In partnership with

baseform

Grundfos Utility Analytics

Data analytics for water and wastewater network monitoring and asset management

Introduction

Less than 1% of available data is effectively used*. The cost of this could run into hundreds of millions of Euros because prediction, prioritising and planning suffer from non-data-driven decisions. Increasingly, water utilities are harnessing the power of this data; the digital utility is becoming a reality.

Grundfos has entered a strategic partnership with Baseform to bring powerful digital services to water utilities. The Grundfos global value proposition is being up-scaled to serve the water digital market with Grundfos Utility Analytics, a state-of-the-art Artificial Intelligence (AI), machine-learning asset management technology provided by Baseform.

Grundfos Utility Analytics facilitates comprehensive system monitoring, real time updates, sophisticated system analysis, and pre-emptive problem solving, ultimately saving utility companies time, hassle, and money — if they act on the diagnoses and information provided.

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By Cedric MacLeod, Lead Application Manager, Digital Water, Grundfos

GRUNDFOS

Possibility in every drop

Purpose

This whitepaper is an introduction of how advanced analytics can support water utilities, lifting performance and improving decision making. Using data-driven intelligence, Grundfos Utility Analytics draws on data from a variety of sensors and predicts events within water and wastewater networks to a high degree of accuracy, allowing utility teams to work pre-emptively to resolve issues before they become major problems.

Utilities in general rehabilitate between 0.5% to 2% of their water network each year. This means renewing the entire network can take 50 years or more. With Grundfos Utility Analytics, the water utility can accurately quantify and qualify water losses, provide the ability to identify the likelihood of pipe failure, and calculate the relationship between pipe replacement plan, failures prevented and ROI on a year-to-year basis. We will discuss this in the whitepaper.
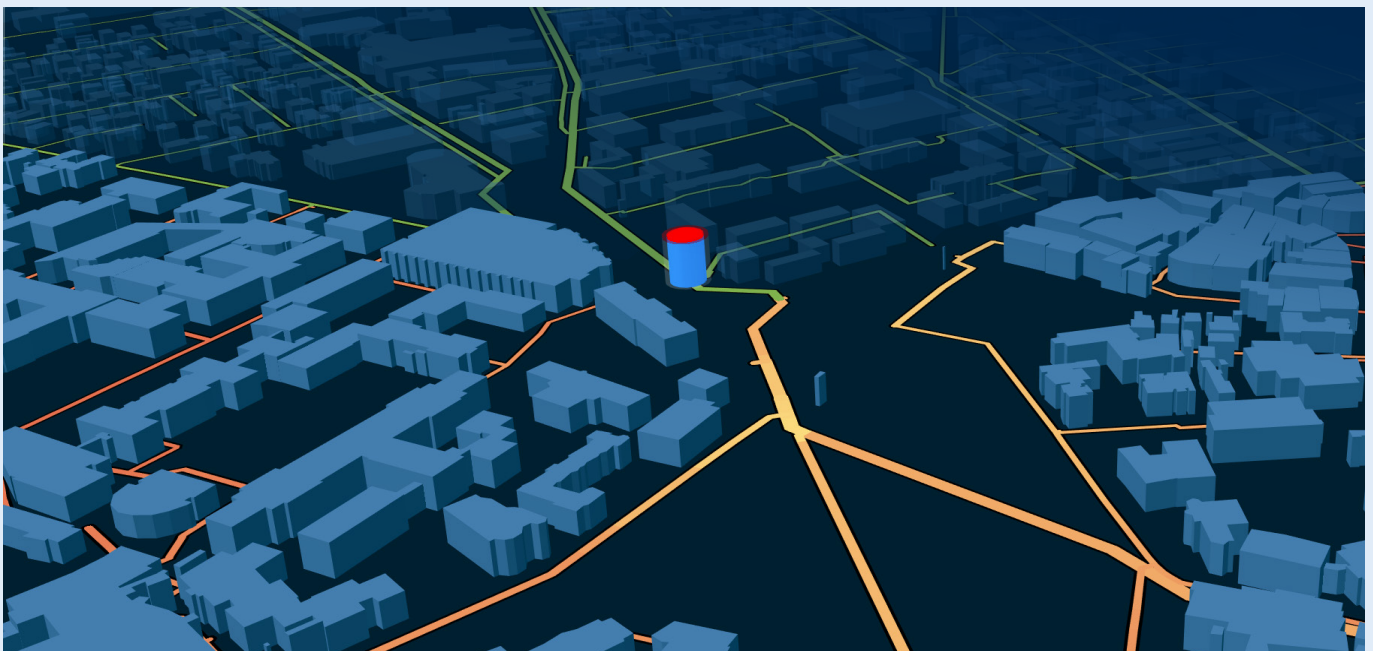

Executive summary

Water utilities today face many challenges, such as aging infrastructure, city congestion, water resources, and limited CAPEX. This requires them to become smarter. Exploiting the digital capabilities in all their applications – water intake, water distribution, water and wastewater treatment, wastewater transport, and stormwater networks – is paramount. The data is there already, but it is not being used. That is what Grundfos has set out to change, in partnership with Baseform.

Grundfos Utility Analytics is a dynamic, subscription-based software platform for water utilities. The platform gathers system data via sensors, collates it, and presents results derived from this data to the user. Grundfos Utility Analytics facilitates comprehensive system monitoring, real time updates, sophisticated system analysis, and pre-emptive problem solving, enabling utility companies to act on the diagnoses and information provided.

Powered by Baseform, Grundfos Utility Analytics embraces the ability not only to collect data, but also to clean the data, synchronise it in real time and space, and fill in the data gaps, where it can be applied, for example, to improve water and wastewater network monitoring and improve water and wastewater network asset management, as discussed in actual cases in this whitepaper.
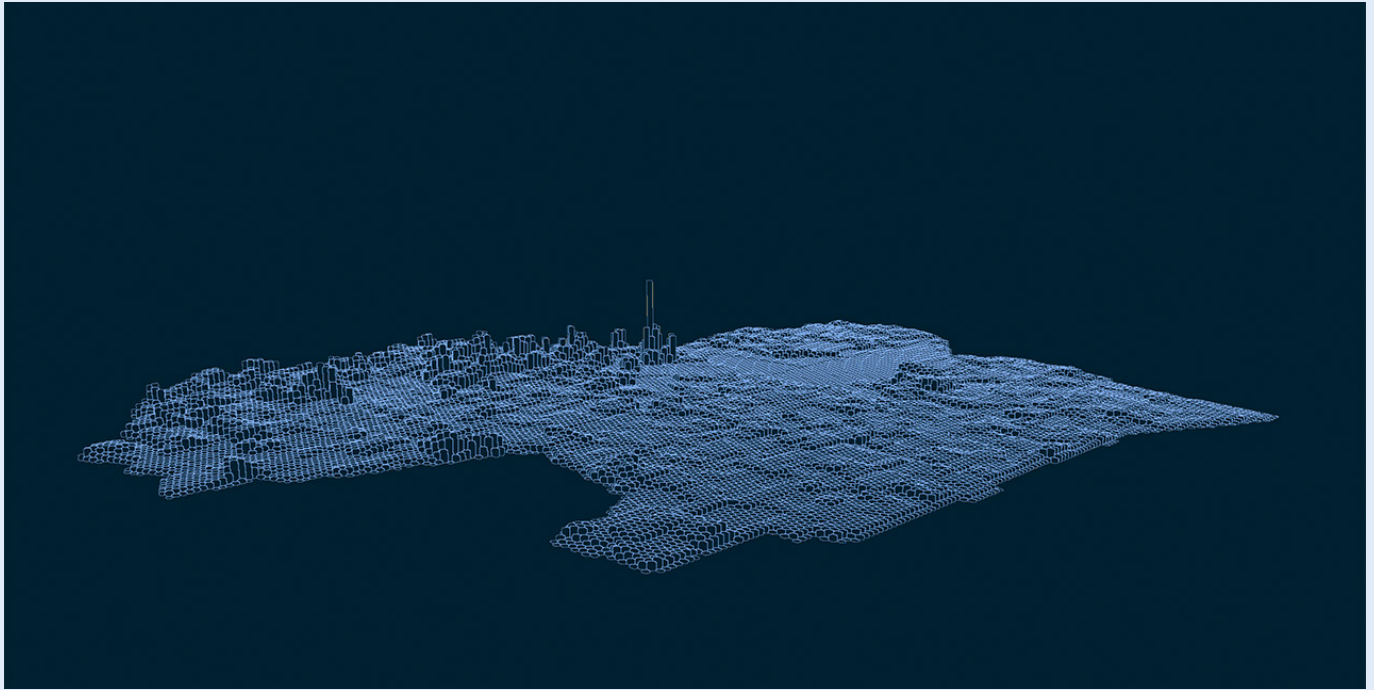
Water digitalization now a reality

Water and wastewater networks are regarded as critical infrastructure, and the water utilities and water companies who serve cities and municipalities are required to deliver safe and reliable water and wastewater services without interruption. This means that the systems we see today are not dissimilar from the systems installed fifty or more years ago. This is largely because there is an understandable unwillingness to modify what has been proven to work for so long and utilities are cautious in trying new technologies. While these networks – for the most part – meet requirements, keeping pipe leaks, non-revenue water and infiltration under control cost utility companies millions. Money, time, and energy are all literally poured down the drain.

In the era of Big Data, where your phone, your laptop, your watch, and even your car can all connect to The Cloud and share data, smart solutions on a wider scale – that of an entire city – can offer large-scale solutions. Data in itself has little value, but the real value lies in the analytics and the presentation of the results of the analytics. Using data-driven intelligence, Grundfos Utility Analytics enhances the capabilities of existing systems without the need for invasive or disruptive modifications.

Digitalization embraces the ability to collect data, establish trends and make better business decisions. It is not about technology itself. It is about how technology is used to create new revenue and value-producing opportunities.

Grundfos Utility Analytics is a dynamic, subscription-based software platform for water utilities. Grundfos Utility Analytics gathers system data via sensors, collates it, and presents results derived from this data to the user. This innovative software works in the background to strengthen the utility's ability to monitor, diagnose, predict, and plan.

The challenges facing water utilities

Aging infrastructure, city congestion, water resources and limited CAPEX are requiring water utilities to be smarter. Observing the trend in all markets and successful achievements in the industrial market, water utilities are under pressure to exploit the digitalized universe in all their applications: water intake, water distribution, water and wastewater treatment, wastewater transport, and stormwater networks.

Water utilities are required to use digitalization to, for example, improve water and wastewater network monitoring, for:
• Fast detection of pipe bursts
• Finding leaks
• Reducing water losses and NRW
• Preventing sanitary sewage overflows (SSO)
• Reducing water infiltration and inflow (I&I)

And to improve water and wastewater network asset management by:
- Reducing pipe failure rate
- Maximising the outcome from CCTV video inspection
- Predicting pipe failure
- Evaluating service risk
- Producing defendable pipe replacement plans
- Establishing CAPEX requirements with technically supported Return on Investment (ROI)

The digital transformation of water utilities has started. More and more technologies are being made available, many with their own analytics software. The analytical offerings are many, some to support hardware sales, some to support consultancy services, some focused on assets other on network performance. Water utilities are being offered so many interesting solutions, they are having difficulties knowing which ones to pick.

A cloud-based software for urban water and wastewater networks
The Grundfos Utility Analytics software is unique, because it empowers water utility staff to use and incorporate data insights into their daily work process to:
- Monitor
- Diagnose
- Predict
- Plan

Grundfos Utility Analytics is purely data driven. Its digitalization embraces the ability not only to collect data, but also to clean the data, synchronise it in time and in space and fill in the data gaps. These apps work in conversation with each other to connect each department and provide only the relevant information needed, meaning your teams are not overloaded with unnecessary content to sift through. The following features differentiate Grundfos Utility Analytics from other solutions:

- One platform where all the water utility network data can be stored, providing a 3D user interface for the entire water utility to see and understand specific indicators benched against their KPIs
- An ability to accept data from all sensor types and compatible with all known SCADA/network telemetry systems
- It covers the operational, tactical and asset planning areas used by most departments and which are all fundamental to improving a water utility's performance
- It combines data from different sources improving analytic outcomes and then combines analytical outcomes to further enhance the value delivered to the water utility

How Grundfos Utility Analytics works

With a range of modules specifically designed for different user groups within the water utilities industry, all system events, water losses, infiltration and inflow, and more can be tracked in real time. Grundfos Utility Analytics also takes this one step further, effectively collating the information provided to offer useful insights.

Grundfos Utility Analytics is non-intrusive and cloud-based, meaning no installation is needed, nor is any system integration required. The data moves one way only, and you always remain in complete control of your data, providing a base for analysis with the highest level of data security. By implementing the web based Grundfos Utility Analytics software, improvements and possibilities can be acted upon that significantly strengthen the utility's ability to Monitor, Predict, Diagnose and Plan, with all this feeding into a City overview.

Utility data
SCADA / GIS / Inspections
AMR / Billing / Other

Grundfos Utility Analytics data sync technology

Capture > **Clean & Enrich** > **Process** > **Present**

External data
Weather / CENSUS / Other

Grundfos Utility Analytics web agents

APPS

City
- People
- Network
- Zones 3D

Monitor
- Maps
- Events
- Meters
- Spectrum

Diagnose
- Network Model
- Indices
- Minimun Energy
- Water Balance
- Energy Balance

Predict
- Failure Prediction
- Inspecation Analysis
- Component Importance
- Risk of no service

Plan
- Compare & Prioritise
- Indicators
- Financial Analysis
- Infrastructure Value Index

Monitor – to increase your operational efficiency in real-time

You are effectively listening to your network and able to react in real-time to water losses and other events. The Monitor module collects feedback 24/7, all year round, ensuring a complete picture about the system and consumer behaviour. You will also be able to quantify and monitor your distribution zones for prioritisation.

Diagnose – builds understanding as a basis for actions

While the Monitor module gives you a real-time overview, and the Predict module enables you to operate and plan proactively, the Diagnose module provides the all-important understanding about factors to improve network performance, water quality and reduce energy consumption.

Predict – lets you learn from your system

Good planning relies on precise predictions, and this is necessary to keep one step ahead of events like leaks and pipe bursts. The Prediction module will keep your water losses under control and reduce the risk of no service.
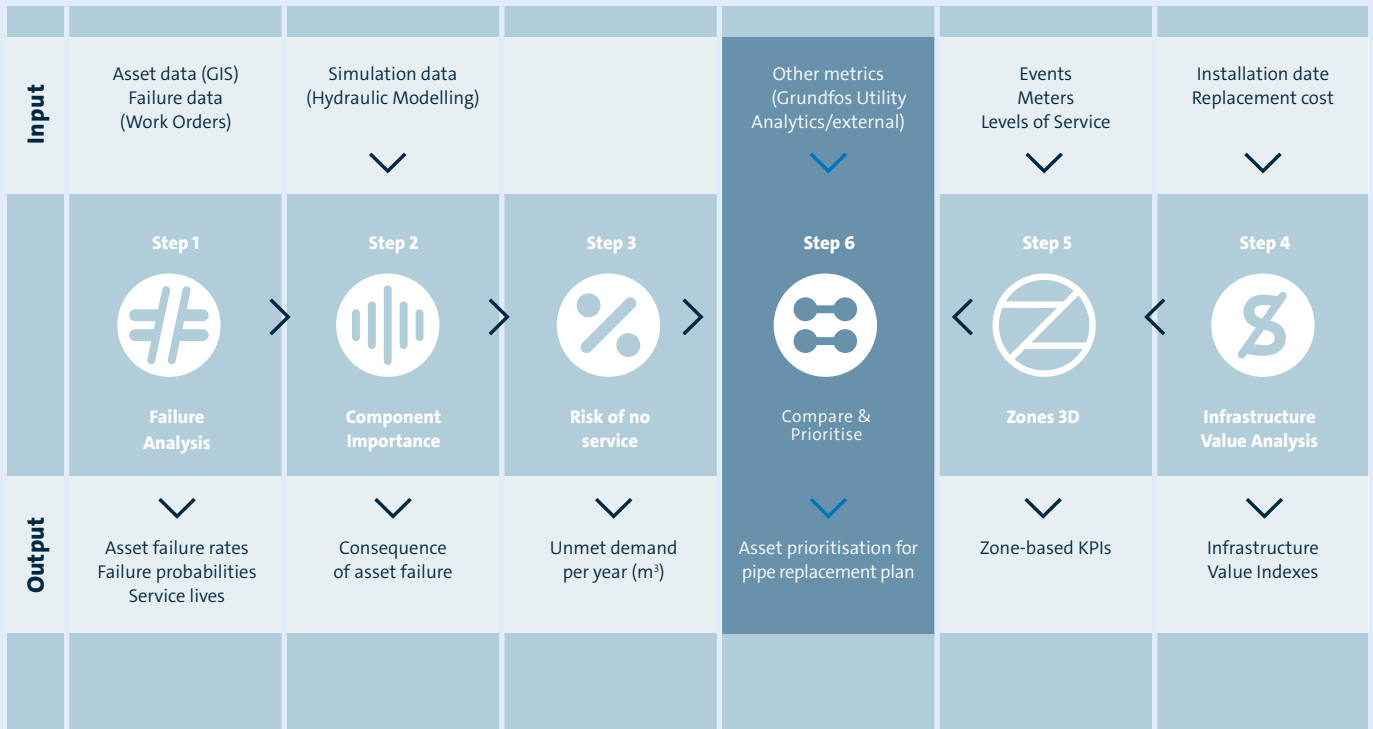
Plan – helps you prioritise and plan your time, space and investments

The Planning module enables you to optimise short- and long-term prioritisation alike and by this improving the utility's overall business. Strategic decisions and investment planning is then based on solid calculations, comparisons, predictions and diagnoses.

City – allows everyone to see and understand the big picture

Non-expert users can visualise and understand the water utility's most important KPIs. Data quantities and outcomes from analytics of all four of the modules are shown in 3D maps for viewing zonal KPIs and metrics, performance and physical infrastructure of individual pipes within the network and consumption behaviours based on demographics and building infrastructure.

Applying Grundfos Utility Analytics

Input	Asset data (GIS) Failure data (Work Orders)	Simulation data (Hydraulic Modelling) ⌄		Other metrics (Grundfos Utility Analytics/external) ⌄	Events Meters Levels of Service ⌄	Installation date Replacement cost ⌄
	Step 1 Failure Analysis	**Step 2** Component Importance	**Step 3** Risk of no service	**Step 6** Compare & Prioritise	**Step 5** Zones 3D	**Step 4** Infrastructure Value Analysis
Output	⌄ Asset failure rates Failure probabilities Service lives	⌄ Consequence of asset failure	⌄ Unmet demand per year (m³)	⌄ Asset prioritisation for pipe replacement plan	⌄ Zone-based KPIs	⌄ Infrastructure Value Indexes

The above illustration shows how water utility data is used. Inputs and outputs from each app in combination feed off each other to enhance asset management.

Let us now look at the following example of leakage diagnostics, and how the Grundfos Utility Analytics software tool can be applied. A high level of non-revenue water (NRW) is detrimental to a water utility's financial, environmental and public image viability. However, deciding on the best course of action to reduce NRW is difficult.

Water Balance

Water Balance

| Data | Indicators | Value |

System profile
Library
File info
Import/Export

Water Balance data can be exported to and imported from Excel spreadsheets. Imported data will replace existing values; please try exporting first, editing data on Excel and then importing.

EXPORT   IMPORT

Reference year 2015 [change]   System input volume (corrected for known errors) 1,630,360 m³   Remaining to justify 89,746 m³ (6%)

System input volume (corrected for known errors) (6/6)	1,630,360 m³
System input volume	1,630,360
Water abstracted	0 m³
Billed water imported (raw or treated) (billed by others)	1,630,360 m³
Unbilled water imported (raw or treated) (billed by others)	0 m³
System input volume errors	0
Water abstracted	0 m³
Billed water imported (raw or treated) (billed by others)	0 m³
Unbilled water imported (raw or treated) (billed by others)	0 m³
Billed authorised consumption (12/12)	1,346,237 m³
Unbilled authorised consumption (13/13)	4,637 m³
Apparent losses (4/4)	91,733 m³
Unauthorised consumption	1,542 m³
Consumption due to illegal use of hydrants and irrigation taps	42 m³
Consumption due to illegal connections	1,500 m³
Authorised consumption errors	90,191 m³
Authorized metered consumption errors	90,046 m³
Authorized unmetered consumption errors	145 m³
Real losses (3/4)	98,007 m³
Real losses on raw water mains and at the treatment works	
Leakage on transmission and/or distribution mains	49,664 m³
Leakage and overflows at transmission and/or distribution storage tanks	750 m³
Leakage on service connections up to the measurement point	47,593 m³

Water Balance is a tool within the Diagnose module and is a library-based, IWA-compliant water audit standard framework for rigorous, automated diagnosis, NRW reduction and asset management. It provides a breakdown of the zone-based water balance, such as real losses, authorised billed consumption, apparent losses, unauthorised consumption and NRW, for any meaningful time frame compatible with your data.

Water Balance analytics will quickly show you which zones have higher NRW with a clear breakdown of how it all adds up: pipe leakage, unbilled consumption and consumer meter errors. This is extremely useful when prioritising various actions and investments such as repair and replacement. Grundfos Utility Analytics software ensures benefits at the strategic, tactical and operational levels of your water utility, covering people, the network and zones.

Other data also join the conversation
Alongside the information gathered by sensors within the water or wastewater network, Grundfos Utility Analytics can collect and combine information on:
- Pipe materials, pipe aging, and loads
- Soil conditions
- Contractors
- Historical work records and inspections
- Consequences of failure

Taking all variables into account, Grundfos Utility Analytics can perform risk-based comparisons with unprecedented accuracy, factoring in all of the information available. The software conducts simulations to assess the impact of a pipe break, creating a sequence of prioritisation for minimal system disruption that is updated in real time.

Reacting in real time to water losses, infiltration and inflow and other events

Grundfos Utility Analytics makes it possible for a utility to follow events in their water or wastewater network and react in near-real time to water losses, infiltration and inflow and other events.

The key to operational efficiency is proactively detecting deviations to normal network behaviour and acting upon them immediately. Response time to events anywhere in the network is reduced and systematic calculations of water balance for the entire system on a zone level are also available.

The MONITOR module in Grundfos Utility Analytics collects feedback 24/7 to validate records and lets you learn about system and consumer behaviour. You are effectively listening to your network and can react in near real-time to events. You will also be able to quantify your zones for prioritisation, meaning you can:

- Reduce water losses, leakage levels and pipe bursts
- Detect, localise, quantify, and get warnings of Inflow & Infiltration events
- Reduce reaction time and maintenance costs on pipes
- Significantly improve reliability with focus on most critical investments
- Reduce risk of fines for above-threshold loss of NRW
- Ensure environmental and regulatory compliance by reducing the risk of overflow events

CITY apps set the scene for the Grundfos Utility Analytics solution with its dynamic 3D spatial and time analytics continuously running in the background. CITY apps let even non-expert users visualise and understand the water utility's most important KPIs, giving you the whole picture. Log in to your Grundfos Utility Analytics account in the cloud — and get immediate access to updated and high-level views into all your data.

- One set of data for all and a holistic overview
- Performance, consumption, and events analytics
- Get an overall 3D city view within zones

The CITY apps that visualise and provide an overview of the data from all sources and of your network performance

Case 1 – Water network monitoring and pipe maintenance

To assess the impact of predictive data analytics, the software was applied at a large water utility company in Texas, USA.

Between 2005 to 2014, the water utility had recorded 20,000 pipe breaks, each resulting in costly downtime, expensive fixes, and customer complaints. They were curious to see how many pipe breaks could have been predicted in advance by the software.

The challenge was as follows: From January 2015 to October 2017 the water utility recorded 5,034 pipe failures in the water distribution network. Compared to the historical data provided, they wanted to see which pipes the software predicted had failed.

Firstly, existing failure records were fed into the software, as well as a complete GIS asset data inventory. The software was put to work and after just three days dedicated to reconciling and validating the utility's data set, the first results were generated.

Had the utility replaced the top 1% of the pipes prioritised by the data analytics software, they would have prevented 24% of the pipe breaks that occurred between January 2015 and October 2017. Replacing the top 5% would have prevented 49% of breakages.

Prioritised pipes replaced	Top 1%	Top 5%	Top 50%
Pipe failures prevented	24%	49%	92%

Extrapolating from this information, the software's Prediction Apps could then be used to develop a pipe replacement plan for the water utility to implement in their routine system update schedule.
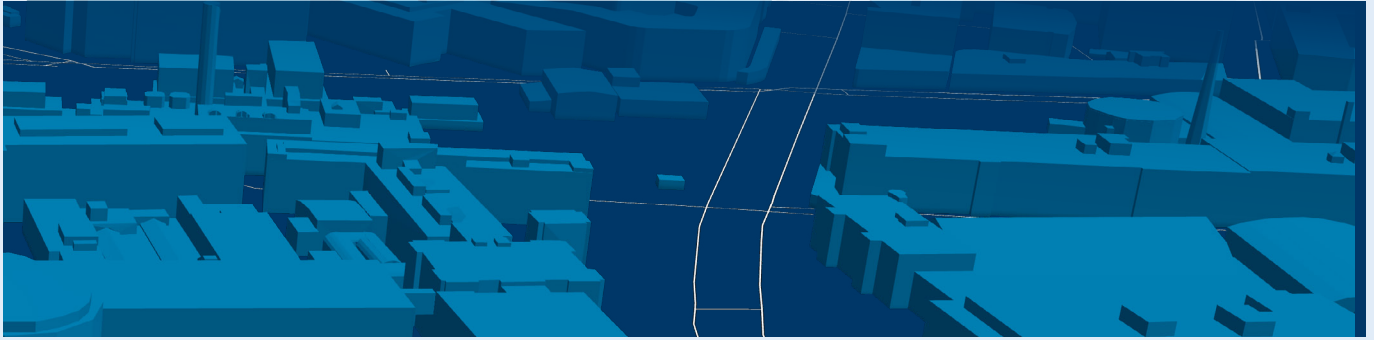
Making strategic decisions and planning investments based on data-driven analytics

Grundfos Utility Analytics helps the utility make strategic decisions and plan investments based on data-driven analytics, comparisons, predictions, and diagnose; for example, prediction of asset lifetime and forecasting the risk of no service.

This enables optimisation of water or wastewater network services, reduction of wastewater CCTV inspections, and diagnosis of network efficiency. The utility can also project short and long-term performance, explore intervention alternatives and plan infrastructure expenditure.

The PLAN module in Grundfos Utility Analytics opens these possibilities, to prioritise sectors, assets and projects based on proven analytics derived from data, to:

- Improve operational efficiency
- Improve planning of repair and replacement
- Enable more reliable prioritisation of short-term actions
- Optimise utilisation of resources

The PLAN module enables the utility's management team to optimise their short and long-term prioritisations alike, with clear quantification of breaks, costs and risk avoided, and overall ROI. Decision-making and prioritising will be based on data-driven intelligence; for example, when predicting drinking water losses and pipe breaks, infiltration & inflow in sewer systems, evaluating system performance, and when working out pipe replacement and sewer inspection plans. This:

- Reduces CAPEX through optimised expenditure and service life, lowers equipment costs and helps focus on the right investments
- Reduces OPEX through higher maintenance predictability and lower service costs
- Improves compliance accountability and reduces the risk of fines and penalties
- Enables better cost planning
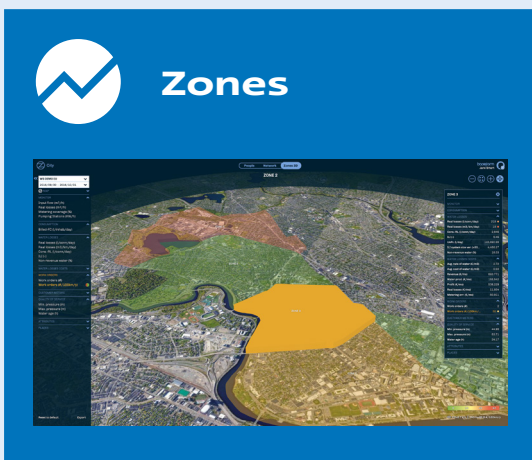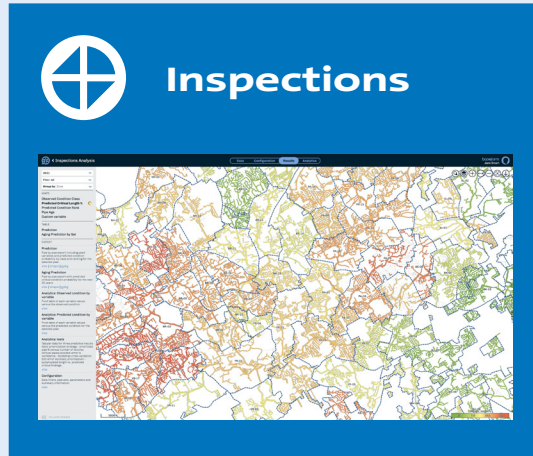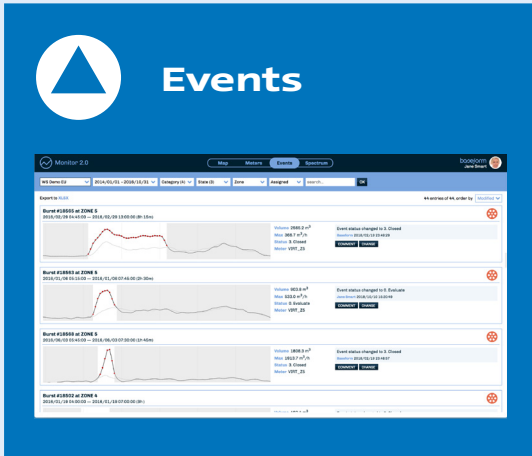
These are some of the apps used in supporting and improving pipe replacement planning

Improved pipe replacement plans

One of the major issues facing water utilities is long-term pipe replacement costs. Grundfos Utility Analytics resolves this by helping you optimise asset planning and your pipe replacement plan.

The software monitors the network and closely follows the asset maintenance records, in order to predict bursts or leakages, and informs the operator which pipe is likely to fail first, while the network management system also indicates when a burst occurs and in what area it is located. It also projects short and long-term performance, explores intervention alternatives, and lets you plan infrastructure expenditure.

The data is utilised to optimise and improve pipe replacement strategy, justify CAPEX, and reduce overall pipe bursts and field service resources. Once you have your pipe replacement plan in place, your operations manager and field crews will be able to benefit from precise prioritisation on a day-to-day basis and as new data become continuously available.

While the pipe replacement plan is a part of your tactical asset management, it therefore also provides profits on the short-term financial side. Plus, it enables your utility to enhance customer satisfaction by reducing the number of leaks and other unwanted events.
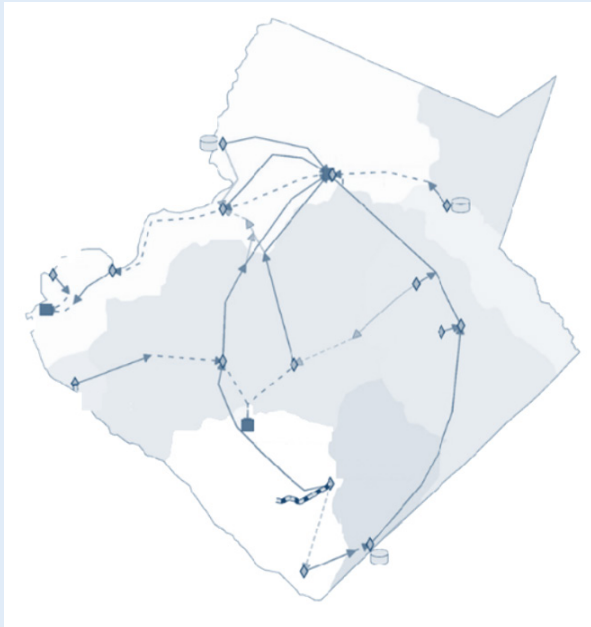
Case 2 – Wastewater network asset management

A water utility in Georgia, one of the fastest-growing areas in the USA, is faced with increasing wastewater flows with an expected yearly population growth of 2%. The assets of the the city's water utility will rapidly reach maximum capacity because of the fast-growing population. Capital cost investments are therefore needed to increase the capacity of pipes, pumping stations and most of all treatment plants. One effective way to reduce and delay investment is to reduce infiltration flows; and efficient inspections mean a quicker reduction of infiltration flows and at a lower cost. Currently, an area of 450 square miles (1,166 square km) is served by 2,800 miles (4,500 km) of gravity mains and 280 miles (450 km) of pressurised mains. More than 200 sewage pumping stations transport to 3 wastewater treatment plants, and there are more than 120 gravity flow monitoring stations in the network.

The water utility chose the data analytics software for the solution's ability to monitor flow and quantify I&I at system and zonal level, and its predictive capability for optimising their sewer inspection program and predicting structural and operational defects. The software also provided a definitive data-based source for long-term renewal planning and let the utility quantify infiltration and inflow with a platform for viewing and interpreting various data sources in one environment. Also provided was a platform for planning to account for future capacity challenges. In fact, it brought all data together in a way supporting systematic, fact-based, and defendable solutions that meet their challenges.

The outcome was USD 1.3 million saved on an annual inspection budget on USD 2 million, which equates to savings of 65% for the same level of results as before. All detailed I&I metrics were detected and quantified at system and catchment/sub-catchment level and combined with pipe inspections for direct repair and renewal. Furthermore, operation and maintenance planning inefficiencies were reduced by 50%, infrastructure planning and designing the capacity of pump stations and of treatment plants were optimised, and improved decision making will improve large, planned investments by 2% at least.

Conclusion: Strengthening our partnership with water utilities

Grundfos Utility Analytics facilitates comprehensive system monitoring, real time updates, sophisticated system analysis, and pre-emptive problem solving, ultimately saving utility companies time, hassle, and money.

The Baseform software platform development was started by the fusion of a water asset software expert with a water R&D engineer, each with over 25 years of experience and backed up with unique inhouse mathematical and statistical/AI expertise. Grundfos Utility Analytics is available as a dynamic, subscription-based Software-as-a-Service for water utilities.

Grundfos, with over 75 years' worth of hydraulic expertise, will be leading the deployment of this unique solution and promote further development, so that water utilities can obtain direct benefit. Grundfos will also support further network optimisations with smart integrated pumping solutions.

Please contact Grundfos for more information. We can put you in touch with our Digital Sales Specialists and further support the implementation with our dedicated Customer Success Managers.

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