Pilot Testing of Groundwater Circulation Well Technology for a Caustic Groundwater Plume in a Coastal Aquifer

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presented by

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Background

- a portion of the groundwater beneath chlor-alkali plant has pH values in excess of 7.0 (caustic)
- Client spent 5 years investigating and monitoring the groundwater within this area of the site
- From June 04 to April 05 a pilot test was conducted to assess a GCW designed to neutralize the high pH groundwater

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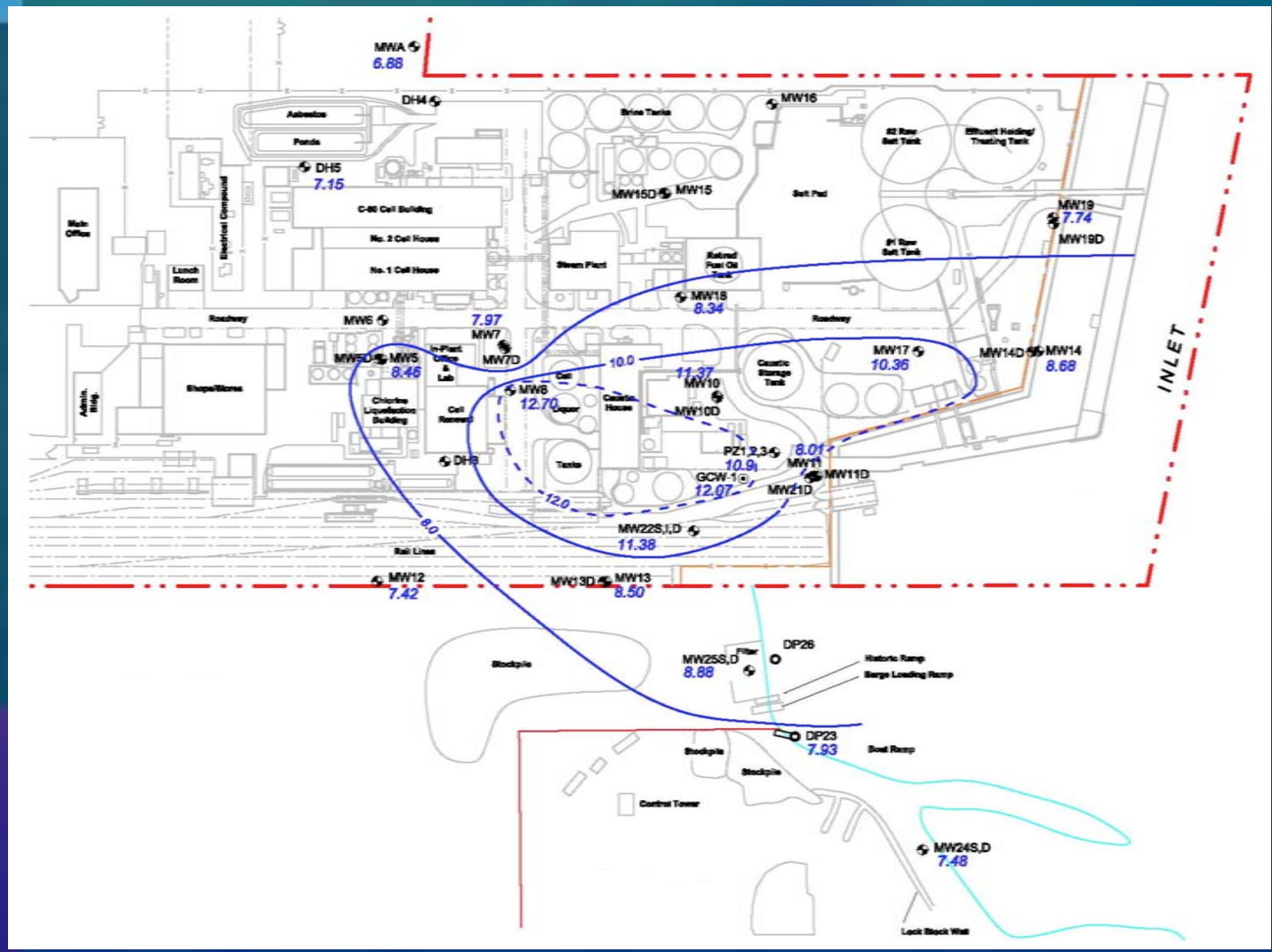
pH Plume Distribution



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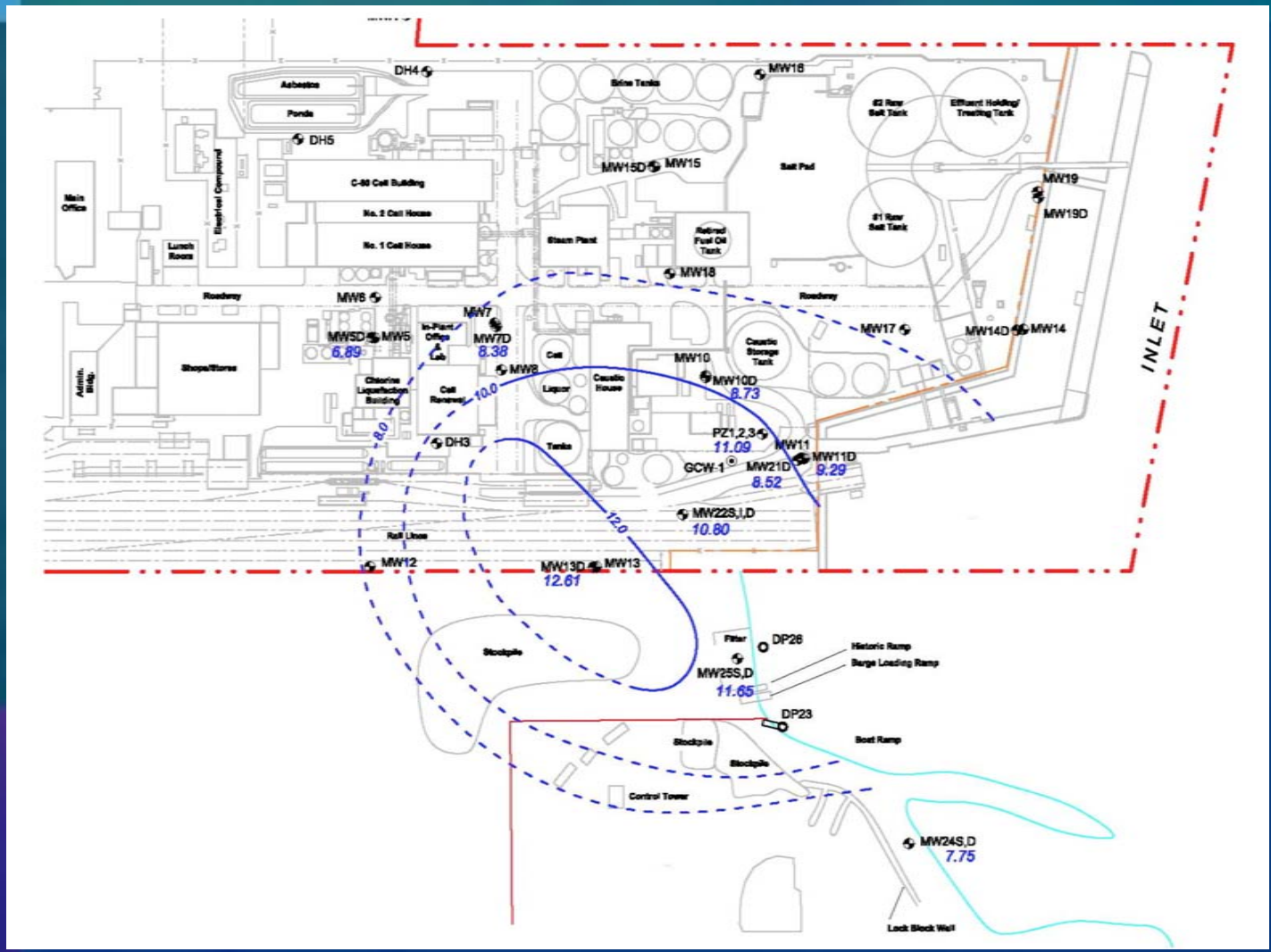

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Summary of Receiving Environment Study Results

pH Plume

- Discharge area located by direct push sampling from a barge
- Area of discharge approximately 75 m^2
- Groundwater discharging from freshwater and saline zones of coastal aquifer

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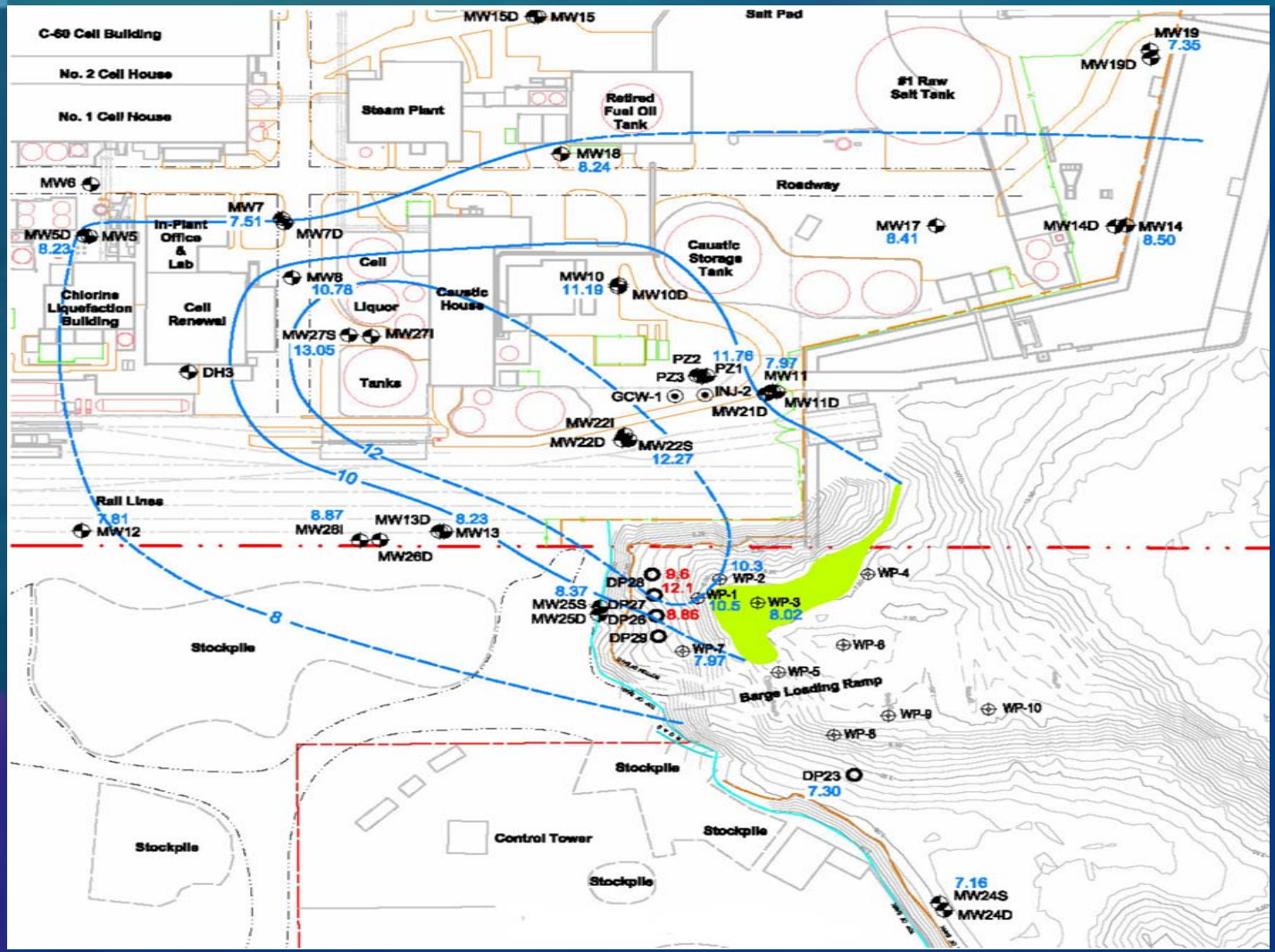
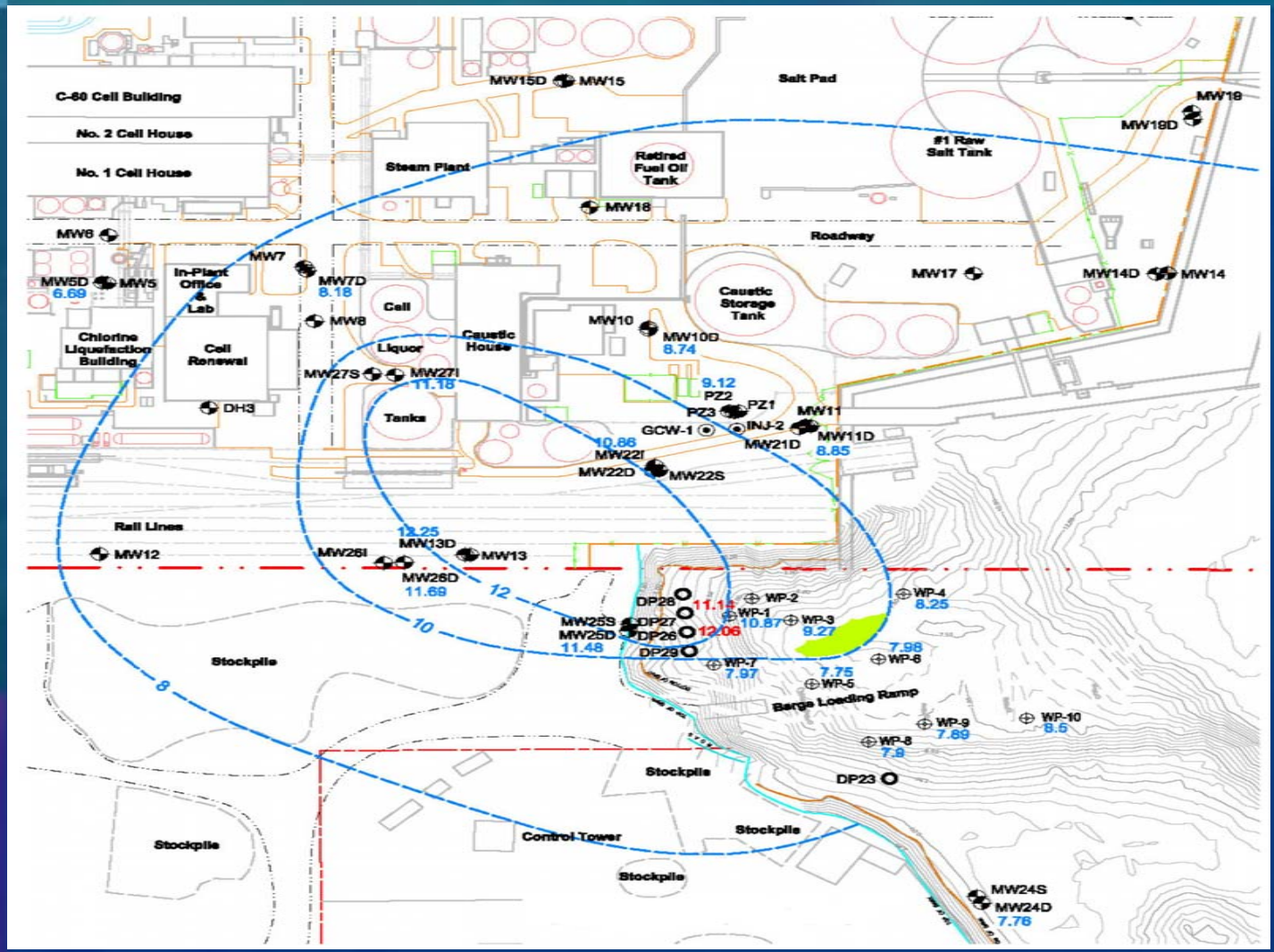
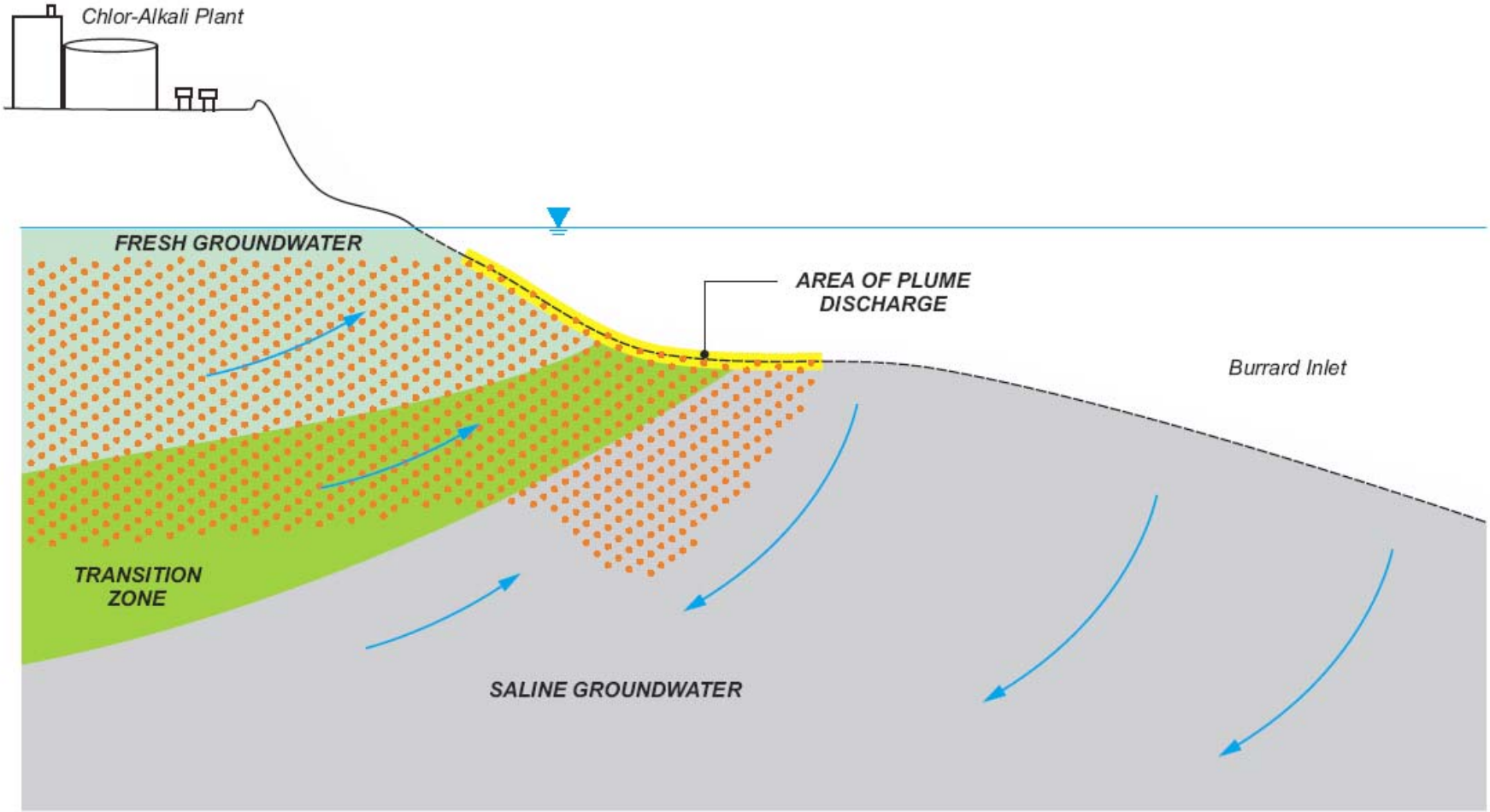
Shallow Discharge Zone



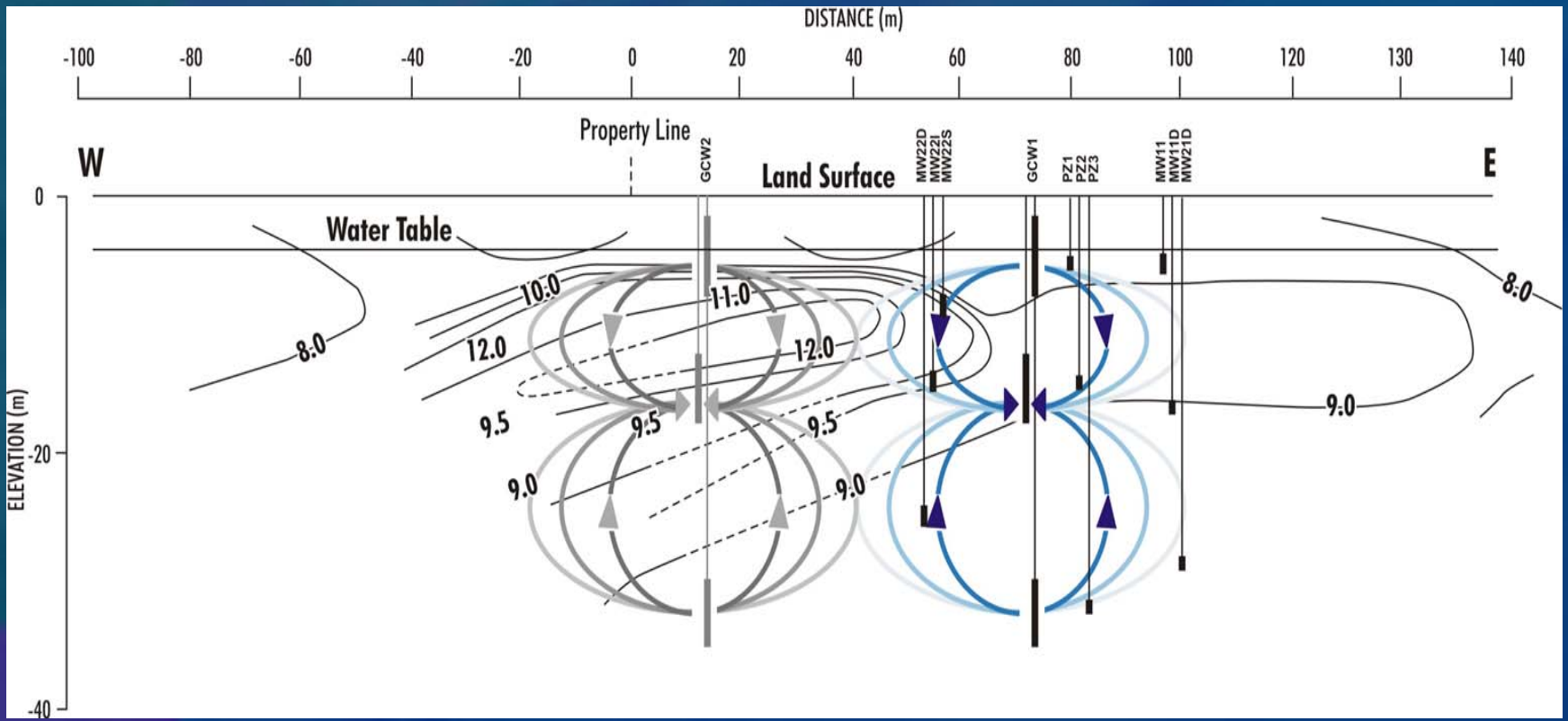
Deep Discharge Zone



Off-Site Receiving Environment Groundwater Discharge Area



Initial System Design



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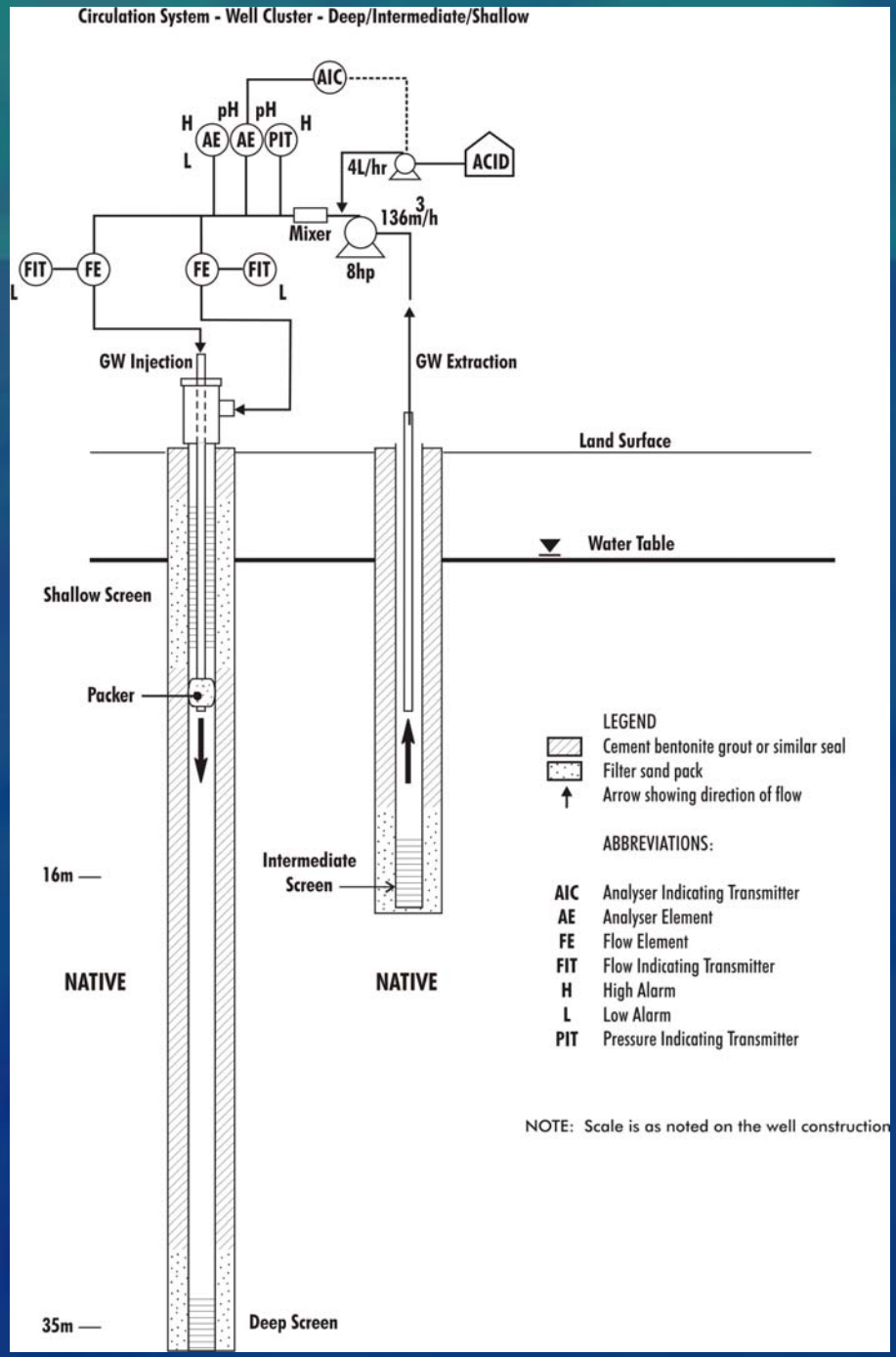
Circulation System - Well Cluster - Deep/Intermediate/Shallow
AIC
H
pH
pH
H
AE
AE
PIT
L
4L/hr
ACID
3
136m/h
Mixer
8hp
FIT
FE
FE
FIT
L
L
GW Injection
GW Extraction
Land Surface
Water Table
Shallow Screen
Packer
16m
Intermediate Screen
NATIVE
NATIVE
35m
Deep Screen
LEGEND
Cement bentonite grout or similar seal
Filter sand pack
Arrow showing direction of flow
ABBREVIATIONS:
AIC Analyser Indicating Transmitter
AE Analyser Element
FE Flow Element
FIT Flow Indicating Transmitter
H High Alarm
L Low Alarm
PIT Pressure Indicating Transmitter
NOTE: Scale is as noted on the well construction

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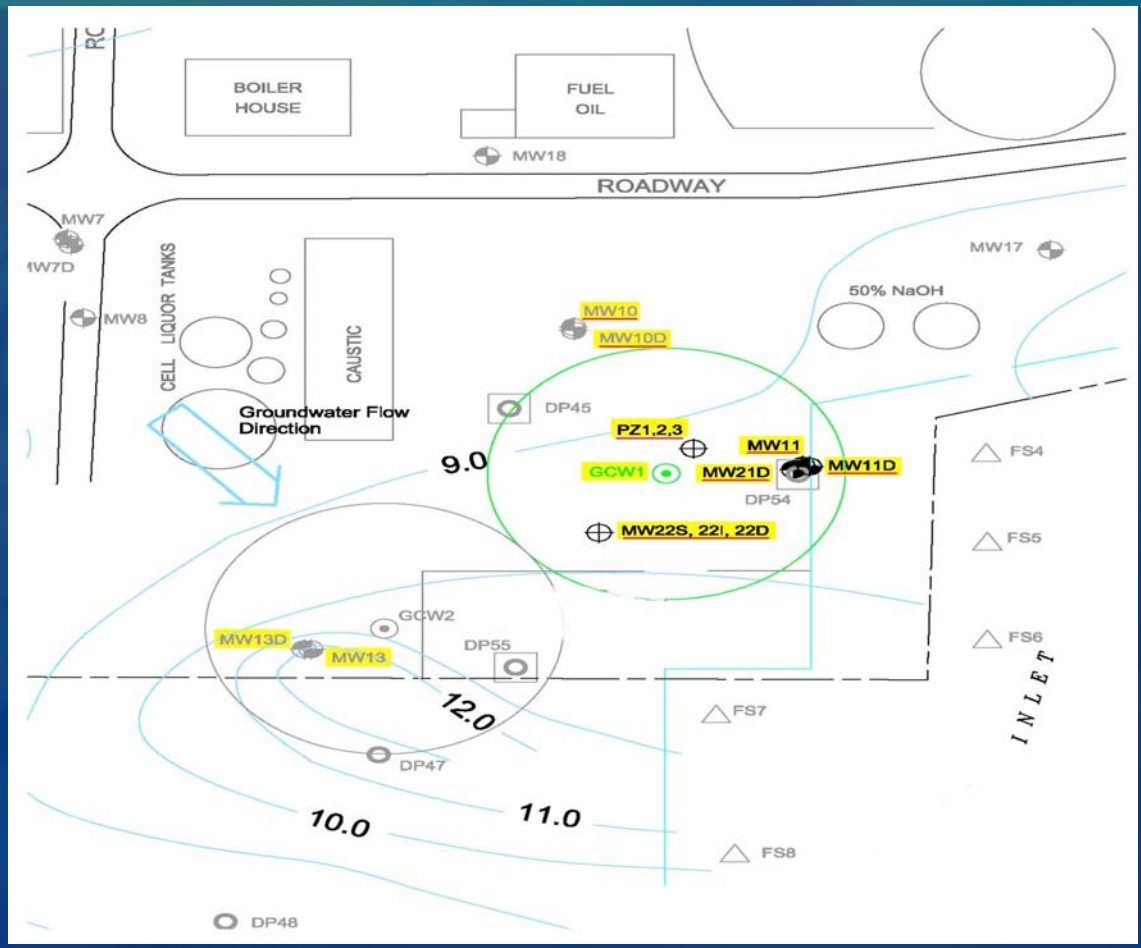
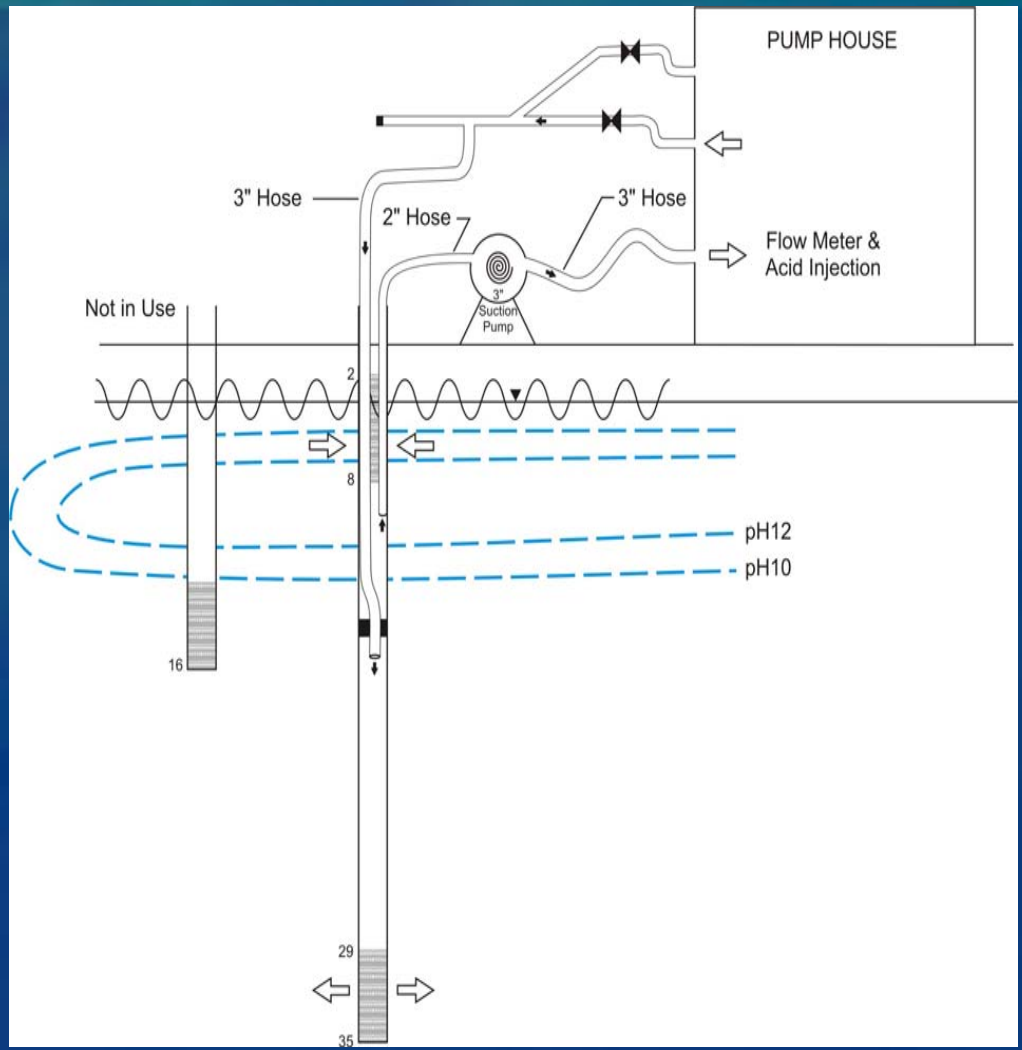
Initial System Design



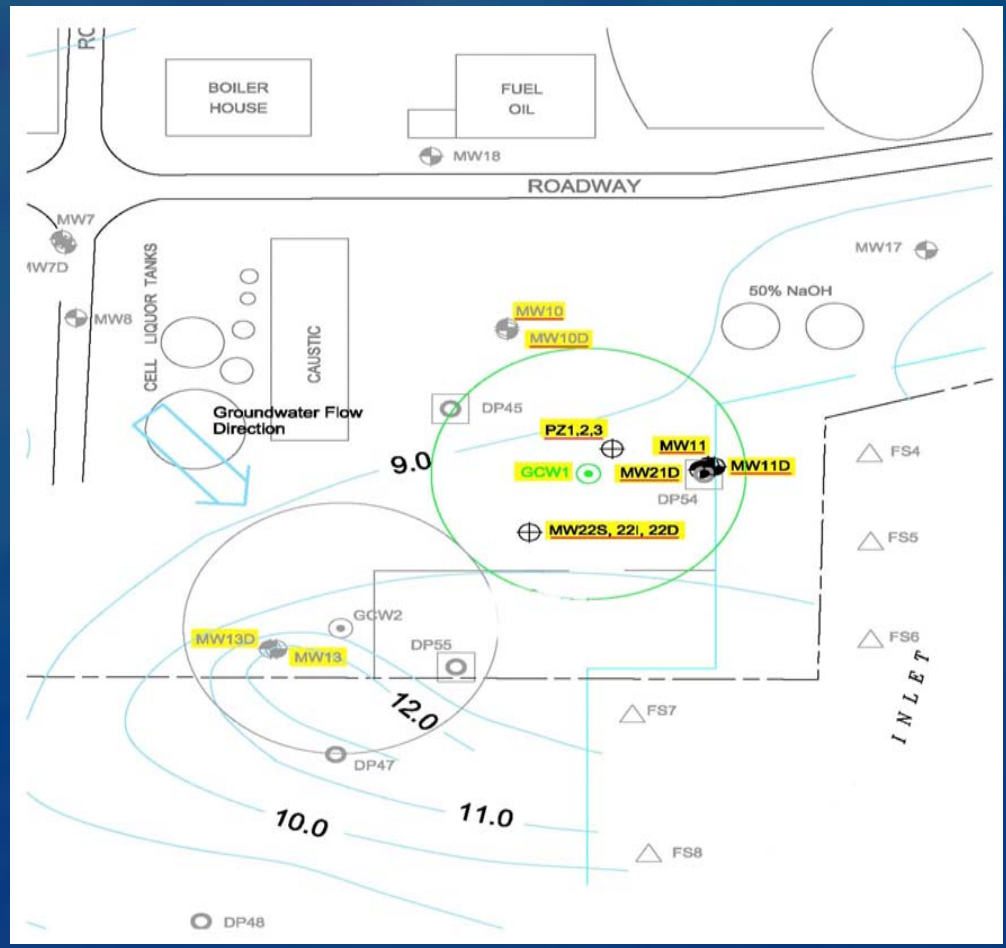
Remedial System Troubleshooting

- Several start-up issues due to scaling of equipment and safety aspects associated with HCL injection
- System had to be re-configured in June and a new pump installed



Remedial System Monitoring

- Performed monthly monitoring of pH in system wells
- pH observed to vary seasonally and over the daily tidal cycle
- Comparison of annual pH values shows a decrease in some wells



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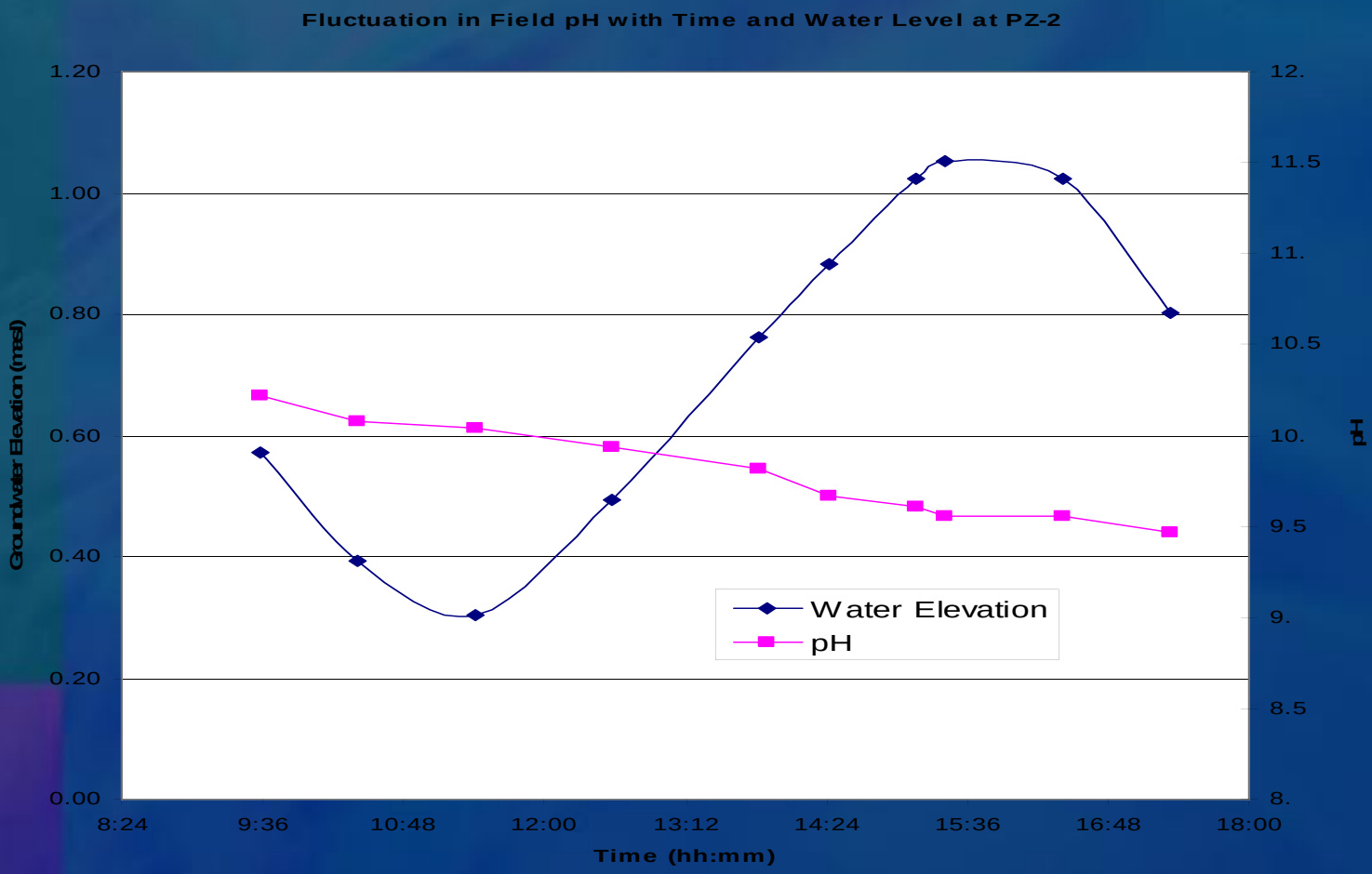
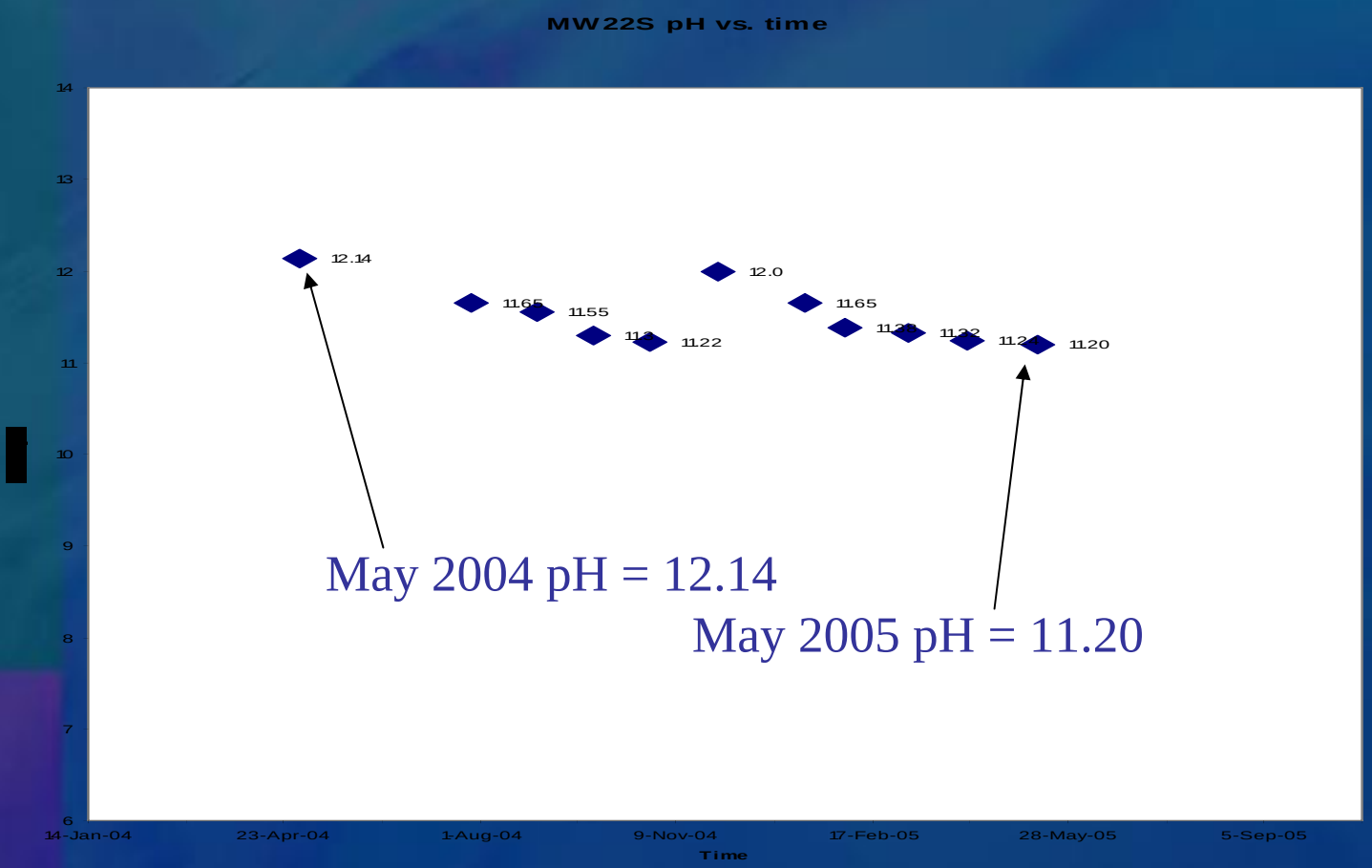
pH over Daily Tidal Cycle



Seasonal pH measurements



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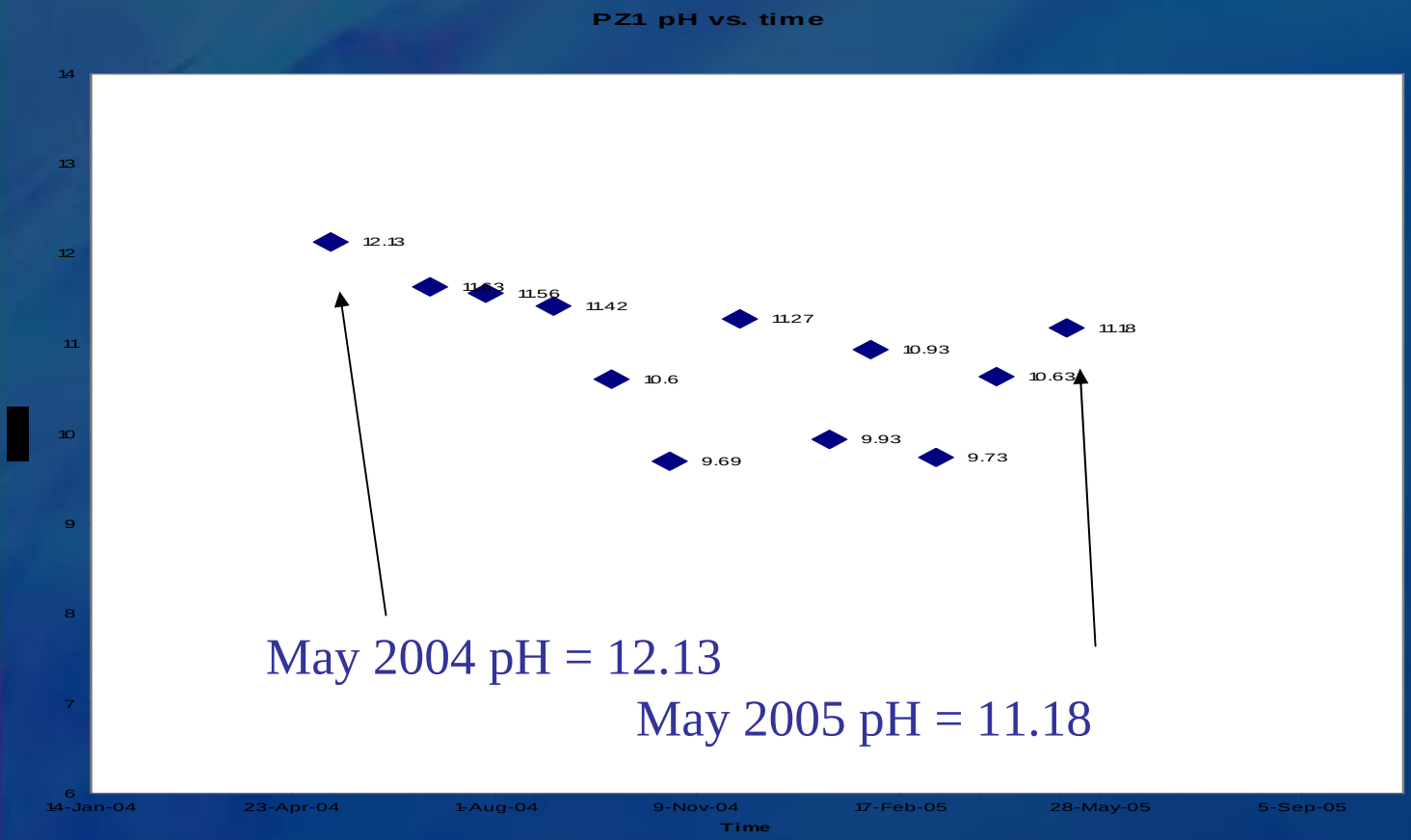
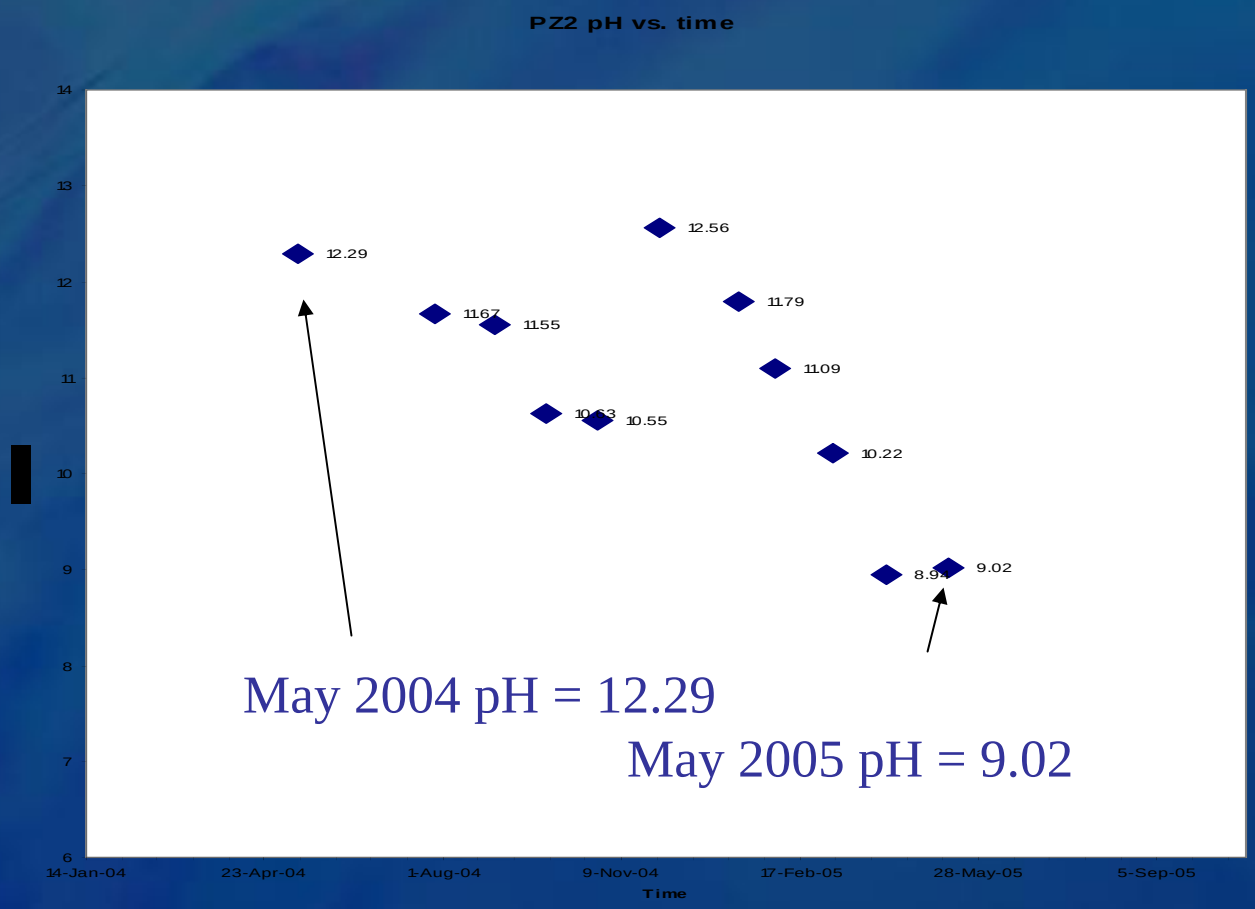


Seasonal pH measurements



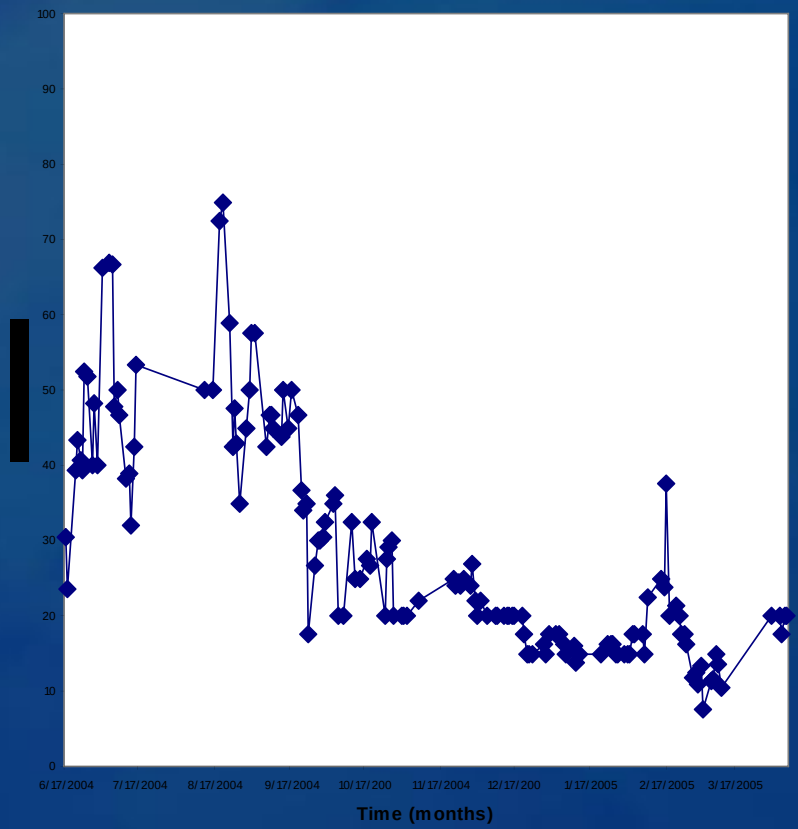
May 2004 pH = 12.29

May 2005 pH = 9.02

Remedial System Troubleshooting

- Pumping rate observed to decrease over duration of pilot trial
- Performed groundwater modeling to predict groundwater treatment zone at the end of the pilot trial

Figure 4. GCW Flow vs. Time



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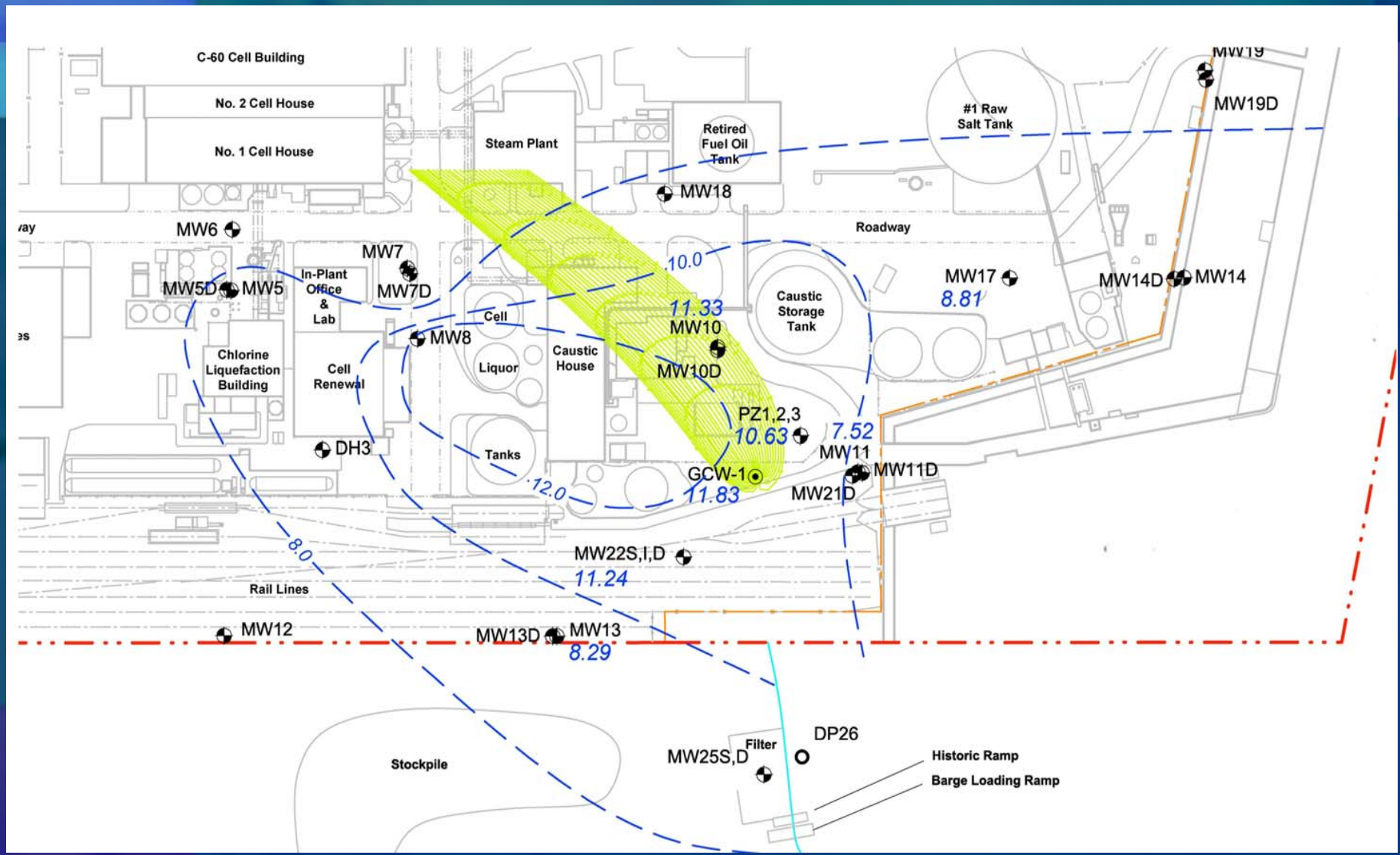
C-60 Cell Building
No. 2 Cell House
No. 1 Cell House
Steam Plant
Retired Fuel Oil Tank
#1 Raw Salt Tank
MW19
MW19D
MW18
Roadway
MW6
MW7
MW5D
MW5
In-Plant Office & Lab
MW7D
MW8
Cell
Liquor
Caustic House
Caustic Storage Tank
MW17
8.81
MW14D
MW14
10.0
11.33
MW10
MW10D
Chlorine Liquefaction Building
Cell Renewal
DH3
Tanks
PZ1,2,3
10.63
7.52
MW11
MW11D
GCW-1
11.83
MW21D
12.0
8.0
MW22S,I,D
11.24
Rail Lines
MW12
MW13D
MW13
8.29
Stockpile
Filter
DP26
MW25S,D
Historic Ramp
Barge Loading Ramp

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Remedial System Troubleshooting

- Decrease in pumping rate attributed to scale formation
- Scale issues associated with extraction of groundwater high in pH and salinity
- Bench tests using soil and groundwater from transition and saline zones produced a gel (salt) and white precipitate

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Remedial System Troubleshooting

- Bench tests using soil and groundwater from freshwater zone produced no precipitates
- Bench tests indicated scale issues related to pH reduction in saline water

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Supplemental Pilot Trial

- Re-configured the system in 06 to assess feasibility of intermediate injection point (well hydraulics / fouling / scaling)
- Installation of an intermediate injection well above the depth of saline groundwater
- Monitored pump rates, water levels and pH in surrounding monitoring wells

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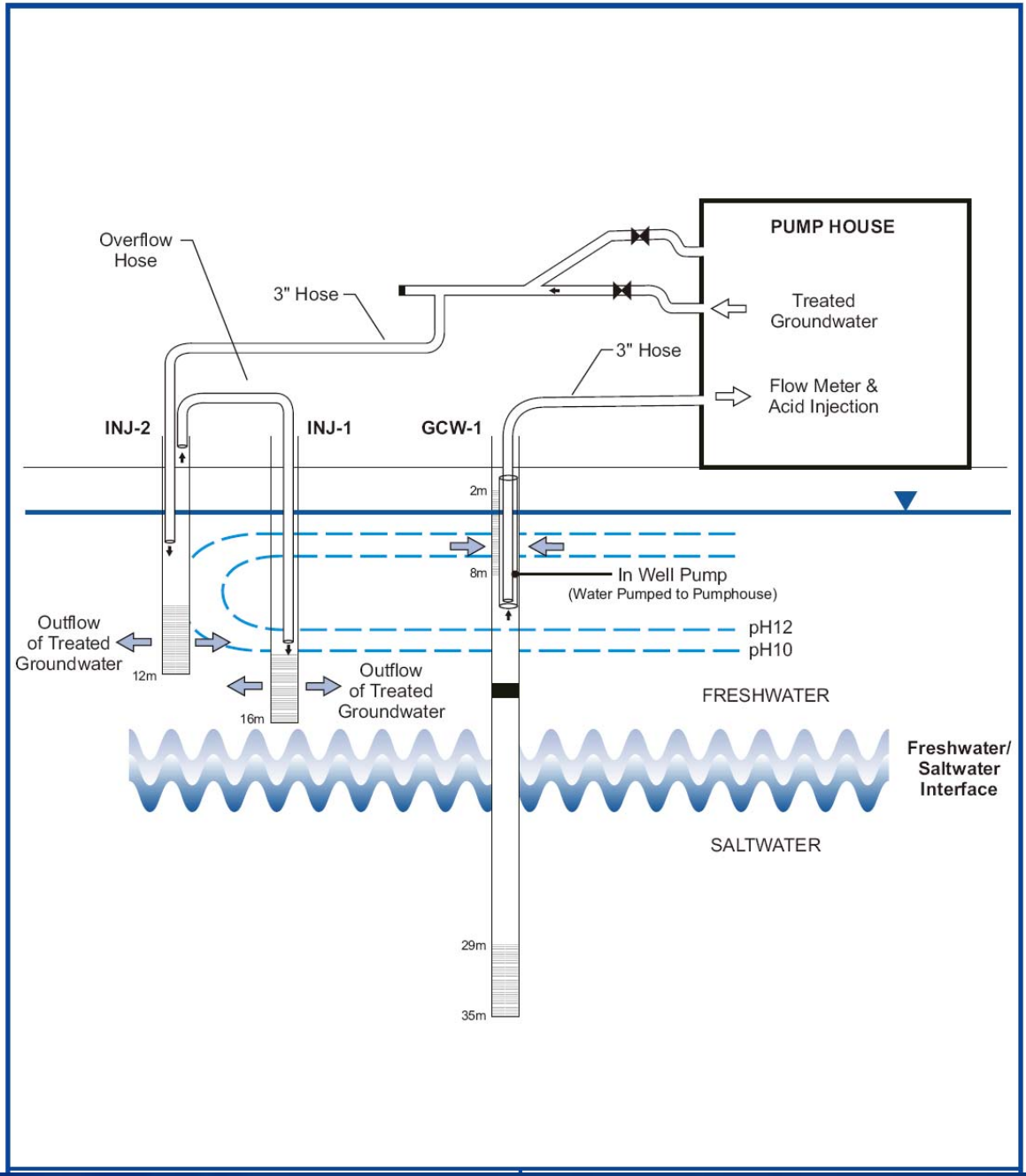
PUMP HOUSE
Overflow Hose
3" Hose
Treated Groundwater
3" Hose
Flow Meter & Acid Injection
INJ-2
INJ-1
GCW-1
2m
8m
In Well Pump
(Water Pumped to Pumphouse)
pH12
pH10
Outflow of Treated Groundwater
12m
Outflow of Treated Groundwater
16m
FRESHWATER
Freshwater/ Saltwater Interface
SALTWATER
29m
35m

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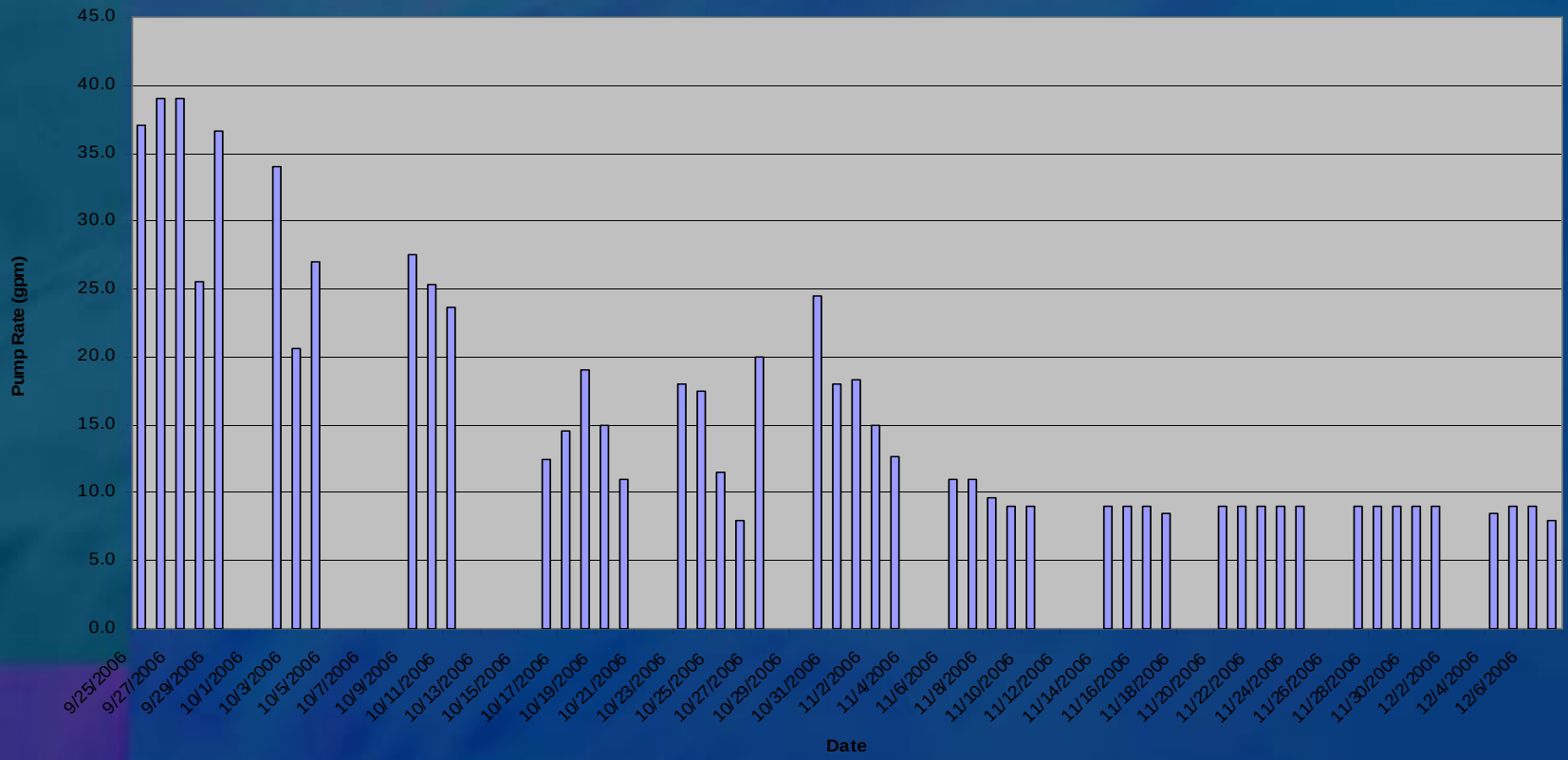
Supplemental Pilot Trial – Average Daily Pump Rates



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Supplemental Pilot Trial Results

- Initial pumping rate between 30 and 40 gpm
- Decreased capacity of injection well required old intermediate extraction well to be used for overflow
- Final pumping rate = 8 gpm
- Transducer data suggested fouling in new injection well however no scale noted in video inspection completed at end of test

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Pilot Trial Conclusions

- GCW technology is not viable at the site
- Groundwater pumping is a viable remediation method for the shallow pH plume
- GCW pilot test fouled the deep soil formation creating a zone of low conductivity
- CO2 injection is an effective method of pH reduction

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