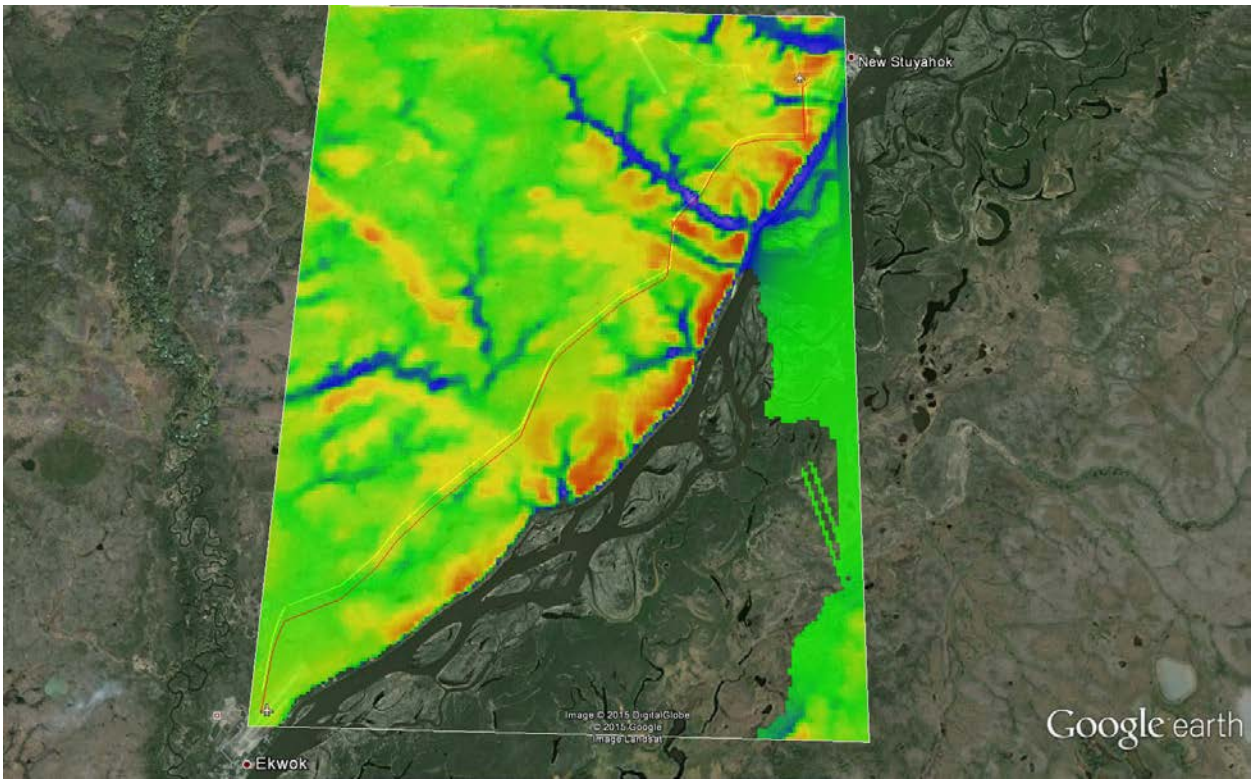
New Stuyahok-Ekwok Intertie Route Wind Power Site Options



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Introduction

This report assesses options for wind turbine sites along the proposed electrical distribution intertie route to connect the villages of New Stuyahok and Ekwok. These villages are located on the northwest shore of the Nushagak River in the Bristol Bay region of Alaska. The analysis is accomplished with WAsP (Wind Atlas, Analysis and Application Program) wind flow modeling software.

Methodology

Two met tower studies have been accomplished in New Stuyahok. The first met tower was located in an open clearing just north of the apron of the old airport with data collection from October 2003 to July 2005. This study indicated a moderate wind resource with fairly high turbulence. The turbulence is likely due to dense brush in the ravine north of the met tower. AEA awarded a feasibility study for New Stuyahok in 2010 which included funding for another met tower study. It was thought that an alternate site might result in wind data with less turbulence. The site chosen for the second met tower is the north end of the old runway. Data from the second met tower (January 2012 to July 2014) indicates a similar wind resource as measured by the first met tower, and also indicates fairly high turbulence as well. The turbulence, though, is moderate in the direction of prevailing winds and higher in non-prevailing wind directions.

The WAsP software analysis was accomplished by assessing the orographic effects of the wind as measured by the first met tower (north of the old airport apron). This met tower was chosen as that location is a natural elevation and hence better interpreted by WAsP software than data from the second met tower. The terrain between New Stuyahok and Ekwok was modeled with a 2 arc-second digital elevation map (DEM) converted from the 1954 USGS topographic map of the area. For this reason, this DEM is of relatively low precision. Alaska is being re-surveyed to produced very high resolution DEM's, but the Bristol Bay region has not yet been included in this effort. The DEM was converted from geographic coordinates to universal transverse meridian (UTM) for use by WAsP and also converted from NAD27 to WGS84 datum to align it with Google Earth imagery. The met tower station was located to the correct easting/northing in the DEM and assigned an elevation by WAsP. The assigned elevation correlates well with Google Earth and the original topographic map. Although the met tower is 30 meters high, an evaluation height of 37 meters was selected in order to predict annual energy production from the new Northern Power Systems NPS100C-24 wind turbine, a likely candidate turbine for New Stuyahok/Ekwok. The wind data was extrapolated from 30 to 37 meters with Windographer software and exported for use by WAsP.

Intertie Route

AVEC's plan is to designate New Stuyahok as the primary powerplant, connect New Stuyahok to Ekwok with a three-phase, overhead, electrical distribution intertie, and convert the Ekwok power plant to standby status. Greg Errico, P.E. has designed two preliminary intertie routes; the final route likely between once staked in the field, according to Mr. Errico.

New Stuyahok-Ekwok intertie route options (yellow and red lines), Google Earth, view northwest

Airspace Restrictions

The New Stuyahok airport (upper right in the image above) has an unattended 3,282 ft. runway with normal left-left VFR traffic patterns. Two non-precision RNAV (GPS) instrument approaches and one RNAV departure are published for the New Stuyahok airport. The Ekwok airport (middle left in the image above) has an unattended 3,319 ft. runway with normal left-left VFR traffic patterns. No instrument procedures are published for the Ekwok airport.

Wind turbines are high structures and hence by nature can have adverse effects on aircraft operations. Federal Aviation Regulation Part 77, administered by FAA, includes descriptions of the imaginary surfaces that radiate from airports and result in potential height restrictions for prospective wind turbine projects. With the New Stuyahok and Ekwok airports, most restrictive is the horizontal surface which surrounds each airport by 5,000 ft. from the sides and runway thresholds and allows FAA to restrict obstructions below 150 ft. above the established airport elevations. Beyond that is the 20:1 conical surface which extends another 4,000 ft. In-line with the runways are the outer and inner approach and transitional surfaces. See the following image for a visual representation of the FAR Part 77 surfaces.

FAR Part 77 airport imaginary surfaces

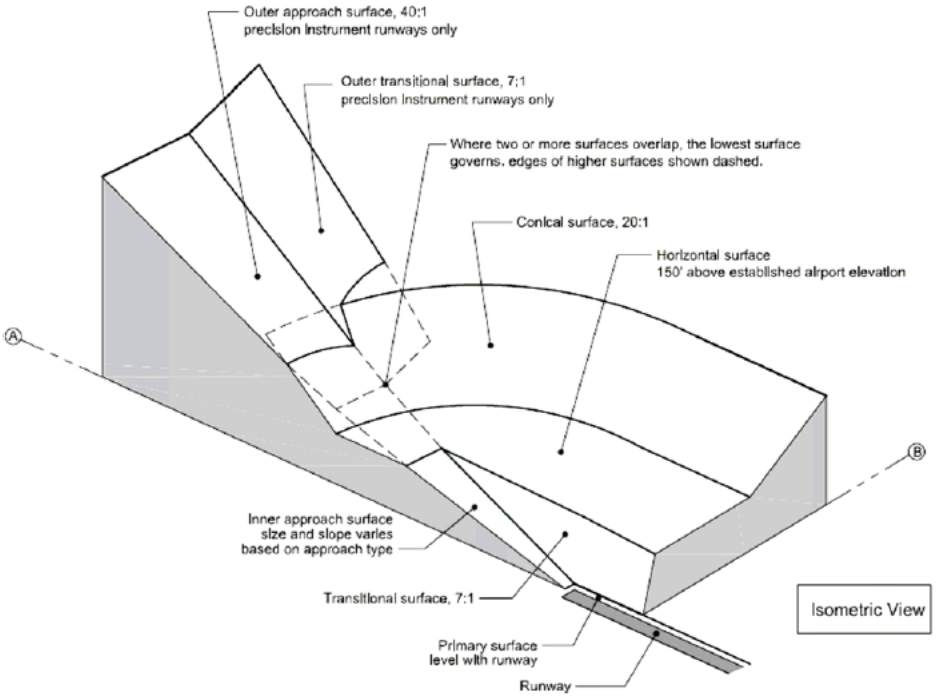
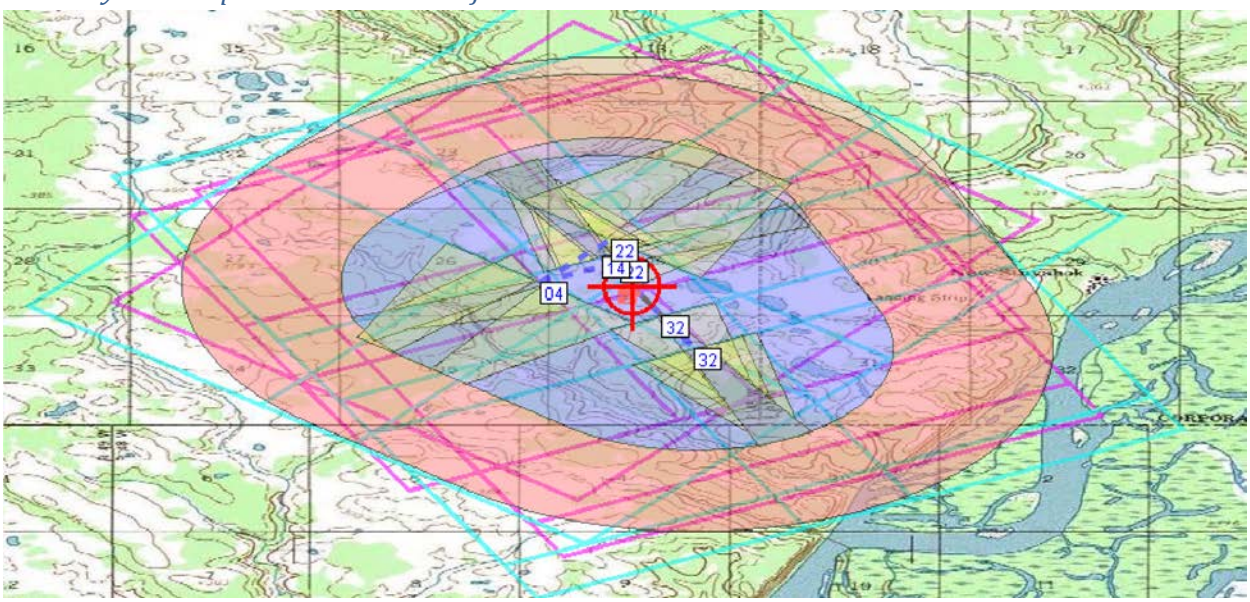


Figure A.3. FAR Part 77, §77.25 civil airport imaginary surfaces.

Compared to Ekwok Airport, the FAR Part 77 imaginary surfaces for the New Stuyahok airport are the most restrictive for wind power options along intertie route as higher terrain and hence windier conditions are nearer New Stuyahok.

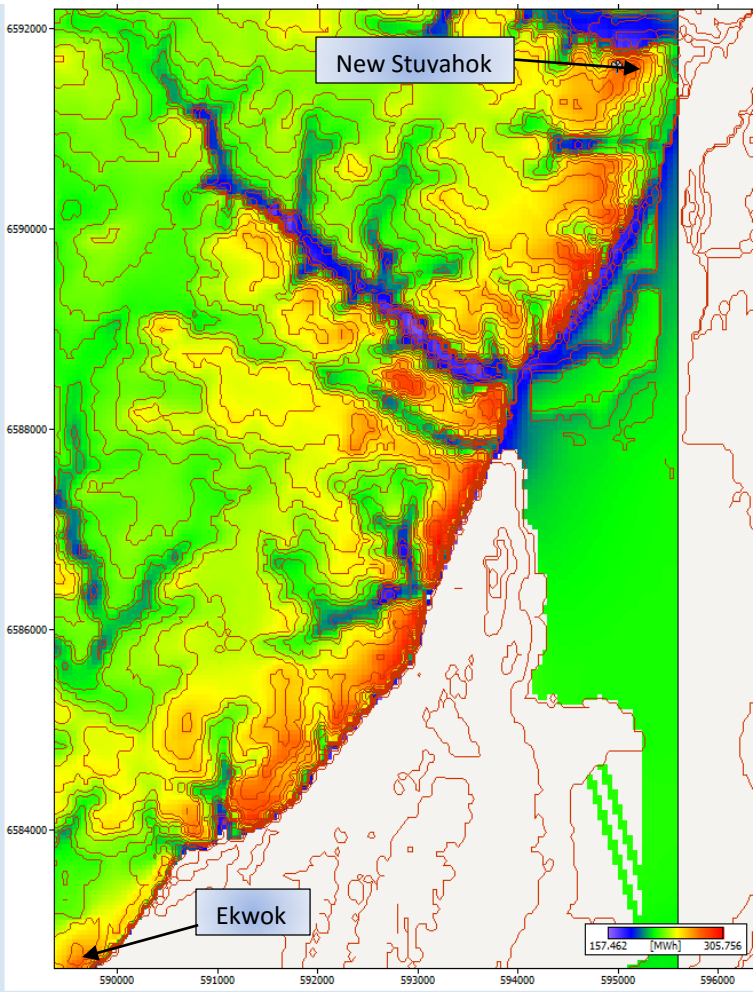
New Stuyahok Airport FAR Part 77 surfaces



WAsP Modeling

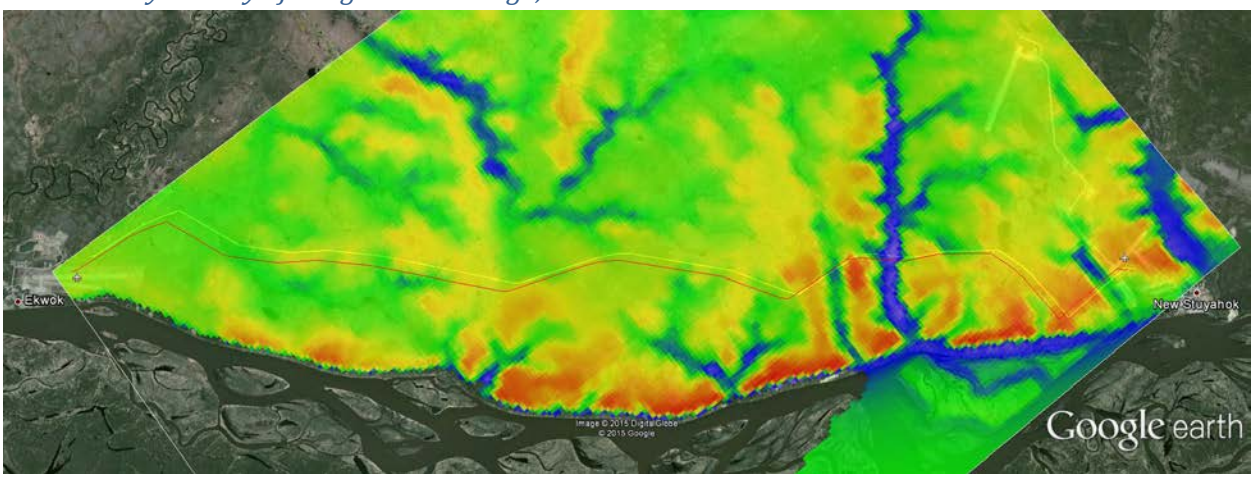
With WAsP software, a resource area from New Stuyahok to Ekwok was created to visually display by color coded wind speed, wind power density, turbine annual energy production (AEP), and/or other data of interest. On examination of WAsP-predicted wind power density, prospective wind power sites along or near the intertie route were identified. In general, these are higher hills and the high bluff edge between New Stuyahok and Ekwok.

WAsP resource map, wind power density



Overlaying the wind power density resource map with Google Earth and the intertie routes yields a map of potential wind power sites on or near the intertie route (following map). As one can see, the more optimal sites (in red) are on or near the river bluff. Practically, nearness to New Stuyahok is desirable as the primary power plant will be located there and hence wind turbines can be more easily managed by full-time plant personnel. Another consideration is alignment of the New Stuyahok and Ekwok airport runways and attendant airspace restrictions associated with each. Note that FAA documentation includes a cross-wind runway in New Stuyahok, even though it is not built.

Wind density overlay of Google Earth image, view to northwest



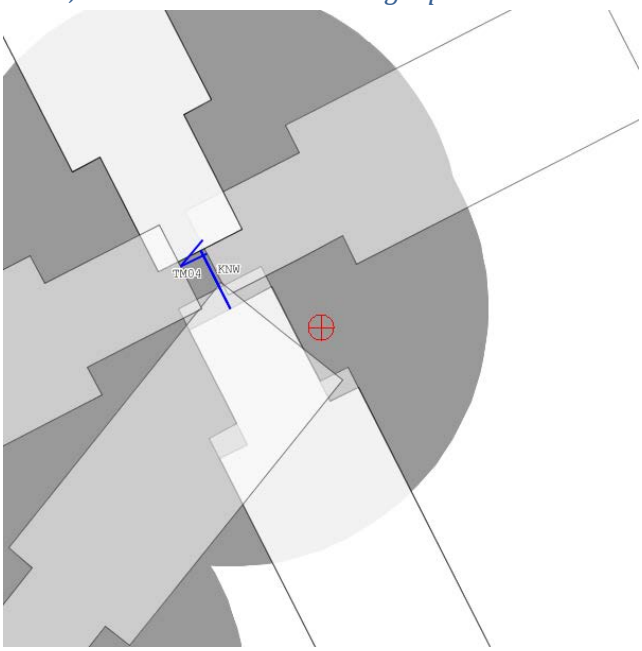
Although a formal FAA obstruction evaluation review is required to assess any site for installation of wind turbines, the FAA notice criteria tool (NCT) is useful to identify the most likely interference issues. With reference to the NCT, several locations are suggested as possible wind power sites along the intertie route.

Site 1

Site 1 is located above the bluff immediately south of the old New Stuyahok airport and just north of where the intertie route makes a 90 degree bend. It is within the control area of the New Stuyahok airport but not under or within runway approach areas.

Site 1 location

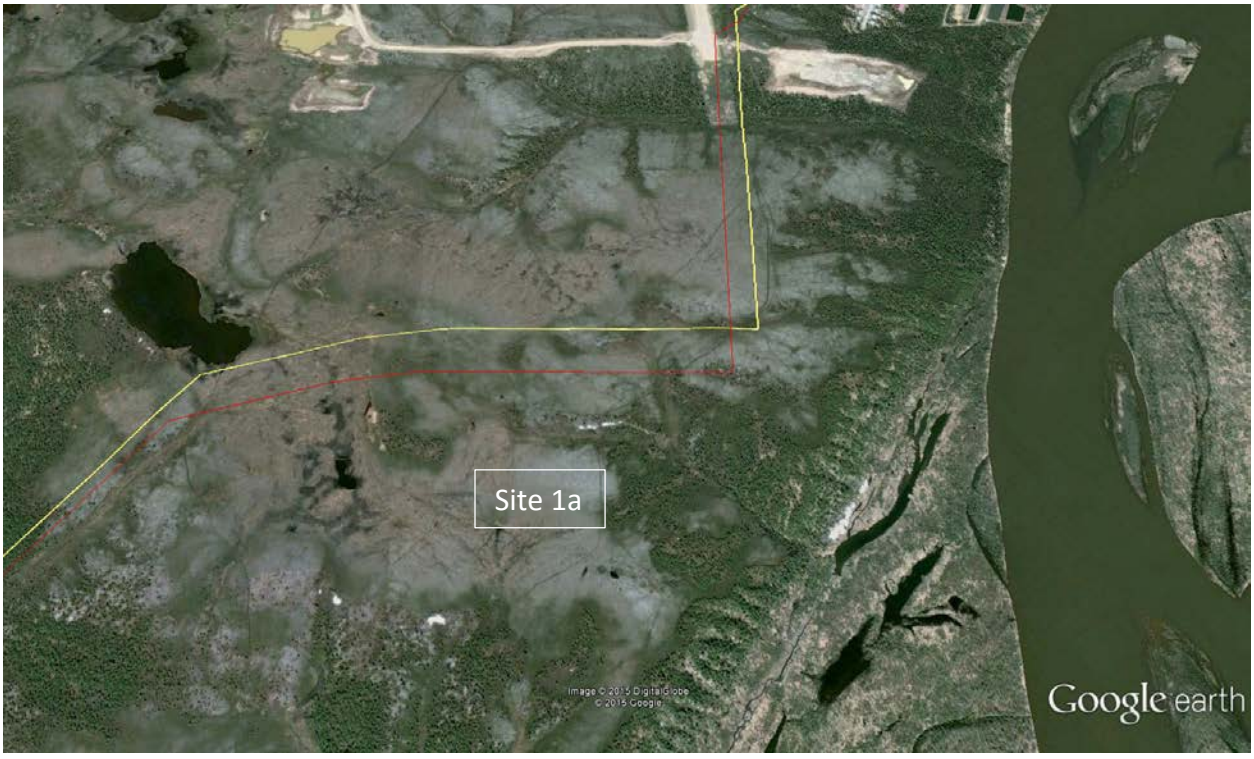
Site 1, FAA Notice Criteria Tool graphic



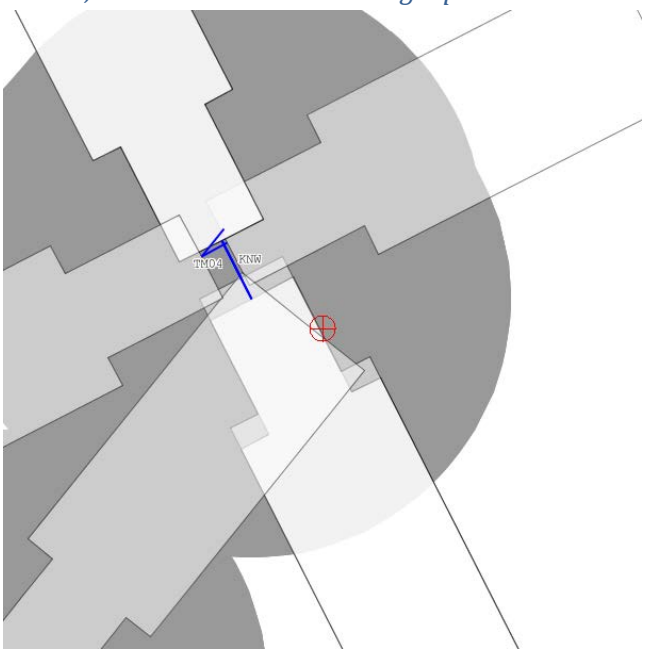
Site 1a

Site 1a is a variation of Site 1 and is located along the bluff just west of New Stuyahok, but slightly south of the 90 degree bend in the intertie route and across a shallow drainage. Like Site 1, it is within the control area of the New Stuyahok airport but not within runway approach areas, although it is close.

Site 1a location



Site 1a, FAA Notice Criteria Tool graphic

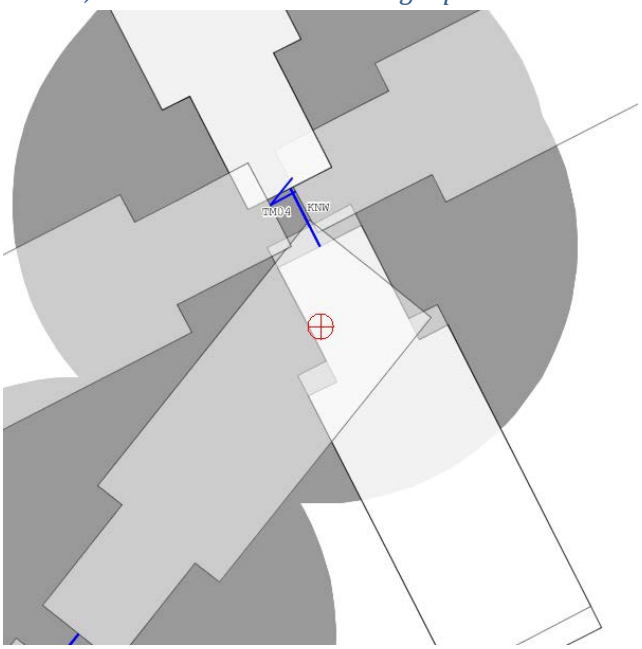


Site 2

Site 2 is a high spot treeless terrain on the intertie route and about 1.25 miles southwest of Site 1a. This site is within the control area of the New Stuyahok airport and also under or within approach areas of the runways for both the New Stuyahok and Ekwok airports.

Site 2 location

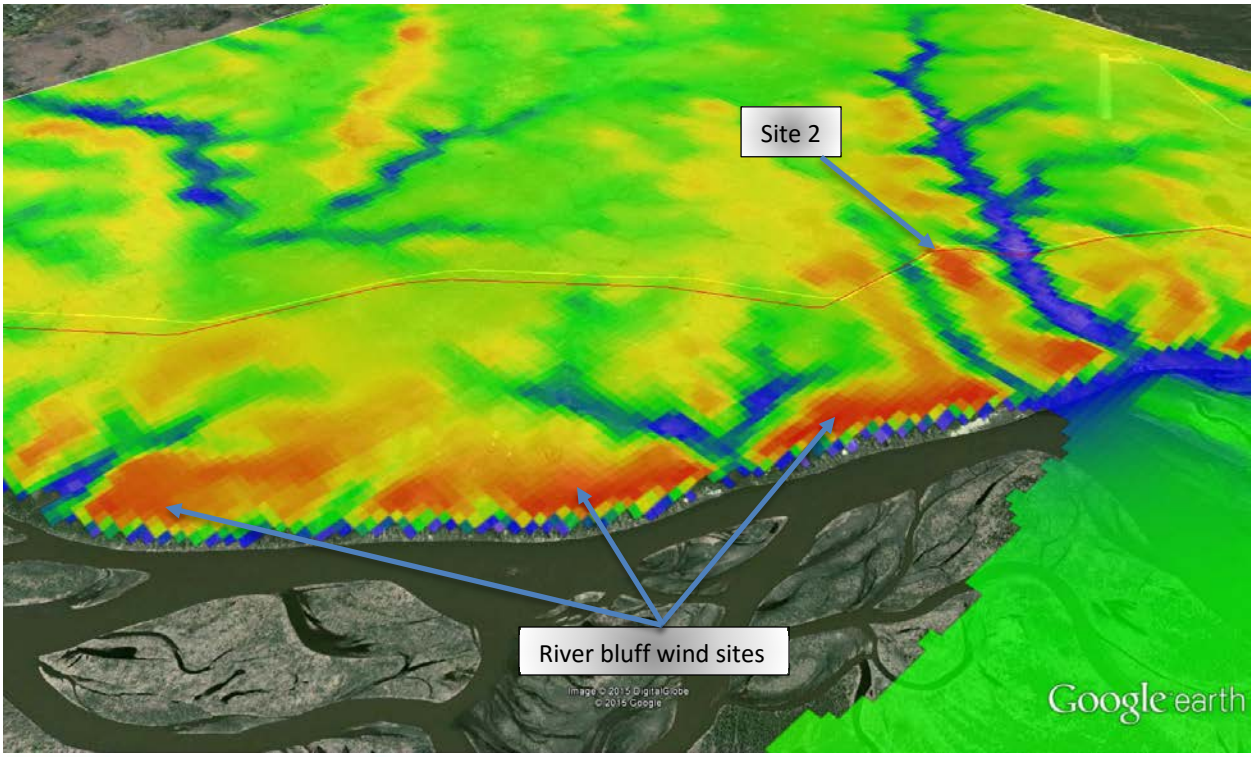
Site 1a, FAA Notice Criteria Tool graphic



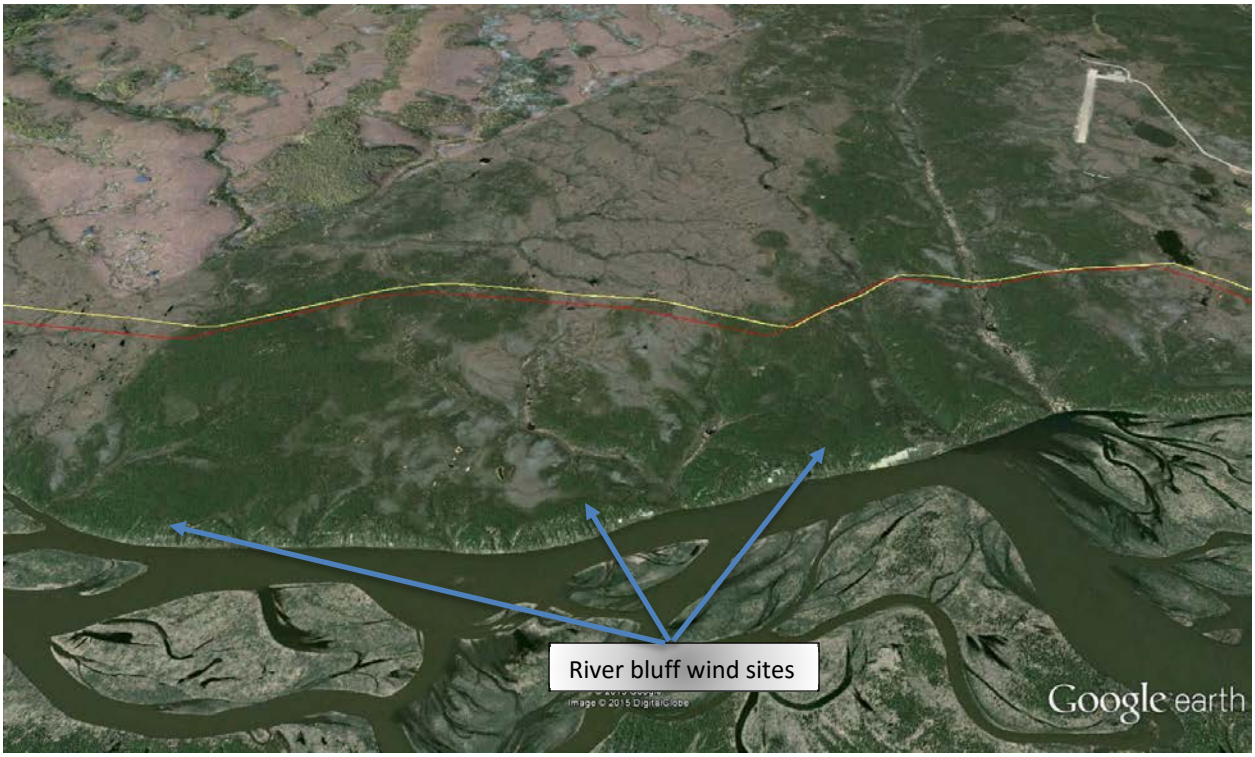
Other Site Options

WAsP software modeling indicates the Nushagak River bluff edges as possible site options, but these areas are relatively far from the intertie route, are tree-covered and within a runway approach area for the Ekwok airport. For this reason, they are not recommended.

River bluff site options



River bluff site options, without wind power density overlay



Recommendation

The wind resource at Sites 1, 1a, and 2 is quite similar (see table below), although Site 2 is slightly better. For wind power development, however, Site 1 is recommended as it is nearest New Stuyahok, presents the fewest airspace restriction issues, and has more room for turbine array layout than Site 1a.

Site 2 is not recommended as airspace restrictions likely would preclude development and, compared to Sites 1 and 1a, a one mile longer access road with a large stream crossing would be required.

Wind Speed Comparison Table (37 meter level, NPS100C-24 wind turbine)

Location	Wind Speed (m/s)	Power Density (W/m^2)	AEP, 100% net (MWh/yr)	AEP, 80% net (MWh/yr)
Site 1	5.82	268	275.6	220.5
Site 1a	5.84	272	277.0	221.6
Site 2	5.93	282	285.0	228.0