



Asset Vulnerability and Resiliency Study

– Guide to Using the Project Vulnerability Scoring Spreadsheet

Introduction

The Regional Vulnerability & Resilience Framework (RVRF) is a system being developed for the KTMPO region to support transportation infrastructure planning with enhanced information on vulnerability to environmental incidents and on infrastructure resiliency. The RVRF develops a composite vulnerability and resilience score for each project, which is then entered as one of the scores in the overall KTMPO project scoring process.

To be consistent with the overall KTMPO project scoring process, the RVRF scoring process has an objective and a subjective component, and a scoring spreadsheet to contain the data and calculations. The objective component is similar in that KTMPO staff prepares the scores and populates the scoring spreadsheet. However, the subjective component is different: rather than developing scores for each project individually, the subjective component consists of weighting factors which are applied to all projects within the spreadsheet. Therefore, the subjective component only has to be set one time; the RVRF Scoring Spreadsheet then calculates the final Composite Scores for vulnerability in the range of 1 – 5.

A final objective component of the scoring process is the Yes/No Resilience Filter. This evaluation is a filter with a value of 1 or 0 which is applied to the composite score. If the project contributes to system resiliency, a multiplier of 1 is applied and the Composite Score in the range of 1-5 is set as the Final Score. However, if the project does not contribute to resiliency, a multiplier of 0 is applied to the Composite Score, and the Final Score is 0. With this filter, projects in vulnerable areas are eligible for points in the overall scoring process, but only receive points if they respond to vulnerability by resiliency enhancements that help avoid, mitigate, or recover from environmental incidents.

This document provides a more detailed guide to using the RVRF Scoring Spreadsheet:

- Formatting of the RVRF Scoring Spreadsheet
- Option to include land use scores
- Weighting Factors and ranges
- Composite Score
- Yes/No Resilience Filter
- Final Score

Formatting of the RVRF Scoring Spreadsheet

The RVRF Scoring Spreadsheet is illustrated in **Figure 1**. It is formatted to follow the KTMPO Project Listing Spreadsheet, with projects grouped according to their funding categories. All headers and rows are identical, so that data from one spreadsheet can be easily imported into the other spreadsheet. The RVRF Scoring Spreadsheet also maintains the same columns as the KTMPO Project Listing Spreadsheet for project identification in columns A - F, but has additional columns for its vulnerability and resilience scoring.

Figure 1: RVRF Scoring Spreadsheet

The screenshot displays the RVRF Scoring Spreadsheet for the Killeen-Temple Metropolitan Planning Organization. The spreadsheet is organized into several key sections, each highlighted with a different color to represent different data categories:

- Project Identification (Pink):** Columns A-F, containing project details such as Project ID, Project Name, Project Location, Project Description, and Environmental Considerations.
- Objective Scores (Blue):** Columns G-L, containing scores for Land Use, Flood, Dam Breach, Wildfire, and Drought vulnerabilities.
- Weighting Factors (Green):** Columns M-Q, containing subjective weighting factors for each vulnerability type.
- Composite Scores (Yellow):** Column R, containing the weighted average scores for each project.
- Resilience Filter (Orange):** Column S, containing a Yes/No filter for project resilience.
- Final Scores (Grey):** Column T, containing the final project scores.

The spreadsheet also includes a header section for the Killeen-Temple Metropolitan Planning Organization and a footer section for the RVRF Scoring Spreadsheet.

The **Project Identification** section is shown highlighted in pink. Its data in columns A-F is imported directly from the KTMPO project listing without change.

The **Objective Scores** section is highlighted in blue, with the data listed in columns G-L. This data for land use and for each of the four environmental incident types is populated in the spreadsheet as the average values of the RVRF grid cells which apply to each project.

The **Weighting Factors** are the subjective scoring section, highlighted in green. The weighting factors are defined in columns M-Q in row 11. The spreadsheet applies the weighting factors to each of the objective scores from columns G-L. The resulting weighted scores are shown in columns M-Q, which are inputs to the Composite Scores.

Composite Scores, shown highlighted in yellow, are listed in column R. These scores are the weighted average of all the component objective scores, using the defined weighting factors. These are the final vulnerability scores for each project.

The **Yes/No Resilience Filter** in column S is highlighted in orange. This filter is developed as an objective evaluation of whether or not the defined project helps to prevent, mitigate, or recover from vulnerabilities.

The **Final Scores**, listed in column T, are highlighted in grey. The data in this column is exported directly to the overall KTMPO project scoring spreadsheet.

Option to use Land Use Scores

The original version of the RVRF Scoring Spreadsheet closely followed the precedent of the FHWA Vulnerability Assessment and Scoring Tool (VAST), and provided scoring for the four types of environmental incidents. However, the purpose of the RFDF is slightly different than the VAST; it is intended to provide vulnerability and resilience scoring of projects as one of the criteria in the overall KTMPO project scoring process. Because of this, an optional version of the RVRF Scoring Spreadsheet has been developed with an additional scoring for land use vulnerabilities.



The land use scores for each grid are similar to the four types of environmental incident types in that scoring is defined in the range of 1 – 5, and the scores are weighted together to derive the composite score for each project.

Figure 2 shows the RVRF Scoring Spreadsheet with the option for including land use vulnerability scores. Column H, highlighted in yellow, contains the objective scores from the RVRF grid. Column M, highlighted in blue, shows the weighting factor for land use and the resultant weighted scores.

Figure 2: Option for Including Land Use Vulnerability Scores

H	I	J	K	L	M	N	O	P	Q
Raw Scores					Weighting Factors				
					30	30	1	30	80
Plan Project Vulnerability Scoring									
Land Use Vulnerability	Flood Vulnerability	Dam Breach Vulnerability	Wildfire Vulnerability	Drought Vulnerability	Land Use Vulnerability	Flood Vulnerability	Dam Breach Vulnerability	Wildfire Vulnerability	Drought Vulnerability
3.42	1.000	0.000	1.000	3.714	102.85	30.000	0.000	30.000	297.144
3.60	1.533	0.000	1.267	3.800	108.00	45.999	0.000	38.001	304.000
2.64	2.814	0.070	2.047	3.349	79.28	84.419	0.070	61.395	267.907
3.66	1.667	0.000	1.000	1.333	110.00	50.000	0.000	30.000	106.667
2.77	1.818	0.000	2.091	3.909	83.18	54.545	0.000	62.727	312.727
2.84	3.308	0.000	2.385	4.077	85.38	99.231	0.000	71.538	326.154
2.44	1.600	0.000	1.900	2.200	73.33	48.000	0.000	57.000	176.000
2.35	1.525	0.000	2.639	1.803	70.52	45.738	0.000	79.180	144.262
2.648	1.626	0.088	2.129	2.626	78.748	48.776	0.088	63.878	210.068

The discussion at the December 2019 Technical Advisory Committee supported the idea of the enhanced version of the RVRF Scoring Spreadsheet, so it the recommended version of the spreadsheet. The 20191220 version of the RVRF Scoring Spreadsheet therefore has adopted this option.

Weighting Factors and Ranges

The weighting factors are a subjective evaluation of the perceived likelihood of an incident happening and its importance to the region. The scores also set the relative likelihood and importance of each criteria relative to the others. For example, if the weighting factors are set as shown in **Figure 3**, then the estimates are that:

Figure 3: Sample Weighting Factors

Weighting Factors				
30	30	1	30	80
Land Use Vulnerability	Flood Vulnerability	Dam Breach Vulnerability	Wildfire Vulnerability	Drought Vulnerability

- Dam breaches are the least likely type of incident.
- Floods and wildfires are equally likely to happen.
- Drought is 4.6 times more likely to happen than floods or wildfires.
- Vulnerable land uses are equally as important as floods and wildfires.

The factors can be any number, and do not have to total to any certain number. The RVRF Scoring Spreadsheet calculates the Composite Score as a weighted average, so no matter what the weighting factors are set to, the Composite Score is defined within the standard scoring range of 1 – 5.

The recommended ranges and defaults for the weighting factors are:

- **Dam Breach Vulnerability** set at 1. This anchors the series of weighting factors and helps define them conceptually as “x times more likely to happen”.
- **Flood Vulnerability** and **Wildfire Vulnerability** could be set roughly equal. By definition, a FEMA 100-year flood has a 1% chance of happening in any given year, but this is not the only rainfall event that can cause flooding. In addition, active climate change is altering the likelihood of flooding. In relation to a dam breach, the chances of these incidents can be considered as considerably greater, and may be set in the range of 20 – 40.
- **Drought Vulnerability** should be weighted higher, because drought or sustained high temperatures is more likely in Central Texas. A range of 70 – 90 seems appropriate for drought vulnerability.
- **Land Use Vulnerability** is not measured in terms of the likelihood of an event, but considers its effect. An event happening in a grid with a nursing home or school will have greater consequences than if it happens on undeveloped land. There is no data defining the worth of different land uses, so setting its range is strictly subjective. Conceptually, one would want to ensure that the Land Use Vulnerability score does not overwhelm the scores of the four other vulnerabilities. Therefore, setting the Land Use Vulnerability in the same general range as Flood Vulnerability and Wildfire Vulnerability, with a range of 20 – 40, seems reasonable.

Composite Score

The Composite Score is calculated in column R as the average value of all five criteria (columns H-L), weighted by the values of the weighting factors (cells M11 – Q11). The formula calculates the composite score in the range of 1 – 5 so that it is compatible with the overall KTMO project scoring process.

Composite scores highlighted in yellow are shown in **Figure 4**. The weighted scores for land use and the four types of incidents are listed in columns M-Q.



Figure 4: Composite Scores

M N O P Q R					
Weighting Factors					
30	30	1	30	80	
Land Use Vulnerability	Flood Vulnerability	Dam Breach Vulnerability	Wildfire Vulnerability	Drought Vulnerability	Composite Score
102.857	30.000	0.000	30.000	297.14	2.630
108.000	45.999	0.000	38.001	304.00	2.901
79.286	84.419	0.070	61.395	267.90	2.883
110.000	50.000	0.000	30.000	106.68	1.735
83.182	54.545	0.000	62.727	312.72	3.001
85.385	99.231	0.000	71.538	326.15	3.405
73.333	48.000	0.000	57.000	176.00	2.072
70.526	45.738	0.000	79.180	144.28	1.987
79.448	48.776	0.088	63.878	210.068	2.421

Yes/No Resilience Filter

The Composite Score values in column R are the final scores for vulnerability. The scores are an indication of the environmental context of each proposed project. A further step is to evaluate how each proposed project impacts and is impacted by vulnerability, and to determine if the project helps prevent, mitigate, or recover from an incident. This is defined as the resilience impact of the project.

The mechanism for evaluating the resilience impact of a project is a simple Yes/No Resilience Filter in column S of the spreadsheet. The criteria for the filter are:

Resilient: Projects Which Address Vulnerabilities

- New streets or bicycle/pedestrian facilities that touch a grid with a “high” or “very high” flood or wildfire vulnerability and contribute to an evacuation route.
- Improvements to a bridge located in a floodplain.
- Improvements to drainage.

Not Resilient: Projects Which do not Address Vulnerabilities

- Add travel lanes to an existing street.
- Improve operational characteristics of an existing street.
- New streets or bicycle/pedestrian facilities that do not touch a grid with a “high” or “very high” flood or wildfire vulnerability and contribute to an evacuation route.
- New construction of an interchange or turnaround.
- Maintenance or resurfacing.

Column Y in the RVRFS Scoring Spreadsheet is a hidden column containing notes on the Yes/No Resilience Filter referencing why each project received its filter score.

Final Score

The Final Score for projects is located in column T. It is the product of the Composite Score in column R times the Yes/No Resilience Filter in column S. If the filter has a value of 1, the Composite Score is populated into column T as the Final Score. If the filter has a value of 0 (meaning that the project does not contribute to resilience), the Final Score is 0.

Figure 5 shows the Composite Score, Yes/No Resilience Filter, and Final Score. The projects in rows 17, 18, 19, 21, and 23 were defined as contributing to the network, and a value of “1” is entered in column S. For these projects, their Composite Scores are populated as Final Scores in column T.

Figure 5: Composite Score, Resilience Filter, and Final Score

	R	S	T
10			Final Score
11			
12			
13			
14			
15	Composite Score	Yes/No Resilience Filter	Final Project Score
16	2.690	0	0.000
17	2.901	1	2.901
18	2.883	1	2.883
19	1.735	1	1.735
20	3.001	0	0.000
21	3.405	1	3.405
22	2.072	0	0.000
23	1.987	1	1.987
24	2.352	0	0.000
25			

The projects in the other rows were evaluated as not contributing to resilience, so their filter values are “0”, and their Final Scores are 0.

Exporting Vulnerability Scores to the KTMPO Project Selection Process

The RVRP is set up so that projects which are in vulnerable areas and contribute to resiliency receive a score relative to their vulnerabilities. Projects which do not contribute to resiliency do not receive any points in the scoring process.

As the RVRP Scoring Spreadsheet is set up to the same format as the KTMPO Project Listing Spreadsheet with the same project categories, headers, and rows, exporting the Final Scores from column T to the KTMPO overall Project Scoring Spreadsheet should be a straightforward “copy and paste” operation.



Summary

The Regional Vulnerability & Resilience Framework (RVRF) Scoring Spreadsheet is set up to conform to the overall KTMPO project scoring process. Objective scores from the RVRF grid are combined with subjective weighting factors to derive the Composite Scores for each project, defining the vulnerability context. As a further step, the RVRF is filtered so that projects which are in vulnerable areas and contribute to resiliency receive a score relative to their vulnerabilities. Projects which do not contribute to resiliency do not receive any points in the scoring process. The filtered score accounting for both vulnerability and resilience is defined as the Final Score. The

The spreadsheet is set up so that the Final Score can be easily exported to the overall KTMPO Project Scoring Spreadsheet. All rows in the RVRF Scoring Spreadsheet are the same as the rows in the KTMPO Project Listing Spreadsheet, so the Final Scores can be imported with a simple “copy and paste”. Project vulnerabilities and resilience can then be evaluated in the overall KTMPO project scoring process along with all the other scoring criteria.