



*Setting the Standard for Automation™*

## **Summary of the King County, Washington, West Point WWTP Flood of 2017**

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**2018 ISA Water/Wastewater & Automatic Controls  
Symposium (WWAC)  
8-9 August 2018, Bethesda, Maryland USA**

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# Brian's Bio

- Control Systems Engineer, Copper Bell Consulting LLC
- 30 years experience in water and wastewater I&C
- I&C Engineering consulting to municipal and industrial clients
- Previously with Kubota Membrane, CH2M, Parsons International, etc. On and off at this plant since 1988
- BSEE from Rose-Hulman Institute of Technology, Indiana
- Professional Engineer, Control Systems, Washington
- Past president, current treasurer of the Seattle ISA local section
- Plays taps for military funerals (Bugles Across America)

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# Site of West Point WWTP



Army  
Fort Lawton

Discovery  
Park

Light  
House

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- 1884 City Engineer Reginald Heber Thomson – Lake Union and Washington getting polluted
- Find somewhere else to dump sewage!
- 1904 studies found West Point beach had nice outgoing currents
- 1918 a 12 ft. diameter pipe discharged there 45 ft. below high tide (still not nice on beach)
- Dumped raw sewage combined with storm water runoff until mid 1960s

# The twelve foot pipe!



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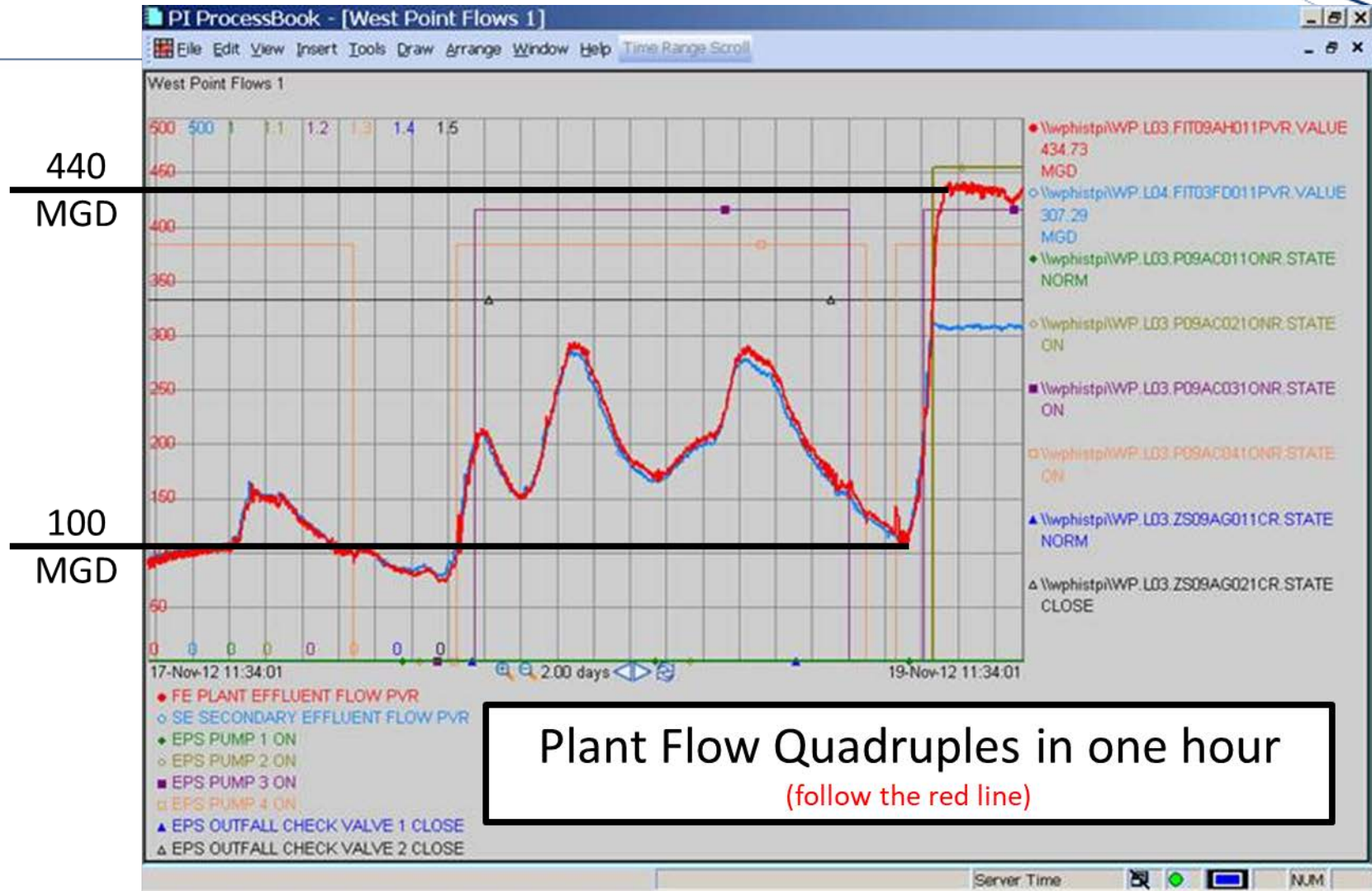
- 1966 Treatment Plant opened with Primary Treatment process
- 1970s Feds decree Secondary Treatment process needed for better effluent quality
- 1980s New expansion planned and designed by CH2M Hill consulting engineering firm
- 1995 Treatment begins with new secondary plant and renovated primary plant
- 2000 to 2017 – Operates with a few plant bypasses due to failures with some “little” floods
- **Feb 9 – Catastrophic failure and plant flood wrecks Primary plant.**

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# Extreme flow rate increases possible



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# Plant conditions just prior to event



- Major Rainstorm - combined wastewater and runoff water is coming into plant fast. A regular wet weather condition.
- 2 in the morning
- Crew of 9 people scattered around the plant
- Plant flow at 450 mgd
- 4 Raw Sewage Pumps (RSP) Running full out
- 3 Effluent Pumps running ~ 100%
- Pretty normal circumstance for a storm

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# Simplified sequence of events



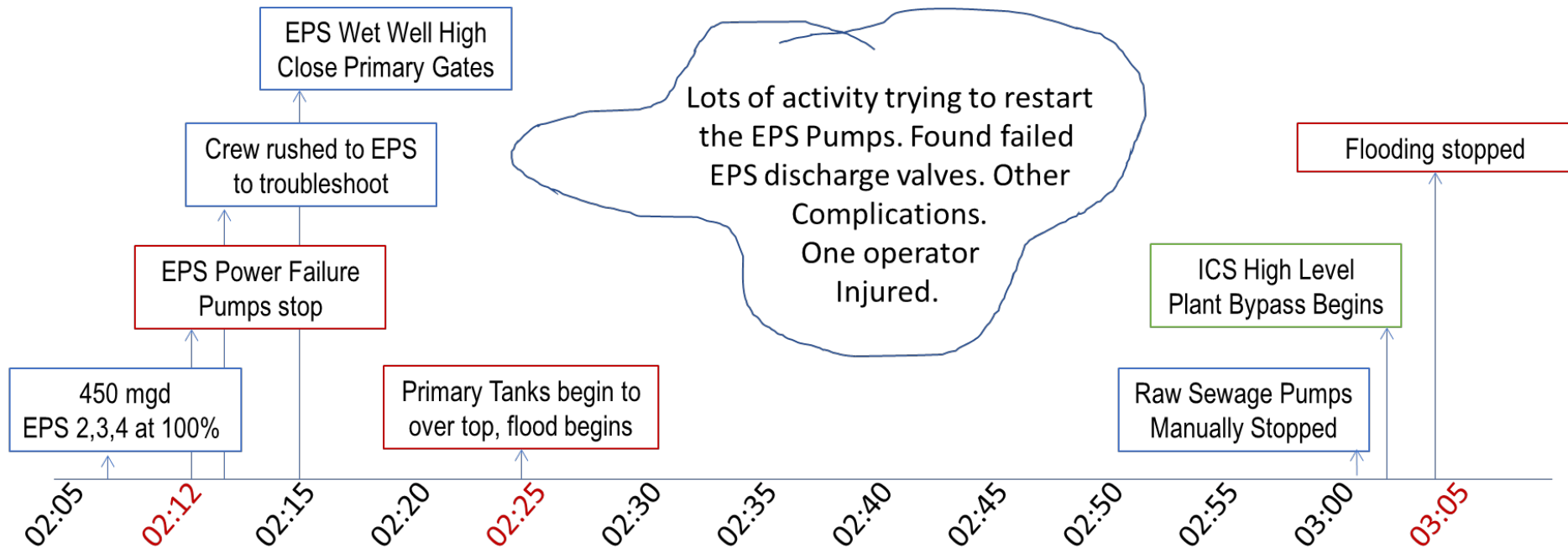
- Motor Control Center power fault caused 2 Effluent Pumps to fail
- Critical valve controls also powered from same Motor Control Center – common to all valves
- Effluent Pump Station reached High level – This closed weirs at the Primary Tanks
- Primary Tanks began to fill and started reaching High levels
- Critical level float switches failed to shut down the Raw Sewage Pumps
- Levels rose and overtopped the Primary Tanks causing flooding to the plant galleries
- Operators stopped Raw Sewage Pumps, Influent Control Structure level rose to High
- Influent Control Structure float switches triggered plant bypass
- Hundreds of control system alarms flooded the operator’s graphic screens

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# Event timeline

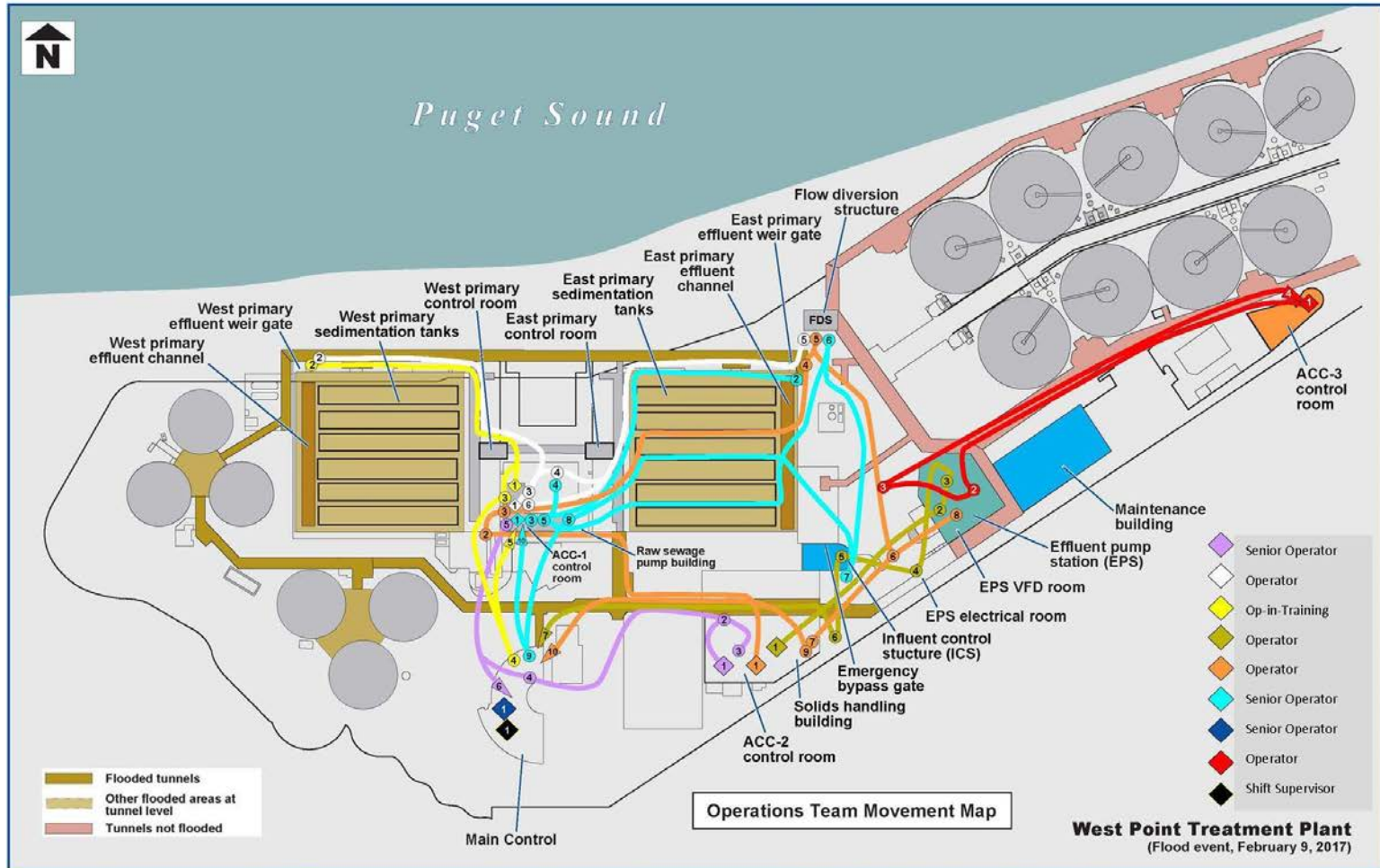


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# Operator movements during event



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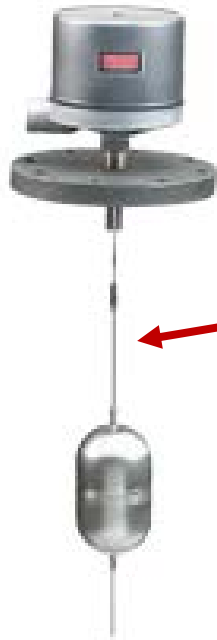
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# Primary tanks high level float switches



The Mercoid Series 301, explosion proof switch



Why did 12 of these all fail at the same time?

All the important high level switches in the Primary Tanks failed because these rods got bent during regular maintenance and cleaning.

It was being done wrong.

<https://goo.gl/VLwqRQ>

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# Old and replacement high level float switches



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# Independent investigation called for



- King County Council itself commissioned and managed the investigation
- Project limited to companies that had not worked at the plant in previous 3 years - This knocked out all the normal consultants who have been working there long term
- Went out for public bid
- AECOM won the project
- They had only 8 weeks to do it!

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- Collect documentation on all the related systems in the failed systems
- Collect all the memos reports already written the staff and by other consultants
- Interview the crew who was on shift and others in management and O&M
- Conduct workshops with plant staff and HAZOP analysis
- Analysis and report writing
- Get close to the deadline, ask for a couple more weeks to finish the report
- Deliver the report and a presentation to the Council and the press at the same time

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- West Point WWTP has many constraints, and the strain on the plant will worsen
  - Location is very small compared to its maximum flow rate (*No hydraulic storage*)
  - Population and urbanization will increase the demand on the plant
  - Climate change may increase the severity of storms in the combined collection
- West Point WWTP does not have sufficient redundancy
  - Maximum flow requires all Raw Sewage Pumps to run with no backup pump
  - The Firm Capacity of the plant, taking redundancy into account, is less than 440 mgd
- West Point WWTP needs a higher level of operational integration to manage interdependencies
- Emergency Response Training did not anticipate this type of emergency

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# The *Normalization of Deviance* Theory of Diane Vaughan, Sociologist and Author



- “Social normalization of deviance means that people within the organization become so much accustomed to a deviant behavior that they don't consider it as deviant, despite the fact that they far exceed their own rules for the elementary safety" People grow more accustomed to the deviant behavior the more it occurs. To people outside of the organization, the activities seem deviant; however, people within the organization do not recognize the deviance because it is seen as a normal occurrence. In hindsight, people within the organization realize that their seemingly normal behavior was deviant.” [1]
- The term “deviant” is meant to convey something that deviates from an internal standard of quality or perhaps an industrial norm.

[1] [https://en.wikibooks.org/wiki/Professionalism/Diane\\_Vaughan\\_and\\_the\\_normalization\\_of\\_deviance](https://en.wikibooks.org/wiki/Professionalism/Diane_Vaughan_and_the_normalization_of_deviance)

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- Plant Design
  - Effluent Pump Station (EPS) electrical redundancy
  - Pump discharge valve hydraulic power redundancy
  - “Hardwired” float switch protection circuits
  - Location and size of plant in the first place
  - Hydraulic storage = zero
- Maintenance
  - Electrical Motor Control Center failure – no cause found
  - Float switch maintenance procedure that was deviant from industry norms
- Operations
  - Culture of “No Bypass” – Major root cause in operational philosophy
  - Operators did not know how much time they had to fix EPS before flooding began
  - Training for this exact scenario – how can they train for every scenario?