Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River

Commission d'enquête sur le déclin des populations de saumon rouge du fleuve Fraser

# Public Hearings

# Audience publique

**Commissioner**

L'Honorable juge /
The Honourable Justice
Bruce Cohen

**Commissaire**

**Held at:**

Room 801
Federal Courthouse
701 West Georgia Street
Vancouver, B.C.

Tuesday, June 14, 2011

**Tenue à :**

Salle 801
Cour fédérale
701, rue West Georgia
Vancouver (C.-B.)

le mardi 14 juin 2011

## APPEARANCES / COMPARUTIONS

| | |
|---|---|
| Patrick McGowan<br>Micah Carmody | Associate Commission Counsel<br>Counsel |
| Mark East<br>Geneva Grande-McNeill | Government of Canada ("CAN") |
| Clifton Prowse, Q.C.<br>Elizabeth Rowbotham | Province of British Columbia ("BCPROV") |
| No appearance | Pacific Salmon Commission ("PSC") |
| No appearance | B.C. Public Service Alliance of Canada Union of Environment Workers B.C. ("BCPSAC") |
| No appearance | Rio Tinto Alcan Inc. ("RTAI") |
| No appearance | B.C. Salmon Farmers Association ("BCSFA") |
| No appearance | Seafood Producers Association of B.C. ("SPABC") |
| No appearance | Aquaculture Coalition: Alexandra Morton; Raincoast Research Society; Pacific Coast Wild Salmon Society ("AQUA") |
| Tim Leadem, Q.C. | Conservation Coalition: Coastal Alliance for Aquaculture Reform Fraser Riverkeeper Society; Georgia Strait Alliance; Raincoast Conservation Foundation; Watershed Watch Salmon Society; Mr. Otto Langer; David Suzuki Foundation ("CONSERV") |
| No appearance | Area D Salmon Gillnet Association; Area B Harvest Committee (Seine) ("GILLFSC") |

**APPEARANCES / COMPARUTIONS, cont'd.**

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|---|---|
| No appearance | Southern Area E Gillnetters Assn.<br>B.C. Fisheries Survival Coalition ("SGAHC") |
| No appearance | West Coast Trollers Area G Association; United Fishermen and Allied Workers' Union ("TWCTUFA") |
| No appearance | B.C. Wildlife Federation; B.C. Federation of Drift Fishers ("WFFDF") |
| No appearance | Maa-nulth Treaty Society; Tsawwassen First Nation; Musqueam First Nation ("MTM") |
| No appearance | Western Central Coast Salish First Nations:<br>Cowichan Tribes and Chemainus First Nation<br>Hwlitsum First Nation and Penelakut Tribe<br>Te'mexw Treaty Association ("WCCSFN") |
| Anja Brown<br>Crystal Reeves | First Nations Coalition: First Nations Fisheries Council; Aboriginal Caucus of the Fraser River; Aboriginal Fisheries Secretariat; Fraser Valley Aboriginal Fisheries Society; Northern Shuswap Tribal Council; Chehalis Indian Band; Secwepemc Fisheries Commission of the Shuswap Nation Tribal Council; Upper Fraser Fisheries Conservation Alliance; Other Douglas Treaty First Nations who applied together (the Snuneymuxw, Tsartlip and Tsawout); Adams Lake Indian Band; Carrier Sekani Tribal Council; Council of Haida Nation ("FNC") |
| No appearance | Métis Nation British Columbia ("MNBC") |

**APPEARANCES / COMPARUTIONS, cont'd.**

| | |
|---|---|
| No appearance | Sto:lo Tribal Council<br>Cheam Indian Band ("STCCIB") |
| No appearance | Laich-kwil-tach Treaty Society<br>Chief Harold Sewid, Aboriginal<br>Aquaculture Association ("LJHAH") |
| No appearance | Musgamagw Tsawataineuk Tribal<br>Council ("MTTC") |
| No appearance | Heiltsuk Tribal Council ("HTC") |

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Vancouver, B.C./Vancouver
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THE REGISTRAR: Order. The hearing is now resumed.
MR. McGOWAN: Good morning, Mr. Commissioner. It's Patrick McGowan. With me is Micah Carmody, counsel for the Commission. Today's hearings will focus on the topic of municipal wastewater. We have three panellists with us this morning. Starting on my left, Dr. Ken Ashley, moving to the right, in the centre seat, Dr. Peter Ross, and on the far right, Graham van Aggelen. Mr. Ashley is not affiliated with any government department, presently; Dr. Ross is with the Department of Fisheries and Oceans; Mr. Van Aggelen is with Environment Canada.
Perhaps we could have the panellists sworn.

PETER ROSS, Affirmed.

GRAHAM VAN AGGELEN, Affirmed.

KEN ASHLEY, Affirmed.

THE REGISTRAR: Would you state your name, please?
DR. ASHLEY: Ken Ashley.
DR. ROSS: Peter Ross.
MR. VAN AGGELEN: Graham van Aggelen.
THE REGISTRAR: Thank you. Counsel.
MR. McGOWAN: Thank you. Mr. Commissioner, I'm going to seek to have each of these witnesses qualified as experts and I'm going to start with Dr. Ross. I'm going to seek to have Dr. Ross qualified as an expert in aquatic toxicology.

EXAMINATION IN CHIEF BY MR. McGOWAN:

Q Dr. Ross, you have a PhD in ecotoxicology which you obtained in 1995?
DR. ROSS: That's correct.
Q You also have a masters degree and a bachelors degree in biology?
DR. ROSS: Correct.
Q Your present position is with the Department of Fisheries and Oceans, where you are an environmental toxicologist, based at the Institute

of Ocean Sciences?
DR. ROSS: That's correct.
Q You've been employed by DFO since 1999?
DR. ROSS: Correct.
Q In your area of research interest, is ecotoxicology and the risks to aquatic life associated with certain chemicals?
DR. ROSS: That's right.
MR. McGOWAN: And on the screen we have Dr. Ross's C.V. I'm going to suggest that be the next exhibit.
THE REGISTRAR: Exhibit 1043.

EXHIBIT 1043: *Curriculum Vitae* of Dr. Peter Ross

MR. McGOWAN: And Mr. Commissioner, based on that examination, I'm going to seek to have this witness qualified as an expert in aquatic toxicology, and subject to any other questions that might be posed.
THE COMMISSIONER: Thank you very much.
MR. McGOWAN: Next, Mr. van Aggelen. I'm going to seek to have him qualified as an expert in toxicology and toxicogenomics.
Q Sir, you're presently the head of the Environmental Toxicology Section in the Environment -- in the Pacific Environmental Sciences Centre of Environment Canada?
MR. VAN AGGELEN: That's correct.
Q You've held that position since 2000?
MR. VAN AGGELEN: Yes, sir.
Q And you've been with Environment Canada since 1996?
MR. VAN AGGELEN: That's correct.
Q Prior to that, you worked with the B.C. Ministry of the Environment for a number of years?
MR. VAN AGGELEN: That's correct.
Q You hold a bachelor of science in zoology and biological sciences?
MR. VAN AGGELEN: That's correct.
Q And through your experience you've developed expertise in the testing of effluents for toxicity to marine and freshwater species?
MR. VAN AGGELEN: That's correct.
Q I wonder if you could, just very briefly, tell the Commissioner what toxicogenomics is.
MR. VAN AGGELEN: Toxicogenomics is the study of the

gene expression within aquatic organisms. Specifically, I work with trout and other salmonids. We look at the gene structure and the molecular structure to look at potential effects as a result of ultra low level contaminants.

MR. McGOWAN: And if we can have Mr. van Aggelen's C.V. marked as the next exhibit.

THE REGISTRAR: Exhibit Number 1044.

EXHIBIT 1044: *Curriculum Vitae* of Graham van Aggelen

MR. McGOWAN: Mr. Commissioner, based on that examination, I seek to have him qualified as an expert in toxicology and toxicogenomics.

THE COMMISSIONER: Yes, thank you very much.

MR. McGOWAN: Thank you. And finally on the qualifications, Mr. Commissioner, we have Dr. Ashley, who I'm seeking to qualify as an expert in three areas: environmental engineering; aquatic ecology; and limnology.

Q Now, Dr. Ashley, I think the Commissioner has heard a fair bit about environmental engineering and aquatic ecology, but I'm not sure the term limnology has come up yet. Could you just briefly explain to the Commissioner what that is?

DR. ASHLEY: Limnology is the scientific study of inland waters, freshwater oceanography, for lack of a better term.

Q Okay. Thank you. You have a PhD in environmental engineering?

DR. ASHLEY: Correct.

Q You have two masters degree; one in environmental engineering and one in aquatic ecology?

DR. ASHLEY: Correct.

Q You're presently an instructor at BCIT in the Ecological Restoration Program?

DR. ASHLEY: Part-time, yes.

Q You're an adjunct professor at UBC in the civil engineering department?

DR. ASHLEY: Correct.

Q And you also work for Northwest Hydraulic Consultants as a senior scientist?

DR. ASHLEY: Correct.

Q And you've previously worked for both the GVRD and the Province of British Columbia?

DR. ASHLEY: Correct.

Q Okay. And is that Dr. Ashley's C.V. on the screen?
MR. LUNN: It is. There's personal information on the top of the page --
MR. McGOWAN: Fair enough.
MR. LUNN: So I've scrolled it down.
MR. McGOWAN: Thank you. I'm going to suggest that this exhibit be the next -- that this C.V. be the next exhibit, Mr. Commissioner, and perhaps, with your leave, we could, at a convenient time, replace the exhibit with one with the personal information blacked out.
THE REGISTRAR: That will be Exhibit 1045.

EXHIBIT 1045: *Curriculum Vitae* of Dr. Ken Ashley

MR. McGOWAN: Thank you.
Q Mr. van Aggelen, I'm going to start with some questions to you about the Canadian Pacific Environmental Sciences Centre. Could you just briefly explain to the Commissioner what that is and where it is situated within Environment Canada?
MR. VAN AGGELEN: The Pacific Environmental Science Centre is the Pacific and Yukon Regions key laboratory for toxicological and analytical chemistry analysis. It forms the, what I would call, the Pacific anchor for Environment Canada's network of regulatory laboratories. There's approximately 55 scientists and technicians that work at the centre in North Vancouver. The lab is divided up into three principal components. There's a toxicology group, a chemistry group, which is subdivided into organic and inorganic chemistry, and there's a water quality monitoring group that's responsible for shellfish water quality monitoring sites.
Q And you're the head of the toxicology section, correct?
MR. VAN AGGELEN: That's correct.
Q And could you just briefly explain to the Commissioner the type of testing conducted by your unit?
MR. VAN AGGELEN: The principal function of my laboratory is to test effluents and materials that are a federally-responsible -- are federally-

responsible discharges, particularly those that are with respect to ***Fisheries Act*** 36(3) provisions, essentially end-of-pipe discharge into waters that are federally controlled, or to waters frequented by salmon or transboundary waters.

Q Now, I understand that the to the extent there's a genomics program within Environment Canada, it's sort of run off the side of your desk within the toxicology program; is that a fair --

MR. VAN AGGELEN: That's correct. Genomics, particularly toxicogenomics, or aquatic toxicogenomics is an emerging field in environmental toxicology, and it shows great promise for furthering our understanding of how chemicals or complex mixtures affect aquatic organisms, in particularly my area of interest is how they affect fish, and we look specifically at key tissues within the fish after they've been exposed to certain contaminants or complex mixtures.

Q Okay. What percentage of the testing that you do in your facility is end-of-pipe testing? So there's traditional regulatory testing as opposed to testing to support your genomics work.

MR. VAN AGGELEN: I would say most probably 90 percent is end-of-pipe discharge.

Q Okay. Now, the end-of-pipe testing focuses on acute lethality; correct?

MR. VAN AGGELEN: That's correct. Environment Canada has a national accredited test for measuring the 96-hour rainbow trout test for measuring acute lethality to effluents.

Q And one of the advantages of genomics is its potential to allow you to assess sublethal impacts, correct?

MR. VAN AGGELEN: Yes, where genomics comes into play is that the end points associated with a molecular expression, you can look at those effluents that are not acutely toxic that don't kill the fish outright, but there may be other levels or other concentrations of chemicals or contaminants in that mixture that may be having effects at the molecular structure.

Q Thank you. Dr. Ross, you're at the Department of Fisheries and Oceans Institute of Ocean Sciences, correct?

DR. ROSS: That's correct.

Q And you have a particular expertise and much of your research is focused on marine mammal toxicology, correct?
DR. ROSS: That's correct.
Q And while you do have experience doing fish toxicology, it's not your primary area; is that correct?
DR. ROSS: I would say that's fair. We do have a very productive collaboration with my good colleague, Dr. Chris Kennedy at Simon Fraser University, and we've been looking at the effects of currently used pesticides on salmon health with a number of different research directions there, and we've published about nine articles on that subject matter.
Q Okay. Does the Department's Pacific Region have a toxicologist whose research regularly focuses on fish and whose area of expertise that is, primarily?
DR. ROSS: No.
Q Is there such an expert in another region in the Department in Canada?
DR. ROSS: We do have a scattering of toxicologists across the country; one in Winnipeg, one or two in the St. Lawrence and Quebec region, one in Nova Scotia, and one in Newfoundland.
Q Does the absence of a dedicated fish toxicologist, does that lead to a gap in either expertise or attention that's paid to this matter, such as this in the Pacific Region?
DR. ROSS: Well, I think it's certainly hampering our efforts to understand whether contaminants present a risk to what's happening to sockeye salmon at present. Not having that expertise means that we really don't have the opportunity to conduct research to explore the matter in depth.
Q Okay. In the Pacific Region presently, is the Department involved in monitoring or researching to determine the potential impacts of municipal wastewater on aquatic life, generally, or more specifically on fish or salmon?
DR. ROSS: No. I think in general terms, following up on my colleague, Mr. van Aggelen's comments about division of responsibilities, we at the Department of Fisheries and Oceans have largely reviewed s. 36 things as the purview of Environment Canada, and there has been an interest in the effects of

contaminants on the health of biota within DFO, but that's largely related to cumulative impacts or non-point source impacts.

Q Okay. Is there anyone at the Department who's tasked with assessing the actual impact of contaminants in municipal wastewater on Fraser salmon --

DR. ROSS: No.

Q -- or Fraser sockeye?

DR. ROSS: No.

Q Is there such a person at Environment Canada, Mr. van Aggelen?

MR. VAN AGGELEN: Specifically, there are folks -- there are scientists within the National Research Centre in Burlington that are part of doing research, but specifically on the coast in Pacific and Yukon regions, there's not a single individual that is solely responsible for sockeye.

Q Is there a group who is tasked with assessing the impact of contaminants in municipal wastewater on the salmon in the Pacific Region?

MR. VAN AGGELEN: Not specifically.

Q Now, we heard a little bit, a moment ago, about the genomics program that you're spending a small portion of your time dealing with. Can you tell the Commissioner how that's funded?

MR. VAN AGGELEN: The genomics program was largely -- is largely funded by an Environment Canada-funded program. The acronym is STAGE, Strategic Technologies for Advancement of Genomics in the Environment. And that's a competitive process within Environment Canada where each fiscal year a submission into -- to apply for funds to continue on with genomics-related work in my lab has to be done.

I've been successful over the last seven years in getting funds to build up capacity and expertise within the lab, and also have been able to partner with and collaborate with individuals at the University of Victoria and Waterloo, and also in advancing our techniques and methods within my lab is to say create capacity and expertise in conducting genomic experiments.

Q One of the genomics experiments which you have conducted resulted in a report titled, Toxicological Evaluation of Emerging Chemicals in Municipal Wastewater Effluents Within the Georgia

Basin, correct?
MR. VAN AGGELEN: That's correct.
MR. McGOWAN: Mr. Lunn, if you could bring up Tab 7 from our list, please.
Q So this is a report which did some work with effluent from the Annacis waste treatment plant and liquid waste from the Capital Regional District, correct?
MR. VAN AGGELEN: That's correct.
Q I wonder if you could just -- perhaps before we get into it, we could mark this as the next exhibit?
THE REGISTRAR: Exhibit 1046.

EXHIBIT 1046: Toxicological Evaluation of Emerging Chemicals in Municipal Wastewater Effluents Within the Georgia Basin, by Graham vanAggelen, et al, March 31, 2009

MR. McGOWAN:
Q And the samples that were taken for this study were taken in 2004 to 2006; is that correct?
MR. VAN AGGELEN: The samples were collected over, I believe, three sampling periods, three years, and there was a fall and roughly a summer campaign, if you want to call it that, where we looked at summer and winter variations in the effluent.
Q Could you explain to the Commissioner, briefly, what the objectives of this research project were?
MR. VAN AGGELEN: This project was funded under regionally -- an Environment Canada regionally-funded program, the Georgia Basin Action Plan, and again, through a competitive process, submitted in a proposal to use the methods that we've been working on, the genomic methods, to look and see if the techniques that we've been developing would lend themselves to looking at emerging chemicals of concern contained within municipal wastewater effluent.

The study looked at non-lethal -- started with non-lethal concentrations, so those concentrations will recall the -- the acronym is NOEC, No Effect Concentration. So fish were exposed to the highest no effect concentration and concentrations that engineers at GVRD and now Metro provided us that were, I guess, relevant to receiving water concentrations downstream of the

Annacis discharge.

So using established testing platforms, we exposed Rainbow trout to various concentrations of Annacis effluent for eight days. And then over that eight day period fish were cropped or dissected for -- their livers were dissected and processed, and then a cohort of those same animals that had been exposed to the effluent were put into clean water, a depuration phase, if you want to call it that, for a further eight-day period, and the same thing was done; we excised out their livers from the various concentrations then performed genomic analysis on it.

The liver is a principal tissue that biologists and toxicologists look at, because largely any contaminants or -- get metabolized and eventually end up in the liver. So the liver becomes a principal target tissue to look at potential endocrine effects or other effects as a result of exposure to low level chemicals.

How we determine the impact of the chemicals on the fish at the various concentrations is what we -- we use what they call a gene chip or a gene array, and on that array we have -- at that time we were doing the study, we had what we call a customized array. We had gone after specific gene targets or specific families of genes, whether they were stressor responsive genes, which are called heat shock proteins. We went after genes that were responsible for reproduction, vitellogenin, and other types of general genes, family groups that the literature and with which we had a fairly good understanding of how, biochemically, they responded to effects.

So cutting to the end point of this, at various concentrations we saw different gene groups showing what they call an up regulation or down regulation, and all these expression levels are compared back to a controlled cohort that had the same testing conditions as with which the exposure concentrations, but obviously they just weren't exposed to any of the potential toxicants. So all the expression levels we saw are normalized back to the control group so that anything we reported was relative or as a consequence of exposure to the various toxicants.

So over the eight -- the 16-day period, we

saw certain gene groups come up, but for the most part, they returned back to background -- background levels after the -- when compared to the depuration phase. But what we did see was that there was spikes in immunoresponsive genes, which would be -- made good sense because, as I say, the fish were in concentrations of municipal wastewater levels that would have triggered immunoresponsive processes to combat any potential infections and things.

But the bottom line is that after the exposures, the majority of the levels of the gene expression returned to background levels, but there was certain levels of the vitellogenin proteins that did stay up. And the interesting thing about vitellogenin is it's a precursor to egg production in females, and the fish that we use were rainbow trout, and they're sexually immature and they're juveniles. So you should not be seeing vitellogenin showing up in two cases; (a) at sexually mature fish, and also the fact that it was pretty ubiquitous across all the fish that we looked at, so it was interesting from that perspective that we saw the expression profiles that we did.

But trying to relate that to, you know, receiving water impacts, a straight line correlation could not be driven -- drawn from our report.

Q Okay. Thank you for that helpful explanation. Is understanding the potential impacts, sublethal impacts or cumulative impacts of certain chemicals, perhaps especially some of the emerging chemicals in municipal wastewater on fish, is this research and the continuation of research like this important to furthering that understanding?

MR. VAN AGGELEN: In my opinion, I think it's critical, because historically the tests that we use in a regulatory arena and those used by proponents for complying with a regulation, the standard test is the acute lethality test. And the majority of tests have -- will pass that test, because there is such strong enforcement on that. So they will not fail the traditional 96-hour LC50 test, which is a test of lethality.

But we know that certainly within the complex mixtures of various industrial compounds,

particularly in wastewater, there is merging chemicals of concern and ultra low levels that have been demonstrated either individually or individual scientists research that are indicative and conclusively causing endocrine disrupter effects, but also the fact that the ability of a lot of these treatment systems do not or cannot remove or treat a lot of these emerging chemicals of concern.

As I mentioned, pharmaceuticals are just one classification. There's another group of chemicals that are currently being used in commerce a thing called nanomaterials, or nanoceuticals, that the pharmaceutical industry is using nanotechnology to further increase the efficacy of delivery of other target compounds to -- for drug treatments. But again, they're excreted out into medicinal wastewater and discharged into the effluents and that the conventional fish bioassays will not be -- and the end points associated with those bioassays will not be able to detect those.

Q Okay. Let me ask you this: In the context, can you relate the degree of funding that's provided to you with your ability to continue or conduct further research of the type that was conducted in this study?

MR. VAN AGGELEN: With respect to genomics, the stage program, as I previously mentioned, is the only source of genomic funding within Environment Canada and that at the end of this fiscal year is coming to a close and a new program is thought to be on -- coming forward, but it will be with the five science-based departments in Environment Canada, so a greater -- and the emphasis is not on aquatic environmental toxicology.

Q Okay. Thank you. Dr. Ross, I wanted to ask you about a study or a piece of research you did. Exhibit 833, please, Mr. Lunn. In 2002, Dr. Ross, you did some research with respect to late-run sockeye and produced a paper with others, titled, Late-Run Sockeye at Risk: An Overview of Environmental Contaminants in the Fraser River Salmon Habitat?

DR. ROSS: That's correct.

Q That's the paper we see on the screen there?

DR. ROSS: Yes.

Q And this was, as opposed to primary research, really a literature-based risk assessment, correct?

DR. ROSS: Yes, that's correct. We felt a little bit blind and in the dark with regard to what was happening with the late-run sockeye crisis that started in the late 1990s and was leading to the loss of tens of millions of fish over a number of years, and it was an altered behavioural or return migration phenomena that was taking place and it was the subject of considerable concern, of course, to the Department of Fisheries and Oceans, the Pacific Salmon Commission, and other parties, and we thought it would behove us to at least get a cursory risk assessment conducted to try to give a little bit of guidance on possible chemical concern in the Fraser Valley that might be leading this effect.

We have 23,000 chemicals on the domestic substances list in Canada. Many of those chemicals are either used or end up in Fraser River salmon habitat. And to understand and/or prioritize which of those chemicals might present a risk or a significant risk, it was something that we felt we could at least try to do with this kind of approach.

Q Now, we'll get into the specific chemicals in a second, but just so the Commission understands, a number of the chemicals that attracted your attention in this study, one of the sources of them is municipal waste; is that correct?

DR. ROSS: That would be correct.

Q And within the body of this study, and specifically in the abstract, you summarize your conclusions and your recommendations for future research, correct?

DR. ROSS: Yes.

Q And you recommend that if we're looking at wastewater research in a couple of areas, the first was a need for further research of the impact of exposure levels for certain key chemicals, including persistent organic pollutants and PBDEs; is that correct?

DR. ROSS: Yes.

Q You recommended further research with respect to surfactants?

DR. ROSS: Yes.

Q And you also recommended further research with respect to certain pharmaceuticals and personal care products, correct?
DR. ROSS: Yes.
Q And are those all chemicals which can be found or sourced in municipal wastewater?
DR. ROSS: With little doubt that would be the case.
Q And how have the recommendations which you made in your 2002 paper been followed up on by the Department of Fisheries and Oceans?
DR. ROSS: Well, I would say that some of the recommendations have taken the form of specific research projects undertaken by myself and collaborators immediately. Some related to current use pesticides and salmon. I would say, yes, on that front. There's a very small funding envelope within DFO nationally; $300,000 a year for providing information on biological impacts of currently used pesticides in support of the Pest Management Regulatory Agency.

Some other research projects either led by myself and/or by my colleagues at the Institute of Ocean Science, where there are two or three other contaminant specialists; Dr. Ikonomou, who's done some work on pharmaceuticals, Dr. Macdonald and Dr. Johannessen, who do some work on transport and fate of certain chemicals in the environment, notably PCBs and PBDEs.

These three colleagues of mine do not look at the effects of those chemicals, but they look at where they end up and why they end there, and environmental processes that might shape their fate in the environment.

So I think it has -- some of the recommendations have borne fruit, if you will, but that there has been no impacts on envelopes, funding envelopes, grants or priorities to direct any of this research.
Q Okay. Thank you. I'm going to move away from you research, now, and ask you some questions specifically about the impacts of municipal wastewater on Fraser sockeye. Perhaps since you've got the microphone on, Dr. Ross, I'll start with you.

Based on your experience and your research, are you able to offer an opinion as to whether municipal wastewater has harmful effects on Fraser

sockeye?
DR. ROSS: Well, as we have discussed already today, we don't really have a mandate to look at end-of-pipe discharges and effects on salmon, but certainly if we look at some of the chemicals of concern in the wastewater stream, there are a number of classes of concern and I think the way I would capture it is in the absence of direct -- much direct evidence from the Fraser River system, we have to rely on some of the literature from other parts of the world, and then we have to serve a risk-oriented approach to try and rank which types of chemicals might present the greatest risk here.

I should point out that there have been several examples from other parts of the world that would underscore the potentially important threat that wastewater treatment streams to present to the health of fish. The widespread feminization of fish has been taking place in the United Kingdom. This is accentuated downstream of municipal wastewater treatment plants and this has been surmised and -- surmised to be largely due to the estrogenic nature of the wastewater stream.

Estrogenic nature simply means the stream has estrogenic potential and can feminize male fish or alter reproductive health in both the male and female fish. That estrogenic nature will come from natural estrogens, from human wastes, from agricultural animals, from birth control pills, but also a lot of pharmaceuticals, synthetic musks and a lot of the persistent bioaccumulative chemicals as well.

So there are a lot of chemicals of potential concern, I would say, in the Fraser River system and certainly being released from wastewater treatment plants.

Q Thank you. Dr. Ashley, I'm going to ask you to weigh in on this question, and if you want to sort of address it in two phases, both acute and chronic impacts, I'm content for you to do that as well, because I understanding your thinking might go along those lines.

DR. ASHLEY: The question being relevant to the Fraser River sockeye (indiscernible - overlapping speakers) --

Q Yeah, municipal wastewater harmful effects, if you believe there are any on Fraser sockeye.

DR. ASHLEY: Potentially there's acute toxicity issue with some of the high concentrations of ammonia that are discharged from a couple of the wastewater treatment plants, the large one at Annacis, which discharges about 500 mega litres per day, and then the Lulu Island treatment plant, they're known for having high ammonia discharge concentrations. Those could potentially cause acute toxicity issues. And the other ones, as Dr. Ross has just said, his concern about emerging endocrine disrupters because of this widespread knowledge around the world, in the UK and in Australia, of sex reversal.

Q Mr. van Aggelen, do you have anything to add to those two answers?

MR. VAN AGGELEN: The only thing I would add to that is that one of the things that researchers have discovered is that the life stage with which the organisms are exposed is critical. So developing fish or early life stages are much more vulnerable or thought to be more vulnerable to low level exposures of pharmaceutical and personal care products over collectively xenoestrogens, as Dr. Ross mentioned.

Q Okay. I'm going to come back to the ammonia issue in a second, Dr. Ashley, but before we come to that issue, on the general issue of the harmful effects of wastewater to the extent there are any on Fraser sockeye, does the state of research impact on the certainty with which you can offer an opinion in this area?

DR. ASHLEY: I think there's a fair amount of published literature that uses a weight of evidence approach to say if there is an effect or not, so the answer is, yes.

Q Dr. Ross?

DR. ROSS: Well, again, I speak with some ambivalence just because of the lack of a tremendous amount of research in this field in the Fraser Valley. But if I imagined, as my colleague, Mr. van Aggelen here had inferred, developing eggs and fry in the headwaters down through smoltification at a very small size and young age within a year in through the Fraser River and estuary and out into the open ocean. As I understand it, there are 90 wastewater treatment plants in the Fraser River valley, and so if we're talking about point-source

discharges and certainly the high level public concern about acute toxicity related to a single point source, I think I would step back a little bit and raise some concern about 90 point sources of which certainly the lower Fraser estuary has the largest by volume discharge, but I would point to the cumulative exposure from a very young age to some of these chemicals of concern throughout their early life and certainly upon return.

And some of the chemicals we're talking about we might characterize as persistent; that is, they don't break down. Once they're released into the Fraser or into the Strait of Georgia, they're around for decades, if not centuries. These would include the dioxins, the PCBs, the organic chlorine pesticides, the PBDE flame retardants.

On the other side of the spectrum, we have chemicals that might simplistically be viewed as non-persistent or less persistent. But when I look at 90 point-source discharges for wastewater treatment plants, those non-persistent chemicals become pseudo-persistent because they're chronically being released and they're being released at virtually every point along the freshwater habitat for these migrating sockeye.

Q Thank you. Mr. van Aggelen, do you have anything to add to that?

MR. VAN AGGELEN: No, I basically just echo with Dr. Ross, is that it's the persistent low-level, continuous exposure of a toxicant that can result in -- certainly from molecular or sublethal effects that could be seen, as I say, that that would be -- that would my take, is that the sum total of all the discharges incoming through with low levels of various contaminants, could contribute to the molecular or sublethal or chronic effects that maybe we're seeing.

Q Okay. Dr. Ashley has identified ammonia as one contaminant of particular concern. Do either of the other two on the panel have any particular contaminants or chemicals that they have identified that are of particular concern and think warrant special attention?

MR. VAN AGGELEN: I'll speak up. As I say, I think that municipal wastewater there is, you know, there's all kinds of things you could say for it, but essentially it's a cocktail. It's a cocktail

of everything, whether it's -- particularly with respect to drugs that people take, to things people pour down the drain. I think that, you know, most people view sewage treatment plants as this magical place where everything gets cleaned, and essentially the treatment of sewage really hasn't changed all that much since, I think, the Romans first introduced us to biological treatment of human waste.

So essentially we can clean up the, you know, conventional things like suspended solids, biological oxygen demand, and to a certain degree control for ammonia. And those, as I think Dr. Ashley mentioned, are all acutely toxic parameters. And those plants that are officially run, or that have upgraded to treat for those, what I would call conventional parameters of toxicity and effluent quality, are in, you know, in check, but as I say, the myriad of chemicals that society puts into a treatment system is -- you can't -- you could spend all day listing them and you still wouldn't come up with the sum total of everything that's in a complex mixture.

Q Thank you. Dr. Ashley, you've identified the Annacis treatment plant and the ammonia issue, which we'll come to in a second. Dr. Ross, or Mr. van Aggelen, are there particular waste treatment facilities or discharge sites that you think warrant particular attention or are of particular concern to you, thinking from a Fraser sockeye perspective?

DR. ROSS: Well, this is a little bit outside my line of expertise, but I'd be looking for those discharging the most in terms of volume, and then I'd be looking at treatment level. That would be two features. So Annacis Island certainly comes to mind in that respect.

I'd also be looking at the vulnerability of the receiving environment, because oftentimes when one looks at sort of national minimum standards or national rules of engagement, one's looking at a certain common denominator and, unfortunately, a lot of these plants -- well, none of these plants discharge into the same body of water. There's different dilution levels, there's different flow rates, there's different depths and different species inhabiting those environments. So those

are some features I'd be looking for with regard to sort of a hazard-oriented approach to identifying wastewater treatment discharge points of concern.

Q And using the criteria you've concerned, are there any particular plants that you identify as ones that would perhaps raise red flags?

DR. ROSS: Well, the overwhelming number amongst those 90 wastewater treatment plants in the Fraser Valley are secondary or even tertiary, and secondary and tertiary will -- it doesn't solve all the problems, but it does reduce the inputs of a lot of harmful compounds, many of the ones we're talking about today, with some variation, and we can certainly speak to that a little bit, but when we get down into the Fraser estuary where we have primary treatment, obviously there is less retention of some of the chemicals of concern to sockeye salmon.

Q Okay. Thank you. I want to come back to the ammonia issue now, Dr. Ashley, and I wonder if you could just explain to the Commissioner what your concern is with respect to the ammonia and the waste treatment plants you identified?

DR. ASHLEY: As discussed, it's one of these older contaminants that have been known for a long time and it's just -- it's acutely lethal, depending on the combination of pH and temperature. And the design of the plants at Annacis and Lulu Island are not particularly effective at converting it to a non-toxic effect, and so they discharge at fairly high concentrations in the effluent stream, 25, 30 milligrams per litre, and then that -- the assumption is that that will be adequately diluted to the point where it's non-acutely toxic to salmonids. Now, that's based on an average. Remember, the Fraser River flows downhill and then it flows back in and then there's a slack tide period, and the concern is that -- I've been out during the wintertime when the Fraser's at its minimum flow, down around 1,000 cubic metres per second, at a slack tide and basically there's a couple hour period where the effluent is just pouring out and it's not moving one way or the other. And so the concept of a dilution zone sort of disappears temporally, and whether that would be a stressor on salmonids that were resident at

the time. Obviously migrating sockeye are not there at that time; this is more for resident fish species in the area.

Q Okay. From a sockeye perspective, are you aware of any evidence that links harmful effects from ammonia from those two plants to Fraser sockeye?

DR. ASHLEY: No.

Q Okay. Is this something you've sort of surmised from looking at the evidence of what's discharged and knowing what you know about Fraser sockeye?

DR. ASHLEY: It's not specific to sockeye, it's just that the concentrations are so high that the plant is not particularly well designed to remove ammonia and that Metro had to develop a separate acute lethal toxicity test to deal with ammonia because the standard Environment Canada test was failing the LC50 test.

Q Okay. You addressed some of your concerns with respect to ammonia and the Annacis plant at the Speaking for the Salmon conference, correct?

DR. ASHLEY: That's correct.

MR. McGOWAN: And Mr. Commissioner, just for your note, Exhibit 12 contains that summary of the presentations from that conference.

Q Now, Annacis Island, you've talked about the different technologies, and just so we're clear, when you refer to the different technologies, you're referring to the fact that Annacis has a trickling filter design as opposed to an activated sludge design?

DR. ASHLEY: That's correct.

Q Okay. And is the retention period shorter with a trickling filter design?

DR. ASHLEY: Yes. There's two types of retention. Co-efficiency is one, is the hydrology retention time, and one is the solids retention time, and both are very short. In a trickling filter solids contact design such as Annacis, is relative to an activated sludge design.

Q Thank you. Mr. van Aggelen, Dr. Ashley referred to a change to the LC50 test, the acute toxicity test conducted on the ammonia -- or conducted with respect to ammonia for Annacis, or to the discharge with respect to Annacis. You know something about that testing change?

MR. VAN AGGELEN: I wouldn't say change is an accurate word. There was what they call a pH control

method that was developed, actually, out of my lab to look at those effluents that where -- I have to back up, Your Honour (sic), that in a conventional bioassay for doing compliance monitoring, the test solutions are aerated at a prescribed rate of 7.5 mils per minute per litre for the duration of the bioassay, and the ammonia, as Dr. Ashley mentioned, is a very complex -- chemically-complex toxic, and that can, depending on the state of pH, it can -- the toxicity can be hugely more toxic as pH shifts.

And what we were seeing as a result of the bioassay is that the aeration rate was driving off or gassing off - I hate to get into scientific jargon - but the carbonic acid ions in the water solutions were being driven off and causing a shift in the pH in the solution and it was converting the total ammonia contained in the solutions to a much more toxic state, which is what they call the un-ionized ammonia concentration. And this was causing, in some instances, erroneous results. In other words, samples were being shown to be more toxic than with which they were.

So we developed a method to control the pH drift in the bioassays by injecting carbon dioxide to compensate for the carbonic acid that was being driven off. So basically we're hence pH control. So with this method we were able to determine if there were acute toxic concentrations of ammonia in the sample that would -- that weren't being converted as a result of a pH shift. So essentially a method to ensure that the method did not report erroneous results and that if there was entrained toxic levels of ammonia or un-ionized ammonia, that we would pick it up in our compliance test.

Q And that test both originally and as modified is designed to test for acutely toxic effects lethality?

MR. VAN AGGELEN: That's correct.

Q Okay. Thank you. I'm going to ask that you bring up Exhibit 616A, please, Mr. Lunn. Dr. Ross, I'm going to ask you some questions about this document. It's a memorandum to the minister, dated December 3rd, 2009, from the Department of Fisheries and Oceans. Are you familiar with this

document?
DR. ROSS: Only through having seen it as an exhibit.
Q Okay. And you've now reviewed it?
DR. ROSS: Yes.
Q Okay. You've given us your views on the potential connection between municipal wastewater and Fraser sockeye. This is a memorandum designed -- addressed to the ministered, titled, Factors Affecting the 2009 Fraser Sockeye Return. I wonder if you could flip to the next page, please. And zoom in on the Analysis/DFO Comment and then number 1. That's sufficient as it is.
Okay, the first point under this heading reads:

> The following factors are unlikely to have contributed to the poor 2009 return:
>
> 1. Pollution in the Fraser River.

Do you support that statement as written in this memorandum?
DR. ROSS: Well, I guess I'd have to say that I haven't seen any data that would empower me to suggest that there's no evidence for pollution having played a role.
Q Okay. Did you participate in the September 2009 DFO Science workshop?
DR. ROSS: Yes, I did.
Q And you made a presentation there?
DR. ROSS: Yes, I did.
Q And was your presentation consistent with the message as articulated in this memorandum?
DR. ROSS: Well, I can't say that it is completely consistent. I think my sense, from reading this statement, Pollution in the Fraser River, there is no record of any Fraser Basin-wide environmental instant that could have impacted fish. It strikes me that the author or authors are referring to an absence of any reported spills or any broad-scale impact. And the fact that with the sockeye returns in 2009 being so poor, the author or authors contributing to this were probably looking at a simple A plus B equals C relationship.
That said, I remain fundamentally concerned that environmental concentrations of a number of endocrine disrupting compounds, both persistent

and non-persistent, can adversely affect the health of sockeye at different life history stages and may increase the risk of mortality through a number of developmental means.

The absence of a spill or the absence of a fish kill, to me, does not indicate the pollution can -- can play no role in affecting the lifelong health of a fish.

Q Thank you. Could we have Exhibit -- sorry, our list of documents number 6, please.

Dr. Ross, you're familiar with the Canadian Council of the Ministers of the Environment and the work that they did to come up with a Canada-wide strategy?

DR. ROSS: Yes.

Q And that's a collection of all the ministers of the environment from each of the provinces and Canada and they got together and worked out a strategy to approach wastewater treatment in Canada, correct?

DR. ROSS: Correct.

Q And speaking very generally, it was designed to create consistent nationally-applied criteria and rules for the treatment of wastewater?

DR. ROSS: Well, as I understand it, that is essentially the hallmark of this CCME effort, a national minimum standard to make things easy in terms of design, operation monitoring and assessment.

Q Okay. And what flowed out of that Canada-wide strategy was the drafting of what are now proposed wastewater system effluent regulations, correct?

DR. ROSS: Correct.

Q And those are somewhat analogous, although certainly not identical to the regulations that were crafted for the pulp and paper industry and metal mining, correct?

DR. ROSS: Correct.

MR. McGOWAN: We have the draft regulations with the proposed, Mr. Commissioner. I'm going to suggest those become the next exhibit.

THE REGISTRAR: Exhibit 1047.

EXHIBIT 1047: Wastewater Systems Effluent Regulations, Regulatory Impact Analysis Statement, March 20, 2010

MR. McGOWAN:
Q Dr. Ross, you had the opportunity, along with some of your colleagues, to review these draft regulations and offer your comments on them?
DR. ROSS: Yes, we had a very short window to respond to the proposed wastewater systems effluent regulations.
Q And you and some of your colleagues reduced your comments to writing?
DR. ROSS: That's correct.
Q And those were put together in a memorandum addressed to a Robin Brown?
DR. ROSS: That's correct.
MR. McGOWAN: If we could have our list of documents number 30, please.
Q And this is a copy of that memorandum?
DR. ROSS: Yes, it is.
MR. McGOWAN: Okay, if that could be the next exhibit, please, Mr. Commissioner.
THE REGISTRAR: Exhibit 1048.

EXHIBIT 1048: Memo to R. Brown from R.W. Macdonald, et al, re Collective Thoughts on the Wastewater System Effluent Regulations, dated February 2010

MR. McGOWAN:
Q I wonder if you'd just take a moment now, Dr. Ross, and address the Commissioner on any comments you have on the proposed regulations and any concerns you have about their adequacy, bearing in mind that our focus is Fraser sockeye?
DR. ROSS: Well, I should start by stating that I played no part in any of the CCME discussions or deliberations leading up to the Canada-wide strategy or the proposed wastewater systems effluent regulations that are not yet in effect but will take place under the guise of the ***Fisheries Act***.
So my only involvement on this file would be this rather rapid turnaround review of the proposed regulations, and as scientists do in terms of peer evaluation, we look for gaps, data gaps, and the like. I think my take-home message was, while it's important to have a clear set of terms of engagement and a national strategy and national regulations would help in that front, I

did express the concern that a national minimum standard does not necessarily upgrade the performance of all wastewater treatment plants.

Certainly a minimum standard of secondary will reduce the risk to some aspects of Fraser River sockeye habitat, because an upgrade from primary to secondary will reduce the release of a number of contaminants of concern.

Specifically, the proposed regulations cover the kinds of chemical constituents or activities thereof that we've been worried about for dozens, if not hundreds, of years by default, the suspended solids, total residual chlorine, de-ionized ammonia, and biological oxygen demand. But they do not, in looking at these four primary conventional pollutants, there is only fleeting mention of site-specific impacts and concerns, only fleeting mention of emerging chemicals of concern, such as the flame retardants or the pharmaceuticals. The reporting of monitoring data appears fairly elementary, and the effects monitoring ceases to be a requirement if there are no adverse impacts observed after a certain number of years.

So I did have some concerns and in looking at government operations and the way in which we do science to look at the broader risk to the receiving environment associated with contaminants, I think I hearken back to the question of cumulative impacts. These regulations were not designed to protect salmon. They were not designed to prevent cumulative impacts associated with multiple treatment plants. And they were not really designed to deal with the concerns that I have about bioaccumulation and biomagnifications food webs. A lot of chemicals, even present at very, very low concentrations, if they're very persistent, they can get into food webs and be found at very, very high concentrations in some organisms of concern, such as marine mammals.

So we did have a number of concerns about a national minimum standard or this common denominator, and we did have some concerns about the fact that site-specific impacts would be subject in some form to local regulatory frameworks, but that that remained, to me, a

little bit unclear. There may be additional ancillary discussions going on to render this a little bit more seamless with regards to provincial regulations and legislation or site-specific requirements under a liquid waste management plan for certain waste treatment plants.

Q Thank you. There's just one other issue I wanted to have your comment on, and that is the issue of biosolids and the extent to which they're dealt with by the regulations. Do you have a comment on that?

DR. ROSS: Well, as I understand it, there is no mention of what happens with the retained sludge, and I do have a concern. If we're talking about persistent contaminants, the PCBs, the dioxins, the furans, the organic chlorine pesticides, the perfluorinated compounds, the polybrominated diphenyl ethers - those are flame retardants that are only recently under the regulatory microscope in North America - these are all very, very persistent compounds. Upgrading blindly from primary to secondary to tertiary does not degrade these compounds, does not breakdown these compounds, but it does retain many of these compounds, because these chemicals are all persistent and they bind to organic materials or to fats in the food web.

The fact that they're so persistent means there's only one way to get rid of them, and that's with incineration at 1,000 degrees Celsius or higher. The half life of most of these chemicals in the environment is in the order of hundreds of years. If sludge is being retained, biosolid is being retained and transferred to agricultural lands, forestry lands, mine reclamation projects, or landfills, those chemicals are maybe not coming out the pipe anymore, but they are entering the environment; they're simply being cycled to another part of what is likely to be Fraser River sockeye habitat.

Q Thank you. Dr. Ashley, you've heard Dr. Ross's comments on the proposed regulations. I wonder if you have any observations to add?

DR. ASHLEY: I agree with everything he said. I think there -- obviously the country needs a national standard, because there's many parts of Canada

that have either no wastewater treatment, like Victoria for example, or places in the north that have fairly rudimentary, but to say that a movement to secondary is going to solve any -- all the concerns about potential contamination in the environment is not true.

Q Okay. Does that conclude your comments?

DR. ASHLEY: We'll probably get back to this one more later?

Q Yes, we will come back to the different treatment levels and I'll allow you to offer your opinion on what's advisable in that regard.

Mr. van Aggelen, do you have anything to add with respect to the proposed regulations?

MR. VAN AGGELEN: No, I concur with Dr. -- Dr. Ross mentioned, just with the added bit that our understanding of how to treat the chemicals is not well understood, and as Dr. Ashley mentioned, blindly saying or going to secondary or tertiary treatment is not the cure. It's better, but it's not -- for the 21st Century knowledge of chemicals as we know it now, secondary and tertiary is not going to take care of our problems, and as we were talking about biosolids, yeah, I have grave concerns about how we are regulating or administering biosolids as a soil additive.

And as Dr. Ross mentioned, I think it's just a means of transferring the potential toxicants from one source to another, and subject to, you know, rain events and other erosional events, it could liberate and start the migration of low level contaminants that have been bound up in the biosolids, and science has proven that there's certainly some of these emerging chemicals of concern have a high binding affinity to the particulate matter in treatment processes and that is all part and parcel of biosolids.

Q Thank you. Dr. Ashley, you have an engineering background, so I'm going to address the next questions primary to you. You mention Capital Regional District, or Victoria, which has very limited waste treatment, not even to the primary level, as I understand it, we have Iona, which has primary, and then there's some different secondary options available; activated sludge and trickling filter.

I'm wondering if you can walk the

Commissioner through sort of the upgrade from nothing to primary and primary to secondary and secondary to tertiary, and explain to him what is gained in terms of removal of contaminants or matters of concern to sockeye with each of the upgrades.

DR. ASHLEY: All right. We'll use the conventional terminology, it was this primary, secondary, tertiary, but I'd like to mention that there is, within the engineering circles, there's different ways of looking at that, and I'll bring that in at the close of this section.

Capital Regional District basically just has a screen mesh, and so that's called preliminary screening, so basically it's to catch rags, sticks, things like that that are fairly large scale, and that's basically it. So that's preliminary treatment. Those exist in all wastewater treatment plants just as a matter of protecting pumps and equipment downstream within the plant so they don't get jammed up, and the rest of the effluents just sail right through. So it's basically a coarse screen.

Primary treatment is basically designed to retain the effluent for a certain period of time and settle out the suspended solids and so it has a settling rate of around 60 to 70 percent of the suspended solids settle out, and around 30 to 40 percent of the biochemical oxygen, that's carbonaceous material in the wastewater that consumes oxygen in the receiving environment.

The movement to secondary, it's -- the containment is held in a plant longer and so the suspended solids removal percentage goes up to around 90 percent. The removal of BOD5 goes up to 60, 70, even 80 percent in good plants, but basically all of the remaining pollutants continue to sail right through and be discharged.

If one moves to tertiary, the conventional sort of designation for tertiary is that it removes nitrogen and phosphorous, and so that was a tertiary plant. So basically those were a secondary plant with an add-on for nutrient removal.

And the next step beyond that, not seen very often in Canada, is called a quaternary treatment plant, where it would actually remove some of

these chemicals of concern. That's used in places like Israel, in Southern California, San Diego, where they're water short.

The term that's emerging, now, is -- within the engineering circles, is often to refer to conventional wastewater treatment, because secondary treatment is so normal these days in many parts of the world. I mean, it was discovered in, I think, 1910 was the first activated sludge plant. It's referred to the term "advanced wastewater treatment" and used the best available technology for the day.

And so those two terms can be used interchangeably, but that's basically the difference between preliminary, primary, secondary tertiary, quaternary, and then the sort of discussion to move to advanced wastewater treatment plant using all of the technology that's available today and proven.

Q Okay. And in terms of the cost differential, what is the cost differential between sort of secondary or moving to tertiary or from secondary to best available technology?

DR. ASHLEY: It depends on how the plant is designed. Some plants are very adaptable towards upgrade to tertiary, conventional secondary treatment activated sludge plants. There's even a company that specializes in rearranging the flow pattern within the plant with very little new tankage that essentially converts them to biological nutrient removal designs.

Quaternary is the really advanced wastewater treatment plants. Those are usually add-ons that the -- as the effluent has to be fairly clear before they can be used for absorption of some of these chemicals of concern at the end. Activated charcoal columns can be used. There's other suggestions that ozone, because of its strong oxidizing capability, can be used once the effluent has passed beyond a tertiary stage.

Other design plants of secondary -- are relatively expensive to upgrade to nutrient removal, just because of the inherent design, so referring to trickling filter plant designs, are not very easily converted to nutrient removal because of their inherent difference in design between a trickling filter and activated sludge.

So you might be looking, in some cases, of a 10 to 20 percent cost increase to go from secondary to tertiary for an activated sludge plant, whereas a trickling filter secondary plant, it might be the -- half the cost of the plant again to convert it to nutrient removal and more advanced containment for emerging chemicals of concern.

Q If we're looking at a plant that's going to be started from scratch, as I think we will hear Iona will likely be, what sort of cost differential would those footing the bill for that be looking at, if they were to go beyond secondary to best available technology?

DR. ASHLEY: Designed at scratch is the time to make the decision, because that's when the cost differential is at its very least, and so it would be probably in about the 20 percent range to go to advanced plants over conventional secondary. It would be very foolish to just build a secondary treatment plant, because by the time it was built it would be technologically out of date, given the new regulations that will be coming down in terms of capture of the emerging chemicals of concern.

Q Okay. Speaking of the Iona plant and the upgrade that is contemplated for that, from a Fraser sockeye perspective, how important is it to look at something beyond secondary for that plant? I'll ask you, first, Dr. Ashley.

DR. ASHLEY: Because it discharges into the estuarine marine environment, it's of less immediate concern than something that was discharging directly into the Fraser, but it adds to the burden of consistent chemicals in Georgia Strait, which obviously would have a concern with the life history of sockeye.

Q Dr. Ross, do you have anything to add to that?

DR. ROSS: Well, for Fraser River sockeye, of course, Strait of Georgia is part of their habitat, and releasing compounds that are ending up in the Strait of Georgia may be out of sight, but it's not entirely out of mind. I can point to our recent study that's in press right now that describes PCBs that have been banned since 1977, and PBDEs that are only now becoming regulated in Canada and have no regulation in the United States. These are both very persistent bioaccumulative and toxic compounds of concern to

the food web, because they get into the fats at the bottom of the food web, they biomagnify. PCBs have heavily contaminated southern resident killer whales because of the legacy of the use of that chemical.

PBDEs have been doubling every 3.5 years in harbour seals in the Strait of Georgia and are now probably plateauing or dropping. Our study examining PCBs and PBDEs in sediments in the Strait of Georgia show very high concentrations around, well, the eastern shoreline of the Strait of Georgia, notably around the outfalls and into Burrard Inlet. So very, very high concentrations of PBDEs, much higher than we would expect based on our observations with PCBs, which indicates, to me, very strong localized point sources of flame retardant chemicals that are coming out of day-to-day use, computers, furniture, carpeting, textiles, electronics, automobiles, landfill leachate, clothing, even. And these things would get into the wastewater stream, whether it's primary or secondary, there's certainly a large fraction ending up going into the plume, into the stream and into the Strait of Georgia.

The concern about that is that over time we're building up a reservoir in the Strait of Georgia, and over time that will start to present biological risks to the critters that live and/or transit the Strait of Georgia.

Q Okay. If we were looking at priorities, where would you put -- rank the priority, in our priorities, the need to upgrade Iona as compared to perhaps other concerns that might exist with facilities, wastewater facilities?

DR. ROSS: Well, other concerns, to me, would extend far beyond the wastewater treatment --

Q Yes.

DR. ROSS: -- plants, of course. Pulp mills are huge producers of some of these estrogenic compounds of concern. Some of the pesticides that are used in agriculture and forestry are of concern. But in terms of a wastewater treatment plant, I would say that anything that reduces the release of compounds of concern and upgrades from primary, secondary and tertiary would all reduce the inputs of current use pesticides, of persistent compounds, of pharmaceuticals, et cetera, but it

doesn't necessarily solve the problem.

I think I would point to a couple of other activities that -- there are times when municipalities or regional governments get sort of blamed for these chemicals, but the fact of the matter is, Metro Vancouver or Capital Regional District did not produce these chemicals of concern. They're stewards of our waste, and as such, there's a heavy responsibility in terms of trying to have wastewater treatment practices that eliminate, potentially, 10,000 or 15,000 chemicals of potential concern in terms of sockeye.

So I think I would point to ***CEPA***, the ***Canadian Environmental Protection Act***, which has, as part of its direction, chemical regulation. And PBDEs are a good case in point. PBDEs are starting to be regulated in terms of ***CEPA***, so there is a chemical regulation side of things to prevent chemicals from getting into the wastewater stream at the beginning of the day.

And the second thing I would point to would be source control. I know that Metro Vancouver and Capital Regional District have very strong and very important source control programs, and source control can target photofinishing labs, can target dentists, can target automobile repair shops, et cetera, and try to prevent some of these chemicals from getting into the stream. It's easier to process them in a reduced risk at that level.

So I may be wandering a little bit for your purposes, but those are a couple of thoughts I did want to get in there.

MR. McGOWAN: No, it's helpful and it saves me a couple of questions which I was going to come to. Mr. Commissioner, this might be an appropriate time for the break.

THE COMMISSIONER: Thank you.

THE REGISTRAR: The hearing will now recess for 15 minutes.

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.

EXAMINATION IN CHIEF BY MR. McGOWAN, continuing:

Q Dr. Ashley, just before we broke, we were talking about priorities and the prioritization of upgrading Iona. In terms of the upgrade to Iona and with respect to priority, where did you place that on your priority list? Is there something that you would give a higher priority to from a Fraser sockeye perspective?

DR. ASHLEY: I would put upgrades to Iona and Annacis and Lulu all on the same priority, because one deals with their freshwater riverine habitat and the other one deals with the marine habitat. That's the complexity of dealing with anadromous salmonids. They spend part of their life history in fresh water and part in the marine environment, and so you have to deal with both.

Q Following the Fraser Report, there was a recommendation made with respect to upgrade to Annacis, and it has in, comparatively speaking, relatively recent times been upgraded to the trickling filter secondary; is that correct?

DR. ASHLEY: Yes, it went from a primary plant to a secondary plant of the trickling filter solids contact design.

Q Okay. Is there an easy fix to address your ammonia concern, or is this a substantial undertaking that you're proposing?

DR. ASHLEY: It would be a substantial undertaking.

Q And can you give us any sense of the magnitude in terms of cost?

DR. ASHLEY: Tens of millions.

MR. McGOWAN: If I could just have a moment, Mr. Commissioner.

Could we have our Tab 10 of our list of documents up, please?

Q Dr. Ashley, this is metro Vancouver's recently approved new Liquid Waste Management Plan. Have you seen this document before?

DR. ASHLEY: Yes, I have.

MR. McGOWAN: Okay. If that could be the next exhibit, Mr. Commissioner.

THE REGISTRAR: Exhibit 1049.

EXHIBIT 1049: Proposed Integrated Liquid Waste and Resource Mgmt, May 2010 [Metro Vancouver]

MR. McGOWAN: And the approval of this new Liquid Waste Management Plan was accomplished by way of a letter dated May 30th at our Tab 29.

If we could zoom in on the paragraph with the number 1 at the start of it, please. If this could be the next exhibit?

THE REGISTRAR: Exhibit 1050.

EXHIBIT 1050: Letter from Lake (BC MOE) to Jackson (MetroVan) re Liquid Waste Mgmt Plan, with revisions, May 30, 2011

MR. McGOWAN:

Q Dr. Ashley, you're aware that Liquid Waste Management Plans are typically approved by the Province of British Columbia and that those approvals sometimes carry with conditions?

DR. ASHLEY: Yes, I am.

Q And the first condition on this letter is:

> The Ministry supports [the] upgrading to secondary level treatment the Lions Gate wastewater treatment plant by 2020 and Iona Island wastewater treatment plant as soon as possible, but no later than 2030.

I wonder if you have any comments on the proposed timing and extent of the upgrades which are being suggested for those two treatment plants.

DR. ASHLEY: I agree with what the Metro Reference Panel, in their original submission to Metro, argues that both plants be done simultaneously and that they be upgraded to best available technology which was considerably beyond secondary treatment.

Q And, Dr. Ross, do you agree with that?

DR. ROSS: I think this would be largely outside my realm of expertise. But certainly if one is to design something to reduce risk associated with discharge of deleterious substances, upgrades to both these plants sooner rather than later would be of net benefit to salmon habitat.

Q All right. Now, Dr. Ashley, Metro Vancouver engages in a fairly substantial planning process associated with liquid waste that gets articulated through the Liquid Waste Management Plan. And that approach is not taken in all municipalities. Is the liquid waste management planning process

one which you believe is beneficial?
DR. ASHLEY: Yes, I do.
Q And part of that process includes Metro Vancouver engaging in environmental monitoring; is that correct?
DR. ASHLEY: Correct.
Q Okay. And we're going to hear something about the Environmental Monitoring Program in evidence tomorrow, but is it a program that you're familiar with --
DR. ASHLEY: Yes, I am.
Q -- for Vancouver? And you're familiar with the new Liquid Waste Management Plan which proposes the continuation of that?
DR. ASHLEY: Yes.
Q I wonder if you have any comments on Metro Vancouver's Environmental Monitoring Program?
DR. ASHLEY: Current or projected new?
Q Either one.
DR. ASHLEY: The existing --
Q Perhaps focusing on the projected new.
DR. ASHLEY: The projected. Could you scroll down to the other clauses in here that --
Q Oh, certainly. I think you're referring to conditions 5 and 6 --
DR. ASHLEY: Yes.
Q -- of the approval and perhaps you could just highlight 5 and 6 for Dr. Ashley.
DR. ASHLEY: It's that there's recognition by the province, who issues the permit and approval for Liquid Waste Management Plan, is that they are also become concerned about the emerging chemical concern that Dr. Ross spoke about, the persistent organic pollutants, PBDEs, that are accumulating at an alarming rate in George Strait and where the marine outlet is for Iona and also for the concern about endocrine-disrupting chemicals. So it needs to build upon studies so that that becomes a larger component of their monitoring program.
Q Thank you. In terms of conducting environmental monitoring if one is concerned about Fraser sockeye, is it important for the environmental monitoring to include the examination of pelagic species or salmon specifically in your opinion?
DR. ASHLEY: Yes, I believe it is important.
Q Dr. Ross, do you have an opinion on that?
DR. ROSS: Well, if one were concerned about the real

world out there in the natural environment, real habitat, real species, then I would suggest that that is the case, particularly with salmon. You know, 96-hour LC50s, lethal concentration 50 tests, in a laboratory with rainbow trout under very strict conditions will provide ease in terms of monitoring for effects, but it does not necessarily do anything more than document risks associated with acute immediate effects.

That's where, I think, when one looks at the cumulative effects in the real world as the long-term endocrine-disrupting effects - that is, effects on the immune system, effects on behaviour, effects on the ability of salmon to smell, and effects on normal growth and development - I think we could go a long way to having better understanding of the nature of the many pollutants that end up in Fraser River sockeye habitat by expanding beyond the laboratory testing procedures currently called for.

MR. McGOWAN: Okay. Thank you. Now, Mr. Commissioner, this letter references back to the 2002 Liquid Waste Management Plan which is at our list of documents number 11, if we could bring that up.

Q Dr. Ashley, you're familiar with this? This is a 2002 approved --

DR. ASHLEY: Yes, I am.

Q -- Liquid Waste Management Plan?

MR. McGOWAN: If that could be the next exhibit.

THE REGISTRAR: Exhibit 1051.

EXHIBIT 1051: Liquid Waste Mgmt Plan, Feb 2001 [Greater Vancouver Regional District]

MR. McGOWAN: Thank you. Mr. Commissioner, just for your benefit, the approval letter is contained within this exhibit. One exhibit contains both of those two documents, the plan and the approval letter.

Q Dr. Ashley, under the 2001 draft and 2002 approved Liquid Waste Management Plan, Metro Vancouver set up an Environmental Monitoring Committee. You're familiar with that?

DR. ASHLEY: Yes, I am.

Q And the terms of reference for that - I think the Commissioner is going to hear tomorrow - contemplated participation from the Department of

Fisheries and Oceans and Environment Canada. Do you, from your experience working with Metro Vancouver and working in this area, do you believe the participation of those two agencies in a Metro Vancouver Environmental Monitoring Committee would be beneficial?

DR. ASHLEY: Yes, it would be beneficial.

Q Okay. And, Dr. Ross, you have some experience with respect to involvement in monitoring of the Capital Regional District's waste water. Can you offer an opinion as to whether the involvement of the Department of Fisheries and Oceans can be beneficial in monitoring wastewater matters?

DR. ROSS: Oh, I think certainly having expertise regarding life history of salmon or some of the other creatures that live or transit the receiving waters in the Fraser estuary, Burrard Inlet, Strait of Georgia, would be beneficial.

I can't really comment as to whether that should be carried out by Fisheries and Oceans or not, but certainly there are a number of candidate experts within the Department of Fisheries and Oceans, both within our Habitat sector, as well as our Science sector that I think would have some important expertise to contribute to such a committee.

Q Okay. Thank you. Dr. Ashley, I wonder if you could just briefly explain to the Commissioner - I'm going to turn to a different topic now, the topic of combined sewer overflows - and I wonder if you could just explain to the Commissioner, just briefly, the manner in which the sanitary and storm water systems are designed presently in Vancouver and New Westminster, and how combined sewer overflow events can occur.

DR. ASHLEY: In many parts of the world that are 100-plus years old, which is certainly New Westminster and parts of Vancouver, the storm sewers were combined into the sanitary sewer and so they were designed under dry weather flow to just send the sewage to a sewage treatment plant. When it rains above a certain intensity and for a certain duration, then the capacity of the sewage treatment plant to handle that additional rainwater runoff, combined with the base flow of sewage means that the system then goes into an overflow mode, and that's what's known as a

combined sewer overflow.
It's different from a sanitary super overflow which is just a sort of failure of the sanitary sewer system due to a pump failure or a pipe break or something like that, that may cause an overflow of raw sewage.
Q Okay. And the combined sewer overflows, do they result in sewage which has not been treated at all being released into the environment.
DR. ASHLEY: Yes, it's raw sewage, and all of the other contaminants that come off the urbanized landscape.
Q Okay. And to the extent that these combined sewers may be discharging into the Fraser River, is there a potential harm to Fraser sockeye?
DR. ASHLEY: It would depend on the timing and the magnitude of the event. Theoretically, there would be a potential risk. You'd have to look at it on a risk-specific event. For acute toxicity certainly; for chronic toxicity and accumulation of persistent contaminants in the Fraser River and which would then be sediment-mobilized down into the estuary, there is a concern.
Q Okay. And what measures are generally needed with respect to -- I take it, Vancouver and New Westminster are the primary areas of concern?
DR. ASHLEY: For Fraser River or for combined sewer overflows in general?
Q For Fraser River.
DR. ASHLEY: For Fraser River, it's basically Vancouver and New Westminster.
Q And what measures are needed to minimize or mitigate the threats posed by combined sewer overflows?
DR. ASHLEY: There is a long-term plan to separate them which generally rolls at the rate of 1 to 1.5 percent of the sewage system per year is replaced, and that's the separation rate unless there is a higher priority that gets added on top of that normal replacement rate.
Q Okay. And that approach is already underway?
DR. ASHLEY: Yes, that approach has been underway for some time.
Q Okay. And do you support that approach to managing this issue?
DR. ASHLEY: Yes, I do. That deals with Metro's combined sewer overflows and the City of New

Westminster has its own replacement rate that needs to be looked at relative to their civic budget, and so it's important to distinguish between Metro Vancouver combined sewer overflows and then individual overflows that are owned by the respective municipalities.

Q Thank you. Dr. Ross, do you have anything to add to the issue of combined sewer overflows?

DR. ROSS: Well, I think Dr. Ashley summarizes some of the concerns and certainly the technology or lack thereof with regard to CSOs. I do know from research that has been carried out in Puget Sound, Washington State, that CSOs and/or some of the runoff associated with city streets have created problems for salmon.

We know that copper is a metal that is very, very toxic. Copper is something that's released through brake pads and some other activities from vehicles. Salmon are extremely sensitive to copper and there are a few sporadic mortalities associated with storm water and CSO discharge.

So separating out the storm sewers and the sanitary sewers is something that would help manage and reduce the release of some of the contaminants of particular concern.

Storm water as well, there are changes to storm water systems that are fairly elementary that would also help to reduce the release of oils or suspended solids, et cetera. So even if one separates the combined into sewage stream and storm sewer discharge, there are means of further refining and reducing the release of various contaminants of concern to salmon.

Q Thank you.

MR. McGOWAN: Could we please have Exhibit 77?

Q Dr. Ross, I'm bringing up the 1994 Fraser Report. It's a document you're somewhat familiar with?

DR. ROSS: Yes, very basically.

MR. McGOWAN: Okay. I'm going to ask that we turn, please, to page 70 of the document, and I'm looking at the page numbers in the bottom centre. If you could highlight recommendation 29, please?

Q Dr. Ross and Mr. van Aggelen, I'm going to address this question to the two of you. There's a recommendation here made in 1995, I believe.

We recommend that the federal, provincial and

local governments join forces to develop effective policies and plans in the Fraser River basin designed to:

- Better treat and control the discharge of effluent into the Fraser River watershed.

Bearing in mind that today's topic is focused primarily on municipal waste water, I wonder if you can address the Commissioner on whether that has taken place?

DR. ROSS: 1994, that comes out of the era of grave concerns about the release of dioxins and furans associated with pulp and paper mills, and those regulations were implemented in the early 1990s. So there would have been action at the time captured -- at the time of this Fraser Report wherein we would have seen upwards of 95 percent reduction in the release of dioxins and furans to the Strait of Georgia because of pulp mill contamination.

There would probably be -- I should point out this precedes my time in British Columbia. I arrived in 1996. So I would rely on colleagues and publications predating my time here.

There certainly were staff and programs at our Water Quality Unit at the Fisheries and Oceans of Canada Water Quality Unit Habitat Branch that would have been very much aware of some of the practices and oversight of the discharge of effluents of different types into the Fraser River system. Unfortunately those colleagues, that Water Quality Unit was disbanded in 2005, so we no longer have access to that expertise or that oversight, and it kind of makes it difficult for me to interpret with great rigidity whether this has taken place or not.

I think there are a number of things that have happened, a number of good things that have happened. A number of priority contaminants have been identified and reduced. There have been some upgrades to discharge processes for pulp and paper mills and some municipal plants. There have been some ancillary or resulting improvements in the quality of habitat for some chemicals and for some types of activities.

On the other hand, there have been some

things that have gotten worse. A number of currently used pesticides are widely used in municipalities, agricultural areas, forestry lands. A number of chemicals, particularly flame-retardant chemicals, have been increasing rapidly in the receiving waters of the Fraser estuary.

I think what I'm trying to do is touch on a few points where I do have some awareness. But I'm unaware of a joining of forces to develop effective policies and plans for the Fraser River Basin.

Q Thank you. Mr. van Aggelen, do you have anything to add to that answer?

MR. van AGGELEN: The only thing I might add to that, not specifically related to policies, is that I believe at that time the Fraser River Action Plan was in place, and I know that there was certainly some degree of activity with Environment Canada looking at water quality along the Fraser at that time.

MR. McGOWAN: Thank you. And if we could turn to the next page, please, Mr. Lunn, and highlight recommendation 30.

Q There's one here, one of these sub-bullets, that I think is particularly relevant and I want to ask you about it, Dr. Ross.

> We recommend that DFO conduct further research on:
>
> - The effect of multiple, sublethal stresses on migrating salmon.

I wonder if you can address the Commissioner on the extent to which this recommendation has been addressed by the Department?

DR. ROSS: Well, several of these bullets are outside the purview of my expertise, but I do have colleagues that have worked extensively over the last couple of decades --

Q Yes, I'm pointing you specifically to the third bullet.

DR. ROSS: The third bullet?

Q Yes.

DR. ROSS: I am aware of colleagues of mine that are looking at multiple stresses on migratory salmon, but these would not include contaminants or

pollution-related stresses.
Q Are they doing it within the Department of Fisheries and Oceans, this research?
DR. ROSS: Yes.
Q Sorry, I interrupted you. You were saying...?
DR. ROSS: Well, just inferring or stating that there's very little in the way of research-related sublethal stresses from a contaminant perspective. I think of note here is that in the old days we used to view chemicals as being acutely lethal. We would see fish kills, we would see belly-up fish. We might have thousands of fish out there in a lake or river system, and that would be associated with an acute release of a toxic contaminant that would be present at a concentration high enough to kill fish.

The problem is that as we have improved our understanding of what causes acute mortality, the numbers of chemicals that we consider to affect fish in a sublethal manner has been increasing exponentially. I mentioned the 23,000 chemicals on the domestic substances list. Many of these chemicals don't kill fish outright and their toxicity would not necessarily be captured by a 96-hour LC50 experimental test, but they might reduce their growth, confuse them, affect their ability to smell, to find their home stream, reduce their immune system, make them vulnerable to disease, outbreaks of disease, or affect their energetics, in other words, their ability to feed and grow, et cetera.

So often sublethal effects of contaminants may not be evident, but when a secondary insult comes along like a virus, like climate change, like a food supply problem or other stress with regard to habitat destruction, that's where the contaminant influence may become a very significant contributing factor. In other words, the contaminants would predispose salmon to a secondary insult.

So I think in that sense it's very important to contaminant research placed in the guise of the real world of salmon habitat, of salmon life history, and understand how these contaminant stresses which are out there are contributing to population level impacts, and I would say that's not happening.

MR. McGOWAN: Thank you very much. Mr. Commissioner, those are my questions for the panel. I believe Mr. East will be next for the Government of Canada.

MR. EAST: Mr. Commissioner, Mark East for the Government of Canada. I'm with my colleague, Geneva Grande-McNeill for the Government of Canada. I will be no more than, I would think, 20, 25 minutes, so probably 12:20, I hope.

CROSS-EXAMINATION BY MR. EAST:

Q I just have a few questions for the panel and maybe I'd like to start perhaps with just a big open-ended one. Maybe to start, just as a platform, we could go to Exhibit 633. I believe it's Tab 28. This is the article - Dr. Ross, maybe I'll start with you - that you published in 2002.

MR. LUNN: Did you say 633?

MR. EAST: Sorry, did I -- it's Tab 28.

MR. McGOWAN: I believe it's 833.

MR. EAST: Sorry, 833, thank you. It's page 21, page 33 ringtail.

Q So under "Summary", in the first sentence, it talks about the percentage of the municipal population as of 1999 in the Georgia Basin, 55 percent:

> ...was served by sewage systems that had either secondary or tertiary treatment, representing a substantial increase from less than 20 percent prior to 1999...

I'm interested in the second line.

> This change likely improve some effluent quality characteristics such as BOD, TSS, and regulated contaminants such as heavy metals, some PAHs, PCBs etc.

So just stopping there, are these what we would call the traditional legacy contaminants that we've been talking about today?

DR. ROSS: Legacy contaminants in my world tend to be ones that have been regulated. So PCBs were regulated in 1977 in Canada. Dioxins, furans are

a byproduct of human activities. They're by-production largely through controls on use of liquid chlorine in the pulp and paper sector. Those regulations were in 1989, I believe. Might have been a year or two later.

So legacy contaminants are ones that we've largely addressed from a regulatory standpoint. But they're termed "legacy" because they're so persistent. In fact, PCBs, even though they've been banned for 35 years, they continue to represent a dominant concern at the top of aquatic webs, for example, because the persistence, they're fat soluble, they get into these animals, they biomagnify and they can affect animals through influencing their endocrine system. So that would be legacy contaminants.

And then perhaps the other term that would be used for biological oxygen demand or suspended solids would be more on the lines of conventional pollutants that are typically associated with a history by humankind to reduce the impacts associated with human waste.

Q Okay. Thank you. And that's an important distinction to make and I appreciate that. What I would like to do is maybe just focus a little bit on the conventional traditional contaminants and then -- much of the discussion we've had this morning, I think rightly so, has been on the new emerging persistent biocumulative and toxic contaminants. But I just want to ask a couple of questions about the traditional conventional contaminants.

Would it be fair to say, remembering that we're here to discuss the potential impacts on Fraser River sockeye salmon, that because of the improvements in water quality, municipal wastewater treatment and other improvements, that we are less concerned about the traditional contaminants as a primary cause for the decline of the Fraser River sockeye salmon? Emphasis on the traditional and conventional contaminants.

Maybe I'll start with you, Dr. Ross, and then ask the other members of the panel.

DR. ROSS: Well, I would start by saying that wastewater treatment plants are designed, by and large, to deal with conventional parameters and pollutants, so that in upgrading, I think I'd have

to defer to my colleague, Dr. Ashley, but the upgrades typically will address and mitigate for those types of conventional pollutants.

Unfortunately we have many thousands of chemicals that are in the wastewater stream that may or may not be addressed through upgrades. Many of them are reduced in terms of their -- they're retained through upgraded processes, but they may not break down. They may still represent a problem at some point depending on what happens to the application of the biosolids.

So I think I would concur with your line of questioning in the sense that we are more concerned today about many of the compounds for which we have a fairly cursory understanding of their toxicity and a fairly elementary understanding of their response to upgrades in levels of sewage treatment.

The upgrades to sewage treatment are typically not designed because of some of these new and emerging contaminants. It's only by happenstance or by good luck that many of these chemicals are removed from the wastewater stream through upgraded treatment.

Q Dr. Ashley?

DR. ASHLEY: The question being do I agree with that statement?

Q That the traditional and conventional contaminants are now less of a concern, increasingly perhaps less of a concern, with the upgrades we've talked about, as a primary cause for the decline of Fraser River sockeye salmon.

DR. ASHLEY: I think some of the conventionals, as it states there, BOD-5 and TSS are generally well treated by conventional secondary treatment plants. As we discussed earlier, the type of secondary treatment plant can have a large effect on other chemicals which are also lumped into the conventional category, namely, nitrogen/phosphorus, and so the nitrogen is in the form of ammonia. We've discussed about the ammonia toxicity issue and the fact that phosphorus is also discharged through with no control on any of these plants. Whether that leads to increases in algal productivity in the lower sections of the River and the marine environment, we all know there's a growing concern about marine dead zones

in estuaries around the world. So conventional treatment of secondary treatment plants of those conventional contaminants has not done anything.

Q Okay. Mr. van Aggelen, do you have anything to add to that question?

MR. van AGGELEN: The only rider is that as long as the plant is running at peak efficiency, 'cause as long as the BOD - biological oxygen demand - and chemical oxygen demand and suspended solids are kept in check, the effluent quality should be sufficient as to sustain life on a short-term exposure. But again, if BOD and COD are not maintained properly, you will have effluents deficient in dissolved oxygen and still result in conventional toxicity.

So the two have to go forward together, in other words, for an upgrade to a plant. You know, BOD quality in addition to upgrades has to be maintained as well.

Q Okay. Thank you. I may just continue on this theme and then I'd like to get back to the issue of some of the engineering and cost issues in a few minutes.

But I want to maybe go to Tab 3 of the Commission's list of documents. It's CAN 025061. I believe this is an Environment Canada document, so maybe I'll ask you, Doctor -- or Mr. van Aggelen if you recognize this document, a public document, "The State of Municipal Wastewater Effluents in Canada." Are you familiar with that? Have you seen this document before?

MR. van AGGELEN: Only since the exhibits were sent to me.

Q Okay. Well, perhaps I can ask Dr. Ashley and Dr. Ross if this is something that you've ever seen or been part of a review before?

DR. ASHLEY: No, I haven't.

DR. ROSS: Just as an exhibit.

Q I'd like to just ask you some -- just use this as a platform for some questions. Maybe go to page 29 in ringtail. I'm interested in the heading that talks about the "Assimilative Capacity of the Receiving Water". I just want to understand how this works and why this is an important factor.

It says here:

The volume and flow of receiving water will

determine its ability to dilute or assimilate effluent discharges and, hence, the extent of toxic effects occurring in the vicinity of the discharge. Although a concentrated effluent may be highly lethal in laboratory tests, receiving systems with a large assimilative capacity may dilute the effluent to the point where it is no longer deadly. However, in small watercourses, intertidal areas, or receiving waters that are subject to periodically low seasonal flows, the water volume may be insufficient to dilute the effluent to non-toxic levels.

And I think this is something, Dr. Ashley, you touched on, especially with respect to the Lower Fraser River. What is the nature of the assimilative capacity of this area, especially in the intertidal zone? Is it something that essentially, when these discharges go out, that they are diluting efficiently, or is there characteristics about this area that we should be concerned about?

DR. ASHLEY: Well, the concept of dilution is sort of central to any effluent discharge. So all of these plants are designed with a dilution of the receiving environment to the effluent in order to theoretically get to non-toxic concentration, so it meets the provincial water quality objectives.

As I said earlier, that over a 24-hour period, the dilution could be fine, but because the Fraser is a tidal system, it has at least four slack water periods per day where the dilution may be substantially less than what is required. So at that point, you may not be getting the required dilution on an instantaneous rate, and if fish were exposed to that, the fish might argue that although the 24-hour dilution rate is fine, the instantaneous dilution rate that they experience at, say, low slack tide in the winter when concentrations are low, may not be appropriate.

The other concept is that traditional engineering taught that the solution to pollution is dilution. That was the old sort of mantra that was taught in engineering school through the '40s, '50s, '60s, '70s and '80s, with the general belief that the type of pollutants that were in

wastewater treatment plants could be diluted down to a certain point where they became a non-issue. That was certainly the argument that the City of Victoria used for decades.

With recent knowledge of the type of persistent chemicals that Dr. Ross and Mr. van Aggelen have discussed, you may dilute it a million times in the receiving environment, but if the bioconcentration by trophic processes reconcentrates a million times, then basically it's a zero sum game. So the solution to pollution is no longer effective when you're dealing with persistent contaminants that biomagnify.

Q Maybe a follow-up question on this to Mr. van Aggelen about the acute lethality test. With respect to testing or monitoring the effluent at some of these wastewater treatment plants, I take it they take - well, you call it a cocktail, I suppose - directly from the municipal wastewater treatment plant and they test it in a laboratory setting using the LC50 test. Is that how that is done?

MR. van AGGELEN: That's correct. The regulatory test for measuring end-of-pipe discharge is you take the end-of-pipe discharge before it enters into waters frequented by fish. It's brought back to the laboratory and it's tested to determine if greater than 60 percent of the fish die in 100 percent concentration over 96 hours. If it passes that, it's in compliance with both usually federal and provincial effluent quality guidelines.

And just following on what Dr. Ashley just said is that the LC50 was -- determined that while it's not acutely toxic within the initial dilution zone, that outside of what they call the IDZ, or initial dilution zone, for a given discharge point, that there would be no chronic toxicity either based on "the model" assimilative capacity of the receiver.

Q And as you talk about the model or the traditional view, is that the sockeye or whatever the fish is that's going to be coming in contact with that effluent, it's never going to come in contact with the effluent that you necessarily testing in the lab?

MR. van AGGELEN: At the test concentration in the lab.

It's going to be exposed at some concentration within the receiver at "x" value.
Q Exactly. So the fish is going to be swimming near the end of the pipe in a receiving environment that, first of all, I suppose has many other contributing contaminants from other sources.
MR. van AGGELEN: Correct.
Q And the concentrations are diluted to -- depending on innumerable factors, I suppose.
MR. van AGGELEN: Correct.
Q I guess where I'm going with this is how do you envision a monitoring - and this is an open-ended question 'cause I don't really know the answer to this obviously - how do you envision a monitoring program for contaminants that's going to take into account the myriad of real-world effects in mixtures that sockeye salmon or other species are going to be swimming through?
MR. van AGGELEN: In my view, if we know the various dilution concentrations or isopleths of concentration of effluent within a given reach of the river or creek or whatever, those concentrations can be tested in a laboratory with the material being discharged to determine if, at those concentrations actually in the receiving environment at a kilometre or two kilometres, three kilometres downstream of the discharge, are eliciting some type of an effect. Again, this is where I believe that toxicogenomics are looking at molecular signals, as a consequence of exposure in the receiving environment, will give us value as to the health or protection of the species with fish.
Q Just following on this theme a little bit, I wanted to ask a question about the cost of research and cost of testing. It's something we haven't really touched on. I'm just curious as to what it takes as far as the economics and the cost of doing testing for each sample in your lab. Can you give us a sense of what's entailed, I guess, economically with respect to testing, just so that we have a sense of what it costs to implement a research or lab-testing program.
MR. van AGGELEN: If I could start with - 'cause we've talked about traditional research methods - the conventional fish bioassay or the 96-hour acute lethality test that we've talked about today is a

test that's been around since the '60s. And that, in every provincial jurisdiction -- and a lot of private consultants actually can do and provide this service. The test is well established, it's an accredited test by the federal government, and there's also private accreditation bodies that actually will go out and certify private labs and government labs to say that they can do this test.

So the conventional fish bioassay, to set a test up -- to set a laboratory up is expensive. It's expensive to keep fish in husbandry, but the actual cost of doing the test for a client can range from, most probably, $200 to maybe $700 for an acute lethality test.

With respect to toxicogenomics as we talked about today, it's an emerging field of aquatic toxicology, and consequently there is, as with any new field, there is -- other than our lab in North Vancouver and maybe some other academic labs at UBC and perhaps at Simon Fraser and U. of Vic. that I'm not fully aware that there's that much availability to do that. As with any new emerging science or emerging method, the costs are quite high. But with respect to genomics, the cost is decreasing 'cause a lot of the methods and techniques we use are coming out of the human health science.

We essentially adopt or modify methods that they use in human or cancer research with respect to genomics and adopt them to my lab. So to set up a genomic program, I would say the cost is quite dear. It's very expensive 'cause it's a lot of statistical evaluations, there's highly-trained individuals that have to be hired. It's not as straightforward as a conventional fish bioassay where the fish are either alive or dead. So there's no interpretation there, as opposed to with genomics, there's a lot of molecular and biochemical analysis that has to be done to look at gene profiles and linking gene profiles to pathways of diversity and then arriving to the conclusion that those genomic signals we see are capable, or were capable of causing some type of harm, whether swimming impairment -- sometimes, for example, if the insulin receptors were high -- insulin receptors are associated with sight. So if the fish have got elevated insulin receptors,

the fish could be blind. So it may look fine, but obviously sight to navigate, or sight to flee from a predator, that fish could be picked off and not be a contributor to the population.

So to get back to your original question, the cost, I believe, is coming down, but to set the programs up, they are very expensive.

Q I guess where I'm going with this is do you have the funding, the money, to do this kind of work right now?

MR. van AGGELEN: No.

Q And to bring this back to the big picture - and this is a question for all the panel - in this hearing today and I believe in some of the evidence in some of the other hearings, we've heard a lot of evidence about the different effects contaminants and other source effects on Fraser River sockeye salmon.

For example, today we heard of a need to do more research into the effects specially of new and emerging chemicals. We also heard some evidence about the costs of upgrading or building municipal wastewater treatment plants. Perhaps to a lesser extent, but I think inherent in a discussion of combined sewage outflows and storm water drains which appear to be a concern, there are capital costs obviously in fixing that problem.

Then there are all the other issues, the problems that we've talked about in other hearing dates. All of these fixes cost money, and there is probably a finite budget. So I guess where I'm going with this, and I'm just going to throw this to the panel to get your thoughts on this, with all these different demands for funding, as a question of priority where would you recommend that attention be paid first?

Just one other caveat, maybe, as part of the answer, I heard maybe two different theories about municipal wastewater treatment. One is that we need to do more work to make sure we get it right, because if the money is spent -- we just want to do it right the first time versus we need to get these things put in place as soon as possible 'cause of the impact on Fraser River sockeye salmon. Are these reconcilable views, and where should we be putting the money, the research and

the budgets that we have on these different factors, and I'll just leave it at that question for all three of you.

MR. van AGGELEN: Being as I've got the red light on, I'll wade in. I think in my opinion there's two things that we need to address. If we are going to continue to use ***Fisheries Act*** 36(3) as a sentinel for protection of Canada's water, I think the science and our methods, our toxicological methods to gauge effluent quality at the end of the pipe, have to be changed. So our ability to determine that the amount of money or the engineering changes that we're putting into whatever upgrades, we have the ability as scientists or regulators to make sure that we have a gauge of understanding the effluent quality.

As I say, the conventional fish bioassay that -- served us well for almost 60, 70 years as a gauge of measuring effluent quality. As we enter into a new era of emerging chemicals and contaminants of concern that we know are eliciting effects on populations, that we as scientists, and again as regulators, must have the tools to ensure that the environment is protected. As I say, whether it's genomics or metabolomics or omic technologies, that's kind of where we are right now. But in the future, 20 years from now, we may have other methods of measuring effluent quality.

So, yes, upgrading, but equal, if not the same amount of fiscal money put towards the scientific authorities to make sure that they have the tools with which we can gauge improvements or potential impacts on the receiving environment.

DR. ROSS: Yeah, I would simply build on that by saying that I think actually science can be very cost-effective. Certainly I have a bit of vested interest here because I rely on research dollars for the work that I do. But in the past, we've had access to budgets where we come up with an idea because of our sort of expert understanding of the literature and some of the hot topics that have emerged from other parts of the world.

Between 1945 and 1990, not a single lake trout reproduced in Lake Ontario. For decades government agencies were cutting back on fish permits and quotas, had a huge very expensive lamprey control program. We were trying to figure

out what was going on. It wasn't until some fairly good detective work by a team of researchers discovered that dioxin levels in the sediments and in the eggs were lethal for four-and-a-half decades. That took science work and that took one set of scientists to uncover that story and to demonstrate that dioxins were present at a concentration that were unacceptable, and it led to population level crash.

In the case of the Maritimes, the aerial application of spruce bud worm pesticide called "Aminocarb" through the '80s and '90s led to a near collapse of Atlantic salmon returns for 13 salmon watersheds. That was related to not the Aminocarb, but its carrier compound which is nonylphenol. It's one of these nasty estrogenic compounds. Again, it was a creative smart guy, Wayne Fairchild, who did the statistics comparing the aerial application of this pesticide to forests, with looking at escapement or the returns of these salmon, and then subsequently some lab-based research, to show that a single chemical was leading to the loss of millions of Atlantic salmon.

Acid rain, a fairly simply process, but devastated tens of thousands of lakes back east, and notably in those cases, salmonids were much, much more sensitive than perch or some of the other species. So lake trout ceases to reproduce below about a pH of 5.7. So as soon as lakes got a little bit acidified, lake trout stopped reproducing.

So I would say that science can be very efficient, very cost-effective, and I think very important in terms of providing insight that is useful from a management or regulatory policy perspective. But without that science, I think as Mr. van Aggelen pointed out, without the science we're not really knowing what we're doing if we are making difficult and expensive choices on upgrades.

That said, in a lot of cases in the past, we've learned from our mistakes and those mistakes were in the past. In other words, we thought DDT was a miracle pesticide. We thought PCBs, they were called the magic liquid by its creator. We were told CFCs were non-toxic and yet they

destroyed the earth's ozone. We often learn these lessons the hard way and after the fact.

Science can do as good a job as it possibly can and try to be precautious. But really, science doesn't operate that way. It really operates on the basis of evidence from past experience or laboratory experience. So I would urge a little bit of precaution as well as a reliance on a weight of evidence, which is an accepted paradigm for human health, a weight of evidence approach where we extrapolate from multiple lines of evidence to support the design of wastewater treatment plants that will reduce the risk for many compounds we're worried about, and for other compounds for which we know nothing but may become a really big problem in the future.

Q Thank you, Dr. Ross, and maybe, Dr. Ashley, I'll leave the last word with you.

DR. ASHLEY: Yeah, I think there was three questions there. Where does the money come from, scheduling and build now or later, to sum it up.

Q Yes.

DR. ASHLEY: Number one, where does the money come from? Obviously it comes from taxpayers, whether it's provincial, federal or a municipal or metro area. That's who ultimately pays for these things and that's the cost of protecting the environment. For years, we've sort of been living in -- the Auditor General has reported on the sorry state of infrastructure in Canada, whether it's bridges, wastewater treatment plants or whatever, and that's partly what some of the CCME Guidelines are to do is to bring up some of these preliminary and primary plants up to secondary standard.

So that essentially the cost of doing business, particularly in B.C. because of the presence of iconic species like salmon and orcas, I think it's even more important that that is done because I think most people in this province like to see those species around, and if you ask them how many extra dollars would you like to pay a year so that you see salmon in the Fraser River or you see orcas in Georgia Strait, most people would be on side with that. So basically it's the cost of doing business if you want to live in a clean environment.

The second question was about scheduling.

The recommendation from the reference panel was that both Iona and the Lions Gate proceed in tandem, and basically because they're going from a relatively crude primary state, and they recommended they went to advanced wastewater treatment which is tertiary or plus, and basically they could be done simultaneously if the amortization period to pay for the plants was extended from the 15-year period which is shown in the charts, which is cost-prohibitive, out to a longer period.

The Metro Finance Committee had considerable deliberations on that and decided, for some strange reason, they wanted to stick to a 15-year amortization period. That's puzzling when you realize that some of the big infrastructure projects that humans use, like bridges, like wastewater treatment plants, are intergenerational so they're used by two or three generations. They have a 50, 60, 75-year lifespan. That it would seem reasonable to have those paid out, amortized over a period that was consistent with their intergenerational services they provide, rather than trying to pay it off quickly and inflating to the price to the point you say it can't be done. So things have to be done serially rather than sequentially.

The last point was to build now or later. I guess that's considering that you sit around and wait for some technology to come along five, ten years from now, and so you maintain the existing technology at Lions Gate and Iona.

There's best available technology now that is quite sufficient that is robust enough that the future regulations which will come out of CCME, because CCME might -- mind you, it's still a white paper and there's tens of millions of dollars of research being done around the world by environmental engineers, civil engineers, on how to remove these contaminants. So if you pick the right design that has the right sort of configuration, the add-ons that will deal with these emerging contaminants, can be added on fairly reasonably as compared to building the wrong type of design up front, which makes it very expensive to retrofit, as the case at Annacis.

MR. EAST: Thank you very much, and those are my

questions, Mr. Commissioner.
THE COMMISSIONER: We'll take the break, then. Thank you.
MR. McGOWAN: Yes, Mr. Commissioner, I was just going suggest we break for lunch.
THE REGISTRAR: The hearing is now adjourned till 2:00 p.m.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.
MR. EAST: Mr. Commissioner, Mark East for the Government of Canada. At the end of my questions before the break, I neglected to mark the document that I looked at as an exhibit. That's Tab 3 of Canada's list of documents, CAN025061. I'd like to mark that as an exhibit.
THE REGISTRAR: That will be marked as 1052.
MR. EAST: Thank you.

EXHIBIT 1052: The State of Municipal Water Effluents in Canada, 2001 [Environment Canada]

MR. PROWSE: Mr. Commissioner, Clif Prowse for the Province of British Columbia. I have assured everyone I will be extraordinarily short this afternoon.

CROSS-EXAMINATION BY MR. PROWSE:

Q My first question I think I will ask of Mr. van Aggelen, in particular, or Dr. van Aggelen, and it has to follow up on my friend's question about money and research and how do we figure out how to spend things. First of all, are you aware of the Canada-wide Strategy for the Management of Municipal Wastewater Effluent, February 2009?
MR. van AGGELEN: I'm aware of it, but specifically --
Q You were not involved in that process?
MR. van AGGELEN: That's right.
Q You weren't involved with the --
MR. van AGGELEN: I was not involved in that.
Q You were not involved with Mr. Arnott, who will be on the next panel.
MR. van AGGELEN: No.

Q And one of the recommendations in that is a recommendation that a committee talk about -- a federal-provincial, I think, committee, give consideration to science and research projects. Are you aware of that recommendation or that committee?
MR. van AGGELEN: I'm not aware of the committee.
Q All right. Secondly, Mr. Lunn -- so I'm referring, Mr. Commissioner, to Exhibit 14, and if the witnesses might look under question 29. This was a question about the federal, provincial and local governments joining force to deal with things on the Fraser Basin. And if you look at the box on the right - I'm sorry - if you look at the box on the right, you'll see reference to the Fraser River Estuary Management Program. Are you aware of that, or have you been involved in that, Dr. van Aggelen?
MR. van AGGELEN: I'm aware of FREMP, yes.
Q And is that something you've been involved with?
MR. van AGGELEN: Indirectly we would have received some samples from the FREMP program in the lab.
Q All right. And the Burrard Inlet Environmental Action Plan, are you aware of that?
MR. van AGGELEN: I'm aware of it, but we don't participate in that study.
Q And the Fraser River Action Plan, I think you did refer to?
MR. van AGGELEN: Yes.
Q And were you -- did you participate in that?
MR. van AGGELEN: Yes.
Q And we've had reference to the, I think the Georgia Basin Council.
MR. van AGGELEN: Georgia Basin Action Plan?
Q Yes.
MR. van AGGELEN: Yes.
Q Were you involved in that?
MR. van AGGELEN: Yes.
Q And we also have the Fraser Basin Council, are you aware of that?
MR. van AGGELEN: I'm aware of it, but don't -- no participation.
MR. PROWSE: All right. Those are my questions, Mr. Commissioner.
MR. LEADEM: Thank you, Mr. Commissioner. For the record, Leadem, initial T., appearing as counsel for the Conservation Coalition.

And I should indicate for the record, Mr. Commissioner, I have two of my clients who have been present throughout this morning, who have sat at counsel table with me, and they are Mr. Douglas Chapman. Mr. Chapman is with the Fraser Riverkeepers. He's a former Crown prosecutor from Ontario, and called to the bar in B.C. He's retired now. And I also have Ms. Christianne Wilhelmson, who is with the Georgia Strait Alliance.

THE COMMISSIONER: Thank you very much, Mr. Leadem.

CROSS-EXAMINATION BY MR. LEADEM:

Q I want to begin by thanking you for a very interesting discussion from this morning, and I hope to pick up from some of that discussion and carry on. And I want to start our discourse by actually looking at some general topics, and then sifting through until we get to wastewater. We, at the -- doing the work of the Commission, generally deal with topics, subject matter, topic-by-topic, and so if this is Tuesday, then this is wastewater management. And so I'm trying to understand in the context of more ecosystem-based management, how wastewater functions or fits into the general Fraser River ecosystem, and whether or not you as scientists should be concerned about loading, about cumulative effects, about other sources of contamination, and other issues such as global climate change. And I just want to throw that open as a general question, because we often heard so much about ecosystem-based management, and people glibly talk about it, but we've yet to see it really be evidenced in action.

So perhaps I can start with you, Dr. Ross, because I found some of your comments to be very interesting this morning. Do you have a reaction to how wastewater fits into this general ecosystem of the Fraser River?

DR. ROSS: Thank you. I think this morning I did indicate that while wastewater treatment plants represent a single entity that falls fairly readily under the guise of regulatory or scientific assessment and monitoring, when one adds up the 90 that would be found within the Fraser River watershed, as well as countless

others in the Strait of Georgia, even within the municipal stream we start to look at a large number and diversity of point source discharges.

My concern in restricting, you know, the problematic of contaminants to wastewater discharges would be indeed the fact that we might ignore some other point sources of concern or some other what we call non-point sources of concern.

Ecosystem-based management, I think, would be touted as a means by which we can do a better job to manage human activities as they relate to the environment. And I think in that respect there's, you know, I think a great deal of sensitivity and awareness about the importance of the environment, protecting the environment, and different components of the environment, such that ecosystem integrity does not fail because of the sum of a thousand cuts or a thousand impacts.

However, it is a management tool, and personally I, and professionally, I struggle a little bit with trying to, I guess, prepare scientific, the scientific method in support of ecosystem-based management. I think there is a struggle at the interface between science and management that is -- there exists a tension, sometimes that's by design, because science has a certain paradigm it operates within, and science provides peer-reviewed products through publishing in the international literature, and then it becomes international knowledge, gets delivered to managers, policy makers, et cetera.

So there is a role for scientists to be actively engaged in management or ecosystem-based management, but I think there's also a strong need for independent science, where the scientists have the capacity to explore their own issues of concern and to embark on discovery and to publish that, and by doing so, will have peer-reviewed defensible scientific insight into some of the important issues of our time.

Touching on the issue of contaminants, finally, I guess I would argue that it's hard to establish certainty outside of single chemical mechanistic cause and effect kind of response, and generally that's done in the laboratory. However, with the 23,000-odd chemicals on the Canadian marketplace, of which at least 660 are of concern,

we end up with complex mixtures.

As an ecotoxicologist, I strive to understand which single chemicals might be problematic, and but then I also strive to make sure that my understanding is placed in a ecosystem-based world. And very, very difficult for regulators to assess complex mixture. It's very, very difficult for the guidelines people, CCME guidelines development people to deal with complex mixtures. And internationally, science and management have really failed, I think, to adequately prepare a paradigm that would address risk associated with complex mixtures, i.e., the real world.

I argue at the end of the day that there is an acceptable paradigm for pursuing the complex mixtures approach, and that is through a weight of evidence. That's a weight of evidence where you rely on the best available evidence from single chemical laboratory based studies to certain types of catastrophic single chemical incidents in the real world, combined with more sort of ecological approaches to ecotoxicology.

Q Thank you for that answer. Before I move off to get the views of one of your colleagues, you talked a bit earlier today about the precautionary approach, and I'm wondering in a world where we don't know enough about the effects of both acute and sublethal effects of some of these emerging chemicals, how we factor in that precautionary approach in terms of what are we doing in terms of the regulation of these compounds, these chemicals, how we are letting them into the market to begin with, and how once they're entered into the market, how we can deal with them, particularly in the case of persistent organic chemicals.

DR. ROSS: A difficult question to answer succinctly. A precautionary approach would be -- is described in Canadian law, in ***CEPA*** and other pieces of legislation, in order to prevent undue harm or impact on the environment, and often in the absence of knowledge or sufficient knowledge to support a certain approach.

My experience, I had spent about eight years in Europe, my experience is the precautionary approach is more protected in legislation in the European community. In fact, they really refer to

it as the precautionary principle, because it carries more weight in courts of law. In Canada, I think we're somewhere between the American model and the European model. But the precautionary approach, as I understand it, is not really applied. It's more of a preamble to legislation.

I think at the end of the day the precautionary approach reflects societal values. How acceptable would it be to release chemicals that have been shown to be endocrine disrupting and have been shown to cause adverse impacts on salmonids or fish elsewhere. How precautionary would it be to release persistent bioaccumulative chemicals that we know can get into killer whales and will be waiting until the end of this century before killer whales are protected from PCBs, that's to name one class of chemical.

So precautionary approach is a policy term, it's a legal term, it's based on some understanding of the science that's out there, and it's adopted, as I would see, to reduce risk.

Q Thank you. I'm going to turn to you, Dr. Ashley. I'm going to restate the original question that I posited to the panel in this way: That you're called upon to give evidence about a specific topic, wastewater, and yet you have to take the realization that the world doesn't operate that way, that we don't just have point sources of wastewater facilities operating at discrete points along the Fraser. We have other sources than point sources of pollution and we have sources of contamination coming from the air. We have lots of different loadings. How do you factor all that into giving advice to this Commission in terms of what we should do about wastewater.

DR. ASHLEY: I would follow what Dr. Ross said, is that there has to be some precautionary principle or where you have some sort of advanced early warning radar type that you're looking at things well in advance of them happening, because by the time they happen, they're often too late or too costly to undo. And so the type of sort of proactive monitoring program would be something that would be a decision that we're going to set up a monitoring network on with some interdisciplinary group as to what to monitor. And so it be done far enough in advance that it would be like early,

early warning, so, because right now the whole planet's changing with climate change, and so you have that as a backdrop by which everything else is layered on top of it from hydrology to loss of pine beetle forest.

And so it's becoming increasingly difficult to sort of manage in real time and you need more lead time, and the only way you can do that is by sort of intelligently figuring out what you need to monitor as far in advance as possible, based on literature and best emerging science.

Q We've heard some evidence from other scientists who have preceded you to the panel about global climate change, and I believe Scott Hinch came and talked about global climate change, and do we know enough about if there's going to be global climate change which is evidenced by increasing water temperature in the Fraser River. Do we know what effect, if any, that might have upon some of these emergent chemicals or some of these other chemicals that you've been discussing, the endocrine disruptors?

DR. ASHLEY: I don't believe so. I think most of the information on temperature increases would be just basically on the physiology of the fish, as Dr. Hinch described. The secondary effects on dealing with chemicals of emerging concern, I don't think has been looked at very much.

Q And I'm not going to neglect you, Mr. van Aggelen. Do you want to weigh in on the general question about loading and how do you -- how do you deal with a point source such as wastewater, knowing full well that the reality of the situation is, is that the Fraser River is subjected to a lot of contaminants on a daily consistent basis.

MR. van AGGELEN: Dr. Ross summed it up quite nicely, but I'd weigh in on the fact that it's the sum total of the constituents that are going to elicit the toxic response. So while we will be able to regulate under ***CEPA***, or the Chemical Management Plan, you know, those chemicals that have been identified through research as being particularly nasty, it's once the mix gets into the effluent that you have all kinds of other activities happening. That we may do research on a parent compound. Once it gets into a complex mixture, there's all kinds of other activities that come

into the chemical transformation of these products.

So I, you know, sticking to my trade, believe that having robust detection techniques, or systems in place that we can monitor or predict the outcome of -- of the mixture before they elicit or create effects on -- at the population level. So I think that, you know, is hanging my hat on the precautionary principle, yes, that's what we should be doing for good robust science. But keeping the principle that we need warning tools or warning mechanisms to predict or -- and also not only predict, but let the regulatory agencies know that there is issues with particular discharges, or point source discharges to, you know, potentially eliminate effects at the ecosystem level.

Q Thank you. This Commission was called into being to -- basically because of the decline of the sockeye in 2009, which was itself a reflection of a consistent decline over the last decade preceding that one. And I was wondering from the aspect of the evidence that you've given, I seem to have got the evidence from Dr. Ross, but I want it confirmed again. You can't rule out that a factor contributing to the decline of the Fraser River sockeye is the presence of contaminants and specifically contaminants that are located in wastewater.

DR. ROSS: I don't think we can rule that out, no. Absence of evidence is not evidence of absence, and I think we could get into a discussion about relative risks associated with different practices. But I did point out this morning that in other examples, in other parts of Canada and the United States and Europe, we've had catastrophic population level consequences associated with single chemicals, some associated with wastewaters, some associated with deliberate application of pesticides.

Q All right. And, Dr. Ashley, do you have an opinion on that general question of whether you can rule out contaminants form wastewater as a contributing factor towards the decline of Fraser River sockeye?

DR. ASHLEY: I think there's two components to that question. One is relative to 2009, the missing

sockeye, and one is relative to the overall stock productivity over the last 30, 40 years. I think the answer to: did municipal wastewater effluent have sort of a smoking gun relationship to what happened in the 2009 return? I don't believe so. Relative to the long sort of decline in stock productivity over the last 30, 40 years, it has been shown that I believe there is a likelihood that wastewater effluent has contributed to that.

Q And, Mr. van Aggelen, do you have an opinion to venture on this topic?

MR. van AGGELEN: I would follow exactly what Ken mentioned, is that, yeah, it's to specifically target the 2009 decline to one event, most probably difficult to do. But did wastewater contaminants contribute to potentially declines in populations? I would say yes, and echoing what Dr. Ross mentioned about the studies of, you know, in the UK on trout populations downstream of municipal wastewater showing the feminization, dual sex characteristics, as a consequence of exposure to xenoestrogens in municipal wastewater, you know, it's -- I'd say it's a strong likelihood.

Q I'm going to now turn to some specific questions, and I'm going to start with you, Dr. Ross, and see if I can get a document, it's document number 4 from the Conservation Coalition's documents. It should be something that you will recognize readily, Dr. Ross, because I think you are the senior author on this. It's a document entitled "Large and growing environmental reservoirs of Deca-BDE present an emerging health risk for fish and marine mammals". Is this a paper that you authored?

DR. ROSS: Yes, it is. It's actually a pre-print. It's available in final published form in the *International Journal Marine Pollution Bulletin*.

Q So since this document you're saying it's now been published in a peer-reviewed journal?

DR. ROSS: Yes, that's correct.

MR. LEADEM: Might this be marked as the next exhibit, please.

THE REGISTRAR: Exhibit 1053.

EXHIBIT 1053: Ross, Large and growing environmental reservoirs of Deca-BDE present an emerging health risk for fish and marine mammals, updated draft

MR. LEADEM:
Q And I'm just going to ask you to turn very briefly to page 9 of that particular document, Dr. Ross, under the heading "Conclusions". And you go:

> Total PBDE concentrations are increasing rapidly in abiotic and biotic matrices in Canada, and have surpassed the structurally-related PCBs as the number one contaminant in sewage, sediments and water in near-urban parts of Canada.

Is that true with respect to British Columbia?
DR. ROSS: Yes, in simple terms, yes.
Q And specifically with respect to wastewater in the Fraser, would that be possibly your opinion?
DR. ROSS: Well, I haven't -- I haven't engaged in any studies of wastewater, but I have colleagues that have been looking at wastewater, and I believe also if one looks at the annual report from Capital Regional District, there is information that would suggest that PBDEs exceed PCBs readily in the effluent from -- from CRD plants. And I would suspect it would be similar for Metro Vancouver.
Q The next document I wanted to put to you is Commission counsel document number 10, please. And this should be an email exchange between yourself, amongst other parties, and a number of other people, and as we go through it I'm going to ask you -- this in part was reflected in what we've now marked, Mr. Commissioner, I believe as one of the exhibits, I believe it was 1048, the memo to Robin Brown. This is, I believe a precursor to that. Do I have that right, Dr. Ross?
MR. LUNN: Mr. Leadem, sorry to interrupt. Tab 10 has been marked as 1049.
MR. LEADEM: Oh, it has been. Oh, sorry. Thank you, my mistake. If we could take you -- if I could just take you to your section of that, Dr. Ross, and I think the easiest way to do that is by

scrolling through.
THE COMMISSIONER: I don't think this is the document you're speaking of.
MR. McGOWAN: Exhibit 1048.
THE COMMISSIONER: 1048, thank you.
MR. LEADEM:
Q The highlights in the blue I think are yours; is that correct?
DR. ROSS: That's correct, and that would come from that same email that was cross-referenced in the (indiscernible - overlapping speakers) --
Q All right.
DR. ROSS: -- exhibit.
Q So firstly, the first question I wanted to ask you is that this provides to us lawyers a very interesting insight into rule making, into regulation, because as I understand it, there is a very compressed timeline in which you are being asked to comment upon proposed regulation. Do I have that right?
DR. ROSS: Yes. We had no -- I was not privy to any of the discussions that led to CCME strategy or to the proposed regulations, or any of the discussion (indiscernible - background noise). So and I would be one of four contaminant experts within DFO's Pacific Region. And I believe the same would hold for my colleagues, as well. So leading up to the email we're in, we were requested by our National Headquarters to review the proposed or the Draft Wastewater Stream Effluent Regulations under the ***Fisheries Act***. We had a matter of two or three days to review all of these regulations, comment and have that sent back to NHQ.
Q So looking at this, at your extract, I want to begin with the paragraph that says:

> That said, the proposed regulations lack clarity (at least for me) on the following scales:...

And then you talk about:

> - the list of end points of concern is restricted to BOD matter, suspended solids, residual chlorine, and un-ionized ammonia. These are with little doubt of concern in a sensitive receiving environment, and are

cheap and easy to monitor.

Then you go on to say:

> However, the only mention of other entities of concern (e.g. pharmaceuticals and personal care products, PCBs, PBDEs, E coli, other pathogens) is in the 'anticipated benefits' of secondary treatment.

And you go on to say:

> There appears to be no legal requirement to monitor for these, consider their fate in the receiving environment, or document the way in which treatment will help 'resolve' these issues in either the effluent or the retained sewage sludge.

Do you know if your concerns are actually reflected in the final document that -- or is it still in draft form?

DR. ROSS: As I understand it, none of our comments were incorporated into the revised ***Wastewater Stream Effluent Regulations***.

Q You go on to say:

> - monitoring is to be carried out by the WWTP operators... --

- that's wastewater treatment plant operators -

> -- I don't need to mention the fox in the henhouse...

So it seems to me that you've got some concerns about the people who are regulating being also the monitors, is that -- or the regulatees being the monitors.

DR. ROSS: Well, you know, it's an interesting -- this was an interesting exercise to me, because as a scientist I was asked to carry out a peer review, which is to evaluate, you know, the scientific defensibility of this document or its implications. And of course, as a scientist, I like to have independence, I like to have peer review, I like to have high quality data, I like

to be able to access that data in order to review it. So if I make comments that have implications for the management or the application of law, it's because I as a scientist view the issue to have relevance in terms of either our understanding of impacts to the environments or understanding of the quality of the effluent.

So I think in terms of these proposed regulations, there were some grey areas that made it a little bit unclear to myself how the data would be collected, critically evaluated, that's part of the peer process to me as a scientist, and then acted upon.

Q And carrying through with some of the other text, if I can -- there's a heading "Cooperation between the two departments is lacking". I don't -- there it is. Just before that bold sentence, there is "From the Office of the Attorney General (2009)", that should read "Auditor General's Office", is that fair?

DR. ROSS: That's correct.

Q And then you talk about cooperation between the two departments, and the two departments being the Department of Fisheries and Oceans and Ministry of the Environment, Environment Canada; is that right?

DR. ROSS: That's right. This is actually a verbatim excerpt from Sheila Fraser's Auditor General Report, 2009, the chapter on the ***Fisheries Act***, as I recall.

Q And have you encountered that in your work where I'm going to call it the left hand and right hand problem, where Canada has two departments and they're not quite connecting. Have you encountered that in your work?

DR. ROSS: I think when one looks at environmental contaminants, one quickly realizes that jurisdictionally they're going to be difficult to handle, because they involve everything from human health to the health of wildlife in the ocean, on land, potentially the activities of mines and mills and factories and urban centres, many, many different jurisdictions. And I think it's safe for me to be able to say that I have struggled upon occasion with understanding, first of all, who is responsible for what, and second of all, what I as a scientist am expected to carry out in

support of the mission of my primary employer, or my sole employer, which is Fisheries and Oceans Canada.

I think this Auditor General's Report itemizes a major case in point, and that is if one is a scientist working on environmental contaminants, and one is worried about the health of salmon or killer whales or shellfish, then one can either deal with the natural resource consequences of that, which would be readily in the purview of Fisheries and Oceans Canada, or deal with single point discharge of effluent from multiple sources, which would be more readily in the purview -- under the purview of Environment Canada and the province.

Q And I'm going to turn to you, Mr. van Aggelen. Have you noticed in your job that there seems to be some disconnect between Environment Canada and DFO in terms of specifically maybe s. 36(3) of the ***Fisheries Act***?

MR. van AGGELEN: Certainly not specifically with 36(3), because that's largely the mandate with which the Department or the folks I work with in the Department works under. That's pollution end of the pipe. So our, you know, certainly from the perspective of the work that I'm involved in, in proving non-compliance to 36(3) it's, you know, kind of the order of the day for us, or with the groups that I work with, Environment Canada. So it's clearly defined as what -- what that is.

Q So aside from where you have got that interplay where you have to talk to DFO because there is a provision in the ***Fisheries Act*** that as I understand Environment Canada is mandated to actually take charge of those deleterious deposition provisions under the ***Fisheries Act***. Do I have that right?

MR. van AGGELEN: That's correct.

Q All right. Aside from that, is there continual communication between DFO and EC in terms of how you're conducting your business? Are there regular meetings between your managers, and things of that nature?

MR. van AGGELEN: Certainly in my capacity as a lab manager, no. In days gone by, and I would say when I first started with Environment Canada in the early '90s there was a lot more between our

lab, and the -- and the DFO lab in West Vancouver, which was, I guess, the home of the pollution, the Pollution Control Group for DFO. There was a lot more, you know, interchange, if you want to call it that, but I would say in the last ten years, limited to no contact.

Q I'm going to now turn to you, Dr. Ashley. I don't know if you have any comments on some of the discussion I've been having about the intersection or lack of intersection between the two government Departments, whether you have any specific knowledge of that, or not. If you have any comments, though, I'd like to hear them now.

DR. ASHLEY: No, I have not been involved in that sort of area for a few years now.

Q I want to turn to Commission document number 21, which I think is a slide show, or slide deck. Is this something that you prepared, Dr. Ashley?

DR. ASHLEY: Yes, I was asked to speak at the Summit on Fraser Sockeye by SFU, so I put this together for them.

Q All right. And so you were called upon specifically to deal with wastewater treatment pants; is that correct?

DR. ASHLEY: It was the general effects of contaminants in sewage and their possible effect on sockeye, yes.

Q All right. I want to go through some of these with you. And if I can get the third slide in, it should be "Emerging concerns in wastewater". So you talk there about the endocrine disruptors we heard some evidence about those, and you identify some of them there. And some of the personal care products, what are POPs?

DR. ASHLEY: Persistent organic pollutants.

Q And then you talk also about nanoparticles, and Dr. Ross talked about those earlier today. Those are an emerging concern, are they?

DR. ASHLEY: Yes, they are.

Q And then we carry on, you provide a definition two slides after that to "What are Endocrine Disruptors?" Is that your definition, or did you get that from the literature somewhere?

DR. ASHLEY: That's sort of an accepted literature definition. You know, it's just the point there was just to stress that what low concentrations endocrine disruptors can exhibit an effect at,

which are lower than the sort of range that typical more conventional toxicant chemistry dealt with at the parts per million or parts per billion concentration.

Q And you itemize that by saying:

> Parts per trillion = 1 second in 30,0000 years.

That's a graphic illustration of what we're talking about and how minute of a particle this can be; is that right?

DR. ASHLEY: Yes. Most people don't -- have difficulty relating to a part per million or a part per billion, so when you put it in a time perspective like that, it makes it easier to understand how small these concentrations are.

Q Now, two slides down from that, you've a got slide entitled "Removal efficiencies at WWTPs", which I found to be really quite interesting, and it deals with activated sludge versus trickling filter plants. And you say:

> Over half of the frequently detected EDCs were reduced by 95% or more by Activated Sludge plants.

Whereas:

> ...10% of the EDCs were reduced by 95% at the Trickling Filter plants.

So as I understand your evidence, you said Annacis Island was a trickling filter plant; is that right?

DR. ASHLEY: Annacis and Lulu Island.

Q And Lulu. So if we're going to go ahead with some form of secondary treatment for Iona, you would certainly recommend activated sludge over trickling filter; is that fair?

DR. ASHLEY: That's correct.

Q The next slides talk about what you've already discussed in your evidence, primary treatment, secondary treatment. And then you talk about, I think this is slide 10, "Effect of WWTP design: 2007 study in England". What was this slide meant to depict?

DR. ASHLEY: It was along the same lines. This was research that I did while I was working for Metro, because I was concerned about the design of the Annacis plants, and so I had a -- I obtained some funding and had a literature review done. I did my own, and then had a resident Ph.D. expert who had written her thesis on this to find out if there were any treatment plants that were more or less effective at removing endocrine disruptors and emerging chemicals. And it just so happened at that time in 2007 some of the first major sort of integrative studies were coming out at the same time, one from Europe, and then one from North America, and both coming to the same conclusion, that trickling filter plants, because of their shorter hydraulic and solid residence time, were less effective at removing endocrine disruptors and emerging chemicals.

Q And a couple of slides after that, I find a slide saying "Effects on salmon migration?" If you can go there, Mr. Lunn. Thank you. So you say there something about "olfactory imprinting". Could you tell the Commissioner why that is important in the context of wastewater compounds and chemicals?

DR. ASHLEY: This was a concept that came up as I was researching this, that realizing that when salmon are smolting, they're going through some complex physiological changes, where they're both getting prepared for -- for life in a marine environment, rather than a freshwater environment, but there's some important developmental changes going on internally in the fish.

And the current belief is that during the smolting process, that there are sensory olfactory cells are actually being formed at that time, and it's almost like a data logger as they're moving downstream. So they're actually growing sensory olfactory cells so they can essentially record what the odour of the stream was as they're moving downstream. So that when they get back on the freshwater phase of their return environment, they'll be able to find their way back to their natal stream. And seeing that the -- on the next slide or two there, that shows that thyroxine is the hormone that's elevated at that time, that triclosan, which is one of these emerging endocrine disruptors, is also a thyroid hormone

disruptor. And so this was just basically speculation that this may be one reason that may confound the olfactory imprinting process that takes place during smolt migration, that this type of chemical may be causing some problems with the olfactory imprinting of out-migrating smolts.

I've never read any research on it and it's purely speculative.

Q All right. But we do know, for example, that all the Fraser River sockeye smolts out-migrate and go past Annacis Island, Lulu Island, and to some extent out to the Strait of Georgia where they may be subjected to the discharge from Iona. Is that fair to say?

DR. ASHLEY: That's correct. As they move down the Fraser River from whatever natal stream, they would be -- they would be subject to all of the contaminants, whether it be pulp mill or various wastewater treatment plants, all the way down the Fraser from Prince George, you know, Lytton, Lillooet, Hope and down to Mission, ultimately to the Fraser Estuary.

Q And then if we go to the end of the slides, I just wanted to talk very briefly about this ammonia issue that you discussed in your evidence earlier today. And I think if we go five slides from the back, we'll get a graph there. This graph is:

Figure 3-1: Annacis Island WWTP - Ammonia Concentration versus pH Value.

What do you -- what's this graph depicting?

DR. ASHLEY: The point was there to show that line was the threshold, the threshold toxicity concentration for ammonia as a function of pH, and just showing where Annacis wastewater treatment plant in an effluent grab was positioned, relative to that -- relative to that line. So anything that was presumably to the right of that line, would have been -- would have been acutely or chronically lethal.

Q And do you remain concerned that this could be a problem for acute lethality in sockeye or any other salmonid that's swimming by at the time that you had these low flows?

DR. ASHLEY: Yes, I do.

Q I'm going to turn to you, Mr. van Aggelen, and

talk a bit about toxicogenomics, and I think you have Dr. Ashley to thank for -- for your presence here, and I'm going to thank Mr. East for making you available. And maybe by explanation, Dr. Ashley, you were one of the reviewers for the Donald Macdonald paper Expert Report number 2 to this Commission, were you not?

DR. ASHLEY: That's correct.

Q And maybe just turn very briefly, Mr. Lunn, to Exhibit 826, pages A-11, A-13, I think. So it's in the appendices of that exhibit. I think if you scroll down a little bit further you'll get a sequence of slides, or some extracts. There we go. And just the text preceding it, just to lead into that.

So I think it's -- you start to talk about aquatic toxicological testing, and then you go on to say that Mr. Macdonald should take a look at toxicogenomics; is that right, Dr. Ashley?

DR. ASHLEY: That's correct.

Q And if we just look at the slides very briefly. You provide an explanation, basic explanation of what's going on with respect to -- and maybe you, with the benefit of Mr. Aggelen, could walk us through these slides. Because I asked Mr. Macdonald about it, and he was unable to do so.

DR. ASHLEY: Well, these are -- these are Graham's slides, so I think he should best walk you through it.

MR. van AGGELEN: All right. Toxicogenomics is basically a catchall phrase for the application of genomic methods or the genome. The genome is composed, as you see on the slide here, transcriptomics, proteomics or metabolomics. And that's each representing a different level of organization within the cell, moving from the whole DNA base down to a protein base and the metabolome.

What we do or what I have been doing is using mostly transcriptomics, or of expression to determine if there are -- the fish are eliciting effects as a consequence of exposure. Proteomics and metabolomics are much more in-depth and much more precise measure of molecular activity. My lab is not concentrating on proteomics or metabolomics. As I say, we're working on transcriptomics for gene array expression

profiles.
Q If we could just turn to the last slide, because I think that tells us -- I think there's one more, Mr. Lunn. So that basically describes the approach that you take; is that right, Mr. van Aggelen?
MR. van AGGELEN: Yes. Yes. It's a common, like I say, what I would say classical environmental toxicology combining genomic applications and then looking at chemical analysis to arrive at a more complete picture of what could be happening as a consequence of exposure.
MR. LEADEM: Now, I was going to do this tomorrow, Mr. Commissioner, with the panel, but I wanted to take advantage of this panel's expertise to see if they can interpret for me some of the data that's contained in reports from Iona Island WWTP effluent. I've shown Mr. East these reports, and I've shown Commission counsel. They're not on my list of documents, but I intend to put them into evidence through a witness tomorrow. But I want to get one of these witnesses to interpret some of the data that we see here.
Q So I'm advised that my client obtained these by going online and essentially getting reports that were available through the Internet from "...Monitoring Results for Operating Certificate Sampling Location: Iona Island WWTP Effluent". And what I want to focus on, looking at the first report, which is dated June 2010 report, is there's various columns, and there's one column entitled "96 Hour LC50", and in bracket "(%v/v)". And then if you follow down that column, and look into the row for June the 22nd, 2010, you see there that there's a number "81". Do you have -- do you have me so far?
MR. van AGGELEN: Yes.
Q What does that -- what is that, or what does that mean? What does that "81" mean?
MR. van AGGELEN: Okay. Just for the definition at the top of the column.
Q Yes.
MR. van AGGELEN: The "96 Hour LC50" stands -- is defined as the over a four-day period, or 96 hours, the lethal concentration that causes 50 percent mortality to the test population. So in short, Your Honour, there's a series of how the

test is performed is there's a series of cascading concentrations. Usually they'd be 100 percent, 50 percent, 25 percent, et cetera, et cetera. And then over and into that test solution, ten -- usually ten under-yearling trout are added and then what is over the course of 96 hours, the analyst would determine the concentration of effluent which caused 50 percent of them to die. So if all the fish died in 100 percent concentration, and none of them died in the 50 percent concentration, the LC50 would be the median point between the 100 and the 50 percent.

And that is what's been done here to get this value of 81 percent. That some series of concentrations has been set up where they have calculated that the lethal concentration causing 50 percent mortality to the test organisms is 81 percent.

Q All right. Now, in terms of passing or failing, do you know -- can you describe it in terms of -- is that a good number or a bad number, or...

MR. van AGGELEN: Under the ***Fisheries Act*** it's at a 100 percent concentration greater than 50 percent of the fish must survive. So this is a -- this is a failure.

Q So this is a failure.

MR. van AGGELEN: Yes.

Q All right. And if I could just do one more with you, looking at July, 2010 report, the next page, once again focusing on the 96 Hour LC50 percent, looking at the data for July the 14th, 2010, I find the number "65". Once again that would be a failure, would it?

MR. van AGGELEN: That's correct.

Q All right. Are any of you familiar with the benthic environment that exists below the outfalls, either at Iona, or Macaulay Point, Clover Point, and if so, can you offer any comments about the benthic environment and how it may or may not have been modified as a result of the outfall?

DR. ASHLEY: I have no knowledge of the Macaulay Point outfall, but I've looked at some of the pictures of the transect along the 80-metre contour off the Iona effluent, which I believe there's 17 monitoring stations, some to the south, and some to the north. And so basically what shows up is

where the twin outfall pipes discharge, there's a zone of considerable organic enrichment, and it's sort of a bell-shaped curve that tapers off north and south as it gets further and further away from the outfall.

The main observations was some of the colouring in some of the clams was there was sort of rust colour in them, indicating that the sediments had low oxygen concentration, and there was iron staining in some of the clam shells. There was a different species composition, ones that were more tolerant, the closer you got to the pipe they were more tolerant of low oxygen conditions. The usual type of effect you'd expect to see in a zone of organic enrichment in a marine outfall.

Q Dr. Ross, do you have any comments?

DR. ROSS: I think a couple of things that I would -- I would offer up. One would be there are some major differences between Capital Regional District receiving environment and sort of the Strait of Georgia, wherein Iona and Lions Gate, in particular, empty directly, and that is that from the Metro discharges the plumes enter into an area of high sedimentation. So there's a very big load of fines and particles coming down the Fraser River that would be considered as natural. These fines, these particles will be burying things over time, and the receiving environment, despite being tidal, and having some other currents associated with freshwater discharge from the Fraser, there would be burial over time. And that's, of course, what I think the natural design of the receiving wastewater is, and that is we hope that these things will be buried or degraded over time.

Capital Regional District, in contrast, is a much more active zone. The Macaulay and Clover Point discharges, they both discharge approximately 60 metres depth, so similar to Iona. But the oceanography is such that it's a very active zone and there's very little sedimentation. So there's a much more limited fingerprint left behind in the local receiving environment. And a lot of the discharge is dispersed, and that would include with these, for these contaminants, well, more dispersed, less of a sedimentation record, less burial, whereas Metro more burial, more

sedimentation. And in both cases there are reports of obvious, there's solids ending up in both environments, and there are some, as Dr. Ashley noted, some effects on benthic community structure.

Some alterations have also been noted in CRD annual reports from Macaulay and Clover Points.

MR. LEADEM: Thank you.

DR. ROSS: I think that encapsulates (indiscernible - overlapping speakers).

MR. LEADEM: Thank you, Mr. Commissioner. Those are my questions.

THE COMMISSIONER: Thank you.

MR. McGOWAN: It might be a good time for the afternoon break, Mr. Commissioner.

THE COMMISSIONER: Thank you.

THE REGISTRAR: The hearing will now recess for ten minutes.

(PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.

MR. McGOWAN: Yes, Mr. Commissioner. Ms. Brown will be next for the First Nations Coalition. But just perhaps before she starts, there were two exhibits referred to by Mr. Leadem which have not been marked, and I am going to suggest that they be marked. The first is this Speaking for the Salmon PowerPoint presentation, and the next is the monitoring results, which were referred to and which I understand are now available in electronic format.

THE REGISTRAR: Speaking for the Salmon will be marked as 1054, and the second document, 1055.

EXHIBIT 1054: Ashley, Contaminants in Sewage, Presentation for Speaking for the Salmon - Summit on FRSS, March 31, 2010 [PowerPoint]

EXHIBIT 1055: GVS&DD Monitoring Results for Operating Certificate, Iona Island WWTP Effluent, June-October 2010

THE COMMISSIONER: Ms. Brown.

MS. BROWN: Thank you, Mr. Commissioner. For the

record, Anja Brown, and with me is Crystal Reeves. Mr. Commissioner, I expect to be approximately 30 minutes in my cross-examination. And for the benefit of the panel, we represent the First Nations Coalition. The coalition is comprised of a number of First Nations from the Fraser River, as well as Fraser River fishing organizations, Fraser River aboriginal fishing organizations, that is, as well as the Council of Haida Nation, and also some of the Douglas Treaty First Nations.

CROSS-EXAMINATION BY MS. BROWN:

Q Now, last week this Commission heard evidence from Dr. Robie Macdonald about the 2005 wind down of the Toxic Chemicals Research Program at DFO. And we heard from Dr. Macdonald about the importance of that program and also how there's been really very little research done in that area by DFO since that time. Dr. Ross, do you agree with that general statement?

DR. ROSS: In general I would agree with that statement. The Environmental Sciences Strategic Research Fund, ESSRF, which was the primary pot of research funds available to us contaminant experts within DFO, allowed for a wide range of proposals to be entertained. And even though it was a science-based peer reviewed funding envelope, it demanded of us, as we proposed research projects, it demanded of us to identify the stakeholders and the client groups in such a way that not only would we be doing cutting edge science, but it would also be meaningful. And we were able to partner with a number of organizations or habitat staff within DFO Pacific Region, but also occasionally with First Nations communities and other government agencies.

Q The Commission also heard from Dr. Paradis, who was part of the team that implemented the dismantling of the Toxic Chemical Research Program. And his evidence was that the funding wasn't lost so much as moved from one research program to another area. Do you agree with that?

DR. ROSS: Well, I can't speak to where the money went. I can only say that prior to 2005 we had approximately $5.4 million per year nationally, and it was for Canada's three oceans to embark on

research that dealt with contaminants, but also a number of other environmental sciences projects. Of that about $1.2 million per year was made available to Pacific Region scientists. And during program review, it was decided with some attempts to provide guidance on the part of scientists, it was decided that contaminant research was not something that was required of DFO, and that that was largely related to point source discharge under s. 36 of the ***Fisheries Act***, and that was the purview of Environment Canada.

So there was a rationale given, the monies disappeared from things that I understood or I had access to as a scientist, and I can't speak to where those funds ended up going.

Q So has the dismantling of the Toxic Chemicals Research Program affected the work that you do and your Department?

DR. ROSS: With little question, the loss of this program has meant that my job as a scientist has become more difficult. I have been very successful at raising money, both from within Fisheries and Oceans Canada, and also from other government agencies, as well as outside groups. But most of these projects tend to be highly targeted projects within Fisheries and Oceans Canada.

I would point to the National Pesticide Research Fund. That's $300,000 per year nationally, that's targeted at only looking at effects of single pesticide chemicals on the health of fish. No complex mixtures, no real world.

I could point to the Federal Contaminated Sites Action Plan that has an interest within DFO and other government Departments at reducing liabilities associated with contaminated sites. Those would be -- those would be federally designated contaminated sites. That has helped us to carry out some what I consider to be good research, albeit targeted.

I would also point to the ***Species at Risk Act*** that recognized very quickly that our southern resident killer whales are endangered, and one of the three major concerns are very, very high levels of PCBs and other persistent compounds and they have supported some of the research that I

carry out.

We've also been fortunate to work with Indian and Northern Affairs and Health Canada, where there's a shared interest in looking at contaminants in traditional foods and this would be shellfish, salmon, harbour seals, and some other species.

So I feel as though at the end of the day the few members of the research community within the federal family have been able to do what I hope is a decent job, albeit one that is constrained by the view that contaminants really are not the responsibility of Fisheries and Oceans Canada, and in my view -- well, in my view, the Environmental Sciences Strategic Research Fund or the Toxic Chemicals Program allowed scientists to seek out, using their own expertise, the problems, the hot topics, the data gaps, whereas now that sort of a mantra has disappeared, and that does make it a little bit more challenging to support research on areas considered to be important to me.

Q I think that really answers, perhaps, what would have been my next question, which was whether the dismantling of the program in 2005 has been one of the reasons why we have these gaps in the data that you and your colleagues have given evidence about today, with respect to the absence of evidence specific to the effects that contaminants and in particular wastewater have on salmon.

DR. ROSS: I'm not sure what the question was exactly to that, but --

Q Is it one of the reasons why there are gaps in the data now, six years after the dismantling of the program.

DR. ROSS: I think there's little question, you know, I've mentioned it this morning, I think scientific research is the way to go if one is to make wise management decisions, if one is trying to understand what's happening in the real world. That's the radar, or those are the eyes at street level to understand what's going on in the natural world.

In tandem with the loss of the toxic chemicals program and our research mandate, we did also lose the Water Quality Unit at our Habitat Branch, and those were the people with street smarts, those were the people that knew all about

land use and practices, and were able to see the consequences of certain actions. Often as a scientist one is behind a computer in the library looking at the problems in other parts of the world, and not on the water all the time. So our Habitat colleagues, the biologists and staff there, and I believe there were only three of them, they were an encyclopaedia of knowledge that helped to guide our approaches to devising important research questions, et cetera.

So I think if we look at the last six or seven years, had we had six or seven years with -- with a more clear mandate and a structured set of opportunities to embark on research that might have given us more answers, then, yes, we would have -- we would have more confidence from which I think I could speak today, or others could speak today.

Q Have the concerns that you've expressed just now, have those concerns been passed on to any of the people that you report to within the Department?

DR. ROSS: Yes.

Q And has there been any follow-up to those concerns?

DR. ROSS: When program review started in approximately 2004, the contaminant scientists within DFO nationally were invited to a series of workshops. One was in Ottawa, one was in Toronto, and those were the only two formal workshops, and we were told that we were going to lose our research funding envelope, and but that it would -- the program would be re-launched and retooled based on our expert, you know, opinions and a new framework. And that the focus under program review would become the biological effects of contaminants rather than simply contaminants, which could be simply measuring chemicals in a fish, or something that would more likely be the purview of Environment Canada or Health Canada, if it were a health risk.

So there were formal workshops in which we were asked for our advice, and we wrote a series of white papers. Two of those white papers have appeared in scientific literature led by Rob Macdonald with a number of coauthors. I wrote a white paper on Priorities for Research for Fish and Marine Mammal Health, and that became a DFO

Technical Report. And those were the three white papers that came out of that.

In consequence there was some deliberations, and we never heard back from National Headquarters on our recommendations for a revitalized toxic chemical program that would focus on biological effects associated with contaminants.

Q My next question is both for Dr. Ross and for you, Mr. van Aggelen, and it's in relation to the questions that you responded to, Dr. Ross to Mr. Leadem before the break in relation to the disconnect or lack of communication between DFO and Environment Canada. And I'll start with you, Dr. Ross, if you have any recommendations as to how that could be improved.

DR. ROSS: Well, I think there are a number of jurisdictional things here that have to do with policies and laws that I may or not be privy to. I'm a scientist, and I think in the past within DFO we've had a core group of four research scientists and numerous support staff, as well as collaborations with graduate students, colleagues and Environment Canada, universities, and we have a pretty decent understanding of what we feel to be the mission of the Department of Fisheries and Oceans.

As just mentioned, we did have very good -- a very good collaborative approach to discussions at formal and working levels with our Habitat staff, and our Habitat staff had, as I understand it, very good connections with their counterparts in Environment Canada, such that I think that the issues related to s. 36 were probably decided upon in close consultation. So at the habitat, stewardship, conservation, conservation protection level, that would be more the Habitat Branch, obviously discussions there would be -- is something that would be useful, but outside my purview.

My impression, and I'd have to defer to my colleague, Mr. van Aggelen, here, my impression is that when -- when we were just decoupled from our contaminant research mandate, it was because Environment Canada was to do this or pick up the slack. And my understanding was that that has not taken place.

But there was a debate within this program

review as to what exactly s. 36 meant. Section 36 to me means end of pipe discharge and the release of a point source deleterious substance into fish habitat. What I study are fish that contain hundreds of chemicals from countless point sources throughout their life history, or killer whales, or harbour seals that also encounter countless sources related to non-point source or multiple points, point sources. So I think there's a very big difference between looking at s. 36 under the guise of the end of pipe, versus what a sockeye salmon or a killer whale or a Dungeness crab are exposed to.

So when we're looking at research, we typically want to look at what are the implications for population. So we're going to be a little bit more removed from the end of pipe, whereas the monitoring and regulatory and enforcement aspects will be dealing more with end of pipe.

So there are a couple of issues that are important there. And I think dialogue both at a scientific working level, as well as the habitat, conservation protection level is going to be important, as well as clarification, as has been outlined, I think, fairly robustly in the Auditor General's report in 2009, is that clarity would -- is needed for scientists within both the Department of Fisheries and Oceans and Environment Canada to enable us to do our jobs.

Q Do you have anything to add, Mr. van Aggelen?

MR. van AGGELEN: Not really. I think Peter has summed it up very nicely. And just that, yeah, the distinction is largely end of pipe is kind of what I'm involved with and looking at, and again as Peter, Dr. Ross mentioned, looking at receiving water effects on those associated animals.

As a means to -- as a suggestion to do something, maybe a closer liaison with, between the two Departments, because as was mentioned when Fisheries dismantled their program at the West Vancouver lab, largely we lost kind of the collaboration that existed between my lab and the folks in DFO, the scientists in DFO that were doing similar or corresponding type of research. Fellows like Dr. Kruzynski, Dr. Bertwell, those people that were doing the kind of pollution-based

effects research on salmon and things like that. So there was a nice, you know, there was a nice connect and there was a lot of collaboration and communication between our two groups at that conjuncture.

MS. BROWN: Mr. Lunn, could you turn up, please, PPR number 15, please. And if we could go to page 51, please. This is a section of the PPR that looks at water quality guidelines and objectives. And paragraph 136 talks about the Compendium of Working Water Quality Guidelines for British Columbia, and it indicates there that:

> These guidelines take into account site characteristics that may influence the toxic action of...[substances] of concern.

It goes on to say that the:

> The 2006 *Compendium* are working guidelines. They provide benchmarks for substances that have not yet been fully assessed and formally approved by the Province.

And they go on to say that:

> They reflect guidelines from various [other] Canadian and North American agencies...

Q So the question is, in the course of the work that you do, and this is really directed at all three of you, how would information that you develop in the course of the scientific studies that you do, either through Environment Canada or through DFO, or through the work that you do, Dr. Ashley, how does that kind of new scientific information make its way into guidelines that are in the process of being developed. If I could start with you, Mr. van Aggelen.

MR. van AGGELEN: With respect to guidelines, if there is a specific chemical or parameter that CCME has identified, and Environment Canada has representation on that, they would come or approach my lab to see if we could perform some of the toxicological analysis required to fulfil the obligations of determining a water quality criteria value for that specific chemical. So

there are, you know, provisions in there. So and they, the CCME guidelines, they have a very -- it's a very prescribed method of how a guideline is derived. It's a representative species from different trophic levels, water quality conditions and things like that. So that principally it's, to use the term, a cookie cutter approach to determine the water quality effects of a given chemical.

Q Do you have anything to add to that, Dr. Ross?

DR. ROSS: Well, we've embarked on some discussions with CCME, and as well as the B.C. Ministry of Environment to discuss the notion of guidelines. I should point out the guidelines are really designed to either clean up a contaminated site or to address a nearby contaminant source that might be continuing to release contaminants into a waterway. So they're really designed not necessarily to protect the environment, but they're designed to reduce the harm or stop something from adding to what might be going on in the environment. So it's after the release of a chemical that guidelines come into play.

I'd like to build on what Mr. van Aggelen had pointed out, and that is that CCME guidelines often deal with single chemicals. They want causal certainty. And that means that the kind of evidence that they use to derive guidelines is based on laboratory experiments with single chemicals that have from my perspective, very little to do with the real world, and that is they will not look at complex mixtures. They want a guideline for copper, a guideline for naphthalene, a guideline for 2,3,7,8,-TCDD.

So I work as an ecotoxicologist. I know full well the challenges of trying to sift through the complex mixtures that we're faced in the real world. But that is the reality, the real world. We have to do a better job of looking at complex mixtures and characterizing the risks posed by complex mixtures, otherwise we're not dealing with the real world.

The second major concern with CCME requirements for guideline development relate to the fact that they will only consider three main end points in terms of toxicity. That's effects on growth, reproduction and mortality. So with

the greatest of respect to Mr. van Aggelen's program, toxicogenomics would not really be considered a candidate field for incorporation into CCME guideline development.

And we argue this point with CCME and some of the people that use CCME guidelines, because we feel that sublethal endpoints are important. Because sometimes, you know, as we get away from the era of big fish kills, we're getting into an era where the expression of certain genes or the subtle alteration of metabolism might have profound consequences for a migrating salmon that's got to head out thousands of kilometres, come back, and as Dr. Ashley noted, they have to smell their stream, that olfactory stream bouquet. They have to find that stream through a rather messy river.

So we do have some concerns about the strict, stringent nature of the requirements for CCME guideline development, and as a consequence it means that a lot of chemicals do not have guidelines. There are very few guidelines out there in actual fact by which we could -- we could, you know, measure sediment, for example, or water and come up with a full understanding of the risk posed by that matrix.

Q This Commission has heard from Dr. Johannessen in earlier hearings that there's very limited data available on water quality on the Lower Fraser. And I think we've heard that from yourselves today, as well. Do you have any recommendations on how scientists can build data on water quality specific to the Lower Fraser?

DR. ASHLEY: I'm not sure what you mean by "build" water quality.

Q To build, sorry, to build the data. Is there a program in place or is there a program being contemplated, for example, the EEM program that I understand is being contemplated for municipal wastewater treatment plants, would something like that assist in the collection of data on a regular basis so that there is a better sense of water quality on the Lower Fraser.

DR. ASHLEY: Yes. I mean, there was -- an organization like Metro does have a variety of monitoring programs that falls under the general category of receiving environment monitoring, and an ambient

monitoring program on the Fraser. But those programs tend to be for internal consumption and presentation at the Environmental Management Committee, and they don't -- they don't really get much farther that that.

So what's really needed is cooperation amongst any of the polluters on the Fraser, Lower Fraser, such that there's some data sharing and it becomes more of a collaborative effort rather than just one agency meeting the regulatory requirement and then -- and then putting the reports on the shelf and not sharing them with the broader community.

Q Dr. Ross, do you have anything to add?

DR. ROSS: Well, as I understand, I believe that the water quality monitoring is carried out under the auspices of the B.C.-Canada Water Quality Agreement, and there are 35-odd stations. If one looks at the list of parameters that are being measured, they are cheap, easy, basic measures. There's no measures for PCBs, there's no measures for pharmaceuticals, you know, it's a very cursory list. So that's a monitoring approach, I think it is useful in many ways, but it could probably be expanded a little bit, at least at a limited number of locations, because it is expensive.

A couple of other points I would suggest, one is -- a lot of these chemicals don't dissolve in water, but they do dissolve in sediments, or they do quickly bind to particles and get into the food web. So one has to look at water, but also what escapes from water. A lot of the persistent compounds are afraid of water, hydrophobic, they're lipophilic. So water isn't the only thing I think we should be looking at.

And then I would also emphasize that there's a distinction that one needs to make between monitoring and research. Oftentimes monitoring means that we either know what the problem is and we want to see if we're doing a good job. Then one can go down the regulatory side of things and look at that.

Another example where monitoring comes in fairly nicely is when one doesn't quite know what one is looking for, but one wants to have a general sense as to sea surface temperature, or something else, and those records have been

instrumental in guiding scientists and managers over a long time.

But there are a lot of -- a lot of examples where monitoring will not capture everything. And I think it gets back to the importance to having scientists out there conducting research that is hypothesis driven, whereby they use the appropriate study design, the appropriate methods to select species, or matrix, or season to get the answer they're going after. So I would draw a very clear distinction between monitoring and research, because they really rarely meet up in perfect synchrony.

Q Do you have anything to add to that, Mr. van Aggelen?

MR. van AGGELEN: Yes. I would just follow what Peter was saying, but I'd say like monitoring can loop you into -- into a very expensive process with no endgame in sight, as opposed to having a very focused, you have to have targets or indicator species that would determine that you're eliciting some type of an effect, or not, or seen a recovery. So there's, when we -- you have to be careful when we say monitoring, because as I say, with respect to new emergent chemicals of concern, you can monitor them, you may not see them, but if you spend huge amount of money and build detection limits and buy expensive instrumentation, you may see them, but all because you can measure them analytically, are they necessary but -- necessarily eliciting some type of an effect.

So it's a fine balance, but I would caution on the side of monitoring, but hypothesis driven with something that, well, at the end of the day you can have a marker or some type of a surrogate that says that, yeah, things are getting better, that either some benthic sediment critter that we could use as an indicator, or a free-swimming organism, or something that would be a yardstick of measure. Not monitoring for the sake of just taking water samples and getting reams and reams of numbers that, you know, people can not really make any judgment on, on an impact.

Q Now, we've heard about the end of pipe testing that takes place with respect to water treatment plants. And is there also testing that's possible or that takes place perhaps the one or the two or

the three kilometres away from the end of that pipe. And I'm not clear on whether that's being done or whether it's even feasible at this point.

MR. van AGGELEN: It's feasible. It's not being done by anyone I know of within Environment Canada with respect to *in situ* toxicity testing.

Q And is that the type of testing that you were speaking about earlier where if testing was done of actual water samples, that you would need to get into toxicogenomic analyses to determine whether there was any cumulative effect of various chemicals that are identified.

MR. van AGGELEN: Yeah, when I was speaking earlier, I was mostly -- it was laboratory-based studies, but that would be subject to modelled or predicted concentrations in the receiving environment. But as I say, the lab does not mimic the real world. The lab gives you controlled testing conditions to look at specific parameters within that. So it's a good indicator. But as I say, I think Dr. Ross could most likely expand upon that, that, you know, until you're looking at the effects mediated or demonstrated on critters in the receiving environment, then it's, you know, that's the real -- that's the real test. But as I say, yes, there's ability to take tests in the lab to help predict or determine if an effluent quality is changing or not.

Q Dr. Ross, do you have anything to add?

DR. ROSS: It would largely, I think, just build on what we've been discussing, and that is that if one is to be precautionary, one would expand, rather than constrain the list of research and/or monitoring approaches to looking at the receiving environment.

I would suggest there are a number of creative designs and it would -- it would expand far beyond my realm. But we are at present working on modelling priority chemicals of concern in the Strait of Georgia food web. We are validating that empirically with certain chemicals, PCBs, PBDEs.

There has been evidence in the past of English sole in Vancouver Harbour having liver tumours and skin diseases, as has been observed in other urbanized areas, like Seattle.

There was a study in the late 1990s by Joanna

Wilson that showed downstream of Prince George that one-and-a-half-year-old juvenile chinook salmon out-migrating had increased what we call biomarker responses. These would be enzymes that are induced by exposure to effluents. The authors were unclear as to whether that was related to municipal wastewaters or pulp mill derived compounds.

Surrogate species have been used, *in situ* studies, caged studies.

There are lots of different models or strategies that research scientists could employ to complement the routines or monitoring and/or toxicity testing that might be carried out under the auspices of a localized discharge permit. And I think a lot of our evidence comes from the past. But if we were looking ahead, even the freshwater reaches of the Fraser or down into the estuarine or the marine environment, there's certainly more that we could do to get a better handle on the nature of contaminant risks in the Fraser River system.

Q You just mentioned --

THE COMMISSIONER: Ms. Brown, how much longer are you going to be?

MS. BROWN: I have about two questions left.

THE COMMISSIONER: Because I have a couple of questions I'd like to ask. So if you could move it along, I'd appreciate it.

MS. BROWN: I'll be very quick.

THE COMMISSIONER: Thank you.

MS. BROWN: I'll wrap it up. Thank you, Mr. Commissioner.

Q Dr. Ross, you just mentioned a study that looks at Dover sole, and I'm wondering why we often hear about studies that are in relation to sole, rather than salmon. Is it because sole is considered a resident specie as opposed to migratory specie?

DR. ROSS: Yes, pretty much. And in harbour areas they're exposed to hydrocarbons, metals, PCBs, dioxins, furans. That's where we tend to find the greatest evidence of adverse effects. When an animal migrates, much more difficult to keep control over the confounding factors in its life history.

MS. BROWN: Thank you. Those are my questions.

THE COMMISSIONER: Thank you.

QUESTIONS BY THE COMMISSIONER:

Q I just had three quick questions for the panel. The first is perhaps for Dr. Ross. I think you mentioned in 2004, Mr. van Aggelen did in any event, the removal of the funding for your Toxic Research Program. That would be about on the eve of the adoption of the Wild Salmon Policy. Can you tell me what understanding you had at that time and what understanding you have now with respect to the intersection between the kind of research you've been talking about here today, and the Wild Salmon Policy.

DR. ROSS: I was not privy to any discussions related to the Wild Salmon Policy.

Q And what is your understanding currently as to the intersection between the Wild Salmon Policy and the kind of research you're doing?

DR. ROSS: I have pretty much never embarked on any discussions about the Wild Salmon Policy or its intersection with contaminants. I think as we've heard today, the contaminant file has been a difficult one for us, and it has been the general view that it has no real home within Fisheries and Oceans.

Q And, Mr. van Aggelen, is there any crossover discussions that you have had with respect to the Wild Salmon Policy?

MR. van AGGELEN: No, Your Honour.

Q The second question I briefly had was, and I think it came up just now. With respect to cross-border issues and contaminants, is there any involvement by DFO or Environment Canada with regard to the Pacific Salmon Commission work or discussions with the State of Washington or the State of Alaska with regard to contaminants?

DR. ROSS: I've been collaborating with the State of Washington since 1996, and we've been working on the harbour seal, one of my favourite study animals, because they don't migrate. They are high on the food chain. They tend to amplify the pollution signals associated with some of these persistent contaminants of concern. And we have been working quite closely with the Washington Department of Fish and Wildlife to characterize PCBs, PBDEs, dioxins, furans, organochlorine pesticides, and a number of new generation flame

retardants at the top of the food chain. And the State of Washington has a program to look at fish health and fish contaminants right down into sediments.

Certainly the State of Washington has had a longstanding concern about the Puget Sound, which is vulnerable receiving environment. It has a long history of contamination, associated with spills and industrial sites, and municipal, military activities. And they've been actually very interested and supportive of trans-boundary work on some of these priority persistent compounds of concern.

Q Mr. van Aggelen?

MR. van AGGELEN: Only, Your Honour, in the case if there was a spill or an infraction on trans-boundary waters where 36(3) provisions would come into play. But other than that, nothing.

Q Thank you very much. And finally I just wanted to raise, I think it was Dr. Ashley who mentioned earlier today, at the end of the day it's the taxpayer that has to be supportive of these programs for research and pay for the cost of installing facilities to address these concerns that you've raised. Is there an education and communication program within DFO or Environment Canada, or that Dr. Ashley may be aware of. We've seen, at least as citizens, a substantial program for recycling for landfill concerns. Is there any program which brings the taxpayer into the equation in terms of their knowledge base, to raise the -- or to raise the awareness around the kinds of issues that you've been talking about. Are there any kinds of programs that address bringing the community into the programs so that they will have an understanding of what you're doing and be supportive? And perhaps programs that, like the recycling programs we've seen throughout the communities across Canada, take some of these toxins out of the system, if possible.

DR. ROSS: Perhaps I'll start on that one. I take very seriously the idea that as a scientist I can't operate in an ivory tower, and I do extensive public speaking and interviews with the media. There's always a very strong appetite here in British Columbia and Washington state when it

comes to salmon, killer whales, contaminants. I find there is a strong appetite for that kind of information. And the feedback that I get is steadfast. The taxpayers seem very, very happy to be investing in protecting some of the creatures that we're discussing today.

I can certainly point to programs that as a scientist I've seen an interest and support for outreach. ***Species at Risk Act*** is a multi-stakeholder oriented and driven piece of legislation whereby stakeholders do have input into recovery strategies. The ***Oceans Act*** began with a tremendous fanfare with a lot of outreach for integrated management, multiple stakeholders. Fisheries management necessarily works with stakeholders.

I sense, though, that in a difficult budgetary time, oftentimes the first things to go are the things that, I guess, have some meaning to some of the people on the street. I think outreach is one of the things that remains vulnerable, as is research or project-oriented money. So sometimes these programs are the first to suffer.

And I would also point to Indian and Northern Affairs and Health Canada, both agencies that are concerned about -- very concerned about contaminants in traditional foods. Health Canada, south of 60th parallel, INAC, north of the 60th parallel, and we have projects under both agencies. They have a very, very strong requirement that we communicate to the public and to the stakeholders, and work with the communities that we're accountable to.

Q Thank you. Mr. van Aggelen.

MR. van AGGELEN: And certainly within Environment Canada there's an outreach, Outreach Group that's, you know, that promotes things, and but one of the things I think through the province is that the one aspect is the returning of unused pharmaceuticals back to pharmacists and not to, I think -- every now and then you see a campaign to say not dumping your drugs down, your unused drugs or spent drugs down --

Q Mm-hmm.

MR. van AGGELEN: -- down your toilet. But as I say, I think that whatever level of government an

investiture in that type of advertising or awareness campaign would go -- certainly pay off dividends in making, you know, the average citizen more aware of certain issues.

But you know, certainly at our -- at our science centre we encourage, are always kind of a bit of a showcase for visiting scientists and other delegates to come by. But with respect to, you know, the person on the street, it's not too much I can say about that, that demonstrates what we do.

Q Thank you. Dr. Ashley.

DR. ASHLEY: While I was at Metro there was quite an effort on getting some messages out on source control to prevent certain pollutants from getting into the wastewater treatment stream.

I brought this scoop along. You may or may not have seen these. If you lived on the North Shore in 2006, Metro Vancouver delivered one to every household on the North Shore and every apartment and every condominium, encouraged people to use one scoop of detergent, laundry detergent, rather than two. Because the instructions on most boxes of detergent, obviously it's the detergent manufacturers would like you to use more, and a lot of detergents are used for -- designed for use in a hard water environment. So in a soft water environment like we have, the type of water in the Metro system, you only need less, less detergent. And one of the compounds in the detergent, the ethoxylates is what was identified as one of the toxicants in the failed fish mortality test at the Lions Gate sewage treatment plant.

And so Metro took it upon themselves to get this message out to everybody in the North Shore to use one scoop, rather than two. And so that was -- it came with a flyer and was a very, very good public outreach campaign. I think over time it fades and people need to be reminded, because I think there's probably these things kicking around in people's houses, they don't know what they mean any more. and so it was a great idea, but requires continual reminder what it is.

THE COMMISSIONER: Thank you very much. Thanks to all of you.

MR. McGOWAN: Mr. Commissioner, that concludes the questions --

THE COMMISSIONER: I think Mr. Prowse...
MR. McGOWAN: Oh, Mr. Prowse.
THE COMMISSIONER: Yes.
MR. McGOWAN: You've got one more...
MR. PROWSE: Sort of like a bad penny, keep turning up.

CROSS-EXAMINATION BY MR. PROWSE, continuing:

Q One question, Mr. Ashley. Last week we had some evidence about the SLIPP Project, which you played a very prominent role in. But are you aware of the extent to which there was public outreach and public participation in the SLIPP Project that contributed to its success?
DR. ASHLEY: Yes, the SLIPP Project is the Shuswap Lake Integrated Planning Process, it had a huge frontend component of public consultation because basically it was a public upwelling of being very unhappy with the rate and pace of development in Shuswap and Mara Lakes, both on the shoreline and the upland region. And so that was a multiagency effort between the Ministry of Forests, Lands and Natural Resource Operations, what it's called now, and DFO, and the Columbia Shuswap Regional District. And they had a series of town hall meetings in Salmon Arm and Chase, and various fire halls around there, too, had the public come out and express what their concerns were about what was going on in Shuswap and Mara Lakes. So that it was realized that because there was -- it was to be a new approach, it was to be a multiagency to sort of fill the gaps in how Shuswap Lake was being managed, it had to have a huge amount of public support in order to make it move forward.
MR. PROWSE: Thank you, Mr. Commissioner.
THE COMMISSIONER: Thank you, Mr. Prowse.
MR. McGOWAN: Yes, Mr. Commissioner. I believe we should adjourn till tomorrow morning, 10:00 a.m., for the next panel.
THE COMMISSIONER: Before we adjourn, I want to thank all three of you for attending here today and for providing us with the benefit of your knowledge, for answering the questions of counsel, and for answering my questions, as well. Thank you very much.
MR. McGOWAN: Thank you, Mr. Commissioner.
THE REGISTRAR: The hearing is now adjourned for the

day and will resume at ten o'clock tomorrow morning.

(PROCEEDINGS ADJOURNED TO JUNE 15, 2011 AT 10:00 A.M.)

I HEREBY CERTIFY the foregoing to be a true and accurate transcript of the evidence recorded on a sound recording apparatus, transcribed to the best of my skill and ability, and in accordance with applicable standards.

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Karen Hefferland

I HEREBY CERTIFY the foregoing to be a true and accurate transcript of the evidence recorded on a sound recording apparatus, transcribed to the best of my skill and ability, and in accordance with applicable standards.

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Diane Rochfort

I HEREBY CERTIFY the foregoing to be a true and accurate transcript of the evidence recorded on a sound recording apparatus, transcribed to the best of my skill and ability, and in accordance with applicable standards.

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Pat Neumann