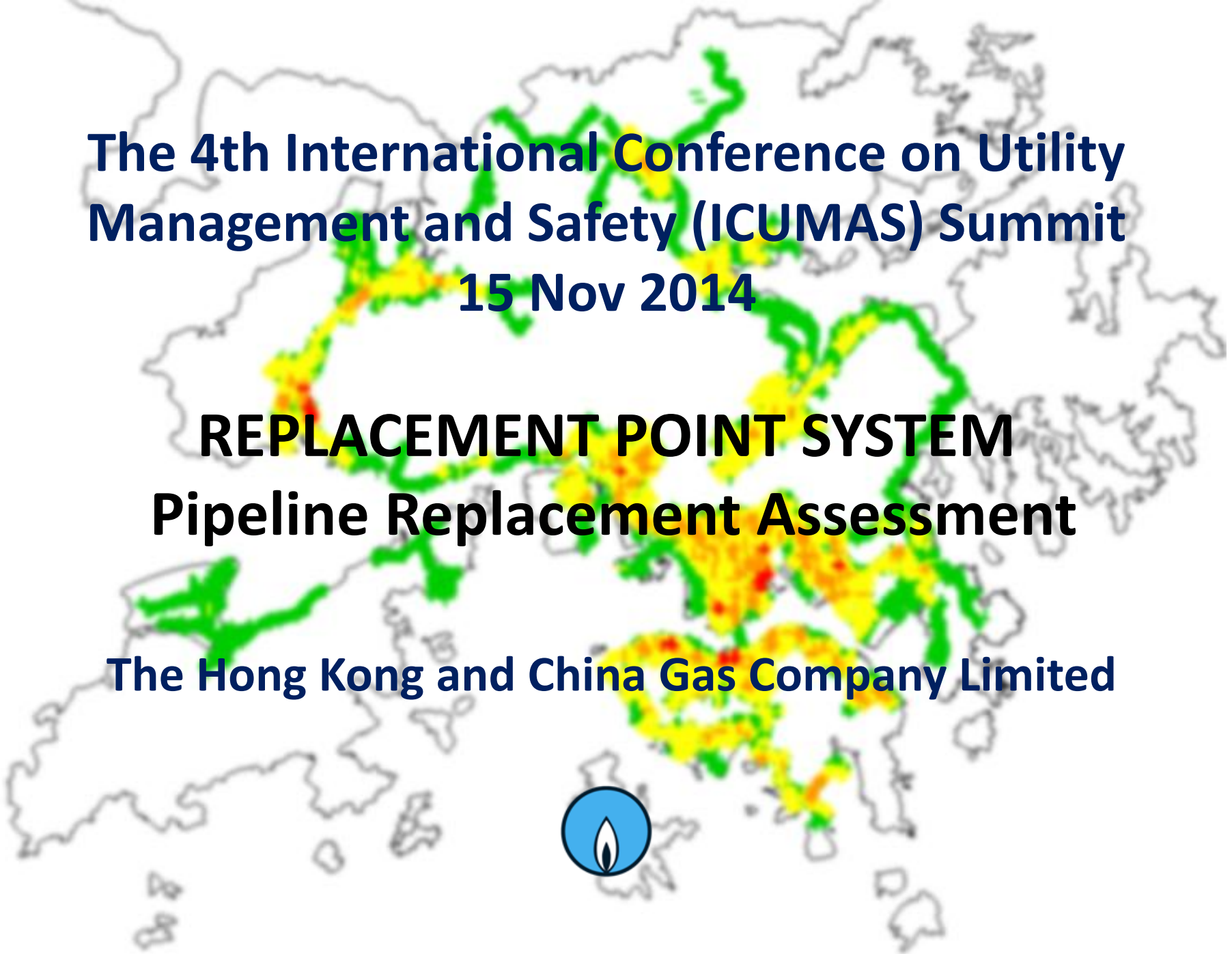


# The 4th International Conference on Utility Management and Safety (ICUMAS) Summit
## 15 Nov 2014

# REPLACEMENT POINT SYSTEM
# Pipeline Replacement Assessment

The Hong Kong and China Gas Company Limited

# Agenda

- Background Information
- Risk Evaluation Approach
- System Features
- System Functions
- Replacement Point System Usage

# Background Information - Towngas Pipeline

- Pipelines design environment in Hong Kong
  - 70% of its land is mountainous
  - High density of high-rise buildings
  - Rapid development
  - Underground utilities closely installed

- Towngas in Hong Kong
  - Serve 1.8 million customers
  - Operate complicated underground network like a spider web
  - Focus on distribution pipeline integrity to ensure public safety

煤氣 Towngas

# Background Information -
# Geographic Information System (GIS) in Towngas

- Established in early 90's
  - Digital electronic maps
    - Purchase from Hong Kong Lands Department
  - Pipeline records
    - Digitize pipeline paper records by data conversion

- Effective for gas facility management

- Strong support for the network day-to-day operation

# Background Information - Replacement Point System (RPS) in Towngas (1)

Under such challenging environment and with existing sophisticated GIS

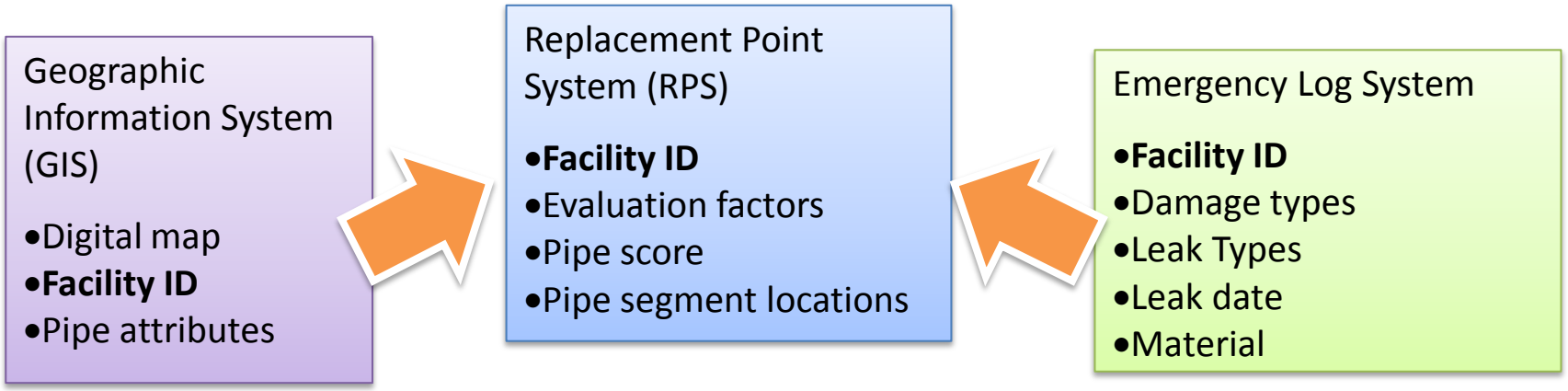
- **Q: Can Towngas have a system to...**
  - Enhance pipeline integrity to ensure public safety
  - Evaluate potential threats effectively
  - Calculate risk level on each underground pipe segment automatically
  - Identify and locate high risk segments quickly
  - Better replacement planning of ageing resources
  - Eliminate tedious manual calculation

- **Ans : Replacement Point System (RPS)**

# Background Information - Replacement Point System (RPS) in Towngas (2)

- Integration of
  - Emergency Log System (ELS)
  - Geographic Information System (GIS)
  - Replacement Point System (RPS)

  By the **facility id** of each pipe segment as the common **key**



# Risk Evaluation Approach
# Point Score

- Evaluation factors applied to individual pipe segment
- Each factor will be given a point value and weighting to determine the final point score

- Final total point score used for replacement prioritization
- “On the safe side” approach

# Risk Evaluation Approach Evaluation Factors (1)

- Protection Factor

| **Protection Measure** | GI pipe without Any Protection | GI pipe with Tapes (CAT) at Screw Joints | GI pipe CAT + Steel Plate | GI pipe with Selected Material Surround + Concrete Protection + Steel Plate |
|---|---|---|---|---|
| **Point** | 10 | 7 | 5 | 0 |

| **Protection Measure** | DI pipe without Any Protection | DI pipe with External & Internal Coating | DI pipe with coating + PE Sleeving | DI pipe with coating + PE Sleeving + Steel Plate |
|---|---|---|---|---|
| **Point** | 10 | 10 | 5 | 0 |

| **Protection Measure** | PE pipe without warning tape | PE pipe with warning tape |
|---|---|---|
| **Point** | 5 | 2 |

# Risk Evaluation Approach Evaluation Factors (2)

- Material Type Factor

| **Steel** | | | **PE** | **DI** | **GI** |
|---|---|---|---|---|---|
| Submerged Arc Weld | Seamless | Electrical Resistance | | | |
| 1 | 1 | 5 | 3 | 10 | 10 |

- Joint Type Factor

| **Joint Type** | Welding | Fusion | Mechanical | Screwed |
|---|---|---|---|---|
| **Point** | 0 | 0 | 10 | 10 |

# Risk Evaluation Approach Evaluation Factors (3)

- Material Wall Thickness & Stress Factor

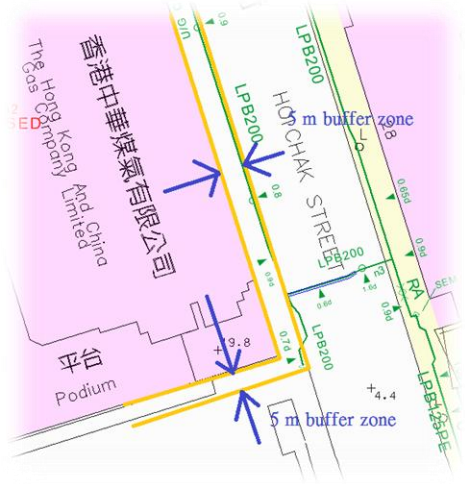
| Wall Thickness | Working Pressure / Material | Point |
|---|---|---|
| Any Class | MP / DI | 10 |
| Any Class | LP / DI | 5 |

| Wall Thickness | Working Pressure / Material | Pipe Size | Point |
|---|---|---|---|
| Heavy | MP / GI | > 50mm | Not Allowed |
| Heavy | MP / GI | < & =50mm | 7 |
| Heavy | LP / GI | All | 5 |

# Risk Evaluation Approach Evaluation Factors (4)

- Proximity distance Factor

| Working Pressure | Distance from Building | | | | |
|---|---|---|---|---|---|
| | < 1m | 1m - < 2m | 2m - < 3m | 3m - < 5m | 5m & above |
| IPA | 10 | 7 | 5 | 3 | 0 |
| MP | 7 | 5 | 3 | 0 | 0 |
| LP | 5 | 3 | 0 | 0 | 0 |




Create a 5-m buffer zone around the building to determine pipes fall into the zone

# Risk Evaluation Approach Evaluation Factors (5)

- Age Factor

| Age (Year) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **System Type** | **1-5** | **6-10** | **11-15** | **16-20** | **21-25** | **26-30** | **31-35** | **36-40** | **>40** |
| Steel Pipe with CP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 10 |
| Steel Pipe w/o CP | 0 | 0 | 0 | 5 | 10 | 10 | 10 | 10 | 10 |
| Ductile Iron pipe | 3 | 3 | 3 | 5 | 10 | 10 | 10 | 10 | 10 |
| P.E. Pipe SDR 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P.E. Pipe SDR 17.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 10 |
| G.I. pipe | 0 | 0 | 5 | 7 | 10 | 10 | 10 | 10 | 10 |

# Risk Evaluation Approach Evaluation Factors (6)

- Ground Condition Factor

| Type of Ground | Dry Condition | Wet Condition | |
|---|---|---|---|
| | | pH Level 5 - 6 | pH Level below 5 |
| Rock | 0 | 5 | 10 |
| Sand | 0 | 5 | 10 |
| Soil | 0 | 5 | 10 |

- Leakage Frequency Factor

| Leakage | 0 | 1 | 2 | *3 & >3 |
|---|---|---|---|---|
| Point | 0 | 2 | 5 | 10 |

*If all the cases happened in a period of 12 months along the same pipeline, additional 5 points shall be given.

# Risk Evaluation Approach Evaluation Factors (7)

- Leakage Type Factor

| Nature | Point |
|---|---|
| Crack line | 10 |
| Widespread Corroded Pipe | 10 |
| Corroded Syphon standpipe | 7 |
| Leaking Joint of PE Pipe | 7 |
| Localized corrosion | 7 |
| Joint seepage - with corroded bolt & nuts | 7 |
| PE valve seepage | 7 |
| Joint seepage - without corroded bolt & nuts | 5 |
| PE/Metallic transition fitting seepage | 3 |
| PE branch fitting seepage | 3 |
| Plug seepage | 3 |
| Pressure / Purge Point on PE Pipe | 3 |
| Syphon standpipe seepage – without corrosion | 3 |
| Valve spindle seepage | 3 |
| Third Party Damage | 0 |
| Physical Damage | 0 |

# Risk Evaluation Approach Evaluation Factors (8)

- Pipe Cover Factor*
  - At carriageway

| **Depth of Pipe (m)** | below 0.6 | 0.6 - < 0.7 | 0.7 - < 0.8 | 0.8 - < 0.9 | 0.9 & above |
|---|---|---|---|---|---|
| **Point** | 10 | 7 | 5 | 3 | 0 |

  - At footpath

| **Depth of Pipe (m)** | below 0.3 | 0.3 - < 0.4 | 0.4 - < 0.5 | 0.5 - < 0.6 | 0.6 & above |
|---|---|---|---|---|---|
| **Point** | 7 | 5 | 3 | 1 | 0 |

*If a pipe section has several depth values, we consider the smallest value, which is the conservative approach.

# Risk Evaluation Approach Evaluation Factors (9)

- Score Calculation

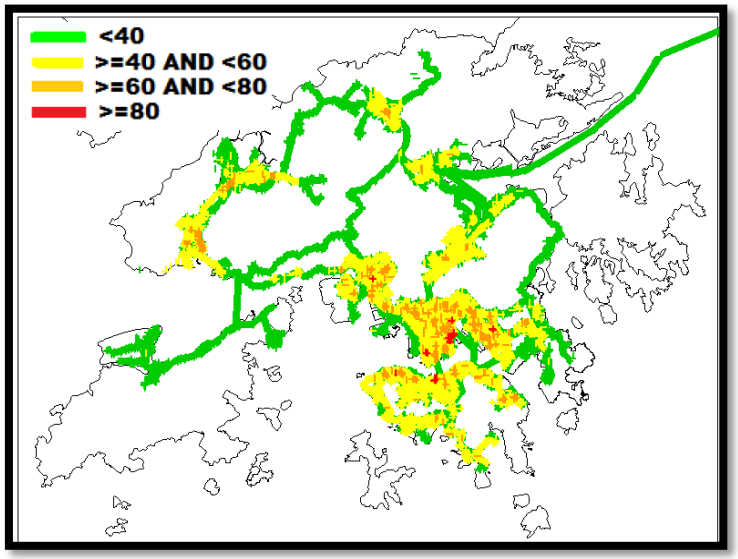
| | Factor | Weighting | Point | Score |
|---|---|---|---|---|
| A | Material Type | 0.75 | | |
| B | Protection | 0.50 | | |
| C | Material Wall Thickness & Stress | 0.75 | | |
| D | Joint Type | 0.75 | | |
| E | Proximity Distance | 1.00 | | |
| F | Age | 1.25 | | |
| G | Ground Condition | 1.00 | | |
| H | Pipe Cover | 0.50 | | |
| I | Leakage Type | 1.50 | | |
| J | Leakage Frequency | 2.00 | | |
| | | | **Total Score** | |

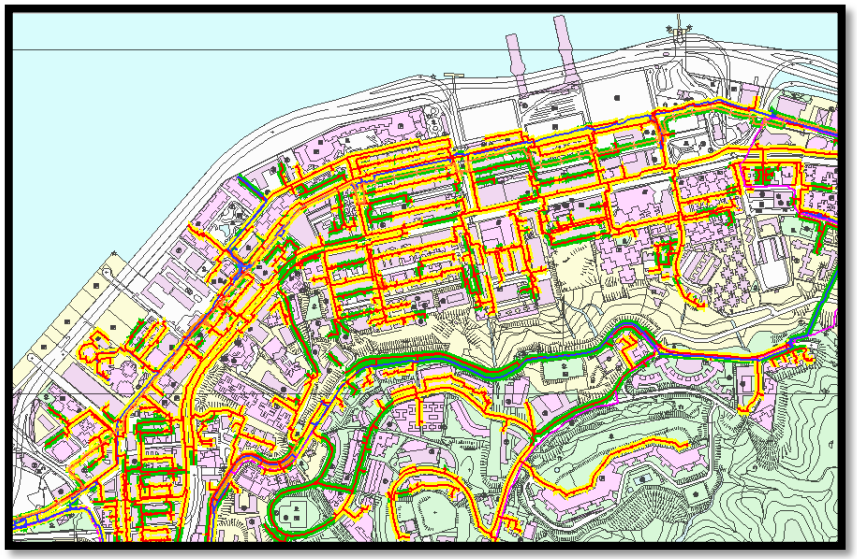
# System Features

- Web based

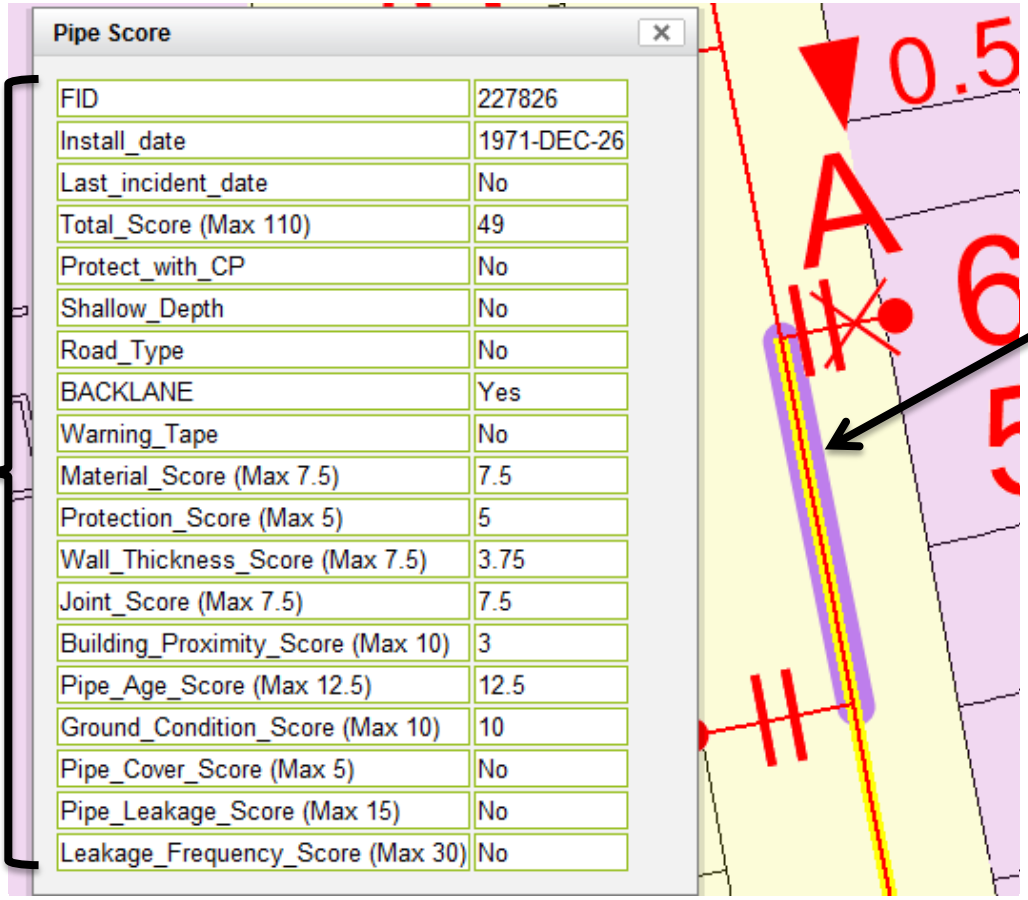
- Integrate with GIS

- Risk-based pipe color according to point scores



# System Functions
# Attribute review

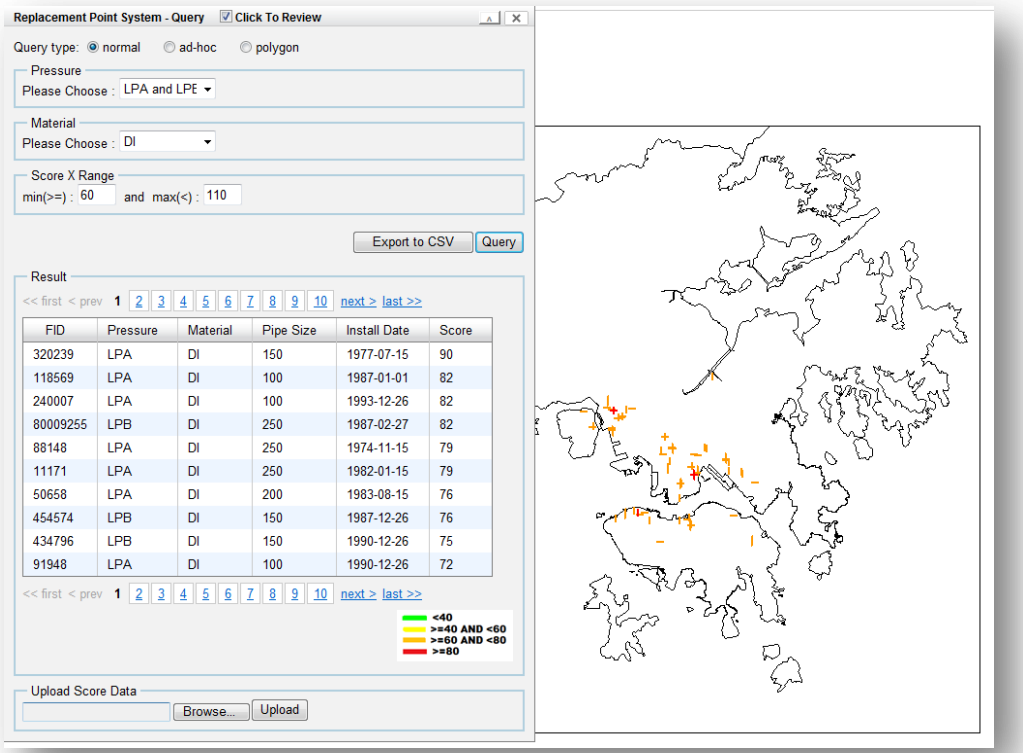



1. User click to select a pipe segment

2. Attributes and point scores of the pipe

# System Functions
# Query by pipe attributes

- Attribute filter
  - Operating pressure
  - Material
  - Range of score
- Result table
  - Allow export to CSV
- Map view update



# Replacement Point System Usage

- At the fingertips for planning engineers
  - Prioritization and scheduling of replacement of ageing resources
  - Better replacement planning
  - A great leap forward in the Towngas Asset Management System

# Thank You