



*Setting the Standard for Automation™*

**Where your Drinking Water  
Comes from...**  
  
**(and how it all relies on  
industrial automation systems)**

Graham Nasby  
City of Guelph Water Services  
Guelph, Ontario, Canada

**ISA Toronto – Annual General Meeting (AGM)**  
May 30, 2019 – Toronto, Ontario, Canada

# About the Speaker



**Graham Nasby, P.Eng., PMP, CAP**  
**Water SCADA & Security Specialist**  
**City of Guelph Water Services**



- 10 years in the consulting sector
- Joined Guelph Water Services in 2015
- Vice-President of Industries & Sciences in ISA
- Co-chair of ISA112 SCADA Systems standards committee
- Voting member of ISA101 HMI Design and ISA18 Alarm Management standards committees
- Named Canadian Expert on IEC/SCC-TC65 with Standards Council of Canada
- Active member of American Water Works Association and Water Environment Federation
- WebMaster for ISA Hamilton Section
- Has published over 40 papers and articles on automation topics
- Received University of Guelph “Mid Career Achievement Award” in 2014
- Named ISA’s technical division leader of the year award in 2013.
- Contact: [graham.nasby@guelph.ca](mailto:graham.nasby@guelph.ca)

# Presentation Outline

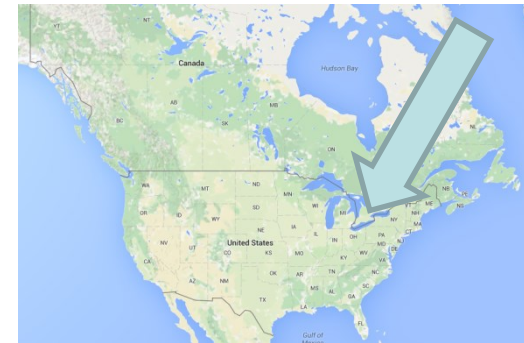


- About Guelph Water Services
- Components of a Municipal Water System
- Operational Framework
- Managing a Drinking Water System
  
- Water Sources
- Water Treatment
- Water Distribution
  
- Municipal Water SCADA Systems
- Components of a typical SCADA System



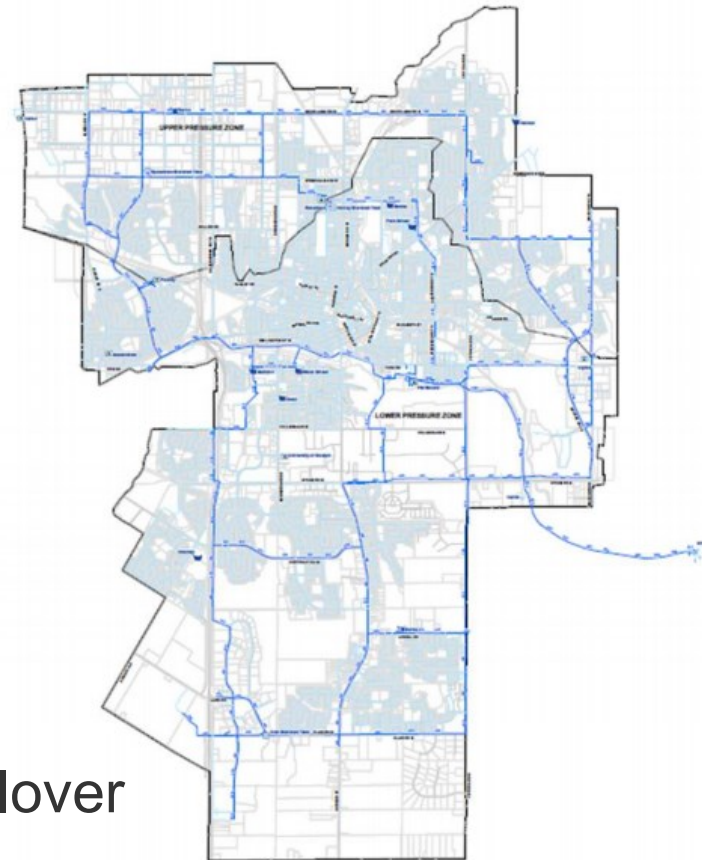
# City of Guelph Water Services

- Guelph, Ontario, Canada
- 140,000 residents
- 21 groundwater wells
- 3 water towers
- 549 km of water mains
- 49,000 service connections
- 2,750 fire hydrants
- 46,000 m<sup>3</sup>/day [12 MGD]



# Guelph Water Facilities

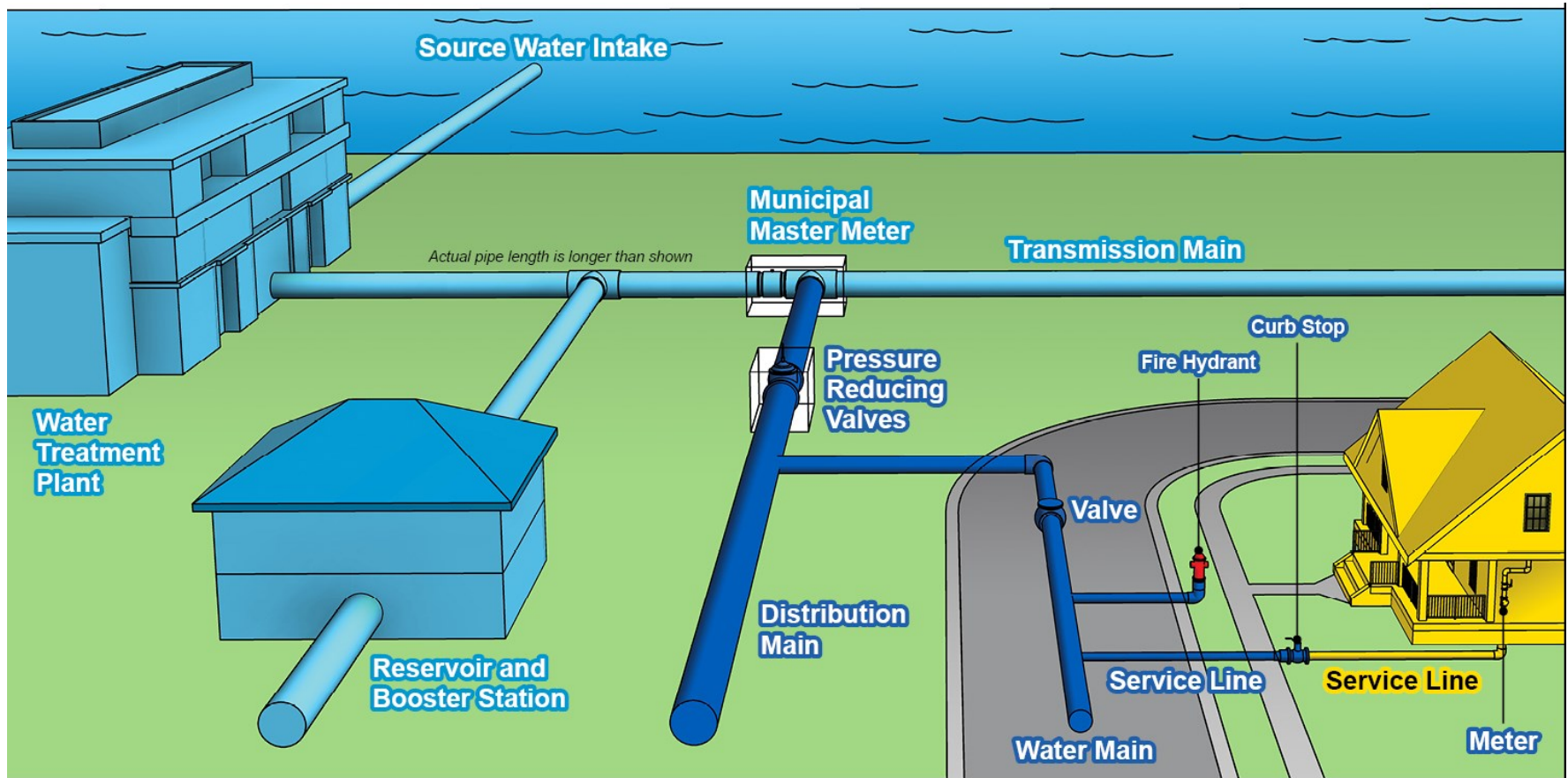
- Approx. 15km x 15km (10mi x 10mi)
- 35 Facilities
  - 4 booster stations
  - 21 wells
  - 2 valve chambers
  - 3 water towers
  - 5 monitoring sites
- High availability SCADA network
  - Primary: private fibre optic
  - Secondary: private wireless, auto-failover
- 40 PLCs plus 2 data centers



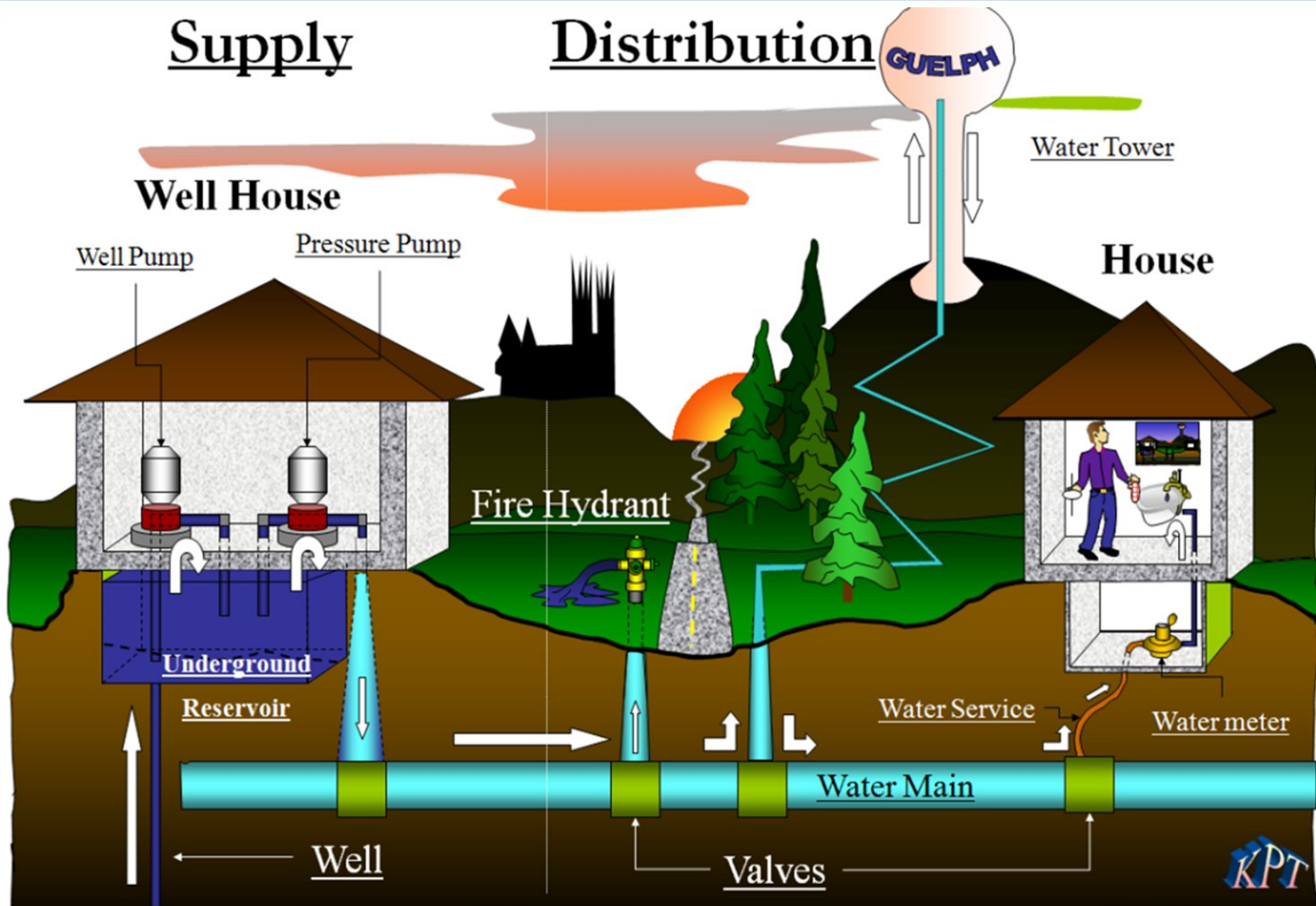
# Introduction



# Typical Surface Water System

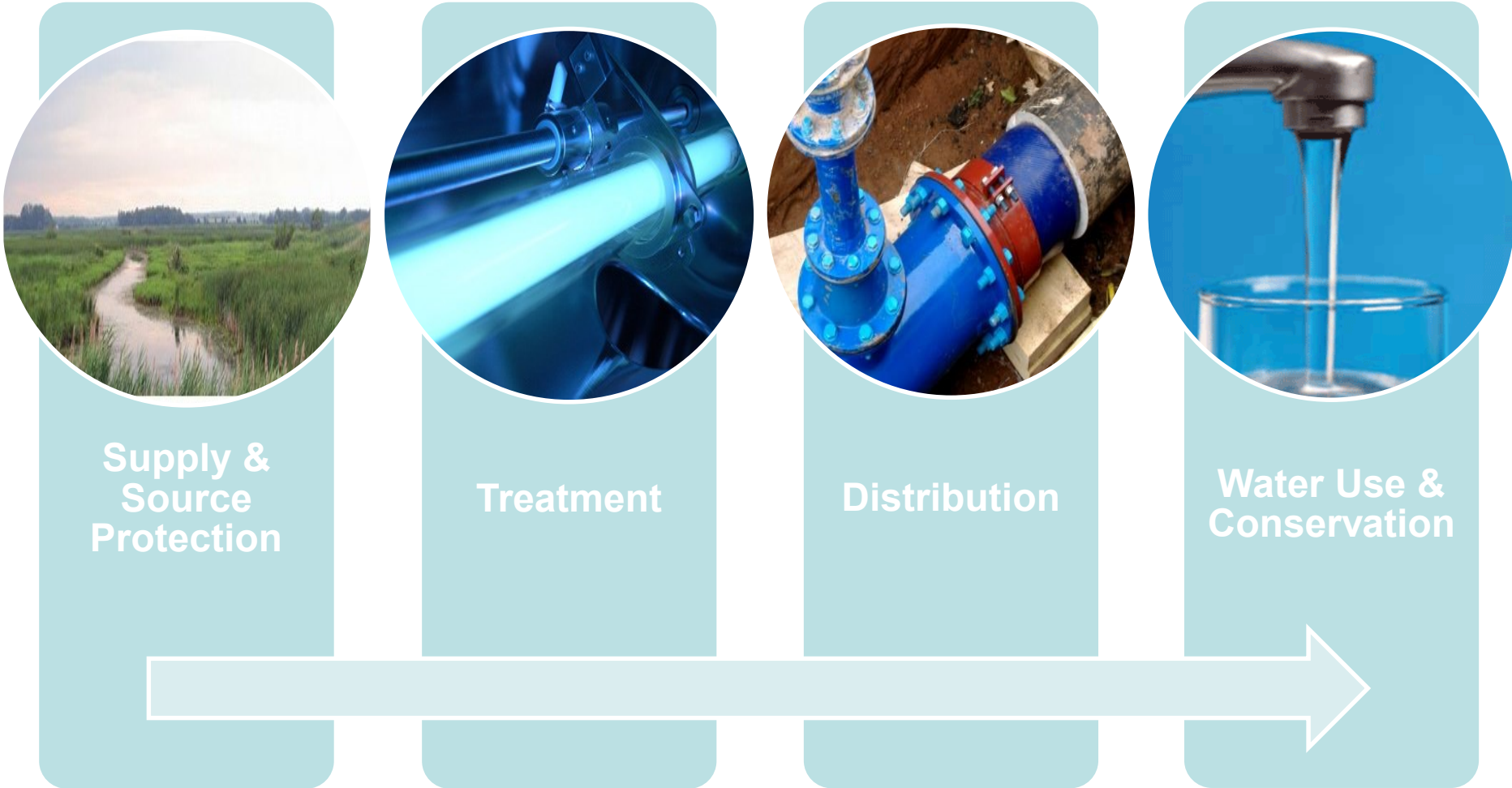


# Typical Groundwater System

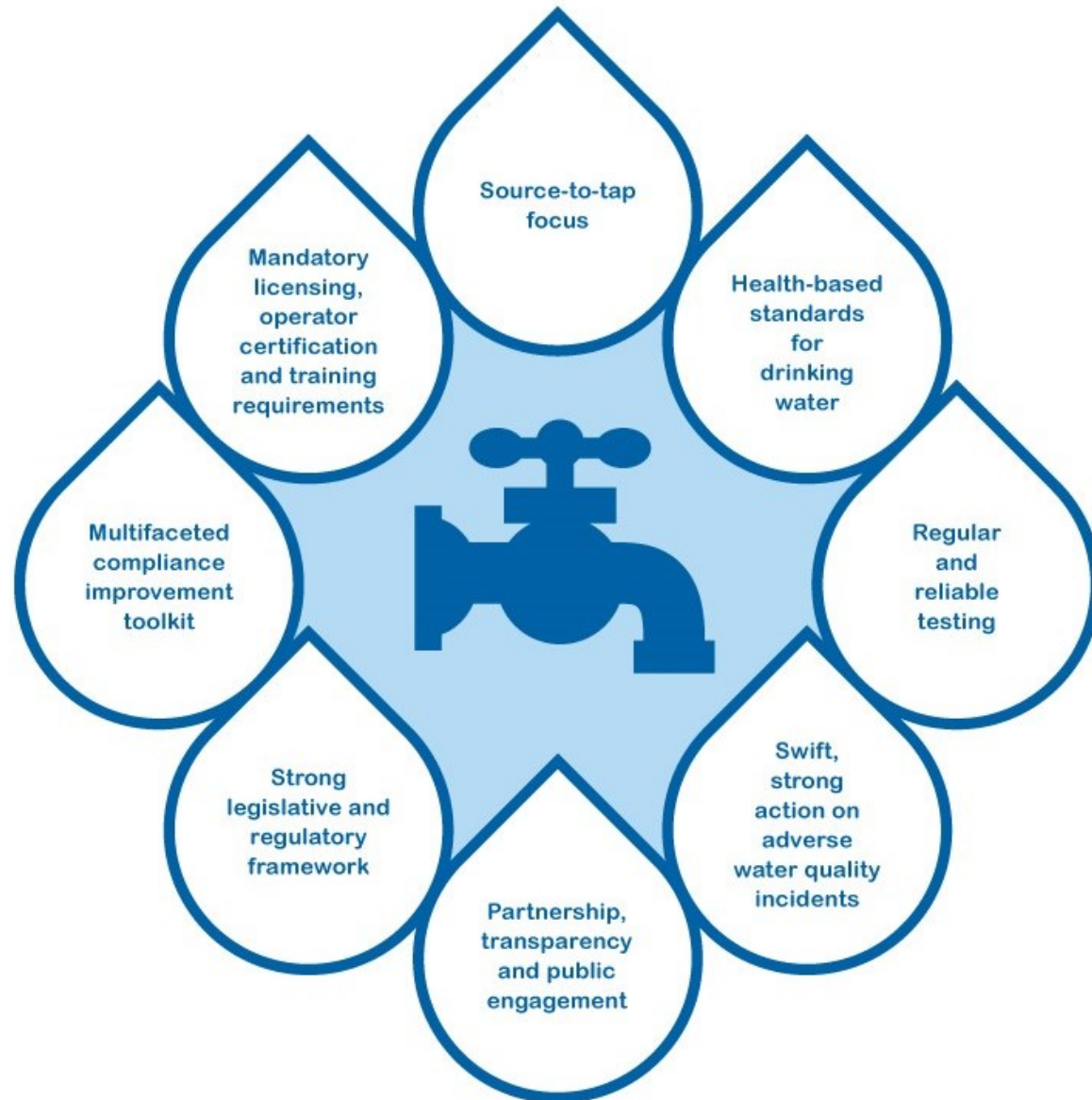




# Components of a Drinking Water System

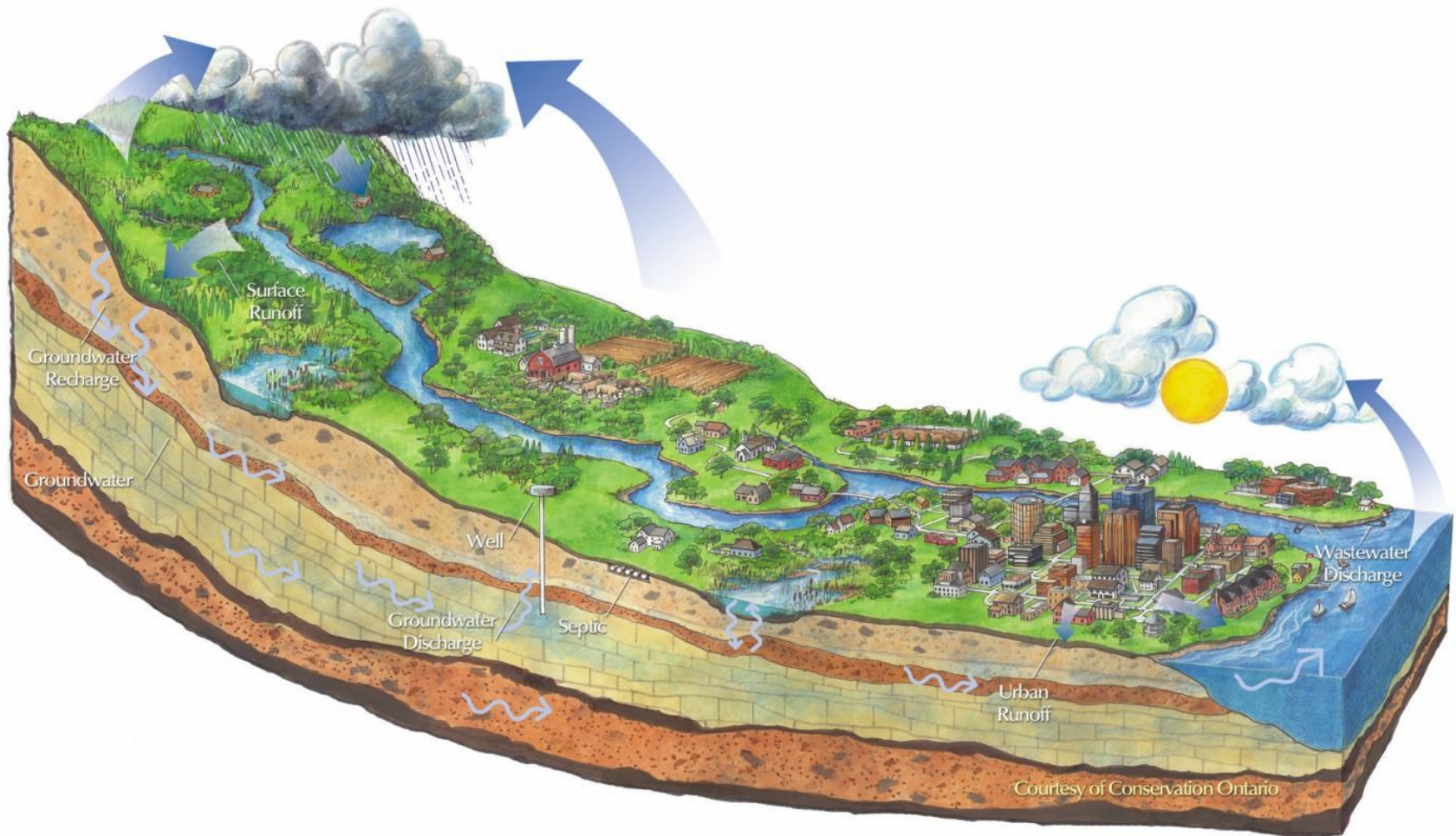


# Operational Framework



# Source Water

# Water Cycle



# Source Water

## Surface Water – A Typical Watershed





# Surface Water River Source



# Surface Water River Source





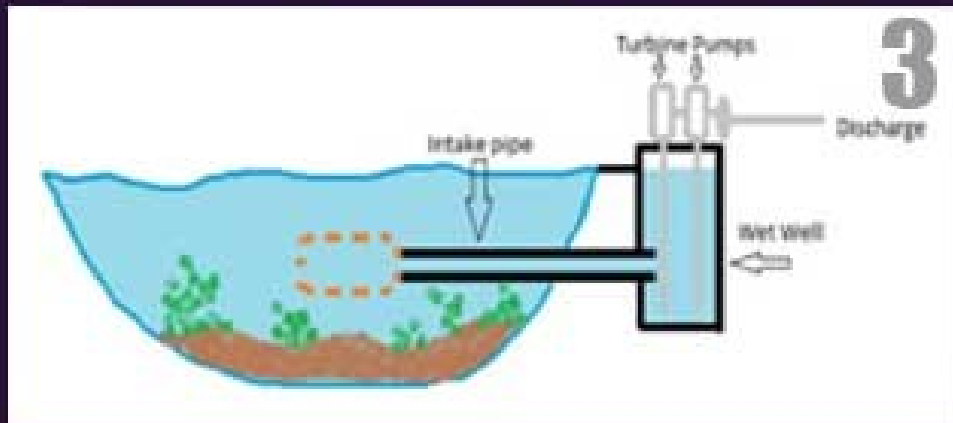
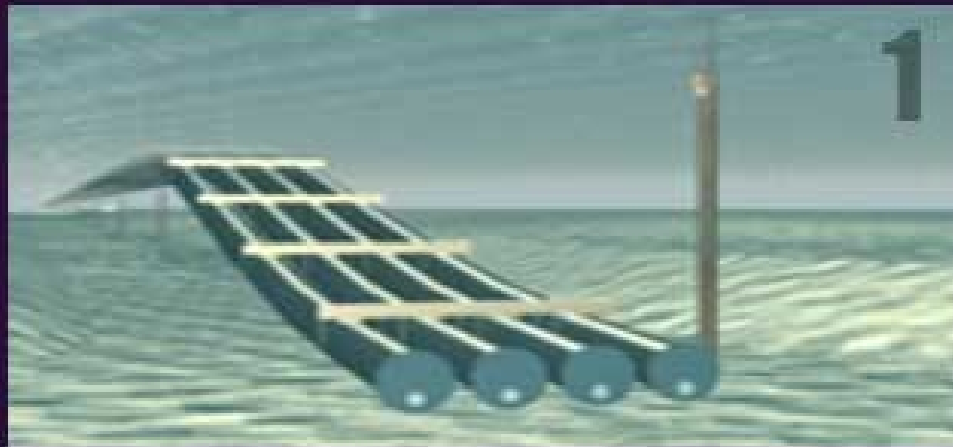
# Surface Water Lake Source



# Surface Water Lake Source

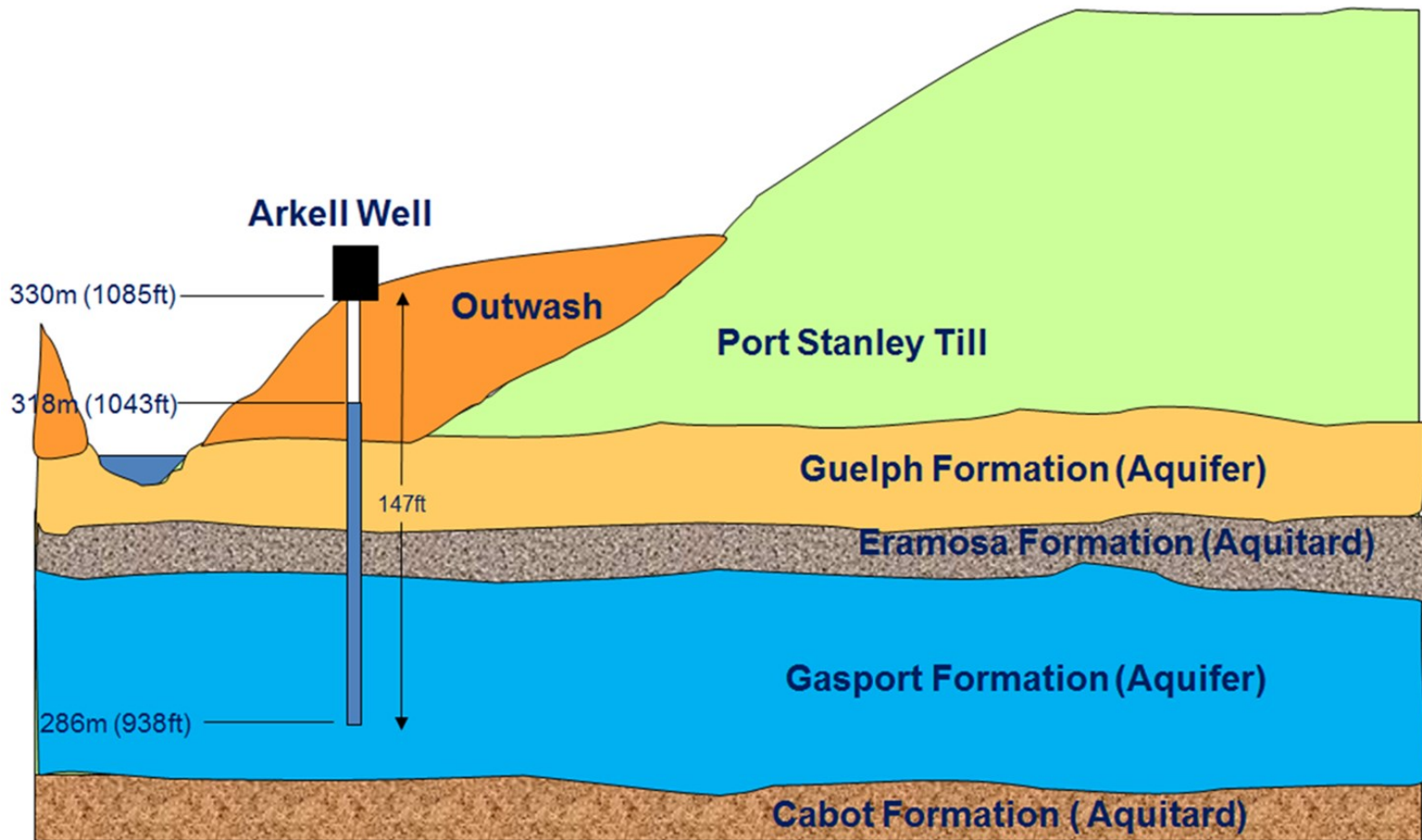


# Intake Structures for a Surface Water Source





# Ground Water Source Example



# Groundwater – Typical Well Pumps

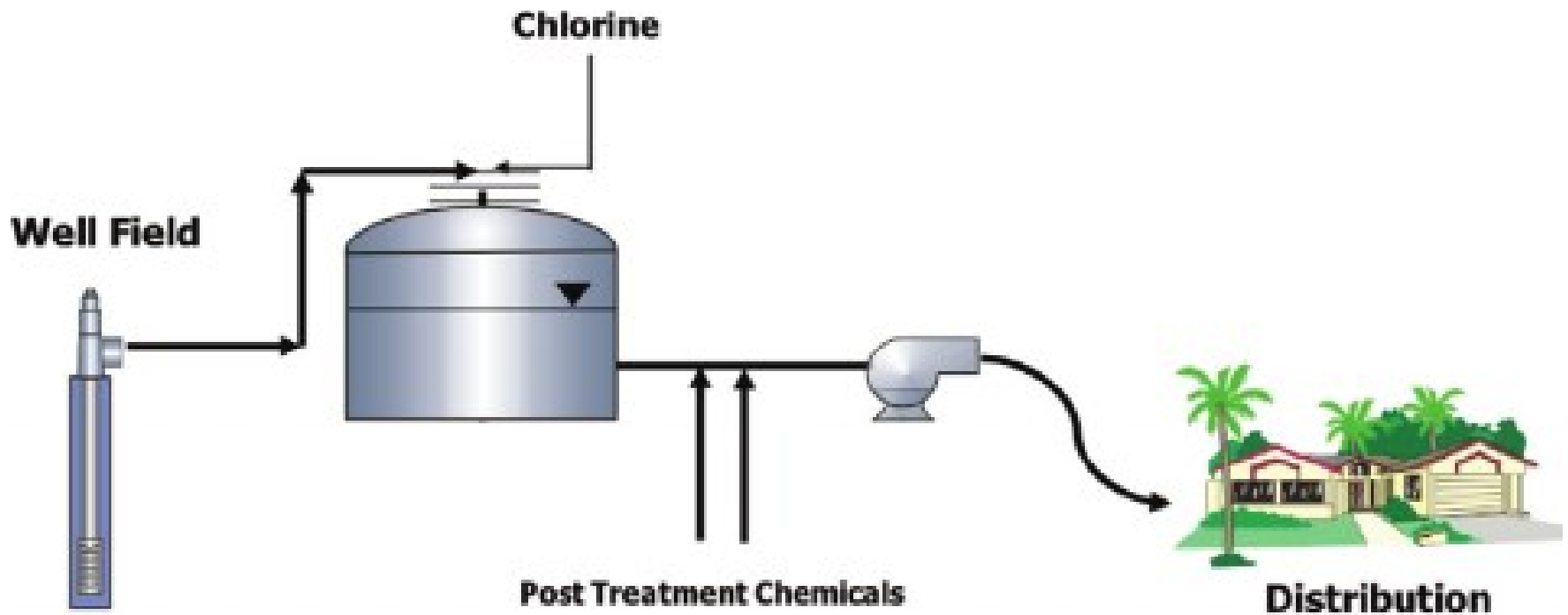


# Groundwater Recharge System



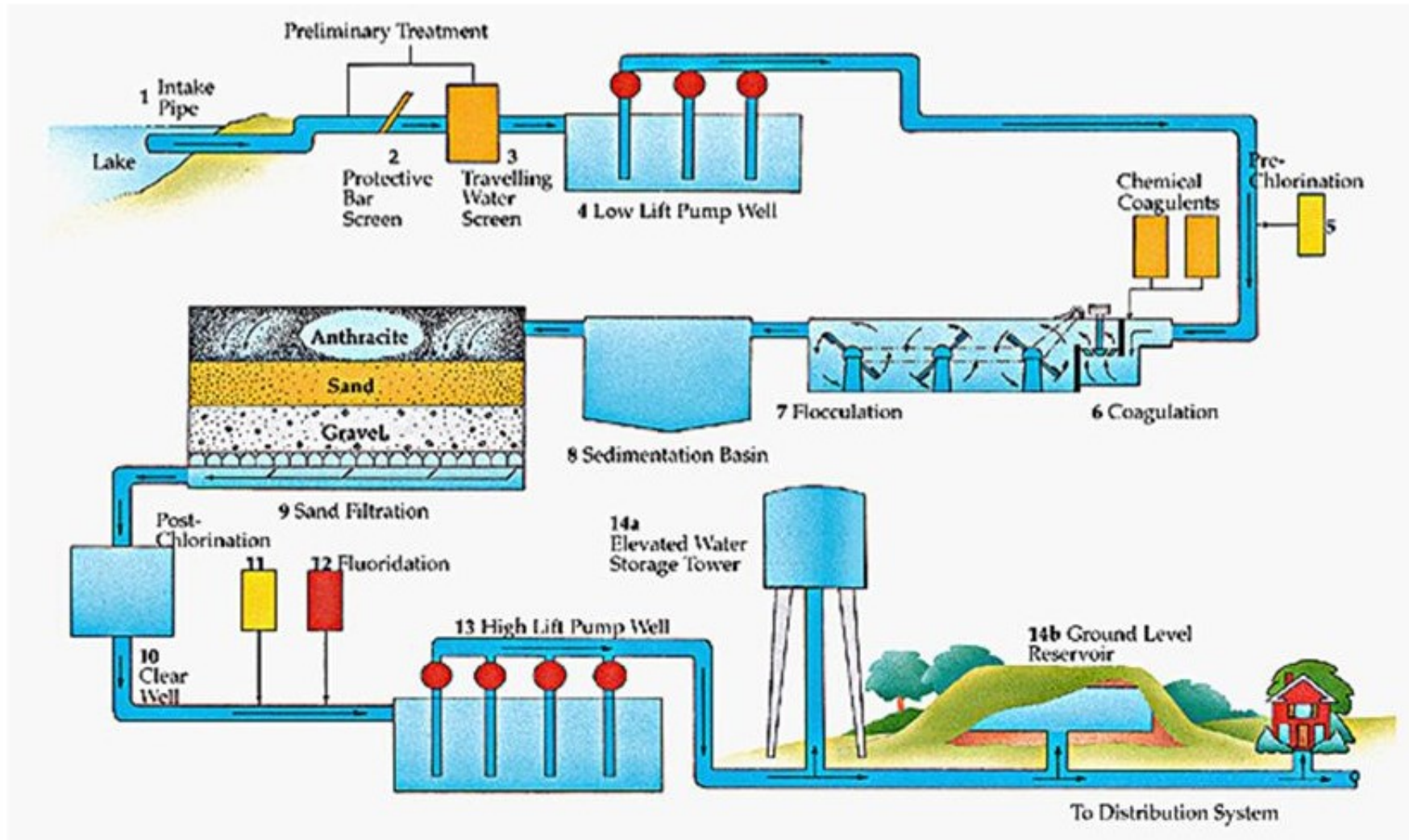
# Water Treatment

# Ground Water Treatment





# Surface Water Treatment (Conventional Filter Plant)

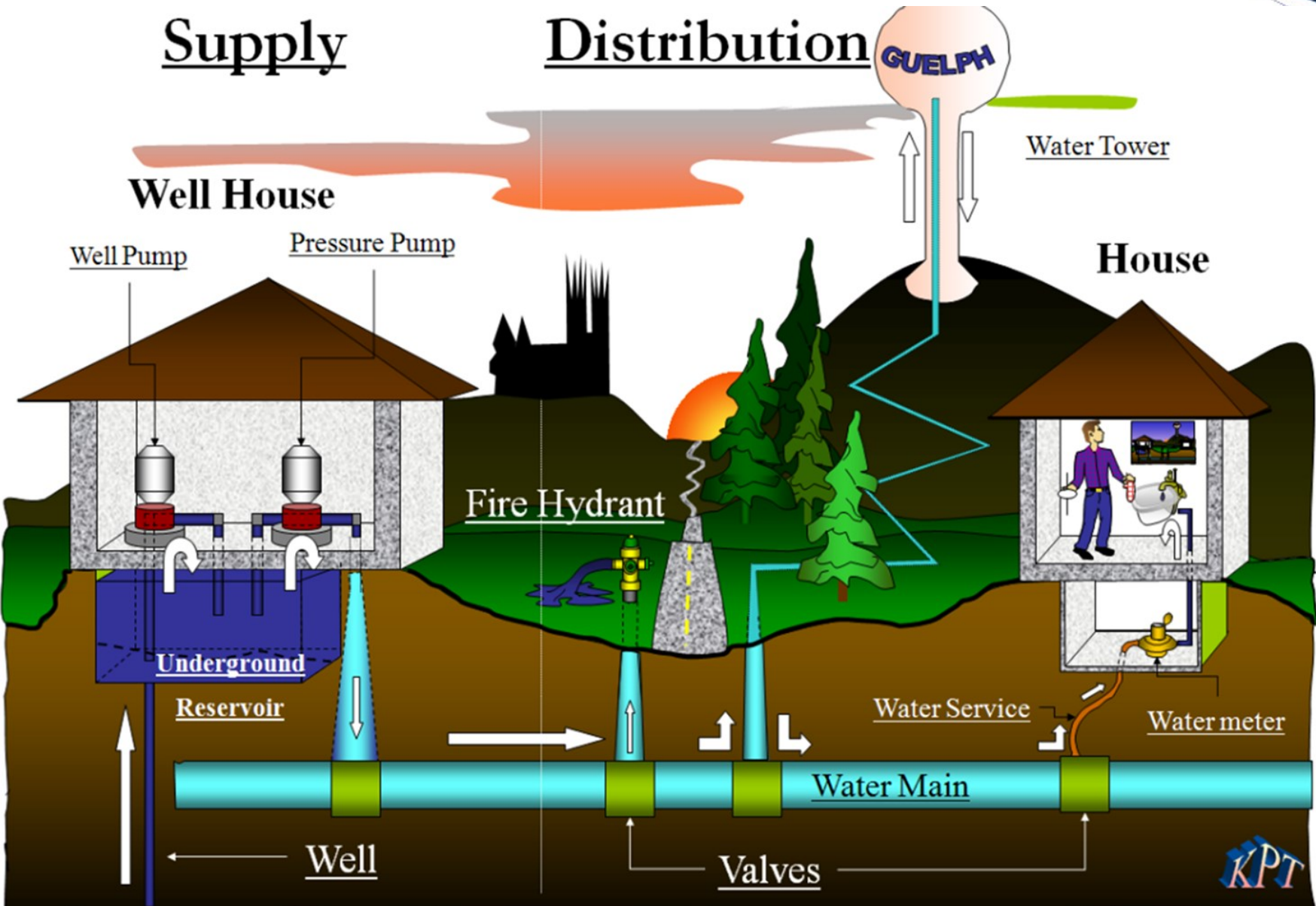


# Water Distribution

# Water Distribution Systems

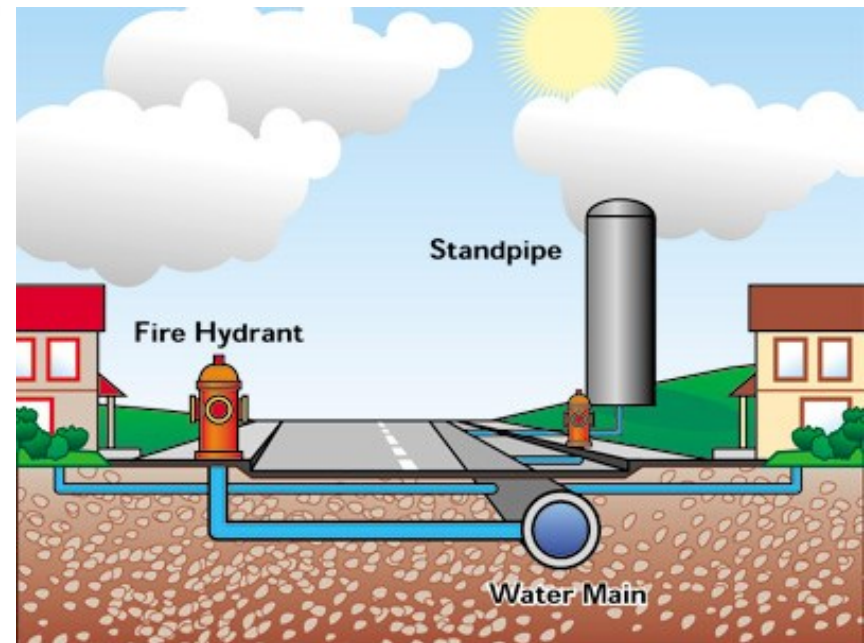
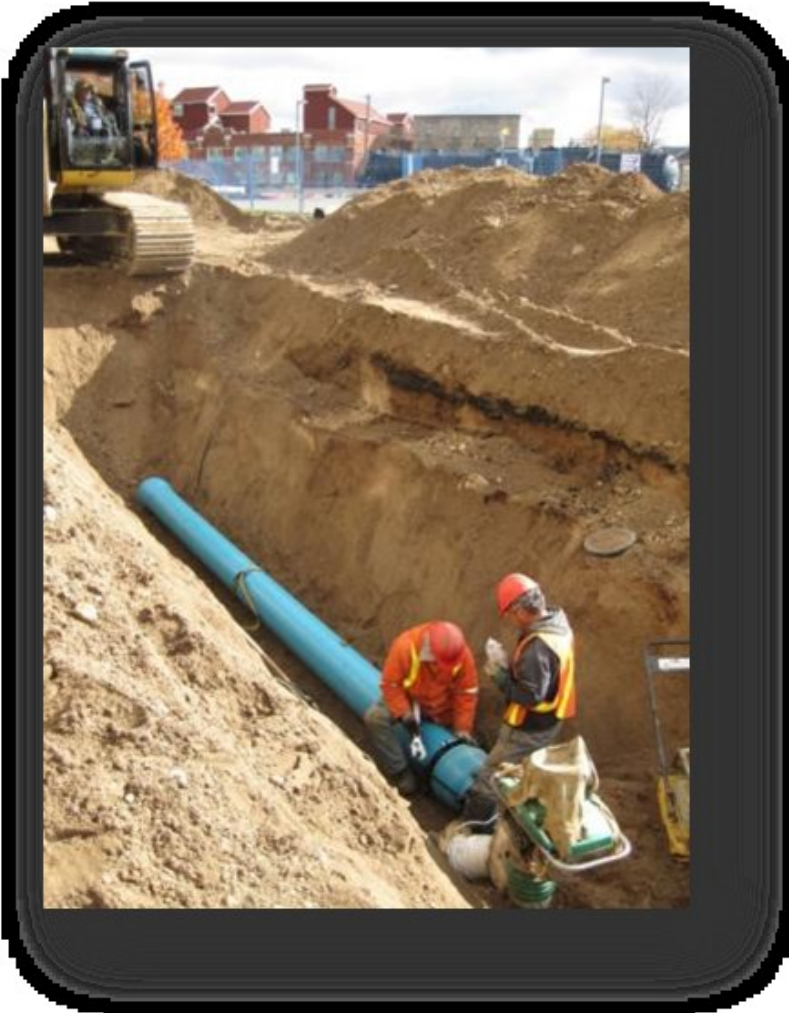
Supply

Distribution





# Water Distribution

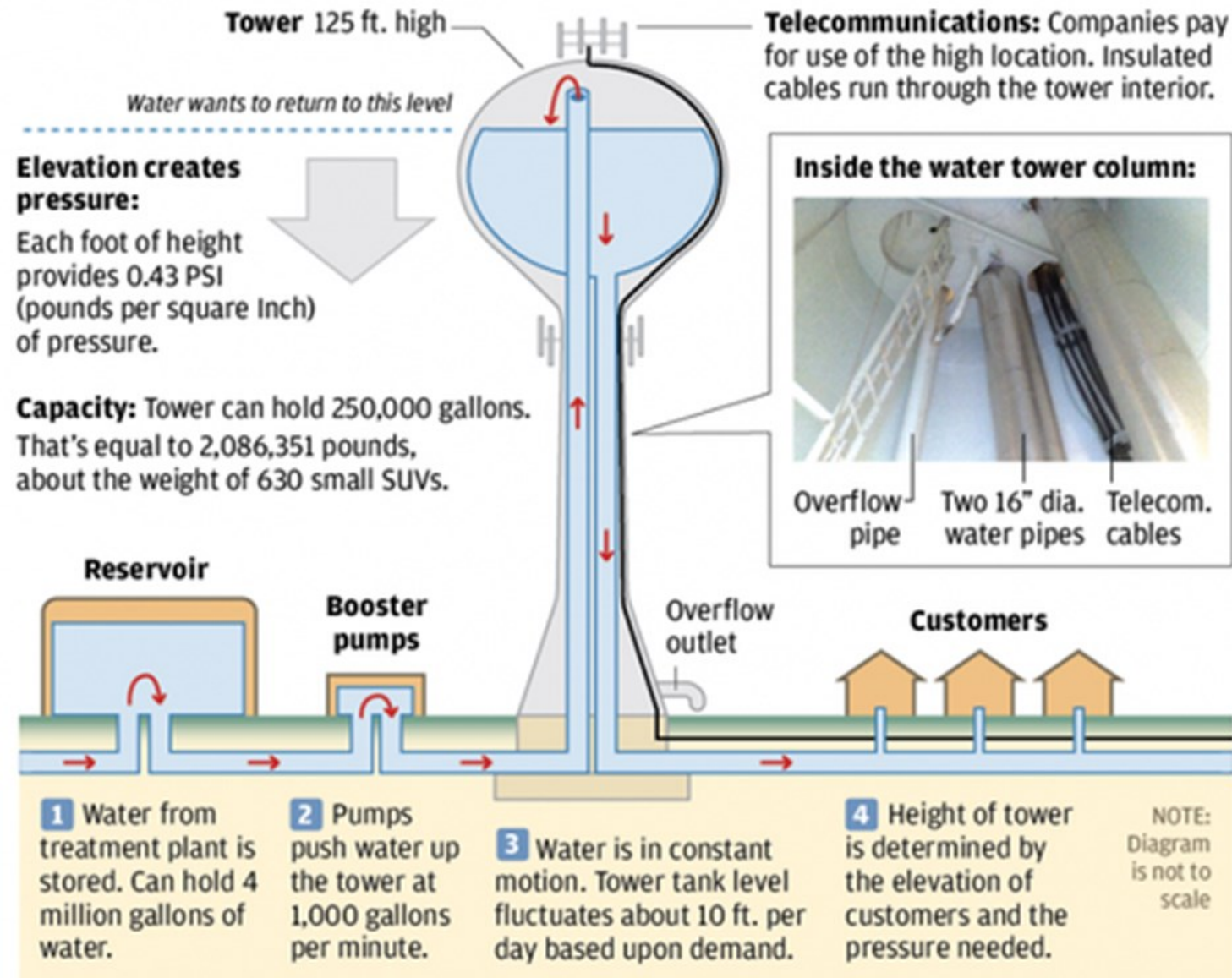


# Water Towers





# HOW A WATER TOWER WORKS



# Watermain Repairs



# **Automated Control Systems at Water Facilities**

**Called “SCADA” in the Water sector  
(SCADA = Supervisory Control and Data Acquisition)**



# What is SCADA?



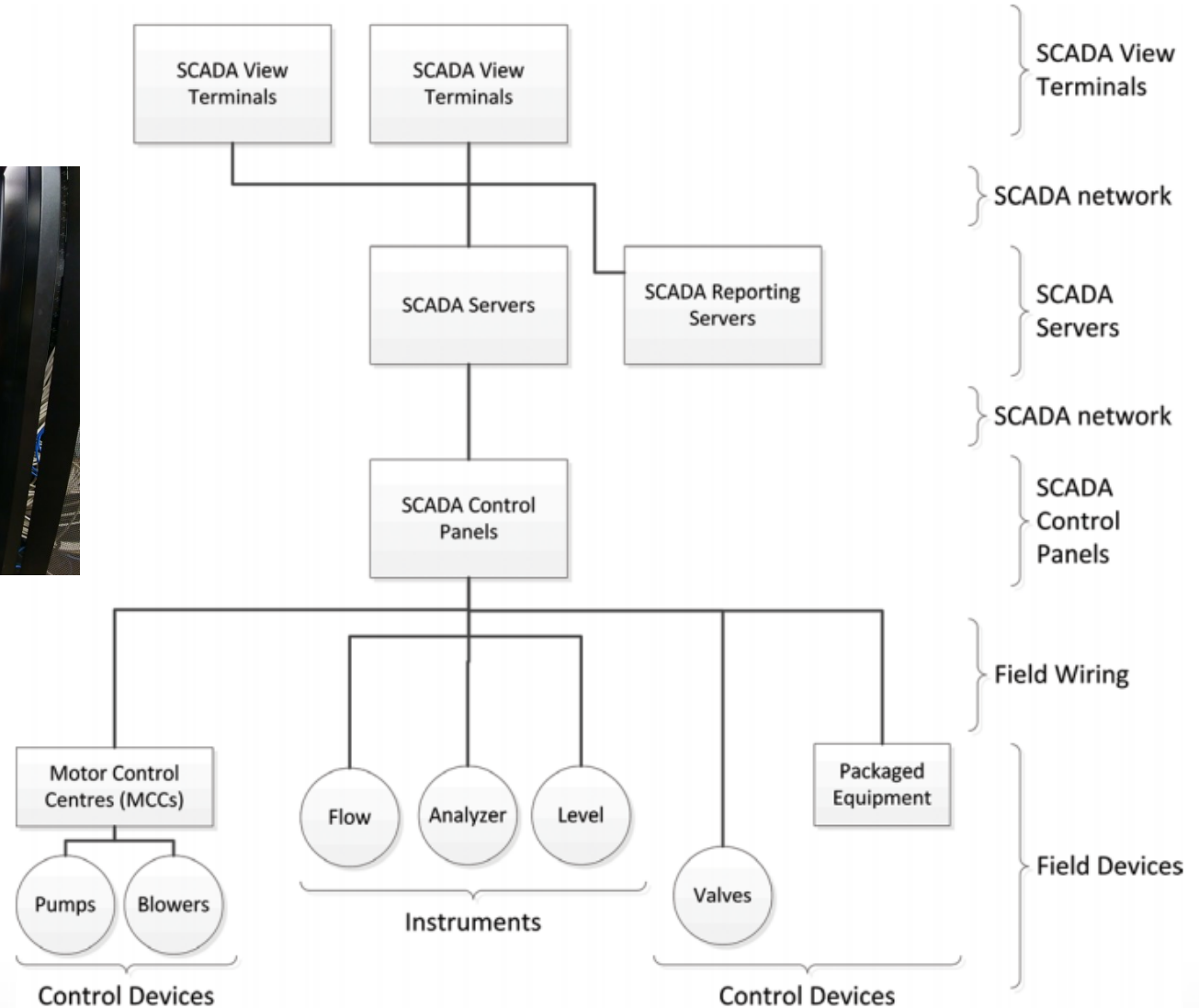
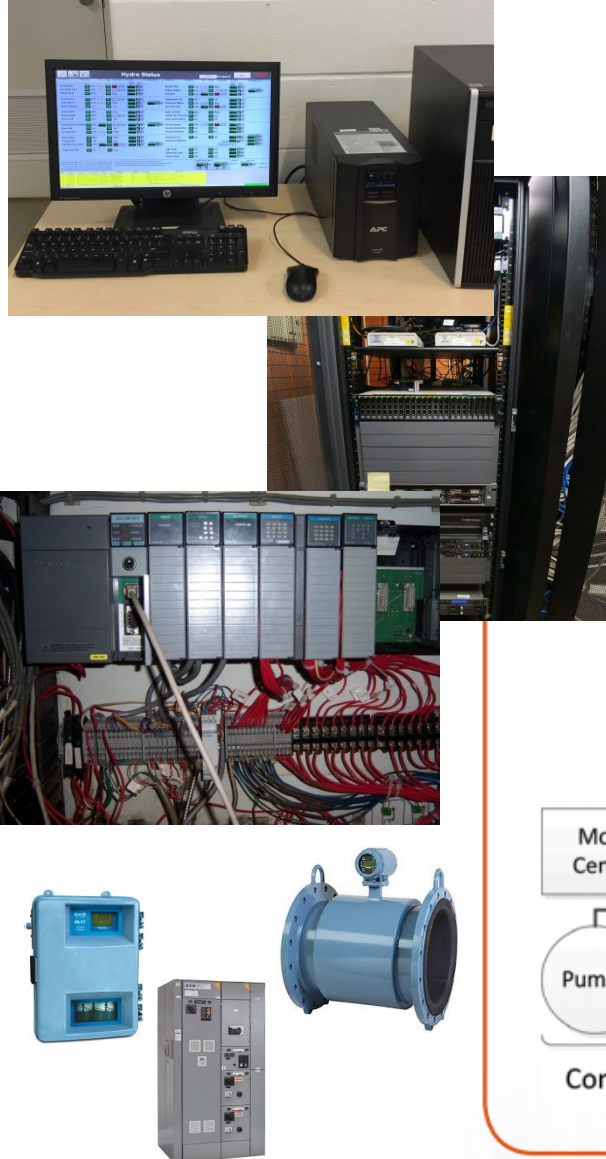
**SCADA = Supervisory Control and Data Acquisition**



# Not SCADA



# Typical SCADA Architecture



# Why we have SCADA systems

- Unattended automatic control of water facilities
- Logging of critical control parameters
  - Chlorine Residuals (e.g., every 5 minutes)
  - Turbidity
  - Well Flow Rates & Daily Flow Totals
  - POE Flow Rates & Daily flow Totals
  - Tower Levels & Pressure
- Provides “visualization” of water facilities to Operators
- Enables remote monitoring and control by Operators
- Triggering and Annunciation of Alarms
- Automated responses (increase chlorine dose, shutdown, etc.)
- Reporting based on logged process data





# SCADA View Terminal

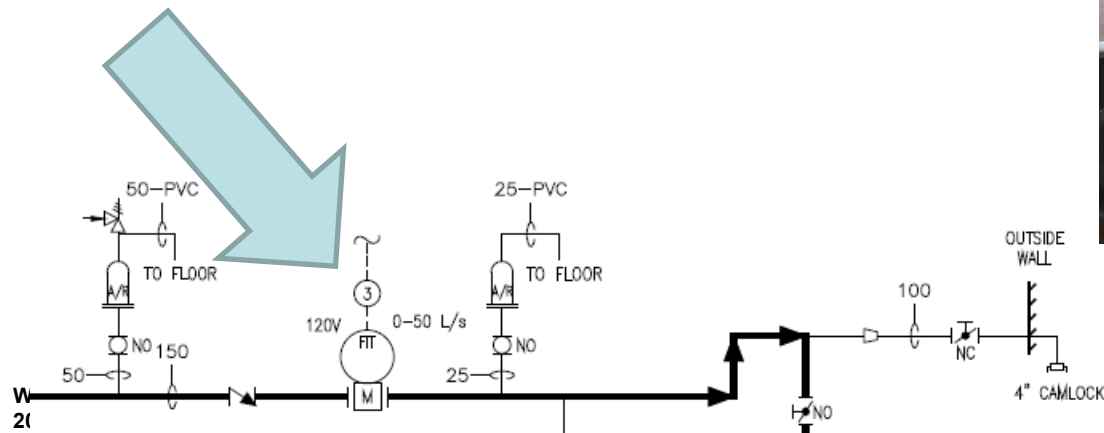
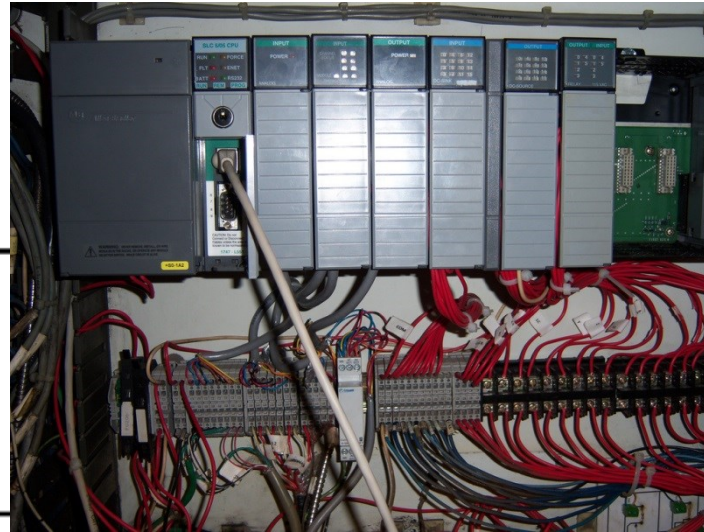
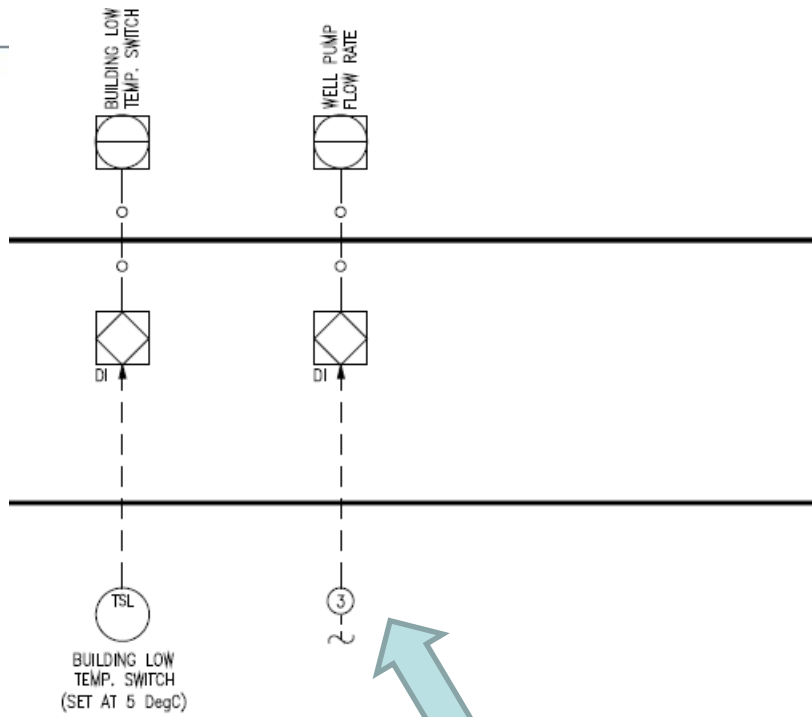




# More Heavily Used SCADA View Terminals

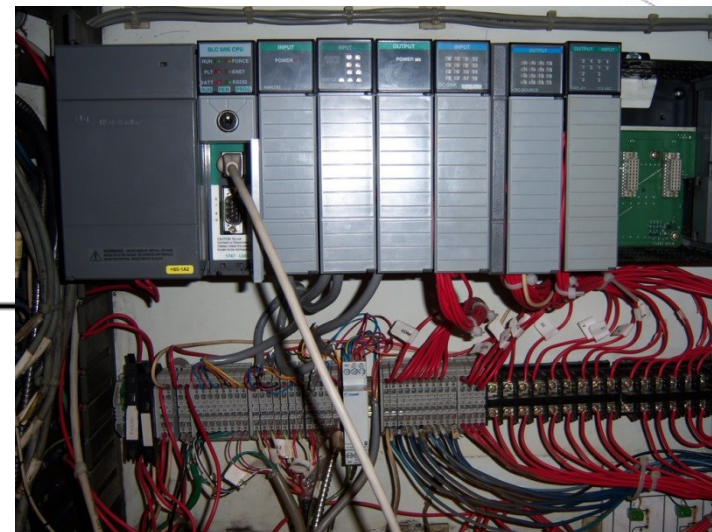
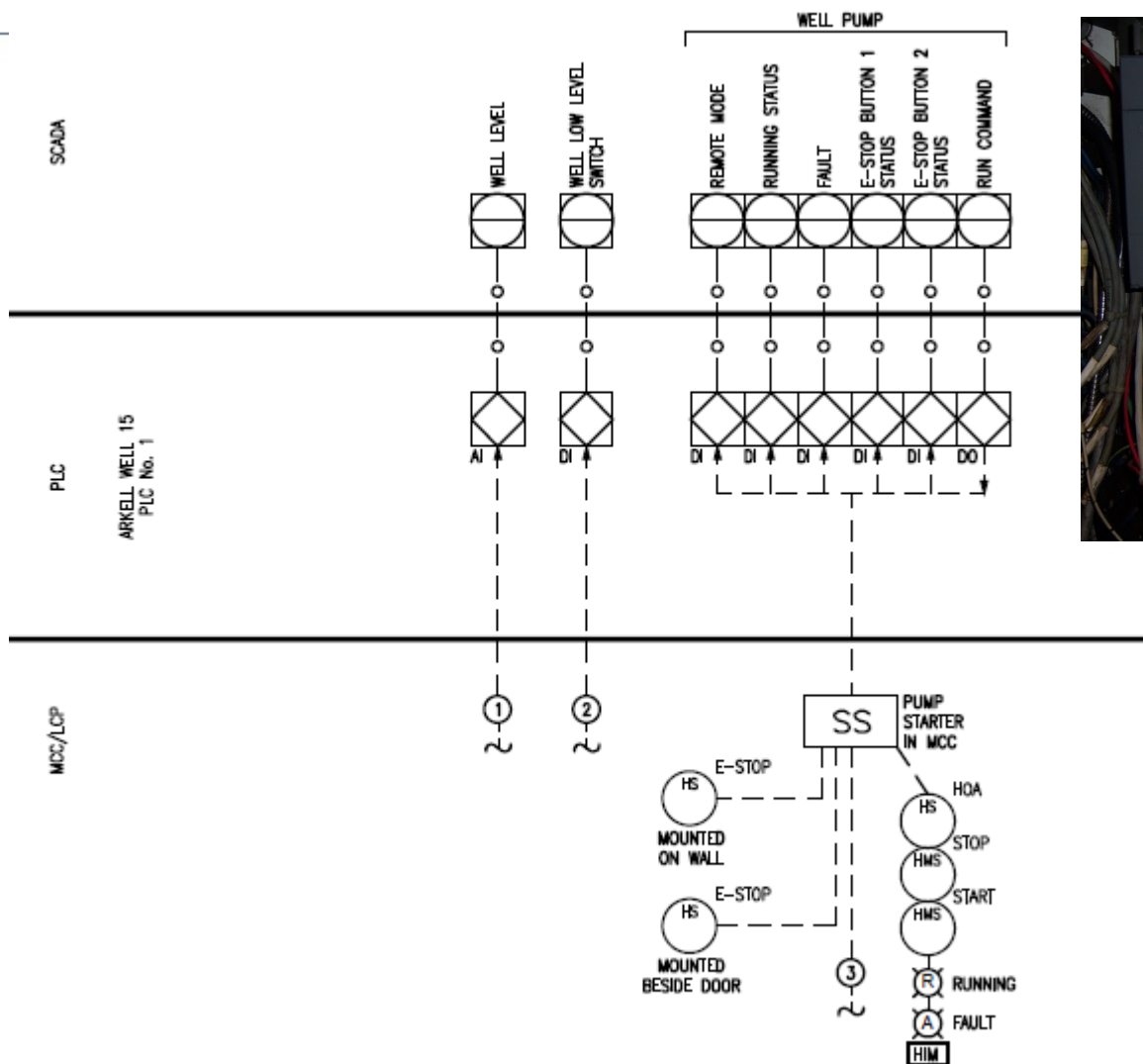


# I/O Level - Instrumentation

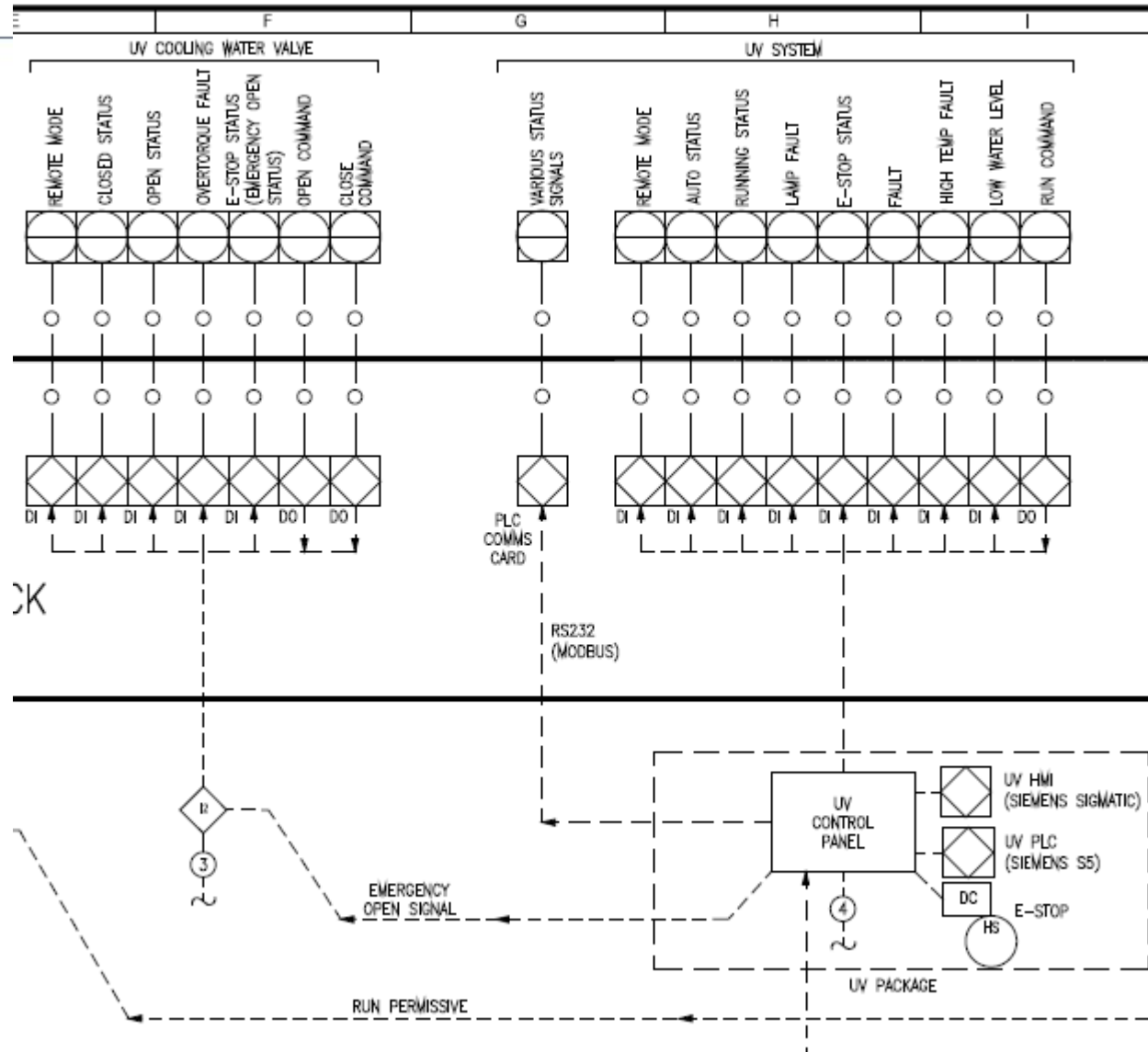




# I/O Level - Pumps



# I/O Level – a more complicated example

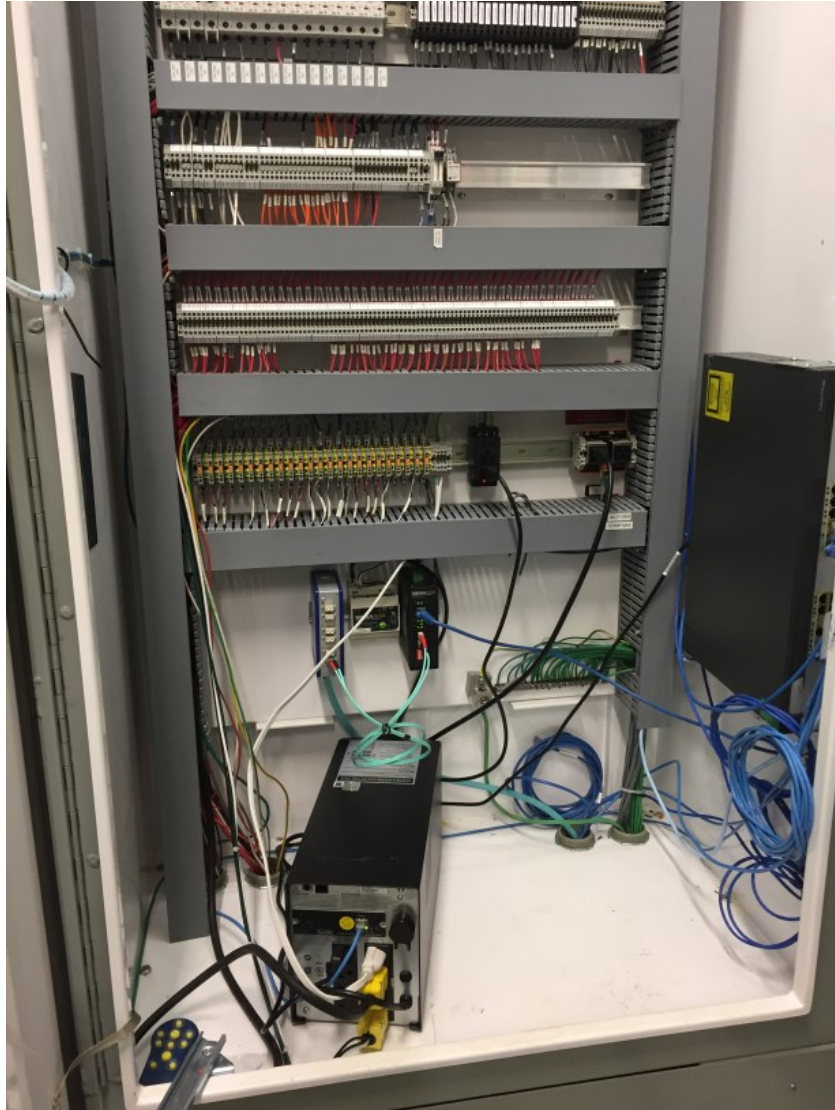


## UV Reactor

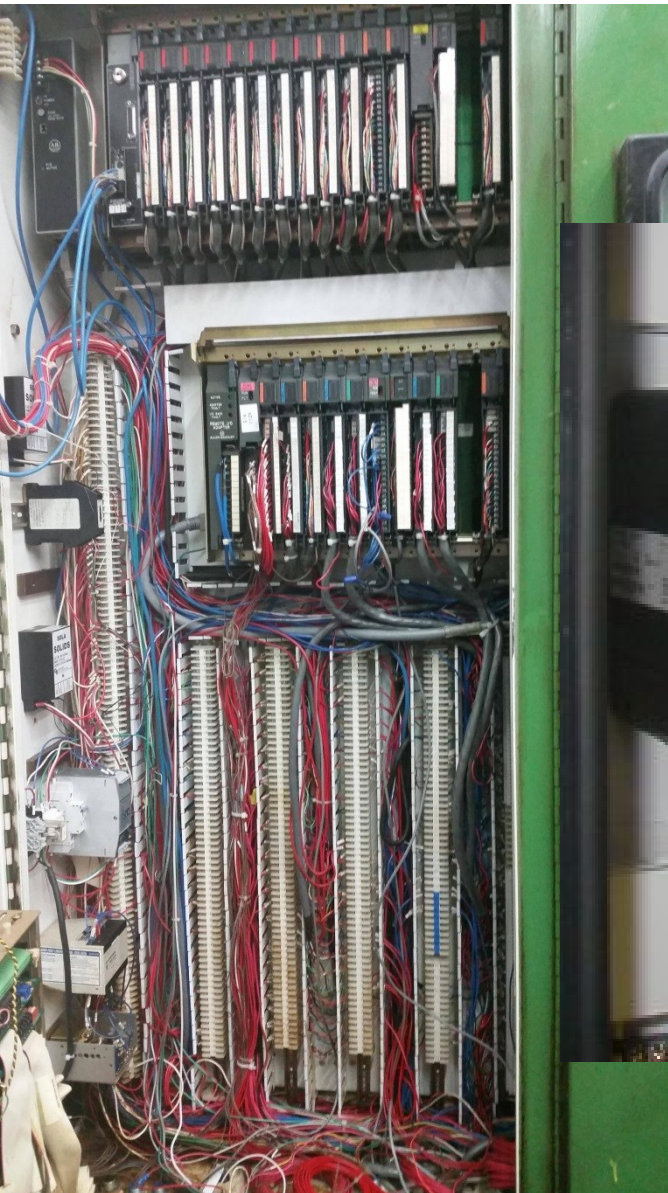




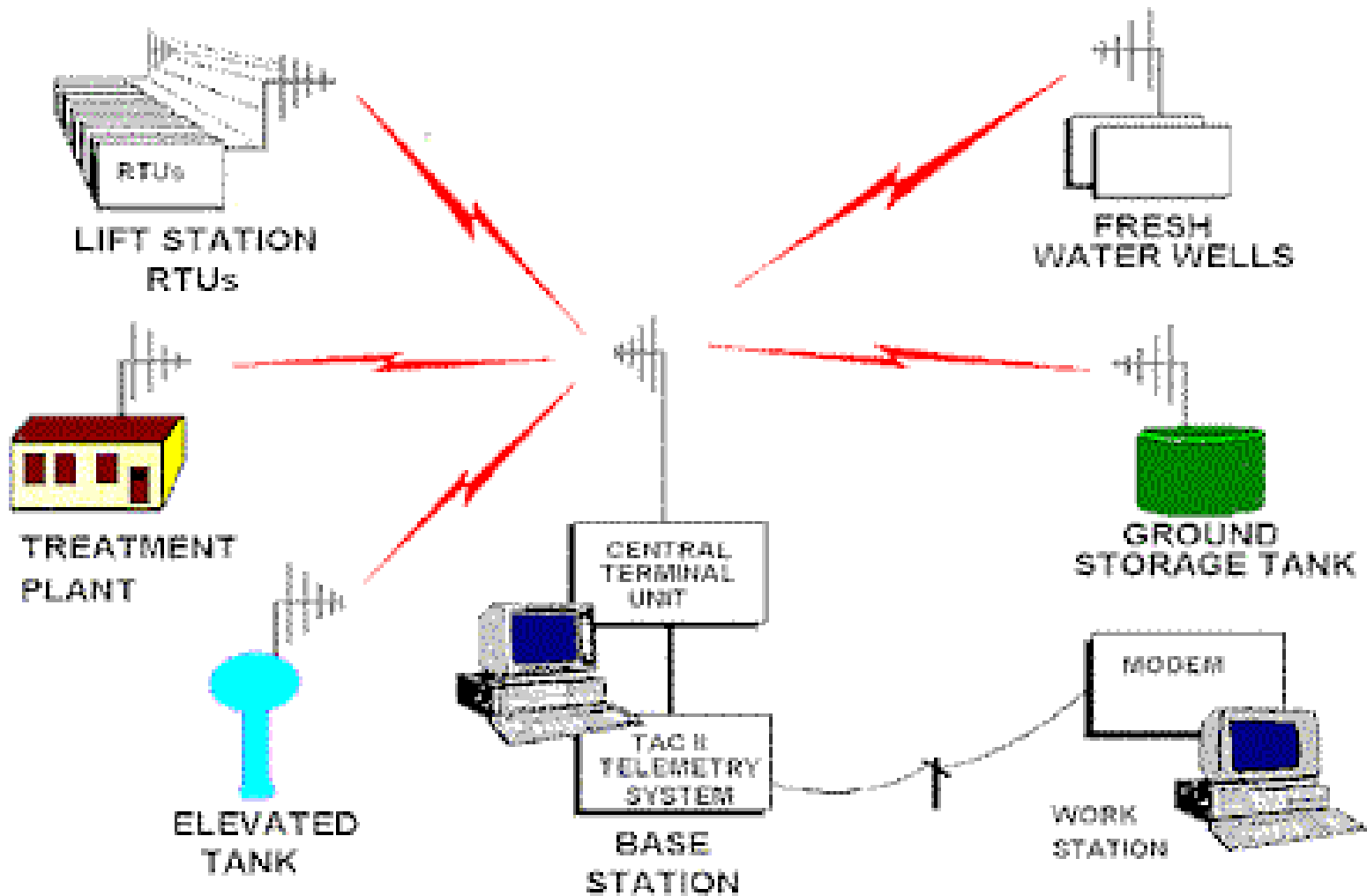
# PLC Control Panels



# PLCs – Old and New Technology

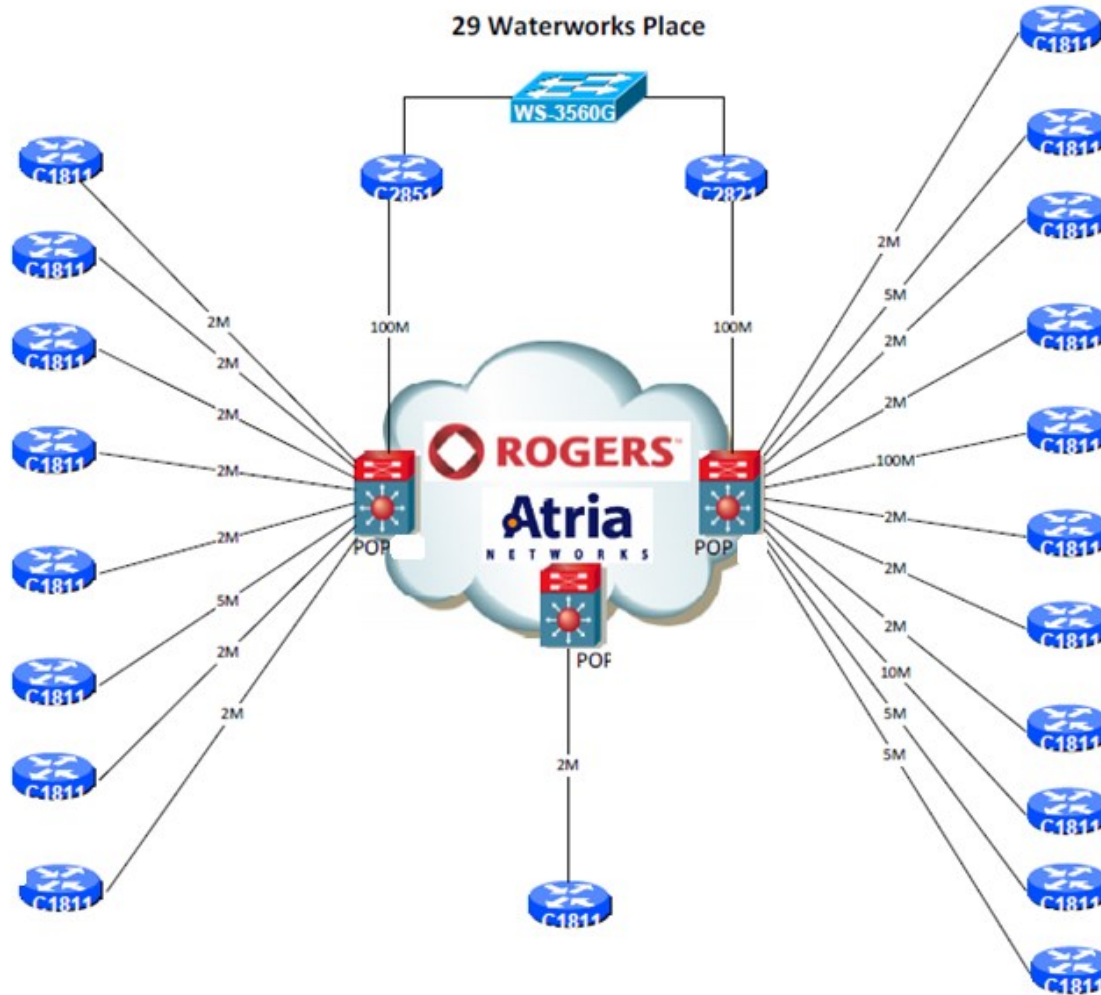


# SCADA Network





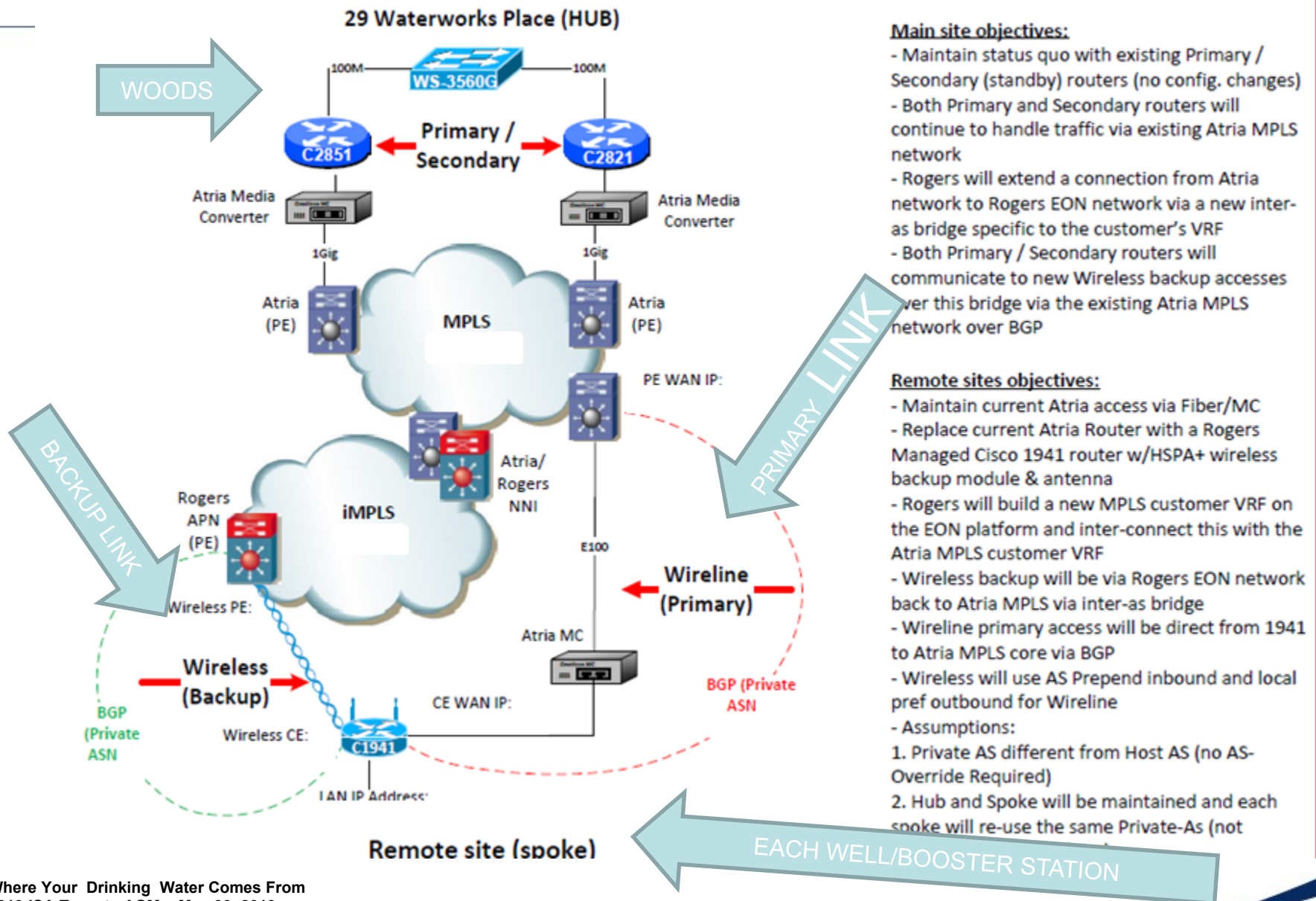
# SCADA Network (Fibre optic example)



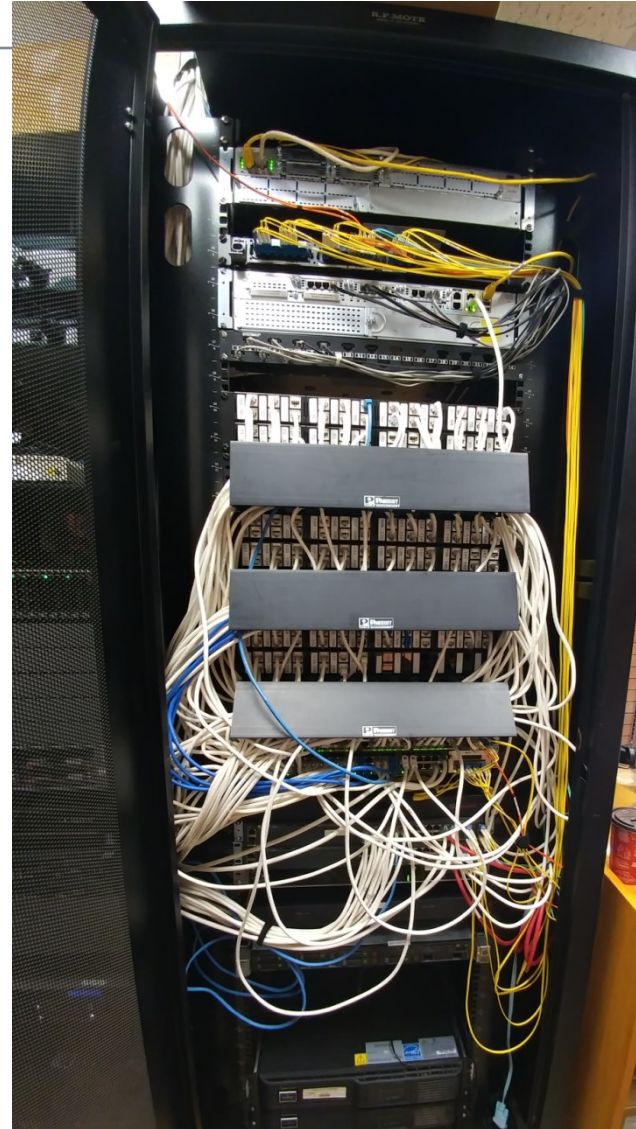
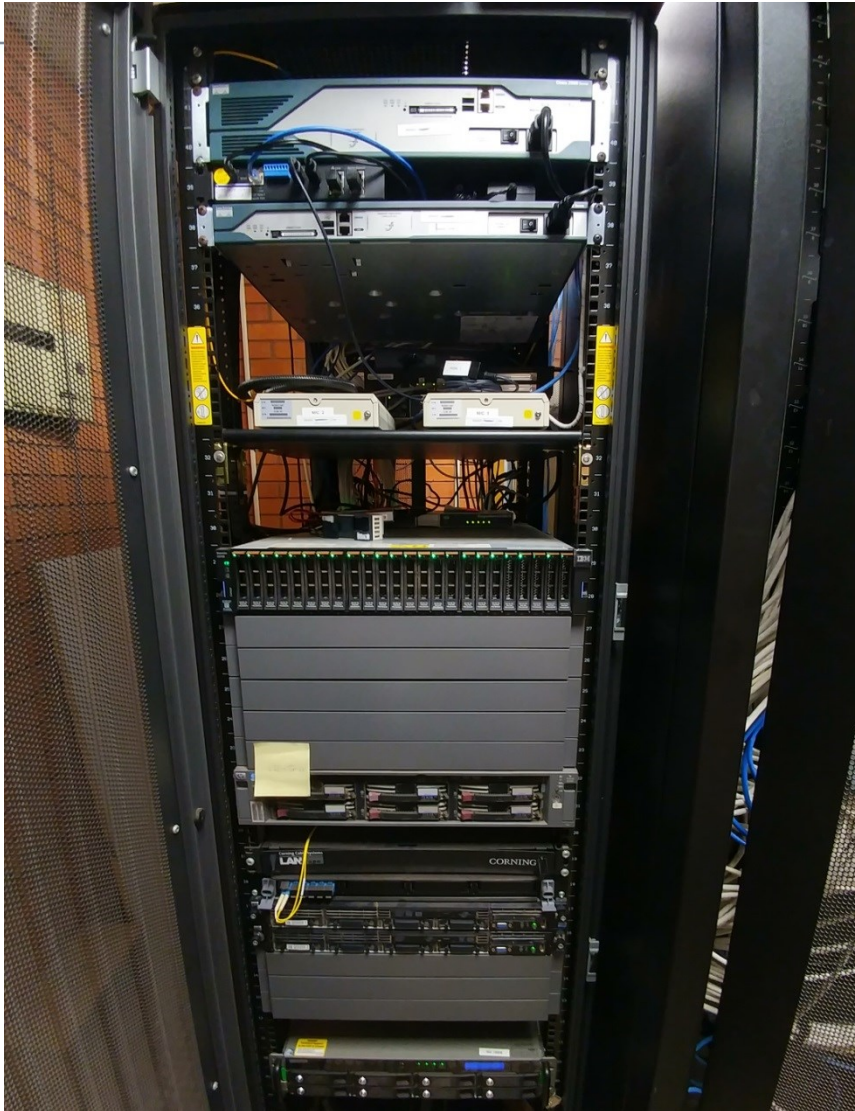


## Example: Guelph Water SCADA Network

### Fibre-topic network with automatic fail-over to Wireless backup

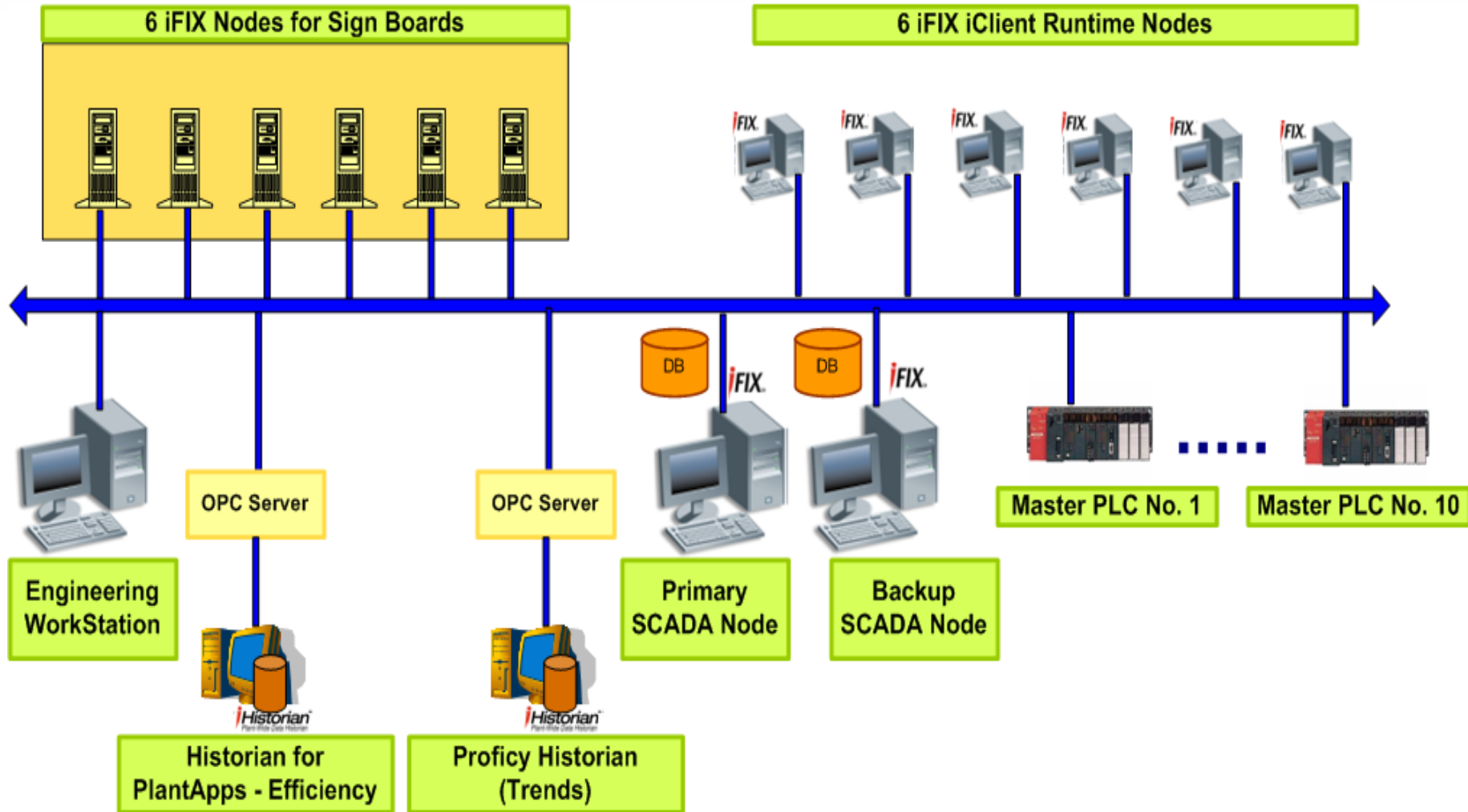


# SCADA Servers

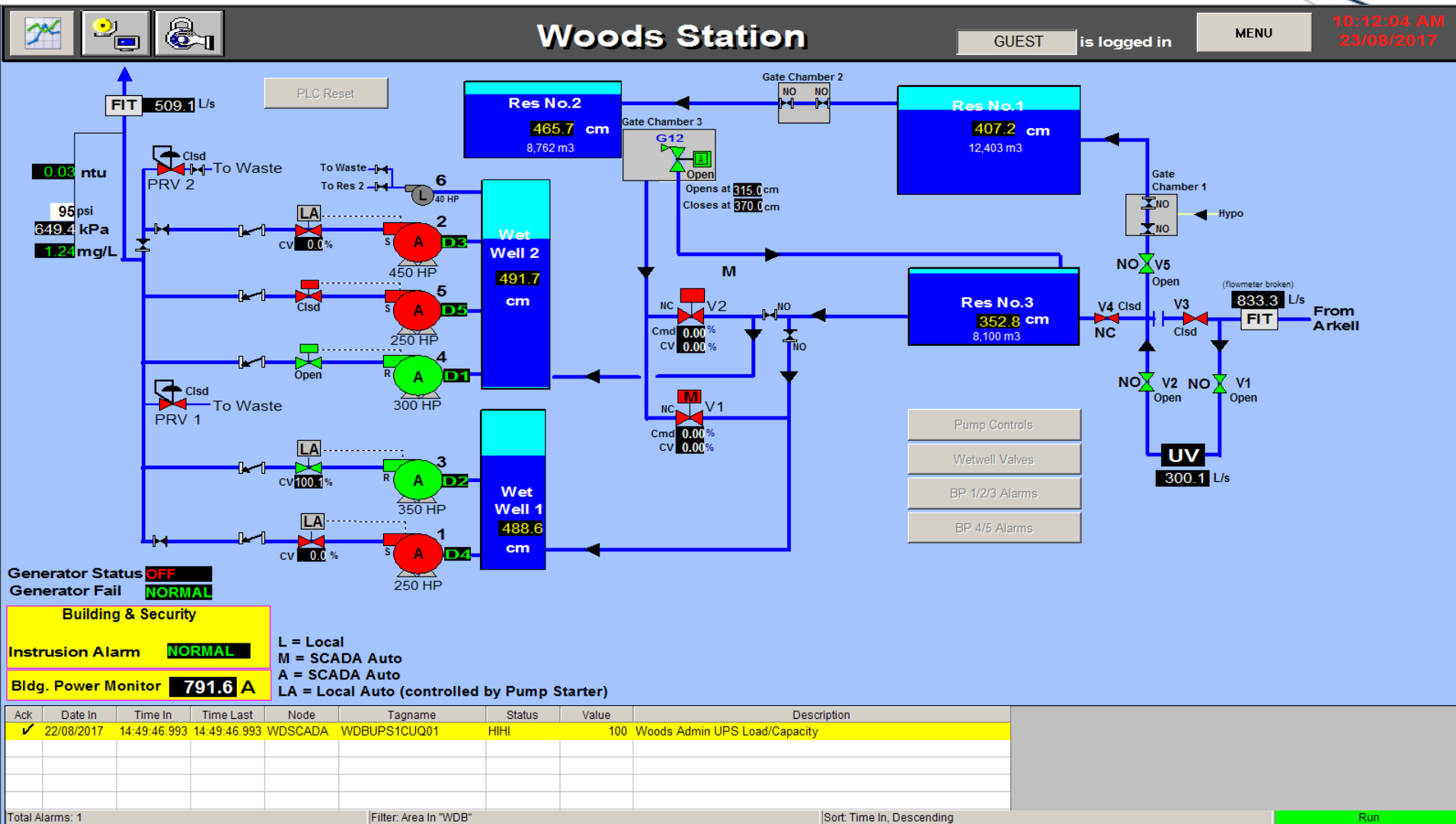




# SCADA Servers - Example

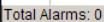


# SCADA Screens



HMI = Human Machine Interface





Filter: Area In "PRB"

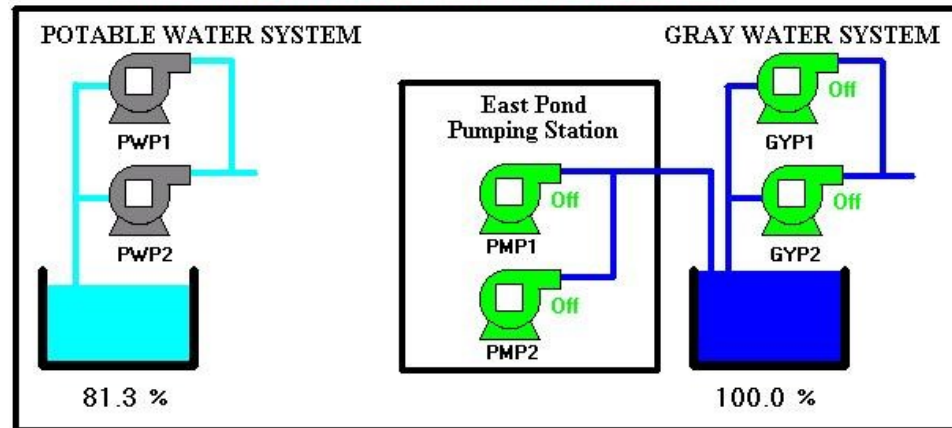
Sort: Time In, Descending

Run

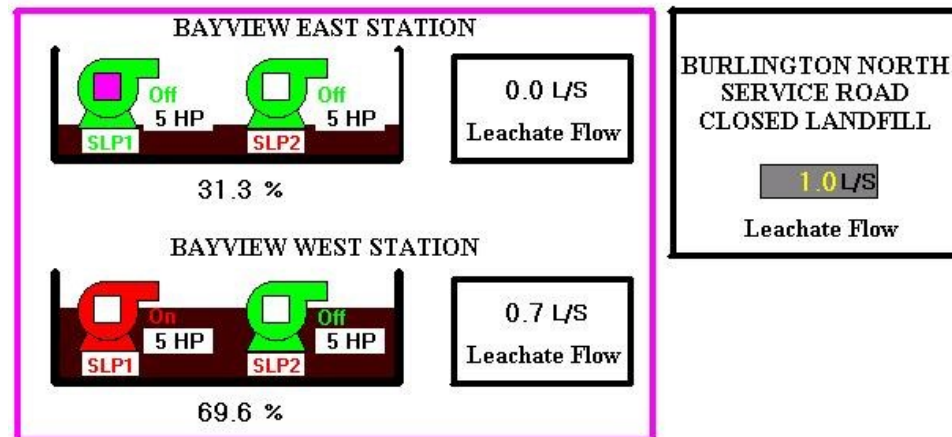
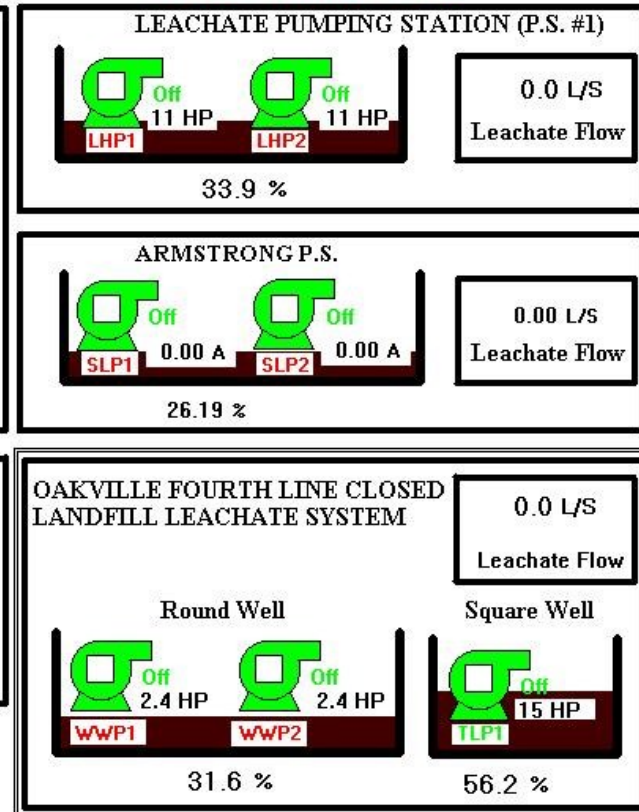
49

# Screens – another example

## HALTON WASTE MANAGEMENT SITE DIAGRAMS



## REMOTE SITE DIAGRAMS



Jul 30	13:13:02	EVENT	DDE	604	BWWSLP1DMDI_SS	Bayview West SLP1 Running Status	ON
Jul 30	13:08:21	EVENT	DDE	99	M11LHP2DM#SP	Leachate Pump #2 Float Stop Command	Off
Jul 30	13:06:00	EVENT	DDE	604	BWWSLP2DMDI_SS	Bayview West SLP2 Running Status	OFF
Jul 30	13:06:00	EVENT	DDE	600	BWWDY1DPAI_CV	Bayview West SLP Duty 1 Current	1

# Alarm System & Call Out Alarms

WIN-911 Log Viewer (Active)

Live **Historical**

Drag a column header and drop it here to group by that column

	State	Most Recent Event	Alarm Point	Condition	Source Type
▶		10/30/2015 9:19:30 AM	Tank Pump	Pump is on	OPCDA
		10/30/2015 9:15:39 AM	Gate Valve	Closed	OPCDA
		10/29/2015 3:15:59 PM	Hopper 1	LO	iFIX

Digital Definition to Edit (1 of 69)

Group: -- All Groups --

Tagname	Description	Group name	Tag Sound	Use Tagname	Use Is/Was	Auto Ack	Access Name
C21_TIT_AH	Glycol Regenerator Temp - A...	Call_Out	Glycol Regenerator Temp - Alarm High	X	X	Never	InTouch Direct Connect
C21_TIT_AL	Glycol Regenerator Temp - A...	Call_Out	Glycol Regenerator Temp - Alarm Low	X	X	Never	InTouch Direct Connect
Chrom_SD_Pf2	Gas Chromatograph - Shutdo...	Call_Out	Gas Chromatograph - Shutdown - PF2	X	X	Never	InTouch Direct Connect
CSG_PSH	Casing Gas Pressure - Safety...	Call_Out	Casing Gas Pressure - Safety High	X	X	Never	InTouch Direct Connect
CSG_Valves_PSL	Casing Gas Valves - Well Cel...	Call_Out	Casing Gas Valves - Well Cellar - Pilot Pressure	X	X	Never	InTouch Direct Connect
E14_Aux	GC2 Discharge Fin Fan - Ru...	Call_Out	GC2 Discharge Fin Fan - Run Status	X	X	Never	InTouch Direct Connect
E1A_E1B_Aux	West Fin Fan - Run Status	Call_Out	West Fin Fan - Run Status	X	X	Never	InTouch Direct Connect
E1C_E1D_Aux	East Fin Fan - Run Status	Call_Out	East Fin Fan - Run Status	X	X	Never	InTouch Direct Connect
E6_PIT_AH	Refrig Fin Fan Press - Alarm ...	Call_Out	Refrig Fin Fan Press - Alarm High	X	X	Never	InTouch Direct Connect
E6_PIT_AL	Refrig Fin Fan Press - Alarm ...	Call_Out	Refrig Fin Fan Press - Alarm Low	X	X	Never	InTouch Direct Connect
Fire_System_Alm	Fire System	Call_Out	Fire System Alarm	X	X	Never	InTouch Direct Connect
GateBuzzer	Gate Buzzer	Call_Out	Gate Buzzer	X	X	Never	InTouch Direct Connect
GC1_Aux	Gas Comp #1 - Run Status	Call_Out	Gas Comp #1 - Run Status	X	X	Never	InTouch Direct Connect
GC1_TIT_AH	GC1 Discharge Temp - Alarm...	Call_Out	GC1 Discharge Temp - Alarm High	X	X	Never	InTouch Direct Connect
GC1_TIT_AHH	GC1 Discharge Temp - Alarm...	Call_Out	GC1 Discharge Temp - Alarm High High	X	X	Never	InTouch Direct Connect
GC1_TIT_TSH_SD	GC1 Discharge Temp - Safet...	Call_Out	GC1 Discharge Temp - Safety High - Shutdown	X	X	Never	InTouch Direct Connect
GC2_Aux	Gas Comp #2 - Run Status	Call_Out	Gas Comp #2 - Run Status	X	X	Never	InTouch Direct Connect
GC2_TIT_AH	GC2 Discharge Temp - Alarm...	Call_Out	GC2 Discharge Temp - Alarm High	X	X	Never	InTouch Direct Connect
GC2_TIT_TSH_SD	GC2 Discharge Temp - Safet...	Call_Out	GC2 Discharge Temp - Safety High - Shutdown	X	X	Never	InTouch Direct Connect
GC3_Aux	Gas Comp #3 - Run Status	Call_Out	Gas Comp #3 - Run Status	X	X	Never	InTouch Direct Connect
GC3_TIT_AH	GC3 Discharge Temp - Alarm...	Call_Out	GC3 Discharge Temp - Alarm High	X	X	Never	InTouch Direct Connect
GC3_TIT_TSH_SD	GC3 Discharge Temp - Safet...	Call_Out	GC3 Discharge Temp - Safety High - Shutdown	X	X	Never	InTouch Direct Connect
G0_PSHL	Gross Oil Header Pressure - ...	Call_Out	Gross Oil Header Pressure - Alarm High/Low	X	X	Never	InTouch Direct Connect
H2S_System_Alm	H2S System	Call_Out	H2S System Alarm	X	X	Never	InTouch Direct Connect
I3_I5_PSH_SD	Water Inj Pump - Hi Discharg...	Call_Out	Water Inj Pump - Hi Discharge Press - Shutdown	X	X	Never	InTouch Direct Connect
I3_I5_PSL1_SD	Water Inj Pump - Suct - Pres...	Call_Out	Water Inj Pump - Suct - Press Safety Low - Shutdown	X	X	Never	InTouch Direct Connect
I3_I5_PSL2_SD	Water Inj Pump - Disch - Pre...	Call_Out	Water Inj Pump - Disch - Press Safety Low - Shutdo	X	X	Never	InTouch Direct Connect
I3_I5_VSD_Status	Water Inj Pump - VSD Status	Call_Out	Water Inj Pump - VSD Status	X	X	Never	InTouch Direct Connect
IAS_PAL1	Instrument Air Supply - Press...	Call_Out	Instrument Air Supply - Press Alarm Low	X	X	Never	InTouch Direct Connect
IAS_PSL2_SD	ESD Pneumatic System - Ele...	Call_Out	ESD Pneumatic System - Elect Equip - Shutdown	X	X	Never	InTouch Direct Connect
IAS_PSL3_SD	Deluge Pneumatic System - ...	Call_Out	Deluge Pneumatic System - Elect Equip - Shutdown	X	X	Never	InTouch Direct Connect
K1A_Aux	Refrig Comp - Run Status	Call_Out	Refrig Comp - Run Status	X	X	Never	InTouch Direct Connect
LEL_System_Alm	LEL System	Call_Out	LEL System Alarm	X	X	Never	InTouch Direct Connect
P108A_P108B_Not_Running	Amine Reflux Pumps - Not R...	Call_Out	Amine Reflux Pumps - Not Running	X	X	Never	InTouch Direct Connect
P113A_P113B_Not_Running	Amine Solution Pumps - Not ...	Call_Out	Amine Solution Pumps - Not Running	X	X	Never	InTouch Direct Connect
P18A_P18B_Not_Running	Water Injection Charge Pum...	Call_Out	Water Injection Charge Pumps are Shutdown	X	X	Never	InTouch Direct Connect
P1A_P1B_Not_Running	Glycol Injection Pumps - Not ...	Call_Out	Glycol Injection Pumps - Not Running	X	X	Never	InTouch Direct Connect
P2_Aux	Hot Glycol Charge Pump - R...	Call_Out	Hot Glycol Charge Pump - Run Status	X	X	Never	InTouch Direct Connect
P4A_P4B_P4C_Not_Running	All Water Circulation Pumps ...	Call_Out	All Water Circulation Pumps Stopped	X	X	Never	InTouch Direct Connect
Purge_Amine	Amine PLC Panel - Lo Purge...	Call_Out	Amine PLC Panel - Lo Purge Press Alarm	X	X	Never	InTouch Direct Connect
Rupture_Disk_Amine	Rupture Disk - Amine Plant ...	Call_Out	Rupture Disk - Amine Plant Vent Line	X	X	Never	InTouch Direct Connect
Rupture_Disk_Sales	Rupture Disk - Sales Gas Ve...	Call_Out	Rupture Disk - Sales Gas Vent Line	X	X	Never	InTouch Direct Connect
SCE_Status	SCE Power Off	Call_Out	SCE Power Off	X	X	Never	InTouch Direct Connect
T0_PSHL_SD	Test Oil Header Pressure - S...	Call_Out	Test Oil Header Pressure - Safety High/Low	X	X	Never	InTouch Direct Connect

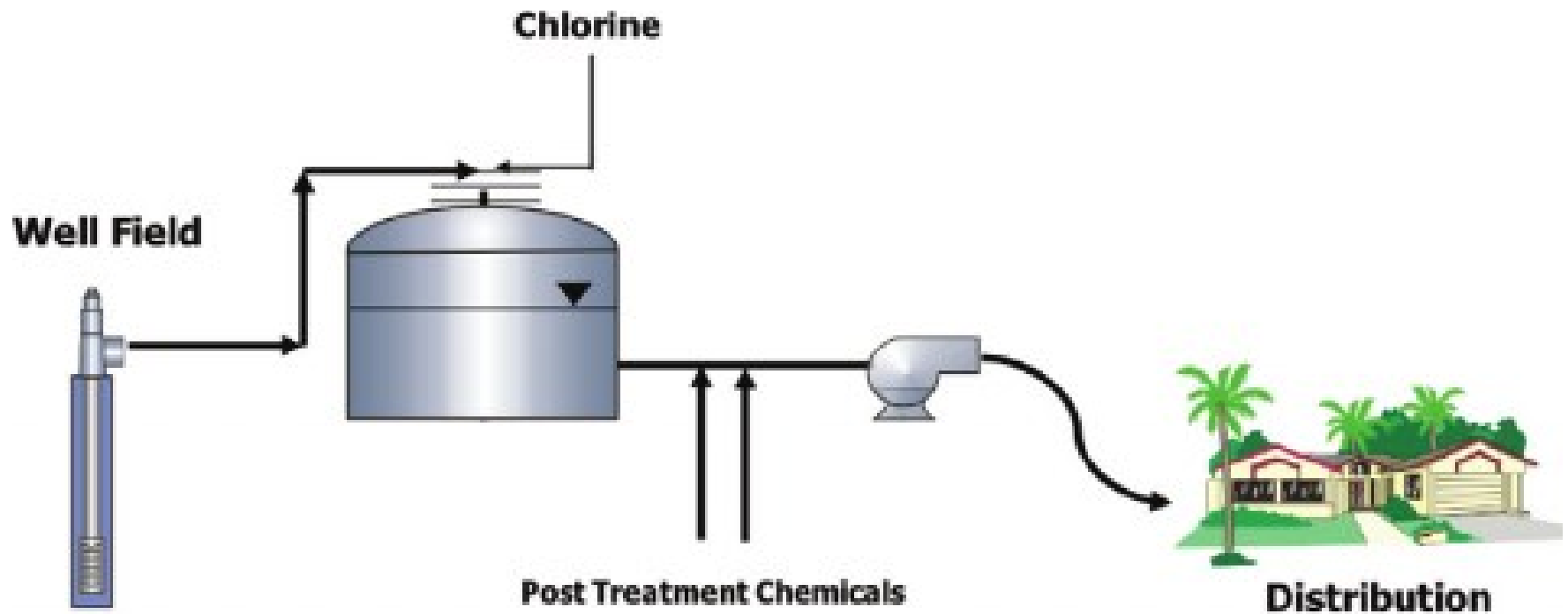
OK New Copy Delete Edit

View alarm details

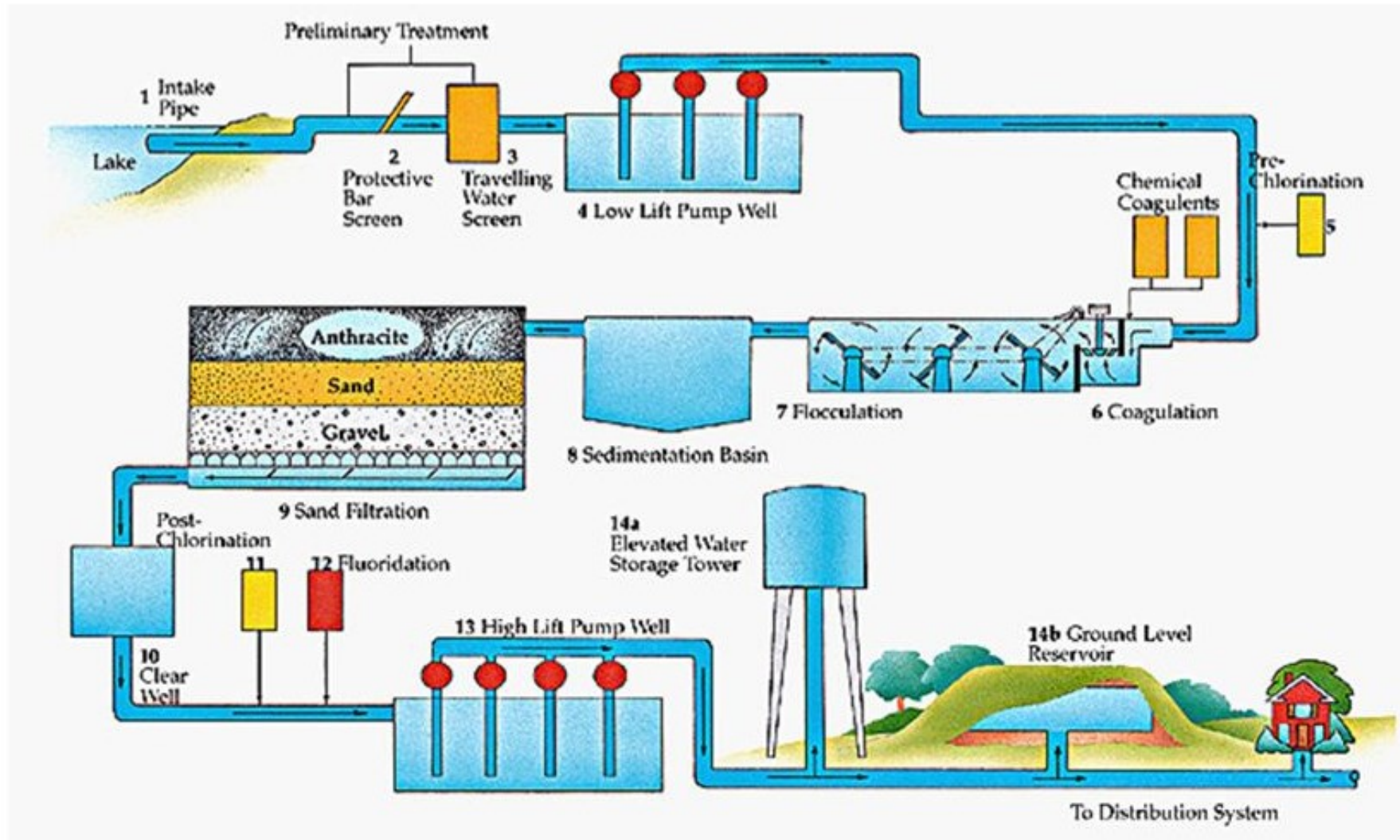
# Typical SCADA Control Techniques

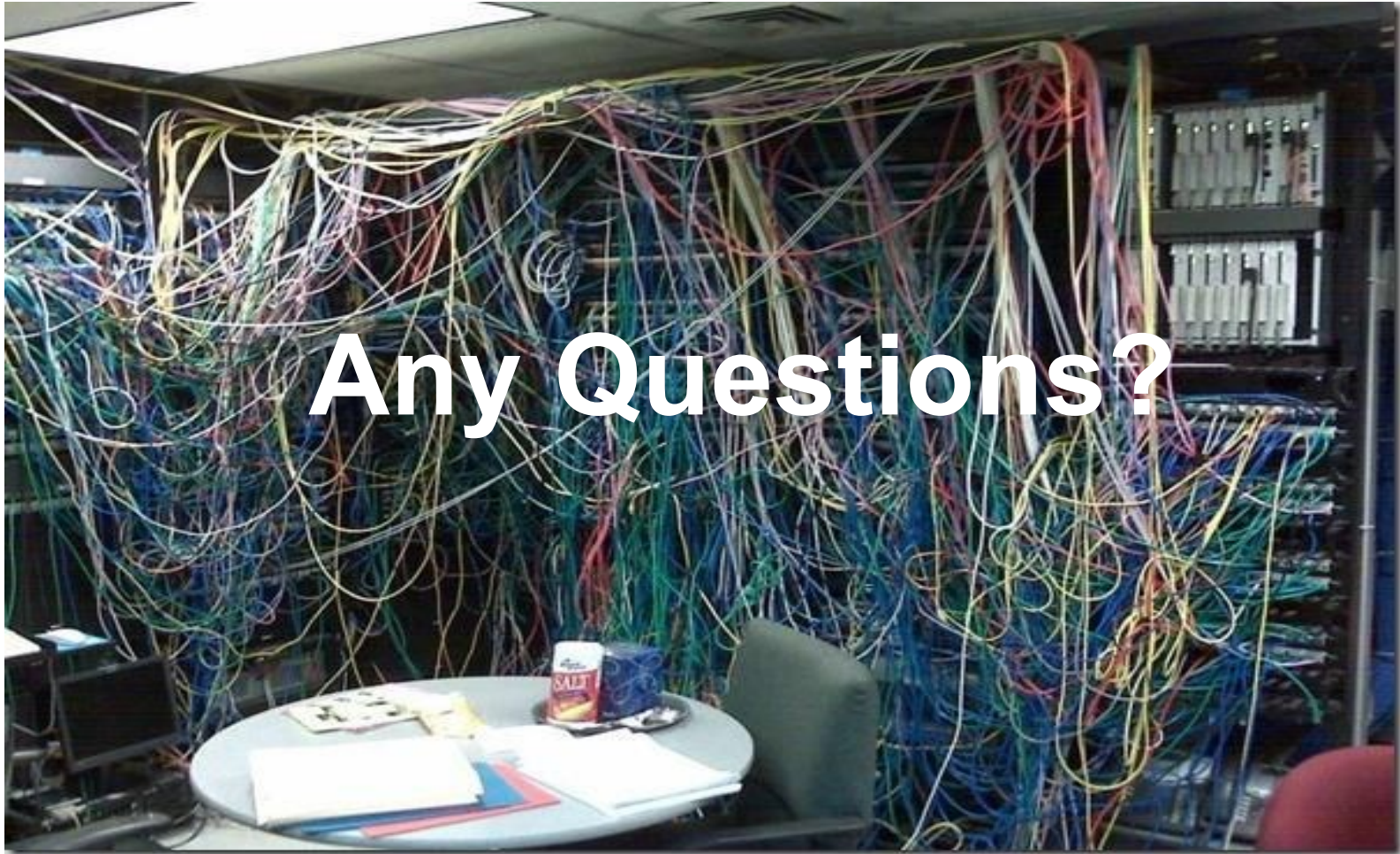


# Ground Water Treatment



# Surface Water Treatment (Conventional Filter Plant)





\* Not a high performance SCADA System