February 2018

Prepared for:

Chefornak Traditional Council

Attention: Bernadette Lewis

101 Complex Drive

City of Chefornak Site Observation Report

Project No. 181012

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PND Project No. 181012

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ENGINEERS, INC.

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1.0 INTRODUCTION

At the request of the Chefornak Tribal Council and based on discussions with representatives from the Bureau of Indian Affairs (BIA) and Alaska Native Tribal Health Consortium (ANTHC), a visit to the community of Chefornak was conducted by PND Engineers in preparation for the upcoming agency meeting to be held on February 21st in Anchorage. The purpose of this visit was to validate and characterize the civil and structural issues of concern in Chefornak and propose a series of tasks to improve the health, safety and welfare of the community.

On February 8 and 9th two Principal engineers from PND, Sean Baginski, P.E., S.E. and Torsten Mayrberger Ph.D., P.E. visited the city of Chefornak with the following goals established:

1. Meet with Tribal, City and Corporation representatives to discuss issues affecting their community.
2. Issues included:
    a. Erosion
    b. Housing
    c. Head Start Building
    d. Potable Water
    e. Sewer
    f. Boardwalks
    g. Fuel
    h. Power Generation-Distribution
    i. Workforce Development
3. Conduct City Wide Cursory Observation/Reconnaissance
4. Field Reconnaissance of nearby resources

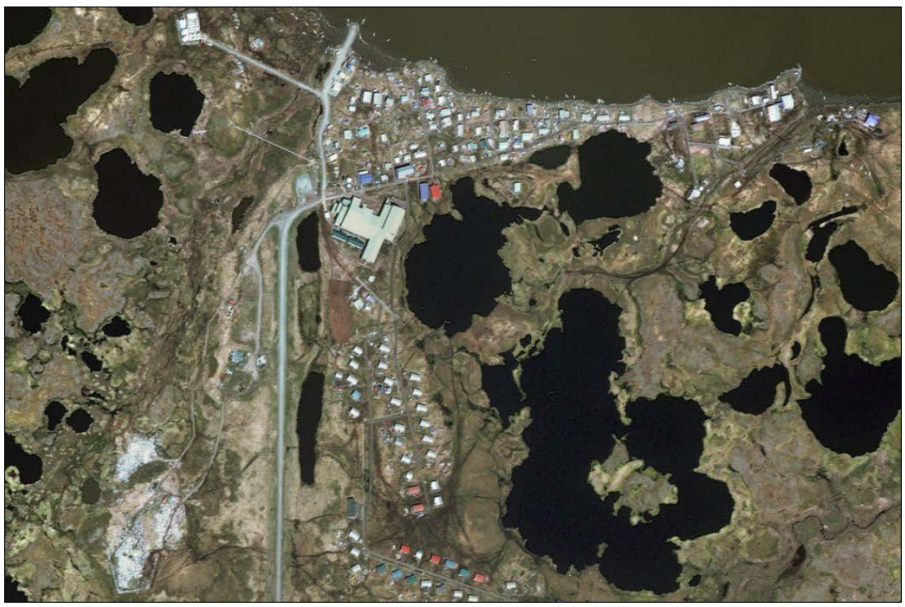

Figure 1. City of Chefornak

1.1 Discussion

The meeting with Chefornak officials and concerned community members was conducted at 7pm on February 8, 2018 at the Chefarnrmute Corporate Conference Room. Approximately 20 people were in attendance including representatives from the Tribal, City, and Corporation Councils. This report is a summary of items identified during this discussion as well as some of the observations noted during the reconnaissance conducted on the following day.

1.2 Erosion

The shoreline conditions of the Kinia River along the riverfront of Chefornak were observed during a walk on the river ice. The observation began at the Tank Farm on the west end of the city and extended to the Head Start Building on the east end of the city. Assisted by village representatives with knowledge of the areas-of-concern and historical photography (1954 and 2004), PND was able to identify those areas most at risk for accelerated erosion. One area extends along the riverbank from a point approximately 1600 feet downstream to approximately 350 upstream of the Barge Landing (Figure 2, Figure 3). Approximately 400 feet upstream of the barge landing is a rocky outcrop that does not appear to be eroding as fast as the surrounding areas. A portion of the shoreline approximately 400 feet in length upstream of this outcrop is actively eroding. As shown in Figure 2, Chefornak is located at the northern extreme of a sizeable formation of Basalt rock formed from the nearby extinct volcano at Tern Mountain approximately 3 miles south of the city.

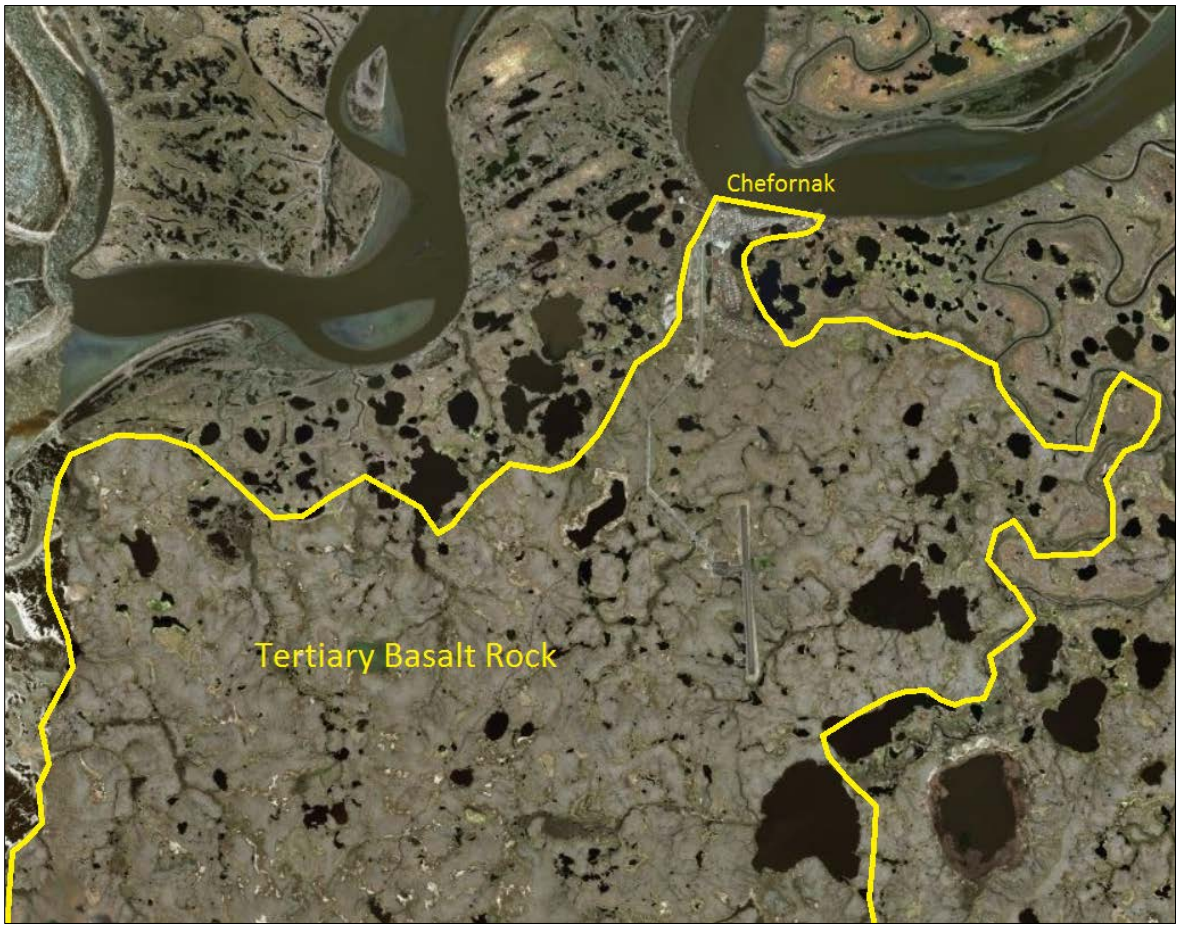

Figure 2. Tertiary Volcanic Basalt Rock (Image Courtesy of Microsoft Bing Maps)

The eastern and western extremes of the city extend beyond the Basalt rock formation and exposed granular material in these areas exhibit higher rates of erosion (Figure 3).

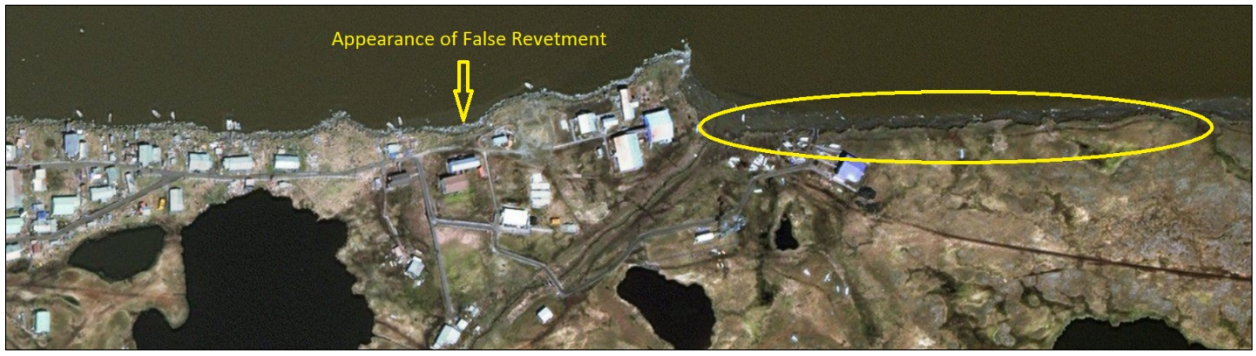

Figure 3. Contact between Basalt Rock and Soil

1.3 Dolly's House

Dolly's House (Figure 4) is perched approximately 12 feet from the embankment at the apex of what appears to be a backchannel forming behind the rocky outcrop. Her house is in poor structural condition, is not level and is positioned at one of the most active zones of erosion. There is cause for concern that the house may be substantially damaged or lost in the upcoming 2018 summer season.

Figure 4. Dolly's House

1.4 Barge Landing

The barge landing (Figure 5 and Figure 6) at Chefornak is crucial to the welfare of this community as it is the primary means of bringing materials, supplies and equipment to the city. During the 2017 spring breakup, a portion of the barge landing approximately 20 feet long was lost off its north end due to erosion. The condition of the remaining landing consists of large, armor size rocks both exposed and submerged in shallow water at the approach, making the landing of barges difficult and unsafe. Without

repair of the barge landing this season, Chefornak will be limited to small aircraft access for transportation of goods and materials which would cause serious delays or cancelation of badly needed health and safety related infrastructure repair projects throughout the community.

The landing in its current condition is not suitable for barge access. Removal of the larger rocks at the end of the landing and shaping/screeding of the shallow approach to sufficient depth to allow safe access for barges is a critical first step to ensure the health and safety of the community can be maintained and improved in the near term. It is recommended that additional bank stabilization measures be taken on portions of nearby shoreline that are most susceptible to the accelerated erosion rates witnessed during the last open water season. This will allow time for a more permanent solution to be developed and implemented without additional loss to the community.

Development of a more permanent solution will require a desktop study of bathymetric and hydrological characteristics of the site, an alternatives analysis of concept level designs for a permanent barge landing. ROM cost estimates and schedules for design and construction would be utilized to inform the selection process. Selection of the most cost effective alternative will be necessary to carry the design forward. This concept development is a critical first step in identifying a stable, safe and reliable alternative barge landing plan to ensure the long term stability of the structure.

The following cost breakdown and schedule is proposed for this work:

1. Design of Immediate repair and reinforcement of the barge landing and nearby susceptible embankment:
    a. Cost: $15,000
    b. Completion Date: 3/21/2018 (Assumes immediate NTP)
2. Construction of Immediate repair and reinforcement of the barge landing and nearby susceptible embankment:
    a. Cost: $390,000
    b. Completion Date: 4/30/2018 (Assumes immediate NTP)
3. Desktop hydrology study, bathymetry and Design of alternatives for permanent replacement of the barge landing:
    a. Cost: $45,000
    b. Completion Date: 6/30/2018 (Assumes immediate NTP)

Figure 5. Extents of Original Barge Landing

Figure 6. Natural Rock at River Bank Erosion

1.5 Thawing Permafrost-Erosion Mechanism

Examination of summer photos of the embankment near Dolly's House (Figure 7 and Figure 8), provided by local representatives, indicates that an accelerated thaw of the permafrost active layer (approximately the surficial 6 feet to 8 feet of soil) is advancing deeper than historically during spring and summer months— leading to accelerated erosion of granular material during summer flooding events and wave action. This leaves behind a large number of natural boulders along the embankment and near the river bank. Spring breakup contributes to erosion as well, redistributing the rock material via ice plucking and erosion of the remaining granular soil matrix. The combination of increased active layer thaw and ensuing ground water runoff through the granular surficial soil, high water and wave action is accelerating the rate of bank migration making prediction of rates based on historical data an unconservative assessment of the situation. Particularly in the last two seasons, erosion rates have increased dramatically necessitating a response, years earlier than expected. It can be seen by comparing photos from Dolly's house in the 1970s and 2018 that the bank has crept to within feet of the structure.

Figure 7. Shoreline looking east of Dolly's House circa 1970's.

Figure 8. Shoreline looking east of Dolly's House

1.6 Housing

Our discussion with local representatives indicated that housing conditions are generally overcrowded with population densities of 7 to 15 people per household and house sizes of approximately 800 to 1000 square feet each. Housing conditions varied throughout the city but generally could be categorized into 3 zones.

Figure 9. Zone 1 Housing

Zone 1: Northern housing-(approximately 30 to 40 homes) Characterized by structures in poor to very poor condition (Figure 9). Most are unpainted, suffering from varying degrees of wood rot, holes, broken windows, doors that become stuck or cannot be closed due to shifting foundations, many are leaning substantially and foundations that are at or near failure due to thaw settlement. Most of the homes in this zone are not good candidates for moving due to their degraded condition. Additionally, the congestion of the area will make maneuvering of structures to a new location problematic. Many of these homes are perched very near the riverbank and should be replaced further inland in phased approach.

Zone 2: Midtown housing (approximately 20 homes)-Characterized by structures in fair to poor condition (Figure 10). These homes were built in the 1970's. They are founded on post & pad, surface foundations and are generally level with no obvious holes or broken windows. There are some structures showing signs of early stage wood rot. No immediate action regarding the structures or foundations in Zone 2 is required periodic monitoring of their condition is recommended.

Figure 10. Zone 2 Housing

Zone 3: Southern housing (approximately 20 homes)-Characterized by structures in good to fair condition (Figure 11). These homes were built in the 1990's or early 2000's and are vinyl sided, founded on piles, level with no obvious holes or broken windows. No immediate action regarding structures or foundations in Zone 3 is required at this time.

Architectural, mechanical and electrical issues were not examined in any detail during this visit, however many appear to have non-functional/disconnected sewage systems.

Figure 11. Zone 3 Housing

1.7 Head Start Building

Building Condition- The Head Start Building, constructed in the 1970's is in poor condition (Figure 12, Figure 13, and Figure 14). Some signs of wood rot are apparent. Adjacent and connected structures are settling differentially with respect to the Head Start Building causing cracking walls and windows, sticking doors, and an uneven floor.

The entire building is tilting on its post and pad foundation due to surface thaw settlement. This problem has be exacerbated dramatically by the additional rapid rate of thaw caused by recent significant and prolonged flood events. Some pads are not in contact with the ground surface and are providing no support to the structure. This causes other members and foundations to support loads for which they were not designed. It is anticipated that this flood season will cause further thaw settlement under the structure which may result in its ultimate collapse given its current condition. Non-structural problems identified include: excessive heat loss due to inadequate insulation, and otherwise compromised building envelope. Additionally hazardous insulation (asbestos) has been indicated as a problem by members of the community.

Figure 12. Head Start Building Foundation

Figure 13. Head Start Building - Shifting Towards River Bank

Flooding Conditions and Child Safety- The Head Start Building's proximity to the river and its relatively low elevation make it one of the first structures in the community to experience the effects of increased flood

Figure 14. Head Start Utility building as seen from the entrance to the Head Start building.

elevations. Because it is located less than 30 feet from the river bank and sits at approximately +10' elevation, it is subject to flooding. This makes it unsafe for the children or anyone else to walk to or from the school during floods. While the river bank at this location appears to be stable, flooding at its present location makes it a problematic site.

Head Start Utility Building – as is shown in Figure 14 above, this building is in very poor condition. It provides electric power, heat, and water to the Head Start building and is at a high risk of failure due to flooding and continued permafrost thaw. Estimating the health and safety impacts associated with foundation and equipment failure due to collapse and flooding are beyond the scope of this report.

1.8 Water

Drinking water for Chefornak is limited and difficult to obtain. While the school has a Reverse Osmosis (RO) System (Figure 15) sufficient to supply the students with drinking water, the equipment does not have the capacity to supply drinking water to the entire community. Currently, drinking water is obtained by collecting ice in 5 to 25 gallon containers from a nearby lake, hauling it by ATV or snow machine to their home and allowing it to thaw. More accessible water sources are not suitable for drinking due to the high salinity caused by tidal influence in most of the nearby water sources.

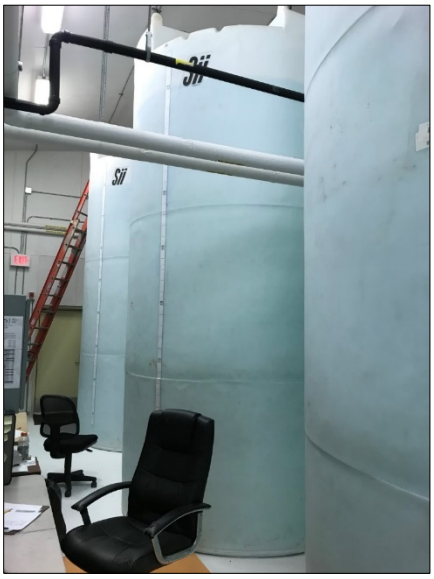

Figure 15. School Water Supply (Desalinated)

An artesian spring (Figure 16) that is believed to be a clean source with sufficient flow rates is located approximately 3 miles south of the city. Piping or hauling could be utilized to access this source and provide much needed, clean drinking water for the community.

Figure 16. Possible Spring-Fed Water Supply

1.9 Sewer

Sewage treatment for the community consists of honey buckets within each home or building. These are regularly emptied into the sewage lagoon. With the recent advancing active layer thaw, the sewage lagoon has drained and now provides little or no treatment value to the system. An improved system is highly recommended for village sanitation and overall health.

1.10 Boardwalks

The boardwalks (Figure 17) in Chefornak appeared to be in good condition, solidly constructed and they provide an effective means for pedestrians and ATV/Snow Machine operators to move throughout the town. Beyond the extents of the boardwalk system however, aerial photography of the area shows signs of significant degradation of the tundra. Extension of the boardwalks and/or linking them with roads or

hardened trails for the highest traffic areas is highly recommended to limit environmental damage to the surrounding landscape.

Figure 17. Boardwalk

1.11 Fuel

Fuel for Chefornak is stored in a tank farm on the west end of town near the river bank (Figure 18). This location was presumably selected for ease of access for fuel barges. The specific location is in a low-lying area that is regularly flooded during spring breakup and summer floods. It is located beyond the western edge of the Basalt formation where it is subject to increased rates of erosion and bank migration. Regular flooding of the site is causing rapid thawing of the underlying permafrost which manifests itself through thaw settlement and resulting differential settlement and failure of the foundations.

Two new tanks were added during the construction of the school in the mid 2000's. They were founded on piles and the ground was maintained in a frozen state by use of thermosyphons. One of the unintended consequences of this design has been that the underlying soil being maintained in a frozen state has caused it to heave enough to prevent water from draining naturally from the original tank farm site. This further exacerbates the problem of ponding water and subsequent that settlement.

Figure 18. Settlement of Tanks

1.12 Power Generation-Distribution

i. Concerns with condition and proximity of distribution lines to existing metal roofed buildings- fire hazard (Figure 19 and Figure 20)

ii. Insufficient embedment to prevent jacking

iii. Poles not as specified?

iv. Many of the existing poles will not survive a wind storm or ice storm

1.13 Workforce Development

i. Self-perform much of the proposed construction work

ii. Opportunities with office embed, mentoring, field training in all aspects of the work.

iii. Perform Quality Assurance for construction projects

Figure 19. Heaved and Leaning Power Pole

Figure 20. Heaved and Leaning Power Poles

2.0 RECOMMENDATIONS

2.1 Erosion

Because Chefornak is located along the outside of a bend of a meandering river, it is expected that these erosion trends will continue at current or even accelerated rates due to floods and warming permafrost if steps are not taken to arrest erosion both directly at the areas of concern and extending upstream to a more stable river bank location or erosion-resistant hard point to prevent future outflanking. Additional measures such as relocation of structures or residents to new structures located outside the path of expected erosion should also be explored.

In order to understand and predict the erosion process in more detail and develop means to combat this erosion, additional field investigations during spring and summer seasons should be undertaken to observe and record flood conditions, survey the stream, and evaluate the bank line. In addition, a desktop hydrology and hydraulics analysis and preliminary alternatives analysis should be completed to determine several suitable options to address bank erosion. The alternatives analysis should take into account local input, costs, availability of material and equipment, and long-term outlooks on both natural riverine processes and City of Chefornak plans.

2.2 Dolly's House

Due to the combination of erosion and thawing permafrost, Dolly's house is at high risk of failure as early as 2018 if recent trends continue. Because of this increased risk, plans to address erosion and/or move residents to a new location should be explored beginning immediately.

2.3 Barge Landing

Due to a failure caused by erosion during 2017 floods, the barge landing is not currently suitable for barge access without removal of some of the larger rocks at the end of the landing and shaping/screeding of the shallow approach to provide sufficient draft for safe barge access.