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Info360 Operational Digital Twin for Water

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Autodesk

Learning Objectives

- Understand trends, benefits, challenges and best practices of deploying operational digital twins
- Learn how the Info360 platform provides a path to deploying operational digital twin for water treatment, distribution and asset management
- Learn How IoT monitoring, operational analytics, machine learning, AI, and physics-based simulation models interoperate to improve performance

Description

Operational digital twins link real-time IoT data with digital representations of real-world processes to model what is happening and to optimize what is going to happen next. In 2021, Autodesk acquired Innovyze's industry-leading water modeling solutions along with the Info360 SaaS platform delivering an operational digital twin for water catchment, treatment, and distribution. Info360 joins together water simulation models used by most utilities worldwide with cloud technology, IoT monitoring, machine learning, AI, and physics-based modeling techniques to create a dynamic digital twin for the entire water processing cycle.

We will demonstrate Info360. We will review operational digital twins and how simulation models can move to the cloud to enable real-time simulation. We will review machine learning and AI modeling approaches that are being used to optimize in real time.

Speaker

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Leading an innovative team and product at Autodesk to improve the efficiency of water and wastewater treatment by providing prescriptive operational recommendations based on real-time and forecasted conditions. Previously led teams of data scientists as we discover innovative ways to apply machine learning and AI models to large scale industrial signals. Helping customers achieve high ROI with performance optimization and downtime reduction.

Successful entrepreneur with track record of developing enterprise solutions, raising capital, building teams and defining business models that grow from start-up to product launch, profitability, acquisition and transition. Senior software executive with 20+ years' experience leading data science, product management, sales & marketing, development and service teams.

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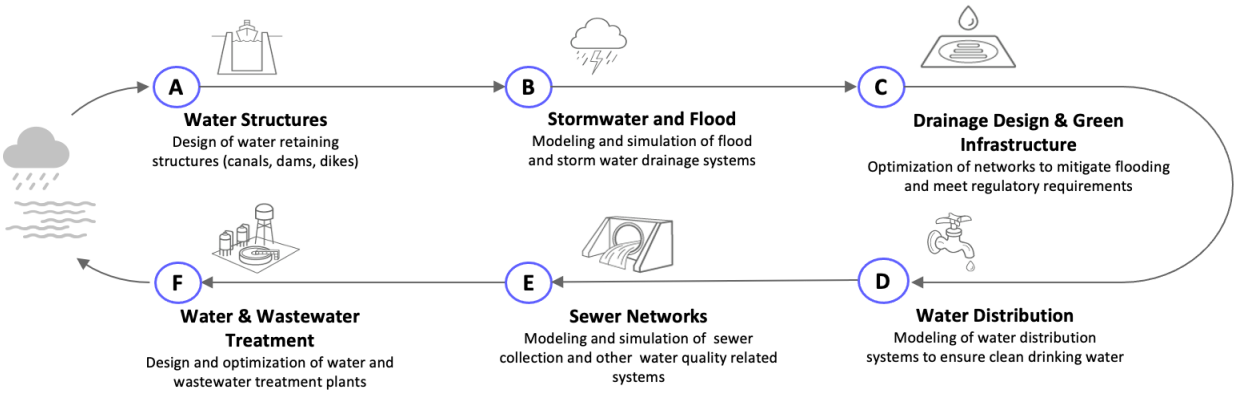
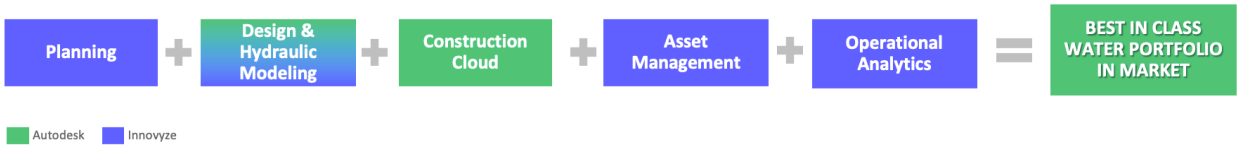
Autodesk captures the water value chain from cloud to sea



Strategic Objective

Autodesk intends to be the leader is design, construction, and operations for the water industry. In pursuit of this goal, Autodesk acquired Innovyze with its suite of market leading hydraulic modeling tools and leading-edge digital twin platform for water.

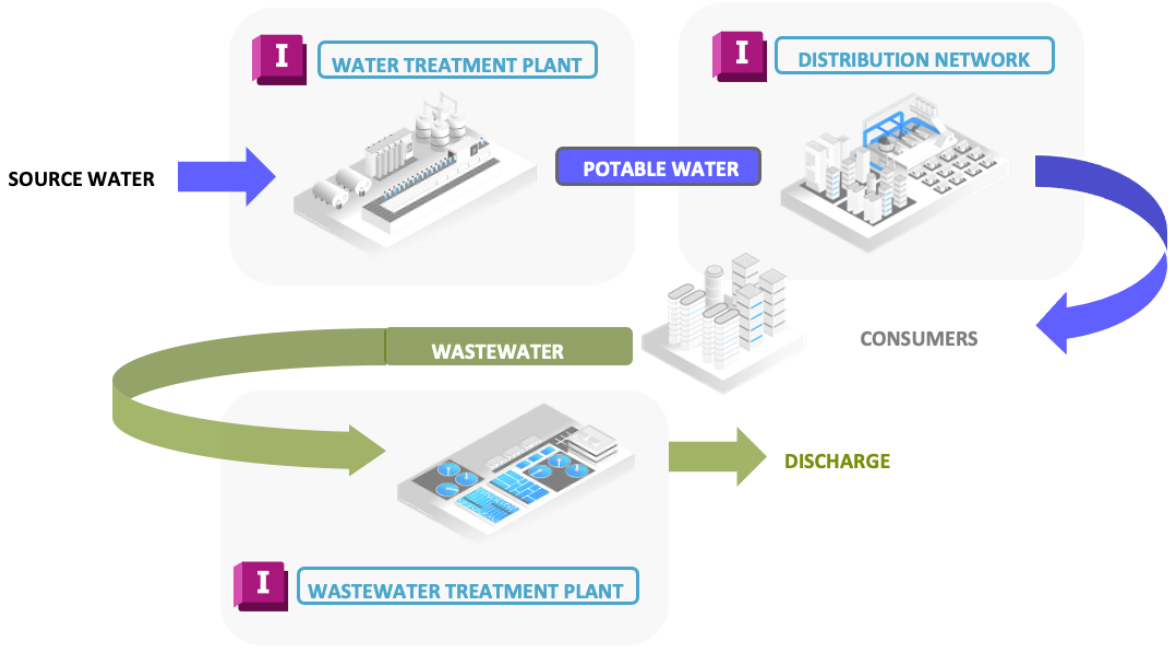


Stronger Together

Together Autodesk with Innovyze covers the entire water value chain with a best-in-class water solutions portfolio.

Operational Vision

Optimize the Entire Built Water Cycle



To achieve this vision, Autodesk has to offer a complete solution to help the water industry operate and optimize its entire water cycle from source to discharge including water treatment, distribution, sewage and wastewater treatment. The entire operational cycle needs to become more efficient and environmentally friendly to meet the world's growing water needs.

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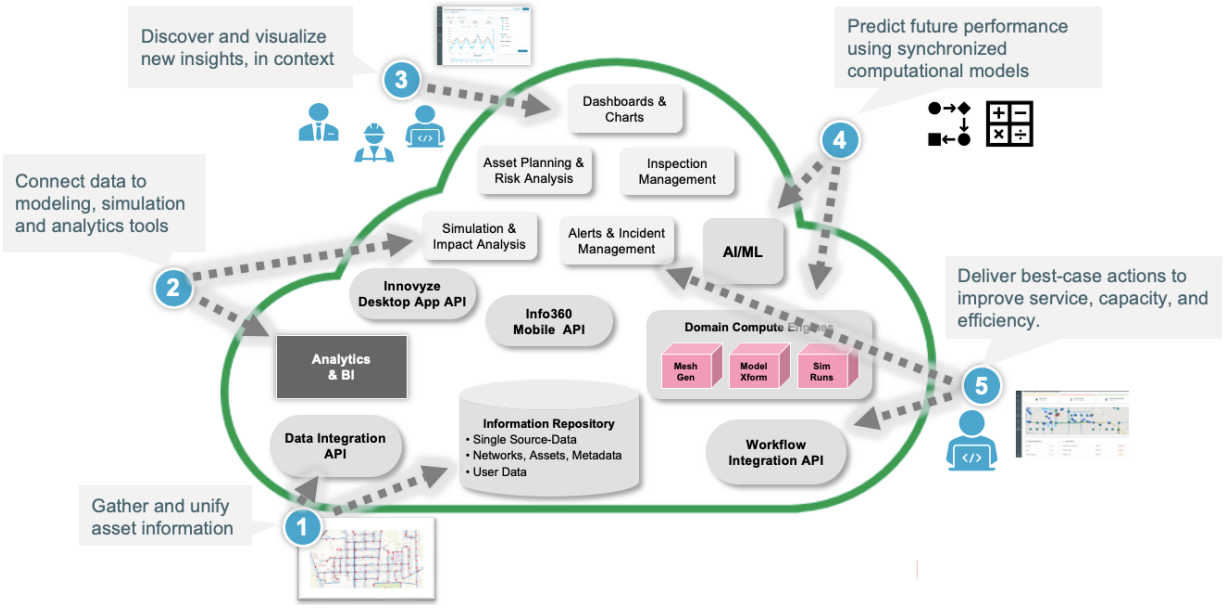
Info360

The Cloud Operational Digital Twin for Water

This handout and the associated presentation primarily focus on Info360 – Autodesk's cloud based operational digital twin for water. It provides cloud-based compute that supports sophisticated analytic, simulation and machine learning models to manage and optimize the industries' complex assets. It securely connects IOT sensor data to a powerful SaaS digital twin platform that's always up to date and infinitely scalable.

What Can the Digital Twin Do?



Autodesk's Info360 provides an excellent example of what a digital twin can do for the industry.

With Info360 you can:

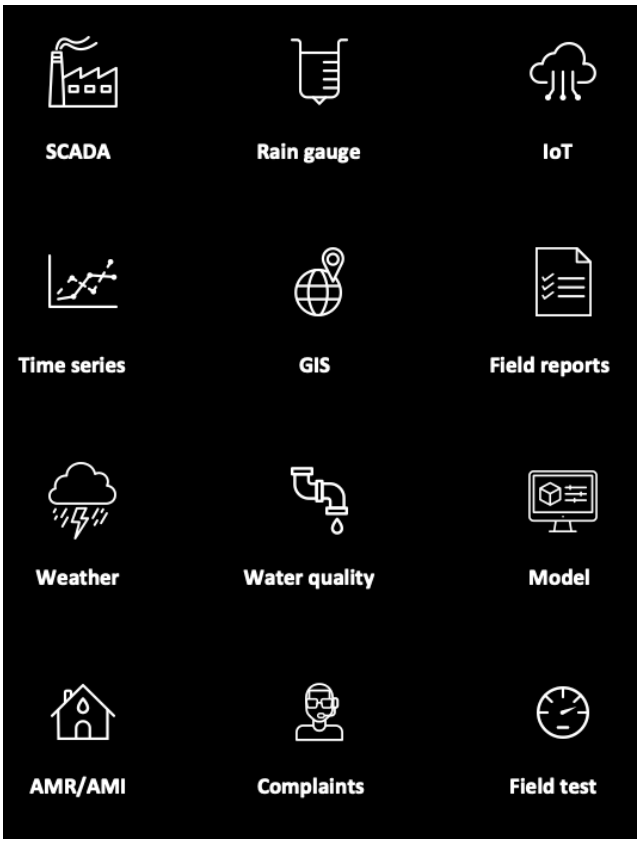
1) Integrate your operations in the cloud sharing information securely with your entire team
2) Connect that data directly to scalable simulation and analytic tools that model your operations
3) Visualize your operation in real-time with configurable workspaces, graphs, reports, and more
4) Forecast and predict future conditions under varying conditions to find optimal setpoints
5) Be confident in taking the best action quickly to improve service, capacity and efficiency.

It's Possible in the Cloud

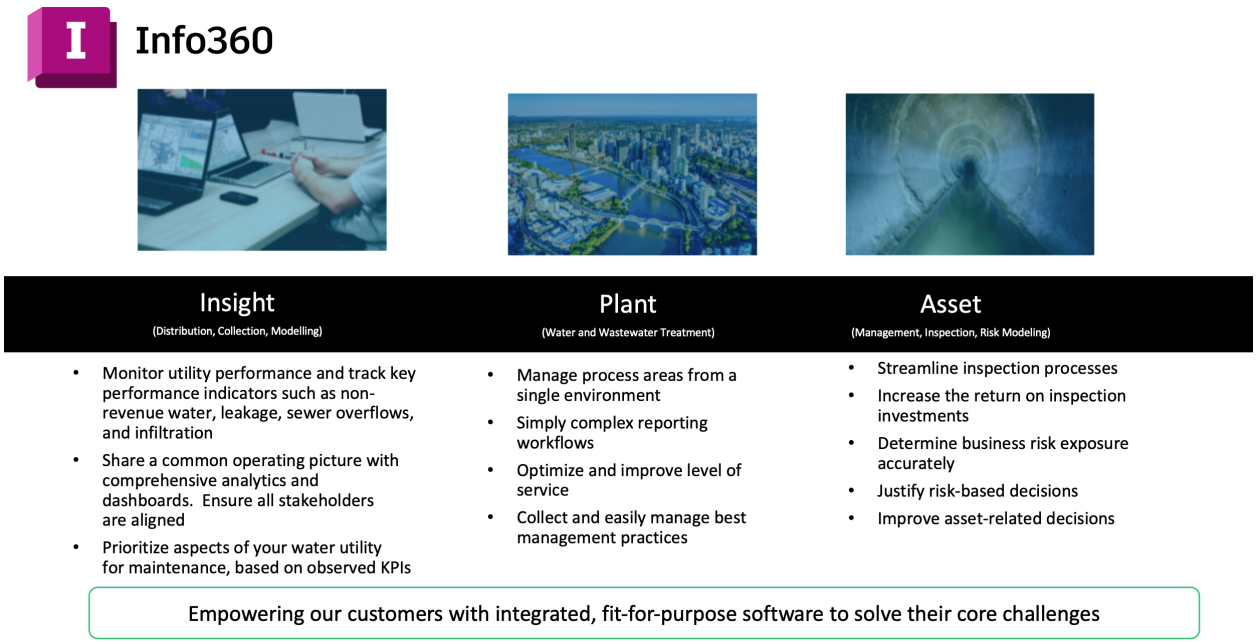
Above illustrates the broad suite of integrated applications from hydraulic modeling for sewar, distribution, and drainage to asset management, risk modeling, machine learning and more. Integrating all of this is only possible using the cloud. This handout will review how these integrate today, from desktop to cloud, to operate and optimize the entire water cycle.

Data is the Key

Info360 accesses and leverages diverse data sets through different types of workflows using various types of analytics. All of the data from each of these sources has not yet been put to its full utility. It's a journey but the subsequent demonstrations will illustrate the progress. The potential benefits in terms of efficiency and transparency are incredible.



Info360 Applications



Info360 is an integrated SaaS Platform that will provide an ever-expanding suite of applications. This handout and the associated presentation reviews each of the three applications currently available:

- ***Info360 Insight*** for Water Distribution, Collection and Modeling
- ***Info360 Plant*** for Water and Wastewater Treatment
- ***Info360 Asset*** for Asset Management, Inspection and Risk Modeling

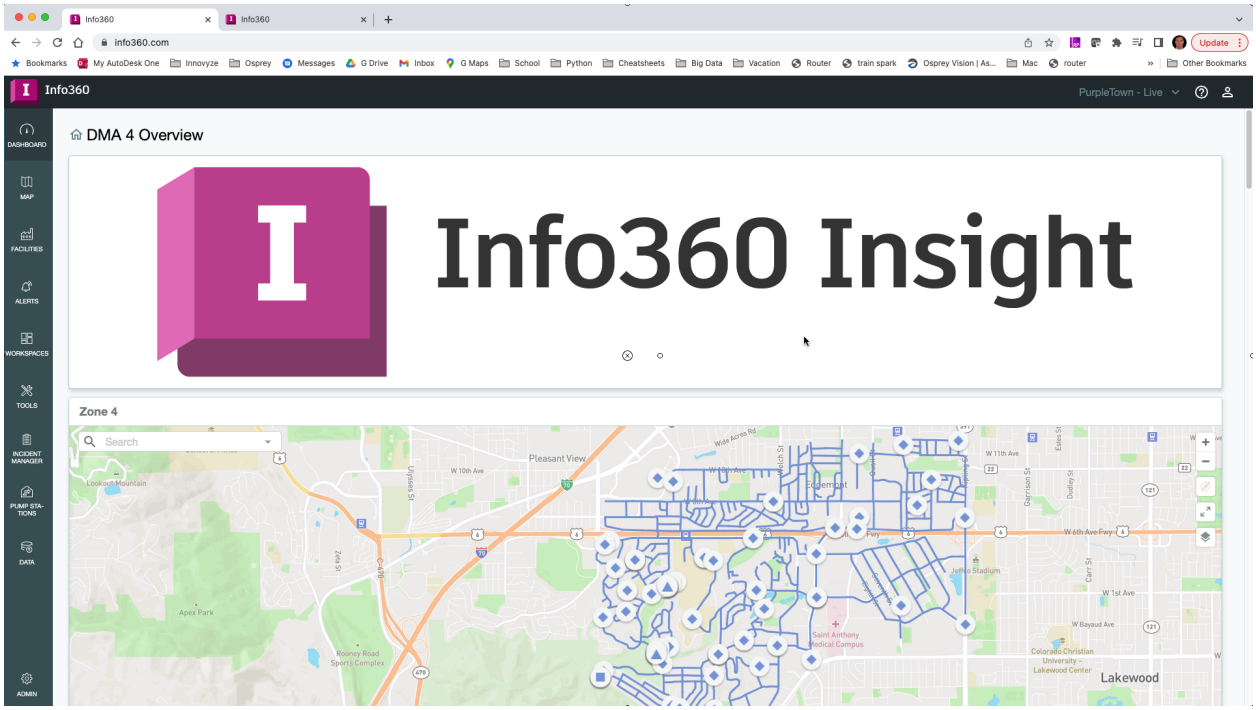
We will also peak around the corner and take a look at some future capabilities to see how Info360 is expanding.

To learn more about the Autodesk Info360 Cloud platform, see the link below:

autodesk.com/campaigns/innovyze-cloud-solutions

Info360 Insight

Operational Performance for Water Networks
Rapid Resolution of Network Incidences



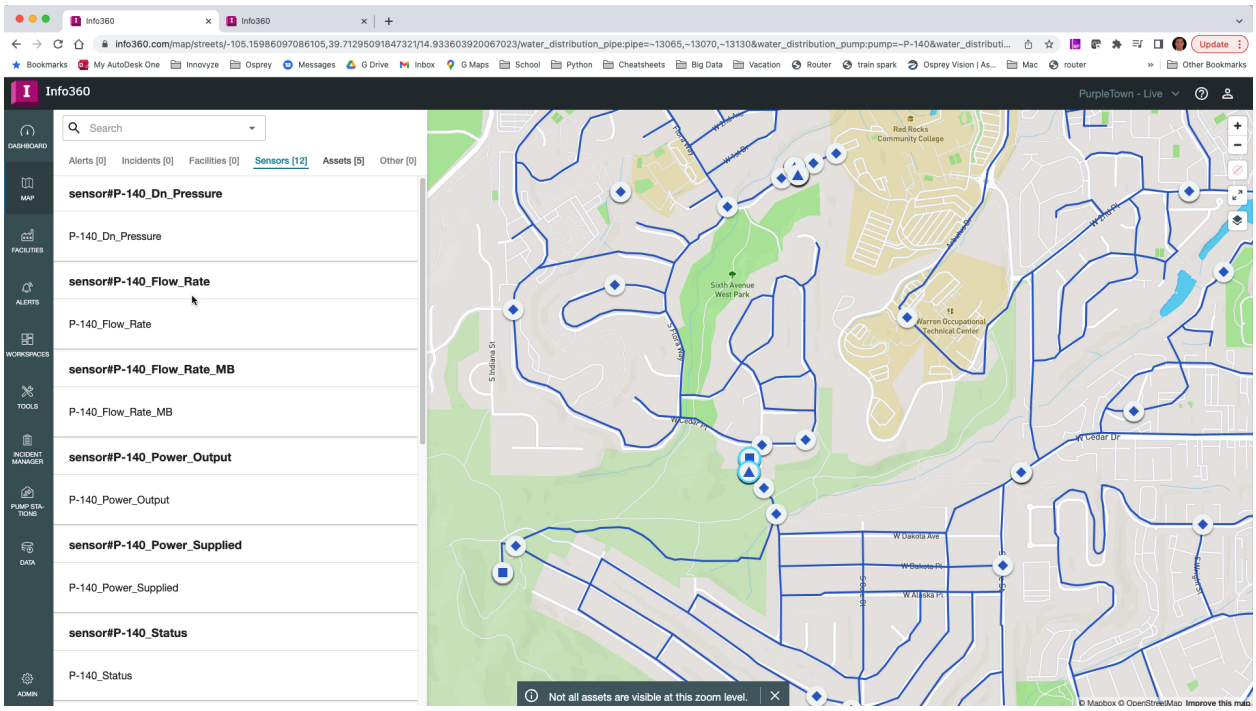
Info360 Insight is the operational analytics platform for water and sewar networks. Open the site, and you land on your dashboard. Here you can create a custom dashboard with just the pressures, volumes, flows and other KPIs and metrics that your operation is interested in.

For example, if your system in a holistic DMA, but you want to really concentrate on leakage, you could add leakage analytics to your dashboard so they are the first thing you see. You will learn more about configuring dashboards and workspaces later in later topics.

For additional information on Info360 Plant, see the product center at

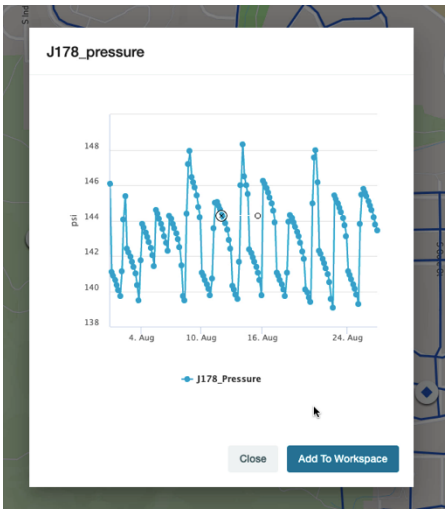
autodesk.com/products/info360-insight/overview

Maps



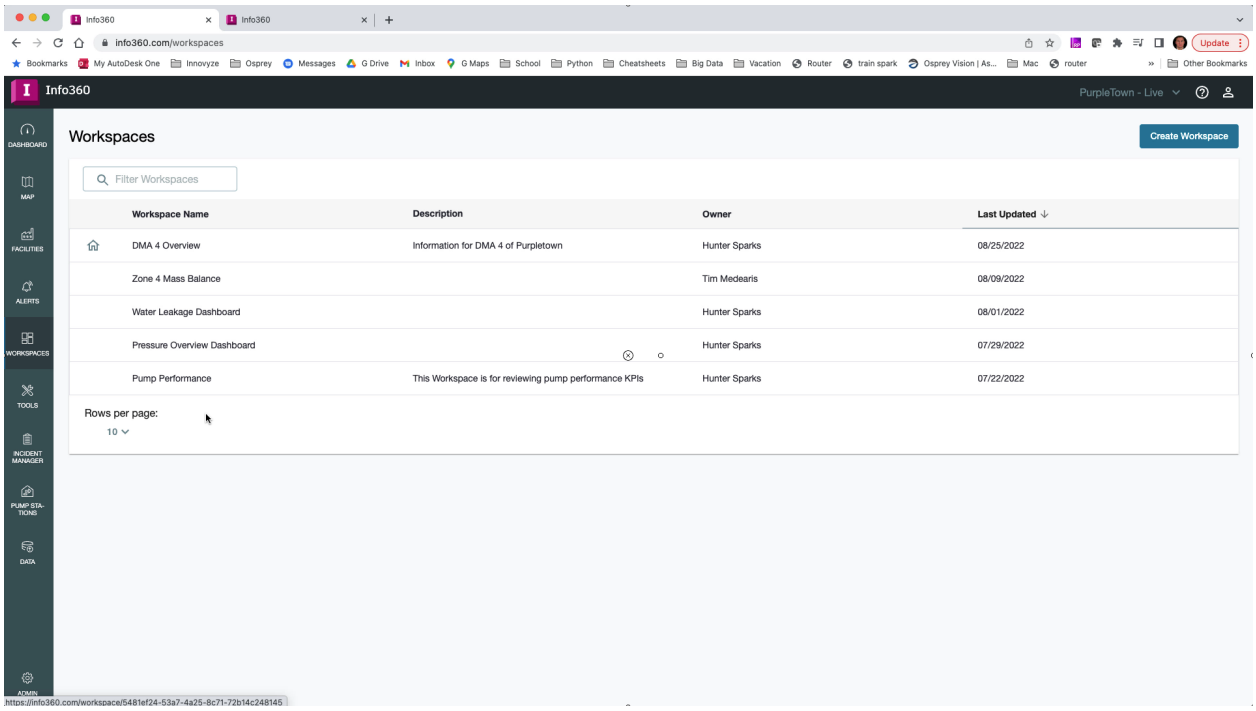
The interactive map is where you can see how info360 interacts with hydraulic models and GIS data. The different diamonds indicate where sensors are located. For example, a storage tank would typically have sensors for tank level and flow in and out. For a pump there would be sensors for flow and pressure both downstream and upstream along with rpm's, power consumption and more. Think of sensors as data streams.

Click on an asset and see the detail of the pipe and sensor information which typically flows from integration with our industry leading hydraulic models like WSPro and InfoWater Pro. The Info360 SaaS platform provides robust integration and collaboration, so information is maintained in one place. In the screen above, this information is from InfoWater Pro, and it is made available in the cloud securely to your organization. There are many points of integration with hydraulic modeling which will by highlighted later.



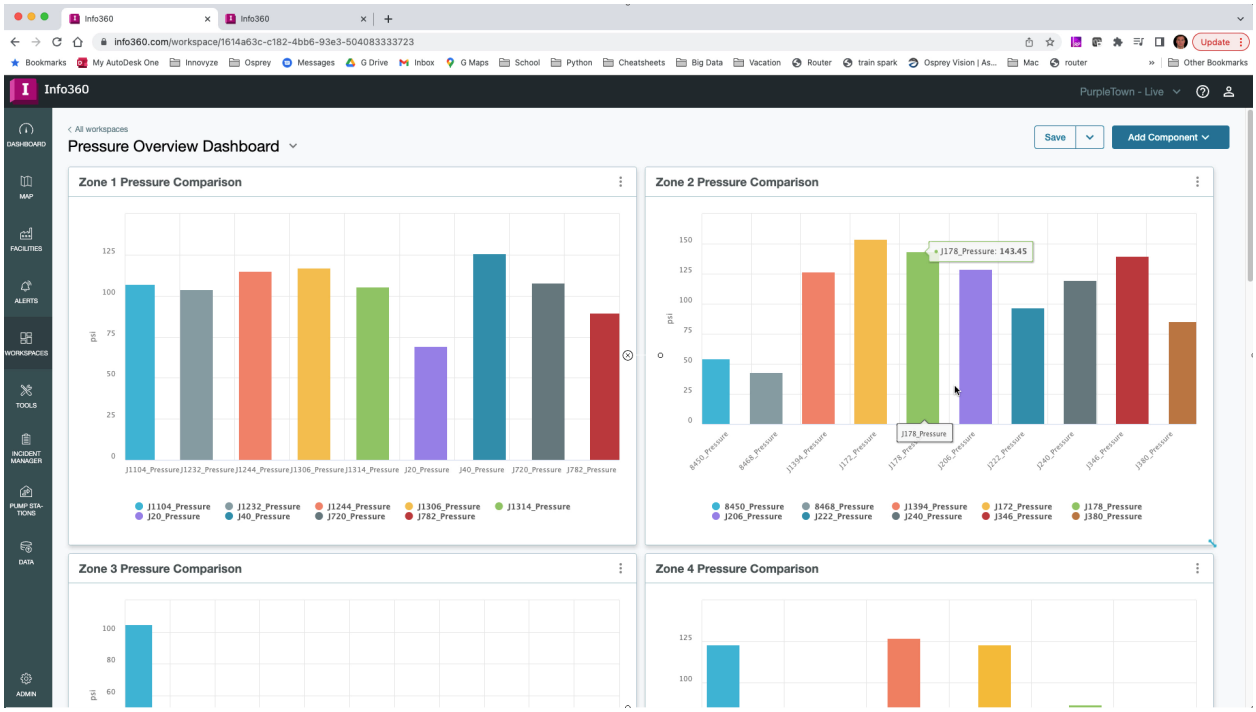
Users do not need to have deep knowledge of Info360 Insight, the SCADA system or the hydraulic model. Those complexities are handled by Info360. You just search, point and click. Now anyone in your organization can look around your hydraulic model, choose sensors they are interested in, and pull up the latest data with a chart. They can even add it right to their dashboard. Someone without a technical background can navigate around the intuitive map, locate information, drill down to detail and even drop that information on a workspace all from a browser.

Workspaces

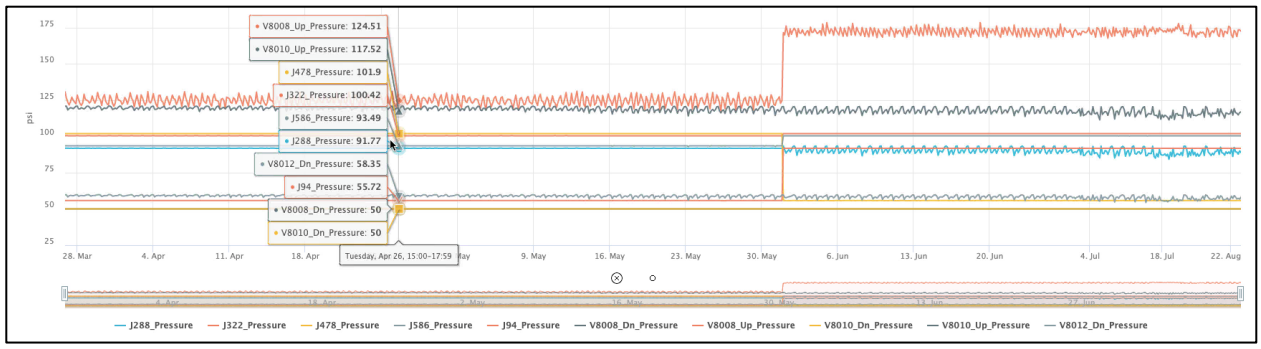


Workspaces are one of the most valuable capabilities of Info360 Insight. Workspaces are also available in our newest application - Info360 Plant for Water and Wastewater Treatment plants. Workspaces allow you to interactively configure the information and visualizations you want to see or share. These can be shared with the entire operation, specific teams, or you can create your own for a particular analysis you need.

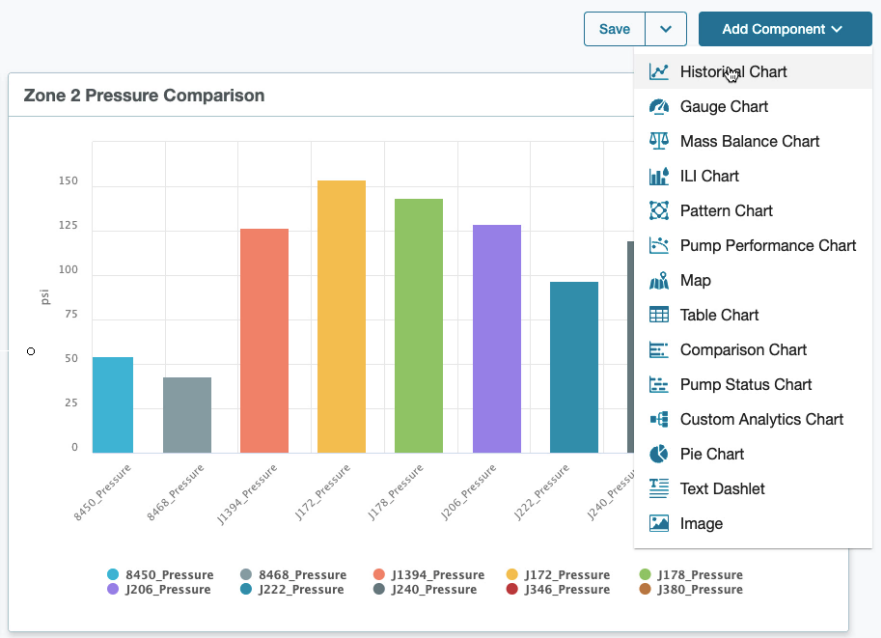
Workspaces can be set-up for different DMAs, facilities such as pump stations or specific areas within your hydraulic model. You can also set up workspaces for different personas - management, engineering, or operators responsible for specific areas. If there is someone responsible for checking leakage or pressures within your live model. You can easily create a specific workspace that focuses just on that information.



Above is an example of a pressure overview dashboard created as a workspace. Here you can see the different pressures across the zones in a single view. There are different charting capabilities to combine multiple pressures in one dashlet showing the different zones in the bar graph.



You can also look at it as a line graph by simply choosing that option from a drop down. There are many different ways to view information. And it is purpose-built for hydraulic modeling.



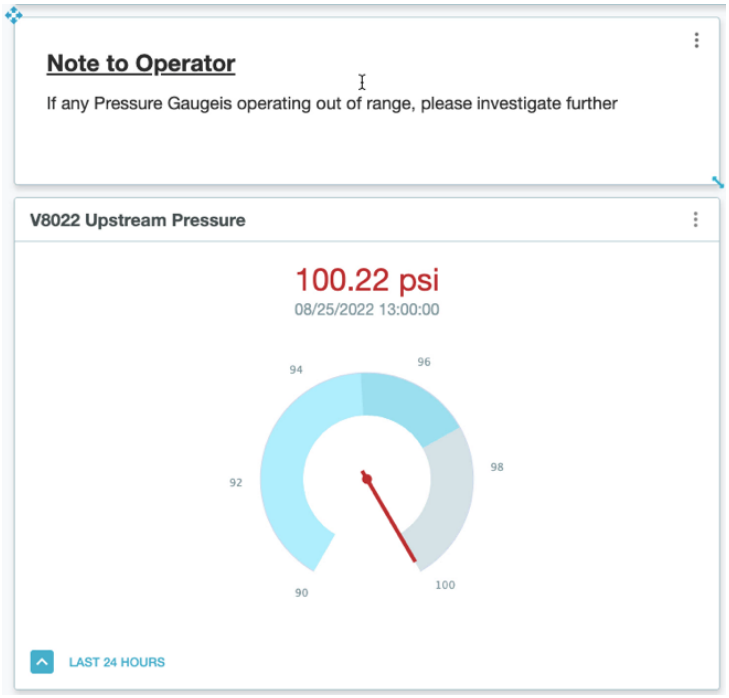
With other dashboarding systems it can be cumbersome to add a new component. As you see on the left, with Info360 you just choose from the drop-down which chart you want.

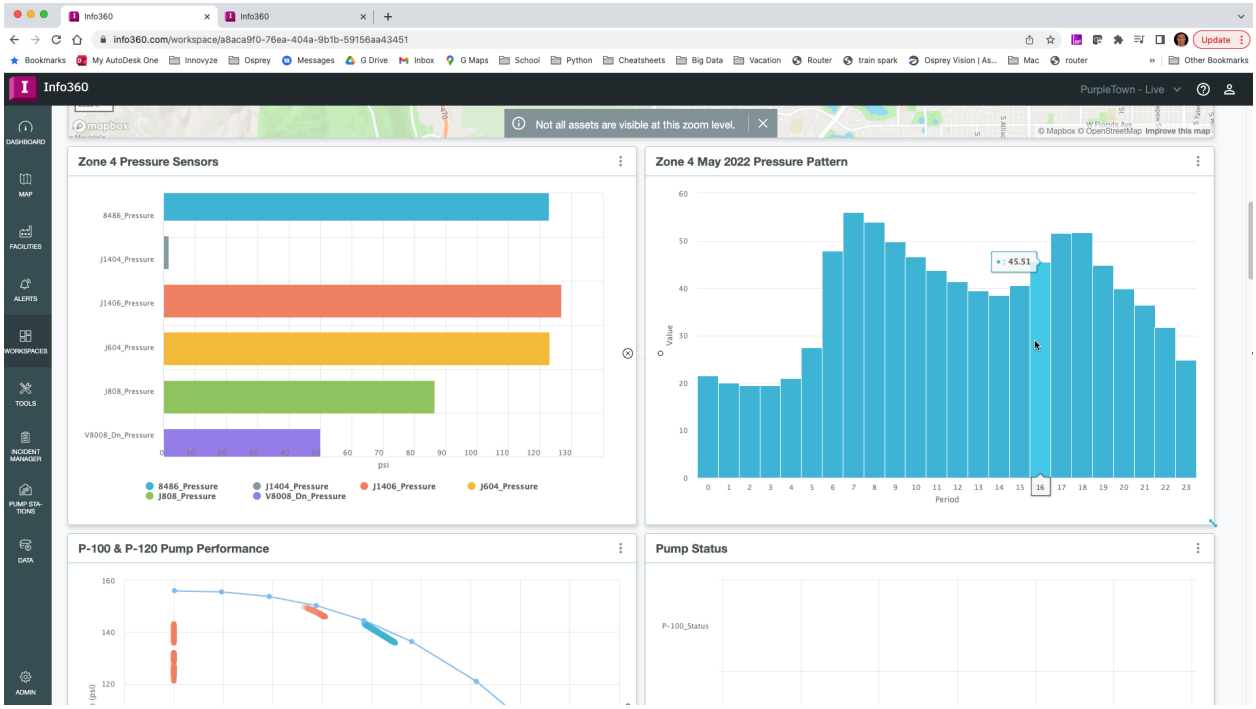
Both current and historical information is readily available in real time on the historical chart.

The gauge chart below provides an illustrated view of a current reading. And there are many different chart components for different tools.

You can add a gauge or any other chart easily by selecting the component and the sensor and just that quickly it is added to the workspace. Use a pressure gauge and an operating range and instantly see if everything is operating within range. If something is operating too high or low, it is highlighted in red to draw your attention and investigate further.

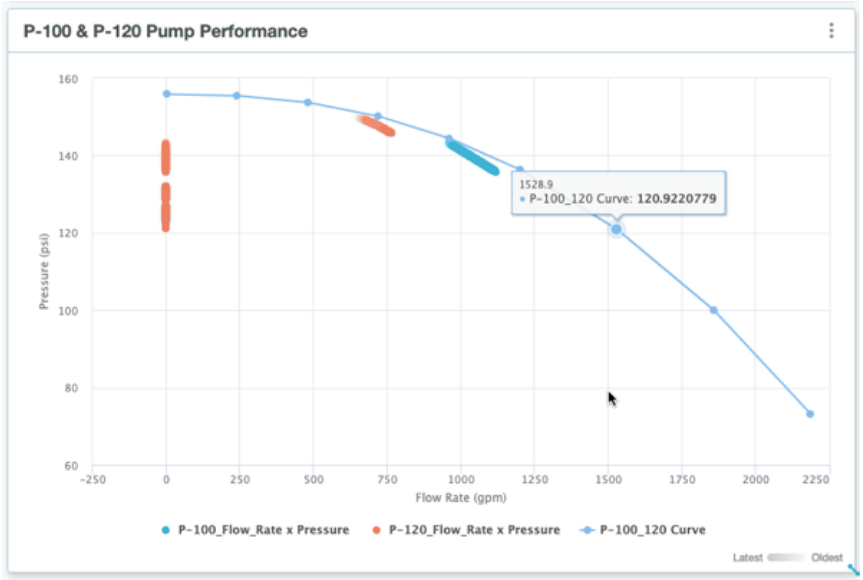
You can even add notes to the operator to indicate what to check or change.



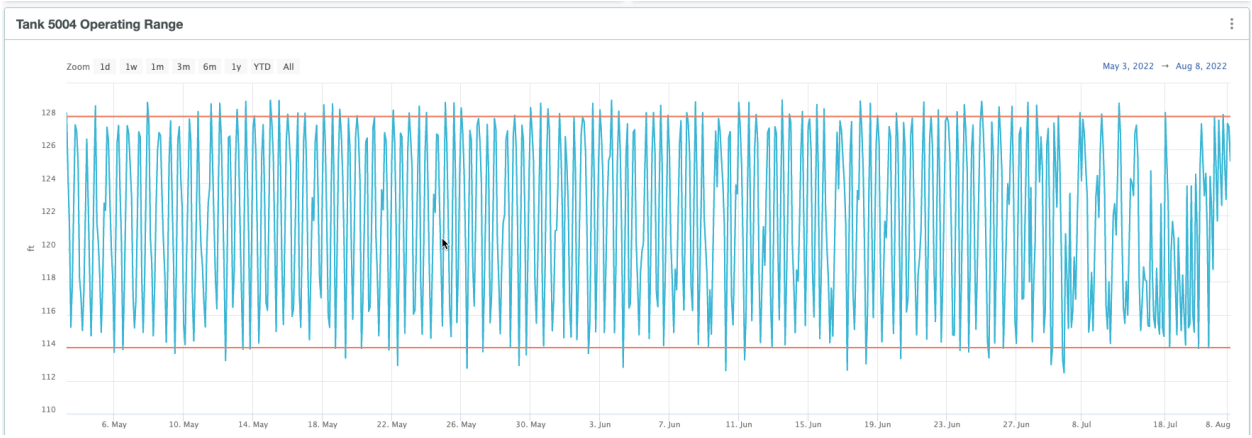


This is the example workspace that is pinned as the dashboard, so instead of looking at specific information this presents an overview of an entire DMA which is a zone within the system. This has a lot more chart types since this workspace is not just looking at pressures. Info360 provides the flexibility to set-up specific workspaces for any situation. Sometimes people want to look at different zones and some people at their specific job or operation.

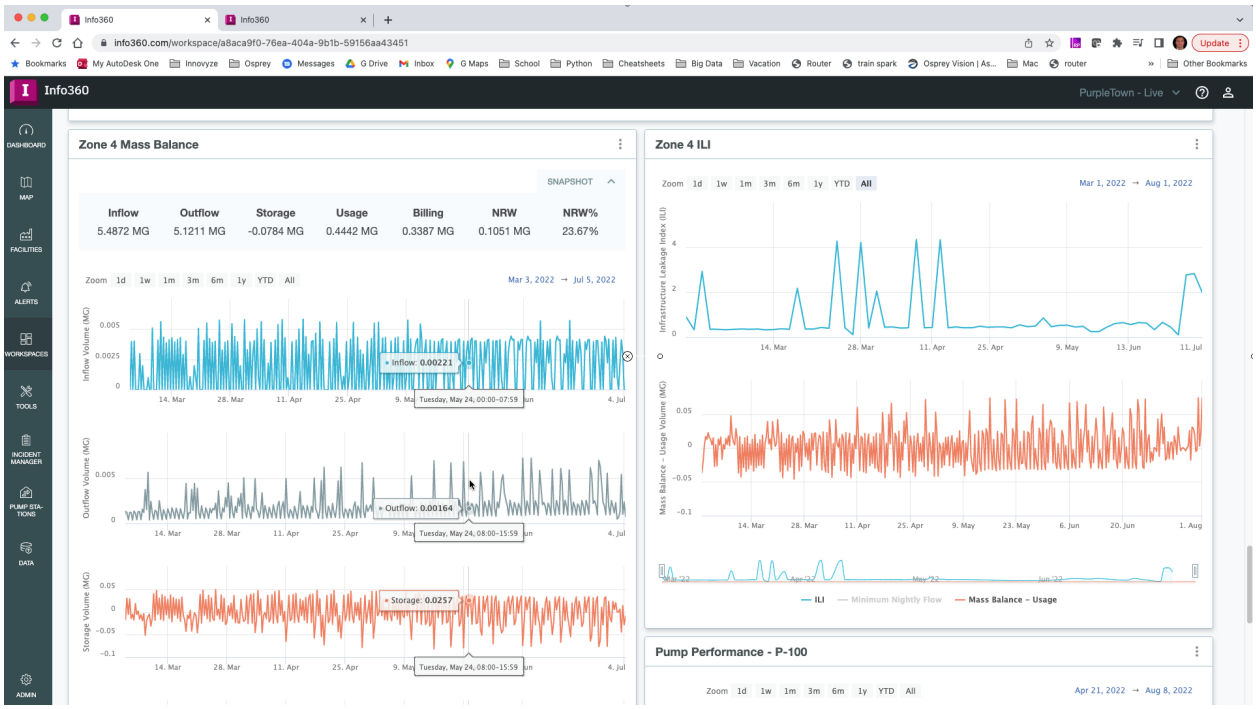
On the right of the screen above, there is an analysis of the diurnal patterns which can be configured through the analytic tools discussed later in this document.



Info360 also connects to your pump sensors getting live data that can be analyzed against your pump performance curves which you can upload yourself. Then you can see how the pump is operating compared to the pump's specifications and see if maintenance or replacement may be needed.



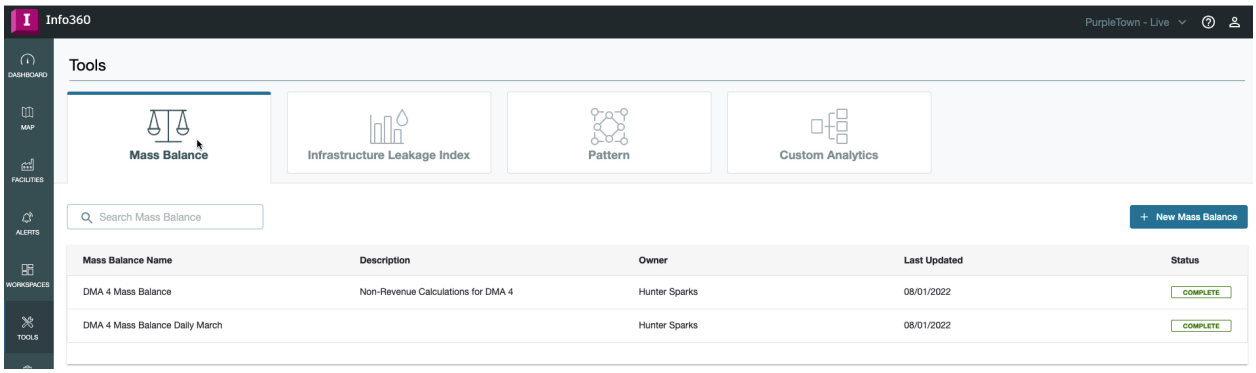
Above you see how Info360 can monitor tank and levels and flows compared to their thresholds. Workspaces are easier to use than excel, can be shared with anyone in your organization, and have instant access to historic and current data from your entire operation.



Above you see how Info360 goes beyond just dashboarding to true water analytics. Info360 automatically calculates water specific KPIs and metrics such as mass balance and infrastructure leakage index or ILI. These are particularly helpful when calculating non-revenue water. Using ILI you can compare leakage for DMAs of different sizes. Larger systems leak more than smaller systems, so ILI standardizes them for comparison.

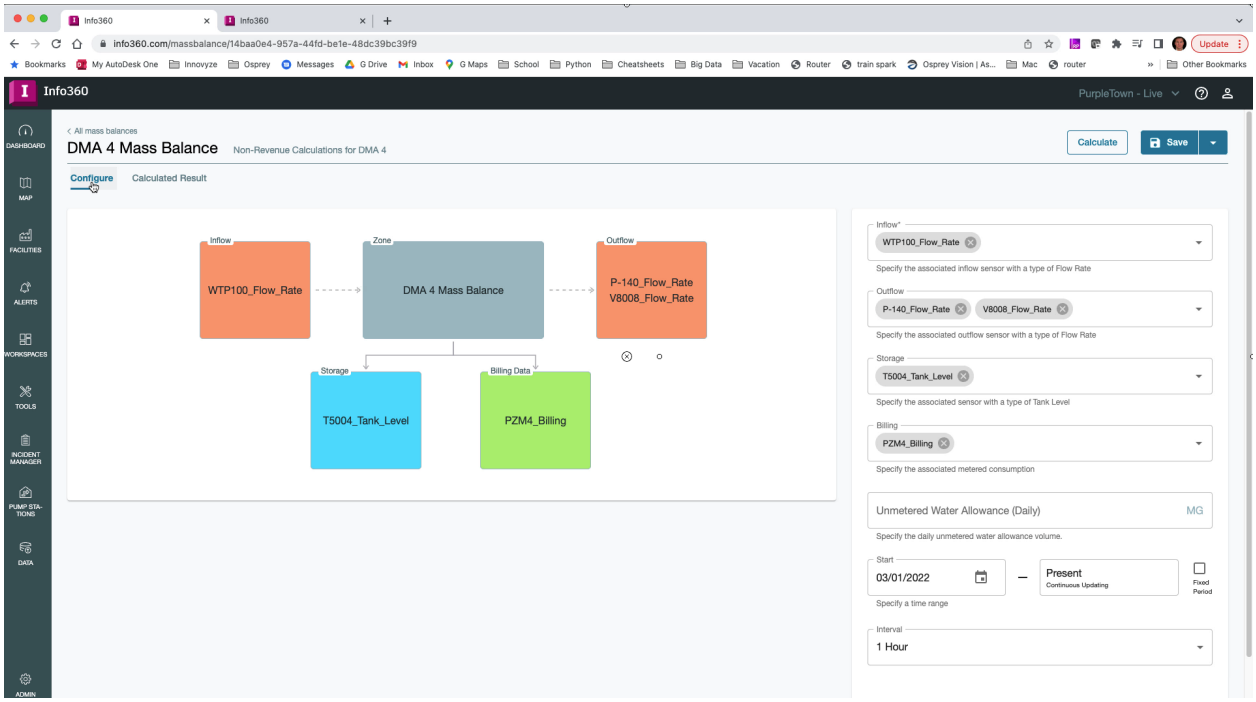
Analytics

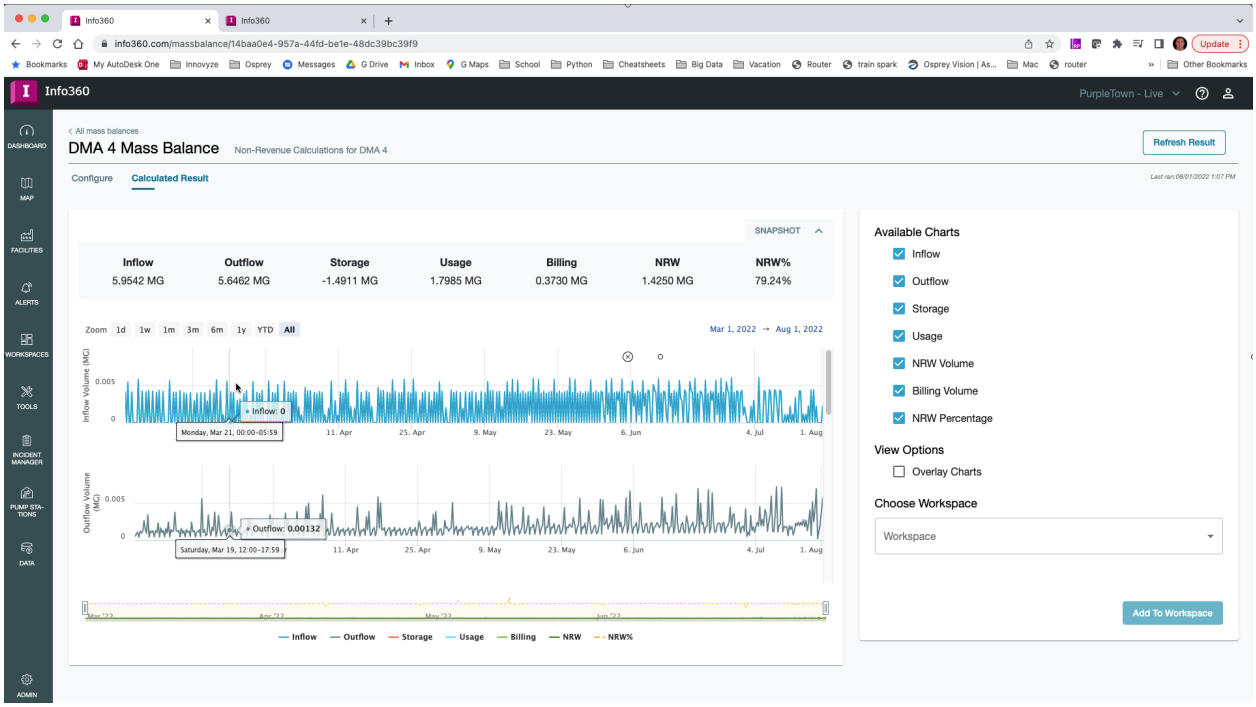
We have seen how workspaces help visualize and share information. Let's see the tools you can use to configure these analytics specific to your operation. Below are our current analytic tools. More are rapidly being developed as customers request.



Mass Balance

Starting with mass balance, here the objective is to not lose water that our customers and community so desperately need. In this example, the network is divided into different DMAs, district metered areas or zones. These are where there are sensors that can isolate the entire area or zone. To calculate mass balance, select the sensors for all the inflows, outflows, storage and tank levels along with billing data.

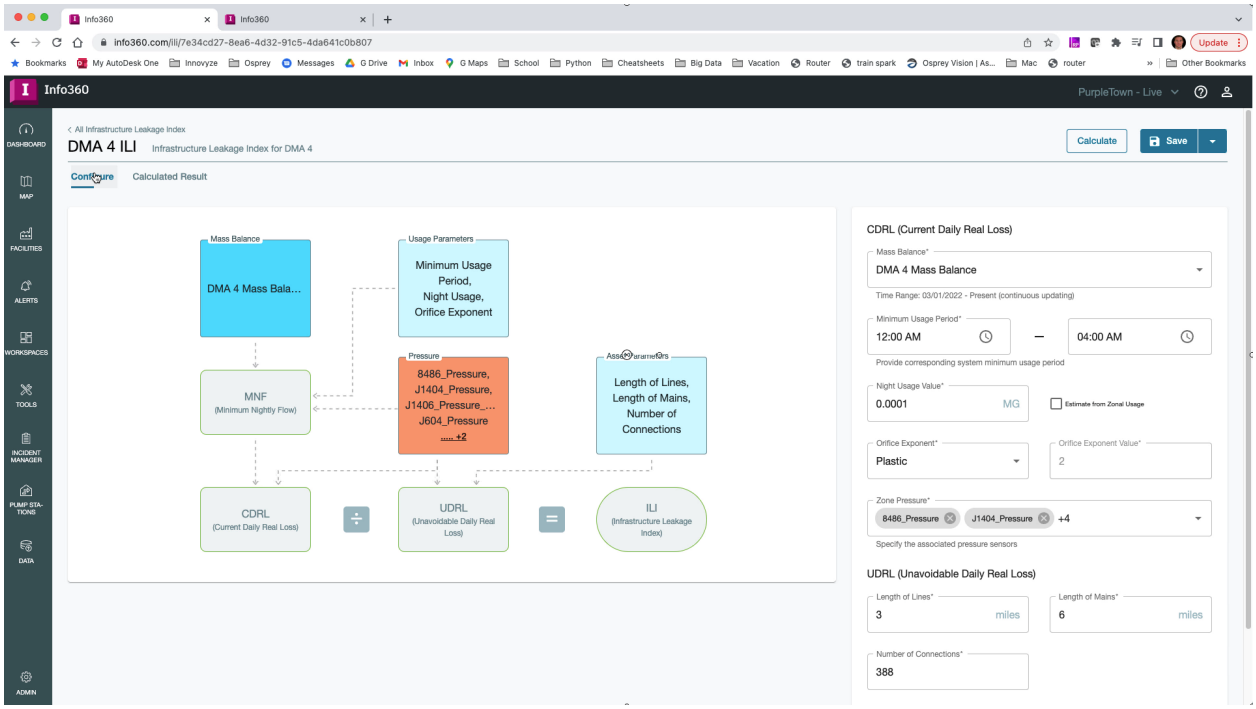




Using the selected information, Info360 Insight calculates how much water should be in the system and how much is leaking out over a period of time. Above you can see the calculations providing you a complete analysis of water flow in the system over time. Zoom in and out and the calculation updates automatically.

Next, you can use the above mass balance calculation to calculate non-revenue water and evaluate how the network is currently working compared to how it should be.

Infrastructure Leakage Index (ILI)

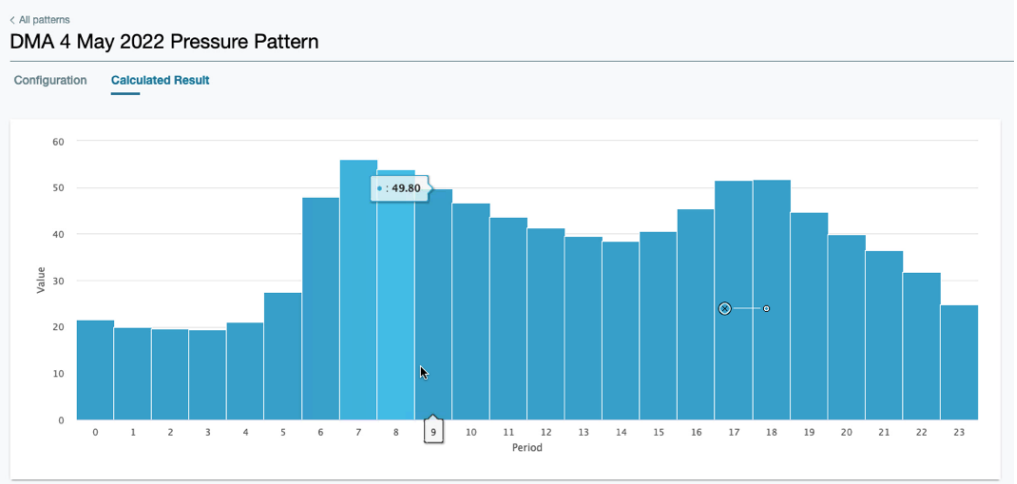


The infrastructure leakage index uses the leakage or non-revenue water as a percentage providing a KPI that can be benchmarked and compared across networks or zones of different sizes. It essentially takes the current real loss and divides it by the unavoidable real loss. The unavoidable real loss is an estimate of the loss expected in the network based on length and size of pipes and number of collections. It is typically calculated by the hydraulic model, in this case InfoWater Pro.

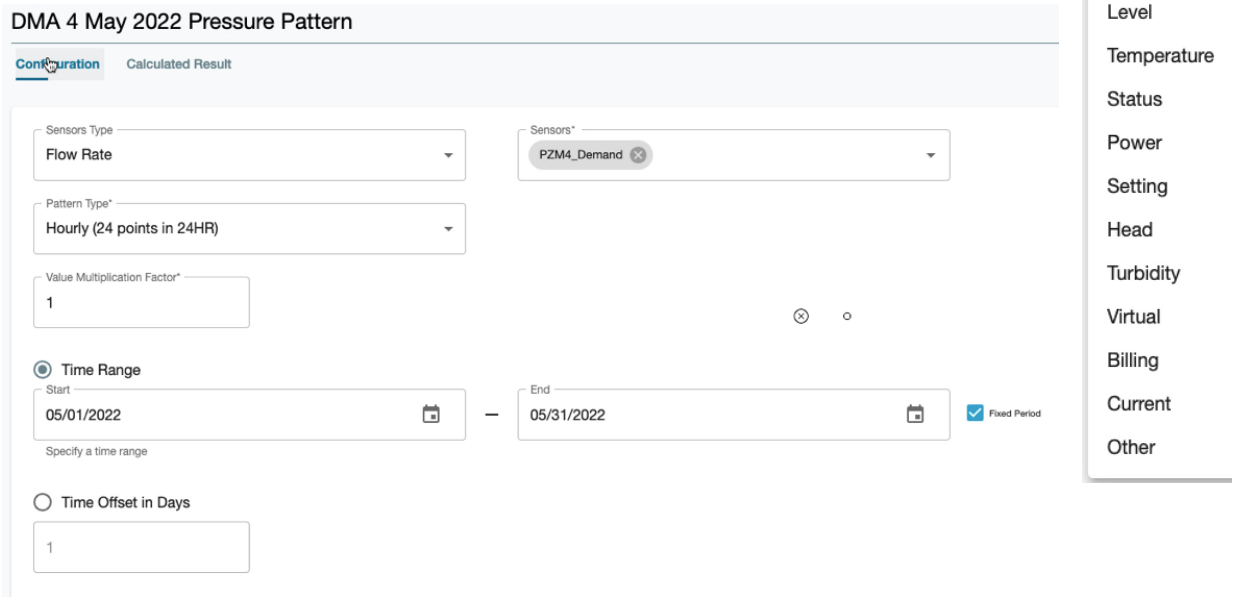
In Info360 Insight, this is all calculated automatically, updated in real time and available to everyone in your operation over a browser.

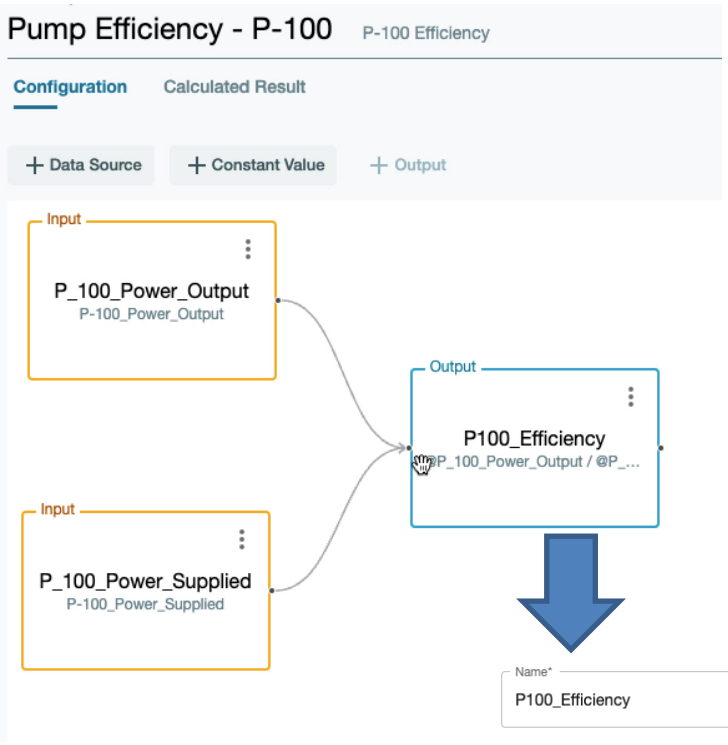
Patterns

These are the diurnal or daily patterns for different sensors and calculations.



Since water usage and flow is very cyclical, you can automatically calculate these patterns for different sensors like flow rate, pressure, volume and different pattern types. These demand patterns and seasonal trends can help predict and adjust for what is likely to occur. And in your hydraulic model such as in InfoWater Pro, you can use these for demand estimation.



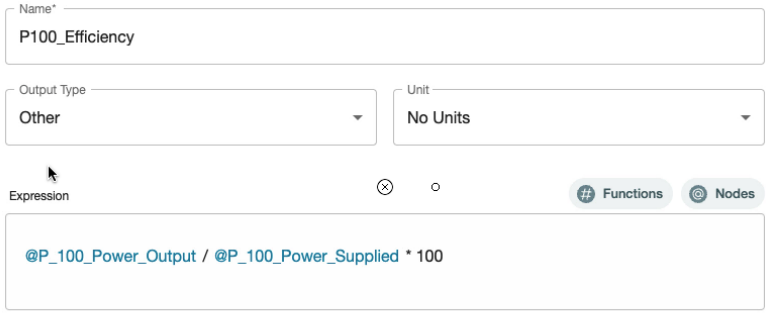


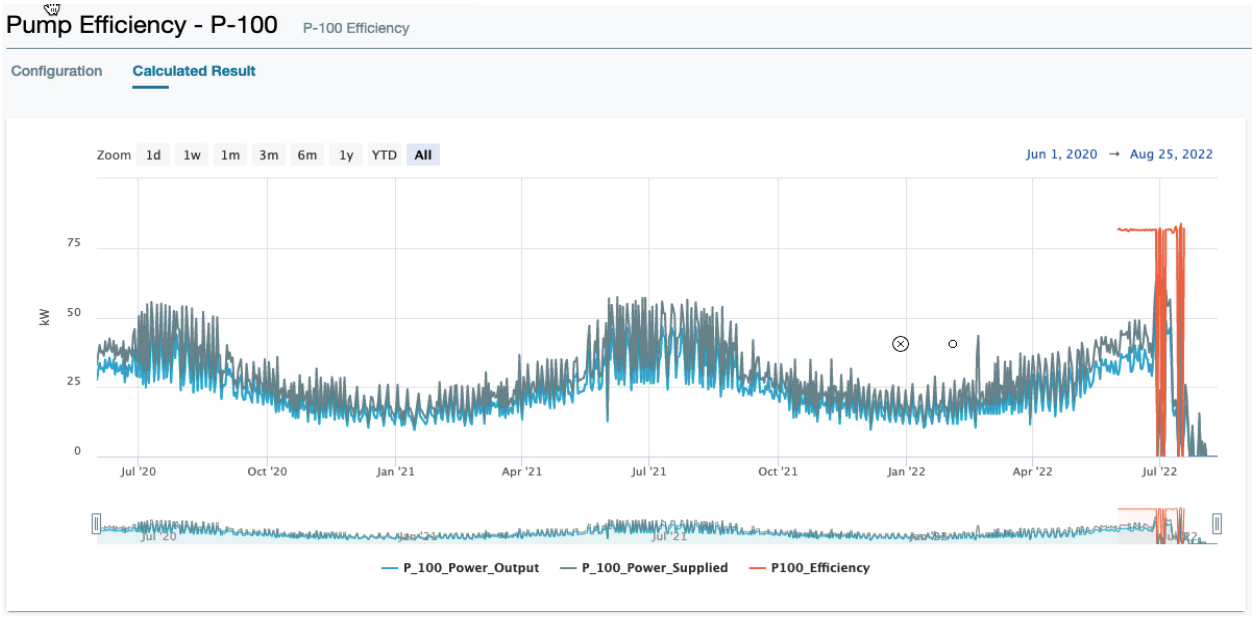
Custom Analytics

Each operation also has its own KPIs and metrics that need to be calculated. For those there are Custom Analytics which is exactly what it sounds like. You use your real time sensor data and automatically apply mathematical functions and operations to calculate almost anything.

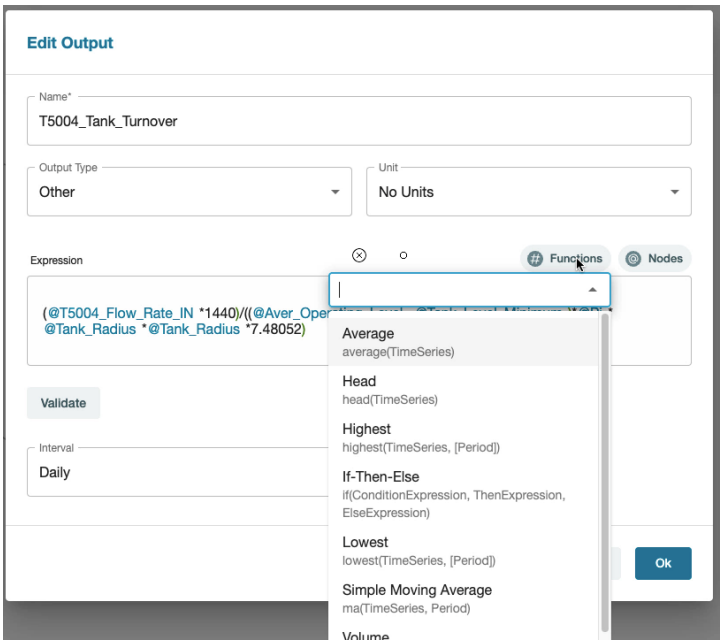
Here is an example of a custom analytic to calculate pump performance and efficiency.

Just two simple data sources with a bit of division and multiplication, and you can compare and benchmark the efficiency of your pump operation.





Above is a more advanced example that calculates tank turnover. In custom analytics you can string together values and data sources, and with a little bit more math you calculate KPIs that have not been created in the system yet.

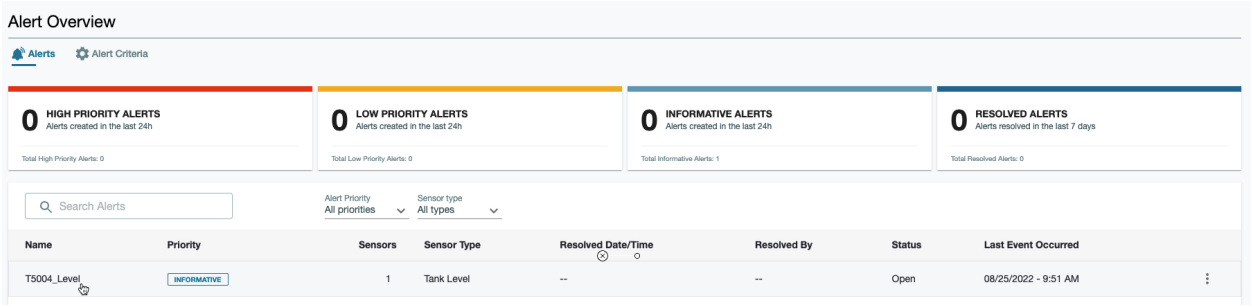


There are many useful functions such as average, highest, lowest and more, with more being added by our development teams with each release. That is one of the key benefits of a cloud-based SaaS application. As new functions are added, they are available to you immediately with no additional cost or upgrade process. You always have the latest and greatest.

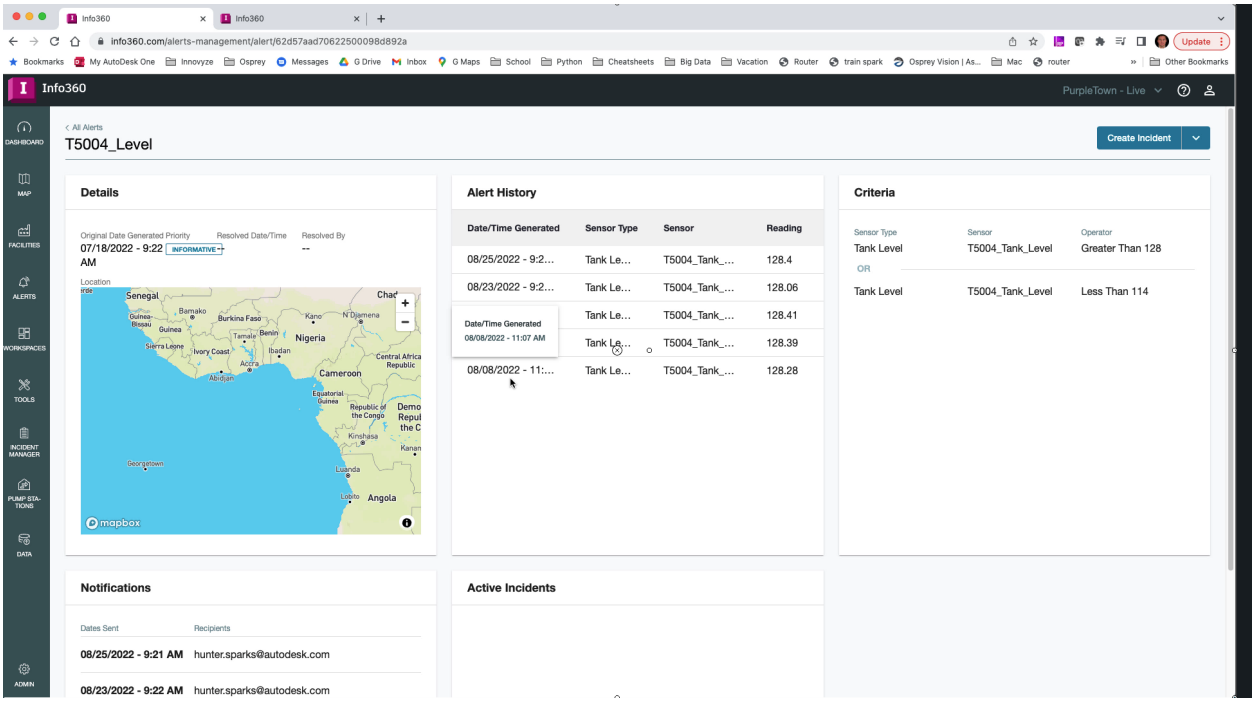
You can add theses custom analytics and any other analytic to any workspace, and it is automatically updated.

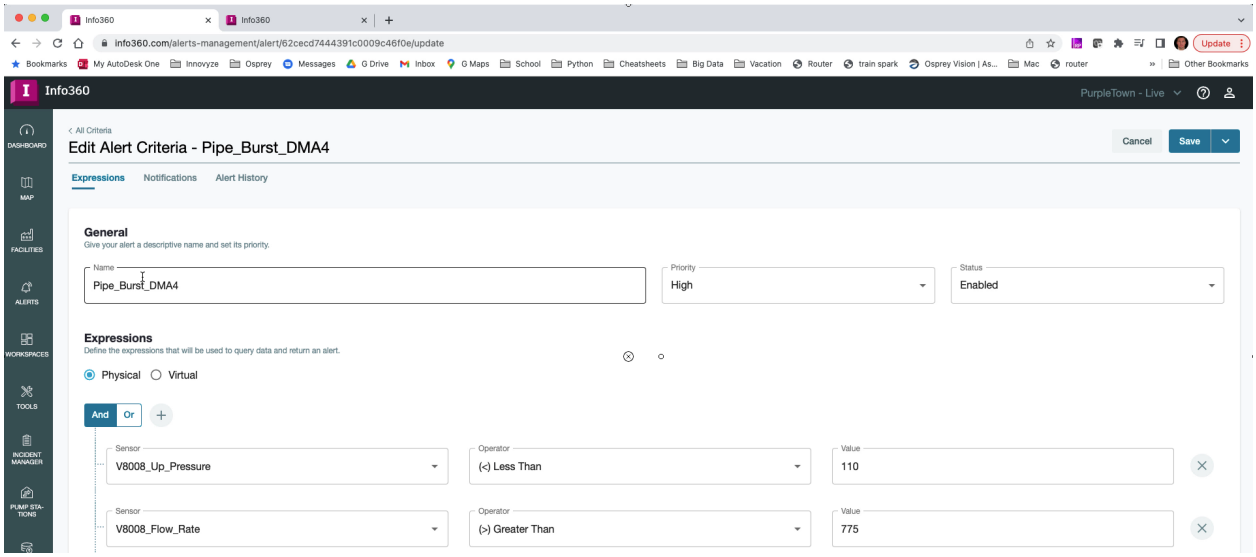
Alerts

Now you can use all this information to make sure the right people are aware immediately of anything they need to take action on.



In the alert example above and below, there is one alert that has gone off. This is just an informative alert set-up to provide updates on tank readings. Here you can see when and why based on the specific criteria as well as who was notified.



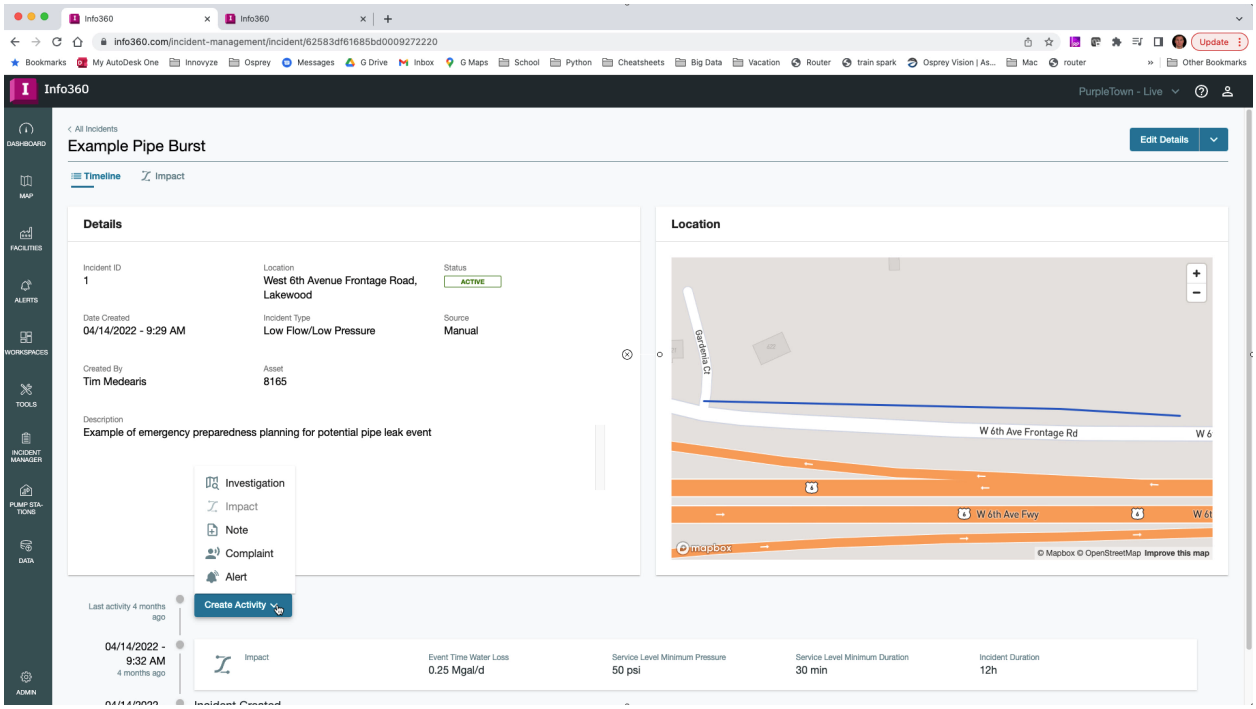


The alert configured above is more sophisticated and tries to identify a potential pipe burst. Different expressions can be strung together including sensor readings along with configured analytics such as mass balance, pump efficiency, tank turnover and others. Alerts will detect if they get out of normal operating range.

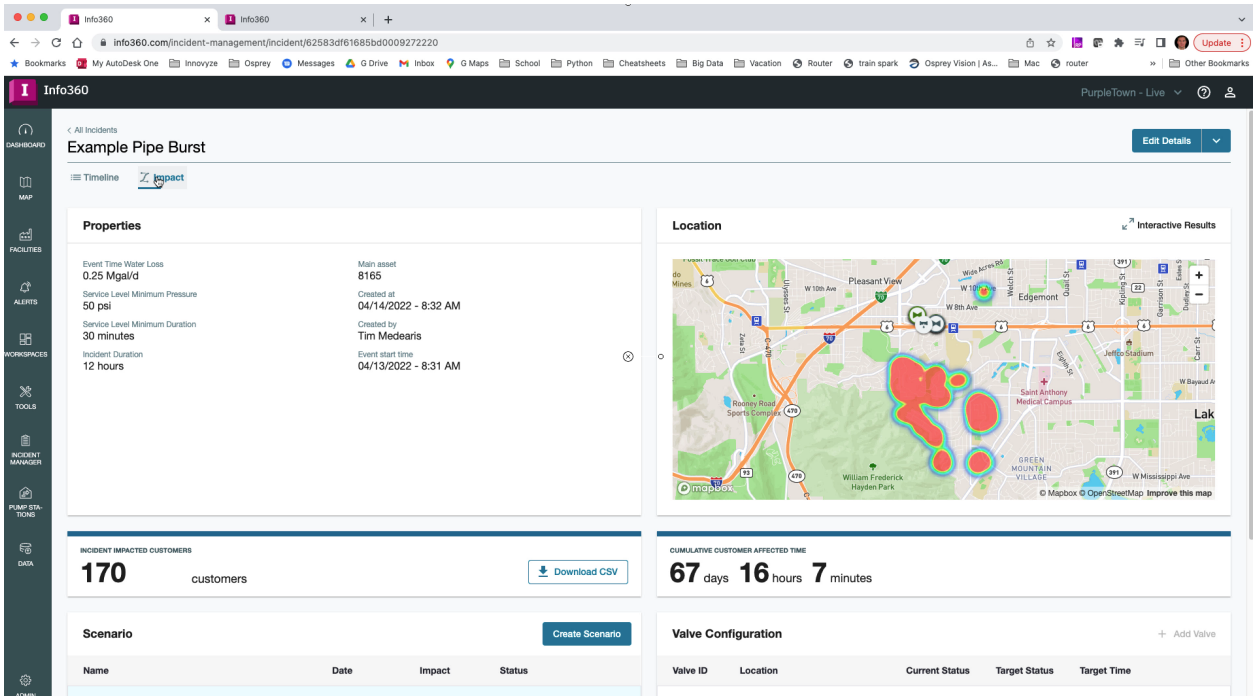
By adding in various and specific conditions just those conditions that warrant our attention are identified to avoid unnecessary notifications. You can also control how often they are checked - real time, hourly or daily - and who should be notified. With timely notification a team can get into the field quickly to limit the number of customers impacted.

Now let's say a pipe bursts. What happens then?

Incident Manager

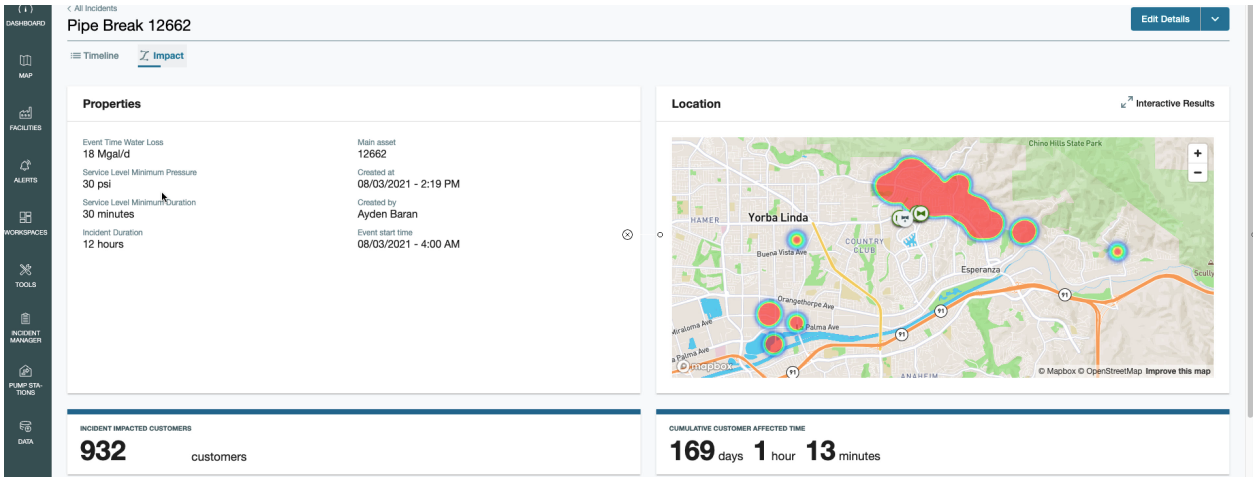


The alert can be pushed to an incident which is a situation or event that needs to be monitored and managed. If there is a pipe burst, it is high priority. Within incident manager, you can create an incident and provide an overview, location and asset, and then maintain an activity timeline logging when a field investigation gets created adding notes and any customer complaints - all tying back to the original incident.



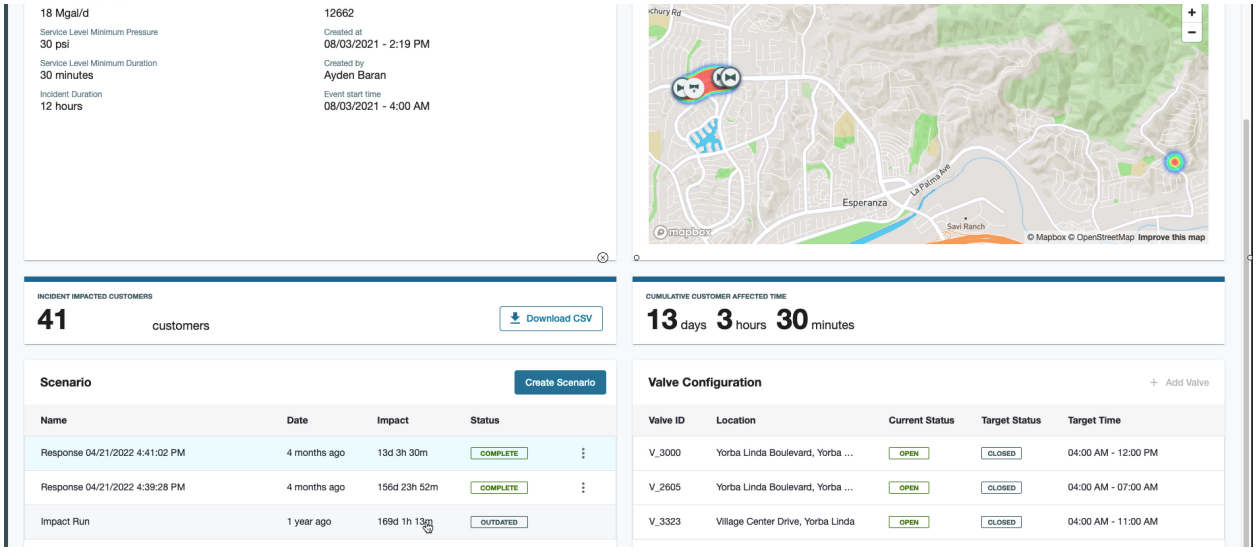
Leveraging the power of digital twin simulation, you can run an impact assessment using your own hydraulic model and your live SCADA data - combining Autodesk's industry leading simulation tools like InfoWater Pro and WS Pro with the power of the Info360 cloud platform.

Let's use this capability to assess this burst incident. Using the event water loss, the resulting minimum service level pressure and minimum service level duration, and how long the incident lasted, you can create different scenarios for what could happen. In the case where you do nothing to mitigate, the heat map shows 170 customers would be impacted for a cumulative affected time of 67 days – that's adding up the impact for all impacted customers.



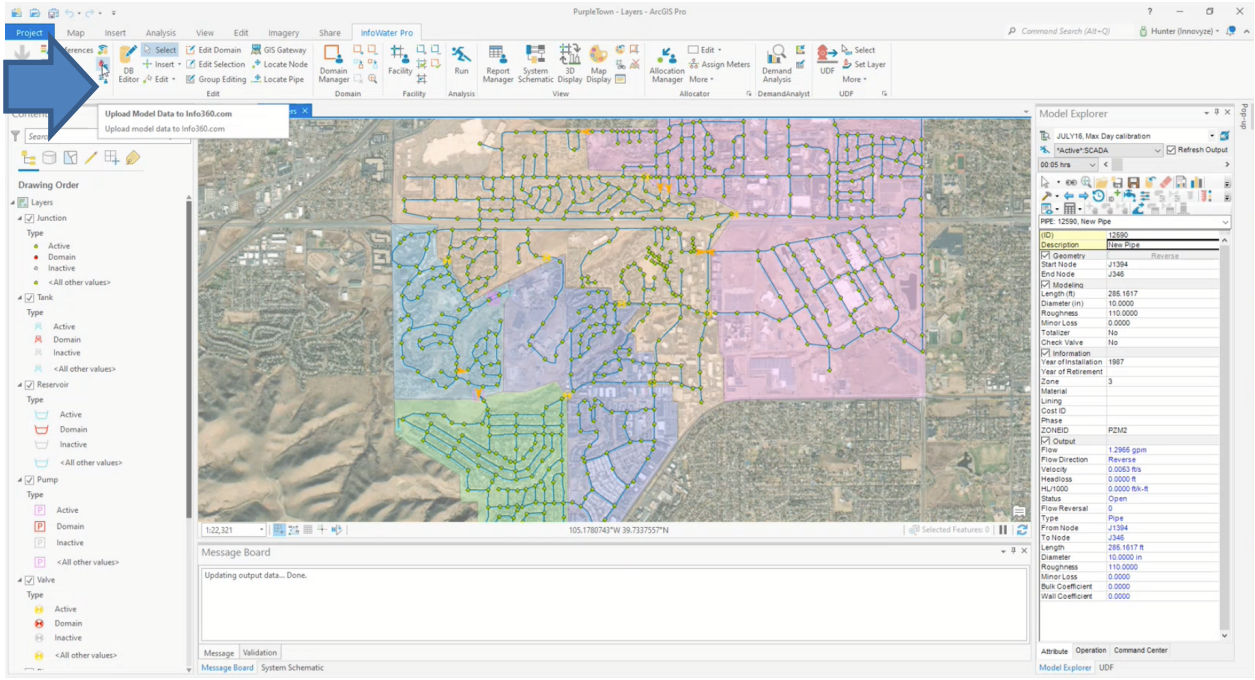
Above is a different incident which provides a great example of the potential impact of planning and taking quick action. The original impact run showed an impact to over 900 customers and 156 cumulative impacted days.

By isolating this zone, this best-case scenario shows just 41 customers impacted for a cumulative 13 days. And it's not just about reducing outage time, just think about the water you're saving.



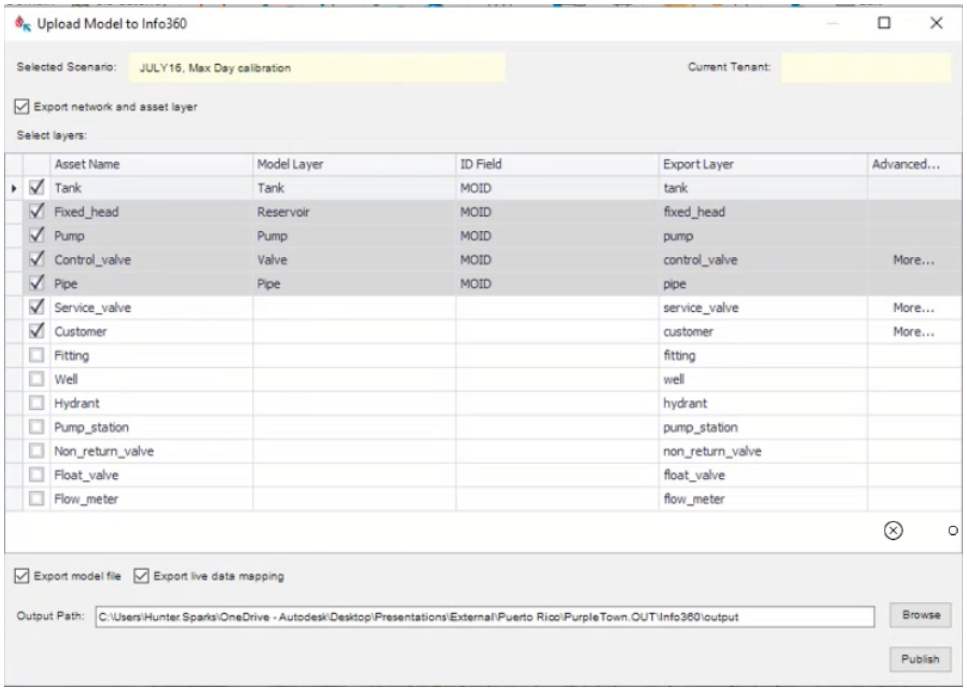
You can also view the interactive simulation results showing the impact over time and the number of customers affected using the time series results from the hydraulic simulation. Comparing the default response with the potential mitigation scenario reveals a pretty dramatic difference helping you decide the best course of action.

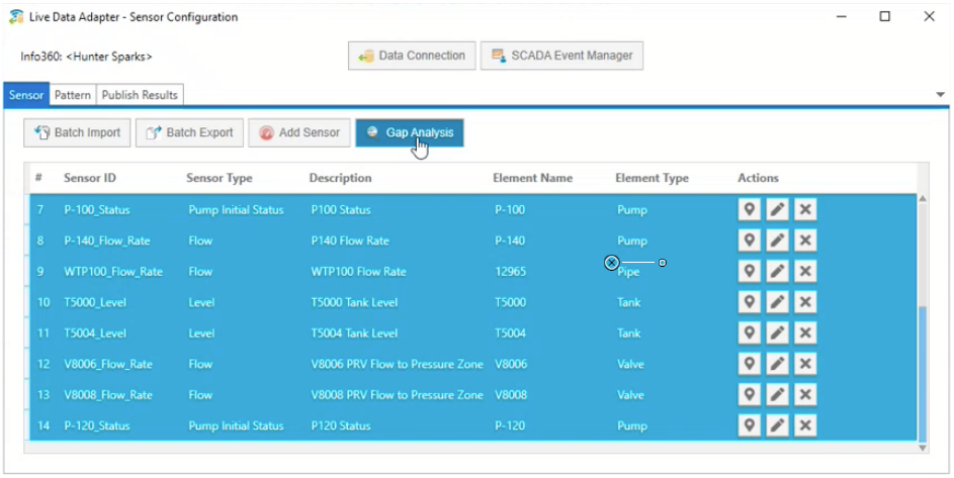
InfoWater Pro with Info360 Insight



Let's see how Info360 interacts with Autodesk hydraulic models like InfoWater Pro. The screen shot above illustrates how simple it is to publish a model to Info360. Under the project you'll find a little raindrop that uploads the model data to Info360.com.

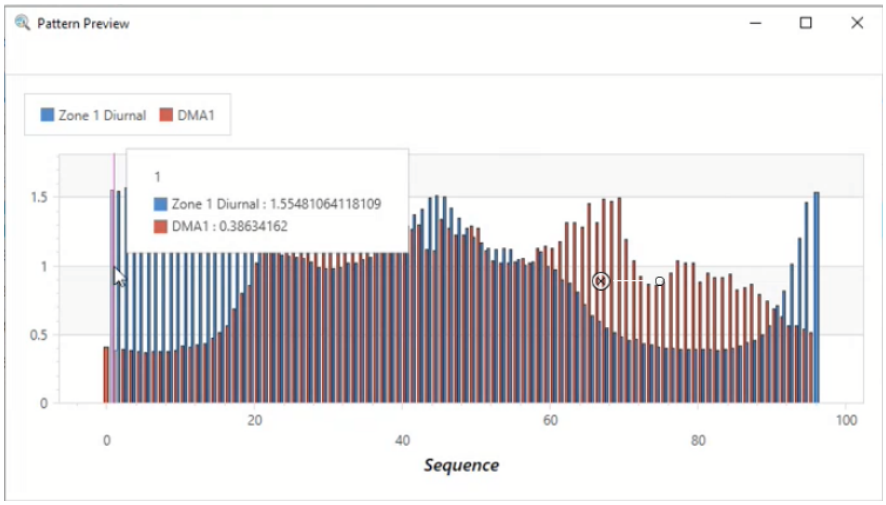
You can also select your scenario and choose what you want to publish into the cloud.





The integration is also 2-way with a live data adapter bringing data from Info360 Insight into your hydraulic model. You can run a gap analysis comparing your hydraulic model simulation run with the actual operation of your network from Info360.

Use the differences or gaps to recalibrate the junctions, pipes and pumps that have discrepancies. Changing settings and controls in the hydraulic model so they better match actual performance under different conditions creates a more accurate model.

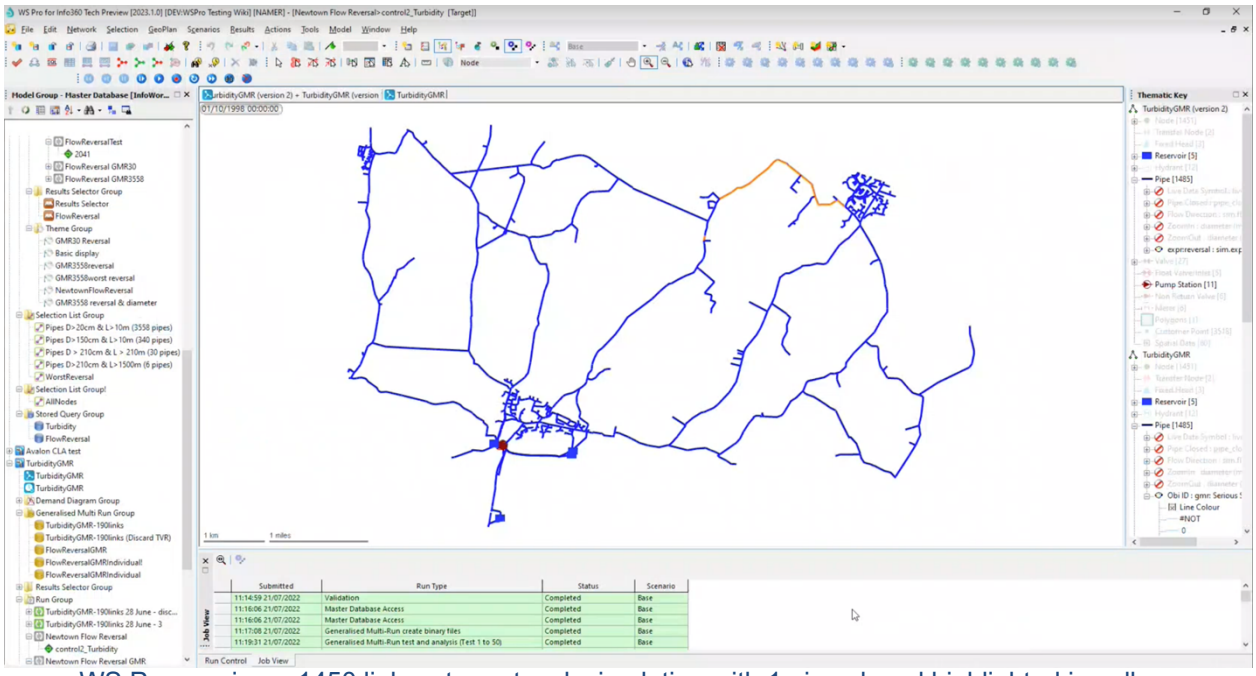


You can also bring in the diurnal patterns that were set-up previously in Info360. Select the patterns you want to use for your different DMAs or zones. These patterns are continuously updated in Info360 so you can use them as demand patterns in InfoWater Pro. You can also upload results of your model runs to Info360 Insight and so you can share and compare them in the cloud

Parallel Simulations with the Info360 Digital Twin and WS Pro

Taking a look into the future, Info360 will drastically improve the scalability of hydraulic simulation modeling by enabling massively parallel simulations of digital twins in the cloud. Say you need to run 1000's of simulations to do risk analysis across different scenarios for design, planning or maintenance. These scenarios can take hours, days or even weeks to run. With Info360 they can run in parallel in minutes leveraging the near unlimited scalability of AWS.

Below is a hydraulic model of a water network in one of Autodesk's water modeling tools, WS Pro. The model has over 1450 pipes or links. What if you want to run a risk analysis of the flow reversal that might occur if any of these pipes were to close or block. The example below illustrates closing just 1 pipe requiring 1 simulation run. To do the risk assessment, 1450 simulations have to run each closing a different pipe.

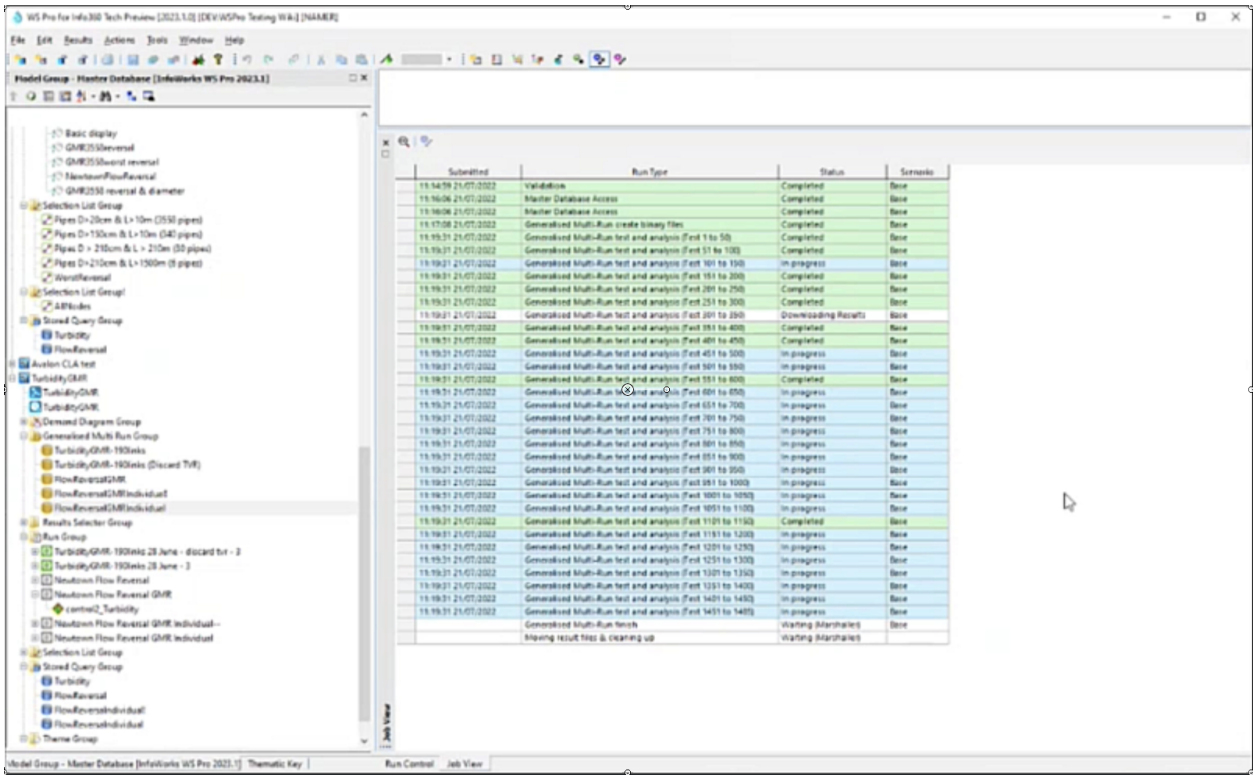


WS Pro running a 1450 link water network simulation with 1 pipe closed highlighted in yellow.

WS Pro has a feature called Generalized Multi-Run or GMR that can stage these simulations and produce a data cube of the results, However, GMR is limited to the capacity of the desktops or compute servers available to that user or site.

Why the Digital Twin is in the Cloud

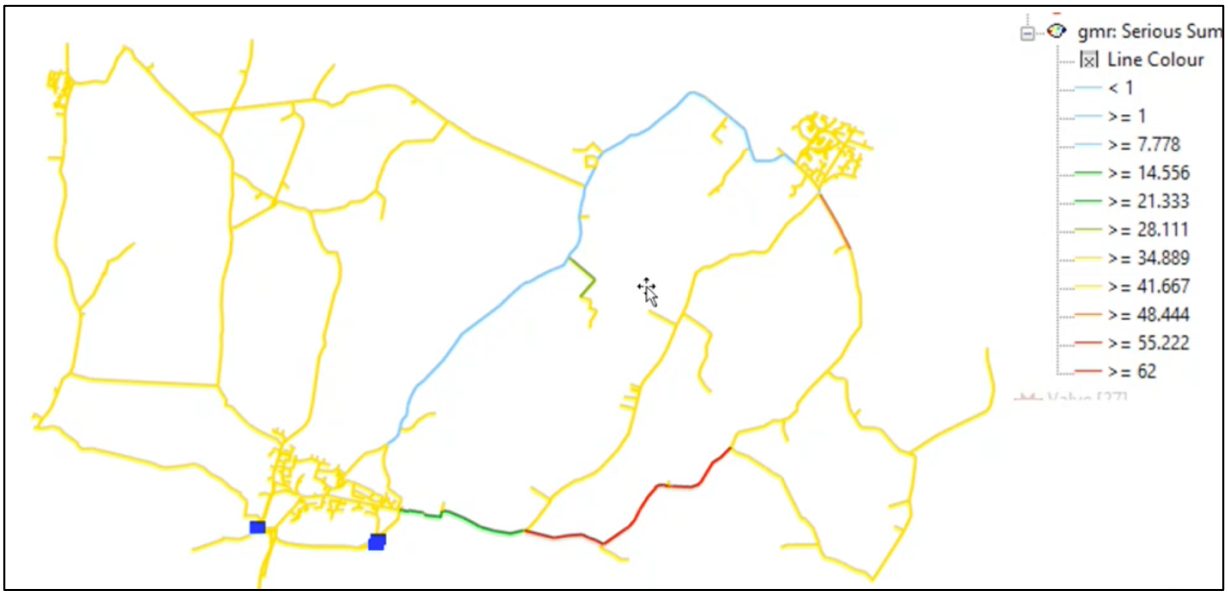
In the near future, instead of running just 1 simulation at a time, you can speed things up using a digital twin running on Info360. Here as example 1450 WS Pro digital twin simulations running in the cloud. Those highlighted in green are complete and those highlighted in blue are in progress. The rest are waiting for everything to complete. These 1450 simulations complete in under 15 minutes.



WS Pro running 1450 simulations in under 15 minutes using Info360 digital twins.

Cloud simulations use AWS Fargate which is a serverless compute engine that provides massively parallel scalability. Each set of simulations is starting up, configuring the model, and setting conditions for each specific scenario. In this case, each scenario closes a different pipe. With the integration between the desktop and the cloud coming soon, the user can instantly launch their digital twins in parallel running 1000's of scenarios on AWS, but with the desktop tools and user experience they are comfortable with.

Expanding The Potential for Analysis



These are the final results with 62 pipes highlighted in red indicating where there is high risk of significant reversals if that pipe were to get blocked. This type of analysis helps focus where maintenance would have the most impact.

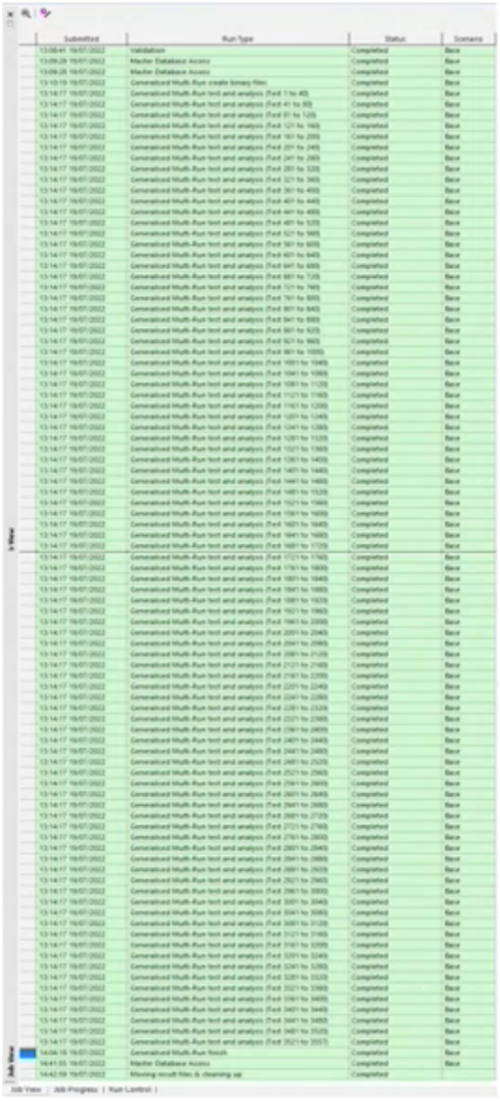
Here is a different view showing where there is a high risk of reversal. For those pipes in black almost anything triggers a reversal, and hence the need to focus on mitigation.

Upping the Scale, Asking Bigger Questions

Instead of a 1450 links, to the right shows a more complex 12,000 link model running over 3,500 different scenarios. In this case, 75 different servers were launched in parallel. Everything completed in under an hour.

And there is no significant additional cost for increasing the speed and collapsing the time. 75 machines running in parallel takes almost the same compute resources as running 1 machine 75 times as long. There are some additional start-up resources, but the difference is generally not significant for typical model and scenario complexities. It just completes faster.

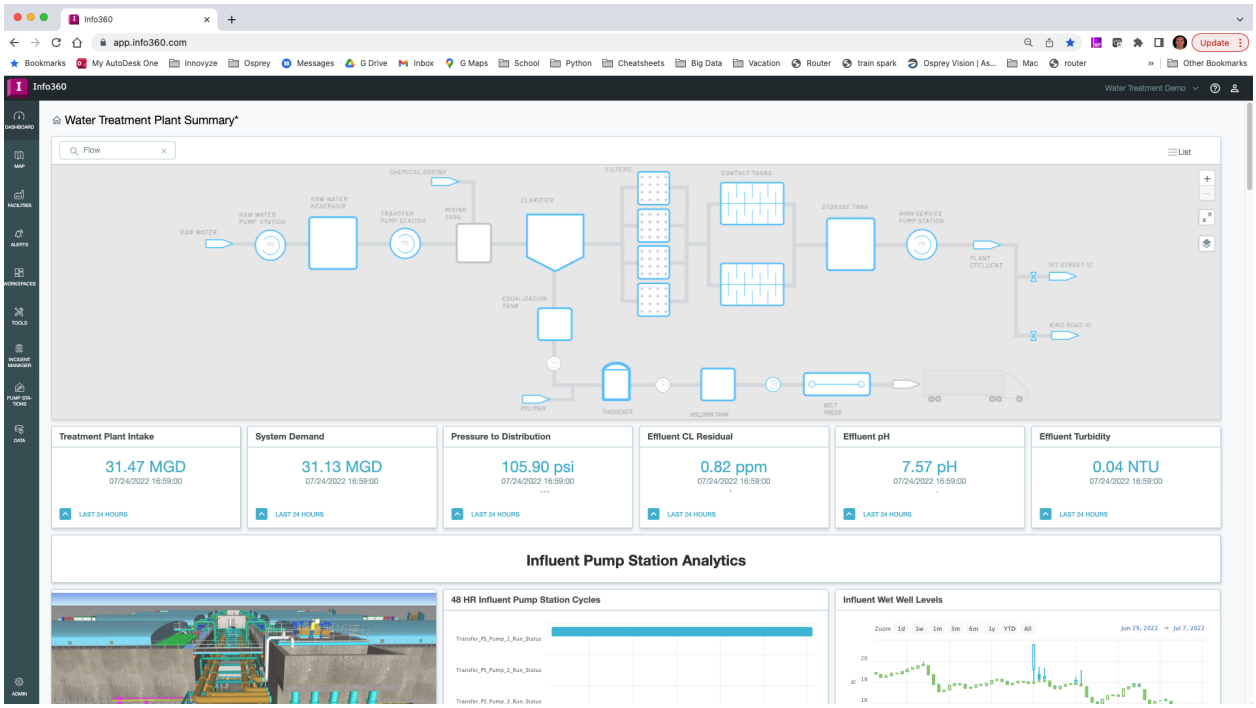
It will be game changing when anyone can simulate and analyze all the potential scenarios that quickly. It will change the nature of the questions that can be asked of digital twins and what is considered possible.



AUTODESK UNIVERSITY

Info360 Plant

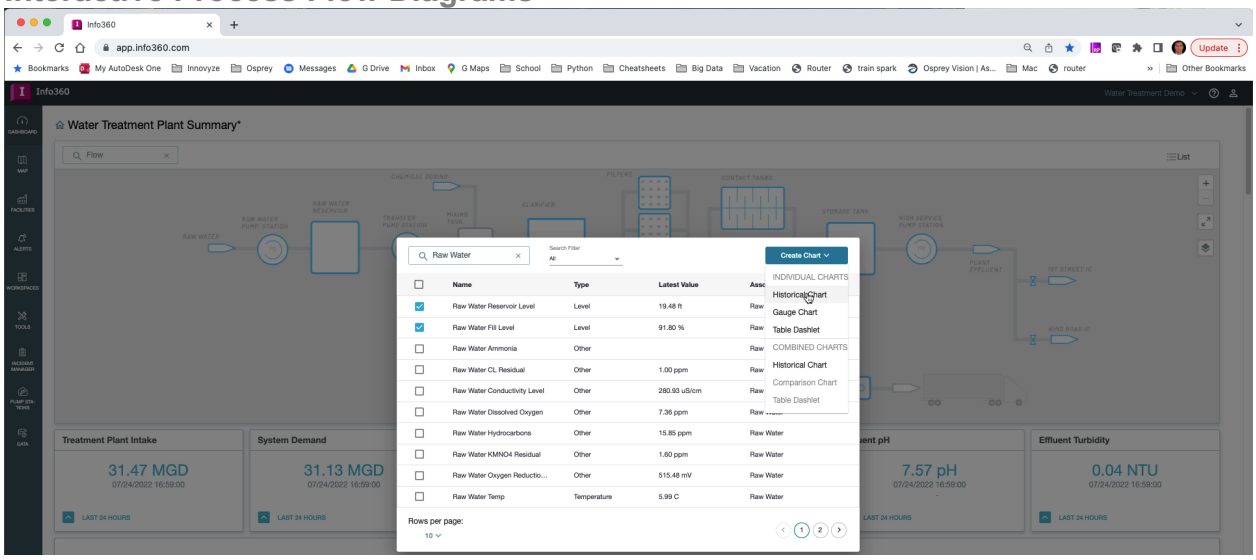
Operational Intelligence for Water and Wastewater Treatment Plants



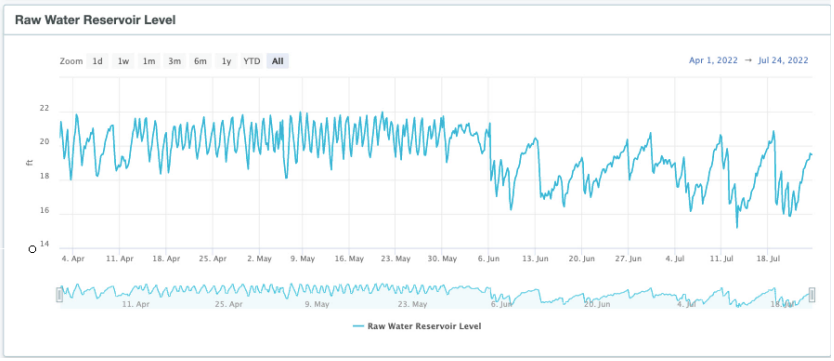
Info360 Plant is our newest offering for the Info360 platform. It focuses on helping water and wastewater treatment plants operate efficiently and effectively. Info360 Plant leverages the power of the Info360 platform and extends many of the features of Info360 Insight that were presented previously including Workspaces, Alerts, Incident Manager and the robust integration to SCADA and other data sources. Rather than review these underlying platform capabilities, let's focus on what's new and how this all works for plants.

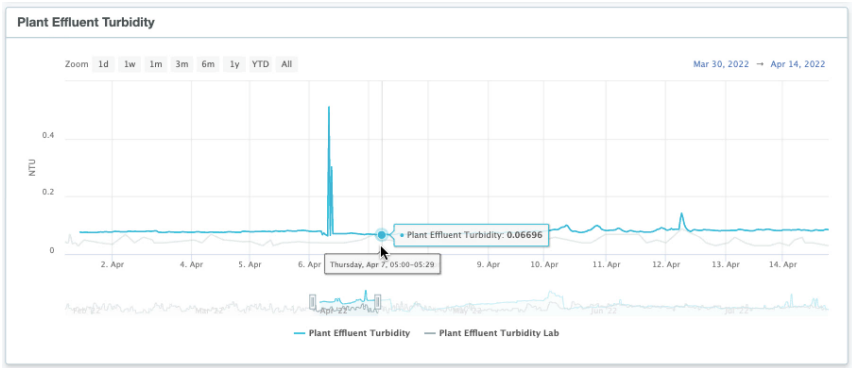
Like Info360 Insight you start with your dashboard, but here the point of focus is the plant process flow providing a visual interface for the plant digital twin. One of the important new capabilities is the ability to create or upload your own process flows and link them to your facilities, operations, and real time sensor data feeds. Here is a sample process flow diagram for a water treatment plant. But this is not a static image.

Interactive Process Flow Diagrams

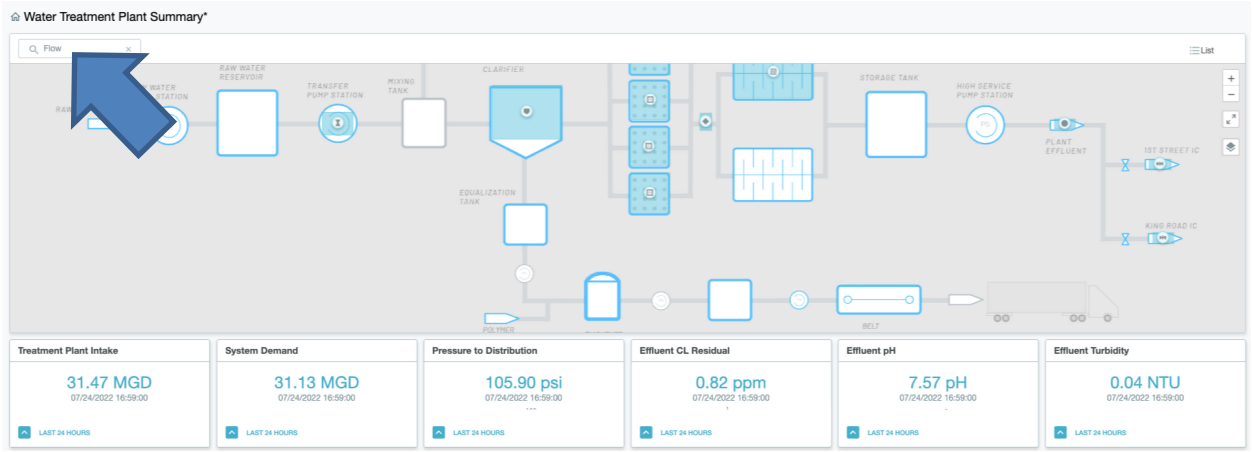


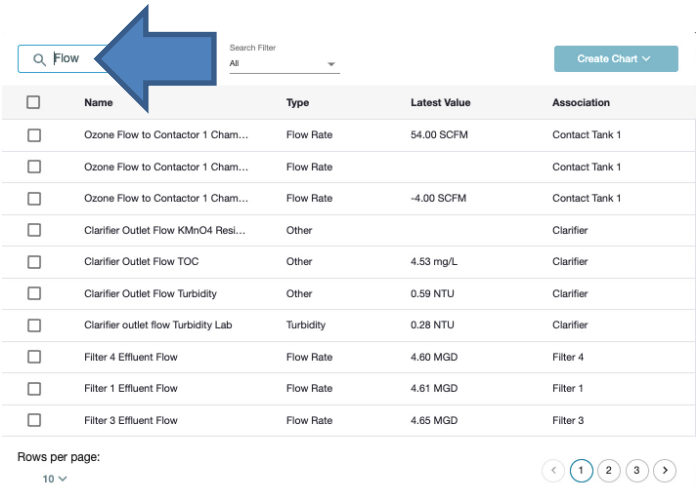
When you click on an operation or facility, a list of the associated sensors and types appears along with their latest readings. This process flow is interactive between the user, the plant and its digital twin. Select Raw Water from the diagram and see all the influent data. And if you need more information, select some sensors along with the type of chart, and it drops onto the dashboard. You can drill into a range of time to focus on a reading that does not seem right.





You can compare charts. Here turbidity sensor measurements are compared with lab measurement to see if there are inconsistencies. The key is how easy it is to take information from your process and create sophisticated interactive visualizations and drop them on your dashboard.





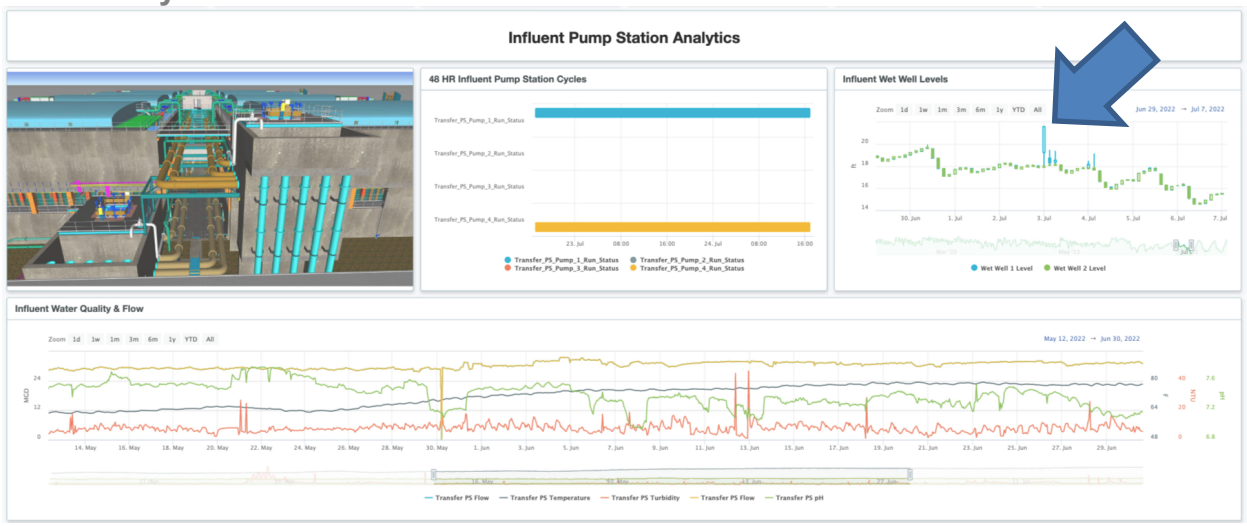
Like maps, process flows are also searchable as well, so you can find assets and facilities in your process digital twin. Here you can see where all the flow sensors are in this operation.

Use the list icon to see the detailed results and narrow down the query to just the sensors you are looking for. Of course, you can instantly drop comparison charts on the dashboard to review more detail.

Right under the process flow, this example overview workspace has the primary metrics used to drive the plant including inflow and total demand along with pressure and key water quality measures. And again, you can drill down to more detail over the last 24 hours.

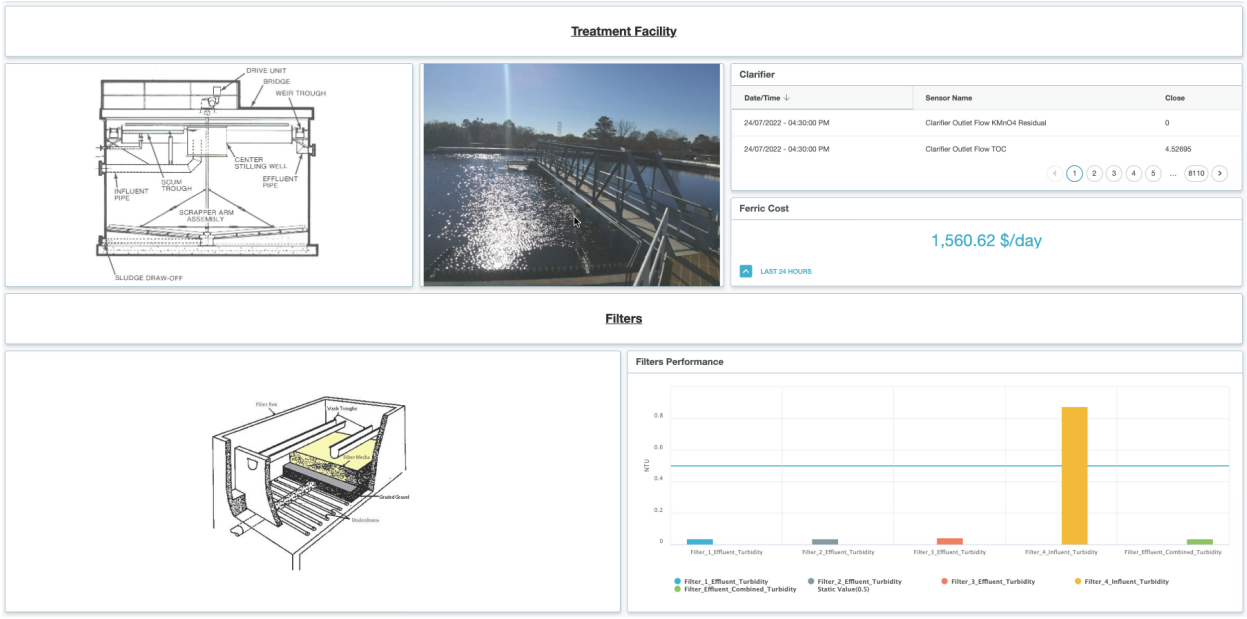
All of this is fully configurable by you.

Plant Analytics



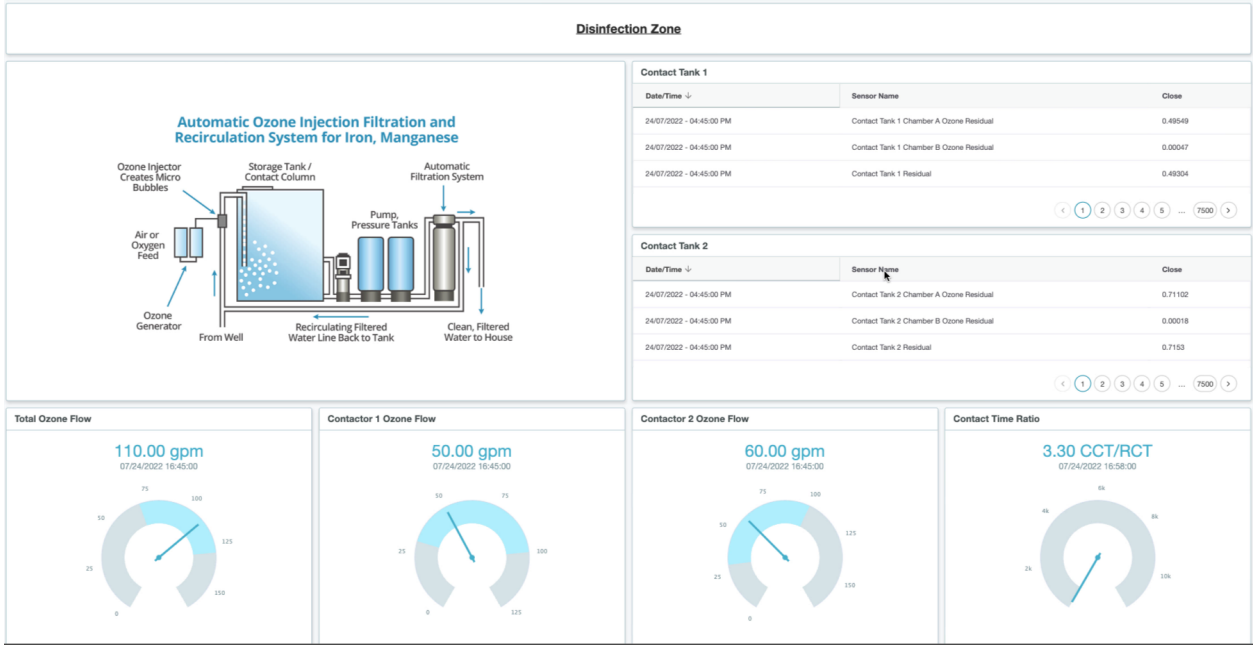
Let's review the other types of analytics you can track for the plant. Above shows more detail on the influent and the inlet pump station including which pumps have been operating.

The candlestick charts provide a great way to identify anomalies like the one indicated by the blue arrow, and you can drill in to get more detail. Below is a great comparison of inlet water quality and flow that can help reveal correlated events.



Above is a schematic of the clarifier along with a picture. Note that these along with P&IDs can be tagged to allow you to interact with the digital twin.

On the bottom right, see how to compare operations using side by side comparison charts to identify potential inconsistencies. Clearly there are issues with filter 4 turbidity.

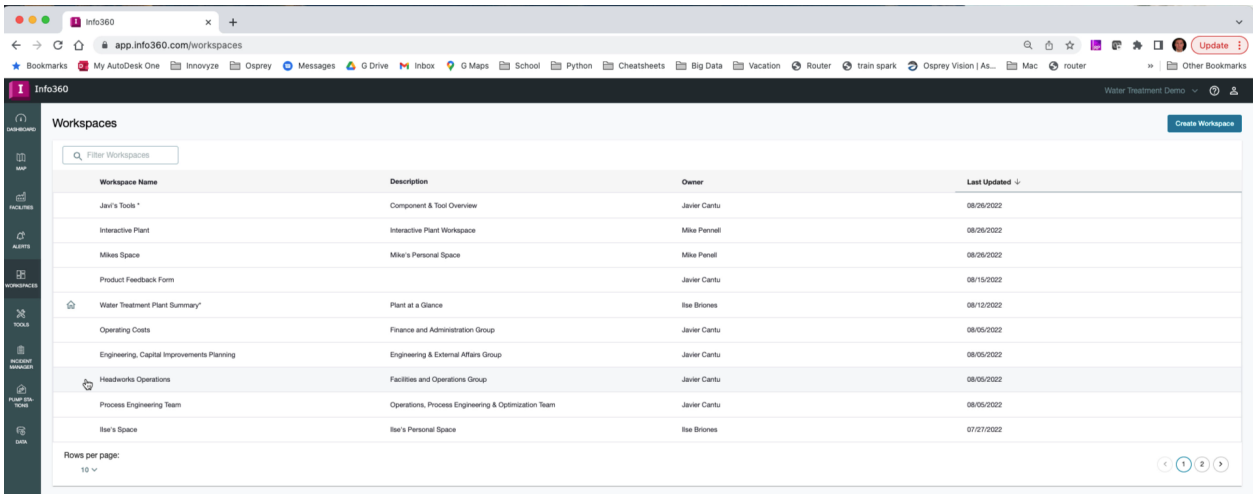


Here are the contact tanks and ozone flow through the disinfection operation. It is easy to see that all flows are normal using the normal zones on the gauges.

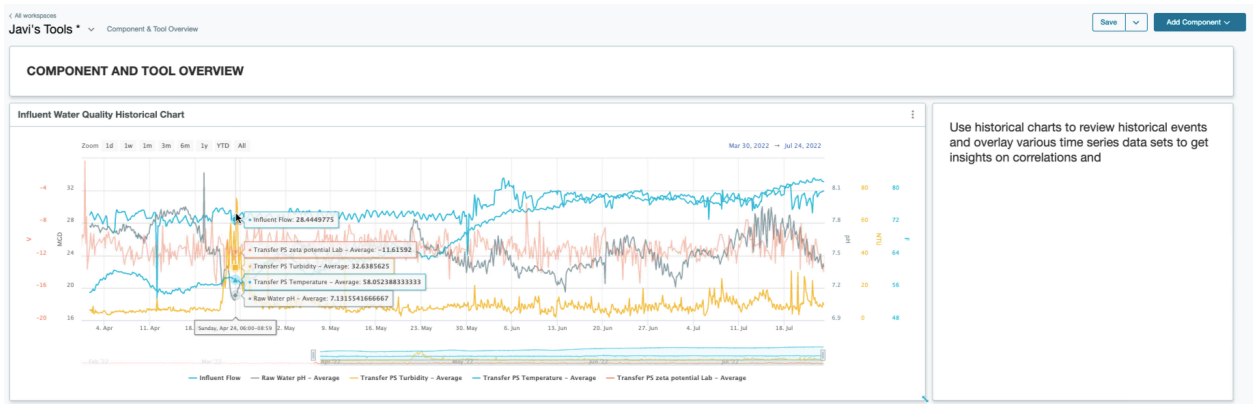
Below the analytics are tracking plant effluent including pump operation and comparative water quality metrics over time.

Let's go to the workspaces where you can make changes to this and any workspace.

Plant Workspaces

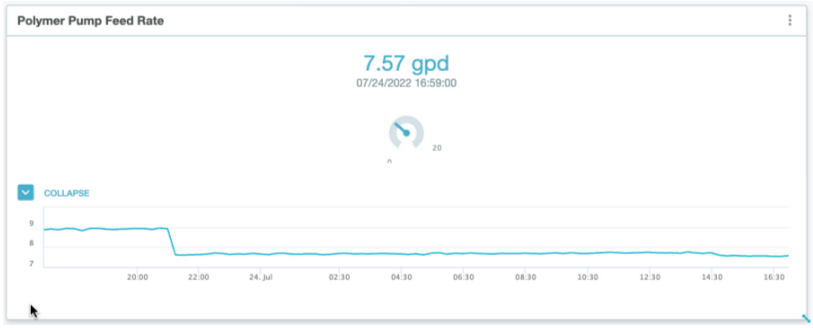


On the workspaces menu, there can be many different workspaces for different operations like headworks or functions like capital planning or groups like process engineering and of course personal workspaces. Let's take a look at a personal workspace.

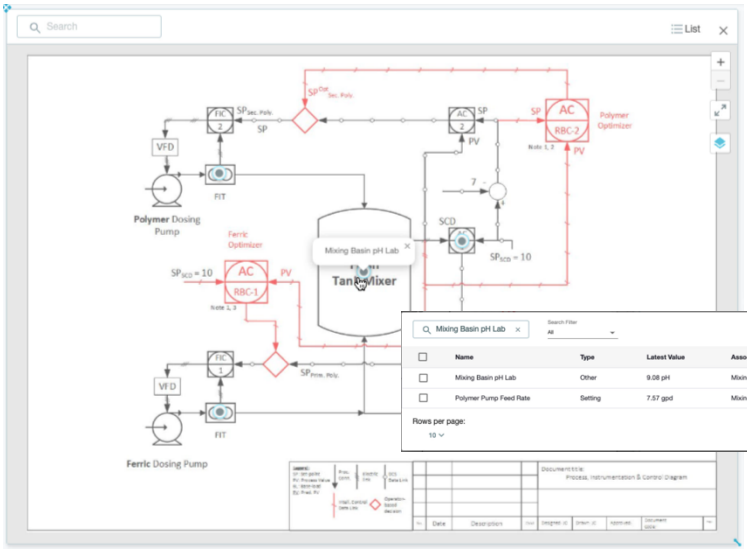


This workspace has some guidance on how these charts can best be used. Historical charts are great at overlaying related metrics like influent and effluent water quality to see the relationships and when there are inconsistencies.

Gauges are for current information and immediate status. And you can drill down to the last 24 hours easily.



Any of the charts can be modified by just adjusting the settings on the dashlet.



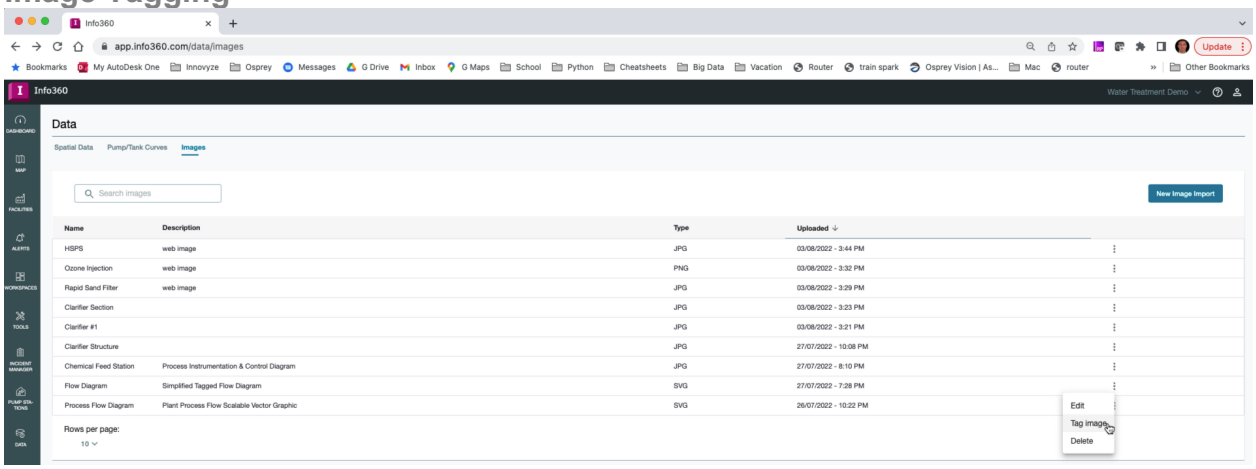
This is an interactive P&ID. These images can be any diagrams you currently use or want to create. You can tag them yourself or our process engineering team can help.

And when you click on an operation you can see all the sensors and metrics associated with it.

Anyone can use Info360 Plant to do whatever analysis they want. Let's say you were having an issue with a clarifier and trying to investigate. You can quickly gather all the relevant current and historical sensor data, charts, graphs, diagrams and document your findings right in a workspace. You can save days or even weeks of work just gathering and analyzing the data.

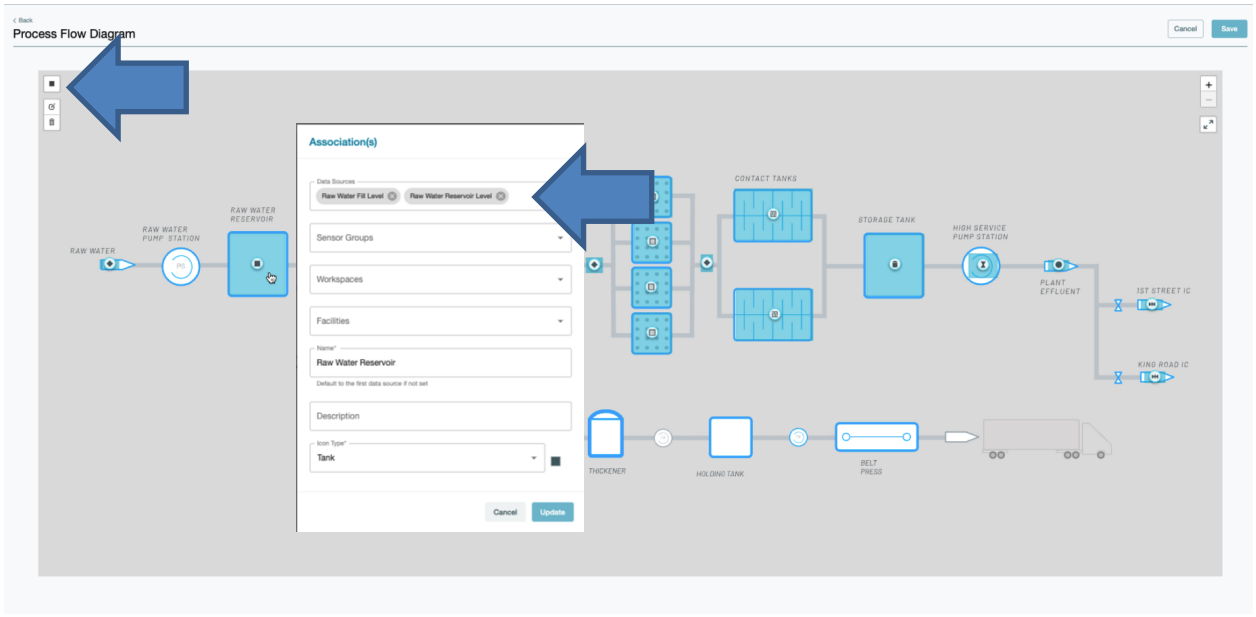
Each workspace and dashlet can also be limited to a specific date range so you can focus your analysis around the time of an anomaly to try to determine what happened and how to mitigate.

Image Tagging

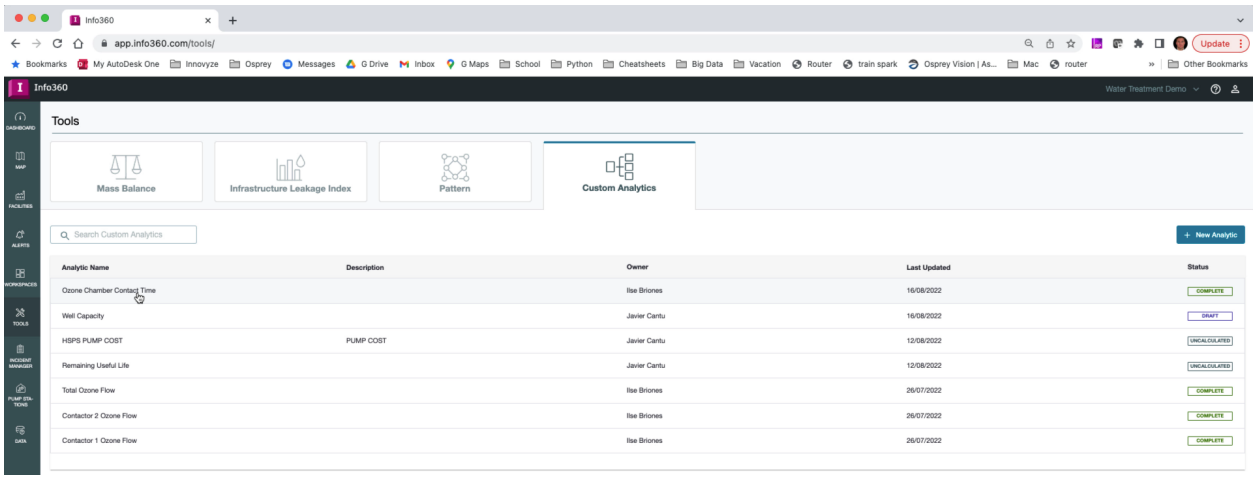


Above are examples of images and types that have been uploaded. Let's tag the Process Flow Diagram that is on our dashboard. Below see the blue highlights indicating this image is already tagged. Click on a facility or operation that is tagged and see how it is configured. Assign data sources or sensor groups. Link to other workspaces and facilities to easily navigate around the information. Give it a name and an icon. And that is a tag.

To create a new tag, click on the tag icon in upper left. Draw a box around the facility. Select the associated sensors searching by name. Assign groups, facilities or workspaces if appropriate, add a name and icon, and save. That is how easy it is. Like tagging a photo. Images are automatically updated throughout everyone's workspaces immediately - the benefits of the cloud. You can do this yourselves or Autodesk has a team of expert process engineers that can lend a hand.

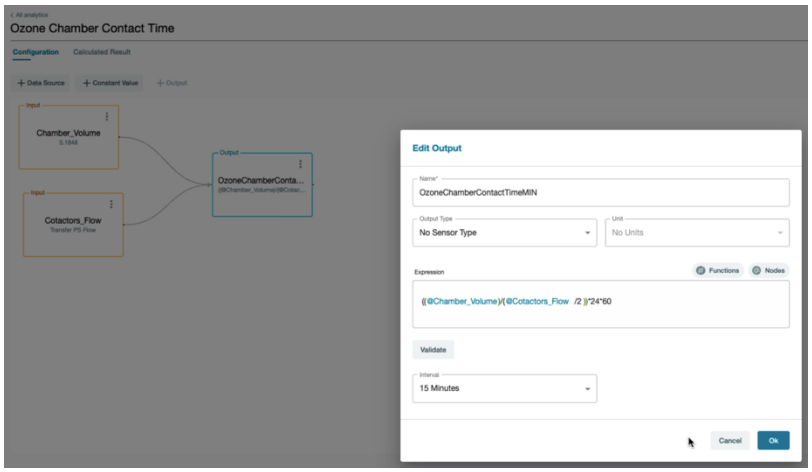


Tools for Plants



Tools and analytics were covered as part of Info360 Insight, and they are very similar in Info360 Plant. Let's just quickly go over how they can be configured for a plant. Some examples include measuring contact time, capacity, pump operating cost, remaining useful live.

Looking at the Ozone Chamber Contact Time, you can see how to create key metrics using live data feeds and mathematical operations and functions.



Analytics can also be strung together to compute aggregations.

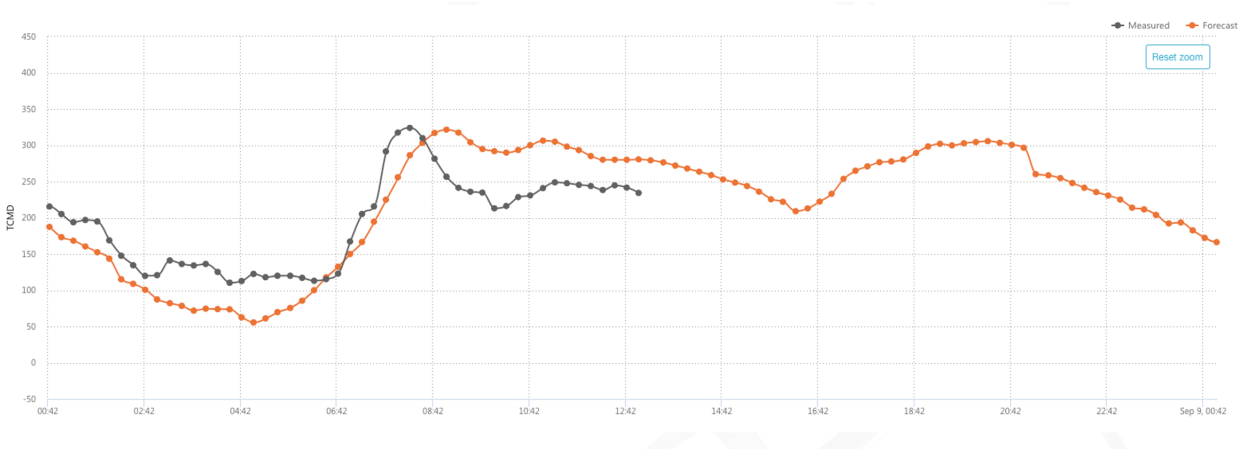
There is more coming in future releases based on customer feedback.

Facilities is a new capability tracks different operations and assets as a group to analyze and visualize them independently. Alerts and Incidents are handled very similar to Insight

Everyone at Autodesk is very excited about our latest Info360 application – Info360 Plant. It fills a gap in our offering to help our customers manage the entire water cycle - now including the water and wastewater treatment plant. It makes Info360 a truly comprehensive digital twin for water.

AI, Forecasting and Optimization

Looking ahead, Info360 is becoming a forecasting and optimization platform based on combining hydraulic and physics-based simulation engines with advanced artificial intelligence (AI) models. Autodesk is integrating the machine learning and optimization engine of the Emagin AI platform for water and wastewater treatment into Info360 Plant.



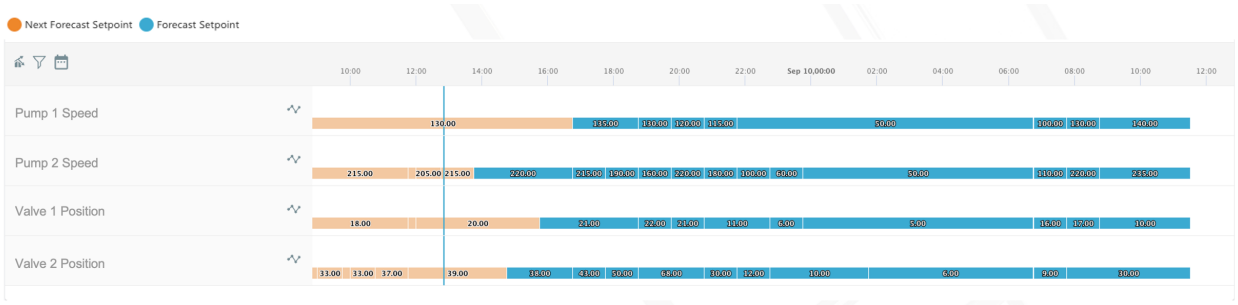
Above is an actual example of an Emagin neural network model working in combination with other machine learning techniques. It is forecasting the water demand based on various conditions and patterns at the plant. In black you see the actual demand while in orange you see the forecasted demand. When fully integrated, these types of models and forecasts will be available on Info360 dashboards, workspaces and reports along with all the other powerful analytics discussed already.

Using the AI based digital twin of the treatment plant, the forecasts can be flushed through the entire plant to forecast flows, pressures, reservoir levels, turbidity, BOD, and other water quality metrics at various points in the process. These types of forecasts give operators and managers a view of future conditions so they can respond quickly to a changing environment. Most importantly, they enable optimization.

Optimizing Setpoints

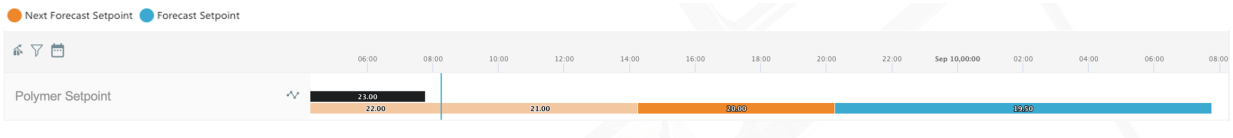
With accurate forecasts and a scalable plant digital twin, it is possible to recommend setpoints by modeling and simulating different potential setpoints to find those which perform the best under expected conditions.

Below is an example Emagin schedule of pump speed and valve position setpoints. It is determined using genetic algorithms to efficiently explore potential setpoints, simulate the impact on the plant using digital twins, calculate the resulting cost and energy utilization, and finally select the best performing result. These digital twin simulations are performed in parallel using the incredible scalability of AWS.



With the integration of these existing AI models and optimization techniques into the Info360 platform, these recommendations and associated forecasts will be available in Info360 dashboards, workspaces and reports.

There are many optimization workflows that will be introduced. Below is an example of a polymer dosing optimization recommendation used to reduce chemical costs and maintain appropriate turbidity levels.

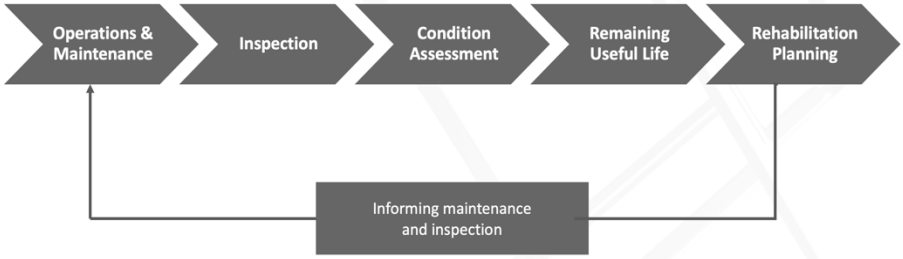


Similar models for aeration and blower setpoints, dewatering, disinfection and many other use cases are also in the works. Autodesk is combining operational analytics for networks and plants, cloud based hydraulic simulation engines running at scale, and advanced AI/machine learning models – all together on the Info360 SaaS platform. All built on the scalability of AWS. All together Autodesk is offering the most powerful digital twin for water available.

Info360 Asset

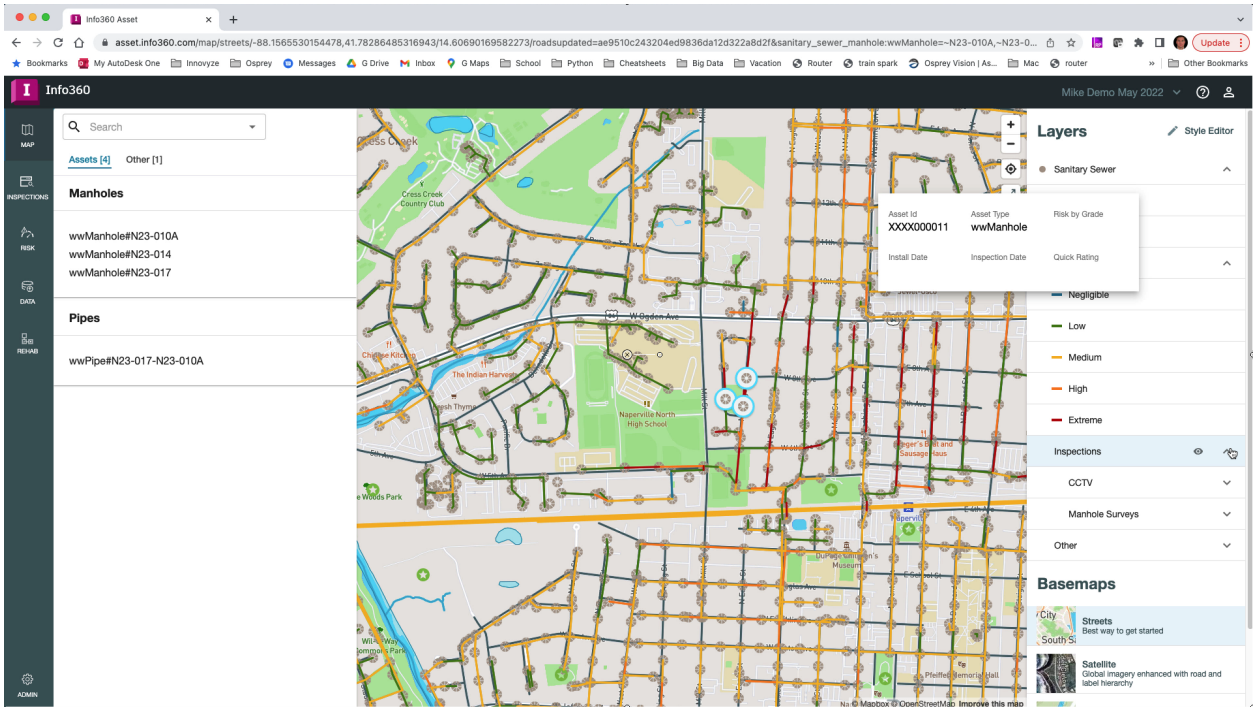
Informed, Actionable Infrastructure Management in the Cloud

Info360 Asset is the Asset Management component of the Info360 SaaS platform. It focuses on the workflow you see to the right.



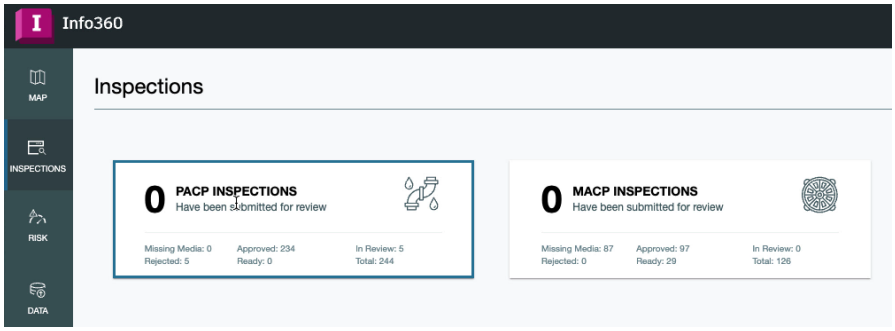
It delivers data-driven capital and O&M plans based on the latest asset condition with highly configurable risk models and prescriptive rehabilitation plans.

Info360 Asset works bottom-up asset-by-asset looking at the likelihood and consequence of specific assets failing, and the available remediation and mitigation plans to avoid failure. It rounds out the Info360 Insight and Info360 Plant operational analytics applications by maintaining the assets that support those operations.



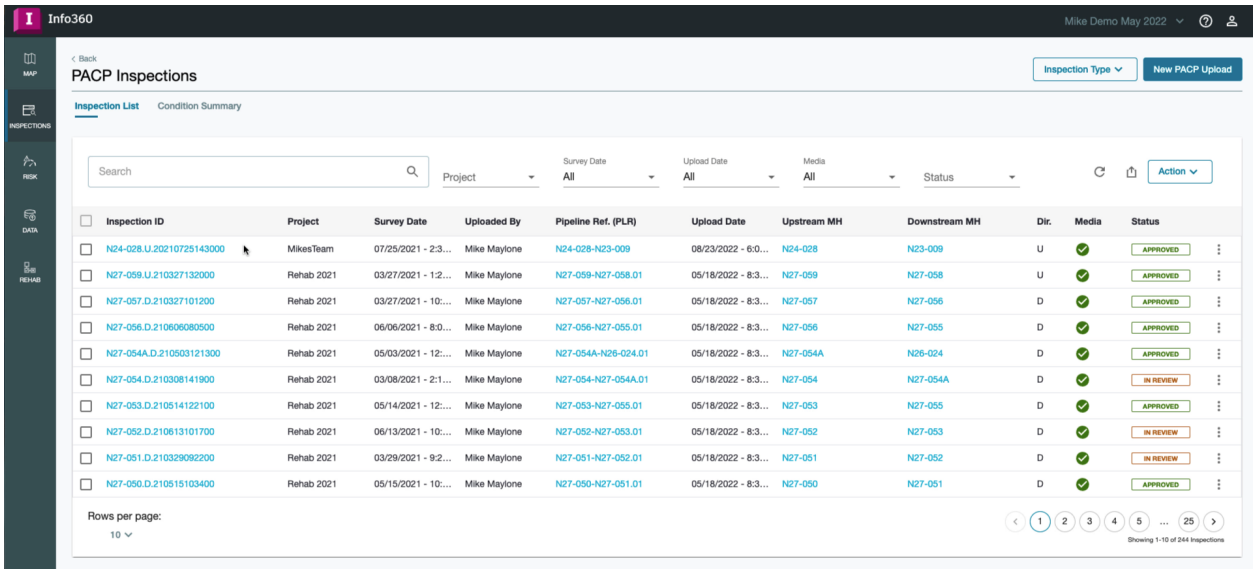
Similar to the rest of Info360, it starts with the map view, but now with of all of the pipe and manhole data for the sewer network. Info360 asset supports sewer data and recently added water distribution assets. As in all Info360, it is fully searchable. You click on any of the assets in view and see all their details and ultimately the relative risk for each asset, the rehab actions that are assigned as well as individual inspections and geospatial data.

Inspections



Info360 manages all your inspection data, including your PACP or pipeline inspections and your MACP or manhole inspections. It handles all the associated data: who surveyed it; when was it surveyed; the material, pipe, and much more.

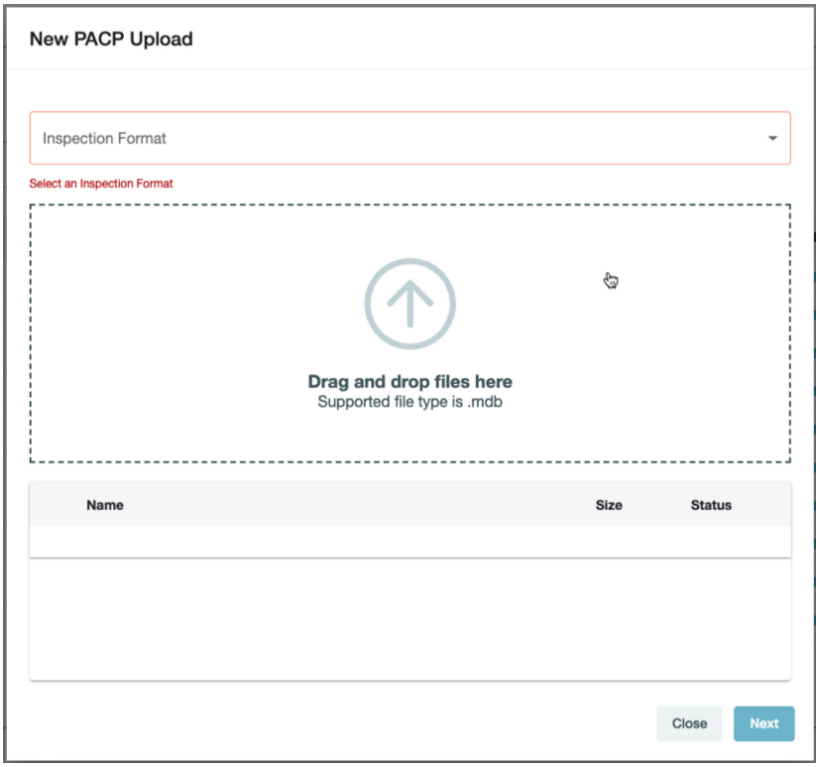
The application calculates scores for all assets to evaluate their condition, and records all defects identified within pipe and manholes. Focusing on PACP or pipe inspections, below is the inspection portal. This is where users at the utility or contractors in the field upload their inspection data directly to Info360. This table shows all the inspections coming in along with all the associated data. There are also built-in workflows for Submission, Approvals and Rejections.



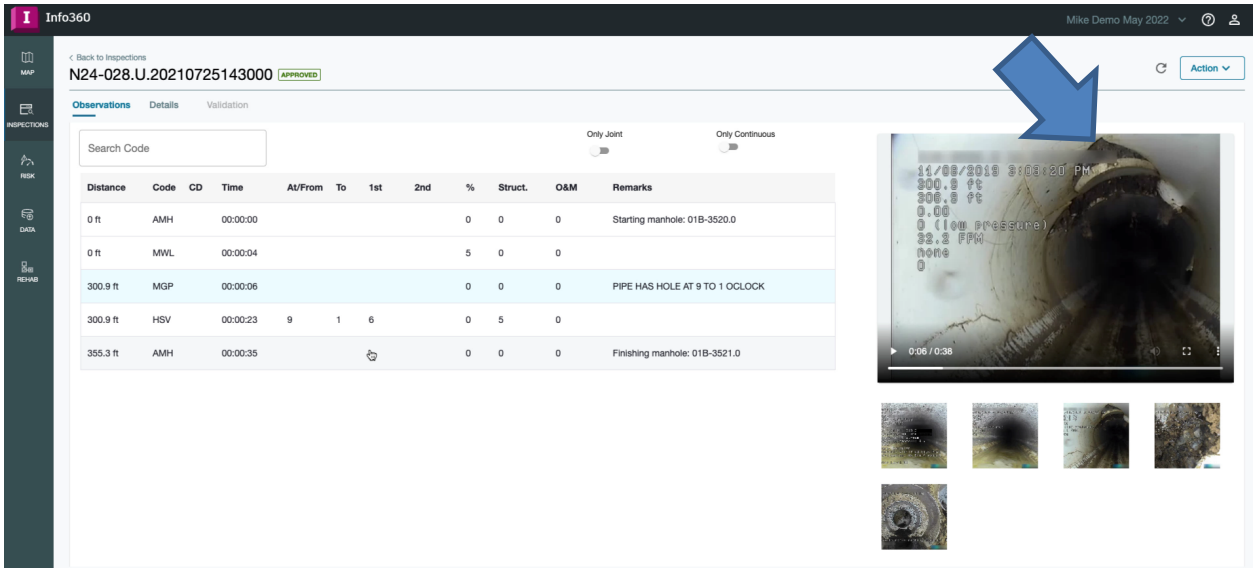
A key advantage of the cloud-based platform is the ability for anyone to upload the data from anywhere. Info360 handles all the validation and security.

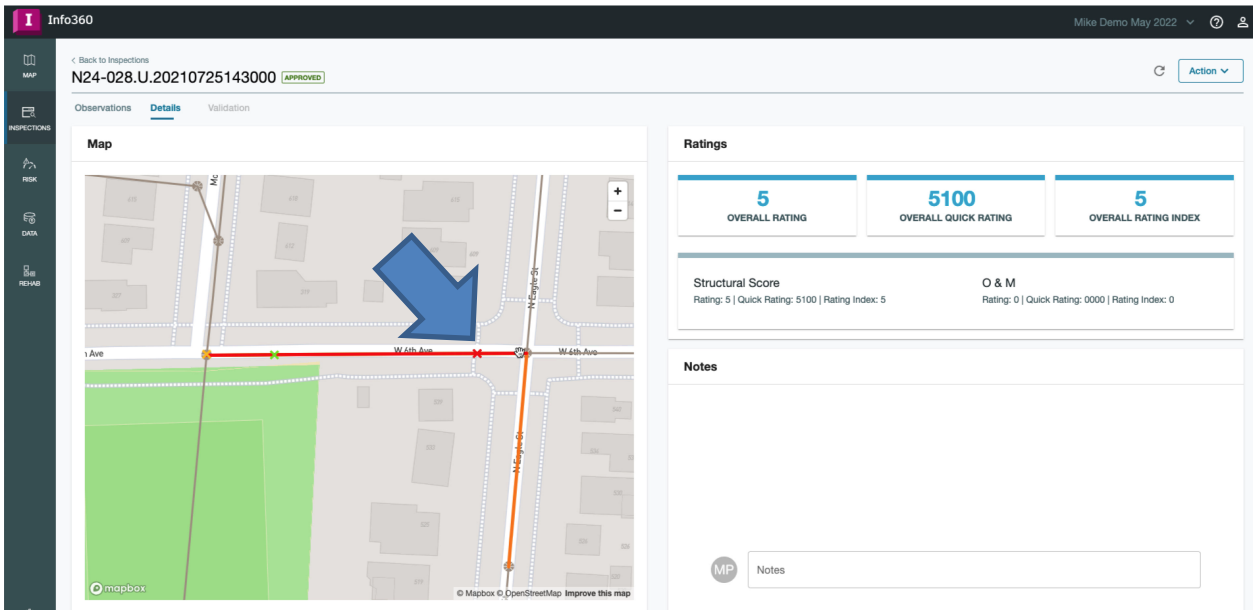
Info360 validates against the PACP and MACP standard with more standards coming. It checks that all the media required has been provided.

The process will also associate all the individual defect images with the inspection video, so during review and approval you are able to review the images and see them on the map.



The inspection below has already been approved. You have access to the full CCTV video which you can play at 2x speed. The system maps out each observation which you see in the list. In this example a hole in the top of the pipe with soil poking through is clearly visible. You can add any other relevant observations as well for future reference.



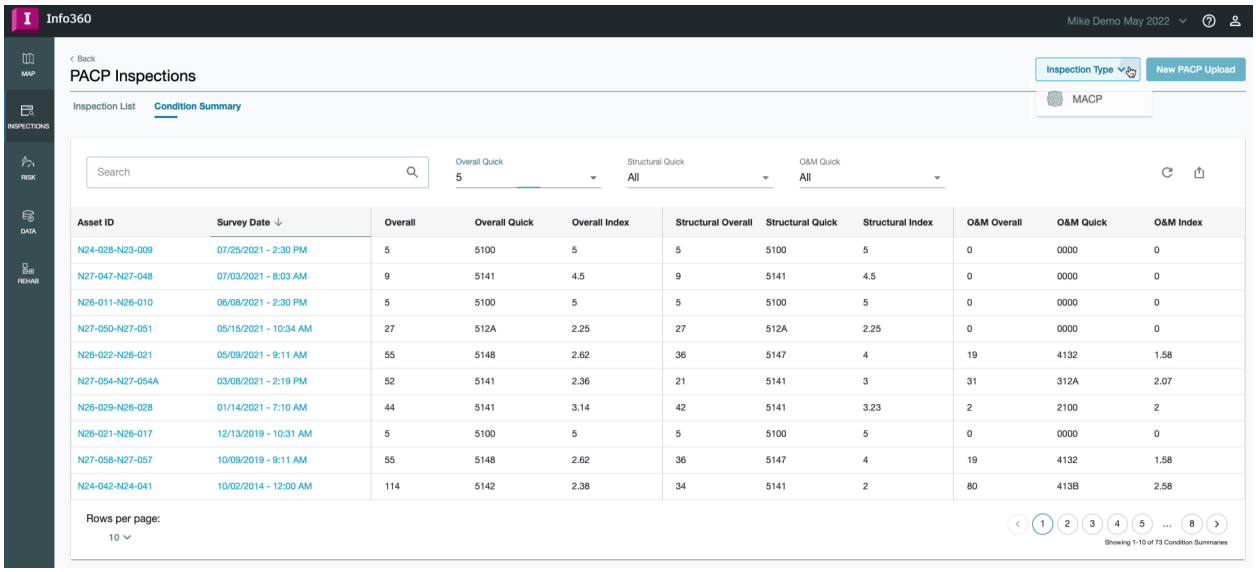


Above the system identifies the defects and where they occur in the pipe to be displayed on the map. The arrow highlights where the defect is marked on the pipe and likely where the hole is.

Below is all the metadata gathered from the inspection that will be incorporated into the risk scores.

General

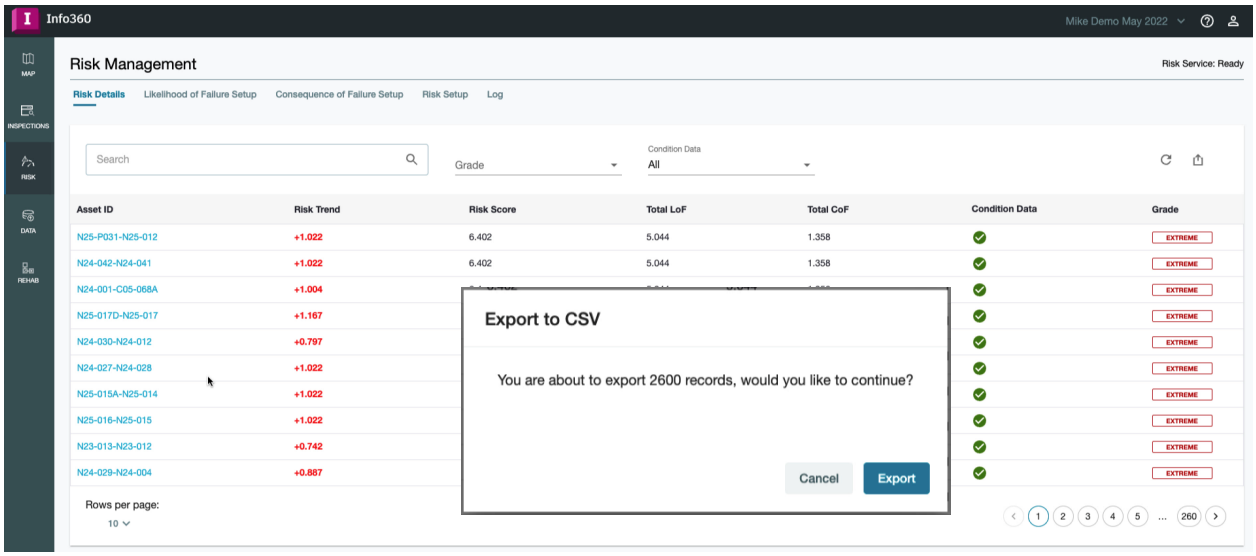
Surveyed By Mike Maylone	Uploaded By Mike Maylone	Reviewed By 123-asc	Reviewer Certificate No. --
Owner --	P/O Number --	Work Order Number --	Media Label --
Project MikesTeam	Date 07/25/2021	Time 8:30 AM	Sheet Number --
Weather 1	Pre-Cleaning N	Date Cleaned 08/26/2022 - 7:00 AM	Flow Control N
Purpose of Survey X	Direction of Survey U	Inspection Technology Used CCTV No	Inspection Technology Used Laser No
Inspection Technology Used Sonar No	Inspection Technology Used Sidewall No	Inspection Technology Used Zoom No	Inspection Technology Used Other No
Status of Inspection CI	Consequence of Failure --	Pressure Value --	



Once approved, the inspection information becomes the condition for the likelihood of failure score in the risk model. Above are listed all the inspections and pipe conditions that have a grade of five which are all the worst-case pipes. Switch to MACP to look at manholes.

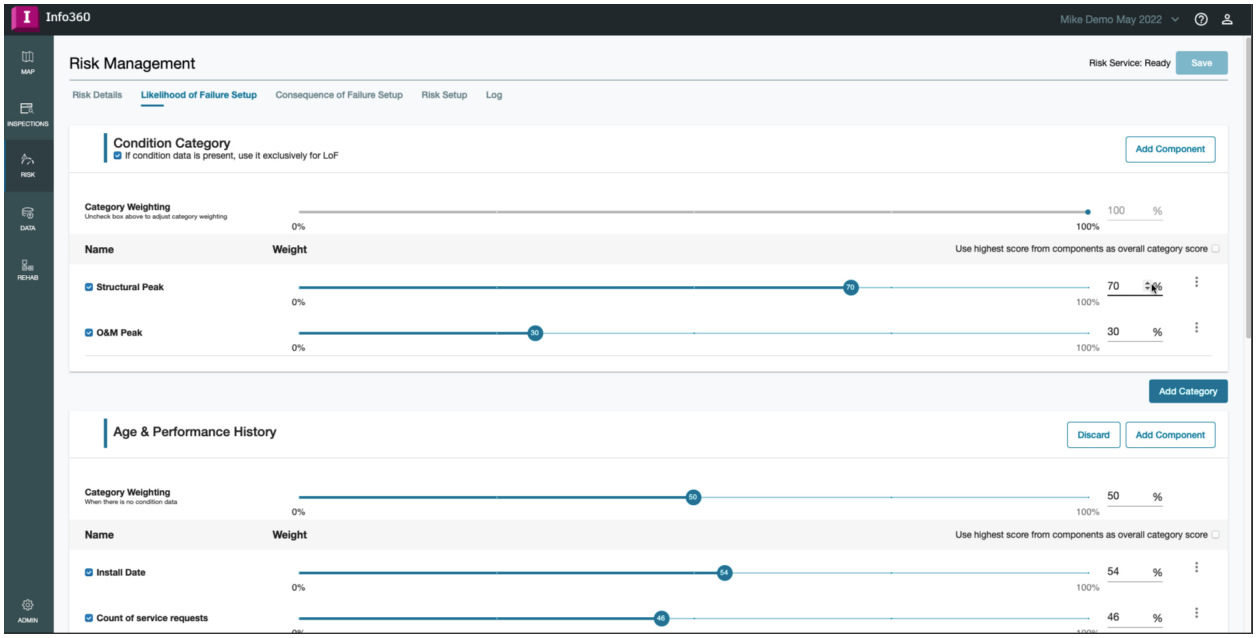
Risk Modeling

The next major workflow is risk modeling. It integrates fully with inspection management using the condition data above. Below is the risk details report showing all assets with risk scores, risk trend, total LoF and CoF and whether or not the pipe has any inspection information. Finally, on the right is the overall risk grade that's been assigned. All this information can be exported to CSV for additional analysis.



You can also just share a unique asset URL and provide all the information anyone needs nicely formatted in real time from Info360, and all data in Info360 is continually updated as new inspections come in and a new risk score is calculated.

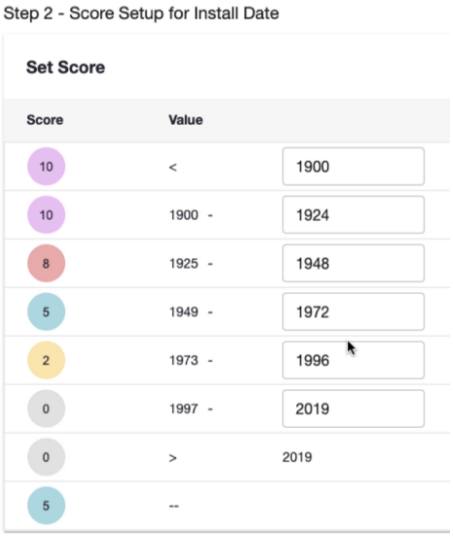
To configure the risk model, first the system assesses both likelihood of failure (LoF) and consequence of failure (CoF), and then an overall risk score is calculated. A different weighting scheme can be applied to LoF or CoF to then define the associated risk rating.

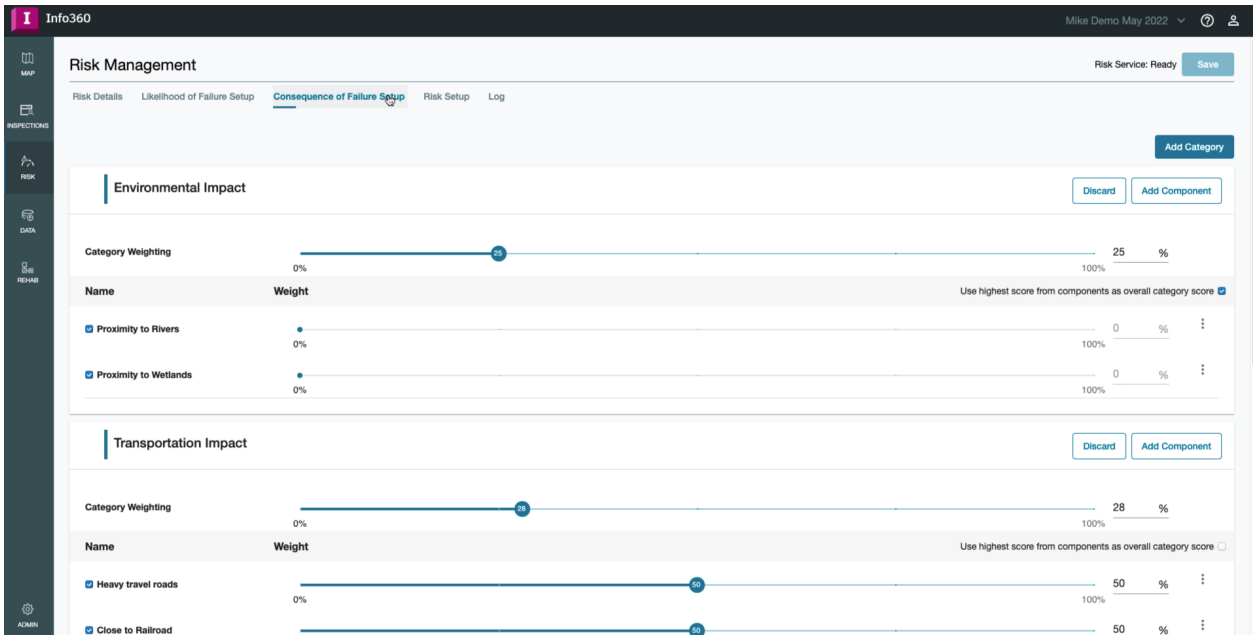


LOF is based on the condition data and the PACP or MACP scoring system from NASCO. In the example above, it is a custom risk model using 70% of the structural peak or worst-case structural defect - like you saw in the image of the pipe with the hole and soil visible. That pipe would be a grade five and give this a high LOF score. There's a 30% O&M or operations and maintenance score.

As you can see on the right, you can assign your own score mapping so its highly configurable. You can also use any other ancillary data and use categories for things like age and performance history and much more. You can even incorporate service requests from the CMS system. This just illustrates the core combination of flexible configuration with consistent methodology.

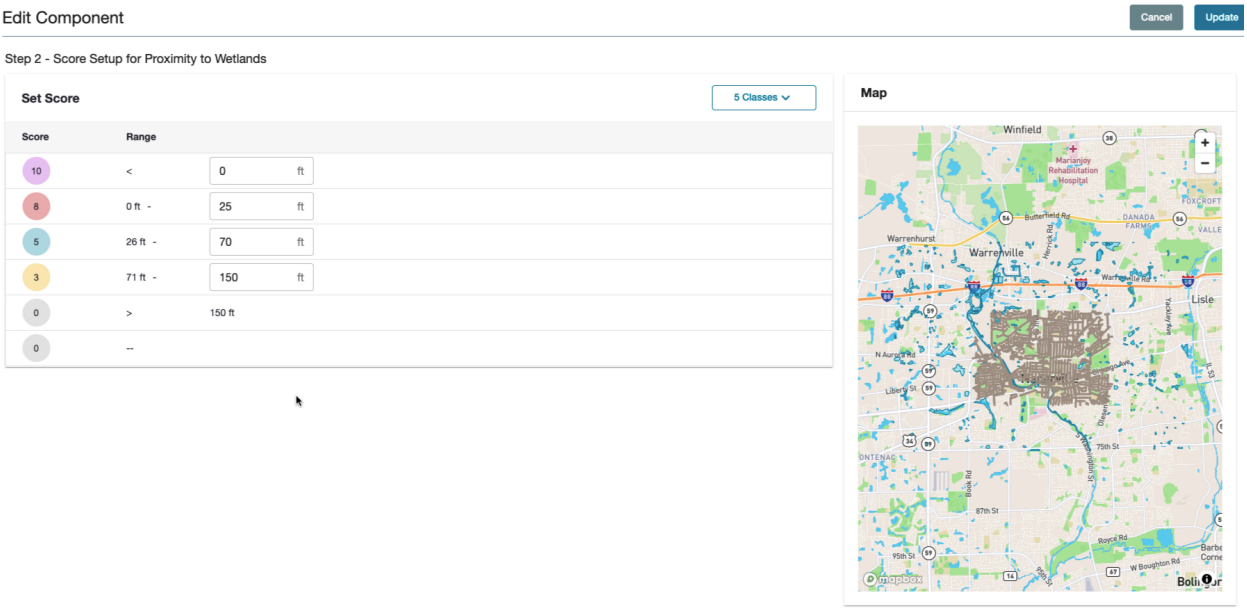
All these are fully customizable based on your needs. This is just an example.

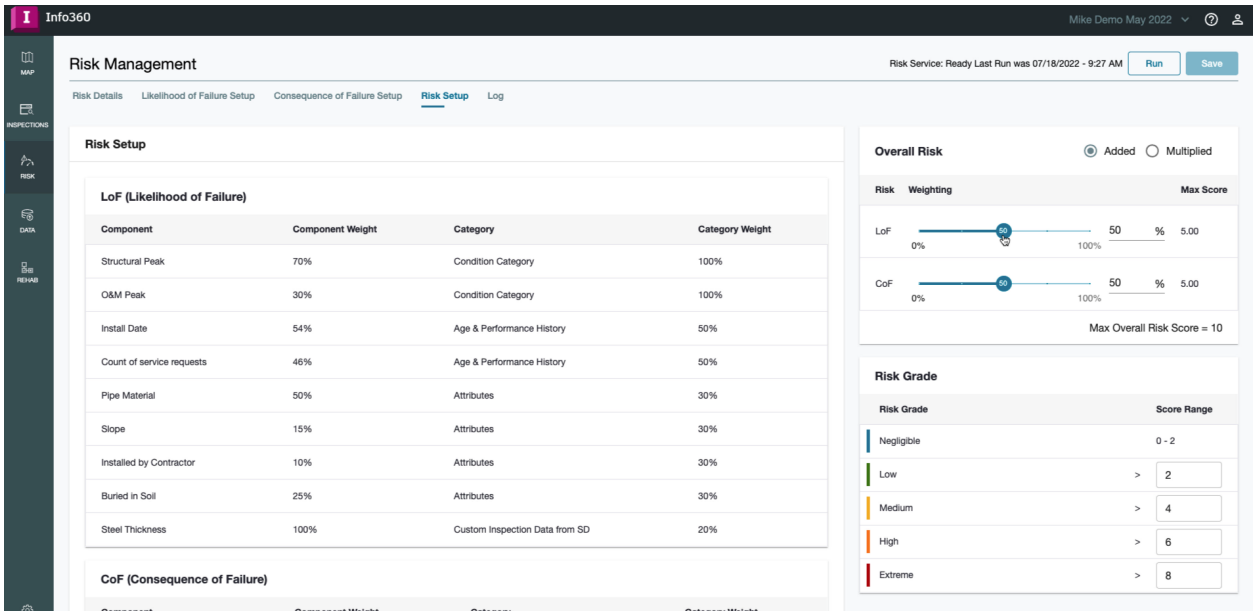




With the consequence of failure model, you can see how Info360 supports spatial analysis as well. CoF scores can be based on the buried depth of the pipe and how close it is to environmental factors like rivers and wetlands. You can include environmental impact, transportation impact and cost to account for the difficulty of repair.

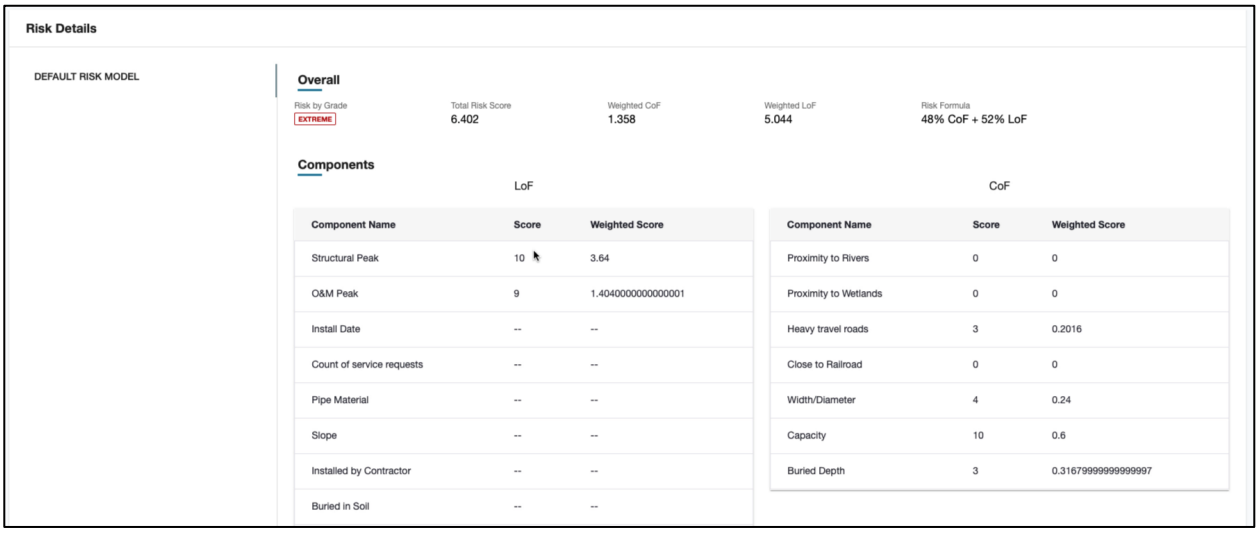
Below illustrates how to consider proximity to a sensitive water body or habitat and proximity to railroads and heavily traveled roads using geo spatial data to calculate distance. You can even include roads from the shared geospatial layer in Info360 or bring in your own tables and link those to assets.





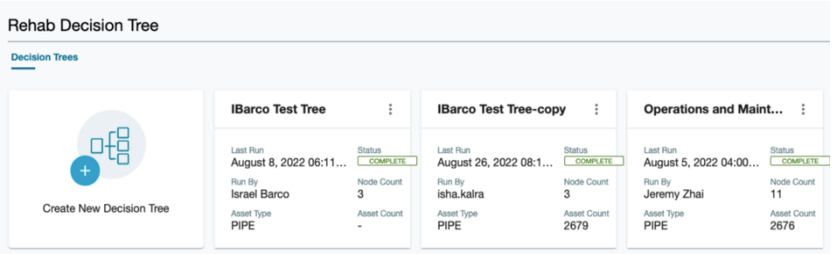
Now let's define the overall risk model using the LoF and CoF scores. You can decide to add or multiply and mix them differently based on each operations modeling approach. Then assign risk grades that will be visible as colors on the map.

Below you can see an asset with its risk details. You clearly see where the rating comes from with the CCTV or closed-circuit TV data, its location, its properties and its overall score. This is an extreme risk pipe with a total risk score of 6.4 out of 10 and showing how the formula that was used to derive it.



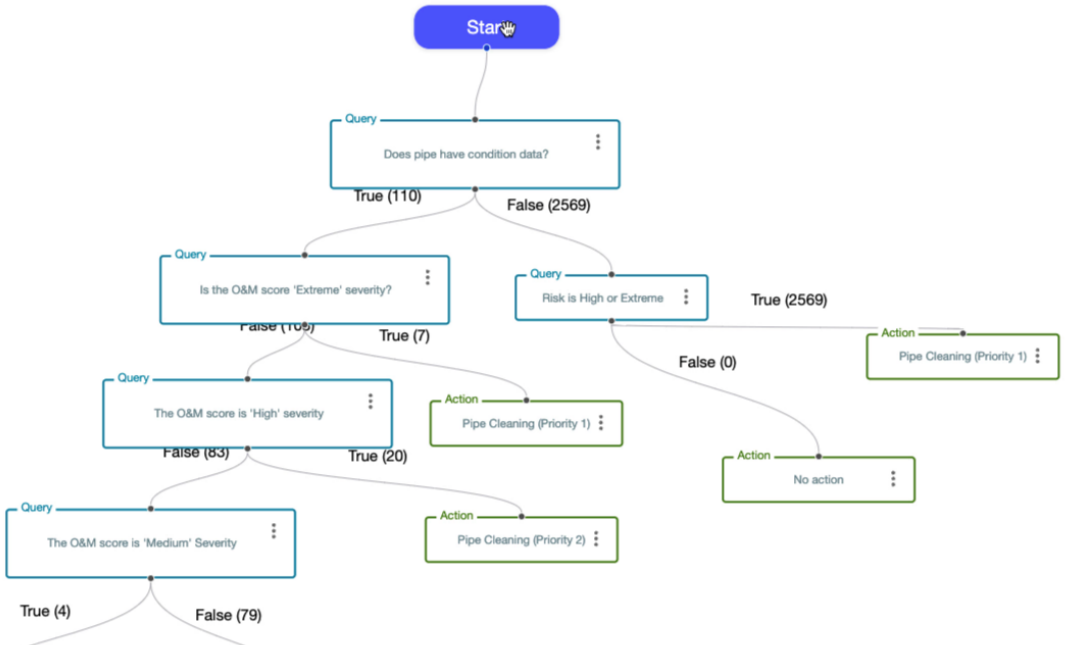
Looking at its component scores, this asset is getting a high score because it has a structural defect with a high O&M score, and it's a higher capacity pipe buried relatively deep under a somewhat traveled road. Everything is transparent and traceable and accessible so your operation can track the health of each asset and ultimately determine the right rehab plan with a justified budget.

Rehabs

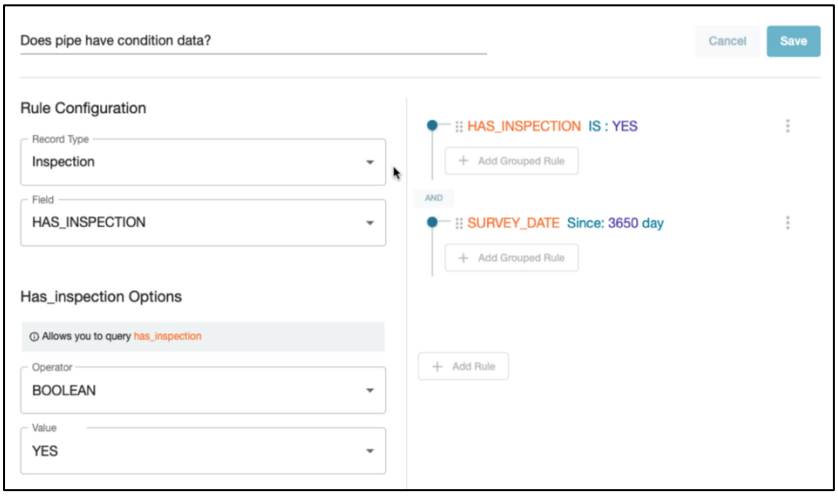


Finally, the rehab decision tree leverages all this information to systematically define a course of action - or provide confidence in taking no action if for example the asset is getting replaced in three months. The objective is to assign the appropriate prescriptive rehab action to each asset.

Below is an example O&M plan for cleaning pipes. You configure an intuitive step by step query logic to get to a recommended action. You start at the top and work your way down the tree.



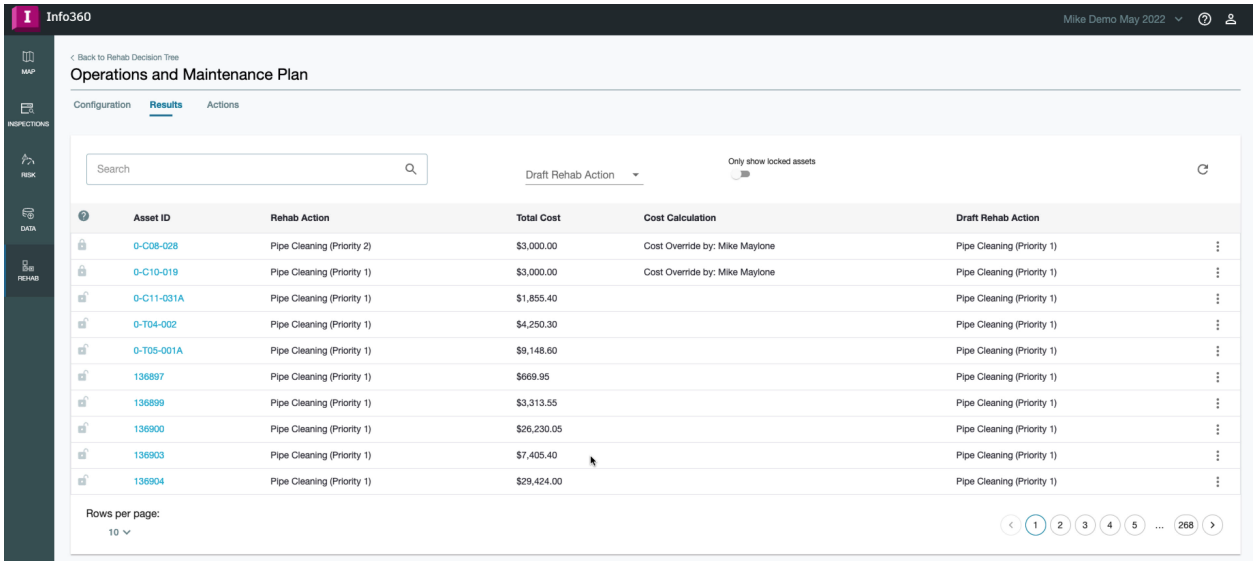
To illustrate, the first question is whether there is condition data. Look at the rule to the right, and it is based on whether there has been an inspection and how long it has been since the inspection. Select the source of the information and the field along the different decision logic.



In this case the answer is a yes or no. You can configure your own rules with different options to meet your criteria.

The logic continues down the decision tree ending in a course of action - in this case indicating a priority for cleaning. You can also see how many assets go down each path, while ensuring that all assets have gone through a methodical decision-making process.

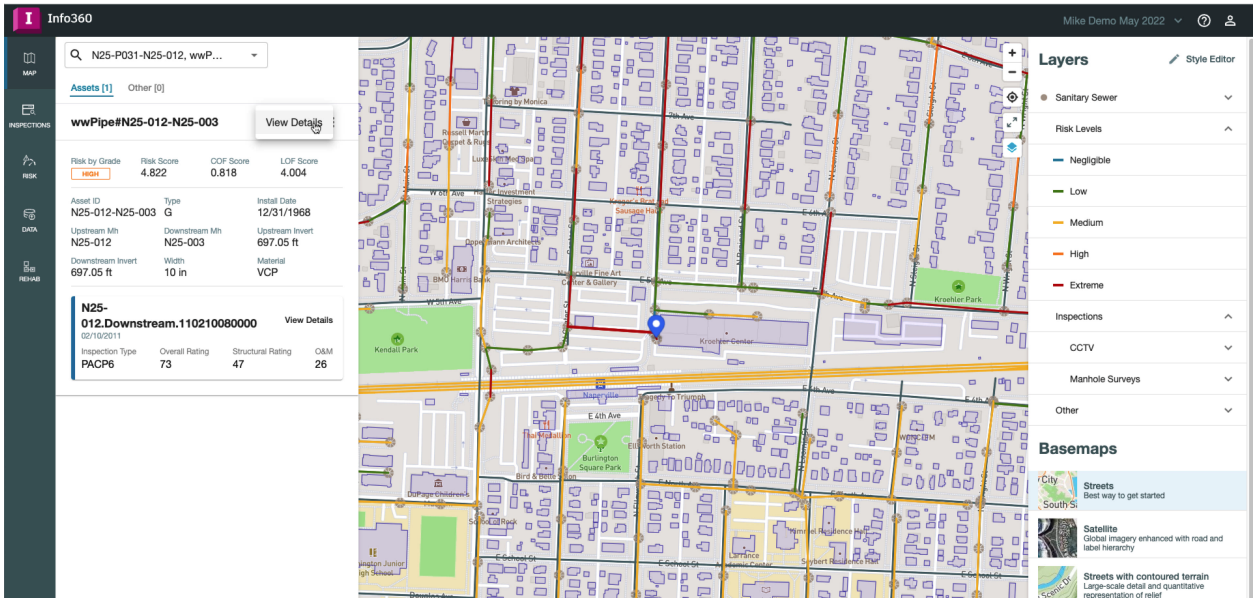
If you have a specific budget or capacity for inspections, cleanings, and rehabs over the next year, this process helps you assess the impact of your scoring and rehab decision tree so you can get the biggest bang for your buck with the resources you have.



Above are the final results, where the system shows all of the assets, the associated rehab actions along with the estimated cost. Info360 calculates cost based on a unit cost - for example by linear feet or meters - so the cost adjusts based on the specific asset.

The Biography of an Asset

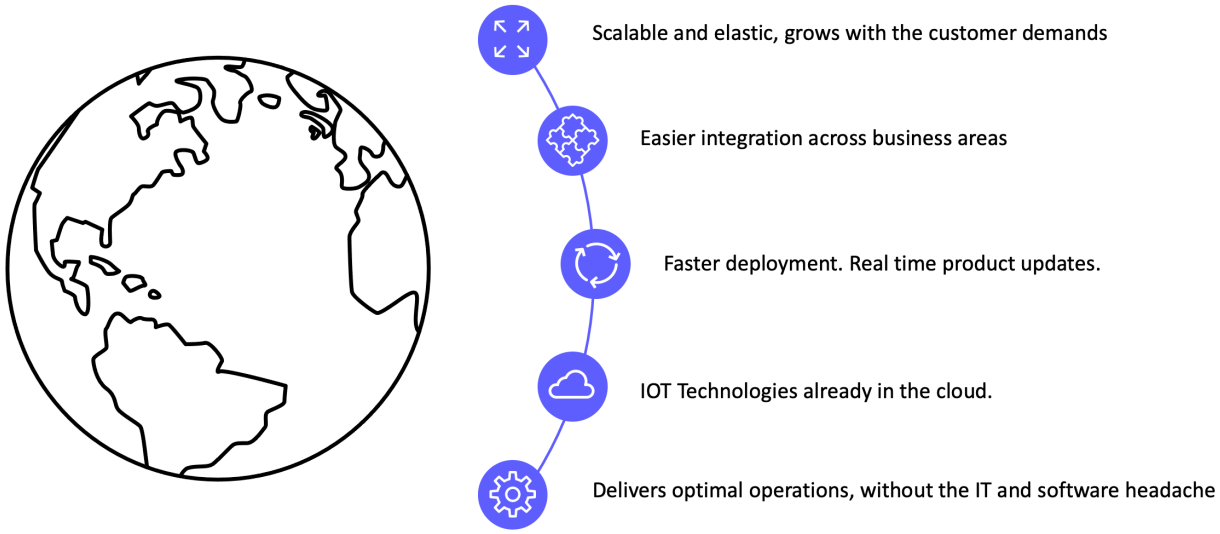
Info360 essentially tracks the biography of each asset. Its ratings, data, risk scores, rehabs, inspections and more all in one view that any authorized user can access. Looking at the map below this is the asset used in our examples above. All its data now shows itself on the map with the other layers. There are the building footprints, roads, and then drill in to see inspections including the geocoded defects. Hover over the pipe and see its risk score.



Info360 Asset provides a comprehensive view of all your asset information along with a set of enterprise workflow processes to consistently inspect, assess, score and rehab your assets.

In combination with Info360 Insight as the digital twin for your water and sewar networks and Info360 Plant as the digital twin for you water and wastewater treatment plants, Info360 Asset helps maintain the assets that keep your core operations running smoothly.

Info360 – Digital Twin for Water



Info360 provides the most comprehensive digital twin for the entire water cycle. Built on AWS, it provides near unlimited scalability to grow with your needs. Autodesk continues to invest to bring new products like Info360 Plant to market on the platform and enable comprehensive integration between management, operations, engineering and asset management.

As a SaaS platform, it deploys quickly with no software installation and maintenance, and it's always up to date. It securely connects IOT sensor data to a powerful cloud based digital twin platform that offers sophisticated analytic, simulation and machine learning models to optimize the industries' complex assets – without the IT headache.