User Guide

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Domain: www.erams.com/prst

PIPE RISK SCREENING TOOL

One Water Solutions Institute

Colorado State University

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EXECUTIVE MESSAGE

Catena Analytics offers powerful platforms for building accessible and scalable analytical tools and simulation models that can be accessed via desktop or mobile devices. Our team has spent the last decade developing the Environmental Resource Assessment and Management System (eRAMS), an open source technology that provides cloud-based geospatially-enabled software solutions as online services and a platform for collaboration, development, and deployment of online tools. Our services are used to assist with strategic and tactical decision making for sustainable management of land, water and energy resources. Thank you for choosing Catena Analytics and the eRAMS platform to meet your data, modeling, analysis and geospatial needs.

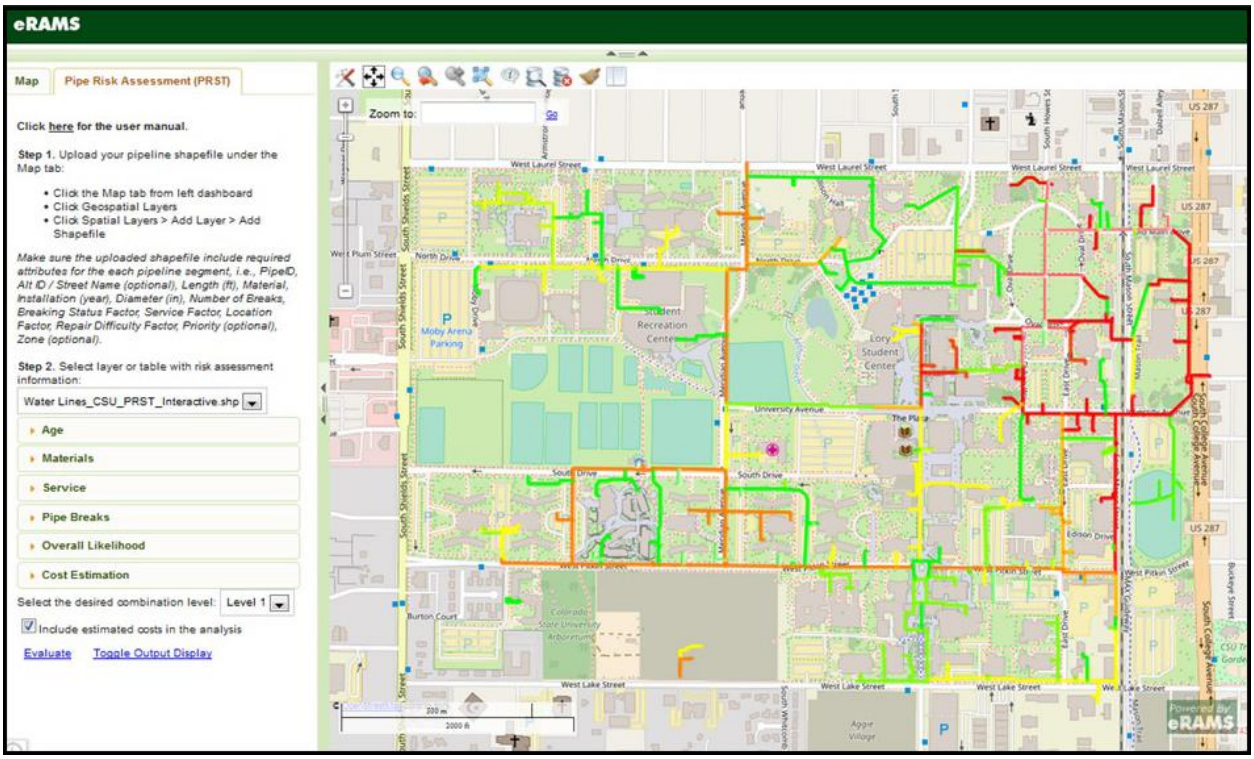
WHO SHOULD USE THIS GUIDE

This guide is a tutorial to get you started using eRAMS and the Pipe Risk Screening Tool. The guide provides instructions for commonly performed tasks and uses of the tool. This tool is intended for use by urban planners and water managers, academic groups, regulatory officials, consultants as well as state, local and federal agencies planning for the future of water resources.

NEED HELP?

After reviewing the guide if you need additional assistance we are here to help! This guide is designed to provide instruction on commonly performed operations and answers to many frequently asked questions. If you find any aspect of the tool challenging or missing information from this guide, please engage an eRAMS expert to guide you through any hurdles. Contact us at: eramsinfo@gmail.com

INTRODUCTION



PURPOSE

Prioritize your water distribution and transmission pipes for renewal projects to identify pipes at greatest risk of failure.

DESCRIPTION

The Pipe Risk Screening Tool (PRST) allows users to prioritize water distribution and transmission pipes for renewal projects. This prioritization will identify the set of pipes most at risk for failure and with the greatest cost-based consequences for inclusion in your capital improvement program (CIP).

The PRST is for analysis of pipe failure risk as part of a utility's asset management program. It is not intended to replace enterprise asset management systems or to be used to manage data on all utility pipes.

SOFTWARE AVAILABILITY

Domain

https://erams.com/prst

Documentation URL

https://erams.com/catena/tools/urban-planning/pipe-renewal-prioritization/

Publication/Citation

Fontane, Darrell and Grigg, Neil. 2013. Water Distribution System Risk Tool for Investment Planning. Water Research Foundation.
https://www.waterrf.org/research/projects/water-distribution-system-risk-tool-investment-planning

System Requirements

A modern web-browser is required to connect and run this tool. Browser options include: Google Chrome v.69, Mozilla Firefox v.62, Safari v.11.1, and Microsoft Edge v.17.

Authorized Use Permission

The information contained in the Pipe Risk Screening Tool (the "Service") is for general information purposes only. Colorado State University's One Water Solutions Institute ("CSU-OWSI") assumes no responsibility for errors or omissions in the contents of the Service. In the Service, you agree to hold neither the creators of the software platform nor CSU-OWSI liable for any action resulting from use or misuse of the Service. In no event shall CSU-OWSI be liable for any special, direct, indirect, consequential, or incidental damages or any damages whatsoever, whether in an action of contract, negligence or other sort, arising out of or in connection with the use of the Service or the contents of the Service. CSU-OWSI reserves the right to make additions, deletions, or modification to the contents of the Service at any time without prior notice.

USING THE TOOL

ACCESS THE TOOL

Public Access

The Pipe Risk Screening Tool can be accessed without registering an eRAMS account. In the public-facing version the data and analysis will only be available for the duration of the browser session. Once the browser is closed the project will no longer be available (i.e. users cannot save their work or share their project).

If a user prefers to save their project, share it with collaborators or revisit their analysis, an account is required. Follow the instructions below to create your free account and save your projects or visit our website to get started: https://erams.com/account/

Create an eRAMS Account

1. From the eRAMS Registration page, select "Register Now" from the top menu and enter a username, password, your first and last name, and your email address. Click “Create Account”.
    - eRAMS will display a popup box alerting you that an email confirmation has been sent to the provided email address
2. Open the email account provided in the registration form from either a new browser window or from your local email application.
    - Search for an email from eRAMS with the subject line “eRAMS Email Check”
3. Open this email and click on the provided link to confirm your email address.
    - ***Note**: If you do not see the confirmation email appear in your email inbox immediately, check your spam or junk email folder to ensure that the confirmation message wasn’t automatically discarded. You may also need to wait a few moments to ensure the email is delivered successfully.*
4. Once you click on the provided email link, you should be redirected to eRAMS, where you’ll be automatically logged in

STEP 1 – UPLOAD SHAPEFILE

Modify Base Layer (optional)

With the GIS interface open, click the "Map" tab on the left dashboard

1. Select the "Base Layers" drop-down
2. Select the desired base layer
    - Options include: Google, Bing, USGS National Map, None (Figure 1)

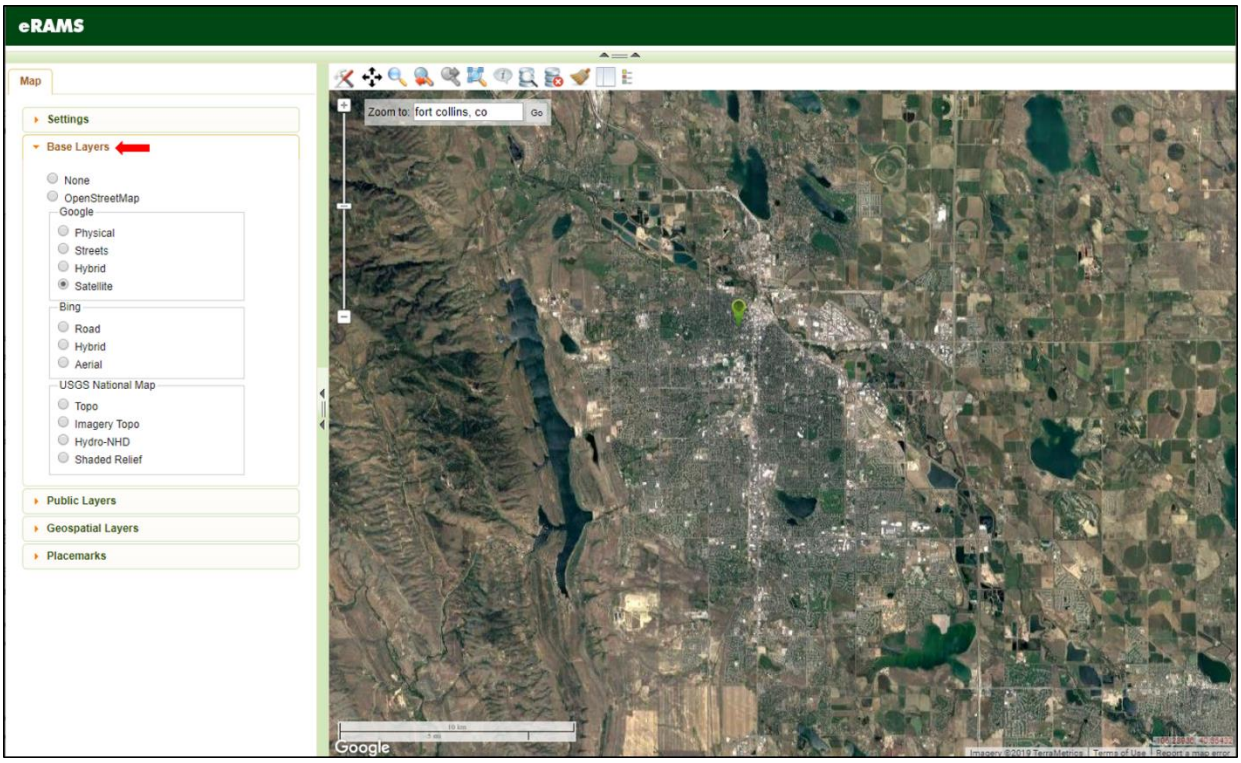


Figure 1: Modify base layer in eRAMS geographic interface

Upload Shapefile

To utilize the Pipe Risk Screening Tool (PRST), a shapefile with the following attributes will be needed. The exact naming system is not required. The tool provides the user the ability to select which layers correspond to which attribute once uploaded. Additional details are available in the Data Requirements section of this guide (see pg. 14)

Table 1: Shapefile attribute requirements

Asset Data	
Pipe ID	Required
Alt ID / Street Name	Required
Length (ft)	Required
Material	Required
Installation (year)	Required

Diameter (in)	Required
Maintenance Data	
No. Breaks	Required
Breaking Status Factor	Required
Service Factor	Required
Consequence Drivers	
Location Factor	Required
Repair Difficulty Factor	Required
Other Considerations	
Priority	Optional
Zone	Optional

To upload the file:

1. Click the "Map" tab from the left dashboard
2. Select "Geospatial Layers" > "Add Layer" > "Add Shapefile" (Figure 2)
3. Once the shapefile is uploaded, you can zoom to extent to see your file
    a. An example of the pipe system for Colorado State University is shown below (Figure 3)

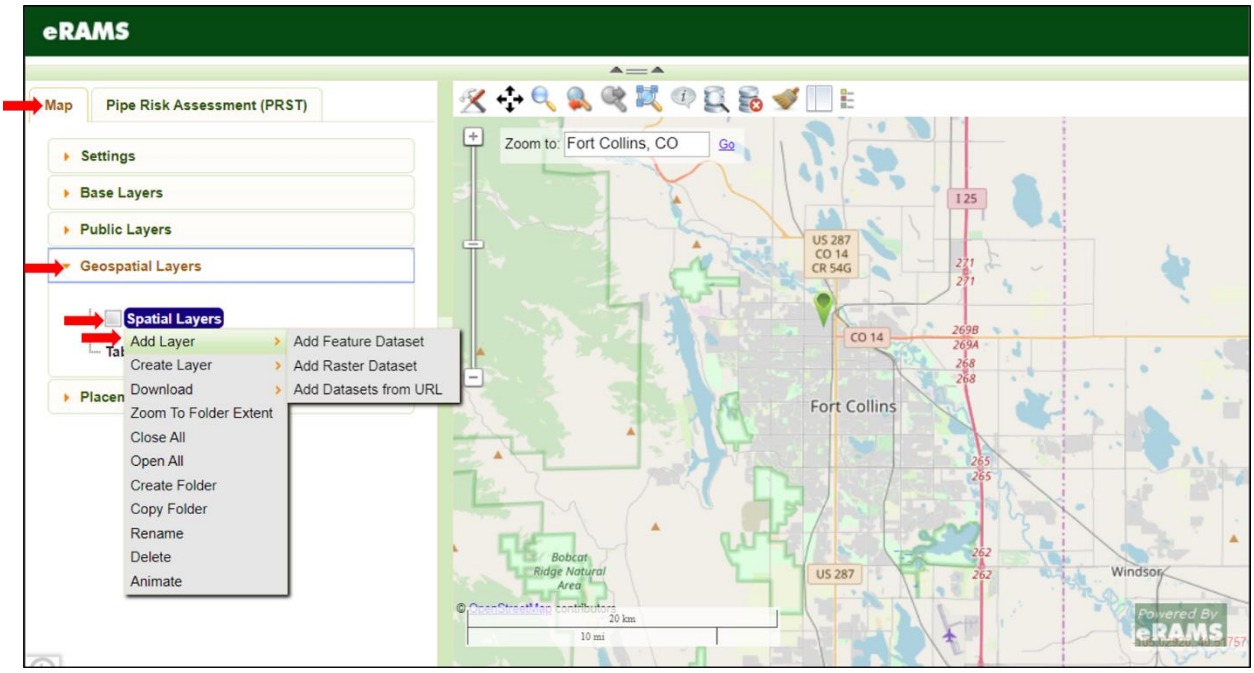


Figure 2: Add a shapefile using the PRST interface

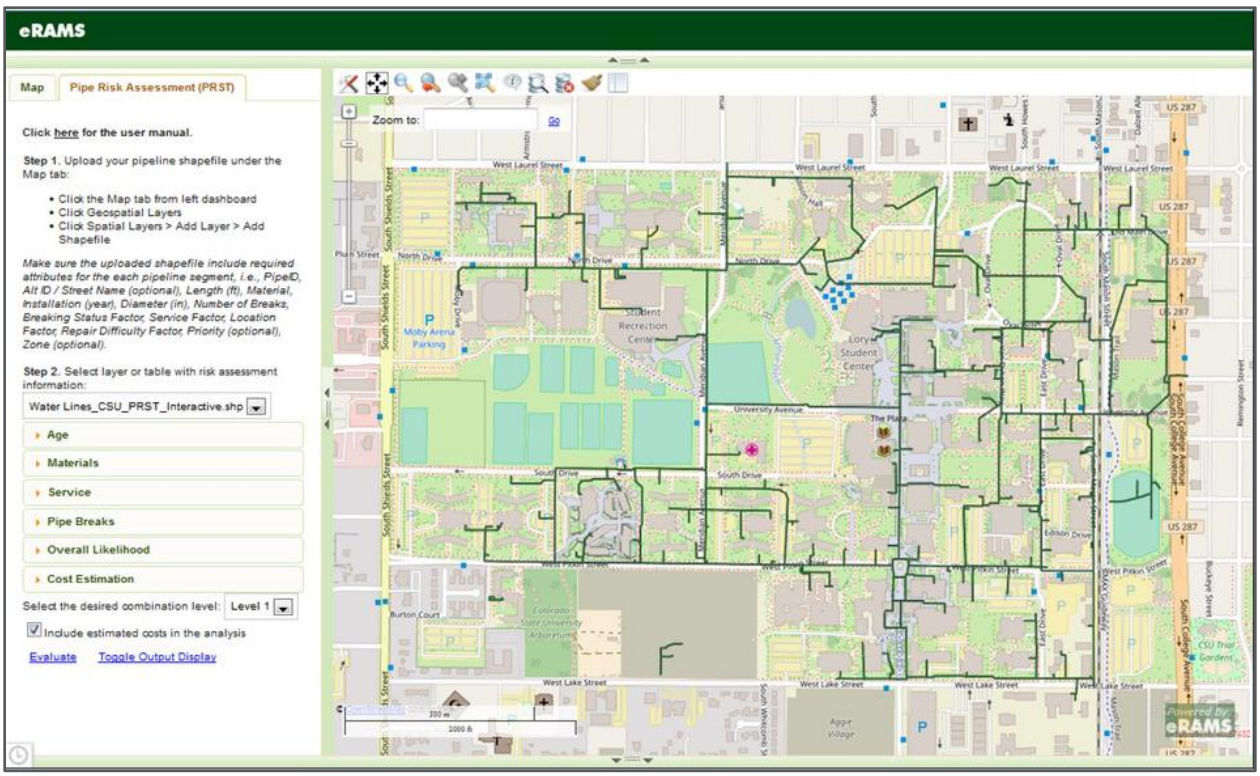


Figure 3: Example of Colorado State University pipe system

Step 2 – Select Layer

Next the user must select the layer with risk assessment information (Figure 4)

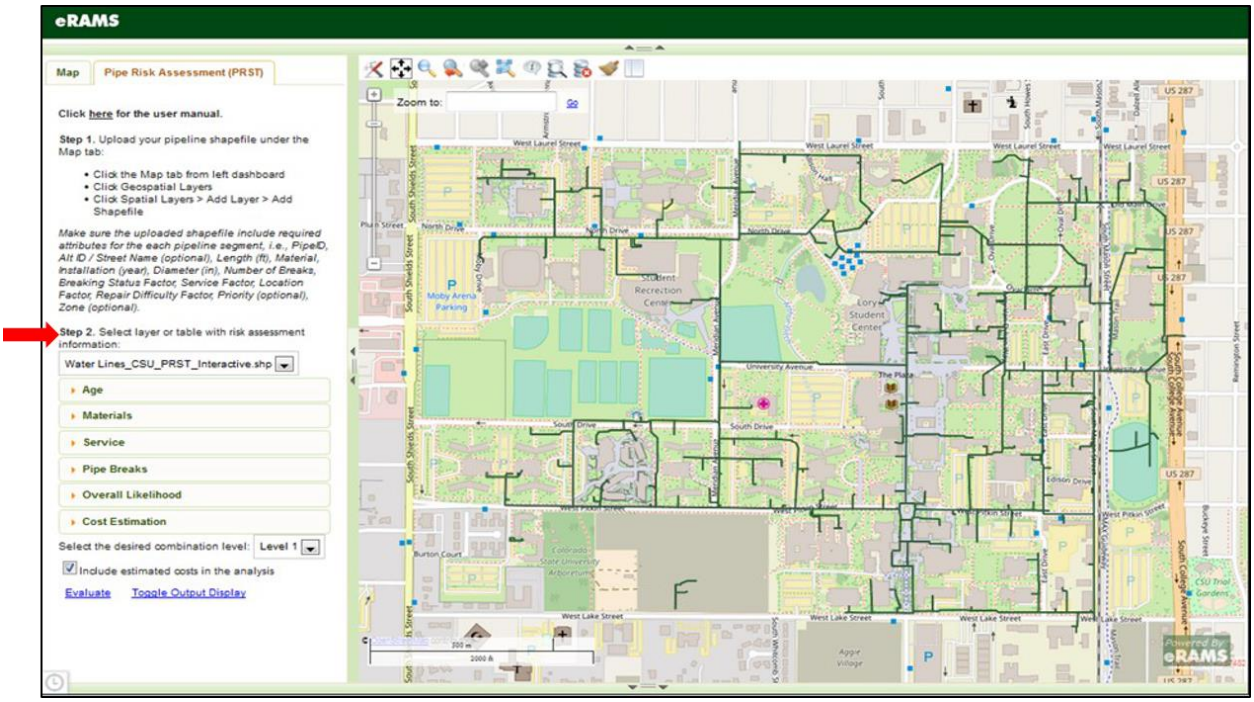


Figure 4: Select layer with risk assessment information

Age

Pipe age is a measure of years in service. Here you can enter estimates of the "Likelihood Index" as a function of age for analysis. Any shape curve (including a bathtub shape) can be defined.

Under the Age drop down, select the "Year Installed Field" and adjust the "Likelihood Index" as a function of age for analysis (Figure 5).

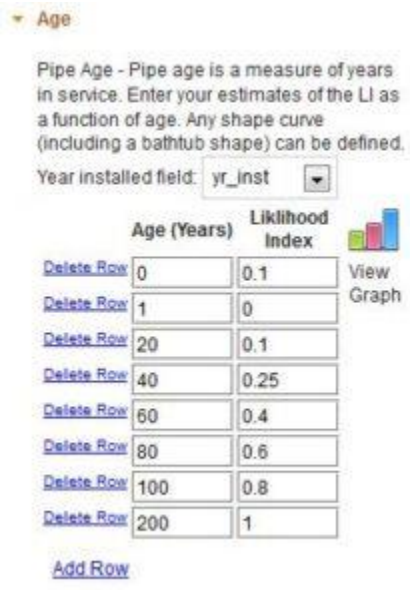


Figure 5: Adjust age of infrastructure

Materials

A table of potential likelihood index modification factors as a function of pipe material is provided under the "Materials" tab. The names or abbreviations of the pipe material in this table must exactly match those in the pipe inventory tab. The default modification factors are typically equal to one; however, if experience indicates that a certain pipe material has a higher failure rate compared to other types of material the factors can be increased to numbers greater than one and the likelihood index will be multiplied by this factor.

Select the "Materials" drop down menu and adjust the "Modification Factor" as needed (Figure 6).

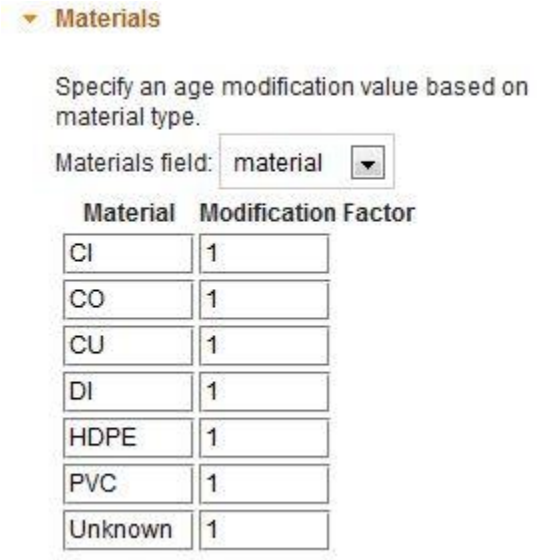


Figure 6: Material modification factor(s)

Service

The table containing the relationship of service conditions to an estimated likelihood index function is provided in the "Service Conditions" tab.

Service conditions are rated either 1 (light), 2 (medium) or 3 (heavy). This is an indicator variable that measures threats such as traffic load, high pressure zone, corrosive soils and any other service condition that might cause the pipe to fail more quickly than average.

Choose the field for "Service" and adjust "Likelihood Index" (Figure 7).

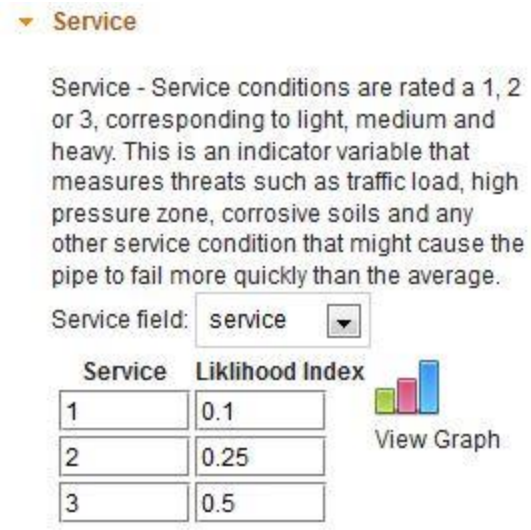


Figure 7: Adjust service conditions

Pipe Breaks

The table containing the relationship of the number of breaks to an estimated likelihood index function is provided in the "Pipe Breaks" tab. To normalize this data, the relationship is based on a break ratio which is defined as the actual number of breaks for a pipe segment as compared to the national average of expected breaks for that pipe segment. The range of this ratio is between 0 and 2.

The "Likelihood Index" is based on national statistics of average conditions that show about 0.3 breaks per mile per year. The ratio of the actual number of breaks to the expected average number of breaks is used as the input to this function. A Break Ratio of 2 means that the number of breaks per mile per year is twice the expected average breaking rate. The breaking status provided in the database is used to increase the Likelihood Index if the time between breaks is decreasing or the breaks are occurring close together. This is done by multiplying the original LI * Break Factor.

Choose the "Pipe Breaks" drop down menu and adjust "Likelihood Index" and modify the "# of pipe breaks", "Pipe Length", and "Breaking Status" as needed.

Overall Likelihood Index

The Overall Likelihood Index Calculation is based on a combination of the likelihood index values for Pipe Age, Service Levels and Pipe Breaks. The relative importance factors for these three items is entered in the table beginning in the "Likelihood Index" tab. These are ratio values and therefore a value of 2 is twice as important as a value of 1. An estimated consequences of failure rating is computed as a function of pipe diameter, location and repair difficulty. The user defines relative importance factors for these items in the table.

Three levels of combinations are used in the spreadsheet. The user enters the weights to use in computing the combinations.

- **Level 1** - is based on the age LI function only
- **Level 2** – is based on 0.5 age for age plus 0.5 for LI of breaks. The LI of breaks is estimated based on the normalized break ratio LI function

- **Level 3** – is based on 0.25 for age, 0.5 for LI of breaks, and 0.25 for service. The LI value for service is estimated by the service LI function

Overall likelihood index of failure = f (age, breaks, service)

To compute the overall likelihood index, the tool uses a weighted average combination of the likelihood indices for age, breaks and service:

Overall likelihood index of failure = w1*LI(age) + w2*LI(breaks) + w3*LI(service)

The tool allows the user to specify the relative importance of the indices which in turn are used to compute the weights (w1, w2, w3). Weights are computed by dividing the individual relative importance values by the sum of all the relative importance values. Figure G.5 shows an example of the table of relative importance factors that are specified by the user (Cells B70:D73). For example, the relative importance factors for Level 3 (1,2,1) will produce weights of 0.25, 0.5, and 0.25.

Adjust the Overall LI based on your priorities.

Cost Estimation

Optional consequences index related to estimated costs. Select Fields for Cost Estimation and adjust the "Consequence Index" with Estimated Cost (Figure 8).

Consequence Index

((Repair Difficulty Factor * (Repair RIF/Sum RIF)) + (Location Factor * Location * (Location RIF/Sum RIF)) + (Size Factor * (Size RIF/Sum RIF)))/3

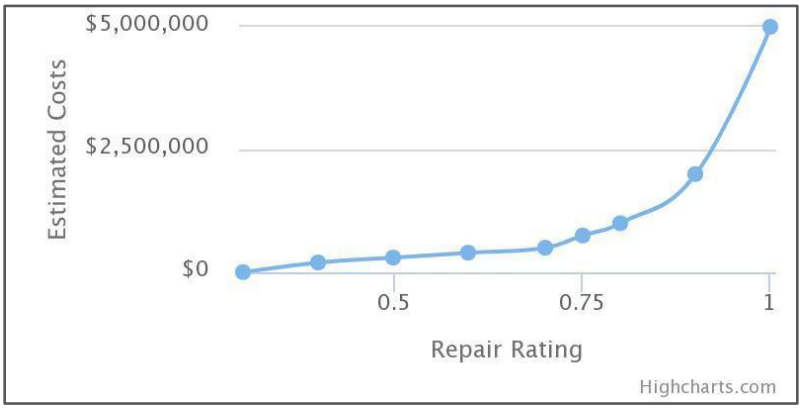


Figure 8: Graphical summary of cost estimation

Step 3 - Select Desired Combination Level

The tool provides three options or levels to compute an overall likelihood index, using combinations of age, breaks and service conditions. The three different methods of overall likelihood index

computation provided are defined below based upon the relative importance factors shown in Figure

- **Level 1** — based 100% on age (w1 = 1.0)
- **Level 2** — based 50% on age and 50% on breaks (w1 = 0.5 and w2 = 0.5)
- **Level 3** — based 25% on age, 50% on breaks and 25% on service condition (w1 = 0.25; w2 = 0.5; w3 = 0.25).

To compute the overall likelihood index, the tool uses a weighted average combination of the likelihood indices for age, breaks and service:

Overall likelihood index of failure = w1*LI(age) + w2*LI(breaks) + w3*LI(service)

Step 4 – Evaluate Results

Once all desired modifications have been conducted, click "Evaluate" and run the model. Results will be displayed on the geographic interface. Toggle over pipes for information on each segment (Figure

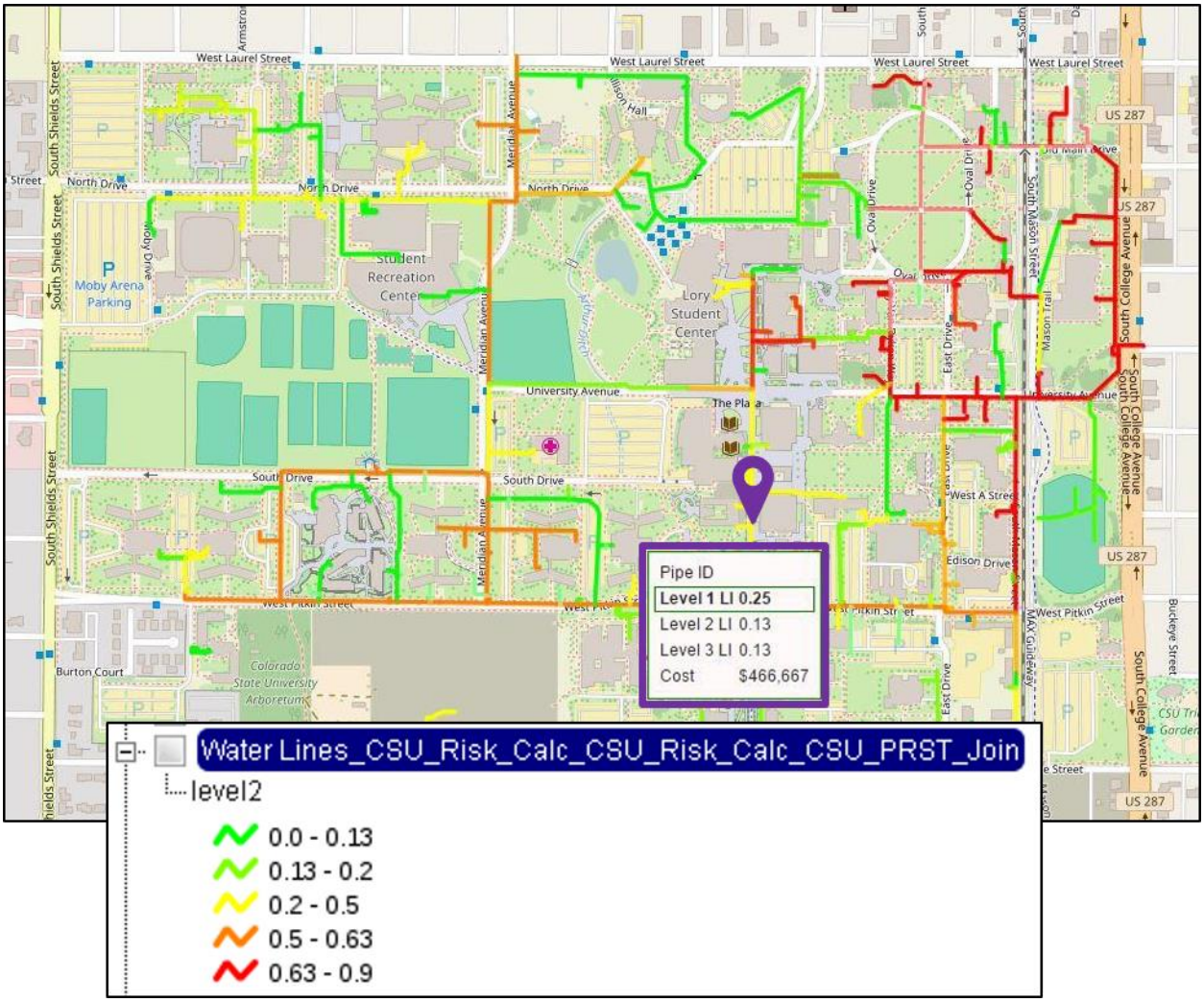


Figure 9: Results display, toggle over pipes for additional information

APPENDIX

Data Requirements

PipeID is a unique identifier given to each pipe segment in the data base. The PipeID is used as the primary identifier of each record and must be provided. If a utility does not have a unique identifier, they might use a set of sequential numbers to serve as the PipeID.

Length (ft) is required for each pipe segment. It is used in the calculation of the expected number of pipe breaks for the age of the pipe.

Material is required for each pipe segment. This may be entered as a name (cast iron pipe) or as initials (CIP); however, the entries for the material must be consistent throughout the database. This will allow the user to filter subsets of pipe segments based upon the type of material the pipe is constructed of. If the pipe material is unknown, a name of "Unknown" might be used so that those pipes can be filtered into subsets as desired.

Installation (year) is required for each pipe segment. This is used in the calculation of pipe age (current year – installation year). If the installation year is not known, it might be approximated by the installation years for other pipe segments in the same area.

Diameter (in) is required for each pipe segment. This is used in the calculation of the consequences score. It is also useful for filtering subsets of pipes.

No. Breaks is required for each pipe segment. This is the number of breaks a pipe segment has experienced and it is used in the calculation normalized break ratio, that is, the ratio of the actual number of pipe breaks divided by the expected number of pipe breaks. If a pipe segment has had no breaks then a 0 should be entered.

Breaking Status Factor is required for each pipe segment. The value of this factor would typically be set to a value of 1. However, if a pipe segment has experienced more than 1 break in a short period of time (for example, within the past 5 years) this might be an indication that the likelihood of breaks is increasing for this pipe segment. The likelihood index computed for the number of pipe breaks based upon age and pipe segment length is multiplied by the breaking status factor. For example, if the utility estimates that a pipe segment is breaking at twice the expected rate, then the breaking status factor should be set equal to 2.

Service Factor is required for each pipe segment. Service factors will have values of 1, 2 or 3, corresponding to a word scale of light, medium and heavy. This is an indicator variable that measures threats such as traffic load, high pressure zone, corrosive soils and any other service condition that might cause the pipe to fail more quickly than expected.

Location Factor is required for each pipe segment. Location factors will have values of 1, 2 or 3, corresponding to a word scale of remote, average and difficult. For example a remote location (factor = 1) would be used where a location is easy to get to and less likely to cause collateral damage. By

contrast a difficult location (factor = 3) would be used where a location is hard to get to and more likely to cause collateral damage and liability payments.

Repair Difficulty Factor is required for each pipe segment. Repair difficulty factors will have values of 1, 2 or 3, corresponding to a word scale of easy, medium and difficult. For example an easy repair (factor = 1) would be used where the access, depth of the pipe segment, and other aspects of the site are amenable to an easy repair. A difficult repair (factor = 3) would be used where access, depth of the pipe segment, unique conditions such as a stream crossing, or a combination of issues would create a difficult repair situation.

Priority is an optional input. This input was suggested to allow users to identify pipe segments with priority for repair or replacement. An example might be pipe segments under a roadway that is scheduled to be rebuilt. This input is used only as a means to filter subsets of pipes. Priorities can be identified using either numbers of an appropriate word scale. This field can be left blank if desired.