Report of Investigation 2021-3 Kotlik

EROSION EXPOSURE ASSESSMENT—KOTLIK

Richard M. Buzard, Mark M. Turner, Katie Y. Miller, Donald C. Antrobus, and Jacquelyn R. Overbeck

Kotlik, Alaska, in 2021. Photo: Alaska Division of Geological & Geophysical Surveys.

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State of Alaska
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EROSION EXPOSURE ASSESSMENT—KOTLIK

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KOTLIK EROSION EXPOSURE ASSESSMENT

This is a summary of results from an erosion forecast near infrastructure at Kotlik, Alaska. We conduct a shoreline change analysis, forecast 60 years of erosion, and estimate the replacement cost of infrastructure in the forecast area. Buzard and others (2021) describe the method and guidance for interpreting tables and maps.

Source data for this summary include the following:

- Delineated vegetation lines and change assessment by Buzard and others (2021) following the methods of Overbeck and others (2020).
- Infrastructure AutoCAD outlines and metadata from Division of Community & Regional Affairs (2006) Community Profile Map series.
- Added infrastructure such as roads, water and sanitation facilities, and outbuildings, delineated if visible in the most up-to-date high resolution (≤ 0.66 ft [20 cm] ground sample distance) aerial orthoimagery (Overbeck and others, 2016).
- Computed infrastructure cost of replacement based on square or linear footage from Buzard and others (2021) and City of Kotlik and Village of Kotlik (2019).

Kotlik is located on the northern Yukon-Kuskokwim Delta where the Kotlik River joins the Yukon River and exits into Pastol Bay and Norton Sound. Most of the community is built south and east of the river junction. Some residences are built on the opposite banks. The landfill is built across the river, further northwest than the

rest of the community (only accessible by boat in the summer). From 1951 to 2015, erosion rates ranging between 1 and 2.3 feet per year widened the river and undermined existing infrastructure (Overbeck and others, 2020). Erosion is caused by permafrost thaw, flooding, general riverine processes, and boat wake (U.S. Army Corps of Engineers [USACE], 2008).

We forecast erosion 60 years from the most recent shoreline (2015) at 20-year intervals on both sides of the Kotlik River to identify the exposure of infrastructure to erosion. USACE (2008) report that erosion protection has been installed in several locations multiple times but did not effectively mitigate erosion. Overbeck and others (2020) found a relict interlocking concrete revetment in disrepair along the riverbanks during a field survey in 2017, reiterating that existing mitigation is inadequate. Shoreline delineations are consistent with the findings that the erosion protection efforts did not stop erosion, so we include these areas in the forecast. Erosion at the landfill cannot be forecast because the shoreline is not visible in aerial imagery due to the muddy substrate resulting from frequent traffic. Overbeck and others (2020) estimated erosion rates of 1 and 2.3 feet per year fronting the landfill.

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Table 1. Quantity of infrastructure with estimated erosion exposure by linear footage (LF) or count (n).

Quantity of Exposed Infrastructure					
Erosion Forecast Date Range	**Buildings (n)**	**Power Lines (LF)**	**Fuel Lines (LF)**	**Water Lines (LF)**	**Boardwalks (LF)**
2015 to 2035	24	892	0	31	242
2035 to 2055	26	955	0	44	500
2055 to 2075	13	430	0	100	480
Combined Total	63	2,277	0	175	1,222

Table 2. Replacement cost of infrastructure forecast to erode per 20-year interval.

Cost to Replace Exposed Infrastructure						
Erosion Forecast Date Range	**Buildings**	**Power Lines**	**Fuel Lines**	**Water Lines**	**Boardwalks**	**Sum**
2015 to 2035	$9,167,000	$178,300	$0	$50,000	$75,000	$9,470,300
2035 to 2055	$9,721,000	$191,000	$0	$0	$0	$9,912,000
2055 to 2075	$8,237,000	$86,100	$0	$20,000	$16,600	$8,359,700
Combined Total	$27,125,000	$455,400	$0	$70,000	$91,600	$27,742,000

Table 3. Cost estimate of exposed buildings and tank facilities by 20-year interval. The count of exposed residential or unspecified buildings is denoted in parentheses. NCA designates buildings with no cost assigned.

Cost to Replace Exposed Buildings and Tank Facilities			
Erosion Forecast Date Range	**Building Type**	**Cost of Replacement**	
2015 to 2035	Residential (18)	$	7,348,000
	Assembly of God Church	$	400,000
	AC Company	$	218,800
	Unspecified (4)	$	1,200,000
2035 to 2055	Residential (21)	$	8,820,900
	Teacher Housing	$	500,000
	Kwipak Inc		NCA
	Unspecified (3)	$	400,000
2055 to 2075	Residential (3)	$	4,943,000
	City Lodge	$	343,800
	School Shop	$	1,250,000
	Kotlik City Council	$	500,000
	Unspecified (7)	$	1,200,000

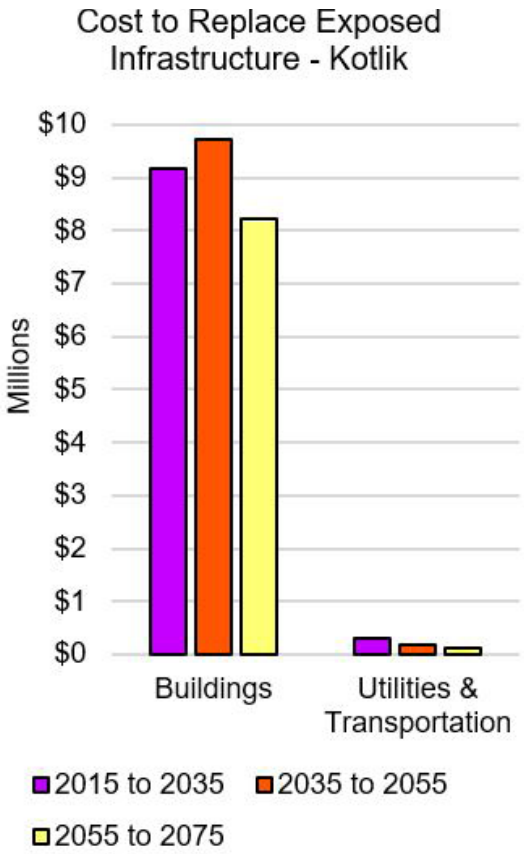

Figure 1. This figure summarizes the replacement cost of all infrastructure in the erosion forecast area. Twenty-year intervals are symbolized by color: purple represents the time interval 2015 to 2035, orange represents 2035 to 2055, and yellow represents 2055 to 2075. The bulk of costs are buildings from 2015 to 2075.

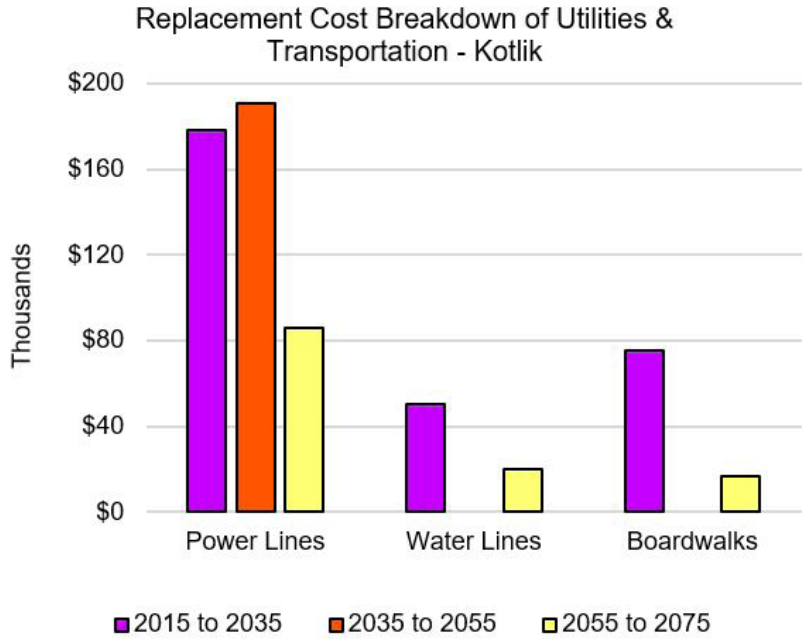

Figure 2. This figure breaks down the replacement cost of all utilities and transportation infrastructure in the erosion forecast area. The greatest cost is erosion of power lines from 2015 to 2055.

In total, we forecast 42 residential buildings, the AC Store, and other buildings are exposed to erosion through 2075 (tables 1–3). Most residences are within the 2055 erosion forecast. By 2075, erosion is forecast to undermine over 2200 feet of power lines and 1200 feet of boardwalk (table 1). The total estimated replacement cost of infrastructure is $27.7 million (± $8.3 million) through 2075 (table 2; figs. 1 and 2).

ACKNOWLEDGMENTS

This work was funded by the Denali Commission Village Infrastructure Protection Program through the project "Systematic Approach to Assessing the Vulnerability of Alaska's Coastal Infrastructure to Erosion." The community of Kotlik was not consulted for this report.

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Buzard, R.M., Turner, M.M., Miller, K.Y., Antrobus, D.C., and Overbeck, J.R., 2021, Erosion exposure assessment of infrastructure in Alaska coastal communities: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2021-3. https://doi.org/10.14509/30672

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Erosion Forecast
Kotlik, Alaska

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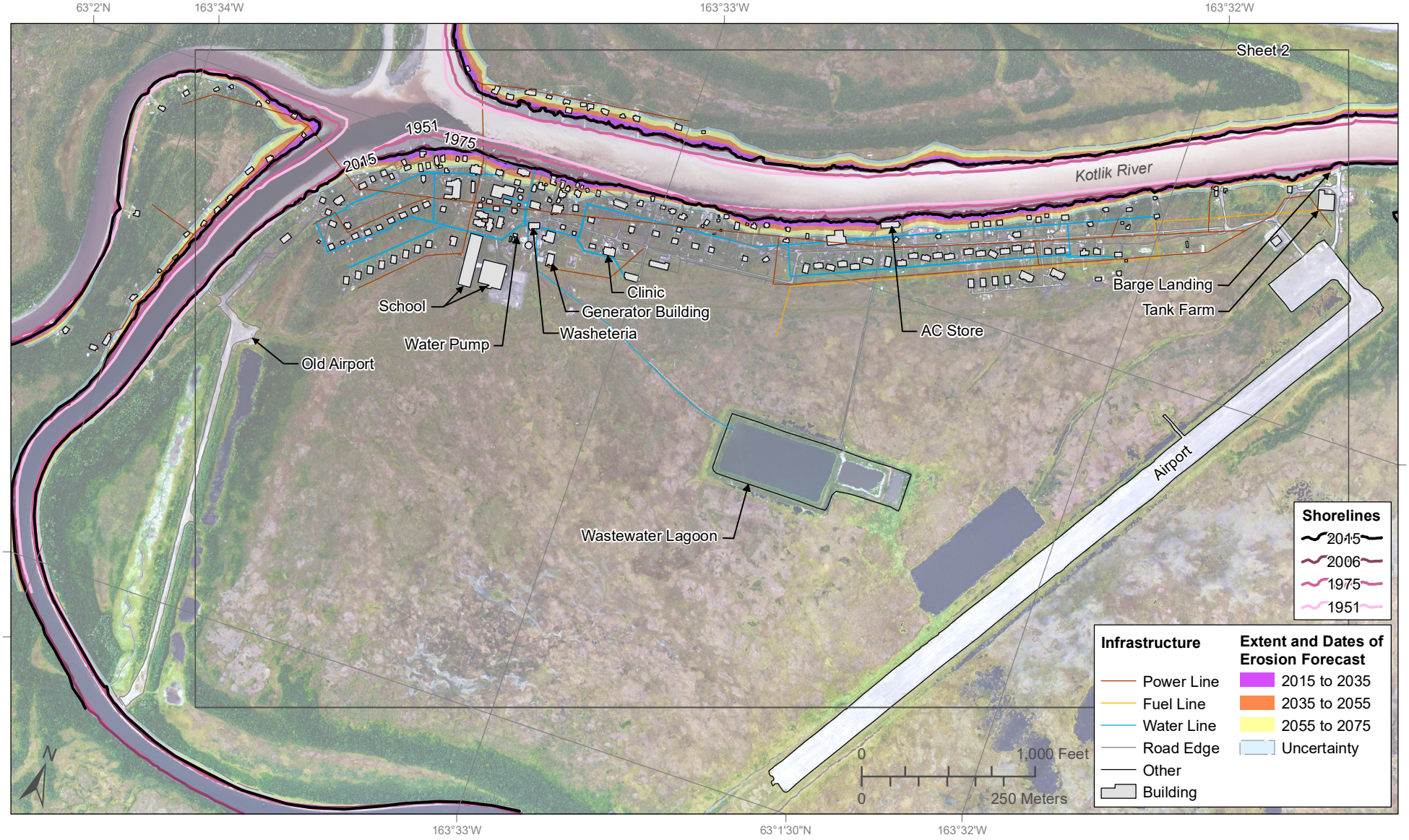
Buzard and others, 2021
Kotlik, Sheet 1 of 2



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Projection: NAD83 UTM Zone 3N. Orthoimagery year: 2015. Orthoimagery available from elevation.alaska.gov

Erosion and accretion of coasts and rivers result in shoreline change. These rates of shoreline change at Alaska communities are calculated from historical and modern shorelines (shorelines shown as lines in pinkscale and labeled by year). The long-term (1951 to 2015) shoreline change rate is used to forecast where erosion could impact community infrastructure. Erosion is forecast to reach the colored areas by specified time intervals: 2015 to 2035 (purple), 2035 to 2055 (orange), and 2055 to 2075 (yellow). The area of uncertainty of the 2075 shoreline at a 90 percent confidence interval is light blue. Areas that are not colored by time interval are not forecast to erode by 2075 based on the historical shoreline change rate. For more detailed information about the impacts to infrastructure from erosion at Kotlik, refer to the Kotlik erosion exposure assessment report.

This work is part of the Coastal Infrastructure Erosion Vulnerability Assessment project funded by the Denali Commission Environmentally Threatened Communities Grant Program. Components of this map were prepared by the Alaska Department of Commerce, Community, and Economic Development (DCCED) using funding from multiple municipal, state, federal, and tribal partners. The original AutoCAD drawing of the infrastructure data layers was converted to ArcGIS.

Erosion Exposure
Kotlik, Alaska

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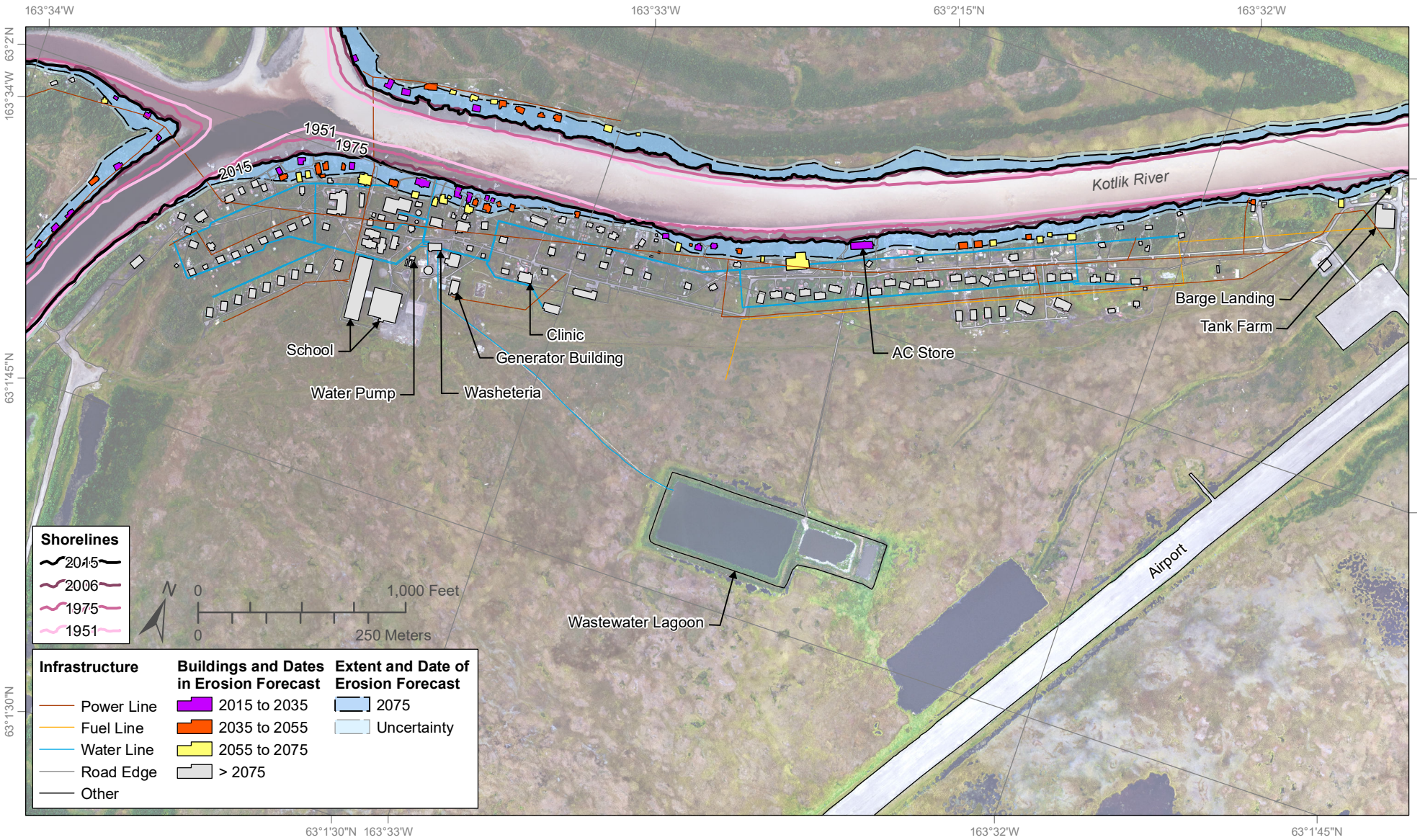
Buzard and others, 2021
Kotlik, Sheet 2 of 2



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