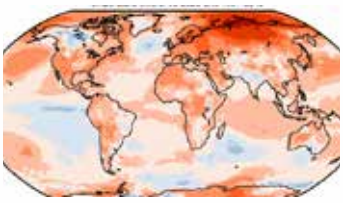
CLIMATE CHANGE PLANNING

Climate change presents several significant threats to "business as usual" for both public and private sector operations. Changes to the hydrologic cycle caused by extreme weather, drought, coastal and inland flooding, and wildfires are increasing. Ongoing climate change phenomena and changes in short- and long-term weather patterns are impacting hazardous waste sites, water resources, and electrical grids, potentially undermining the long-term objective of protecting human health and the environment.

For these reasons, preparations for the challenges posed by climate change are taking on greater urgency. HGL has over 35 years of experience investigating, modeling, designing, and implementing protective remedies to clean up hazardous waste sites for beneficial reuse, as well as modeling groundwater for water resource optimization. HGL's experts develop solutions that address the physical characteristics of sites, focusing on sustainable and resilient alternatives and beneficial outcomes for surrounding communities.

HGL places climate change considerations —including *Vulnerability Assessment, Mitigation, and Adaptation*—at the heart of its planning, design, and construction services and focuses on building Resiliency into every stage of a project. Whether forecasting risk, building optimized strategies to accelerate recovery, or implementing energy- and cost-efficient solutions, HGL is at the forefront in meeting critical environmental challenges.



HGL DISTINCTIONS

HGL has specialized capabilities in the following service areas to address the challenges posed by climate change:

- Sustainable Resilient Remediation
- Water Resource Management
- Green Power Supply and "Smart Grid" Development
- Seasonal Thermal Energy Storage
- Subsurface Carbon Sequestration and Storage

CLIMATE CHANGE PLANNING

SUSTAINABLE RESILIENT REMEDIATION

HGL implements best practices for sustainable resilient remediation (SRR)* for all of its projects. SRR is an optimized solution to cleaning up and reusing hazardous waste sites that limits environmental impacts, maximizes social and economic benefits, and creates resilience against the increasing threat of extreme weather events, sea-level rise, and wildfires. *(ITRC, 2021. Sustainable Resilient Remediation SRR-1)*

SRR principles are incorporated into HGL's approach in the following areas:

Sustainable Site Characterization and Vulnerability Assessment: *From the Preliminary Assessment through the Feasibility Study stage of the CERCLA process, HGL employs climate-informed decision-making, including cost, carbon, and time-efficient strategies such as rapid characterization, scenario building, and adaptive management, to streamline characterization. In addition, HGL project managers consider the evolving climate in both identifying historical fate and transport and assessing potential future impacts from extreme weather events.*

Site characterization and investigation includes conducting a climate Vulnerability Analysis and identifying potential co-occurring and confounding factors. This can include identifying potential long-term trends in temperature, precipitation, and land use that could affect the protectiveness of the site remedy.

BIG RIVER SUPERFUND SITE, MISSOURI

As a nationwide prime contractor for EPA, HGL has incorporated climate change resiliency considerations into its sediment fate and transport analysis for the remedial strategy and remedy design for the Big River Superfund Site in Jefferson County, Missouri. HGL supported development of a conceptual site model (CSM) for remediating over 100 miles of river and floodplain contaminated with lead mine tailings, conducted field reconnaissance, and performed hydraulic and sediment transport modeling as well as a long-term geomorphic trends and climate resiliency analysis. HGL integrated natural processes into remedial alternatives and developed an adaptive management strategy for incremental remedial action under the SRR framework.

Renewable Energy and Greener Cleanups: *Greener cleanup refers to selection of remedies that mitigate the effects of climate change by reducing carbon emissions and maintenance costs and optimizing effort over the life cycle of a hazardous waste site. Greener remedies include supporting low-energy or low-maintenance systems, passive remedies, and monitored natural attenuation (MNA) as well as utilizing materials available near a site.*

As part of efforts to address climate change and overcome challenges at remote locations, remedial projects are increasingly required to incorporate "green" energy supplies. Renewable, passive, and remote energy technologies, such as solar power, reduce carbon footprints and conserve natural resources, resulting in environmental and financial benefits.

KENNEDY SPACE CENTER, FLORIDA

From July 2020 through January 2021, HGL installed and operated a solar-powered air sparge system to remediate chlorinated volatile organic compounds in groundwater at Kennedy Space Center. The National Aeronautics and Space Administration (NASA) had selected an air sparging remedy to reduce contaminants in a "hot spot" area to concentrations that support transition into monitored natural attenuation. To address logistical challenges associated with connecting remediation equipment to a conventional electrical power source, HGL designed a more sustainable system that used solar power to generate 100% of the energy required for its operation. The system significantly reduced both the cost and environmental impact associated with the remedial action by eliminating the need to construct and operate a system with supplied electricity. By using solar power, the logistical challenges of supplying outside electricity were solved, and the greenhouse gases that would have been generated during construction and operation were eliminated. Further, during the construction of the solar-powered system, HGL installed aboveground rather than underground piping to eliminate the need for mobilization of additional equipment to the site, reducing additional greenhouse gas and dust emissions.

The operation of the system exceeded project objectives and attained the more stringent Florida Department of Environmental Protection groundwater cleanup target levels within the air sparge treatment area. The project demonstrated to NASA the benefits of using solar-powered air sparge systems as a sustainable technology to address legacy groundwater contamination where electrical connections were a limiting factor, while simultaneously reducing the environmental footprint of NASA's remediation program.

Remedy Resiliency: *Flooding, fires, hurricanes, drought, and extreme cold can severely disrupt pollution mitigation and environmental remedial actions. According to EPA, resilience is the capacity of any system "to prevent, withstand, respond to, and recover from a disruption" (EPA, 2020).[1] Climate resiliency assessment includes identifying the potential range of environmental conditions (e.g., rain, wind, temperature) and the vulnerability of remedial projects and human and ecological receptors to the extremes of these conditions.*

HGL incorporates climate vulnerability and resiliency analyses into all stages of a project to design, construct, and maintain highly adaptive remedial systems. HGL's approach provides cost-effective solutions that limit the negative impacts of extreme weather events and help ensure that remedial systems are implemented with optimal adaptive capacity.

JOINT BASE LANGLEY-EUSTIS, VIRGINIA

As part of its decades-long support of environmental remediation efforts at the former Langley Air Force Base, now part of Joint Base Langley-Eustis, HGL designed a joint remedy to address contaminated soil and sediment at three neighboring sites. These sites included a former landfill, a pesticide storage area, and a shoreline area adjacent to the landfill known as the LTA Cove. The remedy included dewatering the cove by installing sheetpile cofferdams, excavating/disposing of 17,000 cubic yards of PAH- and lead contaminated soil and sediment on site, constructing a landfill cap, and restoring 5 acres of wetlands.

Approximately 700 linear feet of new shoreline revetment was installed along the landfill slope adjacent to the Back River to protect the soil cover from hurricanes that create high tides and water levels. The revetment, constructed in 2009, has subsequently withstood numerous hurricane and big storm events without failure. For the restored wetlands, vegetated buffers and stormwater controls were created adjacent to them to protect the vegetation from erosion, an increasing threat owing to climate change and rising sea levels.

Remedy Optimization: *Remedy optimization is a formal practice centered on minimizing cost, time, and effort to attain remedial goals. HGL project work includes both model-based, computational optimization, and broader remedial optimization reviews as developed by EPA and DOD. Optimization reviews include climate vulnerability and uncertainty assessment for projects at every stage of remedial actions, from site assessment through closure.*

THIRD-PARTY OPTIMIZATION REVIEWS, NATIONWIDE

HGL's third-party remedial optimization reviews recommend strategies to improve efficiency and effectiveness of remedial actions for sites under both RCRA and CERCLA frameworks. Through contracts with EPA and other federal agencies, HGL has worked on over 100 CERCLA/Superfund sites to optimize remedial actions to reduce energy use, time to cleanup, and cost. Optimization strategies have included reducing monitoring frequency while improving data analysis and reporting, reducing volumes of groundwater extracted to maximize contaminant removal while minimizing energy usage, and recommending alternative remedies at sites where selected remedies are underperforming. Optimization reviews have provided technical information to terminate active remedies and transition to passive remedies, resulting in significant resource and cost savings. Current projects include evaluating remedies for sensitivity to projected climate change impacts.