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UNDER THE WATER POWER ACT

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MONDAY, MARCH 23, 2015
UPON COMMENCING AT 10:00 A.M.

THE CHAIRMAN: Okay, I think we are ready to go.

Good morning. We have two presentations today. First of all, we would like to apologize for the half hour delay in getting going. However, as most of us know, computers can be very frustrating and even maddening at times, especially when they won't work when they are supposed to, or when they don't work when they are supposed to. But we have a new computer and new recorder and we are ready to go now.

First of all, I would just like to remind people about cell phones. Please turn them off. If you need to take a cell phone call, please leave the room. Otherwise, we will throw you out in the snowbanks.

First up this morning we have Peter Zuzek from Baird and Associates, who will talk a bit about erosion on Lake Winnipeg. Baird did a paper for us, which was made available a number of weeks ago, so I assume that we have all seen it.

First of all, Mr. Zuzek, we do swear

witnesses in, so I will ask the Commission secretary to take care of that.

Peter Zuzek: Sworn.

THE CHAIRMAN: Thank you. And just go ahead.

MR. ZUZEK: All right. Thank you, Terry. Good morning everyone, and good morning to those that are watching a video.

So the topic for the presentation today is Lake Winnipeg erosion accretion processes. And I think we are all very, very familiar with the geography here. This map, I think, really hits home the vastness of the watershed that we are looking at, the issues with respect to water supply and how that affects the shoreline on Lake Winnipeg.

So as far as what we are going to do today, cover seven pieces, talk a little bit about Lake Winnipeg water levels, specifically why they are important and how they are important to shoreline evolution. We will talk about shoreline types, erosion and accretion processes. A little bit about erosion rates and context, and share some thoughts with rates in other places in Canada. And then a couple of case studies that I

would like to talk to you about today to further explain the erosion processes and how water levels influence erosion. And then finally, some thoughts about further studies that could be conducted here in Manitoba, if desired, and then we will conclude with questions.

So a little bit about water levels, and this is a graph or a version of it that I think everyone has seen many, many times. And I think the few key things that I want to just reiterate as we get going here, what is important for the work that we do with respect to shoreline evolution, and how shorelines respond to fluctuating water levels.

And when we look at this graph there is obviously some key things that happened since regulation started, and that's the range of water levels has changed on Lake Winnipeg, the range has been compressed. So prior to '76 we had much higher highs and we had lower lows. And then the shift here, once the regulation started in full swing, we've compressed or narrowed the range of water levels. And that really is the question as to what are the influences of doing that on the shoreline, and how does that potentially affect

shoreline evolution, shoreline erosion and accretion processes.

And the next slide here is something that I have borrowed from one of the other reports, Hesslein. And it is an interesting graph for me and the work that we do, it is from 1976 to 2012. The blue is what has been measured, so it is the mean or wind surge eliminated level of Lake Winnipeg, and you can see that it is bounced around roughly between 711 and 715 with a couple of exceedances. The red is the calculated, or estimated level of the lake if regulation structures hadn't been put in place. So if we weren't regulating Lake Winnipeg, the flows were still occurring in a natural way as they did prior to 1976, what would have happened. So with that hypothetical what would the water levels have been had we not started to regulate Lake Winnipeg and make the modifications to the outflows that we did.

And there is, again, some key things to note there, that while we had some exceedances of 715 in the last decade or so, those exceedances would have been even higher had the dam and operations not been put in place. So, again, what

we see here from this graph is that we've compressed the range, we have narrowed the range that the water levels fluctuate now on Lake Winnipeg.

Okay. A little bit about shore types, and shore types are important because geology matters. So when we start to think and talk about how shorelines respond to water level fluctuations, it's always important to start with the geology. That's the framework for the shorelines that we have, and how they respond to fluctuating water levels does depend on their geology. And by and large, bedrock shoreline like we have here, this is on the southwestern tip of Elk Island, is generally stable. There are some very minor and slow erosion processes occurring, but on a human life scale, they are very small and barely measurable in many cases. So a shoreline like this, the bedrock shorelines in Lake Winnipeg are generally not sensitive to water level fluctuations with respect to erosion.

And then we switch to the cohesive shorelines, and we use the term cohesive to be a broad category representing the consolidated glacial settlements that we have in this basin.

And this is the case where the bank is quite low here, a low plain type shoreline, but you can see by the photograph that the entire near shore consists of clay, as does the bank. And these types of shorelines are very sensitive to water level fluctuations, as we will talk about in a few minutes.

There are also many locations where you have these large sand deposits, and these are different than dunes in that these are glacial outwash deposits. They were formed during the deep glacial period. So these are not modern land forms, these sand deposits, they have been there for thousands of years. And depending on the elevation of those features and the elevation of the lake, they tend to have an eroding profile to them, much like a bluff or a cliff, but it is important to understand that these sand deposits have been in the region for a long time. So they are not modern, they can be quite old, and they are also sensitive to water level fluctuations.

And then we switch to depositional beaches, beaches that are stable and creating sand, and Grand Beach is a good example. The head land here at the western end of the beach anchors

this deposit, the barrier beach system, it is quite stable. It is also a very popular recreational destination. It responds differently to water levels because of its stable nature. And so there certainly are changes to the beach as water levels go up and down, but because it is gaining sediment, there is a net accretion to this beach in the long term, it is less sensitive to water level fluctuations.

And then we get to the southern end of the lake, and this is again a broad category here that we refer to as muddy shorelines. And these, again, are generally low profile shorelines. Sometimes the sediments consolidate or are partially consolidated. They are very dynamic, they are changing.

I know the hearings also heard about the influence of isostatic rebound and that impact on the lake surface, and this is an area certainly that is sensitive to the water level extremes and very dynamic and changing.

So the last few slides are really just to put in context some of the next discussions here with respect to erosion, a few basics, and I think just to sort of set the context. The first

one is that erosion is a natural process. Erosion happens on almost all of the lakes in Canada, it happens all around the world. This is not a unique situation to Lake Winnipeg. It is also an important part of creating the ecosystems that we have around the lake. In a general sense, when the forces associated with waves and currents exceed the resisting properties of the soil, you have erosion. And it is not really much more complicated than that. When you have storm events, those storms bring waves to the shoreline. If there is more energy in that wave and the currents than in the soil, it is going to erode the soil and it is going to happen. That's again not something that's unique to Winnipeg or Canada, it is something that happens all around the world.

Water levels, a phrase that we like to use a lot in the work that we do is that water levels don't determine whether the shoreline will erode or not, water levels determine where the erosion will occur. And I will talk about that in a few minutes with some slides. But it is a key point here that the water levels are not the trigger for erosion, it's waves and currents that trigger the erosion process. And what water

levels do is moderate where that erosion process occurs across the profile, or along the shoreline.

So, in other words, if you have very low water levels, if you are below 711 and you have a storm event, it doesn't mean that the shoreline is not eroding. It is the bottom of the lake that's eroding during those low lake levels. So, in other words, the water levels are moderating where the erosion occurs.

During the 2010 weather bomb in October, we definitely had shoreline erosion on Lake Winnipeg, and that was happening up on the beach face and on the cliffs because the water levels were so high.

Another key point I think just to sort of set the stage here is that the Lake Winnipeg shoreline eroded during the pre-regulation era. So, not to be insensitive to the erosion issue because I understand it is very important to many people, but this is not something new or something that started when regulation started.

The next graphic here is a schematic that explains some of the things that I was just talking about. This is for the cohesive or glacial sediment shorelines that we have on Lake

Winnipeg. The one thing that has been well documented in literature is that these profiles tend to have a concave nature to them. So when you take the shoreline and you slice down perpendicular shore, and you measure -- and there is a lot of vertical exaggeration in this graphic -- but it has a concave shape to it in that your near shore slopes upward and then you have your cliff face here. What has been well documented in literature is that as the shorelines evolve, they maintain that shape, the shape of the profile, because that's driven by the wave forces and the water level fluctuations that you have.

So essentially the shape of the bottom on the beaches is a direct result of the energy environment, the water levels and the waves that you have. Over time, if you happen to have historical measurements, you will see that the shape of that profile doesn't change dramatically over time, it just migrates inland.

So that's what we are showing in this graph, that in the deeper water, and in Lake Winnipeg we are talking seven or eight metres, there is still erosion of the bottom occurring, but it is at a much slower rate than it is up at

the beach, as that entire shape of the profile translates in a landward direction.

If I'm lucky we are going to make this little picture work. Okay.

So I'm going to show this a different way. All right. So this next little animation, again, this is a cross section of the near shore environment, this is eight metre depth out here, we have a cliff here, this is from some work we did on Lake Ontario, but the processes are the same. It is showing you how these profiles evolve over time. And it gets back to the graphic that I showed you earlier, that while you have a lot of erosion up at the cliff or at the top of the bank, you also have this erosion occurring on the bottom. We call that lake bed downcutting. And the erosion on the lake bottom is a really important driver, because that influences the amount of energy that reaches the beach. So it is this continuous erosion of the bottom over time that allows these profiles to continue to migrate landward and erode. If the bottom was stable for a time, then eventually the beach would stop to erode.

So this is just some output that comes

from one of the computer models that we use at Baird. Again, you see there is a little bit of erosion on the bottom here, it accelerates at the beach level, and then it continues at the bluff face.

Okay. So we are not really here to talk about shoreline erosion today, but just to put -- shoreline protection -- but to put things in context, I think that is a nice companion graphic. There are often many reasons to armour shorelines, and often riparians like to armour their properties as well. But when you have these eroding cohesive shorelines with glacial sediments, and you focus solely on stopping the erosion at the beach, or at the back of the beach where your cliff is, you don't do anything -- and you might do that with a rock structure or a sea wall -- you don't do anything to stop the erosion in your near shore environment. And eventually, as that continues to erode over time, you will get undermining failures in these structures. These structures fail.

The other factor, the change that happens in the physical environment is that while you might be successful at stopping erosion at the

bank or the bluff for a short amount of time, you still have this lowering or downcutting process out in front of the structure which makes the near shore environment deeper. And if the near shore environment is deeper, that allows larger waves to progressively get into the beach and attack the structure. So there is a cumulative effect there that over time will eventually cause these structures to fail.

Again, I'm not here to debate whether we should or should not do this type of thing to armour shorelines, but it is important to understand that when you do this only at the shoreline, or you use the shore parallel structures, abutments and sea walls, they don't last forever and they require a lot of maintenance, because the lake bottom continues to erode in front of them.

And just a last little couple of slides here on this issue of the downcutting process. There is an interesting dataset here that I want to share with you. It comes from the Lake of the Woods, and it really exemplifies this impact of the wave erosion on the bottom and how that works in concert with the erosion of the

cliffs as well. So this is a dataset that goes back to 1917. We had a system that was in a natural state pre-dam in this range, water levels 352 to 354. Then we had the post dam era. So a structure was built to generate hydroelectric power, the level of the lake was increased by roughly 3 metres. And the site has some similar conditions to Lake Winnipeg, which is why I wanted to show it. It has a lot of these eroding sand cliffs, which are common. It has the eroding banks as well. And it also has some bedrock shorelines that are very stable.

We did a lot of work collecting data at these sites. This is a sample of one of the erosion sites, some typical pictures. And this is a profile. So we collected the depths of the lake bottom, moving up into the beach environment, this shows you, the lower panel here, the location of the profile. And this gray line is the average or the mean lake level prior to the dam and prior to the raising of the lake surface. And you can see that it had a bench, this concave nature, and then a cliff. And then the whole system was changed with the lake surface being increased by 3 metres. And now at this site the waves are cutting a new

platform, and we have a new cliff here. So this wave cutting of the bottoms was preserved at these particular sites, and had the right elevation to match the pre-regulation water level conditions.

And you can see it again on this site, again, where you have -- these pictures are, the red line, the bluff today, the black is today's water level, the mean conditions generally, the gray dashed line is the pre-regulation condition. And you can see that there is almost an exact twin of the site condition where you have the near shore profile bench, or wave cut cliff, and of course that used to go up here and back. Up goes the water level by 3 metres and the waves are cutting a new platform or bench across the profile.

Okay. Slightly different track here then and talk a little bit about accretion. Accretion is an important process, beaches are important for people. One of the things that I often tell folks is that it is important to understand where the sand comes from, and on Lake Winnipeg the sand comes from shoreline erosion. So there is an interrelationship here on these glacial lakes such as Lake Winnipeg. It is the

same in the Great Lakes region. It is the same in other parts across the prairies. When the shoreline erodes, that's where the beach sediment comes from. So if you completely stop erosion, you shut down your sediment supply engine. So there is an interrelationship there. Over time portions of the shoreline on a lake like Lake Winnipeg will erode, and the waves and currents move that sand to a new location. So it is a natural cycle, it is something that we see on all of the glacial lakes.

Currents are important, waves and currents. When the waves approach the shorelines at oblique angles, they generate currents and those currents push the sand and gravel along the shoreline. So while it may erode it at one particular site, the sand may end up somewhere down the coastline because of the waves and current regime at the site.

Again, I use Grand Beach as an example because it is sort of a text book example where you have that natural head land protruding from the shore and trapping the sediment that's moving down that coastline. And because this is a positive or net gain of sand -- there you have the

dunes in the photograph here that are healthy, growing and full of sediment.

And then another interesting little case study here is some photographs from the southern tip of Elk Island. And this stems from some work that Baird has done for the regional municipality of Victoria Beach, looking at the evolution of the shoreline. So the top is again that southern tip of Elk Island, sandy environment. The photograph here in 1948, and then a 2008 image, we have taken the shoreline from 2008, which is shown in red here, and superimposed it back on to the 1948 image to look at changes. And it is quite clear there has been some significant changes to the shoreline over time. The sand spit is much larger today than it was. We actually have this sort of system of dual sand spits now. And then there has been a lot of sand accumulation in this region as well.

And that sand didn't just magically come from somewhere, it came from the eroding shoreline. So I think as we look to the issues along the shoreline, we look at management issues, it is important to understand that where erosion was occurring in one location, while that can be

perceived as a negative, it is a natural process and it does deliver sediments to other regions, which is a positive thing. So it is part of a natural cycle, natural process.

All right. A little bit here now on erosion and putting all of this in context. So we know from -- well, to start, as many of you will know, when we have erosion of a property we often annualize that erosion by dividing by the number of years. So if you lost ten metres of erosion over a 10-year period, scientists, engineers, we like to annualize that into a rate by, for example, metres per year. So I'm going to refer to these erosion rates as metres per year. It doesn't mean that they always occur at those exact increments per year, but it is a means to categorize and compare the erosion rates at different sites and within a lake system.

As we will see a little bit later, the erosion process is generally driven by storm events. So erosion is something that we certainly wouldn't generally categorize as average, but for the purpose of the comparison. So, from the handbook that was put together several years back, the review showed that on average the erosion

rates on Lake Winnipeg are .3 to .6 metres per year. Some are going to be lower than that, and there will be the odd location that's higher.

I want to skip to Lake Ontario, just to put in context another freshwater lake, very similar geology to Lake Winnipeg, similar size. We have done a lot of work on this lake for the International Joint Commission. It is a busy graph, but focus on the red dots. So each one of these red dots along the shoreline, which is the Niagara shoreline of Lake Ontario, this is Niagara Falls here, is a 1 kilometre segment where we categorized the erosion rates, historic erosion rates, we either measured themselves or done a literature review to pull together information from other sources. So we have done this around the entire perimeter of the lake where we averaged together the erosion rates on these 1 kilometre segments. The next graph plots them all. So we have the erosion rates along the Y axis here, the positives are the erosion rates, zero up to a couple of metres per year. The negatives, there is a few negatives here, this lower tail of blue diamonds where we have some accretion happening on Lake Ontario, certainly not as much erosion as the

erosion sites. Then along the X axis here are just the total number of 1 kilometre segments. So we have upwards of 700 measurements where we averaged things together on the 1 kilometre. What you can see here is that the erosion rate, the red line is the average. So the average rate for Lake Ontario is .26 metres per year. So that would put Lake Ontario somewhere near the lower range, but in the same ballpark as what we have here on Lake Winnipeg.

And then, of course, there is always going to be outliers in any type of population distribution. So there are some places on Lake Ontario that are eroding at a much higher rate, up to 2 metres per year, but not very many.

We have done a similar exercise on the Lake Michigan for the U.S. Army Corp of Engineers, and the results here are plotted in a similar way. So in this case the shoreline of Lake Michigan, open coast, about 2300 kilometres, and we had about 1500 kilometres where we had these measurements. We put them all on the graph, we averaged them all, we get .3. So the average erosion rate on Lake Michigan is .3 metres per year, about a foot per year. So, again, similar

to the lower range reported for Lake Winnipeg. And like any population distribution, again, there is outliers of some eroding much higher, but not very many. Then everything below zero here, and again it is a smaller portion, are areas where there is an accretion trend, where the sand is accumulating along the shoreline and growing beaches.

So I showed you those two examples because there is a lot of data and a lot of effort to put these two graphs together, to put in context that the rates that you have on Lake Winnipeg are not unusual, they are in the ballpark of what you have on other freshwater lakes in Canada that have similar types of geology.

And now I'm going to take you quickly here to Lake Erie to show you the other end of the spectrum. And this is some work that Baird is doing for the Elgin County, to put the geography in context, the north shore of Lake Erie here is what we are talking about. This is the Long Point sand spit, sand accumulates here and sand over at the Rondeau. This is all glacial sediments, very high sand content and silt content in these cliffs. And the average erosion rate,

particularly in the eastern end, is 4 metres per year. So .3 is high, .6 is high, but you wouldn't want to be owning properties here and losing 4 metres per year. To put it in context, I think these pictures help to really show the magnitude of the erosion rate here which, to put it in context, are some of the highest rates in the entire Great Lakes basin, Canada or U.S. side. The top of bank in 1978 here is the yellow line, and then the red is where we are in 2010, and this equates to about 120 metres of land loss over a 30 year period. It is quite astounding. So this is now the 2010 photograph in the back drop, everything that is lightly shaded here, and you can see now where the bluffs are today is lost, been eroded at 4 metres per year. So that's the other end of the spectrum.

And this is another example, just to the east of Port Burwell. This is the 2010 photo, 1978. The solid red line is the top of bank, and you can see how the contours are covering the slope here. And now I'm showing you the '78 on the right-hand side. So everything that's lake ward of these bluff contours today is lost. So in this particular location, this campground has lost

over half of its property since 1978.

Okay. So, switching gears now a little bit to some case studies to talk a little bit more about the erosion process and talk a bit more about some other things that have been done, other studies to look at the influence of water level regulation on shoreline erosion.

So this Lake Ontario study, which I just mentioned with the erosion rates, has a similar story to what has happened on Lake Winnipeg with regulation, in that prior to 1960, the outflow of Lake Ontario, which is controlled by bedrock down the St. Lawrence River, was a natural outflow. So the discharge was related to the stage of the lake and the geometry of the outflow. And you had quite broad fluctuations, as you can see here, between 1920 and 1960. And then along came the dam, the Moses Saunders Power Dam in Cornwall Messena area, a very large structure, and the bowl was to keep the lake within roughly about a 4 foot or 1.2 metre operating range. So the new operating range on Lake Ontario was meant to be 74.2 to about 75.4, somewhere up in this range here.

So a similar thing where you had this

natural system that had quite broad fluctuations that are related to the supply of water and the dynamics of hydrology, to a system where we now are controlling the levels to some degree. Of course, the supply of water really dictates the level trend, but the regulation plan does control to some degree. And the idea is that the range has been compressed or narrowed in this post regulation era.

So the work that was done as part of a very large study, multi-disciplinary study, was to look at are their ways, should we develop new ways to regulate the outflow to the benefit of more stakeholders? That was the nature of the regulation review.

This next graph is a busy one, but let me just explain it to you. So we have on the red, the levels of the lake that happen from 1960 to present. That 1958-DD is the historic regulation plan and the historic supplies. Using the computer models, if we had the regulation plan going back as far as 1900, what would the levels have been hypothetically if the dam was in place? So this is a hypothetical graph of what Lake Ontario would look like over a 100-year time

frame, based on the actual supply of water to the system with the dam in place. So you see the red there, and it is generally that fairly consistent narrow range as managed.

And then we have this blue, the pre-project with historic. And pre-project is looking at the historical supplies of water to Lake Ontario and the outflow with no modifications to the channels, no dam in place. So what would have happened on Lake Ontario from 1960 to present? And of course, what happened historically is what happened.

So, again, it is a similar story on Lake Ontario where the blue levels here in the post regulation show that without the dam, the levels would have been higher on Lake Ontario than they were actually with the dam in place.

Okay. So a little bit on some of the technical studies then, this is a site on Wayne County, it is the south shore of Lake Ontario, a place called the Chimney Bluffs, and a typical eroding cohesive profile cliff, some homes very close to the edge. So we are using a tool here that Baird has developed over two decades now called the COSMOS model. It is a numerical model

to simulate erosion processes. And some of these inputs that you require, and not getting into great detail here but just to set the context, we need to have historical and recent profile data, so what was the shore like and the bottom like historically and present? You also need to have time series water levels, time series waves, and time series ice cover. Now, the model runs on an hourly basis to simulate the erosion process, both on the lake bottom and on the cliff. Of course then also you need to have information on the geology and historical erosion rate.

So this next graph is a whole bunch of lines. These lines are representing the beach condition. So the black is again a beach profile, it is a narrow section of it, it goes out to 10 metres in depth here. We just zoomed in on the beach and we are zoomed in on the bluff condition. So here is the shallow near shore portion. This would be a little bit of a narrow beach. And then here is the vertical, a fairly steep portion of the bluff face and then the flat tablelands.

So what all of these lines are doing here, both the horizontal retreat of the cliff face and the downcutting of the near shore here,

we are giving you different estimates for different water level sequences. The waves are exactly the same for all of these modeling simulations. The only thing that's changing is the water level.

So the two that I want to draw your attention to are the two that I just showed you. The pre-project is the hypothetical natural outflow, so had the dam not been in place from 1960 to 1995, it generated the most amount of bank recession. It is the purple line. And then 1958, with deviations, is the current regulation plan, it is what actually happened with the water level, and it is sort of lined up here with the orange line for plan 1958. So the model is simulating that there would have been less recession, there was less bank recession with the actual regulation plan than the natural outflow.

So to go back to this guy, when you have all of these high highs that we had in the last 35 years, hypothetically, if there was no dam versus the red, which is what actually happened, you would get more bank recession at the site.

And this is just looking at the data in a slightly different way, where we are looking

at the cumulative recession. So the recession on the Y axis metres and time on our X axis. So I put this one in here to highlight the fact that again the erosion process is not linear or average, it is driven by the wave climate and the water level regime.

And so the plan, the water level regime that created the most amount of erosion was this pre-project scenario, hypothetically, had the dam not been built. And you can see that at the end of the simulation it generates about 19 metres of erosion. Then if you compare that to '58 deviations, again, it is the orange and red lines here.

And these climate change scenarios are really probably not that relevant today because they are some estimates of what the lake surface would have been like in the future under climate change that I would say are not technically accurate anymore. So I would just disregard the climate change ones. Really, the key thing is to sort of draw your attention to those two lines.

Okay. Moving into something a little closer to home here, Lake Diefenbaker in Saskatchewan, some work that we did with J.D.

Muller & Associates, a partnership that we did in studying the erosion at the site called Elbow Harbour. Again, I present it because it is very similar conditions to many of the sites on Lake Winnipeg. We have the eroding bank, you can see at the back of the beach, we have clay near shore here with a veneer of sand and gravel on top of the clay. So this is a typical cohesive shoreline. The clay is underneath that thin veneer of beach sand.

We had some really nice historical datasets here and they are plotted in this graph. So the black one is where the bluff was in '77, extending out into deep water here, 8 metres roughly from the full supply. And then we had in '84 beach condition and near shore profile in the blue, and then the 2000. So quite a nice sequence here that shows how both the bottom of the reservoir is eroding over time, as well as a horizontal retreat of the bluff face itself. These lines are the water levels, and this reservoir has quite a broad range of fluctuations, on the order of 8 metres. So a lot of changes seasonally in the water levels. The full supply level is around 557, and we get down below 549,

548, in some cases, so a really extreme water level range. But we plot those here on this profile to show you how during the high conditions is when the waves are reaching at the back of the beach, and during the average and lower portions of the range, the waves are hitting this portion of the profile and eroding the bottom of the lake.

So, again, without getting into all of the technical details, we used that beach data, we used a wave climate from the lake, we factored in ice cover and water levels, we calibrated the numerical model, and then we simulated the erosion changes over time. And the graph here again is showing time on X axis, '77 to 2000 roughly, here all of your water levels again, up and down, the full supply is the horizontal green line. And the red line is showing you the cumulative bluff recession. So not the bottom of the lake or that profile, but that cliff face, when is it moving and how much.

And in this particular case, because of the severe highs and lows on this reservoir, it really pulses, it is not a continuous thing at all. The waves only get to the back of the beach when the lake is at or near full supply.

So if you look at all of these steps, again, we had quite a significant amount of erosion in the '78 period, then it was constant, almost no change, jumps up again in '81, big jump in '93, '95. These tend to correspond with the peaks when the lake is near full supply, it has to be at full supply for the waves to get to the back of the beach and attack the cliff face.

So I present this to just show again that interrelationship between the water levels and the wave climate, and how that drives the erosion of these cliff faces.

And there is a few examples in the report that we presented, the sort of hypothetical what ifs, and again this is the actual data from, the black is '77, '84 is the actual condition, '84. And we say what if hypothetically you raise the full supply level? And so during these 4 years, we artificially extended the peak a little bit higher, up to 558 roughly, and what kind of implications would there be? And the blue line shows you what would happen. There would be quite a dramatic increase in the amount of bluff recession, again, because that energy is moving and hitting higher up on to the profile and

hitting the cliff face.

All right. So these sites are very sensitive to water levels, especially at the higher range. But it doesn't mean that erosion doesn't happen during the average and low water level conditions, it is just happening lower down on the profile.

Okay. We are on the second last section here. I want to just spend a few minutes to talk about potential future studies, and I stress potential, we were just asked to think a bit about what could be done in the future. I'm not necessarily advocating that you do any of these things, it is just sharing our experiences with you and things that really all of the stakeholders in the Province of Manitoba may want to consider in the future.

I think the question that is on a number of people's minds is, has regulation increased or decreased erosion rates. And I'm here to tell you today that we can't answer that question without doing some technical studies. So that's not something that you can just draw a conclusion on. It is a very complex question. It is one where you want to take multiple lines of

evidence to look at whether regulation on Lake Winnipeg has actually accelerated or decelerated erosion rates. I don't have the answer for you today, and I wouldn't even want to guess what that answer is. The only way to know what that answer is, is to do a rigorous technical study. And I would emphasize that you would want to take multiple lines of evidence to look at how the lake has responded in that pre versus post regulation scenario.

The other thing that I wanted to touch on a little bit, and this sort of gets more to the planning, is to share some experiences from the, again, the Rural Municipality of Victoria Beach, where Baird has been doing some work for a number of years now. And I just present it as a case study for people to think about with respect to management of the shorelines in the future. And when I talk about management, I think one of the trends that we are seeing elsewhere, and on Lake Ontario, throughout the Great Lakes, certainly a trend is that water level fluctuations have happened, they are going to continue to happen, and the winners in the future are going to be the people that are able to respond to them, that have

a resilient coastline. So one way to be able to manage fluctuating water levels is to have a plan. So that's what we did with the Regional Municipality of Victoria Beach is we developed a shoreline management plan with them.

So the graphic on the left is what we got when we started, and it showed all of this green land lake ward above these properties along the west coast, but reality is when you look at them today, these colour coded ones, in many cases the erosion was now on or into the private property, which was a big problem, a big challenge for them as a community. Because once the erosion started to move on to private property, the eroding bank, it no longer becomes a public beach. And of course, I think most people know that the beaches are quite important to the people in these communities, as they are elsewhere.

So the water level history here, along came the weather bomb in 2010, when we got levels up to 719. I think we have shown you today many cases of what happens when you get those elevated levels on these cliff faces, they erode very quickly and at a much higher rate than the average, which is certainly what happened on Lake

Winnipeg and Victoria Beach. They also had -- and here it's from a planning perspective, we were surprised by the lack of oversight with respect to development. And in this case example here, you can see this is a cliff failure, a bench from a massive failure. The material used to sit up here, and yet there is relatively little control about geotechnical issues and slope failure issues with respect to future development, which is quite in contrast to other jurisdictions in Canada. And then we have these sandy cliffs as well, they are eroding.

So what we have done in this shoreline management plan, and again it is something that other communities around the basin may want to think about, is pro-actively looking at and mapping where will the shoreline be in the future. So we are giving them a 25 and a 50-year estimate of where the shoreline might be, so you understand what your hazards are and what those risks are for your investments along your shoreline. There is an uncertainty band here that grows, because of course there is uncertainty where the shoreline will be the further you get into the future.

We also worked and engaged with the

community quite extensively about what they wanted with the shoreline, what is important to the community, what kind of hazards do you have, what kind of uses do you want to have for the shoreline in the future, how does it integrate with their development plan?

We came up with a series of options and ultimately settled on recommended management approaches for larger reaches of shoreline, not the individual property scale, but looking at the shoreline as a physical system, understanding the erosion and accretion processes, and doing something that's working with the physical processes, not against them. So in this particular case the idea was to build a couple of structures at the end of the beach and nourish the beach artificially with sediment from a local quarry.

So that's enough about that, it is a little more detailed than you needed, but just to give you an idea of some of the things that could be done with respect to shoreline planning in the community scale. And it is something that's done quite extensively in other regions, in the Great Lakes, for example, it is quite extensively done,

and my understanding is it is not really done that much at all in this province.

The other thing that's pretty common throughout the Great Lakes and all of the States and Ontario is hazard mapping. And this is an example of that Elgin County shoreline on the north shore of Lake Erie, and there is an entire policy regime at the Provincial level, passed down to the conservation authorities or sort of local stewardship entities, and they are required to map out where the shoreline will be in 100 years. All right.

So this is one of those areas where the shoreline is eroding at 4 metres per year. And hopefully you can see this red line is the estimate of where the shoreline is going to be in 100 years. And so if a proponent, let's say the landowner of this parcel here wants to come in and build a new home, if it is possible from a zoning perspective, most likely they want to come over and put the house right here, because they want to see the lake and have the views and hear the waves, we have all seen that. Okay. I can't knock them, the views are spectacular when you are up on these cliffs, for sure. But what the policy

regime in Ontario says, you have to be away from the erosion hazard, the new development, for 100 years. So if a proponent wants to build a house, they have to have road access and it has to be behind this red line.

So throughout all of the more developed shorelines in the Great Lakes region, and certainly throughout all of Ontario, except for the very northern portions that are undeveloped, I'm talking Lake Superior, for example, this mapping is available. So if a proponent wants to come in and say, I want to build my house, there is a policy regime that's going to make sure that house is located in a location that's safe for 100 years.

It is my understanding this type of thing is not really done in Manitoba, and that's something that could be done in the future to do a better job of the planning and to minimize the hazards and the risks that future development is exposed to.

And then I think my last slide here is just talking a bit about shorelines, shoreline communities and resilience. The schematic here is what a lot of places, communities across Canada

and the world really for that matter have done, is that linear type of development right on the shore edge, intensively developed, great views for the people that are there, a lot of hazards, has a big impact on ecosystems. And what would be nice to see, and something that I'm a strong advocate for, is a more proactive, more creative future. This may not be the perfect diagram on the right here, but it is showing a green corridor along the lake and focusing the development further inland, in tighter compact communities, in places where you are safe from the hazards, and yet still provide access to the shorelines, places where you can go and recreate, but not getting into that problem of building a home too close or putting your assets too chose to an eroding shoreline.

So I think with that I'm concluding my formal slides. Thank you everyone here today to listen, and those of you on the video conferencing, and I guess we will switch to questions through the Chair. Thank you very much.

THE CHAIRMAN: Thank you, Mr. Zuzek. Manitoba Hydro?

MR. BEDFORD: Could you give us five or ten minutes?

THE CHAIRMAN: Sure. Let's take ten minutes.

(Recessed at 10:55 a.m. and reconvened at 11:05 a.m.)

MR. BEDFORD: We don't have any questions. Thank you.

THE CHAIRMAN: I think they just made your life easier, Mr. Zuzek. Mr. Williams?

MR. WILLIAMS: No questions. Our client just wanted to say we read a lot of what Mr. Zuzek has done in Ontario and elsewhere, and we certainly appreciate that.

THE CHAIRMAN: If you want that on the record, you have to come and speak into a mic.

MR. WILLIAMS: Mr. Chair, and members of the panel and Mr. Zuzek, good morning. I just want to indicate we have no questions, but our client has read with great interest the work of Baird in Ontario, as well as for Victoria Beach, and certainly appreciate his contribution to this process.

THE CHAIRMAN: Thank you, Mr. Williams. Pimicikamak, do you have any questions of the witness? Thank you. Panel

members, Mr. Yee?

MR. YEE: Mr. Zuzek, I'm a bit of a dummy when it comes to erosion so I need clarification. A couple of your slides, the one on erosion basics, you talk about the force associated with the waves and the currents exceeds the resisting properties of soil, it erodes. And again on the other slide you have for sediment transport you talk about waves and current pushing sediment along. I just want clarification what you mean by currents? Are these currents that are caused by the fluctuation of the lake levels, or are they natural currents from say rivers entering, in the case of Lake Winnipeg they are talking about a diversion or putting a new channel in, are these the currents that you are referring to?

MR. ZUZEK: That's a very good question. Probably a clarification first, when we talk about the force of waves and currents exceeding the resisting properties of the soils, that's primarily for the cohesive or consolidated glacial sediments that we have. When we are talking about waves and currents and sediment movements in the diagram you mentioned, about sand

moving along the coastline, those would be -- it is really a different environment. It is a sandy environment, where the sand is moving along the shoreline generally. In those currents -- specifically your question, the currents are those generated by breaking waves. So they are storm-driven waves that approach the beach at oblique angles, will break, create turbulence, generate what we call a long shore current. Those currents will suspend sediment in the water column and move bed load along the bottom, and essentially transport that sand down the beach along the shoreline. So it is the currents that are generated primarily during waves, breaking waves during storm events, and not the general gyre that you might get in a lake like Winnipeg during calmer periods.

So the events that will create sediment plumes, for example, coming out of the rivers, or after a heavy rainfall event, those currents are primarily, the gyres are primarily moving fine silt and clays. And from the standpoint of beaches and how the beaches erode and evolve over time, we are really not interested in the sand and silt fraction because that doesn't

stay on the beaches. I'm primarily interested in the sand and gravel fraction, and that's moved during severe storm events.

MR. YEE: Thank you very much.

THE CHAIRMAN: Ms. Suek?

MS. SUEK: Yes. You know, the charts that you had showing pre and post regulation show lower -- that the highs have been contained and the lows have been -- are less too, you know, there is less, greater fluctuation. Some people who have presented to us feel that because the lows aren't as low either, because that's been contained as well, that the erosion doesn't have enough, I mean, it doesn't have enough time to come back. That it used to be if it eroded, it would come back because of the highs and lows. The fact that the lows aren't as low as they were, is that having any effect on the sediment being deposited or the erosion?

MR. ZUZEK: That's a very good question. Thank you for it. I think it is an important question and it is one of those -- it is a question that's hard to answer in general terms because it is -- it will depend on site specific conditions. So how much sand is in the near shore

environment, what is the geology like, what is the wave exposure like? But certainly in general, and this has been shown on the Great Lakes where there's been more scientific research, I think, than on Lake Winnipeg, as the water levels drop and during falling lake level trends, the downward dips per se, you do have events where -- you do have times where sand is pushed on shore. So water levels drop, not only do the beaches, more of them are now uncovered, because there is less water so the beach naturally gets wider, but you do have -- you can't have the potential for on-shore sand movement during those falling water levels conditions. So it is something that happens, but it is also a very complex process, and it is not one where you can just draw sort of a general conclusion, it is something that you would need to take a look at in a scientific study.

MS. SUEK: I just have one more question. You showed a slide of Grand Beach and you talked about it being a bit protected by the land there. We heard from people around Grand Beach that they were losing considerable amount of the beach, and I didn't hear that here. I'm

wondering, if you have looked at that, have they lost a lot of beach? Is that really protecting them, or what is your, what do you think about that?

MR. ZUZEK: Good question. I think Grand Beach -- to be totally honest we haven't done any specific technical studies there. We have certainly seen the beach, we have seen the photos. I would call that beach, and again this is without having done any background work there, but I suspect that it is what we would refer to as a beach that's dynamically stable. In other words, it definitely doesn't have a long-term erosion trend, because there is a beach there and there wasn't a long time ago. It is a beach that likely changes, the width will change as the water levels fluctuate up and down, partially because some of the beach is getting covered during the highs, and during the lows more beach is becoming uncovered. So there is that natural effect. There is also the movement, on-shore and off-shore sediment, and that's well-documented in technical literature. But by and large, by the nature of that head land that sticks out there, I think the beach is stable in the long term.

Now, that's not to say there aren't periods, or if you have a couple of summers of water levels above 715, you will certainly see some of your beach erode, but it likely comes back when the water levels go back down.

MS. SUEK: Okay, thank you.

THE CHAIRMAN: Mr. Harden?

MR. HARDEN: Bev stole my thunder on the effect of the low level.

Another thing that's been said is that by concentrating levels near, close to the mean by removing the fluctuations, you are concentrating the erosion at a particular narrow range of levels, and that increases the rates at those levels. Can you comment on that?

MR. ZUZEK: Another good question.

So this gets to the question or the need, in our opinion, to answer the broader question of, has erosion accelerated because of the nature of the water level change, from the broad natural fluctuation to the compressed range that we have today? When I say compressed, somewhat compressed in historic. And we studied this in a number of freshwater lakes across Canada and the United States. And until you look at that

in a formal scientific process and a study, it is very difficult to comment. Because what you really need, and this is the only way that we've seen it done in a defensible way, is you need to look at hour by hour, what water level do you have, what kind of wave climate do you have on that hour, and do that over multiple decades, and then compare that for a natural system versus the modified one.

So the computer animation that I showed you there, mind you is a little bit jumpy, but you are actually looking at 30 years of evolution of that profile on an hourly basis. So the physics of erosion on those cohesive sediments is being simulated every hour for 30 years. And so wherever the water level is -- if it is really low you are getting that downcutting on the profile. If the water level comes up high above the beach, the energy goes into the bluff and then you have that horizontal retreat.

So until you do that in a deterministic way with a tool to remove the subjective nature of trying to come to a conclusion, you really don't know. But I think that is a question that could be answered, but it

is not one where you can just give an opinion on, you really need to look at it in a formal way.

MR. HARDEN: Thank you, that was my only question.

THE CHAIRMAN: Thank you. My question sort of flows right out of Bev and Neil as well, and talking a bit about beaches. And you've talked about, at least on the Victoria Beach side of the lake, increased stability of sandy features. We've heard -- we heard from at least one witness in Gimli, in particular, who even came with a figure, and I don't have the notes from that meeting with me, about how many miles of beaches have been lost in the Gimli RM. It was significant. And actually one of the pictures in your presentation, the eroding cohesive shoreline, I know that area, there used to be a very nice beach along there. As an aside, I actually looked at buying a lot, one of these two right here in this picture, but when I saw the eroding shoreline, I didn't. That area now, as another aside, has a rock armour all the way along it, and that may pose other issues, as you've indicated. But do you know anything about the west side of the lake beaches, or if they would have been

influenced differently than the east side beaches?

MR. ZUZEK: Okay. So I guess the first point to make there, one of the colleagues that I work with was very active on the studies around 2000 that lead to the handbook, and he was the one that did the site visits to the west side, it wasn't myself. There is a couple of things that I can maybe raise to try to put your question in context, which I think is, are there less beaches today than there was historically? And there is two general things that we've observed again on these freshwater lakes across North America that can contribute to a reduction in beaches. And certainly one of them is armouring eroding shorelines. The reason I made the point of stating that, the sediment that you have on the beaches on Lake Winnipeg, most of it came from shoreline erosion. So there would have been some sand once the glaciers left, there could have been a bit of loose sediment here and there, but by and large what happened is the lake became a lake, waves were generated by wind and currents and they started to erode materials. So the source of the sand and gravel for the beaches that we do have, and the people hold so dear to them, comes from

the erosion process. And that's a really fundamental point for people to understand.

So then we go to the unfortunate property owner who has an eroding shoreline and they don't want to see their property erode, and I can be certainly sympathetic to that, and they build a structure. And then the neighbour builds a structure, and the next neighbour builds a structure, and they harden the shoreline and they stop the erosion process, and possibly for a long time, possibly for a short amount of time, whatever the scenario is depends on how much they invest in their structure. What they have done there is help their challenge with respect to the erosion, but they have cut off the sediment supply. So you have cut off the supply of new sand and gravel entering the near shore environment by armouring your shoreline, or a long stretch of shoreline.

So while I'm not in a position to draw conclusions from Gimli, but I have certainly done enough other studies throughout the Great Lakes that armouring shorelines along eroding shores with communities will result in less beaches for sure, that's well documented. There is a place on

Lake Erie where 90 per cent of the shoreline is armoured now, and we have measured dramatic changes in the beach environments in that community.

Now, the other piece that -- the other piece of information to share, which comes from one of the previous studies and that's the Lake Ontario work, when that study, and it went through extensive consultation and we were involved, heavily involved for five years. And ten years later they are just now trying to get a new regulation plan in place. So it has been a very extensive consultation process. But we heard from a lot of stakeholders that their beaches, there is less beaches since regulation. And we heard that, and a lot of people wanted to talk to the regulation itself being the issue. And we listened, and we studied that, and as we got further into the investigation and we started looking at the computer modeling that I showed you, what we have shown on Lake Ontario by compressing the range is that you've reduced the long-term erosion rate. And if you reduce the long-term erosion rate by compressing the water level range, that means you are generating less

sediment. So on Lake Ontario, again, in sort of broad conceptual terms, there is less sediment today in the system than there was in the pre-regulation scenario because the shore is eroding slower. There has to be less, we are making less sediment from erosion.

So there is a lot of interrelationships, there is a lot of trade-offs, like anything in life, along shorelines. So one action may often result in an unexpected action somewhere else.

THE CHAIRMAN: There were people, again at Gimli, who said, and I'm not a geologist, said that it was actually when the water was lower that the sand came up on to the beaches and helped the beaches, and they felt that the regulation of the lake had limited those lower levels.

MR. ZUZEK: Yeah. The simplest analogy, there is something called, there is a concept called the Bruun rule, which was developed by a gentleman called Pierre Bruun. And basically he showed that as water levels are lowered, there is an on-shore movement of sediment. And it is a bit like a tube of toothpaste, if you put your hand down on the tube of toothpaste, you are going

to squirt toothpaste up the beach slope. So it does happen, the waves and currents create -- I showed you the example where the eroding profile on that one lake that they raise the level 3 metres, the shape of the bottom is a product of the wave climate, and the water level regime. And so there is an interrelationship there between the bars, and the depths, and the slopes of your near shore environment is directly related to your wave climate, and they create an equilibrium when you are in a similar lake level. When you drop the level of the lake, all of a sudden the system is out of equilibrium because it is not as deep. So as the waves approach the shore, all of a sudden the lake is shallower than it was, and that can result in the on-shore movement of sediment. So it is -- I think the scenario that they are describing in general terms, again, I think it is possible that that's happened. But in a place like Gimli, I think to try to draw some conclusions around causation, you need to look at the broad context of the community, you need to look at the geology, you need to look at the artificial hardening of the shoreline in context of water level regulation. So it is not possible

to simply just take one lightning rod and draw a conclusion, you need to look at the entire picture, the interrelationships, all of the physical processes along the shoreline, and then draw your conclusions, again, if you can, from multiple lines of evidence.

THE CHAIRMAN: Thank you. Just an observation. You mentioned a stretch of Lake Erie where 95 per cent of the shoreline was armoured. About 10, 12 miles south of Gimli there is an area called Dunnottar where there is a number of beaches, and I would guess that probably 75 to 85 per cent of the stretch for 3 or 4 miles along there has been armoured. And there are still some areas that are unarmoured where there is not bad beaches, but a lot of the beach is gone. Whether one caused the other, I can't say. You mentioned in both your report and today's presentation that to determine whether regulation has increased or decreased erosion rates would require a technical investigation. Can you briefly describe what such a technical investigation would involve?

MR. ZUZEK: I think there is at least two things that could come to mind that you would want to do and, again, it is about trying to come

to the conclusion with multiple lines of evidence. I keep coming back to that. You don't want to just simply draw your conclusions from one thing, or a narrow range of, or range of types of science. But I think certainly measuring rates of change could be done. It may have already been done, but you could measure the rate of shore erosion in the pre-regulation and compare that to the rate of shore erosion at a site in post regulation, so simply measuring physical changes on the shoreline. That's not without challenges, because in the pre-regulation era the quality of our mapping and photographs are not as good as they are in the post regulation. But it could be done. It is the type of thing that has been done elsewhere.

Now, the one caveat with that is that the wave climate might be different in the pre and the post. So if you measured changes, and just using round numbers, the erosion rate in the pre-regulation was 2 feet per year, and in the post regulation it is 1 foot per year, or vice versa, 1 foot pre, 2 feet post, you would notice a difference in the rate. But then you would have to ask yourself, have the driving forces changed?

So you would have to quantify the driving forces of change, which is primarily the wave climate on the lake. Maybe it was wavier, there was more energy in the pre-regulation, there is less energy in the post, or vice versa. So measuring gives you one bit of information, but what it doesn't bring into it is that driver of change. Then you have the water levels and the supply of water to the system and how that's changed, so that would need to be looked at.

And then that leads us to the type of thing that we've had a chance to do in the past for other clients, and that's the computer model. And the reason we showed some of those examples today and talked about that in the report is that it pulls it all together. It pulls together the water levels, it pulls together the wave climate and the geology, and the erodibility of the soils. And it is just another piece in the tool box that can be used and it has been used in the past.

So those are a couple of things that could certainly be used. Of course, you can always talk to people too and use local knowledge, traditional knowledge is another form. Those are a few things that come to mind.

THE CHAIRMAN: So it can be done?

MR. ZUZEK: It can be done.

THE CHAIRMAN: Thank you. You also mentioned, again, both in your report and today that -- I will just read from the report:

"Compared with other Provincial and State jurisdictions with management responsibilities for large freshwater lakes, Manitoba has limited policies and regulations."

I guess my question is, do these kind of policies and regulations, are they reasonably available online? I mean, if we went to Ontario or Michigan, or somewhere other, could we find examples of this type of policy?

MR. ZUZEK: Yes. Most of the -- in the States it is primarily the Department of Natural Resources at the state level that will have guidelines for new development. In Ontario, there is sort of a dual responsibility there. Historically it was with the Ministry of Natural Resource. That's been transferred now to the Conservation authorities, and they have generic regulations, and they look at hazards, flooding, erosion, the two big ones, but they also look at

beaches as well, dynamic beach environments. And what they are focused on, these regulations, is, again, locating new development away from the hazards for 100 years. That's the premise, I will refer to that as the planning horizon.

Ontario has the largest planning horizon, or longest planning horizon in the Great Lakes. Other places like Michigan is 60 years. In the State of Ohio, at least the last time I checked, it is 30 years, more the sort of duration of a mortgage type thing. So that's something that is done.

And what I would mention is that I think, while I think it is a good thing to have such a policy, it is not the only thing that you can do either. So what these policies do is dictate where new development can occur in a safe manner. And that in itself is an accomplishment.

In Ontario, just to give the panel some background, it didn't necessarily evolve because the Province of Ontario thought that we should protect people. It happened because there is repeated claims of flood and erosion damage during high water events, and the Province realized, I think we can do something better here

and minimize the amount of people knocking on our door for compensation if we had a better policy to locate new development in a smarter location. So these are good policies.

Now, where I would say that they fall short in a global context is that in many places around the world, including Europe, they are moving to this approach of ecosystem based management. And that would be looking at your ecosystem in a whole context, and the services it provides, and making wise resource management decisions.

So when I get on my soapbox in Ontario and I start kicking sand around, I say, great that you keep the people away from the hazards, but should we develop homes everywhere, should we develop on eroding shorelines?

So there is a lot of important questions that we can ask. And of course, we can always make improvements. I'm not trying to be critical of government in any way, but we learn as a learning community over time, things that we did in the 1960s we don't do today. We don't line creek channels with concrete anymore. We have learned a lot about shorelines and coastlines in

the last several decades and we always make improvements. And that's what we should strive to do as a community. That's why I mentioned that whether it be done at the community level, more as sort of a stakeholder driven exercise, whether it is a bottom up, or whether it is more of a top down governance approach, I think there are things that could be done in Manitoba to improve the resilience of the shoreline communities and reduce hazards and result in a better, safer coastline in the future.

THE CHAIRMAN: I don't think that I have any other questions. Anybody else? Last chance?

Well, I think you got off quite easy today. Thank you very much for your presentation today. Thank you for preparing the paper that we received a number of weeks ago. This issue, shoreline erosion is a big issue with a number of people, particularly around the southern basin of Lake Winnipeg. So the work that you have done will certainly help us explain some of these things. I don't know that we will satisfy everyone, or convert everyone who has other views, but this will certainly help us in coming to

whatever conclusions that we do. So thank you.

And as somebody who has spent a lot of time around Lake Winnipeg, I would like to thank you and your firm for the work that you have done to try and save that southern basin.

MR. ZUZEK: Thank you very much.

THE CHAIRMAN: Thank you. So we are finished early. IISD will hopefully show up at 1:30, so we will come back here at 1:30 for their presentation.

(Recessed at 11:30 a.m. and reconvened at 1:30 p.m.)

THE CHAIRMAN: Okay, are we ready to go? You are ready to go, Hank?

DR. VENEMA: Sure.

THE CHAIRMAN: If you would come up to the hot seat?

Dr. Henry David Venema: Sworn

DR. VENEMA: Good afternoon, ladies and gentlemen, and thank you for your interest in this topic.

The International Institute for Sustainable Development submitted a paper entitled Strategic Large Basin Management For Multiple

Benefits, and I will present some of the highlights of that paper herewith.

So, the intent of the paper is to highlight the geographic context of the Lake Winnipeg basin, particularly its vast watershed area relative to the surface area and volume of Lake Winnipeg. And here is a map of the extent of the watershed, and it extends from the eastern slopes of the Rockies to the so-called water tower of the Winnipeg River system in Northwestern Ontario, back down into South Dakota. So it really receives water from a very, very large drainage area. In fact, the ratio of the volume of Lake Winnipeg to its basin area is by far the lowest of all of the great lakes of the world.

So you can see that the big geographic context is that the buffering capacity of the geographic processes taking place in this large basin is relatively low compared to the other large lakes of the world.

This region is also subject to climate change and the effects thereof. This is a map of Palliser's Triangle, as denoted by an early explorer of Western Canada, and the region is also noted for its high climatic variability, effects

which are expected to become more extreme under climate change projections.

Now, the intent here is to just highlight that ecosystem services from watersheds provide multiple benefits, and that includes notably climate regulation, the potential for well-managed watersheds to buffer the impacts of climate change impacts, watersheds can also increase storage capacity.

Among the ecosystem system services for watersheds is hydropower production. And as IISD has demonstrated in its work, nutrients, which is of course a very major issue with respect to Lake Winnipeg, water purification and so on, these are all ecosystem services that well functioning watersheds provide.

Now, the remainder of this presentation I'm going to focus on a particular aspect of enhanced ecosystem services from watersheds, which are particularly relevant given the nutrient loading stresses, given the climate change stresses, and are applicable across vast areas of this watershed.

The idea of using watersheds and watershed management to increase ecosystem

services is particularly salient, given the fact that we know from recent research that flooding events dominate the nutrient loads to Lake Winnipeg. So the more intense the flooding event, the more extreme the nutrient loading event. And this is actually a non-linear relationship, so it is very important to basically take the flood peak off if you want to deal with nutrient loads. And the modification across this vast landscape, as it has been settled and developed for agriculture, has really tended to exacerbate the peak flows and nutrient flows. And this is confirmed in recent research by Pomeroy, just very recently in southern Saskatchewan, the best sort of analytical work on the influence of wetland drainage on increased peak flooding events.

Now, one of the approaches that combines multiple benefits, flood storage, flood peak production and nutrient loading benefits is this idea of non-point -- sorry, distributed storage. It is important to note that about two-thirds of the nutrient load on Lake Winnipeg is from non-point sources, from background watershed processes and from anthropogenic sources, including agriculture. And one of the

approaches that combines the multiple benefits, increases the flow of ecosystem services, is the concept of distributed storage. And we have several interesting examples in the Lake Winnipeg basin, including the small dam projects at South Tobacco Creek, the North Ottawa impoundment project, and some of the work that's been going on under -- through the University of Manitoba watershed systems science program regarding regraded ditches and filter ponds and back-floated dams.

So in the analysis that IISD did on distributed storage approaches, we noted that when one calculates the value of the ecosystem services, including flood flow reduction, nutrient interception, and potentially carbon management, when one looks at the broader suite of ecosystem service benefits compared to cost, we see the distributed storage approaches have significantly higher than 100 per cent benefit cost ratio. So the -- and those benefits include avoided drought, new wetland habitat, production of biomass, carbon credits, reduced eutrophication and avoided flooding costs. Those are compared with upfront capital costs, operating costs, and the

opportunity cost of using agriculture land for this purpose.

Here are some examples of different styles of distributed storage.

Now, the broader intent of the dimension, the focus on distributed storage is within the context of methods that increase the overall flow of ecosystem services. And we regard the integration of ecosystem services with integrated water resources management as the ascendant paradigm. This quote is taken from the fourth assessment report of the intergovernmental panel on climate change, where it was stated that the paradigm of integrated water resources management will decrease the vulnerability of freshwater systems to climate change. And in the context of Lake Winnipeg, that's very important, as we know that climate change is one of the drivers of nutrient management, of nutrient loading to Lake Winnipeg.

Just a few examples where large scale integrated water resources management has really flourished in a multi-jurisdictional setting include the Columbia River basin, where you see multi-jurisdicitonal planning, adaptive

management, the innovative use of financial instruments to fund conservation and water management activities, Columbia River basin is a good example thereof, and a shared basin between U.S. and Canada.

The Murray-Darling basin in Australia is another very good example of multi-jurisdictional, collaborative, large scale basin management. And here we see, again, the use of innovative fiscal instruments, including water quantity trading, to manage competing stresses in the basin. So we are seeing the application of financial instruments to manage ecosystem services as part of an integrated water resources management paradigm on a large scale more so throughout the world.

Other trans-boundary basins that we have reviewed where this approach is ascendant include the Danube River, the Okavango River in Africa, and the La Plata River in South America.

So the intent here is to alert us to the potential for large scale integrated water resources management across the Lake Winnipeg basin, given the fact that it is these distributed geographic stressors that really drive nutrient

loading into Lake Winnipeg.

So the recommendations, the broader recommendations from this paper are to enhance basin-wide management and governance. Consider the land as ecological infrastructure, look at our watersheds as opportunities to construct multi-purpose ecological infrastructure that combines flood storage and nutrient management, drought protection, downstream aquatic ecosystem management opportunities.

The other key recommendation is to use, increasing the use of financial instruments to generate ecosystem services. And there are -- this is basically a swap between a hard infrastructure for soft infrastructure, which can be done often at lower cost than hard infrastructure investments.

Look at nutrient management issues from an upstream perspective, and look at the climate change benefits, the increased resilience to flood and drought shock as co-benefits from an upstream storage perspective, an upstream ecosystem service, more broadly, ecosystem service enhancement perspective.

So I will leave it at that. We have

not -- I will just mention anecdotally that in the Lake Winnipeg basin, we have not had a structured ecosystem procurement program ever. We have had small scale pilots, but we have never systematically approached the purchase of ecosystem services for multiple benefits. There has never been a structural approach to that.

We have the Prairie Provinces Water Board, we have the Red River Basin Commission, but those are elements only of what a broader integrated water resources management paradigm would look like for the Lake Winnipeg basin.

I will leave it at that for the moment. Those are some of the highlights from the paper that we submitted.

THE CHAIRMAN: Thank you, Dr. Venema. Normally, under our rules of proceedings, someone who just comes forward to make a presentation isn't subject to questioning, but I think, given the nature of your expertise, and your comment to me before we went on the record that you would be open to questions?

DR. VENEMA: Sure.

THE CHAIRMAN: Okay. Are there any questions from Manitoba Hydro?

MR. BEDFORD: Dr. Venema, my name is Doug Bedford, I work at Manitoba Hydro. And I recall, when I read the paper that you and your colleagues filed, one of the questions that I don't think that you address in the paper but certainly crossed my mind was, given the size of Lake Winnipeg, would not upstream reservoirs, plural, have to be enormous in size to have any real impact on inflows into the lake?

DR. VENEMA: We did a calculation -- we did a calculation on the 2011 flood flows and we looked at the Portage Diversion, and the amount of water in the order of 3 and a half million acre feet that flowed through the Portage Diversion in 2011. And it was a fairly rough estimate, but we estimated that one in ten sections holding three feet of water upstream of the Portage Diversion would have eliminated the need to use the Portage Diversion.

MR. BEDFORD: You perhaps wandered into my next question, which is, where would one locate these reservoirs? And I just heard you say upstream of the Portage Diversion, but I think that comment was in specific reference to Portage Diversion and inflows into Lake Manitoba?

DR. VENEMA: Yes.

MR. BEDFORD: So if we turn our minds more broadly to Lake Winnipeg, and keeping in mind the various rivers and streams from whence come the inflows, where would you propose putting these reservoirs?

DR. VENEMA: Well, I mean, there is -- it is a different style of agriculture, basically. I mean the detailed siting, this work was done decades ago, in fact, where some of the sort of in-stream flood locations of storage locations would be, but there is also the broader potential to use, to use the agricultural landscape.

We also estimate that of the 5 per cent of the agricultural land base that's under, on average under a flood claim, if that was repurposed for multi-functional storage, you could likely balance the nutrient load on -- so you would, in those storage locations using 5 per cent of the landscape that's under flood claim, you could balance the nutrient load flowing off that part of the agricultural landscape.

MR. BEDFORD: Help me out here, where is the 5 per cent of the land base that's under flood?

DR. VENEMA: On average about 5 per cent, if you look at a long-term record of flood claims, about 5 per cent of the agricultural landscape is under flood claim. So if you were to use that as a rule of thumb then, and you were using that portion of the landscape for flood storage, and based on our analysis of how much nutrients you could take up in that 5 per cent of the landscape, you would balance nutrient loading.

MR. BEDFORD: Are we talking about the Red River Valley and the Assiniboine River Valley?

DR. VENEMA: Primarily, yeah.

MR. BEDFORD: My recollection from other hearings before the Clean Environment Commission is that it is a horrendous challenge to persuade farmers in the Red River Valley, who have some of the best farmland in the world, to sacrifice even the smallest portions of it for other purposes such as hydro development.

DR. VENEMA: Well, indeed, and this was the experience in that one diagram I showed. This was the experience of our American colleagues as well, in that North Ottawa project, which is upstream of Fargo. The U.S. Army Corps of Engineers did some work and determined that the

lowest cost option was to pursue a distributed storage solution for flood protection for Fargo. It took ten years once that analysis was conducted and the relevant watershed agency was empowered to pursue a distributed storage option, it took about ten years to implement the project because of landowner concerns. Ultimately, the answer was to not sacrifice that land for agriculture, to lease it back to farmers in most years, when it won't be backflooded. And so it took buyouts and then a creative leasing approach to lease back that land.

And it fundamentally took a new financial instrument, they didn't call it that but it was an ecosystem services procurement instrument to effect that.

MR. BEDFORD: One of the things that we learned through the course of this hearing is that, roughly speaking, only about 10 per cent of the inflows into Lake Winnipeg come via the Red River and the Assiniboine River. The Winnipeg River is the primary source of inflows, and my recollection is that estimate is that it accounts each year for not quite half the inflows. So to return to your suggestion that perhaps upstream reservoirs would be an appropriate target, what

about inflows from the Winnipeg River?

DR. VENEMA: Well, I mean our concern has been the issue of Lake Winnipeg eutrophication, primarily. And although the Red River, Red/Assiniboine system accounts for 10 to 15 per cent of the inflows, it is the bulk of the nutrient loading. So if you, and it is the region that's also subject to catastrophic flooding. So if you want to, if you want to effect multiple local benefits, and influence -- and effectively reduce the nutrient loading to Lake Winnipeg, you will be looking at upstream solutions. That's the intent of our paper. The scope is limited to what the major underlying driver of nutrient loading to Lake Winnipeg is, and an approach that creates multiple benefits while responding to it. Our intent is not to generate a general storage solution for Lake Winnipeg, a general upstream storage solution for Lake Winnipeg that would include the Winnipeg River and the Saskatchewan River. Our intent is to propose a paradigm for upstream management most pertinent to the region that delivers the bulk of the nutrients.

MR. BEDFORD: And as I recall your paper, and you have echoed some of it very briefly

in the presentation today, the solution that you are proposing is not a made in Manitoba, Manitoba only solution, given the size of the basin that is the source of the water that flows into Lake Winnipeg, incidentally, as I recall, the ultimate source of some of the nutrients that are in the water, this would only have some hope if it was multi-jurisdictional in approach?

DR. VENEMA: Well, I mean, what we have said at our institute is that -- I mean, the solutions are in some ways, they have a Manitoba pedigree to some degree, certainly the work that South Tobacco Creek has been pioneering. The North Ottawa project is perhaps a very clear general example of what we are talking about, and that's in Minnesota admittedly.

What we have said is that Manitoba, because we are the downstream jurisdiction, there is sort of an imperative that Manitoba demonstrates some leadership on this. But there is also -- so I think the likelihood of a multi-jurisdictional approach would be enhanced with sort of clear policy direction in Manitoba, clear policy commitment in Manitoba.

Ultimately, you do need

interjurisdictional collaboration. And there are precedents for it. My understanding is that there are examples, including the Rafferty Alameda dam, where North Dakota actually worked with Federal and Provincial authorities to increase the storage capacity of Rafferty for protection for Minot. Now, ultimately, as events recently show, that may not have been sufficient protection. But there are precedents for interjurisdictional collaboration, and arguably a precedent for the purchase of ecosystem services.

The North American Waterfowl Management plan is another precedent for interjurisdictional ecosystem services procurement.

MR. BEDFORD: Thank you.

THE CHAIRMAN: Thank you, Mr. Bedford.

Mr. Williams, do you have any questions?

MR. WILLIAMS: Yes, just a few.

Good afternoon, members of the panel, Dr. Venema, my name is Byron Williams. I'm a lawyer with the Consumers Association of Canada, the Manitoba branch.

Just to pick up a little bit on your

conversation with Mr. Bedford, I wonder if you could just provide a definition of ecosystem services procurement instruments?

DR. VENEMA: A definition of that?

MR. WILLIAMS: Or a bit more insight into it anyways, sir.

DR. VENEMA: Well, what would be a good example? I mean, the simplest example would be a carbon market, where obviously you are buying -- particularly, if it is biological carbon. I mean, even smoke stack emissions reduction are an ecosystem services benefit to the atmosphere, a benefit to the global ecosystem. So that's a purchase of an ecosystem service. Another example of an ecosystem service procurement would be a water quality trading system where you -- where, for example, a water treatment plant purchases equivalent reductions of nutrients, of phosphorous and nitrogen reductions, rather than investing in hard infrastructure to lower emissions of phosphorous and nitrogen to the environment, they would purchase them from upstream, from a watershed agency, from a collection of farmers, from an individual farmer, who was enacting some practice that lowered

nitrogen or phosphorous emissions. So water quality trading system is another example.

If you buy your driver's licence -- sorry, a hunting licence in Iowa, you are funding the North American Waterfowl Management program which purchases waterfowl habitat in Canada. So, that's another example, a more sort of, perhaps a less obvious purchase of ecosystem services. But there are, you know, various -- it is a fairly big market now internationally, the trading of ecosystem services, particularly wetlands.

MR. WILLIAMS: Okay. Thank you very much for that.

And you certainly don't need to turn there, but in your submission, your written submission from February, there is also a reference in terms of the use of financial tools to ecosystem service valuation to provide the rationale for investment. And I wonder if you could elaborate on that a bit more with some examples?

DR. VENEMA: Well, a local example?

MR. WILLIAMS: Any example will do, sir.

DR. VENEMA: Okay. Well, the next

major infrastructure investment that the City of Winnipeg is contemplating is combined sewer overflow. This is just an example. It is quite an expensive proposition, multi-decadal investment actually most likely and, you know, in the order of a billion dollars, probably more, probably significantly more to fully do it. And it will largely have an esthetic impact on, you know, there will be fewer sewer overflows with, you know, under high precipitation events there will be fewer incidents where the sewers of the City of Winnipeg overflow and you see basically sewage in the Assiniboine and Red River. So that investment of a billion or so dollars is intended to reduce the incidence of that.

Now, the actual long-term benefit to Lake Winnipeg, for example, is very, very modest. You will reduce the phosphorous load to Lake Winnipeg in the order of 1 per cent by investing a billion dollars. So the public policy decision is, is that billion dollars well spent? And it depends on what the public policy objective is. If the public policy objective is really, as I believe it is, to improve the health of Lake Winnipeg, that billion dollars would be invested

elsewhere, and it would be invested in lower cost ecosystem service procurement upstream through, for example, multi-functional distributed storage programs. So you can buy a lot of nutrient reduction with that kind of money. So it would be a swap of hard infrastructure for soft infrastructure.

I'm not saying that, you know, it is a matter of, it is a public policy debate, why would we do combined sewer overflow? I attended an open house a couple of weeks ago, I happened to participate in the discussion, and I learned that at least the participants in that workshop really valued the health of Lake Winnipeg as the highest priority. If that is in fact the consensus, then that billion dollars would be better spent buying ecosystem services. That's a local example.

MR. WILLIAMS: That's very helpful, sir. Thank you. And thank you members of the panel.

THE CHAIRMAN: Thank you, Mr. Williams. Ms. Whelan Enns?

MS. WHELAN ENNS: Gaile Whelan Enns from Manitoba Wildlands. Hello, Dr. Venema, I'm going to look through the hardware at you and make

sure we can see each other.

You mentioned the Prairie Water Board, you mentioned the Red River Basin Commission, and then you mentioned the Prairie Water Board. I wanted to ask you whether IISD, in your research and presentation now, and also generally in terms of the basin, has reviewed the Prairie Water Management Agreement, whether you see any possible approaches, tools or things that could be done that would make a difference, again, inter-jurisdictionally in terms of your recommendations today?

DR. VENEMA: I think that -- I would hope so. I would hope that the Prairie Provinces Water Board could act as, could be part of the solution. I mean, it is a really -- people will, you know, have reflected on the Prairie Provinces Water Board and have said that you could never get something like that done nowadays. It was a product of the day, I guess '60s, late '60s, early '70s. The Prairie Provinces Water Board to act as a facilitator for ecosystem services markets, I would say likely not, they would probably be the regulator. And you would have another, some other entity that would actually go about the business

of investing. An agency like perhaps the Prairie Provinces Water Board could be responsible for ensuring that those investments are actually producing the claimed environmental benefit. Interesting question.

MS. WHELAN ENNS: Thank you. I was trying to remember how long it has been since the agreement has been opened and renewed. So I'm going to ask for your help on this because I think it hasn't been since the late '60s, early '70s, actually seen a review by the three provinces and a confirmation and renewal?

DR. VENEMA: There has been -- it is a good question. There has been, I think, some discussion of expanding to water quality concerns. I do not believe that those -- those negotiations have advanced particularly.

MS. WHELAN ENNS: Thank you.

You made a reference in your presentation about ways to hold water on the land, and how to, in fact, not need the 3.5 million-acre feet that the Portage Diversion moved in 2011.

DR. VENEMA: Yes.

MS. WHELAN ENNS: We haven't gotten to the point in the hearing yet, in terms of talking

about acre feet of water in Lake Winnipeg in the regulation span between 715 and 711 feet.

DR. VENEMA: Um-hum.

MS. WHELAN ENNS: In your preparation and your research, preparation for your report and your research, has IISD taken a look at the acre feet of water between 711 and 715 in Lake Winnipeg, and how one could start to think about ecosystem services and management of the lake spreading out into the basin on that four foot range?

DR. VENEMA: Well, that's an interesting piece of analysis actually, that would be a very interesting piece of analysis, to allocate -- that would imply, though, that you are considering -- I mean, this goes back to the previous question about the -- I mean, the hydraulic implications of that are significant. To look at the amount of storage required between, the amount of upstream storage between 711 and 715, that's a lot. I guess our point is that you could do that, it wouldn't influence the nutrient load, like only the Red/Assiniboine, the distributor source component in the Red Assiniboine system would significantly influence

the nutrient loading issue. The broader question, I mean, the broader question is, you know, engineered storage, more engineered storage on the other major rivers, and that piece of analysis we have not done.

MS. WHELAN ENNS: Thank you very much.

I wanted to stay in this range a little bit, in relation to the question Mr. Bedford asked you, where the assumption was that the storage of water on the land to reduce the inflows and the impacts on the lake has to be interjurisdictional. So my question is, and this is somewhat based on spending three years in the international sub mitigation committee between the five jurisdictions after the '97 flood. So my question for you is, given that the IJC recommended this for Manitoba, and that there has been other presenters here in these hearings making the similar or related observations as you are making, my question to you is, how many times do you have to hold the water back, and how much of it could be done in Manitoba that would benefit all of Manitoba?

What I'm getting at is that the assumptions are that this is reservoir, it is not

necessarily reservoirs, and it can be a whole systematic change, I believe, in drainage systems. And the reality of post serious floods in the Red River Valley is that the fields that are under water for weeks and weeks, regardless of whether there was any planned retention, all carried bumper crops that year. So what I'm asking you is, does it need to be reservoirs? How many times do you hold the water back? Where is it best to hold it back rather than obviously outside of Manitoba? Have you thought about it as being a water retention system rather than as a reservoir system?

DR. VENEMA: Well, I think that -- I mean, that's the North Ottawa paradigm, right, the North Ottawa project that I showed a diagram of. Basically, it is modestly engineered retention, it is -- the key feature of it is, it is not wet all of the time. And in most years, about three to five years, the land is leased back for normal agriculture. In those other years, this is the interesting part, for the same reason that you get bumper crops in the flooded areas, you have got that nutrient retention. And we are seeing the sort of the spontaneous emergence of macrophytes,

wetland biomass, that are luxury users of those nutrients. Same reason as why you get bumper crops. So, yes, I do agree with you that with modest improvements to the way agricultural landscape is managed, we will see that flood retention benefit, and can manage for that nutrient flux that comes with the flooding.

MS. WHELAN ENNS: Thank you.

Your presentation and your report are noteworthy for the set of recommendations you have made, but you've also not entered into any discussion about the current licence or the current regulation, the 711, 715.

DR. VENEMA: Um-hum.

MS. WHELAN ENNS: What I wanted to ask you was whether that was a deliberate decision in terms of your focus on management on a basin basis, and for ecosystem service markets and improvements overall, or whether there is anything that you would like to say about the current regulation of the lake?

DR. VENEMA: Well, we haven't done modeling work directly on the 711, 715 range. My understanding is that -- my understanding is that because the largest nutrient loads come with the

largest flood events, the fact that you have a higher regulated discharge at 715 than you would under natural conditions is actually a benefit in terms of the flushing effect of nutrients. So if you had the sort of climatic drivers that we do, the large flood events that drive the majority of the nutrients into Lake Winnipeg, having that phenomenon and -- I mean, if you didn't have the higher discharge capacity, you would see higher levels of nutrient retention. So I guess that's the -- with respect to nutrient loading, which has been our primary concern at IISD, I would say that's the major implication of regulation, that it allows you to lower the lake and flush more nutrients than you would under natural conditions.

MS. WHELAN ENNS: Thank you. I'm on -- let me see, looking for a page number here, and not finding one. I'm going to ask you, this is a summary that I'm looking at, at the front of your paper, and I'm on the list of recommendations. Just below it you refer to a Lake Winnipeg Regulation scoping session. I wanted to ask you which session you are referring to?

DR. VENEMA: That was the one held --

Carla, help me out here?

CARLA: I think it was in the work site, but I think it was about a year or so ago I think.

THE CHAIRMAN: Was that the pre-hearing meeting that was held in the next room in, I think it was May of last year?

CARLA: Yep.

MS. WHELAN ENNS: Okay. Thank you.

I was trying to remember whether your work, for instance, in Africa included reservoirs?

DR. VENEMA: My work?

MS. WHELAN ENNS: Your international work before you came to IISD, did it include reservoirs?

DR. VENEMA: It did, as a matter of fact. I studied the operation of the Manantali Reservoir in Mauritania, on the Senegal River basin, and the influence of climate change, how it should be optimally operated under climate change conditions in West Africa.

MS. WHELAN ENNS: And do you consider Lake Winnipeg to be operated as a reservoir?

DR. VENEMA: Well, it is. It is operated as a reservoir.

MS. WHELAN ENNS: Thank you.

I wanted to thank you for your references to the IPCC fifth assessment and say thank you for your report and your presentation.

DR. VENEMA: Thank you.

THE CHAIRMAN: Thank you, Ms. Whelan Enns. Pimicikamak, any questions of this witness?

Thank you. Mr. Yee?

MR. YEE: Thank you, Dr. Venema, it was very interesting. I just have a general question. One of your examples was the Columbia River basin for an example of large basin management planning. You know, given that it is very similar to the Lake Winnipeg watershed in the fact that you have got all of these various jurisdictions, State and Provincial governments and two Federal governments, Canada and U.S., I'm just wondering if you have any comments on how well this is working, because I gather it has been in place for some period of time? Given the competing interests, and you have got all of the regulatory requirements that may vary from jurisdiction to jurisdiction, I'm just wondering how well it is working?

DR. VENEMA: Well, my understanding is that it is working very well, in fact. The coordination between Canada and the U.S. in this case is working very well.

MR. YEE: Thank you.

THE CHAIRMAN: Ms. Suek? Mr. Harden?

MR. HARDEN: Yeah, I have a couple of questions. I'm quite familiar with the South Tobacco Creek project, I believe there was a PFRA analysis of effectiveness of it done some time in the '90s, and that concluded that those sort of small dams were most effective at moderate, for moderate floods, like ten per cent flood or something like that. How do you go on to upscale that then to the sort of very large floods that we have been getting in recent years?

DR. VENEMA: I think the very large floods are problematic. I mean, the analysis, and quite likely you are familiar with this, the Red River basin analysis was for a 20 per cent reduction on 97, you could effect with distributed storage. So that's significant and, you know, that's the clipping, the hydrograph like that would have a very, very significant benefit. So I think that, you know, the challenge -- there has

been criticisms of the American strategy because it is a lot of small projects, and I think that that's surmountable, it is just basically a matter of getting the policy framework right and unleashing essentially the entrepreneurial activity to have people, you know, engage in that kind of land repurposing. So if you get the policy framework right, if you get the financial instruments right, I think you can effect a lot of, you know, a lot of new projects.

If, you know, South Tobacco Creek has been, has wrestled with -- they have been trying to expand that work for a long time. And it has been impeded to some degree by the fact that the financial instruments aren't there. Until recently, the surface water management, we did not really have a surface water management strategy in this province. The new surface water management strategy really encourages this style of distributed storage.

Now, the missing ingredient is the -- so the policy framework is improved, the missing ingredient will be the financial instruments.

Our broader point is that these projects can be a very good investment, and it is

not just a cost centre. If you can start to manage the benefit of flood retention, and our example is actually through biomass production, if you can start to manage the storage projects as revenue generating, then I think you will accelerate the uptake of this style, this style of project, this style of watershed management. That's, I think -- I will give you an anecdote. We have been working on the idea of nutrient interception by biomass production. And if we, even if we discounted the value of the biomass for energy, which is one of its ecosystem services, one of its value, the harvested biomass which contains all of these nutrients, which grows in these flood retention zones, even if we discount the energy benefit, we are still ten times cheaper approximately in the order of magnitude, could be more, than conventional wastewater treatment.

So it is -- perhaps I'm taking liberties in my response here, but the basic message is you need to scale this concept up. The barriers are in part policy, but mostly financial. If you look at all of the revenue and public benefit that flow from these projects, with some creativity on how you implement these financial

instruments, these can be very attractive investments.

MR. HARDEN: Okay. In terms of, I guess, financial aspect of things, what we have seen in recent years is a trend toward larger and larger farms, almost factory farms, if you will, being worked by larger and larger equipment, and resulting loss in wetlands on those farms due to drainage, simply because the farmers don't want to have to try and maneuver this big equipment around these little ponds. What kind of policy or financial incentives can you do to combat that sort of trend?

DR. VENEMA: I don't -- okay, I don't believe that you need to really push against, I mean, I don't think that's the issue. I think the issue is -- so your concern is the fact that you are saying increased wetlands loss, primarily, with these --

MR. HARDEN: Yes.

DR. VENEMA: Well, it is true, that is a major concern. And, in fact, I heard just the other day that a pilot ecosystem services program called ALUS, the alternative land use surface program that was piloted in the rural

municipality, Blanchard Municipality of Western Manitoba, as soon as that pilot program ended, the wetland drainage resumed.

So the point is that farmers will respond to a modest price signal for an alternative purpose, for repurposing their land. The ALUS program wasn't particularly rich, it was in the order of $25 to $50 an acre, I believe. It was -- but it was a sufficient price signal to avoid further wetland loss. So I think the message is that if we recognize the multi-functional nature of the agricultural landscape, recognize the public values therein, and are willing to pay for them, you will see altered behaviour on the part of agricultural producers.

MR. HARDEN: Okay. Those were my questions.

THE CHAIRMAN: I have a couple of questions, the first of which isn't particularly relevant, but I'm curious. In your report when you are talking about the Columbia River basin, you say there are 370 hydroelectric dams in that basin, is that correct?

DR. VENEMA: That's dams of all types,

I believe.

THE CHAIRMAN: There must be an awful lot of small ones.

DR. VENEMA: Yeah.

THE CHAIRMAN: That's a huge number.

Anyhow, that's not really what I wanted to pursue, but I want to talk a little bit about sort of a management regime. You've talked about having a multi-jurisdictional management regime, which in this case would presumably involve three other provinces and at least two states, I mean, the pieces of Montana and South Dakota that are included are not much bigger than this room. But what is in it for the other jurisdictions? There is obviously a lot of benefits for Manitoba, for Lake Winnipeg, but what is in it for the other jurisdictions? What would attract them to become part of such a management regime?

DR. VENEMA: Well, I have pondered this question, and I believe the answer is when multiple benefits of -- there is a leadership question here ultimately. And I would say that the -- you would work with -- it would be hard to orchestrate all jurisdictions to enter into such a

treaty, you know, this won't be an easy task. I think the key ingredients are demonstration by Manitoba of a sophisticated -- basically implementing the surface water management strategy, the creative use of financial instruments to fund the strategy, and in turn the benefits therein, both private and public, and the -- and ultimately the creation of financial instruments to support this. That would certainly increase the likelihood of other jurisdictions collaborating on such a thing.

THE CHAIRMAN: Would there be many advantages for just a Manitoba only -- Mr. Bedford went a bit down this road -- for just a Manitoba only management board?

DR. VENEMA: Well, yeah, there certainly -- I think if it was designed to -- there is certainly benefit. I mean, we've said that Manitoba needs to sort of demonstrate leadership here. Yeah, the short answer is yes. The short answer is yes. However, I mean, it is a bit like what the lake friendly stewards alliance is attempting, to engage sort of on a voluntary basis upstream jurisdictions in best management practices and so forth. There is no question that

a Lake Winnipeg basin board, a Manitoba Lake Winnipeg basin board would be an appropriate first step. However, I think an outreach function to other jurisdictions should be a built-in component of such a board. And I think continually working with the IJC would also be an important step towards trans-boundary expansion of such a management board.

THE CHAIRMAN: I mean, you talk about some of the parties that might be on such a management board, and it would include, I mean beyond other Provincial Governments it would include community organizations, First Nations in the area, non-governmental organizations.

Could they be involved, or such a body with those parties, could they play a role in policy development and management -- policy development for management of the watershed?

DR. VENEMA: Indeed, yes.

THE CHAIRMAN: I mean, they could sort of direct research, I would think that might be -- not necessarily undertake the research, but determine that this needs to be done or that needs to be done.

DR. VENEMA: Well, an advisory

function, yeah. I think, you know, such a management board would appropriately have powers to commission research, and the research questions that it undertook should be informed by such a stakeholder group, for sure.

THE CHAIRMAN: Okay, thank you. I don't think -- we could probably discuss some of this stuff for a long time, but I don't think that I have any more pertinent questions, or any more pertinent questions right now.

So, I would like to thank you for coming out today, for preparing the paper that you delivered to us a number of weeks ago, and for making this presentation. It has added one more important cog in our review of this issue. So, thank you, Dr. Venema.

DR. VENEMA: Thank you.

THE CHAIRMAN: I think that brings us to a conclusion for today. We just had the two presentations. Tomorrow we have the Norway House Fishermen, and we will be on at 9:30 with Norway House Fishermen tomorrow morning. Documents to register?

MS. JOHNSON: As always. Mr. Zuzek's report on erosion and accretion is CEC 19. The

accompanying presentation is number 20. And the Nelson River Hydrologic Project historical document is CEC number 21. The IISD paper is SUB number 7, and the presentation will be WPG 18.

(EXHIBIT CEC 19: Mr. Zuzek's report on erosion and accretion)

(EXHIBIT CEC 20: Mr. Zuzek's presentation)

(EXHIBIT CEC 21: Nelson River Hydrologic Project historical document)

(EXHIBIT SUB 7: IISD paper)

(EXHIBIT WPG 18: IISD presentation)

THE CHAIRMAN: Thank you. So we stand adjourned then until tomorrow morning at 9:30.

(Adjourned 2:50 p.m.)

OFFICIAL EXAMINER'S CERTIFICATE

Cecelia Reid and Debra Kot, duly appointed Official Examiners in the Province of Manitoba, do hereby certify the foregoing pages are a true and correct transcript of my Stenotype notes as taken by us at the time and place hereinbefore stated to the best of our skill and ability.

Cecelia Reid

Official Examiner, Q.B.

Debra Kot

Official Examiner Q.B.