DAM SAFETY FAQ

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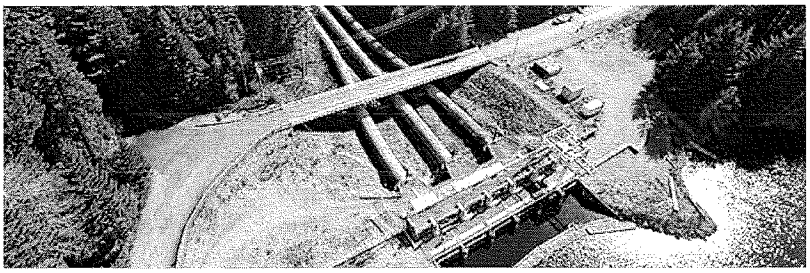
Dam Safety FAQ

Dam Safety Infographic

Seismic Hazard at Jordan River

Dam Safety Reports



Answers to common questions about dam safety at BC Hydro

Get answers below to general questions about dam safety.

Go directly to our FAQ on our action plan at Jordan River.

Jordan River Seismic Hazard FAQ

The following questions were raised by residents during BC Hydro's public meeting held on December 12, 2014 at Sooke, B.C. Get a detailed overview on our Seismic Hazard at Jordan River page.

Emergency Preparedness

How well prepared is BC Hydro for a major earthquake?

How would people be notified of a dam failure?

Under extreme conditions, such as a major earthquake, a dam can fail or breach in different ways, depending on the situation. As part of its notification protocol in the event of a potential dam failure, BC Hydro would inform local and provincial agencies, First Nations and key stakeholders, including media. Emergency protocols are reviewed on a regular basis, including training simulations.

The level of shaking required to damage the dam at Jordan River would be so large that it would cause serious damage to buildings and knock people off their feet. In such an earthquake, anyone who is downstream of the dam would need to leave the evacuation area, just as they would in response to a tsunami warning.

How much time would people have to evacuate if the Jordon River Diversion Dam fails?

It would take a massive earthquake event, likely a magnitude 8 – 9 near the Jordan River, for the Diversion Dam to be seriously damaged to the point where water is released. In this worst-case scenario, water could arrive within 20 minutes to the evacuation area.

How does BC Hydro know if its dams are at risk following a major earthquake?

Following an earthquake, BC Hydro crews will be dispatched to the dams to assess their condition. Before crews can inspect our dams, BC Hydro may be able to monitor the dams remotely through instruments that would indicate whether facilities are at risk. In a major earthquake where buildings are damaged and individuals knocked off their feet, people must move out of the evacuation area as quickly as possible and not wait for any further instruction.

Are the dams safe right now, and what does that mean?

BC Hydro's dams are safe and well managed. BC Hydro has an effective dam safety program that was confirmed in a 2013 independent external audit by two international experts. The Jordan River Diversion Dam is considered to be one of the strongest dams in BC Hydro's system. The dam is not at risk unless a major earthquake (8 – 9 magnitude) occurs near Jordan River.

What would be the maximum rise of water after serious damage to the Diversion Dam? Would it be fast or slow moving?

In the worst case scenario, water at the Jordan River bridge would be expected to rise by about 3.3 metres. The water is expected to arrive in about 20

minutes and peak at about 30 minutes. At its maximum force, water would be fast-moving, strong enough to knock people off their feet. Please see the evacuation map in Slide 18 of the BC Hydro presentation [PDF, 1.3 MB]

Was BC Hydro aware of any recent earthquake in our region in 2014?

Yes, in addition to BC Hydro's monitoring program, we are also notified by Natural Resources Canada about all earthquakes in the region. There are an estimated 400 earthquakes on the B.C. coast every year, the vast majority of which are not felt by anyone.

What would be the regional impact of a magnitude 9 earthquake near Jordan River?

There would be an enormous impact on the region beyond Jordan River, affecting all levels of infrastructure, such as roads, bridges, waterlines, gas lines, and buildings.

Risk Management

What if residents accept the risk of continuing to live in the evacuation area? Is there a level of risk that is acceptable below 1 in 10,000 that would allow homeowners to remain?

There are no simple answers to these questions. BC Hydro is committed to working with residents and the region. At Jordan River, there will always be an elevated level of risk due to the natural seismic hazards, irrespective of the presence of the dams. These questions will be considered in consultation with the Comptroller of Water Rights, following discussions with local stakeholders and First Nations, and in light of responses to BC Hydro's written offers as part of the home purchase program.

When did BC Hydro first come to understand this risk, and how was it communicated?

A multi-year assessment of the seismic hazard at BC Hydro dams was completed in July 2014 when a scientific peer review process was concluded. BC Hydro then began the lengthy process of informing key organizations such as Emergency Management BC and local government agencies, particularly those in the priority areas of Campbell River, Bridge River and Jordan River. BC Hydro then began to inform relevant Provincial Ministries over the following months, culminating in the release of all information on December 5, 2014.

BC Hydro is now in the process of meeting with individual homeowners in the evacuation zone, and working with the Capital Regional District and First Nations to discuss other related issues.

What does 1 in 10,000 mean in terms of earthquake risk?

A widely accepted dam safety guideline states that any dam with people living downstream should have no greater than a 1-in-10,000 chance of failing during any given year. Essentially, a dam should be able to withstand a level of ground motion with a 1 in 10,000 chance of occurring during the year. For Jordan River, this ground motion level is 1.5g ('g' is a measure of the acceleration of gravity).This is an extremely high level of ground motion. Extensive damage to the area (but not dam failure) would be expected at much

lower levels of ground shaking, with a much higher level of chance, in the order of 1 in 500.

What are the immediate and long term plans for those who live near, or use, the Jordan River area?

BC Hydro believes that many of the current activities in the Jordan River area can continue as before. These include day-time pursuits such as surfing and hiking, and commercial activities, including logging. BC Hydro is in discussions with the Capital Regional District regarding the prudence of allowing future residential development and overnight camping in the evacuation area.

People living outside the evacuation area are not included in the home purchase program, but they still need to be aware of the area's seismic and tsunami risks. BC Hydro will be following up with homeowners who live in the evacuation area to discuss our offer to purchase their homes.

Can BC Hydro restrict future residential development and allow current residents to stay?

While BC Hydro does not have the legal authority to restrict residential development, we are pursuing such restrictions with the Capital Regional District. However, there is still an ongoing risk for current residents. To alleviate that risk, BC Hydro is offering to purchase property from residential owners in the evacuation area.

Which set of standards and guidelines does BC Hydro follow in its dam safety program?

With highly engineered structures like dams, it's virtually impossible to set out a prescriptive approach to design. But there are well-established guidelines to ensure that professionals use the appropriate design features. In this case, BC Hydro follows the Canadian Dam Association guidelines and international best practices.

BC Hydro also complies with the BC Dam Safety regulation that sets out the legal requirements covering operations, maintenance, surveillance, and emergency preparedness for dams throughout the province.

Impact on Residents in the Evacuation Zone

Why is BC Hydro offering to buy homes in the evacuation zone?

A long-term study found that the seismic hazard in the Jordan River area is significantly higher than previously understood, due to the area's proximity to the Cascadia subduction zone. While BC Hydro's Diversion Dam is considered very strong, the seismic hazard is almost twice as high as previously understood.

The technical feasibility and financial viability of upgrading or replacing the largest dam (Diversion) to meet this new level of extreme hazard is in question. BC Hydro is considering further studies of its facilities and options to improve their ability to withstand stronger earthquakes.

In the meantime, BC Hydro is taking steps to reduce the risk by working with the Capital Regional District to restrict overnight camping and future residential development, and with the Comptroller of Water Rights to clarify safety and seismic requirements. As part of this process, BC Hydro is offering to buy the homes of landowners in the evacuation area. BC Hydro is also in discussion with First Nations in the area.

Is BC Hydro forcing landowners to sell?

The goal of the home purchase program is to reach mutual agreements with landowners to acquire their homes based on market values prior to BC Hydro's seismic announcement in early December. In light of our updated knowledge of seismic hazard in the area, and the limitation on BC Hydro's ability to meet this significantly increased hazard in a timely manner, we're offering to buy the homes of downstream residents living in the evacuation area. BC Hydro has approval to engage in conversations in order to negotiate purchases.

Does BC Hydro have the power to expropriate?

Under the Hydro and Power Authority Act, BC Hydro can only expropriate property with approval from the Minister of Energy.

How are non-residents protected?

BC Hydro will be collaborating with the Capital Regional District to increase the general awareness and emergency preparedness for people who may be travelling through or visiting the Jordan River area.

Why did some people know about the proposed home purchase program before the landowners were told?

BC Hydro started briefing responsible agencies in July 2014 about the seismic study results, potential implications and how to best communicate this information to the broader public. We can't speculate on whether information was passed along from those meetings.

Assessing Options for Jordan River

Can the Jordan River Diversion Dam be upgraded?

The Jordan River Diversion Dam could be upgraded to increase its ability to withstand stronger earthquakes. But it may not be technically feasible or financially viable to upgrade the dam to such a degree that it meets the most extreme seismic hazard now understood for this region.

What's the possibility of replacing the dam?

There are technical and financial challenges to building a dam sufficient to withstand a worst-case scenario earthquake in Jordan River. BC Hydro is not aware of any dam in the world that has been built to withstand this level of seismic hazard.

Has BC Hydro done a study to determine the costs to fix the dam?

BC Hydro has undertaken a number of internal studies and reviews to study options to deal with this challenge. Conceptual designs have been developed that would partially upgrade the Jordan Diversion Dam.

Does BC Hydro not want to have liability for damage?

Public safety is our number one concern. If BC Hydro were to be found liable for damages resulting from a breach of any dam, we would provide compensation.

What are the legal implications if BC Hydro does not meet the required seismic safety standards?

The BC Dam Safety Regulation sets out legal requirements covering items such as operations, maintenance, surveillance and emergency preparedness. If BC Hydro does not meet these requirements, it would be subject to an order from the Comptroller of Water Rights.

Will BC Hydro examine the possibility of replacing the energy [produced by the Jordan River system] and decommission the dams to protect the community?

BC Hydro has explored these options. Decommissioning the dams would be very costly, and replacing the energy in southern Vancouver Island would be extremely challenging, particularly when considering a gas-fired generating plant option. In addition, removing the dams would increase the flood risk for people and homeowners downstream.

Is natural gas the only alternative to develop firm power? Is there no other way to replace the power generated at Jordan River?

Other than building a new dam and generating station elsewhere on southern Vancouver Island, natural gas generation is the leading option to develop a source of firm power. Under the Clean Energy Act, coal and nuclear power are not allowed, and geothermal is not a viable option for the area.

Can the dams be modified to increase generation while lowering reservoir levels?

The ability to generate electricity depends mostly on the amount of water that is being stored in a reservoir. While different equipment can have some impact as well, the Jordan River facility is at its maximum ability to generate power.

What would happen if the Diversion Dam failed and the flow of water hit Elliott Dam?

If the Jordan River Diversion Dam failed in an earthquake and Elliott Dam survived, the resulting flood water from Jordan would flow over top Elliott Dam but would not cause it to fail.

Did the seismic study review Elliott Dam?

Yes, the study included the region where all facilities are located. The seismic hazard at Elliott Dam is the same as for Jordan Diversion Dam.

Has BC Hydro considered the environmental impact of dam failure?

While we have not undertaken a detailed environmental assessment of the impact of a dam failure, our water use planning process gives us a very good understanding of the ecological environment downstream of the dam. An earthquake large enough to seriously damage a dam will also have a direct and substantial impact on the surrounding environment, even beyond the inundation of water caused by dam failure.

Would the dam be fixed if there were more people living at Jordan River?

BC Hydro would be facing the same challenge as it is today if the population were greater. The technical limitations are very significant, given that we are in the highest seismic hazard zone in the province, if not North America.

What is Worksafe BC's view of workers operating below the dam?

Worksafe BC has general requirements for risk assessment and emergency planning. In the context of work downstream of our dams, our response to those requirements is carried out through BC Hydro's Dam Safety Program.

BC Hydro also follows the Canadian Dam Association guidelines and international best practices. The BC Dam Safety regulations set out requirements covering operations, maintenance, surveillance and emergency preparedness. BC Hydro adheres to those requirements and has informed businesses below the dam of this situation so that they will be able to take the appropriate measures to keep their employees safe.

What is the impact on the Capital Regional District Park?

We will be working with the Capital Regional District on this issue and are recommending that overnight camping in the park be suspended, and that future residential development in the evacuation area be restricted.

Would failure of the dams disturb contaminated sites in the region and carry this material further downstream?

The impact of historic tailings from previous mining activity has not been studied, but we would expect a dam failure or even a large flood event could disturb the mine tailings that were deposited along the riverbank and across from the powerhouse at Jordan River.

Are lower reservoir levels, combined with other renewable power generation options, a possible solution?

If we lowered the reservoirs behind the dams, we would reduce the seismic risk, but lose the ability to help meet peak use demand in southern Vancouver Island. Other renewable power generation options are only helpful if they are firm sources of power, and that rules out wind and solar power as options.

Does the North Island wind farm provide a solution?

Wind power is considered intermittent, which means it can't always be counted upon when needed.

Does BC Hydro have a program to subsidize alternative energy?

BC Hydro does not have a program to subsidize alternative energy, but there are opportunities for communities and small-scale independent power producers to sell into the BC Hydro grid.

The Jordan River System and Operations

Why is power from Jordan River so important?

The Jordan River system includes the Jordan River Diversion Dam and the smaller Elliott and Bear Creek dams. On average, Jordan River produces 242 gigawatt hours per year, enough to supply power to 24,200 homes.

The 170-megawatt system provides 37 per cent of BC Hydro's Vancouver Island generating capacity. However, the system provides about 10 percent of the Island's total peak power needs, as the vast majority of the Island's power needs are served through underwater cables from the mainland.

Reliable power from Jordan River is required to meet the local demand when the radial transmission line from Victoria to Jordan River is out of service for maintenance. This area includes Sooke and Colwood. The Jordan River system also provides important transmission support services by providing voltage support near Victoria during peak load periods, system disturbances and when transmission and substation maintenance is required.

What happens to the power on Vancouver Island if the Jordan River system fails?

The vast majority of power (80 percent) to serve Vancouver Island electricity needs is provided through underwater cables from the mainland. Jordan River supplies one of six transmission lines into Southern Vancouver Island for the purpose of helping to meet peak use demand. If the Jordan system fails, it would limit the flexibility of the Island's power grid.

Does power get exported to the mainland or the U.S?

No, power from Jordan River is used to meet peak demand on the Island, and the rest goes into BC Hydro's grid to supply power throughout the Island and elsewhere. The Island needs to import from the mainland nearly 80 percent of its power. There is no direct transmission line between Vancouver Island and the U.S.

Is the plan to increase power from the Jordan River system to Victoria?

There is no plan to increase power to Victoria from the Jordan River system, which is currently used to supplement the power needs of Greater Victoria during times of peak use demand.

What's the status of the other dams in the Jordan River system?

All three dams in the Jordan River system are considered safe. With the resulting ground motion in a worst-case earthquake scenario at Jordan River much higher than previously understood, Elliott and Bear Creek Dams will be affected. We expect upgrades would be required for the Elliott Dam and could be considered feasible. BC Hydro is not aware of any dam in the world that has been built to withstand this seismic hazard. Failure of Bear Creek dam does not put Jordan River residents at risk.

Why was the water behind the Jordan River Diversion dam at a lower level in early December?

The level of Jordan Reservoir fluctuates with the natural inflows and the demand for power generation. It is possible for the level of the reservoir to change more than 10 metres during the course of a day. With recent storm

activity, the reservoir was likely being lowered to accept the expected high inflows.

What's the dollar value of water behind the dam?

There's approximately 16 million cubic metres of active storage in the Jordan River system. Draining the full reservoir would take about 55 hours. At current residential rates, the value of the water behind the dam is about $1 million.

First Nations and Jordan River

Does BC Hydro's plan require First Nations' support?

BC Hydro will continue to engage with T'Sou-ke and Pacheedaht First Nations on the Vancouver Island Dam Safety Emergency Planning Project for the Jordan River System.

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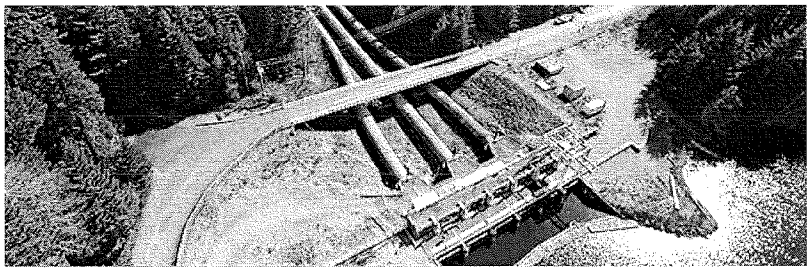

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What's the possibility of replacing the dam?

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Has BC Hydro done a study to determine the costs to fix the dam?

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Will BC Hydro examine the possibility of replacing the energy [produced by the Jordan River system] and decommission the dams to protect the community?

BC Hydro has explored these options. Decommissioning the dams would be very costly, and replacing the energy in southern Vancouver Island would be extremely challenging, particularly when considering a gas-fired generating plant option. In addition, removing the dams would increase the flood risk for people and homeowners downstream.

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Does power get exported to the mainland or the U.S?

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What's the status of the other dams in the Jordan River system?

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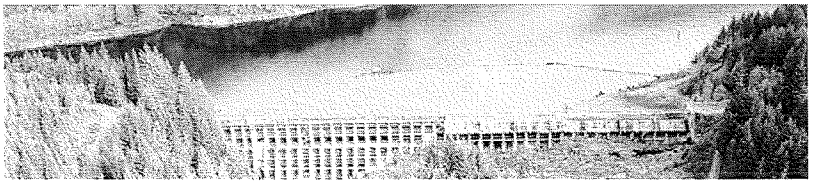
First Nations and Jordan River

Does BC Hydro's plan require First Nations' support?

BC Hydro will continue to engage with T'Sou-ke and Pacheedaht First Nations on the Vancouver Island Dam Safety Emergency Planning Project for the Jordan River System.

SEISMIC HAZARD AT JORDAN RIVER



Study shows Vancouver Island dam has highest seismic hazard in BC Hydro's system

On December 5, 2014 BC Hydro released the results of a six-year, peer-reviewed, seismic hazard study of all regions in B.C. where our 79 dams are located. The study revealed that the expected ground motion at Jordan River in an extreme earthquake event — an 8 to 9 magnitude earthquake — is much greater than previously thought due to its proximity (about 40 kilometres) to the Cascadia subduction zone.

- Dam Safety at BC Hydro booklet [PDF, 10.7 MB]
- FAQ: Questions & Answers from public meeting at Jordan River

Located on the west coast of southern Vancouver Island, the Jordan River system is at the highest seismic hazard within BC Hydro's system. It's three times higher than that of the Lower Mainland, and about double the ground motion hazard of the Campbell River system. This is a very significant change in our understanding of the seismic hazard.

As Vancouver Island is a known seismically active region of the province, BC Hydro had already taken steps to upgrade the Jordan River Diversion Dam, most recently in the early 1990s. As a result, the dam is now one of the more robust dams in B.C.

Technical challenges thwart effective upgrades or replacement of dam

This new study shows that further upgrades or replacement of the dam would be needed to meet guidelines for the required higher level of seismic stability.

BC Hydro is not confident that such upgrades would be technically feasible for the Jordan River Dam. A second upstream dam, the Elliot Dam, would also require upgrades, but these are considered feasible due to the dam's design features.

However, BC Hydro is not aware of any dams in the world that are built to withstand the ground motions expected in the Jordan River system as the result of a massive subduction zone earthquake.

Other options: Lowering water level or decommissioning of dam

BC Hydro also explored the possibility of lowering the reservoir behind the dams, concluding that this would significantly reduce the ability to produce power and require the construction of more transmission lines to serve southern Vancouver Island, at an estimated cost of $100 million to $200 million.

The option to decommission the dams was also reviewed, but would be highly costly, and would create a gap in our supply that would need to be filled through another source of energy. BC Hydro's concerns include:

DAM SAFETY

Dam Safety FAQ

Dam Safety Infographic

Seismic Hazard at Jordan River

Dam Safety Reports

See also

- FAQ: Questions & answers about Jordan River
- BC Hydro presentation to Jordan River residents [PDF, 1.3 MB]
- Jordan River earthquake evacuation map [PDF, 934 KB]
- Dam Safety at BC Hydro booklet [PDF, 10.7 MB]

- Energy sources such as wind and run-of-river provide intermittent power that will be inadequate to meet peak-use demand.
- A natural gas generation option would be limited by pipeline and storage constraints, high costs, and siting and permitting challenges.
- Removal of the dams would put residents, campers and business operations downstream at much higher flood risks.

The safest course of action

The highest risk is to permanent residents or others who may be staying overnight downstream from the Jordan River Dam in a home or in a campground. They would have less ability to respond quickly to a major event.

BC Hydro is working with the Capital Regional District to improve emergency preparedness and awareness of seismic risks, including the potential to restrict future residential development and overnight camping. BC Hydro will also support the Capital Regional District should it wish to explore the potential of installing a warning siren.

Jordan River earthquake evacuation map (PDF, 934K)

We are also in communication with First Nations representatives to discuss this plan and to better understand their interests.

BC Hydro does not believe that restrictions on day-use activities are needed, given the available response time to evacuate the area. Surfing, hiking or logging activities, for example, should continue as before.

Residents living in Jordan River but outside of the evacuation area will not be affected by any release of water from the dams. But they need to understand the elevated seismic risks for this region of Vancouver Island, and make plans for their safety in a seismic or tsunami event.

BC Hydro offer to purchase nine homes

BC Hydro has offered to purchase the nine residences in the evacuation zone. Our goal is to work with each property owner over the coming weeks, and to continue our discussions with all affected residents and other parties in the area to get a full understanding of the situation and to explore other potential solutions.

We appreciate this is very challenging for homeowners, and BC Hydro will do everything it can to be sensitive to their needs. We recognize that homeowners need time to consider all information.

About the Jordan River system

The Jordan River system comprises the Bear Creek, Elliott and Jordan River Diversion dams, including a generating station. This system represents approximately one-third of BC Hydro generating capacity on Vancouver Island.

BC Hydro's generating capacity on Vancouver Island can only meet about 20 percent of the Island's total demand. About 80 per cent of the electricity to power the Island comes from the mainland through underwater cables.

The Jordan River system, which primarily serves greater Victoria, provides about 10 per cent of the electrical supply for Vancouver Island. However, the generating station does not run continuously, but only as needed to meet the peak-use times, when demand for electricity is very high.

Power from Jordan River also helps to support the Vancouver Island grid when there are outages in our transmission system.