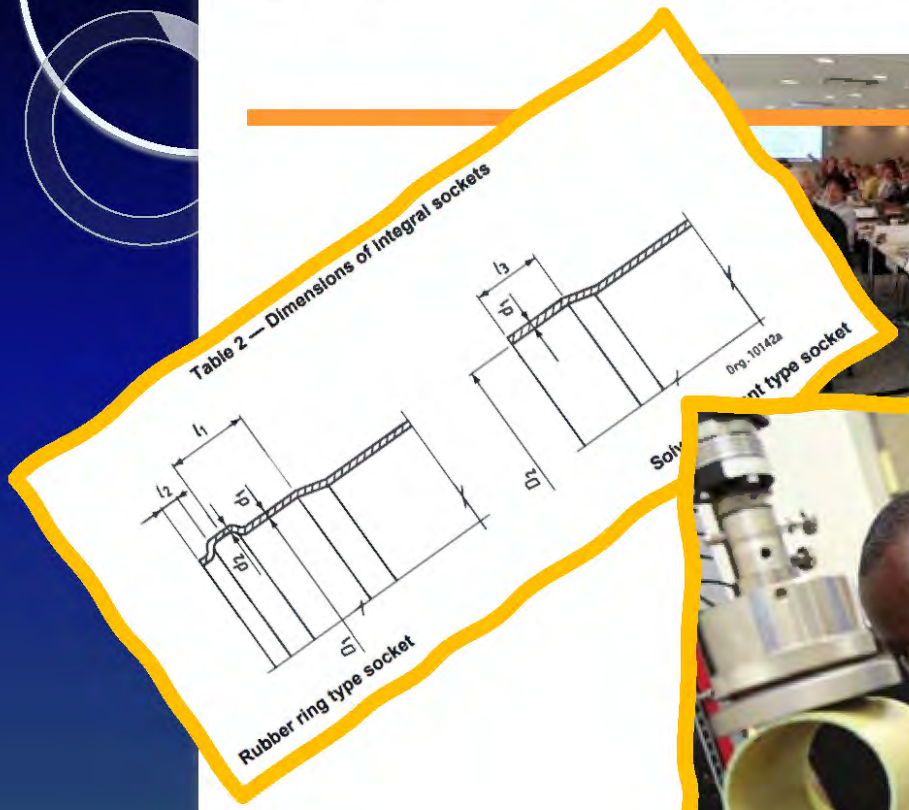
SAPPMA Quality Workshop IV



Co-presented by:
Vollie Brink
Albert Vaartjes
Alaster Goyns
Johann Wessels

Ian Venter

22-07-2020

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SAPPMA Quality Workshops

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SAPPMA

Presenters

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rollepaal ramix

Vollie Brink

Alaster Goyns

PIPES

Johann Wessels

22 July 2020

SASTT SOUTHERN AFRICAN SOCIETY FOR TRENCHLESS TECHNOLOGY

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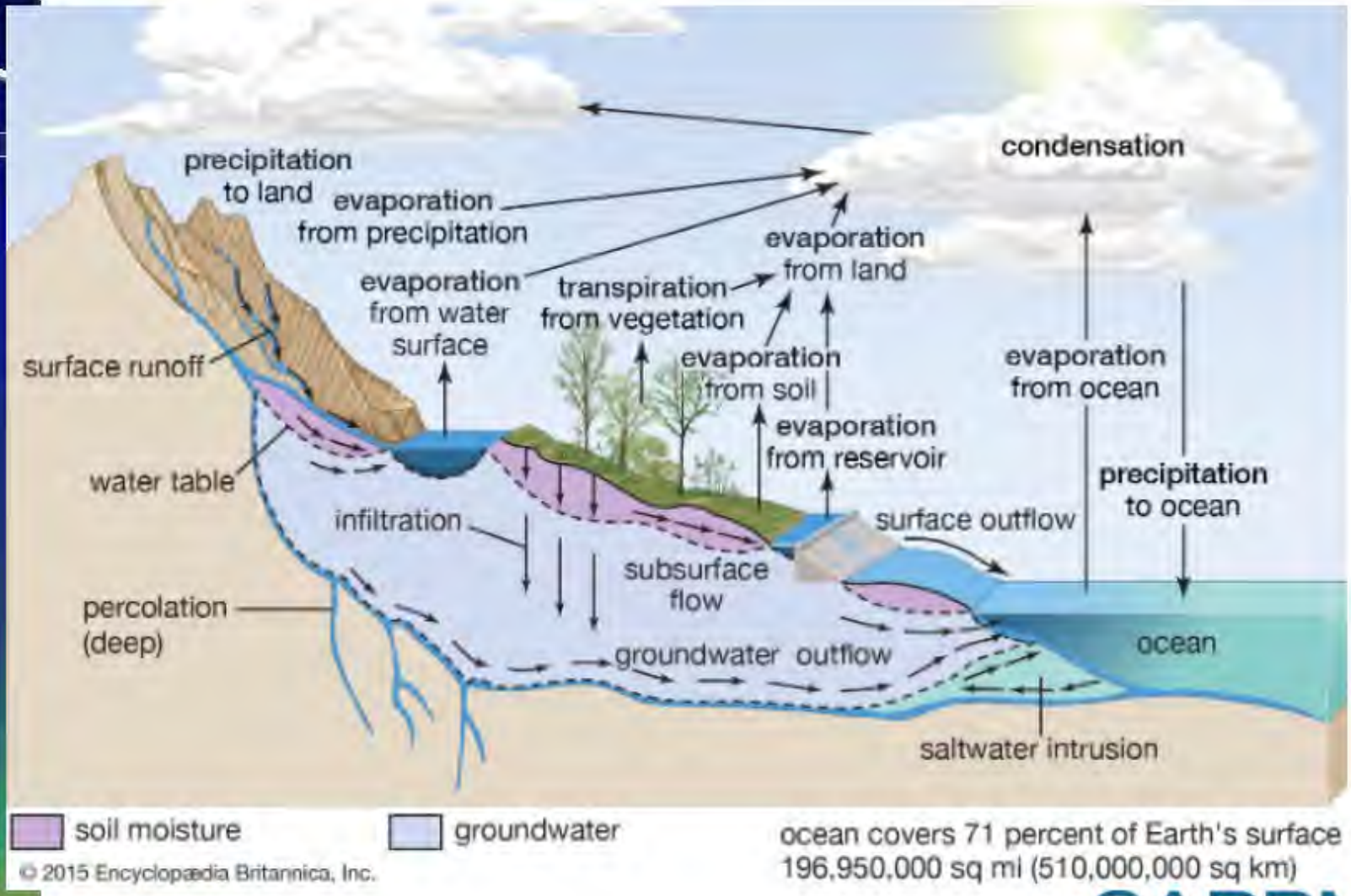
Water Cycle



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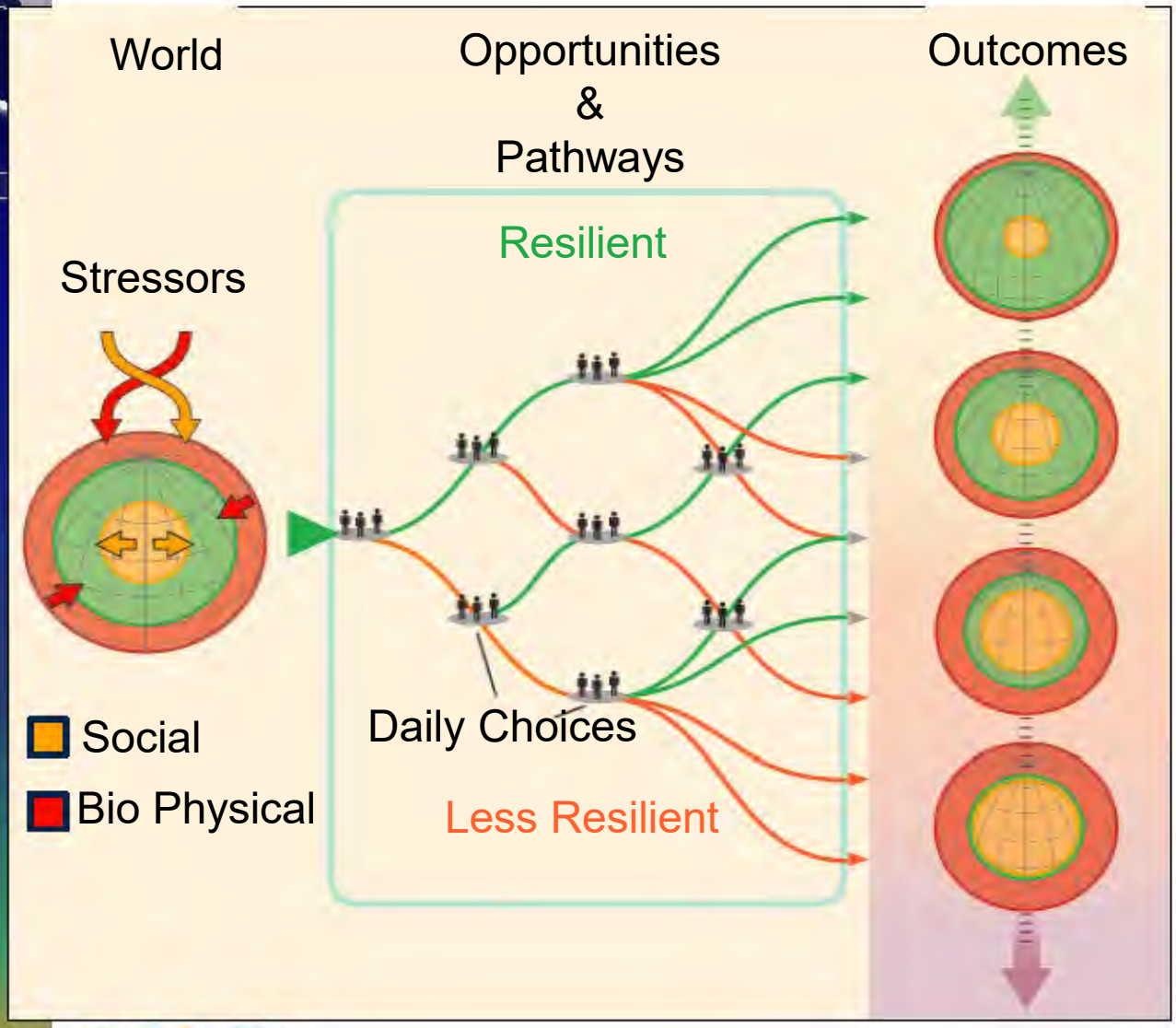
Resilient Opportunities - Pathways



Low Stress/ Risk
High Resilience

High Stress/Risk
Low Resilience

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Sewer Systems

Sewer design and standards

Vollie Brink

Vollie Brink is a professional registered civil engineer with 64 years of experience, practising as a wet services consultant and specialising in all wet services in buildings, building sites and urban developments.


SANS 10252-1:2018

SOUTH AFRICAN NATIONAL STANDARD

Water supply and drainage for buildings

Part 1: Water supply installations for buildings

WARNING

SABS

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Vollie Brink

SEWER SYSTEMS

22 July 2020

SABS ISO NSF cen AENOR bsi. DIN SATAS

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SEWER DESIGN STANDARDS

FOR BUILDINGS AND BUILDING PREMISES

WATER AND FIRE CONSULTING ENGINEERS

THE NATIONAL BUILDING REGULATIONS

THE ”NBR” IS THE PRIMARY STANDARD FOR THE DESIGN OF THE SANITARY DRAINAGE SYSTEM OF

A BUILDING

THESE “REGULATIONS” WERE PROMULGATED IN 1977 AS SABS 0400 AND LATER AS SANS 10400

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NBR “PARTS”

THE NBR CONSIST OF VARIOUS “PARTS” FOR THE VARIOUS ELEMENTS OF A BUILDING

SANS10400-A IS THE ADMINISTRATION REGULATORY PART

SANS10400-P IS THE PART THAT ADDRESS THE SANITARY DRAINAGE, DESIGN AND CONSTRUCTION

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WSD WATER AND FIRE CONSULTING ENGINEERS

SANS10400-P

THE INSTITUTIONAL HIERARCHY

(SEE DRAWING / ORGANOGRAM)

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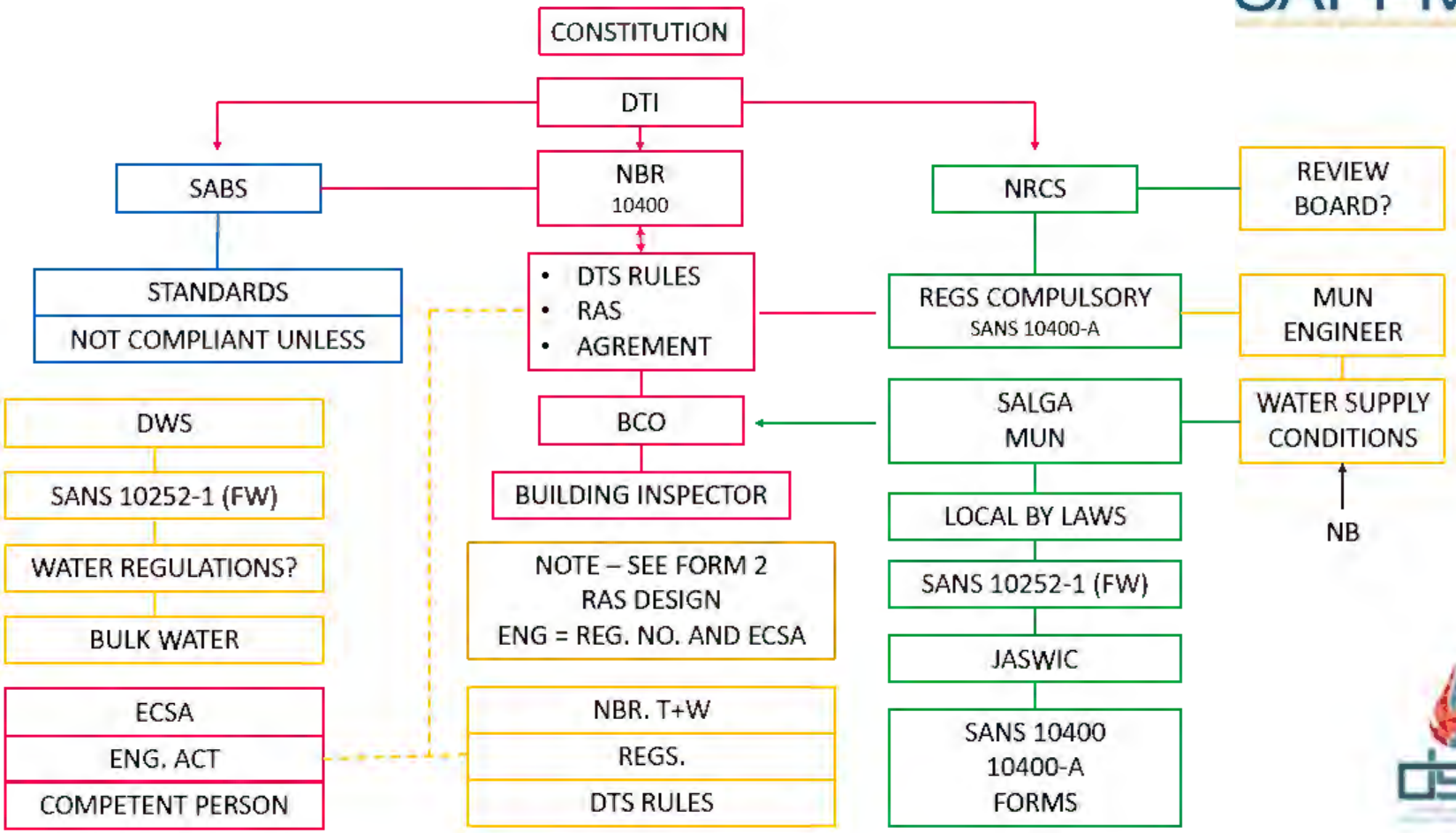
CONSTITUTION
DTI
SABS
NBR
10400
NRCS
REVIEW
BOARD?
STANDARDS
NOT COMPLIANT UNLESS
• DTS RULES
• RAS
• AGREMENT
REGS COMPULSORY
SANS 10400-A
MUN
ENGINEER
DWS
SANS 10252-1 (FW)
WATER REGULATIONS?
BULK WATER
BCO
BUILDING INSPECTOR
SALGA
MUN
WATER SUPPLY
CONDITIONS
NB
LOCAL BY LAWS
SANS 10252-1 (FW)
JASWIC
SANS 10400
10400-A
FORMS
NOTE – SEE FORM 2
RAS DESIGN
ENG = REG. NO. AND ECSA
ECSA
ENG. ACT
COMPETENT PERSON
NBR. T+W
REGS.
DTS RULES

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PART P CONSIST OF:

1. REGULATIONS,

PERFORMANCE SPECIFICATIONS

(SEE ADDENDUMS)

2. RULES,

(DEEM-TO-SATISFY-RULES)

THESE RULES ARE FOR “HOUSING”

AND “OFFICES” AND EXCLUDE COMPLICATED BUILDINGS

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COMPLICATED BUILDINGS

HOSPITALS,

SHOPPING CENTERS,

COMPLEXES,

ETC.

THESE ARE TO BE “RATIONAL DESIGN”

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PRINCIPLES ?

THERE ARE A NUMBER OF “PRINCIPLES” WHICH ARE IN SOME CASES MORE IMPORTANT THAN “REGULATIONS” OR “RULES”.

(SOIL AND WASTEWATER MUST NOT TO BE COMBINED HORIZONTALLY)

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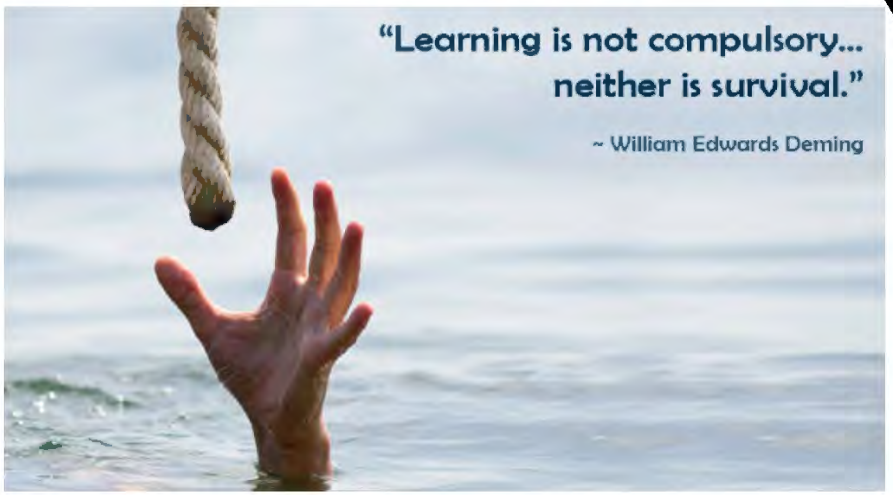
REGULATIONS

THERE ARE ONLY 7 REGULATIONS

A REGULATION IS COMPULSORY

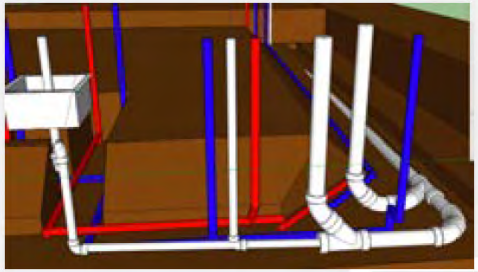
A RULE IS NOT COMPULSORY(?)



WATER AND FIRE CONSULTING ENGINEERS

TERMINOLOGY

THE WORD ”SEWER” IS NOT USED IN BUILDING DRAINAGE,



THE TOTAL SANITATION SYSTEM?

THE SANITARY DRAINAGE OF A BUILDING FORMS PART AND PARCEL OF THE TOTAL SANITATION SYSTEM OF A CITY OR TOWN ETC.

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THE DESIGN OF A BUILDING AFFECTS THE DESIGN OF THE MUNICIPAL SEWAGE SYSTEM

WATER AND FIRE CONSULTING ENGINEERS

HOW?

HOW THE VOLUME OF EFFLUENT DISCHARGED IS CALCULATED

THE VOLUME OF WATER USED TO FLUSH A WC USED TO BE 12 LITER AND NOW IT IS FLUSHED WITH 6LITER, THIS IS CAUSING SERIOUS BLOCKAGES

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THE VOLUME OF WATER TO FLUSH ?

THE NBR?

THE NBR HAVE A “DISCHARGE UNIT” (DU) FOR THE DISCHARGE FROM A “FIXTURE”,

FOR INSTANCE, A WC IS 8DU’S

SEE VARIOUS TABLES TO SIZE PIPING

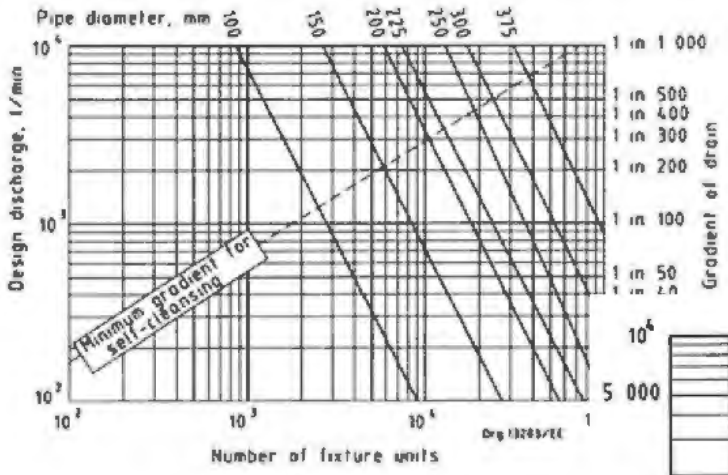
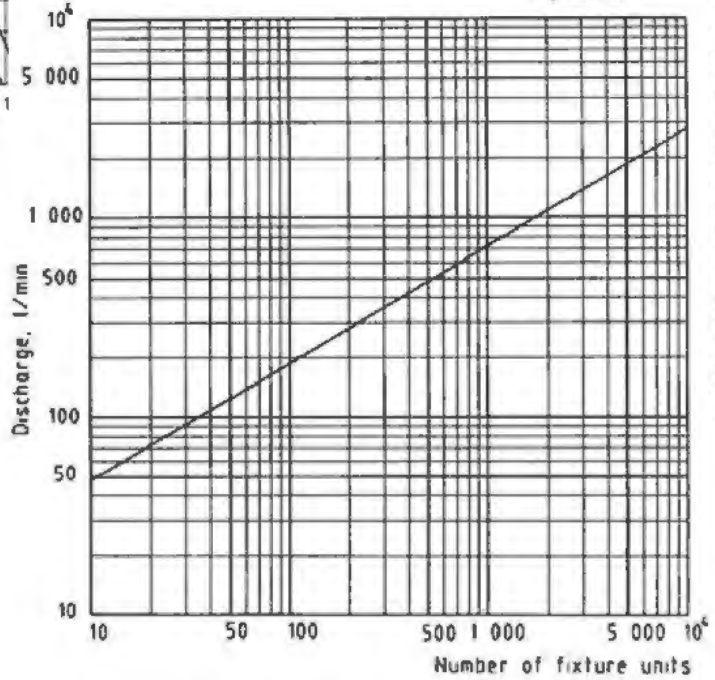
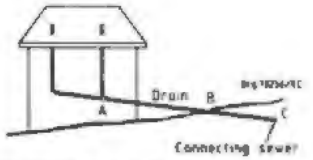


Figure A.5 — Design chart for drains



NOTE - Discharge equals 12,14 x $F^{0.385}$, where F is the number of units

Figure A.6 — Relationship between fixture units and flow, in litres per minute



ABC deemed to be a drain

Figure 17 — Discharge pipe deemed to be a drain

Table 13 — Maximum permissible drain loading

Drg 13284/EC

DESIGN?

THE NBR ALLOW 3 METHODS

1. THE DEEM-TO-SATISFY-RULES (DTSR)

THIS METHOD IS A ”RECIPE” FOR A PERSON WHO IS NOT AN ENGINEER

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2. RATIONAL DESIGN

THIS METHOD IS RESERVED FOR THE “COMPETENT PERSON” WHO IS AN Pr. Eng. or Pr. Tech Eng.

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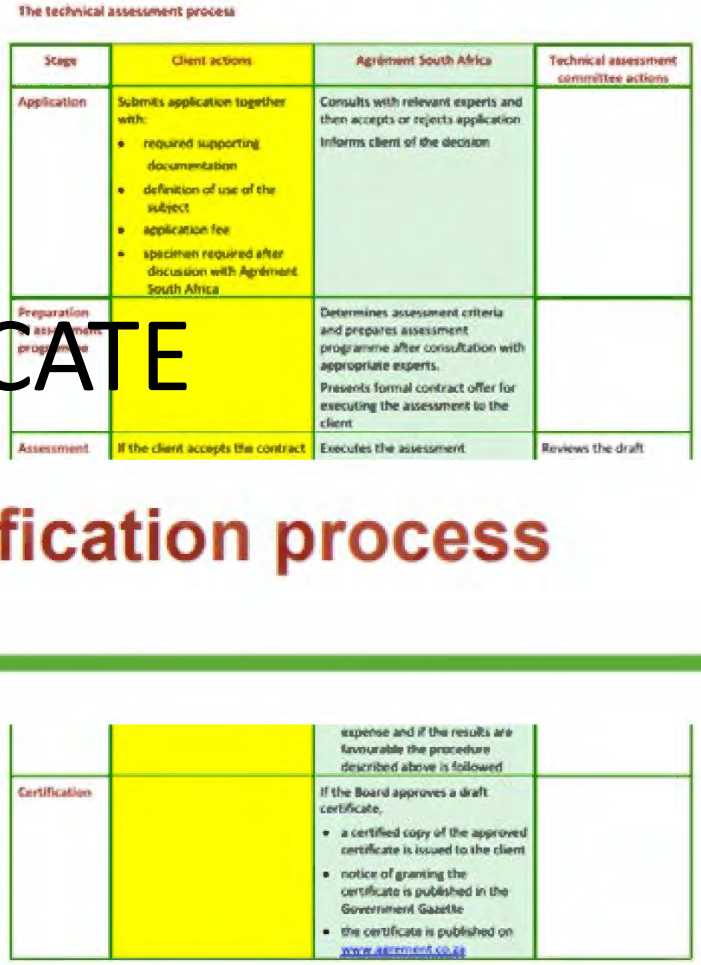
3. AGREMENT CERTIFICATE



The technical assessment process

Stage	Client actions	Agrément South Africa	Technical assessment committee actions
Application	Submits application together with: • required supporting documentation • definition of use of the subject • application fee • specimen required after discussion with Agrément South Africa	Consults with relevant experts and then accepts or rejects application Informs client of the decision	
Preparation [illegible] programme		Determines assessment criteria and prepares assessment programme after consultation with appropriate experts. Presents formal contract offer for executing the assessment to the client	
Assessment	If the client accepts the contract	Executes the assessment	Reviews the draft
		expense and if the results are favourable the procedure described above is followed	
Certification		If the Board approves a draft certificate, • a certified copy of the approved certificate is issued to the client • notice of granting the certificate is published in the Government Gazette • the certificate is published on www.agrement.co.za	

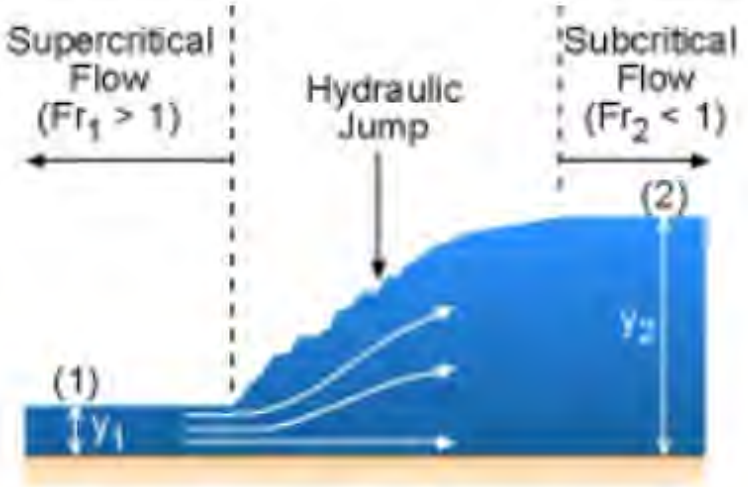
AGRÉMENT SOUTH AFRICA
innovative construction product assessments

The certification process

WHAT HAPPENS IN A PIPE SYSTEM?

TO DESIGN A SYSTEM ONE MUST KNOW WHAT HAPPENS IN THE PIPING

SEE DRAWING



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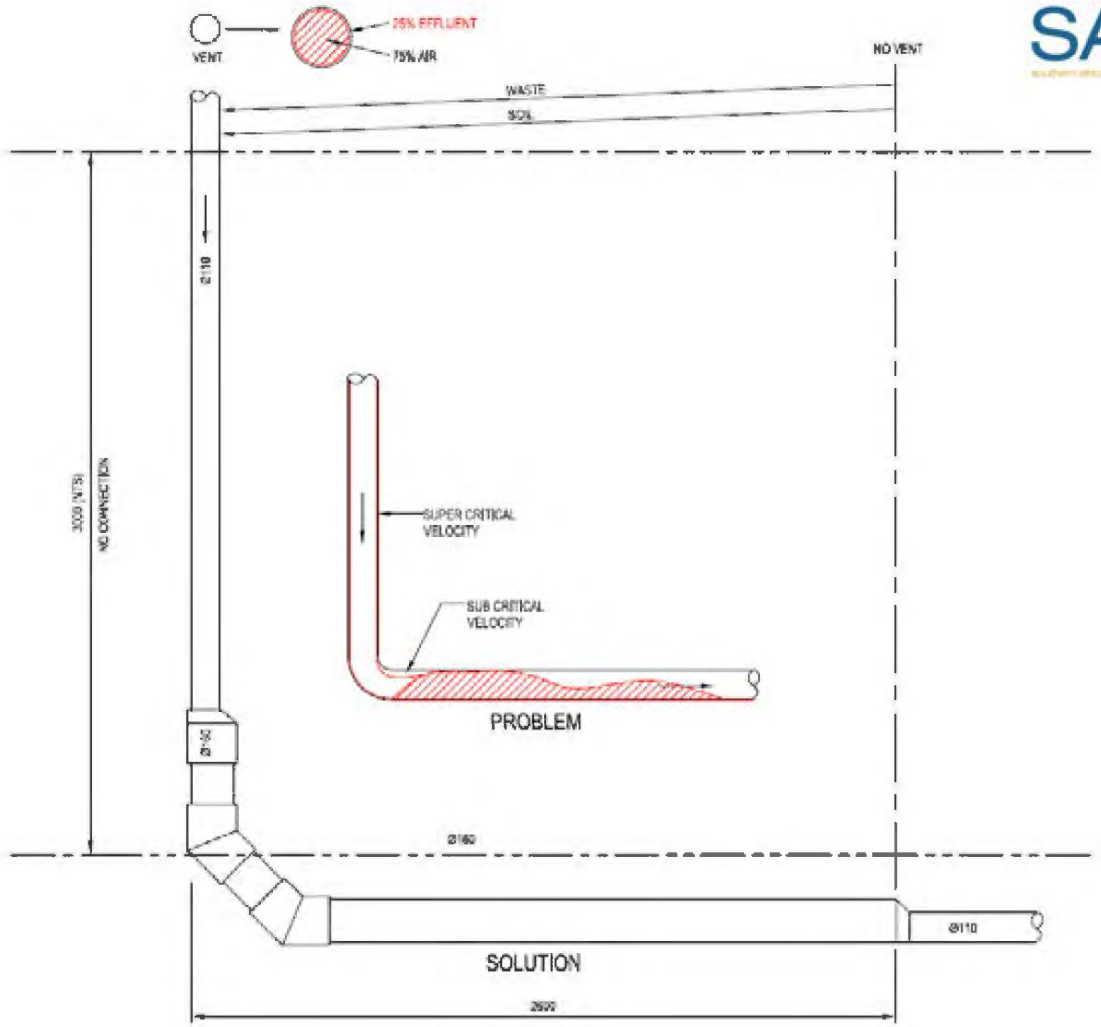
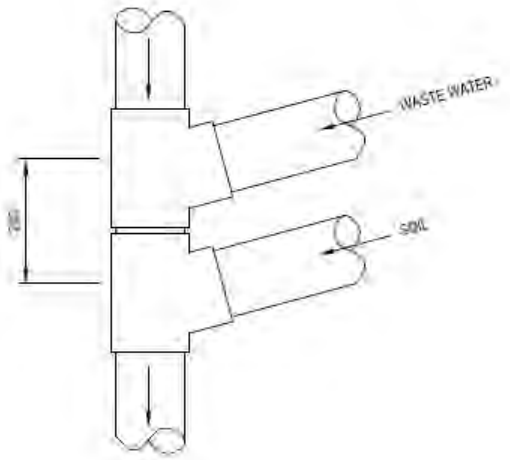
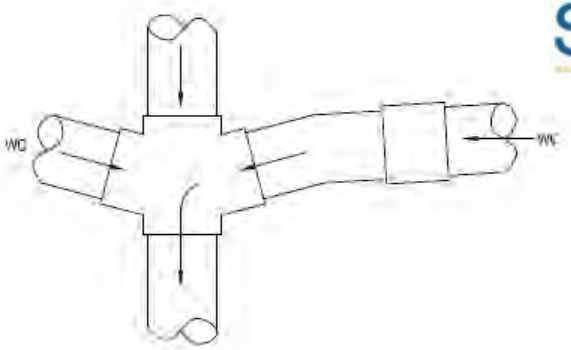
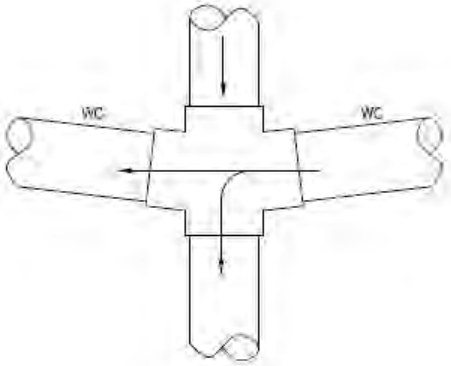

25% EFFLUENT
75% AIR
VENT
NO VENT
WASTE
SOIL
Ø110
3000 (NTS)
NO CONNECTION
SUPER CRITICAL VELOCITY
SUB CRITICAL VELOCITY
PROBLEM
Ø160
Ø110
SOLUTION
2600

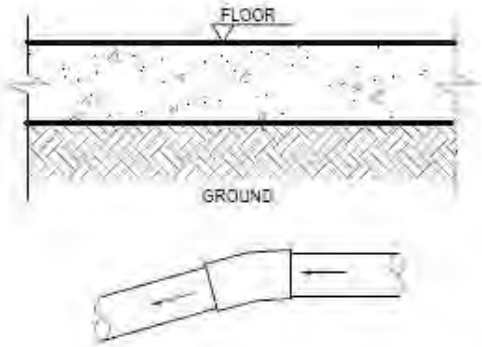




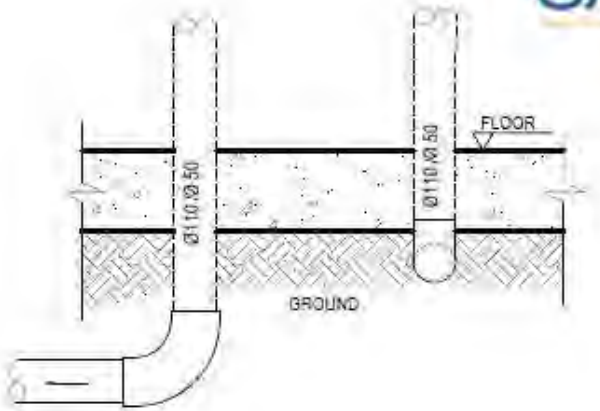
CORRECT



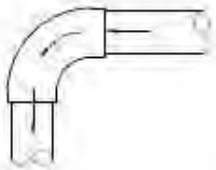
WRONG



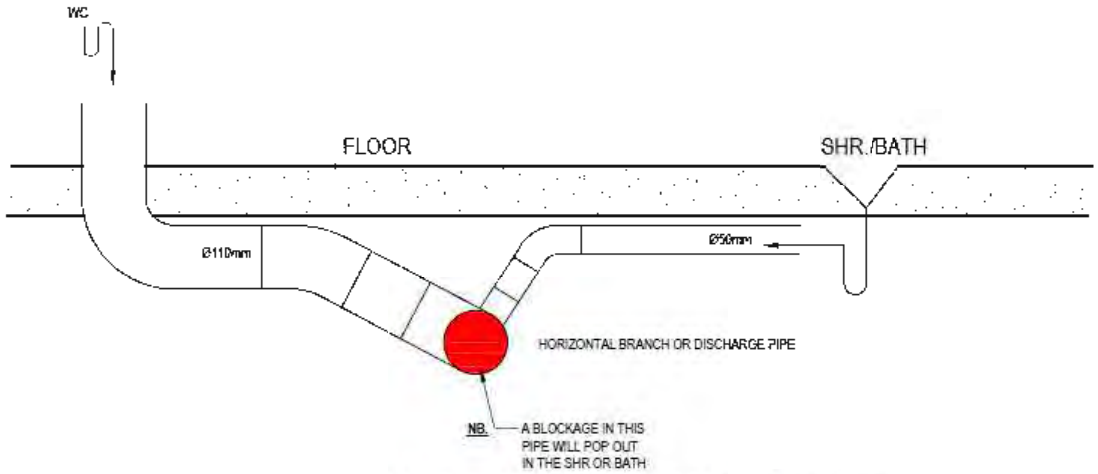
"CHANGE OF GRADIENT" NOT ALLOWED



A "BEND" UNDER A FLOOR IN GROUND IS NOT ALLOWED

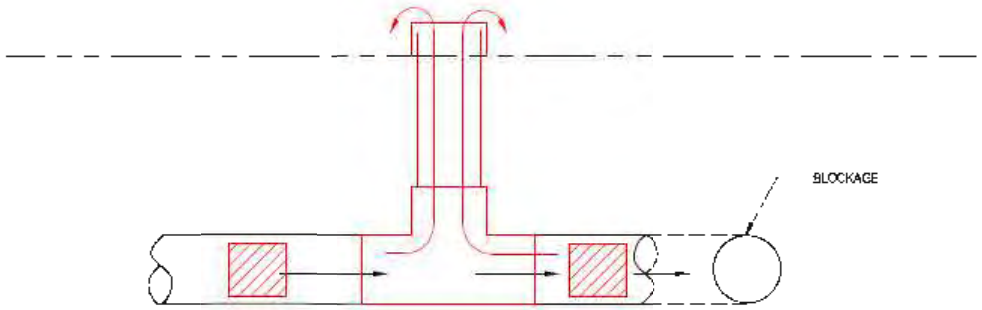


"CHANGE OF DIRECTION" NOT ALLOWED



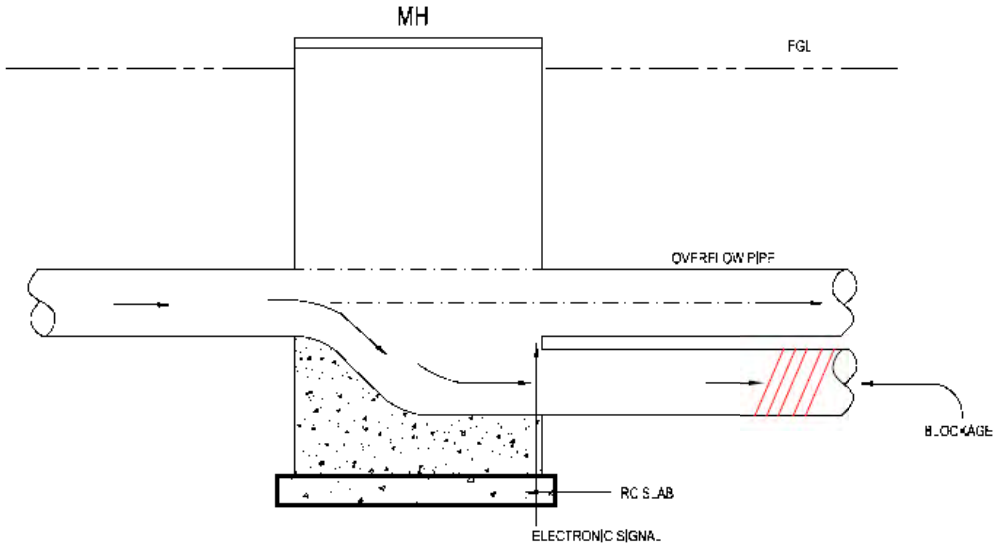
SKETCH 3 - GROUND WATER DRAINAGE DETAIL TYPE 1

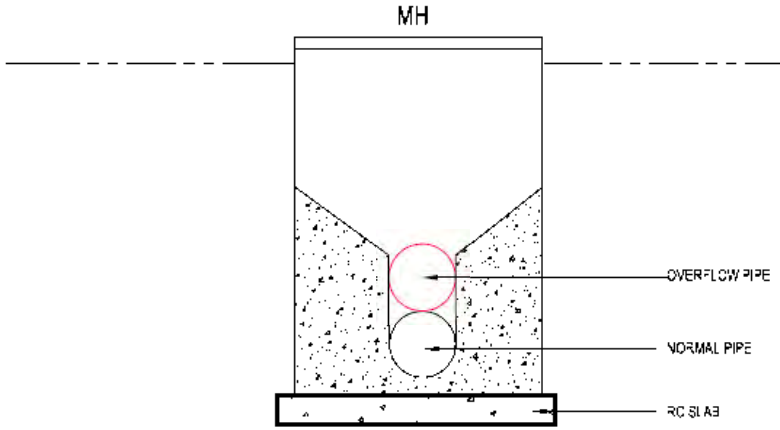
SCALE 1 : 10

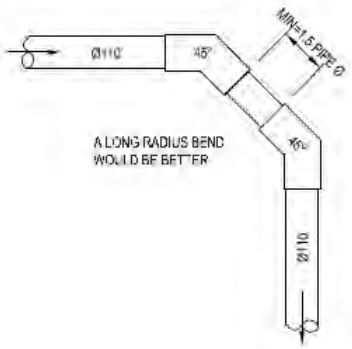


SKETCH 4 - BACKFLOW OVERFLOW

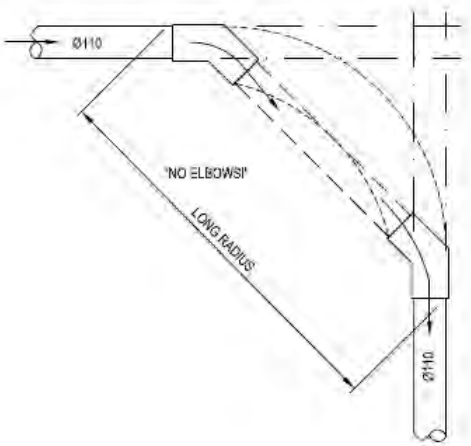
SCALE 1 : 10


MH
FGL
OVERFLOW PIPE
BLOCKAGE
RC SLAB
ELECTRONIC SIGNAL

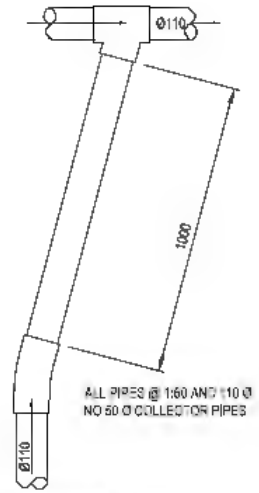

MH
FGL
OVERFLOW PIPE
NORMAL PIPE
RC SLAB



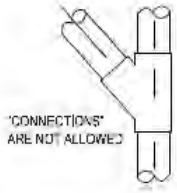
SKETCH 7



SKETCH 8



SKETCH 9



SKETCH 10

WHAT IS NOT ALLOWED IN A DTSR DESIGN UNDER A GROUND FLOOR IN THE GROUND?

1. NO BEND
2. NO CHANGE OF DIRECTION
3. NO CHANGE OF GRADIENT
4. NO CONNECTIONS
5. NO ACCESS (MH/IC (INSPECTION CHAMBER) OR CE (CLEANING EYE)

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6. ALL PIPING INSIDE A BUILDING
   SHALL BE ABOVE GROUND

7. THIS IS AS PER THE DTSR, BUT IT
   CAN BE ADDRESSED BY RAS DESIGN

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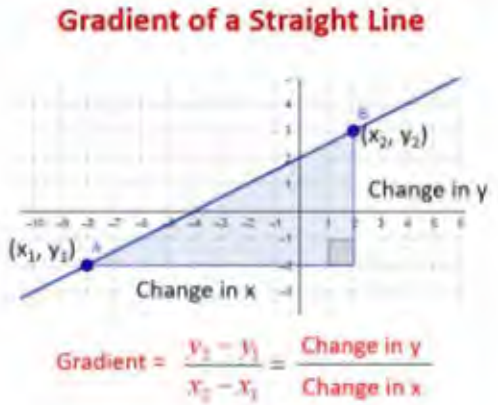
8. WITH THE DTSR DESIGN YOU ARE NOT ALLOWED TO HAVE A GRADIENT LESS THAN 1:60



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RATIONAL DESIGN (RD)

A RATIONAL DESIGN MUST COMPLY WITH “7 REGULATIONS”

SEE PART P FOR THE REGULATIONS AND IN PARTICULAR P2

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LARGE FOOTPRINT BUILDINGS

LARGE FOOTPRINT BUILDINGS WILL REQUIRE PIPING UNDER THE GROUND FLOOR IF IT IS GROUND.

THE DESIGNER MUST THEN FIND SOLUTIONS FOR BENDS, CHANGE OF DIRECTION, CONNECTIONS AND ACCESS ETC.

VERY IMPORTANT

1. DO NOT ALLOW “ELBOWS” UNDER FLOOR
2. ONLY ALLOW LONG RADIUS “BENDS”
3. ONLY ALLOW LONG RADIUS JUNCTIONS
4. DO NOT ALLOW PIPING LESS THAN 100MM DIAMETER (DO NOT ALLOW 50MM UNDER THE FLOOR, IT IS BASICALLY IMPOSSIBLE TO ROD OR TO INSPECT BY CAMERA

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5. IF POSSIBLE, DO NOT USE FLOOR DRAINS,
   AND IN PARTICULAR, NOT IN HOSPITALS

6. PROVIDE VENTILATION FOR ALL FIXTURES IF POSSIBLE (SIMILAR TO TRAP VENTILATION)
7. VENTILATION “MUST” EXTEND TO ABOVE THE ROOF

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THE RD

THE BASIS OF THE DESIGN IS THE 7 REGULATIONS.

ANY INTERNATIONAL ACCEPTABLE DESIGN STANDARD CAN BE USED.

THE LEGAL RESPONSIBLE PERSON IS THE OWNER WHO APPOINTS A COMPETENT PERSON ON HIS BEHALF

DOCUMENTATION

1. SPECIFICATIONS COMPLETE
2. DESCRIPTION OF WORK COMPLETE
3. QA SYSTEM REQUIRED FROM CONTRACTOR
4. INFORMATION ON DRAWINGS TO BE COMPLETE AND ACCURATE, INDICATE ACTUAL INVERT LEVELS AND ACTUAL DISTANCES

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5. WORKS INFORMATION?
6. KICK-OFF MEETING
7. HAND OVER PROCESS
8. HAND OVER DOCUMENTATION
9. COC ‘s
10. GUARANTEES

APPOINTMENT?

WATER AND FIRE
CONSULTING ENGINEERS

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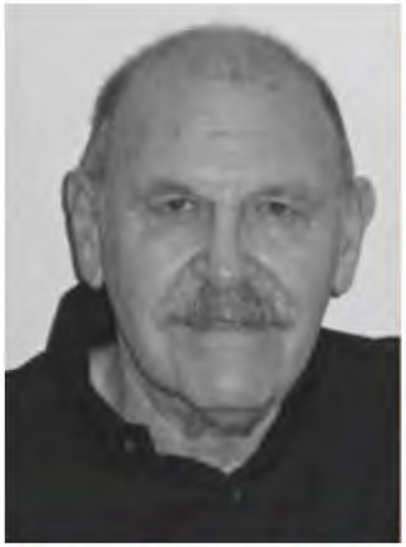
Questions and Answers



Vollie Brink

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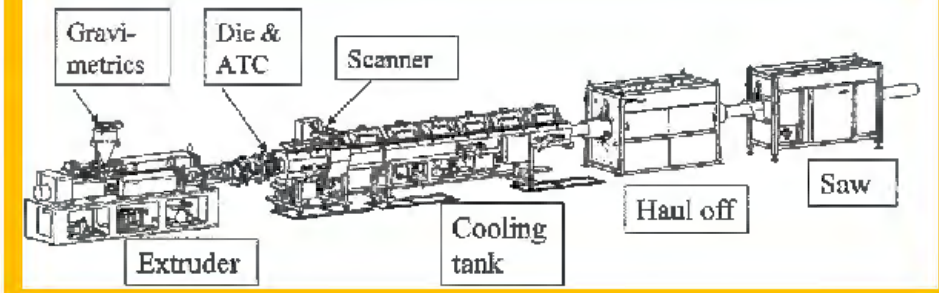
Sewer Systems



Sewer pipe and fitting manufacture

Albert Vaartjes

Albert Vaartjes is the Global Sales Manager RBleu PVC-O at Rollepaal in the Netherlands and is an international expert in PVC Pipe manufacturing.

Rollepaal

solutions in pipe extrusion

Multilayer pipes

SEWER SYSTEMS

QUALITY WORKSHOP IV

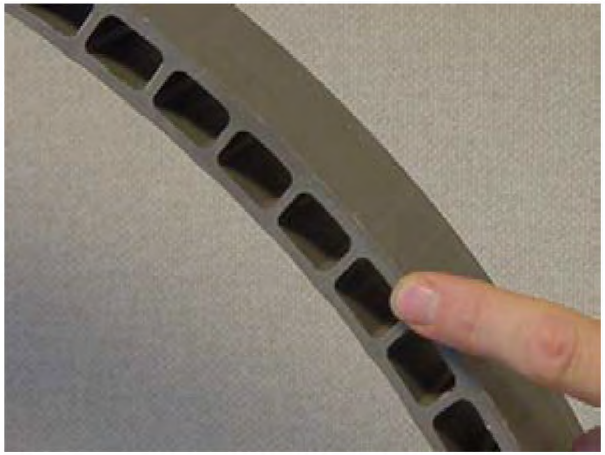
Albert Vaartjes

22 July 2020

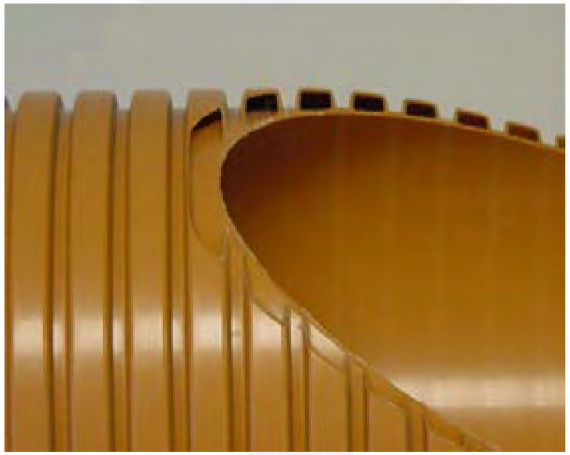
Cost reduction sewer pipes options

Multi layer

Ultra rib



Hollow core



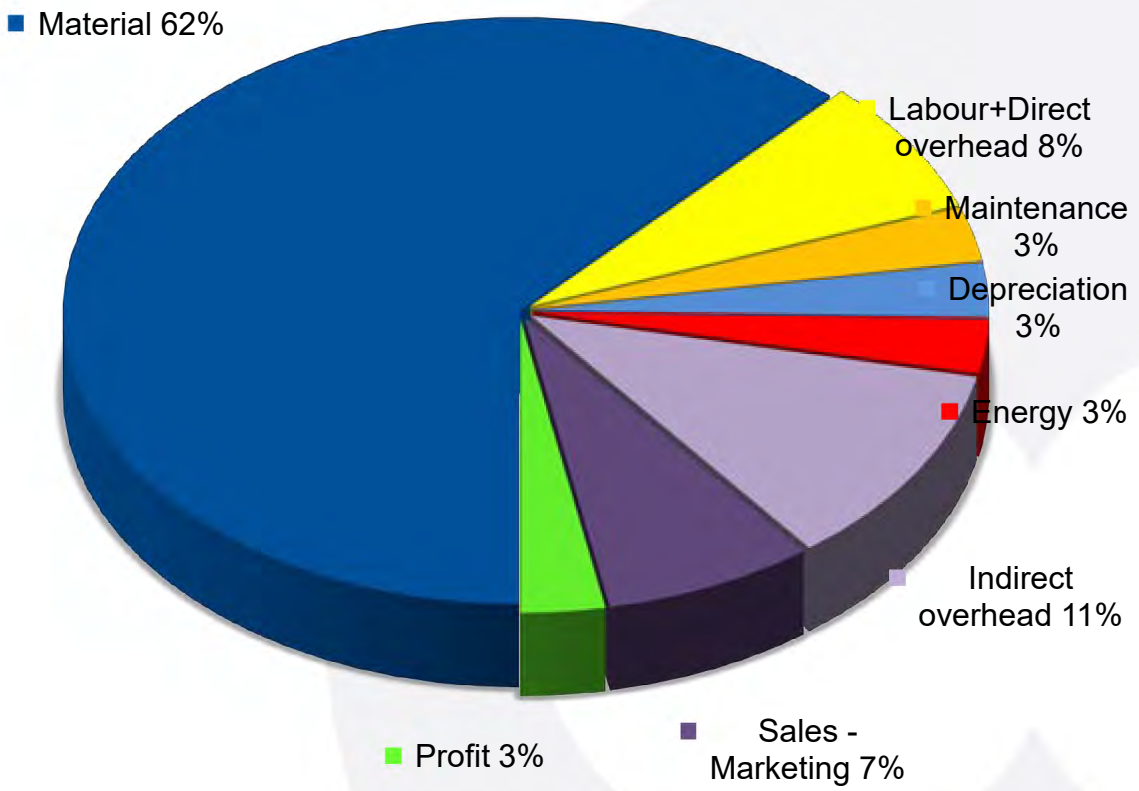
Double wall

Reasons for ML

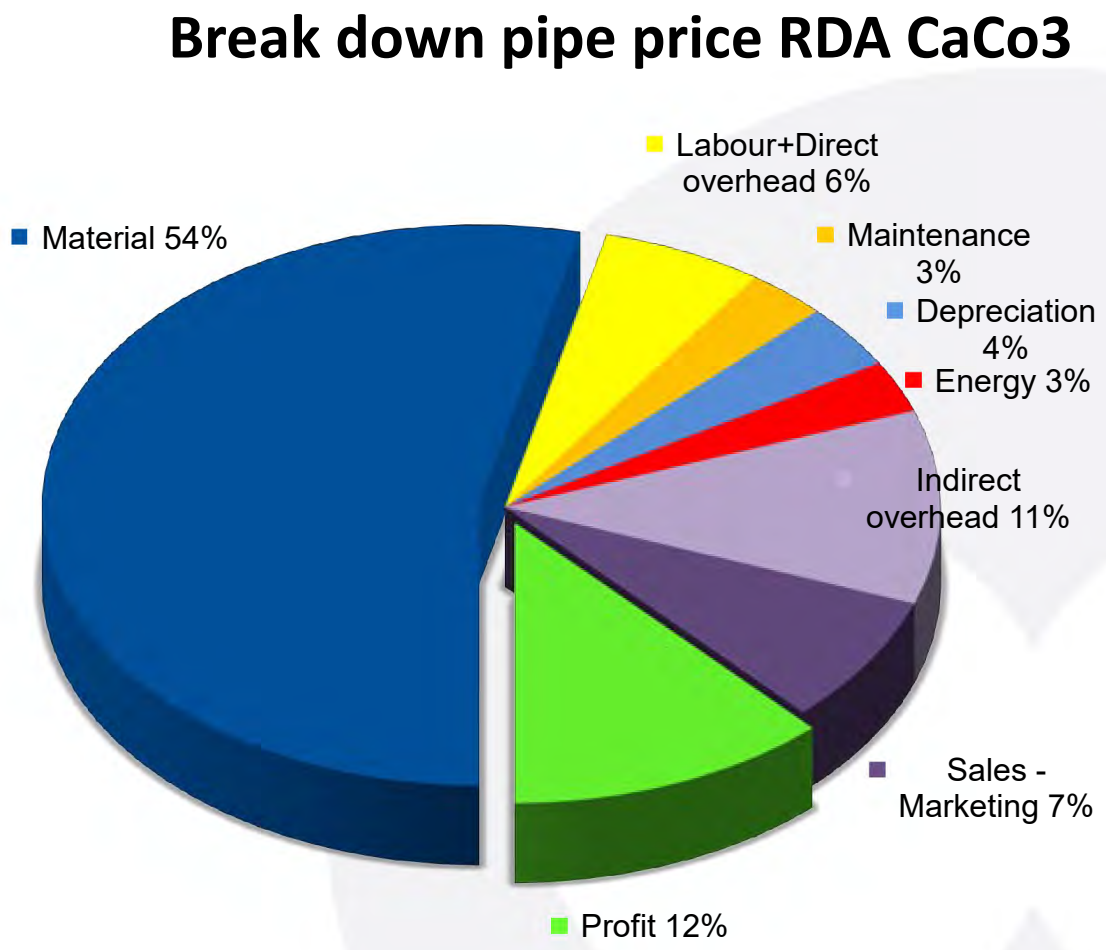
1. Cost Savings by Weight Savings
2. Maximize CaCO3 content in core layer (EN 13476)
3. Process factory scrap in core layer
4. Process Post Consumer scrap in core layer (Sustainable solution)
5. 0.2mm coating at outside and/or inside (UV resistant outside layer , camera inspection inside layer)
6. Marketing tool (different colour of layers,striping)

What Profit do you make on Pipe

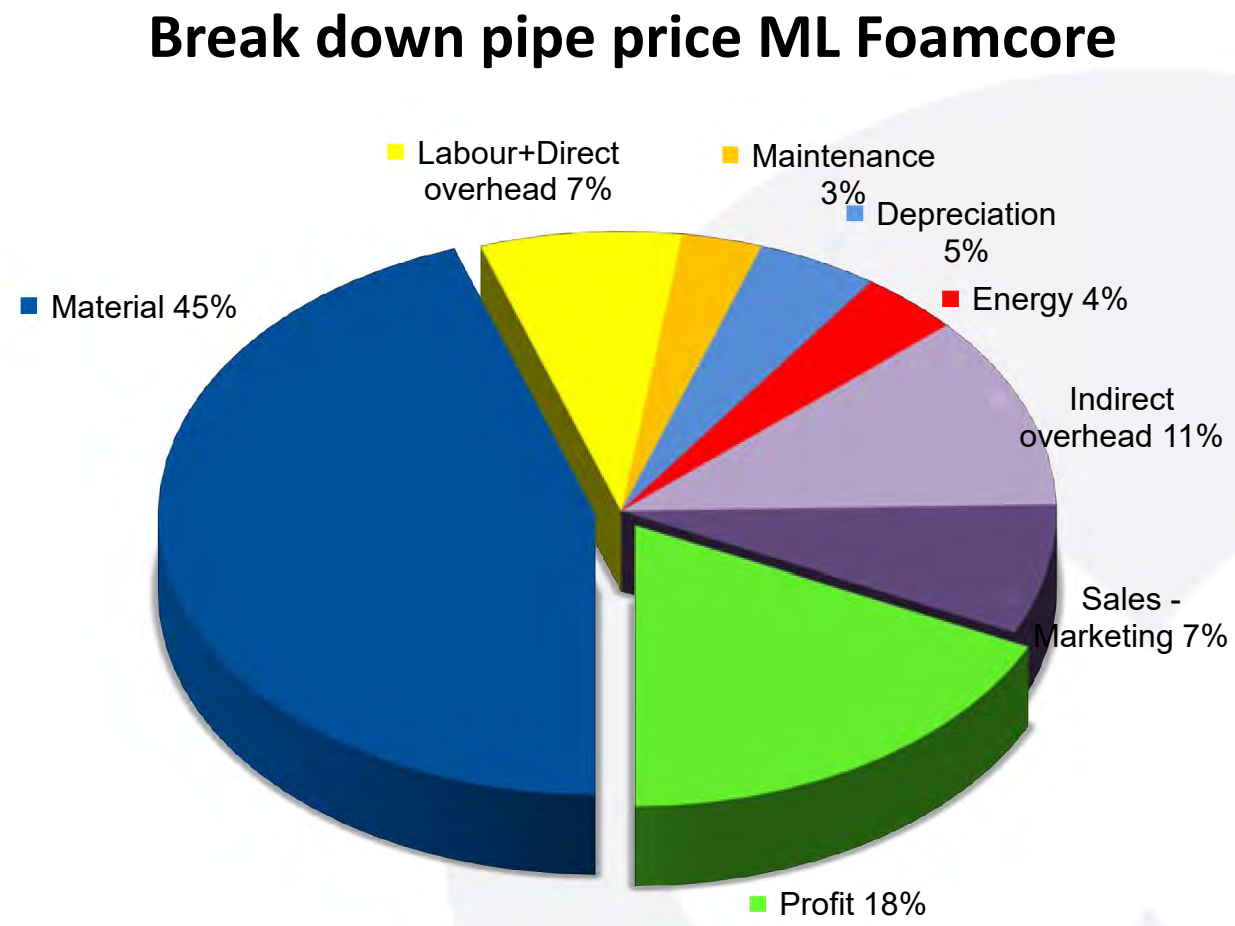
Break down pipe price UPVC



What Profit do you make on Pipe



What Profit do you make on Pipe



Recycling !

In PVC pipes, there are some limits on where recycled material can be used :

1. Not in drinking water pipes

   EN-ISO 1452: 0%

2. In compact sewage pipes

   EN 1401: < 10%

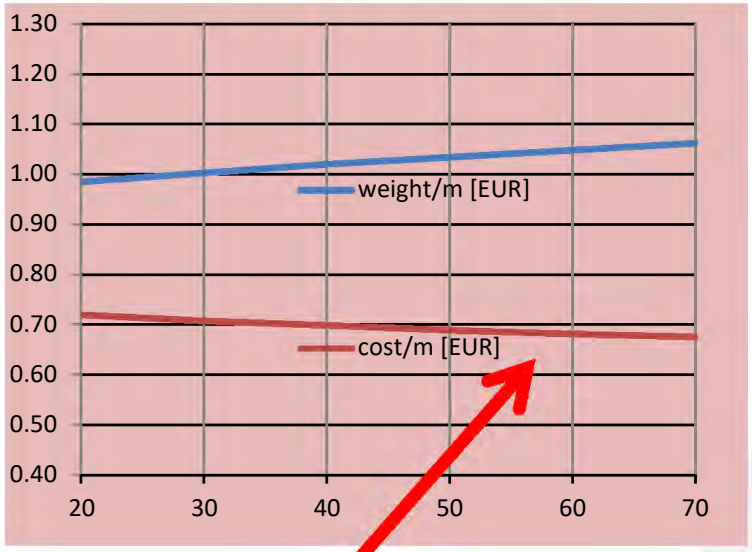
3. In the core of foam pipes

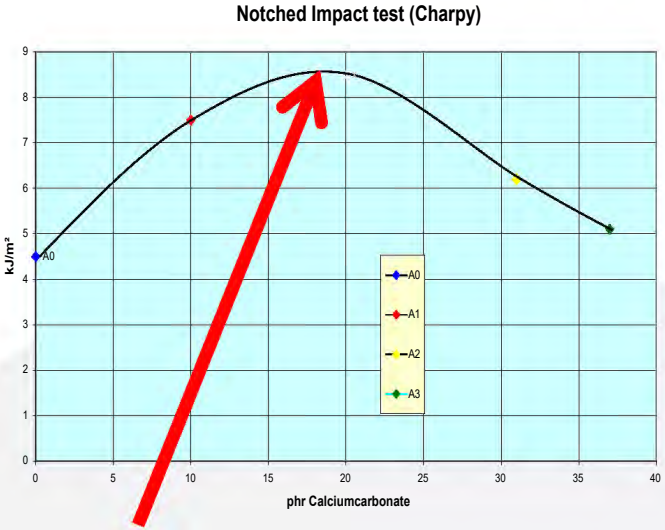
   EN 13476 – ISO 21138: 100%

4. In a central compact layer (structured wall)

   EN 13476 – ISO 21138: 100%

CaCO3 filler

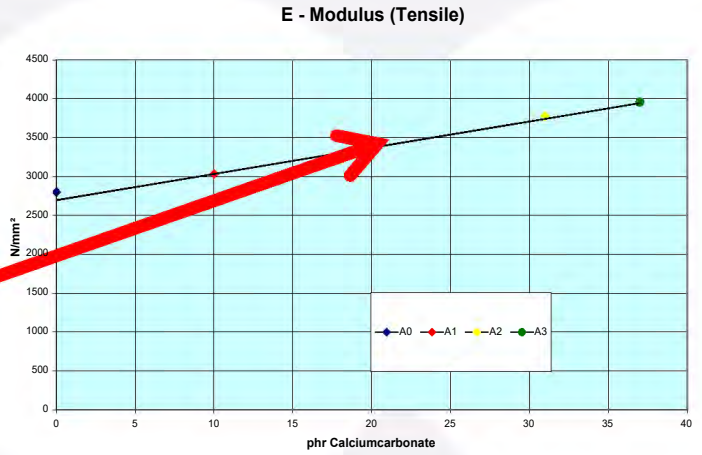




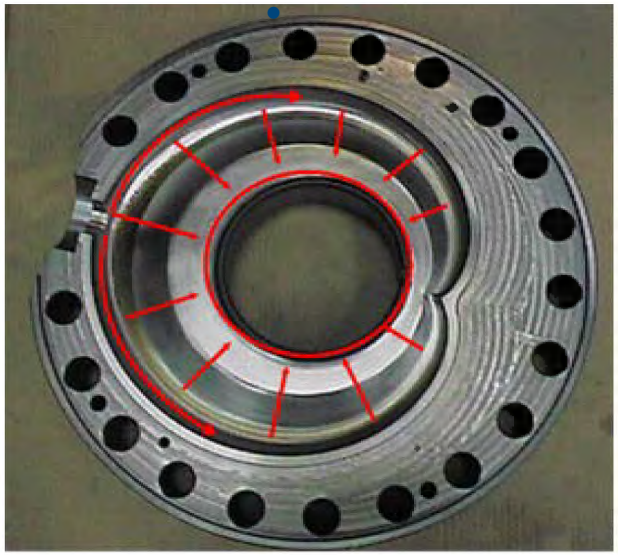
Skin largest impact 18 phr

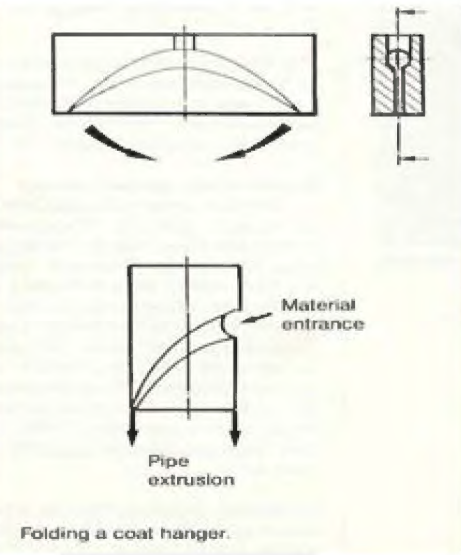
More filler => more foam
Not lowest specific weight but lowest cost per METER

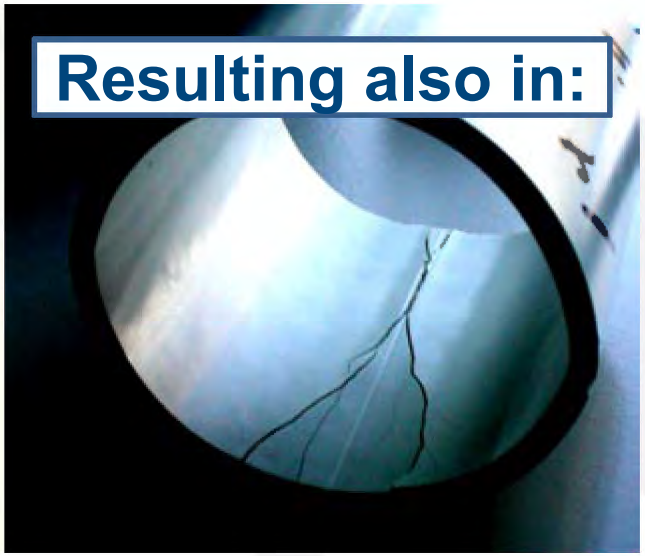
Higher stiffness = thinner skins



Coat hanger (manifold) principle

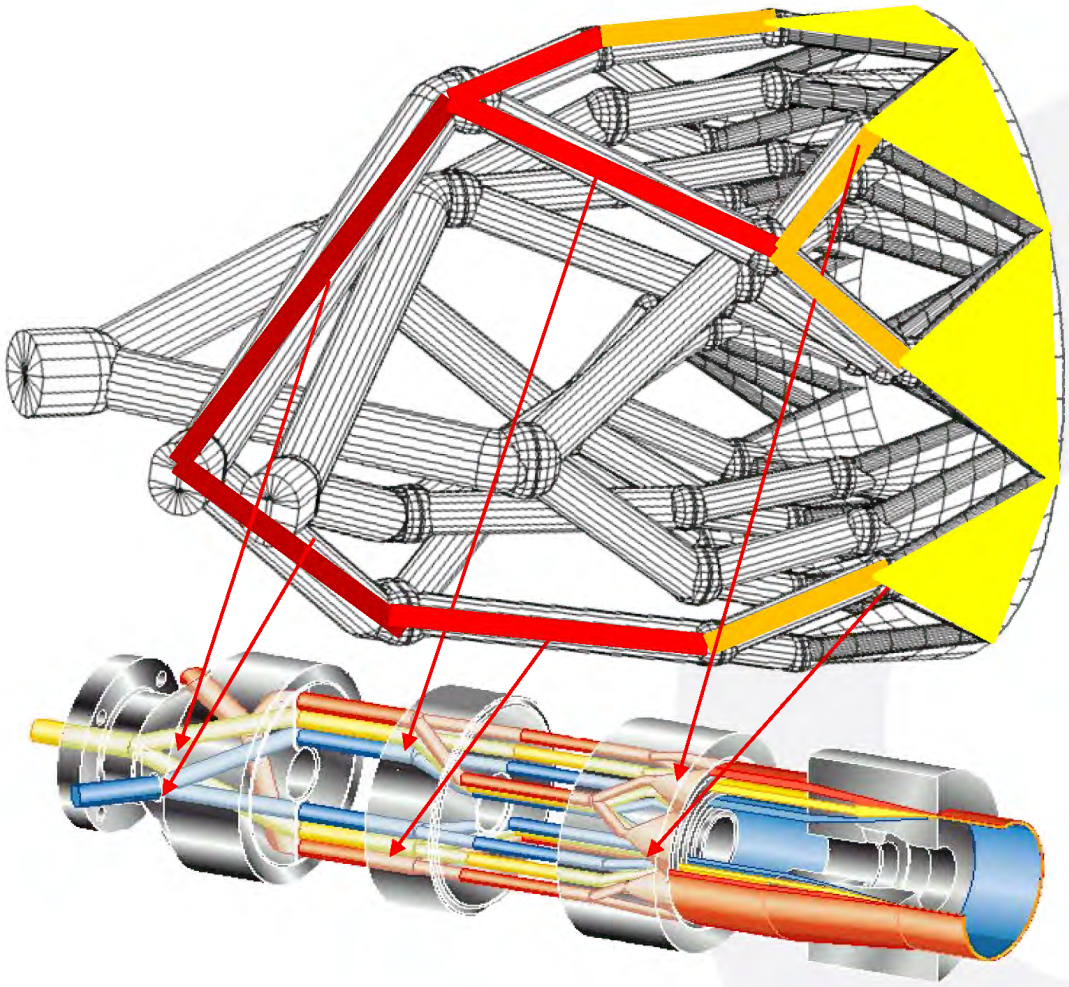






The principle of a coat hanger with different flow lengths for the melt (melt flow is viscosity dependent)
=> uneven melt flow => impact issues at welding line

Integrated ML branching Die



- Equal distances
- Low Inventory
- Precise flow control
- Excellent welding
- Easy to clean
- No weak parts

Rollepaal branching Technology independent on output and viscosity

Integrated Branching Die

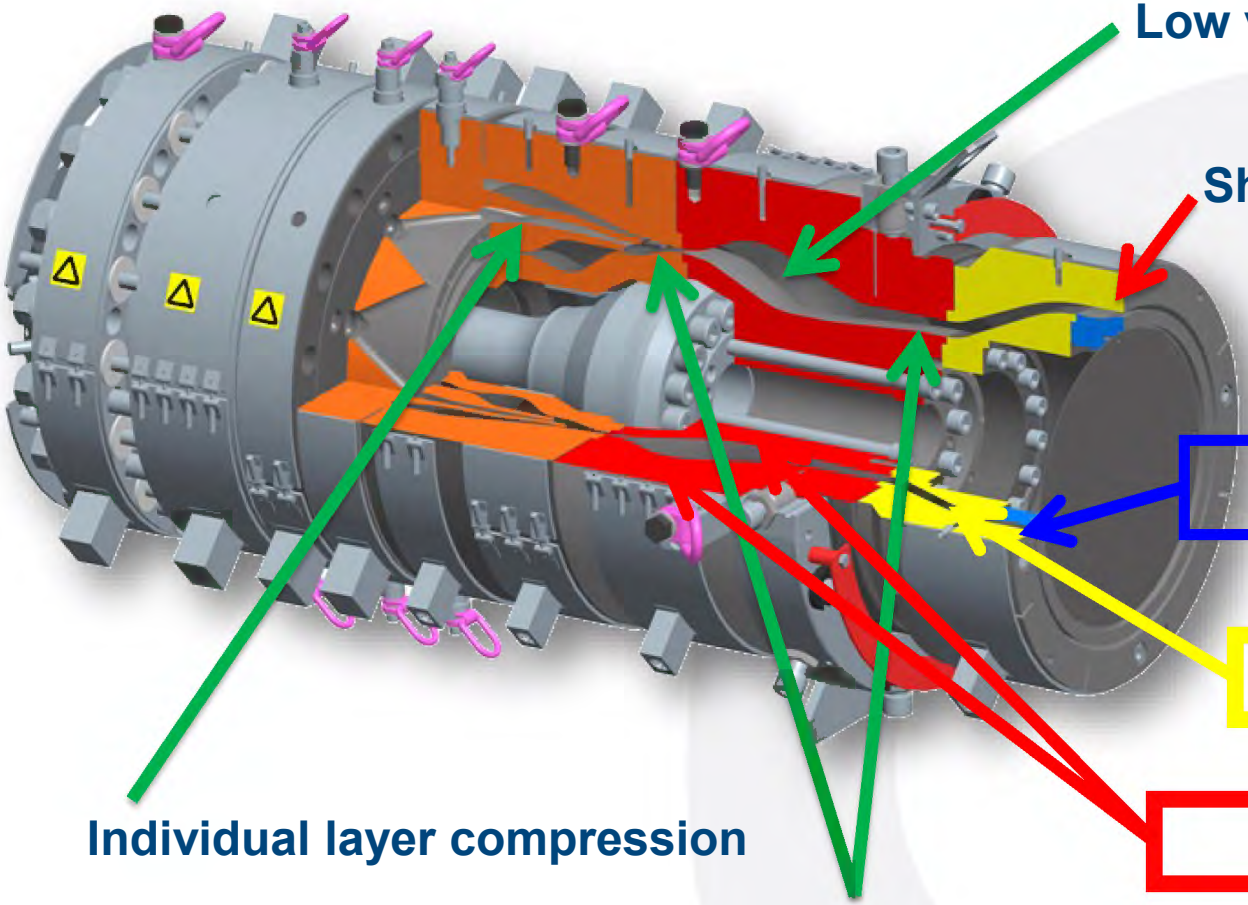
- K57-K67-Scrap-Virgin-High $CaCO_3$ foam
- PVC – PE – PP – ABS – PE/PP combinations
- Formulation (changes) independent
- Suitable for high $CaCO_3$ content
- Output independent
- Low residence time (low stabilizer content)
- Smallest wall thicknesses on skins possible
- Quick Tool Change
- Processing Post Consumer Waste
- High Overall Equipment Effectiveness

ML Flexibility Line

Sewer , Pressure & Foam

Rollepaal PVC foamcore line 630 mm
T-REX 105-30 and T-REX 75-33
RMD 20-630 Die Head
foam core 100% postconsumer scrap

ML Foam Die Technology



Low volume

Short land length

Wall thickness

Diameter change

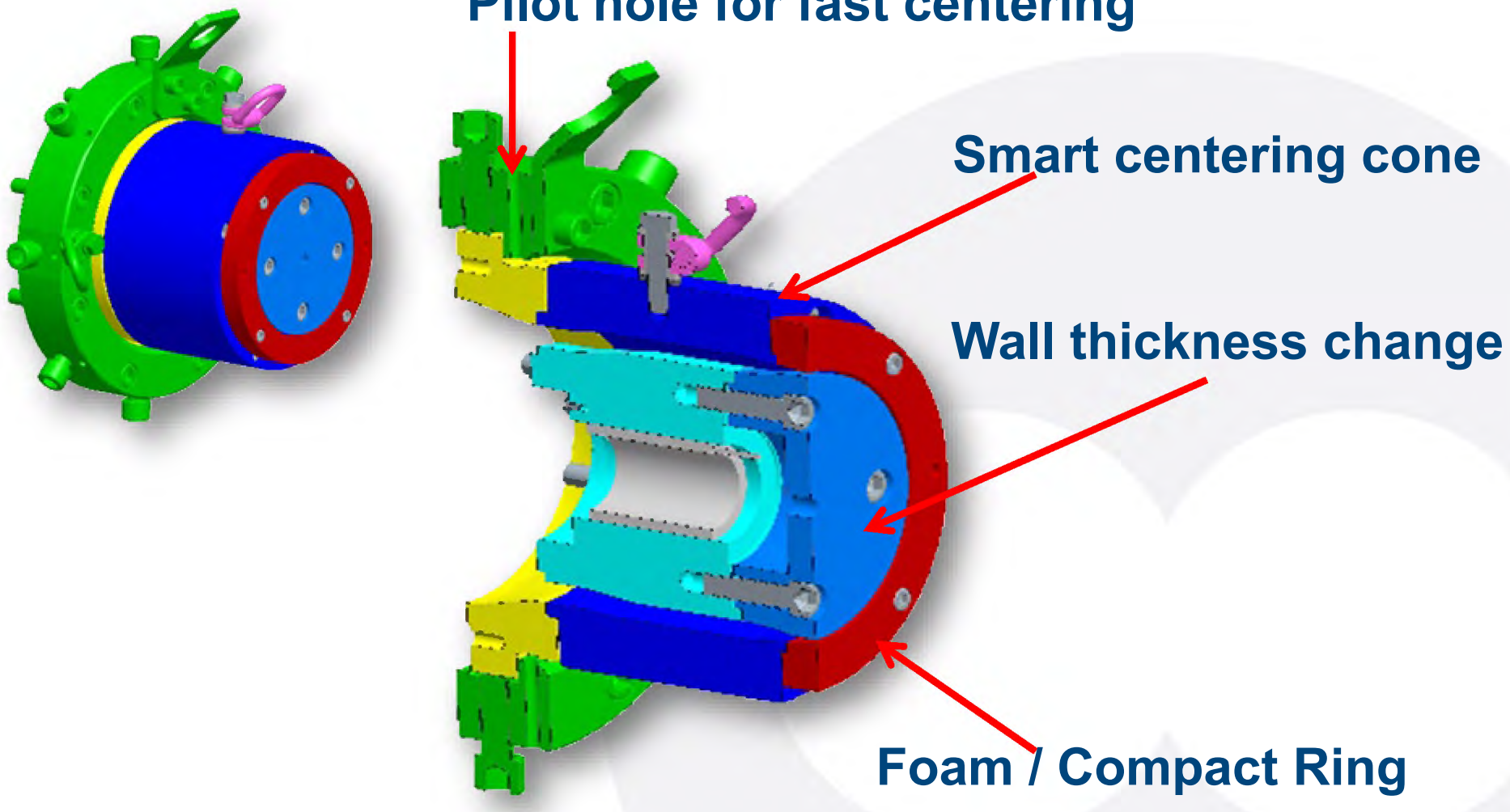
Range change

Individual layer compression

3 layer double compression

Rollepaal

Quick Tool Change



Die-Head Range ML

RMD 4	Pipe size range 20 till 125 mm
RMD 7	Pipe size range 32 till 200 mm
RMD 8	Pipe size range 60 till 270 mm
RMD 12	Pipe size range 85 till 325 mm
RMD 16	Pipe size range 160 till 410 mm
RMD 20	Pipe size range 200 till 520 mm
RMD 24	Pipe size range 250 till 630mm
RMD 32	Pipe size range 315 till 820 mm

RMD 20 Production

From today onwards

- Today, pipe applications shall have a good performance regarding the environment
- A low carbon footprint will give a clear advantage
- PVC, with its low fossile content (43%), already has an environmental advantage
- End-of-life fate, of an item has a strong influence on the carbon footprint

→ Recycling is a key-point in sustainability

Rollepaal

solutions in pipe extrusion

SAPPMA

southern african plastic pipe manufacturers association

Questions and Answers

Albert Vaartjes

rollepaal PIPE EXTRUSION ramix INJECTION MOULDS

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Refreshment Break

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Refreshment Break (3 Minutes)

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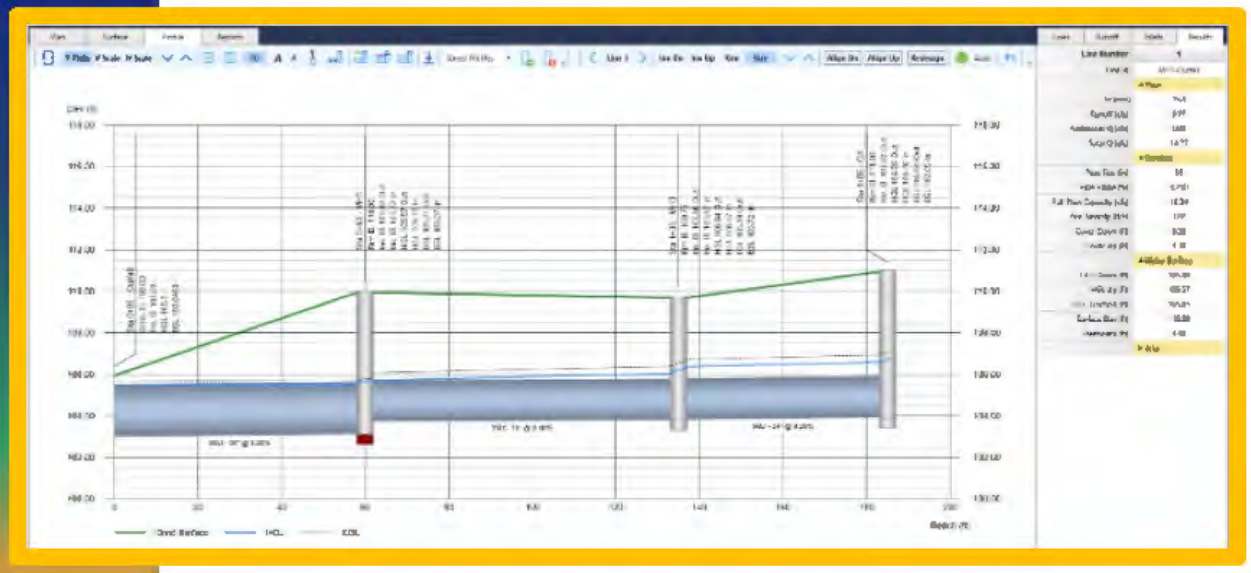
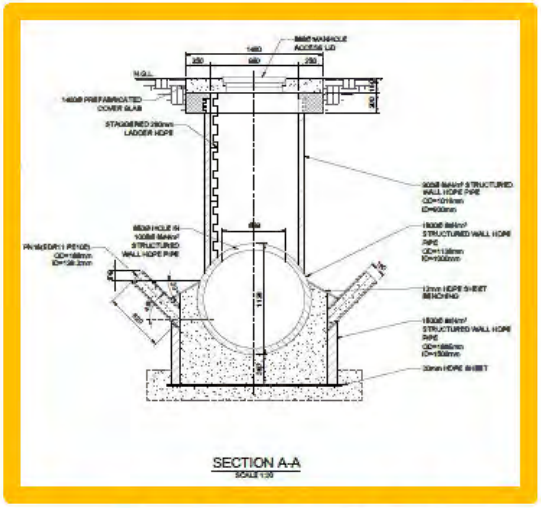
Sewer Systems

Sewer pipe system design principles

Alaster Goyns

Alaster Goyns has been involved with many of the major outfall sewers in South Africa for over 40 years. He is a professional engineer and independent specialist consultant providing a service to larger consultants, contractors and pipe suppliers. His experience covers the development, introduction and launching of cementitious and inert lining systems for sewer pipes in South African market.





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DESIGN PRINCIPLES FOR SEWERS

SAPPMA QUALITY WORKSHOP

Alaster Goyns

22 July 2020

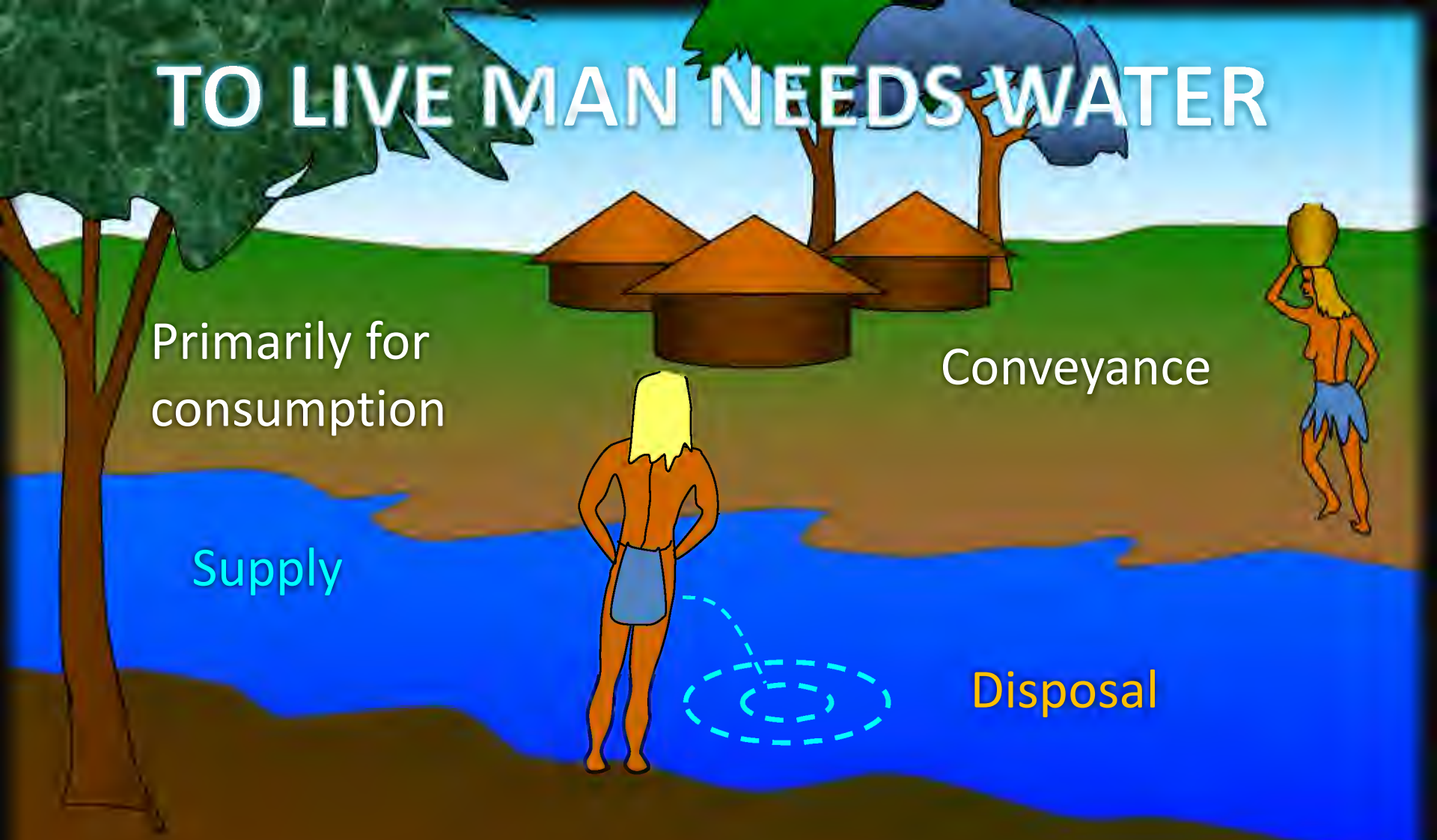
SA SHARES A GLOBAL CHALLENGE

Urban growth and densification

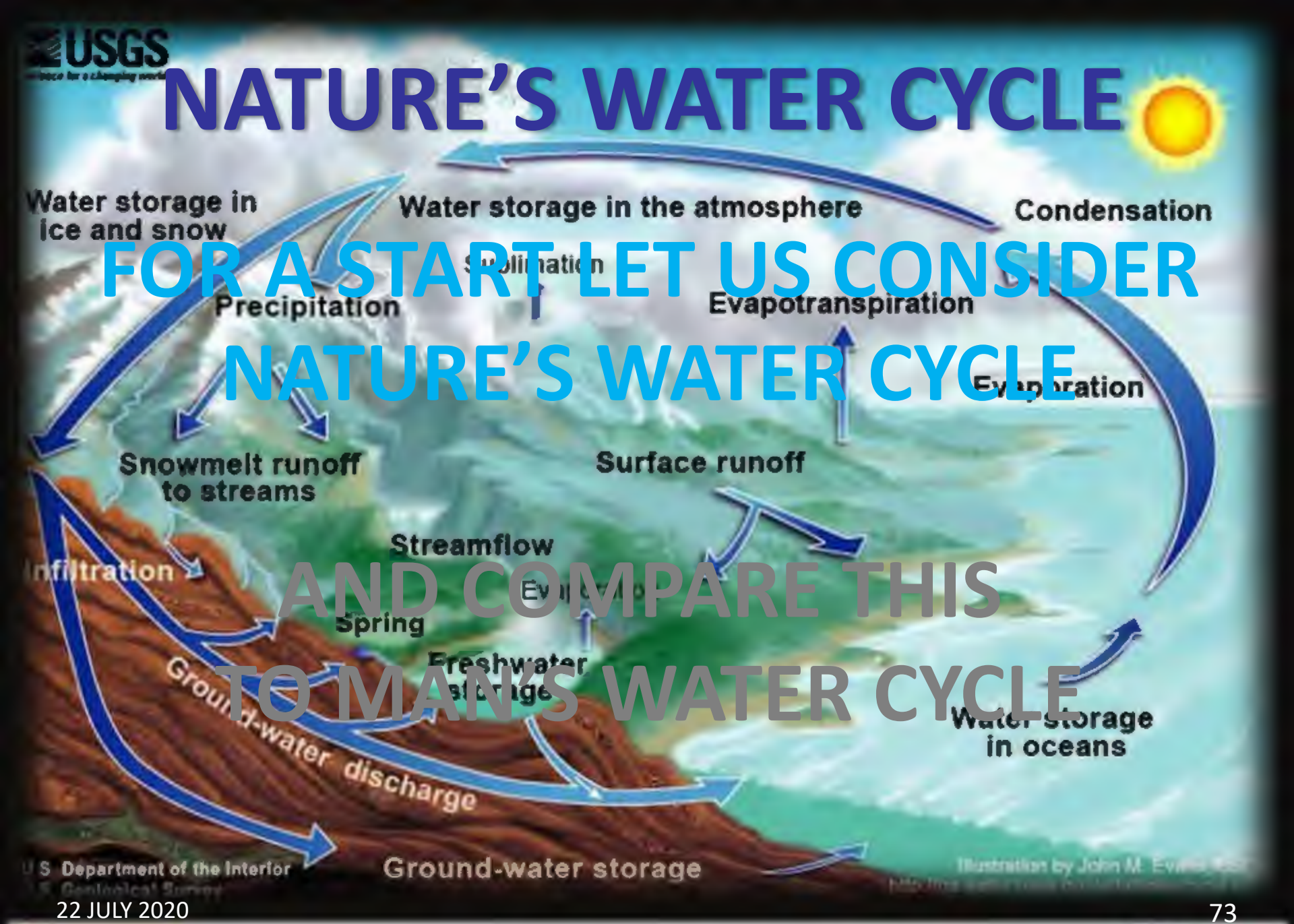
Radical differences within our population

But we all need water services

TO LIVE MAN NEEDS WATER

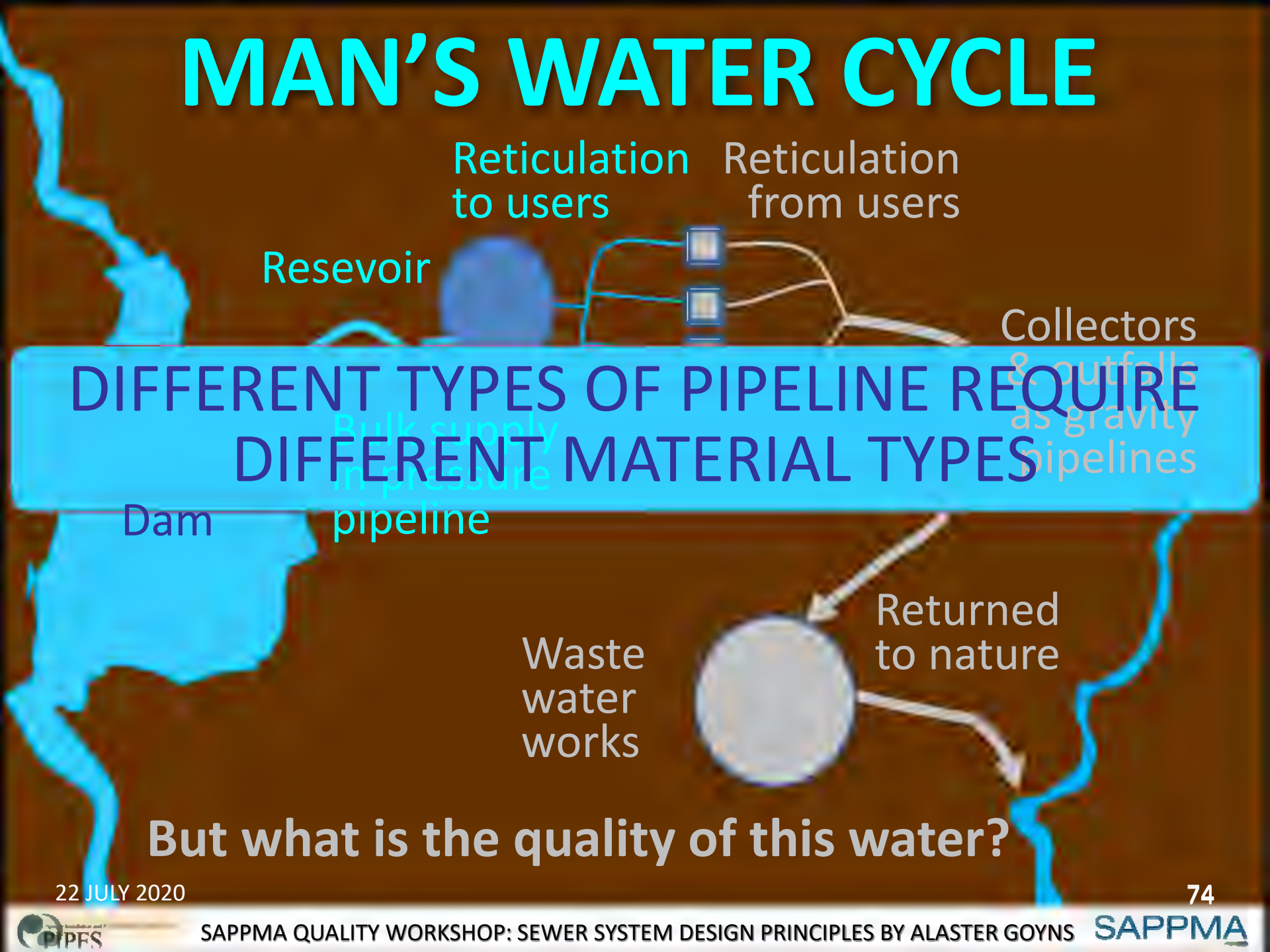


Upstream disposal - downstream supply



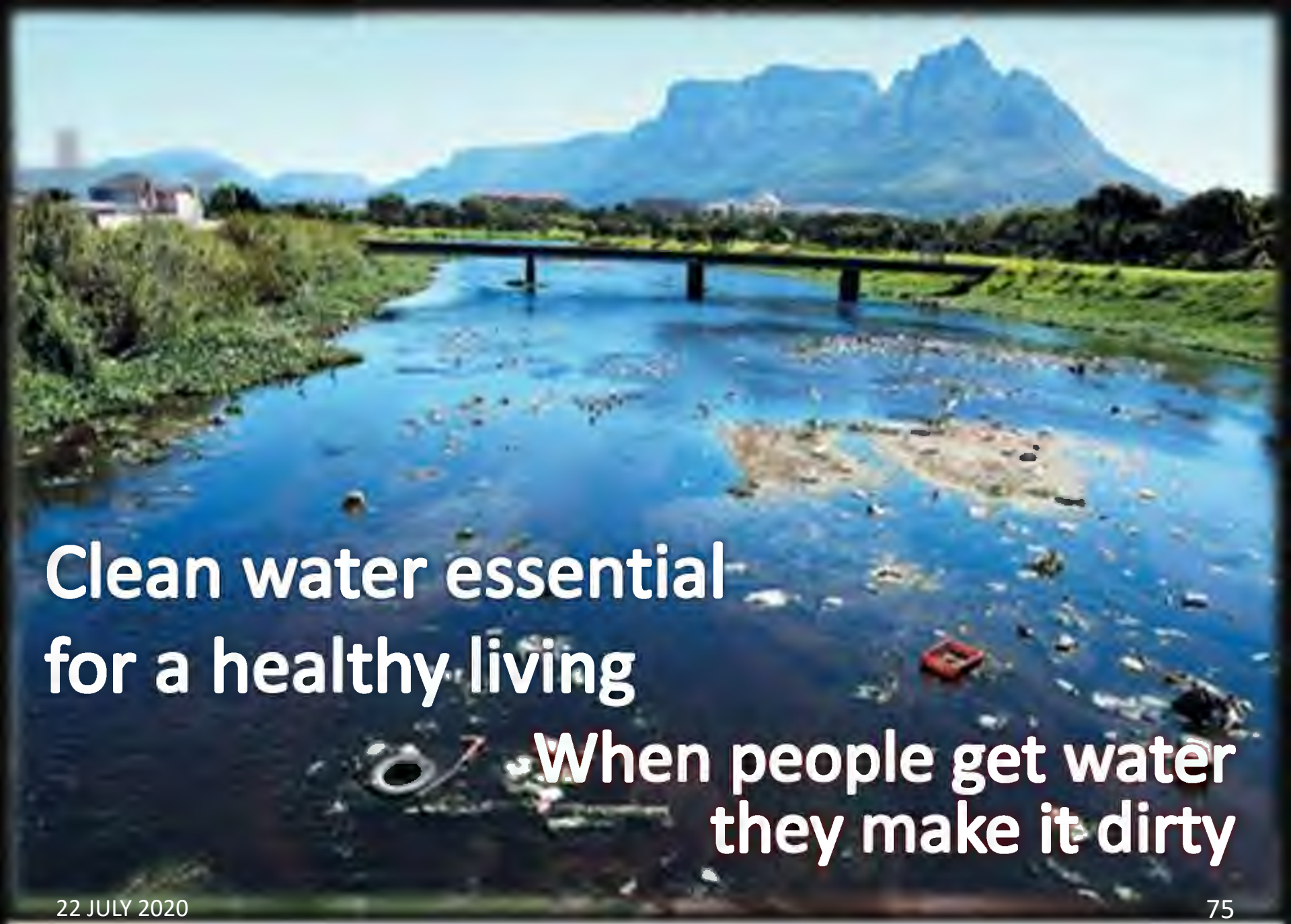
FOR A START LET US CONSIDER NATURE'S WATER CYCLE AND COMPARE THIS TO MAN'S WATER CYCLE

MAN'S WATER CYCLE



DIFFERENT TYPES OF PIPELINE REQUIRE DIFFERENT MATERIAL TYPES

But what is the quality of this water?


Clean water essential
for a healthy living
When people get water
they make it dirty

More die from water borne disease than from aids

Dirty water makes people sick
and the sick people die

But, globally there are about 2 000 000 000
without access to adequate sanitation

MAN USES CLEAN WATER

MAN MAKES WATER DIRTY

MAN SHOULD BE RESPONSIBLE FOR **CLEANING** THIS DIRTY WATER

SO HOW & WHERE SHOULD THIS BE DONE ?

SHOULDN'T JUST THROW IT OUT INTO THE STREET

IT SHOULD BE TAKEN AWAY & CLEANED BEFORE RETURNING IT TO NATURE

OR THE WATER SUPPLY

As providers, how do we address the problem

Meeting the customer's needs and that might be us

When providing pipelines where do we start ?

Must understand the needs and the conditions before designing

FUNCTION OF PIPELINES

Conveying water for man

Fresh water supply

Wastewater disposal

- *sewage*
- *stormwater*
- *industrial*

To provide these pipelines must have the required properties

REQUIREMENTS TO MEET

Primarily function is to

- Supply fresh water
- Take away waste water

Secondary requirements are

- Must provide a structure
- Must be water tight
- Must remain durable

HYDRAULIC PERFORMANCE

Basic principles
- Continuity
- Energy
- Momentum

Parameters to calculate
- Capacity
- Velocity

These give the size needed

But they are not all that is needed
- Turbulence – corrosion potential
- Deposition – results in blockages

These affect durability & operation

Impact of minimum and maximum velocity essential – this usually not done

HYDRAULIC PRINCIPLES

CONTINUITY – what goes in must go out

$$Q_1 = A_1V_1 = Q_2 = A_2V_2 = Q_3 = A_3V_3$$

ENERGY – gravity pulls water downwards

$$Z_1+P_1/\gamma +V_1^2/2g = Z_2+P_2/\gamma +V_2^2/2g + \Sigma H_L$$

MOMENTUM – keeps going in same direction

$$P_f/\gamma = M_1 - M_2 \text{ where } M = q^2/gy + y^2/2$$

WHAT SIZE PIPE NEEDED

Start from expected peak design flow (PDF)

PDF = (ADF) x (PFF) lt/day

Where (ADF) - average daily flow (70 – 160 lt/p/day)

(PFF) - peak flow factor

Legge < 7000 persons

PFF = $6.51/p^{0.38}$ lt/day where p is 1000 persons

Harmon > 7000 persons

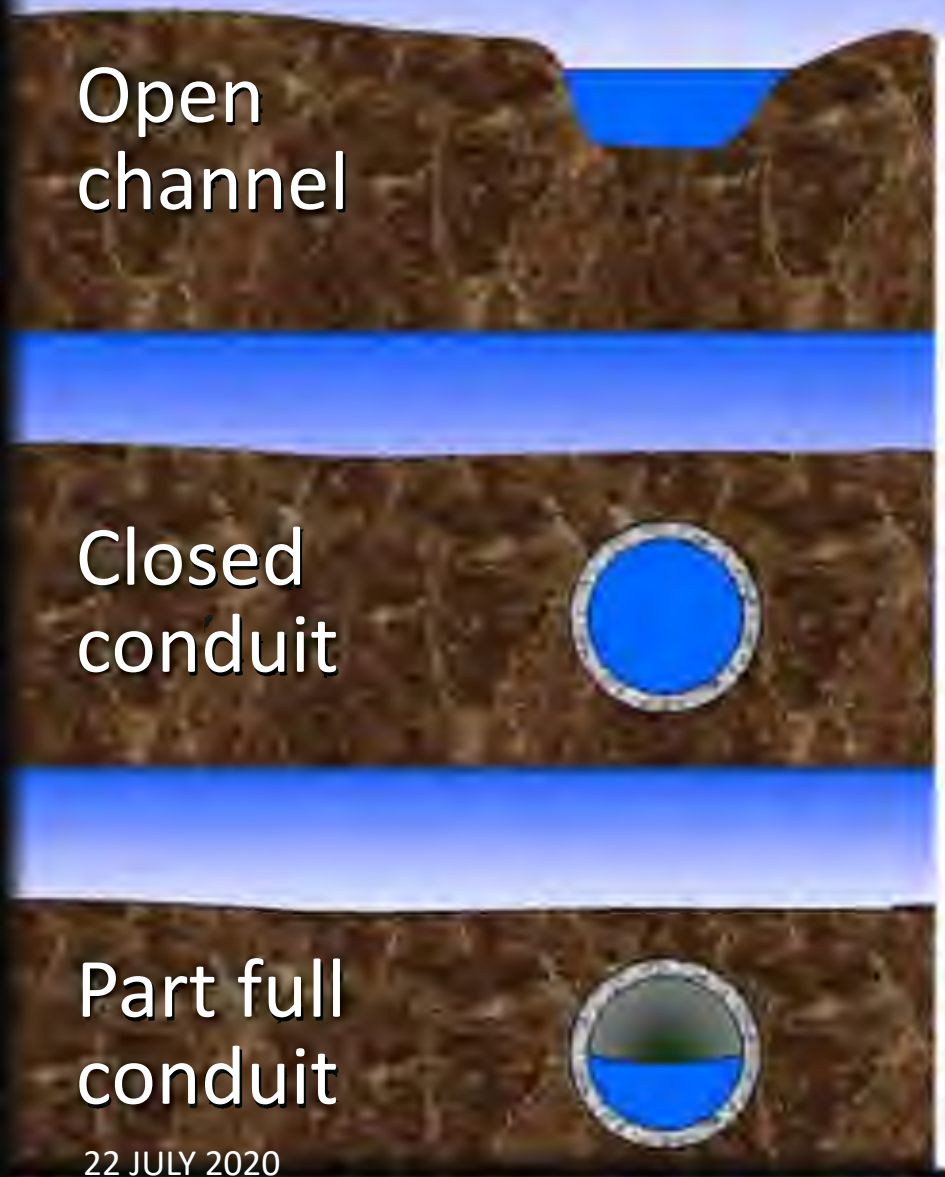
PFF = $1 + \{14/(4 + p^{0.5})$ where p is 1000 persons

For 1000 people assuming 110 lt/p/day

PDF = $1000 \times 110 \times 6.51/(1^{0.38} \times 24 \times 3600)$ = 8.29 lt/s

To this value need to add infiltration due to leaks and groundwater infiltration

CONDUIT/FLOW TYPE

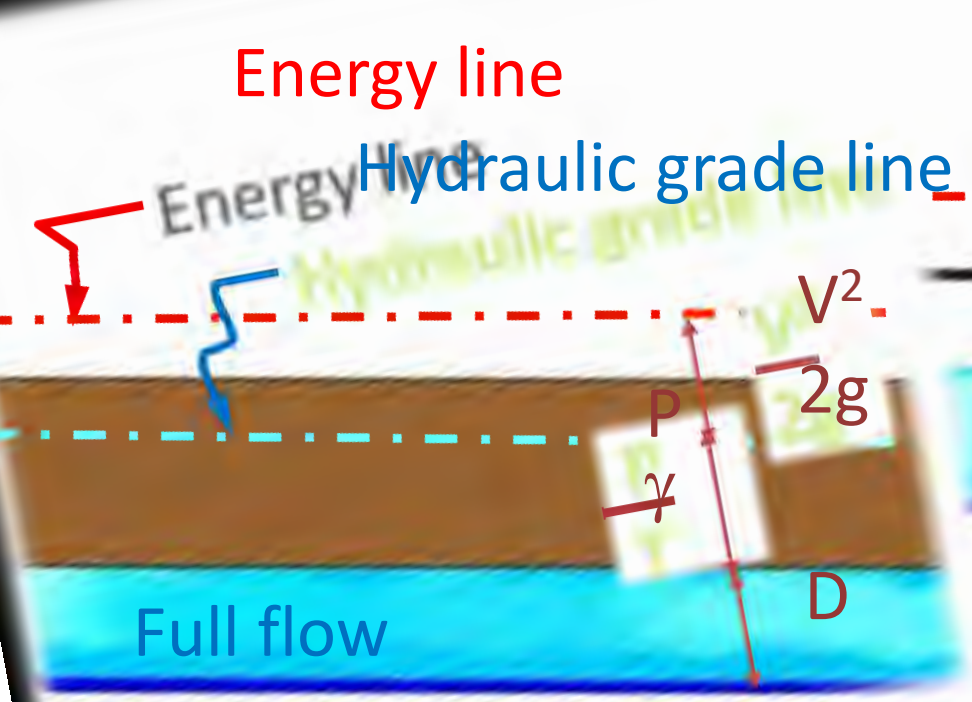


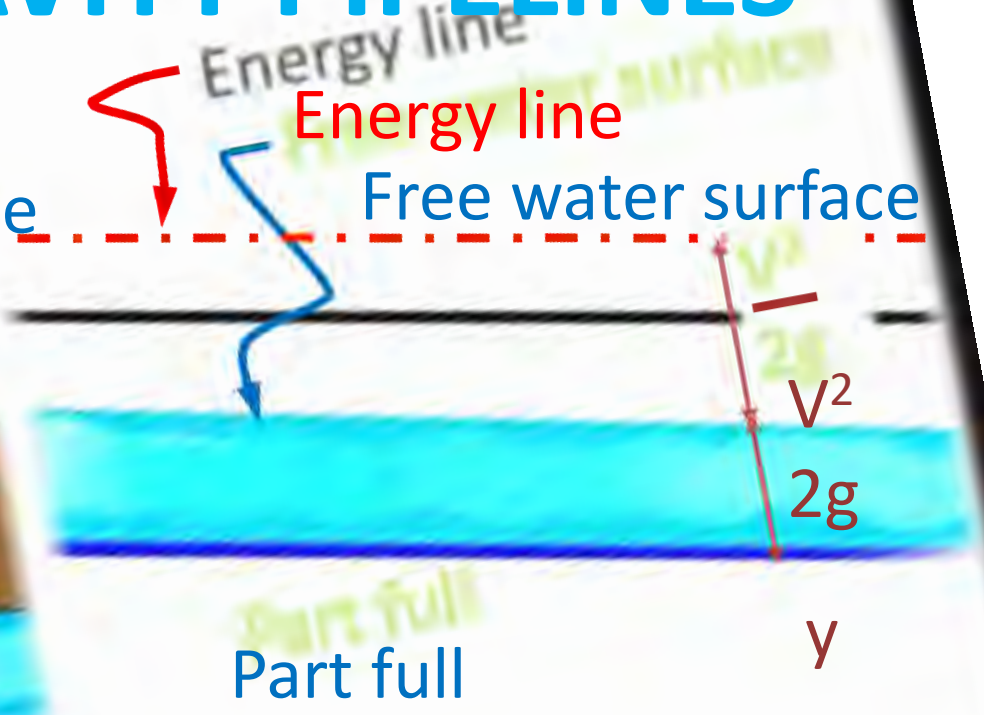
Stormwater drains & sewers buried; usually flow as open channels

Stormwater drains flow intermittently; sewers flow continuously

Designer needs to understand similarities and differences

FLOW IN GRAVITY PIPELINES





Most stormwater & sewer outfalls are designed to operate as part full gravity systems

$$\text{Total energy, } H = y + \frac{V^2}{2g}$$

WHAT IS FLOW REGIME ?

General relationship between gravity & momentum

$$\frac{\text{MOMENTUM}}{\text{GRAVITY}} = \text{FROUDE NO} = \frac{Q^2T}{gA^3}$$

In rectangular channel this reduces to

$$\frac{\text{MOMENTUM}}{\text{GRAVITY}} = \text{FROUDE NO} = \frac{V}{\sqrt{gy}}$$

Fr < 1	Fr = 1	Fr > 1
SUBCRITICAL	CRITICAL	SUPERCRITICAL

VELOCITY CALCULATION

All friction formulae on same principle as Chezy

$$V = C \times (R \times S)^{1/2}$$

Velocity

Roughness

Gradient

Shape & size

Manning + Continuity easy to use

$V = 1/n\ R^{2/3}S^{1/2}$ & $Q = AV$

Roughness

Discharge

Area

VELOCITY & DISCHARGE

Velocity increases at the power of $D^{2/3}$

If D doubled

Velocity increase 1.59 x

600 ϕ V = 21.716 $S^{1/2}$

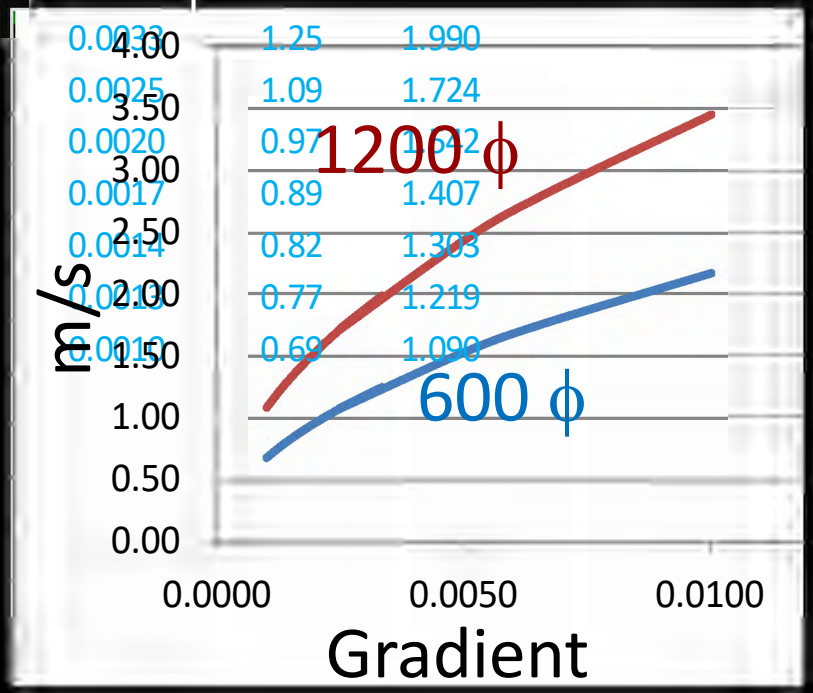
1200 ϕ V = 34.472 $S^{1/2}$

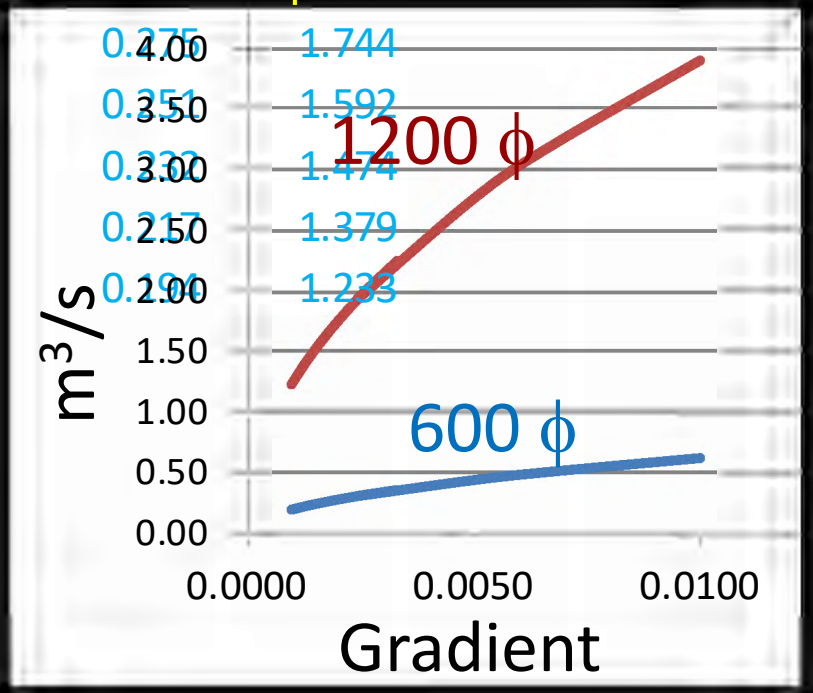
Discharge increases at the power of $D^{8/3}$

Discharge increase 6.35 x

600 ϕ Q = 6.143 $S^{1/2}$

1200 ϕ Q = 39.003 $S^{1/2}$





SENSITIVITY OF FACTORS

FACTOR	ON VELOCITY	ON DISCHARGE
Roughness	Power of -1	Power of -1
Gradient	Power of 1/2	Power of 1/2
Diameter	Power of 2/3	Power of 8/3

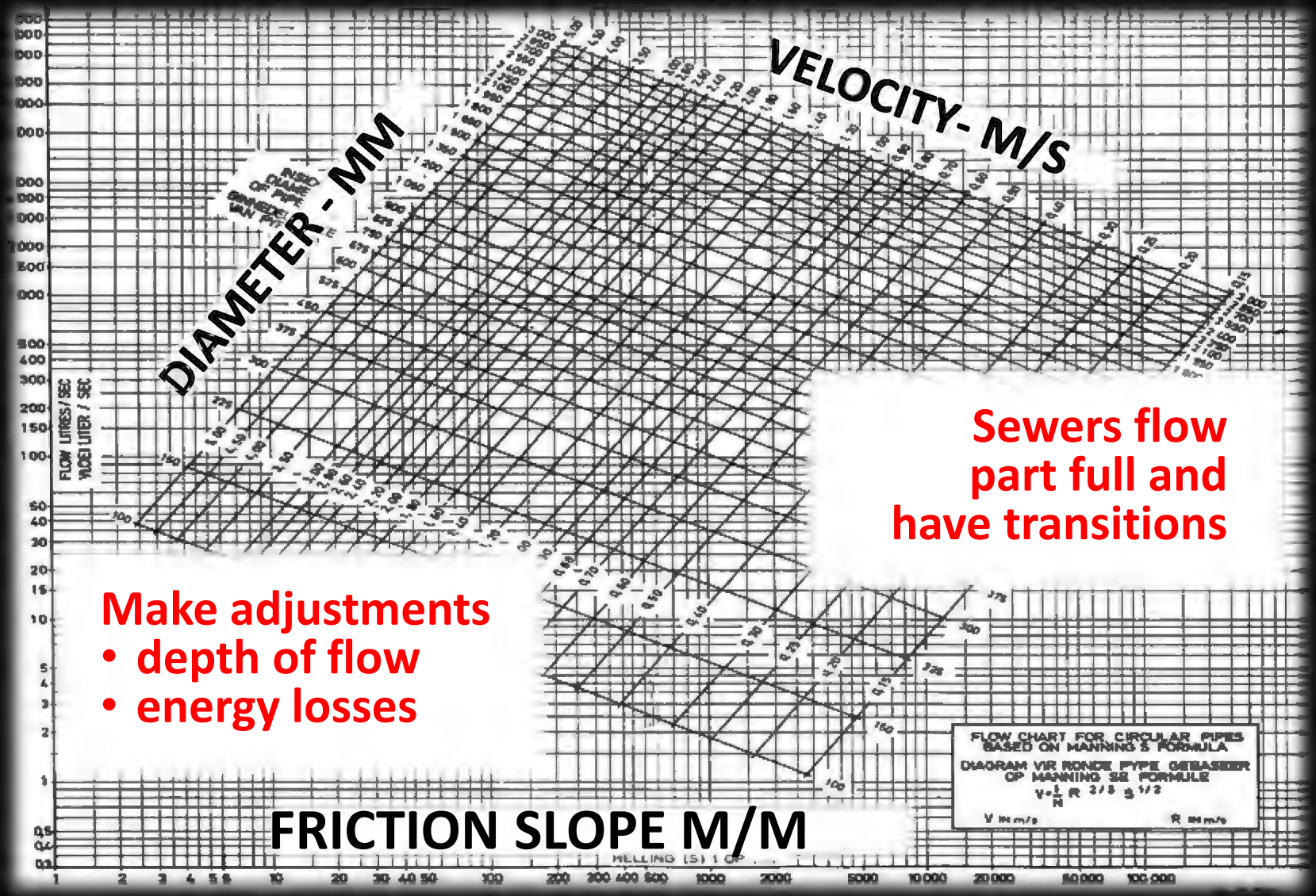
Most significant influence on velocity is roughness

Most significant influence on discharge is diameter

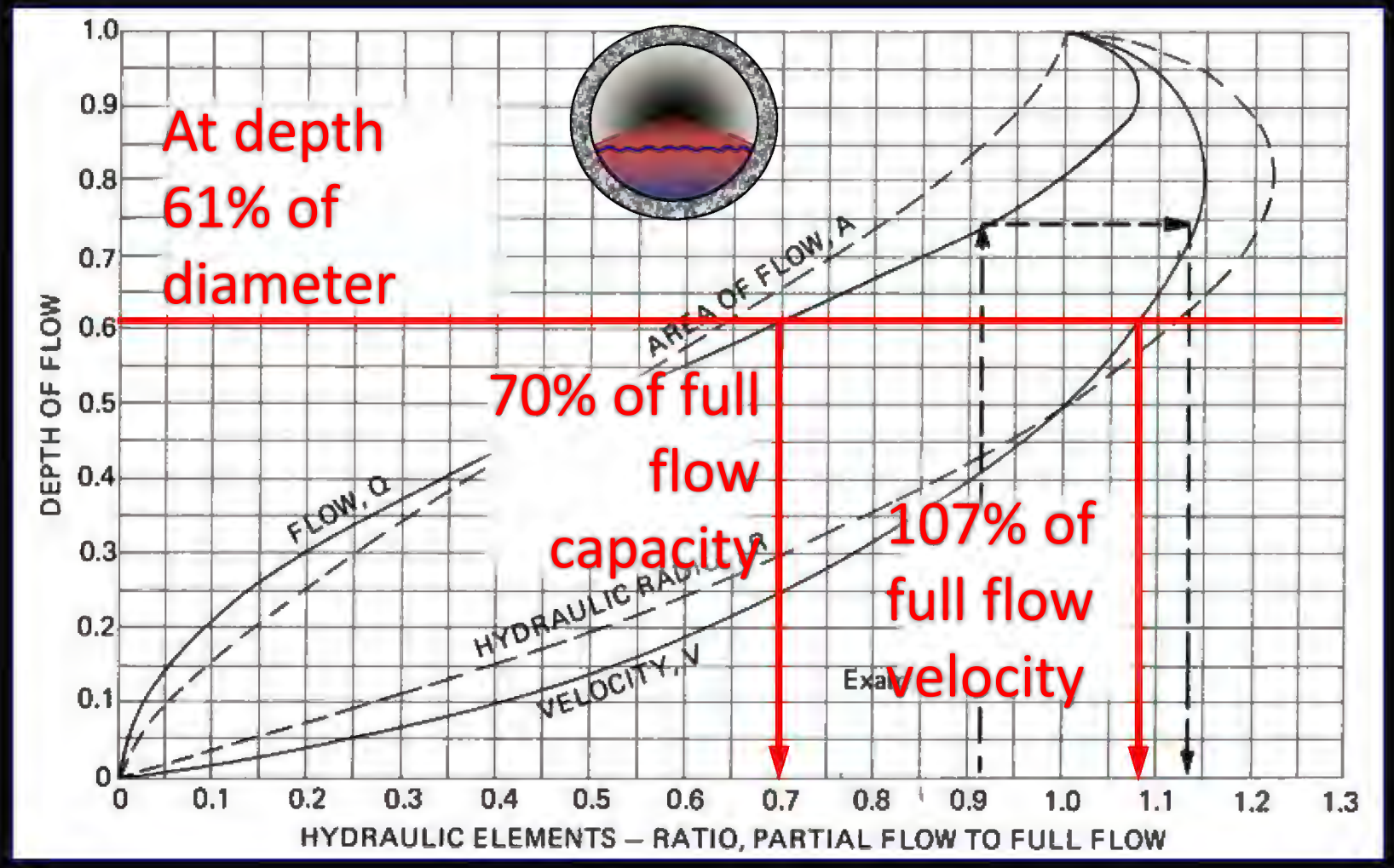
Least significant influence on both is gradient

For sewers roughness determined by the biofilm and the effectiveness of the jointing

PIPE FLOWING FULL



PROPORTIONAL FLOW



HYDRAULIC ELEMENTS:PART/ FULL

FLOW THROUGH SEWERS

Sewers consist of both pipes and manholes

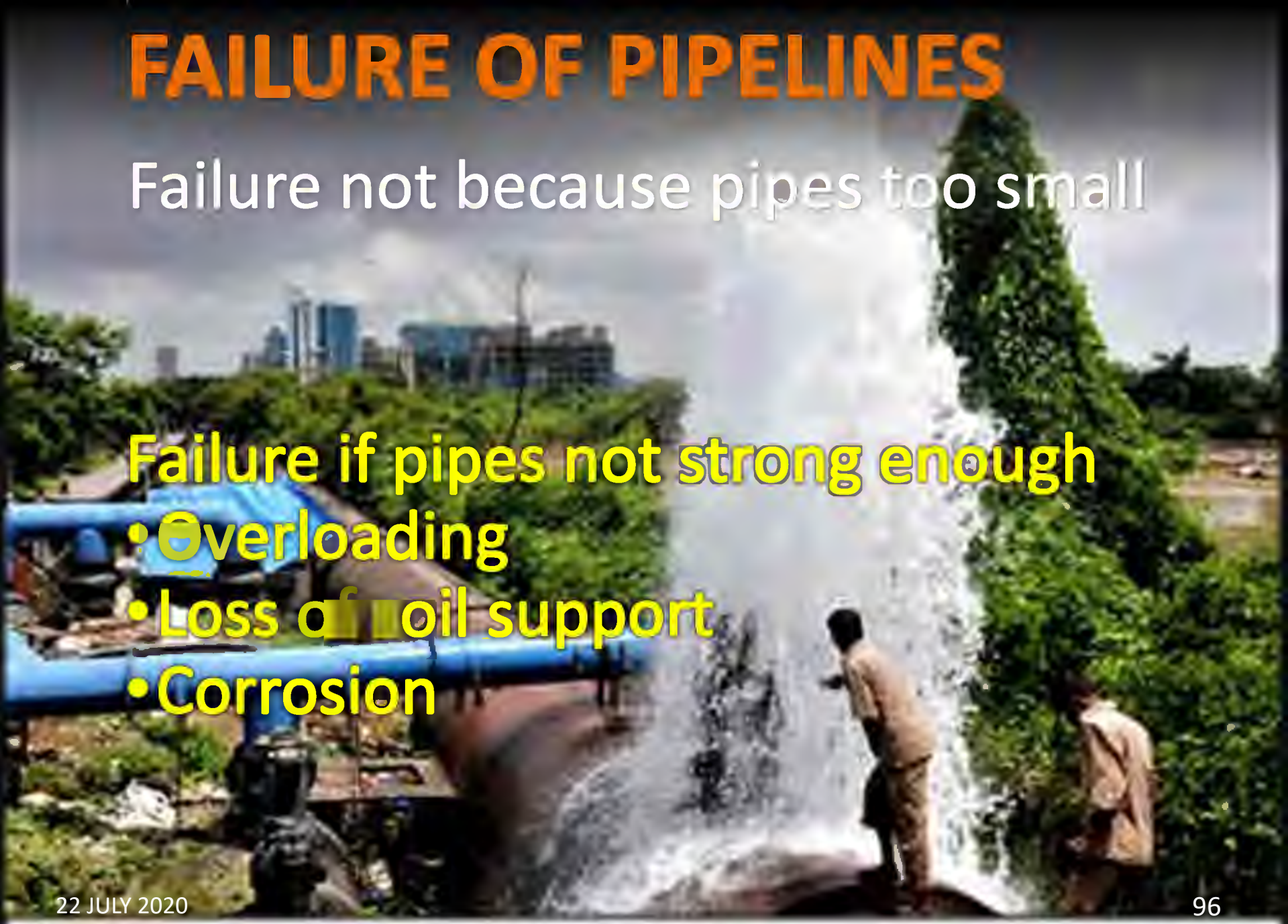
Sewers usually flow as open channels

- both hydraulically long & short sections
- generally treated as hydraulically long
- roughness increased to deal with losses

This may be valid for low velocities but not for the high velocities that can occur in large sewers

FAILURE OF PIPELINES

Failure not because pipes too small



Failure if pipes not strong enough

- Overloading
- Loss of soil support
- Corrosion

STRUCTURAL PERFORMANCE

Primary loads - circumferential loading

- External loads
- Internal pressure

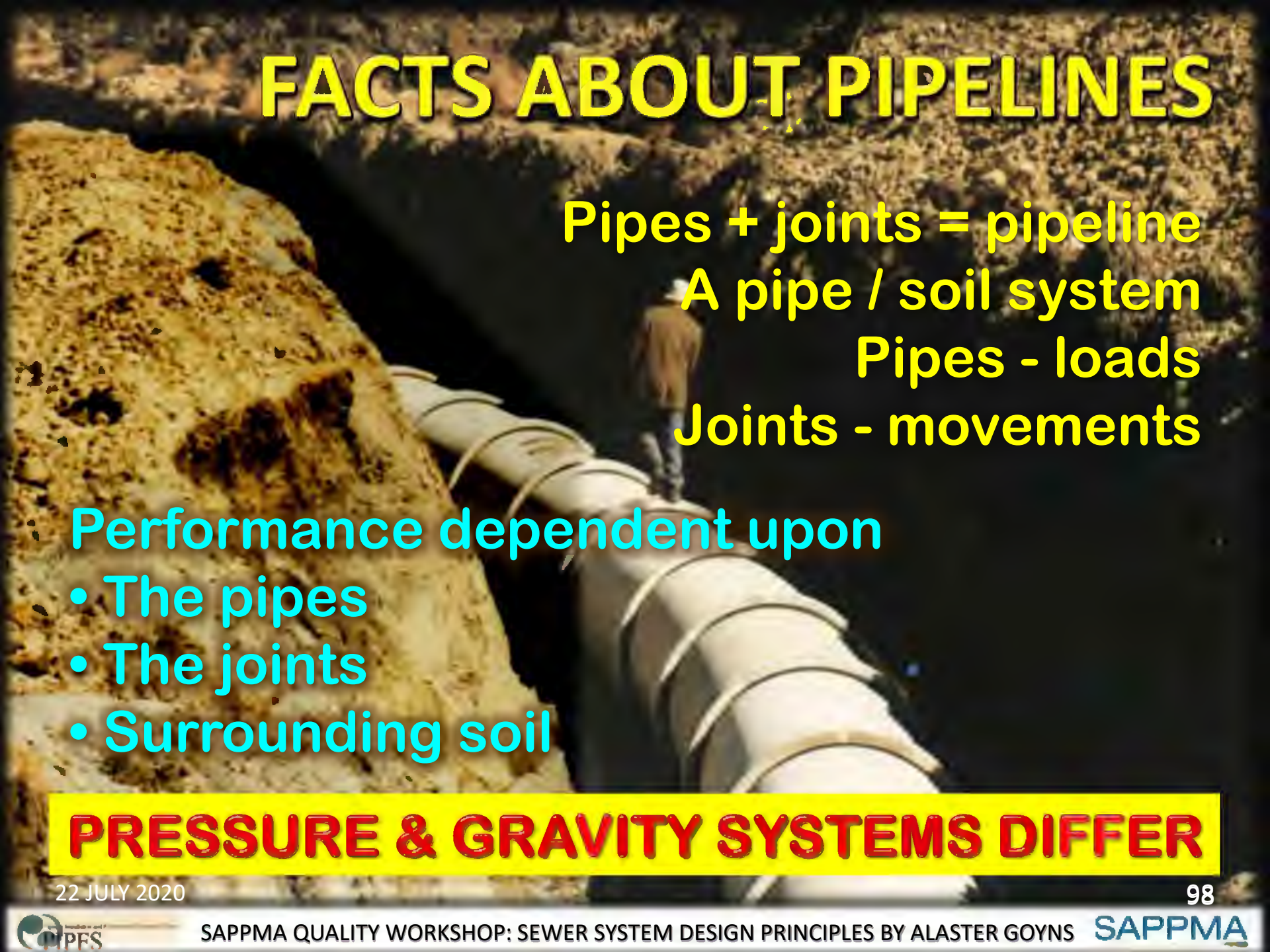
These can be calculated

Secondary loads due soil movements

- Settlement
- Variable water table
- Unexpected events

Difficult to calculate, so estimated

FACTS ABOUT PIPELINES



Pipes + joints = pipeline

A pipe / soil system

Pipes - loads

Joints - movements

Performance dependent upon

- The pipes
- The joints
- Surrounding soil

PRESSURE & GRAVITY SYSTEMS DIFFER

PRESSURE AND GRAVITY SYSTEMS

Pressure pipelines bring us clean fresh water

- Space not so limited
- Can negotiate around other services

Don't follow water courses

- Follow ground profile
- Shallower trenches

Gravity outfalls take away our dirty waste water

- Limited space
- Other services

Follow water courses

- High water table
- Deep trenches
- Variable soils
- Variable foundations

BOTH MUST MEET STRUCTURAL PROPERTIES TO HANDLE LOADS IMPOSED ON THEM

CIRCUMFERENTIAL LOADING

EXTERNAL SQUASH

INTERNAL EXPAND

LINE SQUASH

COMBINED ON SITE

SEPARATED IN FACTORY

SOIL/STRUCTURE INTERACTION

Importance of understanding
- soil/pipe interaction
- pipe behaviour
- soil behaviour
- Site conditions
- Level of design sophistication

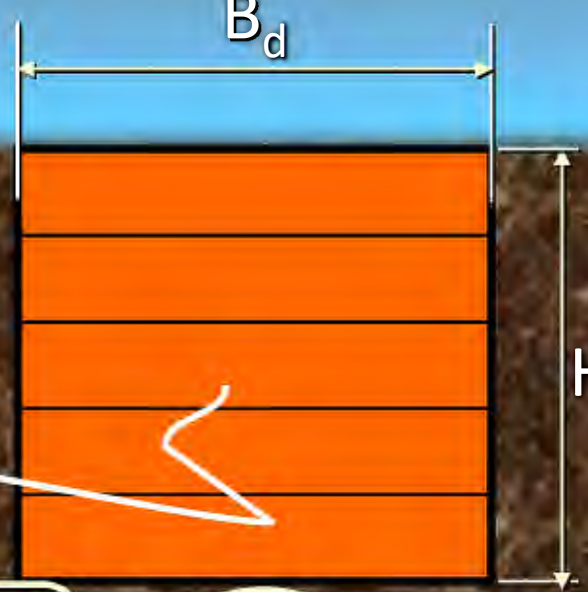
Must base design on actual site conditions

For sustainable pipeline performance must ensure that design requirements are met

Must understand basics facts about pipelines

SIMPLE WAY : DEAD LOADS

Assume material is rigid & frictionless



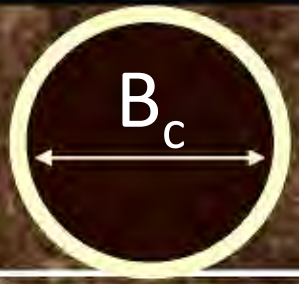
Formation level

Load on pipe
$We = \gamma HB_d$

Material Density
$= \gamma$

Critical plane

Geostatic or prism load



Founding level

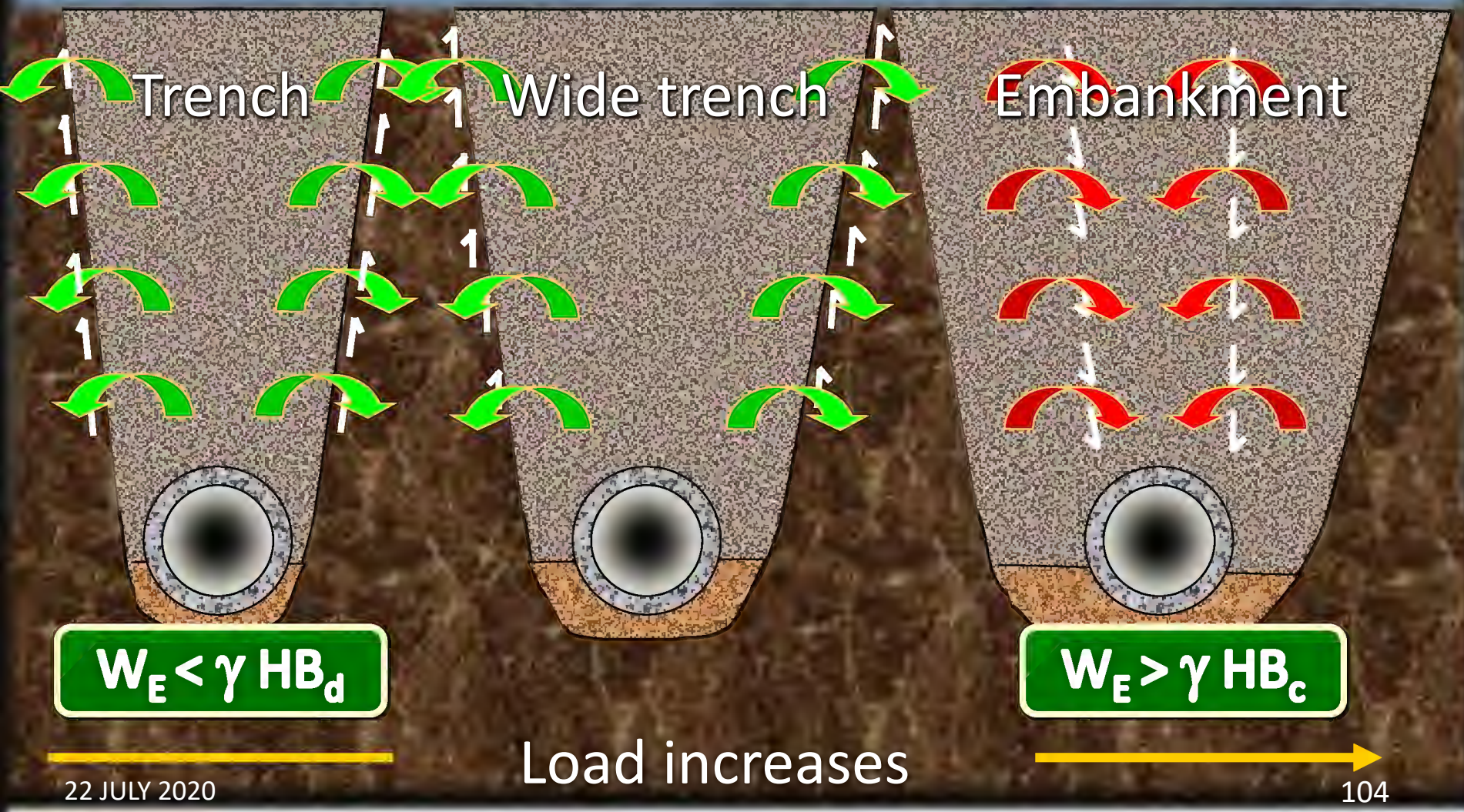
EARTH LOADS ON CONDUIT

EARTH NOT RIGID AND NOT FRICTIONLESS

LOAD ON PIPE $W_E < \gamma H B_d$

INSTALLATION CONDITIONS

Ratio between trench & product widths



HOW DIFFERENT PIPES CARRY LOAD

Initially load that pipe/soil system has to carry is the same

Rigid Pipe

Friction against trench walls

Load shed to trench walls

Pipe keeps its shape

Pipe carries the load

LOAD < γ H B_t

Flexible P

Friction against earth columns

Load shed to earth columns

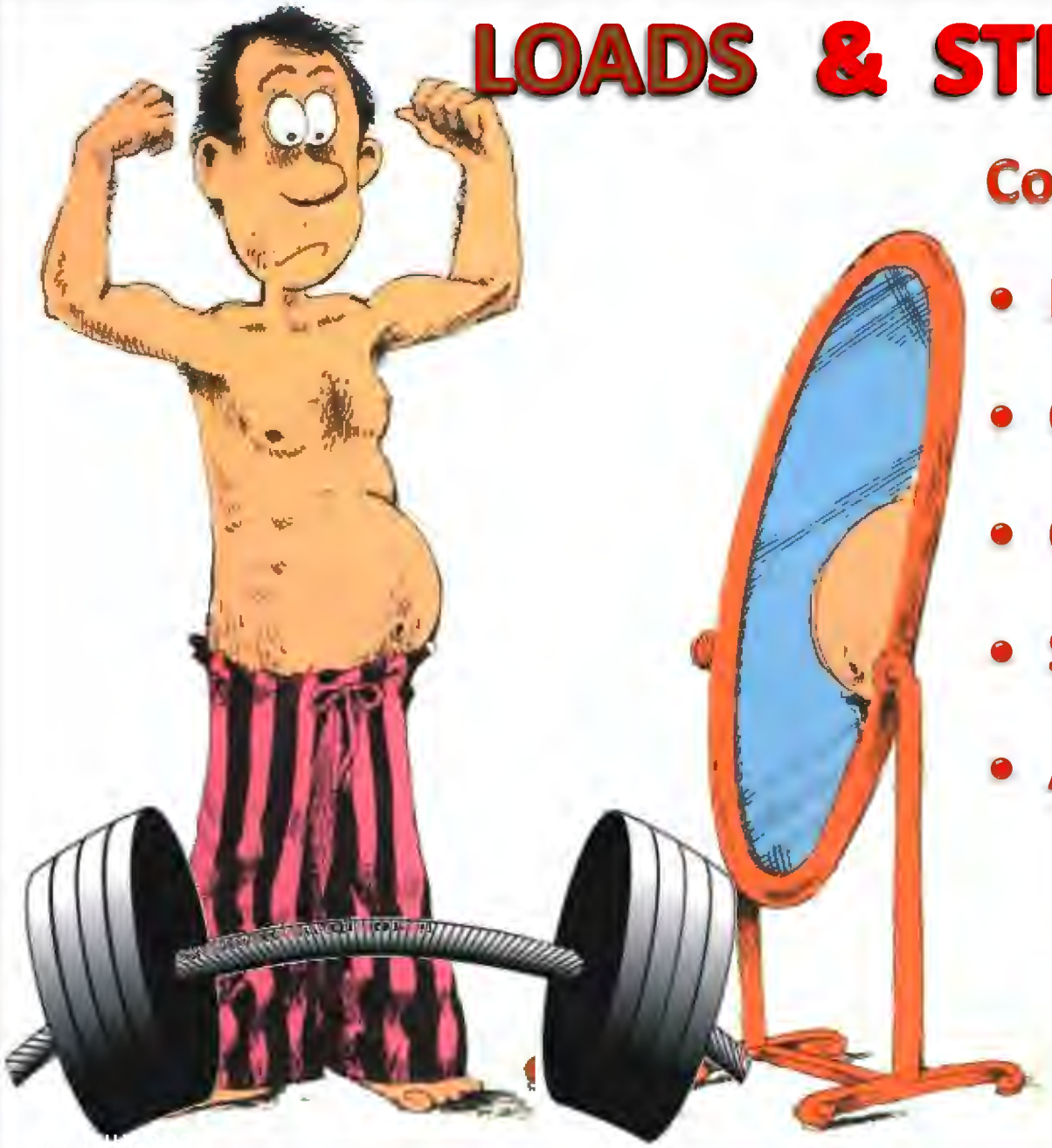
Pipe sheds the load

Pipe deflects

LOAD = γ H B_c

THE FINAL LOAD ON CONDUIT IS SIGNIFICANTLY LESS

LOADS & STRENGTHS



Considerations:

- Loads on conduit
- Conduit strength
- Conduit failure
- Specification
- Actual conditions

WHAT IS MEANT BY FAILURE ?

STRUCTURAL PROPERTIES NEEDED

Load = f(pipe strength and soil strength)

For rigid pipes - Marston
Pipe strength = load / soil strength

For flexible pipes - Spangler (Iowa)
Pipe deflection = load / pipe stiffness + soil stiffness

Marston and Spangler theory 1913- 1941

ESSENTIAL THAT SOIL/PIPE SYSTEM UNDERSTOOD

Must consider installation method - additional loading

- Open trench techniques - just circumferential stresses
- Trenchless techniques - addition longitudinal stresses

NEED FACTORY STRUCTURAL TESTS

For flexible pipes inherent pipe strength is measured by load at 5% deflection in parallel plate test

Pipe stiffness,

$$PS = \frac{F}{\Delta Y} = \frac{EI}{0.149\ R^3}$$

$$PSF = \frac{EI}{R^3} = \text{Pipe stiffness factor}$$

$$PS = \frac{8\ EI}{0.149\ D^3} = 53.69\ \frac{EI}{D^3}$$

$$\frac{EI}{D^3} = \text{Pipe ring stiffness} = S_R;\ \text{So } PS = 53.69\ S_R$$

INTERESTED IN DEFLECTION WHEN PIPE INSTALLED, SO THESE MUST MODEL INSTALLED CONDITIONS

THE DISADVANTAGED NEED AND DEMAND WATER

HOW CAN WE AS PROVIDERS MEET THESE NEEDS ?

22 JULY 2020

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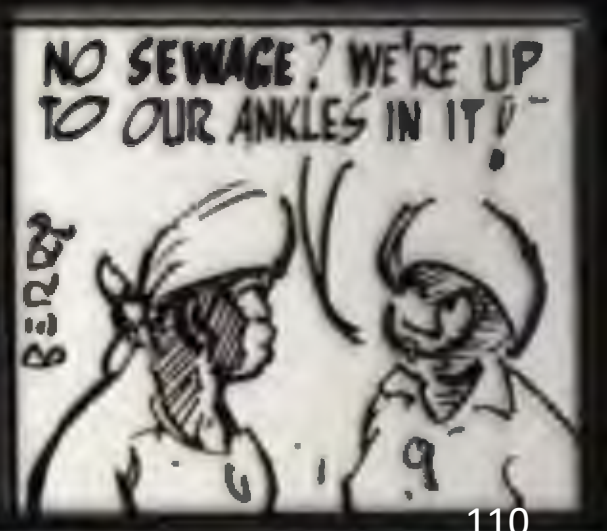
MUST ADDRESS THE QUALITY ISSUE

INITIAL ACCEPTIBILITY ON BASIS OF LOWEST COST IS JUST NOT GOOD ENOUGH



SERVICES MUST
BE RELIABLE
STAY RELIABLE
AND BE SUSTAINABLE

CONSIDER THAT THE HOLES . . . ARE THE ASSETS

Pipes make sure that the assets perform effectively and efficiently so that they:

- convey the required amount of liquid
- do not leak
- do not collapse
- keep on performing their function

Need to understand purpose of holes before making decisions about the pipes to go inside them . . . . . or making decisions about how to fix old ones.

To address service backlog:
1. Install new pipelines
2. Rehabilitate old pipelines

Adopt a realistic approach to effectively provide water services


"It is health
that is real wealth"
Mahatma Gandhi
Healthy water supply and disposal systems
provide primary health care
And we as designers/providers
can help South Africa achieve this

Questions and Answers

Alaster Goyns

Pipeline Installation and Professional Engineering Services
PIPES

SAPPMA

Sewer Systems

Sewer condition assessment & rehabilitation

Johann Wessels

Johann Wessels is a registered professional engineer specialising in alternative sewer pipe materials and the effective utilization of alternative construction techniques.

SAPPMA

SASTT SOUTHERN AFRICAN SOCIETY FOR TRENCHLESS TECHNOLOGY

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southern african plastic pipe manufacturers association

SEWER SYSTEMS

QUALITY WORKSHOP IV

22 July 2020

SASTT SOUTHERN AFRICAN SOCIETY FOR TRENCHLESS TECHNOLOGY

Johann Wessels/
Deon Vos

PIPE SYSTEM CONDITION ASSESSMENT AND REHABILITATION

Presentation will have 6 Parts:

1: Introduction

2: Trenchless technology for construction of new services

3: Trenchless technology for rehabilitation of services

4: Motivation for condition assessment

5: Condition assessment of networks with analogue CCTV(Close circuit television) and rehabilitation

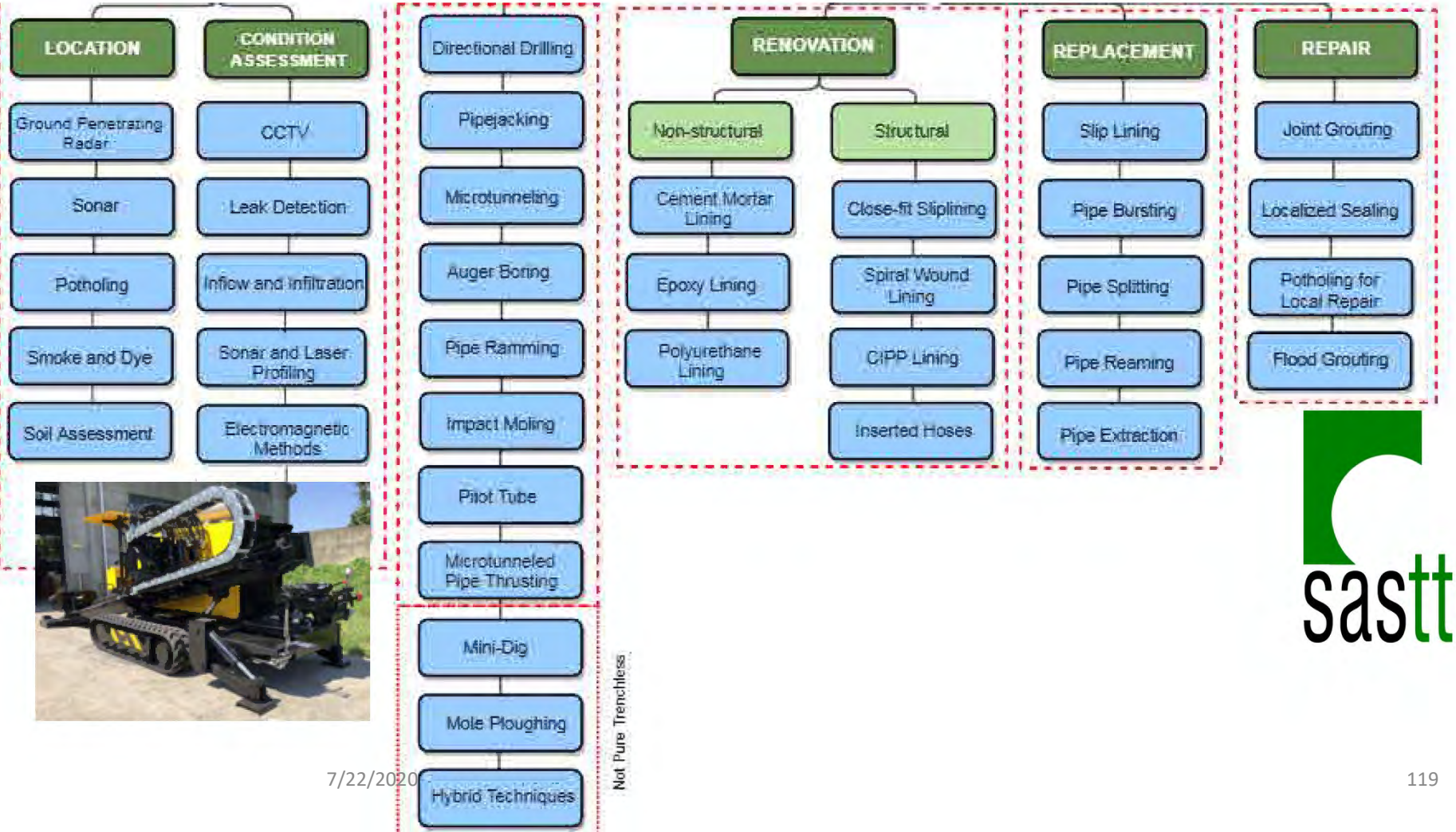
6: Condition assessment of outfalls with multisensor inspections and renovation

Part 1: INTRODUCTION: DEFINITION OF TRENCHLESS TECHNOLOGY

Trenchless technology (TT) is technology for the servicing, rehabilitation and replacement of existing, and the construction of new, public utilities and other services underground without the digging of trenches,

It includes the development of all kinds of underground mapping techniques, tunnelling devices and specialist machinery, materials and equipment.

ISTT GUIDELINES



sastt

You can find the Guidelines on the ISTT website. (You will have to join if not already a member)

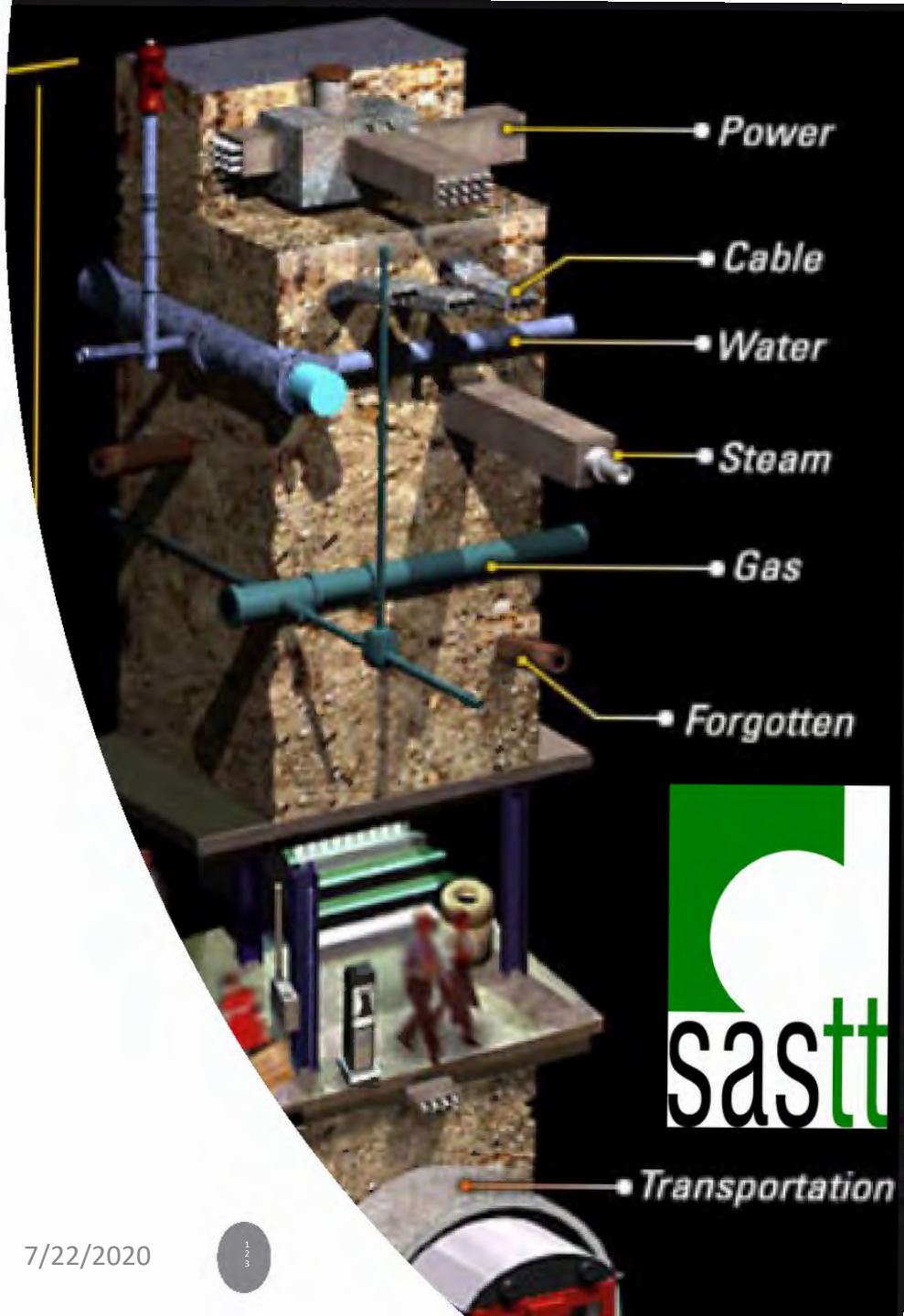
It is interactive and will explain, with pictures, what each technology is all about..

Part 2: TRENCHLESS CONSTRUCTION METHODS AVAILABLE IN IN SOUTH AFRICA

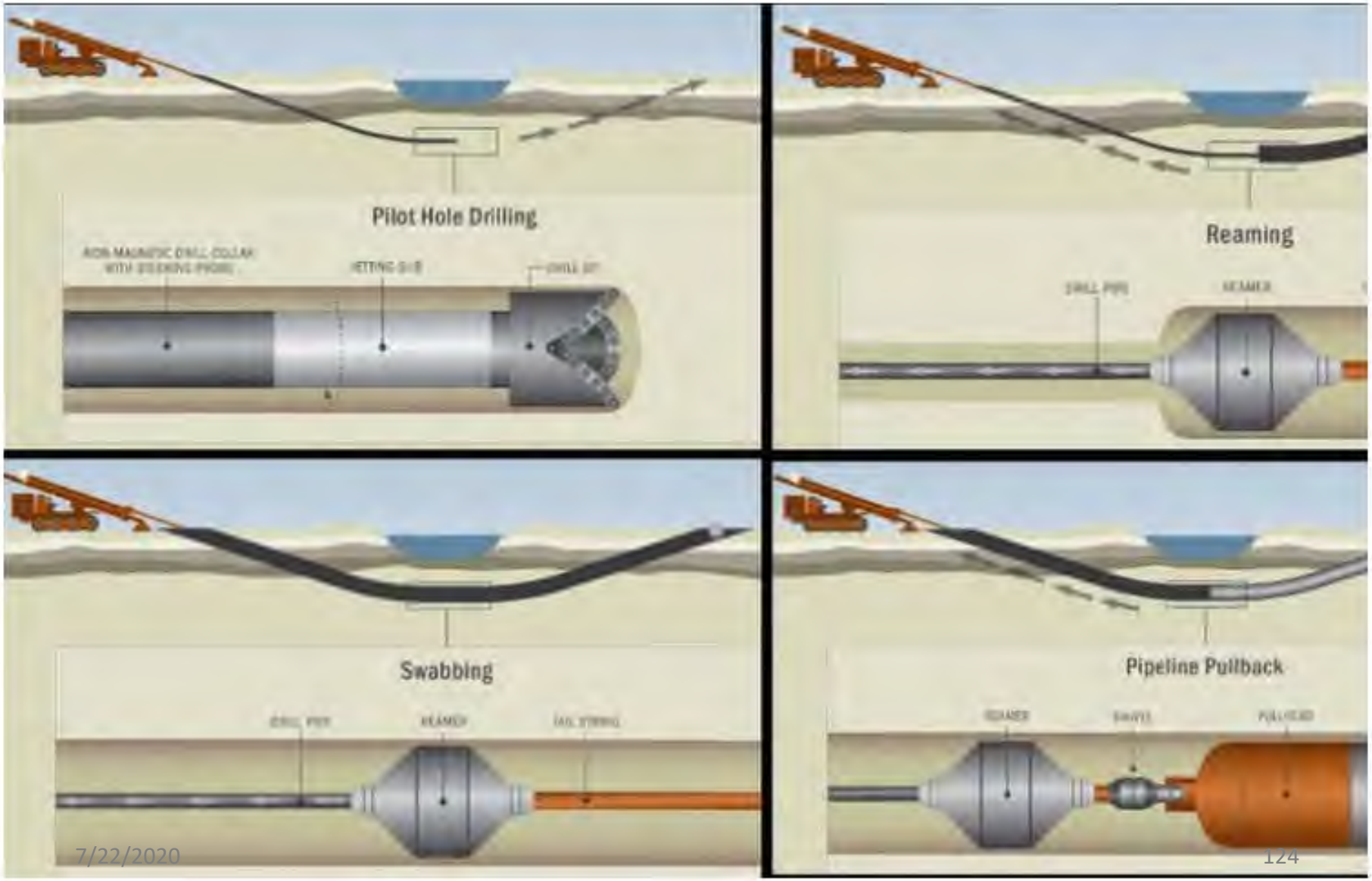
sastt

Horizontal Directional Drilling.

HDD can go underneath existing roads or rivers or in-between existing services to drill a new position, increase the diameter by back reaming, and pulling in the delivery pipe.



Schematic Diagram of HD

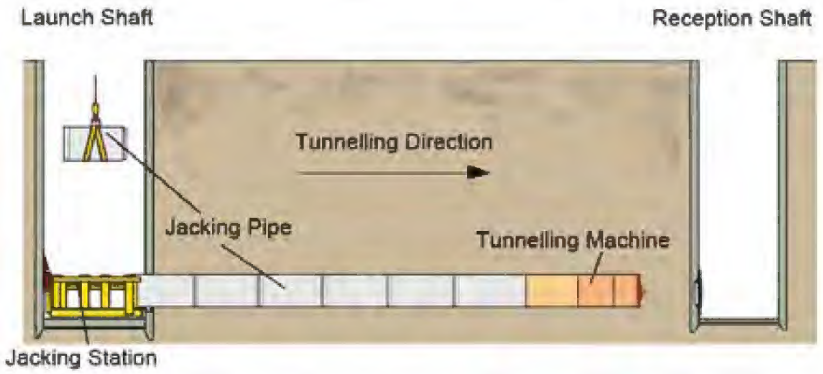


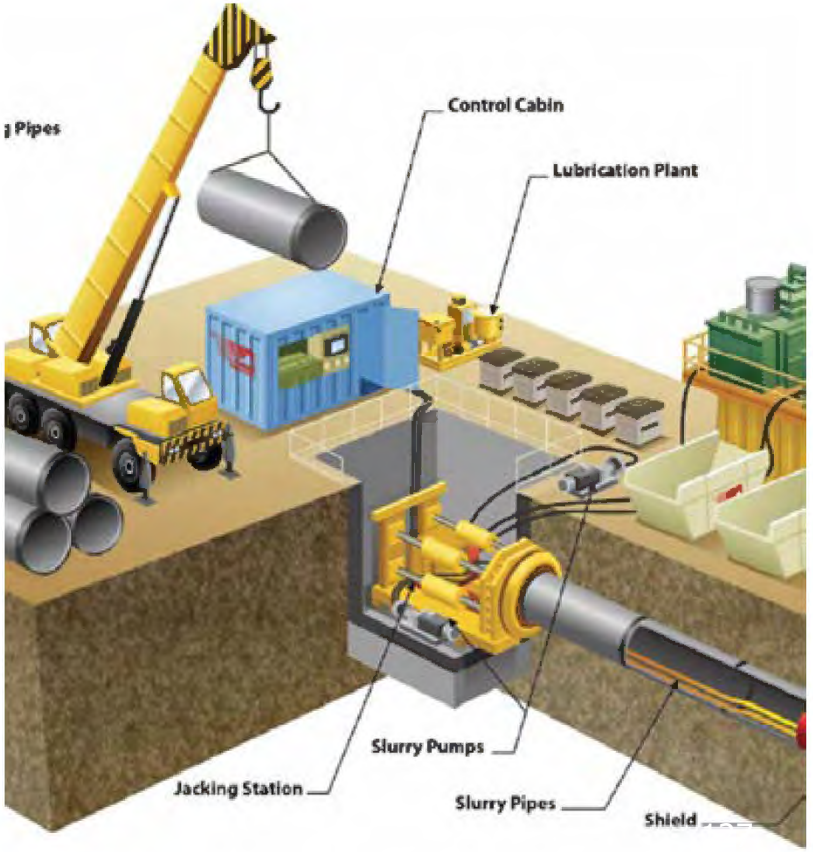
Pipe Jacking

Note that man access is required, therefore only large diameter pipes or culverts are installed.

Micro Tunnelling

There is a tunneling machine in front and pipe sections are added behind as the work is progressing..
For control purposes a laser projected through the pipe on a target behind is utilized.





Auger boring

It is important to note that the setup must be very good- the process is not steerable at all.

- Old technology
- Installation of a steel sleeve 100 - 1000mmø
- Steel casing is jacked simultaneously from the drive pit during excavation
- After installation of the new service in the steel sleeve, the annulus is commonly grouted up
- Restricted by geology
- Essentially non-steerable
- Cost effective

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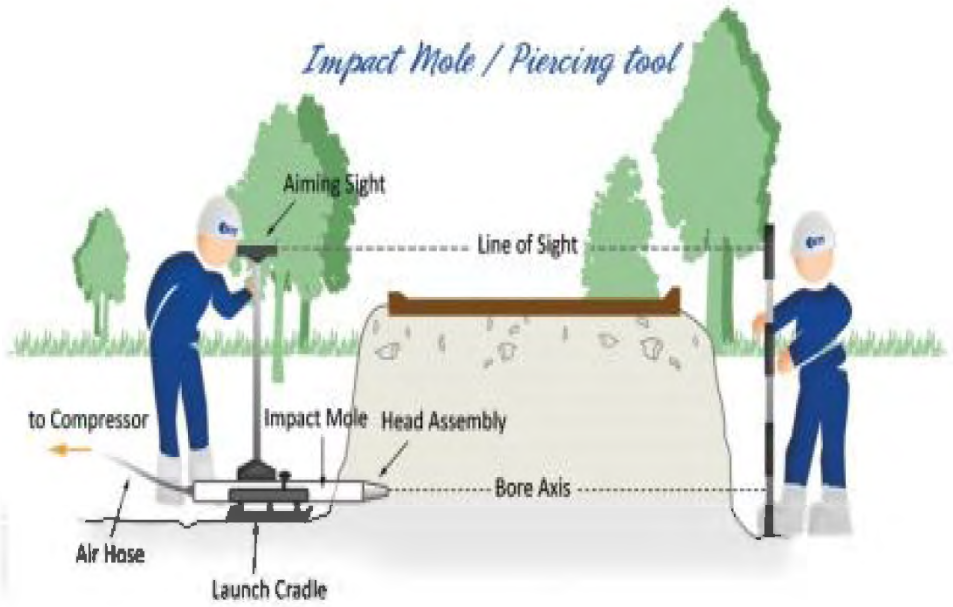
Pipe Ramming

Old technique- the correct setup is very important as the technique is not steerable.

- Old technology
- Installation of a steel sleeve 100 – 1000 mmø
- Steel casing is jacked simultaneously from the drive pit during excavation
- After installation of the new service in the steel sleeve, the annulus is commonly grouted up
- Restricted by geology
- Essentially non-steerable
- Cost effective

Earth Piercing tool/ Impact Moling
Again: the correct setup is very important as the technique is not steerable

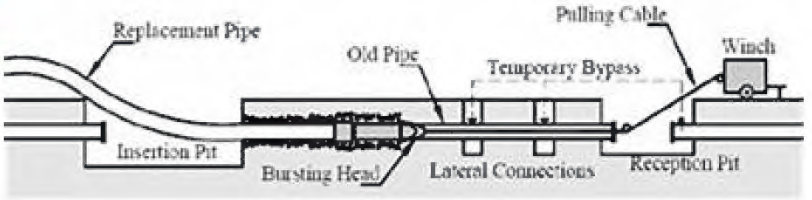


- Widely used
- Installation of small diameter conduits
- Soil displacement by impact using percussion (pneumatically driven)
- The new conduit is normally drawn in behind the mole

Part 3: REHABILITATION METHODS FOR EXISTING SERVICES

Pipe Bursting

(The ability to upsize after destroying the old pipe is a unique ability of this technique, which is very useful)



Cured-In-Place (CIPP) Relining

- **Inserting the inverted IPP lining (using water, air pressure or steam)**
- **Curing the CIPP once it is in place by circulating hot water or steam or pulling through a UV lighting unit**

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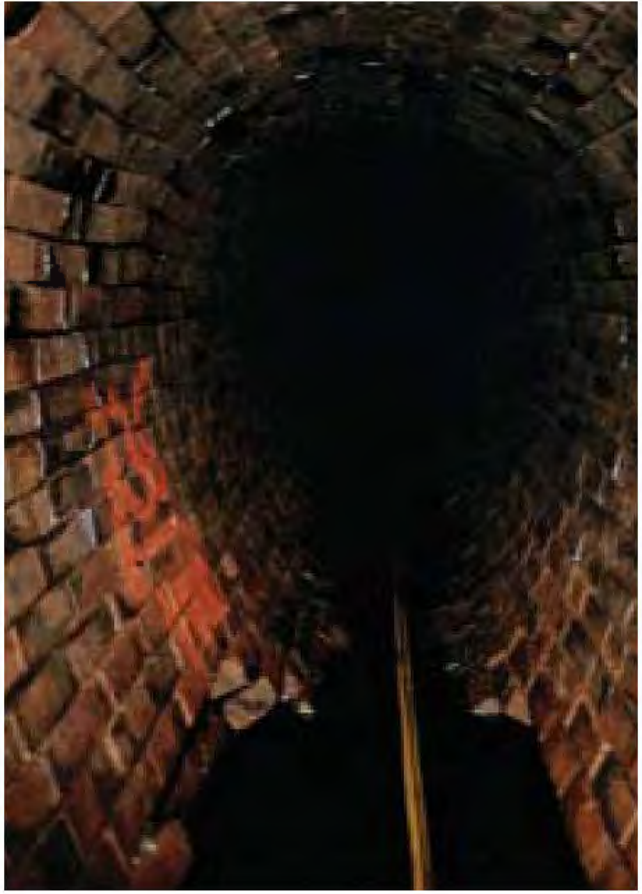


Cured in place pipe (CIPP)

Slip lining – Segmental

(The replacement conduit is specially manufactured for the purpose- in this case lining an egg-shaped conduit)

Spirally Wound Lining

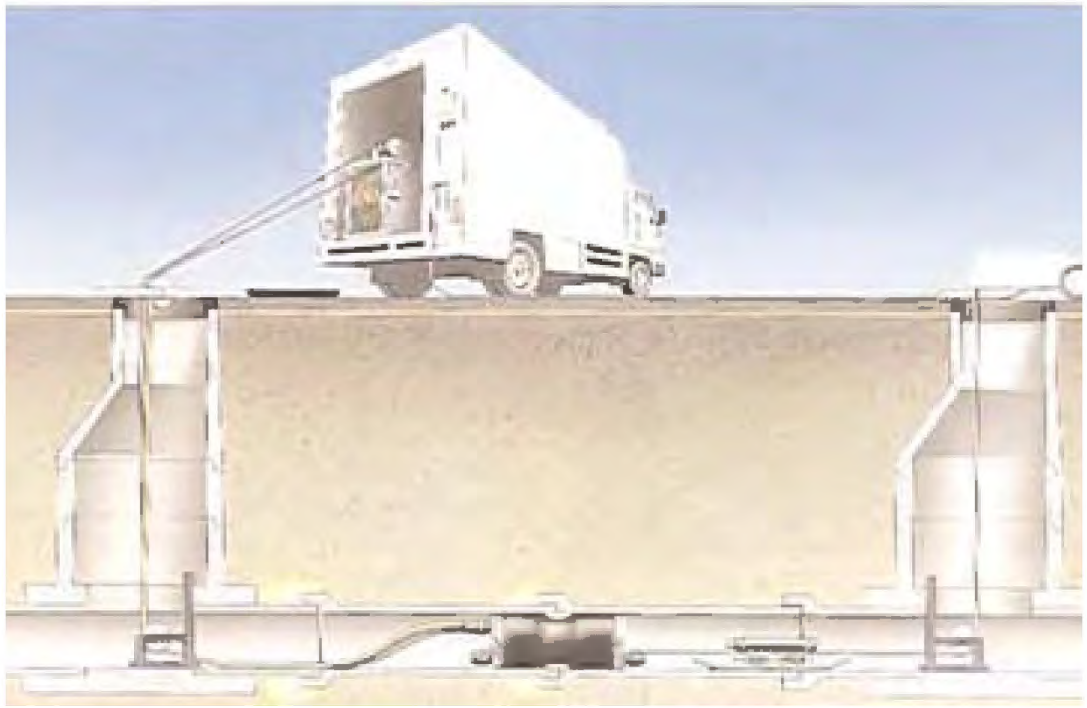
(The materials come in big rolls wherefrom it is winded down and joined inside the conduit. Man entry is needed)

Only suitable for larger Ø pipes and ducts

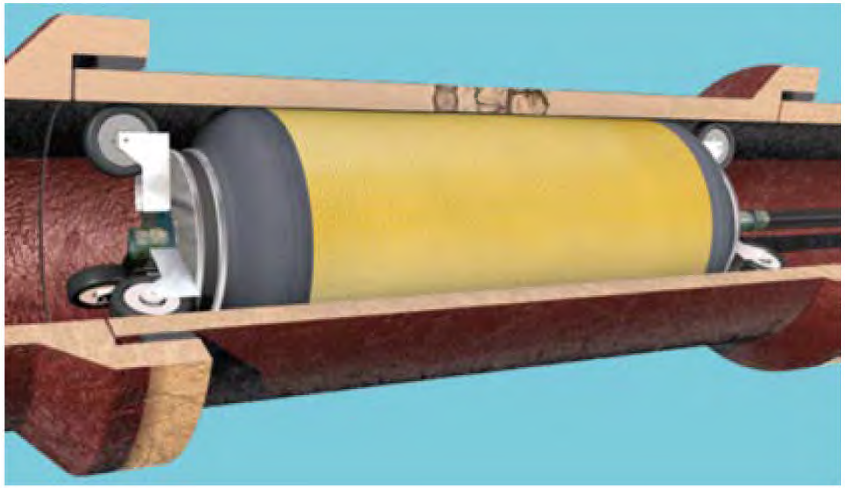
Pipe is installed and can then be fusion welded or chemically sealed

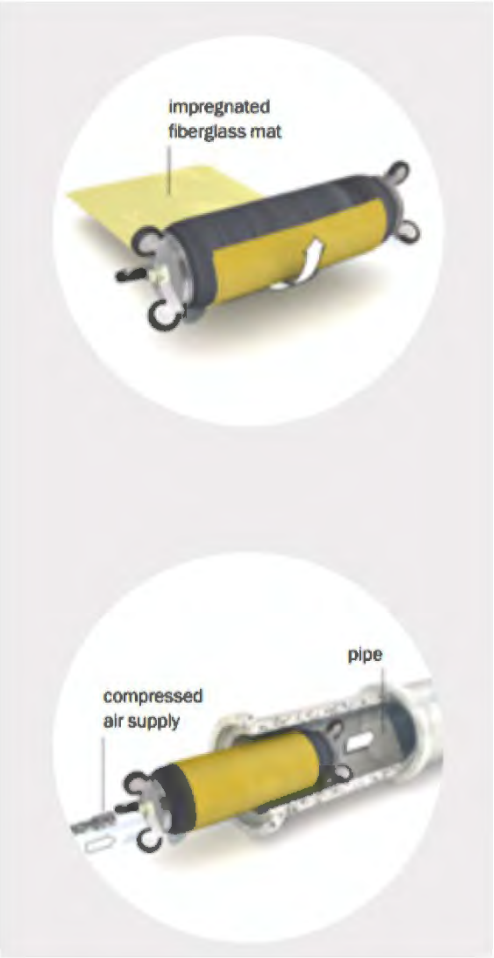
Localized Point Repair to Pipelines

(Repair piece is wetted out with epoxy, placed on a Vetter bag and pulled in place and inflated, then cured)



Point Repairs





A fiberglass mat is impregnated with resin according to a set method, then folded and wrapped around the prepared foil-protected packer.

The pre-assembled repair assembly is introduced into the pipe section with the help of air push rods or pulled in place with a rope.

Close Fit Slip lining

(A distinction should be made between „tight fit" (Fold Down) and „interference fit" (Swage Lining). In last-mentioned case the diameter is temporarily reduced, then pulled in. The pipe then tries to resume the original size, causing a very tight fit.)

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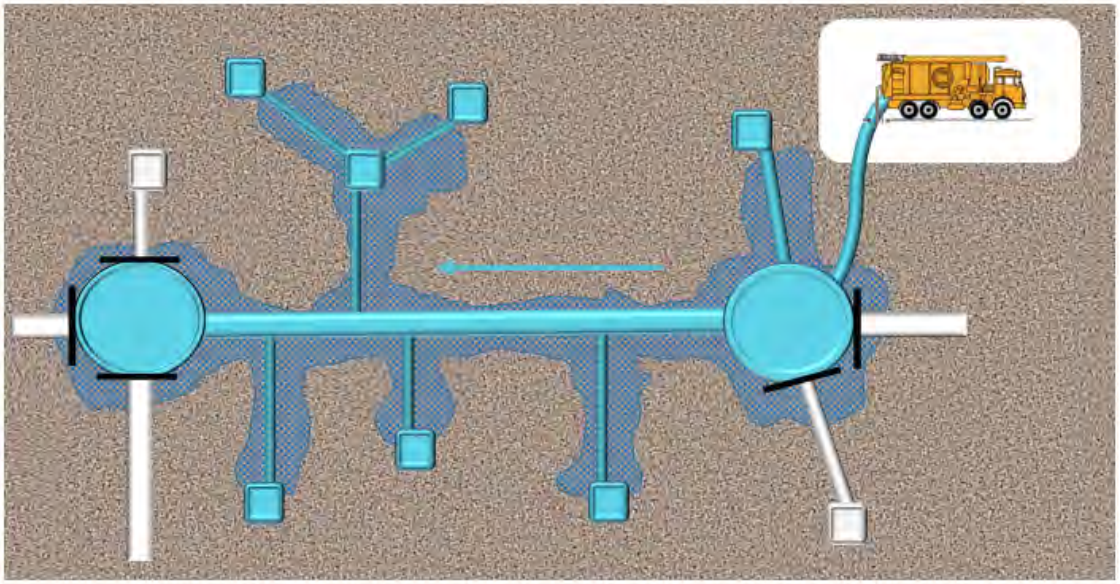


Flood grouting for sewer rehabilitation

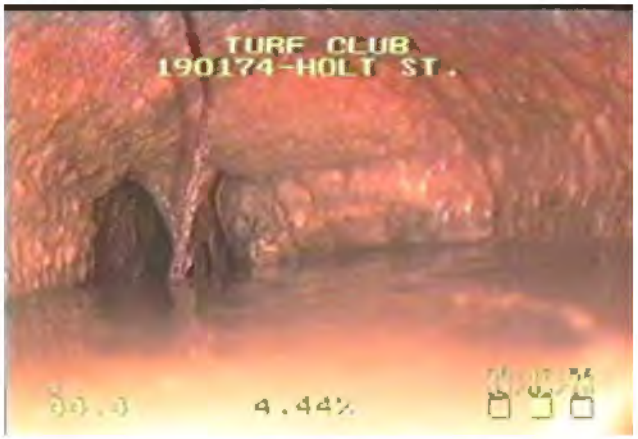
- The fluid is introduced to the pipe by way of sealing off manholes before and after a section to be sealed and filling the manholes with the liquid which will seep through cracks and solidify

Part 4: MOTIVATION FOR CONDITION ASSESSMENT AND REHABILITATION

The customers demand effective service delivery at the lowest cost! One has to understand the needs and capabilities of available techniques and put it together. Overflowing sewers are due to lack of capacity and stormwater ingress, but the overall situation is made worse by..

sastt

Poor physical condition



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Fat build up..

Tree root infiltration

Extreme axial root intrusion

Infiltration causing cavities…

Why specifically trenchless replacement?

Open excavation replacement can cost up to seven times as much as trenchless replacement! And that is not even including the cost of blockage removal and the cost of purification of storm water ingress or infiltrated water!

For Tshwane the issue was forced there was no other option!

A collapsed pitch fiber sewer in Hermanstad had to be replaced: It was under a thick concrete slab, next to a high wall and under piles of car wrecks. I decided to replace by pipe bursting (it was a fairly new technology in South Africa at the time, which was 1987) …

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ICS › 23 › 23.040 › 23.040.01

ISO 11295:2017

Classification and information on design and applications of plastics piping systems used for renovation and replacement

This document provides information and requirements for each of the steps:

1	Investigation of functional performance of the existing pipeline	Clause 6
2	Condition assessment of performance against set requirements	
3	Measures to control risks / pipeline rehabilitation	
4	Pre selection of suitable types of rehabilitation techniques	Clause 7
5	Project specification	Clause 8
6	Selection of technique / installer	
7	Application of rehabilitation technique	Clause 9
8	Acceptance control	
9	Documentation of the rehabilitation process	Clause 10

There's a window of opportunity for replacing sewers using trenchless methods instead of open excavation!

If you do nothing they might collapse and you will be forced to replace them by open excavation, quite possibly at great expense!

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Part 5: CONDITION ASSESSMENT ON PIPE NETWORKS WITH CCTV INSPECTIONS:

Aim at 100% coverage, with repetitions and contract incentives 90% plus is possible.

Use must be made of:

- **CCTV inspections to determine the condition of pipes.**
- **But also taking into consideration:**
- **Flow Analysis data.**
- **Maintenance data.**
- **Storm water transgression data and complaints from the public and Councilors.**

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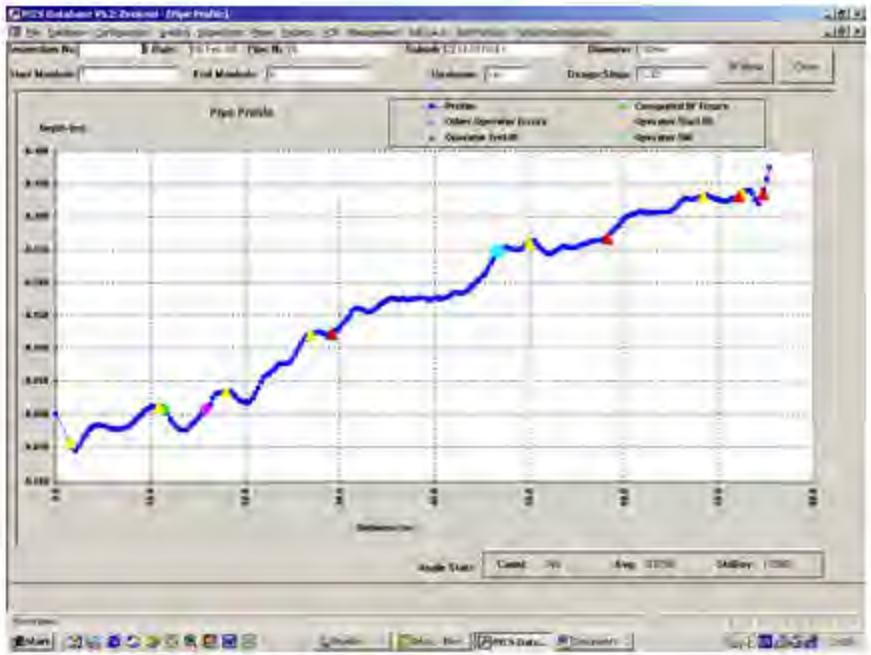
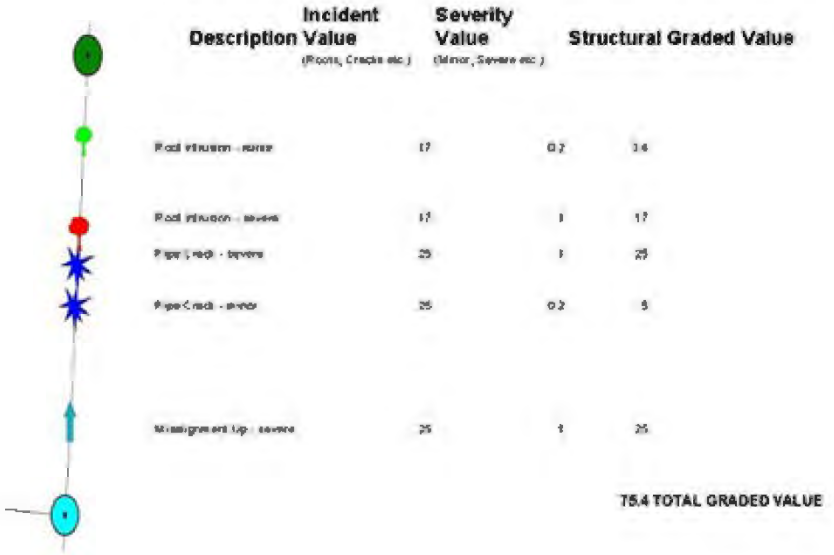
Pipeline profile:

Checking on the pipe slope.



How grading works:

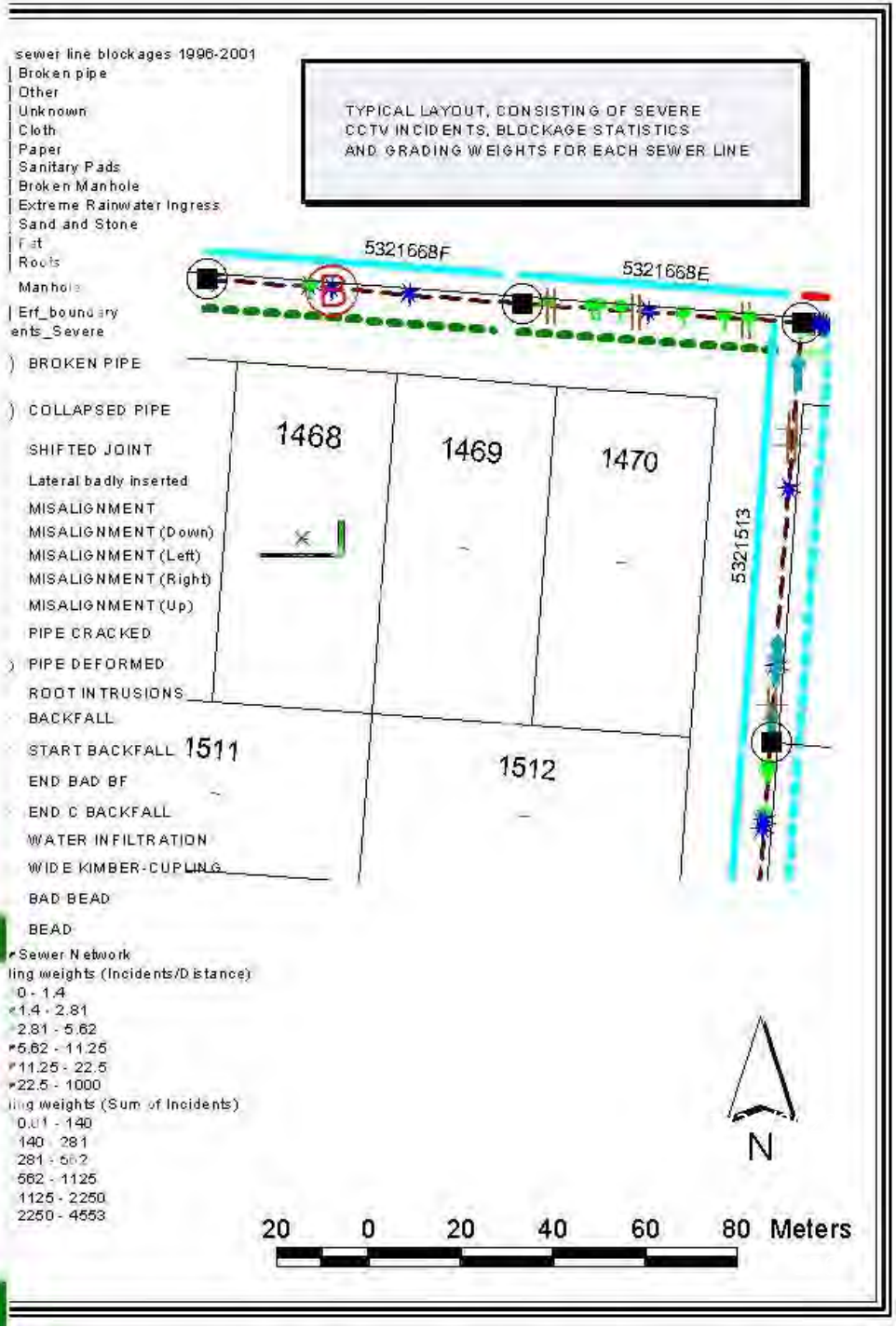


Description	Incident Value (Roots, Cracks etc.)	Severity Value (Minor, Severe etc.)	Structural Graded Value
Root intrusion - minor	17	0.2	3.4
Root intrusion - severe	17	1	17
Pipe Crack - severe	25	1	25
Pipe Crack - minor	25	0.2	5
Misalignment Up - severe	25	1	25

75.4 TOTAL GRADED VALUE

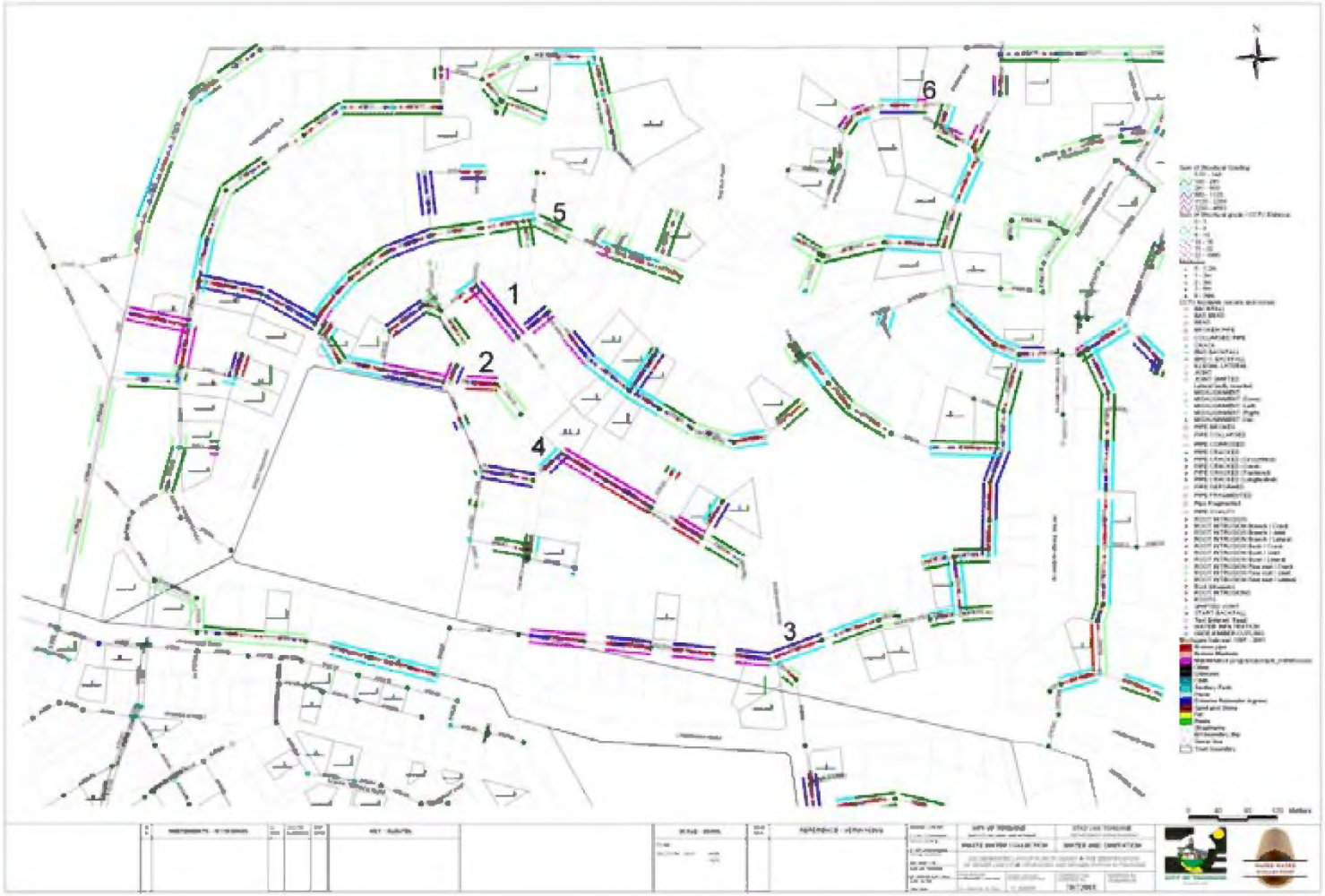
7/22/2020

Grading Plan Explanation



Example Plan with 6 different cases:

Note that we are looking for pipes with a grading weight over 600. Over an average of 60m that means more than 10 grading points per meter.



1+2

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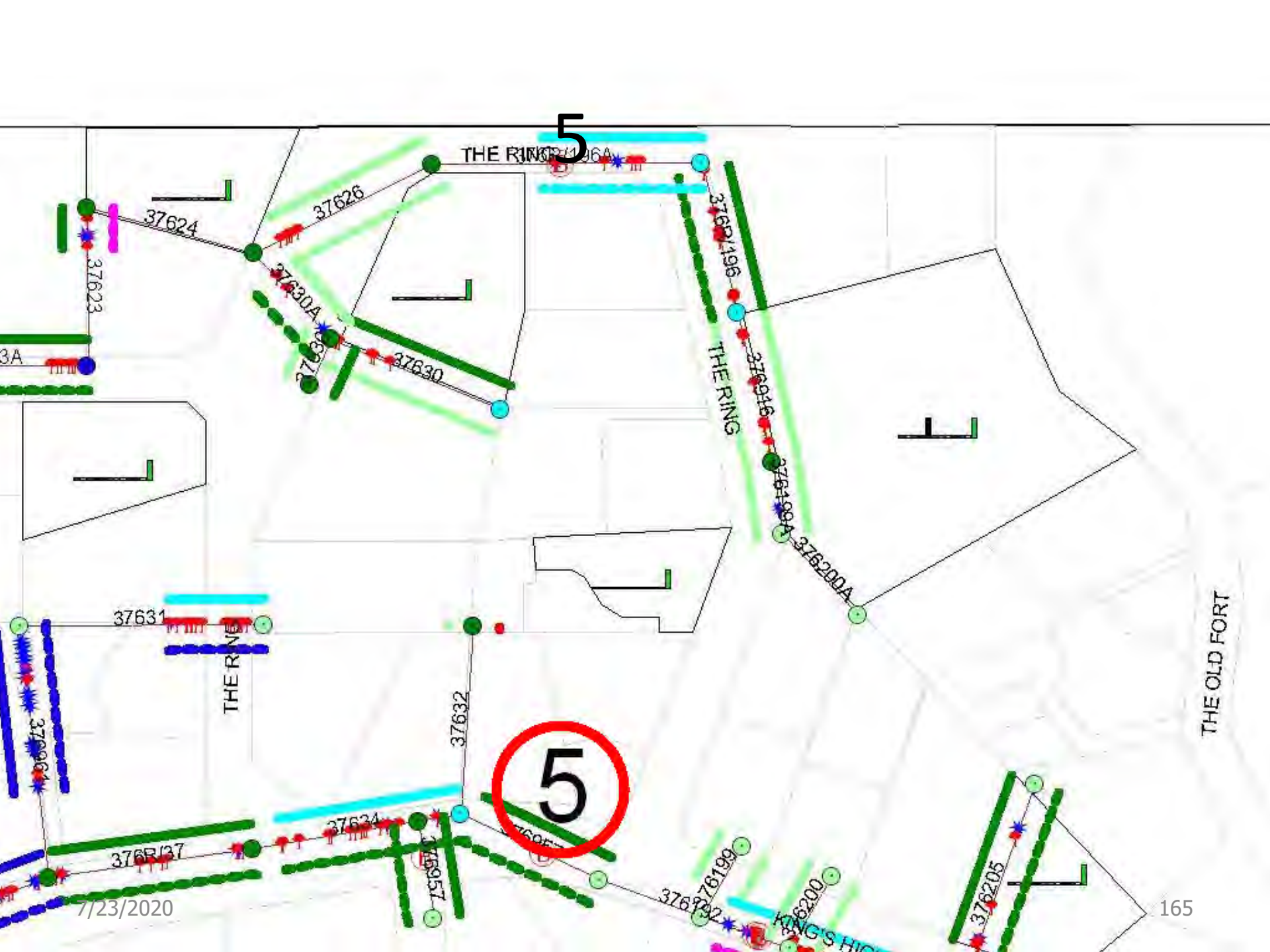
376130
ROSEMARY ROAD
3
376164
376165
376162
QUEENS CRESCENT
376174
376175
376153
376155
376158
376956
LYNNWOOD ROAD
376959


7
4
4
37699
376114
376115
37699
THE LINK
37698
37696A
37696
376116
376118
376128
DIANA
37694
37692
376141
376142
376129
37691
CHURCH AVE


5
THE RING
37624
37626
37623
37630A
37630
37631
THE RING
37632
5
37634
376R37
376199
376200
376205
THE OLD FORT

6


6
3761/218
376248
NORTH SIDE
376254
376250
NORTH SIDE
376215
376214
376213
376211
376209
STRUBENKOP
376219
376219
376220
376252
376253
STRUBENKOP

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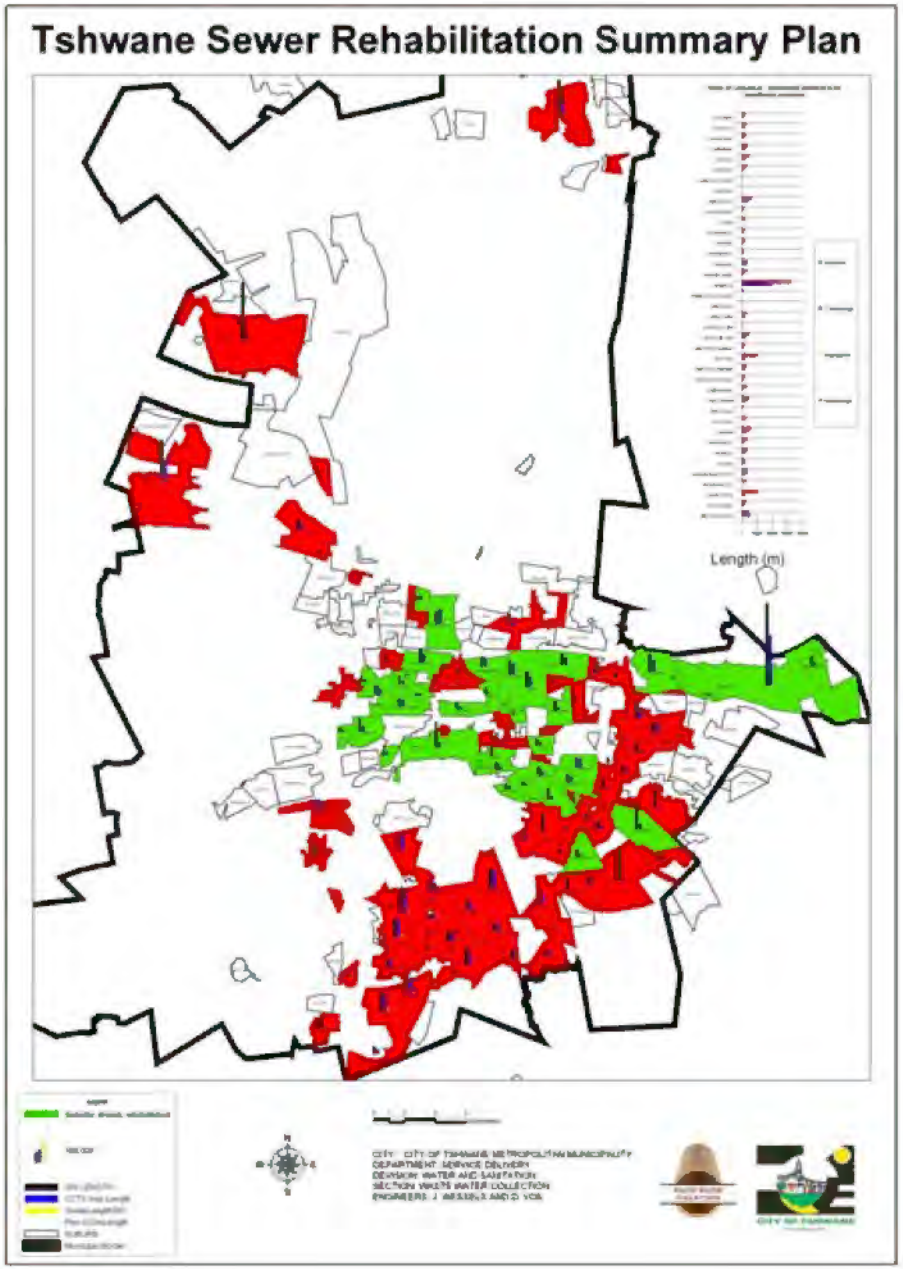
7/22/2020



This plan is used for overall control. The red shows where CCTV and cleaning has been done and the green means rehabilitation has been done. The bars on each suburb: black GIS (Geographical information system) length, blue CCTV done, yellow replacement/ rehabilitation still to be done and white : replacement/ rehabilitation completed.

Blockages before, during and after the contract controls the effectiveness of selection and the quality of the contractor's work. This plan should be done at the end of the retention period.

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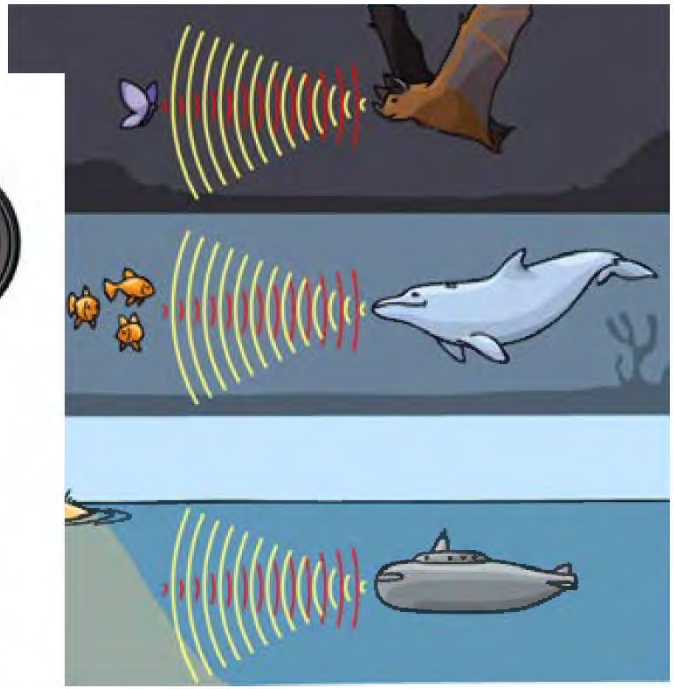
Part 6: CONDITION ASSESSMENT ON OUTFALL SEWERS:

Where:
(Risk) x (Rand value of failure)
= huge!

Condition assessment and prioritization on outfall sewers is even more important than on networks but the technology is different: Multi sensor inspections with laser above waterline augmented by sonar below as well as a digital camera apply.



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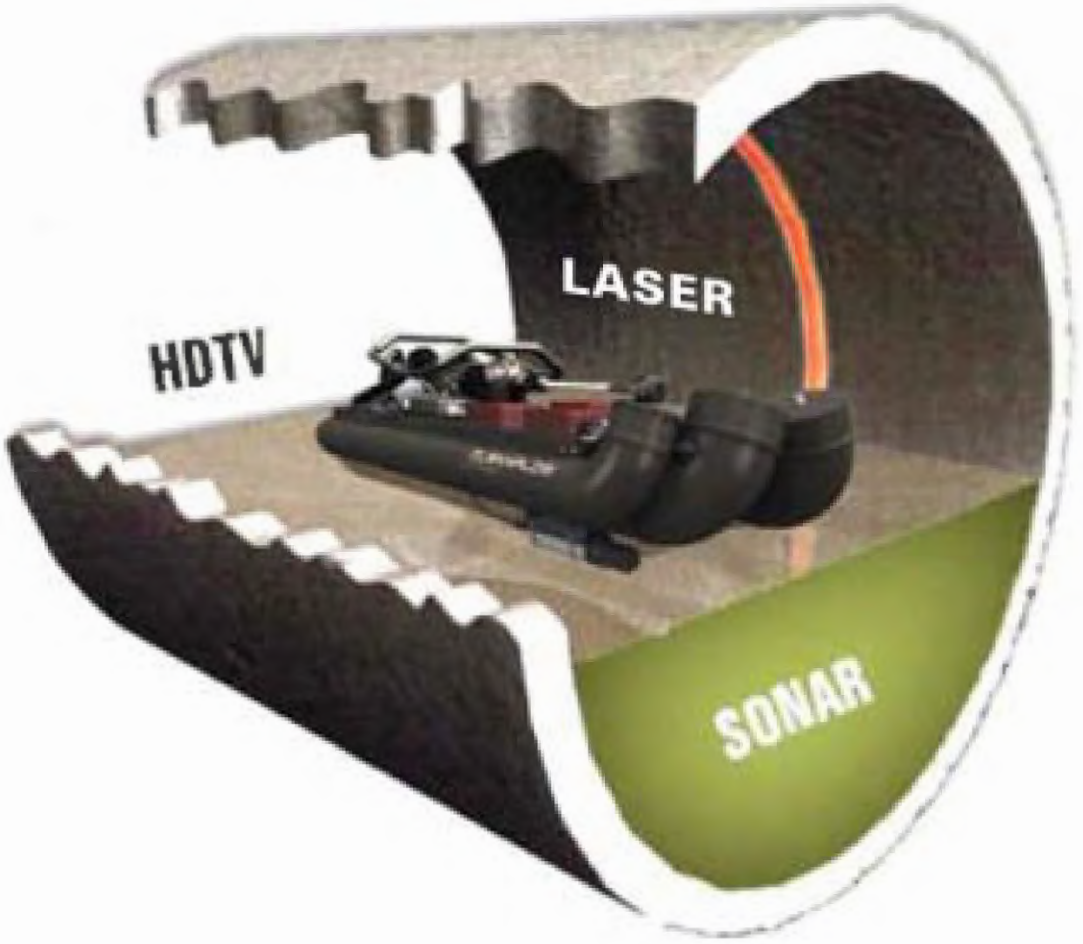
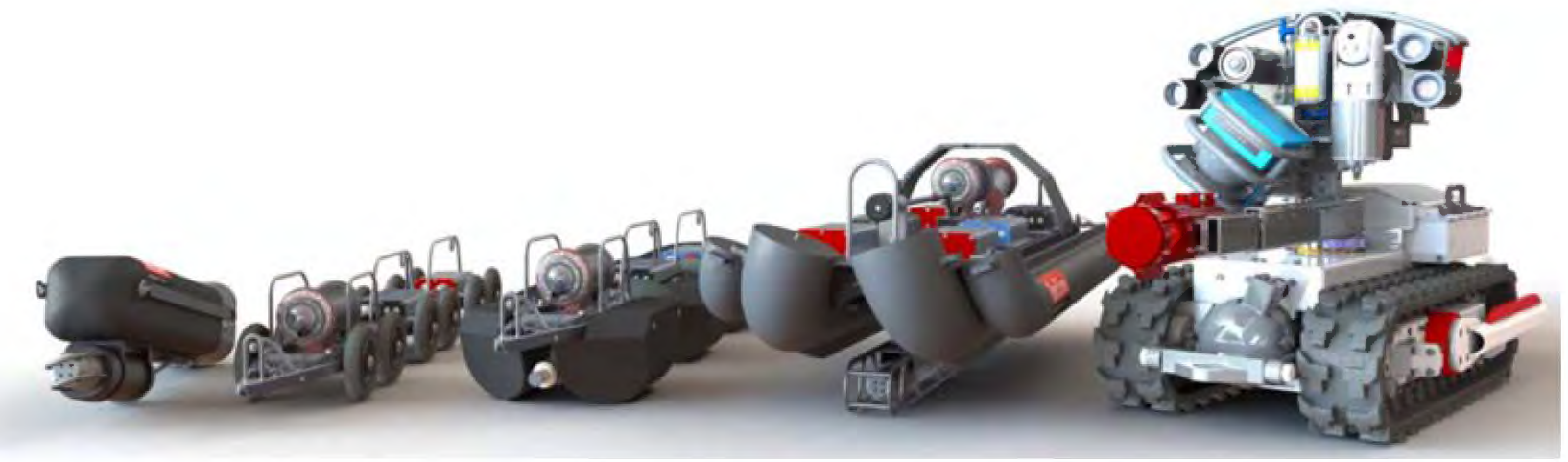
Multi sensor setup



Sonar/ laser equipment



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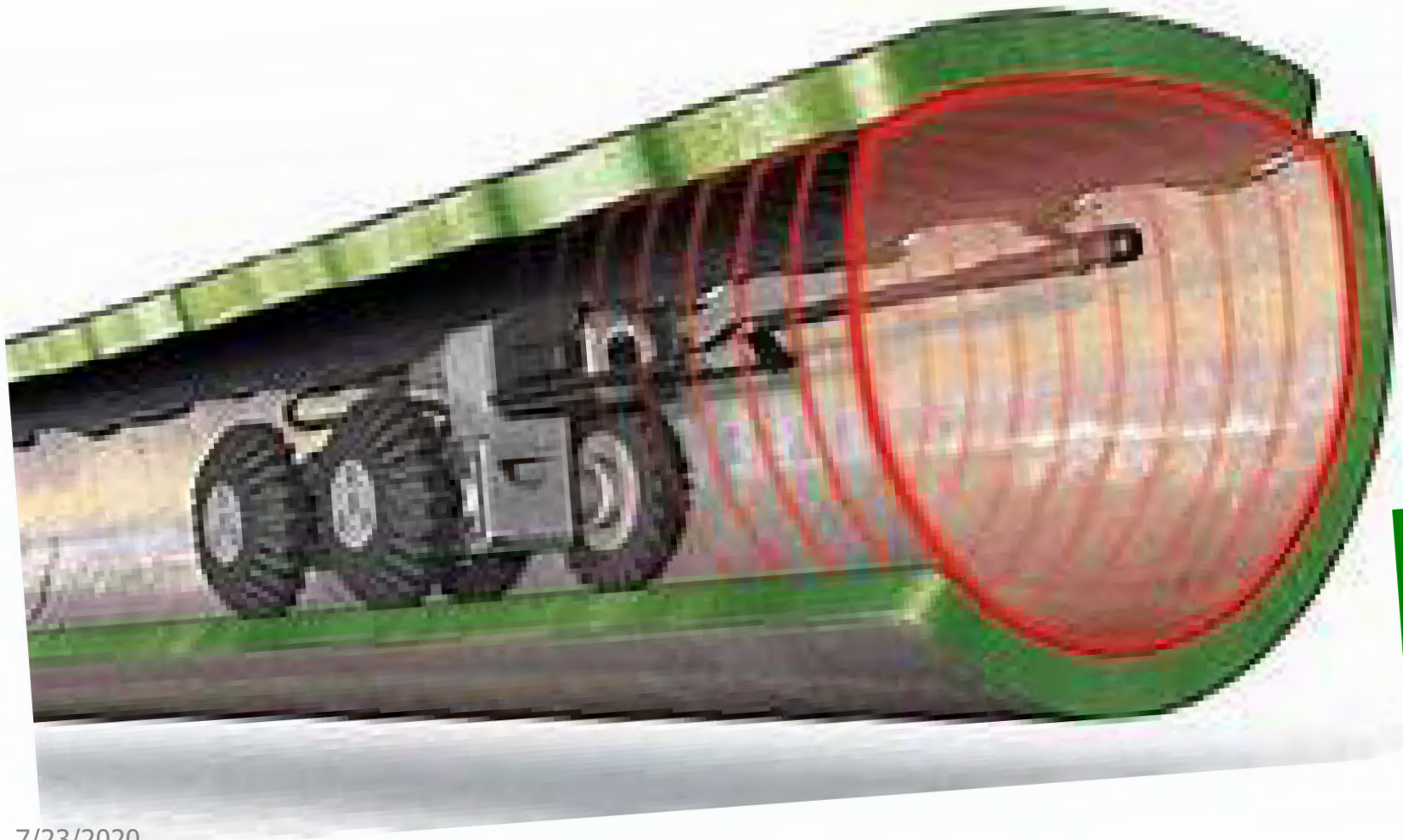
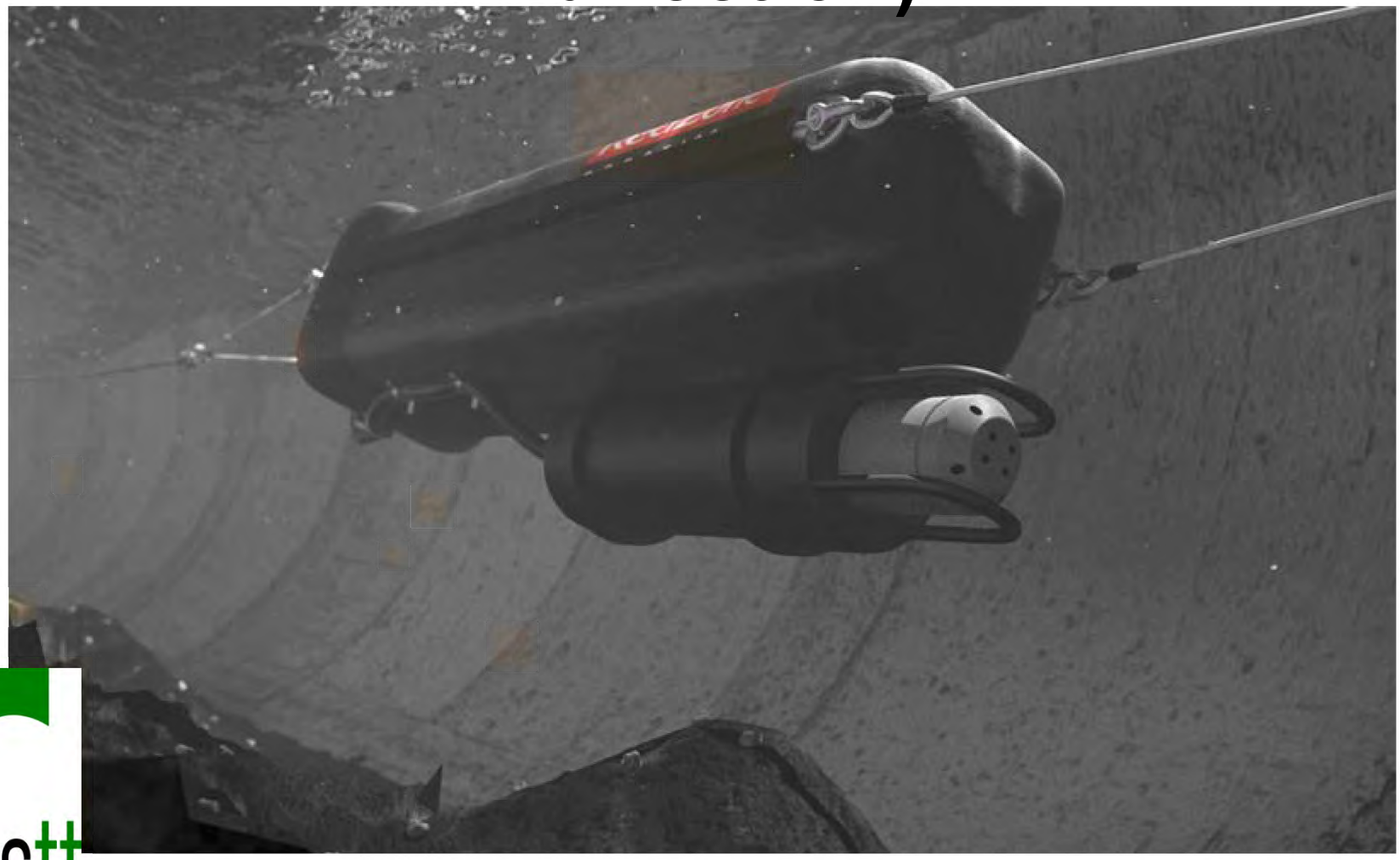
Inserting the crawler

Sonar laser crawler observation

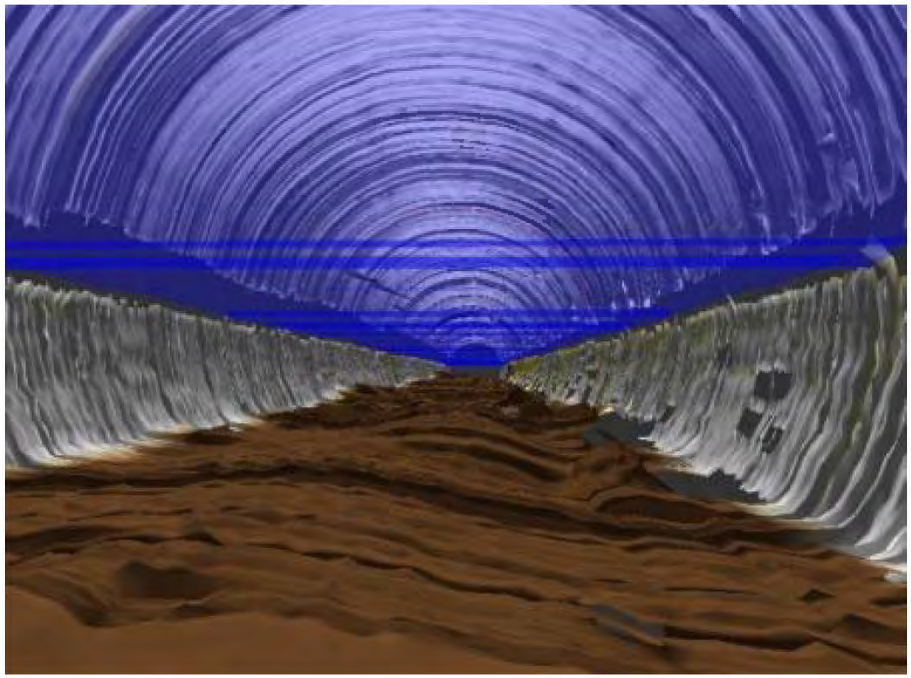


Mostly used is the „Floater” containing all three sensors- laser for above the waterline, sonar for below and digital camera to augment the other two.

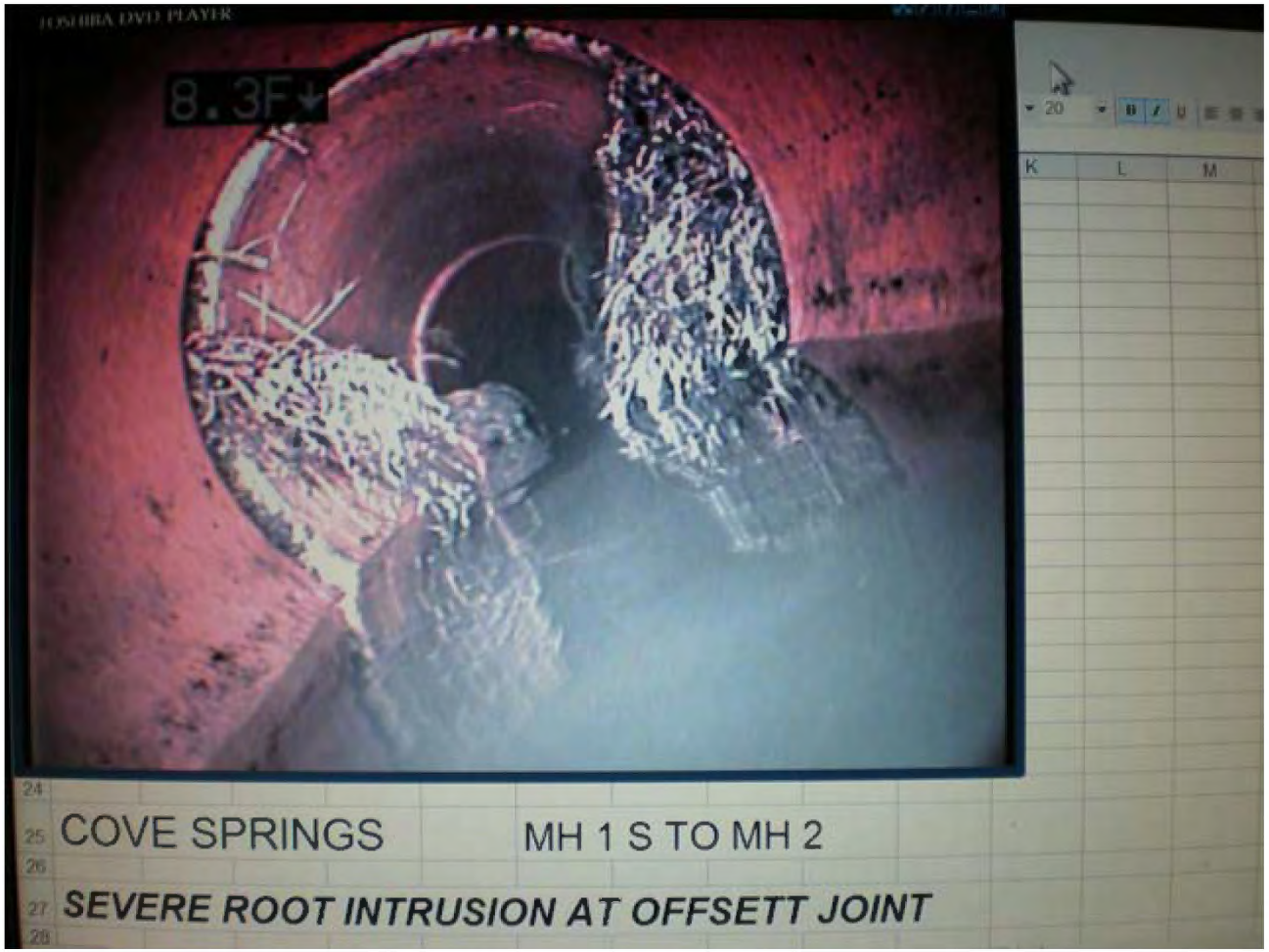
This is how the floater is pulled through the outfall (in the upstream direction)



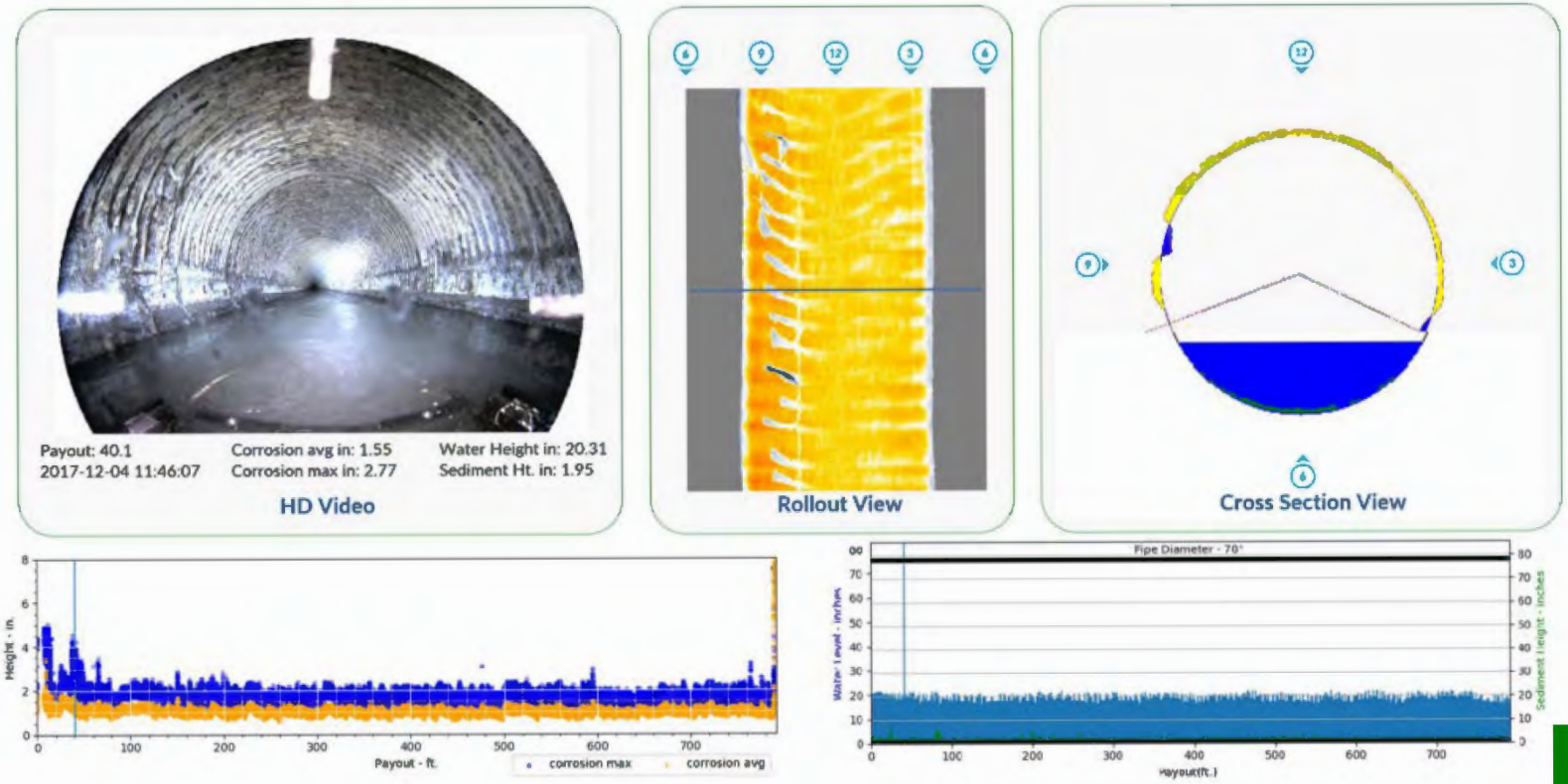
Sonar laser observation in pipe-
All three equipment types take continuous readings. The sonar has a “6 degree of freedom" sensor providing feedback and ensuring accuracy.



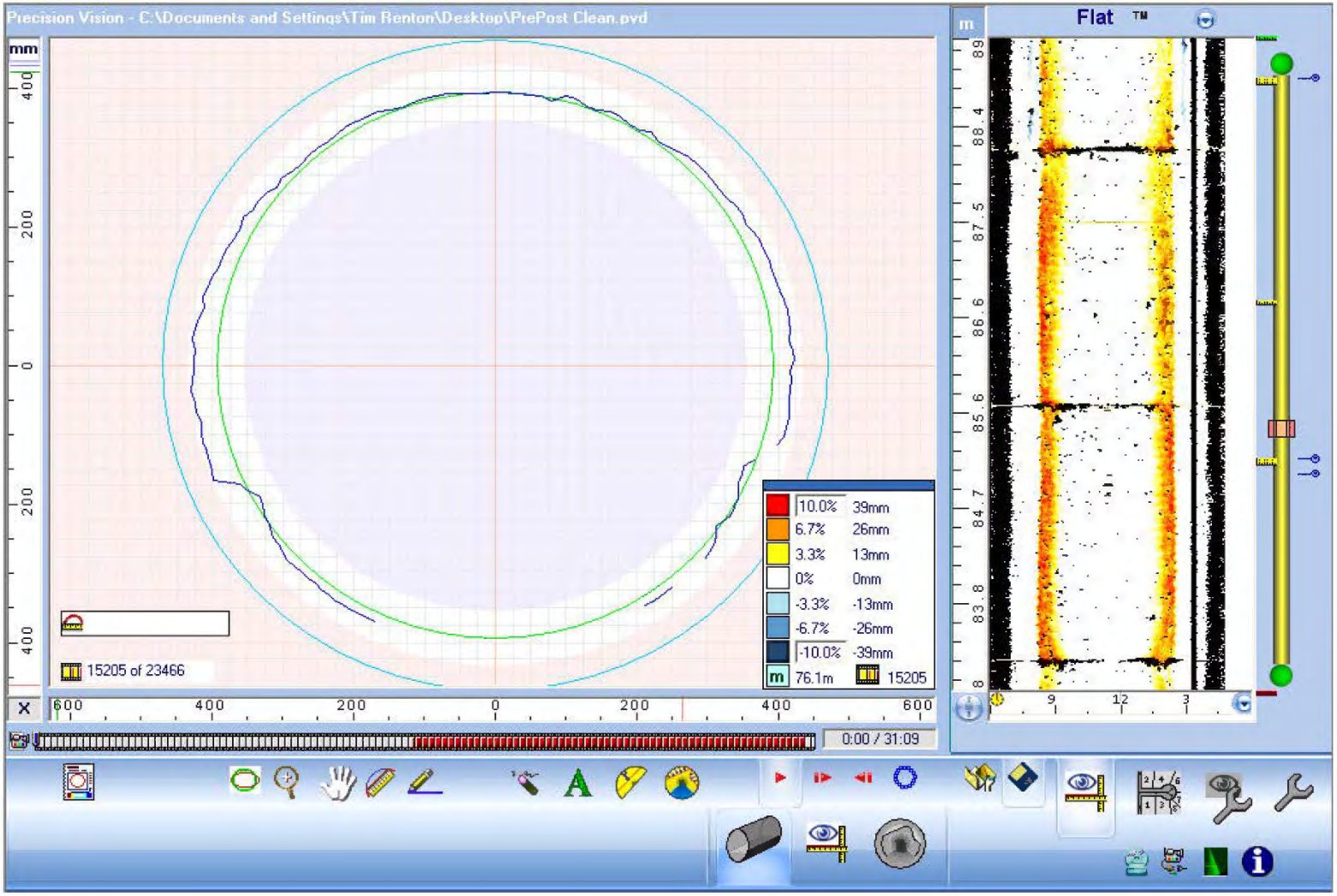
Digital camera observes severe root intrusion.



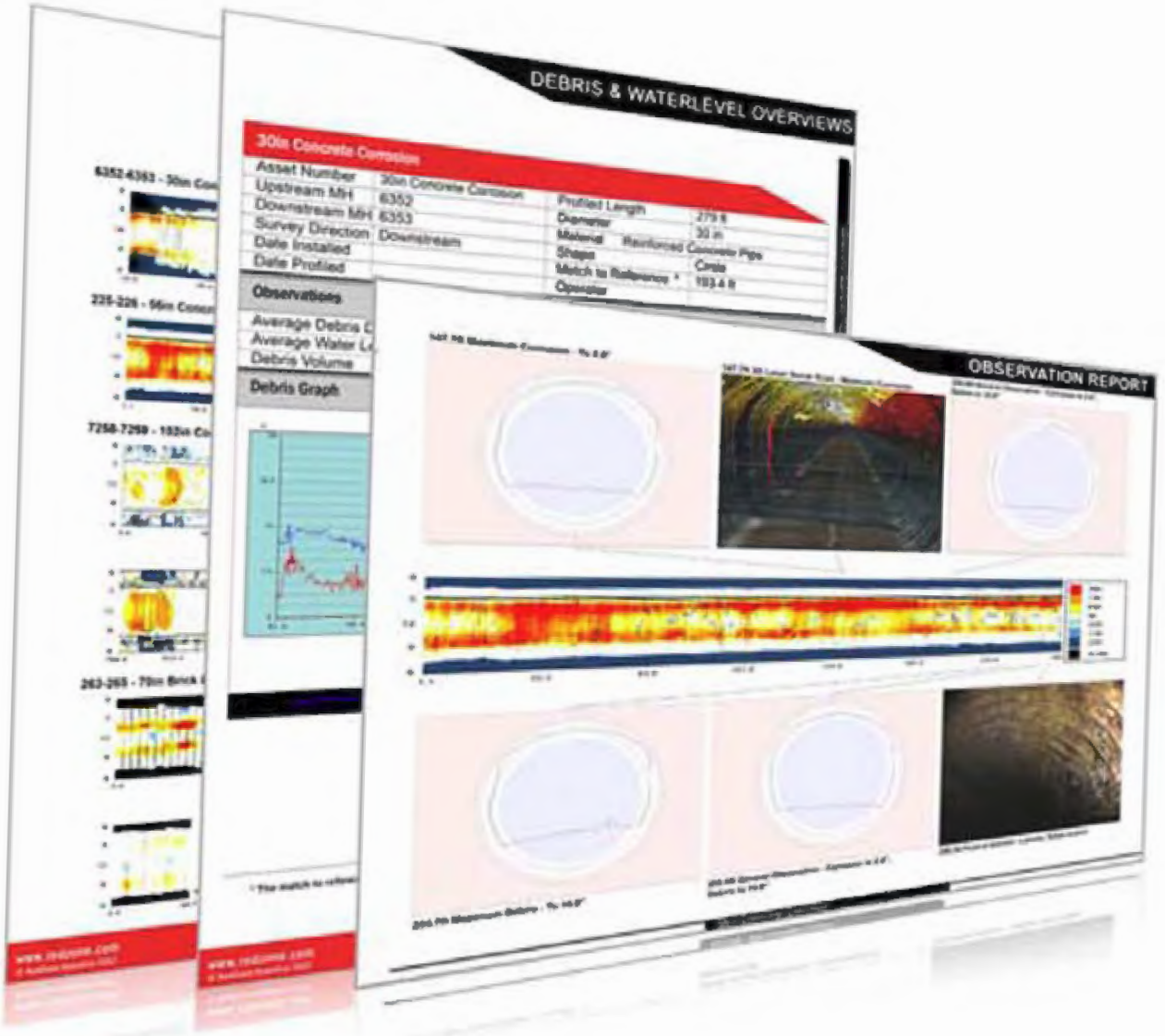
Flat observations report



A closer look at the rolled open view

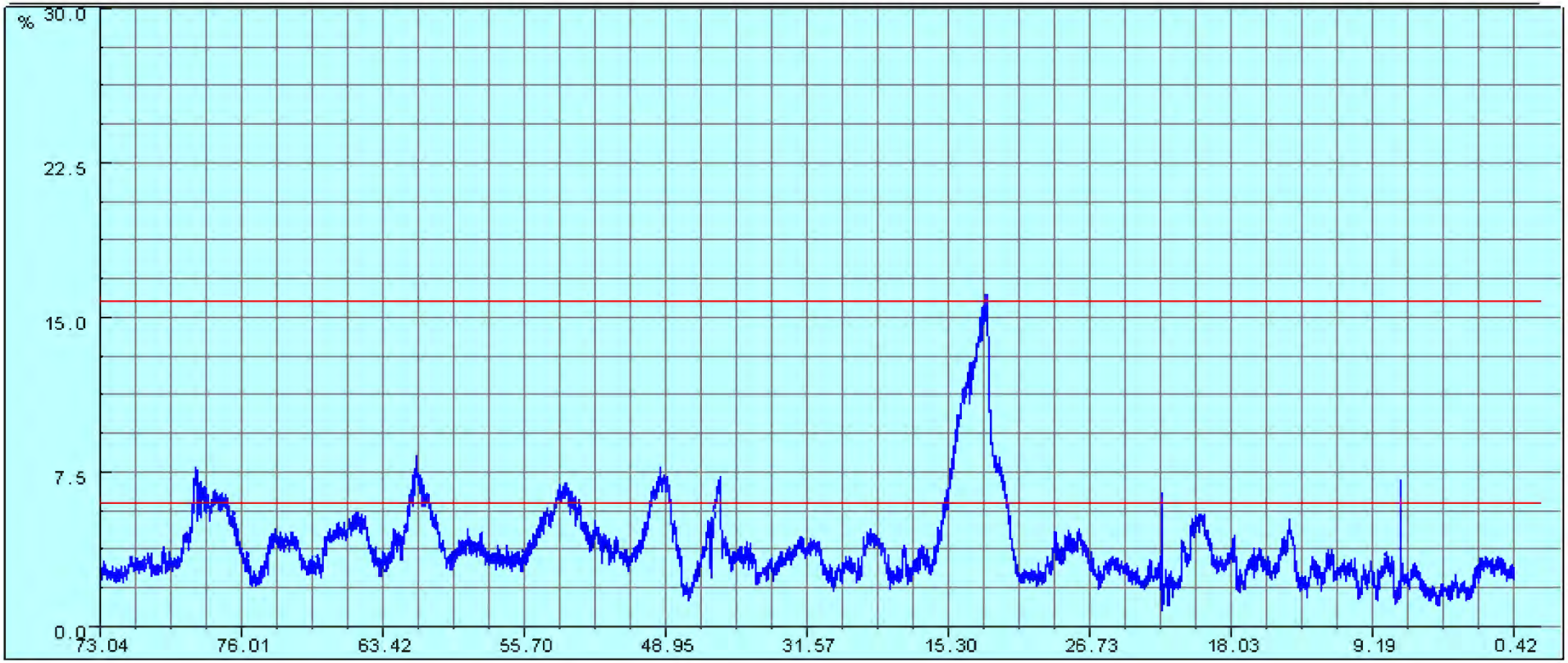


Multi sensor inspections: Report 2



Pipe Ovality Analysis Report

Printed: 12.02.2005



Ovality(q)* as a percentage of original pipe versus time (frame number)

m

SiteID: XX	Asset No: ExMH-A	City: Auckland	Date 03.02.2005
Start Node: ExMH-A7	Finish Node: ExMH-A6	Pipe Length: 74 m	
Start Location: Start Node:	Finish Location: Finish Node:	Pipe Diameter: 340 mm	
	Pipe Material: Relined Concrete		

Comments

Pipe broken at this point. 15.5% Ovality displayed.

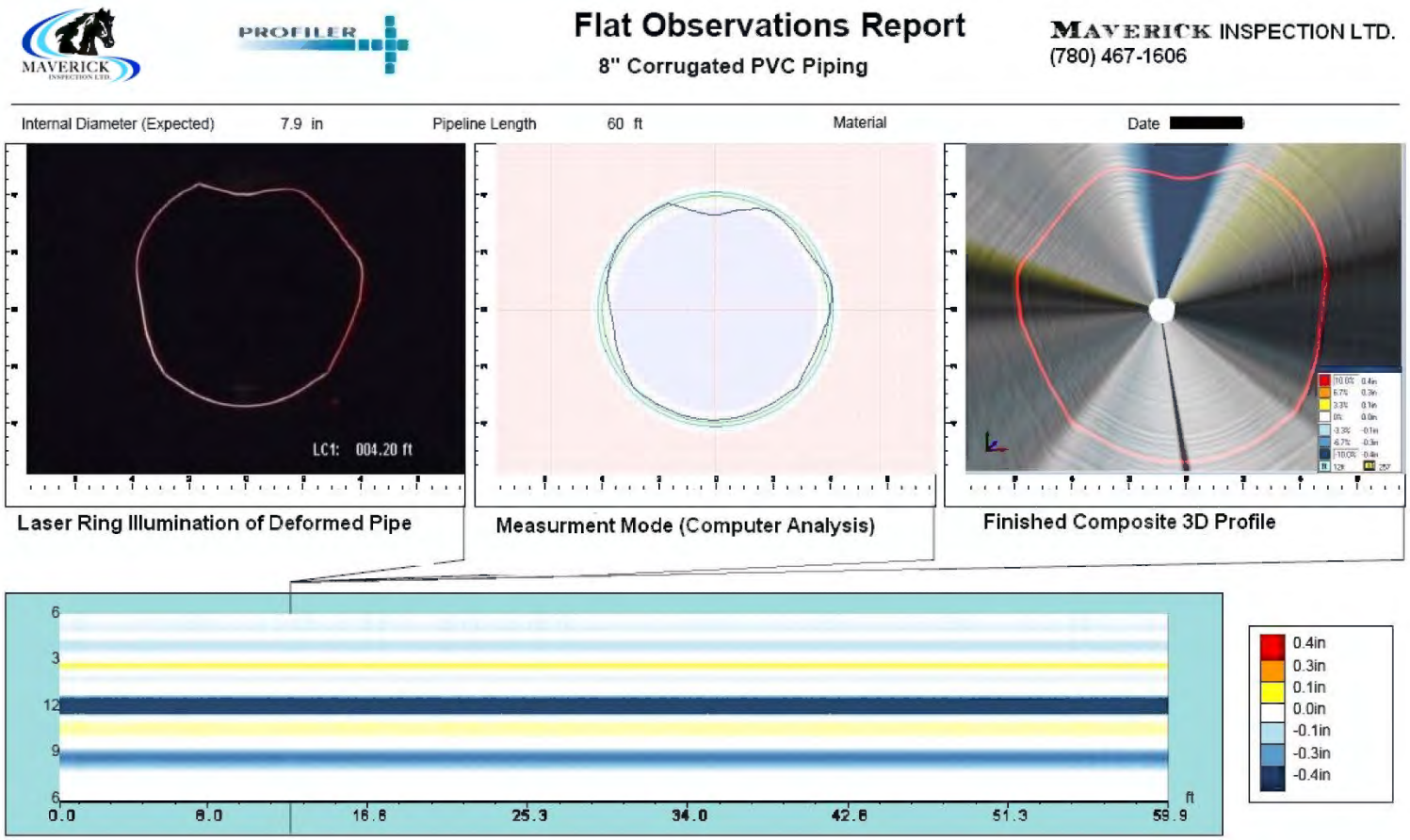
Limit Lines

Upper limit = 15,8

Lower limit = 6

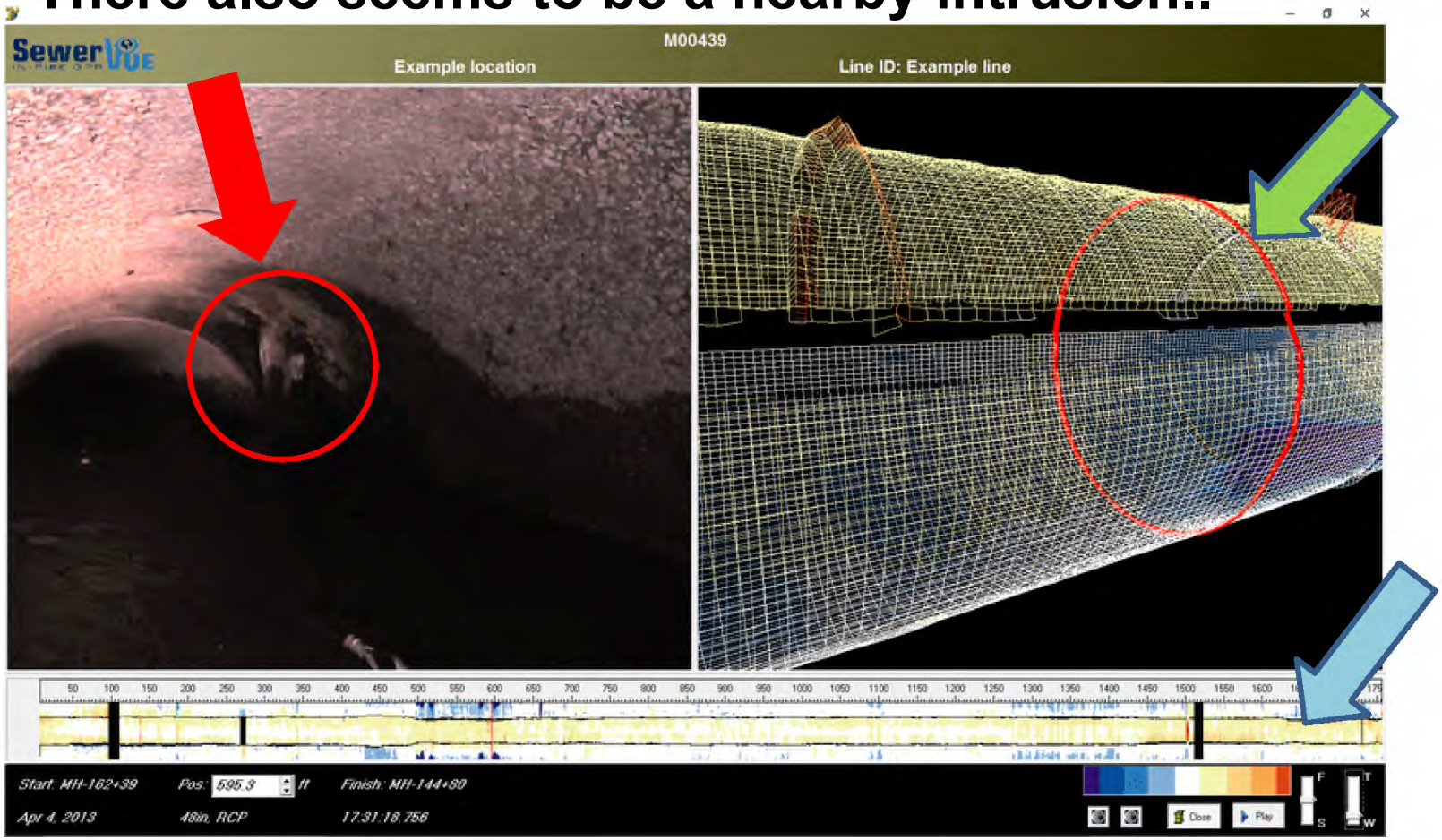
q per ASTM F 1216 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

Sonar laser report
Here is another illustration of ovality observed: a little bit on the sides but mostly on top.



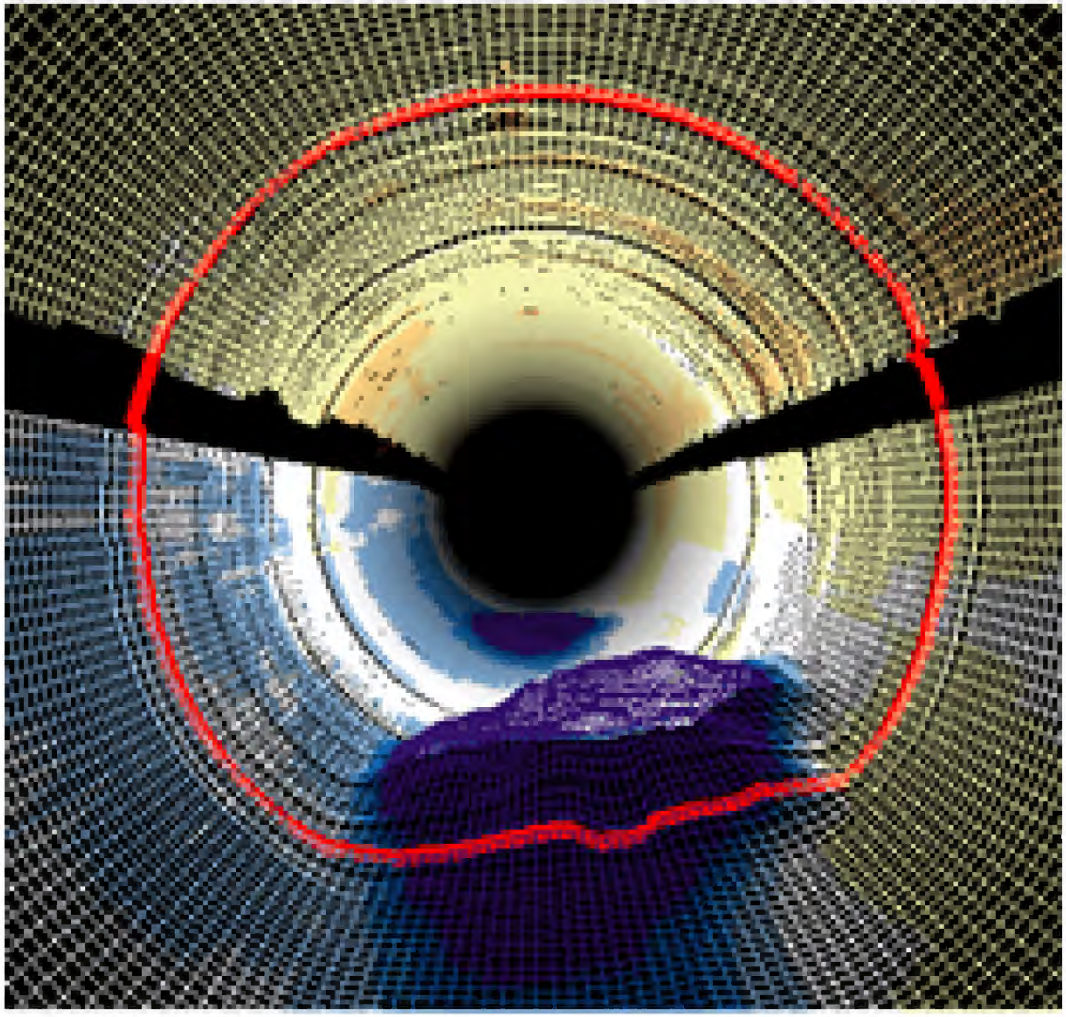
Multi sensor Inspections: Report 3

The red circle on the grid shows where the photograph was taken. The yellow shows very mild erosion. There also seems to be a nearby intrusion..

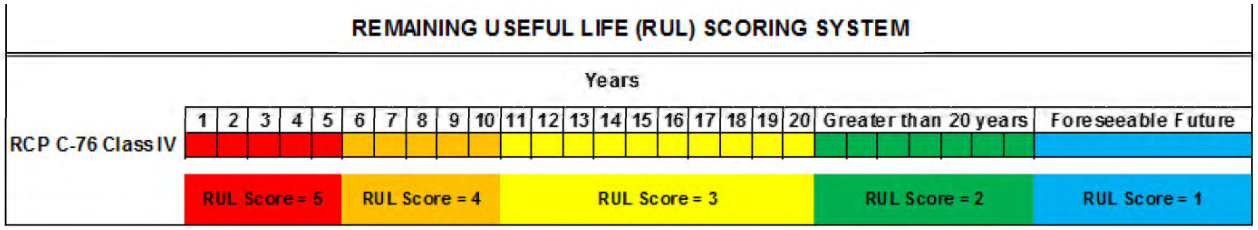


You can have 3D view, which will make it easier to see certain things such as protrusions…The benefits of digital cctv is that certain incidents which are hard to identify with sonar or laser can be very accurately determined with digital CCTV which can be manipulated in a computer to look sideways to the incident and also presents a picture which is recognizable. The digital CCTV augments the sonar and laser observations and the identification of incidents.

Multisensor inspections Report 4: Debris



Remaining useful life scoring



Remaining useful life should be monitored using the inspection data and the as-built drawings.. Exposure of the reinforcing means very nearly a collapsed pipe. Therefore, the number of years left till probable collapse is approximately known, so rehabilitation can be planned in good time. The budget for major rehabilitation can therefore be determined and scheduled.

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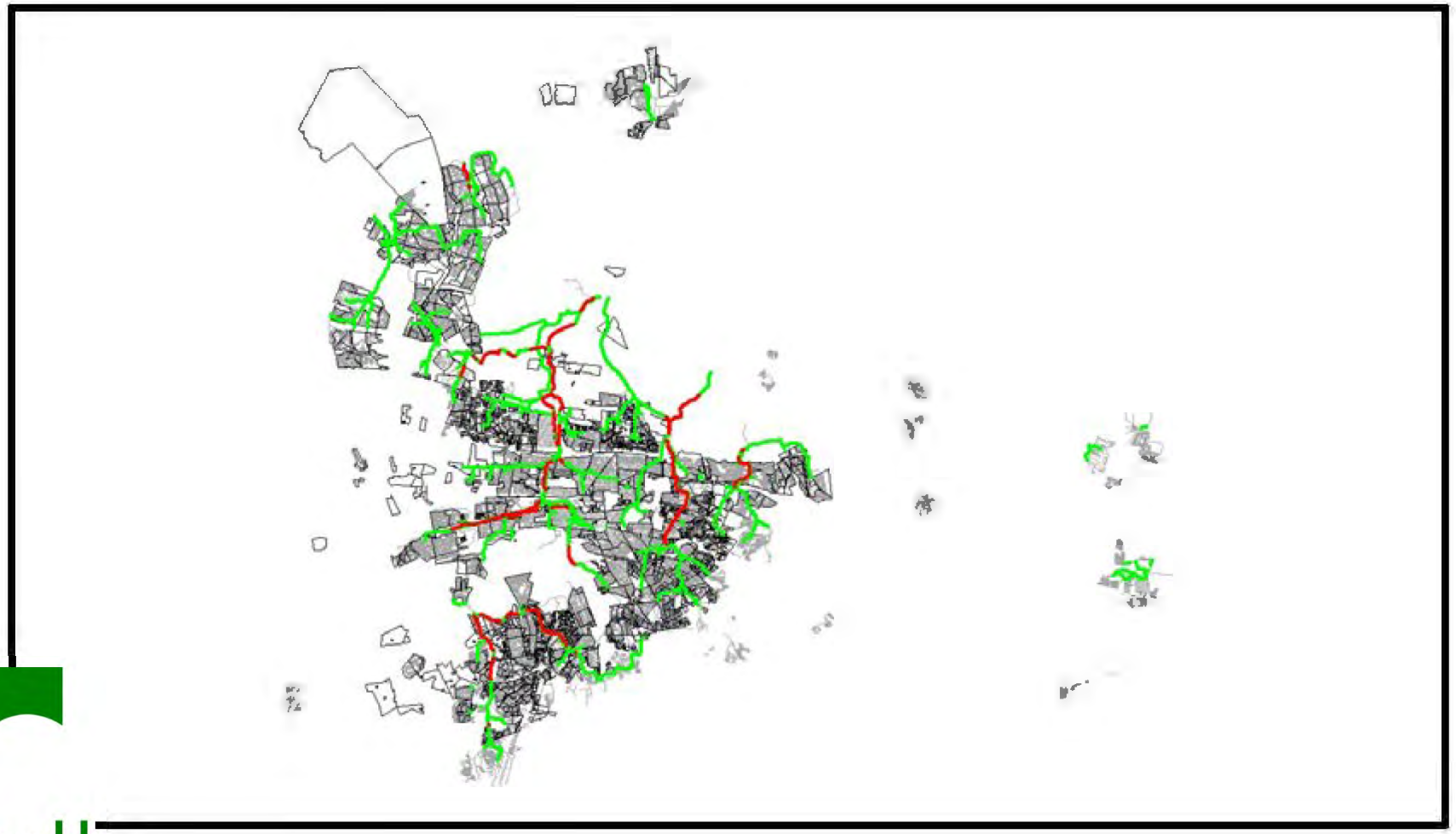
Red: Outfalls inspected in first Tshwane contract, green: were to be done in second contract- not awarded.



- Please share your experiences with us – maybe we can exchange ideas.
- If your sewers are run in crisis management fashion, and this presentation has given you food for thought, I think we have achieved our goals!

How can we serve you should be your motto!

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Questions and Answers

Johann Wessels

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Sustainability

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Choices

Fabrication

Design

Procedures

Operation

Manufacturing

Living

Processes

Construction

Raw Materials

SAPPMA

Thank you

Presenters

Participants
Audience
& Organizers

22 July 2020

SAPPMA

Questions and Answers

ian@sappma.co.za

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