March 16, 2022

Univ of Southern Maine - SNEP Network

Emerging Stormwater Technologies

Live Captioning by Karasch & Associates.

Hello everyone. On behalf of the Southeast Finger Program, welcome to our webinar Emerging Stormwater Technology in Rhode Island: The Jellyfish Filter Seminar. My name is Leah from the New England environmental finance center and I will assist with the program along with Tessa Clark. In case you have not heard this network this mission is to empower communities to achieve healthy watersheds and sustainable financing and climate resilience through stormwater projects. We focus on building local capacity providing no-cost trainings and webinars and technical assistance to communities. If you want to learn more visit the network for more information. Before we begin there are logistics to keep in mind. Everyone will be unmuted to ensure audio quality. We will be able to ask questions by typing them into the questions box on your Control Panel. We look for to answering questions, so type them in at any time. Additionally, you can request a certificate of attendance for joining this webinar. Information on how to do so will be available in a

follow-up e-mail after the webinar. With closed captions available for the webinar. To view close captions click the link in the chat. Also in the control panel under handouts we have the presentations available for downloading. I would like to hand things over to Ryan, coordinator with the Audubon Society of Rhode Island to introduce presenters for the webinar.
>>: Thank you. Thanks for all of your help in the background with technical support. For those of you who are not familiar with the center we started about two years ago after the city of Providence and around 30 stormwater BMPs in Providence so we spent last two years using them to monitor them and research to better understand the function and performance and their overall effectiveness on water quality. We also used BMPs for public outreach and education by implementing educational signage and giving tours and hosting various events and festivals and we also organize trainings and webinars like this to bring together experts in the field and have them share their information and knowledge and lessons learned about stormwater infrastructure. Today's webinar is on the jellyfish filter we hope this is the first of a series of webinars related in collaboration with Rhode Island Department of environmental management going through some of the recently approved stormwater technologies. Today's presenters are listed

here. If you want a full bio, it is available at the URL on the slide. Brian Burns is with the Providence Park Department will talk about a future conceptual planning to install a jellyfish filter and use it as a training site for maintenance of jellyfish filters. And Chris still will be with the Rhode Island Department of environmental management talking about their approval process with these new proprietary stormwater technologies and then Derek Berg with contact engineered solutions will get into the details about jellyfish filter technology and some of the best practices when implementing and designing for the jellyfish filter and then Hernan Peralta and Brian Jarreau will give examples and case studies of projects that they have worked on in Rhode Island already using the filter.

We will break these presentations up with questions and answers. As we said at any time type your questions into the question and answer session and we will have plenty of time to answer them. With that, I will hand it over to our first presenter, Brian Burns.
>>: Thank you Ryan. As Ryan said my name is Brian Burns Deputy -- stormwater innovation center. We are interested in jellyfish filter for a situation we have here in Roger Williams Park. In this screen you will see the lower section is the park. itself. The

park proper in the upper left-hand side of this screen you will see the pond which is fed by a pond called spectacle pond and tongue pond. These are ponds that have varied waterways. They are rich with phosphorus and nitrogen of the other things. When the water leaves the pond it finds its way through a pipe that goes through a couple different and ends up in the inlet shown here going into Roger Williams Park that is a 48-inch pipe that brings all that water here and has for many, many years. At only do we have a problem with the water coming into the park. but we also have a problem with the water that is here now and the sediment in the ponds themselves are embedded with phosphorus and nitrogen and the end result is cyanobacteria. This is a very active park with a lot of people fishing here and we have swan boats and kayaking all sorts of water sports that take place here. So certainly from a public safety stance we need to do better with our water quality. So we could put as many signs as we want the people will do what they do and we need to make sure when they come in contact with the waters in the spark that they are safe. So to that end we are continually looking to improve our water quality and removing phosphorus and nitrogen and other contaminants that make its way into our water. So getting back to the pond, I apologize for my rudimentary drawing. It is not the

fact that I am not good at CAD, did not have time but it tells a better story, a story about the stormwater innovation center and what it is. This is literally a drawing that we made with conversation some of the great members of the stormwater center and DOT. The basic function would be the pipe comes in and goes to a couple testing ports and goes through the jellyfish filter which we hope will remove most of the phosphorus connected to the sediment. Because I won't speak to engineering of this because they are talented far more than me on this call but what we believe will happen is he phosphorus connected to settlement will be removed with the jellyfish filter and we are going to have a secondary facility that we can put different types of removal systems in as they are developed and as we choose. Thinking we will start with biochar. It will basically be a concrete stock structure that we test out for a couple of years with biochar. We might go onto the next think. I hope someone will and find a filter made of mattresses. If we could find a way to utilize them we would be doing well. From a conversation with a couple of experts and researchers we developed this philosophy. And this intent to do this. The reason was why we lead ourselves to the jellyfish filter is because real estate was at a premium. Not a lot of area between our property line and where this pipe comes into

the pond itself. So the jellyfish filter can be used in a very small area. This would be installed in-line in the pipe in line with treatment with bypasses that allow us to deal with the bigger events but in the end this facility will be right next to Roosevelt pond. Onever here from the pond is the casino. Never any gambling at the casino but we do a lot of trainings with the stormwater center at the casino so the hope is to not only install this and get the contaminant removal but also to provide training and some research about how this functions and what is needed to maintain them. So the Department of Transportation has several of these jellyfish filters installed. There installed in highways, but not a great place for training so is a dual cause but we want to have containment removal and want to provide training to agencies that needed. So that is why we came to the jellyfish filter option and we think that the treatment will provide us the contaminant removal that we need and also provide training opportunity around DOT. So that is the mission of the center to provide opportunities for stakeholders to share in challenges and struggles but we know that construction can be difficult in construction and maintenance. That construction if not done right can lead to poor performance which leads to poor water quality. That is what we're looking at here at the

stormwater center and why we do things we do pick the jellyfish option is a possible removal but a training opportunity. The biochar is modular so we can retrofit it but ultimately working together leads to better ways to manage stormwater and that is what we do here at the Providence stormwater innovation center reach out to us at the website and let us know if we can help in any way and if we can provide information we have been gathering about what you have been doing in your home or municipality. With that, I will pass it on to Chris from Rhode Island.

>>: I am coming. Hold on. Sorry.

>>: Hello everyone. Can you see my screen? My name is Chris, an engineer with the Department of environmental management. Today I will present about proprietary stormwater treatment technologies in Rhode Island and how vendors apply and how we review them and certify them. Who is responsible for reviewing and certifying these proprietary stormwater treatment technologies in Rhode Island? That is the responsibility of the Rhode Island technology review committee which consists of Eric Beck, Nicholas Pisani and myself along with Lisa Richardson from the Rhode Island DOT and Ross Singer.

Are there different types of stormwater treatment technology certifications in Rhode Island? Yes. There are three different types. The first one is a retrofit device which is basically something making an older or poorly designed site better and we are flexible on our minimum standards and performance criteria for this because it is still an improvement at the end of the day and ideally honest retrofit projects we would like to see at least 50 pressure of the water quality volume be captured and treated. But we are more flexible on the performance criteria for pollutant removals. Next, we have pretreatment devices group these are used to protect water quality BMPs from getting clogged with things like sediment and trash. We require that any protest prior pretreatment device must show at least 25% or greater removal of total suspended solids. These can also be used as retrofit devices. They're not going to get nutrient removal or necessarily bacterial removal but it will still be an improvement. That is why a can be used as a retrofit another note for pretreatment previously we allowed them to be used as oil water separators as well if they had greater than 500 gallons of hydrocarbon storage but we are no longer allowing that anymore because of some recent discoveries that we made. And last you have water quality BMPs which are the highest level of certification for a device. They must

provide at least 85% removal of TSS and 60% for pathogens and 30% for total nitrogen and total phosphorus. Vendors can also if they can prove with adequate testing that they can get higher pollutant removals, for example, the jellyfish is approved for 50% phosphorus removal, they can do that and also, they can get approvals for other things such as other pollutants like metals. Down at the bottom is application form that vendors have to fill out and submit to us to start the application process.

Moving on, how does the application and review process work for these proprietary stormwater treatment devices in Rhode Island? It starts out with the vendor going out and getting third-party verified tape testing. They get some testing for their device that shows that they get to pollutant removals that we require. They fill out the form that I shall delink to and then they submit the necessary materials specified in the application form to us. Then the review committee reviews the application for completeness and the vendor has an option to give us a presentation on their technology if they choose. Then the TRC evaluates the submittal and determines if the requirements are met and from that point we issue comments and request additional information from the vendor if necessary. Then once we issue comments the vendor

has a opportunity to provide responses and if not satisfactory then we issue more comments and keep doing that until the vendor can provide satisfactory responses or their device just will not get certified. If they do provide adequate responses then the TRC finalizes the certification conditions which include sizing of the devices to make sure they treat water quality volume adequately and things like maintenance and reporting. And then from there the issue the technology certification for that device. It is valid for five years. Once we issue the certification from that point we hold training sessions like this one for review staff in Rhode Island and designers and municipalities and potentially maintenance providers down the road. Pretty promising stuff. I was going to explain tape. TARP is the technology assessment protocol for the Washington Department of ecology. Pretty much the gold standard for testing requirements for the stormwater treatment devices. TARP is the partnership which consists of a few states throughout the country. I believe Massachusetts New Jersey Virginia and California may be a few others. We kind of fizzled out. It is not as relevant nowadays. Another thing I should mention is a lot of the treat treatment devices have been going through the New Jersey DEP for their certification on the TSS removal because they are another good program that has been

doing a lot of good work. Applicants that do not have certification already have the opportunity to submit reports and materials to us that have to be on par with the TARP requirements and that a specified in appendix J of the manual. But this is really not the best process to go through. We have limited staff so conducting a full on review of a technology like this would be a pretty big challenge to take on four us that is why it is best to have vendors get that TARP or New Jersey certification so they can get reciprocity and streamline the process.

Some requirements for reporting on the vendor. They can request a maintenance schedule after the first year of operation if the technology gets transferred to a day for an owner have to let us know any device design changes or model name and number changes. System failures along with what happened and how they fix it. And then annually we require a list of all installs in Rhode Island with the representative who was there showing that it was installed correctly and a listing of any maintenance providers that they may have trained

After that five year period once it runs out and the certification runs out they can get recertified. They have to have adequate

reporting for their certification. And provide us with any additional studies testing or certifications and if they have any previous certifications like expired or revoked then that can potentially lead to issues because we still need to have them show that they still meet the requirements for our rules. Another question you might have is what does the Rhode Island stormwater technology certification look like and what information does it contain? Open that up right here. As you can see we have the Rhode Island DEM header. This is the letter for the jellyfish filter which we are talking about today. Has the vendor information and when it was issued and expires. Then talk about how the device and technology application fits into our rules and how it differs from standard BMPs described in our stormwater rules and then we also explain what testing was done by who and when it was done and basically how it fits into our requirements and why we were able to accept it. And here we have pollutant removal set is approved for I mentioned jellyfish is approved for 50% which is more than the 30% minimum that we require for phosphorus. Some general certification requirements and making sure that they install it properly and use all of the right materials and whatnot. Has to be sized to treat the water quality volume and we explain the sizing as well. Will get into that later. And we have

the maintenance requirements right here. All proprietary water quality BMPs has to be maintained once a year and then there are some required for these devices. They have to have an upstream manhole to collect sediment that has to be cleaned out whenever it gets more than half clogged or at least twice a year and must be inspected. This is the reporting requirements as talk about earlier. And some other general language. In our signature right there. Here is the sizing table. You have the different jellyfish models and the approximate impervious catchment areas that they are able to treat without bypassing and then the associated water quality flow rate that they are able to treat. So for this model right here if they had one third of an acre of a parking lot you needed to treat, you would go with the JF 421 and that would handle it and it would be able to treat that water quality flow rate. And here you have different size filters with their different flowrates. This table is based on the largest size filter but there are some other language in the certification that explains how you get better quality -- water quality flow rates for smaller filters. And some general details at the bottom. Moving on, currently certified technologies in Rhode Island for BMPs we have these four and for pre-treatment and retrofit devices we have storm scepter hide or storm and these three. We are also in

the process of reviewing the recertification application for the modular wetlands system linear which is another BMP previously certified in Rhode Island. And this is proprietary technology and stormwater treatment in general, are pretty new topics generally speaking. It is an evolving world and some things to keep on the radar. EPA has not developed performance cards for these technologies yet but hopefully that is something that they can move forward on any future. Also ASTM is working on developing some standard specifications and requirements for these proprietary stormwater treatment devices. UNH will be heavily involved in that and then another thing to mention is we will be holding more training webinars on other approved technologies with DEM and the Audubon Society and the stormwater center will collaborate on these trainings. I hope you enjoy it. And will open the subject questions now. Also there is my contact information if anyone has any questions about proprietary technologies in Rhode Island I would be the person to reach out to. Thank you.

>>: Okay. Looks like we do have a couple of questions. But feel free to type them in the questions section if you have them. One that says who is responsible for enforcement that installed technologies are being maintained properly after they are

installed? Or does that exist even.

>>: The question was who was in charge of enforcing the maintenance.

>>: Yes or is there any enforcement? Back as of right now for all proprietary technologies we are requiring that the applicant for each project submits a two year maintenance agreement with a maintenance provider that has been certified by the thunder. Saying that they are capable of maintaining that device. Is at least two years into it. Enforcing maintenance has been a challenge for a lot of agencies and that is deathly something that we have to pay attention to and try to take care of in the future but right now we have the two year maintenance contract with just a pretty good start. And Eric might want to speak on that.

>>: One other question here unless Eric has anything more to add. Here is the other question. How successful are the recertifications after five years? Are certifications frequently revoked after those times? How common does that happen.

>>: I got started about a year and half ago when we rebooted this technology review process and prior to that the last round of certifications was about five years earlier so the jellyfish I got recertified and we are working on the modular wetlands recertification right now for those on only two that were certified at

the time. Getting the jellyfish recertified took a bit of a while because we were rebooting the programs and we wanted to make sure we were doing everything properly. We are also having some hiccups with the modular wetlands but that is just doing our due diligence in making sure that all the boxes are checked and making sure we fully understand these technologies and how they work and that they are designed properly. I believe the two devices that were previously certified as BMPs, the jellyfish is already recertified and other is on the way. Another thing is the storm -- another one that was previously certified and that recertification turnover was pretty quick because pretreatment in general tends to be faster of a process than BMP because like I explained in the slides there's a lot more that we ask for for BNP to do for treatment.

>>: Okay, if we want to move onto Derek and his presentation with plenty of time at the end for more questions so feel free to type them in.

>>: Can you see my screen? Hello everybody. I appreciate you taking the time to be here and appreciate having the opportunity to participate thankful for all the participants and folks partnering to put this together and ankle for DNS and the Rhode Island DOT for rebooting this process. It is a lot of what I do. As director of

regulatory operations for the eastern half of the country a lot of my time spent interfacing with programs like this working toward product reviews and approvals in sitting on stakeholder committees I am part of the ASTM group that Chris mentioned I will give a plug to that. Is very active. Virginia's part of it among number of other movers and shakers in the stormwater world and the endgame for some of the initial going to that program is to feed into what will become a national affectation process for innovative technologies in the grand vision is it would be for all technologies but I think there is a recognition that resources are limited and and a lot of states their just are not enough time or expertise to go through a vetting process of technologies like these. Most importantly is refreshing that Rhode Island recognizes that site constraints happen and that is where these systems come into play. We can often work around different constraints and fit in a small footprint and things like that. Today I will spend my time getting into nuts and bolts on what the jellyfish filter is and how it works and the core processes and components. I will get into a bit of a primer on how systems like this are sized as well as talk a bit about performance data and a quick overview on some maintenance basics but get too deep on any of that today but I think there is a nice chunk of time allotted for

questions so do not hesitate to type away as we are rolling along. We will get to as many as 10 and not during the Q&A I know I will certainly do my best to follow-up on anything after-the-fact. So let's get rolling. I thought it would be good place to start and talk about surface or membrane filtration versus bed filtration. The jellyfish filter is a membrane filter. You probably heard of some of the other filters work we have another filter that is a bed filtration system. If there is a cartridge filter with pleated membranes in it, one thing about membrane is they do a very nice job of filtering out foreign particulates. Jellyfish filter is a -- not targeting dissolved pollutants. But his application is particulate and particulate ion pollutants whereas if we are talking about a bed or media filter we can often customize that if we get into more specialized situations looking at dissolved metals or nutrients or things of that nature. With membranes one of the core things to keep in mind is that we are due most of your filtration at the surface you have to have a pretty fine interface that filters out particulate and let water pass through the membrane. Buildups a service cake and the nice thing about a service cake is actually makes the filter improve as far as the ability to remove particulates over time but we have to be mindful of clogging during the design and I'll talk more about that whereas with a bed

filter you get more leniency as far as clogging. You get interstitial spaces between the media and you have ability for particulate to accumulate within the media bed itself. You can have a higher hydraulic loading rate and I will talk more about how that plays out in a minute. A bit more detail about the jellyfish. On the right side of the slide is a jellyfish cartridge. Taking a look at it, it starts to give a handle white has a name that it does. Have these pleated filter tentacles similar to an air filter but these are long and skinny with pleated membranes and the whole point of the pleats was to maximize the amount of surface area in a given footprint. If you were to take a 54-inch long jellyfish cartridge there are 11 pleated tentacles on each cartridge. They all thread into a base plate installed in the system and there is actually a flow control orifice plate on the top of each cartridge so we regulate how much so can get through each cartridge break the reason is that with filters way they are typically tested and design is to establish a maximum hydraulic loading rate that they can operate at and meet their performance objectives as well as have a reasonable amount of longevity out in the field. So with jellyfish we have different sizes. It comes down to if you have depth on your site if you have depth to go 54-inch that will be often your most economical option because a quick rule of thumb is the deeper

we can go the smaller we can make the horizontal footprint. If we had to use a 15-inch long cartridge instead of 54 you are looking at a 4 X increase in the number of cartridges that would have to treat the same amount of water per so you have to be much bigger for that. You see high flow and drain down. I want to explain that and we will see graphics and video they get into that marker the jellyfish has a passive backslash mechanism. At the end of each cycle it ???s water through most of the cartridges in effort to maintain hydraulic capacity and knock a cumulative degree and cake sediment off the surface of the system. It is passive and not pressurized but it helps extend the longevity. The drain down cartridges that are at least one and often more than one drain down cartridge and every system and you will see how that works but those are capped at 50 percent of the hydraulic capacity. The reason is if the drain down cartridges or to clog up the rest of the system would reach the end of their useful life in the backslash mechanism would not work properly. So we restrict those to add some longevity to the drain down cartridges. You see there is a table with a column on the right side of the table that lists sediment capacity and that also factors into sizing. I will talk more in a minute but we don't just look at flow capacity. Filters are much less sensitive to flow then

sedimentation devices like some of the pretreatment practices. You can ramp up the flow on the filter and still hit your performance goals but where you usually suffer is in me longevity side of things. So in a lot of applications filters end up getting installed downstream of some sort of detention or attenuation we can ratchet on the flow quinone situations we do not just look at flow we want to look at how much masses potentially associated with that water quality value and make sure we have enough cartridges to provide reasonable amount of longevity given the amount of mass we will treat.

A typical system. You can see these graphics group. Feel like you need to figure it all out. I will get into more detail on the individual components of the system but you can see this is a typical manhole jellyfish filter system. Flow coming in through an inlet on the left side. Close into this little pool, the maintenance observation wall. Maintenance access while because we provide overhead access directly to that space so you can insert a backer hose directly into the sump and back it out. Also are all of our floatables and oil accumulate in that space. It provides pretreatment to the cartridges. Then goes down below the cartridge deck. Core solids settle into the sump without making it

to the filter. It has a built in pretreatment component to it. The systems are designed with about 18 inches of driving had a crusty system and one of the very nice things about working with a membrane cartridge versus a meeting cartridges that when it comes time to install and/or maintaining systems these membrane cartridges are much lighter than a wet sediment caked media cartridge that will often require lifting equipment to get out of the bulk jellyfish cartridges even when wet and fully utilized we can pull those out with basic maintenance personnel clerk that is on the big differences between a media cartridge which we offer as well.

And animation clip I will show in a minute I will post it a couple of times. This gives you another look or you can see the inlet on the left and flow passes down and there's a separator skirt that wraps around the cartridge and I will show you a good picture in a minute that gives you a better look. It is kind of a skirt that hangs down below the deck and provides a level of protection from any oil or scum or debris from getting wedged inside the membranes and then, obviously, the heavy stuff that can single go to the bottom and flow passes through the chemicals from the outside and hits the surface and flows through the tentacle into the center

of each of the tentacles and there is a drainage channel that leads to the top of the cartridge flow is discharged back on top of the duct and heads out of the system. I will fire this up and posit a couple of times along the way. I will turn over to this automated voice. Contact engineered solutions introduces the jellyfish filter. An engineered stormwater treatment technology featuring pretreatment and membrane filtration in a complex system. The jellyfish filter removes a high level and wide variety of stormwater pollutants. Such as fine particulates oil trash and debris metals and nutrients. Treatment begins as stormwater enters the jellyfish to the inlet and traps floating pollutants behind the maintenance access wall. Water is pushed down to the treatment chamber where a separation skirt around the cartridge tracks oil trash and debris outside the filtration zone and allows sand size particles to settle below the cartridges. Water is forced up from the treatment chamber through membrane filtration and into the backwash pool. >>: Will stop right there for second and give you another more in-depth talk on the backwash pool on the drain down cartridges that imagine before you can see the cartridges have that little 6-inch high wall around them and that is what they are referring to as the backwash pool. In this case this is a fairly small system. The one drain down cartridge located outside of the pool starts

building on the system and give flow coming in and ultimately that drain down cartridge will trickle flow upward to the point where this backwash pool fills and all of the cartridges will start spilling over and contributing to the outflow and what the spool serves as is at the end of the storm event when we treat incoming flows in the system has reached equilibrium that pool of water is unable to push back through the cartridges and discharge out through the drain down cartridges which are outside of that poker that is the passive backwash feature we are talking about when we speak about that.

>>: Once the water has filled the backwash water overflows and connects to the outlet pipe. High-performance membrane filtration provided by the jellyfish filters pleated tentacles ensures long-lasting treatment and provides a large surface area to effectively remove fine sand and silt size particles and a high percentage of particular pollutants such as nitrogen phosphorus metals and hydrocarbons.

>>: And I want to hit on this but it says reactive capacity to these membranes so when talking about removal of other pollutants outside of solid and strictly the particulate found pollutants. I will show you dead in a minute. There is a growing body of research that is paramount of the metals and nutrient and stormwater is

often associated with particulate loads often north of 50% based on the data coming out for a number of these different systems.
>>: Flows back into the treatment chambers through the membrane cartridges in this passive backwash extends cartridge life and keeps them clear for future events. The drain down cartridge outside the backgrounds enables water levels to balance.
>>: So this are pictures I wanted to show you with a real-world view of some of these components and features. Asterisk down at the bottom left corner of this slide trigger that is a standard manhole system given cartridge deck and you can see the backwash pool around the bulk of those cartridges but this one is equipped with two drain down cartridges. You can see the maintenance access while on the left and there's a pipe inserted which is pretty common for anything other than the smaller systems trickle use that as a pressure relief and emergency overflow if we ever got into a situation with the system is clogged and neglected certainly would not want to create any upstream issues as a result so we do provide emergency relief and a majority of the systems to address that. And to your left is a good view of the skirt that hangs down at the bottom of the deck. Cartridges will be on the inside of that and the intent is to keep the

book of oils and greases and things that can come up filters off of those cartridge membranes and circling around at the top right is a similar view looking right down into the maintenance access wall that is generally specified as large enough to send a person down into if there was ever an issue and someone needed to get down in there. The last one on the bottom right you can see crew in there installing the maintenance access wall in the drain down cartridges behind them as well as a standard cartridges in the drain down pool further to the left. In the picture in the center is looking down the manhole view into a small system, Inc. to cartridge one drain down system, probably a 4-foot diameter manhole most likely for something that small.

Working on about standard configurations group manholes are very common for the smaller projects. We can scale up anywhere from 4-foot diameter to 12-foot diameter manholes. That is about the limit that most pre-casters are making manholes these days and there is some structural limitations with specs on how big they can get but the general is once you know how deep you can go you know what your capacity is per cartridge and you can pick out the number of cartridges you need based on your water quality flow. Also do bulk swim get into big projects of much use

jellyfish there is really quite a bit of ability to go large with the vault and we can do multiple smaller units on side as well. Makes more sense to disperse. A nice thing we can do these vaults and I will talk about online versus off-line is the jellyfish is an off-line system not intended to treat flow or help close route through above its water quality volume. But when we are working with a vault system we can do a peak diversion design or we incorporate a bypass structure into the same vault structure upstream of the treatment but we can route water quality treatment into the bag and bypass downstream without needing separate manholes to do that. On the smaller end of things we can design small curb or grated inlet catch basin style systems. Goals are limited I think they both max out at four cartridges and a couple of drain downs in a catch basin style configuration. As I mentioned this is a standard off-line layout 40 manhole jellyfish system, common for systems weight we put them off-line. But does require the junction structures. Designing this the general approaches to design so that we have 18 inches of driving had available between the crest of that diversion manhole and the outlet in the jellyfish system itself and then we are returning flows to a separate junction manhole. If we had a vault design in play we can often put that ball in line and use peak diversion concept to

achieve this without those extra manholes which often times is appealing depending whether or not there is constraints or pace or space imitations. From that perspective we have online design tools and automated design tools and I will steer you to that but this is one of the reasons we prefer before final designs are in place people reach out to our design team to make sure that we are checking all the boxes on what is possible and what makes more sense.. Switching gears, talk about some general filter sizing stuff. Wont get too deep into things. The jellyfish is a membrane filter a fixed prosody. I'm sure there are membranes but from a generic perspective talking about filter performance the type of media and often the gradation a major driver in how well that filter performs. It is not so much an issue with an inner membrane but when we get into specialized media, want to make sure we don't set ourselves up for leaching of previously captured pollutants or toxicity concerns. During the product development process that we have come across we have found to have some toxicity. Not something that can be overlooked. May do a great dog job of filtering stormwater but if toxic to invertebrates or things in your streams is not an ideal solution. Something to be aware of. All things created equal finer media does a better job of filtering but defining the media generally the more rapidly it will

clogged. Always a balance that needs to be struck between those two things. Hydraulic loading rate is going to be a key factor. As I mentioned when we got started the way these filters are designed and tested is to establish the hydraulic loading rate and usually expressed as a flux rate or commonly known as gallons expressed per minute per foot square of area and if you recall back the jellyfish is pretty low is at 0.21 gallons per minute per foot square and we can keep it low and still get slow because of all that surface area we are able to add using a pleated membrane. Or something like a granular cartridge filter loading rates tend to be higher because we have much less surface area per cartridge. Within the stormwater industry, we tend to see things between 0.05 very low all the way up too 10. We have never tested or achieved the kind of results we think are needed to meet modern stormwater regulations. Anything approaching 10 have another filter known as a storm filter that has been around a long time and it is 2 gallons per minute per foot squared. It is a course media. Filter longevity I mentioned. This comes into play when we are downstream of attenuation whether a pond or underground storage structure is very common especially in the eastern US where we get very intense rain events. Treating it in real time is feasible but can be more cost-effective to attenuate

the flow and slow release it from storage because you need a much smaller filter downstream. Holder want to be mindful of the fact that all that water has mass in it and if we go too small with the filter downstream Winter Park unit frequently and that is something we try to avoid by switching to what we refer to as a mast load design. That is where through testing we try to established how much mass the system handle on a per square foot basis before they generally start to clogged. Like all things it is not perfect. We have to make estimates and every site has different constraints and if you have a lot of oils or something unique it certainly can change that math but we try to incorporate it into our logic to make sure we are not setting ourselves up for a giant maintenance burden right out of the chute because I can record the erasing savings that you made on the install of the filter.

A bit about performance, we have heard Chris talk about tarp and TARP and that is exactly the programs that jellyfish have been through figure you want to talk to states that have programs like this to evaluate innovative technologies there is very few that will even open the door if you have not been through tarp and now increasingly TARP trigger there is not that many differences

between tarp and TARP other than TARP is probably a bit more current and has been updated several times. Both came out around the same time. Both are long-term field monitoring programs. Talk about going out in the field and collecting data over a year or more I both have requirements for the minimum amount of storms after capture and data quality and How many samples per storm and how much of the hydrograph you cover for pretty involved stuff and pretty extensive stuff. It is one of the reasons why that reciprocity is gaining traction. These are north of $200,000 when they're all in and start talking about the fact that it is usually done by third parties. Sample analysis is done by third parties so it adds up fast and it is not fast or cheap so being to transfer that data and use the local rainfall for sizing is becoming the norm only stormwater world. The data on the screen here is from a tarp study done at University of Florida under the direction of John Santa Monicas downloader stormwater research. It performed very well done there. Nearly 90% TSS encroaching total phosphorus per decent for total nitrogen as well per nitrogen is a stormwater wildcard results vary a bit more than other pollutants also did well for metals. Our experience is, is doing a good job on phosphorus and usually does a good job on particulate medicine because they tend to

bind to about the same size particle. Have another study now out of Oregon done on a protocol that I just mentioned. Similar results. Always nice when you can reaffirm what he saw on one site with work done on another. In that site we exceeded 60% TPN similar nitrogen results in similar TSS results were not getting much metals on that site so do not have great metals data. Because we were getting on detects for most of the storms. Those do not end up getting recorded as part of the study. A few select certifications. Rhode Island at the top of the list is probably the newest for the jellyfish but at this point the jellyfish has been reviewed and certified or verified or approved. It is approved by the vast majority programs in US and Canada that have a formal list in place for both Maine and Vermont also have lists and here in the Northeast Massachusetts and New Hampshire we are talking to and helpful that they will do something similar in the future as well. And New York State in New Jersey and then to the eastern seaboard of Virginia and the Carolinas that have some form of approval and similarly out West. The list is ever-growing but the data speaks for itself once we get through these long expensive studies it allows us access to participate in stormwater management in most stormwater programs. That is a trade-off of doing a long expensive field study. Maintenance another video

clip that is a giant jellyfish tentacle. I will display and you can see there is an attachment that you can refurbish these tentacles and clean them out on site versus doing a full replacement. I will let this play for a second. I'll stop that there. If you have lots of cartridges that can also be a pretty prolonged process and different folks prefer to do things differently. You can certainly joyful cartridge exchange but it increases the cost of maintenance but it is a viable one. There are instances where cartridges wear out over time. We have had a couple of systems where they were neglected and had very high solids loading and the cartridges got buried in sediment and shredded up a bit. Certainly not out of the realm of possibilities. But we work with some public works crews that prefer to take systems back to their maintenance facilities and clean them out themselves. You can do this work on-site. It is a bit messy but if you have the equipment in a small system is not out of the question to refurbish those cartridges on-site. Generally speaking it is all about getting the cartridges and replacing or refurbishing them and backing out the sump of the system and then getting the cartridges back in. Pretty straight forward. The bigger the system the more involved the maintenance is going to be. Contacta does not provide maintenance services directly but what we do is we have certified

maintenance provider program where we train and certify no and they understand or systems and components and what needs to take place. Have also trained public works departments and devotees and anyone else directly wants hands-on training from us with videos as well. We have a crew of people in our field services team who are responsible something goes wrong during install or someone wants maintenance training. We have a team of people provides that surface. I don't have time to go much deeper on maintenance today but this is a quick primer on how the jellyfish is cleaned and last but not least for me I mentioned at the start that our ultimate preference before the project is in final design. That you reach out and engage with our team if on-site engineers assigned to each state so we have what we call a stormwater design engineer and a consultant unique to Rhode Island and familiar with all the rules there and the design requirements and what is approved. They will be your resources to walk any given project through from design to install. There are a lot of tools on the website. We have design worksheets and tools if you just need a quick estimate of what you're dealing with all the technical documentation and more in-depth maintenance and more in-depth information on system performance and this is true of all of our technologies. If you are ever looking for basic

information that is the place to start short of calling one of us up. That is it for me. I think we're onto our next question-and-answer session.

>>: Looks like we have one. Can you discuss again, the reciprocity with Massachusetts or the lack of reciprocity as it relates to certification yes.

>>: I believe they just kind of work with municipalities on a case-by-case basis.

>>: I can speak with another perspective because I engage with Massachusetts, they are an interesting place not a guilt delegated state. EPA has a role there. They roll up under EPA umbrella. State have some authority through their wetlands rules and as far as innovative technologies (inaudible) they had a bunch of technologies like this jellyfish was on it. As were a number of other things. That was defunded five or six years ago and it has created a bit of an impasse. I think Eric and Chris mentioned that you're talking with them but we are talking about them offering some new form of reciprocity along these lines. Right now they use a lot of these types of systems in Massachusetts per the tricky part or the frustrating part is it often has to go to project by project review. They do not have a fully established list that you can say you are good to go if you cite properly so they are

absolutely allowed and depending on which municipality, they have their preferences. They have different nuances. But there is in everything from the pretreatment practices to more advanced filters but they have not got a fully functioning approved list of the moment. Thank you. A couple other questions that can be combined. How do you dispose of cartridge cleanings and is a cartridge excess sediment wash back into the unit under the ground.

>>: You need to dispose of that as you would any catch basin or stormwater sediment. Obviously, slightly different rules and I'm not a Rhode Island disposal expert but you need to retain that sediment and dispose of it properly as you would any catch basin waste or anything you take out of your stormwater BNP. States do have some testing requirements and if you check over or have contaminated settlement with high metals concentrations or something like that or you had an oil spill, that can change the game but all that stuff you background in the settlement you wash off the cartridges does need to be retained a properly disposed of.

>>: Okay. Does not look like we have further questions but feel free to put them into the question section. We have time allotted at the end of the next two presentations as well for so we can pick those up again, later. We will move on to Hernans presentation.

>>: Good morning, everyone. Jaime technical manager. For the first case study we will talk about a project in College Hill specifically in Providence Rhode Island. The site itself pretty small and congested runoff from the site discharges into the city separate stormwater that ultimately falls to Providence River which is an impaired water body for both bacteria and nitrogen. So that was kind of our pollutants of concern when designing these BNP. Self we knew going into the project that the site is very congested with utilities. We knew that there were poor soil conditions and we had steep slopes to work with. As based on our project springs around with existing conditions coming in as well as understanding what the proposed building footprint will look like, that kind of confirmed that designing and implementing a more traditional BNP would be impractical. So we turned to the approved list and at that time Chris mentioned there were only two treatments are preapproved as a standalone system. One is the jellyfish filter and the other was a modular wetland ended up selecting the jellyfish filter the main reason was that it had a smaller footprint than the modular wetland because of its vertical orientation, so the system we ended up designing 6-foot diameter jellyfish system with I think seven cartridges in the unit. The system was designed to treat the 1 inch treatment over eight

tenths of an acre of drainage area, mostly impervious with a combination of roof pavement as well as hardscape areas. During the design process couple things to consider and I think a couple presenters have already mentioned like all treatment systems who want to consider whether or not there is an off-line or online system. Obviously, off-line would be recommended. It avoids having to oversize a structure to bypass larger flows. For our project had to design as an online for a couple of reasons. One of them was the fact that the site is very congested with utilities so we did not have any room for diverging structures and a bypass so and the fact that the drainage area was less than an acre, small enough that we could design an online system to allow people flows of about four CFS through the system so if you had to design it as an online do consider the headlock through the structure compared to a manhole standard because there is a fill in where system in the unit that could potentially create additional head loss to the system and like most proprietary structures they are designed based on a parameter good couple of things. As designers size a system they can refer to that table that Chris referenced in his presentation to size a system. Looks like the sizing was based on impervious area as well as water quality flow by the second option is you request contact to do the calculation

for you and that is what we did for this project. We sent a contact with the drainage area% impervious as well as a treatment depth and they were able to provide a subcode collation worksheet that shows water quality flow calculations and third what you could do to calculate water quality flow issues the equation prescribed in the manual that is based off of TF five methodology to convert water quality volume two water quality flow. Other considerations is the number and angles of inlet pipes. For our project way to inlet pipes with an awkward angle but the structure was able to accommodate the very tight angle between inlet pipes all these design elements, the good benefit about working with contact is a lot of these design elements can be worked out with them with their assistance. The photo to the right is the unit installed project is two construction. Completion is next year I believe. Ultimately found with this unit is that because it has flat slab there is not much -- it is limited to field adjustments if you have two lower the structure, for example. So what we did for this project and for the project we did a system located at a problem area and the landscape architect did not want to see the casting because it will be very visible pork part of this design was to install these window covers that would sit on top of the actual casting of the unit and would match hardscape area to kind of hide it below the surface.

In order for us to allow flexibility in the field adjustments for the site contractor we set the castings not eight to 12 inches below the finished grade so that if they have two lower the grade they would not have to make any adjustments. There will be eight to 12 inches play to use. However, if we had to raise the grade, we could use bricks or concrete collars to raise those castings. And another insulation note is when the system gets delivered on the site it has all of the internal components except for the filter cartridges itself. So once the site is stabilized that is when either the site contractor or the owner will reach out to contact to initiate that delivery of the cartridges. That was a quick case study at Providence. It was pretty straightforward design. They were very helpful and through the design process we were able to to manage a lot of the challenges that we face with the site because it is ultra- urban and very congested but overall, it went pretty smooth fall as designing that. I would like to turn it over to Brian for the next case study.

>>: I will talk about two different projects. First, project is project Schooner located in Johnston Rhode Island. Next to the intersection of 295 in Hartford. This is a proposed large industrial building with extensive improvements to Hartford and widening in the big problems we had is impaired waterway for bacteria and

copper. High groundwater and high ledge. Steep slopes. Infiltration areas are very limited. And with the Hartford Avenue improvements we have impervious area an existing area not treated and in a limited right-of-way. Not a lot of room to do things. We propose -- we propose jellyfish. Want to help increase the removal across the site and the middle picture we added it to the underground sand filter. Filtration was not possible so we added on a jellyfish to help get those rates then to other areas along Hartford area and limited areas like entranceways going toward the main roadway with limited room to do things we added jellyfish at those locations to maximize water quality to the maximum extent. Give us opportunity to treat as much on Hartford Avenue. The next project is tidewater land Dean in Pawtucket Rhode Island. This is located on the river and this was a former contaminated site and old manufactured gas plant. Abandoned and cleared today but needs to be remediated. It is a site that is long and impaired waterway. And preparing for bacteria nitrogen again. Any increase to the impervious area can cause pollutant loading analysis practices where the jellyfish helps. In the site like every other site we are maximizing the site this is in a very urban area and 10 pounds of stuffing 5-pound bucket. Still the jelly was useful because we had city line coming

through the middle of the site that has probably close to 10 acres of storm water with 80 acres impervious. We were able to take that to off-line configuration and with a 16 by 8-foot structure a really small footprint we were able to treat those 8 acres and get down to the pollutant loading that we need. This is where we see the big benefit in the jellyfish, those tight spots that are hard to reach intruding the maximum extent practical because we could do it in a small footprint and without much of a problem site. Those are my case studies. Back to Ryan.

>>: Okay. Thank you for sharing some of your lessons learned. And when implementing a jellyfish filter. Looks like we have one question for Hernan about specifics of where exactly on the brown campus the project was located.

>>: The project was for the performance arts center. Completion is next year.

>>: Okay. Doesn't look like we have any other questions at the moment. Some more coming in. Here is one about what are some general costs of the jellyfish filter units? Derek?

>>: Hard for me to give you a defined answer. I do not know the priceless but safe to say they are economies of scale and by that I mean if you just need a couple of cartridges it is a few thousand dollar thing but when you get into the mass of systems per

cartridge costs start to go down but similar to a lot of these innovative BMPs they are not cheap per se. They are certainly pain to save that space but if you want to reach out to me I can put you in touch with a consultant who can start to tune in on I ballpark price. I don't have the information at my fingertips.
>>: Okay. Another question says how has recent economic conditions affecting pricing and lead times.
>>: Right now not too bad where watching summer and depending on where they are shipped from with trucking delays have been slowing down we have seen a little bit of slow down with some of our pre-casters and parts of the country but no questionnaire has been some material cost increases. Jellyfish is not as impacted we have taken a hit on steel. We do corrugated steel pipe and that has increased quite a bit in price. But so far jellyfish has not felt that kind of pressure.
>>: Okay. I do not see any more questions coming in. If anyone in the audience has a question you can contact me at the Providence innovation center and I will make sure that your questions get out to the presenters and they will provide an answer back to you. We will be sending out a survey. If you can take time to fill that out the results will help us developing future content and future webinars and stay tune on her website for an

idea of when the next webinars and other events and trainings becoming out. Thank you every one thinking to the presenters and organizers and thank you everyone for attending today.