7 March 2011

Teller-Brevig Mission Alternate Wind Site Selection Analysis, rev. 1

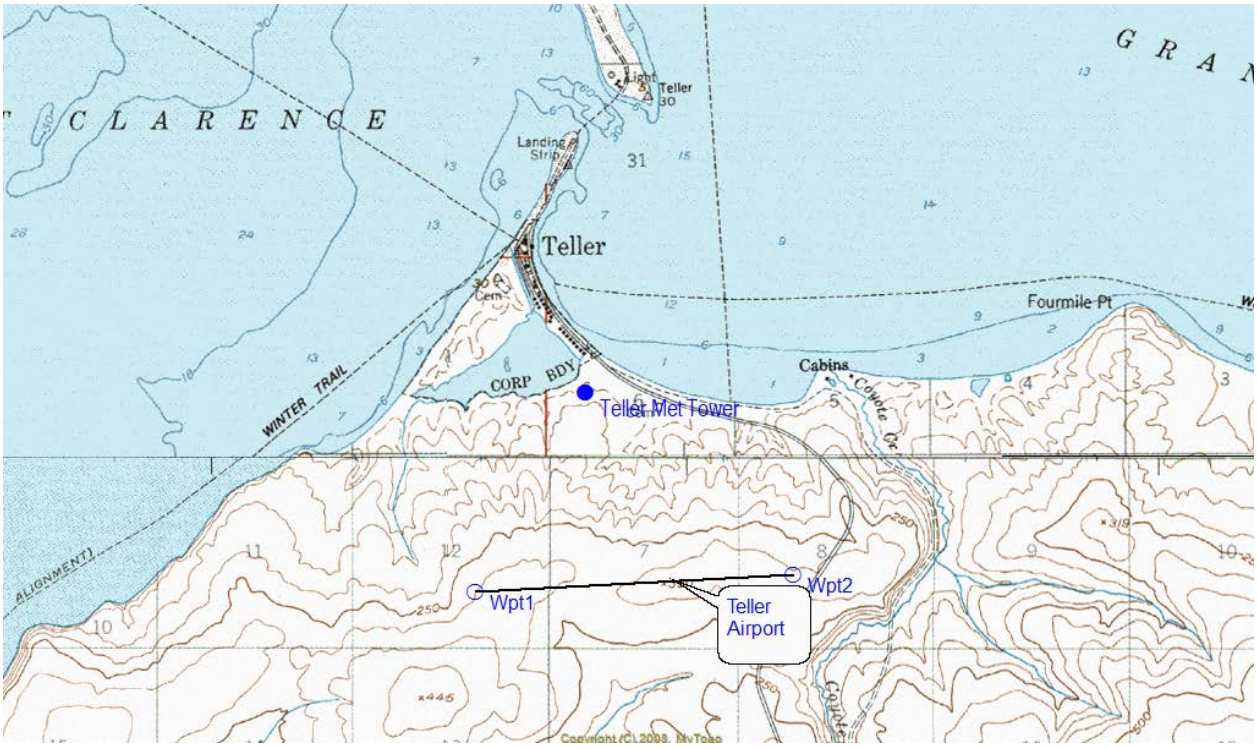
At the request of AVEC staff, an analysis of possible alternative wind turbine siting options in Teller and Brevig Mission is presented in this letter report.

Existing Teller Met Tower Site

The Teller met tower site, shown in Figure 1, was selected by Doug Vaught of V3 Energy, LLC and Chet Frost of AVEC in June 2008 during a trip to Teller to asses siting options for wind turbines. The intent at that time was to find a site presumed to have characteristics favorable for wind power, such as a high wind speed average, minimal icing, and low turbulence. Other site selection factors were proximity to existing roads and power infrastructure, avoidance of conflict with airport airspace, native corporation land ownership, and suitable soil for turbine foundation construction.

The chosen site met the primary criteria of proximity to an existing road and distribution power lines, a dry and accessible site, lack of conflict with Teller airport controlled airspace and landing approaches, and presumed acceptable wind characteristics for wind power development.

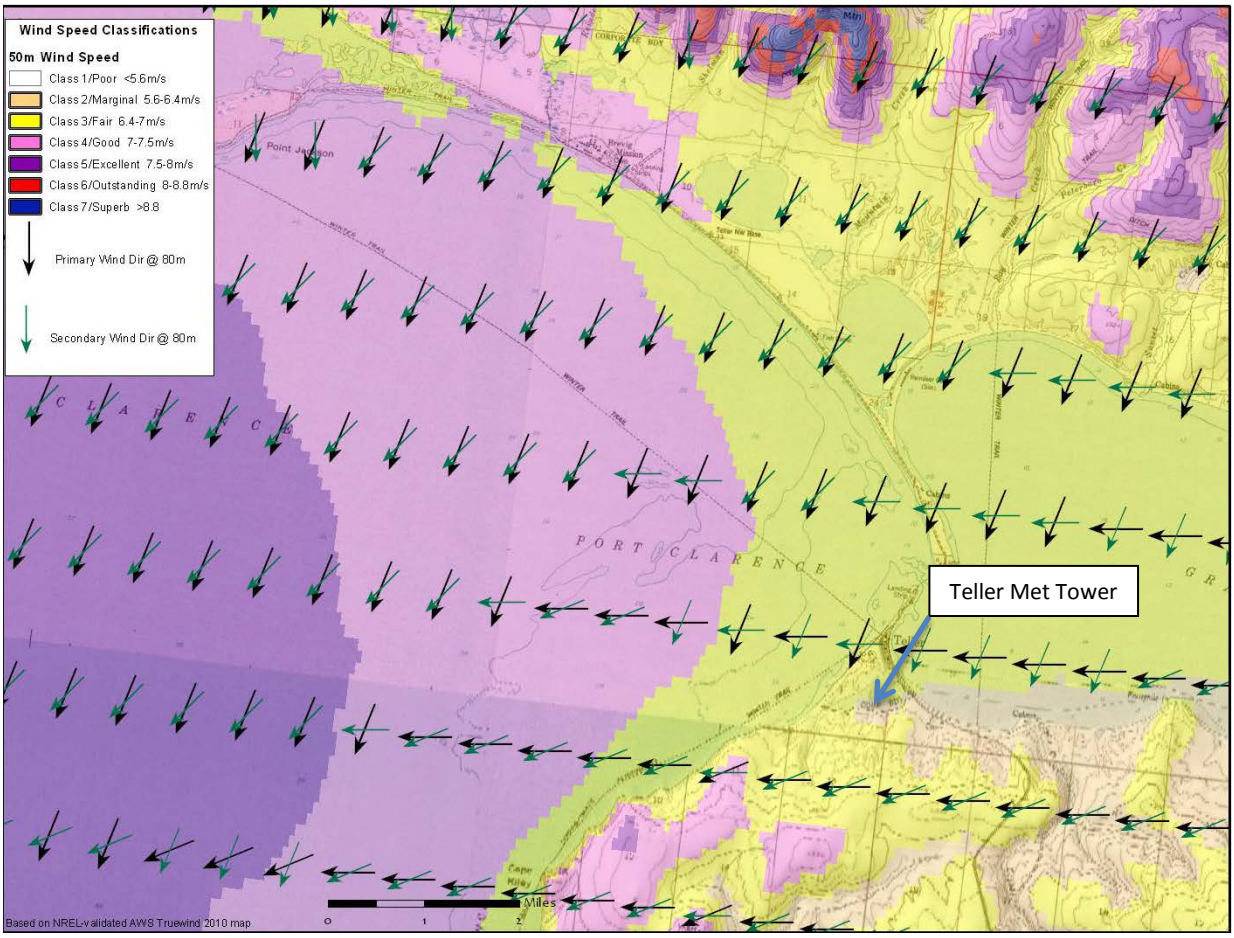
Figure 1, Teller met tower location



Teller Met Tower Data

The Teller met tower was installed in November 2009 and data has been collected through February 2011. A separate wind analysis report will be written to fully describe the wind characteristics of this site, but in short the site is not as promising as had been hoped and preliminarily classifies as high Class 2 to low Class 3. Although the site experiences low turbulence and has a normal wind speed probability distribution, average wind speed is lower than desirable. Predicted capacity factor at the site for a NW100/21 turbine with a 37 meter hub height is approximately 23 percent (100% turbine availability). Referencing Figure 2, an AWS Truewind wind direction and wind class map (beta version) generated by AEA, notice that the Teller met tower data classifies as expected. Also noted in the met tower data is that the predicted primary wind direction of ENE was verified.

Figure 2, Teller AWS Truewind map



Analysis of data from the Teller airport AWOS (automated weather station) indicates that the airport experiences stronger winds, with an approximate seven percent higher wind speed average compared to the met tower site and hence would classify as wind power Class 3. Note in the figure above that AWS Truewind accurately predicts this wind classification at the airport. The higher mean wind speed at the airport translates to a 15 percent comparative improvement in NW100/21turbine capacity factor. Still, predicted capacity factor at the elevation of the airport (presuming 100% turbine availability) is

only 26.7 percent. The problem of course is that turbines cannot be constructed at the airport. Presumably turbines could be installed further up the hill from the existing met tower site, toward the airport, but at some point FAA would object to the location, so at best perhaps a 10 percent comparative improvement of turbine capacity factor from the met tower site may be possible.

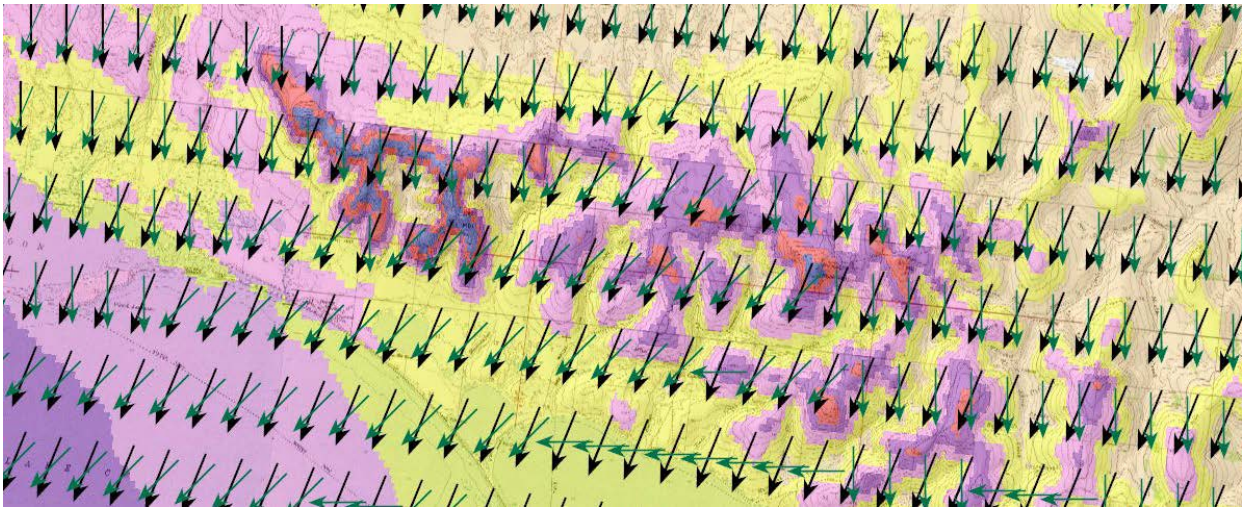
New Site Search Criteria

The challenge then is to identify a wind site with higher wind speeds where the met tower can be relocated and where turbines can potentially be constructed. Ideal siting criteria remains as before: high mean wind speed with low turbulence and minimal atmospheric icing, proximity to existing roads and power distribution infrastructure, non-interference with airport operations, suitable soil for foundations, and acceptable land ownership constraints. It is recognized, however, that meeting all ideal criteria may not be possible. That is, a site with high wind speed (and hence high turbine capacity factor) may not meet road and power infrastructure proximity criteria, the desire for minimal atmospheric icing, and/or desirable land ownership constraints.

Brevig Mission

AWS Truewind mapping (Figure 3) and input from Brevig Mission residents indicates that indeed higher winds are present in Brevig Mission itself (potential Class 4) and in the surrounding hills (up to Class 7).

Figure 3, Brevig Mission AWS Truewind map

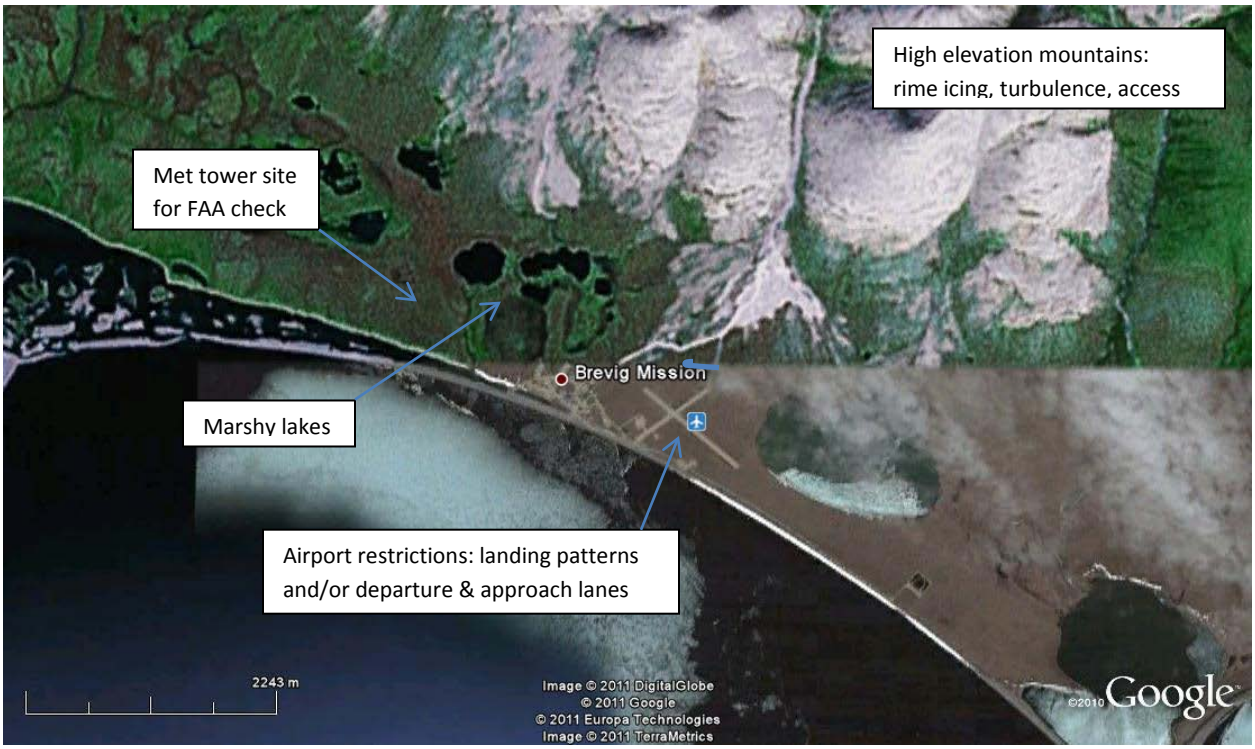


Identifying a wind power site at or very near Brevig Mission is difficult due to the location and configuration of the airport with main and crosswind runways at the edge of the village which require more landing pattern space than single runway airports. Also, with two runways, Brevig Mission has four approach and departure lanes to consider, although one of them extends over the ocean and hence is irrelevant as a turbine location restriction.

Considering Figure 3 and noting the location of the airport in Figure 4, one can see that placement of wind turbines very near Brevig Mission is clearly impossible from an airport operations perspective. Possible Class 4 winds are predicted on lower elevation terrain to the west and northwest of Brevig

Mission, but this terrain is not accessible by road and is separated from the village by a number of marshy lakes that extend from the mountains to water's edge. Developing wind power to the west of these lakes would be difficult and expensive given the need to construct an access road. Also, noted in in Figure 4 as "met tower site for FAA check" and in Figure 5 as a red circled cross, a met tower or wind turbines at a location just west of the marshy lakes is well within airport operation zones and based on experience with several other wind power projects in rural Alaska, is not likely to gain FAA approval.

Figure 4, Brevig Mission Google Earth image

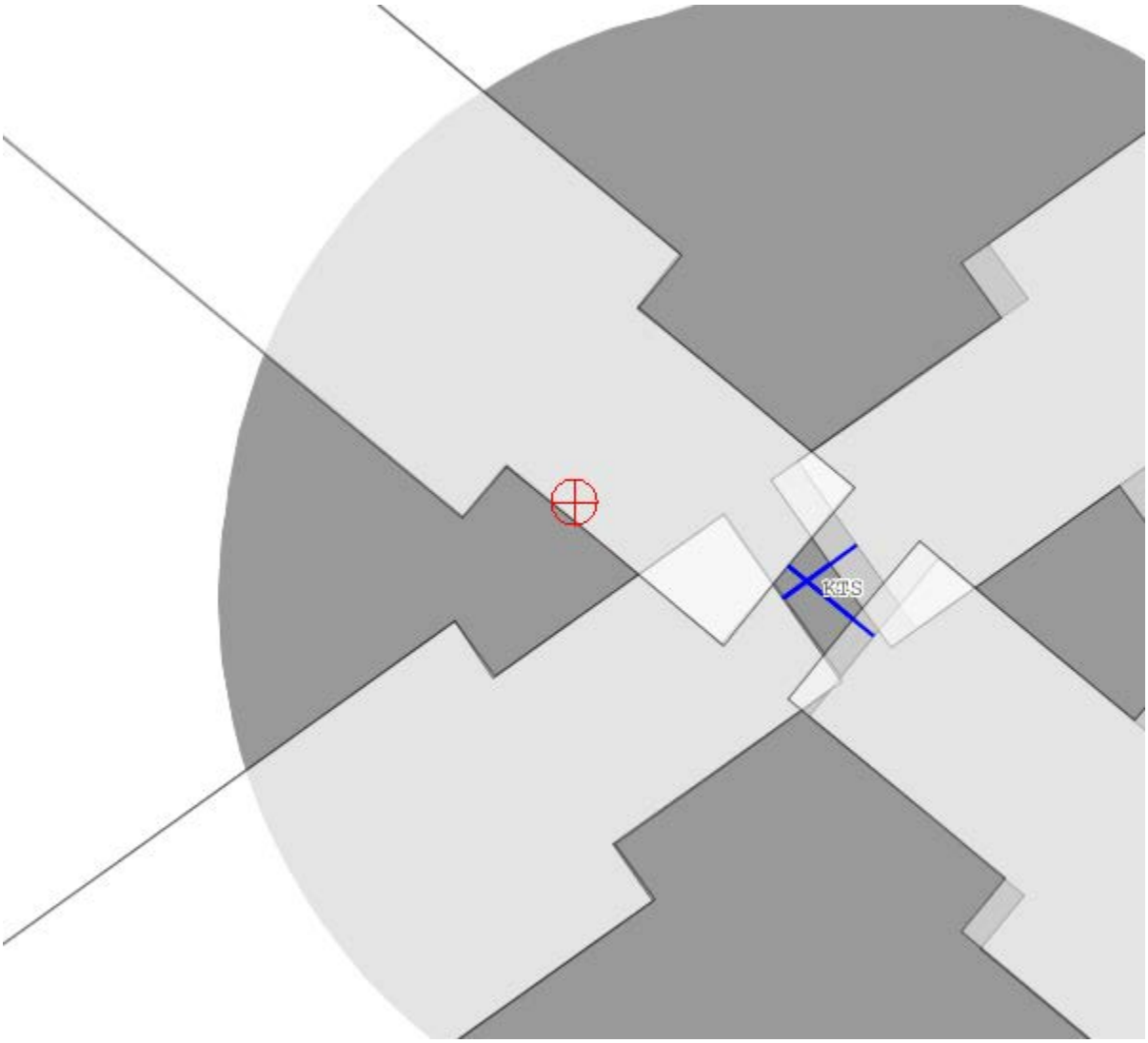


As one would expect, high wind speeds are predicted in the mountains north and northeast of Brevig Mission (refer to Figure 3). There are several problems to consider, however. First, the mountain tops and ridges are very high elevation, from 925 on the ridge north of Shelman Creek (see Figure 6) to nearly 1,400 feet on Red Mtn. These high elevations, combined with the arctic latitude and coastal proximity, virtually guarantees significant rime icing problems. A nearby example of the icing risk is Nome's Banner Ridge wind farm. At only 500 feet elevation, Banner Ridge experiences severe winter rime icing problems which has negatively impacted their wind turbine operations.

Further considering a mountain location for wind power, it should be noted that mountain winds are often very turbulent and gusty, which is highly undesirable for wind turbines. Given the prevailing northerly winds through the mountains north of Brevig Mission, all terrain on south-facing slopes will be in the lee of terrain obstacles and hence highly turbulent. The one possibly turbulence-free location would be the previously mentioned 925 foot elevation ridge north of Shelman Creek (this creek drains southwest toward Brevig Mission. This ridge *may* experience reasonably smooth winds with low shear,

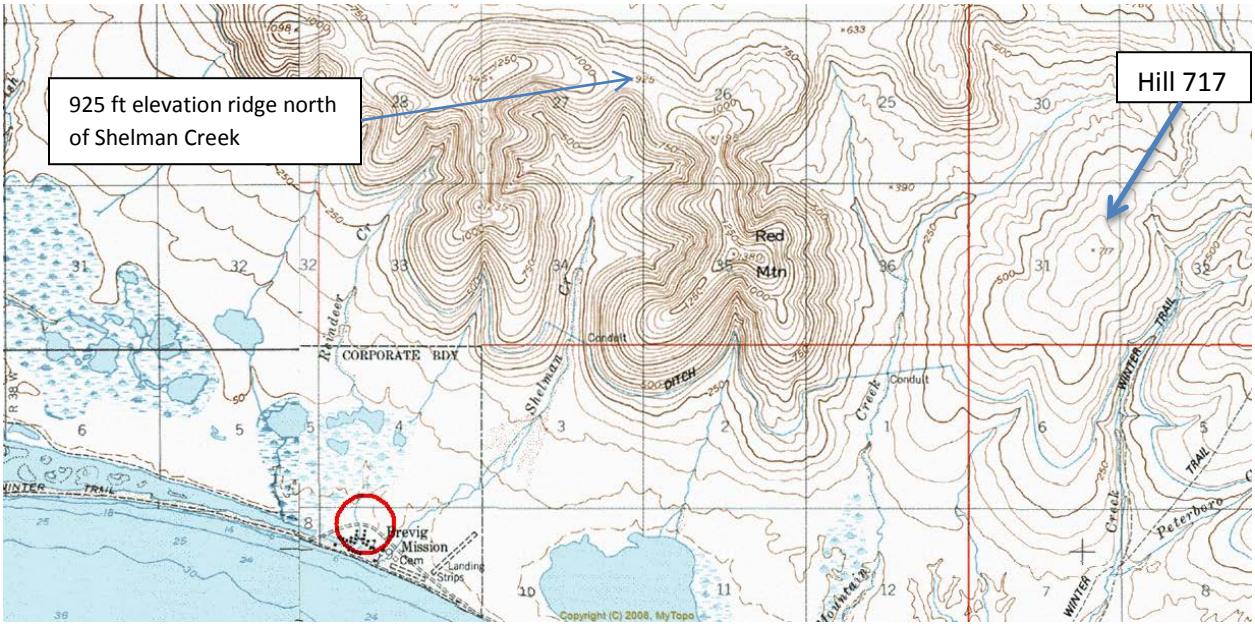
but it is bounded to the south by steep slopes which would make access very difficult and again, its elevation compared to Nome's Banner Ridge indicate likely severe rime icing risk.

Figure 5, Brevig Mission Airport restriction zones



Looking further east of Red Mountain, one can see in Figure 6 a high rounded hill in Grid 31 with an elevation of 717 feet (Hill 717). This hill is predicted in Figure 3 to have a wind classification (Class 5) and may also experience relatively smooth winds, but again, the high elevation poses concern for rime icing risk. Also note that this hill is 4.5 straight-line miles from Brevig Mission, across terrain without an existing access road and the hill top itself is relatively small when considering the need to install multiple turbines for wind power development. Moving further east, undoubtedly a number of sites with acceptable wind characteristics can be found, but they are too far from the village and any existing roads and power infrastructure to be considered at this time.

Figure 6, Brevig Mission Topo Map



Teller

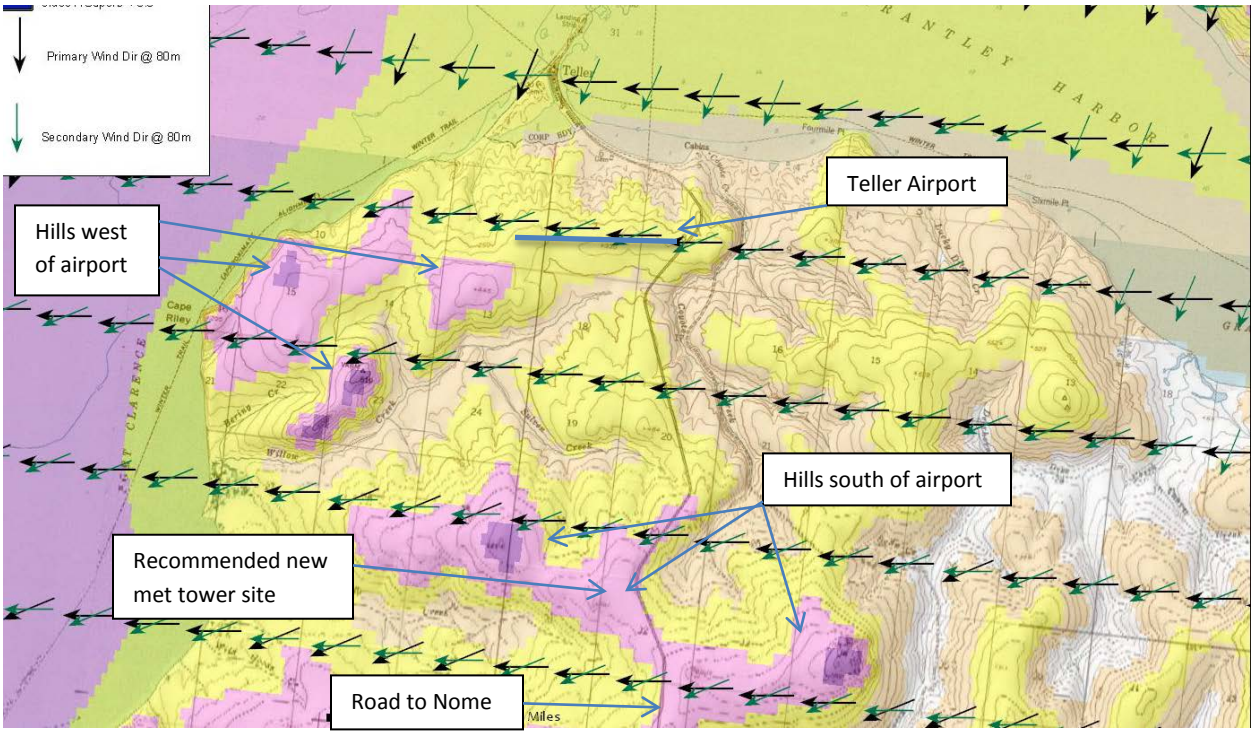
Given that the present met tower site in Teller is located in a marginal location for wind turbine productivity, and considering the wind classification areas of Figure 2 which show that Teller itself, the Teller airport and the immediately surrounding areas are Class 3 and some Class 2 winds, it is necessary to look further to find more productive wind power sites. Referring to Figure 7, the only two realistic options relatively near Teller that are wind power Class 4 or higher are two series of hills: the first a few miles west and southwest of the Teller airport and the other a slightly further distance from the airport, but due south.

The hills west of the airport, although closer to Teller than the hills south of the airport, are potentially problematic, depending on the exact location, with respect to airport operations, especially with respect to navigation aids for ILS approaches and missed approaches lanes. The more significant issue, however, concerning the hills west of the airport are their isolation from existing roads and power infrastructure, which poses the same development hurdle as would Hill 717 and other terrain northeast of Brevig Mission.

The hills south of the Teller Airport are the second possibility for Class 4 and higher winds based on the AWS Truewind modeling in Figure 6. Although these hills are perhaps further from Teller than desired, they are bisected by the Nome-Teller Highway, which is an enormous advantage with respect to constructability and cost of wind power development. At present, single phase power along the Highway exists from Teller to the airport access road. Development of wind power in these hills (refer to Figure 7) would require construction of 3.6 miles of new three-phase distribution plus upgrade of the single-phase line to three-phase from the airport to Teller.

One possible disadvantage of the hills south of the Teller airport is the elevation of about 700 feet. As noted in the earlier discussion regarding possible Brevig Mission wind power sites and Nome's Banner Ridge turbine site, 700 feet elevation is sufficiently high to experience winter rime icing problems. The tradeoff of wind speed and rime icing risk is a tricky problem as the AWS Truewind mapping predicts, and Teller met tower and airport AWSS data has confirmed, that the higher wind speeds desirable for wind power development are found only at higher elevations in the Teller-Brevig Mission area, with the possible exception of lower elevation terrain west of Brevig Mission. But, as noted earlier, the terrain west of Brevig Mission appears to be very marshy and would require construction of access across existing marshy lakes, more complex and expensive turbine foundations, and airport operations interference as previously noted.

Figure 7, AWS Truewind map of new Teller wind site option

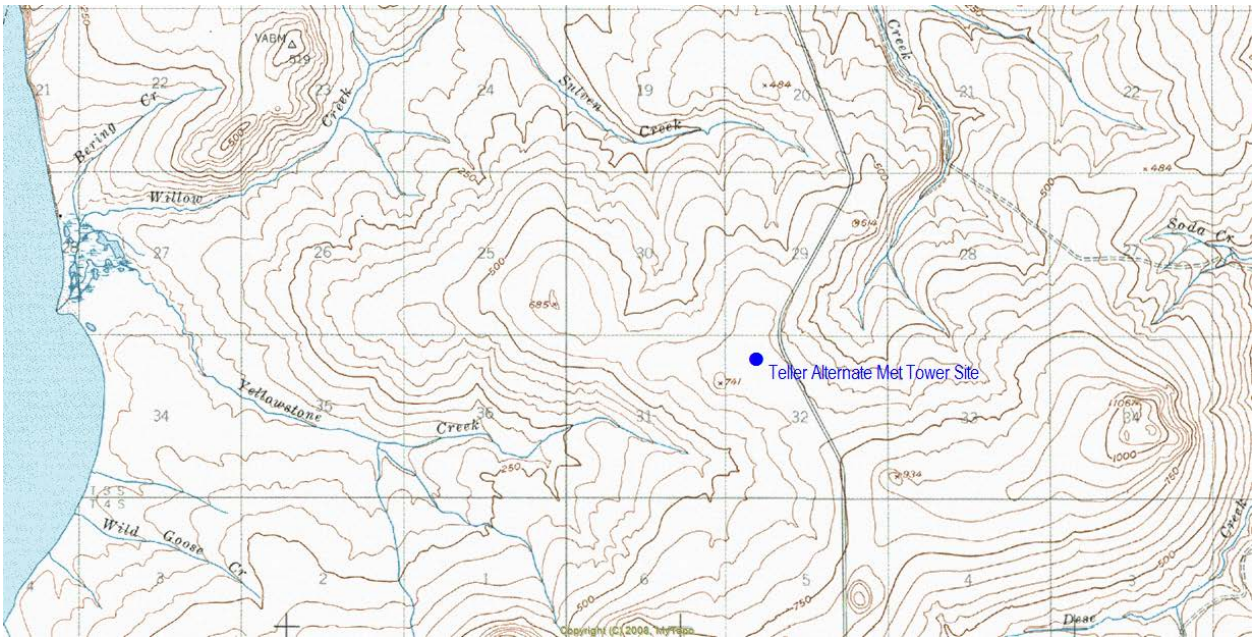


Recommendation

It is recommended that a met tower be installed at the 700 foot elevation hill just west of the Nome-Teller Highway about 3.5 miles south of the Teller airport (refer to Figure 8). This site has the advantage of a higher predicted wind class which if true will result in higher turbine capacity factor. A second advantage of the site includes easy access to an existing road, although note that the road is not at present maintained during winter south of Teller airport. Additionally, construction of new power distribution lines on rocky upland terrain along an existing road is considerably less expensive than across marshy terrain which requires winter-only work, or across virgin terrain which precludes the use of standard utility pole setting vehicles and equipment. Finally, this site and the adjoining Hill 685 about 1.5 miles west appear to be flat and broad enough to enable construction of an access road and layout of several turbines sufficiently spread out to minimize turbine wake effect interference.

Latitude and longitude of the recommended met tower site is at or near 65° 11’ 22.0’’ North, 166° 19’ 14.2” West (WGS84). With use of FAA’s Notice Criteria Tool on their oeaaa.faa.gov website, a 200 foot elevation obstruction on the site does not trigger FAA notice criteria. A met tower up to 200 feet in height may be installed at any time without FAA notice and with no lighting requirement, although painting the met tower with ten-foot alternate red or orange and white bands is advisable to enhance visibility for aircraft.

Figure 8, Recommended Teller alternate met tower site



If an NRG tubular met tower is installed at this recommended site, consideration should be given to using a super heavy duty (eight-inch diameter) or extreme heavy duty (ten-inch diameter) model to improve the odds of the met tower surviving wintertime rime icing events which are likely at the 700 foot site elevation. A meter met tower of 40 meters is preferred as this extends past the hub height of most village-scale wind turbines. Also, given the remoteness of the site and the lack of winter road access, a satellite modem to communicate data is advisable.