

# Targeting & Prioritisation of Sewer Rehabilitation

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## Background

The privatised water industry in England and Wales is tightly regulated. The onus is on the water companies to robustly demonstrate the need for investment funding and hence customer bill rise. Furthermore,



- There is a need to understand and forecast infrastructure asset behaviour and the associated risks
- Business Plans must be based on numeric risk approach
- The cost of maintaining serviceability (i.e. stable collapse rates) needs to be lower than forecast in the Companies' Business Plans

## Context

Considering the 10 Water and Sewerage Companies in England and Wales,

- ~310,000km of sewerage
- Historically CCTV surveyed <0.2% of network per annum, or ~3% since 1990. This is the only basis for understanding the condition of the network
- Sewer rehabilitation budgets only sufficient to address ~0.1% of the network every 5 years
- Equivalent asset lives range from 600 to 1,400 years



## The Challenge

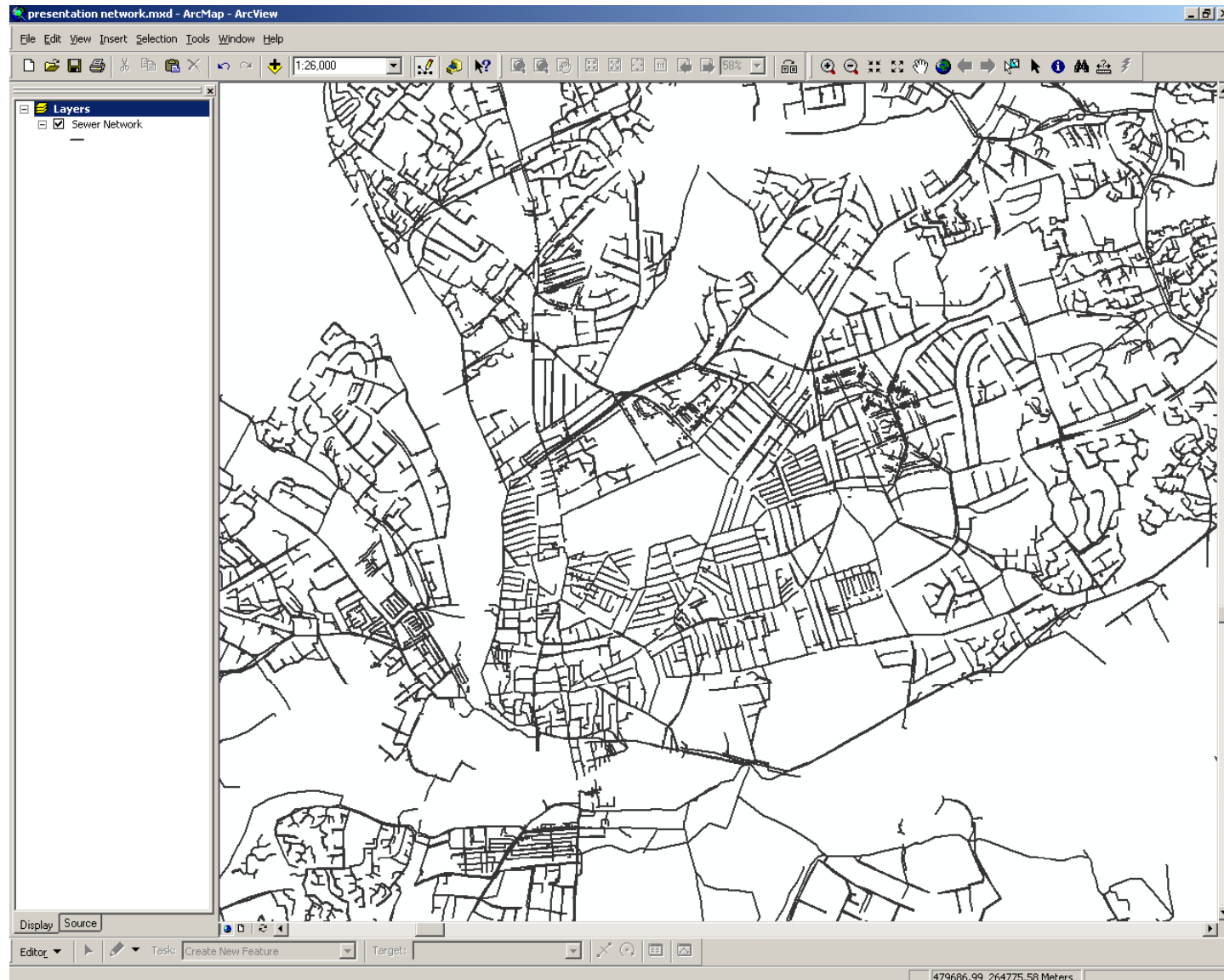
With limited budgets, high customer expectations and stringent regulatory reporting measures, how can the Sewerage Company spend the money it has available for sewer rehabilitation to achieve the best outcomes?

- Which sewers need to be replaced or renovated?
- What state are they in and are they likely to collapse?
- What risk do they pose if they collapse?
- How long can they be left?
- Can other serviceability issues be addressed?

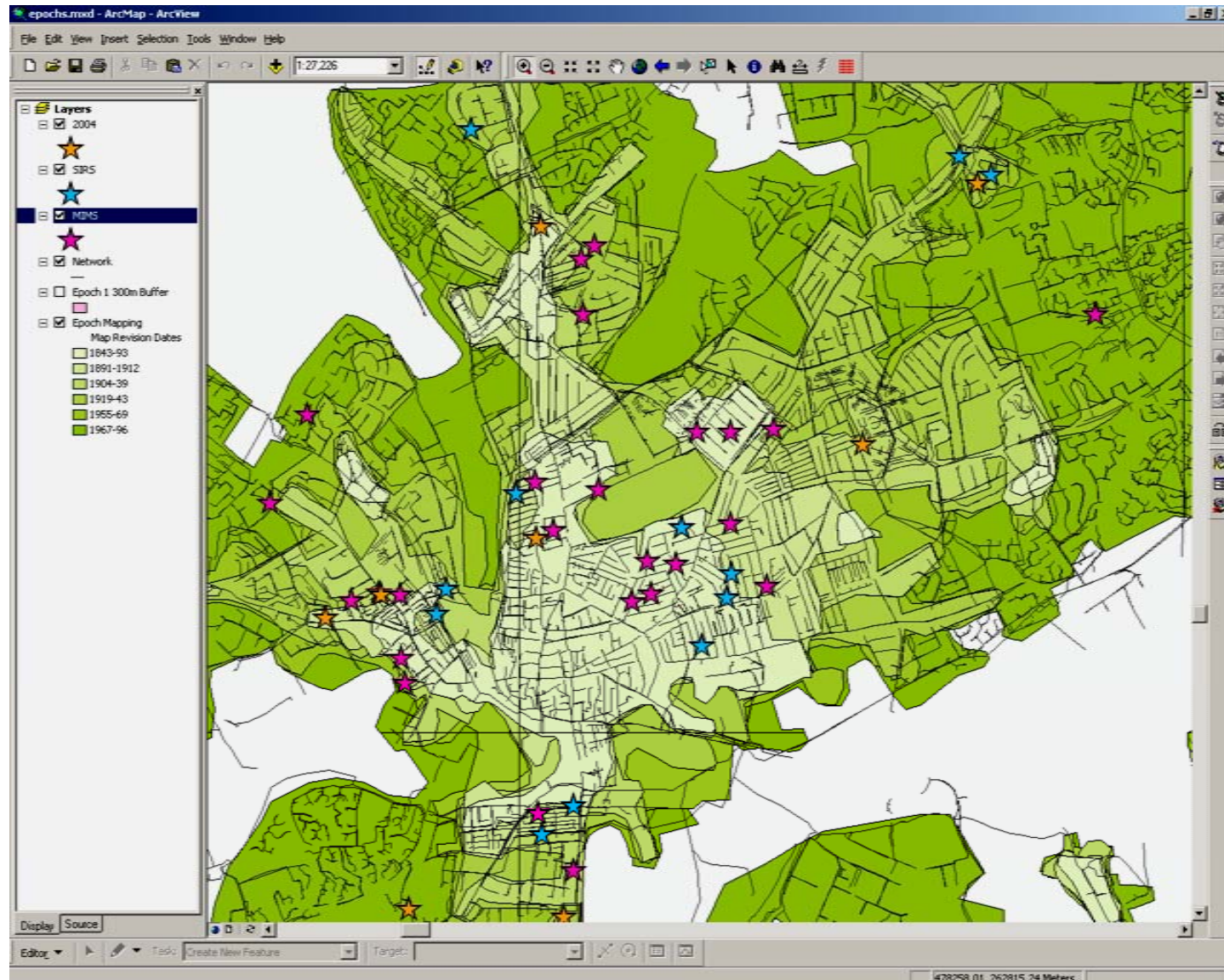




# Sewerage Network

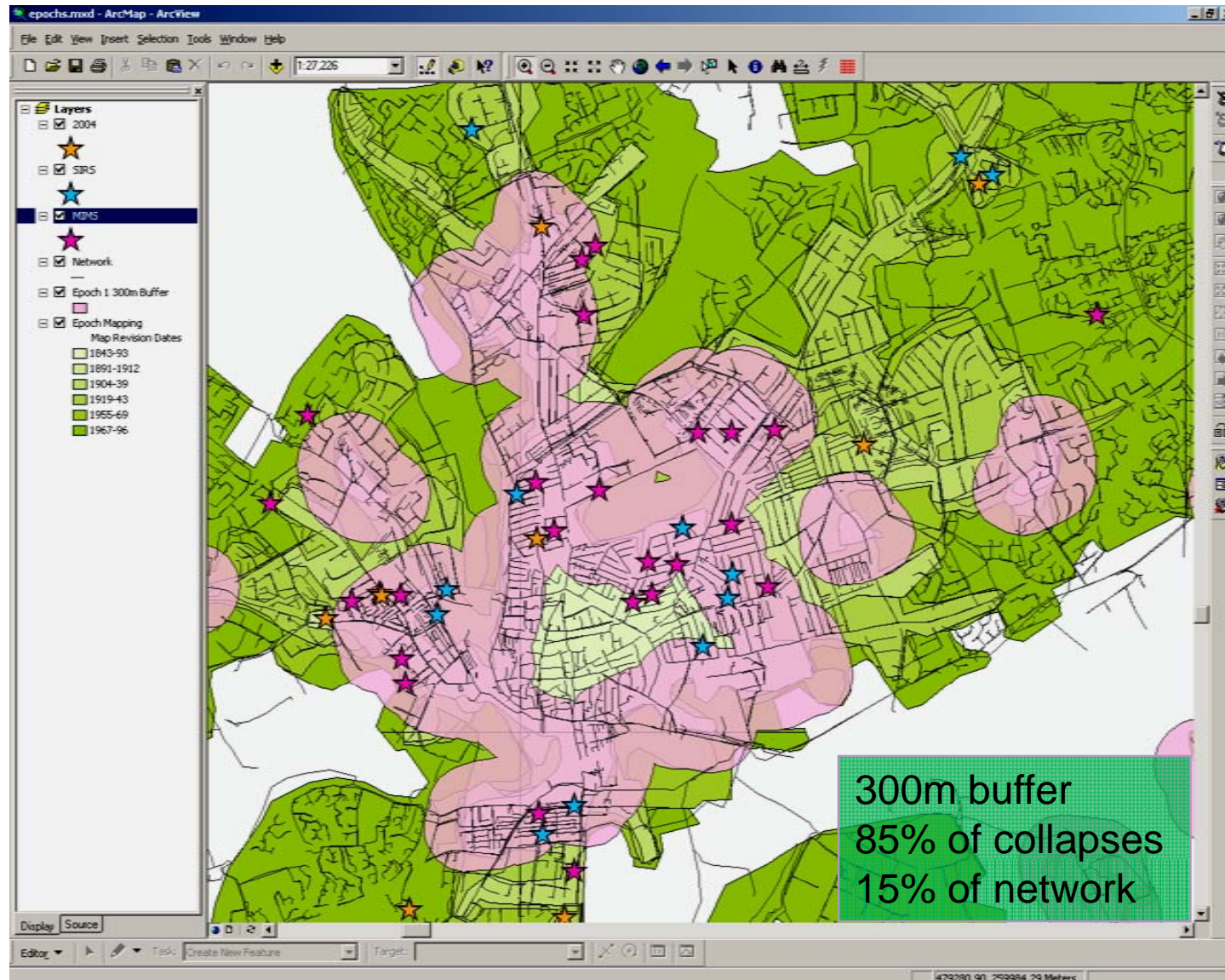


## Historic Collapse Data





## Analysis – Collapse vs. Epoch



## Data Sources

- Corporate GIS
- Historic mapping
- Soils maps
- Topography
- Historic CCTV survey data
- Reported collapses

Extract maximum benefit from data

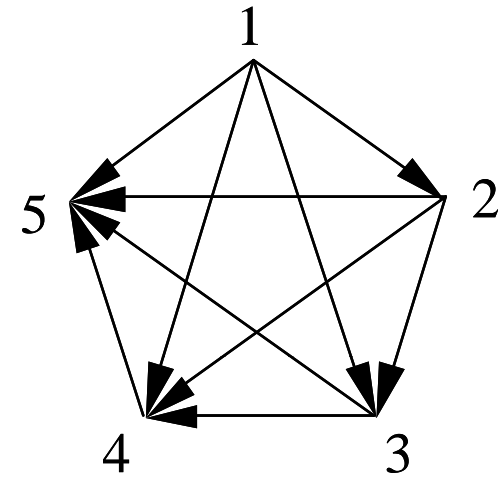
- Data cleansing
- Computed inference
- Geo-location
- Re-analysis



## Collapse Model

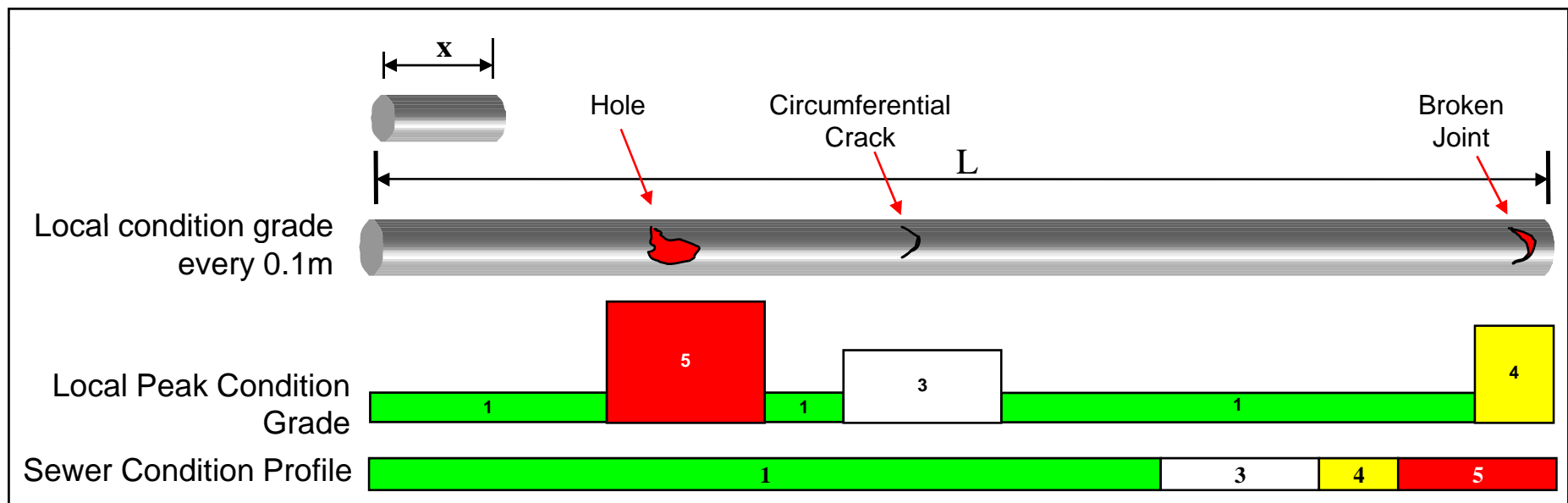
### Strategic Deterioration & Collapse Model

- Asset base stratified into Classes by
  - Age Band
  - Material
  - Size Band
  - Soil Risk
- Mathematical analysis using Semi-Markov chain matrix methodology
- % in class migrating between condition grades
- Calibrated using re-analysis of historic CCTV
- Aligned with recorded collapse data
- Intervention scenarios for investment planning



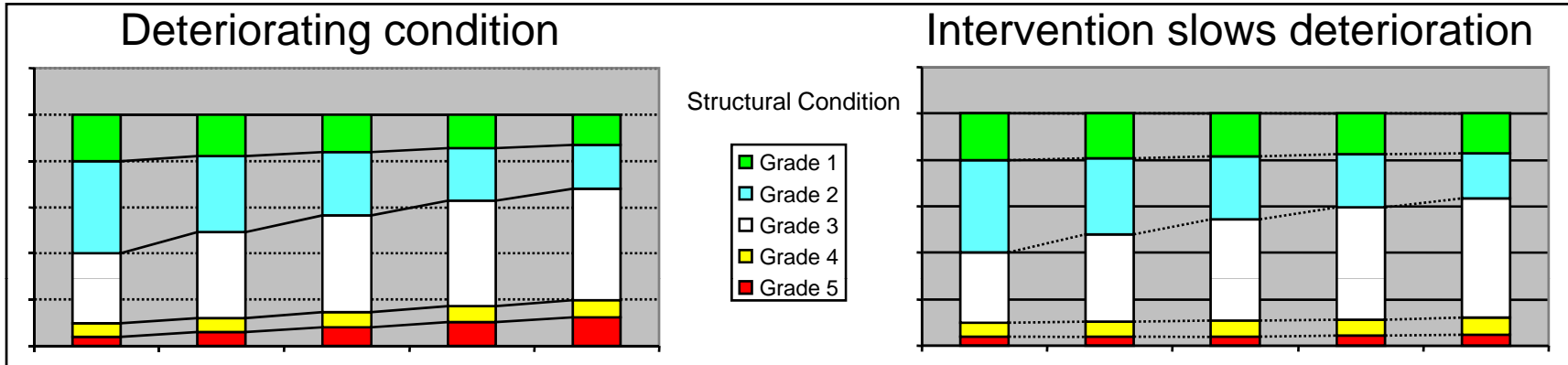
## Sewer Condition Profile

Using a structural condition profile for each surveyed asset, rather than the traditional Peak Score, produces a metric that can be extrapolated to the un-surveyed network based on sewer class



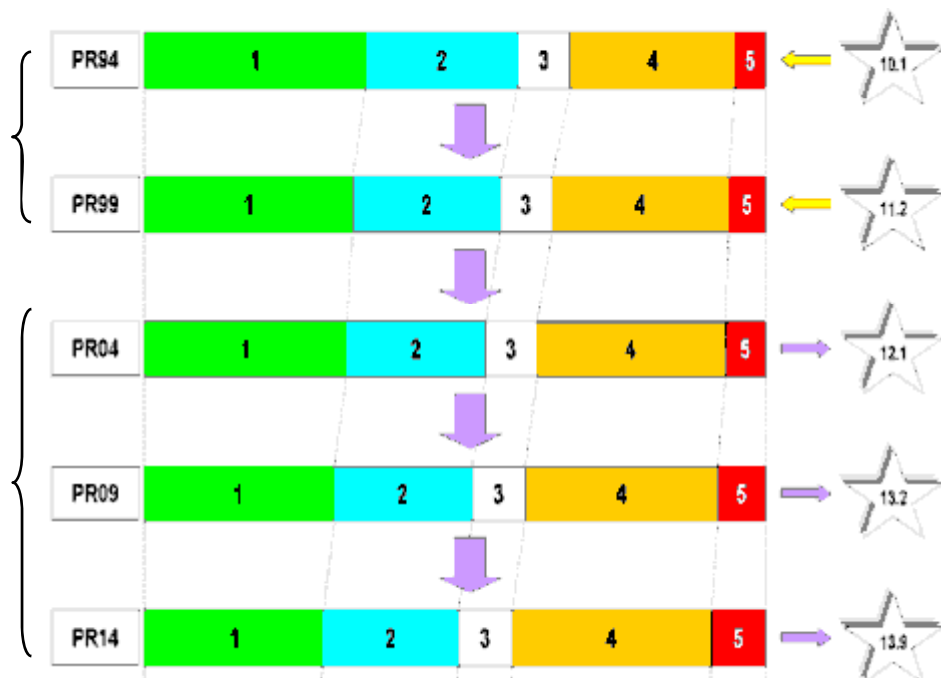
Re-analysis of historic CCTV data in Examiner sewer.dat format via a bespoke data loader and processor into MS Access database

## Predicted Network Condition & Serviceability



Historic condition profile and collapse rates used to calibrate model

Predicted condition profile generates collapse probability

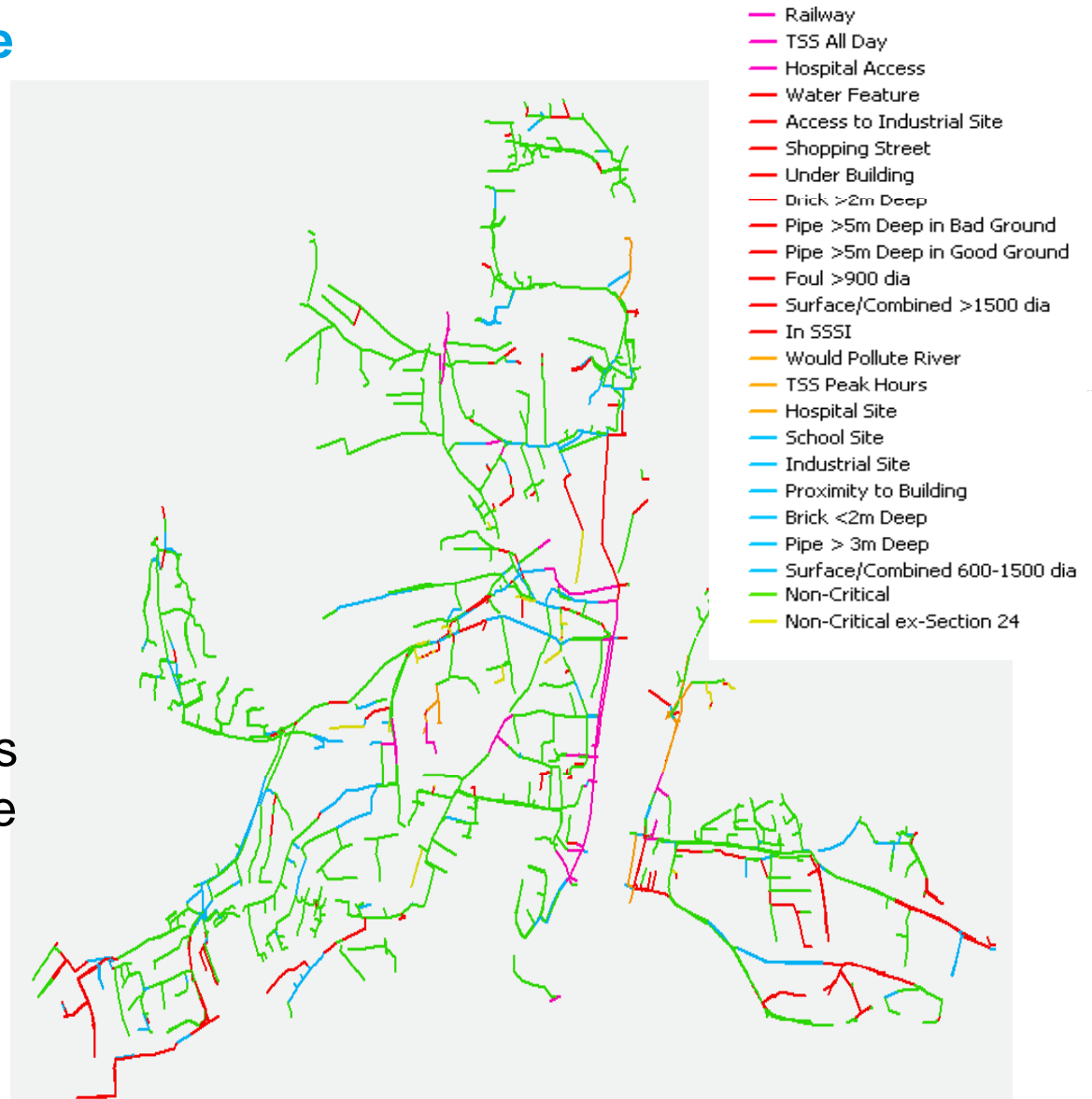


Collapse rate increases as proportion of Grade 4 and 5 increases without intervention (sewer rehabilitation)



## Consequence of Collapse

- Define extended Criticality categories based on WRc Sewer Rehab Manual
- Assessed from first principles
- Determine every driver applying to each sewer and apply most onerous
- Map Criticality categories (40 No.) to Consequence Grades (5 No.)

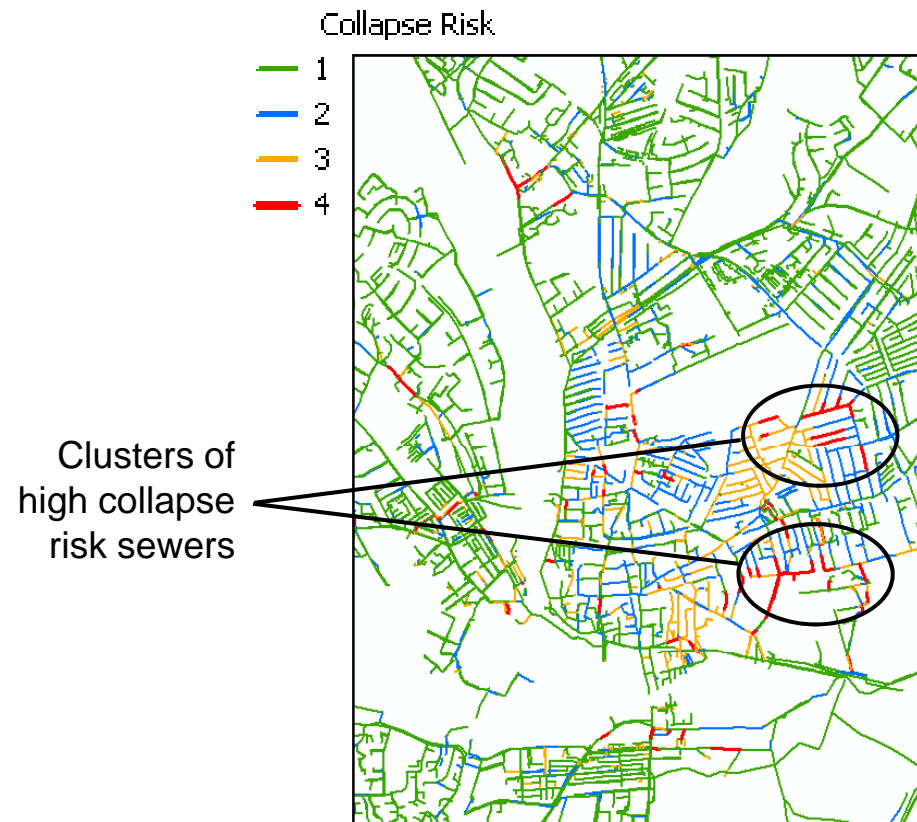


## Collapse Risk

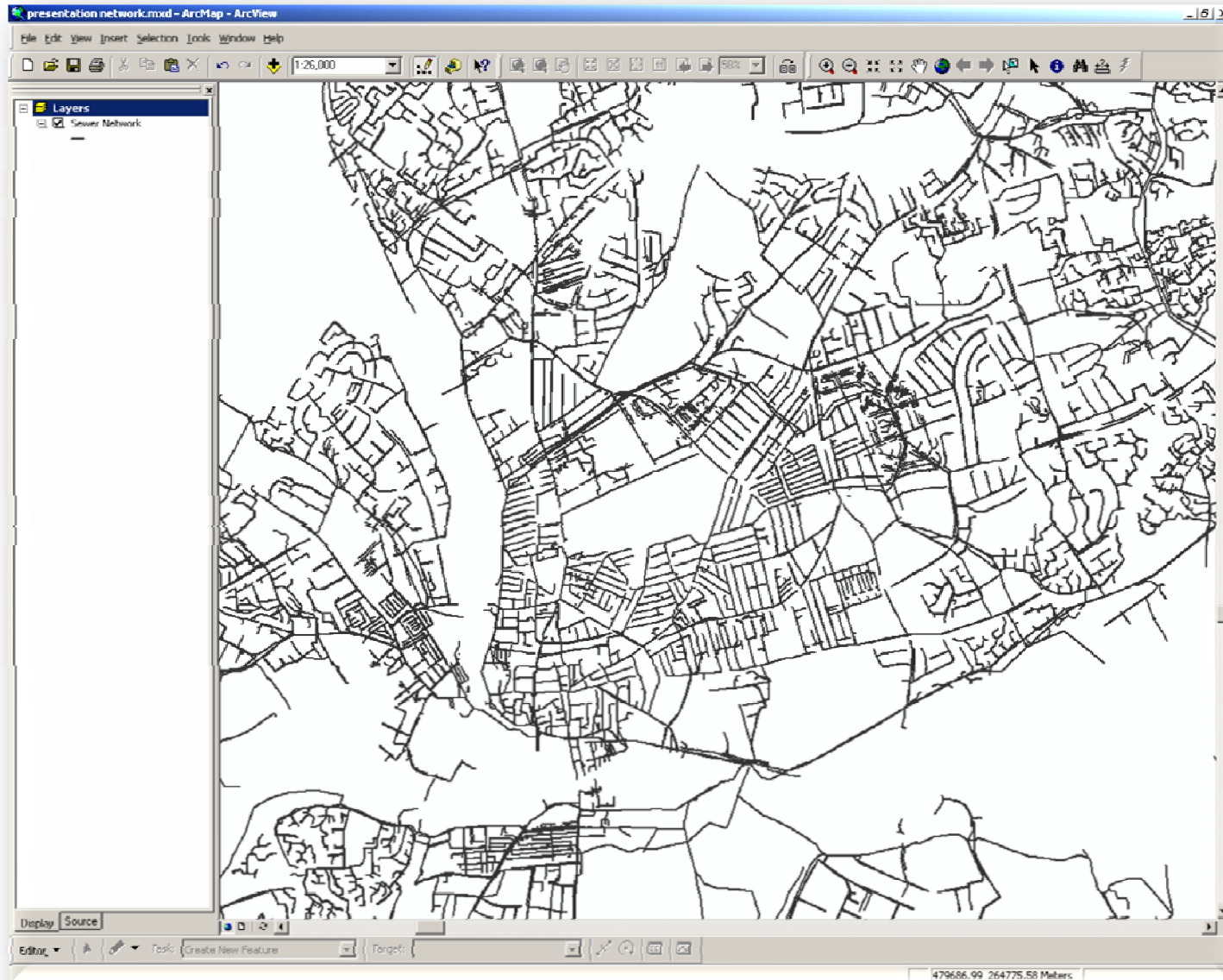
Collapse risk is calculated per asset as,

$$\begin{array}{c} \textit{Likelihood} \\ \textit{(predicted collapse rate)} \\ \times \\ \textit{Consequences of collapse} \end{array}$$

The majority of the network presents a low risk, but sewers most likely to collapse and with significant consequences (e.g. rail crossings, under buildings, large diameter) are highlighted.

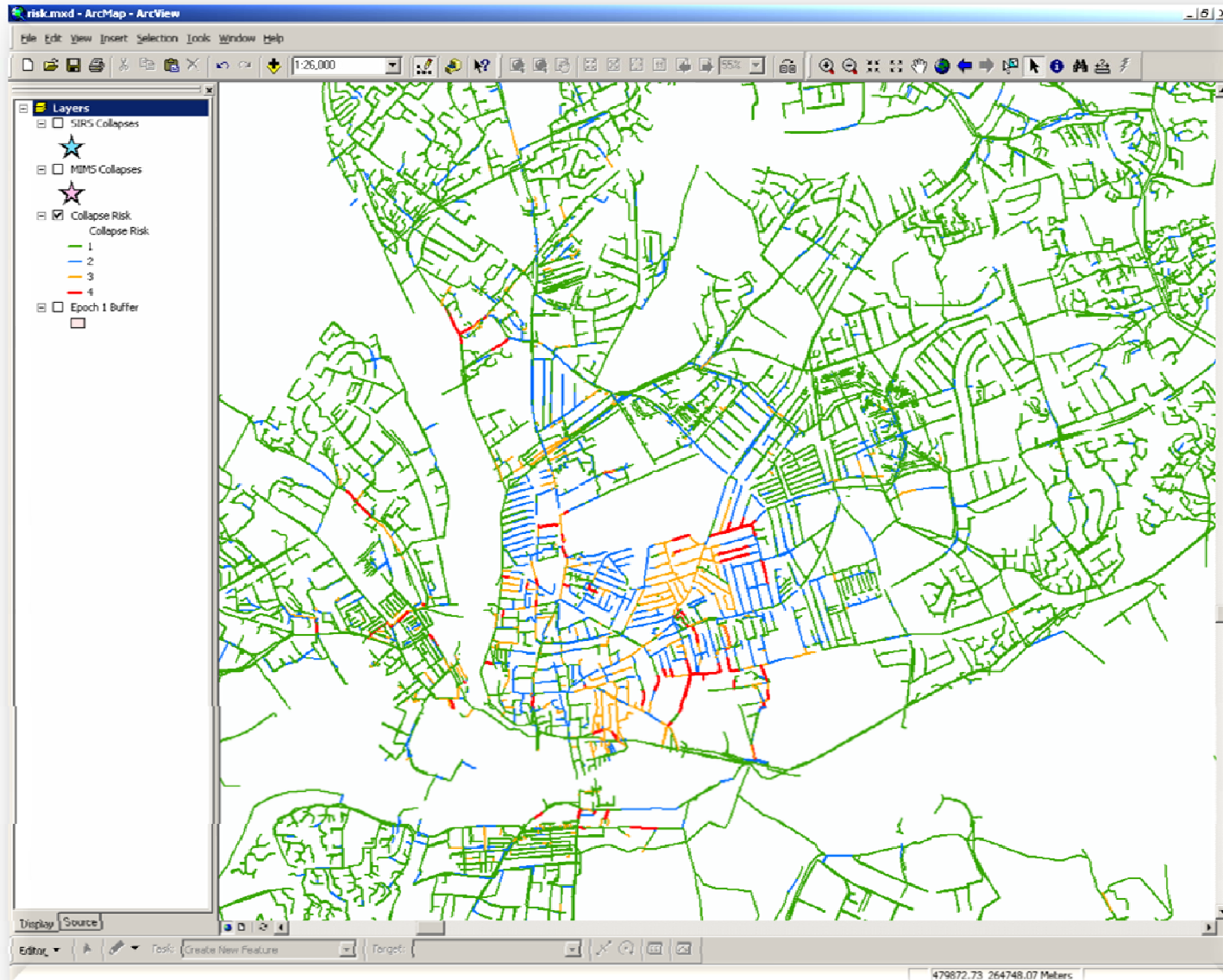


## Sewerage Network (0000's km)



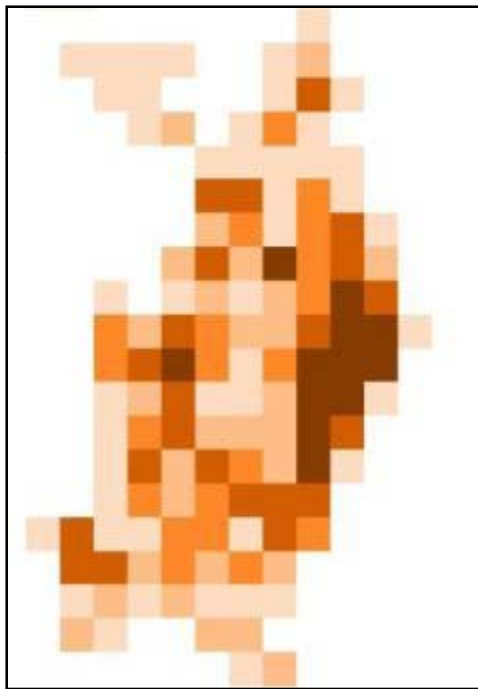


## Collapse Risk (00's km)

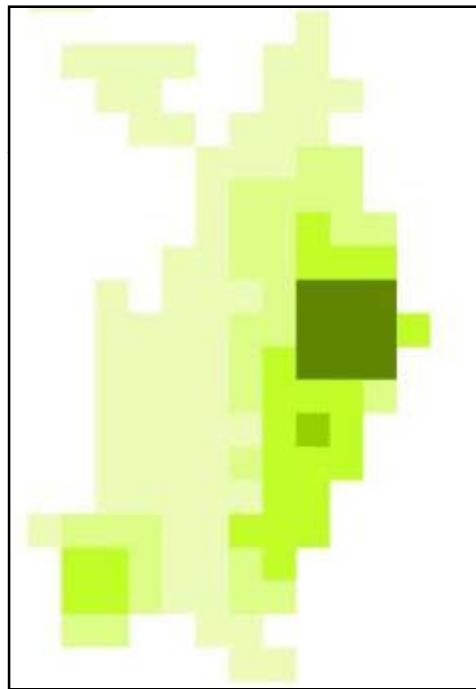


## Multiple Drivers

Condition / Blockages / Property Flooding

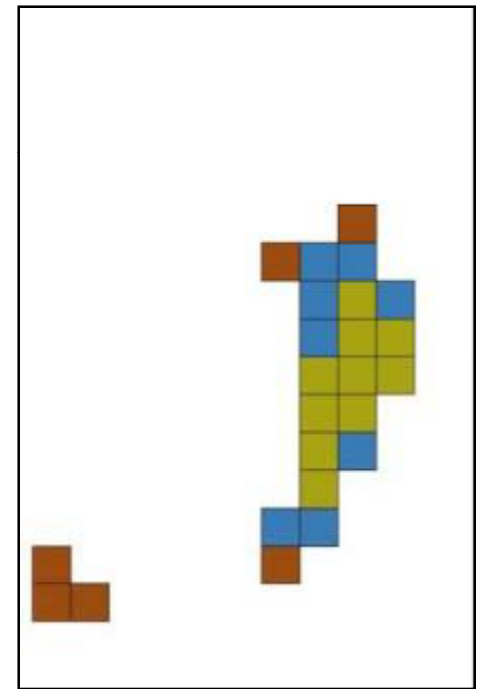


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Prioritised Plan



Collapses / Modelled Flooding / OPEX

## Prioritisation Model Process

Collate and geocode inputs

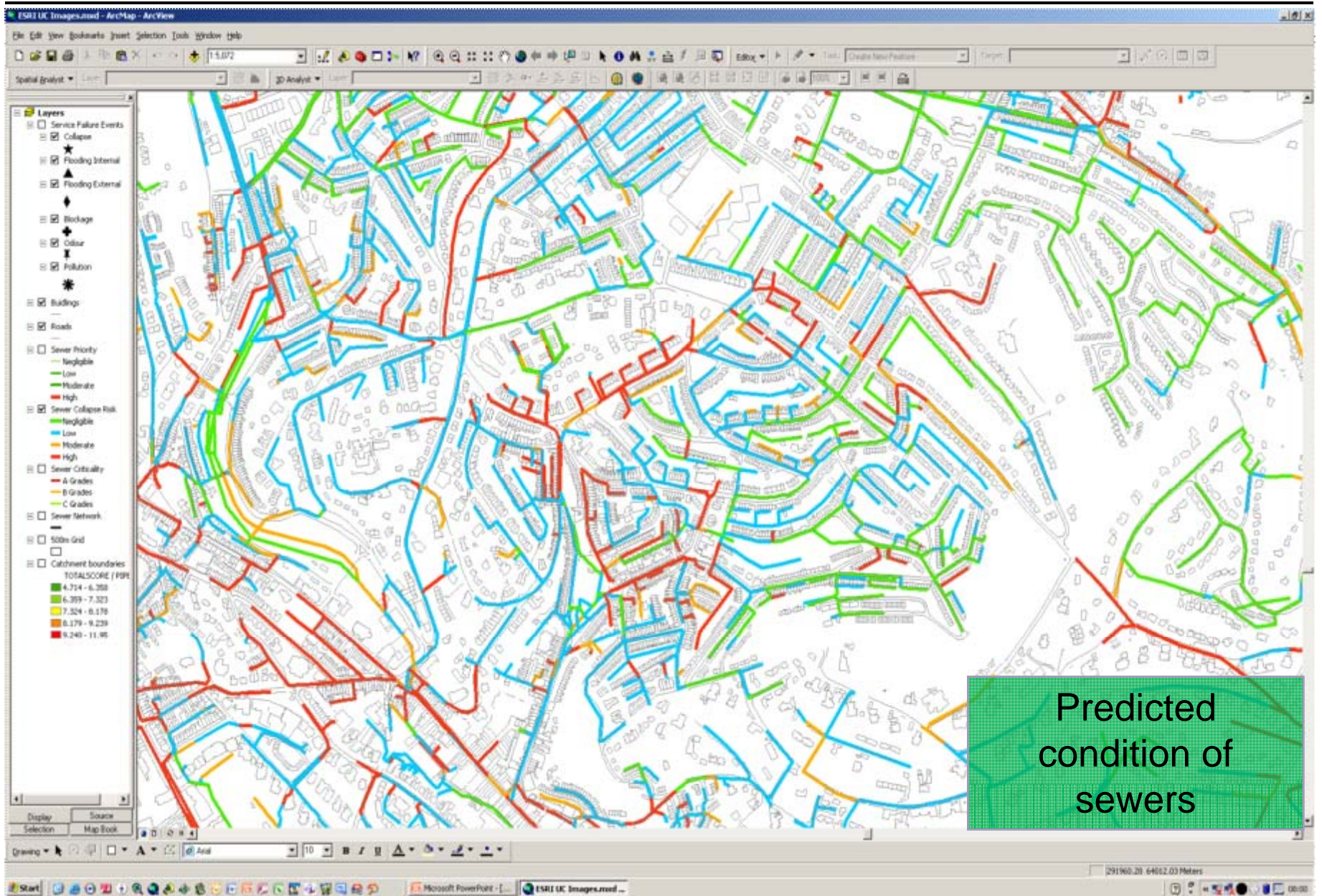
Count events by type within 100m of sewer

Apply 1-5 score using natural breaks

Apply weighting factors (0.0 – 1.0)

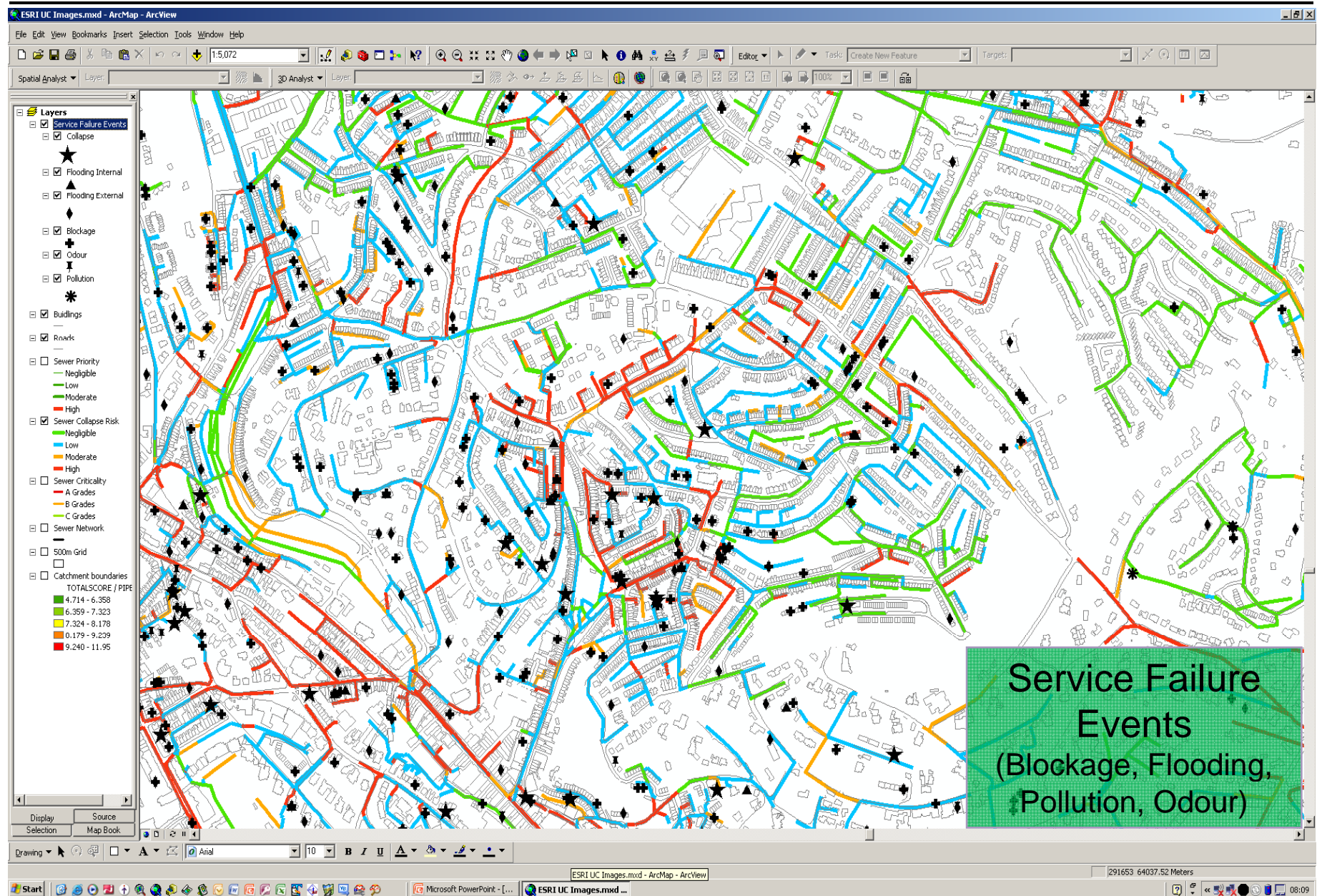
Calculate score at asset and catchment level

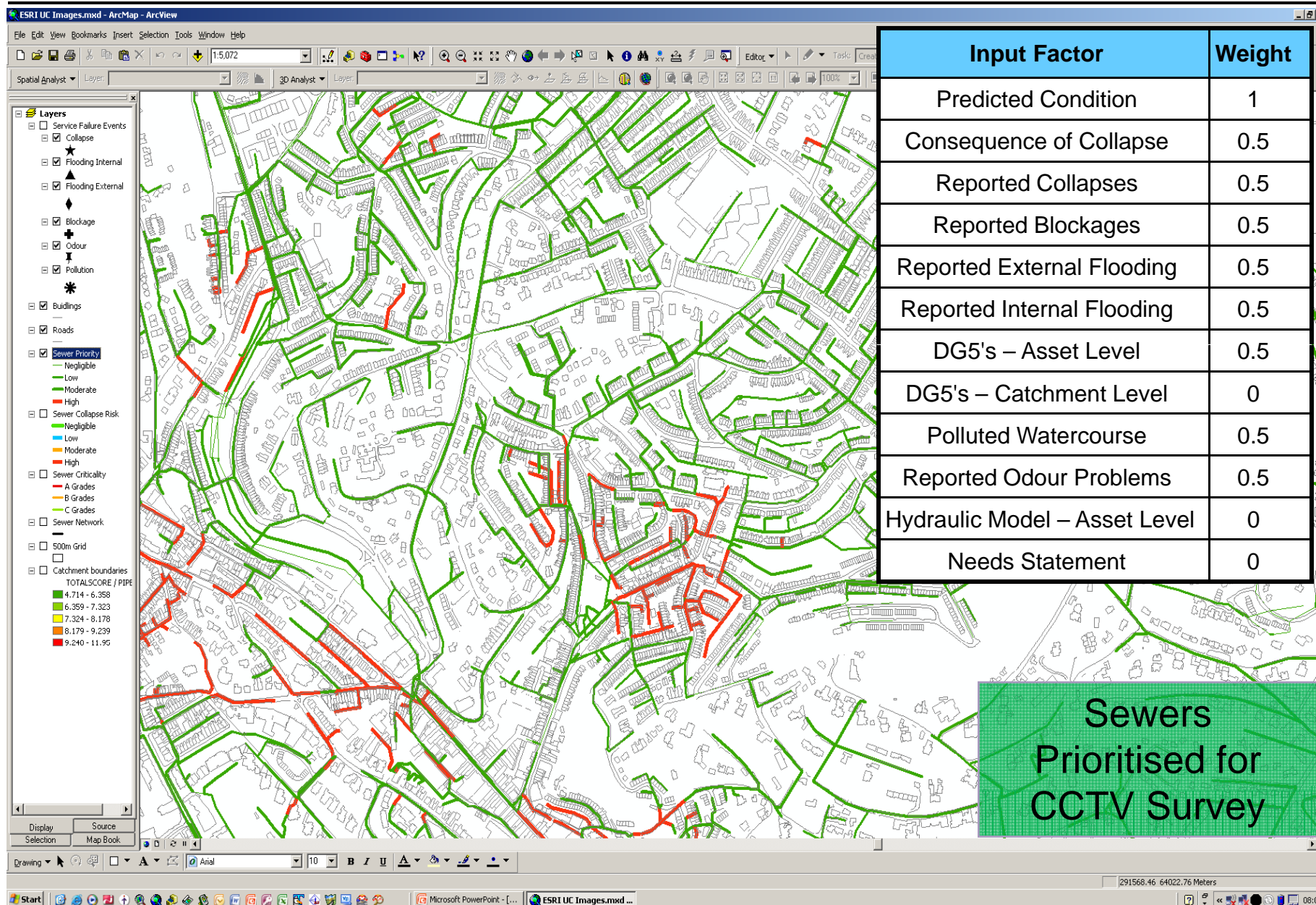






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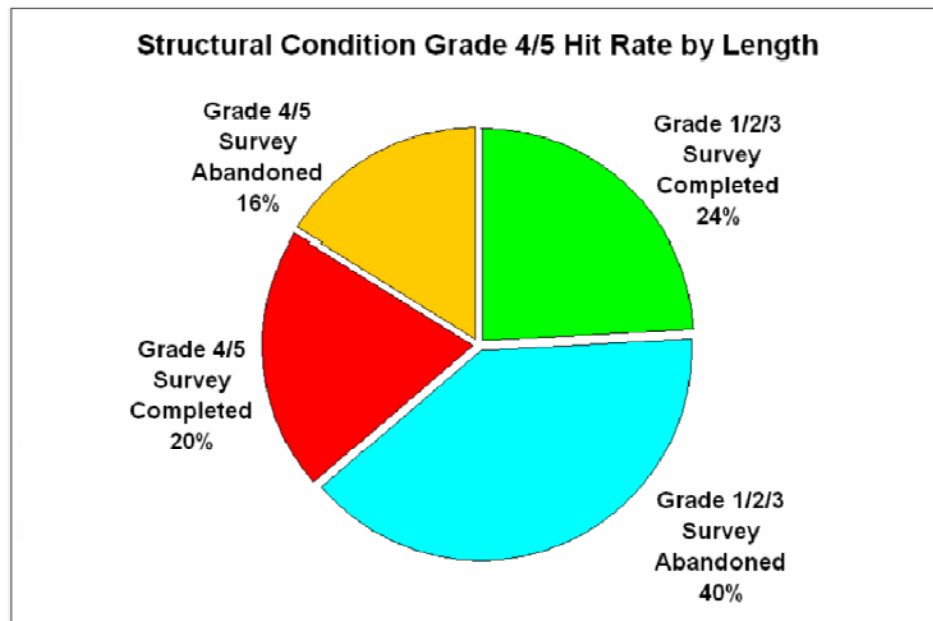


Sewers  
Prioritised for  
CCTV Survey



## Efficiency Savings

The approach has been implemented in two water companies to plan CCTV programmes and yielded up to a 40% return of sewers with rehabilitation requirements, compared to around 15-17% previously, i.e. a



>50% saving in CCTV budget to achieve the same length of sewer rehabilitation.

Additionally, a high percentage of sewers identified for survey required jetting, which resolved a number of additional operational issues in the locality.