2021 Design and Construction at Hazardous Waste Sites Virtual Symposium

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Closed Captioning Transcript

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I

Good morning or good afternoon, depending on your time zone. Welcome. This is Jean with the EPA field services division. I will serve as a technical moderator in the background for today's upcoming DCHWS virtual symposium. For those of you who connected early, we're in the process of refining our welcome screen. I apologize if the screen went white there for just a moment. It looks like we do have our materials up and running just in time to officially begin our session at our scheduled start time of 1:00 p.m. eastern. So, with that,im going to go ahead and turn on our recording and officially welcome everyone to today's 30ual 2021 design and construction and hazardous waste sites symposium. Today, we're carrying on with the virtual symposium. This is day two. We'll be joined by panel 3 and panel four. I am going to go ahead and gently remind each of my presenters and participants if you're on the lines by phone, please be sure that your phone is muted. So, with that very gentle reminder, again, my name is Jean and I will be serving as a technical moderator in the background joining you from E.P.A.'s technology innovation and field services division here in our super fun program. I am going to turn things over to your panel moderators and speakers in just a moment. I would like to walk through a few quick housekeeping items to make sure that everyone understand how to participate. Each day in the virtual symposium, you will be directed to our seminar home page, which looks like this screen shot. I just wanted to remind everyone that at the top of that page, there will be a join webinar button that you can use to click and then check in online to join us to our live broadcast each day. I will also remind you that on that page, there are tabs which will give you information about our presenters, links to access their materials and Bruce through related resources and feedback after the event is done. I encourage you to bookmark this page to use it for reference later on. For those of youable to join us live in the Adobe Connect environment, we'll host everything through Adobe and cover a seer of inter active panel segs today. We encourage you to join us live online when possible. We suggest you disconnect from VPN or virrual remote networks when possible for a broadcast. The audio should be defaulting to everyone through computer speakers or headphones. Everyone listening online is automatically muted. Those of White House choose to call in by phone are also automatically muted when you dial in on the phone. We ask that you remain muted to minimize background noise or audio disruptions. If you're unable to get the online audio to, woke, please take a look at the top of your screen. You should have audio controls.

Look for a green speaker icon that you can use to adjust the size and devices where the sounds are going. Again, if that doesn't solve it, simply let me know using the Q&A window in the lower corner of your screen down in the bottom right. You can privately report technical issues as well as share comments and questions at any type. So if you need assistance or need the call-in details, feel free to ask for that any time in the Q&A window. Just to make sure that everyone is comfortable using their Q&A window, I will ask each of you to go ahead and use that Q&A window and type in a greeting to our presenters. We have a fantastic set of panels and welcoming speakers today. I ask each of you to type into the bottom corner of the Q&A, the greeting to the speakers. The window is private, the audience can't read them. Our panelists and moderators can manage that in the backen. I see so many greetings and welcomes. A number of people are excited to be here and people are connecting from all over. Thank you so much. That is the exact same technique that you will be using to send in your questions, comments and as I said, reporting any technical issues that you may encounter. Now, we will pause later and I will go through our agenda in a moment. I want to make sure that everyone knows you can submit your questions and comments at any point in our broadcast today. There is no need to weight for a designated break. Type them up and we'll get through as many as we can in our allotted Q&A breaks. Our seg is being recorded -- session is being recorded as the 9 viewer virtual symposium will be. When the entire series is done, you will receive instructions by e mail how you can access the recordings and play them back on demand. I will ask you to stay with me until the very end because I will provide important reminders, including how you can share feedback and download a printout of webinar certificate for joining us in this virtual day. All right, visually on the screen, you all will see an interface something like this. There will be presenting a content and a large window on the left. You each have a button. It looks like a box with brackets around it in the upper right you can use to make the slides larger as needed. You will see information about our presenters in the upper corners and as noted, the Q&A window that you can use to send in comments and questions at any time. For those of you requiring live closed captioning, I have already provided a link in the Q&A window that you can use to access closed captioning in an alternate window where you can further adjust the size, color and speed of that captioning playback. With those very brief reminders, let me, again, welcome everyone to our second day here at the DCHWS virtual symposium. Remember, the event has been designed to help facilitate open and frank information exchange amongst professionals in the private and public sectors. They work to provide a variety of forums for presentation, describing current practices and approaches in the areas of hazardous waste design and construction. It also enhances communication networks amongst the stakeholders involved in site cleanup. As we're starting our session, I wanted to provide a bit of background about those who have registered to participate. Although you may not be able to see each other virtually, I wanted to give you a little bit of a picture of who is sitting around the virtual table today. We have over 415 registrants. A large major are coming from the Federal Government with a number of state regulatory agency and a large sector coming from AEC and a number of other participants. We have a great representation with 89 family members and 118 young

professionals. Geographically, we have representing a from all across the United States -- representation from all across the United States, we have a heavy presence from the northeast and have two international attendees joining us. So, we're just so happy to see that we're able to reach a large international audience here to help ensure that the DCHWS message is reaching such a broad audience. Our agenda for two day in the virtual symposium. We will start with the open, remarking in a moment. I will turn it over to the plannary speakers, after they provide opening remarks. We'll start with our first of two panels. The first panel, panel three, they will look at proactive site management. We'll pause for a brief intermission or break and enjoy a few words from issue haven't sponsors and regroup again after the break for panel four, where we will talk about project risk management considerations and disposal challenges. At the very end, I will come back on the line to provide closing reminders. Most of our sessions will be following this format. We'll be joined by a special moderator and three panelists. Each of the panelists have been given 20 minutes to provide a technical presentation. There will be opportunities for engagement with our panelists as well as the facilitated Q&A or questions and answers session after the three-panel presentations are complete. As I noted earlier, please do not be shy. Share in your questions and comments at any time using that Q&A window, and we'll try to get through as many as we can in the time that we have a located -- alloted today. I did want to be sure to thank our event sponsors. Of course, we have our DCHWS symposium committee, the superfund remediation and technology innovation and the Sammy Philadelphia post who helped sponsor this event. We have our event sponsors again, without their generous support, the event wouldn't be possible. I would also like to thank our large business sponsors as well as our small business sponsors for helping to make the event possible. So, without further a do, I would like to introduce everyone to our plannery speakers, who will be providing introductory remarks on today's segs. We'll be joined by two speakers today. We first have, pardon me while I move something here on my screen. My apologies. We'll be first joined by Karen. Show is the cochair of the DCHWS east steering committee and the federal program manager for TTI environmental where she is responsible for business development and contract management for TTI's remediation, decommissioning, demolition and comprehensive storage tank services. That TTI performs with the own crews and heavy equipment nationwide is a prime contractor to the government and private sector. We'll also be joined by Amy baysor. The cochair of the east steering committee and the director of communications and marketing for Coleman holdings LLC. A holding company for Alaska native corporation. And in this role, Amy is responsible for business development pipeline tracking, backlog, strategic planning, marketing, branding, communications, and compliance of business development efforts across the family of companies, including nine subsidiary companies. With those very brief introductions, I would like to welcome our two speakers and I am going to go ahead and turn it over to Karen to begin with her remark s.

Karen, I believe you're off mute?

Yes.

And thank you. Good afternoon, welcome to the Philadelphia post symposium on design and construction issues and hazardous waste site. DCHWS in close sponsorship with E.P.A. I am Karen buniak, the cochair of the sum pieceium and federal program manager for TTI Environmental. Annually, this event hosts more than 400 attendees Nationwide. The application of engineering and science associated with cleaning out waste sites continues to evolve rapidly. We recognize this and together, the Philadelphia post and E.P.A. have facilitated the interactive engagement between professionals from governments and the profit sector related to vigilant and topical issues affecting the voomal field, including state-of-the-art approaches to cleaning up hazardous west sites. This platform for discussion and communications about parents, environmental will changes has created an open dialogue between industry and government decision makers. And this allow the E.P.A. and other federal and state agencies to manage, execute, and bring environmental projects to completion through honest, dialogue and sharing of challenges that would not be realized.

Good afternoon. I am Amy baysor, also cochair of the symposium and director of communications and marketing for Coleman Holdings. The cancellation of our in-person 2020 event, we're anxious to gather again face-to-face in 2022. Mark your calendars for March 30th, 31st, and April 1st, 2022 at the Sheraton, Philadelphia. If you're registered for 2020, as a private industry exhibitor or sponsor, you're automatically signed up for 20 two. If you were a government attendee and sign Up prior to 2021, you will need to reregister. If you have any questions, Karen and I are available to help. The outcome of this ongoing programs multifaceted. The program supports professional development of our attendees by offering professional development hours certified by ACEC New York. This offering resulted in attendees returning year after year and with ongoing demand, and we look forward to your continued participation. The Philadelphia is directly in charge of coordination, management and five area responsibility of this program. The DCHWS steering committee provides leadership for this event I would slick to recognize all of our steering committee members today. Jim [Inaudible] , Andy bullard, lyle Trumbull, Jimmy blake, gordon aruzo, muk fidell, Jamie Wright, Dan amoti and Kate Garufi. The post efforts are extensive as this event provides many opportunities for government and industries to submit abstracts, provide presenting as, sponsor, provide moderators, network and mingle with attend's when in person, made up of government and industry. As we run into the next century as a society and the Philadelphia post 101 system year anniversary. We're proud of dchws as it's the most well-attended technical event in the post history. It exceeds the mission of leading collaborative efforts to identify and resolve national security, infrastructure related challenges.

The Dchws steering committee on behalf of the SAME Philadelphia post is honored to announce this yearee DCHWS scholarship recipient. Each is receiving a $1,000 check from the post. This year's recipients are Kennedy Brown,-like molnar and Aiden [Inaudible] Your attendance at DCHWS makes the effort possible. Thank you for attending. Jean, back to you.

Reporter: All right. Thank you very much, ladies for the opening remarks. I will transition to the introduction to the first panel today. I want to make sure the audience is ready to start. If you're ready to welcome panel three, put a message into that Q&A window and let me know you're ready to start with panel number three. And now they am seeing the messages and we have an excited audience, it's my pleasure to introduce the first panel moderator, Kate Garufi, who is a project manager -- pardon me, project management professional. She's the rocky mountain region remediation lead for HDR based out of Denver, Colorado. In this role, she partners with federal clients, including the U.S. E.P.A. and U.S. Army corps of engineers on complex remediation projects. It comes as no surprise to many of you in attendance today before joining HDR, Kate spent 16 years at the E.P.A. headquarters in her office of superfun remediation and technology innovation. At E.P.A., she was a supper fun program expert and site management design and construction project delivery and technical project 16ing. She holds a master's degree in environmental engineering from Johns hopkins and chemical engineering from Virginia tech. I will turn it to you, Kate, to introduce us to your panel.

Thank you very much, Jean. I will confirm that you can hear me.

Yes, I can.

Okay. We'll get started. So, welcome, everybody, to day two of the 2021 DCHWS symposium. Panel three and four of our symposium, the topic is designing construction project management case studies. I am super excited to moderate panel three, which is proactive site management. We looked earlier at over 400 attendees. A lot of you are owners, federal, E.P.A., corps of engineers, owners of environmental remediation projects and a lot of you are architects, engineering, construction entities that whyer helping your clients -- that are helping your clients deliver projects. As we have been looking at super fun and environmental remediation projects, specifically large sites that are addressed under surplus, we dealt with the low-hanging crew. The projects we have now and the projects you all are managing are large complex multioperatable unit projects. As the site manager and thinking about site management, you're thinking about really three things. You're managing the technical components of design and construction, you're managing the regulatory surplus framework that we're working under, and you're managing stakeholders. So, what we're going to talk about today is really trying to push the concept of proactive site management. So we define the site management and proactive is really creating or controlling a situation by causing something to happen rather than responding or reacting to it. So, proactive site management is a combination of systematic planning and really just, you know, proactive execution. So not being, sitting back relaxing and watching your site, but being proactive and managing and constantly questioning assumptions to get the site moving forward. So, what kind of things can we do to proactively manage a complex site? We can leverage existing regulatory surplus stabilities. In terms of early actions if we have a lot of unknowns. We can use project management tools and techniques. Project management plans, communication plans, structured change management processes, use of consensual site models.

Does adaptivity management ring a bell? We can apply third party reviews and look at value engineering studies and optimization. Finally, especially for you government people on the phone, there is a lot of ways to proactively manage a site and be as nimble as possible by planning, designing construction delivery strategies and acquisition approaches that can allow us to react to changes without getting stuck and bogged down in administration. So, today, we have three case studies that are going to give you examples of how these projects leveled the tools and tech notions that I just referenced -- techniques that I just referenced to get their sites moving forward. Without further ado, we're going to get started. Our first presenter is Paul Favara. Paul is a technology fellow with Jacobs Engineering. He has over 35 years of remediation experience and is a registered engineer. He presented multiple times at this conference and can be a great information about developing and implementing cleanup strategies at complex sites. Before Paul gets started, one of the things we would like to do is get your feedback on what you think adaptive site management is? Please select what you think it is. It's going to give Paul a good starting to point to talk to you about how he applied adaptive management at his case study. Paul, let's give folks a second to respond and I will turn it over to you.

Kate, if I might offer this one suggestion, for those of you who have opted to go full screen with the slides, you may not be able to see the poll question. You may want to escape out of the full-screen view to see the interactive question on the bottom half of your screen.

Thank you for that technology cue, Jean. Paul,ile give you a little feedback -- I will give you a little feedback. People's impressions of site management. 62% of folks think something you should consider is a way to implement cleanup. No, you don't have remodual investigation information to get a final decision document. So that is a little telling, Paul, to what you're going to talk about. People think it's a popular and aspirational term that needs more guidance and examples to provide context to practitioners and implement. That is the feedback from your audience, Paul. Talk to them about your case study.

Great. Thank you, everybody. I am looking forward to presenting this information to you. Titled the present is an adaptive management approach for groundwater remediation and deep fractured rock. That is a beautiful view of some test stands at the Santa Susana field laboratory, the subject of this presentation. So, a little bit of an agenda, we'll hit background topics about the site, the challenges we have at this unique site. And we're address the need for adaptive management and its benefits for this complex site. Near-term activities we have inplemented and are going to implement to inform future site decisions. And adaptive management implementation activities and closing. Jean, can we roll the clock? Should I start that? Okay. Fair enough. So, moving on to the next slide. A little bit of history. This is where the rocket industry in the U.S. was primarily born in no one 48, after -- 1948ard World War II. The developing and testing of liquid-fueled rocket engines and associated components. They used primarily petroleum-based compounds as fuel and liquid oxygen and ox dieder. TCE was the primary solvent to clean the rocket engines. A

little bit of NASA space history. Just about every rocket engine that was tested or used on the Apollo missions were tested at Santa Susana and then, you know, shipped back to Kennedy for launching. But they used TCE after the tests to clean out the engine. 45 gallons was flushed through the engine after the test. And NASA gradually discontinued testing starting in the '80s and conducted their final test at Santa Susanna in 2006, moving to other facilities. In 2007, NASA, along with the two other responsible parties that make up the Santa Susana field lab, Boeing and the department of energy, signed a consent order for corrective action with California DTSC who governs investigate and remediation at California sites. I will be focusing on the NASA footpresent in this project -- footprint in this reject. The other RP ashave similar challenges and also different ones and a overview of the regional site map. We're a little northwest of Los Angeles. The site was initially selected because it was in a remote area. It's not so remote new what with the urban expansion. We got the valley and Los Angeles down here and we have the Simi valley up in the northwest. I will turn my pointer on Jean can you turn on my pointer? There it is. There you go. And next slide. The colored areas represent the footprint of the NASA component. This is primarily called area two. Then we have the area up here called the locks area where -- lox area where liquid oxygen was produced for the rocket . Jean, I think the pointer is not quite working. I am going to abandon that. So, this is a nice view of some test stands. You can see it nestled in the rock infrastructure. The site, if you will, in this valley area. Back when rocket testing was occurring. It was secretive so theyed to keep -- I they wanted to keep prying eyes away from the testing area and it was a good location to put the tests in because the rocks help muffle the noise of loud activity rocket testing. And the picture on the left shows rocket testing in action. You can see all of the energy being released in the rocket test stand. To the right is a satellite view of the test stand and I you can see the spillway coming from the test stand. The exhaust on the left side of the figure comes out of the test stand where that spill way is. Is this that is where also fluids from testing drained into the bedrock and disappeared nicely, the way things were disposed of in the '40s, '50s, and '60s. Sites complex, the scale here on the right. Apologies, it's not too easy to see from a zero sea level all the way up to 2500. Each of these sticks, if you will, that are colored, kind of associate to the scale on the right. Blue is up to one. Light blue up to 10. Green is up to 100. Those are all TCE concentrations of a thousand, 10,000 and 30,000. You can see for those of you that are used to working in fractured rock, those are for the most part, opened bore holes. You can tell by them being hundreds of feet long. The color coding tells you where we have hotspots. This is the profile view. You can see in addition to the long open core holes, which have numerous fractures. And by and large, we usually have about one to two feet of multiple fractures combined and about every 100 feet of, you know, core holes. So, and not surprisingly, you have estimated -- to be 2%. You can see if you squint some profile samples that are depth discrete representing flute wells or Packard samples. The lower figure here is the plan view. All of these plumes are representeddive of trichloroethylene and that is the colors, our main source areas. Alpha plume here that was the test that you showed you in the beginning. This is the bravo area and then

we have another hotspot in the Delta area. These areas generally range from 5 to 30,000 parts per billion TCE with the associated products. And of course, kind of talking about complicated site without looking at the geology. The site is replete with false fractures and joints and we got new surface groundwater and, you know, which is primarily perched and then the chaftward formation, -- chastward formation, which is where all of the contaminants primarily are. The shallow groundwater that I called out on the previous figure, the light blue features here. That usually terminates at 50 to 60 feet below ground level. And there is a clear separation that the deep groundwater, the many focus of our project. So, fractures and stone is, you know, really challenging. So, a linear project, linear approach to a regulatory project doesn't really work at a site like this. There are so many uncertainties. So the challenges we have in site characterization, as you can tell from some of the pictures of the beautiful rocks, it's really hard to put sample locations where you want to ideally place them. You can look at them on the map and say it's great. We put a point here. We can really determine if we have anything downgrading or heading in that direction. The problem is that that point there is, you know, the outcropping and there is no way you can get a rig up there. We also have cultural heritage sites at the location that are no go zones for any activity. And some of those areas primarily like in the Delta area and the southern site, we have, you know, several hundred feet where we just can't not only access the site because of the rock formation, but also the cultural heritage sites. We have real like challenges to put the wells in. Further more as was shown in the profile to you, we have deep wells and the number of our 800 feet, we have one or two in the thousand-feet range. And they go really deep and they expensive. By and large, 90% of the wells fit within the $750,000, range per well. Sometimes our remediation, some sites don't cost that much. That includes the cost for geophysics and testing and installing flukes at some of the wells to get some -- flutes at some of the wells to get long-term incremental data. Perfect nature and extend characterization is not practicable at this standpoint. Both from an access perspective and a cost perspective. We really rely on a weight of evident and we have really great relationship with the regulators. Sometimes we is disagreements in our record facility investigation. We conveyed what we thought was really compelling weight of information to show this northern fault zone, which was kind of key to returning migration off the property in this area, was kind of a really good basis to say, that we don't have contamination out here. We have sampling locations out here where we have pit contamination. The regsulors have a professional disagreement after a couple of back-and-forths. NASA agreed to put in this well, and it was a slant well because we could not get the good access. We had to go in like a ten degrees angle to get the interval that they wanted us to see. And that was an $800,000 data point that returned. It proved our weight of evident. It was frustrating to NASA because we felt like we had the weight of evidence to say, the well was not necessary. Now we have the well to show it's not necessary, but that is an $800,000 data point that creates a new paradigm for thinking. The final major complexity at the site is fractured sandstone is like a sponge and starting rocket operations in the late 1940s and ends the early part of this millennium, we have like 50, 60 years of forward contaminant

defusion into thisinaterix Rock -- diffusion into this matrix rock. The fusion into a rock is a faster process with the fusion out of the rock. That is because the concentration gradients are better when you forward the fusion. When you're back diffusing, you have con condaminants in the fractures and the drowning force for matrix diffusion out of the rock is slower and their is a lot of uncertainty of how much mass is in the rock. Our best guess when we take the rock core samples is plus or minus like an order of magnitude. So, there is really uncertainty about how much mass is really there and how much of it is really attainable or accessible through treatment. So, an estimate of a timer remediation is hard to do. The linear process where you have all of the data, you know, assembled into a nice package with a bow where your models can predict that you are going to be done treating in 15 or 20 years is just not tenable at the site with the complexities as we described here. So, you know, that linear process is, you know, probably, was not designed with these kind of challenging sites in mind. And so with adaptive management, which we think is an approach that all our complex sites should consider is with the site, we can prioritize the sites that need to be cleaned up sooner. When we thought we could have some type of swing at a linear approach, we got a preliminary approval on our facility investigation, which was an indication that you have enough information to go on with your corrective measure study. We submitted this phase one CMS and they agreed with us the source areas needed to be addressed and thought other areas needed more characterization, if we did the linear process, you know. Everything would stop there and we would have multiple rounds of additional data and interpretation to -- interpretation to bring closure. With adaptive management approach, we can start treating at the source areas. The source areas. And in parallel, we can continue to address the regulatory data gaps that are important. And, you know, whether we're doing our design investigations and our monitoring programs. Through our phase one CMS, we have identified the best technologies available for implementing remediation at this site. And woman use all of the findings to inform our final corrective measure study, the phase two after we have better feedback from how these technologies perform. So, the benefits of adaptive management for NASA at this site is we can continue momentum toward meaningful cleanup and address the data gaps on a parallel path. NASA's committed to the community, which is active at this site, to implement meaningful cleanup actions as soon as possible with adaptive management. We're able to do that. As we study field implementation of likely remediation technologies, we will have a better understanding of what these technologies can and can't do and help us with the decision slow matricacies and get agreements with the regulators in advance and what we do under different conditions. And it allows us for a phase two CMS that is going to be built on actual site-specific technology performance information rather than, you know, studies or limited pilot studies or model modeling. Okay. So, what kind of questions are we going to ask? Our main technologies that scored the best were groundwater extraction and treatment. Enhanced by remediation, bedrock vapor extraction. Basically extraction of the bedrock and monitored natural a 10 situation. And some of those questions apply to all of these technologies and some apply to just several or one. One of our biggest questions is how much mass removal and reduction is possible?

Through that for all of these technologies, how sustainable is this mass reduction? We have all seen situations where we put in an SCE extraction well or groundwater extraction well, and we operate it in the very short-term. We're getting good mass removal and then things just bottom out. We either depleted the source and lost connection of the source, or for whatever reason, you know, you're removing meaningful mass. Afterwards, you don't have anything to recover and you're stuck operating the system. We want to see how sustainable that mass production is. And in the case of groundwater extraction, we want to see how sustainable the water recovery is. This is an area that is prone to droughts and other you know, the -- you know, and the concentration fluxes a little bit with the water levels unfortunately. In Southern California, only got about a quarter of the rain that they expect and the season, the rainy season, so we're going to head up on the dry area where we're doing some of the evaluation. We want to know what the optimal frequency is and see if we see things that kind of tale in an extraction system, the pump and treat or the BVE, then we can can say okay. Let's pulse it. Are we going to get, you know, the mass that we want from a pulse system. If that doesn't working we can go to intermittent. Sometimes you have to waited to get that initial volume removed of air or water and you have to wait for stuff to back the defusion. That is the biggest unknobby bop at the site. What is the rate of back diffusion from the matrix into the air and the case of bedrock extraction and into the water in case of the fractures. And that will tell us, you know, are we going to have, you know, continuous and meaningful recovery or are we going to have to operate for a period of time and turn things off for awhile and see if we can recover anything later on? And then, how effective, cost-effective are the technologies? They're not one for one, but if the Tulsa, 10iation in some areas that are not source areas, the natural attenuation can, you know, reduce mass at a rate equivalent to what we might be removing with the GETS or active treatment, enhanced insist use bio, you know, -- insitu bio, why not attenuation. We'll look at the things of effectiveness of cost per unit mass treated and what is our exit strategy looking like for active treatment? We're familiar with sites where we implemented something and, you know, we Kent turn it off from the regulatory standpoint. And there is other questions about distribution of the reagents. So just a little bit on some of the things we have implemented, there is a site where we're doing the groundwater extraction. The yellow area is the NASA part of it. We're extracting groundwater from the wells a total of 35 to 40 gallons a minute, and we're conveying it to the system that is being operated by them. We'll pay them on a per-gallon basis and they discharge it to an inject wells. Some of theiels war producing 100 grams of EOCs for thousand gallons pumped and some are nothing, 0.1 per gallons treated that is what we're doing and the systems are running for a half a year now. In the recirculation system, we're doing enhanced in situ bioto 500 feet and this is our extraction well. We'll have three injection wells. You see the extraction well. Sorry, you can't see it with the pointer in the middle of the site and here it is. I'm sorry. This is the extraction well in the injection wells here and the monitoring well way up here. The hill, as you see, we can't really get -- really starting with this arrow. And the ground really slopes to the south of site. And that is challenging for well placement here. We have done

short-term is studiesifer extraction, three to six weeks and recovered 10 to 12 pounds for week from each of the two systems. We want to sigh how long we can get sustained mass if we operate it for a year then, monitored natural attenuation or adjusting database has, you know, good information on the methane-eth an eating an. The other parameter -- ethane-ethane. Compound specific -- and we're collecting them at the source to have a about ther distribution of this information going deeper with some of these things. We're using microbial insights, laboratory products like census, qpcr for 1-4 diox an to see the kind of degradation we're getting. The count array for the clearinnated eatingeens -- ethinis and using stable isotope probes. We see concentrations reducing in some areas and this is going to help us while things are happening to help us build our case for MNA and our decision logic and exit MNA and whether we need more data. In closing, this is our adaptive management approach we're considering. We can start cleanup sooner at most contaminated sites and some challenging regulatory questions will be answered with the process and that is almost like investigation by remediation to address some of our concerns and NASA and regulators will have a better understanding of wa what can be accomplished and not at the site. And our future CMS, the final decision document for NASA at this site, will be underpinned by a decision framework and actual site-specific technology performance rather than theoretical models. I would like to thank our project team. It's been awesome. Starts with Peter Zorba, our program manager at Santa Susanna field well object and the wonderful ATM of subject matter experts and project managers at Jacob's. Thank you.

All right, thank you, Paul. Great presentation. Before I announce our next presenter, I want to remind folks not to be shy. Please give me some questions to throw out to the panel during the Q&A. We would love to hear your feedback and the questions you have. So, moving on to another challenging bedrock site, our 60 presenter is Ernest ashley, the CDM discipline leader for remedial investigations, a professional geologist in the State of Maine and New York. A licensed environmental professional in Massachusetts. Licensed site professional in Connecticut and board certified environmental scientist. So, before we get into earnest's presenting aker he has a multicomponent question for you. First, he wants to know have you had a site where the CSM changed dramatically? If it does, what did it affect? Did it affect your is, cope, schedule, budget, regulatory compliance and did review of the CSM catch it in a timely manner? Did that promote active site management, I.E. implementing charm opposed to reacting to it. Ernest, it looks like people have a lot of CSMs that have changed. The scope, schedule and budget changes, the big three are the results and you're about 50/50 of the timeliness of the CSM in catching that change and being age to implement change management. Ernest with that, your presentation is up and you're ready to rock. I turn it over to you.

Thank you, very much, Kate. Thank you, everyone, for their interest in this seminar and in this topic. Kate prompted us very well to talk in terms of proactive and adaptive management. I am afraid I have no rockets on my site. But we'll talk today about how we worked on a crystalline bedrock site in Massachusetts and performed adaptive management to work on this facility and with this client. So, this is

perhaps a smaller project and some like the Santa Susanna, but I think it has applications for most of our work. So, let's see if I can advance the slides. Very good. Our problem statement, characterization and remade of DNAPL bedrocks, one of the most expensive and expansive remediation efforts. That is no surprise. That is what we're all dealing with on this project. And then in this case, meeting regulatory expectations and timeframes within the fiscal challenges and functional abilities of a municipality really added to our challenge for this site. So, we recognize that this potential bedrock issue was going to present real technical regulatory and financial challenges for this municipality. And we developed an adaptive and phased bedrock characterization program. And implemented that. I am pleased to approach that adaptive approach resulted in the delineation of the fractured bedrock and the DNAPL that was there. And also, our designs for groundwater and plume containment and ultimately site remediation. Here our site. If I can use the pointer, this is a Municipal wastewater treatment facility for one of the largest industrial cities in Massachusetts. Up at the top of the figure is a municipal solid waste landfill now underneath the solar panels. And while the historic use of the facility dates back into the 1800s, the area where they deposited sludge was up where they needed to put the municipal landfill. They moved the sludge into an area that had a former quarry. This area is now what the city would like to have as the development parcels. They have plans for a new DPW complex on it. And so, we looked and prior consultants working for the municipal solid waste landphillip stalled a upgradient well. It's up gradient because the local regional river is located off to the right in this area over here. But, what turned out to be, you know, the parent downgradient or upgradient direction in this well was 270,000 micrograms per liter of one, 2 DCE supposed to be the upgradient well. The next thing to do would be to look for a potential source of gradient. That turned out to be negative in terms of history there and a monitoring well installed. A further upgradent and turned out to be clean. The rock here is a fractured knife and we did some additional monitoring wells and did not find that the material was going in the downgradient direction but rather, the contaminant was identified as moving cross gradient. So, now, it's time for us to adapt. And we did look to see where this material might be headed. Low and behold in the very lower left-hand part of the slide is another surface water body, a flood diversion channel that may have been intercepting bedrock and had been discharged down the stream to the local river. An adaptive management approach, we're talking about it today in multiple projects and presenting as. For us, it's a systematic or formal process of identifying those areas of uncertainty and how we're going to goba recusing them. We performance uncertainty analogy sits, you know, and it -- analysis, and starts with your initial consensual site model. We want to identify and ultimately prioritize those key uncertainties. Then identify what could be the potential remedial actions in these types of situation and design our sampling needs really based on what we need to top make remedy decisions. -- to know to make remedy decisions. Ile come back to this later. In this particular incident, we also want to maintain the contracting flexibility for the remedial action. So, we'll go about it by implementing our site characterization. And we want to use multiple data quality objectives.

Sometimes screening the information opposed to precise analytical work and to the extent we can realtime data that we can evaluate relative to some established decision logic. And I think you will all recognize those two together combined to be the triad approach. And then, won't to perform frequent conceptual sea model reassessment. What does each step happen? Monitor those and evaluate all of the outcomes from each step we have taken and adjust. You can see in the graphics to the right in both environmental assessment and in the remedial investigation, we really have a circular logic here which risk control is being the central theme, but ultimately, we are developing our conceptual site model and adapting and modifying the plans, continuing to investigate and circling around again, if necessary. So, we call this the green Woodstreet project. And what adaptations did we need to make? Well, obviously, finding a high concentration of chlorinated solveins in a upgradient well involves a new approach to the site. We noted in even our initial monitoring wells that were installed after that, the contaminant transport was not directly downgradent towards that regional river. Whether we detected DNAPL up to three or four feet in one monitoring well after a period of time, that resulted in a new reporting condition, which in Matt mass, required a -- in Massachusetts, required an immediate response action plan. During drilling, we encountered one well with arissue toian conditions and we needed -- Artesian conditions and needed to adapt for that quickly. As the material went offsite or appeared to go offsite, we needed toup stall wells to evaluate -- to install wells to evaluate that potential exposure pathway. Indeed, when we installed a well within 30 feet of an occupied building structure, we exceeded the state's volatilization criteria. That was another reporting condition and another response action plan. And then, as far as characterization during the site investigation work, we did typical driller, packer and inject testing and with the use of widespread pressures in our monitoring wells, that helped us to understand the fracture architecture of this bedrock site. We then performed bench scale testing to identify what the optimum amendments might be for the groundwater remediation as we were focused primarily on an in situ bioremediation approach. When we go did our remodual design, we a -- remedial design, we adapted to make sure we prioritized addressing the offsite migration and dealt with the source area. And we'll be performing pilot testing to confirm all of the elements for our actual full-scale remedial construction. So, at this project, our adaptive management approach was to start withd aboutrock outcrop mapping -- with bedrock outcrop mapping. You can see behind the drilling rig there, there is a outcrop and we got out there with old school compass and mapped the available fractures to identify which way they are striking and dipping and then arranged our drilling accordingly. We also performed the soil gas survey and the GPR survey. Soil gas was helpful in identifying the hotspots within the quarry and the GPR helped us make sure we didn't hit a tank or let's what could have been buried drums. With that, we had to address the findings. We had the DNAPL detection, so we wanted to do additional drilling around that one area to find out how extensive that might be. We had to deal with the lateral contaminant migration, which looked like it might have been going offsite, and identify and address the VI concerns. That all meant that we needed to have communeication plans. Communication with

the client, with the housing authority that was the target of the VI concerns, and with our regulators and potentially with the public. We had holding statements should most of this stuff become the subject of newspaper articles. We a tainted with the second phase of drilling and logging based on all of the information we had learned from the first phase. We also consulted with the city on what were their development plans? Would they be removing material from this area? And then we attempted to make sure that what we were doing in this phase would also be useful for the potential remedial alternative. Some of the monitoring well locations we expect will be part of our ultimate inject thing. And we performed the packer and -- which unabled us to finalize the medial design. Here's pictures in the upper right-hand corner. This is the nicik bedrock and in the left is the exposhure to the quarry wall. One second from the left is a former drill Rod that we found in one of the old drill holes at the top of the quarry wall and you can see a fracture orientation in the upper left. The well that turned out to be a artesian condition -- Artesian condition, we had to have a pipe that could extend the head of the well completion above the static water level, and then this is some of the material that we found in one of our wells. D area off to the right in yellow is identified distribution of VOCs greater than one part per million. And the direction of flow in our new fractured bedrock is towards the apartments that are part of a local housing authority. So, in general, adaptive bedrock site characterization has a good progression from least expensive to most expensive types of data collection. The least expensive is to utilize all of the regional and local geo logic maps and any available sites history information that might clue you in on which way to go in further site character situation. If they're out there always inspect local bedrock outcrops. They can provide you with a tremendous amount of the types of information you're looking for when you boarhole geophysics. Utilize surface screening and geo physical techniques. Again, in our case, GPR, magnetometer and soil gas survey helped us to identify target locations. Then is when doing drilling, we did use both the air hammer down hole drilling and also coring. And while most expensive, coring provides the most relevant information that you can see. The fractures in their dip and faces two see what kinds of contaminations or groundwater movement might be in certain active fractures. It provides the highest quality beerhole for geophysic -- bore he'll for geophysics and if packer testing is necessary. The borehole Joey physics were -- geo physics were key here in the upper per right-hand corner. You can see some of the logs with the optical televiewer. You can see we have a whale of a fracture there at 30 feet. And this is when we drilled into it. We had an artesian condition and noted changes in the water levels in other wells. The area -- what happened to my -- I am going to move through these to get back to where we were. Jean, did we move off of?

No, I apologize for that. If you give me one second, you should get you back to where you were.

There we are.

I will get you back there.

I am at the slide I want to be on. There we are.

Beautiful.

And.

The squiggles in the low hand are the pressure transducers that were actively recording while doing drilling and packer testing. You can see several wells are well connected. We did discreate water sampling using packers and we did a 3D visualization. Then the small bottles are microcosems to evaluate the optimum amendment. One thing we did not do at this siteby I did at others is to line the bedrock borings with flute liners and heated -- we're going back and forth to. Okay, I will get there. With multiple passes of temperature profile, you can identify the areas that cool within the borehole preferentially and those are active fractures where the groundwater would be moving through. ,, I will move on. The other thing we did at this site is a 3D visualization using the leapfrog model. I am not sure if I can zoom in? I don't believe so. In the lower last hand corner are the bed rock monitoring wells. And the red and orange are the concentrations developed in the packer testing. In the upper right-hand corner, we have taken the information from our g ooh we -- borehole geo physics and the dip meter or caliber surveys and ranked the fractures by size. The red ones are the largest and most active fractures. The green ones are smaller fractures and the third ranch turned out to be the fracture our fabric network of the niced aboutrock. The lower right hand --d aboutrock. We connected the dots on the lower right-hand and to see where they might intersect from one well to the next and compared that to the responses we obtained when doing the drilling and/or packer testing. So, finally, how did we adapt the program for our client's considerings? It's important to know your clients. Know in terms of their familiarity with the subject matter you're dealing with. And what they to deal with. You can establish good and productive communications. In the case of a municipality, it's essential that you understand what their fiscal year is. It's not December to December in this case but July to July and what whyer their financial forecasting requirements? They really needed to know in advance for each year and the years to come. You need to explain what the conceptual site model concept is and be able to present the unknowns as not failings but actually the specific directions you're projects going to take to address those unknowns. To address their risks and evaluate what uncertainties are, when we identified the vapor intrusion issue, we had to address that right away to understand the situation and eliminate some of the uncertainty there. We were able to establish some flexibility in our is, cope of work. That was important because there are minor changes, things we wanted to add and it was important because they had a very long kind of procurement to approve our amendments. We wanted to have enough mon in the project that we were able to be adaptive while we were in the field. We had to phase our work over several fiscal years just because that is the cash flow that was available with this client. So therein lies that it's important to project the project costs very early in the project and that meant giving them rough order of magnitude costs as soon as we had the beginnings of the feasibility study. It's key to coordinate with the

regulators and adapt. They came very involvedp truth was a concern and also, there was a timeline for the ability to finish characterization and i initiate remediation and on this site, it took longer than the regulatory framework and so we were age to work with the regulators and get the necessary extensions. And finally, as I mentioned, the contract flexibility. The procurement requirement for a municipality is very strict that there has to be an even playing field. Were not able to work in detail with any one remediation contractor. We had to perform our own bench scale studies and do all of the site characterization work so that we would still have a number of people who could compete for the work when it ultimately goes out to bid. And I believe that ends my presentation. Kate?

Ernest, thank you very much.

And thank you very much. That was a great presentation. Okay, I am encouraging folks again, we're moving on to the last presentation before a facilitated Q&A. If you have any questions about adaptive management, about the complex geologies from the first two projects, how they dealt with clients, please put them in there for the Q&A so we can have some robust discussion. Our third presenter is Matt Germon who is a principal technology with 27 years of experience in environmental remediation, specializing in design, construction and in remediation to address containinant sites using physical, chemical, and bilowomical technologies. He is the program technology major for Jacobs Engineering and leads remedial process optimization technical process for Jacobs. And before Matt jumps into the presentation -- go ahead, Matt, did you have something to say?

I was saying hello.

Okay.

Matt,.

You hear?

I am going to facilitate the two questions before I hand it over to you. So, first question.

Great.

For the audience. Is how many sites have closed the past five years and then Matt would like to know, which I think gives you a spoiler alert for what he is going to talk about, is the sites that you have closed with the performance-based contract used, so, mat, looks like -- Matt, looks like not a lot of sites were closed. If they have been closed, not a lot of performance-based contracting. So,.

Yeah. Very interesting.

And over to you. Yeah, handing it over to you.

Great.

And to sell the product. Just kidding. Go ahead.

Okay, great. Thank you, Kate. My name is Matt Germon. I am here to tell you a story about optimizing operations to act chief closure at four sites at the Vermont air national guard base. Within seven years of implementing a final remedy. This will be a little different than the other presentation you heard primarily because it's less focused on the investigation characterization side and using proactive management approaches and more focused on the operation side. So, we'll get into it here. Just to start with history of the particular air base, this one is local to me. I am a native Vermonter and love 30 miles south of the Burlington airport from the Vermont air national guard is located and this started off in 1946. And starting with the p-47 thunderbolt aircraft. They had P-51 mustang there and when I was kind of in my formidable years, a lot of F-16s overhead through the champagne valley and recently transition to F-35. It's been a, this has been a very big part of the Vermont iconmy and very big perhaps in the state. Associated with, you know, operating air bases, I think everybody is -- won't be surprised to see there are environmental restoration program sites identified. And there were a number here that I am really going to focus in on, four in particular. The first is the fire department training area referred to as site one. Site three is the POL and then 5A, the former refueling pits and 5B, the POL. So, I am going to show you you a graphic, a figure of where we're located on the base. For those of you who visited Burlington, Vermont, via air, that is the runway you land on. And across the grassy area is the international, the green mountainar national guard guard. Starting in the upper lest up here, if maybe you can see that. Site one and this is a fire department training area where that were periodically ignite volatiles and put it out, basically. For a number of years. Between 1960 and 1980 and they also had a second smaller fire department training area in a landfill area where they were reported unknown quantities of oils and solvents and cleaners were disposed of. So, we went through a -- I will explain a regulatory process in a minute. Basically, the system outline is shown on the right-hand side over here and some -- I will discuss that in a minute. So, I guess what I wanted to explain, though, is that there was a product here. The primary COCs were benzene and solvents. And which is different from the site 3-5 b and 5a. Primarily pet rowium, Jp 4 and jp 8 revealing. You can see here, I believe above ground storm tanks, which still exists and the way this worked is they pumped from the above ground storm tanks to underground storm tanks at site 5b. There were two 50,000 underground storage tanks there and to the refueling hot pits at 5a. The other important feature their is is a face, a glacial marine setting. Kind of as you follow my, I guess you can do it. It's kind of along here. The site 3 is much different elevation. Lower than site 5b and 4a. Um, wonderful. So, I want to move to the next slide here and just talk about some of the decisions. This is a state-led site. Vermont Department of Environmental conserving a. They follow a process and there was a lot of character situation work done -- variation work done starting in the '80s and several interacts that occurred and starting the 2,000, including the vapor extraction, multiphase extrack, hide rulic containment measures and starting about 2010, there

was a remedial investigation report including, you know, leading to a feasibility study, proposed plan, record of decision, remedial design in 2011 and finally, remedial construction in 2012, at which point the project movedspo an operation, maintenance, and monitoring phase. And there is a lot of neat technical stuff on the left in terms of the interim actions, the RI and the design and construction. Really, like as I said, I will focus more on the operations and maintenance side for this. So, this was a performance based contract. And these were competitively procured PPCs or performance based acquisition, performance based remediation. I will call it PBC. The way this worked was that it at specific points, transferring from major milestones is in the project, there were, you know, requests for proposals put out, competitively procured and because it was a PBC, we came up with and most of the competition, I believe, came up with specific metrics. And so, the metrics we chose during the course of this procurement was to include a remedy in place with specific date for each site. There were six sites included. We had operations metrics such as system run times. We had NAPL fitness or low measurable and monitoring wells. We included ruducks in COC concentrations of groundwater. We had site remediation goals in seeps and finally, we had state approval to shut systems down and close the sites with NFRAP DDs, a slightly different terminology within the State of Vermont, but the same thing, the site closure. And the way this worked, if you reached the metric, achieved the metric, you got paid value of that metric. If you didn't achieve the metric, you didn't get paid. It's an interesting contract mechanism, especially if you're the project manager, which I was at the time, but this is kind of how it was set up to operate. So, once we got in, again, I explained the construction, the design and construction. We got into operations and really, a lot of these things are operations focused as you can see. So, our approach was to optimize frequently. And so, we were able to dovetail in with one of our communities of practice here at Jacobs for remedial process optimization. I am kind of showing the umbrella of services associated. This is sort of how we characterize and group it. But primarily focusing on design optimization, remedial system evaluation and really, monitoring optimization, LTMO, long-term optimization. So, you know, the approach we found was that the stabment of metrics was key for this process. Both, you know, the final ones were obvious. They were basically the criteria. The intermediate were not so obvious but important because they occurred sooner and importantly, if they didn't occur, then we knew that we had to act. We had to take action. So, we established the metrics up front for each site. We would track the progress and for this instance, we used dashboards, and then we would engage SMEs and sometimes it was a variety of people that we met w and we did this routinely to review the progress. We would look at data analytics and look at, you know, talk about operational challenges. This was a winter climate in Vermont. And we had some difficult winter challenges. Finally, if we felt that progress was not sufficient, we acted. And that was, that was, it's pretty simple, straight forward the approach, that was it in a nutshell and what does this look like? Some of the output is provided here for what we will typically do, if we were having routine RPO calls with our team and were assessing our performance relative to metrics and so in the upper right-hand corner here, I am showing the predicted versus actual groundwater

concentrations. Im not sure what happened to my lines. There were more lines on here. They disappeared and is of suffice to say, if our percent restucks in groundwater were along this line, we felt good. We knew we had to reach the metric out here. If we were, you know, on track to getting that, flip we were slapping high fives and, you know, keeping the foot on the gas. I if we were not, if we were up here, and we should be down here, then we had an issue. So, we would look to the way we could optimize the systems that we had in the ground. And, you know, get back on track, basically. And that included identifying different approaches, different activities to enhance the performance. And I am going to talk about some of the things we did in a few minutes. And then, you know, so another, another example would be the thickness attracting that. This is the dashboard output. Excel based and we have gone to different platforms since. At the end of the day, if we had to take action, then we would facilitate approval to move forward with the action, which I am going to talk about here in a moment [Inaudible]

The optimization output.

Yes?

Matt, real quick, I think I have your chart slightly corrected. I apologize for that. Let me float that in the middle there.

There it is.

Isness there were missing lines. Take a moment.

Thank you.

I have it.

Okay. Great. Yup. I thought I was losing my mind. Just the lines. So, thank you. Yeah, so this is kind of an example of how we're tracking things and here, we're feeling really good. Wow, this thing is working really well. We're getting pretty big reductions and here, not so much. We need to keep watching this, you know, and eventually get there. I think the important thing is to not necessarily how you get this line. I don't know if it was, I can't remember if it's not exponential or someone put a line on a figure. It might have been that. But we had something so that we were landing this thing. And if we were on track like this, we were, you know, sitting up and taking notice and not just running the system, getting out there and, you know, doing, getting into the routine, but proactively looking at the data and take, action if necessary -- and taking action if necessary. Can I advance? Okay. Thank you. Great. Some of the optimization output that we, that came out of this process. You know, a lot of it was just -- is that a real data point? Are we sure there is in the something funny with that data point? So, let's go resatchel to confirm that -- resample to confirm that is correct. We had a big problem at this particular base, and a lot of times the development water would look like chocolate milk and so, we needed to redevelop a few times. Some wells. We were optimizing the locations frequency and list, pretty frequently to target specific

areas. Honestly, to save money in the areas where it was not so necessary. And we got into more of the active, I guess, optimization efforts. We had HDD sde wells. I will talk about thumb in them in a minute. We had corrosion issues with carbon steal in the zone with the SVE well slots and had to brush that out. That was a long well. I will show that to you in a moment. It worked well to open that back up to the subsurface and we had focused treatment in areas of rebound. We had activated carbon-based injects and supplemental air for our SVE and ended up putting a packer in one of our drilled air park is wells. And that is kind --

sparge wells. I will walk through the specifics here and this wrap things up. Site one is the fire department training area and construction landfill. So we had a vertical air sparred system and a horizontal SVE system using shallow trenches, actually. The depth to water was not huge, so we didn't have a lot to work with and each of the systems were air sparge SVE focus, blowers and compressors for the offgas treatment. We used catalytic -- or granular activated carbon. I won't go into the details of that. This is more of the timeline of how things progress. And so, you know, we had how many in place, date of June 2012. And this is really putting the heat on us inters of design -- in terms of design and construction to make sure we were able to flip the switch by a specific date in the contract to meet our metric and get payment for that item. That is a big incent Pfizer for a project -- incent adviser for a project team. Early on, we had NAPL go,way and no longer be measurable and what we would do and this is typical, we would go in to a, you know, data looks really good. We have knocked, taken a big bite out of this. We're below our site remediation goals, which are groundwater primary, or primary groundwater enforcement standards for Vermont, very similar to NCLs. We're below that for some wells. Let's do a rebound assessment. And turn this off. Let it sit idle, do additional sampling and see if there are areas where we experienced rebound. And often, we did experience rebound. So we would completely restart up the system where we would restart the system westbound a focused -- system within a focused area to target the areas of rebound and not worry about the areas that didn't jump back up on us. That was basically the approach in a nutshell. You know, we just by doing that and focusing air and focusing energy into some specific areas, we were able to get to no further remedial action required for nonPFAS compounds. Due to the fair tripping area, this is an AOC being investigated for PFAS compounds at the base and the program for the next phase of the investigation. And we were age to get the COCs identified through the RIFS process taken care of. Not a lot of mash or move but that was the story for that particular site. Site three, again, this is all petroleum related. Fueling the jets, basically, and the above-ground storm tanks are shown here where -- storage tank are stored here. There was a pitch house here that pumped it up the slope up the base. There was a filter that was cleaned periodically in a dry well where excess pet petroleum was dischargeed to and resulted in a lot of LNAPL. We had several fight here measured. You know, a similar timeline on the right. We had a 2012 remedy in plus date that we achieved. We, within almost a year, we got LNAPL to be no longer measurable in wells and started to get into the next January, the rebound assessment. Restarted in focused areas. It jumped back up in some areas. Another rebound assessment and another rebound and

focused areas. We were not getting it in this one well and they were circled and red here, the problems we were having. So, okay. That is not, we're not getting this. We're not on track. We need to act differently. So, we went to an AC-based injection approach using the BOS 200 product and actually, that intruded into one of our monitoring wells and we had to replace thatmon morning well. Then, even after, that we still were not down where we needed to be, so we took another whack at it with traditional air -- [Inaudible] And hit it hard and got there. We got the system shut down and the sampling conducted and wonder able to get no further remedial action after 15,000 pounds. Sat 5a. I am jumping ahead in the flow of petroleum. This is from site 5b the fueling hot pits where this occurs. These are horizontal directionally built wells. We have air spa, rge and wells. This is where they store the aircraft here. We had no vertical access and had to come in under buildings and into the grassy area between international airport runway and the taxi way for the fighter jets. So, did that okay and relative to mark Strong's -- Mark Strong's discussion, these were double-ended wells. What we found was that, you know, with the air sparge, not only did we do the cleaning I talked about for the SVE, we were not getting thep clowns we wanted at the distal end -- the influence we wanted at the distal end of the wells. So, we ended up, you know, this one, we went through rebounds and restarts. Got, you know, changed out our vapor treatment equipment trying to save in moppy there and at the -- money there. At the end, we ended up putting a packer into the well, sliding it down two-third of the way, inflating it and putting the air through that packer to the other site and the distal end of the well. That did the trick and influenced the that was far out on that leg. That worked well. 24,000 pounds. Again, we got to know further remediation required there and about seven years. Finally, sate 5 ob, this is where the underground storm tanks were for the jet full and there was a remedy in place date of April 2012 that we achieved. We had over eight feet of product at this site, and we were able to get that below measurable, and we got into rebound assessments pretty quickly. Our data, you know, again, we're meeting and doing our optimization meetings and seeing this is rebounding. We have a problem, we have to take a differentak here, and we're able to do an AC-based injection and hit it again to get that site closed. That was 24,000 pounds. And so, just some case studies of the four sites. And two more slides here. But the outcome was that we had high run times. So, remember, back in the beginning, I explained the metrics we had to achieve. We got those. We actually got some supplemental savings through operations. And by optimizing things. And that was important. Because of the P ABOUT, C nature. The money was ours to use and invest in the areas and get the metrics achieved. We got closure in six to seven years at four of the sites and achieved the full contract value furt PBC meaning all operational and enclosure metrics we signed up for. The takeaway here is the PBCs pushed the team to aggressively optimize. I don't think we would have been on our game as much if it was a different contract-type approach. We were incentivised to get the most value out of the remediation systems we put in the group. The remedial process operational approach was key to stay on track and progress toward site closure. In this case, the PBC allowed us the flexibility to modify. Week change quickly, and we had the reg -- we could change quickly and had the regulator, constant

communications with the regulator, you know, often, to minimize the transactional and administrate of burden associated with the changes. That was critical also. So, the combination of those makes this a great success story. We have NFRAP at four states and NFRAP DD for three. And this past summer, we completely took the systems out of the ground, abandoned the list and moved the equipment. It was back to green grass where it was asphalt and completely out of the, no longerup nounsing the mission at all. So, very happy to see that happen. A quick shoutout to our projects, Veronica Brieno Rankin, the national guard manager and Winston Pro, who is tired. Richard Spiese was the site manager and helpful in the process and the base representatives were Shannon Kelly and Peter Dufault, they were able to help us walk through the lodgist bes of doing environmental work at the active military base. That is it. Thank you very much.

Thank you so much, Matt. We're going to transition into our Q&A section. So what I would freed our 3 presenters to do is pop on camera. I will give you a couple of moments to do that of about I jump into the question s.All right. We're of waiting for Paul. We had three great presentations there that talked about proactive site management. The first two be, as I would like to call it earlier in the process and Matt, getting sites over the finish line, rounding out. Would like to start first, Matt, with your performance-based contracting. Thanks for claring the PFAS questions or the issue. We got a lot of questions about that and you clarified that. Request you spoke to a performance-based scenario where you have measurements, remedies in place or cleanup levels achieved. When you're implementing a performance-based contract, how do you talk to the owner or handle things like emerging contaminants. Something like PFAS can three remediation timeframes and costs, et cetera, out of the window. How does a conversation like that happen in a contract like performance-based contract?

That is a really good question, a curveball for that particular site we talked about. I
think the.thing was that contracts are pretty cut and dried a lot of times. I think at the end of the day, the client owner was reasonable. is a certain level of trust that they're reason -- trust that they reasonable people and it's clearly the presence of something that was not identified there previously and was a change . I think they were able to overcome the change and focus on what we had identified prior to the presence of those compounds. And kind of wrap that project up and get them taken care of see the base can move into the appropriate investigation for those.

Awesome, great. A follow-on question related to performance-based contracting. When I hear performance-based contracting, I think about risk management and cost control and two things that seem challenging. I wound it interesting in the performance-based contract that the measurement or performance metrics were provided or suggested by the contractor vice being provided by the owner. Can you talk a little bit about how you look at stabbing a performance objective for something in operation maintenance and monitoring? How you evaluate risks and achieving milestones in a strategic perspective, when you're looking at putting together a response to a performance-based contract.

That is a great question. I feel like I can answer that. There are a ton of different ways to do it. There were several, by the way. Twoer to three within the period of time you presented. The way that was done was more of a statement of objectives. That the client owner wanted to achieve. It was up to the contractors to come back to them with the specific metrics and goals that got them to thosend points the best. A lot of the balancing criteria. They were technical focused and that was a predominant waiting on technical approach to act chief that. The met wrecks we felt were most advanitageeous. A competitive environment. I think, I never got to see what the others pitched for their metrics. But, the combination of the technical approach and the costs. We were automobile to secure those. Once you sign up, you kind of -- as contractors, we developed those metrics and signed up for them. An interesting way to do it.

Poke at this a little bit more.

Sure.

If you were, a lot of the folks on the phone are coming from the regulatory perspective meaning that they're probably implementing the projects and writing the statement of objectives or E.P.A., the performance work statement, what would be suggestions putting together, you know, a lot of times at E.P.A. sites, the E.P.A. does the work and the state takes it over. You can't get to the finish line under the contract. You have to get somewhere. If I were doing like a long-term response action contract, and E.P.A. is thinking I have like 10 years before I have to transition this to the state, how would you suggest they work on establishing performance metrics for performance-based contracts in that type of scenario where it's not overly, I guess, risky for you as a person that is putting a proposal in for it. Like what types of things do you think about and when does it work and whether does doesn't it work? That is like an 80 pronged question. You can jump in, too, if you want .

Yeah.

There were more people PBC experienced than myself. I think if anyone told me as a contractor you need to close four sites, would have told them they were crazy. I think that -- I guess my first reaction would be not to be to prescriptive from, you know, from feeding them out. I think the way this worked was good. It put the creativity to the contractors to say, you know, you tell us what you think you can do. This is generally where we want to go. Like we want to transition to the state or you can lay out the big-picture goals of, you know, those are the big steps won't to take and leave it up to the contractors to figure out. Here are the metrics we think are going to best serve that. That would be my suggestion, I guess . There are scenarios that could unfold that don't get to you the metric. You need to be thinking about, you know, the probability of that occurring and how much that is going to, how much revenue that is not going to produce for you . I think that is based on some stories I heard. So.

Thanks, Matt. I know that you talked about performance-based contracting. You are experiencing remediation professionals. Do you have anything to add this?

Kate, the project has to be developed
enough. Enough information to bid on. Incomplete site characterization. The client wants an estimated cost to closure. The information is available for the bidding process. It will probably lead to scope charms and everybody not being happy with the end product.

I add.

Yeah.

And not so much from the contracting basis, but I saw a question in the chat regarding, you know, when a lot of of the characterization work occurred and this relates to how we could provide cost estimates to the client. We did do a good deal of work in just a remedial investigation phase, with youen there we were required to provide a remedy implementation plan. We did not have enough it provide the detail and plans and specs of the ultimate cost. There was a stage where we were doing work under a predesigned character situation phase.

Thank you, I was going to get to that question. I am glad you talked about that. I think, you know, inherently when you talk about performance-based contracts, obviously like an operation maintenance and monitoring type activity, you would think unherrently as Paul referenced, there would be less than lifting a site on the national priorities list and saying, all right, 3, 2, one, go. Tell me how you're going to get the site cleaned up. There is a balance there. I think -- investigation is a constant tool for consensual site model, you know, updates and data gaps that happen through the RI and PDI. For you, it happened in both and as well as the operation and maintenance phase. Matt, I have a couple of targeted questions I am going to ask you for the fractured bedrock preremedy complete project. The quarter question was related to the percent reduction goals. I know you said Vermont water protect standard. Something MCL like. Was it based on that regulatory number?

It was based on it. That is something that would get us down close to where you could go for a site closure. I think it was like 90% reduction in COCs. Those were the identified COCs through the RIFS process, and we had a starting date and we would, you know, our metric would be when we achieved 90% reduction in that on average. Something like that. It was not exactly like 5 micrograms per liter, but it was a percent decrease from a starting point. That is how we approached it.

Okay, great. There were two questions sort of related to remedy in place and the is, cope. Work of the contract. So did remedy in place include design costs and secondarily, did you perform the design? I am assuming they didn't perform the design, it was not included in the costs. Those were the two questions. Can you talk about whether you did the design?

Yes, we does the design. Yes, they were included in the costs. We can a predesign. Pilot
testing. Moving into O&M in design and construction.

Awesome. I am going to move over to more early in the process presenting a, both of which were in challenging fractured rock geology. There was a clarification technically. Did the crystalline nature of the bedrock present any unique challenges opposed to any other type of fractured bedrock?

Yes. Because the transport really is almost, essentially entirely in the fractures. And those fractures could be vertically steep dipping. In our case, most of them were very horizontal and then to understand which ones were connected. That was the intent of instrumenting all of the available monitoring wells in the area for the drilling of the new wells and for the packer testing and then we even did inject testing. Some of these turned out to be dead ends and found there were areas where week not inject very much water. So, our pilot study will be to do some hydraulic fracture ing. We'll understand the full-scale implementation of a series of wells across the property linele that form a barrier to offsite migration.

Okay, thank you, Ernest. Paul, question for you specific to your very expensive slant well. Is that considered to be a horizontal well and what were the drilling techniques used to install the well?

It was not a horizontal well. It was a well that went in on a slight angle. Can't remember the exact angle. Might remember 10% from vertical. The state wanted us to get to a specific zone that that you were interested in. It was under a fairly challenging rock and we stepped back from that. To figure out if week reach it. We could and we would have to go at a shallower or steeper angle. This is where yet helped us. We didn't have to go at a steep angle. It was mostly just the anglation of the drill rig rather than being horizontal.

Okay. Thank you, Paul. While I have you, a sec question related to the technologies that were evaluated and piloted at your project, for the bedrock vapor extraction, which, by the way, the first time I heard about this, was it a -- did you have? How important is a pilot test, you know. What would be the purpose of a pilot test for doing bedrock vanner extraction versus going for the with selecting it and putting it, you know, putting it through even technology in the ground. Can you talk about those considerings?

Great question. -- those considerations?

Great question. As I did, the challenge we had at the site is a lot of contamination and in the Rock matrix. We have the fractures, fact saturated and unsaturated. So the vapor is kind of hanging out in that unsaturated zone. We pull the pore volume and -- a six-week test and showed we could get ten to 20 pounds for week. We saw a decrease in trend. We want to do the long-term test to see how sustainable that mass recovery is. As I mentioned, our biggest challenge is how quickly will the rock give up the contaminant that is stored in there. If we

evacuate the fractures and, you know, we get good distribution from say a 30 horsepower blower, we can get pressure drops pressured at 150 feet away, which is pretty good. But, the question is, once we evacuate the poor volume of air, if you will, how long will it take for thativator to get filled -- that vapor to fill up again to be cost-effective and run the vapor extrack? Do we run it it -- extraction. Do we run it? Do the vapors increase 20%? Eventually, there is an e equal libium of what is being removed and back defused and you get steady removal, or do you run it or bottom out quickly. If you bottom out quickly, when do they recover to define the frequency of when you do it. Is it possible to continue the pulsing or continuous operation to the point where you actually lose that signal to the point where you recovered everything that you can and whatever else you haven't recovered going to stay in there forever. That is the big unknown at the site, the saturated andup saturated zone, how quickly will the mass back diffused to the treated water with the EISB and the pumping of the water, the groundwater extraction system or the suck of the air out with the vapor extraction. How quickly can we get that mass out and when do we hit diminishing returns. Are they temperal or long- term?

Thanks for that. A question for earnest and Paul. I will have you go first. From a regulatory, complex site and regulatory picture isative, when you're working with stakeholders and moving through a remediation process, whether it's state programs, et cetera, that probably follow similar process ease, whether you have -- processes, when you have, say, Paul, your situation at sandstone that has most of the contaminants into the matrix. We have a defusion issue. Ernest, you have the complex fracture system. A lot of times, there is a fine pal aning act versus targeted remediation strategies and points of getting you to hybrid remediation, and the final decisions, scenario. How do you work with stakeholders in getting them moving forward with investigation by remediation to put things in the ground versus trying to throw the flag up and go for, you know, something that is less technology or mass removal focus and more like a TI waiver. I am assuming to both of your sites, why are we going to do anything? Can you talk about how from a contractor's perspective, working with your clients, you massage that contradiction?

Sure, and in our instance, we had two potential objectives to close the site completely. In this area. And we would have to add every monitoring well achieved MCLs and that is probably technically infusible. That would be a definition of no significant risk for any exposure scenario and what will also qualify for closure in this site is no substantial hazard and to remove all of the contaminants above water called feeling limbs or upper concentration limits. We have some area where we have to apply technology to get your closure. The most important thing for the client and regulators is to limit the risk with the offsite vapor intrusion issues and it was a containment in the reductions to the point where week obtain what is called a temporary closure. It would have long-term monitoring when we started Talking to this client, we were clear on what the likely outcomes were.

For my

site, the regsulators will watch you to get the mass that is cost effective. How far we can go is actually the big question. But, somebody who has been in the industry for awhile and worked a lot of sites, I can't think of any sites that have really been super successful without giving it the old try and trying different technologies to show what they can or can't do before you can go down that, you know, TI route. I think my experience is that you have to try something, give it a good effort and use that to demonstrate it. In the case of our -- specifically, we know we can pitch or treat those areas and get probably good substantive reduction and maybe even 90%. How far we go after that, I don't know. There are beneficial masks to treat to satisfy the cost-effective requirement. There is a question of when does cost-effective pass the tolerance of the client and what is cost effective, when does yet pass the tolerance of the regulator? That is to be determined.

I totally agree. Thank you, Paul. So, we have reached our time. I could talk about this forever. I am going to close it off. Ernest, Paul and Matt, great job. Thank you for the animated presenting as and great discussion during the Q&A period. Thanks to our audience for submitting questions. With that, I will hand it over to join for our break.

Thank you. -- Jean for our break.

Thank you.

All right, thank you. I am going to move the screen around here. And I am going to let everyone know that we're going to move on to the next segment in our agenda. So we have approximately 17 minutes or so to start in our brief intermission. I will be moving my panel four speakers into a subconference room to do a quick recap during that break. For those of you in the audience, I invite you to stay with us while we're on break for a brief word from some of our event sponsors. Then again, for panel four, please hang tight. I will move you into a subconference line shortly. [Captioners transition]

[The event is on a recess. Captioner on standby.]

>> All right, we should be gathering back from our reef intermission or break. We are just coming up on our scheduled time to resume with our virtual symposium at 3:10 p.m. Eastern. Again we have just under one minute before we kick things back with our next panel. But I did want to ask those of you if you have come back to your device with sitting at your computer and back at your mobile device or get the phone, you could type the message into the Q&A window and just let me know that you are back and ready to get started and I know that all of our presenters and moderators would greatly appreciate confirmation so by you typing the message in, the virtual equivalent of us watching you physically move back to your seats. If we were all together in person. I want to thank each and everyone of you for typing a message in confirming you are back and ready to get started. I think now that we have reached that time and I see lots of happy, excited messages

for much of participants that get their devices ready to get started, we can go ahead and resume with today's virtual symposium, design and construction issues at hazardous waste sites. My name is Jean Balent and I will be serving as a technical moderator in the background for our broadcast today. Now that we are coming back from our group, we will carry on with our agenda today, moving onto our second and last panel for today's session. We are going to be joined right now but panel number 4, the topic will be project risk management considerations and disposal challenges. We are going to be joined by Steve Gillespie from Sevenson Environmental Services who will be serving as our panel moderator and I will introduce Steve so he can then introduce us to his panel and Steve has project management experience with seven Tenebrae mental which includes 20+ years of cost reimbursable and firm fixed price HDR W remedial actions at house visible and complex region two sites under his leadership projects have achieved over 1,600,000 face man hours worked and recognized by the Army Corps with zero incident awards and commander certificates of achievement. It also received New Jersey Department labor Governors awards were excellent in safety. He has a bachelors of science in the mechanical engineering from Lycra University and a Masters of science in civil engineering from New Jersey engineering of technology and project manager at seven Tenebrae mental chambers work [Indiscernible - low volume] Deepwater New Jersey. With that very brief introduction and virtual round of applause from all of our which is meant Steve I will go ahead and invite you to come off mute and get started with the panel.

Yes, thank you, Jean and good afternoon everybody and welcome, everybody to panel four to the symposium and Jean alluded to, this panel is for project risk management and consideration of disposable challenges and panel four with consist of three presentations that will illustrate the unique considerations and challenges. Mr. Grant Geckeler discussing operational risk control and adaptive change management and through accelerated in situ thermal treatment schedule and Ms. Jean Behr will present case study recovering Cheboygan Harbor and teaming effort to restore navigation depth and removal of contaminated sediments and Mr. John Roberts will present us deep trouble when design phase simplicity means can structure face reality so without further ado let's get into this. I will introduce our first panelist Mr. Grant Geckeler and he comes to us, director of remediation services at the ISOTEC where he focuses his technical efforts on the in situ treatment of organic compounds and metals and multiple phase destruction and emergent P Foss remediation technologies. Grant is based in Southern California and responsible for remedial technology assessments, project oversight and program management. From 2012, through 2020, he also oversaw answer to the more remediation projects across North America and grant named inventor of 2US patents for remediation technologies. That's welcome grant and welcome, grant.

Yes,, thank you for that introduction, Steve. Welcome and I will be talking about Institute thermal treatment but not really. Not in the traditional sense. This is not a discussion about how in situ thermal treatment works, nor is it focused on the science or technology. Really focused on a contractor perspective. It is a story about accelerated

schedules, with aggressive in situ remedy in a redevelopment and how to survive that situation. The story really started nearly 3 years ago when I visited the site with the project team and the regulator in New Jersey. Easter New Jersey. And they said, we want to apply around the deep probable thermal remediation and we want to be finished with verifiable results this time next year.

And I said, well, because I have not done anything too crazy this year, so why not? Let's get to it. And then began the design phase of the project.

The project I mentioned is in New Jersey. It has a long legacy of industrial applications over the last 110 years. It was used, for instance, in world war two part manufacturing aircraft components and was utilized for several different industrial applications thereafter up until about the late 1990s the treatment site was screened initially for and entirely different remediation techniques for application. It was originally screened for excavation and off-site disposal of contaminated soils. The primary impacts were noted as PCE and TCE with some degradation products including DCE and vinyl chloride impacts. The original plan for excavation was fairly straightforward especially because this was and entirely unsaturated beta zone, soil area. And the groundwater was anywhere between 50 and 60 feet below ground surface. But interestingly enough, we will be talking about the glacial filled deposits and the dolomite bedrock in the beta zone. That bedrock layer essentially held the contamination in place, and was a fine layer allowing further downward migration into the groundwater bearing units. However, this was not my typical bedrock site.

This bedrock site was really dominated by a highly variable and undulating bedrock contours. The overall treatment area was fairly small under 7000 square feet. But across that treatment area, the depth to the bedrock varied anywhere from 6 feet, to approximately 42 feet below ground surface. So we had some highly inconsistent and variable undulations, and that was quite a challenge in and of itself, as you can imagine with in situ thermal technique. One consequences that you are going to have a lot of wells installed into the subsurface, and we were targeting them to the bedrock interface.

So during the drilling of the well installation portion, of this project, we predicted what the well installation depth would be and prepare the wells and if we, for instance, predicted dirty 5 feet DGS, it was not 35 feet DGS but it would be something dramatically different like 12 feet DGS so there was a lot of adaptive change management during the drilling and the well installation program. We utilized two different rigs and one was a hello stone auto Rick, converted to air rotary, to install the wells into the bedrock interface. And then about halfway through each we changed over a sonic drill rig for the completion of the well installations.

The remedial action plan originally called for the off-site disposal excavated soils, of course, we are talking now about the in situ remedy. The major reason why excavation was taken off the table in the

in situ remedy explored, was because of the high concentration of PCE and TCE, and the very long distance of soil transportation required to take to a permanent facility that could accept those types of soils.

So essentially the summary is that the higher than originally documented the LC concentrations made excavation about three times as expensive as what was originally forecast. So that was one of the primary reasons to switch over to the Institute remedy -- in situ remedy and this photo shows the general area of the treatment area. The regulator looked at the site. The consultant did a very good risk analysis, and we essentially agreed on the 75% reduction of chlorinated VOC in the target treatment zone with a few different caveats that are listed on the screen. Of course when you are talking about an Institute thermal technique, 75% is kind of a softball number and usually you are talking about in excess of 95 or 99% removal, but 75% check the box and in this case at the end of the presentation you will see that the results for treatment and reduction of those contaminants was in far excess of 75% reduction so the system was comprised of in situ wells and we had a combination of feeding wells to keep the beta soils and also some vapor extraction wells to move the volatile lysed of gaps from the PLC -- VOC being diesel from the treated soil and water treatments. If you see the two banker tanks in this photo and that is another challenge that I will be discussing momentarily and to have a little video here and thank you for starting that.

So the video is a completed project site and ate nice time for me to go through a list of thank youse and recognitions first of all I would love to thank bencher of GMA tics in New Jersey for the UAV video footage and also infrared video of the site as well and I would like to think the project team geocentric SHANNON THOMPSON and Mike Lemberg and my colleagues Jada Carla and Dottie and Michelle Ellen and also I think Kate Griffey, Jim Zaleski and Jean Balent for putting together the wonderful platform .

So you can see we got a lot of moving parts here and my number went to Kelly and recommendation with the remediation is that it is a construction project. It needs to be planned and managed like a construction project because you always have an expect -- unexpected surprises and a lot of the surprises in this instance were undocumented subsurface conditions that needed to be addressed. In a quick and efficient fashion, during the buildout and installation of the in situ remedy and the number 1 concern was potential for vapor migration or contaminant migration through subsurface utilities. We did an initial line out with line tracing and also ground penetrating radar and we found a lot of unexpected utilities that had been in place some of them had been in place for over 100 years and this is what we are dealing with in the treatment area and we have got utility corridor sanitary trenches, two manhole covers and the orange hexagons were manhole entryways into the former sewer system. You can see around the treatment area and the color red are marked out as trenches because after the crest of the regulator, we had to go in and fill up those utility corridors with fillable fill to address the migration concerns. Those are some pictures here of what that look like in practice. It added another layer of complexity and really changed the

portions of the in situ design, so it was in need of collaboration the contractor, at the technical, at the consulting, and at the regulatory levels.

The next slide is another challenge. Energy, or lack thereof. Lack of utilities and energy at the site. The bottom photo shows the termination of a high-voltage line that was relatively adjacent to the site. This is the only source of electricity, and the restriction soon became apparent that only a limited amount of electricity was available. It was the maximum that we could pull from that line, 400 volts -- 400 amps of for, 80 volt free space and that is generally insufficient for most electrical based in situ heating techniques. So we had to turn to an alternative technique that was or that utilized LPG propane instead of electricity for the subsurface heating because we had to use all of the water hundred amps to power the -- 400 amps to present liquid such as vapor extraction and treatment and water treatment systems. There was no sewer connection on site and that meant we had to stage those bigger tanks for water holding and water treatment and after we treated water on site it had to be put away to a permitted facility for final analytics and discharge and the propane of course is being used because there is no natural gas at the site either so the phase of the project which was, how should I say, nearly entertaining for all of the project managers to do a shuffle and a pivot in terms of the precise technology implemented.

The different wells or we show here at the cross sectional hues and we had the heater wells and dual math vapor extraction wells and temperature preferred monitoring points, because so many subsurface utility features and industrial features were documented in the shallow subsurface, generally from just below ground surface to about 8 feet below ground surface. The project team also faced the challenge of having to install additional shallow Vado zone soil vapor extraction wells into certain features that were essentially blocked off or separated by physical features such as concrete and steel in the subsurface. So that was yet another pivot and adaptive change management feature of this specific project.

A picture of the final installation, well field, you could see it looks very nice, perfect picture. And sometimes I talk about perfect or near-perfect projects. This was a very good result at the end of the day, the process of an accelerated in situ remedy definitely had its challenges and at times we would be wondering what else can we be surprised with? But really because the entire project team, all the way from specialty subcontractors, through the consulting engineer and even the regulators at New Jersey DET, because everyone looked at it like a construction project and treated it as a remedial action and construction project, I really feel that is why the schedule end results were achieved on time and on budget in the situation.

Some of those results are predicted here and we are talking about 5000 cubic yards of soil, and from only 5000 cubic yards of soil, we have -- we saw the removal of over 32,000 pounds of chlorinated VOC, principally PCE. We were able to actually recover some and APL the paper treatment system and that went into that for analytics and we saw

results that proportionally matched up fairly well with the vapor analytics at the project site so we had both analytical and liquid-based quantitative results for the types and the volumes of chlorinated VOC's that were actually removed from the subsurface in the in situ application. Retreated just shy of 45 hundred gallons of produced water on site and that produced water primarily came as compensation from the vapor treatment system. And the leading schedule was on point, 102 days of active feeding and operation of the treatment system components. The project used a slightly more fuel as propane LPG then predicted, but it was more or less on par with the additional length of TCH heater wells that were installed to accommodate the actual bedrock depth that were encountered at the site.

Frankly electricity was a limiting factor and there was a lot of attention given to efficient electrical use and came under budget for the electricity used to power things like the vapor treatment system, water treatment system and controls. At the end of the day, it was a wonderful team effort, and really the only reason why it was successful and on budget was everybody looked at it like a team effort. And at the end of the day, the result in terms of the quantified soil that was treated, post remediation sampling, taken at the very end of the project, two months after the project and six months after the project, demonstrated main reductions of chlorinated VOC's that were on the range of 98% reduction and that 98% reduction is far better than the baseline remedial goal that was initially set at 75% removal.

Really, that just shows the effectiveness of these types of targeted and surgical in situ remedies . We had plenty of safety both -- buffs from the results that we actually achieved and demonstrated, versus the original remedial action plan. And today the site looks very different I could not find a good picture of it, but it is now a commercial shopping center, about three years after this remedy was first designed and implemented.

I am cognizant of my time and ate thank you for your attention and we will have time at the conclusion of this platform to discuss some Q&A, thank you for your attention. I look forward to the following presentations.

Thank you for that, Grant, appreciate the in-depth presentation. Like Grant said, we will do questions at the end of the third presentation today. So with that we will move into the second presentation for today. Given by Miss Gina Bayer, and she will be doing the case study for recovering Cheboygan Harbor and unique teaming effort to restore navigation depth and remove contaminated's eminence. A little bit about Jean and before we begin she is principal manager at Jacobs contaminated sediment practice and serves as a program manager for the glaze contacts with the EPA, Great Lakes national program office and she has managed three large fund lead Superfund site cleanups and three large great Lake legacy at sediment projects and her projects one the -- won Western Association of environmental awards twice in the engineering news record best project in the Midwest and the water environment category. As practice lead, Gina monitors trends, technology, innovation, and cutting-edge resource in the field of

contaminated sediment and characterization and remediation, next technical resources to projects and build and sustain's the sediment community of practice within the firm and encouragers partnership, collaboration and information exchange with agencies and universities and vendors and with that let's welcome Gina, welcome, and looking forward to your presentation.

Thank you, Steve. Sound check, everyone can hear me okay?

Yes, we can.

Yes.

Okay, well I am going to jump us off the land and into the water and play in the mud. In this case the water is Sheboygan harbor in Wisconsin. What makes the story of the Sheboygan River cleanup interesting is the sheer number of entities and different projects that were knit together cutting across different programs, goals and funding mechanisms with the end result of restoring functionality of the river and harbor. This talk will cover both the problematic aspect of the two time award-winning cleanup, provide a brief overview of the technical approach, and then highlight some of the more unique construction components.

The Sheboygan River is located on the east side of Wisconsin. I don't see the little blue thing.

Discharges -- there it is. Discharges into Lake Michigan. Due to historic leases of PCB from a manufacturing facility located upstream and Sheboygan falls, and PAH and and APL from a former manufacturing C Marina located right here, the last time the 100 foot wide federally authorized navigational channel at this lower part of the river was fully drenched to its authorized depth of 15, 21 feet, back in 1956. So over time the river and Harvey -- harbor silted in and water depth of as little as 3 feet was observed in 2012. The moment we address a problem for study with EPA Superfund program through potentially responsible parties however, the goal of restoring beneficial uses under the EPA area of concern program and unrestricted dredging and the navigational challenge were not fully met by the Superfund cleanups and so that USC PA Great Lakes national program office or Glenn Pope pull together a Great Lakes legacy project to characterize this 1.2 mile stretch of the river here and then to design and construct a dredging removal upstream of the letter a street bridge and here's the letter a street bridge and downstream of the letter a street bridge a circle [Indiscernible - low volume] to create a strategic dredging project led by the Army Corps of Engineers.

Here I would like to acknowledge the entities involved and to state that any opinions rendered here are my own and do not necessarily represent the agencies or other entities. The project partners in the Great Lakes legacy act were USC PA Great Lakes national program office, the Wisconsin Department of natural resources, the city and County of Sheboygan. And then the responsible parties from the Superfund

program, Wisconsin Public service, and pollution risk services, which filled liability transfer from Tecumseh, small manufacturing facility.

The contractors for the EPA, with [Indiscernible - low volume] Jacobs now and we did the remedial design and data management and design services during construction. The actual construction was conducted by a joint venture of right Marine and Tara. The project led by the Army Corps downstream the debtor a street beach was considered by severance and environmental.

Okay. Let me take that one out.

So the nuts and bolts of a sediment removal project breaks down into doing your best to characterize to and extinct contamination before you start dredging, determining the cleanup goals and then designing your dredge cuts to take into account legal infrastructures such as bridges, week shorelines, utilities, and determining how best for the water and disposal material. Also to be considered is if you need to take additional steps to manage particles that are suspended during dredging that later settle out, so in our A's on this project we manage those with a post red sand cover. Which you can see in this picture here, the sand being spread on the water and then settling down to become a cover.

Things become trickier if you have Tosca levels of PCBs rater than 50 parts per million as we had. So at this project, this warranted adding the EPA record program to larger project team, and Tosca pockets had to be dredged and handled separately. So by the numbers, the total volume of sediment removed under the legacy and project was about 147,000 cubic yards, with 9000 of that being Tosca and meaning it had to be dredged and handled in a separate stream. Following dredging, the six inch think of it was put about nine acres of the project. And that the Army Corps project was removing another hundred 50,000 cubic yards of lesser contaminated material that was downstream of the bridge I sold you the a street bridge.

And here is another picture of the dividing line between the two projects. So we had two sets of directors out at the river at the same time currently, but they approached differently how the dredged material was processed by to loading onto trucks for the trip to the landfill. On the lower part of the screen, legacy at project, and which style with dredge material or pulling up to a dock and the material is being down a conveyor belt and going to a pub mill where additives are added to cure it and then the material will move by excavator to spend more time over here in the drain pan before [Indiscernible - low volume] trucks and off to the landfill.

On the upper part of the screen, the core project did not have available -- as much available land to work with with a plant staging so they ended up direct mixing their drying agent , point is

Right into the scout using the excavator bucket to mix it and then direct loading it to trucks to go out to the landfill.

Another difference between the two projects I will call forward because of the topics that we heard earlier today, was how the specs were different between how to handle the materials and the legacy act project, performance-based speck in which the contractor decided how much additive and what to add based on landfill requirements. On the pouring project it was more perspective and they told him what to add and how much in this ended up being a problem later in the project about a month in when the landfill changed their strength requirements and several weeks into the project.

Here are various pictures of the dredging operations. The first upper left photo is actually hydraulic dredging that was performed by PRS in the upper reaches of the river. In this case the dredge material is piped through a line up to their upland processing area where they used geotextile tubes for watering. The other three photos show mechanical dredging, both with a bucket on an excavator and then a crane operated environmental book.

So now I will talk about some of the more unique components of the design and remedy. NBS modeling was used during the feasibility study and remedial design process to map the various contaminant areas to estimate volume two removal based on various cleanup scenarios. The model output is very useful for data visualization and decision-making and has a viewer that allows you to Zoom and rotate the 3-D model real-time, which I will not attempt to show today.

Model application used in this project including developing dredge prism, accounting for overburden, site slope considers Asians, and over dredge allowance. The model output is converted into can and GIS software directly usable by the stretcher software. -- Dredge her software. Now I have forest life to show you some of the model output. The top image here represent sediment surface elevation as determined with the symmetry. Of the lower image depicts soft sediment thickness [Indiscernible - low volume] and you can see here that there is a thicker deposit of softer sediment that has built before the A Street bridge.

On this slide, the top damage sows PCB extent greater than one part per million. The blue represents one, three part per million. The green, three, five part per million and seven origin [Inaudible static] the read is about 50 million PCBs and in the lower if you you can see -- the Law Review shows the Tosca level so you could see the pockets of the PCB rater than 50 part per million that had to be teased out and dredged as a separate waste stream than the other [Indiscernible - low volume].

This slide, we see the model used for visual comparison of different cleanup goals. The top image shows the impact of sediment if the clinical was set at 45 part per million for a total pH of [Indiscernible - low volume] on the bottom shows how much more volume is added if the cleanup goal is lower to the 18 part per million total pH. Distal became quite useful during our trip feasibility study with all the partners and I think we ended up with over 10 different scenarios, playing with different cleanup numbers.

Last, I would like to point out to you, an exploded view, here on the bottom. Teases out the various layers that were important to this project. The top grade layer, sediment the PRS was responsible for the Superfund program in this stretch of the river. The blue layer is the additional sediment dredge by the legacy program to remove PCBs greater than one part per million. The yellow layer is how much more sediment was added to capture pH removal above 45 parts per million and last, this little brown layer here is actually clean sediment that was required for removal to get the necessary draft for the barge.

Interesting side note, we did find a beneficial use for the clean sediment at a little airport that was expanding. That got derailed at the last minute after public meeting where local residents objected.

So finding records on submerged utilities that cross under rivers can be challenging. In this case, the burial depth of an electrical table cannot be confirmed by the acutely owner so rather than use spar survey electric magnetic technology to pinpoint the vertical position within 12 inches. Disallowed safe removal of the overlying sediment and avoided leaving impacted sediment in place. >> Another unique construction component and we have used this in a number projects now, is using an air bubble pertinent instead of the traditional Phil pertinent to contain turbidity during dredging. A wall of air bubbles keep suspended particles that hit it into little or Texan they end up settling down and they could be dreads at the end of the project team the bubble curtain is constructed by dredging in a trench and here this is right before the café Street bridge and then laying down a perforated pipe and blowing air through it during the project. The main advantage of the air bubble currently is it allows vote traffic over it instead of having to move Phil curtains back and forth if you have to have traffic to. Is has been show to have free passage migratory traffic from fish and [Indiscernible - low volume] at the maintenance replacement of the typical turbidity curtain would've been. It is also more environment friendly in you do not have to decontaminate the landfill at the end.

Then the last concept I want to import is verifying the design of implemented, has met the project objective, and doing so in the near real-time before the construction equipment has been demobilized from the site. Post dredge symmetry and post dredge sediment sampling were conducted within a week of dredging completion and established dredge management units or DMU. Quick turnaround times were used for chemical testing of PCBs and PAH is to avoid standby time charges.

I know you cannot see this, but the flowchart was developed during the design phase that guided decision-making. Including whether a dredge cleanup has been needed. Single point PCB results above 10 parts per million triggered re-dredging. A decision on whether a send cover was needed as a dredge -- on a dredge management unit was based on average post surface concentrations within the DMU. Generally have greater than five parts per million PCBs or 18 part per million's pH is, six inch thick send cover was placed. We kept a rolling surface weighted area of

concentration calculation going throughout this process to make sure that the overall project reached that is W AKT goals at the end.

Post dredge verification effort was closely coordinated effort between the engineer and the two construction contractors who were working upstream with the A Street bridge and re-dredging was required a new dredge contours were created in near real-time. At the end of the day, about 9300 cubic yards were read dredged or 6% of the project total. That equates to a characterization model accuracy of 94% which is a very good especially considering that resettling and resuspension and fluffy are also factors that contribute to re-dredging.

The Sheboygan River cleaner products and three related habitat construction projects that I did not cover in this talk we start the recreational and commercial use of the harbor and River, reduce human and ecological risks and limited beneficial use impairments, which are important to the D lifting and AOC so it put this AOC on the path to D lifting.

Thank you for listening.

Okay, great, Gina, thank you for the presentation. I found it very informative. Just moving on we will get to our last panelist for the day, Mr. John Roberts, he will be presenting to us deep trouble when design phase simplicity meets construction phase reality. John has a BS and MS in geological sciences. He is a professional geologist license in Pennsylvania and Delaware and has 35 years of despairs as and environmental consultant. Major focus of John's career over the last 20 years has been investigation, remediation and regulatory closure of MGP sites on the Pennsylvania act two land recycling program. With that I will turn it over to John and it is all yours, John.

Thank you, Steve. I will assume everybody could hear me and if the volume is not good speak up but otherwise I will assume everything is okay. Again, yes, I'm John Roberts with Stantec consulting and a sit in southeastern Pennsylvania and my co-author on this paper is Gordon Russo, Gordon is with UGI utilities and he is my client for this project. For those of you that you and I don't UGI utilities is the gas distribution utility for Central Pennsylvania and northeastern Pennsylvania.

As a result of that, UGI and Gordon in particular has a spots ability for clean up of -- portfolio of 65 manufactured gas plants. So the paper today, discussion today, is about an interim remedial measure we conducted at one of those sites in Scranton. We did a portion of the remediation this past fall. The paper here is pretty much a traditional case study to talk you through what we did and how it all went. I guess what I hope to highlight here is just -- everything looks pretty simple in two dimensions on paper, but when you get into three dimensions out in the field, just when you thought of everything, reality those who a couple of curveballs. And each of those curveballs has an effect on the project budget and that was a major focus of his paper, the tracking of the budget as this project evolved.

I will state that this site is as Steve said in my introduction, this is at two site and not a CERCLA site words up on-site or other site that it is at two in the closer we are after and this is under the the at two recycling -- land recycling act. I could go on and on for the to 20 minutes about what a manufactured gas plant is, but I don't have time to do that but real quickly, if you look at this site, this is overview of the site probably taken in the late 50s or maybe early 60s and there is a railroad track along the site and is in downtown Scranton so there is a railroad track along the southern portion of the property and there are these big circular structures that are cylindrical tanklike structures and three of them shown on this photograph and there were additional two gas holders present at an earlier iteration of the site so what they do is they bring the coal in on the rail and they take the coal to that long, their building up along the river and they superheat the coal in the absence of oxygen and that would liberate gases that they would capture in these big gas holders the big cylindrical things. Now the gas holders not only do they extend above the ground but they also extend below the ground in many cases. When these plants were all shut down, this plant in particular shutdown in the late 50s early 60s, they basically, in my experience, throw anything that they have available into -- remove the above grade portion and throw anything handy in to fill in the below grade portion. Also as you will see in the photograph or two, during this presentation, the gas holders, subsurface holder of the gas portions are where most of the cavitation is located in the sites.

So with that primer on MGP sites, this is a shot of the site probably taken last year or maybe the year before. I don't know if you could see it but there are a couple of circular structures and maybe I can see it because I'm too familiar with the site but at any rate, we removed a couple of gas holders under a similar IRM in 2018, and then this last fall we did the next phase of investigation and removed two gas holders. At present, there is nothing above grade. Everything is below the above date and left of the MGP structures that we took a look at -- it shown here that is gas holders three on paper and that is 100 foot diameter, 15 foot gas holder and gas holder five, this was a real old gas holder and on paper that was 60 feet in diameter and 20 feet deep.

The reason I get into the specifics on the dimensions of these gas holders is, all of our -- on the proposal phase, when we were preparing the documents, we calculated a lot of quantities. 130 Depp to date, quantity of materials excavated. And quantities of material transported off-site for treatment and disposal. I guess I should back up and say, yes, this is a typical dig and haul job unloading trucks with contaminated dirt and sending them down the Pennsylvania Turnpike.

This captures the various components of the remedy but let's focus for no on that red dotted circle. The red dotted circle is where all the site trains show a location of gas holder one a. But there was one obscure little remedial action conducted in 2009 and sketch map in the back of that suggested that gas holder five was not where it was shown on all the other site drawings, but rather where the blue circle is.

Gordon and I went out there last summer and with an excavator, backhoe, we confirmed it is not where the red circle is. Instead is where the blue circle is. The reason I point that out is because there is uncertainty and unknowns about the details behind gas holder five. So based on what we know about it we assumed it was 60 feet in diameter. And we made all of our to cost -- quantity -- quantity estimates and cost assumptions based on the 60 foot diameter so we started our excavations there and low and behold, there is gas holder five. It's right where the blue circle showed it would be. But it was not succeeded in diameter. Only 40 feet in diameter. Which was a good thing, so what that meant was that we had something on the order of 1200 tons soil less to excavate, transport and dispose than we had budgeted for and that translated to about $220,000 less than we had budgeted. Now this little bar scale on the left here during the dry runs in this presentation some people asked me some questions about that, what it means is zero dollars there is if all of our assumes quantities are spot on, the job will finish right where we estimate it. But that is not always the case in the case of gas holder five, we saved $220,000, so we are doing hundred $20,000 in the green. So green text is a cost less than estimated, a green bar is cost less -- the running total, ahead of budget -- under budget or overbudget, read text you will see it later in other slides are quantities and costs that were more than we had anticipated and then the bar scale, green bar on this one, is a running total of how we are doing and how our costs are tracking relative to budget budget.

Okay, we are feeling pretty good, $220,000 ahead a game and ahead of schedule so we go to two gas holder 15. I'm sorry gas holder three, which we assumed was 15 feet deep and what that I assume that based on?

I assume that based on some soil borings we conducted that were five core soil borings to collect samples for race characterization so we looked at those borings and here's what I saw.

Firstborn showed refusal at 15 feet. Second boring, stopped at 15 feet. Third boring, 15 feet. Fourth boring ended at 15 feet. In the fifth boring ended at 15 feet. So naturally when we calculated the quantities, we assumed 15 foot deep gas holder, and got a pretty joint surprise. So we are dewatering is gas holder to get the soil ready for excavation and my site two provider gives me a call and this is a picture on the right-hand side here. Us dewatering gas holder three. Dig down, sticky pipe in there, stick submersible pump in the pipe and you draw down this tar water, pretty nasty stuff, and you pump it down as much as you can to try that soil up and make it as easy as possible to render it suitable for trucking off-site.

ISight supervisor calls me and he is all optimistic and says everything is going great and got the water drowned down to the 50 feet and pump is another 8 feet below that and we should be able to edit pretty dry before it is time to dig. I stopped dead in my tracks and I thought, how can we get a sump down to the 23 feet? I look back at all of the old projects reports and all the old drawings and then I went back to those boring logs and darn it, if the fifth boring, I think what that

says there in that box is concrete at 23 feet 4 inches. Why that was written in the boring log interval from 10, 15 feet and not down toward the bottom of the boring log, I don't know. But frankly I just missed it. What that did since gas over three was a major part of this IRM, and now we think it is 23 feet dip rather than 15 feet deep it had pretty significant impact on our projected total project cost.

To the tune of close to half 1 million bucks so that took best meant we were ahead of the game by $220,000 but you subtract $475,000 from that and it puts you pretty deep in the hole something around $250,000 over budget at this point in looking.

But then we got a break so this is not gas holder three. This is not Scranton. This is representative of the type of section of dumb, something called a dumpling and this is a gas holder somewhere in England and every gas holder I've ever seen had a flat bottom but as I come to learn, it is somewhat common that gas holders have this dome structure that is called a dumpling. The reason I show this as an example is because I don't have any real good shots of our gas holder three dumpling. But that is what it looked like. I hope that comes through on the photograph, but that is the best picture I could find showing the dome or dumpling on the bottom of the gas holder three.

So what we are figuring is most of those borings that were drilled to do the race characterization sampling were in the center portion of the castle to where it was in fact 15 feet, but that one that showed concrete at 23 feet was more toward the perimeter of the gas holder.

What did that mean? I called Gordon and said we have a dumpling in the bottom of our gas holder and he said that is really good news. What you have to do is calculate the volume of a fuss drum of a cone and I said I don't know what a fuss from of a cone is let alone how to calculate the volume so he sent me this excerpt from MGP -- some sort of archived MGP document that sort of demonstrate -- the reason I included here is the sting must be fairly common these dumplings if somebody is taking the time to work out a formula for one. At the end of the date what did that mean?

That means because we had a dumpling, trying to find the number here, Garnet. I forget how many times we saved. We saved about 1000 cubic yards less than we had anticipated when we thought the thing was -- bottom of the gas holder was entirely 23 feet below grade. That ended up in a savings of 210,000 which brought us up close to our -- not our design but estimated cost as a function of the bidding -- during the bidding process. What our budget was established for the project.

What came next? Okay, we got another break, geometry gods continue to smile on us. The gas holder three, as shown on the drawings is 100 feet in diameter. Oliver Drake calculations were based on 100 foot diameter. Now every gas holder I have ever seen had a flat ball and estimate flat bottom so the dumpling was a surprise to me but every gas holder I have ever seen also has a brick wall, cylinder horizontal brick cylinder that is anywhere from 18 inches, two and half feet thick and in our case, we had two and half foot thick gas holder walls.

So the actual interior diameter of gas holder treat was only 95 feet, rather than 100 feet in diameter. It took me by surprise, and I don't know -- I guess I didn't think about it long or hard, but that is a pretty significant volume of the gas holder. So I guess I think -- Jean, do have the question or do I just need to type through it? Here's a question, a poll question and it don't want to think too hard about this but just a question, the outer wall of gas holder three is doing have feet thick, what proportion of the total volume of that gas holder is compromised by asthma is comprised of the bricks? Just give me your off the top of your head yes,, for, eight, 10%, what you think? Do not put your calculators away -- okay, I am a little surprised. The numbers are coming in -- Jean, on a note of the audience could see it if they cannot, maybe let them see it.

They cannot see how they are voting.

All right, the votes are about half of you think 10%. A third if you think 8% and then the rest of you think four, 6%. I would've fallen in the cap a or B category and the correct answer is 10%. 10% of the volume was made up of the bricks so that is material that we do not need to ship off-site and we do not need to pay for thermal treatment of that material. So not a major component of the job, but $75,000 is $75,000. That was a savings of -- was a volume? 650 cubic yards, roughly, yes. That put us at this point in the game we were little ahead of budget so feeling pretty good.

Then it got interesting. Here is the facility where he took our soil, about doing have hours south of the site in Scranton. I will explain to you real quickly how the soil is treated in this facility.

Let's start with the red arrows, this is a so the comes in, red arrow number 1 comes across the sales and gets weight for payment purposes. Onto the site and red arrow three, staged in this building in six days inside this building. The disposal facility samples this material and get a feel for the parameters for the thermal treatment. When they're ready to treat it they run it through a screening plant at the back of the building here and take it up to the north end of the plant out into the thermal treatment unit. Wanted to that thermal treatment unit and take it out to the yard.

The soil at this point is not topsoil that you could sell at Lowe's, but the volatile organic compound, concentrated of organics has been substantially reduced so there's a landfill nearby that accept for daily cover at nominal or maybe no cause, I'm not privy to the details of that. But I think it's three or close to it.

Where we got in trouble with the green arrows so at the screening plant, four inch screen, that which does not pass through the screens goes through these green arrows onto the garden typically large concrete chunks, that kind of thing, -- and it also has some other materials in it. What they do is they send these guys called pickers up to the stockpiles in the polar rebar and pull out would fragments and

pull up plastic that comes up the works and then what is left is they sent of to a concrete recycling where it is crushed and reused.

Unless when the pickers are picking through it they discover as best as tiles. Which is exactly what happened here they discovered asbestos tiles and tractor back to our so in the building so they shut us down. What did that mean most what we had five trucks on the way that day and two of them had something look at what they got their asbestos results back they turned the other three trucks around and had to drive all the way back up to Scranton five hours of hauling dirt. That we were left with what we thought was 2000 tons of soil remaining on the site.

Now this soil was primarily from deep in gas holder three and if you remember the photograph of the dewatering, there is a lot of tarn that material and it was pretty nasty. The the clip venting concentrations of the soil were in excess of .5 milligrams per liter. Now those of you that are not in the MGP world will say that is hazardous-waste and you will have to take it to model city or Canada or somewhere exotic at exotic prices. And that would've added $640,000 to the cost of the job. But we did not worry about that too much because in the MGP world there is no such thing as a d cap hazardous-waste and the reason is back in 2000 there was a court ruling that was a battery recycle versus U.S. EPA which ruled that as it said in this text down here but wasted generated during the cleanup of an MGP site is basically by definition not hazardous-waste. T clip does not apply to MGP remediation waste.

So we knew that and we could instead of taking it to a hazardous waste landfill, we could just take it to a solid waste landfill somewhere in Pennsylvania. So relative to the big red arrow I had done here before the red bar I had down here, the cause was significantly less as we were able to take it solid waste rather than hazardous-waste.

Next slide. We got most what actually as it turns out what we thought was 2000 tons at the end of the date when we loaded it all up and ended up being 3200 tons. So the financial roller coaster gets another bump in it and adds $170,000 to the cost, in addition to what we had previously estimated.

So I would like to say that is the end of the story. I'm almost at 20 minutes, but we hauled the last of the soil off about six weeks ago in the middle of January and I would like this to be the end of the story, hoping that you guys could give me another couple of minutes and the story continues and there is some interesting lessons going forward.

So we thought we were done. But if you go back to the disposal facility they shut us down on November 23rd and at the time they shut us down there were three stockpiles of soil left there. I will go to each one of them real quickly.

First stockpile, material that was screened and ready to go in the thermal treatment unit when they got the asbestos pile and shut us down. That was from deep in gas holder three and had T clip venting above .5 in the local landfill could not accept it so we had to take it rather than five minutes down the road, we had to take it two and half

hours away in a much higher cost. Second pile, it was material from shallow and gas holder three and had larger quantity than the first pile. But it had lower T clip benzene and the looker landfill could ticket they were couple of minutes way. The quantity was larger but the costs were lower so the incremental cost from this larger pile weren't as dire as the previous one.

Then the last one and most tricky one is the debris from the screening plant that is out there in the yard. It basically is 500 tons of debris from the UGI site, 1500 tons from other generators, and just a handful of asbestos tiles. What the original disposal facility said is we have to take all of that to the local landfill 85 but the 10, 2000 tons, $175,000 added to your job. So is that no, as a counter offer, how about you sift through that pile, get an excavator with a thumb and pull out the large concrete and send that offer concrete cycling and what is left we can then send to you landfill and we will give you a $5000 lump sum, incentivize them to work that pile a little bit. They like to that offer and liked the concept but the final offer was they wanted additional $30,000 for the lump sum to handle -- to cover the cost of digging through the stockpile .

So where does that leave us? Like I said I think at one point before it was a financial real color with a lot of ups and downs early on in the job we were doing pretty well, the asbestos tiles and all that debris that we had not accounted for down to the thermal treatment facility, sunk is pretty deep into the red by the end of the project. We were a little bit over half 1 million bucks overbudget.

So what are the lessons learned? Real quick I'm overtime here, be careful with assumptions and I admit it, I breezed past that concrete at 23 feet on the one boring. I was just trying to get a bid document out the door and I miss that and did not take a second look at it. One, this was for me and your vote is on the question, I think maybe I'm bit of an outlier but little things can mean a lot and basically not quite but the thickness of a line on a drawing can result in $75,000 difference in cost rather than budgeted. As I said we tracked cost real closely on this thing, and there's a lot of reasons why we did that. Gordon wisely built in a 15 percent contingency but we did not anticipate what I called the Black Swan, those tiles. The asbestos in the waste and ramifications of that. End of the date we were about 25% over budget.

Last, open clear communications between all stakeholders. Good work relationship with our contractor, meetings at the site every week, in person. In hindsight I wish we had better communication and a better understanding of what was happening with power soil at the disposal facility. It was a surprise to us that they had been sitting on several thousand tons of our material as of November 23rd that we thought was long gone.

So that is it and hope it was helpful. Looking forward to questions as everybody else's during Q&A period, thank you.

Thank you for the, John. Appreciate it's. I guess that Ann's panel except for the Q&A so again I just want to thank our panelist. John, Grant and -- I'm sorry, Jean? I'm sorry, Gina.

So we will move right into the Q&A part of this. We do have some good questions coming up here. Was start it off with I got a question for John, during the investigation phase there was no indication whether it was pass records or maybe in the boring logs or anything that the asbestos tile were present, how do you think that got missed in the beginning?

Well it is a big old gas holder, right? And everything is underground and as I said in the beginning and I said intentionally, when they decommissioned these plans, they just pushed anything they had available into these gas holders. We found old wooden wagon wheels and for some reason we find a lot of bowling pins, the short answer is, there was no indication of asbestos in our investigation work. They were very small fragments, small fragments just a handful of them in the 2000 tons stockpile done at the thermal treatment facility, making it up, but four or five pounds of asbestos but that shut us down.

I hope that answers the question.

Yes, definitely. Again for you, John, board there any assumptions worked into the initial proposal, for unexpected materials or waste?

Well, we had multiple line items for cost, all assumed quantities. We had a big spreadsheet and the bid sheet was basically our cost tracker during the job so that we had the bidders all fill out this spreadsheet with unit cost for all these various items. Digging gas holder five, unit cost per ton or yard. Digging gas holder three, had a different cost and they had to add another change order for digging gas holder three below 15 feet because that was a little more complicated. But no, how do you budget -- had we known to put a line item in their for disposal of asbestos containing waste, we would've but we did not know there was asbestos there. So no, the answers no, we didn't anticipate anticipate -- asbestos so we do not have a line and for asbestos proposal -- disposal.

Okay, fair enough. Gina, other than typically communities do not like to use waste material in their communities for either Phil or what have you, was there any -- that was the objection to using the clean sediment at that airport expansion?

Steve, I think that gets into the whole how clean is clean and it was their absolutely nothing [Laughter] [Inaudible static] no. So it was not a huge amount. Just a last minute scramble so unfortunately you always try to find some official use, but I did -- the community in general I noticed this [Indiscernible - low volume] you going on that if you are all right let me assure.

The community warmed up to the project once they realize the construction was imminent because they had heard about the project for 10, 20 years. Once it was actually happening, decided to get excited

and mostly because they were going to get restored draft for those of us who had peers on the river, bit of inconvenience because we had estimate to put their peers begin in the spring right away. But the end when they got the reasonable drop both commercial and recreational [Indiscernible - low volume] fully use the river again and were happy about that. It ended up judging, quite and attraction that some especially there's a restaurant right there on the river rock that look up at the dining and they were hopping that summer. All in all --

[Indiscernible - overlapping speakers]

Interesting.

Great. Grant, question for you, was it difficult from a regulatory standpoint to change the revenue from excavation to institute thermal treatment within the -- in situ treatment within the accelerated schedule?

Yes, that was certainly a challenge. Fortunately the regulator was very, very familiar with the site, and this project was one of more than a dozen operable units for areas of concern at the site. So the regulators familiarity with the site, for several years, really played a crucial role. And they were able to pivot and assign the 75% DOC reductions based on prior areas of concern. So that really is probably the primary reason why the remedy was able to be changed, basically within the three, four-month period. And be approved by New Jersey DEP.

Okay. Was there any special considerations you guys had to make sure that? Was there a chance that was not going to fit into that schedule?

Yes, we were really concerned, because the schedule for the redevelopment in this area was very tight. So the initial conversation was sexually in person meeting with the -- was actually in person meeting with the regular guys and go through the timeline and expectations for the review period and it was at that in person face-to-face meeting after, you know, the macro drivers and the project were reviewed and discussed that the entire group of stakeholders, including the regulators, agreed that they thought that they could go ahead and review and work with the contractors and the engineering firm to let and approve the remedy change about three, four month period.

Okay, a right, excellent. Next question, Gina, what was the typical depth for the sediment dredging? I.E. like away from the -- like how far away from the bridge that you have to stay and how deep did you have to go? What was the depth of the set of contamination general and was it characterized during the remedial investigation?

Yeah, so the sediment thickness that we treacherous was basically off the soft sediment onto the glacial till or clay and it really buried. It could be less than a foot in some areas down to over 20 feet thick -- well close down by the bridge. Bridges, we had some offsets and I think it was 5 feet offset from the bridge abutments. You don't want to get too close but then again -- you dredge up to the 5 feet and there

is flooding so you end up getting some ore material. Characterization wide, I would say it was very good for the PCBs and showed you the one slide with the model accuracy, 94%. Probably the most tricky area was around the camp Marina and GP site with the pH that had been characterized by the consultant for re-energy and they missed some of the deeper NAPL so there were some lower last-minute, gosh, you guys did not get all the NAPL when you put in your cover dam wall and sides on the wall, their was scrambling to get on their under to get permission from the eight holders and get permission to all of the NAPL was removed.

Okay .

For this, this would go out for grant and Gina, John pretty much covered it in his presentation, but the challenges that you guys faced on your projects, did they lead to increases in overall project costs and was there any contingency in their to cover those costs if it was the plan for?

Yes, this is -- go ahead, Gina.

Okay the one example I brought up on the two projects in the little curveball I was thrown at both of them when the landfill decided to change their strength requirements, I know that result in change order for the Army Corps project -- on the Legacy act project it didn't because it was set up as a performance spec. So in general though, I know that the cost that was set aside was sufficient -- additional money was not needed.

Okay.

How about --

[Indiscernible - overlapping speakers]

Grant?

Yes, I think every major scope of work, even some minor scopes of work, [Laughter], had at least one change order. The drilling, definitely, because of the different depth to the bedrock. The cost associated with the wells for the same reason. The electrical power drop for the 400 amps. But then again we had some offsetting efficiencies. We used less of a budget for electrical power than was budgeted. We were able to install the project a little bit ahead of schedule and have some cost savings there. But no, in total with so many changes and no unknowns and especially unknown unknown factors, during the project, there were quite a few change orders and such but all in all, the budget was pretty close to the original estimate. I think the variation was within 5% range.

Okay. Okay. Listed for John, -- question for John, lost my place here. John, what a geophysical survey, what that have helped more in your planning to list the gas holders?

Yeah, I think definitely, especially gas holders three, I think the dumpling would have been -- we certainly would've gotten a signature that made a stop and go, what is going on there? We would have -- you know, scratch the surface a little harder and figure out what that was all about. Gas holder five, it wasn't a real tough location. It was on a slope. It would've been hard to do geophysics there and we did not really know where it was. But certainly I think the answer is yes, I think geophysics could've taken some of the mystery out of not only the location but the dimensions of these gas holders.

Okay. I guess it would've been the edges of that would've been too deep for like a ground penetrating radar anything like that?

Yeah, I'm a geophysicist by education, and I had some pet expenses with ground penetrating radar early and I have not really forgiven it and you had to have ideal conditions, ideal contact between your GPR unit and the ground surface. And in and ideal world, that is great. But in the real world at an IDP site it is not and ideal condition.

Okay. Gina, for you, in regards to the silt turning, silt bubble curtain, how is that operated? Was it turned on just during operations during the day or was it just always running?

Yeah, in this case we left it running continuously. Same on the connect the river in Wisconsin. I don't right now it is being used at the Qantas canal in New York and in that case it is been shut down at night. Maybe just rolling into a few more, [Laughter], expansions of the Trinity and I saw some of the questions. So we knew that the Trinity curtain was working because turbidity monitoring was done continuously downstream of it so it felt like it was working. Also the effectiveness is administrative -- at the end of the project, on the clinic and it, we have 2 feet of sediment as you have in front of the curtain and that was not let loose a water goes through the curtain but particulates are not. It also acts as a garbage collector too if you have surface garbage litter on top of the water you can see it all gets backed up behind the curtain. And there are published studies on the permeable curtains out there and you can find them if you go on the website and Google but if anyone has desperate wants to see the McKenna find them feel free to send me and email and I will point them to them.

Okay. Okay. Grant, with the in situ treatment that extracted the PCT CA contamination from the silt clay, till deposits, was it also able to capture any notable PCT seat contamination in the bedrock that was below?

Yes, very good question so the bedrock that was below was dominated by dolomite and it was then -- there were limited fractures, but very, very limited fractures that were really most pronounced in the upper 10, 14 inches of that bedrock layer. So during the pretreatment assessment, there were samples collected from various depths into that bedrock interface. And the only detected VOC concentrations were in the very upper portion, upper several inches, of that dolomite. And the strategy was that we designed and installed the remediation wells into the top 3 feet of the dolomite, to make sure that we were heating,

treating that a proportion of the dolomite. And then, during the post remediation confirmation, SAMHSA program, they were samples of that upper 3 foot section of the dolomite rock collected and analyzed. But to estimate the percentage of contamination found in the rock interface, I would have to say it was far below 1% volume.

Okay. So you did see some, but certainly not a lot?

Yes, yes, we had some detections before the remediation, but they were at least in order of magnitude, if not several orders of magnitude, what were then -- what the mean concentrations were in the overburden.

Okay. Okay. John, getting back to you, was there any reasonable way to have known as best as tiles were present within the older contents? I mean, I know I kind of alluded to that earlier, but like was there any kind of design documents that were available to you guys that would've maybe spell that out a little better?

I do know about design, design -- design documents I'm not sure and I'm thinking about this as the questions are being asked and typically the way we do our investigations, for the gas holders themselves, they are always a target to be remediated so we typically will just did test pits and then early in the investigation, to get some general idea of what is in there and how deep is water and how much dewatering are we going to need to perform? Is it predominantly soil or debris like? But I guess in hindsight we do that early in the project, and at least hereto for, the focus of that was not to look for asbestos tiles.

Yeah.

It was to get a general feel for the physical nature of the material we would encounter, large degree, small debris, clay, soil, wet, dry. Again I will go back to and answer from and early question, you know, I don't even know how many asbestos tiles shards, the shards were 3 inches -- two, 3 inches in size. In the gas holder, you know, is big.

Yeah.

Easy to miss. Easy to miss two inch asbestos short 23 -- [Indiscernible - low volume] 23 foot gas holder, yes, perhaps lessons learned going forward early on in the project, or at some point in the project, test pits, to really look at what, you know, -- look at the debris you will generate when you dig to stop up and send it off site.

How did they actually see it when it went through the separation process and they found those shards? It just seems like so little debris of the asbestos debris versus the large quantity of concrete and those items in the waste pile.

Yeah, the treatment facility -- I don't know all the details but they recently had a bad incident at one of their facilities, somewhere in the Midwest. Of similar, might have been PCBs but probably asbestos, that cost them hundreds of thousands of dollars. And so, they are on egg shells and when they send the takers out -- be -- so they are

really hyper diligent in this day and age, before they clear debris pile to send of to recycling because once it goes off to recycling and you find out after the fact it had asbestos in it or PCBs in it or something, it is a lot harder to put the debris toothpaste back in the tube, so to speak.

Yeah.

So in years past, perhaps a couple of shards went out and you know went out with our soil and just weren't picked up by the pickers. To maybe this case for the Scranton site last year isn't such an anomaly, but with the treatment facility on hyper alert, maybe that is what is happening.

Okay. Sticking with the treatment facility, do you have any other details on why and how the facility may be closed and by whom? Was it local or the state, do you know?

No, no, no, the open for business. They close this down, they set us down and they said you have asbestos and we are not set up to handle your asbestos and turn your trucks around and take them back to Scranton.

Okay.

They weren't shut down, no.

They are doing right by their employees and by their permit and either recycling facilities that received their concrete debris. No, we were shut down, not them.

Got you.

Okay.

I think we are out of time. So again I just want to thank you guys for some great presentations and I'm sure everybody listening definitely got some value out of it. With that, Gina, -- Jean turning it back over to you.

All right, trick is a very much. I will go ahead and walk us through a few final reminders as we get ready to close out day two of the virtual DESI HWS symposium and while I'm going through these final reminders I did want to remind the audience that this is your last call if you have any burning questions or comments that you would like to share with our speakers and moderators today, please be sure to type them into the Q&A window right now and I may be able to squeeze them in before we close today. Before I close us out I want to continue to echo our thanks and gratitude to our event sponsor and again without their support we would not be hosting this session online and I also want to thank our large business sponsors and our small business sponsors for their support. There will be ongoing DESI HWS events throughout the year and the group is planning to host their fall DCHWS in Westpark come from -- excuse me, the fall DCHWS West symposium this fall in Denver,

Colorado. There will be additional information coming out and hopefully a call for abstracts in the summer of 2021. We will also carried on with a series of technical webinars and we will be hosting them including them as part of the ongoing partnership with SAME and the DCHWS seminar series so our very next two seminars will be hosted in may and I encourage you to visit us at Gruen and look at the webinar calendar to learn more about the sessions and sign up for them.

I do want to echo the thanks to each and every one of our panelist, our moderators, our plenary speakers, and to all of those that were involved behind the scenes and helping to run today's session. I know that the event organizers wish they could have held this session in person, but we do appreciate those of you who are able to participate and we have gotten ready a lot of feedback that posting it online has actually opened up doors and opportunities to many of you who would not have been able to attend if it had been held in person. So for those of you that are connecting, I encourage you to use the feedback form which should be visible to you right now in the Q&A window if you scroll down to the bottom and I have included a number of important links and one of those being a link to our online feedback form. For those of you who participate, each state you will have the ability to feel out the feedback form and give us your thoughts on each day of the symposium including the content, our format and even the platform that we were using to host today's session and number of you have given us feedback in the Q&A window throughout the life broadcast and encourage you to submit it in the feedback form because we will be sharing it with the event organizers and again help improve and shape our future sessions. For those of you looking for certificate of participation today, you get if you fill out the feedback form, there will be a box at the bottom of the form that you can check to indicate you are here for the session. And then as soon as you submit feedback you will immediately have access to a certificate that you can say for your own records. You can do that for each day of the series. For the handful of you that are just listening by phone, I want you to follow the links that we would've sent in the reminder email to you and visit the seminar homepage and you will find the link or button to the feedback form right there on the seminar homepage.

If you happen to be one of the lucky people watching this recorded session, you can still click on those links and provide feedback based off the recorded version of today's delivery. We will go ahead and carry on with our third and final day of the virtual symposium tomorrow. Hopefully you all will come right back here again the link and details remain the same each day. We will carry on with our third and final day tomorrow at 1 p.m. Eastern. With that I will again thank each and every one of you for joining us and participating in this virtual symposium. I hope that you will join us when we resume with our final day tomorrow. But that let's go ahead and officially conclude today's life broadcast. >>

[Event concluded]