Utah Department of Transportation Resilience Improvement Plan

May 2024

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Message from the Executive Director

On behalf of the Utah Department of Transportation (UDOT), I would like to express our enthusiasm for the newly developed UDOT Resilience Improvement Plan (RIP) and to underscore its significance in bolstering the resilience of our transportation infrastructure.

In accordance with federal requirements, the UDOT RIP addresses the vulnerabilities of our transportation systems in the face of current and future weather events and natural disasters. This plan is a proactive step towards enhancing our understanding of these vulnerabilities, thereby informing our decision-making and strategic planning to fortify the resilience of our infrastructure.

The UDOT RIP provides us with a comprehensive framework to assess the risks posed by various environmental factors to our transportation assets and systems. The asset assessment outlined in this RIP helps us gauge the probability and potential consequences of such events, enabling us to prioritize and allocate resources more efficiently.

The UDOT RIP not only focuses on immediate resilience measures but also incorporates long-range planning activities and investments. By adopting this approach, we will implement strategies that not only mitigate immediate risks but also foster long-term sustainability and resilience.

The alignment of the UDOT RIP with our long-range transportation plan (LRTP) reinforces our dedication to seamless coordination and alignment across various functional areas and departments. By ensuring consistency with state and local hazard mitigation plans, as well as adherence to regulatory frameworks and standards, we guarantee that our resilience efforts are robust, effective, and compliant.

The UDOT RIP represents a milestone in our ongoing efforts to fortify the resilience of Utah's transportation infrastructure. By embracing proactive planning, risk assessment, and strategic investment, we are poised to enhance the safety, reliability, and sustainability of our transportation systems for generations to come.

Thank you for your interest, and we look forward to realizing the benefits that come with implementing the UDOT RIP.

Sincerely,

Carlos Braceras, P.E., Executive Director

Key Terms

Term	Description
Adaptive Capacity	The ability of a system to adjust to a hazard (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
Asset	A physical infrastructure item with operational, economic, social, or organizational value that UDOT owns or controls.
Avalanche	Avalanches are characterized by the sudden and uncontrolled movement of snow, ice, and debris down steep slopes, typically triggered by factors such as heavy snowfall, temperature fluctuations, or seismic activity.
Criticality	Criticality measures the importance of an asset to the transportation system and to the community. It measures how the loss in function of an asset impacts mobility, safety, disaster preparedness, and overall health, among other possible considerations.
Debris Flow	Debris Flows are rapid, downhill movements of water-saturated debris, including rocks, soil, and vegetation, often triggered by intense rainfall or rapid snowmelt.
Earthquake	Earthquakes are sudden and violent shaking of the ground, often triggered by tectonic plate movements.
Exposure	The degree to which an asset is subject to potential adverse effects of a natural hazard. It can be measured by both current adverse effect levels and future adverse effect levels.
Flooding	Flooding is the inundation of normally dry land by overflowing bodies of water, such as rivers, lakes, or oceans, typically caused by heavy rainfall, snowmelt, storm surges, or the failure of levees or dams.
Natural Hazard	Environmental phenomena occurring naturally in the Earth's system, such as earthquakes, floods, hurricanes, and volcanic eruptions, which pose risks to human life, property, and infrastructure.
Resilience	Resilience is the ability to anticipate, prepare for, or adapt to conditions or withstand, respond to, or recover rapidly from disruptions.
Resilience Risk	A measure that includes both the probability that an asset will be impacted by a hazard and the consequences of that impact. In this plan, the term "consequence" is interchangeable with the concept of "criticality."
Risk	Risk can be applied broadly. FHWA defines risk as a measure that includes both the probability that an asset will experience a particular impact, and the consequence (or severity) of that impact.[1] For this plan, consequence can be viewed as criticality.
Rockfalls	Rockfalls are the sudden and uncontrolled descent of rocks or boulders from a cliff face or steep slope, often triggered by natural factors such as weathering, erosion, or seismic activity.
Sensitivity	The degree to which a system, population, or resource is or might be affected by hazards.[2]
Vulnerability	The extent to which a transportation asset is susceptible to sustaining damage from hazards (including climatic). Vulnerability is a function of exposure, sensitivity, and adaptive capacity.[3]
Wildfire	Wildfires are unplanned and unwanted fires in areas of natural vegetation.

[1] https://www.fhwa.dot.gov/environment/sustainability/resilience/adaptation_framework/chap05.cfm#toc498351505

[2] https://www.fhwa.dot.gov/asset/pubs/hif23010.pdf

[3] https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/teacr/index.cfm

Acronyms

Acronym	Description
AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ATMS	Advanced Traffic Management System
BIA	Bureau of Indian Affairs
BTS	Bureau of Transportation Statistics
CDBG	Community Development Block Grant
CMAQ	Congestion Mitigation and Air Quality
CVTD	Cache Valley Transit District
EMS	Emergency Medical Services
ERM	Enterprise Risk Management
FAP	Forest Action Plan
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GIS	Geographic Information Systems
IIJA	Infrastructure Investment and Jobs Act
ITEP	Institute for Tribal Environmental Professionals
ITS	Intelligent Transportation Systems
JRA	Jurisdictional Risk Assessment
LRTP	Long-range Transportation Plan
MPO	Metropolitan Planning Organization
NPS	National Parks Service
PROTECT	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
RAWG	Risk Assessment Working Group
RIP	Resilience Improvement Project
RCP	Representative Concentration Pathways
RPA	Risk Priority Analysis
STACC	Status of Tribes and Climate Change
SHMP	State Hazard Mitigation Plan
STIP	State Transportation Improvement Program
TAMP	Transportation Asset Management Plan
TCR	Tribal Climate Resilience
T/LPA	Tribal/Local Public Agencies
UDOT	Utah Department of Transportation
USC	United States Code
USGCR	US Global Change Research Program
USSC	Utah Seismic Safety Commission
UTP	Unified Transportation Plan

Executive Summary

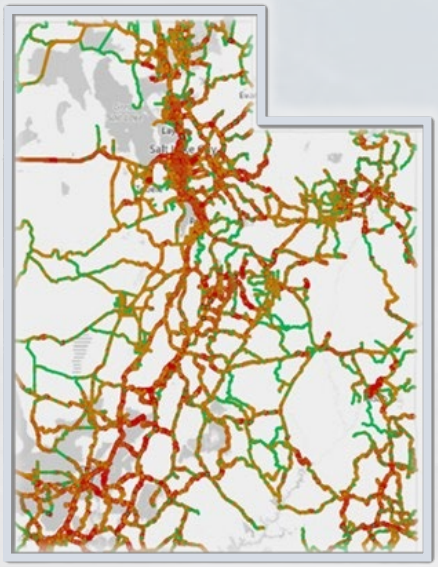
Utah faces a range of natural hazards that pose significant risks to both Utah communities and UDOT transportation infrastructure. The impacts of natural hazards on communities and UDOT infrastructure can be severe, leading to disruptions in transportation systems, property damage, loss of life, and economic hardship. The potential for future deviation from historical trends adds to the uncertainty surrounding the impacts of these hazards.

Recognizing the critical need to bolster resilience in the face of these challenges, UDOT has crafted this RIP to take full advantage of the Federal Highway Administration's (FHWA) new Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) program and related funding opportunities. By establishing an asset assessment approach, implementing supportive tools, and developing a project prioritization process, the RIP aims to integrate resilience considerations into UDOT's transportation decision-making processes. This integration is intended to enhance the state's capacity to limit the effects of and rebound from natural hazards.

Key Asset Assessment Findings

The RIP's asset assessment, developed through foundational research and stakeholder engagement, determines how exposed UDOT's assets (road surfaces, bridge deck, bridge approach, box culverts, and pipe culverts) are to natural hazards (earthquakes, floods, wildfires, avalanches, debris flows and rockfalls). This information is combined with an understanding of how critical these assets are to Utah's communities, economy, and quality of life, as well as to maintaining the state's transportation systems. The asset assessment produce resilience risk scores that help show where assets are most exposed to these hazards and where natural hazards may cause the greatest impacts.

UDOT's 20,500-mile transportation system, based on assessed assets, fall into four natural hazard exposure categories:



Very High
800 miles
4%

High
4,100 miles
20%

Medium
8,000 miles
39%

Low
7,600 miles
37%

Figure 1: Asset assessment results

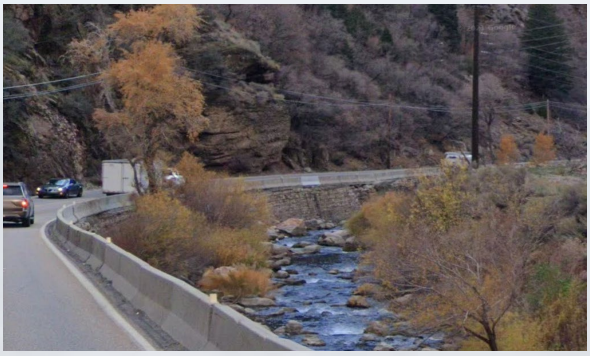
Best Performing Projects by UDOT Region

The PROTECT prioritization process integrates resilience scores and draws upon UDOT's institutional knowledge by soliciting input from Region Office and Division staff. Staff play a crucial role in evaluating the effectiveness of candidate PROTECT projects in addressing exposure to known natural hazards. Utilizing a screening and scoring rubric, staff generate project efficacy scores. These scores are then joined with corresponding resilience risk scores to produce a prioritized project list that guides UDOT's investment decision-making process. Initial assessments reveal the top-performing projects for each UDOT Region to be:

REGION 1

Ogden Canyon MSE Wall Replacement along SR-39

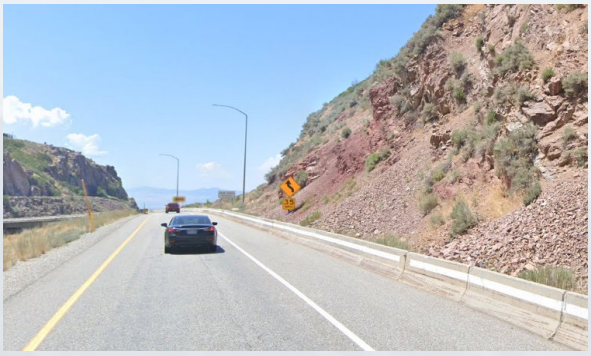
Replaces the current MSE wall that is being undermined by the Ogden River to reduce exposure to flooding/erosion.



REGION 2

I-80; Rockfall and Barrier Improvements

Reduce exposure to rockfalls on the I-80/I-215 connecting ramps.



REGION 3

I-15 Dry Creek Channel Improvement in Lehi

Reduces I-15 and surrounding community's exposure to flooding and related damage.

REGION 4

Rehab/Replace Culverts, Various Locations on I-15

Fix deteriorating culverts (e.g. MP 37.3) to reduce exposure to flooding and related damage.

Introduction

Under the federal Infrastructure Investment and Jobs Act (IIJA),[4] the FHWA's PROTECT program encourages state departments of transportation (DOTs) to adopt resilience planning practices by preparing a RIP as part of FHWA's wider objective to make surface transportation in the United States more resilient to natural hazards. Agencies that complete a federally approved RIP can subsequently reduce the standard 20 percent non-federal cost share for projects paid for with federal PROTECT funding to 10 percent.

FHWA defines resilience as the ability to anticipate, prepare for, or adapt to conditions or withstand, respond to, or recover rapidly from disruptions. Resilience includes the ability to:

- Resist hazards or withstand impacts from weather events and natural disasters.
- Reduce the magnitude or duration of impacts of a disruptive weather event or natural disaster.
- Have absorptive capacity, adaptive capacity, and recoverability to decrease project vulnerability to weather events or other natural disasters.
- Incorporate natural infrastructure where the benefits can be realized.

UDOT has developed this federally compliant RIP to support the department's ongoing efforts to integrate resiliency into its planning, asset management, project prioritization, project development, and decision-making processes.

The Federal PROTECT Program

The PROTECT Program directs federal funds to support investments by states and their local partners in planning and infrastructure improvements that help make surface transportation in the United States more resilient.

In general, eligible infrastructure types include highway, transit, or bicycle and pedestrian facilities, intercity passenger rail, and certain port projects tied to evacuation routes. A complete list of activities eligible for PROTECT formula funds and discretionary grant funds is detailed in Appendix A. Activities Eligible for PROTECT Funding.

PROTECT Formula Funds

PROTECT formula funds[5] are directly apportioned annually by FHWA to state DOTs. FHWA will distribute $7.3 billion in federal PROTECT formula funding over five years. Eligible activities for PROTECT formula funds are limited to:

- Resilience planning*;* limited to developing a RIP; resilience planning, predesign, design, or the development of data tools to simulate transportation disruption scenarios, including vulnerability assessments; technical capacity building to facilitate the ability of the State to assess the vulnerabilities of its surface transportation assets and community response strategies under current conditions and a range of potential future conditions; or evacuation planning and preparation.

[4] Also called the Bipartisan Infrastructure Law (BIL)

[5] https://www.fhwa.dot.gov/bipartisan-infrastructure-law/protect_fact_sheet.cfm

- Resilience improvements to improve the ability of existing surface transportation assets to withstand one or more elements of a weather event or natural disaster, or to increase the resilience of surface transportation infrastructure from the impacts of changing conditions, such as sea level rise, flooding, wildfires, extreme weather events, and other natural disasters.
- Evacuation route activities that strengthen and protect evacuation routes that are essential for providing and supporting evacuations caused by emergency events.
- At-risk coastal infrastructure activities to strengthen or otherwise enhance the resilience of highway and non-rail infrastructure to protect highways that are subject to or face increased long-term future risks.

Utah will receive approximately $65 million in PROTECT formula funds under IIJA. At least 2 percent of each state's PROTECT formula funds must be spent on resilience-related planning.

PROTECT Discretionary Grants

In addition to PROTECT's annual formula fund apportionment, four types of competitive grants[6] are offered within the PROTECT program. For FY22 and FY23, up to $848 million was available for the PROTECT Discretionary Grant Program. PROTECT discretionary grants have broad applicant eligibility for all levels of government including states, local governments, tribes, and MPOs. FHWA administers PROTECT discretionary grant funds.

Figure 2: Interstate 15 in Provo, Utah

[6] https://www.fhwa.dot.gov/environment/protect/discretionary/

Resilience Improvement Plan

A RIP is a strategic framework aimed at enhancing the overall resilience of the transportation system. It achieves this by identifying vulnerabilities, proposing resilience solutions, and prioritizing improvements to address the needs of communities and travelers. Utilizing a systematic approach, the RIP evaluates priority vulnerabilities and risks, integrates multimodal elements of the transportation system, and fosters collaboration with stakeholders, including internal/external partners, to inform decision-making and enhance collective resilience efforts. Additionally, the RIP complements existing processes and plans while serving as a proactive tool for advancing resilience within transportation agencies.

IIJA further describes RIP requirements in 23 USC §176:

A RIP shall…

- Be for the immediate and long-range planning activities and investments of the State or MPO with respect to resilience of the surface transportation system within the boundaries of the State or MPO, as applicable;
- Demonstrate a systemic approach to transportation system resilience and be consistent with and complementary of the State and local mitigation plans required under section 322 of the Stafford Act (42 U.S.C. 5165); and
- Include a risk-based assessment of vulnerabilities of transportation assets and systems to current and future weather events and natural disasters, such as severe storms, flooding, drought, levee and dam failures, wildfire, rockslides, mudslides, sea level rise, extreme weather, including extreme temperatures, and earthquakes. (23 U.S.C. 176(e)(2)(A-C)).

Shall, as appropriate…

- Include a description of how the plan will improve the ability of the State or MPO to respond promptly to the impacts of weather events and natural disasters and to be prepared for changing conditions, such as sea level rise and increased flood risk.
- Describe the codes, standards, and regulatory framework, if any, adopted and enforced to ensure resilience improvements within the impacted area of proposed projects included in the Resilience Improvement Plan;
- Consider the benefits of combining hard surface transportation assets, and natural infrastructure, through coordinated efforts by the Federal Government and the States;
- Assess the resilience of other community assets, including buildings and housing, emergency management assets, and energy, water, and communication infrastructure;
- Use a long-term planning period; and Include such other information as the State or MPO considers appropriate. (23 U.S.C. 176(e)(2)(E)(i)-(vi)).

A RIP may…

- Designate evacuation routes and strategies, including multimodal facilities, designated with consideration for individuals without access to personal vehicles;
- Plan for response to anticipated emergencies, including plans for the mobility of emergency response personnel and equipment, and access to emergency services including for vulnerable or disadvantaged populations;
- Describe resilience improvement policies, including strategies, land-use and zoning changes, investments in natural infrastructure, or performance measures that will inform the transportation investment decisions of the State or MPO with the goal of including resilience;
- Include an investment plan that: (i) includes a list of priority projects; and (ii) describes how PROTECT Formula Program funds apportioned to the State would be invested and matched, which shall not be subject to fiscal restraint requirements;
- Use science and data and indicate the source of data and methodologies. (23 U.S.C. 176(e)(2)(D)(i)-(v)).

Utah's Transportation Asset Management Plan

UDOT's Transportation Asset Management Plan (TAMP) supports preservation of the state's transportation infrastructure. It is an umbrella plan that contemplates the universe of assets and risks critical to UDOT carrying out its mission. The specific objectives of this plan are:

- Formalize a data driven performance and risk-based approach for allocating transportation funds to manage pavements, bridges, Intelligent Transportation Systems (ITS), and signal devices
- Incorporate asset management into intermediate and long-range planning processes
- Incorporate risk management into resource allocation decisions
- Provide an asset management tool with real time data

The following summary of the TAMP's asset perspective stems from the early foundational research efforts of the project. Developing this understanding was crucial to ensuring alignment between UDOT's RIP and the TAMP. UDOT's RIP and the PROTECT prioritization process nests within the TAMP's framework and supports implementation of TAMP strategies.

The TAMP identifies 93 individual assets within 19 asset systems (see Appendix D. UDOT's full list of Identified Assets included in the TAMP), yet only a portion of these assets have the necessary corresponding data to conduct spatial risk analysis. The TAMP employs a management system devised by UDOT's Asset Advisory/Performance Management Committees whereby assets are categorized into three tiers based on their significance to UDOT's performance plan and strategic objectives:

- Tier 1: Generally higher value and programmatic risk
- Tier 2: Generally moderate value and moderate programmatic risk
- Tier 3: Generally low value and moderate programmatic risk

Value is indicated by replacement costs to UDOT, and programmatic risk is based on the probability of risk occurrence and the estimated consequences across financial, political, operational, safety, and environmental considerations.

Tier 1 assets (Figure 3) are managed with performance measures and targets. The strategies for Tier 1 assets include elements such as a detailed inventory, defined maintenance cycles, collection and analysis of condition, predictive performance modeling, and the optimization of asset life cycles in most cases.

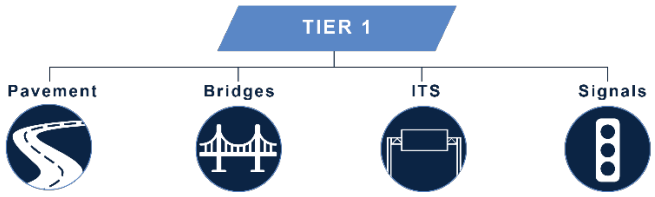


Figure 3: Assets in the TAMP's Tier 1 management level

Tier 2 assets (Figure 4) are managed on an interval or cyclical basis. They hold moderate value and substantial importance for transportation system operation. Strategies for Tier 2 assets include a detailed inventory, defined maintenance cycles, and collection and analysis of condition in most cases. Predictive performance modeling and life cycle optimization are not typically done.

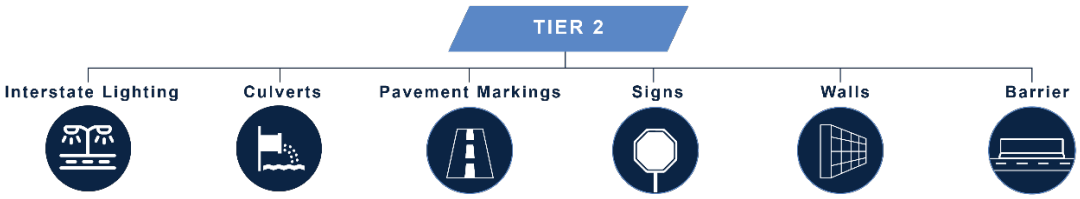


Figure 4: Assets in the TAMP's Tier 2 management level

Tier 3 assets (Figure 5) are managed reactively within funding availability and assessed risk. These assets are typically of lower value with minimal risk for reduced management or failure. Tier 3 strategies involve a limited asset inventory and repair or replacement when damaged.

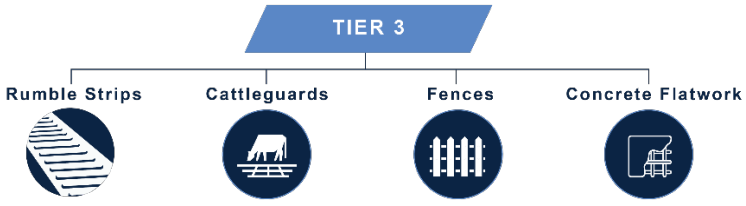


Figure 5: Assets in the TAMP's Tier 3 management level

UDOT's Risk Priority Asset Management Process

Before the inception of the federal PROTECT Program, UDOT embarked on a comprehensive endeavor through its multi-disciplinary Risk Management Working Group, which is now called the Risk Assessment Working Group (RAWG), to craft UDOT's Asset Risk Management Process (Figure 6).

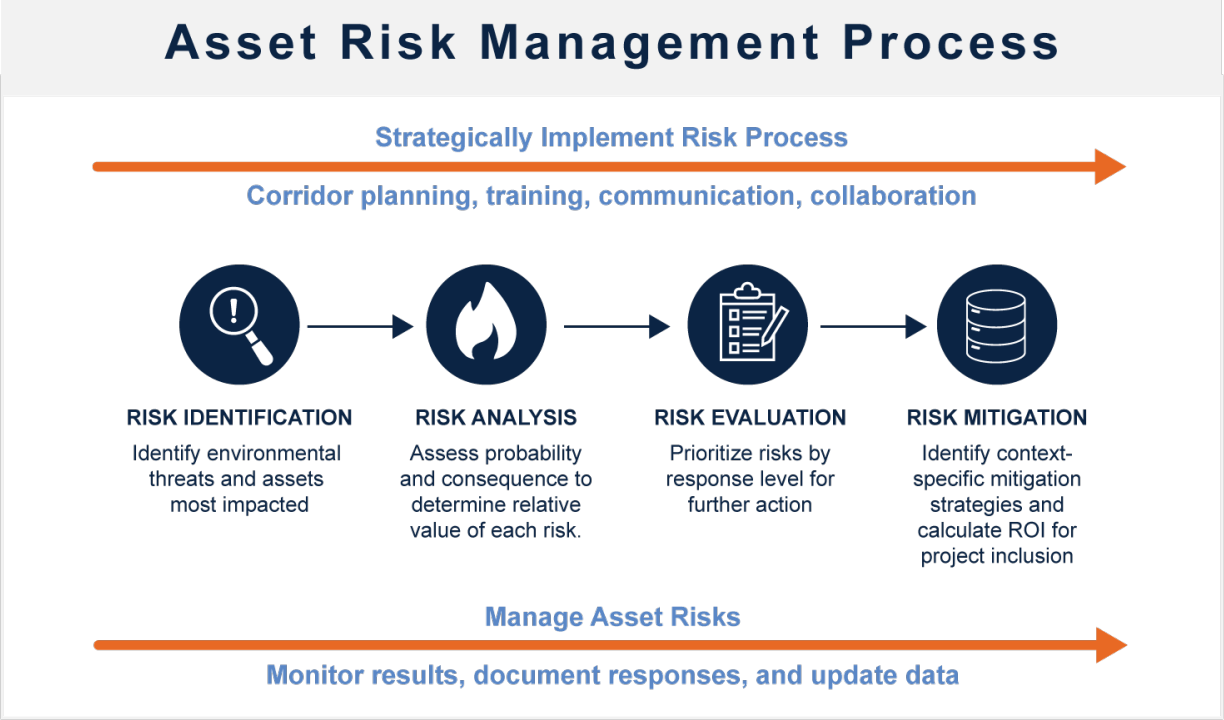


Figure 6: Overview of UDOT's Asset Risk Management Process

The Asset Risk Management Process was guided by four objectives:

- Aligned with UDOT's strategic objectives and performance metrics to ensure coherence in operational endeavors.
- Emphasized transparency and clarity in decision-making processes to foster public understanding and engagement.
- Encouraged qualitative analysis by key decision-makers to enable informed and robust risk assessments.
- Strategically balanced risks against UDOT's overarching goals and objectives to optimize resource allocation.

The Asset Risk Management Process initiative was intended to support and implement TAMP strategies by seamlessly integrating risk and resilience considerations into UDOT's decision-making frameworks.

The methodology underlying UDOT's Asset Risk Management Process included a five-step approach designed to identify, assess, and prioritize threats and hazards posed to individual

assets within the state transportation system. The process advanced to assessing the potential consequences of these threats, considering both owner and user costs. This began with identifying assets and the hazards they encountered, laying the foundation for further analysis. Risk values were computed by multiplying the consequence by the probability of each threat, providing a quantitative measure of risk exposure. Asset criticality of the overall transportation system was evaluated to determine their relative importance. Finally, risks were prioritized by multiplying the calculated risk value by the weighted criticality to address the most pressing concerns.

Integral to UDOT's Asset Risk Management Process was the Risk Priority Analysis (RPA), serving as a centralized repository housing information pertaining to hazards, assets, criticality criteria, and prioritization factors (Figure 7). Leveraging Geographic Information Systems (GIS)-based data, this inventory formed the cornerstone of UDOT's Asset Risk Management Process, facilitating informed decision-making processes. Accessible through a GIS-based StoryMap[7], this relatively comprehensive repository not only enhanced the efficacy of UDOT's risk management endeavors but also promoted transparency and accessibility to stakeholders involved in ensuring the resilience and safety of Utah's transportation infrastructure.

As demonstrated by UDOT's previous resilience efforts through the Asset Risk Management Process and RPA, the agency was well-positioned to seize the opportunity presented by the PROTECT Program and embark on developing a RIP. Viewing the RIP development process as a chance to expand upon its prior successes, UDOT aimed to enhance its existing risk-based approach in comprehending asset vulnerabilities to natural hazards. Additionally, UDOT recognized the potential to create a scalable platform capable of accommodating additional assets, hazards, and criticality considerations as new and improved data became accessible to support achieving TAMP objectives.

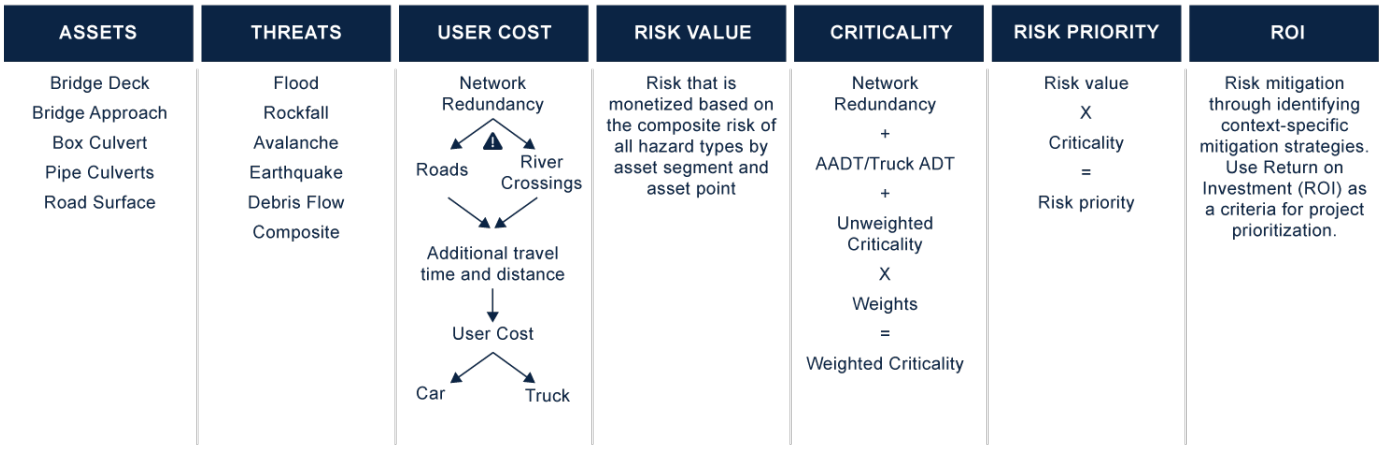


Figure 7: UDOT's RPA methodology

[7] https://storymaps.arcgis.com/stories/48418a2e48c048efbe2a3d87f41f7bd0

Approach to Developing the RIP and PROTECT Project Prioritization Process

UDOT's approach to developing the RIP and the PROTECT project prioritization process was guided by a willingness to rethink what resilience means for the agency and a strong commitment to integrating resilience considerations throughout decision-making processes. The outcome is a plan and prioritization process that:

- ✓ Provides a strategic framework that UDOT can use to integrate resilience considerations within existing decision-making processes.
- ✓ Identifies asset exposure to natural hazard threats leading to an understanding of their vulnerabilities.
- ✓ Assesses how effectively candidate PROTECT projects address known asset vulnerabilities.
- ✓ Broadens UDOT's perspective on its assets, recognizing them not solely as agency-owned and maintained infrastructure, but as resources utilized by communities across the state.
- ✓ Incorporates multimodal considerations within criticality considerations.
- ✓ Includes input from a wide range of internal and external stakeholders.
- ✓ Aligns specifically with UDOT's TAMP, State Hazard Mitigation Plan (SHMP), and more broadly with UDOT's long-range transportation goals and objectives.
- ✓ Complements other UDOT resilience efforts, including operations and maintenance, and UDOT's STIP development process.

The following sections detail how the research and outreach conducted were integrated into the RIP and the PROTECT project prioritization process.

RIP Integration & Planning Horizon

UDOT will strengthen the RIP's role within the TAMP and UDOT's LRTP in future iterations. UDOT's current LRTP calls for and references[8] the development of the RIP to invest in the resilience of Utah's transportation system through performance-based programming.

The RIP has a ten-year outlook and UDOT will renew the RIP every four years and conduct an annual call for project cycle. Through this approach, UDOT sees integration of the RIP taking place on several timeframes:

- **Immediate**: Guide resilient investment decisions through the project prioritization process on an annual basis starting with the adoption of this plan.
- **4-year mid-term**: Algin the RIP with the TIP/STIP process, further integrate within the TAMP and LRTP, and promote coordination to advance shared statewide objectives.
- **10-year, long-term**: Foster a culture of resilience within UDOT, including resilience at every level of decision-making throughout the agency.

[8] https://sites.google.com/utah.gov/lrp-2023/home/resilience?authuser=0

UDOT will continue coordination with MPOs and local agencies to include potential PROTECT program project under the state's RIP. MPOs can adopt the state's RIP by adding a reference to their respective regional LRTPs. Ongoing coordinate will ensure proper inclusion of potential PROTECT projects within existing TIP and STIP processes.

Regulatory Framework

UDOT has not adopted a regulatory framework for enforcing resilience improvements within impacted areas of proposed projects. However, UDOT will continue to integrate the RIP appropriately and together with UDOT Region and Division staff. This may result in an incremental approach to developing a regulatory framework that includes the adoption of resilience-supportive codes and standards.

Foundational Research

The foundational research efforts involved reviewing resilience-related state and tribal plans, as well as state and federal data sources. Findings from the foundational research supported UDOT's efforts to:

- Identify areas of alignment between the UDOT RIP and other state and tribal plans.
- identify potential UDOT RIP stakeholders based on agencies or groups consulted in other state and tribal plan development efforts.
- examine state and federal resilience tools to understand the assets, hazards, and criticality criteria included in other resilience assessments.
- Gain an understanding of resilience activities and approaches implemented by other states that could prove beneficial for UDOT.

Review of State Plans

UDOT developed a RIP that both complements and is informed by existing state plans and related efforts. By reviewing these plans and efforts, UDOT gained insights into how its missions and priorities align with those of other agencies, and how they can mutually support each other. A summarized list of goals, objectives, and actions directly related to UDOT's mission was developed during the foundational research effort. The purpose of this assessment was to provide UDOT with a resource that can be used to generate additional resilience-supporting priorities, strategies, and actions in collaboration with other agencies. This list can be found in Appendix A. Activities Eligible for PROTECT Funding. The recognition of areas where other agency priorities overlap creates collaboration opportunities for UDOT, whether it involves obtaining additional data to underpin resilience analysis or simply being aware of similar efforts, UDOT can benefit from such partnerships.

The foundational review efforts included the following plans due to their focus on understanding and/or mitigating natural hazard threats, prioritizing needs/projects for implementation, and providing insights on how UDOT's RIP can complement these ongoing efforts:

- **State Hazard Mitigation Plan (SHMP)** follows the State Mitigation Plan Review Guide and fulfills federal and local hazard mitigation planning responsibilities.

- **Utah Seismic Safety Commission (USSC) Report** reviews earthquake related hazards and risks.
- **Utah Forest Action Plan (FAP) 2020** assesses state forest resources and reviews changes in the social, economic, and environmental context (particularly shifts in issues and policy priorities) for the State's Forestry and Fire programs. The FAP addresses issues, identifies priorities, and promotes shared stewardship of landscape-scale forest restoration activities across Utah.
- **Jurisdictional Risk Assessment (JRA): Statewide Report** identifies existing gaps to help determine future hazard-specific planning, training, and exercise activities. The JRA assesses risk based on jurisdictional characteristics, vulnerabilities, hazard probability, impact scores, existing mitigation efforts, functional needs data, and access data.
- **Utah's 2023-2050 Unified Transportation Plan (UTP)** identifies and prioritizes transportation projects to create a financially constrained project list that's fiscally prudent and meets transportation needs. Projects are prioritized into three 10-year phases and an "unmet needs" category.

Review of Tribal Plans

Utah is home to more than 50 Tribal Nations and approximately 60,000 Native Americans. Of the 50 Tribal Nations in Utah, eight are federally recognized: Northwestern Band of Shoshone Nation, Confederated Tribes of Goshute, Skull Valley Band of Goshute, Ute Indian Tribe of the Uintah and Ouray Reservation, Ute Mountain Ute Tribe, San Juan Southern Paiute Tribe, Paiute Indian Tribe of Utah and Navajo Nation.[9] The Uintah and Ouray Reservation, about 150 miles east of Salt Lake City, spans 4.5 million acres, making it the second-largest reservation in the country.[10] The scale and remoteness of tribal lands and reservations present particular considerations to defining criticality. The following tribal resilience plans and studies were reviewed to ensure that the impact of transportation resilience on tribes would be integrated into the UDOT RIP:

- **Tribal Climate Resilience (TCR) Program and GIS for Tribal Resilience** (Western, Northwest and Navajo Regions)[11] – The Bureau of Indian Affairs (BIA) TCR Branch provides regional resources to support climate preparedness and resilience for all federally recognized Tribal Nations and Alaska Native villages. Most of Utah lies in the Bureau of Indian Affairs Western Region.[12] Small portions of the Navajo and Northwest Region also overlap with Utah's state boundaries. The resources for the Western, Northwest, and Navajo nations outline relevant policies, initiatives, and data analysis.
- **Status of Tribes and Climate Change (STACC) Report (2021)**[13] – Developed by the Institute for Tribal Environmental Professionals (ITEP) Tribes and Climate Change Program's STACC Working Group, this report "seeks to uplift and honor the voices of Indigenous peoples across the US to increase understanding of Tribal lifeways, cultures,

[9] https://www.visitutah.com/things-to-do/History-Culture/tribal-cultures
[10] https://www.visitutah.com/things-to-do/History-Culture/tribal-cultures
[11] https://www.bia.gov/service/climate-resource-directory/southwest-west-navajo
[12] https://www.bia.gov/sites/default/files/dup/inline-files/idc1-028635.pdf
[13] https://sites.google.com/view/stacc2021-itep/home?pli=1

and worldviews, the climate change impacts Tribes are experiencing, the solutions they are implementing, and ways that all of us can support Tribes in adapting to our changing world."

- **Fourth National Climate Assessment** (Chapter 25, Southwest Region)[14] – As required by the Global Change Research Act (1990), the US Global Change Research Program (USGCRP) produces this report every four years. This report (1) integrates, evaluates, and interprets the findings of the USGCRP, (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity, and (3) analyzes current trends in global change. The Southwest Region covers all Tribal Nations in Utah.

Review of Interactive Data Tools

Reviewing interactive data tools was an effective method to learn about available resilience related data. In addition to reviewing state and tribal plans, reviewing other interactive data tools supported the identification of natural hazard datasets worth considering for the RIP's asset assessment approach. The following data tools were reviewed:

- **Utah Disaster History**[15], as recorded by the Utah Department of Public Works, details Major Disaster, Emergency and Fire Management Assistance Grant Declarations in Utah from 1977 to present.
- **Utah Emergency Fund Map**[16] displays the location of projects that received federal emergency funds during construction.
- **Federal Emergency Management Agency (FEMA) Emergency Declarations**[17] – This tool allows users to explore historic federal disaster declarations by state, county, hazard, and year. The tool produces data visualizations and allows the user to export the raw data for additional analysis. Between 1953 and 2023, 51 Emergency Declarations were declared in Utah.
- **FEMA National Risk Index**[18] identifies communities most at risk to 18 natural hazards, visualizes natural hazard risk metrics, and includes data about expected annual losses from natural hazards, social vulnerability, and community resilience. A risk index for any given hazard is calculated as Expected Annual Loss × Social Vulnerability ÷ Community Resilience.
- **ThinkHazard Map**[19] "provides a general view of the hazards, for a given location, which should be considered in project design and implementation to promote disaster and climate resilience." After the user enters a location of interest, the tool identifies the likelihood of 11 hazards affecting project areas, provides guidance on how to reduce the impact of these hazards, and where to find more information.

[14] https://nca2018.globalchange.gov/chapter/25/
[15] https://dem.utah.gov/utah-disaster-history/
[16] https://uplan.maps.arcgis.com/home/webmap/viewer.html?webmap=b24d12caf2fe4188b7eca3d9b0edc0f8
[17] https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties
[18] https://www.fema.gov/flood-maps/products-tools/national-risk-index
[19] https://thinkhazard.org/en/

The review of the SHMP, other state plans, tribal plans, and interactive data tools provided valuable insights to inform the development of UDOT's RIP. Examining these plans led to a deeper understanding of natural hazard threats, identified priority needs and supportive types of projects, and recognized opportunities for collaboration and integration with ongoing efforts. By leveraging resources such as the Tribal Climate Resilience Program and the Fourth National Climate Assessment, UDOT enhanced its understanding of tribal perspectives, experiences, and needs in the face of climate change and natural hazards. Specifically, the RIP includes projecting future conditions of flooding and wildfires to understand impacts of climate change at the community level.

Stakeholder Identification

The state/tribal plans underwent collaborative development involving stakeholders from local, state, and federal levels across various sectors. Input for the six plans included various contributions spanning the following organizations:

- Utah Department of Transportation
- Utah Transit Authority
- Utah Department of Public Works
- Utah Division of Forestry Fire & State Lands
- Utah Department of Emergency Management
- State Hazard Mitigation Planning Committee
- State Hazard Mitigation Team
- Utah Metropolitan Planning Organizations
- Regional agencies
- Local agencies
- Local communities
- Local health departments
- Public health system
- Medical system
- Mental health system
- Envision Utah’s disaster resilience working groups
- Structural Engineers Association of Utah
- Earthquake Engineering Research Institute – Utah Chapter
- Utah’s largest water conservancy districts
- Institute for Tribal Environmental Professionals
- U.S. Forest Service
- U.S. Federal Emergency Management Administration
- U.S. Bureau of Indian Affairs
- U.S. Global Change Research Program

Shared priorities often pave the way for collaborative efforts, fostering sustained positive impacts on a larger scale. Based on the range of stakeholders identified through the review of state and tribal plans, a specific subset of stakeholders was engaged during the RIP development process. As further detailed in the external engagement section, the following stakeholder groups were engaged through surveys, which was a preferred method of engagement expressed by the stakeholders:

- Metropolitan Planning Organizations
- Utah Association of Counties
- Center for Rural Development
- Utah Transit Authority
- Utah Department of Emergency Management
- Utah Health and Human Services
- Rural Utah Health Association
- Tribes and Tribal Nations

Aligning with existing efforts and engaging a wide range of state and local stakeholders, provided UDOT with the necessary insights to broaden its view of its own assets. This deeper understanding contributed to a comprehensive RIP development process aimed at both enhancing resilience across UDOT's transportation infrastructure and Utah's urban and rural communities.

Figure 8: Logan, Utah

Natural Hazard Identification

By understanding the focal points of the reviewed resources, UDOT gained insights into which natural hazards would be most suitable to include in its RIP asset assessment approach. Figure 9 provides a summary of the natural hazards identified in each of the reviewed plans and interactive tools.

	Wildfires	Flooding	Drought	Geologic Events	Severe Weather	Cyclones	Volcanoes	Avalanches
Asset Risk Management Process		●		●				●
SHMP	●	●	●	●	●			●
UTP								
USSC Report				●				
EERI's Disaster Resilience Planning	●	●		●	●			
Utah Forest Action Plan	●	●	●	●				
JRA Statewide Report	●	●	●	●	●	●	●	●
GIS for Tribal Resilience and Tribal Climate Resilience Program	●	●	●					
Fourth National Climate Assessment	●	●	●		●			
ITEP Status of Tribes and Climate Change Report	●	●	●	●	●	●		
FEMA Emergency Declarations	●	●	●	●	●	●		
FEMA National Risk Index	●	●	●	●	●	●		●
ThinkHazard Map	●	●	●	●	●	●	●	

Figure 9: Hazards identified through foundational research results

Based on the review of plans and data resources, five hazard categories clearly stood out: wildfires, flooding, droughts, geologic events, and severe weather events. These hazards and hazard categories were consistently mentioned in over half of the resources assessed. As a result of their prevalence and potential impact on transportation infrastructure and communities, these were recommended for further consideration for inclusion within the RIP.

Peer State Review

The peer state review included an analysis of resilience planning initiatives in six peer states: New Mexico, Colorado, Oregon, Iowa, Kentucky, and Rhode Island. These states were selected based on their geographic relevance and existing resilience planning efforts. The insights gleaned from this review provided UDOT with potential strategies worth further consideration. Key findings derived from the peer state review offer actionable insights for advancing resilience initiatives within UDOT and with UDOT's partners.

New Mexico:

- New Mexico DOT developed a comprehensive Resilience Improvement Plan aimed at enhancing the state's resilience to various hazards. This plan includes the creation of a mapping tool to identify areas of raw exposure and sensitivity hotspots, aiding in proactive mitigation efforts.
- The Climate Change Task Force collaborated to produce a Climate Strategy Report, which includes a detailed Climate Risk Map highlighting areas vulnerable to climate-related hazards such as extreme weather events.

Colorado:

- Colorado DOT has integrated resilience principles throughout its departmental processes, particularly in transportation asset management. This approach ensures that resilience considerations are systematically incorporated into decision-making processes.
- Colorado DOT conducted a pilot study focusing on a significant stretch of infrastructure (over 450 miles of I-70) to assess potential future damage and closures resulting from physical threats. This study utilized data-driven calculations to determine cost-benefit alternatives for resilience measures.
- Beyond the DOT, Colorado has implemented emergency preparedness assessments and a state emergency operations plan, which address resilience across various sectors within the state.

Oregon:

- Oregon DOT's Resilience Improvement Plan integrates emergency operations and climate change adaptation programs, providing a holistic approach to resilience planning within the transportation sector.
- The establishment of the Climate Change Adaptation Program led to the development of a detailed Climate Adaptation and Resilience Roadmap. This roadmap outlines specific actions that the department can take to institutionalize resilience across its operations.
- Through the Emergency Operations Program, Oregon DOT collaborates with local public work agencies, establishing clear agreements and delineating roles and responsibilities to enhance resilience coordination.

Iowa:

- The Iowa DOT has established two dedicated working groups focused on resilience. These groups aim to ensure that the department is well-prepared to provide a safe, efficient, and convenient transportation system resilient to various hazards.
- Iowa DOT utilizes Transportation Systems Management and Operations (TSMO) and Asset Management strategies to enhance the resilience of its transportation infrastructure. These strategies help anticipate, prepare for, and adapt to changing conditions, enabling quick recovery from disruptions.

Kentucky:

- Kentucky's Resilience Improvement Plan assesses the likelihood and severity of potential hazard events, providing valuable insights into the state's vulnerabilities.
- The resulting assessments are entered into a central GIS database repository, facilitating the identification of system vulnerabilities, and informing targeted resilience initiatives.
- Kentucky Transportation Cabinet employs incident management practices to enhance system resilience, ensuring effective response and recovery capabilities during emergencies.

Rhode Island:

- Rhode Island DOT established the Resilient Rhody program, which focuses on recommending climate resilience actions for transportation and evacuation routes. These actions are aligned with the Transportation Improvement Program (TIP) and Transportation Asset Management Plan (TAMP) processes, ensuring integration with asset management and risk-based planning efforts.
- Rhode Island DOT's grant programs provide funding for transportation projects aimed at improving system resilience, supporting the implementation of resilience measures across the state's transportation infrastructure.

Based on the review of other states, it became clear that Utah compares favorably to others in terms of coordinating emergency operations and risk management strategies. However, like Colorado, Oregon, and Rhode Island, UDOT could leverage the RIP development process to gain a deeper understanding of climate adaptation needs. The RIP process necessitates projecting future conditions, but the lack of data is a limitation for UDOT. UDOT's knowledge of how its assets may be affected by potential future conditions is foundational to its ability to start adapting to the potential impacts of climate change.

Kentucky’s integration of incident management practices to identify vulnerabilities provides a model for UDOT’s further consideration. For example, UDOT currently identifies burn scars left by wildfires and has developed operational procedures to proactively mitigate the risk of debris flows prior to anticipated rainfall events. UDOT could, through future efforts, centralize/expand data collection of erosion, flash flooding, or reports of scouring by Region Office staff to develop additional proactive procedures, develop new projects, and develop project scopes with resilience in mind.

Stakeholder Engagement

To ensure the success of UDOT's RIP, an engagement plan was developed focusing on fostering collaboration and communication among UDOT staff, leadership, and external stakeholders. The summary of UDOT's approach to stakeholder engagement below is further described in the following sections and corresponding appendices as noted.

Internal Engagement Approach:

- The engagement plan sought to leverage the expertise and input of UDOT employees to drive project success. This involved re-engaging the RAWG. Additionally, UDOT leadership was actively involved to ensure alignment and support across the agency.
- Recognizing the importance of regional perspectives, in-person meetings were conducted with staff from UDOT's Region Offices. These meetings provided an opportunity to gather insights specific to each region, ensuring that regional considerations were adequately addressed in the RIP's development.
- A series of meetings were held with both the RAWG and UDOT leadership. These meetings served as platforms for discussing project progress, findings, and next steps, ensuring ongoing engagement and collaboration.

External Engagement Approach:

- The RIP engagement plan identified key stakeholders such as MPOs, tribes, rural communities, and other state agencies. These stakeholders provided valuable input on RIP methodology, data sources, and criteria selection, contributing to the broadening of UDOT's perspective of its assets.
- The external engagement process provided meaningful outcomes, including the identification and assessment of community assets for inclusion in the RIP, verification or refinement of project methodology, and increased awareness of UDOT's efforts among external partners.
- Surveys were conducted, focusing on asset identification and methodology review. These surveys afforded opportunities for stakeholders to contribute their insights and expertise to the project.

Internal Engagement

UDOT's RIP development process relied heavily upon internal stakeholder engagement including leadership, across departments, and Region Offices. A key component of this engagement strategy involved reassembling the RAWG, comprising members with experience supporting prior resilience initiatives within UDOT, notably in pioneering the agency's initial asset risk management process. Leveraging their expertise, internal stakeholders contributed valuable insights into the identification of critical assets, relevant hazards, and considerations of

criticality. Their input was instrumental in shaping the RIP's asset assessment, ensuring a comprehensive and contextually relevant approach.

Internal stakeholders played a pivotal role in refining the PROTECT program's project prioritization process. Their guidance and expertise overlayed real-world considerations for prioritizing projects on top of the data-driven spatial analysis that was undertaken to assess natural hazard threats and asset criticality. By incorporating diverse perspectives and expertise from within the organization, UDOT benefited from a robust and inclusive approach to resilience planning and project prioritization.

Asset Identification

The RAWG previously deliberated on which assets to include in UDOT's RPA. The group considered both the importance of assets but also what data UDOT had available at the time. The RAWG recommended to include bridge deck, bridge approach, box culverts, pipe culverts, and pavement.

Due to the RAWG establishing the importance of these assets, they were carried forward into UDOT's RIP efforts. However, the absence of multimodal considerations was clear. During the first RAWG meeting, members were asked which multimodal asset should be considered. Members strongly responded that both bike/pedestrian facilities and local transit routes were important, but there was discussion about UDOT's ownership of multimodal assets. This discussion resulted in consensus that multimodal considerations should be included but not as assets (Figure 10).

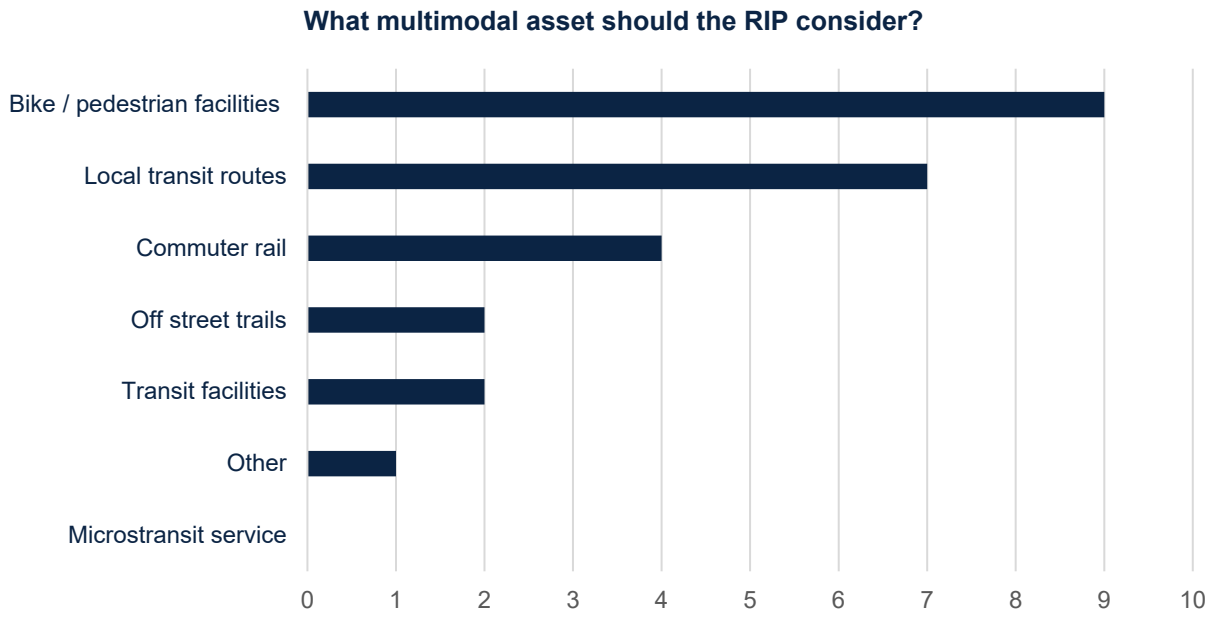


Figure 10: RAWG polling results regarding multimodal priorities

Based on the RAWG's input and available data, local transit routes and bike facilities were included as a criticality consideration rather than treating them the same as state-owned assets which fall under UDOT's direct purview. Based on this outcome, UDOT considered treating roadways with local transit routes and bike facilities as more important compared to roadways without them. After investigation, a suitable sidewalk network dataset was not available.

Natural Hazard Identification

The RAWG provided input on hazard identification and discussed previous deliberations to identify natural hazards incorporated within UDOT's Asset Risk Management Process. Based on the results of these efforts and alignment with findings from foundational research, there was consensus that all previously identified natural hazards from the Asset Risk Management Process initiative should be incorporated into UDOT's RIP efforts. UDOT saw the RIP development process as an opportunity to expand the list of natural hazards and asked RAWG members which additional natural hazards should also be included (Figure 11).

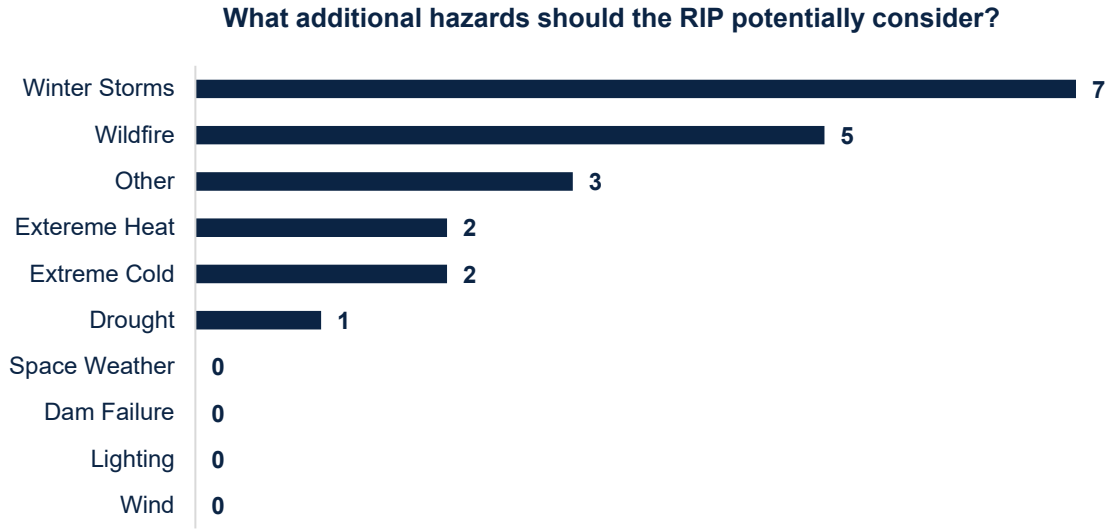


Figure 11: RAWG polling results regarding hazards

The RAWG members identified winter storms, wildfires, and "other" hazards such as debris flows. The RAWG discussed the connection between wildfires and the increased prevalence of debris flows, highlighting how combinations of natural threats can exacerbate one another. For instance, after a wildfire, steep areas are more vulnerable to impact from heavy rainfall, potentially leading to debris flows due to the lack of vegetation to stabilize the soil.

While winter storms were recognized as a significant hazard, there was doubt that infrastructure interventions could mitigate this threat effectively. It was noted that UDOT already has operational procedures in place to manage winter storms, whereas infrastructure improvements and other eligible project types under the PROTECT program could directly address the threats posed by wildfires and resulting debris flows.

After reaching a consensus, the RAWG recommended integrating flood, rockfall, avalanche, earthquake, debris flow, and wildfire hazards into the asset assessment process of the RIP. Despite UDOT's previous recognition of the importance of wildfires in resilience initiatives, the RAWG emphasized their direct threat to assets, emphasizing the need for their inclusion in the RIP.

Criticality Identification

While UDOT's Asset Risk Management Process and RPA primarily focus on assessing risks associated with assets from the agency's ownership perspective, the FHWA RIP guidance urges a broader perspective. This broader view extends to encompass a comprehensive understanding of how communities utilize and rely upon UDOT's infrastructure. By expanding the scope to incorporate community dependencies, UDOT can better identify vulnerabilities and prioritize resilience measures that not only safeguard transportation assets but also enhance community resilience and ensure continuity of essential services during disruptive events (Figure 12).

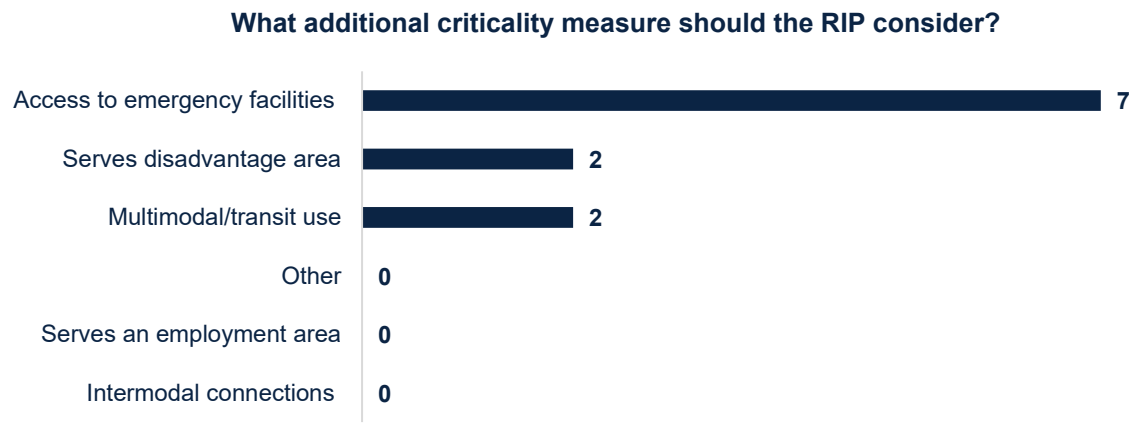


Figure 12: RAWG polling results regarding criticality

RAWG members indicated a strong preference for including access to emergency facilities as an important consideration, while also recognizing serving disadvantaged areas and multimodal/transit use. As noted previously, local transit routes and bike facilities translate well to include as a criticality input based on the asset identification discussion.

As a result of the RAWG's input and further assessment of data sources, UDOT included both proximity to critical community assets such as hospitals and emergency services and whether an asset was within a disadvantaged community.

PROTECT Project Prioritization Coordination

Internal coordination for the PROTECT project prioritization process engaged both the RAWG and UDOT's four Region Offices. While the RAWG provided a broad and comprehensive perspective, the Region Offices contributed specific insights on identifying and prioritizing current projects. UDOT is organized into four Region Offices (Figure 13), each tasked with administering, constructing, and maintaining state roads, highways, and freeways within their respective areas:

- Region One encompasses the northern section of the state, comprising Box Elder, Cache, Davis, Morgan, Rich, and Weber counties. Region One oversees maintenance and construction activities along 942 center-line miles and 2,655 lane miles of state roadway. Additionally, Region One includes two national forests, one national historic site, seven state parks, and three state highways designated as "Scenic Byways."
- Region Two includes Salt Lake, Summit, and Tooele Counties. It serves the most densely populated and urbanized region in Utah. As population growth accelerates, Region Two faces the responsibility and challenge of meeting both current and future transportation needs along the Wasatch Front.
- Region Three is responsible for state roads and a network of strategically positioned maintenance stations across six counties in central Utah: Daggett, Duchesne, Juab, Uintah, Utah, and Wasatch. Region Three addresses a diverse range of transportation requirements in both rural and urban communities. The region has convened an internal asset management council which plays a key role in identifying needs and prioritizing region-level projects.
- Region 4 covers the largest area of the state, comprised of 14 counties (Beaver, Carbon, Emery, Garfield, Grand, Iron, Kane, Millard, Piute, San Juan, Sanpete, Sevier, Washington, and Wayne) as well as a small portion of Utah County.

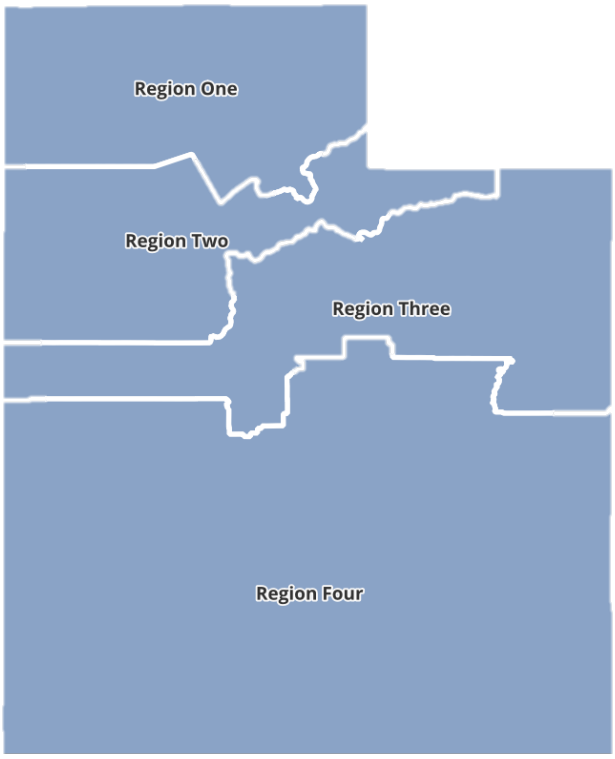


Figure 13: UDOT's Region Office boundaries

RAWG Coordination Outcomes

RAWG members emphasized the importance of transparency and integration across various UDOT processes to ensure alignment with agency-wide efforts rather than being a siloed effort. The conversation underscored the complexities surrounding terminology and metrics, particularly concerning terms like

vulnerability and criticality. RAWG members expressed curiosity about the prospect of weighting criticality considerations and were concerned about the need for an objective process to determine weights noting that different departments and regions would likely reach different conclusions on priorities.

Regional Office Coordination Outcomes

Region 1 staff expressed interest in PROTECT project eligibility related to safety, which includes resilience improvements. This includes two specific project types based on FHWA guidance:

- Expansion of capacity of evacuation routes to support evacuations, including the installation of communication and intelligent transportation system equipment and infrastructure, counterflow measures, and shoulders swiftly and safely.
- Projects to ensure access or service to critical destinations, including hospitals and other medical or emergency service facilities, major employers, critical manufacturing centers, ports and intermodal facilities, utilities, and Federal facilities.

Region 2 indicated a concern about the federalization of projects not originally anticipated to use federal funds based on delivery timeline considerations. Network redundancy was another topic raised due to the lack of alternative routes in rural areas. Staff directed attention to a slide path zone map (Figure 14), which indicates the general location of avalanches and their typical occurrence.

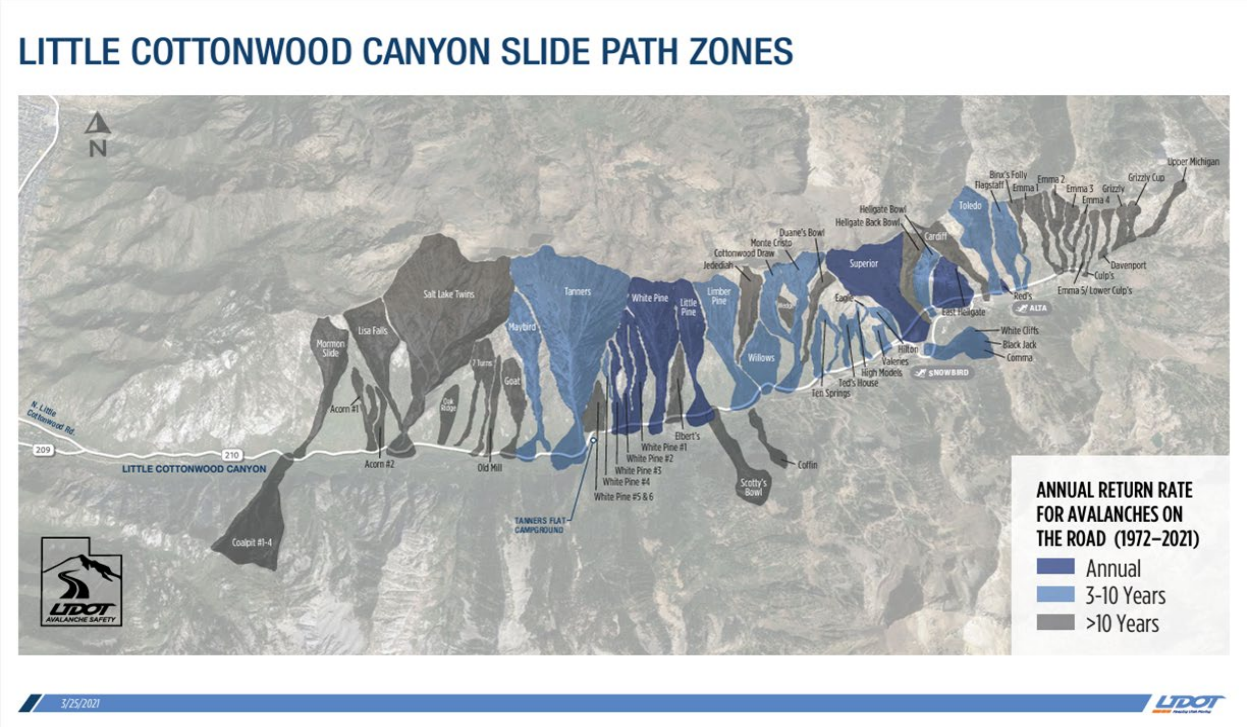


Figure 14: UDOT map of slide path zone along the Little Cottonwood Canyon

Region 3 staff shared a prioritization spreadsheet that they use to identify projects based on factors such as urgency, risk, and benefits. Again, concern about federalization of projects was raised with consensus that not all projects would be a good fit for the PROTECT program. Region 3's prioritization process was recognized as complementary to the PROTECT project

prioritization, where high-ranking, PROTECT-eligible Region 3 projects could then be added to the PROTECT project prioritization process. Staff noted a need to better understand natural hazards statewide and expressed interest in a single source that provided information about natural hazards. They mentioned a lesson learned that constructing debris basins to address rockfall proved to be ineffective because they became full over time.

Region 4 staff also raised the need to address network redundancy limitations in rural areas, especially for towns with one ingress and egress route. An example was presented concerning the closure of SR 95, which resulted in considerable detour times. This illustration underscored the significance of resilience and redundancy in infrastructure planning and management. The lack of resources for communities to support evacuation routes was a specific need identified. It was pointed out that the PROTECT Program could provide funding to support communities in need of evacuation resources.

Discussion with the RAWG and Region Offices garnered useful insight into their needs and priorities, which the RIP development process incorporated. On the administrative side, the need to integrate the PROTECT project prioritization process vertically and horizontally within UDOT was universally accepted. The PROTECT project prioritization screening and scoring rubric in Appendix E. PROTECT Candidate Project Screening and Scoring Rubric incorporates many of the considerations raised by the RAWG and Region Office staff. Concern about federalizing projects was raised so tools used to collect PROTECT projects would need to screen for both eligible and appropriate projects from the Region's perspective. On the technical side, network redundancy, evacuation routes, and the need for centralized hazard data were shared priorities. Network redundancy was included as a criticality input as it was universally identified by UDOT's Asset Risk Management Process, foundational research efforts, and from stakeholders.

External Engagement

External Stakeholders Identified for Outreach

External stakeholder engagement served as a vital component in UDOT's RIP development process. Conducted between December 18, 2023, and February 21, 2024, this engagement gathered insights into crucial community assets, transportation criticality, project prioritization, and the identification of relevant data sources. Metropolitan Planning Organizations (MPOs), local governments, and other stakeholder groups were actively involved in the process, and their input was captured through a series of survey questions.

This collaborative effort ensured that the perspectives and priorities of diverse stakeholders were incorporated into the RIP, fostering community buy-in, and enhancing the plan's effectiveness. By working together with external stakeholders, UDOT developed a process that achieved a resilient transportation system that can continue meeting the needs of the communities it served.

Tribes	MPOs and Local Governments	Other Stakeholders
• Confederated Tribes of Goshute • Navajo Nation	• Cache MPO • Wasatch Front Regional Council • Mountainland Association of Governments	• Utah Health and Human Services • Rural Utah Health Association

Tribes	MPOs and Local Governments	Other Stakeholders
• Northwestern Band of Shoshone Nation • Paiute Indian Tribe of Utah • San Juan Southern Paiute • Skull Valley Band of Goshute • White Mesa Community of the Ute Mountain Ute Tribe • Ute Indian Tribe	• Dixie MPO • Utah Local Association of Counties • Cache Valley Transit District • High Valley Transit District • Park City Transit • Basin Area Transit • Cedar Area Transit • Moab Area Transit • SunTran • Utah Transit Authority • Zion Shuttle	• Utah Emergency Management Department • Center for Rural Development • National Parks Service (NPS)

The complete survey can be found in Appendix F. External Stakeholder Survey.

Community Asset Assessment

Stakeholders were asked which community assets are the most dependent on the transportation system to maintain effective operations. Stakeholders identified several economic and health assets that are dependent upon the transportation system:

Economy:

Local commerce, tourism, growing populations, commercial districts, pipelines, refineries, and special service districts.

Health:

Emergency Medical Services (EMS), emergency management and response, medical supplies, access to hospitals and other healthcare facilities, Northeastern Counseling Center, the health department, walkability, access to healthy food, and safety.

Other:

public utilities, public works, education, school districts, fire department, and law enforcement.

The emphasis placed on health providers, emergency services, and essential government services reflects the internal feedback received within UDOT, contributing to consensus on these priorities. Recognizing the critical role UDOT's assets play in supporting vital infrastructure for the economy was another key insight. Both overarching themes and specific components were evaluated for available data and potential inclusion in critical assessments. In cases where data was lacking, and where UDOT's mission aligns with other agency objectives as identified in foundational research, UDOT could identify strategic areas to collaborate with state agencies and local organizations to either acquire additional data or deepen UDOT's understanding of these topics through ongoing partnerships.

Criticality

Stakeholders were asked which transportation assets are the most vital during an emergency event. In particular, the following assets were identified:

- Bridges over Mill Creek, Pack Creek, and Colorado River
- Roads: Hwy 89/91, SR 30, SR 9, US-191, I-15, West Davis Highway, priority routes to healthcare facilities, major arterial and collector roads, roadways to the park, the four main connections that lead out of the Cache Valley, effective detours, truck routes, and wildfire evacuation routes.
- Public Transportation: Moab Area Transit, Basin Transit Association, UTA, Cache Valley Transit District public transit system, school buses, paratransit vehicles, and fixed route buses.

Stakeholders emphasized bridges, roads, and public transportation as critical assets during an emergency event. This reflects the internal feedback received within UDOT, contributing to consensus on these priorities. The specific roads and bridges identified by stakeholders illustrate the existing opportunity for Region Offices to collaborate with local stakeholders to identify areas of need that candidate PROTECT projects could address.

Recent Experience with Hazards

Stakeholders were also asked if there are unique considerations for specific geographic areas that may not be captured by formal data. This included recent experiences with recent hazard events and associated transportation needs.

- Statewide
    - Quick rockfall cleanup on canyon roads with unstable slopes.
    - UDOT plows deliver predictable snow and ice removal, allowing clear roads that facilitate traffic flow. Regularly reviewing conditions and implementing best practices for staff safety is a cornerstone of effective weather management.
    - Resiliency planning needs to be balanced with everyday functions and safety. Efforts to make facilities more resilient should not make facilities less safe for users on an everyday basis.
    - Low-income households with limited access to personal transportation and students are the most dependent on public transportation.
    - Paratransit vehicles and fixed route buses can be used for evacuations and transit facilities can be used as warming centers in emergency events.
- Region 1
    - Davis County Public Works worked with UDOT to address minor freeway flooding from swollen creeks adjacent to I-15 in spring 2023. Traffic was impacted for a few days and a project to upsize a culvert under I-15 has been

proposed for State funding through the Utah Division of Emergency Management and House Bill 1001.

- Truck drivers who are inexperienced with driving on mountain roads are responsible for several runaway truck crashes in the intersection of US 89 and SR 30. A catch net truck system was installed but never used. A brake check lane was recently built above the catch net system.
- The Basin Transit Association is part of the regional emergency management plan, and the Cache Valley Transit District is integrated into Cache County's Emergency Response planning.
- Sardine and Logan Canyon experience avalanches, minor flooding, and winter-weather related closures.

- Region 3
  - The area west of Utah Lake and the community of Woodland Hills experience wildfires regularly. Wildland fire evacuation routes should be improved, and wildfire breaks that also serve as trails should be considered along foothills (e.g., Highline Canal and future trail). Firebreak roads and trails share maintenance responsibilities and improve monitoring.
- Region 4
  - Mill Creek experienced a 100-year flood in 2022 that inundated the roads with water debris, necessitating traffic redirection. This flood made apparent the deficient flow capacity of bridges, as many were clogged with debris. Active transportation corridors, such as the Mill Creek Parkway, were damaged and shut down for repairs.
  - City of Moab and Grand County are low-income areas that are at risk to climate change and are determined to be disadvantaged by the Climate and Economic Justice Screening Tool. While there is a lot of data to identify where mitigation measures are needed, there is not enough funding to address them.
  - Zion National Park regularly experiences hazards that impact transportation within the park boundaries. This includes rockfalls that force temporary road closures and flooding that leads to sheltering-in-place for the shuttle system.
  - The greater St. George area is home to rivers, bluffs, hills, and plateaus that can amplify the impacts of hazard causing disruption to travel.

Stakeholders' experiences with recent hazards aligned with the Region Office discussions. Ongoing coordination between Region Offices and local stakeholders can provide powerful judgement-based insights while fostering collaboration. This institutional knowledge, paired with quantifiable data, can inform prioritization and decision-making process.

Data, Tools, and Other Resources

Lastly, stakeholders were asked what data and tools they use for resilience planning. Stakeholder organizations used a combination of statewide, regional, and local resources:

- Statewide Resources
    - Utah Healthy Places Index (which identifies location of populations likely to need additional assistance),[20] FEMA Hazus modeling,[21] Threat and Hazard Identification and Risk Assessment[22] in coordination with the Counties, and NPS resources.
- Region 1
    - Bear River Association of Governments Pre-disaster Mitigation Plan[23] and Cache Valley Transit District (CVTD) Safety, Security and Emergency Preparedness plan. The CVTD plan has a matrix that outlines what assets are critical to the CVTD mission. This tool develops a score for the value of each asset based on replacement value, loss impact to health/safety, and loss impact to other assets. This helps inform strategies to protect each asset and determine the cost to replace.
- Region 2
    - MAG Pre-Disaster Mitigation Plan[24] includes hazard layers and mitigation strategies with the MPO's jurisdictions and partners.
- Region 4
    - Grand County Multi-Jurisdictional All Hazards Mitigation Plan,[25] Moab/Grand County Unified Transportation Master Plan,[26] Moab Sustainability Action Plan,[27] and Moab Geologic Hazards reports[28]
- Other Local Resources:
    - Travel demand models, GIS databases, and weather reports.

The identified statewide resources were used in several of the plans that were reviewed in the foundational research process. Several regional entities have developed their own resilience plans as well. UDOT can consider these regional resources for current and future RIP efforts.

[20] https://dhhs.utah.gov/utahhpi/
[21] https://www.fema.gov/flood-maps/products-tools/hazus
[22] https://www.fema.gov/emergency-managers/national-preparedness/goal/risk-capability-assessment
[23] https://hazards.utah.gov/wp-content/uploads/BRAG-Plan.pdf
[24] https://mountainland.org/hazard/
[25] https://grandcountyutah.net/1264/Hazard-Mitigation-Plan
[26] https://grandcountyconnects.com/unified-transportation-master-plan
[27] https://moabcity.org/478/Sustainability
[28] https://moabcity.org/528/Geologic-Hazards-Maps

PROTECT Prioritization Process

UDOT's PROTECT project prioritization process embodies UDOT's commitment to integrating resilience within decision-making throughout the agency. The development of this process was informed by foundational research findings, alignment with the TAMP, and internal and external stakeholder engagement. The prioritization process:

- Considers both immediate needs and long-range planning activities and investments. While current hazard conditions serve as a basis for assessing vulnerability, information for future hazards (flooding and wildfire) is also included.
- Broadens UDOT's perspective on their assets to include an understanding of how communities (hospitals, schools, and emergency services) depend upon these assets.
- Results in an investment plan that includes a list of priority projects describing how PROTECT formula funds would be invested.
- Establishes a transparent process that promotes internal buy-in and adoption.

The PROTECT prioritization process comprises two main components (Figure 15):

- A data driven approach that assesses asset exposure to natural hazards and results in resilience risk scores. These scores consider asset exposure to the natural hazards and criticality criteria identified through consultation with internal and external stakeholders throughout the RIP development process.
- Second, project efficacy scores leverage institutional knowledge from staff to identify projects and then determine how well those projects address a known natural hazard.

The resilience risk and project efficacy scores are combined through a geospatial process. The resulting combined resilience risk and scope efficacy scores become the basis for prioritizing projects and are further considered for PROTECT formula funding. The following sections provide additional details on each step of the prioritization process.

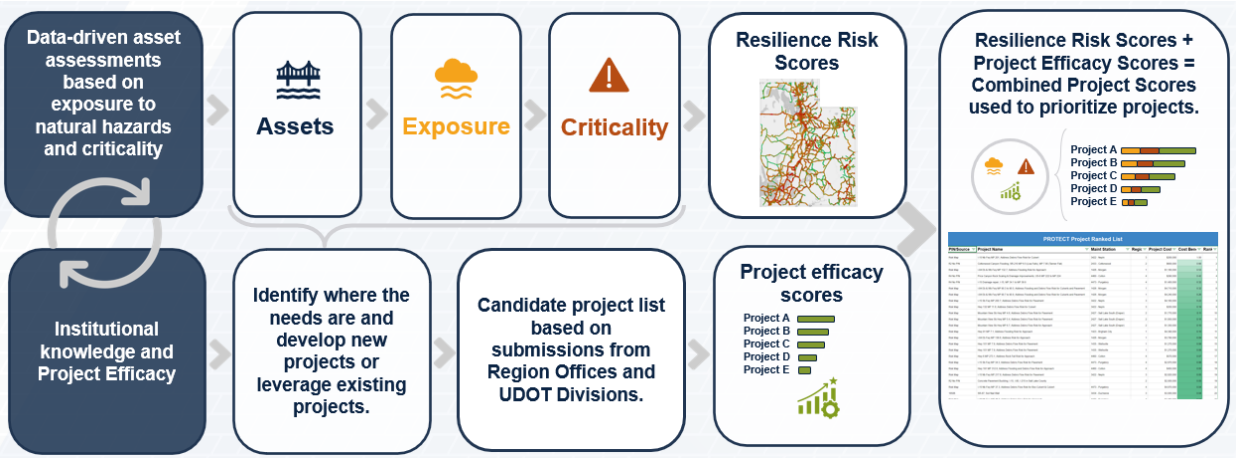


Figure 15: UDOT's PROTECT project prioritization process

Analysis Methodology

This section summarizes how the final datasets for assets, hazards, and criticality were identified and incorporated into the analysis, based on the prior review of the TAMP, previous UDOT resilience efforts (Asset Risk Management Process and RPA), foundational research, and engagement with stakeholders. In total, the RIP's asset assessment approach includes five asset types, six hazards, and six criticality criteria. This section also includes a description of the methodology underpinning the asset assessment. This includes an accounting of:

- The analysis of selected assets' exposure to selected natural hazards
- Determining the criticality of assets based on identified considerations

Each asset is analyzed in terms of its exposure to natural hazards to produce an exposure score. This is done for both exposure to current hazard levels and predicted future hazard levels, where allowed by available data. The exposure score is then combined with a criticality score to produce a resilience risk score (Figure 14). This data-driven process represents one of two inputs that completes the PROTECT project prioritization process. Following this section, the PROTECT project Prioritization section describes how the resilience risk scores were combined with judgment-based project efficacy scores to generate the prioritized list of projects that UDOT will use to inform investment decisions.

Expanding beyond the assets analyzed in the RIP's asset assessment, the TAMP, as noted, considers a full set of 93 identified assets, many of which were suitable for inclusion in this asset assessment. However, for many of these assets, the necessary corresponding data was not available. Considering UDOT's assets that lack spatial data can help avoid potential blind spots by only assessing known assets. While some assumptions can be made regarding the relative importance of UDOT's various asset types, such as through the TAMP tiered management system, relying on institutional knowledge and collaboration remains essential until data gaps are resolved.

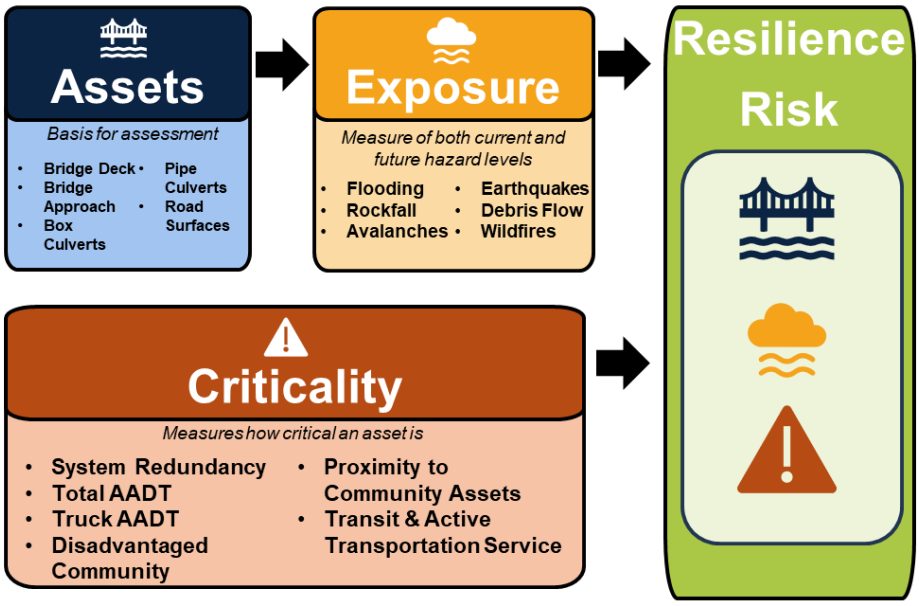


Figure 16: Asset assessment framework

Assets

Within the framework of the TAMP, the focus for asset selection was directed to Tier 1 and Tier 2 assets due to their established importance in supporting UDOT's mission. Building upon alignment with the TAMP and continuing the RAWG's work reviewing assets and available data, the assets identified through UDOT's Asset Risk Management Process were carried forward into the RIP asset assessment. These assets include bridge decks, bridge approaches, box culverts, pipe culverts, and road surfaces.

Consensus reached during the RAWG meetings confirmed the importance of these assets for ensuring the safe operation of UDOT's transportation system and their exposure to natural hazards. This list of assets predates the RAWG, as it was identified as part of two past UDOT pilot risk analysis studies for I-15 and US-40. Even though these five asset types were the ones selected for use in this asset assessment, this does not mean that measuring exposure or resilience risk is only applicable to these asset types. As more asset data becomes accessible and complete, the methods of this asset assessment can be performed across a large variety of asset types. The TAMP provides a framework to prioritize data development. UDOT is in a favorable position, due to its strategic direction and internal collaboration, to determine the next steps.

Asset Data

Asset data was gathered from UDOT's ArcGIS Online data portal[29] via the existing Risk Priority Analysis website[30]. The maps below showcase the geographic distribution of specified assets including bridge decks and bridge approaches (Figure 17), box and pipe culverts (Figure 18), and roadway surfaces (Figure 19).

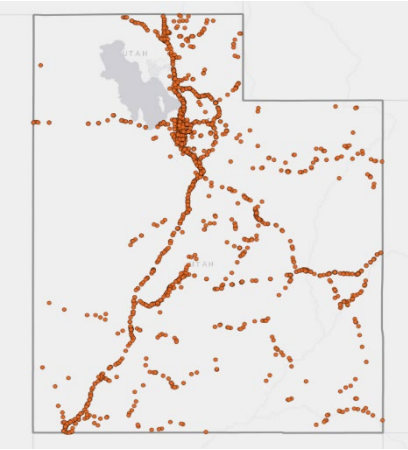


Figure 17: Map of bridges evaluated through UDOT's RPA

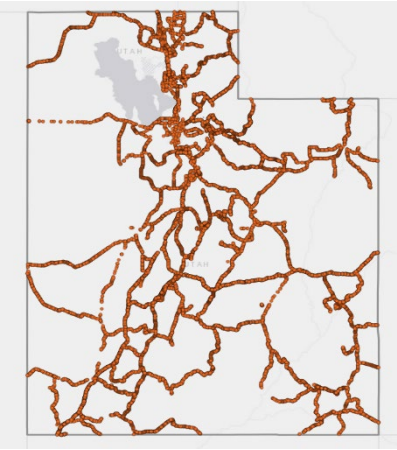


Figure 18: Map of culverts evaluated through UDOT's RPA

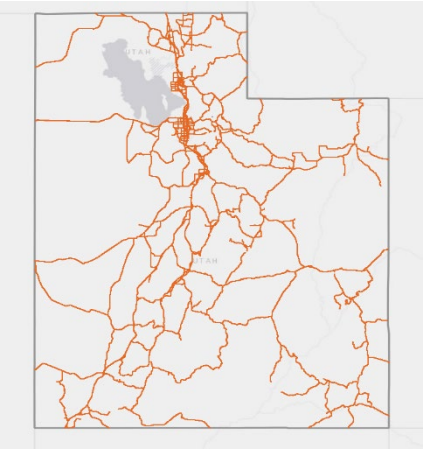


Figure 19: Map of roadway surfaces evaluated through UDOT's RPA

[29] https://portal.udot.utah.gov/portal/home/item.html?id=fd5fe450ecdd46e88699e8f5ae642001

[30] https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41

Hazard Exposure

Foundational research efforts identified wildfires, flooding, droughts, geologic events, and severe weather events as the most prevalent natural hazards in the state. Of these, geologic events and severe weather include multiple related sub-hazards. For instance, geologic events can include earthquakes, rockfalls, and debris flows among others. In support of UDOT's Asset Risk Management Process efforts, RAWG members considered a wide range of hazards including. Following deliberations about practical impacts to UDOT's infrastructure, a subset of hazards was selected for the RPA (Figure 20).

Hazard	Selected for RPA
Earthquake – with respect to bridges	◉
Wind	
Debris flow	◉
Rockfall	◉
Sinkhole	
Flooding	◉
Avalanche	◉
Liquefaction	
Landslide	
Fire	
Winter weather	
Lightning	

Figure 20: Hazards selected for evaluation through UDOT's RPA

The RIP development process revisited this list of hazards for consideration. Wildfire was elevated for inclusion as its own hazard and not as a proxy via debris flow. This direction was further supported by external stakeholder responses regarding impactful recent hazards that they and their communities experienced.

As a result, six hazard types were used for the asset assessment, aligning with and building upon UDOT's Asset Risk Management Process, RPA, external stakeholder engagement, and considering data availability. UDOT's current operations and standard practices do address these hazards. The PROTECT program offers an opportunity for UDOT to be proactive in areas that are currently reactive, and advance proactive efforts where they currently exist such as seismic retrofitting of bridges. Transitioning to a proactive policy stance strongly supports the TAMP's strategic direction as well. These six hazards and a description of UDOT's current practices are provided below:

Flooding: Flooding after storms and floods can be exacerbated by wildfires which reduce the capacity of the ground to absorb water and contribute to debris flow risk. Flooding can also lead to scouring around bridge piers.

Existing mitigation practices: UDOT conducts regular maintenance of drainage systems to ensure efficient water flow, construction of flood control structures such as retention ponds and culverts and implementing emergency response plans to quickly address flood-related incidents. However, to improve operations, safety, and reduce burden on limited operational resources, infrastructure improvements can solve long standing, recurring problems.

Rockfall: Rockfalls present a danger to the public and can impact the utility of UDOT assets.

Existing mitigation practices: UDOT conducts proactive measures such as rock scaling and installation of protective barriers to reduce the risk of rockfall along roadways. Yet the dynamic and persistent threat of rockfalls presents an ongoing challenge to UDOT in maintaining safe transportation routes.

Avalanche: Like rockfalls, avalanches pose danger to the public and can prevent use of roadway facilities limiting access to and between communities.

Existing mitigation practices: UDOT installs control structures, snow fences, and takes proactive action to rapidly clear dangerous snowpacks to reduce the risk of avalanches along roadways. As influence factors change with future conditions, UDOT will need to adapt to changing avalanche threats.

Earthquake – with respect to bridges: Utah experiences frequent seismic activity, primarily associated with its proximity to the Intermountain Seismic Belt and various fault lines.

Existing mitigation practices: UDOT implements seismic retrofitting of bridges, overpasses, and other critical structures. The PROTECT program represents an opportunity for UDOT to advance priority seismic retrofits and incorporate seismic elements within new project scopes.

Debris Flow: Debris flow risk in Utah is a significant concern, particularly in areas with steep slopes, rugged terrain, and a history of wildfires or intense rainfall events. These events can pose serious hazards to communities, infrastructure, and natural resources.

Existing mitigation practices: UDOT currently constructs debris flow barriers, sediment traps, and implements channel stabilization projects to reduce the risk of debris flows along roadways.

Wildfire: Extreme heat and drought typical of Utah's climate increase conditions that lead to wildfires and the state experiences 800 to 1,000 wildfires every season. Wildfires often cause road closures that impede first responders, evacuations, and transportation of goods.

UDOT has resources, including the Emergency Repair Map,[31] the Burn Scar Map,[32] and a post-wildfire mitigation process, to analyze specific occurrence and location of hazards. The Emergency Repair Map track projects that used federal funds to repair damage. The PROJECT Program can provide additional planning support to build upon these data collection and proactive operational practices.

[31] ER Fund Project data (arcgis.com)
[32] Weather Operations - Debris Flow Monitoring - Overview (arcgis.com)

By analyzing these six natural hazards, UDOT can utilize PROTECT program funding to systematically prioritize solutions based on the exposure of assets to these threats. Leveraging long-term infrastructure solutions through the program, UDOT can address longstanding and recurring problems associated with these top natural hazard threats, thereby reducing the need for ongoing maintenance and operation. As a result, UDOT would be better positioned to reallocate operational resources to address shifting natural hazard threats that may arise due to future condition changes, including the impacts of climate change.

UDOT closely collaborates with the Utah Division of Emergency Management, Department of Public Safety, local governments, and stakeholders to designate emergency routes for evacuation, response, and resource movement during emergencies, considering factors like accessibility and connectivity to critical facilities. UDOT also mobilizes resources in collaboration with state, federal, and private partners, deploying personnel and equipment for road clearance and other response activities. Additionally, UDOT develops continuity plans to maintain essential transportation functions, including backup communication systems and fuel supplies, during emergencies.

Hazard Exposure Data

Figure 21 presents the data sources for each selected natural hazard. Where data were available, in this case for flooding and wildfires, a source was identified for both current exposure levels and future exposure levels. As new data on projected exposure levels to hazards become available, the assessment methods described in this section could be replicated to include additional future hazards conditions.

Hazard	Exposure Variable(s)	Data Source Name(s)	Publishing Organization(s)	URL(s)
Flooding	Current Exposure: Annual Flood Occurrence Probability Future Exposure: Forecasted Change in Runoff (inches)	Risk Priority Analysis Map Climate Mapper Tool	UDOT (via FEMA Flood Insurance Rate Maps) University of California, Merced	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41 https://www.fema.gov/flood-maps https://climatetoolbox.org/tool/climate-mapper
Rockfall	Annual Rockfall Probability	Risk Priority Analysis Map	UDOT (via Utah State University Rockfall Damage Risk Study)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41
Avalanches	Avalanche Threat Probability	Risk Priority Analysis Map	UDOT (via Utah Avalanche Center Avalanche Points)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41 https://utahavalanchecenter.org/

Hazard	Exposure Variable(s)	Data Source Name(s)	Publishing Organization(s)	URL(s)
Earthquakes	Annual Earthquake Probability	Risk Priority Analysis Map	UDOT (via UDOT Structures Division earthquake damage models)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41
Debris Flow	Debris Flow Probability	Risk Priority Analysis Map	UDOT (via UDOT debris flow model)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41
Wildfires	Current Exposure: Wildfire Hazard Exposure Level Future Exposure: Forecasted Change in Percent Area Burned	Wildfire Hazard Potential for the United States	U.S. Department of Agriculture University of California, Merced	https://www.fs.usda.gov/rds/archive/catalog/RDS-2015-0047-4 https://climatetoolbox.org/tool/climate-mapper

Figure 21: Selected natural hazard data sources

Details describing the unit of measurement, description of how the natural hazard is represented, and range of values are described below. This also includes details on the spatial joining methods used to join the natural hazards to each of the assets. The earthquake hazard was joined only to the bridge deck asset.

Current Flooding Exposure

Unit of Measurement: Annual Occurrence Probability

Description: Represents the probability of flood occurrence for a given area in a given year. Annual probability of a 500-year flood = 1/500 years (0.002), annual probability of a 100-year flood = 1/100 years (0.01), and areas outside flood zones have a value of 0. The higher the value, i.e. falling within the highest probability flood zone (in this case a 100-year flood zone), the higher the flooding exposure score.

Range of Values: 0, 0.002, 0.01.

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. Annual Occurrence Probability is reflected in the "C_PROB" column.

Future Flooding Exposure

Unit of Measurement: Forecasted Change in Runoff (inches)

Description: Represents the change in the amount of runoff, the amount of water that is drained away from the surface of the land, for each spatial unit. Compares a historical simulation of 1971 – 2000 to a future emissions scenario depicting Representative Concentration Pathways (RCP) 4.5. RCPs consider a range of potential changes in socioeconomic scenarios that consider changes in population, energy, and land use. RCP 4.5 represents a scenario with moderate climate policy which is more realistic than the lack of climate policy under the higher emissions scenario. Values are in inches. The higher the value, the more future runoff is

expected. Negative values mean that there is less runoff expected in that area in the future compared to historic runoff. Note that future exposure values are not used in the scoring process and are only included as additional exposure information.

Range of Values (inches): [-4, 1]

Spatial Joining Methods:

1. Spatial data was downloaded from the Climate Mapper Tool. Menu selections were as follows:
    a. Time Scale: Future: Projections (through 2100)
    b. Impact Area: Hydrology (Contiguous US)
    c. Variable: Runoff Anomaly, Percent Change (%)
    d. Calendar Time Period: Annual
    e. Future Scenario: Lower Emissions RCP 4.5 2010 – 2039 vs. historical simulation 1971 – 2000, mean change
    f. Model: Multi-model mean from 20 MWBM runs forced by downscaled CMIP5 models (default)
2. The spatial data is in a raster format which means the spatial data is stored in a continuous format rendered as pixels on a map. Using GIS software, the raster data was converted to vector format which represents spatial features such as points, lines, or polygons each with an attribute value. This data was converted to polygons.
3. The polygon data was filtered down to the State of Utah by 'clipping' it to the state's official GIS boundary layer.
4. Each asset was spatially joined to the polygon it fell within using an 'Intersect' join.

Rockfall

Unit of Measurement: Annual Rockfall Probability

Description: Represents the annual probability of rockfall risk at a certain level. The rating system comes from a system produced in 2006 by Utah State University[33]. Under this scoring system, assets with the most immediate rockfall threat are assigned a 1, assets with a moderate threat are assigned a 0.5, assets with a low threat are assigned a 0.01, and areas with no threat have a value of 0. These groups are determined using a variety of variables such as erosion rate, effectiveness of a ditch in catching debris, and historic rockfall cleanout regularity. The higher the value, the higher the chance of rockfall at that location.

Range of Values: 0, 0.01, 0.5, 1.

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. Annual Rockfall Probability is reflected in the "RF_PROB" column.

Avalanches

Unit of Measurement: Avalanche Threat Probability

Description: Represents the 100-year avalanche probability determined by the number of avalanches that have occurred at that location over the last 10 years and multiplying by 10. The higher the value, the higher the chance of an avalanche at that location.

Range of Values: 0, 0.002, 0.01, 0.1.

[33] https://geodata.geology.utah.gov/pages/download.php?direct=1&noattach=true&ref=5814&ext=pdf&k=

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. Avalanche Threat Probability is reflected in the "Aval_Prob" column.

Earthquakes

Unit of Measurement: Annual Earthquake Probability

Description: Represents the annual probability of a 5.0 earthquake occurrence. Probabilities are originally represented as the chance of a 5.0 magnitude earthquake occurrence over the next 50 years. For example, the probability of a 5.0 magnitude earthquake happening anywhere along the Wasatch fault was found to be 93% in 50 years. Thus, the annual probability of occurrence is 0.93/50 = 0.019. This hazard was only joined to the bridge deck asset. The higher the value, the higher the chance of an earthquake at that location.

Range of Values: 0, 0.00627, 0.01254, 0.019.

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. Annual Earthquake Probability is reflected in the "Earthquake_Percent_Probability" column.

Debris Flow

Unit of Measurement: Debris Flow Probability

Description: Represents the probability of debris-flow occurrence. Values come from a custom debris flow model that was developed following procedure outlined by the United States Geological Survey. The model uses variables such as basin ruggedness, average storm intensity, and percent clay content of the soil. The higher the value, the higher the chance of debris flow at that location.

Range of Values: [0, 0.4279]

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. Debris Flow Probability is reflected in the "DF_PROB" column.

Current Wildfire Exposure

Unit of Measurement: Wildfire Hazard Exposure Level

Description: Represents the wildfire hazard potential, which is an index developed by the USDA that quantifies the relative potential for high-intensity wildfire that may be difficult to manage. The index values range from 1 to 7 with the higher values representing higher wildfire hazard potential.

Range of Values: [1, 7]

Spatial Joining Methods:

1. Spatial data was downloaded from the United States Department of Agriculture Wildfire Hazard Potential for the United States Publication website.
    a. File name: RDS-2015-0047-4 Data.zip
2. The data comes in a vector format ready to use for spatial joins.
3. The data was filtered down to the State of Utah by 'clipping' it to the state's official GIS boundary layer.
4. Each asset was spatially joined to the polygon it fell within using an 'Intersect' join.

Future Wildfire Exposure

Unit of Measurement: Forecasted Change in Percent Area Burned

Description: Represents the change in the proportion of area burned by a fire for each spatial unit. Compares a historical simulation of 1971 – 2000 to a future emissions scenario depicting RCPs 4.5. RCPs consider a range of potential changes in socioeconomic scenarios that consider changes in population, energy, and land use. RCP 4.5 represents a scenario with moderate climate policy which is more realistic than the lack of climate policy under the higher emissions scenario. The higher the value, the more proportion of area expected to be burned by a fire in the future. Negative values mean that less of the area is expected to be burned by a fire in the future. Note that future exposure values are not used in the scoring process and are only included as additional exposure information.

Range of Values: [-12, 13]

Spatial Joining Methods:

1. Spatial data was downloaded from the Climate Mapper Tool. Menu selections were as follows:
    a. Time Scale: Future: Projections (through 2100)
    b. Impact Area: Fire Modeling
    c. Variable: Percent Area Burned
    d. Calendar Time Period: Annual
    e. Future Scenario: Lower Emissions RCP 4.5 2010 – 2039 vs. historical simulation 1971 – 2000, mean change
    f. Model: Multi-model mean derived from 20 downscaled CMIP5 models (default)
2. The spatial data is in a raster format which means the spatial data is stored in a continuous format rendered as pixels on a map. Using GIS software, the raster data was converted to vector format which represents spatial features such as points, lines, or polygons each with an attribute value. This data was converted to polygons.
3. The polygon data was filtered down to the State of Utah by 'clipping' it to the state's official GIS boundary layer.
4. Each asset was spatially joined to the polygon it fell within using an 'Intersect' join.

Exposure Scores

Exposure scores were calculated for each asset after following the spatial join methods described in the previous section. Only current hazard values were used in the exposure score. First, the raw, non-zero values for each hazard were converted to a normalized value of 1, 2, 3, or 4 by finding the natural breaks in the data using Jenks natural breaks optimization for continuous variables and a value-to-value conversion (shown in the following table) for discrete variables. This normalization step ensures that all raw values were on the same scale. Figure 22 shows the conversion of each hazard's raw values to their normalized values. Note that any NULL values or raw values of 0 were assigned a normalized value of 0.

Hazard	Raw Value Range	Normalized Value
Flooding	-	1
	0.002	2
	-	3
	0.01	4
Rockfall	-	1
	0.01	2
	0.5	3
	1	4
Avalanches	-	1
	0.002	2
	0.01	3
	0.1	4
Earthquakes	-	1
	0.00637	2
	0.1254	3
	0.019	4
Debris Flow	0.00000703 – 0.029	1
	0.03 – 0.1289	2
	0.129 – 0.4279	3
	0.4279	4
Wildfires	1	1
	2 – 3	2
	4 – 6	3
	7	4

Figure 22: Normalized exposure scores

The normalized values were then summed up to an exposure score as described in the equation below. All hazards contribute equally to the exposure score.

$$Exposure\ Score = Flooding_{Normalized} + Rockfall_{Normalized} + Avalanches_{Normalized} + Earthquakes_{Normalized} + Debris\ Flow_{Normalized} + Wildfires_{Normalized}$$

Criticality

Criticality measures the importance of an asset to the transportation system and to the community. It considers how the loss in function of an asset impacts mobility, safety, disaster preparedness, and overall health. Criticality is quantifiable through diverse metrics such as economic factors (e.g., tourism), health and safety considerations (e.g., proximity to hospitals), operational aspects (e.g., Average Annual Daily Traffic (AADT), freight significance, redundancy, transit service, active transportation), and social and equity parameters (e.g., social vulnerability indices or demographic variables).

While the exposure scores measure one aspect of resilience risk (the potential impact of natural hazards on assets), criticality brings in another important aspect, namely, how critical an asset is to the system. If an asset has high exposure to hazards and is also a major connector, has a transit route, and is in an area with lower socioeconomic conditions, this asset may be more important to prioritize than another with high exposure to hazards but with very low usage in an area with high socioeconomic conditions. Combining exposure and criticality scores ensures that assets with more severe negative effects on system users were prioritized.

The final list of criticality criteria used for this project is as follows:

1. System Redundancy (measuring the additional number of miles it would take to access an alternative route if an asset was unavailable)
2. Total AADT
3. Truck AADT
4. Disadvantaged Community Index
5. Proximity to Community Assets (health care facilities, schools, and EMS locations)
6. Transit Service and Bike Facilities

System Redundancy, Total AADT, and Truck AADT were used in the prior RPA. Disadvantaged Communities, Proximity to Community Assets, and Transit Service / Bike Facilities were added for this analysis based on outcomes from internal and external stakeholder engagement.

Criticality Data

Figure 23 outlines the data sources for criticality criteria, including System Redundancy, Total and Truck AADT, Disadvantaged Community Index, Proximity to Community Assets, and Transit Service/Bike Facilities. These sources include UDOT's analysis maps and digital delivery portals, FEMA's National Risk Index, the State of Utah's Geographic Information Database, and the Bureau of Transportation Statistics' National Transit Map.

Criterion	Data Source Name(s)	Publishing Organization(s)	URL(s)
System Redundancy	Risk Priority Analysis Map	UDOT (via UDOT GIS-based redundancy analysis)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41
Total AADT	Risk Priority Analysis Map	UDOT (via UDOT Digital Delivery ArcGIS Portal)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41 https://digitaldelivery.udot.utah.gov/
Truck AADT	Risk Priority Analysis Map	UDOT (via UDOT Digital Delivery ArcGIS Portal)	https://uplan.maps.arcgis.com/apps/MapSeries/index.html?appid=fab82e27ca6047fc855bb97976ea0d41 https://digitaldelivery.udot.utah.gov/
Disadvantaged Community Index	National Risk Index	FEMA	https://hazards.fema.gov/nri/
Proximity to Community Assets (Health care facilities, Schools, EMS)	State Geographic Information Database	State of Utah Geospatial Resource Center	Health care facilities: https://opendata.gis.utah.gov/datasets/f5e5d7c717c946fe9cd6f2c8d0bf8d86_0/explore?location=38.858076%2C-111.508769%2C-1.00 Schools: https://opendata.gis.utah.gov/datasets/333206ff129346e3b8660e8f6f48540e_0/explore?location=39.405391%2C-111.646702%2C-1.00 EMS: https://opendata.gis.utah.gov/datasets/22410f18275646f89824403b74511308_0/explore?location=39.407109%2C-111.668702%2C-1.00
Transit service / bike facilities	National Transit Map Digital Delivery GIS Portal	Bureau of Transportation Statistics (BTS)	Transit lines: https://geodata.bts.gov/datasets/80086198b67c456194b064ba21b82326_0/explore?location=32.736344%2C67.136784%2C3.15 Bike lanes: https://digitaldelivery.udot.utah.gov/maps/d79466d3e8fc46b0968fc1d10da5e69a/explore?location=40.230324%2C-111.516260%2C7.00

Figure 23: Selected criticality criteria data sources

Details describing the unit of measurement, description of how the criticality criteria are represented, and range of values are described below. This also includes details on the spatial joining methods used to join the criticality criteria to each of the assets.

System Redundancy

Unit of Measurement: Additional miles to take an alternative route

Description: Represents the additional mileage a user would have to travel to an alternative route if the asset was not there or unusable. Assets with longer alternative routes would be considered more critical to the system.

Range of Values: [0, 745.53]

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. System redundancy is reflected in the “S1_Delay_Miles” column.

Total AADT

Unit of Measurement: Total AADT value

Description: Represents the total AADT of an asset. Assets with higher AADT would be considered more critical to the system.

Range of Values: [0, 300,000]

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. AADT is reflected in the “AADT” column.

Truck AADT

Unit of Measurement: Truck AADT value

Description: Represents the total Truck AADT of an asset and is an indicator of freight importance. Assets with higher AADT would be considered more critical to the system.

Range of Values: [0, 46,980]

Spatial Joining Methods: No spatial join was needed as the identified assets were already joined to this data from previous RPA efforts. Truck AADT is reflected in the “Truck_AADT” column.

Disadvantaged Community Index

Unit of Measurement: Social Vulnerability Score

Description: Represents the relative level of a community’s social vulnerability compared to all other communities at the same level. A higher social vulnerability score means that a community is more at risk. Considers various social conditions such as poverty level, percentage of vehicle access, and crowding.

Range of Values: [0.04, 98.54]

Spatial Joining Methods:

1. Spatial data was downloaded from the FEMA National Risk Index website.
    a. The site offers both county-level and census tract-level data. For more precise values, the census tract-level data was used.
2. The data comes in a vector format ready to use for spatial joins.
3. The data was filtered down to the State of Utah by ‘clipping’ it to the state’s official GIS boundary layer.
4. Each asset was spatially joined to the polygon it fell within using an ‘Intersect’ join.

Proximity to Community Assets

Unit of Measurement: Number of community assets (schools, health care facilities, and EMS locations) within a 1-mile buffer

Description: Represents the number of community assets, specifically schools, health care facilities, and EMS facilities, an asset connects to. A one-mile buffer captures all nearby community assets.

Range of Values: [3, 50]

Spatial Joining Methods:

1. Spatial data layers of schools, health care facilities, and EMS locations were downloaded from the Utah State Geographic Information Database website.
2. Each layer is in a point-based spatial format.
3. Each asset is buffered by 1 mile.
4. The number of schools, health care facilities, and EMS points falling within each 1-mile buffer is found through an 'Intersect' spatial join between the buffered assets and the community assets.

Transit Service and Bike Facilities

Unit of Measurement: Number of bike lanes and transit routes within a 0.5-mile buffer

Description: Represents the number of bike lane segments or transit route an asset serves.

Range of Values: [2, 26]

Spatial Joining Methods:

1. Bike lane spatial data was downloaded from the UDOT Digital Delivery GIS Portal. The data is available in a line-based format. Transit lines were downloaded from the BTS National Transit Map.
2. The transit lines were filtered to Utah using the "STATE" column in the data.
3. Each asset is buffered by 0.5 mile.
4. The number of transit routes and bike lanes falling within each 0.5-mile buffer is found through an 'Intersect' spatial join between the buffered assets and the non-motorized routes.

Criticality Scores

Like the exposure score calculation described previously, a criticality score was calculated for each asset using the same normalization methods. In the case of the criticality criteria, each is a continuous variable, so the Jenks natural breaks optimization method was used to find the natural breaks in the data to normalize the raw values on a 1 – 4 scale. Figure 24 shows the conversion of each criticality criterion's raw values to their normalized values. Note that any NULL values or raw values of 0 were assigned a normalized value of 0.

Criticality Criterion	Raw Value Range	Normalized Value
System Redundancy	1 – 65	1
	66 –193	2
	194 – 398	3
	399	4
AADT	10 – 14,999	1
	15,000 – 61,999	2
	62,000 – 135,999	3
	136,000 – 300,000	4
Truck AADT	8 – 2,253	1
	2,254 – 6,807	2
	6,808 – 18,059	3
	18,059 – 46,980	4
Disadvantaged Community Index	0.04 – 19.75	1
	19.76 – 43.2	2
	43.3 – 66.42	3
	66.43 – 98.54	4
Proximity to Community Assets	3 – 4	1
	5 – 10	2
	11 – 19	3
	20 - 50	4
Transit / Bike Service	2	1
	3 – 5	2
	6 – 11	3
	12 - 26	4

Figure 24: Normalized criticality scores

The normalized values were then summed up to a criticality score as described in the equation below. All criteria contribute equally to the criticality score.

$$Criticality = System\ Redundancy_{Normalized} + AADT_{Normalized} + Truck\ AADT_{Normalized} + Disadvantaged\ Community_{Normalized} + Community\ Assets_{Normalized} + Transit\ Bike\ Service_{Normalized}$$

Resilience Risk Scores

Resilience incorporates both an asset's exposure score and criticality score. The resilience risk score combines the normalized criticality score with the normalized exposure score. As both of these were normalized using the same scale and have the same maximum value, they each contribute equally to the resilience risk score.

$$Resilience\ Risk = Exposure * Criticality$$

As a final step and to present the results in a categorical manner, the resilience risk scores were converted to a scale of 'Low Risk' to 'Very High Risk' using Jenks natural breaks optimization. Figure 25 shows the conversion of the raw resilience risk scores to their categorical values.

Risk Category	Raw Resilience Risk Score Range
A: Low Risk	0 - 16
B: Medium Risk	17 - 29
C: High Risk	30 – 51
D: Very High Risk	51 - 221

Figure 25: Categorized resilience risk scores

Resilience Risk Results

Of the approximately 207,000 segments analyzed spanning road surfaces, bridge deck, bridge approach, box culverts, and pipe culverts -

- ~5.8% are Very High Risk *(~12,000 segments; ~800 miles)*
- ~29.0% are High Risk *(~60,000 segments; ~4,100 miles)*
- ~35.2% are Medium Risk *(~73,000 segments; ~8,000 miles)*
- ~30.0% are Low Risk *(~62,000 segments; ~7,600 miles)*

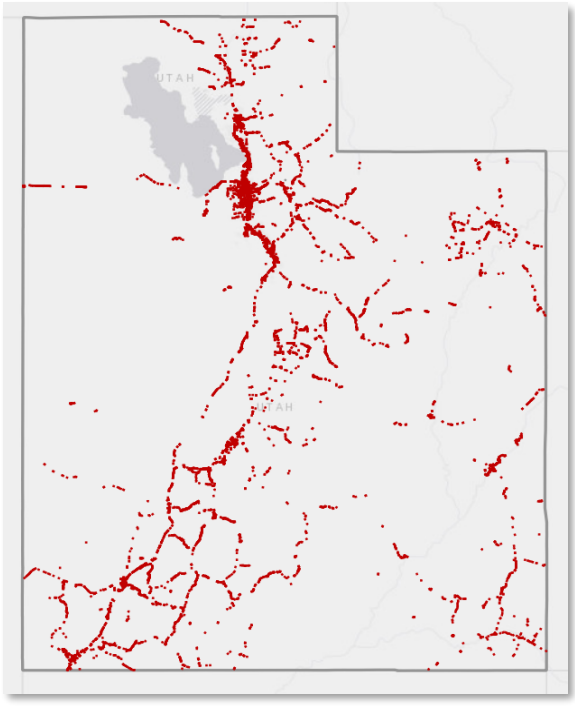


Figure 27: Map of Very High Risk assets

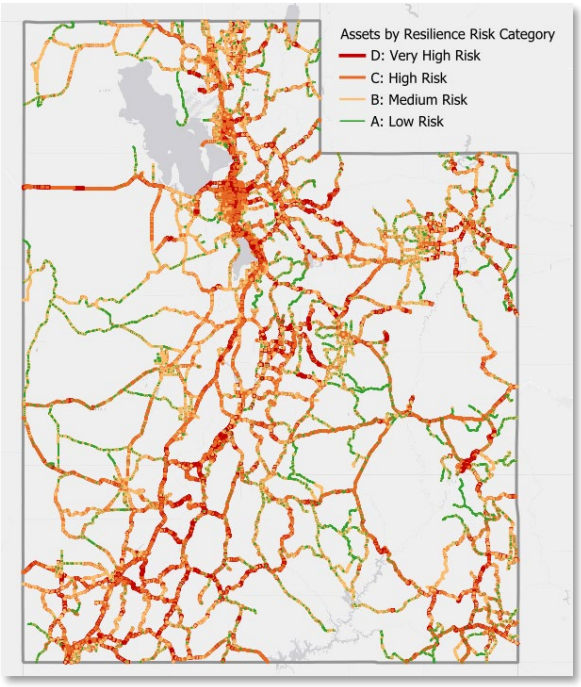


Figure 26: Map of scored assets

Figure 26 shows a map of the assets shaded by resilience risk category. Figure 27 shows the location of Very High Risk assets only.

The Very High Risk segments tend to cluster in more populated areas and along roadways with a higher functional classification. Breaking down the resilience risk scores into their components – exposure score and criticality score, the following two maps show the score results for each.

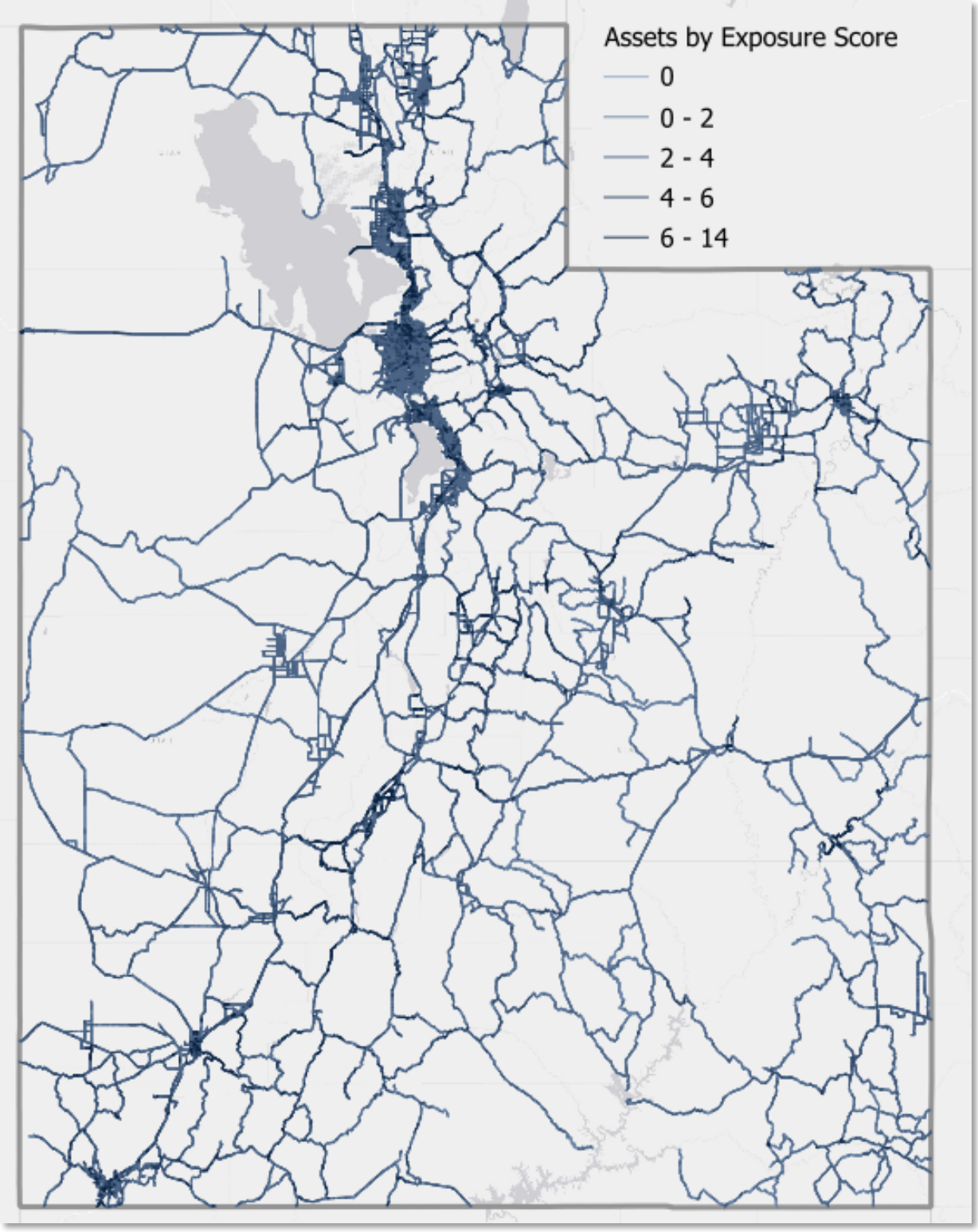


Figure 28: Map of asset exposure scores

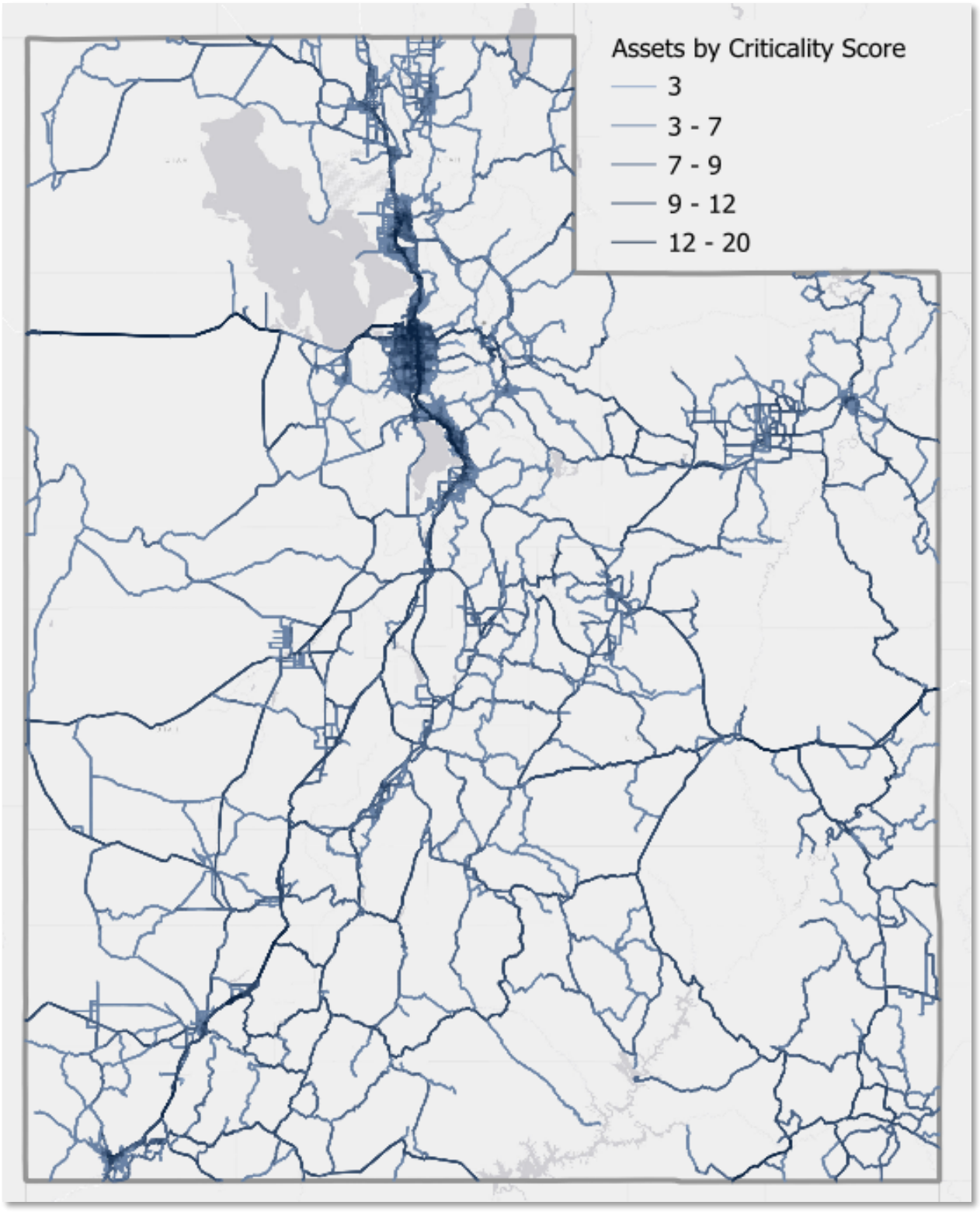


Figure 29: Map of asset criticality scores

The variation in the exposure scores is much more granular than the criticality scores due to the granular nature of the natural hazard data. For the criticality scores, segments along the same corridors often receive the same or a similar criticality score. Generally, criticality scores are highest for high use connectors and segments in more urban areas.

Future versions of this analysis could include refinements to further finetune results. As an example, many rural areas in Utah serve as popular tourism destinations and peak seasonal traffic may vary greatly from day-to-day traffic. Peak traffic volume could be considered for use over a general AADT value to measure criticality of an asset. Another example of a future consideration is to differentiate buffer sizes used for the Proximity to Community Assets and the Transit / Bike Service criteria between urban and rural areas. As urban areas are denser, they often offer more alternatives in terms of a community asset or transit or bike service. The one-mile buffer to capture community assets and the half-mile buffer to capture transit and bike service could be made smaller in urban areas to account for this.

Project Efficacy Assessments

UDOT's newly developed project efficacy assessments conducted using a screening and scoring rubric (see Appendix E. PROTECT Candidate Project Screening and Scoring Rubric), leverages institutional knowledge to judge how well a project scope addresses a known natural hazard(s). The development process drew from discussions with the Region Offices to determine shared concerns such as the need for transparency, making sure a project was a good fit to federalize, and the importance of institutional knowledge.

Staff from UDOT's four Region Offices and the Structures and Geotech Divisions can use data from the risk-based quantifiable approach to identify new projects or align resilience improvements with existing projects. After staff conduct an identification process, they can include candidate projects using the newly developed screening and scoring rubric. This rubric aims to standardize the process, confirming project eligibility and providing judgment-based input on how effectively a project addresses known vulnerabilities.

Screening and Scoring Rubric

The screening and scoring rubric is a workbook with six spreadsheets and consist of three steps:

- **Step 1 – PROTECT candidate project screening**. This step confirms that a project is eligible and determines if the project is a good fit.
- **Step 2 – Project information**. Provides an opportunity to provide basic project information such as asset type, cost, and location.
- **Step 3 – Project scoring.** Contains rating questions meant to determine how well a project addresses a hazard.

Additional background information is provided on two additional spreadsheets: 1) a list providing details about the full range of eligible PROTECT Program activities and 2) an overview of the prioritization process to provide transparency about how project efficacy scores are used.

Lastly, an administration spreadsheet is provided to combine all the information from Steps 1 to 3 so that information can be aggregated from all Region Offices and applicable UDOT Divisions.

Project Efficacy Scoring Methodology

Project efficacy scores are generated for each submitted project. Project efficacy scores can range between 0 and 45, with each question evenly weighted. Scoring questions were developed based on engagement outcomes with Region Office staff and additional review opportunities. The following seven questions are based on a one to five scale where 1 represents the weakest rating and 5 represents the highest rating:

- How well does this project address known natural hazard threat(s)?
    - E.g. If the project fully addresses a known threat(s) then rate as 5. If the project partially addresses a threat(s) then rate as 3. If the project provides only temporary relief of a threat(s) then rate as 1.
- How well aligned is this project with existing plans (state or local)?
    - E.g. If the project is specifically called out within a recent state or local plan then rate as 5. If the project generally aligns with plan goals and objectives, then rate as 3. If it is unclear whether the project supports plan goals or objectives, then rate as 1.
- How strong is the local support for this project?
    - E.g. If the problem that the project will address has received many public complaints, letters from elected officials, and other documented needs then rate as 5. If the project has received relatively modest complaints or advocacy, then rate as 3. If it is unclear or the project has not received any documented public requests, then rate as 1.
- How important is this asset to the community that it serves?
    - E.g. If this asset is critical to the core functions of a community, then rate as 5. If this asset is important but there are alternatives that can keep core functions operational then rate as 3. If this asset has little importance to maintaining core community functions, then rate as 1.
- How important is this asset from UDOT's perspective?
    - E.g. If this asset is critical to maintaining operations and other assets depend on it then rate as 5. If this asset is important but there are alternatives that can maintain operations, then rate as 3. If this asset is not critical to maintaining operations, then rate as 1.
- How ready is this project to move forward?
    - E.g. If this project has completed all design phases and is ready for construction then rate as 5. If this project has completed some design work, then rate as 3. If this project has not started design or completed a feasibility study, then rate as 1.

There are two Yes/No questions where if the answer is yes, 5 additional points are awarded and if no, no additional points are awarded:

- Will this project address a longstanding, recurring maintenance problem?
- Is PROTECT funding the only way to fund this project?

The intent behind rewarding projects that address longstanding maintenance issues is to provide long term solutions to chronic problems. By doing so, limited operational resources can be better directed to address unanticipated problems and their impacts.

Understanding whether a project has no other viable pathway to implementation but for the PROTECT program is a helpful consideration to uplift worthy projects that may be routinely passed over.

Together, these questions represent a starting point for standardizing the inclusion of unique regional considerations into a prioritization process. Staff can further inform themselves about asset vulnerabilities and hazard risks as UDOT's asset data improves and subsequent analyses are made accessible via the RIP GIS tool. The combination of more aware and informed staff, coupled with enhanced data and analysis results, creates a positive feedback loop supporting the integration of resilience within decision-making processes at multiple levels within UDOT.

Figure 30: Cottonwood Canyon, Utah

Combined Candidate Project Resilience Risk and Project Efficacy Scores

Transportation Performance Management Division (TPM) staff will combine resilience risk scores and project efficacy scores using the candidate project locations submitted by Region and Division staff on an annual basis to help inform PROTECT program funding investments. TPM staff will do this through a spatial overlay process to join asset segment resilience risk scores to the project location using a 50-foot buffer to account for project geometries that may not perfectly align with asset segments. Some project locations may only overlap with a single asset segment. However, some projects can cover an entire statewide corridor. To address the range of project size, the spatial overlay process provides resilience risk scores at the candidate project level in two ways:

- Basing the candidate project resilience risk score on the highest corresponding asset segment resilience risk score.

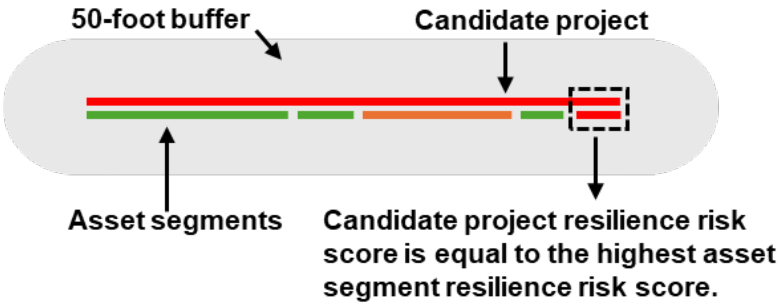


Figure 31: Candidate project resilience risk score method based on the maximum asset segment resilience risk score

- Using a length-weighted average approach to determine the candidate project's resilience risk score based on weighting asset segment resilience risk scores by their length to give a better overall sense of a candidate project's resilience risk.

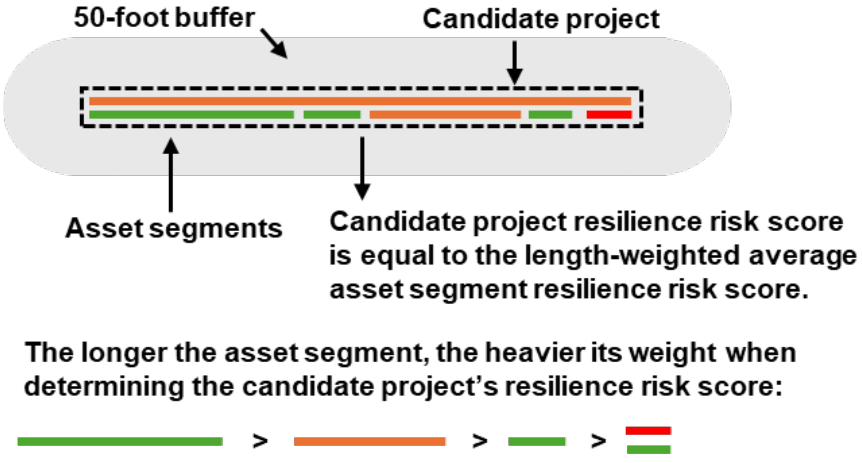


Figure 32: Candidate project resilience risk score method based on the length-weighted average of asset segment resilience risk scores

While both types of candidate project resilience risk scores are provided, the length-weight average approach serves as the basis for UDOT to generate a prioritized list of projects due to its more balanced approach to representing a candidate project's resilience risk. The candidate project resilience risk scores based on the highest asset segment resilience risk score can bring attention to areas of high resilience risk within longer corridor-wide projects.

Project efficacy scores are already associated with the project location based on the candidate project submission process using the screening and scoring rubric. TPM staff combine the project efficacy and reliance risk scores by normalizing the project efficacy scores on a scale from 1 to 100, adding them to the project's reliance risk score and dividing them by two since each score type is evenly weighted.

PROTECT Project Prioritization Results

Region Office staff submitted 29 candidate projects to be evaluated as part of the RIP's development. Figure 33 below shows the number of projects submitted by each Region Office and their combined funding request.

Region	Number of Projects	Total Cost (Millions)
Region One	4	$24.7
Region Two	7	$16.5
Region Three	10	$21.1
Region Four	8	$11.2
Total	**29**	**$73.5**

Figure 33: Submitted candidate projects

Figure 35 shows the full list of projects ranked by their combined resilience risk and project efficacy scores. Each Region had a project that scored within in the top 10 with an even distribution throughout the prioritized list (Figure 36).

Figure 34: Panguitch, Utah

Rank	Project Name	Region	Combined Score	Project Efficacy Score	Resilience Risk Score	Project Cost
1	I-15 Dry Creek Channel Improvement	Three	69.6	39.1	100.0	$5,000,000
2	Ogden Canyon MSE Wall Replacement	One	62.1	91.3	32.8	$16,000,000
3	Rehab/Replace Culverts, Various Locations (I-15; MP 37.3, 69.3, or others identified on risk map)	Four	60.4	95.7	25.2	$2,500,000
4	US-89; Birdseye to US-6 Thistle	Three	59.7	95.7	23.7	$22,500,000
5	Ogden Canyon Barrier	One	58.9	82.6	35.2	$4,000,000
6	SR-222; Snake Creek Culvert Replacement	Three	58.5	82.6	34.3	$1,400,000
7	US-6 Crandal Canyon Culvert	Four	57.8	91.3	24.3	$4,500,000
8	I-15 Drainage repair	Four	57.2	95.7	18.7	$1,400,000
9	I-80; Rockfall and Barrier Improvements	Two	55.0	69.6	40.5	$2,500,000
10	SR-210; Avalanche Mitigation	Two	51.6	100.0	3.3	$6,000,000
11	US-189; Rockfall Protection	Three	51.3	78.3	24.3	$-
12	SR-113; Snake Creek Box Culvert Replacement	Three	50.7	82.6	18.8	$1,500,000
13	Rockfall mitigation SR-158	One	49.1	87.0	11.3	$3,000,000
14	Price Canyon Rock Scaling & Drainage Improvements	Four	48.5	65.2	31.7	$290,000
15	US-89; Birdseye to US-6 Thistle - Culvert	Three	47.3	87.0	7.7	$2,610,000
16	SR-115 Spanish Fork River (MP 6.64)	Three	45.9	39.1	52.6	$-
17	SR-210; Barrier Improvements	Two	45.4	73.9	16.8	$2,000,000
18	I-80; Culvert Rehabilitation Phase II	Two	44.2	69.6	18.8	$2,000,000
19	Snowbasin Slide Repair	One	43.6	82.6	4.6	$1,715,000
20	SR-87; Soil Nail Wall	Three	42.4	78.3	6.4	$3,000,000
21	I-15 Spanish Fork River Bridge	Three	39.9	56.5	23.4	$-
22	US-189; Slide Canyon Avalanche Diversion Structure	Three	33.4	52.2	14.6	$5,000,000
23	SR-36 Flooding	Two	31.7	56.5	6.9	$1,400,000
24	I-70; Flood Control Structure at MP 34.5	Four	21.7	21.7	21.7	$125,000
25	I-70; Gooseberry Interchange Drainage System Repair	Four	20.5	21.7	19.3	$225,000
26	Concrete Pavement Buckling	Two	18.9	17.4	20.3	$2,000,000
27	Cottonwood Canyon Flooding	Two	17.8	34.8	0.8	$600,000
28	SR-211 Culvert Replacement at MP 13.3	Four	6.0	4.3	7.7	$900,000
29	SR-211 Culvert Replacement at MP 7	Four	2.7	4.3	1.0	$1,300,000

Figure 35: The RIP's PROTECT project prioritization results

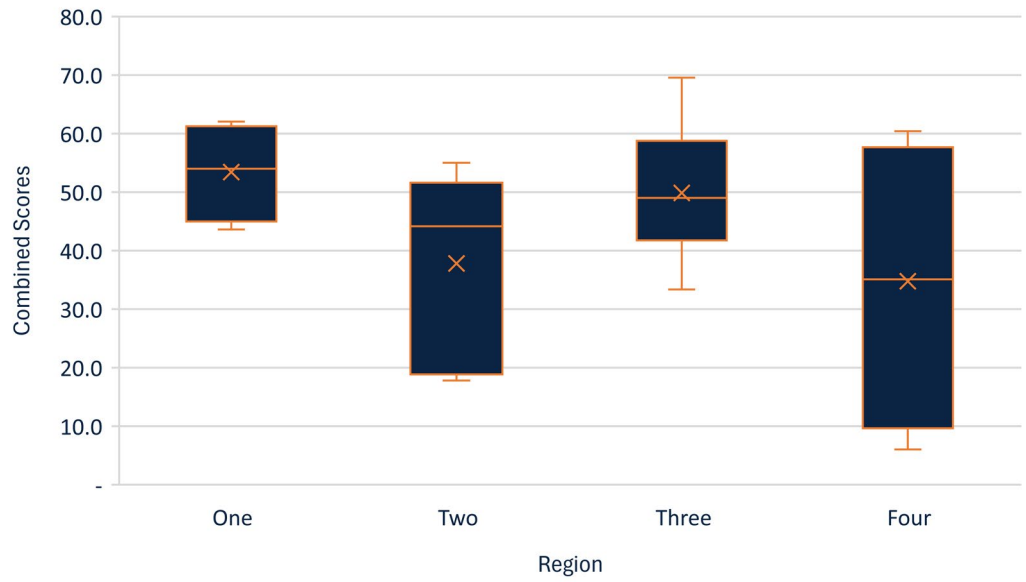


Figure 36: Distribution of combined scores by region

The middle 50 percent of scores, represented by the blue boxes, and the range of project scores, represented by the boundary line, show significant overlap between the Region's combined project scores. The distribution of scores indicates that each Region submitted competitive candidate projects, helping to ensure a fair distribution of investments.

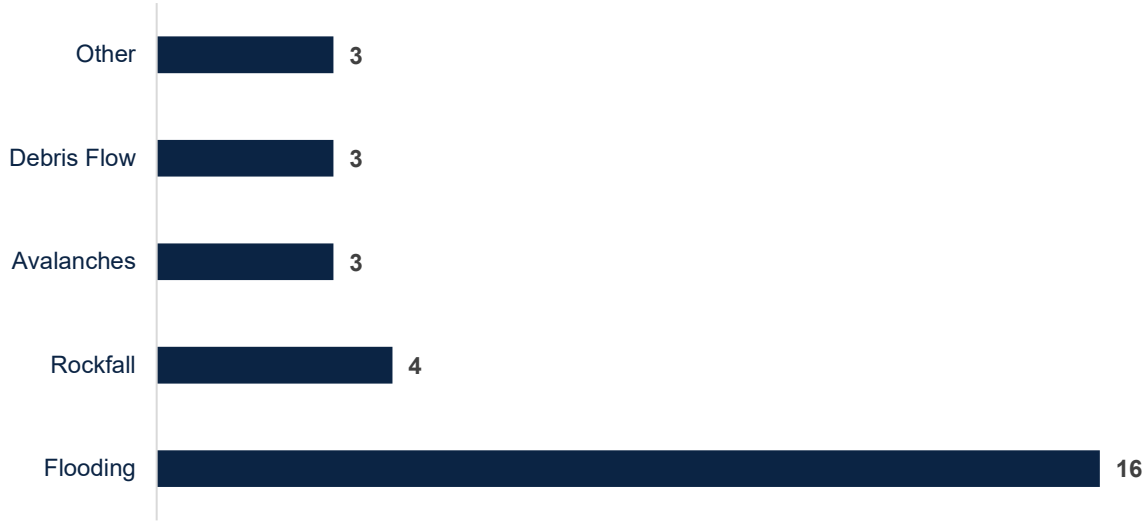


Figure 37: Natural hazards targeted by candidate projects

Most candidate projects that were submitted aimed to address flooding followed by rockfall, avalanches, debris flow, and other hazards such as landslides. Earthquakes and wildfires were the two hazards included in the asset assessment but not targeted by submitted projects.

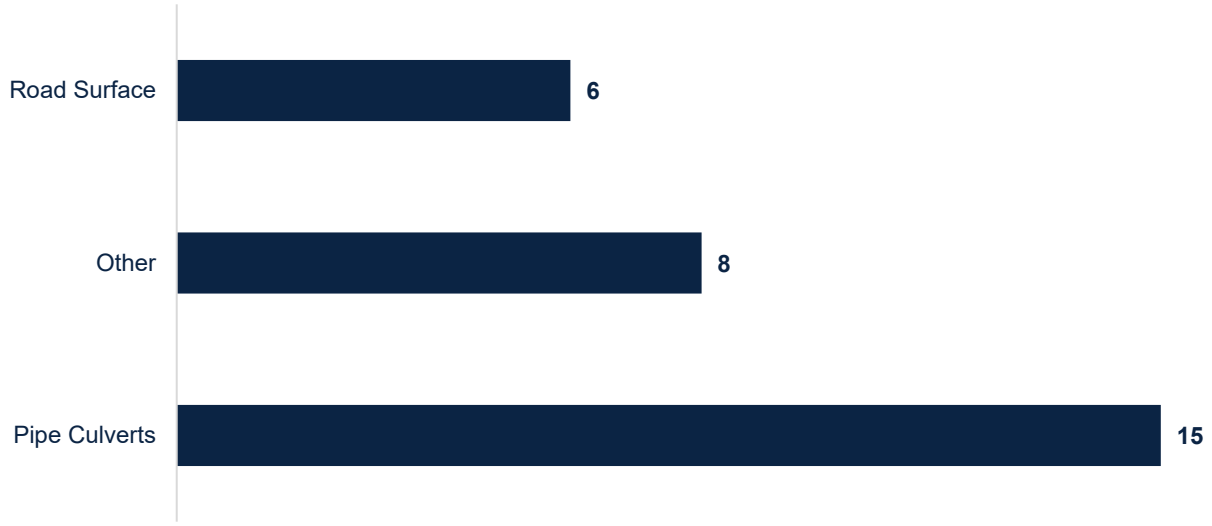


Figure 38: Assets targeted by candidate projects

Pipe culvert was the top asset targeted by submitted candidate projects followed by other assets such as barriers, and roadway surfaces. Box culverts, bridge approaches and bridge decks were the other assets assessed but not targeted by candidate projects.

UDOT staff understand the PROTECT program's project eligibilities based on the variety of projects submitted. The focus on reducing exposure to flooding and improving pipe culverts may stem from a recent UDOT initiative to prioritize the improvement of culverts on a systemwide basis. In the future, candidate projects will also be accepted by UDOT's Geotechnical and Structure Division, which will likely result in projects that target bridge approaches and decks that may aim to reduce exposure to earthquakes. The RIP's scoring processes and project prioritization methods are meant to evolve through ongoing collaboration and further technical development. These processes and methods represent a starting point for UDOT to build upon.

Implementation

UDOT will conduct the PROTECT Project Prioritization process annually, beginning in the fall with a kickoff meeting involving UDOT's TPM Division, Region Offices, and the Structure and Geotechnical Divisions. This meeting offers teams the opportunity to reacquaint themselves with resilience and project efficacy assessment processes, while also facilitating the presentation of changes, updates, and improvements. Staff members will be responsible for submitting candidate PROTECT projects using the screening and scoring rubric by the end of January.

TPM staff will assess candidate projects, exploring potential opportunities to streamline project delivery through existing projects or other efficiencies such optimizing capital programming strategies. Following this assessment, staff will combine project efficacy scores with resilience risk scores to develop the prioritized PROTECT project list.

In the spring, after UDOT has generated a prioritized list of projects, the Utah Transportation Commission will review and approve PROTECT programming recommendations, enabling the

funding of projects on the priority list. Projects will then proceed through UDOT's existing project delivery processes for design and construction.

Alignment and Integration

Alignment

UDOT's RIP development process was guided by larger agency considerations, including alignment with UDOT's strategic direction and long-range goals. The RIP also plays a crucial role in supporting the TAMP. Both the RIP and these larger considerations influence each other, emphasizing the need for ongoing internal coordination and iteration. This section provides a starting point by summarizing existing policies and strategic direction contained within the TAMP and related to the RIP's purpose. Direct connections between the SHMP and the RIP are also specifically identified within this section, specifically regarding hazards to consider and SHMP recommendations.

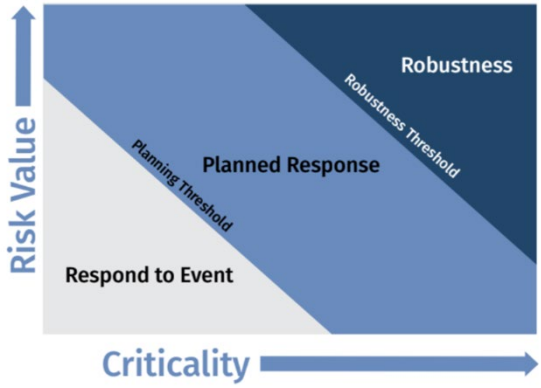


Figure 39: UDOT's asset risk-management approach presented in the TAMP

Alignment with UDOT Asset Management Policies

The TAMP focuses on forecasting what could happen to each asset for each potential natural disaster or weather event. This asset management perspective is important when considering how to preserve assets in good or fair condition. It is important to create the ability to resist or withstand the impacts of events and to reduce the magnitude or duration of impacts. Therefore, the goal of preserving infrastructure is critical to system resilience.

The UDOT RIP contributes directly to the robustness of UDOT's assets and reduces burdens on limited operational resources. Indirectly, the RIP can help obtain a state of good repair for assets in poor condition that happen to be addressed by a priority project that addresses an acute resilience need. Exploring the connection between asset conditions and asset vulnerabilities can help UDOT better understand cumulative system needs.

Alignment with UDOT Risk Management Policies

UDOT uses the American Association of State Highway and Transportation Officials (AASHTO) Enterprise Risk Management (ERM) Guide as a framework to inform decisions and risk responses. The TAMP addresses the strategic, programmatic, project, and activity level of risk (Figure 40).

The RIP most directly supports addressing programmatic risk within this framework. The RIP's purpose is to improve the resilience of UDOT's assets thereby reducing risk, specifically to bridges, culverts, and roadway surfaces. The RIP's analysis methodology can be applied to additional assets, incorporate other hazards, and consider new criticality criteria. The PROTECT Program provides planning resources that can further promote the development of data and strategic coordination, building out the RIP's capabilities using the TAMP's framework to set priorities.

The RIP also aligns with the AASHTO ERM framework through its incorporation of risk associated with the natural environment. Beyond this, regulatory compliance, political influence, and liability to litigation or fraud are also contemplated risks important for UDOT to understand.

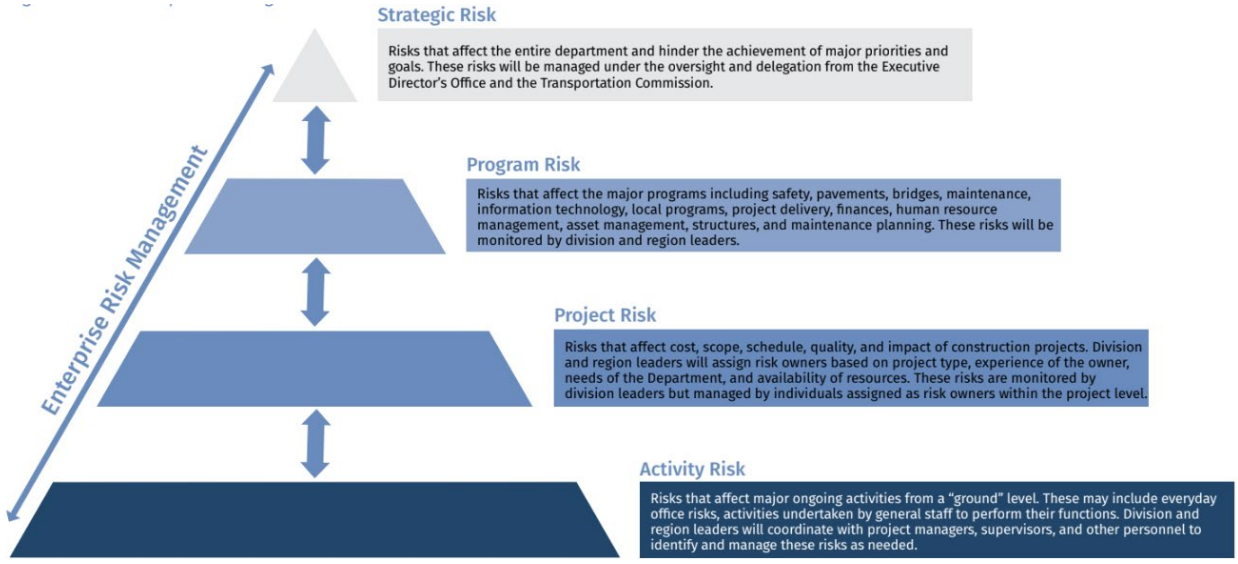


Figure 40: Risk-Response categories for AASHTO's ERM framework

Alignment with UDOT Risk Identification Policies

UDOT has captured asset risks through the RPA.[34] Once the risks were identified, each risk was categorized, the potential impacts of the event were evaluated, and the likelihood (probability) of the risk occurring was determined. These three factors were used to define the risk priority for each risk. Risk priority rankings were divided into the four following categories:

- Critical: Requires prompt action, likely at the executive management level, to implement new strategic or program level controls to treat the risk.

[34] https://storymaps.arcgis.com/stories/48418a2e48c048efbe2a3d87f41f7bd0

- High: Affects the ability of UDOT to carry out its mission or strategic plan. Existing controls may be effective but could require additional action and/or controls to be managed at the executive management level.
- Medium: Impacts the completion of a critical agency function. Existing controls must be effective and possible additional actions may need to be implemented.
- Low: Managed with current practices and procedures. Impacts are dealt with by routine operations which should be monitored for effectiveness.

While logically sound and technically robust, the RPA approach for identifying risks has not been incorporated systematically within decision making processes at UDOT. The RIP development process revealed the importance of collaboration and incorporating feedback into the development process. While the RIP's data-driven approach to identifying risk is like the RPA, it leverages significant institutional knowledge from staff, which in turn promotes transparency, process ownership, and accountability. The RIP establishes a scalable platform where staff have a seat at the table, shaping future improvements and cementing resilience as a core consideration across project development activities.

Alignment with Utah's Statewide Hazard Mitigation Plan

Historically and prior to the PROTECT program, UDOT has been at the forefront of transportation resilience activities. UDOT began the RIP development process with initial foundational research of relevant State plans, processes, and initiatives related to improving infrastructure resiliency. UDOT assessed the State Hazard Mitigation Plan (SHMP) as part of the foundational research to ensure the RIP is aligned with the SHMP. Like the TAMP, the SHMP serves as an anchor point for the RIP's ongoing future development.

The SHMP identified the following hazards for inclusion. Bolded hazards represent those included within the RIP's resilience analysis process.

- **Avalanche**
- Dam Failure
- Drought
- Geologic Hazards (**Earthquakes**, **Debris flows**, **Rockfalls**, Landslides, etc.)
- **Flood**
- Severe Weather
- Space Weather
- **Wildfire**

The SHMP acknowledges that challenges persist in conducting hazard identification and risk assessment analyses. These challenges include limited availability of data, outdated or irregularly updated data, conflicting data sources, and a shortage of adequate tools for conducting comprehensive analyses. Prioritizing data development efforts to focus on the hazards included in the SHMP but not included in the RIP's resilience analysis process can further align the SHMP and the RIP in the future.

The SHMP identifies a range of challenges and opportunities, some of which directly align with the RIP intended outcomes. Areas identified in the SHMP that the RIP can help address include:

- Advocating for increased pre-disaster mitigation funding at the state level.
- Improving education and understanding among legislative and administrative leaders as to the importance and need of pre-disaster mitigation.
- Improving local capabilities in mitigation plan strategy creation and mitigation grant applications.
- Improving protection from floods, specifically through increasing the size of culverts, spans/heights of bridges, installation of wing walls, flood barriers, fortifying structure foundations, and natural infrastructure such as bioswales, energy flow dissipaters, and retention ponds.
- Retrofitting bridges to withstand earthquakes.
- Protecting roads and transportation networks from avalanches.

The influx of PROTECT funding, comprising both formula and discretionary grants, introduces a new financial avenue to bolster resilience initiatives in Utah. The RIP serves as a foundational resource to educate decision-makers on the critical importance of proactive interventions and projects aimed at mitigating risks before the adverse impacts of hazards are realized. UDOT can play a pivotal role as a partner in fostering local capacity to pursue grant funding, whether through the PROTECT program or other available opportunities, thereby advancing initiatives that align with the shared objectives of the TAMP, RIP, and SHMP. The RIP provides UDOT with a clear roadmap to address flooding, seismic, and avalanche protection improvements outlined in the SHMP.

Integration

The RIP development process identified objectives and actions that enhance transportation system resilience in Utah resilience plans, state and MPO agency efforts, and tribal resources reviewed for the development of the RIP. Being aware of these objectives helps UDOT better understand other state and regional agencies and their priorities and direction. Having this understanding is useful when integrating resilience efforts across the state. It can also be useful when building coalitions advocating for statewide legislation or policy changes. The following

sections discuss areas in which the RIP can be better integrated into existing plans and processes and includes recommended next steps for doing so.

Strengthening Resilience Analyses

UDOT has the strategic framework in place through the TAMP to systematically prioritize and address data needs and gaps that prevent further asset assessments. UDOT also has the necessary internal coordination in place through the RAWG to oversee and advance data development activities. Region Offices can engage local partners to gather additional information on what matters to communities, bringing a wider perspective into the mix. The RIP represents an opportunity for UDOT to continue integrating resilience within its internal decision-making through a collaborative, ongoing, and iterative process.

Future Recommendations

- UDOT could, through future efforts, centralize/expand data collection of erosion, flash flooding, or reports of scouring by Regional Offices staff to develop additional proactive procedures, develop new projects, and develop project scopes with resilience to debris flows in mind.
- UDOT could establish a long-term data coordination strategy with relevant state agencies and research institutions.
- UDOT could expand the RIP to incorporate an all-hazards approach (including cyber security hazards, man-made hazards, etc.).
- UDOT could expand its consideration of future stressors in PROTECT project prioritization as data becomes available.

Coordination and Collaboration

UDOT already has strong internal coordination and collaboration through the RAWG and with the Region Offices. Building upon this strength and looking to outside partners can provide additional opportunities to expand understanding of how UDOT's assets are interdependent upon tribal, county, and local assets. Data sharing was identified by external stakeholders as something they were interested in. UDOT has data development needs. This is one area where both parties could benefit. Collaboration can often make the most of limited resources for agencies with shared interests.

Future Recommendations

- UDOT will continue to engage with the MPOs, tribes, local government, and other stakeholders that were identified in the stakeholder engagement process.
- UDOT may identify strategic areas to collaborate with state agencies and local organizations to either acquire additional data or deepen UDOT's understanding of resilience topics through ongoing partnerships.
- UDOT can consider hosting a public, coordinated data source to provide support for local and regional decision making on infrastructure/public facility investments.
- UDOT could expand its proactive approach by encouraging regional offices to collaborate with local organizations to identify hazards before they manifest.

- UDOT Regions can improve its project delivery by incorporating the RIP assessment into the decision-making process by identifying critical assets and potential hazard mitigation improvements to incorporate into project scoping.

Integrating Resilience through the Utah TAMP

The RIP supersedes the previously established RPA, offering a scalable method for evaluating resilience across the Utah Department of Transportation (UDOT) within the TAMP framework. Looking ahead, UDOT can further enhance its risk management practices and further integrate the RIP into its strategic planning processes.

Future Recommendations

- UDOT will examine and evaluate the AASHTO ERM to improve risk identification and responses in the decision-making process at all levels of UDOT.
- In future updates to the Utah TAMP, UDOT will replace the risk assessment and Risk Priority Map with the related elements in the RIP. This will result in full integration of the RIP and the TAMP.
- Through the RIP, UDOT will consider recurring hazards in its decision-making process.
- Leverage the TAMP and coordination through the RAWG and Region Offices to prioritize data development needs, specifically which assets should be added to the RIP's asset assessment.
- UDOT could update its TAMP to integrate future climate risks as well as existing hazards.

Integrating Resilience in Project Selection and Development

Through the RIP's PROTECT prioritization process, resilience-focused projects will flow to UDOT's STIP. However, there are opportunities to think more broadly about incorporating resilience into all projects, regardless of specific funding sources.

Future Recommendations

- UDOT will encourage Region staff to review and incorporate the results of the RIP when proposing projects for consideration in the UDOT STIP.
- Through implementation of the RIP, UDOT will take a more proactive approach to considering resiliency of the system in project selection by channeling Region Office institutional knowledge about known issues and addressing them proactively.
- Where possible, UDOT will work with Region Offices to implement efficient project delivery by integrating resilience improvements within existing programmed projects to address needs without needing a separate standalone project. UDOT and the Regions will cross check existing projects with PROTECT projects to identify where improvements could be streamlined.
- To enhance climate resilience within transportation project contracting requirements, UDOT can stipulate that contractors integrate climate risk assessments and adaptation measures into project design and implementation. Additionally, UDOT may require contractors to adhere to specific performance standards aimed at ensuring infrastructure

durability and adaptability in the face of changing climate conditions by promoting the use of natural infrastructure over manufactured solutions.

- UDOT could develop and adopt project engineering design guidance and standards which integrate climate data to account for identified risks and establish a periodic update schedule to reflect best available hazard data, emerging trends, and technological advances.

Integrating Resilience in UDOT Performance Measures

Timely, regular, and accurate reporting is essential to provide a consistent data set along with meeting federal reporting requirements related to funding. The Performance Management Section of UDOT's TPM Division is responsible for reporting asset data annually through the Highway Performance Management System and reports bi-annually on the federal performance measures. The performance management section sets, reviews, and updates targets with MPO and transit partners. To make more informed, data driven funding decisions, UDOT is working with asset partners to develop ways to forecast performance based on metrics and funding levels.

UDOT takes a collaborative approach to discussing asset resilience by meeting regularly with Asset Stewards. UDOT leverages a goal, strategy, objective, tactic methodology, providing a structured approach to establishing impactful metrics that connect overarching goals to daily operations and decision-making. This systematic framework facilitates the alignment of high-level objectives with actionable steps. UDOT's strategic direction dashboard monitors advancements in safety, mobility, and infrastructure condition, offering a visual representation of performance (Figure 41[35]).

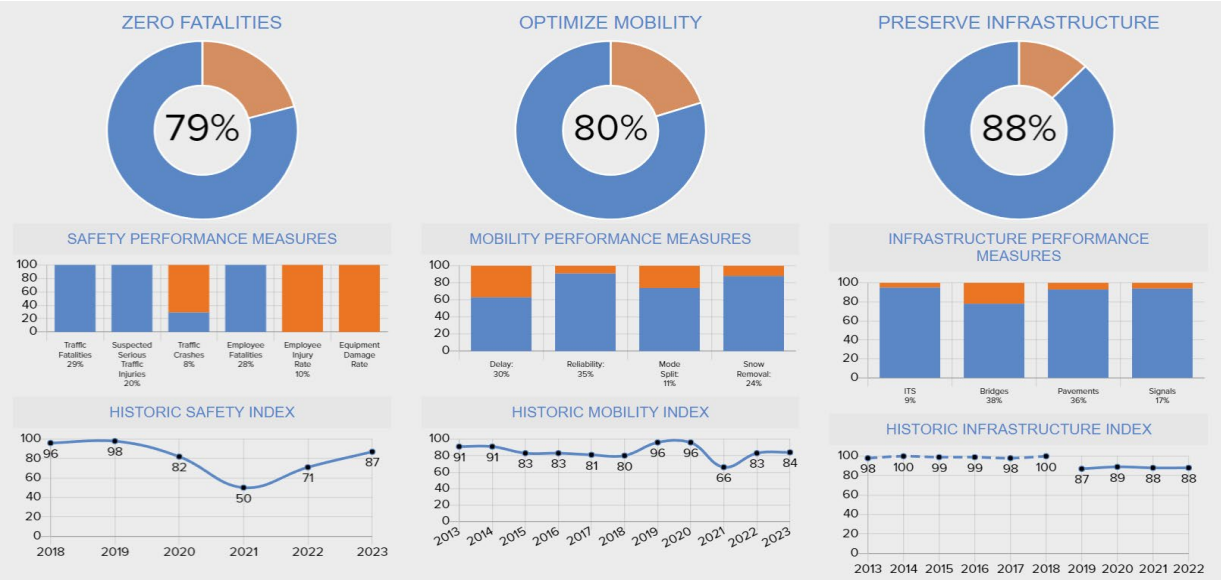


Figure 41: UDOT strategic goals and performance measures

Each UDOT Division is responsible for reporting metrics that drive division-wide decisions and actions in an Annual Statistical Summary[36], which is developed to highlight pertinent information

[35] https://www.udot.utah.gov/strategic-direction/#strategicGoals
[36] https://lookerstudio.google.com/u/0/reporting/159bf8f9-440a-46b3-855c-8ec65e197ec5/page/5ChrB

on highway metrics, assets, and finances. The asset section contains a bridge inventory, which displays information on bridge condition across the state (Figure 42[37]).

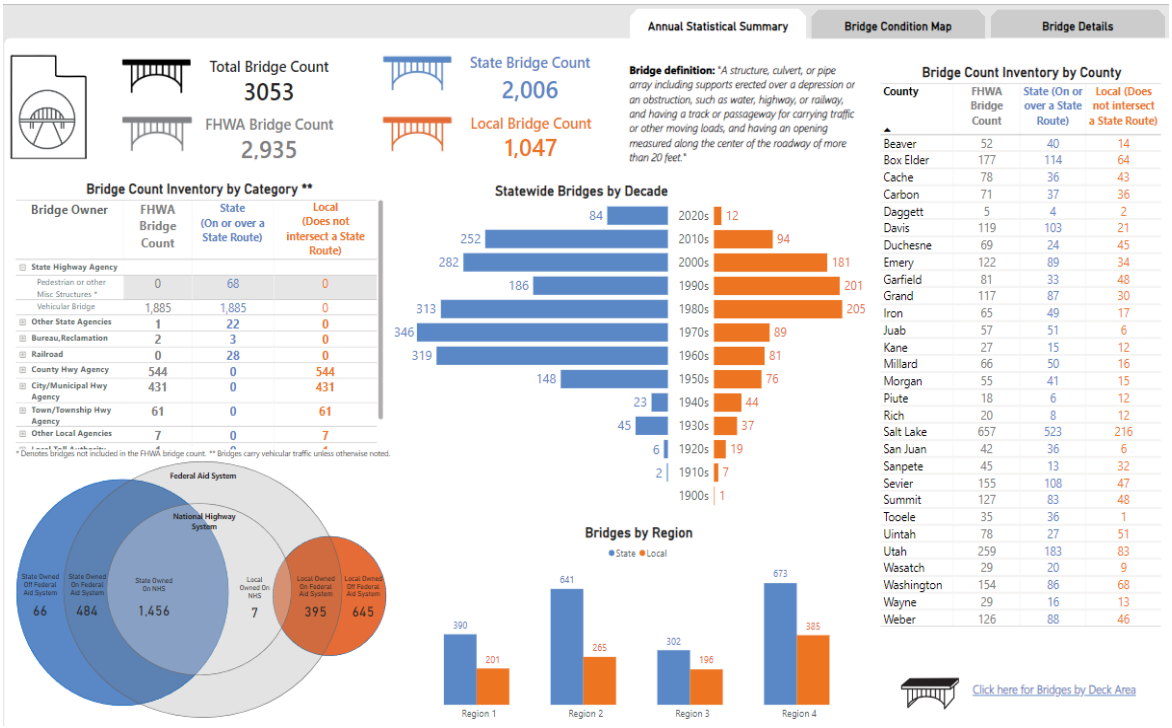


Figure 42: UDOT bridge inventory

In addition to the annual statistical summary, UDOT hosts the Highway Infrastructure Condition[38] dashboard which serves to monitor federal preservation measures covering interstate and non-interstate pavement condition statewide, within each MPO region, and in rural areas. The establishment of the RIP will help UDOT to track progress toward improving resilience and the impact of the projects funded through the PROTECT program to better align the RIP with the agency performance measurement.

Future Recommendations

- UDOT could consider establishing and integrating resilience performance measures or metrics in its existing performance management analyses and publications.
- UDOT could develop tracking tools tied to agency resilience performance metrics to determine effectiveness of resilience investments.
- UDOT could consider integrating performance measure outcomes into decision-making processes.

[37] https://lookerstudio.google.com/u/0/reporting/3206cfcc-7599-41df-964e-a006c9f39fd8/page/p_6gibinafoc

[38] https://app.powerbigov.us/view?r=eyJrIjoiOTc5MGZmZGUtYjM1Ni00NDIzLWFjYWYtZGZmZDU1Y2M4ZTQ1IiwidCI6ImFkZjY2ZWIyLWZjY2YtNDE3My1iZjQ0LTNmNzY3MzBhYTg5ZSJ9

Integrating Resilience Across Other Programs

The UDOT STIP is a six-year program which includes highway and transit projects on the state, city, and county highway systems in Utah. The STIP also includes projects in national parks, national forests, and Indian reservations. STIP projects are funded by a mix of federal and state funding programs, including the PROTECT program. Once projects are in the STIP, funding is obligated and each project continues through UDOT's project delivery process, eventually resulting in construction.

The resilience project needs in Utah are greater than can be addressed with PROTECT funding alone. Funds from federal programs and grants can also be used to address at-risk infrastructure and advance the UDOT RIP's priorities.

The Transportation Alternatives Program is intended to expand nonmotorized travel choices and enhance the transportation experience by improving the cultural, historical, and environmental aspects of transportation infrastructure. This funding focuses on providing bicycle and pedestrian infrastructure which can be used to improve disaster resilience in communities where vehicle access is low.

- Administered by the U.S. Department of Transportation
- Eligibility: Tribal and Local Public Agencies (T/LPAs) are eligible entities, UDOT is not eligible for this funding.

The Congestion Mitigation and Air Quality (CMAQ) Improvement Program funding aims to help states and local governments meet the requirements of the Clean Air Act. Resilience projects that include portions related to public transportation, electric vehicle infrastructure, and micro mobility may be eligible for funding through the CMAQ program.

- Administered by the U.S. Department of Transportation
- Eligibility: Both UDOT and T/LPAs are eligible for this funding.

The Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant program funds projects to build and repair freight and passenger transportation assets. RAISE also allows multimodal, multi-jurisdictional projects that are more difficult to support through traditional federal grant programs. Due to the flexibility, RAISE grants are very competitive and very popular. This funding is likely an appropriate choice for an innovative project that increases resiliency.

- Administered by the U.S. Department of Transportation.
- Eligibility: Any public entity can apply for this funding including State DOTs, tribal governments, MPOs, transit agencies, and counties.

Community Development Block Grants (CDBG)[39] include an entitlement component (formula funds provided directly to certain cities) and funds administered through the Utah Department of Workforce Services. The State of Utah CBDG program provides grants to cities of fewer than 50,000 people and counties of fewer than 200,000. The purpose of the small cities program is "to assist in developing viable communities by providing decent housing and a suitable living environment and expanding economic opportunities, principally for persons of low and moderate incomes." CDBG funds are intended primarily to benefit low- and moderate-income families by

[39] https://jobs.utah.gov/housing/community/cdbg/index.html

funding infrastructure, public buildings, housing rehabilitation, economic development, and planning projects. A resilience related program goal includes meeting urgent community development needs where an existing condition poses a threat to the health and welfare of the community and other financial resources are not available.

- Administered by the U.S. Department of Housing and Urban Development through the Utah Department of Workforce Services.
- Eligibility: Entitlement cities of Salt Lake, Provo, Orem, Ogden, Layton, Logan, Clearfield, Sandy, St. George, Taylorsville, West Jordan, West Valley, Lehi and the urban counties of Utah, Salt Lake and Davis have similar programs designated for their areas and are not eligible for the State Small Cities CDBG Program. Other T/LPAs can apply for these funds.

The Building Resilient Infrastructure and Communities program supports states, local communities, tribes, and territories in their effort to implement hazard mitigation projects.

- Administered by the U.S. Department of Homeland Security.
- Eligibility: States are eligible applicants for up to $2 million per application.

Community Wildfire Defense Grant funding can be used to implement projects identified in a Community Wildfire Protection Plans[40].

- Administered by the U.S. Department of Agriculture Forest Service.
- Eligibility: Eligible applicants include local governments; the Utah Department of Natural Resources; non-profits; and Native American tribes. As UDOT is not an eligible applicant, some form of partnership would be required to access this funding.
- Future Recommendations
- UDOT could prepare for other funding opportunities related to resilience investments by developing a process to match unfunded infrastructure resilience needs to appropriate, non-PROTECT funding opportunities.
- UDOT could identify existing STIP projects across programs with complimentary goals to funding programs that could be used for resilience investments.

[40] https://ffsl.utah.gov/fire/wildfire-community-preparedness/community-fire-planning/

Appendix

Appendix A. Activities Eligible for PROTECT Funding

Description	Activities	Formula Funds	Discretionary Grants
Planning Activities	Resilience Improvement Plan development	X	
	Resilience planning, predesign, or design	X	
	Development of data tools to simulate transportation disruption scenarios, including vulnerability assessments	X	
	Technical capacity building to facilitate the ability of the State to assess the vulnerabilities of its surface transportation assets and community response strategies under current conditions and a range of potential future conditions	X	
	Evacuation planning and preparation	X	
Resilience Improvements	*Surface transportation facility improvement*: resurfacing, restoration, rehabilitation, reconstruction, replacement, improvement, realignment, incorporation of natural infrastructure (green infrastructure), and upgrading to meet or exceed a design standard adopted by the FHWA	X	
	Stormwater mitigation: installation of mitigation measures that prevent floodwaters from intruding into surface transportation systems, strengthening systems that remove rainwater from surface transportation facilities, upgrades to and installation of structural stormwater controls, relocating roadways in a base floodplain to higher ground above projected flood elevation levels or away from slide prone areas, and increasing the size or number of drainage structures	X	
	Bridges: installing seismic retrofits, adding scour protection, lengthening, or raising bridges to increase waterway openings	X	
	Erosion Protection: stabilizing slide areas or slopes, installing riprap, and adding scour, stream stability, coastal, and other hydraulic countermeasures	X	
	Vegetation management practices: improving roadway safety, preventing against invasive species, facilitating wildfire control, and providing erosion control in transportation rights-of-way	X	
	Other: resilience projects that addresses identified vulnerabilities described in the eligible entity's RIP, or any other protective features	X	
Community Resilience and Evacuation Route Projects	Projects that will construct a new evacuation route or eliminate a redundant evacuation route	X	X
	Resilience improvements that will improve evacuation routes	X	X
	Acquisition of evacuation route or traffic incident management equipment or signage	X	X
	Projects that ensure an evacuation route's ability to provide safe passage during an evacuation and reduce the risk of damage to evacuation routes because of future emergency events	X	X
	Restoring or replacing existing evacuation routes that are in poor condition or not designed to meet the anticipated demand during an emergency event and taking steps to protect routes from mud, rock, or other debris slides	X	
	Expansion of capacity of evacuation routes to swiftly and safely support evacuations, including the installation of communication and intelligent transportation system equipment and infrastructure, counterflow measures, and shoulders	X	X
	Projects to ensure access or service to critical destinations, including hospitals and other medical or emergency service facilities, major employers, critical manufacturing centers, ports and intermodal facilities, utilities, and Federal facilities	X	X
At-Risk Coastal Infrastructure Projects	Eligible at-risk coastal infrastructure activities are strengthening, stabilizing, hardening, elevating, relocating, or otherwise enhancing the resilience of highway and non-rail infrastructure, including: bridges, roads, pedestrian walkways, and bicycle lanes, and associated infrastructure, such as culverts and tide gates to protect highways that are subject to, or face increased long-term future risks of, a weather event, a natural disaster, or changing conditions, including coastal flooding, coastal erosion, wave action, storm surge, or sea level rise, in order to improve transportation and public safety and to reduce costs by avoiding larger future maintenance or rebuilding costs. Port facilities and public transportation facilities are also eligible non-rail infrastructure.	X	X

Appendix B. Resilience Goals, Objectives, and Actions

The identified goals for enhancing transportation system resilience, extracted from statewide plans, previous UDOT initiatives, and tribal resources, are categorized into five key areas: planning, data, project prioritization and selection, design and construction, and maintenance and operation. UDOT can evaluate these goals in relation to internal agency needs, aiding in the formulation of strategic goals for resilience.

Focus Area	Goals
Planning	Prepare the state for climate change
	Ensure government continuity
	Advocate, support, and promote the use of state laws and local and tribal regulations and ordinances aimed to mitigate hazards
	Combine hazard loss reduction efforts with other environmental, social, and economic needs of the state
	Assist and support state, local, and tribal planning efforts before, during, and after the effects from hazard events
	Promote education and awareness programs, campaigns, and efforts designed to encourage citizens, private and public entities, and local, state, and tribal agencies to mitigate against hazards
Data	Advance research and data driven decision-making
	Proactively monitor and document climate related impacts to the transportation system
Project Prioritization and Selection	Maximize resilience improvements
	Institutionalize Resilience Priority
	Protect critical facilities, structures, and infrastructure
	Enhance the resilience of infrastructure to climate hazards through investment activities.
	Improve system resilience to emergencies and security threats
Design and Construction	Build climate-resilient infrastructure
	Avoid risk of exposure to natural and technological hazards
	Support state economic development and diversification
	Preserve, protect, and/or restore natural systems, natural resources, and other environmental conditions against hazard events
Maintenance and Operation	Protect communication and warning systems
	Maintain climate-resilient infrastructure
	Ensure the long-term sustainability and resilience of infrastructure and resources
	Increase the resilience of the transportation system to floods, winter weather, and other extreme weather events
	Reduce the vulnerability of natural and built systems, economic sectors, natural resources, and communities to risks

Appendix C. Hazard Mitigation Objectives and Actions

The State Hazard Mitigation Plan lays out a comprehensive set of goals, objectives, and actions for improving resilience to a wide range of hazards, including avalanches, drought, flooding, geologic hazards, severe weather, and wildfires. The Utah Seismic Safety Commission Report and the Utah Forest Action Plan 2020 identify objectives and actions that have the potential to improve the resilience of the transportation system to earthquakes and wildfires, respectively. The following table identifies objectives and actions that UDOT may implement to mitigate the six hazards identified in the UDOT RIP. By monitoring and tracking current and future efforts according to relevant actions within the SHMP, UDOT can understand and communicate its progress in support of reaching corresponding outcomes.

Hazard	Objective	Actions
Avalanche	*Protect life safety and infrastructure from avalanches*	Retrofit critical facilities and infrastructure to withstand avalanches
		Protect roads and transportation networks from avalanches
	Protect life safety and property damage in state-owned facilities from avalanches	Retrofit state-owned facilities most at risk to avalanches
		Ensure that critical state facilities are not built in avalanche zones
Drought	*Educate about water conservation and efficiency*	Hire personnel and/or create volunteer committees to coordinate efficiency efforts
		Fund conservation staff and efforts
		Provide related printed and broadcast materials
		Provide teacher education for classroom use
		Provide speakers for civic groups and schools
		Provide workshops, classes, and events
		Advertise and promote drought mitigation and water conservancy practices.
		Provide demonstrations of water saving technology and practices
	Implement water conservation practices	Provide incentive-based conservation programs
		Provide professional conservation services
		Provide landscape and irrigation services
	Facilitate, review, and update codes, ordinances, statutes, and policies, which influence water efficiency and water source flexibility.	Educate policy leaders on water
		Modify existing building codes or adopt new ones where appropriate to mitigate against drought
		Update and adopt ordinances
		Enforce regulations that promote drought resiliency and water conservation practices
	Reduce the impact of new development on drought	Require water-efficient landscaping
		Require the use of water-efficient appliances and fixtures in new construction
	Promote stricter water efficiency practices in all state managed properties	Require all new facilities to install water efficient landscaping with maintenance schedule
		Require all new facilities to install the most up to date indoor water efficient devices
		Retrofit existing facilities with water saving devices
		Convert existing facilities to water wise landscaping
		Educate employees about water conservation
Flood	*Protect property, infrastructure, and/or environment from flooding*	Sustain and promote no adverse impact
		Place riprap in strategic locations
		Increase the size of culverts and bridges

Hazard	Objective	Actions
		Structurally retrofit and/or floodproof or acquire repetitive loss (RL or SRL) properties and properties in historic districts
		Property acquisitions
		River restoration
		Watershed protection and restoration in areas experiencing drought, wildfire, or erosion
	Provide maintenance, repairs, and improvements to roads, bridges, and drainage structures	Remove debris and vegetation from floodway and drainage structures through a systematic maintenance program
		Improve flood resistance through enhancement of wing walls, flood barriers, foundations, etc. at likely flood impact points
		Construct debris basins, flood retention ponds, bioswales and energy flow dissipaters to control the flood and release of flood waters.
	Mitigate against post-wildfire flooding	Identify areas where re-vegetation and rehabilitation is necessary and prioritize.
		Commence re-vegetation and rehabilitation on a priority basis.
		Construct temporary or permanent debris traps and other flood mitigating structures in wildfire-burned areas
		Identify good practices for Utah communities to prepare for flood after fire prior to fire occurrence and help support implementation.
		Identify good practices for preparing for flood after the fire once the fire has occurred.
		Purchase property to construct flood protection projects or move homes out of risky areas.
		Develop a postfire State Team to assess the damage and potential risk.
	Retrofit, floodproof, or mitigate state-owned facilities against flooding	All new facilities are required to install water efficient landscaping with maintenance schedule.
		All new facilities are required to install the most up to date indoor water efficient devices.
		Retrofit existing facilities with water saving devices.
		Convert existing facilities to water-wise landscaping.
		Educate employees about water conservation
		All new state facilities are required to get flood permits before building.
Geologic Hazards	*Protect lives and property from geologic hazards.*	Retrofit critical facilities and infrastructure to withstand earthquakes and other geologic hazards.
		Retrofit businesses, residential structures, infrastructure, and public buildings (especially in historic districts) to withstand moderate earthquakes and other geologic hazards.
		Better enforcement of the seismic standards in the international building code (IBC) which has been adopted statewide. Adopt IBC appendices L and M and IRC appendix F statewide. Adopt more stringent standards beyond the current IBC to increase resilience.
		Property acquisitions for properties in geologic hazard zones.
		Using flexible piping when extending or replacing water, sewer, or natural gas service.
		Installing shutoff valves and emergency connector hoses where water mains cross fault lines.
		Require secondary water meters and smart irrigation controllers to reduce excessive groundwater near known landslide areas.
	Promote hazard mitigation through programs, incentives, and rebates	Develop a statewide, countywide, or citywide retrofitting program like Fix the Bricks
		Tax credits for retrofitting are available
		Research other creative ways of building resilient communities across the state.
	Protect, retrofit, or find other solutions for utilities	Promote and provide renewable energy such as solar to provide power after an earthquake.
	Protect life safety and property damage in state-owned facilities	Conduct seismic retrofitting for state owned facilities most at risk to earthquakes
		Retrofit or relocate state owned facilities at risk to landslides and other geologic hazards
		Build new state facilities to meet higher code and net zero standards
		Prepare and disseminate brochures, public service announcements, etc. related to severe weather

Hazard	Objective	Actions
Severe Weather	*Provide weather-related information through print, broadcast, and social media.*	Utilize awareness weeks for lightning, severe weather, winter weather, etc.
	Design public buildings, infrastructure, and private property to withstand the effects of severe weather	Encourage all new construction to meet enhanced standards for wind-loading, snow-loading, and other weather-related hazards
		Plan for and maintain adequate road and debris clearing capabilities
		Ensure critical facilities, public buildings, and high occupancy buildings have back-up generators
	Warn people in severe weather-prone areas through appropriate severe weather warning systems	Use integrated public alert and warning systems and other available warning systems and resources to disseminate emergency messages
		Increase participation in the NWS StormReady program
		Promote Wireless Emergency Alerts
	Ensure state-owned facilities are resilient, code compliant, and protected from severe weather	Retrofit state-owned facilities at risk to severe weather
		Ensure critical state-owned facilities are equipped with generators
Wildfires	*Reduce hazardous fuel loading*	Reduce fuel loads around critical facilities and infrastructure.
		Reduce fuel loading within communities located in the WUI
		Support the Utah Prescribed Fire Council
	Provide public information and education regarding wildfire hazards	Develop printed information on defensible space and wildfire hazards.
		Provide information for community meetings and seminars about defensible space.
	Promote local code enhancements that require utilization of defensible space tactics where appropriate	Develop and promote appropriate wildfire code enhancements.
		Give the current WUI code more enforcement avenues
		Mandate wildfire planning be incorporated into development and land use planning.
	Support tools, maps, and information on WUI areas and wildfire hazards in Utah	Facilitate the sharing and consistency of information, analysis, and data across owners.
		Develop digital maps of crucial facilities, infrastructure, and future development areas in the WUI.
	Enhance existing or develop new fire-fighting programs and resources for wildfire suppression	Enhance existing or develop new water sources in wildfire prone areas
		Build and maintain water-filling areas for helicopters.
		Establish dry water hydrants in high hazard fire areas.
	Support the rural addressing program	Complete the rural addressing program and stay current with it.
	Provide public information and education	Develop printed information on defensible space, wildfire hazards, and other hazards that may arise after a wildfire
	Protect life safety and property damage from wildfires for state facilities	Ensure that state owned facilities utilize defensible space practices
		Limit or prevent building critical state-owned facilities in the WUI
		Ensure newly constructed state-owned facilities are code compliant for wildfire hazards and promote the use of enhanced wildfire mitigation practices.
	Restore healthy and resilient trees and forests across Utah	Increase collaborative landscape-scale forest restoration activities across the State.
		Build capacity among partners, stakeholders, and communities to engage in forest restoration activities across the State.

Appendix D. UDOT's full list of Identified Assets included in the TAMP

Steward (Accountable)	Responsible	Asset System	Asset	Management Approach	Asset/Activity Type	Data Collection Frequency
Pavements	Region PME	Pavement	HMA Pavement NHS	Performance Driven +	Built and Managed	1 year
			HMA Pavement Non-NHS	Performance Driven +	Built and Managed	1 year
			PCCP Pavement NHS	Performance Driven +	Built and Managed	1 year
			PCCP Pavement Non-NHS	Performance Driven +	Built and Managed	1 year
			Paved shared use path, trail	Min Maintenance	Built for Others	N/A
Structures		Bridge	Bridge NHS (State + Local)	Performance Driven +	Built and Managed	2 year
			Bridge Non-NHS (State + Local)	Performance Driven +	Built and Managed	2 year
			Bridge Non-Vehicular	Performance Driven	Built for Others	2 year
			Concrete Slope Protection	Reactive	Built and Managed	Reactive
		Culvert - Box/Large Structure	Box Culvert (> 20 ft length)	Interval Driven +	Built and Managed	2 year
			Concrete Headwall (≥ 48 inch dia.)	Interval Driven	Built and Managed	10 year
		Sign	Overhead Sign Structure	Interval Driven +	Built and Managed	5 year
		Wall	Precast Noise Wall (non-retaining)	Reactive	Built and Not Maintained	Reactive
			Gravity Retaining Wall	Interval Driven +	Built and Not Maintained	6 years
			Piling Retaining Wall	Interval Driven +	Built and Not Maintained	6 years
			Cantilever Retaining Wall	Interval Driven +	Built and Not Maintained	6 years

Steward (Accountable)	Responsible	Asset System	Asset	Management Approach	Asset/Activity Type	Data Collection Frequency
			Anchored Retaining Wall	Interval Driven	Built and Not Maintained	6 years
		Embankment	Fill slope	Reactive	Affects Assets not Maintained	Reactive
			Cut Slope	Reactive	Affects Assets not Maintained	Reactive
Maintenance			Riprap	Reactive	Built and Not Maintained	Reactive
TMD		ITS	AWS Advanced Warning Sign	Interval Driven +	Built and Managed	1 year
			CAV Connected Autonomous Vehicle Infrastructure	Interval Driven +	Built and Managed	1 year
			CCS Continuous Count Station	Interval Driven +	Built and Managed	1 year
			CCTV Closed Circuit Television	Interval Driven +	Built and Managed	1 year
			DET Detection Device	Min Maintenance	Built and Managed	Reactive
			ES Electronic Sign	Interval Driven +	Built and Managed	1 year
			ETOL Electronic Tolling Infrastructure	Interval Driven +	Built and Managed	1 year
			EXL Express Lane Device	Interval Driven +	Built and Managed	1 year
			FAL Freeway and Lighting	Interval Driven +	Built and Managed	1 year
			HAR Highway Advisory Radio	Interval Driven +	Built and Managed	1 year
			POECS Port of Entry Count Station	Interval Driven +	Built and Managed	1 year
			RCWIS Rural Intersection Conflict Warning System	Interval Driven +	Built and Managed	1 year
			RM Ramp Meter	Performance Driven	Built and Managed	1 year

Steward (Accountable)	Responsible	Asset System	Asset	Management Approach	Asset/Activity Type	Data Collection Frequency
	Meteorology		RWIS-ESS Roadway Weather Information System/Environmental Sensor Station	Interval Driven +	Built and Managed	1 year
			STO Signal Traffic Operations	Performance Driven	Built and Managed	1 year
			TIS Traveler Information System	Performance Driven	Built and Managed	1 year
			TMS Traffic Monitoring System	Performance Driven	Built and Managed	1 year
			VMS Variable Message Sign	Performance Driven	Built and Managed	1 year
			VSL Variable Speed Limit	Interval Driven +	Built and Managed	1 year
			WWDS Wrong-Way Driver System	Interval Driven +	Built and Managed	1 year
	Data and Analytics		WIM Weigh-in-Motion System	Performance Driven +	Built and Managed	1 year
			FO Fiber Optics	Min Maintenance	Built and Managed	Reactive
			Electrical/Communications Line	Reactive	Affects Assets not Maintained	Reactive
			Cabinet, equipment	Interval Driven +	Affects Assets and Managed	1 year
TMD		Signal	TS Traffic Signal	Performance Driven	Built and Managed	2 year
			Other Overhead Signal Device (HAWKS, Gantries, RRFB)	Interval Driven +	Built and Not Maintained	2 year
			Buried Conduit, Junction Box	Min Maintenance	Affects Assets not Maintained	Reactive
			Electrical/Communications Line	Reactive	Affects Assets not Maintained	Reactive
			Cabinet, equipment	Interval Driven +	Affects Assets and Managed	1 year
T&S		Striping	Pavement Marking Message	Interval Driven +	Built and Managed	1 year

Steward (Accountable)	Responsible	Asset System	Asset	Management Approach	Asset/Activity Type	Data Collection Frequency
			Durable Pavement Marking	Performance Driven	Built and Managed	1 year
			Waterborne Pavement Marking	Interval Driven	Built and Managed	None
		Barrier	End Treatment or Crash Cushion	Interval Driven +	Built and Managed	1 year
			Cast-in-place Concrete Barrier	Interval Driven +	Built and Not Maintained	10 year
			Precast Concrete Barrier	Interval Driven +	Built and Managed	None
			W-Beam Guardrail	Interval Driven +	Built and Managed	2 year
			Cable Barrier	Interval Driven +	Built and Managed	2 year
		Sign	Overhead Sign Panel	Interval Driven +	Built and Managed	1 year
			Ground Mounted Multi-post Sign	Interval Driven +	Built and Managed	1 year
			Ground Mounted Single Post Sign	Interval Driven	Built and Not Maintained	1 year
		Rumble Strip	Rumble Strip	Reactive	Built and Not Maintained	Reactive
		Cattle Guard	Painted Cattle Guard	Interval Driven	Built and Managed	None
			Mechanical Cattle Guard	Interval Driven	Built and Managed	5 year
		Lighting	High Mast Lighting	Interval Driven +	Built and Managed	5 year
			Type A (Small or Rural) Lighting	Interval Driven	Built and Not Maintained	10 year
			Type B (Large) Lighting	Interval Driven	Built and Managed	7 year
			Local/Parking Lighting	Min Maintenance	Built for Others	N/A
		Concrete Flatwork	Pedestrian Access Curb Ramp	Interval Driven +	Built for Others	7 year

Steward (Accountable)	Responsible	Asset System	Asset	Management Approach	Asset/Activity Type	Data Collection Frequency
Maintenance		Fence	Right-of-Way Fence and Gate	Reactive	Built and Managed	4 year
			Chain Link Fence and Gate	Min Maintenance	Built and Managed	4 year
			Snow Fence	Reactive	Built and Managed	4 year
			Wildlife Fence	Reactive	Built and Managed	4 year
			Wildlife Escape Ramp	Reactive	Built and Managed	4 year
		Concrete Flatwork	Concrete Curb and Gutter	Reactive	Built and Not Maintained	7 year
			Concrete Curb	Reactive	Built and Not Maintained	
			Concrete Gutter	Reactive	Built and Not Maintained	
			Concrete Flatwork and Median Filler	Min Maintenance	Built and Not Maintained	10 year
			Concrete Sidewalk	Reactive	Built for Others	7 year
Hydraulics		Culvert - Pipe/CB/Small Structure	Box Culvert (≤ 20 ft length)	Performance Driven	Built and Managed	Variable
			Reinforced Concrete Pipe	Performance Driven	Built and Managed	Variable
			Metal Pipe - Steel and Aluminum	Performance Driven	Built and Managed	Variable
			Thermoplastic Pipe	Performance Driven	Built and Managed	Variable
			Catch Basin, Manhole, Small Hydraulic Structure	Interval Driven	Built and Not Maintained	7 year
			Concrete Headwall (< 48 inch dia.)	Interval Driven	Built and Not Maintained	5 year
			Clean pipe	Interval Driven	Activity	Variable
		Surface Drainage	Graded Ditch	Reactive	Built and Managed	Reactive

Steward (Accountable)	Responsible	Asset System	Asset	Management Approach	Asset/Activity Type	Data Collection Frequency
			Detention/Retention Pond	Interval Driven	Built and Managed	2 year
			Detention/Retention Pond (for others)	Min Maintenance	Built for Others	N/A
Landscaping		Landscaping	Structured Wetland	Reactive	Affects Assets and Managed	Reactive
			Seeded Areas	Interval Driven	Affects Assets and Managed	
			Landscaping	Min Maintenance	Built for Others	N/A

Appendix E. PROTECT Candidate Project Screening and Scoring Rubric

Step 1: Project Screening

UDOT PROTECT Formula Program Project Screening and Scoring Rubric

This screening and scoring rubric is meant for use by UDOT Region Offices and the Geotech and Structure Divisions to screen and prioritize projects for federal PROTECT Program formula funding.

Annual Candidate PROTECT Project Submission Timeline:

1) Kick-off meeting between UDOT HQ and Project Managers in September
2) Candidate projects seeking PROTECT funding due by the end of January. Project information and scoring must be complete by following the three steps below.

You are here

Step 1 — **Project Screening**
This step confirms that your project is eligible and asks a few other questions to determine if the project is a good fit from UDOT's perspective.

Step 2 — **Project Information**
After making sure that your project is a good fit for this funding opportunity, please provide some basic project information.

Step 3 — **Project Scoring**
Provide your assessment of the project based on the questions and rating scale on the project scoring tab.

Project Screening

This information ensures that your project is eligible for the federal PROTECT Program and aligns with other typical UDOT considerations.

Emergency Repair Map Link

PIN	Region/Office	Date	Project Name	Project Status (funded/not funded/removed)	Does this project meet one of the eligibility requirements provide on the "Project Eligibility List" tab? (Yes/No)	Does this project overlap a location improved using federal emergency repair funds? (Yes/No)	Is the project something that is typically federalized? (Yes/No)	Or if this is meant to be a component of an existing project, is that project federalized? (Yes/No/NA)	If this project has not yet started the design phase, can it complete design and construction within 3 years? (Yes/No/NA)	Does this project require ROW acquisition? (Yes/No)	Is this an emergency project? (Yes/No)

Project Screening | Project Information | Project Scoring | >>>> | Project Eligiblity List | PROTECT Prioritization Process | >>>>> | Administratic ...

Step 2: Project Information

UDOT PROTECT Formula Program Project Screening and Scoring Rubric

This screening and scoring rubric is meant for use by UDOT Region Offices and the Geotech and Structure Divisions to screen and prioritize projects for federal PROTECT Program formula funding.

You are here

Step 1 — **Project Screening**
This step confirms that your project is eligible and asks a few other questions to determine if the project is a good fit from UDOT's perspective.

Step 2 — **Project Information**
After making sure that your project is a good fit for this funding opportunity, please provide some basic project information.

Step 3 — **Project Scoring**
Provide your assessment of the project based on the questions and rating scale on the project scoring tab.

Additional information can be found on FAQ and PROTECT Prioritization process tabs.

Project Information

Please enter project information for the projects that you wish to be scored and ranked and then proceed to Project Scoring.

Do not edit these columns

PIN	Region/Office	Date	Project Name	Project Status	Champion	Summary of Project Scope including how this project will partially or fully address known natural hazard threat(s)	Asset Type	Natural Hazard Threat(s)	Total Project Cost	If this a component of a larger project, what is the	Is this project currently on the STIP? (Yes/No)	What is the Project Year?	Please use the link below to draw your project location on a map.	Notes
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Project Screening | Project Information | Project Scoring | >>>> | Project Eligiblity List | PROTECT Prioritization Process | >>>>> | Administratic ...

Step 3: Project Scoring

UDOT PROTECT Formula Program Project Screening and Scoring Rubric

This screening and scoring rubric is meant for use by UDOT Region Offices and the Geotech and Structure Divisions to screen and prioritize projects for federal PROTECT Program formula funding.

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Step 1 — **Project Screening**
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Step 3 — **Project Scoring**
Provide your assessment of the project based on the questions and rating scale on the project scoring tab.

Project Scoring

Scoring is meant to be based on the consensus of Region or Division staff. After all Region / Division candidate projects are entered, staff can meet and provide assessments as together as a group. Providing this input as a group can provide more meaningful insights and considerations leading to better prioritization. The goal of these questions is to help ensure that the project that best address known threat(s) from natural hazards, are most supported, are high priorities, and are the most ready to move forward with minimum risk.

					Based on your knowledge, on a scale from 1 to 5, with 5 being the highest…									
					How well does this project address known natural hazard threat(s)?	How well aligned is this project with existing plans (state or local)?	How strong is the local support for this project?	How important is this asset to the community that it serves?	How important is this asset from UDOT's perspective?	How ready is this project to move forward?	In terms of delivery, how confident are you that this project will not experience delays?	Will this project address a longstanding, recurring maintenance problem? (Yes - 5 Pts, No - 0 Pts)	Is PROTECT funding the only way to fund this project? (Yes - 5 Pts, No - 0 Pts)	Project Efficacy Score
Do not edit these columns						If the project fully ad	If the project is speci	If the problem that th	If this asset is critica	If this asset is critica	If this project has con	If this project does not require ROW acquisition or major utility/exte		
PIN	Region/Office	Date	Project Name	Project Status										0
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Project Screening | Project Information | Project Scoring | >>>> | Project Eligiblity List | PROTECT Prioritization Process | >>>>> | Administratic ...

Appendix F. External Stakeholder Survey

The Utah Department of Transportation (UDOT) is developing a Resilience Improvement Plan (RIP), which sets out to do the following:

- Demonstrate a systematic approach to system resilience
- Conduct a risk-based assessment of vulnerabilities of transportation systems to current and future weather events and natural disasters.
- Uses science and data to develop an investment plan that identifies priority projects and matching funds.

We are conducting this survey to gain insights into which community assets and characteristics stakeholders consider to be most important for UDOT to assess with regards to transportation assets, criticality, and project prioritization. We are also interested in identifying relevant data sources that UDOT can use to inform the RIP development.

Please complete this survey by February 16th.

✱ Please enter your name

Characters Remaining: 100

✱ What is your email address?

Characters Remaining: 100

✱ Which type of organization do you represent?

--Select--

✱ What is your title?

Characters Remaining: 100

Which community assets are the most dependent on the transportation system to maintain effective operations?

Which transportation assets are the most vital during an emergency event?

What data and tools do you use for resilience planning?

What are your experiences with recent hazard events and associated transportation needs?

Are there any unique considerations for specific geographic areas that may not be captured by formal data?