

**2014 Green Infrastructure Webcast Series -
O&M and Green: Best Practices for Green Infrastructure Operations and Maintenance
January 7, 2014**

Speakers:

- **Karen Sands:** Milwaukee Metropolitan Sewerage District (MMSD)
- **Bill Hunt:** Professor and Extension Specialist, NC State University
- **Eva Birk:** ORISE fellow, EPA's Green Infrastructure Program

Transcript:

Slide: 2014 Green Infrastructure Webcast Series - O&M and Green: Best Practices for Green Infrastructure Operations and Maintenance

Eva Birk

Good afternoon and welcome to today's webcast titled, "O&M and Green: Best Practices for Green Infrastructure Operations and Maintenance". This webcast is sponsored by EPA's Office of Wastewater Management. My name is Eva Birk and I'm an ORISE fellow with EPA's Green Infrastructure Program. I will be moderating today's webcast along with my colleague Emily Ashton. Thank you for joining us today.

Slide: Logistics

Before we get to our presentations, I'd like to go over a few housekeeping items.

First, we'll have a question and answer session at the end of today's presentations. To ask a question, simply type your question in the questions box on your control panel and click the send button. If your control panel is not showing, click on the small orange box with the white arrow to expand it. You don't need to wait until the Q&A period to submit your question. There are a large number of participants today, so we highly encourage you to submit your questions early. We will try to answer as many questions as possible at the end of the webcast, however due to the high number of participants, not all questions will be answered. Please feel free to contact the speakers after the webcast. Speaker contact information will be available at the end of this presentation.

If you have technical issues, such as audio problems, please click on the questions box to the right side of your screen, type in your issue and press the send button—we'll do our best to troubleshoot. You can also call the GoToWebinar support number listed on the screen here, and give the assistant our conference ID number, also listed on the screen here.

Lastly, we'd like to remind you that the views and materials presented by our speakers today are their *own*, and do not necessarily reflect those of the EPA.

Slide: Webcast Agenda

What are we going to be covering today? Today we're covering Operations and Maintenance 101. Many practitioners are well aware that sound operations and maintenance, or O&M, is

central to ensuring the long-term success of any green infrastructure investment. Maintenance concerns often center around preserving the hydrologic and water quality functions of green infrastructure over time. However, administrative and social considerations also play a large role. Questions arise such as, “Who will maintain green infrastructure on private property? How can one ensure green infrastructure practices remain functional through the transfer of property from one owner to another?” Or, “How do I know when I’ve reached economies of scale in maintenance and operations costs?” This webcast will provide some valuable perspectives on these issues, as well as a general overview of best practices to consider when creating a green infrastructure Operations and Maintenance Plan. Karen Sands, our first speaker will start with the story of Milwaukee Metropolitan Sewerage District’s evolving approach to maintaining green infrastructure investments. Dr. Bill Hunt will continue with a presentation on basic strategies to maintain green infrastructure performance over time, a bit of O&M 101.

So now I’d like to kick-off today’s webcast by introducing our first speaker, Karen Sands, who will be talking about the Milwaukee Metropolitan Sewerage District’s (MMSD) evolving approach to maintaining green infrastructure investments. Karen Sands is the Manager of Sustainability for the Milwaukee Metropolitan Sewerage District (MMSD). MMSD is a regional agency covering 28 municipalities in southeastern Wisconsin. MMSD is well known as a national leader in green infrastructure implementation. In support of MMSD’s mission, Karen’s sustainability responsibilities encompass green infrastructure, energy planning for conservation and renewables, and climate resiliency. Karen is certified by the American Institute of Certified Planners, and has a certificate in public participation from the International Association for Public Participation. With almost 25 years of planning experience, Karen has held a number of positions in both the public and private sectors.

Now I’ll turn it over to Karen.

Slide: Maintaining the Rain (in Milwaukee) that Stays Mainly on the Plain

Karen Sands

Thank you, and greetings from the frozen plains of Milwaukee. If only it were warm enough to rain today.

Slide: Agenda

In my short talk, I’d like to share with you some background about the Milwaukee Metropolitan Sewerage District (or MMSD) where I work. Then, I’d like to talk to you about our green infrastructure programs. And finally, I’d like to share with you MMSD’s evolving or crescendo’ing approach to O&M for green infrastructure. I say “crescendo’ing” because we, like many others, learn from our mistakes. And, about mistakes, we’ve made a few. For instance, this is a picture of our parking lot several years ago soon after it received a green infrastructure retrofit. The wetlands in the background were planted with native prairie plugs, and the area soon filled in nicely with tall grasses and flowers. Great story, but we didn’t communicate our maintenance needs to the grounds crew who was responsible for mowing the adjacent grass...nor did we think to convey the information in their primary language, which was Spanish. As a result, the entire wetland area was mowed in August after we planted it! You can imagine my dismay when I looked out the lunchroom window and saw the mowing

just finishing up. Of course it all grew back next year, but the experience served as a good lesson that maintenance not only needs to be considered, but also communicated.

Slide: Milwaukee Metropolitan Sewerage District

So, first a little about MMSD. MMSD is a regional agency established by Wisconsin state law. We provide water reclamation and flood management services across 28 municipalities in southeastern Wisconsin. Our planning area is 411 square miles shown here; our eastern boundary is Lake Michigan; our western boundary is generally the sub-continental divide separating us from the Mississippi. Within our planning area, we own about 300 miles of regional sewer pipes called the Metropolitan Interceptor Sewer system or MIS system. Altogether, our 28 municipalities own about 10 times that length, or 3,000 miles of sewer, that connect to the MIS system. Private property owners own another 3,000 miles of pipes called private sewer laterals.

About 6% of our area is a combined wastewater/stormwater system. This is the area in rust-colored diagonal lines shown on the map. The majority of our area has separate wastewater and stormwater systems.

At the downstream end, we own two water reclamation facilities. On a normal dry day, each facility recycles about 75 million gallons of flow or less back to Lake Michigan. On a wet day, each facility can recycle more than 300 million gallons per day.

Slide: Green Infrastructure

We have a number of programs that relate to our water reclamation and out-of-bank flooding responsibilities that we consider “green infrastructure.”

At MMSD, we know that public education is important to scaling up green infrastructure to the scales I’m going to talk to you about in a little bit. Our every drop counts campaign, it runs in the background of our operations and includes really specific actions that people can take when it rains. The idea being that we are all in this together and collectively we can make a real difference. We also have a one stop stopping website dedicated to green infrastructure at www.h2o, and that is the letter O not the number, capture.com.

Besides public education, we have a number of implementation programs that focus on funding. These are the highlights starting with Greenseams and I will talk more about the Greenseams program on a future slide, but just in general, the idea behind that is to protect vast expanses of land in the upstream ends of our watersheds in order to protect our downstream flood management investments. Our rain garden plant sale provides homeowners and nonprofits with rain garden plants at about half-retail-price, and that’s thanks to a collaboration with the Graham-Martin Foundation. We’ve placed about 18,000 rain barrels in the region; barrels that are retrofitted food-grade barrels by the Milwaukee Community Service Corps that otherwise would have ended up in a landfill. And the rain barrel program alone has added over 1 million gallons of new capacity to the system in total. We’ve provided partnership funding for relatively larger green infrastructure projects annually on a competitive basis for nearly 10 years now. We have a green roof program that over the past several years has funded roofs at \$5 a square foot and as a result, we’ve helped to fund over 9 acres of green roofs in the region, including some really cool ones that include things like teaching gardens and restaurants-supported agriculture. We also started a green streets program last year that

competitively awards funding to partners willing to demonstrate public right-of-way practices, and these are just some highlights, but through all this, we've found there is really no magic bullet, but rather there is magic in our funding diversified programs and educating the public that help – so that they can help make green infrastructure more widespread and accepted.

Slide: O&M: Green vs. Grey

So we have significant experience with operating and maintaining big, grey infrastructure that includes our pipes, storage vessels, pumping stations, plants, all that. And that's important. That's the backbone of our system really. We work on that closely with our private operator, Veolia Water North America. And the majority of our operations & maintenance budget is targeted towards those operations, primarily operating our water reclamation facilities and controlling point and non-point sources of pollution. Green infrastructure is only a small part of this budget. We take pride in our high standard of performance in protecting water resources at levels that go well beyond our discharge permit requirements.

Slide: GI Maintenance Expert

We are not, unfortunately, experts on green infrastructure maintenance, and we, like many of you, are learning as we go. So rather than me telling you how to do this right, because we're in the process of figuring that out, and I think we're on the right path to doing that, I'm going to tell you a story, and it's the story of how we've evolved in the past and how we continue to evolve an approach to green infrastructure O&M at MMSD.

Slide: Our Interest in Green Infrastructure

Why are we even interested in green infrastructure, building it and maintaining it? Well, we're committed to meeting our water pollution control responsibilities. We don't specifically have jurisdiction for stormwater management; that's actually a municipal responsibility, not an MMSD responsibility. In seeking its lowest point of discharge, though, we know that stormwater, thanks to gravity, most often drains to the MMSD system or to watercourses that are under our jurisdiction. Because we receive it, we ultimately feel that we need to deal with it. We're committed to meeting conditions of our discharge permit and to reducing pollution loads to area rivers to the maximum extent we can. So, adding green infrastructure capacity, and maintaining it, makes sense to us, even if it's disconnected from our end of the collection system, that's only the downstream end. We're interested not only in catalyzing widespread implementation, but also in making sure it continues to function as it's intended. The whole O&M thing is really important to us because it really needs to work.

Slide: MMSD's Regional Green Infrastructure Plan

To scale up what we do with green infrastructure, we worked with a consultant team last year led by CH2MHILL and Mark Mittag to develop a regional green infrastructure plan. The plan helps us implement what we call our 2035 Vision and that vision includes zero basement backups and zero overflows to area waterways. Something virtually unheard of for a municipality – for a metro area of our size. That vision directs us collect the equivalent of ½-inch of stormwater across the region's impervious cover, or really 740 million gallons every time it rains. That's more than our tunnel system. And it's a really big, audacious goal that's sanctioned by our MMSD Commission and our executive director, Kevin Shafer. As you can

imagine, staff is having a lot of fun with it right now. It's really great to have a stretch goal and we are going to make it at some point.

So the plan also helps us prioritize how we fund green infrastructure, it provides input to our next round of facilities planning set to kick off this year, and it helps us meet our permit. As of last year, we became the recipient of the very first discharge permit in the county that requires green infrastructure. And that's without a consent decree.

Slide: MMSD's Green Infrastructure Program Structure

So we have an MMSD Commission policy that identifies 10 strategies we formally recommend and fund and call green infrastructure. They include storage like rain barrels and cisterns, methods that infiltrate and evapotranspire like stormwater trees and native vegetation, and methods that mimic nature but are really man-made, like porous pavement.

Besides our formal Commission policy recognizing these 10 strategies, we also have a 12-year-old program called "Greenseams." Greenseams is an innovative flood management program that permanently protects properties in the upstream ends of our watersheds with water-absorbing soils or hydrosols. By storing and draining water into the ground naturally, Greenseams helps prevent future flooding while supporting and protecting our structural flood management projects, infrastructure investments worth hundreds of millions of dollars as we seek to contain the 100-year flood or the 1% probability flood as well as provide concrete removal and habitat benefits.

So for Greenseams, we hired The Conservation Fund, a national non-profit organization, to run Greenseams. All land that we acquire through the program remains undeveloped forever, protecting water quality and providing the ability to store rain and melting snow. To date, we've protected over 2,600 acres through this program. So we think it's pretty successful.

And, finally, this summer we began defining green infrastructure to also include soil amendments. Soil amendments are an invisible, but very cost-effective green infrastructure strategy. The idea being there might be certain segments of the population who may never want to make their front yard into native landscaping but we can help them have the most thirsty, sponge-like lawn that acts more like native vegetation lawn. And so through a 4-step process that includes aerating, topdressing, fertilizing and over seeding, we know we can significantly improve how our lawns act, effectively turning them into stormwater sponges.

Slide: Capital vs. O&M Funding

My talk-- the rest of the talk today will focus primarily on the first bullet of green infrastructure activities, those ten strategies I just defined.

Our Commission policy on green infrastructure that I mentioned on the previous slide was passed two years ago and it defines our interest, and I already talked about that, too. It also defines just what we'll fund, and in a revision we may see in 2014 to reflect some bond council advice, it also describes when green infrastructure can be funded in the capital vs. the O&M budget. We are a little unique at MMSD because we do have two budgets; the capital budget is funded primarily by property taxes and the O&M budget is funded primarily by user charges. In short, projects funded under the capital budget tend to be larger and projects funded under the O&M budget tend to be smaller.

Because of the bond council recommendations last year, our capital budget can only be used for green infrastructure when one of three conditions is met to ensure that we have a legally enforceable interest in green infrastructure that we help to fund.

So the first of one of those three conditions is that, MMSD owns the real property where green infrastructure is located and keeps the green infrastructure in place for at least ten years.

Or, the second condition is MMSD obtains a conservation easement from the owner of the real property where the green infrastructure is located, and the conservation easement must satisfy the requirements of a certain Wisconsin state statute and be of a term no shorter than ten years.

Or, the third condition is that where the owner of the real property with green infrastructure is an agency of the State of Wisconsin, we need to obtain a covenant running with the land. And the covenant, like in the first two bullets, must be a term no shorter than ten years.

This capital vs. O&M budget thing is a really important distinction for us and how we convey the need for others to maintain green infrastructure we fund. So in the case of a capital budget funded projects, we have to have this – I'm sorry-- conservation easement.

Slide: MMSD GI O&M Past

So let's look back first. In the initial years of our green infrastructure programs in 2003 or '04, we didn't require any maintenance for projects we funded. It wasn't that we didn't expect projects to be maintained, it's just that we thought early-adopter-type funding recipients would just take good care of their green infrastructure and that we should focus on the funding piece. That faith in our early adopters proved to generally be right, but not always. So, as the years passed, we realized that our compelling operation and maintenance was going to be critical to protecting our investments. Several years into the program, our memorandums of understanding and contracts for funding began to require that a maintenance plan at least be prepared. What we didn't do until last year, however, was formally inspect what we funded.

Slide: MMSD's Green Infrastructure Permit Requirement

That has all changed, though, with the new discharge permit I mentioned. Issued at the beginning of 2013, this permit is a real turning point in our progress with compelling maintenance on green infrastructure that we help to fund.

For each year of the five-year discharge permit term, MMSD is in the unique situation of having to establish 1 million gallons of new green infrastructure storage capacity. We can't use sewer pipes or tunnels to meet this mandate. It has to be green. Buying what we call Greenseams properties can count for up to 75% of that capacity, but the rest must be distributed green infrastructure as we've defined it under MMSD Commission policy.

This slide shows the permit language on maintenance. The first bullet says that we have to ensure that GI that we count for the permit is maintained.

The second bullet says that it not only must be maintained but it must be maintained through the term of the permit.

This is a little tricky because we don't own most of the green infrastructure we'll count, we just fund it. But there are things we can do.

Slide: Capital Projects: Conservation Easement

While we don't typically build and maintain the infrastructure, we do fund others and as a result, we can *compel* them to maintain it through specific agreements. The way we will do this is different for our capital vs. our O&M projects as of last year. For our capital projects, we use a conservation easement. Here's a little explanation of that, and bear with me, but I'm no land use attorney but I talked to one.

A deed restriction is anything that limits the use of land. Deed restrictions, in general, do not favor any particular person or other parcel. An example of a general requirement in a deed restriction is something like: "Owner of Parcel X may not build anything more than 3 stories tall." An easement is one type of deed restriction. An easement favors a particular person or another parcel something like: "Owner of Parcel X must let John Doe cross Parcel X to get to the beach."

A conservation easement is a type of easement where the goal is to protect natural resource values. For green infrastructure projects funded but not owned by the MMSD, conservation easements are preferred because they give us some ownership rights. This ownership is important for capital projects because our statutory authority says we can spend capital money only on things that we own. So the money we raise for the capital budget from property taxes must pay for things that will be part of our sewerage system.

Slide: O&M Projects: Souped Up Maintenance Requirement

Now let's look at O&M projects. These are the relatively smaller projects that don't warrant funding from the capital budget that I showed you back on a previous slide. Maintenance is now listed in two places of our contracts for O&M projects to protect ourselves:

The first area in the O&M contracts is in the reports section where we simply list that the funding recipient must provide us with their maintenance plan before reimbursement can be processed. The second area in the O&M contracts is in the O&M section where we say: "The Partner will maintain the Project for at least ten years. If the Project fails to perform as anticipated or if maintaining the Project is not feasible, then the Partner will provide a report to the District explaining the failure of the Project or why maintenance is not feasible. Failure to maintain the Project will make the Partner ineligible for future District funding until the Partner corrects the maintenance problems."

Slide: Condition Assessment Forms

How do we make sure that funding recipients fulfill their O&M obligations? Well, we will conduct annual assessments. And this is a new thing for us. 2013 was the first year we designed an assessment form and sent interns into the field to establish baseline conditions. We started a database in Excel, but then switched to SharePoint so we could create our own forms with as many fillable or drop-down fields as we needed. Additionally, SharePoint allows us to search based on specific fields, so we can, for instance, easily search on sites that require maintenance. Also, we have the ability to easily export data from the SharePoint site into Excel or other formats as we need it.

There were challenges in determining what to put in the condition assessment forms, with both trial and error both in the office and in the field. The forms will continue to be updated as new field needs arise. And another challenge we encountered was the inability to update the forms in the field at all because of remote access issue but that is something we will work on in 2014.

Other challenges are data gaps, either from very old projects or from 2010 and 2013 projects that are in delay and haven't started. And, still other challenges are with photographs that unfortunately aren't connected to SharePoint.

In the years to come, we'll explore how this can be dovetailed with our actual asset management system. When our condition assessment forms were designed on SharePoint, they were designed to be used with a data-gathering platform similar to Energov, where we're transitioning now with overall asset management.

Slide: Milwaukee-area Municipal Practices

I mentioned earlier that MMSD doesn't currently perform much O&M of green infrastructure unless, of course, it's on our own property. Normally, we help fund green infrastructure and we rely on owners to perform the work. Many of those owners are our own municipalities.

In order to assess the local state-of-the practice, I surveyed our municipal public works directors last March. Of the 28 questioned, I had eight respond for about a 29% response rate. That's not bad, but we probably shouldn't assume this is completely representative – I'm sorry, that's not bad, but we probably shouldn't assume this is completely representative or scientific. Of those responding, two have no green infrastructure and six do. Of those two who do not, both do anticipate owning green infrastructure in the next 5 years, but to date, maintenance and the cost associated with maintenance has been a deterrent to their implementation.

Let's talk about our six municipalities that have green infrastructure and who responded to the survey. Four of them have a formal approach to assessing the conditions of their green infrastructure and one is now working on that now.

Maintenance of municipally owned green infrastructure is performed by a wide variety of parties, and there was really no consistency in the responses I got. In general, some combination of staff, contractors and/or volunteers do the work. In some cases, the contractor has to perform maintenance during the period of establishment while still under contract.

Only one of the six that has green infrastructure said that paying for maintenance is a challenge. About 70% of the municipalities though have stormwater utilities, and those municipalities with utilities really correlated directly with whether they were concerned about maintenance costs or not. Most did say though that in the future maintenance could become a bigger challenge as costs increase and we scale up.

I asked for and received some sage advice from respondents, and two I think are really noteworthy and I should share. One is to keep it simple and not out of sight so that it is maintained. And two, is to discuss maintenance during design right up front.

So what does this survey tell us? Well, I think it tells us that green infrastructure is catching on in our region, and that there's an understanding among our municipalities of the need to maintain it. Maintenance will take at least three things, like a structured program. It will take

ways to keep the cost down, not to mention money, and it'll take people to do the work. In the end, though, it is in our best interest to share what we know about maintenance with our municipalities and to continue to provide a monthly forum for sharing between them, something we do now.

Slide: MMSD O&M Future

What forms might our assistance to municipalities take? Here are three ideas related to the needs I just mentioned.

The first need is a structured program of SOPs and maintenance plans. Some municipalities have these already and those that do might share with those that don't. In our case, 2014 will only be our second year with green infrastructure condition assessments. We will need to develop protocols for things we can't even imagine at this point. For instance, protocols for taking photographs over a number of years. And that is part of the story we are still writing.

The second need is ways to keep the cost down. Finding ways to inexpensively and remotely know when green infrastructure is functioning or when it's not and needs maintenance is another focus of ours. We're collaborating with our private operator, Veolia Water, who is leading a study to help us identify ways to remotely meter and detect green infrastructure performance in different seasons. We think this will be important as we increasingly ramp up green infrastructure and rely on its capacity to manage stormwater. We really need to know that it's working. We're really just at the front end of all this, though, and initial findings from this work with Veolia will take a year or two.

And the third need is people to do the work. MMSD's Procurement & Business Development Manager is spearheading efforts that will advance and evaluate the social and economic benefits to the community, whether it's building rain barrels using a local job training program or using volunteers to build green infrastructure projects in the region's neighborhoods. In this capacity, MMSD's Procurement office will serve as a technical resource to other MMSD departments to more purposely expand neighborhood and community engagement and create high-road employment opportunities with career pathways. We also are looking for connections to training programs and partners, and connections to contractors. They will also measure and track community benefits and impact. This is again really an evolving and new approach that we hope to demonstrate in the years to come, but it will take several years to form.

Slide: Picture

While in much of the world water is scarce, here water scarcity, when it even exists, is generally a temporary thing. In Wisconsin, we are bestowed with 15,000 lakes, 84,000 river miles, and millions of acres of wetlands. There's a huge cultural and economic importance attached to the waters of Wisconsin that translates into extensive tourism and fishing. We drink it, our public health depends on it, and it sustains us. In return, one of the ways that we can sustain it is by implementing and maintaining green infrastructure so we keep water right where it falls in the Milwaukee region. And that's what the smart people I'm fortunate to work and collaborate with are helping me learn to do.

And with that, I'll pass it over to Bill.

Eva Birk

All right, Karen, thank you so much. And just a reminder here, that we will have our question and answer session at the end of both presentations. Thank you again, it was very informative.

And what I will do here is pass the controls over to Dr. Bill Hunt. And before I do a quick introduction for Bill, what I will do is send a poll out to the audience right now. Because what I would like to get a sense for is how many folks are actually viewing it. And we know some folks are alone on their monitors, but there also are several big groups joining us so what I'm doing right now is I'm asking a poll question and what you should be seeing on your screen is a little multiple-choice question.

Slide: Poll Question

So if you could go ahead and fill out that poll, it will take about three minutes here. And then we will turn it back over to Bill.

It's pretty exciting technology, folks. I can see your answers as they come in. So it looks like we have about 80% of folks on their own and then several large groups about of over 20 or more. So thanks to everyone joining us today. And what I will do in about 30 seconds here, we have about 90% of folks voting, so I will turn it over to Bill after quick introduction.

So while you are finishing up the poll, what I will do is introduce Dr. Bill Hunt who will be talking about basic strategies to maintain green infrastructure over time. So Dr. Hunt is the leader of the Stormwater Engineering Research Group in the Biological and Agricultural Engineering Department at NC State University. He is actively involved with best management practices or BMP demonstration, applied research, training and this training includes actually conducting 20-25 workshops and training events a year across the country. So Bill is a busy man. And he's a great presenter. Bill is also an active member of the American Society of Civil Engineers, the American Society of Agricultural and Biological Engineers, and in 2011, Bill was named an Honorary Research Fellow at the University of Auckland in New Zealand. Bill is also currently a CUGE Research Fellow for Singapore National Parks. And I can attest I've heard Bill talk about maintenance once before in a presentation, if there's anyone that can get you excited about how many inches high you should be mowing your green infrastructure practices, or how many days a year you should be street sweeping, it's Dr. Bill Hunt. So with that, I'm going to close the poll and hand it over to Bill.

Slide: Maintaining Green Infrastructure Practices

Bill, I can see your screen. Can you hear us okay?

Bill Hunt

I can hear you great.

Eva Birk

Excellent, so I will hand it over to you.

Bill Hunt

Thank you so very much. I appreciate that wonderful introduction. I've never thought of myself as making people happy regarding how high they can mow their lawn. That's awesome. Okay,

real quickly, a little bit about myself. Let's see if I can -- I apologize, I am trying to get my presentation to move forward. There we are.

Slide: About your Instructor

I have been working at NC State since 1997 and one of the things that I've loved about my job is not only being able to monitor practices, but also to design, construct them and I've highlighted maintenance of stormwater control measures across North Carolina and lots of different types. I will highlight over the course of this talk those that are unique to green infrastructure, specific to green infrastructure. You might see a picture or two of my children. I've got four of them and yeah, they keep me busy.

Slide: What We Saw: Cary Stormwater BMPs (2007)

Okay, in the middle part of the last decade there was, and I'm sure many of you can relate to this, there was a real need to start training people with respect to stormwater control measure maintenance. For example, in Cary North Carolina, which is a suburb of Raleigh, they had over 400 practices and at that time their instructors were telling us that 95% of these practices would fail. And the reason they would fail would be one of three things; they either dealt with sediment, erosion clogging, the fact you had trash, or you had issues with vegetation.

Slide: Enter the... BMP Inspection & Maintenance Certification

So what we did is our response is we went out and we tried to put together all the basic tenants of what you need to know to keep your practices maintained. And we started something called the BMP inspection and maintenance certification in North Carolina.

Slide: Who offers this Certification?

NC State University offers this certification. And what happens is -- we conduct it and then we keep records of people that take it and pass our test, which I'll get to in the little bit, but what we have seen happen across our state is many municipalities and many counties then choose to accept a person that has passed our certification and essentially, in many cases, the cities require people who even do designs to not only BPEs or LAs, but also have passed this maintenance certification because that's how important maintenance is to many communities across our state.

Slide: How Popular is the Certification?

The certification is quite popular. We have been offering, as I said since 2007. And since 2007 we've had more than 2,000 people come to the class and actually pass our test. The test is an important part of the certification process from all over North Carolina. We've also partnered with groups across the United States and the world.

Slide: Success...Across State Borders

You can see here California, Georgia, Illinois; we were just in Tennessee a couple months ago, and across the ocean in places like Singapore and Australia and New Zealand. So needless to say, we are not alone in this boat of worrying about how well practices we put in

the groundwork. There's a lot of people across the globe that are facing very similar types of challenges.

Slide: Course Content

The course content is such that we teach it over the course of about two days. We have lots of different modules and this is one of the reasons I wanted to point this out, if you want to nip maintenance problems in the bud, you don't want to just train engineers and landscape architects. You've got to hit people in the field. That is in fact, the purpose of this class is to change the way people who are doing landscaping look at landscapes that include stormwater control measures. And one of the things that we do and obviously as our class has matured, is we have emphasized concepts that we observe our audience, many of whom are landscapers are consistently missing. So there's a lot of basic stuff that honestly most of you probably would almost roll your eyes at, having be taught. But if you spent most of your life doing something other than stormwater management then some of these concepts are actually pretty new.

Slide: Instructors

Another key in this, and you see me in red, and then the handsome fellow is my colleague, Bill Lord. Is that we bring multiple disciplines to the training and that is very important. Trainings for people that are going to be involved in stormwater control measure maintenance, you've got to be able to touch on both engineering aspects of the design -- and you can tell an engineer did this because he misspelled engineer, Ag Engineer, as well as horticultural and entomology, bugs, plants. That's what people want to know about when they are trying to maintain stormwater control measures. You've got to have a team of people. It just so happens the two of us, end up answering most of the questions, but you've got to have a team of people that can essentially answer these basic questions that come up with respect to green infrastructure practices.

Slide: Picture

One of the key components of our certification is a field test or is a field visit and having the attendees look at the practices and diagnose what problems we have associated with them.

Slide: Picture

And as I've mentioned before, the examination is of course key. And the attendees take that very seriously. Many of them have not had a test since almost high school and so we have most people take this class pass it because honestly, they take that test very seriously. We allow them to keep their notes and whatnot but we don't allow the test of course to be open neighbor.

Slide: Coastal Retention Pond Specialist

Now what does this mean? It means that when people pass this test and take our class and now can basically advertise that they are certified by NC State University to do inspection and to some extent maintenance of stormwater control measures. And essentially, we've observed this to become almost a green jobs initiative, something we've heard so much about over the course of the last five years.

Slide: Has it worked?

So I will return to this, has it worked? I will give you one example in the town of Cary where we were in 2007, where 95% of the practices failed again due to sediment, erosion, trash and trees. Now 95% of them pass.

Slide: Has it Worked? (now)

And when you talk to the folks in Cary and ask them why they basically say people know more about it, they are more educated about it and towns like Cary and cities like Durham and Raleigh across North Carolina are – and much like Karen talked about in the Milwaukee region, are requiring maintenance to occur. So all of this has kind of snowballed with each other and produced what I consider to be a pretty good result. We are not done yet. Certainly some communities are much stronger than others with respect to how practices are maintained, but we are certainly seeing really good results.

Slide: For More Info on the BMP I&M Certification

If you want to learn more about our Inspection and Maintenance Certification, all you have to do is Google something like NCSU BMP inspection and you will find our webpage and you can learn much more about it.

Slide: Maintenance Objectives

What I want to do now is talk a little bit about some of the common elements associated with maintenance with respect to practices in green infrastructure. And I like to say make sure you consider that they are safe, S. A. F. Alright, safety, aesthetics, and function. Now, I'm not going to hit on this a ton over the course -- I should say explicitly over the course of the balance of my presentation, but as I talk about the different maintenance or inspection requirements, think about what types of needs they fulfill. Are they done for safety? Are they done for aesthetics? Are they done for function? Or very often are they done for a combination or all three of those objectives. That to me is really great having safety and aesthetics be drivers for maintenance. Because property owners do care about having a safe landscape. They do care about having a landscape look good. A green infrastructure practices, make no doubt, they are part of the landscape.

Slide: Erosion, Sedimentation, & Clogging

I will focus on two general types of maintenance needs, those associated with sediment and then a little bit later those associate with plants. Keep in mind, I'm leaving a lot of stuff out. But honestly, Eva could only give me 30 minutes.

Slide: Asphalt Generates Sediment

So you might look like you have a nice clean watershed. Your catchments are [indiscernible] but actually if you look at all your parking lot you know that as asphalt breaks down it generates sediment.

Slide: Other Asphalt Pollutants, too: hydrocarbons

And lots of other stuff, too. I should also point out, that poor fella; his hand fell off a week after the picture was made. Okay, that's just a joke. But it generates a lot of stuff. It comes off the parking lot and that does drive filtration based practices nuts! Okay.

Slide: Bioretention Sedimentation Case Study: Eroding Outparcel

Not only does asphalt generate sediment but then we have the problem of the eroding outparcel and I'm sure everybody looking at this presentation can relate to that. You have seen the main store get built, the grocery store get built, and they are waiting for a bank or a pharmacy or a fast food joint to open up and the land in and around the parking lot is not stable and that sediment finds its way to your filtration LID or G.I. based practice.

Slide: Bioretention Sedimentation Case Study: Sediment in Bed

So you can see this bioretention cell literally being bombarded by sediment from an outparcel. So what do you do when that is the situation? Well, it depends on how badly bombarded this thing is, okay.

Slide: Bioretention Sedimentation Case Study: Excavating Sediment

So this is a case where the practice was impacted by sediment for a while and they had to dig out -- this is a bioretention cell, and they pretty much had to dig out the top 6 inches of the sediment, of the soil, of the media I should say, of the bioretention cell to basically break up the confining layers so this practice would drain appropriately, okay.

Slide: Bioretention Sedimentation Case Study: Rebuilding Bed

But that is actually the good case. Because the bad case is when you have sediment that penetrates the media down to the point where the bottom layers, maybe filter fabrics are clogged and in that particular case you see what you see here where they literally had to excavate the entire bed of media and bring in new media. And honestly, folks, this is every bit as expensive as building the practice new, okay. And so preventing your bioretention cells or permeable pavement or any practice, preventing that from being bombarded by sediment is one of the most important things that you can do so you don't have maintenance headaches later on.

Slide: 7 years after repair

I should point out that those cells that I just showed you, after they are repaired, they honestly looked a lot better and I have a picture coming that most of you now can see of what the cell looked like seven years after it had been repaired. Yes, there was still a little bit of sediment but for the most -- coming into it but for the most part, the watershed was stable. And I think everyone would be pretty pleased that was the bioretention cell at the edge of your parking lot.

Slide: If not maintained, permeable pavement can become Impervious

What I want to do now is go from bioretention to one of the other major practices associated with green infrastructure and that practice is permeable pavement. And what we know about

permeable pavement is that if you don't maintain it, it runs the risk of becoming impermeable. And of course, what good is permeable pavement if it is in fact, impermeable? The name tells you everything you need to know.

Slide: Permeable Pavement Problems: Mud and Silt

Well what causes permeable pavements to clog? There are two main drivers. The first driver that I want to talk about that I think most people can relate to is sediment, basically mud and silt and clays, whatever from surrounding soils just like we observed with bioretention. You can have your watershed contribute a fair amount of basically dirt and sediment into the permeable pavement on its surface and cause a clog.

Slide: Permeable Pavement Problems: Sediment

The second driver for clogging happens to be leaf debris. And we will spend – basically, tree debris; leaves, pine needles, things that come out of trees, come off trees can cause our pavements to in fact clog.

There are lots of examples and it does not matter what type of pavement you are looking at. It could be pervious concrete, pervious asphalt, as you can see in this picture, or permeable interlocking concrete pavement systems. No matter what, they are all susceptible to clogging from unstable areas in and around that parking lot.

Slide: Where does mud come from?

Where does that sediment come from? Where does this mud come from? Well, as I talked about before, it could come from out parcels which is what was visible in the picture that I just showed you, or if you are using permeable pavement in the neighborhood, think about how we build neighborhoods and it's not as if they wait until the entire neighborhood is built before the pervious concrete driveway is put down on the ground, or the PICP sidewalk is put on the ground, and as long as the watershed and the surrounding areas aren't stable, again, you run the real risk of having your permeable pavements clog.

Slide: Permeable Pavement Maintenance: Clean the Catchment – Street Sweeper

So what in the world should you do to prevent this from becoming a problem? Well, the answer is you try to keep the area in and around the pavement as clean as possible. You can do it by way of street sweeping the catchment or street sweeping the parking lot that might be draining to the permeable pavement areas.

Slide: Permeable Pavement - Clean the Catchment: Blowing

Some people have even tried blowing debris that might be accumulating on adjoining areas away from the permeable pavement lot. And those are all permeable pavement applications. And those are all – those are both fine activities.

Slide: Some of your Permeable Pavement will (nearly invariably) Clog

But one of the things that we have found is that if you give your permeable pavement a sufficient amount of time to be in place, even if folks do a nice job of keeping the catchment

clean, that is essentially cleaning the parking lot that might be draining to your permeable areas, some of your permeable pavement will invariably clog. Not all of it, but certainly some of it.

Slide: Permeable Pavement Clogging

So one of the things that you need to identify is where in the world does this clogging occur. For most pavement types, it occurs near the top of the pavement. For example, this is PICP. And you can see that clog zone at least highlighted toward the front.

Slide: Depth of Clogging Apparent

That clog zone if you were actually to take the block, the paver, out, the clogging depth would be quite apparent. You can see it here, being roughly an inch and a half thick. Clogging depth has a special name. The name is called the Smutzdecke for those of you that like German. I know Karen is from the Milwaukee area and y'all have a lot of good German sausage. We know about brats, even in North Carolina, Wisconsin is so famous for brats.

Slide: Different PP Systems Clog @ Different Locations

But the German word for clogging is Smutzdecke, alright, which means dirty floor. For those of you that speak German, you're like, okay, that's close enough, Bill Hunt. And the term Smutzdecke or dirty floor has different meanings for different – well it's the same general meaning, it means it's clogged, okay. But that clog thickness, the clog thickness varies based upon the type of practice -- you are looking at the type of permeable pavement you are looking at. For PICP, it happens to be the top 1 1/2 inches. For a concrete grid paper filled with sand, it might only be a half-inch. But for pervious concrete for example, some sort of generic configurations depending upon the surrounding soils that Smutzdecke, that clog zone, could be 4 inches from the surface.

Slide: Though Specific Design Feature have Impact

And obviously depending upon where the clogs – the clog zone is, that leads to a different type of maintenance need or a different type of equipment that you would use to essentially unclog the pavement that you are looking at.

Slide: Permeable Pavement Maintenance: Sweeper/Vacuum Truck

Also, you can do certain things to -- this happens to be pervious concrete but what they've done with this pervious concrete is they actually have an embedded sand at the top. The sand was put in actually to remove metals but the benefit of having that sand in the top of the pervious concrete not only is to help filter out metals but it also prevents a deep – a downward migration of a Smutzdecke, which makes a Smutzdecke cleaner to remove.

Slide: Preventative Maintenance

So how in the world do you remove a Smutzdecke? How in the world do you break it up? Well, that's when having a handy knowledge of street sweepers can come in handy. And there's lots of different types of street sweepers. There are mechanical street sweepers, which I'm actually not going to talk about so much. There are regenerative air street sweepers, which are

particularly good for preventative maintenance of permeable pavements and pervious pavements. And then there are vacuum street sweepers, which I'll get to in a little bit when we talk about restorative maintenance.

Slide: Most Powerful Sweeper: The Vac Truck

So preventive maintenance. Basically, this is maintenance that you are doing before the Smutzdecke is fully formed. You are able to break up the beginnings of a clogging layer with a street sweeper, such as a regenerative air street sweeper. Multiple studies have, and demonstrations have in fact, shown that.

Slide: Vacuum Sweeper Results

But keep in mind if a Smutzdecke or a clog zone is fully formed, and you essentially have to restore it, the regenerative air street sweeper will not do the trick. You have to go with a more powerful street sweeper, namely, you'll have to go with a vac truck. The vac truck obviously employs the most amount of suction and therefore, it has the ability to break up the deepest of Smutzdeckses.

You can see here in this picture very clearly where the vac truck passed and where the vac truck didn't.

Slide: Gravel Loss: A problem?

Where the vac truck passed you not only had all of the Smutzdecke get pulled out of those voids, but you can also see that we had a bit of a gravel loss.

Slide: Gravel Loss

And gravel loss certainly can be problematic from certain types of permeable pavements, namely PICP because that's – the gravel is just to obviously fill up the gaps – those gaps and provide basically the interconnection between the block pavers. But not every single pavement type is subject to gravel loss. And that's an important thing to note, for example, pervious concrete that tends not to be an issue.

Slide: Filling gaps with gravel

If you do in fact have gravel loss from a system, then guess what one of your maintenance needs is going to be? You probably guessed right, you are going to have to fill up those gaps with gravel.

Slide: Permeable Pavement Maintenance: Pressure Washing?

People have also wanted to know are there any other sort of small-scale maintenance techniques that you can use. Certainly, you are not able to street sweep every permeable pavement application there is. It would be handy if you have other options. I used to not be a proponent of pressure washing because I honestly did not believe it worked because honestly I've seen it done and I felt that people would take that wand and angle it the wrong way and drive sediment further down into the pavement and actually in the end, clog the pavement

further. But, you know, everyone can learn anew and I have, specifically there've been a couple of studies that have come out.

Slide: Pressure Washing: Mixed Results

One study that was conducted in Colorado basically said that the clogging that was observed was not able to be reversible by pressure washing, but in all fairness, the amount of clogging they found in the pervious concrete out in Colorado was not that significant and the system was still flowing pretty well. Though, in this case, pressure washing had no beneficial impact.

Slide: Pressure Washing: Mixed Results

However, a study done at, I guess I can say now, the national runners-up at Auburn, of Auburn, down at Auburn University. But it was a great football game last night if you all enjoy college football. They found that using a pressure washer or combining pressure washing with power blowing would actually improve the infiltration by a pretty good factor. I think anyone would agree that a 200-fold increase is not shabby at all.

Slide: Must I Vac Sweep my entire lot?

Permeable pavement, sometimes people take a very conservative approach and say well, you've got to make sure you street sweep, or you've got to make sure you unclog the system once a year or four times a year. But folks, I guess a rhetorical question, but I want to pose it, this is in Chicago. This is outside the Chicago White Sox baseball stadium; it's a pretty big permeable lot. Do you really have to vac sweep that whole lot on an annual basis? What is causing that particular lot to clog, alright?

Slide: Certain Areas Susceptible

What are the drivers for clogging? To be honest with you, that lot you are looking at right there, there's not a whole heckuva lot that will cause it to clog. They will not worry about melting snow because it's during baseball season. There's no trees around it. There are certain areas that are certain parts of permeable pavement applications are in fact, susceptible to clogging and they are where the hardscape and the landscape meet, because that is also where you have your overhanging trees. You can see that in the top picture there, in fact, in this picture on the slide rather. Also where impermeable pavement meets permeable pavement, that interface tends to be a place where clogging can occur because remember impermeable pavement, mainly hot mix asphalt, as it breaks down essentially secretes and leaks sediment that can cause permeable pavement to clog. Where dirty vehicles go, such as garbage trucks can cause clogging and then of course, how in the world to deal with snow. I'm not going to get into that, you could actually have a 15-20 minute seminar on winter weather maintenance of BMPs, which is not a bad idea, maybe even could schedule that for some point in the future.

Slide: Vegetation Issues

What I want to do now is transition over to the other general driver of clogging or I should say of green infrastructure maintenance and that would be dealing with vegetation.

Slide: Permeable Pavement Problems: Weeds and Moss

Vegetation is an important part of green infrastructure and the majority, not all, but the majority of green infrastructure stormwater management practices actually rely on vegetation for a good chunk of the treatment that they provide. Which gets us now, I'll stick with permeable pavement for a little bit, but permeable pavement, you do deal with vegetation on its own, sometimes it will show up and you will see weeds and grasses growing in your permeable pavement.

Slide: Grass growth is a sign of Sediment Accumulation

To be honest with you, when you see weeds and grasses growing in permeable pavement, it is a sign of sediment accumulation.

Slide: Grassed Permeable Pavement

It's a sign that sediment is an issue. And so it's more of a symptom rather than a -- it's more of a symptom that has to be treated. So you see grass, typically in permeable pavement, it's a sign that it's clogged, except when it isn't. And this happens to be an example of a -- I guess I'm not allowed to name the fast food entity but I can tell you that it's in Croatia. We will call it the Golden Fences since it's in Croatia. And they actually intended that lot to be green. It's a permeable application. So as crazy as it might seem, some permeable pavements, the intended maintenance may be mowing. And you can imagine that -- I can imagine telling my wife, "Hey honey, I've got to go outside and go mow the driveway".

Slide: Permeable pavement weed control "dos and don'ts"

When you deal with permeable pavement and you look at grass and weeds there are some real basic things to remember. One is that if you see a fair number of larger weeds, if you do pull them up, you are going to displace pavers, you are going to perhaps break up the pervious concrete. That is a problem. If you see weeds, try to get them when they are younger, okay, because when they are younger they are more easily removed and the biomass does not cause as much of a problem to the pavement. And last, but not least, always remember, always be reminded that some permeable pavements are in fact, intended to be green. They are intended to be vegetated and please don't kill that vegetation. Please, I mean, honestly the need for that would -- removing the vegetation would be to keep it mowed, keep it in check.

Slide: Plant Placement & Replacement in Bioretention

Vegetative health is at, and assessing vegetative health, is absolutely critical with respect to the majority of green infrastructure practices. I'm sure you can all look here and realize that perhaps the system is not quite working right. You see the one plant that has a little bit of feeling towards the top of the picture and then of course, a plant that has absolutely no feeling towards the bottom of the picture.

Slide: Dwarf Yaupon Holly in Saturated Soil

And I'm sure many of you could go around your communities and look across the practices, that particularly bioretention cells that you have in your communities and you could go around and it's almost like a trail of sorrows looking at where the bioretention cells have failed. And it

is usually due in fact to the fact that the too much sediment has in fact come in. But the vegetation – when you show up and you see vegetation dead, that's a sign that your bioretention cell obviously is not working as appropriate. In this case, it's probably due to the system being clogged.

Slide: Gravel verges and grass filter strips = Treatment train

Now the good news is, is if you have bioretention systems, they need not always run the risk of clogging in that you can obviously keep your sediment out of the system or you could even build in a treatment train, which you can see here with a pretreatment tool, a pretreatment practice. In this case, it is just a grassed verge, a grass filter strip with a gravel verge off the edge of the payment and that's enough to capture sediment before it goes into a bioretention cell.

Slide: Damming by Vegetation?

You gotta be careful with the design. We are talking about inspection and maintenance here, but certainly a good chunk of bioretention or any SCM or any green infrastructure maintenance is actually handled by the designer. And you can see that the vegetation, if you're not careful and you allow the vegetation to essentially butt up against the same elevation as a gutter system that you can cause damming or flooding of the parking lot, which of course, is a bit of an issue.

Slide: Better By Design (70mm fall)

One of the things you can do as a designer is actually force there to be a drop from the edge of the pavement onto your vegetative filter strip as you can see – as many of you can see in this picture. And we recommend a drop somewhere to the tune of 2-3 inches.

Slide: Mowing regimens?

And interestingly, that same recommendation that I just showed you, I just talked about, or I'm talking about right now actually was made independently by the folks in Australia. So it's always nice when you can get – when multiple people from different parts of the globe arrive at the same conclusion.

It is never good to ignore what is perhaps the most important BMP or green infrastructure maintenance need and that is mowing. Certainly, our landscapes do get mowed.

Slide: Avoid scalping grass (Filter Strips & Swales)

When you are mowing, there are some things to keep in mind. One, don't mow so close that your grass gets scalped. I know sometimes people think if they mow as those they can, that means they won't have to mow very frequently. I guess that is true if you kill all of your grass.

Slide: Table 2. Guidelines for Mowing Heights

But the health of your system, and basically the longevity of your system is based on the health of your grass that surrounds and protects many practices. So remember that the height

of the shoot of grass matches the depth of the root. And the deeper the roots you have, the more likely your grass is to be healthy and withstand droughts.

Slide: Mowing – Important for Many SCMs

One other thing that I must make a point of is when you mow; a lot of times people assume you can mow a stormwater control measure on the same frequency and on the same schedule that you can mow a normal landscape. However, stormwater control measures are much more easily rutted. Because a small rain, like a half inch of rain in a watershed, is the equivalent of like seven, eight, 9 inches of rain on many stormwater control measures. And how many of you would mow the day after hurricane? I think the answer is not that many.

Slide: What Mowing Can Prevent (Vegetated Filter Strip)

Having said that, we do want to make sure you do mow. Because if you fail to mow, I'm going to show you what can happen. This is a picture that most of you are able to look at right now of a vegetated filter strip. You can all see that, the vegetated filter strip, shortly after it had been mowed. And honestly, I would say it looks pretty good as a vegetated filter strip looks down slope of a level spreader.

Slide: What Mowing Can Prevent

But let me tell you what mowing can prevent. If you fail to mow it, remember there is a fair amount of nitrogen and phosphorus in that runoff. In fact, for those of us in North Carolina and then the base states and other parts of the United States, we all are keenly aware of the need to remove nitrogen and phosphorus. Well, that nitrogen and phosphorus and a lot of water and exposure to sunlight that is nirvana for vegetation. And if you don't mow, literally in the span of a year you can "lose" your practice because of all the vegetation that would grow.

Slide: Fertilizer

People also want to know a little bit about fertilization. And my -- the generic answer I give is yeah, you don't need to worry about fertilizer. There's plenty of nitrogen and phosphorus in runoff, as that prior slide indicates. However, you also are building a stormwater control measure. It is an investment. If you are laying sod down, having a one-time -- so an initial one-time slow release fertilization may not be a bad idea. I'm not talking about fertilizing it every -- three times a year for every year in existence, but if you have vegetation that you need to take, you need it to survive right away, a one-time sort of investment of fertilization is not at all a bad idea, okay.

Slide: Picture

I'm not saying all the time. Sometimes you get plenty of rainfall early on and you are in good shape, you could even avoid slow release fertilization at the outset.

I want to show you a couple of pictures of how well rainfall works as a fertilizer. Some of y'all are probably pretty experienced in the realm of flowers; you might be horticulturalists, whatever. I'm not. But I do know that is Black-eyed Susan. And my buddy, Bill Lord, tells me the genus for that is Rudbeckia. So I'm going to show you a quick little tour of how well my

Rudbeckia grew based on solely rainfall and the nutrients in it. It's 2004. You see what the flower Rudbeckia looks like in 2004.

Slide: Picture

And then you can see what a year of rain allowed that, my Rudbeckia, to do. We did not fertilize it. This is in relatively sterile bioretention soils I might add, and you can see that that Rudbeckia, after one year of rain, without any fertilization, looks quite good.

Slide: Picture

We will go ahead and look at another one of my favorite plants. This one is, which you will see in a little bit, it is called Joe-Pye weed. And Joe-Pye weed, I think its genus name is Eupatorium. It also happens to be the nickname of my second son. That is how much I love bioretention. I name my children after plants that grow in them. How many of you are in the same boat? And I know some of you are. I know some of you are. This is 2004. Boy, my Joe-Pye weed is not looking happy. But I've got good news.

Slide: Picture

It rained in 2004, a decent amount. And my Joe-Pye weed by the time 2005 rolled around look like a winner. I did not need to add any fertilizer, Mother Nature did that with all that nitrogen and phosphorus that found its way into my bioretention cell or shall I say my rain garden.

Slide: Bioretention Pruning

Pruning. I want to close on one last thing. So much of the maintenance that I've talked about you can associate with landscapes anyway, okay. So pruning is a very big issue.

Slide: Picture

Without pruning, you can create a system that -- a vegetated area that becomes basically can harbor people, so to speak, and become honestly, quite unsightly.

So it's very important to make sure that your systems are pruned.

I wanted to close with one last thing regarding costs.

Slide: Costs

People ask me all the time how much does it cost to maintain stormwater control measures. What I like to remind people is stormwater control measures would be landscapes anyway. Stormwater control measures are part of the landscape. That landscape needs to [audio distortion] costs associated with maintaining a stormwater control measure that is part of your landscape.

Slide: Summary

And we found, for example, for bioretention, that bioretention areas cost 15% more to maintain than what the landscape would have cost to maintain to begin with.

So I will go ahead and close with the following summary. One, please protect your green infrastructure devices during construction. If you can survive the construction period, you are in great shape. Secondly, most green infrastructure maintenance is associated with the landscapes anyway. And don't forget safety, aesthetics and function.

Slide: Thank you for your time!

I appreciate your time and thank you for allowing me to go a little bit over.

Eva Birk

Alright, thank you very much, Bill. That was a very informative presentation and I believe I was correct in telling folks that you are actually able to get folks excited about mowing grass.

So with that, we do have a lot of questions coming in. We want to get to them before we close this webcast. What I will do is bring up the speakers contact information on my screen and then we will go ahead with questions. So I am bringing my screen up now.

Slide: Speaker Contacts

Okay, great. So our first question is a timely question, speaking of the weather today in DC, which is about 7 degrees Fahrenheit, and with the wind chill about 10 below this morning when I was walking into the office. I know, Bill, that you mentioned you could give an entire presentation on its own in terms of cold weather practices for green infrastructure maintenance but we do have a lot of questions rolling in for some quick pointers in terms of any design components that can deal with preventative maintenance or green infrastructure practices especially permeable pavement when you are in these cold weather conditions if you are in the North East or if you are in Milwaukee and you are going to have a lot of ice issues, a lot of salting, and a lot of sand coming into these practices.

Bill Hunt

Okay, that's a great question and the main thing you can do is try to focus on -- you can add redundancy, okay. So with certain practice you can put sort of a sacrificial zone in there and allow that to fail and then remedy it basically as soon as the snow season ends. The other thing you can do is actually be very careful as to where snow is plowed to and where snow and the sand associated with it is pushed to. If you can keep it as far away as possible from your stormwater control measure, then honestly that can go a long way in making sure that the system works. The good news is that when the snow season ends with permeable pavement, where ever you might see some collection of the sediment or where run off or melt from the snow that would carry the sand comes, there tends to be a strip or a zone that gets clogged and you just need to budget in a street sweeping at that time of that area. So when April rolls around or whatever, or May, depending on how snowy you are, that's when you just want to go ahead and make sure you hit it with the street sweeper.

Eva Birk

Okay, great. Thanks, Bill.

Okay and so the next question coming in is for both Karen and Bill. And we had a question about a formal arrangement with municipal park agencies and this is mostly for Karen but Bill can chime in as well. Karen, do you have any formal arrangements with any municipal park

agencies for help you to maintain green infrastructure or is the public restricted from using green infrastructure parkland?

Karen Sands

The public is not restricted from using green infrastructure parkland that I'm aware of. Maybe the biggest entity that we work with is Milwaukee County Parks because they own, I don't even know how many hundreds of acres of land, but they are very large land owners in the Milwaukee area, and so they have a lot of opportunity for work not only in their parks, but in adjacent parkways so they have been recipients of competitive funding for our partnership money, particularly in the area of porous pavement I'm thinking. And then very recently we started talking to them about this soil amendments idea that I mentioned just very briefly in the presentation. The idea is to make existing mowed areas as thirsty as possible. And so we would like to undertake an experiment with them to figure out if we treat an area and then don't treat a control area with the practices that we talked about, the aeration, the fertilizing, the over seeding, all that, can we get really good stormwater results and can we prove it, document it and then scale it up? So we do have a lot of opportunity for undertaking projects on county parkland, maybe less on the O&M piece itself, but that is not to say that in the future we won't have more opportunity. I mentioned we are always looking for ways to save money, so partnering on approaches with other municipal and government agencies is something we'd really like to explore particularly through our procurement office and the jobs work that I talked about.

Eva Birk

Great. Do you have anything to chime in there, Bill?

Bill Hunt

I would add something very quick in that I don't know if the question was getting at operation maintenance of practices in parks, but the parks folks employ that first round of defense person. And that's a very important thing to note that people who maintain the landscapes of the parks are also able to maintain your landscape that is also stormwater control measure. We have found that we've actually trained a lot of park staff at our certification because they are the ones that are inherent; they are inheriting the green infrastructure on the parkland. So they happen to employ the right type of person I think to actually keep these practices working. They just have to be trained.

Eva Birk

Yeah, and that actually leads into our next question for both of you as well. That's some great information. So in terms of training staff, not only staff, but this question was particularly focused on volunteer programs. It's for both Karen and Bill. For those folks out there we had a question from Adrian Keno (ph) who is training a bunch of folks, youth actually, in Onondaga (ph) County, a Youth Corps, and they are training youth volunteers in green infrastructure operations and maintenance, mostly for doing basic maintenance activities. And Adrian wanted to know if either of you had any advice for kicking off volunteer programs, what to watch out for, lessons learned on how much can volunteers do in terms of long-term maintenance?

Karen Sands

So our experience is pretty limited with volunteers, but one step off volunteers I would say are interns. They are, you know, not making a ton of money and they're often doing the work for experience that they get for it. This past summer we had what we called our Fresh Coast interns and their job was to educate people about green infrastructure and to maintain and install green infrastructure where there were opportunities. And a project manager that works for me, Bree McDonald (ph) put that together. And we had some internal staff presentations by landscape architects -- landscapers and landscape architects and then some in the field, lots of actually in the field on hands work. I thought it was a nice crescendo for the interns. I think one of the lessons learned though is that interns have a very finite period when they can be involved. So whether they are high school or college, they are generally not available until June and then their availability ends at the end of August. So maybe that's just one of the takeaways I would give is if you are looking for around the year maintenance or very strategic maintenance that is targeted for certain time of year, interns might work for you but something that goes around the calendar might be a lot better.

Eva Birk

Great, thanks. Do you have anything to add, Bill?

Bill Hunt

Just a little bit. Not all volunteers are created equally. That's an important thing to remember. We deal with, I'm part of a land grant school and I'm sure many people here in the audience are familiar with the Master Gardener program that basically your local land grant university runs. And when we've partnered with Master Gardeners, I've found, for example, maintaining rain gardens or bioretention cells, that once we taught them what to do, they did a really good job. Those Master Gardeners tend to be often retired or they have some life experience shall we say, and they tend to be, I found them to be quite reliable when we've worked with them. We've done some work with youth and that's not to say the youth volunteers we've dealt with have not been enthusiastic, because they certainly have been. And while they are doing the maintenance, just like Karen said for a limited time, or inspection, they are pretty fired up about it but then they move onto something else. And I suspect some of them actually end up going into the lawn care industry and probably that program helped them establish the business but as far as relying on sort of our youth volunteers to do the work, that tends to work for a relatively short window before you have to really revamp and retool.

Slide: Next Webcast

Eva Birk

Great. Alright, well thanks both of you for your responses and for your wonderful presentations today. I am changing the slide here and some information about our upcoming webcast, which is about "Case Studies: Implementing Green Infrastructure under Enforcement Orders". So, again I would like to thank Karen and Bill for joining us today with their wonderful experience and expertise and for all of our participants for listening in. So please continue to check out EPA's green infrastructure website for the most up to date information on our 2014 webcasts. And join us for the next webcast listed on the screen here. That ends our webcast for today. So thanks everyone for joining. Take care.

Bill Hunt

Thank you.

Karen Sands

Thank you.

Eva Birk

Thanks.