Dams Sector Consequence-Based Top Screen Methodology

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The 2023 update of the CTS was led by the Dams Sector Management Team. In conjunction with the document, a web-based application was developed to support the implementation of the methodology. The development of the web-based application was led by Idaho National Laboratory in collaboration with CISA. The web-based application is a stand-alone tool accessed via CISA.gov.

Distribution

This Dams Sector Consequence-Based Top Screen (CTS) Methodology and web-based application are available at cisa.gov/resources-tools/resources/dams-sector-consequence-based-top-screen. For additional information and details, contact the Dams Sector Management Team at DamsSector@cisa.dhs.gov.

Notice

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INTRODUCTION

Risk is the potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences. Understanding risk is important to the risk management process because this understanding strongly influences the way risk is measured, analyzed, communicated, and managed. Effective risk management to maintain Dams Sector operations and delivery of services depends on the ability of owners and operators to understand the risks to their facilities and operations and integrate a range of activities to manage those risks to an acceptable level.

Dams, levees, and related facilities are a vital part of the nation’s infrastructure, providing a wide range of economic, environmental, and social benefits through the delivery of critical water retention and control services. Dam projects are complex facilities that typically include water impoundment or control structures, reservoirs, spillways, and outlet works, as well as specialized structures such as powerhouses, canals, aqueducts, and navigation locks. Sector projects are often large in size, remotely located, and span across a large footprint. As a result, they can present unique and significant security concerns. In addition, auxiliary components—also known as appurtenant structures—may be easier to access and damage or destroy and therefore could prove an attractive target to an adversary. Consequences in the Dams Sector include the effects of an event, incident, or occurrence such as a failure of the dam itself, damage or destruction of sector assets, or a disruption in service (i.e., the loss in ability to operate as intended).

Risk analysis and assessment are the systematic examination of the components of risk by examining the threats and vulnerabilities the facility may face and the consequences of an adverse event coming to fruition and then assigning values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing risk management decision-making. Due to the wide variation of asset characteristics within the Dams Sector, sector partners use a range of comprehensive risk assessment methodologies or opt to conduct individual threat, vulnerability, and consequence assessments. Methodologies may differ in overall approach and comprehensiveness as well as expertise and resource requirements.

The Dams Sector Consequence-Based Top Screen (CTS) serves as a consistent, repeatable, and defendable approach to identify those projects whose failure or disruption could potentially lead to more severe consequences relative to others within a given portfolio of dams. By focusing on consequences and decoupling the analysis from the threat and vulnerability components of the risk process, the CTS approach can serve as an effective all-hazards preliminary prioritization scheme for both dam security and dam safety decision-making. The CTS can be used with other tools, analyses, and assessments to ensure a holistic risk analysis for a given project or portfolio. Implementation is completed through a web-based application, which allows the user to generate portfolio prioritization schemes easily and efficiently.

About the Consequence-Based Top Screen Methodology

The Dams Sector Consequence-Based Top Screen Methodology outlines a process for conducting a relative prioritization of a portfolio based on a set of consequence parameters. This guide includes information about the methodology and how to access the web-based implementation tool.

For additional information on risk management in the Dams Sector, refer to the Dams Sector Crisis Management Suite, which helps owners and operators understand the principles of Dams Sector security and crisis management. The suite includes templates to aid in the development of risk management plans, security plans, and crisis management plans. All templates can be accessed on the Homeland Security Information Network—Critical Infrastructure (HSIN-CI) Dams Portal at hsin.dhs.gov/ci/ds. Please e-mail DamsPortal@hq.dhs.gov to request access to the HSIN-CI Dams Portal.

Purpose

The purpose of the CTS is to identify critical facilities within a portfolio, such as those facilities whose failure or disruption could be potentially associated with the highest possible impacts when compared to other facilities within the portfolio.

The CTS approach provides a systematic prioritization to identify those facilities, either individual assets or systems of multiple assets, that reach critical importance based on the potential consequences resulting from severe damage or disruption. A system of multiple assets is defined as a set of individual or structurally independent assets that are not necessarily located in spatial proximity of each other or within a single project but work together to perform one or more primary functions (i.e., water supply, flood damage reduction) within an integrated system. For example, an integrated flood damage reduction system may include a number of structures and components (e.g., spillways, pump stations) that are essential to the function of the system but are not located within the same local area. In general, a system of multiple assets is spatially distributed across the same watershed or within the same floodplain.

As an overarching prioritization technique, the CTS can be utilized as a means to inform and support decisions regarding additional analyses and detailed studies. For example, in the case of an owner responsible for a large portfolio of dams, those sites identified as high-consequence facilities through the CTS approach could be assigned higher priority for conducting detailed flood inundation studies or detailed risk assessments. Another example would be the case of a natural hazard, such as an incoming hurricane threatening a large coastal region. The results from the CTS could effectively inform decision-makers about those facilities within the area that should receive particular attention from the emergency management community because of their potential for significant impacts at the local and regional levels.

Outcomes and Benefits

When considering a large portfolio, it is appropriate to initially identify and characterize the subset of those high-consequence facilities whose failure or disruption could potentially lead to the most severe detrimental impacts.

The potential consequences associated with failure, significant damage, or prolonged disruption of Dams Sector facilities can be quite severe and reach varying levels of significance. By using metrics that cover a range of potential values, the CTS is scalable and can be effectively implemented at different portfolio levels (owner, state, regional, and national) by adopting consequence thresholds that appropriately represent the corresponding scope under consideration.

Effective implementation of the methodology allows for a systematic baseline to:

- Establish common methods, assumptions, and measures to consistently quantify different types of consequence elements (human impacts, economic impacts, and impacts on critical functions). This can lead to a portfolio-wide prioritization framework to facilitate the comparison of consequence information within a given portfolio.
- Consolidate asset consequence information that can assist dam owners in identifying the most significant facilities within their corresponding portfolios in alignment with sector-wide criteria or criteria of their choosing.
- Support the development of accurate estimates for potential impacts associated with high-consequence projects affected by natural hazards or human-caused incidents.

Whenever possible, the information collected through this screening process must meet the following parameters:

- Generated by the appropriate technical personnel—in active collaboration with emergency responders and other relevant stakeholders such as the corresponding state dam safety offices—

using a reasonable and practical level of resources and taking full advantage of previous studies or evaluations.
- Collected in conformance with the appropriate information safeguarding procedures available to owners and operators.
- Consistent, comparable, and collected using similar assumptions.
- Sufficiently detailed to allow for consequence-based prioritization.
- Updated through periodic self-reviews, voluntarily conducted by owners and operators.

Scope

The CTS was developed for voluntary use by Dams Sector stakeholders. This methodology is available to all those who own, operate, or regulate sector assets, or have responsibility for the security and protection of those assets. Dams Sector assets include the following types of facilities:

- Dam Projects
- Flood Damage Reduction Systems
- Inland Navigation Systems
- Hurricane and Storm Surge Protection Systems
- Mine Tailings Projects

The methodology presented in this document covers dam projects, including some or all of the following components:

- Water Retention Structures
- Impoundments
- Water Control Structures
- Hydropower Generation Facilities
- Navigation Structures
- Water Conveyance Structures
- Remote Operations and Control Facilities

For the purposes of this document, the term “dam” will be used to denote the entire facility (i.e., dam project, which may include some or all of the functional components mentioned above).

Due to their special characteristics and functions, other Dams Sector assets such as mine tailings projects, hurricane and storm surge protection systems, and flood damage reduction systems (e.g., levees, flood gates, flood walls, pump stations) are not addressed by this version of the CTS Methodology.

CONSEQUENCE-BASED TOP SCREEN METHODOLOGY

In the case of human threats represented by an intelligent and adaptive adversary, it would be practically impossible to conduct in-depth vulnerability evaluations of all assets in a target-rich environment such as the Dams Sector. A consequence-based risk analysis, conversely, requires less time, money, expertise, and resources, and therefore constitutes an important step in the implementation of a risk management framework that can analyze both smaller and larger portfolios of assets. In addition, a consequence-focused approach can fully support all-hazards considerations involving natural hazards or human-caused incidents, and therefore provide relevant information useful for both dam security and dam safety purposes.

The CTS Methodology consists of the following steps, as described in this document:

- Define the Worst Reasonable Case Scenario
- Assemble Relevant Information
- Complete the Consequence-Based Top Screen
- Generate Relative Prioritization

1. Define the Worst Reasonable Case Scenario

To identify assets associated with high potential consequences, the CTS is based on consideration of the worst reasonable case scenario and its resulting human impacts caused by inundation of downstream populated areas, economic impacts, and impacts associated with loss of critical functions. Prior to completing the CTS, the user defines a worst reasonable case scenario applicable to the portfolio of assets under consideration.

The worst reasonable case scenario represents a condition of total or extremely severe damage to the facility keeping in mind that the situation is not simultaneously compounded or exacerbated by concurrent extreme events, acts of nature, or human error. ***It is important to note that the screening criteria do not consider the structural condition or vulnerability of the facility, nor do they address the likelihood of the natural hazard or human-caused incident triggering the worst reasonable case scenario.*** Therefore, the resulting consequence estimates should constitute a reasonable upper bound to the potential impacts associated with failure, severe damage, or disruption to the facility, regardless of the triggering event.

Defining a worst reasonable case scenario for consequence assessment of Dams Sector assets requires determining an appropriate pool elevation. The objective is to establish the appropriate hydraulic condition that can be reasonably assumed at the site. Although this consequence assessment is conducted without any specific reference to a particular threat or hazard, it must be assumed that the severe damage or disruption will take place under worst reasonable conditions at the site.

Therefore, a reasonably conservative representation of the pool elevation must be selected within the normal operating range between the minimum operating level and the level corresponding to the top of the active storage. The minimum operating level is defined as the lowest level to which the reservoir is drawn down under normal operating conditions and the active storage is the volume of the reservoir available for some use (e.g., power generation, irrigation, flood control, or water supply). The active storage does not include flood surcharge, which is the storage volume between the top of the active storage and the design water level. Figure 1 depicts various types of storage and corresponding pool elevations.

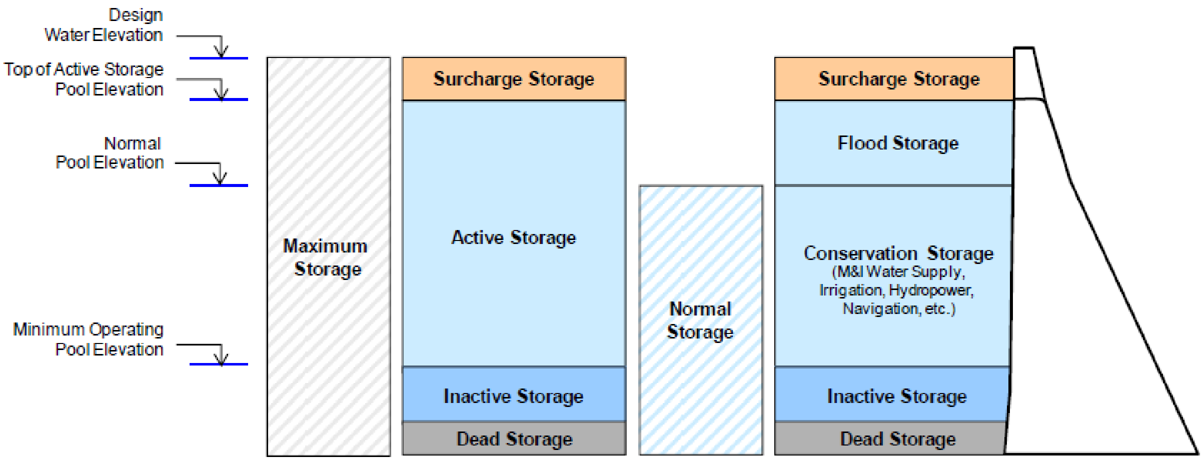


Figure 1: Types of storage and reservoir levels.

The pool elevation corresponding to the *top of active storage* provides, in most cases, a convenient and worst reasonable case scenario*.* For dams with uncontrolled spillways, this elevation would typically correspond to the spillway crest. For dams with controlled or gated spillways, this elevation would typically correspond to an elevation at or near the top of the spillway gates. However, for some projects with unique characteristics, an alternate pool elevation within the normal operating range may be more appropriate for this type of all-hazards screening analysis. In some cases, it may be more appropriate to define the screening scenario based on historical information, selecting a reservoir condition that corresponds to a given exceedance duration (i.e., the pool elevation that is equaled or exceeded a given percentage of the time on an annual basis. See appendix C for additional details). Careful engineering judgment must be used in establishing pool elevations for all-hazards consequence-based screening.

2. Assemble Relevant Information

Prior to completing the CTS, the user identifies and collects the relevant technical information and verifies the accuracy and completeness of the data. This step should include discussions with local emergency responders, as this interaction could identify additional information regarding potential impacts on local and regional communities. The use of the following information and material is encouraged when applying the CTS Methodology:

- Information characterizing the worst reasonable case consequences resulting from failure, severe damage, or disruption to the facility. Any available dam safety studies, previous assessments, and inspection reports may play a crucial role because they may contain much of the consequence information required for the CTS process.
- Inundation maps including sufficient detail to be able to identify and locate downstream population centers, industrial facilities, and other critical infrastructure that could be impacted by the worst reasonable case dam breach scenario.
- Information related to the benefits arising from the project function and operation, as typically collected on an annual basis.
- Emergency action plans, mutual support agreements, incident response plans, recovery plans, continuity of operations plans, community hazard mitigation plans, and any other documents containing information on the project and its potential impact on the well-being of local and regional communities.
- Insurance information for capital replacement and business interruption expenses

Collecting this information and material requires involvement of multi-disciplinary project personnel for data collection and support in the estimation of potential impacts associated with failure, severe damage, or disruption of the project. Therefore, technical personnel knowledgeable on dam safety, operations and maintenance, and any other relevant project functional areas should be involved in the application of the CTS to a given facility within a portfolio of assets.

3. Complete the Consequence-Based Top Screen

The CTS Methodology is implemented through an interactive web-based application, for which the following areas of information are needed:

Compile General Facility Information

This section highlights basic information about the facility and its location.

Project Identification Information

- **Dam Name:** Official name of the dam.
- **Project Description:** Brief overview of the portfolio of assets.
- **State or Federal Agency ID:** Official state or agency identification number for the dam.
- **NID ID Number:** Official National Inventory of Dams (NID) identification number for the dam.

Project Location

- **Longitude:** Longitude at dam centerline as a single value in decimal degrees.
- **Latitude:** Latitude at dam centerline as a single value in decimal degrees.
- **City:** Name of the city in which the dam is located.
- **County:** Name of the county in which the dam is located.
- **State:** Name of the state in which the dam is located.

Consequence Information

This section focuses on the different parameters used as part of the screening and prioritization process.

Consequence parameters provide a characterization of human impacts, economic impacts, and impacts on critical functions. Potential consequences are considered through a number of parameters that quantify impacts or effects associated with failure or disruption of the project. Actual values for consequence parameter data are preferred. However, the CTS tool allows users to select the appropriate parameter values applicable to the facility based on pre-established ranges or bins, should a specific parameter value not be available. Some parameters provide only a measure of the project "capacity" to perform a given function, and do not necessarily constitute a direct measure of consequences. In this case, assume that parameters effectively provide an indirect representation of the total potential consequences associated with the failure, severe damage, or disruption of the project.

The CTS approach focuses on the following potential impacts associated with failure, severe damage, or disruption:

- **Human Impacts:** Impacts on human health and safety caused by inundation of downstream populated areas, industrial areas, and other critical infrastructure assets.
- **Economic Impacts:** Impacts associated with damages to the facility, direct damage to downstream inundated areas, and direct monetary impacts associated with lost project benefits.
- **Impacts on Critical Functions:** Secondary effects associated with the disruption or loss of the critical functions provided by the facility.

Table 1 contains a summary of 14 consequence parameters used in the CTS that correspond to one of the three consequence categories listed above. See appendix B for complete descriptions of each consequence parameter.

Table 1: Consequence categories and parameters against which the CTS screens. *Default critical and maximum thresholds, agreed upon by sector matter experts for the sector nationally, are also provided.*

Consequence Parameters	Criticality Threshold Value	Maximum Threshold Value
Human Impacts		
a. Total Population at Risk (PAR_T) within Flood Scenario Inundation Zone	PAR_T^{CRIT}	PAR_T^{LIM}
b. Close Range Population at Risk		
(i) Population at Risk within 0 and 3 Miles from the Dam (PAR_1)	PAR_1^{CRIT}	PAR_1^{LIM}
(ii) Population at Risk within 3 and 7 Miles from the Dam (PAR_2)	PAR_2^{CRIT}	PAR_2^{LIM}
(iii) Population at Risk within 7 and 15 Miles from the Dam (PAR_3)	PAR_3^{CRIT}	PAR_3^{LIM}
(iv) Population at Risk within 15 and 60 Miles from the Dam (PAR_4)	PAR_4^{CRIT}	PAR_4^{LIM}
Economic Impacts		
a. Asset Repair/Replacement Cost (E_1)	E_1^{CRIT}	E_1^{LIM}
b. Remediation Cost (E_2)	E_2^{CRIT}	E_2^{LIM}
c. Business Interruption Costs (Lost Project Benefits) (E_3)	E_3^{CRIT}	E_3^{LIM}
Impacts on Critical Functions		
a. Water Supply (M_1)	M_1^{CRIT}	M_1^{LIM}
b. Irrigation (M_2)	M_{2a}^{CRIT}	M_{2a}^{LIM}
	M_{2b}^{CRIT}	M_{2b}^{LIM}
c. Hydropower Generation (M_3)	M_3^{CRIT}	M_3^{LIM}
d. Flood Damage Reduction (M_4)	M_4^{CRIT}	M_4^{LIM}
e. Navigation (M_5)	M_5^{CRIT}	M_5^{LIM}
f. Recreation (M_6)	M_6^{CRIT}	M_6^{LIM}

Define Critical and Maximum Consequence Thresholds

A critical consequence threshold is defined as the value at which any additional increase in consequential loss would be critically detrimental. A critical consequence threshold is defined for all of the consequence parameters in order to identify those facilities that are considered critical from a portfolio or sector perspective (i.e., those high-consequence facilities whose failure or disruption could be potentially associated with the highest possible impacts compared to other assets within a given portfolio or across the Dams Sector). The set of critical thresholds equations are as follows:

- Total Population at Risk $PAR_T > PAR_T^{CRIT}$, or
- Population at Risk 0 and 3 miles $PAR_1 > PAR_1^{CRIT}$, or
- Population at Risk 3 and 7 miles $PAR_2 > PAR_2^{CRIT}$, or
- Population at Risk 7 and 15 miles $PAR_3 > PAR_3^{CRIT}$, or

- Population at Risk 15 and 60 miles $PAR_4 > PAR_4^{CRIT}$, or
- Asset Replacement $E_1 > E_1^{CRIT}$, or
- Remediation Cost $E_2 > E_2^{CRIT}$, or
- Business Interruption $E_3 > E_3^{CRIT}$, or
- Total Population Served $M_1 > M_1^{CRIT}$, or
- Annual Water Deliveries $M_2 > M_2^{CRIT}$, or
- Installed Generating Capacity $M_3 > M_3^{CRIT}$, or
- Annual Flood Damages Prevented $M_4 > M_4^{CRIT}$, or
- Annual Navigation Tonnage $M_5 > M_5^{CRIT}$, or
- Annual Recreational Visitors $M_6 > M_6^{CRIT}$

A facility that reaches any of these conditions is considered part of the list of high-consequence assets that exceed the selected criticality threshold.

The maximum consequence threshold is the largest amount of potential impact and/or loss due to a breach or failure of a facility under a worst reasonable case scenario across a portfolio. In other words, the upper threshold for which a number greater will not make a consequential difference.

This type of screening is scalable and can be completed at the owner/operator, local, state, regional or sector level by defining appropriate values for the thresholds corresponding to the different consequence parameters. For the purposes of the CTS, default values have been determined for the sector as a whole on a national level. These values are used in the web-based application, unless changed by the user.

Determine the Parameter Severity Index

Once a portfolio of assets is assembled based on critical thresholds and values are assigned to each consequence parameter, these values must then be normalized to allow for comparison between parameter values as well as assets. This normalized value is called the parameter severity index. Two scaling methods for obtaining the parameter severity index—discrete scaling and continuous scaling—are described below.

Method 1: Discrete Scaling Method

The discrete scaling method was the first to be utilized for the CTS when it was originally created in 2010. This scaling method utilizes standard ranges, or bins, for ease of normalization and use. Bins allow for estimation if exact parameter values are unknown.

Consequence Severity Level

Each consequence parameter can then be characterized by eight possible severity bins, ranging from 8 (least severe) to 1 (most severe). As indicated by Table 2, each severity bin represents standard ranges for the corresponding consequence parameter. As a general rule (with the exception of the upper and lower bounds), each consequence range is bounded by values that are a factor of two greater than those corresponding to the previous range.

Table 2: Severity Bin Standardization Table

Standardized Consequence Parameter Ranges	
Severity Bin	**Consequence Parameter (P_i)**
1	$P_i > 32\Delta_i$
2	$16\Delta_i < P_i \leq 32\Delta_i$
3	$8\Delta_i < P_i \leq 16\Delta_i$
4	$4\Delta_i < P_i \leq 8\Delta_i$
5	$2\Delta_i < P_i \leq 4\Delta_i$
6	$\Delta_i < P_i \leq 2\Delta_i$
7	$0 < P_i \leq \Delta_i$
8	$P_i = 0$

In this table, P_i represents the i^{th} consequence parameter. Δi denotes the characteristic interval selected to define the corresponding consequence ranges. To find the Δᵢ in the standardization table, take the maximum consequence threshold value (see below) and divide by 32, as shown in the equation under severity level 1. The Δᵢ can then be inserted throughout the rest of the table to calculate the remaining ranges. In addition, a zero-consequence level is introduced for completeness.

Normalization of Severity Level to Parameter Severity Index

Once the severity bin of a consequence parameter value is determined, it can then be normalized to a parameter severity index value. Several alternatives could be considered when mapping the severity bin. One approach would be to consider a linear form:

$$C_k = \frac{(n-k)}{(n-1)} \quad k = 1,2, \ldots .8$$

Where n represents the number of possible severity bins (n = 8). Note that $C_1 = 1$ and $C_8 = 0$. An alternative approach is given by a nonlinear relationship of the following form:

$$C_k = \frac{2^{(n-k)} - 1}{2^{(n-1)} - 1} \quad k = 1,2, \ldots .8$$

Where, again, n represents the number of possible severity bins (n=8), and $C_1 = 1$ and $C_8 = 0$. Figure 2 provides the graphic representation of these functions, and how severity bins are mapped to parameter severity indices. In the linear case, each unit change in the severity bin of a given consequence parameter leads to a fixed change in the resulting index, whereas in the nonlinear case, the index changes exponentially.

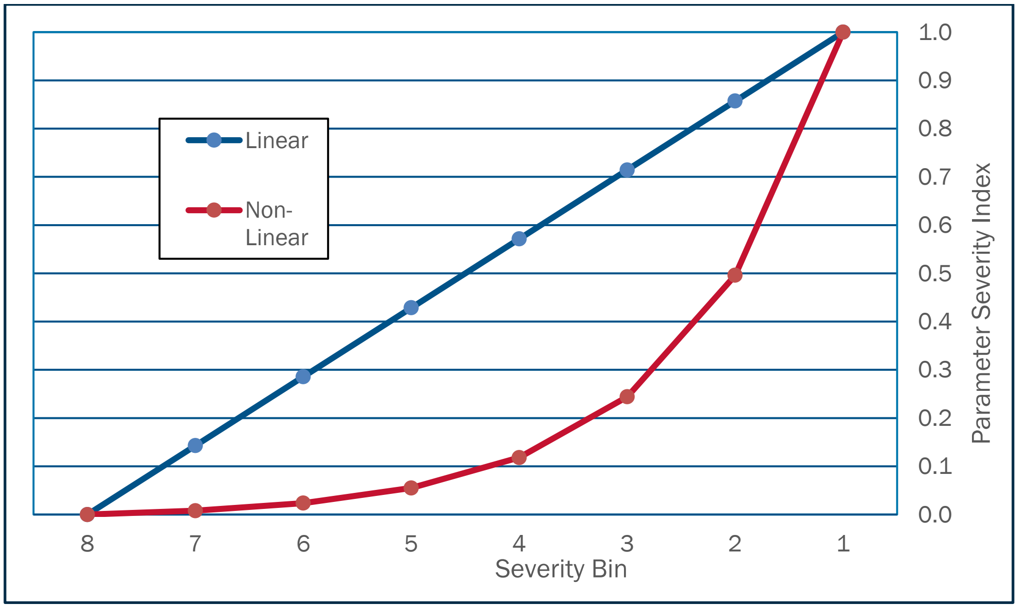


Figure 2: Linear and Non-Linear functions for the discrete scaling method mapping severity bins to parameter severity indices.

Method 2: Continuous Scaling Method

A limitation of the discrete scaling approach is that differences between facilities may be minimized or exaggerated. This is a result of the binning process, which turns the scaling method into a step function. As a result, facilities with significantly different consequence values (such as total PAR of 400K vs. 800K), will be assigned the same value, while others with very little difference in consequence values (for example, a total PAR of 398K vs. 402K) will be assigned different values. Using the continuous scale, the parameter severity index can be directly defined as a function of the consequence parameter value, and therefore allows for a considerably more refined analysis of the differences between consequence parameters across assets. Similar to the discrete scale, the continuous scale function is normalized based on the maximum consequence threshold:

$$n = \frac{P}{P^{LIM}}$$

A continuous family of severity index functions can then be defined as follows:

$$S(n) = n^{\left(\frac{1}{r}\right)} for\ 0 \leq n \leq 1$$

$$S(n) = 1\ for\ n > 1$$

P represents the consequence parameter value, P^{LIM} represents the maximum consequence parameter threshold, and *1/r* is an adjustment ratio to allow for linear and nonlinear analysis. For a linear function, r=1. For a nonlinear function, r=3. The graphic representation of the two functions, using a normalized consequence parameter value, can be seen in Figure 3.

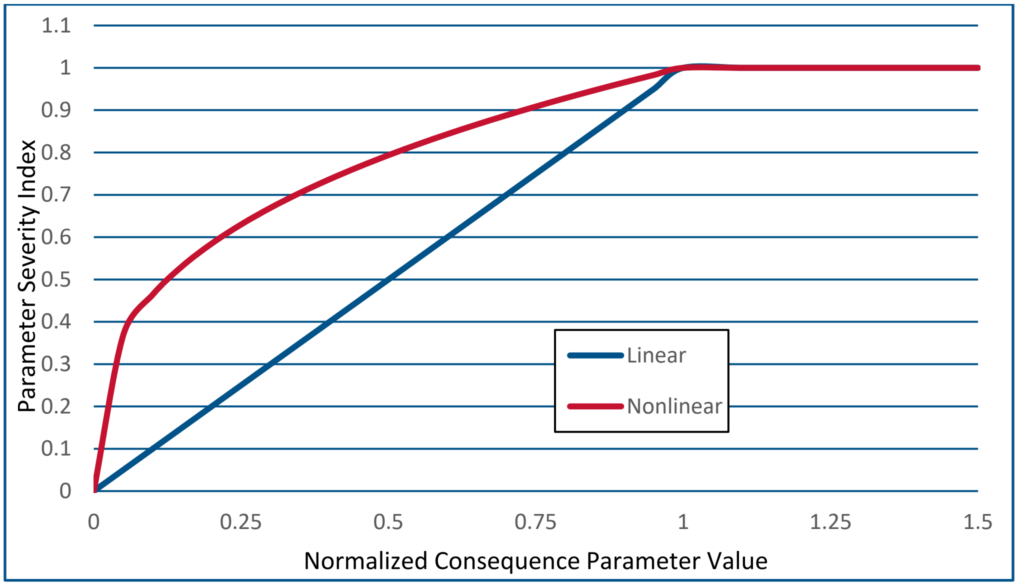


Figure 3: Linear and Non-Linear functions for the continuous scaling method mapping normalized consequence parameter values to parameter severity indices.

Select the Relative Weight of Consequence Parameters

The determination of relative weights provides the flexibility of assigning different relative importance to each of the consequence parameters. Table 9 below lists default values agreed upon by subject matter experts for the sector on a national level.

For each consequence category (Human Impacts, Economic Impacts, or Impacts on Critical Functions), the relative “importance” of the consequence parameters within that category is quantified using a value between

0 and 100. For example, Table 9 shows that the population at risk within the first 3 miles is assigned the highest relative importance (100) with respect to the other population at risk metrics. Similarly, the relative importance of the three categories is also established by assigning a value between 0 and 100. The example shown in Table 9 indicates “Human Impacts” are given the highest relative importance (100) with respect to “Impacts on Critical Functions” (60.18) and “Economic Impacts” (49.41). The relative weight for each consequence parameter can be obtained by normalizing the product of the intra-category and inter-category values in such a way that the sum of the relative weights is equal to one.

Table 3: Parameter, category, and relative weights for various consequence parameters. *Weights reflected are default values agreed upon by subject matter experts for the sector on a national level. Weights can be adjusted to more accurately reflect a user’s portfolio.*

Human Impacts	**Parameter Weight (0-100)**	**Category Weight (0-100)**	**Relative Weight**
Total Population at Risk within Flood Scenario Inundation Zone (PAR_T)	49.3	100	0.0774
Population at Risk within 0-3 Miles from the Dam (PAR_1)	100		0.1570
Population at Risk within 3-7 Miles from the Dam (PAR_2)	77.45		0.1216
Population at Risk within 7-15 Miles from the Dam (PAR_3)	55.74		0.0875
Population at Risk within 15-60 Miles from the Dam (PAR_4)	35.59		0.0559
Economic Impacts			
Asset Repair/Replacement Cost (E_1)	63.16	49.41	0.0490
Remediation Cost (E_2)	100		0.0776
Business Interruption Costs (Lost Project Benefits) (E_3)	58.06		0.0450
Impacts on Critical Functions			
Water Supply (M_1)	100	60.18	0.0945
Irrigation (M_2)	58.83		0.0556
Hydropower Generation (M_3)	66.4		0.0627
Flood Damage Reduction (M_4)	58.59		0.0554
Navigation (M_5)	43.57		0.0412
Recreation (M_6)	20.6		0.0195

4. Generate Prioritization

Once facility data is collected, and critical consequence thresholds are defined, calculate the potential consequence index for all assets within a portfolio.

Calculate the Potential Consequence Index

An overall potential consequence index (PCI) for a facility can be calculated as a weighted combination of the parameter severity index values associated with the 14 consequence parameters. This potential consequence index can be obtained as the sum of products of each parameter severity index value c_i and its corresponding relative weight w_i:

$$\text{PCI} = w_1c_1+w_2c_2+w_3c_3+w_4c_4+w_5c_5+w_6c_6+w_7c_7+w_8c_8+w_9c_9+w_{10}c_{10}+w_{11}c_{11}+w_{12}c_{12}+w_{13}c_{13}+w_{14}c_{14}$$

For a given set of relative weights and once a parameter severity index function is selected, the potential consequence index depends on the individual levels reached by each of the consequence parameters.

Figure 4 below shows PCI outcomes on a sample dataset of twelve facilities using combinations of scaling methods and index functions.

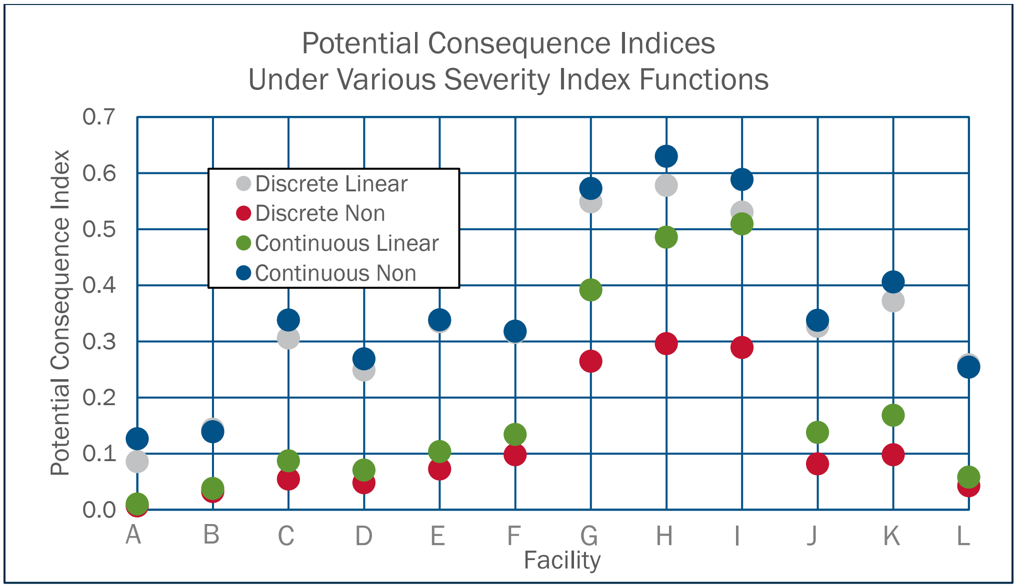


Figure 4: PCIs of a sample dataset of twelve facilities based on various combinations of scaling methods and index functions.

Implement the Prioritization Scheme

The identification of critical assets results in a number of high-consequence facilities whose failure or disruption could potentially lead to severe impacts compared to other sector assets. However, it is possible to establish different subsets within the set of critical facilities by implementing an appropriate prioritization scheme. An overall PCI for the facility can be calculated as a weighted combination of the parameter severity index values associated with the 14 consequence parameters. This index can be used to identify those facilities within the critical set that are associated with the highest potential for severe consequences.

Figure 5 below shows an example of the CTS portfolio prioritization based on a sample dataset of twelve facilities using the discrete non-linear combination. The figure shows the computed values of the potential consequence index for each project, arranged in decreasing order. The CTS portfolio prioritization scheme highlights those projects potentially associated with the most significant combined impacts and can effectively assist in systematically identifying different priority groups within a given portfolio. As is made clear through the prioritization, facilities 7, 8, and 9 have significantly higher PCIs than the other facilities in the analysis.

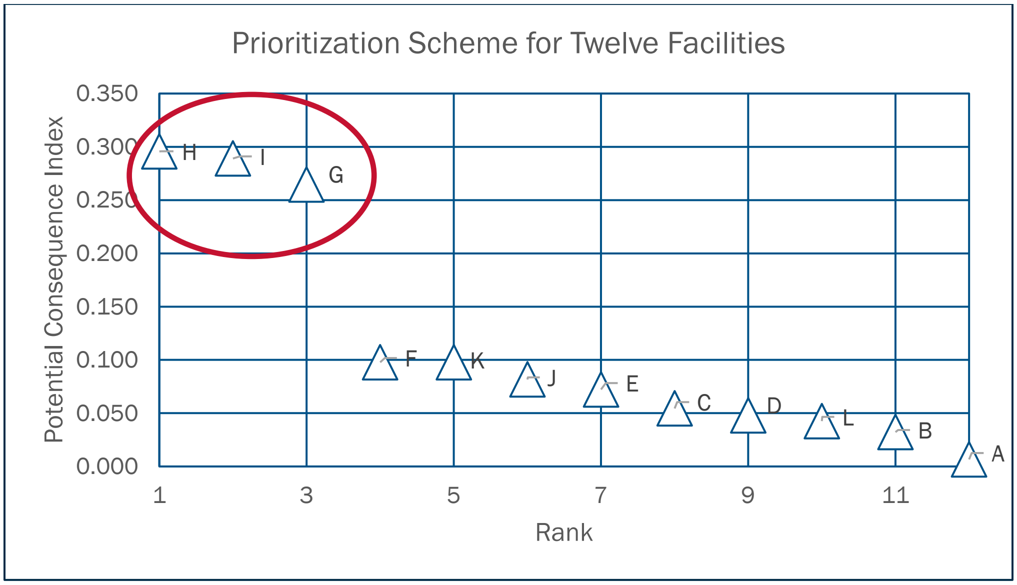


Figure 5: Example of a portfolio prioritization based on a sample dataset of twelve facilities using the discrete non-linear combination.

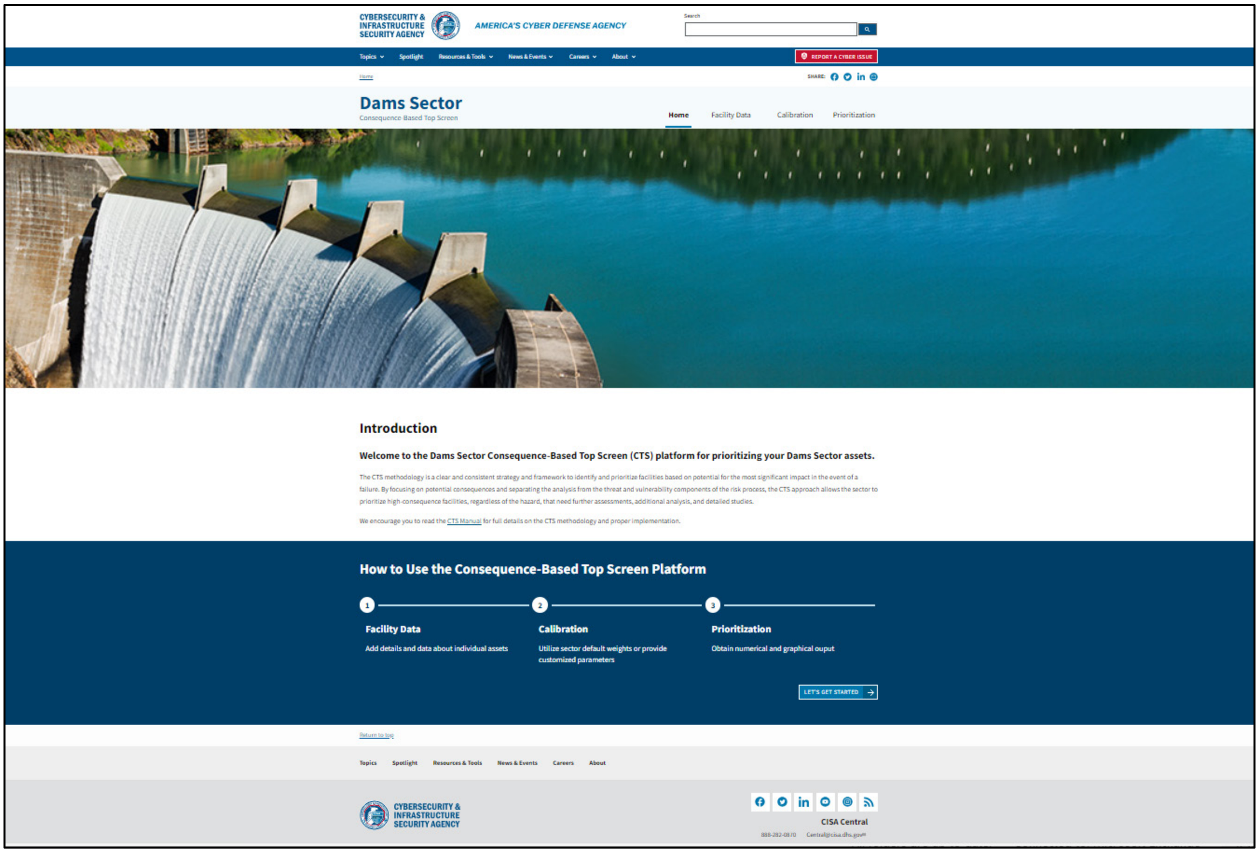
The prioritization scheme should be used within the context of a larger risk assessment and analysis. The CTS Methodology prioritizes based on potential consequences only, and does not consider threats, vulnerabilities, hazard class, or condition of asset. Therefore, other tools and methodologies should be used in concert with the CTS for a complete and accurate risk assessment. Outcomes of the CTS are based on data provided by the user, therefore final prioritization should always be dependent on the considerations of the asset owner.

APPENDIX A: ACCESSING THE CTS WEB-BASED APPLICATION

The CTS web-based application allows Dams Sector stakeholders to easily and efficiently generate portfolio prioritization schemes based on Potential Consequence Index (PCI) values for assets within a stakeholder's portfolio.

This Dams Sector Consequence-Based Top Screen (CTS) Methodology and web-based application are available at cisa.gov/resources-tools/resources/dams-sector-consequence-based-top-screen. The application is run in your web browser, and results can be downloaded to your local drive. **Please note** that data is only stored on user devices.

For questions about the CTS Methodology and web-based application, please contact the Dams Sector Management Team at DamsSector@cisa.dhs.gov.



Introduction

Welcome to the Dams Sector Consequence-Based Top Screen (CTS) platform for prioritizing your Dams Sector assets.

The CTS methodology is a clear and consistent strategy and framework to identify and prioritize facilities based on potential for the most significant impact in the event of a failure. By focusing on potential consequences and separating the analysis from the threat and vulnerability components of the risk process, the CTS approach allows the sector to prioritize high-consequence facilities, regardless of the hazard, that need further assessments, additional analysis, and detailed studies.

We encourage you to read the CTS Manual for full details on the CTS methodology and proper implementation.

How to Use the Consequence-Based Top Screen Platform

1. Facility Data
Add details and data about individual assets

2. Calibration
Utilize sector default weights or provide customized parameters

3. Prioritization
Obtain numerical and graphical ouput

APPENDIX B: CONSEQUENCE PARAMETER DESCRIPTIONS

Human Impacts

Total Population at Risk

The CTS Methodology requires an estimated value for the Total Population at Risk (PAR_T) within the flood inundation zone. For purposes of this methodology, the population at risk is the total estimated number of humans occupying a permanent residence, commercial building, or recreational area in the potential zone of inundation represented by the dam breach flood scenario, where a dam breach is defined as an uncontrolled release due to the partial or complete loss of a facility's capacity to impound water. The (PAR_T) can be determined by viewing the site-specific inundation map prepared for the dam. This map provides an estimation of the boundary of the zone and must be of a scale sufficient to locate all permanent structures and population within the inundation zone. Recent census data can be used to estimate the number of persons located within the entire inundation zone.

Because the approach is based on a worst reasonable case scenario, any persons using recreational facilities (day-use or over-night) within the zone should also be considered, including times of high use such as on holidays or during special sporting or other types of events that attract large crowds.

Table 3 below shows the different ranges considered for this consequence parameter.

Table 4: Severity bins and associated value ranges for Total Population at Risk (PAR_T).

Ranges for Population at Risk (PAR_T)	**Inundation Zone**
Severity Bin	**Total PAR (PAR_T)**
1	PAR_T >800K
2	400K< PAR_T≤800K
3	200K< PAR_T≤400K
4	100K< PAR_T≤200K
5	50K< PAR_T≤100K
6	25K< PAR_T≤50K
7	0< PAR_T≤25K
8	PAR_T =0

Close Range Population at Risk

The CTS Methodology requires estimated values for the population within different downstream distance ranges from the toe of the dam:

- 0 and 3 miles (PAR_1)
- 3 and 7 miles (PAR_2)
- 7 and 15 miles (PAR_3)
- 15 and 60 miles (PAR_4)

For unusual cases, such as facilities that are not fed by a river or other natural means, the toe of the dam is considered to be the most critical location around the walled peripheral of the reservoir with the highest population at risk in the event of a breach. ***This approach is not meant to capture expected loss of life.*** The focus of the methodology is to approximately capture a reasonable estimate of the population that could be most severely affected by the flood scenario arising from the dam failure. This involves not only the possibility of fatalities, but also the disruption associated with emergency response activities, evacuation, and relocation. Table 4 below provides the various ranges and associated severity bins of PARs at different distances from the toe of the dam.

Table 5: Severity bins and associated ranges for Close Range Population at Risk.

Ranges for Population at Risk within a Given Distance from the Dam (PAR_x)				
Severity Bin	**0-3 Miles**	**3-7 Miles**	**7-15 Miles**	**15-60 Miles**
1	$PAR_1>4K$	$PAR_2>8K$	$PAR_3>16K$	$PAR_4>64K$
2	$2K<PAR_1\leq 4K$	$4K<PAR_2\leq 8K$	$8K<PAR_3\leq 16K$	$32K<PAR_4\leq 64K$
3	$1K<PAR_1\leq 2K$	$2K<PAR_2\leq 4K$	$4K<PAR_3\leq 8K$	$16K<PAR_4\leq 32K$
4	$500<PAR_1\leq 1K$	$1K<PAR_2\leq 2K$	$2K<PAR_3\leq 4K$	$8K<PAR_4\leq 16K$
5	$250<PAR_1\leq 500$	$500<PAR_2\leq 1K$	$1K<PAR_3\leq 2K$	$4K<PAR_4\leq 8K$
6	$125<PAR_1\leq 250$	$250<PAR_2\leq 500$	$500<PAR_3\leq 1K$	$2K<PAR_4\leq 4K$
7	$0<PAR_1\leq 125$	$0<PAR_2\leq 250$	$0<PAR_3\leq 500$	$0<PAR_4\leq 2K$
8	$PAR_1=0$	$PAR_2=0$	$PAR_3=0$	$PAR_4=0$

The number of expected fatalities resulting from a dam breach inundation may be significantly less than the population at risk and depends on many factors such as time of warning, depth of flooding, and velocity of the flood wave. Residents immediately downstream of the dam may be at greater risk than those further downstream because the flood wave will reach them sooner. However, in some cases, people located at longer distances could be at greater risk than those closer to the dam, depending on when and how the dam breach warnings are issued. Therefore, distance downstream of a dam in not necessarily a reliable indicator of potential life loss.

Economic Impacts

The economic consequences and impacts are estimated in U.S. dollars and based on the worst reasonable case scenario, as defined previously in the Define the Worst Reasonable Case Scenario section. For purposes of the methodology, the dam breach flood condition is likely to be the initiating case, although site-specific studies may show variations. The scenario resulting in maximum economic losses should be used, which may differ from the scenario that can cause the greatest human impact. All pertinent structures of value located within the downstream inundation zone must be considered. The value estimations should consider whether structures would be damaged or destroyed based on expert judgment and prior case histories of dam failure incidents. If in doubt, total destruction of affected structures should be used. The highest value property losses may not necessarily correspond to the maximum number of buildings and equipment. For example, a central control building or switch gear room at a dam is likely to have a much higher replacement cost value than a maintenance shop or warehouse. Table 5 below shows the different ranges considered for the consequence parameters representing direct economic impacts, which are described next.

Table 6: Severity bins and associated ranges for economic impact parameters ($M).

Ranges for Economic Parameters (E_x)			
Severity Bin	**Asset Replacement Cost ($M)**	**Remediation Cost ($M)**	**Business Interruption Cost ($M/yr)**
1	$E_1>3200$	$E_2>16K$	$E_3>800$
2	$1600<E_1\leq3200$	$8K<E_2\leq16K$	$400<E_3\leq800$
3	$800<E_1\leq1600$	$4K<E_2\leq8K$	$200<E_3\leq400$
4	$400<E_1\leq800$	$2K<E_2\leq4K$	$100<E_3\leq200$
5	$200<E_1\leq400$	$1K<E_2\leq2K$	$50<E_3\leq100$
6	$100<E_1\leq200$	$500<E_2\leq1K$	$25<E_3\leq50$
7	$0<E_1\leq100$	$0<E_2\leq500$	$0<E_3\leq25$
8	$E_1=0$	$E_2=0$	$E_3=0$

Asset Repair/Replacement Costs

Asset repair/replacement costs (E_1) include those costs associated with structures, equipment, units, or other onsite property that would need to be repaired or replaced to restore the original functionality of the facility to the design level.

Asset repair/replacement costs represent a direct loss caused by the damage or destruction of the facility and are estimated whether or not the owner chooses to rebuild.

The economic value to repair or replace the damaged or destroyed facility is estimated in U.S. dollars. For the purpose of this estimation, replacement values are used. Market values, which are volatile, should not be used for this estimate. Similar to human impact, the worst reasonable case scenario which yields the highest costs is used as the basis for this estimate.

Remediation Costs

Remediation costs (E_2) include offsite costs related to property damage and environmental restoration, as well as costs associated with temporary structures and emergency response efforts. For the purpose of this estimation, remediation costs ***should not*** include indirect costs such as lawsuits, increased insurance costs, higher financing/borrowing costs, fines imposed by regulators, or liability costs associated with damage to other property or the environment.

Therefore, this estimate may include the following items:

- Costs to repair or replace downstream property directly damaged by the inundation or any potential cascading failures (e.g., residential, commercial, and industrial property, and critical infrastructure in general).
- Costs to remediate and restore any direct environmental effects caused by the failure scenario, including release of hazardous materials or contaminants.
- Costs associated with temporary remediation measures, such as temporary construction as well as rented/leased facilities or equipment.
- Costs associated with emergency response efforts, search and rescue activities, and any safety/security measures required for public protection within the affected area.

Business Interruption Costs (Lost Project Benefits)

Business interruption costs (E_3) represent the total estimated value of the benefits not being produced over a standard time period during which the facility is considered out of service. These lost benefits are estimated for the ***first 12 months*** after the incident or event. This estimate represents only the value of the benefits not provided by the facility during the first year after the incident, and **does not include** indirect impacts associated with business interruption.,

For the purpose of this estimation, all project purposes associated with quantifiable direct benefits must be considered. This includes benefits such as water deliveries for municipal and industrial purposes, water deliveries for agricultural irrigation purposes, treaty water supply, hydropower generation, flood damage reduction, fish and wildlife, inland navigation, and recreation. For example, to approximate the lost benefits associated with costs of hydropower generation, the facility could estimate an “average annual generation figure” and multiply it by a generic unit value ranging from $47-55 per mega-watt hour (estimated in 2020 U.S. dollars). This product would represent an estimate of the value of the hydropower generation benefits associated with the facility.

Impacts on Critical Functions

The failure or disruption of the facility may severely impact essential services or critical functions that affect populated centers, industrial areas, agricultural regions, flood protected areas, or inland navigation systems. The CTS requires an estimation of the relative importance (in terms of size or capacity) of the critical functions provided by the project. This provides an indirect measure of the potential impacts and secondary effects that could be caused by the long-term interruption of those functions.

Water Supply

The relative importance of this function is quantified through the total population served by the facility as the main water supply source for municipal and industrial use (M_1). Table 6 below shows the different ranges considered for this parameter.

Table 7: Severity bins and associated ranges for water supply consequence parameter

Ranges for Water Supply (M_1)	
Severity Bin	**Total Population Served**
1	$M_1 > 4M$
2	$2M < M_1 \leq 4M$
3	$1M < M_1 \leq 2M$
4	$500K < M_1 \leq 1M$
5	$250K < M_1 \leq 500K$
6	$125K < M_1 \leq 250K$
7	$0 < M_1 \leq 125K$
8	$M_1 = 0$

Irrigation

The relative importance of this function is quantified by the value of annual water deliveries quantified in dollars or annual volume (M_2). Table 7a and 7b below shows the different ranges considered for this parameter. **Note: when using the CTS, you may use one or the other of these parameters, but not both. If you enter data for both irrigation parameters, the parameter with the higher severity level will be used.**

Table 8a: Severity bins and associated ranges for irrigation (M_{2a}, $M) consequence parameters

Ranges for Irrigation (M_{2a})	
Severity Bin	**Annual Water Deliveries ($M)**
1	$M_{2a}>800$
2	$400<M_{2a} \leq 800$
3	$200<M_{2a} \leq 400$
4	$100<M_{2a} \leq 200$
5	$50<M_{2a} \leq 100$
6	$25<M_{2a} \leq 50$
7	$0<M_{2a} \leq 25$
8	$M_{2a}=0$

Table 8b: Severity bins and associated ranges for irrigation (M_{2b}, acre-feet) consequence parameters

Ranges for Irrigation (M_{2b})	
Severity Bin	**Annual Water Deliveries (ac ft)**
1	$M_{2b}>6.4M$
2	$3.2M<M_{2b}\leq 6.4M$
3	$1.6M<M_{2b}\leq 3.2M$
4	$800K<M_{2b}\leq 1.6M$
5	$400K<M_{2b}\leq 800K$
6	$200K<M_{2b}\leq 400K$
7	$0<M_{2b}\leq 200K$
8	$M_{2b}=0$

Hydropower Generation

The relative importance of this function is quantified in terms of total installed capacity (M_3). Table 8 below shows the different ranges considered for this parameter.

Flood Damage Reduction

The relative importance of this function is quantified by the value of annual flood damages prevented (M_4). Table 8 below shows the different ranges considered for this parameter.

Navigation

The relative importance of this function is quantified in terms of the estimated annual navigation tonnage in both directions (M_5). Table 8 below shows the different ranges considered for this parameter.

Recreation

The relative importance of this function is quantified by the number of visitors to the project recreational area (M_6). Table 8 below shows the different ranges considered for this parameter.

Table 9: Severity bins and associated value ranges of various other critical function consequence parameters

Ranges for Hydropower Generation (M_3), Flood Damage Reduction (M_4), Navigation (M_5) and Recreation (M_6)				
Severity Bin	**Installed Capacity (MW)**	**Flood Damage Prevented ($M)**	**Freight Tonnage (kT)**	**Annual Visitors**
1	M_3>8K	M_4>800	M_5>100K	M_6>4M
2	4K<M_3≤8K	400<M_4≤800	50K<M_5≤100K	2M<M_6≤4M
3	2K<M_3≤4K	200<M_4≤400	25K<M_5≤50K	1M<M_6≤2M
4	1K<M_3≤2K	100<M_4≤200	12.5K<M_5≤25K	500K<M_6≤1M
5	500<M_3≤1K	50<M_4≤100	6250<M_5≤12.5K	250K<M_6≤500K
6	250<M_3≤500	25<M_4≤50	3125<M_5≤6250	125K<M_6≤250K
7	0<M_3≤250	0<M_4≤25	0<M_5≤3125	0<M_6≤125K
8	M_3=0	M_4=0	M_5=0	M_6=0

APPENDIX C: N% EXCEEDANCE DURATION POOL ELEVATION

Definition

The N% exceedance duration pool elevation is defined as the resulting hydraulic condition (pool elevation) that is equaled or exceeded N % of the time on an annual basis.

Calculation of N% Exceedance Duration Pool Elevation

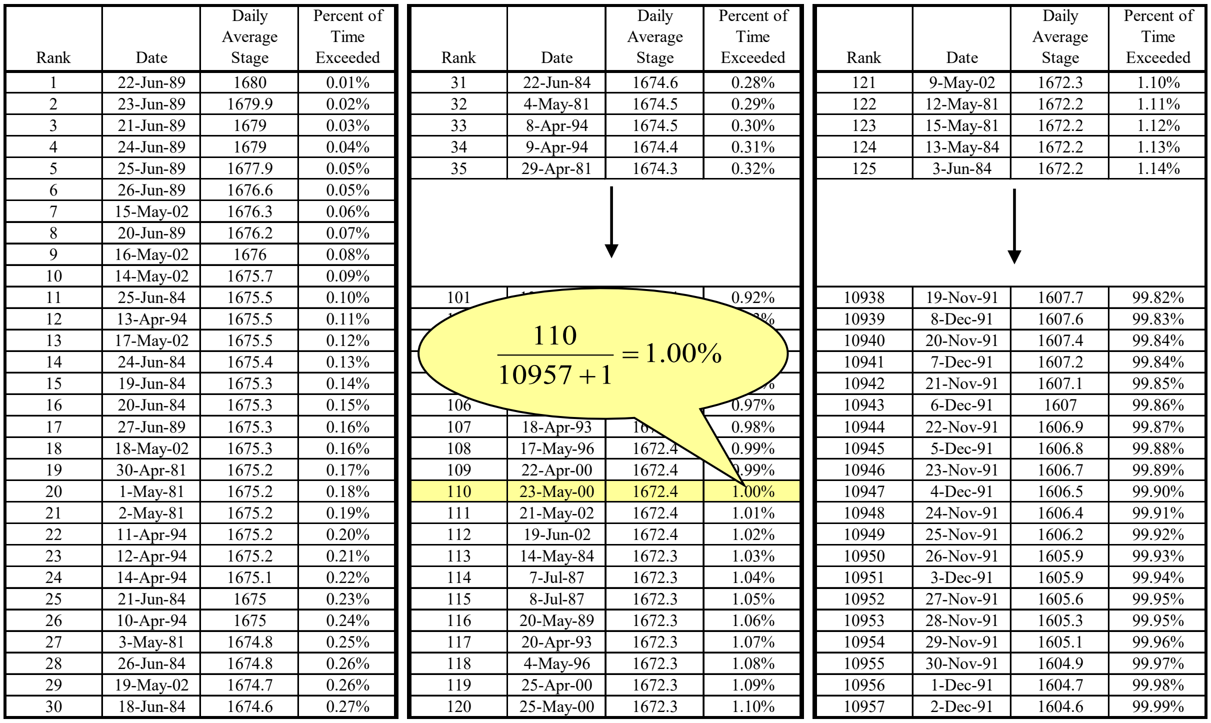
When determining N% exceedance duration pool elevation, utilize the following steps:

- Gather daily average stage for the facility for an entire period of record.
- Sort data according to stage in descending order (highest to lowest stage).
- Rank entries in ascending order (1 through X, with X being the total number of entries).
- The percent of time exceeded is the stage ranking divided by the number of data entries plus 1.

By utilizing the percent of time exceeded column, the N% exceedance duration pool elevation can be obtained. The N% exceedance duration pool elevation is the stage that corresponds to the percent of time exceeded closest to N% without exceeding.

Example

A calculation of the 1% exceedance duration pool elevation is illustrated using a set of recorded pool elevations (daily average stages) over a thirty-year period of record (1978-2007) corresponding to the site selected for this example. Figure C.1 below shows a partial summary of the ranking of daily average stages based on the corresponding percent of time exceeded (calculated as described in the previous section). Figure C.1 also shows the resulting 1% exceedance duration pool elevation. Note that the table does not show the entire data set. Figure C.2 below shows a plot of the recorded pool elevations as a function of time over the period of record. This figure also shows the pool elevation corresponding to the 1% exceedance duration. Figure C.3 below shows the pool elevations as a function of the percent time or exceeded with the 1% exceedance duration elevation highlighted.



Rank	Date	Daily Average Stage	Percent of Time Exceeded
1	22-Jun-89	1680	0.01%
2	23-Jun-89	1679.9	0.02%
3	21-Jun-89	1679	0.03%
4	24-Jun-89	1679	0.04%
5	25-Jun-89	1677.9	0.05%
6	26-Jun-89	1676.6	0.05%
7	15-May-02	1676.3	0.06%
8	20-Jun-89	1676.2	0.07%
9	16-May-02	1676	0.08%
10	14-May-02	1675.7	0.09%
11	25-Jun-84	1675.5	0.10%
12	13-Apr-94	1675.5	0.11%
13	17-May-02	1675.5	0.12%
14	24-Jun-84	1675.4	0.13%
15	19-Jun-84	1675.3	0.14%
16	20-Jun-84	1675.3	0.15%
17	27-Jun-89	1675.3	0.16%
18	18-May-02	1675.3	0.16%
19	30-Apr-81	1675.2	0.17%
20	1-May-81	1675.2	0.18%
21	2-May-81	1675.2	0.19%
22	11-Apr-94	1675.2	0.20%
23	12-Apr-94	1675.2	0.21%
24	14-Apr-94	1675.1	0.22%
25	21-Jun-84	1675	0.23%
26	10-Apr-94	1675	0.24%
27	3-May-81	1674.8	0.25%
28	26-Jun-84	1674.8	0.26%
29	19-May-02	1674.7	0.26%
30	18-Jun-84	1674.6	0.27%
31	22-Jun-84	1674.6	0.28%
32	4-May-81	1674.5	0.29%
33	8-Apr-94	1674.5	0.30%
34	9-Apr-94	1674.4	0.31%
35	29-Apr-81	1674.3	0.32%
↓			
101	[illegible]	[illegible]	0.92%
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
106	[illegible]	[illegible]	0.97%
107	18-Apr-93	[illegible]	0.98%
108	17-May-96	1672.4	0.99%
109	22-Apr-00	1672.4	0.99%
110	23-May-00	1672.4	1.00%
111	21-May-02	1672.4	1.01%
112	19-Jun-02	1672.4	1.02%
113	14-May-84	1672.3	1.03%
114	7-Jul-87	1672.3	1.04%
115	8-Jul-87	1672.3	1.05%
116	20-May-89	1672.3	1.06%
117	20-Apr-93	1672.3	1.07%
118	4-May-96	1672.3	1.08%
119	25-Apr-00	1672.3	1.09%
120	25-May-00	1672.3	1.10%
121	9-May-02	1672.3	1.10%
122	12-May-81	1672.2	1.11%
123	15-May-81	1672.2	1.12%
124	13-May-84	1672.2	1.13%
125	3-Jun-84	1672.2	1.14%
↓			
10938	19-Nov-91	1607.7	99.82%
10939	8-Dec-91	1607.6	99.83%
10940	20-Nov-91	1607.4	99.84%
10941	7-Dec-91	1607.2	99.84%
10942	21-Nov-91	1607.1	99.85%
10943	6-Dec-91	1607	99.86%
10944	22-Nov-91	1606.9	99.87%
10945	5-Dec-91	1606.8	99.88%
10946	23-Nov-91	1606.7	99.89%
10947	4-Dec-91	1606.5	99.90%
10948	24-Nov-91	1606.4	99.91%
10949	25-Nov-91	1606.2	99.92%
10950	26-Nov-91	1605.9	99.93%
10951	3-Dec-91	1605.9	99.94%
10952	27-Nov-91	1605.6	99.95%
10953	28-Nov-91	1605.3	99.95%
10954	29-Nov-91	1605.1	99.96%
10955	30-Nov-91	1604.9	99.97%
10956	1-Dec-91	1604.7	99.98%
10957	2-Dec-91	1604.6	99.99%

$$\frac{110}{10957+1} = 1.00\%$$

Figure C.1: Example determination of 1% exceedance duration pool elevation.

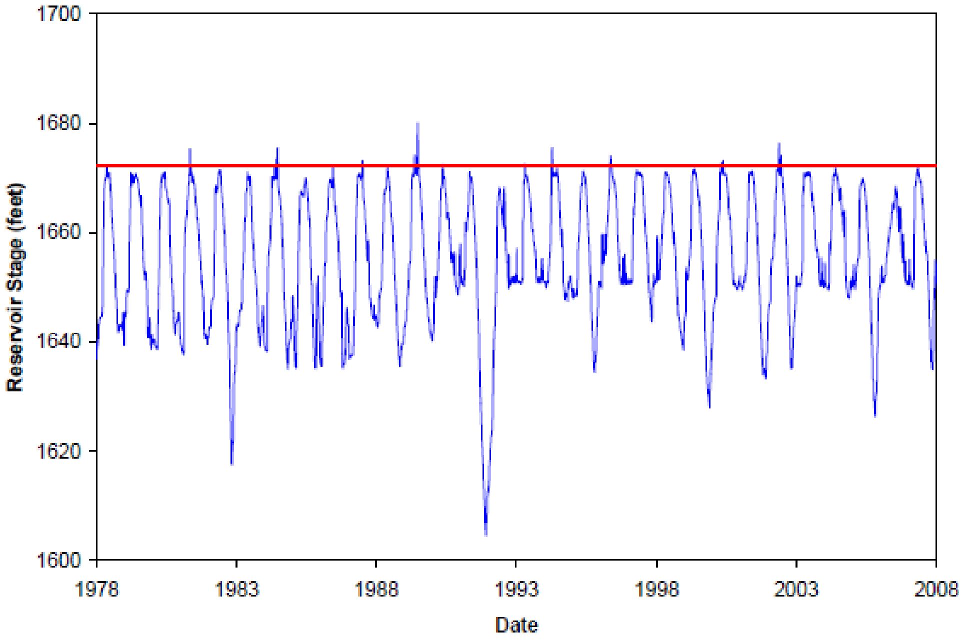


Figure C.2: Recorded pool elevations as a function of time over the period of record.

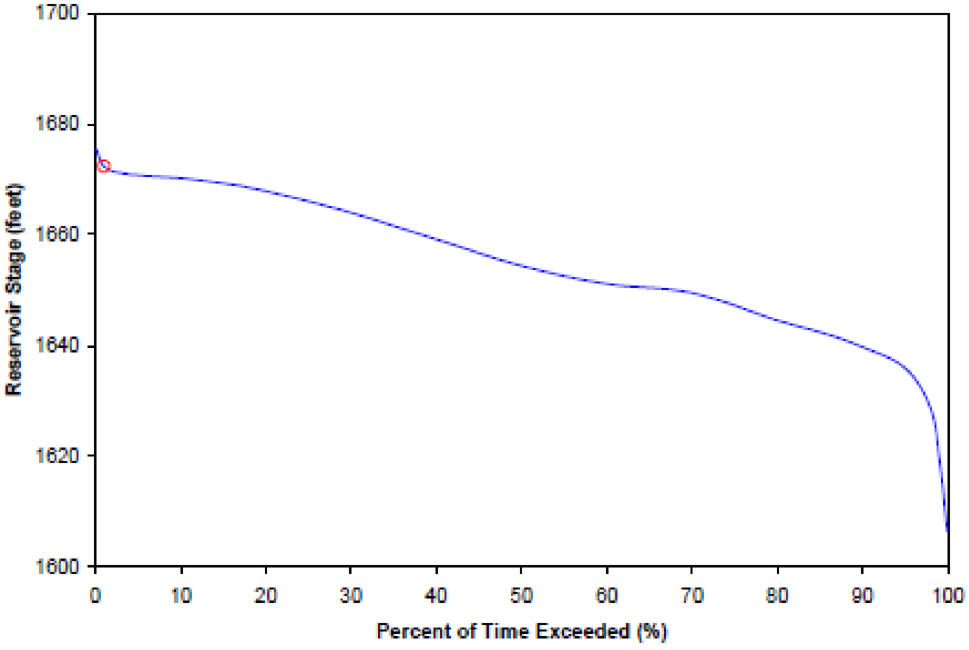


Figure C.3: Pool elevations as a function of the percent time equaled or exceeded.

APPENDIX D: METHODOLOGY DEVELOPMENT

The Department of Homeland Security established a Top Screen Workgroup consisting of members of the Dams Sector Coordinating Council and the Dams Government Coordinating Council to oversee the development of the CTS Methodology. This workgroup—comprised of experts from private industry, state governments, and federal agencies—performed a key role in the development of the screening methodology.

The initial draft of the CTS Methodology was tested in 2007 at Bonneville Lock and Dam, Melvin Price Lock and Dam (both projects owned by the U.S. Army Corps of Engineers), and Rocky Reach Dam (owned by Chelan County Public Utility District No. 1). The main purpose of these initial tests was to evaluate the practicality and onsite resource requirements of the proposed approach. On the basis of experiences and lessons learned during these tests, the CTS Methodology was slightly modified and piloted in 2008.

A first pilot was conducted in April 2008 to validate the ranges used to assess consequences, as well as to support the validation of the thresholds used to identify facilities potentially associated with nationally significant consequences. This effort involved 26 projects in the following states: Idaho, Montana, Nevada, Oregon, and Washington. The pilot set included 20 hydropower projects. Participation in this effort required each project to complete a CTS questionnaire with basic questions regarding project characteristics, infrastructure interdependencies, and potential consequences associated with severe disruption or failure.

Participating projects completed this questionnaire using a web-based password-protected portal. Each respondent's questionnaire was pre-populated with available National Inventory of Dams (NID) facility-specific information. The portal also provided access to geographic information system (GIS)-based maps to aid in identifying potentially impacted populations and infrastructure.

The questionnaire included a number of tables from which participants selected, from pre- established ranges, those consequence estimates applicable to their facility. Different consequence parameters were used to obtain information on population at risk (PAR), asset replacement cost, remediation cost, business interruption costs, population served for drinking water supply, annual value of water deliveries, generating capacity, average annual damages prevented, annual navigation tonnage, and annual number of recreational visits. The tables contained follow-on questions for several of the consequence categories, requesting information such as population centers served by the facility as a potable water supply source, percentage of market share, names of affected water treatment facilities, and other additional information.

In addition to the tables and related follow-on questions, respondents were asked to provide information on which, if any, military installations or federal facilities could be impacted by failure or disruption of the project. Respondents were also provided with a specific list of infrastructure categories (e.g., fossil fuel electric power generation facilities, nuclear electric power generation facilities, major airports, chemical manufacturing plants) and asked to identify which, if any, facilities in those categories would be within the dam failure inundation area. A review of collected data revealed that many of these questions related to interdependencies and cascading impacts were not fully completed by many of the respondents or resulted in inconsistent answers. By comparison, the direct consequence tables were completed and did not appear to be sources of confusion or excessive complexity.

A second pilot was conducted in September 2008 to expand the dataset by including additional projects with different characteristics. This effort included 22 projects in the following states: California, Colorado, Montana, New Jersey, Ohio, and Pennsylvania. This second pilot set included two hydropower projects. A streamlined version of the CTS questionnaire was employed for this second pilot, consisting only of the consequence-related questions involving numerical parameters. Participants provided the corresponding information by completing a spreadsheet sent to the state dam safety officers of the participating states. Because the process was significantly simplified, data collection was simpler, and the spreadsheets were easier to complete and disseminate. However, key information elements, such as how the estimated PAR and economic values were calculated, were not asked. This approach made it difficult to validate the answers and explain any inconsistencies.

These pilot efforts generated a representative dataset based on a balanced mix of 48 dams with different ownership characteristics: federal (13 sites), state (9 sites), local (11 sites), public utility (7 sites), and private (8 sites) owners. In addition, 22 of the participating projects are regulated by the Federal Energy Regulatory Commission. These pilot efforts provided a substantial amount of information that was critical for the refinement of the CTS Methodology.

The original version of the Dams Sector Consequence-Based Top Screen (CTS) Methodology was published April 2010 and incorporated in the larger Dams Sector Analysis Tool, which was later sunsetted. Due to demand for simple, scalable, and cost-effective risk assessment tools in the sector, CISA as the SRMA, reissued the CTS Methodology and a stand-alone web-based application to be utilized as a preliminary risk analysis tool that can guide owners, operators, and other entities with sector asset portfolios.

APPENDIX E: ACRONYMS

CISA	Cybersecurity and Infrastructure Security Agency
CTS	Consequence-Based Top Screen
GCC	Government Coordinating Council
GIS	Geographic Information System
HSIN-CI	Homeland Security Information Network – Critical Infrastructure
NID	National Inventory of Dams
PAR	Population at Risk
PCI	Potential Consequence Index
SCC	Sector Coordinating Council
SRMA	Sector Risk Management Agency