CE-441- ENVIRONMENTAL ENGINEERING II

Lecture 4- calculation of invert levels

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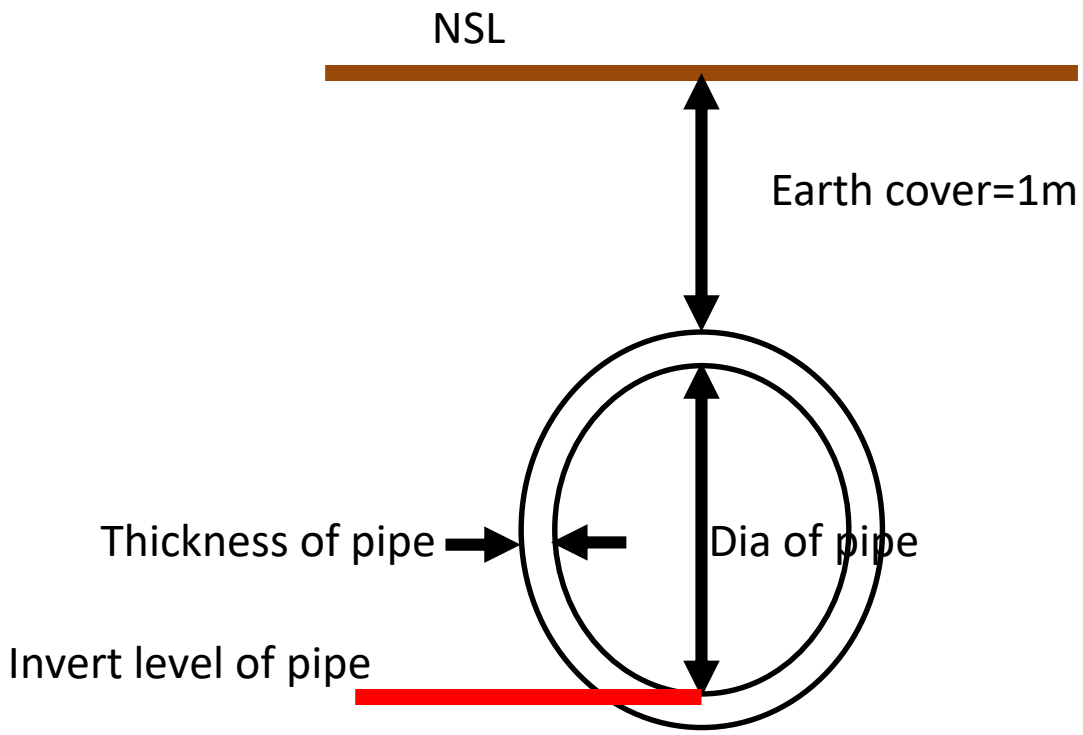
Invert Level

- The lowest inside level at any cross-section of a sewer is known as the **INVERT LEVEL** at that cross section.

SIGNIFICANCE:

- Sewers must be laid at a particular slope to attain self cleansing velocities. The required slope (while laying the sewers) is achieved through calculations of invert levels.

Calculation of Upper Invert Level & Lower Invert Level



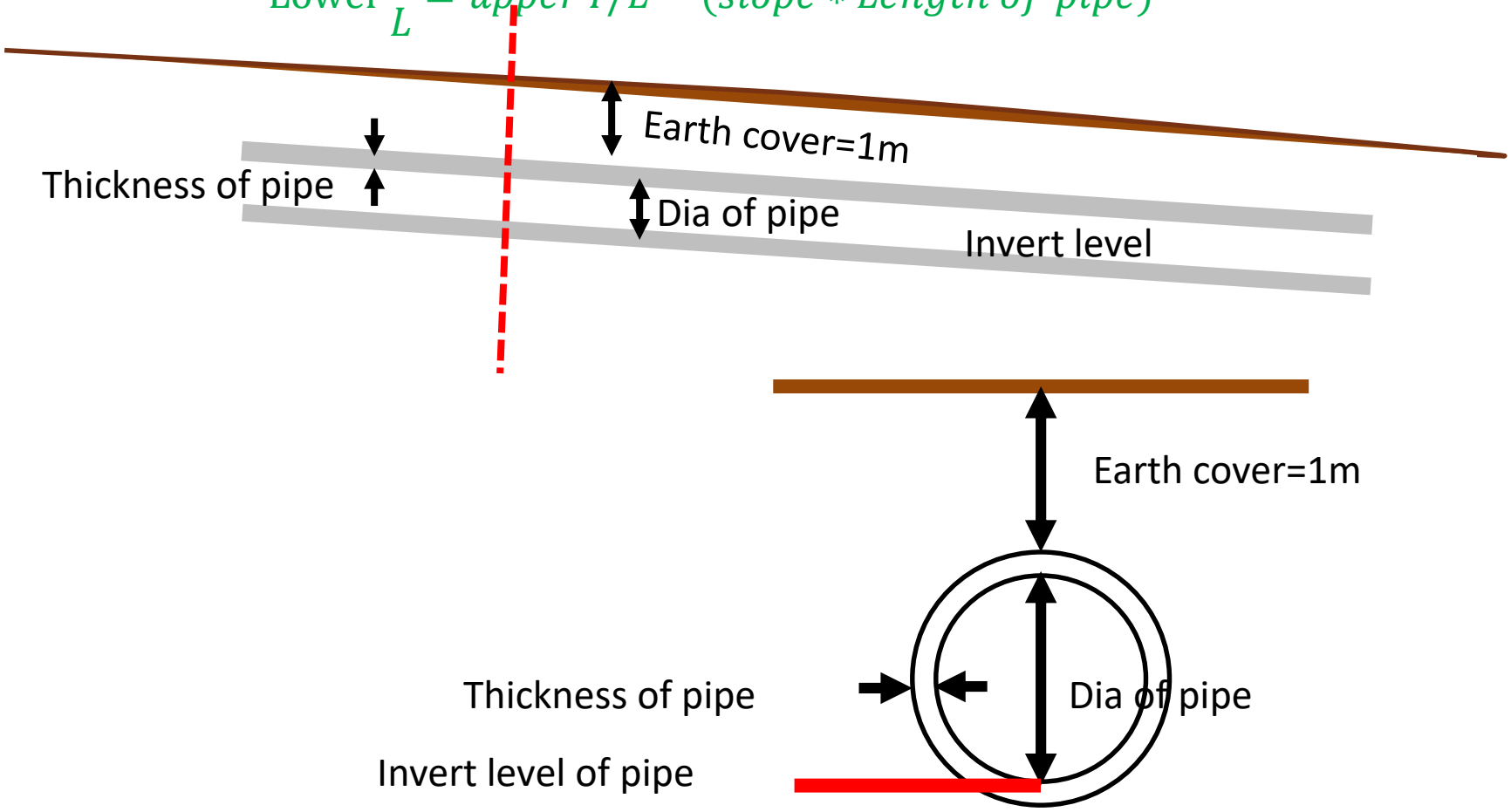
$$\mathbf{Upper\ I.} = NGL - Earthcover - dia\ of\ pipe\ - thickness\ of\ pip$$

$$\mathbf{Lower\ I.L} = upper\ I.L\ - (slope\ X\ Length\ of\ pipe)$$

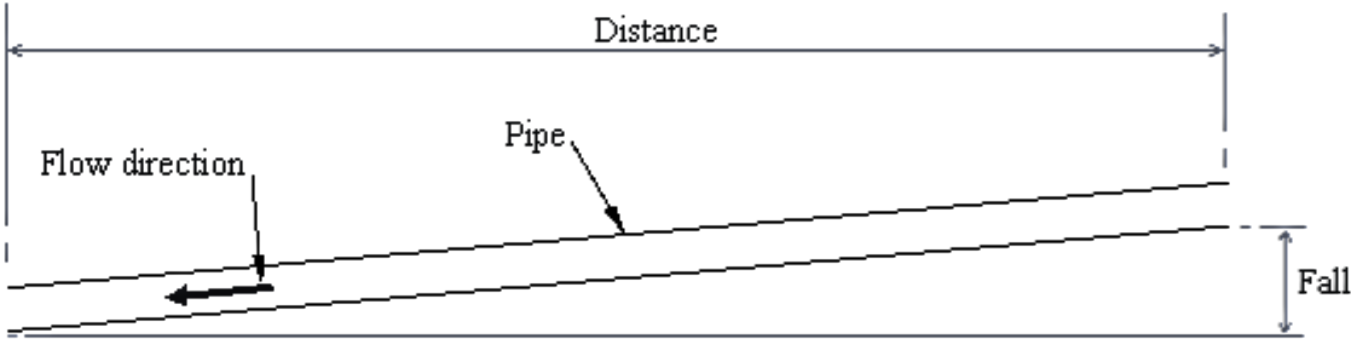
Calculation of Upper Invert Level & Lower Invert Level

$$upper\ \frac{I}{L} = NGL - Earthcover - dia\ of\ pipe\ - thickness\ of\ pipe$$

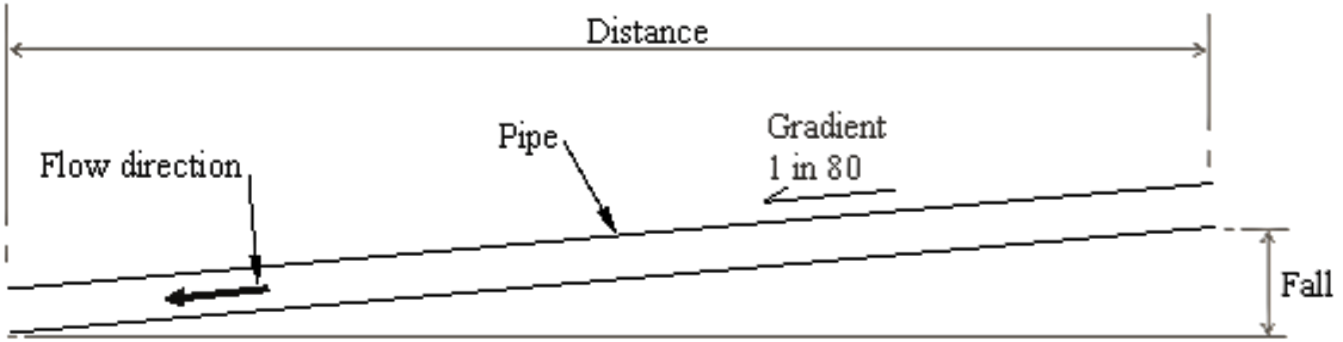
$$\text{Lower}\ \frac{I}{L} = upper\ I/L - (slope * Length\ of\ pipe)$$



Gradients in Pipes



FALL IN DRAINAGE PIPE



FALL & GRADIENT IN DRAINAGE PIPE

Gradients in Pipes

A gradient may be defined as fall divided by distance.

GRADIENT = FALL / DISTANCE

For example is a 24 meter section of drainage pipe has a fall of 0.30 metres, calculate the gradient.

Gradient = 0.30 / 24
Gradient = 0.0125

This can be converted into a gradient written as a ratio or 1: some number.

Gradient = 1 / 0.0125 = 80
Gradient = 1 in 80

The above formula may be rearranged for Fall if the gradient is known:

FALL = GRADIENT X DISTANCE

Gradients in Pipes

For example, calculate the fall in a 50 meters section of water pipework if the gradient is to be 1 in 80.

A gradient of 1 in 80 is converted to a number instead of a ratio.

1 / 80 = 0.0125

Fall = Gradient x Distance

Fall = 0.0125 x 50

Fall = 0.625 meters or 625mm.

Calculation of Invert Level

SINGLE SEWER:

- ✓ U/S Invert Level = NGSL/RL – Depth of Sewer – Thickness of Sewer – Dia of Sewer
- ✓ D/S Invert Level = U/S Invert Level – Drop (Length x slope)

TWO OR MORE SEWERS OF SAME SIZE:

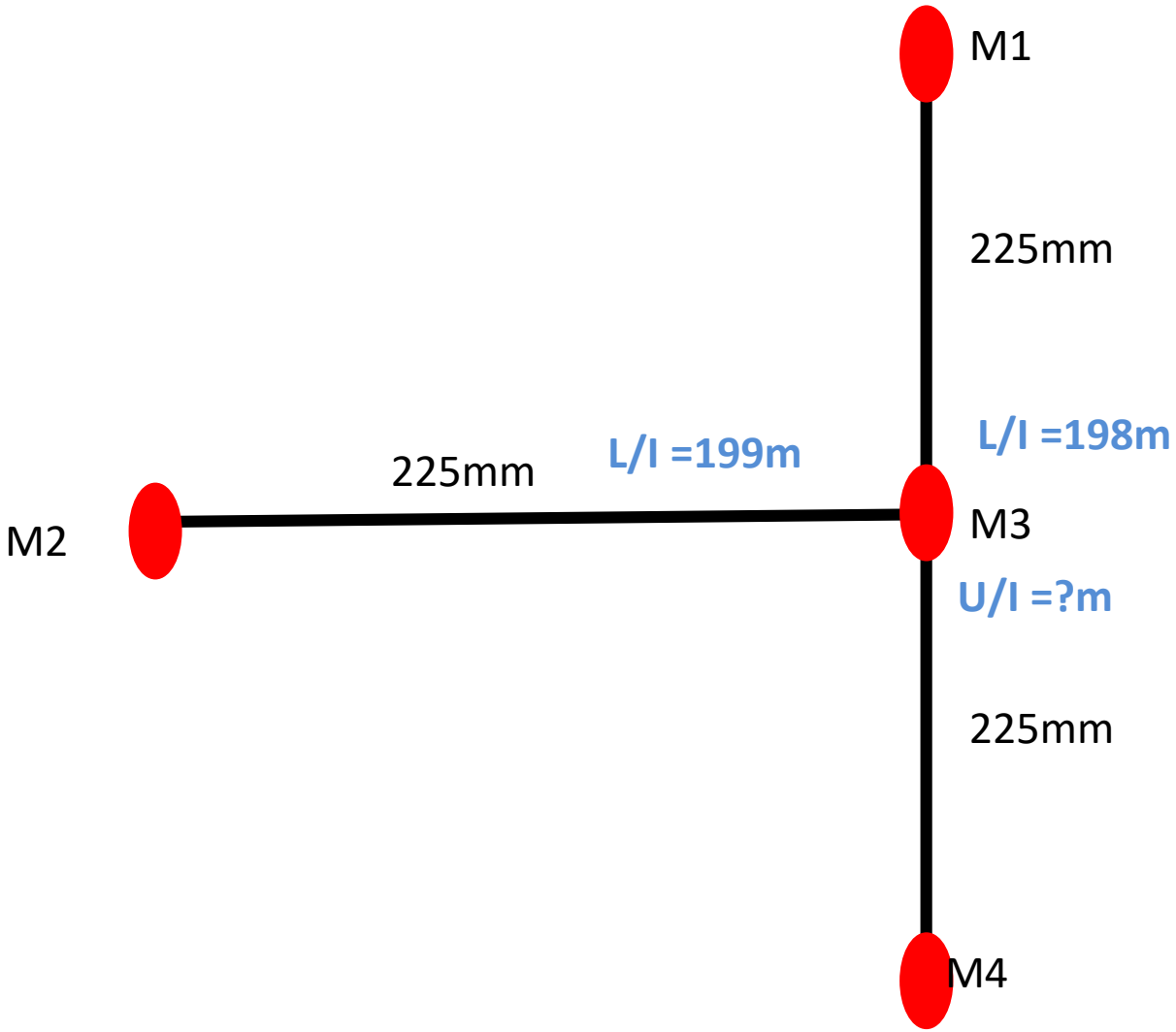
When equal dia sewers discharge in a manhole and the same dia sewers receives the total discharge, LOWEST D/S I.L. among the discharging sewers will be carried as U/S I.L. for the receiving sewer.

SEWERS OF DIFFERENT SIZE:

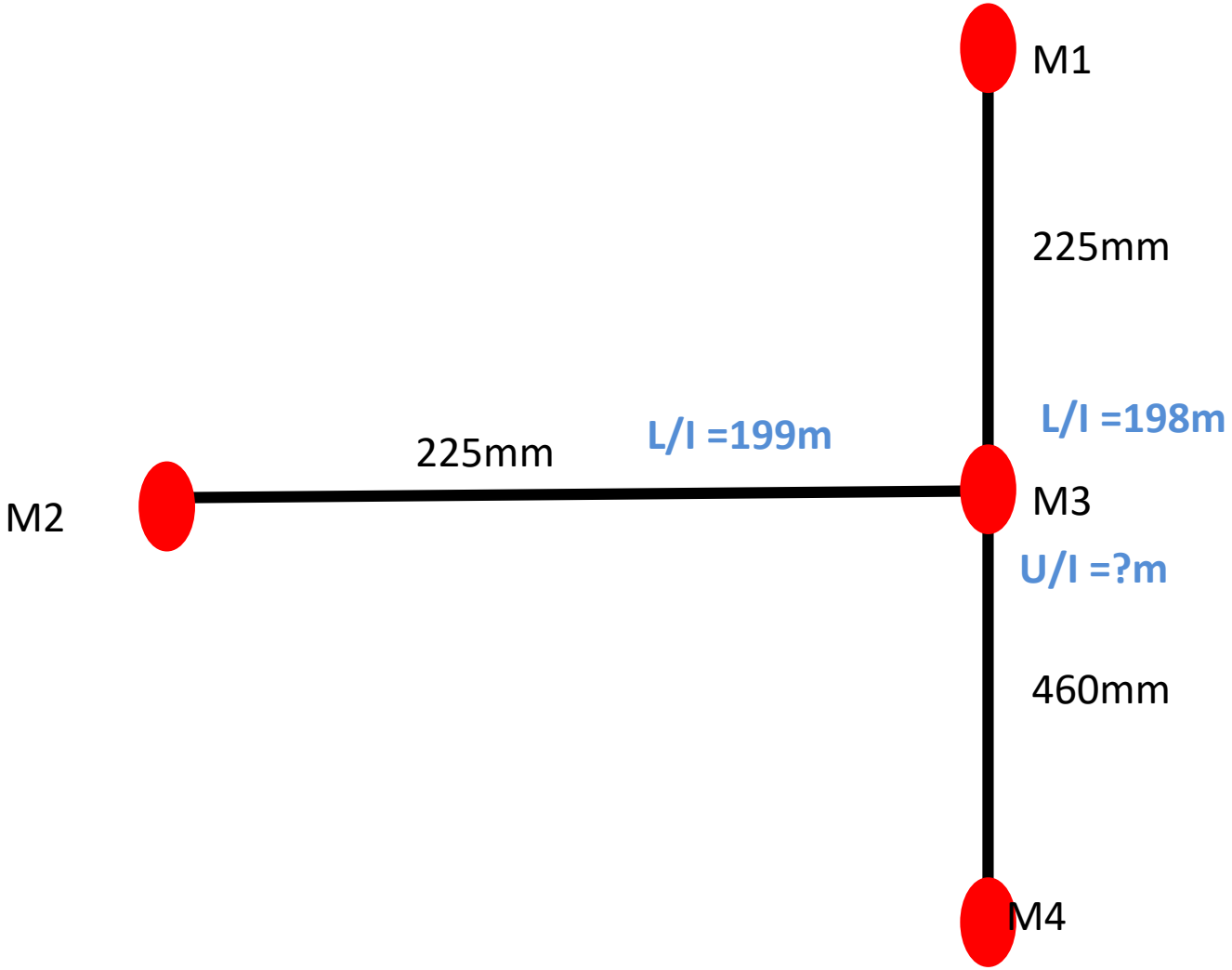
When receiving sewer dia is greater than the discharging sewer;

- ✓ Keep the crowns at the same level
- ✓ Drop the U/S I.L. of the receiving sewer by the difference in the dia of the two sewers.

Calculation of Invert Level-Case 1 (Equal dia pipes)

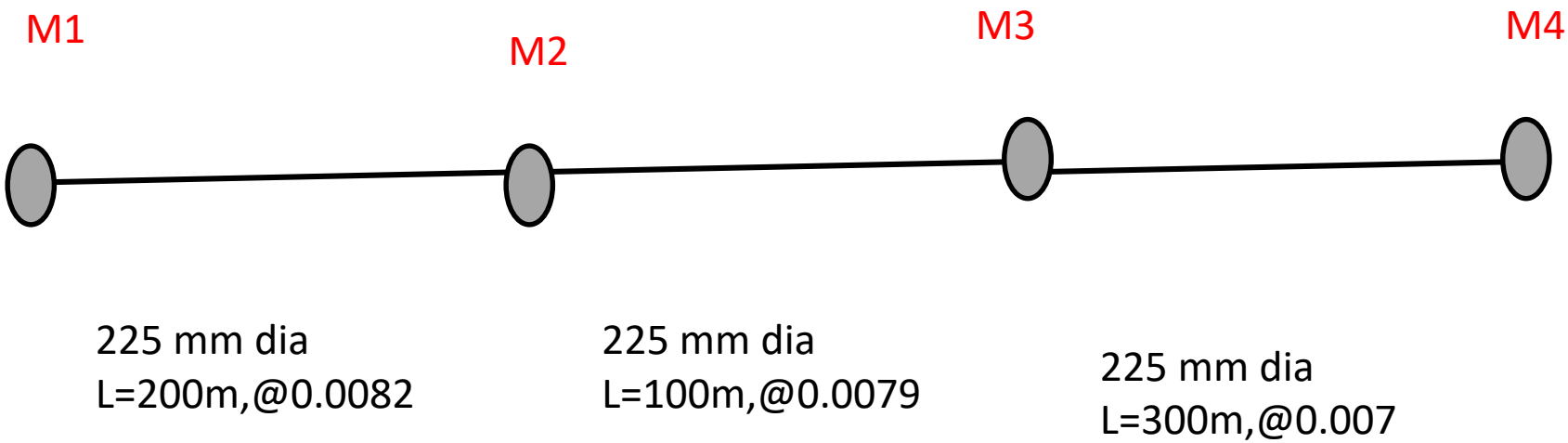


Calculation of Invert Level-Case 2 (Different dia pipes)



Numerical 1

- Calculate upper and lower invert levels at M2 , M3 and M4 if upper invert level of M1 is **100m**



Numerical 2

Calculate upper and lower invert levels at M2 , M3 and M4 if upper invert level of M1 is **200m**

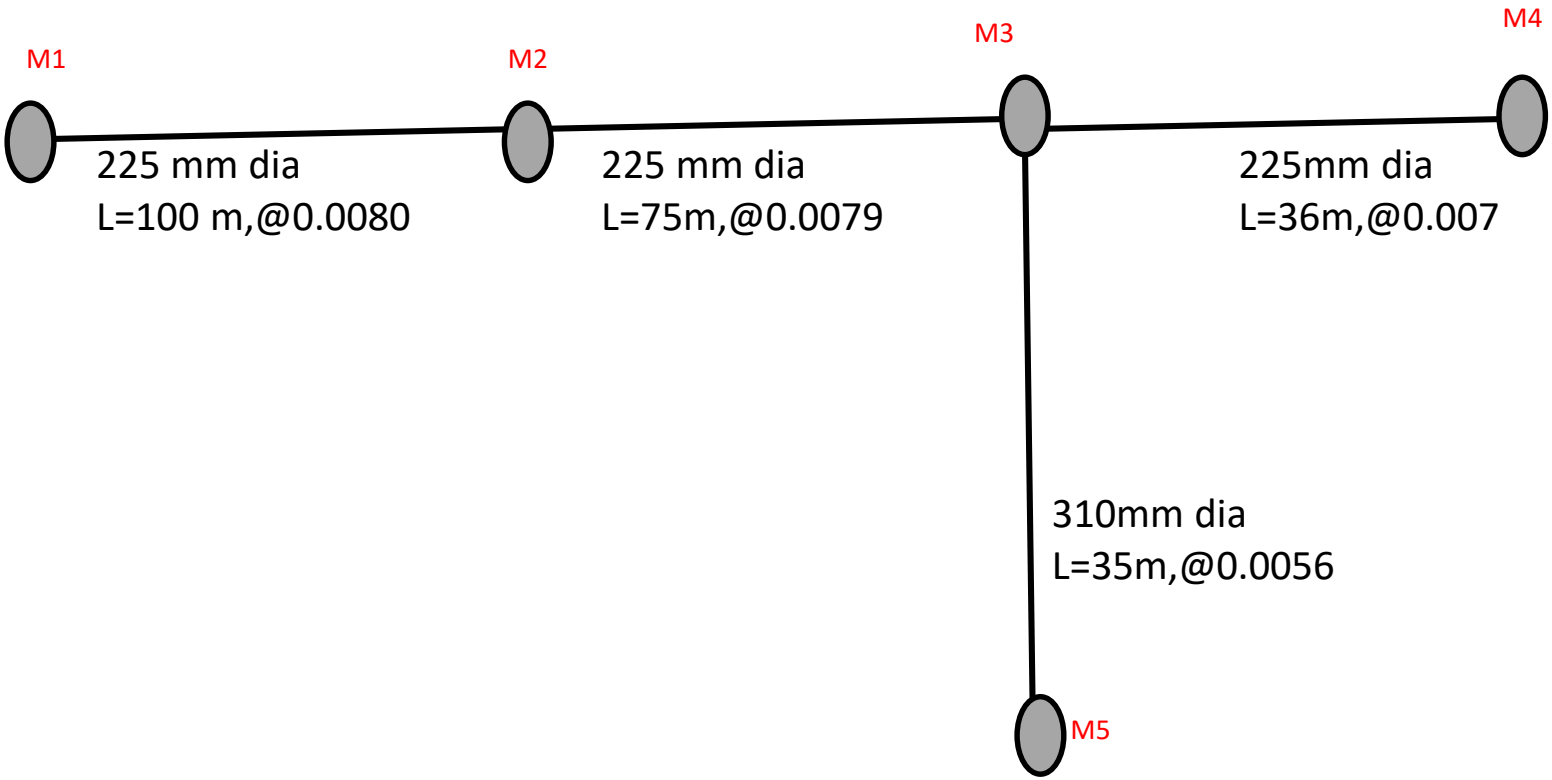
225 mm dia
L=106 m,@0.0082

310 mm dia
L=35m,@0.0080

380mm dia
L=36m,@0.0072

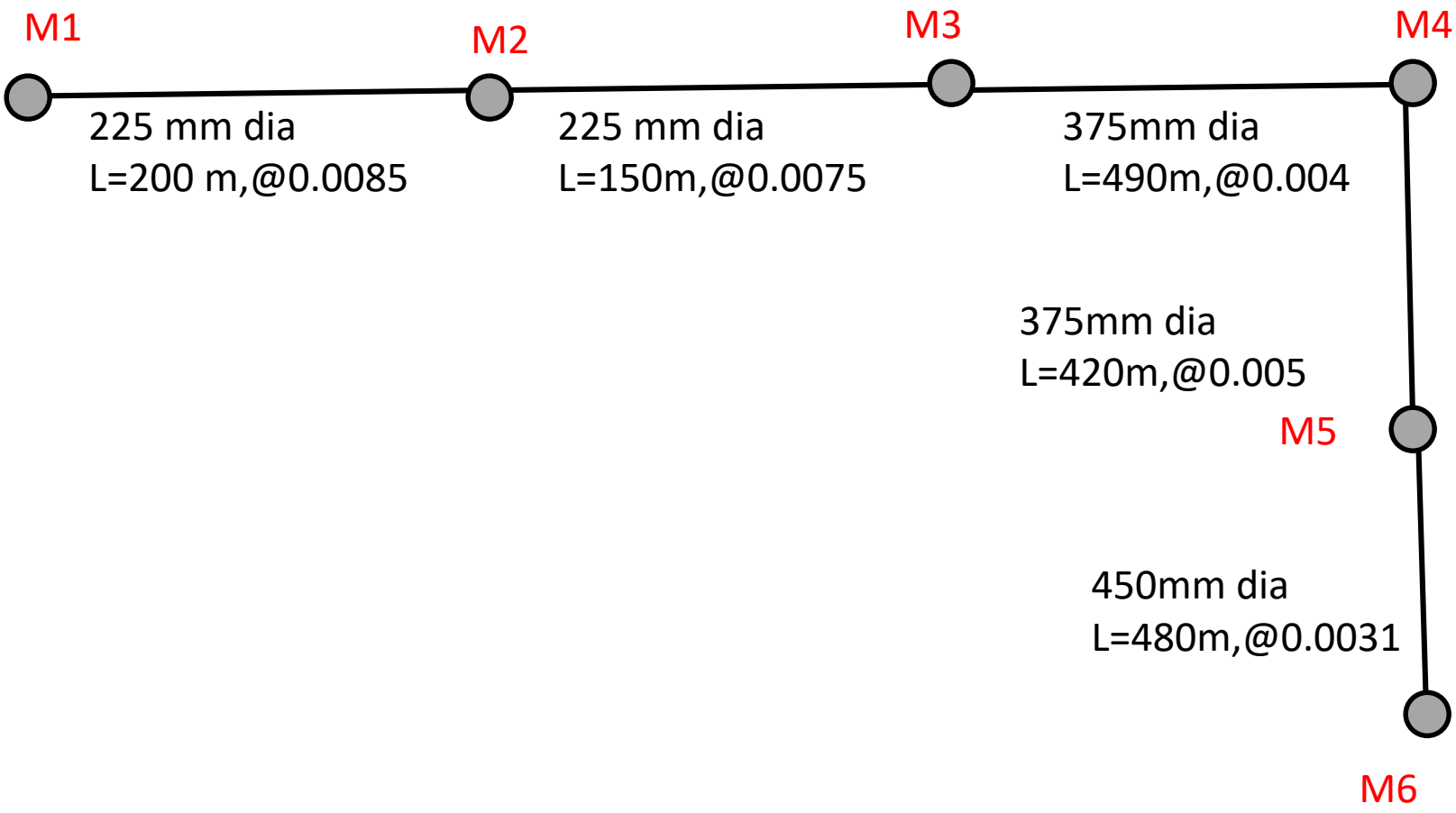
Numerical 3

- Calculate upper and lower invert levels at M2 , M3 ,M4 and M5 if upper invert level of M1 is 135m



Numerical 4

- Calculate upper and lower invert levels at M2 , M3 ,M4 ,M5 and M6 if upper invert level of M1 is 110m



Numerical 5

- Calculate Invert levels for partially combined sewer system. Average water consumption of 400lpcd take **NGL=100 m , Earth Cover=1m and Pipe thickness = 50mm**