APPENDIX G

Erosion Protection Information

DILLINGHAM LAGOON
EROSION PROTECTION ASSESSMENT

DILLINGHAM, ALASKA

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Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

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INTRODUCTION

The City of Dillingham's sewage treatment lagoons (herein called the facility) are threatened by estuarine erosion along the tidally influenced portion of the Nushagak River (the project site), which flows into Bristol Bay southwest of the community. CRW, Inc., (CRW) is assisting the City with analysis to determine whether the facility should be relocated (CRW 2019). CRW contracted with Herrera Environmental Consultants, Inc., (Herrera) to provide input with regard to shoreline erosion protection alternatives. This report assesses the erosion occurring at the project site and the effectiveness of two proposed alternatives to protect the existing facility.

METHODOLOGY

This analysis was intended to be a "desktop" exercise only, without the need for Herrera to visit the project site. Herrera reviewed photographs and several documents provided by CRW. Herrera also examined publicly available documents associated with construction of other riverbank revetments in the Dillingham area.

SITE BACKGROUND

Dillingham is located along the right (north) bank of the Nushagak River near its mouth in Bristol Bay, Alaska. The City's sewage treatment lagoon facility is located northeast of the center of the city (Figure 1). The surface of the riverbank near the lagoons is composed of peat (sometimes called muskeg), typical of this part of Alaska. Underneath this organic-rich, poorly consolidated soil layer are sedimentary deposits from the Nushagak River. These deposits are predominantly sand but are interspersed with silt and clay and have varying degrees of consolidation (Golder 2019).

From an analysis of historical aerial photographs and discussions with CRW staff, recent bank erosion rates have been up to 15 feet per year. According to anecdotal accounts provided by CRW, erosion occurs in clumps (primarily of surface peat) that break off the riverbank during high water events when waves are present.

Based on analysis of historical aerial photographs dating from present to 2005 (Google 2019), it is apparent that the primary channel of the Nushagak River is migrating towards the facility. The left bank of the river has been aggrading and revegetating at about the same rate as erosion has occurred on the right bank adjacent to the facility. It is unclear what larger process is driving the channel migration. Although the proximal cause of the bank erosion may be a combination of waves and high water, the ultimate cause may be migration of the estuarine channel towards the facility. This type of large-scale channel migration will likely be persistent over time, causing ongoing erosion of the north bank of the river.

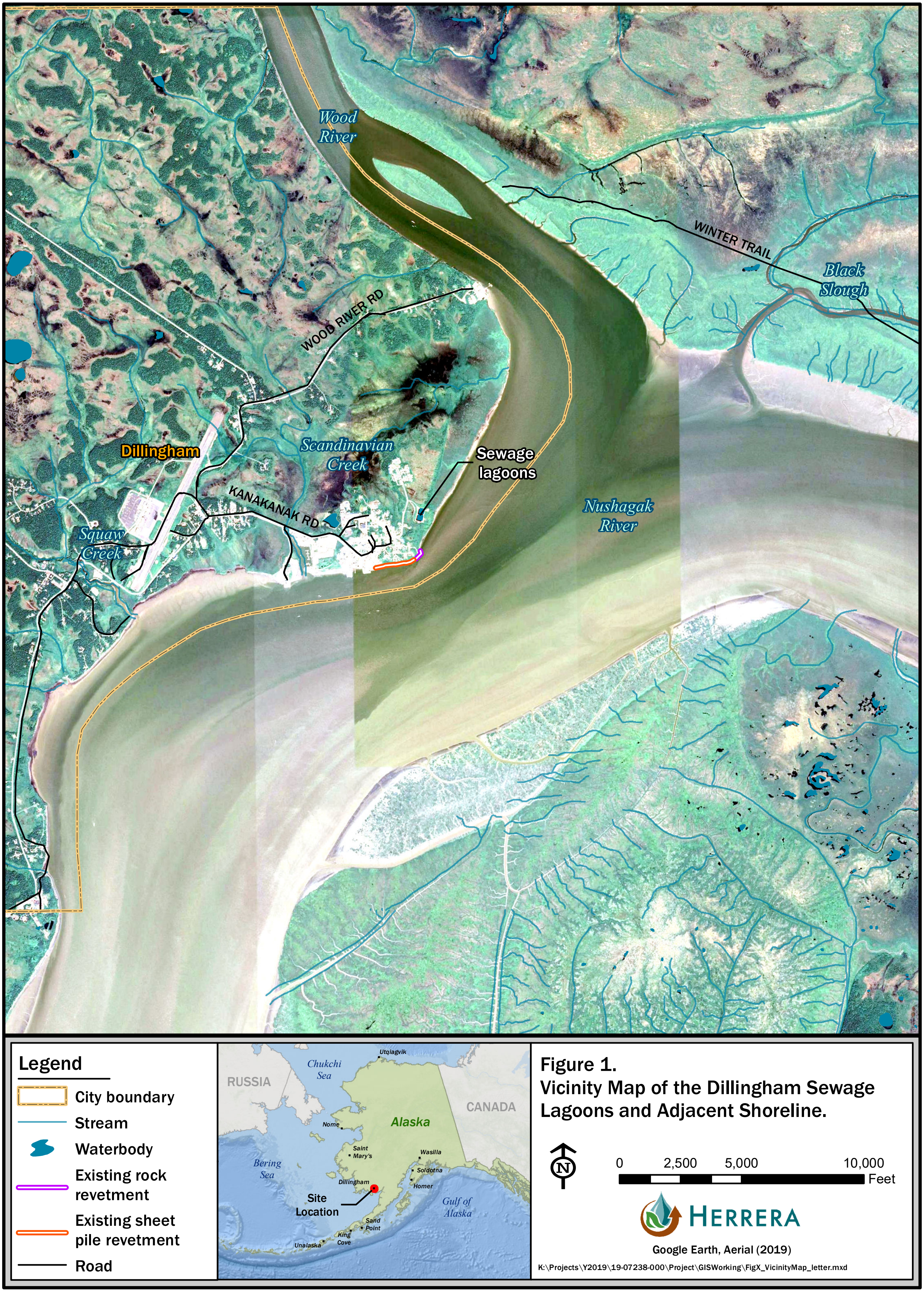

Figure 1.
Vicinity Map of the Dillingham Sewage Lagoons and Adjacent Shoreline.

The tides in Dillingham are macrotidal, having a diurnal tide range in excess of 20 feet. The largest wind fetches in the facility area are in the east-southeast. Based upon guidance from the US Army Corps of Engineers (2008) and wind estimates from the US Army Corps of Engineers (2009), local wind-generated waves are expected to be no greater than 5 feet at the offshore bar that fronts the facility shoreline. This is smaller than the waves along the Dillingham waterfront. Further, the shallow estuary mouth and the bar in front of the facility shoreline should ensure that no ocean swell reaches the facility shoreline.

Anticipated sea level rise may increase the erosion rates over time. However, future sea level rise might also change estuarine circulation in the Nushagak River, which could direct erosion away from the project site. Regardless, sea level rise should be accounted for in the engineering design process.

Proposed Alternatives

The proposed alternatives are outlined in Figure 2. One alternative includes a sheet pile wall to protect the shoreline and the other includes a rock revetment. Typical sections of these alternatives are also shown in Figure 2. The alignment of the erosion protection should be designed so that the upstream end cannot be flanked by the river within 30 years of the construction of the structure. The alignment of each of these alternatives is efficient from an engineering perspective, at the base of an ancient embankment.

Erosion protection features like both of these alternatives have been implemented in the vicinity of the facility. There are some geomorphic differences between these implementation locations (on south aspect shorelines with more open ocean exposure) and the facility site. However, each of these types of erosion protection on the southern shoreline appear to be functional after more than 10 years since construction. Given their appearance after more than 10 years of being built, it is highly probable that they will survive with minor maintenance over their design life, which was planned to be 30 years (US Army Corps of Engineers 2009).

Rock Revetment

Rock revetments are a simple and reliable means to protect infrastructure, widely used around the world. The proposed geometry shown in Figure 2 should be adequate to resist erosion per the scour analysis described later in this report. An important component of a rock revetment is the toe. When founded on fine-grained sediment, as is the case here, a “key” is necessary in the revetment toe to prevent it from being undermined by scouring of the bed. The key should extend below peat in all areas, and preferably below the estimated scour depth presented in this report. Toe rock should not be placed on peat because the revetment will unravel quickly if the toe rock can settle into the peat. The presence of peat may mean significant excavation for the revetment toe key for portions of the revetment that are landward of the shoreline.

There are several sources of rock available in the Dillingham area, which are described by the US Army Corps of Engineers (2010). All of the local sources of rock are graywacke (US Army Corps of Engineers 2010). Graywacke is an acceptable, but not ideal, type of armor rock. The lithology of the material results in internal fractures that can ultimately cause breakdown of the material. Such breakdown of the rock is likely to occur under the prevailing conditions at the facility site. The degradation should not be extreme and should be sufficient to provide adequate function for at least 30 years.

Aside from rock degradation, the primary risk of failure of a revetment in this setting is self-burial of the placed rock and subsequent unravelling of the structure. The beginning of unravelling can be seen as a few isolated rocks in front of an existing rock revetment along the riverbank near the facility site (Figure 3). This can be mitigated by the placement of a geotextile between the native soil and placed rock that prevents differential settling of individual rocks in the base of the revetment (Lagasse et al. 2006).

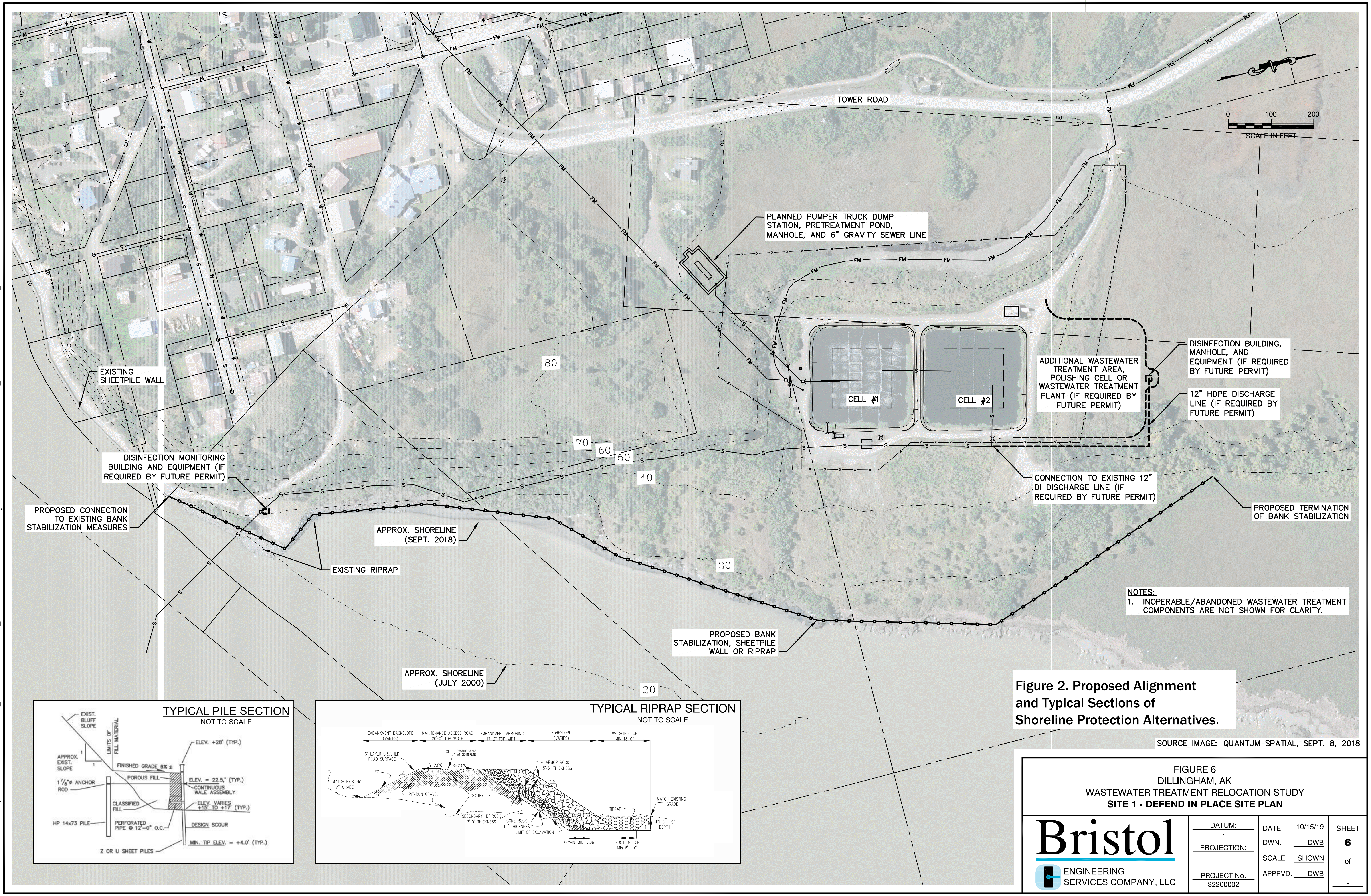

Figure 2. Proposed Alignment and Typical Sections of Shoreline Protection Alternatives.

Figure 3. Rock Revetment Adjacent to the Project Site.

Sheet Pile Wall

A sheet pile wall commonly consists of vertical piles embedded at depth below the ground surface and steel sheets placed for a continuous length in front of the piles, with the sheets held in place via a combination of burying the base of the sheets, interlocking the sheets together, and attaching the sheets to the piles with anchor rods (see sketch in Figure 2). In some ways, the project site is ideal for sheet pile wall protection, owing to the lack of coarse-grained or well-lithified substrate, which can make installation of piles and steel sheets difficult. Local anecdotal accounts report erosion at the toe of a large sheet pile wall protecting the Dillingham waterfront from erosion, though pictures of the wall provided by CRW indicate that the erosion is modest and does not imminently threaten the existing structure.

Sheet pile walls can enhance wave reflection, exacerbating erosion in front of the wall. An analysis of scour potential at the base of a sheet-pile wall to protect the facility is provided later in this report. It is expected that the piles supporting the wall would not have to be longer than 25 feet at the facility site, since design waves in this reach of the Nushagak River are smaller than those on the Dillingham waterfront, where 25-foot-long piles (US Army Corps of

Engineers 2000), along with a riprap countermeasure, were used. However, a geotechnical analysis will have to be performed to confirm stability of a wall considering the results of the scour analysis and considering other features of the proposed construction (i.e., whether or not scour countermeasures are used in combination with a sheet pile wall).

One way to reduce erosion in front of a sheet pile wall is to place a small amount of rock at the base of the wall. This approach has been taken along the Dillingham waterfront sheet pile wall (Figure 4). This material helps reduce wave reflection and buffers underlying fine sediment from turbulence in the water column. Since rock is readily accessible in the Dillingham area, and an access road would be needed for wall construction, an adaptive management scheme could be employed wherein the construction access road is left in place and rock is added to the base of the wall to reduce erosion if it begins to endanger the structure. However, like the rock revetment alternative, the rock will eventually break down and potentially self-bury in the bed.

Figure 4. Sheet Pile Wall on Dillingham Waterfront.