EXPANSION OF THE OR-SAGE ANALYSIS TOOL TO COVER ALASKA

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September 2015

In April 2015, Oak Ridge National Laboratory (ORNL) staff characterized eleven Air Force Space Command (AFSPC) sites for the potential for siting a small modular reactor (SMR) at each site using the Oak Ridge Siting Analysis for Power Generation Expansion (OR-SAGE) tool. An additional site characterization at Clear Air Force Station in Alaska was desired as part of this project. As a result, in May 2015, DOE-NE funded ORNL to add the capability to the OR-SAGE analysis tool to include SMR site analyses in Alaska and Hawaii.

The OR-SAGE tool is a dynamic visualization database. The site evaluation criteria (SEC) represent the database fields from which specific (static) queries can be built. The SMR SEC typically include:

1. Population density less than 500 people per square mile within ten miles of the site boundary
2. Wetlands and open water are excluded
3. Protected lands (e.g., national parks, historic areas, wildlife refuges) are excluded
4. Land with moderate or high landslide hazard susceptibility is avoided
5. Land that lies within a 100 year floodplain is excluded
6. Land with a slope of greater than 18% (~10°) is avoided
7. Land too close to identified fault lines is avoided (the length of the fault line determines the standoff distance)
8. Land located in proximity to hazardous facilities (commercial airports with a 5-mile buffer and oil refineries with a 1-mile buffer) is avoided
9. Land with safe-shutdown earthquake peak ground acceleration (2% chance in a 50 year return period) greater than 0.50 g is excluded
10. Land areas that are more than 20 miles from sufficient cooling water makeup sources (based on taking no more than 10% of available stream flow calculated using 7-day, 10-year low flow data) of at least (bounding values – often select 65,000 gpm for SMR queries)
    a. 84,000 gpm are excluded
    b. 20,000 gpm are excluded

The landslide hazard geographic information system (GIS) layer supported by the US Geological Survey does not currently cover Alaska; however this GIS layer closely follows the slope GIS layer, which is available. Therefore, ORNL staff was able to replicate 9 of the 10 SMR (GIS) data layers noted above for Alaska. The individual GIS layers for Alaska are shown on the subsequent pages in Fig. 1 through Fig. 10. Areas shown in magenta do not meet the SEC query value from the above list.

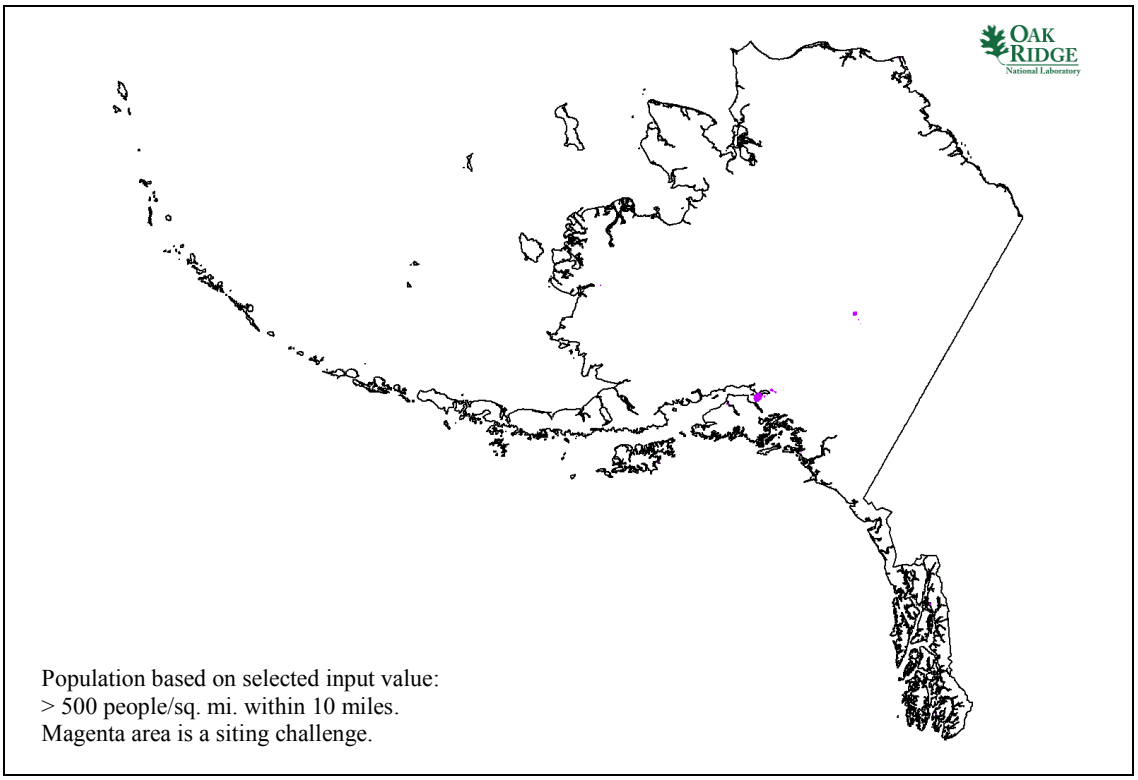

Fig. 1. Nominal, bounding SMR high-population SEC layer.

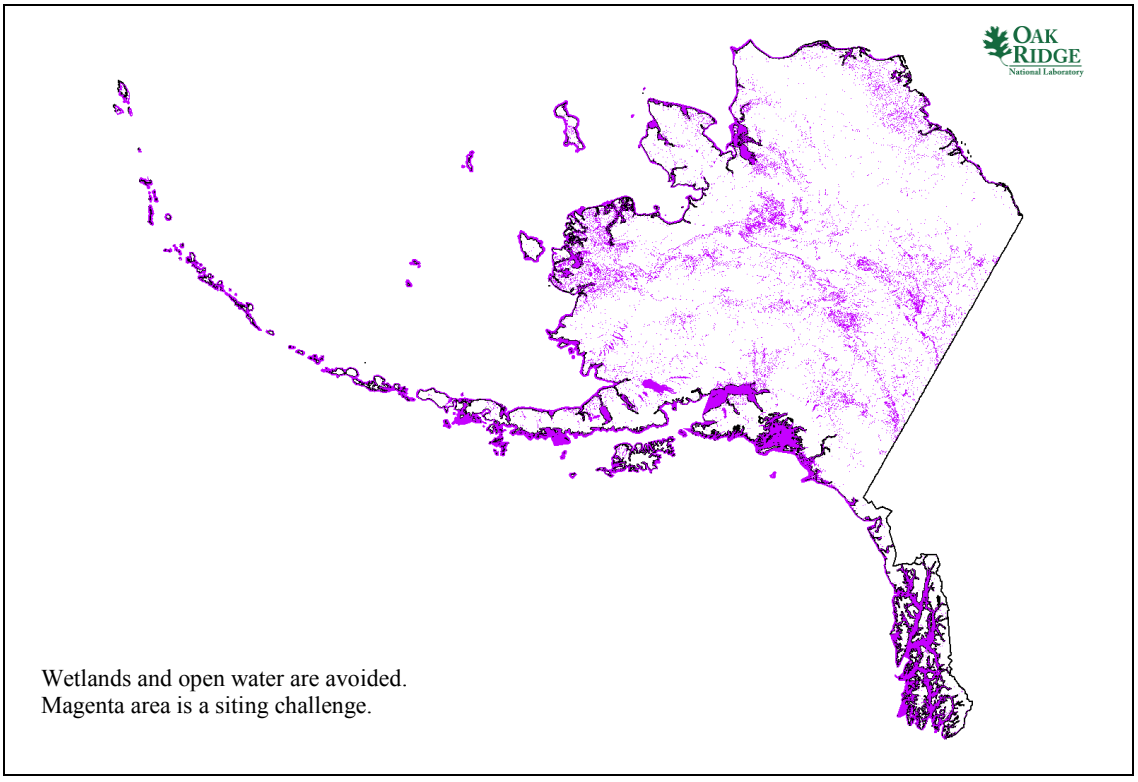

Fig. 2. Nominal, bounding SMR wetlands and open water SEC layer.

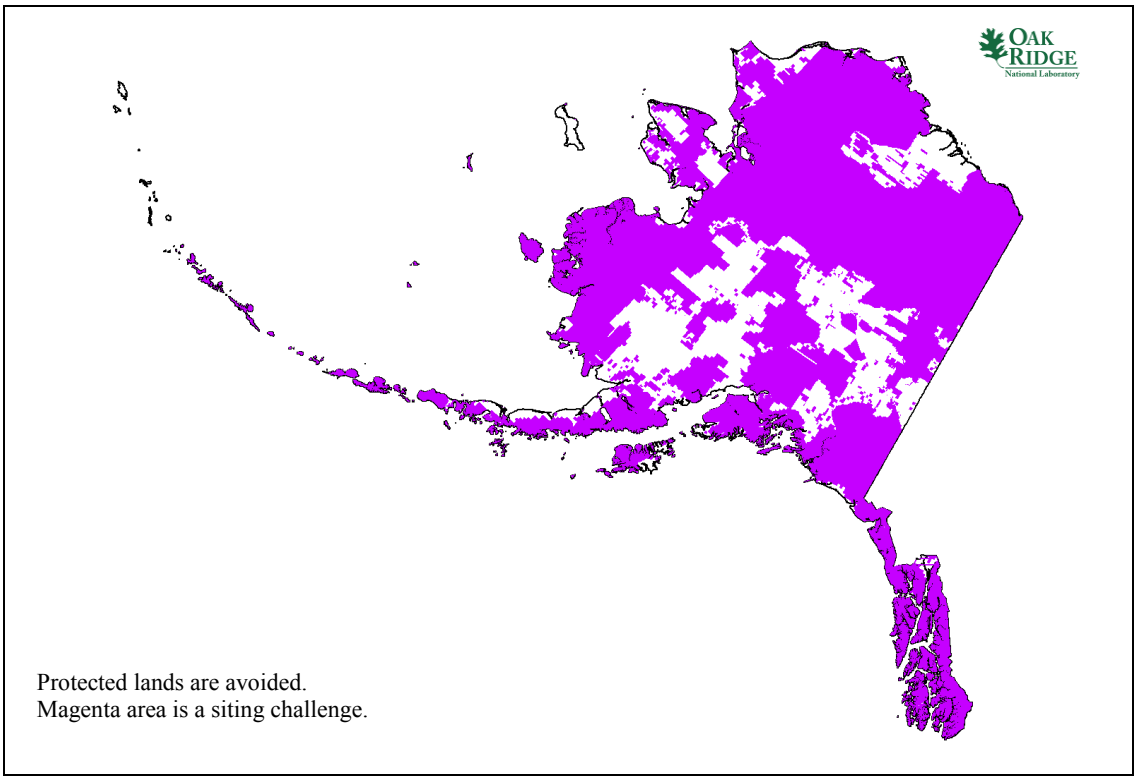

Fig. 3. Nominal, bounding SMR protected-lands SEC layer.

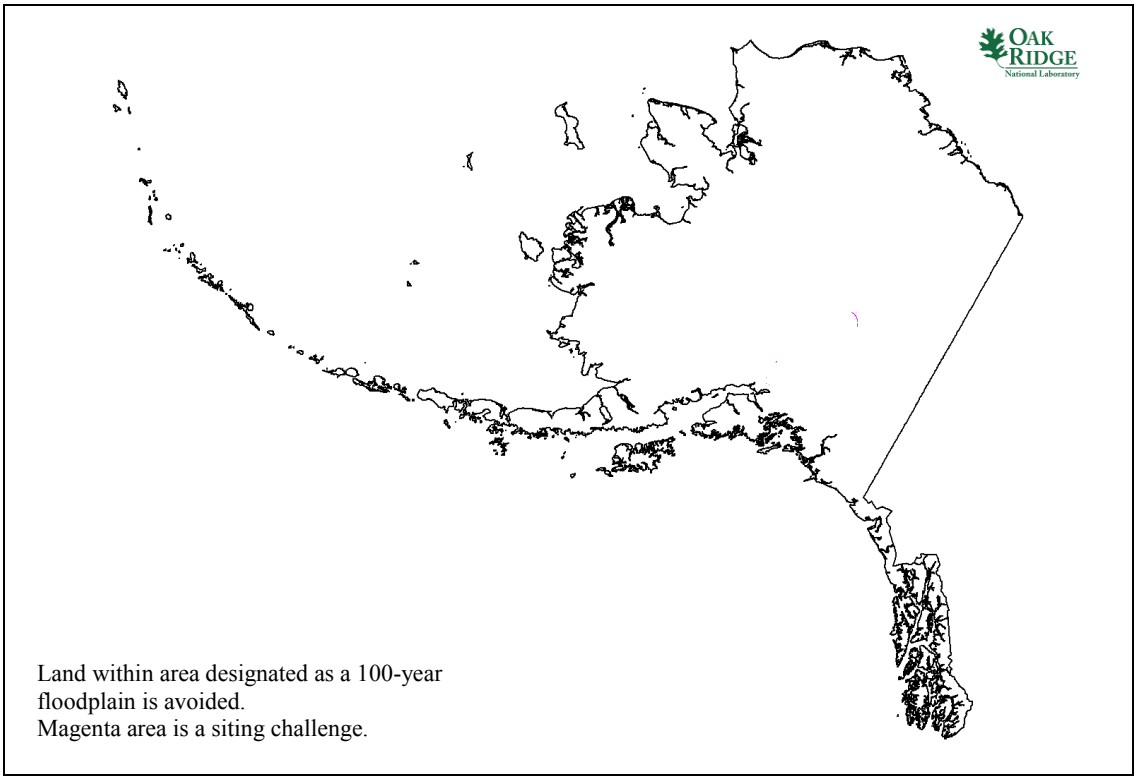

Fig. 4. Nominal, bounding SMR 100-year floodplain SEC layer.

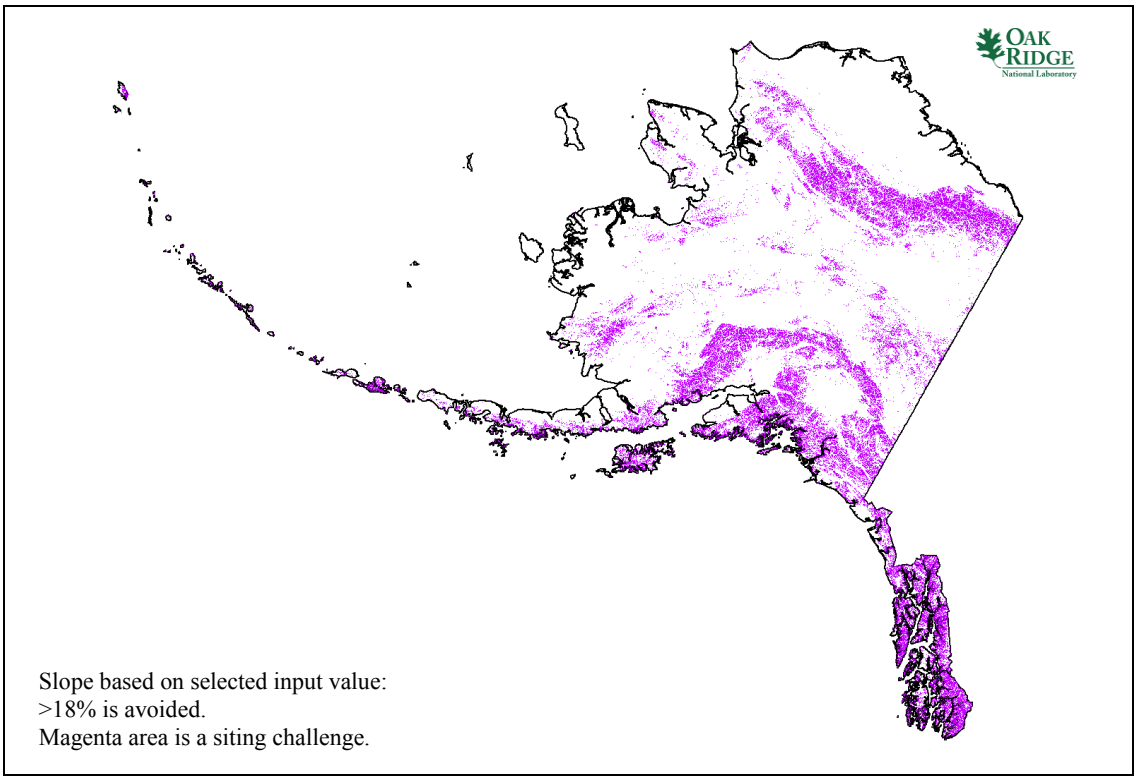

Fig. 5. Nominal, bounding SMR high-slope SEC layer.

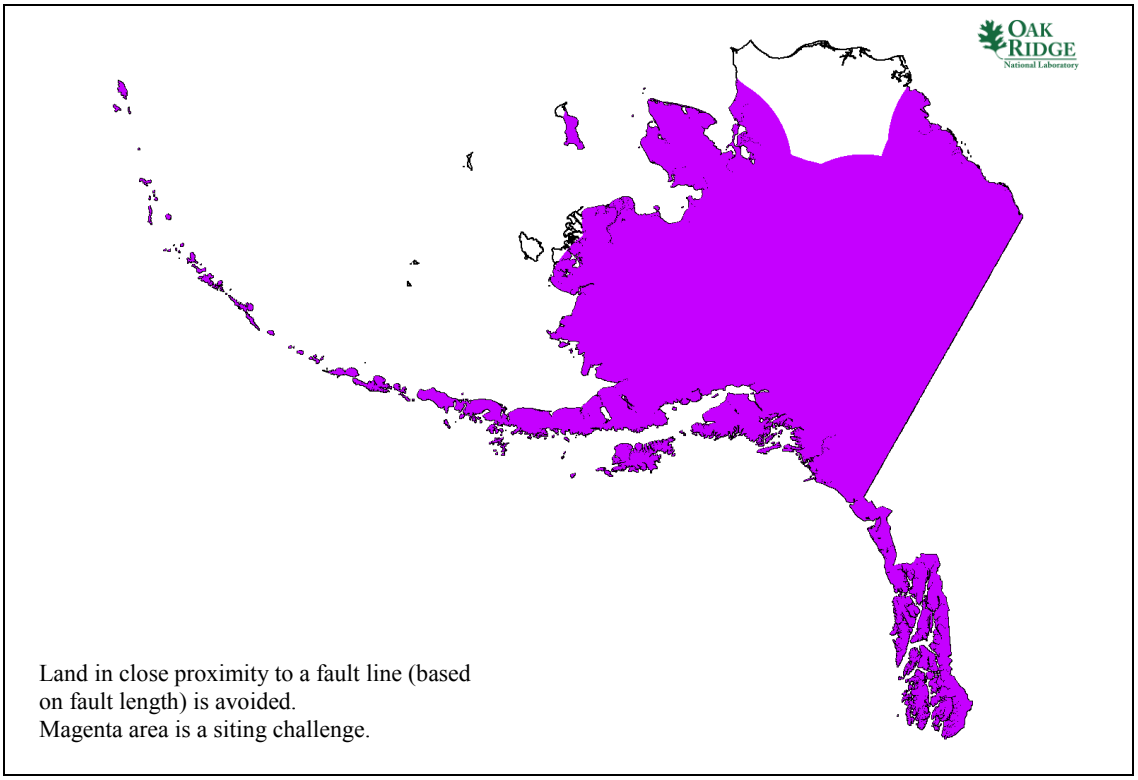

Fig. 6. Nominal, bounding SMR proximity-to-fault-lines SEC layer.

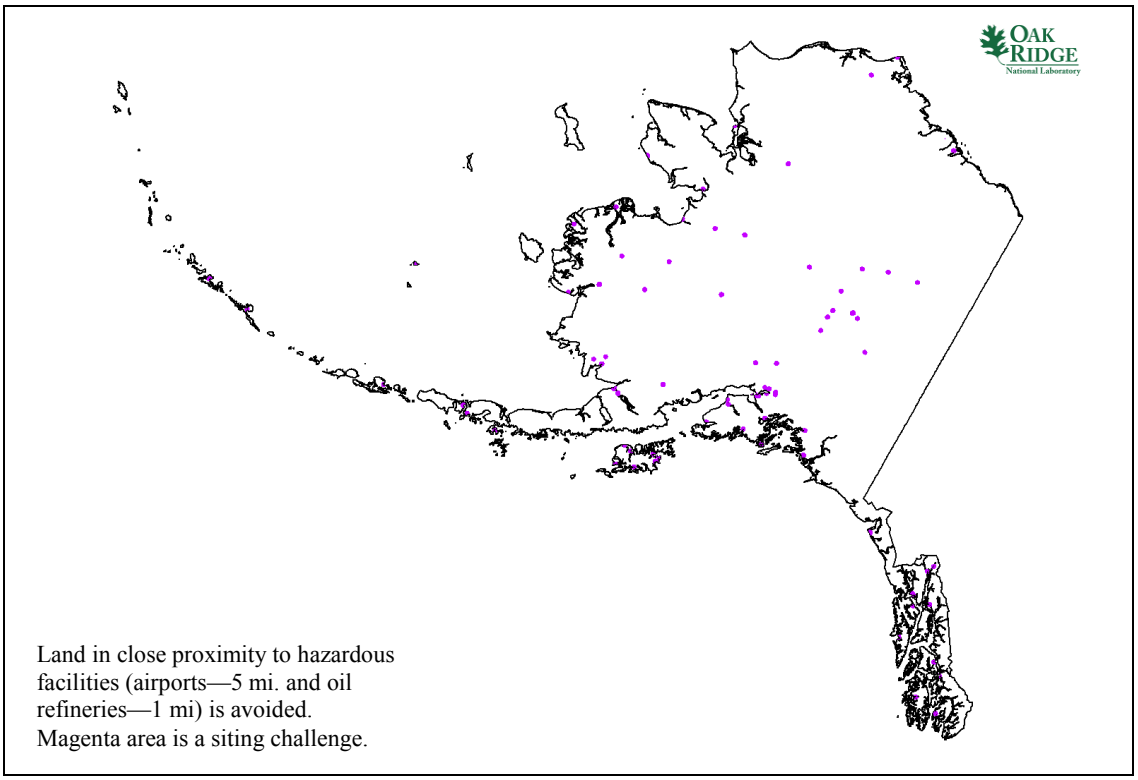

Fig. 7. Nominal, bounding SMR proximity-to-hazards SSEC layer.

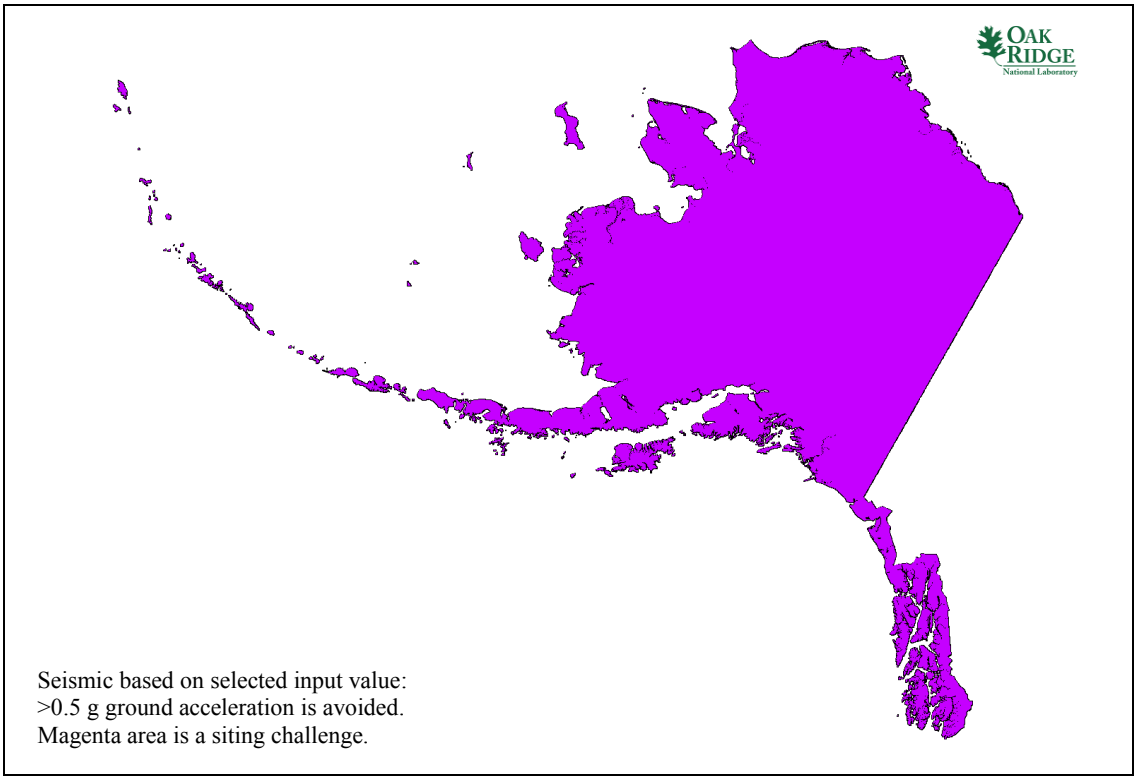

Fig. 8. Nominal, bounding SMR safe-shutdown earthquake SSEC layer.

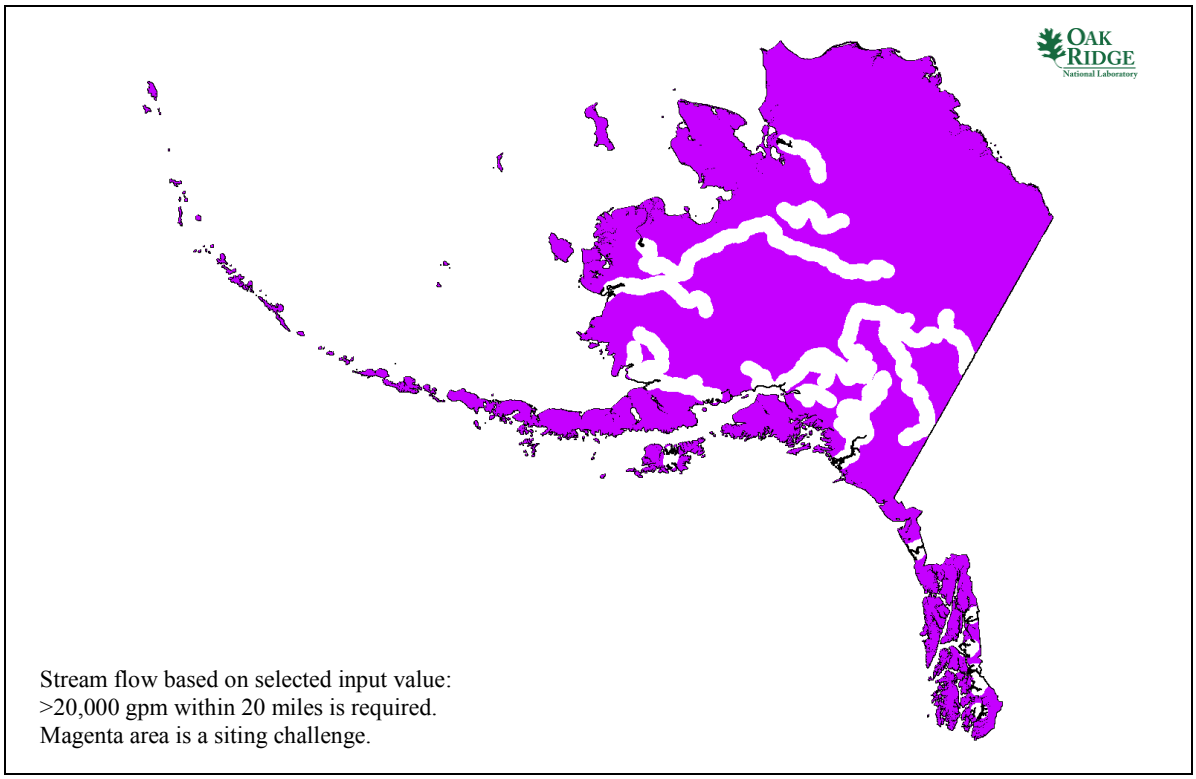

Fig. 9. Nominal, bounding SMR minimum low-stream-flow SSEC layer at 20,000 gpm.

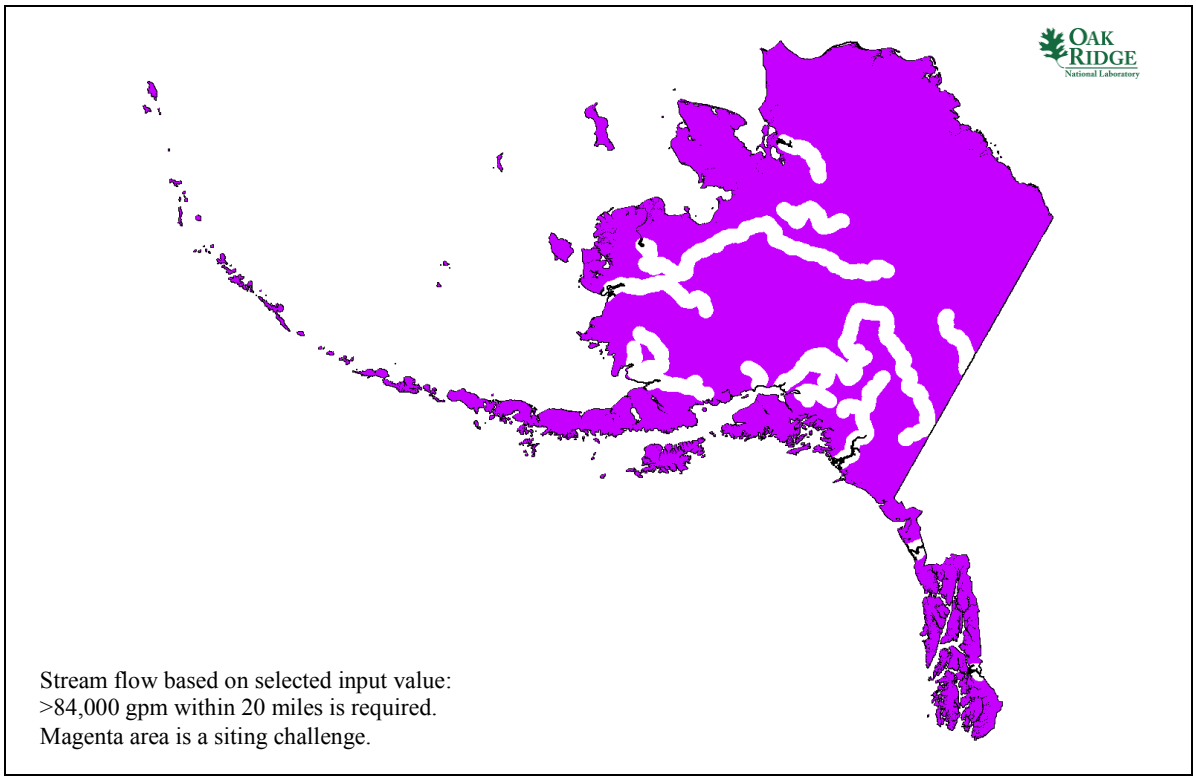

Fig. 10. Nominal, bounding SMR minimum low-stream-flow SSEC layer at 84,000 gpm.

The OR-SAGE tool tracks the parameters for each 100- by 100-m cell. As a result, not only can the cells that are clear of all the SEC layer exclusions be displayed visually, but also cells that are tripped by one, two, or three or more exclusions can be tracked and displayed. This is known as the "SMR composite map," shown in Fig. 11 below evaluated at 20,000 gpm stream flow.

The entire state of Alaska has safe-shutdown earthquake peak ground acceleration (2% chance in a 50 year return period) greater than 0.50 g (see Fig. 8). In addition, extensive faults in Alaska create a siting issue for most of the state (see Fig. 6). The Bureau of Land Management is identified as controlling much of the land in Alaska, which impacts the protected lands SEC (see Fig. 3). The stream gauge system in Alaska is relatively new. Many real-time stream flow gauges do not yet have continuous data over a 10-year span. Therefore, some of the stream flow data is eliminated based on the 7-day low flow 10-year return criterion that is used in the flow calculation. As a result, the stream flow GIS layer is considered conservative (see Fig. 9 and Fig. 10). The composite map is indicative of these cumulative siting issues.

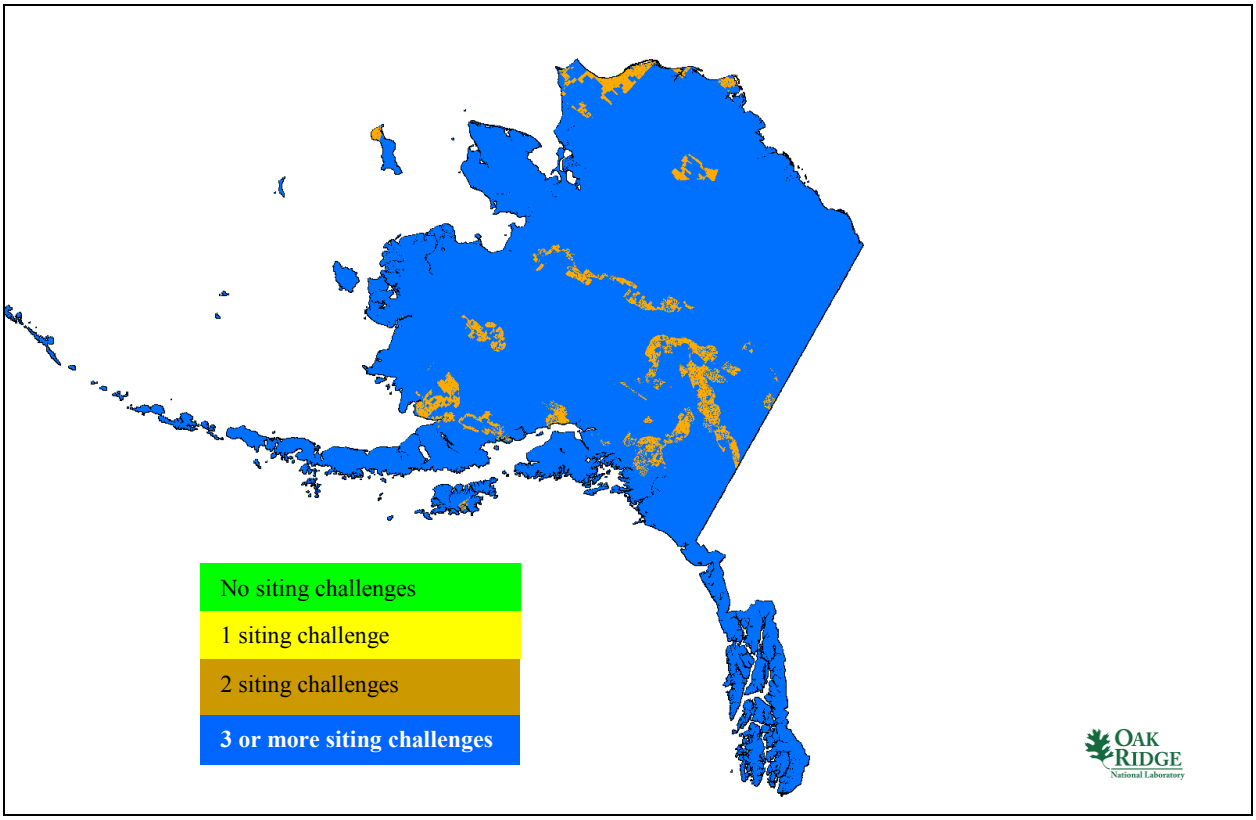

Fig. 11. Alaska composite map at 0.5 g peak ground acceleration and 20,000 gpm stream flow.

The Alaska Composite Map evaluated at 84,000 gpm stream flow is shown in Fig. 12 on the next page.

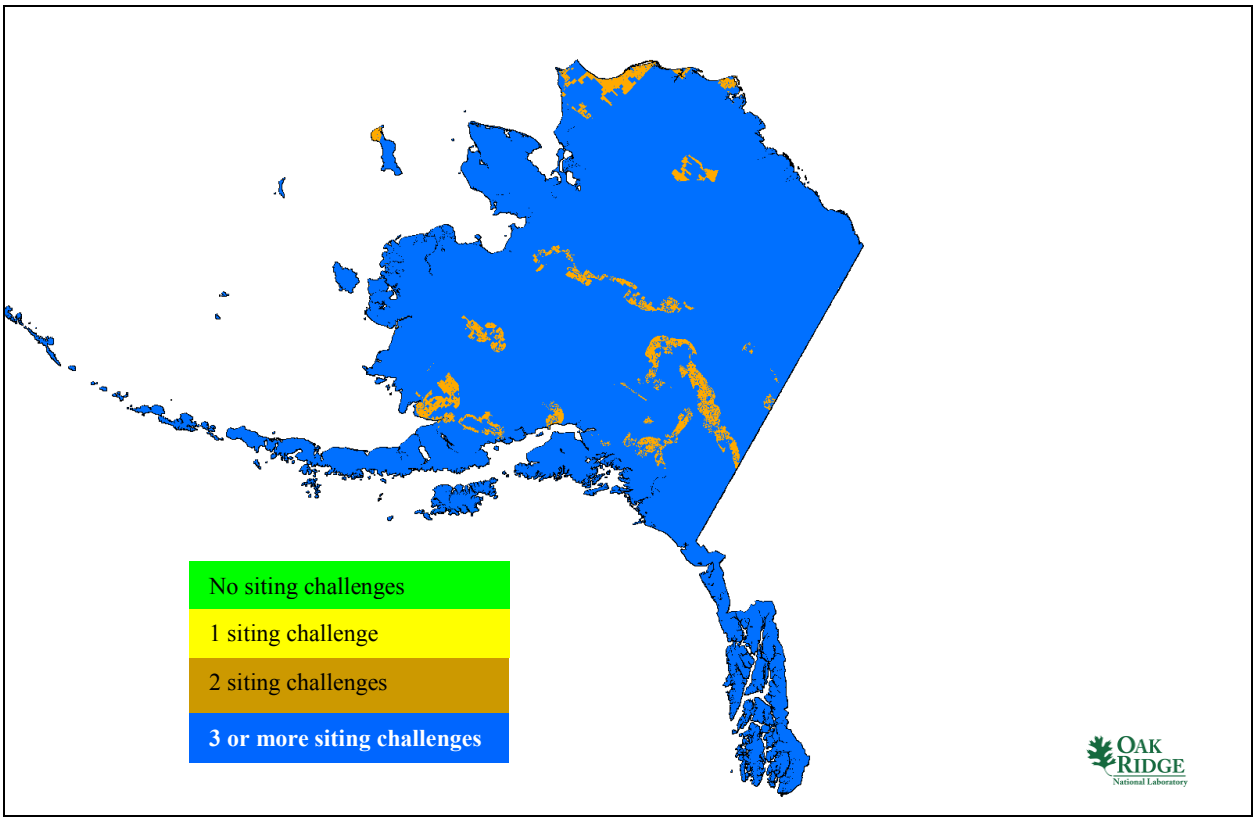

Fig. 12. Alaska composite map at 0.5 g peak ground acceleration and 84,000 gpm stream flow.

Summary

Alaska presents numerous SMR siting challenges. Fault lines and seismic activity are the significant SMR issues for Alaska. These issues could potentially be addressed by an SMR design that is specifically enhanced for this purpose. Land controlled by the federal government can be negotiated in areas with a need for reliable, clean energy. The stream flow issues in much of the state may be relieved somewhat as additional gauge data becomes available over time. In addition, other sources and forms of cooling can be considered. The remaining SMR SEC parameters evaluated are not limiting.