CE2 Engineers, Inc.

TECHNICAL MEMORANDUM

TO: Susan Randlett, P.E., Village Safe Water Engineer

FROM: Paul Weisner, P.E.

SUBJECT: Chefornak Pump House 1 Design Issues

DATE: December 16, 2014

This memorandum describes the background and rationale for the selection of micropiles for the Pump House 1. It will also discuss the logistics of micropile installation, avoidance of demolition of part of existing pump house by changing building shape, and the impact of a GWUDISW determination of ADEC Drinking water on the existing City Well.

Micropile Selection Rationale for Foundation System

CE2 Engineers obtained the services of Golder Associates to perform a field assessment of subsurface conditions at the sites of Pump Houses 1 and 2 in August of 2014, and to make recommendations for a foundation system for the proposed pump houses. Golder found discontinuous permafrost on the sites, with a large thawed area outside of the footprint of the existing foundation.

Because of these large areas of thawed soil next to frozen areas, it was determined that they were not conducive to a Triodetic foundation system because of the possibility of major differential settlements, which could cause a tilted structure.

We looked into helical pier foundations because of the relative ease in which they could be installed. The problem at Chefornak is that the area has many buried lava boulders, so that there was no assurance that we would be able to set the anchors deep enough for anchor integrity.

Golder's experience with freeze-back piles is extensive in Chefornak and western Alaska, with work done on the school and power plant foundations. On the power plant foundation, every pile installed encountered different conditions. Some piles could be drilled down in the silty soil without any problem, and others required drilling through boulders encountered in the subsoil above the lava flow bedrock. The freeze-back pile system has worked satisfactorily, but these piles were specified for relatively large loads, encountered on buildings like a school or power plant. For a small project like Pump House 1, drilled piles with freeze-back would be overkill and too expensive.

Golder's recommendation for a foundation system are micropiles, consisting of 6-in pipe driven to the top of the underlying bedrock (lava flow), where it becomes an end bearing pile. Into the inner space of the pile is a hole drilled into bedrock and fitted with a specialized threaded

anchor rod that is grouted into the bedrock. This rod projects to the top of the pile. When the micropile is proof tested, the threaded anchor rod is pulled upward at 40 kips (40,000 lb) and the hydraulic cylinder pushing upward on the rod pushes downward on the pipe in the ground. In this way, the proof test simulates 40 kips frost uplift and 40 kps building load on the pile. The rod is then fastened to the top of the pipe pile where it can restrain uplift from frost heave.

Frost heave is the governing force in the design of the pile system for Pump House 1. Assuming an ice bond strength of 40 psi to the steel pipe pile, a depth of active layer frost of 4 feet, and a 6.625 inch outside diameter pipe pile, the uplift forces are calculated to be:

F_U = (40 lb/in^2)*(6.625 in*π)*48 in = 39,960 lb ≈ 40 Kips

Loading on the piles of Pump House 1 will be typically 12.5 Kips, so uplift forces due to frost heave governs the pile design.

Another advantage of micropiles is that the ground is not disturbed except for where the pile is driven into the ground, so disturbance to possible archaeological areas on the surface is almost nonexistant.

Micropile Installation Logistics

The drilling equipment used for 6 in steel micropile installations can be moved in a Casa or similar cargo aircraft with a 5,000 lb payload. The drills are light enough to be moved through Chefornak boardwalks, though they may need some matting to prevent damage to the boardwalk.

The largest freight cost will be pipe. Assuming schedule 40 steel pipe, installing piles for the Washeteria, Pump House 1 and Pump House 2 will require about 53 piles, say 40 ft long each, or about 40,000 lb of pipe. To keep costs down, then all pile materials should be barged on the first available barge to Chefornak in Summer 2015. Drills can be flown in and out in the same season.

Construction will have to be done in the summer and through the late fall, if drilling equipment and pile pipe are not flown in early in the spring to speed up construction.

Existing Pump House Issues

Figure 2 (attachment) shows a site plan of Lot 7 Block 2 where the existing pump house is located. This City-owned lot is the only practical location for a new Pump House 1. All surrounding land is privately owned under restricted deed. The existing water source is the City well and will have to continue as the water source for the new Pump House 1. Consequently, Lot 7 Block 3, owned by the City, is the only practical location for the new pump The existing well location is fixed, and if the existing pump house remains, then there is only one location for the new pump house—between the well and the existing pump house.

However, there are some major consequences of this location:

1. Assuming a building size of 20x24, 20x28, or even 18x24, this puts the separation distance between the buildings at 2 to 4 ft, or 1 to 2 ft to an imaginary lot line midway between the buildings. According to Table 602 of the 2009 International Building Code, a two-hour rated exterior wall will be required on the walls facing each other. That means that the north wall of the original pump house will have to be modified with two layers of sheet rock, mudded and taped on both sides to satisfy this requirement. Actual improvements to the existing pump house for fire rating will depend upon the occupancy rating for the building, and will require some careful study in order for the building to meet code requirements.
2. The roof of the original pump house drains down to the north, so it will drain rain and drop snow onto the new Pump House 1, or between the two pump houses, which under winter conditions will develop a destructive ice lens between the buildings. Roofs can be modified to mitigate this problem, but that is significant added expense.
3. The original pump house, if modified and approved by the Fire Marshal, will have restrictions on storage and use of this structure. If this structure catches fire, with no sprinklers and lack of effective fire fighting capability, there is a strong possibility that this structure will burn to the ground and take the new Pump House with it. If an investigation after a fire determines that items stored in the structure were not approved in the Fire Marshal Plan Review, there is a strong chance that the building insurance will not cover the loss. There are reasons why building codes require separation of buildings on properties.

It is my engineering opinion that the original pump house is more of a liability than an asset to the City of Chefornak where it is now located. It is suggested that the new Pump House 1 be constructed and after it is commissioned and on line, then the original pump house be removed from the property. A reasonable method to achieve this would be to jack the building up and put two parallel steel beams like sled runners underneath the side walls, and reinforce with cross beams—in effect, to build a skid underneath the building. The steel skid can be fabricated in Anchorage or Seattle in the spring, then hauled on the barge disassembled, then bolted together on site. In the fall, after the ground freezes up, the entire building can be skidded with the Project D-8 bulldozer to a site where the old building can be reused by the City.

Proposed Pump House 1 Size Considerations

The footprint of proposed Pump House 1, as discussed above, is constrained by available open land on the lot where the well and existing pump house is located. The ultimate dimensions of Pump House 1 will be determined by whether the existing City well is determined to be true ground water, or ground water under the direct influence of surface water. (GWUDISW) A true groundwater well will require about a 20x24 building, which will give adequate access to equipment for operations and maintenance.

If it is determined that the well is GWUDISW, then more filtration equipment will be required to meet water quality regulations, and the footprint will be more near 20x28, as shown in Figure 1 (attached).

Determination of Whether City Well is GW or GWUDISW

The size of Pump House 1 will be determined by whether the City Well is GW or GWUDISW. This determination will drive the design of the new pump house, and the size of the building as well as the type of filtration equipment needed to treat the well water will await the determination by ADEC Division of Drinking Water of the classification of the well water.

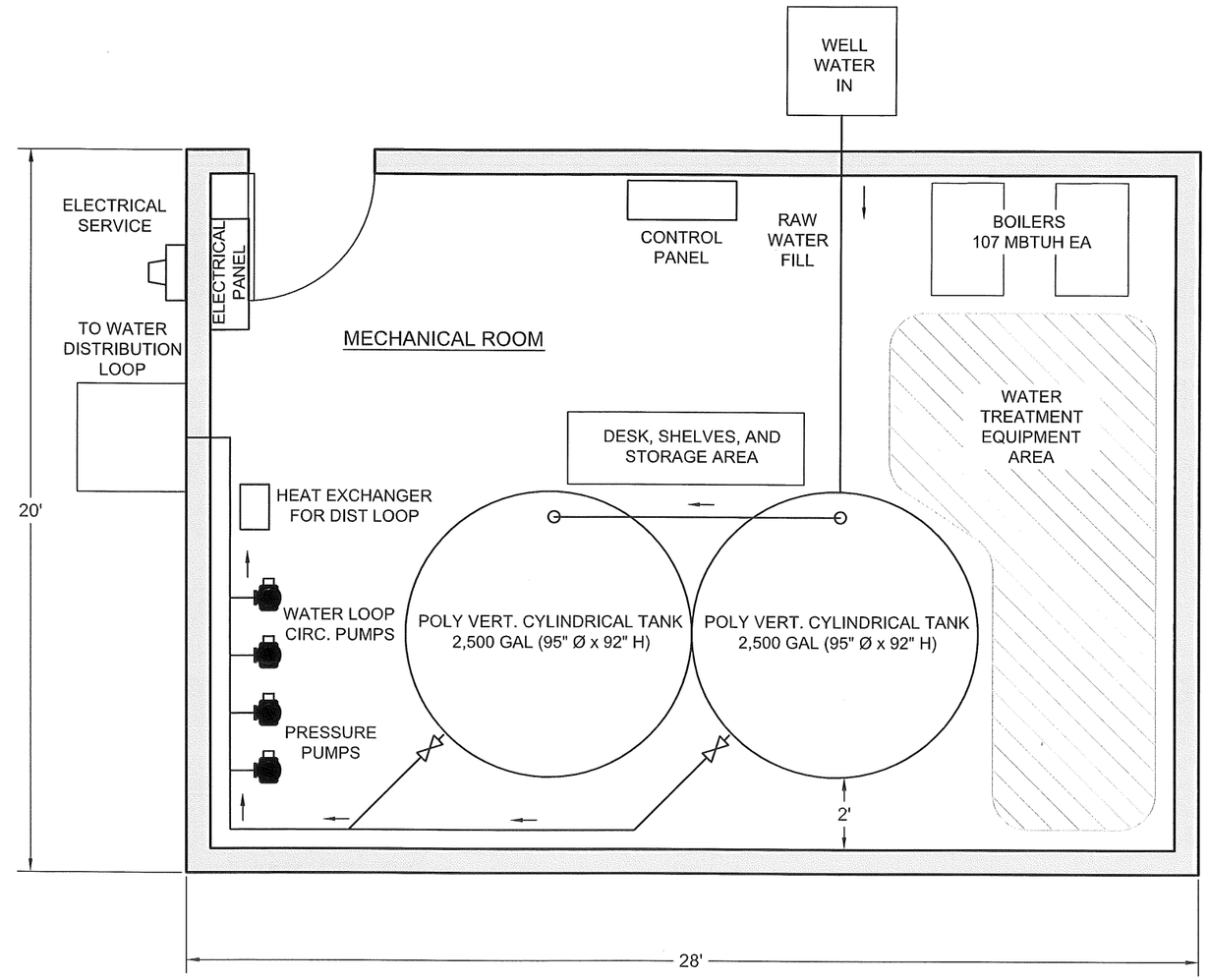
cc. George Wilson, P.E., Village Safe Water
Greg Magee, P.E., Village Safe Water
John Johnson, Village Safe Water
Robert Jimmie, City Administrator, City of Chefornak

Attachments: Figure 1 - Proposed Pump House 1 Conceptual Floor Plan
Figure 2 – Proposed Pump House 1 Site Plan

PROPOSED PUMP HOUSE DESCRIPTION

THE TWO PROPOSED PUMP HOUSES WOULD PROVIDE THE NECESSARY INFRASTRUCTURE THAT WOULD SUPPORT THE ORIGINAL PHS WELL IN THE NORTHEAST CORNER OF THE COMMUNITY, AS WELL AS THE TWO WELLS IN THE SOUTH PART OF THE COMMUNITY DRILLED IN 2002. FEATURES OF THE PROPOSED PUMP HOUSES INCLUDE THE FOLLOWING:

- THE BUILDING WOULD BE CONSTRUCTED OF STRUCTURAL INSULATED PANELS (SIP) FOR HIGH INSULATION VALUE, AS WELL AS RAPID ERECTION OF THE BUILDING SHELL.
- THE BUILDING FOUNDATION WOULD BE A TRIODETIC® SPACE FRAME ON THE TUNDRA. THIS SPACE FRAME WOULD EVENLY DISTRIBUTE THE BUILDING LOAD EVENLY OVER THE GROUND SURFACE WITHOUT THE EXPENSE OF DRILLING AND SETTING PILES.
- AN HDPE ELLIPTICAL HORIZONTAL LEG TANK OF 4,000 GALLONS CAPACITY WOULD PROVIDE A BUFFER BETWEEN THE WELLS AND THE WATER DISTRIBUTION SYSTEM. THIS TANK WAS SELECTED TO PROVIDE A LARGER FOOTPRINT FOR LOWER FLOOR LOADING, AS WELL AS A LOWER TANK HEIGHT TO ALLOW FOR A LOWER CEILING HEIGHT WITH SUBSEQUENT BUILDING COST SAVINGS.
- WATER FROM WELLS WOULD ENTER THE BUILDING AND BE FILTERED, CHLORINATED, AND WOULD FLOW INTO THE WATER STORAGE TANK. A SEPARATE ROOM WOULD PROVIDE FOR CHLORINATION. LEVEL CONTROLS IN THE TANK WOULD CONTROL THE WELL PUMP, AND WOULD PROTECT PRESSURE PUMPS FROM DRY RUNNING.
- TWO PRESSURE PUMPS WOULD PROVIDE PRESSURIZATION OF THE COMMUNITY WATER DISTRIBUTION LOOP THAT FEEDS THE WATERING POINTS AND THE SCHOOL.
- TWO CIRCULATION PUMPS NEXT TO THE PRESSURE PUMPS PROVIDE CIRCULATION OF THE WATER DISTRIBUTION LOOPS, ALONG WITH OTHER CIRCULATION PUMPS IN THE OTHER PUMP HOUSE AND IN THE MECHANICAL AREA OF THE WASHETERIA.
- HEAT WOULD BE PROVIDED THROUGH TWO OIL-FIRED CONDENSING BOILERS FOR THE BUILDING SPACE, WELL HEAT, AND BACKUP HEAT OF THE WATER DISTRIBUTION LOOP. THERE IS ALSO THE POSSIBILITY OF USING WASTE HEAT FROM THE POWER PLANT FOR SOME LOW LEVEL HEATING OF WATER IN THE PUMP HOUSE. THIS WILL HAVE TO BE LATER INVESTIGATED.
- ELECTRIC POWER FOR THE PUMP HOUSE WOULD BE PROVIDED FROM THE VILLAGE POWER PLANT DISTRIBUTION SYSTEM.
- A SIMPLE CONTROL PANEL WOULD PROVIDE AUTOMATIC CONTROL OF THE PUMP HOUSE FUNCTIONS, MONITORING OF THE CRITICAL OPERATIONAL PARAMETERS OF THE PUMP HOUSE AND WELLS, WITH MANUAL OPERATING BACKUP.



NOT REVIEWED

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Scale: 1/4" = 1'-0"
Date: DEC. 2014
Drawn: CM

PROPOSED PUMP HOUSE #1

CHEFORNAK, ALASKA

FIGURE 1

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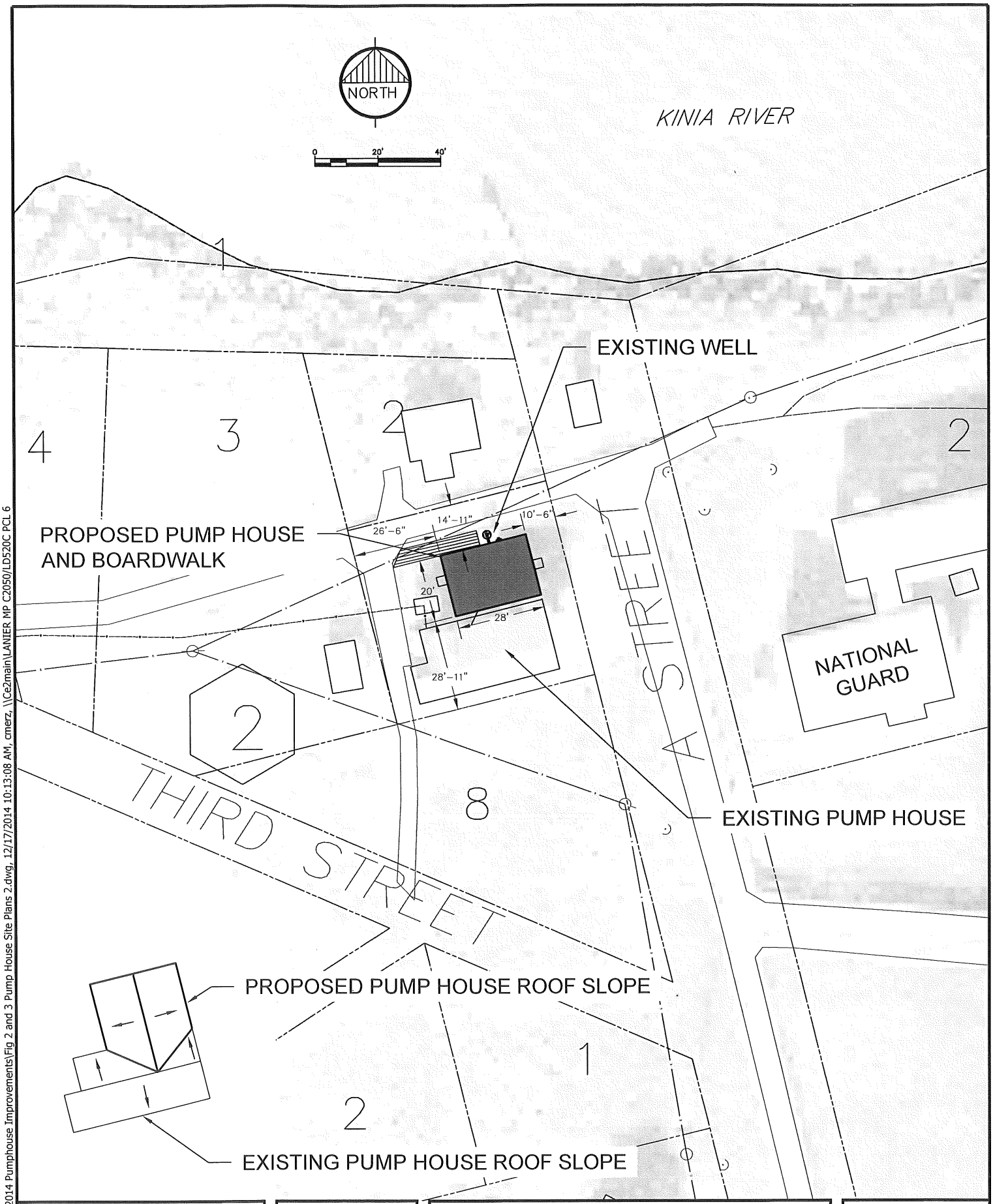

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Scale: 1" = 40'
Date: DEC. 2013
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PROPOSED PUMP HOUSE #1
SITE PLAN
LOT 7, BLOCK 2
CHEFORNAK, ALASKA

FIGURE 2

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