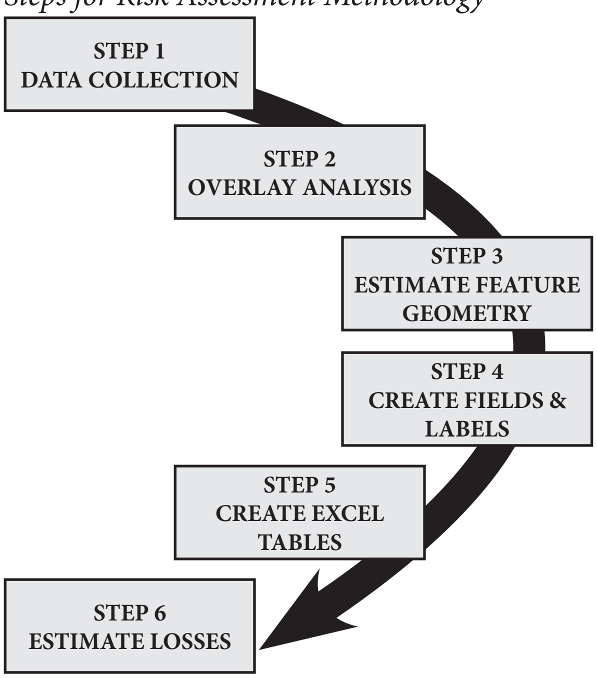
APPENDIX C - DETAILED RISK ASSESSMENT METHODOLOGY

The risk assessment methodology for this plan includes several steps to gather, prepare, input, analyze, and export data to provide detailed information of the potential impacts of natural hazards in Tooele County. The planning team primarily utilized Geographic Information Systems (GIS) software, developed by Environmental System Research Institute (ESRI). This software enables the creation of large data set models in ArcGIS Modelbuilder to input and analyze spatial information. This feature of the software was relied on heavily for processing all spatial layers, and ultimately for generating the spatial information provided in the Community Risk Assessment tables.

GIS analysis also included the use of Python scripting features of ArcGIS to automate the creation of fields and labeling each file with the necessary hazard, input, and jurisdiction information for many output files generated from this hazard overlay process. To help illustrate the methodology for this analysis, the process steps for generating the risk assessment findings of this report are shown below.

Steps for Risk Assessment Methodology



STEP 1 - DATA COLLECTION

Step one is used to identify all available spatial data to be included in the model. This includes all hazard types, jurisdictional boundaries, and input layers that were organized into the following five categories: Agriculture, Critical Facilities, Environmental/Recreational, Infrastructure, and Population. The list below identifies all the hazard and input layers that were identified and grouped by their respective category. See Appendix G for a complete list of layers and data sources/ descriptions.

HAZARD LAYERS

- Dam Failure
- Geologic Faults
- Wildfire (moderate to high risk)
- Flood (FEMA FIRM)
- Flood (Soils)
- Liquefaction (moderate-high to high risk)
- Landslides
- Steep Slopes (20% slope or higher)
- High Water Table (Soils)
- Unsuitable Soils for Buildings (Soils)

INPUT LAYERS

Agriculture

- Agricultural Land (producing)
- Grazing Lands (permits)

Critical Facilities

- Airports
- Bridges
- Broadband Anchors
- Jail/Correctional Facilities
- Dams
- EMS/Fire Stations
- Health Care/Mental Health Facilities
- Law Enforcement Offices
- Places of Worship
- Public Facilities
- Schools
- Water Storage
- Solid Waste/Oil Facility
- Oil/Gas Well
- Senior Care Centers

Environmental/Recreational

- Lakes
- Local Parks
- Outdoor Amenities
- Riparian Areas
- Streams
- Trails
- Wetlands

Infrastructure

- Canals
- Electrical Lines
- Natural Gas Lines
- Railroads
- Roads

Population

- Commercial Parcels
- Population Density
- Residential Parcels

After identifying all available spatial data, the planning team worked to prepare all the hazard layers for analysis. This was based on meetings with technical experts in their respective fields to ensure data accuracy, and also to utilize any categories or ranking of the hazard data that is relevant and most beneficial to assessing risks to people and resources in the region.

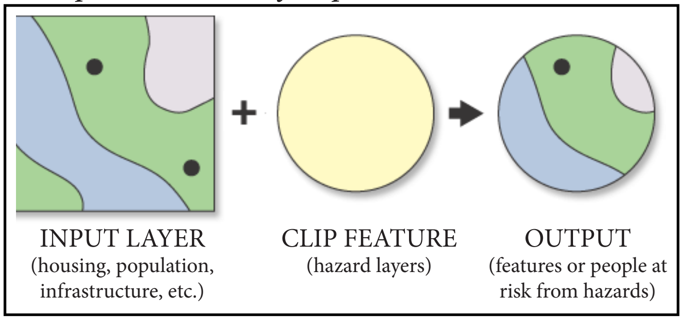
Once all available data was identified and processed, the planning team created the remaining infrastructure layers through digitization in ArcGIS. This included the geocoding of pdf maps for all Questar Natural Gas lines in the region. Ruby Pipeline was also digitized by observing ground disturbance through the use of aerial imagery provided by the National Agriculture Imagery Program (NAIP).

STEP 2 - OVERLAY ANALYSIS

After preparing and organizing spatial layers by category, models were developed to overlay all of the hazard layers with each of the input layers. This was done first at the county level, then at the municipal level.

This process is accomplished with the Clip (Data Management) tool in ArcGIS. The tool extracts all features of a layer that are within the features of another layer - similar to a cookie cutter. Using this tool, each input layer was clipped by individual hazard layer, then clipped by county, and lastly by jurisdictional boundary.

Example Illustration of Clip Tool



The use of ArcGIS Modelbuilder greatly reduced the amount of time necessary to process such a large number of hazard and input layers.

STEP 3 - ESTIMATE FEATURE GEOMETRIES

Once all the overlay models are complete, the resulting output files contain one of three types of geometric features that are either point, line, or polygon. Point features for example include mostly structures or facilities such as airports, bridges, or schools. Line features include things like roads, railroad, or utility lines. And lastly, polygon features include areas such as agricultural land, housing or commercial parcels, wetlands, or parks.

Using the feature geometry of each line or polygon output file, distance or area calculations can be estimated within ArcGIS. This information is added to the attribute table of each layer in order to identify the total linear miles or acres of input features impacted by hazards. This information is then used later to assign dollar values to each feature impacted by natural hazards.

STEP 4 - CREATE OUTPUT FILE FIELDS & LABELS

With the large number of output files created through the modelling process, the ability to easily sort feature information is critical to estimating losses and organizing data by jurisdiction. This required the addition of four fields in the attribute table that help identify:

1. Input Layer - critical facility, road, parcel, etc.
2. Hazard Layer - flood, slope, etc.
3. Jurisdiction - location of hazard impacts
4. Feature Geometry - miles or acres of features impacted by hazards

Due to the large number of files requiring additional attribute fields and labels, Python programming scripts were written in the Pythonwin application to process all remaining files quickly and uniformly. This scripting feature allowed for the labeling of the final output files, and also for deleting any empty shapefiles created as a result of the modelling process where no overlap occurred between hazard and input layers.

STEP 5 - CREATE EXCEL TABLES

With all the models and scripts complete, files were merged according to geometry (point, line, or polygon) and then converted from shapefiles to Excel spreadsheets using the Merge and Table to Excel tools in ArcGIS Toolbox. This was done to minimize the number of ArcGIS licenses needed to complete the value and loss estimates by BRAG staff, and also for the sort and summarize functions available in Excel.

With all the modelling results in spreadsheet format, the planning team could easily assign dollar values to infrastructure input layer losses and quickly summarize those losses by hazard, input layer, and jurisdiction.

STEP 6 - ESTIMATE LOSSES

Dollar values for infrastructure losses were estimated using the following data sources (listed by layer):

Linear Infrastructure Cost Estimates

CANALS	
Cost Estimate	$1.5 million/mile
Source	Bob Fotheringham, Cache County and regional project cost estimates, 2015.
ELECTRICAL LINES	
Cost Estimate	$127,000/mile
Source	Logan Light & Power, 2015.
NATURAL GAS LINES	
Cost Estimate	$1.4 million/mile. Derived by averaging linear foot replacement costs estimated for gas lines ranging from 2”-20”, then multiplying the average by 5280 feet.
Source	Questar Gas, 2015.
RAILROADS	
Cost Estimate	$1.5 million/mile
Source	BRAG Pre-Disaster Hazard Mitigation Plan, 2009.
ROADS	
Cost Estimate	$525,000/mile. Derived with base replacement cost of $350,000/mile with 50% added for unkowns and engineering/inspection.
Source	Bill Gilson, Box Elder County Road Supervisor & Josh Runhaar, Cache County Director of Development Services, 2015.

LETTER FROM QUESTAR GAS REGARDING NATURAL GAS LINE REPLACEMENT COSTS
(Same cost estimates used for Tooele County Pre-Disaster Mitigation Plan)

QUESTAR

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Salt Lake City, UT 84145-0360
Tel 801-324-3539

Dan MacDonald
Operations Engineering

May 27, 2015

Zach Maughan
Bear River Association of Governments
170 N Main
Logan, Utah 84321

To whom it may concern,

In an email dated April 27, 2015, Bear River Association of Governments requested the replacement costs of Questar Gas pipeline facilities in Box Elder, Cache and Rich Counties. Below you will find tables containing the approximate replacement costs per linear foot for both distribution main (IHP) and high pressure main (HP). Any costs for repair or replacement will depend upon the nature of the required repairs or replacement. The estimated costs provided here are based upon the cost of material and labor in May of 2015. Moreover, the scope, timing and nature of an actual project would govern the actual costs and, without additional information, Questar Gas cannot provide more accurate estimates. Accordingly, Questar Gas does not warrant the reliability of this information for any particular purpose and offers it solely for informational purposes.

IHP	
Diameter	$/linear foot
<=3"	$ 60
4"	$ 85
6"	$ 130
8"	$ 160
10"	$ 185
12"	$ 210

HP	
Diameter	$/linear foot
2"	$ 150
3"	$ 165
4"	$ 175
6"	$ 205
8"	$ 240
10"	$ 275
12"	$ 320
20"	$ 590

Sincerely,
Dan MacDonald