Aquifer Replenishment and Land Subsidence, A SWIFT Perspective

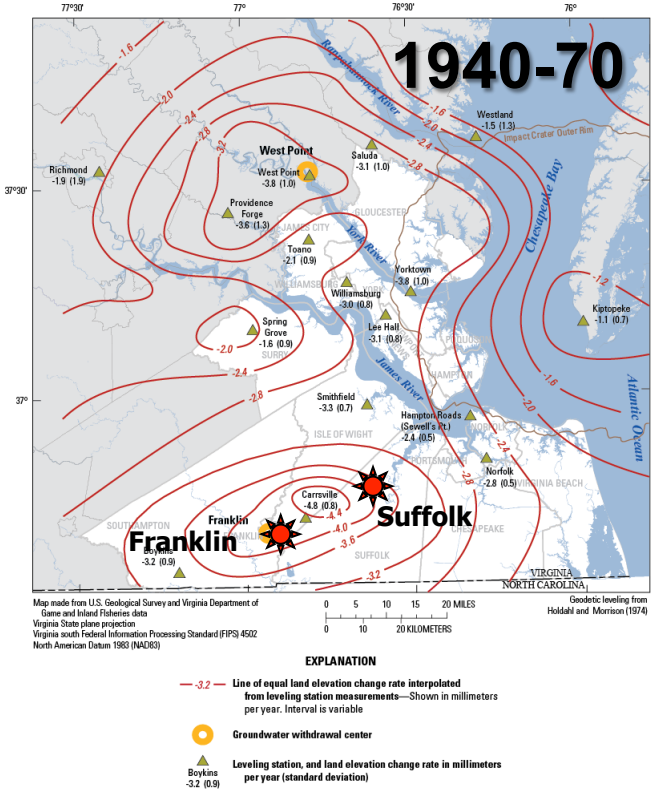
Dan Holloway, PG| Jacobs

David Nelms, PG| USGS (Retired)

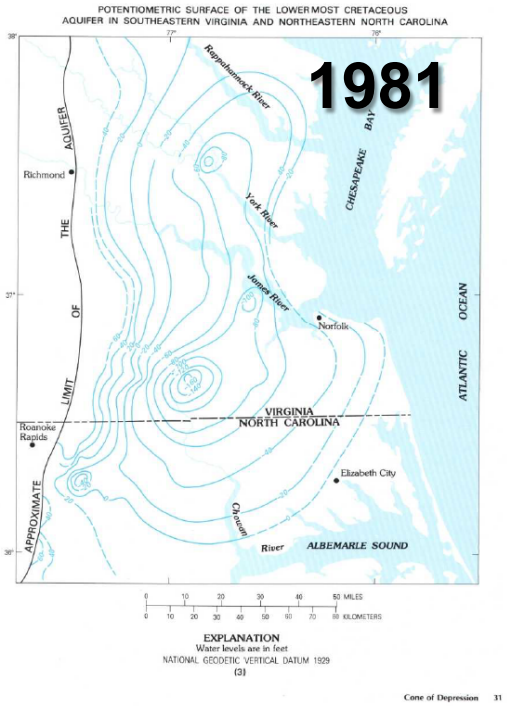
February 5, 2019

Land subsidence in the Virginia Coastal Plain

- Aquifer-system compaction from large groundwater withdrawals
- Aquifer-system compaction combined with glacial isostatic adjustment contribute to high rates of sea level rise in the area
- Measured rates of aquifer system compaction (1979-96)
  - **Franklin** 1.6 mm/yr
  - **Suffolk** 3.7 mm/yr
- Two types of deformation
  - Irreversible inelastic
  - **Recoverable elastic**



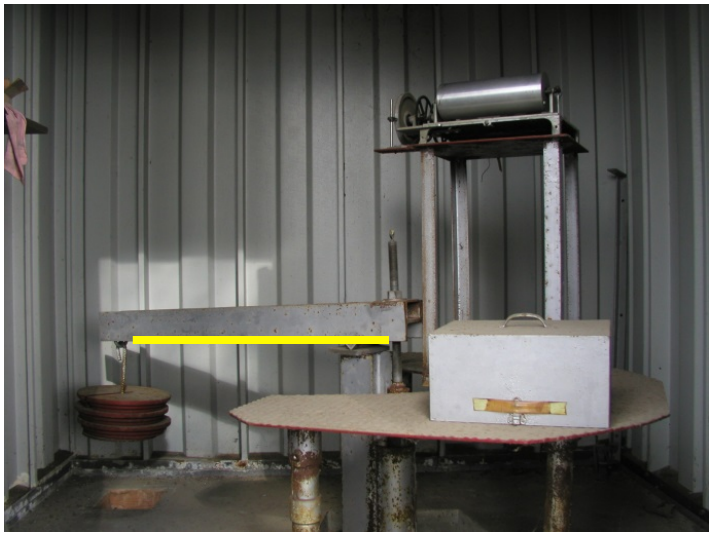
Holdahl and Morrison (1974)
Tectonophysics, 23(4), p. 373–390

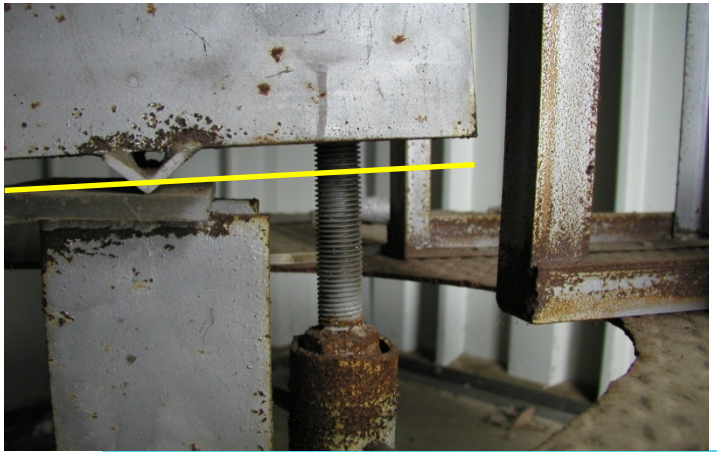


Heath (1983)
USGS WSP 2220

Elastic Rebound of Land Subsidence Example

2002

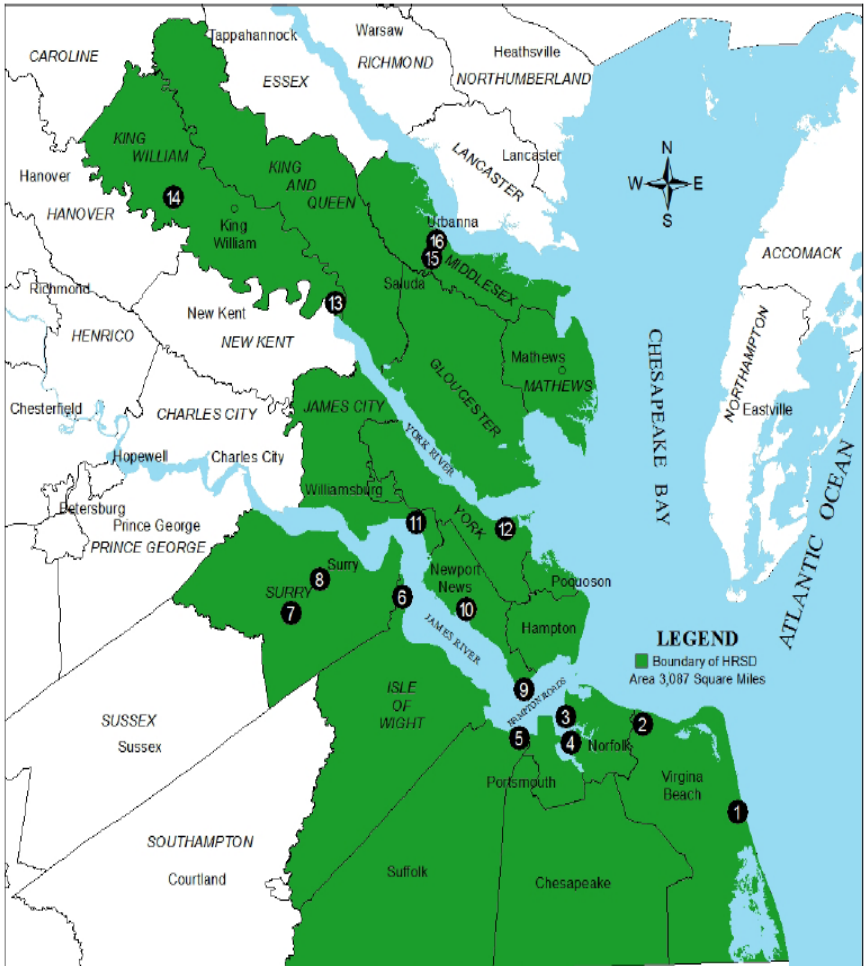




USGS found ground surface rebounded 32 mm between 2002 and 2015 coinciding with reduced groundwater withdrawal by Franklin paper mill from 2009-2010.

2015

Who/What is HRSD?

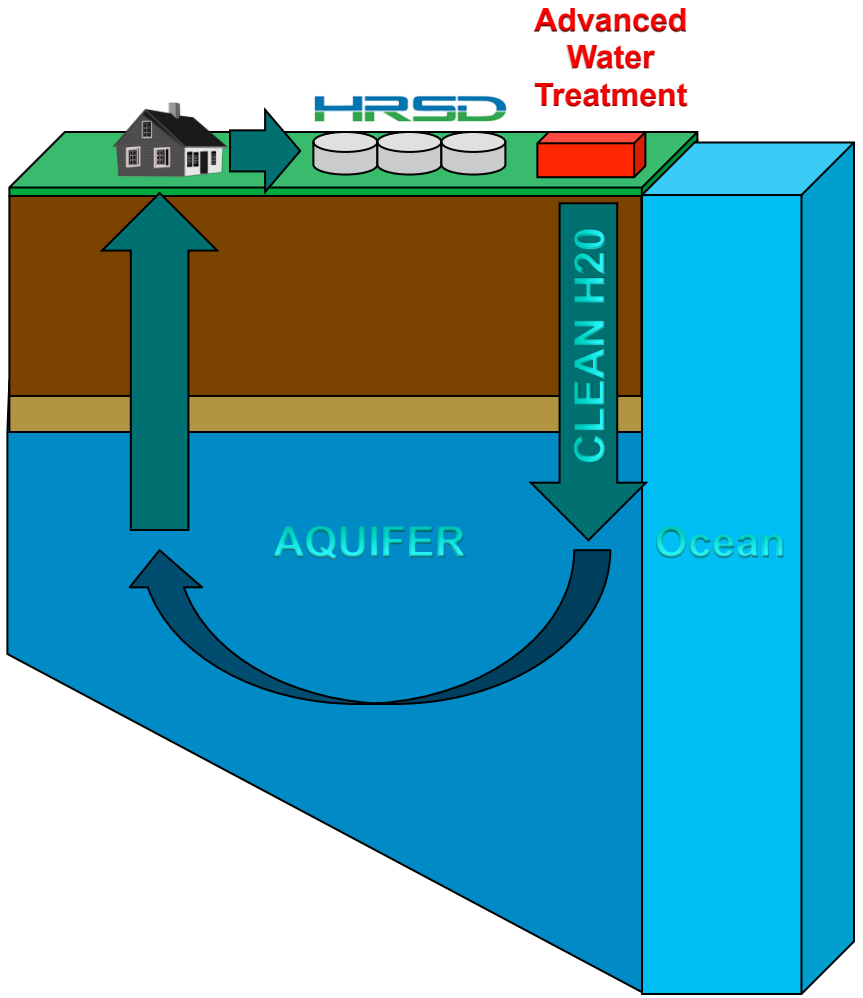


- Provide wastewater treatment for 18 localities (250 mgd treatment capacity)
- Serve 1.7 million people (20% of all Virginians)
- Independent political subdivision with Governor appointed Commission

● HRSD Treatment Facilities

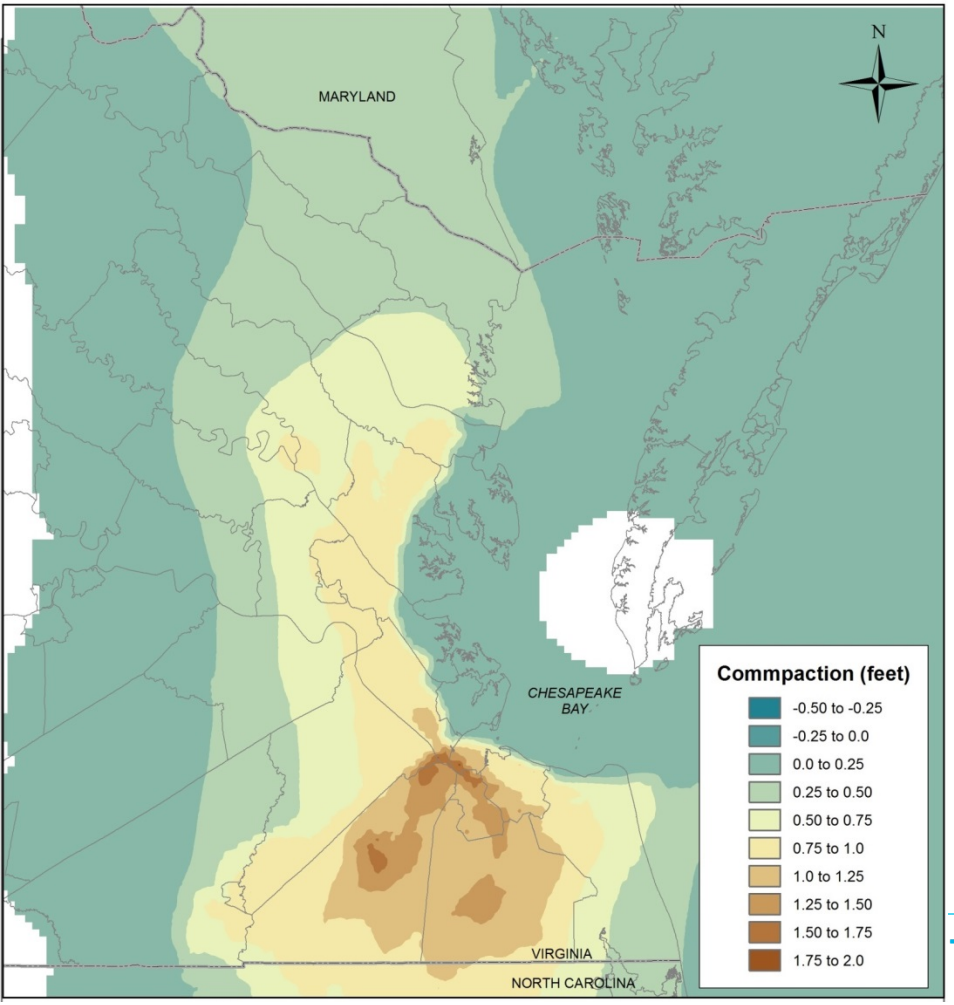
SWIFT – Sustainable Water Initiative for Tomorrow

- Treat water to meet drinking water standards and replenish the aquifer with clean water to:
  - Provide regulatory stability for wastewater treatment
  - **Provide a sustainable supply of groundwater**
  - Reduce nutrient discharges to the Bay
  - **Reduce the rate of land subsidence**

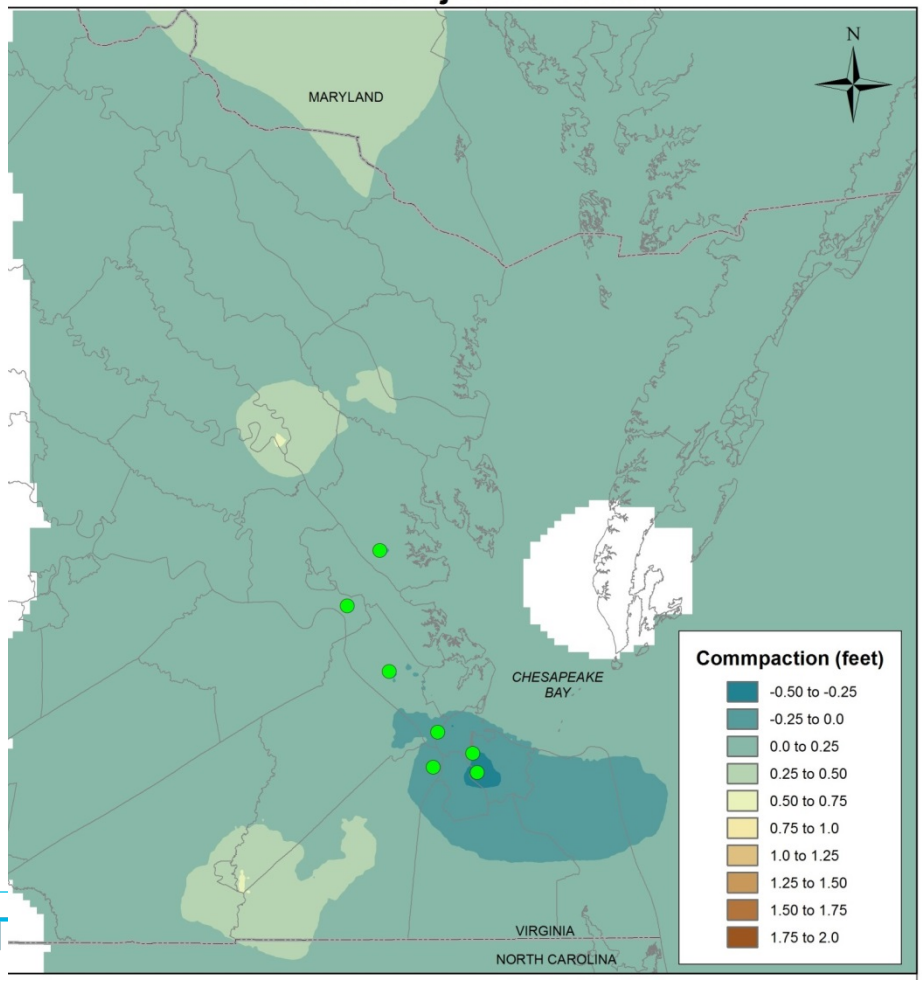


Aquifer compaction without and with SWIFT

Simulated Total Aquifer System Compaction from 1890 to 2064 - Total Permitted

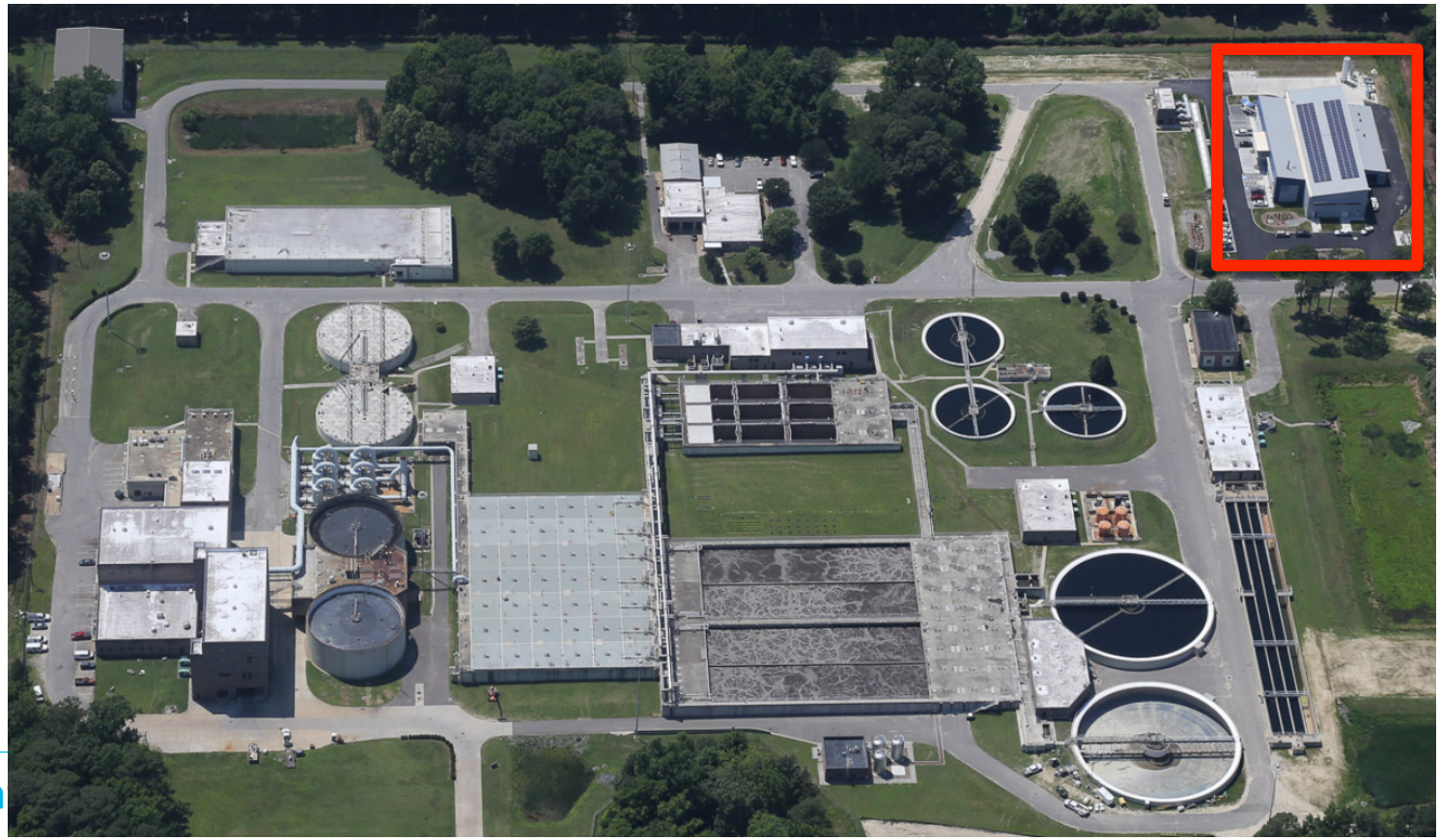


Simulated Total Aquifer System Compaction from 1890 to 2064 - Total Permitted with All Injection Wells

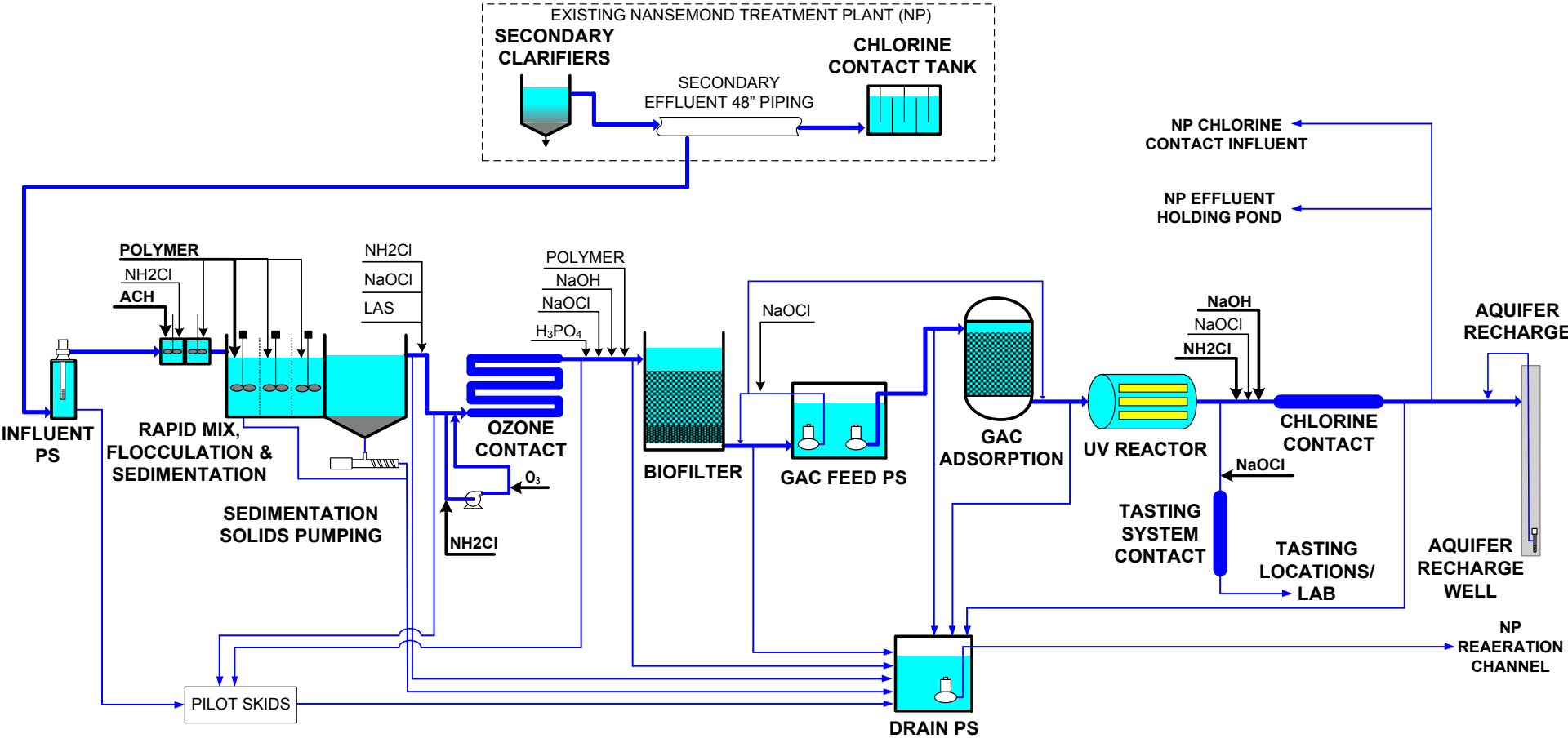


SWIFT Research Center

(1.0 MGD AWT + recharge well + monitoring wells + public outreach and education center + research facilities)

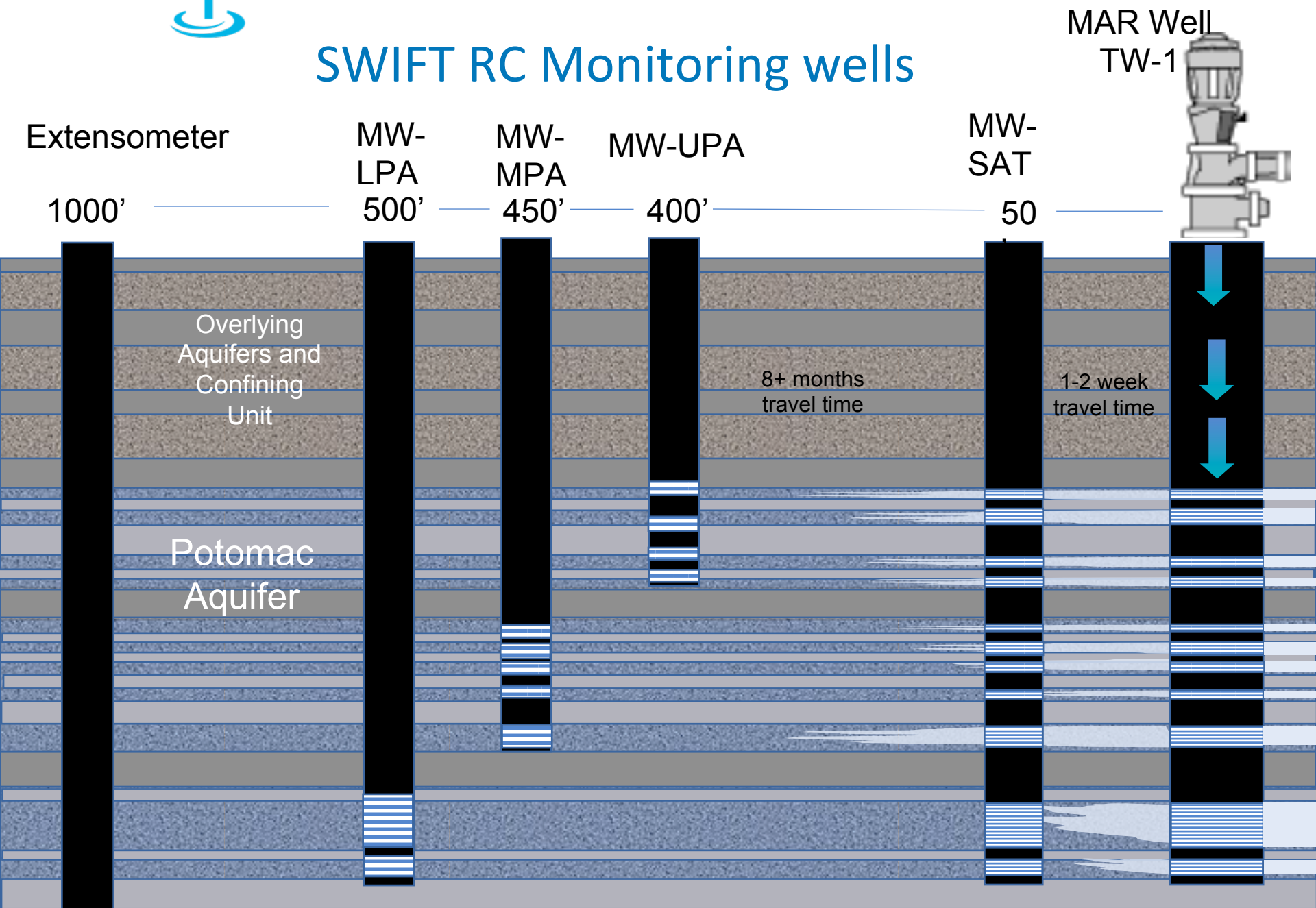


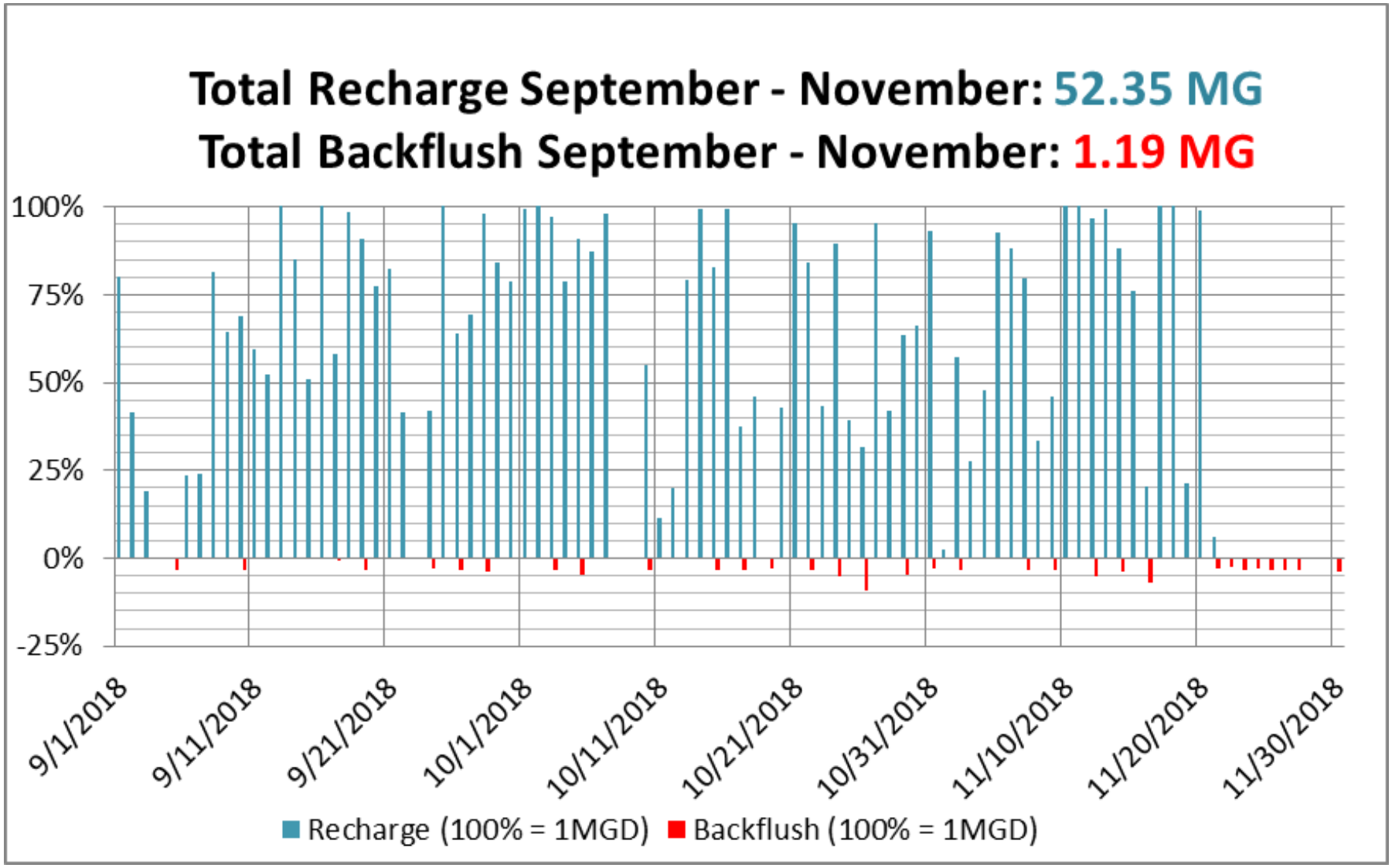
Process Flow Diagram for SWIFT Research Center



SWIFT RESEARCH CENTER PROCESS FLOW DIAGRAM

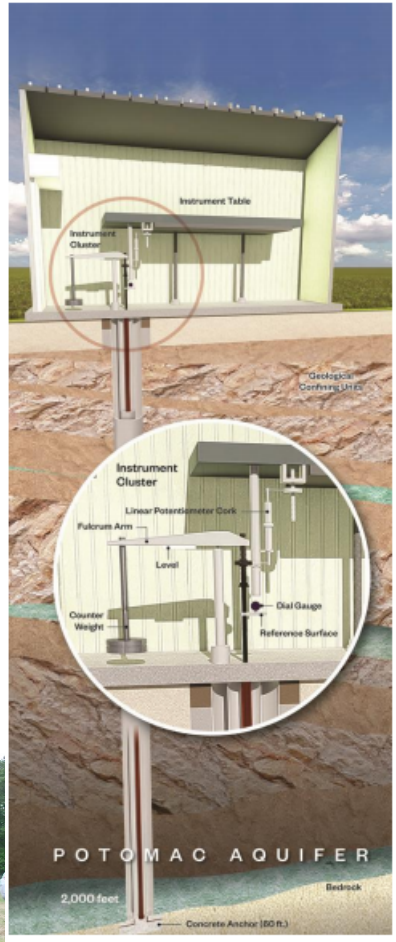
SWIFT RC Monitoring wells



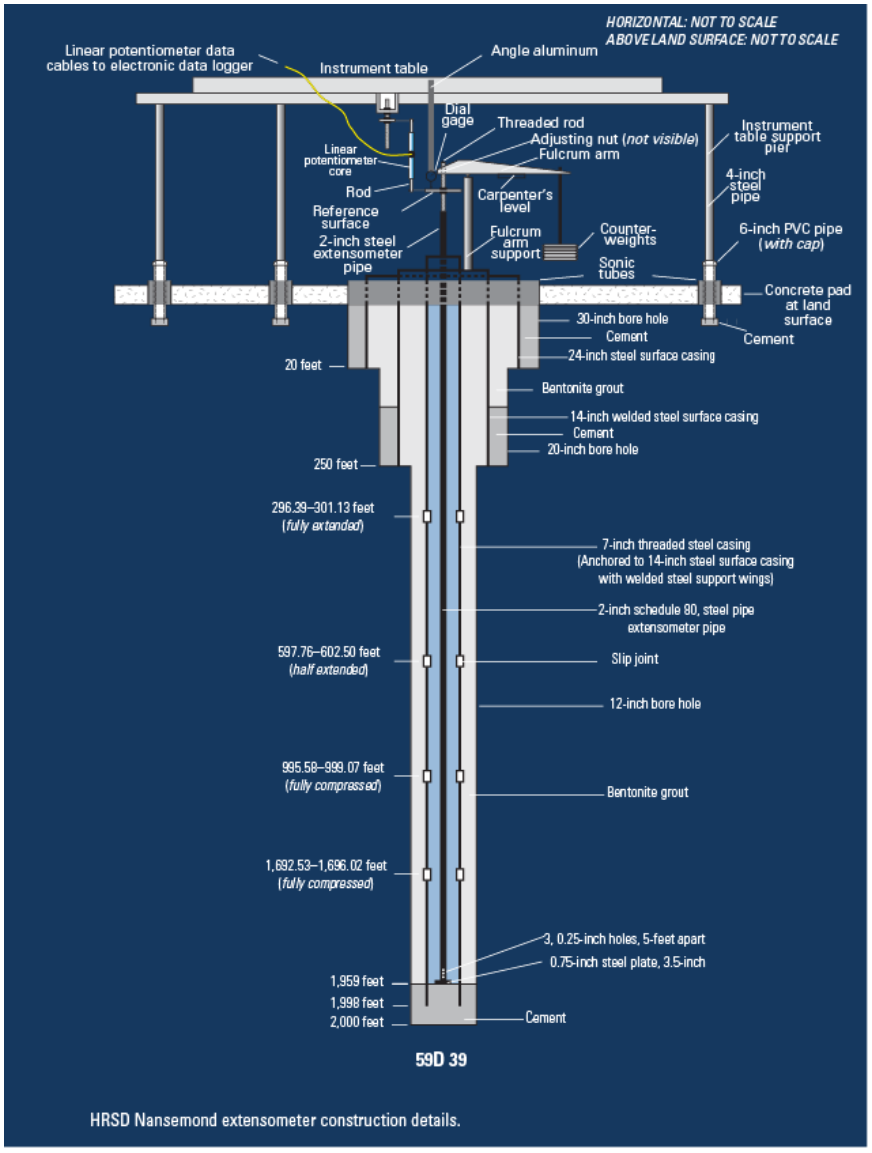

Total Recharge September - November: 52.35 MG
Total Backflush September - November: 1.19 MG
100%
75%
50%
25%
0%
-25%
9/1/2018
9/11/2018
9/21/2018
10/1/2018
10/11/2018
10/21/2018
10/31/2018
11/10/2018
11/20/2018
11/30/2018
Recharge (100% = 1MGD)
Backflush (100% = 1MGD)

Extensometer at SRC

- 1,959-ft pipe extensometer
- 4 slip joints
- Compaction monitored with linear displacement potentiometer (sub-mm)
- 5 observation wells
- 6-min recording interval
- Deep rod benchmark for DGPS surveys
- Continuous GPS to monitor bedrock

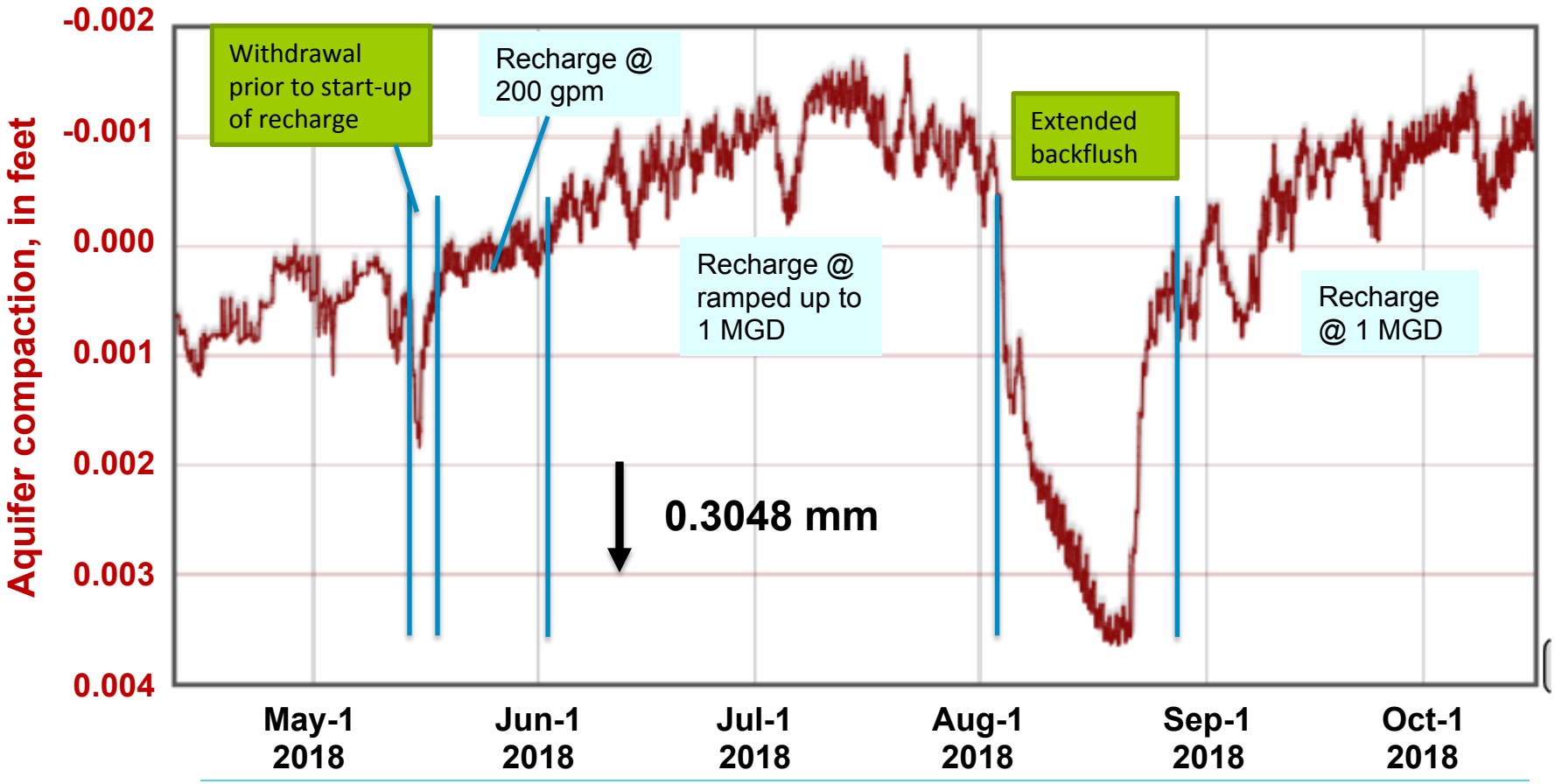


USGS geologists will analyze data produced by an extensometer installed at the SWIFT Research Center to determine changes in land subsidence.

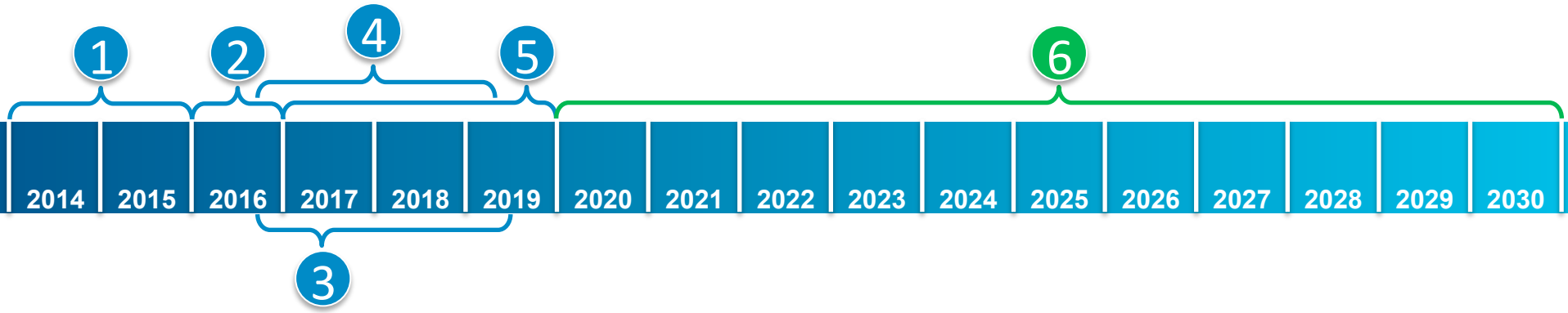


HRSD Nansemond extensometer construction details.

Compaction at Nansemond measured from Extensometer



SWIFT Program Timeline



Phase 1 - Concept Feasibility

Phase 2 - Concept Development & Pilot Testing

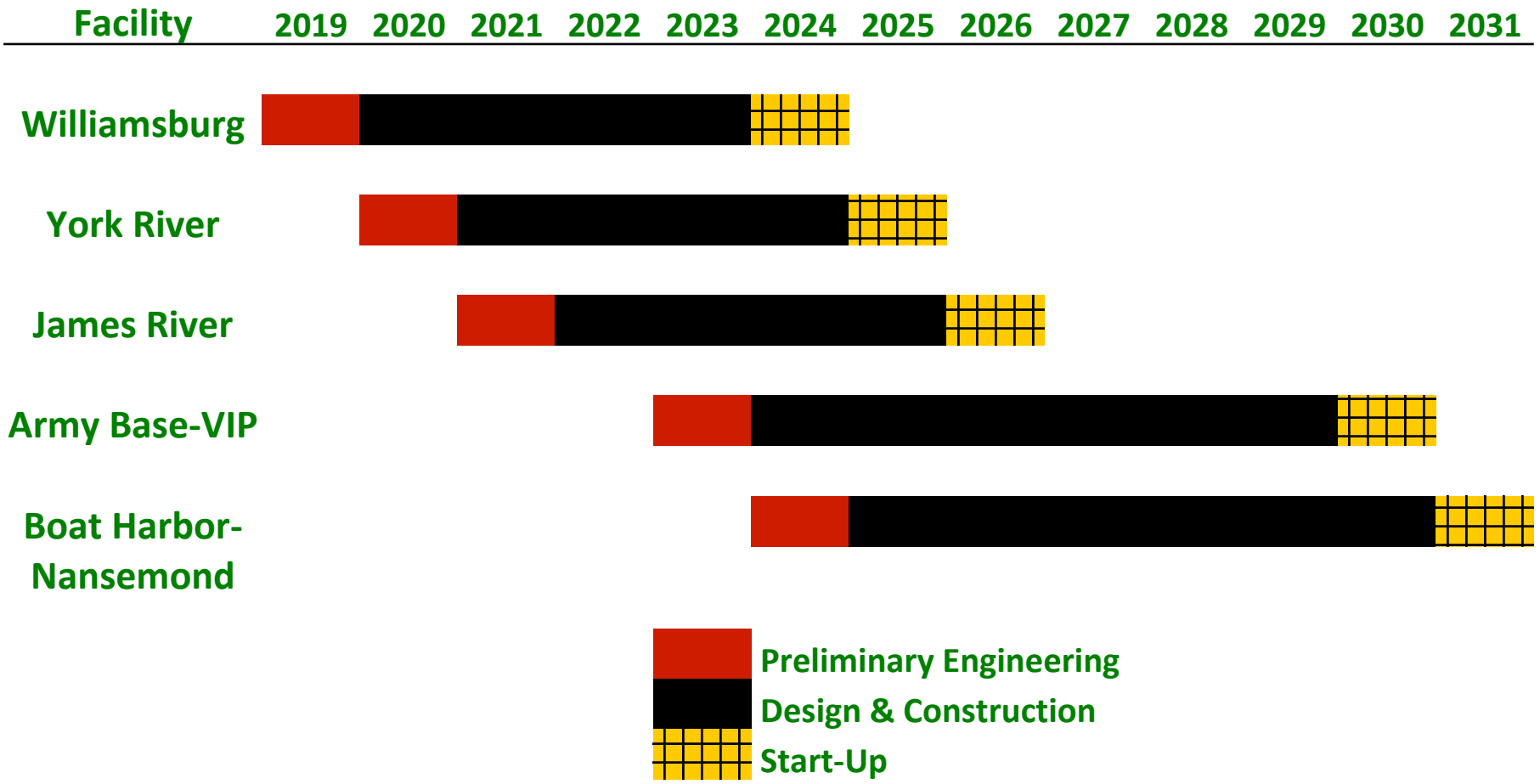
Phase 3 - Concept Demonstration

Phase 4 - Facility Plan Development

Phase 5 - Implementation Plan

Phase 6 - Full Scale Facility Implementation

Estimated schedule for implementation of SWIFT full scale treatment facilities




SWIFTVA.COM
swift
Sustainable
Water Initiative
for Tomorrow