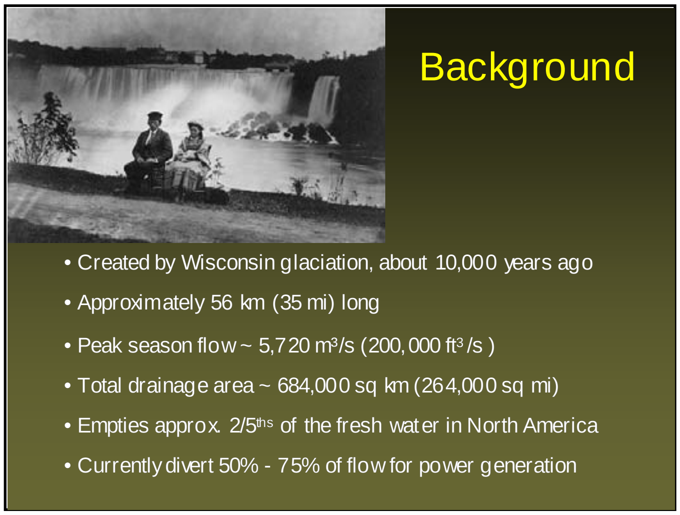
Good morning.

It’s really my pleasure to be here today and I hope you enjoy this brief summary of the work we are doing on the Niagara River.

To begin with, I thought I would show you this satellite shot from NASA which provides a great overview of the Niagara River and the surrounding area. For reference, WE are here (animation) overlooking the most famous section of the river...the new CASINO...just kidding...of course I'm talking about Niagara Falls!



As you are all well aware, the Niagara River has been here for a long time. It was here in 1858 when couples like this didn't have to worry about those pesky safety rails cluttering up their view of the falls and it was here about 10,000 years ago when the retreating ice of the Wisconsin glaciation carved out the Niagara River valley along with the rest of the Laurentian Great Lakes.

In terms of background statistics…

The river itself is just over 50km long and drops approximately 100 metres between Lake Erie and Lake Ontario

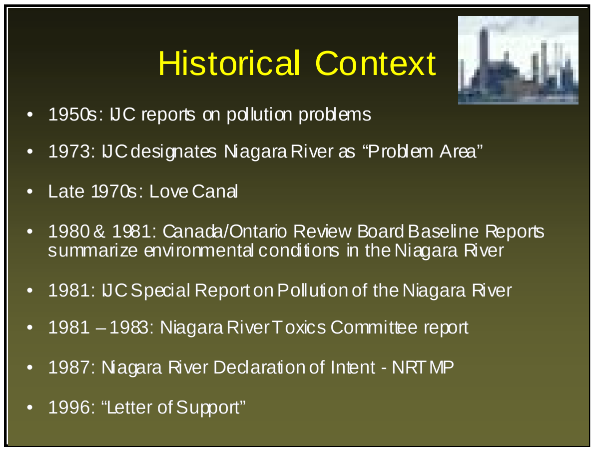
Peak season discharge approaching the falls is almost 6000 m3/s.

And the total drainage area for the Niagara River is just over 680 thousand square kilometres,

In fact, the Niagara empties approximately 2/5ths of the fresh water in North America.

Now, having said that, what goes INTO the Niagara River doesn't necessarily wind up in Lake Ontario RIGHT AWAY!

Discovery of the river's enormous potential as a source of hydro electric power at the turn of the 19th century eventually lead to significant water diversions and now anywhere from 50 – 75% of the flow is diverted for hydro generation.



Proximity to this source of power lead to the rapid industrialization of the area which, in turn, lead to rather severe environmental problems.

(animation) In the 1950s, The International Joint Commission identified a number of contamination issues and designated (animation) the River as a “Problem Area” (or what is now formally known as an “Area of Concern”).

In the wake of (animation) Love Canal and the release of two major reports in the early 1980s, Environment Canada, The US Environmental Protection Agency, the Ontario Ministry of the Environment and the New York State Department of Environmental Conservation came together as “the 4 Parties” and spent two years developing the Niagara River Toxics Committee report (animation).

This report ultimately formed the basis for the signing of the Niagara River Declaration of Intent (animation) which, in combination with a formal Work Plan, constituted the Niagara River Toxics Management Plan.

The overall objective of this document - the NRTMP - was to “achieve significant reductions of toxic chemical pollutants in the Niagara River”

Leading up to the 10 year anniversary of the NRTMP, representatives from the “4 Parties” signed (animation) an official “Letter of Support” which established new milestones for measuring progress and renewed their commitment to a number of key items - including monitoring

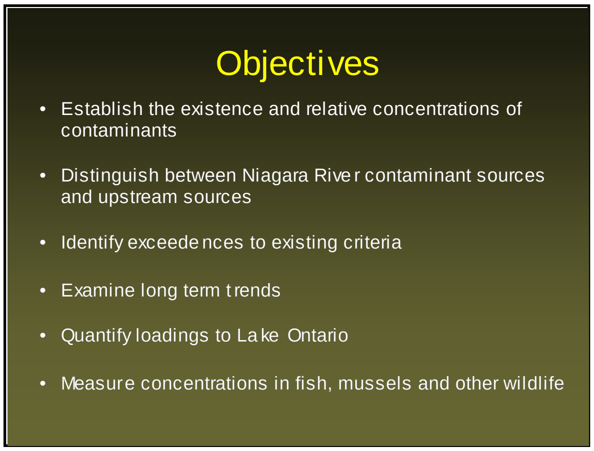
In order to meet these monitoring commitments, the Four Parties established three primary programs:

Upstream/Downstream monitoring which utilizes fixed sampling stations at each end of the river where dissolved and particulate phase samples are collected bi-weekly and analyzed for over 100 compounds including organics, trace metals, nutrients and major ions.

Biomonitoring which allow us to assess localized contamination and substantiate results from the Upstream/Downstream program.

And finally Tributary Screening and Trackdown which are sediment investigations in various tributaries that help identify local contaminant sources.

(animation) In addition to these three programs, monitoring is also conducted by Federal, State and Provincial agencies on both point and non-point sources such as Landfills, Sewage Treatment Plants, and Hazardous waste sites.



The primary objectives for these monitoring programs are to:

- Establish the existence and relative concentrations of contaminants
- Distinguish between Niagara River contaminant sources and those upstream
- And to identify exceedences to existing criteria

However, because of the way these programs are run, (animation) they also provide us with an opportunity to examine long term trends which, in turn, provide us with a coarse measure of improvements over time.

The (animation) Upstream/Downstream program also allows us to quantify loadings to Lake Ontario and the Biomonitoring programs measure the amount of toxic contaminants that are accumulated in fish, mussels, and other wildlife.

1,3-Dichlorobenzene	1,4-Dichlorobenzene	1,2-Dichlorobenzene
1,3,5-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,3-Trichlorobenzene
1,2,3,4-Tetrachlorobenzene	Pentachlorobenzene	Hexachlorobenzene
Hexachlorobutadiene	Hexachlorocyclopetadiene	Heptachlor
Aldrin	Octachlorosytrene	p,p'-DDE
p,p'-DDD	o,p'-DDT	p,p'-DDT
DDT Total	Photomirex	Mirex
α-BHC	γ-BHC	Heptachlor Epoxide
Total Chlordane	α-Endosulfan	β-Endosulfan
Dieldrin	Endrin	Endrin Aldehyde
Methoxychlor	TCPCB	2-Methyl Naphthalene
1-Methyl Naphthalene	Naphthalene	Acenaphthylene
Fluorene	Phenanthrene	Anthracene
Beta-Chloronaphthalene	Atrazine	Metolachlor
Fluoranthene	Pyrene	Benz(a)anthracene
Chrysene/Triphenylene	Benzo(b+k)fluoranthene	Benzo(a)pyrene
Indeno(1,2,3-c,d)pyrene	Dibenzo(a,h)anthracene	Benzo(g,h,i)perylene
Aluminum	Antimony	Arsenic
Barium	Boron	Beryllium
Cadmium	Cobalt	Chromium
Copper	Gallium	Lanthanum
Iron	Lithium	Manganese
Molybdenum	Nickel	Lead
Rubidium	Selenium	Silver
Strontium	Tellurium	Uranium
Vanadium	Zinc	Mercury

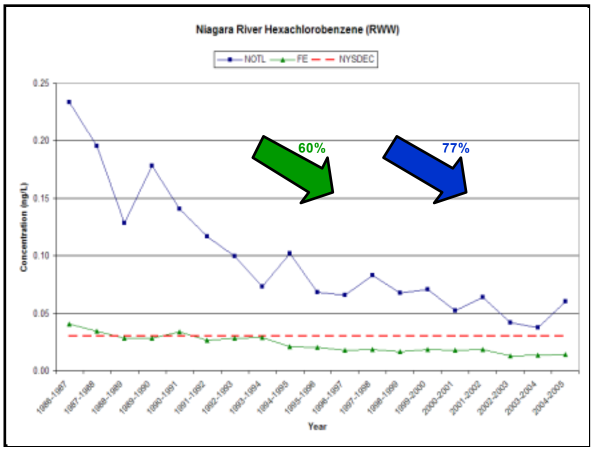
Now, in that suite of over 100 analytes I just mentioned, the Upstream/Downstream program focuses on 78 organics and trace metals which are shown in this table.

After more than 20 years of running the program, we can generally classify this list by those that exceed the strictest agency criteria and those that do not. Ideally, we'd like to tell you that none of the 78 compounds exceed their criteria...I would be out of a job of course, but some might say that's a small price to pay for such a huge success!

Unfortunately, we are not there YET; however, results from our most recent four years of verified data (the 2001-2002 fiscal year to 2004-2005) indicate that only 17 of those 78 compounds exceeded their most stringent water quality criteria

Furthermore, 5 of those compounds (Chrysene/Triphenylene, Iron, Hexachlorobenzene, Mirex, and Benzo(a)pyrene) only exceed at the downstream station – Niagara-on-the-Lake - which is a strong indication of localized contaminant sources.

If we turn our attention to one of these compounds (animation), the banned fungicide Hexchlorobenzene, we can see some characteristics that are fairly common to a number of Niagara River contaminants.



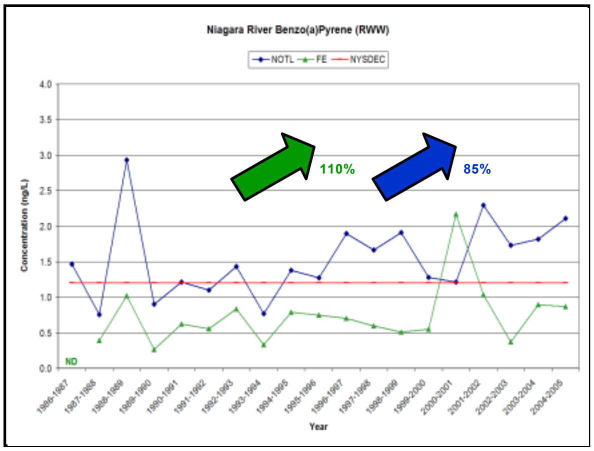
So here we have the long term, mean annual Hexachlorobenzene trends from the Upstream/Downstream program.

The upstream station, Fort Erie – “FE” – is shown in green...Niagara-on-the-Lake – “NOTL” – in blue and the red line indicates the strictest agency water quality criteria for Hexachlorobenzene which was established at 0.03 ng/L by the New York State DEC.

As I mentioned earlier, the Upstream/Downstream program collects both “dissolved phase” and “particulate phase” concentrations and here the “RWW” refers to the “Recombined Whole Water Concentration”...the TOTAL concentration of Hexachlorobenzene in both phases.

Cleary, concentrations of this compound have declined at both stations since 1986...(animation)...

And a 60% reduction at Fort Erie has brought upstream concentrations below the guideline; however, the declining trend at both stations seem to be leveling off and, what’s more, we continue to see exceedances at Niagara On The Lake despite the fact that concentrations have dropped by more than 75%.

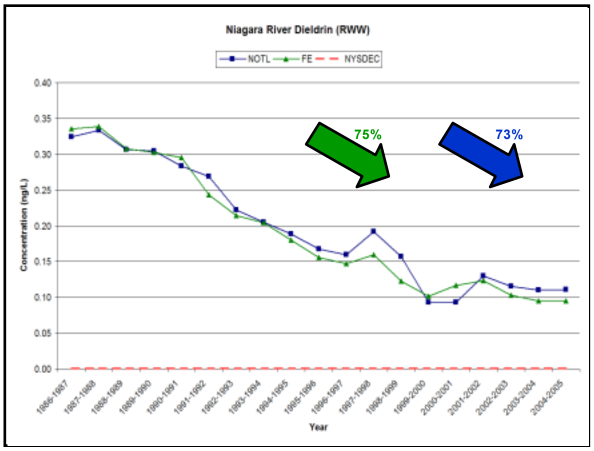


Like Hexachlorobenzene, concentrations of Benzo(a)pyrene are slightly higher at Niagara On The Lake indicating localized sources and are exceeding the New York State DEC criteria of 1.2 ng/L but, in this case (animation), we see a general INCREASING trend at both stations – with concentrations up anywhere from 85% at Niagara On The Lake to slightly more than 100% at Fort Erie between 1986 and 2005.

Of course, this isn't TOO surprising given the fact that Benzo(a)pyrene is a PAH, a polycyclic aromatic hydrocarbon, a class of compounds generally produced from the combustion of things like wood, coal, and gas. With more and more people living in the area, driving their vehicles, heating their homes, etc. it stands to reason that we are going to see this type of trend in Benzo(a)pyrene and similar compounds.

Given these sources and the increasing trends in population and fuel consumption presented by Mary Thorburn in yesterday's plenary session, it appears there may be significant challenges to managing compounds like the PAHs.

That's not to say it can't be done; however.

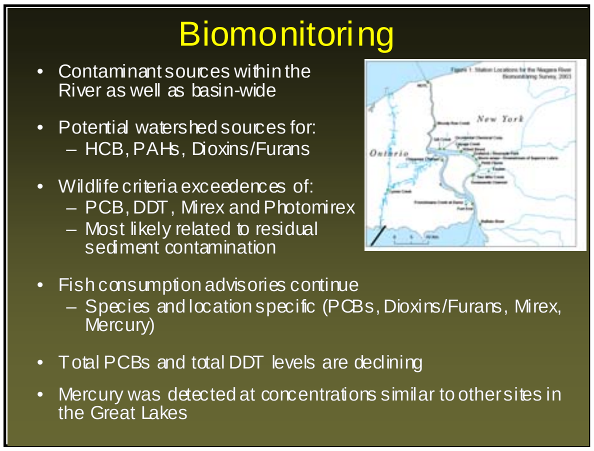


If we look at Dieldrin – a common pesticide that was banned for most uses by the US EPA in 1974, and then totally banned in 1987 – we see evidence of the direct impact of management decisions on concentrations in the Niagara River.

In this case, upstream and downstream concentrations are virtually identical over the period of record which indicates that this compound is coming from upstream or basin wide sources rather than within the Niagara River itself and while concentrations are still above the New York DEC criteria, the difference here is that they already exceed when entering the river.

This, combined with the fact that the declining trends appear to be leveling off in the last 5 to 7 years suggests that further reductions may require a significant level of effort.

Now, as I mentioned earlier, the Upstream/Downstream program is complemented by two other PRIMARY monitoring programs that not only help to corroborate these types of observations, but also identify potential sources and indicate the presence of contaminants when concentrations are below current method detection limits.



The first of these - Biomonitoring - is conducted primarily by the MOE and the New York State DEC through their caged mussel, Young of the Year and Sport Fish programs in several locations along the Niagara, several of which are show here.

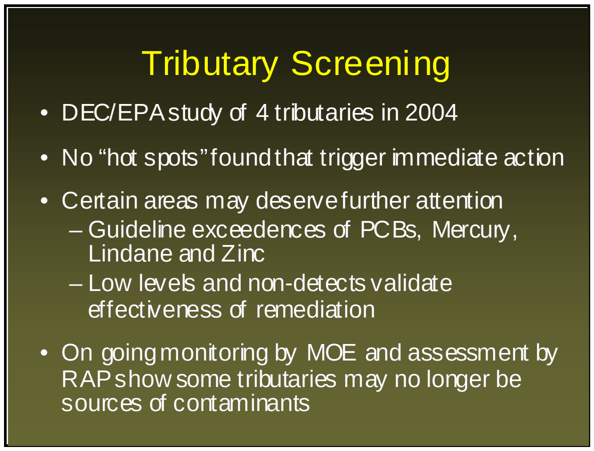
(animation) Like the Upstream/Downstream program, our biomonitoring efforts seem to be showing sources within the Niagara River as well as basin-wide.

More specifically though, these programs have shown potential watershed sources for Hexachlorobenzene, PAHs, and Dioxins & Furans and we are seeing some wildlife criteria exceedences of PCBs, DDT, Mirex and Photomirex.

Results from the fish programs continue to produce consumption advisories for specific species and/or specific locations – particularly for PCBs, Dioxins & Furans, Mirex, and Mercury.

The good news; however, is that PCB and Mirex concentrations were very low at the downstream sites and evidence suggests that PCB and DDT levels are declining.

In addition, fish monitoring has shown that, while mercury is still being detected in the Niagara River, its relative concentration is similar to levels measured in fish samples from other Great Lake locations.

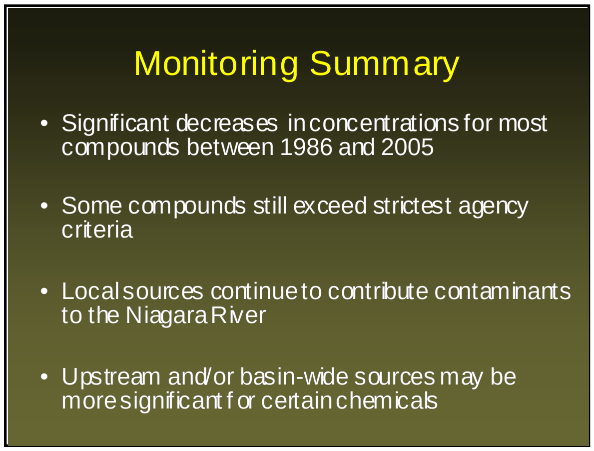


Similar good news is coming out of the Tributary Screening program which helps focus attention on local sources by examining sediment samples from specific tributaries within the Niagara River watershed.

(animation) The New York DEC and the US EPA led a study of on 4 Niagara River tributaries in 2004 and found no specific hot spots that demanded IMMEDIATE action; however, there were certain locations that may deserve further attention due to some guideline exceedences of PCBs, Mercury, Lindane and Zinc.

Having said that, most samples showed relatively low levels and a number of non-detects which certainly illustrate the effectiveness of various remediation projects.

In fact, ongoing monitoring by the MOE and the Niagara River Remedial Action Plan indicate that some tributaries may no longer be contributing contaminants to the Niagara River – Good news indeed!

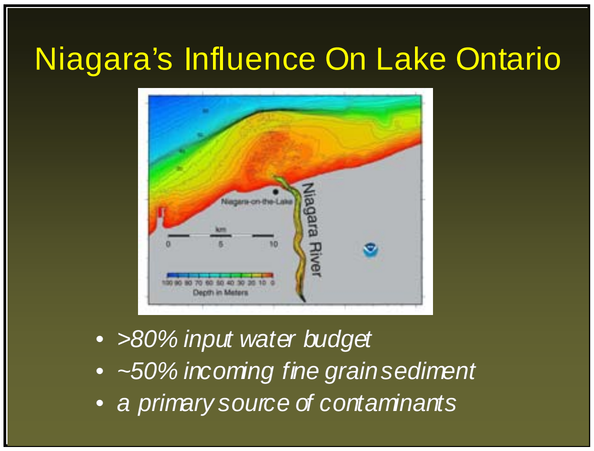


So, as a quick summary of what we have seen from the primary Niagara River Monitoring Programs:

There have been significant decreases in concentrations for MOST of the compounds.

However, there are still compounds which exceed the strictest agency water quality criteria and many of the decreasing trends appear to be leveling off.

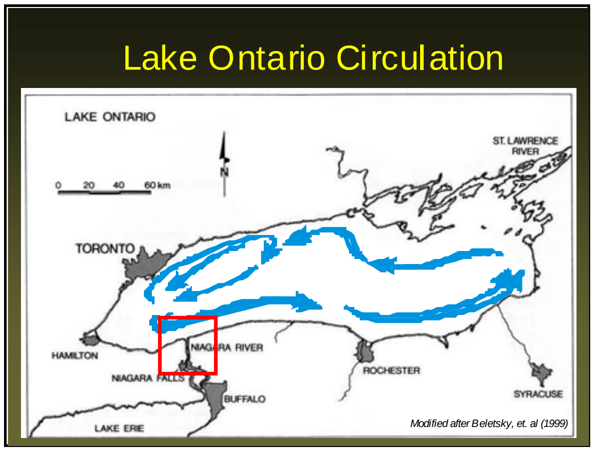
Evidence also suggests that local sources are still contributing to contaminant concentrations in the Niagara River; however, we are seeing that as sources within the watershed are being managed, contaminants coming from upstream or through the air are becoming more prominent



Now, when I was invited to talk about the influence of the Niagara River on contaminants in the nearshore, I thought it would be quite easy!

After all, we know from our work on the Upstream/Downstream Program that the Niagara contributes more than 80% of the input water budget for Lake Ontario and at least 50% of the fine grain sediment and there is a wealth of literature that suggests the river is one of the primary sources of many contaminants in Lake Ontario.

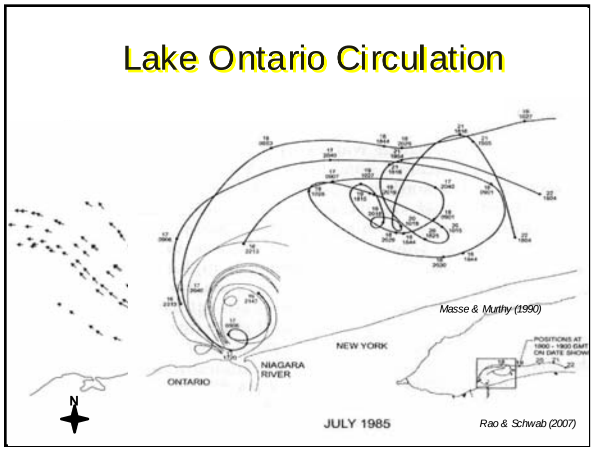
Despite all of this, identifying its specific influence on contaminants in the NEARSHORE of Lake Ontario is a little more complex than I first imagined.



For one thing, water and sediment from the Niagara River is distributed throughout Lake Ontario by a relatively complex circulation.

The circulation in Lake Ontario follows a general counterclockwise motion – simple enough; however, that GENERAL circulation is actually complicated (animation) by a small localized CLOCKWISE pattern along part of the north western section of the lake.

In addition, if we zoom (animation) in for a closer look at the area around the mouth of the Niagara River…(slide)

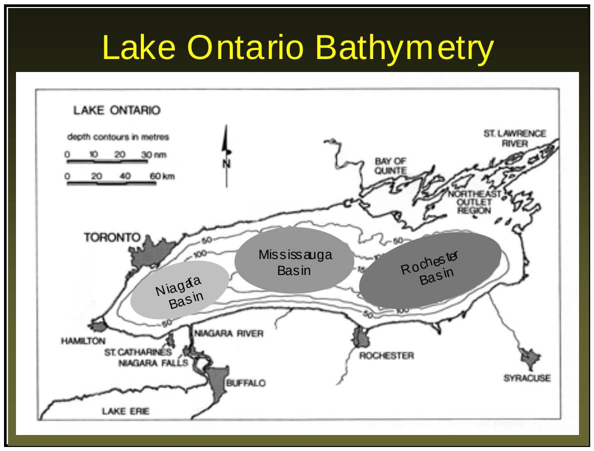


We see that things are further complicated by localized patterns.

Work by Massy and Murthy illustrates that circulation of inputs from the Niagara River can fluctuate anywhere between eastern (animation) and western flow in a very short time frame – 1 day in this case.

Part of the reason for this can be seen in the following figure (animation) which shows some further work by Rao and Schwab that was done on somewhat larger spatial and temporal scales showing measured trajectories of drifters over a period of 6 days

As you can see, inputs from the Niagara River can periodically fall under the influence of localized eddies that dramatically impact the distribution of water, sediment, and their associated contaminants.



In concert with the general circulation, the Lake Ontario bathymetry complicates things in the sense that the lake bottom is basically divided into three primary depositional zones...(animation) the Niagara Basin, (animation) the Mississauga Basin, and (animation) the Rochester Basin.

As a result of the bed topography and the general counterclockwise flow; most of the fine grain sediment - the fraction primarily associated with higher contaminant concentrations - generally settles out into these three deposition areas which are located in the deeper, calmer, offshore waters of Lake Ontario.

Phase Distribution

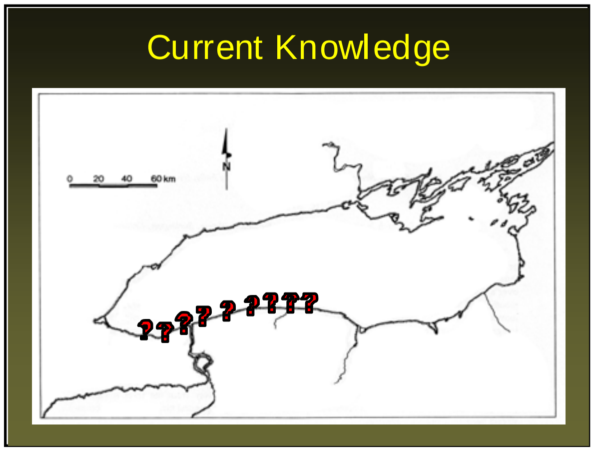
Compound	% in dissolved phase	% in particulate phase
Mirex	0	100
Benzo(a)pyrene	6	94
1,2,4-TCB	90	10
Dieldrin	94	6
1,2,3,4-TTCB	95	5
Atrazine	100	0
Metolachlor	100	0

Another complicating factor is the physical properties of the contaminants themselves.

What most of you probably know is that SOME compounds tend to partition preferentially into one phase or the other.

For example, in the Niagara River, Mirex and Benzo(a)pyrene (animation) are found almost exclusively in the sediment phase while others (animation) such as Atrazine and Metolachlor are found ONLY in the dissolved phase.

As you might expect, the distribution of these compounds within Lake Ontario is influenced by the fact that these phases are impacted differently by both local and lakewide circulation and bathymetry!



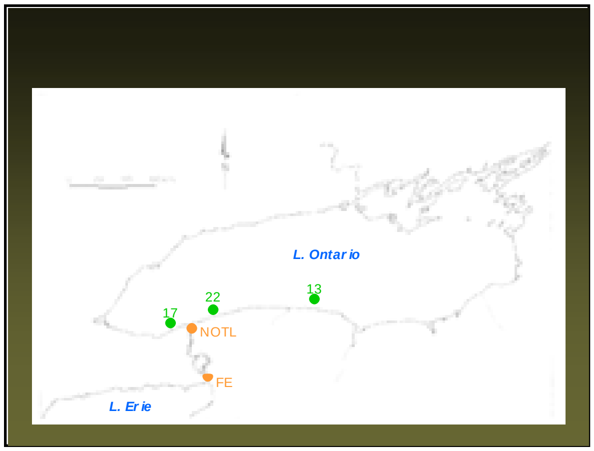
The last “complication” is the fact that very little is known about contaminants in the nearshore area of Lake Ontario.

The primary monitoring programs I have mentioned were developed with a focus on contaminants WITHIN the Niagara River and are therefore not well suited to address this kind of issue.

The MOE and New York DEC have both done some work on their respective sides of the border and there are a few studies in academia; however, almost everyone I’ve spoken with has said the same thing:

> “What an interesting question...”

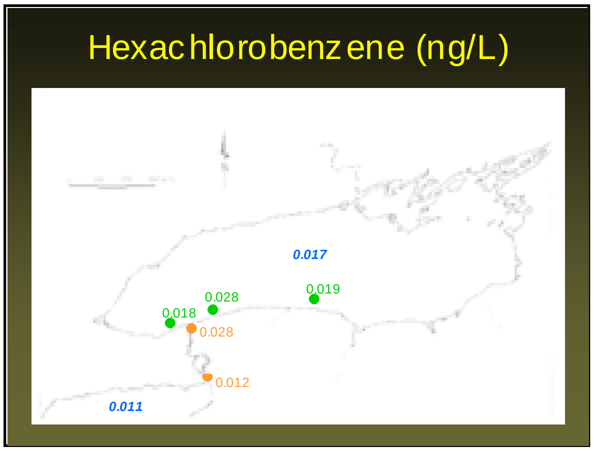
Bearing all these “complexities” in mind, I would like to just quickly show you how our existing data might shed SOME light on this topic.



What I am going to do is compare Upstream/Downstream data from Fort Erie and Niagara On The Lake (animation) with data collected by the Open Lakes Surveillance Program at stations 13, 17, and 22 (animation). These are not “nearshore” stations per se but they are probably the closest approximation we will get near the mouth of the Niagara River from the Open Lakes Program.

Now, because the Open Lakes program ONLY looks at dissolved phase concentrations, my comparisons will focus on dissolved phase values from the Upstream/Downstream program.

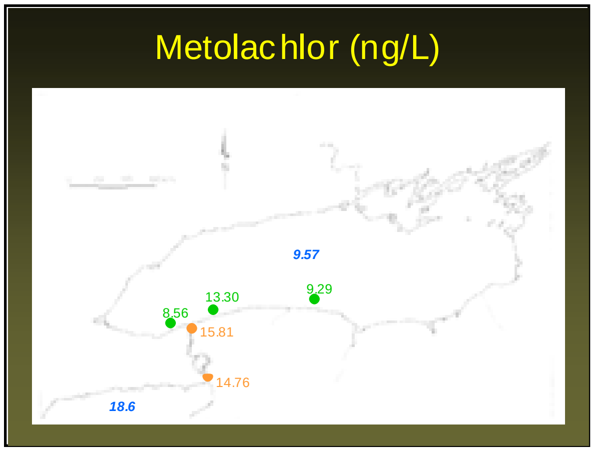
For the scientists here, I should also point out that the Niagara River data I’m using here are Annual Mean values from April, 2004 to March, 2005 sample while the Open Lakes data is taken from the 2005 spring cruise – perhaps not exactly “apples to apples” but certainly close enough to give you a good impression of how the two compare.



In the case of Hexachlorobenzene, we can clearly see the increased concentration downstream in the Niagara River...again, suggesting localized sources of Hexachlorobenzene coming into the river...

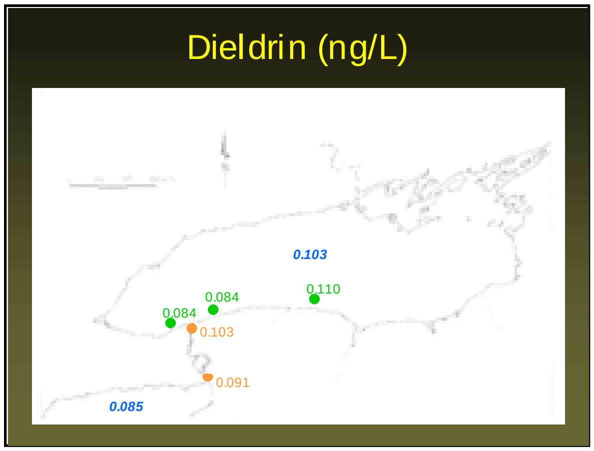
and we have somewhat similar values at the Open Lakes stations in Lake Ontario – perhaps a little higher at Station 22 which makes some sense given that it is directly downstream in that generalized counterclockwise circulation pattern.

Just for reference, you can see how the so-called "nearshore" values compare to the Lakewide averages for the Surveillance Program in Lake Ontario and the Easter Basin of Lake Erie...with nearshore values in Lake Ontario appearing slightly higher than the mean of 0.017 ng/L



If we take a look at another compound such as the herbicide Metolachlor we see a similar pattern.

As I mentioned, the Niagara River concentrations of this compound are only found in the dissolved phase and like Hexachlorobenzene, the nearby surveillance stations seem to exhibit this pattern of higher concentrations immediately east of the outlet and also SLIGHTLY elevated in comparison to the lakewide average.

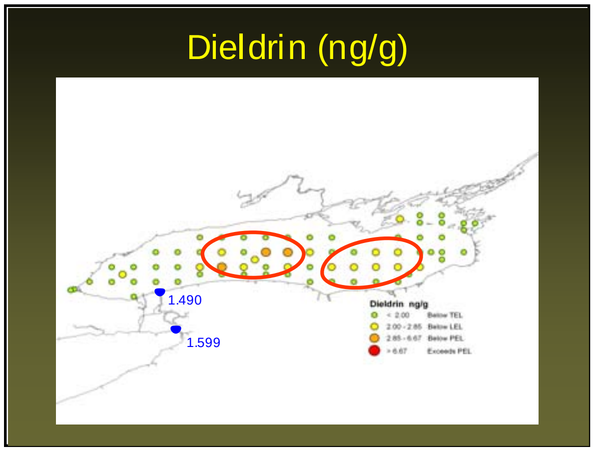


Looking at Dieldrin we see something slightly different.

In this case, the upstream/downstream values in the Niagara River are virtually the same – much like I showed earlier in the long term trend graph.

Likewise, the values for the adjacent Surveillance stations are quite similar to both the Niagara River concentrations AND the open lake averages.

In essence, the values are practically the same and what we are seeing is more of an effect from the relatively homogenous distribution of Dieldrin throughout the Great Lakes basin rather than site specific inputs from the Niagara River or any of the other major tributaries.



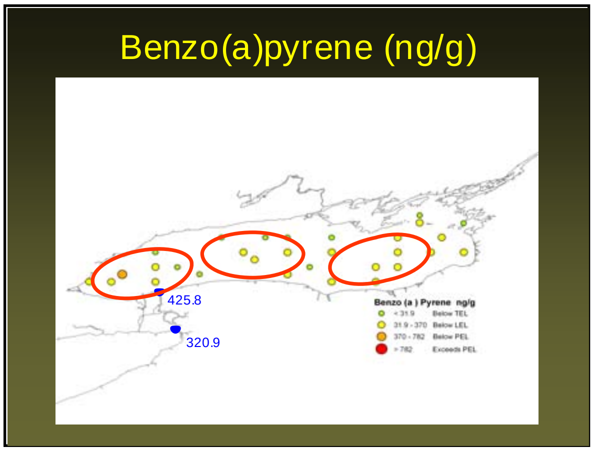
The same is true if we shift our attention to the particulate phase.

In this case we are looking at Niagara River “particulate phase” Dieldrin data in relation to Lake Ontario bottom sediments collected by Dr. Chris Marvin at Environment Canada.

Again, the sample dates don’t completely match up...in fact, Chris’ samples were taken in 1998; however, based on depositional rates and the vertical depth of sample taken, we are confident that the values presented here are indeed comparable to our 2004-2005 data.

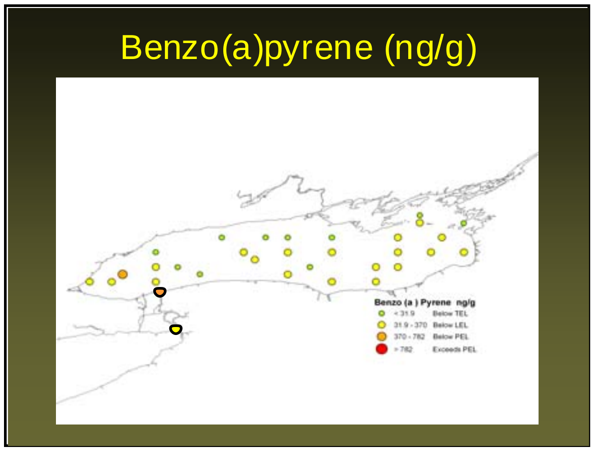
This slide show’s Chris’ bottom sediment data classified according to various “effect levels”. As you can see, most of the values are below the Lowest Effect Levels with the higher concentrations found in those offshore depositional zones – primarily the Mississauga (animation) and Rochester (animation) Basins.

Looking at the 2004-05 suspended sediment concentrations for (animation) Dieldrin in the Niagara River, both Fort Erie and Niagara On The Lake are in the 1.5 ng/g range...which would put them in the first class (animation) – again, basically the same as the majority of Lake Ontario samples.



Unfortunately, the sample distribution for Benzo(a)pyrene – a compound we find almost exclusively in the particulate phase of our Niagara River samples - is not quite as dense as they were for Dieldrin; however, I think that you can still see the tendency toward higher concentrations in the off-shore depositional areas...(animation) the Mississauga Basin, (animation) The Rochester Basin, and, in particular, (animation) the Niagara Basin.

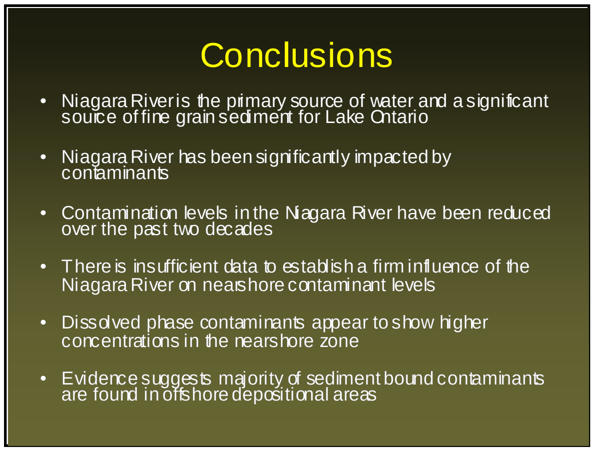
If we overlay the Niagara River concentrations (animation) we see that familiar increased concentration downstream at Niagara On The Lake and, (slide)



when classified using the same “effects level” scheme applied to the bottom sediments, Fort Erie falls below the Lowest Effect Level and Niagara On The Lake a little higher but still below the Probable effect level.

So, I hope that gives you SOME indication of the potential influence and, perhaps more importantly, of the complexities involved in examining this issue.

What I would like to do now is just summarize things with a few conclusions.



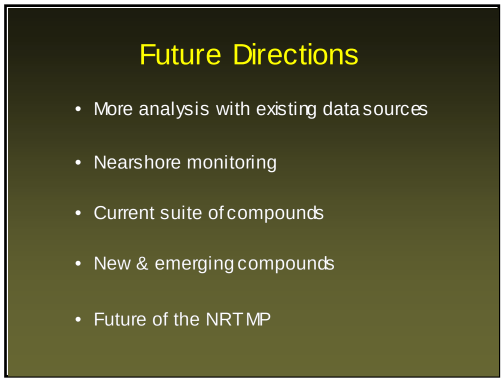
Again, the Niagara River is THE primary source of water and a significant source of sediment for Lake Ontario

Unfortunately, much of this source has been tainted by contaminants which have impacted the Niagara River for decades

In addition, while remediation efforts have resulted in a significant reduction in contamination levels, it appears that the downward trends for many compounds are now leveling off.

At this time, there is a lack of scientific evidence that makes it difficult to establish a firm understanding of the influence of the Niagara River on NEARSHORE contaminants in Lake Ontario; however...

Having said that, what evidence we DO have seems to suggest that some dissolved phase contaminants may exhibit higher concentrations in the nearshore zone while the higher concentrations of sediment bound contaminants tend to be found in offshore depositional areas.



So where does that leave us?

Well, if we really want to determine the influence of the Niagara River on nearshore contaminants in Lake Ontario...we can start by taking a closer look at the existing data - as you have seen, a twenty minute presentation has barely allowed me to scratch the surface

BUT we must bear in mind that the primary data sources I've been talking about today were not developed with this type of question in mind; therefore, a more specific “nearshore contaminant” program would be required to address this issue.

In the meantime, the current Niagara River Monitoring programs are at a bit of a crossroads themselves.

With many of the compounds undergoing such a significant reduction over the past 20 years, the question has been raised as to whether or not we need to continue monitoring these compounds as intensely as we do now and, for some, whether we need to monitor them at all.

At the same time, there are a growing number of so called “new and emerging compounds” that beg the question “should these compounds be added to our current suite”?

These are the kinds of questions that the Niagara River Secretariat is considering. In fact, they have been asked to prepare an “options paper” with recommendations on the future of the NRTMP.

If you would like to hear more about this paper and provide some input to the Secretariat, we ask that you join us in the Niagara River breakout session this afternoon.

On that note, I would like to thank you for your attention.

And, before I finish, I just want to quickly acknowledge the fantastic organizations and individuals who not only helped me put this presentation together but, more importantly, who ensure that water quality monitoring on the Niagara River is as scientifically sound, effective, efficient, and meaningful as possible.

Thank you very much.