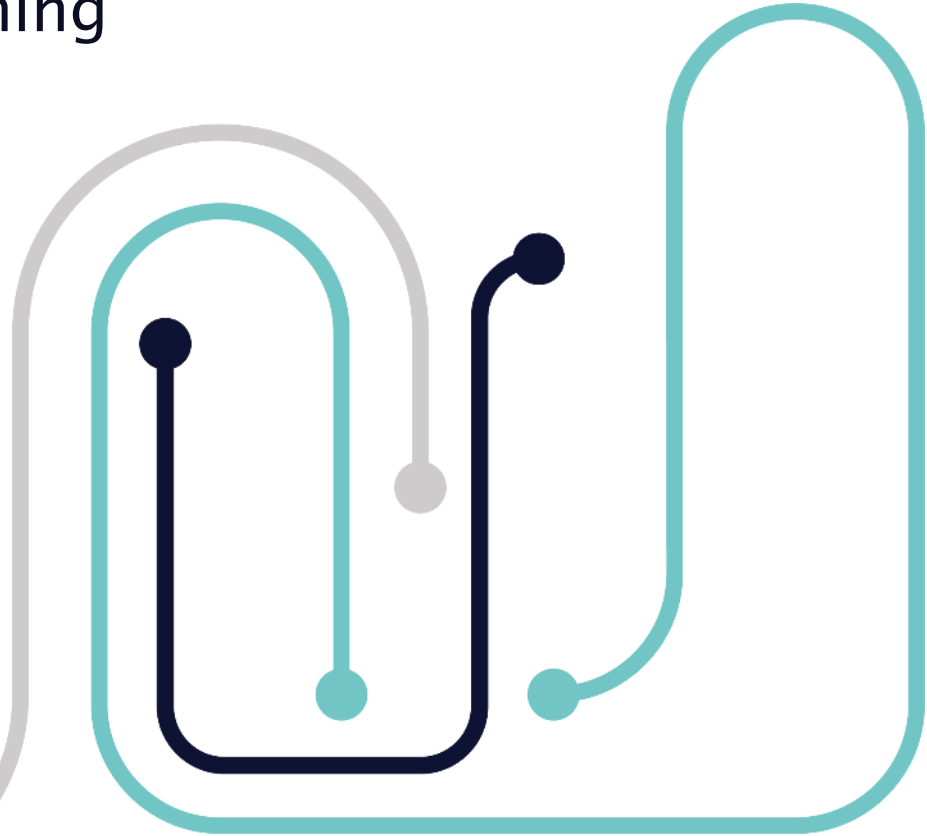


Asset Investment Planning using Tableau

Tim Watson
Stuart Fraser



Agenda

Communicating investment decisions and democratising data

- Overview of ICS
- Asset Investment Planning
- Key Challenges
- Real Case Studies
 - Cadent Gas
 - National Grid
 - Thames Water
- Summary & Discussion

We help our clients link strategic intent to investment plans and delivery

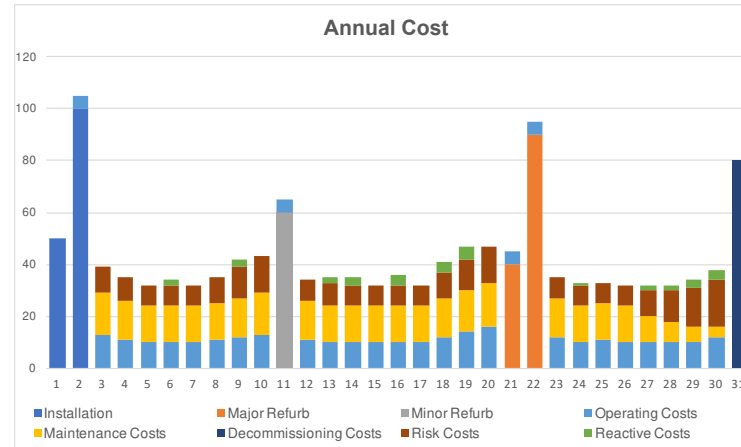
To some of the largest asset owners in the world



Asset Investment Planning (AIP) helps organisations make objective, data-driven decisions to optimise cost and value while minimising risk over the full investment life cycle of an asset.

These need to be answered across the long, medium and short term

- What is the current and future level of whole life cost and risk presented by the asset base ?
- What are the costs and benefits of investment ?
 - Individual single investments
 - Investment strategies
 - Programmes of work
- What is the best mix of investment to meet defined balance of cost, risk and performance ?
- What is the payback period of investments, strategies or plans ?
- How can the spend and intervention types be optimised to allow efficient procurement and delivery ?
- Presentation and visualisation of the risk, with and without investment, from asset through to company level



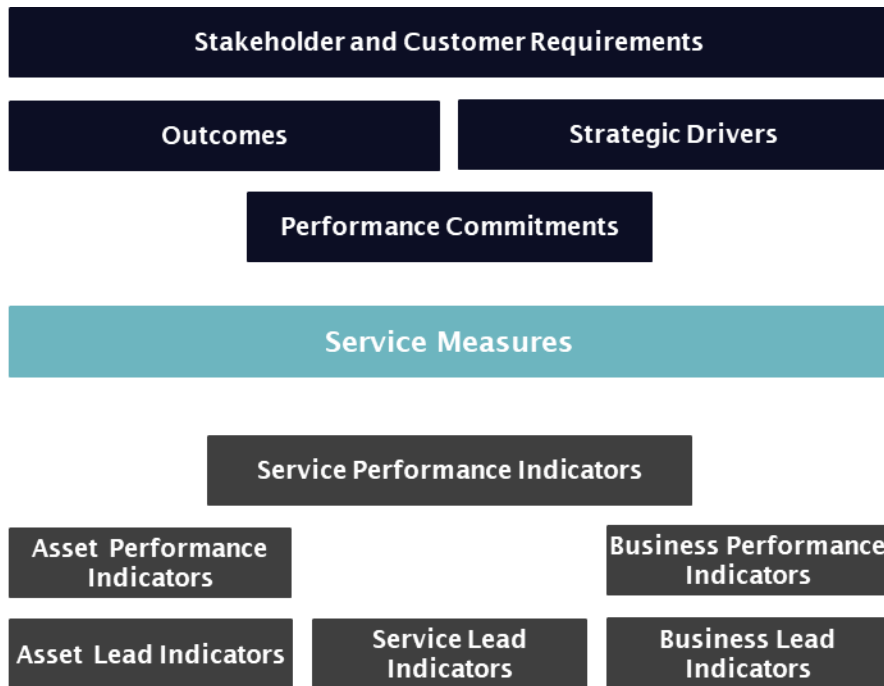


AGEING ASSETS

A gas mains explosion

A 'Golden Tread' visibly linking asset and business performance to corporate and social objectives

A Service Risk Framework aligns all measures and priorities across the organisation



Top down

The communication of investment plans is critical in gaining approval from key stakeholders and regulatory bodies to ensure that money is well spent and provides sustainable value.

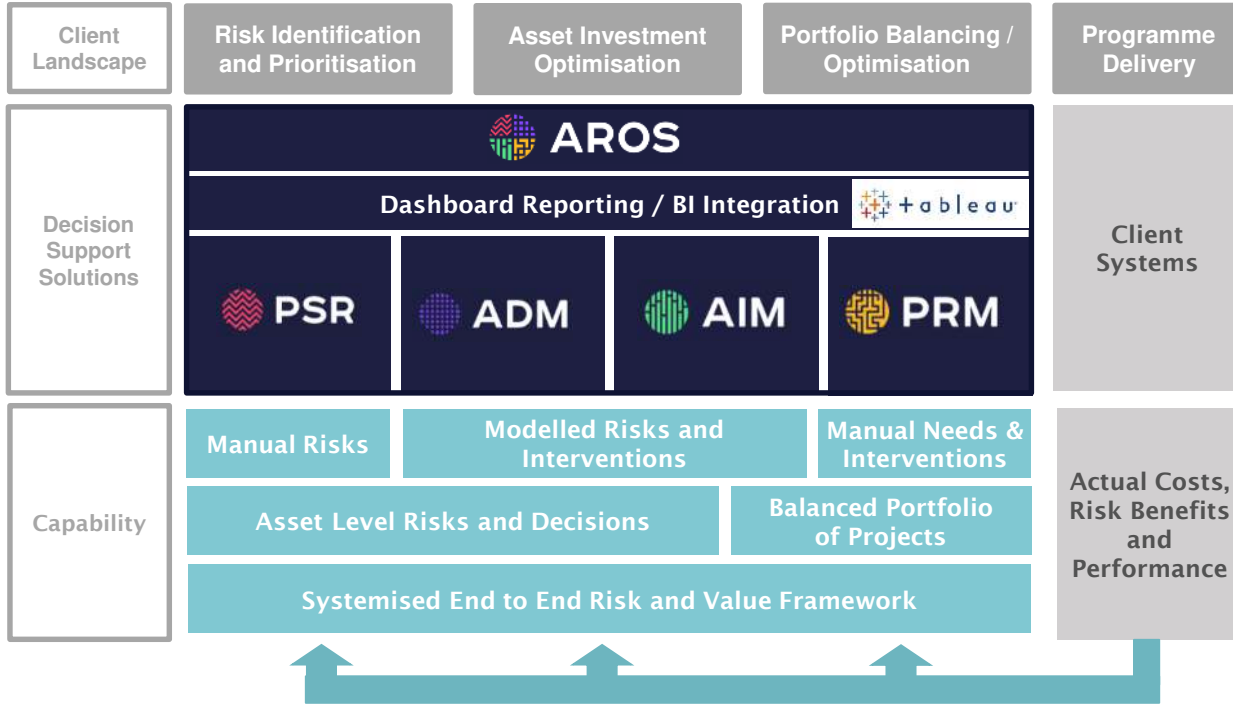
Bottom-up

AROS - Asset Risk and Optimisation Suite

Systemised end to end solution for planning and delivery



An integrated suite of modules using decision analytics to support the entire investment process



PSR – Plant Status Review

- Process safety based assessment, prioritisation and monitoring of asset risks

ADM – Asset Data Manager

- Rapid and repeatable processing of asset data to support continual investment decision making

AIM – Asset Investment Manager

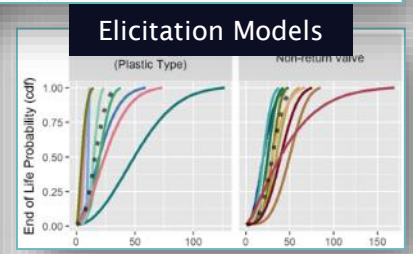
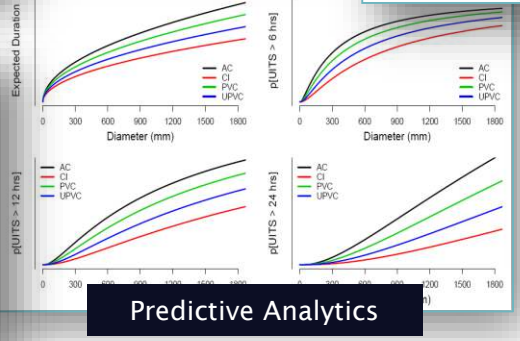
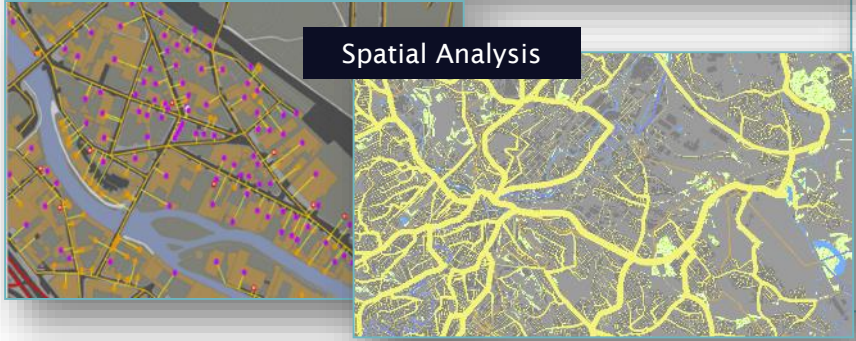
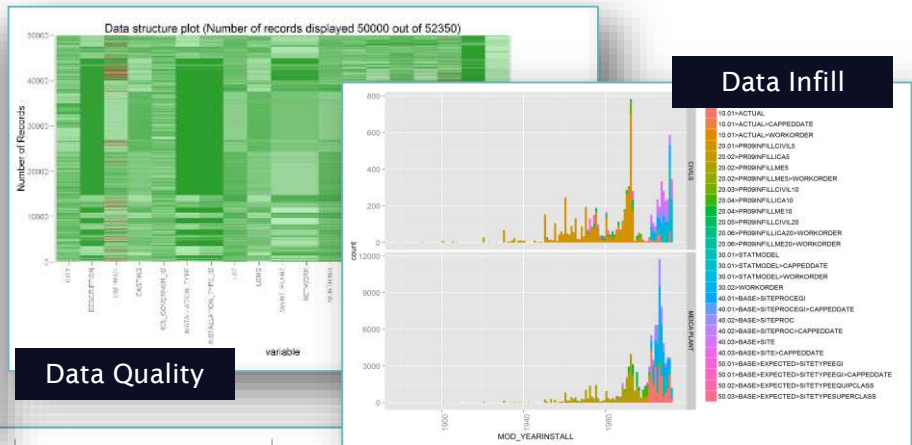
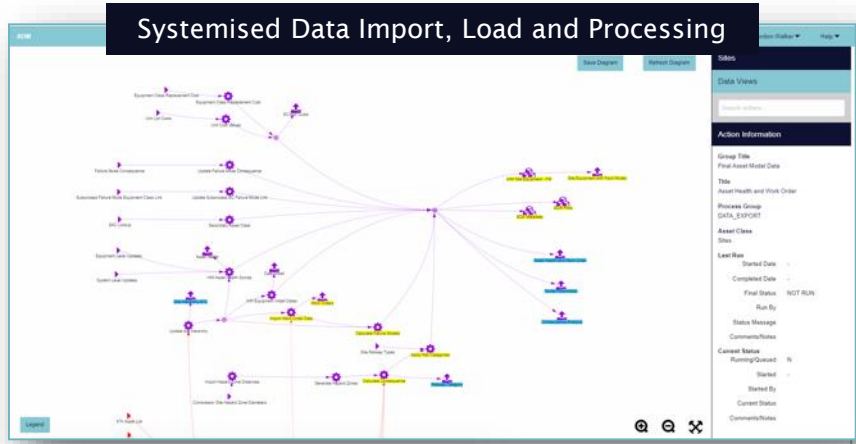
- Optimal planning of asset class investment programmes across millions of individual assets

PRM – Portfolio Risk Manager

- Whole life value based assessment of investment and cross driver optimisation of investment programme

ADM provides consistent and efficient data integration, processing and analysis

Links and processes all data required for AIM and PRM



AIM links individual assets to monetised risk

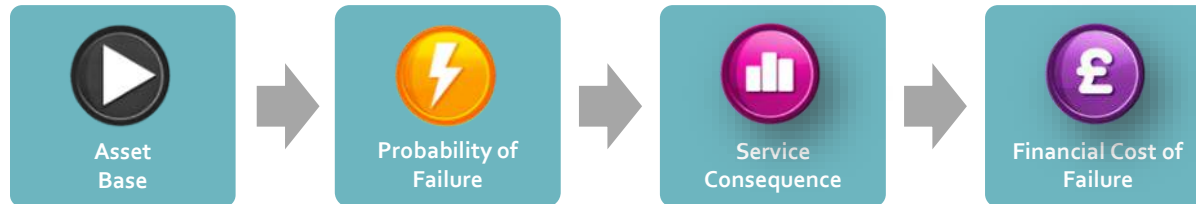
AIM facilitates the linkage of individual assets to monetised risk



The impact of the assets and investment is understood in terms of risk to Service Performance

Understand impact on success of organisation using Service Performance

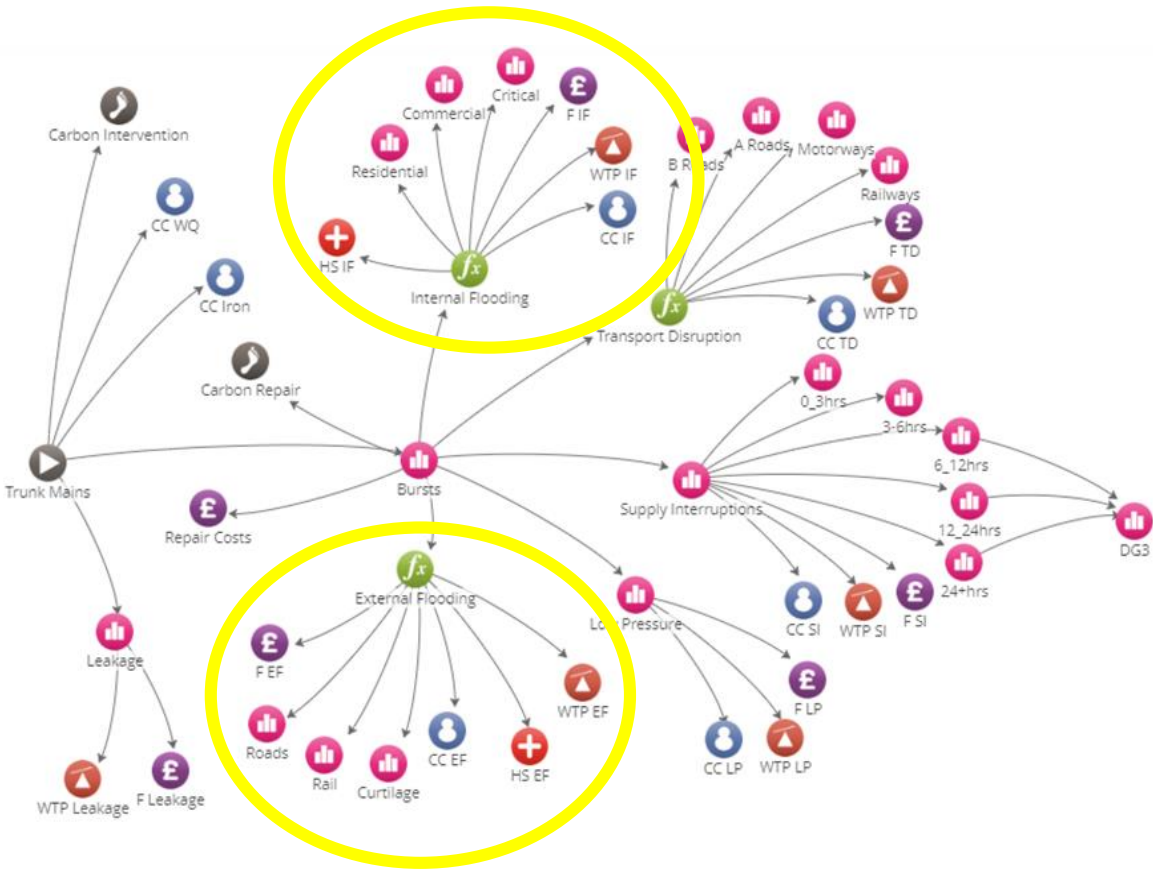
Understand strategic direction and the value of Service Performance



- A visual representation of risk drives consistency and transparency
- Linking engineering through to the boardroom
- A common language of economic service risk
- Highly configurable

This week's Herne Hill flood will cost Thames Water and its insurers around £4 million, it emerged today.

<http://www.standard.co.uk/news/london/thames-waters-4m-bill-for-herne-hill-flood-after-burst-water-main-8753870.html>



2D Flood Risk

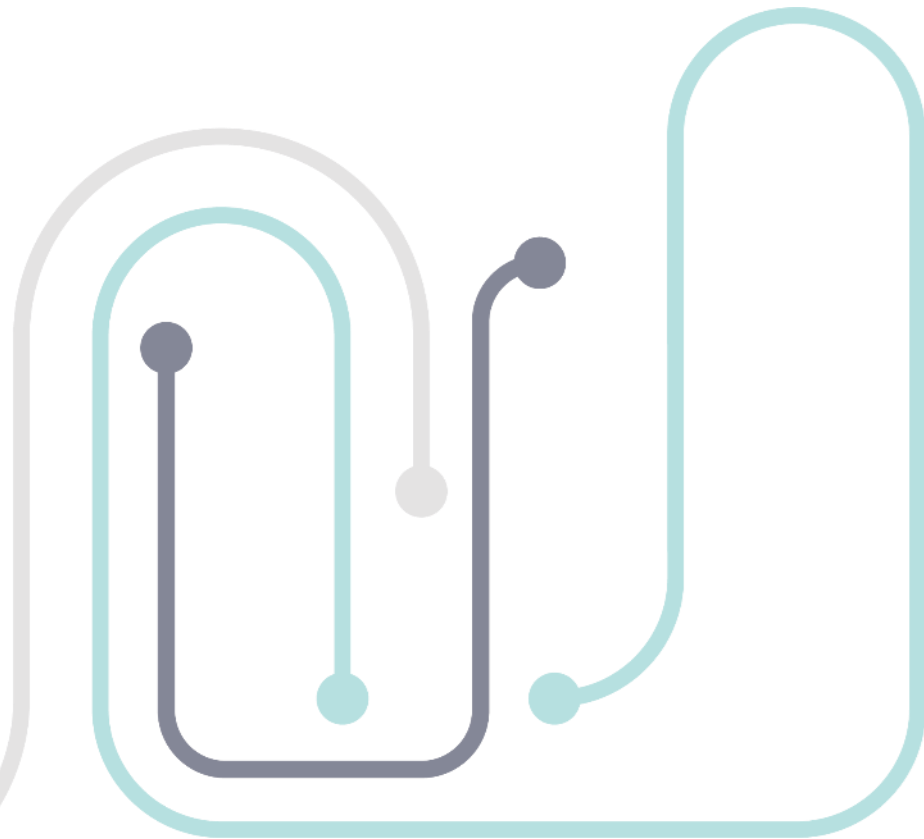
London and the Thames Valley 125,000 Simulated Mains Failures

Key Challenges

Many diverse challenges...

- Data
 - Not big data...
 - But messy and complex
 - Many sources
 - Spatial & Temporal
 - Data quality
- Process
 - Systemised and repeatable
 - Auditable and Transparent
 - Speed & setup
- People & Communication
 - Multiple levels in the business
 - Bottom-up and top down
 - Getting people to use Tableau
- XLS hell → Tableau hell???
 - Control versus individual insights (??)
 - Too many tableau masters!
 - Is it too easy?

National Grid Transmission



NGGT - Determining the investment for strategic infrastructure



Bottom-up to Top Down

REPORT TEMPLATES (6)

Project Scope Report Tim Watson 25 May 2018 11:14	Risk Matrix Report Tim Watson 30 May 2018 17:05	Scenario Report Report Tim Watson 25 May 2018 11:14	Reactive Risk Report Tim Watson 25 May 2018 11:57
Benefit Report Report Tim Watson 25 May 2018 11:54	Risk Report Report Tim Watson 25 May 2018 11:14		



ICS NOMS Dashboard Attributes

Spatial view of Psr



Data Discovery

- Attributes
- Feeder History
- Baseline & Risks
- Scenario Discovery
- Intervention Discovery
- Risk Summary

Tree Map showing Psr by count and total length

Attribute	Count	Total Length
UNKN		
KIBA10		
BALO12		
BALO11		
KIBA11		
KIBA12		
BAKE14		
BAKE27		
BALO09		
BALO11		
BALO12		
BALE14		
BAMAD7		
BAPE20		
BAW02		
BAW04		
BAVE05		
BIEN04		
BIEN06		
BIFA27		
BAJAL4		
ELBR07		
BOCO10		
BISH06		
BRM12		
BRST09		
BRW04		
BURPA09		
CAMA27		
CARU07		
CATR12		

Reporting

Time Step	ICS_ASSET_ID	Probability of Failure	Financial	Safety	Environmental	Availability
2018	000023454-0-0285-A08-0402	5.7974624762302E-04	11.372019348867	0.78754661703869	1.4292131877910	0
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867
2018	000023454-0-0285-A08-0402	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867	1.1572019348867

Risk Matrix

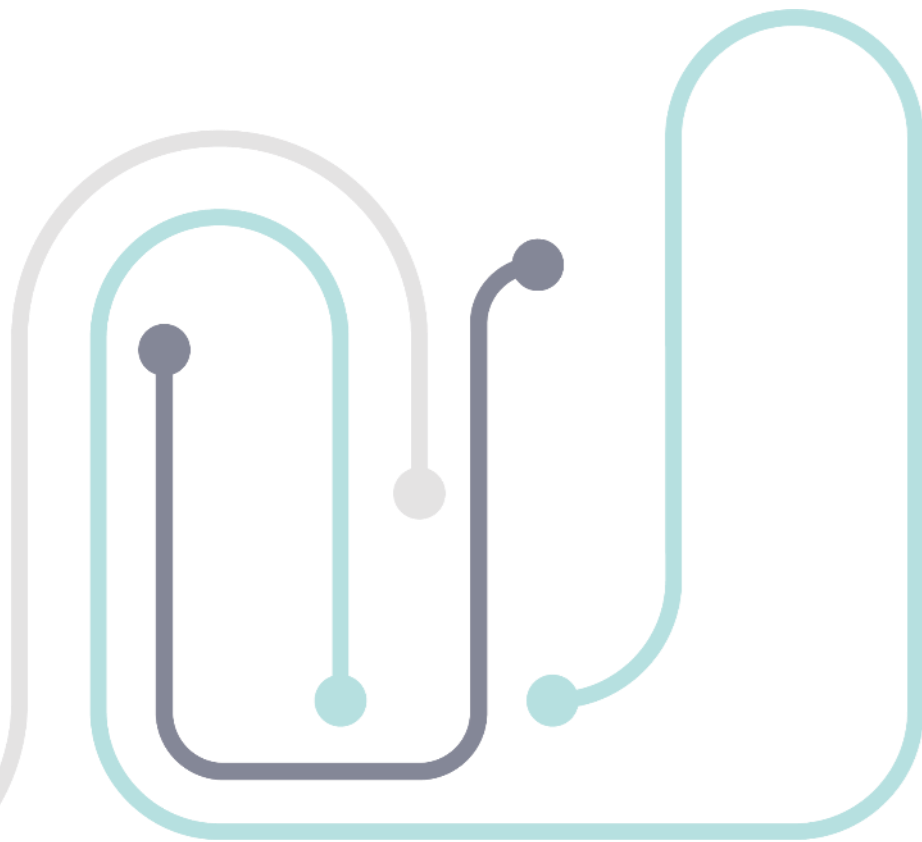
Number of assets and total monetised risk

Scenario	2018	2022	2018	2022
C-4	271	271	£1.343k	£1.343k
C-5	1.483	1.483	£7.809k	£7.809k
C-6	6.522	6.522	£21.619k	£21.619k
C-7	1.521	1.521	£7.821k	£7.821k
C-8	211	211	£1.343k	£1.343k
C-9	1.401	1.401	£7.316k	£7.316k
C-10	6.483	6.483	£21.557k	£21.557k
C-11	17.071	17.071	£78.07k	£78.07k

Service Risk by Scenario and Year

Scenarios	2018										2022			
	AH1	AH2	AH3	AH4	AH5	Total	AH1	AH2	AH3	AH4	AH5	Total		
Stable Risk	£20.28k	£3.06k	£1.44k	£2.09k	£21.34k	£68.21k	£29.28k	£3.34k	£3.34k	£3.34k	£3.34k	£42.94k		
Reactive Only Maintenance	£59.29k	£1.26k	£0.34k	£20.08k	£20.16k	£101.07k	£39.36k	£3.34k	£3.34k	£3.34k	£3.34k	£53.64k		
Maintenance	£89.476k	£214.46k	£11.16k	£29.34k	£103.06k	£272.252k	£72.252k	£6.68k	£6.68k	£6.68k	£6.68k	£96.56k		
Total	£168.965k	£216.34k	£12.84k	£51.51k	£191.75k	£641.532k	£171.29k	£13.36k	£13.36k	£13.36k	£13.36k	£293.04k		

Cadent Gas



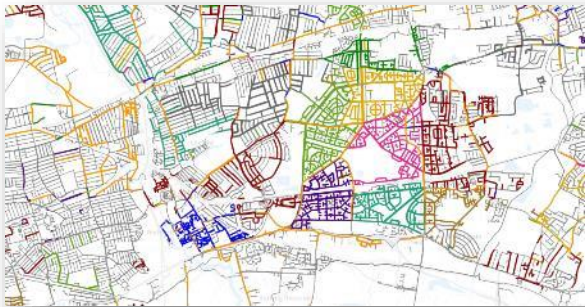
Gas Case Study: Asset Driven Optimisation Programme

Gas Distribution Mains – Dec 2017

Cadent

Your Gas Network

- Cadent Gas is a gas distribution company
- Formerly known as National Grid Gas Distribution
- Maintains 131,000 kilometers of distributions mains
- Supplies 11 million homes



Client Need

- Opex costs rising 30% year on year due to lack of targeting both opex and capex investment at asset level

Solution

- **Data Integration**– linking and cleansing of asset data.
- **Cost Modelling** – predicting asset level costs of repair based on activity incl. job and travel times at a district post code level. Replacement costs are predicted using diameter and material at a district post code level
- **Failure & Deterioration Modelling** – Asset level predictive functionality to identify pipes with high probability of failure.
- **Systemised Process** – Consolidation, simplification and automation of process, including the development of a much wider and deeper range of business questions and what-if optimisation scenarios.

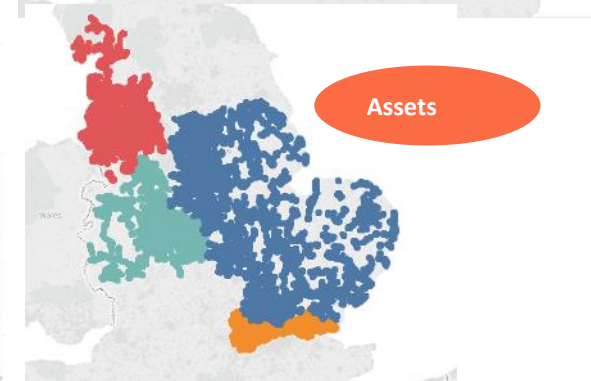
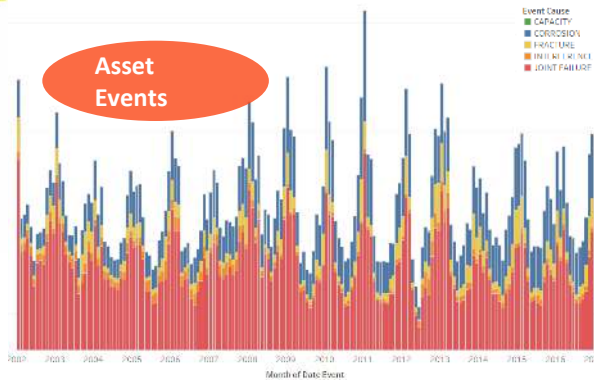
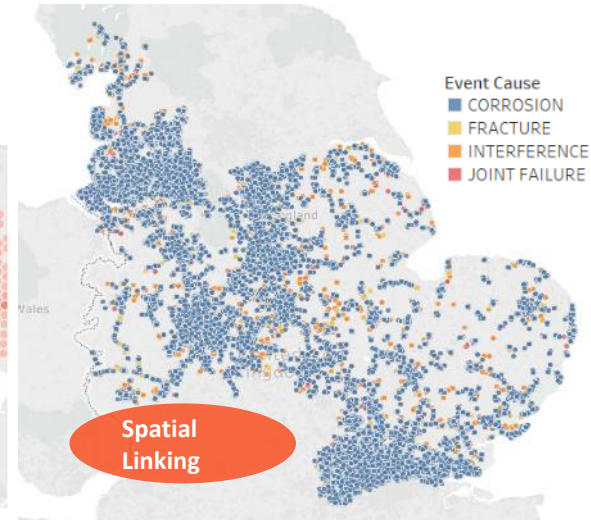
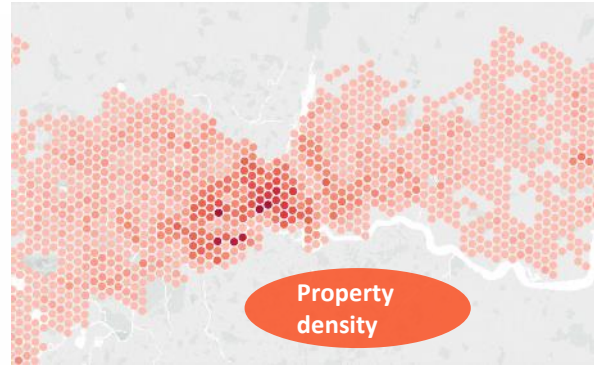
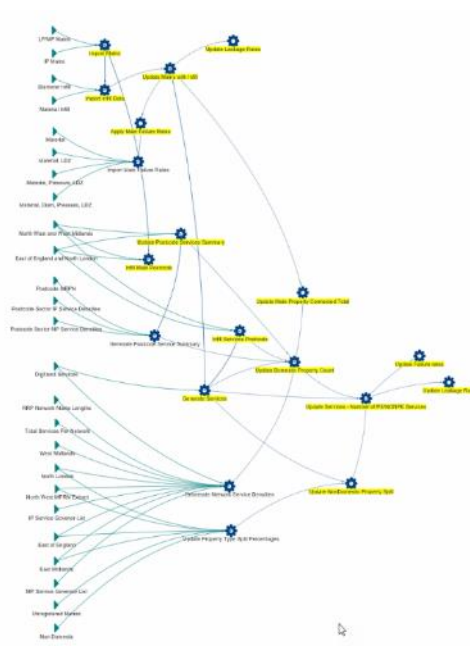
Benefits

- Predictivity capability has improved from a historical level of 1:5 to 1:2, representing significant value for Cadent.
- **2 year OPEX savings of 25%, approx. £5m**
- **TOTEX (24yrs) savings of £81 million**
- **Whole life net benefit approx. £300 million**
- The increase in predictivity has allowed Cadent to optimise the investment programme at pipe level, resulting in significant efficiency gains across all four networks.
- Rolled out across all 4 networks for GD2 long term investment plan

Data Understanding and Preparation

2 million pipes with 2.2m failure events over 12 years

- OS MM
- ESRI GIS
- SAP
- XLS
- CSV
- MRPS

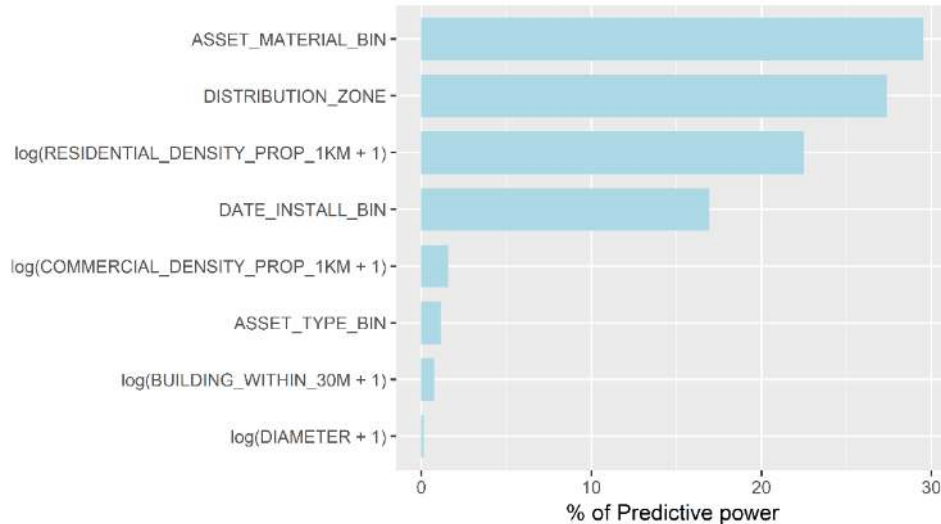


Predictive Analytics – Asset Level Failures

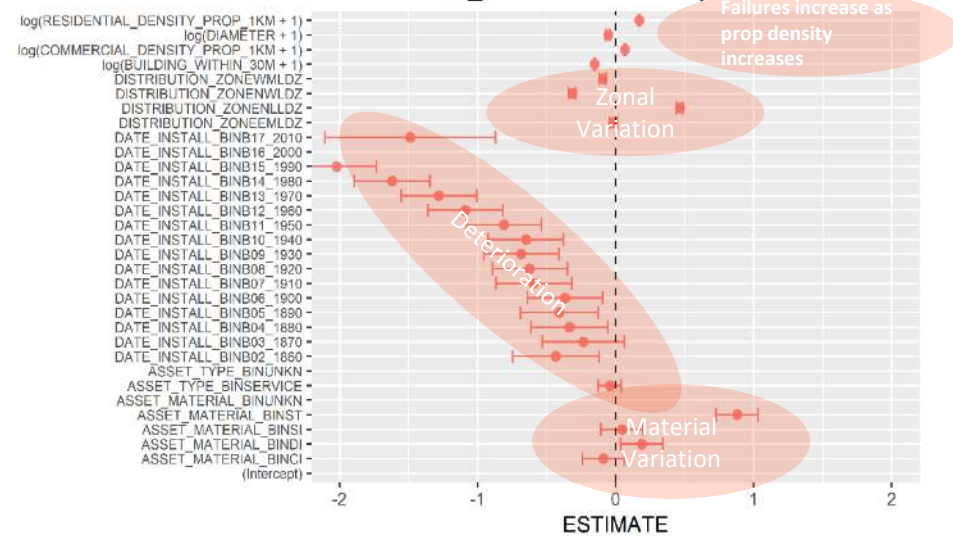
What asset has a higher chance of failing



Relative Importance of Predictor Variables



CORROSION_TOTAL Coefficient plot

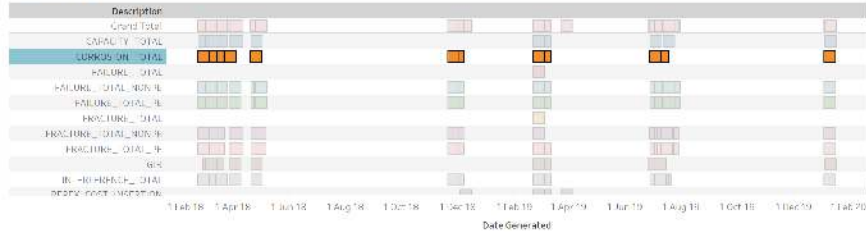


Model Dashboard

Auditable and repeatable

Model Results Dashboard

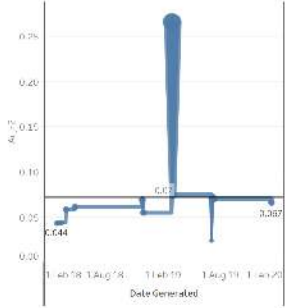
Model Generation



Day of Date Generated:
29 February 2018 to 10 January 2020
and Null values
Measure Names
Aggr

Model Summary

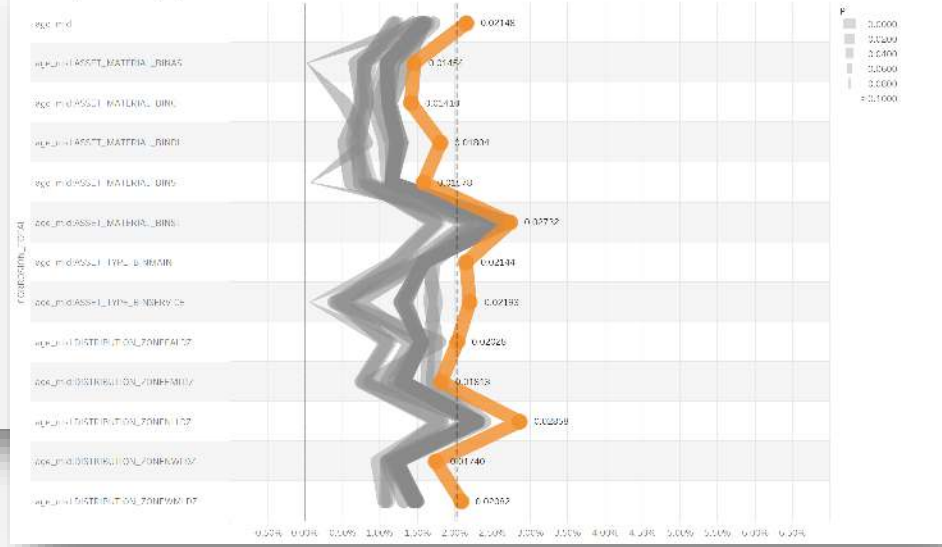
	Adj2	R2	Obs	FIT	Theta	Df Null	
CORROSION_TOTAL	11/07/2015 22:55	0.541	0.517	56,552	62,666	0.139	841,804
	10/07/2015 09:16	0.573	0.517	56,552	62,666	0.138	841,804
	05/07/2015 21:01	0.571	0.517	56,552	62,666	0.138	841,804
	04/07/2015 05:36	0.571	0.517	56,243	62,469	0.134	841,804
	13/07/2015 14:51	0.575	0.525	57,074	62,848	0.139	841,804
	06/03/2015 11:34	0.575	0.525	47,870	60,510	0.171	682,595
	27/02/2015 10:42	0.766	0.768	179,888	78,045	0.477	2,615,078



Tracking predictive models and model diagnostics over time

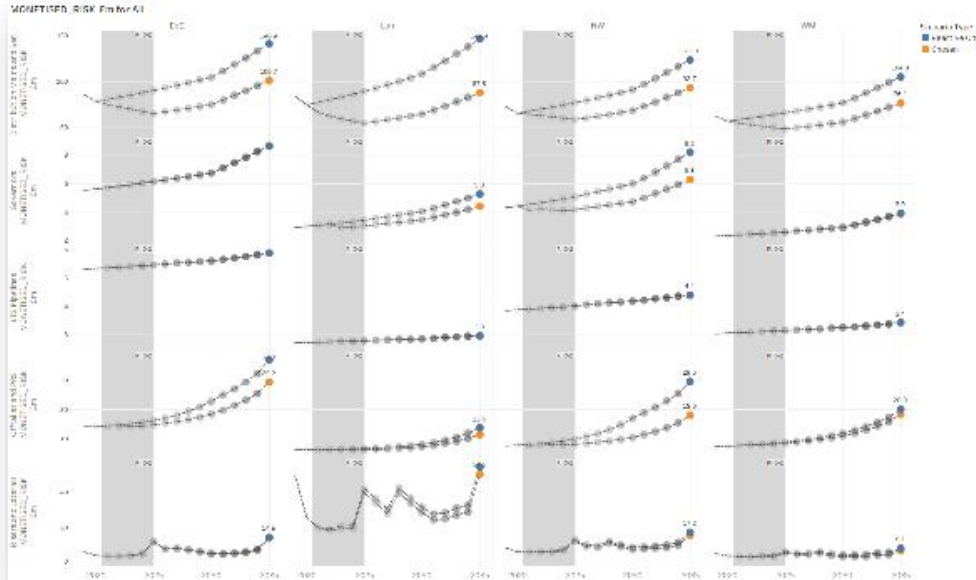
Model signature viz – changes in predictor variables over time

Model Signature: 09/01/2020 11:08:52

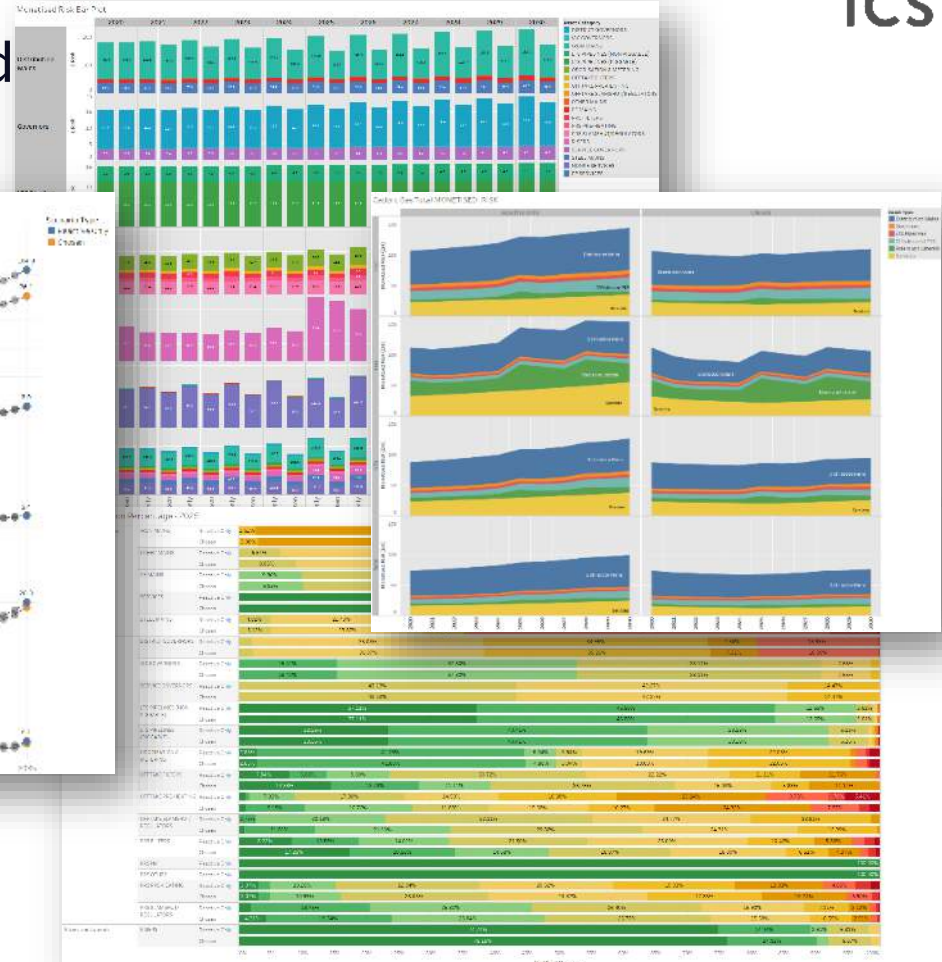


Risk and Investment Dashboard

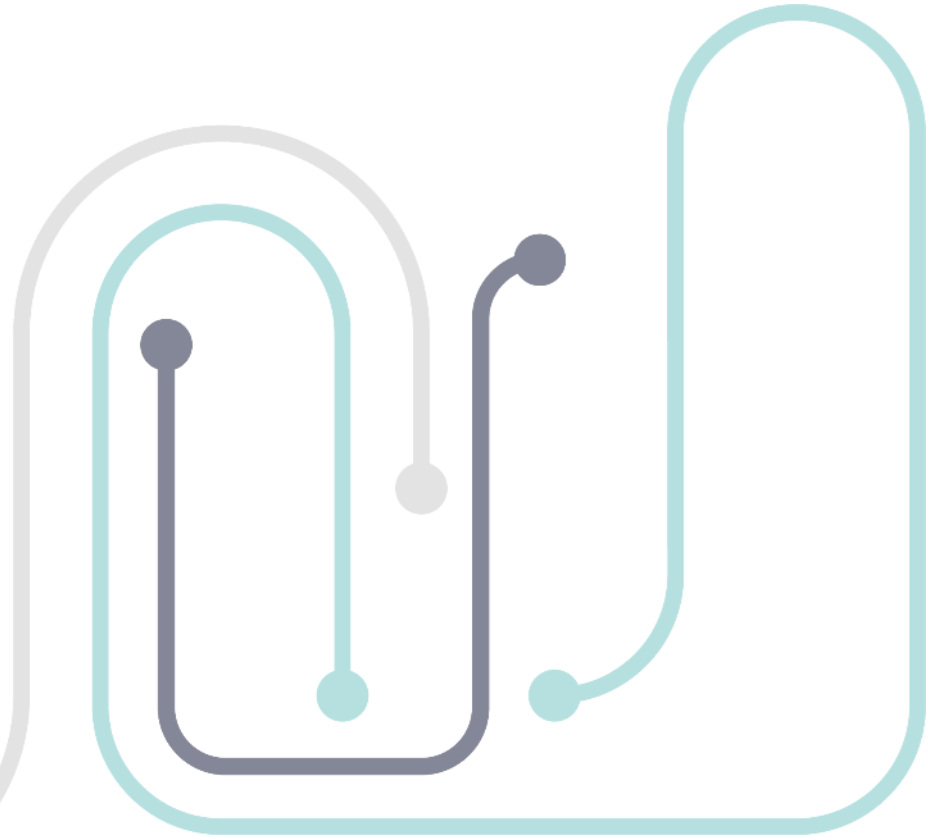
Data and results can be accessed directly by Cadent



Top down and drilldowns into key risks over time horizon



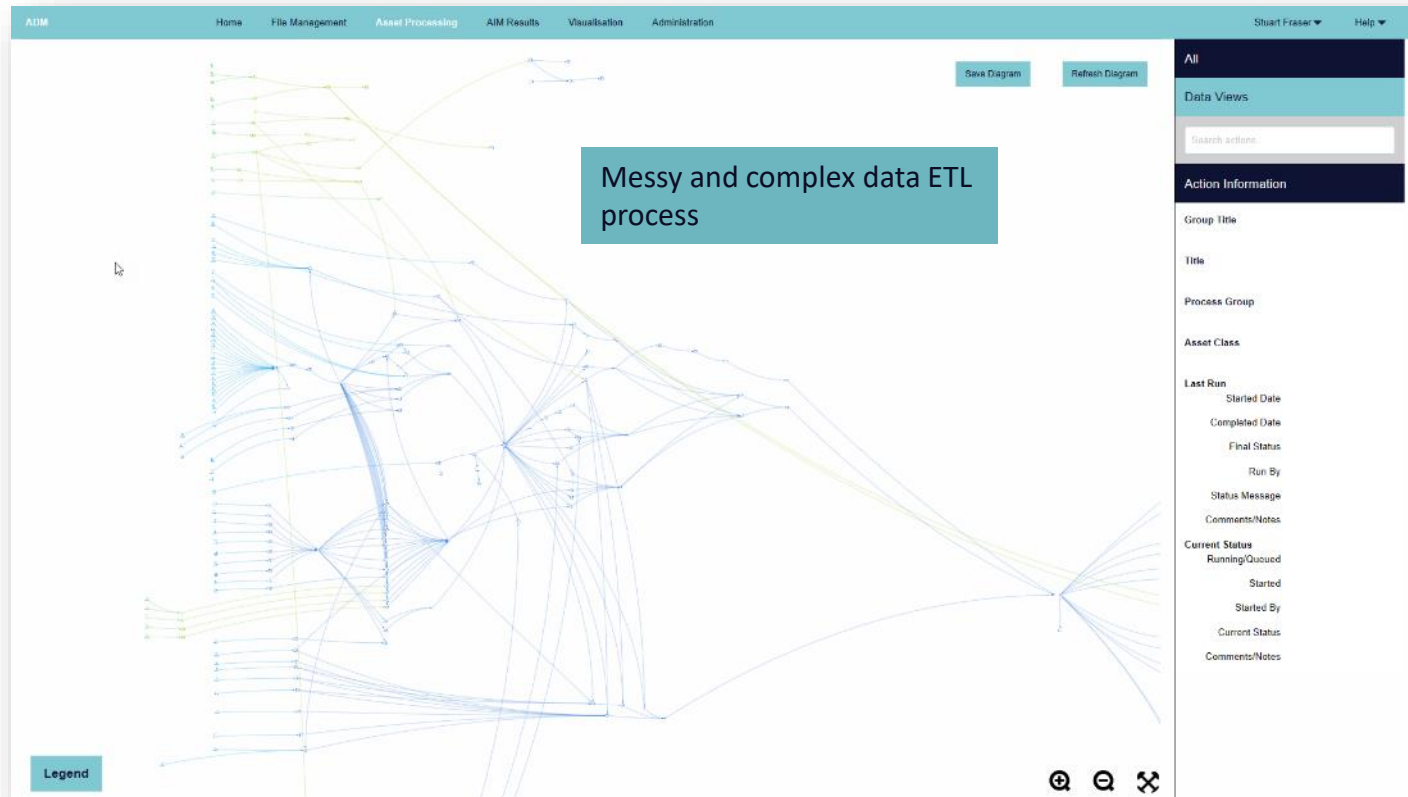
Thames Water



Thames Water Collating and Structuring Data

Multiple datasets, multiple formats

- 150 data sources
 - Structure
 - Content
 - Assess
 - Cleanse
 - Link
 - Process
 - Export



Thames Water Collating and Structuring Data



Data Structure and refreshes

- List of dataset
- Structure
- Refresh Dates
- Metadata
- Number Rows
- Number Nulls
- etc

ADM Data Sources

Data Sources

Asset Class	Category	Display Name	Mode Type	Format	
	Cost Centre	Line Zones	PROCESS	CSV File	
Height Data		ES Cost Models	PROCESS	CSV File	
		Mains Height Data from 2012 LiDAR	PROCESS	CSV File	
		Mains Height Data from 2016 FA LiDAR (Highest Resolution)	PROCESS	CSV File	
Infill Methods		Mains Inside M25 Height Data	PROCESS	CSV File	
		Mains Outside M25 Height Data	PROCESS	CSV File	
		Data from Thames Year Last database	INGRESS	CSV File	
		Historic Infill Method from PRL3	PROCESS	CSV File	
		Trunk Diameter Manual Updates	PROCESS	CSV File	
Interventions		Trunk Diameter Test Mining	PROCESS	CSV File	
		Existing Interventions	PROCESS	CSV File	
Leakage Data		Active Leakage Areas	PROCESS	CSV File	
		DMA Availability	PROCESS	CSV File	
		DMA Daily Leakage and Op Incl right line	PROCESS	CSV File	
		DMA Detection Hours	PROCESS	CSV File	
		DMA Leakage Properties	PROCESS	CSV File	
		DMA Leakage Properties Infill	PROCESS	CSV File	
		DMA Minimum Nightlines	PROCESS	CSV File	
		DMA Weekly Leakage	PROCESS	CSV File	
		FM2 Leakage	PROCESS	CSV File	
		DQ2 Data Linked to CPPs by Thames	PROCESS	CSV File	
Low Pressure		DMA Pressure	PROCESS	CSV File	
		DMA Weekly Average Pressure	PROCESS	CSV File	
Pressure Data		Zonal Pressures	PROCESS	CSV File	
		Cast Iron Probability Data	PROCESS	CSV File	
Probability Data		VCAP Lines	PROCESS	ESR File G	
		ITS	PROCESS	CSV File	
Supply Interruptions		SI Mains Reference Data	PROCESS	CSV File	
		AMFG Existing Interventions	PROCESS	CSV File	
Trunk/Main Data		Infill	PROCESS	CSV File	
	Water Infra Assets		Boundary Boxes	PROCESS	ESR File G
			Chambers	PROCESS	ESR File G
			Change of Characteristic (COC)	PROCESS	ESR File G
		Connection Mains	PROCESS	ESR File G	
		Connection Meters	PROCESS	ESR File G	
		Control Pillars	PROCESS	ESR File G	
		Customer Valves	PROCESS	ESR File G	
		Distribution and Trunk Mains	PROCESS	ESR File G	
		End Items	PROCESS	ESR File G	
		Fittings	PROCESS	ESR File G	
		Hydrants	PROCESS	ESR File G	
		Loggers	PROCESS	ESR File G	

Tracking data and processing over time

Data Structure

Source Column Name	Column Name	Column Description	Data Type	Data Length
1	geobc_oid	GEOB_C_OID	NUMBER	4
2	OBJECTID	OBJECTID	NUMBER	4
3	ENABLED	ENABLED	NUMBER	1
4	ENABLED_resolved	ENABLED_RESOLVED	NVARCHAR2	60
5	CREATIONUSER	CREATIONUSER	NVARCHAR2	20
6	DATECREATED	DATECREATED	DATE	8
7	DATEMODIFIED	DATEMODIFIED	DATE	8
8	LASTUSER	LASTUSER	NVARCHAR2	100
9	GENID	GENID	NUMBER	8
10	G_SID	G_SID	NUMBER	7
11	SHORTG_SID	SHORTG_SID	NVARCHAR2	13
12	TWGUID	TWGUID	NVARCHAR2	40
13	SUBTYPECD	SUBTYPECD	NUMBER	1
14	MATERIAL	MATERIAL	NVARCHAR2	10
15	MATERIAL_resolved	MATERIAL_RESOLVED	NVARCHAR2	60
16	OPERATINGPRESSURE	OPERATINGPRESSURE	NUMBER	1

Timeline

Process Name: Load Distribution and Trun...
Rows: 1,042,003; Duration: 71.0 mins

Metadata

Column Name	Value
BECDWTYPE	1000K DK
DFACTOR	1000K DK
GLAWBACK	1000K DK
GLAWBACK_RESOLVED	1000K DK
GLAWBACKDATE	1000K DK
DMBREP	1000K DK
COHORT	1000K DK
COHORTSOURCE	1000K DK
COMMENTS1	1000K DK

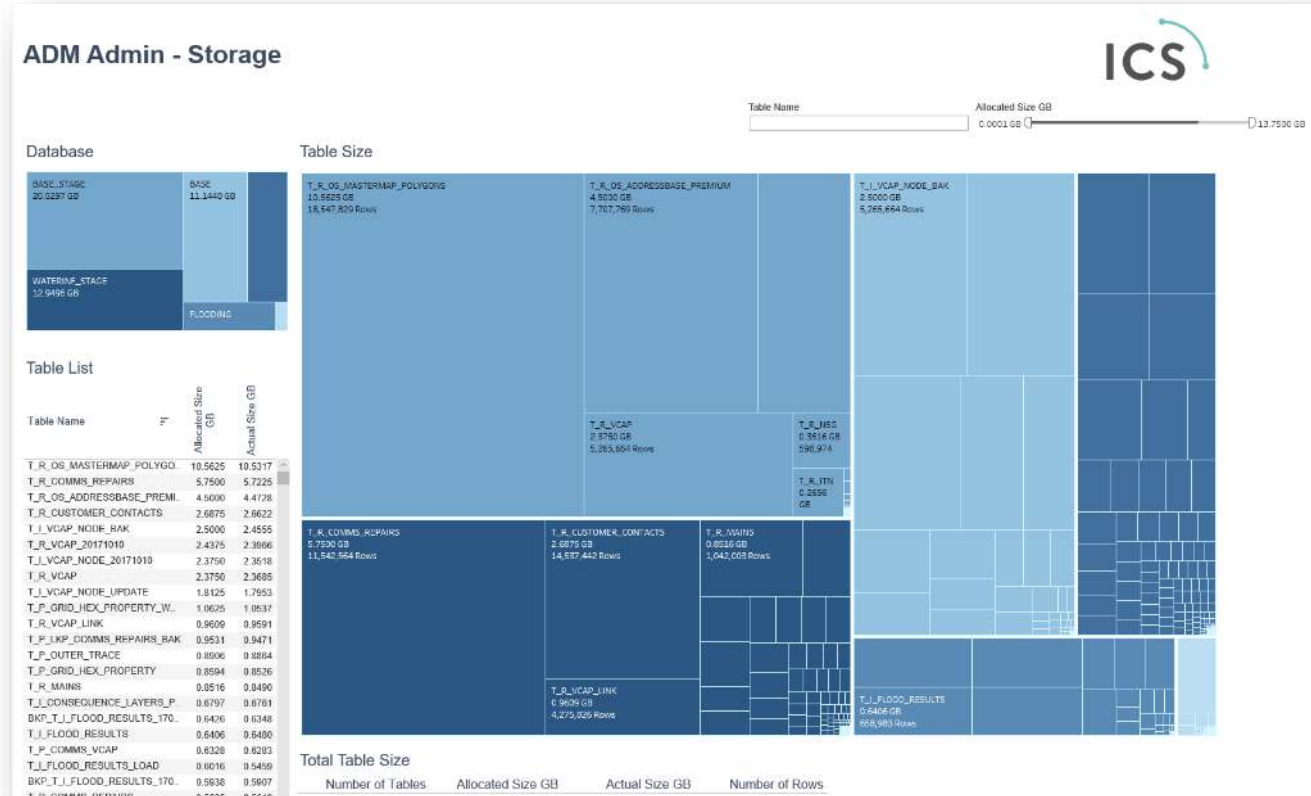
Measure Names

- (All)
- Duration
- Duration Size
- Num Distinct
- Num Duplicates
- Num Nulls
- Num Rows
- Num Zero
- Number of Rows
- Std Deviation
- Sum

Thames Water Collating and Structuring Data

Monitoring Growth and Storage

- Data Storage
 - Schema Level
 - Table Level
 - GB/Number of Records



A large number of the assets within a Water and Wastewater utility can cause flooding if they fail

These have a significant impact on those affected

- Water
 - Water Distribution Network – 500,000 to 1,000,000 pipes
 - Service Reservoirs
 - Raw Water Reservoirs
 - Water Treatment Works
- Wastewater
 - Wastewater Collection Network (Sewers) - 500,000 to 1,000,000
 - Pumping Stations
 - Sewage Treatment Works
 - Overflows

Mains Failure



Sewer Surcharge



An example of the consequence of flooding on the Water Distribution Network

Flooding of this scale can cost up to £4m in real terms plus the associated reputational impacts

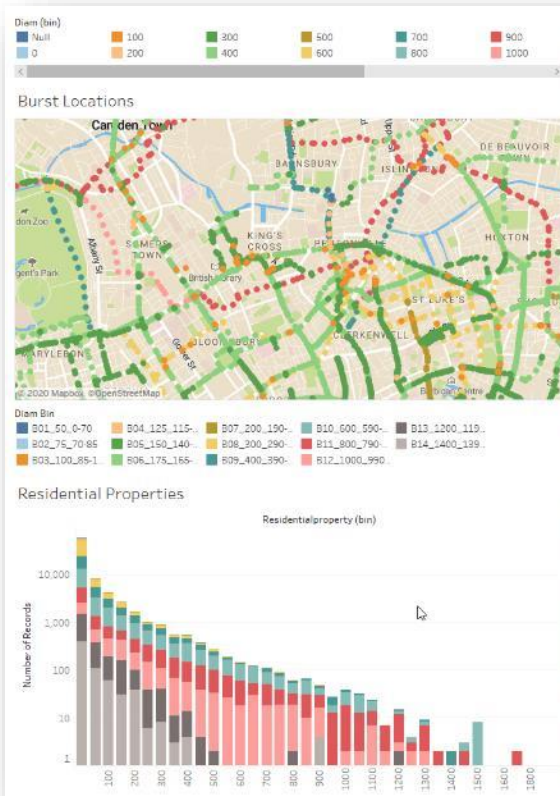
- The majority of the water distribution network is relatively small diameter, however
- The larger Trunk Mains have the potential to cause serious flooding
- What happens when these fail?
 - Flooding
 - Property Damage
 - Loss of Business
 - Pollution
 - Traffic disruption



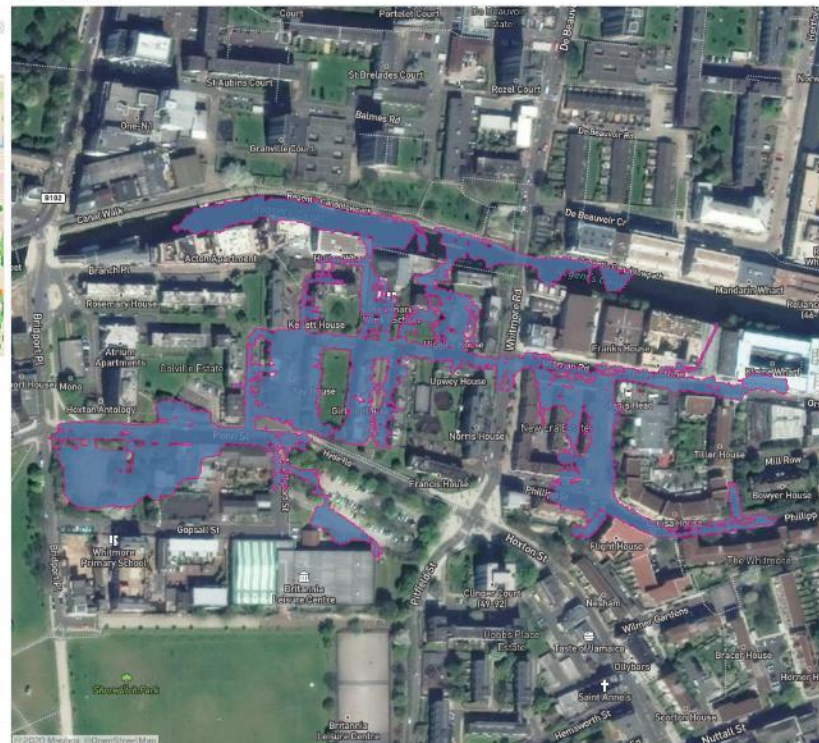
Thames Water Flood Risk Assessment

Spatial View of Flood Risk

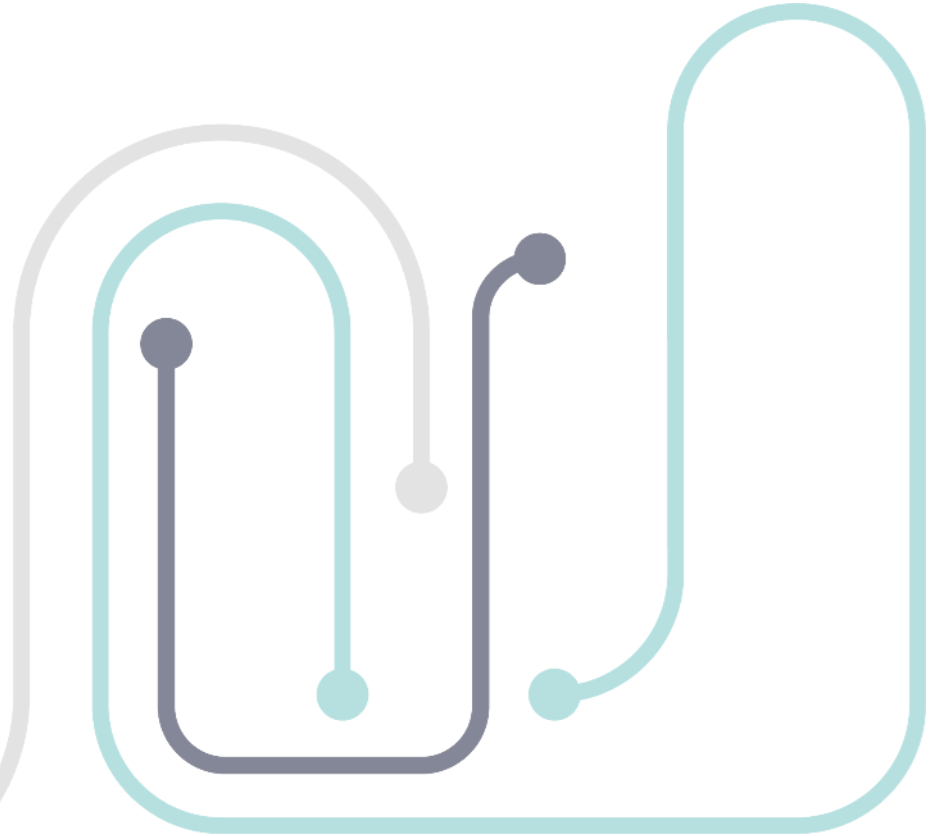
- 125,000 Locations
 - Tableau Mapping
 - Google Maps
 - Spatial Results



Flood Extents



Summary & Discussion



Asset Investment Planning using Tableau

Communicating investment decisions and democratising data

- Tableau is used throughout our consulting and software services
 - Bottom-up and top down
- Increased use of Tableau Server to:
 - maintain consistency
 - open up the value in data to a wider audience
- Many challenges to overcome
 - Understanding data content and context
 - Design for re-use, avoid client specific where possible
- Well designed process is key!
- Resources