

Activity 4b: Reducing uncertainty in the use of non-destructive, indirect measurement with LPR

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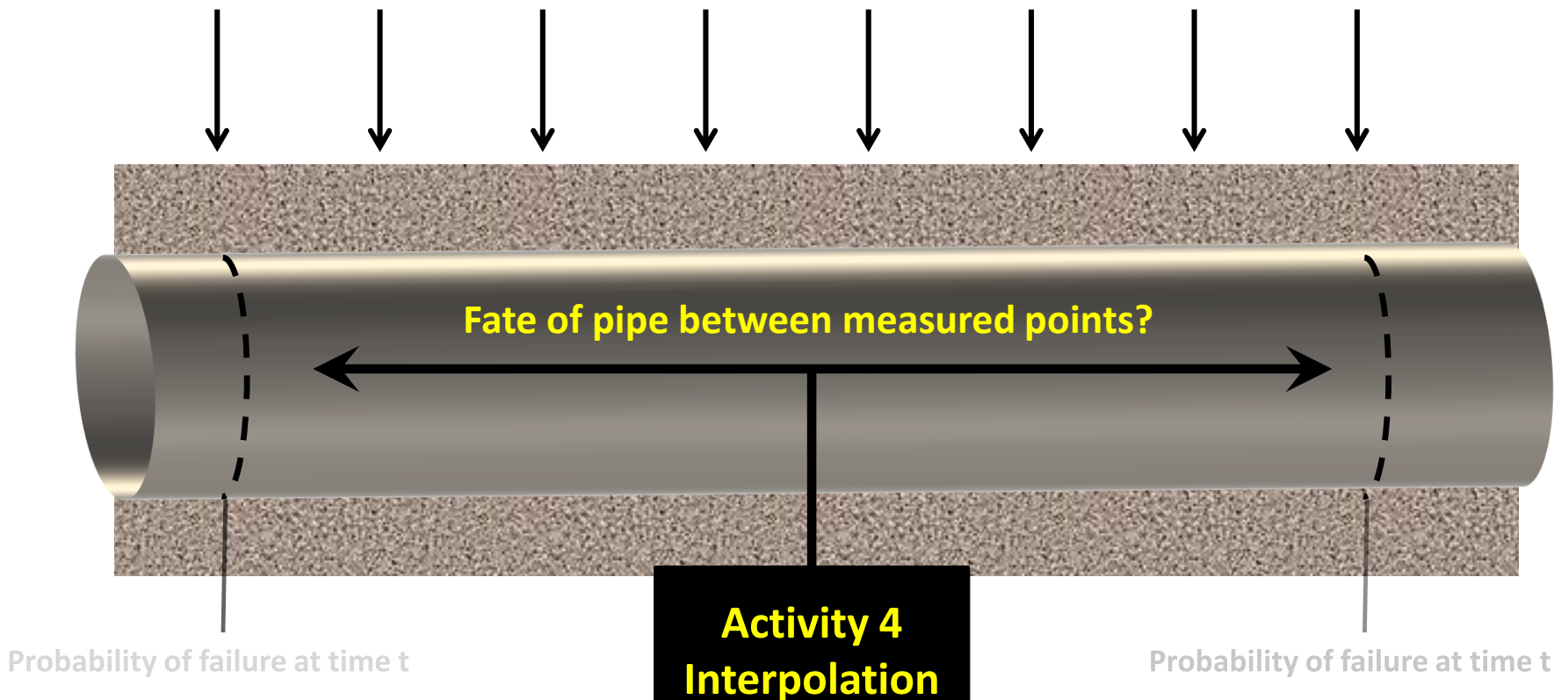
Activity 4b

1. **Report 1:** Current knowledge of the Theoretical basis of LPR
2. **Report 2:** Relationship between theoretical basis and practical application of LPR
3. **Identifying sources of uncertainty in LPR process**
4. **Making improvements to the LPR-> pit rate model**

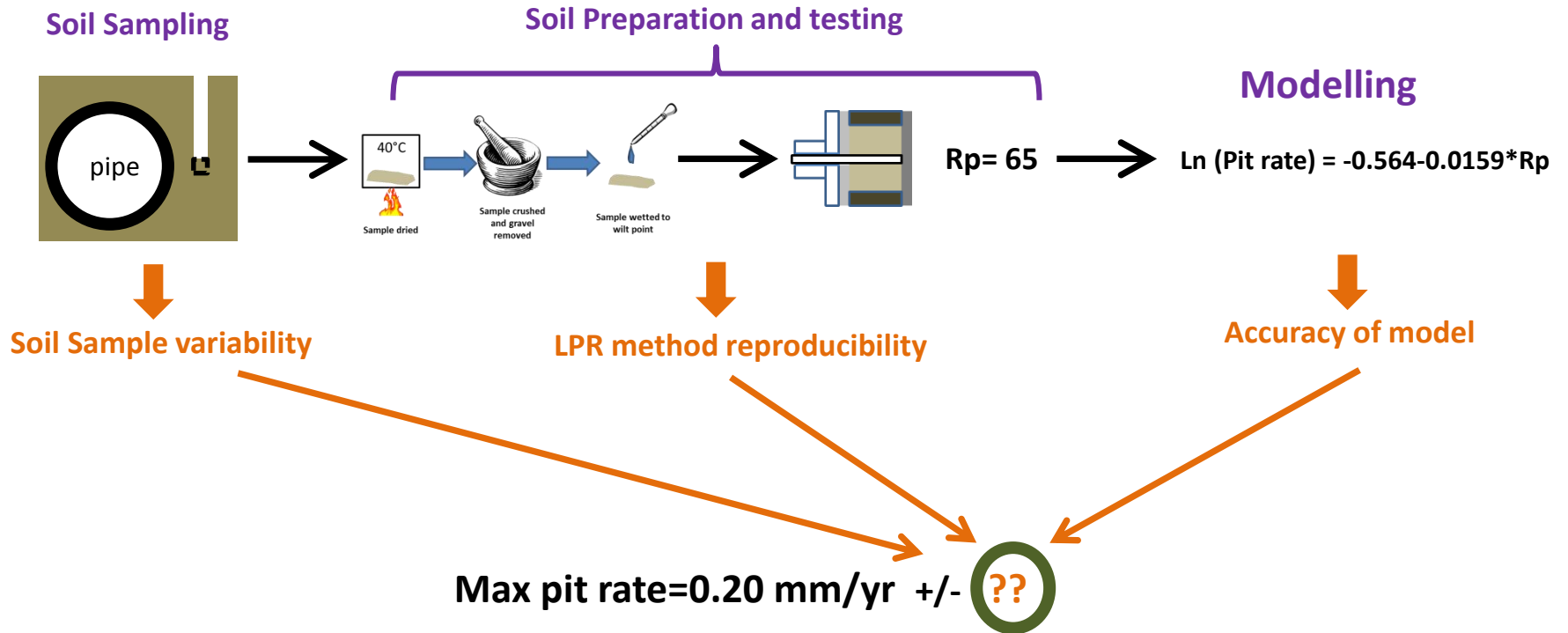
Activity 4b

Why are we looking at LPR in Activity 4?

LPR – cheap, easy, shown to correlate well with corrosion



3. Identifying sources of uncertainty in the LPR process

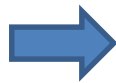


3. Identifying sources of uncertainty in the LPR process

LPR method reproducibility

LPR reproducibility for duplicate samples

Very well mixed Sydney
test bed clay samples



7 to 20% variation between duplicates

Very well mixed Perth
sandy samples



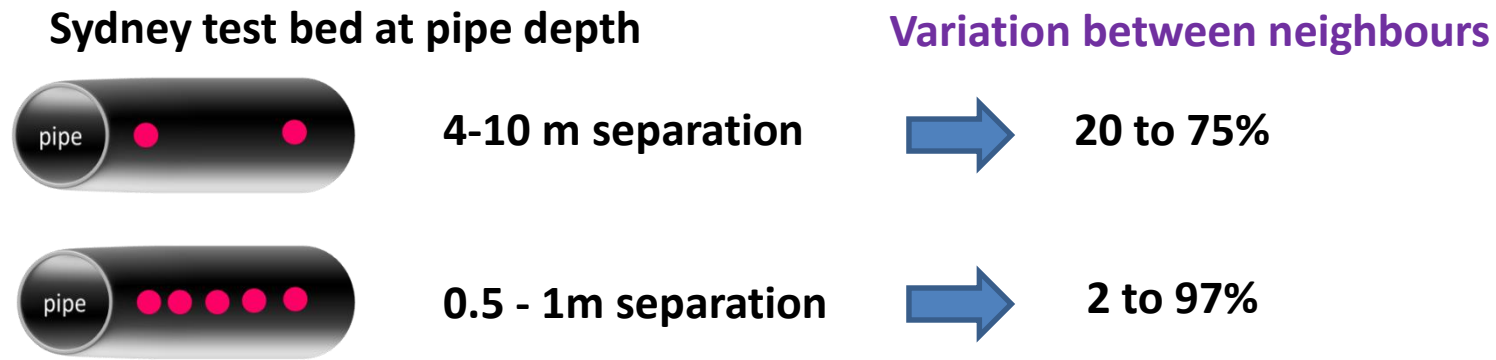
20 to 37% variation between duplicates

- Repeatability good
- Sandy soils harder to duplicate but corrosion very low so not critical
- Variation equivalent to $< \pm 0.02\text{mm/yr}$ variation in predicted pit rates

3. Identifying sources of uncertainty in the LPR process

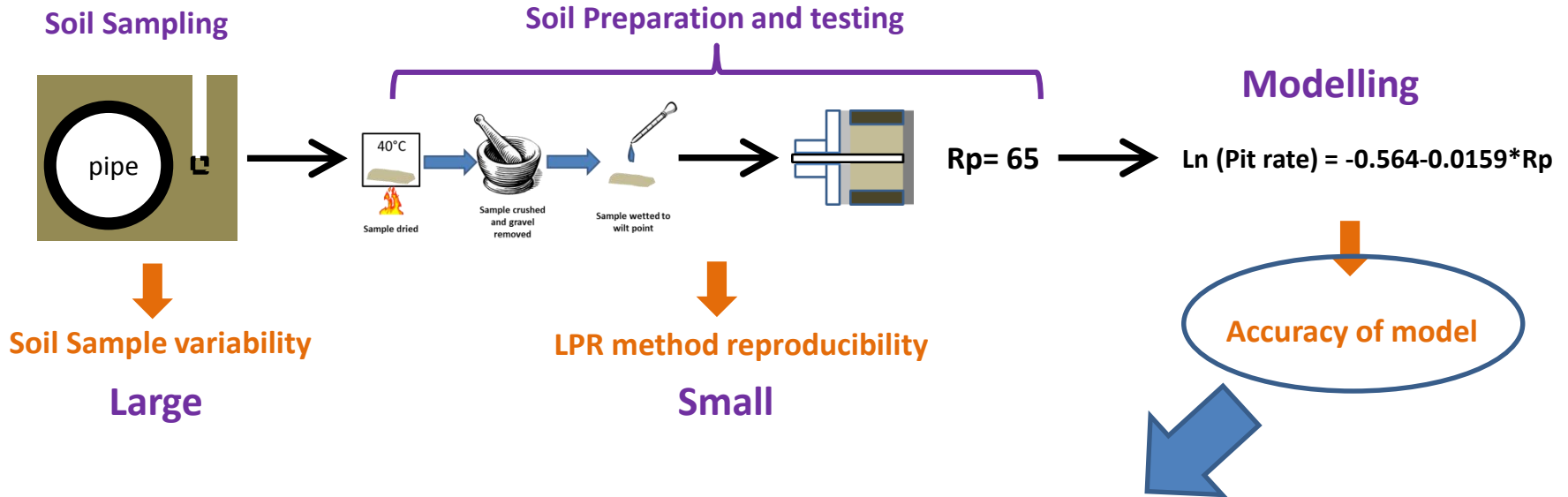
Soil Sample variability

LPR variation with small changes in soil sampling position



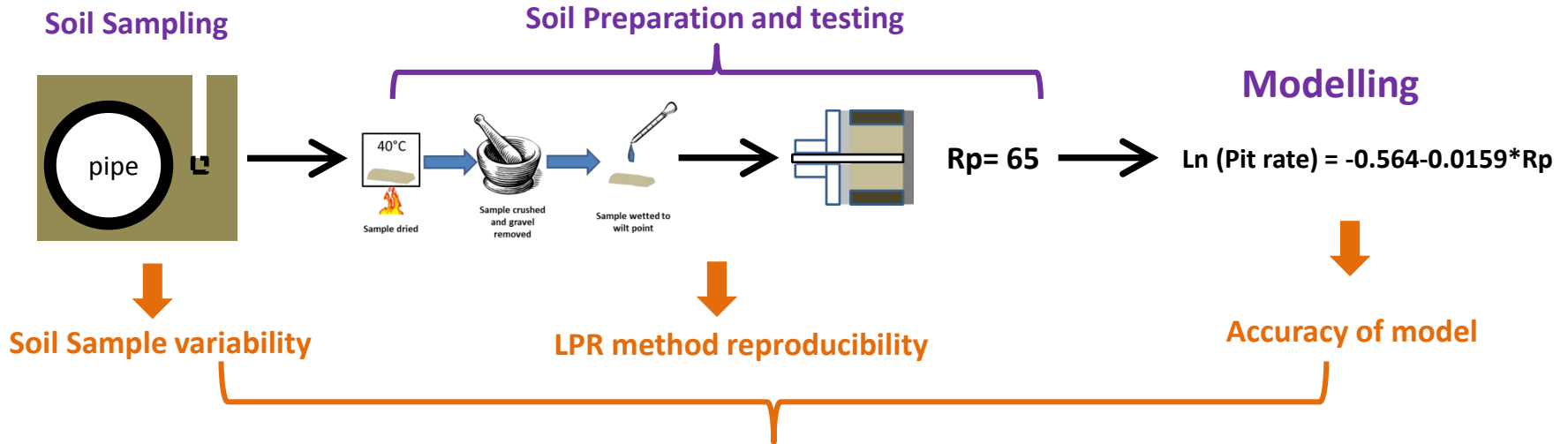
- This uncertainty includes variability due to method reproducibility
- Very large changes over short distances (**Rp up to 3× over 2m, pit rate up to +/- 0.1mm/yr**)
- Due to real changes in soil properties
- Much larger source of uncertainty than from LPR method itself

The LPR process



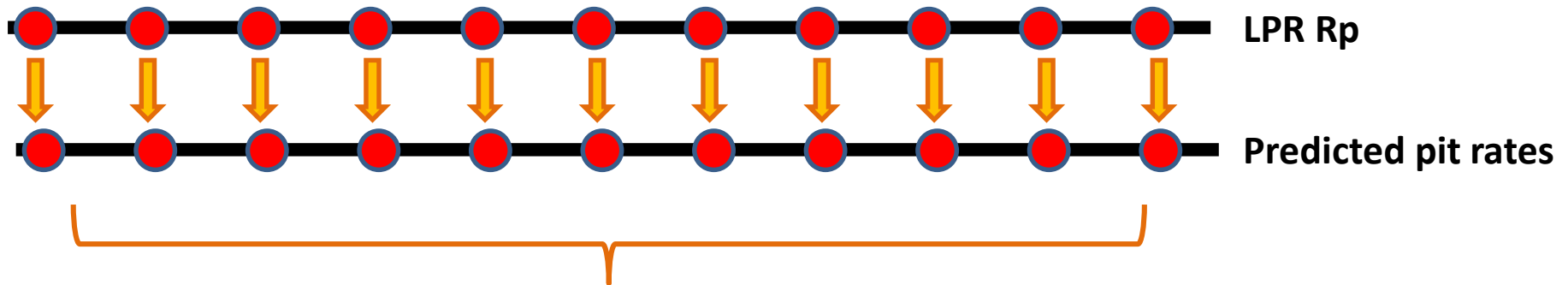
- Original formulation based on 30 cast iron pipe samples
- BUT we need original data to make a statement on uncertainty
- Despite much searching – unable to track it down

The LPR process

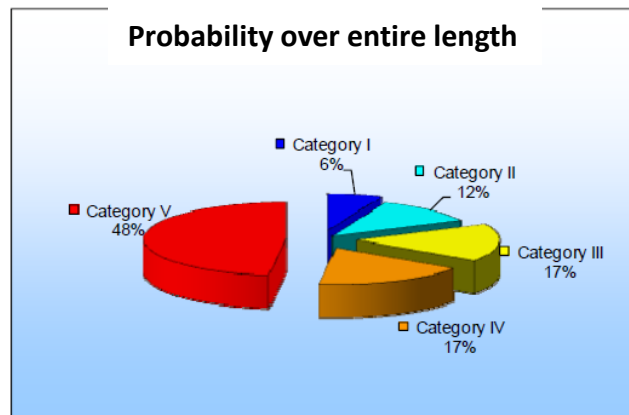


- Even assuming model works perfectly – it is clear that there is a considerable degree of uncertainty in LPR prediction due to variation in soil properties over even small distances.
- Pitting rates predicted at a given location using LPR should be treated with caution as R_p value can change a lot depending on exactly where you take the sample.
- **But LPR still useful!**

PCA overcomes this issue by basing its findings on statistical analysis of many samples taken along pipe



Statistical analysis of entire data set



← Other factors based on experience

4. Improvement to LPR-> pit rate model

$$\ln(\text{Pit rate}) = -0.564 - 0.0159 * R_p$$

UTS – ML model ← **Data needs:**

- LPR analysis + observed pits + other factors
- And lots of it

Not enough data

Pending work.

- **Will write papers (×2) outlining:**
 - **Current knowledge of the Theoretical basis of LPR**
 - **Relationship between theoretical basis and practical application of LPR**
- **More progress on improving LPR-> pit rate algorithm ??**



The End