DINO LUSTRI: Good afternoon, everybody, and thanks for attending the Hydraulics and Hydrology Water Resources Tools in your Infrastructure Suites. My name is Dino Lustri. I'm a licensed engineer and surveyor in Ohio and in Florida. I'm also heavily involved in surveying, a member or a past president of PLSO, Professional Land Surveyors of Ohio.

My history, my experience is water resources, I've pretty much used every model that's out there in the last 25 years. I am very involved with it, another hat I wear is a professional witness in court. So a lot of what I'm going to show you today is rooted in trying to defend yourself. So this class is a high overview of the tools that are in Autodesk products. But it's also kind of some wisdom based on lawsuits that I've been involved with to try and tell you that there's a right program or a right application to use for certain tasks.

You don't want to show up with the rational method, when somebody else is showing up with the SWMM model. So add to that, I'm just going to dive right into it. I'm going to bore a little bit. I know it's after lunch, but I'm going to take you down a notch with boring PowerPoint. And then after I give you kind of the background and everything, I'm going to dive into examples, and try and give you a feel for everything. So the majority of this hour is going to be actual demonstration. But I have to start here.

So the class summary is in there. I'm not going to read it to you. The goal of today is to familiarize you with the H&H tools included in the Autodesk Infrastructure Suites. At the end of the class today, you should be able to describe which tools are available in the different suites, and determine which tool will best suit the requirements being asked of you.

You can decide if you can terminate any of the competitive applications you may have, Haestad Methods, all those. I've used those as well. And quite honestly right now, I only own the Infrastructure Design Suite Premium, Autodesk Vehicle Tracking and that's it. Those two packages are what I use in my day-to-day consulting world. That's my home business versus the airport, some tips and tricks for general hydraulics and hydrology efforts, things I like to use and the software I'm going to share with you as well today. So let's start with where these tools came from.

There's a lot of legacy tools from Land Desktop, DCA, Softdesk, all those old versions of civil-flavored Autodesk software. But somewhat recently 5-6, maybe 7 years ago, Autodesk

acquired the assets of Intellisolve. That's Hydrographs, Storm Sewers and Express. I was lucky, because I used it before Autodesk acquired it. So I had some history with it before they got it. And it's still in there now. So it's a nice thing.

Boss International sold three of their assets to Autodesk a couple years later. RiverCAD is called River Analysis now. And I have some good news. So actually my class is a little dated. River Analysis used to be only available in the Ultimate Suite. Now anybody with Civil 3D, who's on subscription that's not even the suite by the way, not the Premium Suite, but just Civil 3D with subscription has access to River Analysis now. So you just need to go to your application manager and get online and download it and add it.

StormNET is now what we call SSA, Storm and Sanitary Analysis, which is synonymous with the SWMM model, SWMM Stormwater Management Model. And finally Water Network Technologies that was acquired but it has still not been released. So we're not quite sure where and when that's going to happen.

So I'm going to start off with Express Tools. What Express Tools gives you are hydraulic calculators. They're very simple. You enter the variables that you have, and it spits out an answer. It's that straightforward. So some of the equations that are used in culverts is the Bernoulli's energy equation. But it uses Manning's to determine head losses due to pipe friction.

There's the equation for it. And by the way, everything I'm going to show you today is in the handout. So there's no real reason to write anything down. Furthermore, in case you haven't already, this manual that I have here, I wrote or put together about five years ago. It's aged, or the screen captures are from older versions. But quite frankly, it still applies today. The reason I put this together, for those of you who tried to learn this software, there aren't any really good resources for you to learn the steps to accomplish a task.

There's a tremendous amount of information having to do with reference material. So there's like a 500-page SSA manual in there. But there's nothing in there that tells you, do this, do this, do this, do this. So this is a collection of examples that I've accumulated with the help of Autodesk, and of course personal experiences. I've littered all kinds of things that I like to do in it, like equations or expressions.

So if you like to label a pipe, and it has the flow capacity showing when it's in Civil 3D, I have a

real good exercise in here that you can mimic. I've given you all the CAD and data files and everything else as well. So that's all part of the handouts that you have, including this PowerPoint.

So channels, it uses the Manning's equation to compute the Q's at varying depths of flow. That's very simply the Manning's equation. It's an iterative procedure. So what's positive about this is that you can find out the capacity of a swale or a ditch at varying depths. And that's pretty handy. It's good to print that out, shove it in the file so you have proof as to why you're moving forward a certain way.

Inlets utilizes HEC-22. And there's different equations for on sag and on grade. By the way, all of these equations can be found in the help files as well of the related software. But I thought putting these all together in one source for you would make it easier for you to compare with other applications you have to it.

Now I have this little animation here. Not because that specific detail is important, but because I want to emphasize to anybody who does this kind of work. It's our responsibility to know the limits of the equations that are in the software. It's not Autodesk's responsibility. We need to know when we can use one equation over another. That particular slotted inlet equation will only work if your Q is less than 5 and 1/2 cfs, and the slope is less than 0.09. Who knows that? Unless you do the research, you won't. And then of course, if there's a litigation involved, you'll get a rude awakening when that comes up.

Hydrology, now this component lies in the Express Tools. But I'm outright tell you that I don't think you should bother with this, mainly because Hydrographs is in there. So why use this if Hydrographs is there? Having said that, these are the equations that are used in it.

And then we go to weirs, again HEC-22 and of course Richard French's *Open Channel Hydraulics,* which anybody who's taken civil college has probably had a copy of. And those are the equations for the various shapes that you see there, weir shapes. If you have anything more complex than what you're seeing up there, my recommendation is to use SSA for it. SSA gives you the flexibility to do some really unique shaped weir.

Now here's my first tip. For the Express Tools, if you are always editing the variables, the defaults that are in that software when you're doing an exercise or doing an analysis, there is an Express.ini file. It's a text file. It's located in that path, of course, with your name or your username in that spot. You can edit the file and assign your variables for your area or what

your defaults should be. And then you don't have to do it every single time when you're using the software.

Hydrographs, the second package acquired from Intellisolve. And here is a list of hydrology applications or equations or different types, I guess, to be used. TR-55, TR-20 are probably the most prevalent. Here is the-- it's the unit hydrograph method. It uses TR-20. Now I have an animation here again. Again, not because of that one is specifically important, but to emphasize that we need to know if 484 make sense where we live, or where we're doing the analysis.

So mountainous is 600. Swampy is 300. What number should you pick in there? That's up to you. That's something you need to research and find a comfort, and know it defaults to 484. And you'd be surprised how many people just move right through the software and do an analysis with that number. That's all fine if nothing bad happens. But I hope nobody gets into litigation.

The third package of software is Storm Sewers. Storm Sewers uses the Bernoulli equation and there's a component here that I find to be a very important item to bring to everybody's attention. It uses the Manning's equation to determine head losses due to pipe friction. What this means is that this particular tool is good for sizing of sewers, peak flow analysis, not analyzing an existing system that's at varying depths of flow. That's not how this one works.

For that matter, the majority of your other softwares that you have are like this. They're not-- and we'll get to it here in a moment-- they're not analyzing the pipes at varying degrees of depth. They're not analyzing the pipe for surcharge events, where the hydraulic grade line spikes. That's not what an analysis is all about. This is for sizing a pipe, and this is what it's good for.

Even though there are words in the software that says analysis, enhanced modeling analysis, don't let that fool you. There's no analysis going on. It's a sizing. It's a peak flow design.

So here's a tip for that. So in Storm Sewers, when you finally enter all your data and you have the four analysis options-- I'm going to use the word-- there is one called EMS, Enhanced Modeling System. What you need to know about that particular option is that you need to run it three times. Because the first time you run it, you'll get an answer over here. The next time you run it, it'll be over here. The next time it'll be here. So as you keep running it, it converges to an answer.

Now it's supposed to happen in the background within the software. But this is my way of saying you prove it to yourself. Find that comfort level. Run it a couple times and see if the answer changes. There's a lot more of this in the help file. So if in doubt, please pursue it to find out how it's working.

Now we come to the big one, Storm and Sanitary Analysis. Storm and Sanitary Analysis can do anything that I've just shown you that those other packages can do. It can do all of it. I'm going to get to that more in a little bit.

So here's the hydrology modeling capabilities. You've got TR-55, TR-20, and the wide range of others. That's not really as big of a deal as this, the hydraulic modeling capabilities.

Kinematic Wave and Steady Flow are the standards. Kinematic Wave is what's in Storm Sewers. Kinematic Wave and Steady Flow is what's available in most of the other softwares you probably own, like Haestad methods, FlowMaster-- I can't remember the others anymore. But the majority of software out there utilizes those first two.

The one that's a big deal is Hydrodynamic, the Saint-Venant equations. Now there was a time when I knew how to do differential equations, and that is long past. So I tried to learn it or relearn it, so that I can give you some insight into how those equations work. But unfortunately there's just not enough time left in the day for that. So to that end, I have a lot of papers that-- or a lot of thesis that were written on this topic. If anybody wants them, reach out.

But bottom line is, what does Saint-Venant do for you? It models the channels in reverse. So that if you have a surcharge event, or the flow reverses direction, it models it properly. That's a big, big deal. So right off the bat here the hydraulic modeling can do storm sewers, sanitary and combined, open channels, streams.

By the way I learned that FEMA will accept the SWMM model, which is SSA, to model floodplains. I do not have that document for you. It did come from somebody I trust. But I'm going to say if you're interested in pursuing that, look into that information. Open channels, steams, bridges and culverts, curb and gutter drain inlets, detention ponds. Now we have Hydrographs Why use this one?

Hydrographs is good for simple pond design, simple. If you have cascading ponds, ponds in a series, ponds in a parallel, if you have any kind of a unique situation you should probably go

this direction to SSA, force mains and flood overflow routing. So in summary, Kinematic Wave and Steady Flow cannot model backwater. It's similar to Storm Sewers, and all it shows you is hydraulic grade line spikes. That's it.

That's OK if all you're doing is sizing a sewer. That's perfectly fine. Hydrodynamic, however, can model backwater effects, flow reversal, surcharging, looped connections, pressure, tidal, interconnected ponds. That's incredibly important. So oftentimes when people contact me about issues they're having with SSA is they're running their model in those first two, Kinematic Wave and Steady Flow, and they're getting weird results. And then it's simply changing the toggle to Hydrodynamic, and all of a sudden things start making sense again. There's a lot more to it than that but that's oftentimes the issue.

So in SSA, the equations used for open channel and partially filled is Manning's. For Steady Flow and Kinematic, the slope is the pipe slope. That's again, a very important part. For Hydrodynamic, it is the friction slope. That's a big, big deal. And I can't explain it in the class, but something you should research and get familiar with.

For pressurized systems, Hazen-Williams or Darcy-Weisbach replace Manning's. Now let's be clear. It's not for potable water systems. I don't recommend you use SWMM for a potable water pressure pipes type system. It's not intended to do it. In theory, some of the equations are applicable. But I don't recommend it.

So now in a grand summary here, why should you use the other packages? I just presented to you four packages of software, Storm Sewers, Express and Hydrographs, and then SSA. So why don't you just use SSA all the time? Well because it's overkill. It takes a lot of time to enter all that data. And quite frankly if all you're being tasked to do is, let's say a cul-de-sac, and you need to do the storm sewer and you're sizing a pipe, Storm Sewers is the way to go. To that end, the reason why-- which I will be showing you here in the demonstration-- is the interactive Peak Flow design. Hydrographs and Storm Sewers has a real nifty screen, which I will show you that makes it really easy for you to see the immediate results when you make tweaks to the model or to the design.

So it really depends on what you're being asked to do. If whoever's giving you the direction, mentions the word analysis, for example, if a city engineer says, I want to know how your proposed improvements are going to affect our existing system, SSA, SWMM. You're submitting a set of improvement plans to a city and it's a new storm system and you just need

to prove that its sized to the 10-year or 25-year, whatever it is you're required, Storm Sewers. These are the things that you need to be aware of.

So I'm not going to go into detail on River Analysis. Because that's literally a whole other class. But it's HEC-RAS with benefits. It takes advantage of all the terrain tools in Civil 3D. So to be clear, HEC-RAS is something you can download for free from the Army Corps website. And the engine that's in River Analysis is HEC-RAS. So it's the equivalent, identical model. It's just you get the benefit of all the tools that are in Civil 3D.

Does anybody here do floodplains? All right. You know how hard it is to make cross sections and to get them in the right direction, and to get all the proper information into those sections? This takes that out of the mix. This makes it tremendously easier to do. And now in the past classes, I used to have to tell people you'd have to pay to buy it in the Ultimate Suite. Now you own it. If you guys have Civil 3D, and you're on subscription, you now own River Analysis.

So we're going to dig and dive right into some demonstrations here today. I'm going to start with showing you where these tools are. So in Civil 3D, on the Analyze tab, on the Design Panel, here is Storm Sewers, Hydrographs, Express, and then there's a nifty tool called Stage Storage which helps you extract pond volumes based on elevations. It's really handy. And in my manual I have exact steps to follow to utilize it.

I'm going to launch Hydrographs as a start. And because I don't do this too often anymore, I don't want to mess up the actual steps or put the wrong variables in as I go. So right off the bat I'm going to add a hydrograph. I'm going to go to SCS. I'm going to call Preconditions. It's going to be 10 acres.

And curve number, here's a nifty thing. There's a little magnifying glass there. It brings up table 2-2-- I can never remember it-- c, I believe it is, from the TR-55 manual, the CN values that we always have to look up. So it's right there handy for when you have to do it. There's also a composite curve number generator. So if I do 2 acres at 98, which is impervious; and 8 acres at-- and this is what I need to remember just so the numbers come out right-- I believe I used 80. And if I didn't, we'll get through it.

So therein lies some information there. Now here's TR-55. I'm not going to do TR-55 here, because it takes a little bit of time. But there's your sheet flow, shallow concentrated, and of course, channel. I do want to bring this to your attention. You see that 300 feet maximum for sheet flow? I've used that for years to extend my time and concentration to make it last longer,

so I'd have better results, right? Nowadays 100 feet is the requirement or the maximum that you're permitted to use. Again, this is an item you should be aware of. You need to be aware of it. Just because the software says 300 foot max, doesn't mean you're allowed to do that.

AUDIENCE: Who determined that?

DINO LUSTRI: That was studied by Army Corps, I believe. No, let's see.

AUDIENCE: SCS.

DINO LUSTRI: Thank you, SCS. You're right.

AUDIENCE: Paper 28, I think.

DINO LUSTRI: And that-- great. I should have that for you, and I didn't have that. But thanks. Which paper was that again?

AUDIENCE: I think it was 28, but I could be wrong.

DINO LUSTRI: OK. 28.

AUDIENCE: It's 20-something.

DINO LUSTRI: Thank you. So I'm going to cheat a little bit here. I'm going to go to User, and I'm going to do Time of Concentration, and type in 60 minutes just for the sake of getting us through. Now from where I live, I'm in the west side of Cleveland in Ohio. Were dead flat. But we're also a type 2 storm distribution in my area. The majority of the United States is a type 2. If you're out on the edges all the way from Seattle, all the way to Florida, basically there's a different distribution for you. So you've got to know which one it is.

There's that 484 number I referred to earlier. Again, something you need to be aware of and familiar with. I click OK. I accept it, and now I have a hydrograph. I'm simply going to copy it and paste it. So I have an identical hydrograph. I'm going to double-click on it, and I'm going to type in post, for post-construction.

I'm going to go to-- let's see-- 90 as my CN. And my time of concentration is going to go down to 35 minutes. OK. Exit. I now have two hydrographs, simply existing conditions, pre-construction, post-construction.

Now I forgot to mention this button, Precipitation. Here's your SCS 24-hour precipitation in

inches. And you can enter whatever numbers you want in there, based on whichever rainfall data you're going to use. You can save it and share it amongst the rest of your designers in your office. So you don't have to enter this information every time. But it's that easy, and it's that available.

So now we're going to move over to ponds. But really quick before I do that, does anybody in here-- has anybody ever heard of the critical storm method? No? Wow. It must be only a Midwest or an Ohio thing, apparently. Basically all that means is if you're designing a detention basin, all the storms up to the critical storm need to be held back to the one-year pre-development outflow. So there's an equation in here, if you're interested in it.

But ultimately I'm going to say we're going to design for a five-year critical storm. So I'm going to start with a pond. And I'm going to type in a name for it. And then I'm going to type in an elevation. And I'm going to hit Apply. I'm just going to fake some contour data in here. And by the way, there's no connection between Civil 3D and Hydrographs. So if you do staged storage in Civil 3D, you can't export that in any way to Hydrographs. You can, however, export it to SSA. It's got a really unusual ending to the file name. I think it's aecc_sst.

And if you do a staged discharge effort in Civil 3D, you can bring that right into SSA. This, unfortunately, we have to do manually. So I'm going to do this just a couple more times. And then I'm going to emphasize to you how bad it would be if I were to go click on one of those tabs right now. I'd lose all this effort that I just did. So hidden down here in the bottom right is the Done button.

You hit that button then it saves the information. It's stored. So don't forget that. I've done that and followed up with some very creative words afterwards.

Now we go to Outlets. Now the thing with outlets is you need to know what all these columns mean. And in the manual and in the help file, there's this exhibit that tells you exactly what they are. So very briefly letter A here represents the pipe that exits or leaves your outlet structure. So whatever structure it is you're designing, the pipe that takes the flow away from it, that's A. So for our purposes, we're going to make it an 18-inch, one barrel, and it's going to be at 100. And it's could be 50 feet long at 1%.

Now B, what's B? I'm assuming everybody here has to deal with water quality at some point. So B can be your water quality orifice. So this could be a 2-inch, let's say. And the elevation of

that is 100.1. And C can be your detention orifice. And if I recall the elevation of that one it's 101.6.

Now here's a part that I missed when I started using Intellisolve over a decade ago, 15 years ago. Multistage, you must set this to Yes if you want these to act simultaneously. What this means is if the flow starts to fill in the pond, and the 2-inch orifice starts to let it go, then it rises up to the 101.6, the 6-inch. As soon as it hits that, if you don't have this set to Yes, the flow that exits the 2-inch will stop. And you'll only get flow exiting the 6-inch. That's not real.

So why is this in here? There are a lot of engineers out there, reviewing engineers, that have been doing this for a while that want you to oversize your pond. So if you set these to No, your pond is going to be bigger than it really needs to be. Bottom line is I've been required to have that set to No. I disagree with it. But at the end of the day, it costs money is what it boils down to.

Now over here we have a weir. So let's call it the-- if all hell breaks loose the water has to spill out and you need to get rid of it. So the crest elevation that I'm going to use is 105. And the length is 10 feet. And here again is Multistage. Now the weirs default to Yes, which makes sense. It's going to be leaving the 6-inch and overflowing at the same time.

So before you click on any other button, don't forget to hit this Compute button right here. If you don't hit that, you lose your work. So now we made it through. And we're going to go to the pond tools. Let me just check something real quick. I made the mistake yesterday of not entering a number, and I don't want to repeat it.

So that's the curve of your pond outflow based on the criteria we just gave it a couple seconds ago. Now here's what I like about it. This little dialogue right here gives you the ability to show the target line. So remember what I said. We're going to do a five-year critical storm. So I'm typing in the 3.157 Q cfs, from the one-year existing runoff. And I'm going to do that for every storm up to and including the five-year.

Then I'm going to match the pre-construction conditions by just typing in the exact same cfs that was permitted. I'm sorry I can't type and talk, apparently. I need 361. And then I'm going to switch this back to post, And hit Estimate Storage. So what you're seeing on the screen now on that graph is the green line is your target line. That's what you're permitted to let go. The blue is the Q that you're actually letting go.

So what I'd like to show you, now this is why I think Hydrographs is better than SSA for simple pond design is what I'm about to show you right now. Down here in this bottom corner, this interactive dialogue down here, I just moved the interactive slider up to half. So I'm going to move in half increments. I'm going to pick the C orifice, which is the 6-inch, and I'm going to start making it bigger.

As you notice, the blue line is moving towards the green line. Now I just got to an 8-inch diameter, if I go to 8 and 1/2, which I'm not aware of that pipe, anywhere but if I go to an 8 and 1/2, I'm really close. But I'm going to go back to 8, just to give me a little cushion. What this means is you don't want to make that blue line go past the green line. If you do, you're releasing flow at a greater rate than you're permitted, based on your design.

Similarly, I'm going to go to the weir, and I'm going to lower the crest elevation from 105 in half-foot increments. Now you see I crossed the green line. So at this point I would be letting more flow go than I'm permitted when it starts to top the pond. So I'll raise that back up a little. And now, so what you're doing is you're moving that blue line as close as you can to the green line. And what that does is optimizes the size of your pond. You don't need to build more pond if you can make this work.

This is the reason why I like Hydrographs for simple pond design. If you try to do this in SSA, you're going to have to look at the results that you've done the first time, make changes, perform analysis, look at the results again, make changes, perform analysis. You're going to have to do those steps over and over again, and enter quite a bit more data than I did here.

It works. It'll work. I just don't think that's a good use of your time, if all you're doing is sizing a pond. If you're analyzing how a pond works in the greater system, SSA. If you're sizing ponds, and this is your only purpose and you need to generate a report so you could submit it to a reviewing engineer, this is perfectly good. And I've been using this for over 15 years, and haven't had any issues so far.

OK. So that's Hydrographs. I'm going to skip over now to Storm Sewers. And Storm Sewers is launched from inside Civil 3D, or well-- now at this point, it's only inside-- Utility Design. Again, you have all of these drawings and all the data files, you have this as part of the handouts. I purposely brought in an old file. Because I want to emphasize to the importance of this dialogue right here.

Autodesk changed the programming language from VBA to .NET a couple releases ago. All of

the stormwater management tools are heavily dependent on .NET. If you don't make this conversion, you are going to get mistakes. You are going to have issues. All right? So it's very important that any old drawings that have pipe networks in them that you do this conversion. Not only do you have to do the conversion, you have to save the drawing, and you have to do audits. Audit, audit, audit in Civil 3D. Make sure you're OK.

And so now I have a drawing. And I have a pipe network here. It's kind of hard to see. But it's this aqua-colored, with an outlet to the pond, et cetera, et cetera. Now I'm going to go a little old school. I'm going to export this to an STM file. All you have to do really is click on it, and up in the contextual ribbon you have the option of going to Storm Sewers or going to SSA. And it'll bring this model straight into it.

I kind of like to show this, just to give you an idea of what you're dealing with. So under Pipe Networks, there's the pipe network. Right-click Export to Storm Sewers, and I'm going to shove this on the desktop as 123, Save. And now I'm going to launch Storm Sewers. So obviously you could have done that in a fell swoop just by going off the ribbon. I just like to show this the other way.

So I'm going to open the STM file that I just exported, and there it is. Now to that end, we have a lot of data that we got to enter in here in order to make this work. And I'm going to cheat a little bit. And I'm going to put just some 1 cfs in here. The drainage areas are 0.5, the C factor 0.65.

And I'm going to give you some humor here in a second. Check out the n value. For those of you who can't see that, that's 10. That means the water evaporates the second it hits the pipe. So what we do there is we change it to 0.013. We'll do that quickly here. I don't know. You might use 0.012 in your neck of the woods.

Now again, here's a little trap. If you don't click this hidden check box, OK in the bottom right, you're going to lose all the edits you just did. So please remember to do that. I clicked OK. Now I go to Run, and here's the screen. I mentioned the four types of analyses that you can do, calculations.

I hate using that word, but that's what they use here. So here's Analysis with Design. There's the Enhanced Modeling System I referred to earlier that you have to run three times, Full Design and Capacity Only. Now personally I'm on the west side of Cleveland. We're flat. I have to dictate what the inverts are, and then I have the size of the pipe accordingly. There's no

choice when it comes to that. So I really only use this for capacity. I only use this to size pipe.

Having said that, I'm going to show you Analysis with Design. And I'm going to get a little bit of an error there, but ultimately I'll get the screen. So I wish I could make this bigger. But if I drag that out, it doesn't exactly grow.

So what you're seeing here, the red line represents the hydraulic grade line, which is great to see there. Here's that slider again. This is the interactive nature of this dialogue, which is why I'm pushing you to consider this for simple design, for peak flow design. So right now I want to take this invert and raise it up. So I highlight the up invert, and I'm going to move it up in half-foot increments. No problem.

I want to take the 18-inch, and make it a 24-inch, no problem. I want to go upstream. This is the next leg up. Now the inverts aren't matching there. I could have brought this other invert up a little further. But I'm going to go all the way upstream and show you this one here. Now there's all kinds of things you can do. I mean I can raise the whole entire pipe up. I can bring it down. I can go to the upstream invert and purposely-- I'm doing that to show you how the hydraulic grade line reacts immediately to me messing with the model.

This is why I like it. You get the immediate results. You get to see it work. The second you're done, you can export this back into Civil 3D. So to that end, by the way, you can turn on the energy grade line, which is right here. I know you can't see it. It's a dotted black-and-white dotted line across the screen.

Here's a neat button. You can omit the weird pipe sizes, 21, 27 and 33. So they're not even considered. Little things like that are in here, and they're nice. But ultimately that's what I wanted to show you about storm sewers. So now I'm going to switch back to Civil 3D in order to give you a couple tools and things that are in Civil 3D that I find to be really useful.

When you click on the surface, everybody knows that a Civil 3D surface is one entity, and it highlights. So I'm going to go mess with the style. And I'm going to break a rule. I'm not going to use the style. I'm just going to mess with one that's currently active. And so what you're seeing now represents watershed areas. It's as simple as a style.

Now there's a lot of-- I call mistakes on this, because the surface was generated from contours. And whenever you have that, you've got to do some cleanup. Unless you have points that you can augment this with, you're going to have to do the cleanup. Now we don't

have enough time today for me to show you how to clean it up. But ultimately it's a pretty fairly simple process.

Now one of the things that I would like to show you is a command that's been in the software for a long time. But the people who use it, it's like you play with it for five seconds, and then that was nice. Now move on. It's the water drop. So what's the purpose of the water drop?

So as you see me clicking like a mad person here in this watershed, and then going to these other watersheds, you're getting the general idea that it works really well. That's where the green lines are actually represented very well. What's the point? So what did I do by polluting my drawing with all these cyan lines right now?

It's for the next command you're going to use, the Catchment Area command. When you click on that button, if I go and click somewhere-- I'm trying to get a spot there-- I just got a useless watershed. That thing is meaningless. It does nothing for me. However if I go click to this water drop line and pick, I just got a very accurate representation of the area that flows to that location. So water drop is the first step to you doing a catchment, which helps quite a bit.

Now this is me getting on a soapbox again. Don't use layer commands when you're doing Civil 3D efforts. Use Styles. Use the controls that are meant to be used for Civil 3D. And what I mean by that is if I want to erase all these cyan lines right now, don't do a layer isolate, or try to and use it that way. Click on one of them, right mouse click, and hit Select Similar. Then hit Delete. Click on the one item, right-click, select Similar. I only had one there, and hit Delete. No there's COGO points that come in as part of this. Don't do that on that one. The COGO points will all go away.

Now I'd like to show you, though that these watersheds areas are on here. But when you click on it, you see everything highlight? Well, what if I only want this watershed and say this watershed? Well there's a nifty little tool up here called Extract from Surface. So I'm going to Extract Objects. I don't want the border. I don't want all of them. So I'm going to Select from Drawing, pick it. And now I'm going to pick this one, and this one.

Now you're not going to see much of a change. Because the Style is still turned on. So what I'm going to do is I'm going to click on this, and change the style to none or no display. And those are the resulting polylines that came up. Now I'm going to break a cardinal rule again, just for the sake of clarity, and move the resulting lines out into an open area there.

Now in the past when we wanted to get this entire area as one area, we used to have to play the trim game. You'd trim out the lines in the middle, and then you did polyline edit, and you joined the lines together. And that takes some time. So what I'm going to show you is an undocumented command called Linework Shrinkwrap. If you type linework at the command line, there's going to be a list of eight or so linework commands. They're undocumented. So I really can't tell you what they do. But this one I can tell you what it does, because I use it all the time and I love it.

Linework Shrinkwrap allows you to envelop an area. And when I hit Enter, it creates a closed loop of an area. This is very handy.

AUDIENCE: [INAUDIBLE]

DINO LUSTRI: Civil 3D. I can tell you that this command is used when you're doing corridor models, and you're doing-- it's used in the background when you're doing a boundary on your corridor model to generate a surface. It's really important. But it's there. So we can use it for whatever we want.

Now those other linework commands, if you figure out what they do, please tell me. I'd love to know.

AUDIENCE: [INAUDIBLE]

DINO LUSTRI: That is. And I can list it. And I can get an area, which is right there. So that's handy. Now part of that, I'll show you another one. I want to know what this area, this area, and this area is. So I'm going to do a command called BPOLY. Now BPOLY is the exact same command as boundary, which is the exact same command that when you launch the hatch command, it launches-- it's the first step in the hatch command. In order to create a hatch, it makes a boundary, whether you know it or not. It's in there. But BPOLY boundary are the same command.

So when I click Pick Points, and I take here, here, and here, and then I move the original star out of the way, these are all individual closed polylines of those areas. Now I use my up arrow key to cycle back to Linework Shrinkwrap, because I hate typing it. And I window it. And now I have the enclosed area for the entire part. This is really handy when you're doing quantity takeoffs of pavements areas, seating. But those couple commands are really handy, and I hope you find them to be as useful for you.

AUDIENCE: [INAUDIBLE]

DINO LUSTRI: Yes it is, it better be. So I showed you Linework Shrinkwrap, BPOLY. Now we're going to go to-- I made a mistake. I should've launched SSA first and imported. I'm going to import a SWMM model. And whenever you bring in a SWMM model into SSA, you have to use what's called a Hot Start File. The hot start file basically tells the software, so whoever did it in SWMM put in all the settings. They did the time period from which you're analyzing. They applied all kinds of other analysis options in there. So when you export from SWMM, it generates an INP input file. And it also generates an HSF file. The HSF stands for Hot Start File.

That simply means so that you can launch it, and have the exact same settings as the original model. So it's really important that you have it. Now what I mean by made a mistake, is I should have done this before I showed you all the Civil 3D, so we didn't have to wait through it. But this shouldn't take too much longer to get through. Ultimately SSA has quite a bit of power in it. And I'm going to show you when this is finished, I'm going to try and show you the reasons that I really like it for the purpose of selling a project.

And what I mean by that is you're usually talking to laypeople and not engineers. When you're the engineer, or you're the design firm who's analyzing a situation and trying to sell a solution to a city or governing agency, usually, to that end it's incredibly hard to convince them when you show them a report with a bunch of numbers in it, and nobody gets that. I mean it's hard enough for us to read through that, let alone to give it to a council number.

So what I'm going to show you here is what I think is the best benefit. Because it'll get them to spend money. It'll get them to realize or recognize the issue, and spend the money in order to fix it. So there's going to be two things I'm going to show you here. I'm going to show you a profile view that basically will show it in a profile view. And it'll show the surcharging event as it rises in the pipe and peaks. And you'll see the limits of that.

And then the second thing I'm going to show you is the actual plan view. And I'm going to re-theme the lines that are in the plan view, so that they grow in size and change colors, based on how full the pipe are. And that's a really, really high helpful one. That's the one I like the most. So here we're rounding near the end.

Now this is a small city in South Central Ohio called the city of Washington Courthouse. The engineer was kind enough to give me this data file. Obviously they have issues. Otherwise

they wouldn't have analyzed it. So what I'm going to show you here is that profile that I just mentioned, so I click on one junction. I go Start Profile Plot, and then I go to an outfall.

If you can't tell, it's highlighted in magenta color there. And I'm going to hit Show Plot. So there you see the result. And I'm going to do an animation on it. Now by the way, you can turn off all these labels. You can zoom in, zoom out; there's a number things you can do there. But I'm going to increase the animation speed, and hit Play.

See that little Record button? You can record a little video file. So you don't have to bring this to council meetings. You can just bring a video file to show it. When I hit Play, you'll notice that the pipe starts to fill. Now this is obviously analysis over time. Now the blue lines that are at the top of all the junctions represent the peak.

Now there's a double peak there, if you just didn't notice. It went down. It subsided. Then it went back up again. That's incredibly important when you're doing an analysis of systems like this. So this is a really handy tool for you to see that. Oftentimes people who only analyze this in a table or tabular type of format, they miss the second peak, which is a big deal.

So I'm going to stop this one. And I'm going to go back to the plan view. And I'm going to Display Options. So I'm going to go to Display Options and turn off all the nodes. I'm going to make the links show based on their capacity, so how full they are. I'm going to turn on the border and the proportional to value. So the links will grow in size if they're full is what that means.

I'm going to turn off the flooding and surcharging, and I'm going to add a legend for the links. So there that legends basically 25%, 50%, 75% and 100% full with the different colors. Now right off the bat this system, without any analysis in more than half of it, is running 50% full. So right off the bat, this tells me that their system is sized somewhat inadequately.

But now here's the animation that I'm going to tell you-- this is what's going to get them to open the checkbook and to start spending money to resolve the problem. That's a smelly neighborhood, right? That is a sanitary system, by the way. There's no denying the impact that that has on even a layperson. I mean it's right there, crystal clear. And it's something that you can use to further the cause. If you're a consulting engineer, or you're a city engineer representing-- a consulting engineer representing a city, this is incredibly useful.

So now there's another tool that I'd like to show you in MAP. So for those of you who don't

know, Civil 3D has 90% of-- 90-95% of MAP in it. There's two parts that I'm going to show you today that are not in Civil 3D. And for that reason I would push you to get the Premium Suite, as opposed to just buying Civil 3D, for the purpose of why we're here, hydraulics and hydrology.

One of those items-- let me open up the drawing first. Because that's going to take a couple seconds. So this is a regular drawing. No, it's not a regular drawing. It's a drawing based off of an infrastructure model. And I'll show you what that means here in a second as soon as it comes up on the screen. It's a very simple model. But this is like a GIS right now. This is AutoCAD-based but it's GIS. It's got a lot of data. That simple bit of lines you see there has a wealth of data in them.

And what I'm going to show you is it works very much like GIS. If I zoom in, more data shows up. So that if you have an entire city on here, and you're zoomed way out, you don't get overwhelmed and your system crawls to a halt. Now that's the part I'm going to show you is under File, New. And here at the top, Industry Templates.

These are out of the box, in the software for you to start, for example, a water or wastewater, survey, gas, electric. You can start your own database for whatever area. So if you're a city, I would start here. This would be my first step. Create a new drawing based on this industry template. And then you can modify the variables that are in it. And what I mean by that is this.

So that little part right there, it's not in Civil 3D. It's only in MAP. The other part is this maintenance workspace. You can't open a maintenance workspace in Civil 3D. It's only in MAP. And the reason why that's important is when I click on this Attributes button, and I pick one of these pipes and hit enter, I get this screen.

If you have a stack of manhole stabs, invert checks, you send the surveyors out. And they measure down to the inverts. And you've got a stack of those, and you need to enter them into a database, the best way to do it is right here. And the reason why this is such a good idea is because-- let's just face it. A lot of that tedious work, you hire an intern, and you get them to start entering that data in there. And here's what happens.

For those of you who are familiar with databases, if I type capital S, capital A, capital N. And then the next time I type lowercase s, lower a, lower n, and then the next time I spell out sanitary. And the next time I do capitalize S, lower a, lower n; that's four different variables. That's not the same thing. So what you get to do here is you can actually enter what options

they have to choose. So there's no question as to what it is.

If it says SAN there, they pick SAN. And it's the same every time. This little tiny thing here, it's like data integrity. It's incredibly important that we keep our data that clean. Because otherwise it just prolongs the agony of setting up a model. So this little screen here and this functionality is only available to us in MAP. So again, this may not benefit everybody. But those of you who have to do large amounts of effort here, this will definitely bring you that.

So I'm going to revert back to our PowerPoint. And I'm going to give you a quick summary. So what software can you replace? My recommendation to you is when you get back to your office, you compare the equations that are functional in the software that Autodesk gives you, compare them to the ones you have. And if they're the same, if you're comfortable with that, I firmly believe that you can get rid of the old software. Now don't be hasty about it.

The first couple projects when you start using this, you should be comparing the answers from both, and figuring out why they're different, if they're different. That's an incredibly important part to migrating to a new analysis software. Which suites have which tools? That's an aged line. You now have all. If you have Infrastructure Premium, you have all the H&H tools.

In the past, the Ultimate Suite had River Analysis in it. But now River Analysis is in the Civil 3D with subscription. MAP has the maintenance workspace to facilitate the gathering of data, which is an incredibly handy tool if you do this a lot, eight hours a day, every day kind of a thing. And of course Civil 3D has Stage Storage, Water Drop, Catchment, Watershed Styles, and of course those Undocumented Commands, which I think are really useful.

I have to end with find your comfort zone. Calibrate your models. Compare, verify. It is up to you to find your comfort, and to make sure that you can defend yourself when you're in any situation that could potentially turn litigious. Flooding is a big one.

So I'd like to thank you guys. I'll stick around here for any answers. But please, if you enjoyed the class, if you felt this was worthwhile, please give me some of your feedback online. I'd really appreciate it. Thank you very much for spending time with me today.