Optimised Long Term Condition Based Renewals of Hastings District Council Trunk Sewers

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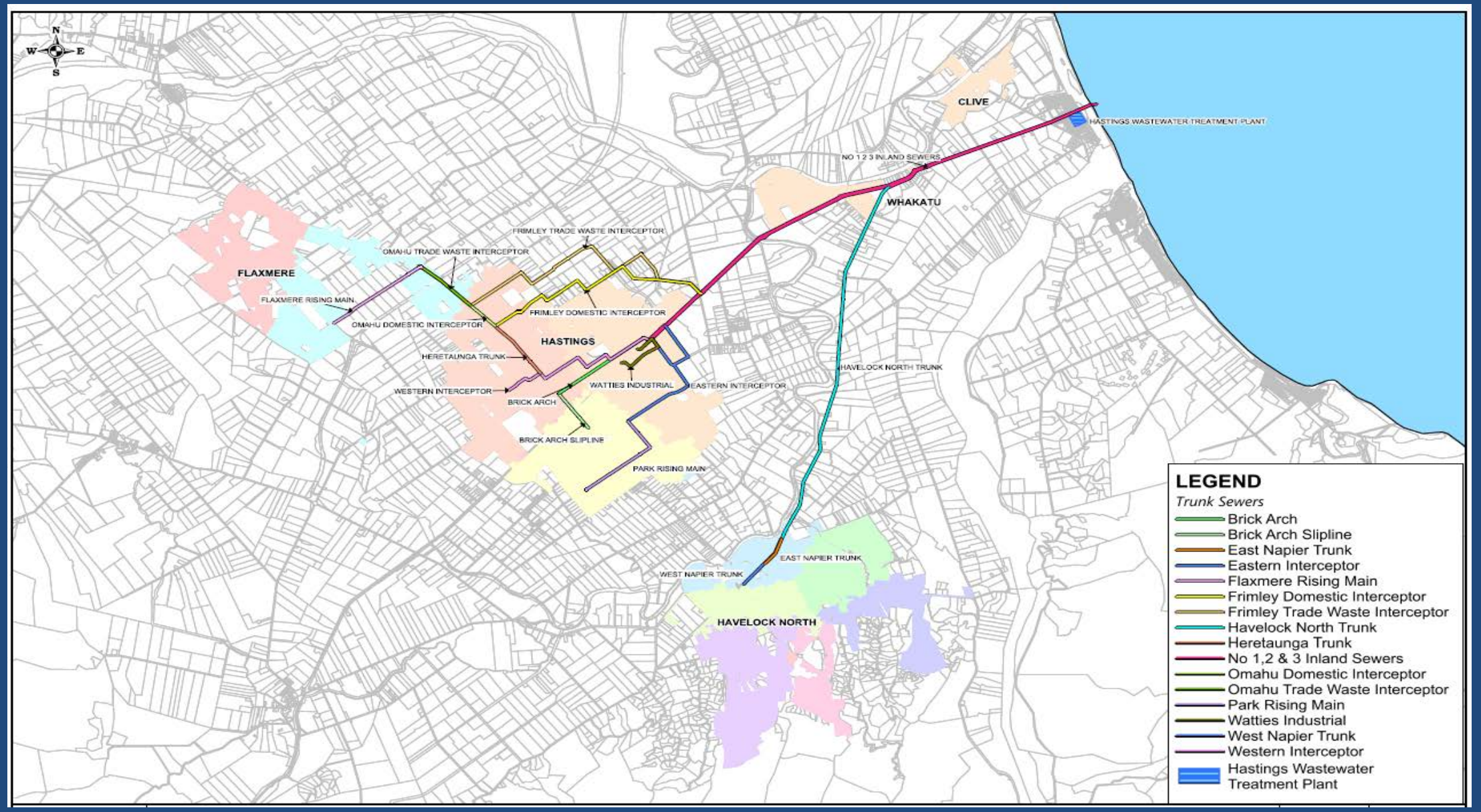
Introduction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W
E
S
CLIVE
HASTINGS WASTEWATER TREATMENT PLANT
NO 1 2 3 INLAND SEWERS
WHAKATU
FRIMLEY TRADE WASTE INTERCEPTOR
OMAHU TRADE WASTE INTERCEPTOR
FLAXMERE
FLAXMERE RISING MAIN
FRIMLEY DOMESTIC INTERCEPTOR
OMAHU DOMESTIC INTERCEPTOR
HASTINGS
HERETAUNGA TRUNK
HAVELOCK NORTH TRUNK
WESTERN INTERCEPTOR
WATTIES INDUSTRIAL
EASTERN INTERCEPTOR
BRICK ARCH
BRICK ARCH SLIPLINE
PARK RISING MAIN
EAST NAPIER TRUNK
WEST NAPIER TRUNK
HAVELOCK NORTH
LEGEND
Trunk Sewers
Brick Arch
Brick Arch Slipline
East Napier Trunk
Eastern Interceptor
Flaxmere Rising Main
Frimley Domestic Interceptor
Frimley Trade Waste Interceptor
Havelock North Trunk
Heretaunga Trunk
No 1,2 & 3 Inland Sewers
Omahu Domestic Interceptor
Omahu Trade Waste Interceptor
Park Rising Main
Watties Industrial
West Napier Trunk
Western Interceptor
Hastings Wastewater Treatment Plant

- Traditionally HDC programmed trunk sewer renewals using an age -based methodology.
- Most of the trunk sewers would require replacement in the next two decades or so.
- Mismatch between the forecast age-based renewal profile and actual asset condition and performance.
- This led HDC to adopt the optimized sewer renewal strategy

Condition and Risk Based Trunk Sewer Renewal Framework

- HDC categorized their assets into three broad criticality categories
- A, B, and C being high priority and critical, high priority and non critical, and low priority assets, respectively.
- Condition assessment based on CCTV inspection and scoring in accordance with New Zealand Pipe Inspection Manual Guidelines
- Verification done by core sampling, laser/sonar survey, coring and laboratory testing.
- Level One broad remaining life categorization (>5 years) using custom developed structural scoring (MWH, 2013).
  - Uses the pipe condition information (core samples, CCTV and profile data) as well as broader understanding of the pipe materials and their historical performance.
- Level Two comprises prioritization- (1-5 years) in respect of the order and timing of rehabilitation of all pipes with an expected life of less than 5 years.

Criticality Categorisation

- Large diameter (generally 375mm diameter or larger)
- Critical to the function of the wastewater network
- Surrounding connectivity within the network
- Service large catchments and convey significant flows
- Would cause significant disruption above and below ground in the event of structural failure
- Have a low number or no lateral connections
- Are high value assets within the network

Condition Assessment

Trunk Sewers Investigated To Date

- Complete coverage of the Three Inland Main Sewers and Frimley Domestic Sewer
- 75 % coverage of the Eastern Interceptor
- Partial completion of the Heretaunga Trunk Sewer
- 25% completion in the Omahu Domestic Trunk sewer
- Work in progress in the Omahu Industrial Sewer

Expected Wall Thickness

- Data was provided by Humes on typical pipe construction for the reinforced concrete pipes made historically(Refer table on next page)
- The trunk sewers with diameters greater than 825mm are likely to have oval reinforcement cages. This means that the rebar will be closer to the internal wall at the pipe soffit.
- There will be some variation in the placement of the rebar within the pipe wall e.g. 5 mm tolerance is common.
- Pipe with oval cages is required to be orientated correctly in the trench for optimum life. Incorrect orientation is a potential reason for variation in rebar location and cover depth around the pipe wall.
- The smaller diameter pipes, based on the core results, appear to have circular cages, which aligns with the information provided by Humes.
- Reinforcement within the pipe is a circular mesh cage. Distances to the reinforcement will vary depending upon if the reinforcement encountered runs longitudinally or circumferentially along the pipe.

Pipe Diameter (mm)	Sewer Construction date	Wall thickness (mm)	External wall to centreline of reinforcement (mm)	Expected internal cover to centre of reinforcement (mm)
Historical				
450	1962	38 (S,X,Y) 41 (Z)	CIRC cage, 0.55 times wall	17.1 to18.5
525	1962-3	41 (S,X)	CIRC cage, 0.55 times wall	18.45
600	1958-1962	44 (S,X), 48 (Y), 54 (Z)	CIRC cage, 0.55 times wall	19.8 to 24.3
825	1958-1962	54 (S,X)	CIRC cage, 0.55 times wall OVAL cage 10 – 14 cover inside T & B, 19 – 23 outside haunches	24.3 or Soffit 40 to 44 Side 31 to 35
825	1938	54 (S,X)	OVAL cage, 12 to in T & B, 20 to outer sides	Soffit 42 Side 34
1050	1938	64 (S,X)	OVAL cage, 12 to in T & B, 20 to outer sides	Soffit 52 Side 44
1050	1958	64 (S,X), 70 (Y), 86 (Z)	OVAL cage, 12 to in T & B, 20 to outer sides	Soffit 52 to 74 Side 44 to 66
1200	1958	76 (S,X,Y), 92 (Z)	OVAL cage, 13 to in T & B, 21 to outer sides	Soffit 63 to 79 Side 55 to 71
1350[3]	1970's	76 (S,X), 82(Y), 98 (Z)	OVAL cage, 13 to in T & B, 21 to outer sides	Soffit 63 to 85 Side 55 to 77
1575 1800	1970's Unknown	88 (assumed to be the old Class Y for 1600 dia pipe) Unknown	OVAL cage, 10-16 to in T & B, 22-27 to outer sides Unknown	Soffit 72 to 78 Side 61 to 66 Unknown

Failure Mechanism

Corrosion

- Typically- soffit first and that if side wall corrosion is present it will be at a slower rate.
- If reinforcement is central, then corrosion of the soffit reinforcement is more critical than for the pipe wall.
- High risk-when reinforcement is exposed (in the soffit or wall) then collapse of the roof is more likely to occur.
- If reinforcement is oval (and the pipe has been placed correctly), then collapse will occur sooner.
- That means that pipe condition assessment can be based on the extent of reinforcement exposure.

Embeddment

- External pipe support has not been used in assessing the priority for pipe rehabilitation or replacement.

Condition Assessment

CCTV Inspection

- CCTV inspection and visual scoring of the pipe to determine a condition score.
- Results were for each sewer were categorized on the following basis :

Condition Score Category

0 to <1.06 (1)

1.06 to <2.06 (2)

2.06 to <3.06 (3)

3.06 to <4.06 (4)

4.06 to < 5 (5)

Unknown

Condition Assessment

Laser Profiling

Laser profiling of a portion of the CCTV inspected pipe length to estimate effective cover

Also to provide a comprehensive view of any corrosion by measuring the existing internal diameter and determining the change compared with the original internal diameter, for the full pipe circumference.

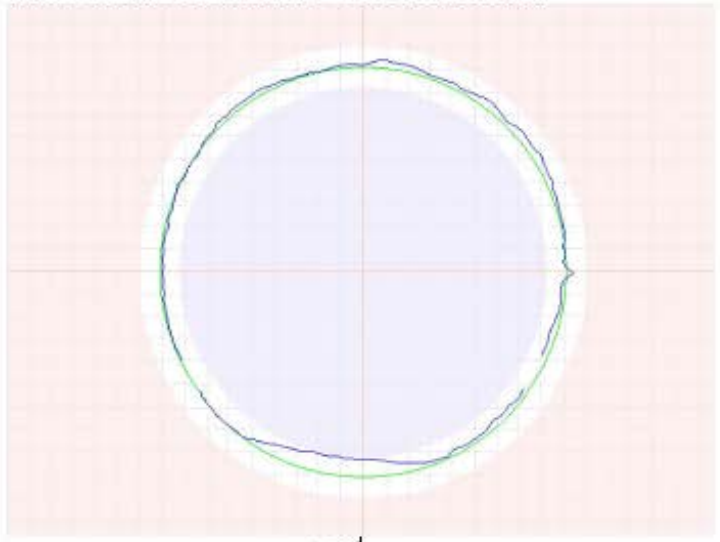
This information was used to help determine locations for core sampling.

Frimley- corrosion up to 34mm

Generally insignificant areas of mild corrosion

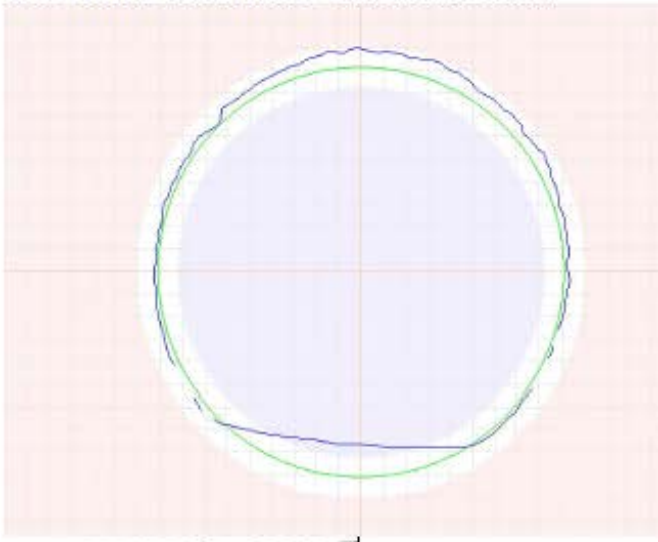
Observation Report

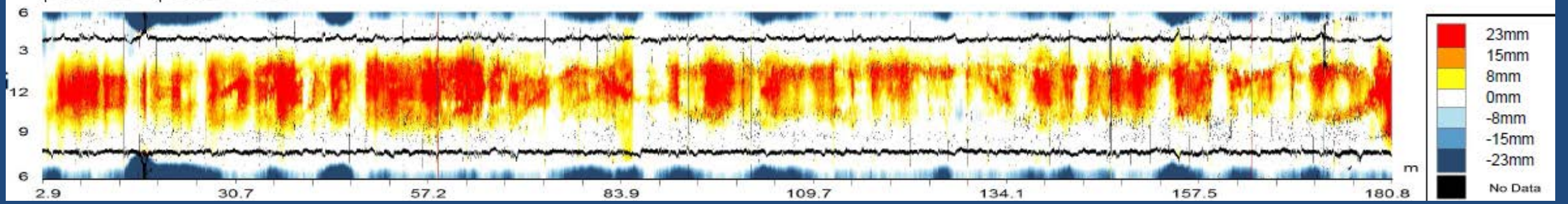
3.2m General Observation - Corrosion to 9mm



3.2m General Observation - Corrosion to 9mm

20m General Observation - Corrosion to 21mm





Asset No.	Diameter (mm)	General Corrosion (mm)	Equivalent Visual CCTV Score	General Condition	Location
51155384	457	181	>23 mm	Very Poor	Hapuka St; in carriageway
51155369	525	29	0 mm - 22 mm	Poor; newly renewed in 2015.	Lindisfarne College driveway
51154047	600	240	10 mm - 20 mm	Poor	Under driveway and buildings on Tomoana Warehousing
50002013	600	100	0mm – 10 mm	Good	Under paddock on 1002 Pakowhai Road
51133265	600	277	0 mm – 10 mm	Reasonable	Agricultural land between 1411 and 1419 Pakowhai Road

Condition Assessment

Pipe Coring

- Pipe coring of selected pipes to confirm structural pipe condition.
- This was used to establish sound wall thickness to guide pipe remaining life estimates.
- Selection of cores based on a spread of pipe condition, diameter and age
- Taken from inside for large dia and outside for small dia
- Positions on the inside of the pipes – the top (12 o’clock), side (3 o’clock) and bottom (4 or 5 o’clock).

Visual Assessment

Score	Description
Score 1	No significant pipe wall deterioration visible.
Score 2	Pipe material corroded and aggregate exposed.
Score 3	Rebar staining visible but rebar not exposed and/or severe aggregate exposure.
Score 4	Rebar just visible, generally less than 25% diameter.
Score 5	Rebar significantly exposed, generally between 25-50% diameter.

Level One Assessment

Typical Description	Reinforcement Cover at top (mm)	Residual Life (Years)	Equivalent Visual CCTV Score	Summary Score	Recommended Action
Pipe in sound condition. Liner (if any) generally remaining.	Original cover	>50	<1.05	1	No work.
Liner is corroded or missing and/ or up to 5mm of concrete has corroded at the top (reinforcement not visible).	>10	25-50	1.06 - 2.05	2	Monitor sample sites at least 10 yearly.
Up to 10mm corrosion of concrete at top or rust staining from steel apparent.	5-10	10-25	2.06 – 3.05	3	Monitor all sites at least 5 yearly. Address isolated areas and faults.
Reinforcement just showing (up to 25% bar diameter) or heavy rust staining, minor spalling.	<5	0-10	3.06 – 4.05	4	Replace / reline within 5 years. Consider high risk sites first.
Reinforcement exposed more than 25% bar diameter or absent.	Nil	0-5	>4.05 or greater than 5% of length in score 5	5	Replace/reline immediately. Consider high risk sites first.

Level Two Assessment

Level Two is a risk-based refinement stage to smoothen the gaps that cannot be adequately covered by Level) One
e.g

- Capturing and assessment of isolated pipes/segments on a stretch of pipe in good condition
- Prioritising pipe rehabilitation for the immediate (5 year) planning horizon

Risk ID	Risk Category	Score 1	Score 2	Score 3	Score 4	Score 5
1	Exposure to traffic loads:	Pipe within grazing land	Pipe is located in intensively cultivated land with potential heavy machinery	Pipeline passes under or close to property access way	Pipe passes under or within road reserve corridor of local road	Pipe passes under or road reserve corridor of arterial road
2	Ground conditions / Soils	Coarse granular / well drained soils e.g. sands	Coarse grained soils with high water tables	Medium textured soils with low water tables	Medium / fine textured soils with high water tables	Organic soils with high water tables
3	Proximity to Buildings / Amenity Asset	Pipe more than 20m from any asset or amenity feature	Pipe passes close (20m) to any other significant amenity feature – e.g. pond, tree stand	Pipe passes under yard, garden or other significant amenity area	Pipe passes within 10m of external wall of building or dwelling	Pipe passes under building commercial or dwelling

Conclusion

- So far the correlation of CCTV and laboratory based assessments showed that CCTV inspection scoring was conservative for pipes categorised into medium risk categories whereas laboratory results were more conservative for pipes categorised into the high risk category. Coring and laboratory verification will continue to be used as a verification tool.

- This methodology has identified a number of pipe segments requiring rehabilitation within the next ten years and now forms the basis of HDC's LTCPP instead of the age-based assets used in the previous approach.

- It has also been established that CCTV inspections are now getting into CCTV re-run mode and HDC are gearing to start monitoring deterioration by comparing previous and current CCTV inspection results.

- Based on HDC's experience on the previous rehabilitation programme, it is now acknowledged that for some pipe rehabilitation methods, establishment costs are higher than the pipe rehabilitation costs proper. In preparing their rehabilitation specifications, it is now HDC's preference to also reassess the pipes adjacent to the target pipes for the cost benefit of bringing forward their repairs to take advantage of the significant establishment costs of the target pipe.

- The assessment has confirmed the value of condition-based scoring to develop more appropriate estimates of residual life. To ensure that the renewal planning remains valid, further CCTV inspections of selected sections of the trunk sewers need to be completed to monitor the rate of deterioration. It is recommended that a CCTV inspection schedule be developed to enable inclusion of budget for the activity.

- Currently, HDC are continuing with the investigation and rehabilitation programme targeting the remainder of the trunk sewers.