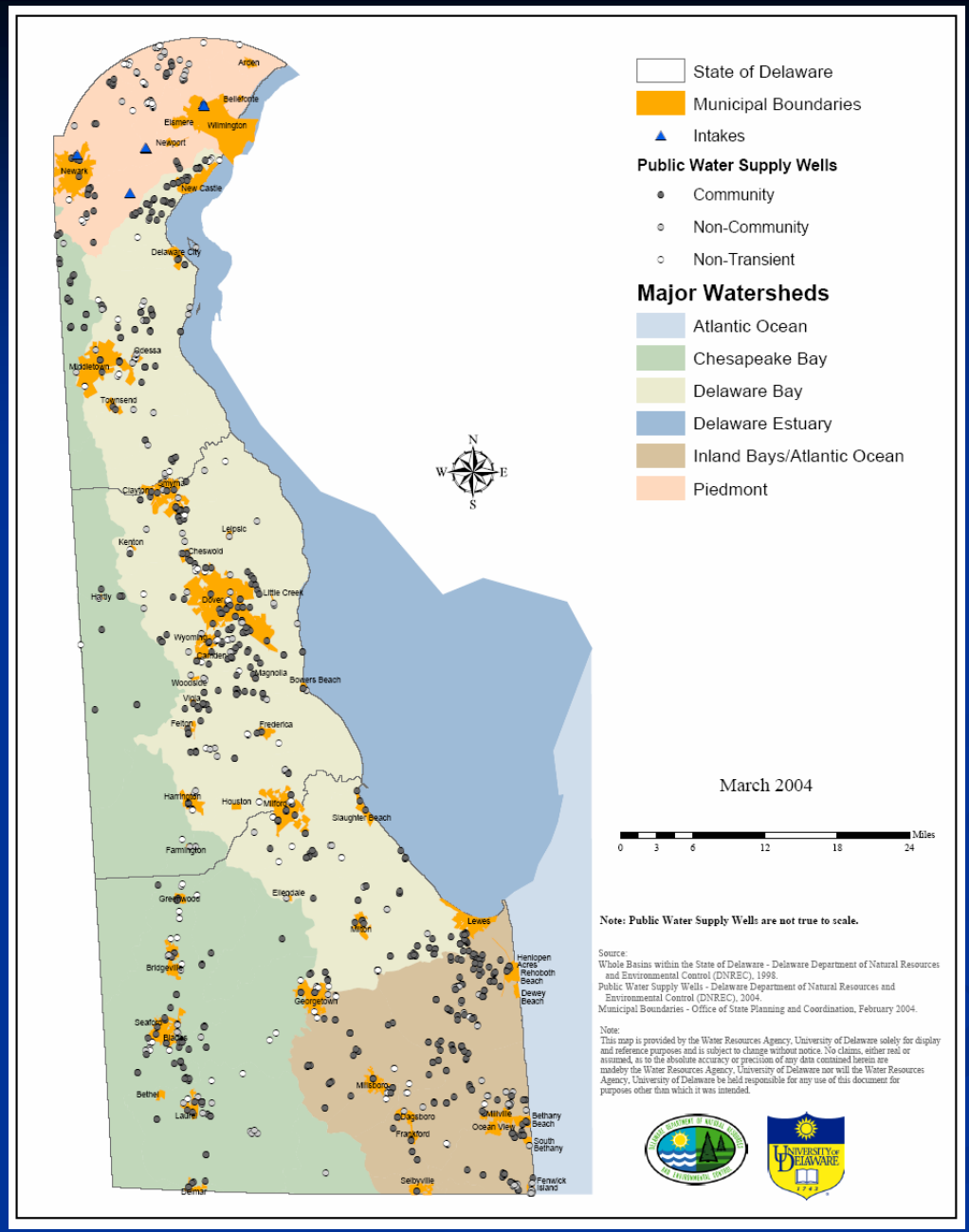
Delaware


State of Delaware
Municipal Boundaries
Intakes
Public Water Supply Wells
Community
Non-Community
Non-Transient
Major Watersheds
Atlantic Ocean
Chesapeake Bay
Delaware Bay
Delaware Estuary
Inland Bays/Atlantic Ocean
Piedmont
N
W
E
S
March 2004
Miles
0 3 6 12 18 24
Note: Public Water Supply Wells are not true to scale.
Source:
Whole Basins within the State of Delaware - Delaware Department of Natural Resources and Environmental Control (DNREC), 1998.
Public Water Supply Wells - Delaware Department of Natural Resources and Environmental Control (DNREC), 2004.
Municipal Boundaries - Office of State Planning and Coordination, February 2004.
Note:
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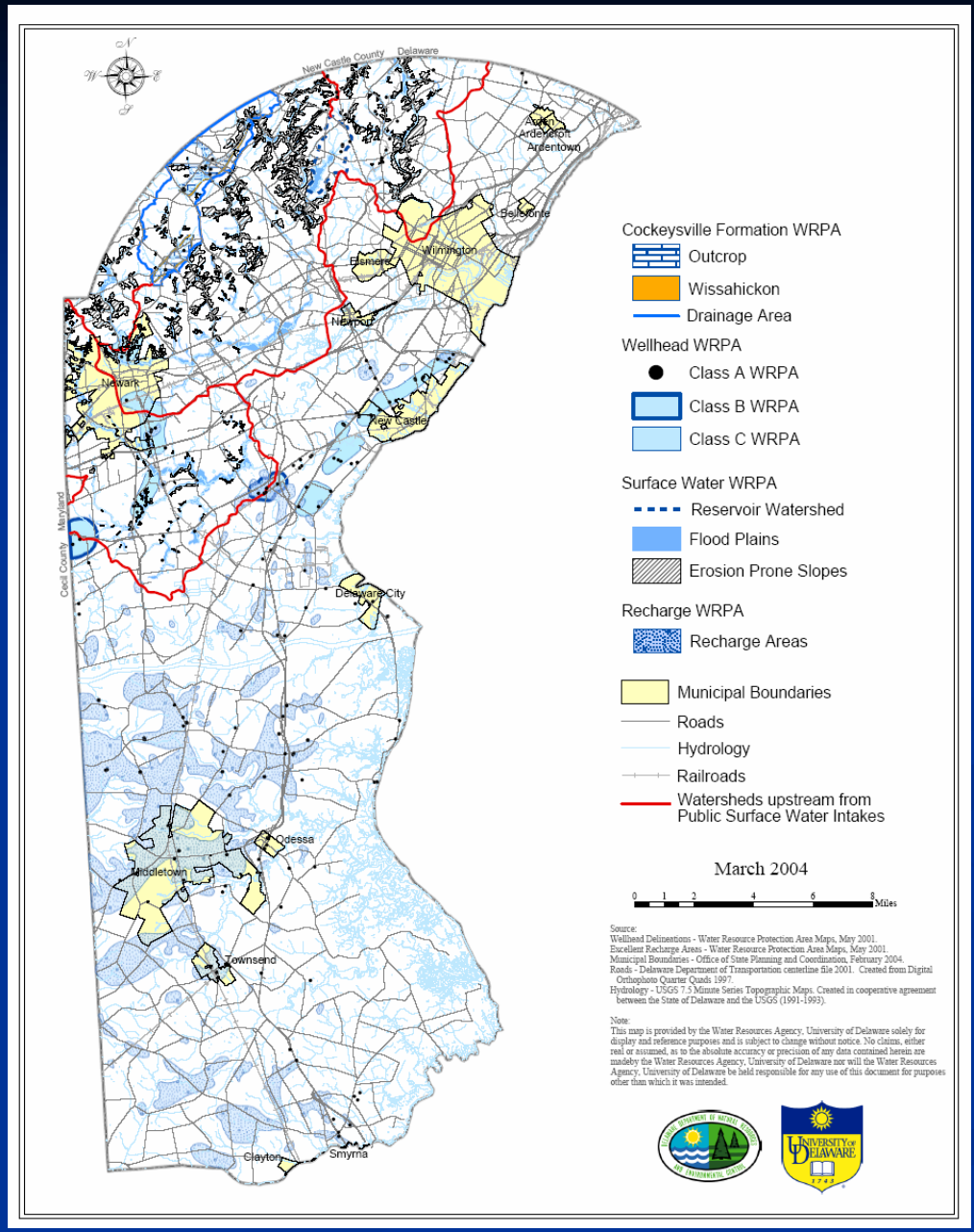
Arden
Bellefonte
Elsmere
Wilmington
Newport
Newark
New Castle
Delaware City
Odessa
Middletown
Townsend
Smyrna
Clayton
Leipsic
Kenton
Cheswold
Harrington
Dover
Little Creek
Wyoming
Camden
Magnolia
Woodside
Bowers Beach
Viola
Felton
Frederica
Hartly
Houston
Milford
Slaughter Beach
Farmington
Greenwood
Ellendale
Lewes
Milton
Henlopen Acres
Rehoboth Beach
Dewey Beach
Georgetown
Bridgeville
Seaford
Blades
Bethel
Laurel
Millsboro
Dagsboro
Frankford
Millville
Ocean View
Bethany Beach
South Bethany
Fenwick Island
Selbyville
Delmar


New Castle County
Delaware
Maryland
Cecil County
Ardencroft
Ardentown
Bellefonte
Wilmington
Elsmere
Newport
Newark
New Castle
Delaware City
Odessa
Middletown
Townsend
Clayton
Smyrna
Cockeysville Formation WRPA
Outcrop
Wissahickon
Drainage Area
Wellhead WRPA
Class A WRPA
Class B WRPA
Class C WRPA
Surface Water WRPA
Reservoir Watershed
Flood Plains
Erosion Prone Slopes
Recharge WRPA
Recharge Areas
Municipal Boundaries
Roads
Hydrology
Railroads
Watersheds upstream from Public Surface Water Intakes
March 2004
0 1 2 4 6 8 Miles
Source:
Wellhead Delineations - Water Resource Protection Area Maps, May 2001.
Excellent Recharge Areas - Water Resource Protection Area Maps, May 2001.
Municipal Boundaries - Office of State Planning and Coordination, February 2004.
Roads - Delaware Department of Transportation centerline file 2001. Created from Digital Orthophoto Quarter Quads 1997.
Hydrology - USGS 7.5 Minute Series Topographic Maps. Created in cooperative agreement between the State of Delaware and the USGS (1991-1993).
Note:
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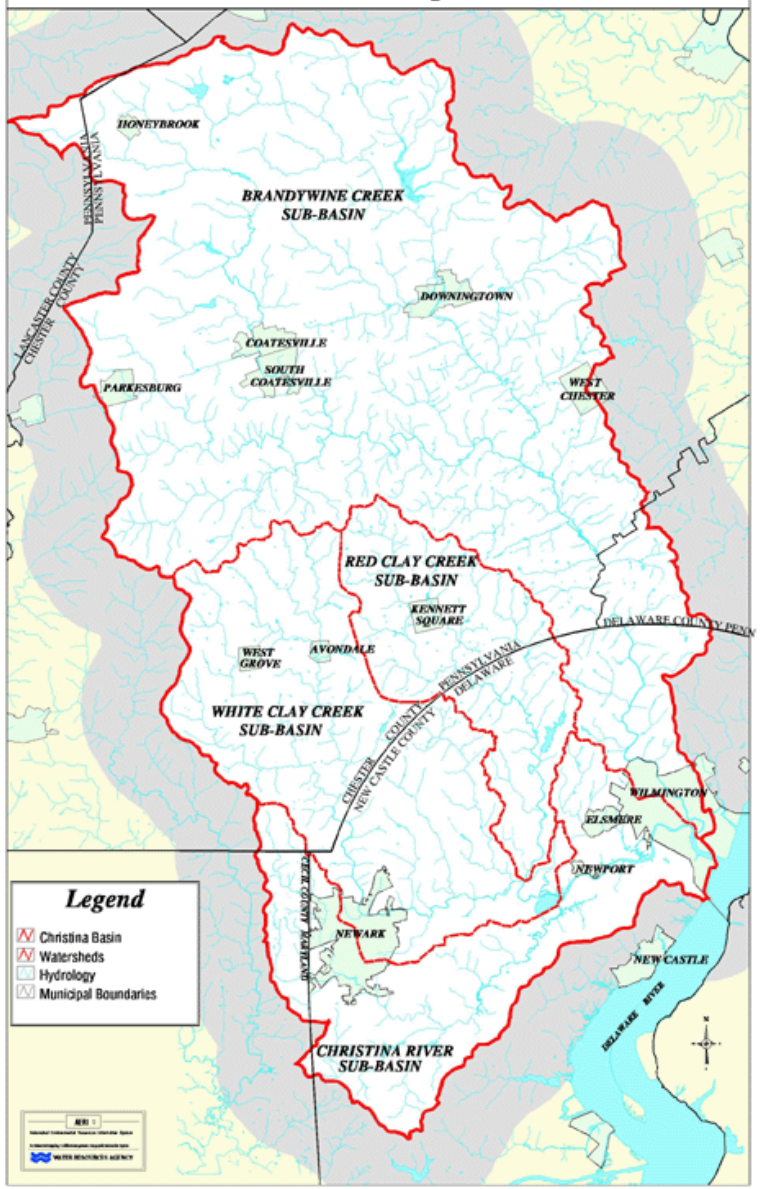
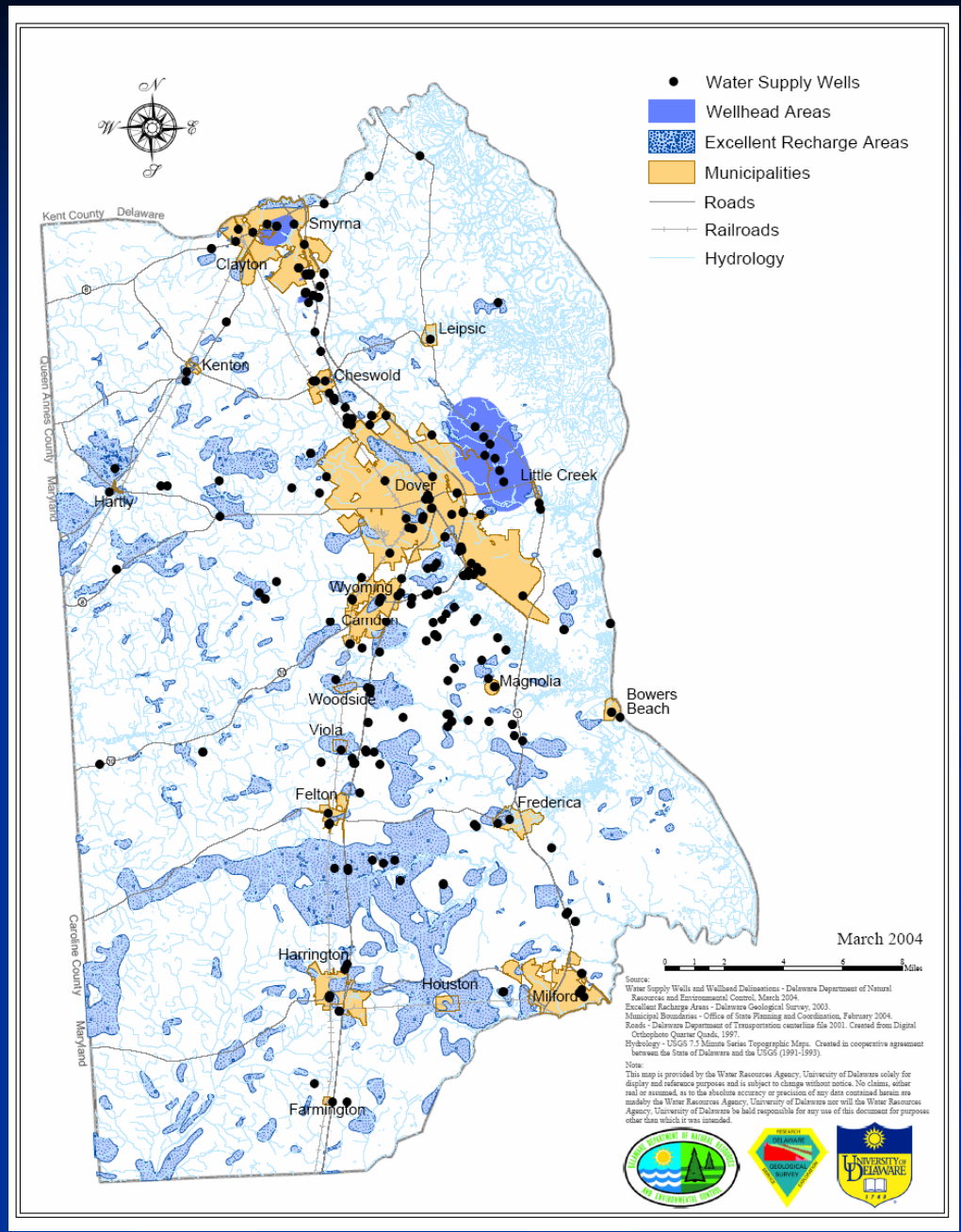
Christina Basin Water Quality Management Strategy
Base Map




Water Supply Wells
Wellhead Areas
Excellent Recharge Areas
Municipalities
Roads
Railroads
Hydrology
Kent County Delaware
Queen Annes County Maryland
Caroline County Maryland
Smyrna
Clayton
Leipsic
Kenton
Cheswold
Dover
Little Creek
Hartly
Wyoming
Camden
Magnolia
Bowers Beach
Woodside
Viola
Felton
Frederica
Harrington
Houston
Milford
Farmington
March 2004
0 1 2 4 6 8 Miles
Source:
Water Supply Wells and Wellhead Delineations - Delaware Department of Natural Resources and Environmental Control, March 2004.
Excellent Recharge Areas - Delaware Geological Survey, 2003.
Municipal Boundaries - Office of State Planning and Coordination, February 2004.
Roads - Delaware Department of Transportation centerline file 2001. Created from Digital Orthophoto Quarter Quads, 1997.
Hydrology - USGS 7.5 Minute Series Topographic Maps. Created in cooperative agreement between the State of Delaware and the USGS (1991-1993).
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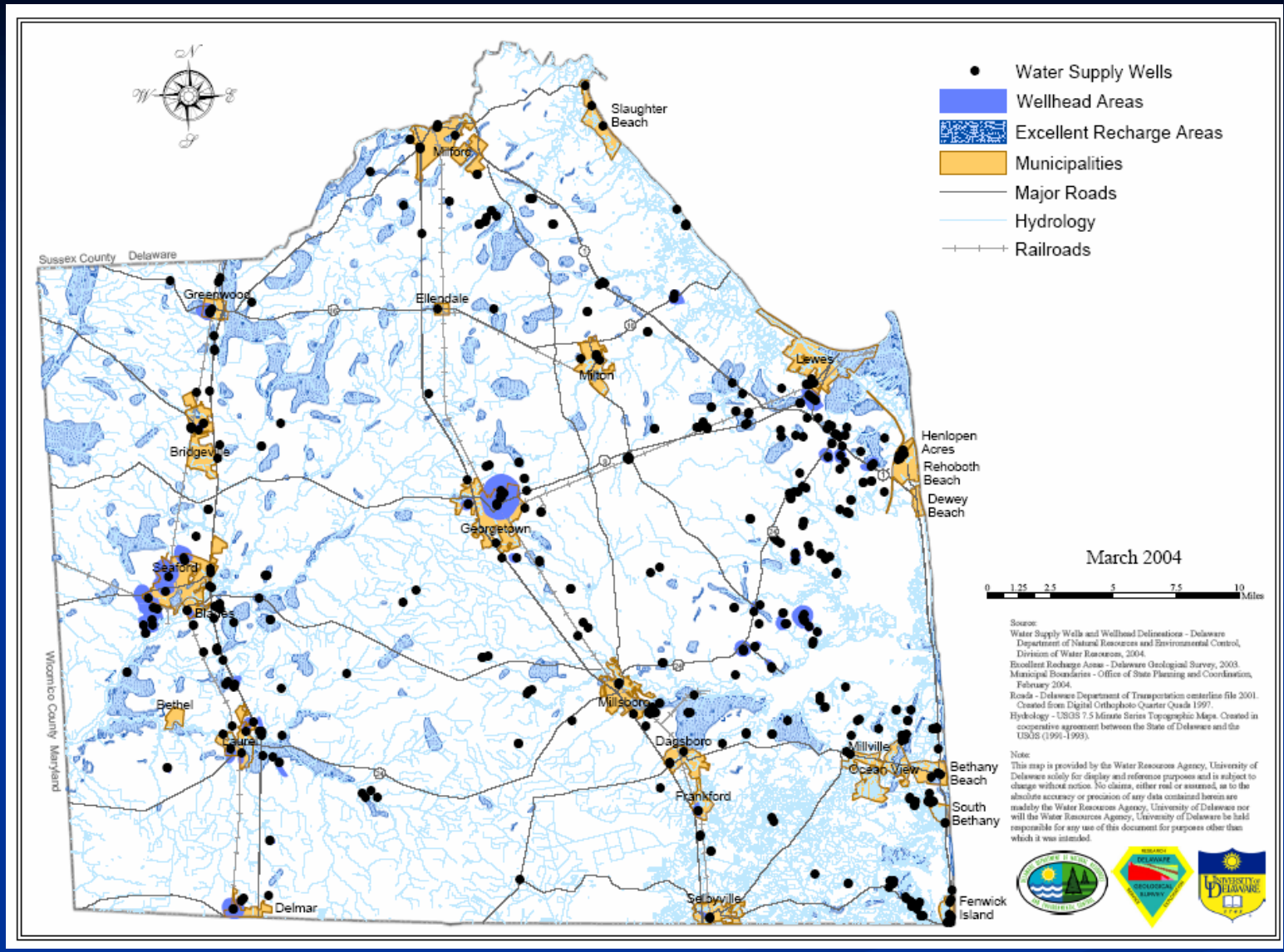
Water Supply Wells
Wellhead Areas
Excellent Recharge Areas
Municipalities
Major Roads
Hydrology
Railroads
Slaughter Beach
Milford
Sussex County Delaware
Greenwood
Ellendale
Milton
Lewes
Henlopen Acres
Rehoboth Beach
Dewey Beach
Bridgeville
Georgetown
Seaford
Blades
Wicomico County Maryland
Bethel
Laurel
Millsboro
Dagsboro
Millville
Ocean View
Bethany Beach
South Bethany
Frankford
Selbyville
Fenwick Island
Delmar
March 2004
0 1.25 2.5 5 7.5 10 Miles
Source:
Water Supply Wells and Wellhead Delineations - Delaware Department of Natural Resources and Environmental Control, Division of Water Resources, 2004.
Excellent Recharge Areas - Delaware Geological Survey, 2003.
Municipal Boundaries - Office of State Planning and Coordination, February 2004.
Roads - Delaware Department of Transportation centerline file 2001. Created from Digital Orthophoto Quarter Quads 1997.
Hydrology - USGS 7.5 Minute Series Topographic Maps. Created in cooperative agreement between the State of Delaware and the USGS (1990-1993).
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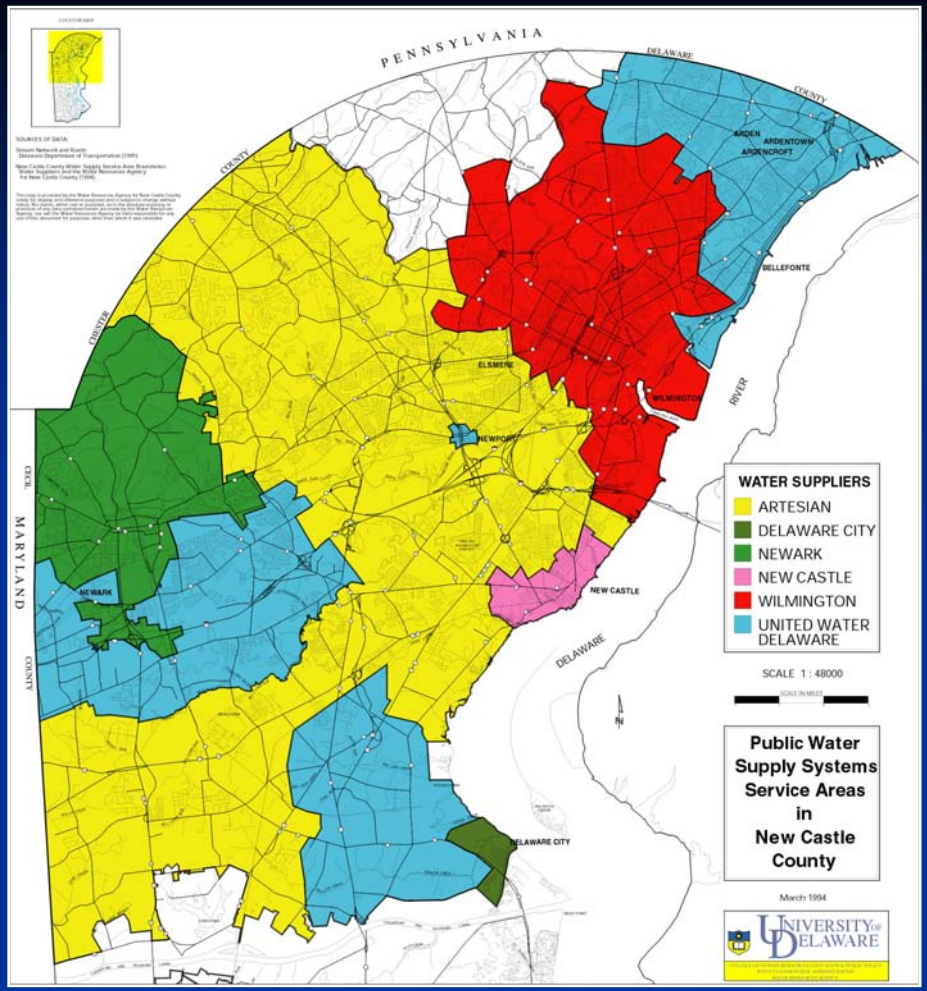
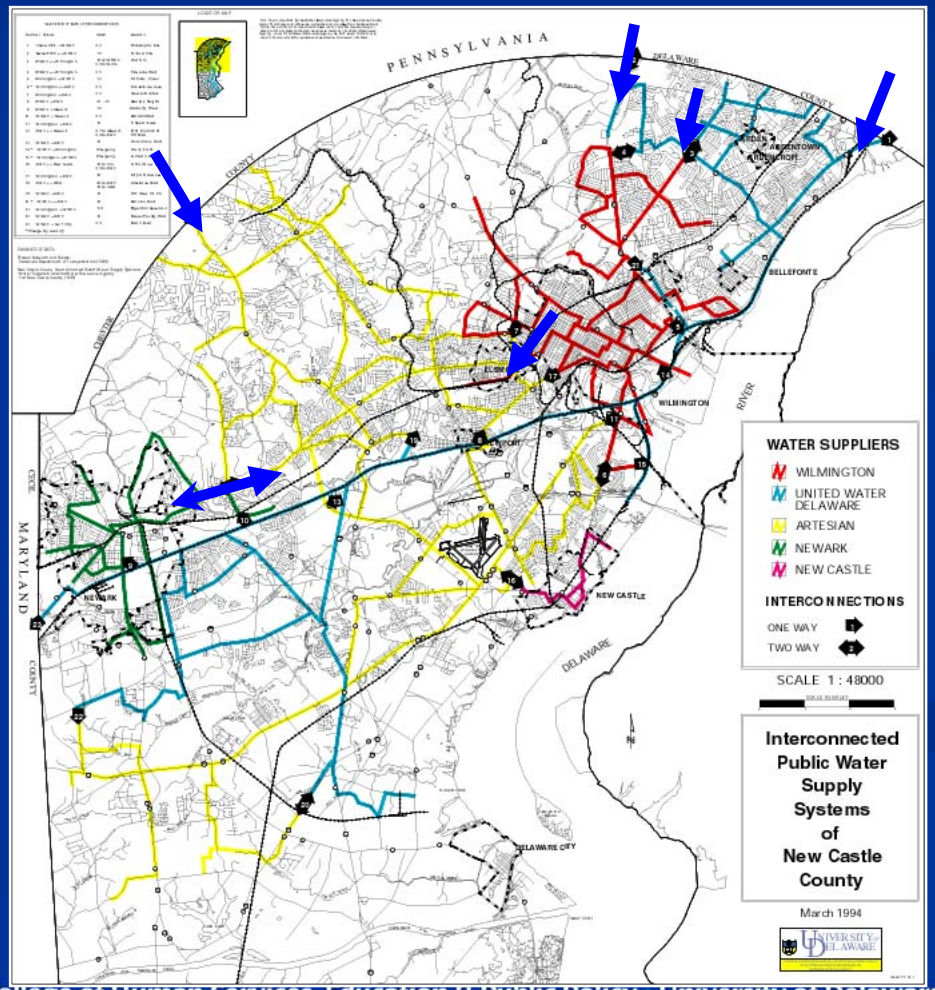
New Castle County

Public Water Supply System Service Areas





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water resources agency

Public Water Demand in Northern Delaware

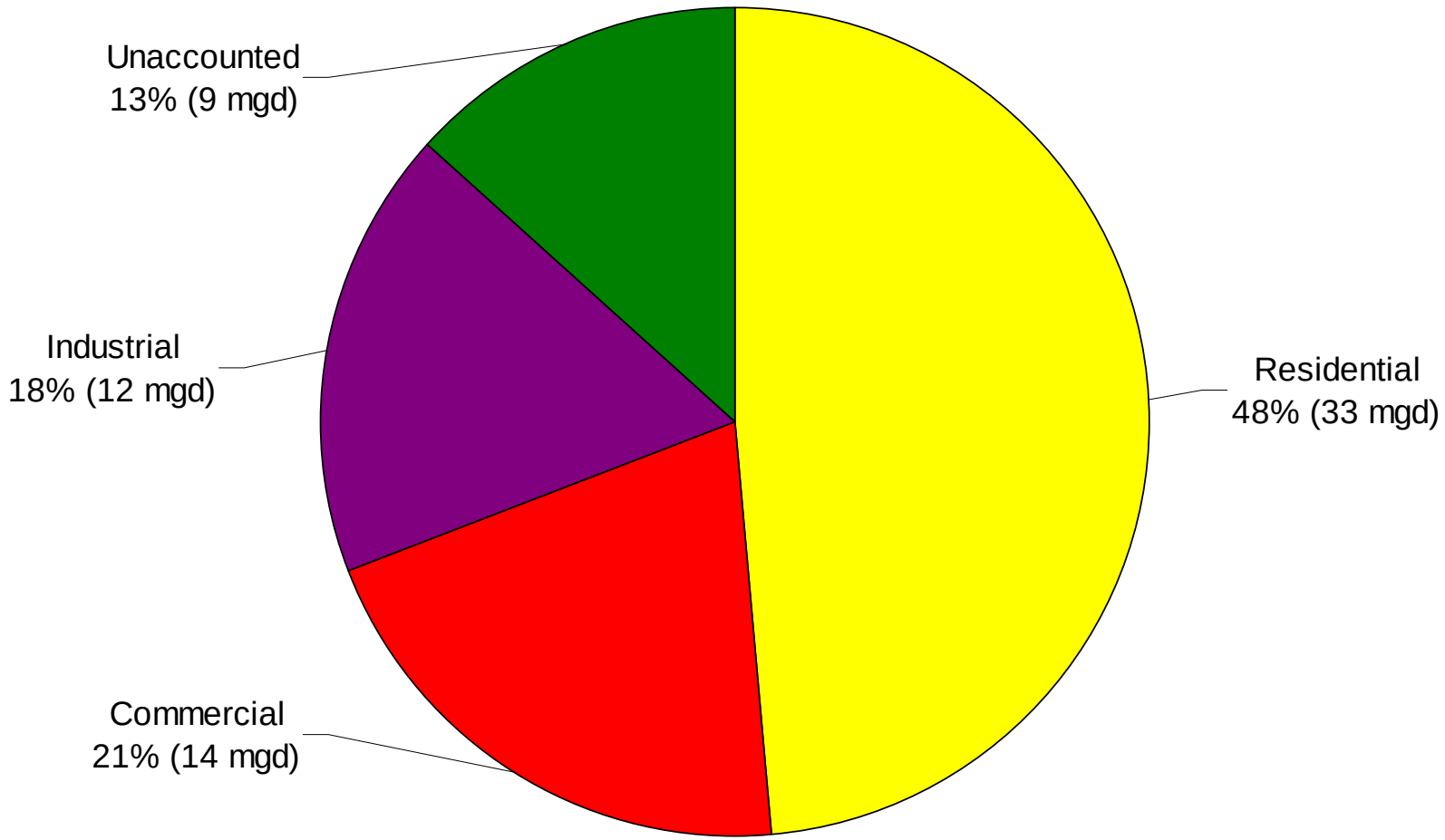


Figure 4: Brandywine Creek at Wilmington Streamflow Data, October 2001 - December 2002

*The 7Q10 is the minimum flow necessary to protect fishery and habitat that is likely to occur for 7 consecutive days, once every 10 years

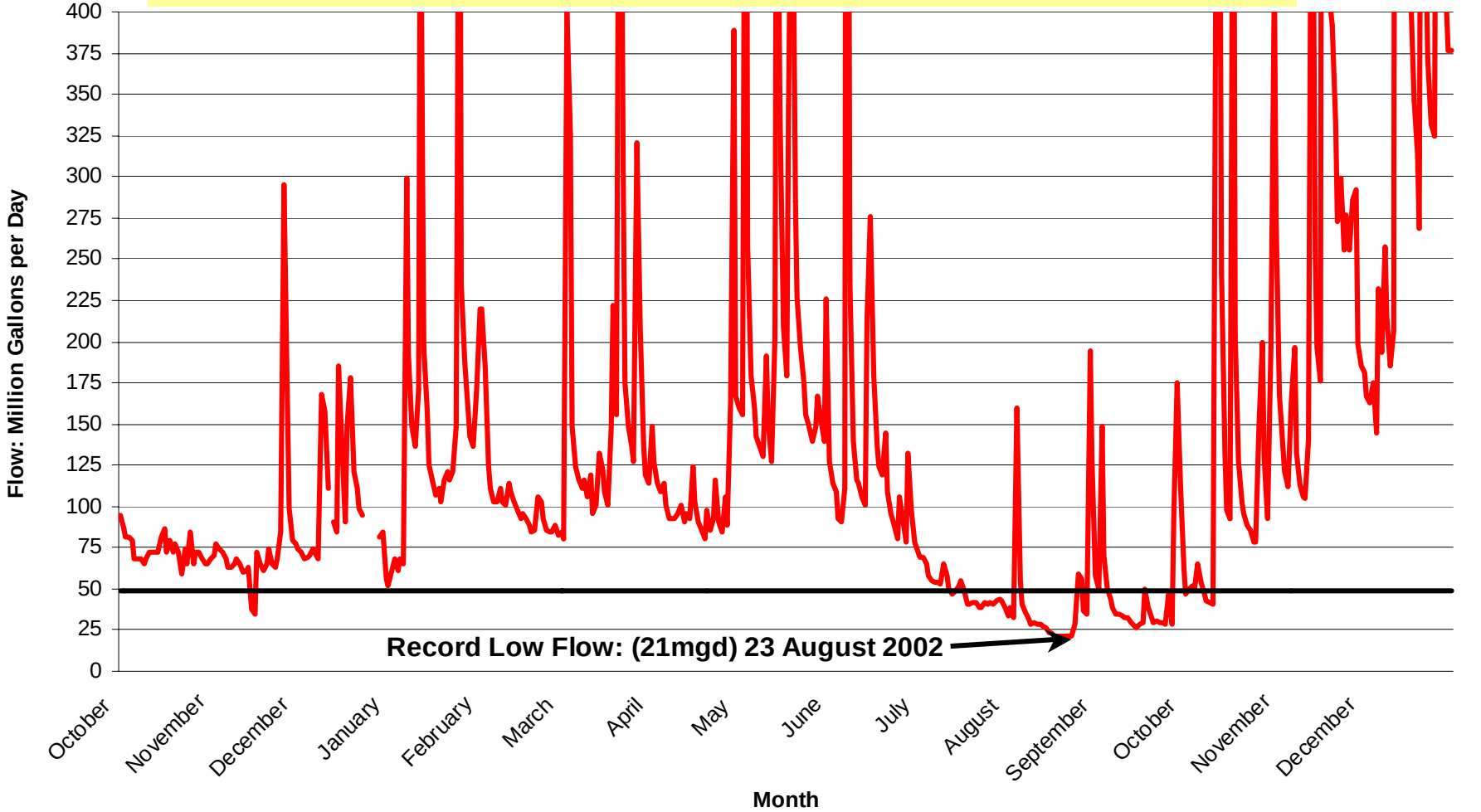
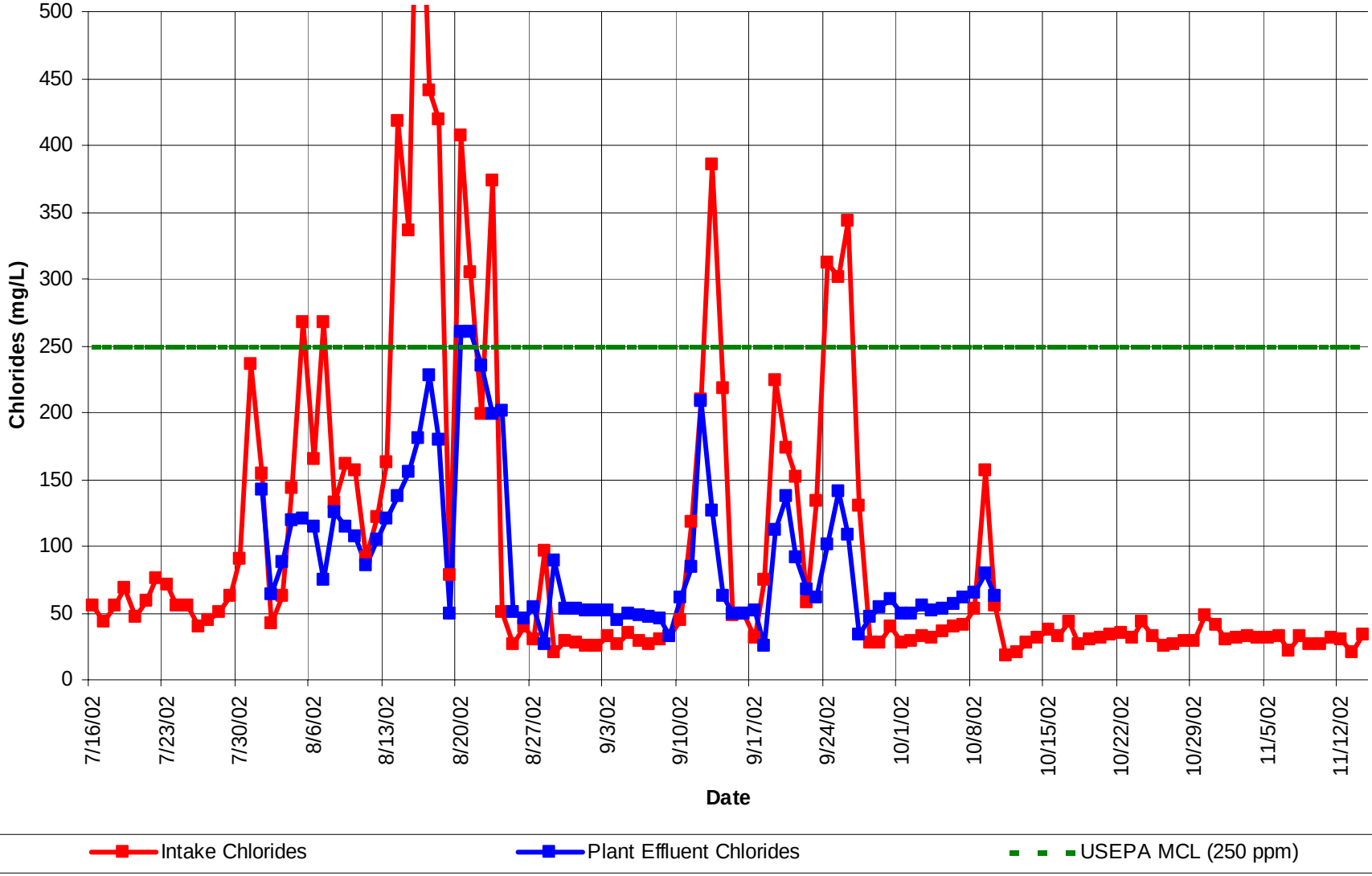
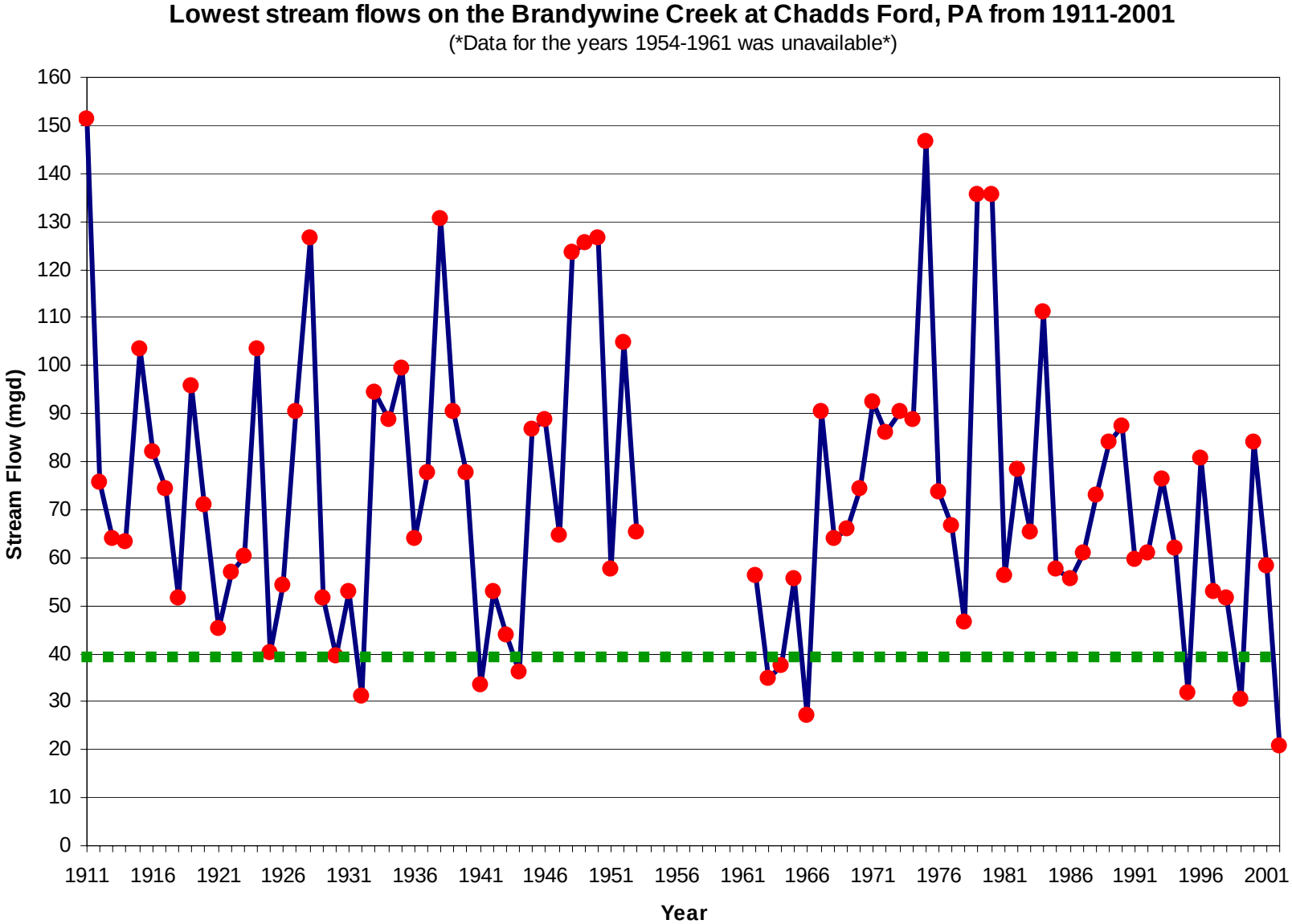


Figure 11: Chlorides, White Clay Creek at Stanton, July 2002 - November 2002




Lowest stream flows on the Brandywine Creek at Chadds Ford, PA from 1911-2001
(*Data for the years 1954-1961 was unavailable*)
Stream Flow (mgd)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1911
1916
1921
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
Year

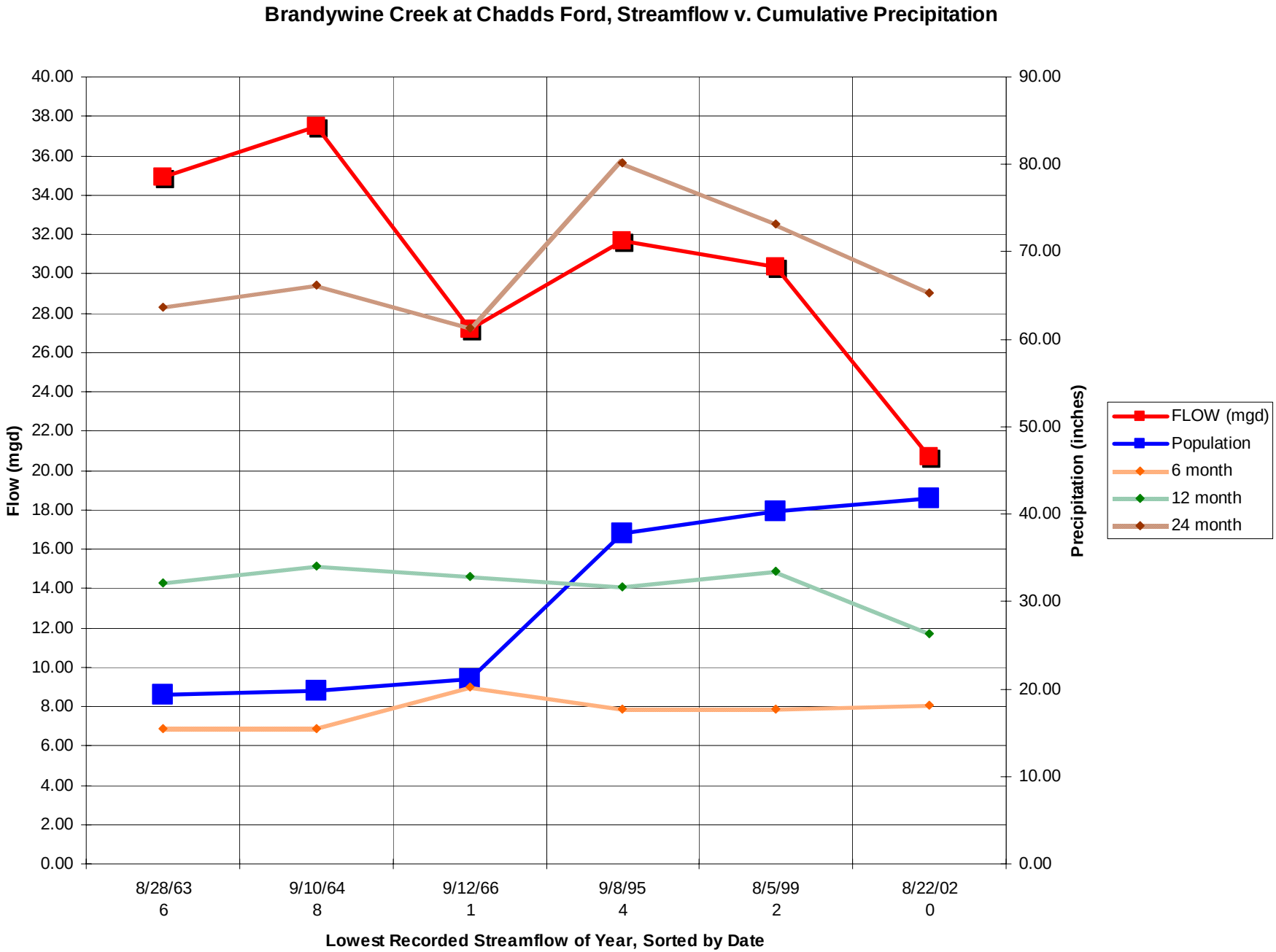
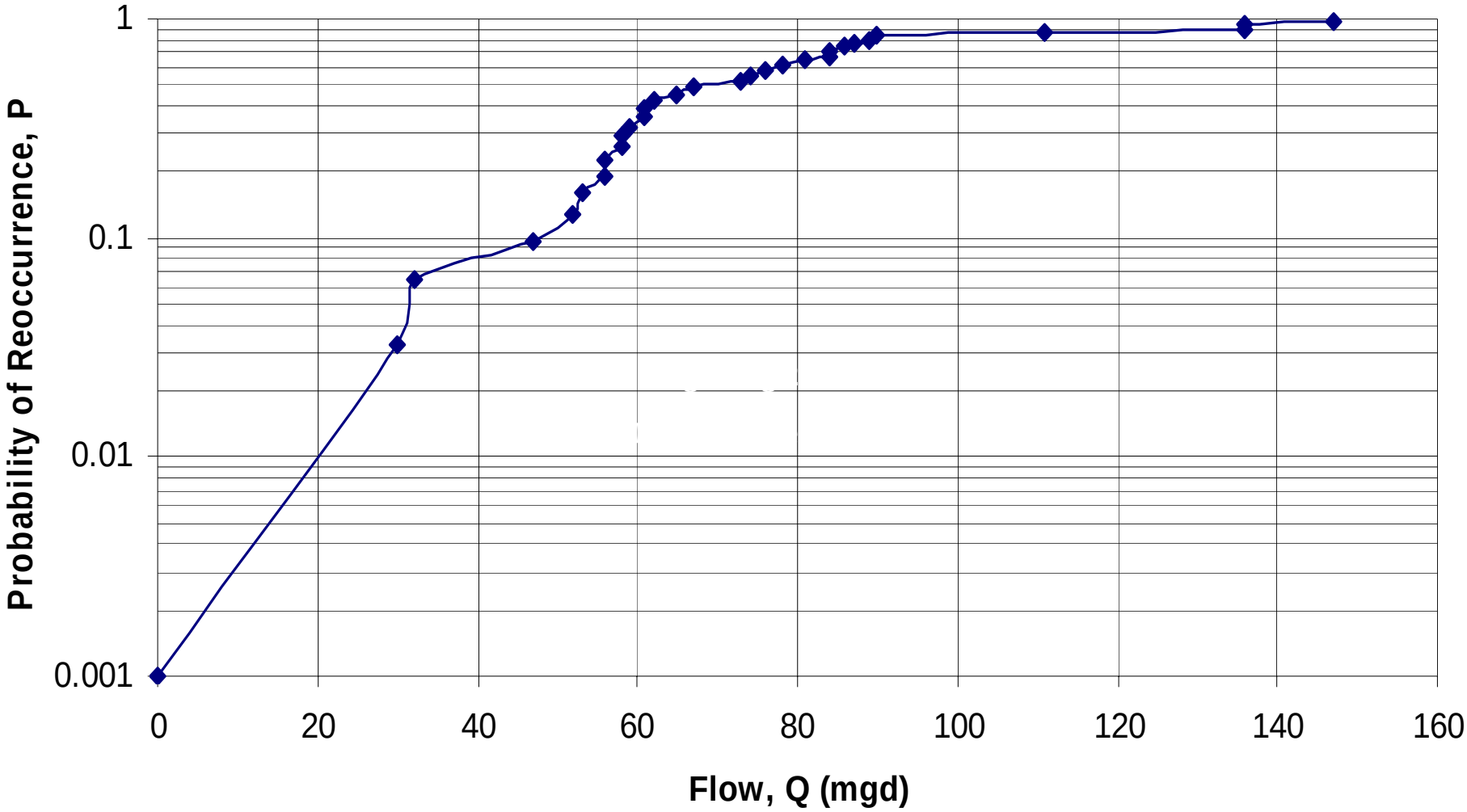

Brandywine Creek at Chadds Ford, Streamflow v. Cumulative Precipitation
Flow (mgd)
Precipitation (inches)
40.00
38.00
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
FLOW (mgd)
Population
6 month
12 month
24 month
8/28/63
6
9/10/64
8
9/12/66
1
9/8/95
4
8/5/99
2
8/22/02
0
Lowest Recorded Streamflow of Year, Sorted by Date

Figure 18.

Estimate of Low Flow Recurrence Interval with the Weibull Distribution

Brandywine Creek at Chadds Ford - 1972-2001



2020 Supply/Demand Curve (mgd)

Scenario	Supply	Demand	+/-	Vol (mg)
1. No 7Q10	93	90	+3	180*
2.7Q10 Wc	85	90	- 5	-300*
3.7Q10 B&W	73	90	- 17	-1020*

**** Volume required assuming a 60-day drought period***

FUTURE WATER SUPPLY OPTIONS
"A" LIST
COMMITTED TO BY WATER PROVIDERS

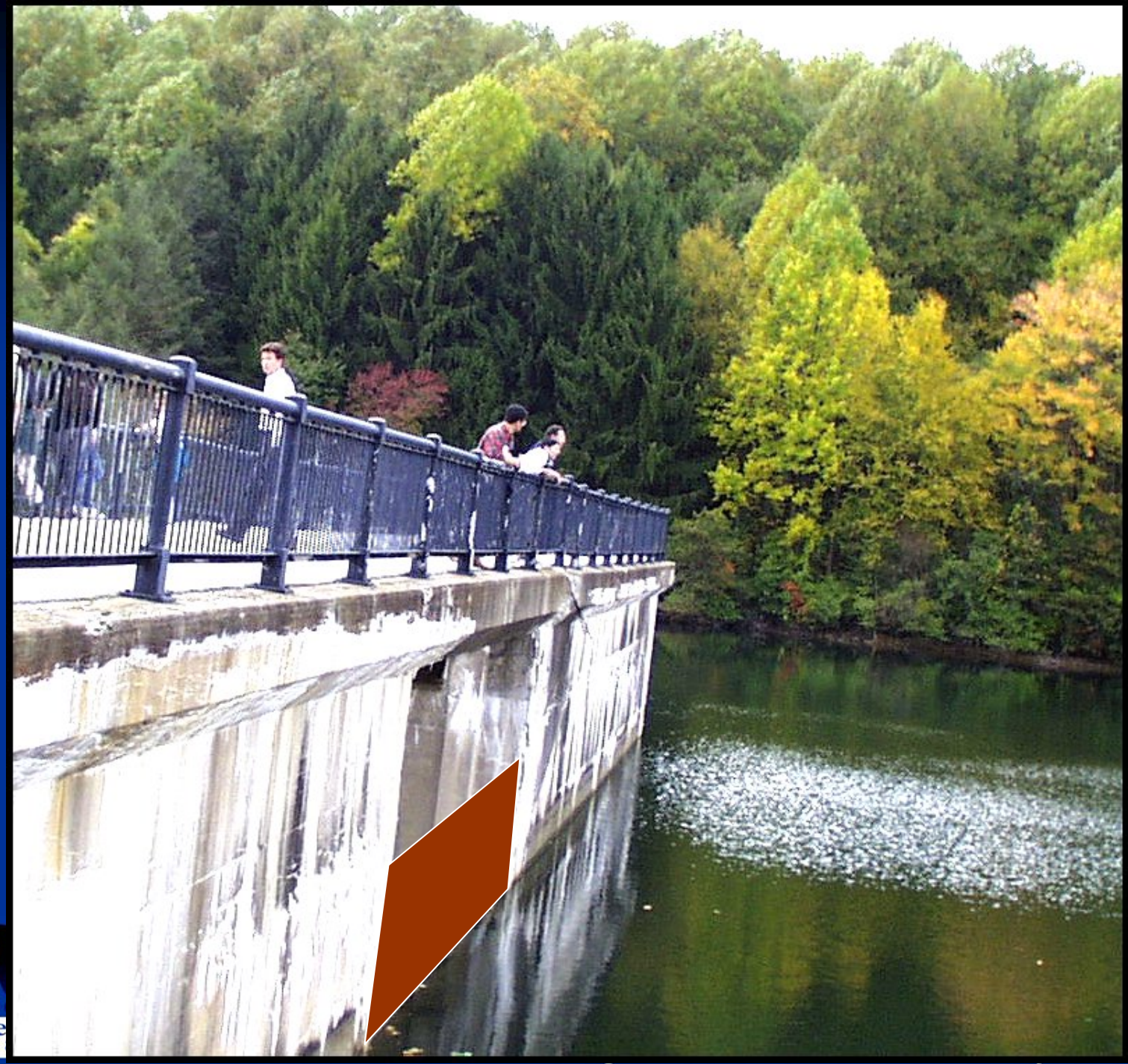
• Newark Reservoir	300 mg
• Access Hoopes Reservoir	500 mg
• AWC Wells N. of C & D Canal	120 mg
• Newark S. Wells Iron Treatment	60 mg
• Artesian ASR Wells	120 mg
Total	**1100 mg**

FUTURE WATER SUPPLY OPTIONS
"B" LIST

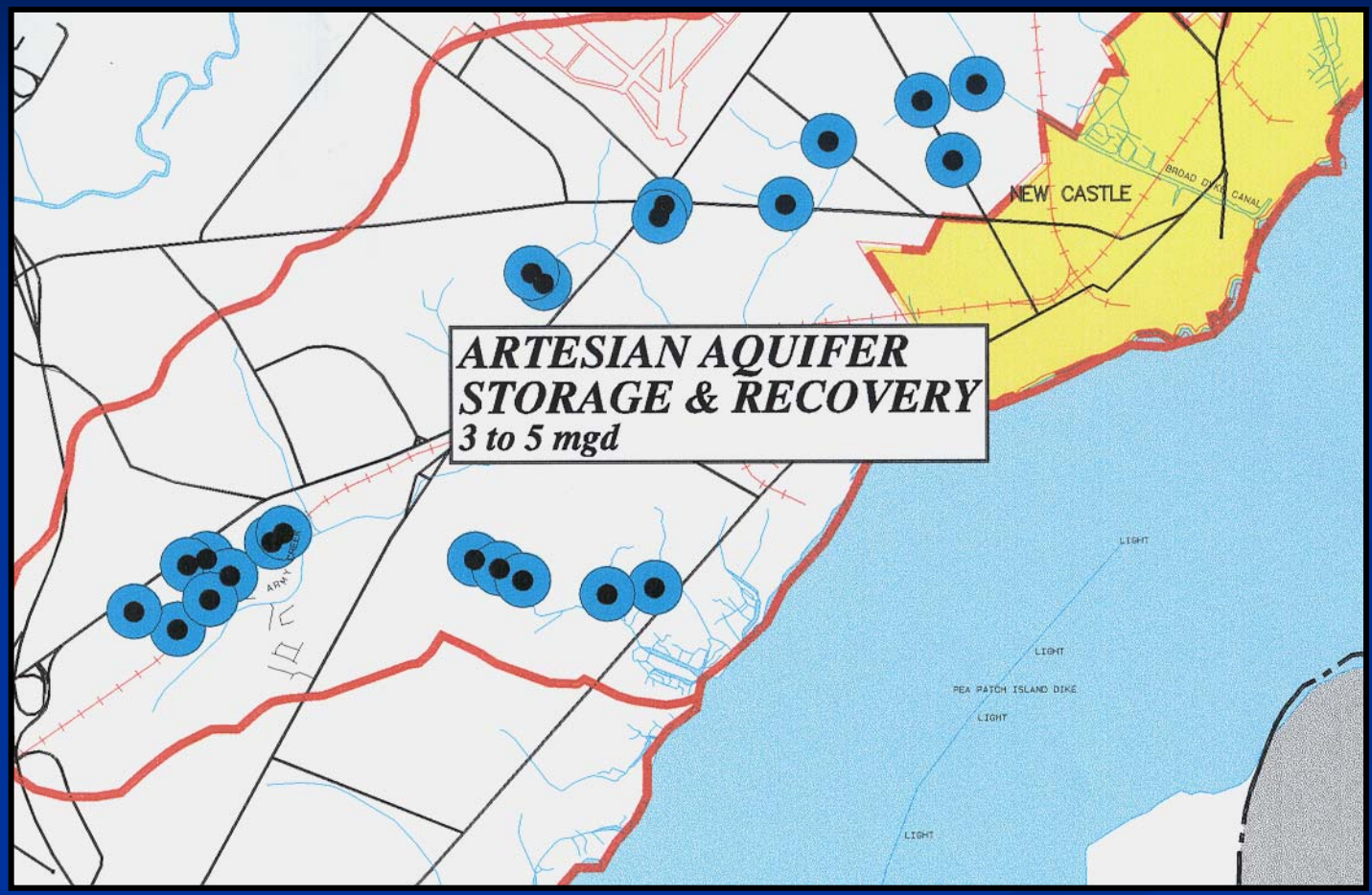
ACHIEVABLE IN LONGER TERM

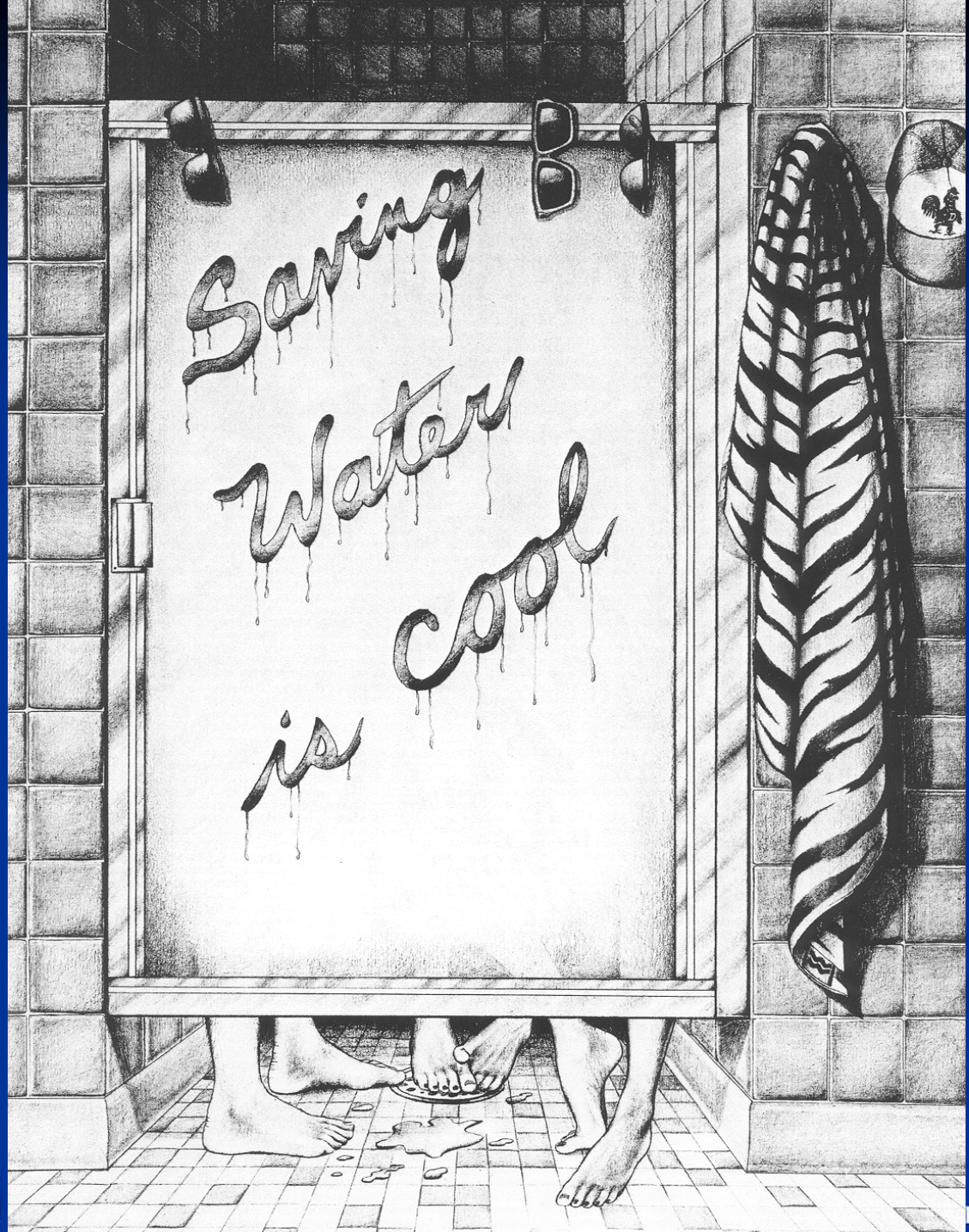
- Increase CWA/AWC Inter. **180 mg**
- Raise Hoopes Reservoir WL **300 mg**
- AWC C&D Canal Pipeline **300 mg**
- Philadelphia to DE Pipeline **1200 mg**
- Bread & Cheese Is. Reservoir **500 mg**

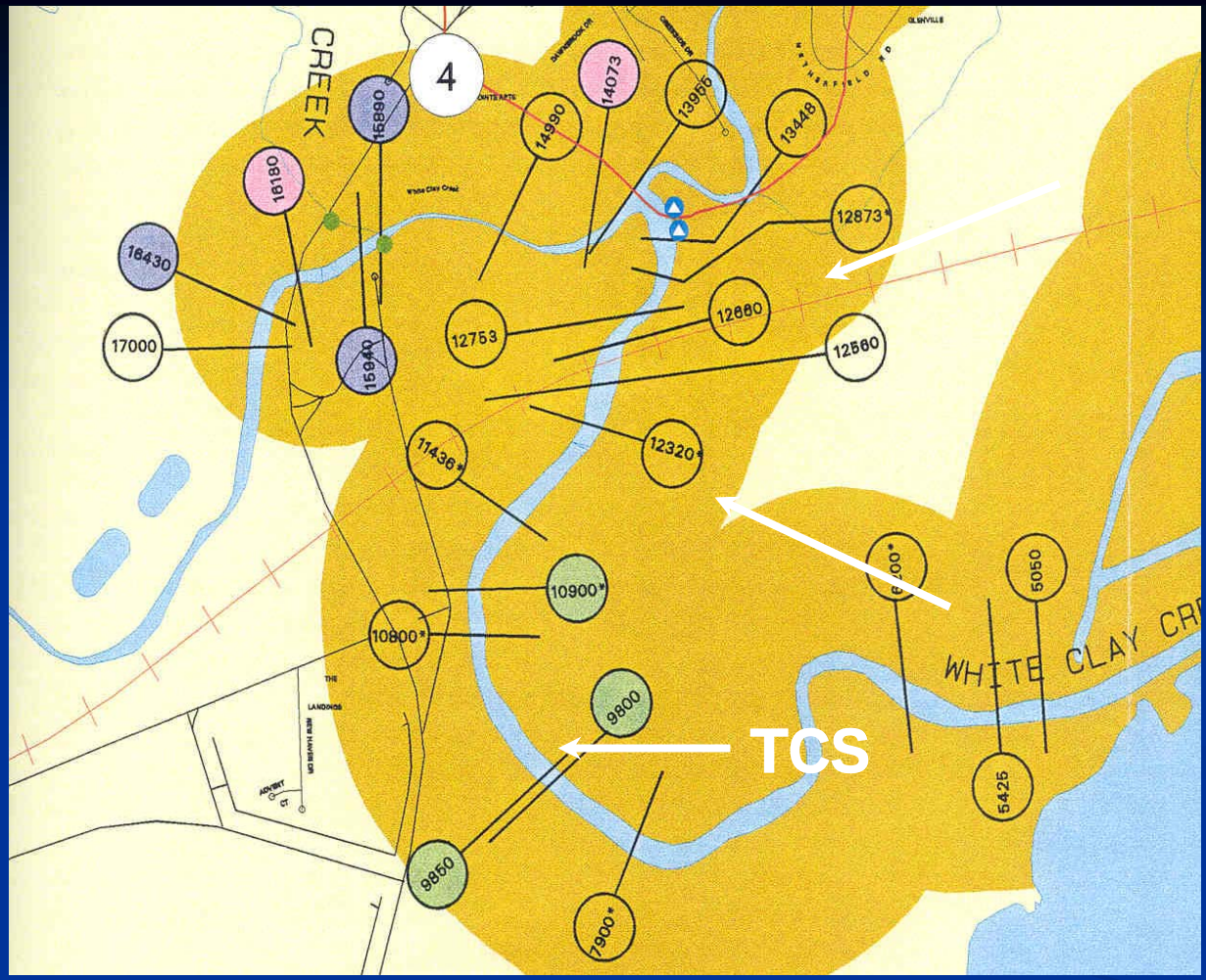

Paper Mill Road
Old Paper Mill Road



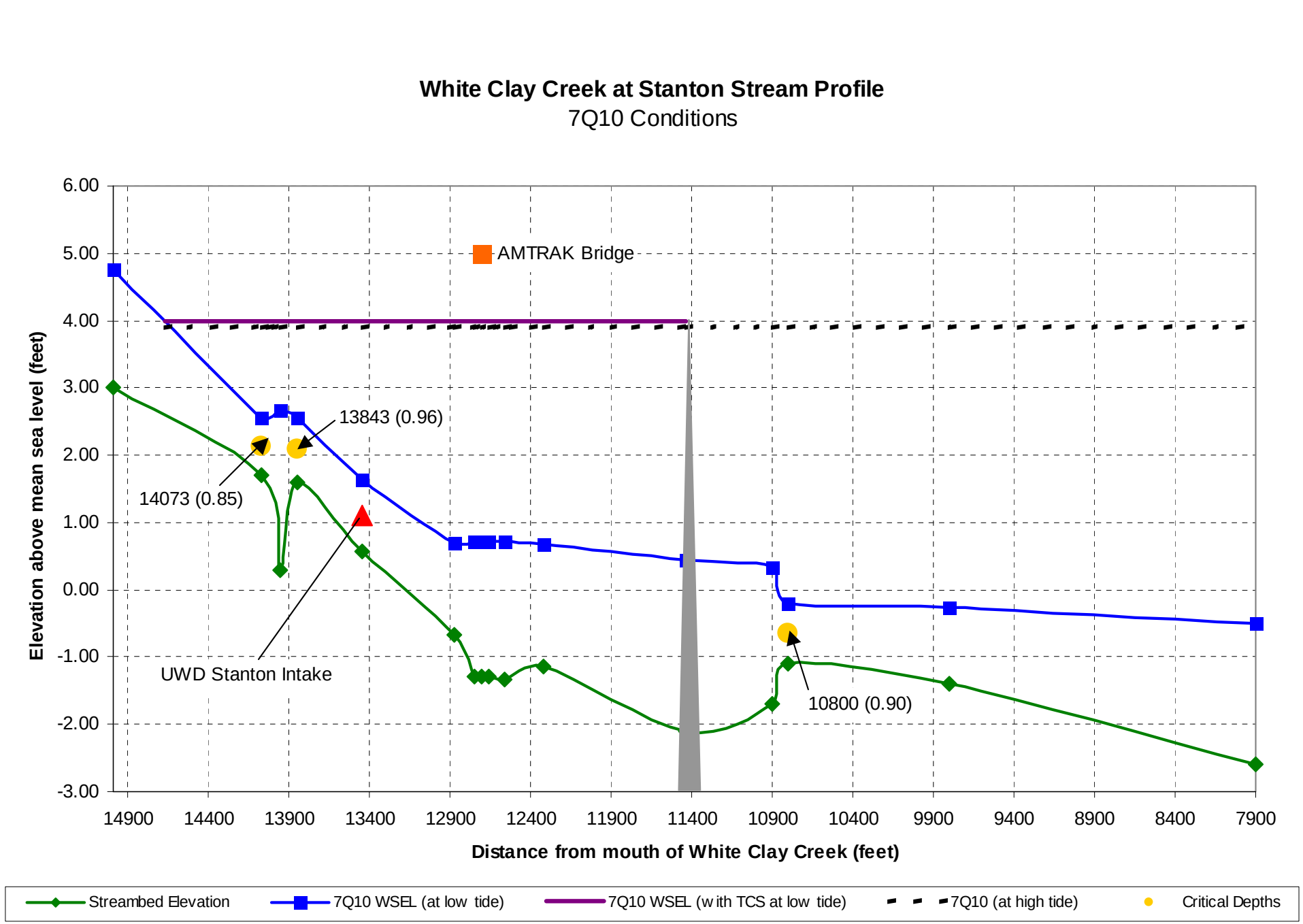
Hoopes Reservoir

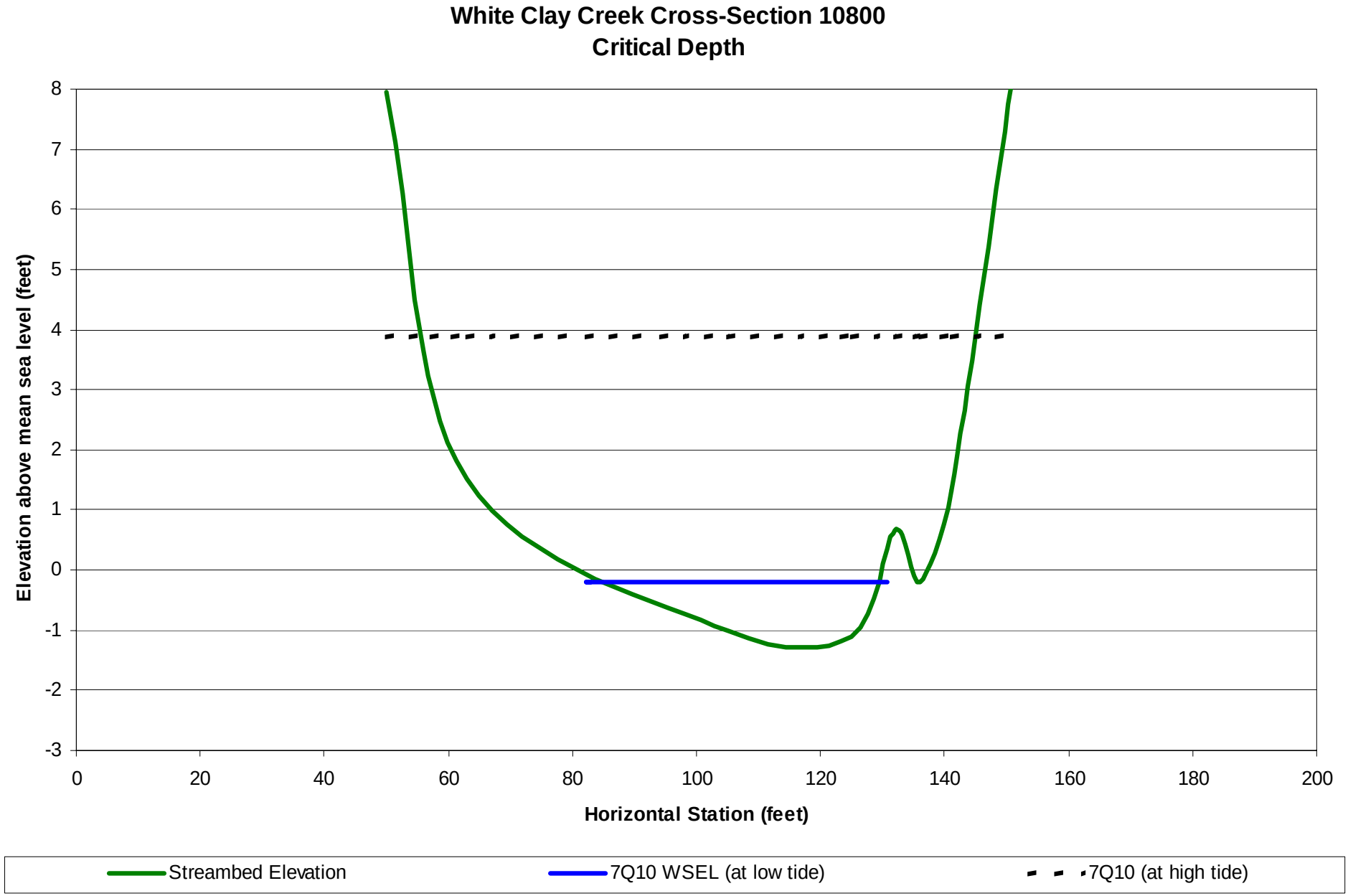

ARTESIAN AQUIFER
STORAGE & RECOVERY
3 to 5 mgd
NEW CASTLE
BROAD DIKE CANAL
LIGHT
LIGHT
PEA PATCH ISLAND DIKE
LIGHT
LIGHT


Saving
Water
is
cool

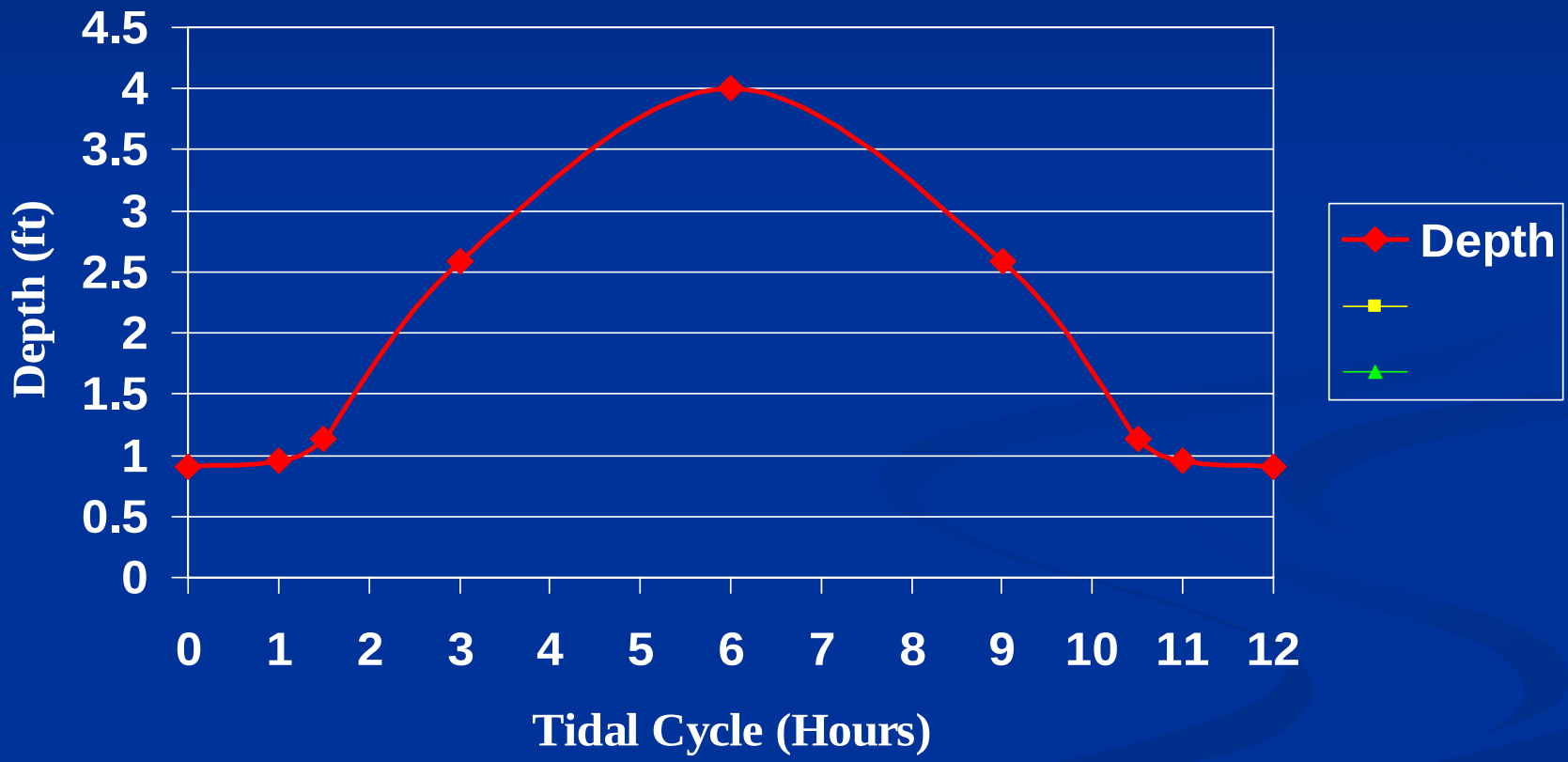


White Clay Creek at Stanton


White Clay Creek at Stanton Stream Profile
7Q10 Conditions
AMTRAK Bridge
13843 (0.96)
14073 (0.85)
UWD Stanton Intake
10800 (0.90)
Elevation above mean sea level (feet)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
14900
14400
13900
13400
12900
12400
11900
11400
10900
10400
9900
9400
8900
8400
7900
Distance from mouth of White Clay Creek (feet)
Streambed Elevation
7Q10 WSEL (at low tide)
7Q10 WSEL (with TCS at low tide)
7Q10 (at high tide)
Critical Depths


White Clay Creek Cross-Section 10800
Critical Depth
Elevation above mean sea level (feet)
8
7
6
5
4
3
2
1
0
-1
-2
-3
0
20
40
60
80
100
120
140
160
180
200
Horizontal Station (feet)
Streambed Elevation
7Q10 WSEL (at low tide)
7Q10 (at high tide)

White Clay Creek at Stanton Station 10800

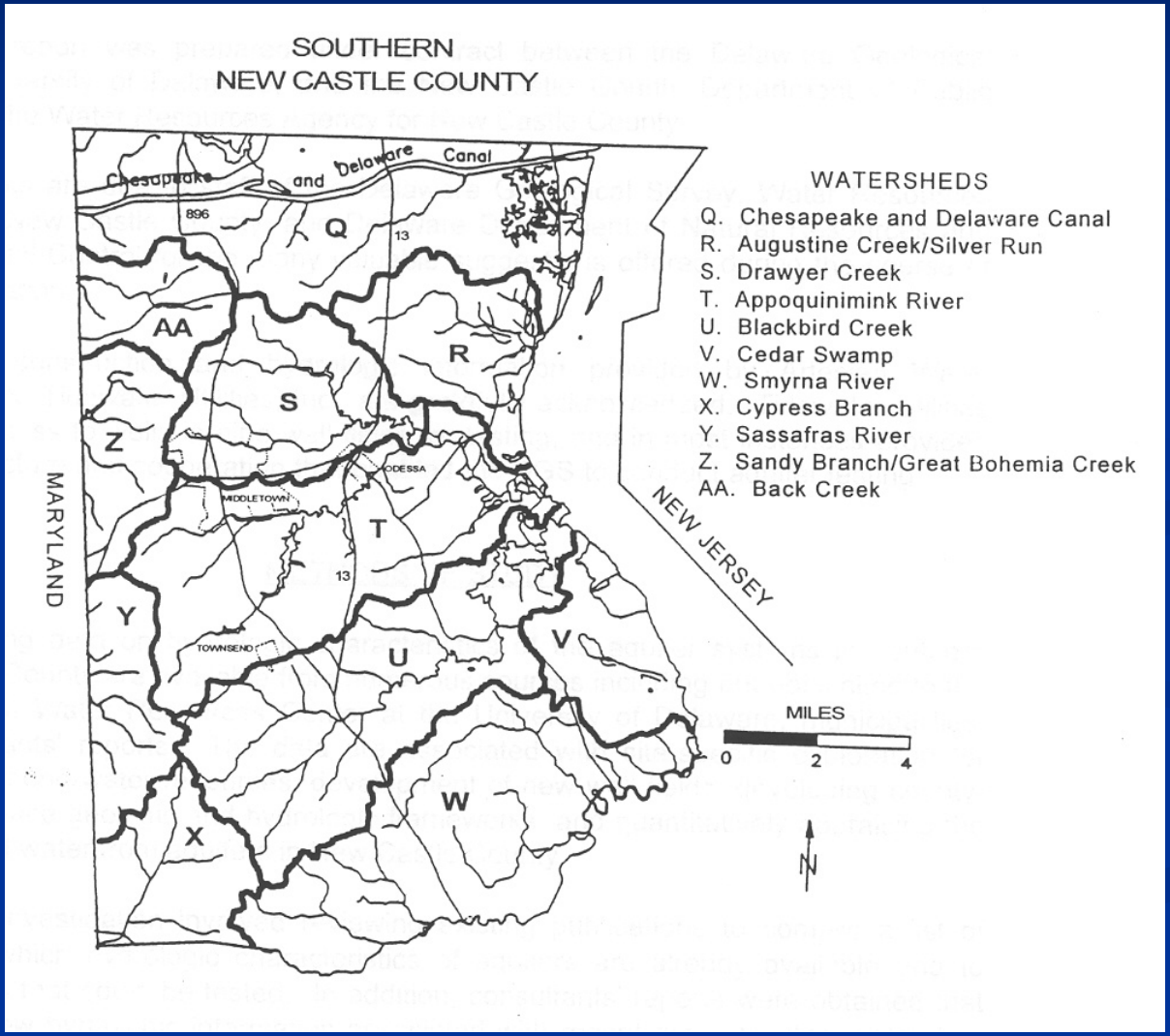


At 7Q10 = 17.2 mgd, TCS uninflated

DGS Watershed Map

southern New Castle County

(Baxter and Talley, DGS, Aug 1996)



Availability vs. Supply

southern New Castle County

Watershed	Availability	Supply
C & D Canal, Aug. Cr.	2.62	3.57
Drawyer Cr./Appo. R.	5.73	4.67
Blackbird Creek	3.94	0.22
Cedar swamp	0.31	0.00
Smyrna River	2.83	1.05
Cypress Branch/Chester R.	1.54	0.00
Sassafras River	1.37	0.00
Great Bohemia Creek	1.18	0.40
Back Creek	0.55	3.42
Total So. NCC	20.07 mgd	13.33 mgd

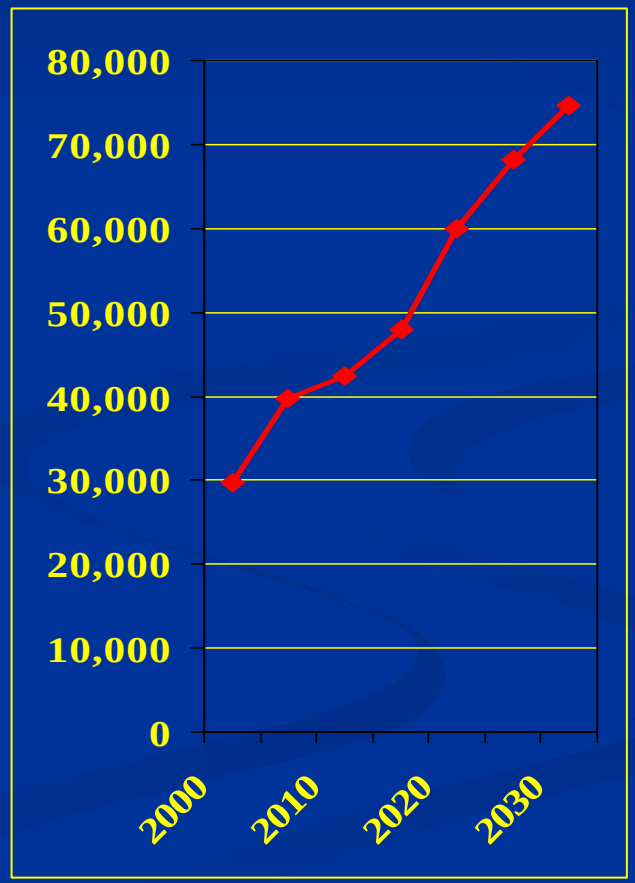
Population

southern New Castle County

(Source: DE Population Consortium, 2004)

Year	Pop.	% Increase
2000	29,682	0 %
2005	36,792	24%
2010	42,420	15%
2015	47,985	13%
2020	59,992	12%
2025	68,115	14%
2030	74,587	10%

30 year increase = 151%



Public Water Demand

southern New Castle County

Year	Population	Indiv. Wells (4000 wells) = 12,000 pop.	Water Demand Normal (100 gpcd)	Peak (200 gpcd)
2000	29,682	17,682	1.7	3.5
2005	36,792	24,792	2.5	5.0
2010	42,420	30,420	3.1	6.1
2015	47,985	35,985	3.6	7.2
2020	59,992	47,992	4.8	9.6
2025	68,115	56,115	5.6	11.2
2030	74,587	62,587	6.3 mgd	12.5 mgd