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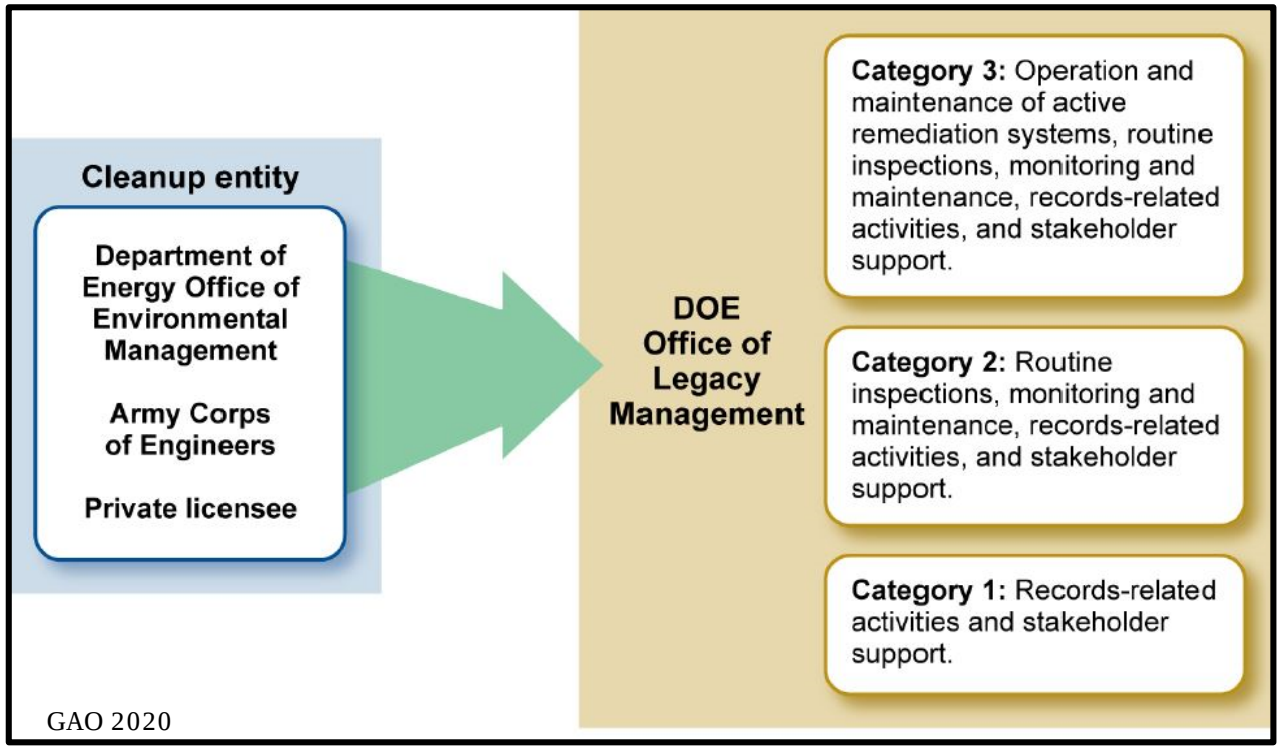
Assessment of Climate Vulnerabilities at DOE Office of Legacy Management Sites

David S. Shafer, PHD
Technical Director for Long Term Stewardship
Department of Energy
Office of Legacy Management (LM)
Westminster, CO

Background

- DOE-LM created in 2003 to manage post-closure responsibilities of sites.
- LM sites have no continuing mission for DOE, although beneficial reuse of sites is a goal.
  - Fewer potential climate issues with infrastructure, site workforce, etc. as at EM and other DOE sites.
- Primary LM focus in DOE CARP is resiliency of environmental remedies to climate change.
  - *Priority 1 of 2021 DOE CARP: Assess Vulnerabilities and Implement Resilience Solutions*
  - LM started assessment in response to GAO recommendation in May 2020.
  - Lawrence Berkeley National Lab awarded contract to support.
  - Principal Investigators: Dr. Haruko Wainwright and Dr. Ken Williams

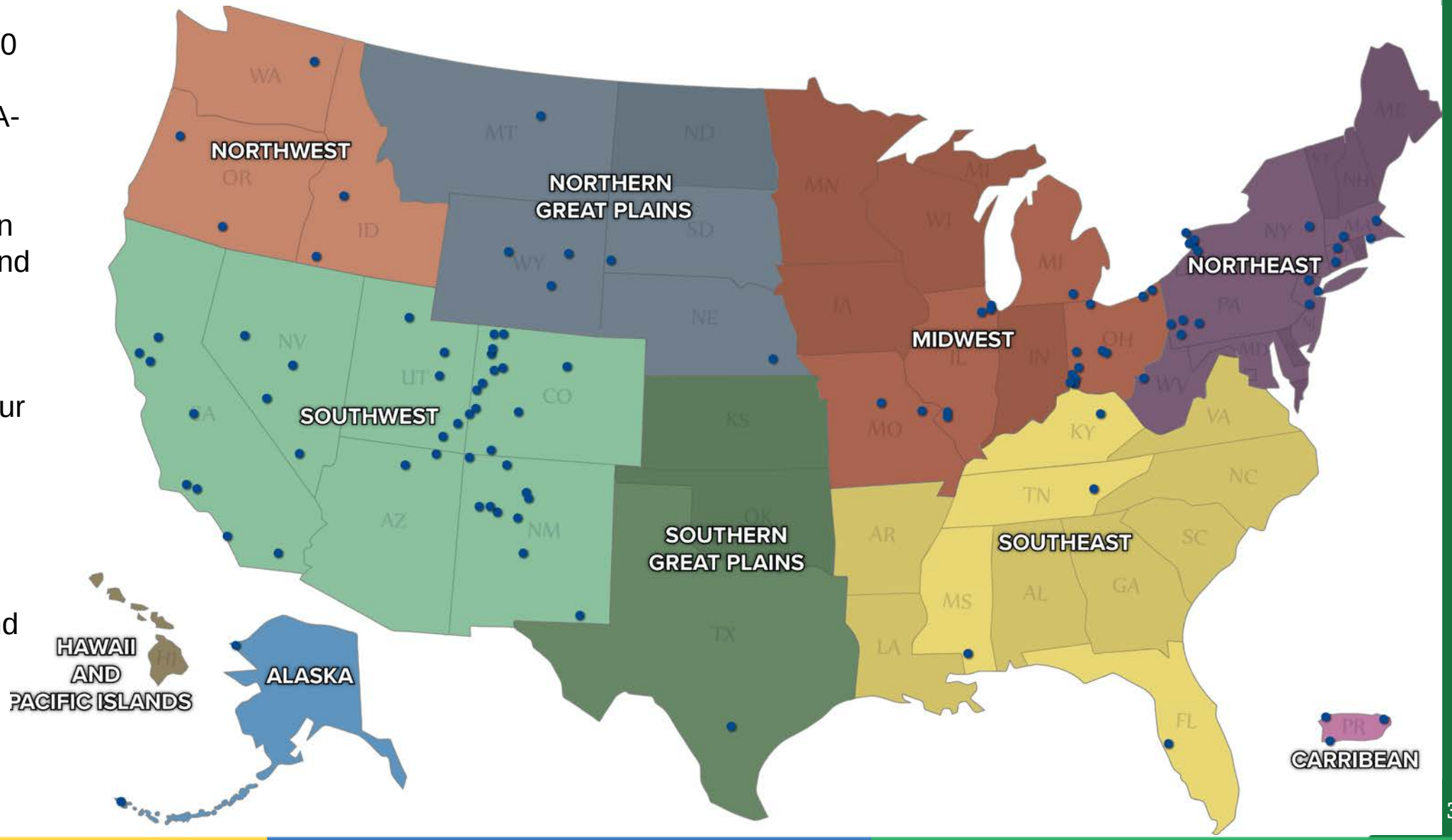


Analysis includes LM's current 102 sites as well as 26 other sites anticipated to transfer by FY2030.

BERKELEY LAB

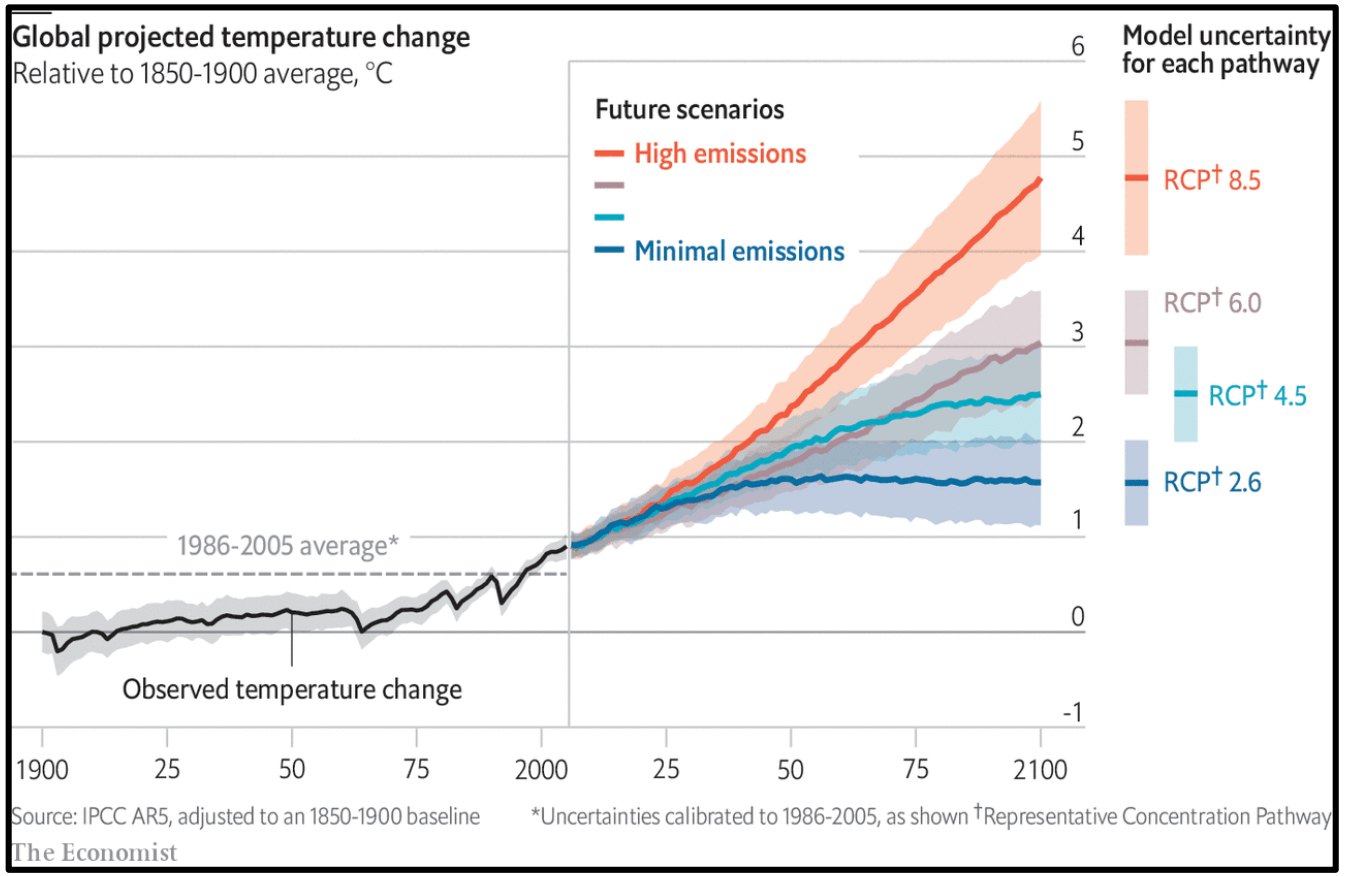
Location of LM Sites as a Function of Climate Regions (NCA-4)

- LM sites in 9 of the 10 National Climate Assessment #4 (NCA-4) Regions.
- Highest concentration in Southwest (SW) and Midwest (MW) and Northeast (NE).
- Many SW sites in Four Corners Region are former uranium ore processing and disposal sites.
- Many sites in MW and NE are in urban and industrial areas.



Approach being taken to identify important processes and vulnerable sites

- Use U.S. Global Change Research Program (USGCRP) and Intergovernmental Panel on Climate Change (IPCC) tools for consistency.
- Surveys of site managers (federal and contractor) for site-specific phenomena (*institutional knowledge*).
  - Within same NCA-4 regions, much variability, especially in western U.S.
- IPCC Inter-model comparison for four different greenhouse gas emission scenarios (*concentration pathways*).
- RCP4.5 and 8.5 scenarios results to be compared for LM sites. Range of 2°- 4° C temperature increase by 2100.



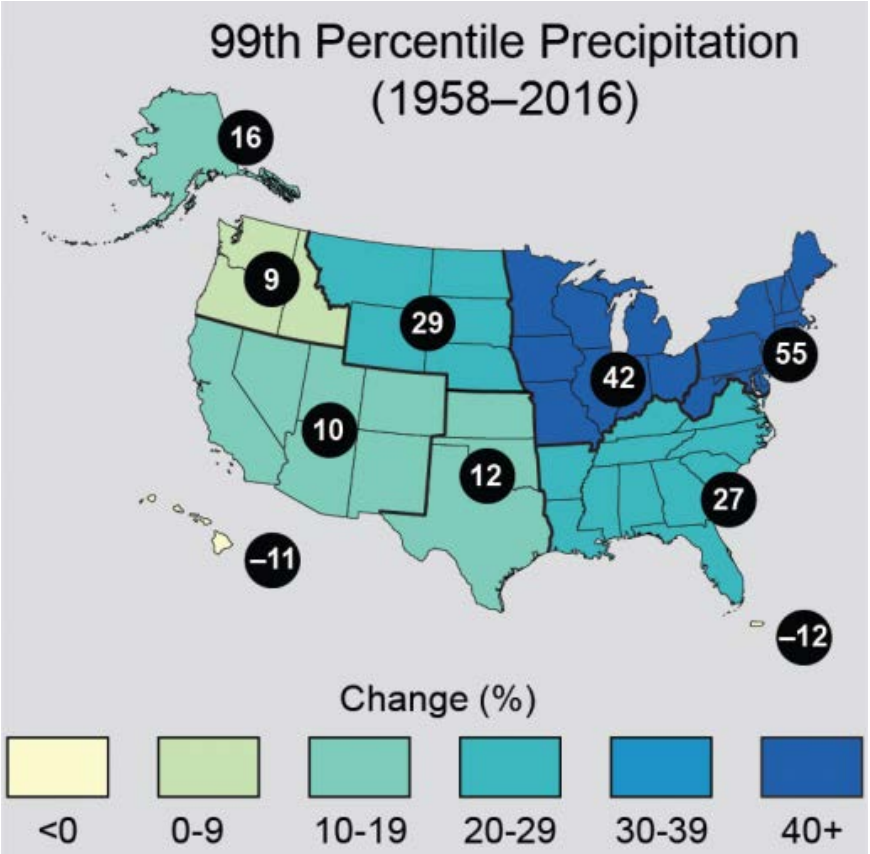
Approach being taken to identify important processes and vulnerable sites (cont.)

- Use individual models of IPCC ensemble for higher resolution modeling.
  - Example: European Center for Medium Range Weather Forecast Reanalysis Forecast Analysis (ERA-5).
  - Provides climate data set at approximately 14 km² spatial resolution.
  - Other site-specific modeling and forecasting to use open-source software and Google Earth Engine© for spatial analysis.

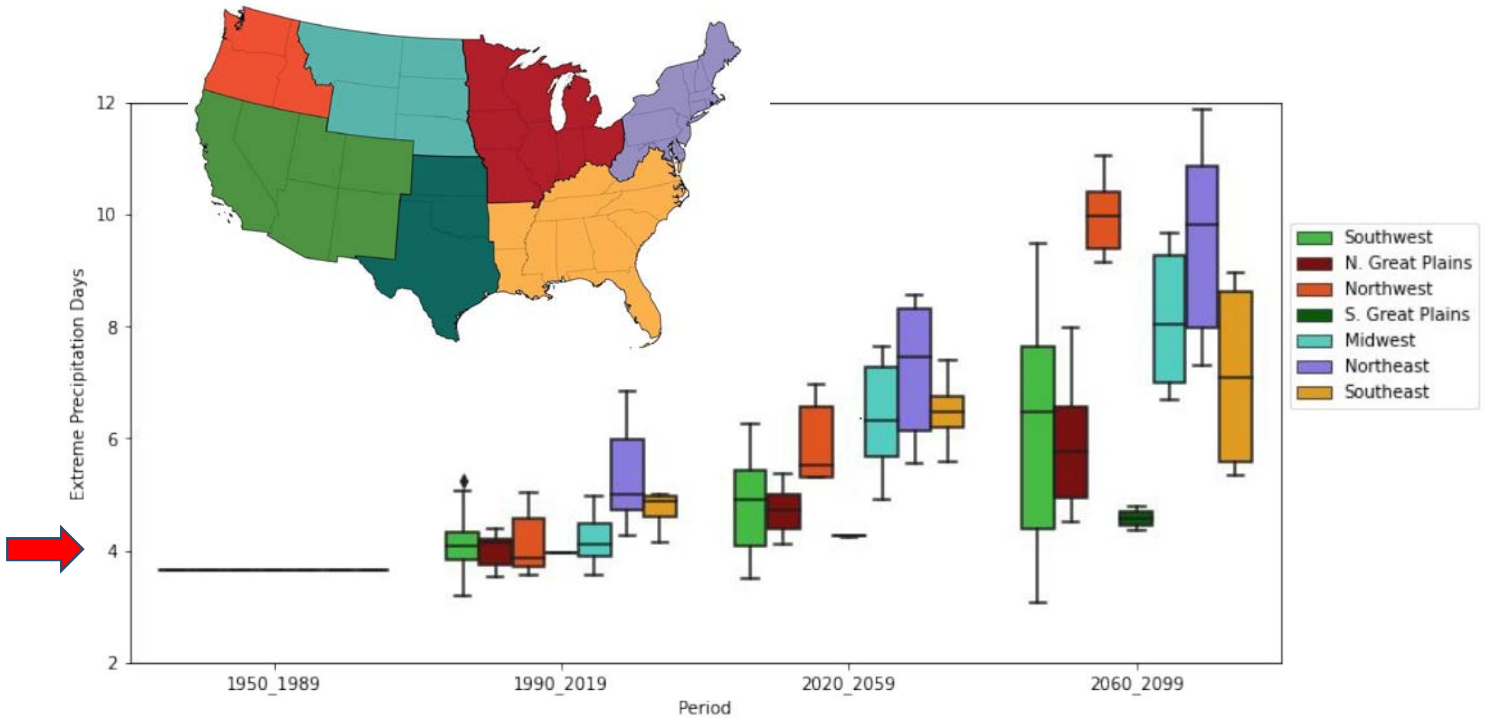
Riverton, Wyoming Site: More frequent site flooding because of more instances of rapid early summer snow melting in Wind River Mountains.

Important Trend for LM Sites: *Increase in Extreme Precipitation Events*

Observed Historical Change in Extreme Precipitation Events



From 4th National Climate Assessment (2017), US Global Climate Change Research Program



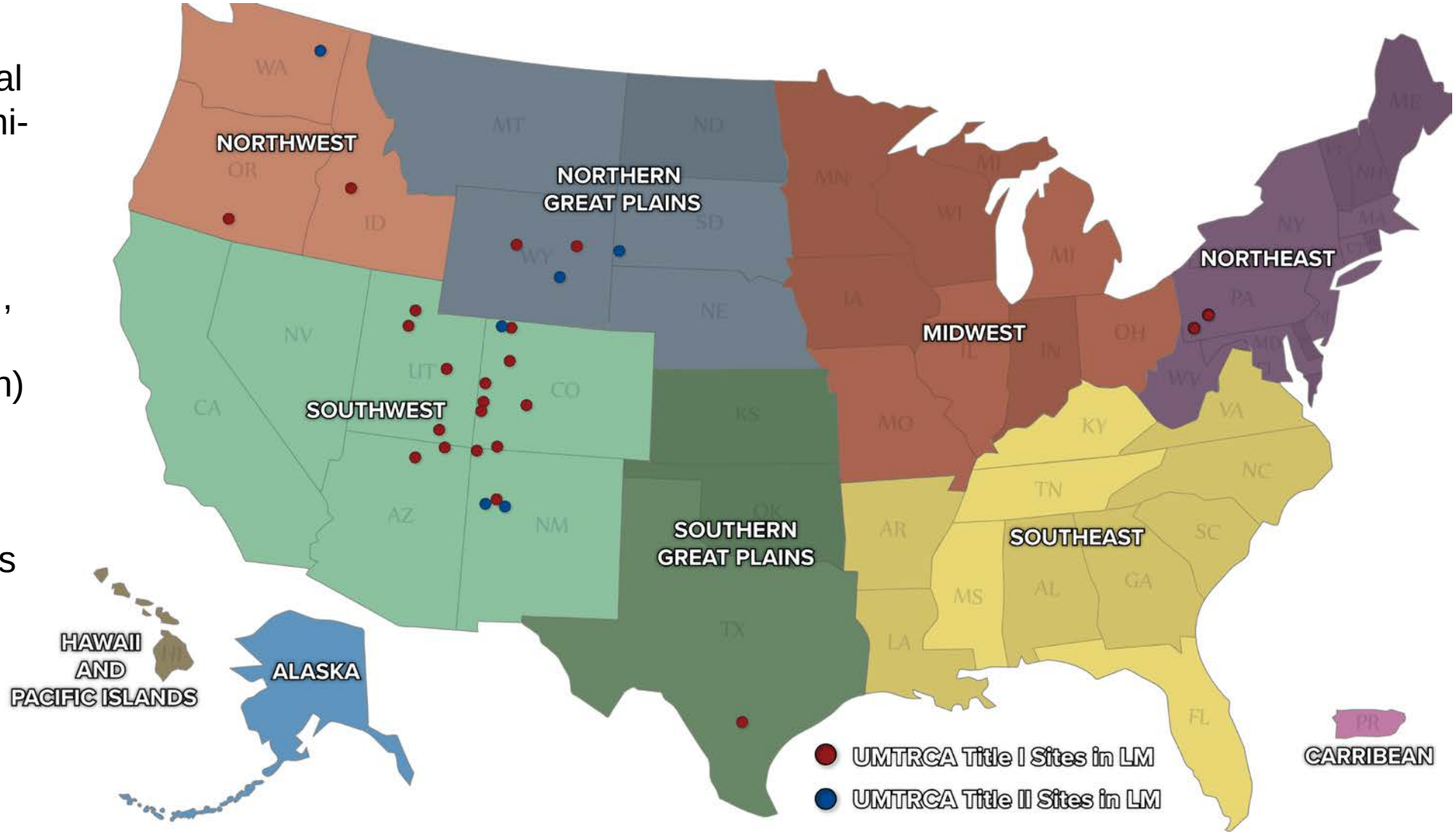
For the contiguous US, only the Southern Great Plains (SGP) and part of SW are projected to have virtually no change in total or in extreme precipitation events during the rest of this century.

Climate change scenarios and feedbacks of concern for LM sites

- Increased erosion of cells/landfills and associated drainages because of increased precipitation intensity.
- Erosion of soils with low levels of radioactive soil contaminants.
- Increased precipitation intensity increases dissolved oxygen in aquifers.
  - Reduced attenuation of chlorinated solvents; possible increase in dissolved uranium in alluvial aquifers.
- Loss of vegetative cover from higher temperatures and more intense drought in SW and SGP.
- Increased frequency and intensity of fires in SW, NW, and Northern Great Plains (NGP).
  - Native grasses replaced with non-native annuals.
  - Evapotranspiration (ET) for waste disposal sites less dependable.
- Damage to infrastructure from increased precipitation and precipitation intensity in MW and NE.

U Mill Tailings Disposal Sites in Southwest Region are of Significant Concern

- When UMTRCA written in 1978, natural processes in arid/semi-arid regions poorly understood.
- Rates of change (e.g., soil formation, vegetation succession) much faster than projected.
- LM doing large repairs at some sites now.
- Climate change causing or exacerbating issues at these sites.



Uranium mill tailing disposal cells were major environmental remedy investments that were designed to perform a minimum of 200 years

Headward erosion of drainages adjacent to L-Bar Cell, New Mexico

Erosion beneath riprap rock cover at Mexican Hat, Utah

* 44 waste disposal cells, landfills, and other impoundments at 30 LM sites

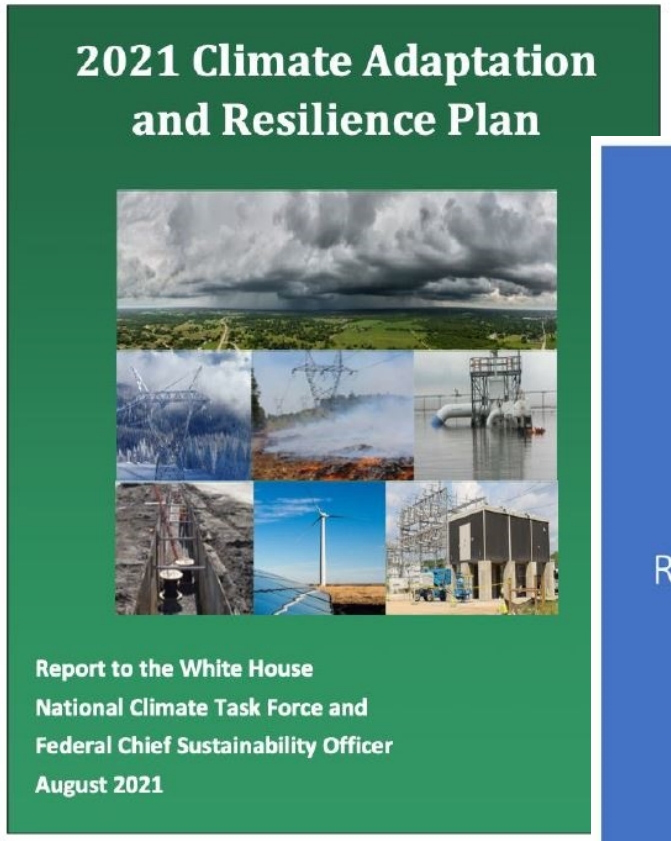
Ongoing work for December 2021 report by LBNL

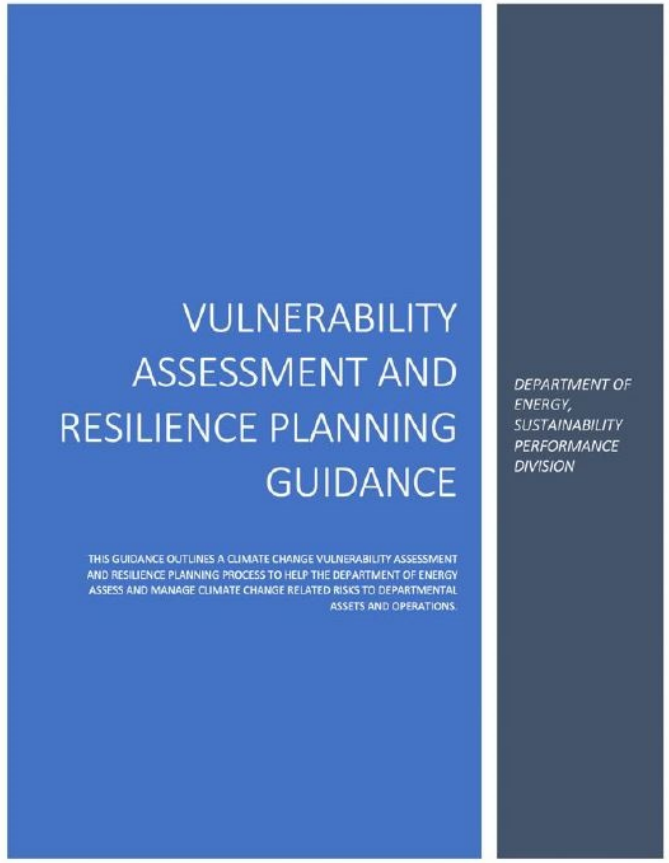
- Complete evaluation of extreme precipitation events for all sites. Focus to date on waste disposal sites.
- Compare precipitation forecasts against Probable Maximum Precipitation (PMP) calculations used for cells/landfills.
- Forecasts for drought (*Standardized Precipitation-Evapotranspiration Index*) and wildfire frequency.
- Evaluate types and frequency of monitoring as part of **long-term surveillance & maintenance** of LM sites.
  - *Examine condition of whole landscape, not just single remedies.*
  - *What additional observations/data should we collected at sites?*
  - *Concept of event driven monitoring*

UAS baseline LiDAR and photogrammetry surveys of landfills and cells being completed. Already have identified features at sites difficult to detect on ground.

CY 2022 Activities

- LBNL findings will be incorporated into site-specific Vulnerability and Resiliency Plans (VARPs) for LM sites.
  - *Feedback/input from stakeholders and Tribal Nations is anticipated.*
- Plan and prioritize resilience and adaptation solutions and plans.
  - *Streamline by more detailed analysis of "archetypal sites" and clustering of similar LM sites.*
- Update Environmental Liability (EL) estimates for LM sites.
- VARPs updated at least every 4 years.





David S. Shafer, Technical Director for Long Term Stewardship, DOE-LM, Westminster, CO USA 80221 david.shafer@lm.doe.gov. (303) 410-4806