

EXECUTIVE SUMMARY

A. Background and Need

The South Fork Tolt Dam (Tolt Dam) is a large dam owned by the City of Seattle that supplies 30% of the water to the Seattle metropolitan area. The dam is 14 river miles upstream of the City of Carnation, WA (population 2,158). In the remote event that there is a major incident or failure of the dam, the City of Seattle owns and operates a warning system (commonly referred to as the Tolt Early Warning System) that includes seven audible outdoor sirens that would be activated to warn and trigger evacuation of the downstream inundation area, including much of the City of Carnation. If a failure occurred, there would be at least 1.5 hours until the leading edge of the flood wave arrived at the City of Carnation.

Over the past several decades, the sirens have been tested weekly on Wednesdays at noon. However, over the past five years, the sirens have also broadcast several unplanned soundings and false alarms. This began on July 28, 2020, when the siren system activated announcing that the dam had failed and that everyone needed to evacuate. Chaos resulted as people tried to evacuate, and roads became clogged. Many people had feelings of fear and doom. As the sirens continued to blare, City of Carnation officials were not able to verify whether the dam was failing or not. Once verified as a false alarm, operators were still unable to turn the sirens off. The siren system issued this false alarm continuously for 38 minutes. The event traumatized many in the community and has had lasting emotional impacts on some residents.

In response to this 2020 false alarm event, the City of Seattle accelerated a siren replacement project that was initiated in 2016 and was already well underway. The construction, installation, and testing of the new siren system resulted in additional unplanned soundings of both the old and new systems. This continued until March 27, 2024, when the new system experienced an unplanned sounding. At this point, the old siren system had already been permanently decommissioned. Following this March 27 incident, the City of Seattle temporarily deactivated and isolated the new siren system, requiring manual activation by a human operator to sound the sirens.

On March 29, 2024, the regulator for the safety of Tolt Dam, the Federal Energy Regulatory Commission (FERC), instructed the City of Seattle to evaluate and implement alternatives to the existing siren system. In its letter, FERC noted that from all indications Tolt Dam was safe for continued operation. It was also noted that the siren system component of the Tolt Early Warning System both predated the project's FERC license as well as the prevalence of cell phones and reverse 911 alert systems. To quote FERC, "The current siren warning system does not appear to be consistent with standard of practice at other FERC regulated projects with similar public alert requirements and circumstances. The combination of the siren testing frequency and series of false alarm events has clearly become detrimental instead of beneficial to public safety." The numerous unplanned soundings and false alarms reduced trust in the Tolt Early Warning System and may have, by extension, reduced trust in the safety of Tolt Dam.

In response to this letter, the siren system was turned off. In the absence of the siren system, alternative methods (such as ALERT King County, Wireless Emergency Alerts, the Emergency Alert System, text messaging, TV/radio broadcast, reverse 911, and others) would be used by emergency managers to warn and evacuate the public in the remote chance of a major incident or failure of Tolt Dam.

On May 20, 2024, the City of Seattle committed to FERC to engage reputable industry experts to perform an independent assessment of the Tolt Early Warning System by June 2025. The independent team's collective experience and expertise would encompass:

- dam safety and risk,
- emergency management,
- public alerting and warning systems,
- human, organizational and operational performance, and
- public communication.

The Review Team consisted of a senior dam safety engineer, a warning specialist, a risk communication expert, and an engineer project manager with significant experience in dam failure consequence analysis.

This report is the result of the independent Review Team's work over a five-month review period. The team reviewed pertinent documentation and conducted interviews with representatives of the City of Seattle, the City of Carnation, King County Office of Emergency Management (OEM), King County Sheriff's Office, Eastside Fire and Rescue, NORCOM, FERC, the National Weather Service, the City of Duvall, Riverview School District, Carnation-Duvall Citizen Corps, Sno-Valley Senior Center, and Remlinger Farms.

B. Summary Findings

1. Tolt Dam

1.1 – The dam is continuously monitored, well-maintained, and safe.

- The City of Seattle is operating a sound dam safety program.
- According to recent dam safety assessments performed by independent consultants, Tolt Dam is well monitored and maintained. It is in good condition.
- The dam safety regulator (FERC) has standard of practice regulations for dam safety and is requiring the City of Seattle to follow those regulations for Tolt Dam.
- A recent dam safety comprehensive assessment estimated that the dam has an extremely small chance of failing (a 1 in 10,000 or 0.01% chance of happening in any given year) and assigned the dam a "moderate" risk classification. The risk assessment of the dam found it to be in satisfactory condition with no significant adverse conditions observed. Based on the findings of the assessment, the City of Seattle is performing studies to further understand or reduce risks for extreme seismic events.

- While continued monitoring of the dam and studies of potential vulnerabilities are warranted, the risk assessment concluded that the dam can continue to be operated normally. If higher risks were to be identified in future assessments, the City of Seattle would be required to take additional actions (e.g., investigations, repairs, changes in operation, or emergency planning efforts) to reduce risk within acceptable limits (FERC, 2015).
- The Emergency Action Plan for Tolt Dam was found to meet industry standards and federal requirements. It is being regularly updated, tested, and exercised.

2. Tolt Early Warning System

2.1 – There is a loss of confidence in the early warning system.

- Over-warning due to frequent tests, unplanned soundings, and/or multiple false alarms reduce the credibility of warning systems. In the case of the Tolt Early Warning System, some residents, public officials, and City of Seattle staff have expressed a loss of confidence in the associated siren system.
- This loss of confidence may hinder communication and timely response of the public during an actual emergency event. There is a need for continued community engagement, public outreach, and other efforts to rebuild trust.

2.2 – The early warning system is complex. High reliability cannot be guaranteed.

- The Tolt Early Warning System is inherently complex with multiple indoor and outdoor sirens, computer and manual remote activation options, multiple communication technologies, power supplies, dam monitoring equipment, and complex and frequently exercised testing protocols.
- The past unplanned soundings were caused by many different things including computer problems, water infiltration, maintenance (short circuit), confusion with a separate nearby siren system, human error, and operator ergonomics (unreadable display panel).
- Sound problems including too loud/too soft and garbled words have also plagued the system.
- The system complexity, commissioning problems, multiple unplanned soundings, and false alarms lead the Review Team to believe that it would be nearly impossible to prevent new mis-soundings and false alarms were the system to be put back in operation without significant simplifying modifications.

2.3 – Given modern warning technologies that are currently in place, the need for the siren system is questionable.

- The sirens associated with the Tolt Early Warning System are currently turned off. Other warning methods that are currently in place (such as ALERT King County) would be used in an actual event. These methods include wireless emergency alerts (text messages), radio and television broadcast, tone alert and weather radio, reverse 911 phone calls,

social media, and potential route alerting and loudspeakers by King County deputies or other first responders.

- These non-siren warning methods are considered to be a diverse and effective collection of warning channels, though special efforts need to be made to ensure residents who live the furthest upstream in the inundation zone where cell coverage is limited can be contacted.
- There are no federal regulations regarding early warning systems for dams. In a few instances, FERC has required a warning system to be installed where residences or other facilities are near the dam and response time is limited. This is not the case for Tolt Dam where the leading edge of a dam failure flood wave would take at least 1.5 hours to reach the City of Carnation.
- Given the decades long history of the siren system's existence and testing, some public officials and residents in and around Carnation believe that the sirens are necessary to protect the community.
- Sirens provide a more rapid initial warning than other available methods. However, given at least 1.5 hours before a dam failure flood would arrive, research shows that other methods would likely provide adequate warning without the sirens.

3. Roles, Responsibilities, and Teamwork

3.1 – There is confusion about who is responsible for warning and evacuation.

- For many decades, the City of Seattle has maintained and operated the siren system to warn people in and around the City of Carnation to evacuate in the remote event of a Tolt Dam incident or failure. While the City of Seattle does not provide on-the-ground response during an evacuation, the siren system instructs residents to evacuate, which implies that the City of Seattle has assumed decision making responsibilities for both warning and issuing evacuation recommendations.
- Within the United States, dam owners do not typically have any responsibility for evacuation or warning of the public. The Federal Guidelines for Dam Safety (FEMA, 2013) and FERC Engineering Guidelines (FERC, 2015) stipulate that, "Dam owners should not assume or usurp the responsibility of government entities for evacuation of people" except in cases where response time is extremely limited (which is not the case for Tolt Dam).
- The City of Seattle has for decades assumed some of the warning and evacuation responsibilities (with the siren system), which may have contributed to an overreliance on the siren system and a weaker state of readiness by the City of Carnation, which is still developing its own plan for evacuating people at risk.
- This unique situation has created confusion. Many stakeholders including public safety officials are not clear about who has the authority to issue an evacuation recommendation for the City of Carnation.

3.2 – Under state law, King County and the City of Carnation are responsible for warning and evacuation.

- The State of Washington delegates emergency management responsibilities to local (i.e., county or city) governments. Under the Washington Administrative Code (WAC 118-30) and the Revised Code of Washington (RCW 38.52), political subdivisions are directed to establish local organizations for emergency management which prepare and implement comprehensive emergency management plans for pertinent hazards that could impact local residents. These plans include warning and evacuation responsibilities.
- By law, the City of Carnation is responsible for emergency management within its incorporated limits. The City of Carnation has limited avenues to share information or warn its residents of a hazard apart from the Tolt Early Warning System. A community Facebook page and city website can be used to post information. In an actual emergency, the City of Carnation would rely on King County OEM and other regional partners to communicate warning information. They would rely on limited contract support from the King County Sheriff and Eastside Fire and Rescue to implement traffic control or evacuation.
- By law, King County is responsible for emergency management in unincorporated areas that would be impacted by a dam failure. This includes areas around the incorporated limits of Carnation including those residences that are furthest upstream and would be the first impacted in a dam failure scenario. In an emergency at Tolt Dam, the county would activate ALERT King County upon being notified by City of Seattle that there is a confirmed incident or failure of the dam.

3.3 – Current emergency management coordination efforts need improvement.

- Collaboration and coordination between local emergency managers and other stakeholders appear to have improved over the last few years.
- King County OEM regularly facilitates Zone 1 Coordination and Tolt Dam Regional Work Group Meetings.
- Some participants in these coordination meetings indicate frustration with a lack of accountability and results.
- Participation in the meetings is voluntary, and while King County OEM facilitates the meetings, they do not have authority to enforce actions or deadlines.

3.4 – Local emergency planning is improving but still needs work.

- The City of Carnation's Comprehensive Emergency Management Plan is being actively updated and improved. This plan provides an important framework for the City of Carnation to develop the tools and capacities it needs to effectively respond to an emergency. The City of Carnation also hired a part-time emergency manager in 2023 and developed Hazard Mitigation Plan Annex to the King County Hazard Mitigation Plan in 2025. The Annex was approved by Carnation City Council in June 2025.
- The latest version of the City of Carnation's Comprehensive Emergency Management Plan does not include a detailed evacuation plan for any of the identified hazards. The City

of Carnation has developed a pedestrian evacuation concept to move people to higher ground as well as evacuation driving routes within City limits, but more detailed and comprehensive evacuation planning is needed to come up with optimum strategies and plans for implementing those strategies.

- While the Comprehensive Emergency Management Plan is intended to address all hazards that could occur in the City of Carnation (e.g., wildland fires, riverine flooding, and earthquakes), the Review Team observed that the City of Carnation and its residents have placed a considerable focus on dam failure even though its risk ranking is lower than severe weather, flood, and earthquake hazards (City of Carnation, 2025). This is understandable given the attention, fear, and distrust that the recent Tolt Early Warning System false alarms have created.
- The responses of residents and staff during past false alarm events suggest that the City of Carnation lacks the resources and capacity to implement their plan, support emergency response, or issue warnings during an actual emergency. They would be heavily reliant on King County OEM, King County Sheriff, Eastside Fire and Rescue, and other regional partners.

C. Summary Recommendations

1. Establish Emergency Management Roles and Responsibilities in Accordance with Washington State Law

In order to establish a path forward for the Tolt Early Warning System and general emergency management in the region, local emergency managers and public safety officials must establish a unified understanding of agency roles and responsibilities. Both King County and the City of Carnation should acknowledge and coordinate responsibility for emergency management within their jurisdictions as required by law (see Summary Finding 3.2). This includes warning and evacuation responsibilities unless formally delegated to and accepted by the City of Seattle. The City of Seattle should focus its dam owner efforts on the safe operation and maintenance of the dam and transfer its warning activities in a responsible and deliberate manner to King County and the City of Carnation unless otherwise agreed upon. The City of Seattle retains the responsibility to assess the condition of the dam and provide notification and evacuation recommendations to King County, the City of Carnation, and other relevant emergency management agencies as outlined in the Emergency Action Plan for Tolt Dam.

Given this lack of alignment as well as past grievances, it may be difficult for all parties to implement the transfer of responsibilities and agree upon specific emergency management roles and responsibilities amongst themselves. The Review Team recommends that the City of Seattle engage an independent mediator experienced in government policies and law to help address these issues and lay the groundwork for improved coordination. Possible mediators include the State of Washington Emergency Management Division which provides planning assistance to local governments and emergency planners or the William D. Ruckelshaus Center, a joint effort of Washington State University and the University of Washington, which helps parties involved in

complex public policy challenges work together to develop shared solutions. At a minimum, participants should include the City of Seattle, King County OEM, and the City of Carnation.

The outcome of these mediation efforts should be a formal written agreement between all parties that outlines emergency management roles, responsibilities, and areas of collaboration in the region in accordance with state and local laws. Regional coordination meetings that are currently being facilitated by King County OEM should also continue with a greater commitment by all parties to accountability and action.

2. Invest in Local Emergency Planning and Preparedness during a Transition Period

While recent efforts have been made by the City of Carnation to improve emergency planning, additional work is needed. The City of Carnation currently lacks the resources and capacity to implement their Comprehensive Emergency Management Plan, support emergency response, or issue warnings during an actual emergency. As noted in Summary Finding 3.1, the City of Carnation appears to be in a weaker state of readiness in part due to the City of Seattle's long-term assumption of warning and evacuation responsibilities.

To facilitate the orderly transfer of warning responsibility to local authorities, the City of Seattle should provide short-term support to the City of Carnation in the form of financial or other resources. The intent of this support is to allow the City of Carnation an opportunity to develop additional emergency management capabilities to warn and evacuate its residents. Specifically, the City of Seattle should assist the City of Carnation in improving their Comprehensive Emergency Management Plan and developing:

- **Evacuation Plan.** More detailed evacuation planning is needed to come up with optimum strategies and plans for implementing those strategies. This should include a traffic study to guide the development of evacuation zones and routes and gain an understanding of the time needed to evacuate the area. Furthermore, evacuation plans should be developed based on an all-hazard approach. The current pedestrian evacuation plans focused only on dam failure are not a comprehensive strategy.
- **Communication Plan.** A communication plan and strategy is needed to keep affected residents informed and educated. In the event that another warning occurs, there should be multiple official sources where residents can go to obtain timely, consistent information about the emergency.

It would also be appropriate for the City of Seattle to support the addition of a full-time, professionally trained emergency manager to City of Carnation staff for multiple years, the extent to be negotiated during mediation. While it is not the City of Seattle's long-term responsibility to finance or support emergency planning and management within the City of Carnation, this temporary support can accelerate the improvement of the City of Carnation's capabilities and preparedness, thereby reducing the dependence that has been created by decades of reliance on the City of Seattle's siren system.

As new and improved emergency plans are developed, the City of Carnation should request the participation and technical assistance of King County OEM in order to strengthen collaboration and mutual support. Joint exercises should also be conducted to validate the City of Carnation's emergency plans and identify opportunities for improvement.

In addition to obtaining technical and financial support from others, the City of Carnation should explore other opportunities to enhance its internal emergency communication and management capacity. The City of Carnation ultimately holds legal responsibility for supporting its residents, and strengthening local capability in a manner that will endure without continued external support is essential for effective, long-term emergency preparedness and response.

3. Modify or Remove the Siren System

Changes to the Tolt Early Warning System are needed to reduce the complexity of system and address the loss of confidence. The detection elements of the Tolt Early Warning System have performed well and should be maintained by the City of Seattle, including the dam failure and incident detection equipment at Tolt Dam and the communication network which allows continuous remote monitoring of the dam. Problematic elements include the indoor and outdoor siren system in and around the City of Carnation as well as the complex and frequently exercised testing protocols.

At present, the decision whether to remove or retain the siren system lies with the owner and operator of the system: the City of Seattle. If the City of Seattle elects to decommission the siren system, there is justification for such an approach as outlined below. However, there is also justification to retain the siren system if the City of Carnation and/or King County were willing to accept ownership and operation as entities who are legally responsible for warning and evacuation of the public. It would be best if this decision was made after the City of Carnation has had time to develop more mature emergency management capabilities as described in Recommendation #2. While that capacity is being developed, it is recommended that the siren system remain disconnected and only non-siren warning methods be used.

When King County OEM and the City of Carnation are prepared to move forward, they should make a collaborative decision whether or not to adopt the siren component of the Tolt Early Warning System. In deciding which option to choose, the benefits of a siren system must be weighed against the cost of maintaining the sirens and the negative impacts of potential future false alarms on members of the community. The Review Team recommends that one of two options be implemented to improve reliability and decrease the complexity of the system:

- Option 1: Remove the Siren Component of the System – There is justification to remove the siren part of the system given that there are no regulatory requirements for such a system, a diverse and effective collection of modern warning channels is already in place, a minimum of 1.5 hours is available to implement those warning channels should a dam incident occur, and there is potential for negative impacts on warning-weary residents should future false alarms occur. Removal of the siren component of the system would

greatly simplify the Tolt Early Warning System, eliminate siren soundings, and significantly reduce the potential for future false alarms.

If this siren removal option is selected, improvements to the existing network of warning channels should be considered. One primary way to enhance the effectiveness of existing channels would be to increase the number of people opting in to King County's warning service (ALERT King County). This would require a fairly intense and collaborative effort, going beyond mere public information. Various community events as well as outreach by the Carnation-Duvall Citizen Corps could be utilized to encourage people to sign up. A coordinated effort with the School District could also be employed to educate students on the need for opting in.

Physical improvements to improve early warning could include installing electronic highway signs for use with all hazards (not just dam failure) and distributing NOAA weather alert radios to residents who do not have cell phones or wireless network coverage at their place of residence. One other possibility would be to construct cell phone towers to provide service to areas that don't currently have reception.

- Option 2: Retain and Simplify the Siren System – If the City of Carnation and/or King County decide to retain and take ownership of the siren part of the system, then it needs to be simplified to ensure greater reliability (See Summary Finding 2.2). The siren system is the most rapid means of warning and would add an additional layer of redundancy to existing warning channels. Public officials and residents in and around Carnation appear to have mixed feelings about the siren system. Some feel it is necessary to protect the community, while others experience stress and anxiety during routine siren tests.

If the siren system is retained and recommissioned, the design should be simplified in a variety of ways. This could include decoupling the siren system from the dam monitoring system and satellite connection so that sirens must be manually activated. Another suggestion would be to eliminate the voice capability of the sirens which has caused confusion and frustration. A single siren signal pattern could be adopted for both testing and warning situations, and residents could be directed to seek additional information from pre-determined official sources when they hear the sirens go off rather than immediately evacuate.

Regardless of the selected modifications, it is also recommended to dramatically reduce the frequency of live testing of the sirens. The established approach of weekly testing creates several problems including alienating the public and diminishing public trust in the system. The Review Team recommends either a yearly or twice-yearly testing of the sirens, preferably in conjunction with a hazard preparedness event.

As noted, there is justification for either approach. Neither option will be without controversy in the community given the troubled history of the system. Mediation may be required to address the potential transfer of ownership if the City of Carnation or King County decides to retain the

system either individually or under a joint agreement. If the siren system is removed, mediation may also be helpful in determining what additional physical improvements (if any) should be installed and who will be responsible for initial costs and long-term maintenance. The City of Seattle should remain engaged in the project until the siren system is either fully decommissioned and other alternative methods of warning have been improved; or the siren system is simplified and fully commissioned, and ownership is transferred to local authorities.

4. Bolster Community Outreach Efforts

Regardless of whether or not the siren system is retained, additional outreach and education are necessary to inform residents about the various hazards that could impact the City of Carnation and the surrounding areas, including the potential for dam failure. There is a significant amount of mistrust within the community that is directed towards any government authorities that are perceived to be associated with Tolt Dam or the Early Warning System, and long-term efforts are required to rebuild that trust. Both on an individual and collaborative basis, the City of Seattle, City of Carnation, and King County OEM should continue to administer and improve community engagement, education, and preparedness outreach efforts within their respective spheres. It would best serve the community if an all-hazard emergency management approach is implemented and emphasized among residents. The Carnation-Duvall Citizen Corps and other local organizations may be helpful partners in these efforts. Residents should opt in to ALERT King County to be promptly notified in the event of an emergency.

Specific to the City of Seattle's efforts, a reset on community engagement and outreach regarding Tolt Dam is warranted and would be facilitated by creating a community advisory group. This would consist of a group of local residents who are active in emergency preparedness who meet at least quarterly with dam safety engineers, information officers, and emergency managers from the City of Seattle and King County. This group would work to identify opportunities for better engagement with and education of community members. The City of Seattle should develop a Communications Plan that includes continuing involvement in community education and outreach activities such as annual tours of the dam for residents and participation in the "Be Dam Ready" community event. This plan should also clarify coordination between Seattle Public Utilities and Seattle City Light.

Consistent with newer practices within the dam safety industry, City of Seattle should publicly release the complete set of dam breach inundation maps from the Tolt Dam Emergency Action Plan. This increases transparency and will help communities and their residents make more informed decisions about protective action planning.