

Getting More Green for your Stormwater Infrastructure

Webcast Transcript

Tuesday, May 5th, 2015

Speakers:

- **Chris Kloss**, U.S. EPA
- **Dan Christian**, Tetra Tech
- **Andrew Potts**, CH2M HILL

Transcript:

Slide: Getting More Green for your Stormwater Infrastructure

Eva Birk:

All right, good afternoon, everyone, and welcome to today's webcast titled, "Getting More Green For Your Stormwater Infrastructure." This webcast is sponsored by U.S. EPA's Office of Wastewater Management. My name is Eva Birk and I'm an ORISE Fellow with EPA's Green Infrastructure Program. I'll be moderating today's webcast along with my colleague, Emily Ashton, so thank you for joining us.

Slide: Logistics

And before we get to our presentations, I would like to go over a few housekeeping items. First, we will have a question and answer session at the end of the presentations and in order to ask a question simply type your question into the "Questions" box on your control panel and click the "Send" button. If your control panel is not showing, go ahead and click on the small orange box with the white arrow to expand it. Sometimes it just gets contracted in the corner of your screen.

And also you don't need to wait until the end of the presenters' presentations to ask a question and answer, but you can just submit your question electronically and we will sort through them here as the presenters are presenting. And we will try to answer as many questions as possible at the end of the webcast; however, due to a high number of participants not all questions will be answered. So please feel free to contact our speakers after the webcast and we will have their contact info available at the end of this presentation. Also at the end of this presentation in about 2-3 weeks we will also have slides and a transcript available on the U.S. EPA website.

So moving on here, if you do have any technical issues such as audio problems please click on the "Questions" box to the right of your screen, type in your issue and press the "Send" button, we will do our best on our end here to troubleshoot with you. And you can also call the GoToWebinar support number listed on the screen here, 1-800-236-6317 and give the assistant our conference ID number, which is a unique conference ID number and that's also listed on the screen here for you.

Lastly, I would like to remind everyone that the views and materials presented by our webcast speakers today are their own and do not necessarily reflect those of EPA.

Slide: Webcast Agenda

So today what are we going to be talking about? We are going to be talk about different ways of communicating both cost and savings as well as multiple benefits related to green infrastructure and we know that this is a big question facing many municipalities. One often makes the decision to begin a green infrastructure implementation at scale and then the question becomes how much will it cost and more importantly, how can I insure that the shape and form of my implementation program is optimizing based on costs. So we get that question a lot. And then the last and more important question that we often hear along with that is how can I communicate these opportunities for cost savings to both my public sector stakeholders as well as private stakeholders.

So on this topic, we have three great speakers today. First, our very own Chris Kloss, our National Green Infrastructure Coordinator here at US EPA's Office of Water, will discuss factors that impact the cost of controlling stormwater and opportunities to use green infrastructure in ways that provide overall best values to communities. And then next we will turn it over to two leading professionals from the field, Dan Christian and Andy Potts will detail both case studies and successful approaches to cost savings. So Dan, Andy, and Chris, welcome to the webcast and thanks for joining us. We have them all on mute, but I'm pretty sure Chris in the room here said thank you. [Chuckling]

Well, with that I have the pleasure of introducing our first speaker, Chris Kloss, and as I mentioned before, Chris is here with us in the Office of Water's Green Infrastructure Program. He serves as the Green Infrastructure Coordinator and our program does support EPA's regulatory and nonregulatory programs by assessing how green practices can address wet weather issues and achieve community and environmental goals. Our program also collaborates with federal, state, local, and nongovernmental organizational partners to assess how green infrastructure can be used to create sustainable infrastructure and provides outreach and technical support to communities throughout the U.S.

Now Chris has a Masters in Environmental Policy from University of Maryland, an MS in Civil and Environmental Engineering from Virginia Tech and a BS in Biological Resources Engineering from University of Maryland. He's been working on green infrastructure and stormwater issues for the past decade with experience in the nonprofit sector before joining EPA. And I can say from working directly with Chris here at U.S. EPA headquarters, he has a great wealth of knowledge on these issues and we are very happy to have him presenting on our own series today. It's about time, Chris. Thanks for joining us.

Slide: Interpreting the Costs of Green Infrastructure & Stormwater Control

Chris Kloss:

Thanks very much, Eva. A couple of things before we dive in, I just wanted to thank everybody for joining in on the webcast today. We've been doing this for a little over a year now and this effort that Eva and Emily have been heading up for us is one of the key components of our outreach on green infrastructure we view it as something that's very valuable and we hope that you all do as well. I also wanted to preference the comments a little bit by mentioning that a lot of what I'll talk about today is work that Greg Schaner in our office and Bob Newport up in the Chicago office kind of spearheaded as part of some community meetings that we had in the last couple of months where we got out and worked with some states to look at some of the benefits that they could achieve by looking at different ways to manage storm water. So we -- myself included here owe a lot of gratitude to them for developing a lot of these materials as we go forward.

And lastly, Eva kind of mentioned this a little bit, we've kind of framed this webcast series as bringing in non-EPA folks, outside experts to share their knowledge and experience with you. We are kind of changing that up a little bit today. We still have two outside the experts, but we've thrown me into the mix as well so it kind of balances out the expertness of it. But we will see how this goes and hopefully I will not mess things up too much in the control room for Eva and Emily today as we go on.

But with that, we will kind of dive in. I want to talk a little bit about some work that we've been doing here, a few case studies and hopefully set things up pretty well for Dan and Andy to kind of talk through some work that they've done and some of the good findings that they have.

Slide: EPA GI Cost-Effectiveness Study

So first off, just to start off, one of the issues that is always surrounded green infrastructure is this dialogue about the potential for it to save costs on stormwater management and this slide here is just a summary table from one of the first studies that EPA did and this came out in 2007. So this topic has been going on for quite a bit of time so this isn't a new thing and we have a number of case studies that have shown that green infrastructure can save money when we incorporate it into different types of development projects.

Slide: Other Sources of Information for the Costs of Green Infrastructure

Hang on one second. Thank you. And we are not the only ones that have looked at it. There been a number of – there's been a large deal of literature out there by a number of different folks that have looked at this. A few years ago the American Society for Landscape Architects generated a bunch of case studies, about 500, and when they looked at it, about 75 percent of the instances in which green infrastructure was used, the costs were either neutral or lesser costs than using gray infrastructure. What was interesting about this was that about half the case studies they provided were actually retrofits, which tend to be some of our more costly stormwater management cases. So what we are finding is a great deal of literature out there that suggests that green infrastructure can save money and that's what a lot of our talk will be about today. Now right off the top, we will be quite upfront about it, green infrastructure is not always cheaper. In some cases it will cost more and a lot of times, I think, we need to talk

about green infrastructure as part of overall value in what you're getting out of it and I think a lot of times multiple benefits, the water quality benefits we get out of it would even justify paying more for it upfront but I think what we are finding from all this literature is that there are a number of key factors that will drive where the costs go and that there are a couple of key component that we see as reoccurring that actually end up having us in situations where we have lesser costs and if we can consistently replicate those factors, we've a good chance of having projects that have a lot of value to them as well as can save some cost as well.

I apologize. My slides are a bit slow advancing.

Slide: Analysis of Costs and Performance of Different Stormwater Practices

So I'm going to take a couple of slides here and talk about an analysis that we did as part of an effort when we were looking at changes to our national stormwater program and a couple of the things that I will talk about our two components of that. When we looked at this, we did an assessment of site level costs. So basically we looked at a number of different site types, residential, institutional, commercial, et cetera and did a simulated analysis of what the cost would be to implement green infrastructure or stormwater retention, the requirements on those properties. Once we had those site level costs, we then took a projection of development over the next 20 years to then build up state-level and national level costs to do that.

Slide: Site-Level Analysis Goals

So one of the important things that we did when we looked at the site level cost analysis was exactly that, we tried to determine certain site characteristics, how much impervious cover there was, what the source areas were, was it going to be a rooftop, a parking lot, a roadway that was generating the runoff and then we wanted to develop costs and importantly these costs were developed relative to what the current baseline was. So if there were already existing requirements, we wanted to see what the delta was between doing stormwater retention and what they currently were doing, so these were not just the totality of the cost, these were the difference in cost and what would be spent currently.

Slide: BMP Types: Retention/Treatment

So what we did, we modeled a number of different BMPs that could be placed on the site and what the model did was go through a simulation to determine what the least cost approaches were based on the feasibility of the site. If you were a site that was nearly 100 percent impervious, it would – and was parking lot, obviously a green roof would not be a viable option, but it would have a logic that it would go through to determine what were the available types and then from there, once it had solutions, it would determine the cost based on cost curves we had developed. That was the least cost approach for doing it. So you might have five or six solutions, the model would then go through and pick which one had the lowest cost coming through. So basically what we saw from this was that the type of site that you had and the different site constraints, commercial looked a little bit different than residential, the soil types, et cetera were the big drivers in what was [indiscernible].

Slide: Summaries of Predicted Construction Spending & Predicted Projects for years 2020 – 2040

And then from that we also look at projections of development patterns over the next 20 years. We used ICLUS, which is an Office of Research and Development product here at U.S. EPA that's the Integrated Climate and Land Use Scenario model, which projects out development over the next few decades to see trends in where this development will occur and then we also compared it to other data that were out there like Global Insights that projected where new development patterns in the United States would be.

And one of the key things, this is a fairly busy slide, but I wanted to kind of point out in the bottom portion of the slide, if you look at the number projects, about 70 percent of development is going to take place within existing MS4s, that's both new and redevelopment, but it's in areas that we are already regulating. And then another 20 percent of development is going to be outside the regulated MS4, but it's going to be new development and I'll bring that up again as a key point, but if you look at it, almost 90 percent of our development is what we consider for the purposes of cost, cost favorable. And we will see that in some trends going forward as well.

Slide: Some Example Results

So I have a couple of examples here. I am using the state of Illinois. We develop costs for each state. We did a workshop in Illinois so we already had the slides on it so that's why I'm using it here, but these data are available for each state and the trends that I'll show you for Illinois are somewhat representative of the trends nationwide.

Slide: Retention Estimates

And then also included in this as we go forward is the cost that I'll show. We ran a bunch of different scenarios for this. We pulled one for the purposes of the presentation. The cost here represent if a ninetieth percentile retention standard were adopted for new development and an eighty-fifth percentile retention standard for redevelopment. And I also want to note that we did include in our model some modest reductions in impervious cover when it made sense. It was largely a BMP placement tool that we used, but we did allow the model to take some look at what we called environmental site design changes that did not assume anything very large. Quite honestly, we very purposely constrained ourselves in this so we might make minor modifications to a parking stall that's normally 9 feet by 18 feet but we did not assume that there was any changes in parking ratios that were on the book. So that, if the model determined that it made a little more cost sense to shrink the size of the impervious cover, it would do that and then apply the BMPs and that would make sense logically as well because you are not generating as much runoffs and then you downsize your BMPs as well.

Slide: Commercial project type

So for Illinois, we estimated that there were going to be about 20,000 plus commercial projects. I'm going to show two examples here, one being commercial and one being single-family residential. So over the next 20 years we would have about 24,000 projected projects for the state of Illinois and these are pretty much the site characteristics that we would estimate for those projects that were taking place. So a couple of acres of site size and about half of the site would be impervious cover. And then what the model kicked back to us was the various BMPs that would be used and you can see the relative percentages that were chosen and the reason we are getting way more than 100 percent is that there were different source areas that we -- for which we were controlling, so the roof of the commercial center would have BMPs associated with it, as would the parking lots as well. And we also allowed the model to distribute flow to more than one BMP so we would have a maximum of two BMPs for each source area so you can see how these percentages would add up very quickly.

Slide: Single Family Residential project type

Similarly, for single-family residential, we had about half the number of single-family residential projects as what we estimated for commercial. But, you can see that there is a little bit different acreage and impervious cover. And, again, these are two of the factors that will affect the BMPs that are used. So a single-family residential has overall larger percentage of acreage and less impervious cover. So quite logically, the practices that you would use there, you have a little bit more space and a little bit more opportunity, than you would on some typical commercial sites.

Slide: Stormwater retention's estimated impacts on commercial developments

So what we've found is kind of what we are trying to get at here and it's interesting in some regards. So if we look at commercial property, when the model allows there to be an impervious surface reduction or impervious cover reduction, I'm sorry, you can actually save money by retaining stormwater. If the model constraints itself and does not allow there to be an impervious cover reduction, it's only a slight more to introduce a retention standard. Now for redevelopment what we found was that it was generally more expensive to retain stormwater in redevelopment scenarios but you can see that it's more expensive to do any stormwater management in redevelopment scenarios as opposed to new development. So what we would generally conclude from this is that the costs are fairly neutral for commercial new development within an MS4 and that's largely because MS4s already have existing regulations on the book and what we are really doing is not so much imposing a new regulation, but kind of changing the way in which we manage stormwater, so there are some trade-offs there.

Slide: Retaining stormwater saves money for single family home developments

Now when you look at single-family residential, what we really found here is that there's a lot of opportunity for cost savings across the board and I think our model kind of supported what the literature supports as well, is that given the right set of site conditions that you have a lot of opportunity to do things a little bit more efficiently and smarter. So the question would always

come to us, how can you impose a new regulation and actually save money because intuitively it doesn't make sense. And I think here with green infrastructure what we're doing is just kind of changing the paradigm a little bit. In most places that we are looking to develop, we are already managing stormwater for number of different reasons. We're managing it to reduce flooding. We're managing it to improve water quality so when we come in and talk about adopting a retention standard, it's not something that is new, it's just a change. And the way that we make that change can allow us to actually save some money as we do it. And the most important thing that we probably can say about single-family redevelopment is that the phrase "timing is everything" really applies to it and that if we can get out with green infrastructure as we develop and incorporate it into the site from the get-go, there's a lot of opportunity to actually save some money at the front side, as opposed to coming in with stormwater management on the back side, when it can be much more costly to do so.

Slide: Changes to Site Design and Performance Can Save Money

And a couple of other notes that we just want to highlight other than the fact that I actually took this picture myself, this is one of the big box stores down the road from me and I've trained my kids who are 11 and 9, unfortunately for them they have to live with this on the weekends, but this parking lot is never much more full than this, even at peak times, and there are just vast quantities of parking that are just never used at this place. And I think what we have found through our work going around on site visits around the country is that there are a lot of what I would call legacy ordinances that were put in place a number of years ago that had a lot of merit that now that we think about stormwater a bit differently, could actually be updated and have some benefit. I don't know that the change would be uniform across the country, but there are lots of things that we could do with parking ratios, one, but even just configuration, shared parking. Our Office on Sustainable Communities put out a lot of literature on this as well as some other folks that have looked at smart growth type principles but I think they gel well really here with what we do a stormwater management and provide some opportunities to do this. And I think a lot of communities are already doing this and a lot of times not for water quality, it's for livability issues because all this expanse of asphalt is making this development -- this is a pretty standard development much more spread out than it would have to be. It really limits pedestrian foot traffic and things like that.

The other note that I would make is, I mentioned this briefly a few slides ago, is that most places have retention storage, if not for water quality purposes, just about everywhere that we looked in the country had some flood management requirements as well. So if we actually keep the water on site, what we found is we took a look at how much could we reduce downstream flood storage when that water is actually not being discharged? It's akin to not having as big of a footprint of impervious surface, if your runoff signature is less, you don't need as big of a retention structure. What we found is that's where you can actually get some significant cost savings. So it's, and I'll mention this again a little bit later, it's how wide your lens is when you look at cost and savings of doing stormwater control. It's not always what's the cost of the bioretention cell or what's the cost of permeable pavement, it's what is the overall site development cost that you have.

Slide: How Green Infrastructure Can Save Money – Boulder Hills, NH (UNH Stormwater Center)

So I'm going to walk through just a couple of examples that kind of highlight and corroborate what we found in our model. I think that right, before I leave the model, I think what we found, I think I would generally categorize as being similar to what we see in the literature, that there is a lot of potential for savings. In some cases, it's not going to be cheaper, but on balance, a lot of the trends we saw were very similar to the literature that we've seen over the past decade.

So my first two examples here are from a document entitled, "Forging the Link", which many of you may have already seen but University of New Hampshire Stormwater Center put this out. They looked at a 24 unit condominium community that was built a little over five years ago. And what they found is that they had about a 5 percent cost savings by using porous asphalt for the road, driveways, and sidewalks in this community. What's interesting is when you look at the overall cost of the project, if you just look at the cost of the roadways and sidewalks and driveways, the cost actually went up for those because the permeable asphalt was more expensive than the traditional materials.

Slide: Boulder Hills, NH (UNH Stormwater Center)

Where they actually got the cost savings was from the fact that they didn't have to build two stormwater retention ponds and they saved on some of the erosion and sediment control. So again, what the green infrastructure was, actually, if you just looked at that line item, it looked like it was more costly, but on balance, the project cost less because of the overall cost savings in the trade-offs they made on stormwater management.

Slide: How Green Infrastructure Can Save Money – Greenland Meadows, NH(UNH Stormwater Center)

Similarly, they did a case study on a commercial development project. This was very similar. They used four and a half acres of porous asphalt and a gravel wetland here to manage the stormwater on-site. And what they found was that they had nearly a 10 percent savings in overall stormwater management compared to the conventional design.

Slide: Greenland Meadows, NH (UNH Stormwater Center)

And again, it's very similar to the previous example. They spent almost \$1 million more on paving, which on the face of it you would think, wow, that's quite a cost expenditure for that to do green infrastructure. But if you looked at what they were able to save and avoided, cost on green infrastructure far outweighed that. So again, on balance here, we have green infrastructure as a line item looking a bit more costly, but the totality of the project being less costly because of the trade-offs and the cost savings that they were getting.

Slide: Inver Grove Heights, MN

And then the last example that I wanted to show was Inver Grove Heights in Minnesota. And this was a place where they've actually developed what is essentially a zero discharge site. And that is demonstrated because last year they had nearly 10 inches of rainfall over a very short period and they did not have any discharge from the site itself. This site itself was kind of funky. They call it kind of hydraulically disconnected. In order to develop this with gray infrastructure they would've needed 13 pumping stations and about 20 miles of piping just to get this to the Mississippi River to discharge. And they felt it was cost prohibitive really to do that so they adopted a very distributed green infrastructure system here that made use of what we consider the bread-and-butter green infrastructure practice, rain gardens, permeable pavement, and then they had two regional infiltration basins. So when they got this 10 inches of rain, they did see overflow from their small scale practice, but it went to the infiltration basins and did not discharge. And what they found is not only is a zero discharge they saved about \$18 million in upfront construction costs and overall, over the course of the project, they think they will have about \$30 million in life cycle cost savings. So this is a situation where they are actually getting a better environmental outcome with reduced costs.

Slide: Regulated MS4 Program Universe

And then just a couple of slides I wanted to kind of tie some of this back. This here is a map of where our regulated MS4s are, both the Phase I and the Phase II, and what we see is that the regulated MS4s don't cover that much land area. I think it's about 2 percent of our overall land area, but it covers about 80 plus percent of the population. And if you remember back a few slides ago, this is where most of the development is going to occur and so that means that we already have stormwater regulations in place. There's already stormwater being managed for water quality and, again, in most places across the country, even if you're not within a regulated MS4, you are doing some sort of stormwater management for safety, flood.

Slide: Opportunities

But, I wanted to tie that back a little bit because we also took a look at these regulated MS4s and found that 99 percent of those MS4s have landscaping ordinances for green space on commercial properties. So whether these be 5-10 percent green space in your parking lot, buffer strips between the commercial property and the adjoining property, create some lot distance, what we found is that about 10 percent plus the site was already being dedicated to green space, so it does not take a whole lot of effort to take the green space with the tree on the top part of the slide and turn it into the bioretention cell on the bottom and really dual-purpose this. We really have a lot of opportunities within our regulated communities to make changes to the way that we design our sites that are not that onerous and just take a little bit of change.

And what we have really found is that the cost for green infrastructure often don't lie in the actual site themselves, it's the transactional cost of going through the effort of changing your codes and ordinances, updating your standards and specifications. It's the time and the effort it takes to set up the process to be able to do green infrastructure because a lot of times that's the biggest barrier. You don't have the flexibility in your codes, you don't have the standards

and specs in your BMP manual for folks to be able to do it easily and that's where the time and effort gets tied up.

Slide: Lancaster, PA Alley 148 Greened for 10% Added Cost + 200,000 gallons captured per year

And then lastly, I wanted to introduce the concept, and Andy will talk about Lancaster in much more detail than I, but this concept of piggybacking that a lot of communities are already using. This was an alley reconstruction that the city of Lancaster did. They were upgrading the alleys primarily because they were degraded after years of having independent trash haulers, they had really beat up, I think at one point they had 27 or so independent trash haulers driving over these valleys again and again and really just putting them in a state of disrepair and they needed to improve them. But when they did this they kind of smartly took a look at it and said oh, this is an opportunity for us to do stormwater management as well. And what they found is that to add in the stormwater management to this was only about a 10 percent additional cost of doing the alley improvement by itself anyway. So this really gets at the thought of long-term planning strategies for implementing green infrastructure and taking advantage of the opportunities that are going to be on the books anyway. If we go back and do stormwater retrofits solely for the sake of doing stormwater they can be rather costly, but if we look at where we're during transportation projects anyway, where we have a lot of opportunity to just to kind of – just to add water to it and do some infrastructure improvements, a lot of all of those other mobilization costs, a lot of the cost to tear up the streets and do it are already being considered in that cost estimate, we can already take good advantage of that.

Slide: US EPA Green Infrastructure Program

So a couple of last thoughts, those last couple of examples that I mentioned, the opportunity to piggyback on capital improvements and to make some -- take some opportunities like that, we actually did not include in our cost analysis that we did here, so the numbers I showed you did not really reflect the opportunity to kind of downsize some of those costs largely because trying to estimate that and where those opportunities would be was just too much of a challenge to kind of figure out in a simple model. And we also did not push impervious cover down in our cost model as far as we thought we could given some of the literature that we saw. We wanted to be pretty conservative and be able to kind of justify the estimates that we had in there, so we thought our costs were on the conservative side, but we think that in totality, a lot of what we were finding is what you all have seen in the literature, and we think there's a lot of opportunity to even do green infrastructure a bit more efficiently through that.

So with that, that's kind of what I had in a nutshell. I think Dan and Andy will have some really good on the ground examples to kind of share with you and I thank you for letting me join in the discussion today. So I'll turn it back to Eva.

Eva Birk:

Great. Thanks, Chris. I really appreciate the presentation and that transition to the work on the ground in cities like Lancaster is good because that's what Andy and Dan will be getting into in

more detail. So, thanks.

Poll Question

So before we turn it over to Dan's presentation, what we're going to do is launch a quick poll for the audience. It helps us understand here how many folks are tuning into our webcast series so it should be popped up on your screen right now. Go ahead and just select how many people are viewing your screen and again, if you do have questions for Chris, Dan, or Andy, we will have a Question and Answer period at the end of the webcast and you can go ahead and just forward those to us in the "Questions" box. So it looks like our results are almost in. And while we are waiting for that to load, I'm going to go ahead and start introducing Dan.

So Dan Christian is a Senior Project Manager and Water Resources Engineer with Tetra Tech and Dan specializes in stormwater management programs, policies and implementation bringing over 25 years of experience. Dan has prepared numerous studies and designs for a wide variety of stormwater control measures such as rain gardens, bioretention, infiltration, porous payment, water conservation, and others and then often works with green infrastructure and roadway corridors as well site development. So Dan's clients often include nonprofit organizations located throughout the U.S. as well as state, county and local government entities. Dan attended Michigan State University and received a Bachelors and Masters degree in civil engineering. And Dan is married, has two teenage sons and in his free time enjoys getting outdoors and camping, hiking, and fishing. I agree with you on the last three things, Dan, except I think that I will enjoy them less in the DC area in a few months when we have about 80 percent humidity. So I'm with you on most of those though. So with that, we'll go ahead and hand it over to Dan. We have unmuted you here. Can you hear us okay, Dan?

Slide: Benefits of Green Infrastructure

Dan Christian:

I can. I seemed to have lost my screen that shows what the viewers are seeing.

Eva Birk:

Well we can see your slides fine.

Dan Christian:

You can see my slides? Okay, so I'll just go ahead.

So thank you for joining today. I wanted to touch base a little bit on some of the benefits of green infrastructure. Chris talked a lot about the economic benefits and so I'm going to touch on those a little bit, but I'm also going to hit quite a bit on the social benefits as well as the environmental.

Slide: Diagram

This slide shows a common diagram or a triple bottom line approach with the environmental, economic and social and then the overlapping issues between those. And I should mention that what I'm going to do is run through a range of different benefits that we can see with green infrastructure and then touch briefly on quantifying some of those benefits and finish up with a brief example showing how we integrate some of the benefits into a real project.

Slide: Chart

So the triple bottom line approach is a good approach. The problem I have is every time I start trying to draw a nice linear path of what the benefits look like and how things are linked together, I end up with this spider web nest of what it looks like. So take, for example, planting a tree. We plant a tree. We put it in and we reduce runoff and we can reduce some water pollution that can lead to some stream stability. The reduced pollution and the improved stream stability leads to an increased habitat and improved overall ecological health of the stream. That can lead to an increased recreational use of the stream, which can bring more people outdoors, make people happier, but then also on the economic side of it, we increase our community economics by having more people rent the canoes and buy the fishing poles and lures, so it improves the economy, which then allows us to go back and plant more trees. So we end up with this complicated relationship that all of these different entities on the benefits of something as simple as planting a tree.

Slide: Chart – Green Infrastructure Benefits and Practices

Another example of how to look at it, this diagram comes from the Center for Neighborhood Technology's, CNT's book also with American rivers, this book is called, "The Value of Green Infrastructure." And what they did is they lined up the different benefits, for the different practices like green roads and tree planting, what you see in the first column, and then they lined up different benefits across the top. And then they identified through this bubble chart diagram what benefit might be realized by the different green infrastructure practices. And really when I start thinking about all the different benefits, the only way I can kind of go through and describe the different benefits is just to jump in and start talking about what the different benefits are and then hopefully people can see how they are all highly intertwined with one another.

Slide: Hydrology

So to me, the first benefit that we have to talk about is the improved hydrology. Not only is this a benefit for green infrastructure, this is really the target. This is our objective. This is what we are trying to accomplish is to improve the hydrology. The definition of green infrastructure for stormwater management, if you read it off of EPA's website talks about mimicking the natural hydrology. So it's both a benefit, but it's also the goal. When we introduce the green infrastructure what we're doing is increasing the intersection by the plants, increasing storage and promoting infiltration. We are getting more plant water uptake and increased time of concentration and all of this leads to that core objective of decreasing the runoff volume and decreasing the rate of runoff. And if we accomplish our mission, then that leads to the reduced

infrastructure needs that Chris was just talking about and the reduced flooding and it can increase our water supply because we are pumping more water back into the ground, recharge the groundwater aquifers. So to me, the hydrology is the absolute cornerstone benefit of green infrastructure.

Slide: EPA Nonpoint Source Pollution

Along with the hydrology is some of the water quality issues that Chris also touched on. There's lots and lots of information about the benefits for water quality with green infrastructure. We see the different practices. Take out nutrients and they remove sediment and a variety of things. And a lot of this is captured very well on the EPA Nonpoint Source Pollution website, the EPA Green Infrastructure website and has wonderful summaries of what all this is.

Slide: International Stormwater BMP Database

The International Stormwater BMP Database is another excellent site to learn about all the water quality benefits that can be realized with green infrastructure. This site, if you're not familiar with it, is where the researchers, both from academia, as well as municipalities and consultants, all share information on what we are learning about different green infrastructure practices with specifically what they are doing to remove pollutants and improve water quality. So that's a great resource if you are not familiar with it.

Slide: Air Pollution Reduction

Beyond water quality we can also look at air pollution. The trees and vegetation in our environment tend to intercept pollutants. They can take gaseous based pollutants consume them into the plant material and we can look at practices like green roofs to provide added benefits for this. So here is a study, and I should mention that at the bottom of my slides I do reference the sources of these studies, this information, and at the end of the presentation there are some slides for the reference material, if you are interested. That will be posted with the presentations.

Slide: Urban Heat Island Effect

But here in this case, you can see that the air pollution removal by green roofs we get a variety of different removal rates, so air pollution is another benefit. That goes along with the urban heat island effect. We know that in our urban areas, particularly during summer time, the added buildings and the pavements tend to absorb and warm-up the overall urban areas so they tend to be warmer than the surrounding rural areas. This results in a higher energy demand during the summer and ambient temperatures increase. Now we can reduce those temperatures through things like increasing soil reflectivity and increasing vegetation density. So, for example, we can put on things like green roofs and plant more trees.

Slide: Greenhouse Gas Emissions

The greenhouse gas emissions, as we use – as our urban areas are higher in temperature during the summer, we are using more energy than to cool our buildings. And so there is an energy cost with that, and if we plant more of those shade loving trees or the trees that provide the shade cover, we can reduce our energy consumption and so we can actually put a value on that in quantifying our benefits of green infrastructure.

Slide: Greenness and General Physical Health Benefits

Now there's also lots of social benefits associated with green infrastructure. For example, and it really shouldn't come as a surprise to anyone that people generally perceive streets with trees and gardens as much more pleasurable to go for a walk along. Access to the gardens increases the frequency and the amount that we are out there walking, which leads to reduced stress, lower likelihood of obesity. We have studies that show a direct correlation between higher greenness and lower body mass index or BMIs, regardless of the residential density characteristics. So in the green environments can even help us reduce -- reduce the mortality rates.

Slide: Mental and Emotional Health Effects

We also have mental and emotional health effects. There are significant relationships that have been found between the open spaces and the experiences of stress. And -- I'm going to pick up the phone because it sounds like I'm crackling a lot. So hopefully this is better. Other research has shown that in times of natural settings that when we spend time in natural settings, we can reduce our stress and we increase our ability to recover from fatigue. So there's lots of benefits associated with this. The kids we find have less severe symptoms for ADD if we get them outside in the wilderness, playing outside around trees. We even have desk workers, a study that showed desk workers who have the ability to look out a window at vegetation have 23 percent fewer incidences of illnesses just by having that view from their office.

Slide: Crime Reduction

We see reductions in crime. An interesting study around the Chicago area where they looked at a correlation between green and trees around buildings and the level of crime and they found a direct correlation that as we increase the vegetation around these buildings, you reduce the crime. And these were in the same general areas. So really fascinating research there.

Slide: Community Cohesion

We also see community cohesion in general. Generally speaking, if you put in the trees, there are stronger ties to the neighborhoods, there's a greater sense of safety, there's healthier patterns for the children's out playing, the use of the common spaces increases and we reduce the crime. So here's different studies that came to the same conclusions. Fundamentally what

it means is that vital well used neighborhoods, the common spaces really increase and strength the relationship between residents and deter crime thereby creating healthier and safer neighborhoods.

Slide: Property Value

And we see property value increases. Adding a tree in front of a house can increase the value by \$7,000 according to a Pacific Northeast study, which in this particular study was about two and a half percent of the house sale value. Having a house near open space whether it's an urban park or a golf course or a natural area, it increases the value of the house. Another study up in the Pacific Northwest showed that by putting in the low impact development techniques around the property, we increased the property values by three and a half to 5 percent. So it suggests that people are willing to pay more for these environmental benefits and neighborhood amenities. And not only is this value good for the homeowner, but it's also good for the community because then we increase our tax revenue base for our communities.

Slide: Porous Pavements

Now I've been talking a lot about porous pavements or vegetation systems. Porous pavement systems also have some interesting added benefits associated with them. For example, one study shows that melting water seeps directly through the pavement instead of refreezing. What this means is then we reduce our need for the deicing agents and we reduce the liability with slips and falls and that has been supported by observational data as well as some laboratory biomechanical investigations.

Another interesting benefit of porous pavement is the reduction in the noise levels. We see 5-6 decibel reduction on average with the use of porous pavements and some studies have shown a reduction as high as 14 decibels. We also see a decrease in the hydroplaning and a decrease in the glare. And again, these are issues that because we have no puddles on the pavement, we don't have a hydroplaning issue. Some of these are really hard to put into a quantification or a valuation node, but these are interesting benefits that we can point people to.

Slide: Quantifying Benefits

When we do need to quantify the benefits, again, we start with the runoff reduction benefit and to me that is the cornerstone of green infrastructure. There's lots of different ways that we can quantify that runoff reduction. Common methods, curves numbers, rational, small storm hydrology, etc. and there's wonderful models out there. You can do it by hand. It's very easy to do on a piece of paper or calculator or you can use a model like the National Stormwater Calculator, which is available from EPA. It's free. It's very easy to use and it does a wonderful job of quantifying generally looking at more the average annual benefits.

If you particularly are interested trees, you can look at a model like iTrees. And then there is also this really neat model by CNT, the Center for Neighborhood Technology, called the Green

Values National Stormwater Management Calculator. This is an online web tool that you enter some basic information about your site and it provides a wealth of information on potential benefits from air pollution, carbon sequestration, et cetera.

And then I did mention this book again and the Value of Green Infrastructure. It's a really nice book and it goes through a variety of different practices and not only helps you quantify the process to calculate the quantification, but also the valuation of those benefits, so how do we put many of the benefits into a dollar value is discussed in the book. Some benefits we can do and some are a little bit more challenging.

Slide: Example Project Integration

Now lastly, I will just mention a project that I'm currently working on as an example of how we integrate some of these benefits into a real world project. This project is for the city of Grand Rapids, Michigan. We are looking at green infrastructure opportunities throughout the city. And as we go through and identify opportunities and we figure out what can we place where and how much is it going to cost, we've then are also looking at quantifying some of the other benefits associated with it.

Now it's a very personable thing to look at what benefits to consider. Do you consider the crime reduction or do you consider the water quality issues? And what I find is it's a case-by-case issue. Each community is a little different. In the case of Grand Rapids, they have this sustainability plan that they prepared back in 2011. And this is a wonderful plan that they went through and they looked at a triple bottom line analysis for economic, social and environmental issues and they came up with very, very specific goals and targets that they wanted to accomplish. And they did it in a very smart fashion. They're specific, they are measurable, they are realistic, they are all time-based, so it's something that you can really put your pencil to.

Slide: Sustainability Plan Targets

What I show on the slide is kind of a subset of those targets. So, for example, the first three items, the increased wellness, reduced occurrence of crime, an increase the neighborhood conditions, those come from some of their social goals. And the approach I took with this project, which is still ongoing and is modifying as we go, but is to identify those green infrastructure practices with vegetated solutions as things that would work towards those targets. With the other environmental goals that Grand Rapids has, for example, reduce the CO2 emissions, increase the green roof area, reduce stormwater discharge, these are things that I can actually quantify in numeric terms as far as gallons removed or square foot area added and in many cases also add a dollar amount. So the way that we did this was to -- for each of our areas of interest we prepare this one page summary form which looks at the watershed land cover characteristics, what is training to the particular area. What types of green practices we are proposing for the area. We add up the cost and then what I want to draw your attention to is down at the bottom of it, we provide the benefits. So, for example, we can say that new trees planted, this particular one has two new trees planted, with an area of 600 square feet canopy area, in 10 years that's an estimate, and then again, an estimate for 50

years. And in this way, we can provide – we can link back the specific green infrastructure opportunities identified with the specific targets that the city identified in their sustainability plan. And then the idea being we can summarize whether we have 25 or 100 of these, it doesn't matter, we can summarize that and use that information to help prioritize what projects to do first. So that's a brief overview of some of the benefits and how we are using some of these different types of benefits into our project integrations. And with that, I'll turn it back over to Eva.

Slide: Thank You

Eva Birk:

Great. Thanks, Dan. That's a great presentation and really appreciate you sharing some of those tools so we can have all the information in a tabular format because we all know that's kind of the best way to present things especially to city councils, councilmen, different ways of communicating are important, so thanks for that.

Slide: Cost Saving Approaches for Implementing Green Stormwater Infrastructure

Great. So we are moving right along here. We are only running about five minutes behind, which is good. It means we will still have plenty of time for Question & Answer. So I'll go ahead and introduce our next speaker, Andy Potts. Thanks for being with us today, Andy. Andy has over 15 years of experience in stormwater management, green infrastructure, water resources and sustainable site design applications. He focuses on green infrastructure and LID systems design and implementation, green streets, innovative stormwater management, LEED, hydrological analyses and modeling, plan reviews, stormwater manuals and watershed studies. Andy was a chemical co-author for the Michigan LID manual, the Pennsylvania Stormwater BMP manual and 4 chapters in the 2014 West Green Infrastructure Implementation manual. He also had a role to play in the AFC book on permeable pavements so he's been a leading professional in the field for a very long time. We're happy to have you with us today, Andy. Also wanted to mention he has an MSPE from UVA. He's a professional engineer and is a LEED accredited professional in building design and construction. And I wanted to mention, Andy, that we had some comments in the room about UVA verses Virginia Tech. We won't say them on air. So --.

Andrew Potts:

I'll refrain as well.

Eva Birk:

Great. Excellent. So we can see your slides. Looks great. Take it away, Andy.

Andrew Potts:

Thanks so much, Eva. I'm going to jump in here. I think it builds nicely off of what Chris and Dan were talking about and I will share some specific cost saving approaches that the city of Lancaster is using to reduce the cost of implementing green infrastructure.

Slide: Outline

I'll jump right in here. A fair amount to cover but I think we will do it just in perfect timing, hopefully. I wanted to start with acknowledgments and I'll go into a quick introduction of the program and give a brief overview very quickly, but then I want to go into the case studies of where we are applying this concept of integrated infrastructure and we have a number of different programs we are working with in the city there. And then I'll talk a little bit about a very innovative public-private partnership program that the city has and we will just finish up with some additional information, resources and, of course, questions for all the presentations at the end.

Slide: Acknowledgements

I know acknowledgment usually come at the end, but I felt like they were too important here to save until the end so I wanted to start right off with these. This is an amazing team we are working with at the city. It starts right at the top with the mayor. You can see him reading the Green Infrastructure Plan there on the cover of "netzero" magazine. The Director of Public Works, Charlotte Katzenmoyer, to getting these projects moving and keeping them moving and her great team there in the city, and of course, a whole bunch of folks here at CH2M have also been involved.

Slide: City of Lancaster – Overview

Very brief overview just of the city, in terms of stormwater, it's about half and half separated and combined sewer systems. The separated, well both, of course, are in the Chesapeake Bay watershed so are reacting to the Chesapeake Bay TMDL. Pretty densely populated, about 60,000 in the last census, quite a bit of poverty, as we see in most of our urban environments, and very, very historic city. I think many people on the webcast have probably heard about Lancaster at one point or another. And it is indeed very old, which does pose some challenges, of course, for green infrastructure.

Slide: 2011 Green Infrastructure Plan Envisions Widespread GI

The Green Infrastructure Program started roughly towards the end of 2009, started preparing the Green Infrastructure Plan for them. It was officially released in 2011. And basically it envisioned really widespread green infrastructure throughout the city in terms of all of their major impervious coverage types that are shown on the aerial photograph; roads and alleys, parking, rooftops, you already saw that alley, Chris showed it in his talk in terms of only a 10 percent additional increase. A number of parking lots, rooftops and really a wide array of green infrastructure projects both public and private.

Slide: Green Infrastructure Program Status

Here's a map of other projects in various stages of design and construction all throughout the city. The darkest green dots are those that have been completed, the lighter green are under

construction and actually I think three or four more are under construction now since the weather has broken so we have to update this map continuously and it's already out of date in just a couple of months.

Slide: Green Infrastructure Program Status

And that goes for this table too, but this gives you a sense of how much has been accomplished in just a few short years in a relatively small city. Over 50 projects completed. 20 million gallons per year kept out of the combined sewer and separate storm sewer areas and with over 100 additional in various stages of planning and design. So just a pretty impressive program.

Slide: Building off existing plans: Parks

Again, I'm now focusing on just a couple of elements of it, some of the key elements in terms of this integrated infrastructure theme and we will talk about parks and then streets and other utilities. Parks sometimes I get some puzzled looks when I start mentioning about greening parks, but we've found they can be a great opportunity for managing not only what impervious might be on the park, if there is significant impervious areas, but even maybe more importantly, what's adjacent and surrounding them. And so the Green Infrastructure Plan actually recognized that the city already had a good plan in terms of renovations calling for renovations in a number of city parks and so the plan recommended and looked at opportunities to integrate green infrastructure with those park improvements. The first project was done before the plan was even released. I'll get into a little more detail on that in a moment, but so far there have been four park renovations already completed and they all include significant green infrastructure, not just a demonstration rain garden, so it's been a very successful program.

Slide: Integrated Infrastructure: Green Parks

I'll just give you two quick examples – two of the four I'll go through quickly. First, in the Northeast area of the city, 6th Ward Park.

Slide: Expanding the Benefit of the Park – 6th Ward Park (2010)

One of the main ideas in the park improvements plan was to move the basketball court away from the residences. There was some noise complaints and other things and so that existing basketball court was shifting up towards Ross Street to the north. In addition to one of the first thoughts being potentially using a porous basketball court was also looking at what additional runoff could be brought into the system, so we looked at adjacent streets, found that we could very easily intersect those drainage areas, shown outlined in purple, and bring those into the porous basketball court system.

Slide: Sixth Ward Park

So the main technology here is a porous basketball court with storage infiltration beds underneath to manage that – both what falls on the court and the adjacent impervious areas. By pulling in all those streets we are able to capture over 700,000 gallons a year. Total cost for the project was \$116,000, but they were going to spend \$50,000 just on the court, if it had just been a plain, standard basketball court, so the incremental cost or really what the G.I., the green infrastructure cost in this case was about \$67,000 which equates to about 9 cents a gallon. Certainly in this area being in the combined sewer we were focused on gallons per year. I know a lot of people -- communities think in terms of dollars per acre so just to translate that, it's about \$87,000 per acre. So again, very cost effective and was also picked up a number of local, state and Chesapeake Bay Stewardship Fund saw the value in this and also provided some funding so that's not even accounting for the fact that it was also funded largely through grants.

Slide: 6th Ward Park Re-dedication Ceremony

Dedication ceremony. You can see, got a great turnout. Local and state officials, of course, test the porous asphalt. I took the video out just because of the webcast issues, but you can see them all about to empty their buckets onto the porous asphalt there.

Slide: GREEN PARKS

Moving South to the southwestern part of the city, just looking here – this slide is loading relatively slowly, but the second park that was done and a larger park was you can see in the blue square there, Brandon Park.

Slide: BRANDON PARK

It's a fairly large park in a historic valley and the concept; I'll show you the concept plan here. Quite extensive green infrastructure proposed for this project. A number of vegetative curb extensions, bioretention areas interconnected, large porous pavement areas in certain places and it's nice when you can see some of these more significant projects they actual become visible on aerial photographs, which is loading now. You can see that plan with essentially implemented as shown. We'll show you some of the runoff statistics here. It's 4 million gallons per year at about 15 cents a gallon so again, a very significant project. One of the largest to date in the city and some curb extensions were proposed that were not absolutely necessary from a stormwater perspective but there were some need for traffic calming so you can see the vision there, landscape architects rendering of what it might look like. And then I will follow up with some still photos here. This is – the one loading now is shortly after construction, again, obviously vegetation has not really taken hold yet. There it seems to be loading a little bit slowly here. Vegetation had not really taken hold yet, but then the following photograph would be from last year after about two years of growth and you can see things really starting. If it loads, you can see some things really starting to really thrive there.

Slide: BRANDON PARK – WABANK ST. CURB EXTENSIONS

A couple other photographs from the park. Actually down at the change order, the basketball courts were originally envisioned just to be standard asphalt, but the contractor actually approached the city and said hey, you know, you like a porous basketball court, would you want to consider one here and the city said well, how much will it cost and the cost was so reasonable that the city went ahead and added that in addition to all the bioretention. You can see that – I'll zoom in on that in a minute. It was in terrible condition with puddles, and [indiscernible], and all sorts of things and it's now a nice playing surface. And Dan mentioned the reduced sound from porous pavement.

Slide: BRANDON PARK photo

We've heard that anecdotally from these projects in the city and the neighbors seem to love the fact that the noise is reduced. The kids love it because they dry out immediately after rain. There are no puddles. They can go out and play so it's been very successful from that perspective. Talk about triple bottom line benefits that you might not have originally thought of in terms of a recreational facility.

Slide: BRANDON PARK photo

Follow up a few other pictures just of some of the larger bioretention and constructed wetland areas and we just recognized as a garden of distinction by the state Horticultural Society.

Slide: Integrated Infrastructure: Green Streets & Alleys

Moving on to the next integrated infrastructure program it's surrounding green streets and alleys. Thank you, Chris, you already set this up for me.

Slide: Composite Prioritization Criteria Yielded Most Cost-effective Green Streets Opportunities

I won't have to talk about alley 148, but basically we looked at combining a number of things to develop – to score and come up with a list of the lowest overall green street costs and the best streets potential for green streets. So we overlaid things like pavement conditions, kind of an obvious one, but also ADA priorities, so replacing a large number of ADA ramps throughout the city. You can see an example there of where we incorporated a vegetative curb extension as a part of one of those projects. Street slope, tree canopy coverage, location in the combined sewer or MS4 area, all those things are kind of overlaid and we develop a list of potential projects that then, of course, have to be vetted and appealed.

Slide: Broad St. & New Dauphin St. Green Street

Here's an example at Broad Street and Dauphin Street right down by the Conestoga River. And it was an awkward intersection, a very long pedestrian crossing you can see there and the concept here was essentially to make that more of a conventional intersection, take up some

of that excess pavement, use that area for bioretention. The after photo should be loading here in a moment. There it goes, it looks like. And also improve area out in front of those homes; give them a little bit of buffer from the street. And you can see here is the before picture, again, that kind of awkward, long, angled pedestrian crossing to what it is today. Beautiful landscaping, a nice buffer for those streets, a shorter, safer crossing for pedestrians and on top of it, 550,000 gallons per year of run off pulled out of the system very cost-effectively at only 14 cents per gallon.

Slide: Using Traffic Safety & Transportation Funding To Reduce Accidents and Runoff while Enhancing Local Business

Probably the highest profile project in terms of the green streets and integrated infrastructure is at [indiscernible] and Walnut. And here was a very awkward intersection, again, with a lot of traffic accidents largely associated with this odd right turn lane where the white car and the red car are about to collide, that happened quite frequently, and so this project was really driven by safety, both from pedestrians and vehicles, very awkward crossing. Essentially, almost no way to cross on this side of the road at least without risking your life. Not a very good way to cross on the northern portion of the road and so, again, it was reconfigured into more of a conventional intersection. Everyone knows what they are supposed to do. It's safer for pedestrians and shorter pedestrian crossing and we used curb extensions, both for traffic calming and stormwater management. Permeable paver for parking inside the seating area. And they monitored traffic speeds before and after and this was one of the main entrances into the heart of downtown Lancaster and really where you want people to start slowing down as they are entering the denser part of the city. And they found a 5-mile per hour reduction in traffic speed. So just again, the triple bottom line benefits.

Slide: Integrating Traffic Improvements Improves Safety, Local Business, and Brings New Funding Sources

It was built with both transportation funding and green infrastructure grant funds. Obviously, it helped tremendously, you see this local business, the Lancaster Brewing Company, and yes, that did make it one of our favorite projects, but we like them all. Again, relatively cost-effective, especially for such a high profile and significant project here. It was recognized by the state as the Governor's Award for Environmental Excellence and also won the Best Curb and BMP in the Bay Award last year along with its \$5,000 prize, so that was great, great for the city to be recognized with that.

Just leave with one more before and after picture just to show how we take this kind of sea of excess asphalt and concrete and make it into a beautiful amenity that serves stormwater, it serves the city and certainly supports the local businesses and makes the area a more attractive place. The local restaurant, the Lancaster Brewing Company, is embracing the farm to table movement like so many other places and are actually starting to grow their own produce in the planter that is adjacent to the permeable paver patio.

Slide: Integrating with water and sewer upgrades – Greening Spruce Street

The last program in terms of integrating infrastructure is looking at doing it with other utility improvements and here's just a quick example, Spruce Street, where they were conducting a sewer replacement, and by the time they were done with this relatively deep sewer, the whole alley was basically torn up and instead of just backfilling with normal materials, we worked with the city to install storage infiltration trenches and capture the stormwater as part of this alley.

Slide: Spruce Street Greening Project (2013)

And we actually get a significant amount of runoff from driveways and parking areas that tie in and you can see a show of a couple of before and after. Not very dramatic; it's conventional asphalt in this case, but you can see they infiltrated the storage trench under construction but the overflow structure and the final product is a new fully constructed alley that also captures 250,000 gallons per year at 8 cents per gallon.

Slide: Innovative Public-Private Partnership Using State Revolving Funds (PENNVEST in PA)

The last thing I want to talk about is this innovative public-private partnership that the state is leading with -- the city is leading with state revolving funds. It's a 7 million-dollar loan that funds green infrastructure implementation on both public and private, about half and half. Initially we identified 45 sites with about 25 percent -- the thought of adding about 25 percent throughout the life of the program. And it was originally divided into five group bundles projects for bidding kind of based on project type, location and so on, and what made sense and those were bid out and we are now in construction. We've done probably about 15 project so far; another three or four under construction as we speak. The basic premise is the city will pay up to 90 percent of the green infrastructure cost if it's on private property. The property owner will pay the remainder so they have a fairly significant skin in the game, but they also then take on responsibility for long-term maintenance so the city therefore, doesn't have to worry about the maintenance.

Slide: Photo

One of the first -- I'll just give two case studies from this program and wrap things up. The first one was a local painting company. The owners were very -- wanted to really show leadership in this area. They had a fairly large facility. They certainly had the opportunity for some green infrastructure so we were able to incorporate a decorative rain garden on the edge of their parking area and manage some water off that rooftop there.

Slide: Photo

And then their main front entrance and parking area were in terrible condition and had actually had done some utility repair work and torn it up even further, so the main entrance area received stormwater planters and the parking area was redone as permeable pavement parking lot and I don't even have a picture here, but the sidewalks were done with pervious

concrete and new street trees and tree trenches were put in as well. So a nice project example done cost-effectively and without a long-term O&M responsibility on the city's part, which is now the responsibility of the owners.

Slide: 317 N. Mulberry

317 North Mulberry is the second example I'll finish up with and that was again, part of the PENNVEST program and in this case was actually done integrated with a redevelopment project. This is a historic building being renovated into condos. Certainly challenging in terms of coordination and sequencing, but we were able to work through those issues and probably the thing I found most interesting about this is we proposed about a 10-foot strip of permeable pavers in the driveway area. That was all that was needed from a stormwater perspective, but the developer actually liked the look of them so much that he expanded 100 percent his cost the decorative permeable pavers to the entire driveway and parking area. And also, we also worked with the neighboring facilities to capture quite a bit of off-site runoff into the facility and again, very cost-effectively, under 20 cents per gallon with almost 400,000 gallons captured per year.

Slide: Photo

A couple of after photos here, taking a moment to load. And hosted -- the EPA hosted a green infrastructure press conference there last year and you can see last April, about a year ago Sean Garvin came out and kind of helped with a ribbon cutting so speak...

Slide: Triple Bottom Line Benefits

partially to announce the release of this triple line benefit study that EPA did. So that kind of tying back into some of Dan's work. This was a study commissioned by EPA, and funded by EPA on the benefits of Lancaster's Green Infrastructure Program and what it came up with was some pretty significant annual savings in terms of \$4.2 million in energy, air quality and climate related benefits per year, if the plan is implemented fully and over \$660,000 per year in reduced treatment costs from the reduced volume of water getting to the treatment plant. So pretty impressive annual benefits as it relates to the plan.

Slide: Additional Information

Lots more going on with the program as you probably got a sense of. I went through those few case studies relatively quickly. A lot more information is available at saveitlancaster.com. I certainly invite you to go there.

Slide: QUESTIONS?

And with that, I will wrap up here and I think we will open it up to questions.

Eva Birk:

Great. Thanks, Andy. That was an awesome presentation and it's great to see those real down in the details case studies out there especially Lancaster where they have had good experiences scaling up their municipal programs. So thank you for that. It's very helpful.

Slide: Speaker Contacts

So with that, we have plenty of time left for some question and answer with our speakers today. And first I'm going to hand it over to Chris for a moment. We had some specific questions for him and so Chris, we had a few general questions on whether or not the analysis that you outlined in your presentation is available to the public yet, what kind of model did you use and whether that model was run for every state in the U.S.

Chris Kloss:

Thanks, Eva. And I'll take those a little bit out of order. The model that we used we actually developed in-house, a companion office of ours actually built it from the ground up so it's not something that's available for other folks to use. It was specific to the effort that we had. We are considering ways that we can actually share some of these data with folks. We do have information for each of the lower 48 states that we have. We do have state-level estimates, what we're trying to do is figure out a way that we can extract those data out from a very detailed millions of records into something that is usable. We did workshops in three states last year where we tried to pull out just those states and it's a bit of effort so we're trying to figure out ways that we can share that in a beneficial and easy to use way so we are still working on that and we will let folks know if we are able to get something out to share.

Eva Birk:

Great, thanks. Second question for Chris is whether or not the model you are referring to include ongoing maintenance costs.

Chris Kloss:

That's actually a great question and was something that I neglected unfortunately to say during my remarks. The costs that were developed here actually included not only the capital cost, it included ongoing and operational maintenance as well as replacement cost as well so it was a pretty comprehensive lifecycle analysis of costs. So those cost per acre that were shared did include all three of those components as well so that was a factor in the overall cost. So it was not just installing it, it was the long-term care for those systems and ensuring that they worked and within the 20 year horizon of the development analysis, if those were BMPs that were going to need to be wholesale replaced, that cost was factored in as all.

Eva Birk:

Great. Thanks. And then one more question for Chris in particular was whether or not there is any examples that EPA has published on how to go through that process you talked about of changing ordinances and getting green infrastructure on the books.

Chris Kloss:

Sure, EPA a few years ago put out the Water Quality Scorecard which kind of walks communities through different places that they can look to assess their codes. And we have actually conducted probably about half dozen technical assistance projects with a couple of communities across the country where we worked with them to go through either using the Water Quality Scorecard just going through their code individually to see where there were opportunities to improve those from a water quality standpoint and what the recommendation would be. So if you go to our website and look up under technical assistance I think under the “learn” button we have there, it will take you to the three years of, which we’ve been doing technical assistance, and those projects, there will be reports there that kind of walk through each of those, where comments were made, where changes could be made and some of the example language that could be used as well.

Eva Birk:

Great, thank you, Chris, and thank you for your presentation today. We have one or two questions for Dan in particular. Can you hear us, Dan?

Dan Christian:

Yes, I can.

Eva Birk:

I heard something briefly on the line. You might be muted.

Dan Christian:

Can you hear me now?

Eva Birk:

Oh, great, excellent. So one question in particular for you, Dan, is where can we find the references that you shared at the end of your presentation?

Dan Christian:

I guess the slides didn't show, but I have on the presentation, there are two slides that list out all the bibliography information for the references and those references come from a wide variety of journal articles, websites, books, whatever. So go to the library or look them up online, but the bibliography information is there.

Eva Birk:

Okay, great. So we will also have your slides available on EPA's website where Chris just mentioned there's another tab you can open up called “training”. So it's USEPA.gov/greeninfrastructure and then go to the “training” tab at the middle bottom of the screen, we do have all the slides for webcasts archived there and you can reference Dan's references there as well.

And the second question for you Dan is, when you've had such a great experience in the field

with different projects rolling out, after these BMPs are in the ground and business owners have time to adapt to the street scape, for example, being very different with green infrastructure practices versus without them, what kind of feedback have you gotten post-construction particularly from small businesses and storefronts on whether foot traffic has increased or whether they've seen increases in property values, all the studies you mentioned showed us percentages, but I'm just wondering if you have any anecdotal stories of particular projects where you saw a difference.

Dan Christian:

We do have some projects and I would say that we did the range of emotions. Some business owners really like the projects. They find it beautiful. They are willing to go out and maintain practices. Other times, unfortunately, I would say the business owners are not overwhelmed with the projects. We do try as part of that to go through and have an outreach with all the projects that are designed now in order to get the business owners to buy into things up front. I know that the businesses, such as the restaurants that have outdoor eateries, I think tend to really like the greenness aspect and so I think often times they have expressed some of the more positive results. And, I don't know, Andy might have some good examples for Lancaster along those lines, too.

Eva Birk:

Great. Thanks, Dan. And, Andy, I'll just turn it over to you, do you have any examples on a similar topic from Lancaster?

Andrew Potts:

I mean so far probably the biggest one is the plumbing along on the intersection I mentioned and the business is thrilled. Essentially they are at capacity now in terms of their kitchen can't keep up with their seating because of the beautiful environment and if it's a nice day, people want to go and sit outside the brewery. Who can blame them?

Eva Birk:

Great. Awesome. And then, Andy, the other question we had for you that came in was just in general, in Lancaster in particular, did you see that there was a learning process the city had to go through in terms of how they were going to optimize on costs for these best management practices whether they put one or two -- you identified different parks where they put demonstration projects in the ground. After that first wave of implementation, did you see the city kind of go through a process of saying, okay, if we're going to be doing this in a regular -- in a regular format that we are going to be doing every time we do a capital improvement project, how are we going to optimize on cost that way and going through sort of a learning process there? Did you see the city going through that kind of conversation and what helped and what didn't help?

Andrew Potts:

That's a really good one. I don't know that I have real specific answers, but there certainly was that process. It was a little informal and learning project by project. A lot of it is deciding when to, for example, sometimes you already have contractors on board through your street paving

or whatever, do you try and do things as a change order or as a new project and weighing the cost of going out to bid and the time delays and all that versus the pricing that often isn't very good if you try and do things as a change order. So certainly that, learning how to balance those things, how to effectively manage construction changes when you do want to make those changes, having continually refining standard details and things like that to kind of fine-tune both construction cost, but then also maintenance is a big thing and of course, maintenance costs and so the city is learning, oh, I like this type of pretreatment better than this one. My crews can -- technically they may be equivalent, but for some reason or another, whatever equipment they have, their crews, they prefer one type over another, so things like that are continually on the move and being refined.

Eva Birk:

Great. And was that informal feedback that came from the operations folks or was that something that Lancaster tracked in terms of like a lifecycle cost analysis?

Andrew Potts:

They are tracking lifecycle costs. That specific example was really working with the maintenance guys and out in the field talking about what they prefer and then updating those standard details accordingly and then that cost gets factored into their lifecycle analysis.

Eva Birk:

Great. That's helpful. So I think I will open it up now to Chris, Dan, and Andy and we had a few general questions just for the entire group. And the first question was, sort of along the line we've been talking about, when -- do you have basic estimates on cost savings that will occur when you are installing specific BMPs? In your experience, especially Dan and Andy in the field, what were the best ways to communicate that -- those findings and that message once you had that data on hand? We know there's a lot of different stakeholders and decision-makers out there that might be interested in that information but you only have a certain cost per project going into the ground, so did you experience success or stumbling blocks when you targeted a certain audience for that message, whether it was City Hall are a general public outreach or outreach typically to maintenance and operations staff at the city? What worked well for getting the message out? And Andy or Dan, you can take a stab first.

Andrew Potts:

I will jump in with a quick at least anecdotal story and then I will let Dan take over. One thing we found, and like I said, the city has just been amazing in terms of leading the program and Mayor Gray very quickly got on board and one of the things I thought he did particularly well was kind of communicate to some of these issues that get somewhat complicated to the general public. So I guess my, at least one answer to that is, just trying to make it meaningful and kind of connect with people's common sense whenever you can. So the big thing -- one of the big messages the Mayor had is why do we want to pay to treat rainwater. We are all paying this cost to treat this rainwater down at the plant. If we get it out of the sewer systems, we don't have to treat it, we don't have to pay for treating it or pumping it. And so it was just a very common sense and he said it much more eloquently than I just did, and to me it was just one way in that particular triple bottom-line benefit that you could very easily get people to

understand that concept and it just made overwhelming sense to the public.

Eva Birk:

Great, thanks. Anyone else have anything to add on that question?

Dan Christian:

I think I'd just add that I think it's helpful when the person at the top of the community is on board with it. It always makes the communication easier. What we found to be helpful and effective is lots of frequent communication. It is not enough to do something once. You have to really talk to lots of different people using lots of different techniques so we will have a technical flyer summarizing some of the technical engineering details and cost for one target audience. We will have more of a colorful flyer with big picture items for a different group. We will have information on websites, information to be presented at commissions and councils. So lots and lots of frequent communication seems to be the key.

Slide: Next Webcast

Eva Birk:

Great. Thanks, Andy and thanks, Dan. I think that we are just out of time here and I want to give you one big thank you again from our entire program for sharing your time today. We really enjoyed your presentations. Thanks to Chris Kloss as well for being with us here at headquarters. And unless anyone has anything else to add, I'm going to go ahead and wrap things up. Great.

So one quick reminder is that we will have slides available on U.S. EPA's website, the Green Infrastructure page, in 2-3 weeks. And we are showing you on our screen now the address you can find those slides. And then we want to invite you, as well, to join us on our next webcast on July 7th titled, "Paying for Stormwater, the Benefits of a Utility" featuring speakers Robert D. Chandler, Assistant Public Works Director for the city of Salem, Sheila Dormody, Director of Policy for the city of Providence, Rhode Island, and Andy Reese, Vice President of AMEC Foster Wheeler. Registration will be open in late June. Make sure that you stay tuned to our website or our green stream listerv to get update on when registration is open. And other than that, thanks for joining us on our webcast today. Great, everyone, thanks.