Report of Investigation 2021-3 Newtok

EROSION EXPOSURE ASSESSMENT—NEWTOK

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

Newtok, Alaska, in 2014. Photo: ShoreZone, shorezone.org.

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EROSION EXPOSURE ASSESSMENT—NEWTOK

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NEWTOK EROSION EXPOSURE ASSESSMENT

This is a summary of erosion forecast results near infrastructure at Newtok, 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 (DCRA, 2004) 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 Native Village of Newtok (2015).

Newtok is located in the Yukon-Kuskokwim Delta on the Ninglick River. Erosion at Newtok is driven by channel erosion of the Ninglick River, which is part of an estuary that empties into the Bering Sea. From 1951 to 2015, the Ninglick River migrated and eroded at multiple bends, including

the one where Newtok is located. In addition to channel migration, coastal storm surge reaches Newtok and waves develop over the width of the river, resulting in erosion from flooding and wave impact (Overbeck and others, 2020). U.S. Army Corps of Engineers (USACE, 2009) reports various erosion protection projects were active from 1983 to 1989 but do not identify the exact location of the protection. In 1994, the Newtok Traditional Council began the relocation process (USACE, 2009), and by 2019, 30 percent of the population relocated to a new community site, Mertarvik (DCRA, 2019). Efforts are ongoing to relocate the remaining 70 percent of the population.

We forecast erosion 60 years from the most recent shoreline (2015) at 20-year intervals to identify the exposure of infrastructure to erosion. The analysis is carried out on the Ninglick River side of Newtok. The slough that borders the community, Kealavik River, is not included in the analysis because the shoreline is nearly stable, while erosion rates along the Ninglick River are up to 72.8 feet per year (Overbeck and others, 2020). Nearly 100 percent of Newtok's infrastructure is in the 2075 erosion forecast area. This includes the airport, wastewater lagoon, landfill, school, and clinic,

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as well as several residences and other buildings, power lines, roads, and boardwalks (tables 1–3). The total estimated replacement cost of infrastructure exposed to erosion is $126.4 million (± $37.9 million) by 2075 (table 2; figs. 1 and 2). We do not estimate erosion exposure for fuel lines because data were not available.

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 Newtok was not consulted for this report.

Table 1. Quantity of infrastructure with estimated erosion impacts by linear footage (LF), square footage (SF), or count (n).

Quantity of Exposed Infrastructure							
Erosion Forecast Date Range	**Power Lines (LF)**	**Water Lines (LF)**	**Roads & Boardwalks (LF)**	**Buildings & Tank Facilities (n)**	**Airport (LF)**	**Landfill (SF)**	**Wastewater Lagoon (SF)**
2015 to 2035	2,007	1,675	6,155	58	220	0	69,320
2035 to 2055	3,373	1,854	10,892	58	730	145,240	0
2055 to 2075	1,191	254	1,347	23	520	0	0
Combined Total	6,571	3,783	18,394	139	1,470	145,240	69,320

Table 2. Replacement cost of infrastructure exposed to erosion per 20-year interval.

Cost to Replace Exposed Infrastructure						
Erosion Forecast Date Range	**Power Lines**	**Water Lines**	**Roads & Boardwalks**	**Buildings & Tank Facilities**	**Airport, Landfill, & Wastewater Lagoon**	**Sum**
2015 to 2035	$401,400	$670,000	$461,600	$60,305,500	$8,230,000	$70,068,500
2035 to 2055	$674,500	$741,500	$816,900	$34,073,200	$8,300,000	$44,606,100
2055 to 2075	$238,200	$101,600	$101,100	$6,090,500	$5,240,000	$11,771,400
Combined Total	$1,314,100	$1,513,100	$1,379,600	$100,469,200	$21,770,000	$126,446,000

Table 3. Cost estimate of erosion impact to buildings and tank facilities by 20-year interval. The count of exposed residential or unspecified buildings is denoted in parentheses.

Cost to Replace Exposed Buildings and Tank Facilities			
Erosion Forecast Date Range	**Building Type**	**Cost of Replacement**	
2015 to 2035	Residential (19)	$	8,362,700
	Teacher Housing	$	3,000,000
	School	$	35,000,000
	Tribal Council	$	1,000,000
	Power Plant	$	3,250,000
	Clinic	$	2,500,000
	Airport Garage	$	150,000
	Water Facility	$	4,000,000
	Tank Farm	$	933,600
	Unspecified (5)	$	2,542,800
2035 to 2055	Residential (33)	$	13,728,800
	United Utilities Co	$	7,000,000
	Post Office	$	150,000
	CVRF Office	$	500,000
	Old BIA School	$	3,500,000
	Power Co	$	7,225,000
	Church	$	1,000,000
	Community Hall	$	4,000,000
	Store	$	500,000
	Tank Farm	$	1,300,000
	Unspecified (3)	$	1,769,400
2055 to 2075	Residential (9)	$	3,715,500
	Tank Farm	$	2,375,000

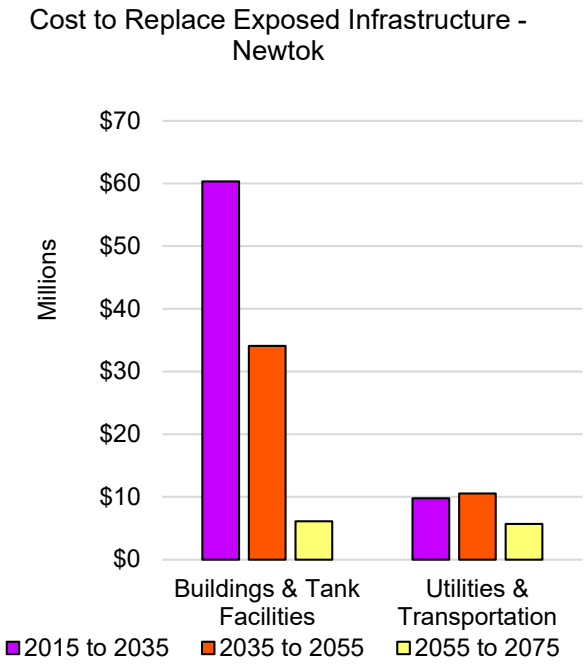

Figure 1. This figure summarizes the replacement cost of all infrastructure in the erosion forecast area. Twenty-year intervals are symbolized by color: purple represents the time interval 2015 to 2035, orange represents 2035 to 2055, and yellow represents 2055 to 2075. The bulk of costs are buildings,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

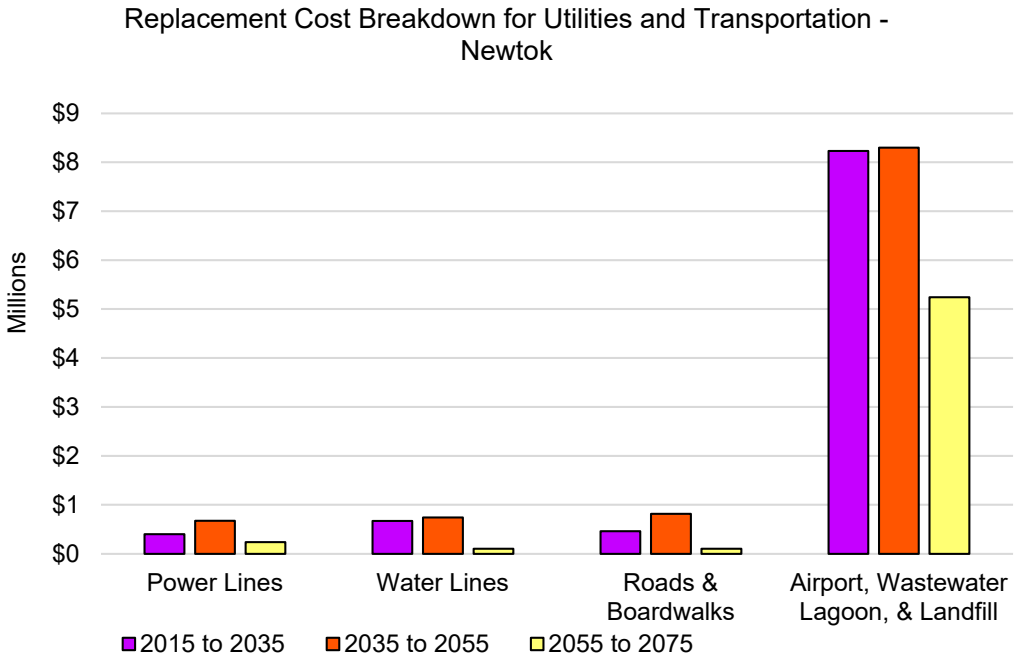

Figure 2. This figure breaks down the replacement cost of all utilities and transportation infrastructure in the erosion forecast area. The greatest cost is erosion of the airport, wastewater lagoon, and landfill from 2015 to 2055.

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Erosion Forecast
Newtok, Alaska

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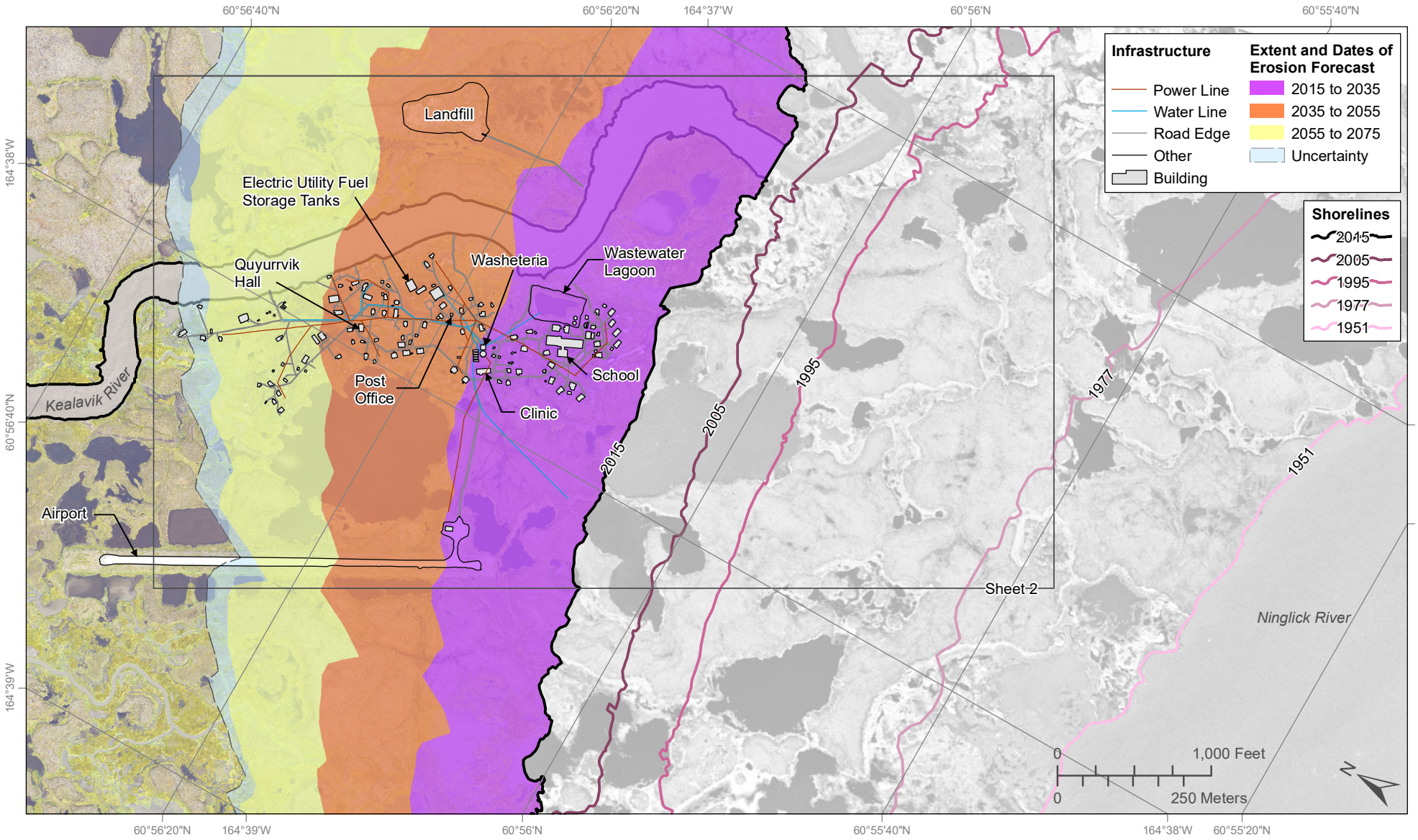
Buzard and others, 2021
Newtok, Sheet 1 of 2



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Projection: NAD83 UTM Zone 3N. Orthoimagery years: 2015 & 1951. 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 Newtok, refer to the Newtok 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
Newtok, Alaska

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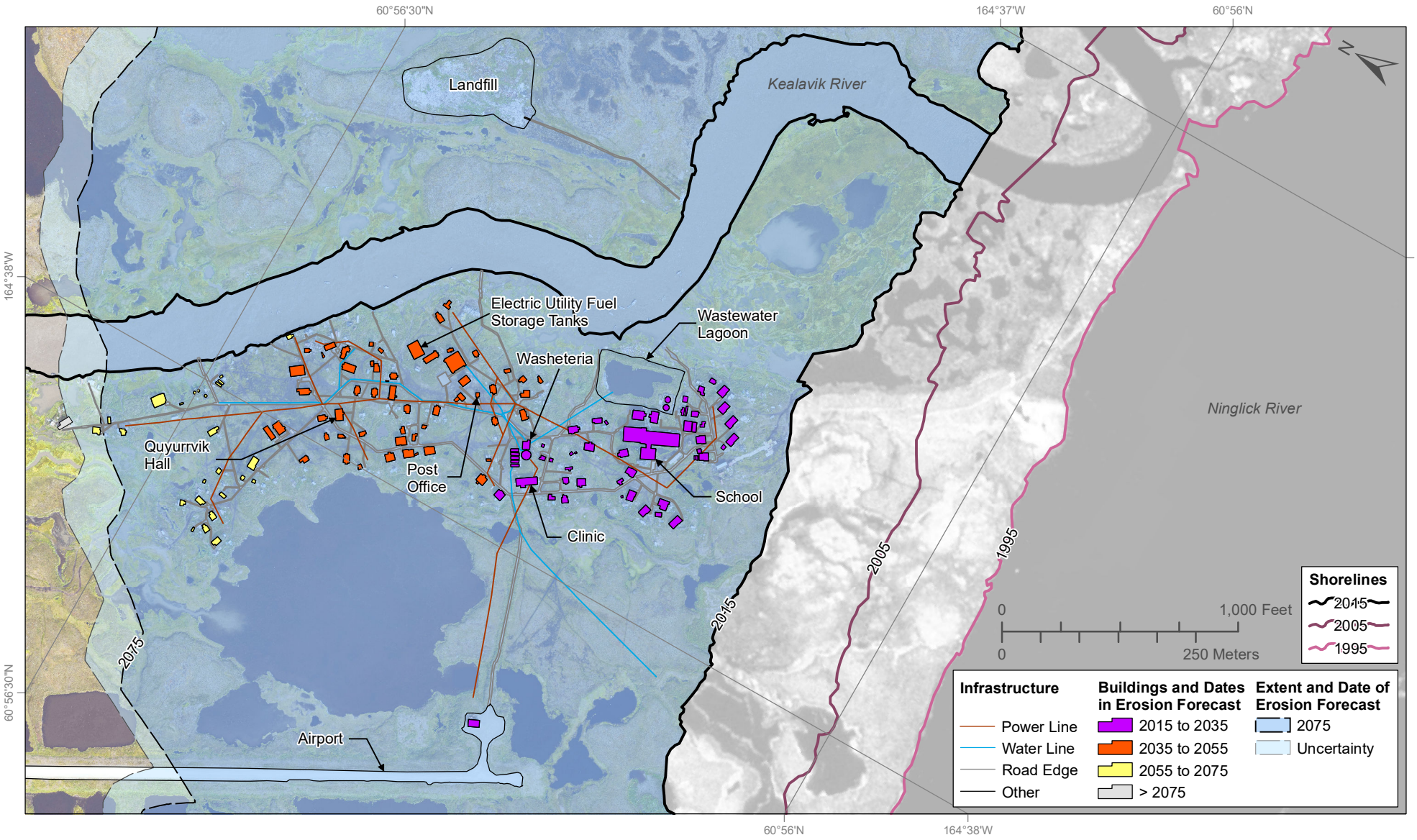
Buzard and others, 2021
Newtok, Sheet 2 of 2



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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 year 2075 (dark blue) with a 90 percent confidence interval area of uncertainty (light blue). Buildings forecast to be impacted by erosion are colored by the range of years when the impact is forecast to occur: 2015 to 2035 (purple), 2035 to 2055 (orange), 2055 to 2075 (yellow), and no impacts expected by 2075 (gray). For more detailed information about the impacts to infrastructure from erosion at Newtok, refer to the Newtok erosion exposure assessment report.

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