

ASDSO

Technical Knowledge Base Task Force

Report to the Board of Directors

January 8, 2021 DRAFT

1. Executive Summary

This report presents the Technical Knowledge Base Task Force's investigations of the feasibility for ASDSO to develop and maintain a "Technical Knowledge Base" (TKB). It identifies the scope, challenges, and level of effort required. The TKB is envisioned to be a living technical resource to provide dam safety engineers access to sound technical knowledge, current design standards, and best practices in a well-organized, vetted, widely available, and easily searchable source. The TKB Task Force was chartered by the ASDSO Board in September 2019. The focus of the TKB described in this report is the design, maintenance, and repair of small to medium size dams typical of the majority of dams regulated by the states. Larger dam projects generally have more resources and a board of consultants to guide design, and are therefore not the target topic of the TKB at this time.

Given the ongoing advancement of the state of practice within the dam safety field and the broad range of specialized disciplines required, the TKB must be easy to update and maintain and allow for distributed and specialized editorial authority. After much discussion, the Task Force concluded that initially, the target audience of the TKB should be State Dam Safety Agencies. Such a tool is needed to serve state dam safety agencies that have limited time and resources. Although targeted at state regulators, consulting engineers will also find it a valuable resource to stay abreast of the standard practices in the industry, and dam owners will appreciate knowing that the engineers they hire will have access to this reference. Several platforms for the TKB are presented and examples provided with discussion on the advantages and disadvantages of each. Schedule and budget estimates for implementing the TKB are explored in addition to a recommended phased implementation approach. The Task Force believes that an initial phase could be implemented immediately through volunteer labor of ASDSO members and be available for release within 1-2 years. Future phases would allow for more detailed or expanded content and could be authorized and funded a la carte. This report is intended to provide the ASDSO Board with the information they need to decide whether this is an effort that ASDSO should initiate, and if so, how best to pursue it. A proposed structure of the TKB using one TKB subject as an example is provided in an attachment.

The TKB Task Force wholeheartedly endorses the development of the TKB and recommends that ASDSO begin development as soon as possible within the resources available. The recommended approach includes:

- Utilizing a Wiki-based Format
- Consultant Led Development of Initial Phase
- State Regulatory Staff as Target Audience
- Rapid Development of First Phase (< 1 yr)
- Focus on Sm/Md Size Dams
- Phased Development Approach
- Mgmt. and Maint. by ASDSO committee
- Solicit Recognized Industry Experts to Serve as Editors

2. Introduction

The concept of a Technical Knowledge Base (TKB) was borne out of the frustration of state dam safety regulators struggling with design submittals for construction of, modifications to, and repairs on small to medium size dams. These designs oftentimes don't meet the standard of practice in the industry, loosely defined as the minimally acceptable standard of care within the profession. Many inadequate submittals are prepared by engineers who do not have significant experience working on dams and thus are not familiar with these standard practices. The ASDSO model dam safety program recommends that regulatory staff be licensed professional engineers. These regulators are primarily tasked with ensuring compliance with statutes and regulations. As professional engineers, they also have a duty to ensure compliance with the standard of care in the industry. This often results in the regulator coaching the engineer towards an acceptable design, which is inefficient for owners and regulators, is a drain on staff resources, and may be construed as being beyond the statutory authority of the regulator. Most state dam safety agencies have limited staff and resources with which to accomplish their responsibility. This is further exacerbated by the limited budgets of many state programs which do not allow for hiring senior staff familiar with the state of practice. More junior staff is typically hired, and the state programs must provide necessary training to develop their expertise. These issues are described in the meeting notes from the March 25 2019 "Best Practices Workshop" held in Westminster, CO prior to the 2019 ASDSO Western Regional Conference. That report (Westminster Best Practices Report) included three initiatives, one of which served as the basis for chartering the TKB Task Force to study the subject of developing a high-quality technical guide for dam safety engineers.

The TKB is envisioned as a tool that state regulators can easily refer to as the highest quality authority on all aspects of dam engineering to 1) advance the industry toward the use of standard practices, 2) serve as a resource to educate and support regulators, 3) serve as an authoritative reference for regulators when providing comments on technical aspects of designs to less experienced consulting engineers, 4) serve as a resource for expert consultants who are submitting designs to regulators who may not have experience with the issue being addressed, 5) aid dam owners in identifying qualified engineers and 6) serve as a mechanism for States to share tools and technical information with each other. It must be easily searchable and, given the evolving nature of the field, easily updatable and transparent. It can also serve as a design resource for consulting engineers to stay abreast of the current state of practice, challenging that state of practice when warranted, and highlighting areas where further research or standardization may be necessary.

This report summarizes the findings and recommendations of the TKB Task Force developed while executing the charter authorized by the board to explore the plausibility and scope of what a TKB might entail. It includes recommendations on the approach, but it will be up to the ASDSO Board to decide what path forward to take, based on the desired schedule and available budget.

Consistent with the Westminster Best Practices Report, the TKB Task Force agrees that the primary audience of a TKB should be state regulators. This aligns with the mission statement of ASDSO:

**“Improve the condition and safety of dams through education,
support for state dam safety programs,
and fostering a unified dam safety community.”**

In addition to aligning with the organization's mission statement, the TKB will support the following primary goals:

- Improve state dam safety programs
- Advance and expand the technical expertise of dam and levee safety practitioners.

While the target audience is state regulators, the TKB will also be useful for consulting engineers and dam owners seeking up-to-date guidance to support their projects. Development of a TKB will have several ancillary benefits to ASDSO:

1. Increasing the visibility of ASDSO within the broader dam safety and civil engineering community.
2. Increasing recruitment of new members to the organization.
3. The TKB could form the basis for a dam safety certification program in the future.
4. Filling a void, as FEMA has recently stated its desire to get out of the "guidelines business", due to budgetary issues.
5. May become a potential funding stream if corporate sponsorships of various topics are solicited. Income could be used to provide stipends to content developers and/or technical editors.
6. Engaging membership and providing a forum for building community through crowd-sourced input.
7. Forum for States to share their tools and guidelines.

This report was prepared by the ASDSO Technical Knowledge Base Task Force. Chartered in September 2019, the TKB Task Force includes the following members:

Jeremy Franz (CO) - Task Force Leader
Hal Van Aller - ASDSO Board Liaison
Jon Garton (IA) - Owner Education Committee Liaison
Alon Dornitz (NY) - Training Committee Liaison
Mark Baker (Dam Crest) - Dam Failures and Incidents Committee Liaison
Michele Lemieux (MT) - Dam Design and Construction Committee Liaison
Mark Killgore (VA)
Greg Paxson (Schnabel)
Garrett Jackson (RJH)
Mike Hand (WYOH2OPE)
John Clark (City of Aurora)

The TKB Task Force thanks ASDSO Executive Director Lori Spragens, Communications Manager Katelyn Riley and Intern Dominik Booth for their support during the developing this report.

The TKB Task Force wholeheartedly endorses the development of the TKB and recommends that ASDSO begin development as soon as possible within the resources available. The TKB directly supports the mission and goals of the organization and will significantly contribute to the safety of dams nationwide.

3. Purpose Statement for a Technical Knowledge Base

A draft purpose statement for the TKB is proposed below:

“This Technical Knowledge Base is a living technical resource developed and maintained to provide dam safety engineers access to sound technical knowledge, current design standards, and best practices for dam safety in a well-organized, vetted, and widely available source.”

4. Summary of Previous and Related Projects and Activities.

The concept of a TKB is not new. Several previous efforts explored by ASDSO have touched on aspects similar or related to it. The most relevant previous efforts are summarized here. The description of most of these efforts includes a list of pros/cons related to fulfilling the need for a Technical Knowledge Base.

- 4.1. Design Review Guidance: Chartered in 2011, the Advisory Committee authored this paper which explored how state regulators could best structure their technical reviews of dam design, rehabilitation, and repair projects. The paper was finalized in November 2014, but has not been widely circulated or formally endorsed by ASDSO. The final draft is available here:
https://asds.sharepoint.com/:b:/r/sites/ASDSOTKBTaskGroup/Shared%20Documents/Previous%20Similar%20Efforts/DamSafetyTechnicalReviews_TAB%209-ASDSO%20Task%20Force%20-%20Paxson%20White%20Paper%20-%20FINAL%202014-11-17.pdf?csf=1&web=1&e=c0YXP5
- 4.2. Embankment Dam Reference Toolbox (EDRT / É-durt): In 2011, the States of Montana and Wyoming pooled their federal assistance grants and hired DOWL-HKM to develop the Embankment Dam Reference Toolbox, or EDRT:
<https://damsafety.org/content/embankment-dam-reference-toolbox-edrt>. Version 1, published in 2012, compiled state and federal resources pertaining to the design of small and intermediate size embankment dams. A second version was published in 2014 and was available for purchase from ASDSO as a ‘Thumb Drive’. References were categorized into the following topics:
 - Embankment Design
 - Spillway Design
 - Outlet Works Design
 - Structural Design
 - Laws, Regulations and Links
 - Hazard Classification and Breach Analysis

This project was revolutionary at the time, since it was the first attempt to compile various design standards related to dams in one place. However, it has already become somewhat dated. Thumb drives, while convenient, become a “dead end” that cannot be easily updated with new, more relevant information as it becomes available. Although the EDRT could be maintained as a website, resources to do so are limited and it has not been updated since the second version was released in 2014. A PDF of the

EDRT concept is available here:

<https://asds.sharepoint.com/:b:/r/sites/ASDSOTKBTaskGroup/Shared%20Documents/Previous%20Similar%20Efforts/EDRT%20Full%20PDF.pdf?csf=1&web=1&e=tHB7d9>

The EDRT is probably the past effort that most closely matches the vision for a TKB. More on this topic will be discussed later.

Pros	Cons
<ul style="list-style-type: none"> • Excellent compilation of standard references in one location • Covers a broad range of topics 	<ul style="list-style-type: none"> • Not easily updatable as new information becomes available • No commentary on applicability of linked documents • Limited to the ‘basics’ and does not cover specialized topics. • Copyright concerns created limitations

- 4.3. ASDSO Program of Study: The ASDSO “Program of Study” was created by ASDSO’s Training Committee in collaboration with ASDSO staff. It was last updated in 2019 and its primary purpose is to guide the development of training courses, webinars, short-courses, guidelines, and other educational opportunities to serve the ASDSO membership and those working in the dam safety engineering community. Study topics are organized into thirteen broad categories including:

- Awareness
- Construction Management
- Dam Safety Program Management
- Emergency Action Planning and Management
- Environmental including Dam Removal and Tailings Dams
- Failure Investigations
- Geotechnical
- Hydrology and Hydraulics
- Inspection
- Operation and Maintenance
- Risk Analysis and Risk Informed Decision Making
- Seismic
- Site Security
- Structural

The Program of Study is available to download from the ASDSO website:

<https://damsafety-prod.s3.amazonaws.com/s3fs-public/files/ASDSO%20Program%20of%20Study%202019-Public%20View.pdf>

- 4.4. Suggested Reference Materials: In December 2000, ASDSO published a list of “Suggested Reference Materials for State Dam Safety Programs”. The list was updated in 2010 and includes two tiers of references. Tier I documents are more fundamental, basic

documents that should be prioritized. Tier II documents cover more specialized and less universal topics. Now 10-years old, this document needs an update, but could provide a useful source of information to populate a TKB. The most recent version of the Model Library is available here:

https://asds.sharepoint.com/:w:/r/sites/ASDSOTKBTaskGroup/Shared%20Documents/Previous%20Similar%20Efforts/ASDSO_ModelLibrary_2010%20Revisions.docx?d=w589efa24378c401f88c79ad08b3a6d23&csf=1&web=1&e=yxjwBH

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> Provides a framework for organizing training efforts Establishes a standard list of keywords for categorizing content 	<ul style="list-style-type: none"> No guidance to standard references Covers broad/general topics

- 4.5. Resource by Topic (RBT): Prior to the latest update of the ASDSO website in 2017, a “Resources by Topic” section was available. This section included pages for specific topics. The pages included a listing of papers by title. Screenshots of the old RBT pages are available here:

<https://asds.sharepoint.com/:f:/r/sites/ASDSOTKBTaskGroup/Shared%20Documents/Previous%20Similar%20Efforts/Old%20Resources%20By%20Topic?csf=1&web=1&e=nCOXlp>

Limitations of the RBT were that it was not searchable and required active maintenance by ASDSO staff. Volunteers from the membership were assigned sections to review periodically for update, but those reviews occurred rarely, if ever. Some of these limitations are being addressed by the Resource Database discussed next.

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> Ease of access 	<ul style="list-style-type: none"> Not searchable Required active maintenance by ASDSO staff Volunteers editors rarely reviewed

- 4.6. Resource Database: With the release of the latest version of the DamSafety.org website in, ASDSO staff converted an older “Endnote” database into the new Resource Database. It is provided as a member benefit and is searchable based on many fields including Title and Author among others. It includes all technical papers published by ASDSO, including conference papers and journal articles, as well as links to resources outside of ASDSO. The Resource Database is available for access here:

<https://damsafety.org/resource/search>

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> Searchable Indexed on many fields ASDSO Member-only Benefit 	<ul style="list-style-type: none"> “Raw” content without editorial introduction to provide context Not intended to store documents published by other organizations

- 4.7. R&D Database: In 2020, ASDSO staff has been developing a Research and Development Database (“R&D Database”) to catalog recently completed and ongoing research on topics related to dam safety. This project was funded by FEMA and is intended to serve as a repository of projects that researchers can reference to build upon and avoid unnecessary duplication of efforts. Another benefit is to facilitate networking, interest, and collaboration among researchers. The R&D database will be available on the ASDSO website when finalized (expected in Q4 2020 or Q1 2021).

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> • Searchable • Indexed on many fields • Facilitates collaboration by researchers 	<ul style="list-style-type: none"> • Research topics may not be accepted as industry standard yet

- 4.8. DamFailures.org: The DamFailures.org website was initiated in 2013 by Gannett Fleming with funding from FEMA. It compiles dam safety “lessons learned” and supporting case studies of dam failures in an engaging “story board” fashion. Each topic includes a description and background, photos and videos if available, best practices, and other resources related to the case study or lesson being discussed. The site is currently hosted and maintained by ASDSO and managed by the Dam Failures & Incidents Committee (DFIC). Updates to the website require ASDSO staff expertise and resources to perform due to the platform (Wordpress).

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> • Allows engineers to learn from mistakes of the past • Connects failures to Lessons Learned 	<ul style="list-style-type: none"> • Does not reference industry standard publications

- 4.9. DamOutletWorks.org: The DamOutletWorks.org website was originally developed in 2018 by DOWL for the State of Montana using State Assistance Grant funds to be a repository of case histories of outlet works related construction and rehabilitation projects at small dams. It includes both good and bad outcomes and provides lessons learned from each. Its ownership has recently been transferred to ASDSO for hosting and maintenance.

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> • Allows engineers to learn from mistakes of the past • Highlights commonly overlooked issues related to outlet works rehabilitations 	<ul style="list-style-type: none"> • Focused on one topic • Requires maintenance by ASDSO staff • Concerns about providing design advice created limits

- 4.10. Training Aids for Dam Safety: In the 1980s the Bureau of Reclamation led the effort to develop the “Training Aids for Dam Safety” or TADS workbook and video series with support from all of the federal dam safety entities, several states, ASDSO, and USCOLD (now USSD). It is described as a self-instructional study course in dam safety practices and consists of 21 modules, 9 of which include supporting videos. The series including videos have been digitized and are available from FEMA as DVDs at

(<https://www.fema.gov/emergency-managers/risk-management/dam-safety/resources-general-public>). Some have also been uploaded to YouTube. Topics covered are organized into three major categories including:

- Dam Safety Inspection
- Dam Safety Awareness, Organization, and Implementation
- Data Review, Investigation, Analysis, and Remedial Actions for Dam Safety

The primary focus of the series is not on design standards or criteria, but on dam safety evaluation. Although the series is somewhat dated, most of the material is still relevant. The video quality while adequate, does not meet current expectations.

TADS was evaluated by the National Dam Safety Review Board (NDSRB) Work Group on Dam Safety Training (WGDST) in 2013. FEMA funded a pilot study that involved updating the TADS that was believed to be most out of date (Seepage through dams). The pilot study provided an idea of the costs and level of effort. It was subsequently determined by the NDSRB that the cost to comprehensively update all of the manuals was too high, given the current financial resources available to FEMA. The final result of the pilot project TADS update can be found here:

https://asds.sharepoint.com/:b:/r/sites/ASDSOTKBTaskGroup/Shared%20Documents/Previous%20Similar%20Efforts/FEMA_TARC_TADS_ModQ_508_100815.pdf?csf=1&web=1&e=hlPGpQ

The WGDST evaluation can be found here:

<https://asds.sharepoint.com/:w:/r/sites/ASDSOTKBTaskGroup/Shared%20Documents/Reference%20Documents/2013-03-29%20TADS%20Modules%20Evaluation.doc?d=w127668e8f7654527881c8af93ed8452e&csf=1&web=1&e=ln2zON>

The TADS material and the WGDST commentary is a good example of material that should be included within the TKB with appropriate warnings and caveats.

Pros	Cons
<ul style="list-style-type: none"> • Focused on dam safety evaluation • Great example of collaboration amongst dam safety industry leaders 	<ul style="list-style-type: none"> • Some material is out-of-date • Not focused on design standards • Videos are dated and not high quality

- 4.11. Western Dam Engineering Technical Notes: The states of Montana, Wyoming, Colorado, and New Mexico collaborated to fund the development of these technical notes authored primarily by AECOM staff in newsletter form beginning in 2013. The issues highlight dam safety topics prevalent in the western US, but the topics covered apply globally. Articles include case studies and design guidance based on the state of practice. Sixteen issues have been released to date. An archive of past issues is available on the ASDSO website: <https://damsafety.org/basic-page/western-dam-engineering-technical-note>

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> • Diverse range of topics covered • Example calculations included 	<ul style="list-style-type: none"> • Not peer-reviewed • No real organizational structure • Not easily searchable

4.12. State Email Queries: Occasionally, ASDSO will receive a question from members posed to other states and forward those to state representatives and/or general membership to solicit responses. A recent example compiled state dam safety regulations... Previous queries have been compiled under “Resources for State Regulators” section of the ASDSO website. The goal is to transition to using the Collaborate platform for this type of query. Collaborate includes a “room” that is limited to state dam safety representatives/regulatory staff for more private discussion of this type of topic.

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> • Provides a forum for communication solely among state regulators and fosters honesty and openness • Previous queries maintained on DamSafety.org 	<ul style="list-style-type: none"> • Inefficient

4.13. National Guidelines: ASDSO maintains a library of published “National Guidelines” on its website. These are generally documents that have been edited, reviewed and approved by multiple federal agencies. They tend to focus on overall dam safety philosophy and do not provide sufficient detail or approaches to produce designs.

<u>Pros</u>	<u>Cons</u>
<ul style="list-style-type: none"> • Provide high level philosophical guidance for establishing dam safety goals 	<ul style="list-style-type: none"> • Generally do not provide technical details

5. General Outline for the TKB

A TKB could be organized in a variety of ways. One option is to follow the ASDSO standard keywords, consistent with the program of study listed in section 4.3 above. That would allow direct correlation to the topics and work already being performed by the organization. Another option would be to organize the topics relevant to the dam and reservoir system(s) and its physical features. An example high level outline is presented below. This would allow users to access the information relevant to the features or system they are most interested in.

- | |
|---|
| <ul style="list-style-type: none">I. Dam<ul style="list-style-type: none">a. Embankmentb. Foundationc. Filtersd. Drainse. Zoningf. Crestg. Freeboardh. Erosion Protectioni. InstrumentationII. Outlet Works<ul style="list-style-type: none">a. Intakeb. Control Structurec. Gates and Valvesd. Conduitse. Tunnelsf. OutfallIII. Spillway<ul style="list-style-type: none">a. Hydraulic Capacityb. Lining/Erosion Controlc. Energy DissipationIV. Site<ul style="list-style-type: none">a. Hydrologyb. Seismicityc. Geology |
|---|

Both organizational systems have merit. One key benefit of the platforms presented below is the ability to cross-reference topics to both organization systems. Each topic and document referenced by the TKB could be “tagged” to multiple topics within both organization systems, allowing users to access data through multiple avenues.

One of the most critical requirements for the selected platform is search-ability. Users must be able to enter a search term to discover all documents in the system that contain that term. Search-ability should include both a general search which would return results from that term across all documents and fields including content, and also more advanced search capability to search within specific fields for the documents (similar to the Resource Database: e.g.: Title, Author, Abstract, Topic, Keyword, etc.).

In addition to broad search-ability, it would be beneficial if users also had the option to search for topics through ‘curated’ topic pages developed by the administrator or sponsor of each section/topic. This would allow users to see how the topic they are interested in integrates into the broader framework of the dam/reservoir system and demonstrate how all aspects of

dam design relate to each other to create a safe system. To put this concept into context: If a dam is facing a rehabilitation of the outlet works, the engineer of record (EOR) must ensure the changes do not impact the ability of the reservoir to pass the inflow design flood and there is still a means to control the reservoir level at normal pool and provide emergency drawdown. In other words holistically look at the reservoir, rather than focus on the component being upgraded. This is a concept often overlooked by less experienced engineers.

A key benefit of many of the platforms available is that the organizational structure can be easily updated on the fly. This is particularly true of the Wikimedia format.

5.1. Sample section(s)

5.1.1. Wiki Pilot

As a pilot project, the TKB Task Force, with assistance from ASDSO staff, converted the embankment dam section of the EDRT into a Wiki-style formatted website. This was performed in order to demonstrate the functionality of the Wikimedia format and to estimate the level of effort required to convert a pre-existing document into one of the optional formats for the TKB. The Wiki version has been maintained live on-line and can be explored here:

https://jonsweb.net/damwiki/index.php?title=Main_Page

Several things to note about this example include:

- Linked documents go to a ‘landing page’ for the reference where additional notes about the document can be presented. This can include a brief description of the document along with any recommended guidance on use, common misperceptions on the topic, obsolescence and links to superseding documents, known errata, and commentary if warranted. The landing page could also serve as a link to copyright/proprietary external references that must be purchased and cannot be shared freely by ASDSO. Some examples include ASCE journal articles, ASTM/ACI/PCA/AISC standards, and CEATI publications.
- The current version of the wiki does not contain all sections of the EDRT. Only the embankment dam section was converted as a test case.
- Recommendations for revisions can be made by any registered user. Readers are encouraged to create an account to test this process.
- When editorial mode is deployed, suggested edits are not published until approved by the editor assigned to that page. When a revision is suggested, it prompts the editor to review the suggested edit. If accepted, the revision is published. The editor also has the opportunity to revise the edit prior to publication.

5.1.2. Example Topic Outline

To further demonstrate the anticipated content of the TKB, the Outlet Works topic was developed more thoroughly as an example. It is intended to demonstrate the

level of detail expected and introduce a scheme for how the TKB might be developed in phases to make the project more manageable. The phased approach would start with basics and expand to provide additional commentary/context and eventually more advanced topics over time. The draft outlet works topic outline is included as an attachment to this report.

5.2. Sources of Material

There is a wide variety of material available to compile into the TKB. A partial list is provided here as a starting point.

- ASDSO Sites
 - DamFailures.org
 - DamOutletWorks.org
 - Suggested References for State Dam Safety
 - Program of Study
- Other Dam Safety/Civil Engineering Organizations
 - USSD
 - ICOLD
 - ASCE
- Corporate sites
 - ACI
 - ASTM
- National Standards
 - FEMA
 - ICODS
 - NDSRB
- Federal Agencies
 - USACE
 - FERC
 - DHS, CISA
 - Reclamation
 - NRCS
 - TVA
 - USGS
 - NWS

It is recommended that a state specific guidance section should be incorporated into the TKB. Although these sections would not provide 'official' authoritative materials, state programs may find them easier to update on a regular basis than their official state websites. States report that official state websites are restrictive of content, limiting their ability to share resources. States have informally been sharing each other's resources for years, mainly hearing about valuable tools or guidance via word of mouth. This would allow states improved access to helpful guidance and tools and ensure use of

the latest version. States would be responsible for keeping the material on their “State Page” up-to-date. Examples of materials in this section could include.

- State guidance documents and spreadsheets
- Western Dam Engineering Technical Notes
- State of Washington Technical Notes
- State of Montana Guidance Documents and Tools
- State of Colorado Guidance Documents and Tools
- California Dam Safety Program Research
- Others

Candidates states for development of state pages as early examples are presented below:

- State of Colorado Guidelines
 - Dam Breach Analysis with spreadsheets
 - Early Warning Systems
 - Hazard Classification
 - Hydrologic Hazard Analysis
 - Subsurface Investigation Plans
 - Project Review
 - Regional Extreme Precipitation Study
 - Hydrologic Basin Response Parameter Estimation
 - Comprehensive Dam Safety Evaluations
- State of Montana Technical Notes & Construction Permit Review Aids
 - Spillway Capacity Evaluation
 - Loss of Life Determination
 - Simplified Evacuation Mapping
 - Chimney Filter / Drain Design and Construction
 - Downstream Hazard Classification
 - Potential Failure Modes Analysis
 - Specification Requirements & Specifications review checklists
 - Use of Pumps and Siphons in an emergency
 - Construction Design Review Guidance
- State of Washington Technical Notes
 - Technical Notes
 - Dam Break Inundation Analysis and Downstream Hazard Classification
 - Selection of Design Performance Goals for Critical Project Elements
 - Design Storm Construction
 - Guidelines
 - Dam Design and Construction
 - Technical Tools

- Hydraulic Computations for Open Spillways and Riprap-Lined Channels
- Hydraulic Computations for Drop Inlet Spillways

5.3. Disclaimer

Similar to the Dam Safety Journal, the TKB should include a standard disclaimer about its use to limit liability of the organization. An example from the ASDSO Journal of Dam Safety is provided below which could easily be adapted for the TKB:

“The material presented in this ASDSO publication has been prepared in accordance with generally recognized engineering principles and practices, and is for general information only. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. The contents of this publication are not intended to be and should not be construed to be a standard of the Association of State Dam Safety Officials (ASDSO) and are not intended for use as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document.

No reference made in this publication to any specific method, product, process or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASDSO.

ASDSO makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefore. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.”

6. Recommended Platform for the TKB

Three main options were considered as possible platforms for the TKB. While a fourth, “stand-alone” format was briefly considered, the obvious incompatibility of a “one-and-done” document with the need for the TKB to be a living document eliminated it from further consideration. The three options considered were: Wikimedia, custom website, and template-based website.

Wikimedia

A Wikimedia based format was investigated due to its open-source software and ease of deployment in addition to the ease with which revisions can be proposed and accepted. This approach follows the same one used for the popular website Wikipedia.org. The example EDRT conversion is an example of this format. It was set up by Taskforce member Jon Garton and populated by ASDSO intern Dominik Booth.

- Pros: “Plug-and-Play” - no custom programming required
Crowd-sourced editing - any registered user can suggest revisions

- Editorial control - any proposed changes must be approved by an editor
- Collaborative environment
- Distributed editorial review capability
- Relatively easy to learn - many on-line tutorials available
- Maintains complete history of the website - easy to revert to previous versions
- Automatically generates a table of contents
- Built-in search function
- Least expensive option

Cons: Format isn't as engaging
Potential overload for editors if many revision suggestions are made

Custom Website

This approach would be similar to the DamOutletWorks.org website. It could also be compared to the old "Resources-by-Topic" page from previous editions of the ASDSO website.

Pros: Customizable format - most flexible option
Fancier 'look and feel'
Format may be easier to navigate / user friendly

Cons: Cost for Web Developer / Outside expertise
Likely the most expensive option for initial development
Less likely to be frequently edited/revised
More challenging editorial workflow
Demand on ASDSO Staff Resources to perform updates

Template-Based Website

This approach would be similar to DamFailures.org website and portions of the current ASDSO website. Potential platforms that could be used include Wordpress and Drupal.

Pros: Less expensive than custom website
More engaging/user friendly format than wiki
Establish a similar format to other ASDSO websites that users are familiar with

Cons: Less flexible than a custom website
Less likely to be frequently edited/revised
More challenging editorial workflow
Demand on ASDSO Staff Resources to perform updates
Training for Editors likely required

Each of these options could be incorporated into the existing ASDSO website. They could be accessible on either the public facing site, or within the 'members only' section.

Based on the pros/cons of these three options, it is the Taskforce's recommendation that Wikimedia be utilized as the platform for the TKB due to the ease of deployment, ability to "crowdsource" revisions from all users, and a more efficient review and publication workflow that places fewer demands on ASDSO staff.

7. Project Scope and Estimated Level of Effort

The need for a TKB has been demonstrated, and the benefits to the organization and the dam safety community are apparent. Hence, it is recommended to begin development as soon as reasonably practical. In order to become the industry standard as the "go-to" source for technical information related to dam safety, the quality of the TKB must be a high priority. Holding quality paramount, the time it takes and the cost to develop the TKB will generally be inversely proportional with adequate project controls. Rapid development will require simultaneous voluntary engagement of many professionals who are already busy with other projects. Devoting the necessary time to ensure a quality product will require motivation. On the other hand, a quality product could still be developed on a volunteer basis at low cost, but it will take longer to develop.

No matter what approach is taken to develop the TKB, the task force recommends that content be developed in a phased approach.

Phase I Develops the organizational structure and basic content outline, establishes a style guide, sets up review and publication procedures, and populates the outline with publications already accepted as industry standards (e.g.: Reclamation, USACE, FEMA, and other published documents). This is illustrated in the Outlet Works topic outline. Placeholders for future topics should be included with notation that the topics are earmarked for future development ("Under Construction"). Identify 2-3 states with existing tools and guidance that may be of interest to others to set up State specific pages.

Phase II Adds commentary to the basic topics in the outline, and reviews more recent documents/publications that may not have wide acceptance in the industry yet. Review of these newer documents would be performed by the topic editors, who could add notes and commentary on the landing page leading to the reference. This might include documents like the Western Dam Engineering Notes.

Phase III Allows all states to create their own page in the TKB with guidance specifically related to their dam safety programs, using lessons learned from States that set up pages in Phase I. This could include Rules, Policies and Procedures, Guidance Documents, and dam safety related tools such as spreadsheets, inspection templates, or other information relevant to engineers tackling similar issues.

Phase IV is the maintenance phase, where the TKB content is reviewed at a regular interval. New standards can be incorporated as they become available, and old material that has become dated and is no longer accepted as industry-standard can be removed or appropriate caveats added warning users about known issues.

[EDRT-Wiki conversion example](#)

As ASDSO staff assisted with the pilot project to convert the EDRT into the wiki based format, hours working on the project were tracked. Dominik Booth, ASDSO Intern, reported that he put 8 hours into conversion of the Embankment Dam section of the EDRT into the Wikimedia format. He estimated that a week's worth of time would be required to convert the remaining balance of EDRT into wiki format. This is for material that is already compiled and merely needs to be converted to the wiki format.

Dominik reported that the formatting and "language" of Wikimedia is relatively easy to learn. There are many on-line resources including tutorial videos available for virtually any aspect of the Wikimedia format that is needed.

As mentioned above, original development of EDRT was funded by the states of Montana and Wyoming through their federal assistance grants. The cost to those states for the initial effort was approximately \$20,000. However, it is believed the consultant put more effort into the project and donated a significant amount of labor to complete. The update to the EDRT published in 2014 had a similar cost, bringing the total for development of that project to \$40,000.

DamFailures.org website example

As a point of comparison, the cost to develop the initial DamFailures.org website (not including content) was on the order of \$30,000, funded by FEMA and performed by Gannett Fleming. The total cost of the project included development of the initial ten case-studies and lessons learned, and was a more expensive effort requiring research and peer review with a total budget of \$215,000. The project was completed within a year. After its initial development, the website has been relatively inexpensive to operate. Managed by the DFIC, about 6-10 new case studies and lessons learned are added to the website every year. Content developers are offered a small stipend of \$1,500 per topic as compensation. The stipends have been funded by FEMA with a budget of \$10,000/year.

Estimated Schedule and Budget

The level of effort required to develop a TKB depends on the platform chosen. Because the task force recommends that Wikimedia be selected, the estimate presented here is based on that platform. The committee believes that the initial Phase I development is the biggest hurdle, and it is the only phase of development described here. Once the site is up-and-running, it is believed that a voluntary committee could further develop and maintain the TKB.

Volunteer-led

The task-force believes that ASDSO membership has the expertise and willingness to develop the architecture and content of the TKB on a volunteer basis. This would likely require that either an existing committee add this responsibility to their charter, or a new committee be created whose only responsibility is the development and management of the TKB. There will be sufficient workload that a new committee may be most appropriate.

As mentioned above, this approach would be inexpensive for the organization, but would require more time to develop. The first step would be to formulate the basic outline of

topics and put out a call for volunteers to join the committee and develop content. As currently envisioned, each main topic would require a sub-committee to share the load of topic organization and content development. The sub-committee chair would be the default editor for their section, reviewing and approving content for inclusion.

Consultant-led

Another alternative is for ASDSO to issue an RFP for consulting services with a scope of formulating the TKB and developing the basic level of content. Responsive firms would need to demonstrate mastery of the platform as well as in-house expertise on the subject matter for development. Review of the consultant's work could be performed by an existing committee with assistance from ASDSO staff. Although a specific budget for this project is difficult to estimate, the task force feels it would be a similar level of effort to the development of the EDRT, on the order of \$50,000 - \$100,000. Performance requirements could include a schedule for development to ensure that adequate resources are provided to perform the work in a timely manner. The scope of services could also be adjusted to fit the available budget.

Funding sources

Potential funding sources for the work to develop and maintain a TKB have been identified. Some options may not be available immediately, as the project is in development and contributors may want to see a proof-of-concept product first.

- Sponsorships - ASDSO could offer consulting firms or individuals the opportunity to sponsor a page/section of the TKB. Doing so would allow placement of a banner ad at the top of the page.
- An alternative to sponsorships would be to incorporate the "Industry Directory" into the TKB. Consultants and contractors alike could make a donation for inclusion in listing their contact info in their chosen area(s) of expertise. It is envisioned that this could serve as a resource for both dam owners looking to hire qualified consultants and/or contractors and also to consultants from smaller firms who may need to build a team with the expertise of a sub-consultant on a subject matter that they are less familiar with.
- Subject Matter Experts could volunteer as an editor of a page or section of the TKB to be listed as the page sponsor. A co-editor or tiered editorial structure could be provided to prevent pages from becoming too specifically oriented toward the page sponsors.
- Although not consistent with the recommendation that the TKB be a free resource, providing the TKB as a members-only benefit (behind the pay wall of the website), could provide motivation for non-members to join the organization, generating revenue through additional dues. This would lead to improving their overall competence and awareness of dam safety issues by gaining access to ASDSO training, newsletters, etc. A hybrid approach could also be explored where basic portions of the TKB are open to the public, but more advanced topics require membership to access.
- It may be an option to seek federal funding from FEMA. This could impose further restrictions on format and accessibility (e.g.: Section 508 compliance). If this requirement is known when starting the project, it should be relatively easy to accommodate. Difficulties arise when trying to retrofit an existing website for

compliance. Federal funding may also include requirements about accessibility - it may need to be available freely to the general public, and may restrict sponsorship by for-profit corporations. Federal funding may also impose contracting restrictions, but those would likely be easily accommodated. Timing of FEMA funding may also be a problem, as FEMA prioritizes projects for funding one or more years in advance.

- ASDSO could consider applying for a National Science Foundation (NSF) grant. In general, NSF grants tend to favor Universities, so for this approach ASDSO may need to find an educational institution to collaborate with. However, one of the directives of the NSF is to increase educational awareness of key public policy issues <https://www.nsf.gov/eng/about.jsp>. A strong argument could be made that the benefits of the TKB fit the guiding principles of the NSF. There may be some strategic partnerships that could be forged to utilize this funding stream. The work could be led by the civil engineering department at a university with a strong dam safety program such as the State University of New York or the Stanford National Performance of Dams Program. Other organizations such as the “Hydropower Research Foundation” may also be willing partners.

8. Schedule for Development of the Technical Knowledge Base.

Given the clear need for the TKB, the task force recommends that ASDSO begin pursuit of this effort as soon as possible as a high priority. It is understood that the board must manage all organizational goals within existing budget constraints. To that end, the schedule and budget described above should provide the board flexibility in selecting the most suitable path forward.

The first phase of development could be completed within a year if consultant-led, or within 2-3 years by a volunteer-led effort. Much of the material that would be incorporated during the first phase of development is readily available and can be easily added to the TKB with minimal commentary needed. If budget for a consultant-led project is available, the first phase would likely make more progress than a volunteer committee. Once complete, the first phase would serve as a proof-of-concept that may be needed to generate more interest in the project and open up additional funding options.

The second phase of development would likely take longer, as the materials are more scattered and less widely accepted and will require more thorough review and vetting prior to inclusion in the site. It is expected that by this time, enough interest would be generated from the membership to create a full standing committee to guide and produce the project. This phase is envisioned to take 2-3 years to develop by the volunteer committee. Alternatively, if the proof-of-concept TKB generates sufficient interest that it is beginning to generate revenue, that revenue could be used to contract with a consultant to more fully develop the site.

By the time the TKB development reaches its third stage of development, it is expected that it could be managed solely by a volunteer committee. This phase would create the option for states to add their own relevant information to the TKB. Since this step is voluntary and not required, it can be done in an ad-hoc fashion without the need for schedule constraints. As this section of the TKB grows, it is expected that other states will see the benefit and add information relevant to their state as they see fit.

9. Estimated level of effort and schedule to maintain the Technical Knowledge Base.

Once the TKB is developed through the third phase, it would enter into a fourth and final or maintenance phase. It is envisioned that this phase would be led by a volunteer TKB committee consisting of the editors assigned to each main topic area within the TKB. Each topic area covered may require a sub-committee with multiple individuals to contribute.

It is anticipated that the volunteer TKB committee would develop timeframes for regular review of content to ensure ongoing relevance and consistency with the state of practice. This is expected to include at least an annual review, and a more in-depth review on a less frequent basis, perhaps once every five years. In-depth reviews could be opened up to include more of the membership to ensure a broad cross-section of industry experts are able to provide input. One of the benefits of a wiki based platform is that users can review and suggest revisions as needed, on an ongoing basis, thereby distributing the workload.

Website analytics could be used to identify higher-use areas of interest and how they might evolve over time to help focus efforts of the editorial process.

10. Recommendations for participants in developing the Technical Knowledge Base

In order for the TKB to be established as a high quality resource on dam safety topics, it will need contribution from recognized industry leaders and subject matter experts who will be responsible for review and approval of its contents. This will require a framework that requires peer reviews and vetting of referenced materials prior to inclusion. Documentation of the review process should be included on the website to ensure transparency of the review process. This may include listing documents that were considered for inclusion but were not ultimately added along with a list of reasons why they were excluded. Explaining the exclusion transparently would likely eliminate some suggested topic revisions.

Based on the level of interest from industry leaders, it may be necessary to implement some level of screening or interview process for topic editors. Panels of experts may also be engaged to perform peer reviews providing a system of ‘checks and balances’ on the topic content. Resumes and/or Brief Biographies of editors could be provided on their topic pages.

11. Recommendations on potential alliances with other organizations to promote the TKB

Partnerships with other dam safety and civil engineering organizations should be pursued to assist with the development and maintenance of the TKB and to avoid development of competing efforts. This includes dam safety-specific organizations such as USSD and ICOLD, in addition to more general civil engineering organizations such as ASCE. While ASCE may have less focus on dams, their membership includes experts in many technical fields that are directly related to dams.

The civil engineering industry as a whole is diverse and many partnerships could be forged by leveraging the TKB to demonstrate that the standard of care can be established in a single location. It is envisioned that the TKB could serve as a model for other industry topics to follow and confirm ASDSO as a leader and valuable partner in the industry.

As mentioned above, the development of the TKB could be a significant step towards developing a curriculum for a certification process for engineers. Similar to Medical Doctors receiving ‘board certification’ in their area of practice, this credential could prove beneficial

to dam owners seeking the services of professional engineers qualified to perform the specialized type of work required to safely maintain, operate and construct a safe dam. The prospect of certification is not new and is also being explored by USSD. Collaboration between the two organizations towards this common goal is recommended.

12. Next Steps

The next step towards a TKB is for the ASDSO board to decide the best path forward and establish budget and schedule criteria for the project. It is expected that this may result in chartering a new committee or revising the charter of an existing committee to lead the effort. The members of the TKB Task Force stand ready to assist with the next steps as needed.

Respectfully submitted for your consideration - The ASDSO TKB Task Force

Attachment - Outlet Works Topic Outline and Structure for TKB

Note to reviewers: Red italics notes are intended to provide additional background and context. The general structure for this example topic is to have 5 main categories, Basics, Components & System Integration, Rehabilitation/Replacement, Operation and Other.

Outlet Works: Basics *This would be the equivalent of Outlet Works 101, a more skilled engineer would bypass this section; propose to use annotated photos instead of drawings, keep content high level and reference ASDSO webinars. Initial TKB efforts should be focused on engineers that are beyond the basics. However, the TKB would be incomplete without a "101" section, so this would be tackled in a second phase*

- [ASDSO Webinar on Outlet Works by Joe Monroe](http://damsafety.org) <http://damsafety.org>
- Terminology (*use a general outlet works drawing annotated with terminology*)
- General Components (*we could get into a lot of detail here, recommend this stay upper level*)
 - Intake Structures
 - Low level
 - Drop inlet
 - Conduits
 - Materials (concrete, steel, HDPE, PVC, etc.)
 - Location – low level, high level (overflow)
 - Terminal Structure
 - Gates/Valves (*general descriptions – several annotated photos*)
 - Control
 - Center Control
 - Upstream control
 - Downstream control

Outlet Works: Integration into Dam & Reservoir as a System *There are many disciplines that feed into each item and all must be integrated into an adequate design. It's generally up to the Engineer of Record (EOR) to coordinate into one cohesive functional system. Projects addressing one issue may have ramifications on other parts of the system. A challenge of the TKB will be to cross reference topics with each other.*

- 3 Core Requirements of Every Dam
 - Pass the Inflow Design Flood
 - Principal Spillway
 - Auxiliary Spillway
 - Reservoir storage
 - Overtopping (if designed for it)
 - Fuse Plug
 - Control the reservoir at Normal Pool
 - Drop inlet
 - Overflow pipe
 - Gated control (non-passive reservoir control)
 - Facilitate Rapid Drawdown when needed
 - Low level outlet
 - Pumps (*rare, but possible*)
 - Siphons
 - Stoplogs

- Disciplines – Cross reference to each topic above and system integration
 - H&H
 - Structural
 - Geotech/Geology
 - Mech/Elec
 - ...

Outlet Works: Components *This section is targeted for a more experienced state dam safety engineer who needs detailed information on a particular topic. Each subtopic would reference external documents and/or case studies for information. This section will rely heavily on FEMA best practices manuals)*

- Gates
 - Types ([Add Reference here; USBR, NRCS](#))
 - Design ([Add Reference Here](#))
 - Strengths ([etc.](#))
 - Limitations
 - Seating head/non Seating head
 - Limit nuts
 - Operation
 - Stems
 - NOTES & CONSIDERATIONS *Each subsection should have a section where information not found in references is located; state resources could be referenced here*
- Valves
 - Types
 - Design
 - Strengths
 - Limitations
 - NOTES AND CONSIDERATIONS
- Conduits and Penstocks
 - Materials ([FEMA Best Practice Manual - Conduits](#))
 - Hydraulics
 - Structural Aspects (lifelines, thrust blocks etc.)
 - NOTES AND CONSIDERATIONS
- Tunneled Outlets *Reference to Geology Section*
- Control
 - Upstream control
 - Hydraulics
 - Types
 - Downstream control
 - Hydraulics
 - Types
 - Emergency bypass
 - Center Control
 - Hydraulics
 - Types
 - NOTES AND CONSIDERATIONS
- Intake Structures
 - Low level Intake

- High Level Intake
- Multilevel Intake
- Drop inlet Structures
- NOTES AND CONSIDERATIONS
- Downstream Energy Dissipation (FEMA best practice manual) *For topics where there is a comprehensive best practice manual, one consideration is to not break it down in the TKB, rather direct the user to the best practice manual. The FEMA energy dissipation manual is a great example of this.*
- Gate Operators
 - Mechanical
 - Electrical
 - Hydraulics

Outlet Works: Rehabilitation/Replacement *This section would be targeted towards the state dam safety engineer that is reviewing a design submittal and needs resources and information to help them with their review. This will be the most challenging section to develop. Primary references will be NRCS documents, the dam outlet works.org website but other federal documents would be referenced as well). State developed references would be of use here.*

- Existing Condition Evaluation (damoutletworks.org – focus)
- Rehabilitation
 - Slip Lining – Solid Pipe
 - HDPE
 - CIPP
 - Other
 - Internal Sleeves and Bands
 - Seepage Control
 - Filter Diaphragm requirements (link to other part of TKB)
 - Construction Considerations (link to other part of TKB)
 - Dewatering
 - Cofferdams
 - NOTES AND CONSIDERATIONS
- Replacement
 - Plastic Pipe
 - PVC
 - HDPE
 - Other
 - Concrete Pipe
 - Precast
 - Cast in Place
 - Steel
 - Other Pipe
 - Pipe Bedding, Encasement, Cradles
 - Concrete
 - Plastic
 - Steel
 - Other
 - Seepage Control

- Filter Diaphragm requirements (link to other part of TKB)
- Incorporate into chimney filter
- Construction Considerations (link to other part of TKB)
 - Dewatering
 - Cofferdams
- NOTES AND CONSIDERATIONS

Outlet Works: Operation *This section needs to be included in order for the TKB to be complete but is a lower priority to be completed in a later phase.*

Outlet Works: Other *There will always need to be an “Other” section to capture unique things that State Dam Safety officials deal with. A few examples include 1) internal inspections: how often, and what to look for), 2) Potential Failure Modes related to outlet works.*