10 yr	$1,629
Air Scour Blower	$20,000	10 yr	$3,258
Booster Pumps	$20,000	10 yr	$3,258
Sludge Centrifuge Parts	$3,560	3 yr	$1,214
Inflation		5 %	

Water Treatment Cost

Yearly Power cost	$	28,132
Total yearly chemical cost	$	126,438
Total Yearly Labor Cost	$	14,235
Capital Equipment Replacement	$	11,368
cost of backwash per year	$	23,908

Estimated Annual Sludge Dewatering & Disposal O&M Cost (see separate estimate)

Sludge Centrifuge Power Cost	$	2,641
Sludge Chemical Cost	$	14,778
Sludge Disposal	$	28,500

Total yearly operating cost for Conventional treatment package	**$**	**250,000**

(Bldg O&M Cost is Calculated Separately)

Water Treatment Plant Adsorption Clarifier and Nanofiltration Costs (monthly/yearly)

Daily Water Consumption	1,000,000	**gpd**
Monthly Water Consumption	30,000,000	**gal/month**
Yearly Water Consumption	365,000,000	**gal/year**

User Data:

Design Flow	1.8	MGD
Design Flow	1250	gpm
Storage Volume	848,000	gallons
Time to Fill Tanks	0.5	days
Annual Water Production	365,000,000	gallons

Operational Costs:

Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Burdened labor rate for an Operator	$60	/hr

Description	Number	Phase	Voltage	kW	Total Connected load kW	Amps	Total kWh	Run Time per day Hours
Instrumentation etc	1	1	110	1	1	10	24.00	24
Backwash pump	1	3	460	29.8	29.8		5.07	0.17
Air scour blower	1	3	460	11.2	11.2		0.93	0.0833
AC Chem. Mixers								
Alum mixer	1	1	110	0.37	0.37		0.74	2
Soda ash mixer	1	1	110	0.37	0.37		0.74	2
Polymer mixer	1	1	110	0.25	0.25		0.13	0.5
AC Dosing pumps								
chem pumps,.	3	1	110	0.03	0.09	3	2.12	23.5
Clearwell booster pumps	1	3	460	44.742	44.742		621.42	13.88889
NF Booster pumps	2	3	460	44	88		2112.00	24
CIP Pump	1	3	460	14.9	14.9	3.9	0.09	0.006
CIP Heater	1	3	460	18	18	4.9	0.11	0.006
NF Chemical dosing pumps	3	1	110	0.03	0.09	3	2.16	24
Sub Total (kW)					**208.812**			
Total load for plant (KWH)							**2769.493027**	
Total amps						**24.8**		

Power Cost:	$0.1145	$/kWh
Daily Power Cost	$317.11	
Daily Production	1,000,000	gallons
Cost per 1000 gallons	$ 0.32	
Yearly Power cost	$115,744	

Estimated Chemical Dosages AC Plant:

Chemical	Typical Dosages (ppm)	
Polymer	0.1	(1 max)
Alum	40	(20-50)
Soda Ash (Sodium Carbonate)	25	(typ. 50% of alum)
Potassium Permangante	2	

Flowrate	3.785	MLpd	
Raw Water DOC	7	mg/L	
Solids Content After Dewatering	40%		
Sludge Volume	489	kg/day	kg -> lb
Sludge Volume	1079	lb/day	2.2046
Sludge Volume	197	ton/year	

Backwash Water

backwash flow rate	2112	gpm
backwash frequency	3	days
backwash duration per filter bed	10	minutes
# of filter beds	2	
backwash volume per year	5139200	gallons
cost of water	0.0022	$/gallon

cost of backwash per year	$	11,424	$/year

Estimated Chemical Dosages NF/finished water:

NF recovery	90%		
Acid NF feed	0		
Sodium Hypochlorite	4		
Anti Scalant	2		
Soda Ash Finished	25		
Flowrate in usgpm	1050		net daily average both trains
Plant Run Hours	24		
Total Galls per Day NF production		1,000,000	net daily average both trains

Total Pounds of Chemicals Used Per Day				
	#/day	#/month	$/#	Cost/day
Polymer	0.83	25.44	$ 2.51	$ 2.10
Alum	333.69	10177.54	$0.41	$ 137.63
Soda Ash	208.56	6360.96	$0.30	$ 62.04
Potassium Permanganate	16.68	508.88	$2.18	$ 36.41
Anti-Scalant	16.68	508.88	$ 4.21	$ 70.24
Acid NF feed	0.00	0.00	$ 0.58	$ -
Hypochlorite	33.37	1017.75	$ 2.25	$ 75.12
Soda ash Finished	208.56	6360.96	$ 0.30	$ 62.04

chemical cost of soda ash alone	$	45,286		
Daily chemical operations total	$	446		
Chemical cost per year		365	days	$162,635

Water Volume Summary & Waste Summary

Total daily NF waste:		111,111	gals
Cost of wasted water	$	247	$/day
Cost of wasted water	$	90,149	$/year

Offline Cleaning once every 90 days

NF System CIP Cleaning	# required	$/#		Cost/occurance
High pH clean Avista RoClean P111	350	4.83	$	1,691
Low pH clean Avista RoClean P303	350	5.4	$	1,890
per CIP occurance total			$	3,581
daily cost assuming occurance every	90	days	$	40
cost per	365	days	$	14,521

Total yearly chemical cost	$177,156

labor Cost

labor Requirement:				
average hours/day of operation for chemical preperation, monitoring and adjustment.			1 hrs	
average hours/day for minor maintenance of treatment equipment			0.333 hrs	
labor rate per hour			$60	
labor cost/day for operation of treament equipment		$ 60.00		
labor cost/year for operation of treament equipment	cost per	365 days		$ 21,900
labor cost/day for minor maintenance of treatment equipment				$ 20
labor cost/year for minor maintenance of treatment equipment		365 days		$ 7,293

Total Yearly Labor Cost	$ 29,193

Capital Equipment/Membrane Replacement Costs

NF membranes	216 membranes, cost to replace today (freight extra)		$ 185,000
NF membranes because of good pre-treatment assume		8 years	
inflaton		5 %	
Cost/year for membrane replacement	$34,166		

Capital Equipment Replacement:	Cost	Expected Equipment Life	Annual Cost
Chemical Systems	$10,000	7 yr	$2,010
Backwash Pump	$10,000	10 yr	$1,629
Air Scour Blower	$20,000	10 yr	$3,258
Booster Pumps	$20,000	10 yr	$3,258
Sludge Centrifuge Parts	$3,560	2 yr	$1,780
Inflation		5 %	

Total Yearly Capital Equipment/Membrane Replacement Costs	$46,101

Estimated Annual Water Treatment O&M Cost

Yearly Power cost	$115,744
cost of backwash per year	$11,424
Cost of wasted water	$90,149
Total yearly chemical cost	$177,156
Total Yearly Labor Cost	$29,193
Capital Equipment and Membrane Replacement	$46,101

Estimated Annual Sludge Dewatering & Disposal O&M Cost (see separate estimate)

Sludge Centrifuge Power Cost	$ 2,196
Sludge Chemical Cost	$ 12,289
Sludge Disposal	$ 23,700

Total yearly operating cost for AC and nano membrane treatment	**$ 507,952**

(Bldg O&M Cost is Calculated Separately)

WTP BUILDING - EXISTING BUILDINGS

System Data:		
Existing Roughing Filter Building	1,936	ft^2
Control Building	1,936	ft^2

Operational Costs:		
Burdened labor rate for an Operator	$60	/hr
Labor - Operation and maintenance of building	1	hr/wk
Misc Materials and Supplies	$500	/yr
Floor Resurfacing	$300	/yr
Electricity	$0.11	/kwh

Capital Costs:	Cost	Expected Equipment Life	Annual Cost
Unit Heaters (2 total)	$2,000	15 yr	$300
Inflation	5 %		

Electrical Demand:

Equipment	Power	Usage (hr/day)	Yearly Demand (kwh)	Annual Cost
Building Unit Heater	1,500 watts	9	3,696	$423
Building Lights	0.4 watts/ft2	6	3,392	$388
Misc. Building Power	1,500 kwh/yr		1,500	$172

Estimated Annual Building O & M Cost

Labor		$3,200
Materials (Routine O&M and repairs)		$500
Electricity		$990
Equipment Replacement Cost		$300
	Total	$5,000

WTP BUILDING EXPANSION
OPTION 1

System Data:

Existing Roughing Filter Building	1936	
Additional Roughing Filter Building Area	1936	ft^2
Control Building	1,936	ft^2
Total Building Area	5,808	ft^2

Operational Costs:

Burdened labor rate for an Operator	$60	/hr
Labor - Operation and maintenance of building	1	hr/wk
Misc Materials and Supplies	$500	/yr
Floor Resurfacing	$300	/yr
Electricity	$0.11	/kwh

Capital Costs:	Cost		Expected Equipment Life	Annual Cost
Unit Heaters (3 total)	$3,000		15 yr	$500
Inflation		5 %		

Electrical Demand:

Equipment	Power	Usage (hr/day)	Yearly Demand (kwh)	Annual Cost
Building Unit Heater	3,000 watts	9	7,391	$846
Building Lights	0.4 watts/ft2	6	5,088	$583
Misc. Building Power	1,500 kwh/yr		1,500	$172

Estimated Annual Building O & M Cost

Labor		$3,200
Materials (Routine O&M and repairs)		$500
Electricity		$1,610
Equipment Replacement Cost		$500
	Total	$5,900

NEW WTP BUILDING
OPTIONS 2-3

System Data:

Total Building Area	11,736	ft^2
(New Treatment Bldg + Control Building)		

Operational Costs:

Burdened labor rate for an Operator	$60	/hr
Labor - Operation and maintenance of building	2	hr/wk
Misc Materials and Supplies	$500	/yr
Floor Resurfacing	$300	/yr
Electricity	$0.11	/kwh

Capital Costs:	Cost		Expected Equipment Life	Annual Cost
Unit Heaters (6 total)	$6,000		15 yr	$900
Inflation		5 %		

Electrical Demand:

Equipment	Power	Usage (hr/day)	Yearly Demand (kwh)	Annual Cost
Building Unit Heater	9,000 watts	9	22,174	$2,539
Building Lights	0.4 watts/ft2	6	10,281	$1,177
Misc. Building Power	2,000 kwh/yr		2,000	$229

Estimated Annual Building O & M Cost

Labor		$6,300
Materials (Routine O&M and repairs)		$500
Electricity		$3,950
Equipment Replacement Cost		$900
	Total	$11,700

NEW WTP BUILDING
OPTIONS 4-5

System Data:

Total Building Area	8,236	ft^2
(New Treatment Bldg + Control Building)		

Operational Costs:

Burdened labor rate for an Operator	$60	/hr
Labor - Operation and maintenance of building	2	hr/wk
Misc Materials and Supplies	$500	/yr
Floor Resurfacing	$300	/yr
Electricity	$0.11	/kwh

Capital Costs:	Cost		Expected Equipment Life	Annual Cost
Unit Heaters (5 total)	$5,000		15 yr	$700
Inflation		5 %		

Electrical Demand:

Equipment	Power	Usage (hr/day)	Yearly Demand (kwh)	Annual Cost
Building Unit Heater	7,500 watts	9	18,478	$2,116
Building Lights	0.4 watts/ft2	6	7,215	$826
Misc. Building Power	1,750 kwh/yr		1,750	$200

Estimated Annual Building O & M Cost

Labor		$6,300
Materials (Routine O&M and repairs)		$500
Electricity		$3,150
Equipment Replacement Cost		$700
	Total	$10,700

BACKWASH DISPOSAL - ALTERNATIVE A-1
SEWER SERVICE EXTENSION TO WWTP (BELOW GROUND)

Operational Costs:

Burdened labor rate for an Operator	$60	/hr
Equipment Operating Cost	$50	/hr
Backwash Clarifier Tank Cleaning	40	hr/year
Inspection and cleaning sewer collection system		
Labor - Operator	10	hr/year

Estimated Annual Operation & Maintenance Cost

Operator Labor	
Sewer Collection System	$600
Tank Cleaning	$2,400
Equipment	
Sewer Collection System	$500
Total	**$3,500**

BACKWASH DISPOSAL - ALTERNATIVE A-2
SEWER SERVICE EXTENSION TO WWTP (ABOVE GROUND)

Operational Costs:

Burdened labor rate for an Operator	$60	/hr
Equipment Operating Cost	$50	/hr
Backwash Clarifier Tank Cleaning	40	hr/year
Electrical Heat Trace		
Sewer Line Length	1,300	feet
Days Per Year Heat Trace Operational	60	days
Electricity Service Charge	$13.50	/mo
Electricity	$0.1145	/kwh
Inspection and cleaning sewer collection system		
Labor - Operator	10	hr/year

Estimated Yearly Electrical Demand

Equipment			Usage (hrs/year)	Yearly Demand (kwh)	Annual Cost
Heat Trace	10	watts/foot	1440	18,720	$2,143

Estimated Annual Operation & Maintenance Cost

Operator Labor	
Sewer Collection System	$600
Tank Cleaning	$2,400
Heat Trace Electricity	$2,305
Equipment	
Sewer Collection System	$500
Total	**$5,805**

BACKWASH DISPOSAL - ALTERNATIVE B
SEWER SERVICE EXTENSION ALONG WOOD ST

<u>Operational Costs:</u>

Burdened labor rate for an Operator	$60	/hr
Vacuum Truck Operating Cost	$50	/hr
Inspection and cleaning sewer collection system		
Labor - Operator	20	hr/year
Backwash Clarifier Tank Cleaning	40	hr/year

Estimated Annual Operation & Maintenance Cost

Operator Labor	
Sewer Collection System	$1,200
Tank Cleaning	$2,400
Equipment	
Sewer Collection System	$1,000
Total	**$4,600**

BACKWASH DISPOSAL - ALTERNATIVE C
MARINE OUTFALL

Operational Costs:

Burdened labor rate for an Operator	$60	/hr
Vacuum Truck Operating Cost	$50	/hr
Inspection and cleaning sewer collection system	20	hr/year
Backwash Clarifier Tank Cleaning	40	hr/year

Estimated Annual Operation & Maintenance Cost

Operator Labor	
Sewer Collection System	$1,200
Tank Cleaning	$2,400
Equipment	
Sewer Collection System	$1,000
Total	**$3,600**

BACKWASH DISPOSAL - ALTERNATIVE D
BACKWASH RECYCLE

Operational Costs:		
Burdened labor rate for an Operator	$60	/hr
Electricity	$0.1145	/kwh
Backwash Clarifier Tank Cleaning	40	hrs per year
Backwash Volume	11,500	gallons per day
Backwash Recycle Pumps		
Power	1	hp
Power	0.75	kW
Flow	100	gpm
Pump run time	115	minutes
Energy Consumption	1.4	kWh per day
Capital Cost	$1,500	
Expected Equipment Life	7	yr
Inflation	5%	

Estimated Annual Operation & Maintenance Cost

Capital Replacement (Recycle Pump)	$302
Labor	$2,400
Electricity (Recycle Pump)	$60
Total	**$2,761**

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Vanderbeken Enterprises Ltd.

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Throughput Data

2.00	m3/h
2.0%	%DSw/w
20,000	DS ppm
40.00	kg/h solids
60	kg/day solids
15,000	kg/year solids

	HIGH	**LOW**
Capture rate	98%	98%
Centrate TSS ppm	400	400

Solids Discharge	50%	40%
Dry Cake kg/hr	80	100
Dry Cake tons/year	30	38
Landfill $/ton	$ 120	$ 120
YEARLY DISPOSAL COST	$ 3,600	$ 4,500

Operation

1.5	hour/day
5	days/week
50	week/year
375	hour/year
750,000	litres/year

10	years
3,750	hours operation

Polymer consumption

low consumption	high comsumption	
8	10	kg poly/dry ton solids
0.320	0.400	kg/hour 100% active
45%	45%	% Polymer Activity
0.71	0.89	kg/hour neat emulsion polymer
1.07	1.33	kg/day
267	333	kg/year neat emulsion polymer
$ 7.00	$ 7.00	CAD Price neat polymer per kg
$ 1,867	$ 2,333	POLYMER PRICE

DRYCAKE
Vanderbeken Enterprises Ltd.

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Decanter Replacement Interval Normal Conditions

S: Suggested replacement; C: Integrity and functionality check of the part and replacement if necessary.

YEAR	14	30	46	62
hour per replacement	5,000	11,000	17,000	23,000
BEARINGS AND SEALS	S	S	S	S
JOINT FLANGE FOR HYDRAULIC PUMP	C	C	C	C
FIFTH WHEEL OF SLUDGE SCRAPER	S	S	S	S
TRANSMISSION BELTS	C	C	C	C
CYCLOIDAL GEARBOX SEALS	C	C	C	C
SCREW	C	C	C	C
BOWL	C	C	C	C
SLUDGE SCRAPER BLADE	C	C	C	C
SENSORS OPERATION	C	C	C	C
INTEGRITY OF MACHINE COMPONENTS	C	C	C	C
ELECTRIC BOARD OPERATION	C	C	C	C
INTEGRITY OF ELECTRIC BOARD COMPONENTS	C	C	C	C

DR250E Start-up Spare Parts Kit

Decanter Startup Toolbox

Items	Part #	QTY	Kit Price USD
Wrench set	-	1	Free of Charge
Weir plate puller	-	1	
Bowl and Scroll Speed Sensor	-	1	
Bearing Grease Gun (1 cartridge)	-	1	
Gearbox Grease gun (1 cartridge)	-	1	
Washing Solenoid Valve (internal wash)	-	1	
Washing Solenoid Valve (external wash)	-	1	
Intake Oil Filter	M1120023	1	
Return Oil Filter	M1120024	1	
Sludge Feed Pump Stator (w/pump purchase)		1	
Polymer Feed Pump Stator (w/pump purchase)		0	

Decanter Recommended On Hand Spare Parts

Items	Part #	QTY	Kit Price USD
Bowl Belt kit (3 belts)	M1040078	1	$ 445
Scroll Belt	M1040006	1	$ 200
Cover and Gasket Kit	C1010045	1	$ 350
	-	-	-
		KIT PRICE	$ 995

Decanter Parts and Consumables Kit (2 years)

Items	Part #	QTY	Unit Price USD
Bearing Grease Cartridge	M1170002	15	$ 510
Gearbox Gear Cartridge	M1170001	8	$ 50
			-
2 year package			$ 3,000
Bowl Bearing supply side	M1060017	1	-
Bowl Bearing gear side	M1060016	1	-
Scroll Bearing supply side	M1060014	1	-
Scroll Bearing gear side	M1060015	1	-
Scraper bearing front	M1060007	1	-
Sludge Feed Pump Stator		1	-
Polymer Feed Pump Stator		1	-
		KIT PRICE	$ 3,560

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Wash Water Consumption

Decanter Wash water

1000	L/h	Washing consumption DR250E
5	min	Shut down Time
83	L	Shutdown Water Consumption per Shutdown
83	L	Shutdown Water Consumption Daily
0.417	m3	Shutdown Water Consumption Weekly
20.8	m3	Shutdown Water Consumption Yearly

Internal and External Washing	
Quality:	Reuse Water
Pressure:	30-50PSI

Polymer Makeup Water

low consumption	**high comsumption**	
267	333	Neat Polymer Consumption per year kg
0.25%	0.25%	Dilution Ratio
0.13	0.16	m3/year Water for Polymer Makeup

Dewatering System Electric Power

Equipment	Component	kW	HP	Voltage	Amp
DR250E	Main Motor	11	15	575	19.13
DR250E	Scroll Motor	0	0.00	24	0.00
DR250E	Scraper	0.37	0.50	575	0.64
DR250E	Solenoid Valve External Wash	0.010	0.013	24	0.42
DR250E	Solenoid Valve Internal Wash	0.010	0.013	24	0.42
SFP	Sludge Feed Pump	1.5	2	575	2.61
PFP	Polymer Feed Pump	0.55	0.74	575	0.96
CONV	Conveyor	1.5	2.01	575	2.61
	Total	14.9	20		27
Average Consumed Power		9.7	Kw/h		17.4
Yearly number of operation		375	hours		
Electricity Price		0.1145	$/kW		
ELECTRICITY PRICE		$ 417	$/year		

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Throughput Data

2.00	m3/h
2.0%	%DSw/w
20,000	DS ppm
40.00	kg/h solids
316	kg/day solids
79,000	kg/year solids

	HIGH	LOW
Capture rate	98%	98%
Centrate TSS ppm	400	400

Solids Discharge	50%	40%
Dry Cake kg/hr	80	100
Dry Cake tons/year	158	198
Landfill $/ton	$ 120	$ 120
YEARLY DISPOSAL COST	$ 18,960	$ 23,700

Operation

8	hour/day
5	days/week
50	week/year
1,975	hour/year
3,950,000	litres/year

10	years
19,750	hours operation

Polymer consumption

low consumption	high comsumption	
8	10	kg poly/dry ton solids
0.320	0.400	kg/hour 100% active
45%	45%	% Polymer Activity
0.71	0.89	kg/hour neat emulsion polymer
5.62	7.02	kg/day
1,404	1,756	kg/year neat emulsion polymer
$ 7.00	$ 7.00	CAD Price neat polymer per kg
$ 9,831	$ 12,289	POLYMER PRICE

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Decanter Replacement Interval Normal Conditions

S: Suggested replacement; C: Integrity and functionality check of the part and replacement if necessary.

YEAR	3	6	9	12
hour per replacement	5,000	11,000	17,000	23,000
BEARINGS AND SEALS	S	S	S	S
JOINT FLANGE FOR HYDRAULIC PUMP	C	C	C	C
FIFTH WHEEL OF SLUDGE SCRAPER	S	S	S	S
TRANSMISSION BELTS	C	C	C	C
CYCLOIDAL GEARBOX SEALS	C	C	C	C
SCREW	C	C	C	C
BOWL	C	C	C	C
SLUDGE SCRAPER BLADE	C	C	C	C
SENSORS OPERATION	C	C	C	C
INTEGRITY OF MACHINE COMPONENTS	C	C	C	C
ELECTRIC BOARD OPERATION	C	C	C	C
INTEGRITY OF ELECTRIC BOARD COMPONENTS	C	C	C	C

DR250E Start-up Spare Parts Kit

Decanter Startup Toolbox

Items	Part #	QTY	Kit Price USD
Wrench set	-	1	Free of Charge
Weir plate puller	-	1	
Bowl and Scroll Speed Sensor	-	1	
Bearing Grease Gun (1 cartridge)	-	1	
Gearbox Grease gun (1 cartridge)	-	1	
Washing Solenoid Valve (internal wash)	-	1	
Washing Solenoid Valve (external wash)	-	1	
Intake Oil Filter	M1120023	1	
Return Oil Filter	M1120024	1	
Sludge Feed Pump Stator (w/pump purchase)		1	
Polymer Feed Pump Stator (w/pump purchase)		0	

Decanter Recommended On Hand Spare Parts

Items	Part #	QTY	Kit Price USD
Bowl Belt kit (3 belts)	M1040078	1	$ 445
Scroll Belt	M1040006	1	$ 200
Cover and Gasket Kit	C1010045	1	$ 350
	-	-	-
		KIT PRICE	$ 995

Decanter Parts and Consumables Kit (2 years)

Items	Part #	QTY	Unit Price USD
Bearing Grease Cartridge	M1170002	15	$ 510
Gearbox Gear Cartridge	M1170001	8	$ 50
			-
2 year package			$ 3,000
Bowl Bearing supply side	M1060017	1	-
Bowl Bearing gear side	M1060016	1	-
Scroll Bearing supply side	M1060014	1	-
Scroll Bearing gear side	M1060015	1	-
Scraper bearing front	M1060007	1	-
Sludge Feed Pump Stator		1	-
Polymer Feed Pump Stator		1	-
		KIT PRICE	$ 3,560

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Wash Water Consumption

Decanter Wash water

1000	L/h	Washing consumption DR250E
5	min	Shut down Time
83	L	Shutdown Water Consumption per Shutdown
83	L	Shutdown Water Consumption Daily
0.417	m3	Shutdown Water Consumption Weekly
20.8	m3	Shutdown Water Consumption Yearly

Internal and External Washing	
Quality:	Reuse Water
Pressure:	30-50PSI

Polymer Makeup Water

low consumption	**high comsumption**	
1,404	1,756	Neat Polymer Consumption per year kg
0.25%	0.25%	Dilution Ratio
0.13	0.16	m3/year Water for Polymer Makeup

Dewatering System Electric Power

Equipment	Component	kW	HP	Voltage	Amp
DR250E	Main Motor	11	15	575	19.13
DR250E	Scroll Motor	0	0.00	24	0.00
DR250E	Scraper	0.37	0.50	575	0.64
DR250E	Solenoid Valve External Wash	0.010	0.013	24	0.42
DR250E	Solenoid Valve Internal Wash	0.010	0.013	24	0.42
SFP	Sludge Feed Pump	1.5	2	575	2.61
PFP	Polymer Feed Pump	0.55	0.74	575	0.96
CONV	Conveyor	1.5	2.01	575	2.61
	Total	14.9	20		27
Average Consumed Power		9.7	Kw/h		17.4
Yearly number of operation		1,975	hours		
Electricity Price		0.1145	$/kW		
ELECTRICITY PRICE		$ 2,196	$/year		

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Throughput Data

2.00	m3/h
1.9%	%DSw/w
18,700	DS ppm
37.40	kg/h solids
374	kg/day solids
93,500	kg/year solids

	HIGH	LOW
Capture rate	98%	98%
Centrate TSS ppm	374	374

Solids Discharge	50%	20%
Dry Cake kg/hr	75	187
Dry Cake tons/year	187	468
Landfill $/ton	$ 120	$ 120
YEARLY DISPOSAL COST	$ 22,440	$ 56,100

Operation

10	hour/day
5	days/week
50	week/year
2,500	hour/year
5,000,000	litres/year

10	years
25,000	hours operation

Polymer consumption

low consumption	high comsumption	
8	10	kg poly/dry ton solids
0.299	0.374	kg/hour 100% active
45%	45%	% Polymer Activity
0.66	0.83	kg/hour neat emulsion polymer
6.65	8.31	kg/day
1,662	2,078	kg/year neat emulsion polymer
$ 7.00	$ 7.00	CAD Price neat polymer per kg
$ 11,636	$ 14,544	POLYMER PRICE

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Decanter Replacement Interval Normal Conditions

S: Suggested replacement; C: Integrity and functionality check of the part and replacement if necessary.

YEAR	2	5	7	10
hour per replacement	5,000	11,000	17,000	23,000
BEARINGS AND SEALS	S	S	S	S
JOINT FLANGE FOR HYDRAULIC PUMP	C	C	C	C
FIFTH WHEEL OF SLUDGE SCRAPER	S	S	S	S
TRANSMISSION BELTS	C	C	C	C
CYCLOIDAL GEARBOX SEALS	C	C	C	C
SCREW	C	C	C	C
BOWL	C	C	C	C
SLUDGE SCRAPER BLADE	C	C	C	C
SENSORS OPERATION	C	C	C	C
INTEGRITY OF MACHINE COMPONENTS	C	C	C	C
ELECTRIC BOARD OPERATION	C	C	C	C
INTEGRITY OF ELECTRIC BOARD COMPONENTS	C	C	C	C

DR250E Start-up Spare Parts Kit

Decanter Startup Toolbox

Items	Part #	QTY	Kit Price USD
Wrench set	-	1	Free of Charge
Weir plate puller	-	1	
Bowl and Scroll Speed Sensor	-	1	
Bearing Grease Gun (1 cartridge)	-	1	
Gearbox Grease gun (1 cartridge)	-	1	
Washing Solenoid Valve (internal wash)	-	1	
Washing Solenoid Valve (external wash)	-	1	
Intake Oil Filter	M1120023	1	
Return Oil Filter	M1120024	1	
Sludge Feed Pump Stator (w/pump purchase)		1	
Polymer Feed Pump Stator (w/pump purchase)		0	

Decanter Recommended On Hand Spare Parts

Items	Part #	QTY	Kit Price USD
Bowl Belt kit (3 belts)	M1040078	1	$ 445
Scroll Belt	M1040006	1	$ 200
Cover and Gasket Kit	C1010045	1	$ 350
	-	-	-
		KIT PRICE	$ 995

Decanter Parts and Consumables Kit (2 years)

Items	Part #	QTY	Unit Price USD
Bearing Grease Cartridge	M1170002	15	$ 510
Gearbox Gear Cartridge	M1170001	8	$ 50
			-
2 year package			$ 3,000
Bowl Bearing supply side	M1060017	1	-
Bowl Bearing gear side	M1060016	1	-
Scroll Bearing supply side	M1060014	1	-
Scroll Bearing gear side	M1060015	1	-
Scraper bearing front	M1060007	1	-
Sludge Feed Pump Stator		1	-
Polymer Feed Pump Stator		1	-
		KIT PRICE	$ 3,560

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	**March 23rd 2017**
Offer	**17060-E1701**
Revision	**00**

Wash Water Consumption

Decanter Wash water

1000	L/h	Washing consumption DR250E
5	min	Shut down Time
83	L	Shutdown Water Consumption per Shutdown
83	L	Shutdown Water Consumption Daily
0.417	m3	Shutdown Water Consumption Weekly
20.8	m3	Shutdown Water Consumption Yearly

Internal and External Washing	
Quality:	Reuse Water
Pressure:	30-50PSI

Polymer Makeup Water

low consumption	**high comsumption**	
1,662	2,078	Neat Polymer Consumption per year kg
0.25%	0.25%	Dilution Ratio
0.12	0.15	m3/year Water for Polymer Makeup

Dewatering System Electric Power

Equipment	Component	kW	HP	Voltage	Amp
DR250E	Main Motor	11	15	575	19.13
DR250E	Scroll Motor	0	0.00	24	0.00
DR250E	Scraper	0.37	0.50	575	0.64
DR250E	Solenoid Valve External Wash	0.010	0.013	24	0.42
DR250E	Solenoid Valve Internal Wash	0.010	0.013	24	0.42
SFP	Sludge Feed Pump	1.5	2	575	2.61
PFP	Polymer Feed Pump	0.55	0.74	575	0.96
CONV	Conveyor	1.5	2.01	575	2.61
	Total	14.9	20		27
Average Consumed Power		9.7	Kw/h		17.4
Yearly number of operation		2,500	hours		
Electricity Price		0.1145	$/kW		
ELECTRICITY PRICE		$ 2,780	$/year		

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	**March 23rd 2017**
Offer	**17060-E1701**
Revision	**00**

Throughput Data

2.00	m3/h
2.0%	%DSw/w
20,000	DS ppm
40.00	kg/h solids
380	kg/day solids
95,000	kg/year solids

	HIGH	LOW
Capture rate	98%	98%
Centrate TSS ppm	400	400

Solids Discharge	50%	40%
Dry Cake kg/hr	80	100
Dry Cake tons/year	190	238
Landfill $/ton	$ 120	$ 120
YEARLY DISPOSAL COST	$ 22,800	$ 28,500

Operation

9.5	hour/day
5	days/week
50	week/year
2,375	hour/year
4,750,000	litres/year

10	years
23,750	hours operation

Polymer consumption

low consumption	high comsumption	
8	10	kg poly/dry ton solids
0.320	0.400	kg/hour 100% active
45%	45%	% Polymer Activity
0.71	0.89	kg/hour neat emulsion polymer
6.76	8.44	kg/day
1,689	2,111	kg/year neat emulsion polymer
$ 7.00	$ 7.00	CAD Price neat polymer per kg
$ 11,822	$ 14,778	POLYMER PRICE

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	March 23rd 2017
Offer	17060-E1701
Revision	00

Decanter Replacement Interval Normal Conditions

S: Suggested replacement; C: Integrity and functionality check of the part and replacement if necessary.

YEAR	3	5	8	10
hour per replacement	5,000	11,000	17,000	23,000
BEARINGS AND SEALS	S	S	S	S
JOINT FLANGE FOR HYDRAULIC PUMP	C	C	C	C
FIFTH WHEEL OF SLUDGE SCRAPER	S	S	S	S
TRANSMISSION BELTS	C	C	C	C
CYCLOIDAL GEARBOX SEALS	C	C	C	C
SCREW	C	C	C	C
BOWL	C	C	C	C
SLUDGE SCRAPER BLADE	C	C	C	C
SENSORS OPERATION	C	C	C	C
INTEGRITY OF MACHINE COMPONENTS	C	C	C	C
ELECTRIC BOARD OPERATION	C	C	C	C
INTEGRITY OF ELECTRIC BOARD COMPONENTS	C	C	C	C

DR250E Start-up Spare Parts Kit

Decanter Startup Toolbox

Items	Part #	QTY	Kit Price USD
Wrench set	-	1	Free of Charge
Weir plate puller	-	1	
Bowl and Scroll Speed Sensor	-	1	
Bearing Grease Gun (1 cartridge)	-	1	
Gearbox Grease gun (1 cartridge)	-	1	
Washing Solenoid Valve (internal wash)	-	1	
Washing Solenoid Valve (external wash)	-	1	
Intake Oil Filter	M1120023	1	
Return Oil Filter	M1120024	1	
Sludge Feed Pump Stator (w/pump purchase)		1	
Polymer Feed Pump Stator (w/pump purchase)		0	

Decanter Recommended On Hand Spare Parts

Items	Part #	QTY	Kit Price USD
Bowl Belt kit (3 belts)	M1040078	1	$ 445
Scroll Belt	M1040006	1	$ 200
Cover and Gasket Kit	C1010045	1	$ 350
	-	-	-
		KIT PRICE	$ 995

Decanter Parts and Consumables Kit (2 years)

Items	Part #	QTY	Unit Price USD
Bearing Grease Cartridge	M1170002	15	$ 510
Gearbox Gear Cartridge	M1170001	8	$ 50
			-
2 year package			$ 3,000
Bowl Bearing supply side	M1060017	1	-
Bowl Bearing gear side	M1060016	1	-
Scroll Bearing supply side	M1060014	1	-
Scroll Bearing gear side	M1060015	1	-
Scraper bearing front	M1060007	1	-
Sludge Feed Pump Stator		1	-
Polymer Feed Pump Stator		1	-
		KIT PRICE	$ 3,560

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	**March 23rd 2017**
Offer	**17060-E1701**
Revision	**00**

Wash Water Consumption

Decanter Wash water

1000	L/h	Washing consumption DR250E
5	min	Shut down Time
83	L	Shutdown Water Consumption per Shutdown
83	L	Shutdown Water Consumption Daily
0.417	m3	Shutdown Water Consumption Weekly
20.8	m3	Shutdown Water Consumption Yearly

Internal and External Washing	
Quality:	Reuse Water
Pressure:	30-50PSI

Polymer Makeup Water

low consumption	**high comsumption**	
1,689	2,111	Neat Polymer Consumption per year kg
0.25%	0.25%	Dilution Ratio
0.13	0.16	m3/year Water for Polymer Makeup

Dewatering System Electric Power

Equipment	Component	kW	HP	Voltage	Amp
DR250E	Main Motor	11	15	575	19.13
DR250E	Scroll Motor	0	0.00	24	0.00
DR250E	Scraper	0.37	0.50	575	0.64
DR250E	Solenoid Valve External Wash	0.010	0.013	24	0.42
DR250E	Solenoid Valve Internal Wash	0.010	0.013	24	0.42
SFP	Sludge Feed Pump	1.5	2	575	2.61
PFP	Polymer Feed Pump	0.55	0.74	575	0.96
CONV	Conveyor	1.5	2.01	575	2.61
	Total	14.9	20		27
Average Consumed Power		9.7	Kw/h		17.4
Yearly number of operation		2,375	hours		
Electricity Price		0.1145	$/kW		
ELECTRICITY PRICE		$ 2,641	$/year		

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	**March 23rd 2017**
Offer	**17060-E1701**
Revision	**00**

Throughput Data

2.00	m3/h
2.0%	%DSw/w
20,000	DS ppm
40.00	kg/h solids
372	kg/day solids
93,000	kg/year solids

	HIGH	LOW
Capture rate	98%	98%
Centrate TSS ppm	400	400

Solids Discharge	50%	40%
Dry Cake kg/hr	80	100
Dry Cake tons/year	186	233
Landfill $/ton	$ 120	$ 120
YEARLY DISPOSAL COST	$ 22,320	$ 27,900

Operation

9.3	hour/day
5	days/week
50	week/year
2,325	hour/year
4,650,000	litres/year

10	years
23,250	hours operation

Polymer consumption

low consumption	high comsumption	
8	10	kg poly/dry ton solids
0.320	0.400	kg/hour 100% active
45%	45%	% Polymer Activity
0.71	0.89	kg/hour neat emulsion polymer
6.61	8.27	kg/day
1,653	2,067	kg/year neat emulsion polymer
$ 7.00	$ 7.00	CAD Price neat polymer per kg
$ 11,573	$ 14,467	POLYMER PRICE

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	March 23rd 2017
Offer	17060-E1701
Revision	00

Decanter Replacement Interval Normal Conditions

S: Suggested replacement; C: Integrity and functionality check of the part and replacement if necessary.

YEAR	3	5	8	10
hour per replacement	5,000	11,000	17,000	23,000
BEARINGS AND SEALS	S	S	S	S
JOINT FLANGE FOR HYDRAULIC PUMP	C	C	C	C
FIFTH WHEEL OF SLUDGE SCRAPER	S	S	S	S
TRANSMISSION BELTS	C	C	C	C
CYCLOIDAL GEARBOX SEALS	C	C	C	C
SCREW	C	C	C	C
BOWL	C	C	C	C
SLUDGE SCRAPER BLADE	C	C	C	C
SENSORS OPERATION	C	C	C	C
INTEGRITY OF MACHINE COMPONENTS	C	C	C	C
ELECTRIC BOARD OPERATION	C	C	C	C
INTEGRITY OF ELECTRIC BOARD COMPONENTS	C	C	C	C

DR250E Start-up Spare Parts Kit

Decanter Startup Toolbox

Items	Part #	QTY	Kit Price USD
Wrench set	-	1	Free of Charge
Weir plate puller	-	1	
Bowl and Scroll Speed Sensor	-	1	
Bearing Grease Gun (1 cartridge)	-	1	
Gearbox Grease gun (1 cartridge)	-	1	
Washing Solenoid Valve (internal wash)	-	1	
Washing Solenoid Valve (external wash)	-	1	
Intake Oil Filter	M1120023	1	
Return Oil Filter	M1120024	1	
Sludge Feed Pump Stator (w/pump purchase)		1	
Polymer Feed Pump Stator (w/pump purchase)		0	

Decanter Recommended On Hand Spare Parts

Items	Part #	QTY	Kit Price USD
Bowl Belt kit (3 belts)	M1040078	1	$ 445
Scroll Belt	M1040006	1	$ 200
Cover and Gasket Kit	C1010045	1	$ 350
	-	-	-
		KIT PRICE	$ 995

Decanter Parts and Consumables Kit (2 years)

Items	Part #	QTY	Unit Price USD
Bearing Grease Cartridge	M1170002	15	$ 510
Gearbox Gear Cartridge	M1170001	8	$ 50
			-
2 year package			$ 3,000
Bowl Bearing supply side	M1060017	1	-
Bowl Bearing gear side	M1060016	1	-
Scroll Bearing supply side	M1060014	1	-
Scroll Bearing gear side	M1060015	1	-
Scraper bearing front	M1060007	1	-
Sludge Feed Pump Stator		1	-
Polymer Feed Pump Stator		1	-
		KIT PRICE	$ 3,560

DRYCAKE
Vanderbeken Enterprises Ltd.

Date	**March 23rd 2017**
Offer	**17060-E1701**
Revision	**00**

Wash Water Consumption

Decanter Wash water

1000	L/h	Washing consumption DR250E
5	min	Shut down Time
83	L	Shutdown Water Consumption per Shutdown
83	L	Shutdown Water Consumption Daily
0.417	m3	Shutdown Water Consumption Weekly
20.8	m3	Shutdown Water Consumption Yearly

Internal and External Washing	
Quality:	Reuse Water
Pressure:	30-50PSI

Polymer Makeup Water

low consumption	**high comsumption**	
1,653	2,067	Neat Polymer Consumption per year kg
0.25%	0.25%	Dilution Ratio
0.13	0.16	m3/year Water for Polymer Makeup

Dewatering System Electric Power

Equipment	Component	kW	HP	Voltage	Amp
DR250E	Main Motor	11	15	575	19.13
DR250E	Scroll Motor	0	0.00	24	0.00
DR250E	Scraper	0.37	0.50	575	0.64
DR250E	Solenoid Valve External Wash	0.010	0.013	24	0.42
DR250E	Solenoid Valve Internal Wash	0.010	0.013	24	0.42
SFP	Sludge Feed Pump	1.5	2	575	2.61
PFP	Polymer Feed Pump	0.55	0.74	575	0.96
CONV	Conveyor	1.5	2.01	575	2.61
	Total	14.9	20		27
Average Consumed Power		9.7	Kw/h		17.4
Yearly number of operation		2,325	hours		
Electricity Price		0.1145	$/kW		
ELECTRICITY PRICE		$ 2,585	$/year		

Appendix I – Community Resolutions

CITY AND BOROUGH OF WRANGELL, ALASKA

RESOLUTION NO. 08-14-1299

A RESOLUTION OF THE ASSEMBLY OF THE CITY AND BOROUGH OF WRANGELL, ALASKA, TO ACCEPT A LOAN IN THE AMOUNT OF UP TO $542,249 FROM THE STATE OF ALASKA, DEPARTMENT OF ENVIRONMENTAL CONSERVATION

WHEREAS, the City and Borough of Wrangell has determined that several of Wrangell's water mains are corroding and starting to fail; and

WHEREAS, the costs to maintain sections of the water mains continue to escalate, and replacement of these corroding mains would result in lower operating and maintenance costs; and

WHEREAS, the City and Borough of Wrangell seeks to obtain the necessary financial assistance to replace water mains and make water system improvements; and

WHEREAS, the State of Alaska, Department of Environmental Conservation is able to offer loan funding through the Alaska Drinking Water Fund; and

WHEREAS, the City and Borough of Wrangell applied for and received priority funding in the State's FY15 Intended Use Plan to apply for loan term that would be 20 years at 1.5% interest; and

WHEREAS, the City and Borough of Wrangell is authorized under WMC Chapter 6.3 to borrow money when authorized by the Assembly for use by a utility or enterprise of the borough and that repayment of the loan including interest comes exclusively from said utility.

NOW, THEREFORE, BE IT RESOLVED BY THE ASSEMBLY OF THE CITY AND BOROUGH OF WRANGELL, ALASKA:

The Assembly hereby authorizes and directs the Borough Manager to make, accept, and execute a loan agreement up to $542,249 for funding in the form of a loan through the State of Alaska Department of Environmental Conservation Drinking Water Fund for the replacement of water mains and water system improvements.

ADOPTED: August 26, 2014

David Jack, Mayor

ATTEST: Kim Lane

Kim Lane, Borough Clerk

City & Borough of Wrangell
Incorporated Borough May 30, 2008
Incorporated City June 15, 1903
Alaska

CITY AND BOROUGH OF WRANGELL, ALASKA

RESOLUTION NO. 01-17-1359

A RESOLUTION OF THE ASSEMBLY OF THE CITY AND BOROUGH OF WRANGELL, ALASKA, TO ACCEPT A LOAN IN THE AMOUNT OF UP TO $322,650 FROM THE STATE OF ALASKA, DEPARTMENT OF ENVIRONMENTAL CONSERVATION

WHEREAS, the City and Borough of Wrangell has determined that the last of Wrangell's two original ozone generators is failing and is at the end of its useful life; and

WHEREAS, the current equipment is obsolete, costs to keep the generator operating continue to escalate, parts are no longer available and replacement of the generator would result in lower operating and maintenance costs; and

WHEREAS, the City and Borough of Wrangell seeks to obtain the necessary financial assistance to replace the obsolete ozone generator; and

WHEREAS, the State of Alaska, Department of Environmental Conservation is able to offer loan funding through the Alaska Drinking Water Fund Program; and

WHEREAS, the City and Borough of Wrangell applied for and received priority funding in the State's FY 2016 Intended Use Plan; and the term of the loan would be twenty years at 1.5 percent interest; and

WHEREAS, the City and Borough of Wrangell is authorized under Wrangell Charter 6-3 to borrow money when authorized by the assembly for use by a utility or enterprise of the borough and that repayment of the loan including interest comes exclusively from the said utility.

NOW, THEREFORE, BE IT RESOLVED BY THE ASSEMBLY OF THE CITY AND BOROUGH OF WRANGELL, ALASKA:

The Assembly hereby authorizes and directs the Borough Manager to make, accept and execute a loan agreement up to $322,650 for funding in the form of a loan through the State of Alaska Department of Environmental Conservation Clean Water Fund Wastewater Loan Program for the purpose of acquiring and installing a new ozone generator at the water treatment plant.

ADOPTED: January 24, 2017

David Jack, Mayor

ATTEST: Kim Lane, Borough Clerk

City & Borough of Wrangell
Incorporated Borough May 30, 2008
Incorporated City June 15, 1903
Alaska

Appendix J – Short Lived Assets

SHORT LIVED ASSET SCHEDULE, LISTING & REPLACEMENT COST

CITY OF WRANGELL, ALASKA **7-Jul-15**

FIVE YEAR REPLACEMENT ASSETS

Equipment	Unit	Quantity	Unit Cost	Total Cost
- Mechanical Blowers	each	3	$3,000	$9,000
- Gen-Eye Camera System	each	1	$15,200.00	$15,200
- Lift Station Submersible 7.6HP Pumps Start Kits	each	20	$550	$11,000
- SCADA Radios	each	5	$1,200	$6,000
Management				
- Computers & Software	each	1	$4,000	$4,000
- Copier/Printer	each	1	$1,000	$1,000
Total five year replacement budget				**$46,200**
Annual contribution				**$9,240**

TEN YEAR REPLACEMENT ASSETS

Equipment	Unit	Quantity	Unit Cost	Total Cost
- Building Interior Painting	ft2	2500	$2.50	$6,250
- Building Heater	each	1	$8,000.00	$8,000
- Crane on Pick-Up Truck	each	1	$6,200.00	$6,200
- Weather Tight Sampler	each	2	$6,500.00	$13,000
- CAT Excavator	each	1	$46,800.00	$46,800
- Sewer Dept. Utility Service Truck	each	1	$60,000	$60,000
- Sewer Dept. Truck	each	1	$32,000	$32,000
- Lift Station Submersible Pumps, 7.6 HP	each	10	$6,000	$60,000
- Duplex Grinder Pumps, 2 HP, Explosion Proof	each	2	$24,000	$48,000
- Simplex Grinder Pumps, 2HP	each	23	$2,100	$48,300
Total ten year replacement budget				**$328,550**
Annual contribution				**$32,855**

FIFTEEN YEAR REPLACEMENT ASSETS

Equipment	Unit	Quantity	Unit Cost	Total Cost
- Lift Stations' Pumps, 2 HP	each	2	$2,000	$4,000
- Lift Stations' Pumps, 3.5 HP	each	4	$2,500	$10,000
- Lift Stations' Pumps, 5 HP	each	6	$3,500	$21,000
- Lift Stations' Pumps, 25 HP	each	2	$6,500	$13,000
- 16' Mechanical Screen	each	1	$10,000	$10,000
Total fifteen year replacement budget				**$58,000**
Annual contribution				**$3,867**

TOTAL ANNUAL CONTRIBUTION, 5, 10 & 15 Yr Needs	**$45,962**

SHORT LIVED ASSET SCHEDULE, LISTING & REPLACEMENT COST

CITY OF WRANGELL, ALASKA
WATER SYSTEM
FIVE YEAR REPLACEMENT ASSETS

Equipment				
Copier/Printer	each	1	$450	$450
Total five year replacement budget				**$450**
Annual contribution				**$90**

TEN YEAR REPLACEMENT ASSETS

Equipment	Unit	Quantity	Unit Cost	Total Cost
Chlorine Cell	each	3	$12,000	$36,000
Transformer	each	1	$2,500	$2,500
Water Softening System	each	1	$500	$500
Valve repair parts	each	1	$250	$250
Flow Meter	each	1	$5,000	$5,000
Clearwell Pump Contactor	each	1	$1,500	$1,500
Turbidimeter	each	1	$2,900	$2,900
Computers and Software	each	2	$1,500	$3,000
Chemical Systems	ls	1	$10,000	$10,000
Backwash Pump	each	1	$8,000	$8,000
Air Scour Blower	each	1	$10,000	$10,000
Booster Pumps	each	2	$10,000	$20,000
Total ten year replacement budget				**$63,650**
Annual contribution				**$6,365**

FIFTEEN YEAR REPLACEMENT ASSETS

Equipment	Unit	Quantity	Unit Cost	Total Cost
Water Dept. Utility Service Truck	each	1	$60,000	$60,000
Water Dept. Truck	each	1	$30,000	$30,000
Laboratory Equipment	ls	1	$10,000	$10,000
Total fifteen year replacement budget				**$100,000**
Annual contribution				**$6,667**

TOTAL ANNUAL CONTRIBUTION, 5, 10 & 15 Yr Needs	**$13,122**