Report in completion of University of Alaska Anchorage
Civil Engineering Project CE 686

Evaluation of injection well efficacy to address saltwater intrusion in water supply wells at Hooper Bay, Alaska

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1. Abstract

Saltwater intrusion affects water quality in coastal water supply wells, increasing salinity in drinking water and thereby negatively impacting communities. Hooper Bay, AK is a community in west Alaska that has experienced relatively high salinity water in their water supply wells. Injection wells are evaluated here in an effort to provide a possible solution to further saltwater intrusion in Hooper Bay wells. Analytical modeling is utilized to perform the investigation. Steady-State 2D horizontal models provide potential placement, spacing, and pumping rates for the proposed injection wells.

2. Introduction

2.1. Hooper Bay Hydrogeologic Setting

To avoid confusion between Hooper Bay the city and the water body, the city will be referred to as Hooper Bay, and the water body will be referred to as Hooper Bay (bay).

The town of Hooper Bay, AK is located in coastal western Alaska. See Figure 1 for a location map. Hooper Bay has historically experienced water quality issues related to saltwater intrusion in its water supply wells. Water quality data was not available to this study due to its remote location.

The hydrogeology of Hooper Bay is not well defined. The town is located overlying Yukon-Kuskokwim Delta. Surficial sediments are predominantly composed of sand of varying grain sizes.

Permafrost is present in the subsurface overlying the screen interval of the water supply wells. Permafrost is considered to have very low permeability, and therefore aquifers underlying continuous permafrost are considered to be confined.

2.2. Saltwater Intrustion

Saltwater intrusion occurs in coastal areas where permeable formations exist. Freshwater ($\boldsymbol{\rho}$ = 1000 kg/m^3) is less dense than seawater ($\boldsymbol{\rho} \approx 1025 - 1035$ kg/m^3), and therefore freshwater floats on seawater. Seawater is driven inland by its hydraulic head. Groundwater supplied by infiltrating precipitation, rivers, and other water bodies flows toward the sea. The result is a wedge of saline groundwater that extends inland below the fresh groundwater some distance that depends on the aquifer characteristics and the flow of fresh groundwater (Bakker and Post, 2022).

In the absence of water supply well pumping, the saltwater wedge would extend inland some distance. See Figure 1 for a cross-section diagram of the situation. When the water supply wells are pumped, the wedge moves upward and inland toward the water supply wells due to the extraction of fresh water from the aquifer. See Figure 2 for a cross-section diagram. The proposed injection wells would push the saltwater wedge back toward the coast and down away from the screen of the water supply wells. See Figure 3 for a cross-section diagram.

2.3. Injection Wells

Injection wells are a method utilized to prevent saltwater intrusion to extraction wells (EPA, 1999). Injection wells are most commonly used to address saltwater intrusion in confined aquifers. The possible presence of continuous permafrost in Hooper Bay as a confining layer makes the prospect of applying injection wells to solve the issue of saltwater intrusion to water supply wells potentially feasible and promising.

3. Methods

3.1. Water Supply Well Drilling Logs

Drilling logs from the 2001 drilling of the water supply wells in Hooper Bay were reviewed to establish the site conceptual model. The logs include a limited amount of data and information on the aquifer sediments. The logs are provided in Appendix A.

3.2. Analytical Groundwater Models

Analytical groundwater models are developed to address the injection well system conceptual design. Analytical models are simpler than numerical models and require fewer input data. With the limited data available on the hydrogeology and water quality of Hooper Bay, the selection of analytical models is preferable due to the reduction of assumptions made in model construction.

The model selected for Hooper Bay is found in “Analytical Groundwater Modeling: Theory and Applications using Python” by Mark Bakker and Vincent Post. The model is adapted to reflect the hydrogeologic setting of Hooper Bay and the injection well system. The adaptations originate from the fundamental equations governing shallow confined interface flow as found in “Analytical Groundwater Mechanics” by Otto Strack.

A horizontal, steady-state, two-dimensional model is utilized to address the placement, spacing, and flowrate relative to extraction pumping for the proposed injection wells. The original model is found in "Analytical Groundwater Modeling: Theory and Applications using Python" as Section 7.5: A well in uniform background flow near the coast. The model constructs a flownet from the stream function and discharge potential within the aquifer. It also determines the discharge potential as a function of distance from the coast.

3.3. Model Assumptions

Several assumptions are made to simplify the problem and inform the models. The thickness of the aquifer is assumed to be near the bottom of the well boreholes. This has very little effect on the performance of the model or the conclusions drawn from it because if the aquifer is extended deeper, the saltwater does not change position at a given location.

The hydraulic conductivity is assumed to be 40 m/d, which is a common value used for sand (Fetter, 2001). The aquifer is assumed to be completely confined, which seems reasonable because the drilling logs indicate continuous permafrost. The uniform background flow toward the coast is assumed to be 0.5 m^2/d. This value was selected using parameter estimation based on model runs that provided a realistic saltwater wedge toe location in the absence of water supply well pumping (~400 m inland). The well nest was treated as a single well with a combined pumping rate as the wells are closely spaced relative to the distances to nearby seawater bodies.

4. Results and Discussion

4.1. Model Output Data Use Disclaimer

The analytical models used to evaluate the efficacy of injection wells at Hooper Bay are constructed with relatively sparse input data. For a final design of the system, further investigation would be necessary. Subsurface exploration would be required to determine the limits and continuity of the permafrost, the variability of the YK Delta sand, the depth to bedrock, and any other variations in the hydrogeology. Water quality data would be necessary to determine the actual position of the toe of the saltwater wedge and calibrate the model. Pump test data would be necessary to determine the hydraulic conductivity of the aquifer. The results of the model presented in this report should be considered rough estimates to guide further exploration, planning, and design.

4.2. Water Supply Well Critical Discharge

Pumping rates are evaluated for the five existing water supply wells and proposed injection wells in Hooper Bay. The 2020 census population of Hooper Bay was 1,375 (US Census Bureau, 2020). If the residents of Hooper Bay consumed water at the average rate in the United States,

~82 gallons per day (EPA, 2024), this would amount to roughly 78 gpm of demand in the community. Therefore roughly double that (150 gpm or 818 m^3/d) is likely a conservatively large estimate of pumping rate for the water supply wells.

The critical discharge for a well and a nearby water body is the discharge above which the well will capture water from that water body. The critical discharge to capture water from the Bering Sea is much greater (order of magnitude) than Hooper Bay (bay) as the distance between the wells and the coast is much greater. Therefore, the critical discharge related to Hooper Bay is considered the limiting discharge for the water supply wells.
At a pumping rate of 818 m^3/d or 150 gpm, the effect of pumping on the discharge potential along the axis from the water supply wells to the Bering Sea is minute. At that distance, the effect of pumping is minor compared to the effect of the background groundwater flow regime. For this reason, the only axis considered is the line from the water supply wells and Hooper Bay (bay).

4.3. Injection Well Placement

The placement of the injection wells between the water supply wells and Hooper Bay (bay) is roughly estimated. The factors affecting the placement of the wells include the distance between the injection and water supply wells, the distance between the injection well and Hooper Bay (bay), and the injection pumping rate. If the well doublet is too close together, then injection water will rapidly flow to the water supply wells. In the event that injection water is pumped from the river, a short hydraulic residence time in the subsurface could lead to a loss of filtration efficacy and contaminant breakthrough. The injection well should also be far enough away from Hooper Bay to allow for tidal fluctuations and account for sea level rise.

Given a pumping rate of 818 m^3/d or 150 gpm or 30 gpm/well, the optimal placement of the injection well is determined to be roughly $x_i = 0.353x$ where x is the distance between Hooper Bay (bay) and the water supply wells. See Figure 7 for model results. This provides a minimum of 0.5 km between the water supply wells and the injection well. Additionally, the minimum buffer between the injection well and Hooper Bay (bay) is 0.35 km.

4.4. Injection Well Pumping Rate

At this water supply well pumping rate and injection well placement, the injection well is determined to have an optimal pumping rate of $Q_i = -2Q/5$, where Q is the water supply well nest pumping rate. At this rate, the saltwater wedge is pushed back towards the coast. While -Q/5 would provide this condition, -2Q/5 provides a safety factor that would allow for tides and storms without pushing water back toward the water supply wells.

4.5. Injection Well Spacing

The spacing of the injection wells is roughly estimated using the width of the well discharge zone in the model. The width of the discharge zone of the injection well where the axis to Hooper Bay is shortest (850 m) is about 300 m. Making adjustments for a radial arrangement of the wells and the slightly wider discharge zone (due to longer axes to Hooper Bay), it is estimated that four injection wells would be needed to sufficiently protect the water supply wells from Hooper Bay. Proposed locations are provided in Figure 8.

4.6. Saltwater Infiltration

Hooper Bay is subject to periodic storm surge from the Bering Sea and resulting saltwater inundation. Injection wells are utilized to protect the water supply wells from saltwater intrusion that occurs underground. Infiltration of seawater from above the land surface is a separate issue that injection wells are not adequate to address. Further investigation and analysis of storm surge events would be required to provide the relative influence of these events on the water quality in Hooper Bay.

5. Conclusion

The efficacy of injection wells for addressing saltwater intrusion at water supply wells in Hooper Bay, AK is evaluated above. Analytical models were used to determine the critical discharge of water supply wells and proposed injection well placement, pumping rate, and spacing. The model output data are informed by a limited amount of input data and should be considered rough estimates pending further investigation and analysis. A four injection well system is estimated to be sufficient to remediate saltwater intrusion from Hooper Bay (bay). Well placement is recommended at x_i = 0.353x and injection pumping rate is recommended at Q_i = -2Q/5. Model results indicate saltwater intrusion from the Bering Sea is unlikely and injection wells are not proposed to the west of water supply wells.

6. References

Bakker, M. and Post, V. 2022. Analytical Groundwater Modeling: Theory and Applications. CRC Press/Balkema

EPA. 2024. WaterSense. Accessed 10/25/2024 at: https://www.epa.gov/watersense/statistics-and-facts

Fetter, C. 2001. Applied Hydrogeology. Prentic Hall, Inc.

Strack, O. 2017. Analytical Groundwater Mechanics. Cambridge University Press.

US Census Beaureau. 2020. Hooper Bay, Alaska. Accessed 10/25/2024 at: https://data.census.gov/all?q=Hooper%20Bay%20city,%20Alaska

7. Figures

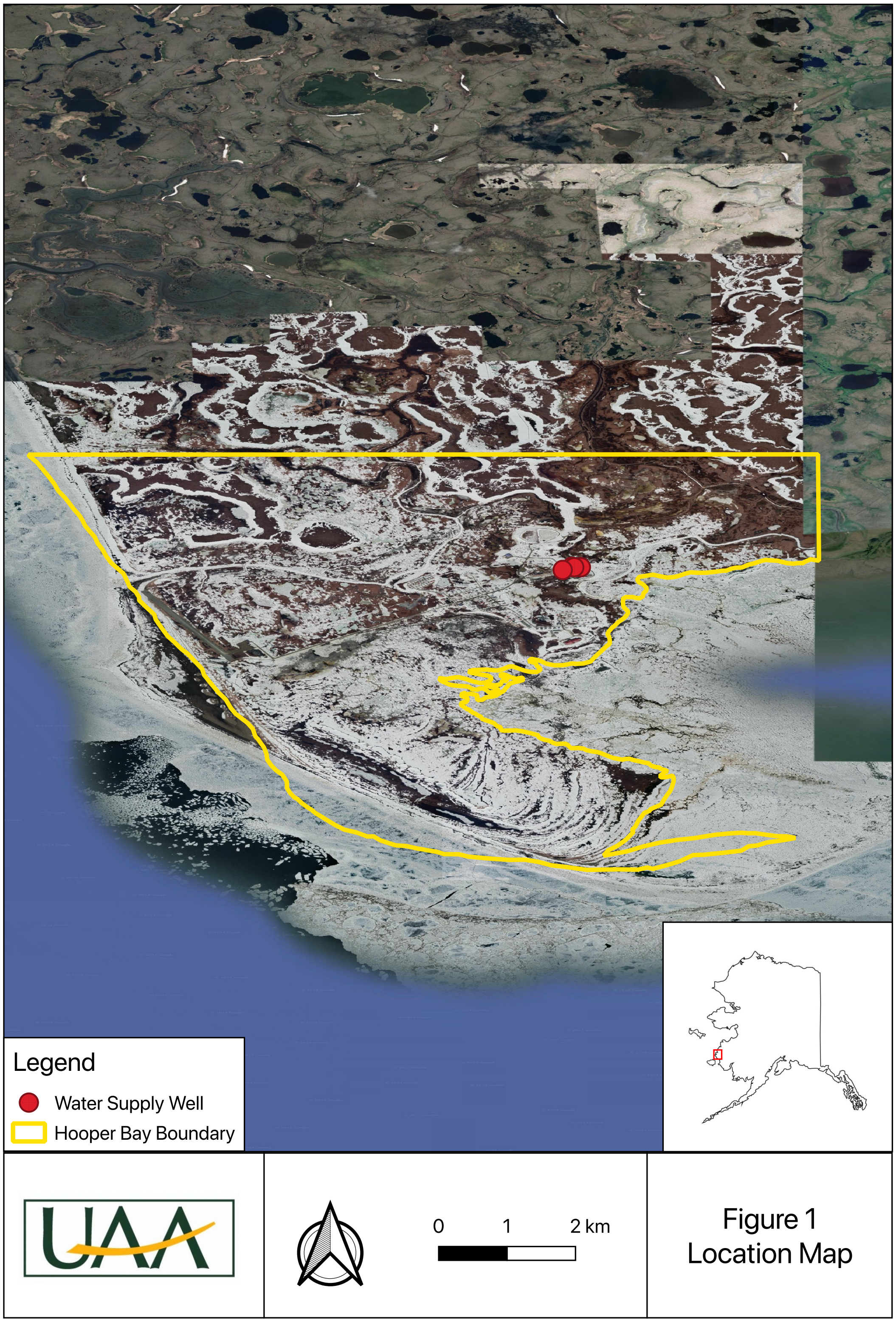

Figure 1
Location Map

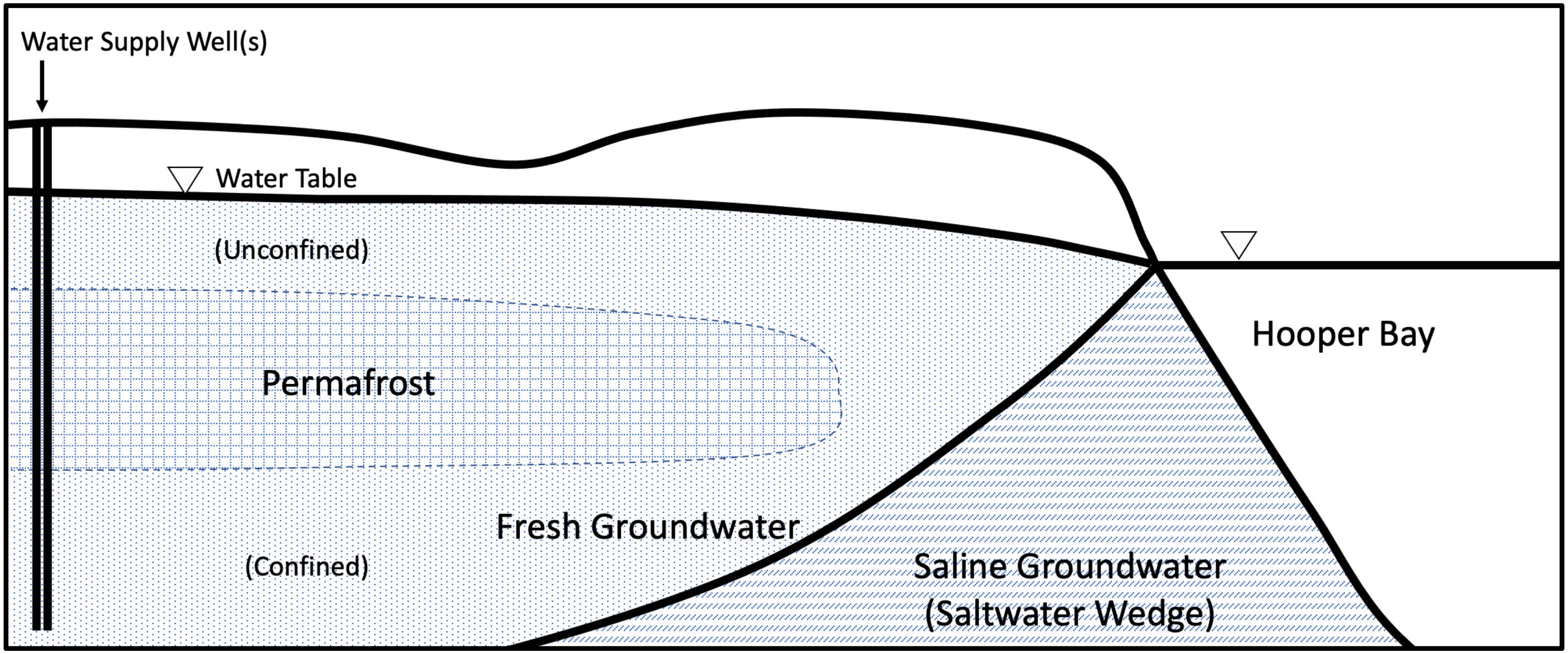

Figure 2 – Cross-section diagram of no water supply well pumping scenario along axis between the water supply wells and Hooper Bay (bay).

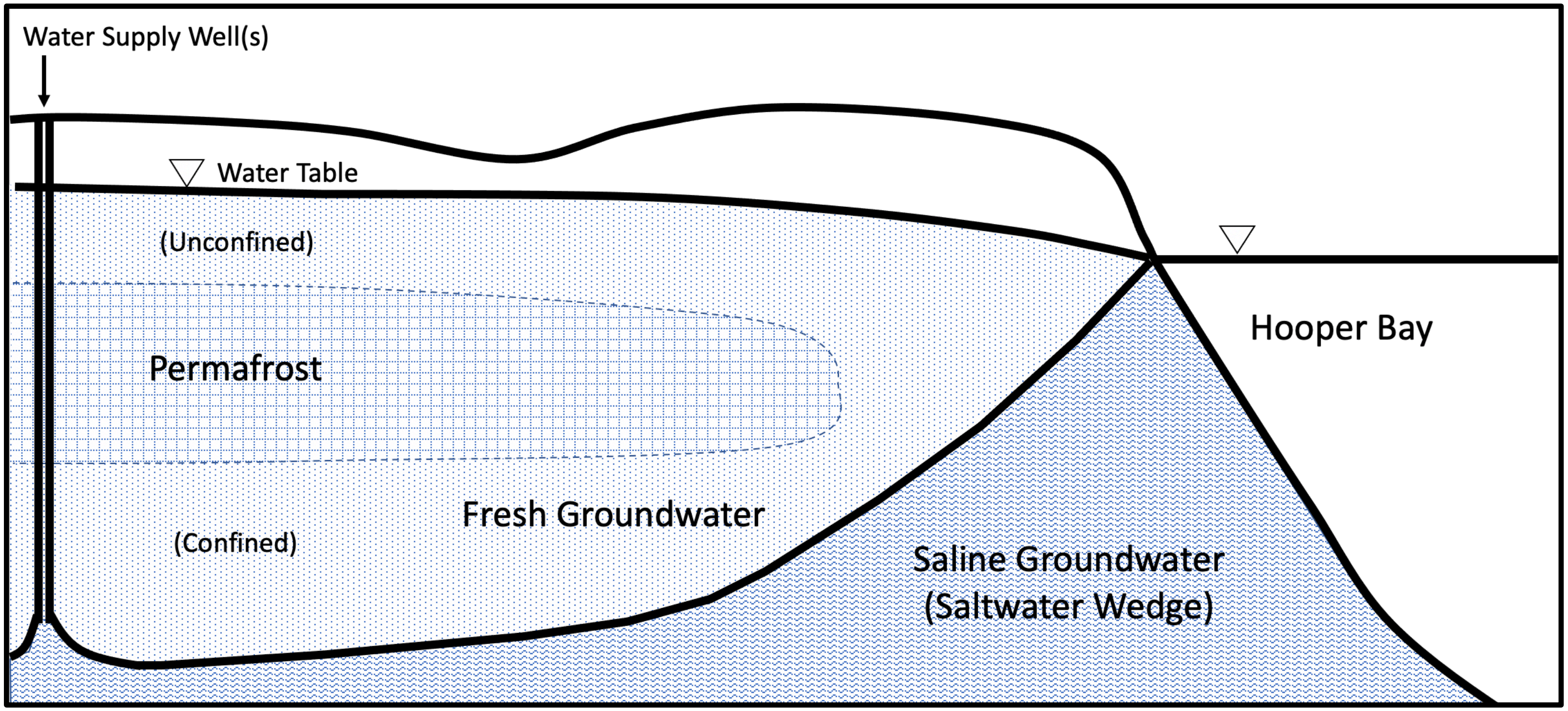

Figure 3 – Cross-section diagram of water supply well pumping scenario along axis between the water supply wells and Hooper Bay (bay).

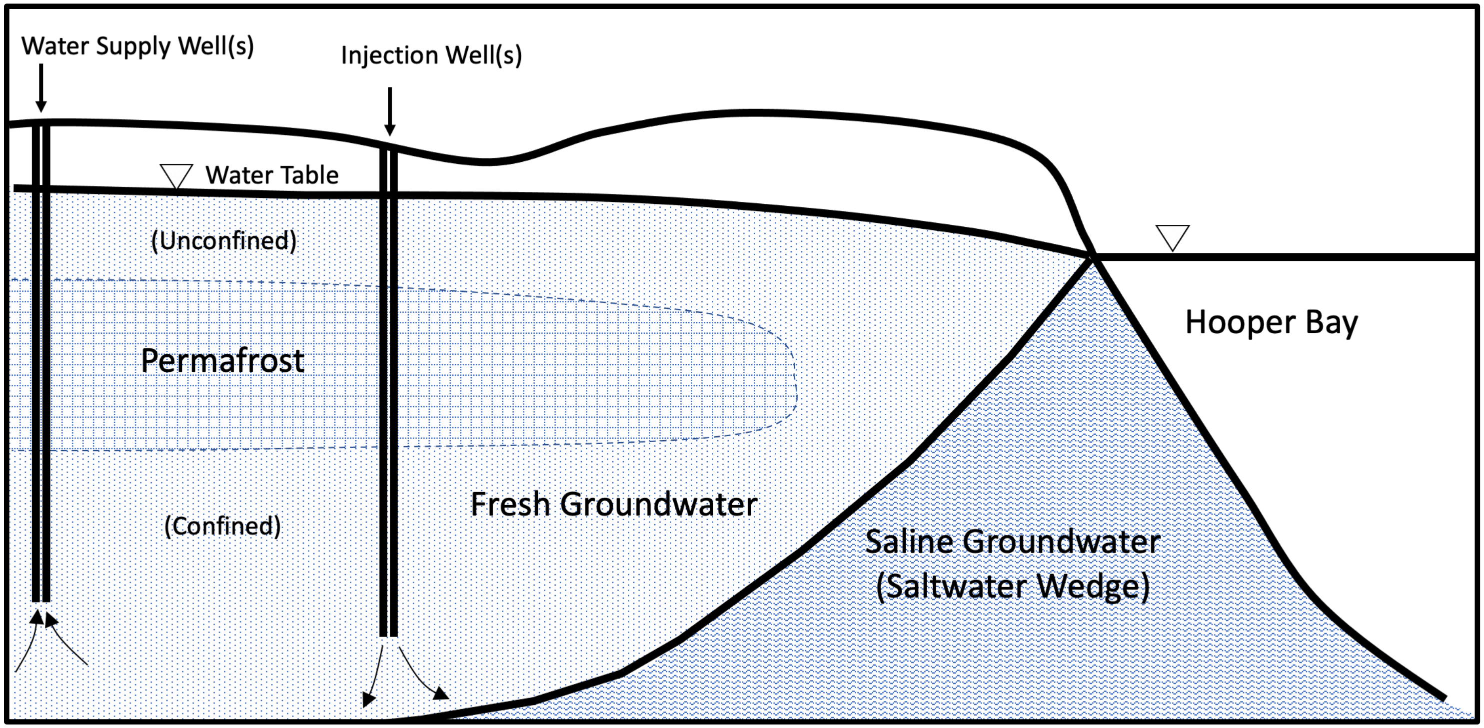

Figure 4 – Cross-section diagram of injection pumping scenario along axis between the water supply wells and Hooper Bay (bay).

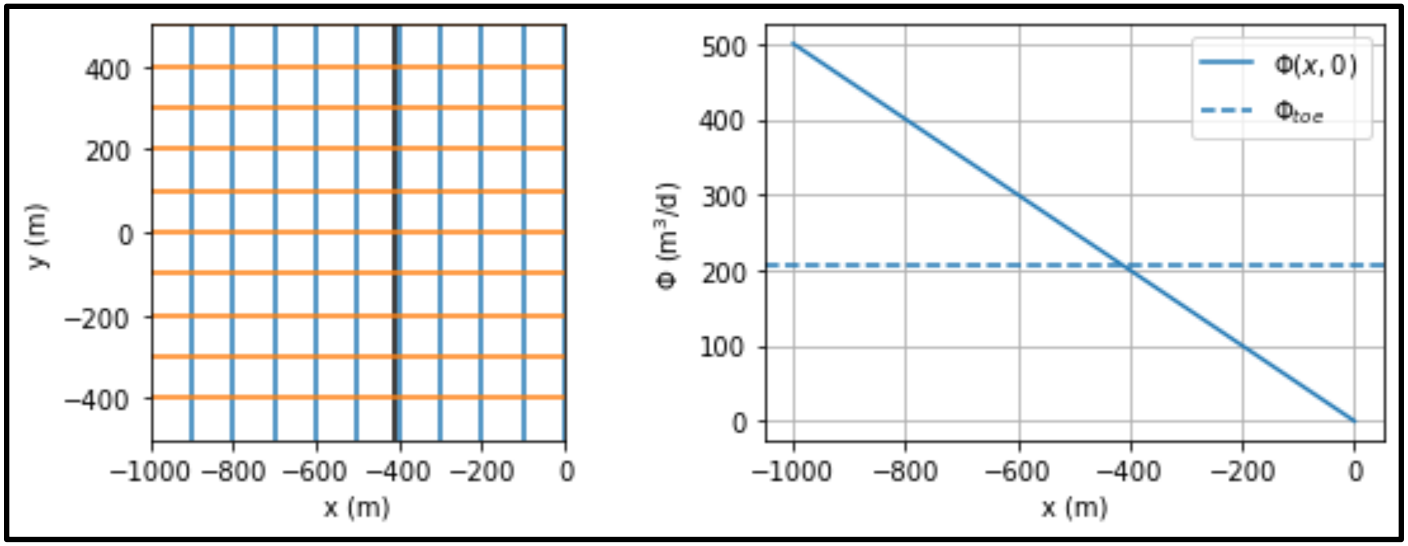

Figure 5 – Analytical Model Results for no water supply well pumping scenario. Compare to Figure 2.
Left: Flownet with equipotentials in blue, flowlines in orange, and location of saltwater wedge toe in black. Hooper Bay coastline at x = 0 m.
Right: Discharge potential along the axis from Hooper Bay to the water supply wells. Hooper Bay coastline at x = 0 m.

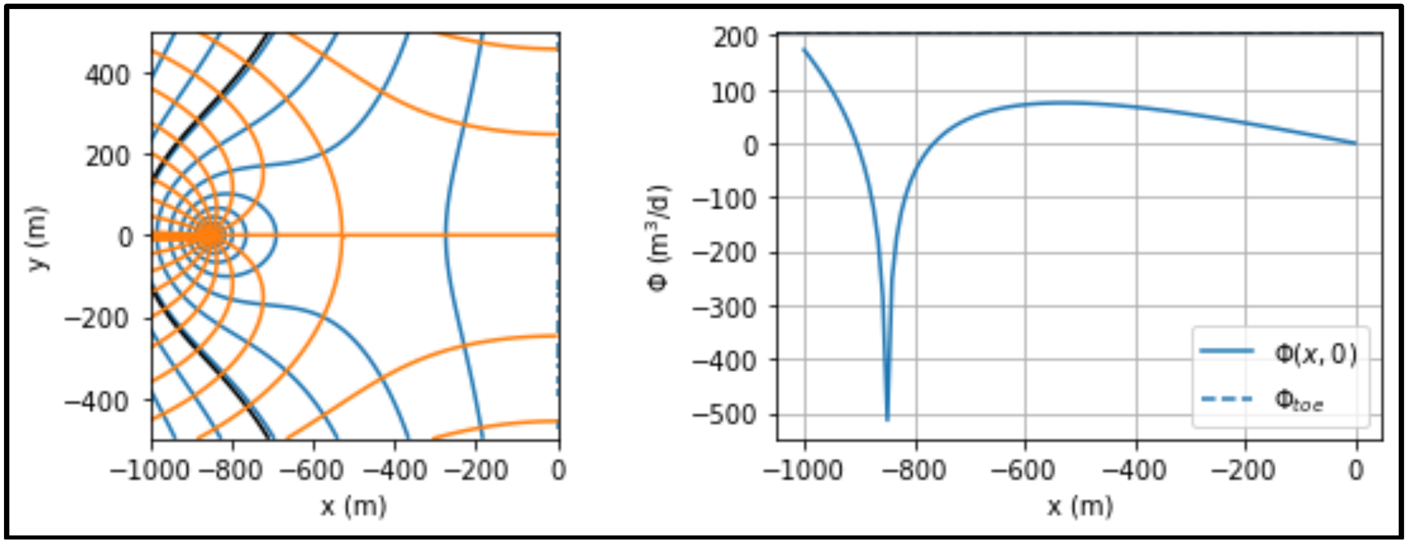

Figure 6 – Analytical Model Results for water supply well pumping scenario. Compare to Figure 3.
Q = 1200 gpm, x = 850 m with no injection well.
Left: Flownet with equipotentials in blue, flowlines in orange, and location of saltwater wedge toe in black. Hooper Bay coastline at x = 0 m.
Right: Discharge potential along the axis from Hooper Bay to the water supply wells. Hooper Bay coastline at x = 0 m.

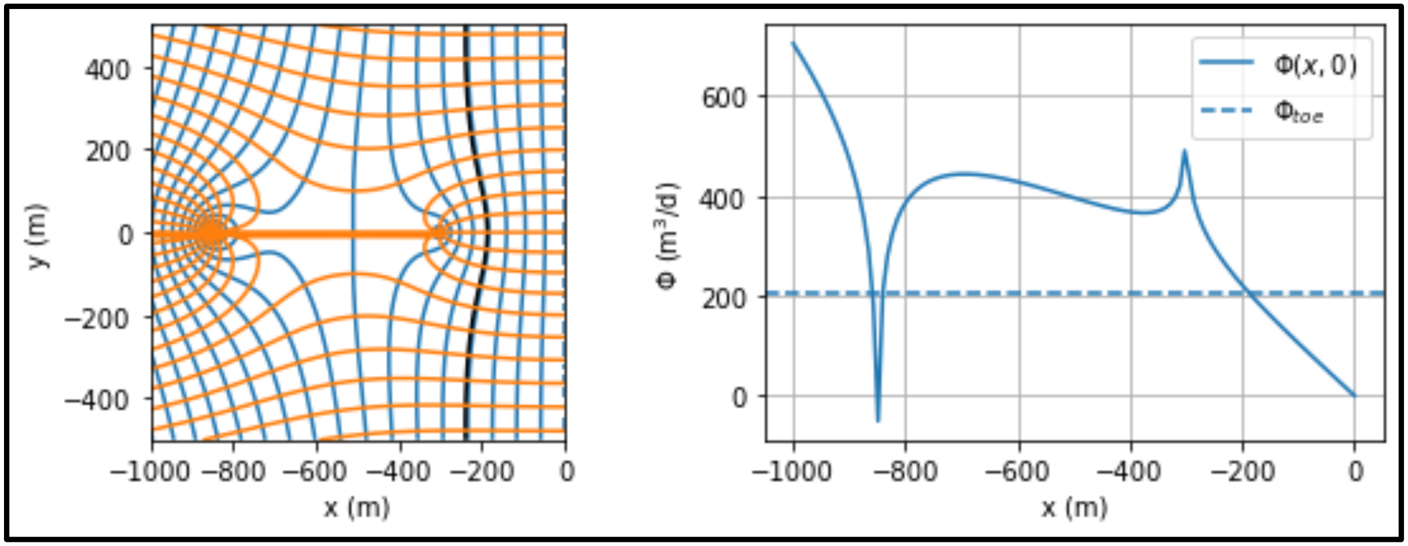

Figure 7 – Analytical Model Results for injection well scenario. Compare to Figure 4.
Q = 1200 gpm, Q_i = -2Q/5, x = 850 m, x_i = 0.353x.
Left: Flownet with equipotentials in blue, flowlines in orange, and location of saltwater wedge toe in black. Hooper Bay coastline at x = 0 m.
Right: Discharge potential along the axis from Hooper Bay to the water supply wells. Hooper Bay coastline at x = 0 m.

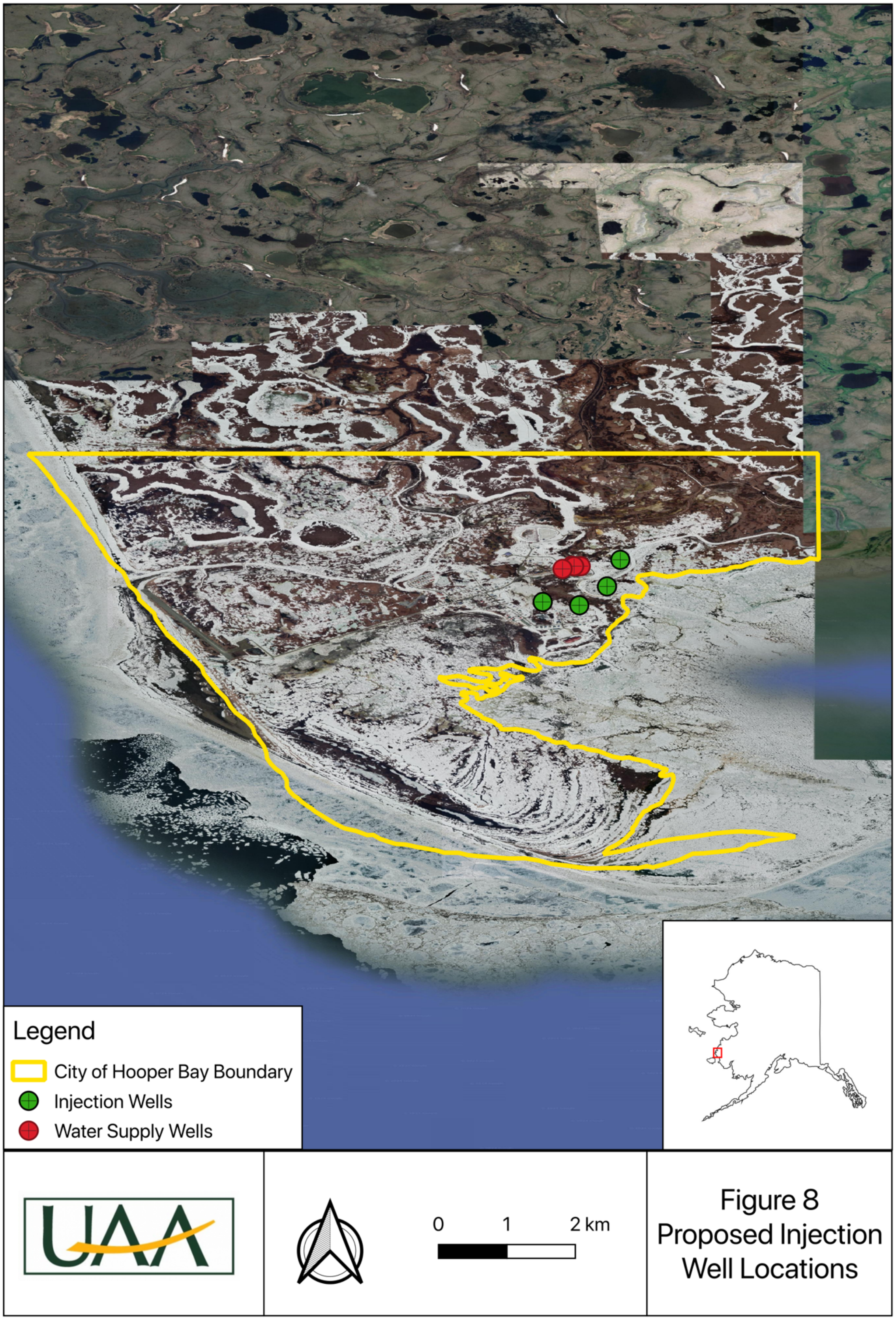

Figure 8
Proposed Injection Well Locations

Appendix A – Drilling Logs

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 10 / 03 / 2001, Completed: 10 / 08 / 2001

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Hooper Bay	U.S. Survey 4420	10	4	City of Hooper Bay, P.O. Box 29, Hooper Bay, AK 99604

Meridian Seward Township 17 N Range 93 W Section 26 , ___ 1/4 of ___ 1/4 of SE 1/4 of SW 1/4

BOREHOLE DATA: (from ground surface)

Material: Type, Color & wetness	Depth From	To
Topsoil	0	2'
Silt with a little dry brown clay	2'	16'
Water in fine gray sand	16'	25'
Water--fine sand	25'	28'
Frozen silt	28'	36'
Blue Permafrost	36'	62'
Blue Clay (not frozen)	62'	83'
Frozen blue silt	83'	103'
Water in fine and medium sand	103'	105'
Hard packed sand & rock (no water)	105'	115'
Water fine sand	115'	117'
Water fine sand/streaks of medium sand	117'	121'
Water fine sand	121'	122'
Fine sand very little water	122'	125'

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other ______
Well use: ☒ Public supply, ☐ Domestic, ☐ Other ______

Depth of hole: 124' 4" ft, Casing stickup: 3' ft
Casing type: Steel Thickness 0.322 inches
Casing diameter: 8 inches Casing depth 114' 11" ft
Liner type: NONE Diameter: ___ inches Depth: ___ ft
Note: ......

Static water (from top of casing): 2' ft on 10 / 08 / 2001
Pumping level & yield: 58' feet after 120 hours at 100 gpm
Recovery rate: ______ gpm, Method of testing: ______
Development method: surge & bail Duration: 18hours

Well intake opening type: ☐ Open end ☐ Open hole, Other ☐
☒ Screened; Start: 114' 11" ft, Stopped 124' 4" ft
Screen type: 10 slot Slot/mesh size 0.012 & 0.020
☐ Perforated; Start: ______ ft, Stopped ______ ft
Start: ______ ft, Stopped ______ ft
Gravel packed ☐ Yes ☒ No From ______ ft to ______ ft
Note: 1-5', 0.012 & 1-5', 0.020 screen with packer

Grout type: Bentonite Volume 200 pounds
Depth; from 10 ft, to 20 ft

Pump intake depth: ______ ft
Pump size ______ hp Brand name ______

Was well disinfected upon completion? ☒ Yes ☐ No
Method of disinfection: Sodium Hypochlorite Solution

Driller comments/ disclaimers: ......
Well No. W-01-5

Well driller name: Roy Longbotham, Jr.
Company name: R & L Drilling & Leasing
Mailing address: 18957 Avenue 318
City: Visalia State: CA Zip 93292
Phone number : (____) ____ - ____

Drillers signature:
Date: ___/___/______

Alaska state law requires that a copy of this well log be forwarded to the Department of Natural Resources within 45 days (AK statutes 38.05.020, 38.05.035, 41.08.020, 46.15.020 and AK regulations 11 AAC 93.140). Faxes are acceptable.

Alaska DNR, Division of Mining, Land and Water,
550 W 7th Avenue, Suite 1020
Anchorage, AK 99501-3562

Phone (907)269-8639 and fax (907)269-8947

If the well is within city limits, the City of Anchorage requires that a copy of this well log be forwarded to the city within 60 days and another copy of this log be forwarded to the owner of the property, on which the well is located, within 30 days.

City Permit Number: ______
Date of Issue: ___/___/______

Parcel Identification Number: ____-____-____

Is well located at approved permit location? Yes ☐ or No ☐

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 08 / 28 / 2001, Completed: 09 / 11 / 2001

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Hooper Bay	U.S. Survey 4420			City of Hooper Bay, P.O. Box 29, Hooper Bay, AK 99604

Meridian Seward Township 17 N Range 93 W Section 26 , ___ 1/4 of ___ 1/4 of SE 1/4 of SW 1/4

BOREHOLE DATA: (from ground surface) **Depth**

Material: Type, Color & wetness	From	To
Tundra	0	2'
Brown Clay and Silt	2'	32' 6"
Fine Sand and water	32' 6"	33'
Fine gray packed sand	33'	36'
Gray sand and Clay	36'	40'
Fine gray packed sand	40'	52'
Gray Clay and Silt	52'	81'
Brown Clay and Silt	81'	84'
Fine Sand and water	84'	84' 6"
Frozen Brown Clay	84' 6"	96'
Permafrost (blue)	96'	119'
Very fine sand & water w/wood chips	119'	133'
Fine, clean water sand	133'	137'
Coarser, clean water sand	137'	137' 6"
Fine, clean water sand	137' 6"	141'
Coarser, clean water sand	141'	144' 6"
Medium, clean water sand	144' 6"	147'
Fine, clean water sand	147'	151'
Fine Sand	151'	152'

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other ________
Well use: ☒ Public supply, ☐ Domestic, ☐ Other ________

Depth of hole: 151' 8" ft, Casing stickup: 3' ft
Casing type: Steel Thickness 0.322 inches
Casing diameter: 8 inches Casing depth 132' 6" ft
Liner type: NONE Diameter: ____ inches Depth: ____ ft
Note: ....

Static water (from top of casing): 8' 2" ft on 09 / 21 / 2001
Pumping level & yield: 46.5 feet after 70 hours at 75 gpm
Recovery rate: ________ gpm, Method of testing: ________
Development method: surge & bail Duration: 32.5 hours

Well intake opening type: ☐ Open end ☐ Open hole, Other ☐
☒ Screened; Start: 132' 6" ft, Stopped 151' 8" ft
Screen type: 10 slot Slot/mesh size 0.010
☐ Perforated; Start: ________ ft, Stopped ________ ft
Start: ________ ft, Stopped ________ ft
Gravel packed ☐ Yes ☒ No From ________ ft to ________ ft
Note: 20 ft of 0.010 screen with packer

Grout type: Bentonite Volume 200 pounds
Depth; from 10 ft, to 20 ft

Pump intake depth: ________ ft
Pump size ________ hp Brand name ________

Was well disinfected upon completion? ☒ Yes ☐ No
Method of disinfection: Sodium Hypochlorite Solution

Driller comments/ disclaimers: ....
Well No. W-01-3

Well driller name: Roy Longbotham, Jr.
Company name: R & L Drilling & Leasing
Mailing address: 18957 Avenue 318
City: Visalia State: CA Zip 93292
Phone number : (______) ______ - ______

Drillers signature:
Date: ____/____/________

Alaska state law requires that a copy of this well log be forwarded to the Department of Natural Resources within 45 days (AK statutes 38.05.020, 38.05.035, 41.08.020, 46.15.020 and AK regulations 11 AAC 93.140). Faxes are acceptable.

Alaska DNR, Division of Mining, Land and Water,
550 W 7th Avenue, Suite 1020
Anchorage, AK 99501-3562

Phone (907)269-8639 and fax (907)269-8947

If the well is within city limits, the City of Anchorage requires that a copy of this well log be forwarded to the city within 60 days and another copy of this log be forwarded to the owner of the property, on which the well is located, within 30 days.

City Permit Number: ________________
Date of Issue: ____/____/________

Parcel Identification Number: ______-______-______

Is well located at approved permit location? Yes ☐ or No ☐

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 08 / 10 / 1999, Completed: 08 / 16 / 1999

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Hooper Bay	U.S. Survey 4420	9		City of Hooper Bay, P.O. Box 29, Hooper Bay, AK 99604

Meridian Seward Township 17 N Range 93 W Section 26 , ____ 1/4 of ____ 1/4 of SE 1/4 of SW 1/4

BOREHOLE DATA: (from ground surface) Depth

Material: Type, Color & wetness	From	To
Brown Silt some clay	1'	19'
Silt & runny clay	19'	36'
Frozen Silt	36'	67'
Clay Not Froze	67'	101'
Ice	101'	115'
Cracks open water and ice	115'	122'
Fine sand & water	122'	144'
No water Hard Silt	144'	146'

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other ________
Well use: ☒ Public supply, ☐ Domestic, ☐ Other ________

Depth of hole: 144' 10" ft, Casing stickup: 3' ft
Casing type: Steel Thickness 0.322 inches
Casing diameter: 8 inches Casing depth 137' 10" ft
Liner type: NONE Diameter: ____ inches Depth: ____ ft
Note: ....

Static water (from top of casing): 13' 11" ft on 08 / 16 / 1999
Pumping level & yield: 95 feet after 3 hours at 50 gpm
Recovery rate: ________ gpm, Method of testing: ________
Development method: surge & bail Duration: 3 hours

Well intake opening type: ☐ Open end ☐ Open hole, Other ☐
☒ Screened; Start: 137' 10" ft, Stopped 144' 10" ft
Screen type: 10 slot Slot/mesh size 0.010 & 0.015
☐ Perforated; Start: ________ ft, Stopped ________ ft
Start: ________ ft, Stopped ________ ft
Gravel packed ☐ Yes ☒ No From ________ ft to ________ ft
Note: 1-5', 0.010 & 1-5', 0.015 screen with packer

Grout type: Bentonite Volume 200 pounds
Depth; from 10 ft, to 20 ft

Pump intake depth: ________ ft
Pump size ________ hp Brand name ________

Was well disinfected upon completion? ☒ Yes ☐ No
Method of disinfection: Sodium Hypochlorite Solution

Driller comments/ disclaimers: ....
Well No. W-99-2

Well driller name: Roy Longbotham, Jr.
Company name: R & L Drilling & Leasing
Mailing address: 18957 Avenue 318
City: Visalia State: CA Zip 93292
Phone number: (____) ____-____

Drillers signature:

Date: ____/____/________

Alaska state law requires that a copy of this well log be forwarded to the Department of Natural Resources within 45 days (AK statutes 38.05.020, 38.05.035, 41.08.020, 46.15.020 and AK regulations 11 AAC 93.140). Faxes are acceptable.

Alaska DNR, Division of Mining, Land and Water,
550 W 7th Avenue, Suite 1020
Anchorage, AK 99501-3562

Phone (907)269-8639 and fax (907)269-8947

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City Permit Number: ________________
Date of Issue: ____/____/________

Parcel Identification Number: ______-________-________

Is well located at approved permit location? Yes ☐ or No ☐

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 07 / 31 / 1999, Completed: 08 / 09 / 1999

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Hooper Bay	U.S.Survey 4420			City of Hooper Bay, P.O. Box 29, Hooper Bay, AK 99604

Meridian Seward Township 17 N Range 93 W Section 26 , ____ 1/4 of ____ 1/4 of SE 1/4 of SW 1/4

BOREHOLE DATA: (from ground surface)

Material: Type, Color & wetness	Depth From	To
Brown Silt (fine) w/ some clay	0	38'
Grey Silt (fine) and Clay	38'	62'
Grey Clay	62'	74'
Grey Clay and Silt (fine)	74'	80'
Brown Silt (fine)	80'	86' 6"
Grey Clay and Silt (fine)	86' 6"	115'
Non-bearing water sand	115'	124'
Hard Formation	124	126' 6"

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other ________
Well use: ☒ Public supply, ☐ Domestic, ☐ Other ________

Depth of hole: 126.5 ft, Casing stickup: 3' 2" ft
Casing type: Steel Thickness 0.322 inches
Casing diameter: 8 inches Casing depth 119.5 ft
Liner type: NONE Diameter: ____ inches Depth: ____ ft
Note: ....

Static water (from top of casing): 13 ft on 08 / 04 / 1999
Pumping level & yield: 83 feet after 36 hours at 41 gpm
Recovery rate: ________ gpm, Method of testing: ________
Development method: surge & bail Duration: 48hrs

Well intake opening type: ☐ Open end ☐ Open hole, Other ☐
☒ Screened; Start: 119.5 ft, Stopped 126.5 ft
Screen type: 10 slot Slot/mesh size 0.010
☐ Perforated; Start: ________ ft, Stopped ________ ft
Start: ________ ft, Stopped ________ ft
Gravel packed ☐ Yes ☒ No From ________ ft to ________ ft
Note: 2-8" x 5 ft screens w/ packer

Grout type: Bentonite Volume 200 pounds
Depth; from 10 ft, to 20 ft

Pump intake depth: ________ ft
Pump size ________ hp Brand name ________

Was well disinfected upon completion? ☒ Yes ☐ No
Method of disinfection: Sodium hypochlorite Solution

Driller comments/ disclaimers: ....
Well No. W-99-1

Well driller name: Roy Longbotham, Jr.
Company name: R & L Drilling & Leasing
Mailing address: 18957 Avenue 318
City: Visalia State: CA Zip 93292
Phone number : (______) ______-______

Drillers signature:
Date: ____/____/______

Alaska state law requires that a copy of this well log be forwarded to the Department of Natural Resources within 45 days (AK statutes 38.05.020, 38.05.035, 41.08.020, 46.15.020 and AK regulations 11 AAC 93.140). Faxes are acceptable.

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Anchorage, AK 99501-3562

Phone (907)269-8639 and fax (907)269-8947

If the well is within city limits, the City of Anchorage requires that a copy of this well log be forwarded to the city within 60 days and another copy of this log be forwarded to the owner of the property, on which the well is located, within 30 days.

City Permit Number: ________
Date of Issue: ____/____/______

Parcel Identification Number: ____-______-______

Is well located at approved permit location? Yes ☐ or No ☐

40138

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
WATER WELL LOG

Drilling Started: 09 / 12 / 2001, Completed: 10 / 02 / 2001

City/Borough:	Subdivision:	BLOCK	LOT	Property Owner Name & Address:
Hooper Bay	U.S. Survey 4420	6	2	City of Hooper Bay, P.O. Box 29, Hooper Bay, AK 99604

Meridian Seward Township 17 N Range 93 W Section 26, ____ 1/4 of ____ 1/4 of SE 1/4 of SW 1/4

BOREHOLE DATA: (from ground surface) Material: Type, Color & wetness	Depth From	To
Grass and Tundra	0	2'
Brown Clay and Silt	2'	18'
Fine gray silt	18'	37'
Permafrost	37'	45'
Frozen gray Clay	45'	57'
Fine gray packed sand	40'	57'
Frozen gray clay and silt	57'	64'
Thawed gray clay	64'	88'
Blue Permafrost	88'	135'
Fine, non bearing water sand	135'	137'
Fine, water bearing sand	137'	142'
Medium, water bearing sand	142'	146'
Fine, gray pack sand	146'	159'

Drilling method: ☐ Air rotary, ☒ Cable tool ☐ Other ____
Well use: ☒ Public supply, ☐ Domestic, ☐ Other ____

Depth of hole: 149' 4" ft, Casing stickup: 3' ft
Casing type: Steel Thickness 0.322 inches
Casing diameter: 8 inches Casing depth 144' 4" ft
Liner type: NONE Diameter: ____ inches Depth: ____ ft
Note: ....

Static water (from top of casing): 3' 1" ft on 10 / 02 / 2001
Pumping level & yield: 78'2" feet after 96 hours at 45 gpm
Recovery rate: ____ gpm; Method of testing: ____
Development method: surge & bail Duration: 14 hours

Well intake opening type: ☐ Open end ☐ Open hole, Other ☐
☒ Screened; Start: 144' 4" ft, Stopped 149' 4" ft
Screen type: 10 slot Slot/mesh size 0.012
☐ Perforated; Start: ____ ft, Stopped ____ ft
Start: ____ ft, Stopped ____ ft
Gravel packed ☐ Yes ☒ No From ____ ft to ____ ft
Note: 5 ft of 0.012 screen with packer

Grout type: Bentonite Volume 200 pounds
Depth; from 10 ft, to 20 ft

Pump intake depth: ____ ft
Pump size ____ hp Brand name ____

Was well disinfected upon completion? ☒ Yes ☐ No
Method of disinfection: Sodium Hypochlorite Solution

Driller comments/ disclaimers: ....
Well No. W-01-4

Well driller name: Roy Longbotham, Jr.
Company name: R & L Drilling & Leasing
Mailing address: 18957 Avenue 318
City: Visalia State: CA Zip 93292
Phone number: (____) ____-____

Drillers signature:
Date: ___/___/___

Alaska state law requires that a copy of this well log be forwarded to the Department of Natural Resources within 45 days (AK statutes 38.05.020, 38.05.035, 41.08.020, 46.15.020 and AK regulations 11 AAC 93.140). Faxes are acceptable.

Alaska DNR, Division of Mining, Land and Water,
550 W 7th Avenue, Suite 1020
Anchorage, AK 99501-3562

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