Chapter 3

The Lifetime of a Dam

(Draft)

By Dr. Sandra Hoffmann: December 2013

Asking the question; "How long do earthfill dams last?" leads a person into some interesting discussions. Clearly the issue of duration features very big when prorating the initial cost to construct across time and production of megawatts of electricity. If the Prosperity tailings pond dam is any guide then the answer to the question may well be less than ten years.

Here is a reference to the Elwha River Dam and a discussion of dam endurance.

"Once past the half-century mark, dams begin to degenerate; Concrete walls degrade, earthworks erode and seep, spillway gates rust and lose tensile strength, and sediment clogs reservoirs, reducing their capacity. In the worst-case scenario, an aging dam could fail, causing catastrophic flooding." (1)

More to the point: the record of soil/slope instability of the Peace River Valley, siting of the new BC Hydro dam, un-affectionately known as "Site C", is renown. Below is an excerpt from the "Site C Environmental Impact Statement, July 1980".

"Landslides, and to a lesser extent flowslides, have played a significant role in the development of the lower Peace River valley; some of the valley slopes are still marginally stable. Most past slides have been shallow seated, and it is for this reason that relatively minor disturbances (e.g. road cuts or fills) can reactivate movement." (2)
It is hard to imagine a more descriptive assessment of a place with serious instability issues that no amount of subsequent engineering work would alter.

What have Experts written about the Peace River Valley?

The following is taken from Gregory Hartman's thesis titled "The Quaternary Stratigraphy and History of Valley-Fill Sediments in the Charlie Lake Area of Northeastern British Columbia". (Published in the Canadian Journal of Earth Science 45: 549-564)

" The modern Peace River valley was cut during the early Holocene and coincides only in part with its Middle Wisconsinan counterpart. Glacial Lake Mathews sediments, which infill the interstadial valley, are locally exposed in the walls of the modern valley and its tributaries. **Weak, plastic clay layers within the glaciolacustrine sequence have developed shear planes on which over 900 landslides have occurred." (3)**

The takeaway from this observation is that the Peace River Valley is comprised of a lot of very slippery layers of clay, something the engineers at Prosperity failed to appreciate and grapple with.

In the words of a local geotechnical engineer, Ian H. Harder;

" Every substantial hillside and valley in the Peace Country is a geohazard. It would be very difficult to identify which slopes are stable and which pose a threat to potential movements.
Most river valleys are the result of valley fill (Till of various consistencies and residual soils) following six or seven glacial events. The bedrocks consist of clay shale, siltstone or sandstone and are very indurate, weak and water bearing. Depending on the type of winter, the vadose zone can vary significantly and is very instrumental in instigating a lot of shallow slips and translational movements." (4)

Can a statement be less declarative, the Peace River Valley simply put, has no bedrock to anchor a dam into and what is there is mostly in motion. The local saying is "Everything is flat in the Peace country, and whatever isn't, really wants to be."

Here are two quotations from professionals who regularly get their "hands dirty", so to speak. The first is from a report by Dean Daniel of the British Columbia, Ministry of Transportation, in 2006.

"Most slope stability issues occur in the Fort St John region and south, west and east. There are many sites along the Peace River towards Hudson's Hope.

Slope stability issues revolve around pore water pressures, no note of seismic triggers. [This seismic issue is causing more and more concern now that the region is much more active with fracking.]

Failures may occur during rainstorms with high pore water pressures or during dry weather.

Failure planes tend to be surficial however there are many deep-seated slides; failure planes are generally within the glacial lacustrine in the region, a layer of bentonite near the contact with bedrock, or at the contact with shale or sandstone.

2001 was a heavy rainfall year with various landslides; noted that various scientists from around the world visited the region during this time." (4)

So it seems, ground instability of the Peace River Valley is a known phenomenom that attracts scientists from around the world.

Even BC Hydro engineer, Andrew Watson, has recognized that land/slope instability on the Peace River is a hazard that could cripple the generation of electricity from a Site C, specifically;

"Such landslides at the construction site could occur rapidly, from various heights of the high river bank, due to the instability of certain slopes in the area.

--- there is a real possibility of shoreline erosion, which is a factor in the potential for landslides. " (5)

Now what about the cost of the Site C dam?

As one would expect there is a history of cost variability when presenting hydro dam construction projects. In the late 1980s the estimates for an earth fill dam at the same Site C location was under $3 billion. Then more recently the total cost increased to about $7 billion and even more recently to nearly $9 billion. It seems that when it comes to correctly costing dams the industry has an unparalleled record of being wrong. If there were someone crazy enough to post betting odds on dam construction cost estimate accuracy could the reader imagine what they would be?

It is instructive to look at the international record of cost inaccuracy. A World Commission on Dams has shown on average there is 50% cost overrun on large hydro dam projects such as Site C.

"The Wuskwatim dam in northern Manitoba began producing hydroelectric power last year, marking the completion of one of that province's largest construction projects. When all the bills were tallied this year, ratepayers learned that the cost had almost doubled, to $1.8-billion, from the $988-million estimate that was offered up when construction began in 2005. Manitoba Hydro officials blamed unprecedented increases in input costs on everything from cement to fuel to labour." (6)

These project cost overruns are always someone else's fault or an unanticipated increase of inputs. Proponents should choose better experts who probably would rightly advise building is not an affordable idea in the circumstances.

So what is the effective life of a reservoir?

The situation for Site C is very troublesome.

"If the Site C project were to proceed to construction, the sediment currently contributed to the Peace River from the newly regulated area (between Peace

Canyon Dam and Site C) and related tributaries would be trapped in the reservoir (-3 million tonnes/year). (7)

The Halfway River is the largest single sediment source with an annual average contribution of 2.3 million tons (BC Hydro calculation, 1976). (8)

According to Natural Resources Canada "The hazard presented by landslides involves not only failure of ground beneath a structure and the impact or burial of moving debris, but also such secondary effects as landslide-dammed floods and landslides-generated waves." (9)

If the foregoing were not enough, increased instability risk is being generated by increased seismic activity in the Region.

According to Steve Garner, a geotechnical engineer with BC Hydro, (2006) ;

" Seismic issues in this area have gone up over past years.
Reservoir stability has responded to seismic issues.
Reservoir related slides in Peace Canyon.
Big issue is weak shale beds with bentonite interbeds along Peace River and others. (10)"

This assessment of stability uncertainty is complimented by a 2006 presentation by Dr. Marten Geertsema.

" Terrain stability mapping is a real challenge in northeast BC as described in his paper presented in Quebec City, 2005.
Need a better understanding of bedrock topography, permafrost locations, fossil permafrost locations, of slide mechanisms of undrained loading when rock falls on soil, and slow moving creep deformation.
Indicates that mountain deformation is a problem and the number of large landslides is increasing."(11)

There is another risk factor to consider, the Domino Effect.

The lifetime of the proposed Site C dam is further compromised by a dependency upon the integrity of the larger W.A.C. Bennett dam upstream. This dam has been reported as having a 100-year life expectancy and is already in its 47th year. The W.A.C. Bennett dam has already experienced internal erosion problems only 28 years after completion. Photographic evidence is presented on the following page.

"Sinkholes in an earthfill dam signal erosion within the structure. Calls of alarm went out immediately and communities downstream prepared for evacuation.

Round-the-clock dam monitoring and surveillance were set up and a sinkhole investigation was assembled. Torrents of water were released to lower the level of the reservoir, representing a loss of generating capacity of more than $1 million per day. Local newspapers and television stations carried the story of possible disaster if the dam was to let go. **It was feared that the entire downstream valley could be wiped out. A second sinkhole was discovered on September 8, 1996.**" (12)

From the pen of Jack Farrell, Comptroller of water rights for the Province;

"It worked out well. But I don't think any of us will ever feel completely comfortable with the Bennett dam again. It must be watched very closely for the rest of its life." (13)

Recognition Of Slope Instability

"Landslides have played a significant role in the development of the Peace River Valley. Some of the valley slopes are marginally stable and there are many historic and currently active landslides."

"The inherent slope instability is a significant issue for the construction of a dam." (13)

(Two plates showing BC Hydro's record of demand exaggerations.)

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(1)
(2)

(3) From Site C Environmental Impact Statement, July 1980;

(4) "The Quaternary Stratigraphy and History of Valley-Fill Sediments in the Charlie Lake Area (NTS 94A) of Northeastern British Columbia" plus "Quaternary stratigraphy and glacial history of the Peace River valley, northeast British Columbia; Canadian Journal of Earth Science 45:549-564 by Gregory Hartman.

(5) "Stage 1 Review of Terrain Hazard Assessments and Mapping in Northeast British Columbia, Oil and Gas Commission, Final Report, 2006" by Ian H. Harder, Geotechnical Engineer.

(6) "The 1957 Peace River Bridge Collapse, Taylor, BC" by The Association of Professional Engineers and Geoscientists of British Columbia;

(7) "Stage 1 Review of Terrain Hazard Assessments and Mapping in Northeast British Columbia, Oil and Gas Commission, Final Report, 2006 by Frank Maximchuk, Senior Geotechnical Engineer.
(8) http:www.globallethbridge.com/Newfoundland+announces+massive+energy+deal/3848716/story.html
(9) "Site C Seminar Outlines Potential Hazards" by Andrew Watson, project engineer for BC Hydro;

(10) http://www.the globeandmail.com/news/british-columbia/bc-hydros-site-c-dam-faces-fiscal-regulatory-minefield/article15579932/
(11)

of Potential Downstream Changes from Site c operations-Preliminary Findings.pdf
(12) http:catalystforscience.ca/pdf/10/ESS/NRCLandslides/Notes-Landslides.pdf
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