



It took only a few hours to win BC government approval for major changes to the Site C dam design. Photo by Don Hoffman.



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It was the bureaucratic equivalent of waiting for Timbits and a double-double at the Tim Hortons drive-thru.

In the space of just hours on a single day in June 2020, the provincial government office in charge of dam safety rubber-stamped a request to embark on a costly fix at the Site C construction project.

The fix was needed because the notoriously unstable layers of sedimentary shale on the Peace River's south bank had shifted following construction activities. And the shifting of that "soft rock" had destabilized major components of the dam, including a massive sloped wall consisting of millions of tonnes of concrete.

Yet the the provincial water comptroller's office never publicly disclosed what had gone wrong at the **\$16-billion-and-counting megaproject** (<https://www.jwnenergy.com/article/2021/3/1/british-columbias-site-c-dam-to-cost-16-billion-de/>) .

Details on the swift approval by the only government office with the power to halt Site C's construction because of safety concerns are contained in more than 8,000 pages of documents the provincial government released in response to a freedom of information request by the Canadian Centre for Policy Alternatives.

The documents show that on June 26, 2020, the provincial water comptroller's office received an 18-page report from Tim Little, Site C's "independent engineer." It proposed a major, costly change to the dam's design.

Little's job was to feed information on Site C from BC Hydro, the publicly owned hydro utility spearheading the project, to the provincial government office in charge of dam safety.

It was that office's job to review Little's submissions, weigh the consequences and decide whether to issue BC Hydro with permits that would let it advance to each new phase of construction, or to order course corrections.

Little's report was a bombshell. The connections between layers of soft sedimentary shale beneath the dam had weakened, causing tiny, but troublesome, ground movements.

Worse, this had happened after millions of tonnes of roller-compacted concrete — a type of concrete which can be laid down quite quickly — had already been placed to make a huge, sloped wall known as a buttress, the foundation for some of Site C's most critical infrastructure, including its powerhouse, turbines and spillway.

"Detailed mapping of excavations and monitoring with geotechnical instruments during construction to date have identified that certain bedding planes have lower strengths and are more critical to stability than previously considered in the design," Little reported to Richard Penner, a professional engineer who, in turn, reported to water comptroller Ted White.

That has "led to design revisions" for the dam's foundations, Little reported.

It is hard to overstate the seriousness of Little's warning.

The buttress — which formed one arm of the dam — was sitting on top of what geologists call "soft" or "near" rock. There was a risk the shale layers were weaker than thought and could shift, causing ground movement.

Yet in a matter of hours, the regulator gave BC Hydro everything it asked for, with nary a hint from the water comptroller's office that a delay was in order.

All of this was a sad but foreseeable outcome, says U.S. energy economist Robert McCullough, who has studied Site C in detail, has decades of experience analyzing hydroelectric projects across Canada and who was once an executive at Portland General Electric, a privately owned hydro facility in Portland, Oregon.

Site C is simultaneously a BC Hydro project and a B.C. government project, because as a Crown corporation BC Hydro's sole shareholder is the province. Effectively, that means the government is regulating itself at Site C.

"This is an ongoing concern for me — the lack of separation between the reviewer and the entity being reviewed," McCullough says. The lines get even blurrier, he suggests, when a key player in the regulatory process has deep ties to both BC Hydro and the Site C project itself.

In this case, Tim Little was a senior engineer at BC Hydro where he worked on various aspects of the Site C project. He then became a consultant to BC Hydro before being nominated by BC Hydro to be Site C's independent engineer. The B.C. government then accepted the Crown corporation's nominee, appointing Little to be the critical liaison between BC Hydro and the water comptroller's office.

What made Little's report even more disturbing was that Site C's design called for the potentially unstable buttress to be joined by an as-yet-to-be-built earthen wall.

The shale below the critical corner where the buttress and earthen wall would meet to form a highly unusual L-shape dam was also weaker than previously thought. It, too, needed "enhancement."

If ever there was a time to push the pause button, this was it. Yet, in a matter of hours on the very same day that he received Little's report, Penner granted BC Hydro everything it asked for.

"My decision is to authorize BC Hydro to proceed with Stability Enhancements for RCC Buttress and Earthfill Dam Right [south] Bank as described in the submission," Penner wrote, adding elsewhere that without the changes, the whole thing might come crashing down.

"With the decrease in interpreted shear strength of the underlying bedding planes, the structure is subject to failure," Penner wrote.

Anchoring three million tonnes of concrete?

The most immediate of the approved changes or enhancements outlined by Little and approved by Penner called for BC Hydro to sink 162 steel bars or rods in front of the buttress, where just shy of three million tonnes of concrete was in place.

The reinforcing bars were intended to anchor all of that mass, preventing it from moving.

"The selected approach is to install foundation anchors extending across bedding planes BP29A and BP30 in the bedrock below the base of the RCC [roller-compacted concrete] buttress. There will be three rows of 54 anchors, each consisting of 75 mm, 20 m long non-tensioned steel bar," Little said in his report of June 26.

Little did not elaborate further on what would be required to do this. But clearly much work lay ahead.

A total of 162 angled holes would have to be drilled through layers of shale and weak bedding planes, and each hole would need to be almost as long as a five-storey apartment building is high.

What made Little's report even more notable, however, was his use of the future tense. "The selected approach is to install.... There will be three rows."

This suggested that the proposed fixes were some way off.

But clearly that was not the case. We know this because in a subsequent report written by Little on July 20, a photograph shows a pile of the anchor bars that would be used to shore up the vulnerable buttress at Site C. The photograph is dated June 23, 2020.

In other words, three days before Little submitted his bombshell report, BC Hydro had already invested in the material that would be used for the critical foundation enhancements — a signal that the publicly owned utility felt that no regulatory roadblock would be placed in its way or that

it would proceed with the enhancements with or without the approval. The cutline accompanying the photograph reads: "Core buttress anchors (975 mm diameter threadbares) being prepared for installation."

Also revealed in Little's July 20 report is that "by the end of June" 133 of those 162 holes were already drilled, with 30 of the steel bars already inserted.

Little's July report also revealed something else: For "several months" he'd been meeting with BC Hydro officials and Site C's **technical advisory board** (<https://theconversation.com/i-visited-nuclear-shelters-in-prague-to-see-how-cities-could-prepare-for-nuclear-war-191459>) to discuss problems at the construction site.

A project risk

Less than two weeks after Little's disclosures, provincial Energy Minister Bruce Ralston held a press conference on July 31, a Friday heading into the long weekend.

Ralston announced that the government had appointed former deputy minister of finance Peter Milburn to investigate Site C's problems and spiralling costs.

Ralston did not address what the water comptroller's office knew about problems at Site C, when it learned of those problems, or what it had done about them.

The press conference coincided with BC Hydro's voluntary filing of a quarterly report on Site C with the BC Utilities Commission. (Under normal circumstances, the commission would have been the arm's length overseer of the project, but it was removed from that role by the BC Liberal government in 2010, a decision that the current government opted not to reverse.)

In a cover letter accompanying the filing with the commission, BC Hydro CEO Chris O'Riley first blamed the project's skyrocketing costs and delays on COVID-19.

But he later wrote "a project risk has materialized on the south bank. Towards the end of December 2019, investigations and analysis of geological mapping and monitoring activities completed during construction identified that some foundation enhancements would be required to increase the stability below the powerhouse, spillway and future dam core areas... the foundation costs are anticipated to be more substantial than initially expected in January."

Neither Ralston nor O'Riley was asked then about when BC Hydro had officially alerted the water comptroller's office to those problems. But BC Hydro's filing with the utilities commission indicates that senior executives knew of serious "project risk" issues long before Little filed his June 2020 report — a fact well-documented in an **investigation by the Narwhal** (<https://thenarwhal.ca/site-c-dam-geotechnical-problems-bc-government-foi-docs/>) .

BC Hydro's most recent report to the utilities commission was in June. It notes that in addition to the 162 steel rods used to stabilize the buttress in 2020, even more reinforcements are now needed. The report flags that another 48 "large diameter concrete-filled vertical steel piles" now must be placed near the dam's powerhouse.

The latest "enhancements" will allegedly be completed by next spring at undisclosed additional cost to Site C's already bloated \$16-billion price tag.

The independent engineer

When BC Hydro nominated Little to be Site C's independent engineer, the water comptroller's office quickly deemed him to be an "appropriate and satisfactory" choice.

Little was not, however, independent, at least not by commonly accepted definitions of the word. He had worked for years as a BC Hydro engineer before forming a consulting company, with BC Hydro as its main client.

According to BC Hydro **financial statements**

(<https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/accountability-reports/financial-reports/annual-reports/BCHydro-FIA-F21.pdf>) , T.E. Little Consulting Inc. received more than \$2 million in the past 10 years, with the bulk of that money covering Little's services as Site C's independent engineer.

By accepting Little's nomination, the water comptroller's office was knowingly basing its decisions on the advice of someone who had deep ties to BC Hydro and was personally and professionally invested in the Site C project.

Which comes as no surprise to McCullough.

"It would be very unusual that a decision-maker would appoint an advisor who is likely to oppose his project," McCullough says, when what you really need is someone who is there to provide a firm check and balance.

Decades of warnings

Ever since the massive W.A.C. Bennett and smaller Peace Canyon dams commenced operations in 1968 and 1980 respectively, BC Hydro had planned to build other dams on the Peace River.

But getting the third dam — Site C — built was another matter.

In 1991, Little, then a BC Hydro employee, was one of two authors of a peer-reviewed paper in the *Canadian Geotechnical Journal* that discussed the "**rebound potential** (<https://cdnscepub.com/doi/10.1139/t92-043>)" of "soft rocks" or "near rocks" at Site C.

That rock was shale; the dominant geological feature at Site C. Such "soft rock" can move in a process called "rebounding" after large excavations occur.

Little and co-author Alfred Hannah, then an engineer with Klohn Crippen, a company later involved in Site C's design, noted this phenomenon.

"Nonelastic or time-dependent rebound, otherwise known as heave or swelling, is a well-known phenomenon associated with certain soils and rocks, predominantly clay based, that are sensitive to moisture. In the case of soft rocks, or 'near rocks,' clay shales and shales are most likely to exhibit swelling characteristics. The swelling of shales can be initiated in response to unloading by erosion or excavation, and (or) by exposure to water."

In plain language what Little and Hannah said was that shale, which is not really a rock at all, is a temperamental material. Dig around it, expose it to water, and watch out. As political commentator and satirist John Oliver would say, that is a “wow” statement if ever there was one. Because if you’re building a dam you’ll do a lot of digging and you’ll encounter a lot of water — for the lifetime of the project.

Little, Hannah and many others knew decades ago that the presence of so much shale at Site C posed daunting engineering challenges, particularly on the south riverbank.

It was those uncertainties that eventually led Site C’s architects to toss out the original and more **conventional dam design** (<https://greenenergybc.files.wordpress.com/2010/04/site-c-artist-rendering2.jpg>) , which cut across the Peace River Valley in a more or less straight line.

What was once straight became a dramatic **L-shaped structure** (<https://www.sitecproject.com/about-site-c/site-c-project-components>) featuring a massive concrete wall or buttress that paralleled the south riverbank from west to east and an earthen dam that cut across the river valley from north to south to join the concrete edifice at a sharp right angle.

As first **reported in The Tyee** (<https://thetyee.ca/Analysis/2020/09/11/Site-C-Radical-Risky-Makeover/>) , the reason for the new dam design was **explained** (<https://www.nxtbook.com/naylor/CDAQ/CDAQ0317/index.php#/p/12>) in a paper written by six professional engineers who either worked for BC Hydro or for two major engineering firms — SNC Lavalin and Klohn Crippen — and presented to delegates attending a Canadian Dam Association conference in Halifax in 2016.

The new L-shape dam was intended to liberate the structure from all the layers of shale “rock” and the weak bedding planes separating it.

BC Hydro engineer Andrew Watson, one of the authors of the paper, later **explained** (<https://www.alaskahighwaynews.ca/local-news/bc-hydro-files-site-c-report-3480246>) the change to a reporter with the Alaska Highway News.

“The new design will minimize the depth of the excavation required under the generating station, which will reduce concerns about foundation stability.”

We now know this wasn’t the case. The massive wall of concrete constructed parallel to the problematic riverbank quickly became embroiled in its own stability problems.

Milestone or millstone?

Notable problems that have delayed scheduled construction activities and inflated Site C’s costs include a 400-metre-long **tension crack** (<https://www.sitecproject.com/update-4-tension-crack-on-north-bank-of-Site-C-dam>) on the excavated north riverbank that necessitated the removal of hundreds of thousands of additional tonnes of earth, problems completing the **drilling of diversion tunnels** (<https://thenarwhal.ca/peace-valley-residents-hold-out-hope-for-site-c-dam-injunction-as-eviction-day-looms/>) , which led to delays in diverting the Peace

River around the construction site, and **dangerous buildups** (<https://www.policynote.ca/minding-the-shop/>) of dust and falling slabs of concrete in a drainage tunnel.

But one thing that BC Hydro's contractors did get done well ahead of schedule was to pour all of the concrete to make the buttress that subsequently was identified as at risk of failing.

On Nov. 1, 2019, BC Hydro boasted in a press release that another 585,516 cubic metres of roller-compacted concrete had been placed that year. The "major milestone" was achieved "seven months ahead of schedule," bringing the total volume of concrete poured at the site to more than 1.2 million cubic metres, which BC Hydro noted was six times more concrete than that used to build the world's tallest building in Dubai.

What BC Hydro did not say in that press release is that such concrete has its drawbacks.

Unlike conventional concrete, which is wetter and poured into forms that hold it in place until it hardens, roller-compacted concrete is a drier mix that is placed with asphalt pavers and then compacted by vibrating rollers.

Its great advantage is that it can be laid down quickly, without joints, forms or steel reinforcing, all of which increase costs. It is also strong and durable. If done right.

But on CivilJungle, a website that discusses products used in engineered projects, there are warnings about its downsides. "Water seepage" can be a major problem, necessitating the drilling of drainage infrastructure before the concrete is laid. The other thing to **avoid is placing** (<https://civiljungle.com/roller-compacted-concrete/>) roller-compacted concrete on "foundation rock" that is of "poor quality," which any geologist will tell you abounds at Site C.

BC Hydro also didn't say, as it boasted about its great concrete pour, that some of that concrete was placed well before its own construction plans called for.

We know this, thanks to other documents filed with the water comptroller's office by Little.

On June 2, 2017, Little reported to the water comptroller's office that a drainage tunnel on the south bank was far behind schedule, thanks to the buildup of dangerous levels of silica dust in the tunnel and portions of the tunnel's concrete liner crashing to the floor.

The original construction plans called for the tunnel to be drilled "in advance" of the buttress because, as Site C's engineers knew, water and exposed shale were a bad mix that decades earlier contributed to the **1957 collapse** (<https://www.thecanadianencyclopedia.ca/en/article/collapse-of-the-peace-river-bridge>) of a suspension bridge spanning the Peace River not far downstream from Site C.

But because of the delays in drilling the tunnel, BC Hydro was in a bind. Its construction schedule called for concrete to be poured, but the tunnel was nowhere near done.

"As Independent Engineer for the Site C project, I have received a submission from BC Hydro requesting permission to commence construction of the powerhouse buttress, tailrace wall and downstream spillway stilling basin. Those components are the RCC structures scheduled to be

constructed in 2017,” Little wrote in his report submitted to Bruce O’Neill, then deputy water comptroller.

Little then recommended that the concrete be poured as per BC Hydro’s request and that, in the absence of the drainage tunnel, temporary wells be used to assist in capturing and diverting potentially dangerous and destabilizing water flows.

As would be the case a few years later with Little’s bombshell report on instability issues at the buttress, it took the water comptroller’s office just hours on the same day to issue the requested approval.

With a stroke of a bureaucratic pen, BC Hydro received permission to flip things on their head.

The concrete would be poured first. The pesky drainage tunnel finished later.

Asked to comment on the same-day-approvals, Harry Swain, the long-standing federal public servant, former deputy minister of Industry Canada and chair of the joint review panel of the then proposed Site C dam, said he was troubled on two counts.

First, the regulator’s decision to allow Little to be Site C’s independent engineer “does not pass the most elementary test of independence,” Swain said.

But he said it’s what the regulator then did with the reports Little provided that raises even more concerns.

“The instantaneous approvals of major construction changes by the water comptroller’s office is inexplicable,” Swain said. “At best, it is possible that extensive consultations between that office and BC Hydro preceded the formal approval of documents. Even then, careful scrutiny of the final texts of these lengthy and technical documents would be expected. At worst, senior government officials may have applied unrecorded pressure on the sole regulator to hasten approvals.”

An inquiry? Don’t count on it

For 44 years, Ken Farquharson was a civil engineer, working on major projects including BC Hydro’s Mica and Keenleyside dams. In an interview he gave in December 2020, eight months before he died, the **engineer and committed environmentalist**

(<https://www.legacy.com/ca/obituaries/theglobeandmail/name/ken-farquharson-obituary?pid=199855093>) said projects of Site C’s magnitude demanded more rigorous oversight from one provincial office with authority to ensure safe dam construction.

“I do not believe recommendations of this magnitude coming from a proponent should be turned around on a dime by a government engineer,” Farquharson said. “This is not effective consideration.”

Marc Eliesen, a former president and CEO of BC Hydro, adds that as more information comes to light about the “disastrous boondoggle” at Site C, the decision by the Liberal government to exempt the project from independent oversight by the BC Utilities Commission, and the NDP

government's decision to maintain course, looks worse with each passing day.

"The complete lack of provincial regulatory oversight, the escalating construction cost, and the ongoing geotechnical risks to public safety — all cry out for an independent commission of inquiry into the building of Site C," Eliesen says.

But it is almost certain that any inquiry will have to wait until Site C is done.

Ralston rejected the idea of an independent inquiry when asked about it during his July 2020 press conference.

By then it was clear that the government was in thrall to the sunk cost fallacy — the idea that too much money had been spent at Site C to walk away, even though walking away may have been the best thing to do given the expenses and risks that lay ahead. ■

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