Comments on the Considerations for the Embro Dam Environmental Assessment.

By

Donald Campbell, M. Sc., Landowner, [redacted] (not in the watershed but a taxpayer)

21 May 2016

Introduction:

We were told the undertaking of the Class Environmental Assessment has been by The Upper Thames River Conservation Authority and The Township of Zorra.

There have been two public meetings regarding this Environmental Assessment for the Embro Dam. At the first, June 23, 2015, the subject of Dam safety and stability was addressed and the existence of two engineering reports that were both in agreement that the Embro Dam did not meet current safety and stability specifications for earthen dams were made known with no details given. (Acres International, 2007 and Naylor Engineering Associates, 2008). The liability of the owner was also discussed briefly with no real understanding given of the gravity of the liability, as outlined by Rylands v. Fletcher, 1868 (LR 3 HL 330), the standard for strict liability in this country, and with very direct application because it is about liability and negligence of a dam that gave way. The balance of the meeting was taken to describe the process of Environmental Assessments and the methodology that would be undertaken by the Upper Thames River Conservation Authority (UTRCA) and Ecosystems Restoration Inc., (ER) a consultant.

At the second meeting, May 10, 2016, the results of the study for alternative suggestions with what to do with the Embro Dam site were presented by an employee of Ecosystems Restoration, Mr. Wolfgang Wolter. Results were presented from 2 draft reports from 2015: one on existing environmental conditions including 4 appendices, A, B, C, D, (by UTRCA) and one on existing geomorphic conditions (by ER), augmented by several poster boards and power point slides, not all illustrated in the reports. It was evident that the presenter knew very little about the data collected by UTRCA and its implications on his work for solutions on dam safety. As two examples, he did not know the data for a 50 year, 8 day snowmelt event, the standard that he or the company was apparently working to. Nor did he know any details about the cyanide levels that were above provincial guidelines. The details on the Cyanide concentrations have since been added to the presentation slides and the levels of Cyanide are almost double the MOE standard. In my opinion, at that level, it ought to have raised eyebrows to determine the source. The concentration of 0.092 ug/g is an equivalent concentration to 0.092 mg/kg. The LD_{50} for cyanide compounds vary from 5 to 11mg/kg orally and from 11 to 100 mg/kg for inhalation or dermal exposure. (Science Lab.com, MSDS information). Data for Hydrocyanic acid is available from the Center for Disease Control at http://www.atsdr.cdc.gov/toxprofiles/tp8-c3.pdf and this can be lethal at dosages of 100 ppm when breathed for as little as 10 minutes.

At the second meeting, several topics that had not been mentioned in the first were brought forward: as examples, the possibility of extending a cold water creek for some distance, possibly 2 kms, downstream, and increased accessibility for fish to the upper levels of the watercourse without the obstruction of the dam.

No mention of the liability, or summary of the engineering reports, or meteorological data were brought forward at the second meeting and no mention of the usage of this conservation area facility was made.

Only two questions regarding costs were asked by the Mayor of Zorra: how much, and who pays? The estimates of costs were given verbally as the estimate from the engineering company in 2007-8 of $200,000, and so a probable $300,000 today, with additional costs if one of the more sophisticated schemes were selected.

I asked several other questions at the time, including the effort put into looking for Jefferson's salamanders, a species at risk, cyanide concentrations, liability, shallow well location, and others.

My overall analysis:

In determining a course to take on the analysis of this project, I have read both engineering reports by Acres International and Naylor Engineering Associates and the draft reports and appendices of 2015. I have copies of the two draft reports and have attended both meetings. I also have firsthand knowledge of the effects of Rylands v. Fletcher, the law case.

There does not seem to be any conflict that there is either maintenance required to upgrade the Embro Dam to current standards or its removal to end an unsafe dam. The question of liability is the top priority for my analysis. The second priority for my analysis is total cost of the project and then how the cost is reconciled with a cost/benefit to the community.

To locate this pond, Acres says in at least 3 instances in their report that the pond is south of the village of Embro, Naylor says it is north of the village. Acres is not correct. Both engineering reports say the dam is on Spring Creek while the UTRCA calls the watershed the Youngsville Drain. The creek in the watershed immediately west of the Youngsville Drain is called the Embro Creek in the UTRCA report. I will use the nomenclature of the UTRCA in this report.

To make a good recommendation on Liability, one needs good facts on which to base the risk of a failure of any kind, and some understanding of the facts that might provoke a catastrophic failure with all of the water behind the dam set free.

None of the 2015 reports including appendices have any weather data in them, and there is no mention of what the storm event is, in numerical terms, for their standard or whether we are experiencing more frequent, or more severe weather events, although those of us who do live in the area know that, in fact, we are experiencing heavier rainfalls in shorter time spans, more frequently. This is confirmed in the Acres report in a comparison of Tables 6.1 and 6.2. The liability of this project ought to be determined by accepting the simulation data of the chosen rainfall events in the Acres' report with ensuing run-off and watershed loading into the dam catchment area, the rate of rise into the catchment basin and the rate of water exit from the catchment basin. That material shows that in only two incidents of historical weather events does the dam overflow the crest by simulation. It ought to be noted that in Figures 6.5, 6.6 and 6.7 of the same chapter of the Acres' report, the simulation calibration curve is higher than actual in each event modeled. This model could now be run with both the current weather data and proposed systems to estimate differences in downstream water flow and potential damage to downstream property. Without such a mathematical approach, all else is but a guess. It ought

to behoove the UTRCA, as owner, that there might be at least an educated guess, rather than a blind faith approach with regards to their liability. However, there is the shoe on the other foot that might argue that the removal of the dam facilitated immediate runoff and damage that would have been less had the reservoir been maintained, and so the owner could be deemed negligent for its removal. See the last paragraph of page 6-23 of the Acres' report.

The application of Rylands v. Fletcher in this country is well known and I have used the principle and case against the Township of Zorra for the loss of trees to their roadside spray programme. The principle of Strict Liability is forthrightly set out in this case.

To illustrate how difficult it is to attempt to quantify risk from these reports (as measured by the volume of water withheld by the dam) consider the data regarding the surface size of the pond. Without the surface size, it is virtually impossible to define volume withheld in the dam catchment.

In the executive summary of the Acres study, the area of the pond is stated as 0.008 km^2 or 0.08 hectares. In Figure 1 of the same executive summary the area is stated as 0.005 km^2. In section 3.1 of the Naylor Engineering report, the area is considered to be 6500 m^2. On page 3 of the Existing Environmental Conditions report the area is given as 0.8 hectares, and the site is further expanded on Page 17 as a structure of 91 meters and a lake 183 m long by 91 m wide. Then to complicate things even further, Appendix F of Appendix D suggests that in 1959, "the new structure is 300 feet and a lake (600 feet at the dam narrowing to 200 m x 300 feet long)". On May 17, 2016, I went and measured the pond with a Golf Buddy, a laser device claimed by the manufacturer, Deca Systems Corp., to be accurate to within 1 yard or 0.9144 m. My measurements were as follows: the dam is 91 m. from outside lateral edge to outside lateral edge. The distance within the pond from the dam to the inlet (a large granite boulder on the east shore) was 183 m. (See photo on panel 12 of the Environmental Highlights powerpoint presentation : http://thamesriver.on.ca/wp-content/uploads//FloodStructures/OtherStructures/Embro-PIC2-UTRCApresentation-2016-05-10.pdf. There was a further 45 m to the culvert at the road. The narrowest point of the pond was 137 m. from the dam, and at that point, the pond was 40 m wide. The water width at the outlet structure was 77 m. There is additional surface area at the same level as indicated in the Existing Geomorphic Conditions report in Figure 1-3, but in this figure, they have a rise of about 0.1 to 0.15 m from the culvert on road 84 to about the station XS11 at 400 m. on their scale of chainage with no reason in the Thalweg to have a rise in water level.

There are considerable differences in the description of the pond, and the closest to my measurements, although it overstates the area of water at the existing overflow level, is that of the UTRCA at 91m x 183m. or 16,653 m^2. My measurements indicate that it would be 9,934 m^2 if I treat the area as a rectangle and triangle attached. Both of these methods overestimate area due to the narrowing of the pond on both sides and so for convenience sake, 10,000 m^2 might be reasonable considering the area above the 183 m distance with the same surface level. In any event 10,000 m^2 is one hectare so the errors in the various reports are substantial and make quantifying the volume of water in the catchment nearly impossible and verifying it no better. That ER has calculated the volume of 30,000 m^3 as the possible catchment volume as reported in the second presentation, would mean that the current pond would have sides at 90° vertically for the whole of the area and that the dam would be overridden for the whole of the length. From their Figure 1-3, this is not the case. Once again, this significantly overestimates the potential liability.

With respect to costs, the presenter, Mr. Wolfgang Wolter, a senior project manager of ER, said at the meeting, that the estimates from the engineering reports were in the neighbourhood of $200,000.00 and that inflation from 2007-8 to now meant that that would be $300,000.00. Mr. Wolter considered that as moderate in the descriptions on the slides that considered costs. Only Acres estimated costs for rehabilitation and at less than $81,000. 00, (Table 11.5 in Acres' report) and therefore the verbal estimates of costs were not particularly accurate, given Mr. Wolter's formula for inflation, unless things have become much worse than he projected or the designs are incredibly cost intensive.

At some time in the past, and within the last 25 years, this pond has been drained and the silt cleaned from the pond floor, although this was not recognized in the questionnaire in Appendix E of the Acres' report. It is the recollection of both Mr. Fred Munro (personal communication) and me that the excavated silt was all deposited on the south and west face of the dam. On inspection by the author on May 17, 2016, it was observed that there was considerable earthen support for the back slope that extended to almost half the length of the dam or about 44 meters from the west. It also appeared that the fill on the backside was higher than the water level in the pond at the level of the current overflow, although I had no way of measuring that easily. This surface sloped off down the hill but was considerably less steep than the 1V:4H recommended in the engineering reports and for a much greater distance than was suggested in those reports. What may need to be incorporated, may be the seepage layer and drain that, in all probability, was not installed at the time, because that fill was placed prior to the engineering reports. This silt removal may also make the predictions by ER of the silting rate moot, because the rate with the current silt levels appears slower than it really is.

At the second meeting, it was stated that 3 shallow wells (that were unable to be identified but were of concern for effects if the pond were drained), as discussed in the meeting would be indicated on the Figure 7 of the Environmental Conditions report once posted on the website for general distribution. In fact there are 5 noted on the updated Figure 7 of the UTRCA. Further to my discussion with Mr. Fred Munro, Ornum Farms now rely on two drilled wells for the farmstead on Lot 16 Conc.4. that are both artesian and overflow constantly. The blue dot in the upper left corner of Figure 7, may be a well bore, but it is on top of the hill and is the exit for a manure transmission line that is below the creek bed, as some security to avoid spills. All the shallow wells marked are on the property of the UTRCA and therefore only impact the owner of the dam. However, the flow from the wells may have biased the conclusions for recharge mentioned in Appendix A of the UTRCA report.

There are several other areas that require comment. The first is the suggestion that a cold water creek could be continued below the dam for up to two kms. At no time has the measurement of water temperature or flow been considered from the Embro Creek to the west, which joins the Youngsville Drain, estimated at 400 m south of the overflow of the Dam.

It should be noted that the diurnal temperature of the upstream flow in Figure 9 of the Existing Environmental Condition study and again as Figure 2 in Appendix B, is such that daytime upstream water temperatures are nearly the same as those downstream of the dam, and if plotted as Daily Maxima against each other, the difference would not be very great. Figure 3 shows that the upstream water temperatures are higher than the downstream temperatures at some times in the day, but if both curves in Figure 3 were integrated, it is obvious that there is more area under the downstream curve than the upstream curve so, there is more heat energy in the water downstream than in the upstream water. It is the night time minima that remain

different. This suggests that the water mixing in the pond would be different from day to night. The daytime mixing would occur on the surface of the pond because the water is of similar temperatures and the night time mixing would have the colder water subsiding as it entered the pond. Therefore, at night the flow exiting the pond would be surface water pushed up and out by water entering and staying low, and the water exiting will be warmer than the inflow from the calorimetric effects of the past day. Daytime overflow would also be surface water exiting but a mixture of old and new water if the currents managed to get new water to the overflow structure in the day. It would appear as if cooler water temperatures in the upper part of the watershed might be maintained more effectively with more tree cover. During the early 1980's, I did own the west part of lots 17 and 18, conc. 4, which did include this drain, and there was almost no tree cover on the creek on that 150 acres at that time.

With regard to fish and the effects of the dam on their accessing the upper reaches of the drain, the species count above and below differs by 13, with more below, as shown in Appendix C. No mention was made of those species that were cold water fish and those that were not. Thus the benefit for extending the range or the accessibility of the cold water creek is not well defined in this report.

Without the temperature data and flow rates from the Embro Creek, no estimate of the calorimetric data can be ascertained from this report and therefore no real estimate of how far below the dam the cold water creek might realistically extend. It is unlikely that it would be much past the confluence of the Embro Creek.

A further area for comment is the water flow data in the Environmental Conditions report and Appendix A .There were no HOBO measuring devices or any flow meters of any kind on any part of this water system within a reasonable distance to measure water flows. On page 11 it is assumed that the weather patterns for Embro and Harrington are similar. That is not a particularly good assumption. Mr. Charles Munro kept weather records while he was alive and in a discussion with him, he said that his farm at lot 16, conc. 4, immediately north of the pond on Road 84, received 2" (5 cms) more rainfall a year than Braemar, a small hamlet just 4 miles (about 6 kms) east of the Embro Road (County Road 6) on road 84. Harrington gets more snow than the Youngsville drain as the nominal southerly limit of a snowfall line is about Brooksdale. (It was pointed out to Mr. Wolter and Mr. Goldt at the meeting in June of 2015 that there was a good dataset of precipitation near the Harrington water shed with Mr. Robert Matheson on the 31st Line. Whether that dataset was obtained is not known.)

Thus comparisons made by extrapolations made this way of apparent water flows between the Youngsville Drain and Harrington watershed are not reproducible in any scientific way. There is no scientific reason to join the data points in Figure 9 of Appendix A, because these are one day measurements not continuous measurements, and it would appear as if the readings on 11 June 2016 indicate a difference in weather pattern. Unlike section 6 of the Acres' report, there was no detailed calibration to observed measurements over time to attempt to justify this method. As well, although shallow aquifers are mentioned in both water sheds, no mention was made of artesian wells overflowing within 300 meters of the Embro Pond inlet. In any event, the flows measured and reported do not come anywhere near the 50 year, 8 day snowmelt that is the standard. Nor do they represent a rainfall event like the one in 2000, or the one in the mid to late 80s when we received more than 180 mms (7 inches) of rain in less than 36 hours in early June. When the method for estimating flows and water level rises was so clearly laid out in the Acres Report at 6.2, the reason for not using that is not understood.

There are other minor errors in the text of the Geomorphic report. In table 1-1 section 1, there is no separation of the drain from Private property by trees. All of that land including the Youngsville Drain is on that farm, which has been in the Munro family for 5 generations now, and it has been private for all five generations.

Within the Environmental Conditions report, it is not really reasonable to present data in charts with the lines joining the points because all data reported are taken on a particular day with 4 sample dates, and amount to "snapshots", rather than peaked, continuous curves as shown.

As a plant physiologist by training, the comments about orthophosphorus availability and uptake on page 5 of Appendix B, are of questionable accuracy. Normally phosphorus is absorbed by specific root clusters in the top few centimeters of soil while the plant is in the juvenile stage for most grasses and cereals. This occurs well before mid to late summer, as Winter wheat absorbs 90% of its phosphorus by the time it has reached 25% of its growth. In maize, the uptake continues past anthesis but at a declining rate, with almost no uptake at or beyond physiological maturity in the fall. In a study on phosphorus loading into Holiday Creek by researchers from the Canada Center of Inland Waters in Burlington, results showed that 50% of the phosphate that entered the stream was adsorbed onto soil particles. That experiment centered on my home farm at Lot 16, conc.1, less than 3 miles west of the Dam. This effect is illustrated by comparing suspended solids in Figure 9 with the phosphorus data in Figure 6 of this same appendix. With the current undertaking by Canada and the United States to reduce nutrient loading into watercourses emptying into Lake Erie, particularly phosphorus, more emphasis ought to be given to remediation that does cause settling out of suspended solids with the associated clean-outs over time, than has been suggested in this report. At the very least, the terms of this international undertaking ought to be known before implementing any changes to this watercourse. It is a chance to lead, not redo once things are better understood. Within the last few slides of the second meeting that outline pros and cons of each choice put forward, silt deposition and impedance of silt transport are always considered as negative effects. These two processes do have the advantage of decreasing Phosphorus runoff and ought to be reconsidered as positives within the new phosphorus control initiative between Canada and the United States.

To conclude the second meeting, Mr. Wolter said that the data from all of the reports and public input would be used in a "risk matrix" to come up with the best solution. This would include the cultural, economic, technical and environmental material and suggestions put forward, mostly by the UTRCA and ER.

The current science to deal with weather simulations is an iterative approach because of the number of possibilities that arise to predict weather. The same sort of approach ought to be undertaken here because each of the four main criteria have several divisions within each group and so every choice offers a different outcome. Using a linear or non-iterative approach will bias the results to the method of input of choices. For a description of the weather prediction process, it is described in the lecture given by Dr. Tim Palmer of Oxford University in Waterloo, Ontario on May 4, 2016 that is available on the website of The Perimeter Institute in the Video Library. The title of the lecture is Climate Change, Chaos and Inexact Computing.

The second presentation includes comments about building a natural watercourse in some options suggested. I would like to point out that in the case of the Van Mannen Drain

heard before the Provincial Drainage Referee, The Township of Zorra's lawyer argued that any improved watercourse was no longer a natural watercourse and that was accepted by that Referee. This watercourse cannot be re-established as a natural watercourse, unless the dam is removed and everyone just walks away. The proposals are anything but natural watercourses.

Conclusions:

It is particularly discouraging to see the lack of quality in a report of this kind. It has very little data on which to make decisions that significantly impact both owners of dams and taxpayers. There have been major oversights not to include weather data of any kind when there is data available. There have been some considerable overestimations and underestimations in pond volumes and underestimations of dam profiles on the south west surface. There has been some misrepresentation of data by presenting graphs with continuous lines rather than points, because there is no continuity to the dataset used. And there has been a great amount of disinterest on getting the facts accurately reported for the meetings by Mr. Wolfgang Wolter. He has not had the information when he ought to have. It makes for very discouraged tax payers who foot the bill for such so called experts or consultants.

To my mind, there are only two choices for the future of the dam. Both engineering reports say the risk of failure of the Embro Dam is very low, even if the dam is topped by overflow. While the nomenclature of the wording has been changed by the Ministry, (the lowest class of risk is now "low") a dam that meets safety and stability codes still might be an acceptable risk. The choice ought to be the cheaper of only two projects: to take out the dam completely and fashion a simple watercourse to take the 50 year event as outlined by Acres at 6.3.5 for the spillway with the additional 3 m^3 capacity for the normal drop inlet volume, or follow the Acres and Naylor reports and refurbish the dam. By adding the shell as Naylor Engineering Associates Limited describes it, some additional height will be added, and from the data in Tables 6.8 a and b and 6.12 of the Acres' report, it would appear as if that may prevent the dam from being overtopped. I suspect that the fall between the culvert on Road 84 and the current dam outlet is some of the steepest on the immediate watercourse, and so the construction of the 230 m of watercourse to withstand the 50 year event, may be the more expensive option of these two. Any other choice is not warranted from the current reports because of the lack of good data on which to base choices.

I realize that part of the decision process will rest with the owner, their outlook to liability and the purpose of having such a small holding for day use and how they want to manipulate the environment to suit their mandate of the Conservation Authority Act. In any event, the cost incurred for the benefit of the few day users, or cold water access for a fish population will be high when stated as a cost per use per day. That cost can only be offset by the decrease in liability of either of these two choices when compared to the present risk and liability. Having two engineering reports that agree that the dam is not up to current specifications does document negligence if neither report is acted upon, and the dam fails. It is a wonder that no report is included from the Risk Management Advisor of UTRCA, when such a position exists, because risk is also a part of the environment at this site.

References:

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http://thamesriver.on.ca/wp-content/uploads//FloodStructures/OtherStructures/EmbroDam-EmbankmentStability-NaylorOct2008-REPORT.pdf

Material Safety Data Sheet, Potassium Cyanide:
http://www.sciencelab.com/msds.php?msdsId=9927707

Material Safety Data Sheet: Sodium Cyanide:
http://www.sciencelab.com/msds.php?msdsId=9927711

Toxicological Data for Hydrocyanic Acid: http: //www.atsdr.cdc.gov/toxprofiles/tp8-c3.pdf

Rylands v. Fletcher URL: http://www.bailii.org/uk/cases/UKHL/1868/1.html

From: "Don Campbell" <[redacted]>
To: "Goldt Rick" <goldtr@thamesriver.on.ca>
Date: 5/25/2016 8:09 PM
Subject: Embro Dam
Attachments: Report on the considerations for the Embro Dam Safety Considerations.docx

Hi Rick:
I seemed to have a problem with saved files on the weekend and realized that you did not get the complete file. I hope this sorts that out. I ought to have commented that the option with the pond beside the creek would leave the area subject to mosquito production if there were no flow through that pond, and hence the very real probability of West Nile Virus and possibilities for both Malaria and Zika if there is any movement in the mosquito population that harbours that virus. In any event, that pond offers some real risks for the UTRCA. There ought to be 7 pages in the attached file.
Don

Comments with regards to the Class EA for the Dam holding the Embro Pond

From Donald Campbell, [redacted]

Two engineering studies in the hands of the Upper Thames Conservation Authority have apparently shown that there are problems with the integrity of the dam holding the Embro Pond. It was stated that the construction of this dam in 1958 or 59 is now not up to "current standards" and therefore this Class EA has been undertaken.

This appears to be a problem of insurance risk based on Rylands vs Fletcher (1868) LR3 HL330. This does not seem to be an environmental or ecosystem choice, nor a flood control choice. The fact that engineering reports have shown definite weakness within this dam is a cause for a duty to care. That means the choices for that duty to care are that either the dam and spill way are made sufficient to withstand a current big rain event, or the structure is removed and the rain event is now an act of God and so damage exempt from insurance claims.

While the public was invited to comment on a presentation by the Ecosystem Recovery employees, they really did not define the problem in definite, clear terms. I asked the question and received no defined answer for the problem to be solved. There was no definition of what aspects did not fit current construction standards, except to say some angles were wrong and perhaps the materials and core were not proper, but no criteria for data selection were given.

Without the problem being specifically defined, there can be no assurance that data collection that Ecosystem Recovery undertake are relevant to the real problem, however they may relate to an undefined problem and bigger report and consulting fee. In discussions after their presentations, I suggested to Mr. Wolfgang Wolter that many of these studies must have been because of pressure from insurance companies and the strict liability imposed by the historical definition of that in Rylands vs Fletcher. Mr. Wolters agreed that insurance companies played a big part in especially American studies on dams, and the risk of payouts by them, although he had, as far as I could gather, never heard of, or read the court's decision in this case (which is a case involving dams).

For that I submit that the decision can be found at the following web address: http://www.bailii.org/uk/cases/UKHL/1868/1.html

It is somewhat disconcerting to think that The UTRCA has not defined the problem before hiring another engineering firm to do research on the solutions for the dam's conditions when they have two engineering reports in hand on which to base a defined problem. I for one have never seen a problem resolved without the problem well and narrowly defined because collecting and analyzing any data may not be relevant and only relevant data need be collected and analyzed.

The original dam apparently held 3000 cu. m. and the pond has since silted in. The angles of repose of the dam are apparently not what they would be if built today. The mapping of the silt in the pond had been done but no calculation on volume change had been made. Whatever the volume of water held now, it is less than 3000 cu. m. because of silting and so all the pressures on the dam are reduced from the initial build. It would seem that the challenge now is to consider the effect of a big rain event on the overflow capacity, because the effect of a rain event will be to raise the water level at a rate that will be determined by the rate of inflow less the rate of outflow. If the spillway is sufficient, there should be no more water force on the dam than with a full pond. If the inflow is greater than

the outflow, the water will rise and pressures on the dam will increase for at least the duration of the rain event, or until the outflow is equal to or greater than the inflow. This is a fairly simple calculus to determine those changes. While the angles of repose may not be correct, the only changes that can be made are with materials added to the current structure and that will entail either working under water or drain the pond to add and shape the wet side of the dam. Adding more to the berm will not change the core weakness if that is contained in the current reports.

It would seem that if the dam is to be maintained, the safety of the spill way is the most important aspect. That would entail sufficient capacity to take the overflow and sufficient protection to avoid any and all erosion from that flow, since any wear on the backside of the dam will be subject to massive erosion and dam failure. While the watershed for this project was measured at some 7 or 8 square kilometers, the actual watershed of the creek that flows into the Embro Pond is more like 325 to perhaps 500 hectares, and while the runoff from the whole watershed would affect downstream owners, there would only be the additional volume currently held by the pond should it fail catastrophically. If that one time surge is too great a risk for damage to houses on the north edge of Embro, then there is no option but to remove the structure to avoid failure.

The silt currently in the reservoir is only a problem if there is a catastrophic failure and it would leave the site relatively quickly in that failure. By definition, silt is highly erodible and easily carried by water. This material in the base of the pond has all been washed away once, so there will be no effort required to have it move again. Therefore, if the dam is removed, this silt needs to be removed so it will not change ecosystems downstream in a big rain event.

If the dam is to be removed, then it would seem to be wise to contract the silt removal for sale, hopefully with the possibility of silt sales equaling dredging costs. I have removed materials from the pond on Lot 16 in the first concession, and we had Higgs Construction remove the materials from the pond with a 2 cu. yard bucket dragline and then let those piles dry out before trucking. They had no trouble reaching 100' out into the pond for collection of materials. There are a number of contractors selling soils, so there is opportunity for competitive bids for the sale of this material.

The restoration or rehabilitation or additional construction to upgrade to current standards for this dam is only justified if there are ecological, habitat, or flood control benefits that outweigh insurance risk. It will incur costs to remove the dam or shore up the system, but the major risk is the liability. Please be straight with whatever solutions are proposed and the liability ought to be first on the list. My feeling is that not much data need be analyzed for that, beyond what the insurance companies have already told you.

Donald Campbell