

Evaluating the Health of Aging Irrigation Infrastructure on a Statewide Level

Issue Framing

Problem

A large portion of irrigation infrastructure in the West is upwards of 50 years old. Prior to failure of structures, it would be beneficial to states to have priorities and cost estimates for the repairs and replacements water managers will eventually face. This will allow states legislatures to leverage or set aside funding to help with the cost of repairs.

- This problem is twofold. States first need good methods for assessing the structural integrity of existing irrigation infrastructure.
 - Ideally, assessment instructions could be sent out by the state to individual irrigation districts and companies (etc.) to be completed and then sent back to the state.
 - Assessment practices need to be straightforward and subjective enough that an engineer does not need to be hired.
 - Assessment information collected should identify critical infrastructure to inform how the funding for projects should be prioritized.
- Once the necessary information has been collected, states then need to know how to prioritize funding for the projects.
 - This is the trickiest bit. Do states prioritize small projects or large ones? Is the size of the project defined by the cost of repairs, by the number of acres served by the system, or the number of people that use that system? Larger irrigation districts usually have bigger water projects that serve more acres and more people, but they also usually have more resources from which to procure funding.
 - Or perhaps water projects are prioritized by their services. Does the infrastructure serve to water crops or provide household living needs? What kind of crop does the water go toward and should projects be prioritized that way? What about large transport systems that serve multiple kinds of uses?
 - Should an arbitrary method be used like first come first serve?

It is also important to note that different states talk about the replacement of their infrastructure differently. While agriculturally dominant western states are simply focused on keeping their infrastructure functional (California being the exception), the rest of the states are currently focused on supporting water efficiency efforts. In these states, priority for funding goes to those projects that can show that they are conserving water. Much western water infrastructure is so old however, that any updates or replacements to the system will likely result in more efficient water use. Though the focuses and the way the problem is being talked about are different, the topic throughout is the replacement of irrigation and water infrastructure. It is important that western states realize this as they consider how to assess and prioritize infrastructure replacement. Conservation focused states may be able to provide applicable examples of how to assess and prioritize water projects.

Methods

In order to get a grasp on how states are assessing their irrigation infrastructure needs, I reached out to the water departments of 10 states. I used individual contacts that were given to me by Sue Lowry, the current president of ICWP. The contacts were her personal acquaintances. With most of these contacts, the goal was that they could get me in touch with the best person within the department. With the exception of Idaho, I received responses from all the states and was able to glean at least some preliminary information. Email and phone communications were supplemented with internet research.

Template for Initial Email sent

Subject: Irrigation Infrastructure Assessment

Dear Amy,

My name is Kimber Logan and I am doing some research for the Interstate Council on Water Policy (ICWP). I got your contact information from our president Sue Lowry. I know you work with *interstate compliance issues*, so I don't know how much you will know about this topic, but I'm hoping you will be able to point me in the right direction.

ICWP is trying to put together a document on different state Existing Irrigation Infrastructure Assessment Practices. The goal is to end up with a shared product that gives states ideas on how to best assess the current health of their irrigation infrastructure, without having to call in an engineer. The need for something like this became apparent to ICWP a few years ago when a major shared irrigation pipeline between Nebraska and Wyoming broke without warning (the Goshen canal). The emergency repairs cost \$4 million, and the reciprocal economic loss was estimated to be around \$15 million. If better assessment procedures had been in place, the idea is that the irrigation district would have had more warning and would have been able to come up with a proactive solution that was not so costly.

Can you point me in the direction of where I can find information on the methods *CWCB* uses to evaluate the structural soundness of its existing irrigation infrastructure? For example, information on how repair projects are prioritized, or what signs and symptoms need to appear for entities to qualify for repair funding. Is it common practice for individual irrigation entities to employ engineers to inspect irrigation infrastructure?

Again, I'm not sure who the best person would be to talk to about this, but I'd appreciate any help you can give me. I am available to talk on the phone or over zoom if that would be a better way to communicate. Thank you so much for your time.

Sincerely,
Kimber

Key Resources

- [Priority Rating System for Asset Inventory and Assessment Grants](#) from North Carolina
 - These documents lays out guidelines for how to prioritize funding applications
 - It takes a specific approach, assigning point values to certain aspects of an application. Projects with the highest point values are given priority.

- [Technical Assistance Prioritization Matrix](#) from North Carolina
 - This matrix lays out an example of the different priority levels assigned to different kinds of projects
 - It is a descriptive approach that is more general in nature but provides enough guidelines to at least categorize different kinds of projects.
- [Colorado Ag Producer Survey of Infrastructure Needs](#) Colorado Cattleman's Association survey of agricultural producers to better understand their irrigation infrastructure challenges and needs.
 - The problem: in many watersheds – particularly in the mountains – much of the irrigation infrastructure is not in fully functional condition. Some of the infrastructure is a century old or more and needs repair or replacement.
 - Improving irrigation system components – especially surface water systems – can benefit other water interests, like goals of supporting healthy watersheds, robust recreation and tourism, vibrant and sustainable cities, and viable and productive agriculture.
 - A majority of respondents indicated that on-farm efficiency improvements represented their greatest irrigation-related need. This was followed closely by improved control of infrastructural delivery components to the field edge or across the field, such as headgates or lateral ditches. Other needs included well and / or pump improvements, field leveling to irrigate crops or pastures more evenly, and more labor or automation to reduce labor.
 - Regarding off-farm irrigation *delivery* needs, 48 percent of producers listed lining or piping ditches as the greatest priority. Slightly more than a third (36 percent) said their diversion structure needed improvement.
 - The report addresses barriers to irrigation infrastructure projects.
 - A key question asked was “Would a low-cost or no-cost irrigation system assessment be useful if it identified potential solutions?”
- [North Fork of the Gunnison River Irrigation Management Plan](#) in Colorado
 - This report focuses provides assessment methods and an evaluation matrix for irrigation infrastructure on a 35 mile river reach. The goal of the overall report is to improve irrigation infrastructure efficiency. This goal is equivalent to that of replacing aging and broken infrastructure.
 - Irrigator needs were identified in two ways: through interviews with ditch board members and water users and through a brief river infrastructure assessment focused primarily on the diversion infrastructure
 - The efficiency of an irrigation diversion (system efficiency) is the measure of diverted water consumptively used for crops as a percentage of the total water diverted for irrigation.
 - Preliminary cost estimates were provided for potential improvements to provide a sense of scale and to help identify which projects may be fundable. Once practical potential improvements were identified, they were ranked with a relative priority scale.

- [Olesen Ditch Inventory](#) in Eagle County, Colorado
 - This report is a part of the Eagle County Conservation District's efforts to conduct an irrigation asset inventory. It provides an example of an assessment technique.
 - The evaluation is specific and technical and includes a piece-by-piece inventory of the ditch's features and their current condition.
- [Irrigation Conveyance Evaluation](#) project, conducted by Dr. Fipps at Texas A&M
 - The project combined a series of methodologies or components designed to provide a quick and cost-effective analysis of the conditions and operational performance of an irrigation district and the distribution network.
 - This work developed a detailed infrastructure condition GIS which is fully documented on the web site.
- Nebraska
 - In 2021 the NE legislature set aside \$50 million to address NE's aging infrastructure.
 - This project is mid process. So far, a survey was sent out to the state's 60 irrigation districts. It asked about infrastructure needs and what kind of system the district was operating. Responses were only received from about half of the irrigation entities. The survey questions are as follows:
 - *Name of Delivery Provider:*
 - *Type of Organization: irrigation district, canal company, or other*
 - *Water diverted from (name of river or stream):*
 - *Project:*
 - *Estimated year project was built:*
 - *Headgate:*
 - *Flume:*
 - *Return structure:*
 - *Other:*
 - *Has the main canal been rebuilt, reshaped, cleaned out &/or rehabilitated? Please explain:*
 - *What are your current sources of revenue or other funds:*
 - *What potential sources for funding are you aware of:*
 - *What are your current rehabilitation needs:*
 - *In what order of priority would you list your rehabilitation needs:*
 - *What is your estimated cost of your rehabilitation needs:*
 - *Any additional information:*
 - The survey is being followed up with regional meetings. The purpose of these meetings is to inform irrigation entities of the Nebraska DNR's intentions and gather more information about entity needs.
 - It is expected that the focus of the funds will go toward smaller entities. Highest priority will be given to "critical infrastructure." These are the projects that need to be completed or else the entire operation will fail. Making systems more efficient will be of secondary priority.
 - Once the funding system has been established an application process will be created. NEDNR's goal is to keep this process as simple as possible so that

people can apply relatively easily, making the funds more available to the smaller irrigation entities. Ideally, funding will be distributed to a wide variety of entities.

- [Preliminary Inventory of Irrigation Infrastructure](#) from Montana in 2009
 - “The purpose of the inventory is to provide . . . an understanding of the condition of existing irrigation systems throughout Montana and an estimated cost of completing necessary improvements. Many irrigators, agency personnel and others recognize that there are irrigation systems throughout the state that are in poor condition. Because irrigated agriculture is of significant value to the state economy, the Montana State Legislature has directed the DNRC to investigate the extent to which the State’s irrigation systems require repair.”
 - This inventory included four main components:
 - [Summary of Existing Information](#) - describes the condition of the United States Bureau of Reclamation irrigation projects in Montana, and irrigation projects owned by the State of Montana and operated by the DNRC
 - The Bureau of Reclamation serves over 365,000 acres of irrigated land in MT. The investigation revealed that there are some major issues with a few of the USBR projects.
 - The State-owned projects include ten canal systems that include approximately 250 miles of canal and twenty dams that deliver over 293,000 acre-feet of water.
 - [Mail survey sent to irrigation water supply organizations](#) - obtained a list of irrigation water supply organizations, developed and mailed out a questionnaire, and compiled the responses.
 - The survey was sent to 229 irrigation water supply organizations and replies were received from 81 of those recipients.
 - Approximately one-third of the respondents indicated that one or more components of their irrigation systems are impaired.
 - The biggest hurdle was the fact that many of the operators are also farmers and ranchers, and they are very busy people. Relatively few of the State’s water supply organizations have full time employees whose sole responsibility is operation and/or management of the system or company.
 - [On-site evaluation of 10 irrigation systems](#)
 - An effort was made to choose systems in various locations and of various sizes.
 - The intent of the physical evaluations was to help determine if the responses to the mail surveys were accurate. Detailed system analysis was not the intention.
 - Eight out of the ten sites that were visited exhibited noted impairments. The on-site evaluations indicated that the mail survey responses might be *understating* the incidence of infrastructure impairments.
 - [Development of a Geographic Information System database](#)

- The database includes locations of all the ditches for the systems that either responded to the mail survey or were physically inspected. In addition, the locations of all USBR and State-owned projects are included.
 - This could be a useful tool to help prioritize funding decisions and answer questions about the state's existing irrigation infrastructure.
- The goal of this project was to assess the general condition of irrigation infrastructure in Montana and arrive at an estimate of the amount of money needed to bring the state's irrigation infrastructure to full operating condition. Based on the information gathered in the survey, it is estimated that \$343 million is needed to repair all the irrigation infrastructure associated with private systems, irrigation water supply organizations, USBR projects and State-owned projects. It is recognized that several Bureau of Indian Affairs projects are also in need of extensive repairs; however, cost estimate information for these systems was not available for use in this inventory
- This report is very good at laying out its methods and identifying best practices. Some examples:
 - "When the survey was developed, it seemed pertinent to know about the composition of the irrigation systems, e.g. the type of materials in the diversion structures, but this information is probably less important than it originally seemed because while a large amount of data were generated, it did not help identify infrastructure problems. *The questions regarding the performance of the system components were more to the point of this study.*" (emphasis added)
 - "According to the superintendent, the system works adequately during high flows and the trashrack keeps most debris away from the headgate structure. However, the trashrack appears to be in bad condition and needs to be replaced in some sections. For example, the concrete piers are cracking and the middle support is almost destroyed. The wooden planks used to access the structure are in need of replacement and not structurally sound. Several steel pipes are rusted out and no longer effective."
- Siphons and flumes were the infrastructure components most commonly identified as needing repair or replacement.
- This investigation did not reveal any common theme among the systems that are in need of major repairs. *While age of the systems can be a factor in infrastructure condition, there did not appear to be a direct correlation between advanced age and poor condition among the systems included in this study.* Additionally, location within the state did not appear to be a factor as no geographic pattern in system condition was evident. Small systems and large systems each present challenges and advantages so size does not seem to play a particular role. Possibly further investigations would reveal some type of pattern that could be used to assist agency personnel and other decision makers.

- Things to consider when prioritizing funding
 - The costs associated with fixing the problems on some systems are much higher than what the water users can afford to pay.
 - Another item to consider is that the value of irrigation systems often goes beyond simply the value of the crops that are irrigated. Most of the irrigation systems around the state have been in existence for several decades and some have been around for a century or more. Ecosystems have developed in conjunction with the artificial presence of water.
 - A problem at or near the beginning of a ditch system which would render most or all of the system inoperable would be considered a higher priority than a problem near the end of the ditch. The potential for irrigation infrastructure failure to cause damage to other structures or to the environment is another important factor to consider.
- Irrigation System Survey Report for the State of Wyoming in 2021
 - This is the most recent report for the statewide inventory of irrigation infrastructure. The attempts to receive answers for this report were a little more aggressive and the questionnaire a little more robust this year. The response rate was about 50%.
 - The survey asked entities to identify structures and conveyances under their care by type (e.g., lined main canals, lateral pipelines, main flumes, secondary pump stations, etc.) and provide information about their age and condition. They were also asked about the status of dams and reservoirs, as well as anticipated projects.
 - Conveyances and structures were classified by irrigation system size: large conveyance facilities of 200 cfs or greater; medium conveyance facilities of 100-199 cfs; and small conveyance facilities of less than 100 cfs.
 - This report found that conveyances tend to be older than structures, which implies that conveyances do not need to be replaced as often.
 - The condition of conveyances and structures by irrigation size shows that the majority (58%) of large conveyances were reported as being in fair condition.
 - Nearly half (47%) of the reported miles of conveyances in medium-sized systems were reported as being in poor or very poor condition.
 - Small irrigation systems reported the greatest proportion (51%) of conveyances in good or very good condition (Figure 3a).
 - Structures: a large portion (73%) in medium-sized irrigation systems were reported as being in very poor condition, whereas the largest portion in large (51%) and small (30%) irrigation systems were reported as being in good condition (Figure 3b).
 - *So it looks like bigger systems do get more attention. And smaller systems are easier to take care of. Struggling the most with medium sized systems.*
 - Reservoirs:
 - Most reservoirs (47 of 54) were reported as being in fair or better condition.

- Those reported in poor or very poor condition ranged in size from less than 500 acre-feet to 100,000 acre-feet.
- For all planned projects that included a cost estimate (142), the total cost is anticipated to exceed \$173 million, of which about \$93 million of state funding is anticipated (Table 3). Most projects (106) are anticipated to occur within the next 5 years, but 34 projects are anticipated to occur between 6-10 years from the time the survey was completed.

Results

- **Most states have not attempted to assess irrigation structures statewide. It is left to irrigation districts or individual river basins to assess their own needs.**
- Different states have different goals for their infrastructure.
 - Eastern states are concerned with replacing infrastructure to increase water conservation.
 - Western states are concerned with replacing infrastructure that is old and deteriorating.
 - Though talked about differently, everyone is looking to create efficient water transfer systems.
 - The irrigation focus is much smaller in the East than the West.
- Ag focused states in the West are very interested in how to address aging infrastructure.
- Colorado has broken down its water management by major river basins. Each basin performs its own assessments to determine its needs, and coordinates with individual ditch and irrigation companies. Each basin is responsible for accumulating its own funding, for some of which it may apply to the state.
- **Nebraska is running a pilot program to try and assess aging infrastructure needs across the state. This program should be watched as it progresses.**

Further Research

- Get ahold of Montana!
- Watch Nebraska as it progresses with its pilot program.
- Look into North and South Dakota, Idaho, New Mexico, Arizona, and Utah.
- Read carefully through the documents in the Key Resources list and create recommendations for how (1) how the structural health of irrigation infrastructure should be assessed, and (2) how irrigation structural projects should be prioritized.
 - Likely this project would consist of making two lists: (1) of all assessment practices come across, and (2) all the different factors funding for projects can be prioritized by.
 - From these lists, recommendations of best practices can then be made.