Harmful Algal Blooms Transcript

[Lisa Matthews passes speaker role to Joe Williams]

Speaker Joe Williams: Thank you Lisa. This is Joe Williams as Lisa said, I am the Deputy National Program Director for the Safe and Sustainable Waters Resources Research Program. The National Program Director for the program is Suzanne VanDunnrick, and she's apologized for not being able to be available today. I'll only be available for a few minutes and then I'm going back into another meeting. But I wanted to welcome you to the webinar today, and just give you a little background. Basically the Safe and Sustainable Waters Resource Research program is essentially divided into 4 topical areas of research, meaning watershed sustainability, nutrients, green infrastructure, and water systems which covers our drinking water, waste water and water reuse areas of research. As you might suspect, HABs or Harmful Algal Blooms work – it touches on all 4 of these areas. But for today though, with what Dr. Tom Speth will be speaking to and Hannah Holsinger will also be speaking to is related to more of a drinking water treatment aspect and the management of cyanotoxins coming through those systems. With that, I'm not going to take a lot of time here, simply because I know you joined the webinar to hear from Tom and Hannah, so I'll say again welcome to the webinar and at this point I think I'm turning it over to Tom.

Speaker Tom Speth: Ok thank you very much Joe, so welcome to the webinar. I'll be giving a very brief – about 15 minutes or so – of a bit of a background discussion and on some of our drinking water research that we are doing then I'll be handing it over to Hannah to give the second talk.

So here's a little bit of a background. HABs we know are a very complex issue. We know that nitrogen and phosphorous levels can cause harmful algal blooms. We know that different algal and cyanobacteria strains bloom under different conditions, at different times, and have spatial variability both horizontal and vertical. We know that strains produce different toxins at varying amounts at different times during a bloom. We know that our analytical methods tell us different pictures of what's going on. With regards to that the toxins can be intracellular, within the cell, or extracellular, outside dissolved in the water column. With all that, the topic of my brief talk today will be about drinking water treatment and how it's a balancing game between processes. The figure on the right is from one of our inland water projects at Harsha Lake in southwest Ohio. It's just there to remind me that there are a whole other aspects of Safe and Sustainable Water Research (SSWR) projects, as Joe alluded to. This figure shows that in agricultural areas, a lot of the nutrients can come from agricultural practices. The SSWR Program has a wide range of activities such as these nutrient kind of issues, looking at nutrient trading programs, blooming dynamics, online sensors, remote sensing, analytics with regards to toxins and also health effects of the toxins. My talk and Hannah's talk will be a brief subset of what's going on in SSWR.

So the next slide shows just a listing of the subset of the cyanobacterial strains across the top, and a number of toxins, non-inclusive of all the toxins, coming down here on the left. Different strains produce different toxins – some just one, some multiples. It's a very complex matrix of things. We know that our analytics, the 544 method for Microcystin and Nodularin and the 545 that EPA's put out for anatoxin-

a(S) and Cylindrospermopsin only measure a subset of all toxins that are produced by all the various strains. It is indeed a very complex issue.

Here is a slide, a little bit of the spatial aspects from Marsanco – they put together some Data and EPA was involved in running some analytics for the bloom event in 2015. Here the analytics along the river, and you can see the red are the very high concentrations, the blue are the low. You can see it's not a uniformed coding or uniformed degree of bloom along the river. There are some hot spots but it's not clustered in one particular area. Over the large spatial dimensions there is not a consistency. In fact the concentrations vary by four orders of magnitude during the bloom event.

Here is a picture of a river is a straight segment it's even more pronounced when there's a bend in the river. But even by the meter by meter spatial scale, you can see the cyano-blooms being very inconsistent and not a blanket type covering over the water. Both horizontally and vertically you can get a different cyanobacterial concentration if you measure during a bloom event, so that's always a concern.

On the next slide, we have a bit going toward Lake Erie. I was asked to talk a little about Lake Erie and some Toledo work that we've been doing. Lake Erie is a lake that if you're looking at it in terms of modeling, it's really 3 lakes for modeling purposes – a deep end on the east side, kind of a moderately deep section in the middle and a very shallow western basin. The western basin is usually what we pay attention to because it is very shallow, it can be warm, water can be churned up, nutrients can be churned up and there is a high nutrient loading into the western side of Lake Erie, so that's where we concentrate at. This is a NOAA slides.

As is this [it is a NOAA slide] with NASA. This is the bloom event back in 2014 when Toledo had all its problems. So Toledo's here, right at the western side of Lake Erie, and you can see the bloom. Even though Toledo's intake is 3 miles into the Lake, the bloom caught it quite unfortunately heavily. You can see the bloom just on the western side of the Lake. If we fast forward to 2015, we're measuring in the Toledo in the summer of 2015. We didn't see much because the bloom was somewhere else on Lake Erie in 2015. Not only spatial large dimensions, short small dimensions, but temporally the blooms change day to day and year to year. So you never know what quite to expect.

This is a slide documenting even before the Toledo episode, EPA was doing projects on Lake Erie looking at cyanobacterial blooms with numerous water utilities that we've worked very closer with and that have been very helpful to us, including Toledo – a very good research relationship. We've been monitoring toxins through the plants on Lake Erie. Not all plant every year, but whatever we thought we would concentrate on in terms of specializing, in terms of the particular type of treatment or a particular part of the lake. We've been doing this for years and have been active in this area. We've also been doing other lakes, such as inland lakes, we've been working on the Ohio River, as I've mentioned. We've been looking at a number of reservoirs and such in Region 8 and will continue to do that work out into the future. But with regard to Lake Erie we've been concentrating on some of these oxidants that can be added to the lake [such as] permanganate and ozone also with powder activated carbon trials. We're scheduled to put in a pilot system into Toledo with multiple trains so we can look at changing treatment during a bloom event and what it might help with, but I have to say it's been delayed a little bit. We hope to get it in by this summer but frankly the efforts in Flint, MI have been delaying just the amount of time we've had to put this system in. So we're hoping to get this in this summer.

Just a short thing about analytical methods, and how it impacts things. It tells you different pictures so the ELISA-based techniques are broad-based techniques. It can measure anything that has this functional group on the molecule so it will measure everything with that functional group, which is 80+ toxins for Microcystins. It's a group type of analyses in measuring the congeners or variants of toxins. If you do a free-thaw method, you can get at both what's internal to the cell and what's external to the cell. They're relatively easy, inexpensive and quick for the ELISA technique.

The LC-MS/MS technique, that's what we would use if we're interested in looking at a particular congener or variant. Right now the research methods can give you about 13 or so variants fairly easily. Again with the freeze-thaw technique we can look at internal and external levels. However, with the LC-MS/MS technique, they require a certain amount of expertize and analytical [noise interruption] but anyways, we've got the EPA method for the LC-MS/MS [noise interruption] I believe I'm back on line, but I'll keep going. The ELISA technique, we are continuing working on those so the OW (Office of Water) has been working up the UCMR method for the ELISA technique on Microcystin and Cylindrospermopsin for use in UCMR. It's not an EPA method per say, but it will be rigorous enough for the UCMR purposes. We are also working on an ambient method. We have a drinking water method for UCMR for I believe 6 Microcystins and Nodularin, and we will be working that up for the ambient waters in the future. The ELISA techniques – just a short thing – the state of Ohio has done a very good job at clearing up a lot of the procedural things for the ELISA techniques to avoid some of the confusing issues that happened during the Toledo episode of sorting out the data. So if you've interested in looking at their techniques for making sure that the ELISA technique doesn't give you some false artefactual readings, that would be another source to go to.

In the next slide, it's a little bit now getting into treatment. So the toxin as I mentioned can be in the particulates, which the solids removal processes can remove fairly effectively, or they can be in the water column dissolved. However, solids removal processes wouldn't be effectively at all there, you have to rely on either one of two things. One is an oxidant like either permanganate or chlorine or ozone to degrade the disinfectant, but they may not be effective enough so I'll get into a little bit of that. Or go into an absorption technology such as GAC or powder, which is granular activated carbon in a filter, or PAC in your conventional treatment process can be effective to absorb the toxin.

Ok so this is a treatment plant typical of what's up in Lake Erie, very typical of the Toledo plant. So I hope you can see my arrow on the upper left here, and that's the intake. I believe that's a picture from the HABs episode in 2014. The intake as I mentioned is 3 miles off-shore, and this is where they add permanganate. So it moves along to the low service pumping station where powder activated carbon can be added. It goes through rapid mix flocculation and sedimentation where you get a fair bit of particulate removal. This is where all along, this way the permanganate can break up the toxin, the PAC can absorb it and there's a little bit of a trade-off between PAC and permanganate in terms of conflicting interaction between the two, which is problematic but doable. The sedimentation will remove the particulate toxin. It goes through the filters, which removes more particulates in cells. So everything after filtration that's within the cell has been removed generally. Then a plant will add chlorine, and that can help break down the rest of the toxin if you don't have any additional advanced technologies than these.

A little bit of data, since we don't have a lot of time – and I'm sorry because when we moved the slides with this layout, I lost a little bit of the x-axis but I'll explain it to you – so here we've got the raw water here. In this episode, and this isn't Toledo but another plant in Ohio in August of 2014, coming in you've got about 8 milligrams per liter and it's all within the cell, so extracellular toxin is zero. Hit it with permanganate, and it comes down to the next sampling stop where [it's] post-permanganate. The permanganate takes out a fair bit of the toxin, but it's also breaking up the cell. So it first breaks up the cell, releases the toxin and then degrades its. The problem in this case is [that] you're increasing the extracellular toxin or the toxin that's in the dissolved state, you're increasing it and that's more difficult to remove. So you add PAC to it and you get a decline through absorption of the toxin through the extracellular toxin but not all of it. Then go through sedimentation, so here's where you see a lot of removal of toxin because a lot of it's still in the cell, and that's all removed and you get PAC absorbing the toxin and any residue permanganate that may be out there that's also degrading the toxin. You get a fairly low level of toxin post-sedimentation, it goes through filtration and you hit it with chlorine, and in this case it's zero at the end. So that's a good result; however, you can see that if perhaps you didn't add permanganate, you could take things out in sedimentation and filtration and not have to worry about releasing the toxin into extracellular form.

So that's kind of the take home message of this topic. So as we're going through this plant as I've shown you before, if you've got permanganate early on then one of the things is if you have a bloom – and this is research that EPA is doing is these trade-offs between what type of treatment do you have at your facility and if you have a bloom what is it in? Is it in extracellular form or intracellular form, and that would help dictate - if you know that – can we develop tools that can help dictate what you should do during a bloom event. During the Toledo event as I mentioned, there were some issues of resolving what was happening in the plant, largely because of analyses issues but once that was resolved pretty quickly we knew the plant was coming around. With adding in additional PAC and chlorine, we got it under control, or the plant got it under control rather, so there was no need to take off permanganate, although it might have been helpful.

One of the issues too during a bloom event that plays into it too, is that if the intake is 3 miles off-shore, in Toledo if they're running at about one hundred million gallons a day – it's 2 hours before the water gets to the low service pump station – it takes a long time - then about another 4 or 5 hours to get to the water to plant and then another 5 hours to get through the plant then 17 hours through the clearwell. So it takes over a day for water to wash through the plant, so whenever you take off permanganate it will be over a day before you see the total results after the clearwell. I have to say that working with the state of Ohio during the Toledo event was a very professional and wonderful experience because the state of Ohio's Mike Breaker's drinking water group I have to say is outstanding. They sent Heather Raymond down to our facility to work with us going over the data and looking at the analytical results, the group was fantastic to work with and very professional. I have talked to them and Ohio EPA's Director Craig Butler was great during the whole episode too. I couldn't work with a better group of people, top shelf all along I have to say. It was a difficult experience, but the people were outstanding.

Final slide on treatment [is] modeling permanganate. This is what we're doing, so we're looking at permanganate issues. We can use an approach like microbial inactivation using concentration multiplied by time to give a modeling of what kind of removal you would expect. So concentration of the disinfectant multiplied by time of exposure to the toxin, and you can develop a model and this can be

used for predictive purposes. So we're doing that at EPA, trying to develop tools for utilities and states to use as I've mentioned before for if there's a bloom event then how do you work these trade-offs between permanganate, PACs and conventional treatment. We're doing this with different waters and at different pHs so that we can translate this to other facilities.

Finally in conclusion, I'll quickly wrap this up - if the bulk of the toxin remains in the cell, particulate control can be very effective. Common doses of oxidants like permanganate and ozone can be sufficiently high to damage cells and release the toxins, yet potentially too low to completely degrade the released toxins, which can be difficult to remove, and so the optimal removal of the oxidants and PAC regarding their points of application and dose needs to be evaluated for a given plant and bloom event, so that's where EPA is working to understand this better for all waters so that we can give tools to utilities and states that can understand and predict this treatment performance.

So with that I just want to do a quick call out in a couple of weeks, Nick Dugan who is the head of SSWR or EPA's algal toxin research in ORD will be giving a talk along with Heather Raymond from Ohio EPA. Getting into a little bit more details - so in a couple weeks stay tuned for that. If you google EPA Small Systems webinar, you can get the details on that. With that webinar series, we do offer continuing education contact hours for people who need it for their licenses and such. So with that I'll hand it over to Hannah.

Speaker Hannah Holsinger: Thanks Tom. I hope everyone can hear me. I'm going to be giving an overview of some of EPA's activities to support public water systems as they manage the risks from cyanotoxins in drinking water.

A brief overview of the presentation. I'll give a brief overview of some of our past activities moving on to a document we put out last summer titled *Recommendations for Public Water Systems to Manage Cyanotoxins in Drinking Water.* Then I'll give a brief overview of H.R. 212 and the Drinking Water Protection Act that lead us to develop our Strategic Plan for helping systems manage these risk, and then I'll move on to a quick discussion on some of our ongoing activities.

Some of EPA's activities with cyanotoxins in the past, we've included algal toxins on the Safe Drinking Water Act's Contaminant Candidate Lists (CCLs) all previous ones including draft CCL 4, and this is a list we put out every 5 years of contaminants we're concerned about. EPA detected microcystins in the 2007 National Lakes Assessment (NLA), where 30% of lakes had microcystin detects. Over 1% had detections were above 1 µg/L at the time when we looked at this that was above the world health organization level. As Tom mentioned we've been working to develop analytical methods, the 544 and 545. We recently a few weeks ago held a public meeting to obtain feedback on cyanotoxin management as well as any lessons learned that we have gained since the last algal season as we move forward into this season. We've included some information for public water systems on cyanotoxins, including a Fact Sheet that's available on the website, on the CyanoHABs website that Leslie D'Anglada and [another contact] maintains so there's a lot of great information on that. I'll have a link to that on my last slide.

Last summer in June we released Drinking Water Health Advisories (HA) for 2 cyanotoxins including microcystins, which current data suggest that the liver is the target organ of toxicity. It is an acute and sub-chronic toxicity that confirm the liver, kidney and testes as target organs. Again, the main endpoint for the health advisory focus is the liver. Currently, there is not enough information available in the literature to assess the carcinogenic potential. For cylindrospermopsin, the main target for this – the data suggests liver and kidney as the target organs. For this one, the kidney is primarily affected. Again, like microcystin, there is limited information regarding the carcinogenic potential.

The exposure pathway of these health advisories was oral ingestion through drinking water, and the 2 exposed life stage that were evaluated were children and adults. As you can see here in the table, there are 2 levels for each microcystin and cylindrospermopsin. Also, at the time the health effects support documents were released that contain information on these health effects. A third one was released on cyanotoxin A at the time it was determined that there was not sufficient information to release health advisor value for that, but there is a health effects support documents for cyanotoxin A. Just to note, these Health Advisories are non-enforceable and are intended to provide technical guidance to states and other officials as they determine how to best move forward with their systems and what they find in their levels of water. As well as information in the health advisories contain treatment technologies information as well as analytical methods.

Alongside of the Health Advisors we released a support document to help systems decide what to do with these health advisory levels. This document is intended to help utilities and public water systems manage their risks from cyanotoxins, so we need to recognize that the most appropriate course of action is really going to vary on a case by case basis as these source waters and system capabilities will vary based on each system.

This slide here shows an overview of where the document is going to go. My next few slides will give a little more detail between each of these step. To go through these quickly, the first step is if your surface water vulnerable to cyanobacteria and harmful algal blooms, if it is how do you prepare and how do you look for these blooms. If you're seeing blooms, move on to steps 3 through 5, start monitoring if you think you have cyanotoxins in your source water, moving on to monitoring in your finished water. If you find cyanotoxin in your finished continue to move on to additional finished water samples.

In step 1 the key objective is to determine if source water is vulnerable to harmful algal blooms and cyanotoxin contamination. The information that systems can use to determine if they're vulnerable, can be based on a variety of sources of information: has the source had previous blooms, have they had previous cyanotoxin occurrences; look at water quality parameters such as water temperature, pH, depth; source water assessment information this was required under the 1996 Safe Water Drinking Act and this is a great resource, some systems have updated this some have not, but this contains some great information about the source. Climate and weather information [such as] what have the recent rainfall patterns looked like, has there been a lot of recent rainfall that would lead to recent run-off. Land use, what's the land use in the watershed surrounding the source water as well as what are the nutrient levels and the nutrient loadings into the source water.

If you've determined that the system is vulnerable to Harmful Algal Blooms, move on to preparation and observation. So this is sort of a two part step. If you do believe that your system is vulnerable, you're going to want to prepare what to do if there is a bloom. This can involve determining if there are certain seasons your systems are more vulnerable, and if your source is vulnerable is your current treatment in

your plant sufficient to remove the levels of cyanotoxins you might expect to have. If you don't think your system is sufficient, consider any supplemental treatment such as powder activated carbon. Or if your system is consistently challenged by blooms, consider any long-term treatment enhancements such as GAS.

Other parts of preparation, you want to prepare for any monitoring or sampling that you may need to do. This can involve setting up contracts with outside labs if you don't have a lab or if your lab is not sufficient, or if you do have a lab order some of these monitoring or sampling tests. As well as you will want to set up communications with primary agencies, state and local public health officials, so if there is a cyanotoxin event in your drinking water, you already have these communication channels open. Another key part to point out as far as communication is that I think it's beneficial is that it's important to establish partnerships with other users of the source water who may have sampling information [and] who may already in which the system would not have to repeat that monitoring, really make those key connections. As well if there are other drinking water utilities pulling off the same source, they may have information that can be shared.

We've identified 3 potential ways to observe for blooms. The first of which is visual, do you see a bloom in your source water if you have a large source water, is the bloom near your intake? Look and evaluate system effects, we recognize not all blooms are visual some of these may move throughout the water column or they might just not be visible. So if there are any changes in the treatment, such as is there a shortened filter run-time, increased chlorine demand, as well as look at indicators in your source, chlorophyll A, cycocyananin, [and] have there been recent spikes in nutrient levels. These are things that can be looked at holistically to identify whether or not there are things going on with your source water.

So steps 3 through 5 the key objectives, are monitoring treatment and communication. If your finding think you have a bloom [then] move on to monitor the source water. If you find cyanotoxins in your source water, move on to monitoring in the finished water. Again these steps, how these steps will want to continue will vary based on each public water system. Some may move straight to monitoring finished water if they think they have a problem, especially if they know this is a problem they may have. So some of key objectives are determined, have cyanotoxins broken through to your finished water, is your treatment sufficient to remove this, if not are there treatment steps that you can begin as soon as you think you have a bloom or might have a cyanotoxin problem [then] go ahead and begin these treatment adjustments – not wanting to wait until the very end. Then move on to any communications you may want to have with public to help them reduce their risk.

This image I won't go into too much detail. This is just an example of something that can be used for step 5 when cyanotoxins are found in the finished water, based on the different levels found in the water, recognizing that there are the two levels, the child and adult level. There are communications, treatment actions and monitoring within this stop light approach. This is all detailed in our recommendations document, which is posted on the cyanoHABs website.

Now I'll move on to discuss H.R. 212. In August 2015, President Obama signed H.R. 212 the Drinking Water Protection Act into law. This directed EPA to develop and submit a strategic plan for assessing and managing risks associated with algal toxins in drinking water provided by public water systems. We developed this plan with input from various offices at EPA, including the regional offices. We worked with our Federal Partners as part of the Interagency Working Group, and this Working Group was established by the Harmful Algal Bloom and Hypoxia Research and Control Act Amendments of 2014.

We also obtained input through stakeholders and the public, we held a listening session webinars, which the attendees included states, utilities, industry representatives and environmental organizations as well as the general public, and we obtained input on things that we could include in our strategic plan. We submitted this strategic plan to Congress in November 2015.

Our strategic plan that we developed included steps and timelines to assess human health effects, as well as including, evaluating and summarizing all the risks to human health from cyanotoxins in drinking water. We also included steps and timeline to create a list of algal toxins, and maintain this list of toxins that may occur in public water systems that may have adverse human health effects, as well as to publish health advisors on those listed if we determine there is sufficient information. We also included steps and timelines to provide treatment options as well as looking at treatment and monitoring guidance.

We also included steps and timelines for summarizing the causes of the HABs as well as those factors that will cause these blooms to grow, for these cyanotoxins to bloom up into harmful algal blooms, as well as what is causing these bacteria to produce the toxins and release these toxins. We also included steps to evaluate and recommend feasible source water protection practices and activities as well as trying to put recommendations that we included in the support document we released last summer to help public water systems engage in source water protection, as this is going to be very important to help prevent these HABs from happening in the first place. We also included in the strategic plan, ways of strengthening collaboration and outreach as well as looking into cooperative agreements and technical assistance that we could provide to states and utilities. We also included in the strategic plan some information gaps, especially regarding those items that I listed bulleted in the previous slides on some of the information that would be helpful for us to know regarding those different activities. We also included all of the activities the other Federal Agencies are working on regarding cyanotoxins and human health.

Some of our ongoing activities that we have ongoing right now, we are working on developing cyanotoxin management plan templates. These are meant to help utilities nationwide, and we are developing templates using 5 utilities, and we are helping them develop their own management plans based on the recommendations that we put out last summer so that we in turn can use these plans as examples, as templates to provide real-world settings of what real-world utilities are doing to help manage their risks. These utilities represent a variety of sizes, a variety of sources, a variety of treatment trains so that we could really take the recommendations we put out last summer to really try to see exactly how they could be used, and how they could be tweaked to each individual utility. We hope to have these out by 2016. We also included cyanotoxin monitoring on the proposed UCMR 4 list, and this is the unregulated contaminant monitoring rule. That proposed list is out now. We have also been partaking in regional workshops. So far we've had 3 regional workshops, and EPA has 10 regions. These are on source water focused as well as clean water act and drinking water act to help look at this problem holistically and not from just a drinking water but as a clean water issue. As I've mentioned we had a public meeting to obtain feedback on other activities that we could do to help support the public and utilities, and we've heard what was said at this public meeting as well as past public meetings so we are currently looking into any risk communication tool that we could help develop as we recognize that these health advisors and cyanotoxins can be very complicated to explain to the public for these utilities as well as for the states. We hope to continue to support the states and utilities in their cyanotoxin management efforts as we move forward.

Here are the contacts. I also put contacts for Lesley D'Anglada so if there are any specific questions regarding the health advisory you can email her or you could also email me and I can send it her way. I also have Katie Foreman, she is leading the effort on the H.R. 212 Strategy Implementation. Again, here is the link for the CyanoHABs website. This is an amazing resource, this website has a plethora of information that will be really useful. I'll put another plug for the CyanoHABs website.

That is all I have, so thank you.