

*Predictive maintenance in  
below ground structures  
– first year experience*

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# Agenda

- 100+ Sites
- 150+ pumps stations
- 200,000+ cycles
- 13 month experience

- Data from ALL cycles collected + any anomalies

## Agenda:

1. Predictive - is what ?
2. How do we do it:
  - a) Sensor suite
  - b) Upload
  - c) Analyzing software
  - d) The Service Analyst
3. Case studies
  - a) The broken float
  - b) Broken and leaking pipework
  - c) Failing pumps
4. Specific conclusions:
  - a) Less unplanned breakdowns
  - b) Client savings on periodic service
5. Way forward
  - a) Analysis
  - b) New sensors
  - c) Overall

# Predictive maintenance – our challenge

PPS perform 4000+ services visits/year  
Most are on fixed contract (2 service/Year)

- Can we adjust the interval?:
- Risk vs cost
- **What data do we need?**

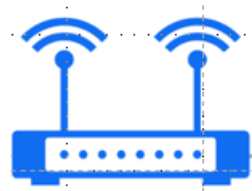
The breakdown rate is 12/100 sites & year

- Is costly (outside office hrs)
- Is high (why?)
- If flood → very costly
- **What data do we need?**

# *The basic flow*



The basement  
Sensors



Client  
gateway



Cloud



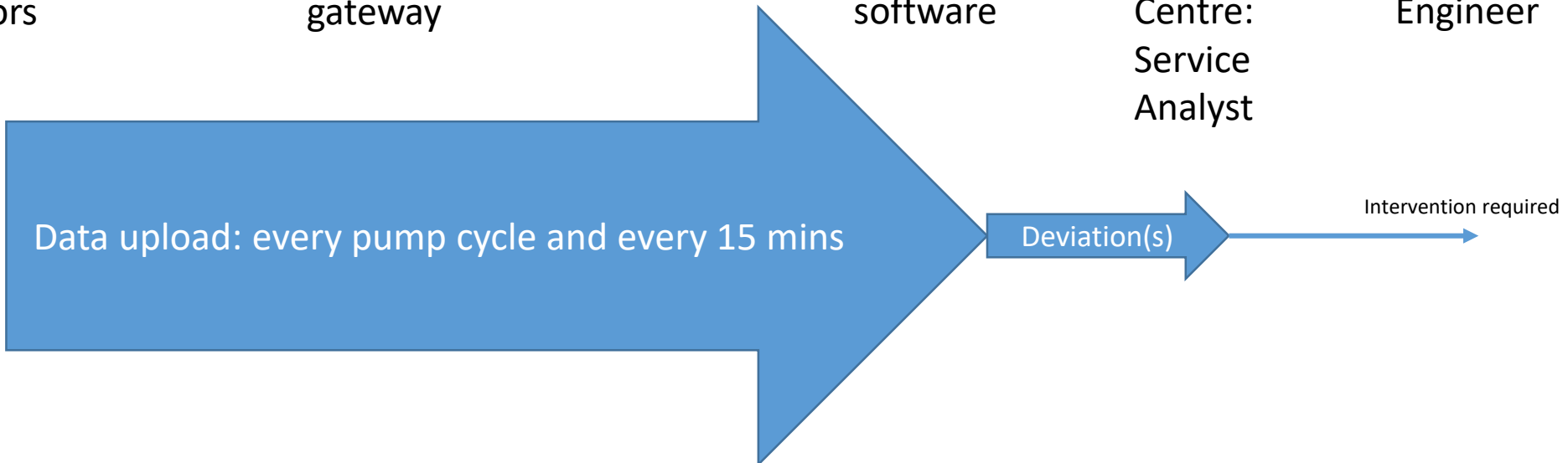
Analytic  
software



Operation  
Centre:  
Service  
Analyst



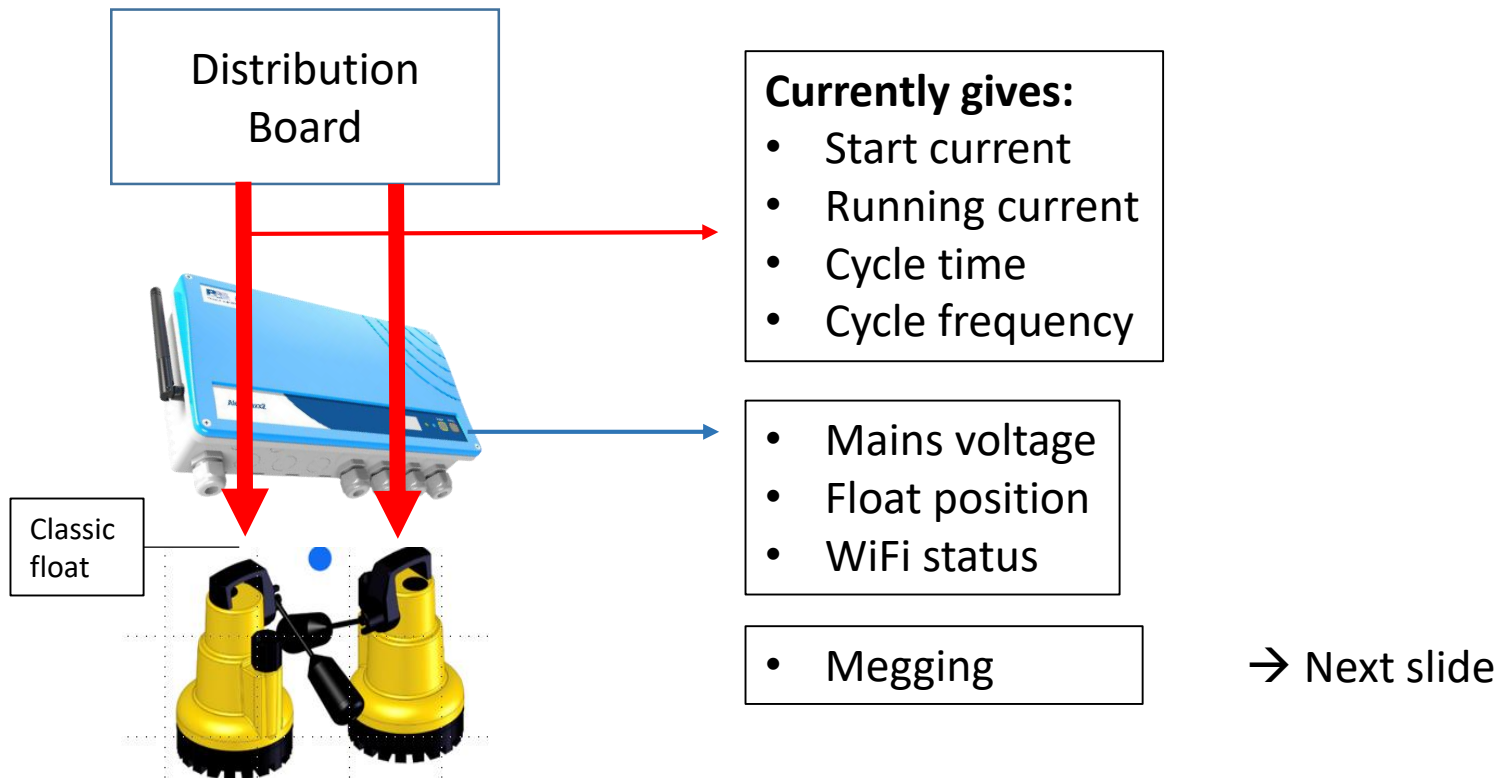
Service  
Engineer



# The sensors suite



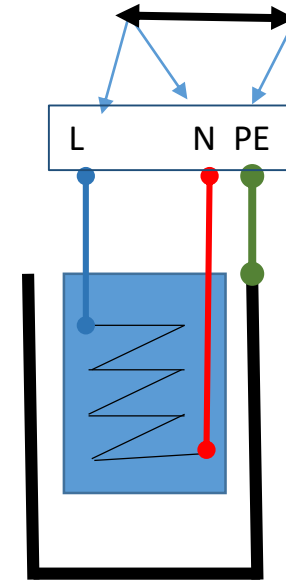
- Most basements pump stations have a high level alarm
- We selected our Hi level alarm as the sensor platform



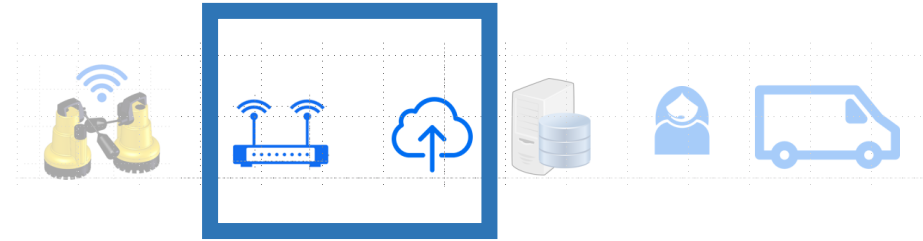
# Megging

- Megging = the resistance between cover or protective earth (PE) and motor windings – Live (L). Usually in “MegaOhms”
- Has been used over 100 years as a “quality” measure of electrical motors
- Standard practice and used in all serious maintenance situations
- Industry practice, when a motor is below 1M $\Omega$  → replace motor
- Is included in our sensor suite
- The unit “meggs” every 2 days. Data is uploaded

This is what is measured

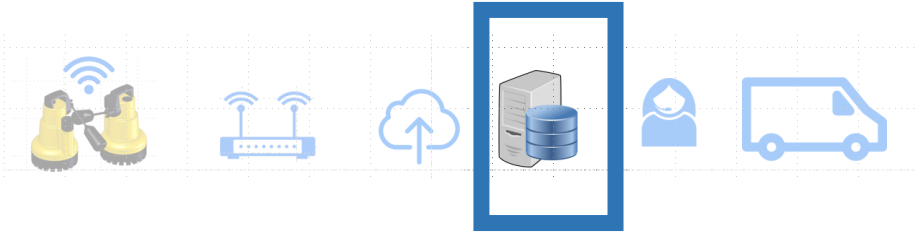


# *Upload*

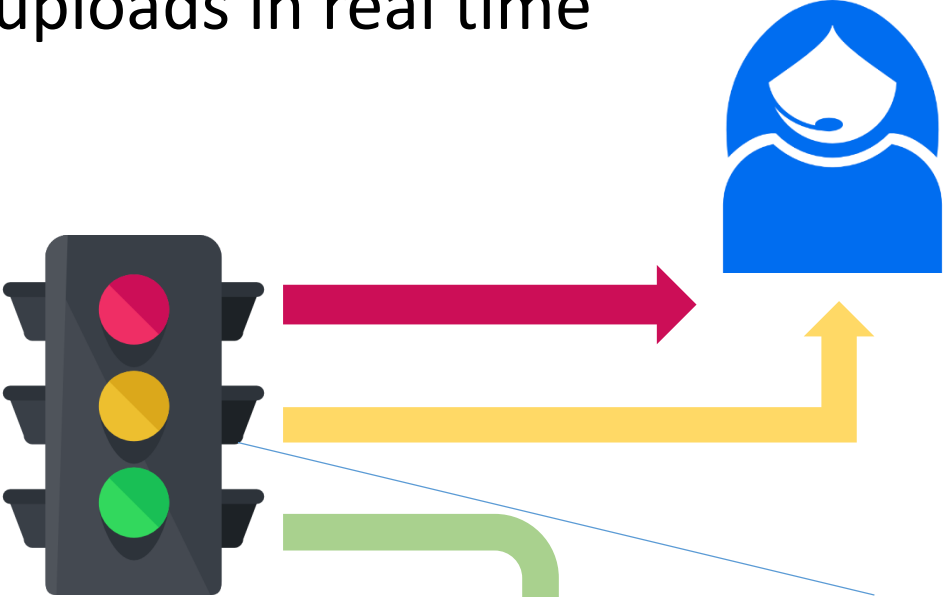
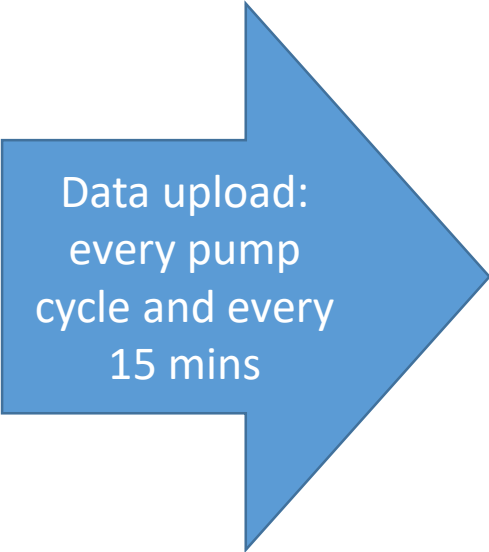


- In reality all residential properties have WiFi
- Signal strength usually excellent
- The cloud upload is done to a well established cloud service (Microsoft)
- No issues with response time or down time

# Analytic software



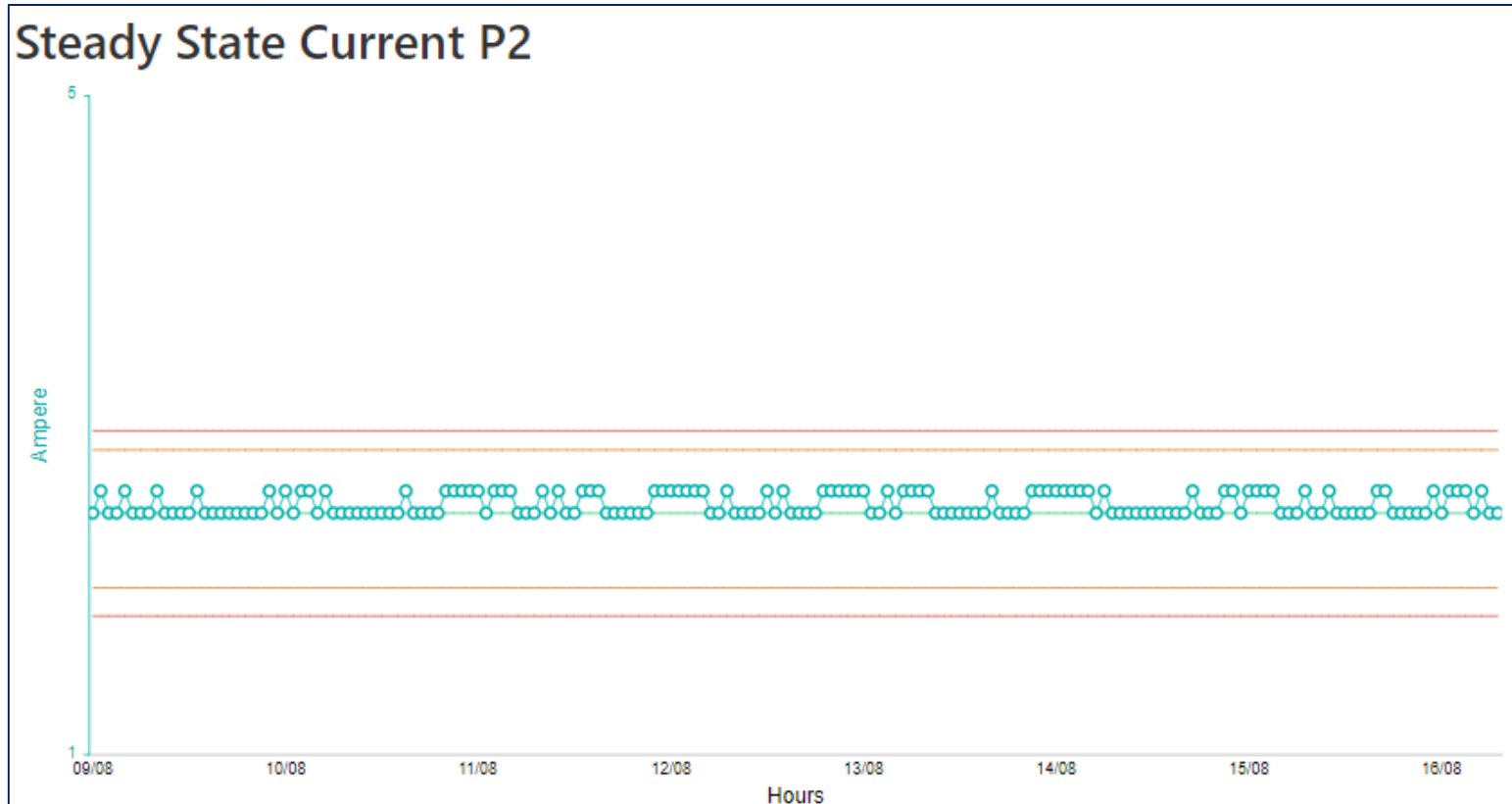
Evaluates ALL the uploads in real time



- Three key criteria:**
- Critical events
  - Thresholds
  - Trends



# Example – threshold (current)



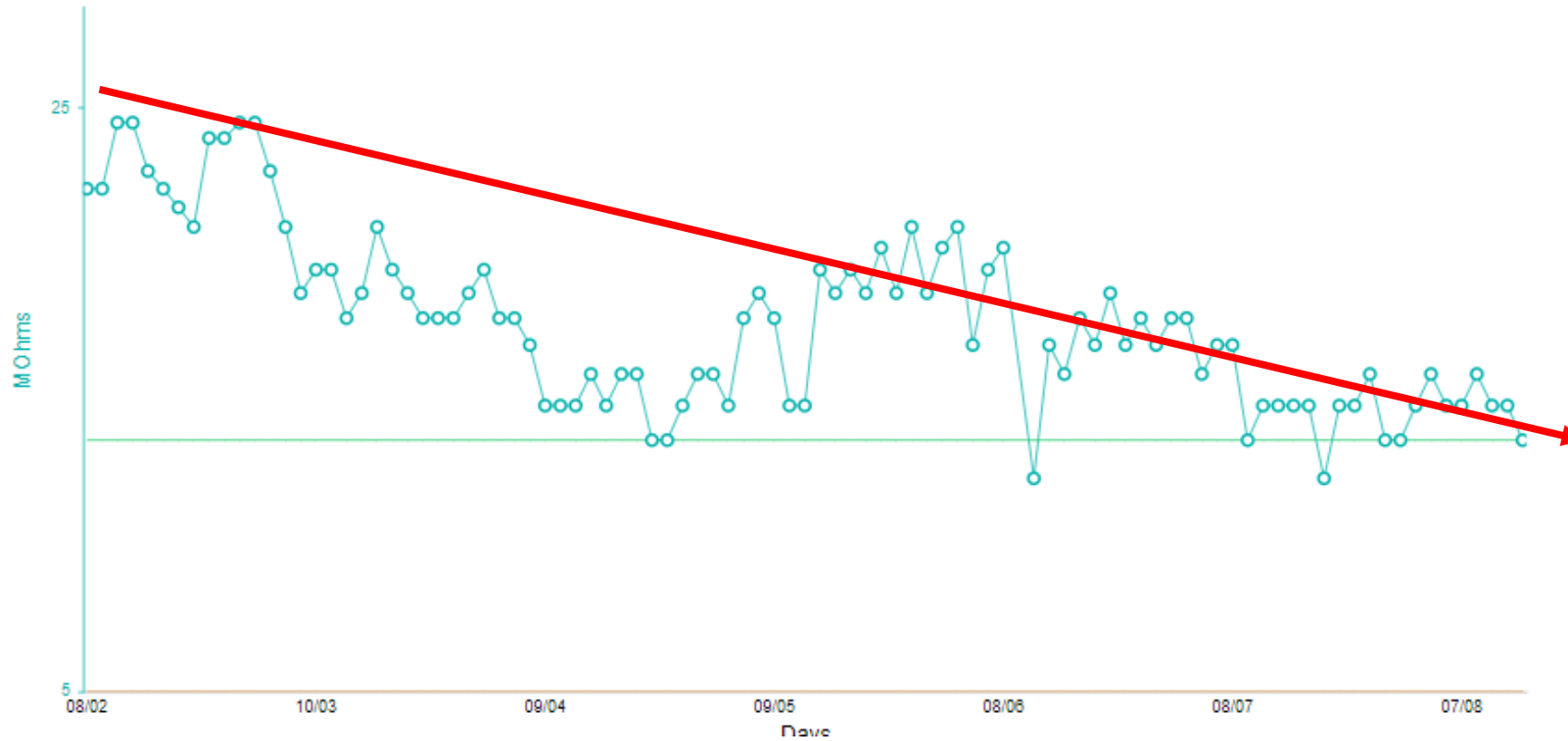
Upper threshold

Lower threshold

The Service Analyst will adjust the thresholds – if required

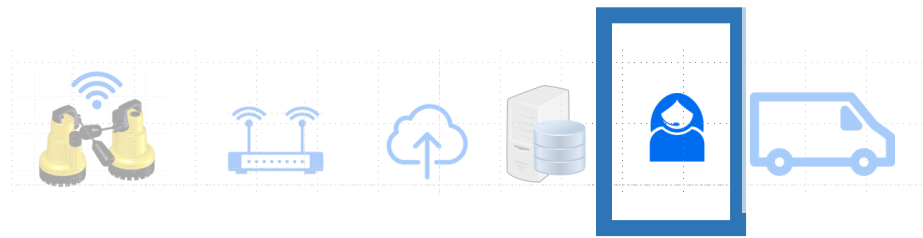
# Example – trends (ie megging)

Megger P2



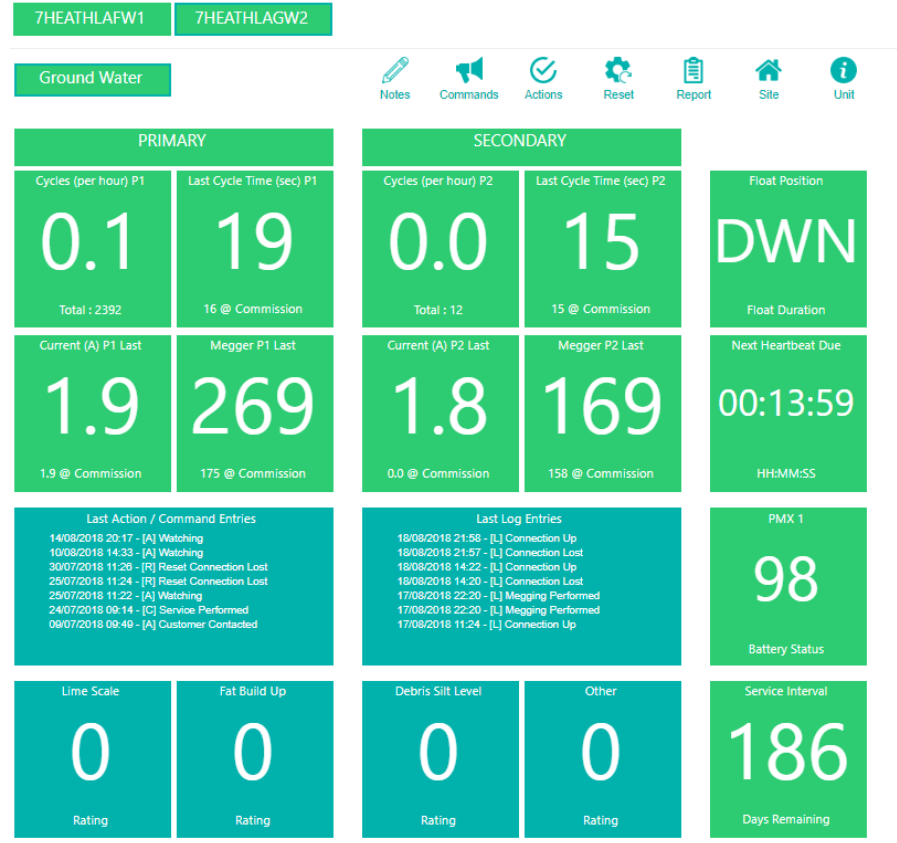
- This unit is not critical (yet)
- The alarm is set to monitor the slope
- Most likely the pump will last another 6 Mo

# The Service Analyst



## The Analyst can:

- Access the data
- Get graphs
- Get correlations
- Revise thresholds
- Make notes
- Command more data
- Sound alarm at site



## The Service Analyst:

- A new skill
- A merge of:
  1. Pump Engineer
  2. Service rep
  3. SW savvy
  4. Academic skills
- Crucial for success

# Case #1 – a “broken” float switch



**The Alarm:** Cycle time: 20→40 secs



## **Analysis:**

1. Site history: very stable → An irregularity
2. Cyc/hr: 1 → 0.5 cyc/h. → Same volume is pumped \*)
3. Current is stable. → Pump is OK
4. No high water alarm → Situation under control

## **Conclusion:**

- Float is not working correctly
- Send service engineer during the day – urgent but not critical



**Note:** \*)  $20 \times 1 = 40 \times 0.5$  is same amount

# Case #2 – broken and leaking pipework



**The Alarm:** Cycle time: 20 → continuous



**Analysis:**

- 1. Low intensity site (0.1cyc/h) → Can survive a few hrs
- 2. Current slightly lower → Dry pumping ?
- 3. No high water alarm . → Not critical yet

**Conclusion:**

Either:

- Dry pumping
- or
- Leaking pipe
- Send service engineer during the day



**On site:** Pipe was loose – water recycled within chamber

# Case #3 – megging

## **Background data:**

The median for ALL pumps has: 88M $\Omega$ m → 67 M $\Omega$ m (6Mo)

This is as expected and along industry standard

## **Breakdown data**

12 Breakdowns/100 Site Years

- 6 pump related
- 6 floats and misc

This would imply that we on our 60 site years would have pump **3.6 failures**

## **Our decision (at startup)**

“Replace any single pump, that meggs <1M $\Omega$ m”

→ **2 Pumps** replace at the standard



## **IMPLICATION:**

**3.6 unscheduled breakdowns was replaced with 2 pump changes on scheduled visits**

**Caveat:** Statistically somewhat small sample

# *Conclusion #1*

The collected data (especially current & megging) is sufficient to make very precise evaluation of the pump station status.

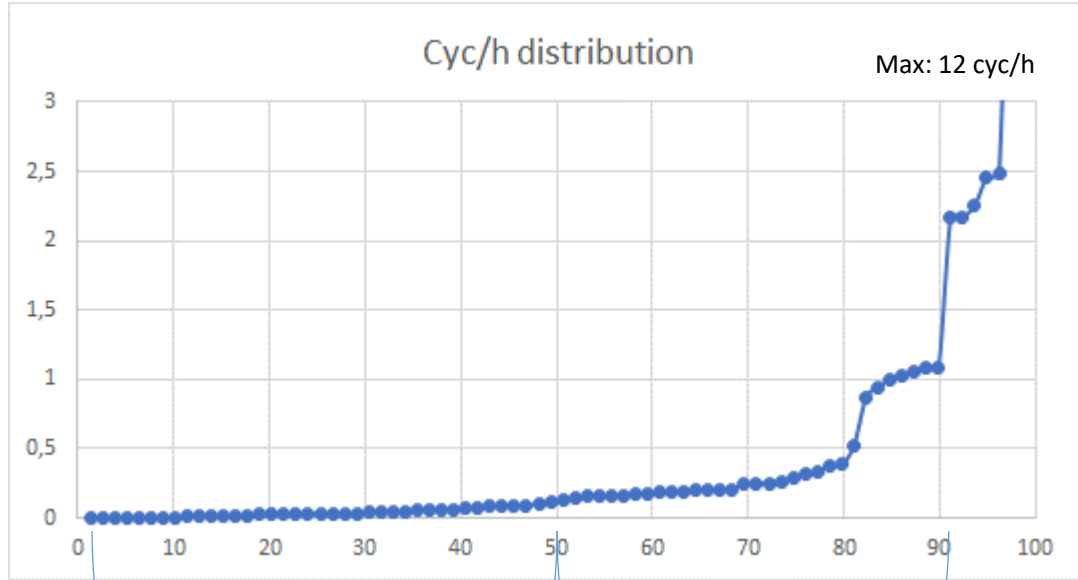
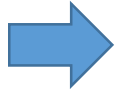
## *Means:*

- Less unscheduled visits
- Good data for 'tweaking' scheduled visits i.e. Dynamic servicing
- We can be somewhat "braver"
- Visit site with the right parts can be on the van

# Conclusion #2

## Dynamic servicing

From our database

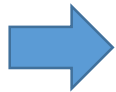


50% <0.1 cyc/h

40% 0.1-1 cyc/h



Current industry approach  
2 visits/Y



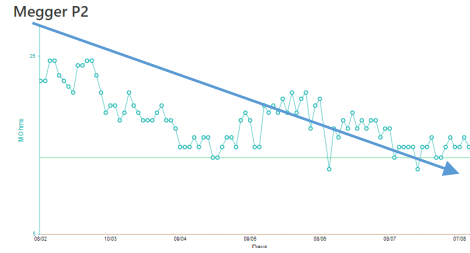
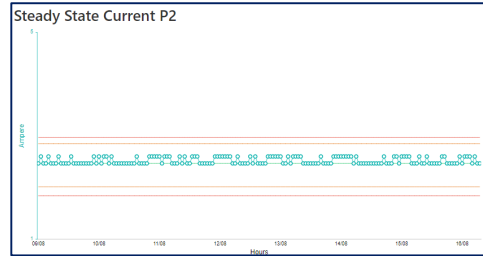
**Adjust interval to "reality"**



Cost of ownership will go down



# Way forward - analysis



Visual inspection

Analyze thresholds

Analyze trends

True machine learning

(history)

(very good)

(started)

(2019)

As our data and knowledge increase, we will be able to tackle the 12 Breakdowns/SiteYear

# Way forward – sensors

- The sensor suite is sufficient at this moment
- The key ones are:
  - Hi level alarm
  - Current
  - Megg data
- Most other parameters can be derived from those

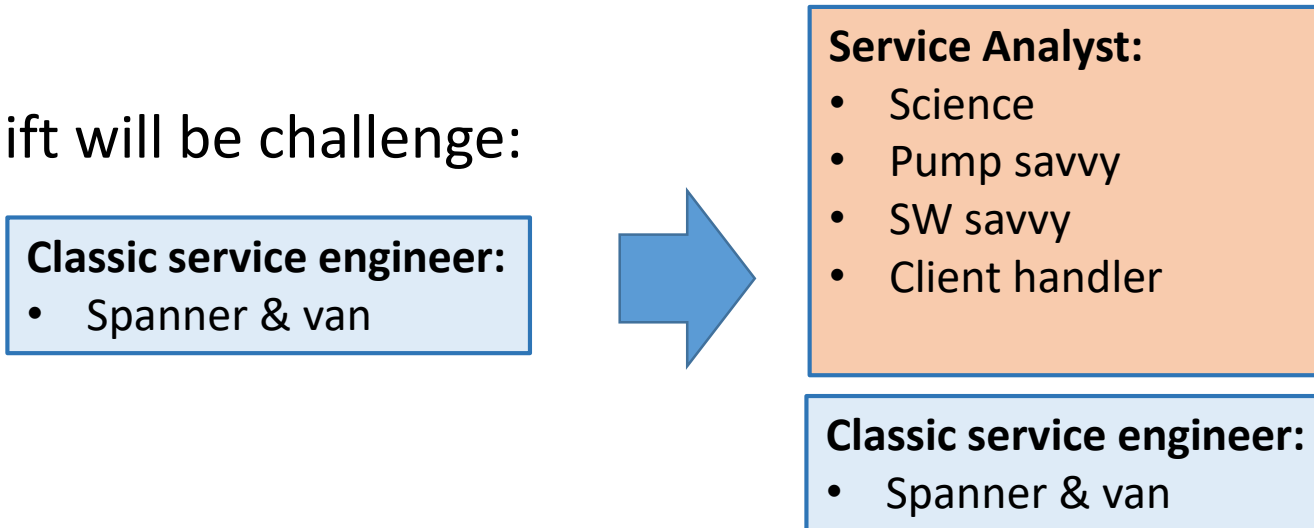
## *However*

- Cost for sensors are going down.
- This open possibility for “new” sensors
- Computer power and AI allows us to process the data:
- Possibly:
  - Sound/Vibration
  - Video/Picture

# Way forward

- As number of sites grow, our knowledge and skills increase
- The software can be constantly enhanced
- We already have more data about operational pumps than most manufacturers
- The concept will also work well in the “light commercial” environment
- We are inviting other service providers to participate in the concept

The skill shift will be challenge:



*This is the way forward – there is no U-turn.....*



*Thank you*