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>> Good morning everybody. My name is Christine, I am the regional branch chief with NOAA's national survey. I will be your facilitator today. So first welcome to the tidal and water level datums workshop. I will start by going over a few best practices in virtual logistics. To optimize bandwidth and create an uninterpreted audio experience please close tabs or apps on your computer. Excessive use of bandwidth can cause choppy audio. There's a closed captioning button to the right of the hand at the top of your screen. If you need to use closed captioning please click on that. Due to the privacy act please keep your cameras off and your voices muted. If you have questions, please drop them in the questions chat box which we will be monitoring. Please note that there's no conference call number available for this session. If you are having any technical or audio issues during the course of this session, please type a note in the technical issues chat box and we will be happy to assist you. Please be advised that by participating in this meeting you are giving consent to be recorded. Lastly, the purpose of this workshop is to learn more about and discuss the upcoming the national tidal datum update. You will hear multiple presentation from the offices at NOAA such as the machine operate services. You will hear from the U.S. Army corps of engineering and a few consulting companies including JOA surveys, LLC and baseline. As much as we are able, we want to hear from you. So please use the chat box to send us your concerns, questions and comments. Thank you very much for joining today. Now I have the pleasure of introducing our welcoming speaker. Merion Wesley is the acting director of NOAA's center for operational ocean graphic products and services or co-ops. The source for accurate, reliable, timely water level and current measurements. In this role she oversees and continues to improve this

24 hour a day operation to provide mariners with historic, realtime and forecast data on ocean conditions along the 95,000 coastline. Dr. Wesley's career with NOAA spans over 20 years with much of that time spent advancing climate research and transition of research to operations. She joined co-ops in 2017 as the deputy director and has been the acting director since January 2023. Dr. Wesley has a BA in physics and English from Yale University and a master of science and PhD in oceanography from the university of Hawaii. Welcome.

>> Thank you so much, Christine. It's a real honor to kick off this great workshop. So I'd like to thank all of you who are a part of our two-day virtual workshop on tidal and water level datums. It's provisional to our national and shipping communities and also to coastal managers. As Christine said I'm the acting director of NOAA's center for co-ops. Our mission is to provide data for the mission and our mission is information accessible by anyone at any time from any place as needed to protect their lives and livelihood. In co-ops we maintain the national water level observation network a permanent observing system that includes 210 continuously operating systems. A quarter is located this the great lakes, which is non tidal providing water level data for the international management of those water resources. They provide the national standards for tide and water level datums using charts, coastal engineering, international treaty regulation and boundary determination. These data used to support safe and efficient navigation with realtime environmental intelligence, mapping and charting of the nation's coastal oceans and coastal hazards and costal planning. As you will learn none of this is possible without the context of datums. Here in co-ops we have the responsibility of maintaining two of the nation's vertical reference frameworks the tidal datum and the water datum. We are currently engaged in major updates to both the national tidal datum epic. Over next two days you will hear from panelists involved in the updates to these datums and those effected by these updates. We hope you participate in a question and answer sessions and take advantage of the expertise available to you over the next two days. I just want to take a little bit of time to thank you for joining us today and to thank all of our panelists and speakers who are presenting these great workshops. I would like to call out our partners, the NOAA service and the U.S. corps of engineering. We have multiple state partners as help us fill datum gaps including states of North Carolina, Florida and Alaska. Being part of the broader update is critical. Through your work together and everybody who is contributing to this effort, you're also contributors to our co-ops mission. So thank you so much for that. Lastly to thank everybody who is behind the scenes, organized this event, has made the technology work, has made all of this happen, thank you so, so, much. I wish you a great and successful workshop. Back to you.

>> Thank you for that welcome and introduce. I'm excited that we can jump right into our workshop. Please take it away, Mike.

>> All right.

Well, first I would like to mirror Mariam's thank you for everybody for taking the time out of their days to attend this and be able to the updates that are up and coming. You know, this is a major enhancement, major event. I also want to give a shout out to my team, the datums team here who are currently working on updating all of the control stations and subordinate stations so that way we can move from the 1983 as part of the epic. You will hear me say this many times but I will start off by putting out one word that is key to everything that you need to do right now in preparation. Metadata. Know what you're working with, know where you're working from and everything so as we transition to the new epic for both the national tidal datum update and national great lakes datum which is tomorrow's needing, you need to have that metadata, record that metadata and have that so you can transform going forward. So speaking to national tidal datum epic, a couple of things to go through. You have to understand that the reason we do the national tidal datum epic and deal with tidal datums is a couple of things. You have two significant entities that define tidal datums along the coast of the U.S. and everywhere in the nation. You have the effects based on astronomy, so the effects of the sun and the moon pulling and the gravity from them pulling and causing the actual tides. That is the main driving force. You also do have the hydrodynamic effects which heavily effect the time of tides and the range of tides. So deep water ocean tides are one thing but as they approach the coastline once you have the impact of reduce and the showing that is actually going to significantly change the time of the tide and the range of the tide as you come into each coastal area and whatnot. That's one of the biggest things we deal with looking at tidal datums. As said, the astronomical effect, if you imagine the location of the sun relative to the Earth and the moon relative to the Earth, as we spin around each other over time where you have the apogee perigee, the distance between the sun and the Earth, the Earth and the moon and everything, you're looking at about -- it's actually 18.61 year period until the alignment of the sun to the Earth to the moon are identical. This is the defining factor which created the need for the national tidal datum Epoch since the biggest effects on tides are based on the sun and the moon. If you look at this image in the lower graphic you can see the mean range of tides. So that's the difference between mean high water and mean low water. You can see the effect to this. The red line there is the mean range of tides annually and the blue lines are the monthly mean ranges. So between peak and peak or trough and trough is that 18.61 year period. Historically we relied upon manual hand calculations. So averaging up to 19 years instead of 18.61 year period. Through

minimal if any statistical significance into the value, it's sub millimeter variance. It is historically easier to work with full year periods and we continue going forward with that. One of the other things to consider is the variance and different tidal types around the world, around the nation where on the east coast you have pretty much -- where you have very consistent high tide to low tide. The gulf coast you're primarily getting one high tide, one low tide per year. West coast you're getting mixed which you're getting a significant variance in the changes in tides between high tide, low tide over the full month period. But at the same point of time one of the biggest things that you have to realize, tidal datums and everything, is the transition and the variance can change significantly in a very short distance. For example, the lower right-hand side here, if you look at Puerto Rico there's about a 16.5 mile difference between where it goes from a semi to two. So from one tide a day to one tide a day. That's one of the important things when dealing with any project or whatever you're working on you have to take into consideration and make sure you understand what tidal regime you are in and how it affects you. So from that what really matters, why do we really care about it. Well, if you start at the top left of this image, you're looking at about 7 day period where you can see the high tides and low tides, you know, and just see the range of tides. You're basically looking at in this the predicted versus the actual observed where predicted is red, observed is in blue. The top middle is looking at a full month. So you're actually getting the effects of spring tides and leap tides coming into it where the spring tides you have the larger range of tides because as the sun and Earth move around relative to the -- or relative to the Earth, when they are in alignment or opposed you have a larger range of tides but when they are opposed you have the small range of tides. The large is the range of tides. You can see that very well within this graphic of how it effects the tide range. The top right, what we're looking at is we're actually looking at a monthly mean, local mean sea level at the same station. Over a time period of multiple months. As you can see, you have a seasonal effect that comes into interaction with the tides. And the range of tides and everything like that. So you're looking at basically I believe that's about a meter change from the winter up until the fall. The bottom left is you're looking at about a 7-year period where you really start seeing the effects of significant things such as el nio, la nina that are effecting the local water levels. So these are all things that come into effect and why we want to look at a long period to mute out these seasonal and periodic effects and finally the bottom middle is looking at sea level trends which is one of the products that co-ops does where we look at the long term time series of the water levels at our gauges and detrend data and be able to provide a sea level trend associated with that tide station going forward. This is important for planning. This is vital for training because we have associated them

with air bounds associated with it. So if you're dealing with a project that has a 50 year life cycle, 100 year life cycle you can't build that project to mean sea level today. You have to build that to be mean sea level in 50 years if it's 50 year life cycle. So you need to anticipate and plan for what the changes are going to be over the long time frame. Again, depending where you are at along the coast, you know, you get relatively stable on the west coast and northeast coast but once you start getting into like the gulf coast where you have significant subsidance or get into southeast Alaska where you have statistically significant glacier isostatic rebound, so basically up rise in land. Grand isle over 9 millimeters per year change. You get up into the Alaska and other places like that, you have 17, 18 millimeters of relative sea level change there which is negative. So Alaska, individuals in Alaska are gaining shoreline. Individuals in the gulf coast and most of the continuous U.S. are losing. So why are we here today? Why do we have all of you guys here as participants? The most important, the national tidal datum Epoch. The point that co-ops is updating it. And the national tidal datum Epoch is a 19 year period looking at the significant effects of the sun and the moon upon the range of tides. By using that 19-year period we're able to mute out the short term effects such as la nina, el nino and other effects and what we have done with the national tidal datum Epoch is we allow for consistent relationship from location to location so that way whether you're in Maine, Mississippi or Alaska or the Pacific islands you're able to discuss the tidal datums and they're on the same reference period so that way we have consistency and are able to relate and compare one to the other. So, again, historically the NTDE was updated every 20 to 25 years. We're looking a little bit late now. But we're working through it, the new tidal datum update is going to be 2002 to 2020. The anticipated release date is 2025 unfortunately due to COVID and other resource limitations, that might get pushed back. We're still aiming for that date. But we will keep, you know, partners all updated and be able to let you know when it's going to be released. One of the main things we want to do with the updating of the national tidal datum Epoch as well as international great lakes datum is the idea is try to co-release them in very close proximity to the national geodatic surveys release of their new othro methical data to allow our partners to transition the projects, tools and transition everything in a very close time frame to one another. The last thing you want to do is have to change your project site today for the geodetic datum and 15 years later have to change it for the tidal datum. So we are trying to work and make life as easy as possible for our partners. So within the tidal datums and the information, a couple of main products. This is when it boils down to the metadata. This is looking at information on the benchmark sheet where when you're working on a project you're working on a survey, whatever you're working on, you want to record this information if you're using the tidal datum from

that location. From the bottom in the tidal datum section, the benchmark sheet, the top box there gives you the Epoch. The data series that was used, control stations, so if it's a subordinate station that doesn't have that full 19 years it's relying on another station to give it that 19 year equivalent, this is all vital information to record. I can't tell you the amount of times I've had people call in and they're working on a historic presentation or historic project that it just says, levelling is based on main sea level. What station? What time frame? What Epoch? Without that information you're putting yourself at a hard stop trying to find someone else's information but at the same point in time when you're working on projects realize this project will potentially be revisited in the future so you want to make life easy for your next person that works your position and two people down that work for your position, et cetera, when they come back and visit 50, 70 years later that if you give them all the proper metadata then they're able to reference and transition what you did to the current stance of the official national datums, whether it be geodetic datums, tidal or water level datums. We also have the same information is available on the datum itself where you have all the datums on the top. You have the information about the actual control station, everything else, the bottom gives you the time series analysis and then you have the full series of datums that are available. What's nice is on the right-hand side there you do have the graphic and you're able to adjust the datum reference. What you're using as a reference zero, if you're using feet or meters as well as -- right now you have the option of 60, 70, 8 for the superceded. If we have a published value you can provide that and obtain that. The present is the 83-2001 datum. As we move forward you'll end up having under that Epoch area two superceded datums and the present being the 02-20. The thing to realize with tidal datums, what we have is when talking about the national tidal datum Epoch we have what is called a control station. So this is a station that has that full 19 years of data that we use a process called first reduction which is a straight mathematical average of all the datums over that 19-year period. In a perfect world if money was free we would have a tide station every couple of miles along the entire coast. Unfortunately that does not happen. So therefore what we have to rely on is the ability to use a shorter time frame and a shorter period observation. For example, Vdatum that you're doing a three month data collection, a lot of hydrographic support is one month or so of data but by comparing with a method that is called simultaneous comparison. So you're looking at how the water level variance in between the subordinate station and the control station happens over that time frame. You're looking at how they change relative to one another. You're taking that difference, averaging it out and applying that to the accepted national tidal datum Epoch, NTDE, at the control station which then gives you an NTDE equivalent at the subordinate station. One of the important things to

realize is when you're dealing with tidal datums, a lot of the reason to do the update, the national tidal datum Epoch is to account for global sea level change. But one thing a lot of people don't realize is not only does local mean sea level change with that, but you're ranges of tides can also change with that especially when you're looking into abatements. Here we're looking at south San Francisco bay. The blue labels are GT, the great range. That's the difference between high and high water and mean low or low water. That is for the current Epoch, so the 83-01. Then you have the GT for 60-78 in green. So as you can see at all these locations the tidal changes have increased between the two Epochs. A lot of that is based on the point that since local sea level itself in this region has risen you're able to propagate more water into this basin with less frictional interaction between the water and the bathymetry. More or less you're able to pump more water into the system at a more rapid base. There's not constricted at the entryway into San Francisco bay. So you're getting more water coming into the bay now than you had historically just because the water levels are higher and they can flood in and flow in easier. So that's one thing to consider when going forward. So why do tidal datums matter? One of the key points is tidal datums define boundaries. They define what is the separation between privately owned land, state owned lands and federally owned land. Why does this matter? Well, a significant change in tidal datums can greatly effect what you own to the point where as an example followed a tribe out of Washington state reached out to us and created a partnership so we could install four water level gauges to better define the relationship for travel lands to state lands because that variance enabled to tribe to say we have fishing rights on this land, we have worm, clam, all of those collection points is on our land so we have authority over this, no one else can come in here and fish unless they have a permit or are part of the tribe. You have the same thing elsewhere when it comes to oil production, everything else. So it is of very vital importance. It's the point one of our partners at the national geodetic survey was giving a presentation down in Texas and the individual question, is the government going to pay them for the land that we are stealing because we were updating the datum. So one of the important things to realize is ignoring the national tidal datum Epoch changes there is a significant chance of financial problems. When you look at the slides looking at Army corps efforts in dredging. When you look at the 63-78 Epoch you are looking at .23 change in elevation of the tides. So if you were looking at dredging 10,000 foot by 400 foot channel, if you ignored this change you're looking at about 34,000 cubic yards of over dredging which would equate to \$340,000 in over dredging at the assumption of \$10 per cubic yard. This is in a soft sandy bottom. If you're going into an area that has a rocky bottom where you actually had to go blast, you're looking at a figure of 10 to 20 on top of that. So by ignoring that change it can cost

local ports, the federal government and anybody else significant amount of money if they're paying to have a channel come in that is expected to be dredged to, say, 20 feet mean low water or whatever it happens to be. So there are areas within the U.S. that we actually use a modified procedure for tidal datum computation. So what it is in these areas, we look at a 5-year period for mean sea level, mean tide level, tide level because these are areas which have significant relative sea level change. So just look at the numbers here. You know, areas like the battery in New York city, you're looking at about a 2.83 millimeters per year change. So that's 14 millimeters per five years or 56 millimeters for 20 years. Similar in San Francisco at 1.89. So you're looking at basically 9.5 millimeters in 5 years, 38 in 20 years. But when you look at areas that have significant relative sea level change, such as grand isle down in the gulf coast at 9.7, by the time you're at 5 years you're already at 45 millimeters. If we waited to the 20 year period you're at 181 millimeters of sea level change. Even worse like when you look at skagway, Alaska you're at 17.5 per year. At 5 years you're at almost 88 millimeters change. At 20 years you're basically at 352 millimeters change. Which is a significant change. If you waited the full 20, 25 years for a full Epoch you would throw off the charts significantly. So as I said, what we do in these regions is we look at a 5 year for the mean sea level, mean tide level. However mean low water, mean lower lower water, mean high water, mean higher higher water are still based on that full 19 year Epoch period. The stars are long term stations and the blue dots with the subordinate stations. These are all the areas effected and get a modified procedure. So that 5 year Epoch datum. So like I started off the meeting with, metadata. Metadata matters, metadata is vital. Without metadata you have nothing. So why does it matter? Well, one of my close friends here, Dave Doyle that will be presenting later, he provided me with these two graphics. We are looking at New York city on these two graphics. These are some of the datums that exist within New York city that they were able to define the relationship between the datums. In New York city each one of the waterways, bridges, subways, they set a local datum for it. There was no easy or direct relationship between one or another. So as you can see, if you start talking and looking at stuff from the 20s for constructural documentation, things like that, there's datums everywhere but they are not as easy as you think because trying to relate one project to the next, even if they are literally a stone throw away from each other, if they set their own zero reference frame and wasn't defined, this is where it comes into the importance of ensuring all your projects are linked to the official national datum whether it be the national tidal datum Epoch, international great lakes datum or the NSRS, national spatial reference system. So currently is North America datum of 1988 which is going to become 22 through NGS. So the datum whether lipsoital or geometric, it's good that you have a good understanding

of the tide to the datums so that way anybody can come back and repeat your work. If there ever becomes a question then you have documentation and information. But in reality you might ask why does this really matter. Let's just do a theoretical job that happened. You know, they were building a bridge. They hired two firms to build each half of the bridge. Company A used North American data of 1983 for their horizontal position. Company B did all their stuff on the international of 2000. When they met in the middle there's a little bit of a problem because there is that offset between the two of them. So you have to ensure that you're using the same reference frame for your work and understand the importance of the variance, especially when dealing with older projects that may have been on a previous historic tidal datum Epoch. Could have been on national geodetic of 29, et cetera. So you need to understand what the zero is and understand where you're referencing so that way you can best practice, ensure that your work is replicatable and most importantly as we move to new datums you can take the work you did today, you did tomorrow and transition it once we update the datum to have that relationship that you can put that project on the new datum. Another example is you had a family in southeast Alaska. They spent a ton of money to rent a sailboat and everything going up there. When they got on the boat they saw they had a nautical chart published in the 50s. Why does it matter? Why spend money on a new chart when we can use this chart? There's a sea level vary advance of 17.12 millimeters per year. They thought they had clearance to get over this obstruction. They learned the hard way that metadata matters and making sure you're in the current reference and time frame matters. Again, when it comes to metadata this is elevations on one of -- it's an NGS level in benchmark but it is also part of the benchmark network at our tide station which is in lake Ponchatrain, Louisiana. What you're looking at here is looking at elevation variances over time for the vertical datums. So you can look at different realizations of NGVD 29 which changed from 8.235 feet went to as low as 6.689 feet. So this mark relative to that height changed significantly from 52 to 84. Then the same thing, you look at NAVD 88, it started at 6.75 feet and the most recent observation realization was 6.14 feet. So you're looking at about a little less than half a foot variance there. But if you don't record this and account for this you run into a significant risk of your project failing, your survey failing, your construction failing, and it's just -- it's vital to know the metadata, know the variance and know the potential variance so when you're doing your work whether it be marsh restoration where you're going out there and planting thousands of dollars of spartina, you have to realize what the sea level is going to be in the future with your planning now so you don't plan it too low that it gets washed out and dies. As well as levy construction, everything else, land surveys. So, again, national tidal datum Epoch is coming up. Anticipated 2025. We

shall see with work requirements and everything and personnel if we make that deadline or if we end up having to push back. It's definitely something we are going to keep everybody informed on. But we want to keep you guys head's up of what's coming, what we're doing, how it can effect your work, how you can prepare for this, AKA, maintain your metadata. Make sure everything you collect today you know the reference frame, you know what it is involved in, you know the relative heights, what the reference zero is. It is all vital moving forward that you have that information so that way in five years if you're still working on the same project you're able to transfer. That's all I have today. So we have some time, about 7 minutes for questions.

>> All right.

Thanks, Mike. That was great. Lots of great information and it's always good to hear you explain things. Thanks a lot. Right now we don't have any questions but we do have several comments that I'll go into here in a moment. I would encourage folks to drop your questions into the question pane because you've got access to Mike right now to answer datums questions. The first comment that we've got is relevant to Mike what you were talking about in Alaska. You know, Alaska is a really big place. The comment from Jackie is that where there are the most enlon stations Alaska's shoreline is raising up out of the water due that glacier. In other regions where we have less observations Alaska faces impacts than other parts of the nation faces. So things are moving differently in different places. That's why it's so important to have local observations. Next few comments here are from Lou from New Jersey. Most professionals do not want to design bridges or structures to a potential water level that is 50 years in the future from the design date. This is for experienced and qualified professionals and not to be left up to the professional surveyor. Other geospatial professionals need more training and education is the comment. Goes onto say that in New Jersey more than 50% of the benchmarks have been destroyed and the remainder have not been maintained. There seems to be a lack of interest from the state agencies. So NOAA datum sheets refer to many stations that have been destroyed many years ago. So Mike, actually can you talk a little bit about what happens when tidal benchmarks are destroyed? Can you tell from the data sheets?

>> Unfortunately unless we are contacted by individuals that are destroying and doing construction there we are unaware that the mark is no longer there. Once we've stopped observing at that station we don't have the resources to go back to the 2000 plus subordinate stations and active stations we have on any regular basis to relevel or even just see and redefine weather stations. That's why it's very important for the stuff like Gaylen does where GBS benchmark. Anybody if you're out there, if you're working on a project and you're recovering your mark and it's

not recovered, it's very important to take the time and do a recovery statement to NGS and they will end form us if it's not one of their marks. If you're searching for tidal, we will be able to record that, that it's not been not recovered, potentially destroyed and be able to drop it off the benchmark sheet. This is something I will talk about later today about the moving forward and the enhancements of the datum page and the benchmark sheet page. But right now unless someone informs us that they haven't been recovered or that they have been destroyed, we don't know.

>> Right. Thanks, Mike. That's really helpful. Yes, thanks for the plug for GPS on benchmarks. You know, that's definitely something that we are looking for people to continue participating in through the end of this year. Not sure if I remembered to introduce myself but I'm Gaylen Scott doing the questions and comments here. Continuing on with Lou's comments, he said during construction of bridges and structures over tidal waters a major construction problem is the mixture and mixing without clear explanation of water levels in reference to mean high water, mean lower lower water, mean tide and ABD 88. The construction personnel need one datum to reference to. The preferred method is to reference and convert everything to NADB 88. There are too many cost over runs due to misunderstandings. That really caught my attention, Lou. That's something that we're always very interested in is hearing those antidotes or stories where data has cost money, time, problems for people. We work hard to try and make the -- explain things and help people get them right. Having those stories would be helpful if you want to email them to us or drop them in the box.

>> If I can speak on that. That's one of things we run into. It was called mean sea level of 1929. So often you will find people that will look at old project and see mean sea level and it's the tidal datum of mean sea level, not NGVD 29.

>> Right. Right. Yes, where metadata is crucial.

>> So here's one. Where can I find contact information for New Hampshire, Massachusetts and Connecticut? Who do I contact for each state?

>> When it comes to water levels if it has not been presented yet, you can contact user services at co-ops at tide.predictions.NOAA.gov. If you go to NGS's website and search for their regional advisers, you have your regional adviser that can definitely help you with anything associated with geodetic and everything or there will be an expert that services that region that if it's a tidal question they will be able to point you to the correct person here at co-ops.

>> Great. Thanks, Mike. We do have a couple more questions coming in. Thank you folks. One here is, is there a mechanism that can calculate projected rise on land? I guess net zero to where you are standing on land.

>> Well, that is something that is more of an NGS effort.

>> Yes.

>> And with them going to the new datum they are going to have a time specific relationship associated with their datums. I don't know whether you want to speak to that real quick, Gaylan knowing that we're at time.

>> Yeah. I'll make it real quick. So we do have -- we do compute vertical velocities at our core stations. But, you know, understanding how things are moving in between cores is a little more difficult. Co-ops does have a publication out there about estimating vertical location from the tide gauge methods. That's one method. I would definitely say contacting your regional geodetic adviser to talk about vertical land motion in your region. Moving along here. Let's see. Tony has a question here. With today's computational abilities once the Epoch program is set up for fifth year calculations would it be untenable to continue the calculations by truncating the first year and adding a last year effectively providing a running average type of result?

>> We are looking at the process of updating the tidal datum Epochs at a more rapid stance. Unfortunately there is still a significant requirement to have personal interaction associated with it that you have to have the oceanographers here at co-ops look, review the data, do the computations, find the best controls and everything like that. We are looking to move from update every 20 to 25 years to hopefully do more expedited and more rolling Epoch as it were. So that's something that right now we're looking at. Once we get this Epoch done there is definitely a large conversation that is happening already that will be analyzed and we will look at the science behind it and actually do a little bit of case study to figure out the best path forward. But, yes, we are definitely considering doing more of a rolling Epoch, not a yearly change. But it might update the national tidal datum Epoch every 10 years. We also have to take into account the legal constraints and everything like that since it does define the land boundaries and everything that ensuring that each state has their documentation. Because if you do it too often it's hard to maintain and monitor on a larger scale for boundaries.

>> Thanks, Mike. That's great. We're running out of time. Do we have time for me to read a couple more comments?

>> Yes. Yes. You have about five more minutes.

>> Okay. Excellent. There's a couple of comments here, I just want to read through them. Sean said procedures for reporting to NGS and NOAA et cetera need to be streamlined in order to provide convenient future access for others. So I can say from the NGS perspective that's definitely something that we're working on as we're moving towards NSR modernization. Another one. So Laura provides information about contacting the co-ops stakeholder services branch. The email address is in the chat. It's tide.predictions@noaa.gov. Also the regional geodetic

adviser information is also in the chat there. You can follow that link. Paul has a question, what about the special case and considerations in the great lakes? I'll say that Paul you're in luck because tomorrow is a full workshop focused on the great lakes and the international great lakes datum. So the final question here is from Matt. It was very interesting to hear -- to see how the geodetic datums have changed over time. Does that imply that, for example, the offsets from NADB 88 to station datum and tidal datums may vary over time even without shifts to a new Epoch? Relatedly is the relationship between the station datum and the tidal datums generally constant over time?

>> Station datum is an arbitrary zero reference that co-ops creates when we install a station. What that allows us to do is over time have all water level observations set relative to an arbitrary zero. So there is not a time dependent associated with our elevations above our reference zero. Over time, yes, definitely the tidal datums to the ortho datums such as NADV 88 or if, you know -- to make sure we acknowledge other people here, PRVD 02, Puerto Rico vertical datum of 02, you know, virgin island vertical datums and all the other ones and as we move forward it will all be one for the 22. The variance does change over time because you have the effects of movement. That's going to be the change in the orthometric heights. You have the variance of global sea level. So between the two of them they would always change. Tidal datums above station datum, that is also going to change because station datum is set as zero and as we have sea level variability it's going to go up or down relative to that station datum. Unfortunately station datum beyond internally doesn't mean much of anything because it's just an arbitrary datum that we set at co-ops at the installation of a gauge. So that way we ensure all of our water levels are set to the same zero and station datum is defined as what we call our primary benchmark. So the main benchmark in the ground or defraud, we hold that as constant, the offset of that mark and what we call station datum. So that way we can monitor sensor stability but also monitor change relative to the reference frame.

>> Excellent. Thanks, Mike. I think that was really good. That's all we have for questions right now. I think we are right on time to move on to the next session.

>> Great.

>> Definitely --

>> Real quick, any questions please feel free to reach out to as Laura put in there the tide.predictions@noaa.gov. We are here to help you at any point in time. So just reach out to us and we'll do what we can to answer any of your questions and support you in any way we can.

>> Thank you, Mike. Thank you, Mike for that presentation. Thank you Gaylan for facilitating that discussion and the questions from the audience. Really appreciate it from all of you. All right.

So the next part of our agenda is a group of presentations about using the datum. So because we have four presenters I'm going to quickly introduce all four presenters and then turn it over to them. We should have between 8 and 9 minutes at the end of all the presentations to go over some questions from the audience. So first up, our first presenters been Dave Doyle who owns base 9 geodetic consulting services which provide consulting to public and private agencies and companies. Next we will be joined by Mark Huber who previously worked for and retired from the U.S. Army corps of engineering at the end 2019 and now enjoying his extra time playing with his seven grand kids. Dennis is from NOAA's national geodetic survey. Dennis has worked for the last 18 years as the NGS geodetic adviser and is currently the NGS gulf coast regional geodetic adviser. Last but not least Nathan Wardwell is the national imaging partner in Alaska that specializes in measuring water levels for tidal datum determinations. Dave please take it away.

>> Thank you, Christine. It's a great pleasure to be a part of this today. Before I get started into my brief presentation, I wanted to give a shout out to the combined efforts. The agency has an incredible history, well over 215 years of providing both geodetic and tidal datum support and infrastructure to the United States. I've had the exceptional pleasure and honor of having capabilities of working in numerous countries around the world and I've got to admit the relationship that I've often encountered between NGS and co-ops is unlike anything that I've ever seen anywhere else. So a shout out to the agencies. Okay. You've heard a fair amount now about certainly Mike talked a lot about the metadata. I'm going to speak to that a little bit later in the other presentation. You're going to see a bit of redundancy and redundancy in science is a good thing. Mike highlighted the issue of boundaries. You know there's any number of surveyors participated today. I just wanted to start off by highlighting the importance of the tidal datums for boundary, legal boundary issues. Mike went into that in great depth and co-ops is provided this slide that's been used many, many times. I just want to reference that to the surveyors. Make sure they're well aware of the importance of the tidal datums in just legal boundaries that we have to deal with. One of the things I wanted to talk about is since we are now in the environment of incredible levels of positioning technology and you've heard now a fair amount about the changes in datums from both agencies, that is from both the national geodetic survey and co-ops coming along at about the same time. I think one of the really important things that users, many of you who are on this presentation today, one of the important things to take home is, well, what are the changes going to be in my backyard so that you can

go back to your companies, your clients and be able to give a perspective in particularly the case of tidal datums what the height differences are going to look like. Mike has already talked about that somewhat. The national geodetic survey has provided a great tool and I've highlighted it here called xGEOID20. It will hopefully predict -- it's not an absolute yet. Hopefully that's coming in the next two years. It predicts to a high degree of integrity what the changes in heights across all vertical datums in the United States are going to look like. So what I've done in this particular slide is to take that tool and select stations at -- two tide stations, sandy hook, New Jersey, the other in Seattle on opposite sides of the country. You can do that anywhere. The data you see here, Simpson, these are marks that are both tidal marks, tidal benchmarks and benchmarks in the national spatial reference system published by the national geodetic survey. So it's quite easy to download that data, have access to it. What I've done is to -- if we just look at sandy hook, for example, I've taken the position for sandy hook, the latitude, longitude and height, I've run through it the program. It now gives me a predicted height for the new vertical datum, the North American Pacific geodetic of 22 per the geodetic side and then I simply use the sea level trends that co-ops has out there. They are terrific. I've talked to Mike about this, can I use this, are these viable. He considered they are. I take the height difference in the case at sandy hook 4.2 millimeters a year extrapolated out over 19 years and that gives me an idea of what those changes are going to be. In top in blue what I've done is taken the existing Epoch and see here's what sea level is, you can pick any datum you want. Here's what mean sea level is at this station. This is what it's very likely going to look like under the new national tidal datum Epoch. Down below that. What I've done now is bring in the published value for NAVD 88 and compared it with the existing sea level value which in sandy hook seven P tenths of a meter, quarter of a foot. Now predicting what that will look like with the adoption of the new tidal datums and the new geodetic datums in a couple of years. You can see the dramatic difference between the two. I know those kinds of elements are important so to many users out there. I highly recommend -- it's a very simple process that many of you out there who have to deal with your clients, tell them what this is going to look like take advantage of that. Go out and do that for yourself. We need to anticipate the heights. For the tidal datums they are typically going to be passive marks as you see on the left. In the case as we're moving forward active stations or cords continuous operating systems are preferred through GNSF technology. It has really exploded the capacity for users to achieve exceptionally high levels of positional integrity and regrettably in many cases without understanding the fundamental science behind it. So I just want to very quickly as I run down in my session to highlight the perspectives on how you transfer those heights from a tide station to some site that is going to be a

away from that station and you do it to a high degree of integrity. The best, the best without a doubt is to perform what is referred to as levelling. I've just given you a link here. This is the lowest order of geodetic levelling defined by national geodetic survey defined by the United States. It is the best way to do it. That being said, it's also expensive. It requires a considerable amount of training for whatever staff you might have. For many surveyors they are very familiar with this. There's lots of other folks who want to be able to transfer these heights without being surveyors. So increasingly the use of GPS, what we refer to as GNSS, global navigation satellite technologies you want to transfer heights. There's a good way to do it, efficient and reasonable simple. Regrettably there are sources that users need to be aware of. The national survey has a publication out now, NOSNGS 58 which gives exceptionally good guidelines to serve heights. That's critically important. There's going to be changes to that coming. Right now this is the task you want to use. I wanted to highlight here if you're going to do that just be very careful, make sure you're using good quality procedures. So things such as using a fixed height pole typically, that's going to be about 2 meters. Make your observing sessions at least 2 sessions that are separated by four hours. So you get a constellation of satellites and process them as they become available, 17 hours later. I want to end up by talking about the importance of understanding the uncertainty in various products, one is the use of the geodetic model. Right now the model, 18, just hear one example, it come out in the nearest millimeter but has an uncertainty of 4 centimeters. It's important for users to understand that as part of their metadata. My time is up. We need to transfer on to the next speaker. I just hope you'll pay attention to. So of these aspects that I have outlined here. Thank you.

>> Thank you, Dave. I think next up is Dennis. Is that right? I'm sorry, is that --
Dennis, yes. We can hear you. Yes.

>> Okay. All right. Well thank you Dave for the beginning of this session presentation. As said, my name is Denis, the gulf coast region GDPR advisor. So I cover Louisiana, Mississippi, Alabama and Florida. So I want to play off of what Dave has talked about but talk about the use of, you know, by NGS as far as the national tidal datum Epoch but also how that plays into products for our stakeholders. So NGS being a agency within NOAA one of our missions is to define, maintain and provide access to what has been said is the national spatial reference system, the NSRS. That's made up of latitude, longitude, height, scale, gravity, orientation. These make up the national coordinate system. The maintenance of that is keeping u up with these various components as they change over time. So one of the other missions that we have is the determination of the national shoreline. This -- you know, the United States has approximately 95,000 miles of shoreline. So NGS surveys these coastal regions of the U.S. to determine an accurate and up to date

national shoreline. This is a -- it's a big part of NGS. We determine this national shoreline to the mean lower, lower water line. It's used to demarcate the U.S. territory limits. It finds the reference for the U.S. economic zone. It provides a geographical reference for the coastal resources. As I said it takes a lot as far as to keep up with that because that national shoreline is an ever changing thing. So in these -- in the NSRS we have two components. We have the -- what was historically the horizontal side or now a geometric datum. Then we have the vertical datum. The current datum is the North American vertical datum of 1988. NGS determines this datum. It's a terrestrial based datum. So it was all based on -- Dave talked about geodetic leveling. It was levelled all across the country to the coastline. We used the NTDE as far as coastal regions, tried to make ties between that and the tidal datums. We do this as a -- not only for the terrestrial and for ourselves in defining the datums but plays in to support of things like the FEMA flood mapping program and storm surge and inundation modelling. There's also coastal survey, mean high water level lines. There's also PRE and post storm infrastructure building and rebuilding. There's bridges, roads, buildings, levies, all of these various things that are, you know, constructed in the coastal regions. You heard that we're now in the workings of modernizing the NSRS. So that's defining new reference frames datums. So the -- on the vertical side we're going to have NAPGD2022 which is going to be a geo potential service. So it's going to be a gravity-based datum, a geoid. It will be equivalent to basically to global mean sea level. Now one of the big components of that is understanding what the gravity is for the U.S. now and so we have been getting this gravity snapshot or snapshot of the gravity over the years and the American interest as far as -- this program has been -- is grad -- grav d. It's using airborne on airplanes and using some other additional information to model that gravity for this new vertical datum. Now the -- one of the shortcomings of NAVD88 was that it basically stopped at the shoreline. There's a lot of work that goes into the -- in the near shore area. You can see on the picture on the right this is an example of their flight lines. They would fly this -- collecting this airborne gravity 100 to 150 kilometers offshore. So we want to extend that where NAPGD 2022 will cover. So it's going to cover that 100 to 150 kilometers offshore. You know, it would be known as the near shore area. As Dave has said as far as utilizing accurate GNSS observations and referencing NAPGD 22 we're expecting that users will be able to obtain a 2 centimeter metric orthometric sight in that area. We are not expecting in that large open ocean area between California and Hawaii but you will in that 100 to 150 kilometers offshore. That's on the national level. As I said as far as this is going to be equivalent basically to global mean sea level. There are variations as far as on the local level, local mean sea level variations. So we have to provide for that as we work to develop and publish this new vertical reference

frame. So one of the ways that we're doing that is we are one of four agencies within NOAA who are working, have developed continuing to improve this program it's called the vertical datum transformation program or Vdatum. You will hear more about this this afternoon by Steven white. But having that information to be able to have this transformation between the two and having those local mean sea level ties is very important. So one of the ways that we're doing this is through GNSS observations. We make those -- we're doing it currently for NEVD 88 making these ties between geodetic NAVD 88 benchmarks or heights relative to these tidal benchmarks. It's being done through geodetic leveling but also Dave talked about accurate GNSS surveys and establishing heights that way. So it's being done through GNSS blue booking projects which establish 2 centimeters orthometric heights. Then we have another process where people go out and process and observe and make ties to these tidal benchmarks and then it's submitted to us and we use that information also for making these connections between the national datums and the local mean sea level datums. Just to kind of sum things up, both the NTDE and modernized NSRS are scheduled for release in 2025. Having an up to date NTDE will provide for better alignment to the actual ocean service between the geoid which will be our new datum. It's going to help coastal and energy planners, engineering, surveying and lots of other people in the tasks that they do. So that's all I have. I will pass it onto mark Hubert.

>> Thank. I worked with the Army corps of engineers. We have maintained a good working relationship with NOAA. They are good partners. I see a lot of old friends and colleagues. I want to reiterate what Mike said earlier about metadata. Metadata is critically important. As we transition to new datums it's even more critical. I told -- I've been telling people I work with and students in our classes that if you don't include metadata with your data you're not only being reckless, you could be dangerous. Giving somebody data and they are not knowing what the reference datum is can really give you some catastrophic results. So I just wanted to reiterate that before I went on. Holy smoke. Hold on a minute. The corps of engineers is aware of how important the new datums that are coming out. Our current policy states that our projects will be connected to the NSRS and where applicable also the NWLON, the national water level observation network. It's our policy that all of our projects are designed, constructed and maintained with respect to these national datums. Not just one of them, they need to be connected to both the geodetic datum and the local water datum whether that's a river, a pool behind a dam or the lake, rivers or oceans. So as I said we recognize -- we recognize NOAA as the authoritative source for datum frames. Everything we do we want to use NOAA's information, their expertise in providing that initial zero for us. That datum. Everything we do references off of that. Our policy dictates that as I said our policy

dictates that our projects are connected to this NSRS. A firm connection to the local water surface and the national geodetic datum is critical. That's how you relate the water surface relative to whatever infrastructure the corps is designing and constructing. You need to know what that relationship is so you know where water -- where that water surface is related to the top of the dam, the top of the levy, the top of the flood wall, what have you. It's those connections to those two datums and knowing what those connections are is very critical. We very much understand how important that is. We take great lengths to make sure that we do have firm connections. The Vdatum, I want to see the development of that because it helps us make that firm connection. So in our current policy not only do we have to have these connections to the datums we have to have three passive marks on every project. What that enables us to do is to go back to those physical reference points throughout the design and construction and maintenance and operation of our long term projects to see what is happening through time. Our projects sometimes have a 50 to 100 year life cycle so we need to know what is happening with that project through a periodic inspection. To know whether or not we're on track to maintain that level of protection throughout the project's life. As Mike also mentioned earlier with that dredging scenario, when we use the latest national tidal datum Epoch we're dredging to the proper depth, not over dredging and that saves a tremendous amount of money. V datum provides that connection to the tidal datum when we're using with tides. Very, very critical to us. We have also developed some tools that enable us to project tides or water levels into the future based on the IPCC projections and equations. We also have several engineering documents out that give our engineers guidance on how to project where sea level will be in the future and what things to look for. It allow us to select a project, give the parameters and it will give you projected sea level change. You can put in critical elevations such as first floor, the elevation of generators, whatever you have and it will show you where the projected sea level will over top these critical elevations over time. So it's a pretty good tool, it's been in use for a long time. It's used by people all over the country. It's very popular. So this displays how important the tidal datums and knowing where the water surface is to the corps of engineers. We have another tool that was developed after the calculator that actually uses the co-ops API and grabs realtime wherever the user selects a gauge, grabs data from co-ops and develops a lot of projections. It does monthly means. In fact Mr. Cavelle asked about a moving average. It will do a five year moving average, 19 year moving average. It does a lot of things. It just goes to show the importance that we place on knowing where that water surface is and knowing where it will be in the future. So both of these tools are used a lot and are very, very useful. We talked about the future and projecting into the flood walls and stuff. This is a typical diagram of a

project. As you move left to right it's moving forward in time. On the left it's constructed, designer constructed above a projected water level surface. As you move over towards the right and you go through time, you see how things move. There's subsidence that happens. As you move over in time you can see that flood wall would sink. NAVDAD gets defined. The realization gets redefined as we have those regional Epochs. You also have -- you can see local mean sea level gets redefined from left to right. All of those change those relationships between the water surface and the geodetic datum and our infrastructure. This slide is used to show our engineers how you want to look into the future and incorporate these projected changes. It's really, really important to the corps of engineers. That's all I have. We can move on to the next presenter.

>> Thanks, mark. You can go when you're ready. Nathan if you're speaking we can't hear you.

>> What about now?

>> We can hear you now.

>> Had to turn my mic on. I'm Nathan, managing partner of JOA surveys. Again, I'll provide a bit of an industry perspective on tidal datum Epochs. You'll probably as Dave Doyle pointed out there will be some overlap also with my presentation and Mike's presentation. There's -- I did appreciate a lot of the comments on metadata and the importance of metadata because that will be a bit of the focus for what I will discuss here today. I'll try to advance. How do I advance? Let's see here. JOS surveys was established in 2003. Since then we've installed almost 400 tide stations for NOAA in 27 states and U.S. territories. We've published almost 1300 over shared solution ins the NGS database. This picture here really kind of shows the work that we do specifically related to tide. So we spent a lot of time in selling equipment to measure water levels for datum determinations supporting the V datum determination. This is Cook Inlet Alaska in a region that has a tidal range varying from 18 to 30 feet throughout the inlet. So any time that we're starting a project, supporting a project, looking into vertical control I really take a look at -- I consider a few things about the tidal datum. The length of the series, the tidal Epoch and the trend. This is showing sea level trends. I noticed the trend increased on this plot that I received from co-ops recently versus on what was shown on Mike's plot. So increasing sea level trends there. I appreciated the comment earlier about how this is not necessarily representative of all the sea level trends in the state of Alaska because of the gaps in observing that work. So considerations, length of data series, tidal Epoch and age of data. So I looked at a region in Florida, so Pensacola bay, Florida. I highlight three locations with published benchmark in datum. Hernandez is based on two months of data. Pensacola is a long term station, the datums based on 19 years of data. And Pensacola beach pier based on one month

of data. It's referenced as the 83-01 Epoch. When you look at the age of the data itself though, Hernandez point's data, those two months of data were collected in 1977. Pensacola spans the entire tidal datum Epoch is from 83-01. And then Pensacola beach pier is one month of data from collected in 2021. So, you know, something to consider are the datums for Hernandez point, for example, going to be updated to the new Epoch. How many locations will there be lost, that won't be updated to the new Epoch because of the age of the data itself. Going into that tidal datum Epoch, a little bit more. So we had the opportunity to work in America Samoa last year. When I got those, it was a project for the Army corps of engineers. When I got the statement of work one of the first things I looked at was the control station because the scope of work said to provide tidal datums connected to the 83-01 Epoch. So I look at that station and see this interesting sea level trend and in note about an earthquake increasing subsidance and this additional note that says the datums were based on data from 2011 to 2019 and the title datum Epoch is 000200. So just pointed out because I need to advise your clients of like, well, it's not technically going to be on th current national tidal datum when you have that situation. Here's for grand isle, Louisiana. Mississippi river delta. Currently mean sea level at the site is 8 centimeters higher than the published mean sea level of value. In 75 years relative sea level rose about 77 meters. So when you look at the -- on the -- either the datums page for the site or the tidal benchmark page where you retrieve this metadata, it will show that the datums are based on data from 1983 to 2001 and also data from 2012, January of 2012 and May 2012 to December 2016. So no control station used. The tidal datum is 2012-2016. This goes back to this Epoch that Michael was speaking about earlier. So the range, the tidal range was defined from the 19 year period and mean sea level defined essentially from the modified Epoch. I really appreciated the comment earlier about doing a running average for these modified Epochs. It's something I've thought about for a while. Maybe considering the approach that NGS is taking to implement -- that they are implementing through the modernization effort of introducing survey Epochs and reference Epochs. For example, for a tidal datum you could have a reference Epoch that would be the national tidal data Epoch and then an Epoch that would be the most recent five year time period. Here's a sea level trend for Pluto bay, Alaska. The mean sea level at this site is currently 8 centimeters higher than the published mean sea level value itself. Then when you dig into the metadata you see the note of the datums are based on data from 1983 to 2004. March 2006 to February 2008. July 2008 to June 2011. A lot of that is because of, you know, dealing with ice and challenges there at the site. No control station was used in the datum computation but the tidal datum Epoch for this site is reported as 1983 to 2001. Which technically isn't possible since none of the data was collected during that -- no I

guess some of the data was collected during that time frame. Since it's not connected to a control station that has that tidal datum Epoch that's not the actual Epoch. So just kind of really as I was looking at this, you know, basically to sum it up not all tidal datums are created equal. I'll just end it with a picture of one of our team members looking out over the ocean towards the north pole from the northern most point in Alaska after doing some manual water level measurements. That's it for me.

>> All right. That was a great series of presentations by Dave, Denis, mark and Nathan. We have some questions that have come in through the questions box. If folks out there have other questions please get them in now. The first one is a comment. This is really for just generally for NOAA staff here. Keith willberg says that I believe New Hampshire is a mean high level water, not a mean low water state as shown on the diagram that I think both Mike and Dave Doyle presented, the diagram. We know that diagram is in a whole lot of publications. So we need to check that where New Hampshire is listed on the diagram. Keith's comment was seconded by James Franklin who agreed with him. Mike, there were questions about how to get in touch with the co-ops datums team. Mike put the email address into the chat there but it's NOS.co-ops.datums@noaa.gov. Next couple of questions we have are about FEMA. One Tara is asking what -- would you be able to discuss a little bit how this will impact FEMA flood maps. Often that is what municipalities want shown for flood elevation. So let's throw that out to Denis.

>> Let me -- just a minute, please.

>> Sure. There's another question here from Alan Johnson in FEMA, region 6 just kind of following up on this in a similar vein. FEMA flood maps will continue on the same public acceptance process. What is needed for the local officials to have and use the five year updated adjusted information for structural projects submitted for building permits? What steps are underway to educate and share the website with these local state officials? I apologize, I think that's probably going to be more for Mike. Let's -- Tara was talking about your information, Denis, about how the new datum will effect FEMA flood maps and the Mike.

>> Well, certainly anything changes as far as the land datums changing or going to a flood mapping reference. You know, as far as we define the datums and then, you know, the flood mapping is certainly the -- FEMA, that's their task, mission. So, you know, we try to tie the two together as far as, you know, outreach and information. You know as we try to interact and work with the -- as far as NGS, working with the floodplain managers as much as we can to try to educate them on what is happening as far as the datums so they can apply, we also have connections as far as in between NGS and FEMA. So we try to have as much cooperation as possible.

>> Excellent. Thanks, Denis. Mike, are you out there? Can you take this question about how -- what is needed for local officials to have and use the five year updated adjusted information? Mike, are you out there? Then I guess let's -- any of the other panelists want to take a crack at that one? In terms of using the five year averages. All right. We'll have to come back to that. We need to make sure that we have the right folks on the line for the questions I'm asking here.

>> I have one comment about that one.

>> Go ahead.

>> This is Nathan. It's not necessarily going to ask the question. I have a request that would follow up with that. Currently the superceded five year Epochs are not available through the datums page or the -- well through the datums page. Making that available would be very helpful for the community.

>> Excellent. Thanks.

>> This is Mike. I was taking off as a presenter so I didn't have the availability to turn on my mic. Per the FEMA question, unfortunately can't really speak to that. That would be more if we had someone on here from FEMA that they could speak to that. We can only provide the information to them. It's up to them to update their maps based on the additional information. Per the comment about the modified procedure, the five year, this is something that in the later presentation that I'll be giving today definitely bring that up in there because we want the notes of how we can best support the end users. Something we've talked about and we need to work with the ability to figure out internally how to best display that on the website. That has been a discussion. Right now when you go to the datums page you have the ability to go between the current Epoch and the previous Epoch 60-78. As with go to the next Epoch we want to give the ability on there to transition these three Epochs but also we want to look into the availability to display and have people able to accept the -- or view the various modified procedure Epochs. That is something that is future enhancement. Please with the next conversation that I'll be presenting on of the future we'll need to discuss that and definitely bring that up there as a question, comment, so that way we can report that user need and once we have it documented that gives us the ability to push that forward a lot better.

>> Excellent. Thanks. Thanks, Mike. Sorry to call on you when you weren't accessible. Last question here before we take our break. This is -- we've got Steven white on the line with V datum. Can you talk a minute about the limitations of V datum software in the bay area? Particularly locked in waterways and going long distances from the mouth of the rivers. I think that has to do with the model grid domains.

>> Yeah, sure thing. Can you hear me?

>> Yes, sir.

>> Okay. Awesome. Thank you. Yeah. So V datum definitely can be limited in bay areas in particular. I mean, there are also areas that we just do not currently have coverage. We'll kind of talk a little bit more about that this afternoon, Alaska, the Pacific islands. We don't have observations to feed our model runs. There can be other things, lack of shoreline. Any of those things can really impact our models. We can make them where we can't even run the models or gives results. So sometimes we have to omit those areas. Then, you know, really talking about going up into rivers in this. As you move away from, you know, tidally influenced areas, you know, those tidal datum relationships start to break down or just not relevant. At some point, you know, you have to start figuring out where do you go from there. You know, is it an orthometric data more appropriate for your applications. I think that talks about some limitations. We will talk more about V datum this afternoon and hopefully we can fill in some more answers to that.

>> Excellent. Thanks, Steven. I'm going to cut it off here so we can take our lunch break.

>> Thank you again to all our presenters. Thank you for facilitating the discussion. I don't believe we got to all the questions but we are looking at all the questions and even if it takes -- we have to do it offline we will make sure to look at all the questions that come in and follow up with folks. It also sounds like some of them are a great lead into some of the conversations we're going to be having this afternoon. But before we get there, we are going to go on a one hour lunch break. Just thank you everybody again for your participation this morning. Please meet back with us virtually at 1:45 p.m. eastern time for the second half of the day. We're running 4 minutes behind. You have a 56 minute lunch break. See you back here at 1:45 p.m. eastern. Thanks, everybody.

>> [Lunch break being taken until 1:45 p.m. E

>> [Lunch break being taken until 1:45 p.m. ET]

>> Good afternoon everybody and welcome back. At the time I think we're going to go ahead and jump right back in and continue the remainder of our workshop. If anybody new has joined us this afternoon my name is Christine, I work at NOAA's national geodetic data survey and I'm helping to facilitate today's event. For this afternoon, I'm going to reinvite one of our presenters from this morning, Mike, he will be giving presentation on the needs for the new datum. Once again he's with NOAA co-ops and works there as an oceanographer. Please take it away, Mike.

>> Thank you, Christine. Thanks everybody for joining us today. The presentation will be rather short here. I'm hoping to have an open discussion. Please put all your questions, comments and everything in the chat because we definitely will benefit from any feedback you can give us on how we can best support your needs, your requirements as the end user. Because this is vital for us to understand this

information and is vital for us to be able to augment our planning and everything to make sure that we can give you the best support needed. So with this upcoming new datum for the datum co-ops we have two main products we present. We have the actual datums page which presents the information on the tidal datums themselves which includes in the upper portion information about the station, the data is accepted, the units that the datum is presented in. If it is a primary or subordinate station. It will have the control information there. So next to control station you can see right here for dolphin island it was used in Pensacola, Florida as its control. So that means that at that point in time on the Epoch dolphin island did not have that full 19 years worth of data. If a -- if you look at the datum and there's nothing listed in the control station, that means that it is a control station. We provide here the list of all the tidal datums from mean higher high water to mean low lower water including the equivalent and where available high water intervals, low water intervals. This being a gulf station you have granage internals. As well as below that you have highest astronomical computation and lowest tides which again will be updated concurrently with the new datum. Finally, you know, you have the information on the time period needs for the analysis. For those who were here this morning, you heard me ramble on and use the word multiple times of metadata. Metadata, metadata. So make sure when you are taking this information in and using this station for your projects you record all the associated information such as station, date published, control station, Epoch as well as the time frame used. Currently right now we have the ability for you to select and adjust on the lower right hand side the reference datum. It defaults to low level water, which is the chart datum. You can adjust that by clicking and having the pull down menu come down and it will then adjust all of the datums on the left-hand side so whatever you want the reference to be. You also have the option to select whether you want to do meters or feet for the units. Currently we only have available for the Epochs the present Epoch. If this station had a superceded you can click on that and it will provide you that information. Moving forward we plan to have two superceded datums there. So the 60-78 and the present being O 2-20. Once we release the datum. Our second main product is going to be the benchmark sheet which again here is the datum section. Higher up in the sheet you have the two reach statements for the station and the benchmarks including the lat and longs for all the benchmarks and the station itself. Again you have the metadata associated with the life of the time series, the Epoch, what control it used. You also have available information on the tidal datums at this location. All specified relative to mean low level water. And then the bottom area gives you the datum references to the benchmarks as their height relative to mean low water and mean high water. This is a static document that user input would be greatly appreciated of how we

can adjust this moving forward. Obviously for legal concerns the benchmark heights above low level water and mean high water need to be locked down and standard because of the legal requirements. There is an anticipation to put a third column there that you could select benchmarks above whatever reference datum you want as well as -- as we become more advanced in our communications, everything with NGS altering their database, merging the IDB and the OPUS databases that we're trying to be a little bit more dynamic so we make sure that any benchmark that has a connection between co-ops and NGS's database that we have those links. Right now it requires a manual process to update the benchmark sheet. That's something that we are looking at in the future is to make this a little bit more dynamic and more useful. But, again, we would really appreciate any comments and input on how better to do that. One of the other applications we actually provide is the tidal analysis -- sorry, I can't talk. The tidal analysis data calculator. Short term would be called the TAD. What this allows you to do is take any water level that you've collected and run it through this tool to be able to get yourself an Epoch equivalent or a first reduction datum depending on what you need. This tool will be enhanced and will be focused to be able to once we release the new Epoch to pull the new Epoch. So when you request NTDE datum you'll be able to use this tool for whatever system you use. This application is able to handle local as well as pretty much any time interval where all of co-ops water levels are collected and processed on a 6 minute time interval for all of our data products as we do the computation for the actual water levels and then that's averaged out or we pull the individual hourly heights, which is on the hour and then average that out, all of that, to be able to give a monthly mean value. So depending what you're attempting to do, what you need for your products, that's all available on our website. So right now I basically want to open this up to the group. You know, we really need to know and want to know what you would like to see changed or updated and what additional information you would like to see included in the products. Obviously with future planning once we release the new datum, NTDE as well as NGS, Steven white will be talking later about the Vdatum tool and the adjustments for that. Note that it will take a little time after the release of the new datums for all those modelling to be finalized. Co-ops itself plans to enhance the benchmark sheets and the datums page to better support the user needs. We are as I said earlier looking into researching the needs to do a more regularly updated and more periodic update to the national tidal datum method. So what I want to do is I want to sort of open the floor now to questions. So please add into the chat any questions you have, thoughts you have so we can document what you would like to see altered to our web pages and the data we provide that is going to better support your needs. Because this is what we really will benefit from knowing so

that way as we go forward for the Epoch. We can make sure that all of our enhancements are going to be best to support your needs, address your needs and everything else. So again, sort of a short presentation but I wanted to open this floor up to have an open discussion with everybody. Please type in your questions or thoughts and we can address them. I don't know who the moderating this session now but if we can speak to the comments that come in.

>> Thanks, Mike. I'm still moderating this session. We're not getting any questions yet but we do have another comment here. This is Lou from New Jersey. Said I would suggest that NOAA provide the professional instructions on how best to use the active tide stations and the New Jersey tide telemetry stations. The actual in realtime stations can be used as primary and the project specific tide location as the secondary. This will encourage more professionals to establish local project specific tidal data. Any thoughts on that, Mike?

>> No, that's a very good point. Obviously if your project is co-located or closely located to an existing active tide station, you know, your best bet is to use that information. Otherwise the wonderful thing is we have created a vertical datum transformation tool, Vdatum. The variance in hydrodynamics within the basins as well as the surface, TSS. It's a separation of local mean sea level and this point in time which is the orthometric height. Steven white will be talking to this later. You can use that tool to be able to get those conversions at any site where we have transformations available. Realize that you might have to shift a little bit because we only extend it so far inland. Again, if there's any questions with that reach out to the V datum team or co-ops specifically. We can provide you any support with use of that tool. We need to get you that information and the values you need going forward. As we move forward to the new datums, both tidal datums and geodetic datums Vdatum itself will be enhanced to be able to give transformations. We are looking at the ability right now to be able to transfer in between the new Epoch and the superceded Epoch. So 02-20 and 83-01. So that way if you have the tidal datums on 83-01 you be able to use that tool to do those transformations for you also.

>> All right. Thanks, Mike. Lou followed up by saying that New Jersey USGS in conjunction and support with New Jersey DOT has at least a dozen such stations. New Jersey tide telemetry that has over 20 years of data that could be shared with NOAA. So I think that may be a conversation for your tiered data policy.

>> We've actually begun a partnership with USGS. We continue to work. It started within the MidAtlantic including New Jersey. So we have a number of sites that we have started a partnership on to bring in the data and process datums and everything for that for areas that are considered to be datum gaps and everything. Obviously it's a process that's going to take time to move forward and make sure we're on the same page between USGS and co-ops. But we have started that

interaction and those discussions and we have actually published a couple of datums for locations within New Jersey.

>> Excellent. Thank you, sir. Drew comments that about metadata saying that I think it would be good practice to include on the benchmark sheet how the station datum is defined for that station. Then I think he's saying also to highlight what the primary benchmark is and its elevation. So I think the main comment there is about indicating on the benchmark sheets about how the station datum is defined for each station.

>> Again, station datum itself is an arbitrary that historically station datum was set to be equivalent to the depth that we would not expect water levels to go below because historic computer software and everything could not handle negative numbers. As far as what the PVM is, the first listed benchmark on the benchmark sheet is the primary benchmark. So the very top one on every single benchmark is the PBM. You know, again that is just what we use as a reference to store in our database because all levels that we store in our co-ops database are heights relative to the PBM. But on every benchmark sheet the first one listed is going to be the PBM. When we have to adjust and change to a new PBM, whether it has been identified as unstable or destroyed or have any other issues, the benchmark sheet will be updated to have the new PBM listed there at the first mark.

>> Excellent. Thanks. So here's a good question. Ronald tubman writes, I guess referring to the form that you showed earlier about the station. So the form will get you the info for the closest station? If you're close to two stations how do you determine which one to use?

>> That is one that really takes a little bit of effort and expertise because tidal datums themselves are only valid at the location they were collected when they were collected. As you go up a lot of times what you will end up doing is we will actually do interpolation in between stations. If you are doing V datum and you're splitting two stations your best bet is to use V datum because that's a modelled value. It takes into account the hydromorphology and hydrodynamics within the area to be able to give you that value. So it is going to be more precise than just taking a straight average of the two stations. You can average the two of them and obviously put a weighting factor depending on the distance. If you're a third -- one-third away from station A and two-thirds from station B you're obviously going to want to weigh station A heavier in the relationships. It would give you a good assessment of the equivalents or what values to use.

>> Thanks, Mike. I think that's really helpful. Here's one that is a nice set up I think. It's a suggestion for a future tool that you may already be able to address. Robert barren suggests future tools. Publish local tidal datum determination procedures

including specific project site specific observation tools and a means to determine the tidal datum. So isn't that what you guys have done already?

>> That is within the tidal datum computation tool. There is both a technical report assessing the accuracy of that tool as well as standard operation procedures that go into the methodology of how you can use the tool.

>> I know there's a new video that you put out recently about using that tool to compute tidal datums.

>> There is also on co-ops web page if you go under publications there are three documents that one defines how and methodology for computation tidal datums, one defines computation of predictions. I forget the third one. They go in depth with all the information about the actual math behind it, if you want to set up your own spreadsheet or whatnot to compute. Again, we've created the tidal datum calculator which allows you to not have to do manually creating a program to do the computation. So that will definitely benefit you in the long run and allow you to get that datum for your area of interest.

>> Yes, sir. Give a shout out to co-ops for getting that comment video out there to explain the tool and providing that tidal datum calculation tool. It's really a great service. We have a question here from Kelly Carnigan. Are there plans to work with Canadian hydroservice to provide tidal datum converge between CS datum and U.S. datums.

>> For the coastal areas that has not been discussed. Tomorrow's meeting on the international great lakes datum we will work very closely with our Canadian counterparts to ensure that all the lakes are on the same reference of the international great lakes datum. However, the transformation tidal datums between U.S. and Canada and predictions we have not worked in the past to ensure that we are on the same reference zero and the same Epoch. I believe you can probably speak better to this. With the new geodetic datum there's been a great work between U.S. and Canada to make a uniformed transformation between North America including Mexico, U.S. and Canada.

>> Yeah. Mike, between the U.S. NGS and the Canadian geodetic survey we've been working together to implement NATREF which will be the new horizontal system for the North American Tectonic plate. As for the agreement and working with NAPGD 2022 we're still working with the Canadians how that will be rolled out and supported but we are definitely working on that together. It should be consistent and we are in direct communication with them about how this is going to be implemented. Mike, here's one from Jack Riley about datums and benchmark sheet updates. Will all the HTML presented information be available via web services data queries? For example, tidal benchmark heights above datum?

>> I believe they will be. I am not 100% sure on that. I can definitely find that information out.

>> Okay. Nathan wardwell said making benchmark and harmonics available via the co-ops would be helpful. So there's a plug for making that available. So just a follow up on the question about questions about New Jersey tide stations from Laura. Laura says that co-ops has worked with USGS and New Jersey to take in some of their station data and we have calculated tidal datums at several of their locations. So that kind of coordination is taking place actively now. And then nay tan wardwell writes in a comment here. It would be helpful to have all five year Epochs published and accessible via tides and currents. More frequent 19 year Epoch updates, more frequent five year Epoch updates showing the computation method, MMMC, TBYT, modified, standard, Fred, et cetera on either the benchmark sheet or datums page. Updated error estimates for tidal datums. For example for Pruto bay, Alaska is 0.000 meter even though 19 years of data is not used in the datum determination. Title error estimates for Alaska based on using control stations. So a lot packed in there. Do you want to provide any thoughts for Nathan?

>> Yeah. That's definitely a good point, Nathan. Thanks for your input. We will take this and record this as we're moving forward and doing the modifications to the websites to include the computation method. As for the -- as I mentioned previous presentation we are looking at the availability of doing a rolling Epoch. So more dynamically update them on a shorter time frame. As for the error estimates, that's something we're still working out and likely will be part of the updated websites. Per the Alaska we have a technical document out there which is focused on the error associated with first reduction datums in regions of high --

>> Sorry.

>> Political change which we basically did analysis in Alaska to look at what the errors are associated with the various Freds -- for those who don't know, FRED is a first reduction datum. That's what we use for our control stations. So it's a straight mathematical average. Especially in Alaska where we have limited number of NWLON stations and a lot of them are a shorter time frame that we have to rely on under that 19 year period as well as stuff like Pago, pago where after the earthquake there was a significant adjustment where historically pago pago had a full 19 year period for the Epoch and then it got adjusted because we had to use a shorter time frame for the computation just because the variance and the shift in sea level change there due to subsidance and variable Alieument we had to cut and have only used the data post earthquake once it sort of levelled off to recompute a datum there. We do have a technical document out there that looks at the various errors associated with a non controlled station using a first reduction datum until you get to that 19 years where you consider the datum error to be zero. Note that

the datum error is just the error associated with getting that 19 year equivalent between stations. It does not take into account other component errors. That is just the error associated with that. It's something we definitely do plan to add to the web page once we have the resources and at least have the associated errors flagged for the datums.

>> Thanks, Mike. So there's a little bit of a conversation going on in the chats here. Folks we do welcome more questions. We have time for them. Alexis did put into the chat the link to the YouTube video on the national tidal datum Epoch update. And then Nathan was following up on Jack's comment saying making benchmark and harmonics available via the co-ops API would be helpful. Todd responded saying that it is. Tidal harmonic constants are available through the co-ops metadata API. For example metadata API for harmonic constants at particular tide station in Alaska is available at a link that he provided in the comments there. So there is a lot of good information on what is available at the APIs. Colleen wrote in that the tidal analysis datum calculator is available and she provides the link in the chats there. And the user guide and technical report are also available from the links. So check out that -- check out the chat box for the link to the tidal datum calculator. So we have Alan Johnson from FEMA region 6 writing in to say I would conquer with Nathan that keeping local and state officials knowledgeable and where data is and how to use it will assist wiser floodplain management. Too much of FEMA data -- excuse me. Too much of FEMA data is getting to be 15 to 20 years or older in areas such as those subject to subsidence and sea level rise leaves new construction more vulnerable to coastal surge flooding. Respond to that at all, Mike?

>> That's a good point. We have recently hired on experts in our reach. So we have our reach specialists here now that are able to work on techy and how to translate it and reach out to our partners. For example Alexis who set up this meeting and everything, she is our current out reach specialist as working heavily on NTDE and IGLD. But we are definitely making up path forward and move forward to be able to better communicate with the partners both in general and also figure out how to take the jargon out of it. I could talk for hours on end that would make half the people here go cross eyed.

>> Yes, we -- in our offices we do have that ability don't we, going down the rabbit hole. So here's a question from Robert Barren. He said that Connecticut is published tide elevation data on NAVD 88 for jurisdictional limits. Is it a reasonable assumption that the new NTDE can be a linear proration of heights between control stations?

>> No, because you do have regional variability. Since tidal datums include both terrestrial movement and global sea level variance, since those two components go

into it, station to station the variance in the NTDE between Epochs will change differential. It might be relatively small depending on the region you're in. That's something you would have to look at and determine what your error tolerances and what your error balance are where with your separations. If holding consistent variance is within the error tolerance and you would have to document that and provide that information along with your product. Again, it goes back to the statement that seems to be used quite often today since the start of my presentation through everybody's presentation is metadata. As long as you define what you're doing and how you're doing it and you document it, then it's recorded. Others can replicate what you've done.

>> Yes, sir, documentation and metadata crucial, crucial, crucial for this kind of work. So I'm going to throw out a question that we have for the audience and then I'll ask another question to you, Mike. You know, given what we're doing here with this workshop and co-ops is working hard to try to meet user needs, question for the audience here is what types of trainings would you like to see? If you could drop some suggestion into the chat box, we would appreciate. So what -- how can we help you, what kind of trainings would you like to see? So in the meantime Maria hope here asks what is the decision making process for selecting new benchmark locations? Any chance some could be placed at the public boat launches in the great lakes?

>> A lot goes into the selection of benchmarks. A lot of it boils to proximity to the station as well as setting class of marks. Unfortunately a good number of the boat launches qualify as a class D mark because it is not deep concrete where we prefer to keep it as something that's a class A, B or C mark. If there's a need and interest you can reach out to co-ops with that interest and put in a request that can be put into our project notes to determine and recon if we can put a station there. Depending how close that launch is to our station makes it a little bit more because if it's not closely located we have to take into account the levelling distance and levelling time that we're required to tie that water level into the benchmark. This would be a great question, hopefully you're attending tomorrow's meeting on the IGLD. But as we do the enhancement, I'll give a shout out for tomorrow's meeting, great lakes are moving from -- IGLD is a geodeticly based datum but moving from traditional line levelling to be more of a GNSS-based datum. So with the transformation if you need one there you can set that mark, take a GPS on it and be able to use the various tools that NGS and whatnot to get that relationship to the IGLD elevation as well as get that comparison between that height difference, the water level station where they will all have bubblish dynamic height because IGLD itself is dynamic height based system, not orthometric based system. Tune in tomorrow for a lot more on that.

>> Thanks, Mike. There's a follow up question. Is there a process for getting local input in terms of where you put the tidal benchmarks for new stations?

>> Generally when our crews go out or contract out there's an effort to reach out to the local entities and local government or other organizations. But if there's a need for a specific thing that if you know that you would benchmark from a region that a tide gauges in or a tide gauge is going to be put in aspects like V datum and stuff, again reach out to co-ops user services. We can provide that information, add it to our project constructions. We can't guarantee that we'll be able to address all questions and, again, Laura just put it in the stakeholder services branch email, which is tide.predictions@noaa.gov. If you provide that information we at least have a record of it when we go forward and plan to set new marks that we can look at that site and take into consideration the public need.

>> So Lou is asking for your thoughts on the approach they take in New Jersey. He said that New Jersey geodetic survey based upon their experience over head had tied an additional benchmark near coastal areas. New Jersey geodetic survey included them in the NGS database. New Jersey you don't think advised the professionals to use this information data on the older tidal benchmarks with caution and infer some NABD 88 and NGDB elevations to older tidal benchmarks that are lacking elevations. Any thoughts? Does that make sense?

>> This is likely going to be something that will be more of a question for NGS. Part of it is you -- if you have a good historic record of elevation differences between the benchmarks in your network and a continual advancement of ties to the orthometric datums you can infer the differences. Obviously the best bet, especially now that we're going to using GNSS but at the same point in time you can always go read blue book waters from your water level gauges by running that half kilometer or longer distance to two known benchmarks that are in the NGS's IDB to validate that you do not have height differences and actually get published values on all the marks that you hit via blue booking which requires, you know, a forward and background on all marks. You were able to recover those two marks at that extent and their relationship has not changed. I will point this to gaylan because this is a lovely aspect.

>> Yes. Thanks, Mike. I only play meetings if there's no other geodetics around. I suggest you talk to your friendly regional NGS geodetic advisor up there in the northeast. We got a minute and a half left. I just want to get through some of these other comments. So that was a good conversation. What's available on the co-ops website and web services. Jack Riley writes that many observations metadata and derived products are accessible through co-ops web services. However one notable gap is the tidal benchmark above data. That information is only currently available via the benchmark sheet HTML text. Laura reminds everybody that you can reach

out at tide.predictions@noaa.gov. The final question from Paul boyce. This can round us out here, Mike. How will updates to the NTDE impact planning for sea level rise? How is this info reaching organizations and the public?

>> Within co-ops since we look at a long term sea level rise everything is set relative to station datum. So the new Epoch will not change it. I don't know if mark Hoover is still on the email but I know Army corps they reset their zero for their modelled and anticipated, you know, 10%, 20%, 50% confidence intervals that when the new Epoch comes out the zero reference for the start of it will change but within co-ops we just look at the actual absolute sea level rise. We do not include anticipated forecast variance. We just go with what the actual observations are and include that. That goes through history all on the same zero and that's why we use station datum. That doesn't change over time based on Epochs.

>> Thanks. There's one last question here before we wrap it up. I'm going to -- John bean writes, are there any plans to quote, unquote clean up the NGS benchmark database to remove old or missing marks. I'll just take that one. I'm about to drop it in the chat here. NGS relies on local stakeholders to help us clean up the database because we don't have our surveyors out there recovering these marks anymore. We encourage you to submit a mark recovery to NGS. I'm going to drop the link in the chat here. If you can provide us with evidence that a mark has been destroyed, then we can certainly mark it as destroyed. Otherwise we'll mark it as not found or whatever other information you want to provide. So please consider filling out and submitting recoveries to us. That takes us to the end of our time here, Mike.

>> Thank you. Thank you everybody for your input.

>> Thank you. Thank you, Mike. Thank you gaylan. Thank you everybody online for participating in that with your comments and questions. All right.

So I am here to introduce the next speaker on our agenda and that is Stephen white who will be talking about Vdatum. Stephen is a colleague of mine at NOAA's national geodetic survey. He is the staff cartographer at the remote sensing division where he leads and coordinating the coastal mapping program. Please take it away, Stephen.

>> Can you hear me?

>> Yes.

>> Thank you, Christine. Okay. So we'll go ahead and just jump into this. Okay. So kind of thinking about Vdatum as a program it's kind of a three tiered program. it really starts out with the foundational data observations. This can be geodetic, it can be tidal. Those observations then feed into our modelling. The models is a really large portion of V datum and not -- I really won't get into too much of the hydrodynamic models. It's a large component against all the tidal datums. Then we also have the TSS or the topography of the sea surface that gets us from the

geodetics to the water levels. And then the third tier is the software out reach and development training itself. Currently we have four V datum interfaces that we're supporting. We have the downloadable. We also have a command line so that you can programatic call V datum. These two are really where you are going to do your large number crunching if you have like terabytes of data. We also have an own line web interface. It's very similar to the downloadable but the one thing it does is has web map and has some layers that we kind of try to help educate and get people to understand what is going on within V datum. Then we also have an API which you can call when you don't know V datum is being invoked. Since COVID we have been doing a lot of development, whether it was the low water datum for the great lakes, con 5.0, 3.0. We've listen releasing Alaska, long island sound. We started uncertainty, the phase two, and I'll talk about that. We have geoids. There's a lot as well as the Chesapeake bay, west coast, HTP version updates as well as starting to get into inland river datums. So kind of thinking programatically what are our strategic priorities. This has been for a while. Trying to create consistency between regional models as we've been preparing we've kind of going away. I'll try to make sense of that. Then we've also -- you know, this is kind of a goal. We're trying to bring down our uncertainties of what we can control down to around 10 centimeters. There's areas where we just can't reach that. So points in time. You know, just increasing coverage, you know, whether that's going upstream, creating areas. Really the next generation topography of the sea surface model. It's something we've been working over a decade for. This really puts us into where we can go into the new NSRS and really become a lot more physically meaningful. There's spatial variable uncertainty. So we'll talk about that as well. Uncertainty. On the left side of the slide, this is our phase one approach. It's giving a single uncertainty value depending on how you're traversing the road map for a regional area. So in the top left you'll see what we have previously. Here in the next few months we're going to be rolling out the Puerto Rico U.S. virgin islands model. We have gone from red to green there. Again, what we're trying to migrate towards is a spatially varying uncertainty model. As we're going back and iterating through these models we create these SVU layers. These are created both for the tidal datum models as well as the TSS. The thing is instead of giving uncertainty value for region, each observation will have its unique uncertainty where it falls. It's one of the ways we really try to bring down the uncertainties or expand coverage is through water level observations. Whether it was through supplemental funds or base funds to really get at some areas we had known gaps whether it's in the gulf of Mexico and then also some supplemental funding that really helped water level observations in southeast South Carolina, a little bit of Georgia and then the big effort in Puerto Rico and U.S. virgin islands will help bring down uncertainties and create

consistency as well. One area that has been a major focus I would say here in the last few years is Alaska. It's a large area, a lot of data gaps. This slide here just shows, you know, what we've kind of internally funded. This is based off of an assessment of known gaps. So we currently what we have funded and then what we are looking to get observations for. There are certain funding mechanisms currently out there we're looking at to try to achieve these. So what I'll kind of cover here going forward the next few slides, increasing coverage, that next gen TSS and SVU. So, again, Alaska is that area we've been focusing on. There's a lot of effort going into building the hydrodynamic models now. But with these there's certain things we need. We need updated shoreline. We know that shoreline has been a problem. What you're seeing over the left, that is in green is currently the cusp plan that we're currently integrating into that Alaska model. That area of the west we have filled that gap, we are just working on further upstream areas. Currently we'll hit southeast shoreline. Again as the hydrodynamic models are being built we noticed issues. We need updated to produce accurate models. So there can be some issues. Now other observations. This is more on the geodetic side. So doing GNSS observations that can be shared. Once we have those observations we can go back and process them to understand new geodetic to tidal relationships with needed. As we share whether it's NOAA doing it or the public we can scrape that data. The more data we get over time, you know, the more we can start understanding what are the possible uncertainties and what are the possible changes in height. So there's a big effort to get these observations, own the title benchmarks so that we know so that we can produce this next gen TSS as well as supporting or tying into the new NSRS. This is the way you would tie into it. GNSS observations. That really feeds into an important component. This is, again, something we've been working on for over a decade now. Tom was really pushing us towards this and the geoids a long time ago. The initial release was down in southeast Alaska. That's because we knew there was issues within ABADA. We also released this on ex-17-B. Since then we've been a little more consistent in all the west coast Chesapeake Delaware bay as well as the soon to be released over here on the right, the Puerto Rico U.S. virgin IE Lance. That is all based on 20 B. What we're doing here is integrating data. We're just reprocessing that. What you're kind of seeing on the bottom is this SVU field. You start seeing tracks kind of through that. What these are, those track that is you're seeing, those are the repeat missions that come over and over and over consistently. Then you have the geodetic tracks. As you get away from these repeat tracks our uncertainties start to increase. You can see as you get closer to the coast and things that are in -- uncertainties usually decrease for the most part unless you're going upstream where we lose data and things kind of increase as well. That's been a big effort to

produce a physically meaningful field so when we go to the new NSRS we can start tying these water levels to that. Another big thing that we're trying to do is migrate to a regional modelling approach. You just have numerous regions currently in V datum. What we want to do is get to four regional models. With the release of the west coast in March of 2022 that was our first regional model release. From there we've been talking about that Alaska model we're working on. Currently it's looking FY 25. From this there Summer we'll start working on the Pacific islands. It's looking FY 27. Then the big east coast gulf of Mexico Caribbean model. So those are really the four models that we will have. The hope is it allows us to be more agile. We can frequently update, ingest new data. If there are fixes, issues, this and that we can address those a little more frequently than we have in the past. So I've kind of been talking about how we're preparing for this NSRS. I'm not sure if you can see my cursor or not but on the left side when you down here at NAVDA that's how we were tying in the tidal datums in the past. As the ex-geoids have become part we started to migrate and produce these fields. This will be U.S. west coast, Chesapeake bay, Delaware bay, Puerto Rico, U.S. virgin islands here soon. We are tying into the tidal datums. We also have been trying to explore handling some inland datums. You can see how we have supported the CRD which is through the NGS hybrid. Okay. So again we've been talking at the NTDE update here. Also been talking about -- well, tomorrow you will be talking about IGLD 2020 update. Then there's also the modernized NSRS. Again, you know, it was initially supposed to be released in 2022 but due to COVID and other things there's still looking to done partially in the mid-2025 and will be replacing. So going to NATREV 22. There's a lot of clicks here. It will go to the NATG 22. You can see the genome is much larger than previous. We also have the American and Guam that's being supported in the south Pacific. There's the changes between the differences. There's going to also be a lot of state planning coordinate system updates that are rolled out. Again, AGS is taking a data first approach. Again, this is just talking about all the different data that will be coming out. These are actually all slides from drew Smith who is the national partial reference modernization manager. His last public presentation. So I think the thing is here the tools that data delivery system, the thing that we are really looking at is the release of NADCON, VERTCON seasoned the SPS 2022. Those are things that will go in V datum. Just the timeline. Middle of 2025. That's been talked about. Really kind of hitting on this GEOID 22 schedule. You can see the beta. They are I believe not producing anymore experimental GEOID. They hope to have this released in the fall. So you will most likely see this in V datum come 2024, released during that time. Then we'll be looking for GEOID 2022 to start getting that and integrating that in. If you're looking to find out more on the NSRS, these blueprints, these documents, please dive into them. They can provide you much,

much more detailed information than I can. But the thing that really I think we're here kind of to talk about is how do we get V datum updated with both the NSRS, the NTDE and IGL 2020. So I think the real thing is when does the V datum team actually see the data and the tools. Until we have those, I mean, we will be having to wait to look how to integrate and implement these into that tool. Again, we will initially try to put in the new NSRS that we will integrate NATVON, VERTCON. That should be rolled out in Vdatum in 2026 and then the new national tidal datum. Again, once we have this data we can start thinking about analyzing and how to best implement it. Really the thing that we would like to see is making sure we have that NTDE or the new tidal datum Epoch tied to the new national spatial reference frame. So all those connections have been made. Then, you know, when we kind of start thinking about how do we do these updates in V datum. Can it just be the TSDS. It is a local mean sea level change. I think from the slides, the slides that Mike showed earlier the tidal datum fields might have to be updated. Probably will have to be updated. Do we need to rerun these hydrodynamic models with this data. Now we are going to kind of get into what is that strategy or what do we foresee of how we're implementing that. I think this generally shows that road map. Not sure if you can see my cursor or not. We are looking to support more inland water. We should have the Mississippi water plain or LWRP 2007 implemented. Then you see how we're progressing to the new tidal datums. We are going through NATREF, GEOID 2022 to get the NAT G2022. From there IGO 2020. This shows how we will be implementing or supporting the tidal datum Epochs. So, again, we were saying all this needs to be tied to the new national spatial reference system. You will see we will traverse into local sea level 8301 to a TSS. If you want to back out and come into the new tidal datum it will be a separate TSS that gets you the local mean sea level 02-20 and then on to the tidal datums. So that's currently how we are looking to implement and possibly will change seeing how tools and data are developed. So just kind of thinking about the schedule that we have. So here -- this is probably a little optimistic. The whole Hawaiian Pacific models this could be the most to have NSRS and NTDE incorporated. We are looking at a release of 2027. So things have to start moving fairly quickly. Probably a little more realistically you will see this in the Atlantic Caribbean gulf model. At this point we will have all four of these regional models. As we start we will update the NTDE and NSRS for that. Thinking out even further longer range currently V datum supports out to the EEZ. It would not be a stretch to support out to the GEOID 202. So I think that was generally all I was going to highlight or brief on V datum. Just this last slide just kind of shows the current hydrodynamic modelling efforts. You see Alaska and then moving into Pacific this Summer. Thank you.

>> Thank you. We have time for questions about V datum with Stephen on the line. The first question is about model domain, Stephen. JS Allen asks, how will this look for local coverage? I think what you're showing here on the screen now is the coverage that you're working on. Is that right?

>> Yeah, correct. Correct. So I should say so if you know you're doing transformations those are global. You know once you get into orthometrics you start limiting to domains. I think as Galan was saying you're starting to see coverage tidally. We are trying to make sure we at least get the EEZ covered. Then expand from there. Getting into global you start dealing with other observations and how do you make those consistent and how you're timing. It gets it a little bit more complicated with the larger you go.

>> All right. Thanks, Stephen. So we have one from Natalie treadwell at TCarta. How will NOAA conduct shoreline mapping in the areas needed to complete the hydrodynamic modelling in Alaska? Is there a plan in place to ensure that surveys can be conducted in the areas needed prior to FY 25? Is NOAA's NGS working with the Alaska mapping executive committee to ensure that data gaps have been conveyed as priority areas or will these surveys be conducted internally by NOAA?

>> On the shoreline side we are making an effort to have updated. I wouldn't say it's the cusp land is how all the product manager kind of phrases it. So we will have shoreline here in the next year for the state of Alaska that will feed into V datum. Now of the math metric survey side, that's a lot more difficult issue. If you saw the coverages that are needed, that's a large expanse and that becomes very, very expensive. All of those areas are currently up on sea sketch as known gaps that V datum would like to see. Please refer to C sketch to obtain areas where we need it. Yeah, a lot of times that data -- I mean whether it's being acquired, processed and gets into our modelling, it takes probably longer than the time frame that's needed to get it into that initial model. I think the thing that we should really highlight here, especially with the state of Alaska, I mean, you know, we know there's lots of water level observation gaps, lots of issues. Over the next decade we are planning to iterate through this model as we get new observations as we get new data to help improve it. We know there's going to be high uncertainties associated with particular areas of this model. So it will be the iterative approach over the next decade or even longer to, you know, enhance the model, bring down the uncertainties associated with that. That's just a really kind of -- I want to throw this plug out. We provide those uncertainty estimates. I hope people are using those. Especially as we go to this SVU please be aware of the uncertainties associated with the transformations. As you try to take those into account and make sure, you know, that you can support that level of uncertainty in your particular applications. I mean there's going to be particular applications that need 2 centimeter uncertainty.

It's going to be well beyond that. If there's an area that needs let's say 15 or 20 or 30, you know, it could be well within that. So you just have to be really particular based on your application and the uncertainty of the transformation but also the uncertainty of the data that feeds into that as well.

>> So Stephen I will definitely echo your point there about that spatially varying uncertainty. I think that's one of the greatest additions to the V datum product in recent years. It really does provide that understanding of where the tool is applicable for which applications and allows people to really make their decisions on what they use and how much confidence they place in the results, you know, based on where the observations are that are going into the model. So kudos to you and the team for getting that spatially varying uncertainty in there. I think it's a really big deal. Are the -- are those SVU grids available to the public?

>> Yes, they are. So within each regional model folder, let's say there's a mean lower load water dot gtx, there will be an MMLW underscore. Those are there and available. If you're on the online web application there's a layer that you can click on. Often it will tell you where SVU is currently available, where it's not currently available. If SVU is available then it is defaulting to that SVU uncertainty calculation instead of the MCU. But, yeah, those SVU grids are available within each regional model folder of the software.

>> Excellent. Thanks. Just following up on a couple of things you said here. Colleen dropped into the chat box there the link to C sketch for U.S. mapping coordination project. You mentioned that in terms of, you know, how we know who is going where. So I'd encourage folks to check that out. It's one of the ways that, you know, federal agencies are coordinating mapping. You know, mapping once and using many times. I'm going to go into just a comment that -- from the end of the last session about cleaning up the NGS database with recovery reports. The comment is that the history of older monuments as a large amount of value that professionals utilize. So if we do clean up the database make sure that the archive data is easily retrieved by the individuals that need it and want this info. Data should not be made inaccessible. I just want to assure you that we do not make the data inaccessible. When a mark is reported as destroyed in the NGS database you have to make sure that you select when you're looking for benchmarks data sheets that you do select include destroyed marks in there. Yes, we recognize that those historic marks even if they are not in the ground anymore do contain important historical information that's valuable from lots of different applications. So we definitely hear you. So we have a question from Paul boyce here. As vertical datums are updated are projects being reviewed for rationale impacts? For example dredging may have contractor windfalls and a company and taxpayer burden. Dredged channels and basins may be based on past industry uses that has ceased for decades. Will U.S.

Army corps of engineering update so unnecessary dredging is not performed? Stephen, I'm not sure that's necessarily a question for you. Do you want to address that or should we punt that?

>> I would say at least how we're doing it, we usually release a model before our technical memorandums make it out. But we do try to document what we've done, what the data that was used within V datum, whether we're doing what has been updated or what the differences are, especially as we're kind of going down different road maps it gets a little harder to do that. We do put it out technical memorandums on the development and the data used. So really hopefully people are focusing on that and they can really dive in and see how it might impact their particular project.

>> Excellent.

>> Well, Mike here. Let me chime in real quick. Let's side bar that one to the next working discussion and maybe Jim can speak to that better.

>> Very good point. Very good point, Mike. I was just asking about Jim or mark. So, yes, let's put that for later and Paul we'll get back to that and see if we can't get some insights from Army corps. All right.

It looks like we are out of the questions. Out of the questions that we have so far. We still are interested to hear from anybody in the audience what trainings you may be interested in or what additional support we can provide in terms of out reach for all of this stuff. So folks can drop that into the box there. I will look back to Christine or Alexis, how you want to proceed now since we're a little bit ahead of schedule.

>> Thank you everybody for participating. I believe we could make our break a little bit longer because we just had a short 10 minute break. So I believe that we can actually take our break now and then rejoin at 3:25. Then we will have our last group of presentations for the day which is a really great panel of folks that are going to talk to you. So I think let's make that the plan. We will break a little bit early. You know, 25 minute break. Please be back on time at 3:25 eastern.

>> [Break being taken until 3:25 p.m. ET

>> All right everybody. We'll be getting back started again in just a moment. As people are making their way out, I just wanted to make sure that folks saw that there is an option to explore your Adobe connect screen and find some files that have fact sheets and find some web links that have some information. You should definitely check it out. It's definitely relevant to all the conversations we've been having today. So just wanted to point those out to folks and encourage you to check those out. Without further adieu I would like to kick it off to our final panel of the day which I'm really excited to introduce. This panel will be talking about historic relationship older reference systems. First James with U.S. Army corps of

engineering. Mr. Jim is involved with survey and geospatial engineering related activities within the U.S. Army corps of engineers and specifically the Army geospatial center. Next we will have Ed Carlson who is the Pacific region geodetic advisor which provides -- in that role he provides training, guidance and assistance to constituents managing geospatial activities. The framework in coordination with the system for all the positioning activities in the U.S. We also have Nicole joining us. She's a former geodetic advisor who worked in Alaska. Dave Doyle will be returning. He again owns baseline geodetic consulting services which provides consulting to public and private agencies and companies. And last but not least we have Dan margin joining us. Dan has worked as NGS for an advisor for 19 years and been the northeast regional geodetic advisor since 2015. With that over to the panel and you can hand it off from here. Jim is up next, is that correct?

>> Yes. Can you hear me okay?

>> Yes, we can hear you. Take it away.

>> Great. Thank you very much. It's an honor to be doing this with a great group of other esteemed geodetics and other datum officianos. So appreciate the opportunity to be involved. I'm going to start off with kind of we're dealing within the corps. You can see from this little -- it's kind of hard to see but the kind of reference there of all the different water surfaces and the different datums and different things that we have to deal with across the corps is pretty unique from the coastal areas, inland areas, different water surface, different areas that kind of interact with coastal areas and non coastal areas. So we have kind of specific concerns and issues that we have to deal with on a somewhat regular basis. So I'm going to talk a little bit about them in the few minutes that I have. Hopefully answer some of your questions. So, you know, to stress the importance of water level datums, you know, the USACE is concerned with where water is going to flow and the importance of water levels and how they relate to our projects. Katrina highlighted this importance and what can happen when we don't keep up to date with current water surfaces and make assumptions about historical information which this also includes talking about flood risk management projects, flood control projects as well as navigation. Katrina highlighted some of those things and made us take a look at how it's related to various things and how it's related to each other. So also included in the importance of water levels is when we talk about -- it's spelled out in our hydrographic survey manual. In here it kind of goes through and talks about all of our federal navigation and resource projects must be referenced to a specific tide gauge which also needs to be referenced to an established vertical datum whether it's hydraulic or tidal. So those things are really important in the hydro graphic survey goes into that and how those things should be related. We are also dictated by the water resources development act which kind of basically spells

out for our navigation projects of how things should be related and what they should be related to. And then also who we should provide that data to as well. So it's important for us as we go down that process. Mark mentioned this earlier but our current policy and guidance that's out there, we have an engineer policy guidance engineer regulation we call it and we also have a guidance document that kind of goes along with that. Mark mentioned how we put these into place. These are put into place after Katrina and the lessons learned after that. It focuses on the idea of ensuring proper data connections whether it's to the geodetic, water level surface, the local datums as well. Those kind of policy states how that should be done and -- sorry, what should be done, the policy states what should be done and addresses the local and superceded datums as well including water level surfaces. You know, how these older projects and older references kind of play a role in that too. The guidance kind of spells out how that policy should be carried out and how to implement that policy and how to update it to the current datums. So the engineer regulation it kind of as I mentioned this ER is the over all policy when it comes to relating elevations to nationwide datums. It addresses different types of projects, what connections need to be made and within corps the water levels are vitally important. I mentioned that a couple of time. They're location dependent and a lot of those water surfaces are location dependent and impacted by local conditions. The impact that Norfolk is going to have down in Jacksonville district, in New Orleans, those are all going to be local depending on those conditions also having the connections to the geodetic can provide consistency across large areas. Some of our projects when looking at large areas we need to have a common datum. In some cases the -- if -- in situations where we have water level surfaces that are very isolated to particular areas and impact areas we have to kind of have something to kind of tie those together. That's where some of these -- like the geodetic data connections can help us in those areas. Again, also important to understand the relationship between the water level and the geodetic and how it might impact our projects that's kind of critical in making sure that we maintain that. A lot of what we discovered too is we have a lot of legacy or local or legacy datums. When we're dealing with these local and legacy datums we have to consider several things. We have to kind of look and see where do they come from and if they were tied to any specific datum down the road. So what was the relationship between the older datums and how do they relate and then where did they come from. What we might need to resurvey to establish a relationship, might have to go out and try to find either benchmarks or things that were tied to it so we can develop that relationship. Establish that relationship and document it and to keep it current. Again, in high dynamic areas we deal with a lot of change. So we have to kind of address that as well to make sure that we're taking that into

consideration. And then we also might need to periodically reevaluate or continuously monitor for changes over time. That's an important aspect as well. The changes as we get into the impacts of these new tidal datums and geodetic datums we are trying to go through that process of getting all of our legacy datums tied to the national tidal datum Epoch so when we get further in time when these new datums come up it's an easier lift, easier transformation over to these. It's an involved process. It involves changing O and M manuals, involves changing information that has to go along with that. If projects already connected to the NSRS it makes the transition simpler and easier because it has a consistent datum across the way. I'm sure the importance of metadata, I think Mark talked about it, I think Mike talked about it as well, you know this idea of metadata so critical that we have that. Then communication with our local, public and local sponsors. I think that's an important aspect that we have. A lot of them don't understand the importance of these datums. They don't understand why these things are changing and what the relationship is. So we have to kind of -- we have to kind of address this as well. Again future changes, updating our policy, updating our guidance documents, those are things that we kind of continuously look at and we update those periodically as they go through. Again, if you have questions as you go through if you're looking for a point of contact, you can contact me and here's my point of contact information to address things that specifically is related to the USACE side of the house. If I can't answer the question or I can't provide the answer I can point you to the right direction who it needs to go to. I think that's it. Pass it off to Ed Carlson.

>> Ed, you may be on mute. If you can enable your microphone at top of your screen so you can begin your presentation. All right. I think Ed is having a little bit of trouble so I'm just going to skip ahead here to Nick Kinsman to give her talk here.

>> Sound check.

>> Yep. We can hear you.

>> Great. Ready to roll. So what -- great set up from the arm corps there. Thank you very much. I wanted to just dive right into some examples. We talk about these areas of really significant subsidence for uplift. Alaska conserve is a really great illustrative member of why paying attention to the temporal element of our datums is critical in data collection, data use and in regulatory framework. So I'm going to give you a couple of case study examples from Alaska to really drive this home, the importance of the time dependency. It's really because these things are so measurable and apparent in Alaska but everything we're talking about and you've been hearing about in this entire presentation, the series, really it's happening everywhere. It's just happening at much larger and more apparent rates here in Alaska. I think I can control the slide advancement. I can. So this first example is

from Juno. This is one of two I'm going to show you. This really I wanted to emphasize how the geodetic to tidal relationships change to time and how significance that difference can be. So Juno is our capital city in southeast Alaska. The relative sea level trend is falling. That's because the land is uplifting really rapidly with the loss of glaciers and even though the local sea level is rising the land is out pacing the sea level rise. So this is the core station located near the glacier right near Juneau. 2 cent matters of uplift. So the land is really moving fast. This is the situation here in Juneau. So what does that mean to these relationships and how does that effect people on the ground. This is a really complex plot. On the left side you can see how the tidal datums have changed through time. Now the Juneau with the rapid changes there, the modified five year calculation used, so you can see the different local tidal datums, the mean lower low water going up a couple of millimeters every year. On the right side the three different surfaces, those three curves you see, that's the land uplift. This has all been generalized for the sake of this example. It's on that land surface we place the passive control benchmarks. So with the really rapid rebound you have a big difference in the relationship itself between the geodetic and the tidal datums. This really matters when you're doing things like flood mapping. So if a local surveyor or the Army corps or anyone doing an engineering project is utilizing that passive control mark and using a fixed relationship to the local tidal datum for the purposes of creating a flood map, for example, or determining what a spill over height might be, they need to be checking that their relationship is contemporary. Those little brackets on the right side in green, they have been diverging further and further and further every year. So a great example I think is that there may be a published height on that mark in 2004 of some value. 10 years later a surveyor uses it to complete an elevate certificate. Let's say a contractor at some point is collecting a new elevation surface there in Juneau. Which one of those published heights are they using? If the local flood map is tied into the tidal datum you got to be keeping track of that relationship through time and not just updating the tidal Epochs and the national geodetic data but also ensuring all of that Epoch information is publish in the metadata is critical to being able to track this and assuring that the products are as accurate as possible. The next example I wanted to show you is in Cordova. You can see a very complex relative sea level trend. Positive to steady. The record starts in 1964. Just as a little context here, this is an example to show you the impacts on regulatory activities like flood mapping. Prior flood insurance study for Cordova covered 1979 to 2015. They got a new flood insurance study in 2015. A lot has been different in that time. This is what happened in 64', why we see that change in sea level trend. The major earthquake, the Alaska earthquake March 27th, 1964. This part of Alaska uplifted more than 3 feet. So what happened is immediately after the

earthquake the post seismic adjustment started lowering the land back down closer to the water level again. That post seismic adjustment meant we got some really accelerated local relative sea level rise, complex trends, exacerbated by changes in the land surface. So coincidentally right after the earthquake a lot of development occurred in Cordova. So you've got a lot of uplift, tons of houses being built and then the sea level starts accelerating as the land adjusts back to where it was before the earthquake occurred. This created some real world situations in the regulatory framework for flood insurance. So I'm going to show you an example where the names have been changed to protect the innocent. It really drives home why the Epoch matters. So the base flood elevation in 1979 with the flood information study that was done and the current flood insurance rate map, the base flood elevation was 18 feet relative to mean lower water. So if Fred, his house is there, obtains an elevation certificate in Cordova back in 1994, he's above the base flood elevation, doesn't need insurance. So this is a experiment but it's drawn from real world events. Fast forward, his next door neighbor Susan who visibly lives up the hill from him, she got her certificate in 1994. The surveyor did everything correctly. They did an elevation certificate saying the house was 17.9 feet above water which is below the base flood elevation because the local tidal datum has changed. Okay. So Susan's house is physically up the hill from Fred but she has to pay for flood insurance and Fred doesn't. This is the result of people not paying attention to the Epoch and why the Epoch is important. So you can see the difference there. Fred is out of the flood zone purely due to his grandfathered elevation. This is a regulatory crazy thing. They're not really measuring things relative to the same flood insurance datum. That's the really big challenge. So FEMA guidance has not caught up to our understanding of how things change around. It technically states that the base flood elevation stays fixed even if there's subsidance. That's ambiguous because the base flood relative to a non fixed datum, like a tidal datum that's changing through time. So this is obviously not the way elevation decision -- or insurance decisions should be driven. Since these slides were created just in the last week or two, the state of the science report was published on the federal flood risk management study by the White House which is encouraging everyone to pay attention to the changes in our datums. The national tidal datum Epoch update and the modernization of the national spatial reference system because Epoch matters. It has impacts on people's bottom line when they are getting insurance for their homes. So in this particular example this is a real snapshot from the updated -- whoops -- 2015 flood insurance study for this case study in Cordova. What they did was they included a transformation calculation in the flood insurance study when it was released in 2015 initially. It doesn't include the Epoch information though. So if someone were to use the information provided

in this equation here and apply it to Susan's house her elevation would be correct for the purposes of setting flood insurance rates. If it was applied to Fred's just doing that subtraction from his elevation certificate which has mean lower level water on it but in a superceded tidal Epoch his certificate would no longer be compliance with the new federal -- with the new flood insurance standard study. So how is a local floodplain manager to know the difference when they are going through the process of elevation certificate updates? It really comes down to this metadata and ensuring that we have this information out to the public that we're communicating it and that people can access that because they have had to update this flood insurance study to reflect the Epoch information and that means people aren't swimming in the dark doing datum forensics anymore. Two quick examples from Alaska at the end member. Over to you, Ed.

>> Thanks, Nic. Ed, can you hear us this time? Or can we hear you?

>> Can you hear me?

>> I can hear you, great.

>> Sorry about that. Bad connection here in Germantown, Maryland. Didn't pay my electric bill. Okay. I'm going to talk about the Pacific vertical datums that we have. I've been the advisor for the region since 2002. When I came out here mostly my area of work was Guam, side pan, midway and the Hawaiian islands. I've done work in the other islands which also have tidal datums that were established back in the 60s and 70s by co-ops or at that time it was NOS or Costeogetic survey. The problem we have on the islands is when I first got there everybody would be doing work and say I'm doing levelling, I'm using this benchmark, I'm tieing into it, I'm trying to come together and we have different elevations. As you can see we have a mismatch of times when levelling was done on the islands, what tidal stations they were tieing to and the different dates. So we have different local tidal datums. In our database unfortunately we don't have anything that differentiating which tidal datum it is, if it's 1929 or '33 or when they did it, just the local tidals that we have. So we have all these different dates on the -- of course you can see in Hawaii, kuai and Maui the level was done. NOAA has not done any leveling on the island and same thing with Leni. In the other outer islands as I call them there were done in Guam in '63 by co-ops. The northern were all done tidal datums were derived for their elevations as ux see just using 29 days of data, 56 days of data and 29 days of data. Since then co-ops has come in and we have done -- set up a tide gauge and done long term side pan to get better elevation. One of my first things I did out on the island is trying to get everybody consistent so we're on a vertical datum and local, the most recent tidal datum. We did work in 2002 in American Samoa, 2004 in Guam. We all gave them vertical datums at that time. We did a paper on it called the development of comprehensive datums in the Pacific. You can read them. Since

then mother nature had an earthquake in America Samoa so they are from a vertical datum to local tidal datum. We will be working out there in the future. So what has happened in Hawaii, mostly the main island, we had levelling done but of course it was on a different tidal datum, national tidal datum in 27. We had work done in '69 which is on a different tidal datum. So people are using these benchmarks and using these elevations. When they are trying to connect to each other they are having problems especially doing floodplain mapping which Nick just eluded to getting certificates, elevation certificates they were having problems. So we had other relative minor levelling done over the years between this Epoch. So in 2015 the state of Hawaii decided that they are going to relevel all the islands and set up the bench network again through the department of transportation. We did all this levelling. We tied these benchmarks to one tide station, one tidal benchmark in the Epoch. When we put on the data sheet an owl those benchmarks after we got the statement done we put this statement, the heights were determined by differential levelling and adjusted by NGS in 2019 holding the station fixed and the elevation that was also used. That was part of our metadata. We couldn't put -- we still call them local tidal datum stations in our orthometric height table. This satisfied so we could get some metadata. We also took all the old previous projects that we had and put them together and adjusted them to the levelling that was done in 2017 and -- 2016-2017. We had common points in a network on all those lines. They were held fixed. We also put a statement on all those benchmarks to how they were tied and that information. So people can go back and follow and trace it. Also what I did is I made a table of all of the new elevations plus the superceded elevations. So everything is all on one tidal datum which is the 1983-2001. We did the same thing on Maui when they did the levelling on Maui in 2019, 2018-2019. All the white circles are the original levelling that was done. We tied it to the tidal C and all the blue marks are the old superceded or the old levelling we had that was tied in. Leni did not have any vertical work. So it was done. We tied to a tide station that the university of Hawaii had running and co-ops determined the main sea level elevation of the benchmark and we adjusted it to that. That's the levelling for the island of Leni. It's very sparse but the rest of the island is hilly and also it's all pineapple fields and nobody lives in that area. So this is all where the population lives mostly. So what are we doing to get ready for the rest of the -- for the 2025 tidal datum. Well Hawaii is going to finish up the levelling for Kuai and the island of Hawaii, that's going to be done under contract. They are in the process of doing Kauai. We're going to relevel the America Samona since the earthquake of 2009. From what I understand, I just heard today we're going to do the recon and then relevel next year. With that I'm ready to pass it on to the next person.

>> Great. Thank you, Ed. I think it's Dave next.

>> Yes, it is. Thank you very much. Thank you. I want to -- I'm ending up this particular session. So I want to talk to the issue of these datum transformations. Just as background, I had the great fortune of being one of the project managers for the development of the North America datum of 1983 back in the 80s. What I quickly found is that in those times very few people had any significant amount of high accuracy geospatial information, a few U.S. corps of engineers, a couple of states but by and large not so much. Today with the advent of space-based positioning technologies, obviously GPS and GNSS plus the huge advantages in geographic information system, so many communities are sitting on mountains of high accuracy geospatial information, both horizontal and vertical. Stephen White did a great job with V datum. I want to just put out some information because I've had literally decades of dealing with professionals on these topics. These are just a few elements that I think are vitally important to understanding any datum transformation. Given our limited time I'm not going to go through each one of them at great length. I do want to highlight a couple. Number three, how accurate are the existing coordinates or heights. That's your metadata. Again, we've beat -- I want to say we beat it to death but we haven't. We can't say it enough. How accurate are your existing data? How accurate do you want your new values? If you have relatively high accuracy, a couple hundreds of a foot, a couple millimeter tidal datum information and you're relying on that and we're going to go to the new tidal datums or the new geodetic datums, whichever way you're looking at it, do you want to maintain that level of integrity. Well, it's entirely possible that whatever tool issues that is the datum transformation tool, whether it's provided by the national geodetic survey or co-ops, through V datum, it's entirely possible at those levels it is not going to support that. So you need to be aware that these datums may need to actually be resurveyed to keep up with the positional integrity that you're looking at. You cannot improve the accuracy by simply performing a transformation but you can degrade it. I've seen that many, many, times. Get to know who the authoritative source is. Many people listening to this are very likely to acquire datum transformations through software, through a whole range of different vendors that are not necessarily NGS or co-ops. They may come with other packages, GNSS receivers or GIS software. They will have transformation tools. But where do they come from? What's the source? How can you rely on them? Make sure that before you use any of these tools that you understand what that is. I want to highlight just some of this. Like everybody has been talking about, metadata. My personal perspective is coordinates and heights without any appropriate metadata have the same value as a boundary line in Google Earth. The surveyors who are online will know what I mean by that. It's just a wild guess. It's a cartoon. So the

metadata is so critically important. I want to highlight what some of those metadata elements are. We've kind of talked around them in various presentations but I just kind of bring them together here. So there's the geodetic datums, whether it's the older ones, NGBD 29 or NAVD 88 and high height there with NAVD 88 that only applies to the states Alaska. There are the island datum as we just had a nice presentation from Ed Carlson. I can't tell you the number of times I've seen requests for proposals for surveying and mapping from many federal agencies that are having for NAVD 88 in the island areas whether it's Hawaii or Puerto Rico or the virgin islands and it never existed. So understanding that is critically important. The new vertical datum 22, which will now have an Epoch, Epochs are going to be kind of new for many people outside of places like Louisiana or the gulf coast. Obviously the national tidal data Epochs that are existing out there. I will show you an example of one of those in a moment. The units of measure, these are changing. Meters or two different feet that are used in the United States, particularly for the use of state plane coordinates that again Stephen mentioned. The vast majority of users of the national spatial reference system and other data in most states are actually using state plane coordinates and as of right now they can be in either what is referred to as the U.S. survey foot or the international foot with the new datums from NGS, the U.S. survey foot goes away, everything will be the international foot. They can be significantly different, as much as 10 or 15 feet. You need to know that. With heights it's usually not a problem. The accuracy of data. How good is it really. I can't tell you, I'm going to show you the amount of data I have seen over the last 30 to 40 years that have been collected by so many professionals that you look at it and it might be out to X number of decimal places with nothing with accuracy. The number of digits have nothing to do with accuracy. How good is it really? How is the data collected? How is it processed? All of these things go into understanding the accuracy of these data which is so vitally important to understanding the structure of our geodetic datums. Geodetic and tidal datums. I want to share with you now just a couple of examples of what I refer to as bad metadata. I literally have hundreds of these that I've collected over the years. These are just two that I often share when I'm giving presentations to surveyors and engineers. Hopefully it will get the point across and goes to the heart of what I think nic was talking about. So here are two separate pieces. These two are not related to one another. They are from two separate documents. The one at the top is from a surveyor's plat that was actually done for a NOAA office in the state of Washington. It was done for the office of coastal management. They had asked a surveyor to come in and provide some survey marks in the coastal -- you know, small coastal area to look at changes in the impacts of sea level change. What you see here are the permanent or semipermanent at least data elements for the points that could combat the NOAA

office could use to come back time after time after time to see how things were changing. Of all of that good data, I know the surveyor who performed the work, he's a very good professional, but he gives almost no metadata other than he puts in MLLW, the heights are mean lower low water. Okay. That's fine. We have coordinates. He shares no information about what datum they're on. They look like U.S. state plain coordinates but he doesn't provide that. If they are -- obviously if it is mean lower low water, okay, that's fine. New hires no tidal datum Epoch there. Which station were they derived from. When I looked at this data and I looked at the accuracy I checked out the closest tide station, it's about 7 miles away. How is that data transferred? Did he level over to it? Did he perform GNSS? I know the answer but none of that information is available. Over time this data gets used for multiple other activities that we are perhaps never even intended originally. Essentially to me other than the relative sense from one point to the next within the context of that area it's pretty much worthless data. At the bottom highlighted in blue regrettably comes from FEMA. This was for the U.S. virgin islands. They produced a set of tide maps for the three islands, three major islands of the U.S., virgin islands, saint Thomas, saint Croix and Saint John. There was no data, we were working on it. When they shared with me the data I'm not going to go through and pick out each point because that's a whole other issue to deal with, I'm just using one example, one benchmark, one quote benchmark, unquote, I pulled out. You see the height. It's up to four places in height. Just so everybody understands, a change of one in the fourth place is three tenths oh of a millimeter. That's only slighter larger than the width of a human hair. There's nothing there that says how good that height is really. How is it derived? I'm pretty sure I know how it was but I don't have a full report on it. It says that the heights are local tidal. Okay. Fine I suppose. But there are three islands. Saint Thomas, saint Croix, Saint John. Which island? Are they individual for each island? Which tide gauge was used? Fortunately there are not many tide gauges out there. When you say local tidal, which tidal datum? It could mean low, high water. There's nothing there. There's nothing there from the national -- which tidal datum Epoch was used. So the -- and the positional methodology is totally void. Relying on in information can be very skeptical. So I put these in as just examples that are out there and regrettably there are far too many of these as we look at much of the data that is prevalent in our user community. So anyone who is on this presentation needs to be attentive to these kinds of issues when you're either working with other federal, state, local government agencies, communities. However that works for you. Please pay attention to that. I'm so glad metadata has been raised so many times here. I'm close to --

>> I don't want to cut you off but we are kind of over time. So if you could wrap up.

>> Okay. I'm wrapping up right now.

>> Awesome. Thank you.

>> So really the end of my presentation -- and virtually all of my presentations when I'm giving something somewhere good coordination begins with good coordinates and without that you basically have nothing. That's really the end of where I am. I think Dan Martin is available but I don't think he has a particular presentation. Hello?

>> Correct, yes. We're still here, Dave. I think we have about 6 or 7 minutes for questions if there are any questions. Then I will move into wrap up for the day. Is Galen available for questions?

>> Yep, I'm here. Just trying to unmute myself. So we have a couple of comments here that I'll go through. We have time if anybody wants to throw anymore questions into the -- in there. So I will say folks who have been asking about the recording of the presentations and the question and answers from these -- that have been going on here, those will be made available, the recording will be on the co-ops website. The questions and answers and such will be distributed to participants. So worry not. I've got a comment here from Allen Johnson from FEMA region 6. Says great information, Nicole. This 18 foot issue is exactly why FEMA is getting away from in or out for insurance rating. However agree that if rerated Fred would be required to carry flood insurance. Nick responded, yes, Allen, getting away from in or out helps a ton. Every millimeter matters in ensuring the best available information is in any type of flood insurance rate maps as elevation surfaces are combined with past event data, flood models, et cetera. Bottom line, we can't afford to ignore the Epoch. Nick goes onto provide a link in the chat there that y'all can see to the new white house state of the science report which has a notable call out for the importance of datum Epochs. Especially in areas of vertical land motion. So check out that link that Nic provided there. That is what we have for questions and comments at the moment.

>> All right.

Well, I think that means I can move into closing remarks. Is that right?

>> Christine?

>> So --

>> It was my --

>> So there was one question that we had held over for Jim to talk a look at. So if we have a couple of minutes we may want to do that. Sorry, this is Dan Martin. I know you can't see who this was. The other thing that I just wanted to bring up as a closing remark, I think Dave's presentation was very appropriate way to close out today's session, is that -- literally if you listen to any of the presentations today you can pick up on, you know, a handful of common themes, didn't matter who was presenting or what particular item they were presenting on. The critical importance

of the metadata which we've ignored for so long in the geospatial industry and how important that is today. Also I think the relationships of the datums and interdatums that we work with that we've also kind of ignored. We can say I'm in low, low water or I'm in NABD 88 and your project may have a component that is particularly important to or relies on the rise and fall of sea level or those types of things. So we're basing our project on one datum irrespective of what is actually forcing the change in the area. Right. So these interrelationships between the datums becomes very important when we talk about project planning and preservation of works. So I just want to kind of throw that out as an observation. Yeah, we have a few minutes so maybe Jim -- that question to Jim could be a good thing to do.

>> Excellent. Thanks, Dan. Nice summary there. So Jim, do we have you on the line?

>> Yep, I'm here.

>> Excellent. All right.

So Paul asked earlier about, you know, whether Army corps updates projects when the datums are updated. So I'll read his question directly here. As vertical datums are updated are projects being reviewed for rational impacts? For example project depths for dredging may have windfalls and company or taxpayer burden. Dredged channels and basins may be based on past industry uses that has ceased for decades. Will Army corps update project definitions so unnecessary dredging is not performed?

>> Yeah, you know, the short answer to that is yes. The longer complicated answer gets complicated. For the most part, the issue we deal with is when things go through Congress and things are dedicated to a specific thing so we're trying to move away from is trying to make sure that we address that when that information goes up to Congress to be, you know, approved for a particular depth of water for a particular project or things like that. So those things are being addressed. In our policy we specifically address those issues and address those. So, yes, districts are supposed to be addressing those as they go through. You know, feel free to reach out to me and I can provide a much more detailed, you know, response if need be.

>> Great. Thanks, Jim.

>> Yep.

>> Paul, I hope that answered your question there. And it appears to me that we've addressed all the questions that I can see. So --

>> All right

>> -- I'll turn it back to you.

>> Wonderful. Perfect times. Thank you everybody. To wrap up, on behalf of NOAA and our presenters here today we would like to thank you very much, each and every one of your for participating. Thank you to the audience for questions and

comments. It helps us understand how we better serve you as we roll out these datum updates. I really want to thank our presenters again through their great presentations. We've heard how vital to have access tidal datum and understand the changes that will be expected with NTDE update. We heard a broad change of topics really from understanding how historic relationships with datums play a role on upcoming NTDE updates, understanding how tools are being developed more consistently to gather data and we're really looking forward to get multiple perspectives on how datums are being used by agencies and organizations around the country. With that, we will take any -- we will look through the questions one more time and see if there's anything, questions or comments that we missed and put that into consideration going forward. We do plan to generate a document of questions posed and will send it to you once it's completed. Please share this information with other stakeholders. We plan to have on going out reach and possible another workshop in the near future to continue these conversations. Also this come up a couple of times today. Please do consider joining us tomorrow for the second day of the workshop on the international great lakes datum and the low water datum. The day begins at 9:00 a.m. eastern tomorrow morning. So thank you again for participating. Please reach out to us if you have any further questions, concerns or input. Thanks everybody.